# FOUNDATION REPORT

## 5TH STREET BRIDGE OVER THE FEATHER RIVER
## BRIDGE NO. 18C0142

## AND

## 2ND STREETOVERCROSSING
## BRIDGE NO. 18C0143

## SUTTER COUNTY, CALIFORNIA

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Prepared for:

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EMI Project No. 13-121

August 5, 2016

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

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Geotechnical & Earthquake Engineering


August 5, 2016

EMI Project No. 13-121

Dokken Engineering
110 Blue Ravine Road, Suite 200
Folsom, CA 95630

Attention: Mr. Matt Griggs

Subject: **5th Street Bridge over the Feather River, Bridge No. 18C0142**
**2nd StreetOvercrossing, Bridge No. 18C0143**
**Yuba City, Sutter County, California**

Dear Mr. Griggs:

Attached is our Foundation Report for the 5th Street Bridge over the Feather River (Bridge No. 18C0142) and 2nd Street Overcrossing (Bridge No. 18C0143) bridge replacement projects in Yuba City, Sutter County, California. This report follows the California Department of Transportation (Caltrans) Foundation Report Preparation for Bridges (2009b), and presents the results of our analyses and recommendations for design and construction of the bridge foundations for the subject bridge.

We appreciate the opportunity to provide geotechnical services for this project. If you have any questions please do not hesitate to contact us.

Sincerely,
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# 1.0 INTRODUCTION

## 1.1 Purpose and Scope of Work

This Foundation Report (FR) presents the findings and conclusions of a geotechnical study conducted by Earth Mechanics, Inc. (EMI) for the 5th Street Bridge (Bridge No. 18C0142 Replace) over the Feather River and 2nd Street Overcrossing (OC) (Bridge No. 18C0143 Replace) in Yuba City, Sutter County, California. This report presents results of our foundation analysis and provides design and construction recommendations to assist Dokken Engineering (Dokken) in preparing the project Plans, Specifications, and Estimates (PS&E) for the project. Current report supersedes all previous reports.

The geotechnical services provided for this project included the following tasks:

- Collection and review of existing geotechnical information;
- Geotechnical field exploration including drilling and logging of exploratory borings;
- Laboratory testing of selected subsurface soil samples;
- Engineering analysis to develop foundation design and construction recommendations;
- Preparation of this report to present our findings, conclusions, and recommendations.

## 1.2 Project Description

The City of Yuba City, in cooperation with the City of Marysville and the California Department of Transportation (Caltrans), has proposed to replace the 5th Street Bridge over the Feather River (Bridge No. 18C0142) and the 2nd Street OC (Bridge No. 18C0143). The existing bridges are rated as "functionally obsolete" by Caltrans under the Federal Highway Administration (FHWA) inspection criteria, due to inadequate lane and shoulder widths. In addition, due to forecasted increase in vehicular traffic between Yuba City and Marysville, the existing two lane bridges will operate at failing levels of service by 2035, and additional traffic lanes will be necessary. The proposed project will also improve pedestrian and bicycle access between the two cities.

### 1.2.1 Project Location

The project site is located in Sutter and Yuba Counties between the cities of Yuba City and Marysville. In the project area, the 5th Street trends in a west-east direction and crosses over the Second Street, the Feather River and the Riverfront Park Complex on the east bank of the river. At the bridge site the Feather River flows in a northwest-southeast direction. Levees with maximum slope of 2 to 1 (horizontal to vertical) protect the adjacent Yuba City to the west and Marysville to the east of the river during high floods. The site location map is shown in Figure 1.

### 1.2.2 Existing Structure

The existing 5th Street Bridge was built in 1958 as a 26-span bridge comprising of a 21-span main bridge, a two-span slab bridge over the west levee, a single-span slab bridge over the east levee, and a two-span bridge over the 2nd Street at the west approach. The bridge has a total length of 2,071.78 feet, and total width of 35.41 feet. It carries one lane of traffic in each direction over the Feather River and across the Riverfront Park Complex. The two spans over the

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main Feather River channel are 151.3 feet long and use cast in-place post-tensioned concrete girders. Other spans are approximately 80 feet long and use pre-cast pre-stressed concrete I-beams.

Bridge foundations are supported on 16-inch hexagonal precast pre-stressed concrete (PCC) piles, with some piles battered in longitudinal or transverse directions. There is also a railroad bridge parallel to the 5th Street Bridge, approximately 50 feet (from centerline to centerline) to the south.

### 1.2.3 Proposed Structures

Based on the preliminary plans provided by the structural engineers, the proposed 5th Street Bridge replacement alternative is a 10-span cast-in-place post-tensioned (CIP/PS) concrete box girder bridge supported by closed-end, seat abutments and square multi-column piers. The proposed bridge has a total length of about 1,868 feet and total deck width of about 76.5 feet, and provides two traffic lanes in each direction. The beginning and end of this bridge will be set at El. +92.58 feet and +87.57 feet, respectively. The horizontal alignment of the replacement bridge will be shifted to the north, away from the railroad bridge.

The 2nd Street OC replacement is a single-span precast prestressed wide flange girder bridge supported by closed-end, seat abutments. It is proposed to carry 2 traffic lanes in each direction and a westbound off-ramp to 2nd Street over 2nd Street in Yuba City. The proposed bridge has a total length of 148 feet, and variable total width between 86.9 and 106.2 feet. The beginning and end of this bridge will be set at El. +84.81 feet and +90.16 feet, respectively.

## 1.3 Limitations

This report is intended for use by Dokken Engineering, the City of Yuba City, and the California Department of Transportation for improvements proposed for the proposed project. This report is based on the project as described herein and the information obtained from the exploratory borings at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. Also, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site; however, subsurface conditions and characteristics of soils between exploratory borings can vary. Findings reflect an interpretation of the direct evidence obtained. Recommendations presented herein are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Modifications to the project plans or variations in subsurface conditions may require re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained herein are applicable to the specific design elements and locations which are the subject of this report. Data, opinions, and recommendations herein have no applicability to any other design elements or to any other locations, and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

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EMI is not responsible for construction means, methods, techniques, sequences, or procedures, or for safety precautions or programs in connection with the construction, for the acts or omissions of the Contractor, or any other person performing any of the construction, or for the failure of any worker to carry out the construction in accordance with the final construction drawings and specifications.

Services performed by EMI were conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

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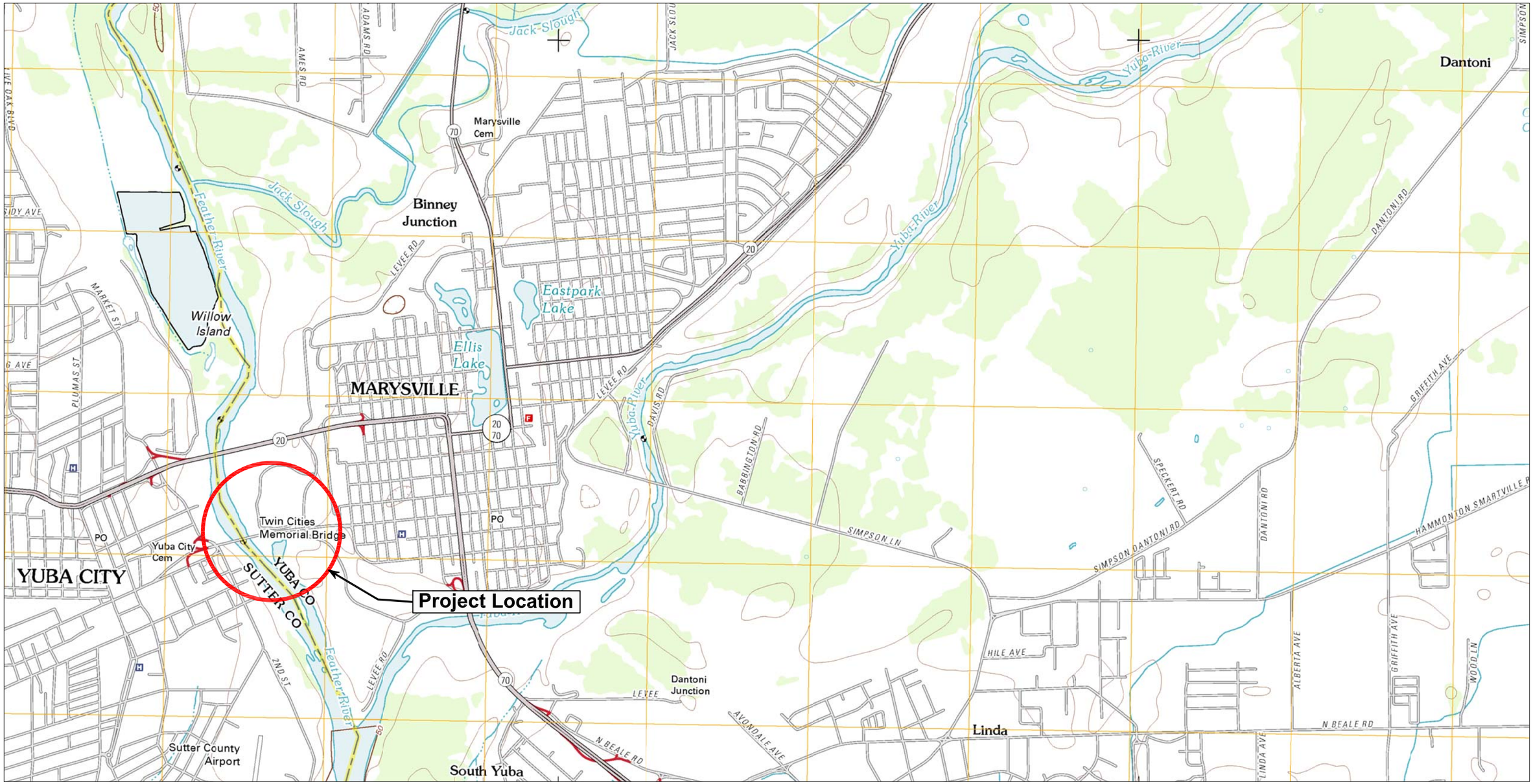


N

0 2,000 4,000 FEET

SCALE 1" = 2,000'

**Earth Mechanics, Inc.**

Geotechnical and Earthquake Engineering

5th Street Bridge Replacement Project

Project No. 13-121 | Date: August 2015

SITE LOCATION MAP

REFERENCE: USGS Topographic 7.5 Minute Quadrangle Maps - Yuba City Quadrangle (2012)

Figure 1

# 2.0 FIELD INVESTIGATION AND LABORATORY TESTING

## 2.1 Existing Information

Previous geotechnical studies at the site are as follows:

- The as-built LOTB from a soil report by Porter, Urquhart, McCreary and O'Brien (1957),
- A Preliminary Geotechnical Report by Taber (2008),
- Seismic and Liquefaction Study for the 5th Street Bridge Replacement Project – Bridge No. 18C0142 (Dokken, 2013),
- CPT Site Investigation – 5th Street Bridge, Yuba City, CA (Gregg Drilling, 2011), performed for the aforementioned seismic and liquefaction study by Dokken.

Previous boring data includes 3 rotary wash and 4 piston type sampler borings from the as-built LOTB, one boring and 7 CPTs from Taber 2008 investigation, and 6 seismic CPTs from Dokken seismic and liquefaction study performed by Gregg Drilling in 2011. Table 1 shows the information from previous explorations. Top-of-hole elevation at the time of investigation was between +63 and +33 feet. The deepest CPT (DE-CPT-02) was advanced to El. -60.5 feet, approximately 105 feet below grade. LOTB sheets are included in Appendix A.

Vertical control of all of the existing available subsurface information is based upon the National Geodetic Vertical Datum of 1988 (NGVD 88).

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**Table 1. Previous Exploration Information**

| Date of Drilling | Boring No. | Type | Approx. Ground Surface El. (ft) | Approx. Bottom of Hole El. (ft) | Water Level El. (ft) |
|---|---|---|---|---|---|
| 1956 | P-1 | Piston Sampler | +53 | -10 | N/A |
| 1956 | W-2 | Wash | +33 | -19 | N/A |
| 1956 | W-3 | Wash | +36 | -25 | N/A |
| 1956 | W-4 | Wash | +47 | -18 | N/A |
| 1956 | P-5 | Piston Sampler | +56 | +16 | N/A |
| 1956 | P-6 | Piston Sampler | +52 | +0 | N/A |
| 1956 | P-7 | Piston Sampler | +57 | -4 | N/A |
| August 2007 | CPT-1 | CPT | +61.4 | -19 | N/A |
| August 2007 | B-1 | Auger/Rotary | +53.6 | -28 | +41.1 |
| August 2007 | CPT-2 | CPT | +54.6 | +3 | N/A |
| August 2007 | CPT-3 | CPT | +54.6 | +5 | N/A |
| August 2007 | CPT-4 | CPT | +53.9 | +12 | N/A |
| August 2007 | CPT-5 | CPT | +51.6 | -12 | N/A |
| August 2007 | CPT-6 | CPT | +53.8 | -20 | N/A |
| August 2007 | CPT-7 | CPT | +55.2 | -28 | N/A |
| May 2011 | DE-CPT-01 | Seismic CPT | +63 | -37 | N/A |
| May 2011 | DE-CPT-02 | Seismic CPT | +54.5 | -60.5 | N/A |
| May 2011 | DE-CPT-03 | Seismic CPT | +54 | -46 | N/A |
| May 2011 | DE-CPT-04 | Seismic CPT | +50 | -46 | N/A |
| May 2011 | DE-CPT-05 | Seismic CPT | +52.5 | -47.5 | N/A |
| May 2011 | DE-CPT-06 | Seismic CPT | +55 | -45 | N/A |
| Note: All elevations are based on NAVD88. | | | | | |

## 2.2 Supplemental Field Investigation

A field investigation program initially consisting of drilling 13 geotechnical borings was planned at the subject bridge site to determine subsurface conditions and collect soil samples from the site. 12 soil borings on land were completed between October 8 and December 12, 2013, and they were drilled using rotary-wash technique with a truck-mounted drill rig equipped with a 5-inch diameter auger. However, due to the issue of permit delay and special equipment required, WR-13-003 in the Feather River cannot be finished at the preparation of this report. As the subsurface condition has been well defined by the available soil information from the above 12 borings and previous subsurface investigation, drilling this boring will be performed later only for confirmation purposes. Per the request by structural engineers for locating possible barrow materials to construct abutments, one additional boring by hand auger (HA-13-014) was performed on March 4, 2016, in a basin area about 300 feet northwest of the 2nd Street OC.



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General soil exploration information from those borings is summarized in Table 2. Approximate locations of borings are shown in Figure 2 (excluding HA-13-014).

**Table 2. Soil Exploration Information performed by EMI**

| Boring No. | Approx. Station | Boring Type | Station Line | Approx. Offset (ft) | Approx. Ground Surface El. (ft) | Approx. Bottom of Hole El. (ft) | Approx. Groundwater El. During Drilling (ft) |
|---|---|---|---|---|---|---|---|
| R-13-001 | 34+82 | RW | "F" Line | 14 Lt. | +85.2 | -84 | +42.2 |
| R-13-002 | 35+91 | HSA | "F" Line | 14 Lt. | +61.8 | +56.7 | NE |
| WR-13-003 | Not completed | - | - | - | - | - | - |
| R-13-004 | 40+42 | RW | "F" Line | 17 Lt. | +55 | -85.5 | +31 |
| R-13-005 | 42+61 | RW | "F" Line | 4 Rt. | +52.5 | -90.5 | +46.5 |
| R-13-006 | 44+50 | RW | "F" Line | 26 Lt. | +54.5 | -85.5 | +48.5 |
| R-13-007 | 46+50 | RW | "F" Line | 15 Lt. | +54 | -86 | +45.5 |
| R-13-008 | 48+50 | RW | "F" Line | 27 Lt. | +53 | -87 | +41 |
| R-13-009 | 50+50 | RW | "F" Line | 26 Lt. | +51.2 | -86.3 | NM |
| R-13-010 | 52+40 | RW | "F" Line | 6 Rt. | +55.4 | -89.5 | NM |
| R-13-011 | 54+35 | RW | "F" Line | 26 Lt. | +87 | -14.5 | +44 |
| R-13-012 | 32+73 | RW | "F" Line | 32 Lt. | +61.8 | -38.6 | +39.8 |
| R-13-013 | 33+90 | RW | "F" Line | 2 Rt | +63.4 | -38.1 | +53.4 |
| HA-13-014 | NM | HA | "F" Line | NM | +61.0 | +60.0 | NM |

Notes:

1. Stations and offsets are approximate.
2. GSE = Ground Surface Elevation estimated from topographic plans
3. HSA = Hollow-Stem Auger; RW = Rotary Wash; HA = Hand Auger.
4. NE = Not Encountered, NM = Not Measured
5. All elevations are based on NAVD88.

Our field representatives visually classified the soil cuttings in accordance with Caltrans' Soil and Rock Logging Classification Manual (2010a) and maintained a detailed record of subsurface materials as well as the groundwater conditions encountered in the exploratory borings. The Log-of-Test-Borings (LOTB) sheets, and other pertinent information are presented in Appendix A. It should be noted that the lines designating the interface between materials on the LOTB sheets and boring records generally represent approximate boundaries. The actual transition between subsurface materials is usually gradual.

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When subsurface conditions permitted, alternating relatively undisturbed soil sampling and Standard Penetration Test (SPT, ASTM D1586) were performed in the borings at 5-foot depth intervals. Relatively undisturbed drive samples were obtained using a Modified California split-spoon sampler (3.25-inch outer diameter) lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT were performed with a SPT sampler (1.4-inch inside diameter) without liners. The SPT sampler was driven into the ground using a 140-lb hammer free falling from a height of 30 inches. The number of blows to advance the samplers was recorded at every 6 inches of penetration, or until refusal. Only the total number of blows for the final 12 inches or less of driving of the SPT sampler is shown on the LOTB sheets. The total blow counts required to drive the SPT sampler for the last 12 inches is referred as the Standard Penetration Resistance (N-value), and can be used to correlate in-situ soil strengths. The rated efficiency of the hammer as provided by the drilling contractor was noted and reported on the LOTB sheets.

After completion, the borings were backfilled with a one-sack lean cement mix in accordance with the requirements of the County of Sutter. The surrounding ground surfaces were restored to generally match the existing condition.

## 2.3 Laboratory Testing

Laboratory tests were performed to determine relevant physical characteristics and engineering properties of soils that exist at the site. Selected soil samples were tested to determine soil classification and physical and engineering properties. A list of tests performed, the corresponding test methods, and purpose of testing is presented in Table 3.

The laboratory soil tests were conducted in general accordance with California Test (CT) methods or American Society for Testing and Materials (ASTM) standards. The locations where tests were performed are shown on the LOTB sheets in Appendix A and the test results are presented in Appendix B.

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**Table 3. Explanation of Laboratory Tests Performed**

| Type of Test | Applicable Test Method | Purpose |
|---|---|---|
| Dry Density | ASTM[1] D 2937 | Estimate in-situ soil density |
| Moisture Content | ASTM D 2216 | Estimate in-situ soil moisture content |
| No. 200 Wash | ASTM D 1140 | Estimate percentage of gravel, sand, and fines content |
| Sieve Analysis | ASTM D 422 | Determine grain size distribution |
| Pocket Penetrometer | - | Estimate unconfined compressive strength of cohesive soil |
| Atterberg Limits | ASTM D 4318 | Evaluate plasticity of fine grained particles |
| Direct Shear | ASTM D 3080 | Estimate strength parameters of soil |
| Unconsolidated-Undrained Triaxial Compression | ASTM D 2850 | Estimate strength parameters of soil |
| Consolidation | ASTM D 2435 | Estimate compressibility parameters of soil |
| Compaction Test | ASTM D 1557 | Determine maximum density and optimum moisture of soil |
| Sand Equivalent | ASTM D 2419/CT[2] 217 | Determine sand equivalent of soil |
| Soil pH | CT 532/643 | Determine corrosion potential of site soil |
| Minimum Resistivity | CT 532/643 | Determine corrosion potential of site soil |
| Sulfate Content | CT 417 | Determine corrosion potential of site soil |
| Chloride Content | CT 422 | Determine corrosion potential of site soil |

Notes:

1. ASTM = American Society for Testing and Materials.
2. CT = California Test Method.

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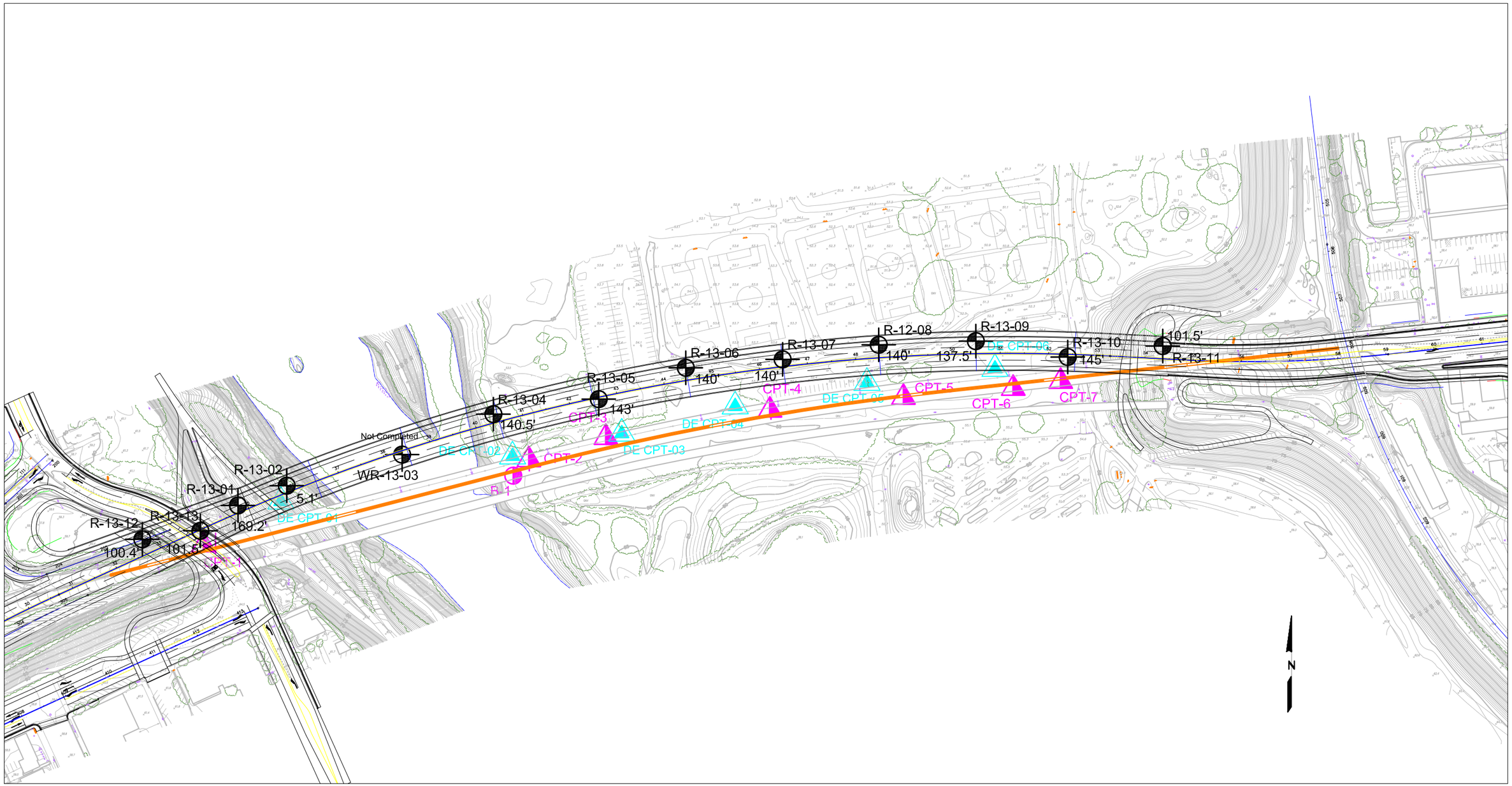


R-12-01 Location of Mud Rotary Boring by Earth Mechanics (Depth)

CPT-1 Location of Cone Penetrometer Test Sounding by Taber (2008)

DE CPT-01 Location of Cone Penetrometer Test Sounding by Dokken (2011)

B-1 Location of Geotechnical Boring by Taber (2008)

Location of Proposed Bridge Pier and Abutment

0 200 400 FEET

SCALE 1" = 200'

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5th Street Bridge Replacement Project

Project No. 13-121

Date: August 2015

Boring Location Map

Figure 2

# 3.0 GEOLOGY

## 3.1 Physiography

The project area is located within Sacramento Valley within the northern portion of the Great Valley physiographic province. The Great Valley is an elongated, asymmetric structural trough extending approximately 450 miles long and 50 miles wide in a general northwest-southeast direction. The province is bounded by the Sierra Nevada Mountains to the east, the Coast Ranges to the west, the Transverse Range to the south, and the Klamath Mountains to the north. The Great Valley is underlain by a very thick sequence of Holocene to Jurassic age alluvial sediments. These sediments have been folded along an asymmetric syncline axis which lies to the east within the central portion of the Coast Ranges. The thick sequences of alluvial sediments are underlain by basement rock of the Sierra Nevada Mountains.

## 3.2 Stratigraphy

The project site is located at the western edge of Yuba County which is underlain by alluvial deposits associated with alluvial fan, stream channel and stream terrace deposition. The alluvial deposits vary in age from recent Holocene alluvial deposition associated with the Feather River as well as older alluvial formations including the Modesto and Riverbank Formations. Both the Riverbank and younger Modesto formations consist of upper and lower members, which are distinguishable by the soil horizons. The Holocene to Pleistocene alluvium overlies the sedimentary and volcanic deposits associated with the Sutter Formation. Mantling the Sutter Formation is the Chico Formation which consists of thick sequences of marine sandstone and conglomerate with some minor siltstone. Units are shown on the Regional Geologic Map (Figure 3).

The geologic formations in the area, following the nomenclature of Helley and Harwood (1985), and Saucedo and Wagner (1992) in descending stratigraphic order are:

- Alluvial and Stream Channel Deposits, Holocene (Qa and Qsc);
- Modesto Formation, Pleistocene (Qmu and Qml);
- Riverbank Formation, Pleistocene, (Qru and Qrl);
- Sutter Formation, Pliocene, MioCene and Oligocene, (Ts);
- Chico Formation, Cretaceous, (Kc);

The project site is immediately underlain by stream channel deposits and alluvium associated with the Feather River. These deposits consist Holocene age unconsolidated silts, sands and gravels with unit thicknesses varying between less than a foot to 80 ft thick regionally. Locally the Holocene alluvium is underlain by the upper member of the Modesto Formation which consists of tan to light gray alluvial gravel, sand, silt and clay. The Pleistocene age Modesto Formation is mapped a terrace along the west side of the Feather River. The eastern edge of the project site is underlain by the upper member of the Riverbank Formation. The Riverbank Formation is older than the Modesto Formation and consists of dark-brown to red alluvial gravels, sands, silts, and minor clays. The project site also has some man-made levees which are located underneath the existing bridge abutment. The levees are composed of artificial fill material derived locally as graded and compacted alluvial soils.

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### 3.2.1 Faulting

The project site is located within the Sacramento Valley region of the Great Valley Geomorphic Province. The region consists of numerous active and potentially active faults including the Cleveland Hill (Foothills Fault System), Swain Ravine lineament (Foothills Fault System), Spenceville Fault (Foothills Fault System), Dunnigan Hills, and Sulphur Creek Fault. Of these faults, the Cleveland Hill fault is identified as Alquist-Priolo (AP) Earthquake Fault Zones defined by the Alquist-Priolo Earthquake Hazards Act of 1972 revised in 1994. The AP faults not only represent earthquake shaking hazards, but have a potential for surface ground rupture. The type and magnitude of the seismic hazard affecting the site are dependent on the distance and causative faults and the intensity and magnitude of the seismic event. Other potentially active faults may not be identified as AP Earthquake Fault Zones because their locations are not well defined and/or they have not generated earthquakes in historical time. Locally, smaller faults exist within the valley floor within the vicinity of the site location as well. The project corridor does not enter into any AP fault zones and does not cross any active fault traces. The nearest active/potentially fault is over 15.3 miles away from the project site (Figure 4).

#### 3.2.1.1 Foothills Fault System, Northern Reach Section (Cleveland Hill Fault, Swain Ravine linament, and Spenceville fault)

The Foothills Fault System is located east of the project site and extends north-northwest along the eastern margin of the Great Valley geomorphic province. The Foothills Fault System is broken up into numerous separately mapped normal fault lineaments including the Cleveland Hill Fault, Swain Ravine lineament, Prairie Creek lineament, and Spenceville Fault. Other segments including the Bear Mountain Fault Zone extend further south as part of the Foothills Fault System. According to Microearthquake studies within the Sierra foothills since 1975, the Foothills Fault System is seismically active between Oroville and Folsom. The study indicated a reoccurrence pattern of low level magnitude 1.0 events over an extended time period (Cramer and other, 1978). The closest segment (Spenceville fault) of the Foothills Fault System is located 15.3 miles east of the project site.

#### 3.2.1.2 Great Valley Fault System

The nearest segment of the Great Valley Fault is located approximately 34 miles west of the project site. The Great Valley fault system is a compressional feature that extends approximately 326 miles northwest-southeast along the western margin of the San Joaquin Valley. The fault system is a blind thrust system comprised of 14 segments. The southern segments are considered to be the source of both the magnitude 6.4 1983 Coalinga earthquake and the magnitude 6.2 1985 Kettlemen earthquakes. One of the northern segments is believed to be the source of the 1892 Winters-Vacaville earthquakes. According to Caltrans ARS Online, the Great Valley fault system is capable of producing earthquakes of moment magnitudes 6.4 to 7.1. The fault is considered active though is not identified to be within an AP Earthquake Fault Zone as it is not clearly defined.

#### 3.2.1.3 Dunnigan Hills Fault

The Dunnigan Hils fault is located approximately 28 miles southwest of the project site. The

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fault is considered to be potentially active but is not delineated within an Alquist-Priolo Earthquake Fault Zone. The fault extends northwest-southeast between the town of Dunnigan and an area to the northwest of the town of Yolo.

#### 3.2.1.4 San Andreas Fault (North Coast)

The San Andreas fault (North Coast) is located approximately 96 miles southwest of the project site. The San Andreas fault zone (SAFZ) is located approximately 67 miles southwest of the project site. The SAFZ extends approximately 600 miles between the Salton Sea and Cape Mendocino. The SAFZ is the plate tectonic boundary between the North American Plate and the Pacific Plate. The last major earthquake to occur on the southern segment of the SAFZ was a magnitude 7.9 earthquake at Fort Tejon in 1857. The fault is considered to have the potential of generating a maximum moment magnitude of 7.9. Most areas along the SAFZ have been designated as AP Special Studies Zones.

## 3.3 Seismicity

The project site is located in the Sacramento Valley region of northern California which contains few active and potentially active faults and is considered a region of low to moderate seismic activity. Seismicity in the valley is widely dispersed across the valley and along its margins. Moderate seismic activity has occurred along the southwest margin near Lake Berryessa and within the Coast Ranges-Sierran block boundary zone where the 1892 6.5 moment magnitude Vacaville-Winters earthquake occurred. Additionally, in the Sierran foothills near Oroville, a $M_L$ 5.7 earthquake occurred along the Cleveland Hill Fault in 1975. Additionally, some moderate seismicity has been recorded within the Sacramento Valley interior along the Willows and Corning faults. All of the moderate seismic events occurred over 10 miles away from the project site location.

The only historical seismicity that was relatively proximal to the project site includes a series of events occurring between 1975 and 1977 with magnitudes ranging from 0.7 to 2.1. Two events were located southeast of Honcut and one event east of Marysville (Marks and Lindh, 1977). The 2.1 magnitude event occurred 10 km east of Honcut.

## 3.4 Geologic Hazards

### 3.4.1 Fault Rupture

There are no known active surface faults within the project limits so ground rupture is not a factor. The nearest active fault is located approximately 15 miles from the project vicinity (Figure 4), as a result low to moderate ground shaking should be anticipated at the site in the event of an earthquake.

The California Division of Mines and Geology (2007) has not identified Alquist-Priolo Fault Zones through the site; therefore, the risk of ground surface rupture and related hazards is considered low.

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### 3.4.2 Landslide

The only slopes within the project limits include stream banks associated with the Feather River and man-made fill slopes and embankments associated with roadway and freeway improvements, there is no evidence of existing deep-seated landslides in the project area. Minor surficial slumps may occur along the stream banks in response to undermining and erosion by the streams, though the embankments have been maintained as part of the proposed bridge improvements. The bridge abutments were analyzed for slope stability, and the risk for landsliding is considered low.

### 3.4.3 Liquefaction

The site has a high liquefaction potential due to presence of loose coarse-grained deposits and high groundwater levels throughout the soil profile. Previous studies by Taber (2008) and Dokken (2011) indicate widespread liquefaction potential. Due to high potential for liquefaction at the site, comprehensive liquefaction hazard assessments have been performed in Section 5.2.

### 3.4.4 Flooding

According to Dokken (2013), Wreco (2012) performed hydraulic analysis of the Feather River using HEC-RAS model provided by MBK Engineers. The model represented the Feather River and its tributaries from major reservoirs within the watershed basin to its confluence with the Sacramento River (2006). According to this study, the 100-year and 200-year events had peak flows of 165,000 and 192,000 $ft^3$/sec.

Water surface elevation in the Feather River was measured at El. +41.8 feet in November 1956. The design flood high water level on as-built drawings is El. +82.5 feet. This elevation is a few feet below the crest of the levees. Since seismic and flood load cases are considered separately, for liquefaction analyses and seismic design a lower groundwater elevation can be used (see Section 4.2)

### 3.4.5 Scour Evaluation

According to Taber (2008), scour data for the existing bridge was provided by TRC. The data indicated that total scour on the order of 6.8, 8.1, and 7.7 feet was anticipated at Piers 3, 4, and 5 of the existing 5$^{th}$ Street Bridge, respectively. The more detailed scour study for the proposed replacement bridge alignment by Wreco (2016) is described in Section 5.4.

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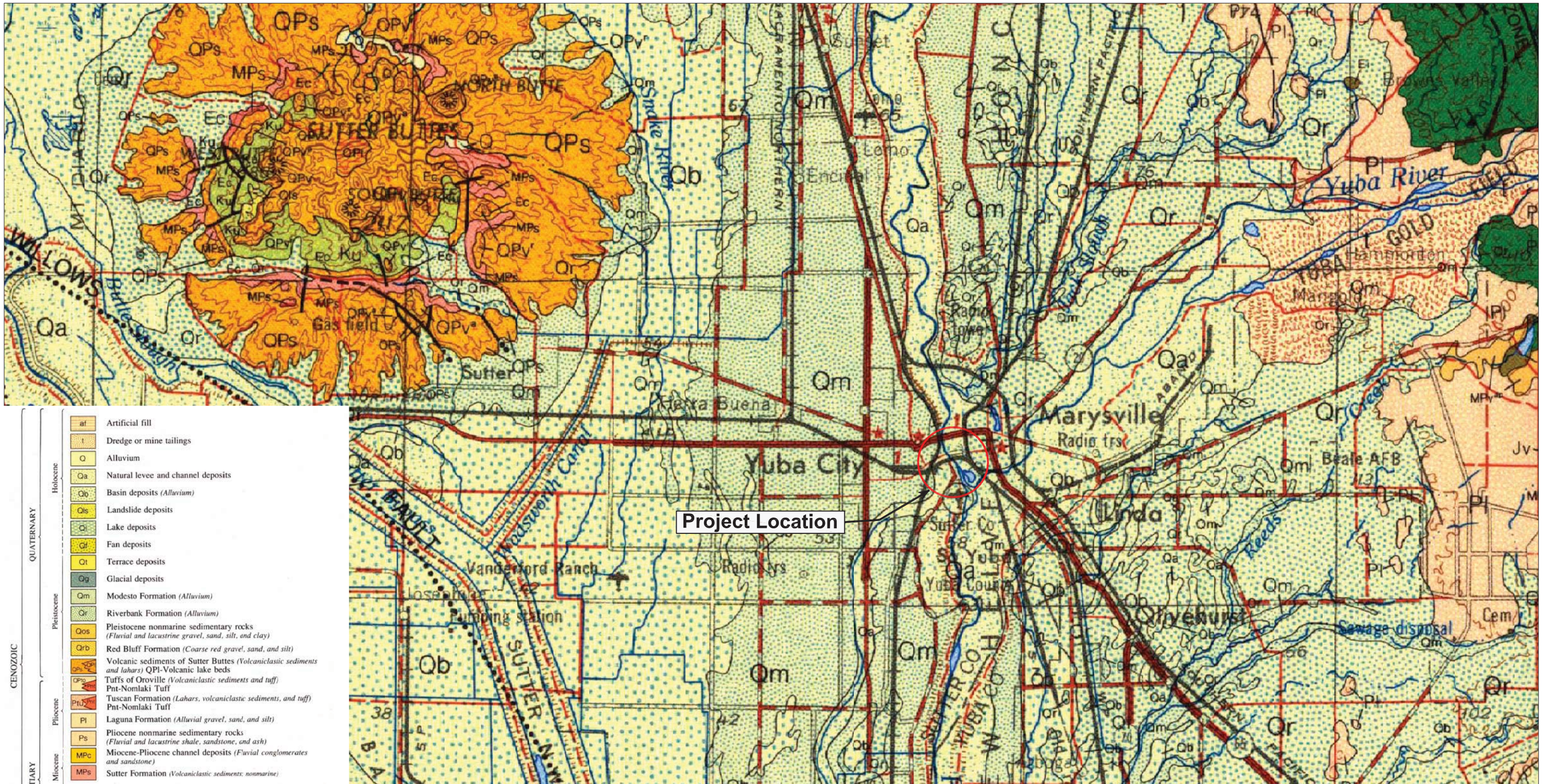


| | | | | |
|---|---|---|---|---|
| CENOZOIC | QUATERNARY | Holocene | af | Artificial fill |
| | | | t | Dredge or mine tailings |
| | | | Q | Alluvium |
| | | | Qa | Natural levee and channel deposits |
| | | | Qb | Basin deposits *(Alluvium)* |
| | | | Qls | Landslide deposits |
| | | | Ql | Lake deposits |
| | | | Qf | Fan deposits |
| | | Pleistocene | Qt | Terrace deposits |
| | | | Qg | Glacial deposits |
| | | | Qm | Modesto Formation *(Alluvium)* |
| | | | Qr | Riverbank Formation *(Alluvium)* |
| | | | Qos | Pleistocene nonmarine sedimentary rocks *(Fluvial and lacustrine gravel, sand, silt, and clay)* |
| | | | Qrb | Red Bluff Formation *(Coarse red gravel, sand, and silt)* |
| | | | QPs | Volcanic sediments of Sutter Buttes *(Volcaniclasic sediments and lahars)* QPl-Volcanic lake beds |
| | TERTIARY | Pliocene | QPo | Tuffs of Oroville *(Volcaniclastic sediments and tuff)* Pnt-Nomlaki Tuff |
| | | | PnT | Tuscan Formation *(Lahars, volcaniclastic sediments, and tuff)* Pnt-Nomlaki Tuff |
| | | | Pl | Laguna Formation *(Alluvial gravel, sand, and silt)* |
| | | | Ps | Pliocene nonmarine sedimentary rocks *(Fluvial and lacustrine shale, sandstone, and ash)* |
| | | Miocene | MPc | Miocene-Pliocene channel deposits *(Fluvial conglomerates and sandstone)* |
| | | | MPs | Sutter Formation *(Volcaniclastic sediments; nonmarine)* |
| | | Oligocene | | |
| | | Eocene | Ec | Capay Formation *(Sandstone and shale; marine)* |
| | | | Ei | Ione Formation *(Quartzose sandstone, claystone, and conglomerate; mostly nonmarine)* |
| | | | Tg | "Auriferous" Gravels |
| | CRETACEOUS | | Ku | Upper Cretaceous rocks *(Shale and sandstone; marine)* |
| | | | Kc | Chico Formation *(Sandstone, conglomerate, and siltstone; marine)* |

N

0 10,000 20,000 FEET

SCALE 1" = 10,000'

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Geotechnical and Earthquake Engineering

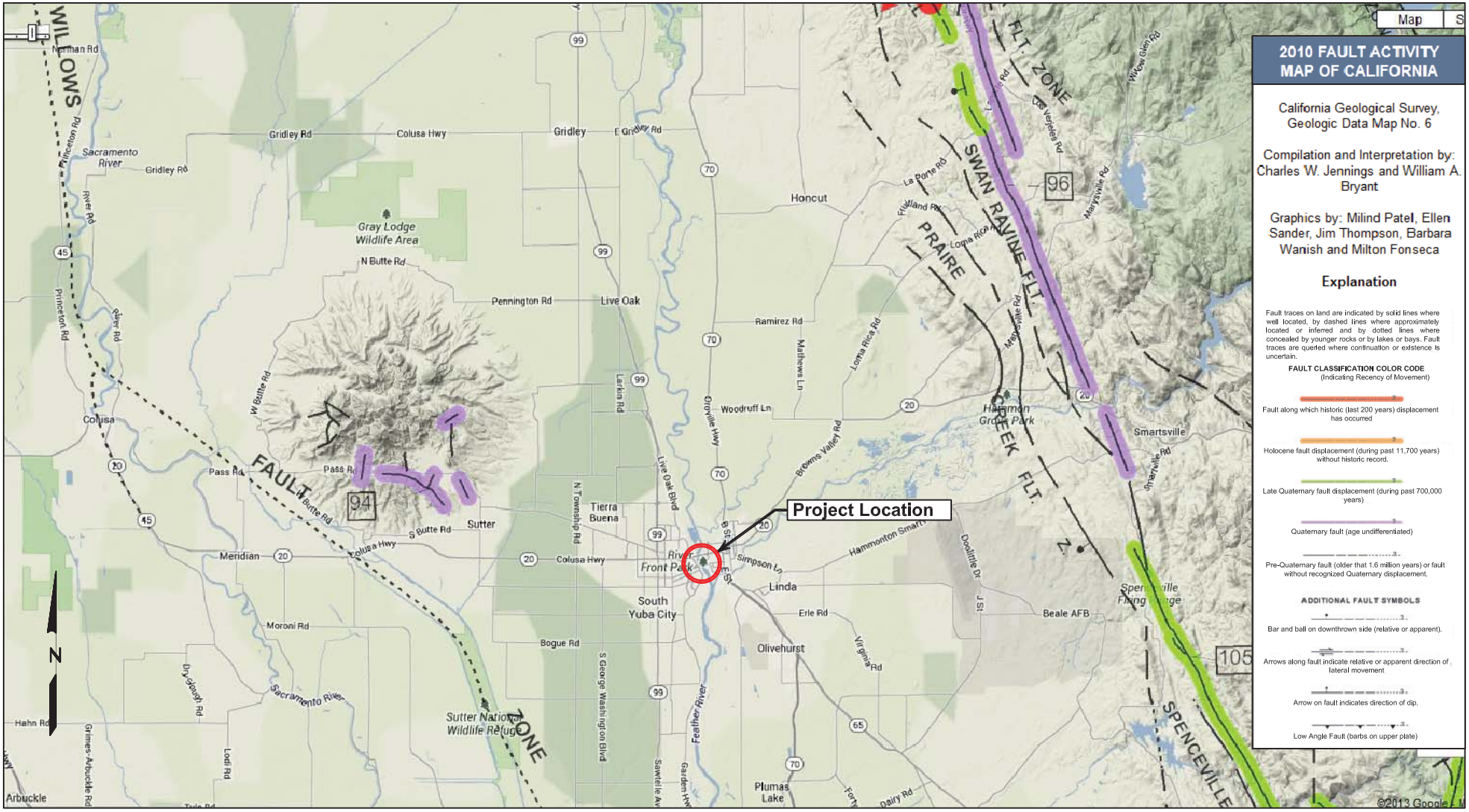
5th Street Bridge Replacement Project

Project No. 13-121 Date: August 2015

# REGIONAL GEOLOGIC MAP

REFERENCE: Saucedo, G. J. and Wagner, D. L., 1992, Regional Geologic Map of the Chico Quadrangle, California, California Geological Survey, Regional Geologic Map No. 7A, 1:250,000 scale.

Figure 3




0 25,000 50,000 FEET

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5th Street Bridge Replacement Project

Project No. 13-121

Date: August 2015

Regional Fault Map

Figure 4

# 4.0 SUBSURFACE CONDITIONS

## 4.1 Subsurface Conditions

Soil stratigraphy is defined by the available soils information and the exploratory borings (described in Section 2.0) performed under the supervision of EMI personnel for the project and previous subsurface investigation performed by others.

Soil boring data indicates that the top 25 to 40 feet of site soils (above approximate El. +20 feet) are generally very loose to loose silty sand, sand, and soft sandy silt. These soils are followed by about 20 to 25 feet of interbeded layers of medium dense sand, sand with pea gravel, silty sand, and stiff sandy silt. The sandy deposits are generally fine to coarse grained. Below this depth (approximate El. +0 feet) the soil layers consist of dense to very dense sand and silty sand, and very stiff to hard sandy silt. Standard penetration test (SPT) blowcounts were larger than 50 below El. -20 feet. It should be noted that in some CPTs at about El. -20 feet there is a transition from sandy soils to silty soils, resulting in a drop in soil resistance.

The soil exploration performed in the levees indicates the west levee is made of loose clayey sand, while the east levee comprises of medium dense silty sand and medium stiff to stiff clay and silt.

It should be noted that the above soil description is general and is intended to describe the subsurface in very broad terms. The soil description above should not be construed to mean that the subsurface profile is uniform and that soil is homogeneous within the project area. Details on stratigraphy at each borehole location are provided on the LOTB sheets presented in Appendix A.

## 4.2 Groundwater Conditions

Groundwater was encountered in August 2007 at El. +41.1 feet in Boring B-1 near Pier 5 of the existing bridge. Also, water surface elevation in the Feather River was measured at El. +41.8 feet in November 1956. The observed ground water levels in the recent 2013 investigation were between El. +31 feet in Boring R-13-004, and El. +53.4 feet in Boring R-13-013.

The design flood high water level on as-built drawings of the existing 5$^{th}$ Street Bridge is El. +82.5 feet. This elevation is a few feet below the crest of the levees. The current design flood high water level for a 200-year event per plans is El. +79.6 ft. Since seismic and flood load cases are considered separately, for liquefaction analyses and seismic design a lower groundwater elevation can be used. It is assumed that during the seismic event the groundwater is near the top of the main channel of the river. Therefore, groundwater at El. +50 feet is recommended to be used for seismic and liquefaction design. For slope stability analyses a higher groundwater at about El. +80 feet should be considered as a flood extreme event.

## 4.3 Idealized Soil Profiles

Based on the information collected from borings and CPTs, idealized soil profiles for foundation analysis and design were developed along the proposed bridge alignment. The subsurface profile beneath the proposed structure is shown in Figure 5A, 5B and 5C. It should be noted that the

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loose silty/sandy material (light-orange colored) stretching underneath across the east bank of the Feather River up to Abutment 11 is potentially liquefiable layer as identified in Section 5.2. In this figure, the vertical red line segments denote potential liquefaction zones, which are identified in either CPT or SPT data. Due to some variation in soil conditions along the proposed 5$^{th}$ Street Bridge, individual idealized soil profile and soil parameters for geotechnical design were developed for each support location. For the relatively uniform subsoil condition at the 2$^{nd}$ Street OC, only one idealized soil profile was developed. These site-specific individual idealized soil profiles and soil parameters are included in Appendix C.

The soil internal friction angles in Appendix C are primarily based on published correlations with SPT blow counts (Lam and Martin, 1986). The blow counts obtained from non-standard penetration tests using a Modified California Sampler were converted to standard blow count using the Burmister's standard relationships (Winterkorn and Fang, 1975) with a conversion factor of 0.5 for coarse-grained soils and 0.7 for fine-grained soils. The above internal friction angles obtained using the SPT correlation is also comparable to the laboratory test results in Appendix B.

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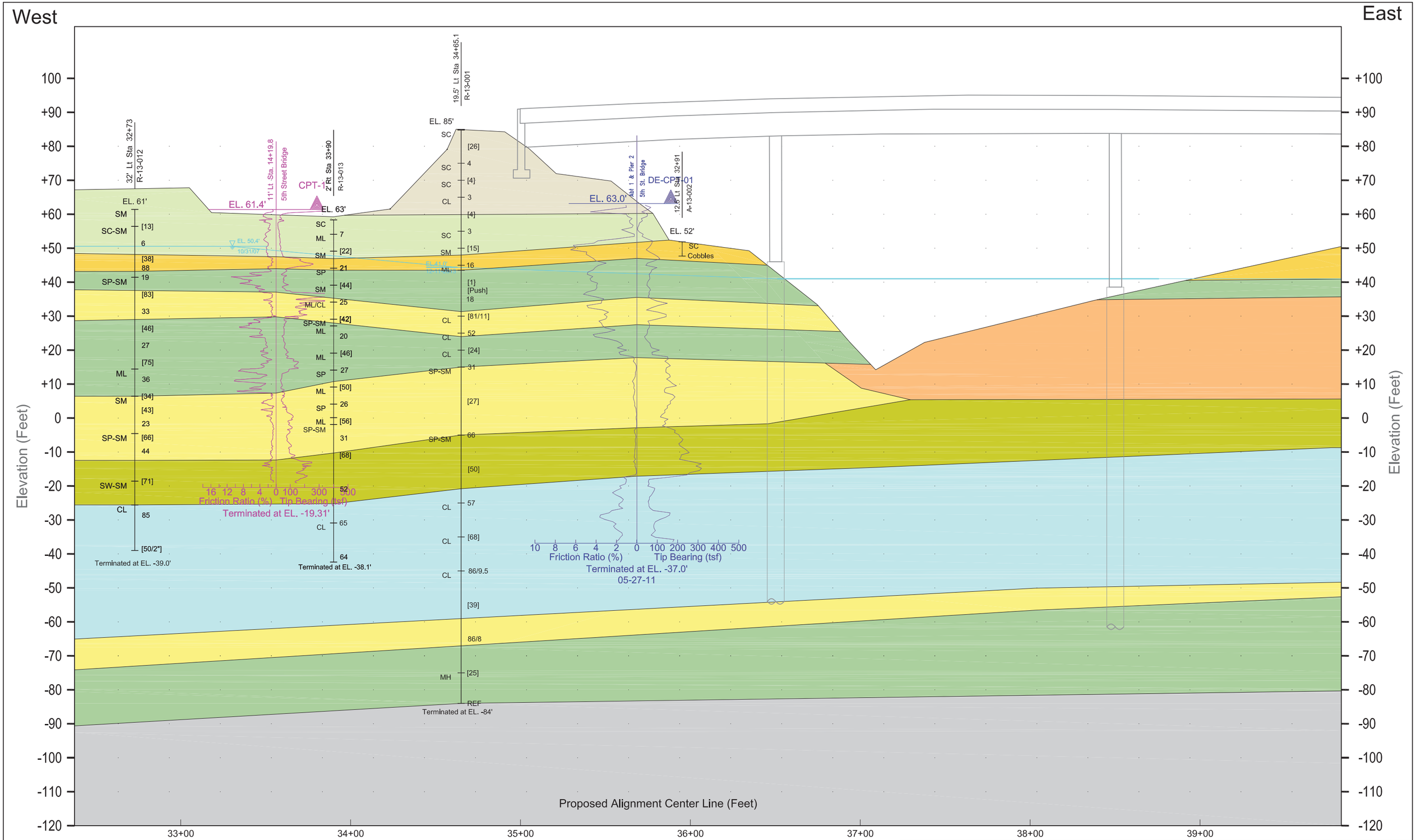
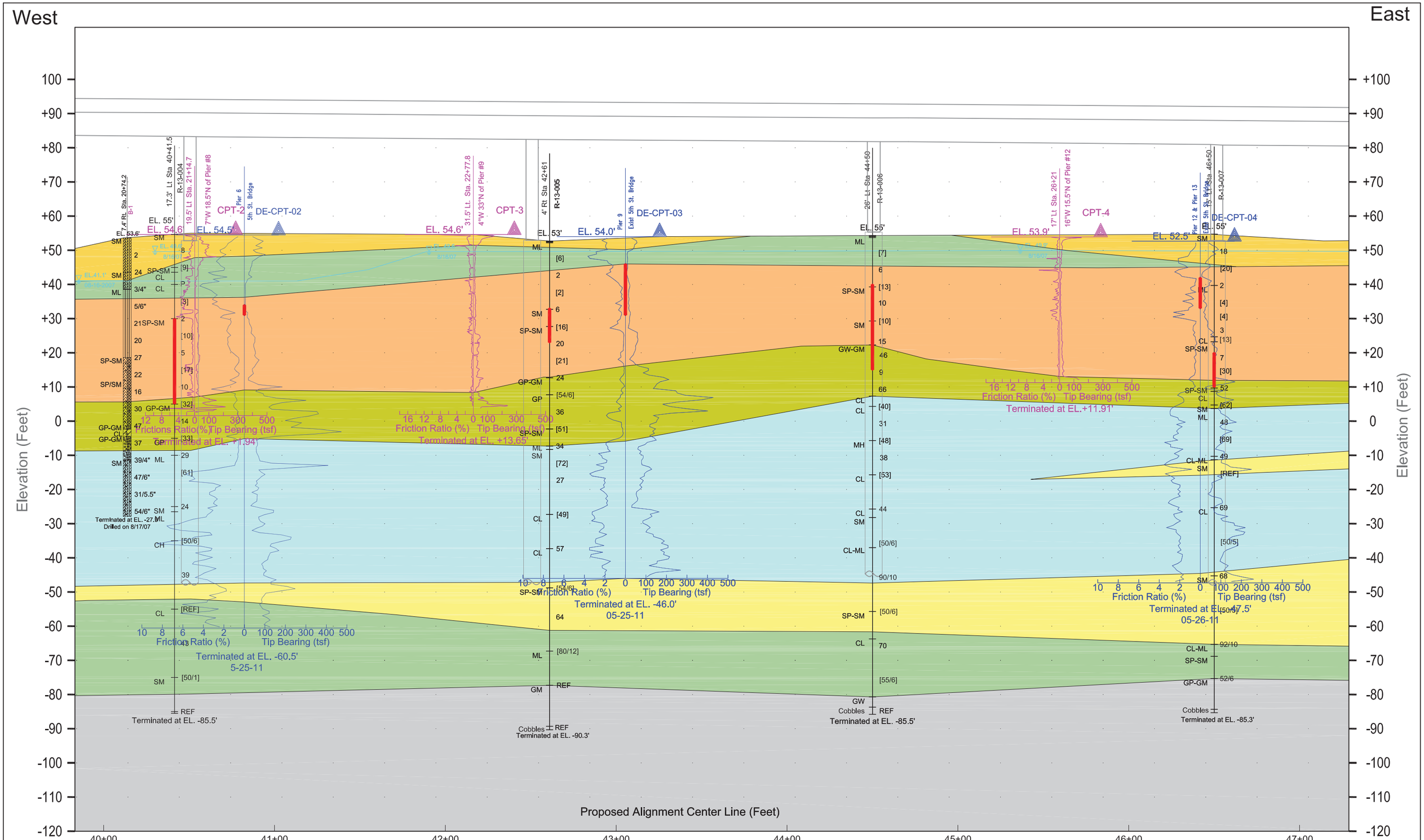
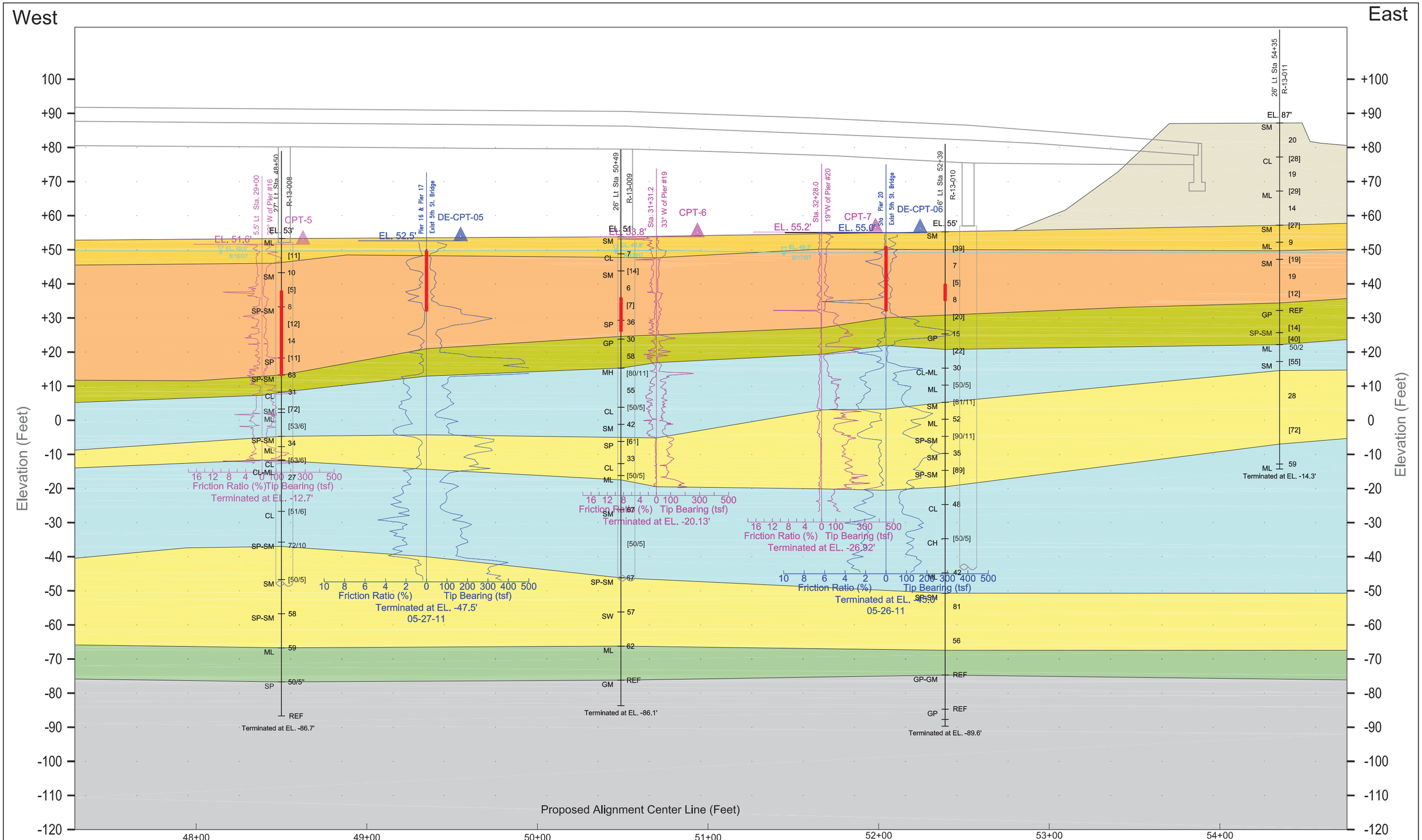

West
East
Elevation (Feet)
Proposed Alignment Center Line (Feet)
33+00
34+00
35+00
36+00
37+00
38+00
39+00
32' Lt Sta 32+73
R-13-012
11' Lt Sta. 14+19.8
5th Street Bridge
CPT-1
2' Rt Sta 33+90
R-13-013
19.5' Lt Sta 34+65.1
R-13-001
Abt 1 & Pier 2
5th St. Bridge
DE-CPT-01
12.8' Lt Sta 32+91
A-13-002
EL. 61'
EL. 61.4'
EL. 63'
EL. 85'
EL. 63.0'
EL. 52'
SC
Cobbles
EL. 50.4'
10/31/07
EL. 41.0'
Terminated at EL. -19.31'
Terminated at EL. -39.0'
Terminated at EL. -38.1'
Terminated at EL. -37.0'
05-27-11
Terminated at EL. -84'
Friction Ratio (%)
Tip Bearing (tsf)
F Fill
A SILTY SAND
B SILTY SAND with GRAVEL
C SANDY CLAY to SILT
D SAND with SILT
E GRAVEL with SILT
F CLAY
G GRAVEL
SILTY SAND / Potentially Liquefiable Zone
Soil Contact (Interpreted based on subsurface information)
Groundwater Table
Approximate Static Groundwater Table
Scale:
Horizontal = 1"=50'
Vertical = 1"=25'
2X Vertical Exaggeration
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering
5th Street Bridge
Subsurface Cross Section
Figure 5A
SHEET 1 OF 3


West
East
Elevation (Feet)
Proposed Alignment Center Line (Feet)
40+00
41+00
42+00
43+00
44+00
45+00
46+00
47+00
CPT-2
DE-CPT-02
CPT-3
DE-CPT-03
CPT-4
DE-CPT-04
R-13-004
R-13-005
R-13-006
R-13-007
Friction Ratio (%)
Tip Bearing (tsf)
Terminated at EL. -85.5'
Terminated at EL. -90.3'
Terminated at EL. -46.0'
05-25-11
Terminated at EL. -60.5'
5-25-11
Terminated at EL. +11.91'
05-26-11
Terminated at EL. -85.3'
Fill
SILTY SAND with GRAVEL
SAND with SILT
CLAY
SILTY SAND / Potentially Liquefiable Zone
SILTY SAND
SANDY CLAY to SILT
GRAVEL with SILT
GRAVEL
Soil Contact (Interpreted based on subsurface information)
Groundwater Table
Approximate Static Groundwater Table
Scale:
Horizontal = 1"=50'
Vertical = 1"=25'
2X Vertical Exaggeration
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering
5th Street Bridge
Subsurface Cross Section
Figure 5B
SHEET 1 OF 3


West
East
Elevation (Feet)
Proposed Alignment Center Line (Feet)
48+00
49+00
50+00
51+00
52+00
53+00
54+00
CPT-5
EL. 53'
EL. 51.6'
R-13-008
DE-CPT-05
EL. 52.5'
Pier 16 & Pier 17
Exist 5th St. Bridge
Friction Ratio (%)Tip Bearing (tsf)
Terminated at EL. -12.7'
Friction Ratio (%) Tip Bearing (tsf)
Terminated at EL. -47.5'
05-27-11
Terminated at EL. -86.7'
R-13-009
CPT-6
EL. 51'
EL. 48.8'
Sta. 31+31.2
33' W of Pier #19
Terminated at EL. -20.13'
Terminated at EL. -86.1'
CPT-7
EL. 55.2'
EL. 55.0'
Sta. 32+28.0
19' W of Pier #20
Pier 20
DE-CPT-06
EL. 55'
R-13-010
Terminated at EL. -26.92'
05-26-11
Terminated at EL. -89.6'
R-13-011
EL. 87'
Terminated at EL. -14.3'
F Fill
A SILTY SAND
B SILTY SAND with GRAVEL
C SANDY CLAY to SILT
D SAND with SILT
E GRAVEL with SILT
F CLAY
G GRAVEL
SILTY SAND / Potentially Liquefiable Zone
Soil Contact (Interpreted based on subsurface information)
Groundwater Table
Approximate Static Groundwater Table
Scale:
Horizontal = 1"=50'
Vertical = 1"=25'
2X Vertical Exaggeration
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering
5th Street Bridge
Subsurface Cross Section
Figure 5C
SHEET 1 OF 3

# 5.0 CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Seismic Study and Recommendations

The site is located in seismically active northern California and is subject to shaking from both local and distant earthquakes. The nearest substantial local sources of earthquakes are provided in Table 4, along with their fault type and their maximum earthquake magnitude according to the Caltrans Fault Database V2a (Merriam, 2012). The site to fault distances were determined using the Caltrans ARS Online web tool V2.3.06 (Caltrans, 2013a).

**Table 4. Fault Data**

| Fault | Fault Type (1) | Maximum Earthquake Magnitude | Distance from Site to Fault (miles) | Surface Fault/Blind Fault |
|---|---|---|---|---|
| Foothills Fault System northern reach section (Spenceville fault) | N | 6.5 | 12.7 | Surface |
| Foothills Fault System northern reach section (Swain Ravine fault zone) | N | 6.5 | 16.0 | Surface |
| Great Valley 03 Mysterious Ridge fault | R | 7.0 | 34.4 | Blind |
| Bartlett Springs fault | SS | 7.2 | 64 | Surface |
| Maacama fault zone | SS | 7.4 | 70 | Surface |
| San Andreas fault (North Coast) | SS | 8.0 | 96 | Surface |

Notes:
1. N = Normal, R = Reverse, SS = Strike Slip.

For seismic design purposes, ARS curves can be developed in accordance with the Methodology for Developing Design Response Spectrum for Use in Seismic Design Criteria (SDC) (Caltrans, 2013b) procedures, considering the following response spectra:

- Deterministic Criteria based on late-Quaternary faults in 2012 fault database (Merriam, 2012);
- Probabilistic Criteria based on 5% in 50 years probability of exceedance ground motion; and
- Minimum Deterministic Spectrum based on a $M_w$ = 6.5 vertical strike slip event occurring at a distance of 7.5 miles from the site.

The design ARS curve is the envelope of the above spectra.

### 5.1.1 Soil Type Classification

The preliminary parameters of small-strain shear wave velocity for the upper 100 feet ($V_{s30}$) of subsurface materials were estimated using the measured velocities in six seismic CPT soundings performed in 2011. Based on these measurements, the whole project site has an estimated $V_{s30}$ of 305 m/sec (~1,000 ft/sec) and it could be initially classified as a Soil Profile Type D, per Figure B.12 of the Caltrans SDC.

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However, the 5th Street Bridge site has a high liquefaction potential (see Sections 2.4.3 and 5.2), therefore it is classified as a Soil Profile Type F. According to Appendix B of the Caltrans SDC, for Soil Profile Type F, a site response analysis is required for both preliminary and final seismic designs. For the 2nd Street OC site with negligible liquefaction potential, no site response analysis is needed to develop the corresponding seismic design criteria.

### 5.1.2 Design Acceleration Response Spectra for 5th Street Bridge

In order to perform site response analyses for this bridge site, base ground motions were developed for firm-ground conditions where liquefaction is not anticipated. The firm-ground condition was assumed at El. –100 ft based on the review of the idealized soil profile. The site classification for firm-ground was characterized with a $V_{s30}$ of 560 m/sec (~1,840 ft/sec) over a depth of 100 feet below this elevation. This $V_{s30}$ value was used in the Caltrans ARS Online V2.3.06 tool (Caltrans, 2013a).to determine seismic criteria for firm-ground conditions serving as 'reference rock motion' in subsequent site response analyses to evaluate pier specific earthquake time histories.

#### 5.1.2.1 Seismic Design Criteria for Firm-Ground

The deterministic and probabilistic acceleration response spectrum (ARS) curves for firm-ground conditions (at El. -100 ft) were developed by the Caltrans ARS Online V2.3.06 tool. The firm-ground spectra were used to develop spectrum-compatible acceleration time histories, which were subsequently used as base motions in site response analyses.

The Caltrans ARS Online tool develops the deterministic spectrum using the average of median response spectra calculated by two Next Generations Attenuations (NGA) ground motion prediction equations developed by Campbell-Bozorgnia (2008) and Chiou-Youngs (2008). These equations are applied to all faults considered to be active in the last 750,000 years (late-Quaternary age) that are capable of producing a moment magnitude earthquake of 6.0 or greater. The Caltrans ARS Online tool obtains the probabilistic spectrum from the USGS (2008) National Hazard Map for 5% probability of exceedance in 50 years. Both deterministic and probabilistic spectra account for site effects through incorporation of the parameter $V_{s30}$.

To account for near-fault effects, Caltrans ARS Online applies a period-dependent adjustment factor to the probabilistic and deterministic ARS curves. For sites within 15 km of a causative fault, such as the subject site, the adjustment is zero for $T \leq 0.5$ seconds, then ramps up linearly to a 20% increase at $T = 1$ second and remains at a 20% increase for $T > 1.0$ second. Caltrans ARS Online applies an additional amplification factor based on the average of the basin amplification factors included in the Campbell-Bozorgnia (2008) and Chiou-Youngs (2008) Ground Motion Prediction Equations for the site-specific $Z_{1.0}$ and $Z_{2.5}$ values.

The following table summarizes the pertinent site specific input data for the deterministic and probabilistic analyses:

| | |
|---|---|
| Site Latitude, Longitude: | 39.1390°, -121.6053° |
| $V_{s30}$ – Shear Wave Velocity for firm ground: | 1,840ft/sec (560 m/sec) |

Based on ARS Online results, the minimum deterministic response spectrum controls the design response spectrum for the project. The resulting firm-ground ARS curve together with its digitized coordinates is presented in Figure 6.

### 5.1.2.2 Startup Ground Motions

For site response analysis and soil-structure interaction studies of the bridge, time histories of spectrum-compatible bedrock motions are required. The first step in developing spectrum-compatible bedrock motions is selection of seed motions. These motions are generally selected from a large database of recorded ground motions.

Seismic hazard deaggregation results are used for identification of most likely earthquake magnitude and source-to-site distances that has the highest contribution to the seismic hazard at the bridge site. According to the ARS Online results presented in Section 5.1.2.1, the seismic hazard at the bridge site is controlled by the minimum deterministic criteria, which is characterized by an M 6.5 vertical strike-slip event occurring at a distance of 12 km (7.5 miles) from the site. Although this scenario establishes the minimum spectrum, the spectrum is intended to represent the possibility of a wide range of magnitude-distance scenarios.

Based on these results, three ground motion records are selected from the ground motion database for use as startup motions. Records from earthquakes of moment magnitudes ($M_w$) ranging from 6.4 to 7.5 with rupture distances of between 12.8 to 15.6 km are selected. The earthquake events include Loma Prieta (1989), Imperial Valley (1979) and Kocaeli (1999). Table 5 shows the selected three startup ground motion sets.

**Table 5. Startup Ground Motions**

| Set | Year / Name of Earthquake | Earthquake Magnitude | Station Name | $V_{s30}$ (m/s) | Closest Distance (km) | Fault Type(1) |
|---|---|---|---|---|---|---|
| 1 | 1989 Loma Prieta | 6.93 | Gilroy Array #3 | 350 | 12.8 | RO |
| 2 | 1979 Imperial Valley | 6.40 | Calexico Fir Station | - | 15.6 | SS |
| 3 | 1999 Kocaeli | 7.51 | Arcelik | 523 | 13.5 | SS |

Notes:
1. N = Normal, R = Reverse, RO = Reverse-Oblique, SS = Strike Slip.

Two components of the start-up motion (fault normal – FN and fault parallel - FP) were spectrally matched to the firm-ground design ARS using RSPMATCH v2.2 computer program (Abrahamson, 1998).

As part of the spectral matching procedure, a baseline correction is applied to the ground motions. The baseline is computed by fitting the displacement time history to a high order polynomial (order 4 to 7) and excluding the constant and linear terms. The second derivative of this displacement baseline is computed and it is subtracted from the acceleration ground motion. The resulting ground motion is baseline corrected in acceleration, velocity, and displacement. The startup and spectrum-compatible firm-ground motions are shown in Appendix D.

### 5.1.2.3 Site Response and Kinematic Soil-Structure Interaction Analyses

In order or develop pier-specific time histories and the design ARS curves for the subject site, site response and kinematic soil-structure interaction analyses were performed.

Equivalent linear site response analyses were conducted using the computer program SHAKE91 (Idriss and Sun 1992) to estimate ground motions at various depths. The dynamic shear modulus and damping of soil layers were estimated using relationships provided in the Electric Power Research Institute (EPRI) for sands (EPRI, 1993) and the Vucetic and Dobry relationships for clay (1991). These relationships have been adopted by Caltrans for major toll bridges as well as by the Nuclear Regulatory Agency for nuclear power plants. Soil layer shear wave velocities were determined based on the nearby CPT measurements (DE-CPT-01 to DE-CPT-05), and can be found in Appendix C. The firm-ground motions were applied as input motion at elevation of -100 feet for all support locations. Site response analysis was performed at each support of the 5th Street Bridge for two horizontal components of the ground motion. Free field motions were estimated at the selected depths at an interval of 5 feet for soil-structure interaction (SSI) analysis. For the post-liquefaction scenario, a reduced shear wave velocity of 300 ft/sec was assigned for all liquefiable layers.

Our kinematic soil-structure interaction analysis consists of modeling the total pile-soil foundation system for each individual pile from the pile tip up to the pile cap using our in-house KIPS program, which is dedicated to performing kinematic soil-pile interaction analyses (EMI 1999). Linearized lateral soil resistance (p-y) and axial soil resistance (t-z) springs are modeled in KIPS and the depth varying free-field motions from SHAKE are input to the KIPS program to define the ground excitation level to the bridge structure. The kinematic motion is calculated at the pile cut-off elevation or pile cap level and implicitly contains the statically condensed forces transmitted from the ground to the superstructure along the entire embedded pile length. Therefore, the effects of the depth-varying shaking intensity in soil column, the depth-varying soil stiffnesses, and the pile properties are included in the solution. The kinematic motions formed the basis for development of ARS design curves for the pile-supported structure. A detailed formulation of kinematic motion and its discussion can be found in a MCEER report (Lam and Law 2000). Estimated depth-varying free-field and kinematic motions are included in Appendix D. Figure 7 depicts the fault-normal spectral results at Bent 5 under the post-liquefaction condition for Motion Set 1. Due to the coupling effect of soil-structure interactions, the kinematic motion of Bentr 5 foundation system at the pile cut-off elevation resembles the free-field motion at a depth of about 30 feet.

### 5.1.2.4 Design Acceleration Response Spectra

Figure 8 shows the resultant kinematic motions of 11 5$^{th}$ Street Bridge supports resulting from three motion sets and two horizontal components under the pre-liquefaction condition. In this figure, the thick solid black line represents the firm-ground input motion at elevation of -100 feet, and the thick dotted black line depicts the mean plus one standard deviation curve of all kinematic motions (a probability of about 84%). For reality, a practical ARS curve should be smooth-wise with only one peak, and hence the solid blue line represents the smoothened curve for the mean plus one standard deviation curve, which is recommended as the design ARS curve

for response spectrum analyses of the bridge. Figure 9 shows those curves for the post-liquefaction condition.

Figure 10 shows our recommended non-liquefied and liquefied ARS curves together with their digitized coordinates. These two sets of our recommended ARS curves can be adopted by the structural engineers in their linear response spectrum analyses of the bridge. For non-linear time history analyses of the bridge, pier specific kinematic time histories can be used. The recommended ARS design curves can also be shown on the general plan of final PS&E drawings to document the basis of seismic design.

### 5.1.3 Design Acceleration Response Spectra for 2nd Street OC

As aforementioned, no liquefiable soil layer appears underneath this bridge site and the Caltrans ARS Online V2 (2012) was used directly to develop the corresponding ARS curve. The design ARS curve and the digitized coordinates are presented in Figure 11. The following table summarizes the pertinent site specific input data for the deterministic and probabilistic analyses:

| | |
|---|---|
| Site Latitude, Longitude: | 39.1384°, -121.6079 |
| $V_{s30}$ – Shear Wave Velocity for firm ground: | 787ft/sec (240 m/sec) |

The value of the $V_{S30}$ adopted at this bridge site was correlated based on the SPT blow counts of EMI Borings R-13-012 and R-13-013.

### 5.1.4 Ground Rupture

No major faults traverse through the whole project site area. The California Division of Mines and Geology (2007) has not identified Alquist-Priolo Fault Zones through or in the proximity of the site; therefore, the risk of ground surface rupture and related hazards is considered low.

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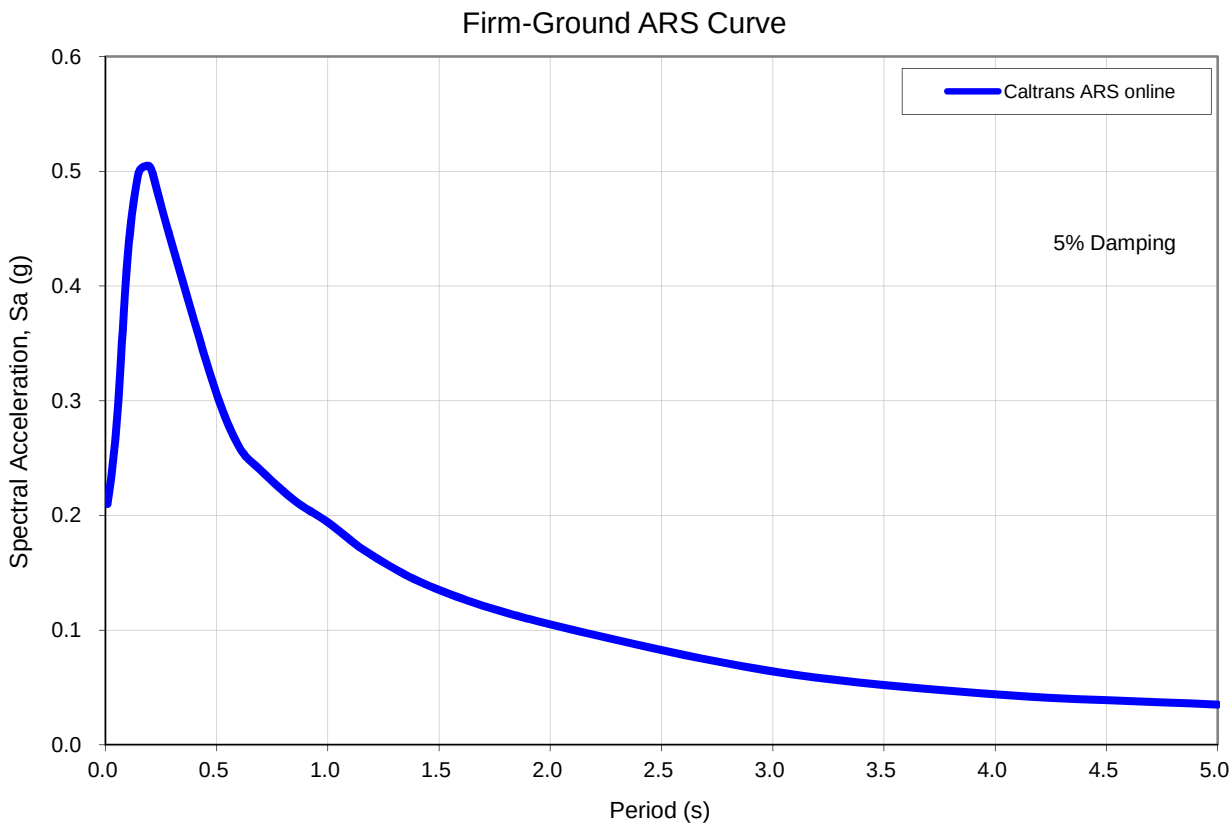


**Site Data**

| | |
|---|---|
| Latitude (degrees) | 33.139 |
| Longitude (degrees) | -121.605 |
| Shearwave Velocity, Vs30 (m/sec) | 560 |
| Peak Ground Acceleration (g) | 0.210 |

**Spectral Coordinates (Caltrans, 2012)**

| Period (sec) | Acc. (g) |
|---|---|
| 0.010 | 0.210 |
| 0.050 | 0.277 |
| 0.100 | 0.425 |
| 0.150 | 0.499 |
| 0.200 | 0.504 |
| 0.250 | 0.470 |
| 0.300 | 0.436 |
| 0.400 | 0.369 |
| 0.500 | 0.306 |
| 0.600 | 0.260 |

| Period (sec) | Acc. (g) |
|---|---|
| 0.700 | 0.239 |
| 0.850 | 0.213 |
| 1.000 | 0.194 |
| 1.200 | 0.165 |
| 1.500 | 0.135 |
| 2.000 | 0.105 |
| 3.000 | 0.064 |
| 4.000 | 0.044 |
| 5.000 | 0.035 |

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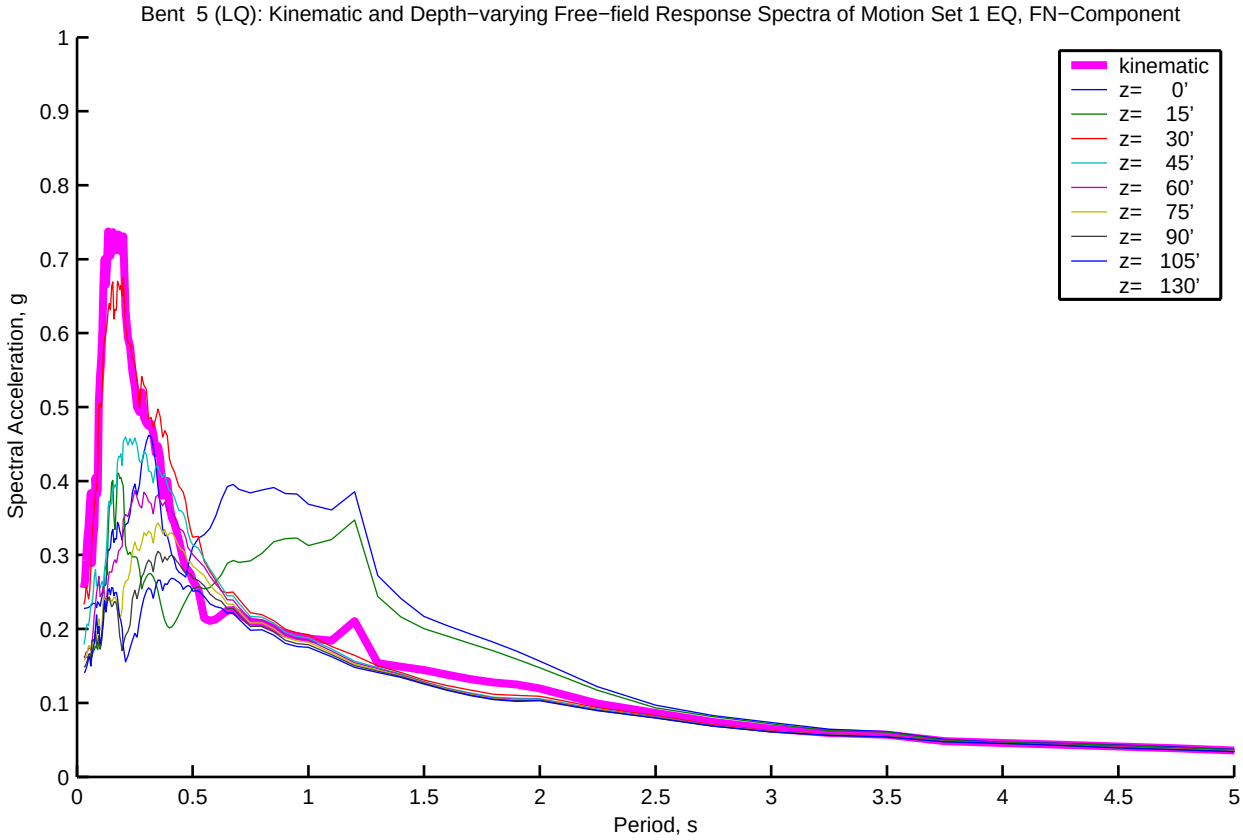
Geotechnical and Earthquake Engineering

I 5th Street Bridge

Project No.: 13-121 | Date: 08/26/2015

Firm-Ground ARS Curve

**Figure 6**



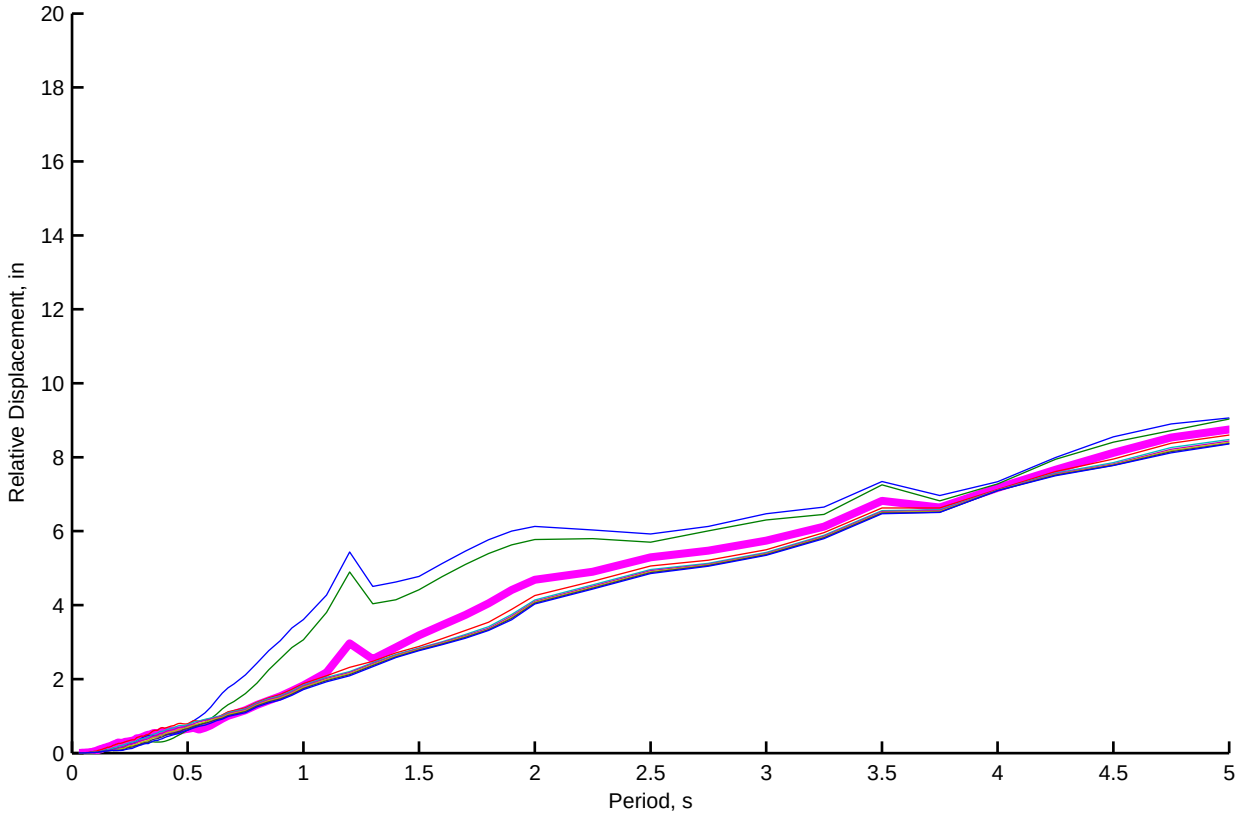
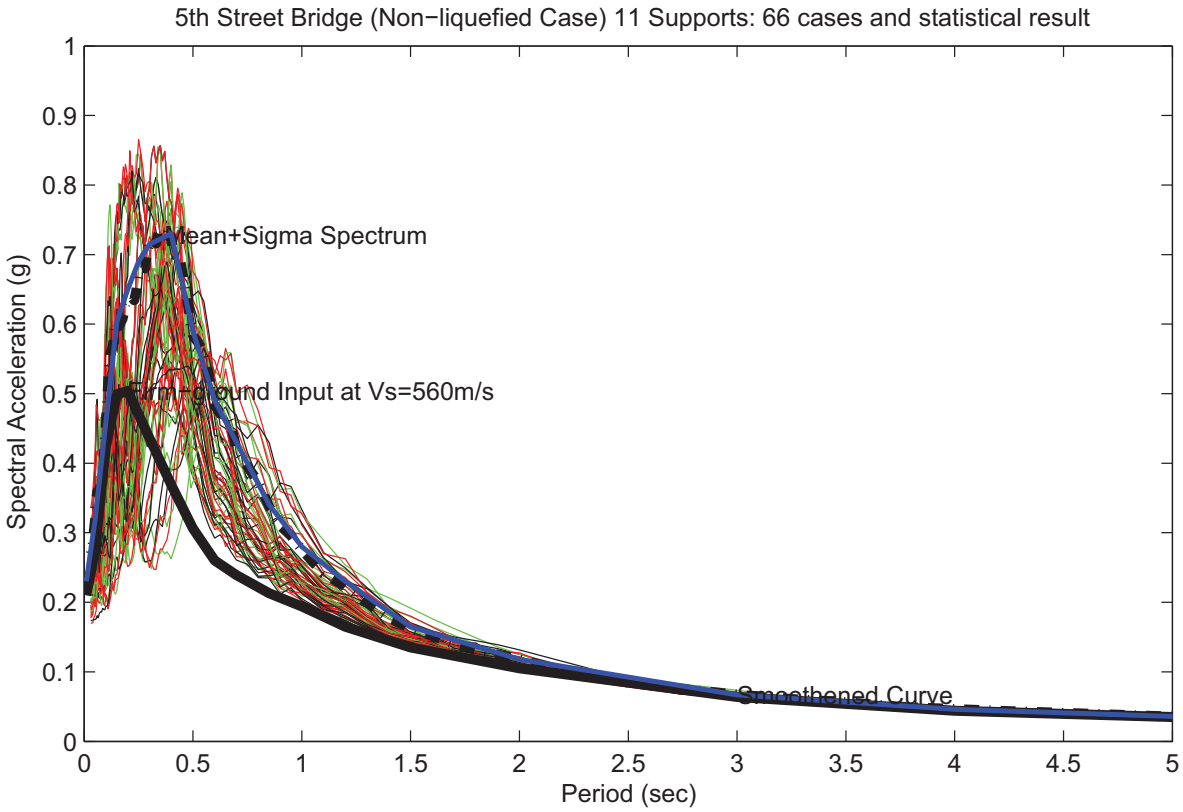




Figure 7. Fault-Normal Free-Field and Kinematic Motions at Bent 5 under Post-Liquefaction Condition for Motion Set 1



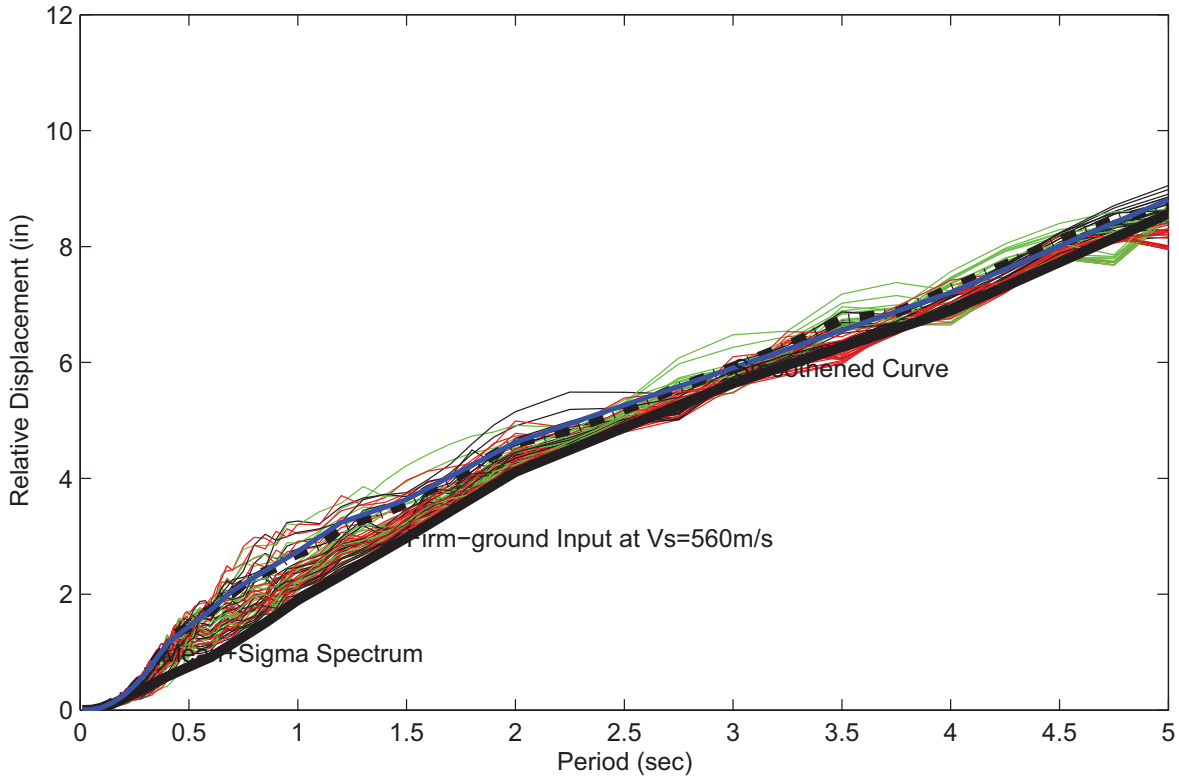
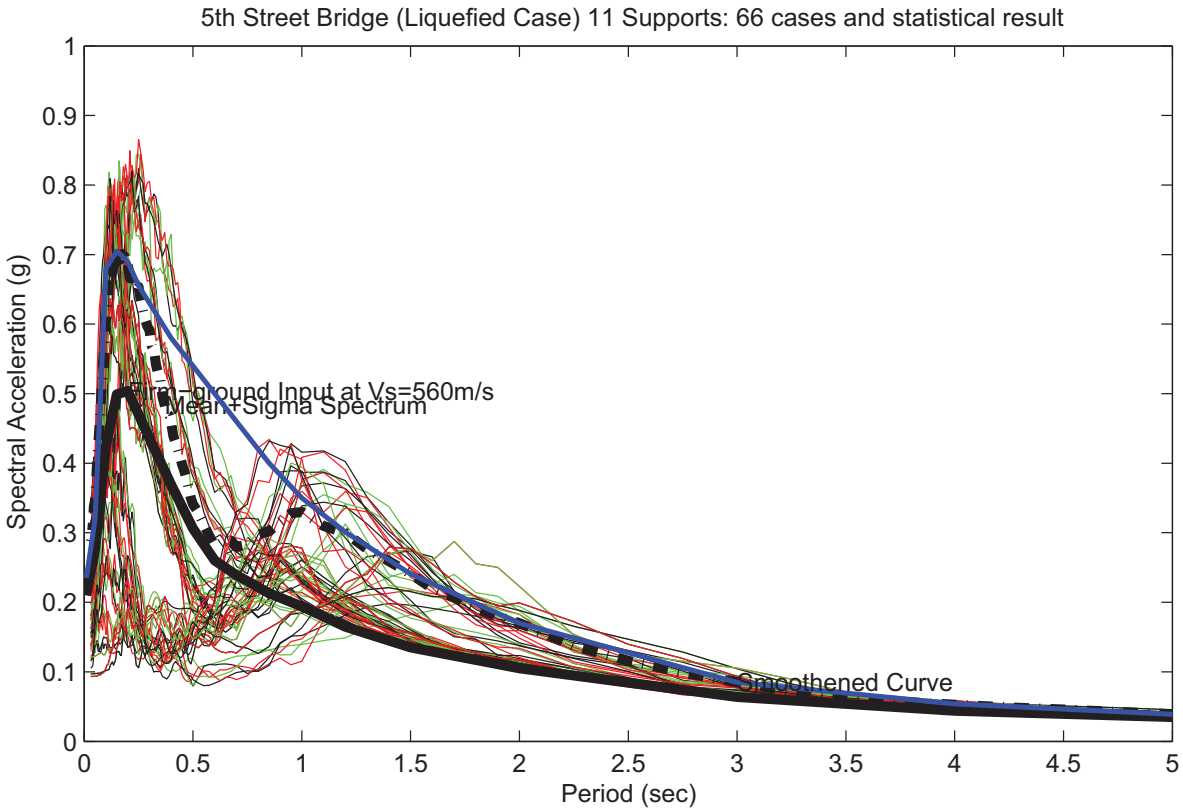




Figure 8. Resultant Kinematic Motions of 11 5th Street Bridge Supports for Pre-Liquefaction Condition



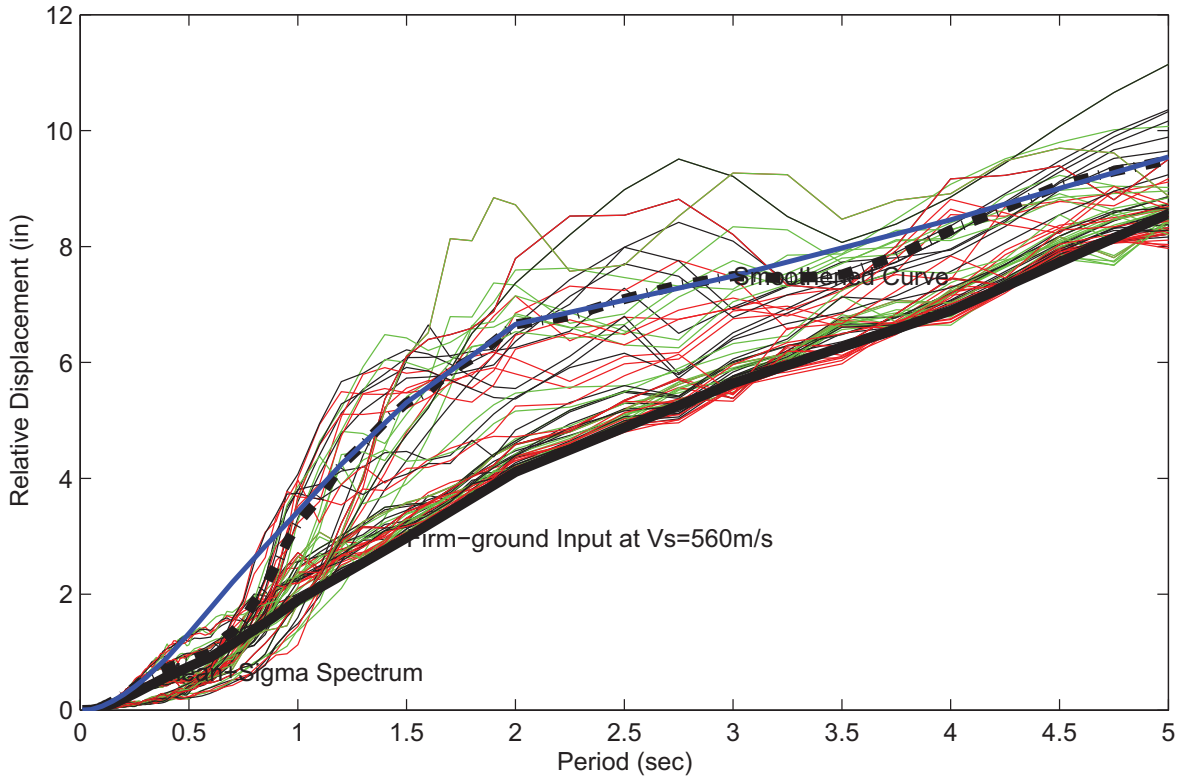
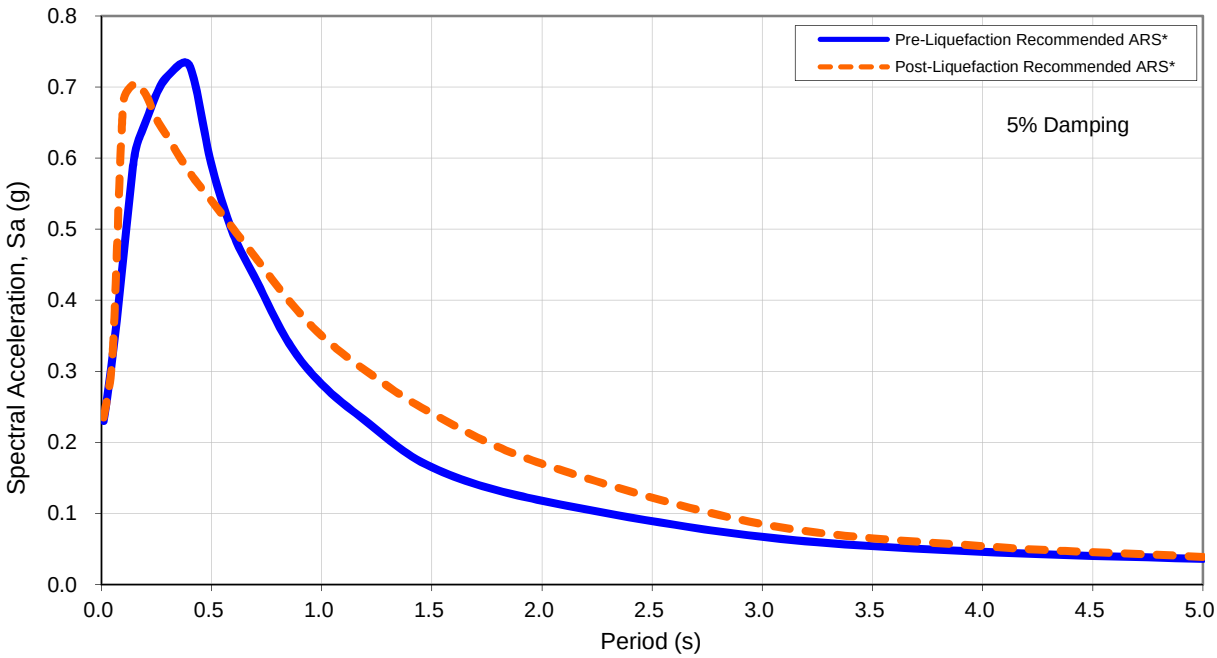




Figure 9. Resultant Kinematic Motions of 11 5th Street Bridge Supports for Post-Liquefaction Condition




Latitude: 33.1390 Longitude: -121.6053

Spectral Coordinates

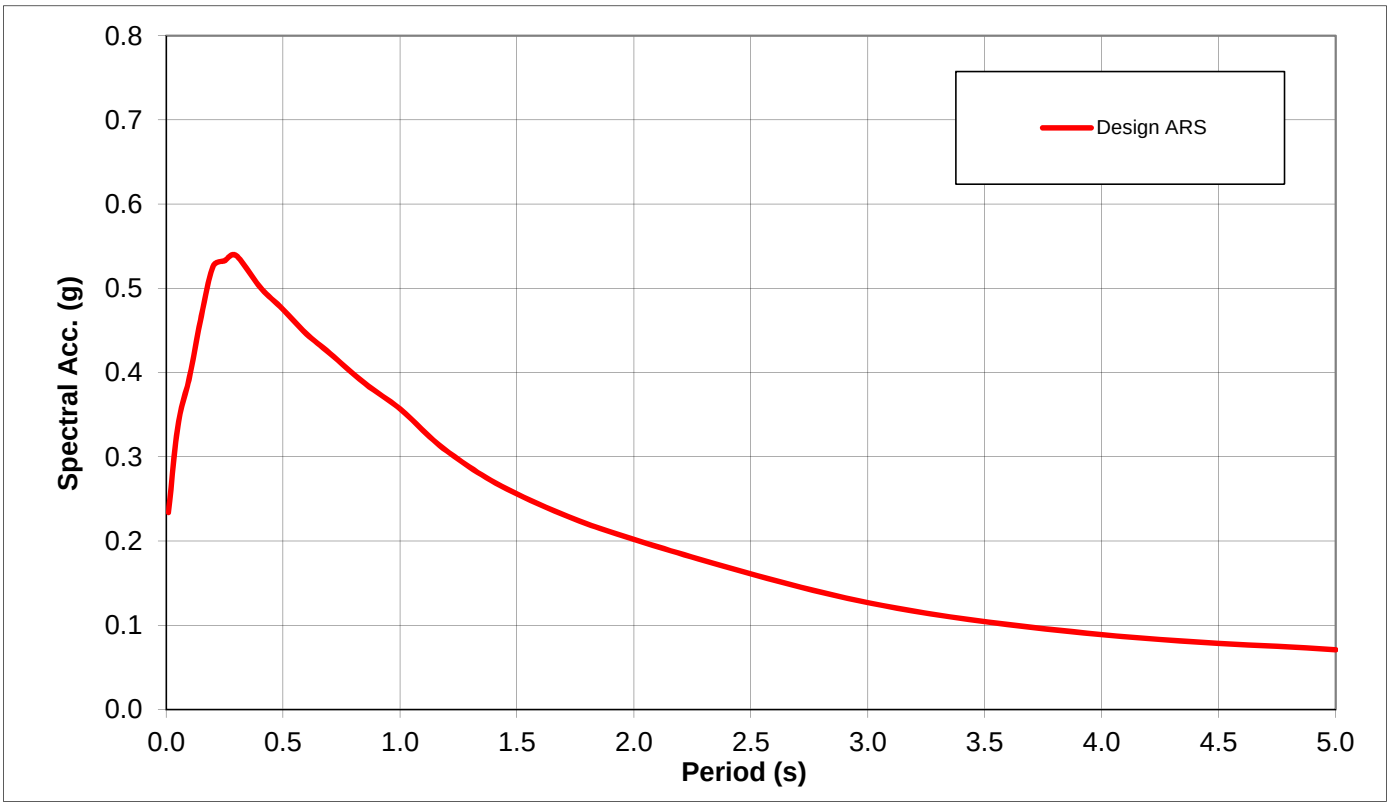
Pre-Liquefaction

| Period (s) | Acc. (g) |
|---|---|
| 0.010 | 0.230 |
| 0.050 | 0.319 |
| 0.100 | 0.460 |
| 0.150 | 0.603 |
| 0.200 | 0.650 |
| 0.250 | 0.690 |
| 0.300 | 0.715 |
| 0.400 | 0.730 |
| 0.500 | 0.590 |
| 0.600 | 0.492 |
| 0.700 | 0.430 |
| 0.850 | 0.340 |
| 1.000 | 0.282 |
| 1.200 | 0.230 |
| 1.500 | 0.165 |
| 2.000 | 0.118 |
| 3.000 | 0.067 |
| 4.000 | 0.046 |
| 5.000 | 0.036 |

Post-Liquefaction

| Period (s) | Acc. (g) |
|---|---|
| 0.010 | 0.235 |
| 0.050 | 0.320 |
| 0.100 | 0.680 |
| 0.150 | 0.705 |
| 0.200 | 0.690 |
| 0.250 | 0.655 |
| 0.300 | 0.630 |
| 0.400 | 0.580 |
| 0.500 | 0.540 |
| 0.600 | 0.500 |
| 0.700 | 0.460 |
| 0.850 | 0.400 |
| 1.000 | 0.350 |
| 1.200 | 0.301 |
| 1.500 | 0.241 |
| 2.000 | 0.170 |
| 3.000 | 0.085 |
| 4.000 | 0.054 |
| 5.000 | 0.039 |

*based on kinemation motion results




**Design ARS Curve for 5% Damping**

Shear Wave Velocity ($V_{s30}$) = 240 m/s

Design ARS

| **Period** (sec) | **Acc.** (g) |
|---|---|
| 0.01 | 0.234 |
| 0.05 | 0.337 |
| 0.10 | 0.395 |
| 0.15 | 0.467 |
| 0.20 | 0.526 |
| 0.25 | 0.533 |
| 0.30 | 0.539 |
| 0.40 | 0.502 |
| 0.50 | 0.475 |
| 0.60 | 0.446 |
| 0.70 | 0.423 |
| 0.85 | 0.387 |
| 1.00 | 0.357 |
| 1.20 | 0.307 |
| 1.50 | 0.256 |
| 2.00 | 0.202 |
| 3.00 | 0.127 |
| 4.00 | 0.089 |
| 5.00 | 0.071 |

## 5.2 Liquefaction

### 5.2.1 Previous Liquefaction Studies

Taber (2008) evaluated liquefaction potential using SPT, CPT, and laboratory test data, based on the methods published by Youd et al. (2001). The analyses were performed for one boring and seven CPTs (CPT-1 through CPT-7), using a PGA value of 0.20 g and groundwater at El. +50 ft. The conclusion was that extensive liquefaction potential exists in top 25 to 50 ft of the soil profile between Pier 5 and Abutment 22 of the existing bridge. Dokken analyses were performed on data from six CPT soundings, using a PGA of 0.22 g, earthquake moment magnitude of 6.5, and groundwater elevation at ground surface at each CPT location. The results of these analyses were generally in agreement with Taber results. According to Dokken's analyses, a ±35-ft thick sandy soil layer located between approximately El. +50 to El. +10 ft has high liquefaction potential. This layer extends from the Feather River channel east to approximately Pier 20 of the existing bridge. Under the design seismic event this soil is predicted to have a high potential for lateral spreading and seismically induced settlement.

### 5.2.2 Liquefaction Analyses Using 2013 Boring Data

Liquefaction potential at the site was also evaluated using the SPT blowcounts from the recent soil investigation. The analyses were performed using a PGA of 0.227 g and moment magnitude of 6.5. These analyses confirm that liquefaction potential exists for the soil layer between EL. +50 to El. +10 ft, and between Pier 2 and Abutment 11.

The analyses results are included in Appendix E. The results are shown in graphical format on Figures 5A, 5B and 5C.

### 5.2.3 Liquefaction Analyses Using CPT Data

EMI performed an independent liquefaction analysis using CPT data for DE-CPT-01 through DE-CPT-06. These analyses were performed using CLiq v.1.7 computer program (Geologismiki Software, 2016). The analyses results are included in Appendix E. The results were consistent with results shown in graphical format on Figures 5A, 5B and 5C.

The results from liquefaction analyses (both SPT- and CPT-based) were in general agreement with previous studies and indicated that liquefaction potential exists between Pier 2 and Abutment 11 of the new bridge. The zone with liquefaction potential is depicted on Figures 5A, 5B and 5C.

### 5.2.4 Seismically-Induced Settlement

Taber (2008) used the data from one boring and seven CPTs to evaluate seismically-induced settlement. It was evaluated between 0 and 12 inches, with an average value of 5.25 inches.

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According to Dokken's analyses, seismically-induced settlements were estimated to be up to 11 inches in the region between the existing Piers 8 to 14 (DE-CPT-03 to DE-CPT-05), with settlement extending from the ground surface to approximately 40- to 50-feet below ground surface (bgs). Settlement between the existing Piers 2 to 7 (DE-CPT-01 and DE-CPT-02) was estimated from 3 to 8 inches, extending from depth 67 to 83 feet bgs. At the east extent of the Feather River floodplain near Pier 20 (DE-CPT-06), up to 8 inches of settlement was predicted, extending to a depth of 75 feet bgs.

Seismic settlements were also evaluated by EMI using CPT data from DE-CPT-01 through DE-CPT-06. The computer program CLiq was used to evaluate settlements. Based on these analyses (Appendix E), vertical settlements were in the range of 0.7 to about 7 inches.

### 5.2.5 Liquefaction-Induced Lateral Spreading

Taber consultants (2008) estimated lateral spreading displacements on the order of 5 to 8 inches near existing Piers 4 through 8. Potential for lateral spreading involving the levees could not be evaluated by Taber due to lack of soil data.

In order to evaluate the EMI performed slope stability and sliding block analyses for different sliding mechanisms for liquefied soil conditions. Based on these analyses it appears that sliding blocks in vicinity of Abutment 11 of the proposed bridge have the lowest yield coefficient. Based on liquefaction analyses results in Appendix E, the average clean sand SPT resistance $(N_1)_{60\text{-}cs}$ for the liquefied layer was determined to be about 17. Using the equation by Idriss and Boulanger (2007), the normalized residual shear strength ratio was evaluated as 0.38 if void redistribution effects are insignificant, and 0.14 if void redistribution effect is significant. For the 5$^{th}$ Street Bridge site conditions, the effect of void redistribution is judged to be insignificant, because there are no continuous layers of low permeability soils next to the liquefiable soils. Therefore a normalized residual strength ratio of 0.28 was used in slope stability analyses and yield coefficient evaluations.

The yield coefficient for sliding masses involving Abutment 11 approach embankment of the proposed bridge was evaluated to be about 0.13 g (see slope stability analyses in Appendix E). This values is more than 50% of the site PGA, therefore, as discussed in Section C.11.6.5.2.2 of the AASHTO LRFD Design Specifications (AASHTO, 2012), the permanent ground deformation is expected to be less than 1 to 2 inches. This deformation is judged to be an insignificant factor in design of the bridge foundations.

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## 5.3 Soil Corrosivity

As part of the 2013 site investigation and laboratory testing, samples representative of soils throughout the project area were tested to determine corrosivity including minimum resistivity, pH, soluble sulfate content, and soluble chloride content. Eight soil samples were tested for corrosivity using the procedures described in California Test Methods 417, 422, 532, and 643. Corrosion tests were also performed by Taber Consultants on two samples from their 2008 boring. The soil corrosivity test results are summarized in Table 6.

Test results indicate pH values between 5.49 and 9.44, minimum resistivity values between 1,100 and 7,700 ohm-cm, chloride values between 11.8 and 278 parts per million (ppm), and sulfate values between 10 and 210 ppm.

According to Caltrans criteria (Corrosion Guidelines V2.0, 2012), soils are considered corrosive if the pH is 5.5 or less, or chloride concentration is 500 parts per million (ppm) or greater, or sulfate concentration is 2,000 ppm or greater.

Based on these test results and Caltrans criteria, all the measured corrosivity parameters, except one border line pH value of 5.49, are indicative of non-corrosive soils.

For structural elements, appropriate corrosion mitigation measures for "corrosive" conditions shall be provided depending on the service environment, amount of aggressive ion salts (chloride or sulfate), pH level and the desired service life of the structure.

**Table 6. Soil Corrosion Test Results**

| Boring No. | Sample No. | Sample Depth (ft) | Soil Type | Minimum Resistivity (ohm-cm) | pH | Chloride Content (ppm) | Sulfate Content (ppm) |
|---|---|---|---|---|---|---|---|
| R-13-001 | 4 | 20 | Sandy lean Clay (CL) | 1,100 | 9.44 | 278 | 210 |
| R-13-004 | 2 | 10 | Poorly-graded Sand with Silt (SP-SM) | 4,400 | 7.77 | 30 | 136 |
| R-13-004 | 4 | 20 | Lean Clay (CL) | 3,100 | 7.25 | 30 | 126 |
| R-13-005 | 1 | 5 | Silty Sand (SM) | 6,500 | 7.08 | 169 | 10 |
| R-13-007 | 1 | 5 | Silty Sand (SM) | 5,100 | 7.65 | 241 | 30 |
| R-13-009 | 2 | 10 | Silty Sand (SM) | 7,700 | 7.19 | 102 | 30 |
| R-13-011 | 4 | 20 | Sandy Silt (ML) | 4,700 | 7.77 | 162 | 30 |
| R-13-013 | 2 | 10 | Silty Sand (SM) | 6,000 | 7.33 | 114 | 30 |
| B-1 (8/2007) | 3 & 4 | 15 – 20 | Sandy Silt w/ Gravel (ML) | 3,750 | 5.49 | 11.8 | 62.1 |
| B-1 (8/2007) | 15 & 16 | 75 – 80 | Silty Sand w/ Gravel (SM) | 1,130 | 7.77 | 14.8 | 31.5 |

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## 5.4 Scour

Based on the estimates by TRC that are provided in the Preliminary Geotechnical Report by Taber (2008), total scour on the order of 6.8, 8.1, and 7.7 feet is anticipated at Piers 3, 4, and 5 of the existing 5th Street bridge, respectively.

Wreco (2016) recently performed additional study along the alignment of the replacement bridge and provided the scour information under several conditions. The current Caltrans LRFD practice considers the following scour depths in pile analysis at each limit state,

- The total depth of long-term degradation scour, contraction scour and local pier scour should be considered under Service Limit State;
- The total depth of long-term degradation scour, contraction scour and 50% of local pier scour should be considered under Strength Limit State; and
- Only the depth of long-term degradation scour and contraction scour should be considered under Extreme Limit State.

According to the current scour data provided by Wreco (2016), the scour depths and design surface elevations at the nine support locations of 5th Street Bridge near Feather River channel and in the flooded plain are summarized in the following table:

**Table 7. Summary of Scour Depths**

| Support | Original Grade[1] (ft) | Scour Depth | | Design Surface Elevation (ft) | | |
|---|---|---|---|---|---|---|
| | | Long-term Degradation and Contraction Scour Elevation (ft) | Local Pier Scour Depth (ft) | Service Limit State | Strength Limit State | Extreme Limit State |
| Bent 2 | 42 | 32.8 | 8.6 | 24.2 | 28.5 | 32.8 |
| Bent 3 | 36 | 10.6 | 17.4 | -6.8 | 1.9 | 10.6 |
| Bent 4 | 54 | 43.3 | 11.4 | 31.9 | 37.6 | 43.3 |
| Bent 5 | 53 | 49.0 | 9.9 | 39.1 | 44.1 | 49.0 |
| Bent 6 | 55 | 50.4 | 8.8 | 41.6 | 46.0 | 50.4 |
| Bent 7 | 55 | 48.8 | 9.6 | 39.2 | 44.0 | 48.8 |
| Bent 8 | 53 | 48.0 | 10.5 | 37.5 | 42.8 | 48.0 |
| Bent 9 | 52 | 49.9 | 10.1 | 39.8 | 44.9 | 49.9 |
| Bent 10 | 55 | 50.5 | 9.9 | 40.6 | 45.6 | 50.5 |

Notes:
1. Estimated from the given plans.

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These scour estimates were used in foundation analysis and design of the 5th Street Bridge. Pile cut-off elevations were determined by the structural engineers based on these scour depths, and they were used by EMI in geotechnical design. No scour is considered for the 2nd Street OC, where no river and channel is present.

## 5.5 Foundation Type

Due to the project site's seismicity, high vertical and lateral load demands are anticipated on the bridge foundations. Shallow foundations are not considered a suitable foundation type for the proposed bridge structure, primarily because of large loads, the presence of loose and fine-grained soil at relatively shallow depths, and liquefaction and seismic settlement potential. Therefore, deep foundations system is recommended. For the deep foundation alternatives, soil conditions indicate that Cast-In-Drilled-Hole (CIDH) piles, concrete Cast-In-Steel-Shell (CISS) piles, driven steel and driven precast concrete piles are all feasible alternatives for the proposed structure.

As discussed in the previous sections, soil liquefaction was one of the geotechnical issues that influenced the selection of the recommended foundation types. Large diameter piles generally perform far better than smaller diameter piles during liquefaction because lateral resistance of a pile foundation depends on its flexural stiffness EI (the pile moment of inertia I is proportional to $D^4$ where D is the pile diameter). It is therefore desirable to employ as large a diameter as practically possible to resist lateral loading on the pile. For large diameter shafts, site soils may present difficult driving conditions at depth for CISS piles. Besides, pile driving is generally not allowed in existing levees; therefore CIDH piles are the preferred pile alternative.

Based on these considerations, for the 5th Street Bridge, 118-inch diameter CIDH piles are recommended for pier foundations. A wet construction method is anticipated which generally requires gamma-gamma cross hole testing as a standard of practice to verify pile concrete integrity.

For the 5th Street Bridge abutments, CIDH piles or driven precast concrete piles were evaluated as potential alternatives. Since the abutment foundations will be within the footprint of the existing levees of the Feather River, pile driving is not permitted per USACE guidelines. Based on these considerations, 2-foot diameter CIDH piles are recommended for abutments.

For the 2nd Street OC, which is located completely in land and is not underlain by liquefiable soil layers, Caltrans standard Class 200 driven piles are recommended at two abutment locations.

## 5.6 Pile Design for the 5th Street Bridge

The Load and Resistance Factor Design (LRFD) method is used for both abutment and bent piles. The foundation design data sheet and foundation loads were provided by the structural designers following the latest Caltrans Memo to Designers 3-1 (Caltrans, 2008), and are shown in Table 8 and Table 9, respectively. As discussed in Section 5.4, scouring should be considered in pile design for the piers within the Feather River channel. The scour depth estimates were considered by structure engineers in determining the pile cut-off elevations, as shown in Table 7.

**Table 8. Foundation Design Data Sheet for the 5th Street Bridge**

| Location | Design Method | Pile Type | Finished Grade El. (ft) | Pile Cut-off El. (ft) | Pile Cap Size (ft) | | Permissible Settlement under Service Load (inch) | Number of Piles per Support |
|---|---|---|---|---|---|---|---|---|
| | | | | | B | L | | |
| Abutment 1 | LRFD | 24-in CIDH | 81-87 | 72.75 | 16 | 86.8 | 1 | 32 |
| Bent 2 | LRFD | 118-in CIDH | 38-50 | 13 | - | - | 1 | 3 |
| Bent 3 | LRFD | 118-in CIDH | 25* | 13 | - | - | 1 | 3 |
| Bent 4 | LRFD | 118-in CIDH | 55 | 13 | - | - | 1 | 3 |
| Bent 5 | LRFD | 118-in CIDH | 53 | 45 | - | - | 1 | 3 |
| Bent 6 | LRFD | 118-in CIDH | 55 | 45 | - | - | 1 | 3 |
| Bent 7 | LRFD | 118-in CIDH | 53 | 45 | - | - | 1 | 3 |
| Bent 8 | LRFD | 118-in CIDH | 52 | 45 | - | - | 1 | 3 |
| Bent 9 | LRFD | 118-in CIDH | 52 | 45 | - | - | 1 | 3 |
| Bent 10 | LRFD | 118-in CIDH | 55 | 41 | - | - | 1 | 3 |
| Abutment11 | LRFD | 24-in CIDH | 73-78 | 66.75 | 10.0 | 85.0 | 1 | 18 |

Note: * Estimated bottom of channel elevation.

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**Table 9. Foundation Design Loads for the 5th Street Bridge**

| Support No. | Service-I Limit State (kips) | | | Strength Limit State (Controlling Group, kips) | | | | Extreme Event Limit State (Controlling Group, kips) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Load | | Perm-anent Loads | Compression | | Tension | | Compression | | Tension | |
| | Per Support | Max. Per Pile | Per Support | Per Support | Max. Per Pile | Per Support | Max. Per Pile | Per Support | Max. Per Pile | Per Support | Max. Per Pile |
| Abutment 1 | 1217 | 183 | 629 | 6506 | 267 | 0 | 0 | - | - | 0 | 0 |
| Bent 2 | 7985 | 2927 | 7323 | 11113 | 4101 | 0 | 0 | 3,799 | 1,503 | 0 | 0 |
| Bent 3 | 8389 | 3079 | 7718 | 11581 | 4245 | 0 | 0 | 3,620 | 1,599 | 0 | 0 |
| Bent 4 | 9138 | 3287 | 8487 | 12587 | 4514 | 0 | 0 | 4,005 | 1,945 | 0 | 0 |
| Bent 5 | 7780 | 2939 | 7053 | 10800 | 4059 | 0 | 0 | 3,773 | 1,551 | 0 | 0 |
| Bent 6 | 7804 | 2983 | 7138 | 10592 | 3997 | 0 | 0 | 3,762 | 1,638 | 0 | 0 |
| Bent 7 | 8617 | 3167 | 7839 | 11735 | 4314 | 0 | 0 | 4,321 | 1,723 | 0 | 0 |
| Bent 8 | 7745 | 2924 | 7011 | 10773 | 4051 | 0 | 0 | 3,927 | 1,550 | 0 | 0 |
| Bent 9 | 7889 | 3019 | 7230 | 10617 | 4006 | 0 | 0 | 3,936 | 1,569 | 0 | 0 |
| Bent 10 | 7191 | 2760 | 6523 | 9942 | 3807 | 0 | 0 | 4,443 | 1,843 | 0 | 0 |
| Abutment 11 | 1066 | 237 | 636 | 4590 | 345 | 0 | 52 | - | - | 0 | 0 |

### 5.6.1 Downdrag Load Due to Liquefaction

According to Figures 5A through 5C, a 15 to 35 feet thick potentially liquefiable layer is present underneath the Bent 3 through Abutment 11. Wherever this layer is present, the downdrag loads from settlement of the liquefiable layer should be considered in determining design pile lengths.

According to EMI's analyses on existing CPTs (DE-CPT-02 to DE-CPT-06) (Section 5.2.4), seismically-induced settlements were estimated to be up to 7 inches in the region between proposed Bent 3 to 10, with a settlement zone up to a depth of 35 feet. A neutral axis analysis was performed to determine the downdrag loads on CIDH piles. A neutral axis for downdrag is an elevation along the pile, above which the soil applies negative skin friction on pile. Assuming a displacement of 0.1 to 0.5 inch is needed to mobilize friction between the soil and pile, the neutral axis for downdrag consideration for Bent 3 through Bent 10 was estimated to be at elevation of +30 feet.

For the Service Load Limit State with a permissible pile-head settlement of 1 inch, a downdrag load equal to two times the soil resistance above the neutral axis was added to the service load, according to the AASHTO (2010) procedure (Section 10.7.4).

For the Extreme Event Limit State, piles were designed for the liquefied condition, as a worse case scenario. For CIDH piles in the zones with liquefaction induced settlement potential (Bent 3 through Abutment 11), downdrag loading was considered. However, it should be noted that in absence of an allowable displacement criteria, liquefaction induced downdrag has no impact on

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ultimate axial resistance of the piles. In the event of liquefaction-induced settlement, the downdrag load will be added to the structural load demand. Should the new larger demand becomes close to or exceed the ultimate resistance; the pile will undergo a large settlement on order of several inches. This large settlement will in turn reduce the downdrag load, because if the pile displaces further than the surrounding soil at a certain depth, the skin friction will act as an upward resisting force, eliminating the downdrag load at that depth. This mechanism can be demonstrated using a displacement-based downdrag analysis. Based on this explanation, pile tip elevations for the Extreme Event Limit State under the liquefied soil conditions were determined by neglecting the soil resistance above the neutral axis. On the other hand, no downdrag considerations were taken into account for determining the pile tip elevations for the Strength Limit State. The design tip elevations were further verified by a displacement-based liquefaction-induced downdrag analysis, as described below.

The computer program BMCOL76 (Matlock and Bogard, 1977) was adopted to conduct this displacement-based downdrag analysis. A series of nonlinear skin friction (t-z) and tip resistance (q-u) springs, calculated by SHAFT computer program, were used in the BMCOL76 pile model. The liquefaction-induced settlement profile calculated from the CPTs in the liquefaction zone (DE-CPT-02 to DE-CPT-06) was applied as soil movement in the model. The BMCOL76 analyses results at two support locations are included in Appendix E. Given the design pile length controlled by the Strength Limit State, these results indicate that: 1) the downdrag phenomena disappears when the pile top settles more than 6 inches; and 2) at a pile top settlement of 6 inches, the axial resistance exceeds the load demand (nominal compression) defined by the Strength Limit State.

### 5.6.2 Pile Axial Capacity

The axial capacity of CIDH shafts were estimated using the computer program SHAFT (Ensoft, 2007) using FHWA method (O'Neill and Reese, 1999). Based on AASHTO LRFD BDS (2010) recommendations, a group efficiency factor of 1.0 was used in the calculations. For the strength limit state, per California Amendments to AASHTO LRFD Bridge Design Specifications – Fourth Edition (Caltrans, 2011), a resistance factor of 0.7 was applied to the ultimate resistance.

The calculated factored axial geotechnical capacities and pile tip elevations for CIDH piles are presented in Table 10. Pile Data Table for the bridge plans is provided in Table 11. Axial pile capacity calculations are provided in Appendix E.

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**Table 10. Foundation Design Recommendations (5th Street Bridge)**

| Location | Pile Type | Cut-off El. (ft) | Service-I Limit State Load (kips) per support | Total Permissible Support Settlement (inch) | Required Factored Nominal Resistance (kips) | | | | Design Tip El. (ft)[1] | Specified Tip El (ft)[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Strength Limit | | Extreme Event | | | |
| | | | | | Comp ($\varphi$= 0.7) | Tension ($\varphi$= 0.7) | Comp ($\varphi$= 1.0) | Tension ($\varphi$= 1.0) | | |
| Abut 1 | 24" CIDH | 73.75 | 183 | 1 | 268 | 0 | TBD | 0 | +24 (a-I)<br>+? (a-II)<br>+42 (c)<br>+29 (d) | +24 |
| Bent 2 | 118" CIDH | 18.0 | 7985 | 1 | 4101 | 0 | 1,503 | 0 | -102 (a-I)<br>+2 (a-II)<br>-39 (c)<br>-72 (d) | -102 |
| Bent 3 | 118" CIDH | 18.0 | 8389 | 1 | 4245 | 0 | 1,599 | 0 | -108 (a-I)<br>-15 (a-II)<br>-40 (c)<br>-72 (d) | -108 |
| Bent 4 | 118" CIDH | 18.0 | 9138 | 1 | 4514 | 0 | 1,945 | 0 | -116 (a-I)<br>-22 (a-II)<br>-42 (c)<br>-72 (d) | -116 |
| Bent 5 | 118" CIDH | 45.0 | 7780 | 1 | 4059 | 0 | 1,551 | 0 | -79 (a-I)<br>-1 (a-II)<br>-33 (c)<br>-45 (d) | -79 |
| Bent 6 | 118" CIDH | 45.0 | 7804 | 1 | 3997 | 0 | 1,638 | 0 | -68 (a-I)<br>+3 (a-II)<br>-28 (c)<br>-45 (d) | -68 |
| Bent 7 | 118" CIDH | 45.0 | 8617 | 1 | 4314 | 0 | 1,723 | 0 | -82 (a-I)<br>-5 (a-II)<br>-34 (c)<br>-45 (d) | -82 |
| Bent 8 | 118" CIDH | 45.0 | 7745 | 1 | 4051 | 0 | 1,550 | 0 | -78 (a-I)<br>+1 (a-II)<br>-23 (c)<br>-45 (d) | -78 |
| Bent 9 | 118" CIDH | 45.0 | 7889 | 1 | 4006 | 0 | 1,569 | 0 | -67 (a-I)<br>+8 (a-II)<br>-26 (c)<br>-45 (d) | -67 |

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| Location | Pile Type | Cut-off El. (ft) | Service-I Limit State Load (kips) per support | Total Permissible Support Settlement (inch) | Required Factored Nominal Resistance (kips) | | | | Design Tip El. (ft)[1] | Specified Tip El (ft)[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Strength Limit | | Extreme Event | | | |
| | | | | | Comp ($\varphi$ = 0.7) | Tension ($\varphi$ = 0.7) | Comp ($\varphi$ = 1.0) | Tension ($\varphi$ = 1.0) | | |
| Bent 10 | 118" CIDH | 45.0 | 7191 | 1 | 3807 | 0 | 1,843 | 0 | -57 (a-I)<br>+7 (a-II)<br>-16 (c)<br>-45 (d) | -57 |
| Abut 11 | 24" CIDH | 66.75 | 237 | 1 | 345 | 52 | TBD | 0 | -7 (a-I)<br>+? (a-II)<br>+22 (a-I)<br>+5 (c)<br>+22 (d) | -7 |

Notes:

1. Design tip elevations are controlled by: (a-I) Compression (Strength Limit), (b-I) Tension (Strength Limit), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement, (d) Lateral Load.
2. The specified tip elevation shall not be raised above the design tip elevations for tension, lateral load, and settlement.

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**Table 11. Pile Data Table for the 5th Street Bridge**

| Location | Pile Type | Nominal Resistance (kips) | | Design Tip El. (ft)[1] | Specified Tip El. (ft)[2] | Nominal Driving Resistance (kips) |
|---|---|---|---|---|---|---|
| | | Compression | Tension | | | |
| Abutment 1 | 24" CIDH | 385 | 0 | +24 (a)<br>+42 (c)<br>+29 (d) | +24 | N/A |
| Bent 2 | 118" CIDH | 5860 | 0 | -102 (a)<br>-39 (c)<br>-72 (d) | -102 | N/A |
| Bent 3 | 118" CIDH | 6065 | 0 | -108 (a)<br>-40 (c)<br>-72 (d) | -108 | N/A |
| Bent 4 | 118" CIDH | 6450 | 0 | -116 (a)<br>-42 (c)<br>-72 (d) | -116 | N/A |
| Bent 5 | 118" CIDH | 5800 | 0 | -79 (a)<br>-33 (c)<br>-45 (d) | -79 | N/A |
| Bent 6 | 118" CIDH | 5710 | 0 | -68 (a)<br>-28 (c)<br>-45 (d) | -68 | N/A |
| Bent 7 | 118" CIDH | 6165 | 0 | -82 (a)<br>-34 (c)<br>-45 (d) | -82 | N/A |
| Bent 8 | 118" CIDH | 5790 | 0 | -78 (a)<br>-23 (c)<br>-45 (d) | -78 | N/A |
| Bent 9 | 118" CIDH | 5725 | 0 | -67 (a)<br>-26 (c)<br>-45 (d) | -67 | N/A |
| Bent 10 | 118" CIDH | 5440 | 0 | -57 (a)<br>-16 (c)<br>-45 (d) | -57 | N/A |
| Abutment 11 | 24" CIDH | 385 | 0 | -7 (a)<br>+22 (b)<br>+5 (c)<br>+22 (d) | -7 | N/A |

Notes:

1. Design Tip Elevations are controlled by the following demands: (a) Compression, (b) Tension (c) Settlement, and (d) Lateral Loads.
2. The specified tip elevation shall not be raised above the design tip elevations for compression, settlement, or lateral load.

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## 5.7 Pile Design for the 2nd Street OC

Unlike the 5th Street Bridge, Caltrans standard Class 200 driven piles were selected for the 2nd Street Bridge abutments. Also per Caltrans policy, LRFD method is used for abutment piles. The foundation design data sheet and foundation loads were provided by the structural designers, following the latest Caltrans Memo to Designers 3-1 (Caltrans, 2014) format, and are shown in Table 12 and Table 13, respectively.

The axial capacity of Class 200 driven piles were estimated using the computer program APILE (Ensoft, 2007). Specifically, we used the Nordlund method outlined in the AASHTO LRFD Bridge Design Specifications (2007) to compute the geotechnical resistances in the predominantly cohesionless onsite soils. The pile capacity is based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials. Group efficiency is not a design issue for cohesionless soils as long as the on-center pile spacing is at least 2.5 times the maximum pile width per Section 10.7.3.9 of AASHTO LRFD Bridge Design Specifications (2007). Uplift resistance is taken to be two-third of the skin friction in compression.

The calculated factored axial geotechnical capacities and pile tip elevations for the Class 200 piles at the abutments are presented in Table 14. The Pile Data Table is provided in Table 15. The axial pile capacities are based on soil resistance only and may be further limited by the pile-head connection details. Because no potentially liquefiable layers exist at this subject bridge site, downdrag is not a design consideration.

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**Table 12. Foundation Design Data Sheet for the 2nd Street OC**

| Location | Design Method | Pile Type | Finished Grade El. (ft) | Pile Cut-off El. (ft) | Pile Cap Size (ft) | | Permissible Settlement under Service Load (inch) | Number of Piles per Support |
|---|---|---|---|---|---|---|---|---|
| | | | | | B | L | | |
| Abut 1 - Rt | LRFD | Class 200 | 70.0 | 65.5 | 9 | 58.5 | 2 | 21 |
| Abut 1 - Lt | LRFD | Class 200 | 64.0 | 62.0 | 11 | 69.5 | 2 | 26 |
| Abut 2 - Rt | LRFD | Class 200 | 75.0 | 69.25 | 14.5 | 74 | 2 | 28 |
| Abut 2 - Lt | LRFD | Class 200 | 64.0 | 59.25 | 8 | 33 | 2 | 19 |

**Table 13. Foundation Design Loads for the 2nd Street OC**

| Support No. | Service-I Limit State (kips) | | | Strength Limit State (Controlling Group, kips) | | | | Extreme Event Limit State (Controlling Group, kips) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Load | | Perm-anent Loads | Compression | | Tension | | Compression | | Tension | |
| | Per Support | Max. Per Pile | Per Support | Per Support | Max. Per Pile | Per Support | Max. Per Pile | Per Support | Max. Per Pile | Per Support | Max. Per Pile |
| Abut 1 - Rt | 1096 | TBD | 628 | 3705 | 263 | N/A | 62 | TBD | TBD | TBD | TBD |
| Abut 1 - Lt | 3149 | TBD | 2651 | 4650 | 276 | N/A | 66 | TBD | TBD | TBD | TBD |
| Abut 2 - Rt | 3500 | TBD | 2886 | 4972 | 266 | N/A | 78 | TBD | TBD | TBD | TBD |
| Abut 2 - Lt | 1654 | TBD | 1294 | 3302 | 280 | N/A | 78 | TBD | TBD | TBD | TBD |

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**Table 14. Foundation Design Recommendations for the 2nd Street OC**

| Location | Pile Type | Cut-off El. (ft) | Service-I Limit State Load (kips) per support | Total Permissible Support Settlement (inch) | Required Factored Nominal Resistance (kips) | | | | Design Tip El. (ft)[1] | Specified Tip El. (ft)[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Strength Limit | | Extreme Event | | | |
| | | | | | Comp ($\varphi$= 0.7) | Tension ($\varphi$= 0.7) | Comp ($\varphi$= 1.0) | Tension ($\varphi$= 1.0) | | |
| Abut 1 - Rt | Class 200 | 65.5 | 1096 | 2 | 263 | 62 | TBD | 0 | -6 (a-I)<br>+? (a-II)<br>+15 (b-I)<br>+? (c)<br>+30 (d) | -6 |
| Abut 1 - Lt | Class 200 | 62.0 | 3149 | 2 | 276 | 66 | TBD | 0 | -10 (a-I)<br>+? (a-II)<br>+15 (b-I)<br>+? (c)<br>+30 (d) | -10 |
| Abut 2 - Rt | Class 200 | 69.25 | 3500 | 2 | 266 | 78 | TBD | 0 | -7 (a-I)<br>+? (a-II)<br>+13 (b-I)<br>+?? (c)<br>+30 (d) | -7 |
| Abut 2 - Lt | Class 200 | 59.25 | 1654 | 2 | 280 | 78 | TBD | 0 | -11 (a-I)<br>+? (a-II)<br>+13 (b-I)<br>+? (c)<br>+29 (d) | -11 |

Notes:

1. Design tip elevations are controlled by: (a-I) Compression (Strength Limit), (b-I) Tension (Strength Limit), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement, (d) Lateral Load.
2. The specified tip elevation shall not be raised above the design tip elevations for cases (c) and (d).

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**Table 15. Pile Data Table for the 2nd Street OC**

| Location | Pile Type | Nominal Resistance (kips) | | Design Tip El. (ft)[1] | Specified Tip El. (ft)[2] | Nominal Driving Resistance (kips) |
|---|---|---|---|---|---|---|
| | | Compression | Tension | | | |
| Abut 1 – Rt. | Class 200 | 380 | 90 | -6 (a)<br>+15 (b)<br>+? (c)<br>+30 (d) | -6 | 380 |
| Abut 1 – Lt. | Class 200 | 395 | 95 | -10 (a)<br>+15 (b)<br>+? (c)<br>+30 (d) | -10 | 395 |
| Abut 2 – Rt. | Class 200 | 380 | 115 | -7 (a)<br>+1? (c)<br>+30 (d) | -7 | 380 |
| Abut 2 – Lt. | Class 200 | 400 | 115 | -11 (a)<br>+13 (b)<br>+? (c)<br>+29 (d) | -11 | 400 |

Notes:

1. Design Tip Elevations are controlled by the following demands: (a) Compression, (b) Tension (c) Settlement, and (d) Lateral Loads.
2. The specified tip elevation shall not be raised above the design tip elevations for compression, settlement, or lateral load.

## 5.8 Lateral Pile Capacity

Lateral resistance for CIDH piles was evaluated using the computer program LPILE 6.0 (Ensoft, 2010). LPile soil parameters for all supports are provided in Appendix C (Idealized Soil Profiles). The API Sand model (API 2000) was used to internally generated p-y curves for sandy soils. The Soft Clay (Matlock, 1970) model and the stiff clay without free water model (Reese, 1975) were used to internally generated p-y curves for soft and stiff fine-grained soils, respectively. Group efficiency factors (GEF) or p-multipliers for pile supported foundations were estimated using the procedure presented in the Group 7.0 Technical Manual (Ensoft, 2006).

### 5.8.1 Lateral Pile Solutions for 5th Street Bridge Piers

For pier foundations, lateral load solutions were used to estimate spring coefficients at pile cutoff elevation. These spring coefficients were provided to the structural designers to incorporate in the global bridge model. For Bent 3 through Bent 10 with a pile center-to-center spacing (SP) of 26 feet, GEFs of 0.86 and 0.72 were used in the longitudinal and transverse directions, respectively. For Bent 2 with a little larger SP (27.67 feet), GEFs of 0.88 and 0.74 were adopted in the longitudinal and transverse directions, respectively,

### 5.8.2 Lateral Pile Resistance for the 5th Street Bridge Abutments

For the CIDH piles at 5th Street Bridge abutments, GEFs of 0.75 (Abutment 1) and 0.85 (Abutment 11) were used in the LPILE models. For abutment piles, a 20-foot long permanent

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casing with an effective thickness (thickness after subtracting sacrificial thickness due to corrosion) of ½ inch was used to increase bending stiffness. Moreover, the abutment piles were assumed to have partial fixity to the pile cap. The concrete section was assumed to have rotational fixity, but the steel shell was assumed to be pinned at pile head. Lateral pile solutions for the 5th Street Bridge abutments are shown in Table 16.

**Table 16. Lateral Pile Solutions for Abutments 1 and 11 of the 5th Street Bridge**

| Support Location | CIDH Pile Diameter (inch) | Pile Head Deflection (inch) | Pile Head Shear (kips) | Maximum Moment (kip-in) | Depth to Maximum Moment from Pile Head (feet) |
|---|---|---|---|---|---|
| Abutment 1 (GEF =0.75) | 24 | ¼ | 16.4 | 1,312 | 0.00 |
| | | 0.4 | 26.1 | 2,094 | 0.00 |
| | | ½ | 32.5 | 2,613 | 0.00 |
| | | 1 | 62.6 | 5,145 | 0.00 |
| | | 2 | 112.6 | 9,833 | 0.00 |
| Abutment 11 (GEF =0.85) | 24 | ¼ | 48.9 | 2,456 | 0.00 |
| | | 0.4 | 69.9 | 3,736 | 0.00 |
| | | ½ | 81.1 | 4,501 | 0.00 |
| | | 1 | 120.7 | 7,763 | 0.00 |
| | | 2 | 170.8 | 12,857 | 0.00 |

### 5.8.3 Lateral Pile Resistance for the 2nd Street OC Abutments

For Class 200 driven piles at the 2nd Street OC abutments, GEFs of 0.85 (Abutment 1) and 0.87 (Abutment 2) were used in the LPILE models. Pile head connection for these abutments was assumed to be pinned to the pile cap. Lateral pile solutions for the 2nd Street OC abutments are shown in Table 17. According to the plans, the first row of piles in the font of each abutment will be battered into the ground. Additional lateral resistance will be provided by the horizontal components of the axial capacities of these battered piles.

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**Table 17. Lateral Pile Solutions for Abutments 1 and 2 of the 2nd Street Bridge**

| Support Location | Pile Type | Pile Head Deflection (inch) | Pile Head Shear (kips) | Maximum Moment (kip-in) | Depth to Maximum Moment from Pile Head (feet) |
|---|---|---|---|---|---|
| Abutment 1 (GEF = 0.85) | Class 200 | ¼ | 5.4 | 231 | 5.6 |
| | | ½ | 10.1 | 457 | 5.6 |
| | | 1 | 16.8 | 881 | 6.1 |
| | | 2 | 25.2 | 1,643 | 6.5 |
| Abutment 2 (GEF = 0.87) | Class 200 | ¼ | 5.5 | 234 | 5.6 |
| | | ½ | 10.2 | 461 | 5.6 |
| | | 1 | 17.1 | 890 | 5.85.41 |
| | | 2 | 25.6 | 1,657 | 6.510.1 |

## 5.9 Bridge Abutment Walls

### 5.9.1 Earth Pressures

Static Earth Pressure. If abutment walls are free to move laterally at the top, a static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. If lateral movement at the top of abutment walls is restrained, the lateral earth pressure for a free draining, level and compacted backfill should follow Section 5.5.5.11 of the Caltrans Bridge Design Specification (Caltrans, 2004). For this condition, we recommend a coefficient of active lateral earth pressure of 0.3, a coefficient of at-rest lateral earth pressure of 0.47 and a soil unit weight of 120 pcf.

A uniform lateral pressure due to traffic loading, equivalent to a vertical pressure produced by at least 2 feet of earth with a soil unit weight of 120 pcf, should be added to the above lateral earth pressure. Therefore for abutment walls that are free to move laterally at the top, the recommended uniform lateral earth pressure is 72 psf; for abutment walls where lateral movement at the top of the abutment walls is restrained, the recommended uniform lateral earth pressure is 113 psf.

Seismic Earth Pressure. The seismic lateral active earth pressure was estimated using the Mononobe-Okabe analysis with a seismic coefficient of 0.12 g, which is one-half of the PGA of about 0.24 g, as recommended by AASHTO (2007). For walls that are free to rotate, the seismic increment should be modeled as a triangle with an equivalent fluid pressure of 9 pcf. This seismic increment should be added to the static earth pressure. The resultant of the seismic lateral pressure increment should be applied at 0.33H above the bottom of the footing.

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### 5.9.2 Passive Resistance

Under seismic loading, an ultimate passive earth pressure of 5 ksf may be used for the approach backfill and abutment walls with an effective height equal to or greater than 5.5 feet. For abutment walls with effective heights less than 5.5 feet, the maximum passive pressure shall be reduced proportional to the wall height (e.g., for a 4 feet high wall, the maximum passive pressure is [4/5.5]x5ksf = 3.6 ksf). The horizontal movement at which the maximum passive pressure is expected to be fully mobilized can be determined following the procedure outlined in Section 7.8.1 of the Caltrans SDC (2013b).

## 5.10 Approach Embankments

To elevate the road grades to the proposed finished grade at the bridge approaches, about 3 and 6 feet of additional embankment fill will be placed at two abutments of the 5$^{th}$ Street Bridge and the 2$^{nd}$ Street OC, respectively. The approach embankments for both bridges will be retained by Caltrans Standard Type 1 retaining walls.

### 5.10.1 Bridge Abutment Slope Stability

The "global" stability of the proposed slopes at the bridge abutments were evaluated for both static and pseudo-static conditions using the computer program Slide 7.0 (Rocscience, 2016). The idealized soil profiles below each abutment of 5$^{th}$ Street Bridge and that of 2$^{nd}$ Street OC, as shown in Appendix C, were used in the slope stability model. The material used for the proposed embankment fill was modeled with a friction angle of 32 degrees and minimum cohesion of 100 psf. For liquefied soils, a normalized residual strength ratio of 0.28 was used.

Slope stability analyses for the static condition were conducted using a 240 psf (equivalent of 2-feet soil surcharge) to represent traffic loading, with the design water table at El. +80 feet. In accordance with Caltrans guidelines (Caltrans, 2009), stability analysis for the seismic condition was performed using the pseudo-static approach with a seismic coefficient of 0.08 g; Caltrans guidelines require a seismic coefficient equal to one-third the peak horizontal acceleration but not exceeding 0.2.

According to the results of the analyses, the slopes meet the minimum required factor-of-safety for deep-seated failure of 1.5 for the static condition and 1.1 for the seismic condition per Caltrans guidelines (Caltrans, 2009). A summary of the slope stability results is presented in Table 18. Appendix E provides graphical results of the slope stability analyses.

The yield coefficient of the critical failure planes going through Abutment 11 approach embankment was evaluated to be about 0.13 g.

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**Table 18. Factor of Safety for Slope Stability**

| Location | Static | | Pseudostatic | |
|---|---|---|---|---|
| | Circular Failure | Block Failure | Circular Failure | Block Failure |
| 5th Street Bridge, Abutment 1 | 1.772 | N/A | 1.475 | N/A |
| 5th Street Bridge, Abutment 11 | 2.025 | 1.97 | 1.171 | 1.163 |
| 2nd Street OC, Abutment 1 | 2.17 | N/A | 1.68 | N/A |
| 2nd Street OC, Abutment 2 | 1.58 | N/A | 1.15 | N/A |

Other forms of external stability such as sliding and overturning of the retaining walls and abutments shall be evaluated by the bridge designers.

For embankment slopes with a gradient of 2:1 (H:V) or flatter, surficial stability should not be a design concern. For steeper embankment slopes up to a gradient of 1.5:1 (H:V), slope paving shall be provided to prevent surficial instability and erosion. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (2015) is recommended.

## 5.11 Abutment Wingwalls

Due to the anticipated fill heights at the abutments, typical wingwalls cantilevered off the abutment backwall are not feasible. Caltrans Standard Type 1 retaining walls are required on both sides of the approach embankments at abutments of the 5th Street Bridge and the 2nd Street OC to retain the proposed embankment fill. For the 5th Street Bridge, retaining walls are about 26 and 140 feet in total length at Abutment 1 and Abutment 11, respectively, and vary from 2 to 15 feet in design height. For the 2nd Street OC, retaining walls are about 38 and 80 feet in total length at Abutment 1 and Abutment 2, respectively, and vary from 5 to 36 feet in height.

### 5.11.1 Earth Pressures

An active earth pressure coefficient of 0.3 and a soil unit weight of 120 lb/ft$^3$ are recommended for a level backfill. For cantilever retaining walls, a static active lateral earth pressure of 36 psf per feet of depth is recommended for a level backfill. A traffic surcharge equivalent to a vertical pressure produced by at least 2 feet of earth should be added to the above lateral earth pressure values. Other design requirements are specified in Section 3.20 of the Caltrans Bridge Design Specifications (Caltrans, 2000).

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### 5.11.2 Foundation Recommendations

The retaining wall footings will be embedded in import fill material placed as part of the project improvements. At Abutment 11 of 5th Street Bridge where medium dense sandy and stiff clayey materials appear in top 30 feet and liquefiable layers at elevations from +50 to +35 feet, compacted structure backfill overlying native soils are suitable for support of Caltrans Standard Type 1 retaining walls on spread footings up to a design height of 5 feet. At Abutment 1 of the 2nd Street OC, due to the presence of compressible near surface material, compacted structure backfill overlying native soils are suitable for support of Caltrans Standard Type 1 retaining walls on spread footings up to a design height of 10 feet.

Spread Footings. Fill placement should be performed in accordance with Section 19 of the Caltrans Standard Specifications (2015). In addition, the upper 4 feet of fill placed below the footing bottom should be required to meet the Caltrans Standard Specification (2015) requirements for structure backfill. The limits of the select fill material should extend laterally from two feet beyond the edges of the footing out and down at an inclination of 1:1 (H:V) to natural grade. The select fill material should be compacted to at least 95% relative compaction determined using CT 216.

Assuming the above earthwork is performed, the estimated net allowable and gross allowable uniform bearing stress of the compacted fill will exceed the demands for Caltrans Standard Type 1 retaining walls as shown on the Caltrans Standard Plans (2010b) for retaining walls up to 10 feet in design height. The estimated settlement of proposed retaining wall footings is estimated to be less than 1 in for the service limit state. The gross allowable uniform bearing stress is based on a resistance factor of 0.45 per AASHTO LRFD Bridge Design Specifications.

Pile Foundations. Due to the limited bearing capacity of native soils, deep foundations consisting of Caltrans Standard Class 200 driven piles will be required for Caltrans Standard Type 1 retaining walls greater than 10 feet in design height at Abutment 2 of the 2nd Street OC. 24" CIDH piles are recommended for the abutments of the 5th Street Bridge, where driven piles are not allowed in the existing levees. Table 19 shows the design data for wingwall piles.

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**Table 19. Abutment Wingwall Pile Design Data Sheet**

| Location | Wall Design Height (ft) | Pile Type | Footing Bottom Elevation (ft) | Pile Cap Size (ft) | | No. of Piles | Max. Load per Pile (kip) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | B | L | | Service | Strength | Extreme I | Extreme II |
| 5th Street Bridge, Abut 1S | TBD | 24" CIDH | 79.0 | TBD | TBD | 2 | TBD | TBD | TBD | TBD |
| | TBD | | 83.0 | TBD | TBD | 5 | TBD | TBD | TBD | TBD |
| 5th Street Bridge, Abut 11N | TBD | | 74.0 | TBD | TBD | 4 | TBD | TBD | TBD | TBD |
| | TBD | | 76.5 | TBD | TBD | 3 | TBD | TBD | TBD | TBD |
| 5th Street Bridge, Abut 11S | TBD | | 70.0 | TBD | TBD | 3 | TBD | TBD | TBD | TBD |
| | TBD | | 72.0 | TBD | TBD | 3 | TBD | TBD | TBD | TBD |
| | TBD | | 74.0 | TBD | TBD | 3 | TBD | TBD | TBD | TBD |
| | TBD | | 76.0 | TBD | TBD | 3 | TBD | TBD | TBD | TBD |
| 2nd Street OC, Abut 2N | TBD | Class 200 | 63.58 | TBD | TBD | 4 | TBD | TBD | TBD | TBD |
| | TBD | | 67.25 | TBD | TBD | 4 | TBD | TBD | TBD | TBD |
| | TBD | | 70.83 | TBD | TBD | 3 | TBD | TBD | TBD | TBD |

Axial Pile Capacity. The calculated axial capacities and pile tip elevations for a single driven Class 200 pile and a single 24" CIDH piles were evaluated using computer programs APILE (Ensoft, 2007) and SHAFT (Ensoft, 2007), respectively. The results are summarized in Table 20. Uplift resistance is taken to be two-third of the skin friction in compression. Pile group effects can be neglected if the on-center spacing is equal to or greater than 3 times the pile width.

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**Table 20. Pile Data Table – Abutment Retaining Walls**

| Location (Wall Height) | Pile Type | Nominal Resistance (kips) | | Design Tip El. (ft)[1] | Specified Tip El. (ft) | Nominal Driving Resistance (kips) |
|---|---|---|---|---|---|---|
| | | Compression | Tension | | | |
| 5th Street Bridge, Abut 1S (H = ?ft) | 24" CIDH | 200 | 0 | +35 (a)<br>+? (c)<br>+40 (d) | +35 | N/A |
| 5th Street Bridge, Abut 1S (H = ?ft) | 24" CIDH | 200 | 0 | +35 (a)<br>+? (c)<br>+40 (d) | +35 | N/A |
| 5th Street Bridge, Abut 11N (H = ?ft) | 24" CIDH | 200 | 0 | +10 (a)<br>+? (c)<br>+35 (d) | +10 | N/A |
| 5th Street Bridge, Abut 11N (H = ?ft) | 24" CIDH | 200 | 0 | +10 (a)<br>+? (c)<br>+37 (d) | +10 | N/A |
| 5th Street Bridge, Abut 11S (H = ?ft) | 24" CIDH | 200 | 0 | +10 (a)<br>+? (c)<br>+33 (d) | +10 | N/A |
| 5th Street Bridge, Abut 11S (H = ?ft) | 24" CIDH | 200 | 0 | +10 (a)<br>+? (c)<br>+35 (d) | +10 | N/A |
| 5th Street Bridge, Abut 11S (H = ?ft) | 24" CIDH | 200 | 0 | +10 (a)<br>+? (c)<br>+35 (d) | +10 | N/A |
| 5th Street Bridge, Abut 11S (H = ?ft) | 24" CIDH | 200 | 0 | +10 (a)<br>+? (c)<br>+37 (d) | +10 | N/A |
| 2nd Street OC, Abut 2N (H = ? ft) | Class 200 | 200 | 0 | +4 (a)<br>+? (c)<br>+32 (d) | +4 | 200 |
| 2nd Street OC, Abut 2N (H = ? ft) | Class 200 | 200 | 0 | +4<br>(a)<br>+? (c)<br>+35 (d) | +4 | 200 |
| 2nd Street OC, Abut 2N (H = ? ft) | Class 200 | 200 | 0 | +4 (a)<br>+? (c)<br>+38 (d) | +4 | 200 |

Notes:

1. Design Tip Elevations are controlled by the following demands: (a) Compression, (b) Tension (c) Settlement, and (d) Lateral Loads.
2. The specified tip elevation shall not be raised above the design tip elevations for compression, settlement, or lateral load.

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Lateral Pile Capacity: Lateral pile analyses for a single pile were performed for a free-head condition using the computer program LPILE6.0 (Ensoft, 2010). The resulting pile-head shear and maximum moment for a range of pile-head lateral deflections are shown in Table 21. The solutions presented in Table 19 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and other connection details. Linear interpolation can be used for solutions between pile-head deflections of 0.25 and 2 inches.

Non-linear soil resistance versus lateral pile movement curves were generated internally by LPILE according to the methods proposed by: API (2000) for sand; Reese et al. (1975) for stiff fine-grained soils; and Matlock (1970) for soft fine-grained soils.

The on-center spacing between two adjacent piles perpendicular to the face of the wall is at least 3 pile diameters. Based upon the recommendations for pile group reduction factors (P-Multipliers) for piles with a minimum 3 diameter on-center pile spacing provided in California Amendments to AASHTO LRFD Bridge Design Specifications – Fourth Edition (2011), a P-Multiplier of 0.60 was included in the analysis to account for group effects.

**Table 21. Lateral Pile Solutions – Abutment Wingwall Piles**

| Support Location | Pile Type | Pile Head Deflection (in) | Pile Head Shear (kip) | Max Moment (kip-in) | Depth to Maximum Moment from Pile Top (ft) |
|---|---|---|---|---|---|
| 5th Street Bridge, Abut 1S | 24” CIDH | ¼ | TBD | TBD | TBD |
| | | ½ | TBD | TBD | TBD |
| | | 1 | TBD | TBD | TBD |
| | | 2 | TBD | TBD | TBD |
| 5th Street Bridge, Abut 11N,S | 24” CIDH | ¼ | TBD | TBD | TBD |
| | | ½ | TBD | TBD | TBD |
| | | 1 | TBD | TBD | TBD |
| | | 2 | TBD | TBD | TBD |
| 2nd Street OC, Abut 2N | Class 200 | ¼ | TBD | TBD | TBD |
| | | ½ | TBD | TBD | TBD |
| | | 1 | TBD | TBD | TBD |
| | | 2 | TBD | TBD | TBD |

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# 6.0 CONSTRUCTION CONSIDERATIONS

All work should be performed in accordance with the Caltrans Standard Specifications (2015) except as indicated in the Special Provisions prepared for the project improvements.

## 6.1 Earthwork

### 6.1.1 General

Earthwork should be performed in accordance with Section 19 of the Caltrans Standard Specifications (2015). Appropriate measures should be taken to prevent damage to adjacent existing structures and utilities. Design and construction of temporary slopes or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational safety and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If an excavation shoring design is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

Heavy construction equipment should not be used immediately adjacent to shoring due to large lateral pressures induced by such equipment unless the shoring is designed to accommodate resulting pressures. Excavated soils or construction materials should not be stockpiled adjacent to shoring or open excavations. Stockpiled soil and construction materials should be set back a distance at least equal to the height of the excavation.

In fill areas, complete removal of compressible surficial materials including topsoil, loose or soft alluvium, and unsuitable fill is required prior to fill placement. The top 8 inches of material within all areas to receive compacted fill should be scarified and re-compacted to 90% relative compaction; the scarification should extend horizontally a minimum distance of 2 feet from edges of new fills or structures. The scarification should be performed beneath all new embankments. Fill placed on sloping ground should be properly keyed and benched into existing ground and placed as specified in Section 19-6 of the Caltrans Standard Specifications (2015). A fill key should be placed at the toe of fill slope. The key should be excavated 2 feet below existing grade. The bottom of the fill key should be firm and unyielding prior to placing compacted fill.

### 6.1.1 Material for Fill

On-site Soils: In general, the on-site soils are not corrosive and they can potentially be re-used as compacted fill for backfill. Due to their variable moisture content, moisture conditioning will be necessary to achieve the required degree of compaction.

The following is a summary of the gradation, sand equivalency, plasticity index and peak friction angle of the onsite soils as sampled.

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**Table 22. On-Site Borrow Source Analysis**

| Boring No. | Depth (ft) | Soil Type | Gradation (% Passing) | | | | | | | | | Sand Equi. | Plast. Index | Peak Angle ϕ' (°) | Maxi. Dry Density (pcf) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6" | 4" | 3" | 2" | ¾" | #4 | #30 | #50 | #200 | | | | |
| R-13-001 | 0-5 | SM | 100 | 100 | 100 | 100 | 100 | 97 | 85 | 67 | 31 | - | NP | 33 | 100 |
| R-13-011 | 0-5 | CL | 100 | 100 | 100 | 100 | 100 | 97 | 90 | 83 | 60 | - | 11 | 29 | 112 |
| HA-13-014 | 0-5 | CL | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 91 | 68 | 15 | - | 33 | 125 |

Recently the structural engineer inquired whether the top portion of the exiting levee can be incorporated in construction of the new abutments of the 5th Street Bridge. It should be noted that loose / caving soils were encountered during drilling of the top 30 feet of the Boring R-13-01 in vicinity of the Abutment 1. In addition, according to compaction test results the maximum dry density of the levee material, as shown in Table 20, is low. Therefore, suitability of this material should be verified through compaction tests during construction.

Earthwork factors in general earthwork application consist of the shrinkage factor and the bulkage factor. The shrinkage factor measures the reduction in volume of soil from its in-situ condition in the borrow source to its final compacted stage. The bulkage factor measures the increase in volume of soil from its in-situ condition in the borrow source to a loose state in transportation. Theoretically, these factors can be calculated based on laboratory testing results. However, in practice, the volumetric changes of on-site materials in different stages of grading vary drastically with unaccountable factors such as losses in hauling, imprecision in grading and variations in compaction effort, etc. All these factors can lead to the need of import or export on a planned balanced earthwork project.

Although accurate grading factors cannot be determined, the volume change of near-surface soils (upper 5 feet) after compaction is estimated to be on the order of +5% to -5% for determining preliminary earthwork quantities. Excavated materials may be assumed to bulk 3 to 10% for hauling purposes.

Imported Fill: Each proposed borrow source should be sampled (at least 50 pounds), tested and accepted for use prior to delivery of the soils to the site. Contractor should allow a minimum of 3 working days for required geotechnical laboratory testing. Soils imported prior to acceptance may be rejected if they are not suitable.

Slurry Cement Backfill: In areas where mechanical compaction of soil is impractical due to space constraints, slurry cement backfill using a two-sack mix meeting requirements of Caltrans Standard Specifications 19-3.03F (2015) typically may be substituted for compacted backfill.

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### 6.1.2 Cuts and Excavations

Temporary cuts may be required in areas where drainage improvements and footings are proposed. Temporary excavations, including temporary shoring, necessary to construct the bridge abutments or other structures will need to be designed by the contractor for local and global stability, once the means and methods of construction are determined.

### 6.1.3 Groundwater Control

Groundwater was encountered in Boring B-1 (2007) at elevation of +41 feet, and the design groundwater elevation is +50 feet. Therefore, groundwater is expected to be encountered within pertinent depths of construction. Should groundwater be encountered during footing construction, it should be controlled in accordance with Section 19-3.03B of the Caltrans Standard Specifications (2015). Any seepage or groundwater removed from an excavation should be tested and disposed of in compliance with all applicable local, state and federal requirements.

Free water should not be allowed to stand in any excavations. If excavations become flooded, at least the bottom 6 inches of soil should be removed and replaced or re-compacted to 95% relative compaction. Additional removals may be required at the discretion of the project Engineer.

## 6.2 CIDH Pile Construction

1. The CIDH piles should be constructed in accordance with Section 49-3 of the Caltrans Standard Specification (2015).

2. For on-center pile spacing less than three times the pile diameter, no two adjacent piles can be constructed concurrently. No borings or excavations should be drilled immediately adjacent to another pile until the concrete in the other pile has attained a minimum compressive strength of 1,800 psi.

3. Pile boreholes should be inspected and approved by the geotechnical engineer prior to the installation of reinforcement. Extreme care in drilling, placement of steel, and the pouring of concrete is essential to avoid excessive disturbance of pile boring walls.

4. Loose soils should be cleaned from the bottom of the borings using a cleanout bucket. Concrete placement by pumping or tremie tube to the bottom of the pile borings is recommended. Specifications should require that sufficient space be provided in the pile reinforcing cage during fabrication to allow the insertion of a tremie tube for concrete placement. The pile reinforcing cage should be installed and the concrete pumped immediately after drilling is completed.

5. During the current site investigation, groundwater was encountered in soil borings between elevations +31.0 and +53.4 feet. Based on these elevations it is expected that the groundwater will be encountered during pile construction. Actual groundwater elevation may be different during construction due to seasonal rainfall, surface runoff and other man-made conditions.

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6. Sandy soils susceptible to caving were encountered in our soil borings and these materials are expected to be within pertinent depths of construction of the CIDH piles. To prevent caving from occurring, a wet construction method or an oscillator/rotator method with a full length temporary casing can be used.

7. As a minimum Caltrans requirement, Gamma-Gamma testing should be performed to detect anomaly in concrete for CIDH piles installed below water. Equally spaced 2-inch diameter (Schedule 40) PVC access tubes should be pre-installed in CIDH piles to facilitate Gamma-Gamma logging. Since Gamma-Gamma logging tests anomalies generally around the PVC tubes, Cross-hole Sonic Logging (CSL) can be performed as a complementary test for anomaly between tubes so that if any anomaly is found, its limits can be more precisely determined.

8. For wet pile construction, the contractor should be required to maintain a minimum 10 ft head of slurry over the piezometric surface at all times during CIDH pile construction. The minimum 10 ft head of slurry should be required during shaft excavation to help avoid a "quick" condition at the bottom of the CIDH pile excavation. Water should not be allowed as slurry, even if fulllength casing is used during shaft excavation. For the construction joint at the bottom of the column reinforcement for Type I or Type II shafts, the minimum 10 ft slurry head over the piezometric surface should be required to be maintained until the concrete has reached its initial set.

9. If caving occurs, a temporary casing maybe required during construction. Casings should have an outer diameter equal to or exceeding the pile diameter. Temporary casing should be pulled as the concrete is being poured while always maintaining at least a 5 ft head of concrete inside the casing. Contractor can choose to use a "wet" method of construction to control caving. Driven or vibrated temporary casing must be removed unless approved by the Engineer. Any impacts from driving or vibrating casing must be evaluated by the contractor, and the contractor is responsible for proving to the owner that any potential damage due to driving or vibrating casing has been mitigated.

10. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with a low-strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

### 6.3 Driven Pile Construction

1. Piles should be driven at least to the specified tip elevation and the bearing value should be checked with the pile-driving formula given in Section 49-2.01A(4)(c) of the Caltrans Standard Specifications (2015) using the nominal driving resistance). However, if the specified tip elevation is reached without achieving the design load, pile driving should continue until bearing is attained. In this case, it may be prudent to allow the pile to "set up" before continuing the driving.

2. The selected pile-driving hammer such as diesel-type hammers should be able to deliver sufficient energy to drive the piles at a penetration rate of not less than 1/8 inch per blow at

the required bearing value. Vibratory hammers and undersized predrilling below the embankment fill are not allowed for pile installation.

3. Drivability of piles was considered for the bridge site. Based on the available soil boring data, hard driving may be encountered beginning at El. +30 feet.

### 6.4 Backdrain and Backfill Requirements for Abutment Walls

Caltrans Structure Backfill should be used as backfill material behind the bridge abutment walls as shown in Figure 12. Backfill should be compacted in accordance with Section 19-5 of the Caltrans Standard Specifications (2015). Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. The relative compaction should be based on the maximum density determined by California Test Method 216. Jetting or flooding to compact backfill is not recommended. Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the abutment walls in order to avoid damaging the walls due to large lateral earth pressures.

Backdrains should be installed behind abutment walls to relieve hydrostatic pressure. Backdrains should be constructed in accordance with Bridge Detail 3-1 on Sheet B0-3 per Caltrans Standard Plans (2010b) or the geocomposite drain alternative per Section 6 of the Caltrans Bridge Design Details (1992).

### 6.5 Review of Construction Plans

Recommendations contained herein are based on current design information. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations presented in this report may require modification or additional recommendations may be necessary based on the final design.

### 6.6 Geotechnical Observation and Testing

It is recommended that inspections and testing be performed by qualified geotechnical personnel during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill,
- Shoring installation, if necessary,
- Pile construction,
- Backdrain installation and backfilling of bridge abutment walls and retaining walls,
- Removal or installation of support of buried utilities or structures, and
- When any unusual subsurface conditions are encountered.

### 6.7 Differing Site Conditions

The analyses and recommendations contained in this report are based on the data obtained from the review of available geologic references, our site reconnaissance, soil borings, and laboratory

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testing. The soil boring logs indicate subsurface conditions only at specific locations and times drilled, and only to the depths penetrated. Boring logs do not necessarily reflect subsurface variations that may exist between such locations. If variations in subsurface conditions from those described in this report are noted during construction, the recommendations presented in this report must be re-evaluated. In the event that any changes in the nature, design, or location of the proposed facilities occur, the conclusions and recommendations in this report should not be considered valid unless the changes are reviewed and conclusions of this report are verified in writing by the designer. Therefore, upon encountering any site conditions that are perceived to differ materially from those conditions anticipated in this report, the resident engineer should contact the geotechnical designer immediately.

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## 7.0 REFERENCES


Abrahamson, N.A., 1998, RSPMATCH v2.2, A Computer Program to Generate Spectrum-matched Time Histories.

American Association of State Highway and Transportation Officials (AASHTO), 2010, AASHTO LRFD Bridge Design Specification, 5th Edition.Washington, DC: AASHTO.

American Petroleum Institute (2000), API Recommended Practice and Planning, Designing, and Constructing Fixed Offshore Platforms – Working Stress Design (RP 2A-WSD), Washington, D.C.

American Society for Testing and Materials (ASTM), 2010, Annual Book of Standards. Soil and Rock; Vol. 04.08.

California Department of Transportation (Caltrans), California Test Methods, various dates.

——, 2015, Standard Specifications.

——, 2013a, ARS Online Web tool V2.3.06, http://dap3.dot.ca.gov/ARS_Online/

——, 2013b, Seismic Design Criteria, Version 1.7, April.

——, 2012, Corrosion Guidelines, Version 2.0; Office of Materials Engineering and Testing Services, Corrosion and Structural Concrete Field Investigation Branch, November.

——, 2011, California Amendments to AASHTO LRFD Bridge Design Specifications - Fourth Edition, November.

——, 2010a, Soil and Rock Logging, Classification, and Presentation Manual, 2010 Edition.

——, 2010b, Standard Plans.

——, 2009, Foundation Report Preparation for Bridges, December.

——, 2008, Memo To Designers 3-1, July.

——, 2004, Bridge Design Specifications, August.

——, 2003, Bridge Design Specifications, November.

——, 2000, Bridge Design Specifications, July.

——, 1992, Bridge Design Details, Section 6, November.

Campbell, K., and Bozorgnia, Y., 2008, NGA ground motion models for the geometric mean horizontal component of PGA, PGV, PGD, and 5% damped linear elastic response spectra for periods ranging from 0.01 to 10 s.; Earthquake Spectra, Vol. 24, pp. 139-172.


DRAFT

Chiou, B., and Youngs, R., 2008, An NGA model for the average horizontal component of peak ground motion and response spectra: Earthquake Spectra, Vol. 24, pp. 173-216.

California Geological Survey, 2007, Hart, E.W. and Bryant, W.A., (1997 interim revision 2007) "Fault-Rupture Hazard Zones in California", Alquist-Priolo Earthquake Fault Zoning Act, Special Publication 42.

Dokken Engineering, 2013, Bridge Type Selection Report for 5th Street Bridge over Feather River and 2nd StreetOvercrossing, May 3.

Earth Mechanics, Inc. (EMI), 1999, KIPS Program: Kinematic Interaction for Pile and Soil.

Ensoft, 2010,Computer Program LPILE6.0, A Program for the Analysis of Piles and Drilled Shafts Under Lateral Loads.

Ensoft, 2007, Computer Program APILE Plus 5.0, A Program for the Analysis of the Axial Capacity of Driven Piles.

Ensoft, 2007, Computer Program SHAFT 6.0, A Program for the Study of Drilled Shafts Under Axial Loads.

Ensoft, 2006, Computer Program GROUP 7.0 Technical Manual.

GeoLogismiki Software, 2015, CLiq v.1.7 - CPT Liquefaction Assessment Software, http://geologismiki.gr/products/cliq/.

Gregg Drilling & Testing, Inc., 2011, Full Report on CPT Investigation on 5th Street Bridge, June, 3.

Helley, E.J and Harwood, D.S., 1985, Geologic Map of the Late Cenozoic Deposits of the Sacramento Valley and northern Sierra Foothills, California, USGS: Miscellaneous Field Studies Map MF-1790.

Idriss, I.M., and Sun, J.I., 1992, User's Manual for SHAKE91, University of California, Davis, November.

Lam, I.P and Law, H., 2000, Soil Structure Interaction of Bridges for Seismic Analysis, Technical Report MCEER-00-0008, September.

Matlock, H. and Bogard, D., 1977, Guide for Data Input for BMCOL 76 with Supplementary Notes. Dept. of Civil Engineering, The Univ. of Texas, Austin Texas, May 20.

Matlock, H., 1970, "Correlations for Design of Laterally Loaded Piles in Soft Clay," Proceedings, Offshore Techniolgy Conference, Houston, Texas, Vol. I, Paper No. 1204, pp. 577-594.

Marks, S., and Lindh, A., 1977, Regional Seismicity of the Sierran foothills in the vicinity of Oroville, California, in press.

DRAFT

Merriam, M., 2012, Caltrans Fault Database (V2b) for ARS Online, California Department of Transportation, Sacramento, CA.

Rocscience, 2016, SLIDE 7.0 – 2D Limit Equilibrium Slope Stability Program, Toronto, Canada.

Saucedo, G. J. and Wagner, D. L., 1992, Regional Geologic Map of the Chico Quadrangle, California, California Geological Survey, Regional Geologic Map No. 7A, 1:250,000 scale.

Taber Consultants, 2008, Preliminary Geotechnical Report for 5th Street Bridge Seismic Vulnerability Evaluation and Rehabilitation/Replacement Strategy, February 29.

Tokimatsu, A.M., and Seed, H.B., 1987, Evaluation of Settlements in Sands Due to Earthquake Shaking, ASCE Journal of Geotechnical Engineering, Vol. 113, No. 8, August.

U.S. Geological Survey, 2008, Probabilistic Seismic Hazard Analysis, https://geohazards.usgs.gov/deaggint/2008/

Vucetic, M., and Dobry, R (1991), "Effect of Soil Plasticity on Cyclic Response," J. Geotechnical Engineering, ASCE, 117 (1): 89-107.

Wreco, 2016, Hydraulic Report for the 5th Street Bridge over Feather River.

Winterkorn, H.F. and Fang, H.Y., 1975, Foundation Design Handbook, Van Nostrand Reinhold Company, New York, NY.

Wreco, 2012, Location Hydraulic Study Report, November.

Youd, T. L., Idriss, I. M., Andrus, R. D., Arango, I., Castro, G., Christia, J. T., Dobry, R., Finn, W. D. L., Harder, L. F., Jr., Hynes, M. E., Ishihara, K., Koester, J. P., Liao, S. S. C., Marcuson, W. F., III., Martin, G. R., Mitchell, J. K., Moriwaki, Y., Power, M. S., Robertson, P. K., Seed, R. B., and Stokoe, K. H., II., 2001, "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils," Journal of Geotechnical and Geoenvironmental Engineering, ASCE, 127(10): 817-833.

Winterkorn, H.F. and Fang, H.Y., 1975, Foundation Design Handbook, Van Nostrand Reinhold Company, New York, NY.

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# APPENDIX A

# LOG-OF-TEST-BORINGS AND CPT SOUNDINGS

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BENCHMARK

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) For Soil Legend, see Caltrans Standard Plan A10F and A10G.

| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | ==== | ==== |

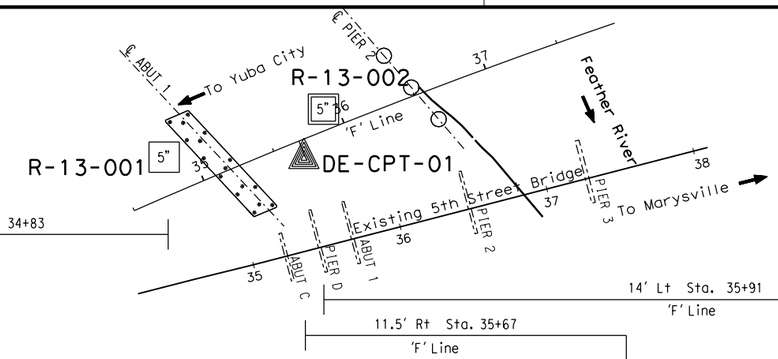
Amir G Zand — REGISTERED ENGINEER — DATE XX-XX

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

*The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.*

EARTH MECHANICS, INC.
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545




N

**PLAN**
1" = 50'

25' Lt Sta. 34+83 'F' Line

11.5' Rt Sta. 35+67 'F' Line

14' Lt Sta. 35+91 'F' Line

## R-13-001

EL. +85.0'

| Blows | Recovery | Sample | Description |
|---|---|---|---|
| | | | ASPHALT 3" thick. |
| 26 | 2.4 | M UW | CLAYEY SAND (SC); brown; moist; fine SAND; nonplastic fines. Medium dense; few GRAVEL, max.½in. dia.; mostly medium to fine SAND; some low plasticity fines. |
| 4 | 1.4 | M PA | CLAYEY SAND with GRAVEL (SC); very loose; moist; 16% GRAVEL, max.½in. dia.; 44% medium to fine SAND; 40% low plasticity fines; Sampled from shoe. |
| 4 | 2.4 | M UW DS | CLAYEY SAND (SC); very loose; moist; few GRAVEL, max.½in. dia.; mostly medium to fine SAND; some low plasticity fines. |
| 3 | 1.4 | M CR PI | SANDY lean CLAY (CL); soft; brown to dark yellowish brown; moist; some medium to fine SAND; mostly nonplastic fines. |
| 4 | 2.4 | | No Recovery. |
| 3 | 1.4 | M C PA | CLAYEY SAND (SC); very loose; yellowish brown; moist; 3% GRAVEL; 51% medium to fine SAND; 46% low plasticity fines; lost mud circulation, boring relocated. |
| 15 | 2.4 | M UW | SILTY SAND (SM); medium dense; brown; moist; mostly medium to fine SAND; some nonplastic fines; lost mud circulation. |
| 16 | 1.4 | M | SANDY SILT (ML); very stiff; brown to dark yellowish brown; moist; some fine SAND; mostly low plasticity fines; lost mud circulation several times, |
| GWS EL. 41.2' 10-16-13 | 1 | 2.4 | No Recovery. |
| | P | 2.4 | Wet; few GRAVEL; little fine SAND; mostly low plasticity fines; lost mud circulation. |
| 18 | 1.4 | | |
| 81/11 | 2.4 | M UW PA PP | SANDY lean CLAY (CL); hard; olive brown mottled with dark yellowish brown; moist; few GRAVEL, max.¼in. dia.; 41% fine SAND; 59% medium plasticity fines; few mica; PP>4.5 tsf. |
| 52 | 1.4 | PP | Lean CLAY (CL); hard; light brown; moist; few fine SAND; mostly medium to high plasticity fines; PP=3 tsf. |
| 24 | 2.4 | M PP | SANDY lean CLAY (CL); very stiff; light brown to yellowish brown; moist; few fine SAND; mostly medium plasticity fines; PP=3 tsf. |
| 31 | 1.4 | | Poorly-graded SAND with SILT (SP-SM); dense; gray to olive gray; moist; trace GRAVEL; mostly coarse to medium SAND; few medium plasticity fines; lost drilling mud. |
| 27 | 2.4 | M | Medium dense; light gray to gray; moist; mostly medium to fine SAND; few nonplastic fines. |
| 66 | 1.4 | | Very dense; few GRAVEL; mostly coarse to fine SAND; few nonplastic fines; trace mica. |
| 50 | 2.4 | | Dense; moist; mostly fine SAND; few nonplastic fines. |
| 57 | 1.4 | M UW PP | SANDY lean CLAY (CL); hard; gray; moist; few GRAVEL; mostly medium to fine SAND; some nonplastic fines; PP>4.5 tsf. |

## DE-CPT-01

EL. +63.0'

## A-13-002

EL. +63.0'

| Blows | Recovery | Sample | Description |
|---|---|---|---|
| | | | CLAYEY SAND with GRAVEL (SC); yellowish brown; moist; rounded GRAVEL, max. 4 in. dia.; mostly coarse to fine SAND; some nonplastic fines. |
| REF | 1.4 | | COBBLES; brown to gray; moist; mostly rounded GRAVEL, max. 6 in. dia.; some coarse to fine SAND; few nonplastic fines; hard drilling, rig chattered violently. No recovery. |

Terminated at EL. 58.0'
12-10-13
Hammer Efficiency Ratio (ERi) = 86%

| Blows | Recovery | Sample | Description |
|---|---|---|---|
| 68 | 2.4 | PP | Lean CLAY with SAND (CL); hard; gray; moist; little fine SAND; mostly high plasticity fines; PP=3 tsf. |
| 86/10 | 1.4 | M UW PP | Lean CLAY (CL); hard; gray to grayish brown; moist; few medium to fine SAND; mostly high plasticity fines; PP>4.5 tsf. |
| 39 | 2.4 | PP | Moist; fine SAND; high plasticity fines; PP>4.5 tsf. |
| 86/8 | 1.4 | PP | Moist to wet; fine SAND; high plasticity fines; pp>4 tsf. |
| 25 | 2.4 | M | SILT (ML); very stiff; gray and olive; moist; few medium to fine SAND; mostly low plasticity fines; PP>4.5 tsf. |
| REF | 1.4 | | Rock fragments in shoe; fine grained; black; fresh; hard. |

Terminated at EL. -84.16'
12-12-13
Hammer Efficiency Ratio (ERi) = 86%

ELEVATION (ft): -20, -30, -40, -50, -60, -70, -80, -90, -100, -110

ELEVATION (ft): +90, +80, +70, +60, +50, +40, +30, +20, +10, 0, -10, -20, -30, -40

10 8 6 4 2 0 — Friction Ratio (%)

100 200 300 400 500 — Tip Bearing (tsf)

Terminated at EL. -37.0'
05-27-11

STATIONING ALONG 'F' LINE

32+00 33+00 34+00 35+00 36+00 37+00

**PROFILE**
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY | K. THANT | M. HOSHIYAMA/K. THANT FIELD INVESTIGATION BY: | PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION | A. ZAND PROJECT ENGINEER | BRIDGE NO. 18C0142 | 5TH STREET BRIDGE OVER FEATHER RIVER |
| SIGN OFF DATE | CHECKED BY | T. MAR | DATE: 10/03/2016 | | | POST MILES LOCAL | LOG OF TEST BORINGS NO.1 |

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: xxxx
PROJECT NUMBER & PHASE: xxxx
CONTRACT NO.: xx-xxxx

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | | |

REGISTERED ENGINEER — DATE XX-XX

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

EARTH MECHANICS, INC.
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545

BENCHMARK

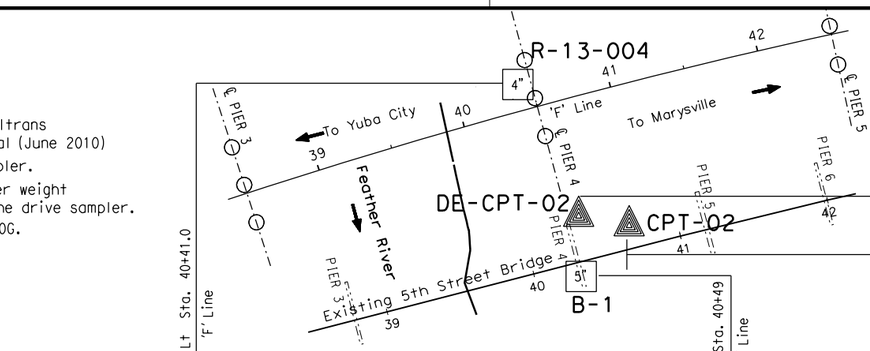
NOTES:

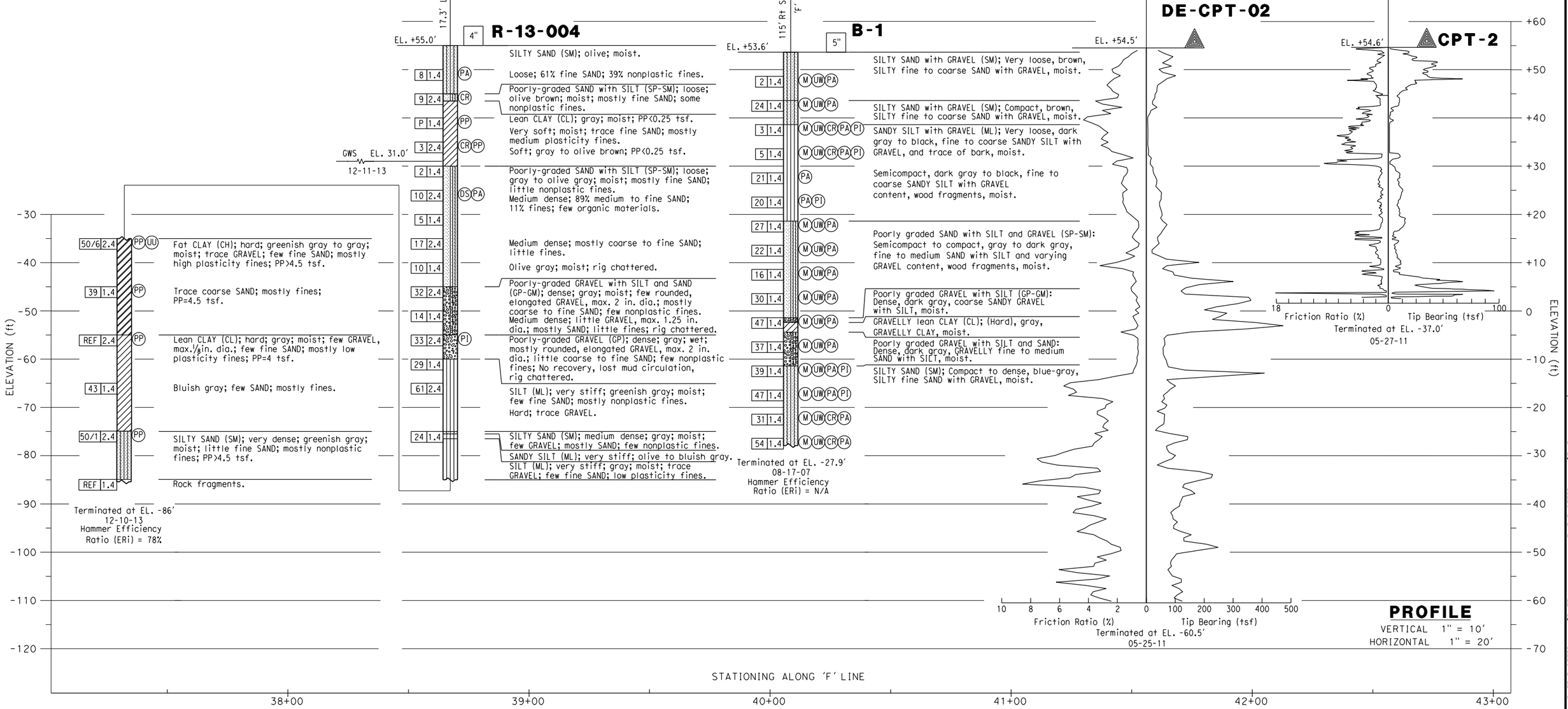
(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) For Soil Legend, see Caltrans Standard Plan A10F and A10G.




| | | | |
|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY | K. THANT | M. HOSHIYAMA/K. THANT — FIELD INVESTIGATION BY: |
| SIGN OFF DATE | CHECKED BY | T. MAR | DATE: 10/03/2016 |

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

A. ZAND — PROJECT ENGINEER

BRIDGE NO. 18C0142 — POST MILES LOCAL

# 5TH STREET BRIDGE OVER FEATHER RIVER
# LOG OF TEST BORINGS NO.2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: XXXX
PROJECT NUMBER & PHASE: XXXX
CONTRACT NO.: XX-XXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES — SHEET — OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER — DATE PLOTTED => $DATE — TIME PLOTTED => $TIME

BENCHMARK

NOTES:

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(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) For Soil Legend, see Caltrans Standard Plan A10F and A10G.

| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | | |

REGISTERED ENGINEER — DATE XX-XX

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

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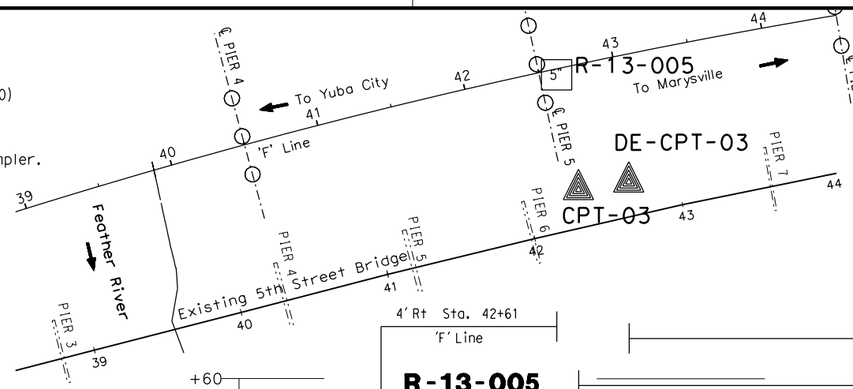
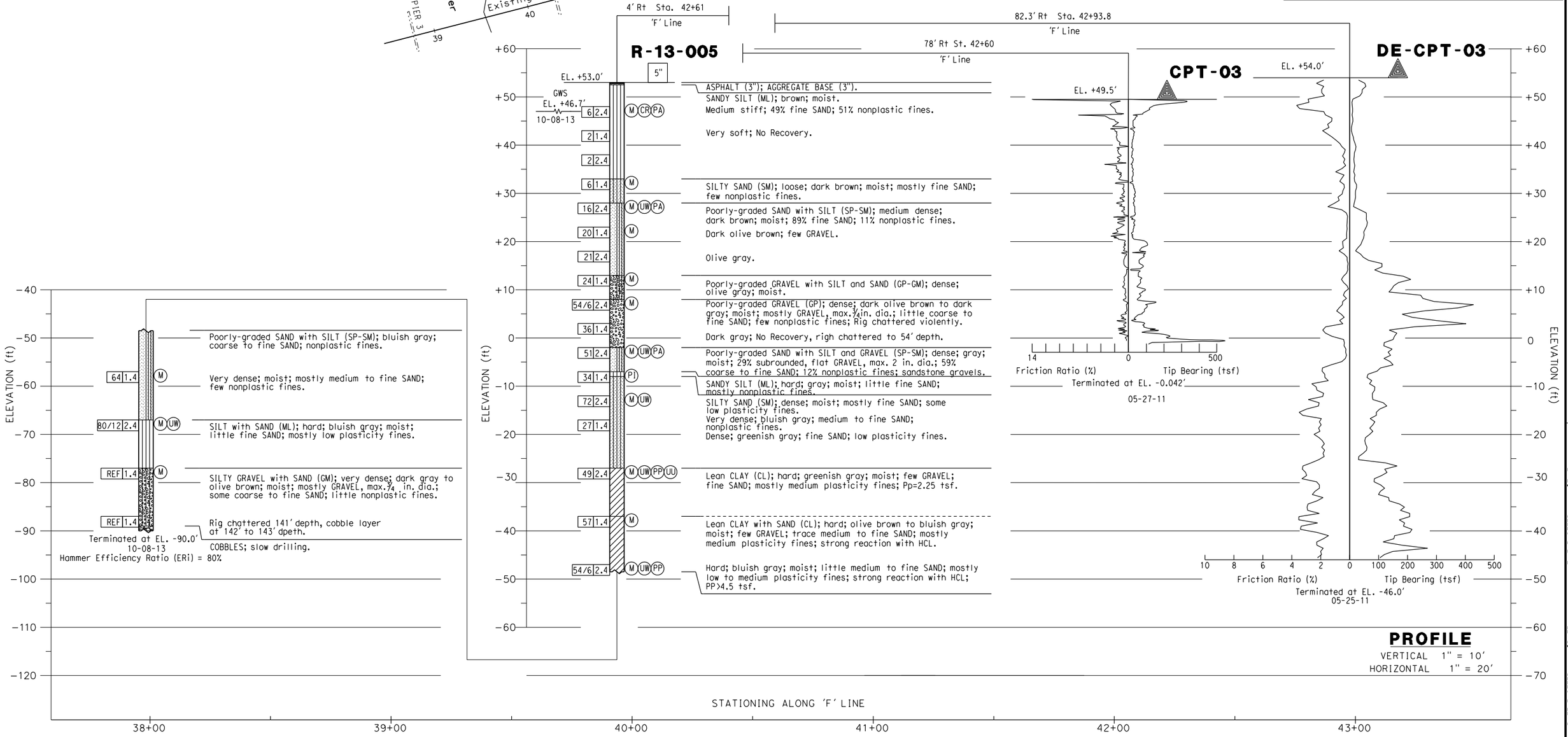
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545




**PLAN**
1" = 50'




**PROFILE**
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

| | | | | | |
|---|---|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY K. THANT | M. HOSHIYAMA/K. THANT FIELD INVESTIGATION BY: | PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION | A. ZAND PROJECT ENGINEER | BRIDGE NO. 18C0142 |
| SIGN OFF DATE | CHECKED BY T. MAR | DATE: 10/03/2016 | | | POST MILES LOCAL |

**5TH STREET BRIDGE OVER FEATHER RIVER**

**LOG OF TEST BORINGS NO.3**

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: XXXX
PROJECT NUMBER & PHASE: XXXX
CONTRACT NO.: XX-XXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCHMARK

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

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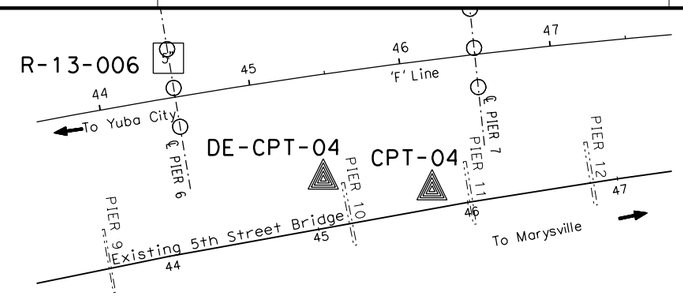
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) For Soil Legend, see Caltrans Standard Plan A10F and A10G.




**PLAN**
1" = 50'

| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | | |

Amir G Zand
REGISTERED ENGINEER
XX-XX
DATE

PLANS APPROVAL DATE

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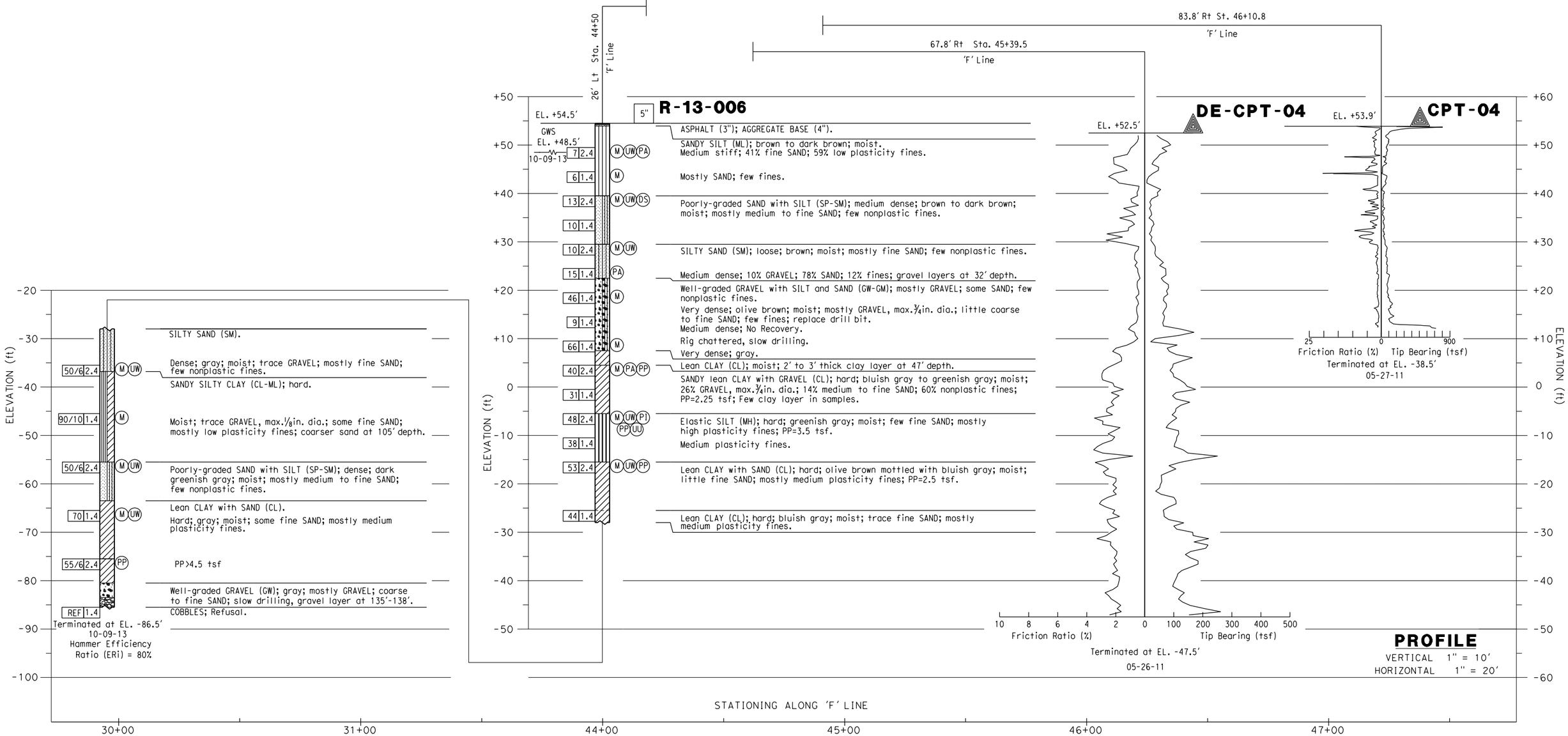
REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

EARTH MECHANICS, INC.
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545




**PROFILE**
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY | K. THANT | M. HOSHIYAMA/K. THANT FIELD INVESTIGATION BY: | PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION | A. ZAND PROJECT ENGINEER | BRIDGE NO. 18C0142 | 5TH STREET BRIDGE OVER FEATHER RIVER |
| SIGN OFF DATE | CHECKED BY | T. MAR | DATE: 10/03/2016 | | | POST MILES LOCAL | LOG OF TEST BORINGS NO.4 |

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: xxxx
PROJECT NUMBER & PHASE: xxxx
CONTRACT NO.: xx-xxxx

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCHMARK

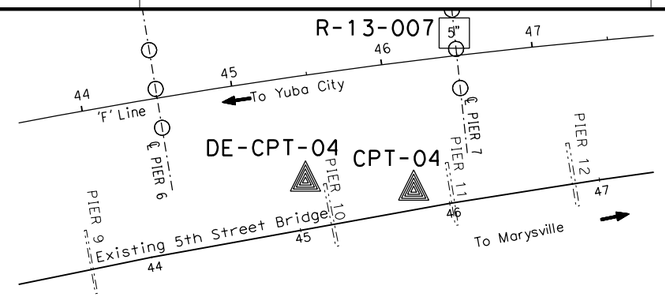
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) For Soil Legend, see Caltrans Standard Plan A10F and A10G.




**PLAN**
1" = 50'

| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | | |

Amir G Zand
REGISTERED ENGINEER
XX-XX
DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

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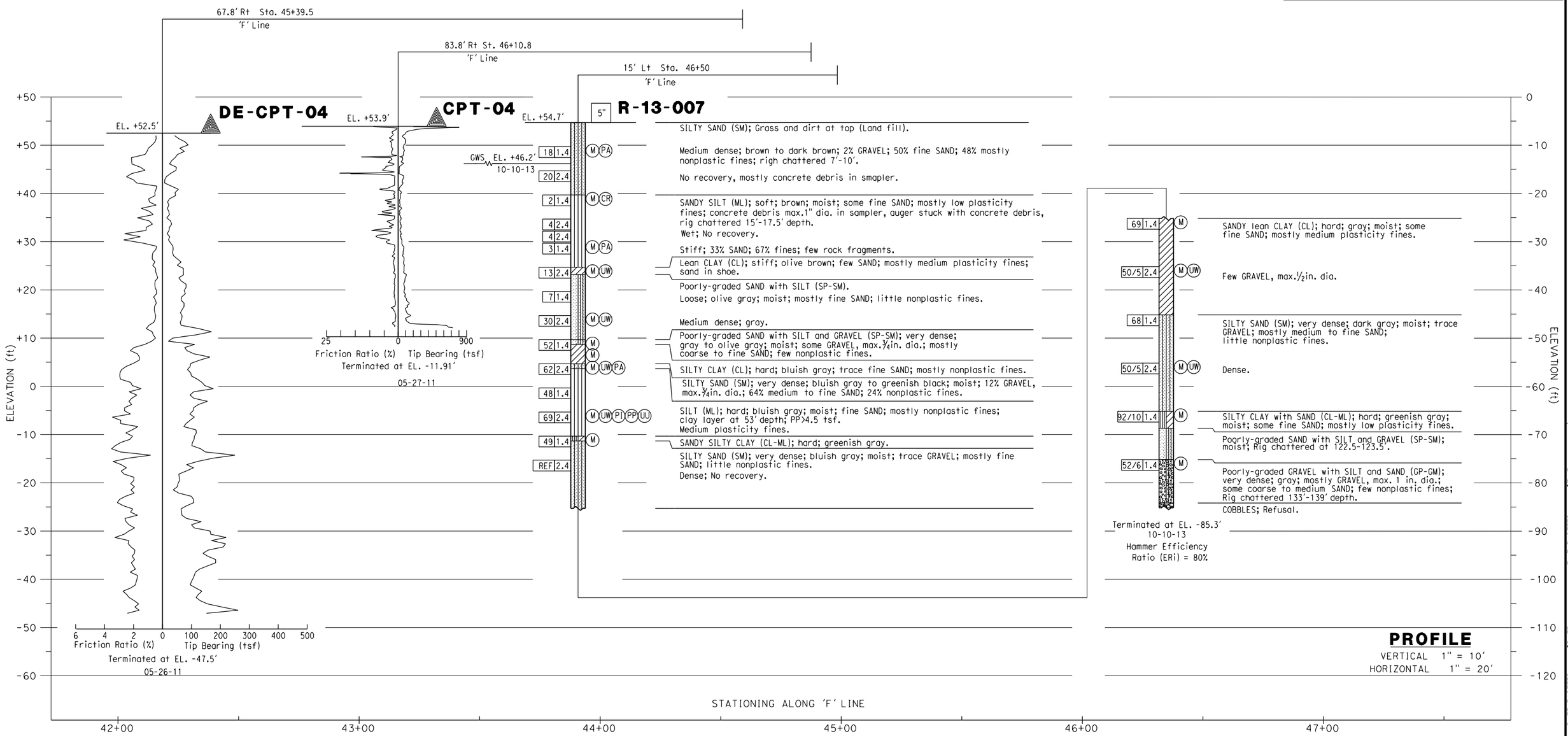
HAYWARD, CA 94545




**PROFILE**
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

| | | | | | |
|---|---|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY | K. THANT | M. HOSHIYAMA/K. THANT FIELD INVESTIGATION BY: | PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION | A. ZAND PROJECT ENGINEER |
| SIGN OFF DATE | CHECKED BY | T. MAR | DATE: 10/03/2016 | | |

BRIDGE NO. 18C0142
POST MILES LOCAL

# 5TH STREET BRIDGE OVER FEATHER RIVER
# LOG OF TEST BORINGS NO.5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: XXXX
PROJECT NUMBER & PHASE: XXXX
CONTRACT NO.: XX-XXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCHMARK

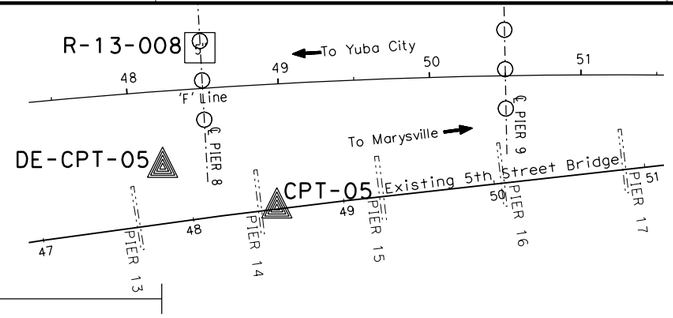
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) For Soil Legend, see Caltrans Standard Plan A10F and A10G.




| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | ==== | ==== |

REGISTERED ENGINEER — DATE XX-XX

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

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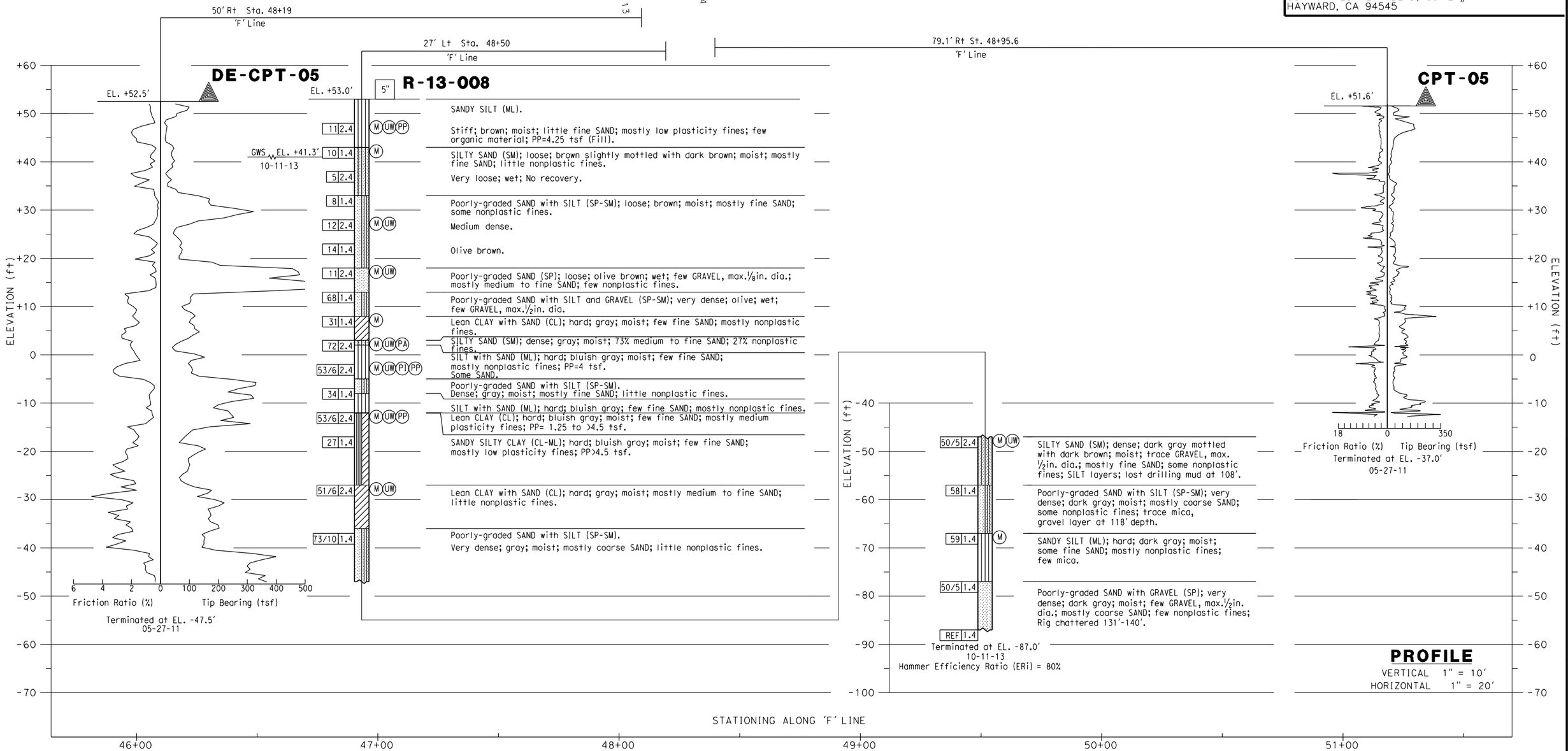
EARTH MECHANICS, INC.
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545

**PLAN**
1" = 50'




| | | | | | |
|---|---|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY | K. THANT | M. HOSHIYAMA/K. THANT FIELD INVESTIGATION BY: | PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION | A. ZAND PROJECT ENGINEER |
| SIGN OFF DATE | CHECKED BY | T. MAR | DATE: 10/03/2016 | | |

BRIDGE NO. 18C0142 — POST MILES LOCAL

# 5TH STREET BRIDGE OVER FEATHER RIVER
# LOG OF TEST BORINGS NO.6

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: xxxx
PROJECT NUMBER & PHASE: xxxx
CONTRACT NO.: xx-xxxx

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES — SHEET — OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCHMARK

NOTES:

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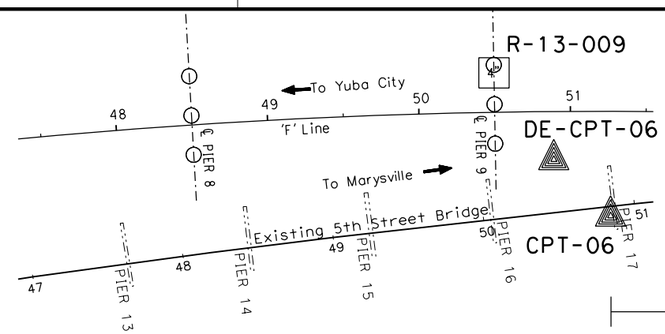


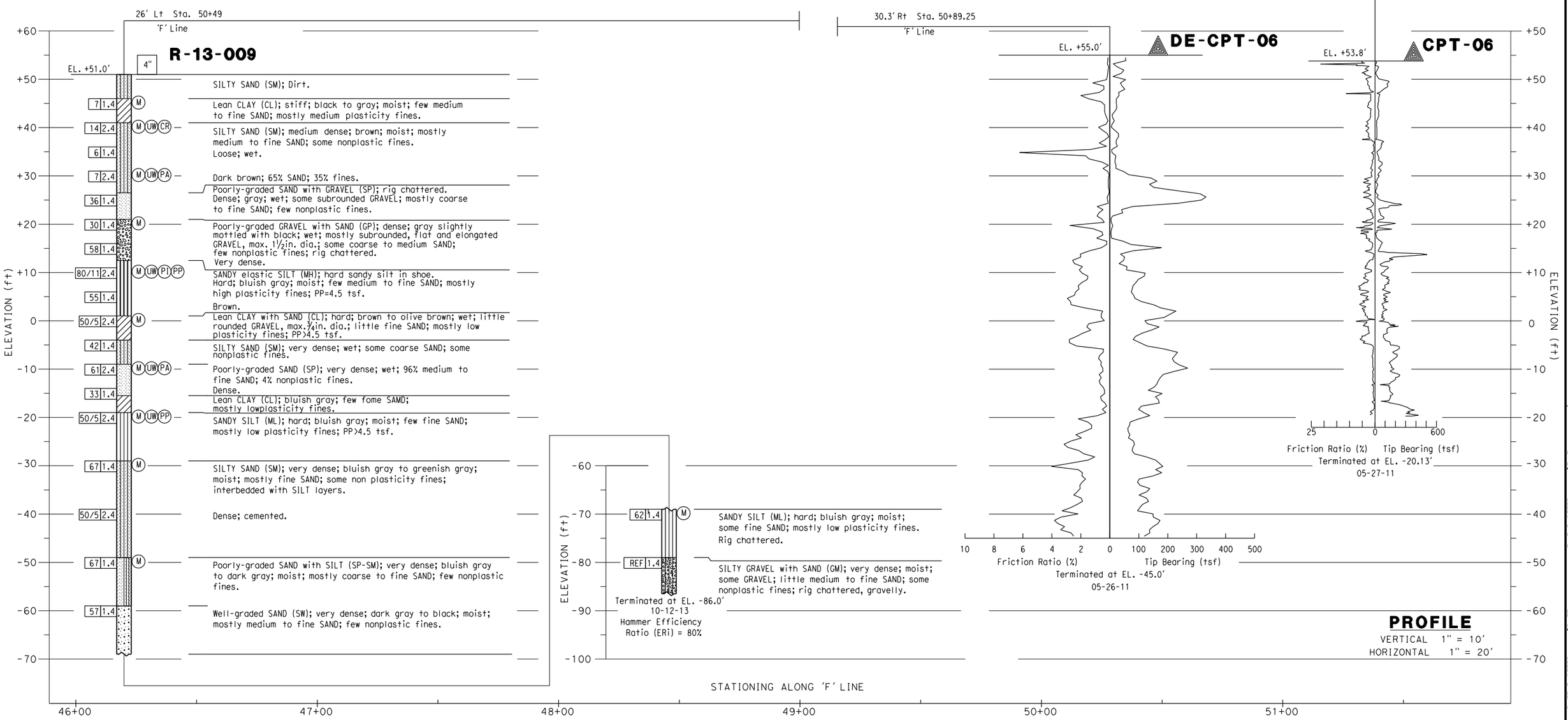


| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | | |

Amir G Zand — REGISTERED ENGINEER — DATE xx-xx

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

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EARTH MECHANICS, INC.
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545

| | | | |
|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY | K. THANT | M. HOSHIYAMA/K. THANT FIELD INVESTIGATION BY: |
| SIGN OFF DATE | CHECKED BY | T. MAR | DATE: 10/03/2016 |

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

A. ZAND — PROJECT ENGINEER

BRIDGE NO. 18C0142 — POST MILES LOCAL

# 5TH STREET BRIDGE OVER FEATHER RIVER
# LOG OF TEST BORINGS NO.7

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: xxxx
PROJECT NUMBER & PHASE: xxxx
CONTRACT NO.: xx-xxxx

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES — SHEET — OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER — DATE PLOTTED => $DATE — TIME PLOTTED => $TIME

BENCHMARK

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

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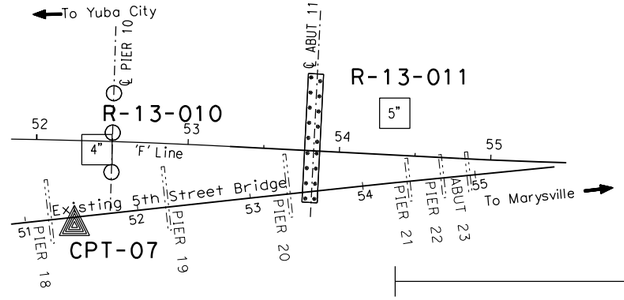

**PLAN**

1" = 50'

| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | ==== | ==== |

Amir G Zand — REGISTERED ENGINEER — DATE XX-XX

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

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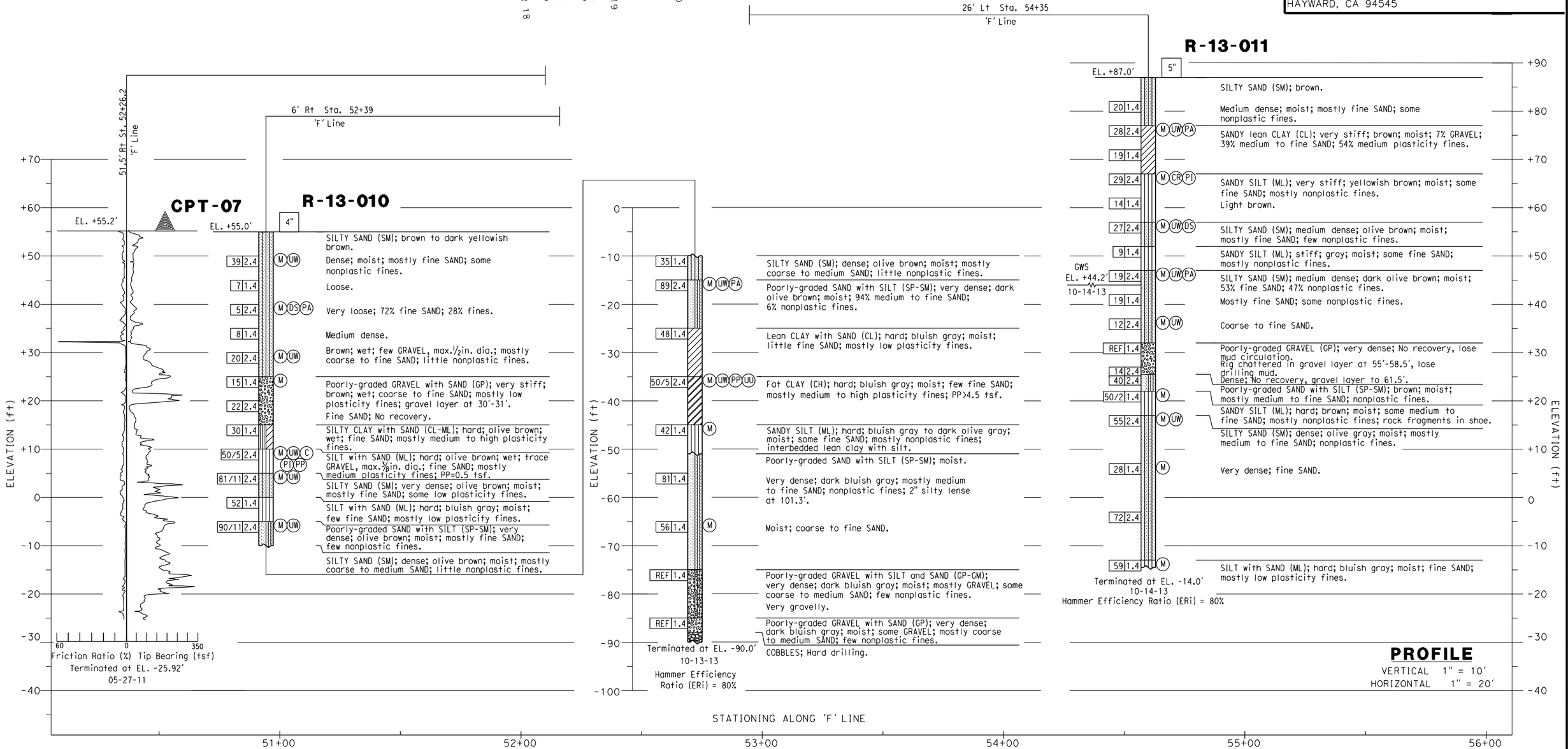
EARTH MECHANICS, INC.
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545




**PROFILE**

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

| | | | | | | |
|---|---|---|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY | K. THANT | M. HOSHIYAMA/K. THANT FIELD INVESTIGATION BY: | PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION | A. ZAND PROJECT ENGINEER | BRIDGE NO. 18C0142 / POST MILES LOCAL | 5TH STREET BRIDGE OVER FEATHER RIVER |
| SIGN OFF DATE | CHECKED BY | T. MAR | DATE: 10/03/2016 | | | | LOG OF TEST BORINGS NO.8 |

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: XXXX
PROJECT NUMBER & PHASE: XXXX
CONTRACT NO.: XX-XXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCHMARK

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

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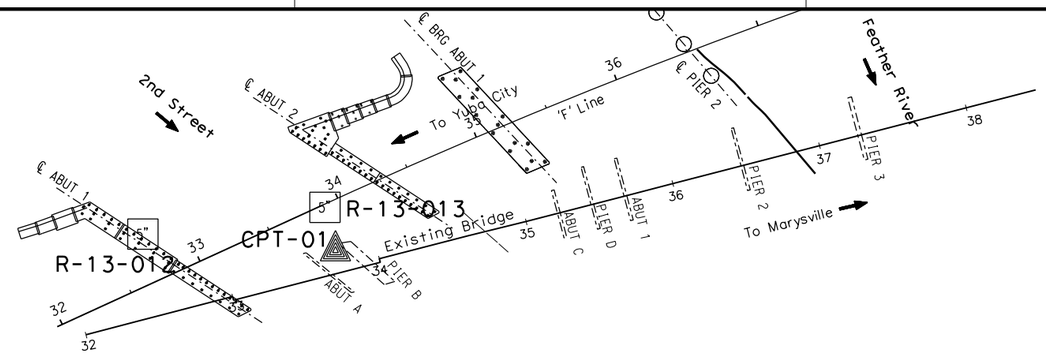
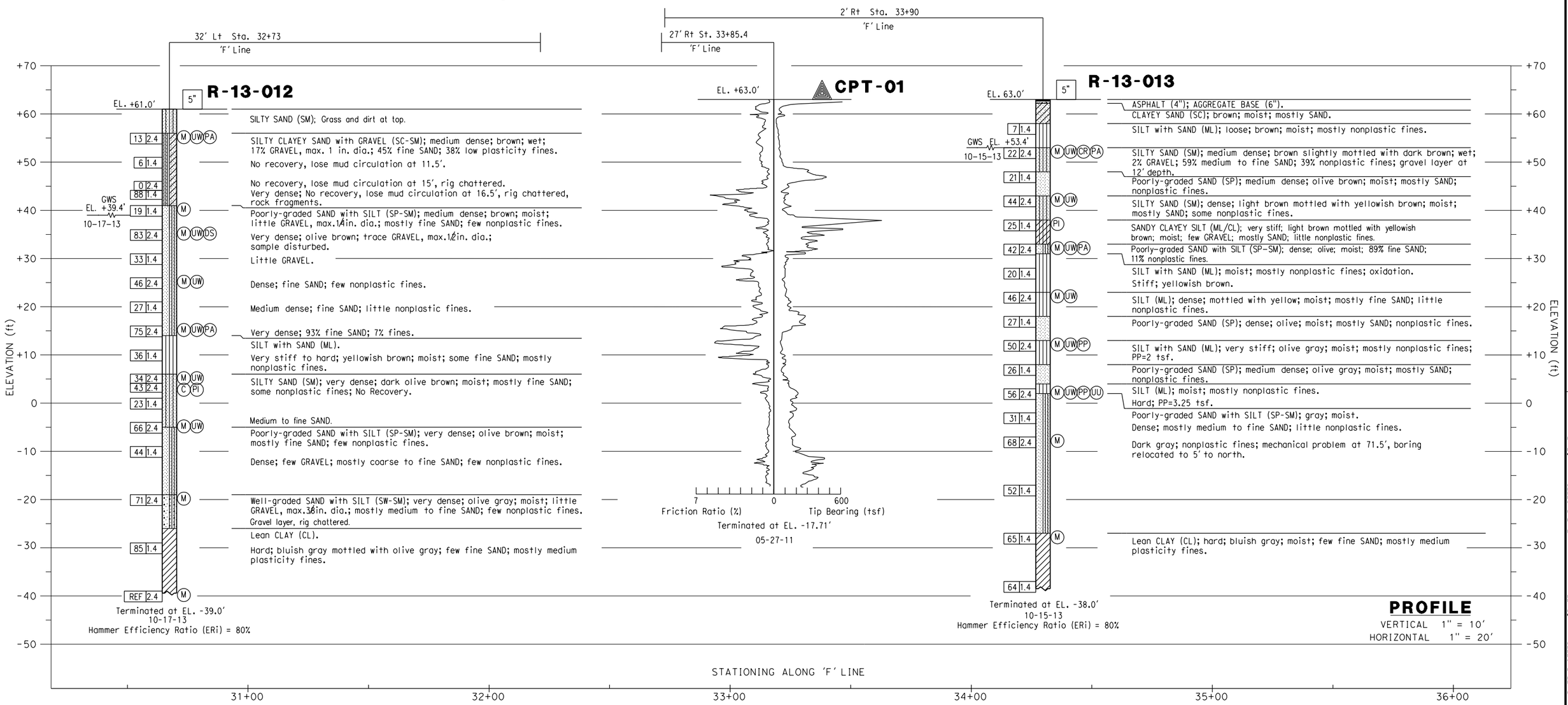
(4) For Soil Legend, see Caltrans Standard Plan A10F and A10G.




| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | | |

REGISTERED ENGINEER — DATE XX-XX

PLANS APPROVAL DATE

*The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.*

REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

EARTH MECHANICS, INC.
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545

DESIGN OVERSIGHT

SIGN OFF DATE

DRAWN BY K. THANT

CHECKED BY T. MAR

M. HOSHIYAMA/K. THANT
FIELD INVESTIGATION BY:
DATE: 10/03/2016

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

A. ZAND
PROJECT ENGINEER

BRIDGE NO. 18C0143
POST MILES LOCAL

# 2ND STREET UNDERCROSSING
# LOG OF TEST BORING NO.1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: XXXX
PROJECT NUMBER & PHASE: XXXX
CONTRACT NO.: XX-XXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES SHEET OF

FILE => $REQUEST

PROJECT ID:

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCHMARK

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) For Soil Legend, see Caltrans Standard Plan A10F and A10G.

| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | SUT/YU | . | . | ==== | ==== |

Amir G Zand
REGISTERED ENGINEER

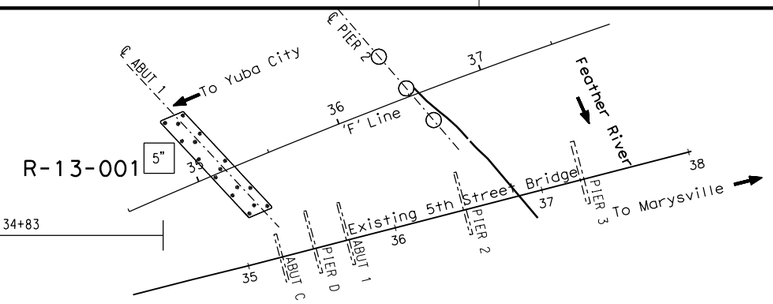
XX-XX
DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER AMIR G. ZAND NO. GE 3029 EXP. 06/30/17 GEOTECHNICAL STATE OF CALIFORNIA

*The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.*

EARTH MECHANICS, INC.
3541 INVESTMENT BLVD, SUITE #4
HAYWARD, CA 94545




N
**PLAN**
1" = 50'

## R-13-001

EL. +85.0'

5"

| Blows | Moisture (%) | Sample | Description |
|---|---|---|---|
| | | | ASPHALT 3" thick. |
| 26 | 2.4 | M UW | CLAYEY SAND (SC); brown; moist; fine SAND; nonplastic fines. Medium dense; few GRAVEL, max.½in. dia.; mostly medium to fine SAND; some low plasticity fines. |
| 4 | 1.4 | M PA | CLAYEY SAND with GRAVEL (SC); very loose; moist; 16% GRAVEL, max.½in. dia.; 44% medium to fine SAND; 40% low plasticity fines; Sampled from shoe. |
| 4 | 2.4 | M UW DS | CLAYEY SAND (SC); very loose; moist; few GRAVEL, max.½in. dia.; mostly medium to fine SAND; some low plasticity fines. |
| 3 | 1.4 | M CR PI | SANDY lean CLAY (CL); soft; brown to dark yellowish brown; moist; some medium to fine SAND; mostly nonplastic fines. |
| 4 | 2.4 | | No Recovery. |
| 3 | 1.4 | M C PA | CLAYEY SAND (SC); very loose; yellowish brown; moist; 3% GRAVEL; 51% medium to fine SAND; 46% low plasticity fines; lost mud circulation, boring relocated. |
| 15 | 2.4 | M UW | SILTY SAND (SM); medium dense; brown; moist; mostly medium to fine SAND; some nonplastic fines; lost mud circulation. |
| 16 | 1.4 | M | SANDY SILT (ML); very stiff; brown to dark yellowish brown; moist; some fine SAND; mostly low plasticity fines; lost mud circulation several times, |
| GWS EL. 41.2' 10-16-13 | 1 | 2.4 | No Recovery. |
| | P | 2.4 | Wet; few GRAVEL; little fine SAND; mostly low plasticity fines; lost mud circulation. |
| 18 | 1.4 | | |
| 81/11 | 2.4 | M UW PA PP | SANDY lean CLAY (CL); hard; olive brown mottled with dark yellowish brown; moist; few GRAVEL, max.¼in. dia.; 41% fine SAND; 59% medium plasticity fines; few mica; PP>4.5 tsf. |
| 52 | 1.4 | PP | Lean CLAY (CL); hard; light brown; moist; few fine SAND; mostly medium to high plasticity fines; PP=3 tsf. |
| 24 | 2.4 | M PP | SANDY lean CLAY (CL); very stiff; light brown to yellowish brown; moist; few fine SAND; mostly medium plasticity fines; PP=3 tsf. |
| 31 | 1.4 | | Poorly-graded SAND with SILT (SP-SM); dense; gray to olive gray; moist; trace GRAVEL; mostly coarse to medium SAND; few medium plasticity fines; lost drilling mud. |
| 27 | 2.4 | M | Medium dense; light gray to gray; moist; mostly medium to fine SAND; few nonplastic fines. |
| 66 | 1.4 | | Very dense; few GRAVEL; mostly coarse to fine SAND; few nonplastic fines; trace mica. |
| 50 | 2.4 | | Dense; moist; mostly fine SAND; few nonplastic fines. |
| 57 | 1.4 | M UW PP | SANDY lean CLAY (CL); hard; gray; moist; few GRAVEL; mostly medium to fine SAND; some nonplastic fines; PP>4.5 tsf. |

| Blows | Moisture (%) | Sample | Description |
|---|---|---|---|
| 68 | 2.4 | PP | Lean CLAY with SAND (CL); hard; gray; moist; little fine SAND; mostly high plasticity fines; PP=3 tsf. |
| 86/10 | 1.4 | M UW PP | Lean CLAY (CL); hard; gray to grayish brown; moist; few medium to fine SAND; mostly high plasticity fines; PP>4.5 tsf. |
| 39 | 2.4 | PP | Moist; fine SAND; high plasticity fines; PP>4.5 tsf. |
| 86/8 | 1.4 | PP | Moist to wet; fine SAND; high plasticity fines; pp>4 tsf. |
| 25 | 2.4 | M | SILT (ML); very stiff; gray and olive; moist; few medium to fine SAND; mostly low plasticity fines; PP>4.5 tsf. |
| REF | 1.4 | | Rock fragments in shoe; fine grained; black; fresh; hard. |

Terminated at EL. -84.16'
12-12-13
Hammer Efficiency Ratio (ERi) = 86%

ELEVATION (ft): -20, -30, -40, -50, -60, -70, -80, -90, -100, -110

ELEVATION (ft): +90, +80, +70, +60, +50, +40, +30, +20, +10, 0, -10, -20, -30, -40

STATIONING ALONG PROPOSED 'F' LINE

32+00 33+00 34+00 35+00 36+00 37+00

**PROFILE**
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

| | | | |
|---|---|---|---|
| DESIGN OVERSIGHT | DRAWN BY | K. THANT | M. HOSHIYAMA/K. THANT FIELD INVESTIGATION BY: |
| SIGN OFF DATE | CHECKED BY | T. MAR | DATE: 10/03/2016 |

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

A. ZAND
PROJECT ENGINEER

BRIDGE NO. 18C0143
POST MILES LOCAL

# 2ND STREET UNDERCROSSING
# LOG OF TEST BORINGS NO.2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: XXXX
PROJECT NUMBER & PHASE: XXXX
CONTRACT NO.: XX-XXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES SHEET OF

PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

# APPENDIX B

# LABORATORY TEST RESULTS

DRAFT

# TABLE A-1 SUMMARY OF LABORATORY TEST RESULTS

**Project No.** : *13-121* **Project Name :** Dokken, 5th Street Bridge PSR PR

| Boring No . | Sample No. | Sample Depth (ft) | Soil Identification (group symbol) ASTM D2488/D2487 | Moisture Content ASTM D2216 ( % ) | Total Unit Weight ASTM D2937 (pcf) | Pocket Penetrometer (tsf) | Torvane Shear (tsf) | Grain Size Distribution GR:SA:FI (%) | Sand Equivalent (CT-217) | Atterberg Limits ASTM D4318 ( LL/PL/PI ) | Soil-Minimum Resistivity CT-532 (ohm-cm) | Soil-pH CT-532 | Soil-Soluble Sulfate Content CT-417 (ppm) | Soil-Moisture Free Chloride Content CT-422 (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R-13-001 | *D-1* | 5 | SC | 17.7 | 137.2 | | | | | | | | | |
| R-13-001 | *S-2* | 10 | SC | 39.5 | | | | 16:44:40 | | | | | | |
| R-13-001 | *D-3* | 15 | SC | 39.9 | 107.2 | | | | | | | | | |
| R-13-001 | *S-4* | 20 | CL | 46.1 | | | | | | 42/28/13 | 1100 | 9.4 | 210 | 278 |
| R-13-001 | *S-6* | 30 | SC | 52.1 | | | | 3:51:46 | | | | | | |
| R-13-001 | *D-7* | 35 | SM | 15.4 | 130.3 | | | | | | | | | |
| R-13-001 | *S-8* | 40 | ML | 37.6 | | | | | | | | | | |
| R-13-005 | *D-1* | 5 | ML | 26.1 | 109.1 | | | 0:49:51 | | | 6500 | 7.1 | 10 | 169 |
| R-13-005 | *S-4* | 20 | SM | 30.0 | | | | | | | | | | |
| R-13-005 | *D-5* | 25 | SP-SM | 32.4 | 121.4 | | | 0:89:11 | | | | | | |
| R-13-005 | *S-6* | 30 | SP-SM | 28.2 | | | | | | | | | | |
| R-13-005 | *S-8* | 40 | GP-GM | 17.1 | | | | | | | | | | |
| R-13-005 | *S-9* | 45 | GP | 6.3 | | | | | | | | | | |
| R-13-005 | *D-11* | 55 | SP-SM | 17.9 | 128.2 | | | 29:59:12 | | | | | | |
| R-13-005 | *S-12* | 60 | SC | | | | | | | 47/29/18 | | | | |
| R-13-005 | *D-13* | 65 | SM | 27.5 | 123.1 | | | | | | | | | |
| R-13-005 | *D-15* | 80 | CL | 50.9 | 103.1 | 2.25 | | | | | | | | |
| R-13-005 | *S-16* | 90 | CL | 32.7 | | | | | | | | | | |
| R-13-005 | *D-17* | 100 | CL | 36.6 | 116.6 | >4.5 | | | | | | | | |
| R-13-005 | *S-18* | 110 | SP-SM | 21.5 | | | | | | | | | | |
| R-13-005 | *D-19* | 120 | ML | 36.4 | 116.1 | | | | | | | | | |
| R-13-005 | *S-20* | 130 | GM | 12.8 | | | | | | | | | | |
| R-13-006 | *D-1* | 5 | ML | 26.2 | 114.9 | | | 0:41:59 | | | | | | |
| R-13-006 | *S-2* | 10 | ML | 24.5 | | | | | | | | | | |
| R-13-006 | *D-3* | 15 | SP-SM | 27.4 | 120.3 | | | | | | | | | |
| R-13-006 | *D-5* | 25 | SM | 34.4 | 117.5 | | | | | | | | | |
| R-13-006 | *S-6* | 30 | SP-SM | | | | | 10:78:12 | | | | | | |
| R-13-006 | *S-7* | 35 | GW-GM | 8.4 | | | | | | | | | | |
| R-13-006 | *S-9* | 45 | GW-GM | 4.8 | | | | | | | | | | |
| R-13-006 | *D-10* | 50 | CL | 33.1 | | 2.25 | | 26:14:60 | | | | | | |
| R-13-006 | *D-12* | 60 | MH | 46.1 | 111.4 | 3.5 | | | | 61/32/9 | | | | |
| R-13-006 | *D-14* | 70 | CL | 44.1 | 113.2 | 2.5 | | | | | | | | |
| R-13-006 | *D-16* | 90 | SM | 31.6 | 121.6 | | | | | | | | | |
| R-13-006 | *S-17* | 100 | CL-ML | 30.6 | | | | | | | | | | |
| R-13-006 | *D-18* | 110 | SP-SM | 26.0 | 126.7 | | | | | | | | | |
| R-13-006 | *D-20* | 130 | CL | 33.9 | 116.2 | >4.5 | | | | | | | | |
| R-13-007 | *S-1* | 5 | SM | 17.1 | | | | 2:50:48 | | | | | | |
| R-13-007 | *S-3* | 15 | ML | 26.6 | | | | | | | 5100 | 7.7 | 30 | 241 |
| R-13-007 | *S-5* | 25 | ML | 45.3 | | | | 0:33:67 | | | | | | |
| R-13-007 | *D-6* | 30 | CL | 44.0 | 114.6 | | | | | | | | | |

# TABLE A-1 SUMMARY OF LABORATORY TEST RESULTS

**Project No.** : *13-121* **Project Name :** Dokken, 5th Street Bridge PSR PR

| Boring No . | Sample No. | Sample Depth (ft) | Soil Identification (group symbol) ASTM D2488/D2487 | Moisture Content ASTM D2216 ( % ) | Total Unit Weight ASTM D2937 (pcf) | Pocket Penetrometer (tsf) | Torvane Shear (tsf) | Grain Size Distribution GR:SA:FI (%) | Sand Equivalent (CT-217) | Atterberg Limits ASTM D4318 ( LL/PL/PI ) | Soil-Minimum Resistivity CT-532 (ohm-cm) | Soil-pH CT-532 | Soil-Soluble Sulfate Content CT-417 (ppm) | Soil-Moisture Free Chloride Content CT-422 (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R-13-007 | *D-8* | 40 | SP-SM | 14.4 | 130.5 | | | | | | | | | |
| R-13-007 | *S-9-1* | 45 | SP-SM | 7.4 | | | | | | | | | | |
| R-13-007 | *S-9-2* | 46 | CL | 40.4 | | | | | | | | | | |
| R-13-007 | *D-10* | 50 | SM | 33.4 | 120.3 | | | 12:64:24 | | | | | | |
| R-13-007 | *D-12* | 60 | ML | 41.4 | 112.7 | >4.5 | | | | 46/28/18 | | | | |
| R-13-007 | *S-13* | 65 | CL-ML | 33.3 | | | | | | | | | | |
| R-13-007 | *S-15* | 80 | CL | 36.1 | | | | | | | | | | |
| R-13-007 | *D-16* | 90 | CL | 32.1 | 119.2 | | | | | | | | | |
| R-13-007 | *D-18* | 110 | SM | 19.2 | 132.5 | | | | | | | | | |
| R-13-007 | *S-19* | 120 | CL-ML | 36.4 | | | | | | | | | | |
| R-13-007 | *S-20* | 130 | GP-GM | 12.1 | | | | | | | | | | |
| R-13-008 | *D-1* | 5 | ML | 18.6 | 116.4 | 4.25 | | | | | | | | |
| R-13-008 | *S-2* | 10 | SM | 22.1 | | | | | | | | | | |
| R-13-008 | *D-5* | 25 | SP-SM | 33.9 | 118.8 | | | | | | | | | |
| R-13-008 | *D-7* | 35 | SP | 24.2 | 122.6 | | | | | | | | | |
| R-13-008 | *S-9* | 45 | CL | 50.3 | | | | | | | | | | |
| R-13-008 | *D-10* | 50 | SM | 33.4 | 114.5 | | | 0:73:27 | | | | | | |
| R-13-008 | *D-11* | 55 | ML | 44.7 | 110.7 | 4.0 | | | | 44/28/16 | | | | |
| R-13-008 | *D-13* | 65 | CL to CL-ML | 28.8 | 124.4 | 1.25 to >4.5 | | | | | | | | |
| R-13-008 | *D-15* | 80 | CL | 43.9 | 108.0 | | | | | | | | | |
| R-13-008 | *D-17* | 100 | SM | 28.5 | 117.9 | | | | | | | | | |
| R-13-008 | *S-19* | 120 | ML | 29.8 | | | | | | | | | | |
| R-13-009 | *S-1* | 5 | CL | 36.3 | | | | | | | | | | |
| R-13-009 | *D-2* | 10 | SM | 16.8 | 122.4 | | | | | | 7700 | 7.2 | 30 | 102 |
| R-13-009 | *D-4* | 20 | SM | 22.4 | 128.0 | | | 0:65:35 | | | | | | |
| R-13-009 | *S-6* | 30 | GP | 5.0 | | | | | | | | | | |
| R-13-009 | *D-8* | 40 | MH | 29.6 | 119.2 | 4.5 | | | | 51/29/22 | | | | |
| R-13-009 | *D-10* | 50 | CL | 33.8 | | | | | | | | | | |
| R-13-009 | *D-12* | 60 | SP | 26.9 | 126.2 | | | 0:96:4 | | | | | | |
| R-13-009 | *D-14* | 70 | ML | 21.5 | 132.5 | >4.5 | | | | | | | | |
| R-13-009 | *S-15* | 80 | SM | 35.9 | | | | | | | | | | |
| R-13-009 | *S-17* | 100 | SP-SM | 18.0 | | | | | | | | | | |
| R-13-009 | *S-19* | 120 | ML | 31.8 | | | | | | | | | | |
| R-13-010 | *D-1* | 5 | SM | 6.6 | 130.2 | | | | | | | | | |
| R-13-010 | *D-3* | 15 | SM | 15.9 | | | | 0:72:28 | | | | | | |
| R-13-010 | *D-5* | 25 | SM | 15.2 | 137.7 | | | | | | | | | |
| R-13-010 | *S-6* | 30 | GP | 5.3 | | | | | | | | | | |
| R-13-010 | *D-9* | 45 | ML | 44.8 | 109.4 | 0.5 | | | | 39/26/13 | | | | |
| R-13-010 | *D-10* | 50 | SM | 38.2 | 113.9 | | | | | | | | | |
| R-13-010 | *D-12* | 60 | SP-SM | 18.9 | 130.4 | | | | | | | | | |

# TABLE A-1 SUMMARY OF LABORATORY TEST RESULTS

**Project No.** : *13-121* **Project Name :** Dokken, 5th Street Bridge PSR PR

| Boring No . | Sample No. | Sample Depth (ft) | Soil Identification (group symbol) ASTM D2488/D2487 | Moisture Content ASTM D2216 ( % ) | Total Unit Weight ASTM D2937 (pcf) | Pocket Penetrometer (tsf) | Torvane Shear (tsf) | Grain Size Distribution GR:SA:FI (%) | Sand Equivalent (CT-217) | Atterberg Limits ASTM D4318 ( LL/PL/PI ) | Soil-Minimum Resistivity CT-532 (ohm-cm) | Soil-pH CT-532 | Soil-Soluble Sulfate Content CT-417 (ppm) | Soil-Moisture Free Chloride Content CT-422 (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R-13-010 | *D-14* | 70 | SP-SM | 23.0 | 126.5 | | | 0:94:6 | | | | | | |
| R-13-010 | *D-16* | 90 | CH | 33.7 | 114.4 | >4.5 | | | | | | | | |
| R-13-010 | *S-17* | 100 | ML | 41.2 | | | | | | | | | | |
| R-13-010 | *S-19* | 120 | SP-SM | 20.3 | | | | | | | | | | |
| R-13-011 | *D-2* | 10 | CL | 17.5 | 129.0 | | | 7:39:54 | | | | | | |
| R-13-011 | *D-4* | 20 | ML | 16.9 | | | | | | N.P. | 4700 | 7.8 | 30 | 162 |
| R-13-011 | *D-6* | 30 | SM | 15.2 | 129.0 | | | | | | | | | |
| R-13-011 | *D-8* | 40 | SM | 17.5 | 130.6 | | | 0:53:47 | | | | | | |
| R-13-011 | *D-10* | 50 | SM | 20.3 | 134.0 | | | | | | | | | |
| R-13-011 | *S-13* | 65 | ML | 27.8 | | | | | | | | | | |
| R-13-011 | *D-14* | 70 | SM | 24.9 | 127.5 | | | | | | | | | |
| R-13-011 | *S-15* | 80 | SM | 26.9 | | | | | | | | | | |
| R-13-011 | *S-17* | 100 | ML | 31.7 | | | | | | | | | | |
| R-13-012 | *D-1* | 5 | SC-SM | 15.3 | 139.3 | | | 17:45:38 | | | | | | |
| R-13-012 | *S-4* | 20 | SP-SM | 22.0 | | | | | | | | | | |
| R-13-012 | *D-5* | 25 | SP-SM | 15.4 | 136.0 | | | | | | | | | |
| R-13-012 | *D-7* | 35 | SP-SM | 25.9 | 125.9 | | | | | | | | | |
| R-13-012 | *D-9* | 45 | SP-SM | 22.1 | 127.6 | | | 0:93:7 | | | | | | |
| R-13-012 | *D-11* | 55 | SM | 33.7 | 120.5 | | | | | N.P. | | | | |
| R-13-012 | *D-13* | 65 | SM to SP-SM | 21.8 | 129.0 | | | | | | | | | |
| R-13-012 | *S-15* | 80 | SW-SM | 14.3 | | | | | | | | | | |
| R-13-012 | *S-17* | 100 | CL | 29.4 | | | | | | | | | | |
| R-13-013 | *D-2* | 10 | SM | 12.2 | 122.5 | | | 2:59:39 | | | | | | |
| R-13-013 | *D-4* | 20 | SM | 11.1 | 119.3 | | | | | | 600 | 7.4 | 30 | 114 |
| R-13-013 | *S-5* | 25 | ML | | | | | | | 28/28/0 | | | | |
| R-13-013 | *D-6* | 30 | SP-SM | 27.0 | 122.2 | | | 0:89:11 | | | | | | |
| R-13-013 | *D-8* | 40 | SM | 27.5 | 121.1 | | | | | | | | | |
| R-13-013 | *D-10* | 50 | ML | 35.1 | 111.6 | 2.0 | | | | | | | | |
| R-13-013 | *D-12* | 60 | ML | 31.7 | 115.6 | 3.25 | | | | | | | | |
| R-13-013 | *S-14* | 70 | SP-SM | 22.2 | | | | | | | | | | |
| R-13-013 | *S-16* | 90 | CL | 24.0 | | | | | | | | | | |

# TABLE A-1 SUMMARY OF LABORATORY TEST RESULTS

**Project No.** : *13-121* **Project Name :** Dokken, 5th Street Bridge PSR PR

| Boring No . | Sample No. | Sample Depth (ft) | Soil Identification (group symbol) ASTM D2488/D2487 | Moisture Content ASTM D2216 ( % ) | Total Unit Weight ASTM D2937 (pcf) | Pocket Penetrometer (tsf) | Torvane Shear (tsf) | Grain Size Distribution GR:SA:FI (%) | Sand Equivalent (CT-217) | Atterberg Limits ASTM D4318 ( LL/PL/PI ) | Soil-Minimum Resistivity CT-532 (ohm-cm) | Soil-pH CT-532 | Soil-Soluble Sulfate Content CT-417 (ppm) | Soil-Moisture Free Chloride Content CT-422 (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R-13-001 | *D-11* | 55 | CL | 23.9 | 128.9 | >4.5 | | 0:41:59 | | | | | | |
| R-13-001 | *D-13* | 65 | CL | 37.6 | | | | | | | | | | |
| R-13-001 | *S-15* | 80 | SP-SM | 27.5 | | | | | | | | | | |
| R-13-001 | *D-18* | 110 | CL | 36.9 | 117.8 | >4.5 | | | | | | | | |
| R-13-001 | *D-20* | 130 | CL | 34.8 | 119.6 | >4.5 | | | | | | | | |
| R-13-001 | *S-23* | 160 | ML | 39.1 | | | | | | | | | | |
| R-13-004 | *S-1* | 5 | SM | 18.3 | | | | 0:61:39 | | | | | | |
| R-13-004 | *D-2* | 10 | SP-SM to CL | 0.8 | 80.1 | | | | | | 4400 | 7.8 | 30 | 136 |
| R-13-004 | *D-4* | 20 | CL | 56.3 | 102.2 | | | | | | 3100 | 7.3 | 30 | 126 |
| R-13-004 | *S-5* | 25 | SP-SM | 28.5 | | | | | | | | | | |
| R-13-004 | *D-6* | 30 | SP-SM | 36.5 | 115.6 | | | 0:89:11 | | | | | | |
| R-13-004 | *D-8* | 40 | SP-SM | 28.2 | 118.8 | | | | | | | | | |
| R-13-004 | *D-10* | 50 | GP-GM | 9.1 | 144.1 | | | | | | | | | |
| R-13-004 | *D-12* | 60 | GP | 1.5 | | | | | | N.P. | | | | |
| R-13-004 | *S-15-1* | 80 | SM | 25.6 | | | | | | | | | | |
| R-13-004 | *S-15-2* | 80.5 | ML | 34.5 | | | | | | | | | | |
| R-13-004 | *D-16* | 90 | CH | 34.2 | 120.9 | >4.5 | | | | | | | | |
| R-13-004 | *D-18* | 110 | CL | 37.7 | 120.9 | | | | | | | | | |
| R-13-004 | *D-20* | 130 | SM | 31.1 | 116.2 | | | | | | | | | |

# UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D2850

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Dokken, 5th Street Bridge PSR PR | | | **Project No:** | 13-121 |
| **Boring No.:** | R-13-010 | **Tested by:** | RJ | **Date:** | 11/02/13 |
| **Depth (ft):** | 90 | **Checked by:** | | **Date:** | |
| **Sample No.** | D-16 | **Sample Type:** | R | | |

**Sample Description:** Gray , CLAYSTONE (CH)

| | 1 | 2 | 3 | | |
|---|---|---|---|---|---|
| Diameter (in.): | 2.42 | 2.42 | 2.42 | Average: | 2.420 |
| Height (in.): | 5.075 | 5.054 | 5.075 | Average: | 5.068 |

| **Moisture Content Calculation** | | |
|---|---|---|
| Wt. Wet Sample + Container (gms): | | 185.42 |
| Wt. Dry Sample + Container (gms): | | 153.38 |
| Container (gms) | No. 63 | 58.4 |
| Moisture Content (%) | | **33.7** |

| **Density and Saturation** | |
|---|---|
| Wt. Wet Sample + Container (gms) | 916.82 |
| Container (gms) | 228.92 |
| Wet Density (pcf) | **112.3** |
| Dry Density (pcf) | **84.0** |
| Void Ratio | **1.006** |
| % Saturation | **90.5** |

Assume Gs=2.70

| Test Data Filename: | 13121B10D16.trx |
|---|---|

**SKETCH / PHOTO AFTER TEST:**

PHOTO FILE NAME: est In Process\13-121 - Dokken, 5th Street Bridge PSR P

| **Shear** | |
|---|---|
| Rate of Deformation (% strain / min) = | **1** |
| Confining Stress (ksf): | **7.18** |

**Failure Criterion:** **criterion 1 is used**

1. the maximum deviator stress within 15% strain
2. the stress at 10% strain for no peak stress.

| **At Failure** | |
|---|---|
| Deviator Stress (ksf) | **14.35** |
| Eff. Minor Principal Stress (ksf)= | **7.18** |
| Eff. Major Principal Stress (ksf)= | **21.54** |
| Axial Strain (%)= | **13.06** |

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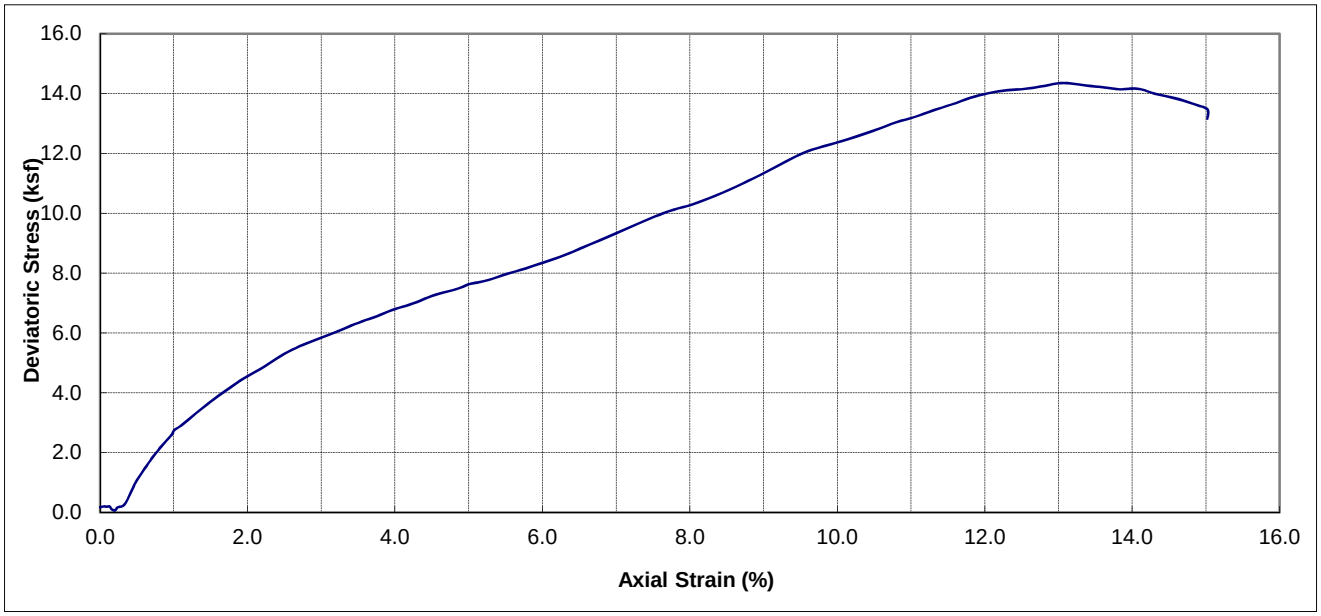


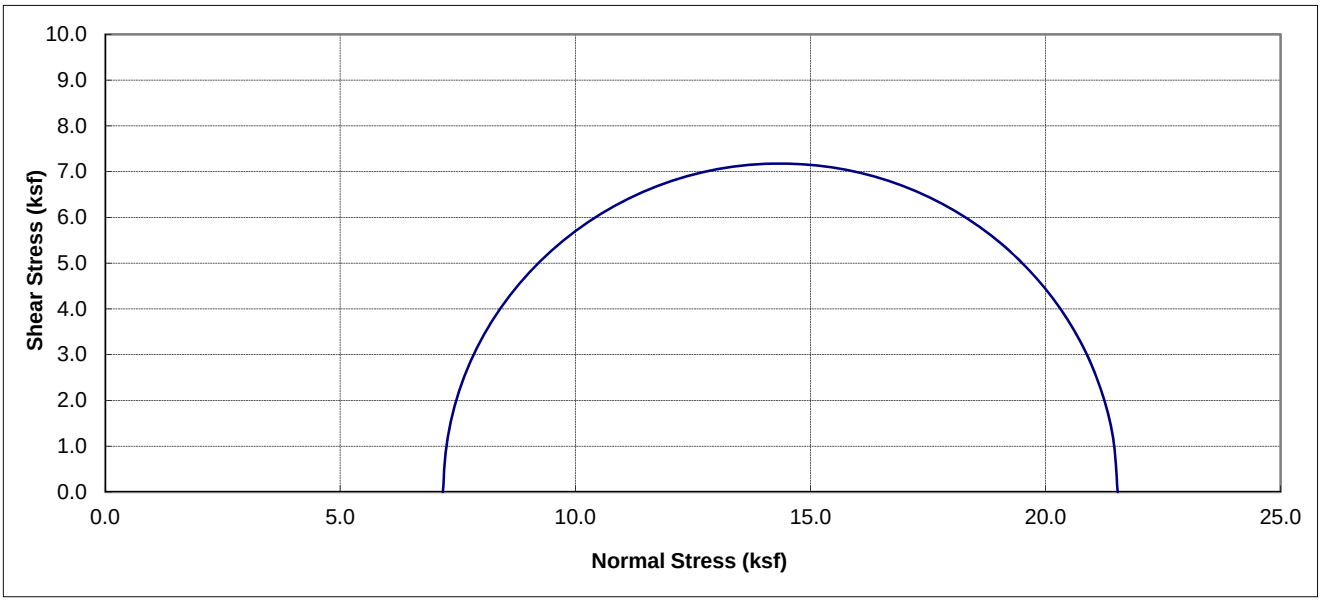


| Boring No. | Sample No. | Depth (ft) | Soil Type | Dry Density (pcf) | Moisture Content (%) | Conf. Stress (ksf) | 10% Axial Strain Dev. Stress (ksf) | Initial Saturation (%) |
|---|---|---|---|---|---|---|---|---|
| R-13-010 | D-16 | 90 | Gray , CLAYSTONE (CH) | 84.0 | 33.73 | 7.18 | 14.35 | 90.5 |

| | |
|---|---|
| **Earth Mechanics, Inc.**<br>Geotechnical and Earthquake Engineering | **Dokken, 5th Street Bridge PSR PR** |
| | **UNCONSOLIDATED UNDRAINED TEST** |
| **Project No. :** 13-121 **Date :** 11/02/13 | **(ASTM D2850)** **Figure No. :** |

# UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D2850

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Dokken, 5th Street Bridge PSR PR | | | **Project No:** | 13-1214 |
| **Boring No.:** | R-13-005 | **Tested by:** | RJ | **Date:** | 11/02/13 |
| **Depth (ft):** | 80 | **Checked by:** | | **Date:** | |
| **Sample No.** | D-15 | **Sample Type:** | R | | |
| **Sample Description:** | Olive to Gray , LEAN CLAY (CL) | | | | |

| | 1 | 2 | 3 | | |
|---|---|---|---|---|---|
| Diameter (in.): | 2.42 | 2.419 | 2.424 | Average: | 2.421 |
| Height (in.): | 5.054 | 5.030 | 5.054 | Average: | 5.046 |

| **Moisture Content Calculation** | | |
|---|---|---|
| Wt. Wet Sample + Container (gms): | | 183.45 |
| Wt. Dry Sample + Container (gms): | | 141.32 |
| Container (gms) | No. 60 | 58.52 |
| Moisture Content (%) | | **50.9** |

| **Density and Saturation** | |
|---|---|
| Wt. Wet Sample + Container (gms) | 845.01 |
| Container (gms) | 228.92 |
| Wet Density (pcf) | **101.2** |
| Dry Density (pcf) | **67.1** |
| Void Ratio | **1.512** |
| % Saturation | **90.9** |

Assume Gs=2.70

| Test Data Filename: | 13121B5D15.xls |
|---|---|

**SKETCH / PHOTO AFTER TEST:**

PHOTO FILE NAME: est In Process\13-121 - Dokken, 5th Street Bridge PSR P

| **Shear** | |
|---|---|
| Rate of Deformation (% strain / min) = | **1** |
| Confining Stress (ksf): | **6.34** |

**Failure Criterion:** **criterion 2 is used**

1. the maximum deviator stress within 15% strain
2. the stress at 10% strain for no peak stress.

| **At Failure** | |
|---|---|
| Deviator Stress (ksf) | **6.53** |
| Eff. Minor Principal Stress (ksf)= | **6.34** |
| Eff. Major Principal Stress (ksf)= | **12.87** |
| Axial Strain (%)= | **10.04** |

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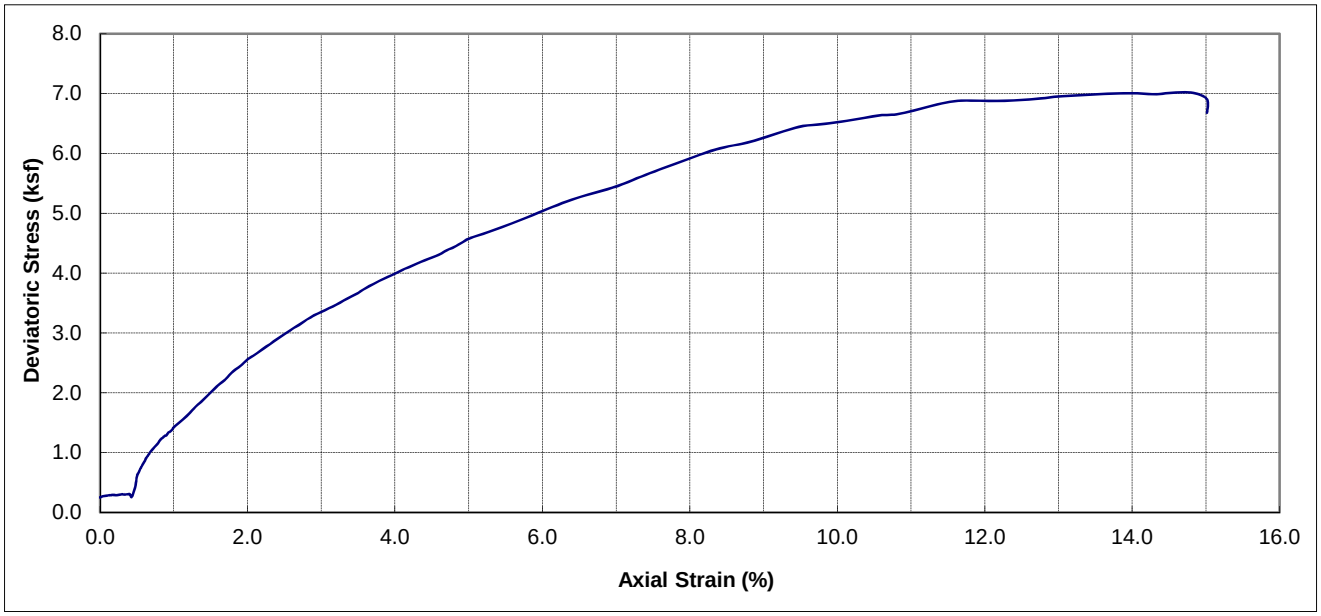


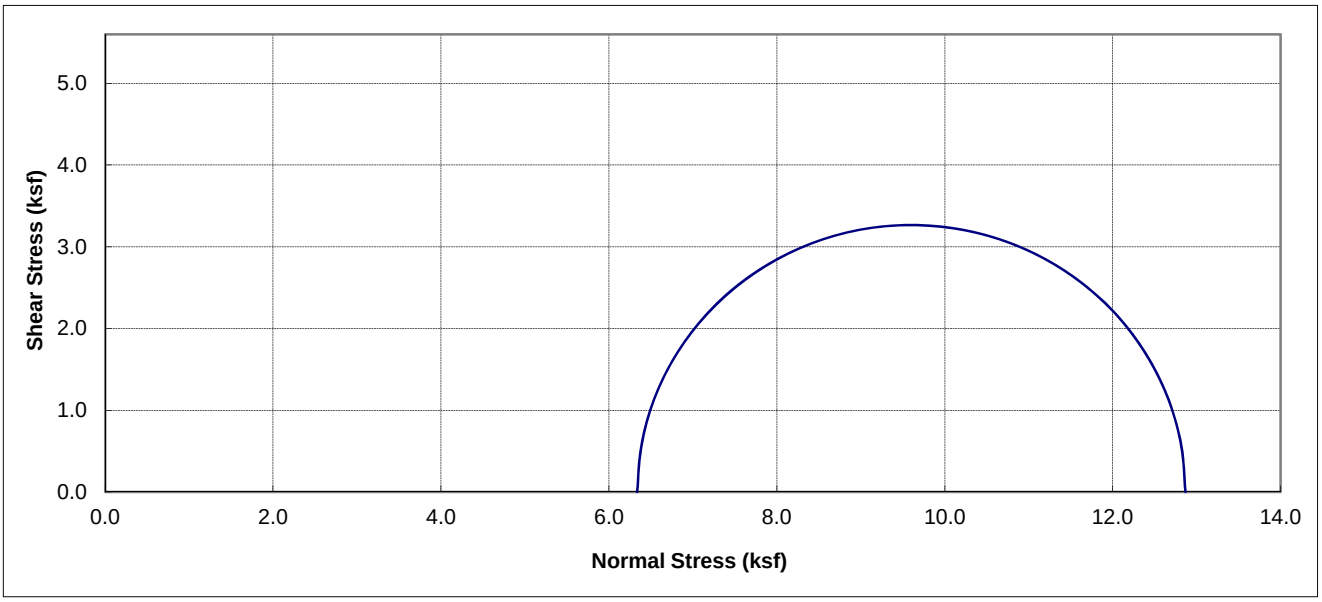


| Boring No. | Sample No. | Depth (ft) | Soil Type | Dry Density (pcf) | Moisture Content (%) | Conf. Stress (ksf) | 10% Axial Strain Dev. Stress (ksf) | Initial Saturation (%) |
|---|---|---|---|---|---|---|---|---|
| R-13-005 | D-15 | 80 | Olive to Gray , LEAN CLAY (CL) | 67.1 | 50.88 | 6.34 | 6.53 | 90.9 |

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**Dokken, 5th Street Bridge PSR PR**

**UNCONSOLIDATED UNDRAINED TEST**
**(ASTM D2850)**

Project No. : 13-1214 | Date : 11/02/13 | Figure No. :

# UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D2850

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Dokken, 5th Street Bridge PSR PR | | | **Project No:** | 13-1214 |
| **Boring No.:** | R-13-006 | **Tested by:** | RJ | **Date:** | 11/02/13 |
| **Depth (ft):** | 60 | **Checked by:** | | **Date:** | |
| **Sample No.** | D-12 | **Sample Type:** | R | | |

**Sample Description:** Gray , LEAN CLAY (CL)

| | 1 | 2 | 3 | | |
|---|---|---|---|---|---|
| Diameter (in.): | 2.41 | 2.418 | 2.415 | Average: | 2.414 |
| Height (in.): | 5.082 | 5.077 | 5.072 | Average: | 5.077 |

| **Moisture Content Calculation** | | |
|---|---|---|
| Wt. Wet Sample + Container (gms): | | 193.75 |
| Wt. Dry Sample + Container (gms): | | 151.22 |
| Container (gms) | No. 61 | 58.96 |
| Moisture Content (%) | | **46.1** |

| **Density and Saturation** | |
|---|---|
| Wt. Wet Sample + Container (gms) | 888.94 |
| Container (gms) | 228.92 |
| Wet Density (pcf) | **108.1** |
| Dry Density (pcf) | **74.0** |
| Void Ratio | **1.277** |
| % Saturation | **97.5** |

Assume Gs=2.70

| Test Data Filename: | 13121B6D12.trx |
|---|---|

**SKETCH / PHOTO AFTER TEST:**

PHOTO FILE NAME: est In Process\13-121 - Dokken, 5th Street Bridge PSR P

| **Shear** | |
|---|---|
| Rate of Deformation (% strain / min) = | **1** |
| Confining Stress (ksf): | **4.75** |

**Failure Criterion:** **criterion 1 is used**

1. the maximum deviator stress within 15% strain
2. the stress at 10% strain for no peak stress.

| **At Failure** | |
|---|---|
| Deviator Stress (ksf) | **8.97** |
| Eff. Minor Principal Stress (ksf)= | **4.75** |
| Eff. Major Principal Stress (ksf)= | **13.72** |
| Axial Strain (%)= | **10.53** |

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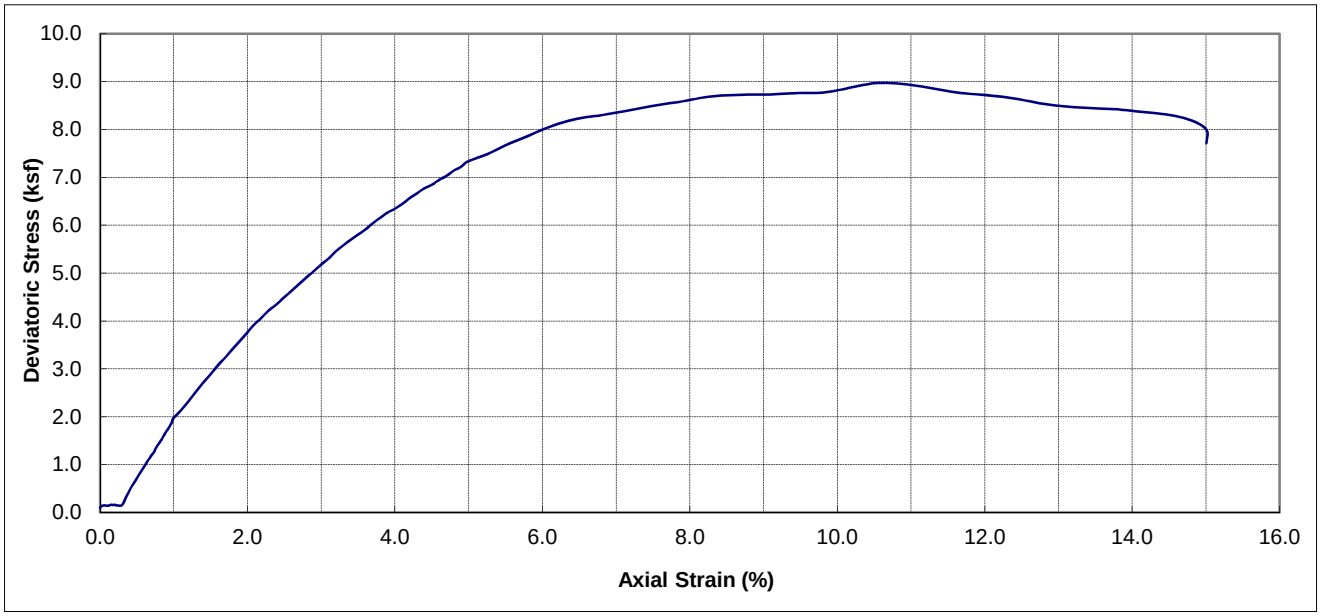


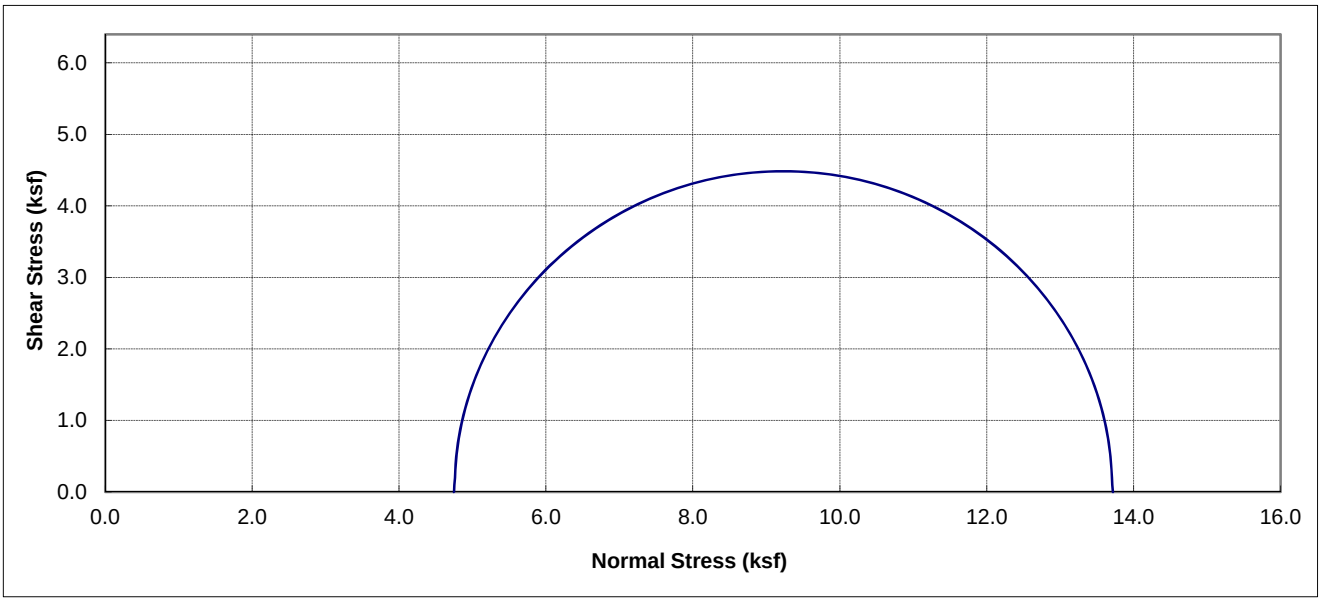


| Boring No. | Sample No. | Depth (ft) | Soil Type | Dry Density (pcf) | Moisture Content (%) | Conf. Stress (ksf) | 10% Axial Strain Dev. Stress (ksf) | Initial Saturation (%) |
|---|---|---|---|---|---|---|---|---|
| R-13-006 | D-12 | 60 | Gray , LEAN CLAY (CL) | 74.0 | 46.10 | 4.75 | 8.97 | 97.5 |

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**Dokken, 5th Street Bridge PSR PR**

**UNCONSOLIDATED UNDRAINED TEST**
**(ASTM D2850)**

Project No. : 13-1214 | Date : 11/02/13 | Figure No. :

# UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D2850

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Dokken, 5th Street Bridge PSR PR | | | **Project No:** | 13-1214 |
| **Boring No.:** | R-13-007 | **Tested by:** | RJ | **Date:** | 11/02/13 |
| **Depth (ft):** | 60 | **Checked by:** | | **Date:** | |
| **Sample No.** | D-12 | **Sample Type:** | R | | |

**Sample Description:** Gray , LEAN CLAY (CL)

| | 1 | 2 | 3 | | |
|---|---|---|---|---|---|
| Diameter (in.): | 2.42 | 2.425 | 2.419 | Average: | 2.421 |
| Height (in.): | 5.014 | 5.024 | 5.017 | Average: | 5.018 |

| **Moisture Content Calculation** | | |
|---|---|---|
| Wt. Wet Sample + Container (gms): | | 192.46 |
| Wt. Dry Sample + Container (gms): | | 153.52 |
| Container (gms) | No. 62 | 59.35 |
| Moisture Content (%) | | **41.4** |

| **Density and Saturation** | |
|---|---|
| Wt. Wet Sample + Container (gms) | 905.69 |
| Container (gms) | 228.92 |
| Wet Density (pcf) | **111.5** |
| Dry Density (pcf) | **78.9** |
| Void Ratio | **1.136** |
| % Saturation | **98.3** |

Assume Gs=2.70

| Test Data Filename: | 13121B7D12.xls |
|---|---|

**SKETCH / PHOTO AFTER TEST:**

PHOTO FILE NAME: est In Process\13-121 - Dokken, 5th Street Bridge PSR P

| **Shear** | |
|---|---|
| Rate of Deformation (% strain / min) = | **1** |
| Confining Stress (ksf): | **4.75** |

**Failure Criterion:** **criterion 2 is used**

1. the maximum deviator stress within 15% strain
2. the stress at 10% strain for no peak stress.

| **At Failure** | |
|---|---|
| Deviator Stress (ksf) | **9.02** |
| Eff. Minor Principal Stress (ksf)= | **4.75** |
| Eff. Major Principal Stress (ksf)= | **13.78** |
| Axial Strain (%)= | **10.04** |

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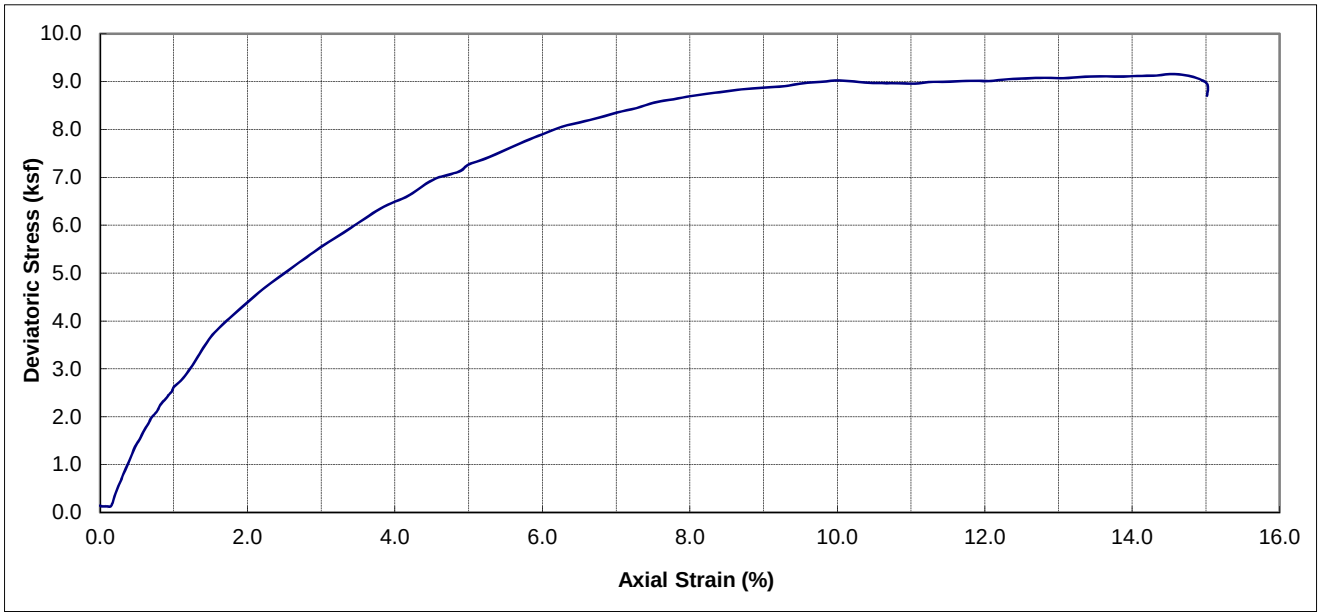


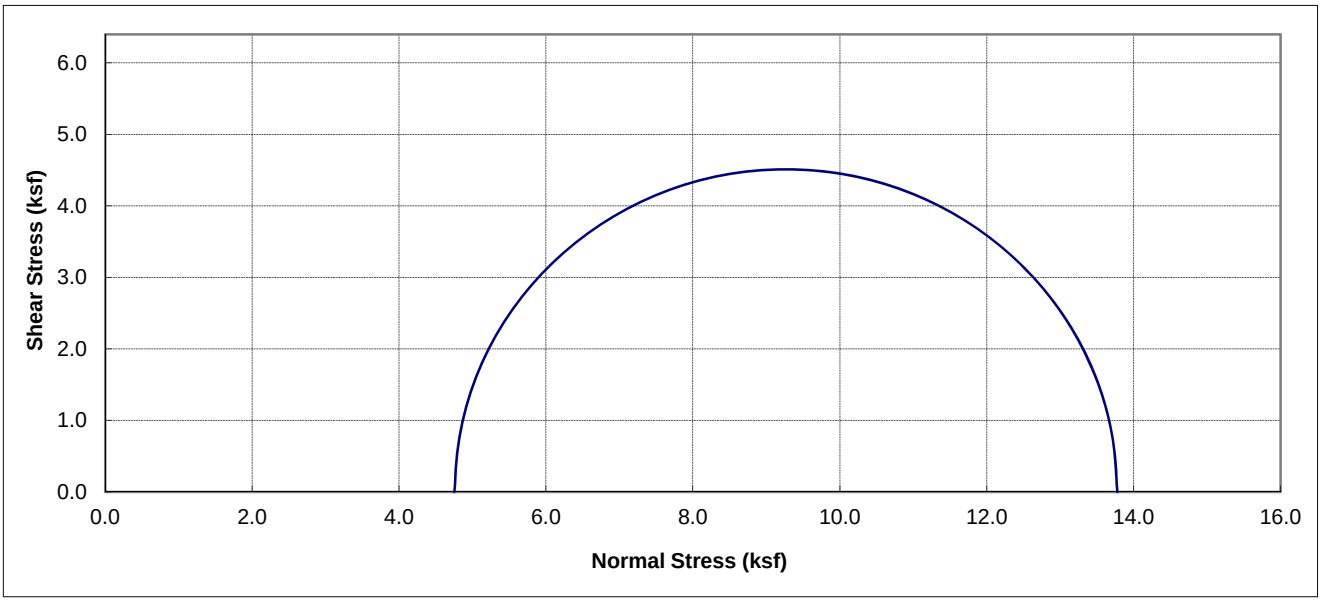


| Boring No. | Sample No. | Depth (ft) | Soil Type | Dry Density (pcf) | Moisture Content (%) | Conf. Stress (ksf) | 10% Axial Strain Dev. Stress (ksf) | Initial Saturation (%) |
|---|---|---|---|---|---|---|---|---|
| R-13-007 | D-12 | 60 | Gray , LEAN CLAY (CL) | 78.9 | 41.35 | 4.75 | 9.02 | 98.3 |

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**Dokken, 5th Street Bridge PSR PR**

**UNCONSOLIDATED UNDRAINED TEST**
**(ASTM D2850)**

Project No. : 13-1214 | Date : 11/02/13 | Figure No. :

# UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D2850

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Dokken, 5th Street Bridge PSR PR | | | **Project No:** | 13-121 |
| **Boring No.:** | R-13-004 | **Tested by:** | RJ | **Date:** | 01/02/14 |
| **Depth (ft):** | 90 | **Checked by:** | | **Date:** | |
| **Sample No.** | D-16 | **Sample Type:** | R | | |
| **Sample Description:** | Gray , CLAYSTONE (CH) | | | | |

| | 1 | 2 | 3 | | |
|---|---|---|---|---|---|
| Diameter (in.): | 2.413 | 2.416 | 2.42 | Average: | 2.416 |
| Height (in.): | 5.037 | 5.038 | 5.060 | Average: | 5.045 |

| **Moisture Content Calculation** | | |
|---|---|---|
| Wt. Wet Sample + Container (gms): | | 191.96 |
| Wt. Dry Sample + Container (gms): | | 157.75 |
| Container (gms) | No. 9 | 57.66 |
| Moisture Content (%) | | **34.2** |

| **Density and Saturation** | |
|---|---|
| Wt. Wet Sample + Container (gms) | 955.08 |
| Container (gms) | 228.92 |
| Wet Density (pcf) | **119.5** |
| Dry Density (pcf) | **89.1** |
| Void Ratio | **0.892** |
| % Saturation | **103.5** |

Assume Gs=2.70

| Test Data Filename: | 13121R4D16.trx |
|---|---|

**SKETCH / PHOTO AFTER TEST:**

PHOTO FILE NAME: st In Process\13-121 - Dokken, 5th Street Bridge PSR P

| **Shear** | |
|---|---|
| Rate of Deformation (% strain / min) = | **1** |
| Confining Stress (ksf): | **7.20** |

**Failure Criterion:** **criterion 1 is used**

1. the maximum deviator stress within 15% strain
2. the stress at 10% strain for no peak stress.

| **At Failure** | |
|---|---|
| Deviator Stress (ksf) | **17.83** |
| Eff. Minor Principal Stress (ksf)= | **7.20** |
| Eff. Major Principal Stress (ksf)= | **25.03** |
| Axial Strain (%)= | **7.78** |

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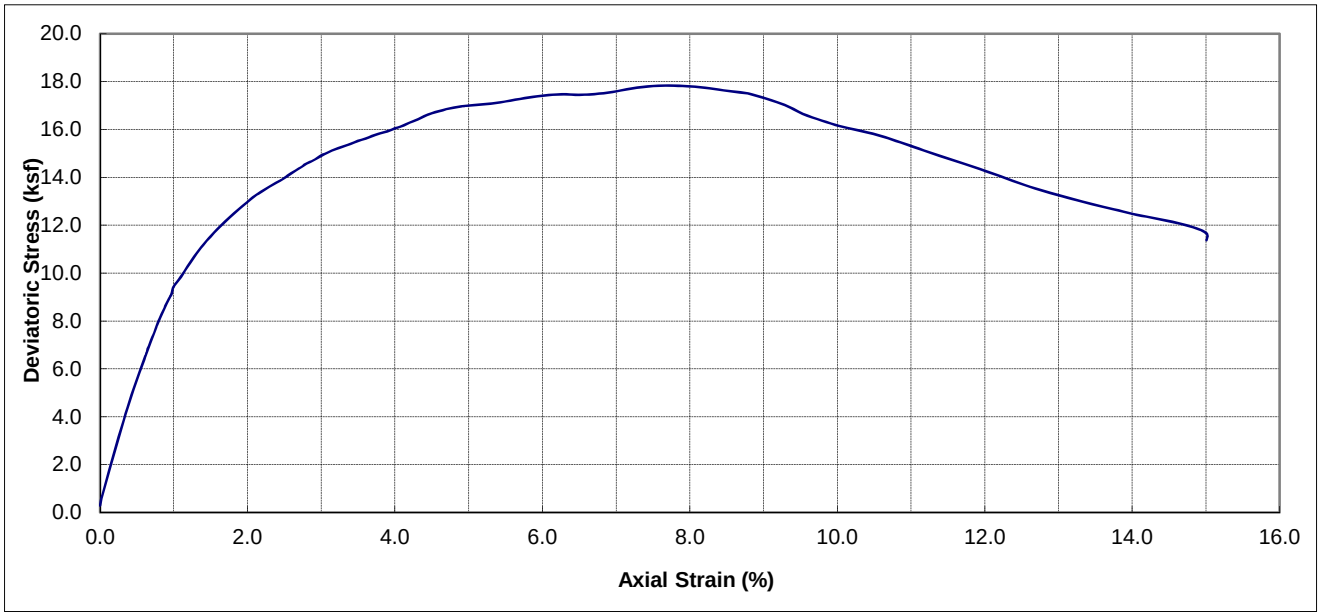


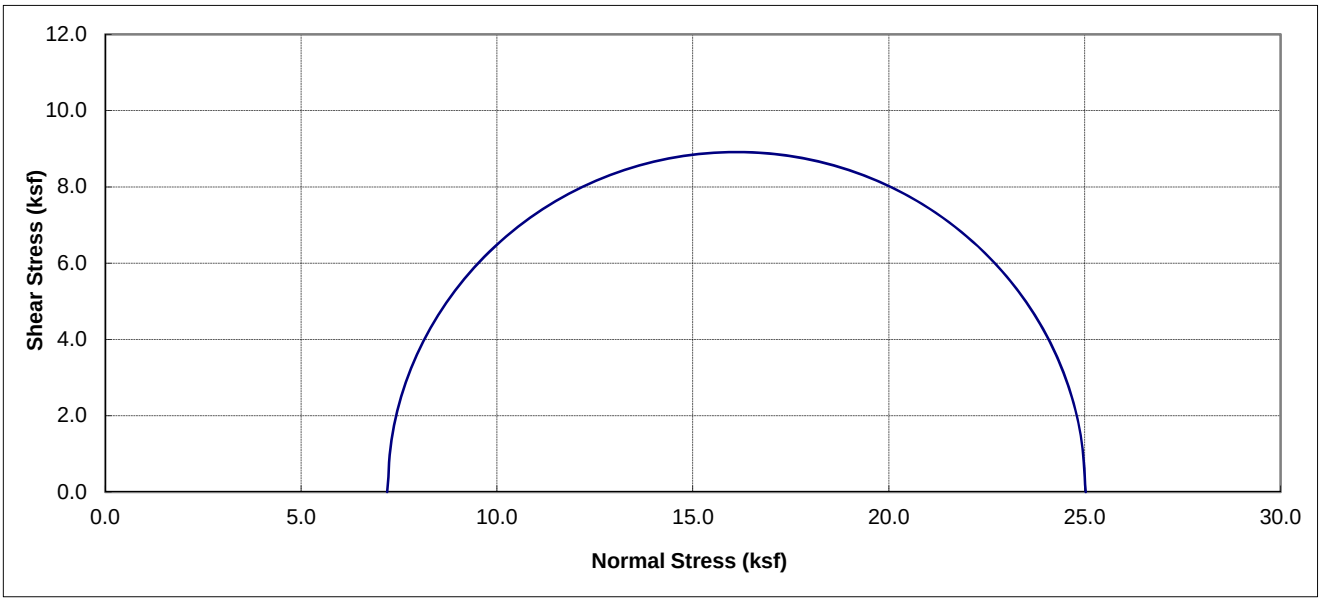


| Boring No. | Sample No. | Depth (ft) | Soil Type | Dry Density (pcf) | Moisture Content (%) | Conf. Stress (ksf) | 10% Axial Strain Dev. Stress (ksf) | Initial Saturation (%) |
|---|---|---|---|---|---|---|---|---|
| R-13-004 | D-16 | 90 | Gray , CLAYSTONE (CH) | 89.1 | 34.18 | 7.20 | 17.83 | 103.5 |

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Geotechnical and Earthquake Engineering

**Dokken, 5th Street Bridge PSR PR**

**UNCONSOLIDATED UNDRAINED TEST**
**(ASTM D2850)**

Project No. : 13-121 | Date : 01/02/14 | Figure No. :

# COMPACTION TEST

( ASTM D-1557-91 )

| | | | | | |
|---|---|---|---|---|---|
| Project Name : | Dokken, 5th Street Bridge PSR PR | | | | |
| Project No. : | 13-121 | Sampleing By : | | Date : | |
| Boring No. : | HA-13-14 | Prepared By : | TK | Date : | |
| Sample No. : | B-0 | Test By : | KK | Date : | 3/21/2016 |
| Depth ( ft/m ) : | | Calculated By : | JF | Date : | 3/23/2016 |
| Location : | | Checked By : | RJ | Date : | |
| Description : | Brown, SANDY lean CLAY (CL) | | | | 1 |

| Estimated Moisture Content (%) | Field | 10 | 4 | 6 | 8 |
|---|---|---|---|---|---|
| Container Number | | S-57 | S-58 | S-52 | |
| Wt. of Wet Soil + Container (gm) | | 552.64 | 584.98 | 611.47 | |
| Wt. of Dry Soil + Container (gm) | | 518.48 | 536.84 | 547.56 | |
| Weight of Container (gm) | | 64.66 | 62.70 | 63.09 | |
| Moisture Content (%) | | 7.53 | 10.15 | 13.19 | |
| Weight of Wet Soil + Mold (gm) | | 3945.00 | 4045.00 | 4005.00 | |
| Weight of Mold (gm) | 1960.00 | 1960.00 | 1960.00 | 1960.00 | 1960.00 |
| Wet Density (pcf) | | 131.41 | 138.03 | 135.39 | |
| Dry Density (pcf) | | 122.22 | 125.31 | 119.61 | |

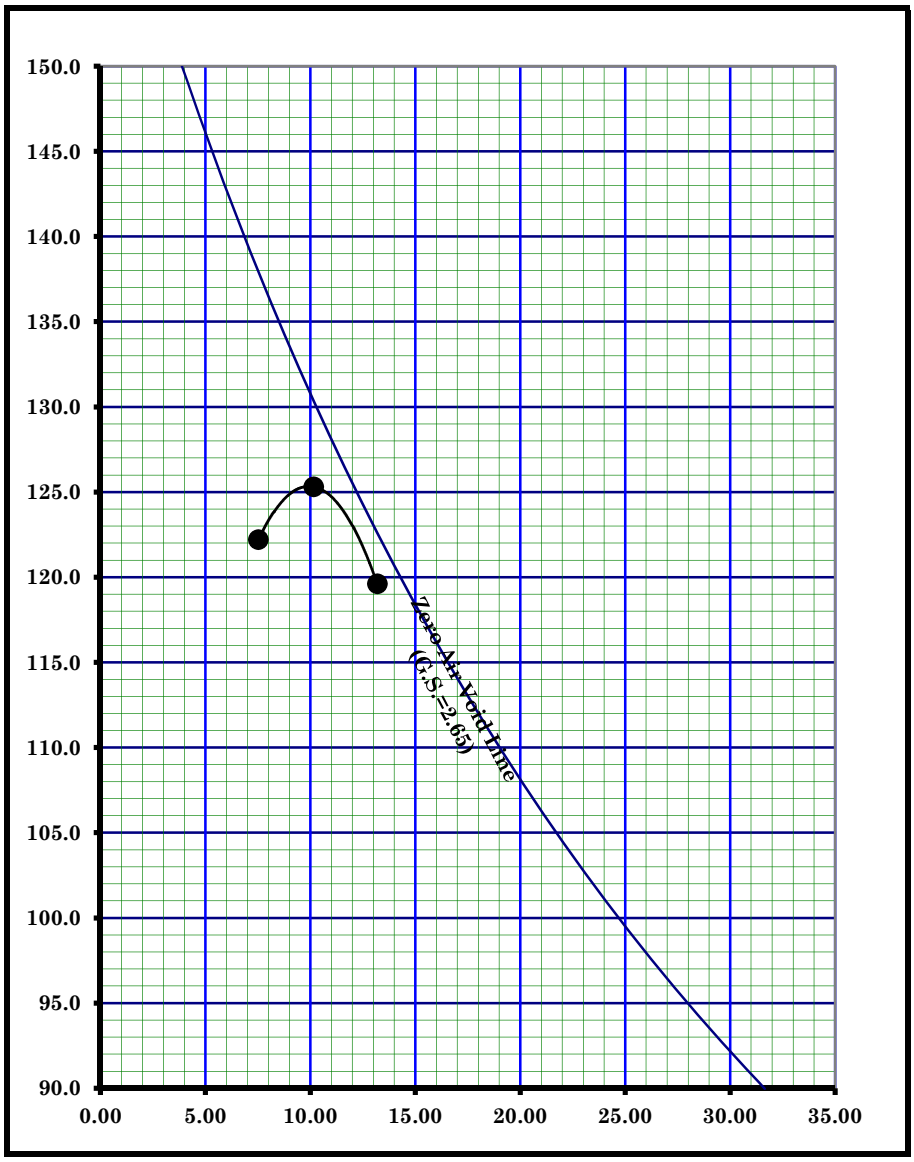
Hammer Weight : 10 (lb.)

Hammer Drop : 18"

| Rammer Used | | |
|---|---|---|
| | Manual | |
| | Mechanical | X |

Total Wt. of Soil : 22340.00

| Sieve | Weight Sample Retained | % of | % of Passing |
|---|---|---|---|
| 3/4" | 0.00 | 0.00 | 100.00 |
| 3/8" | 0.00 | 0.00 | 100.00 |
| No. 4 | 3290.00 | 14.73 | 85.27 |




| Mold Volume ($ft^3$) | 0.0333 |
|---|---|

## Test Method

**A** — 4" Mold; 5 Layer; 25 Blow / Layer

X — Material Passing No. 4 Sieve; If < 20% Material + No. 4 Sieve

Mold Volume ($ft^3$) = 0.0333

**B** — 4" Mold; 5 Layer; 25 Blow / Layer

# — Material Passing 3/8" Sieve; If > 20% Material + No. 4 Sieve; < 20% Material + 3/8" Sieve

Mold Volume ($ft^3$) = 0.0333

**C** — 6" Mold; 5 Layer; 56 Blow / Layer

# — Material Passing 3/4" Sieve; If > 20% Material + 3/8" Sieve; < 30% Material + 3/4" Sieve

Mold Volume ($ft^3$) = 0.07502

**Other** — 6" Mold; 5 Layer; 56 Blow / Layer

If test Specimen > 5% by weight of Oversize (Coarse Fraction) and material will not be included in the tests. (>40%+No.4, >30%+3/4" Sieve)

Correction must be made to the unit weight and water content of test specimen

| Maximun Density | | | | Optium Moisture |
|---|---|---|---|---|
| Dry | | Wet | | |
| (pcf) | ($kN/m^3$) | (pcf) | ($kN/m^3$) | (%) |
| 125.5 | 19.8 | 138.1 | 21.7 | 10.0 |

# COMPACTION TEST

( ASTM D-1557-91 )

| | | | | | |
|---|---|---|---|---|---|
| Project Name : | Dokken, 5th Street Bridge PSR PR | | | | |
| Project No. : | 13-121 | Sampleing By : | | Date : | |
| Boring No. : | A-13-01 | Prepared By : | TK | Date : | |
| Sample No. : | B-0 | Test By : | KK | Date : | 3/21/2016 |
| Depth ( ft/m ) : | | Calculated By : | JF | Date : | 3/23/2016 |
| Location : | | Checked By : | RJ | Date : | |
| Description : | Brown, SILTY SAND (SM) | | | | 1 |

| Estimated Moisture Content (%) | Field | 10 | 4 | 6 | 8 |
|---|---|---|---|---|---|
| Container Number | | M-1 | M-2 | M-3 | |
| Wt. of Wet Soil + Container (gm) | | 504.36 | 477.49 | 611.62 | |
| Wt. of Dry Soil + Container (gm) | | 472.56 | 441.80 | 547.85 | |
| Weight of Container (gm) | | 147.62 | 147.89 | 147.14 | |
| Moisture Content (%) | | 9.79 | 12.14 | 15.91 | |
| Weight of Wet Soil + Mold (gm) | | 3490.00 | 3625.00 | 3675.00 | |
| Weight of Mold (gm) | 1960.00 | 1960.00 | 1960.00 | 1960.00 | 1960.00 |
| Wet Density (pcf) | | 101.29 | 110.23 | 113.54 | |
| Dry Density (pcf) | | 92.26 | 98.29 | 97.95 | |

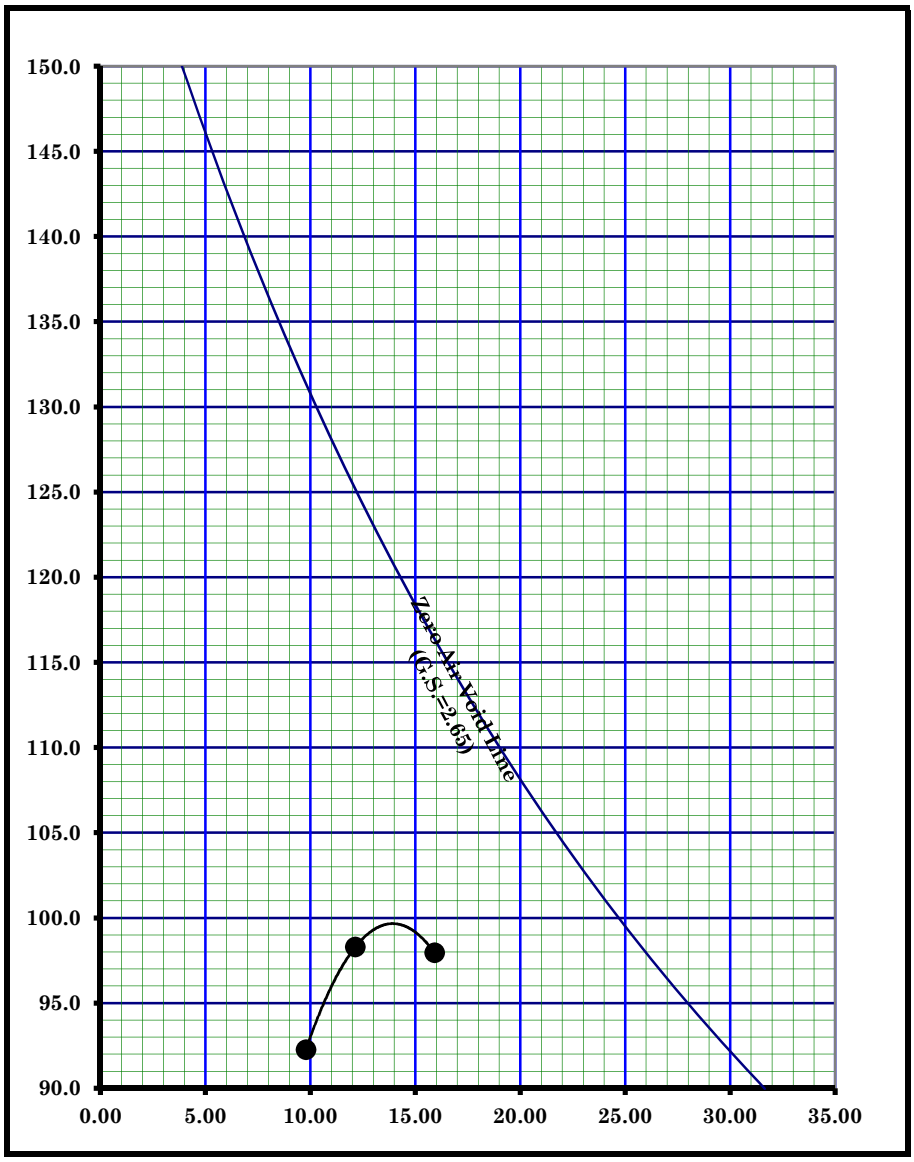
Hammer Weight : 10 (lb.)

Hammer Drop : 18"

| Rammer Used | | |
|---|---|---|
| | Manual | |
| | Mechanical | X |

Total Wt. of Soil : 22340.00

| Sieve | Weight Sample Retained | % of | % of Passing |
|---|---|---|---|
| 3/4" | 0.00 | 0.00 | 100.00 |
| 3/8" | 0.00 | 0.00 | 100.00 |
| No. 4 | 3290.00 | 14.73 | 85.27 |




| Mold Volume ($ft^3$) | 0.0333 |
|---|---|

## Test Method

**A** — 4" Mold; 5 Layer; 25 Blow / Layer

X — Material Passing No. 4 Sieve; If < 20% Material + No. 4 Sieve

Mold Volume ($ft^3$) = 0.0333

**B** — 4" Mold; 5 Layer; 25 Blow / Layer

# — Material Passing 3/8" Sieve; If > 20% Material + No. 4 Sieve; < 20% Material + 3/8" Sieve

Mold Volume ($ft^3$) = 0.0333

**C** — 6" Mold; 5 Layer; 56 Blow / Layer

# — Material Passing 3/4" Sieve; If > 20% Material + 3/8" Sieve; < 30% Material + 3/4" Sieve

Mold Volume ($ft^3$) = 0.07502

**Other** — 6" Mold; 5 Layer; 56 Blow / Layer

If test Specimen > 5% by weight of Oversize (Coarse Fraction) and material will not be included in the tests. (>40%+No.4, >30%+3/4" Sieve)

Correction must be made to the unit weight and water content of test specimen

| Maximun Density | | | | Optium Moisture |
|---|---|---|---|---|
| Dry | | Wet | | |
| (pcf) | ($kN/m^3$) | (pcf) | ($kN/m^3$) | (%) |
| 100.0 | 15.7 | 114.0 | 17.9 | 14.0 |

# COMPACTION TEST

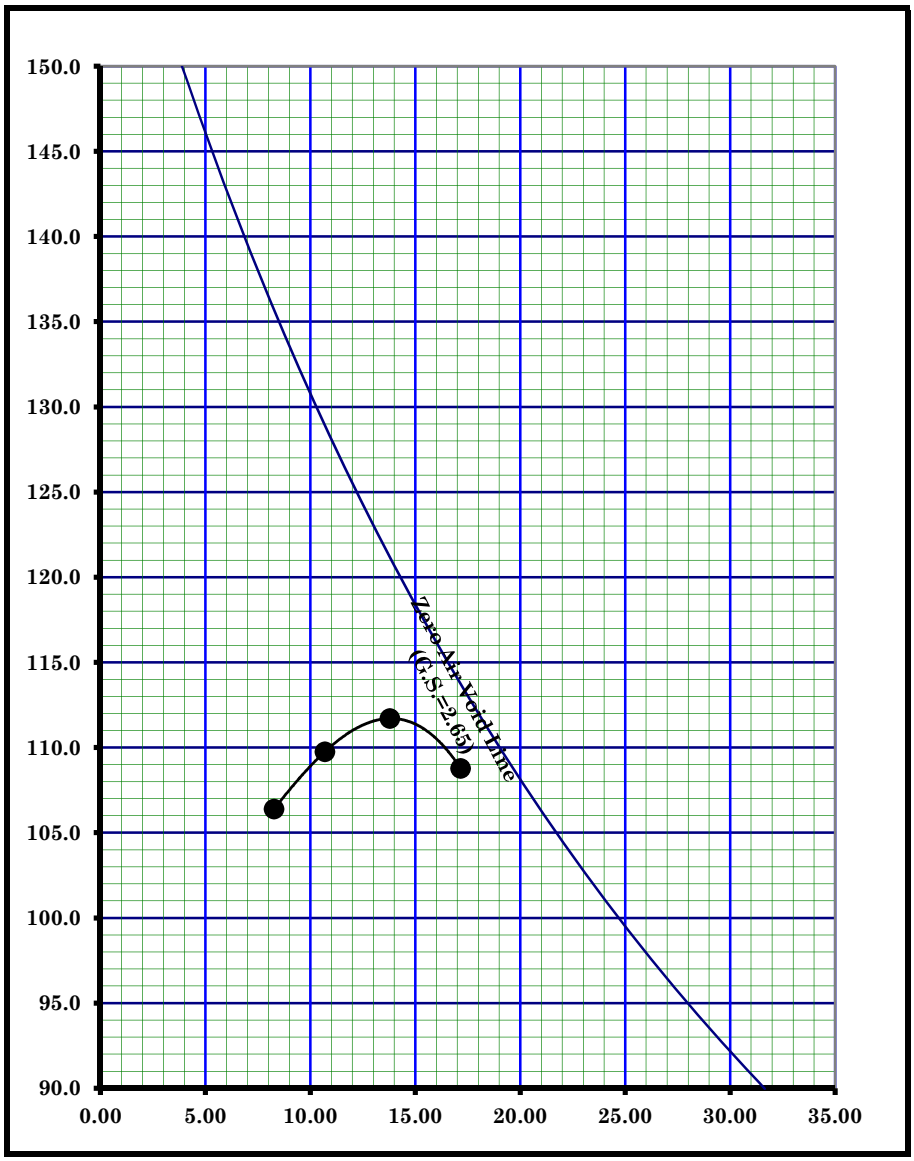
( ASTM D-1557-91 )

| | | | | | |
|---|---|---|---|---|---|
| Project Name : | Dokken, 5th Street Bridge PSR PR | | | | |
| Project No. : | 13-121 | Sampleing By : | | Date : | |
| Boring No. : | R-13-011 | Prepared By : | TK | Date : | |
| Sample No. : | B-0 | Test By : | KK | Date : | 3/21/2016 |
| Depth ( ft/m ) : | | Calculated By : | JF | Date : | 3/23/2016 |
| Location : | | Checked By : | RJ | Date : | |
| Description : | Brown, SANDY lean CLAY (CL) | | | | 1 |

| Estimated Moisture Content (%) | Field | 10 | 4 | 6 | 8 |
|---|---|---|---|---|---|
| Container Number | | S-44 | S-17 | S-23 | S-10 |
| Wt. of Wet Soil + Container (gm) | | 471.91 | 517.65 | 485.58 | 557.34 |
| Wt. of Dry Soil + Container (gm) | | 442.95 | 478.78 | 440.51 | 493.17 |
| Weight of Container (gm) | | 92.97 | 115.12 | 113.68 | 119.08 |
| Moisture Content (%) | | 8.27 | 10.69 | 13.79 | 17.15 |
| Weight of Wet Soil + Mold (gm) | | 3700.00 | 3795.00 | 3880.00 | 3885.00 |
| Weight of Mold (gm) | 1960.00 | 1960.00 | 1960.00 | 1960.00 | 1960.00 |
| Wet Density (pcf) | | 115.19 | 121.48 | 127.11 | 127.44 |
| Dry Density (pcf) | | 106.39 | 109.75 | 111.71 | 108.78 |

| | | | |
|---|---|---|---|
| Hammer Weight : 10 (lb.) | | | |
| Hammer Drop : 18" | | | |
| Rammer Used | Manual | | |
| | Mechanical | X | |
| Total Wt. of Soil : | 22340.00 | | |

| Sieve | Weight Sample Retained | % of | % of Passing |
|---|---|---|---|
| 3/4" | 0.00 | 0.00 | 100.00 |
| 3/8" | 0.00 | 0.00 | 100.00 |
| No. 4 | 3290.00 | 14.73 | 85.27 |




| Mold Volume ($ft^3$) | 0.0333 |
|---|---|

## Test Method

**A** — 4" Mold; 5 Layer; 25 Blow / Layer

[X] Material Passing No. 4 Sieve
If < 20% Material + No. 4 Sieve
Mold Volume ($ft^3$) = 0.0333

**B** — 4" Mold; 5 Layer; 25 Blow / Layer

[#] Material Passing 3/8" Sieve
If > 20% Material + No. 4 Sieve
< 20% Material + 3/8" Sieve
Mold Volume ($ft^3$) = 0.0333

**C** — 6" Mold; 5 Layer; 56 Blow / Layer

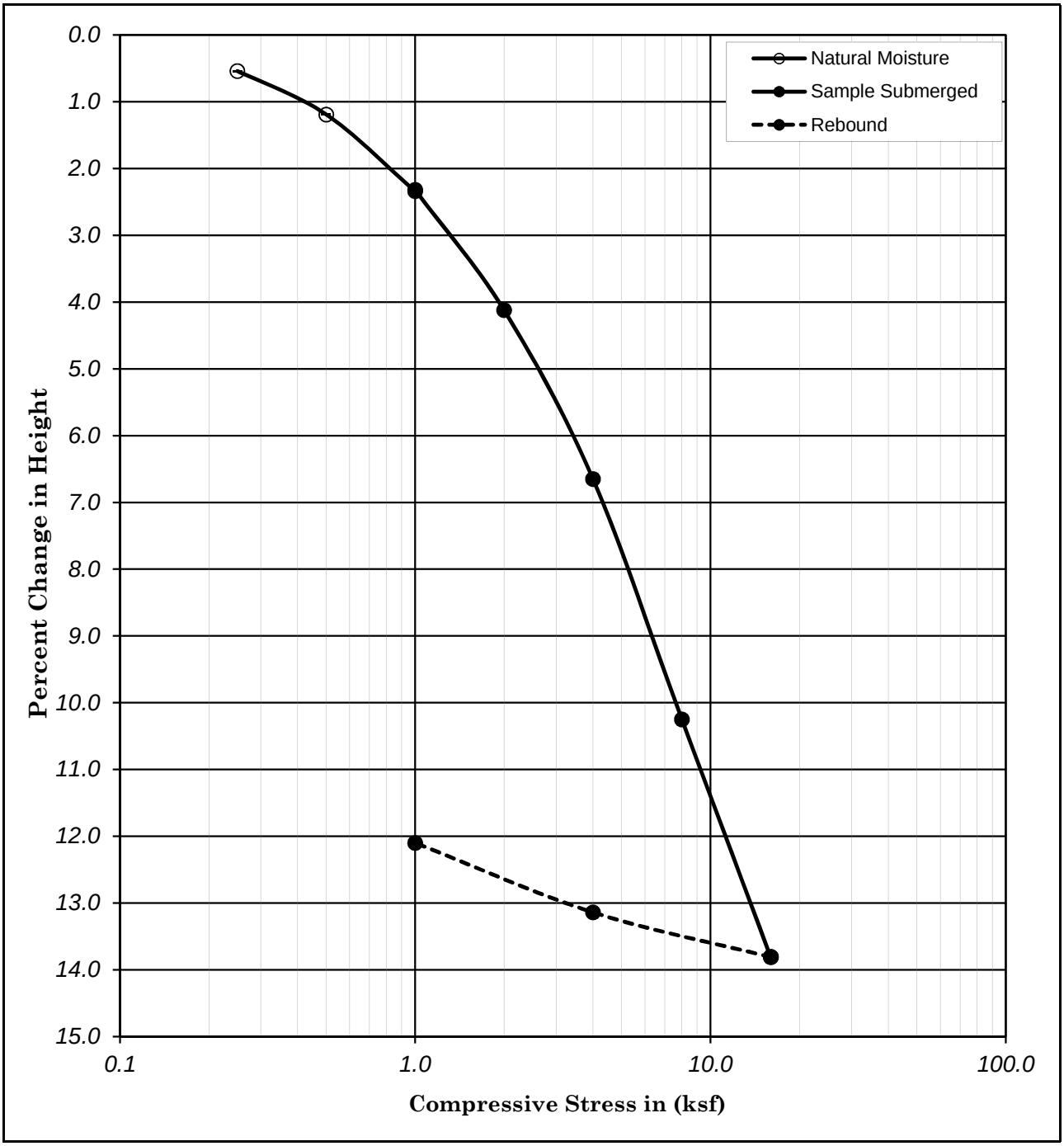
[#] Material Passing 3/4" Sieve
If > 20% Material + 3/8" Sieve
< 30% Material + 3/4" Sieve
Mold Volume ($ft^3$) = 0.07502

**Other** — 6" Mold; 5 Layer; 56 Blow / Layer

[ ] If test Specimen > 5% by weight of Oversize (Coarse Fraction) and material will not be included in the tests. (>40%+No.4, >30%+3/4" Sieve)

Correction must be made to the unit weight and water content of test specimen

| Maximun Density | | | | Optium Moisture |
|---|---|---|---|---|
| Dry | | Wet | | |
| (pcf) | ($kN/m^3$) | (pcf) | ($kN/m^3$) | (%) |
| 112.0 | 17.6 | 127.7 | 20.1 | 14.0 |




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring No. | : R-13-010 | | | Liquid Limit : | - | | Moisture Content (%) | Dry Density (pcf) | Dry Density (kN/m³) | Percent Saturation | Void Ratio |
| Sample No. | : D-9 | | | Plastic Limit : | - | | | | | | |
| Depth (ft) | : 45.0 | 46.5 | | Plastic Index : | - | Initial | 39.28 | 83.19 | 13.09 | 103.33 | 1.03 |
| Depth (m) | : 13.73 | 14.18 | | Specific Gravity : | 2.70 | Final | 31.57 | 94.65 | 14.90 | 109.16 | 0.78 |

Description : Olive-brown, SANDY SILT (ML)

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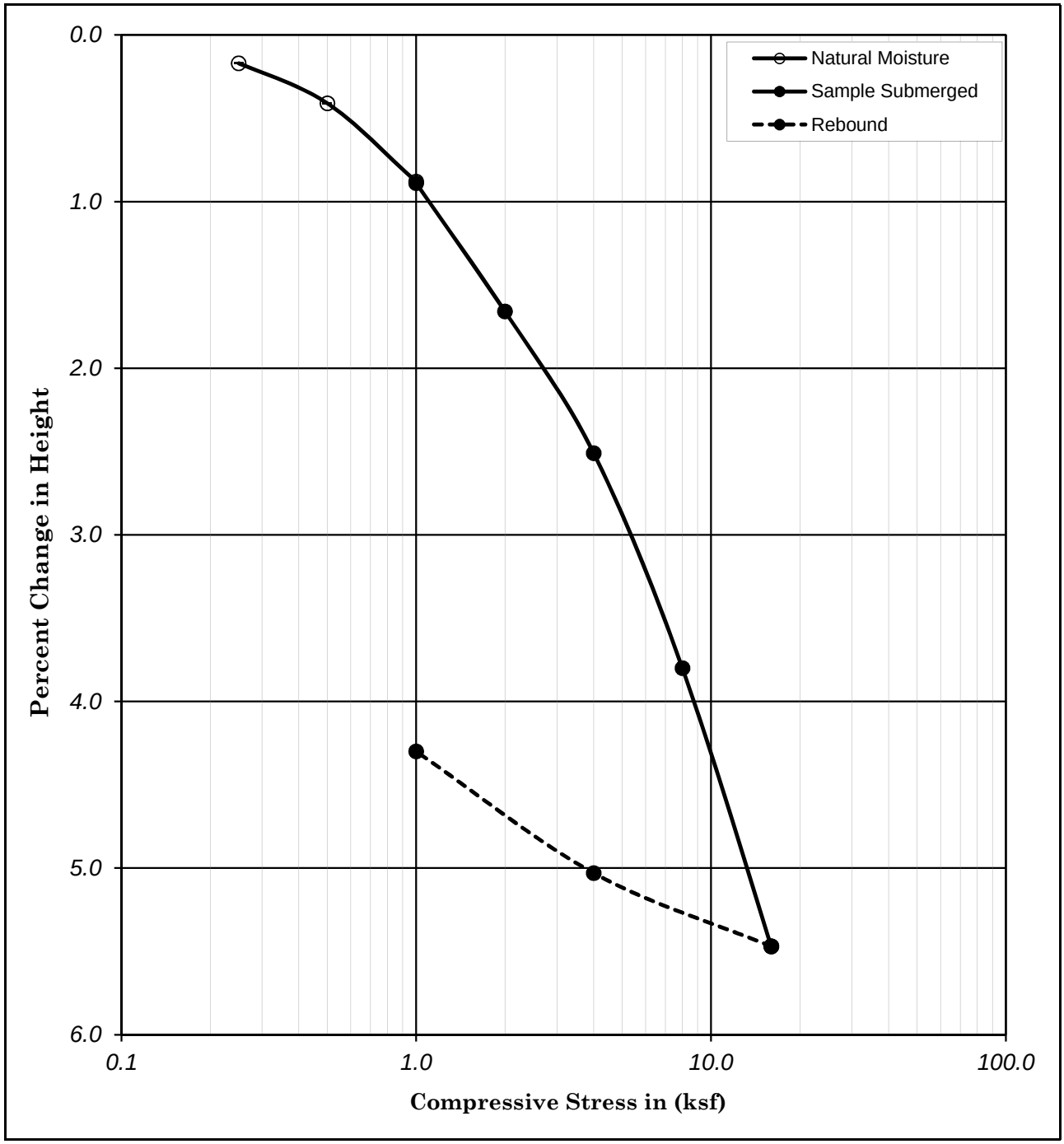
Geotechnical and Earthquake Engineering

Dokken, 5th Street Bridge PSR PR

Project No. : 13-121 11/20/13

# CONSOLIDATION TEST
( ASTM D-2435 / CT-219 )




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring No. | : R-13-012 | | | Liquid Limit : | - | | Moisture Content (%) | Dry Density (pcf) | Dry Density (kN/m³) | Percent Saturation | Void Ratio |
| Sample No. | : D-11 | | | Plastic Limit : | - | | | | | | |
| Depth | (ft) : | 56.5 | 58.0 | Plastic Index : | - | Initial | 34.68 | 88.78 | 13.97 | 104.18 | 0.90 |
| | (m) : | 17.23 | 17.69 | Specific Gravity : | 2.70 | Final | 32.69 | 92.78 | 14.60 | 108.05 | 0.82 |

Description : Dark olive-brown, SILTY SAND (SM)

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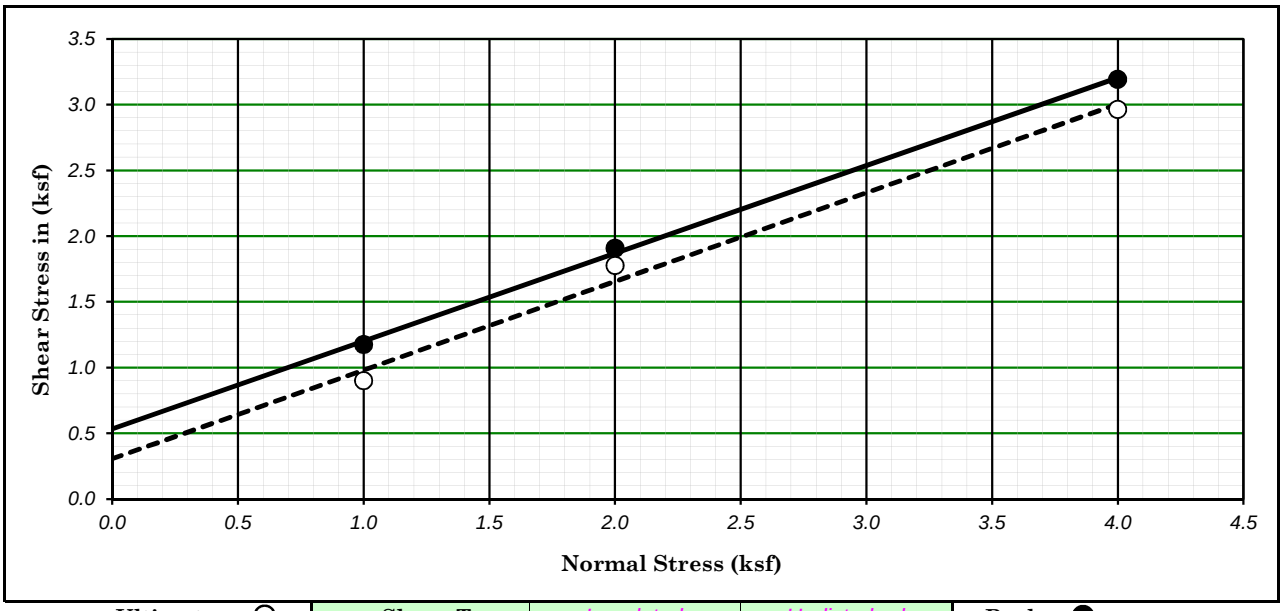
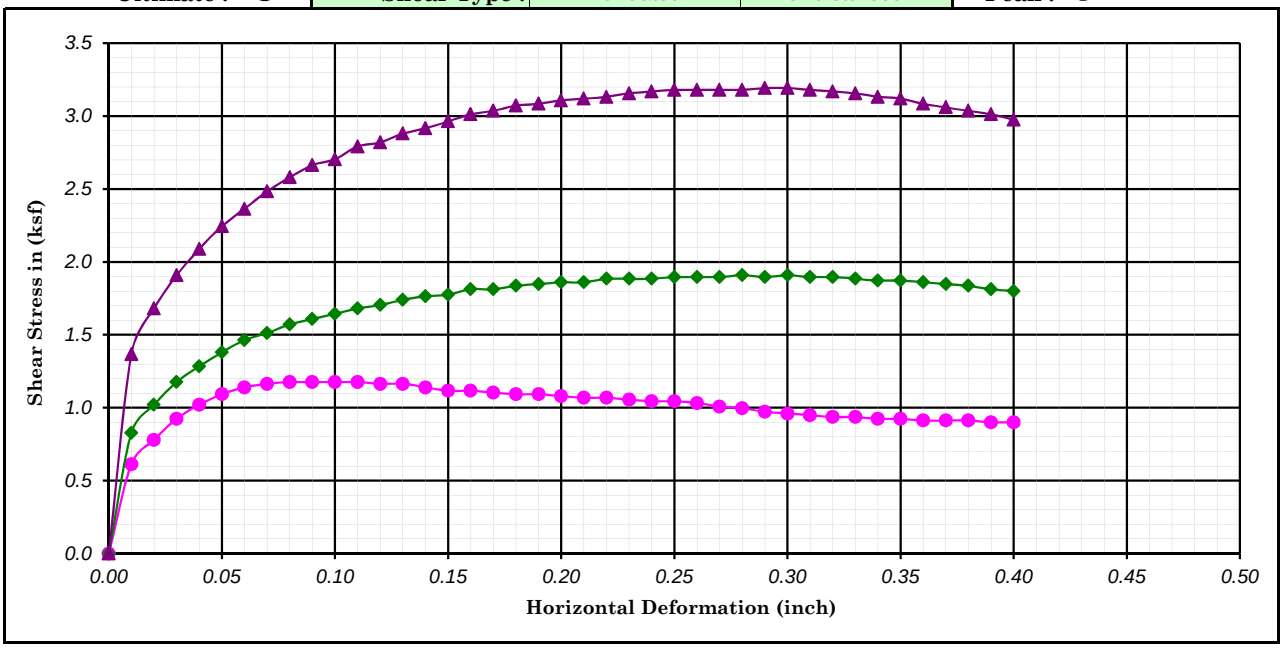
Dokken, 5th Street Bridge PSR PR

Project No. : 13-121 11/20/13

# CONSOLIDATION TEST
( ASTM D-2435 / CT-219 )




| Ultimate : ○ | Shear Type : | Inundated | Undisturbed | Peak : ● |
|---|---|---|---|---|




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. : R-13-001 | | Strength Intercept (C) : | 0.53 | (ksf) | Peak | 0.31 | (ksf) | Ultimate |
| Sample No. : B-0 | | | 25.57 | (kPa) | | 14.65 | (kPa) | |
| Depth (ft/m) : 0.0 | 0.00 | Friction Angle ( ϕ ) : | 33.73 | Degree | | 34.00 | Degree | |
| Description : Dark brown, SILTY SAND (SM) | | | | | Shear Rate (inch/minute) : | | 0.02 | |

| SYMBOL | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | DRY DENSITY ($kN/m^3$) | VOID RATIO | NORMAL STRESS (ksf) | NORMAL STRESS (kPa) | PEAK STRESS (ksf) | PEAK STRESS (kPa) | ULTIMATE STRESS (ksf) | ULTIMATE STRESS (kPa) |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 14.01 | 88.27 | 13.89 | 0.91 | 1.00 | 47.88 | 1.18 | 56.31 | 0.90 | 43.09 |
| ◆ | 13.72 | 88.56 | 13.94 | 0.90 | 2.00 | 95.76 | 1.91 | 91.36 | 1.78 | 85.03 |
| ▲ | 14.50 | 88.61 | 13.95 | 0.90 | 4.00 | 191.52 | 3.19 | 152.83 | 2.96 | 141.92 |
| | | | | | | | | | | |

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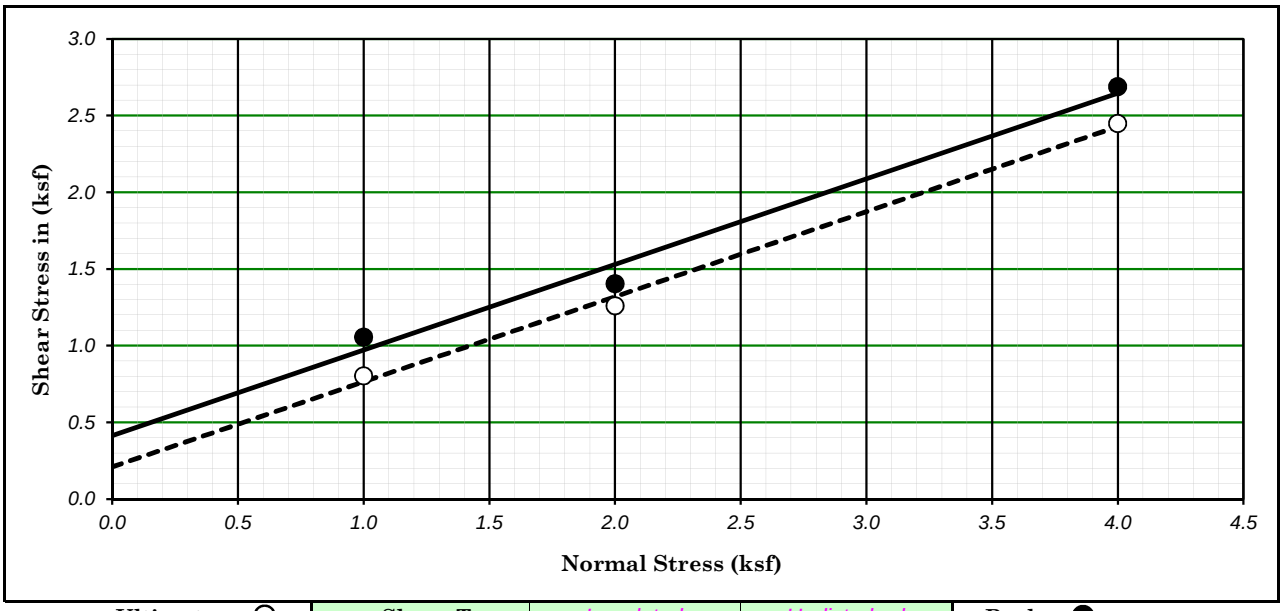
Dokken, 5th Street Bridge PSR PR

# DIRECT SHEAR TEST (ASTM D-3080)

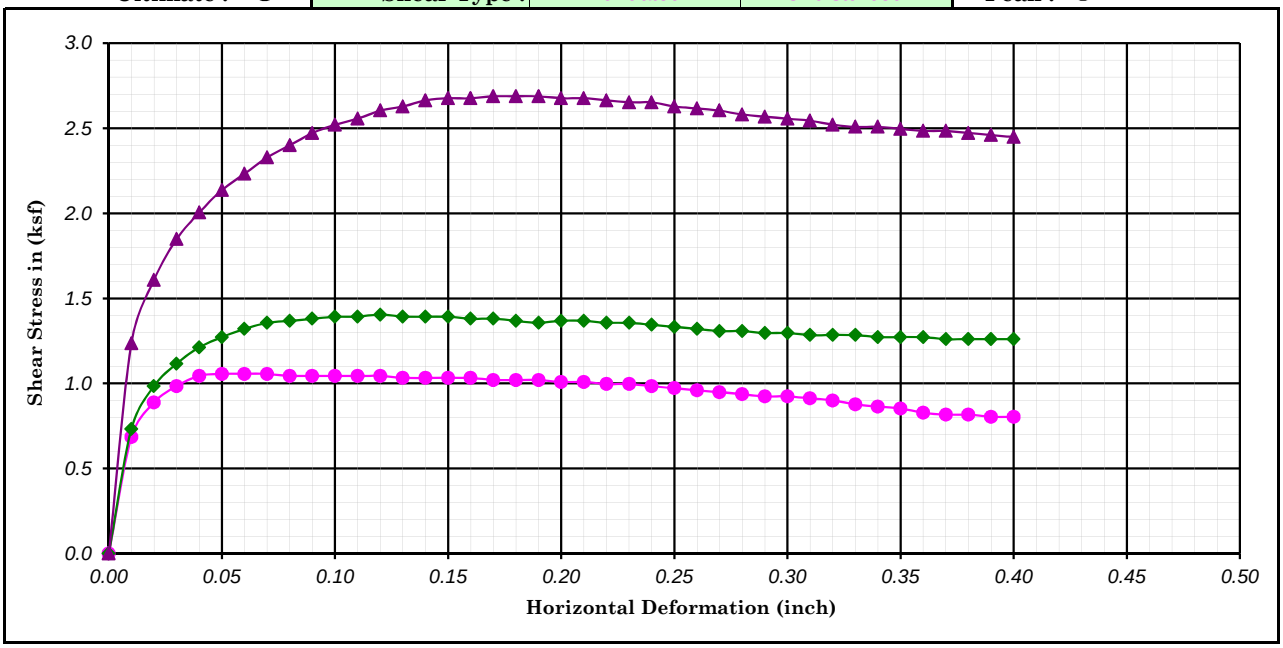
Project No. : 13-121

Date :

Figure No. :




| Ultimate : ○ | Shear Type : | Inundated | Undisturbed | Peak : ● |
|---|---|---|---|---|




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. : R-13-011 | | Strength Intercept (C) : | 0.41 | (ksf) | Peak | 0.21 | (ksf) | Ultimate |
| Sample No. : B-0 | | | 19.82 | (kPa) | | 10.05 | (kPa) | |
| Depth (ft/m) : 0.0 | 0.00 | Friction Angle ( ϕ ) : | 29.16 | Degree | | 29.01 | Degree | |
| Description : Dark brown, SANDY lean CLAY (CL) | | | | | Shear Rate (inch/minute) : | | 0.02 | |

| SYMBOL | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | DRY DENSITY ($kN/m^3$) | VOID RATIO | NORMAL STRESS (ksf) | NORMAL STRESS (kPa) | PEAK STRESS (ksf) | PEAK STRESS (kPa) | ULTIMATE STRESS (ksf) | ULTIMATE STRESS (kPa) |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 26.37 | 91.39 | 14.38 | 0.84 | 1.00 | 47.88 | 1.06 | 50.56 | 0.80 | 38.50 |
| ◆ | 25.09 | 92.64 | 14.58 | 0.82 | 2.00 | 95.76 | 1.40 | 67.22 | 1.26 | 60.33 |
| ▲ | 25.60 | 90.95 | 14.32 | 0.85 | 4.00 | 191.52 | 2.69 | 128.70 | 2.45 | 117.21 |
| | | | | | | | | | | |

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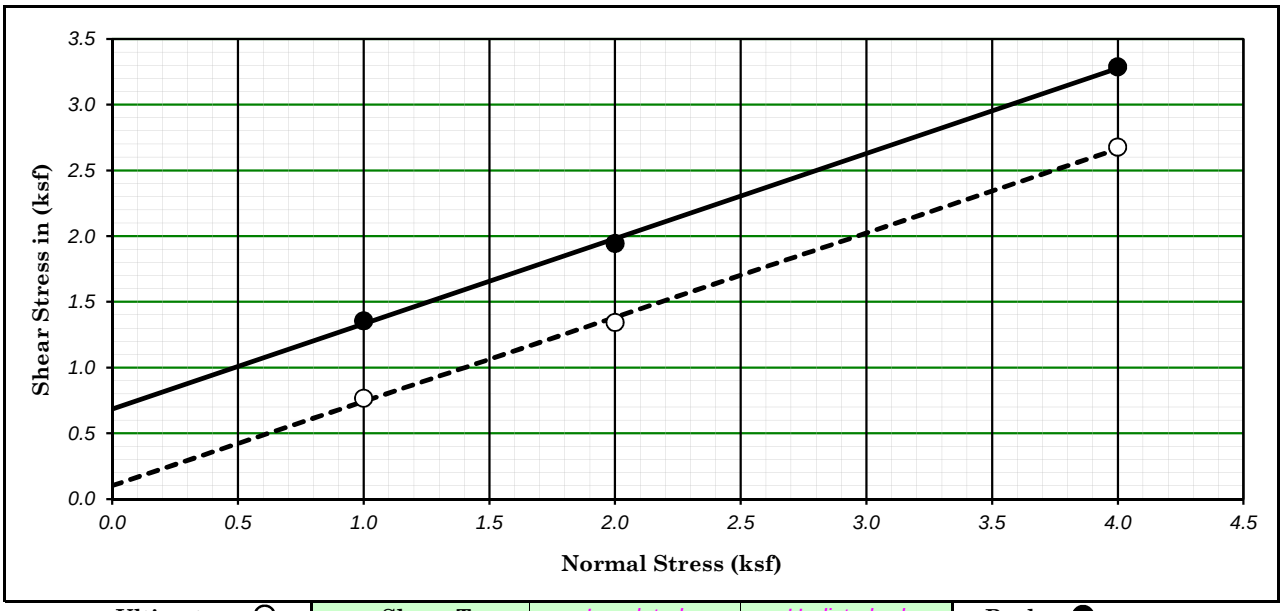
# DIRECT SHEAR TEST (ASTM D-3080)

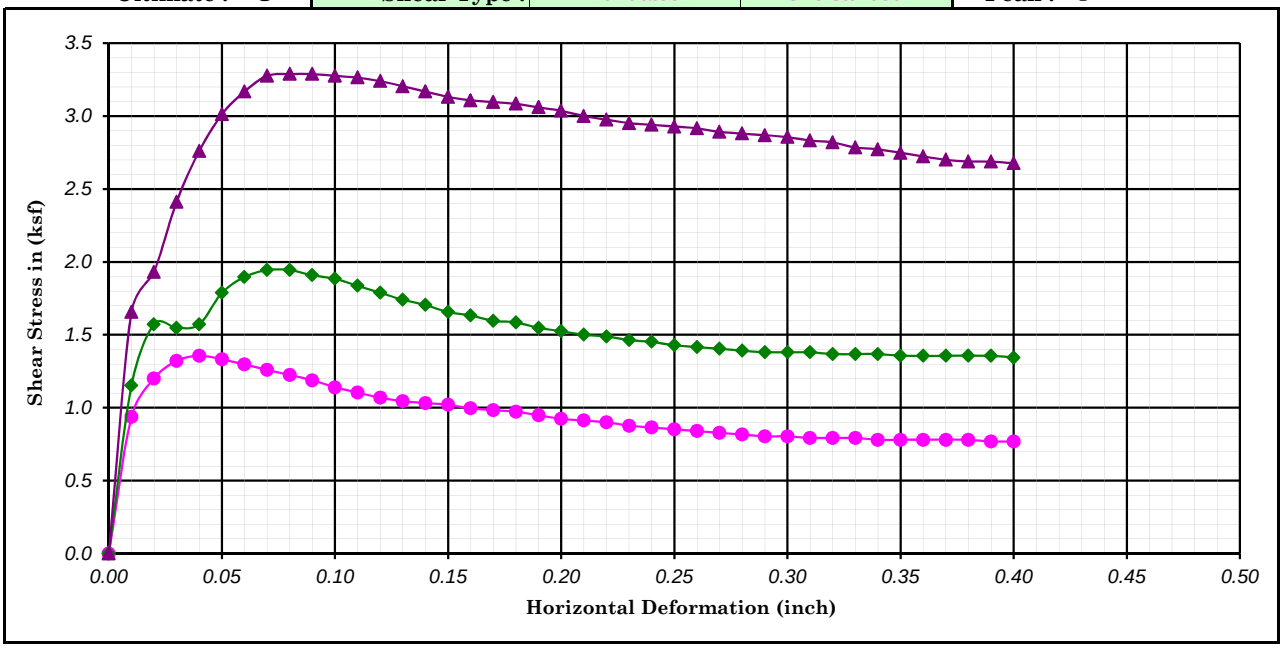
Project No. : 13-121

Date :

Figure No. :




| Ultimate : ○ | Shear Type : | Inundated | Undisturbed | Peak : ● |
|---|---|---|---|---|




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. : HA-13-014 | | Strength Intercept (C) : | 0.68 | (ksf) | Peak | 0.10 | (ksf) | Ultimate |
| Sample No. : B-0 | | | 32.75 | (kPa) | | 4.88 | (kPa) | |
| Depth (ft/m) : 0.0 | 0.00 | Friction Angle ( ϕ ) : | 32.94 | Degree | | 32.63 | Degree | |
| Description : Dark brown, SANDY lean CLAY (CL) | | | | | Shear Rate (inch/minute) : | | 0.02 | |

| SYMBOL | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | DRY DENSITY ($kN/m^3$) | VOID RATIO | NORMAL STRESS (ksf) | NORMAL STRESS (kPa) | PEAK STRESS (ksf) | PEAK STRESS (kPa) | ULTIMATE STRESS (ksf) | ULTIMATE STRESS (kPa) |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 20.89 | 107.96 | 16.99 | 0.56 | 1.00 | 47.88 | 1.36 | 64.93 | 0.77 | 36.77 |
| ◆ | 20.74 | 108.34 | 17.05 | 0.56 | 2.00 | 95.76 | 1.94 | 93.08 | 1.34 | 64.35 |
| ▲ | 19.51 | 109.86 | 17.29 | 0.53 | 4.00 | 191.52 | 3.29 | 157.43 | 2.68 | 128.13 |
| | | | | | | | | | | |

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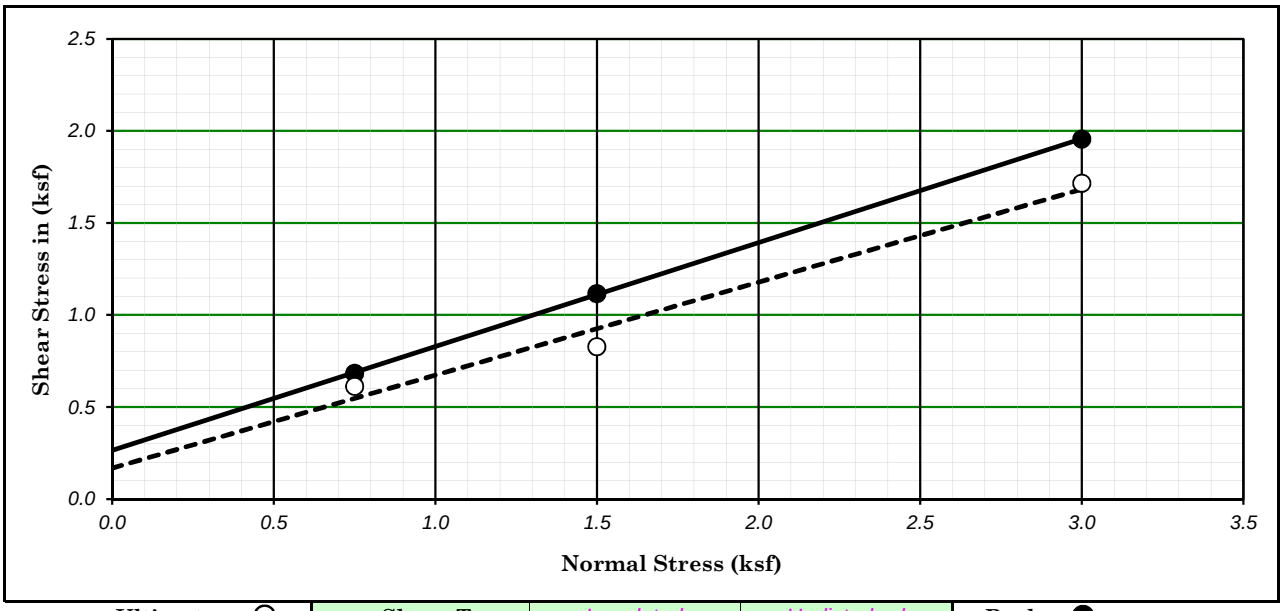
Dokken, 5th Street Bridge PSR PR

# DIRECT SHEAR TEST (ASTM D-3080)

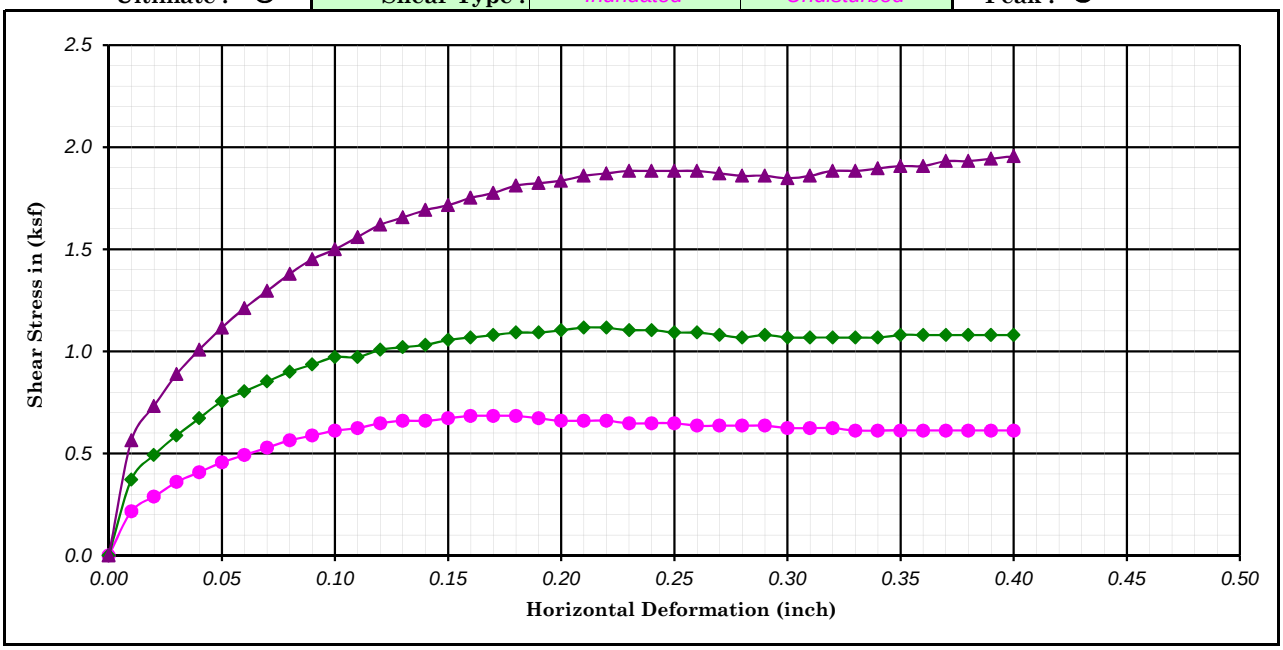
Project No. : 13-121

Date :

Figure No. :




| Ultimate : ○ | Shear Type : | Inundated | Undisturbed | Peak : ● |
|---|---|---|---|---|




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. : R-13-001 | | Strength Intercept (C) : | 0.26 | (ksf) | Peak | 0.17 | (ksf) | Ultimate |
| Sample No. : D-3 | | | 12.64 | (kPa) | | 8.04 | (kPa) | |
| Depth (ft/m) : 15.0 | 0.00 | Friction Angle ( ϕ ) : | 29.45 | Degree | | 26.80 | Degree | |
| Description : Dark yellowish brown, CLAYEY SAND (SC) | | | | | | Shear Rate (inch/minute) : | 0.02 | |

| SYMBOL | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | DRY DENSITY ($kN/m^3$) | VOID RATIO | NORMAL STRESS (ksf) | NORMAL STRESS (kPa) | PEAK STRESS (ksf) | PEAK STRESS (kPa) | ULTIMATE STRESS (ksf) | ULTIMATE STRESS (kPa) |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 43.46 | 77.05 | 12.13 | 1.19 | 0.75 | 35.91 | 0.68 | 32.75 | 0.61 | 29.30 |
| ◆ | 44.35 | 74.17 | 11.67 | 1.27 | 1.50 | 71.82 | 1.12 | 53.43 | 0.83 | 39.64 |
| ▲ | 40.62 | 75.41 | 11.87 | 1.24 | 3.00 | 143.64 | 1.96 | 93.65 | 1.72 | 82.16 |
| | | | | | | | | | | |

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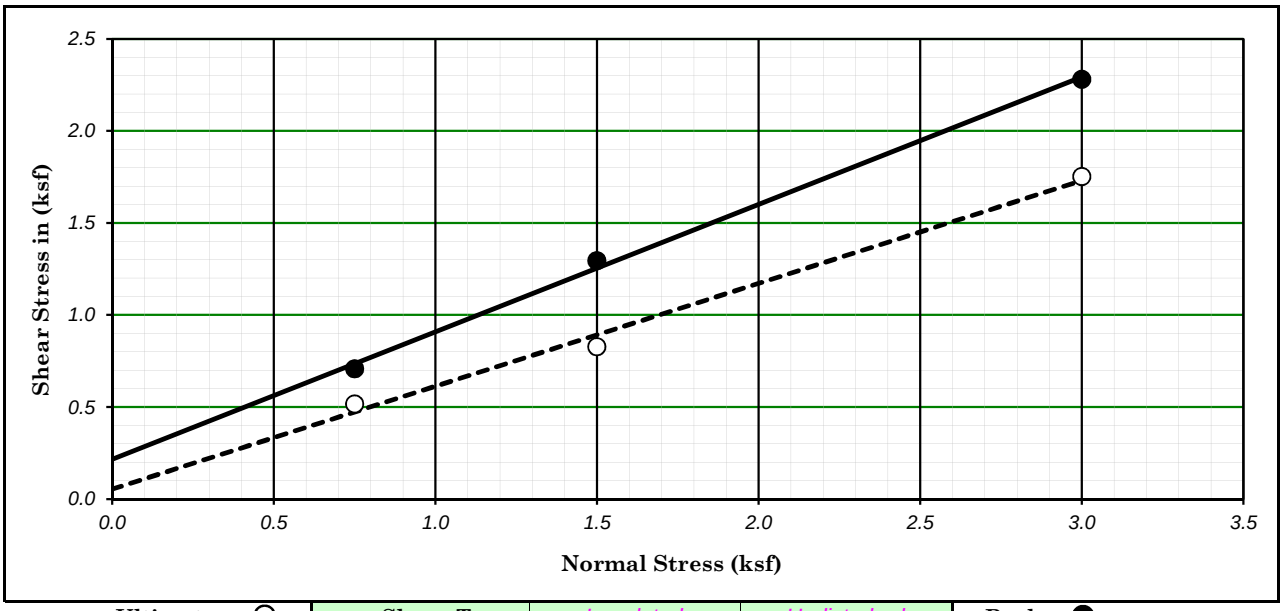
# DIRECT SHEAR TEST (ASTM D-3080)

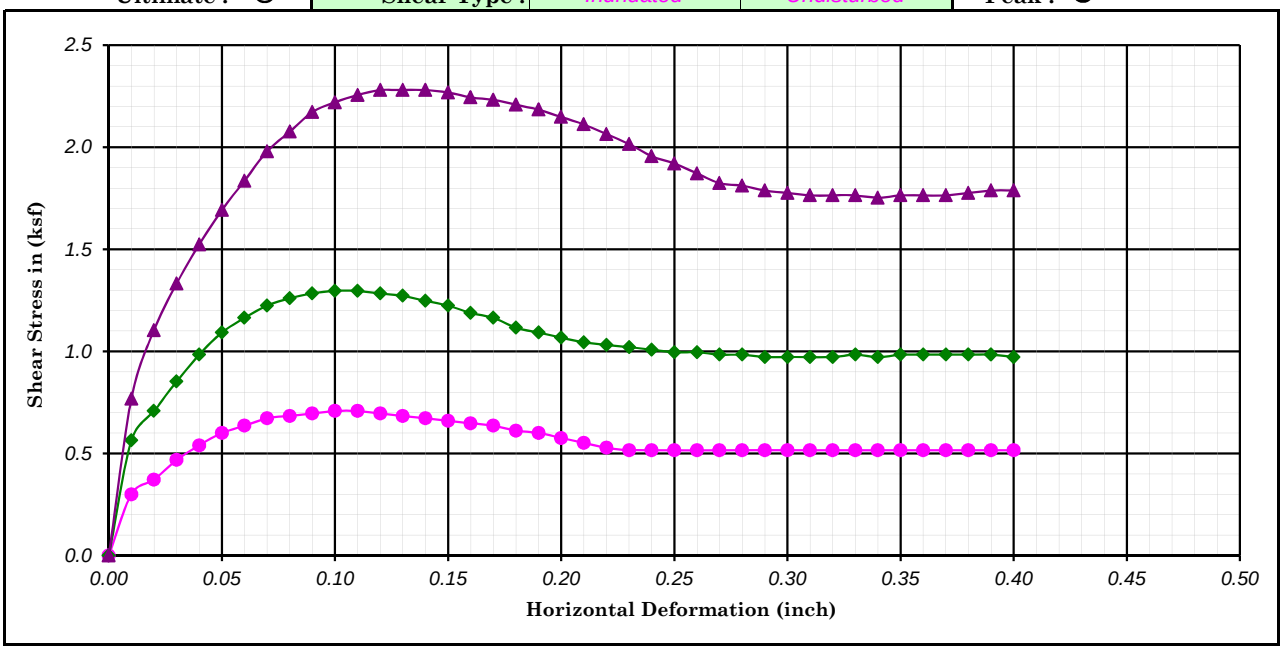
Project No. : 13-121

Date :

Figure No. :




| Ultimate : ○ | Shear Type : | Inundated | Undisturbed | Peak : ● |
|---|---|---|---|---|




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. : R-13-006 | | Strength Intercept (C) : | 0.22 | (ksf) | Peak | 0.05 | (ksf) | Ultimate |
| Sample No. : D-3 | | | 10.34 | (kPa) | | 2.59 | (kPa) | |
| Depth (ft/m) : 15.0 | 0.00 | Friction Angle ( ϕ ) : | 34.71 | Degree | | 29.20 | Degree | |
| Description : Dark olive-brown, Poorly graded SAND with SILT (SP-SM) | | | | | Shear Rate (inch/minute) : | | 0.02 | |

| SYMBOL | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | DRY DENSITY ($kN/m^3$) | VOID RATIO | NORMAL STRESS (ksf) | NORMAL STRESS (kPa) | PEAK STRESS (ksf) | PEAK STRESS (kPa) | ULTIMATE STRESS (ksf) | ULTIMATE STRESS (kPa) |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 29.66 | 92.16 | 14.51 | 0.83 | 0.75 | 35.91 | 0.71 | 33.90 | 0.52 | 24.71 |
| ◆ | 30.05 | 91.82 | 14.45 | 0.84 | 1.50 | 71.82 | 1.30 | 62.05 | 0.83 | 39.64 |
| ▲ | 30.20 | 92.13 | 14.50 | 0.83 | 3.00 | 143.64 | 2.28 | 109.17 | 1.75 | 83.89 |
| | | | | | | | | | | |

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Geotechnical and Earthquake Engineering

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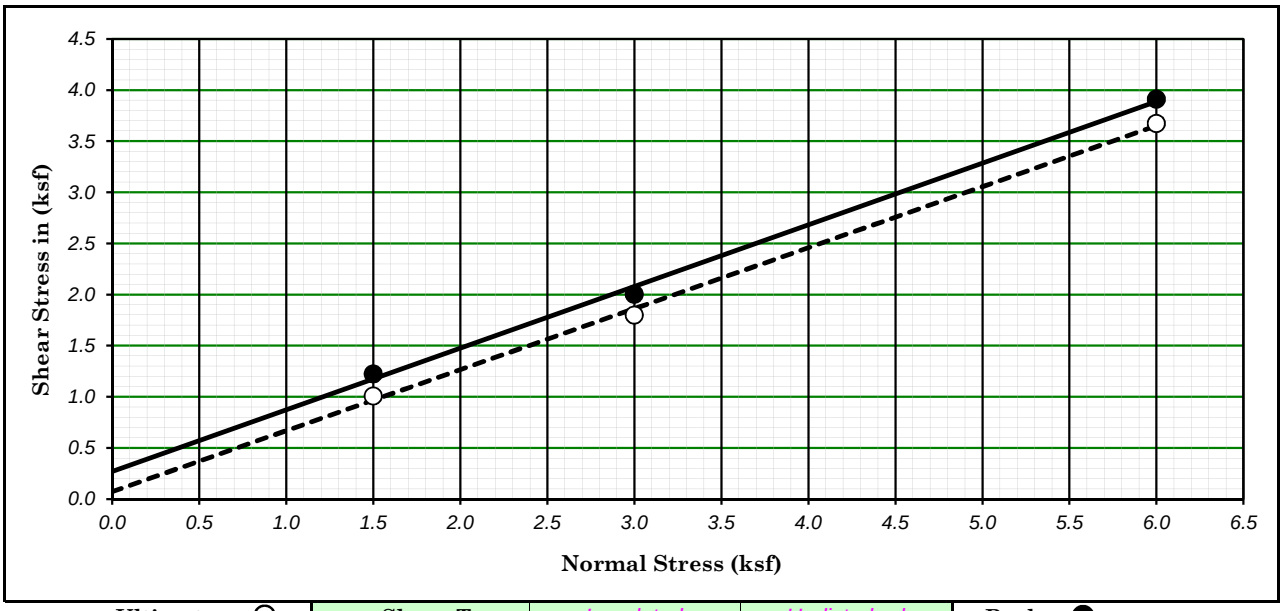
# DIRECT SHEAR TEST (ASTM D-3080)

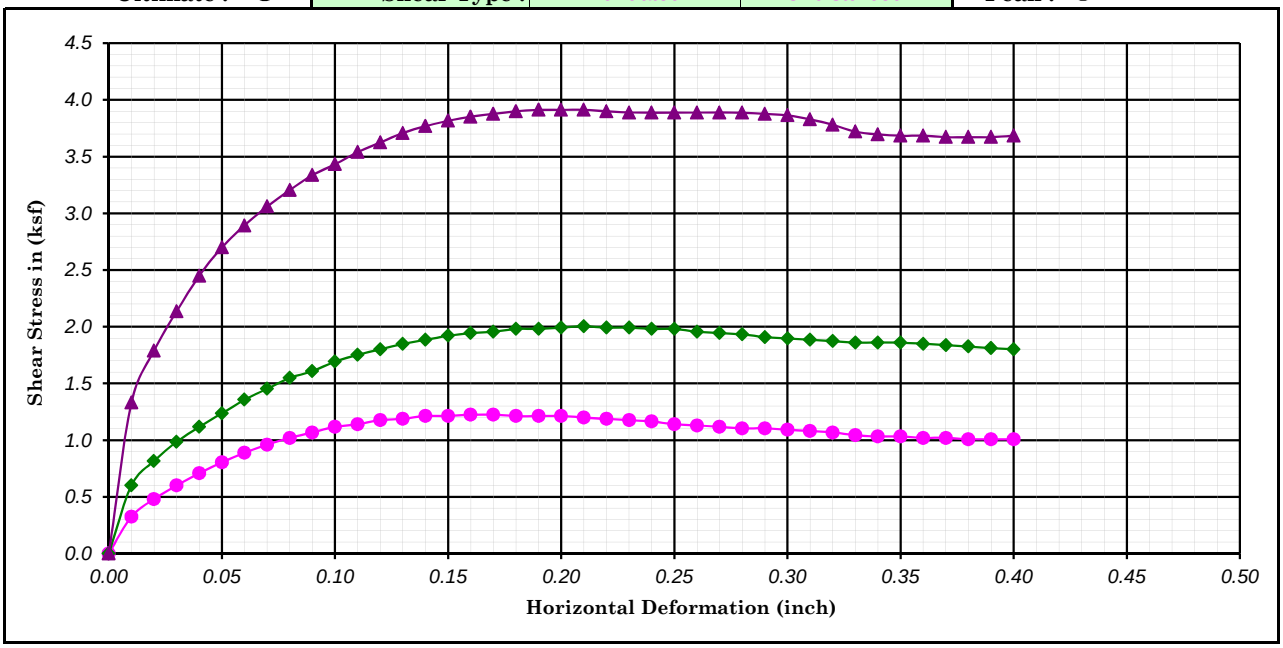
Project No. : 13-121

Date :

Figure No. :




| Ultimate : ○ | Shear Type : | Inundated | Undisturbed | Peak : ● |
|---|---|---|---|---|




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. : R-13-004 | | Strength Intercept (C) : | 0.27 | (ksf) | Peak | 0.07 | (ksf) | Ultimate |
| Sample No. : D-6 | | | 12.93 | (kPa) | | 3.45 | (kPa) | |
| Depth (ft/m) : 30.0 | 0.00 | Friction Angle ( ϕ ) : | 31.08 | Degree | | 30.82 | Degree | |
| Description : Dark gray, Poorly graded SAND with SILT and organic (SP-SM) | | | | | Shear Rate (inch/minute) : | | 0.02 | |

| SYMBOL | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | DRY DENSITY ($kN/m^3$) | VOID RATIO | NORMAL STRESS (ksf) | NORMAL STRESS (kPa) | PEAK STRESS (ksf) | PEAK STRESS (kPa) | ULTIMATE STRESS (ksf) | ULTIMATE STRESS (kPa) |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 40.24 | 79.86 | 12.57 | 1.11 | 1.50 | 71.82 | 1.22 | 58.61 | 1.01 | 48.26 |
| ◆ | 38.93 | 82.45 | 12.98 | 1.04 | 3.00 | 143.64 | 2.00 | 95.95 | 1.80 | 86.18 |
| ▲ | 34.73 | 85.35 | 13.43 | 0.97 | 6.00 | 287.28 | 3.91 | 187.31 | 3.67 | 175.82 |
| | | | | | | | | | | |

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Geotechnical and Earthquake Engineering

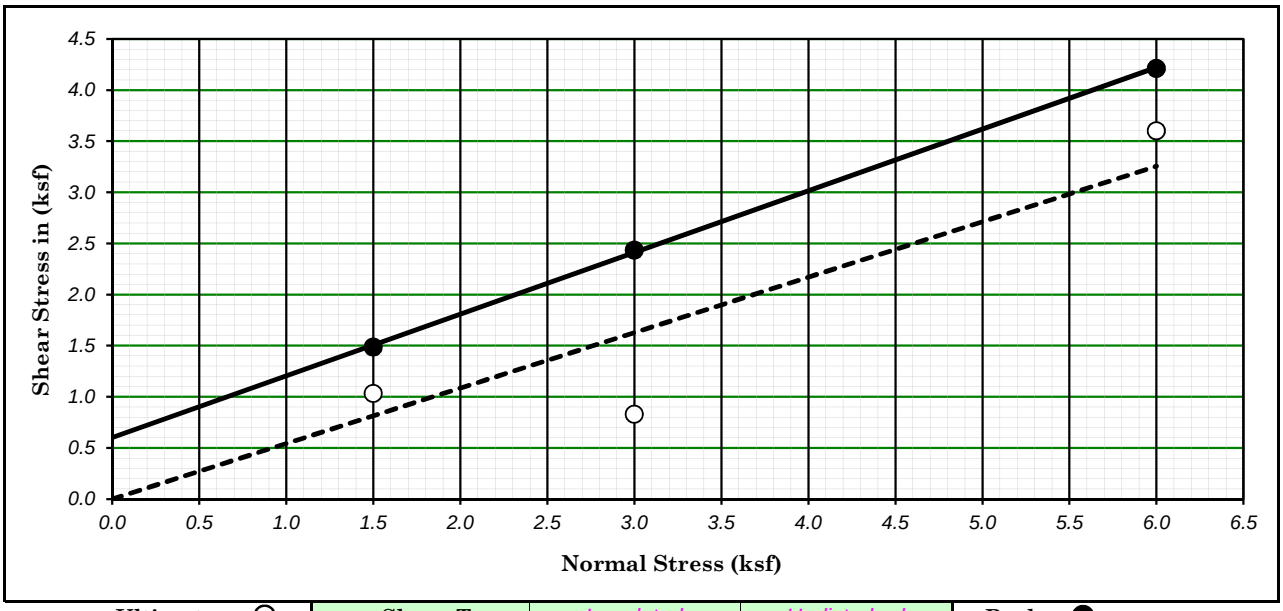
Dokken, 5th Street Bridge PSR PR

# DIRECT SHEAR TEST (ASTM D-3080)

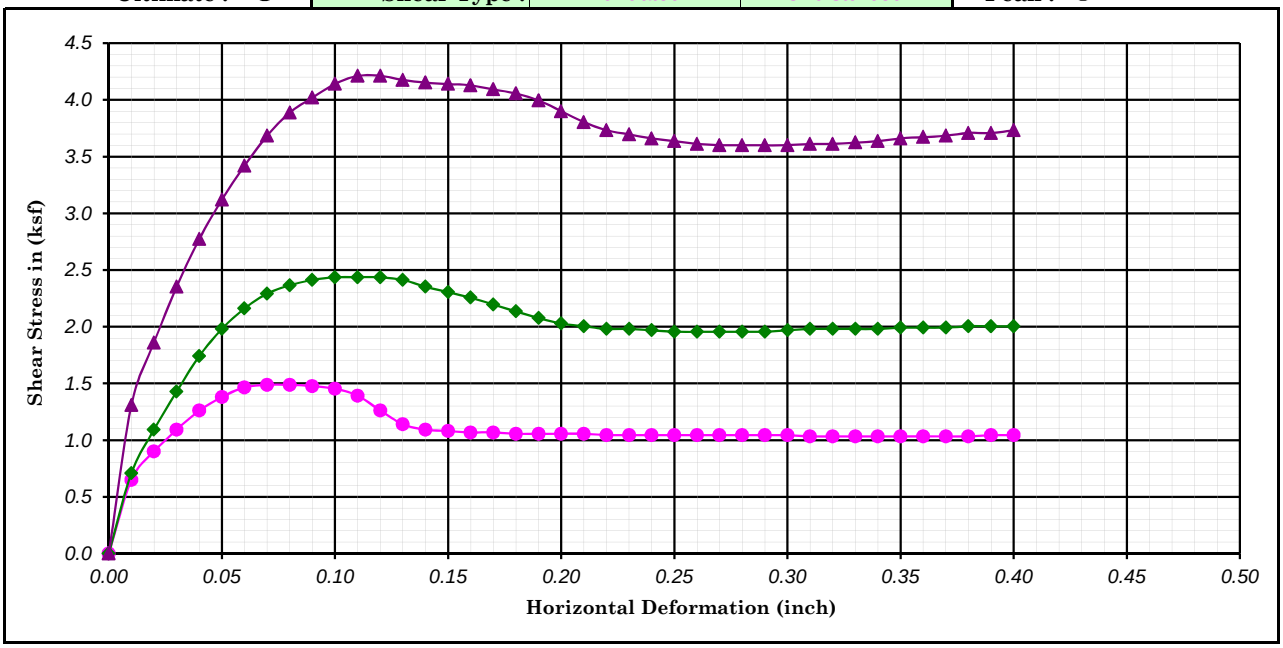
Project No. : 13-121

Date :

Figure No. :




| Ultimate : ○ | Shear Type : | Inundated | Undisturbed | Peak : ● |
|---|---|---|---|---|




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. : R-13-011 | | Strength Intercept (C) : | 0.60 | (ksf) | Peak | 0.00 | (ksf) | Ultimate |
| Sample No. : D-6 | | | 28.73 | (kPa) | | 0.00 | (kPa) | |
| Depth (ft/m) : 30.0 | 0.00 | Friction Angle ( ϕ ) : | 31.11 | Degree | | 28.48 | Degree | |
| Description : Dark yellowish brown, CLAYEY SAND (SC) | | | | | Shear Rate (inch/minute) : | | 0.02 | |

| SYMBOL | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | DRY DENSITY ($kN/m^3$) | VOID RATIO | NORMAL STRESS (ksf) | NORMAL STRESS (kPa) | PEAK STRESS (ksf) | PEAK STRESS (kPa) | ULTIMATE STRESS (ksf) | ULTIMATE STRESS (kPa) |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 19.12 | 110.25 | 17.35 | 0.53 | 1.50 | 71.82 | 1.49 | 71.25 | 1.03 | 49.41 |
| ◆ | 19.08 | 109.81 | 17.28 | 0.54 | 3.00 | 143.64 | 2.44 | 116.64 | 0.83 | 39.64 |
| ▲ | 18.57 | 109.48 | 17.23 | 0.54 | 6.00 | 287.28 | 4.21 | 201.67 | 3.60 | 172.37 |
| | | | | | | | | | | |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

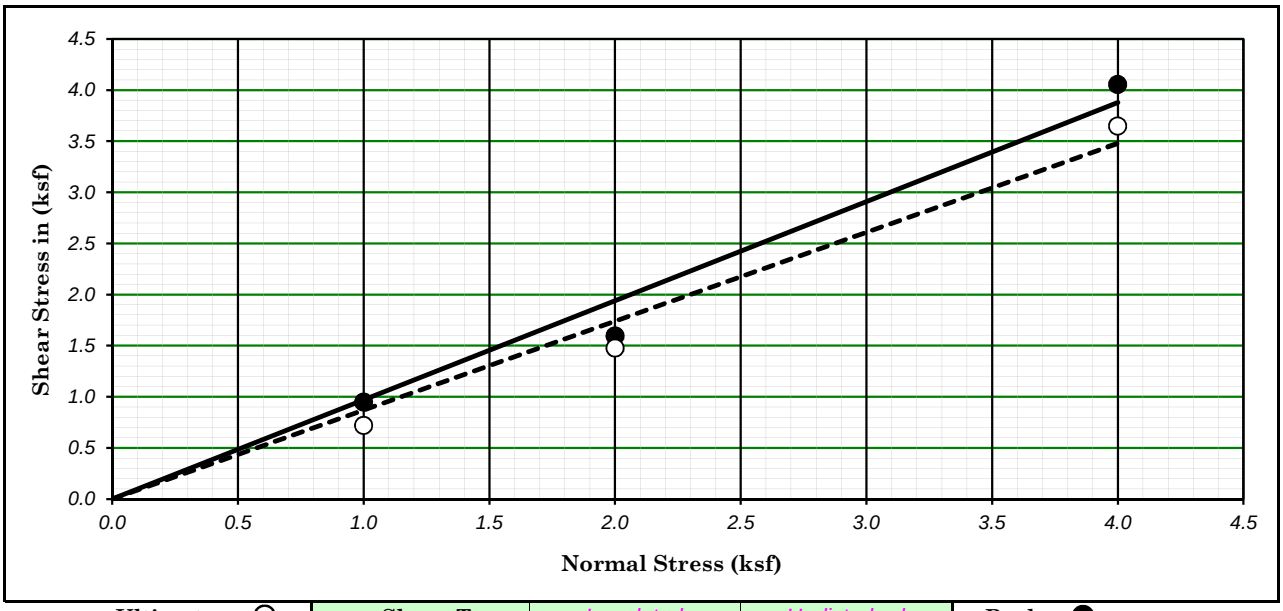
Dokken, 5th Street Bridge PSR PR

# DIRECT SHEAR TEST (ASTM D-3080)

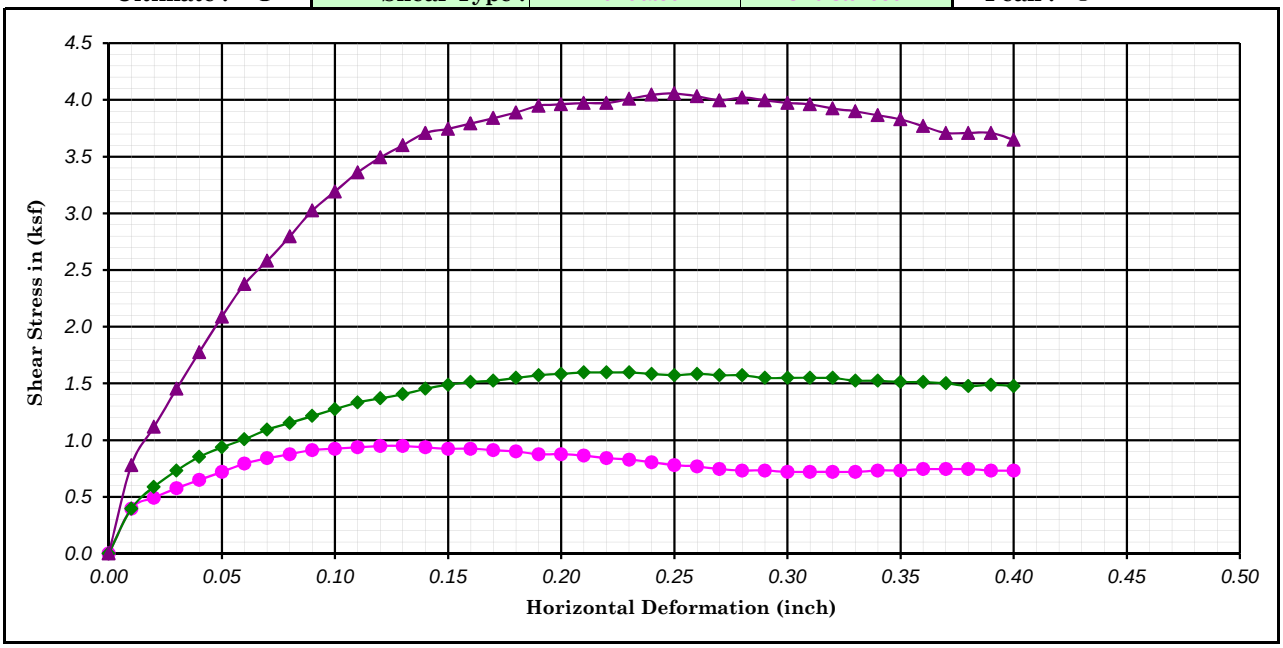
Project No. : 13-121

Date :

Figure No. :




| Ultimate : ○ | Shear Type : | Inundated | Undisturbed | Peak : ● |
|---|---|---|---|---|




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. : R-13-012 | | Strength Intercept (C) : | 0.00 | (ksf) | Peak | 0.00 | (ksf) | Ultimate |
| Sample No. : D-5 | | | 0.00 | (kPa) | | 0.00 | (kPa) | |
| Depth (ft/m) : 25.0 | 0.00 | Friction Angle ( ϕ ) : | 44.12 | Degree | | 41.01 | Degree | |
| Description : Dark olive-brown, Poorly graded SAND with SILT (SP-SM) | | | | | | Shear Rate (inch/minute) : | | 0.02 |

| SYMBOL | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | DRY DENSITY ($kN/m^3$) | VOID RATIO | NORMAL STRESS (ksf) | NORMAL STRESS (kPa) | PEAK STRESS (ksf) | PEAK STRESS (kPa) | ULTIMATE STRESS (ksf) | ULTIMATE STRESS (kPa) |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 23.95 | 102.56 | 16.14 | 0.64 | 1.00 | 47.88 | 0.95 | 45.39 | 0.72 | 34.47 |
| ◆ | 23.80 | 102.97 | 16.21 | 0.64 | 2.00 | 95.76 | 1.60 | 76.42 | 1.48 | 70.67 |
| ▲ | 18.22 | 111.72 | 17.59 | 0.51 | 4.00 | 191.52 | 4.06 | 194.20 | 3.65 | 174.67 |
| | | | | | | | | | | |

Earth Mechanics, Inc.
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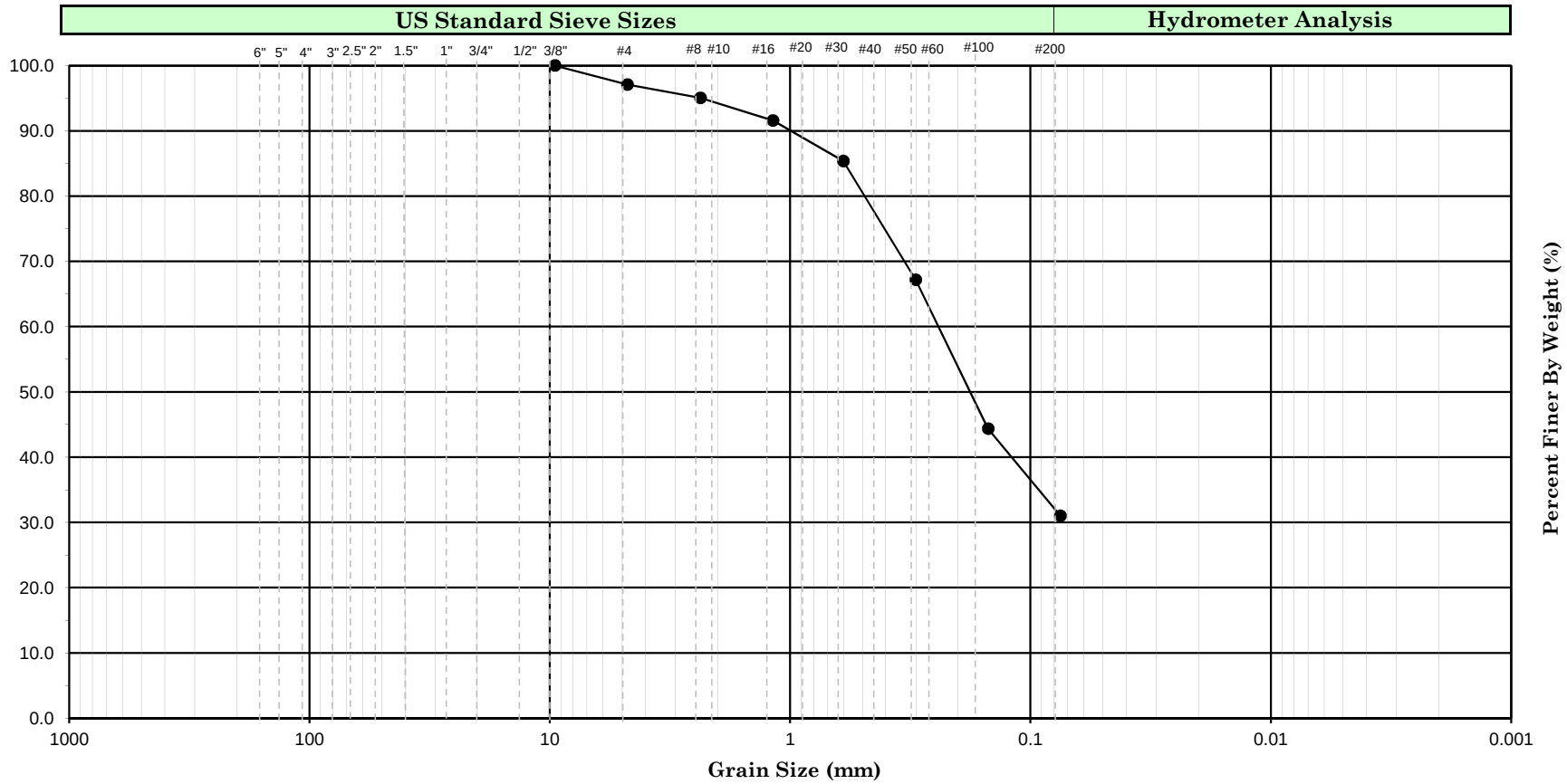
Dokken, 5th Street Bridge PSR PR

# DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 13-121

Date :

Figure No. :




| Cobbles | Gravel | | Sand | | | Silt or Clay |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| Symbol | Boring Number | Sample Number | Depth (ft) | | Depth (m) | | Soil Color | Soil Description | U.S.C.S. |
|---|---|---|---|---|---|---|---|---|---|
| ● | R-13-001 | B-0 | 0 | | | | dark brown | Silty sand | SM |
| | | | | | | | | | |
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| | | | | | | | | | |
| Remark | | | | | | | | | |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Dokken, 5th Street Bridge PSR PR

Project No. : 13-121

Date : 03/18/16

# GRAIN SIZE ANALYSIS
(ASTM D-422)

Figure No. :

| Cobbles | Gravel | | Sand | | | Silt or Clay |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| Symbol | Boring Number | Sample Number | Depth (ft) | | Depth (m) | | Soil Color | Soil Description | U.S.C.S. |
|---|---|---|---|---|---|---|---|---|---|
| ● | R-13-011 | B-0 | 0 | | | | Dark brown | Sandy lean clay | CL |
| | | | | | | | | | |
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| | | | | | | | | | |
| Remark | | | | | | | | | |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Dokken, 5th Street Bridge PSR PR

Project No. : 13-121

Date : 03/18/16

# GRAIN SIZE ANALYSIS
(ASTM D-422)

Figure No. :

| Cobbles | Gravel | | Sand | | | Silt or Clay |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| Symbol | Boring Number | Sample Number | Depth (ft) | | Depth (m) | | Soil Color | Soil Description | U.S.C.S. |
|---|---|---|---|---|---|---|---|---|---|
| ● | HA-13-014 | B-0 | 0 | | | | brown | Sandy lean clay | CL |
| | | | | | | | | | |
| | | | | | | | | | |
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| | | | | | | | | | |
| | | | | | | | | | |
| Remark | | | | | | | | | |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

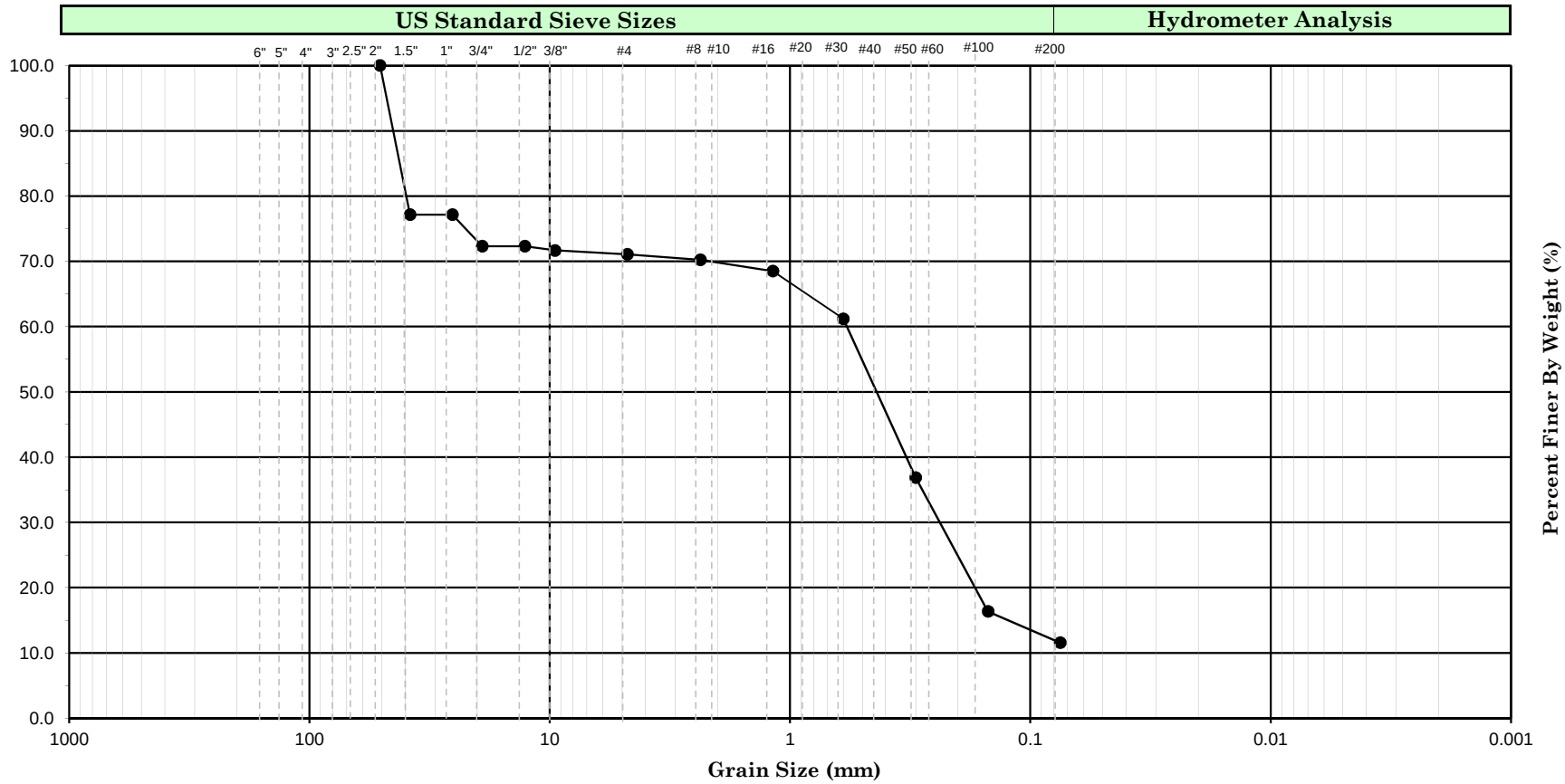
Dokken, 5th Street Bridge PSR PR

Project No. : 13-121

Date : 03/18/16

# GRAIN SIZE ANALYSIS
(ASTM D-422)

Figure No. :




| Cobbles | Gravel | | Sand | | | Silt or Clay |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| Symbol | Boring Number | Sample Number | Depth (ft) | | Depth (m) | | Soil Color | Soil Description | U.S.C.S. |
|---|---|---|---|---|---|---|---|---|---|
| ● | R-13-005 | D-11 | 55 | | | | olive-brown | Poorly graded sand with silt with gravel | SP-SM |
| | | | | | | | | | |
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| | | | | | | | | | |
| Remark | | | | | | | | | |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

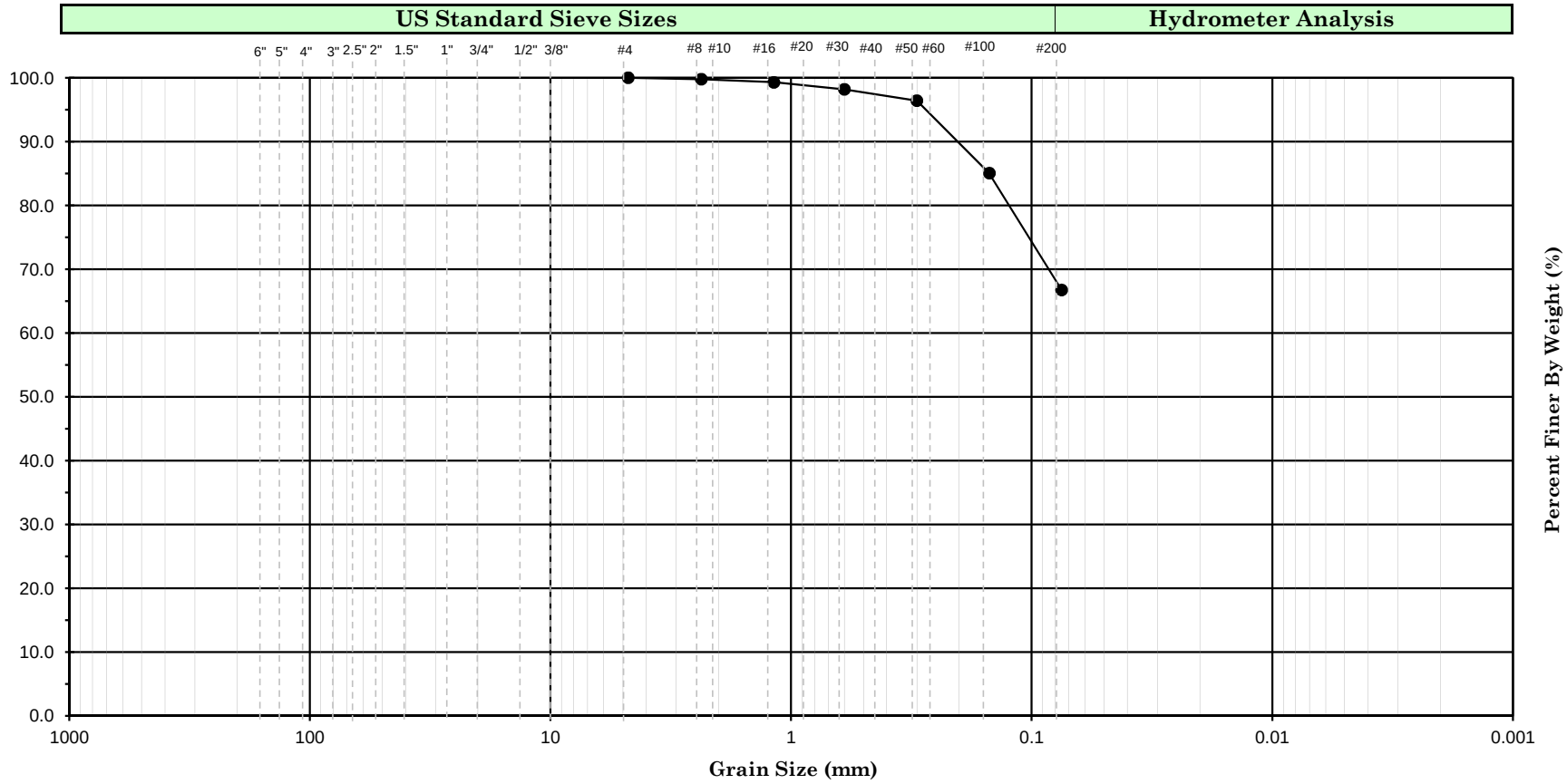
Dokken, 5th Street Bridge PSR PR

Project No. : 13-121

Date : 11/08/13

# GRAIN SIZE ANALYSIS
(ASTM D-422)

Figure No. :




| Cobbles | Gravel | | Sand | | | Silt or Clay |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| Symbol | Boring Number | Sample Number | Depth (ft) | | Depth (m) | | Soil Color | Soil Description | U.S.C.S. |
|---|---|---|---|---|---|---|---|---|---|
| ● | R-13-007 | S-5 | 25 | | | | olive-brown | Sandy silt | ML |
| | | | | | | | | | |
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| | | | | | | | | | |
| Remark | | | | | | | | | |

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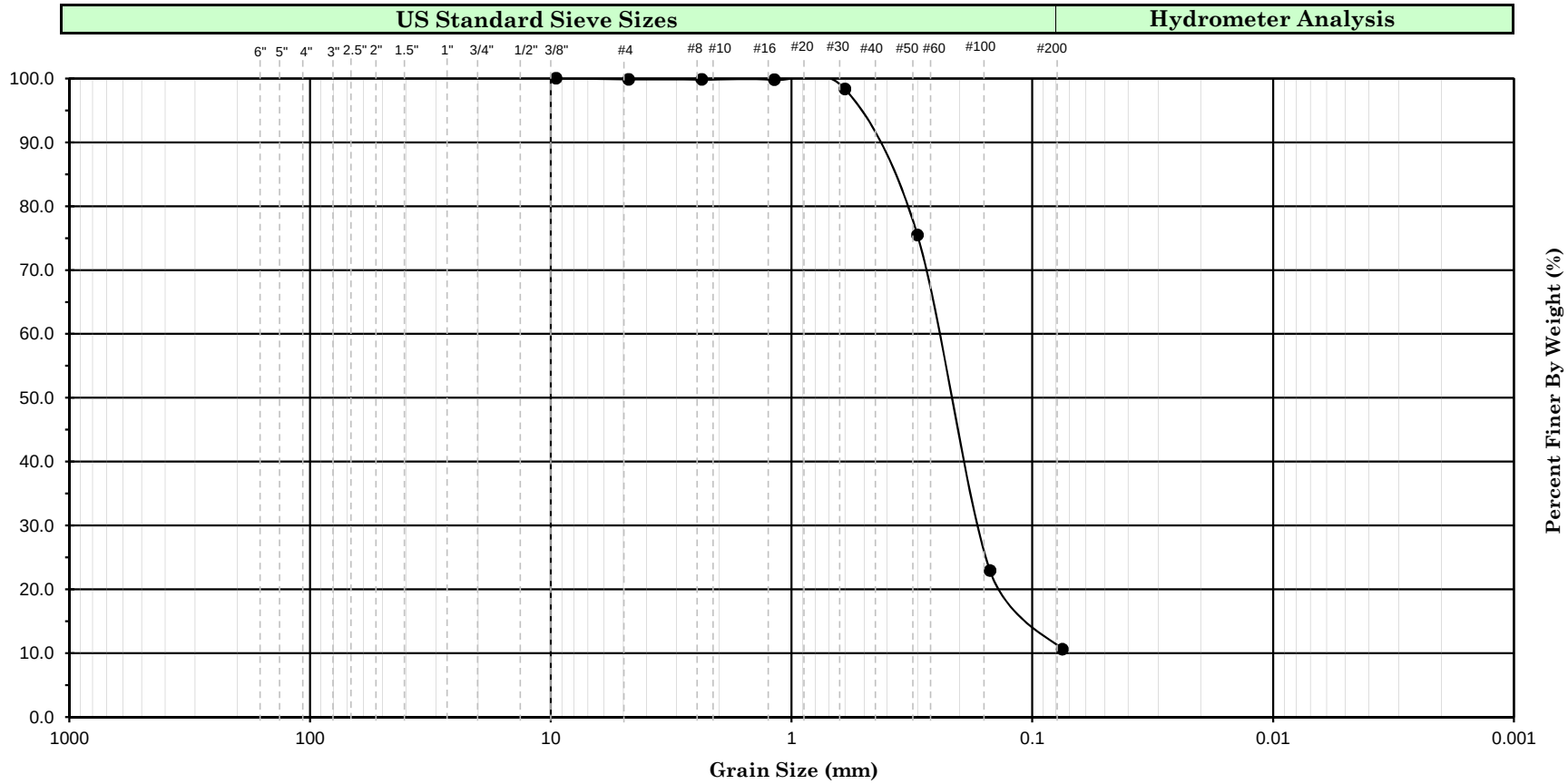
Dokken, 5th Street Bridge PSR PR

Project No. : 13-121

Date : 11/08/13

# GRAIN SIZE ANALYSIS
(ASTM D-422)

Figure No. :




| Cobbles | Gravel | | Sand | | | Silt or Clay |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| Symbol | Boring Number | Sample Number | Depth (ft) | | Depth (m) | | Soil Color | Soil Description | U.S.C.S. |
|---|---|---|---|---|---|---|---|---|---|
| ● | R-13-013 | D-6 | 30 | | | | brown | Poorly graded sand with silt | SP-SM |
| | | | | | | | | | |
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| | | | | | | | | | |
| Remark | | | | | | | | | |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Dokken, 5th Street Bridge PSR PR

Project No. : 13-121

Date : 11/08/13

# GRAIN SIZE ANALYSIS
(ASTM D-422)

Figure No. :

# SAND EQUIVALENT ( ASTM D-2419 / CT-217 )

**Project No :** 13-121 **Project Name :** Dokken, 5th Street Bridge PSR PR

| | | | | | |
|---|---|---|---|---|---|
| Sampled By : | Date : | Computed By : JF | Date : 03/20/16 | Stock Solution Prepared By : | Remark : |
| Prepared By : | Date : | Checked By : | Date : | Stock Solution Prepared at : | |
| Tested By : KK | Date : | | | (Max. 14 Days) Will Expired at : | |

1. Level of Stock Solution should be maintained between 36" & 46" above the work surface.
2. Diluted one full tin (85 ml) Stock solution in one gallon (3.8 liter) water at (21$^0$C).
3. Tested Sample should be passing No.4 Sieve.

| | | | |
|---|---|---|---|
| Boring No. : HA-13-014 | Boring No. : | Boring No. : | Boring No. : |
| Sample No. : B-0 | Sample No. : | Sample No. : | Sample No. : |
| Depth (ft) : 0 | Depth (ft) : | Depth (ft) : | Depth (ft) : |
| Depth (m) : | Depth (m) : | Depth (m) : | Depth (m) : |
| Soil Description CL | Soil Description | Soil Description | Soil Description |

4. Fill plastic cylinder with 4 ± 0.1 inches working solution.

| Sample Drying By / Container Number | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Air : X | Oven : | Air : X | Oven : | Air : | Oven : | Air : | Oven : | Air : | Oven : | | |

5. Pour each tin measurement of specimen into plastic cylinder.

| Tin Can Number | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H | I | A | B | C |
| **Cylinder Number** | | | | | | | | | | | |
| 1 | 2 | 3 | 7 | 8 | 9 | 1 | 2 | 3 | 7 | 8 | 9 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6. Release air bubbles and promote through wetting at : | Time | | | | | | | | | | | | |
| | 11:38:00 | 11:41:00 | 11:44:00 | 15:07:00 | 15:10:00 | 15:13:00 | 15:55:00 | 15:58:00 | 16:01:00 | | | | |
| 7. Stay undisturbed for 10 ± 1 minute to : | 11:48:00 | 11:51:00 | 11:54:00 | 15:17:00 | 15:20:00 | 15:23:00 | 16:05:00 | 16:08:00 | 16:11:00 | | | | |
| 8. Fill working solution up to (15") at : | 11:51:00 | 11:54:00 | 11:57:00 | 15:20:00 | 15:23:00 | 15:26:00 | 16:08:00 | 16:11:00 | 16:14:00 | | | | |
| 9. Stay undisturbed for 20 ± 15 seconds to : | 12:11:00 | 12:14:00 | 12:17:00 | 15:40:00 | 15:43:00 | 15:46:00 | 16:28:00 | 16:31:00 | 16:34:00 | | | | |
| 10. Clay reading (top level of sidment at 20 minute period or line demarcation time, when clay reading falls between 0.1" graduation record the higher). | 10.80 | 10.20 | 10.40 | | | | | | | | | | |
| 11. Sand reading(Lower the weighted foot assemble and record top edge of indicator (inch),substract 10 in.) | 1.50 | 1.50 | 1.60 | | | | | | | | | | |
| Sand Equivalent = Sand reading / Clay Reading | 13.89 | 14.71 | 15.38 | | | | | | | | | | |
| Sand Equivalent — Average | 14.66 | | | | | | | | | | | | |
| Sand Equivalent — Reported | 15 | | | | | | | | | | | | |

# Particle Size Distribution Report

| % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|
| | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| 0.0 | 0.0 | 11.3 | 3.2 | 6.4 | 50.1 | 29.0 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| .75 in. | 100.0 | | |
| .5 in. | 95.4 | | |
| #4 | 88.7 | | |
| #10 | 85.5 | | |
| #40 | 79.1 | | |
| #200 | 29.0 | | |

* (no specification provided)

**Material Description**

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 1.69 $D_{60}$= 0.181 $D_{50}$= 0.134
$D_{30}$= 0.0770 $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= AASHTO=

**Remarks**

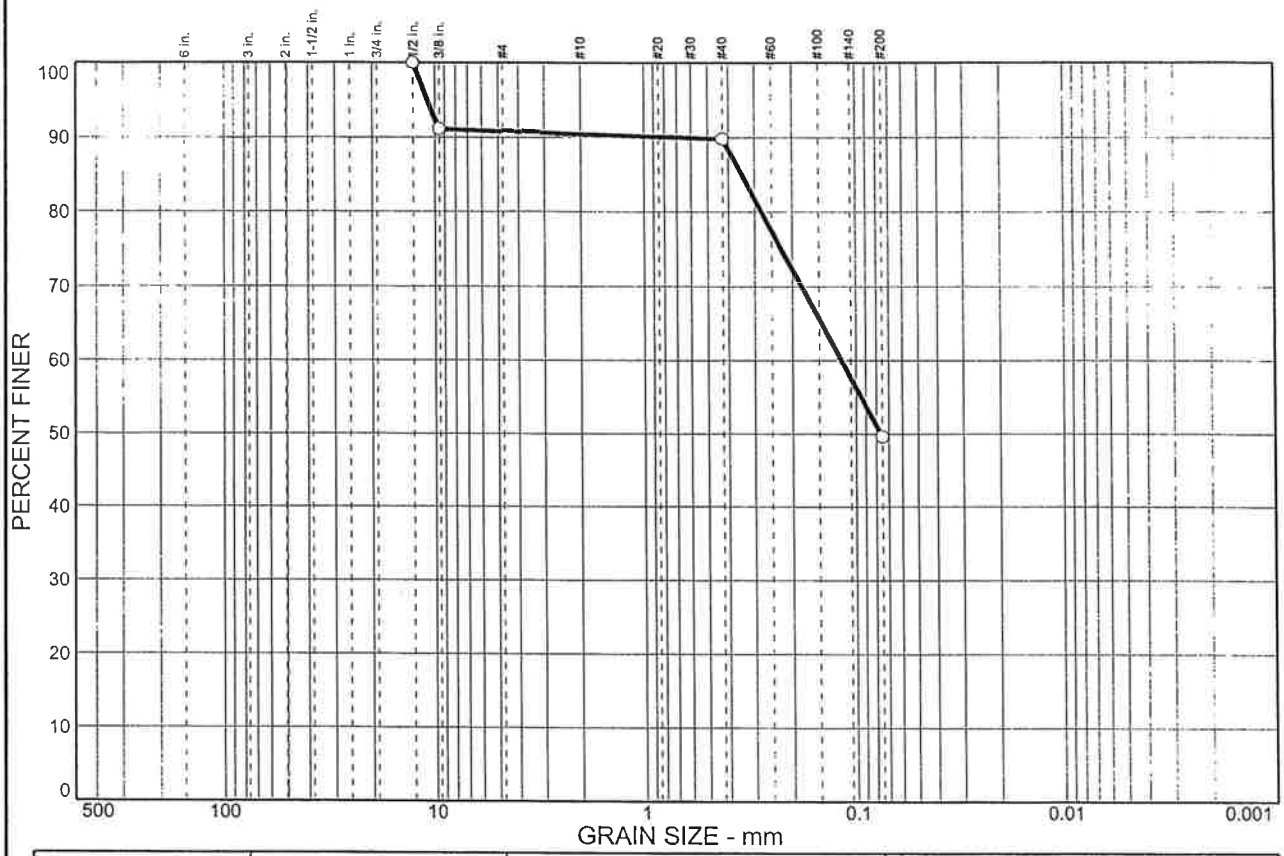
*Note: Samples tested precludes particle sizes>1.4" diameter.
Total dry weight of sample tested=456 grams.

**Sample No.:** 1/2 **Source of Sample:** **Date:** 8-22-07
**Location:** Boring 1 **Depth:** 10.0'-12.0'

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No:** 1R2/304/016 **Figure** 2

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|
| | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| 0.0 | 0.0 | 9.2 | 0.4 | 0.6 | 40.2 | 49.6 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| .5 in. | 100.0 | | |
| .375 in. | 91.1 | | |
| #40 | 89.8 | | |
| #200 | 49.6 | | |

* (no specification provided)

**Material Description**

**Atterberg Limits**

PL= NP LL= 27 PI= NP

**Coefficients**

$D_{85}$= 0.345 $D_{60}$= 0.117 $D_{50}$= 0.0763
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= AASHTO=

**Remarks**

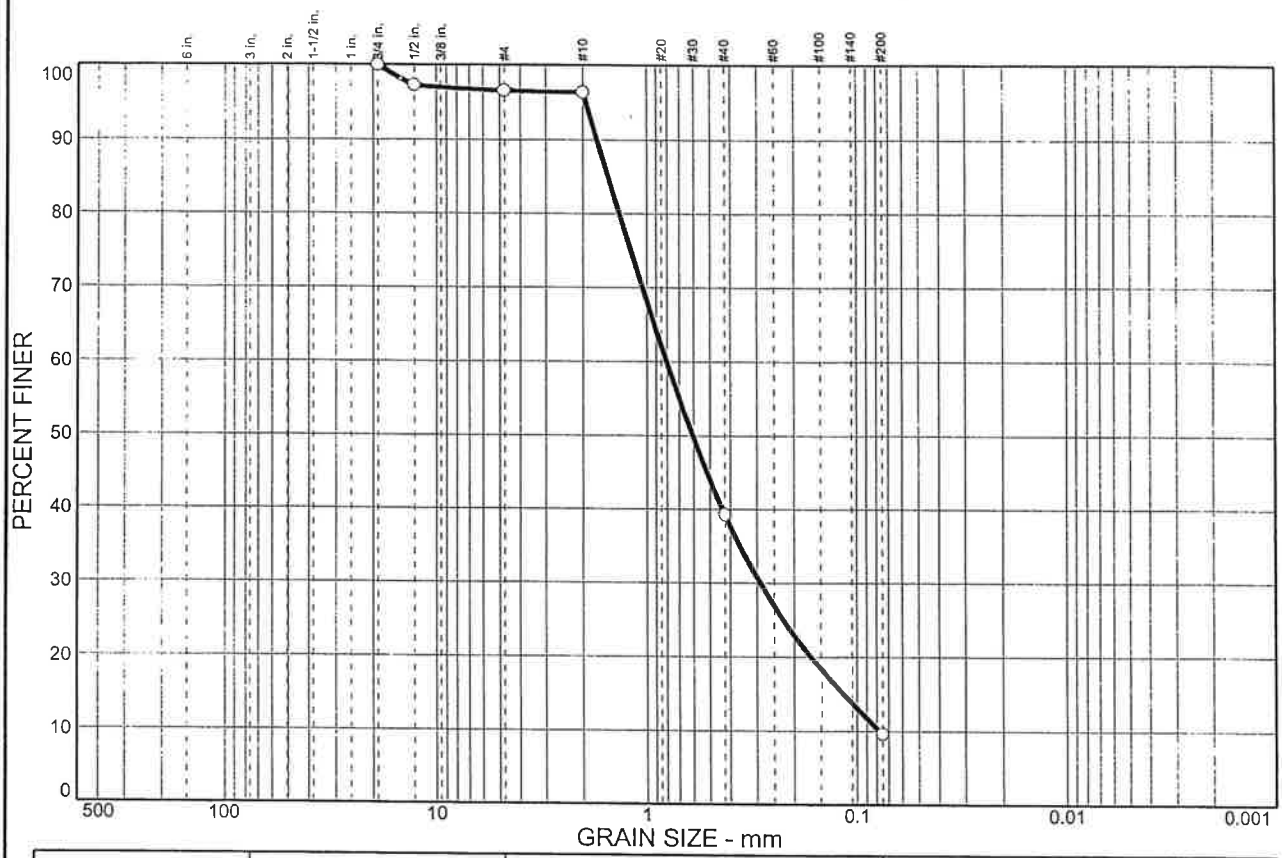
*Note: Sample tested precludes particle sizes>1.4" diameter.
Total dry weight of sample tested=281 grams.

**Sample No.:** 1/3+1/4A+1/6 comp. **Source of Sample:** **Date:** 8-22-07
**Location:** Boring 1 **Depth:** 15.0'-32.0'

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No:** 1R2/304/016 **Figure** 2

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|
| | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| 0.0 | 0.0 | 3.4 | 0.2 | 57.1 | 29.7 | 9.6 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| .75 in. | 100.0 | | |
| .5 in. | 97.3 | | |
| #4 | 96.6 | | |
| #10 | 96.4 | | |
| #40 | 39.3 | | |
| #200 | 9.6 | | |

* (no specification provided)

**Material Description**

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 1.52 $D_{60}$= 0.805 $D_{50}$= 0.604
$D_{30}$= 0.290 $D_{15}$= 0.116 $D_{10}$= 0.0776
$C_u$= 10.37 $C_c$= 1.35

**Classification**

USCS= AASHTO=

**Remarks**

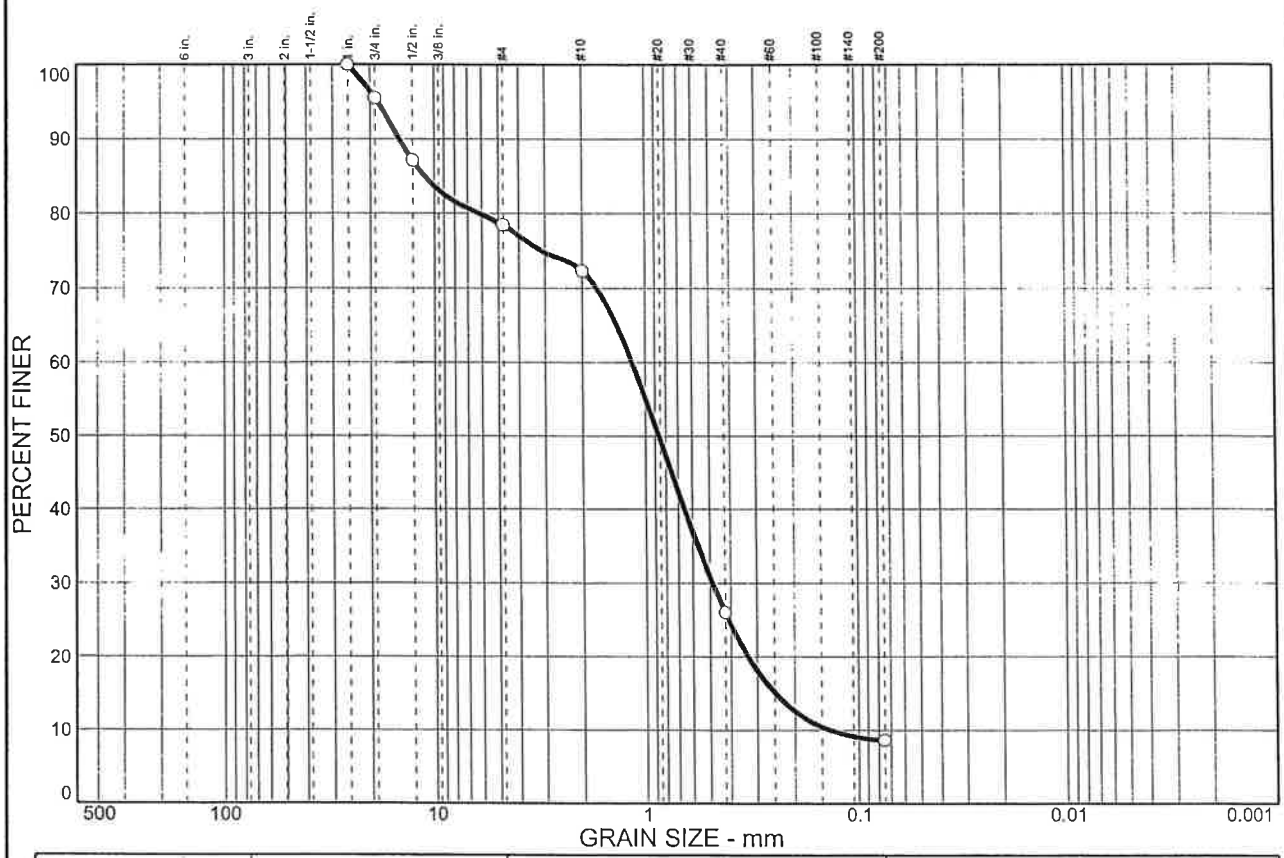
*Note: Sample tested precludes particle sizes>1.4" diameter.
Total dry weight of sample tested=1058 grams.

**Sample No.:** 1/7+1/8 comp. **Source of Sample:** **Date:** 8-22-07
**Location:** Boring 1 **Depth:** 35.0'-42.0'

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No:** 1R2/304/016 **Figure** 2

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|
| | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| 0.0 | 4.5 | 17.1 | 6.1 | 46.3 | 17.4 | 8.6 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 in. | 100.0 | | |
| .75 in. | 95.5 | | |
| .5 in. | 87.1 | | |
| #4 | 78.4 | | |
| #10 | 72.3 | | |
| #40 | 26.0 | | |
| #200 | 8.6 | | |

* (no specification provided)

**Material Description**

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 11.1 $D_{60}$= 1.16 $D_{50}$= 0.864
$D_{30}$= 0.487 $D_{15}$= 0.246 $D_{10}$= 0.137
$C_u$= 8.49 $C_c$= 1.50

**Classification**

USCS= AASHTO=

**Remarks**

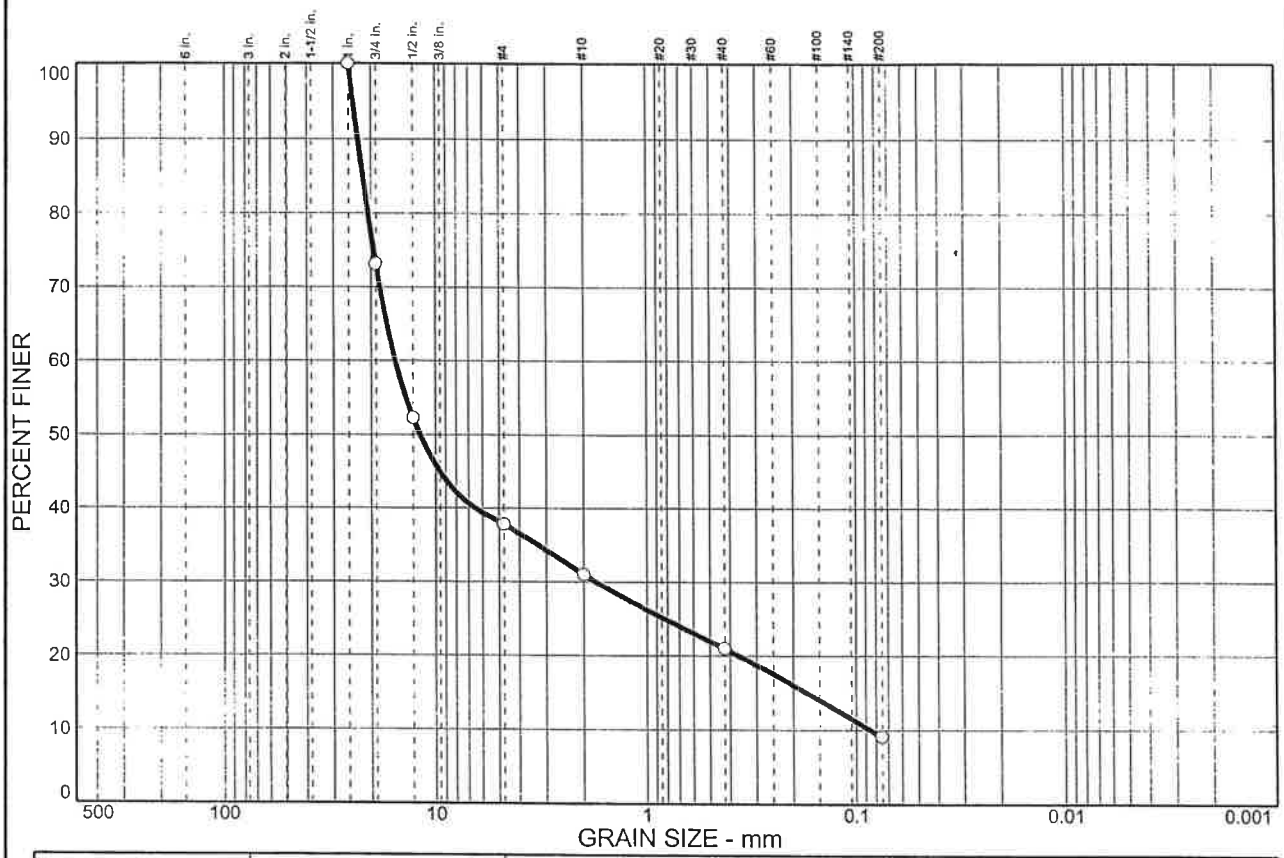
*Note: Sample tested precludes particle sizes>1.4" diameter.
Total dry weight of sample tested=971 grams.

**Sample No.:** 1/9+1/10 comp. **Source of Sample:** **Date:** 8-22-07
**Location:** Boring 1 **Depth:** 45.0'-52.0'

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No:** 1R2/304/016 **Figure** 2

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|
| | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| 0.0 | 26.9 | 35.3 | 6.8 | 10.0 | 11.9 | 9.1 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 in. | 100.0 | | |
| .75 in. | 73.1 | | |
| .5 in. | 52.2 | | |
| #4 | 37.8 | | |
| #10 | 31.0 | | |
| #40 | 21.0 | | |
| #200 | 9.1 | | |

* (no specification provided)

**Material Description**

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 21.8 $D_{60}$= 15.4 $D_{50}$= 11.8
$D_{30}$= 1.75 $D_{15}$= 0.172 $D_{10}$= 0.0850
$C_u$= 181.57 $C_c$= 2.34

**Classification**

USCS= AASHTO=

**Remarks**

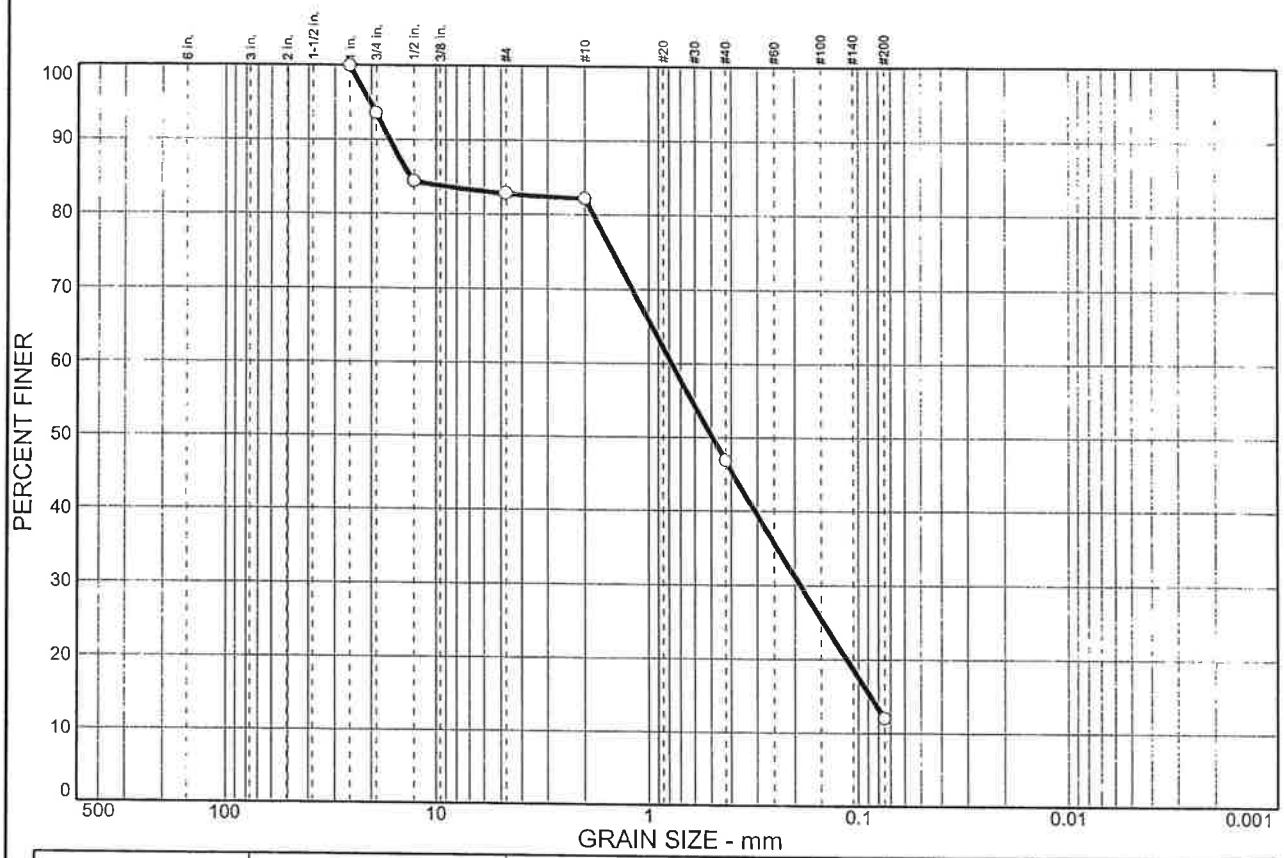
*Note: Sample tested precludes particle sizes>1.4" diameter.
Total dry weight of sample tested=439 grams.

**Sample No.:** 1/11 **Source of Sample:** **Date:** 8-22-07
**Location:** Boring 1 **Depth:** 55.0'-57.0'

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No:** 1R2/304/016 **Figure** 2

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|
| | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| 0.0 | 6.4 | 10.8 | 0.6 | 35.4 | 34.8 | 12.0 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 in. | 100.0 | | |
| .75 in. | 93.6 | | |
| .5 in. | 84.4 | | |
| #4 | 82.8 | | |
| #10 | 82.2 | | |
| #40 | 46.8 | | |
| #200 | 12.0 | | |

* (no specification provided)

**Material Description**

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 13.1 $D_{60}$= 0.773 $D_{50}$= 0.493
$D_{30}$= 0.188 $D_{15}$= 0.0875 $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= AASHTO=

**Remarks**

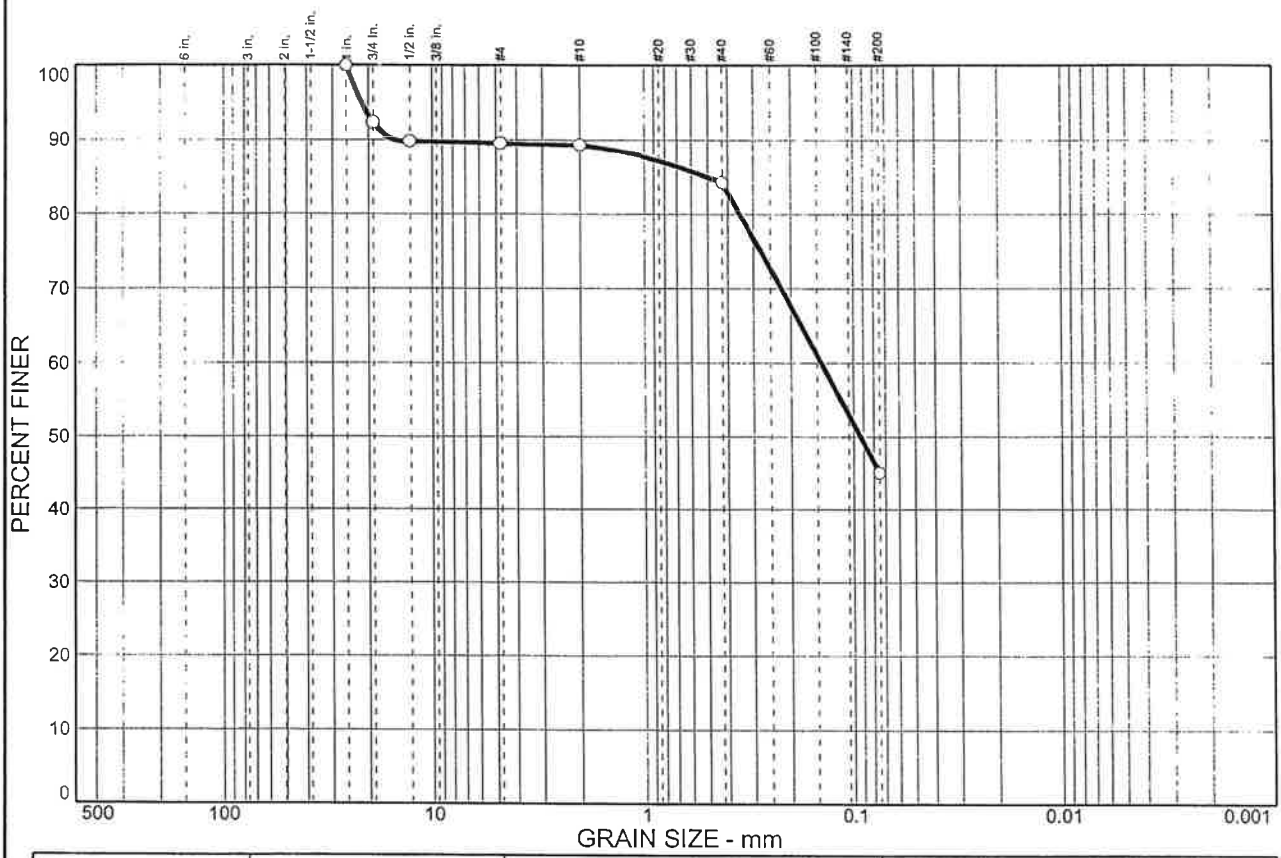
*Note: Sample tested precludes particle sizes>1.4" diameter.
Total dry weight of sample tested=656 grams.

**Sample No.:** 1/12 **Source of Sample:** **Date:** 8-22-07
**Location:** Boring 1 **Depth:** 60.0'-62.0'

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No:** 1R2/304/016 **Figure** 2

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|
| | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| 0.0 | 7.7 | 2.8 | 0.2 | 5.1 | 39.2 | 45.0 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 in. | 100.0 | | |
| .75 in. | 92.3 | | |
| .5 in. | 89.8 | | |
| #4 | 89.5 | | |
| #10 | 89.3 | | |
| #40 | 84.2 | | |
| #200 | 45.0 | | |

* (no specification provided)

**Material Description**

**Atterberg Limits**

PL= NP LL= 29 PI= NP

**Coefficients**

$D_{85}$= 0.498 $D_{60}$= 0.143 $D_{50}$= 0.0929
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= AASHTO=

**Remarks**

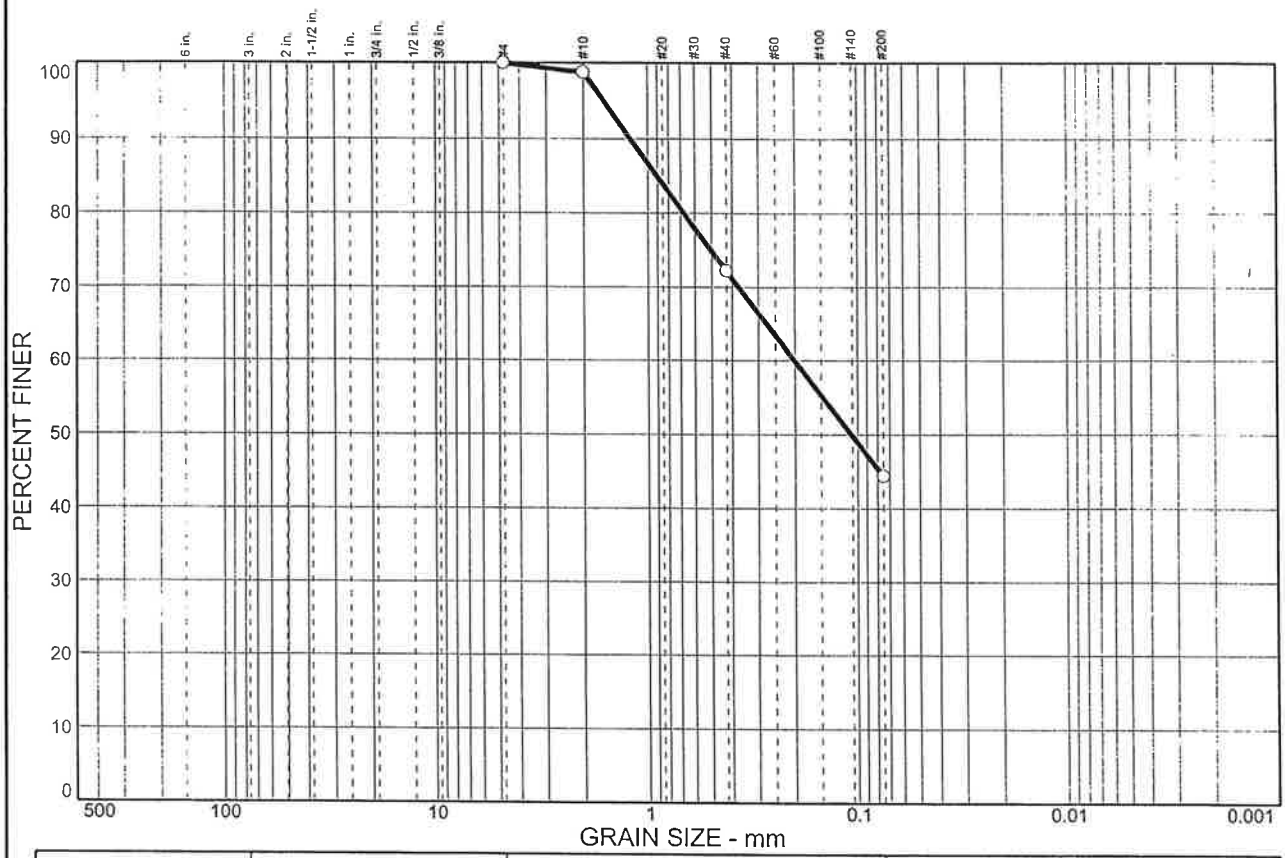
*Note: Sample tested precludes particle sizes>1.4" diameter.
Total dry weight of sample tested=1101 grams.

**Sample No.:** 1/13+1/14 comp. **Source of Sample:** **Date:** 8-22-07
**Location:** Boring 1 **Depth:** 65.0'-72.0'

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No:** 1R2/304/016 **Figure** 2

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | | % SAND | | | % FINES | |
|---|---|---|---|---|---|---|---|
| | CRS. | FINE | CRS. | MEDIUM | FINE | SILT | CLAY |
| 0.0 | 0.0 | 0.0 | 1.2 | 26.6 | 27.8 | 44.4 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| #4 | 100.0 | | |
| #10 | 98.8 | | |
| #40 | 72.2 | | |
| #200 | 44.4 | | |

* (no specification provided)

**Material Description**

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 0.904 $D_{60}$= 0.201 $D_{50}$= 0.107
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= AASHTO=

**Remarks**

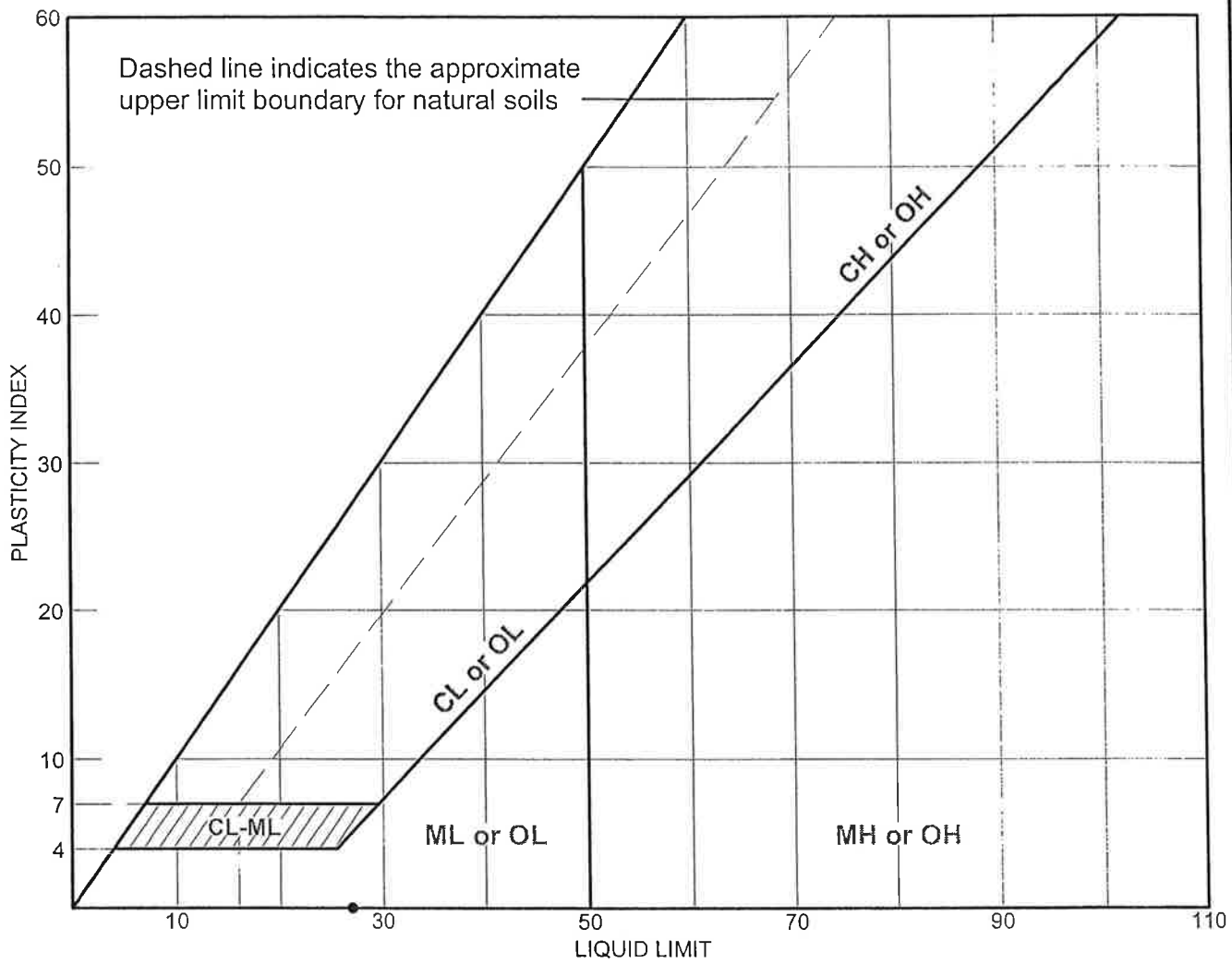
*Note: Sample tested precludes particle sizes>1.4" diameter.
Total dry weight of sample tested=284 grams.

**Sample No.:** 1/15+1/16 comp. **Source of Sample:** **Date:** 8-22-07
**Location:** Boring 1 **Depth:** 75.0'-82.0'

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No:** 1R2/304/016 **Figure** 2

# LIQUID AND PLASTIC LIMITS TEST REPORT




**SOIL DATA**

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | NATURAL WATER CONTENT (%) | PLASTIC LIMIT (%) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | USCS |
|---|---|---|---|---|---|---|---|---|
| ● | | 1/3,4A&1/6 | 15.0'-32.0' | | NP | 27 | NP | |

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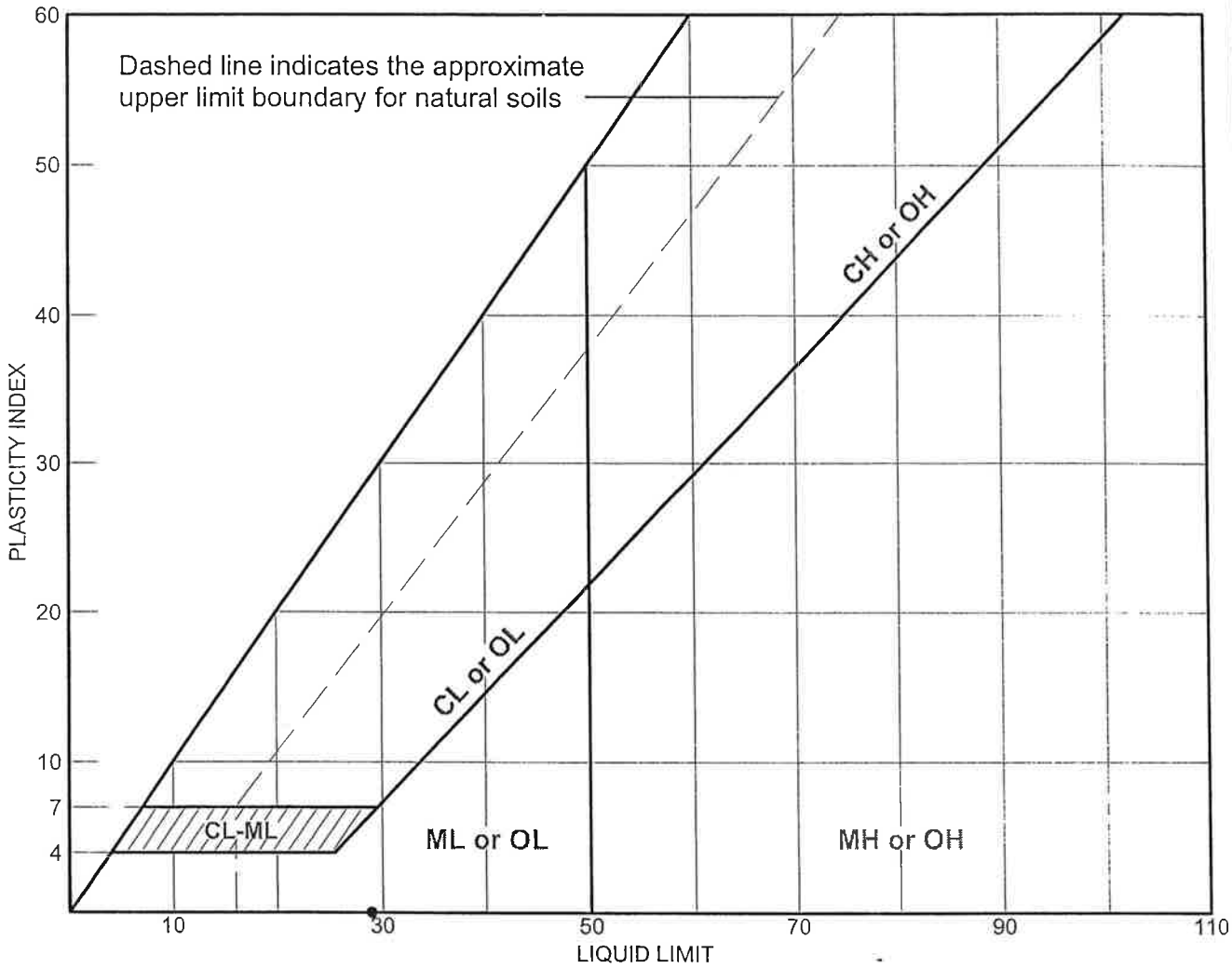
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No.:** 1R2/304/016 **Figure** 2

# LIQUID AND PLASTIC LIMITS TEST REPORT




**SOIL DATA**

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | NATURAL WATER CONTENT (%) | PLASTIC LIMIT (%) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | USCS |
|---|---|---|---|---|---|---|---|---|
| ● | | 1/13+1/14 | 65.0'-72.0' | | NP | 29 | NP | |

Taber
Since 1954

**Client:** TRC
**Project:** Fifth Street Bridge @ Feather River
**Project No.:** 1R2/304/016 **Figure** 2

# *Sunland Analytical*

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557


Date Reported 08/24/2007
Date Submitted 08/21/2007

To: Ralph Fisher
Taber Consultants
3911 West Capital Avenue
W. Sacramento, CA 95691-2116

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : IR2/304/016 Site ID : 1/3+1/4A+1/4B+.
Thank you for your business.

* For future reference to this analysis please use SUN # 51513-102883.

---

EVALUATION FOR SOIL CORROSION

| | | |
|---|---|---|
| Soil pH | 5.49 | |
| Minimum Resistivity | 3.75 ohm-cm (x1000) | |
| Chloride | 11.8 ppm | 00.00118 % |
| Sulfate | 62.1 ppm | 00.00621 % |

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

AUG 27 2007

# *Sunland Analytical*

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557


Date Reported 08/24/2007
Date Submitted 08/21/2007

To: Ralph Fisher
Taber Consultants
3911 West Capital Avenue
W. Sacramento, CA 95691-2116

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : IR2/304/016 Site ID : 1/15+1/16 COMP..
Thank you for your business.

* For future reference to this analysis please use SUN # 51513-102884.

---

EVALUATION FOR SOIL CORROSION

| | | |
|---|---|---|
| Soil pH | 7.77 | |
| Minimum Resistivity | 1.13 ohm-cm (x1000) | |
| Chloride | 14.8 ppm | 00.00148 % |
| Sulfate | 31.5 ppm | 00.00315 % |

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

# APPENDIX C

# SITE-SPECIFIC IDEALIZED SOIL PROFILES AND SOIL PARAMETERS

DRAFT

Site-specific idealized soil profiles and soil parameters for pre- and post-liquefaction conditions are presented in this appendix, including one unified idealized soil profile for the Second Street OC, and individual idealized soil profile per support location for the proposed Fifth Street Bridge.

**Table 1. Idealized Soil Profile and Soil Parameters (2nd Street OC, pre-/post-liquefaction)**

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| Above +60 | Fill | 3 to (26)<br>N = 5 | 105 | 28 | 100 | 10 | - | 1300 |
| +60 to +45 | SM/SC/ML | 6 to (22)<br>N = 7 | 110 | 29 | 50 | 15 above GWE, 15 below GWE | - | 1300 |
| +45 to +35 | SP/SP-SM/SM/ML | 16 to (44)<br>N = 20 | 120 | 33 | 50 | 60 | - | 1300 |
| +35 to +10 | ML/CL | 20 to (75)<br>N = 25 | 125 | - | 2,500 | - | 0.008 | 1300 |
| +10 to -25 | SP-SM/ML | (34) to (68)<br>N = 24 | 125 | 34 | 50 | 70 | - | 1300 to 1400 |
| -25 to -65 | CL | (39) to (86/9.5”)<br>N = 45 | 125 | - | 4,000 | - | 0.005 | 1400 to 1840 |
| -65 to -100 | SM/ML/MH | 25 to REF<br>N = 45 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-01).

## Table 2. Idealized Soil Profile and Soil Parameters (Abutment 1, pre-/post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| Above +60 | Fill | 3 to (26)<br>N = 5 | 105 | 28 | 50 | 10 | - | 600 to 650 |
| +60 to +50 | SM/SC/ML | 3 to (15)<br>N = 7 | 110 | 29 | 50 | 15 above GWE, 15 below GWE | - | 650 to 1100 |
| +50 to +35 | SP/SP-SM/SM/ML | 16 to 18<br>N = 17 | 120 | 32 | 50 | 50 | - | 1100 to 1300 |
| +35 to +15 | ML/CL | (24) to (81/11”)<br>N = 21 | 125 | - | 2,000 | - | 0.01 | 1300 |
| +15 to -20 | SP-SM/ML | (27) to 66<br>N = 23 | 125 | 34 | 50 | 70 | - | 1300 |
| -20 to -60 | CL | (39) to (86/9.5”)<br>N = 45 | 125 | - | 4,000 | - | 0.005 | 1300 to 1840 |
| -60 to -100 | SM/ML/MH | 25 to REF<br>N = 45 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft (for slope stability analysis, use +80 ft).
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-01).

## Table 3. Idealized Soil Profile and Soil Parameters (Bent 2, pre-/post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +42 to +32 | SP/ML | 1 to 18<br>N = 5 | 105 | 28 | 50 | 10 | - | 1000 to 1300 |
| +32 to +17 | CL/ML | (24) to (81/11”)<br>N = 20 | 120 | - | 2000 | - | 0.01 | 1300 |
| +17 to -18 | SP-SM/SM/ML | (27) to 66<br>N = 35 | 125 | 36 | 50 | 90 | - | 1300 to 1840 |
| -18 to -53 | CL | (39) to (86/9.5”)<br>N = 45 | 125 | - | 4,000 | - | 0.005 | 1840 |
| -53 to -100 | SM/ML | 25 to REF<br>N = 45 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

4. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
5. Design ground water elevation is +50 ft.
6. Estimated from the Vs measurements of adjacent CPT (DE-CPT-01).

## Table 4a. Idealized Soil Profile and Soil Parameters (Bent 3, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +35 to +5 | SP/SP | N = 5 | 105 | 28 | 50 | 10 | - | 500 |
| +5 to -10 | SP-SM | 14 to (47)<br>N = 22 | 120 | 34 | 50 | 70 | - | 500 to 1000 |
| -10 to -50 | CL/ML | 24 to (50/6”)<br>N = 30 | 125 | - | 4,000 | - | 0.005 | 1000 to 1840 |
| -50 to -100 | SM/ML/SP | N = 45 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-02).

## Table 4b. Idealized Soil Profile and Soil Parameters (Bent 3, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +35 to +5 | Liquefied layer | N = 5 | 105 | - | 400 | - | 0.015 | 300 |
| +5 to -10 | SP-SM | 14 to (47)<br>N = 22 | 120 | 34 | 50 | 70 | - | 500 to 1000 |
| -10 to -50 | CL/ML | 24 to (50/6”)<br>N = 30 | 125 | - | 4,000 | - | 0.005 | 1000 to 1840 |
| -50 to -100 | SM/ML/SP | N = 45 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-02).

## Table 5a. Idealized Soil Profile and Soil Parameters (Bent 4, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +55 to +35 | CL/SM | (9) to 8<br>N =7 | 110 | - | 800 | - | 0.012 | 500 |
| +35 to +5 | SP-SMP | 2 to (17)<br>N = 5 | 105 | 28 | 50 | 10 | - | 500 to 1000 |
| +5 to -10 | GP-GM | 14 to (47)<br>N = 22 | 120 | 34 | 50 | 70 | - | 1000 to 1200 |
| -10 to -50 | ML/SM/CH | 24 to (50/6")<br>N = 30 | 125 | - | 4,000 | - | 0.005 | 1200 to 1840 |
| -50 to -100 | SM/GW/CL | (50/1") to REF<br>N = 45 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-02).

## Table 5b. Idealized Soil Profile and Soil Parameters (Bent 4, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +55 to +35 | CL/SM | (9) to 8<br>N =7 | 110 | - | 800 | - | 0.012 | 500 |
| +35 to +5 | Liquefied layer | N = 5 | 105 | - | 400 | - | 0.015 | 300 |
| +5 to -10 | GP-GM | 14 to (47)<br>N = 22 | 120 | 34 | 50 | 70 | - | 1000 to 1200 |
| -10 to -50 | ML/SM/CH | 24 to (50/6")<br>N = 30 | 125 | - | 4,000 | - | 0.005 | 1200 to 1840 |
| -50 to -100 | SM/GW/CL | (50/1") to REF<br>N = 45 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-02).

## Table 6a. Idealized Soil Profile and Soil Parameters (Bent 5, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +53 to +43 | ML | N =4 | 105 | - | 500 | - | 0.014 | 500 |
| +43 to +13 | SP-SM | (2) to 20<br>N = 5 | 105 | 28 | 50 | 10 | - | 500 to 600 |
| +13 to -7 | GP-GM | 24 to (54/6")<br>N = 24 | 120 | 34 | 50 | 70 | - | 600 to 1400 |
| -7 to -47 | ML/SM/CH | 27 to 57<br>N = 30 | 125 | - | 4,000 | - | 0.005 | 1400 to 1840 |
| -47 to -100 | SM/GW/CL | 64 to REF<br>N = 64 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-03).

## Table 6b. Idealized Soil Profile and Soil Parameters (Bent 5, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +53 to +43 | ML | N =4 | 105 | - | 500 | - | 0.014 | 500 |
| +43 to +13 | Liquefied layer | (2) to 20<br>N = 5 | 105 | - | 400 | - | 0.015 | 300 |
| +13 to -7 | GP-GM | 24 to (54/6")<br>N = 24 | 120 | 34 | 50 | 70 | - | 600 to 1400 |
| -7 to -47 | ML/SM/CH | 27 to 57<br>N = 30 | 125 | - | 4,000 | - | 0.005 | 1400 to 1840 |
| -47 to -100 | SM/GW/CL | 64 to REF<br>N = 64 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-03).

## Table 7a. Idealized Soil Profile and Soil Parameters (Bent 6, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +55 to +45 | ML | N =4 | 105 | - | 500 | - | 0.014 | 550 |
| +45 to +20 | SP-SM/SM | (10) to 10<br>N = 5 | 105 | 28 | 50 | 10 | - | 550 to 900 |
| +20 to +10 | GP-GM | 9 to 66<br>N = 23 | 120 | 34 | 50 | 70 | - | 900 to 1000 |
| +10 to -45 | CL/.ML/SM | (40) to (90/10”)<br>N = 30 | 125 | - | 4,000 | - | 0.005 | 1000 to 1840 |
| -45 to -100 | SM/CL/GW | 70 to REF<br>N = 64 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-04).

## Table 7b. Idealized Soil Profile and Soil Parameters (Bent 6, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +55 to +45 | ML | N =4 | 105 | - | 500 | - | 0.014 | 550 |
| +45 to +20 | Liquefied layer | (10) to 10<br>N = 5 | 105 | - | 400 | - | 0.015 | 300 |
| +20 to +10 | GP-GM | 9 to 66<br>N = 23 | 120 | 34 | 50 | 70 | - | 900 to 1000 |
| +10 to -45 | CL/.ML/SM | (40) to (90/10”)<br>N = 30 | 125 | - | 4,000 | - | 0.005 | 1000 to 1840 |
| -45 to -100 | SM/CL/GW | 70 to REF<br>N = 64 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-0405).

## Table 8a. Idealized Soil Profile and Soil Parameters (Bent 7, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +55 to +45 | SM | N =18 | 110 | 32 | 50 | 70 +GWE, 50 - | - | 550 |
| +45 to +10 | ML/SP-SM/CL | 2 to (13) N = 5 | 105 | 28 | 50 | 10 | - | 550 to 600 |
| +10 to +5 | SP-SM | (62) to 52 N = 30 | 125 | 36 | 50 | 90 | - | 600 to 650 |
| +5 to -45 | CL/.ML/SM | (62) to REF N = 35 | 125 | - | 4,000 | - | 0.005 | 650 to 1840 |
| -45 to -100 | SM/CL-ML/GW | 68 to REF N = 64 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-04).

## Table 8b. Idealized Soil Profile and Soil Parameters (Bent 7, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +55 to +45 | SM | N =18 | 110 | 32 | 50 | 70 +GWE, 50 - | - | 550 |
| +45 to +10 | Liquefied layer | 2 to (13) N = 5 | 105 | - | 400 | - | 0.015 | 300 |
| +10 to +5 | SP-SM | (62) to 52 N = 30 | 125 | 36 | 50 | 90 | - | 600 to 650 |
| +5 to -45 | CL/.ML/SM | (62) to REF N = 35 | 125 | - | 4,000 | - | 0.005 | 650 to 1840 |
| -45 to -100 | SM/CL-ML/GW | 68 to REF N = 64 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-04).

## Table 9a. Idealized Soil Profile and Soil Parameters (Bent 8, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +53 to +48 | ML/SM | N =6 | 105 | 28 | 50 | 10, 10 | - | 550 |
| +48 to +13 | SM/SP-SM | (5) to 14<br>N = 5 | 105 | 28 | 50 | 10 | - | 550 to 800 |
| +13 to +8 | SP-SM | 31 to 68<br>N = 32 | 125 | 36 | 50 | 90 | - | 800 |
| +8 to -32 | CL/.ML/SM | 27 to (53/6”)<br>N = 32 | 125 | - | 4,000 | - | 0.005 | 800 to 1840 |
| -32 to -100 | SM/ML/GW | 58 to REF<br>N = 60 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-05).

## Table 9b. Idealized Soil Profile and Soil Parameters (Bent 8, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +53 to +48 | ML/SM | N =6 | 105 | 28 | 50 | 10, 10 | - | 550 |
| +48 to +13 | Liquefied layer | (5) to 14<br>N = 5 | 105 | - | 400 | - | 0.015 | 300 |
| +13 to +8 | SP-SM | 31 to 68<br>N = 32 | 125 | 36 | 50 | 90 | - | 800 |
| +8 to -32 | CL/.ML/SM | 27 to (53/6”)<br>N = 32 | 125 | - | 4,000 | - | 0.005 | 800 to 1840 |
| -32 to -100 | SM/ML/GW | 58 to REF<br>N = 60 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-05).

## Table 10a. Idealized Soil Profile and Soil Parameters (Bent 9, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +54 to +49 | SM | N =6 | 105 | 28 | 50 | 10, 10 | - | 600 |
| +49 to +24 | SM/SP | (7) to 36<br>N = 5 | 105 | 28 | 50 | 10 | - | 600 to 700 |
| +24 to +14 | GP | 30 to 58<br>N = 32 | 125 | 36 | 50 | 90 | - | 700 to 800 |
| +14 to -46 | CL/.ML/SM | 33 to (50/5”)<br>N = 34 | 125 | - | 4,000 | - | 0.005 | 800 to 1840 |
| -46 to -100 | SM/ML/GW | 57 to REF<br>N = 60 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-06).

## Table 10b. Idealized Soil Profile and Soil Parameters (Bent 9, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +54 to +49 | SM | N =6 | 105 | 28 | 50 | 10, 10 | - | 600 |
| +49 to +24 | Liquefied layer | (7) to 36<br>N = 5 | 105 | - | 400 | - | 0.015 | 300 |
| +24 to +14 | GP | 30 to 58<br>N = 32 | 125 | 36 | 50 | 90 | - | 700 to 800 |
| +14 to -46 | CL/.ML/SM | 33 to (50/5”)<br>N = 34 | 125 | - | 4,000 | - | 0.005 | 800 to 1840 |
| -46 to -100 | SM/ML/GW | 57 to REF<br>N = 60 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-06).

## Table 11a. Idealized Soil Profile and Soil Parameters (Bent 10, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +55 to +50 | SM | N =10 | 110 | 30 | 50 | 45, 33 | - | 650 |
| +50 to +30 | SM | (5) to 8<br>N = 5 | 105 | 28 | 50 | 10 | - | 650 to 750 |
| +30 to +20 | GP | N = 15 | 120 | 32 | 50 | 50 | - | 750 |
| +20 to -50 | CL/.ML/SM | 30 to (50/5”)<br>N = 34 | 125 | - | 4,000 | - | 0.005 | 750 to 1840 |
| -50 to -100 | SP-SM/GW | 56 to REF<br>N = 60 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-06).

## Table 11b. Idealized Soil Profile and Soil Parameters (Bent 10, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +55 to +50 | SM | N =10 | 110 | 30 | 50 | 45, 33 | - | 650 |
| +50 to +30 | Liquefied layer | (5) to 8<br>N = 5 | 105 | - | 400 | - | 0.015 | 300 |
| +30 to +20 | GP | N = 15 | 120 | 32 | 50 | 50 | - | 750 |
| +20 to -50 | CL/.ML/SM | 30 to (50/5”)<br>N = 34 | 125 | - | 4,000 | - | 0.005 | 750 to 1840 |
| -50 to -100 | SP-SM/GW | 56 to REF<br>N = 60 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft.
3. Estimated from the Vs measurements of adjacent CPTs (DE-CPT-06).

## Table 12a. Idealized Soil Profile and Soil Parameters (Abutment 11, pre-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +88 to +57 | Fill | 14 to (28)<br>N =15 | 110 | 32 | 100 | 70 | - | 600 |
| +57 to +52 | SM/ML | 9 to (27)<br>N =10 | 110 | 30 | 50 | 45, 33 | - | 600 |
| +52 to +32 | SM | (12) to 19<br>N = 6 | 105 | 28 | 50 | 10 | - | 600 to 650 |
| +32 to +22 | GP/SP-SM | (14) to REF<br>N = 15 | 120 | 32 | 50 | 50 | - | 650 to 900 |
| +22 to -48 | ML/SM | 28 to 50/2”<br>N = 34 | 125 | - | 4,000 | - | 0.005 | 900 to 1840 |
| -48 to -100 | SP-SM/GW | N = 50 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft (for slope stability analysis, use +80 ft).
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-06).

## Table 12b. Idealized Soil Profile and Soil Parameters (Abutment 11, post-liquefaction)

| Approx. Elevation (ft) | Predominant Soil Type | Range of Corrected SPT Blowcount [1]; Average (blows/foot) | Total Unit Weight (pcf) | Friction Angle (degree) | Cohesion / Undrained Shear Strength (psf) | Initial Subgrade Modulus, k (pci) | Strain at 50% of the Max. Stress, $\varepsilon_{50}$ | Shear Wave Velocity, Vs[3] (fps) |
|---|---|---|---|---|---|---|---|---|
| +88 to +57 | Fill | 14 to (28)<br>N =15 | 110 | 32 | 100 | 70 | - | 600 |
| +57 to +52 | SM/ML | 9 to (27)<br>N =10 | 110 | 30 | 50 | 45, 33 | - | 600 |
| +52 to +32 | Liquefied layer | (12) to 19<br>N = 6 | 105 | - | 400 | - | 0.015 | 300 |
| +32 to +22 | GP/SP-SM | (14) to REF<br>N = 15 | 120 | 32 | 50 | 50 | - | 650 to 900 |
| +22 to -48 | ML/SM | 28 to 50/2”<br>N = 34 | 125 | - | 4,000 | - | 0.005 | 900 to 1840 |
| -48 to -100 | SP-SM/GW | N = 50 | 130 | 38 | 50 | 118 | - | 1840 |

Notes:

1. Values in ( ) are converted SPT blowcounts corrected for sampler size using a correction of 0.5 for coarse-grained soils and 0.7 for fine-grained soils.
2. Design ground water elevation is +50 ft (for slope stability analysis, use +80 ft).
3. Estimated from the Vs measurements of adjacent CPT (DE-CPT-06).

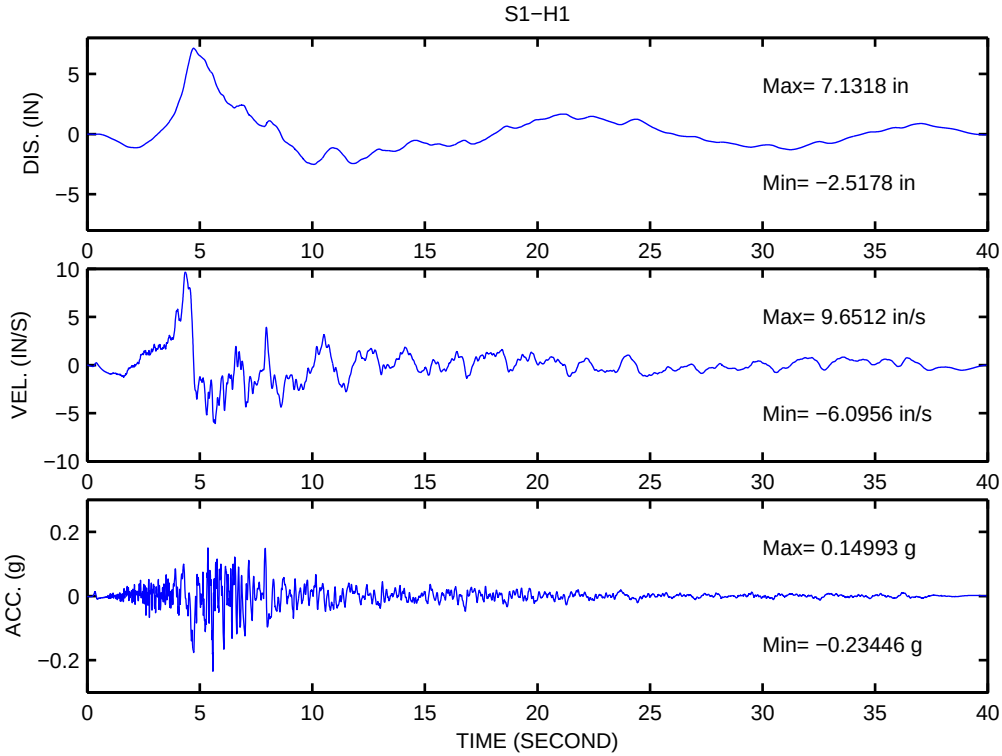
# APPENDIX D

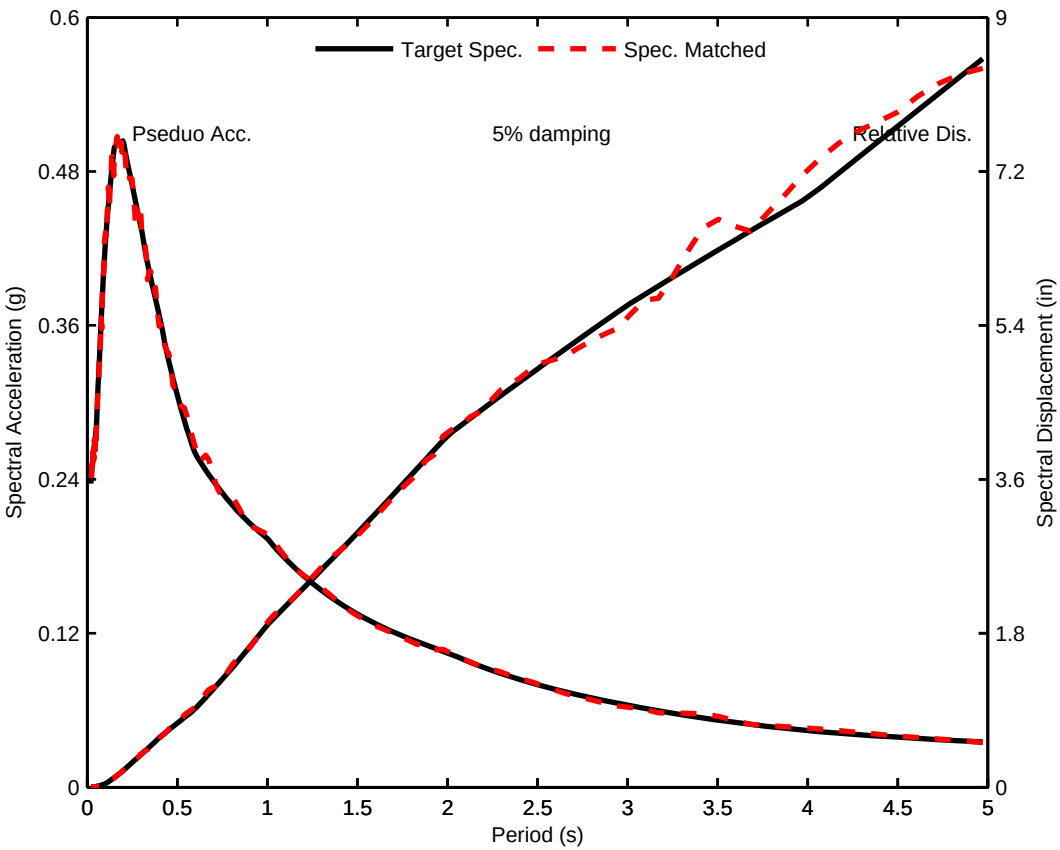
# SPECTRUM-COMPTIBLE, DEPTH-VARYING FREE-FIELD, AND KINEMATIC MOTIONS

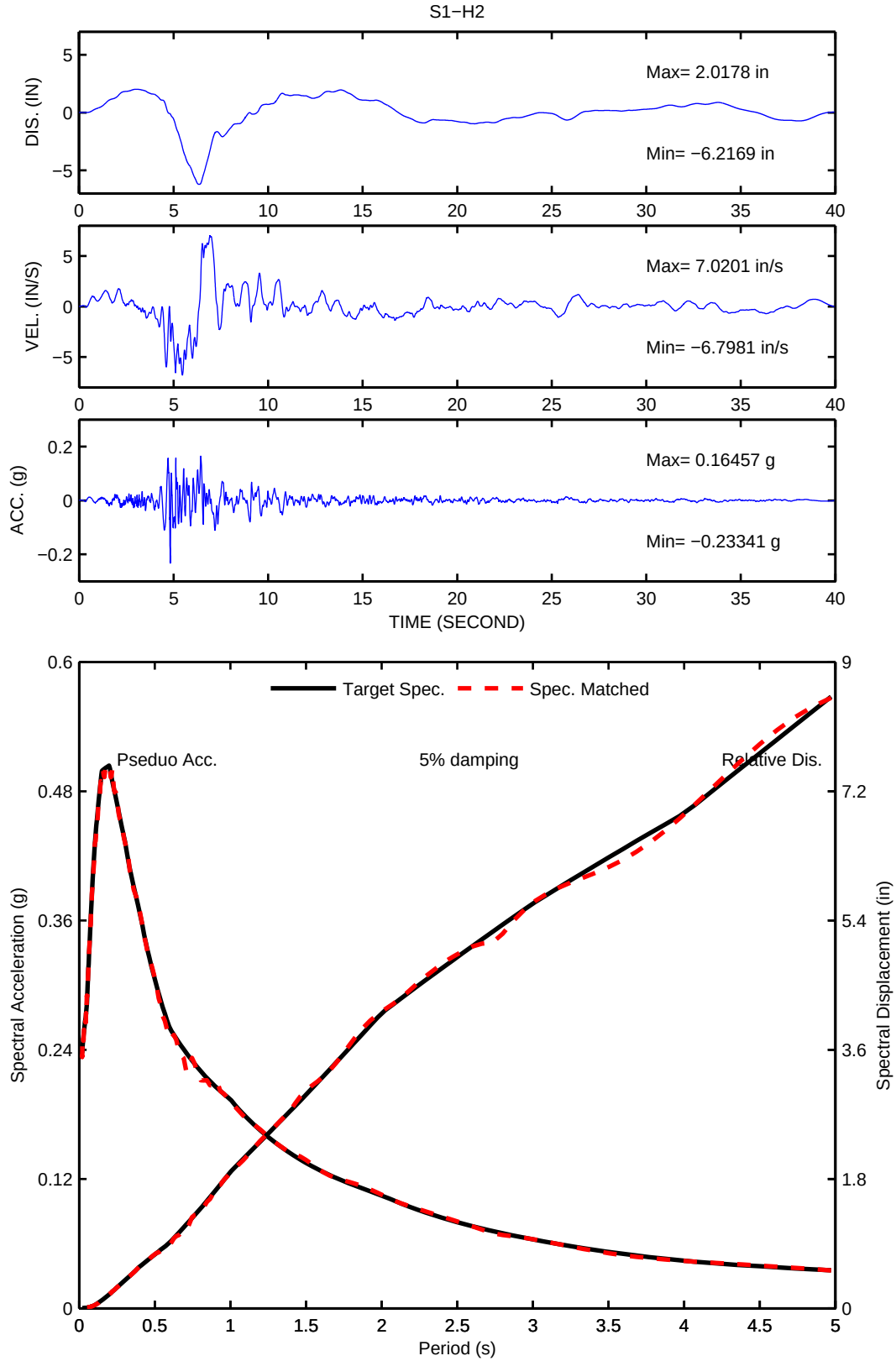
DRAFT

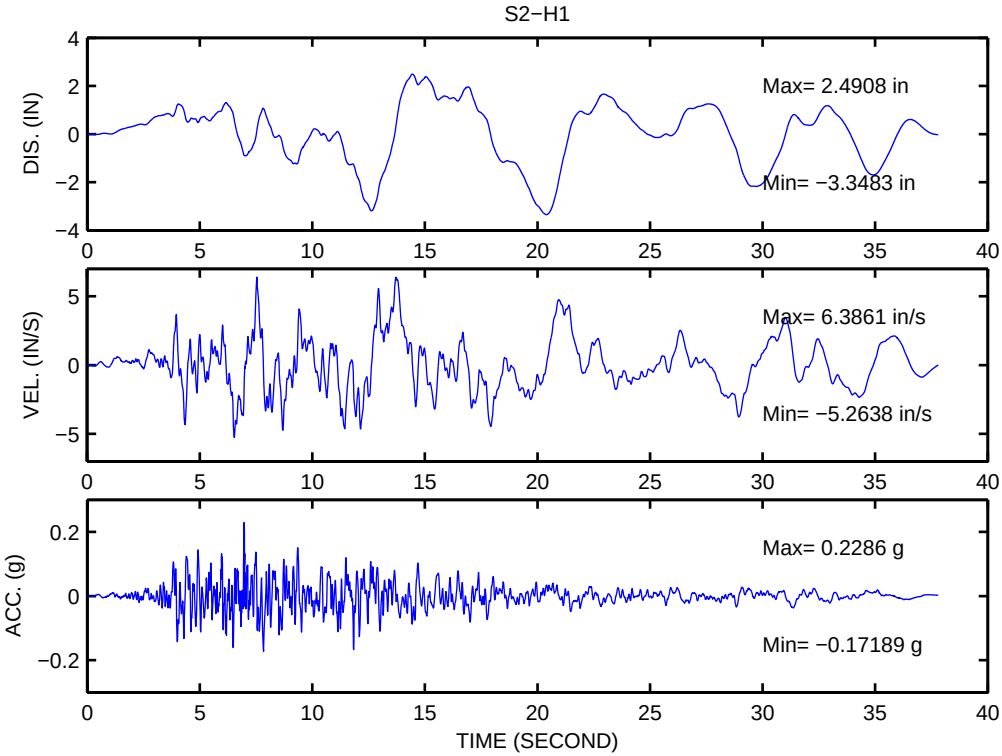
**Spectrum-Compatible Motions (3 sets and 2 components FN, FP)**

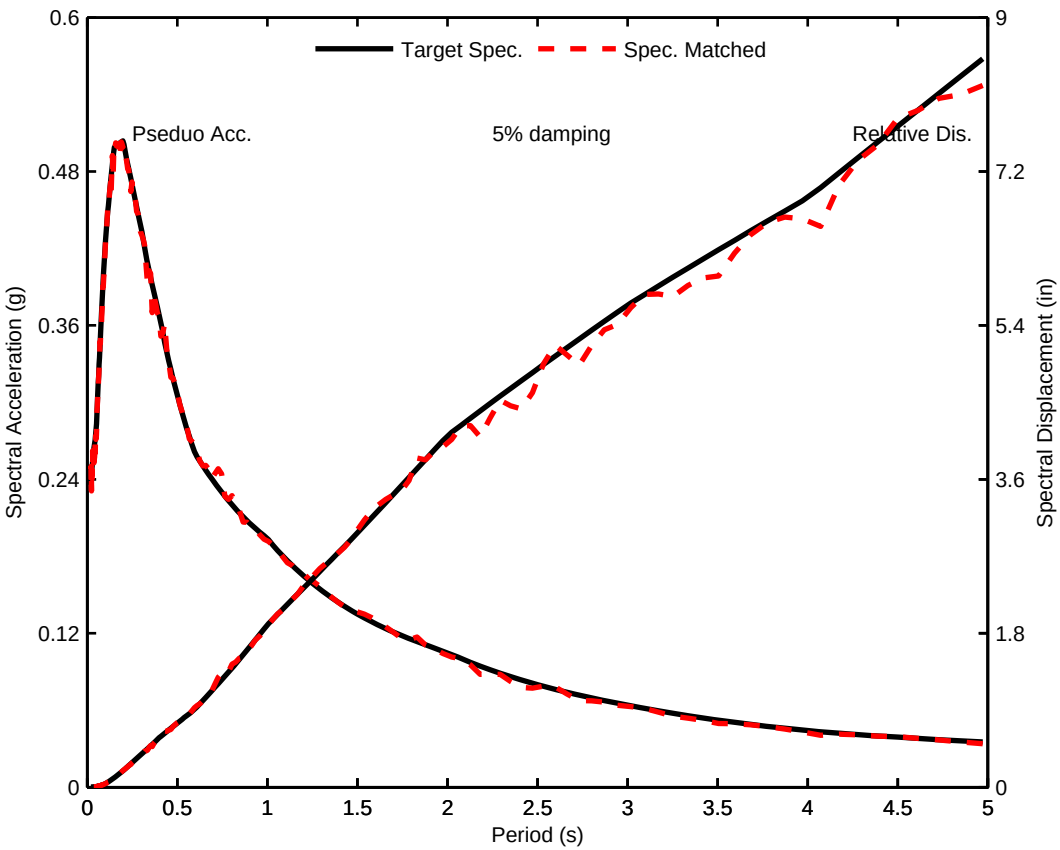
Checked by CY

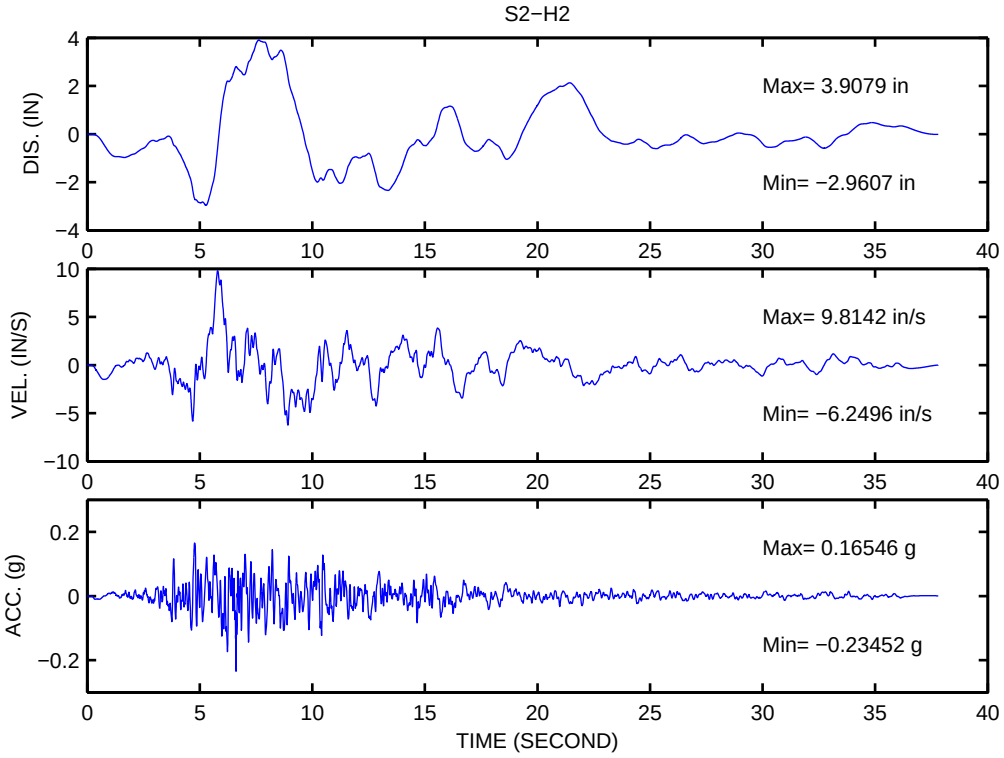

S1−H1
DIS. (IN)
Max= 7.1318 in
Min= −2.5178 in
VEL. (IN/S)
Max= 9.6512 in/s
Min= −6.0956 in/s
ACC. (g)
Max= 0.14993 g
Min= −0.23446 g
TIME (SECOND)

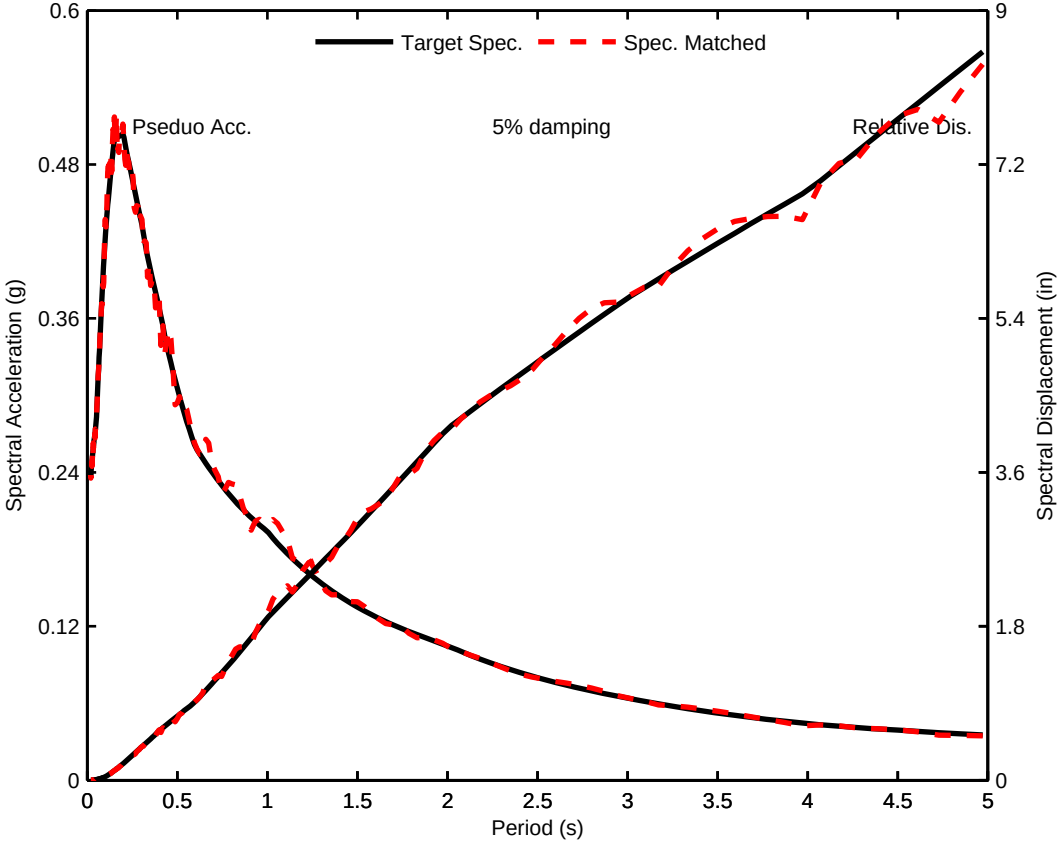

Target Spec.
Spec. Matched
Pseduo Acc.
5% damping
Relative Dis.
Spectral Acceleration (g)
Spectral Displacement (in)
Period (s)

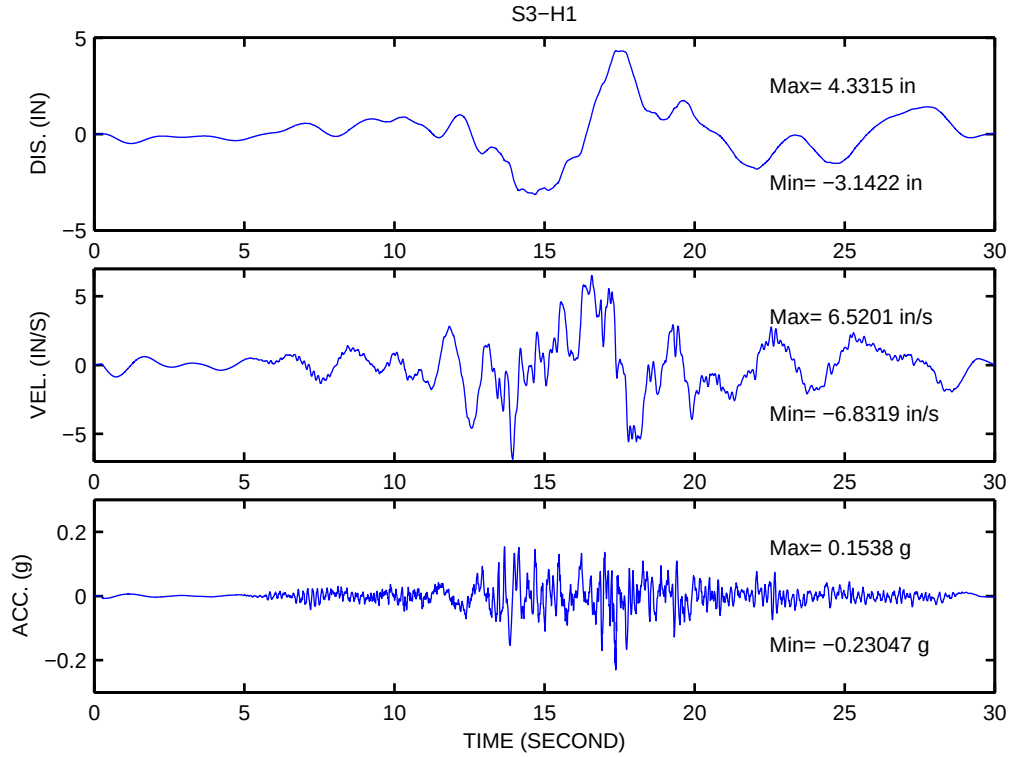

S1−H2
DIS. (IN)
Max= 2.0178 in
Min= −6.2169 in
VEL. (IN/S)
Max= 7.0201 in/s
Min= −6.7981 in/s
ACC. (g)
Max= 0.16457 g
Min= −0.23341 g
TIME (SECOND)
Target Spec.
Spec. Matched
Pseduo Acc.
5% damping
Relative Dis.
Spectral Acceleration (g)
Spectral Displacement (in)
Period (s)

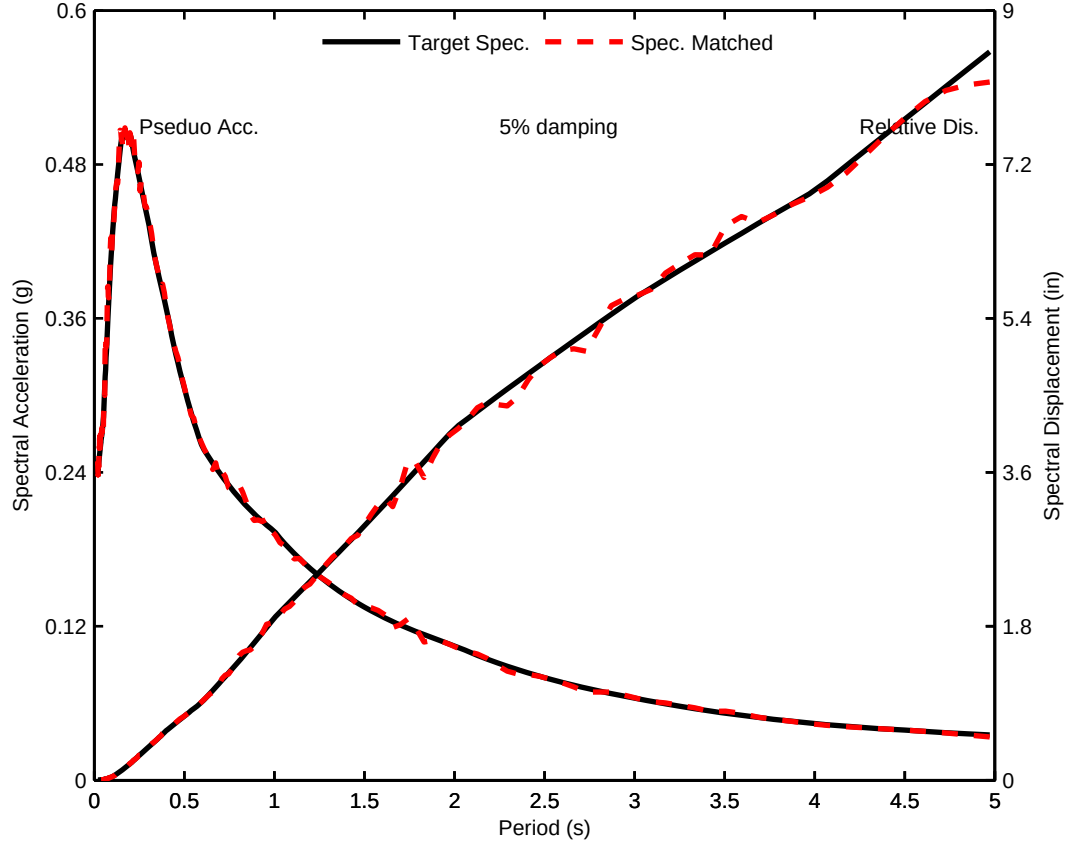

S2−H1
DIS. (IN)
Max= 2.4908 in
Min= −3.3483 in
VEL. (IN/S)
Max= 6.3861 in/s
Min= −5.2638 in/s
ACC. (g)
Max= 0.2286 g
Min= −0.17189 g
TIME (SECOND)

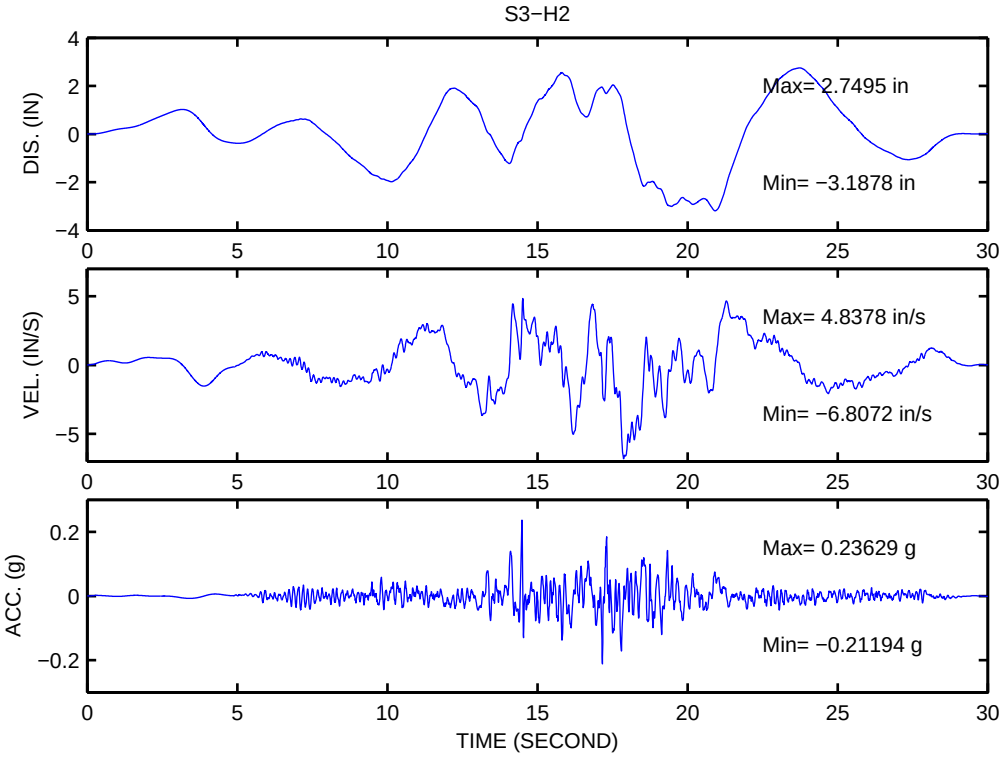

Target Spec.
Spec. Matched
Pseduo Acc.
5% damping
Relative Dis.
Spectral Acceleration (g)
Spectral Displacement (in)
Period (s)

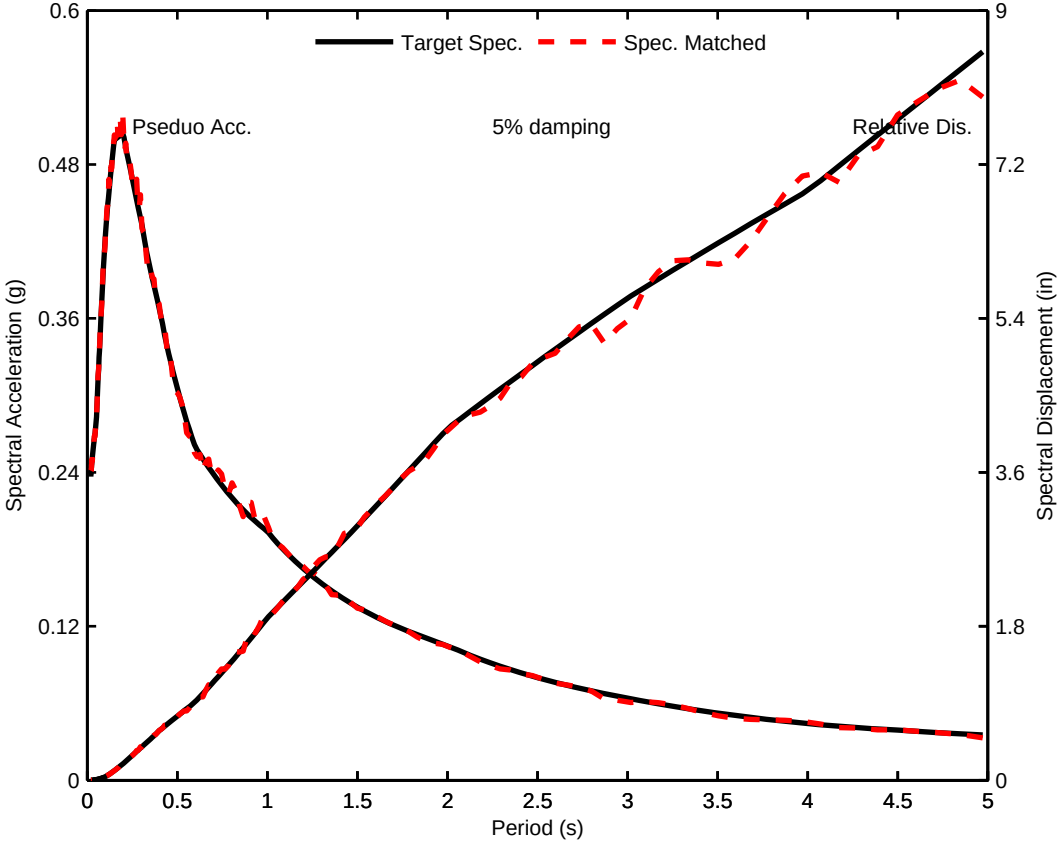

S2−H2
DIS. (IN)
Max= 3.9079 in
Min= −2.9607 in
VEL. (IN/S)
Max= 9.8142 in/s
Min= −6.2496 in/s
ACC. (g)
Max= 0.16546 g
Min= −0.23452 g
TIME (SECOND)


Target Spec.
Spec. Matched
Pseduo Acc.
5% damping
Relative Dis.
Spectral Acceleration (g)
Spectral Displacement (in)
Period (s)


S3−H1
DIS. (IN)
Max= 4.3315 in
Min= −3.1422 in
VEL. (IN/S)
Max= 6.5201 in/s
Min= −6.8319 in/s
ACC. (g)
Max= 0.1538 g
Min= −0.23047 g
TIME (SECOND)


Target Spec.
Spec. Matched
Pseduo Acc.
5% damping
Relative Dis.
Spectral Acceleration (g)
Spectral Displacement (in)
Period (s)

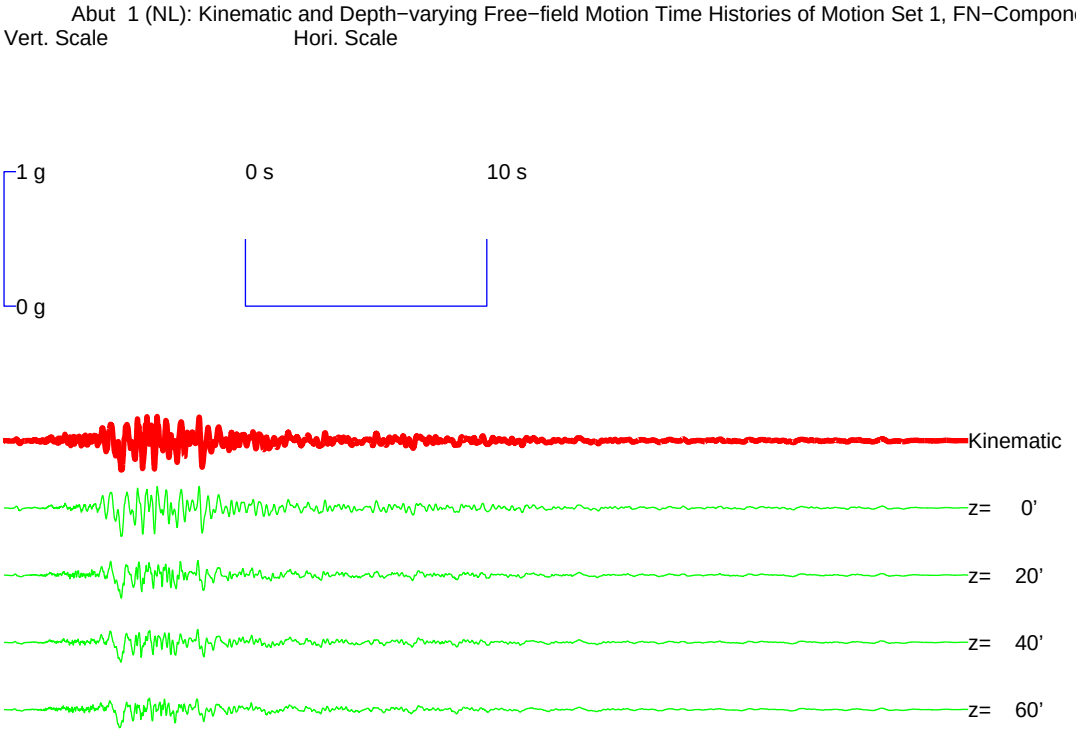

S3−H2
DIS. (IN)
Max= 2.7495 in
Min= −3.1878 in
VEL. (IN/S)
Max= 4.8378 in/s
Min= −6.8072 in/s
ACC. (g)
Max= 0.23629 g
Min= −0.21194 g
TIME (SECOND)

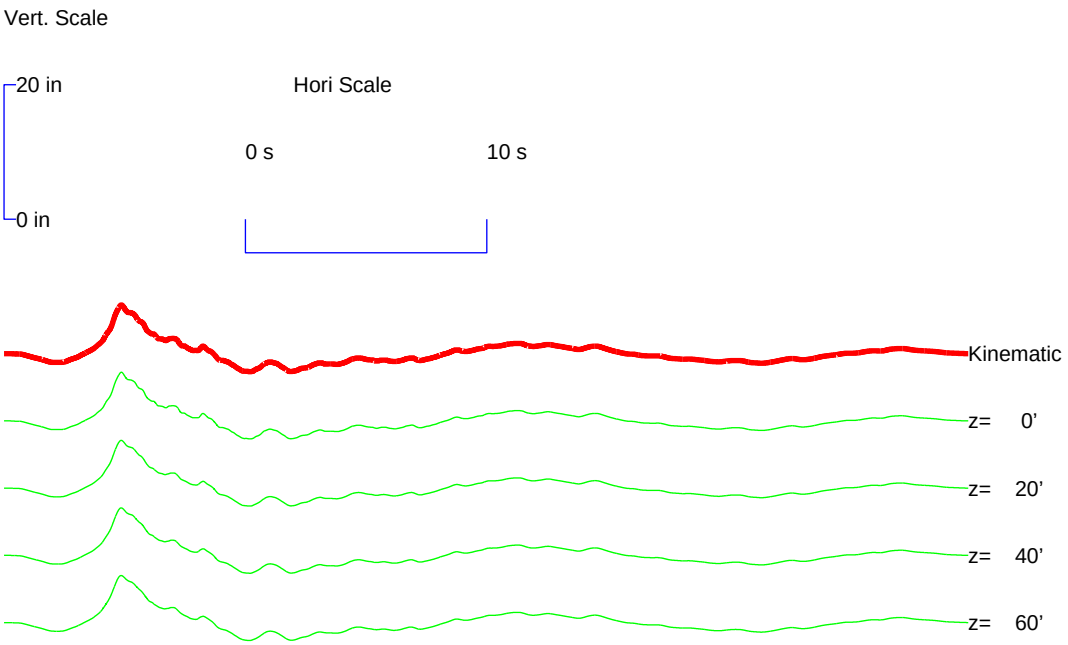

Target Spec.
Spec. Matched
Pseduo Acc.
5% damping
Relative Dis.
Spectral Acceleration (g)
Spectral Displacement (in)
Period (s)

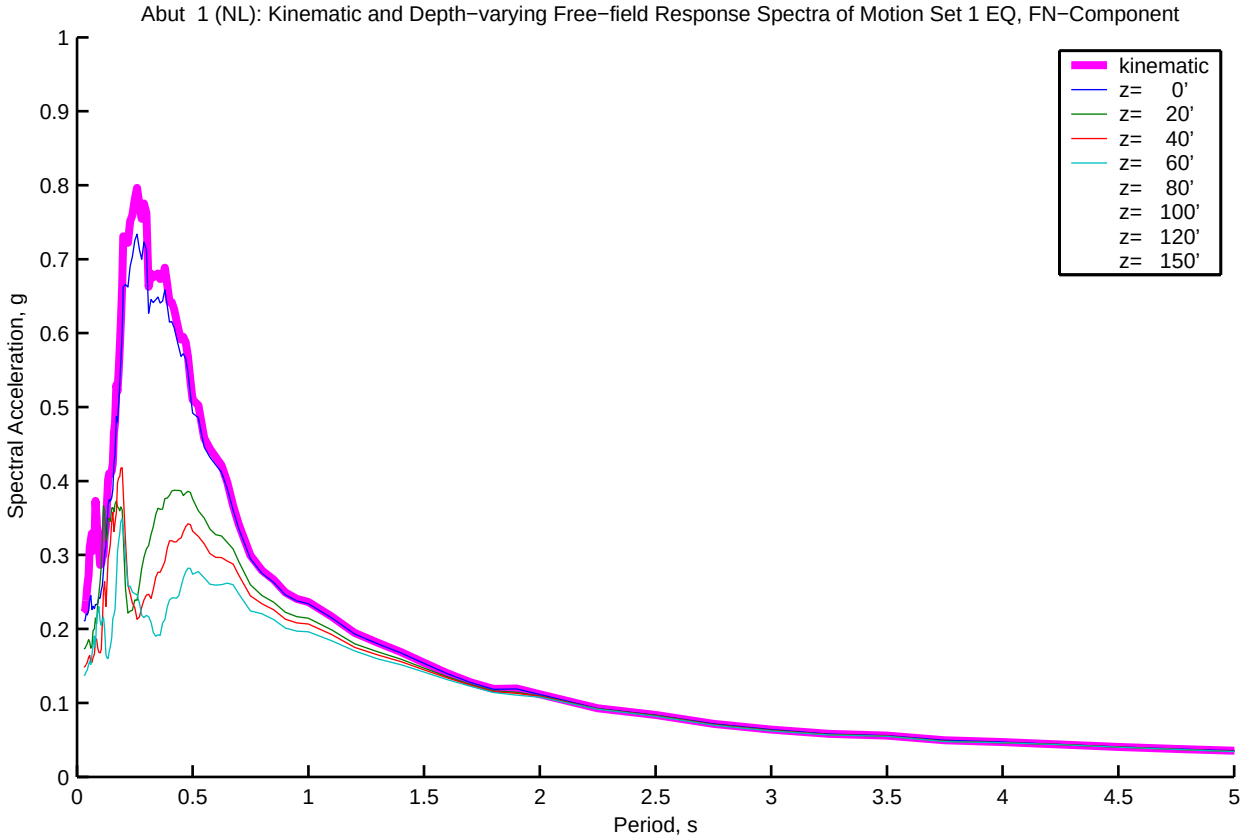
# Depth-Varying Free-Field and Kinematic Motions

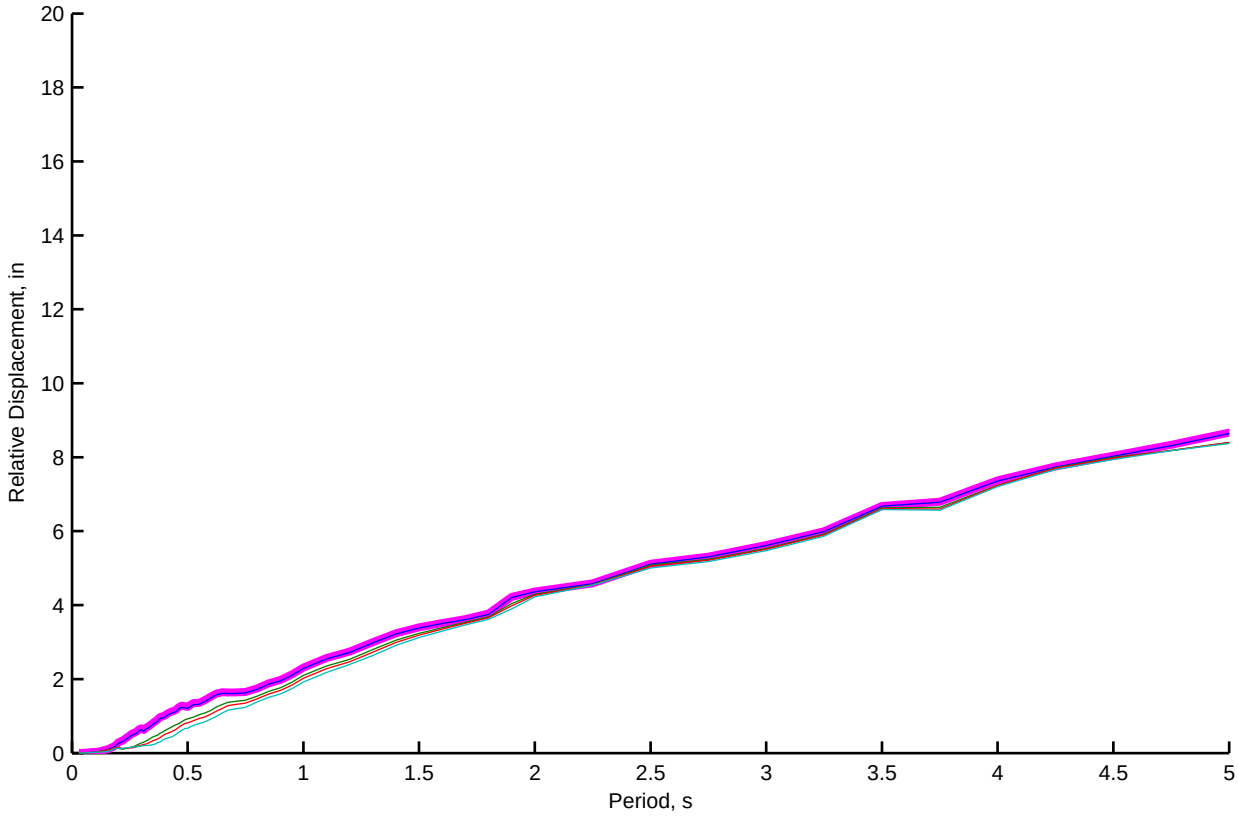
Checked by CY

Abut 1 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

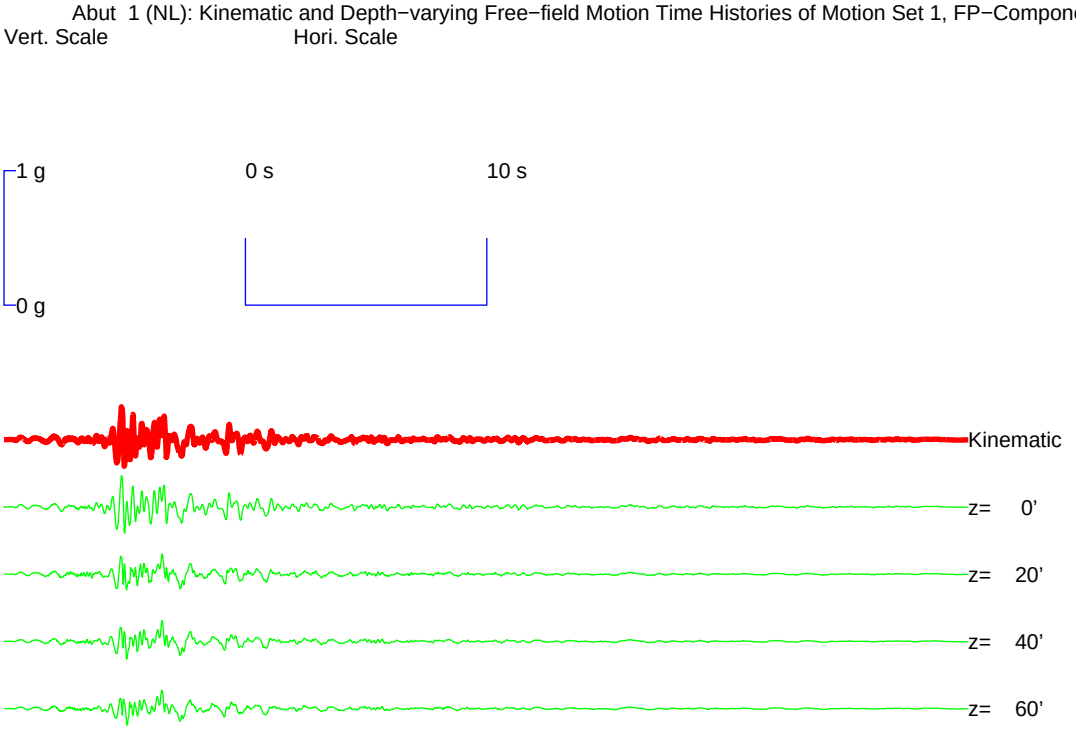


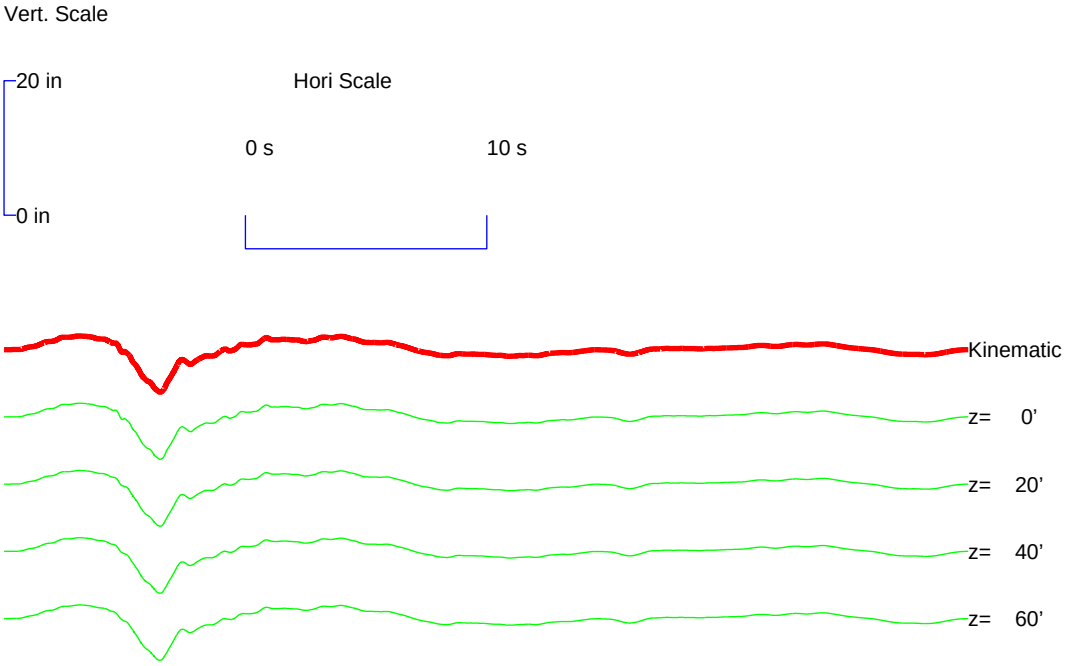



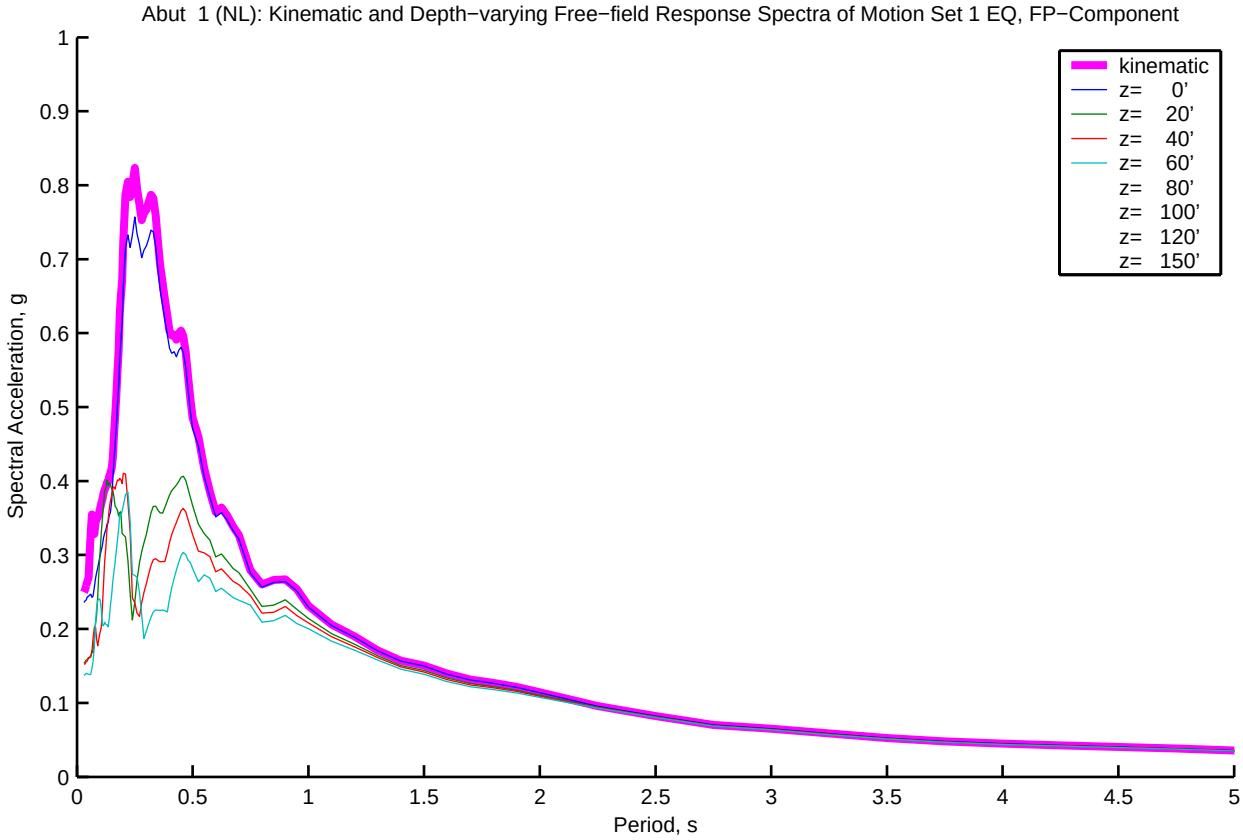

Abut 1 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

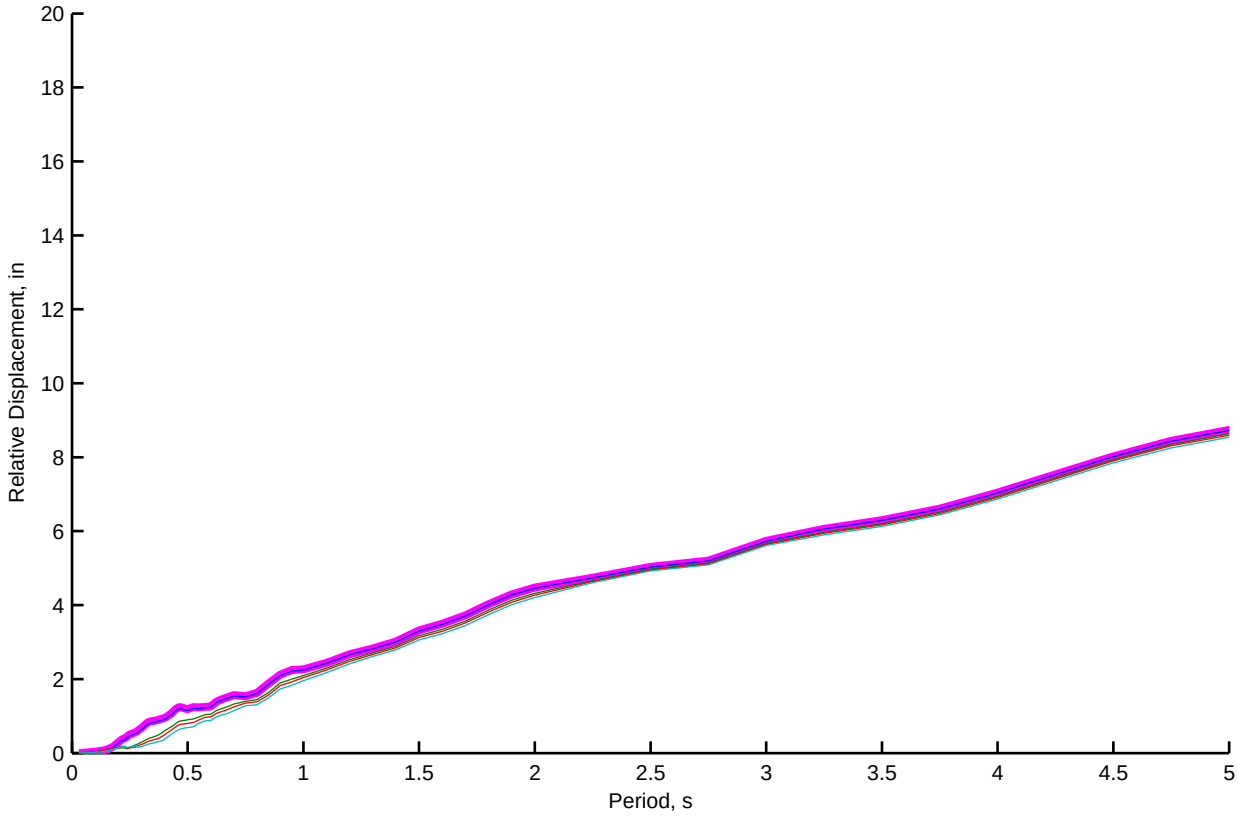

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 1 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

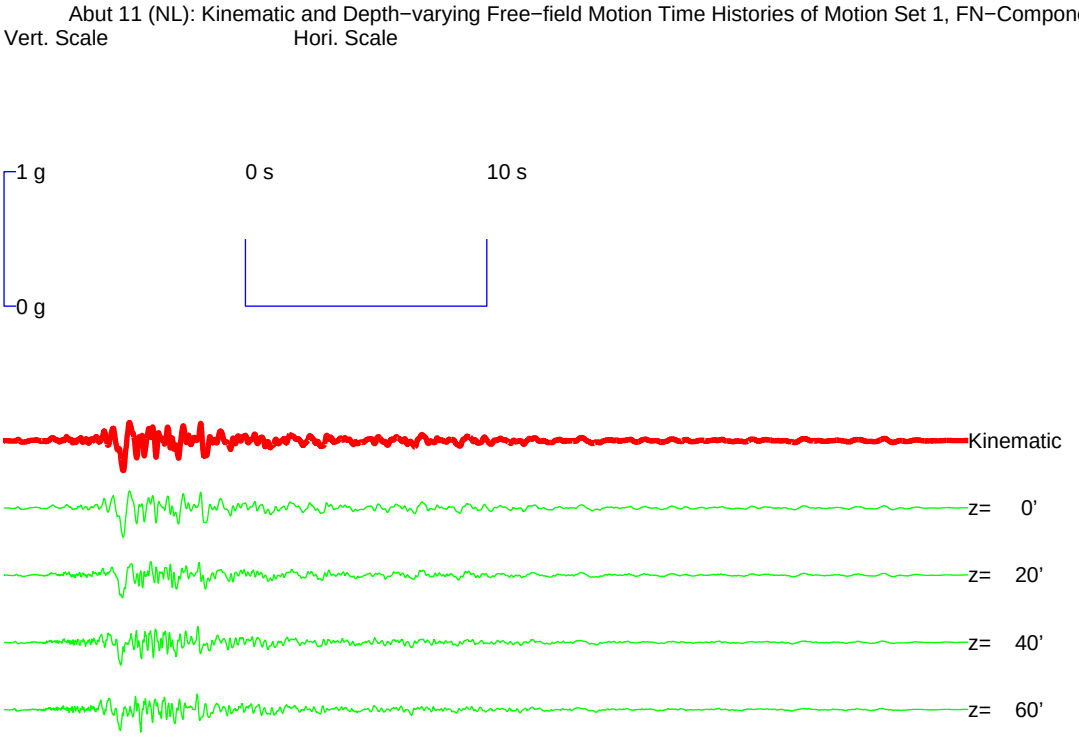


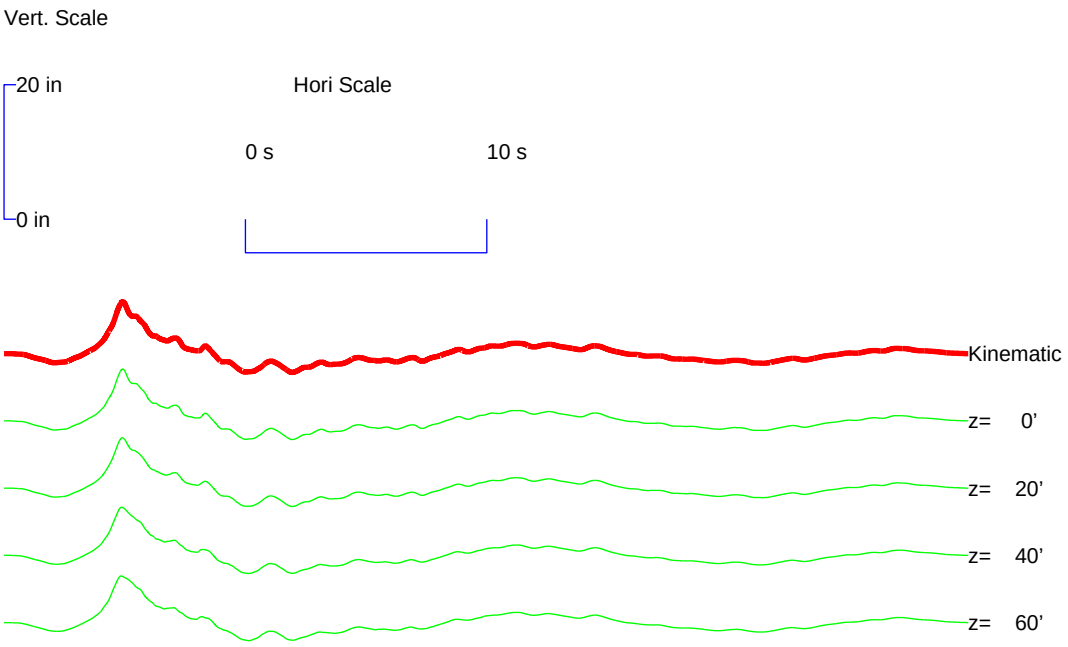



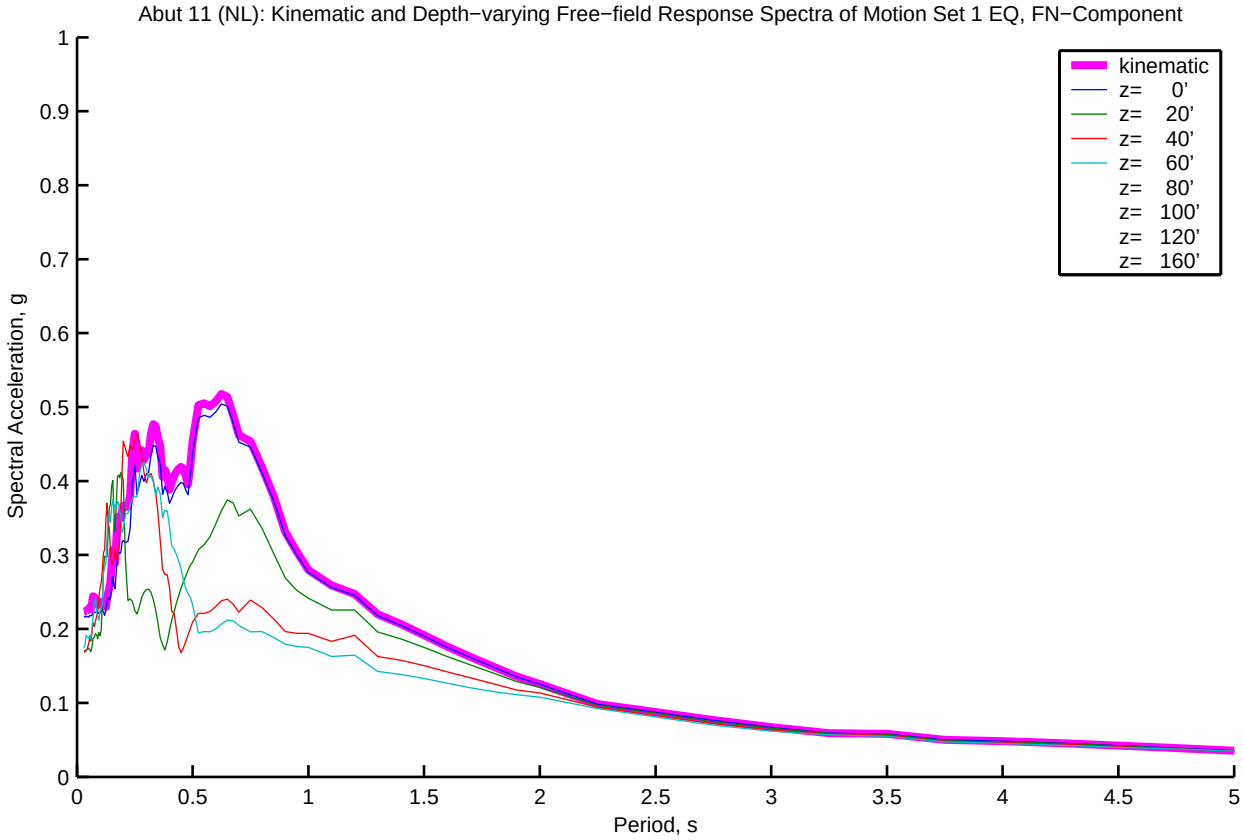

Abut 1 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

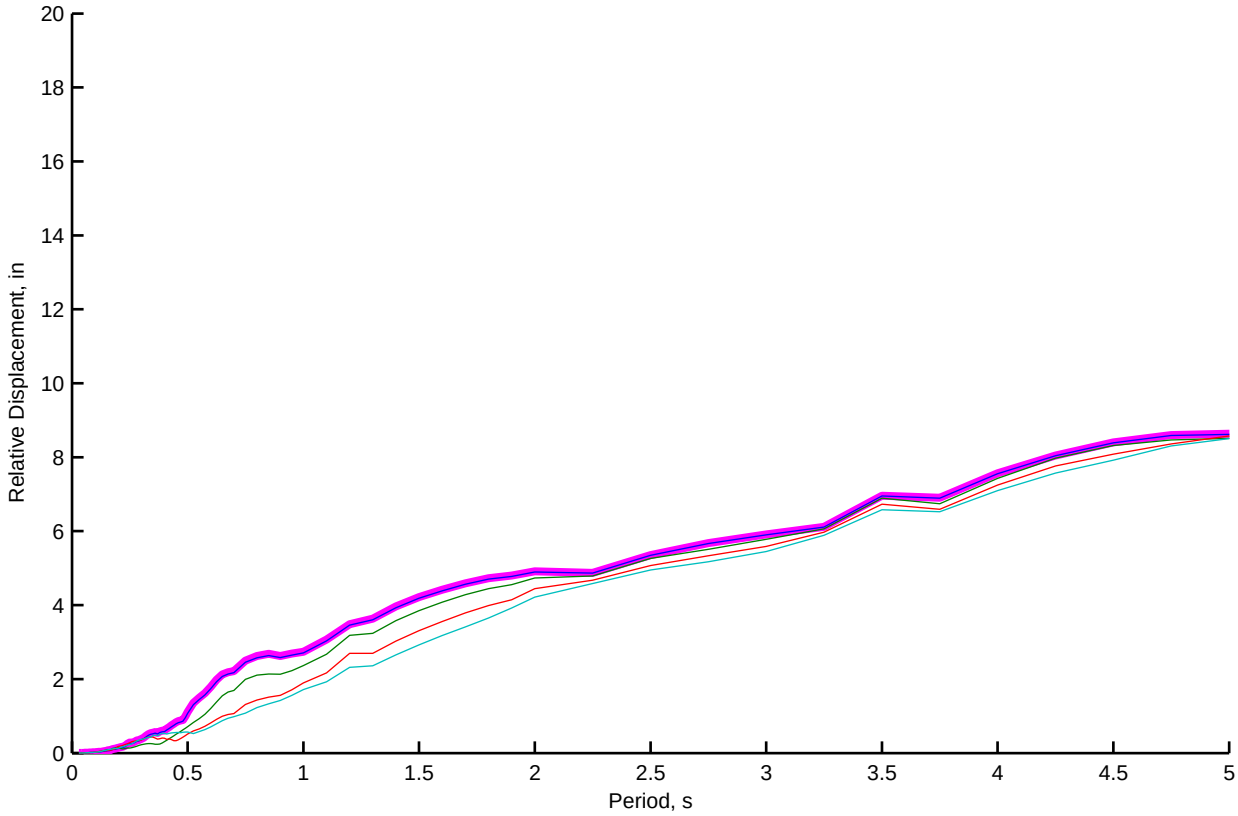

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

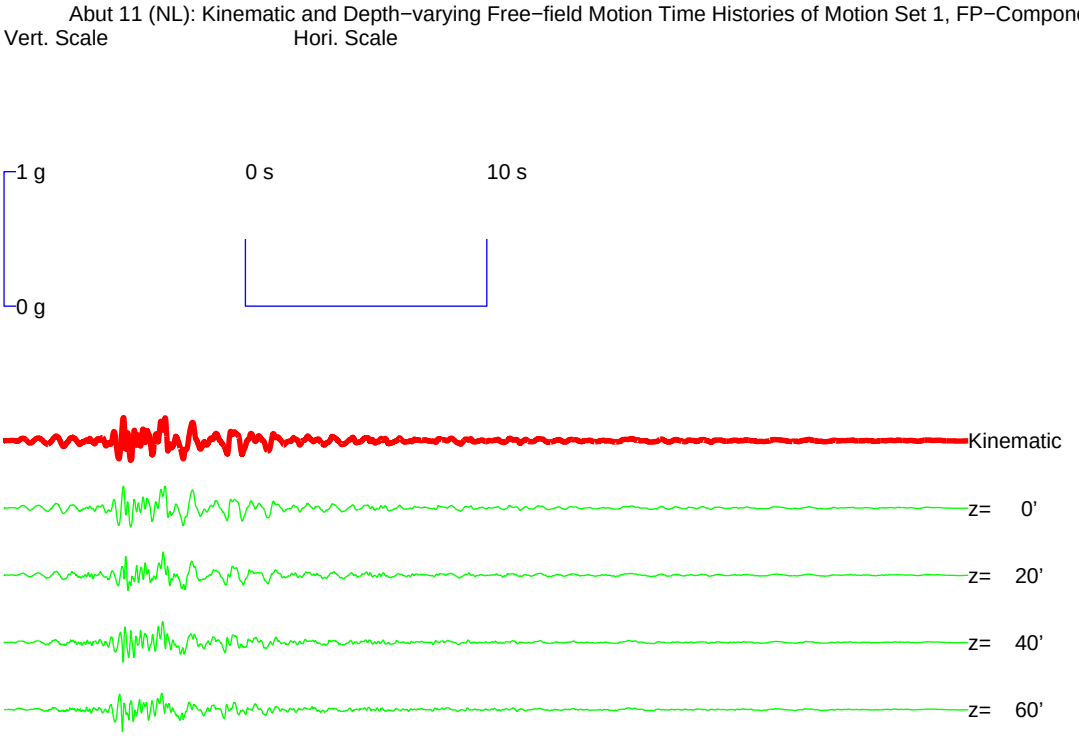


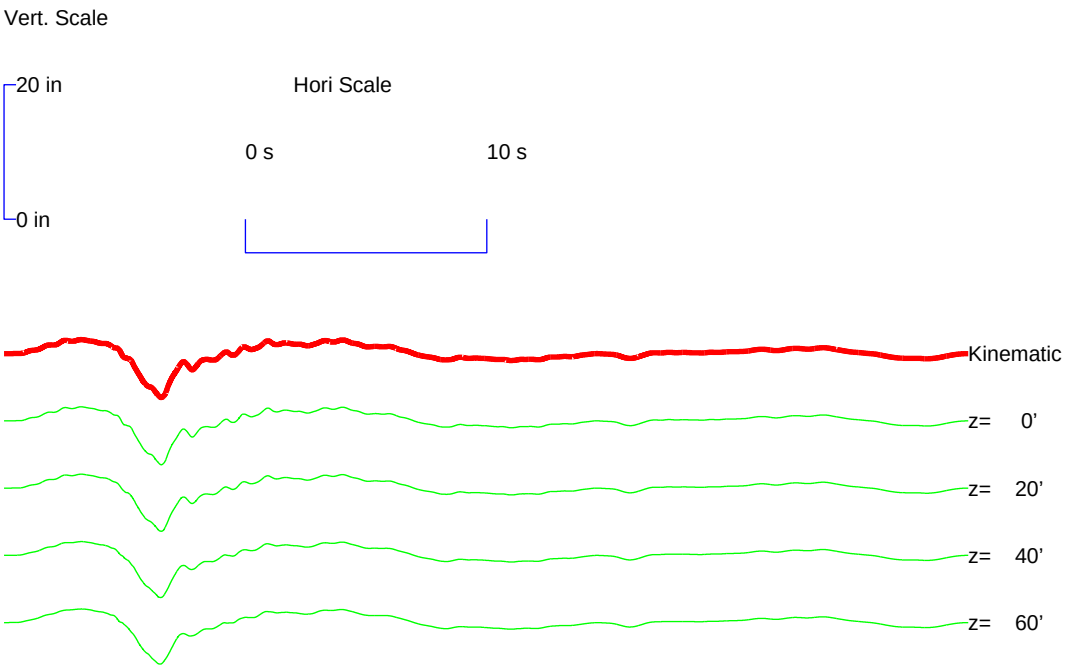



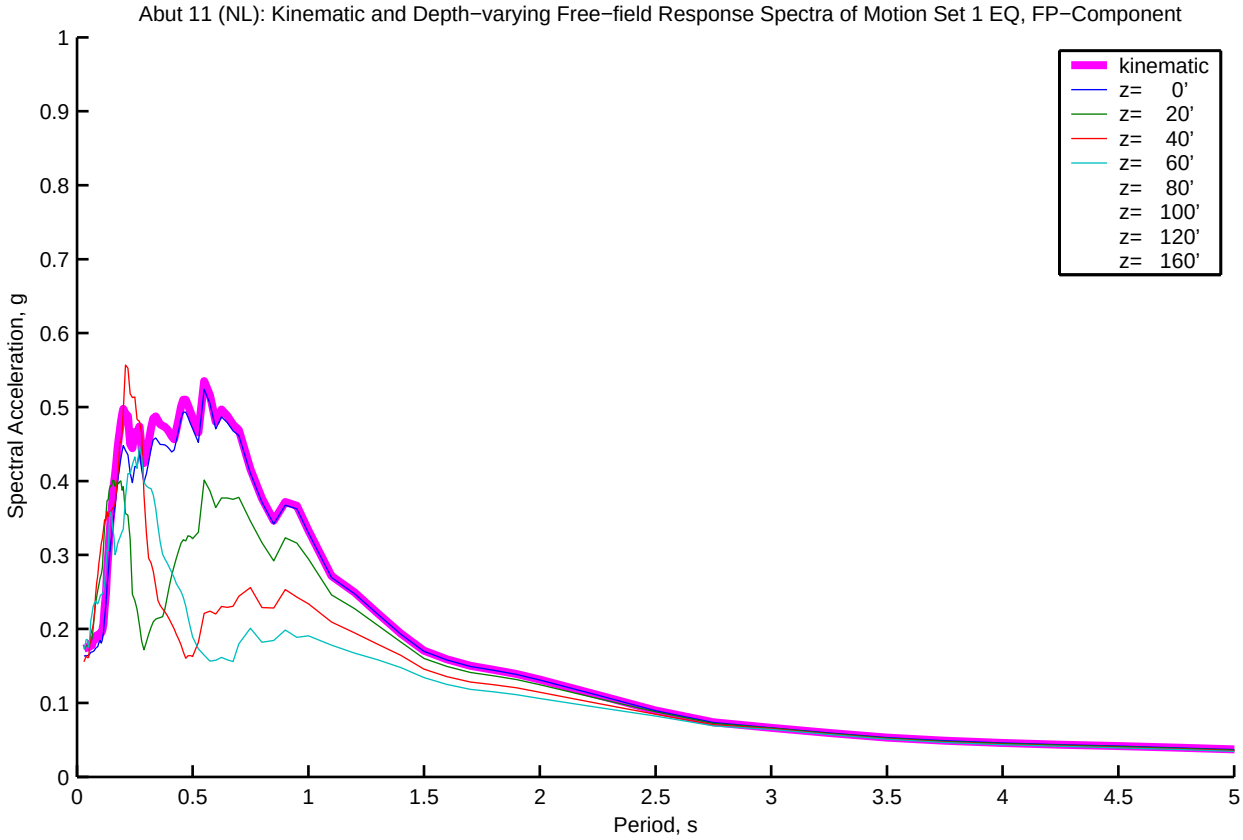

Abut 11 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

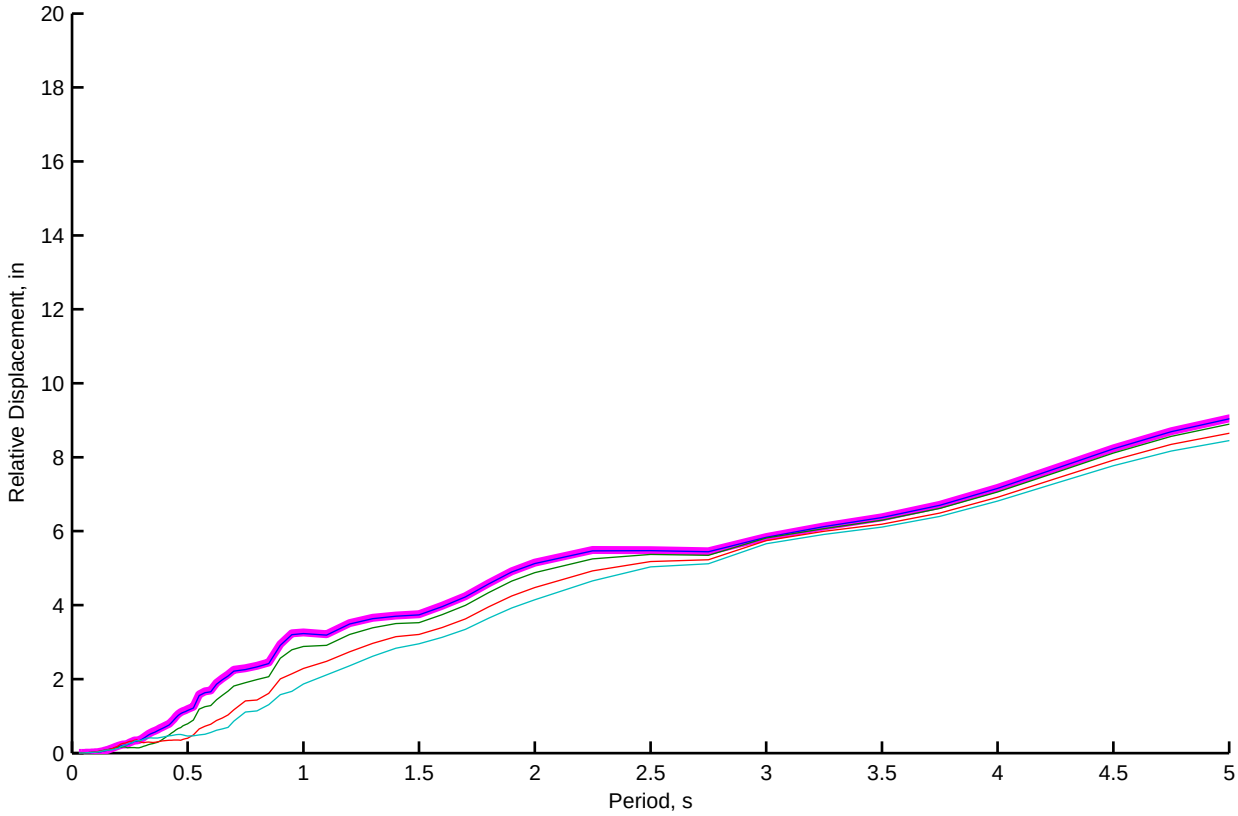

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

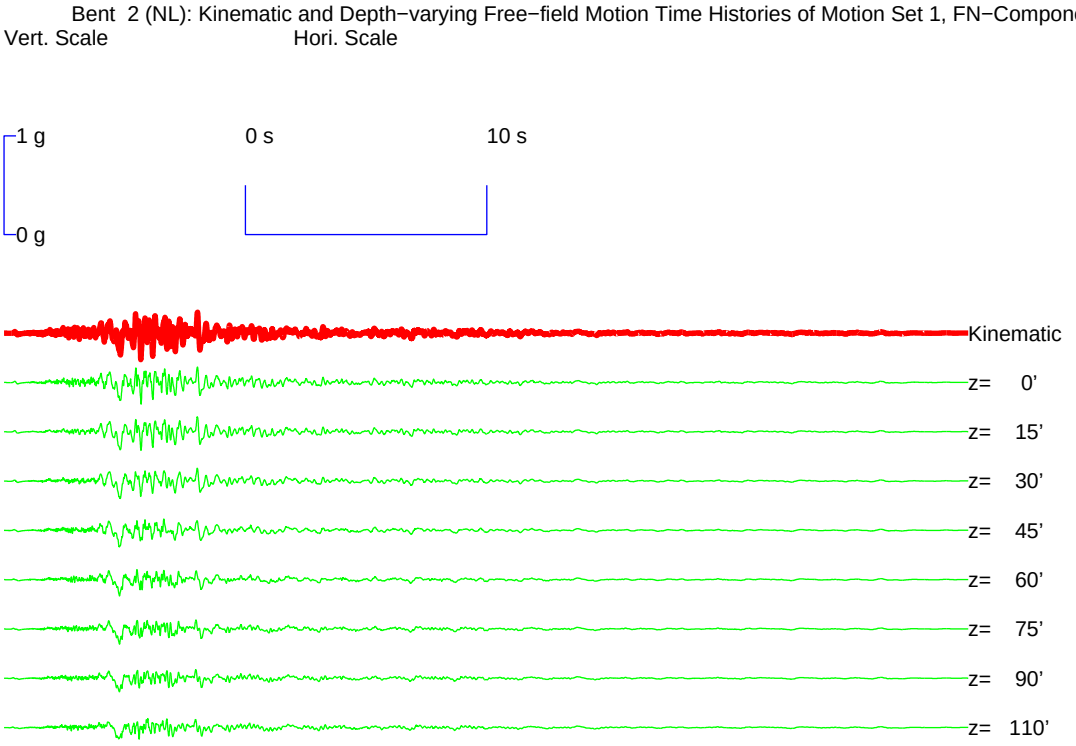


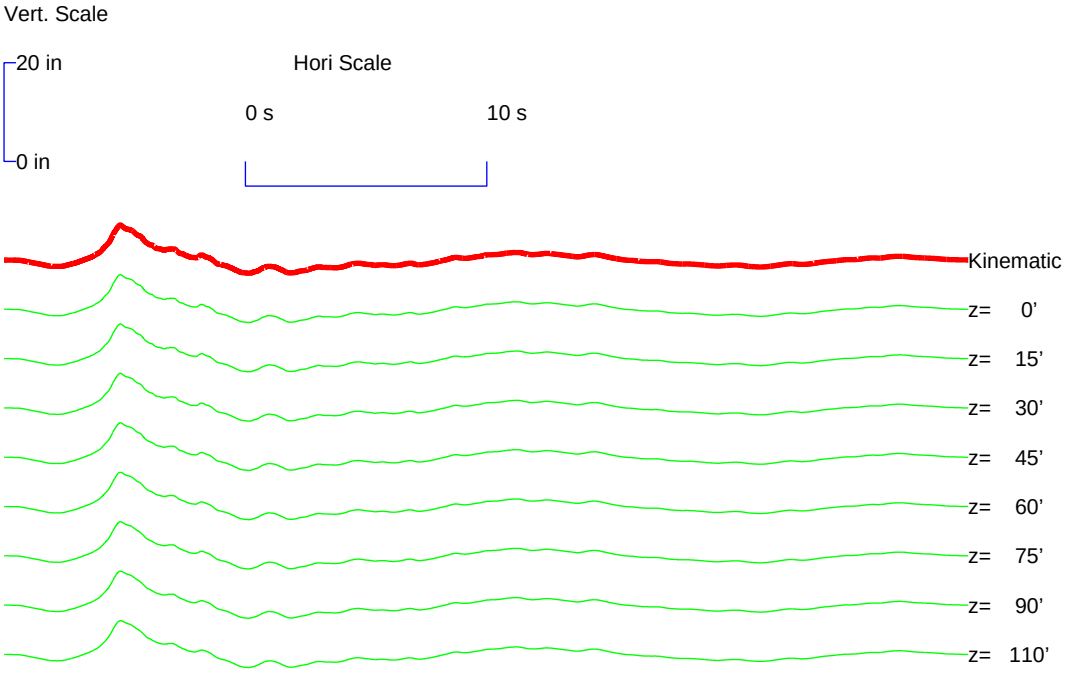



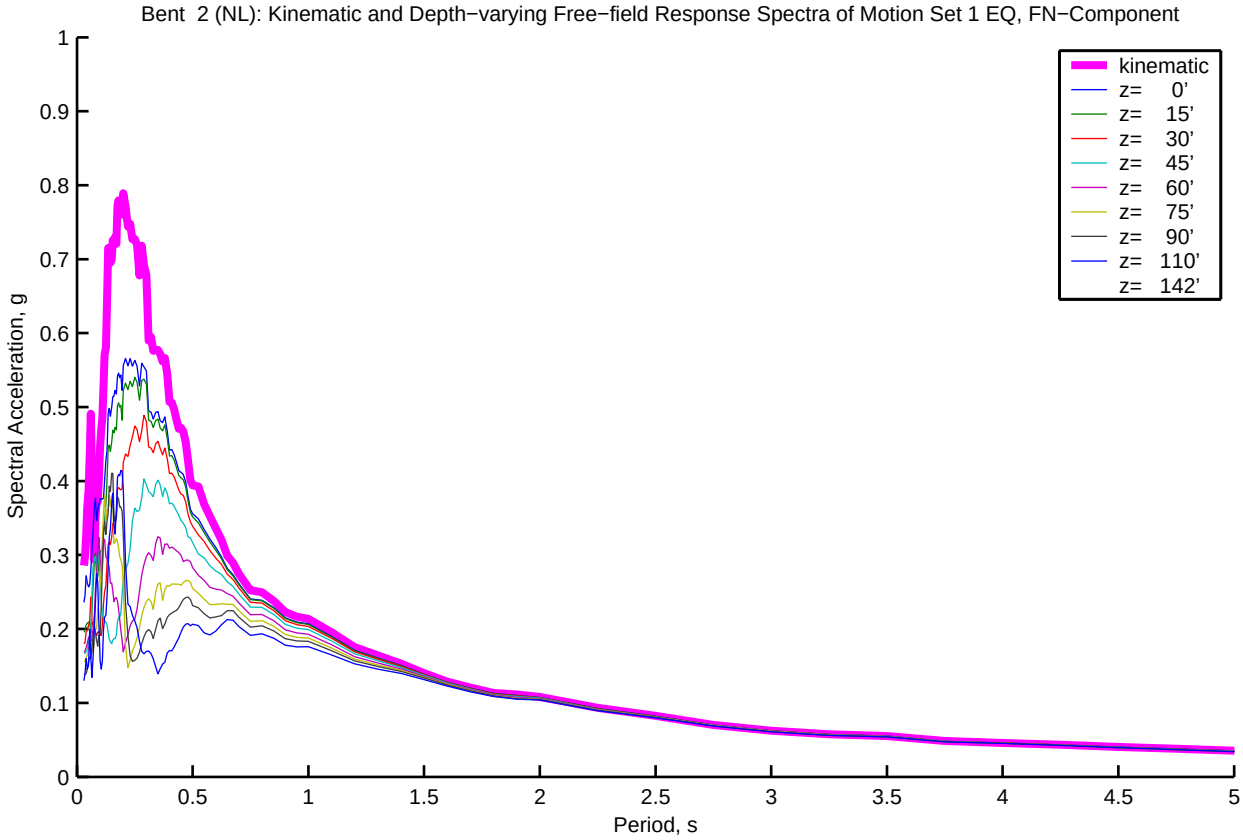

Abut 11 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

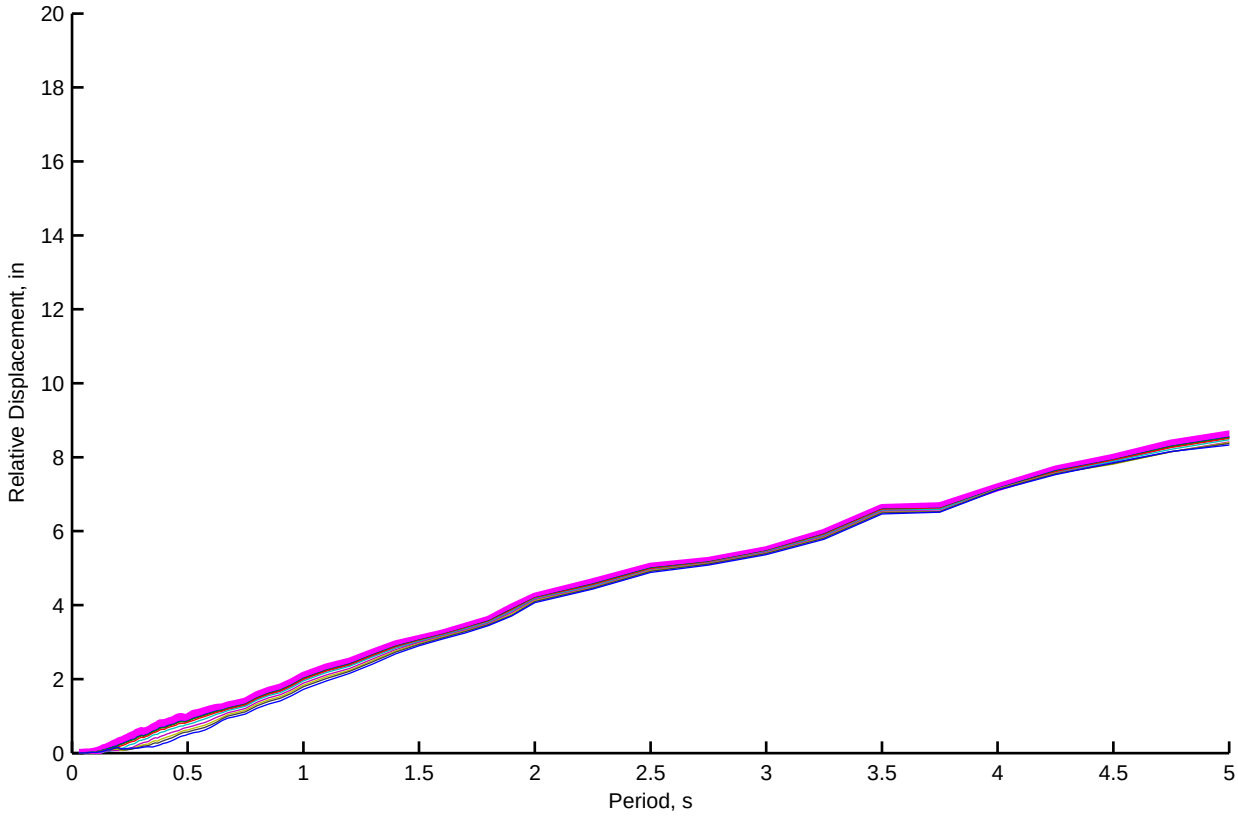

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

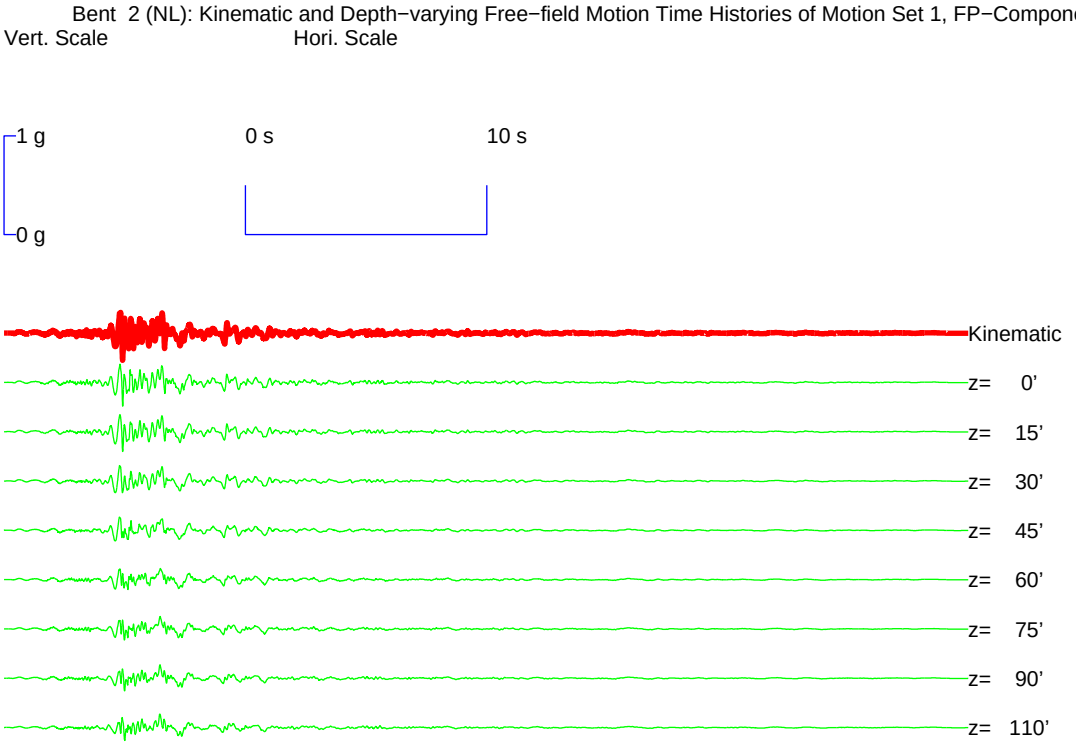


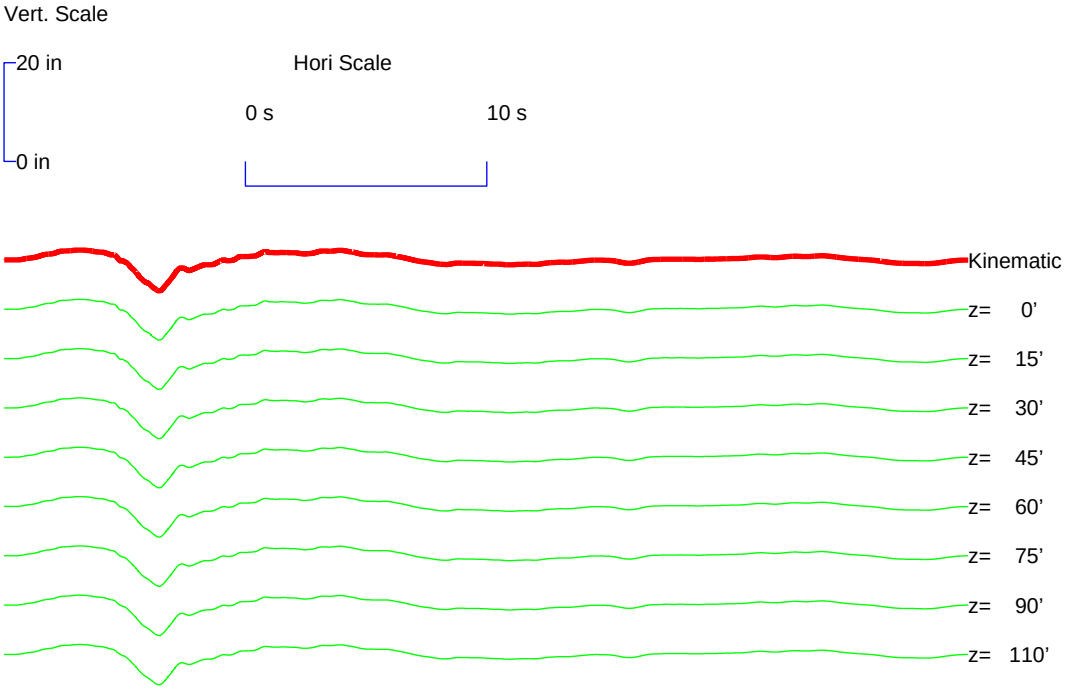



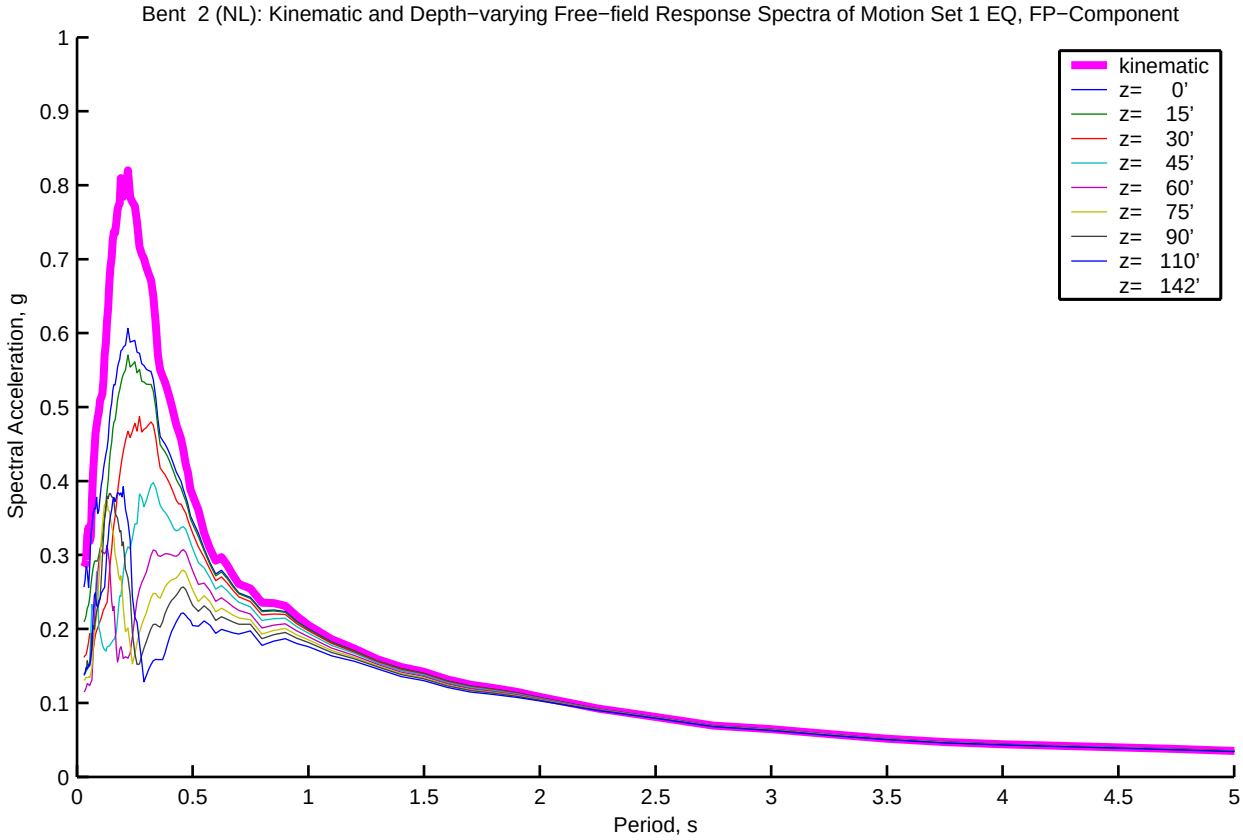

Bent 2 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

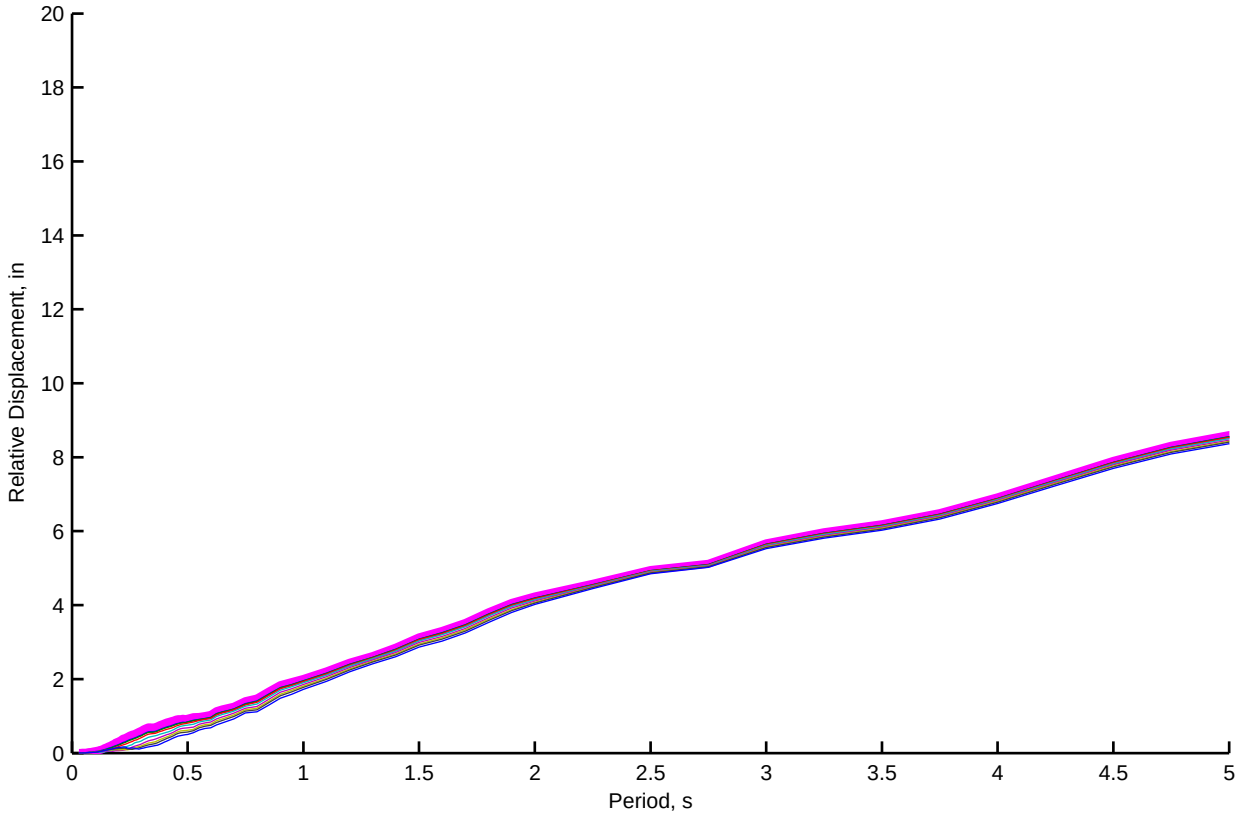

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component




Bent 2 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
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8
10
12
14
16
18
20
0.5
1
1.5
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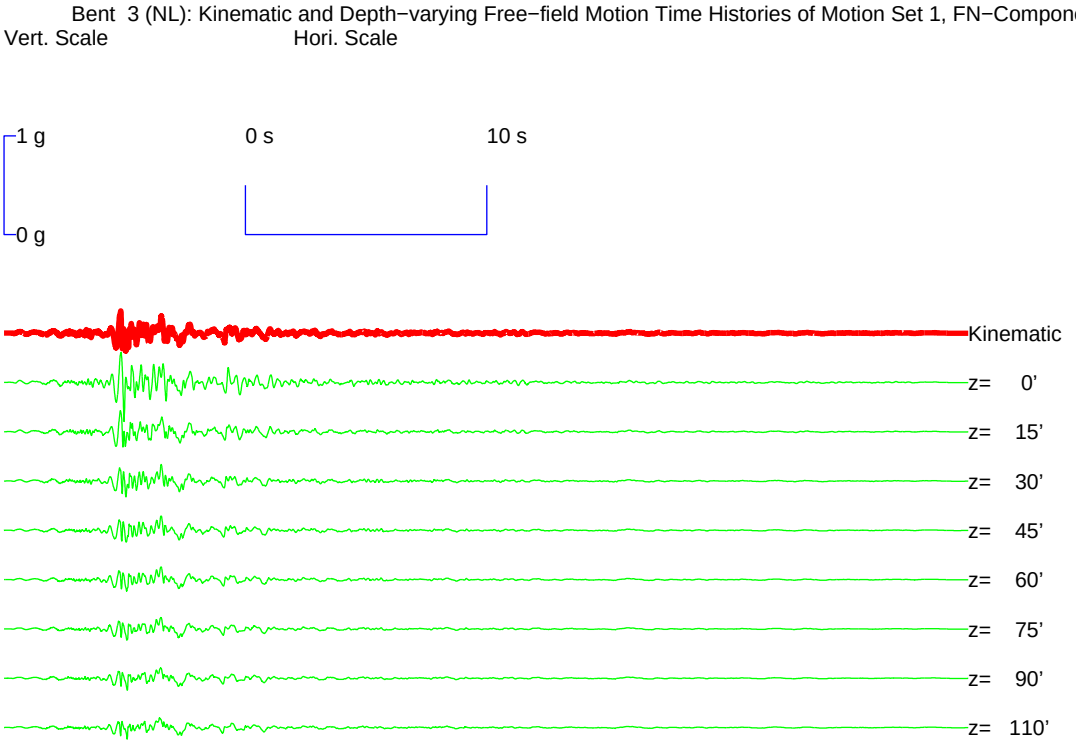
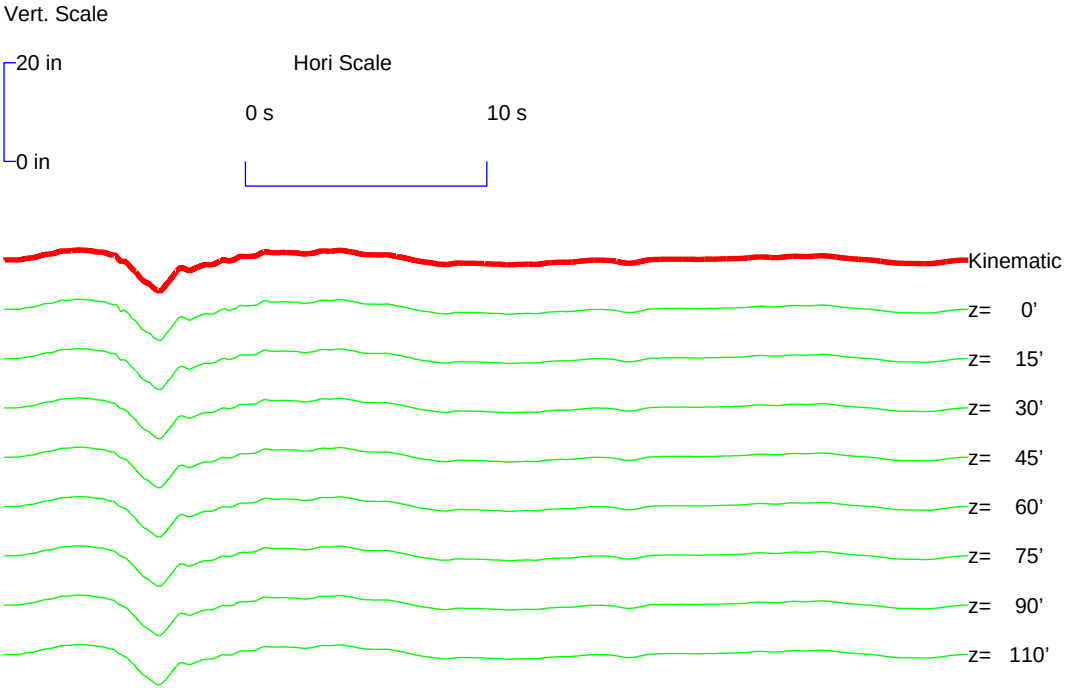
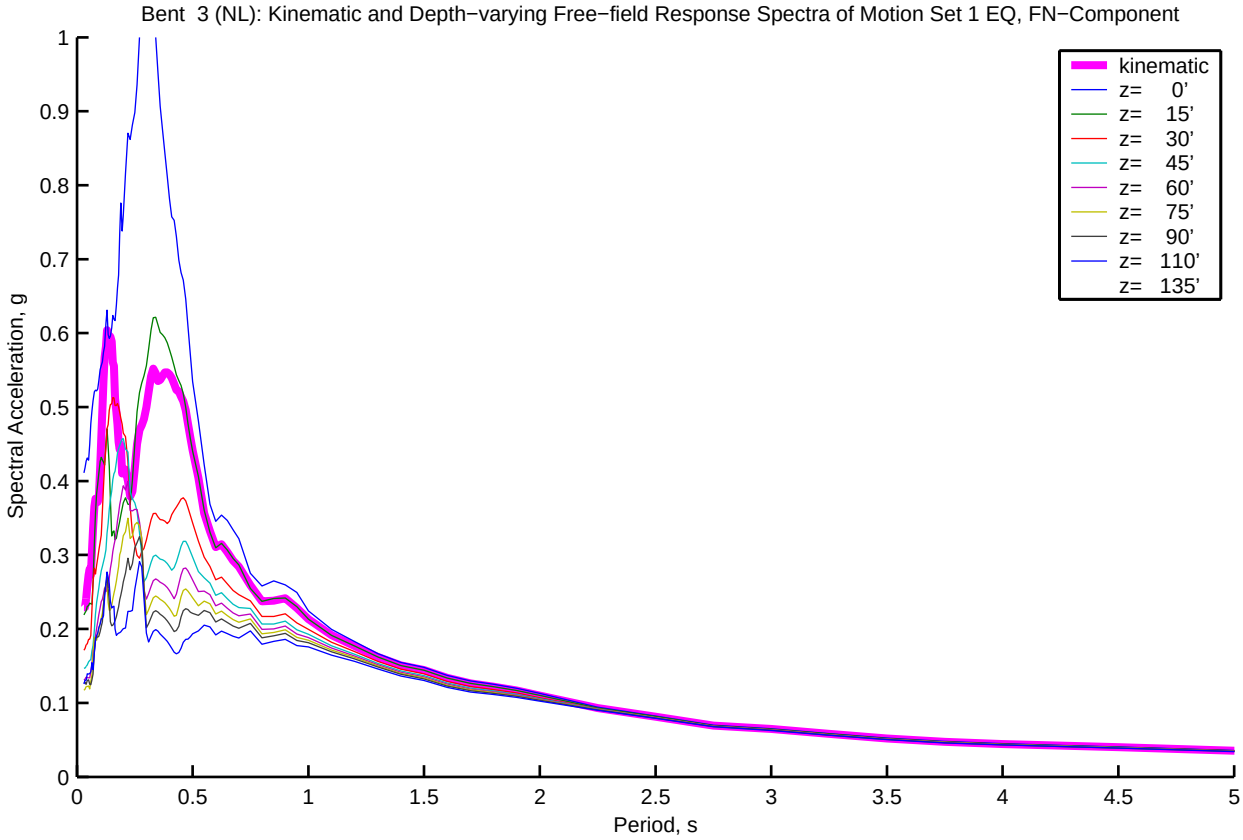
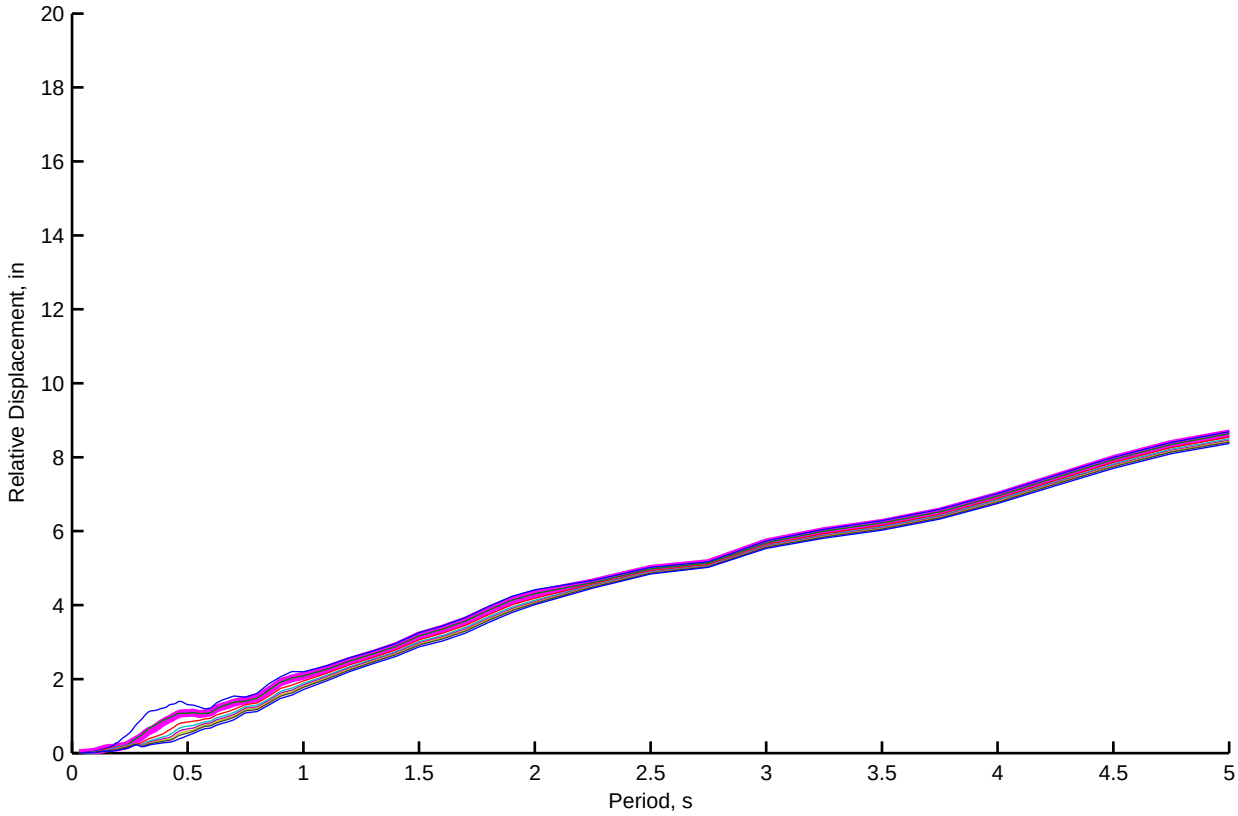
2.5
3
3.5
4
4.5
5

Bent 3 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

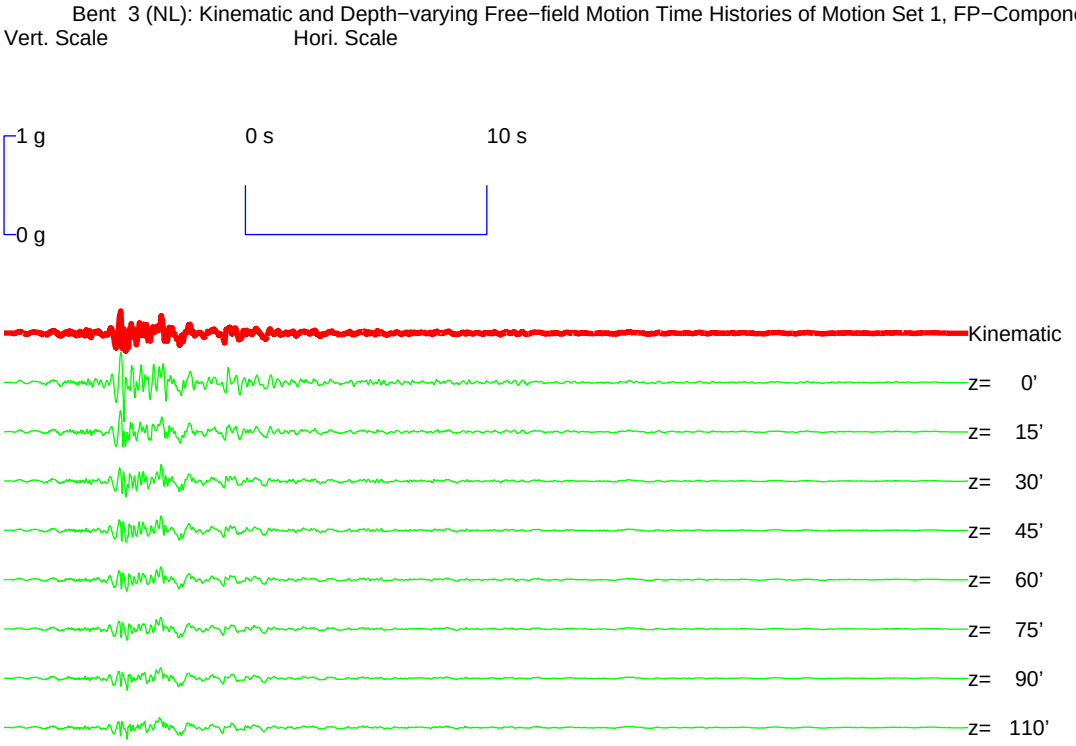


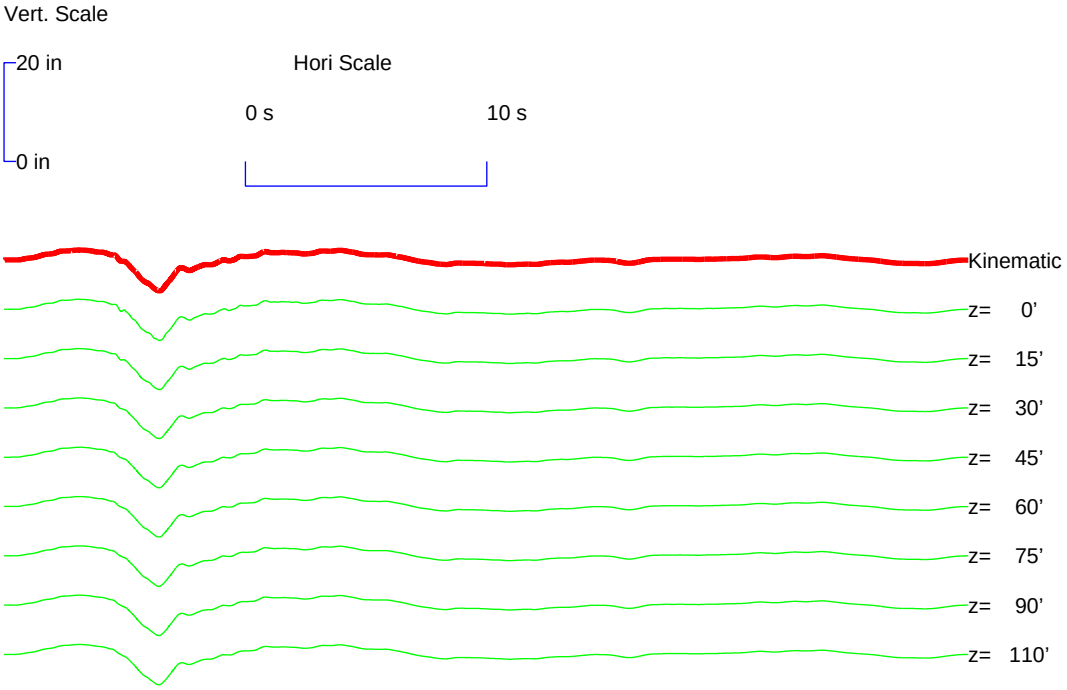



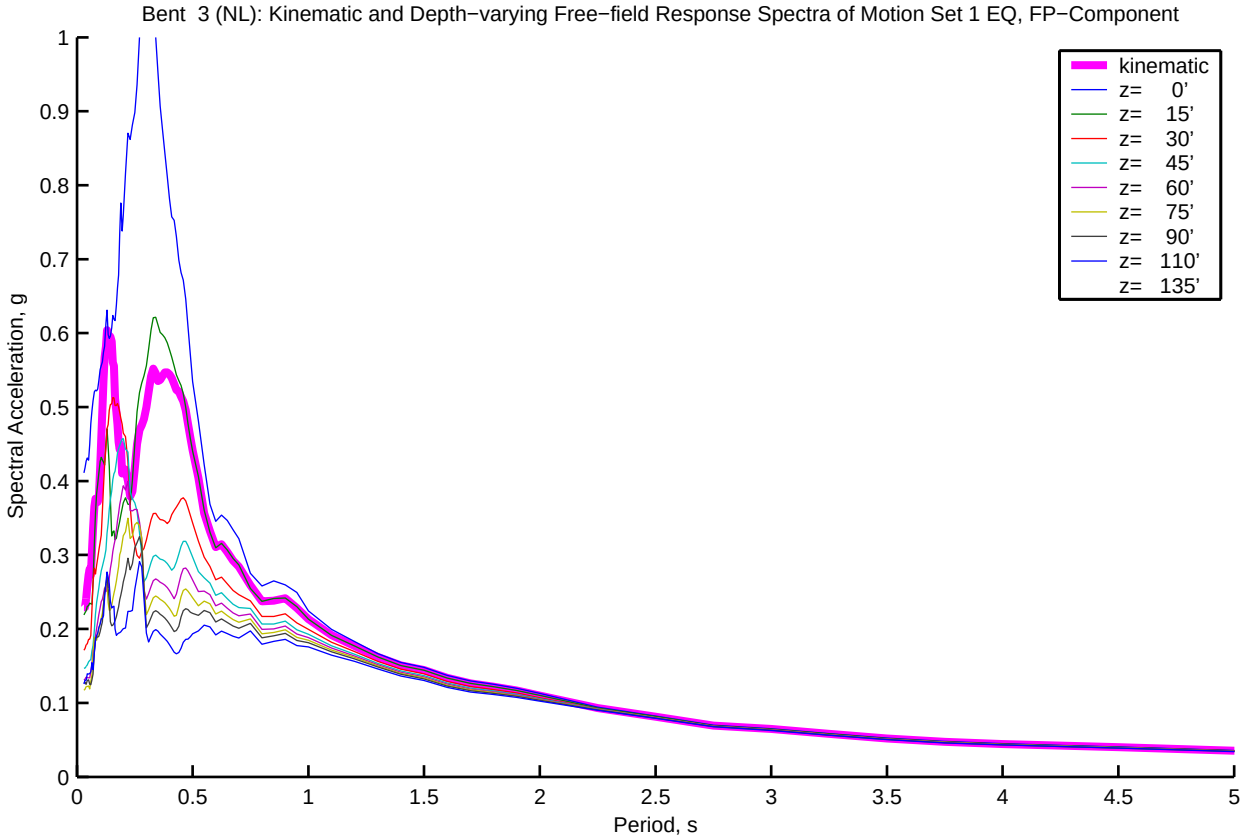

Bent 3 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

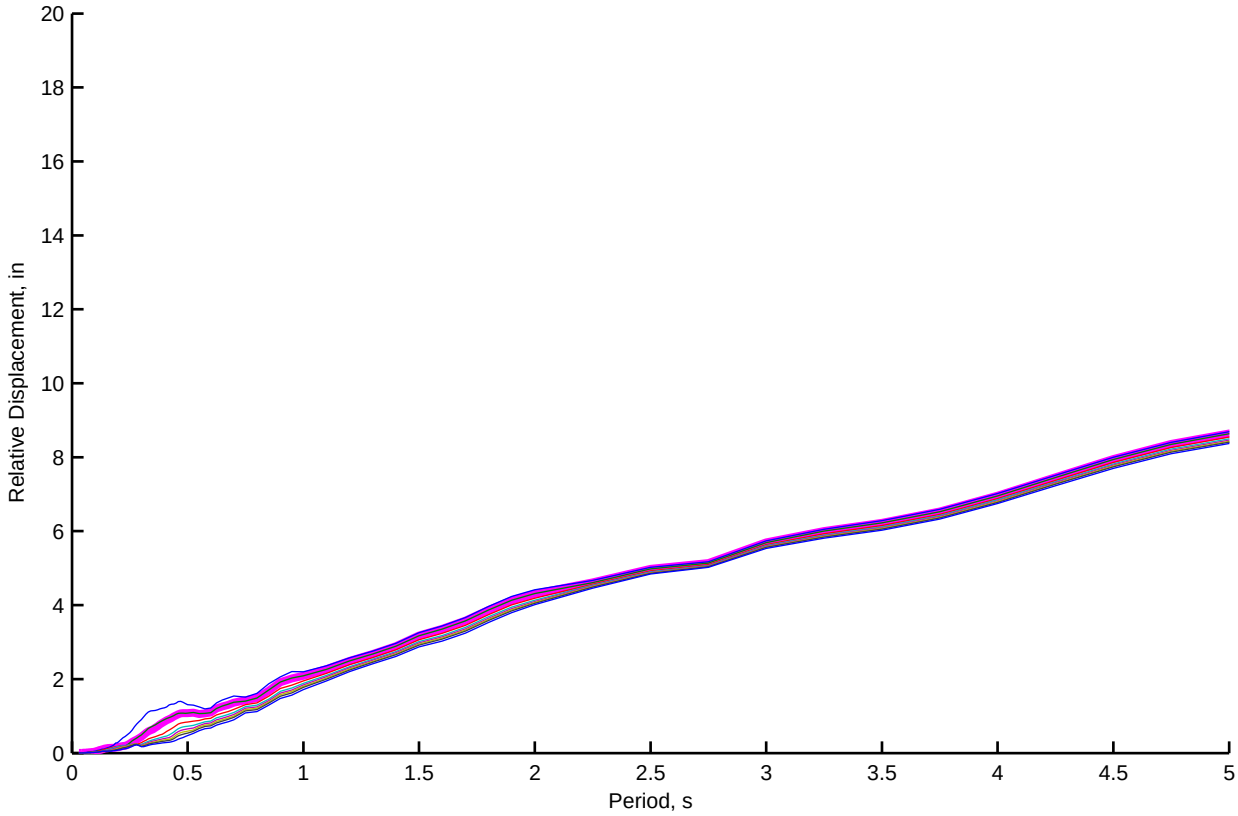

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 3 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

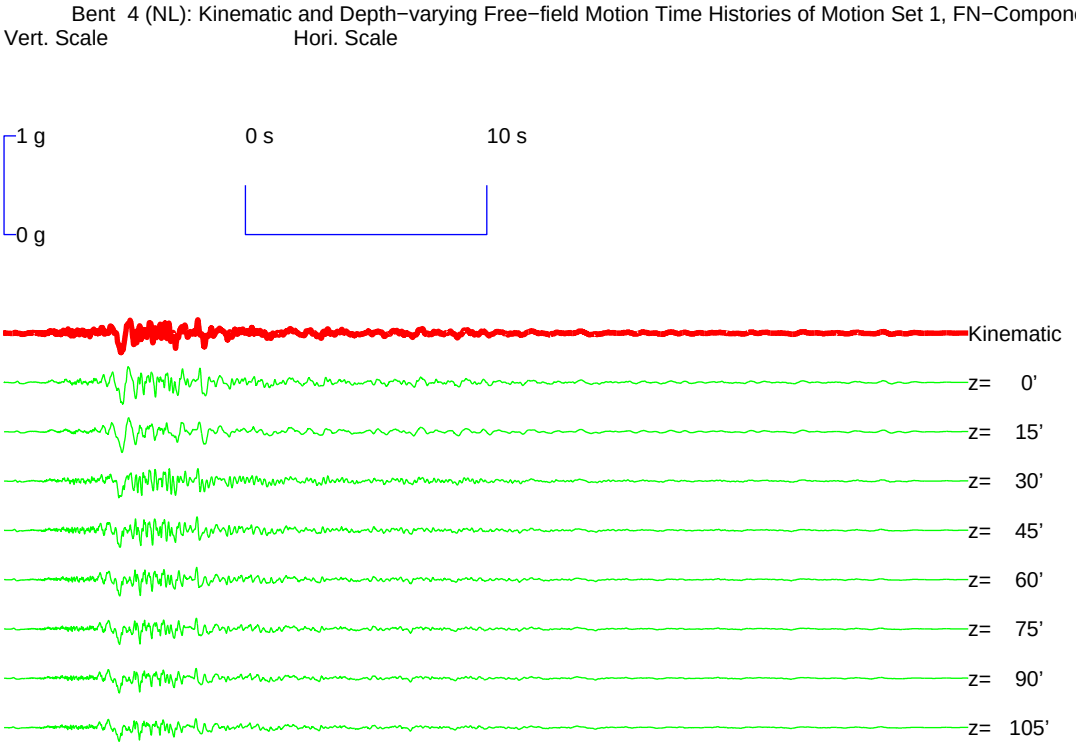


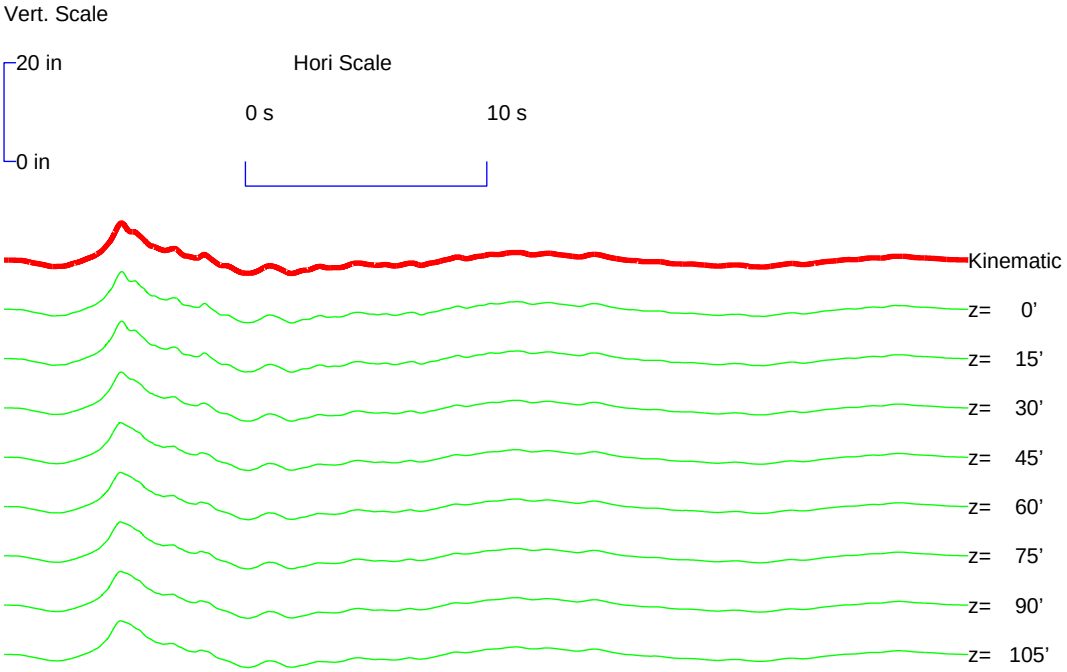



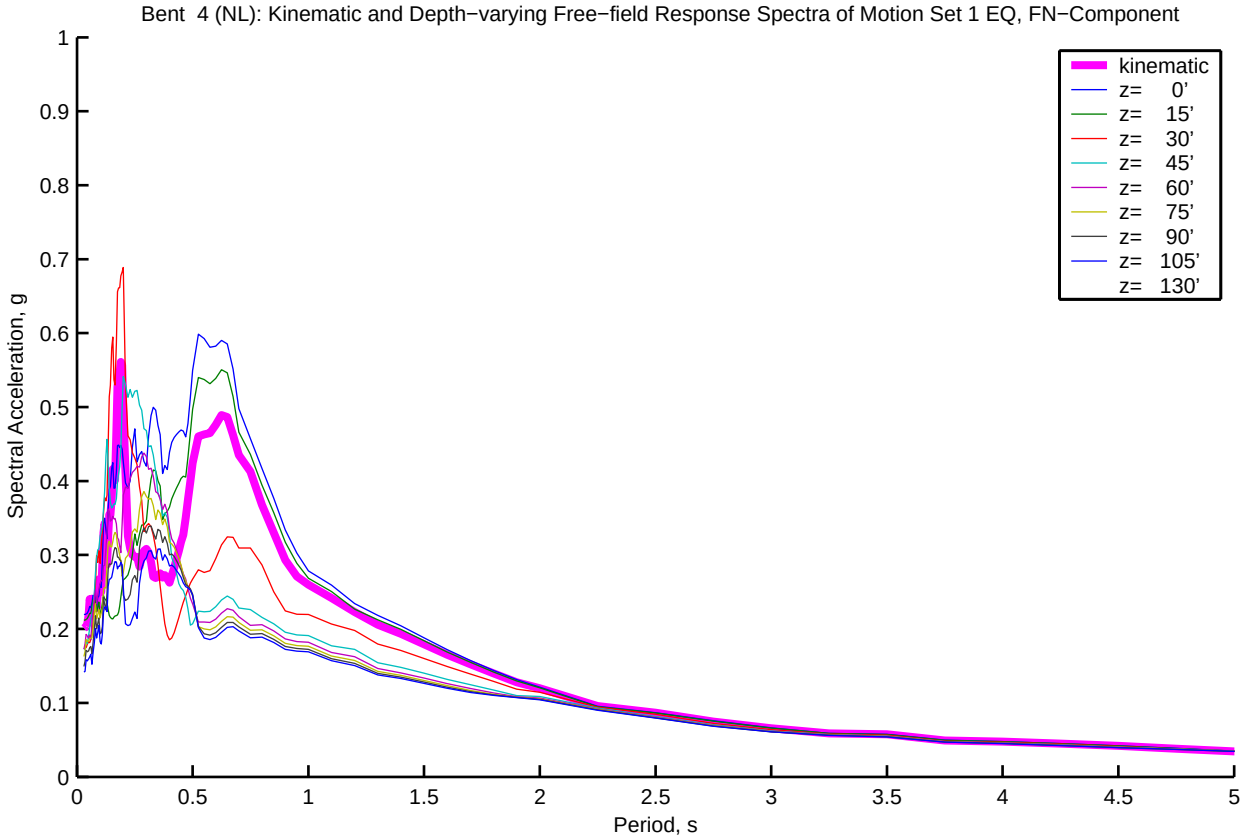

Bent 3 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

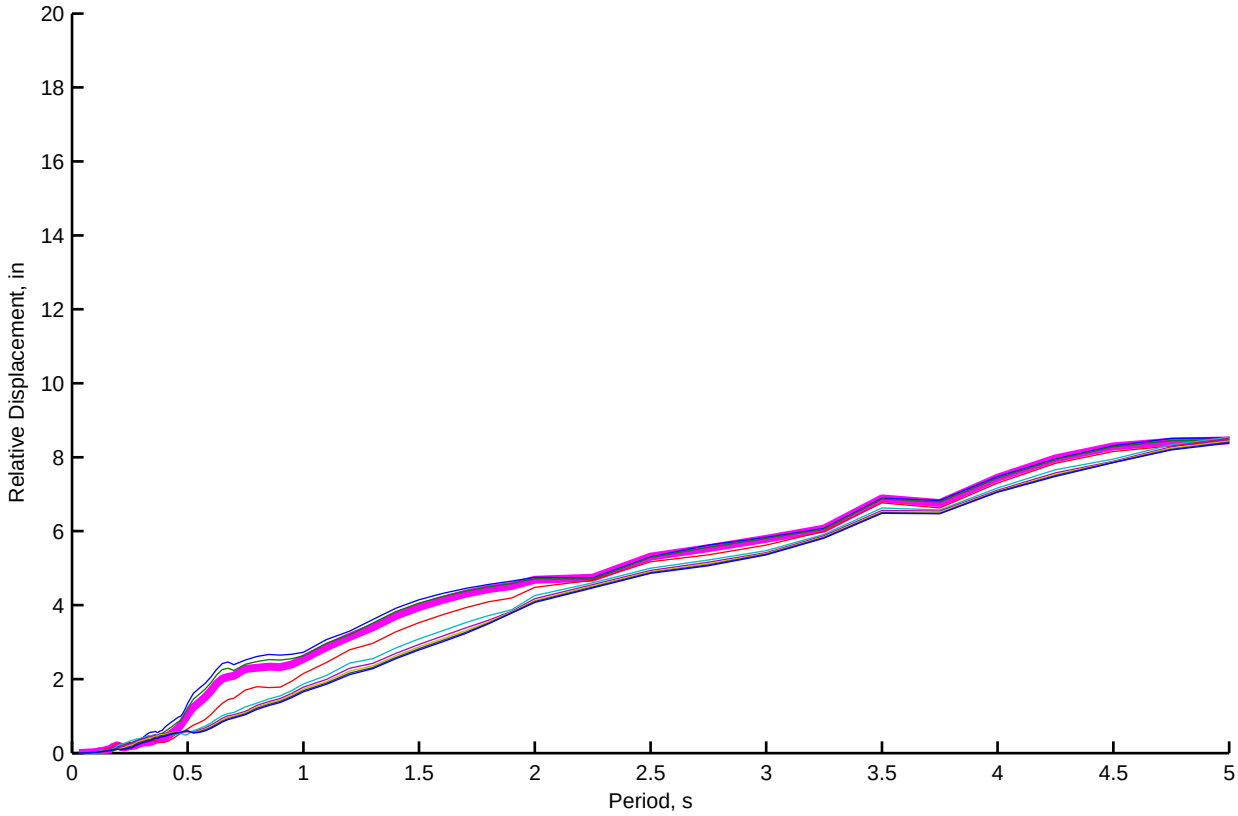

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 4 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

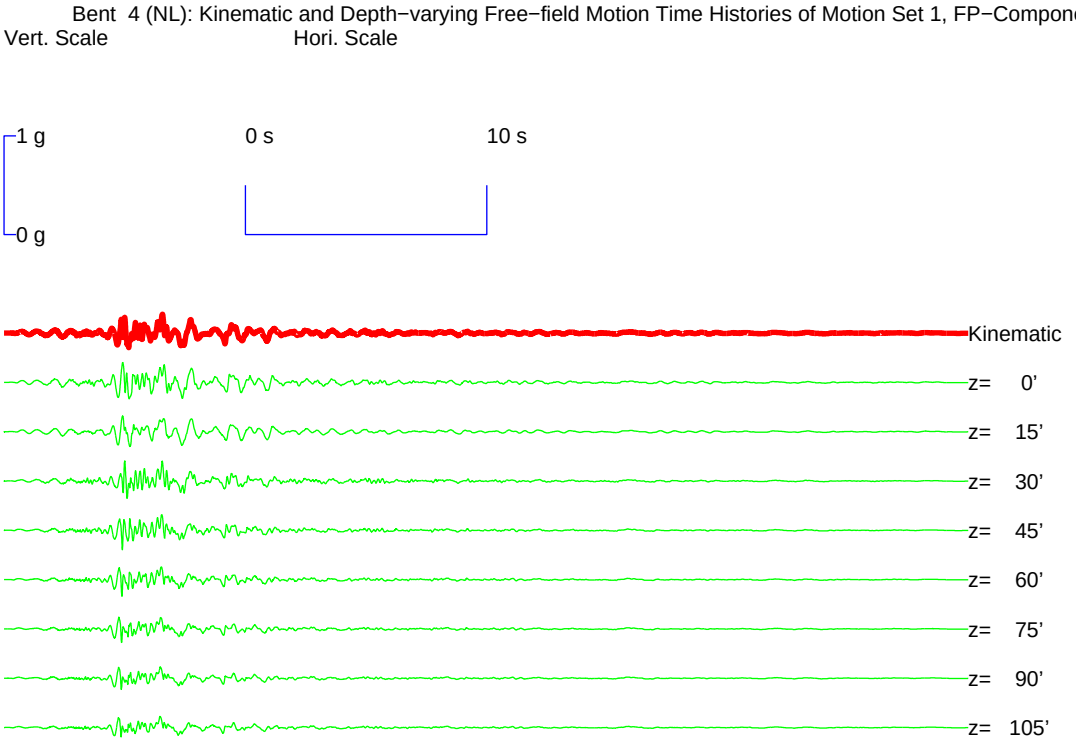


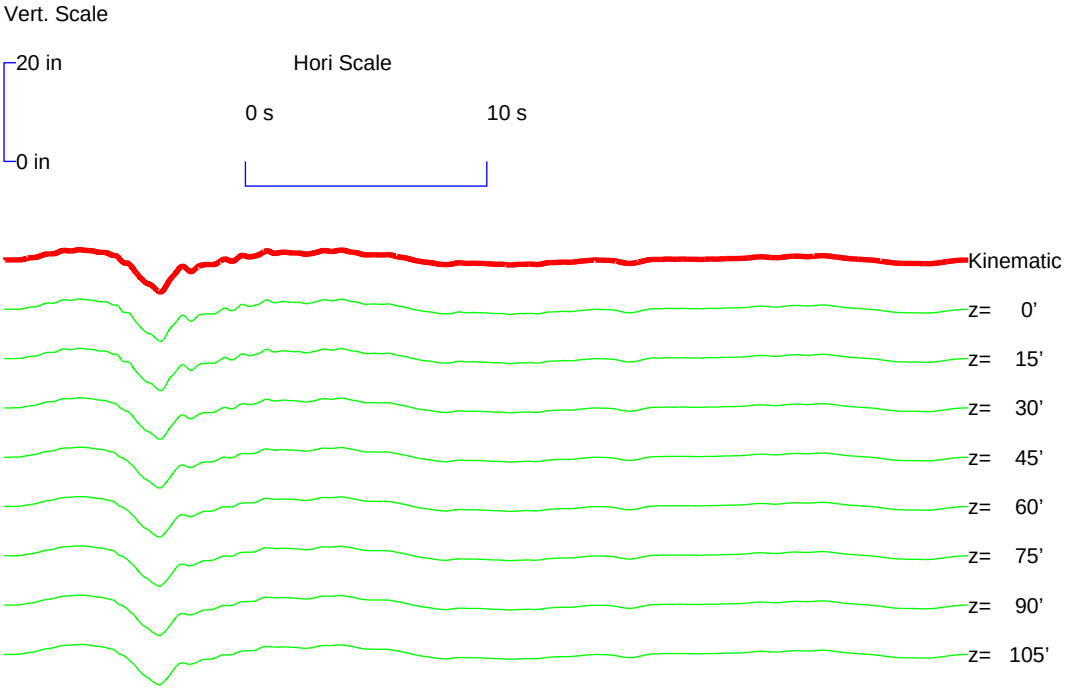



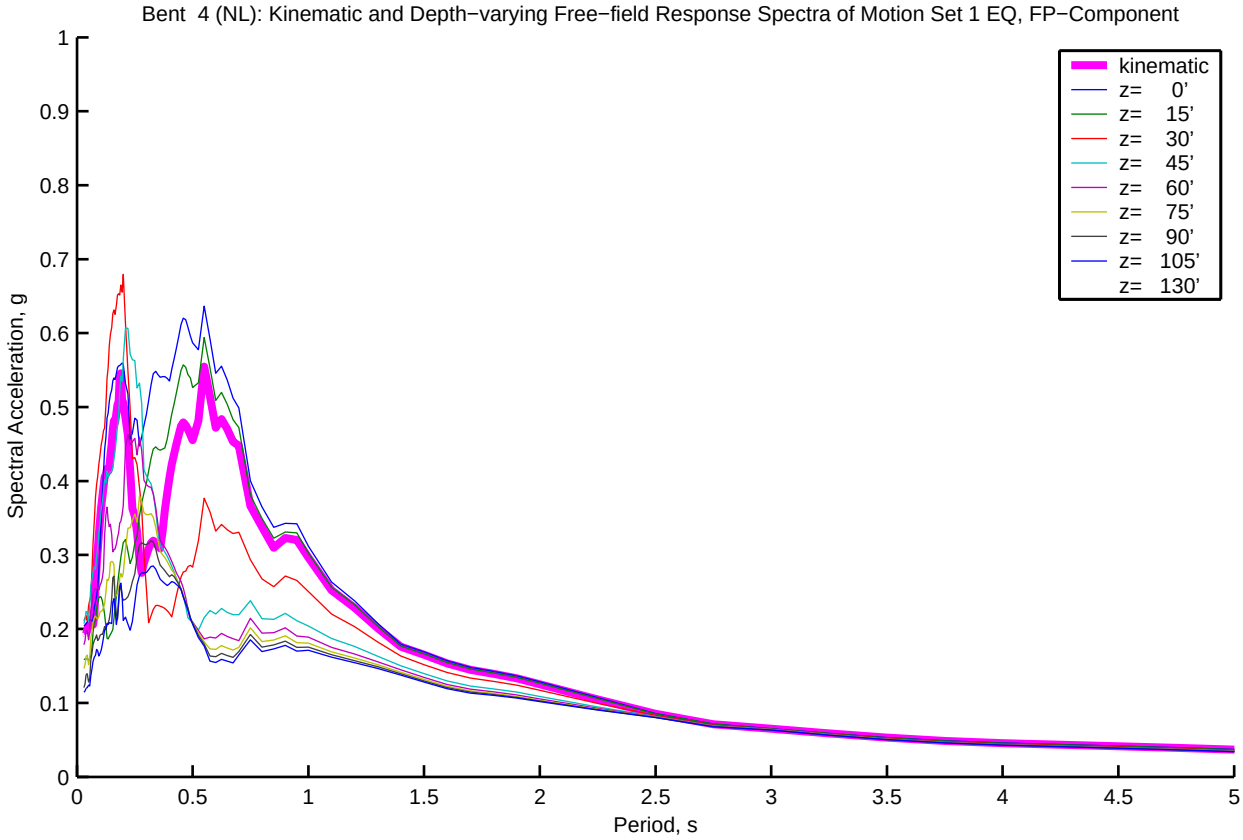

Bent 4 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

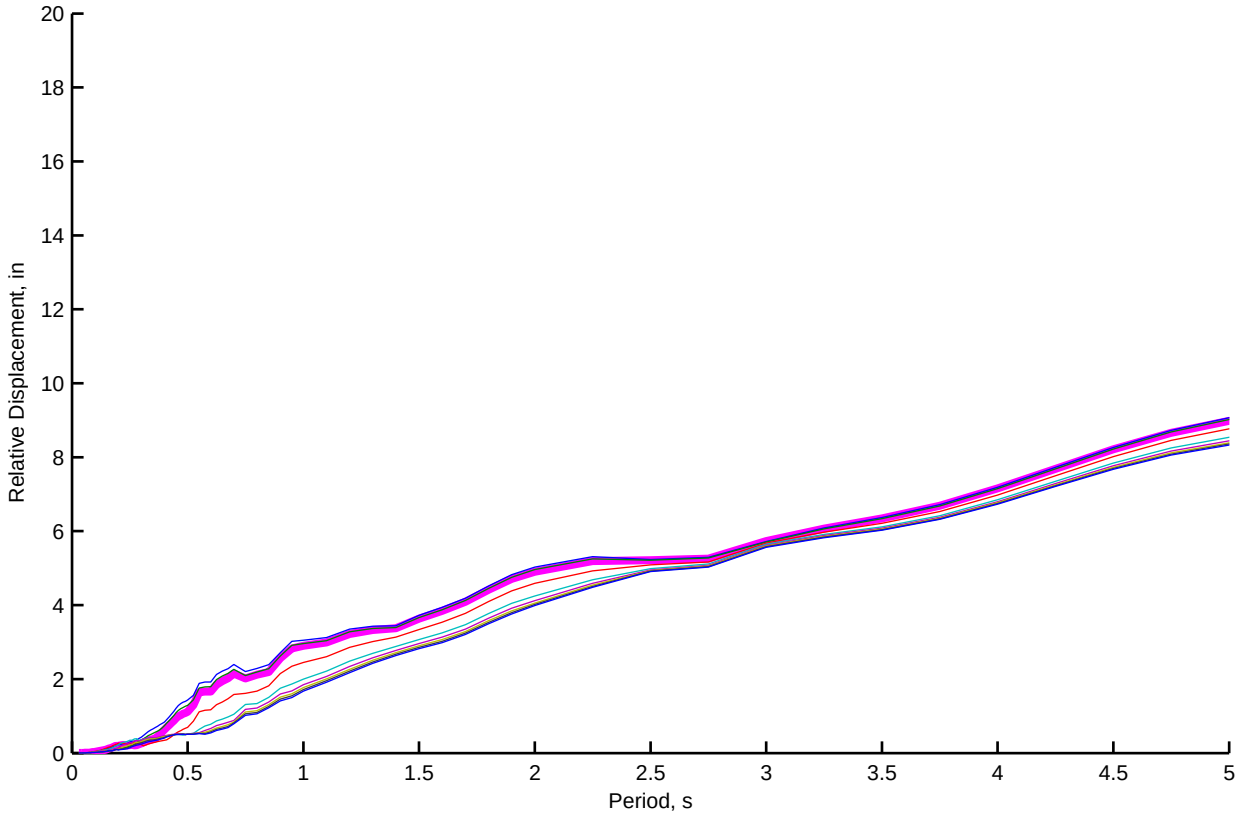

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 4 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

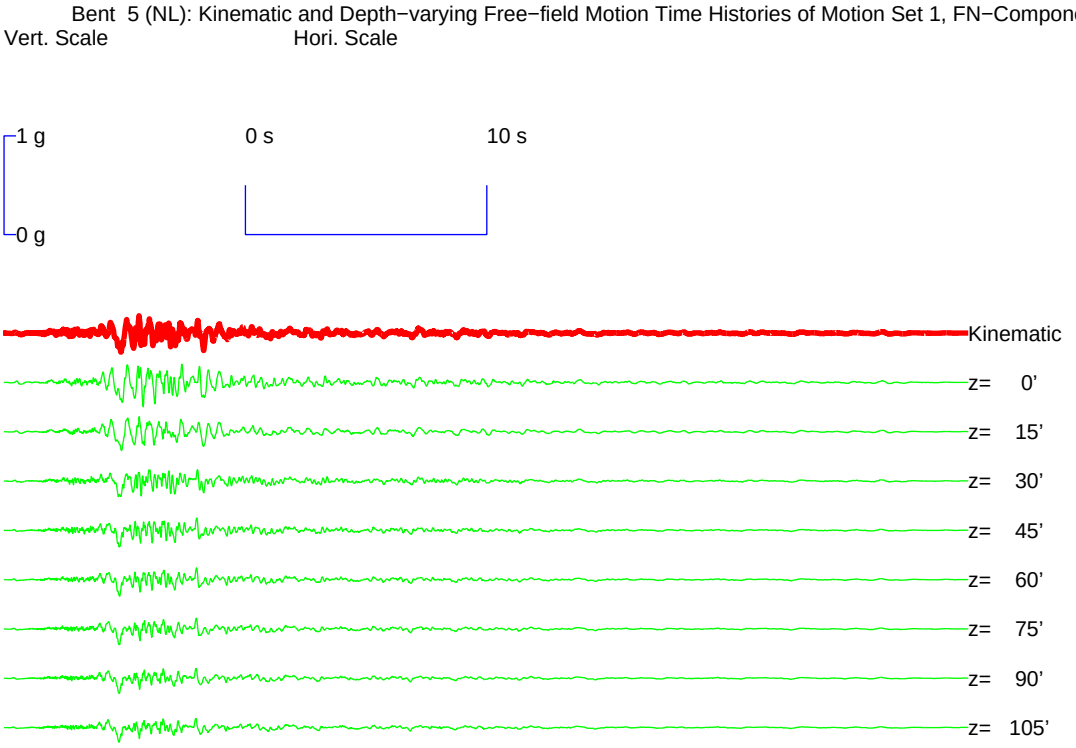


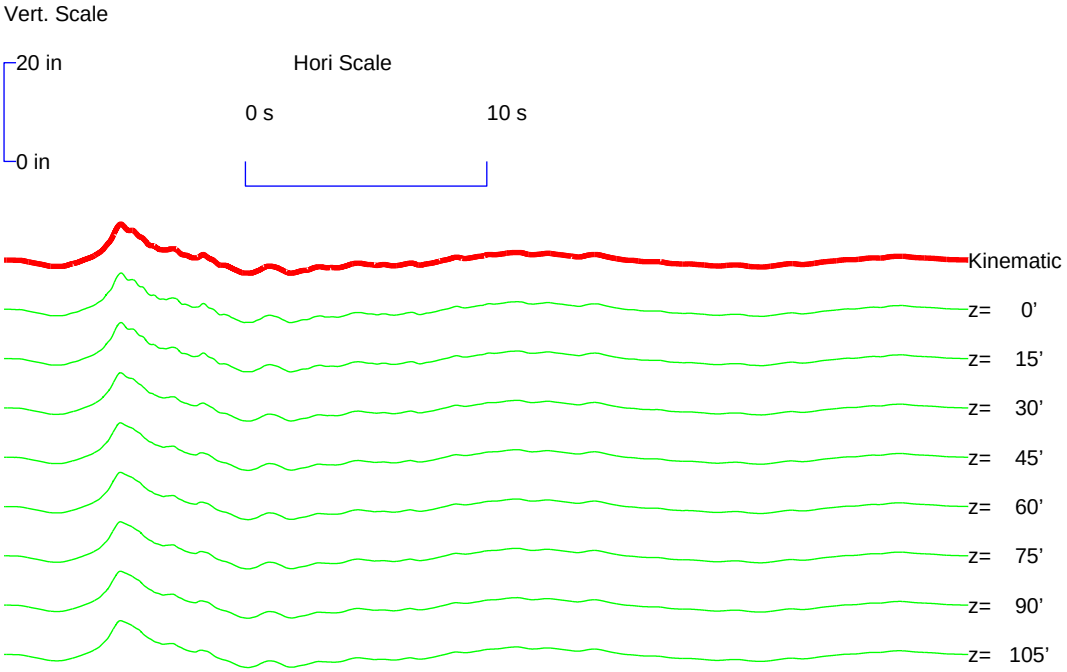



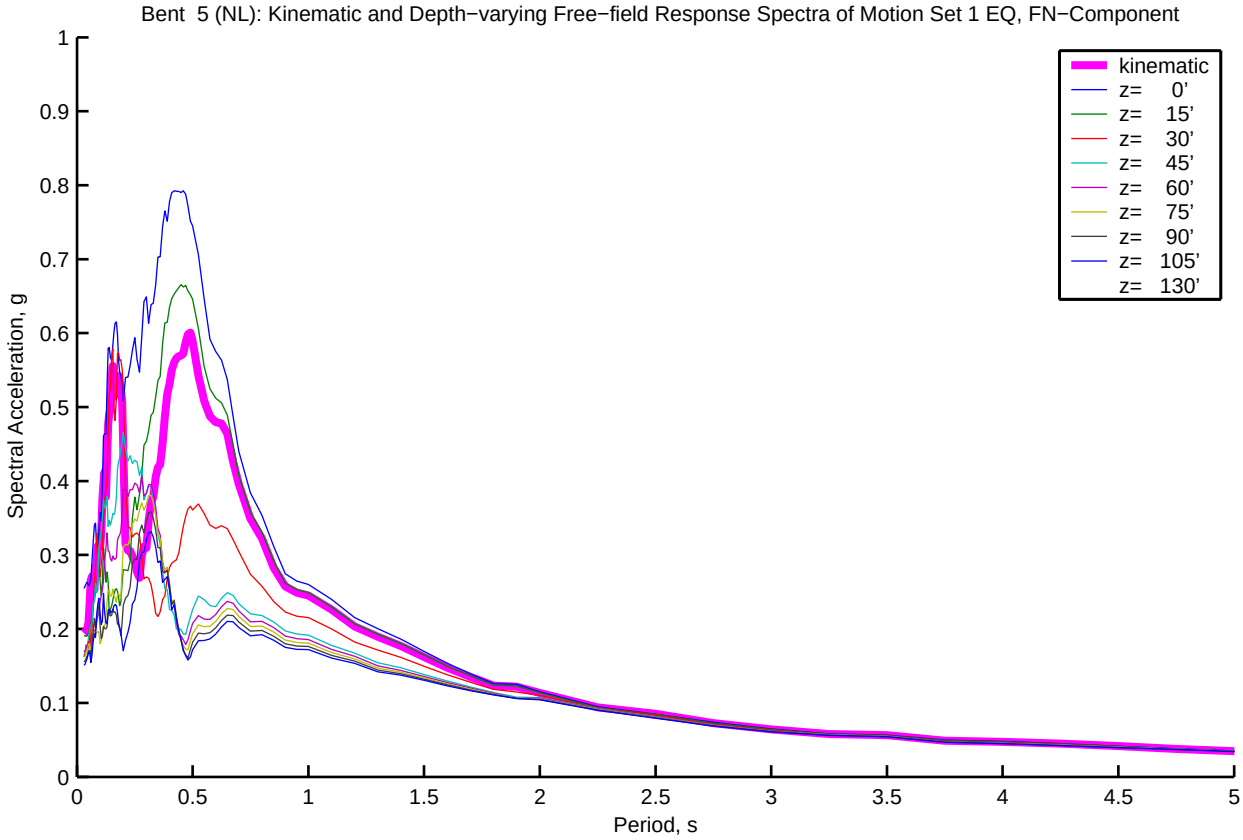

Bent 4 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 5 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component




Bent 5 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
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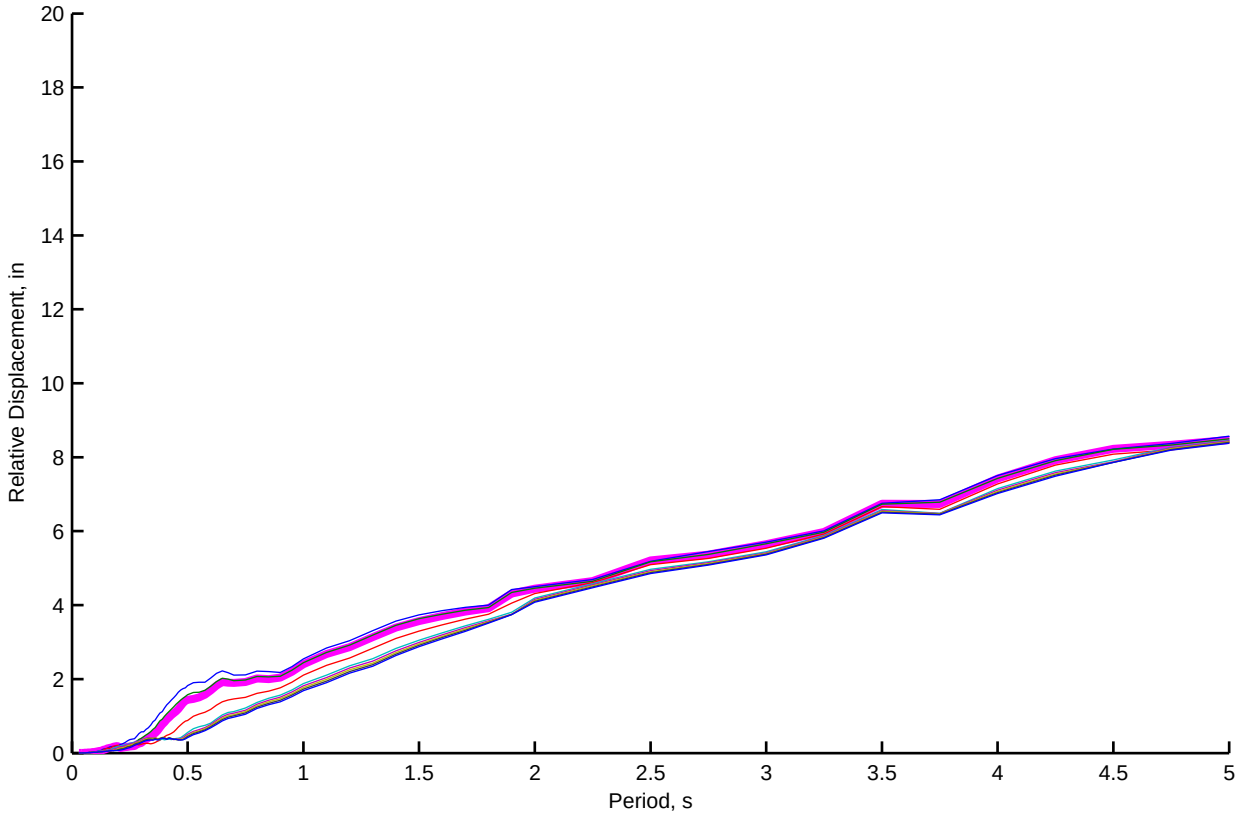
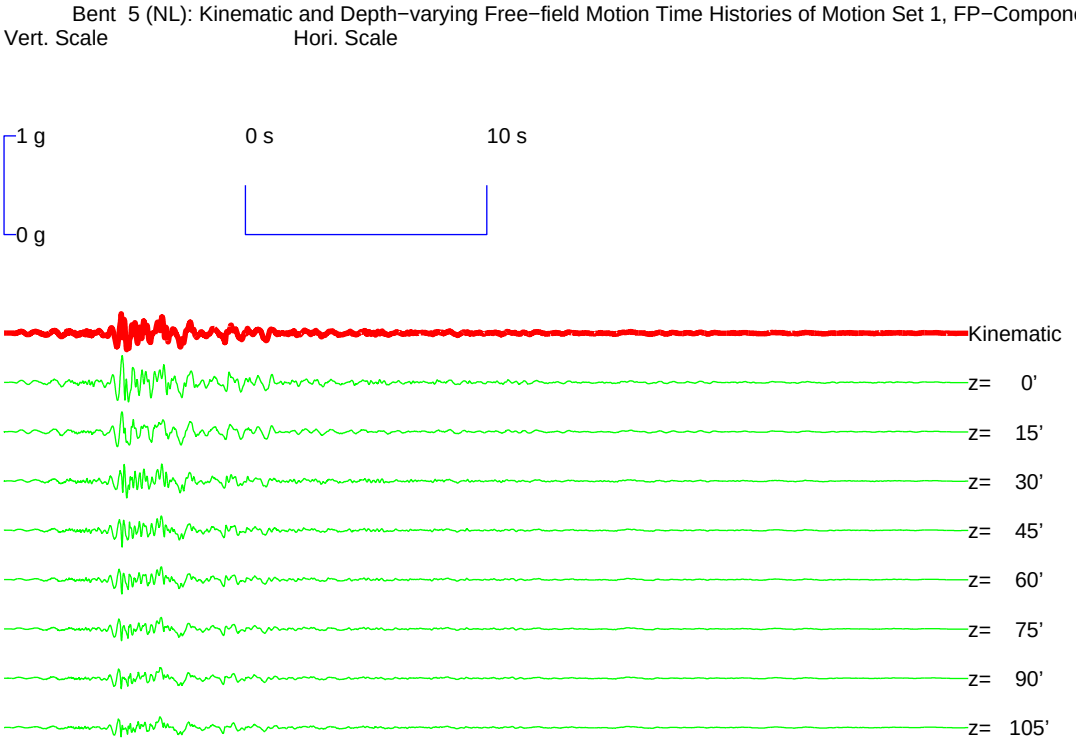
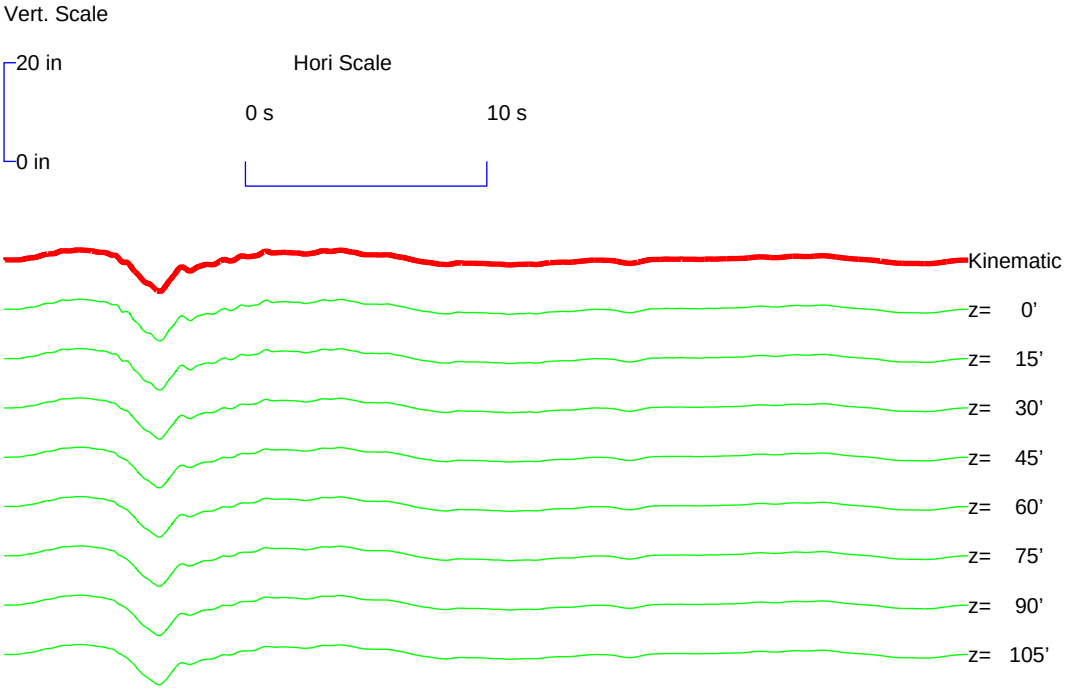
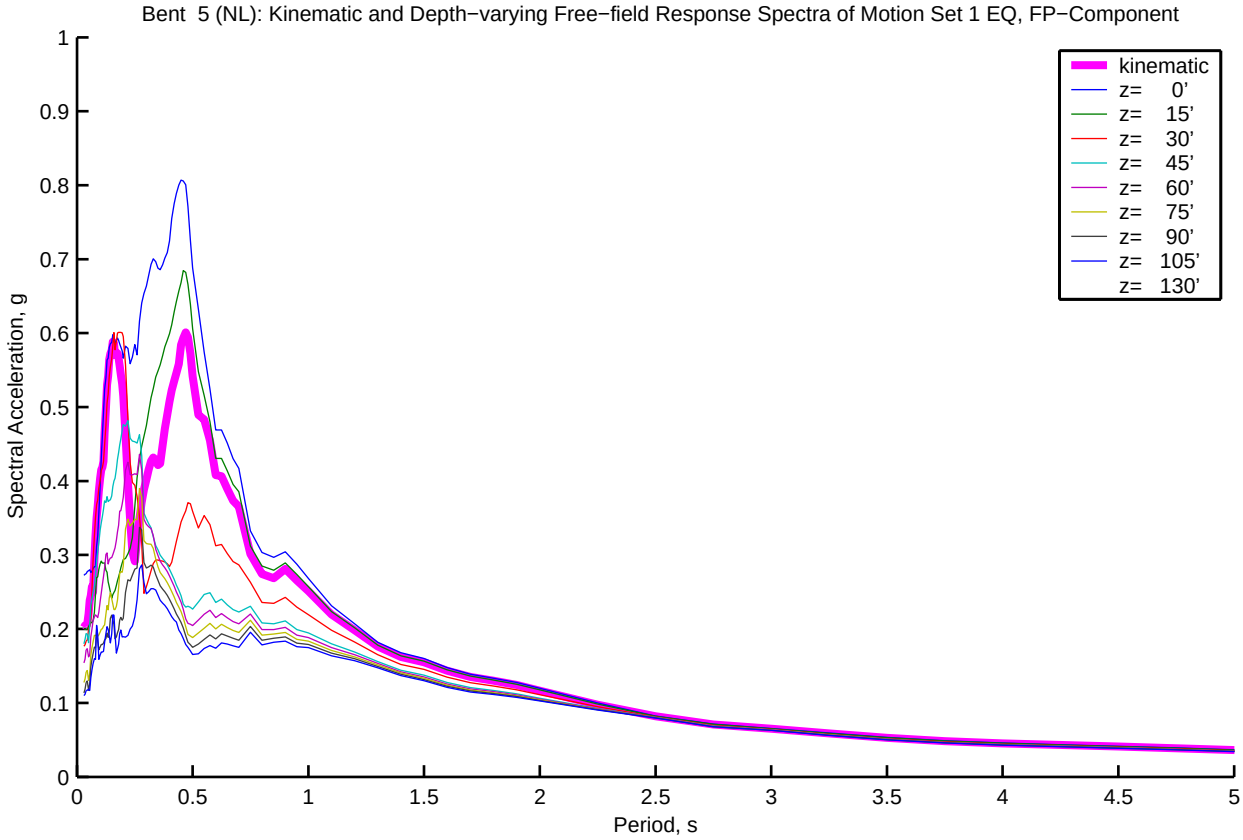

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 5 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component




Bent 5 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
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0.9
1
0.5
1.5
2
2.5
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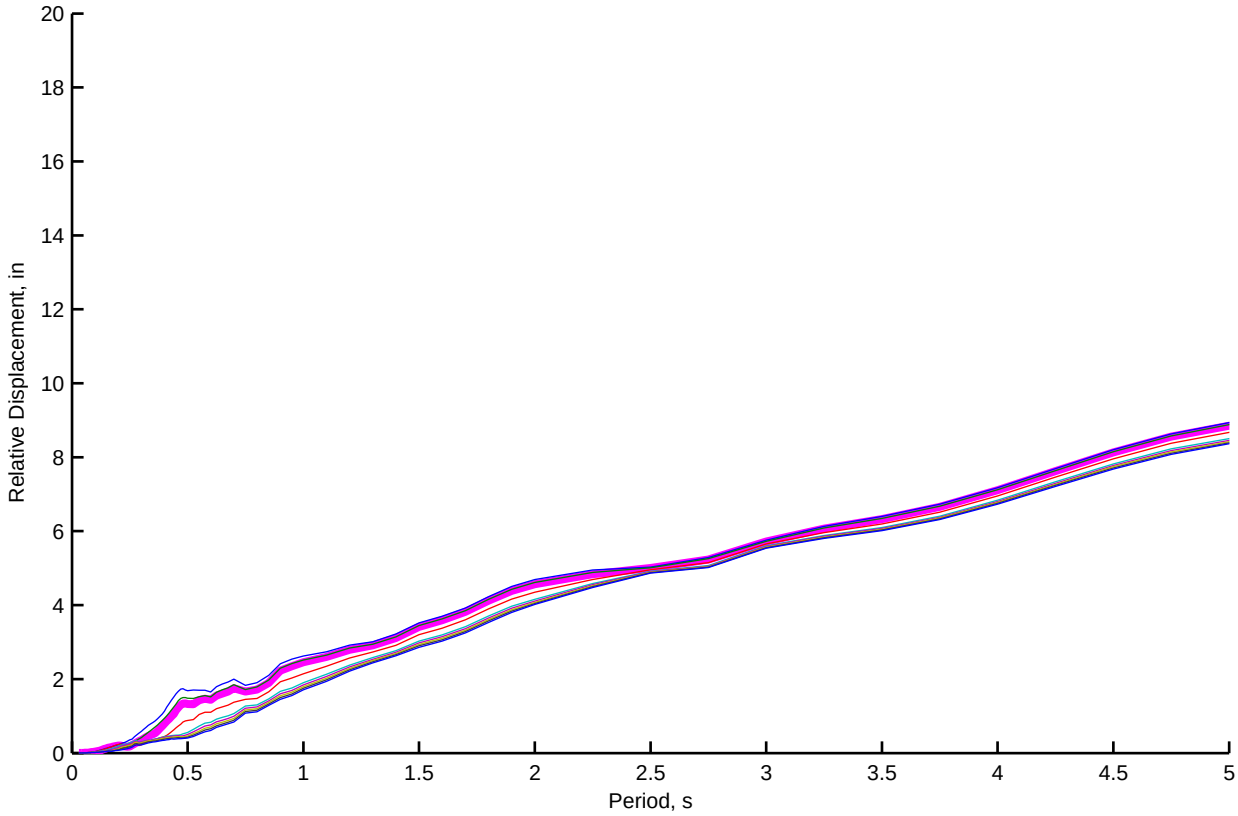
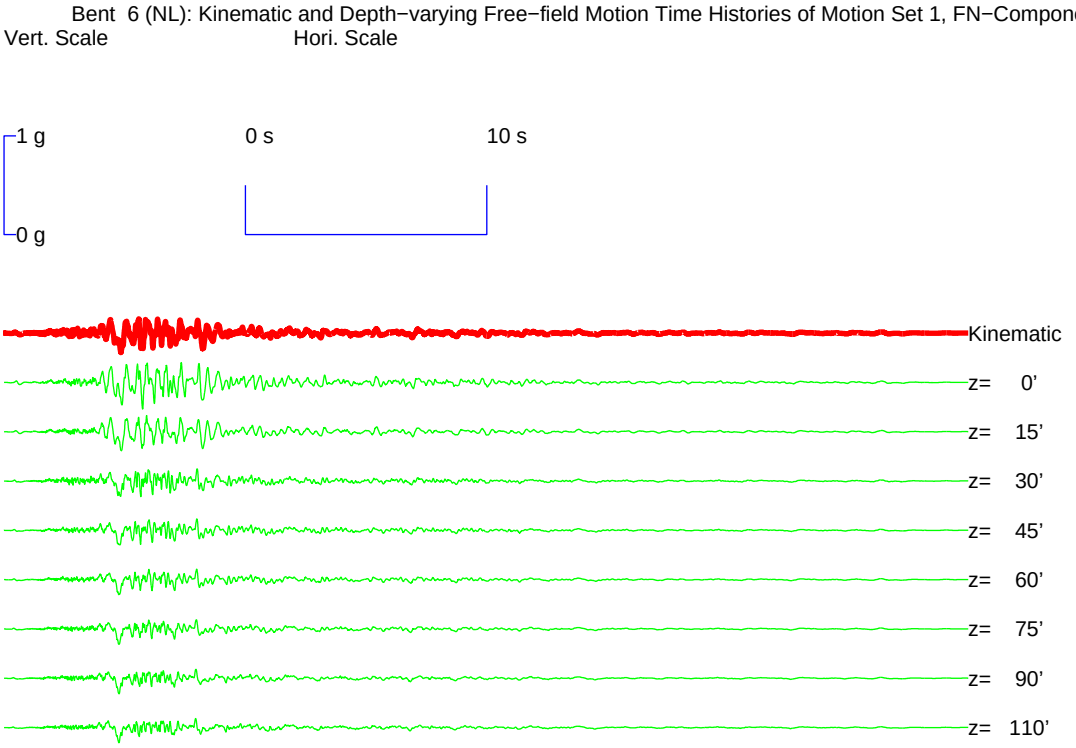
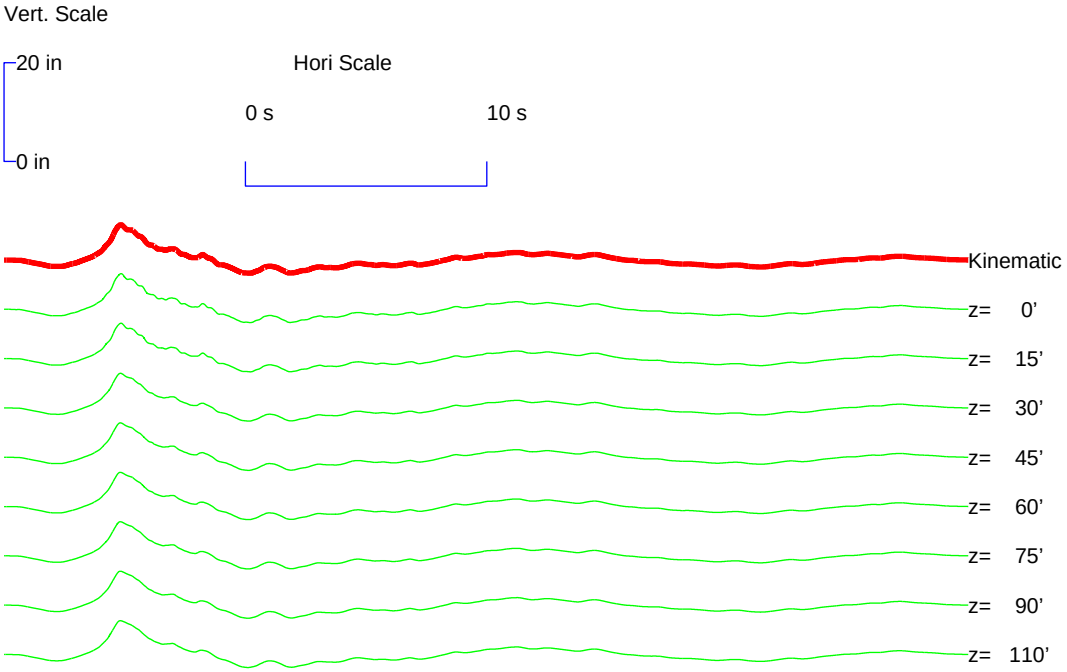
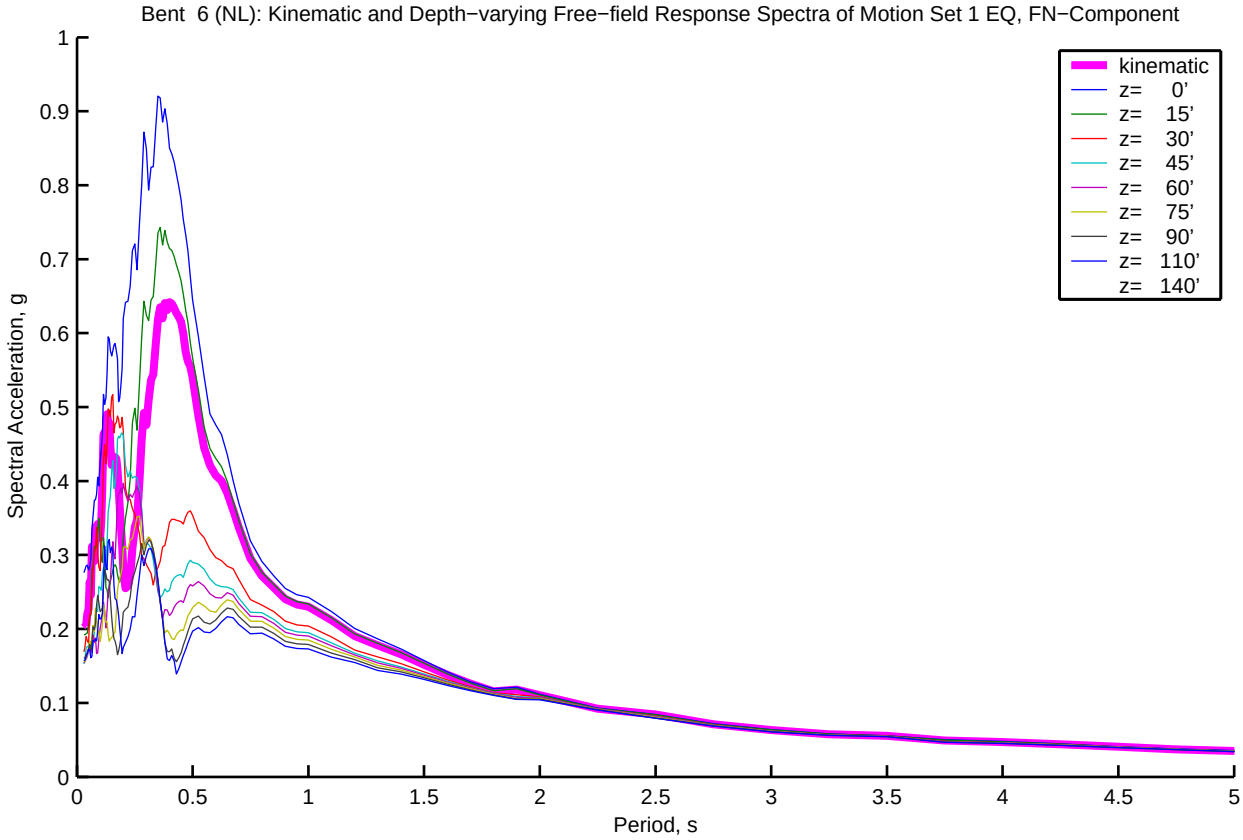
4
4.5
5

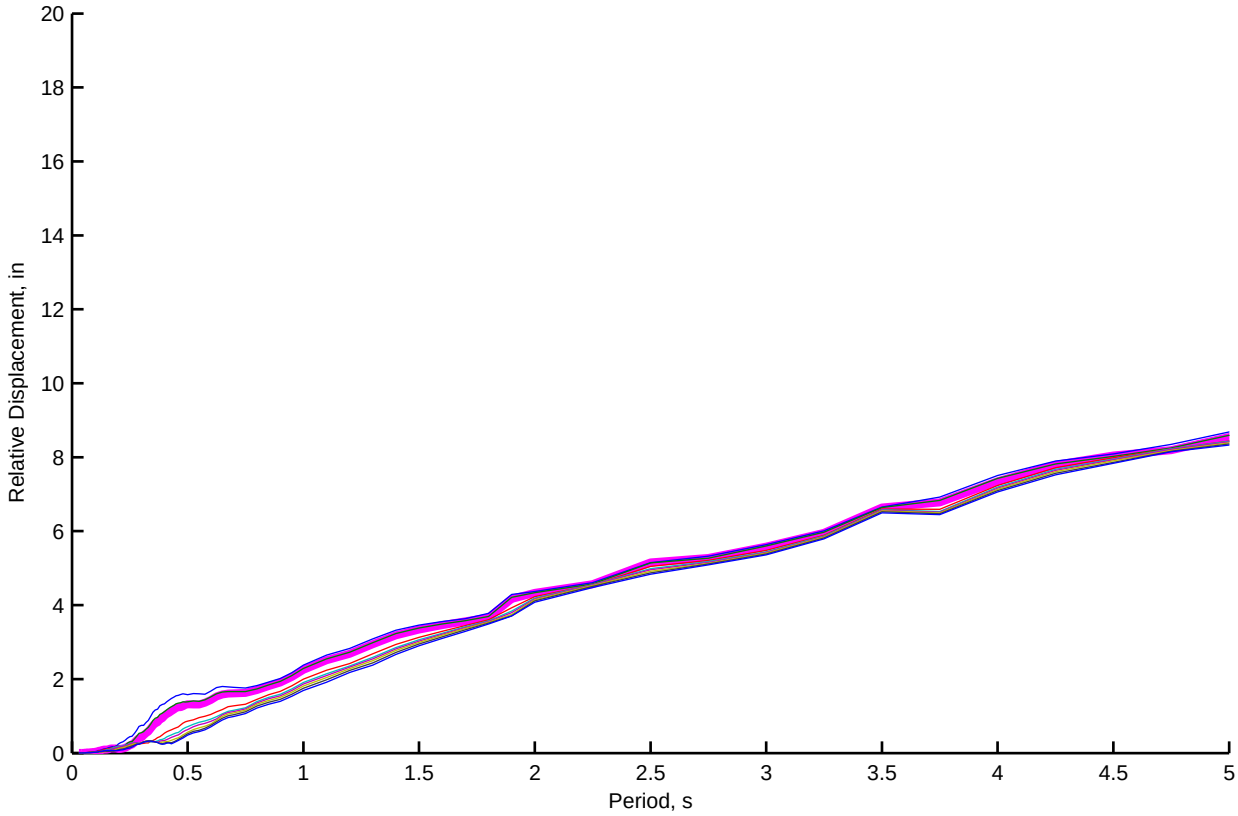

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 6 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

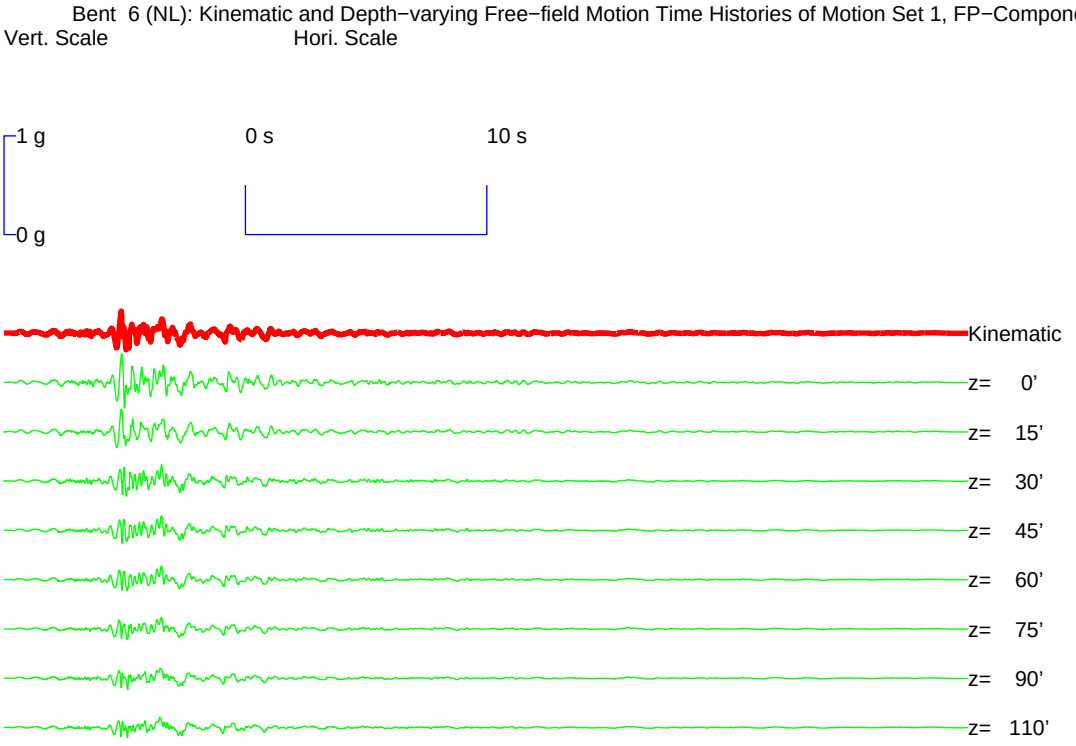


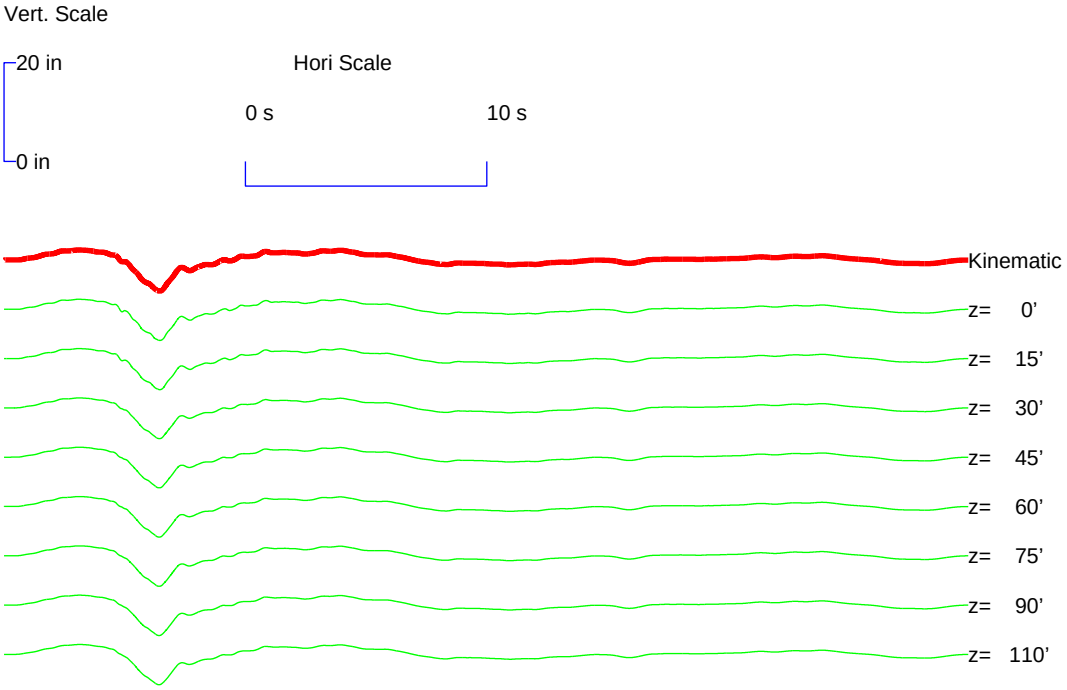



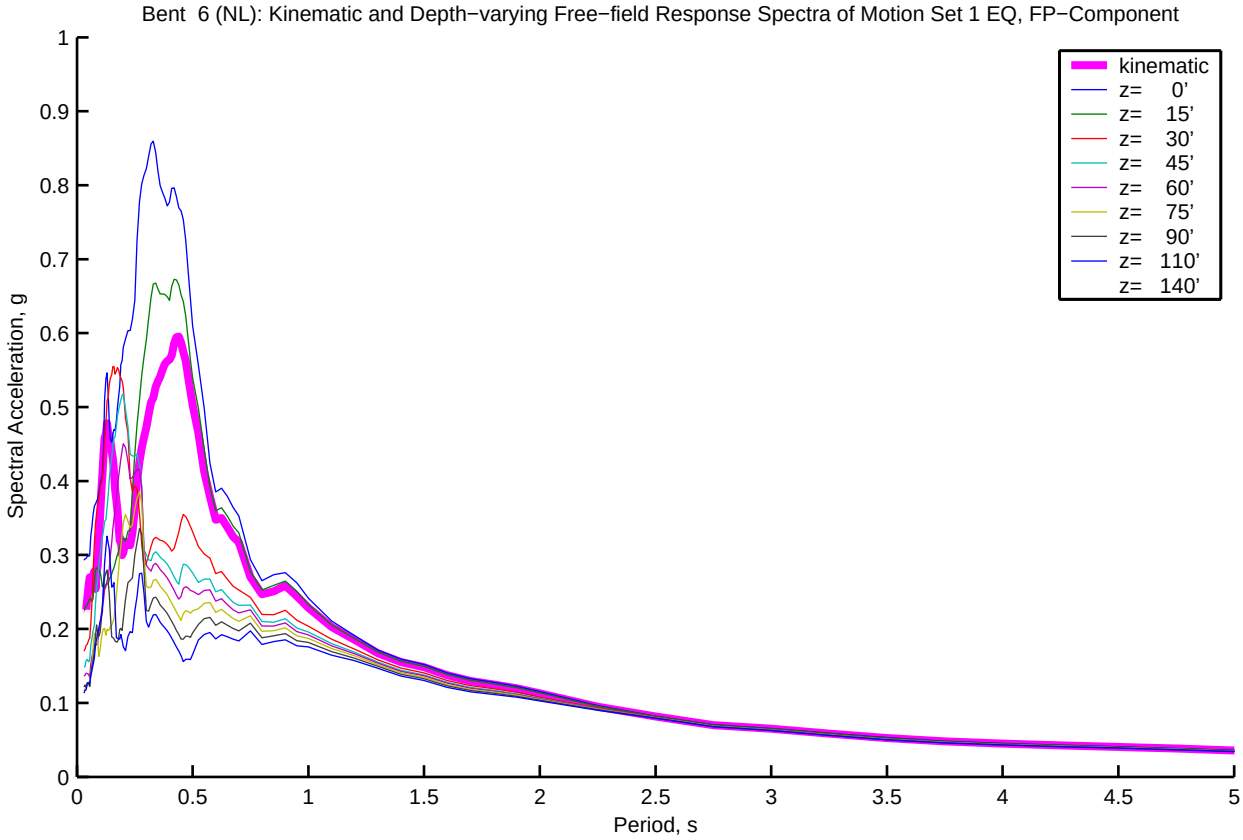

Bent 6 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

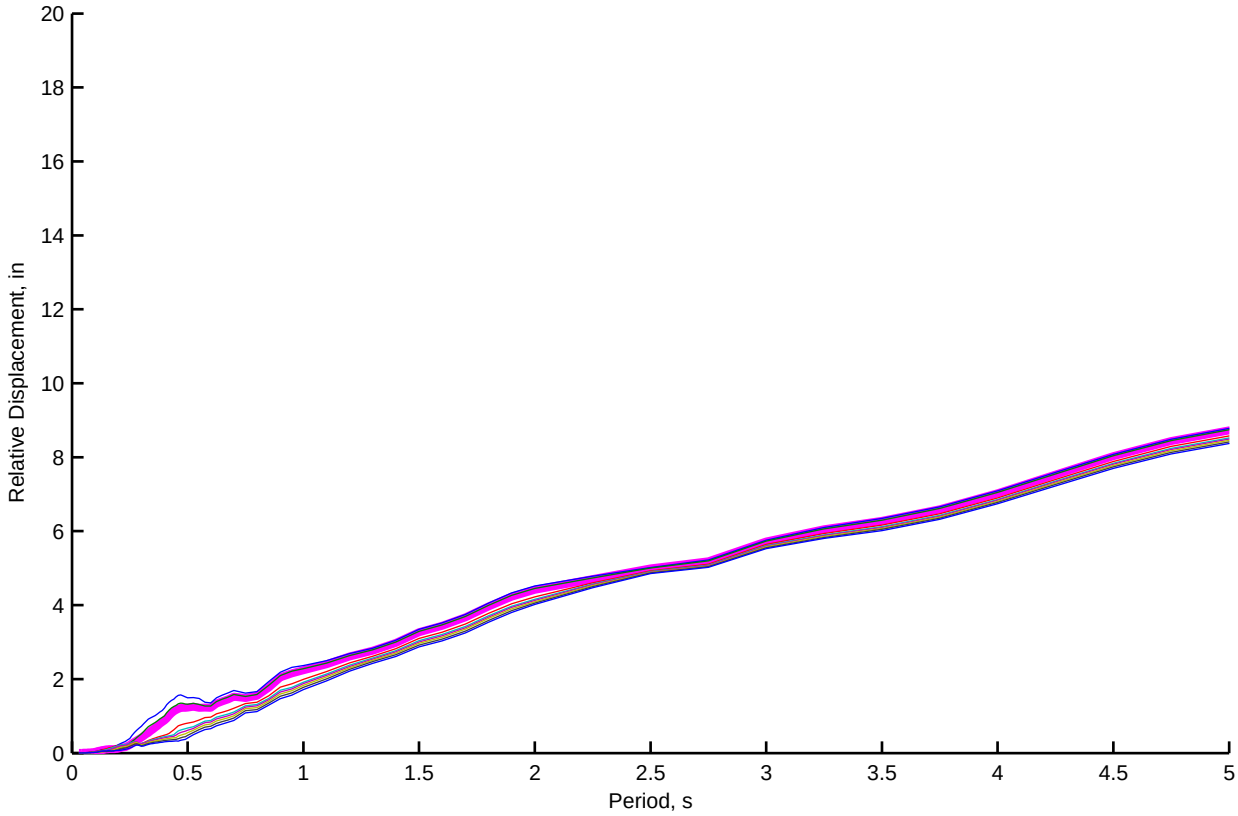

Relative Displacement, in
Period, s

Bent 6 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

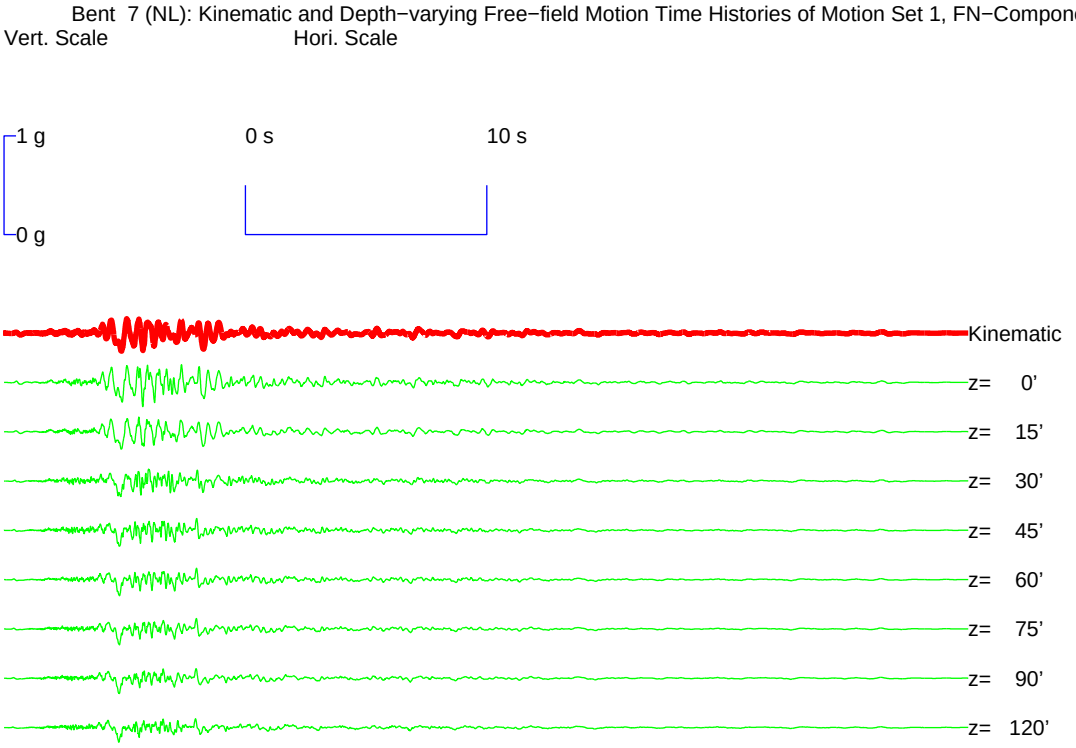


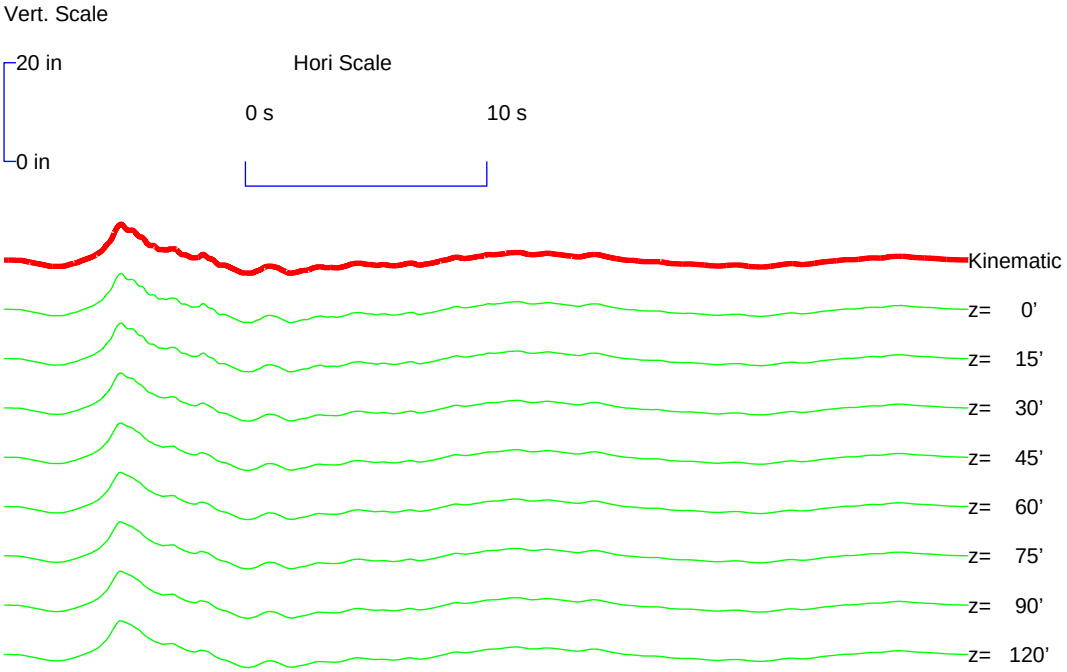



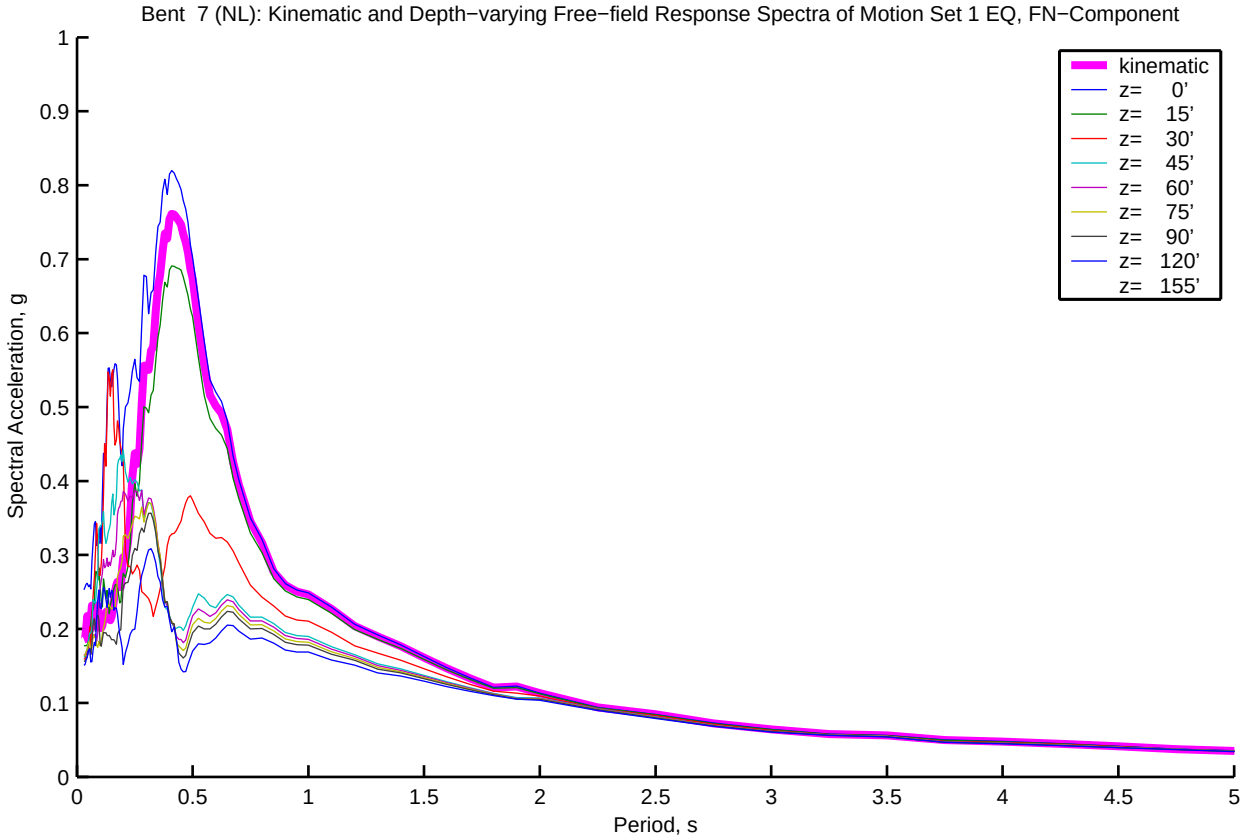

Bent 6 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'


Relative Displacement, in
Period, s

Bent 7 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component




Bent 7 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
0
0.1
0.2
0.3
0.4
0.5
0.6
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4.5
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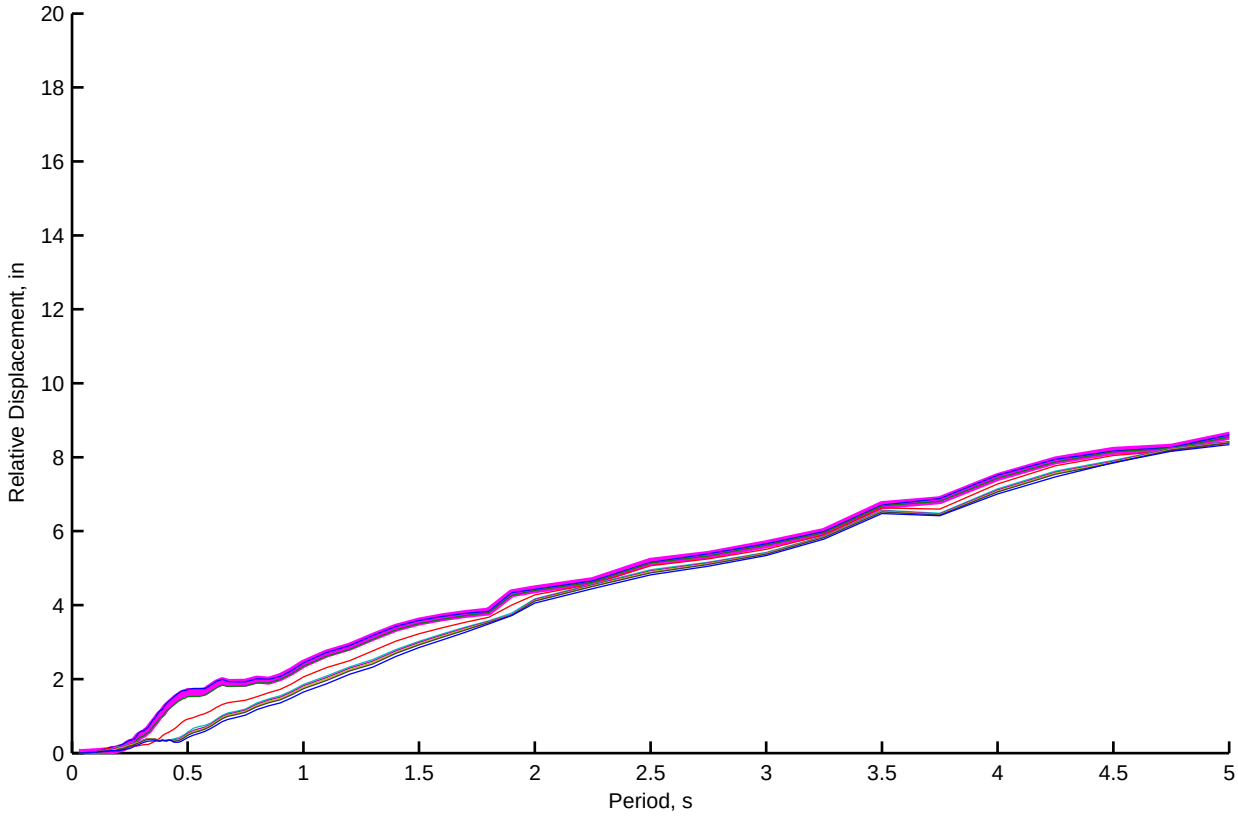
Relative Displacement, in
Period, s
0
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18
20
0.5
1
1.5
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2.5
3
3.5
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4.5
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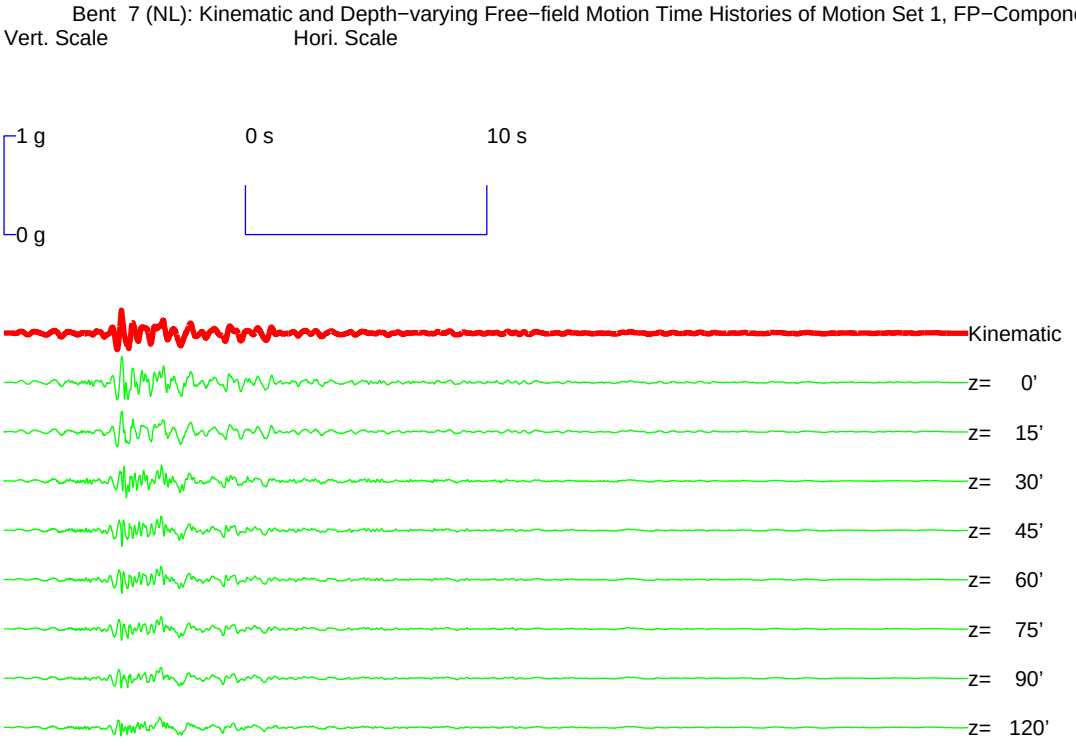
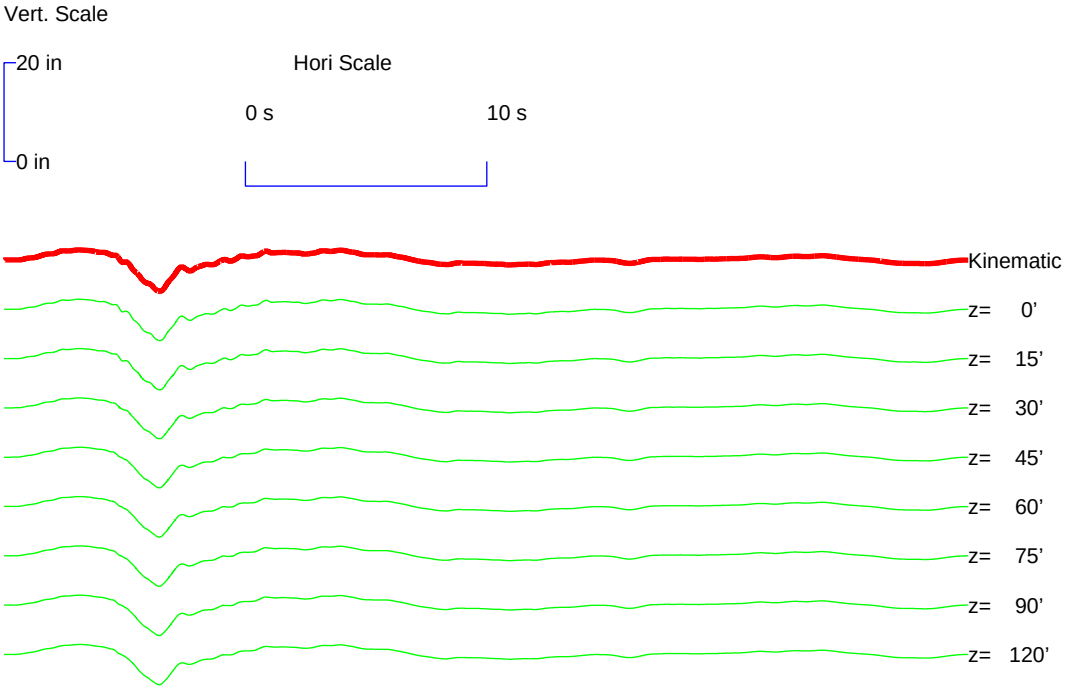
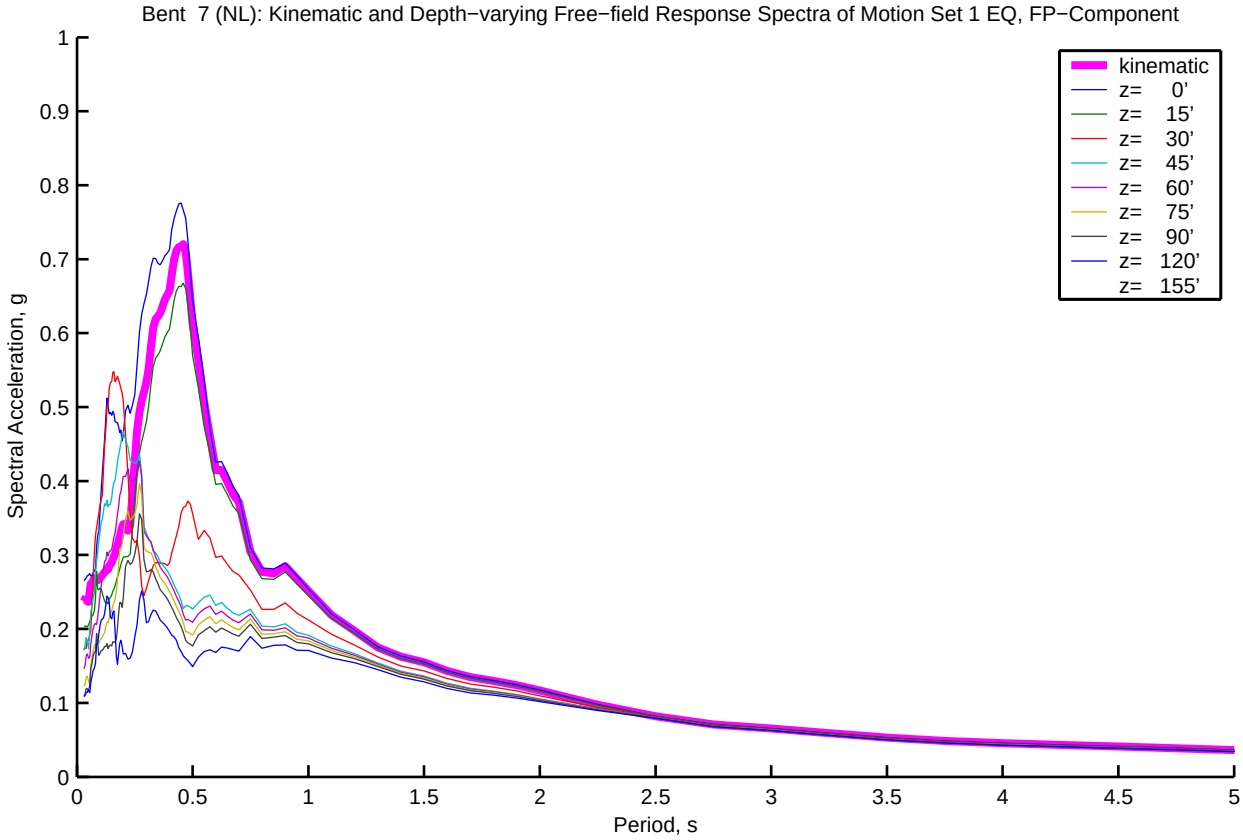
Bent 7 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component




Bent 7 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
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0.5
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3.5
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4.5
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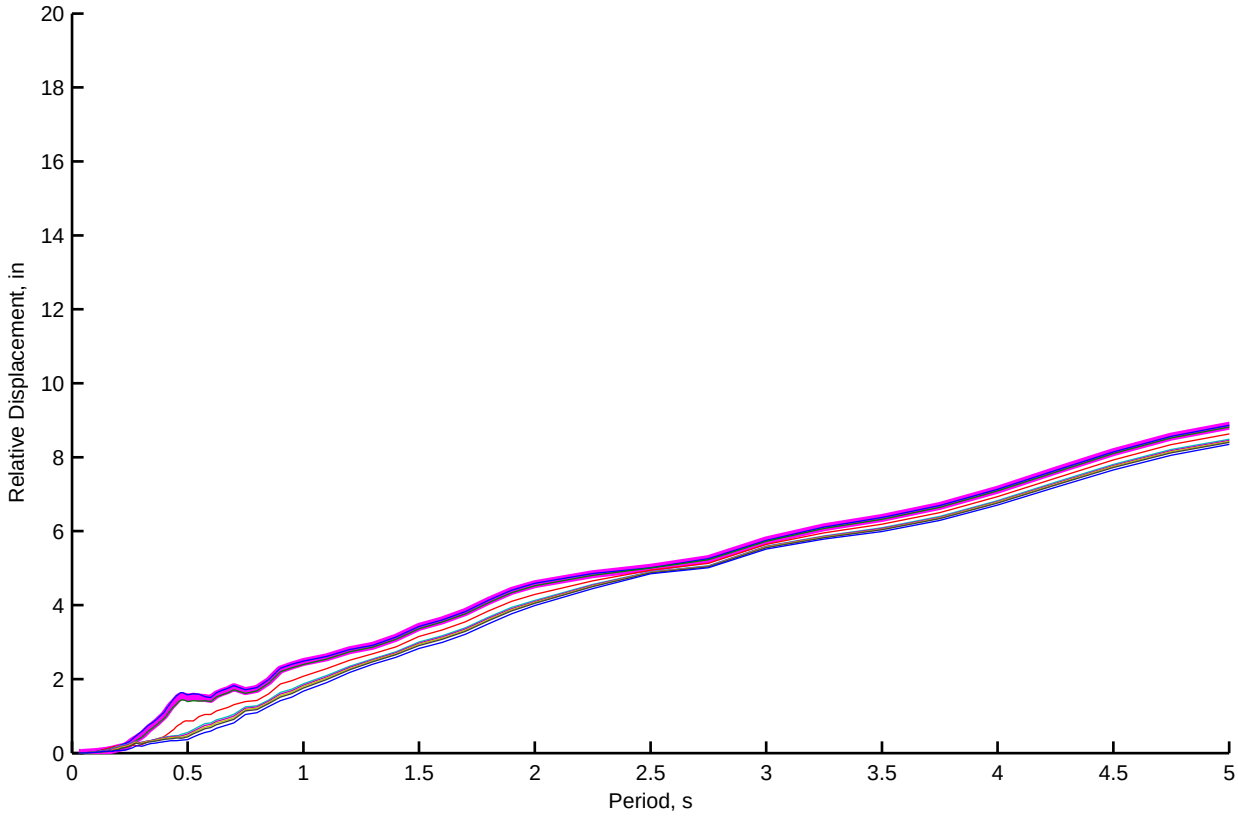
Relative Displacement, in
Period, s
0
2
4
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8
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12
14
16
18
20
0.5
1
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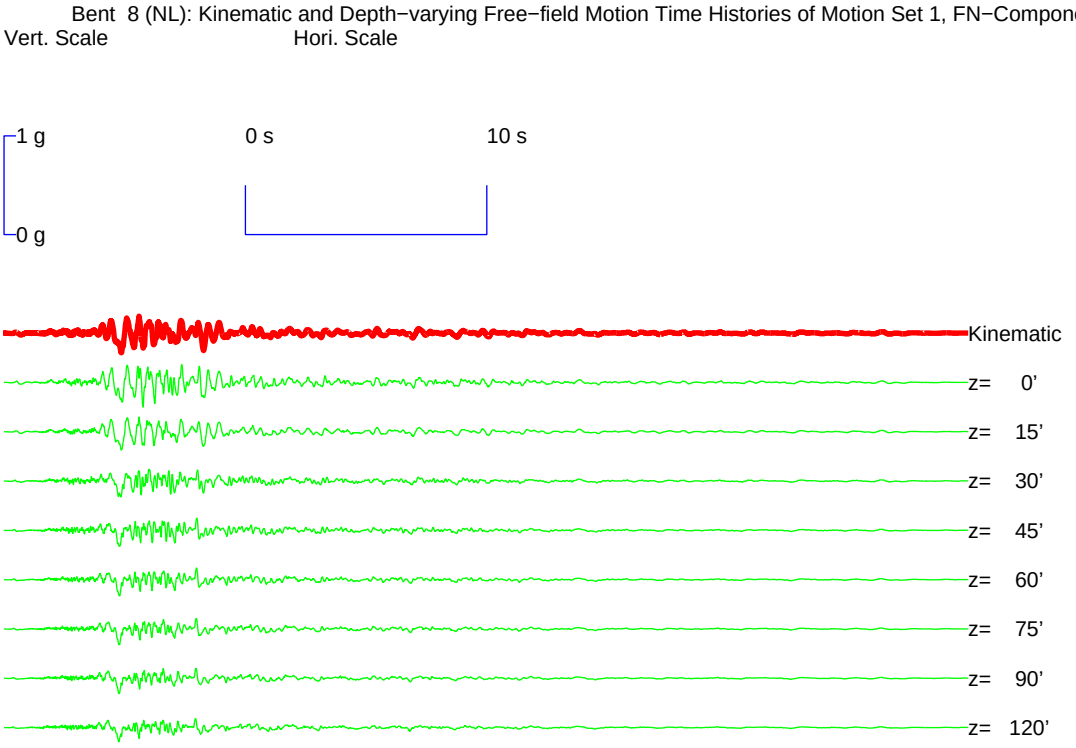
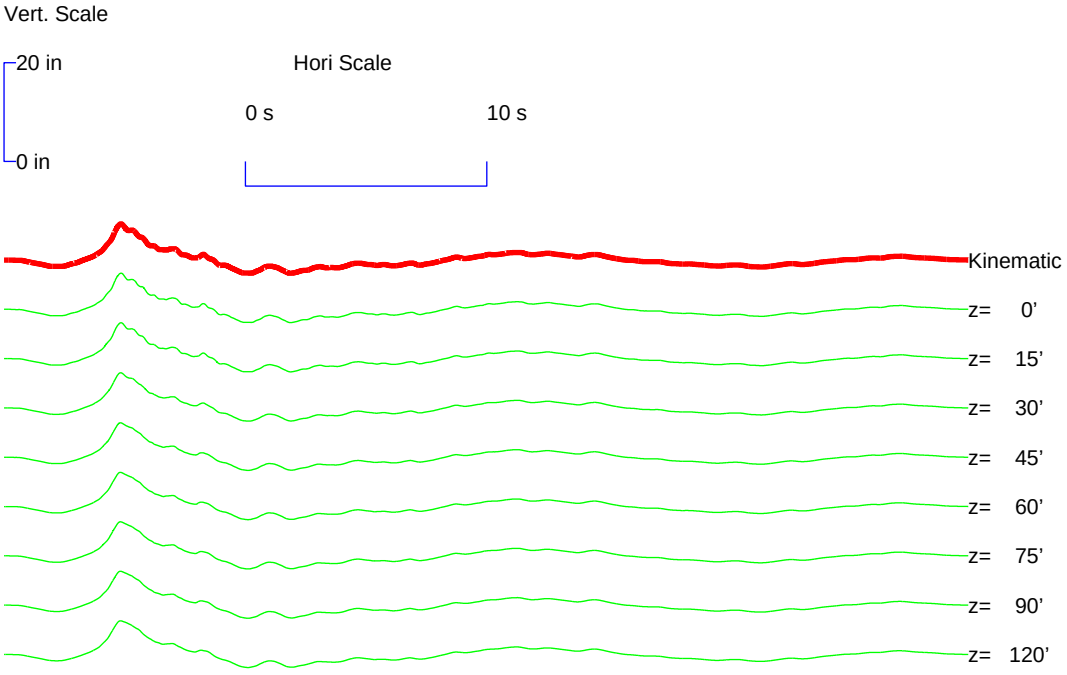
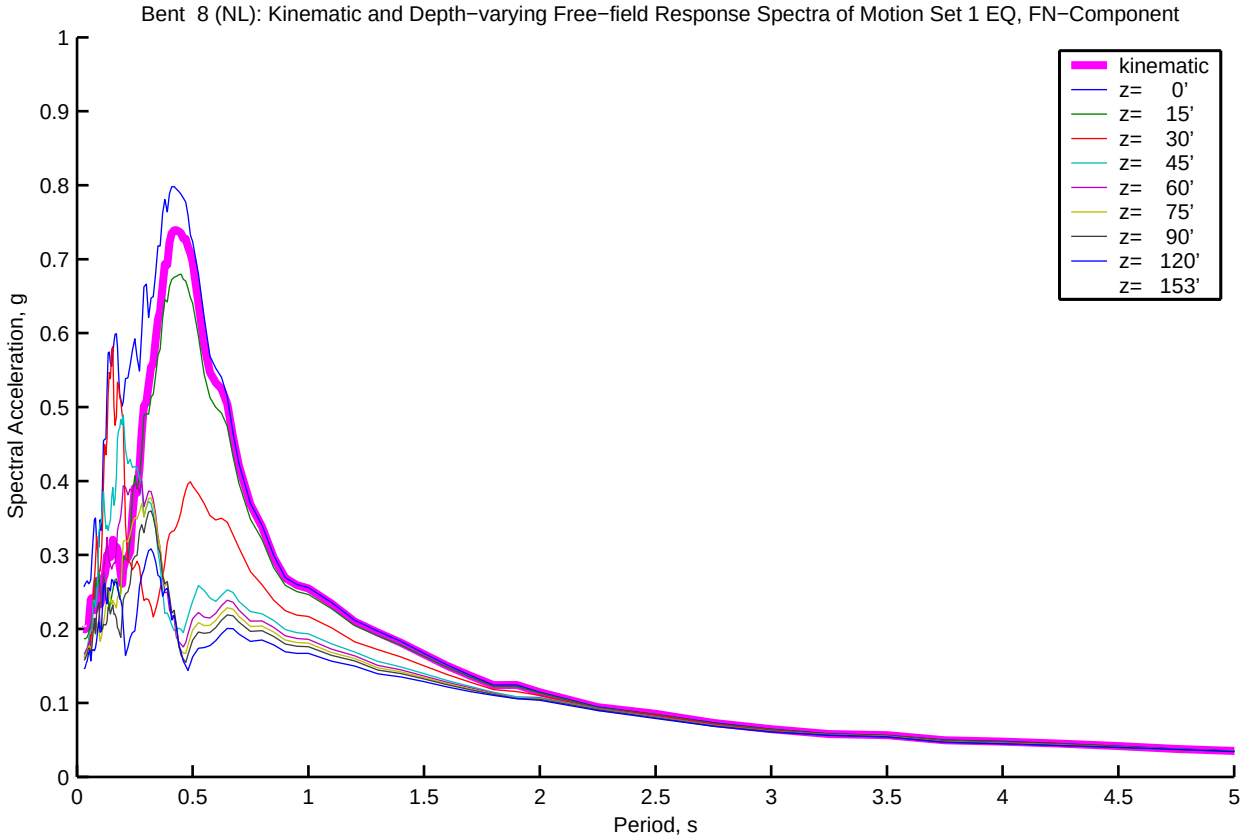
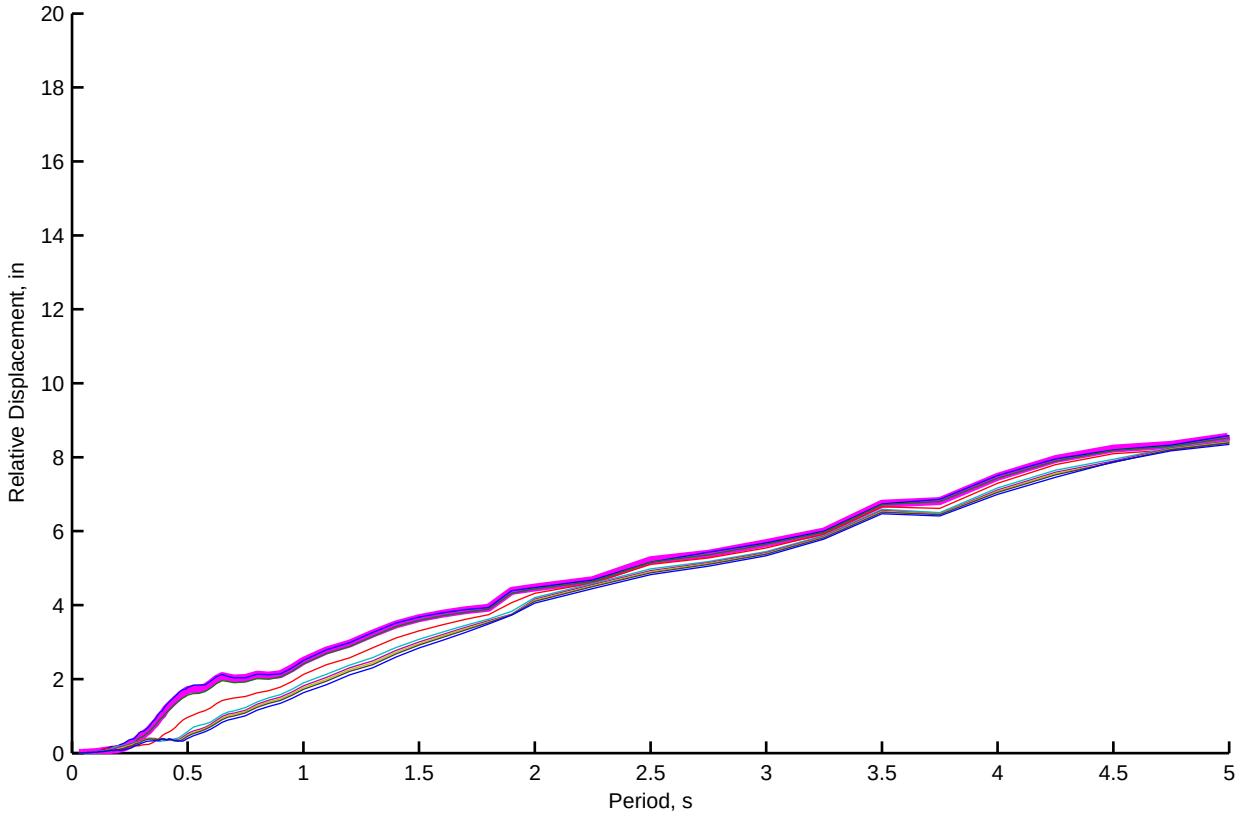
3.5
4
4.5
5

Bent 8 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component




Bent 8 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
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14
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18
20
0.5
1
1.5
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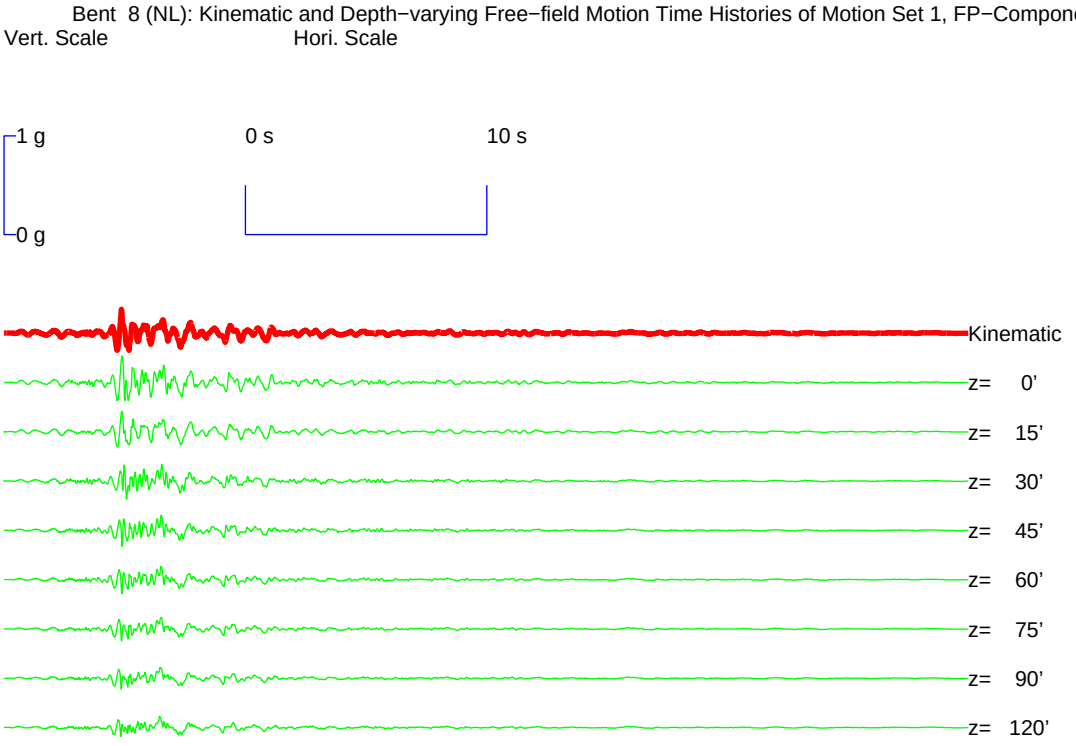
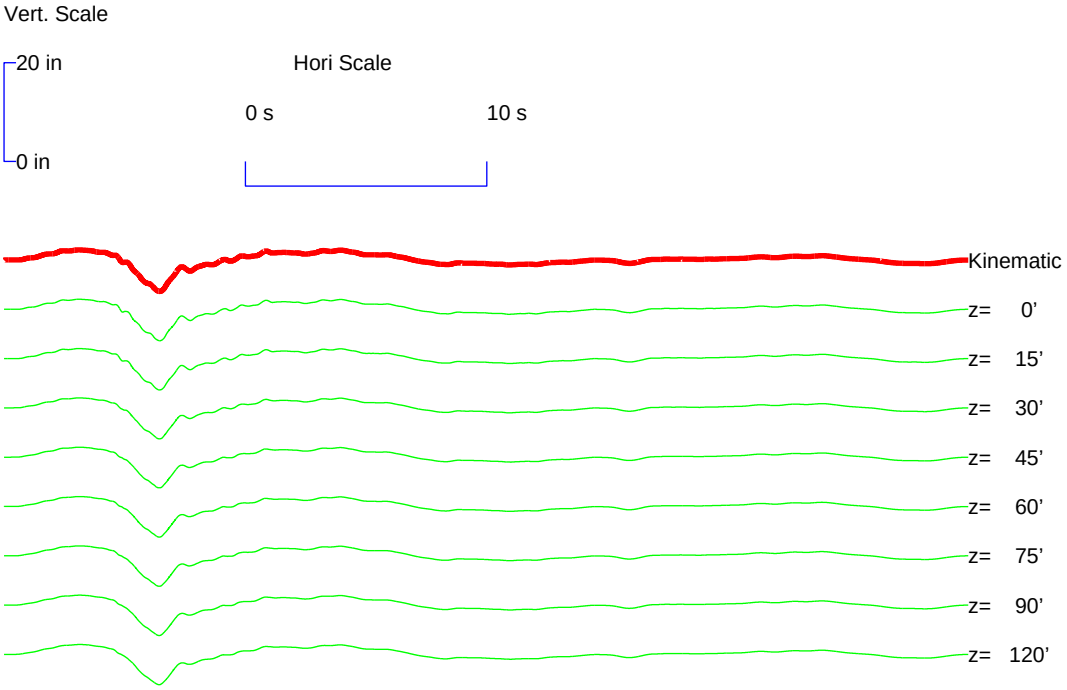
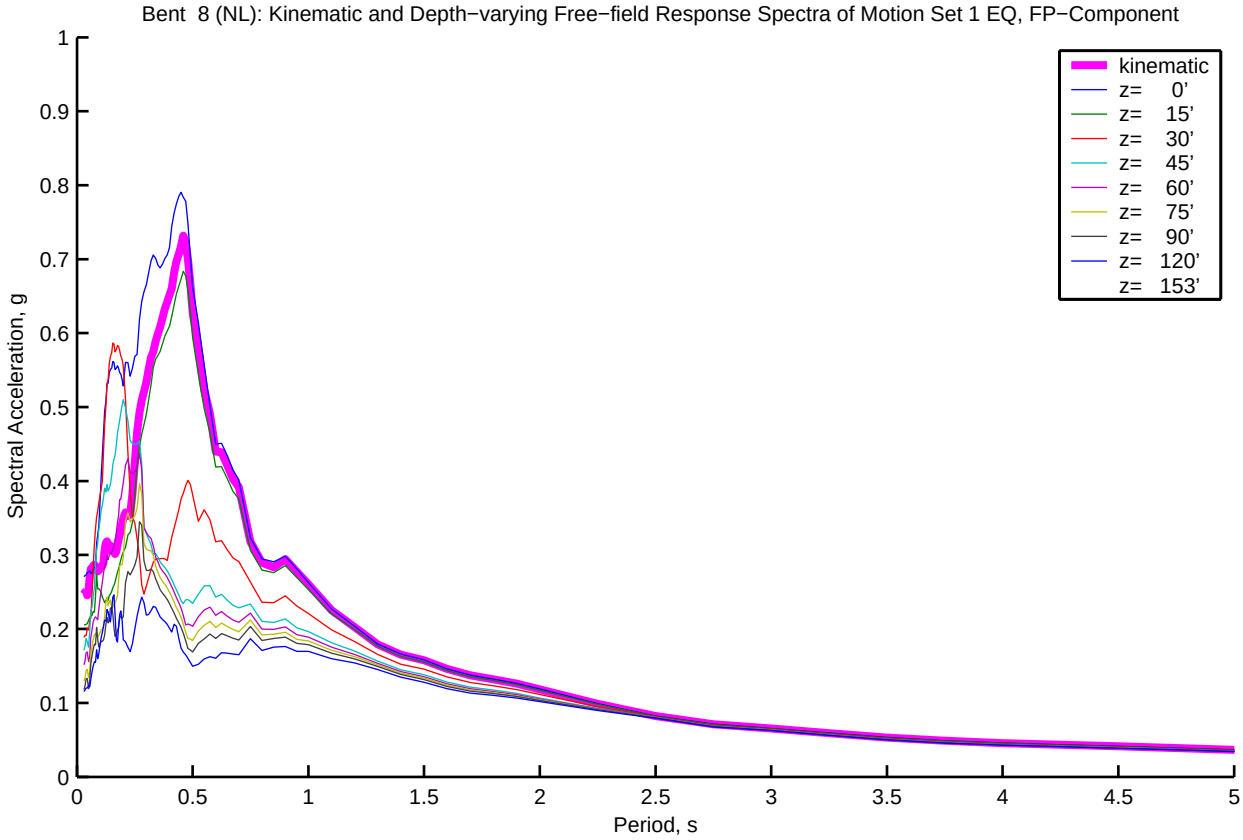
3.5
4
4.5
5

Bent 8 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component




Bent 8 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
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0.9
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0.5
1.5
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2.5
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3.5
4
4.5
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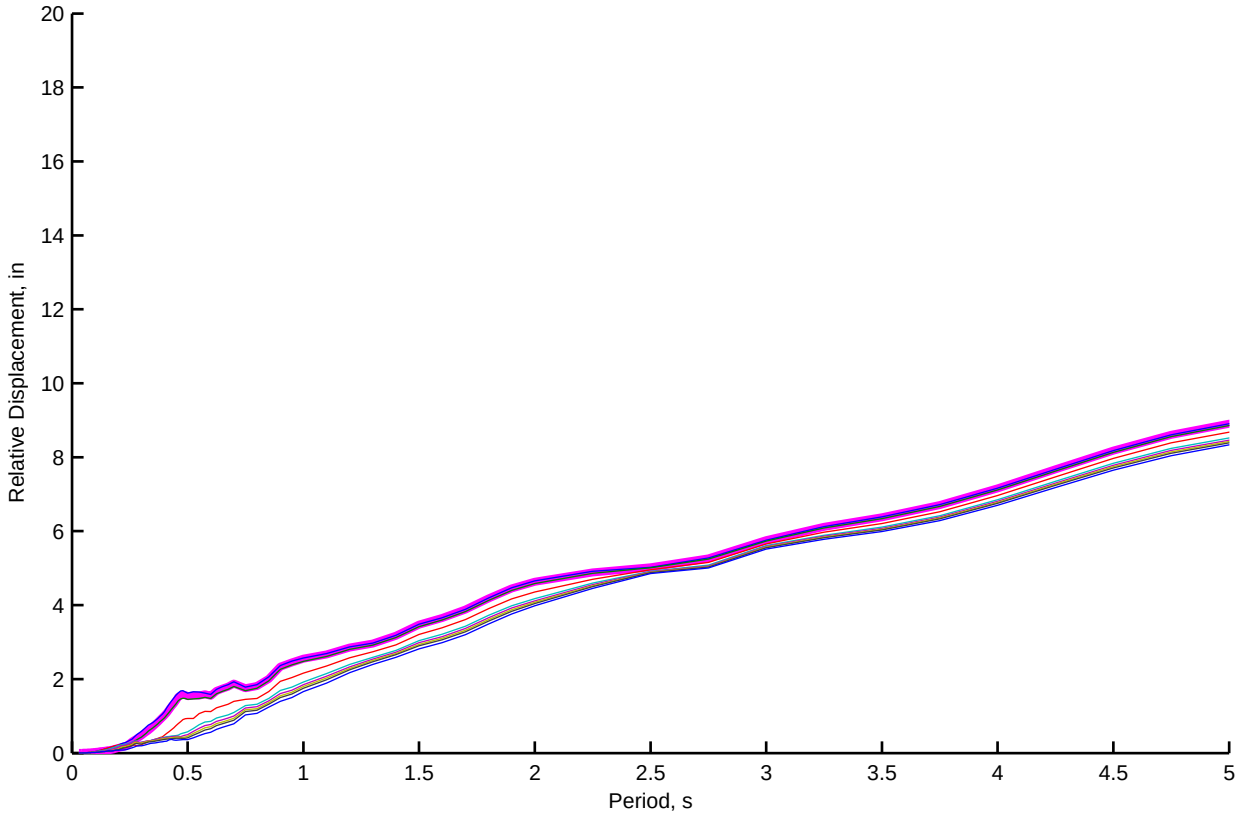
Relative Displacement, in
Period, s
0
2
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12
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16
18
20
0.5
1
1.5
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3.5
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4.5
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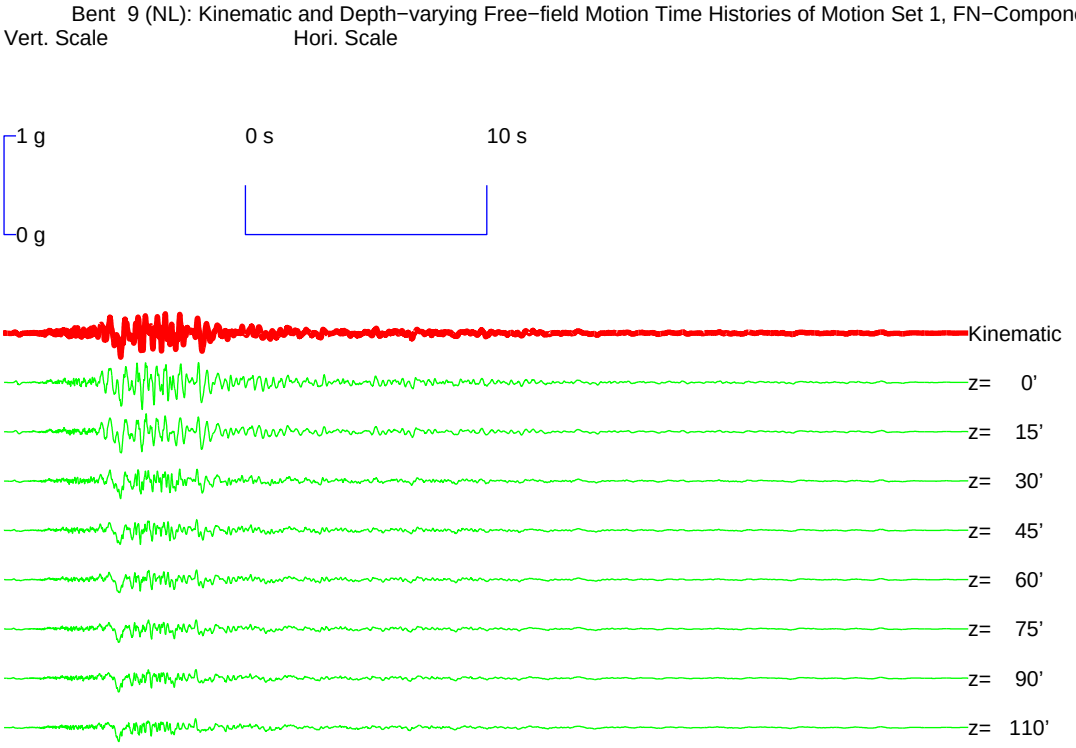
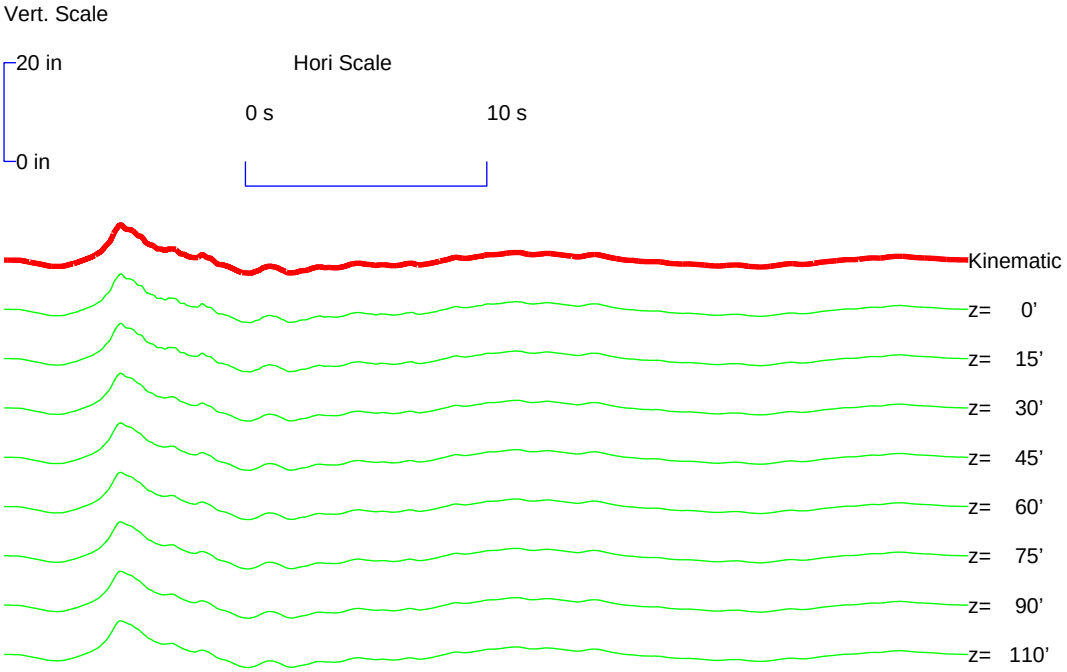
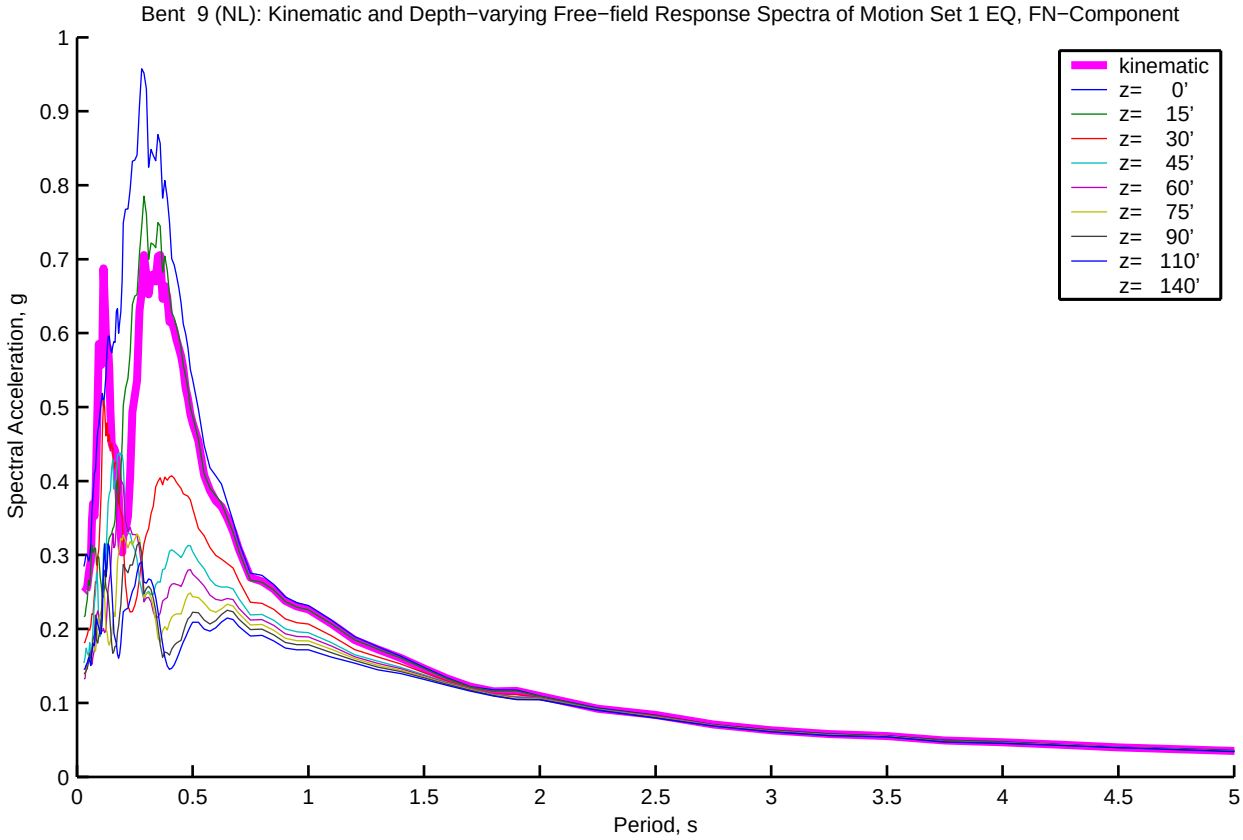
Bent 9 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component




Bent 9 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
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0.9
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0.5
1.5
2
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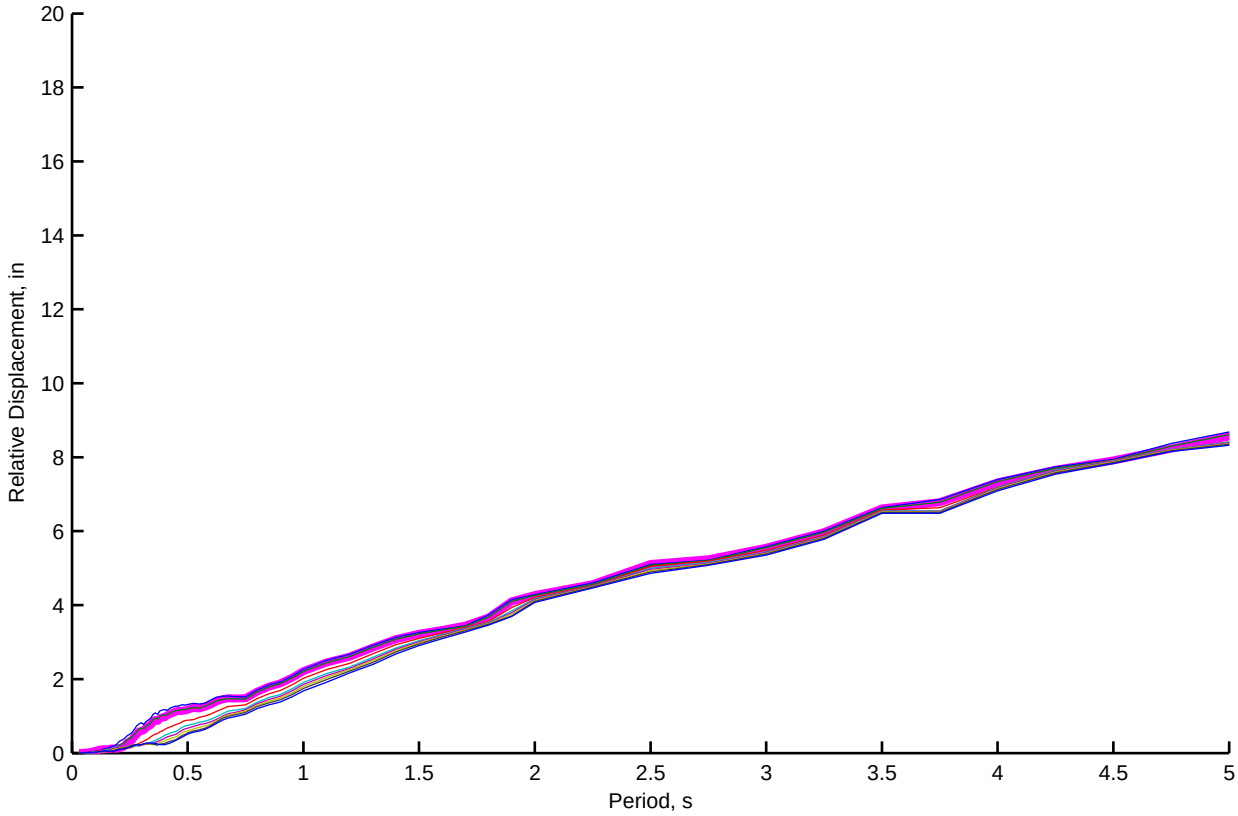
Relative Displacement, in
Period, s
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2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
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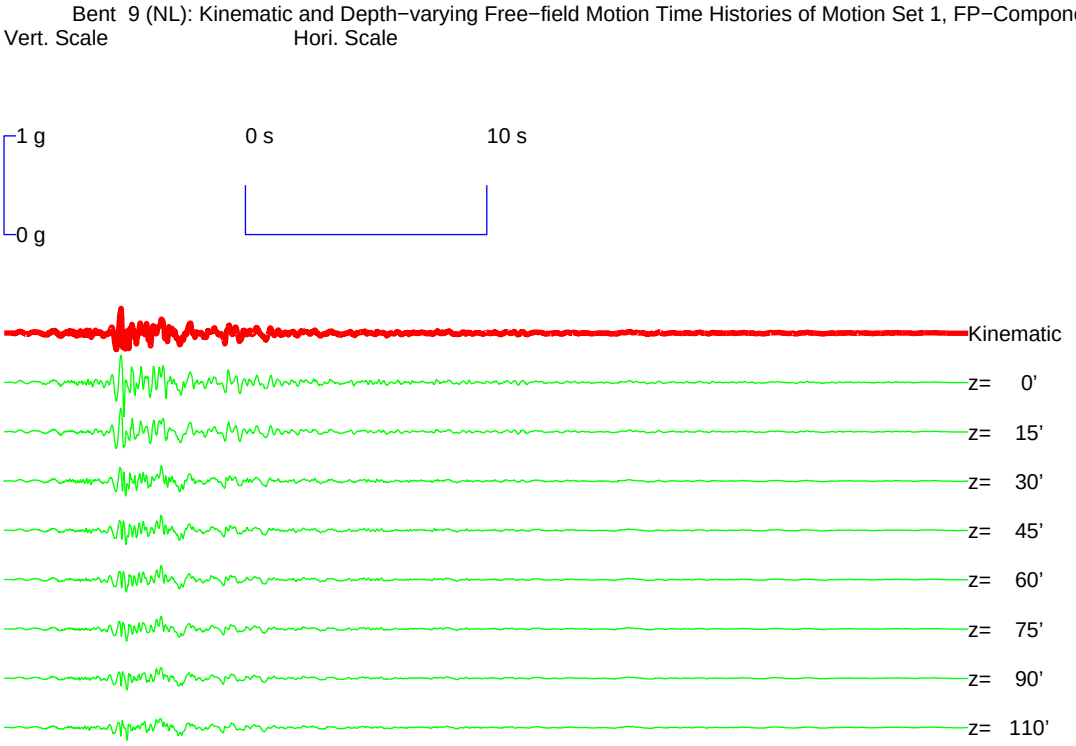
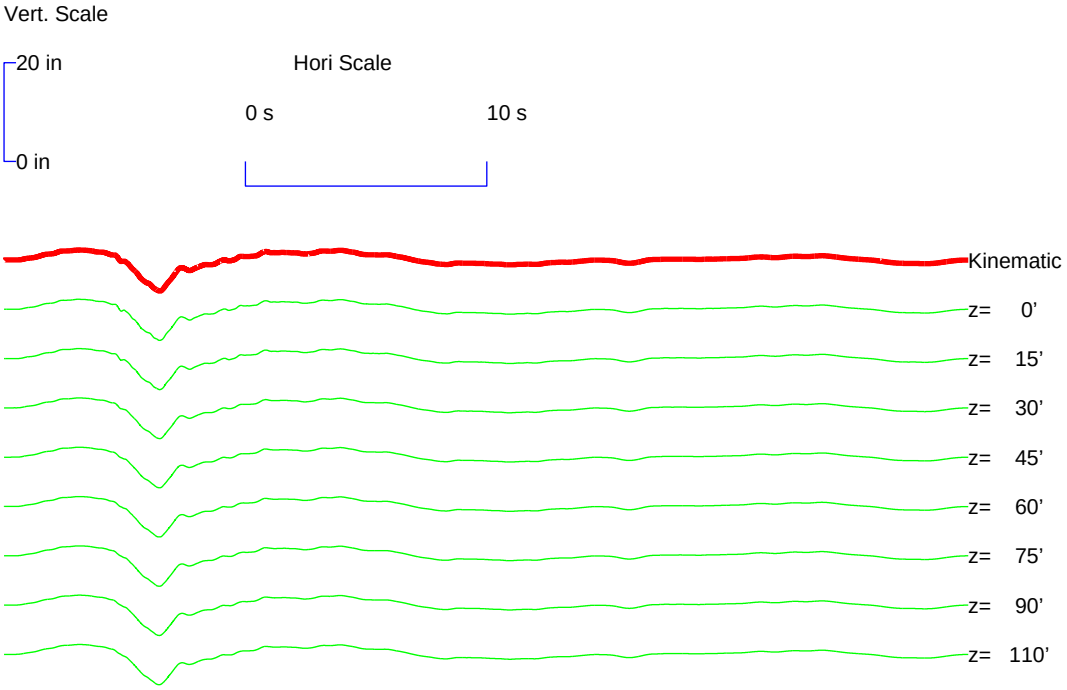
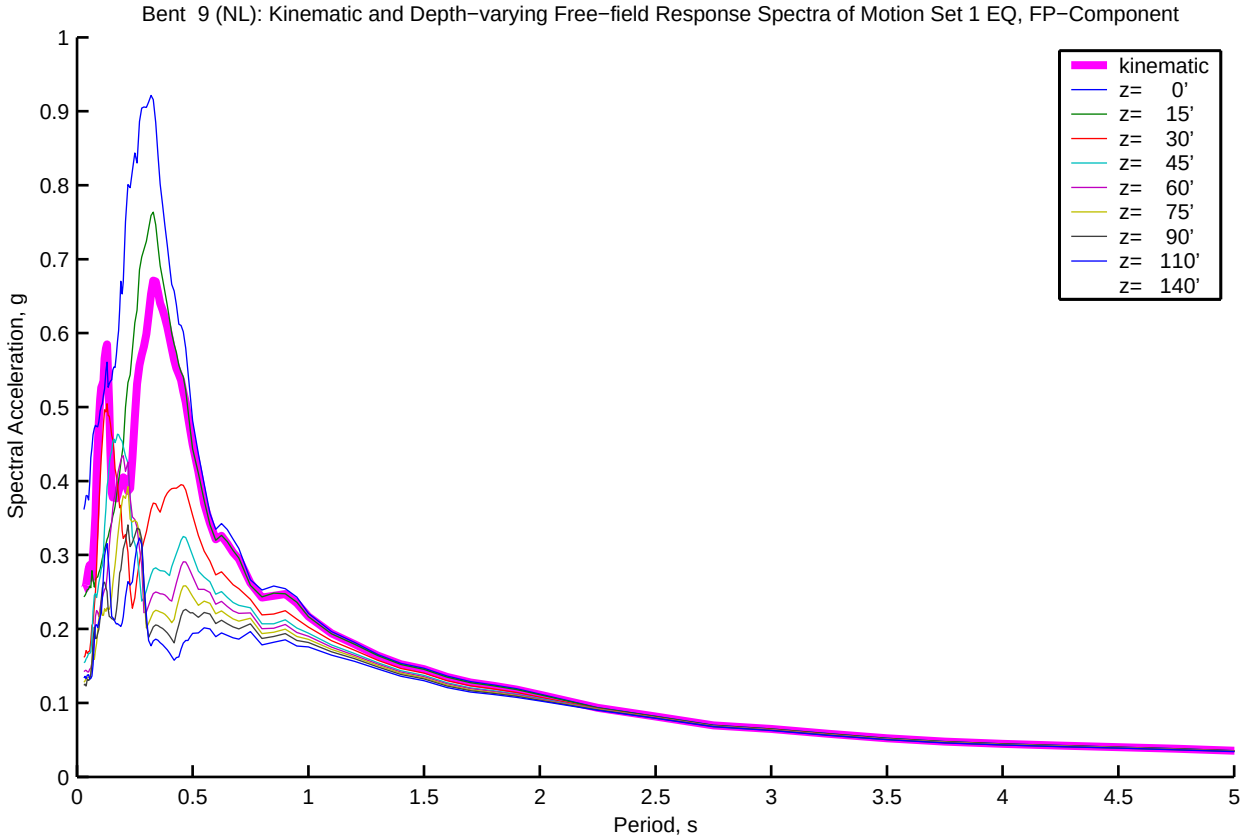
3.5
4
4.5
5

Bent 9 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component




Bent 9 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
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1.5
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3.5
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4.5
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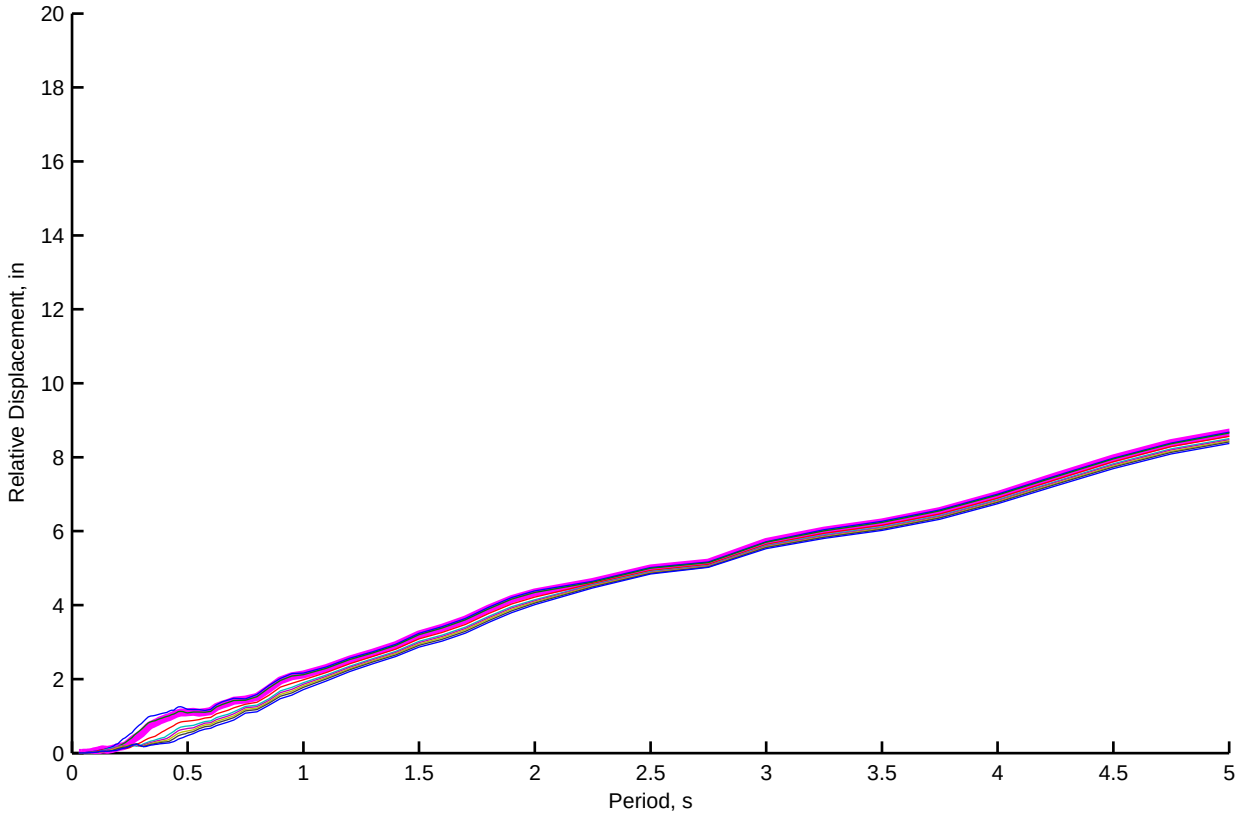
Relative Displacement, in
Period, s
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10
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16
18
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0.5
1
1.5
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2.5
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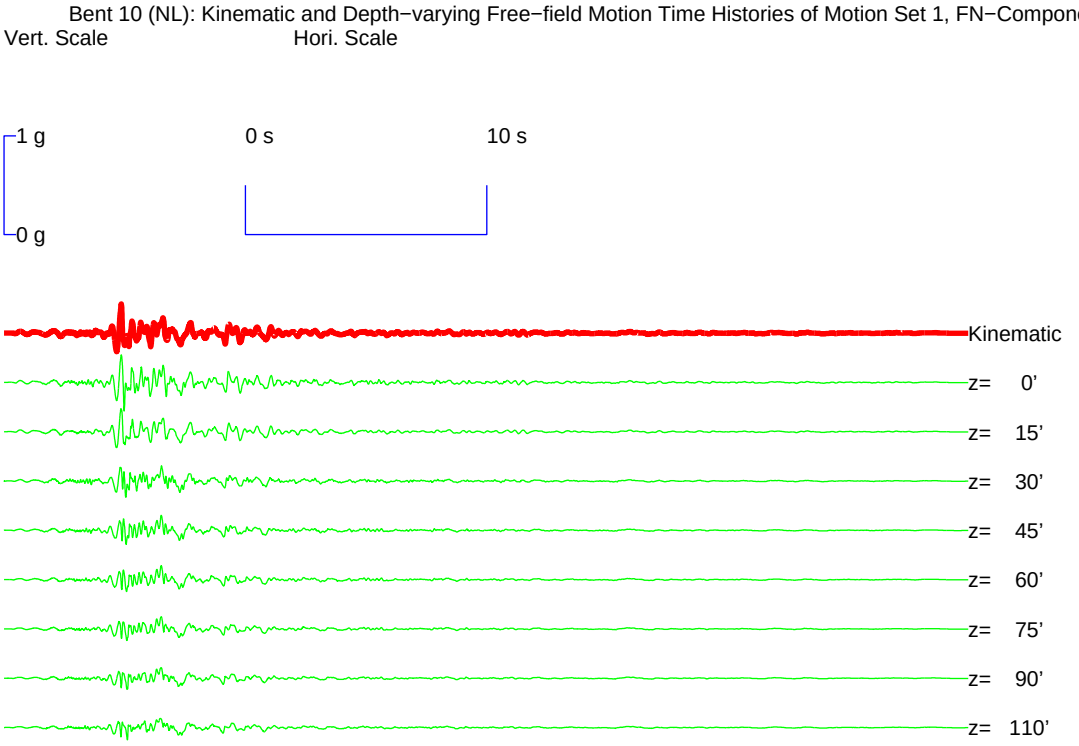
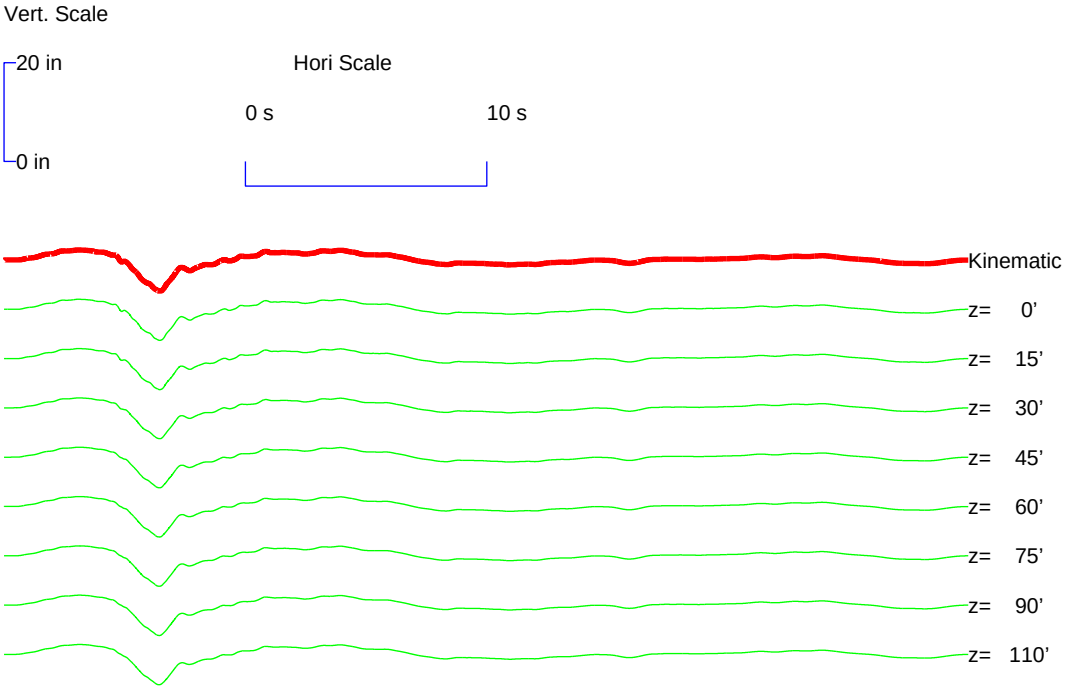
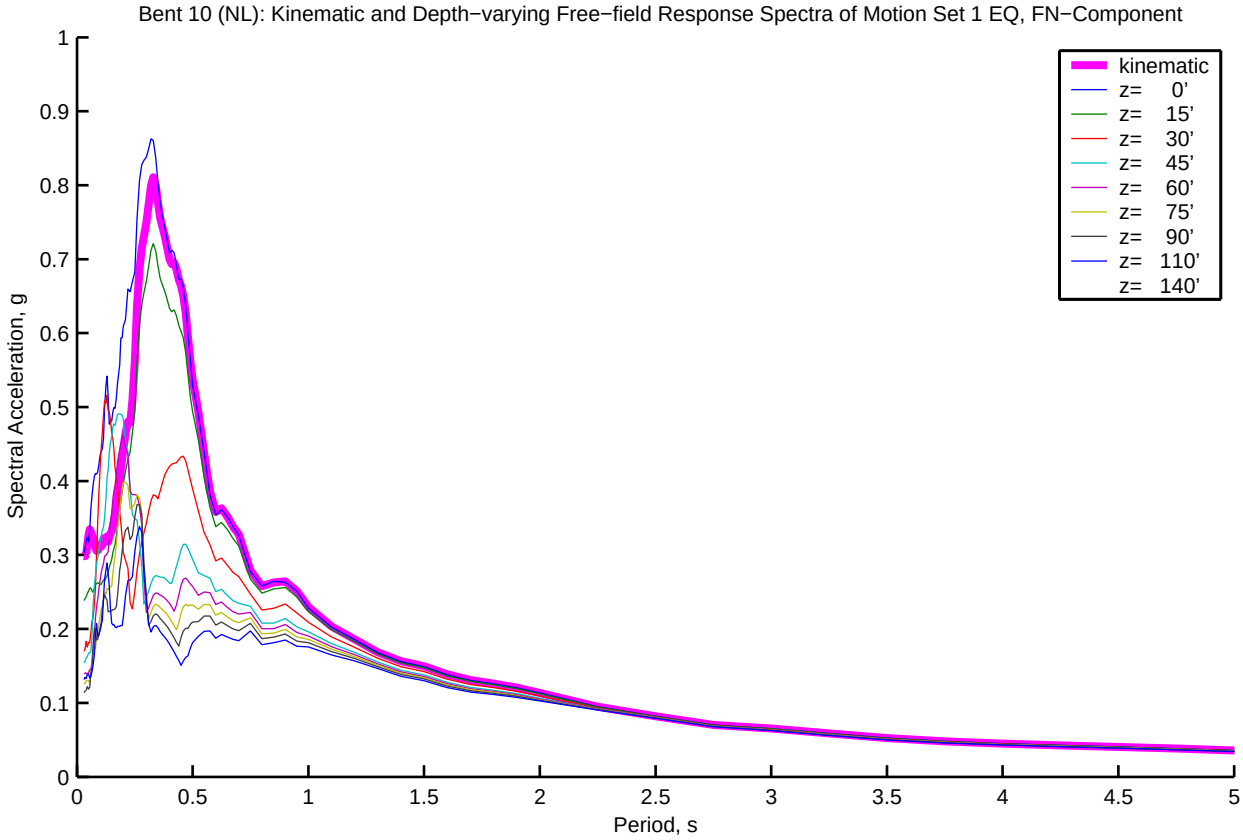
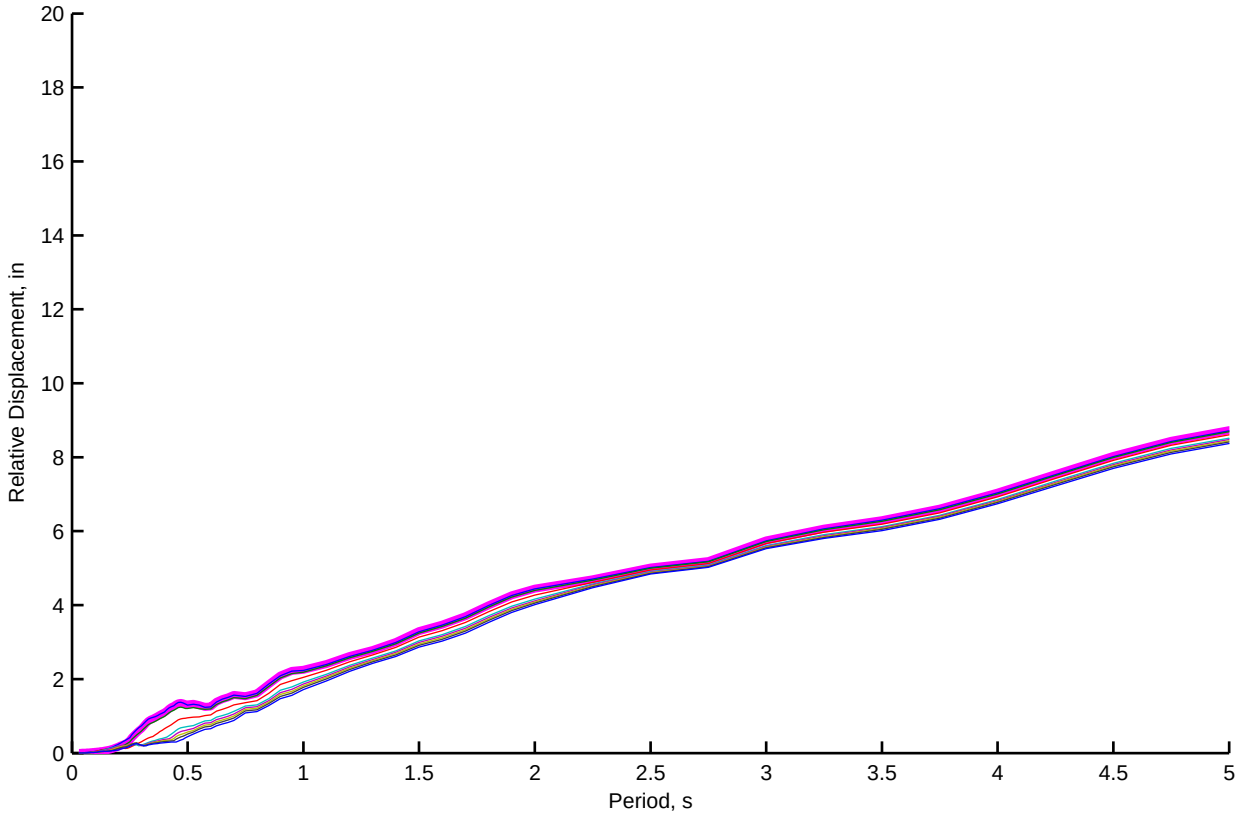
3.5
4
4.5
5

Bent 10 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

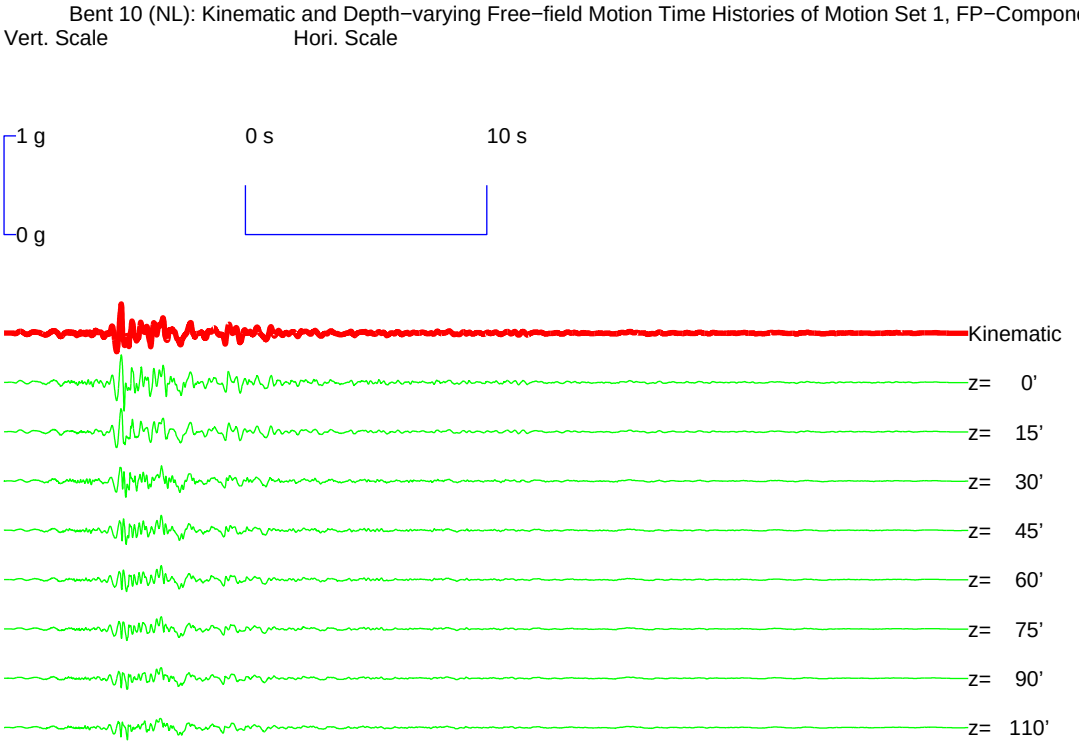


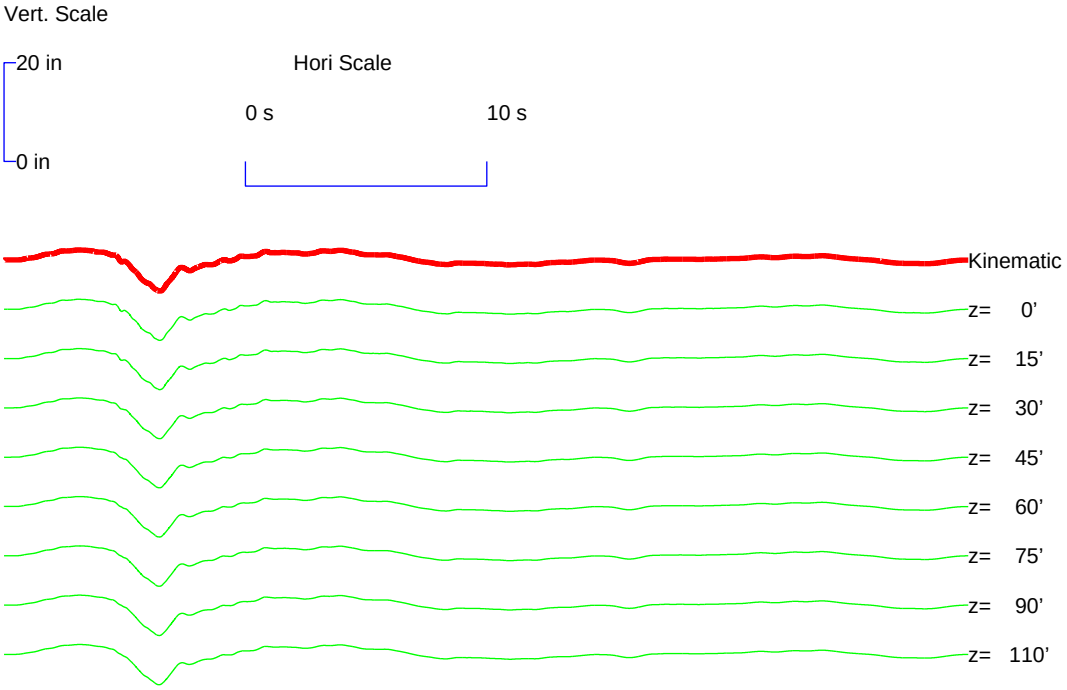



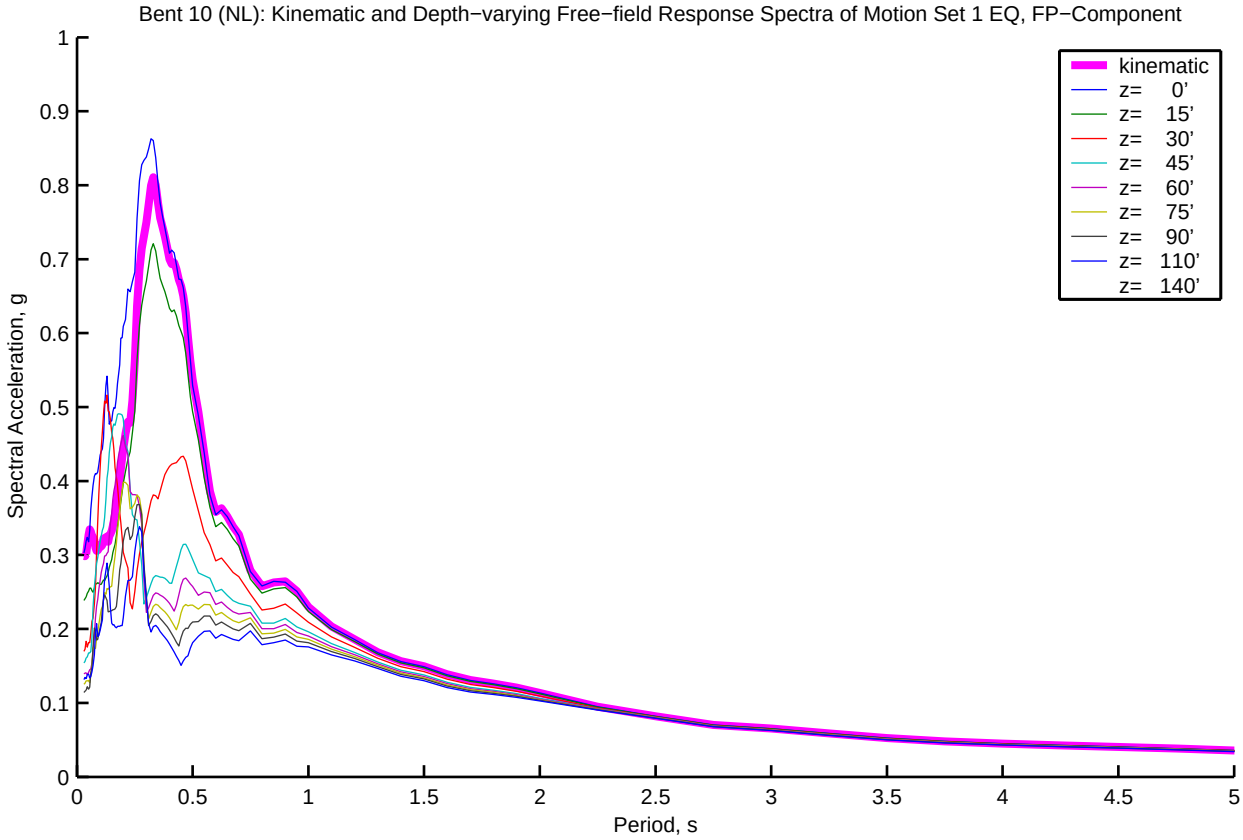

Bent 10 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

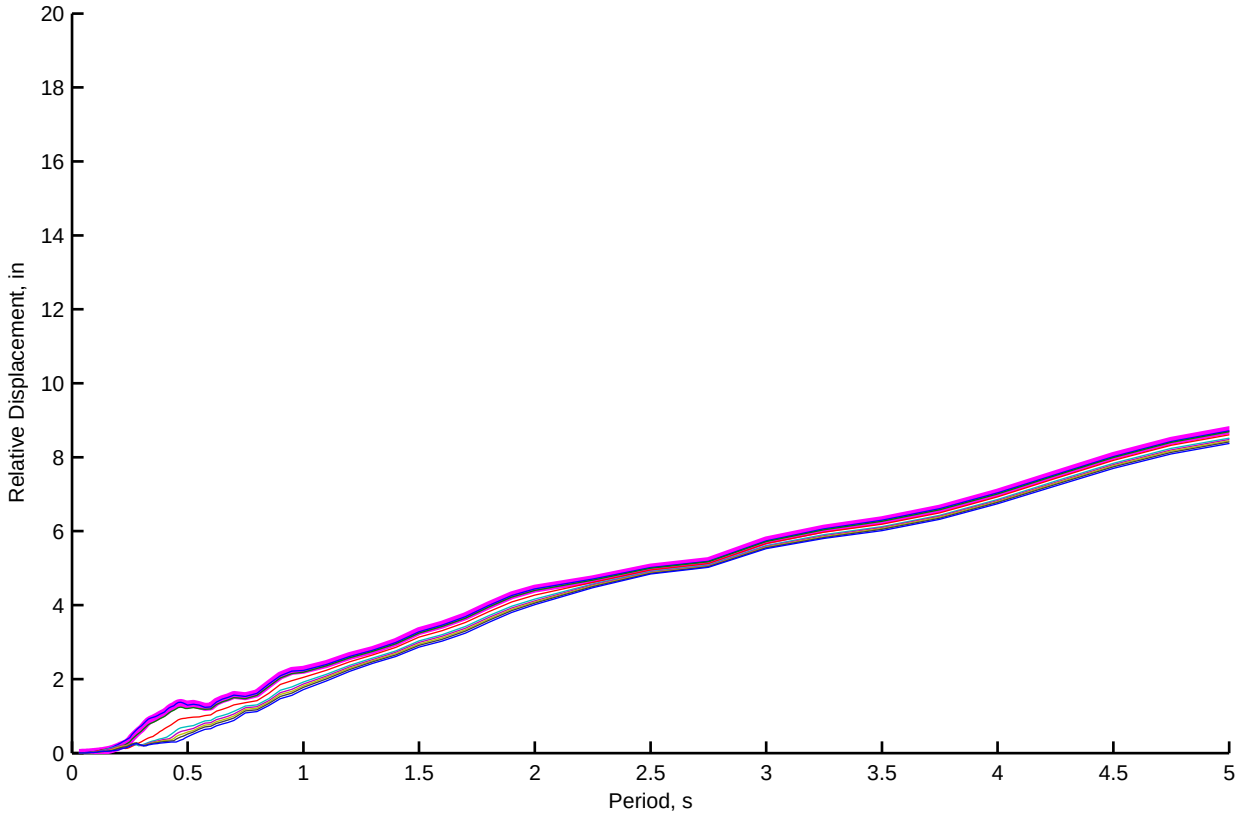

Relative Displacement, in
Period, s

Bent 10 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

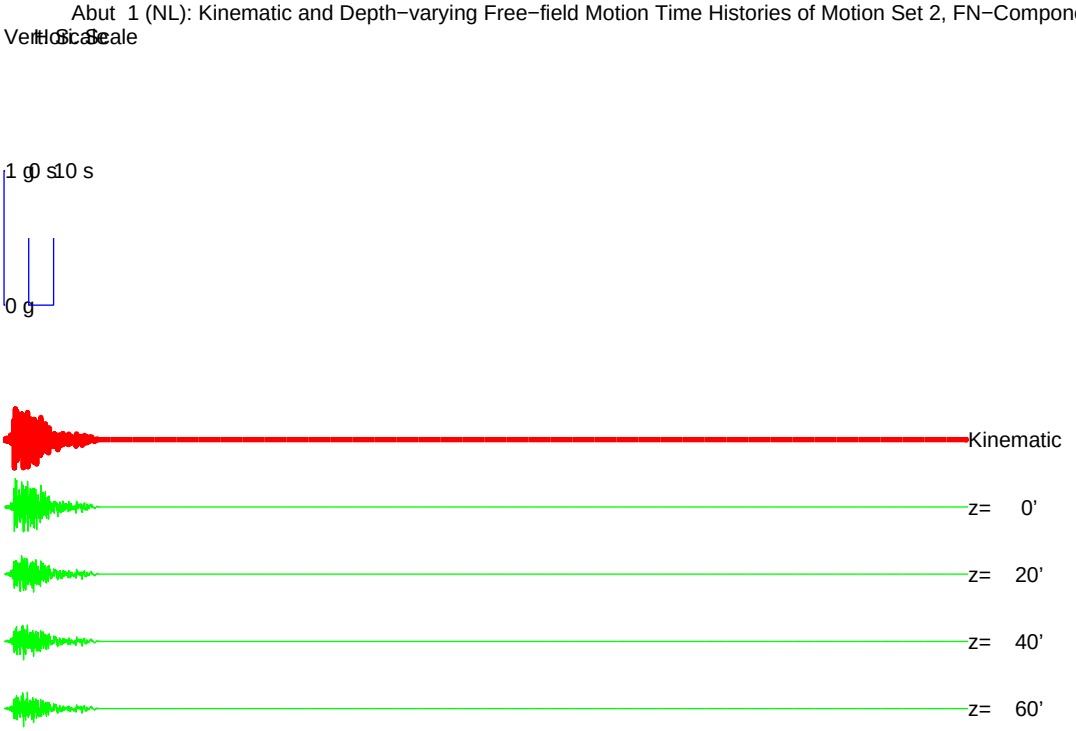


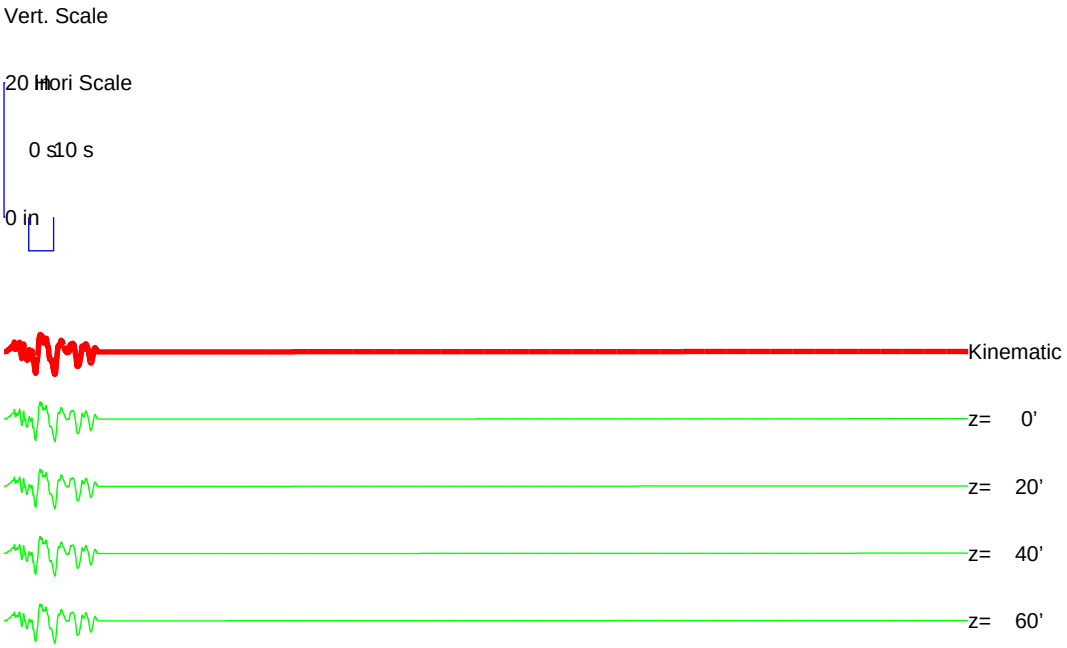



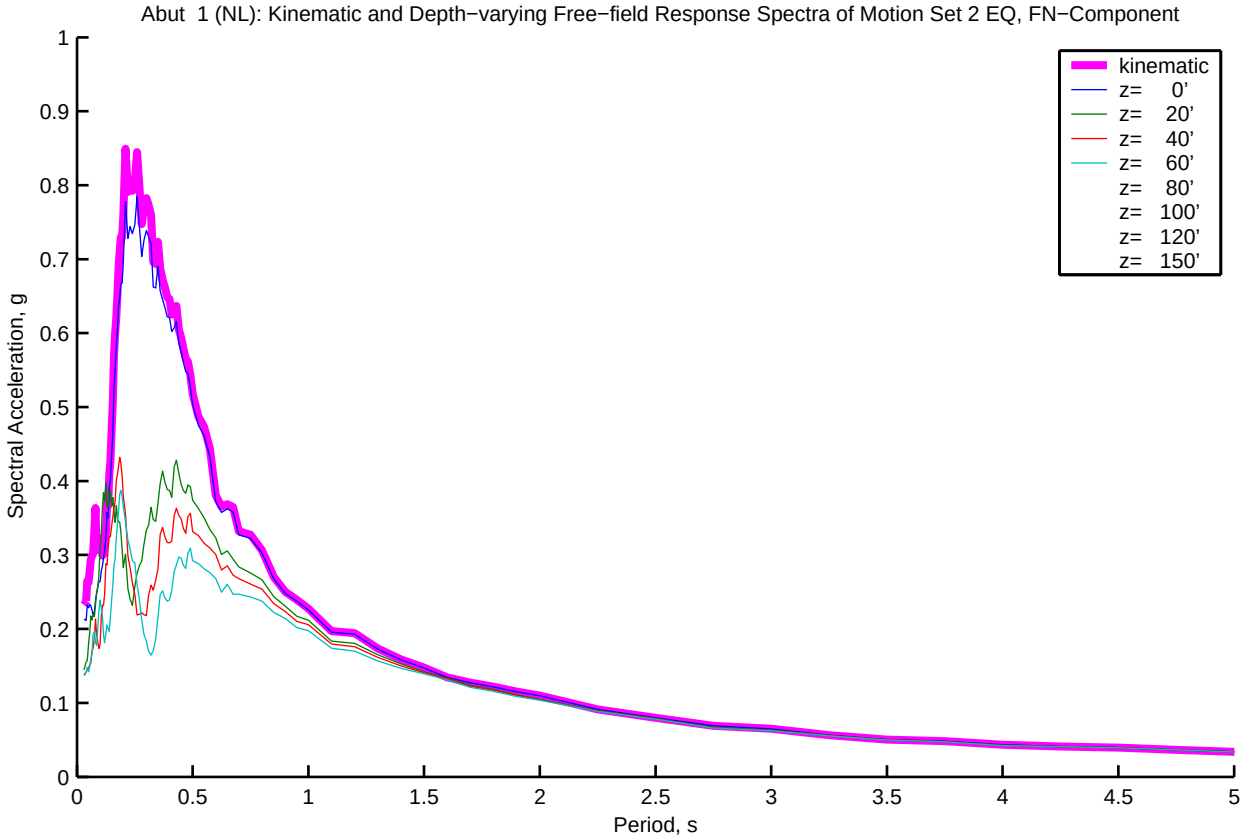

Bent 10 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

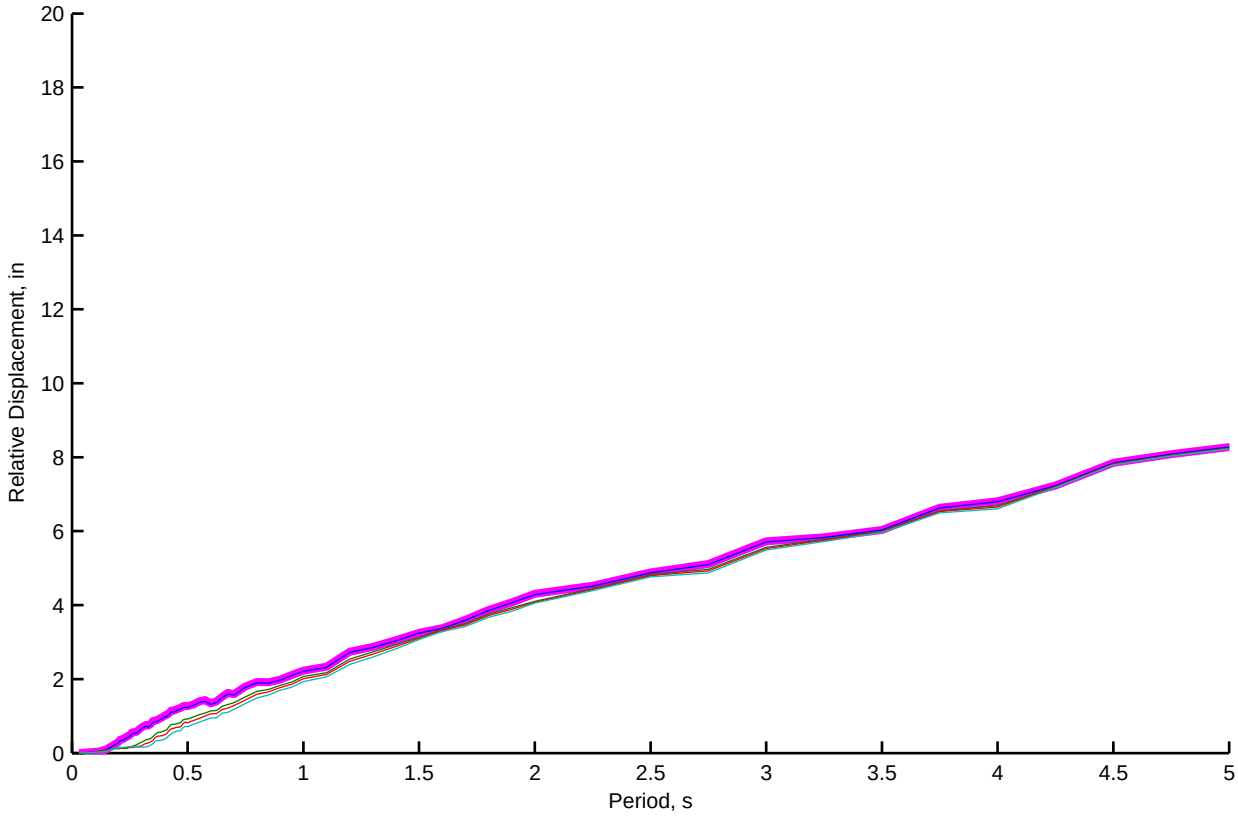

Relative Displacement, in
Period, s

Abut 1 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

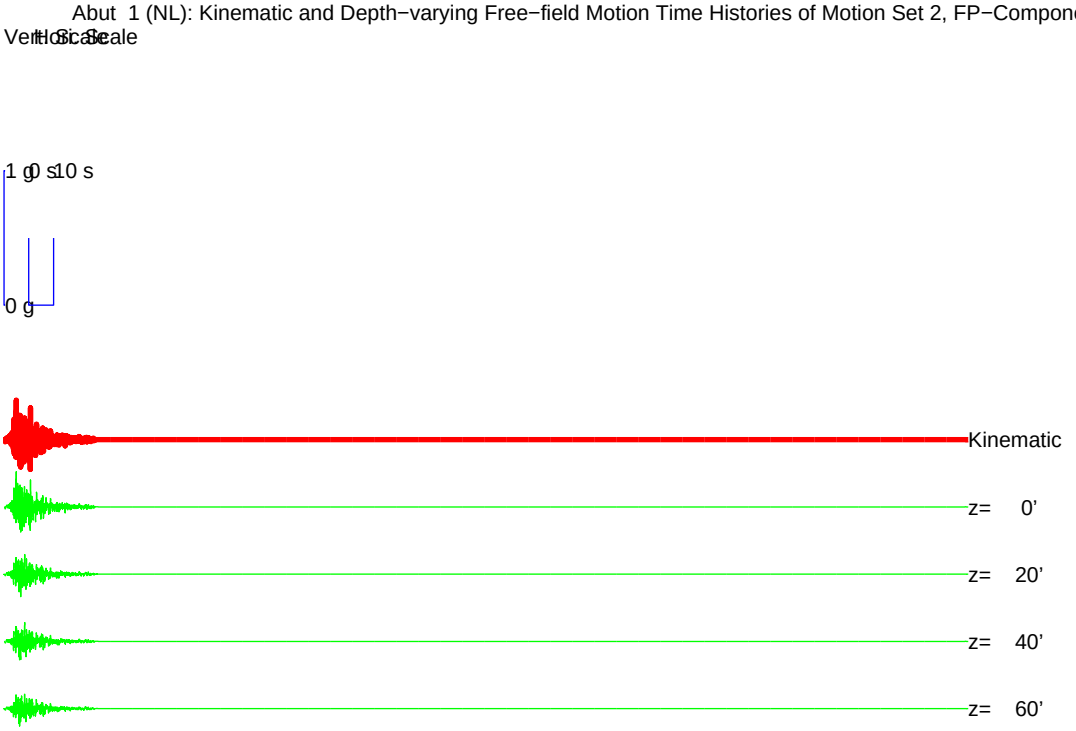


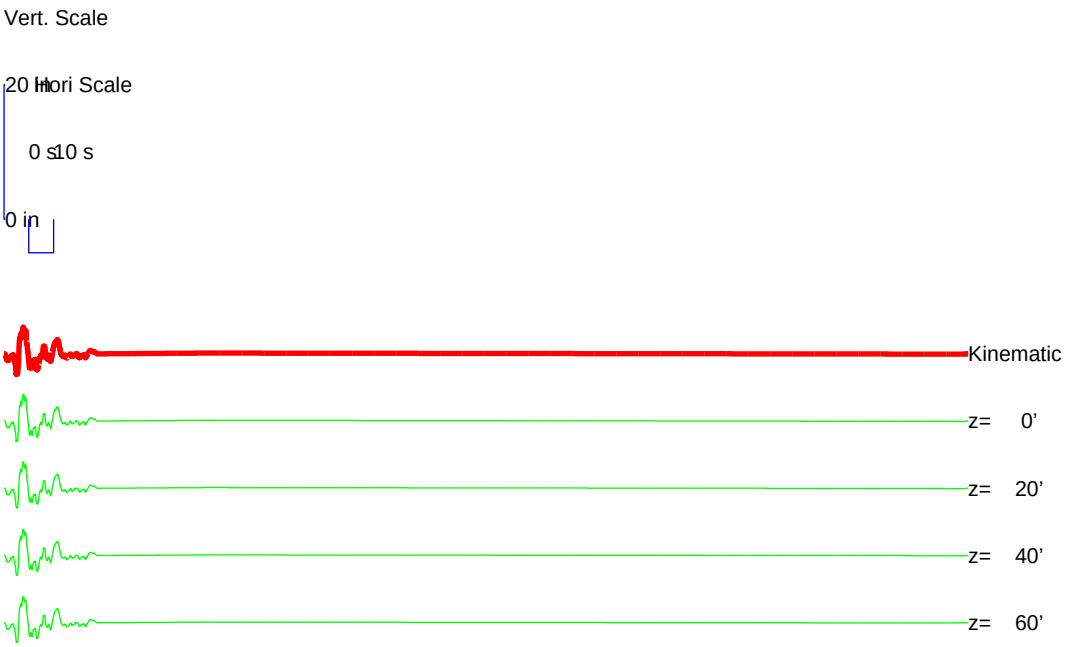



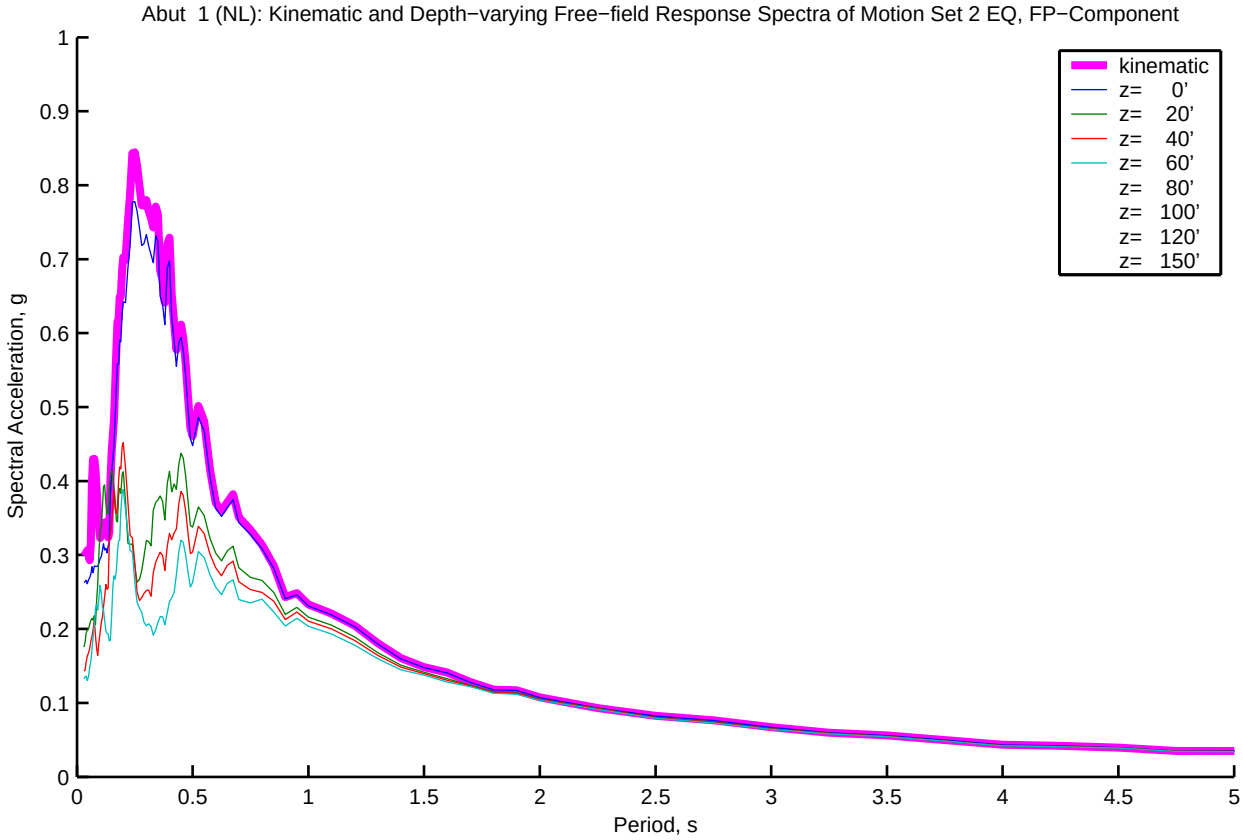

Abut 1 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

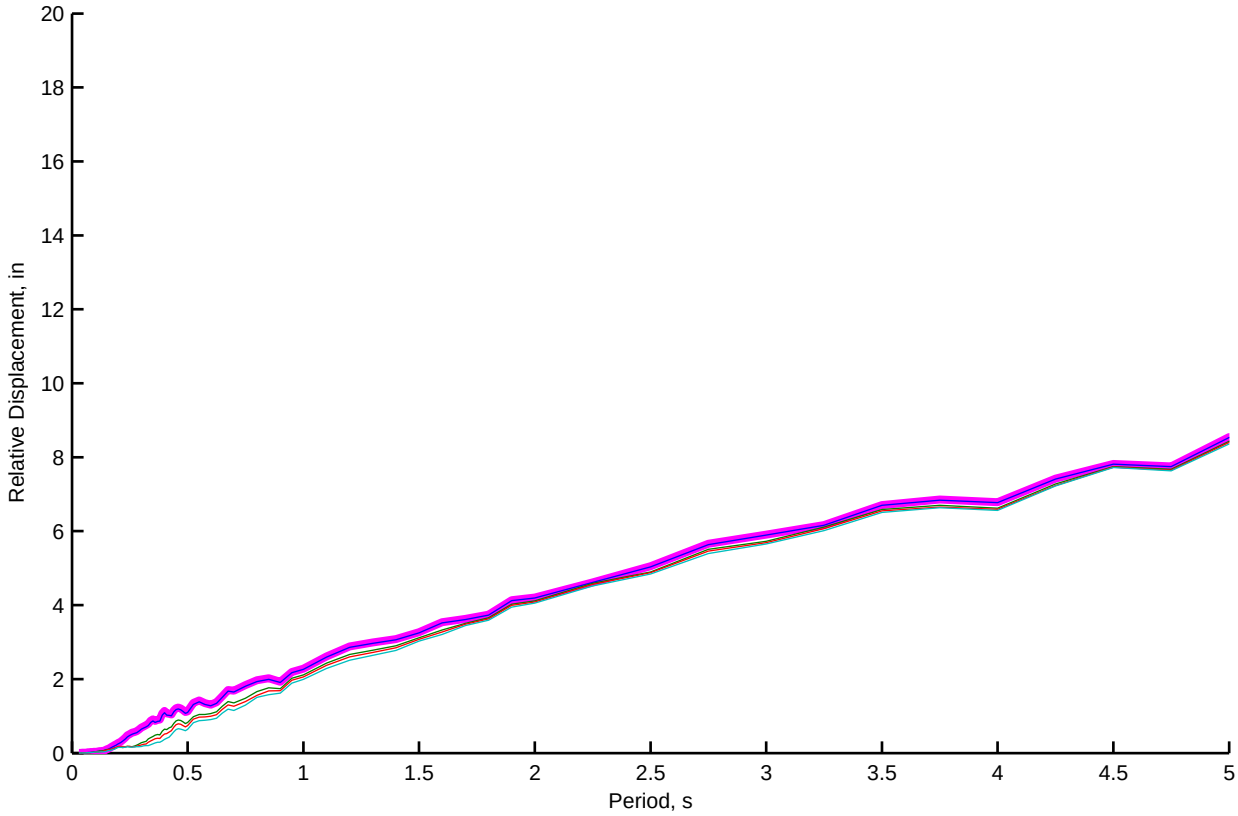

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 1 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

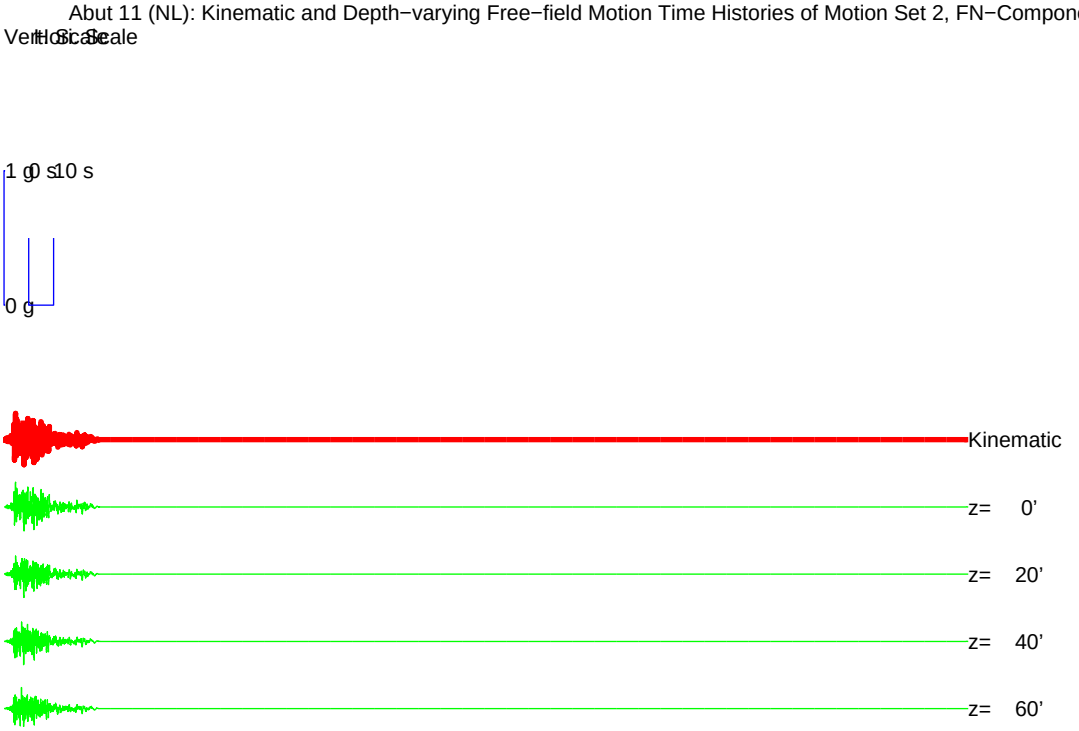


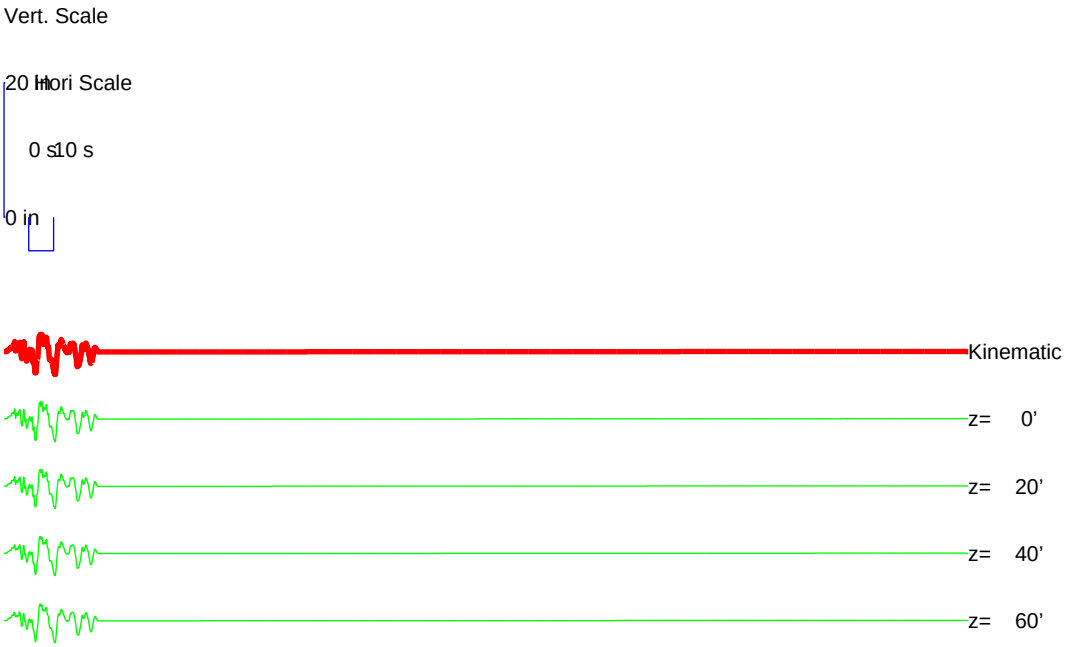



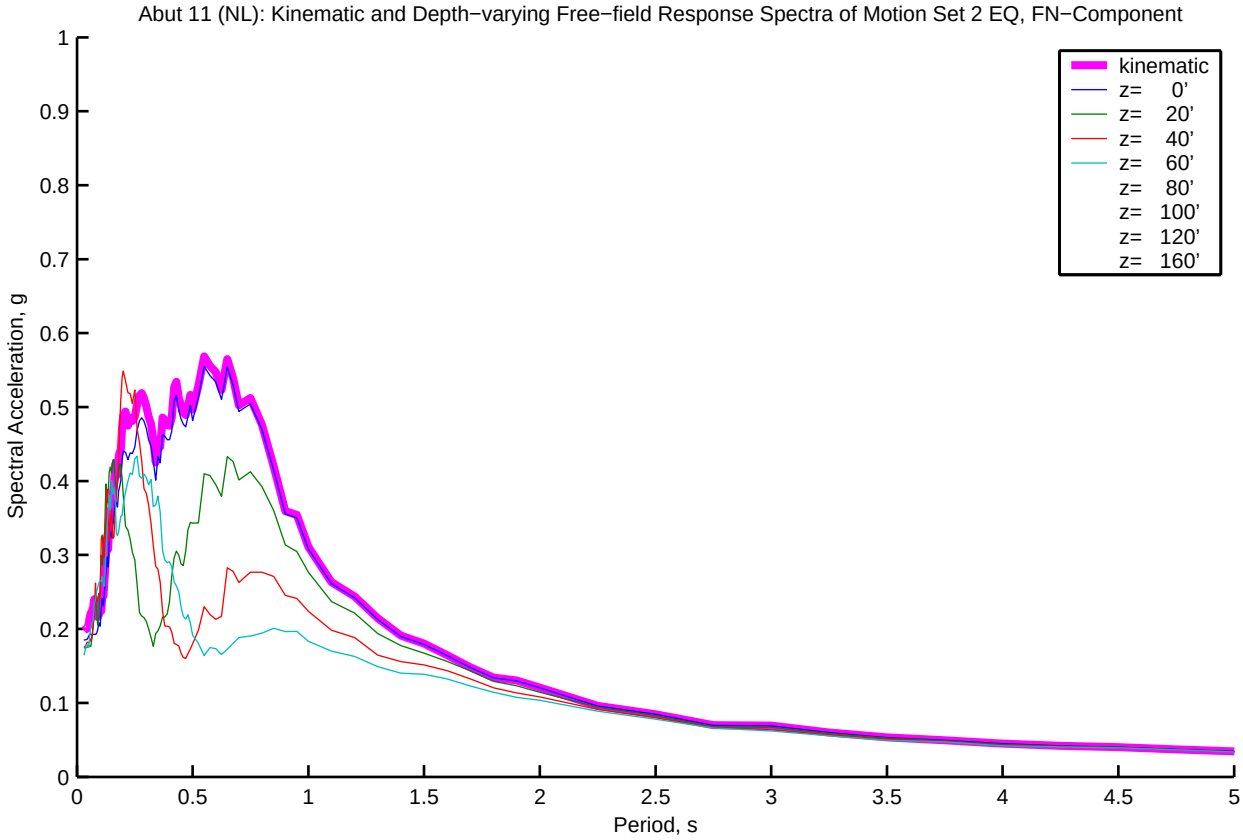

Abut 1 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

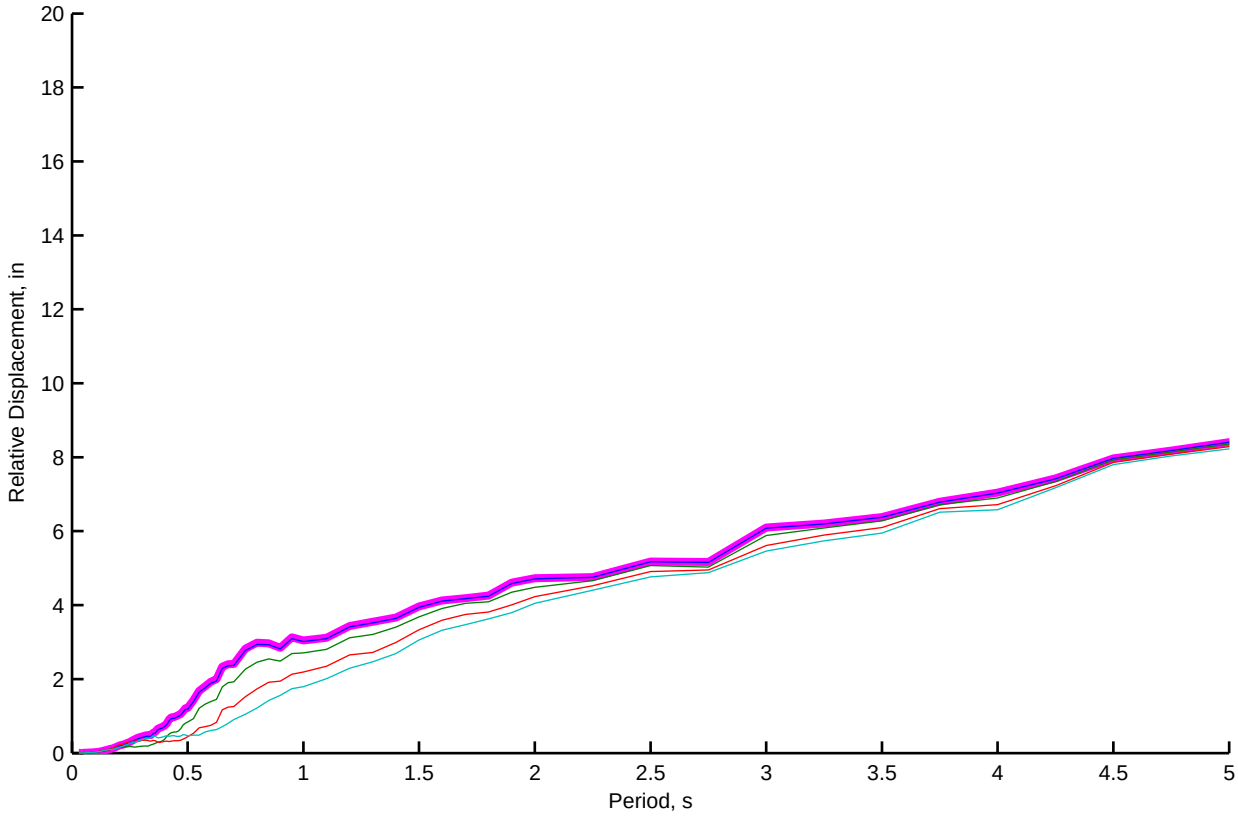

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

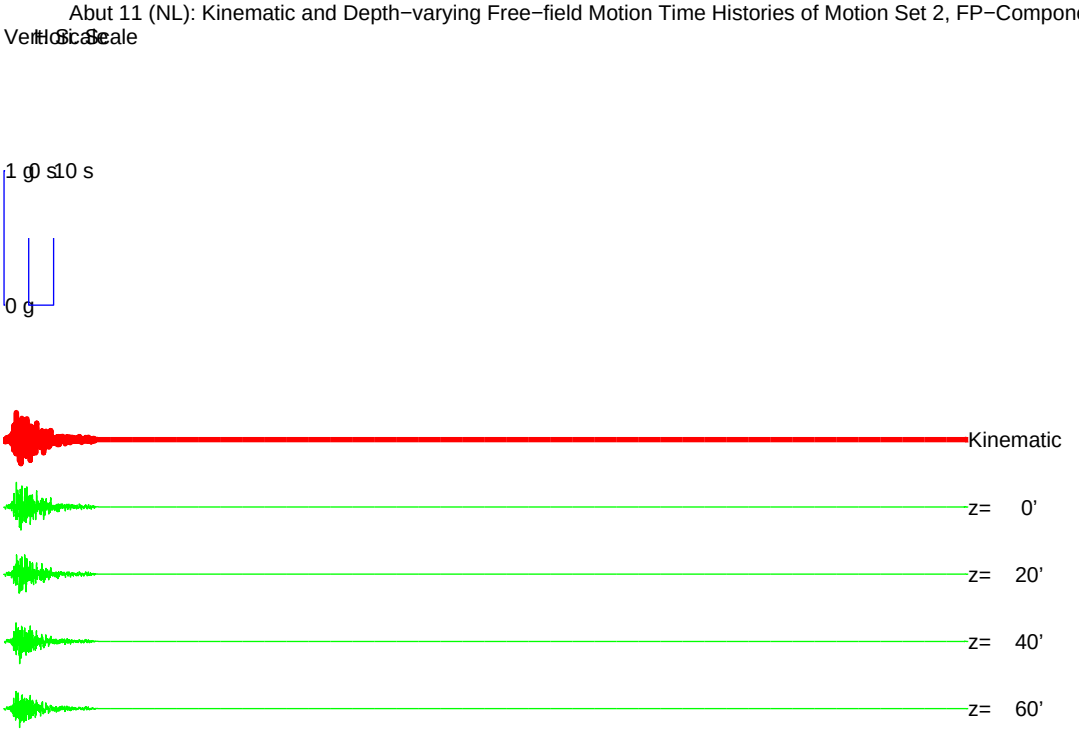


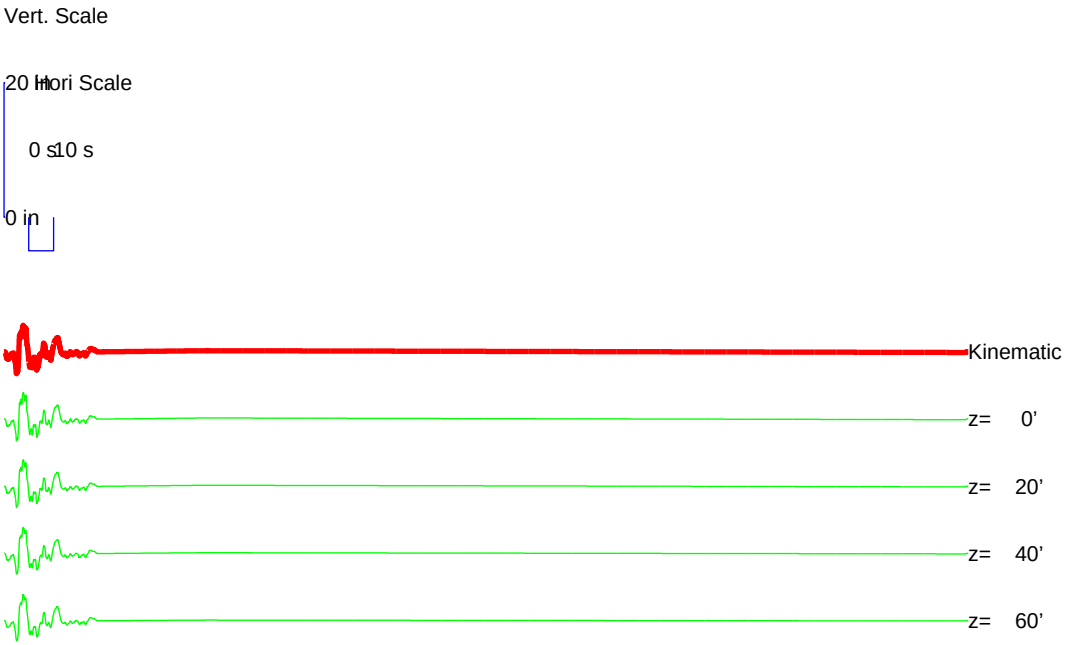



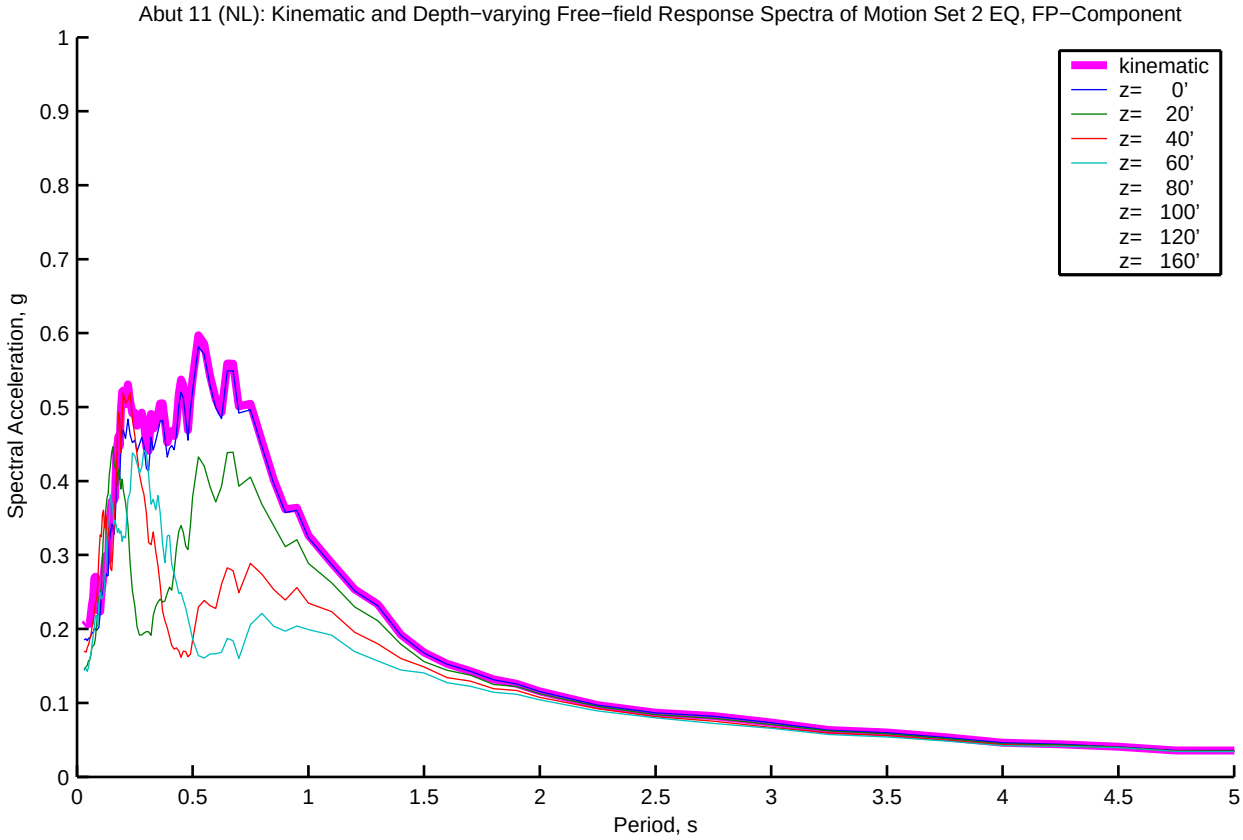

Abut 11 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

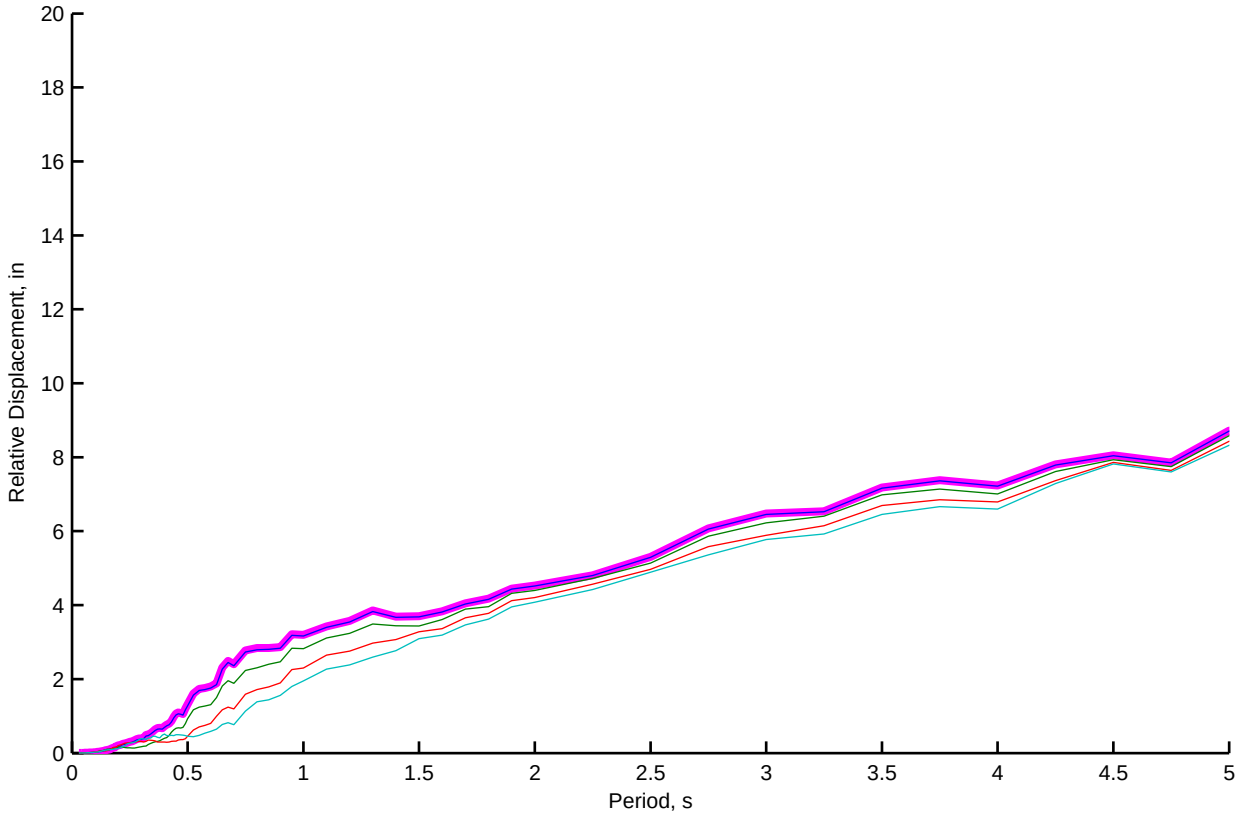

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

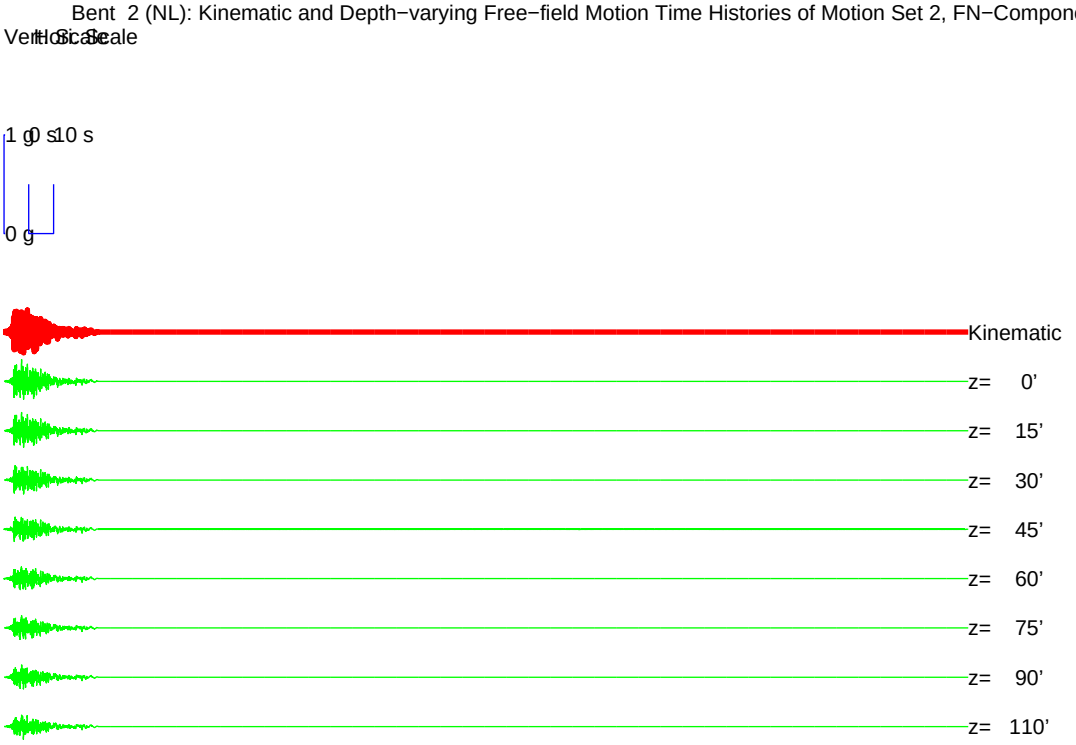


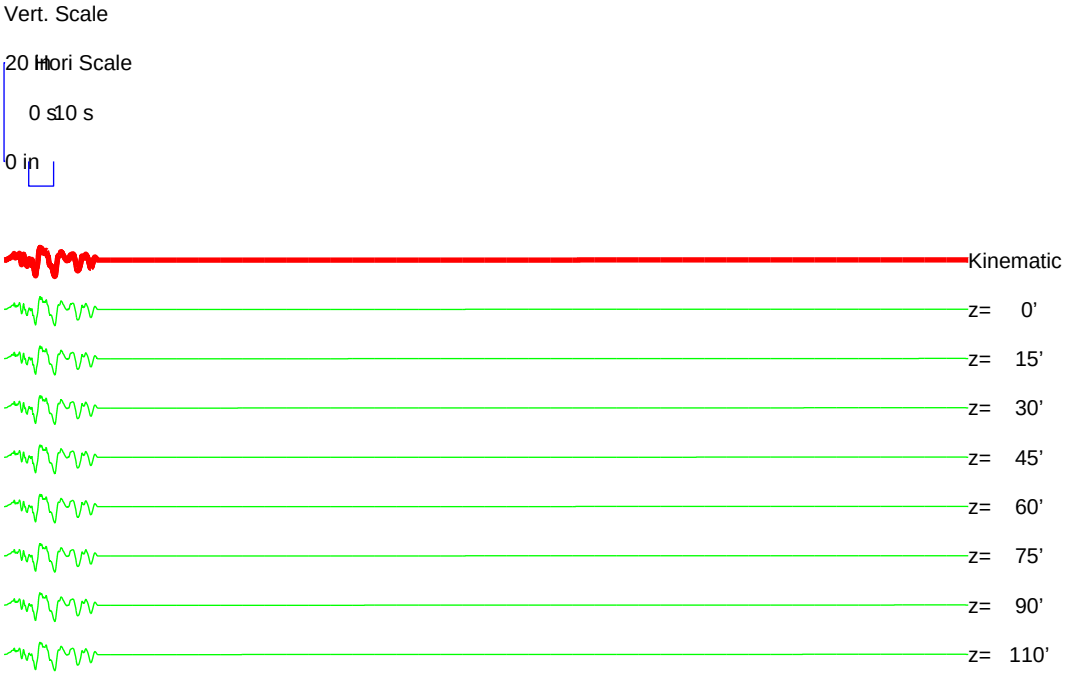



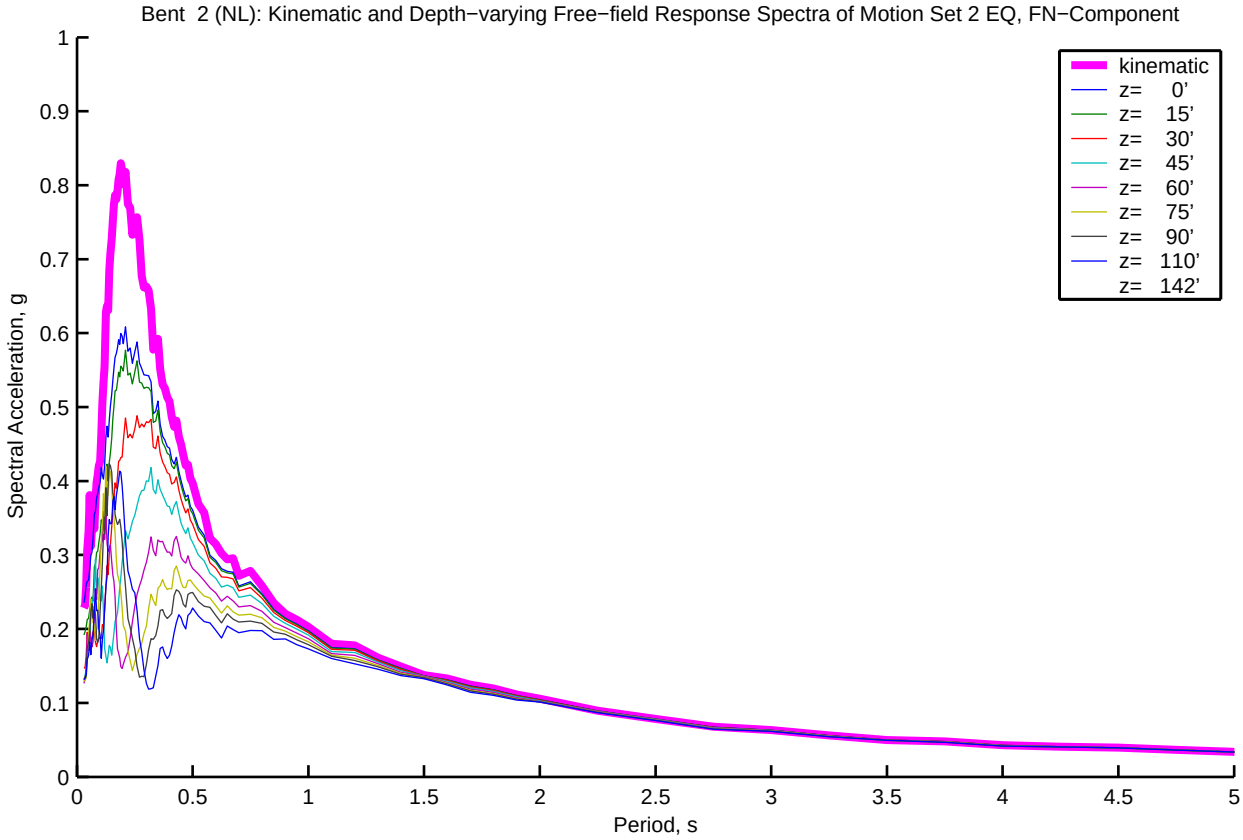

Abut 11 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

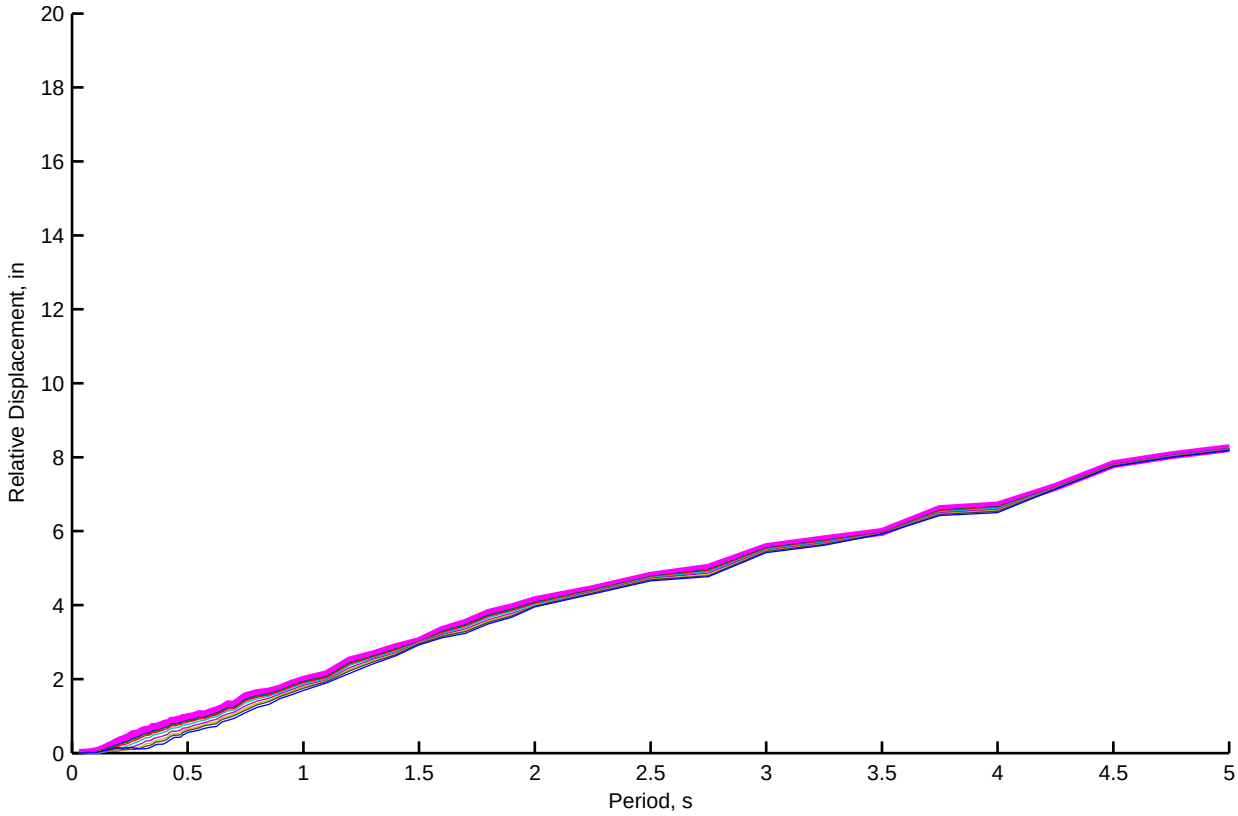

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

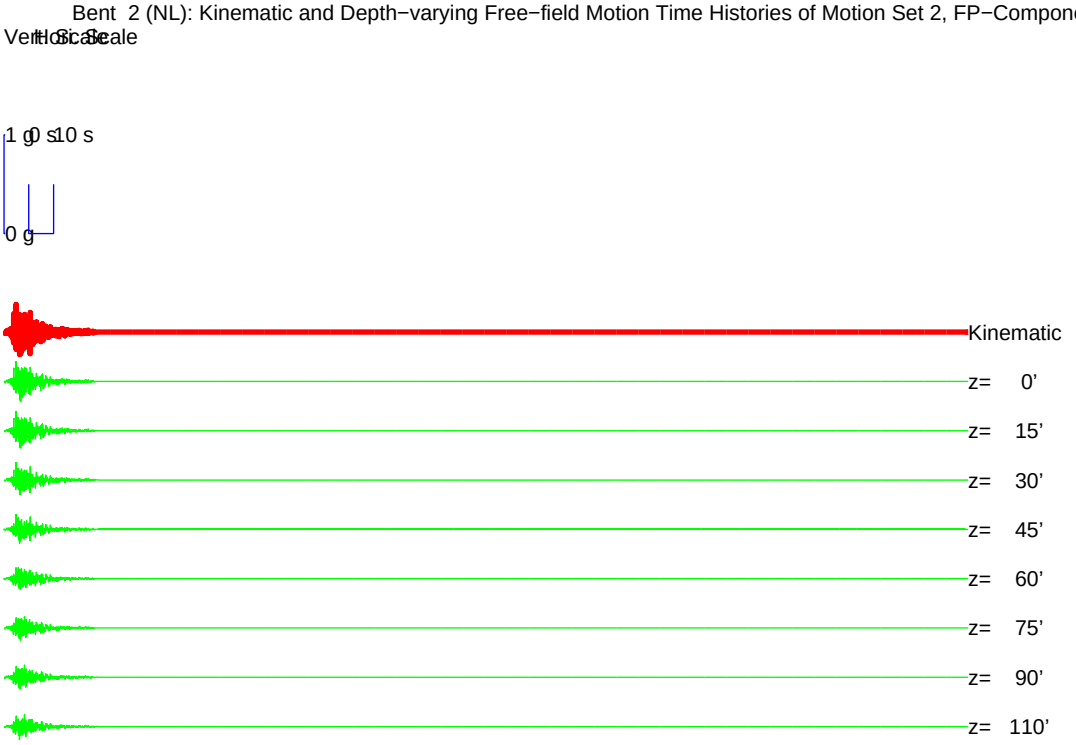


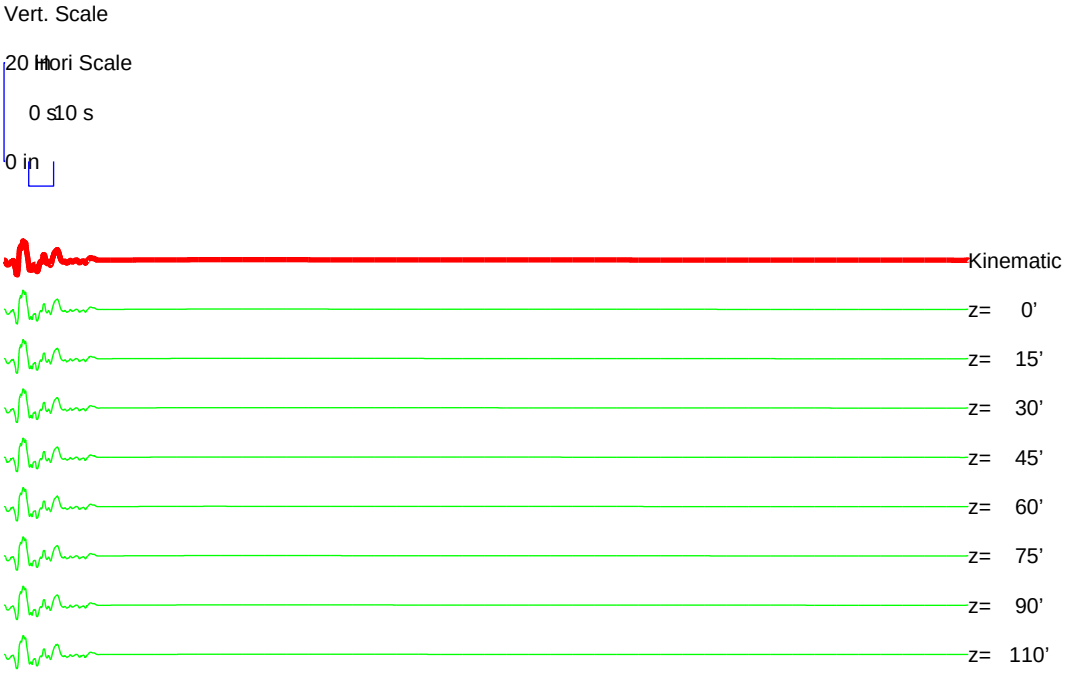



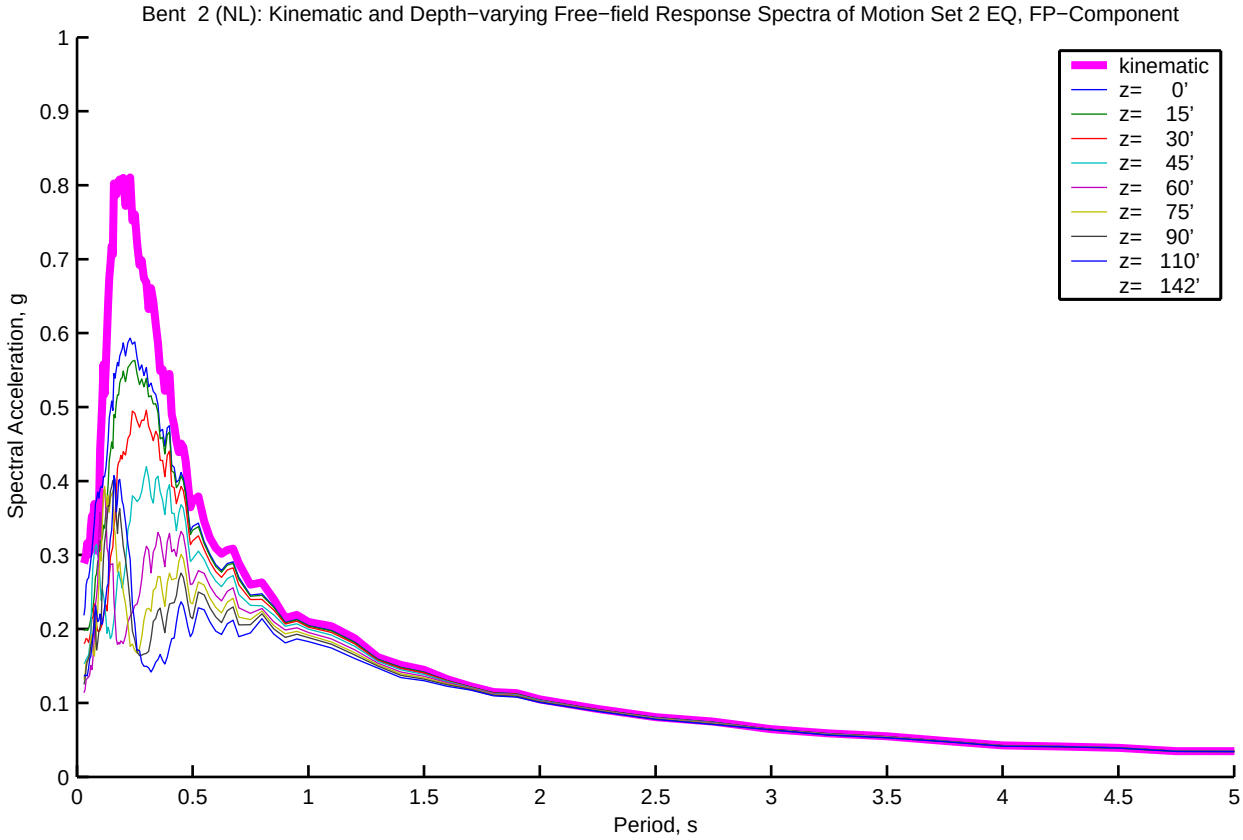

Bent 2 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

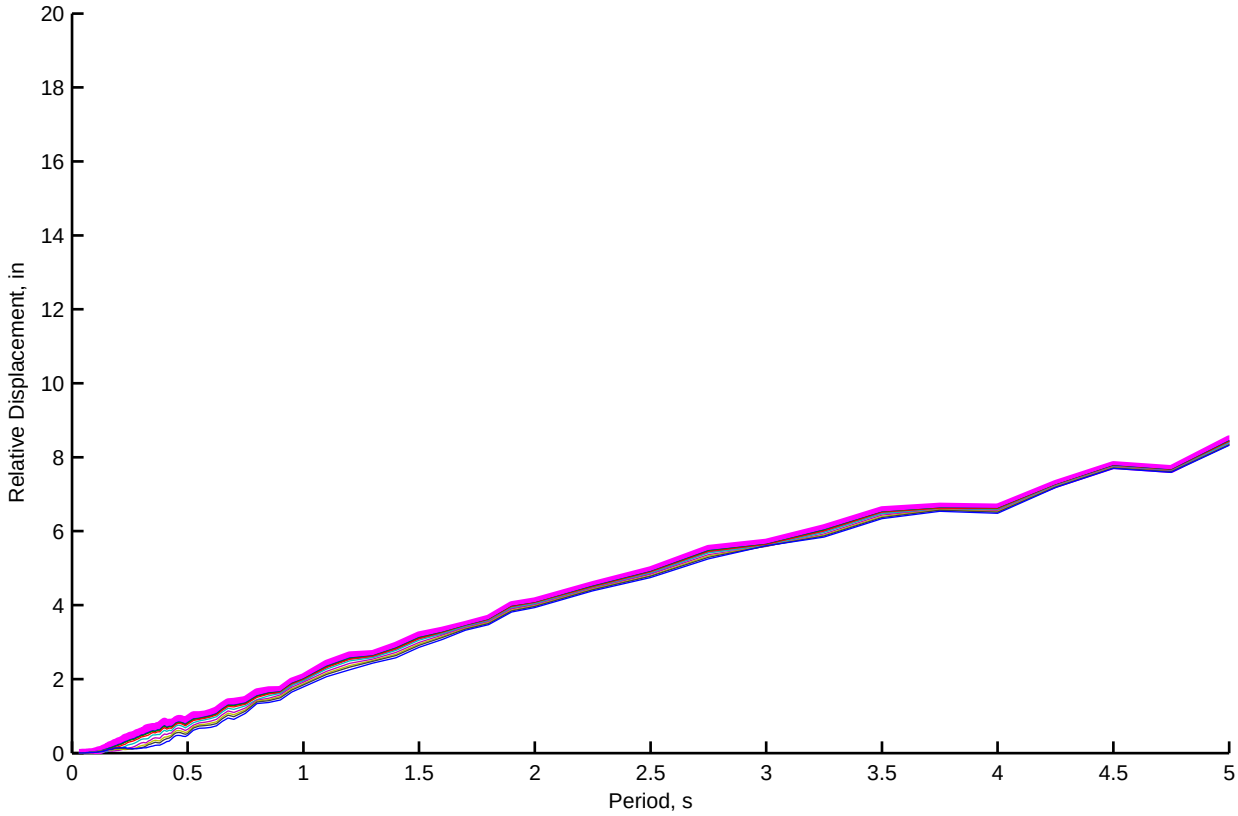

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

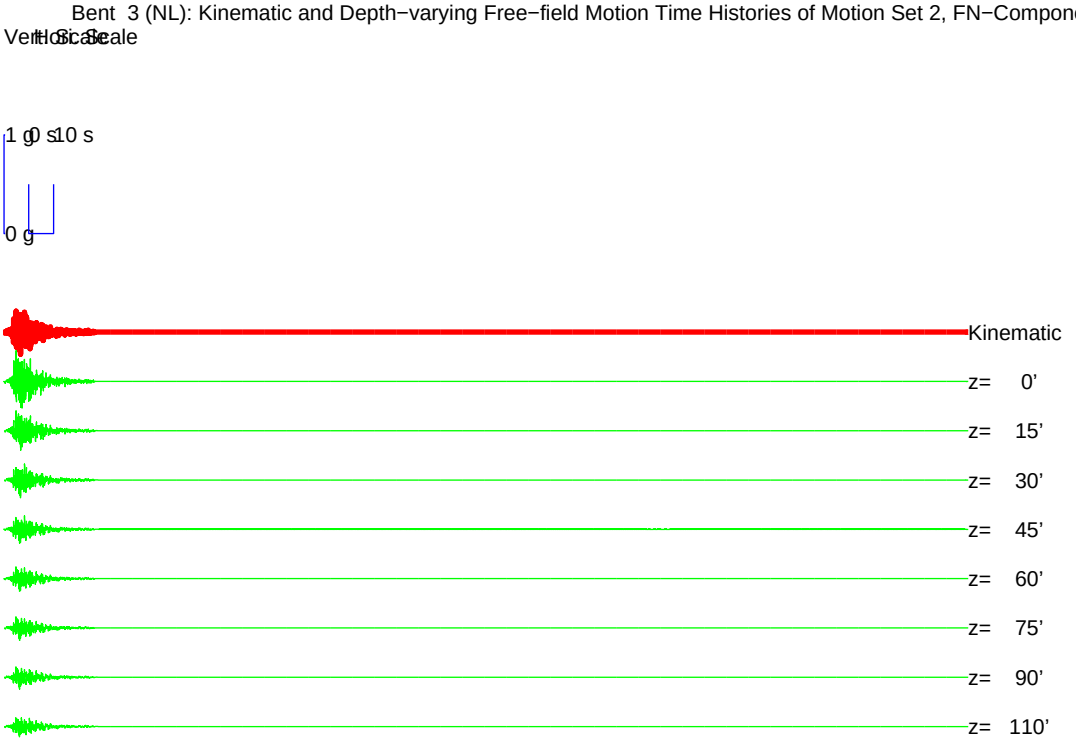


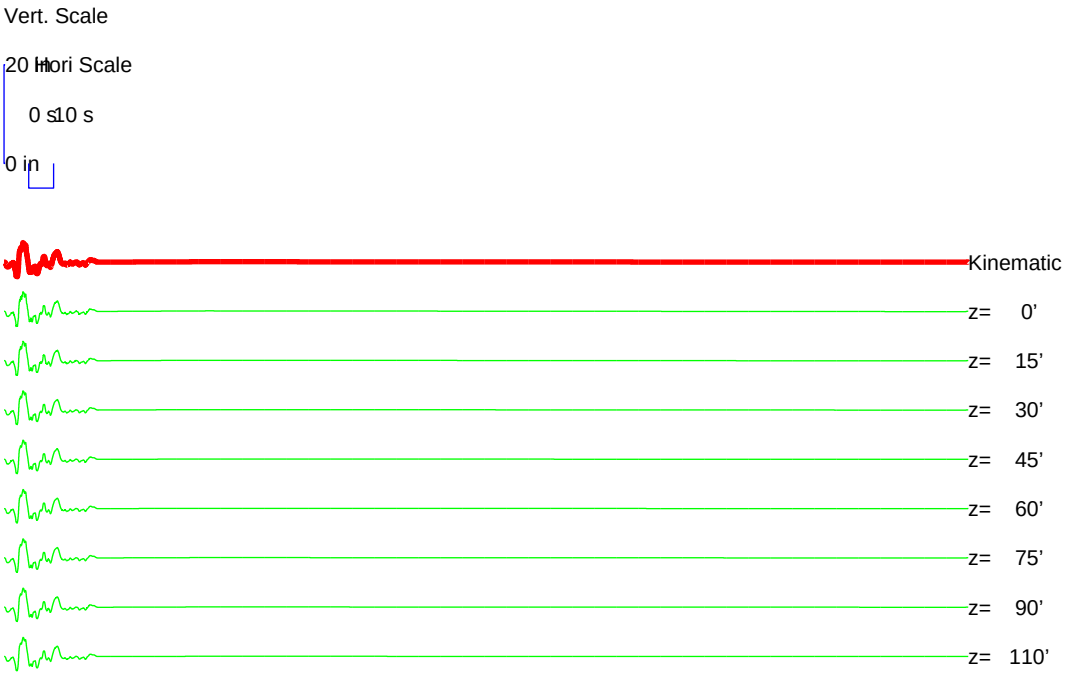



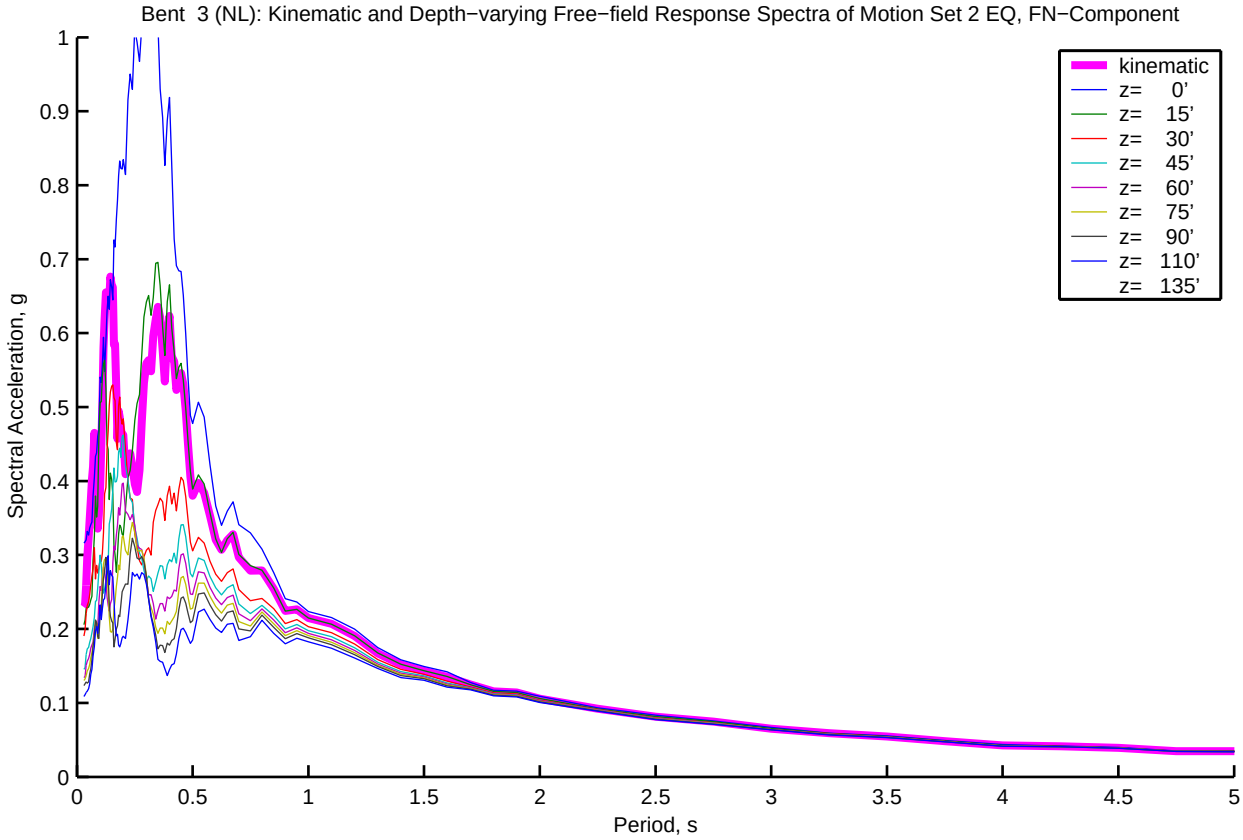

Bent 2 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

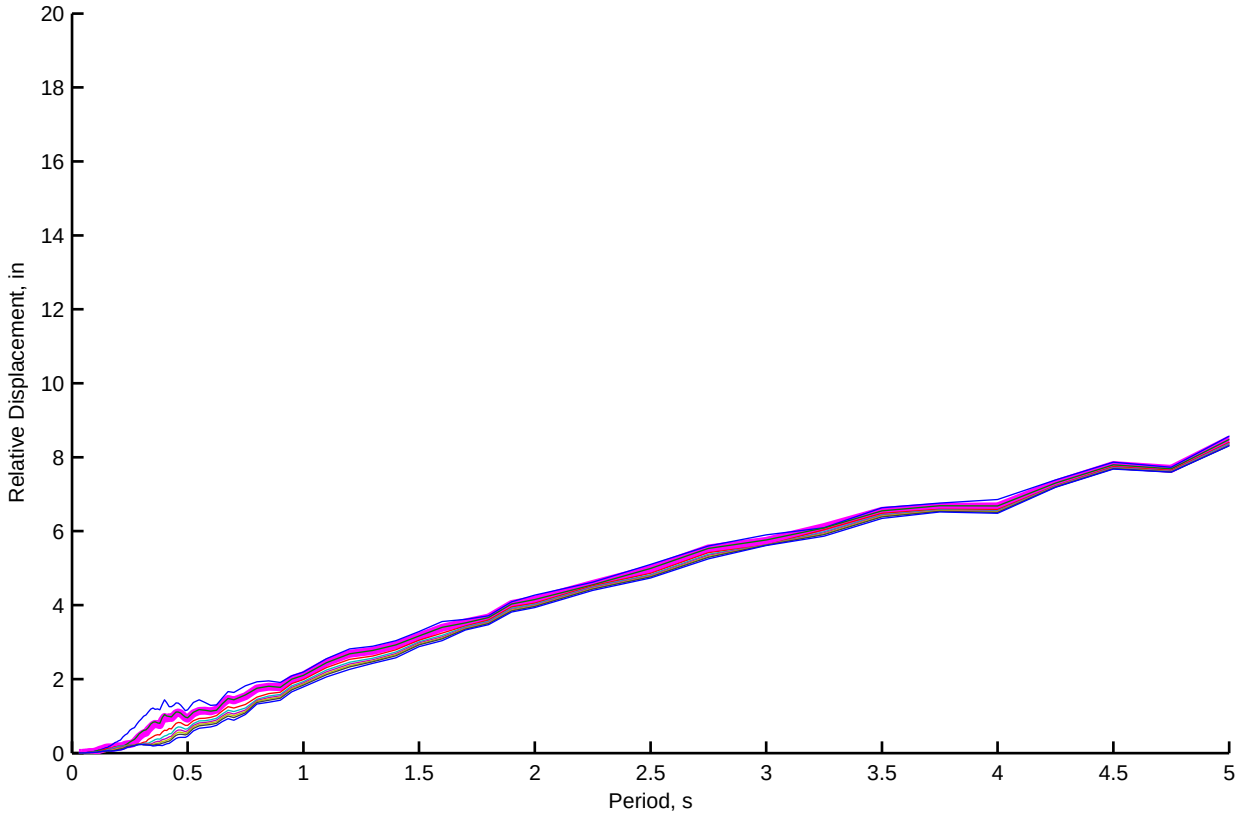

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 3 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

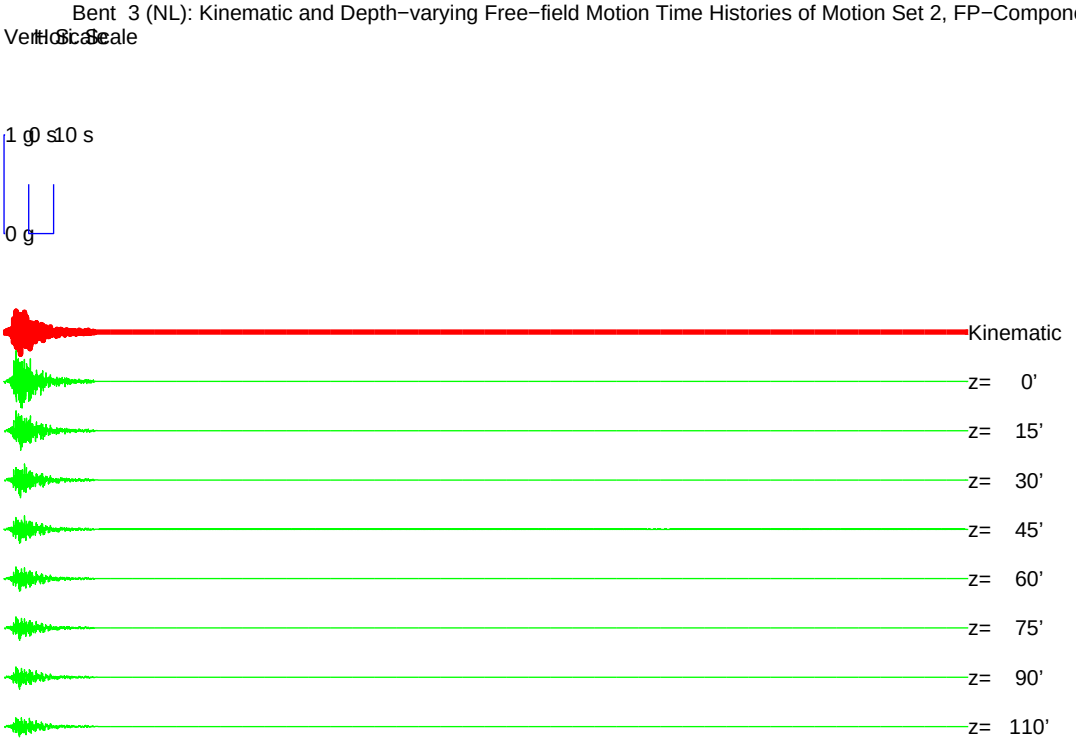


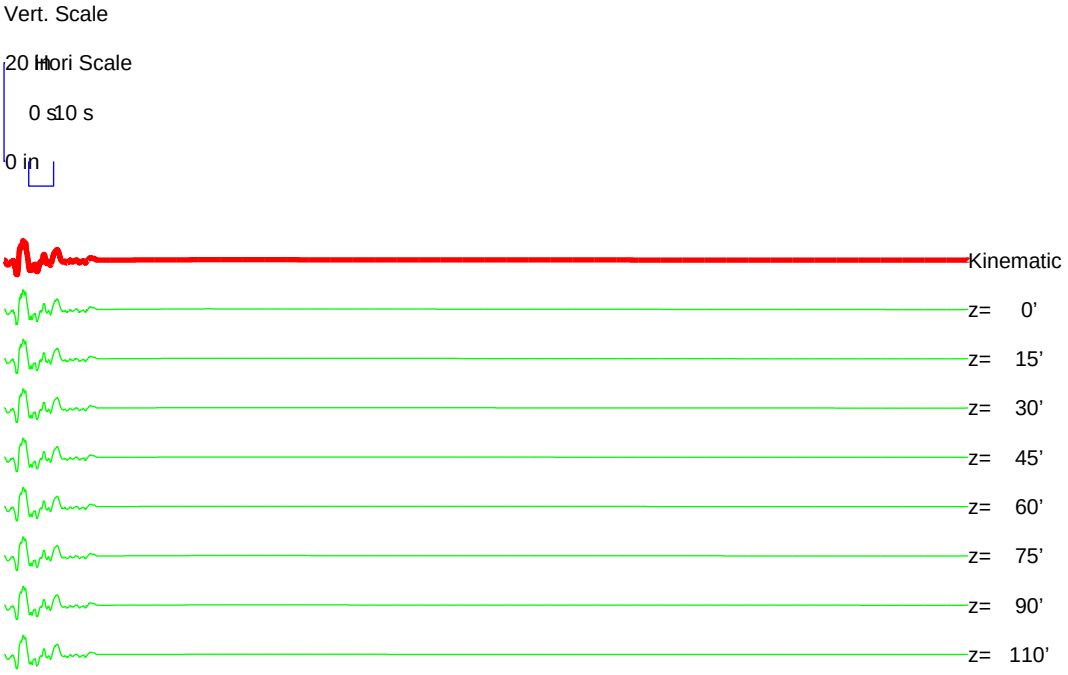



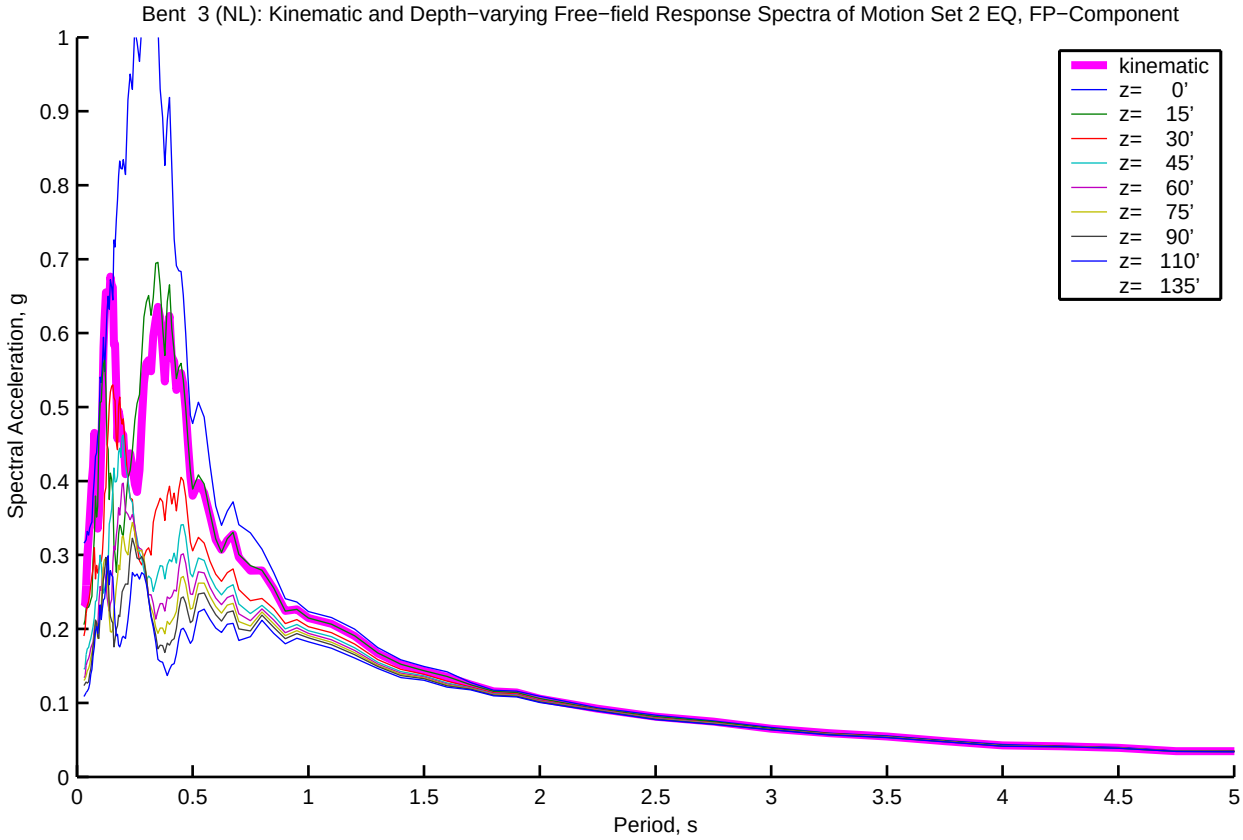

Bent 3 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'

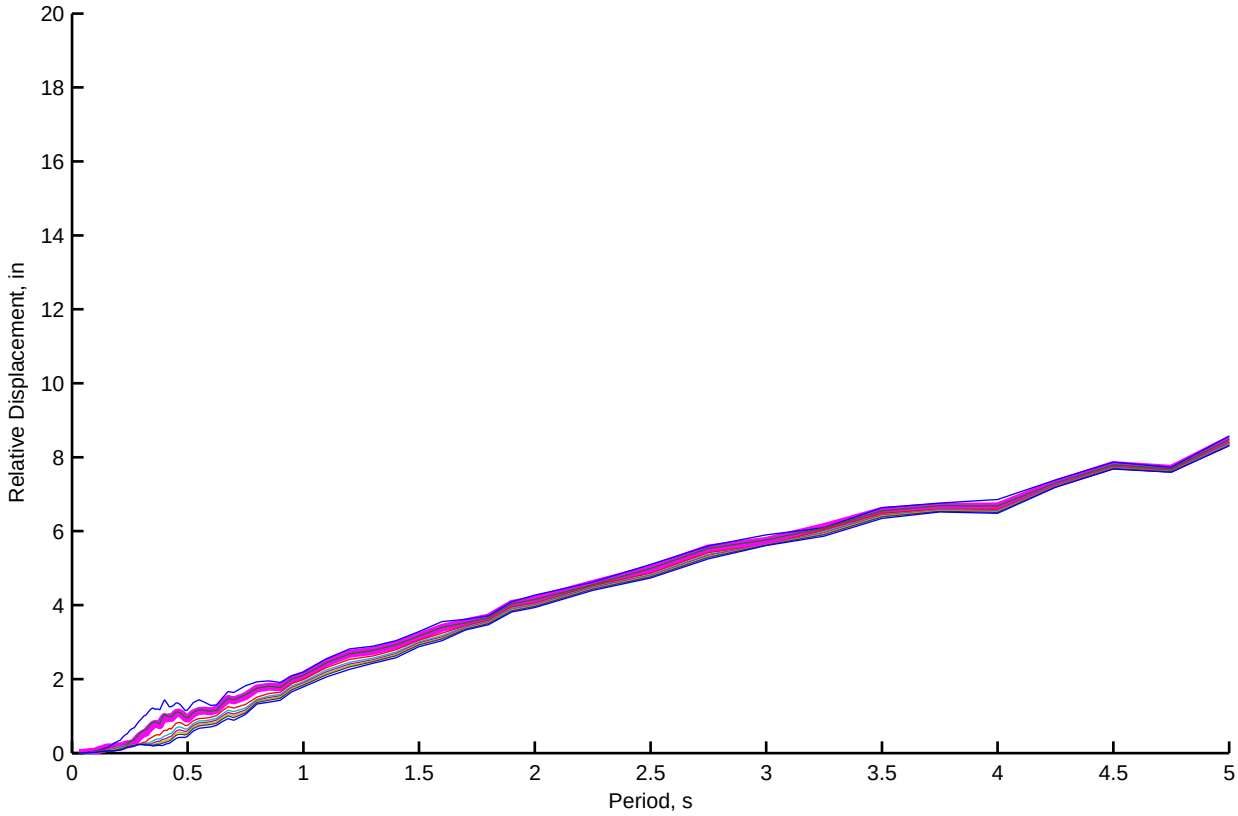

Relative Displacement, in
Period, s

Bent 3 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

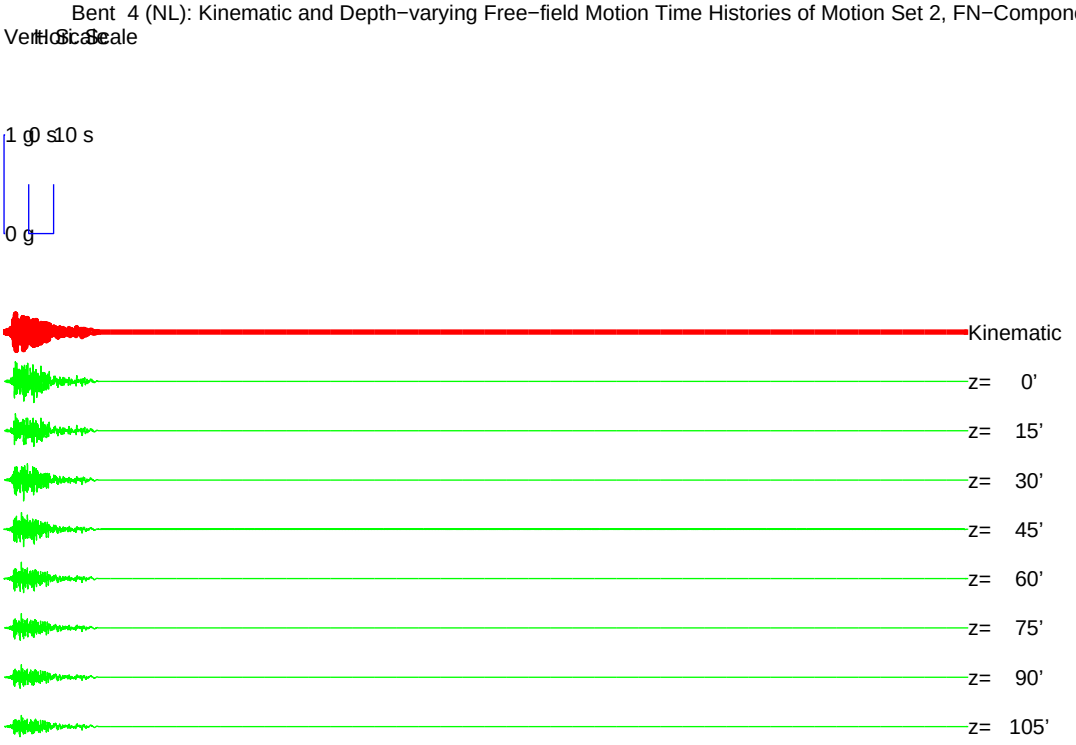


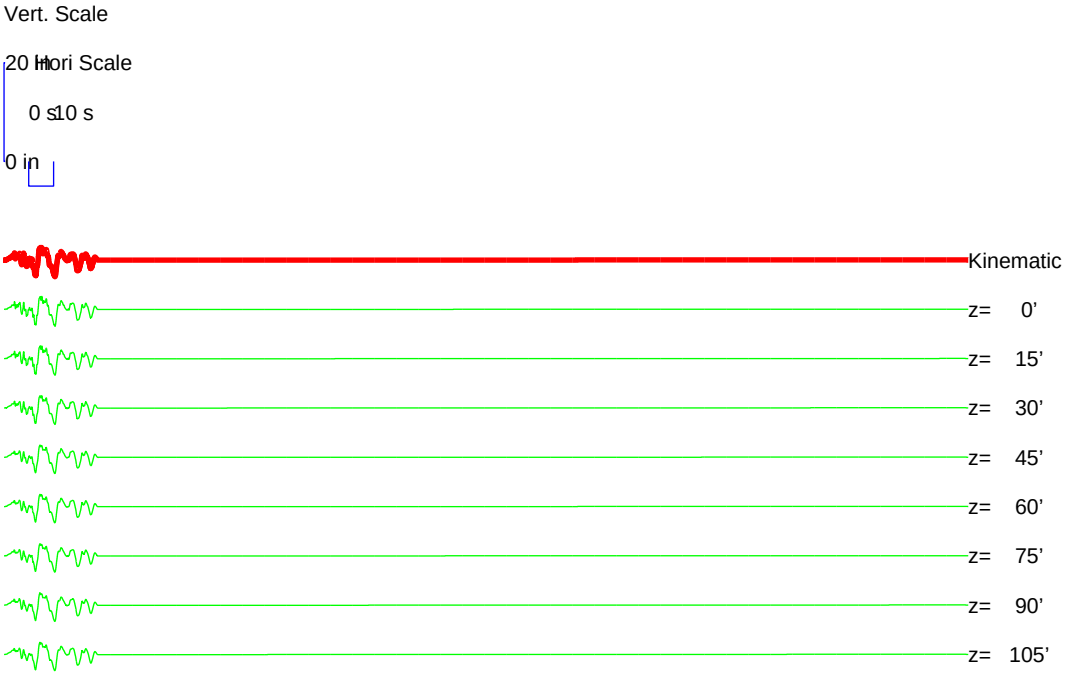



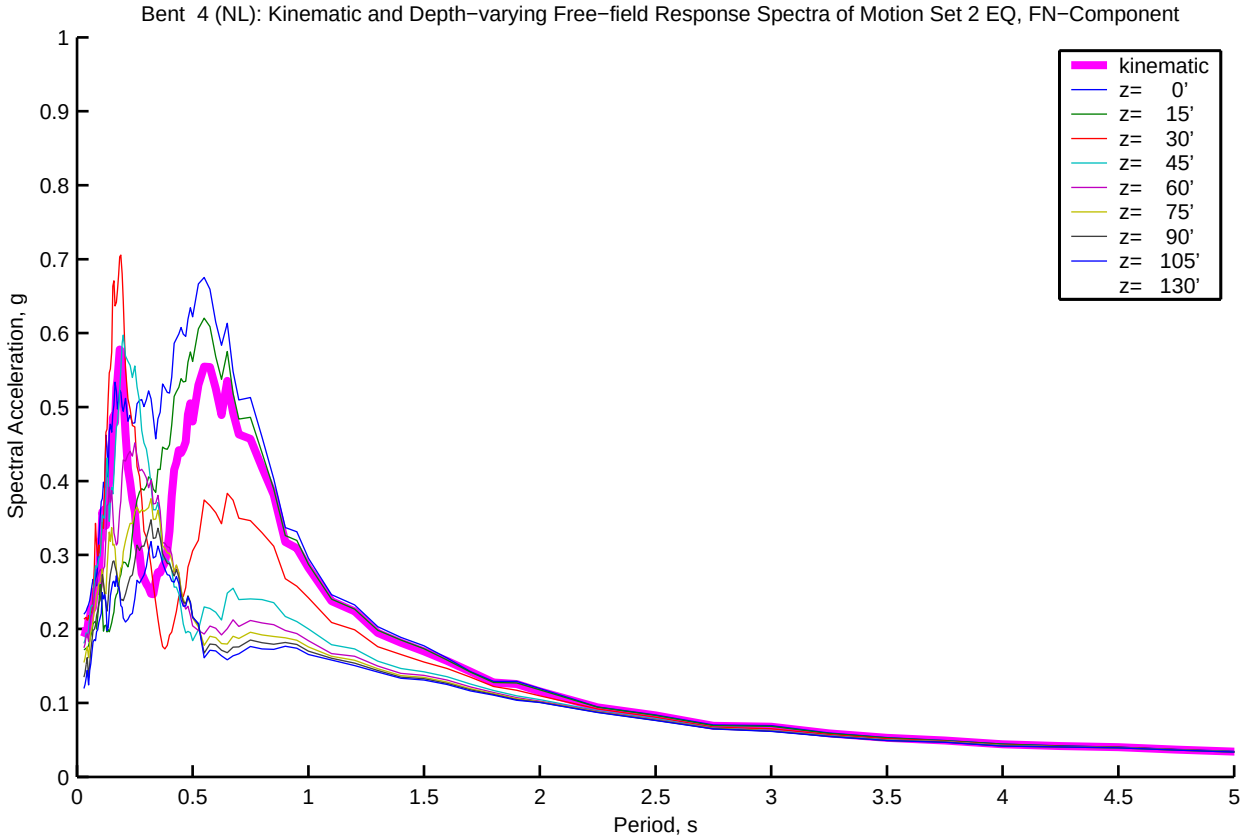

Bent 3 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'


Relative Displacement, in
Period, s

Bent 4 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component




Bent 4 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
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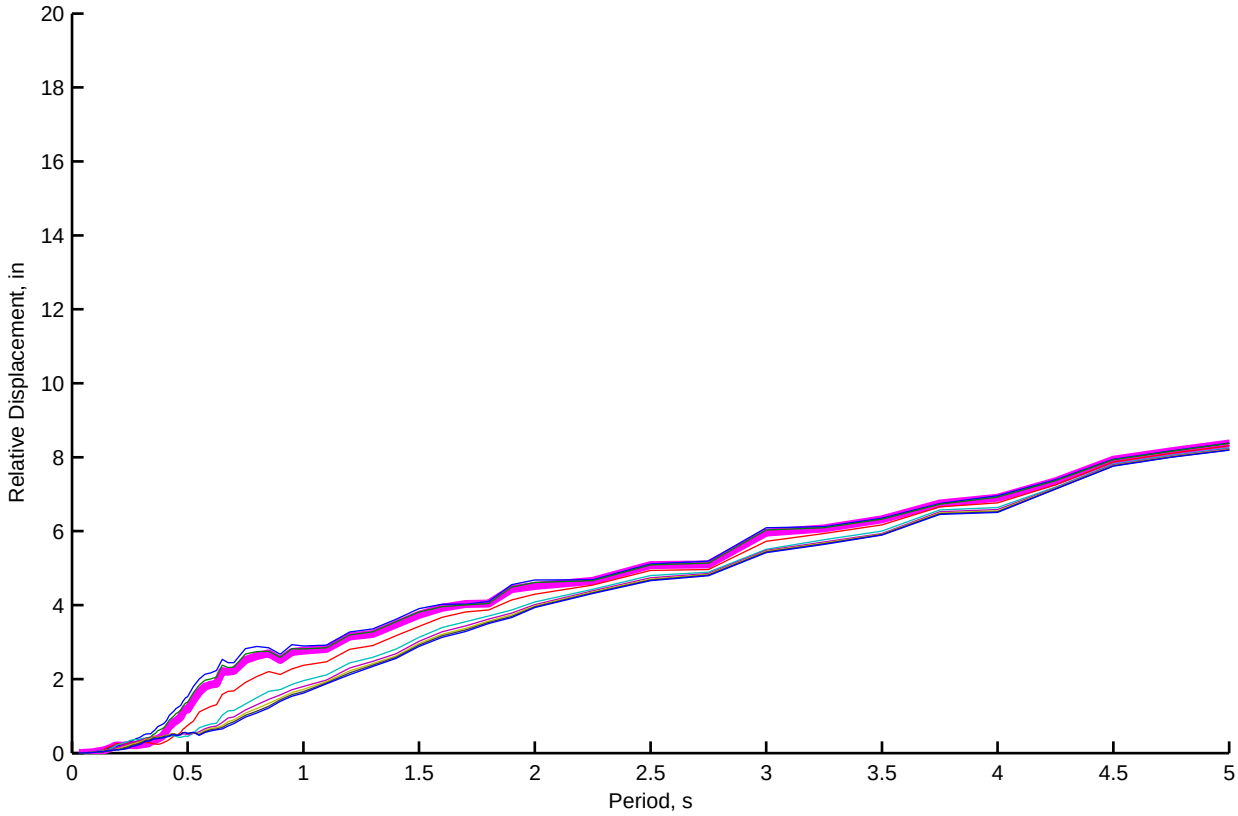
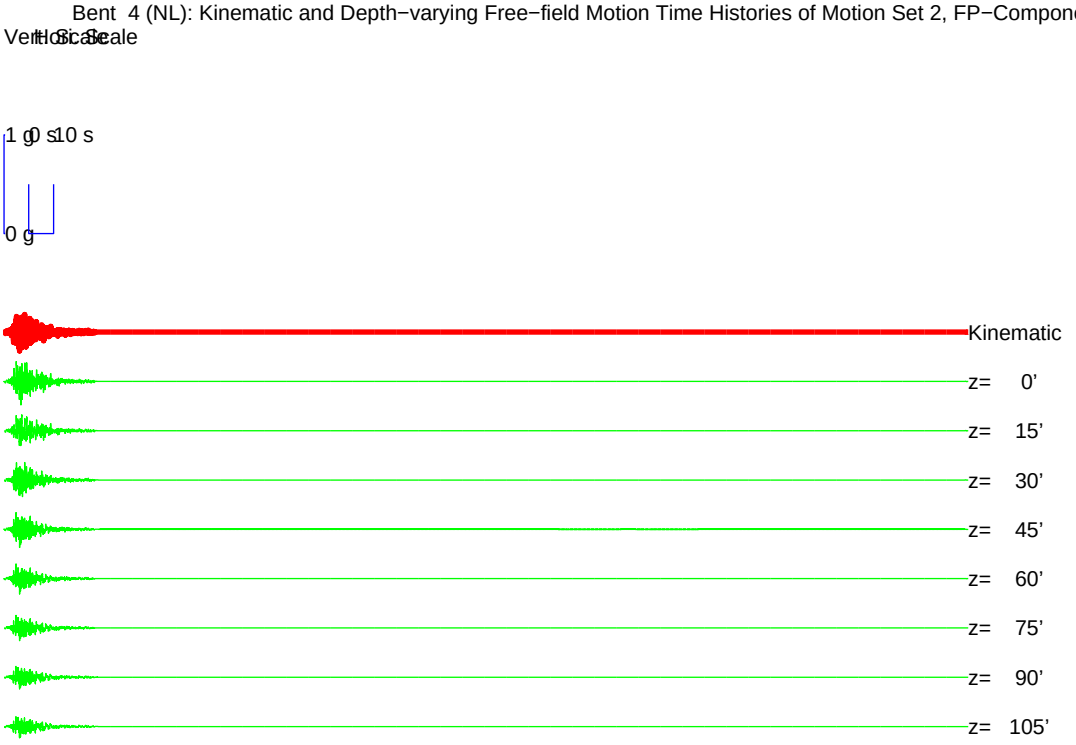
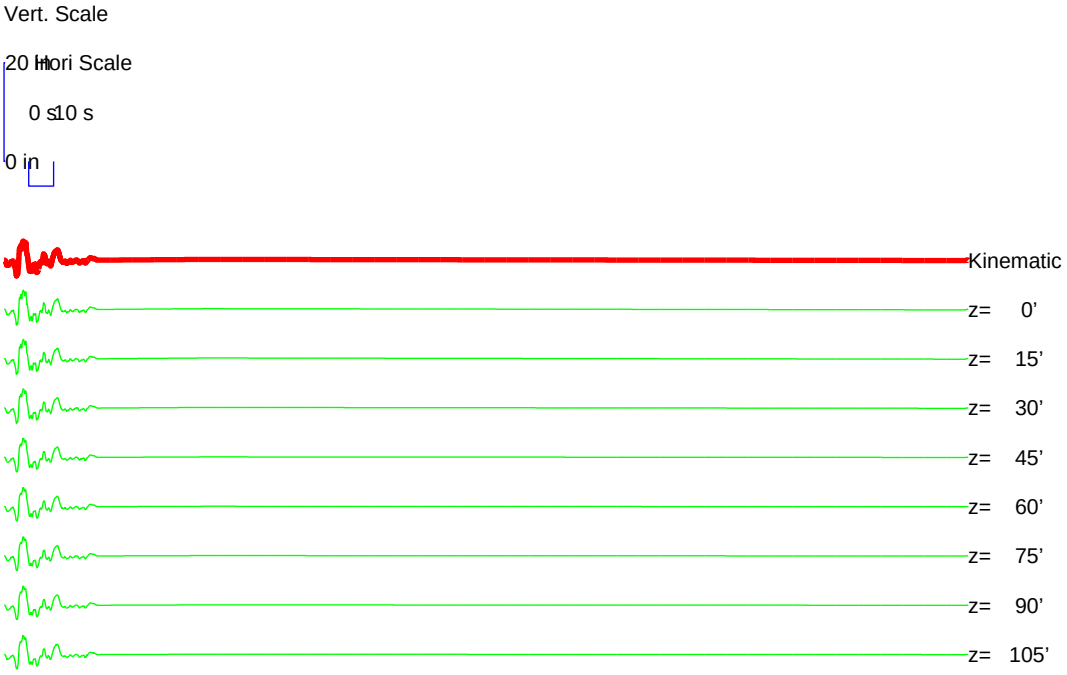
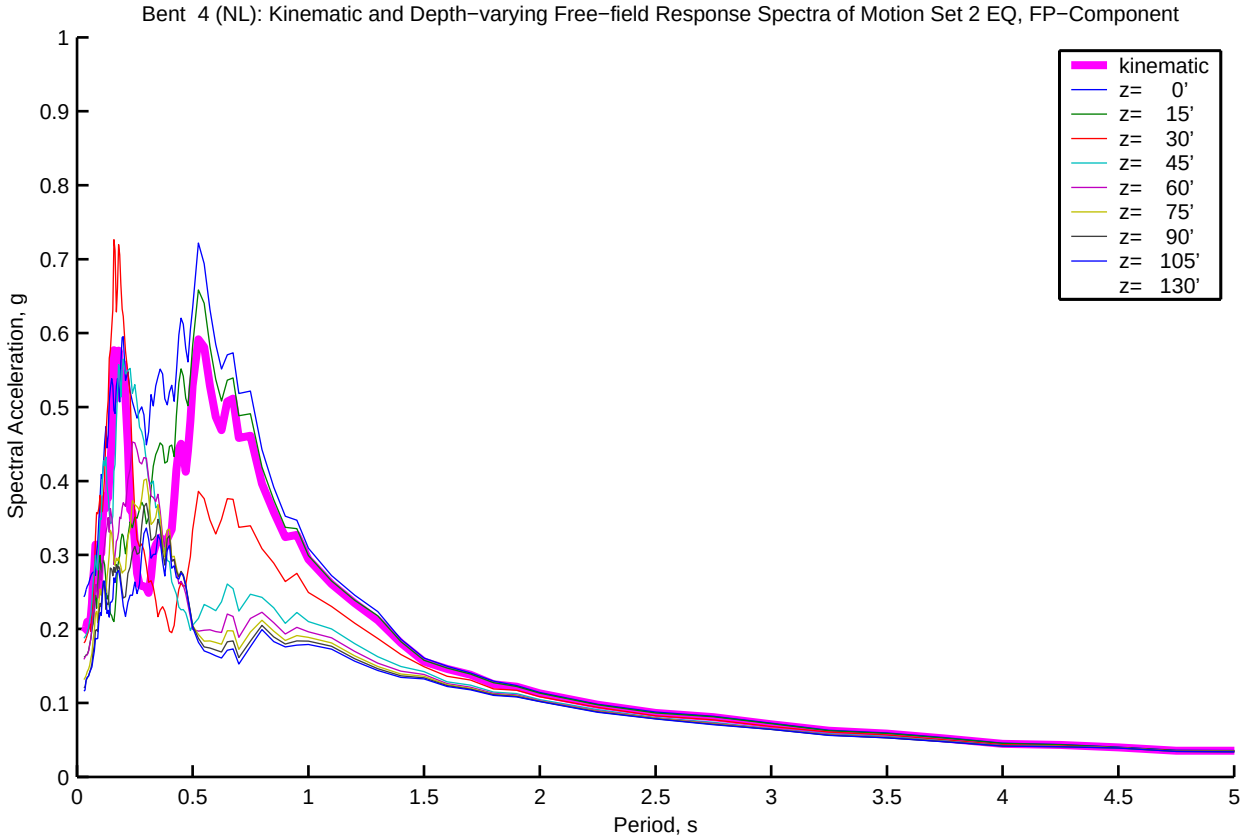
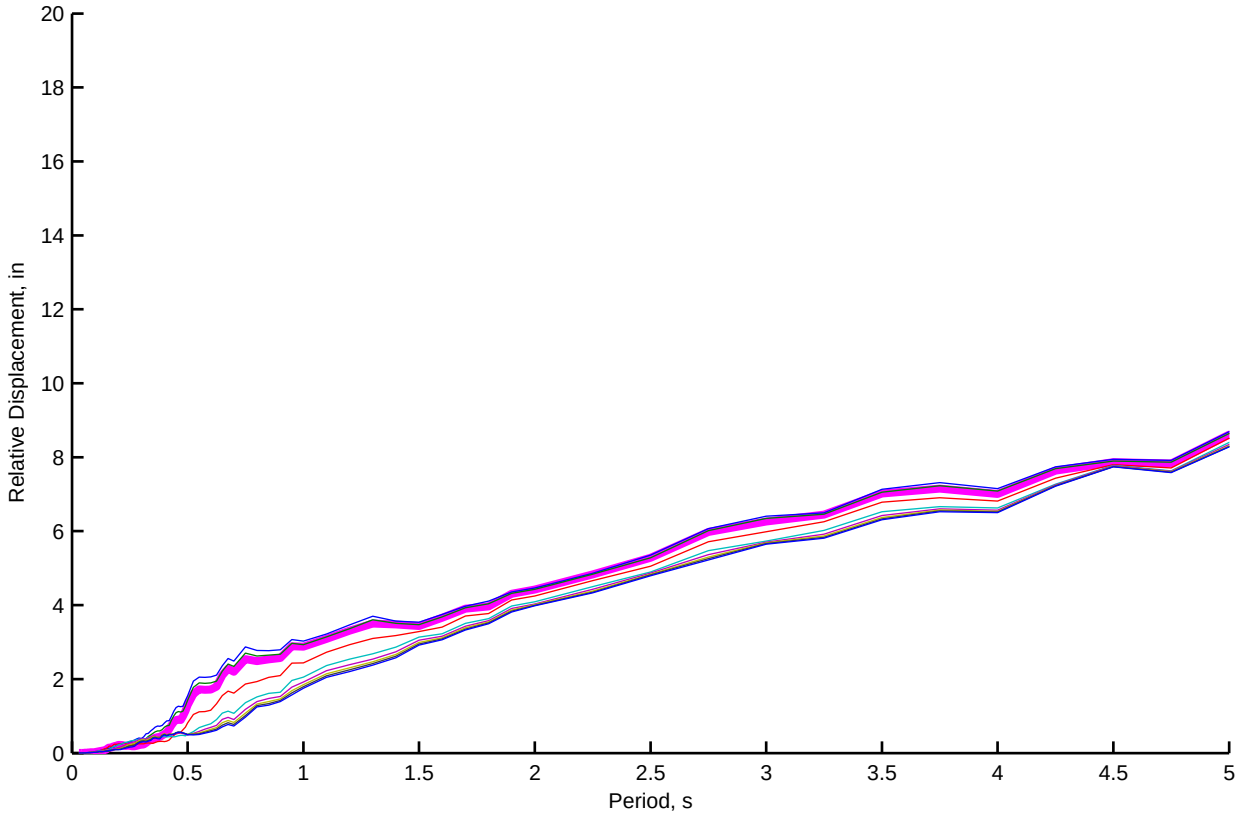

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 4 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component




Bent 4 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
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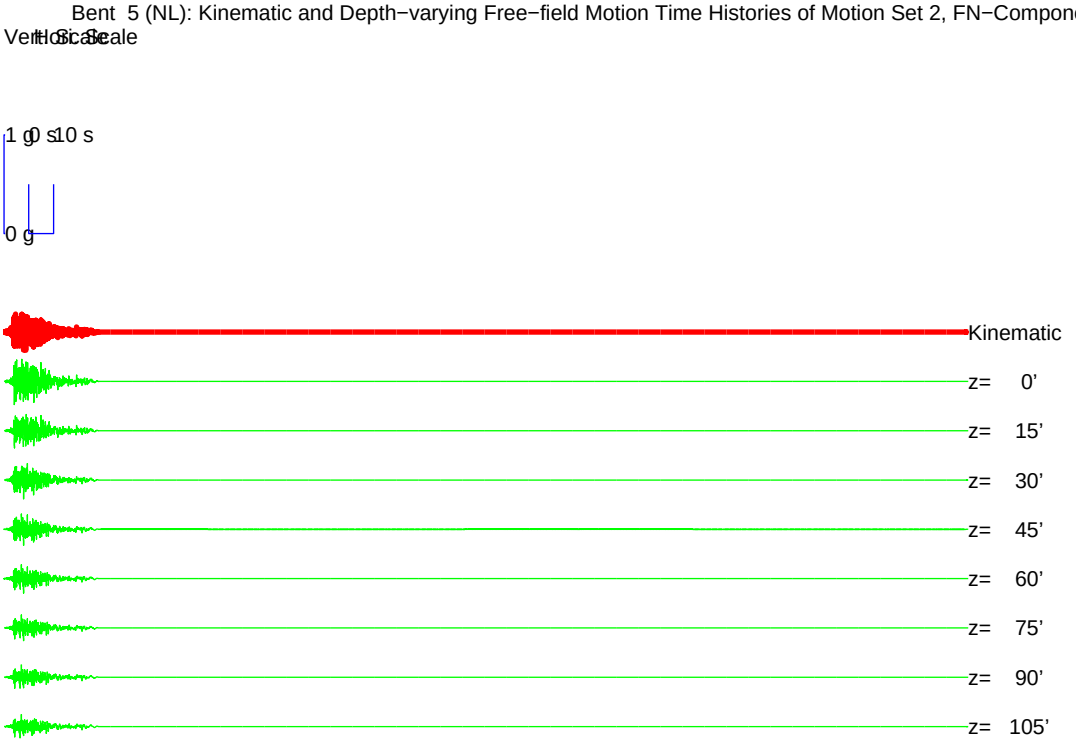
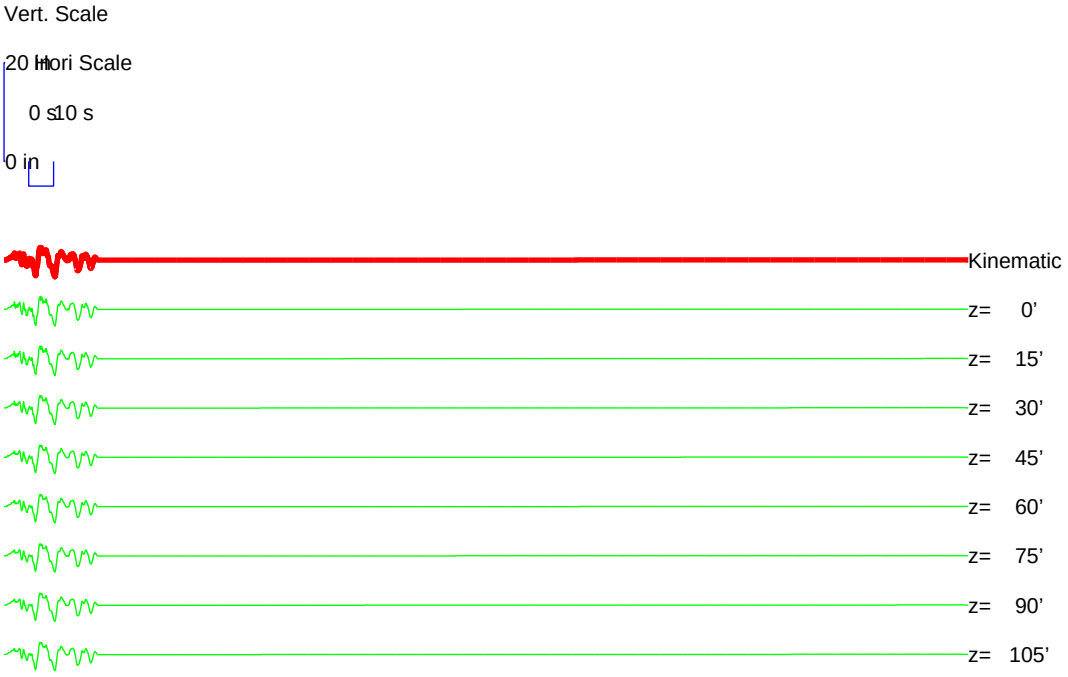
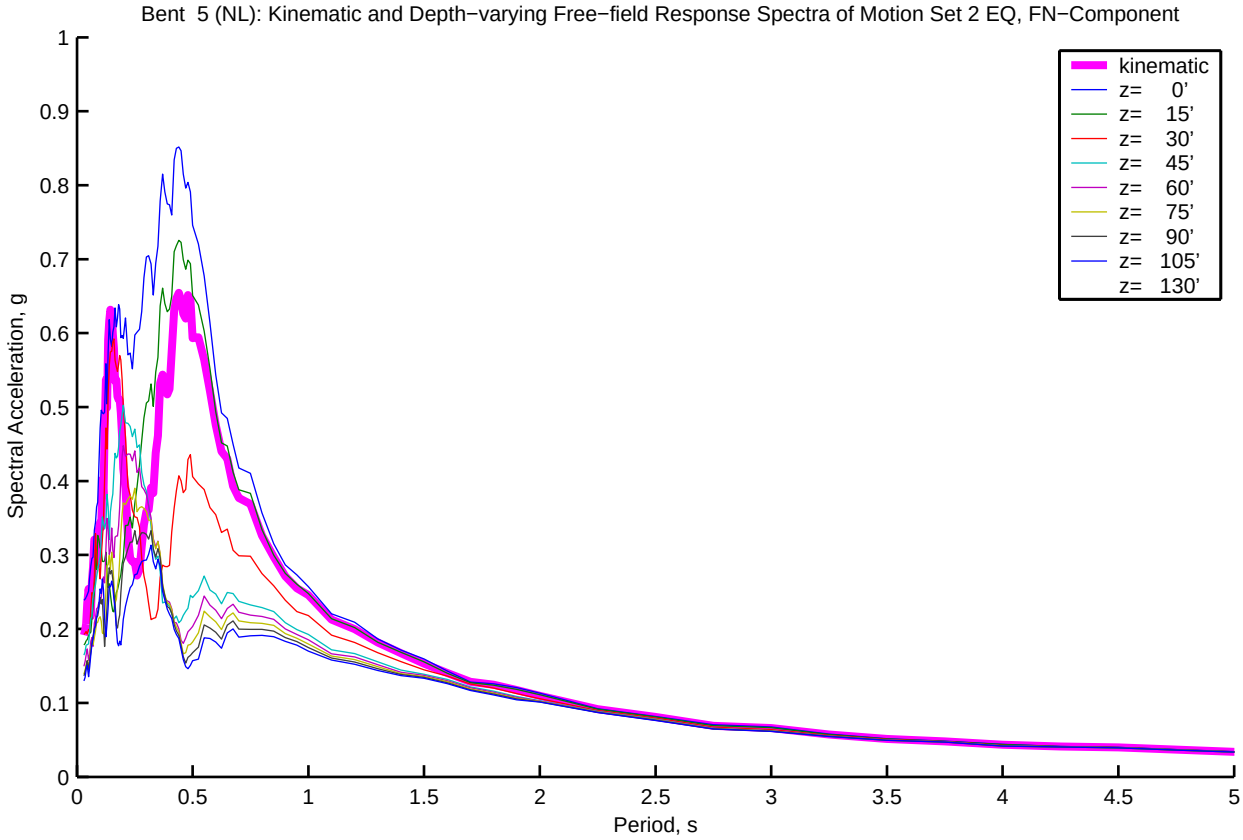
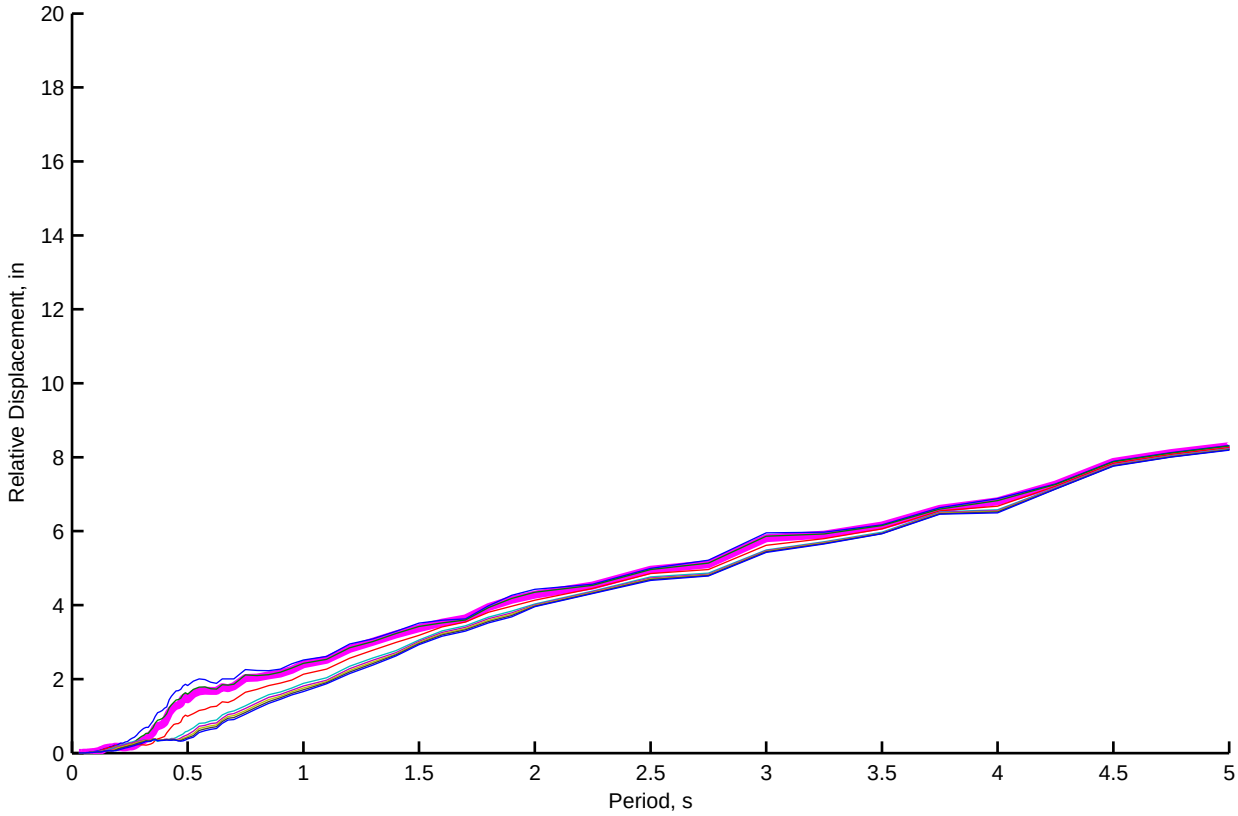
2.5
3
3.5
4
4.5
5

Bent 5 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component




Bent 5 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
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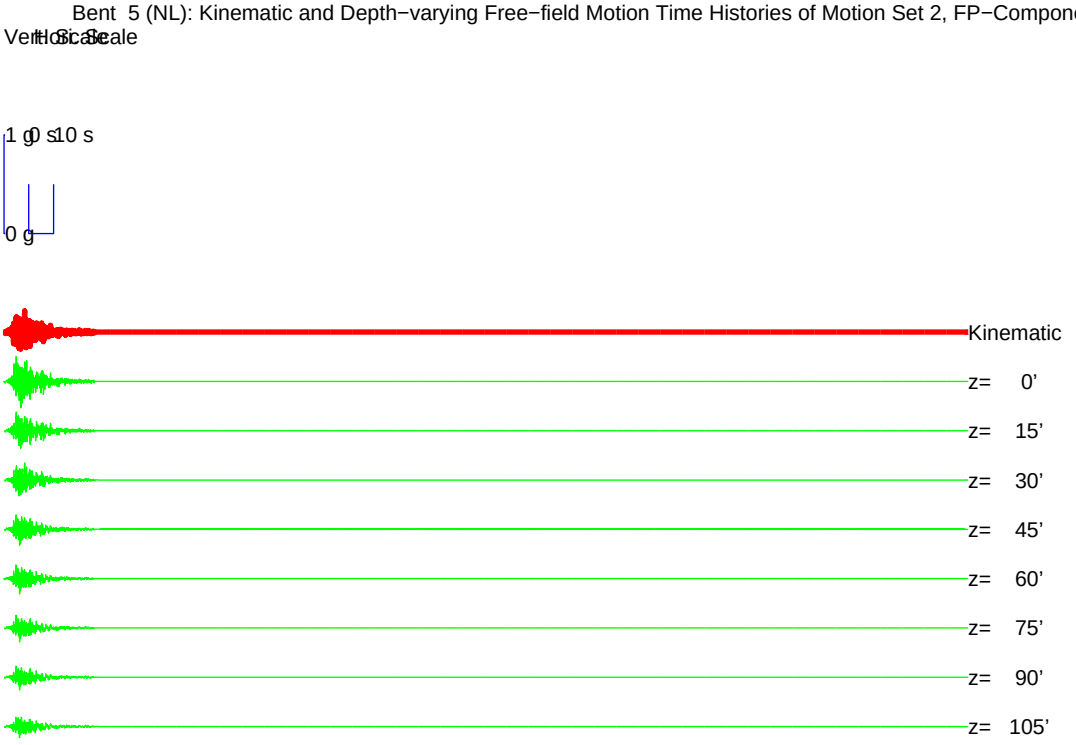
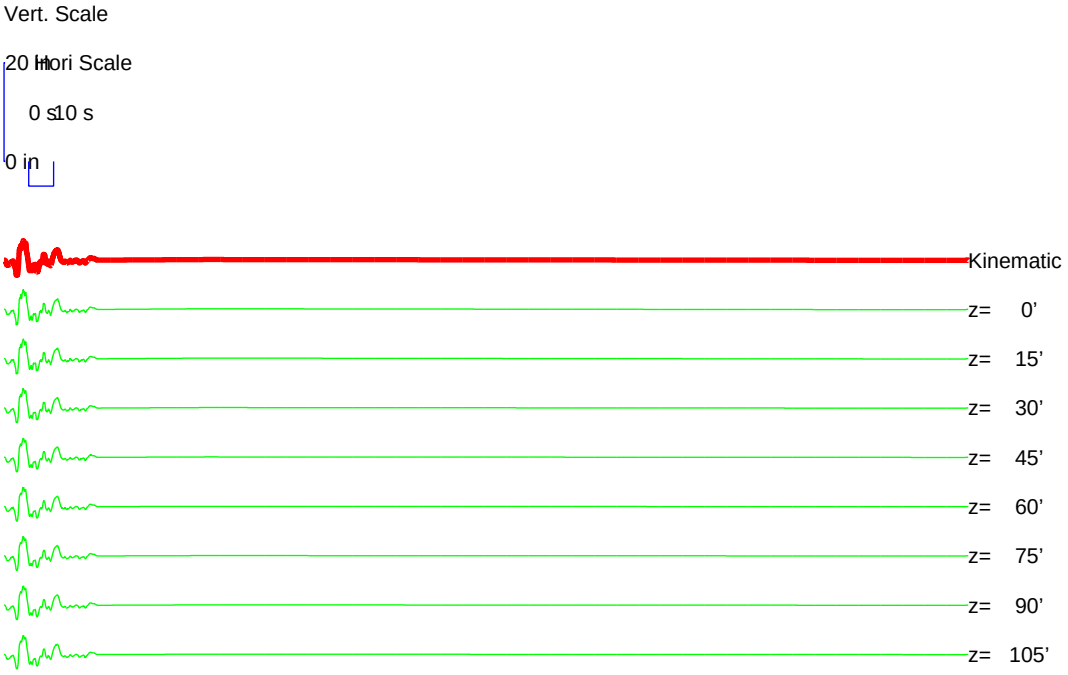
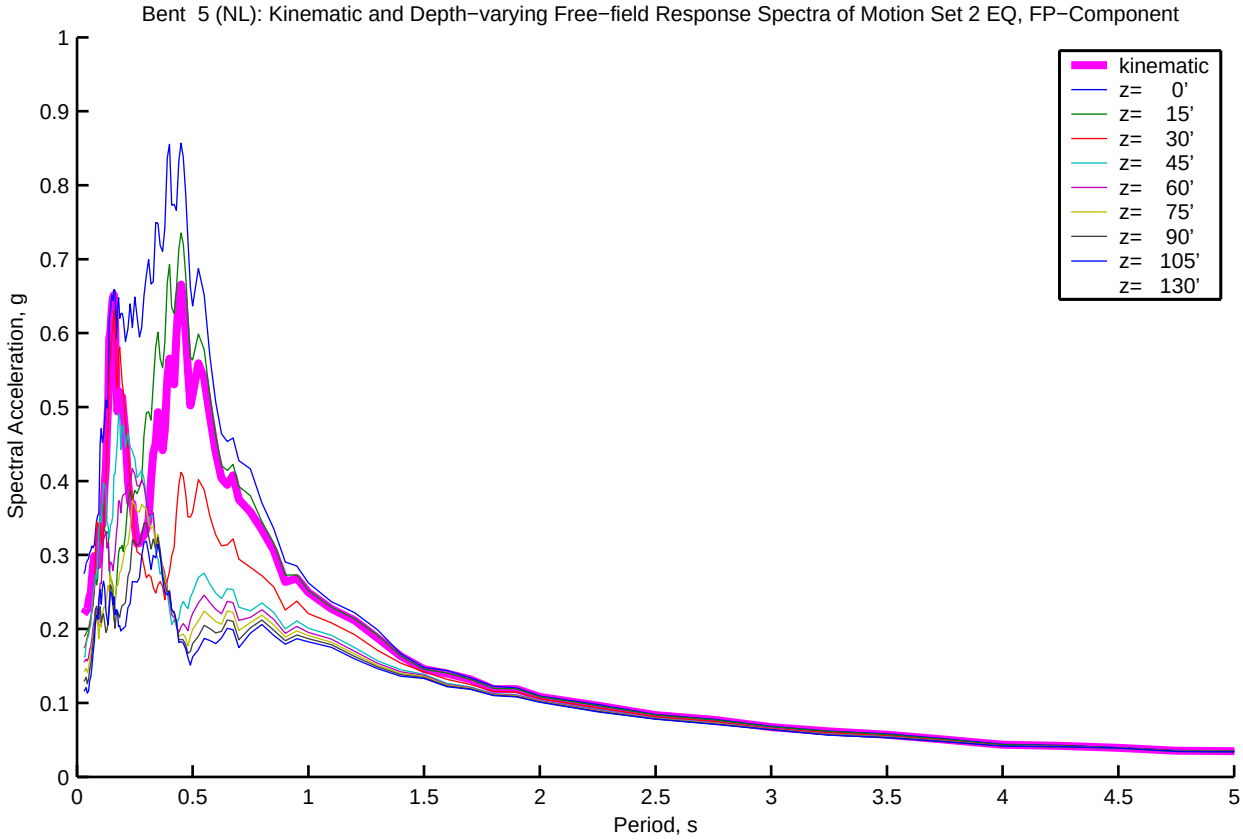
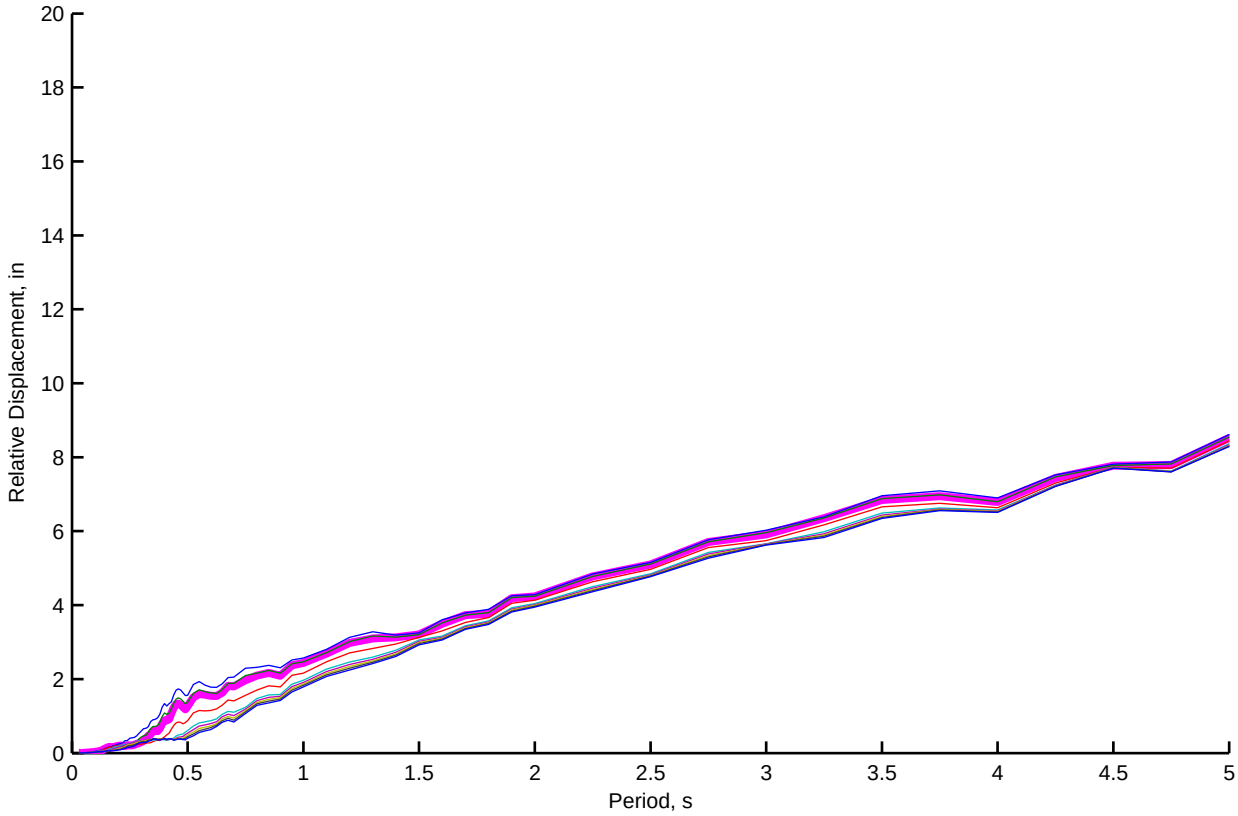
2.5
3
3.5
4
4.5
5

Bent 5 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

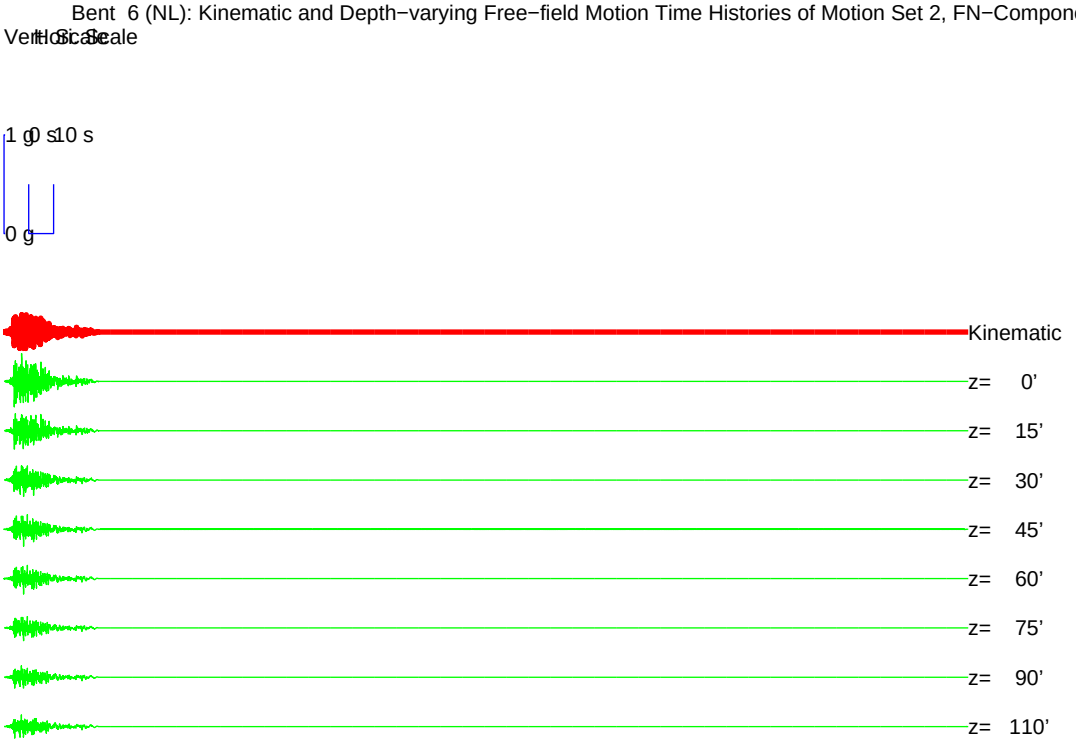


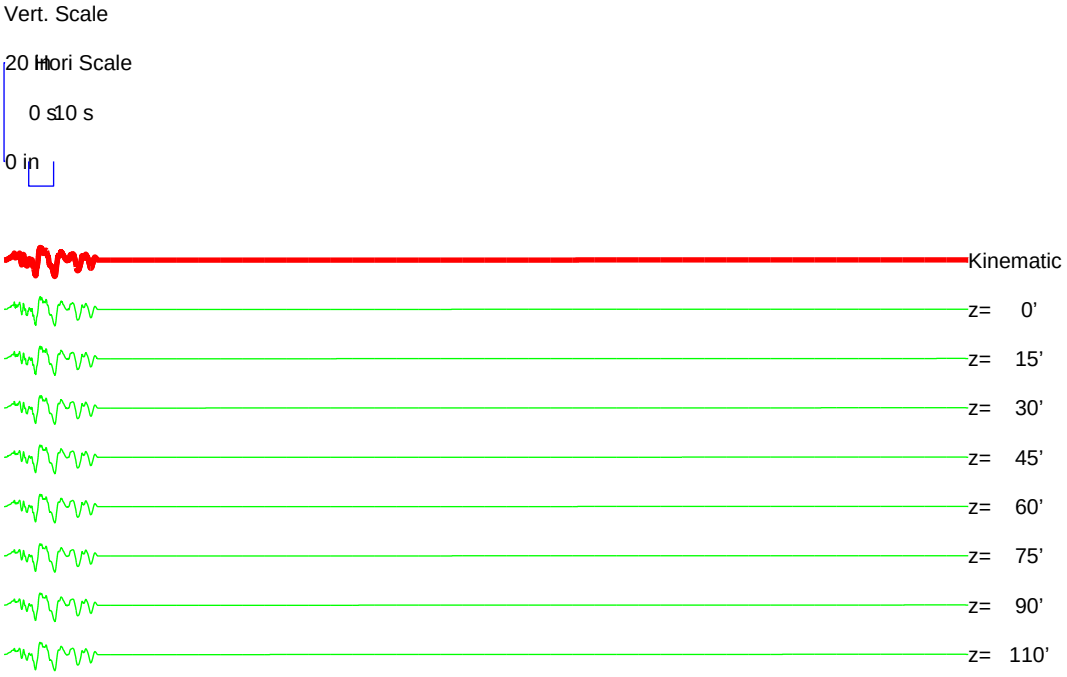



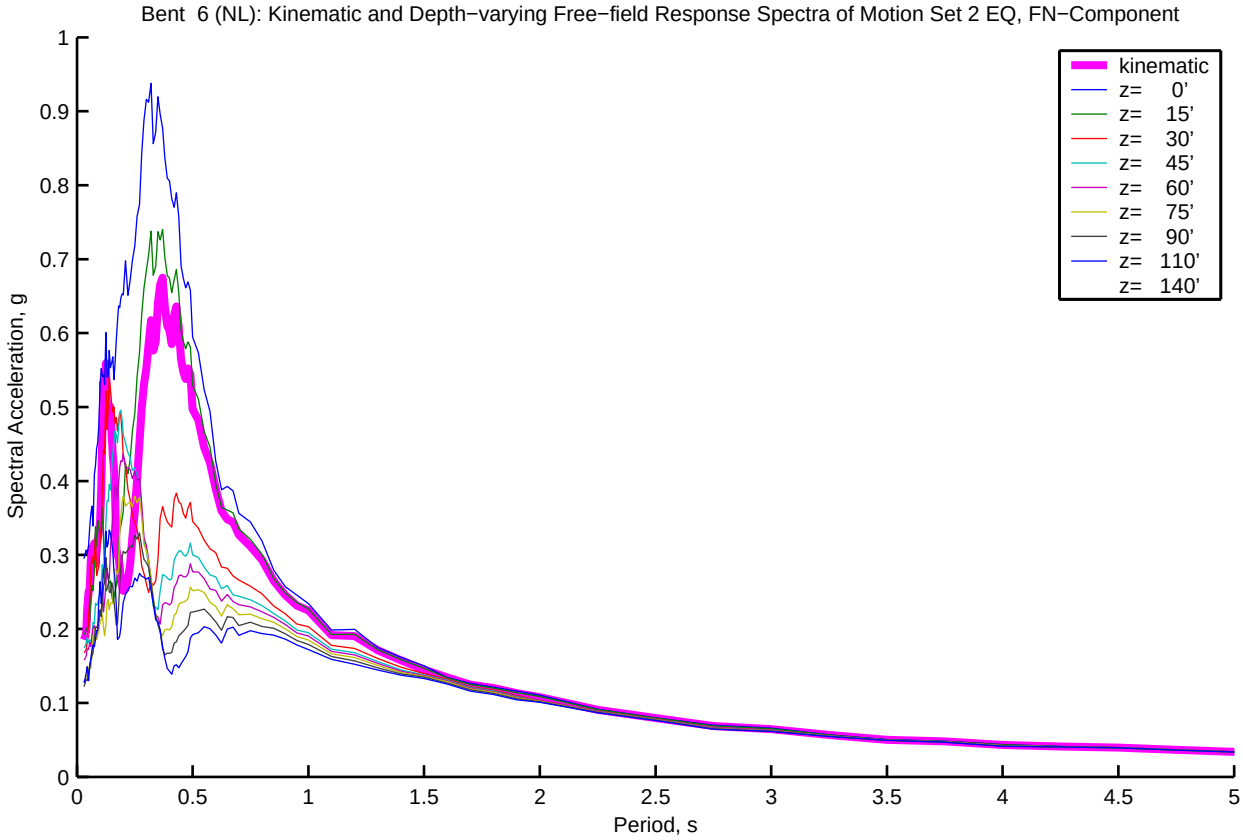

Bent 5 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

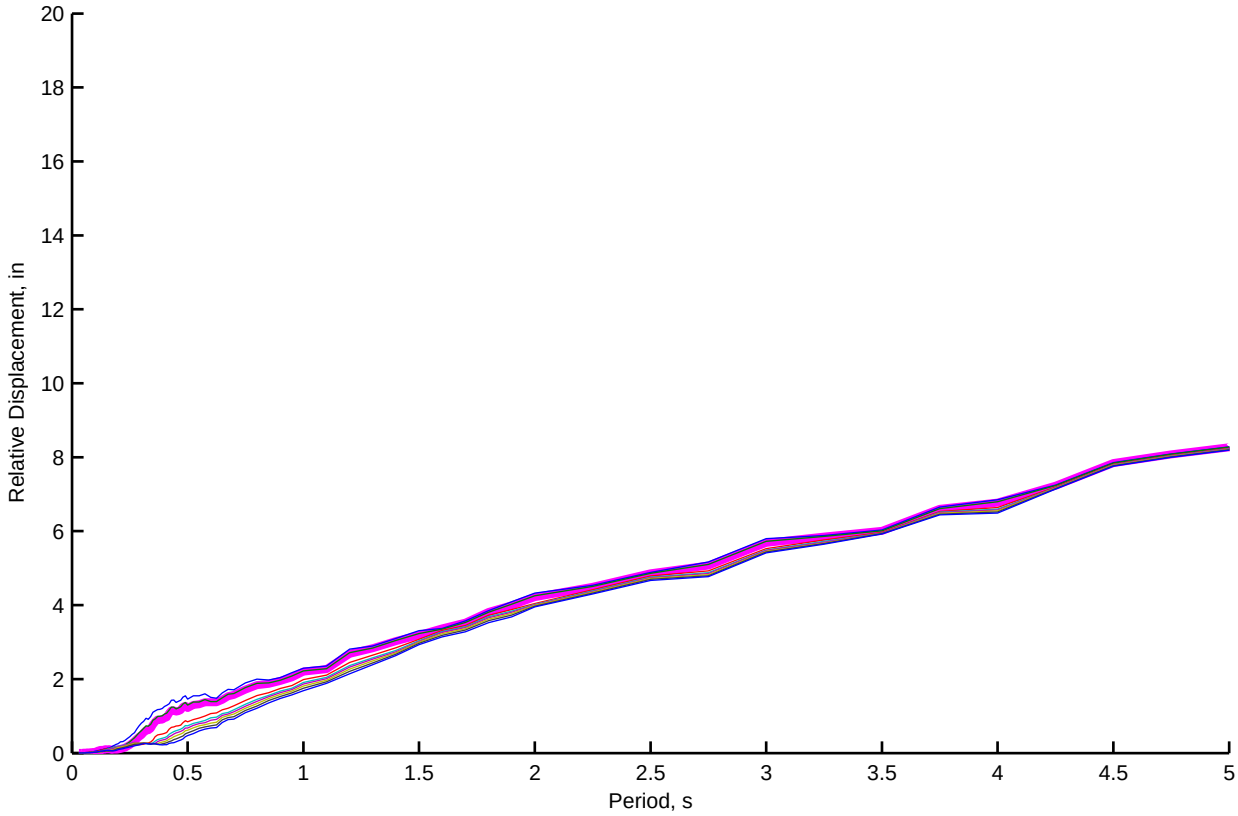

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 6 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

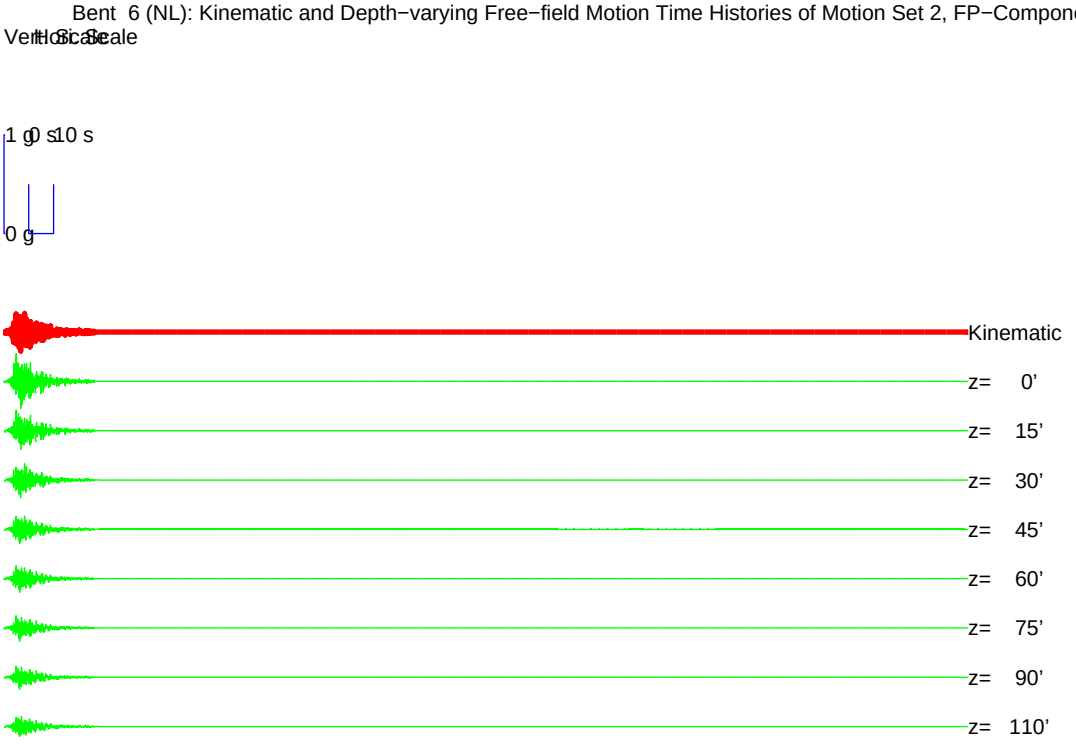


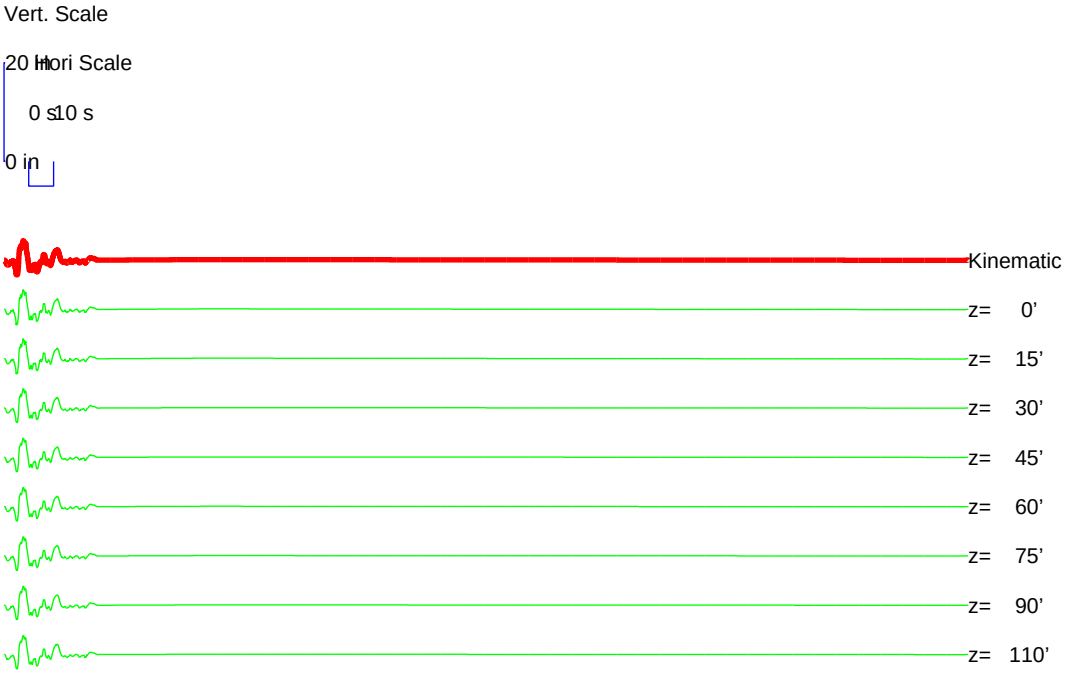



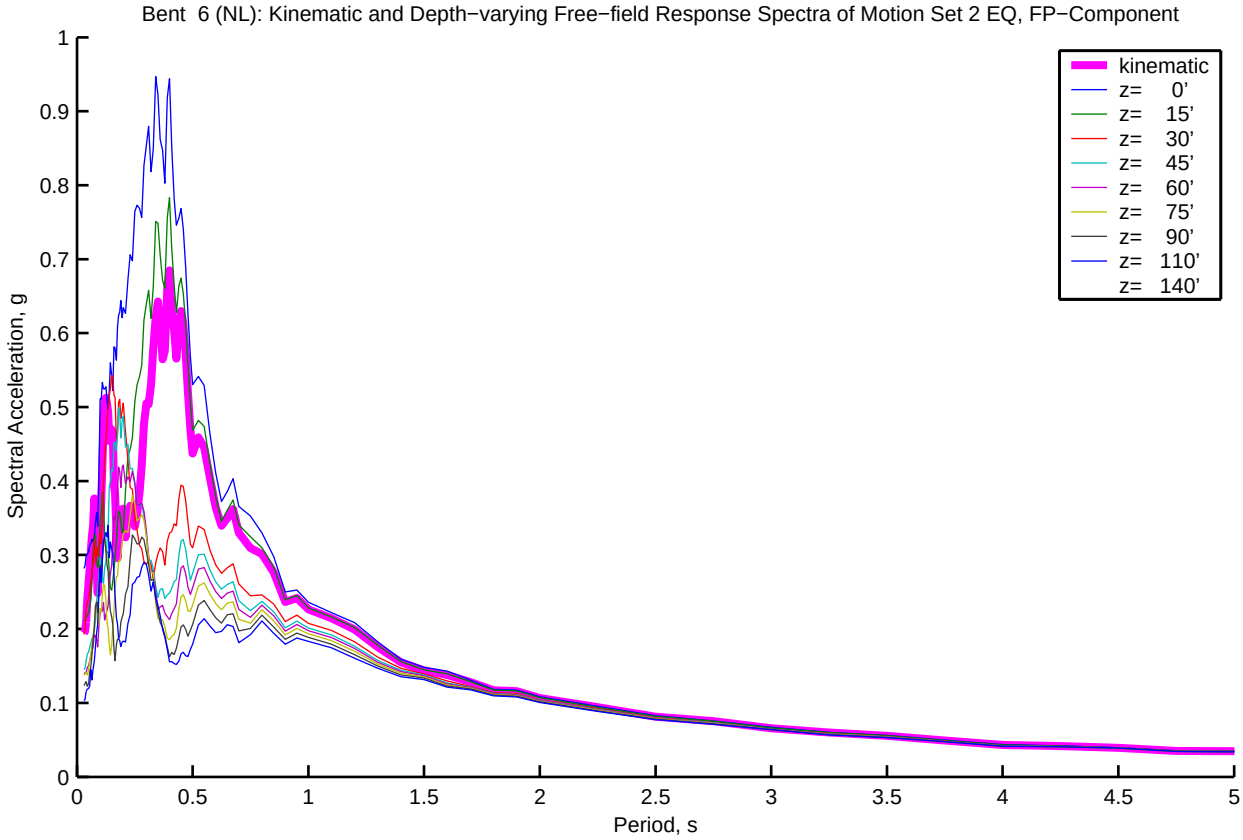

Bent 6 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

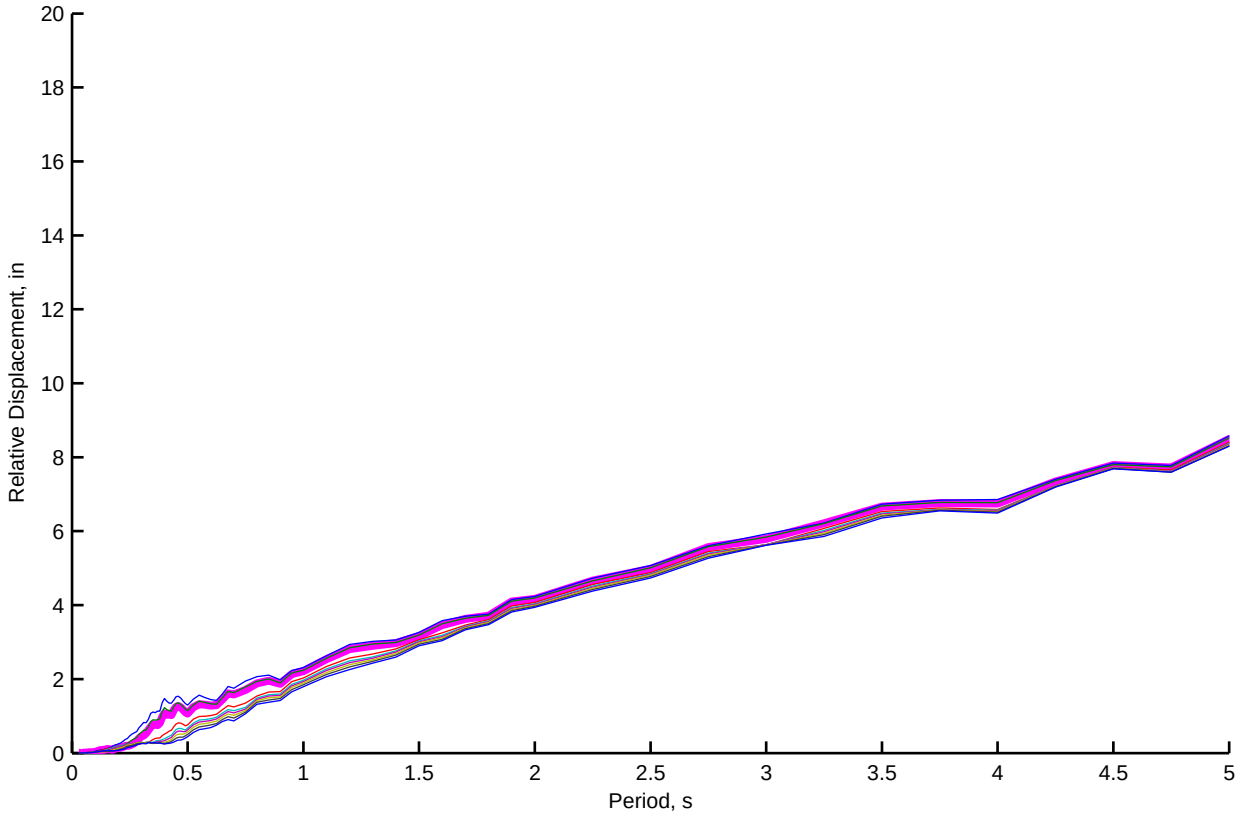

Relative Displacement, in
Period, s

Bent 6 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

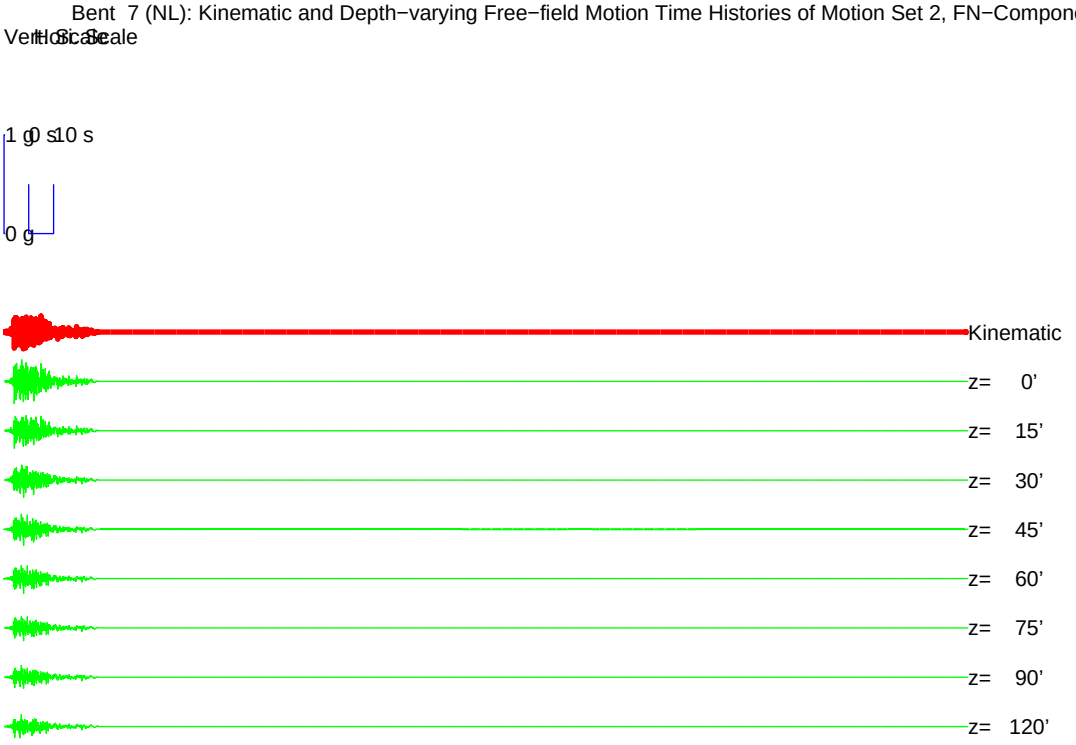


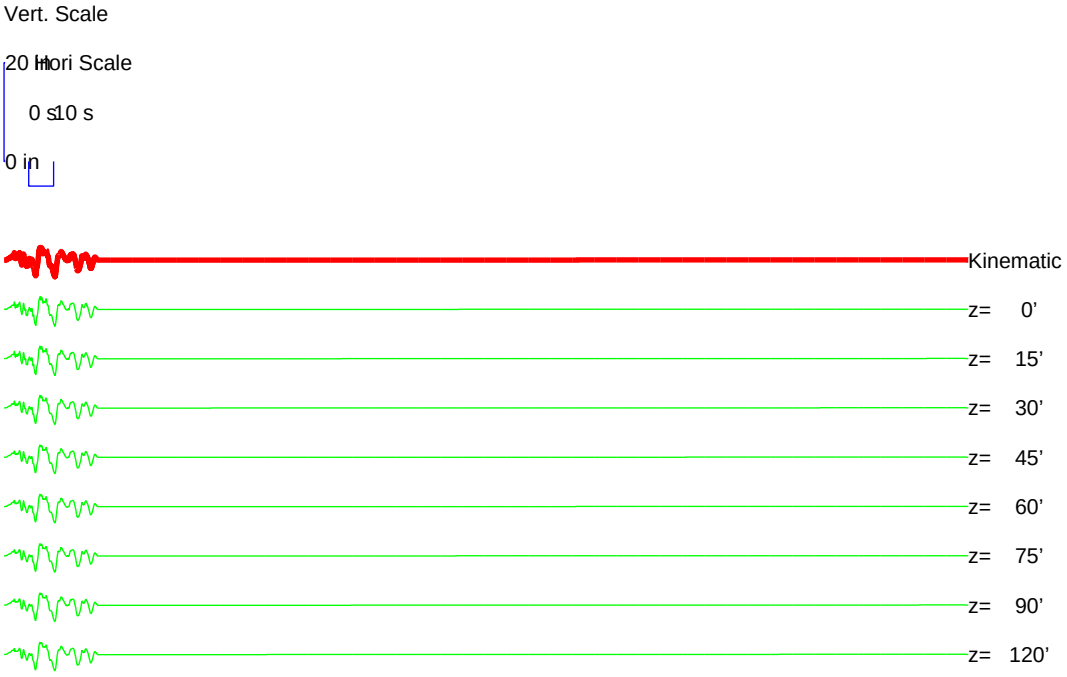



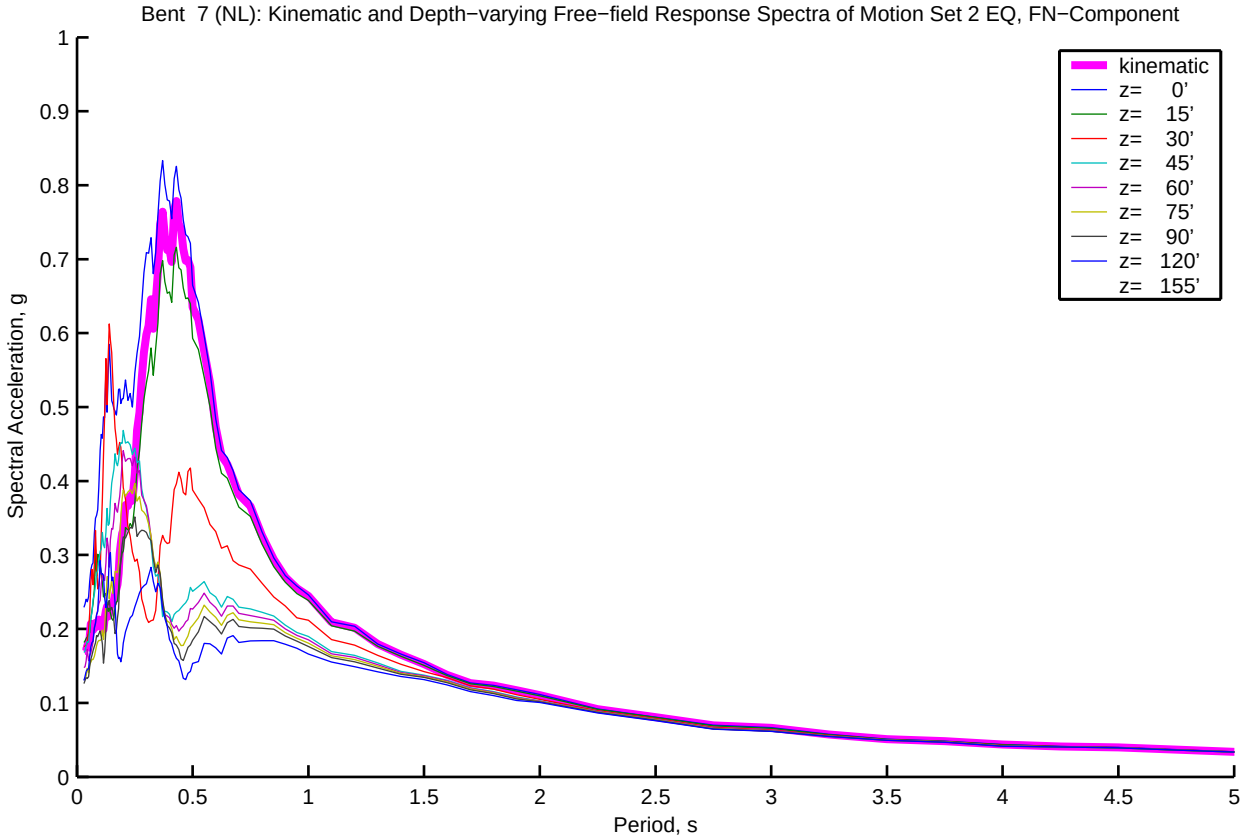

Bent 6 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

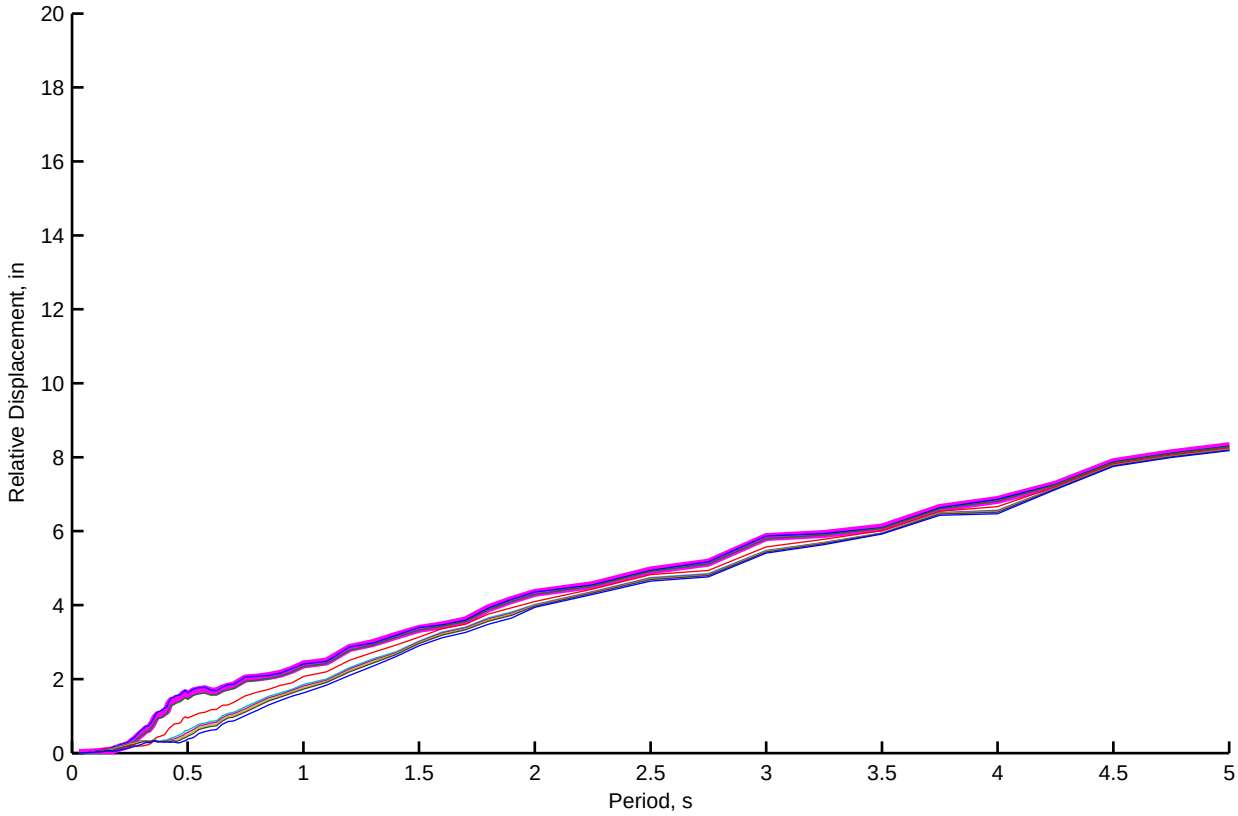

Relative Displacement, in
Period, s

Bent 7 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

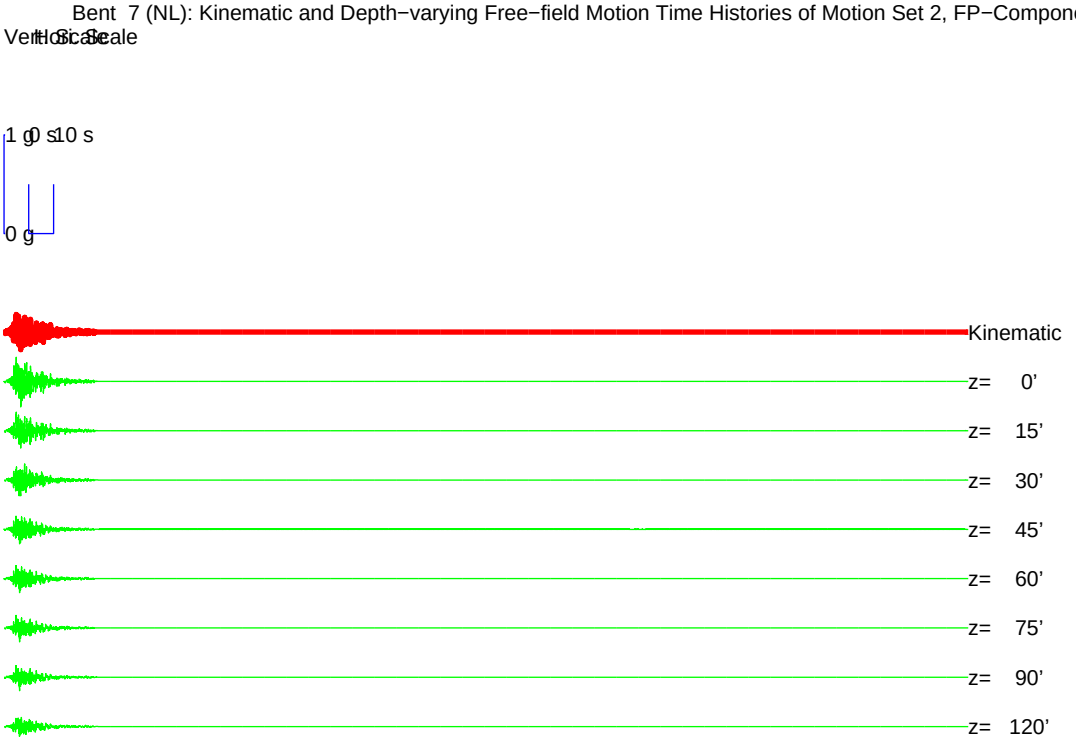


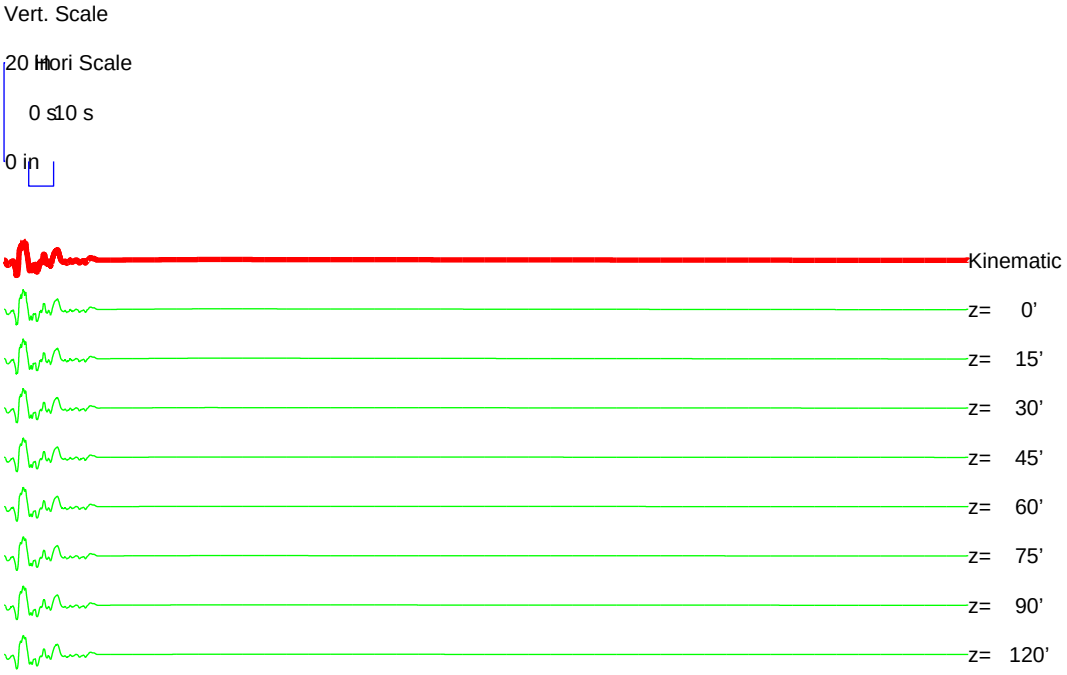



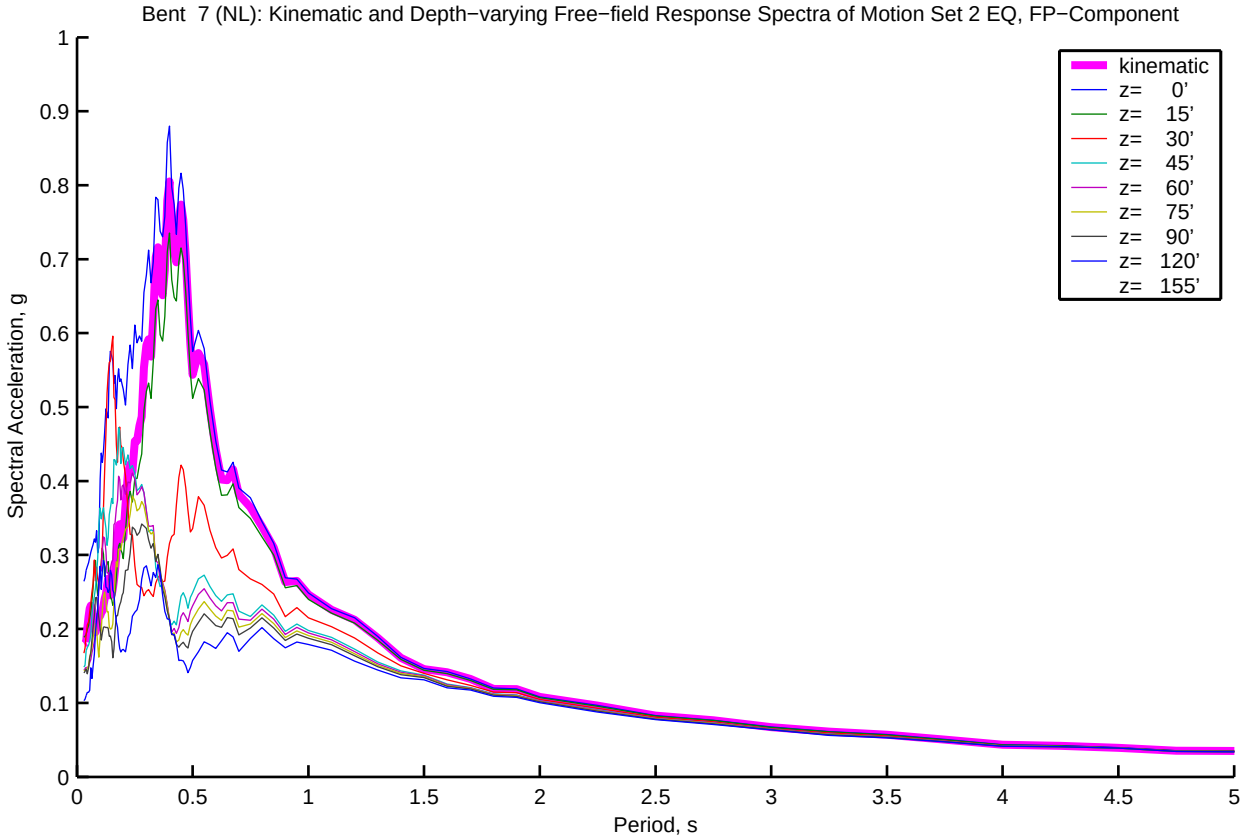

Bent 7 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

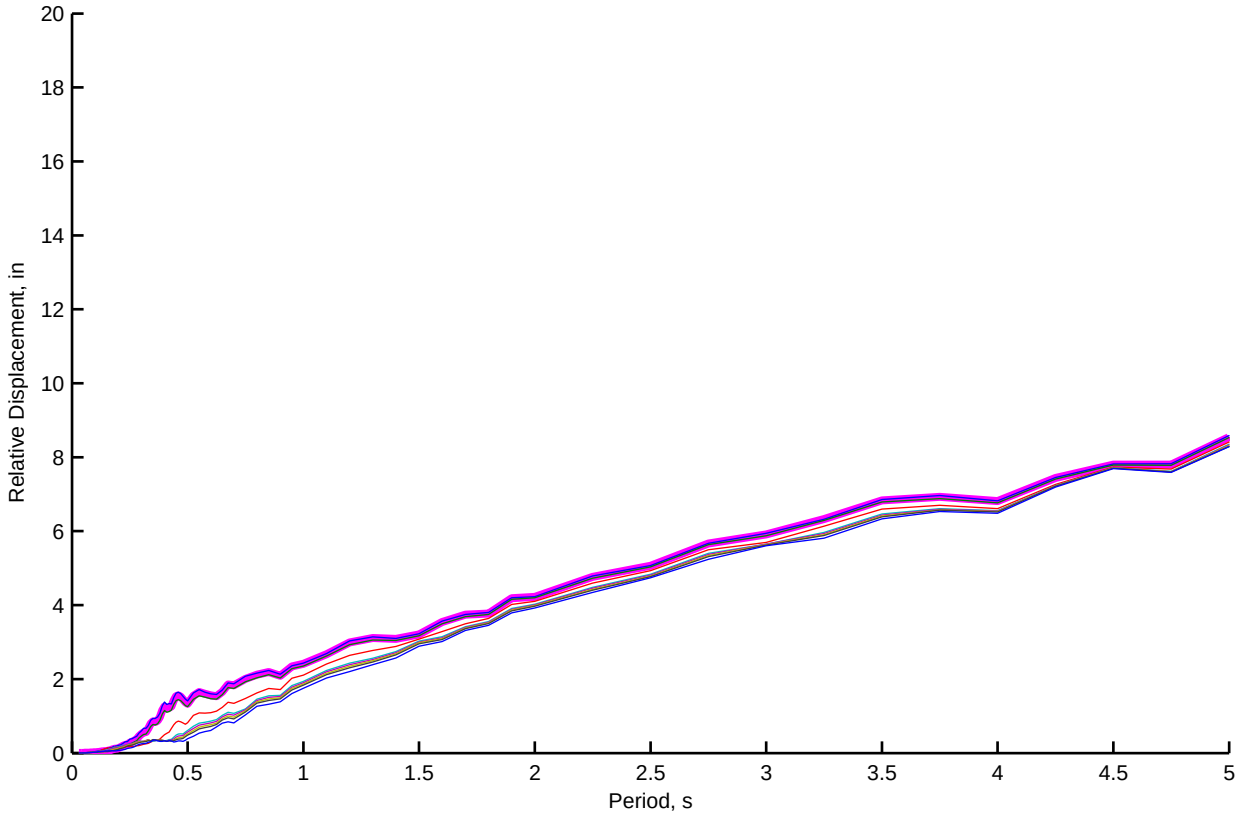

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

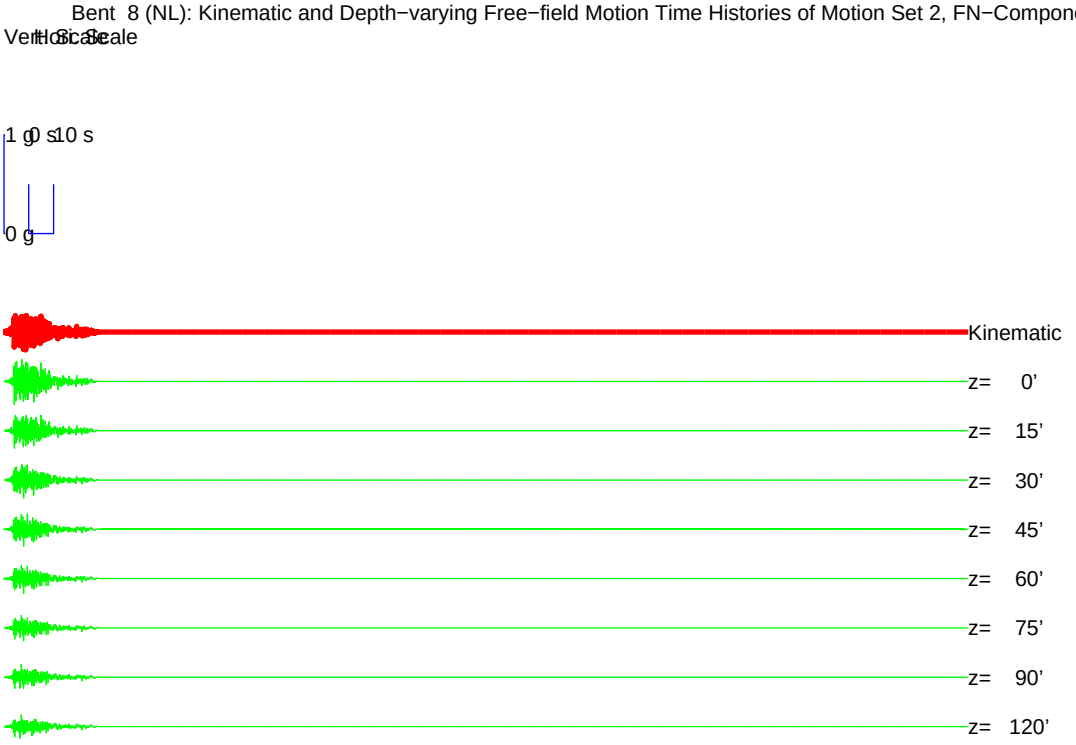


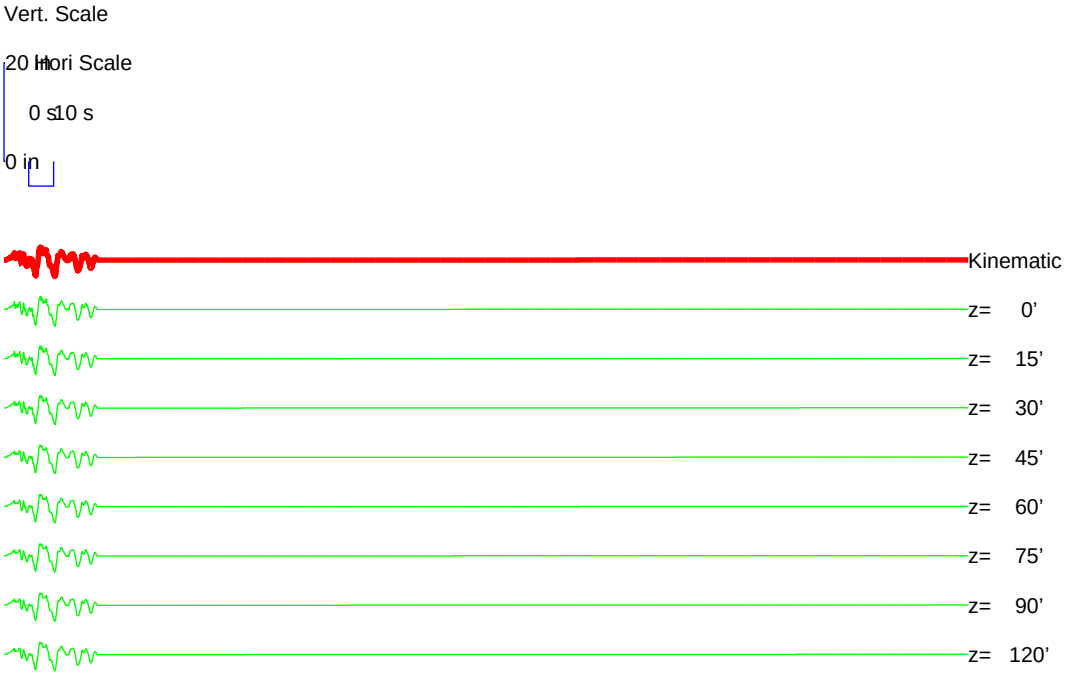



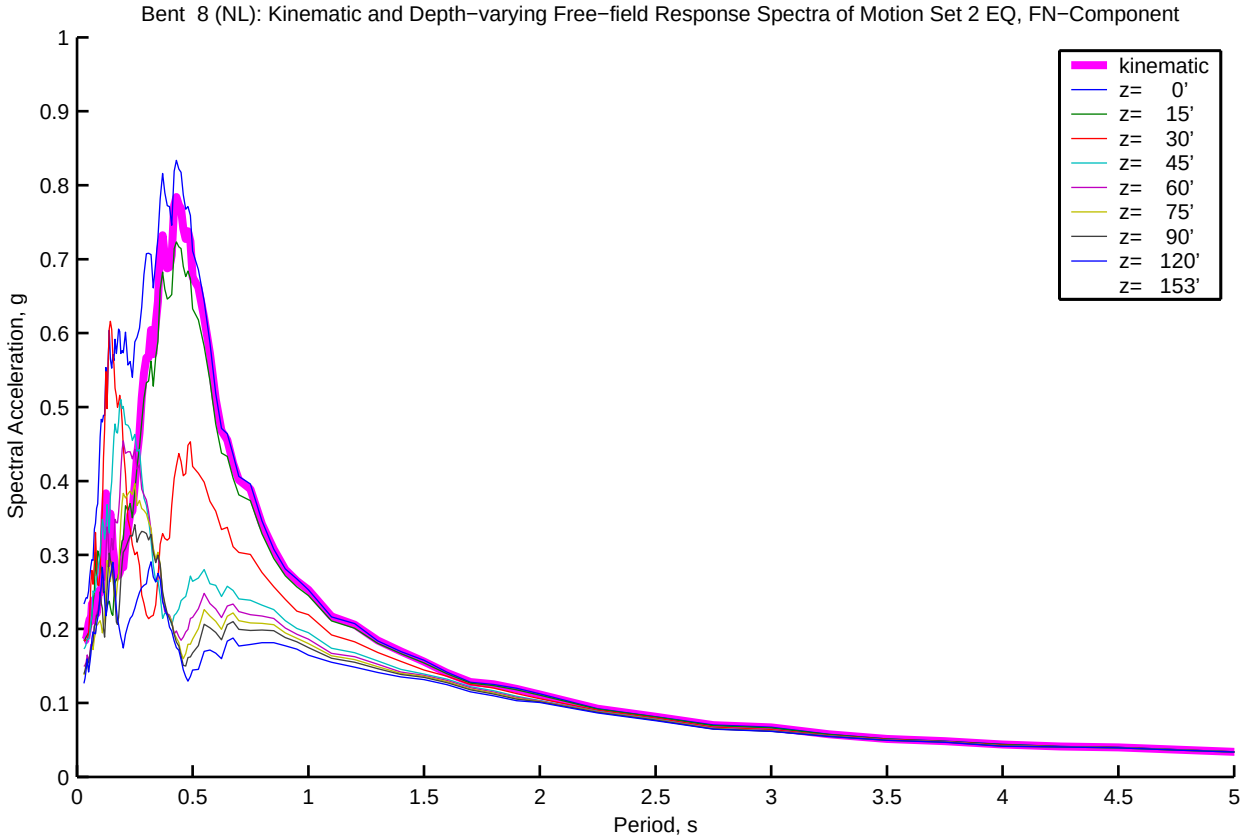

Bent 7 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

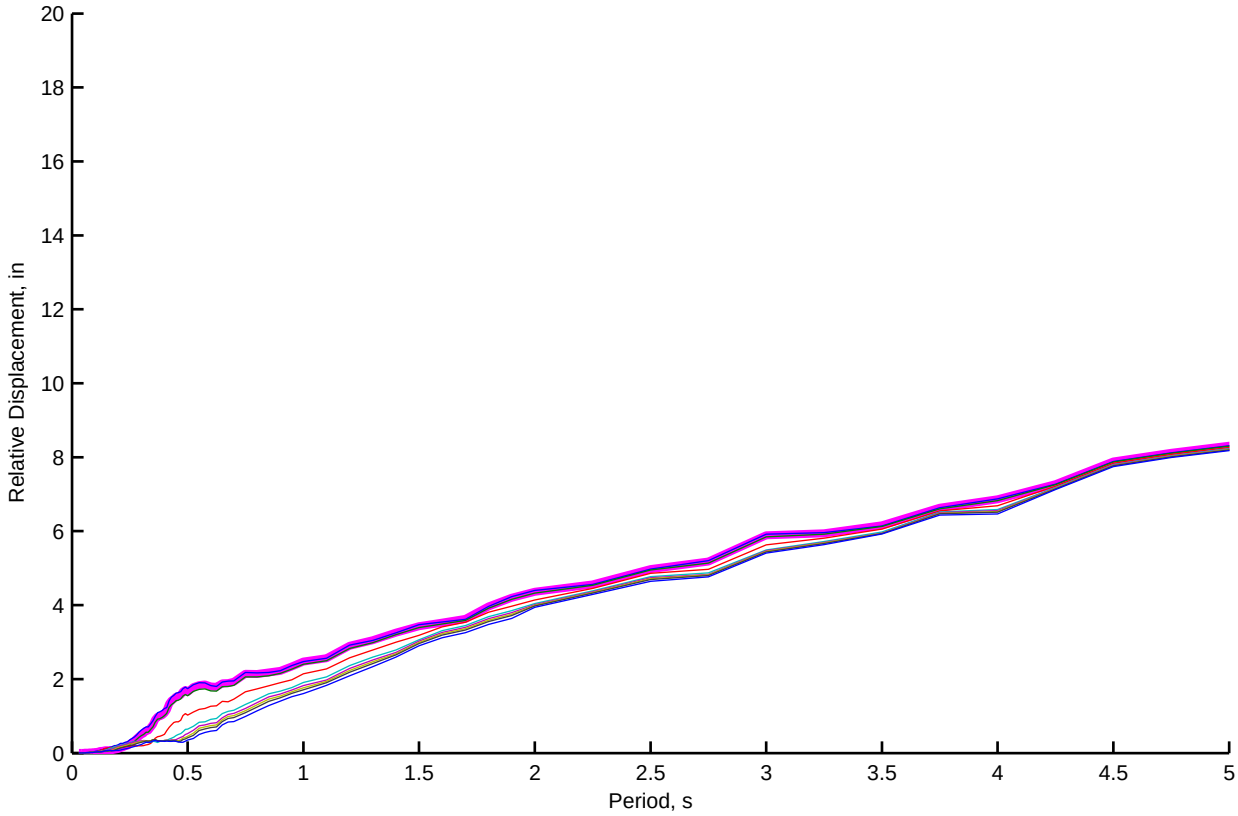

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

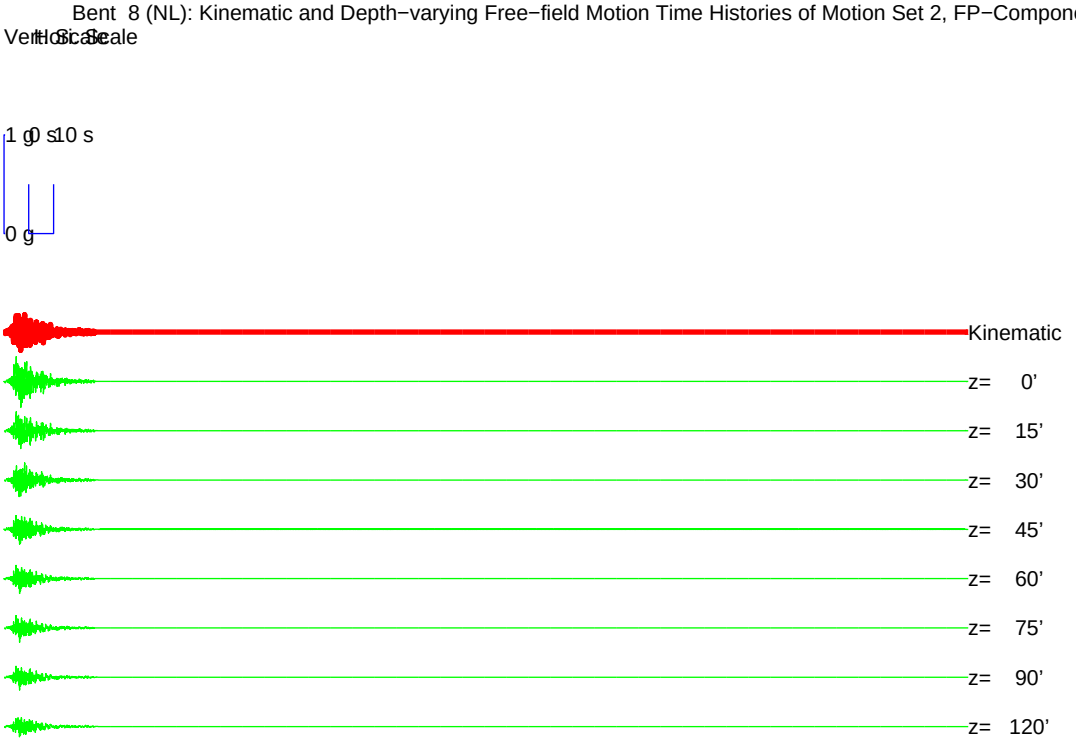


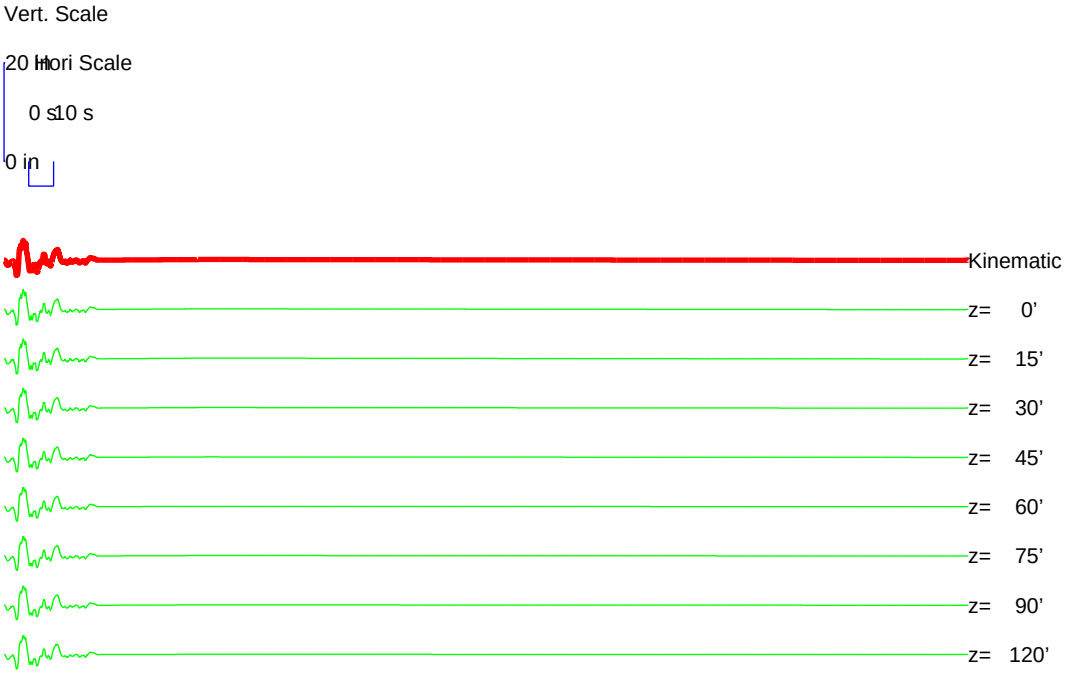



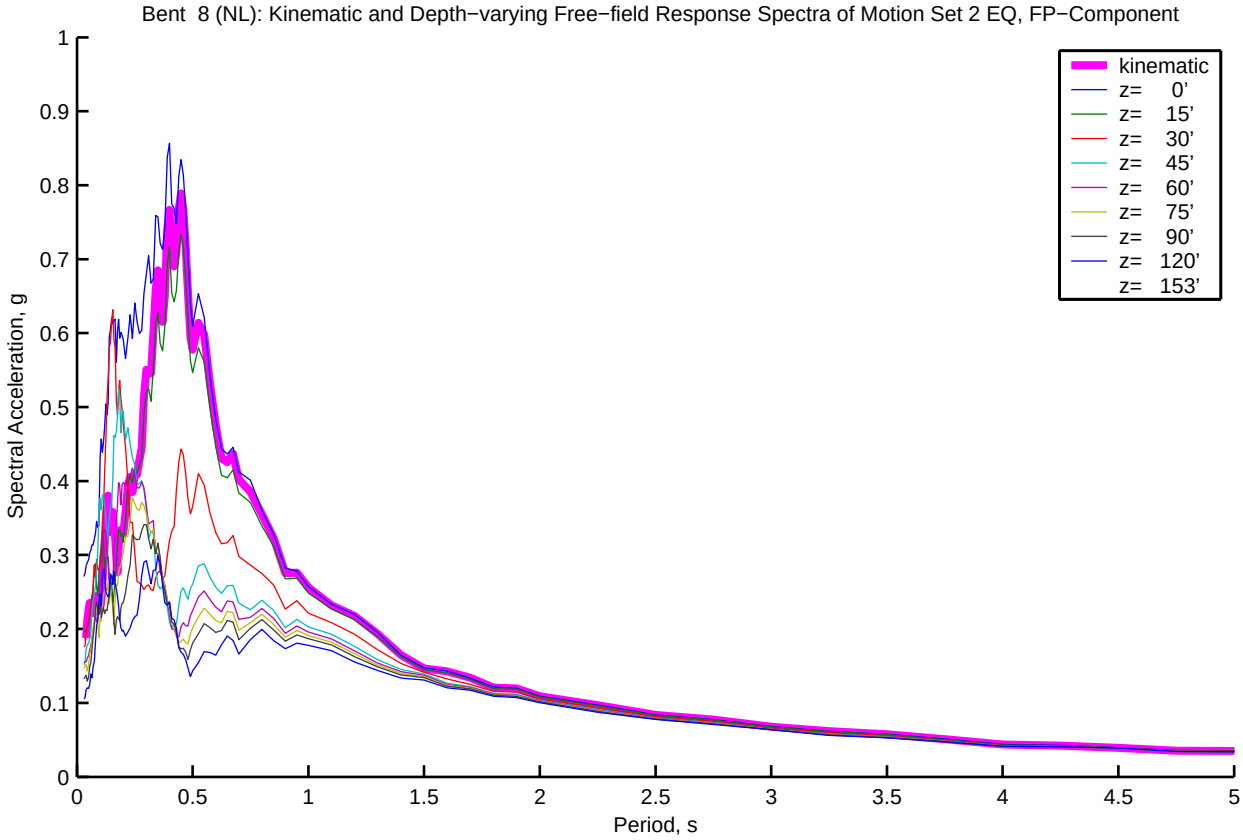

Bent 8 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component




Bent 8 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
0
0.1
0.2
0.3
0.4
0.5
0.6
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0.9
1
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1.5
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4.5
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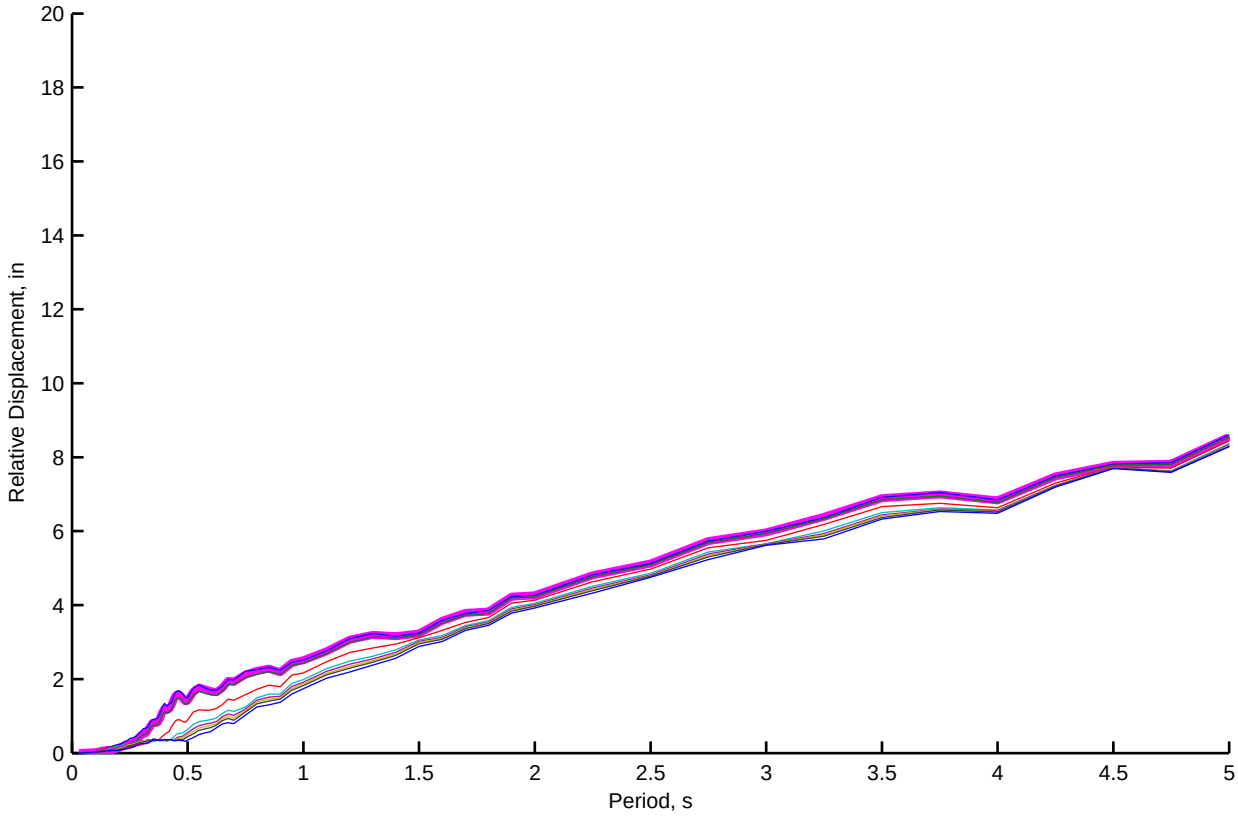
Relative Displacement, in
Period, s
0
2
4
6
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10
12
14
16
18
20
0.5
1
1.5
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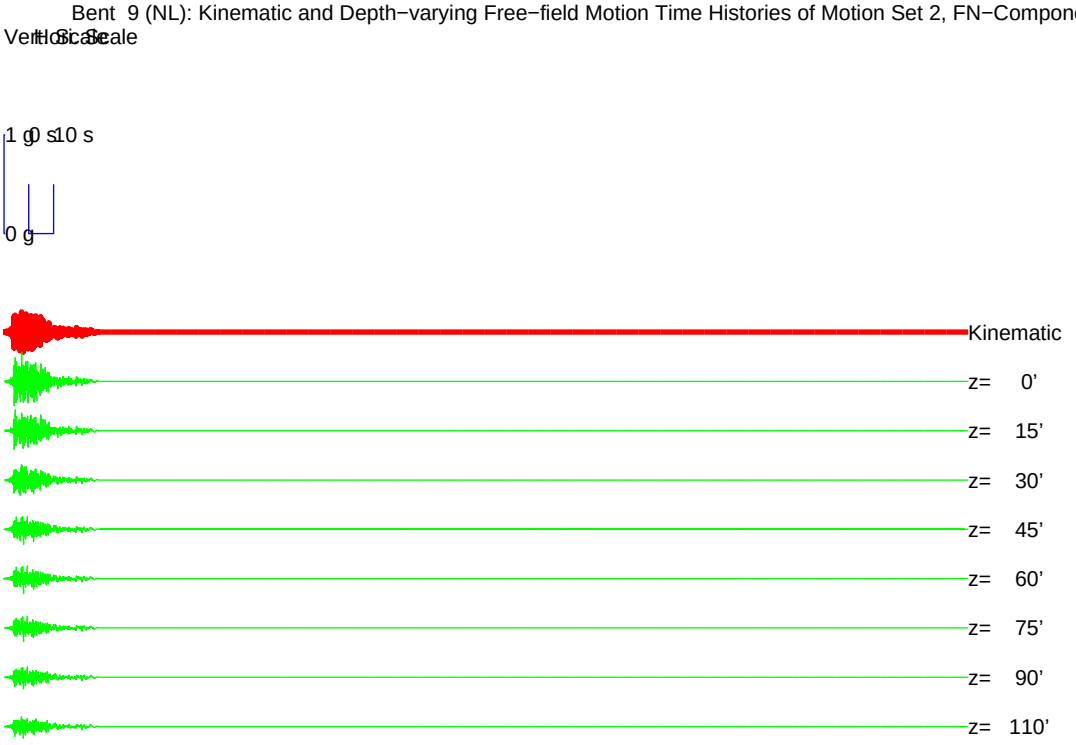
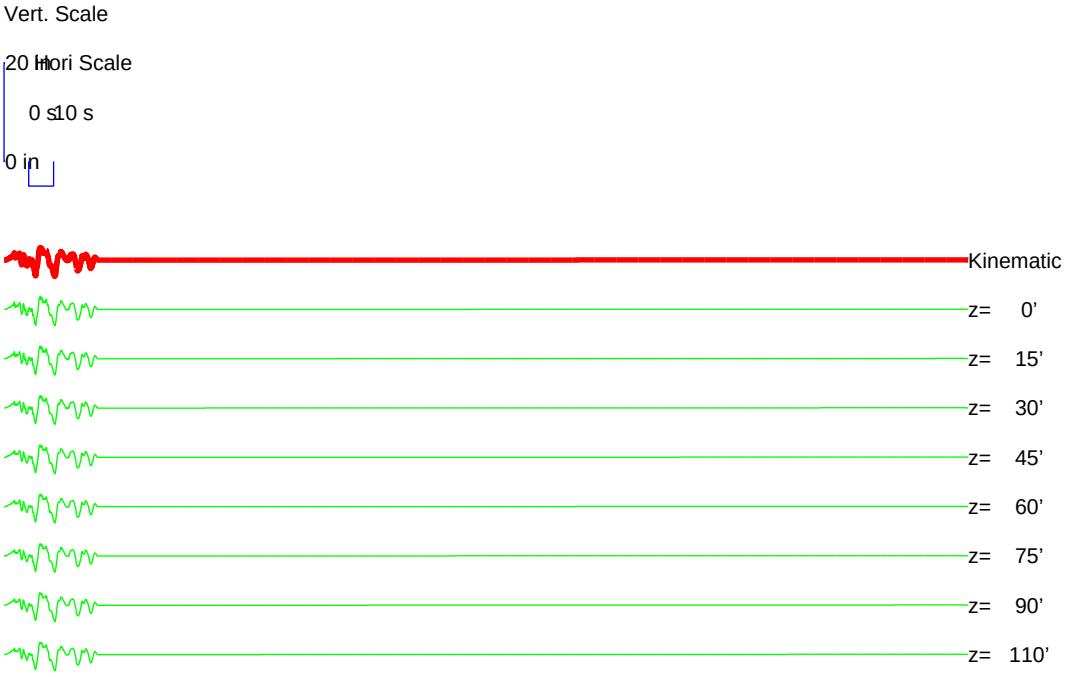
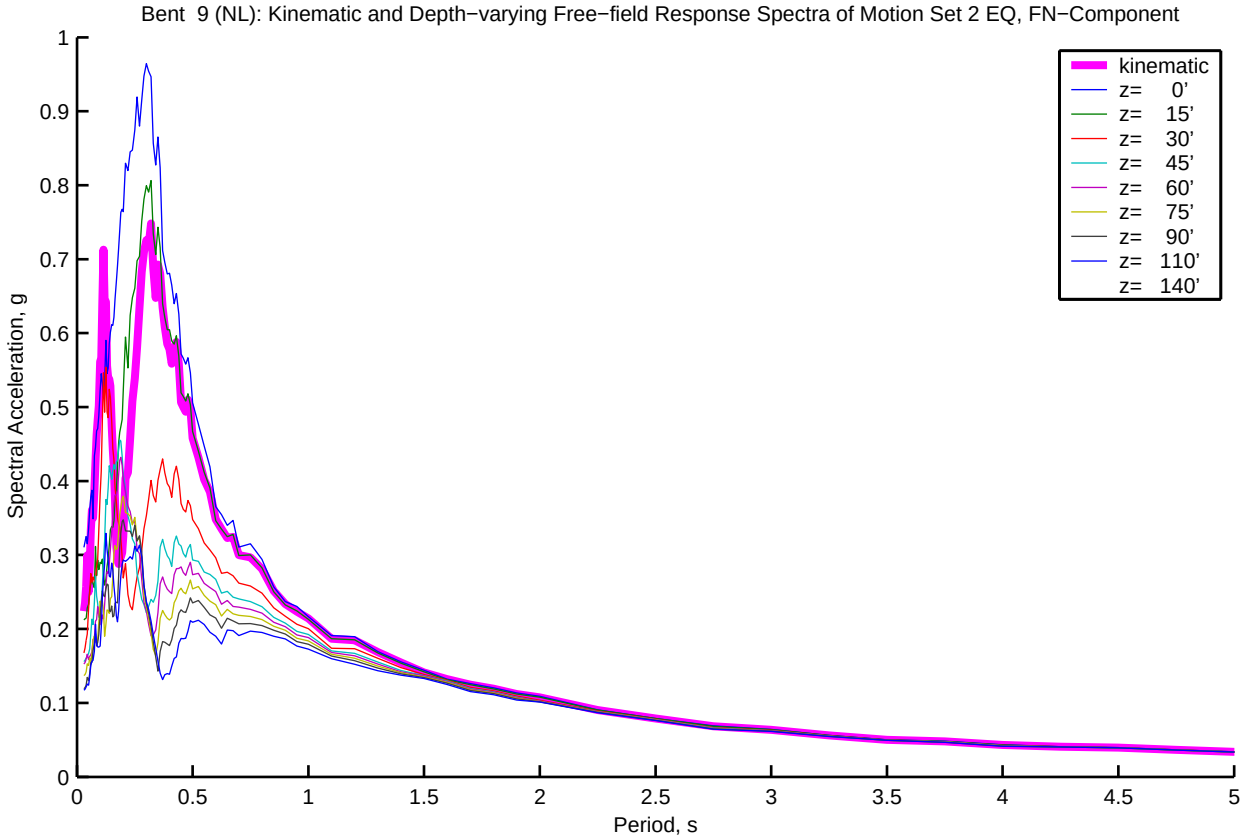
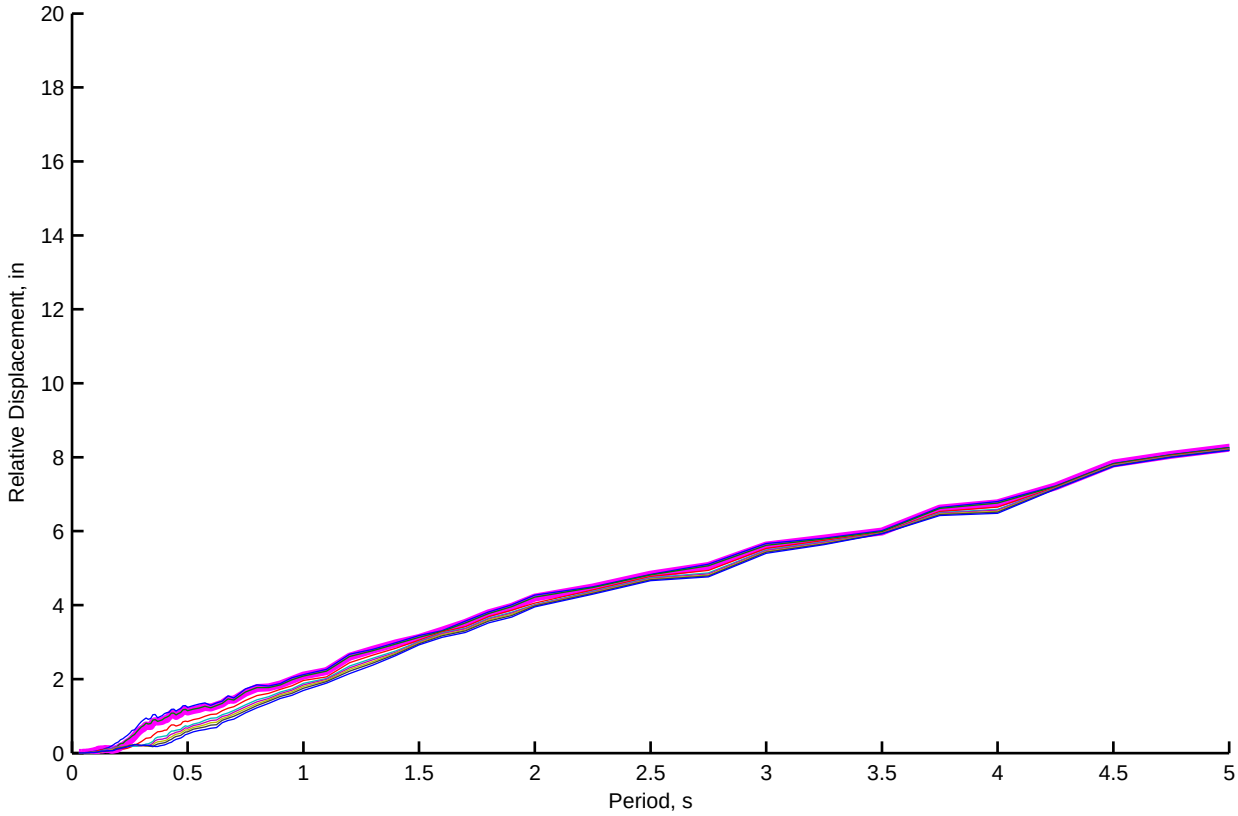
3
3.5
4
4.5
5

Bent 9 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

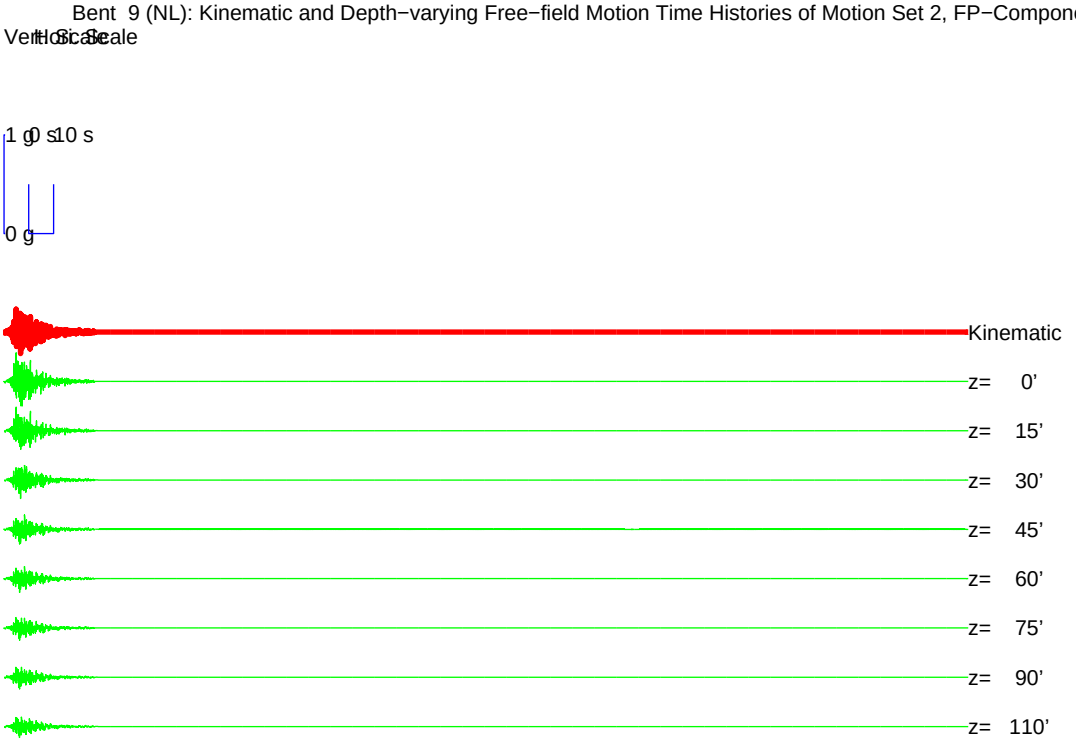


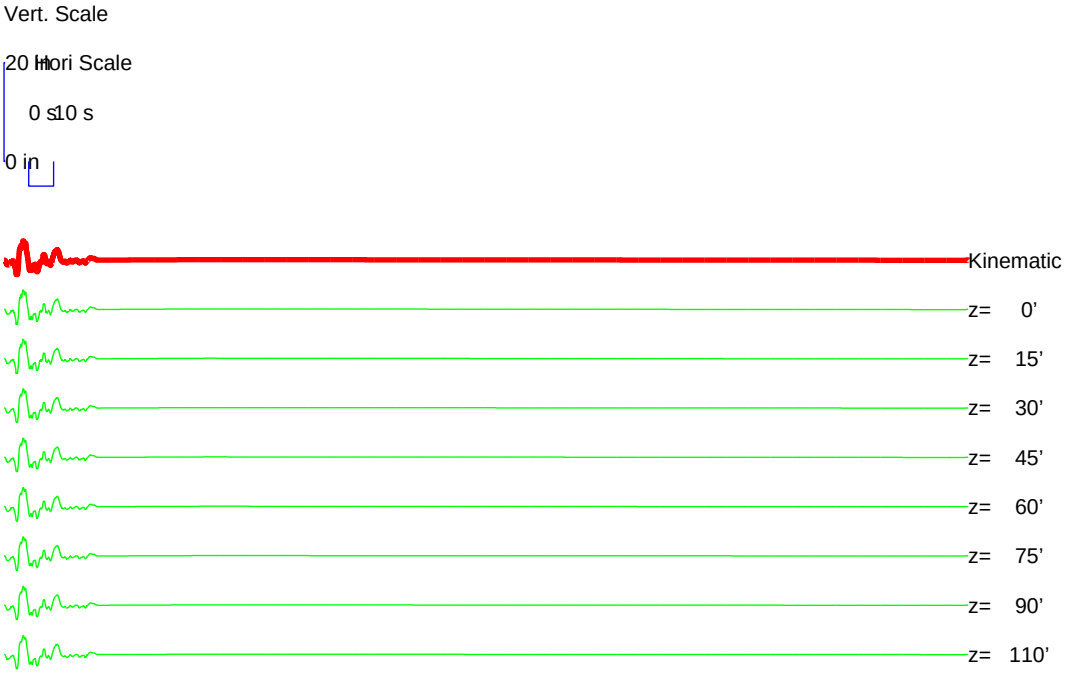



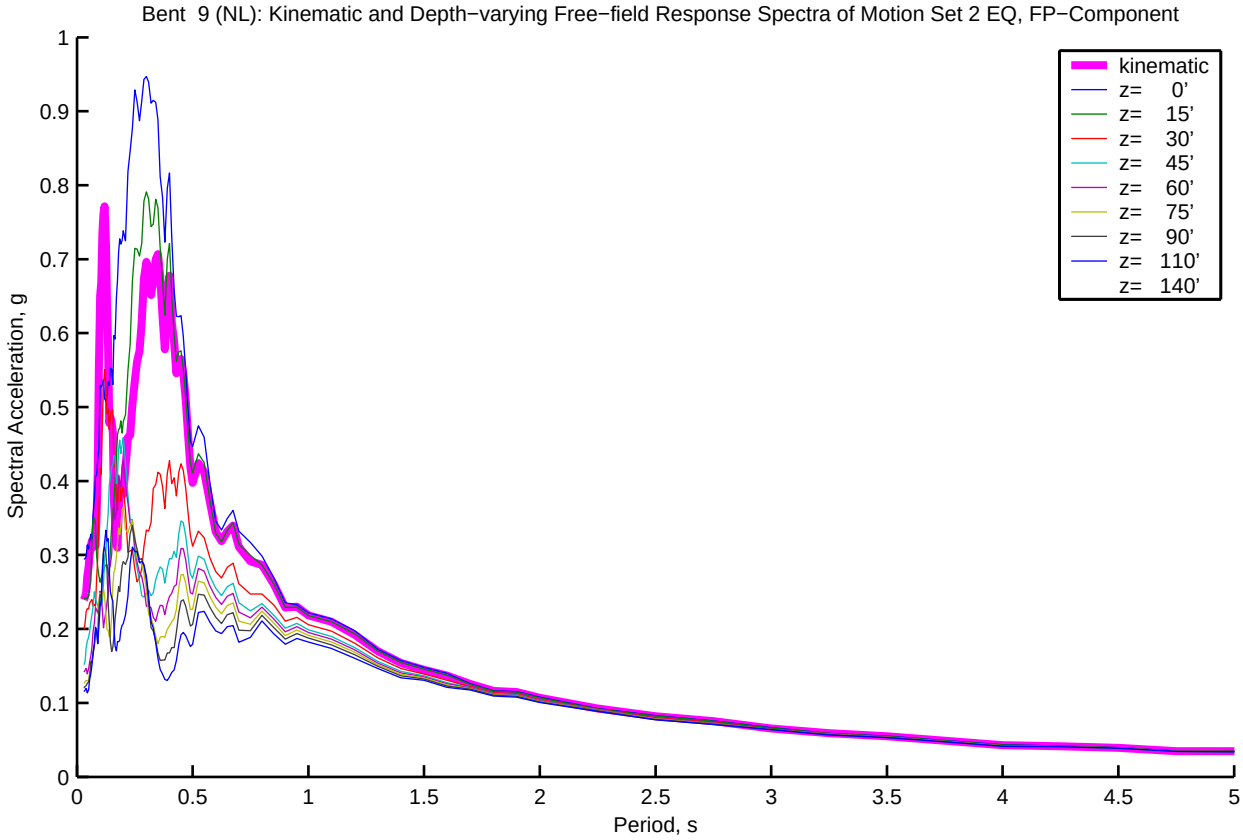

Bent 9 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

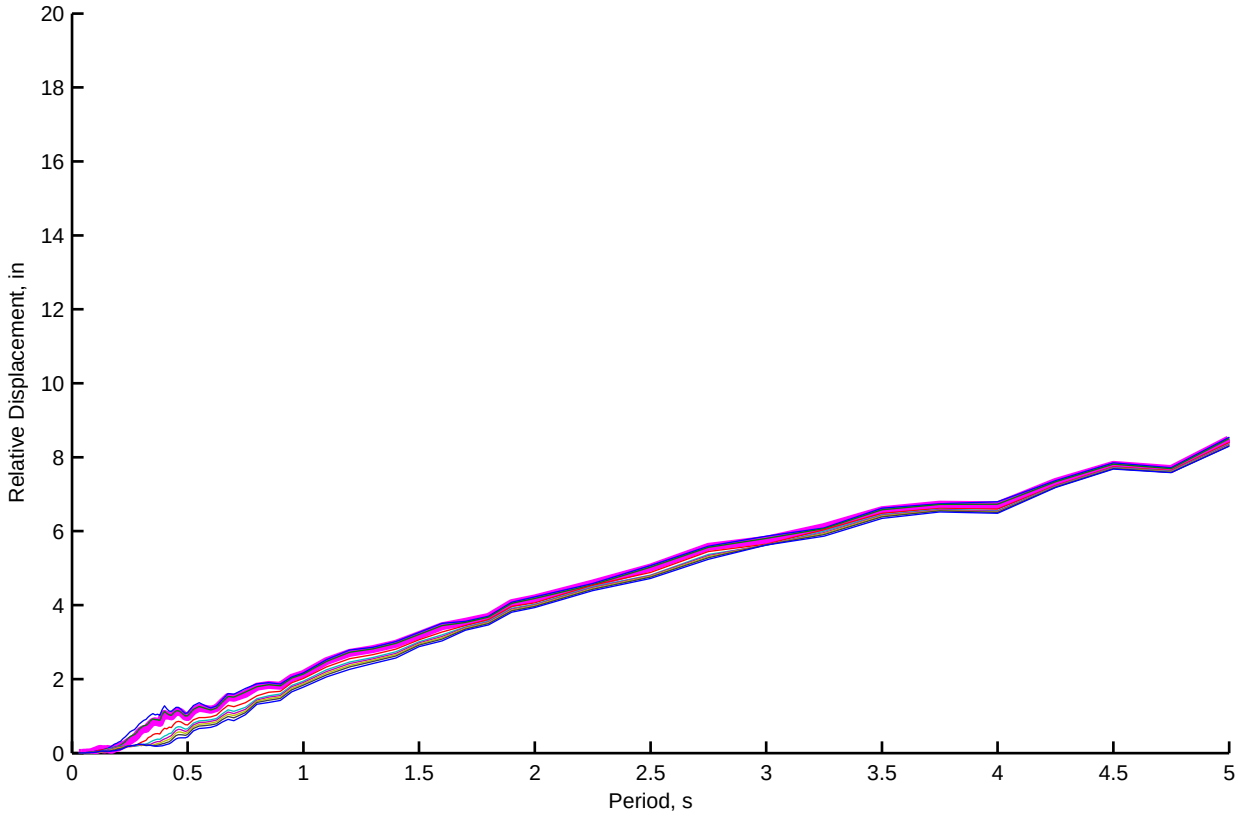

Relative Displacement, in
Period, s

Bent 9 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

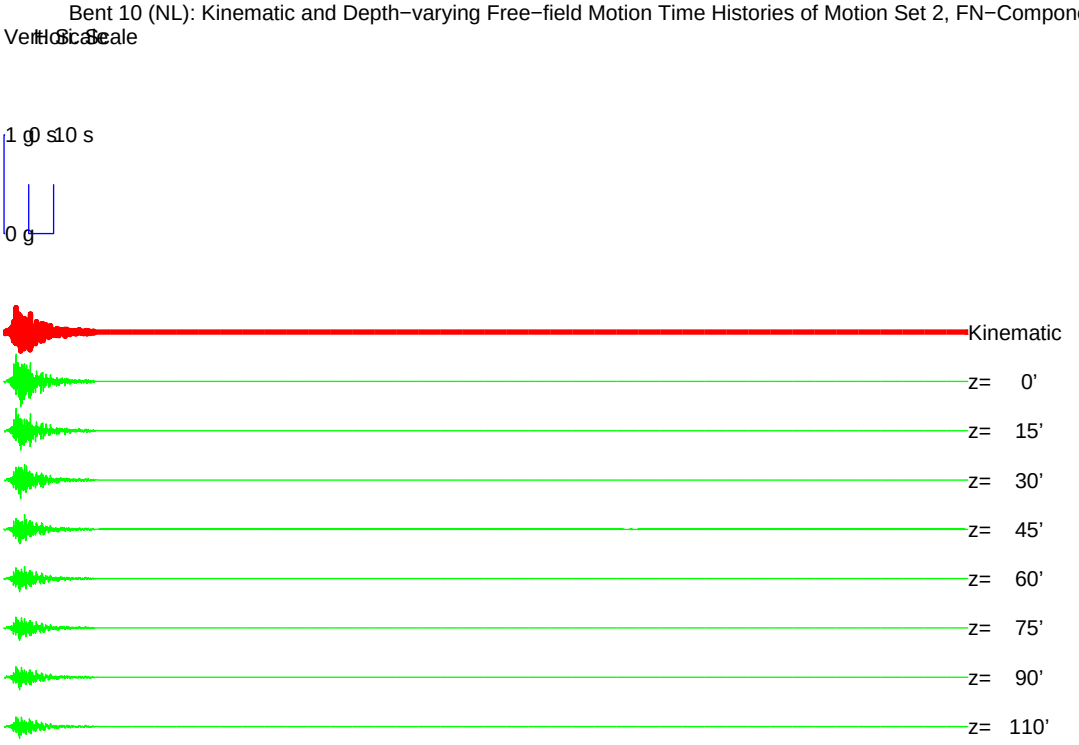


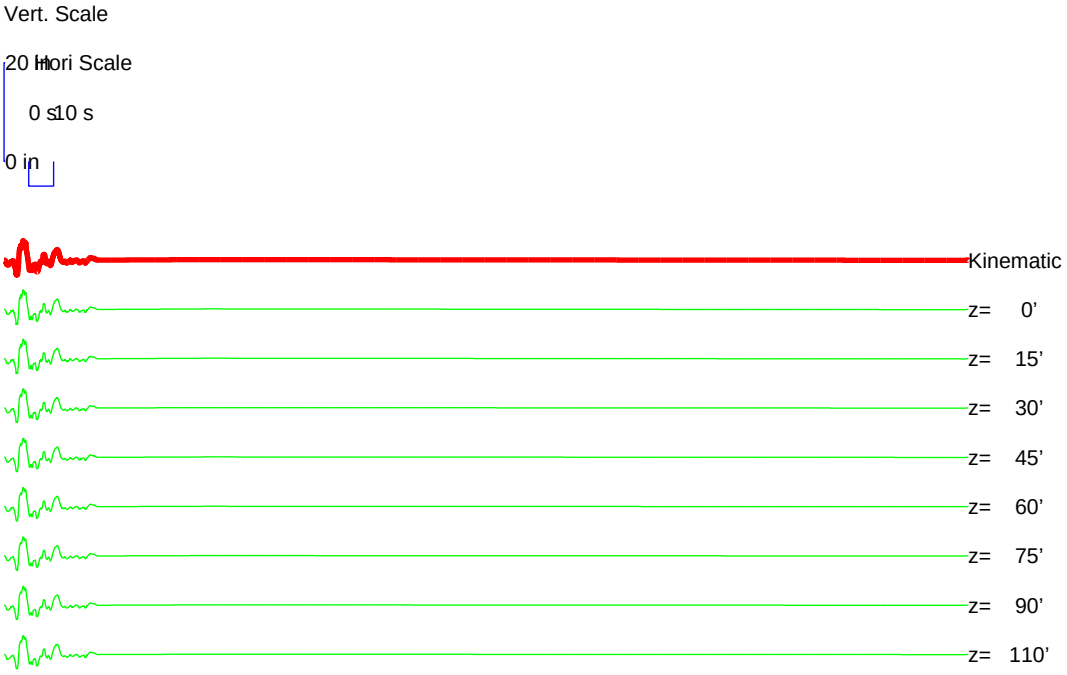



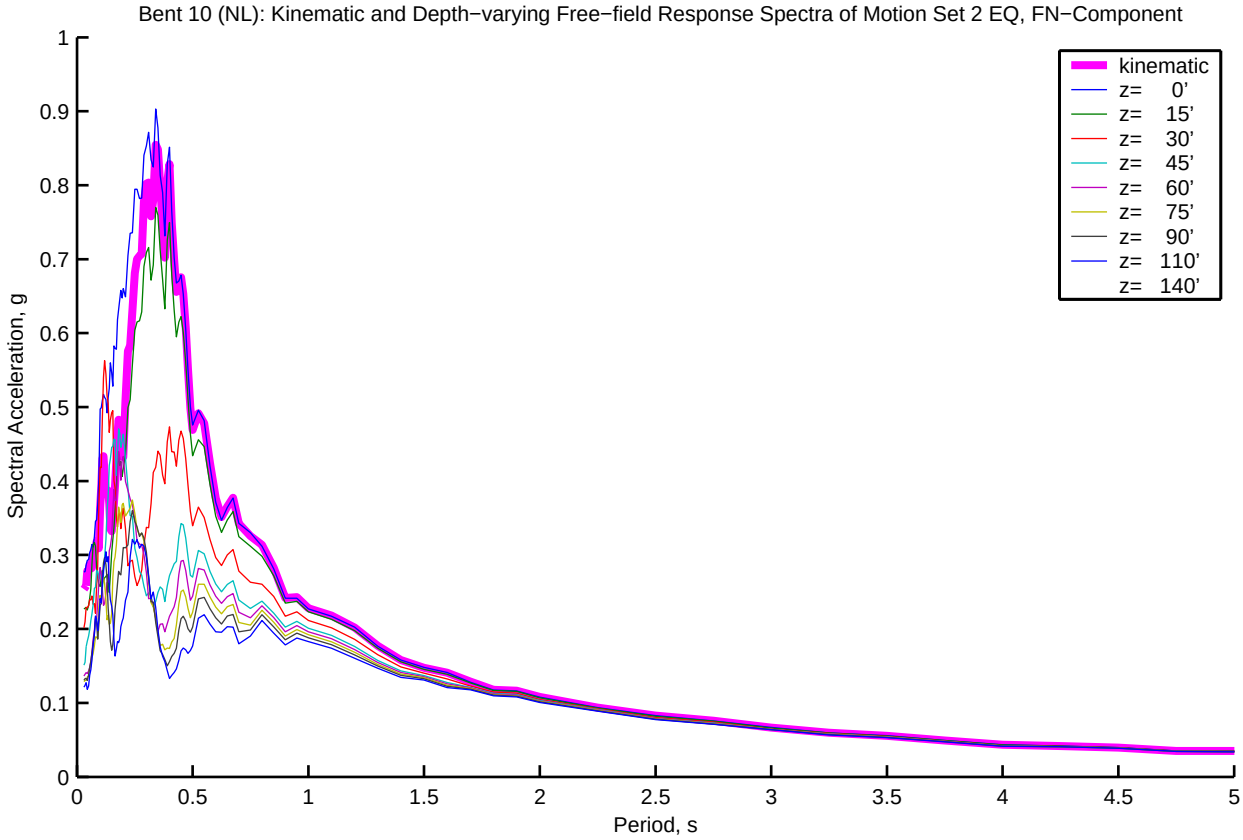

Bent 9 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

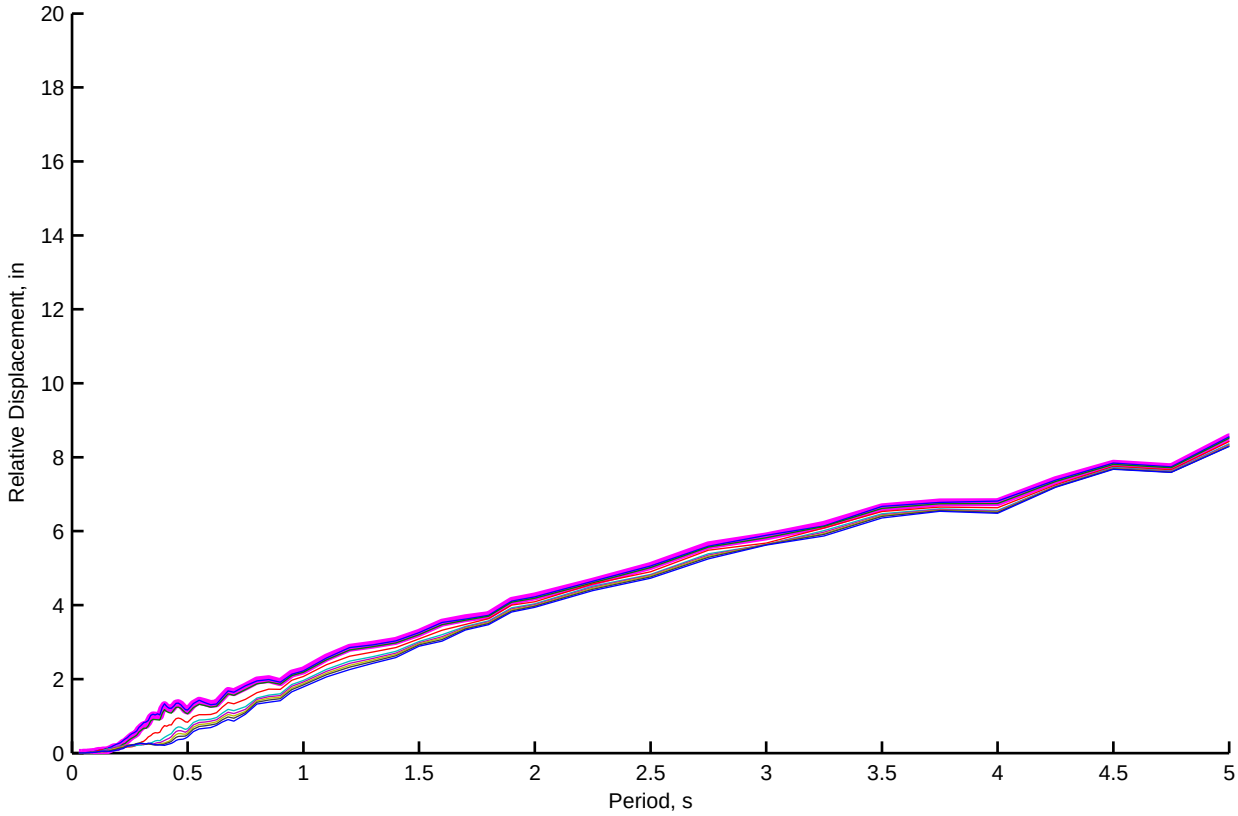

Relative Displacement, in
Period, s

Bent 10 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

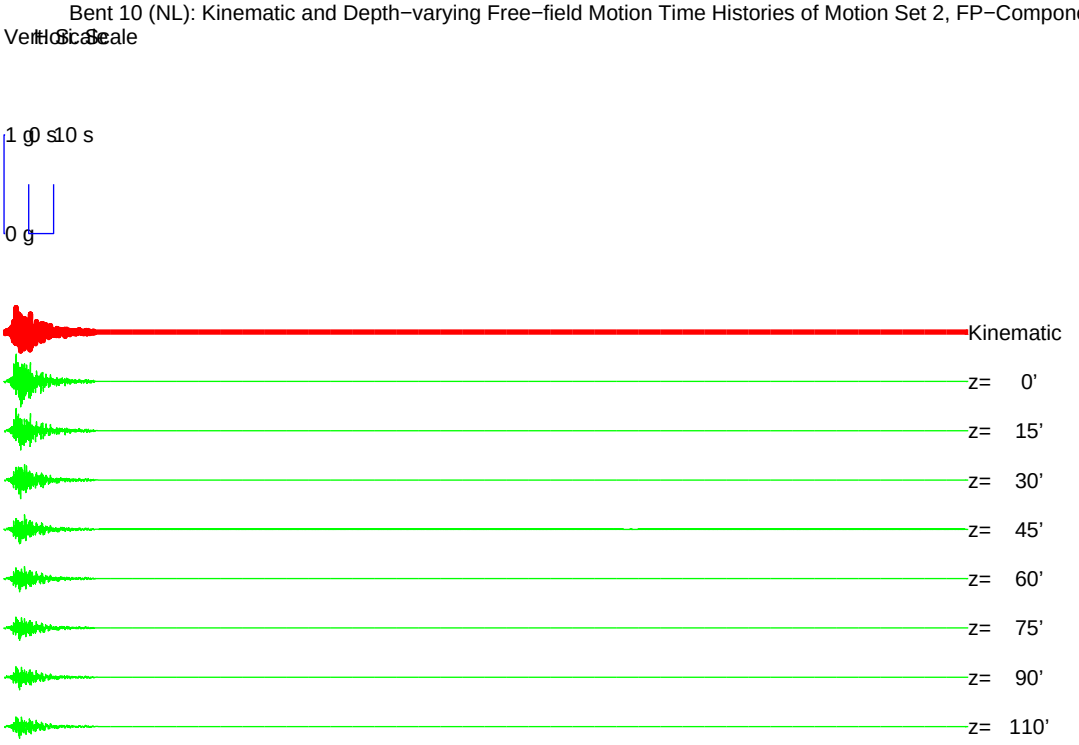


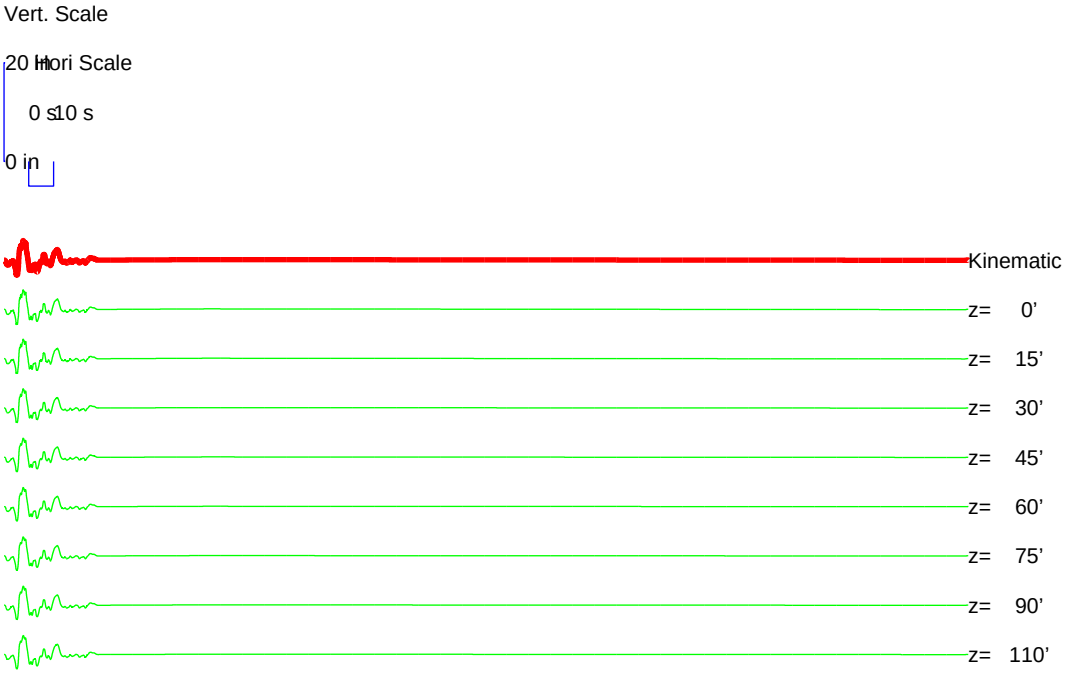



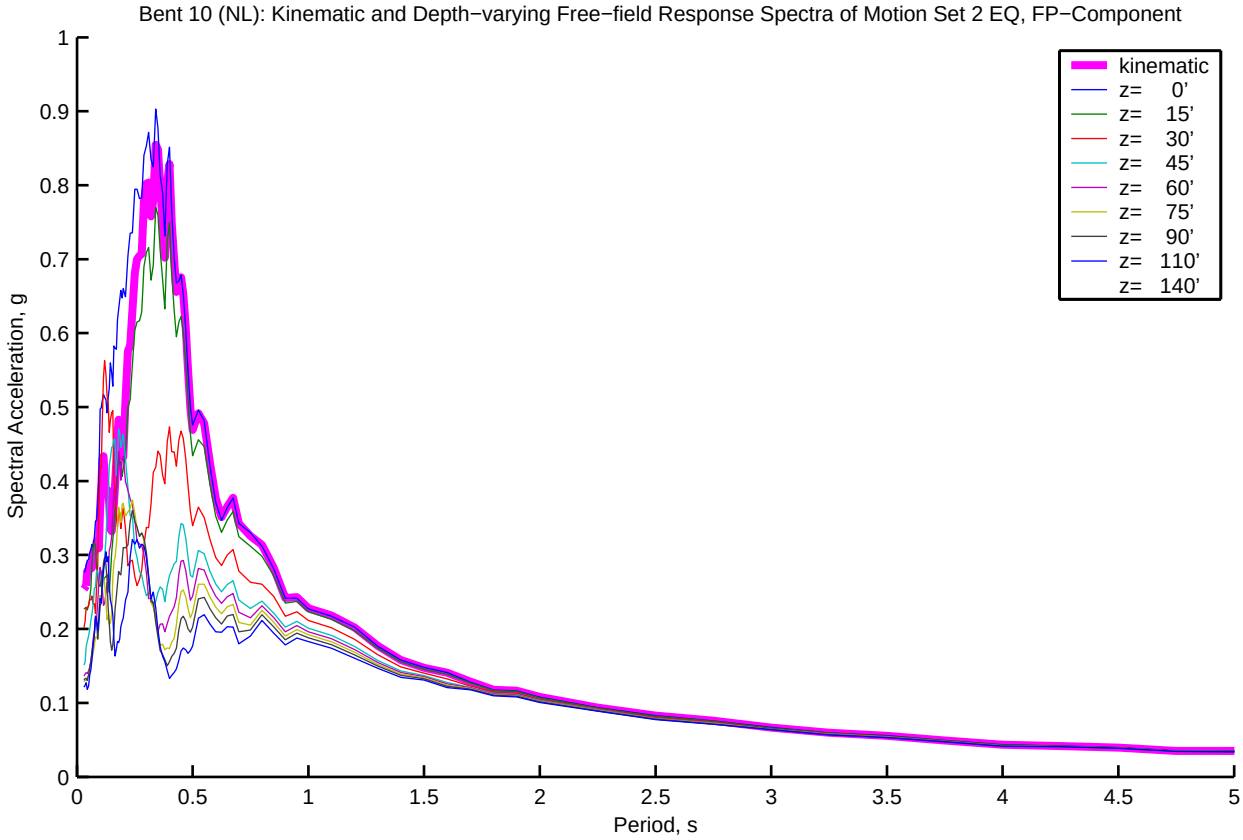

Bent 10 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

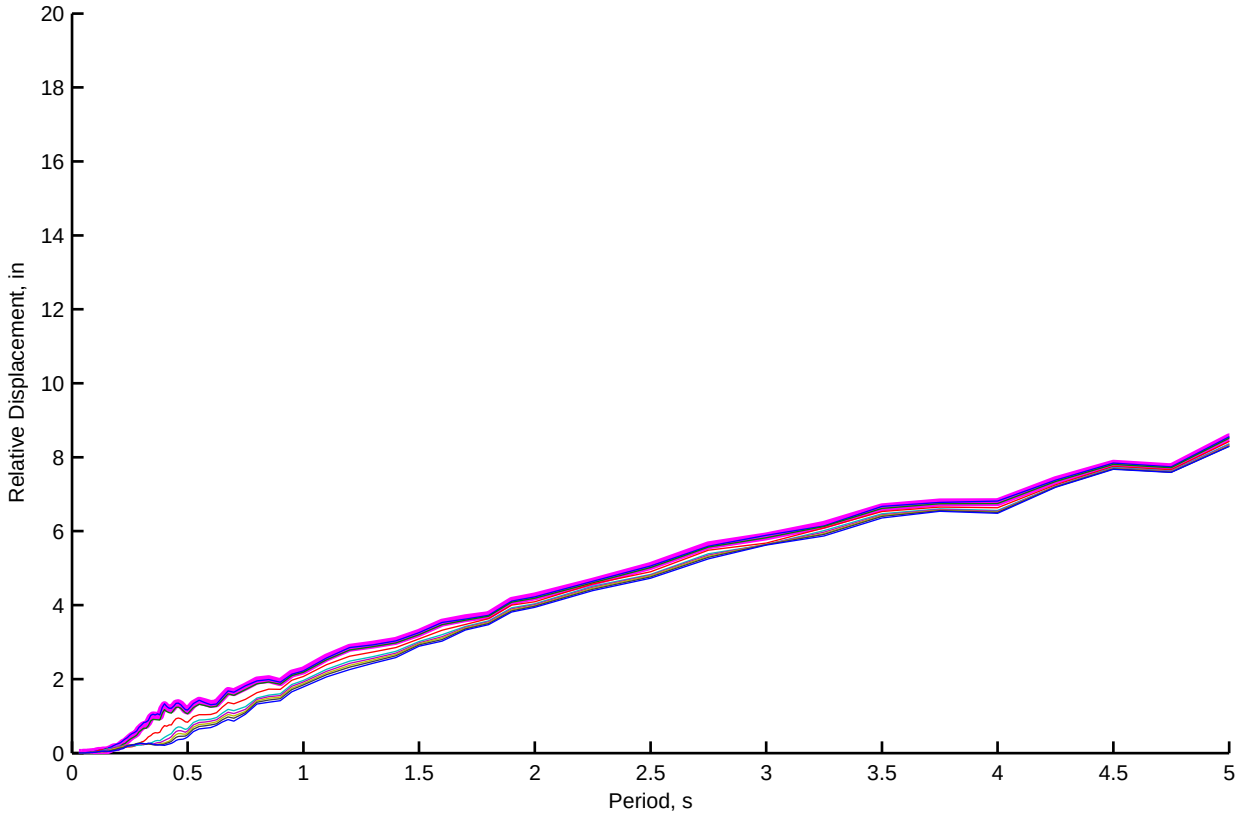

Relative Displacement, in
Period, s

Bent 10 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

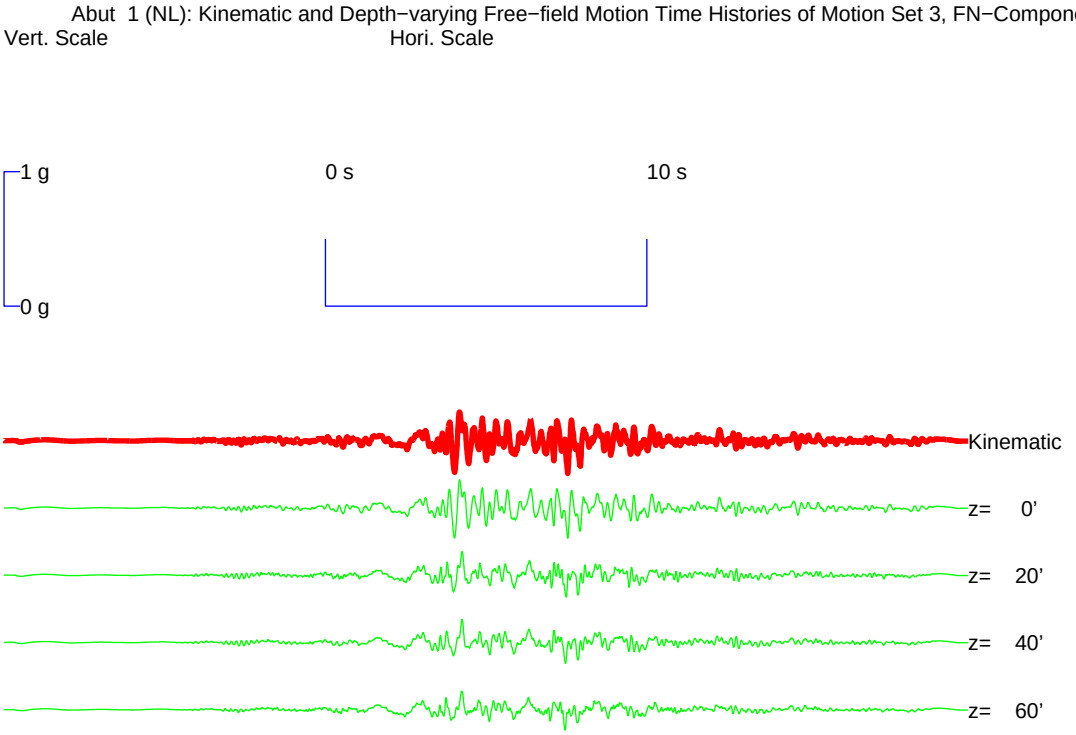


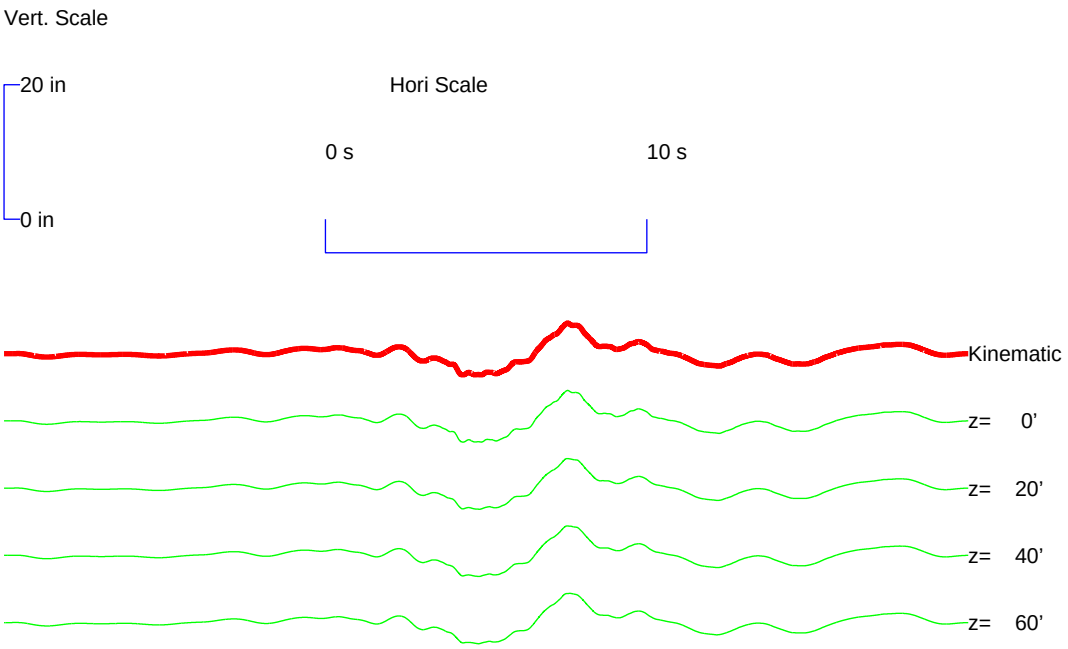



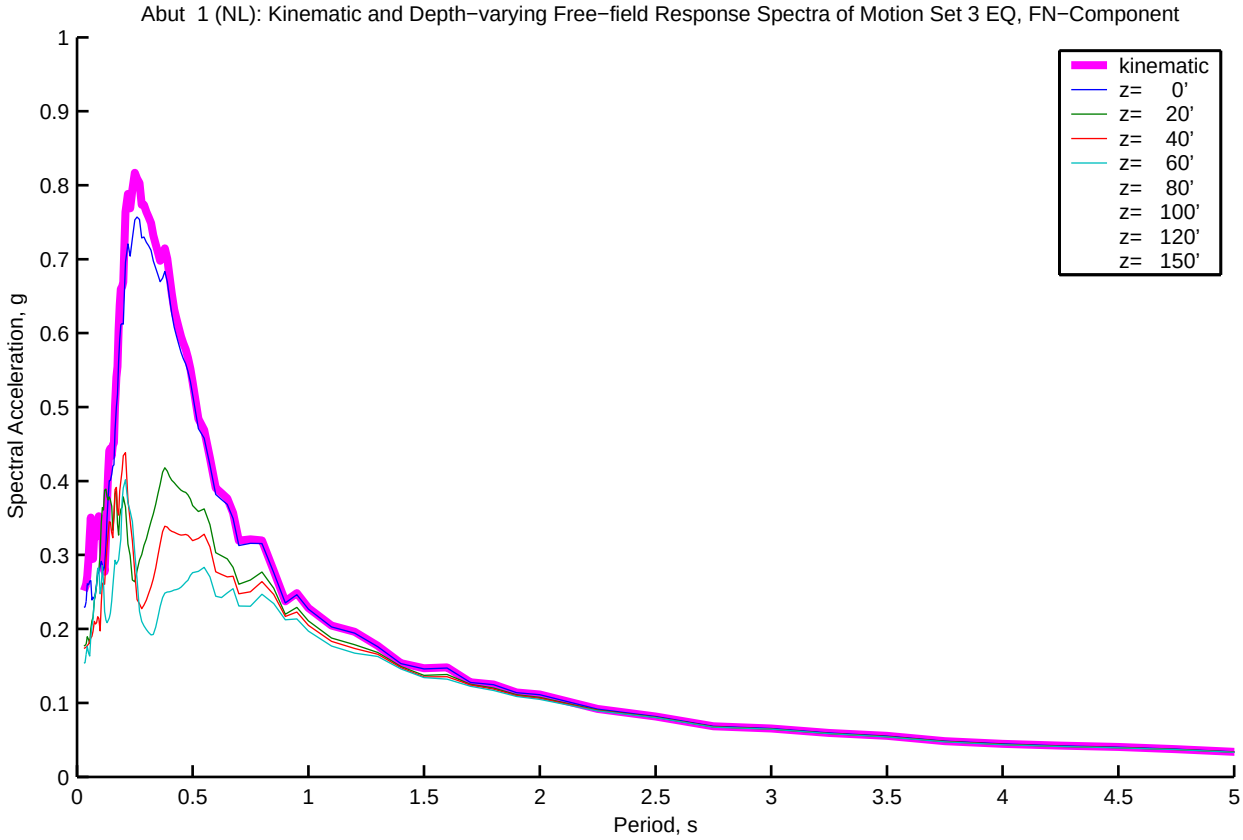

Bent 10 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

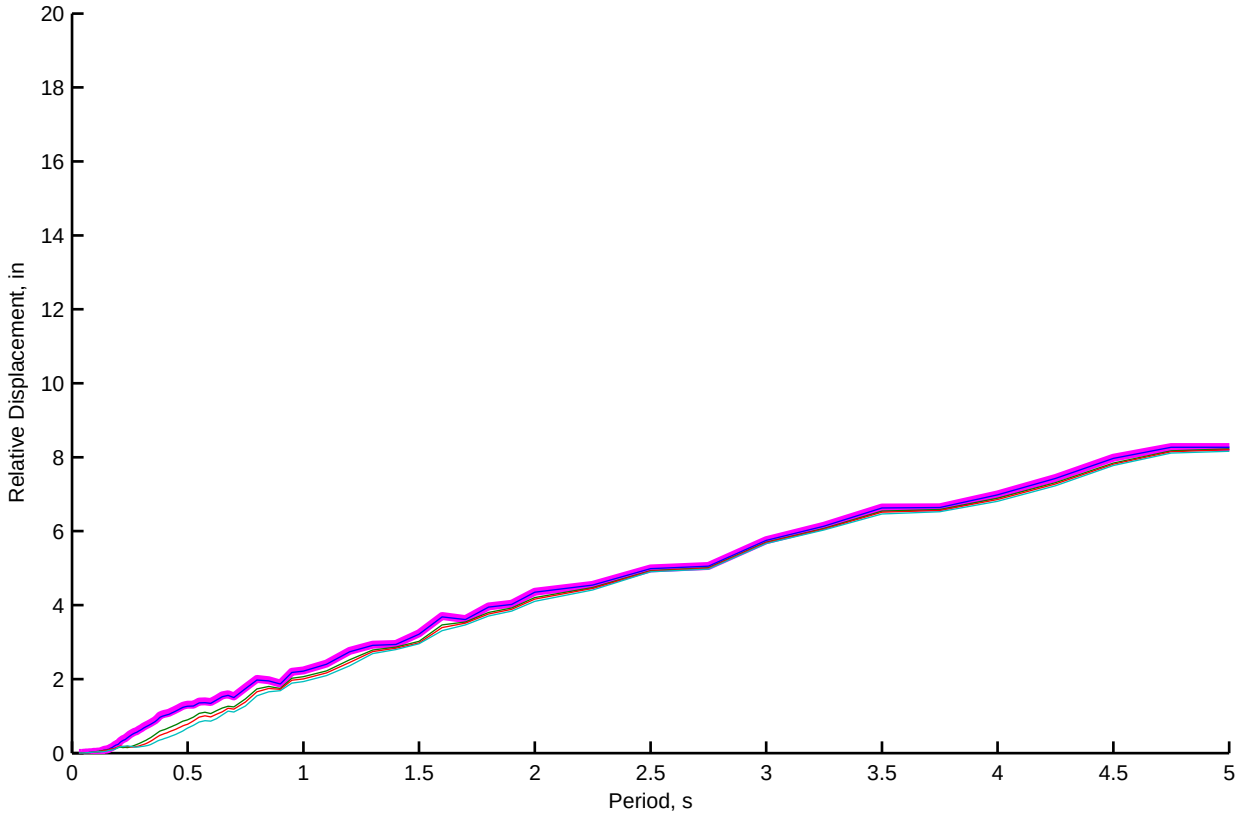

Relative Displacement, in
Period, s

Abut 1 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

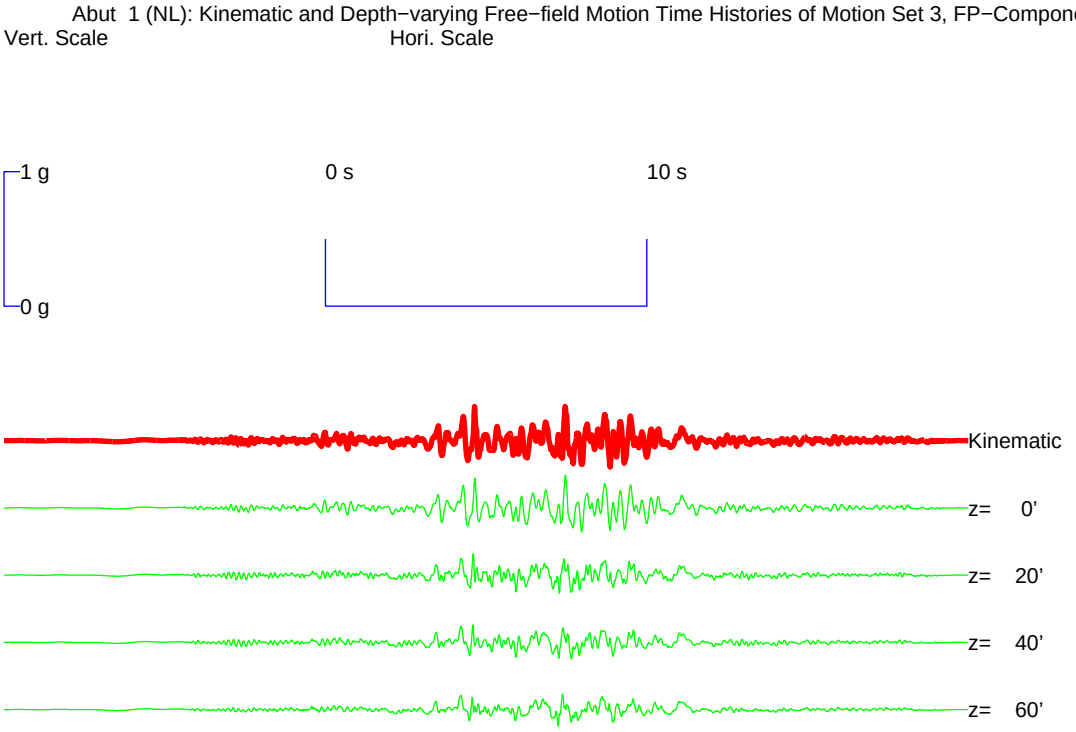


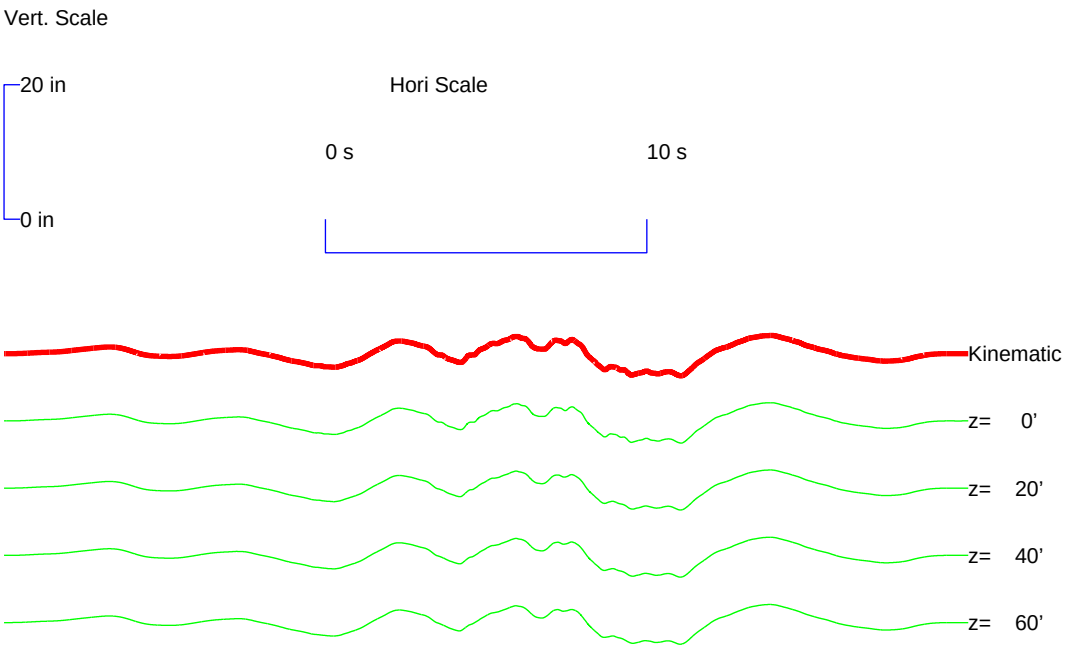



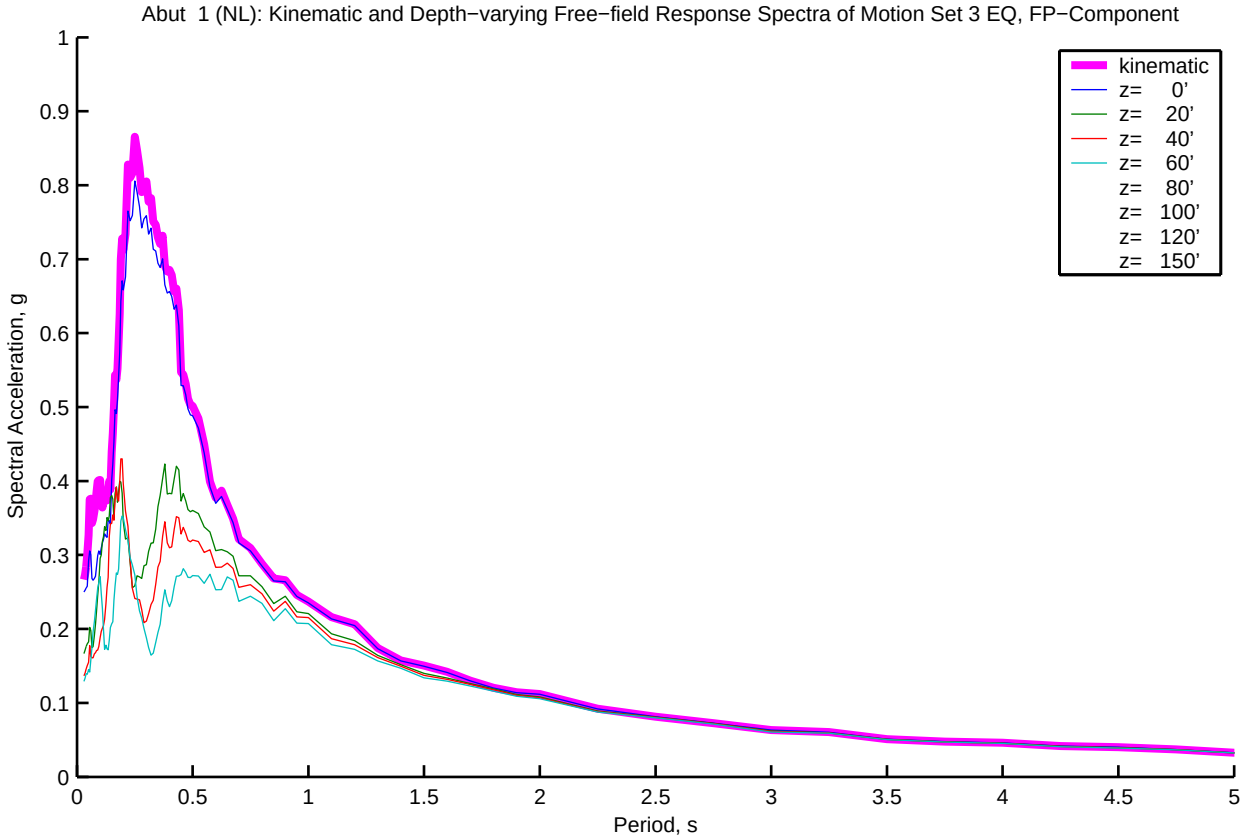

Abut 1 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

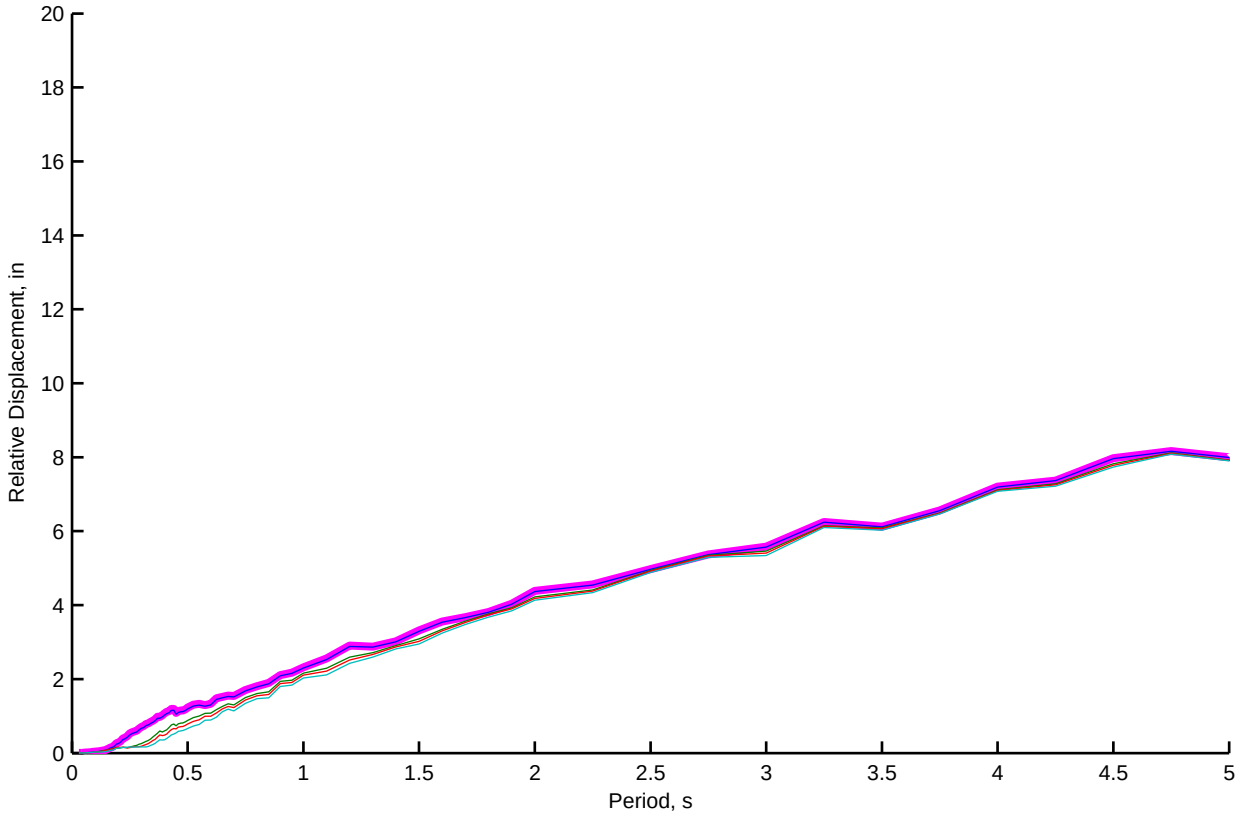

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 1 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

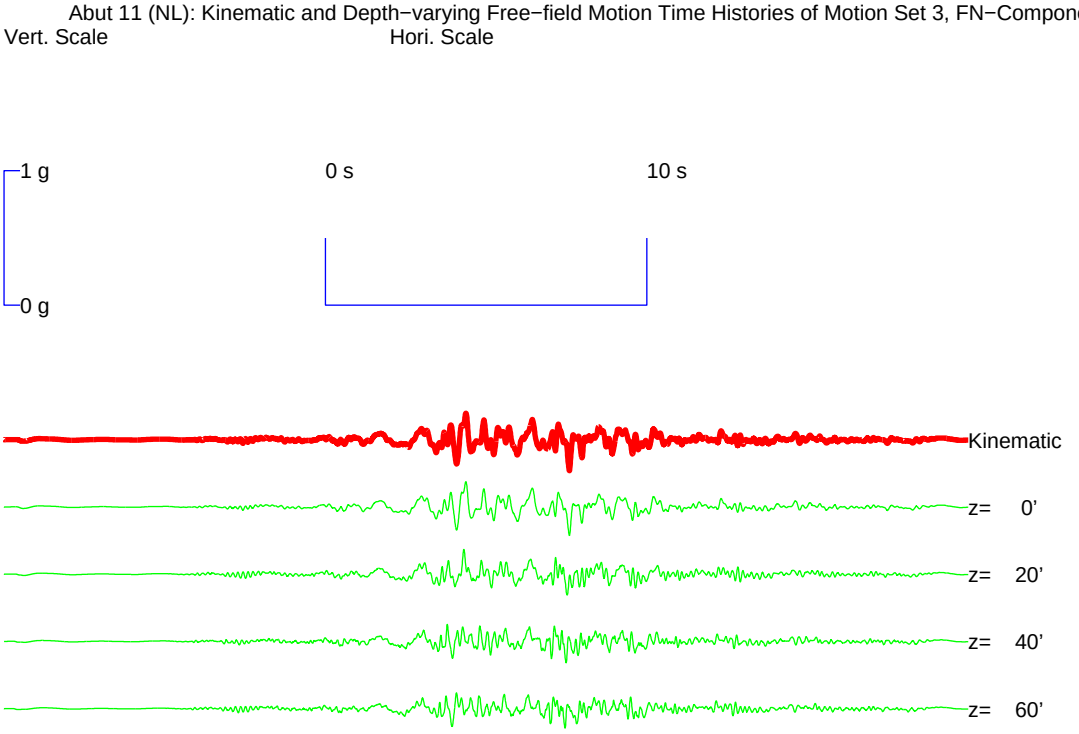


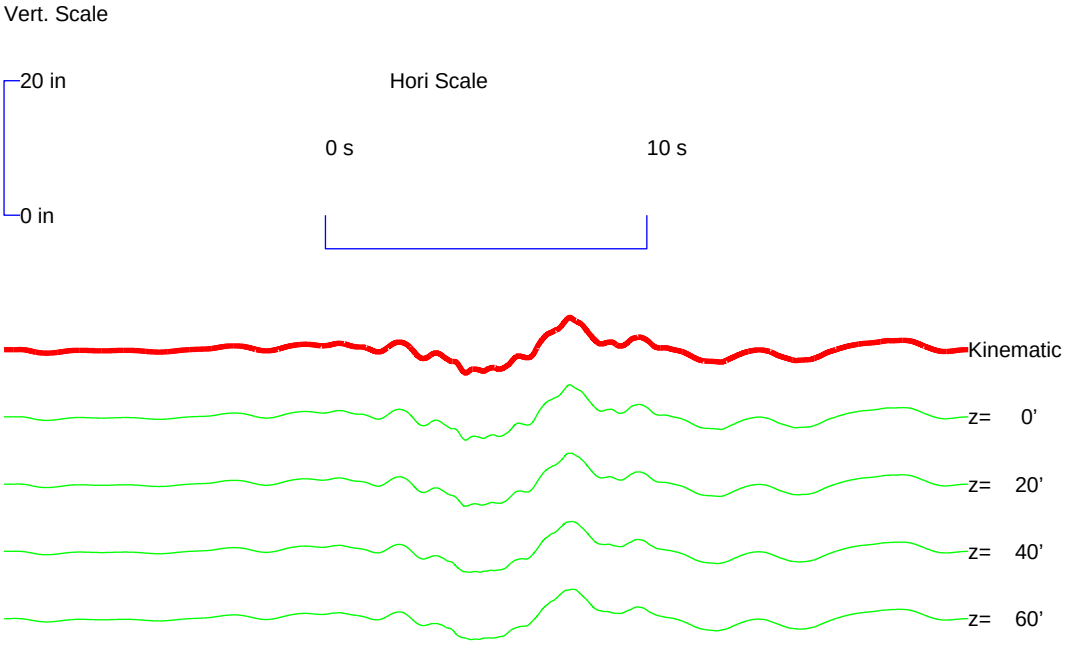



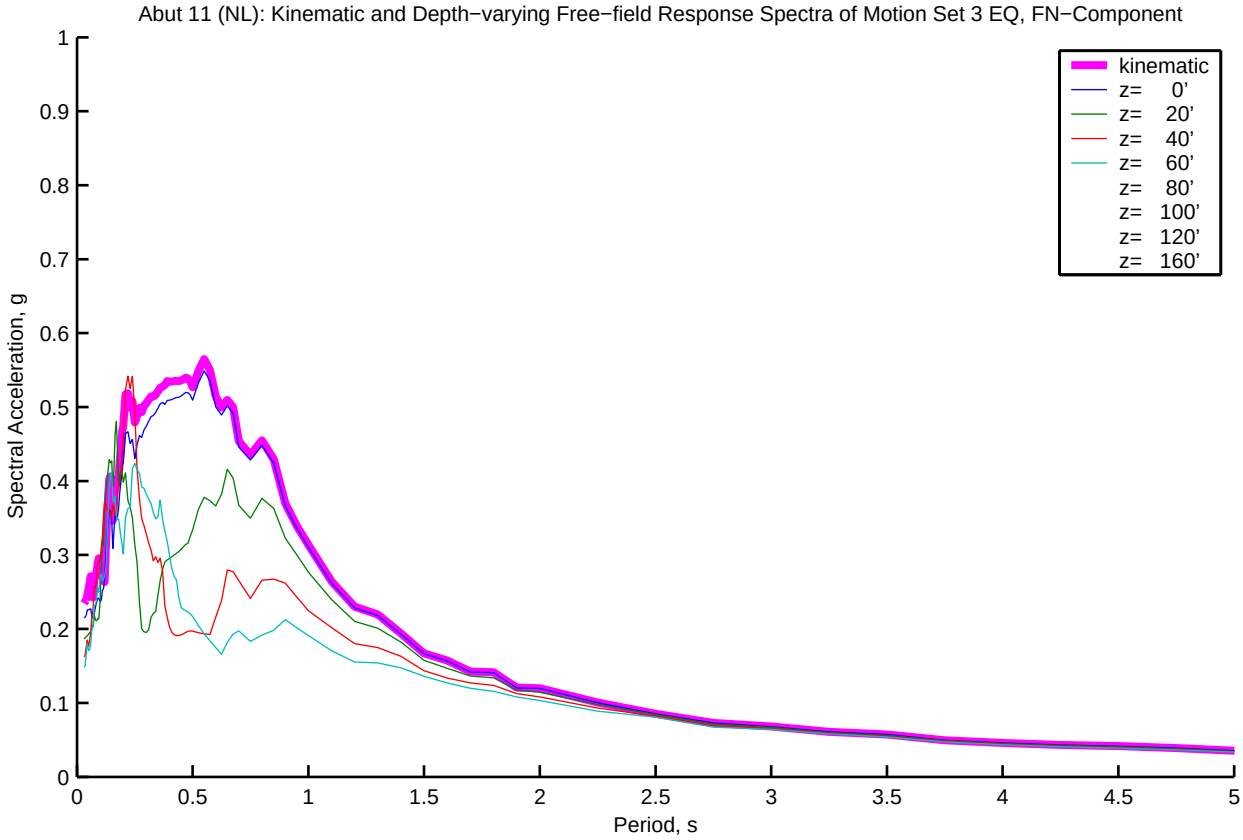

Abut 1 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

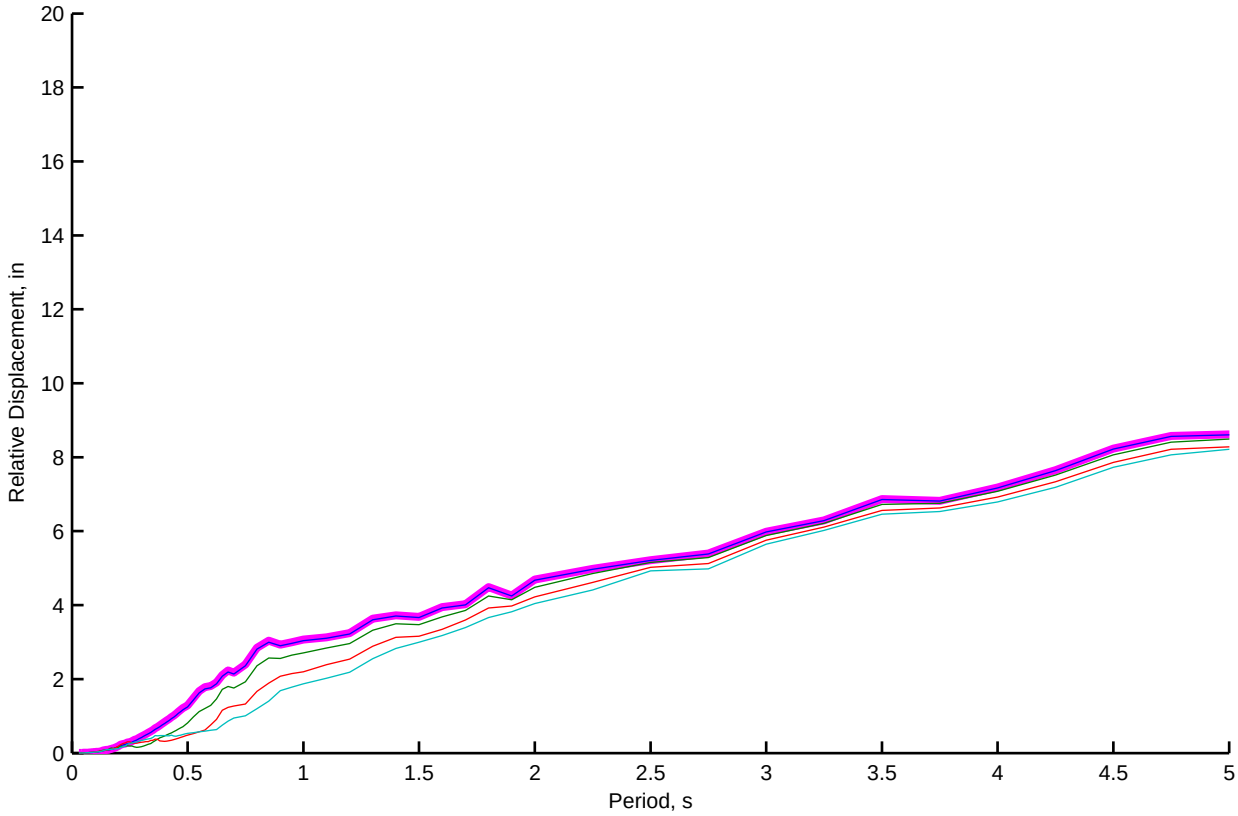

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

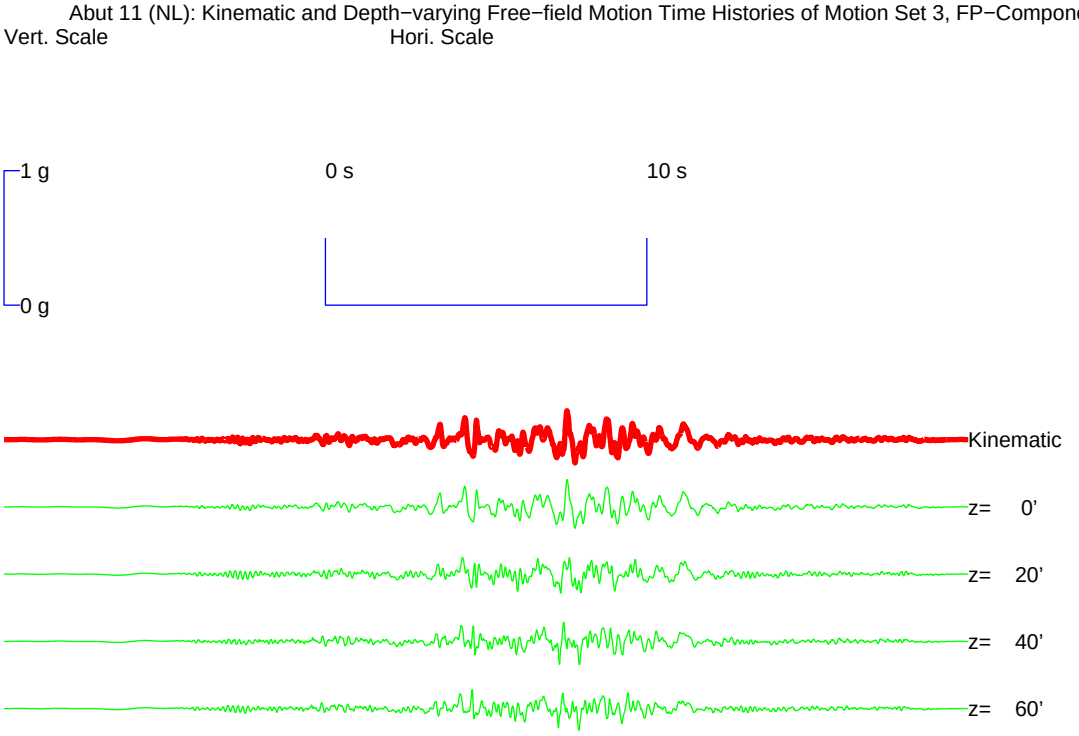


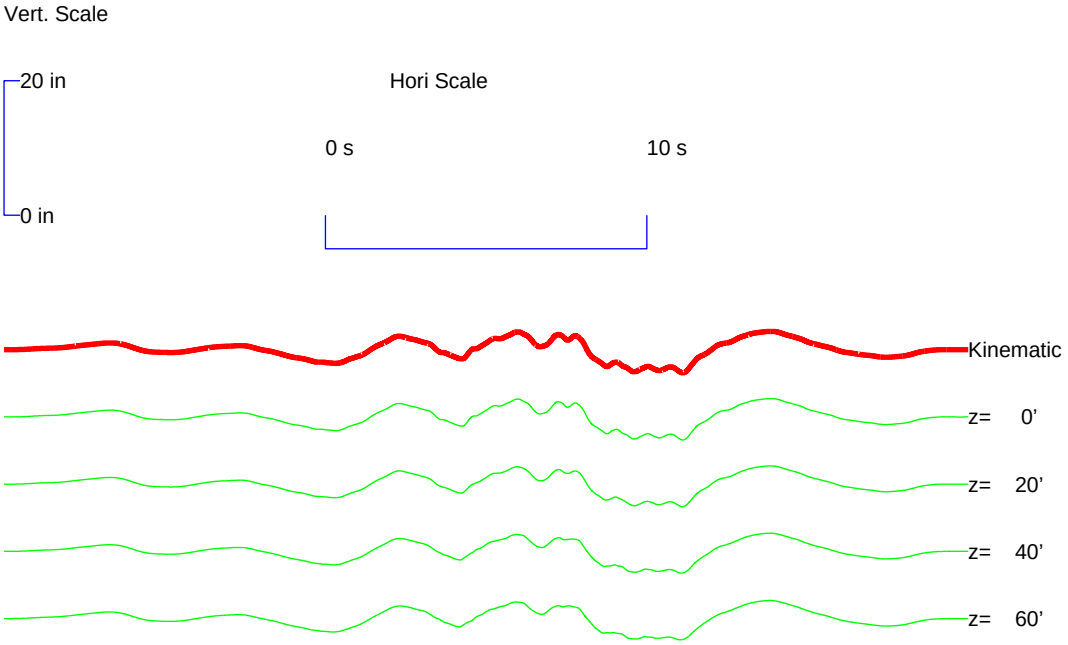



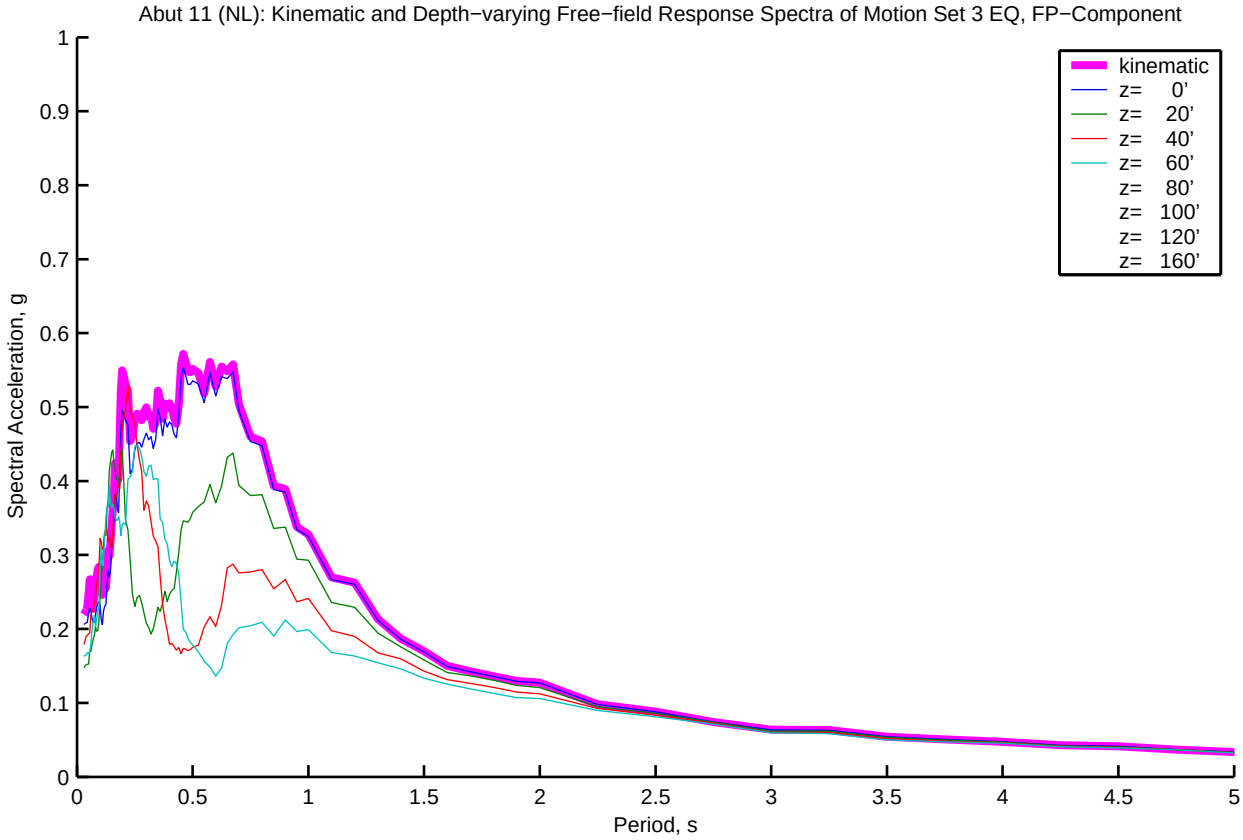

Abut 11 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

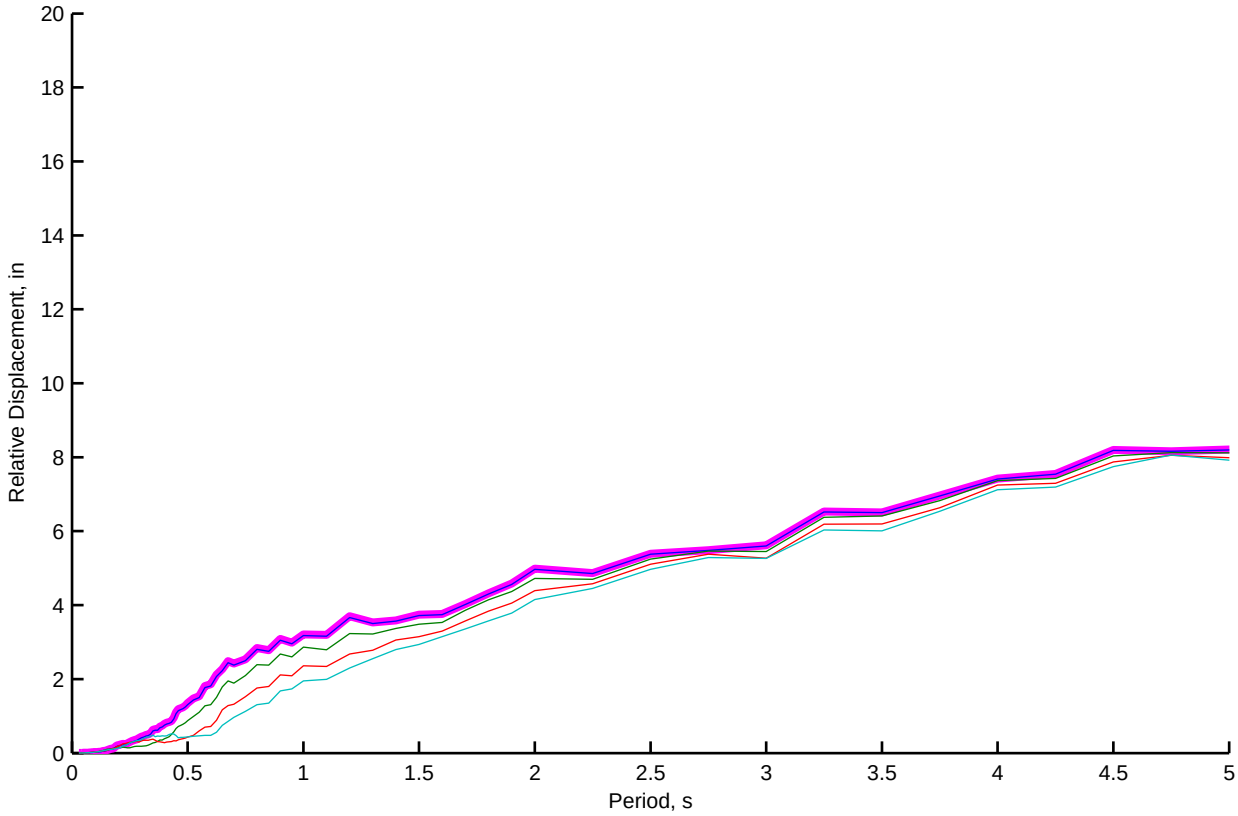

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

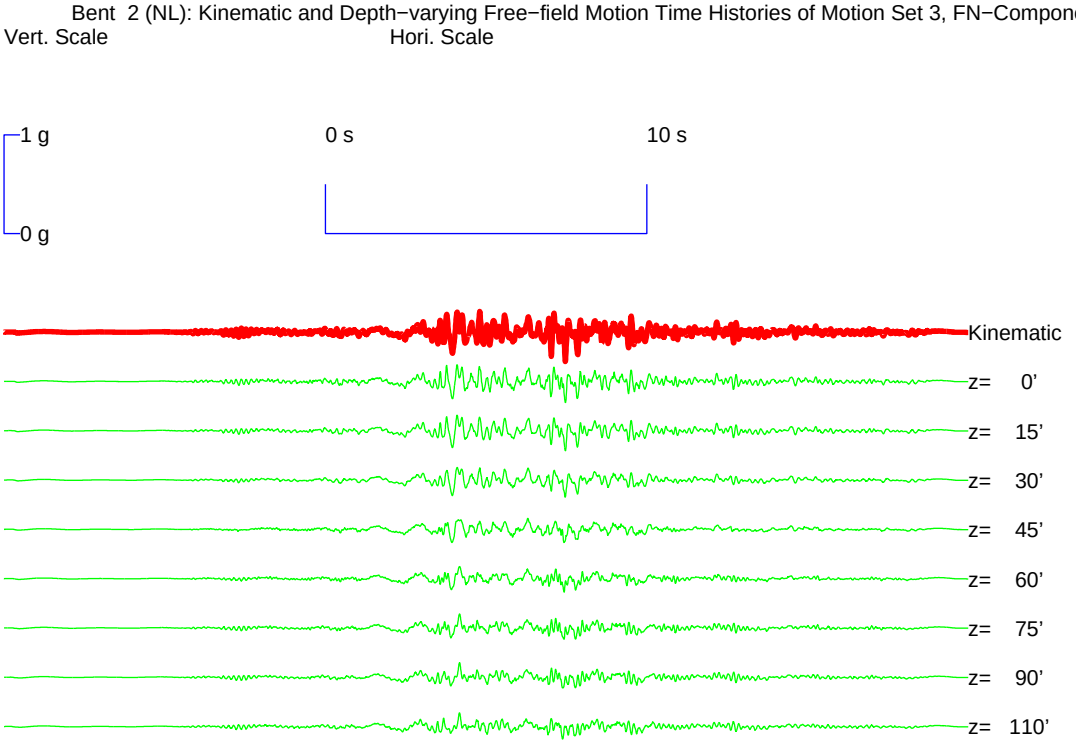


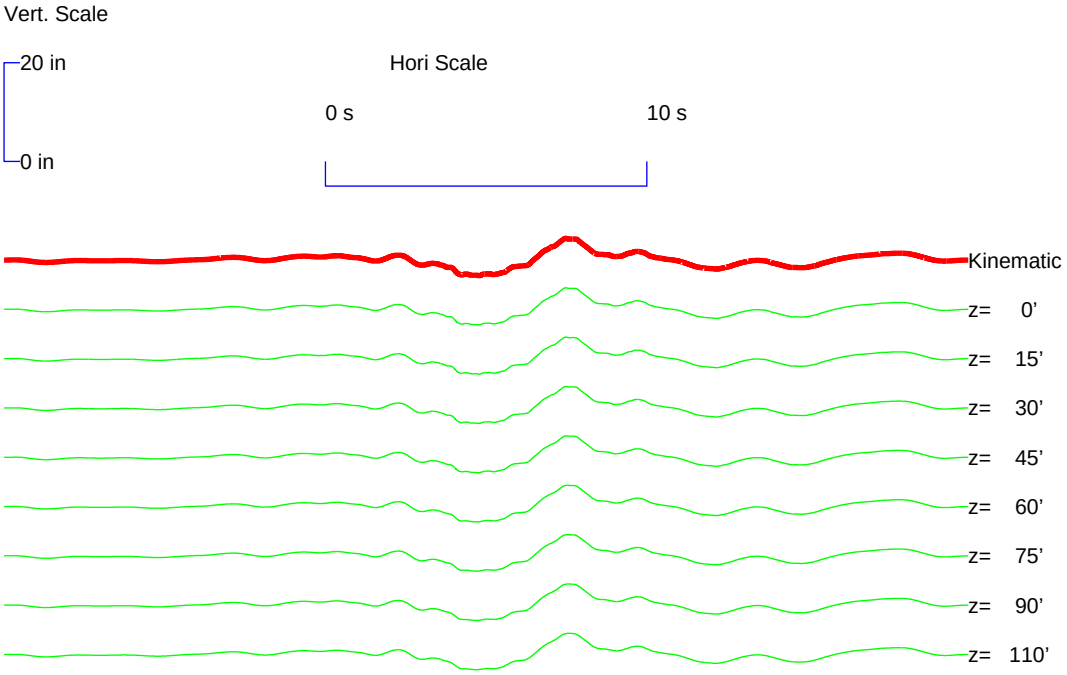



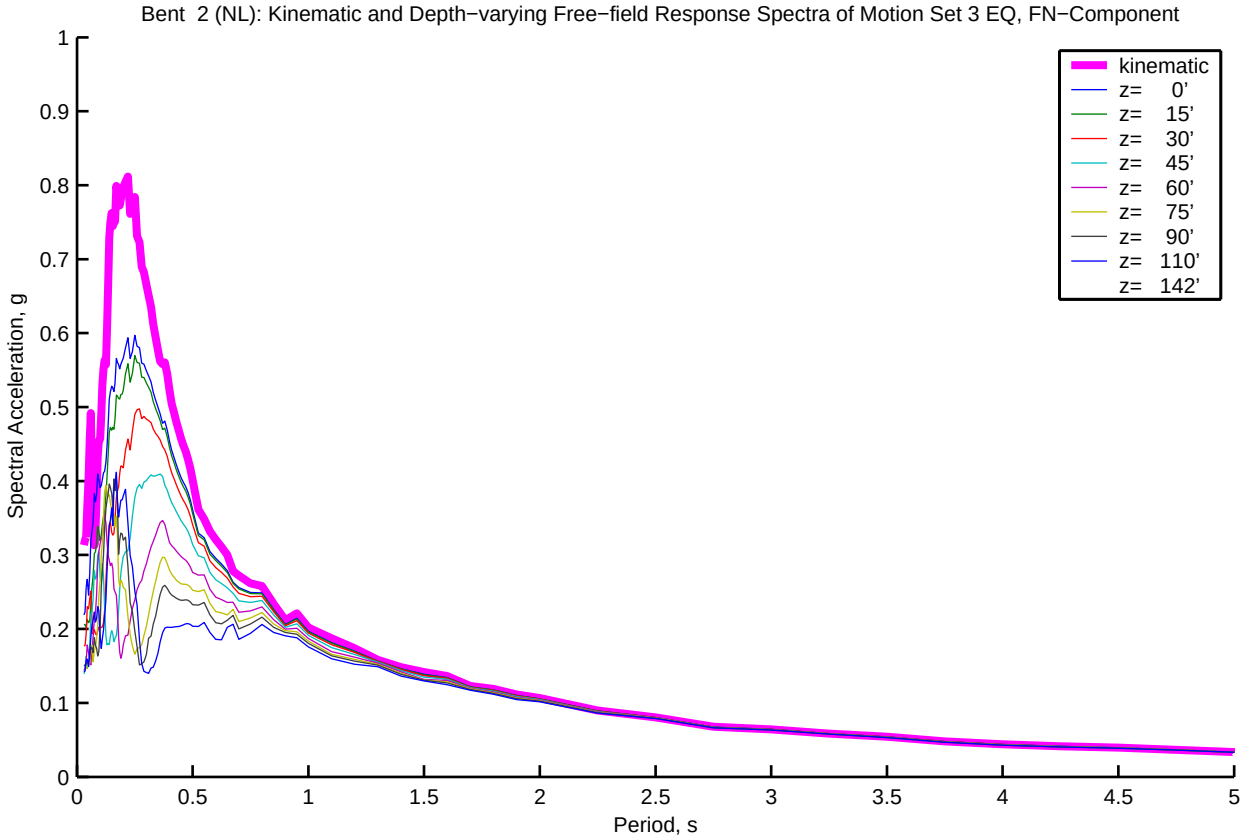

Abut 11 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

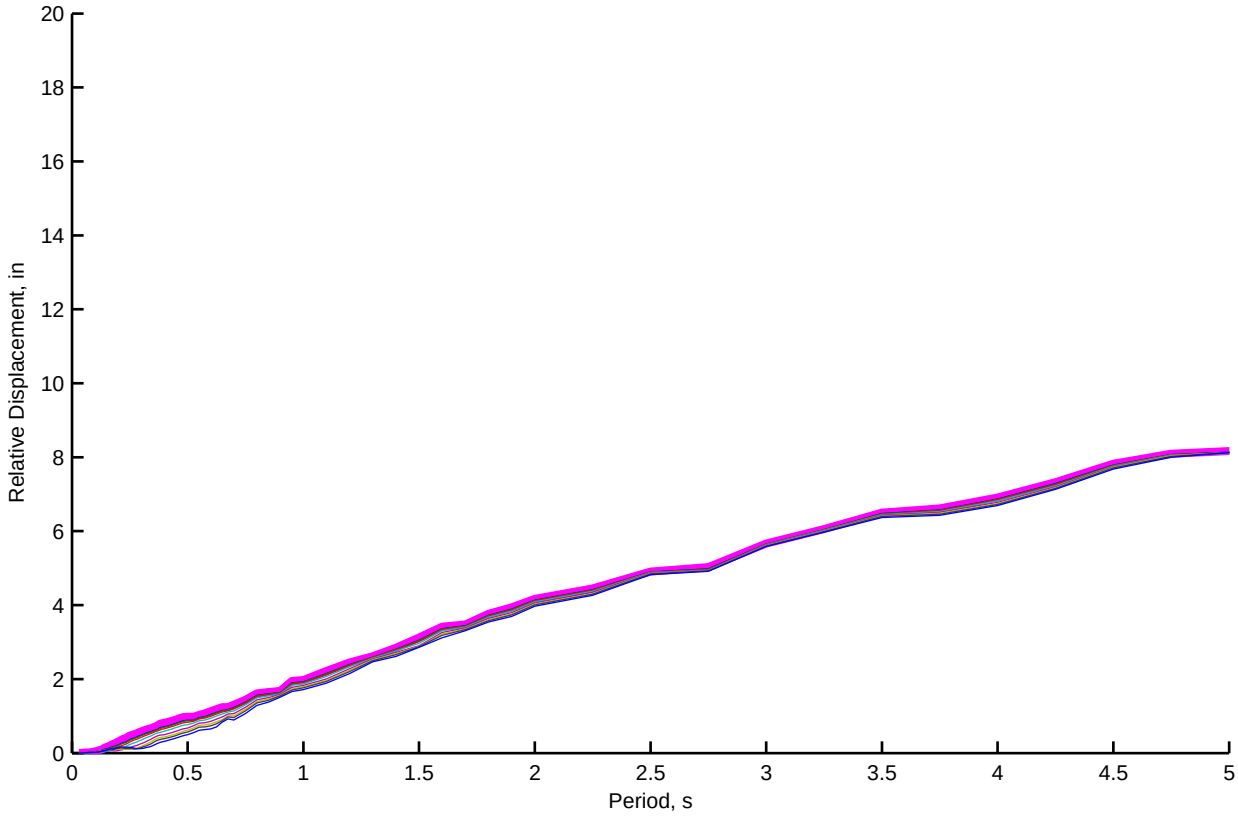

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

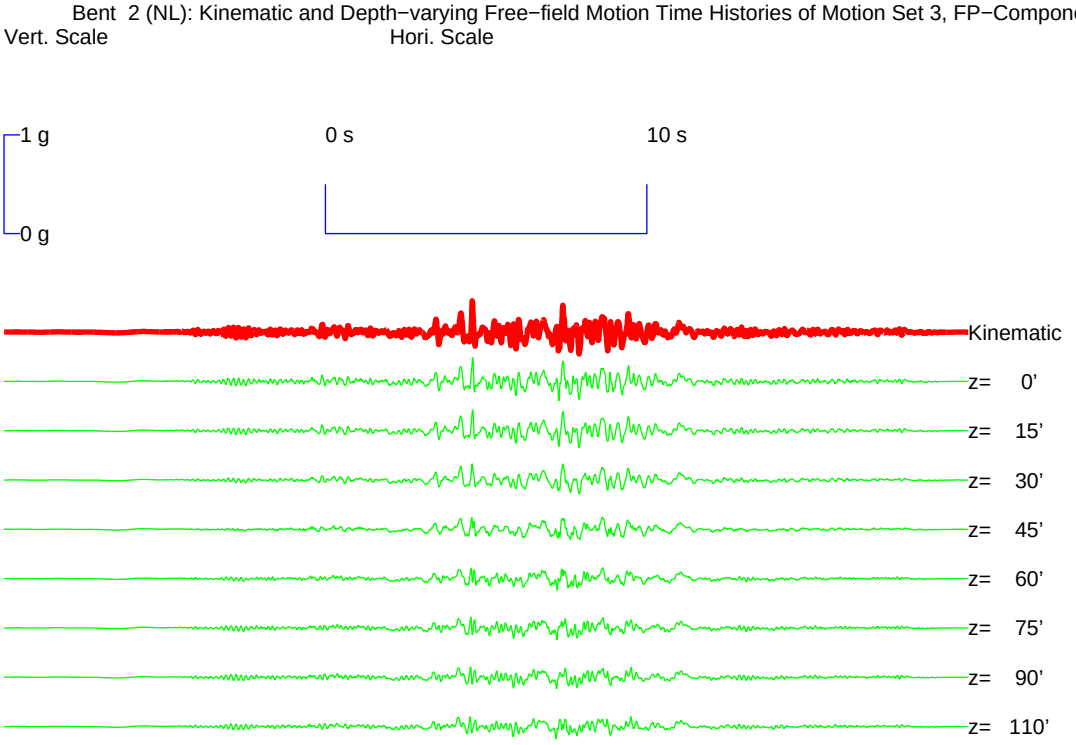


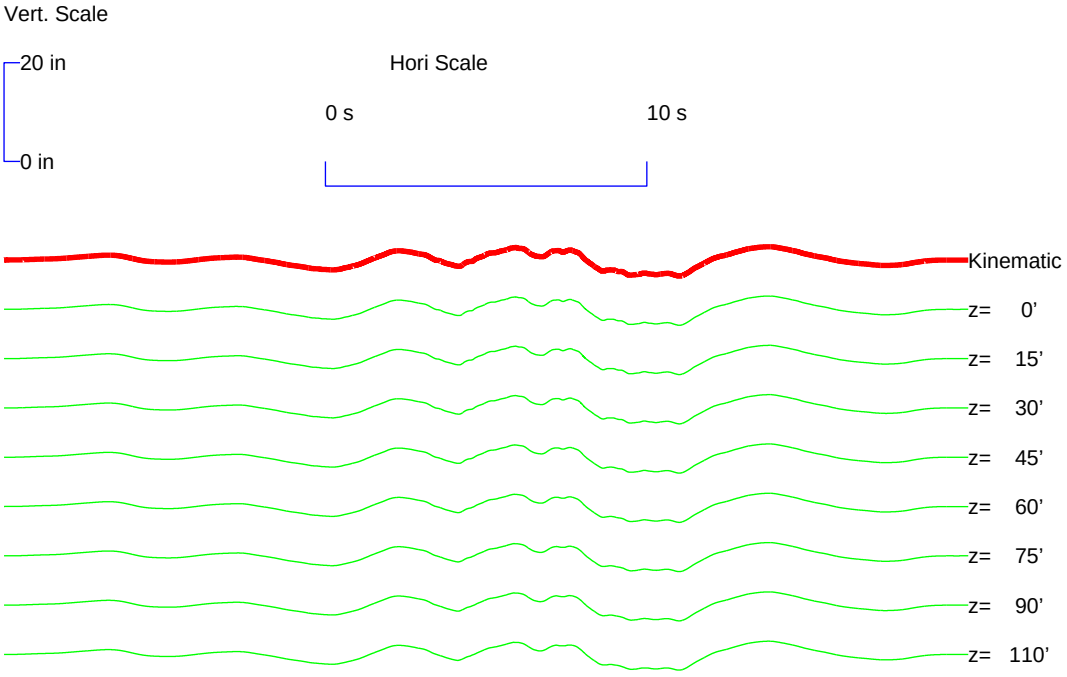



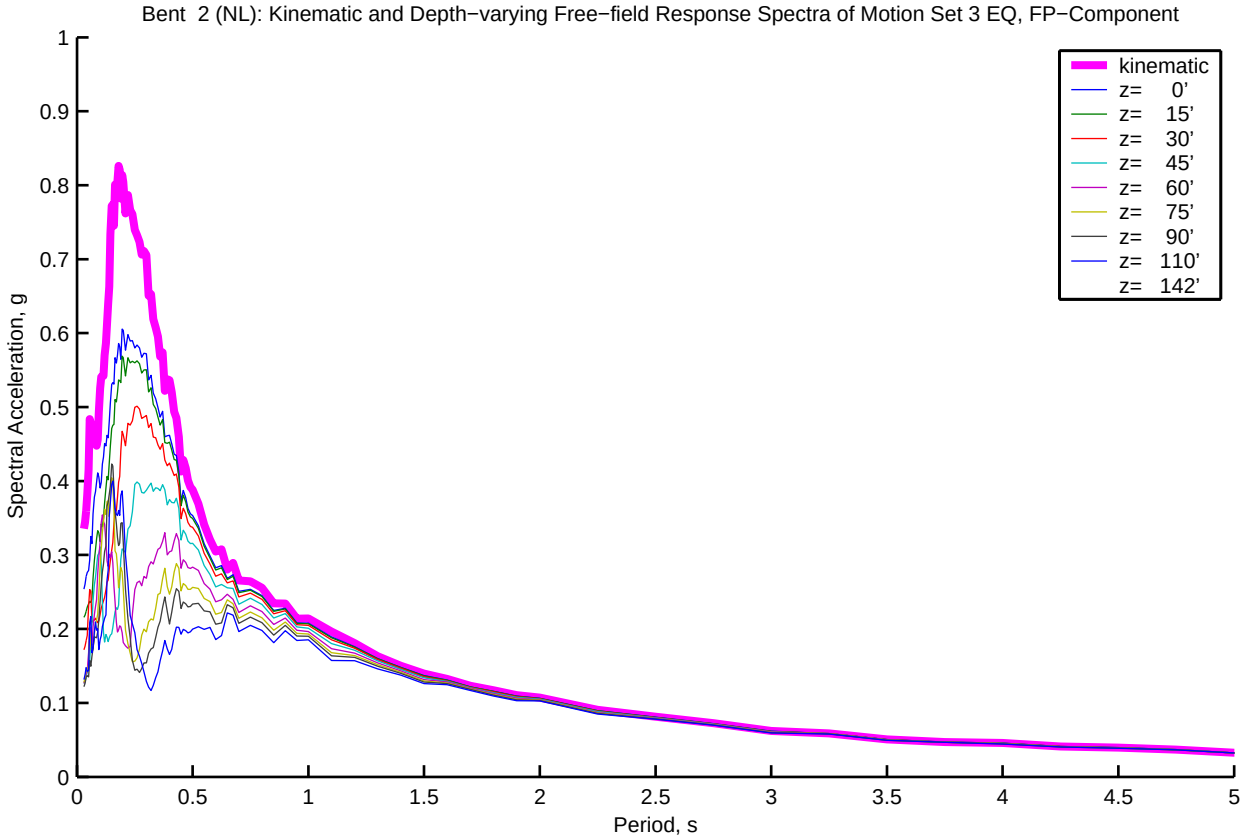

Bent 2 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

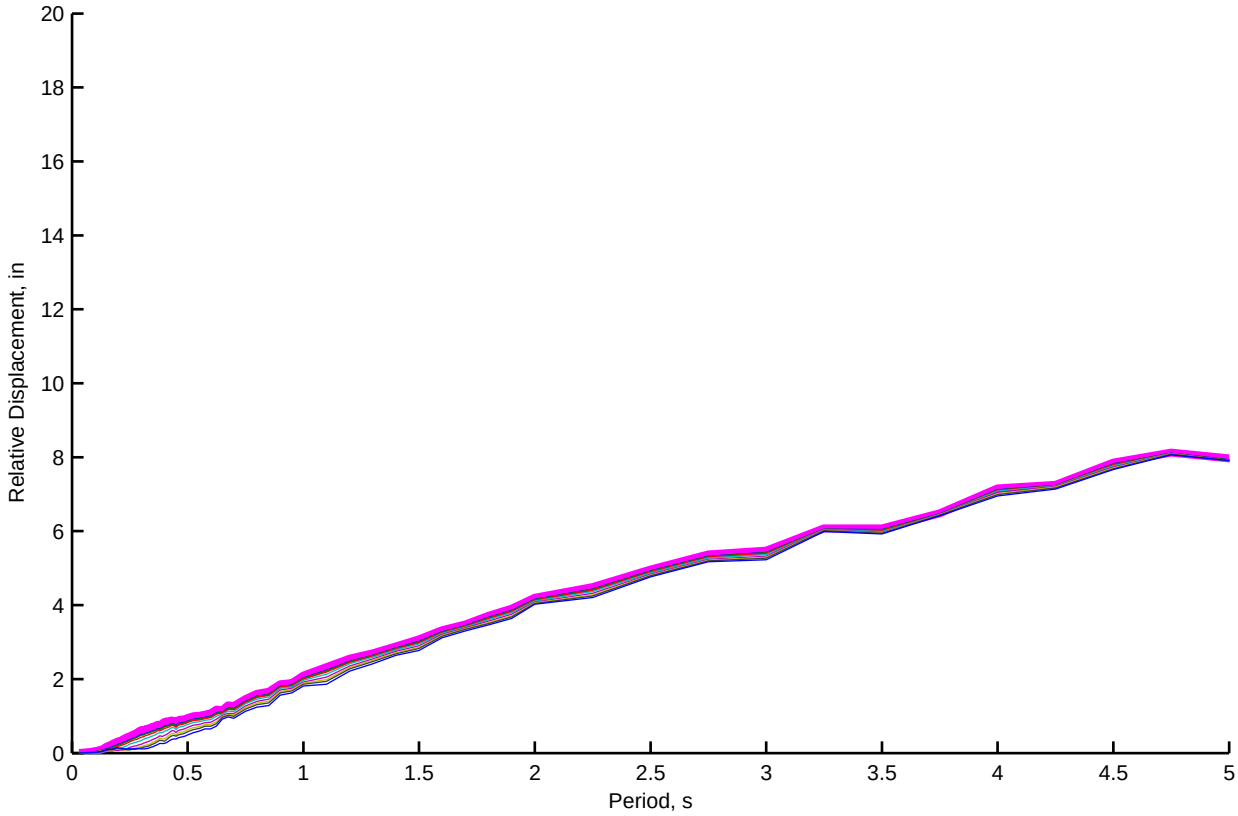

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

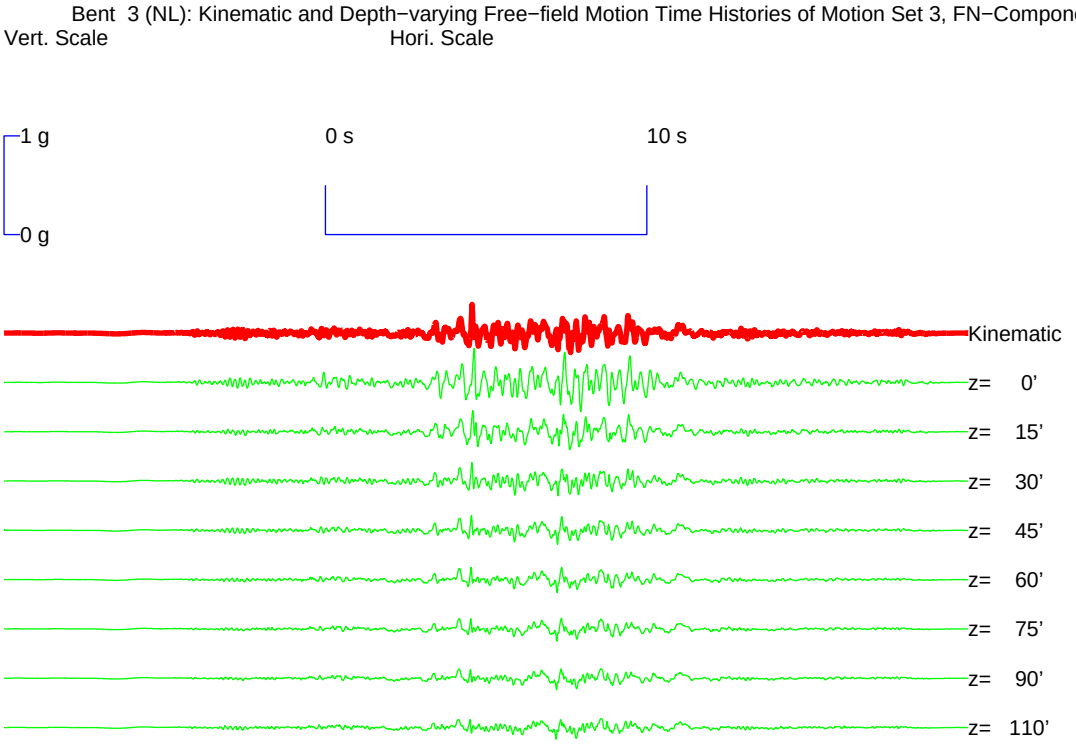


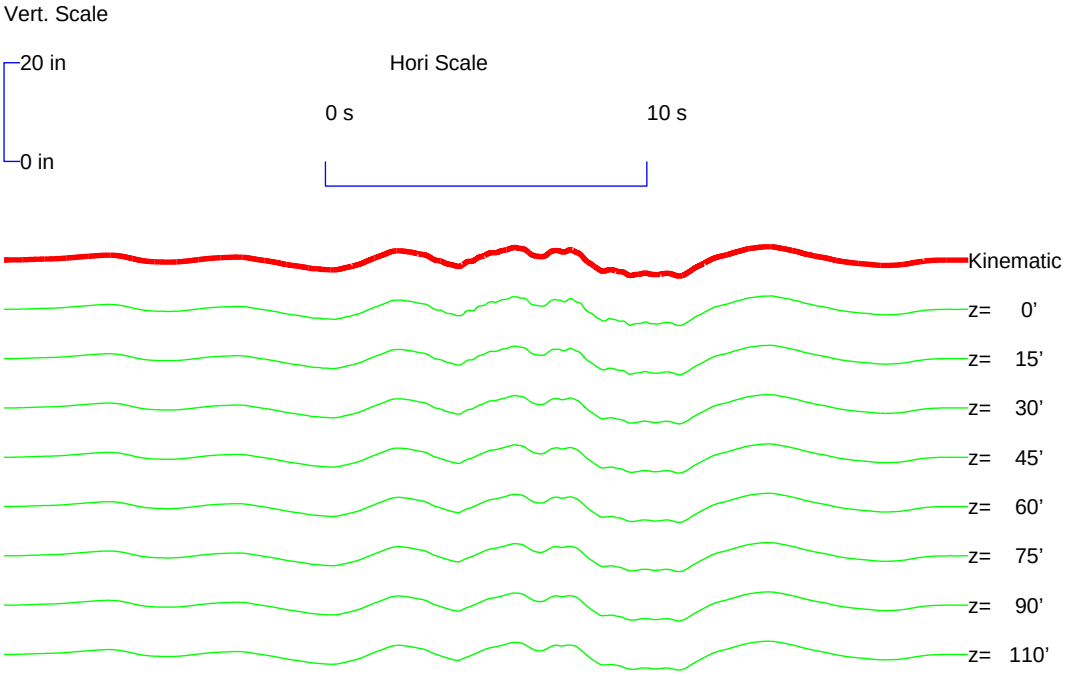



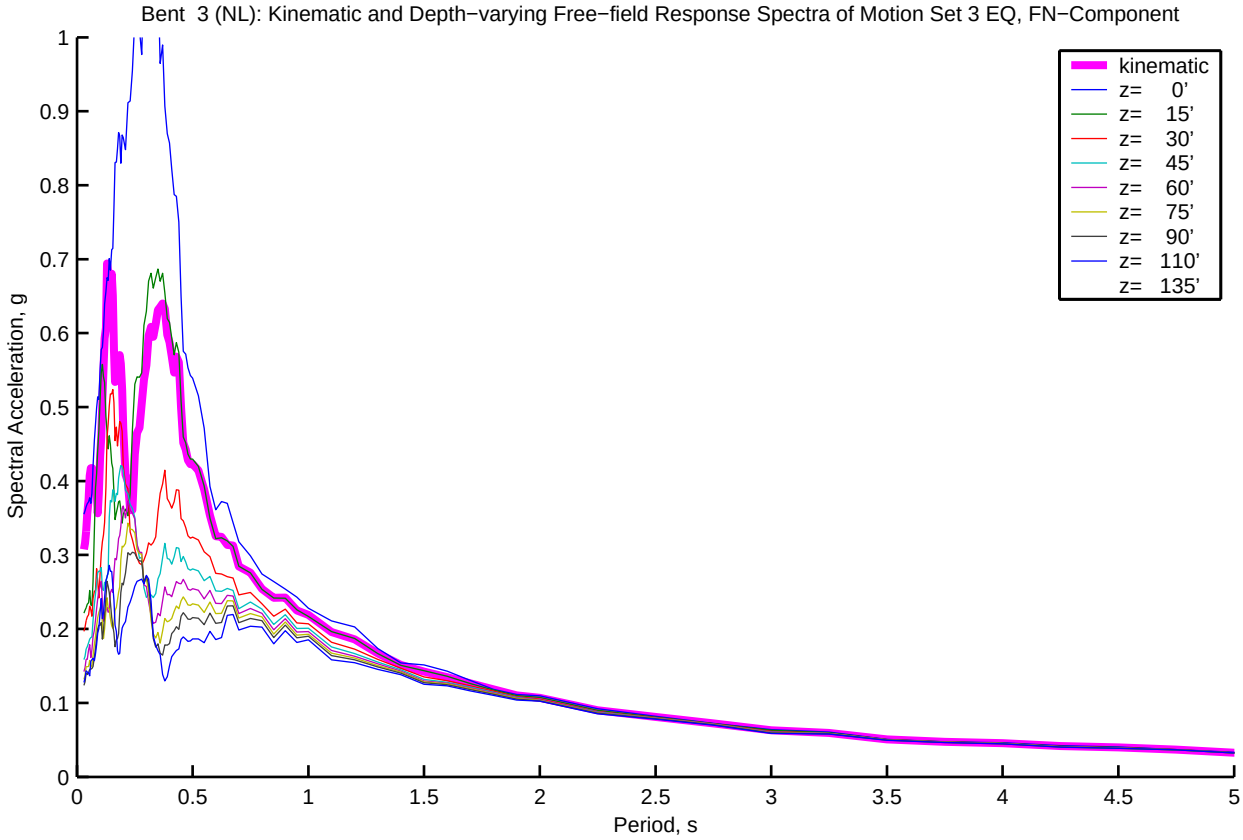

Bent 2 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

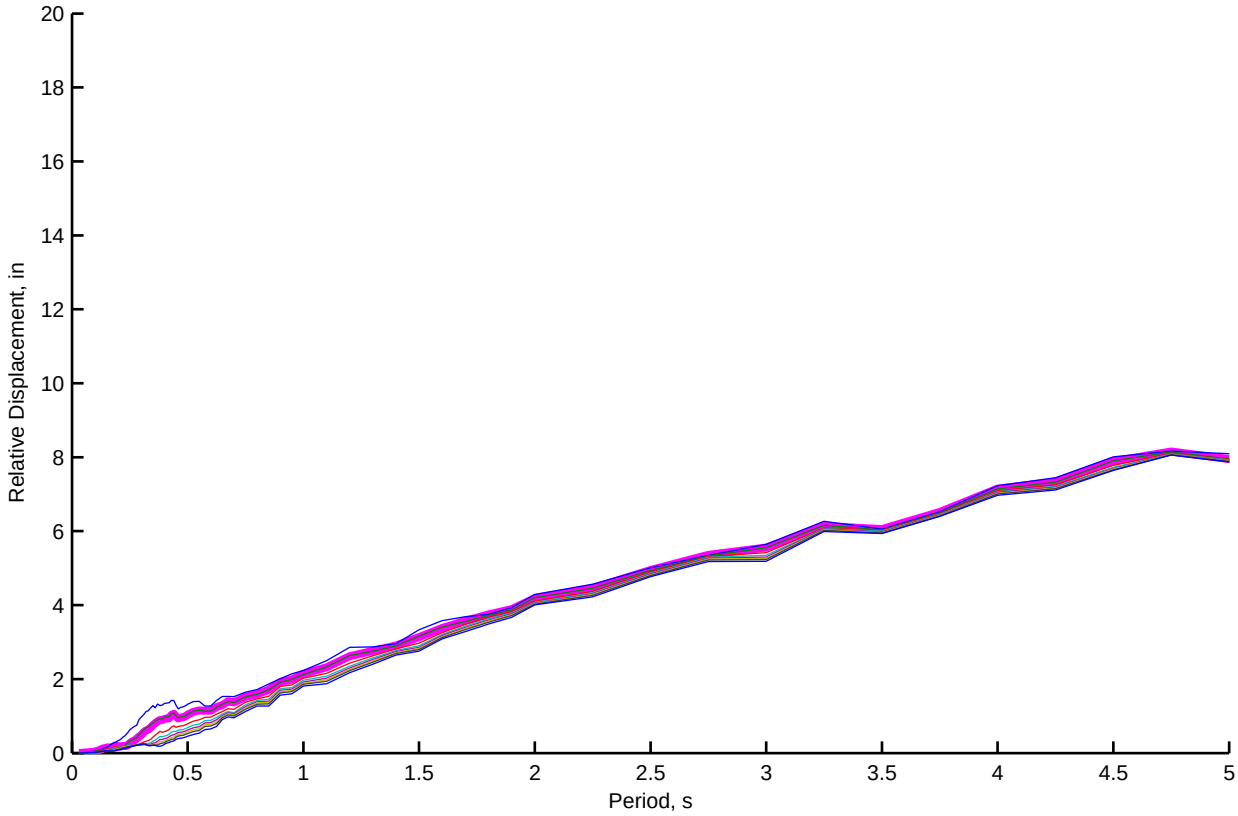

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 3 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

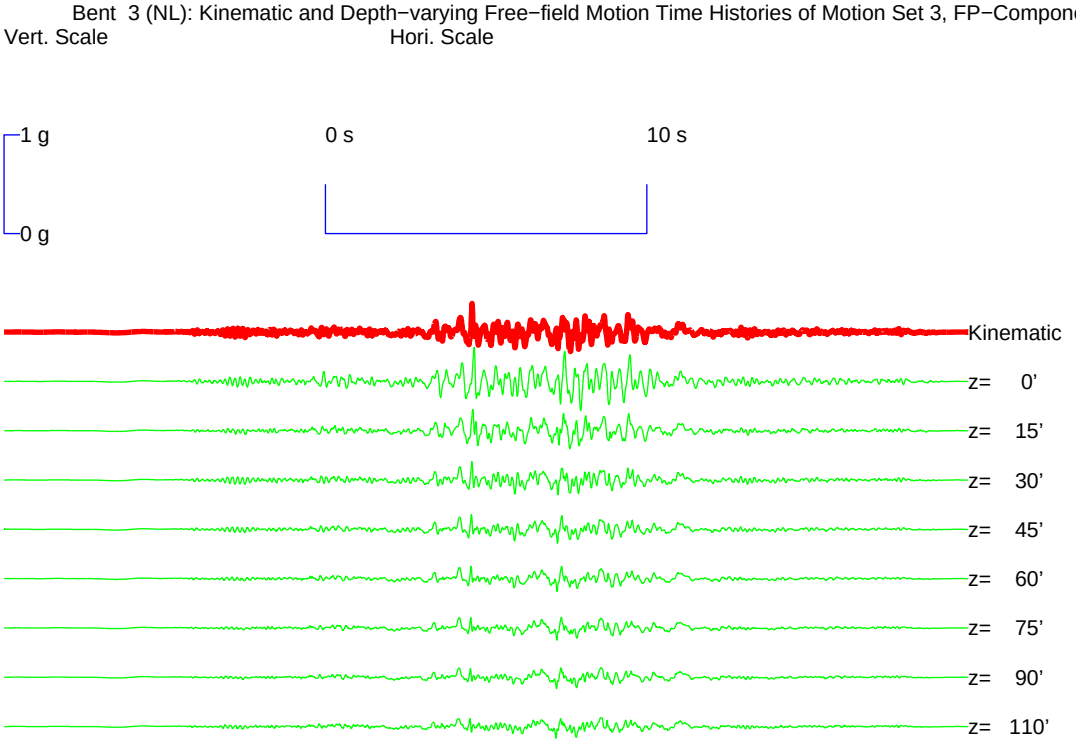


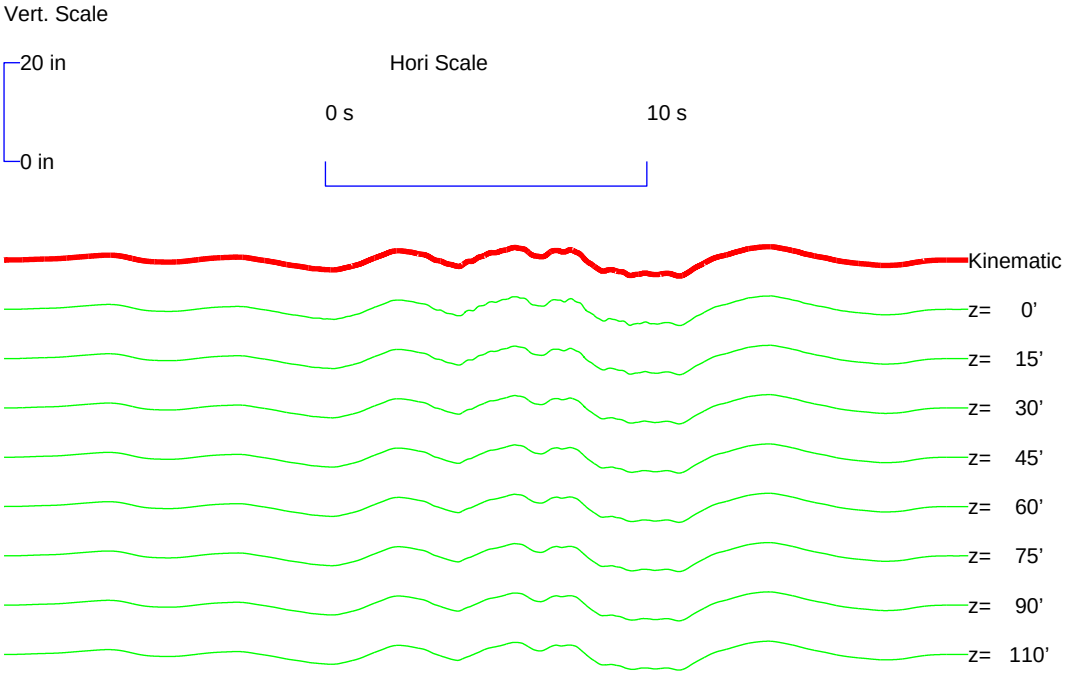



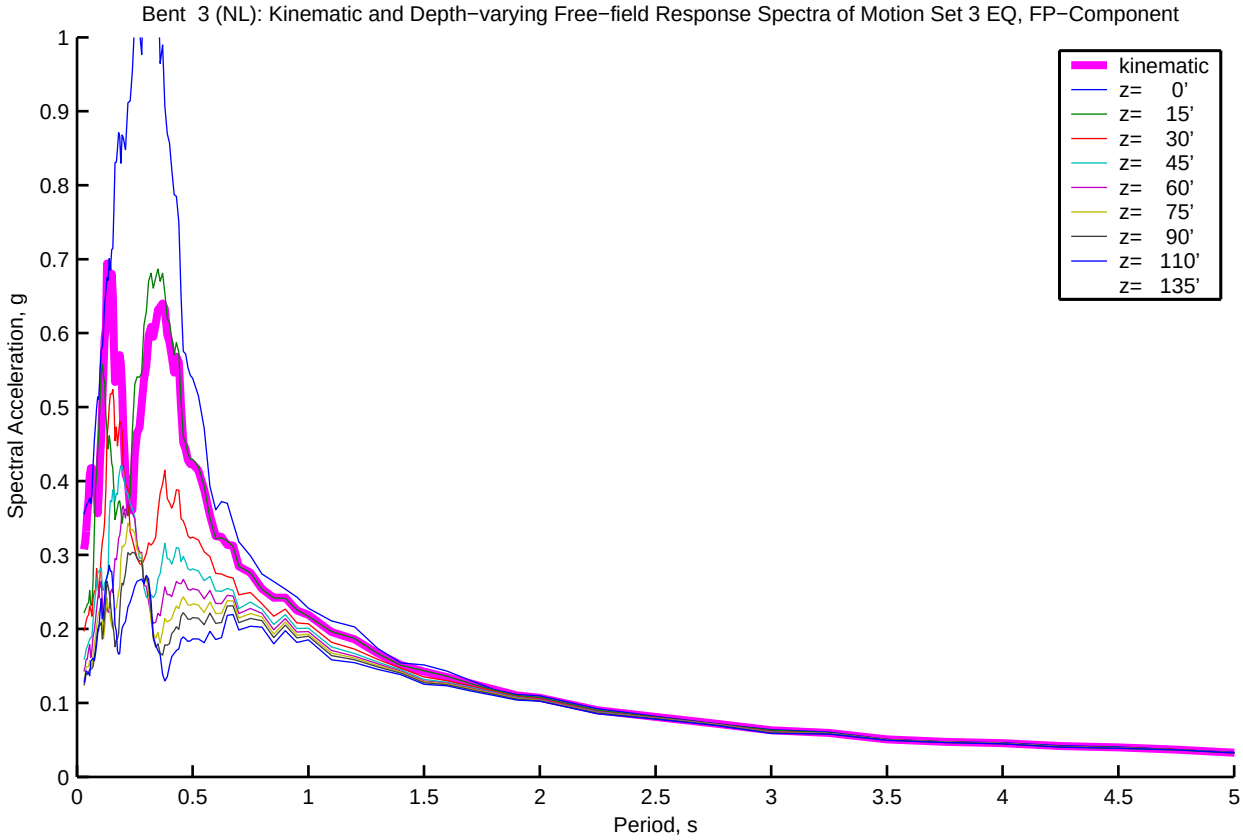

Bent 3 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'

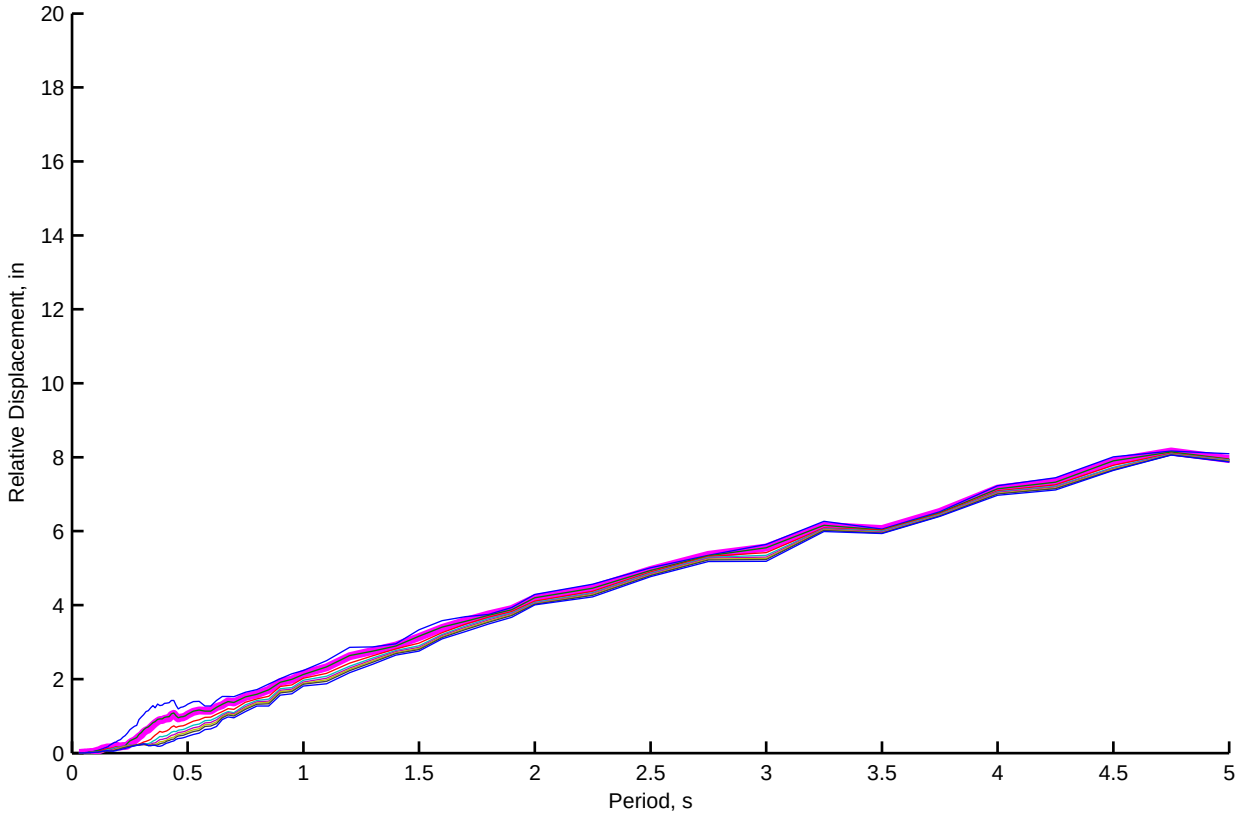

Relative Displacement, in
Period, s

Bent 3 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

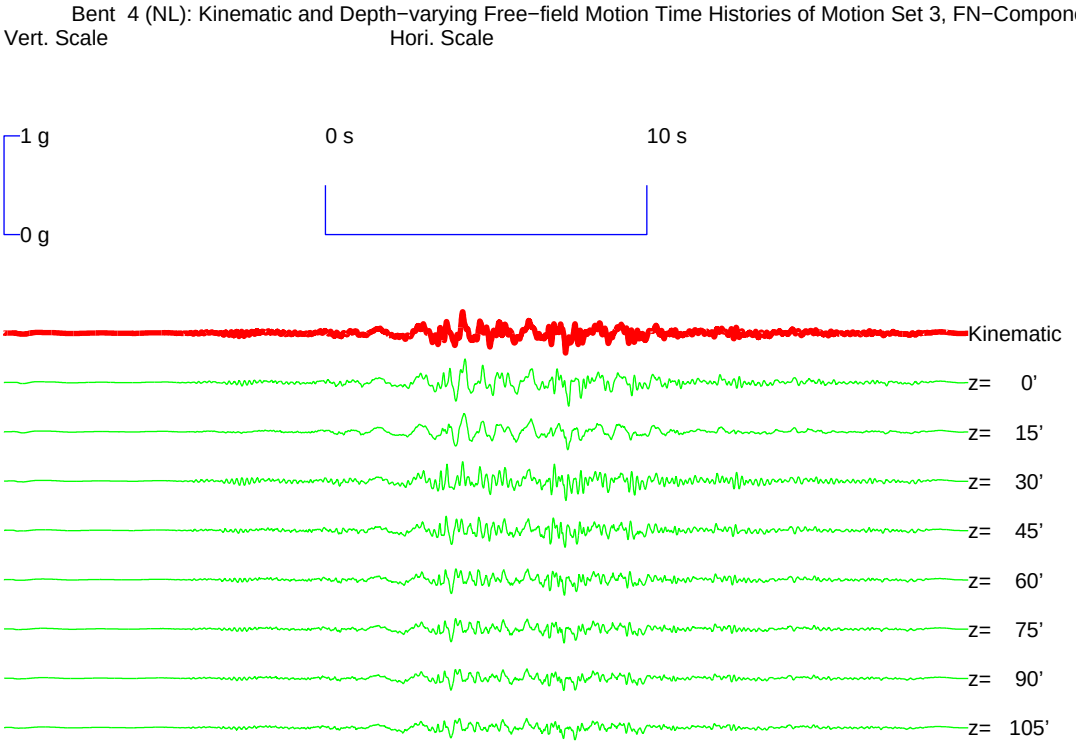


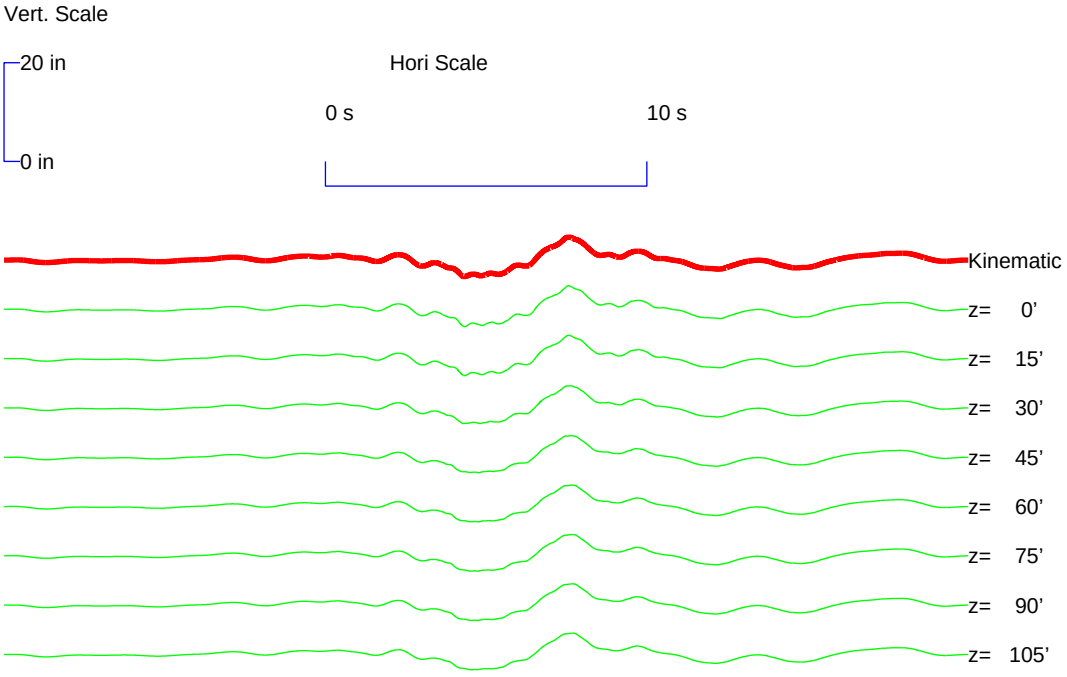



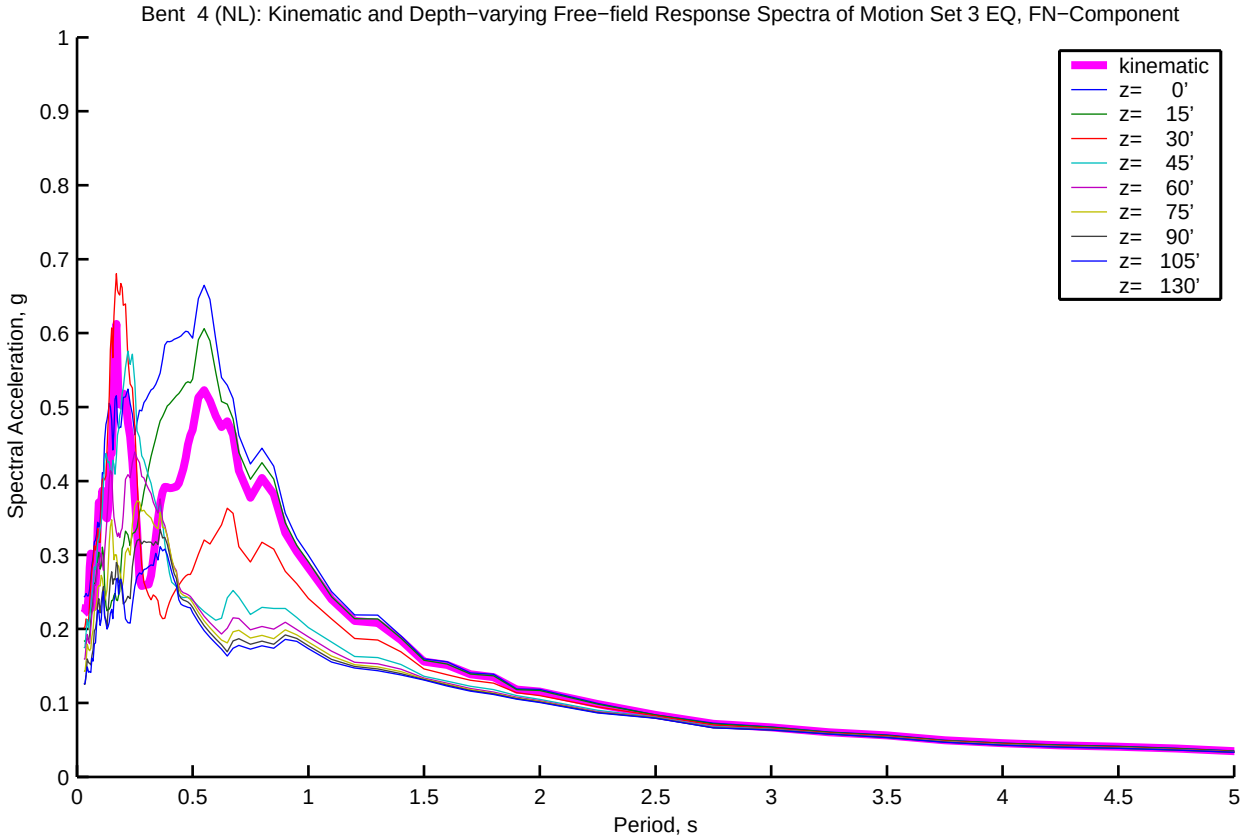

Bent 3 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'

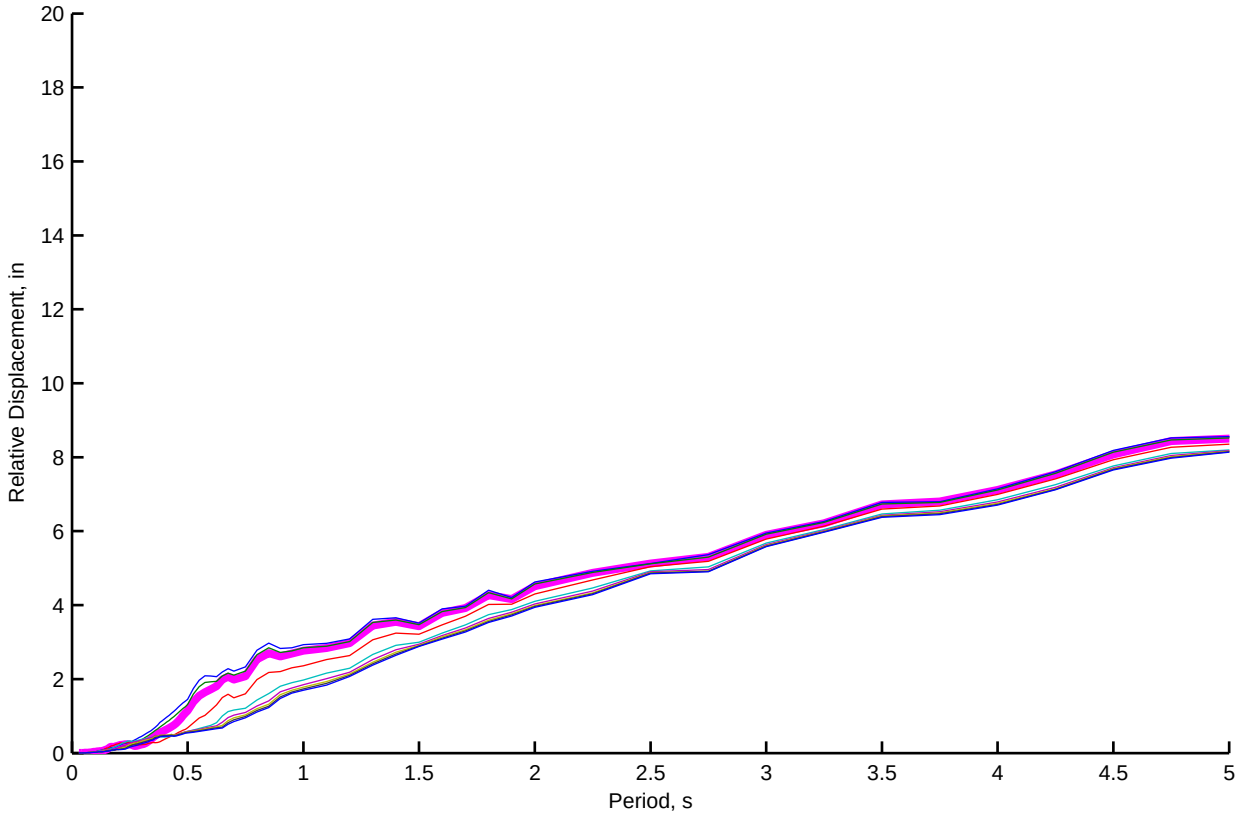

Relative Displacement, in
Period, s

Bent 4 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

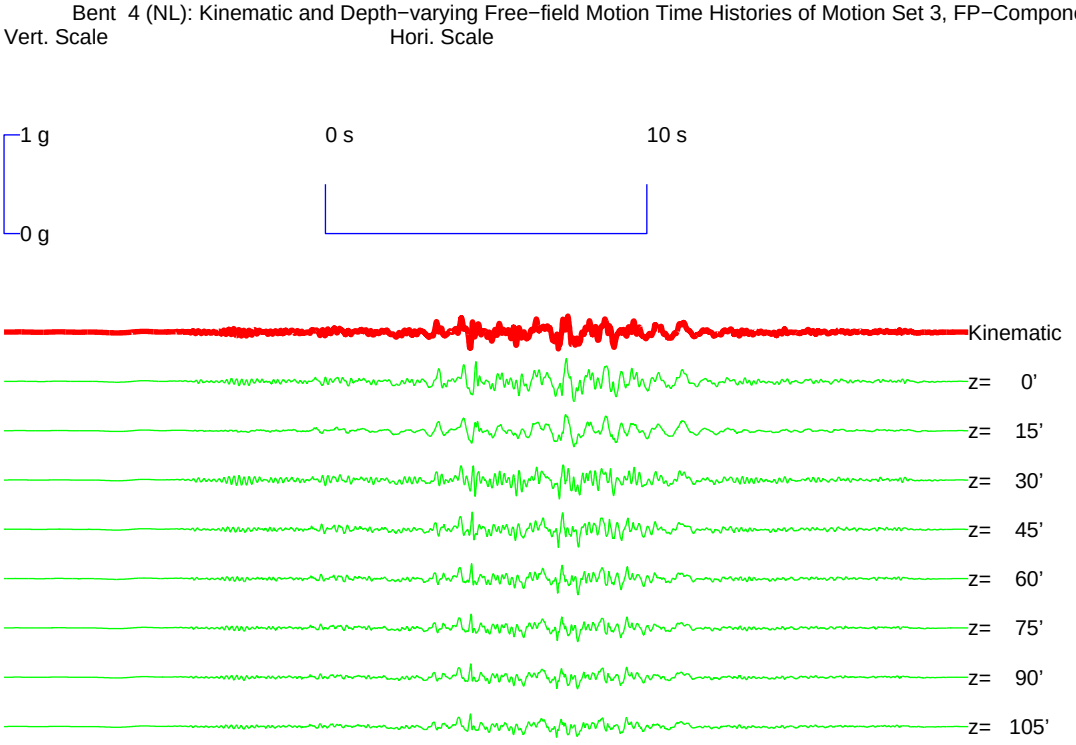


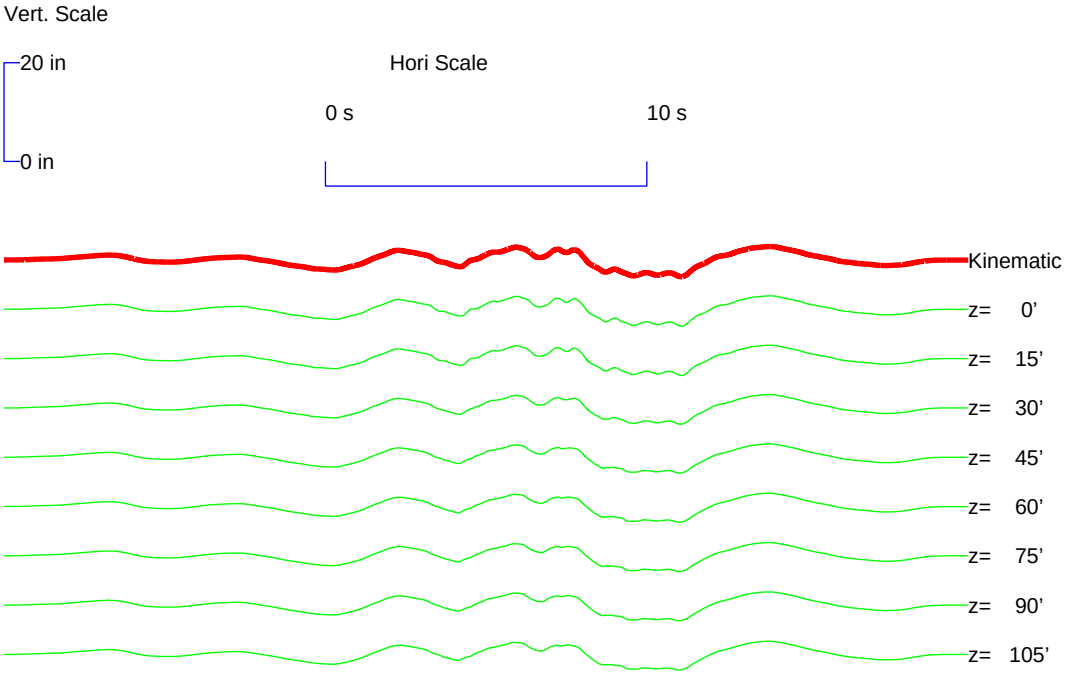



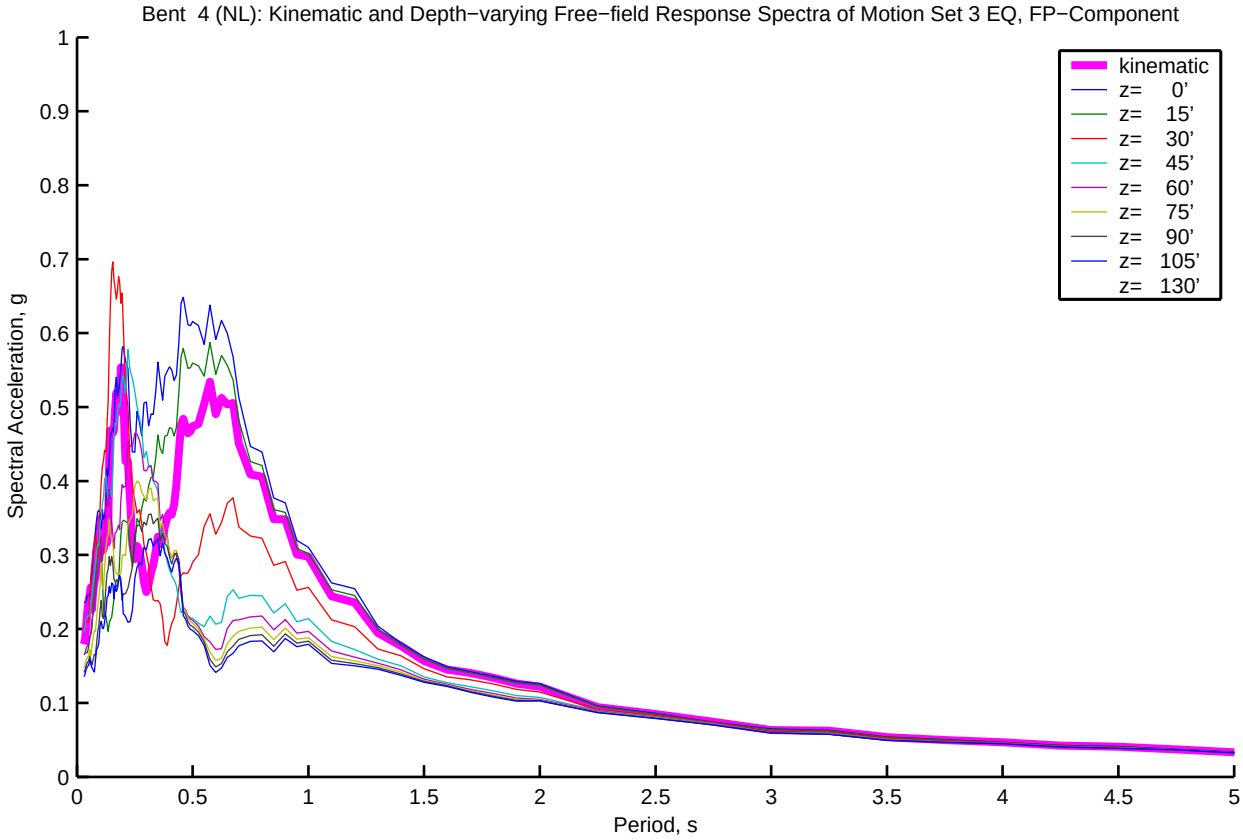

Bent 4 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

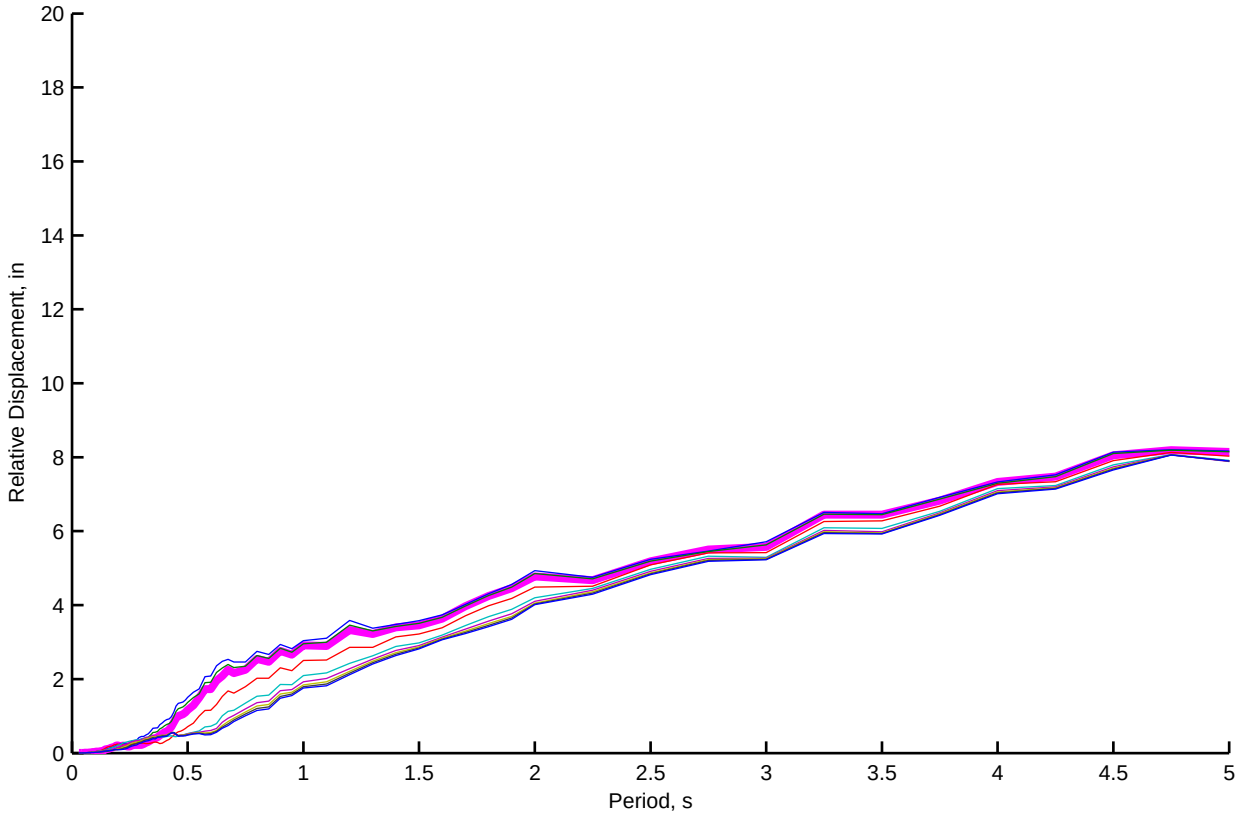

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 4 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

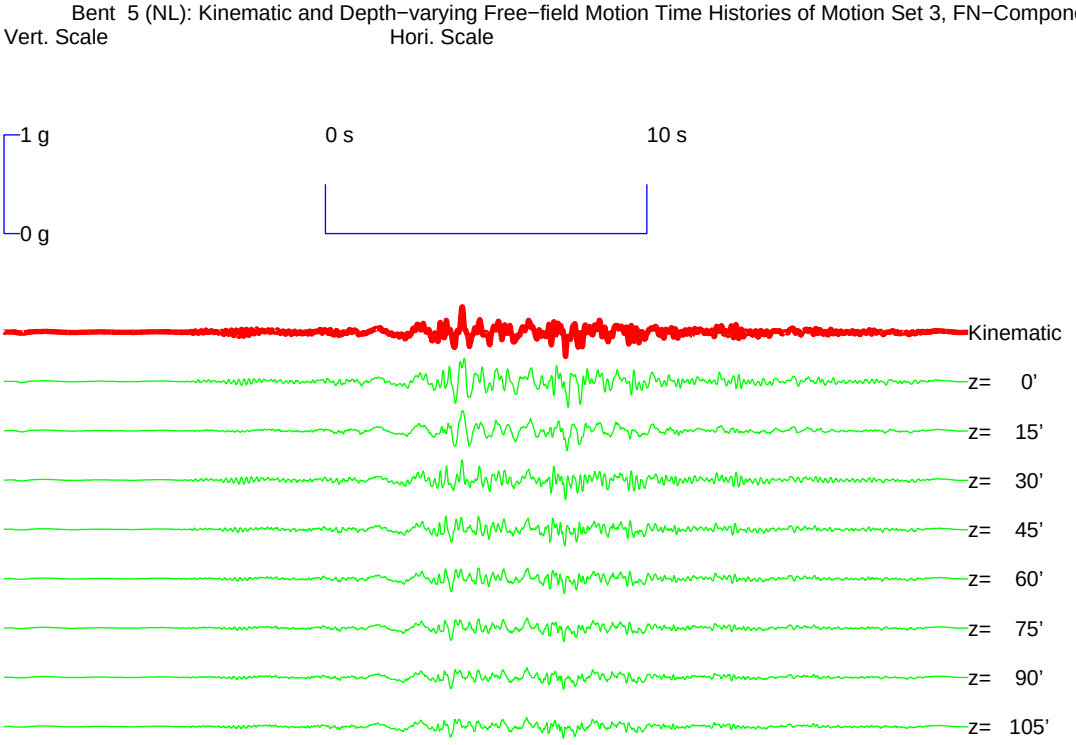


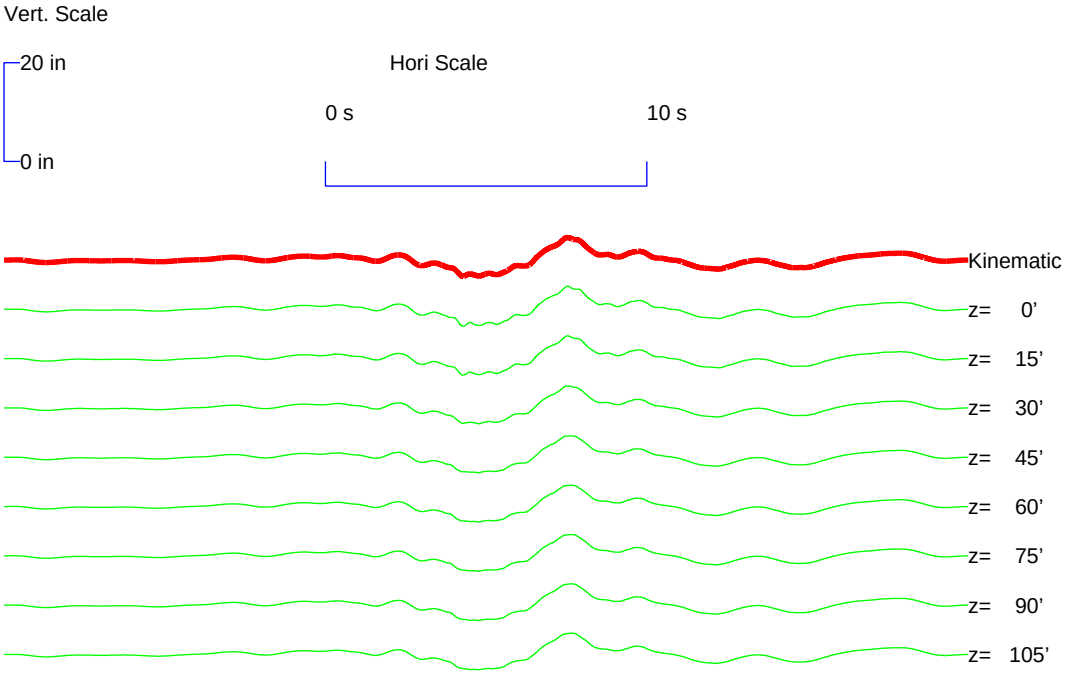



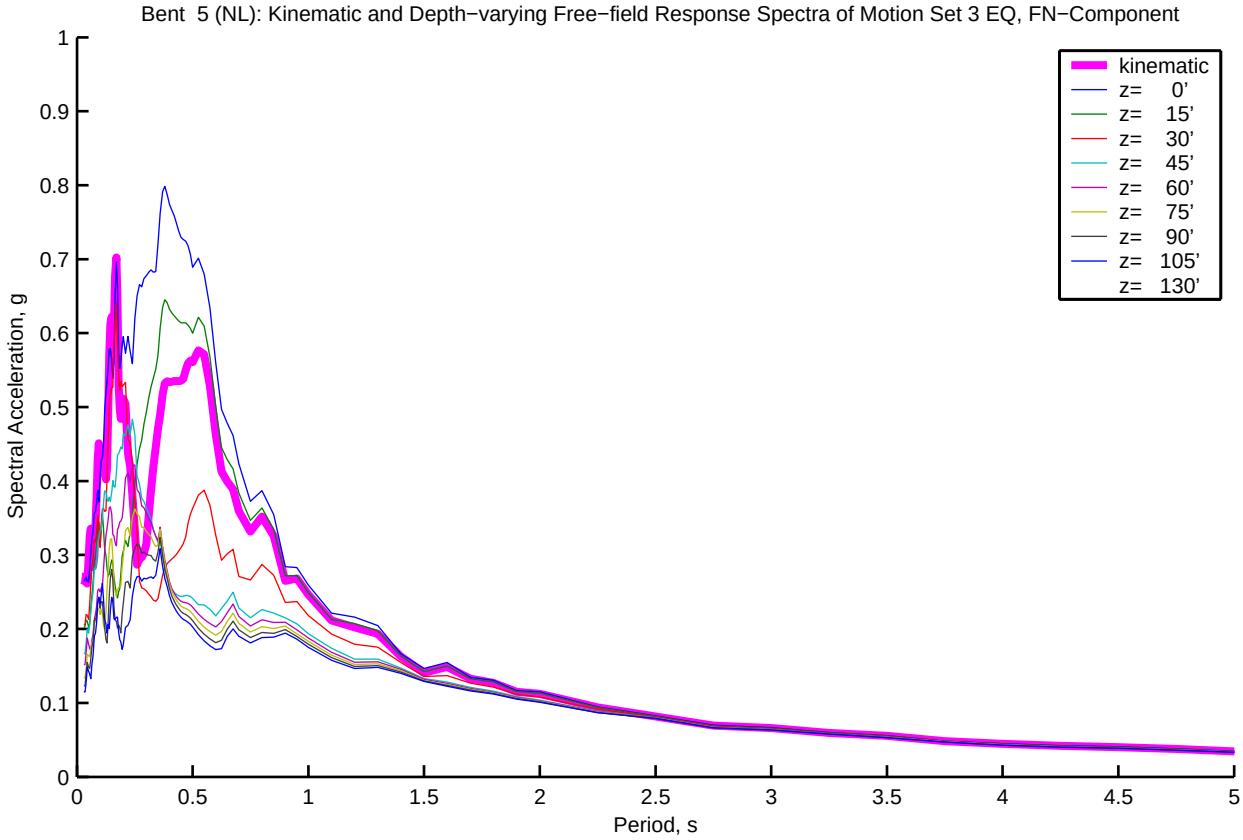

Bent 4 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

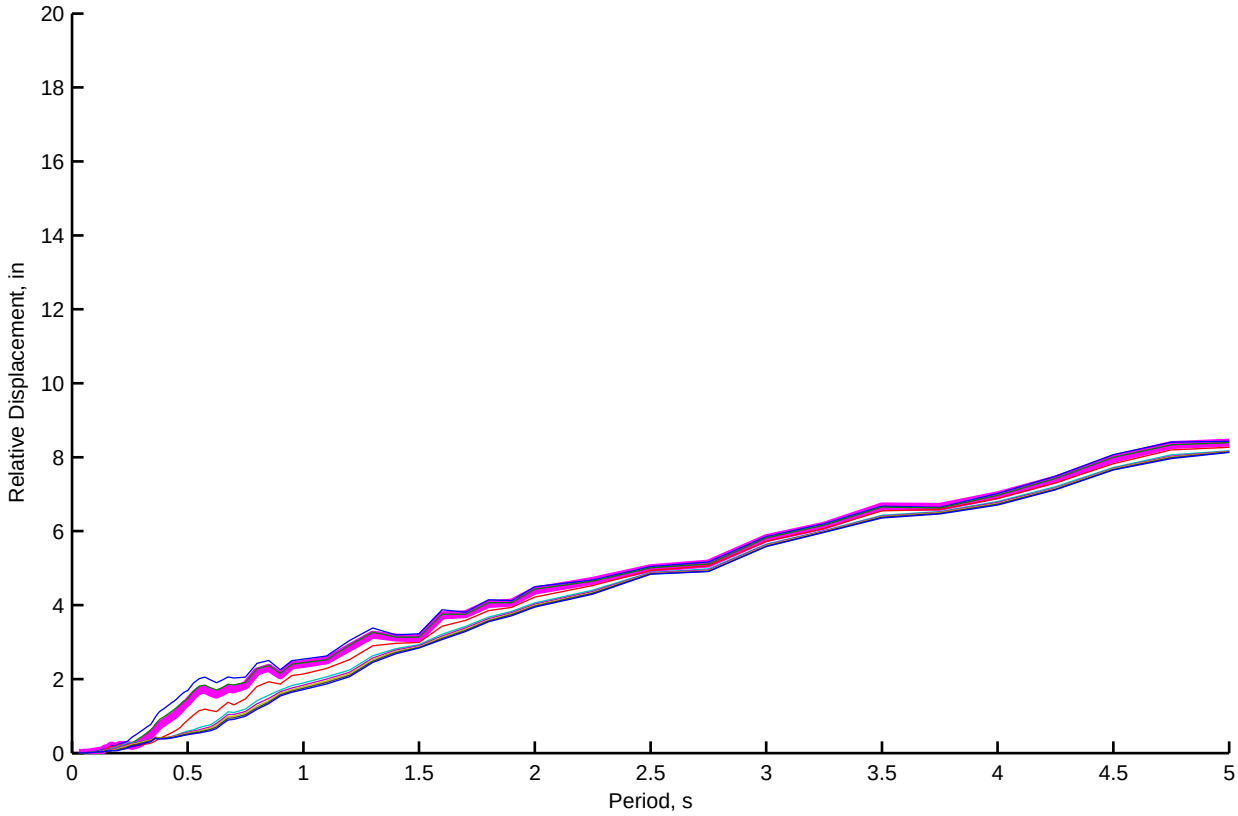

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 5 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

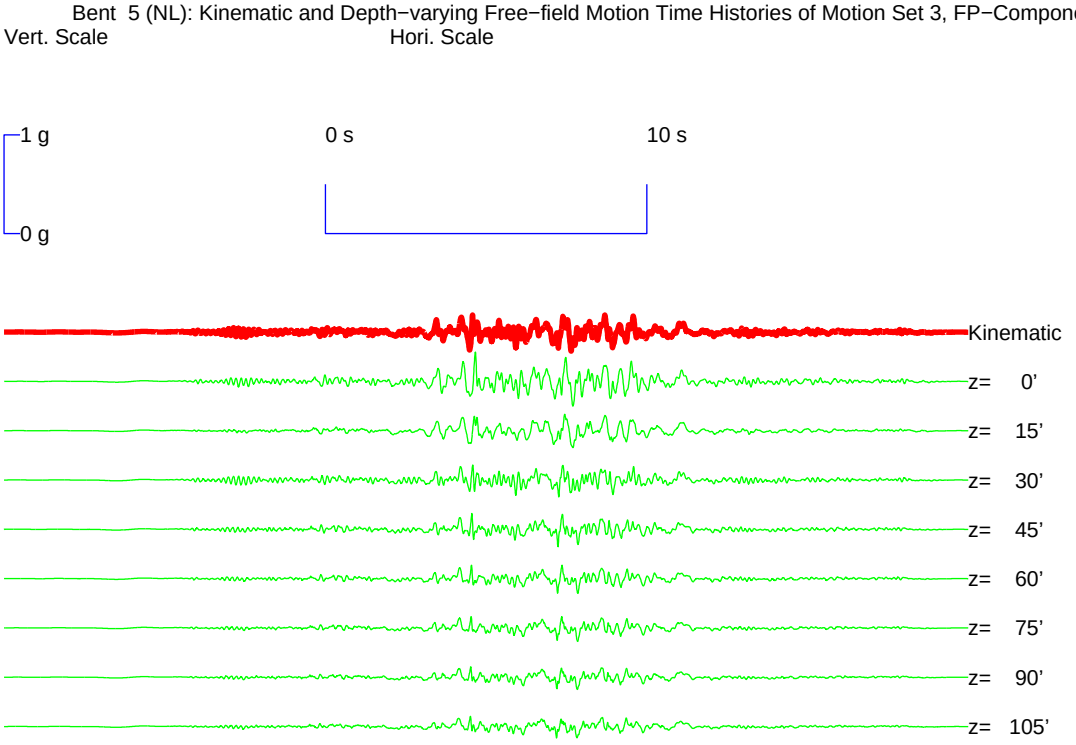


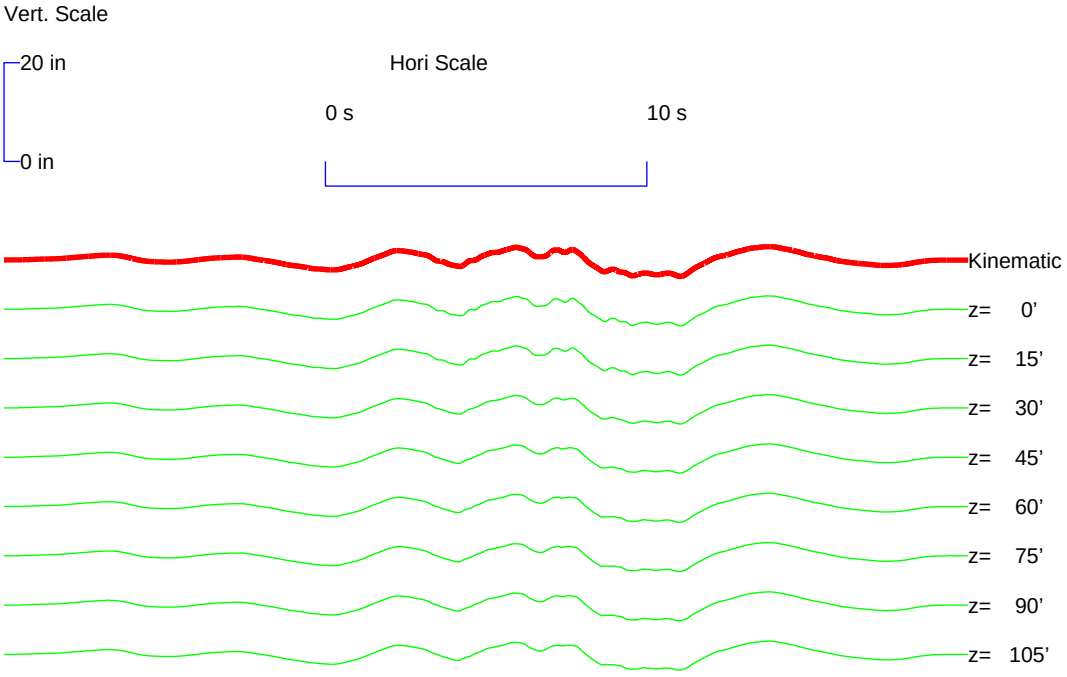



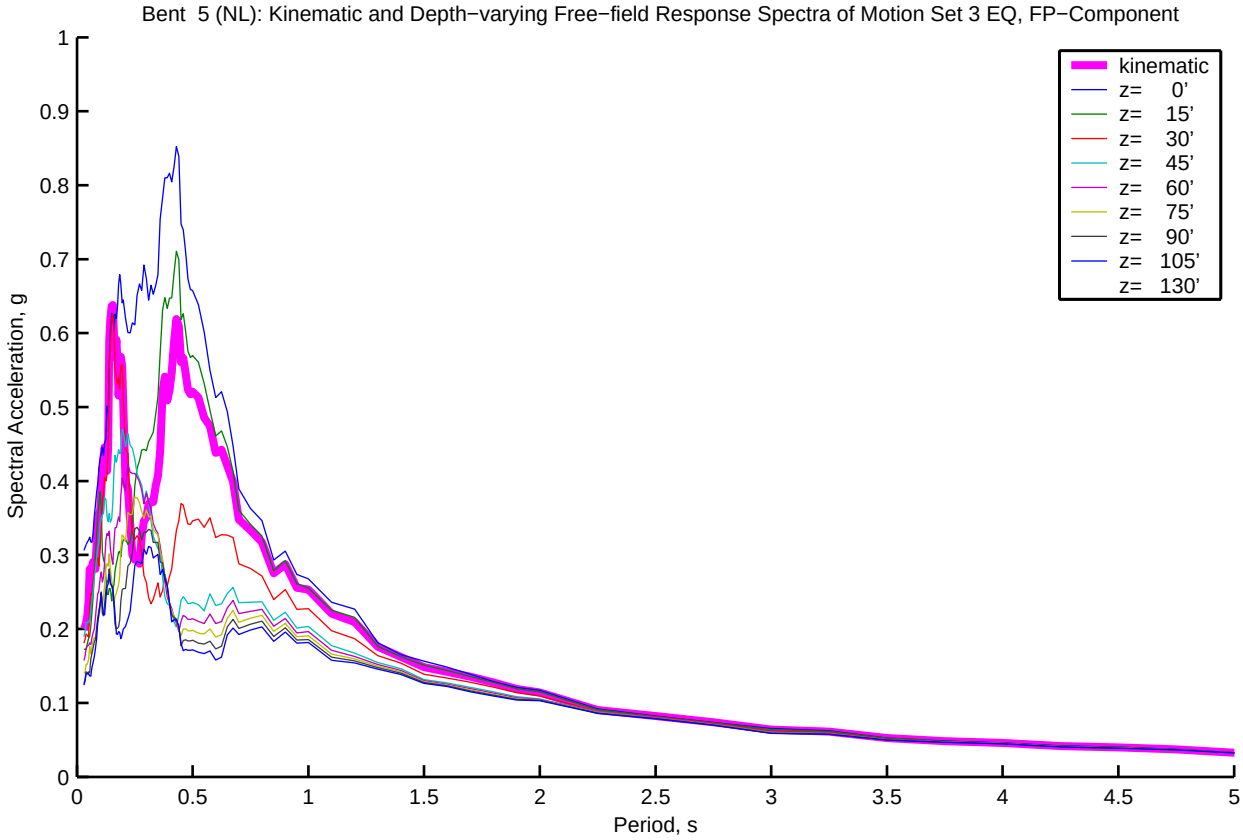

Bent 5 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'

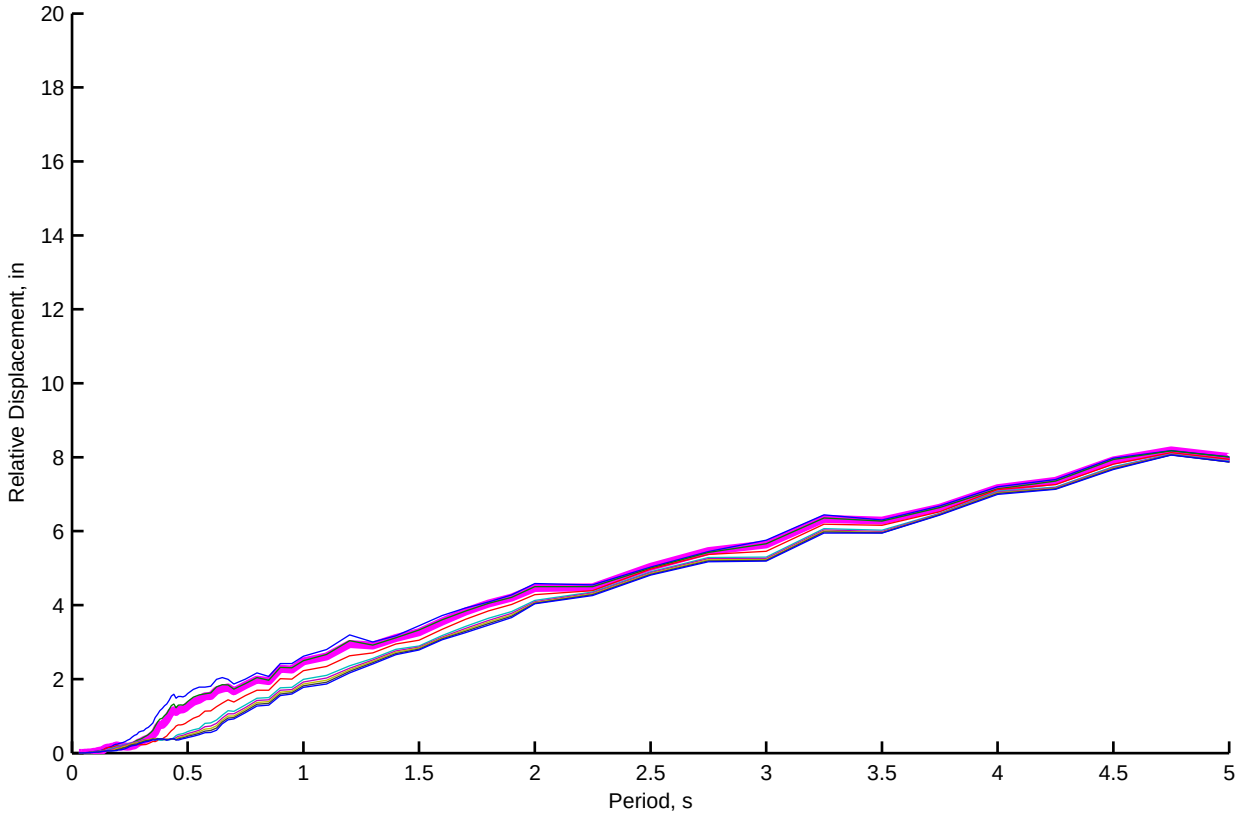

Relative Displacement, in
Period, s

Bent 5 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

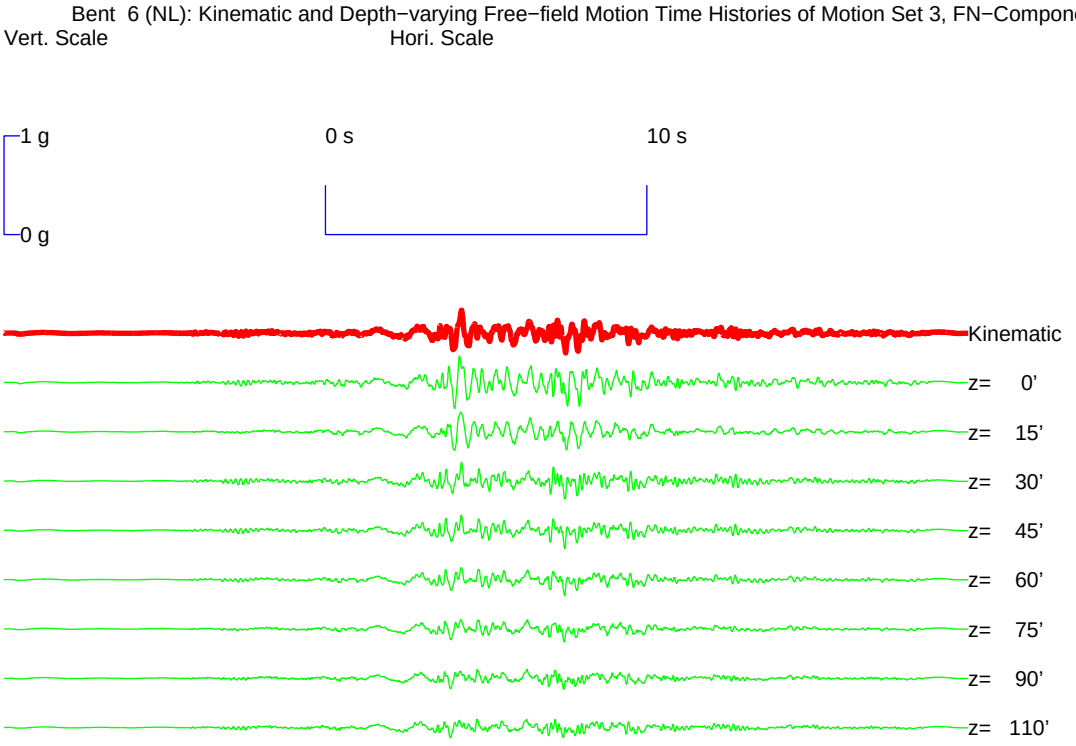


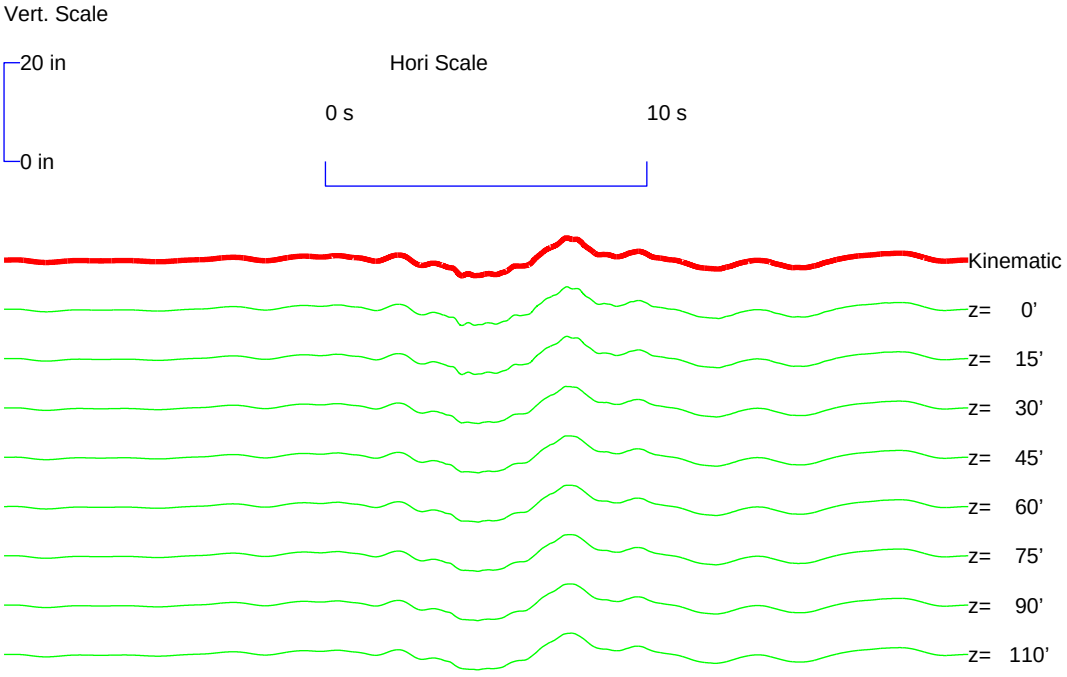



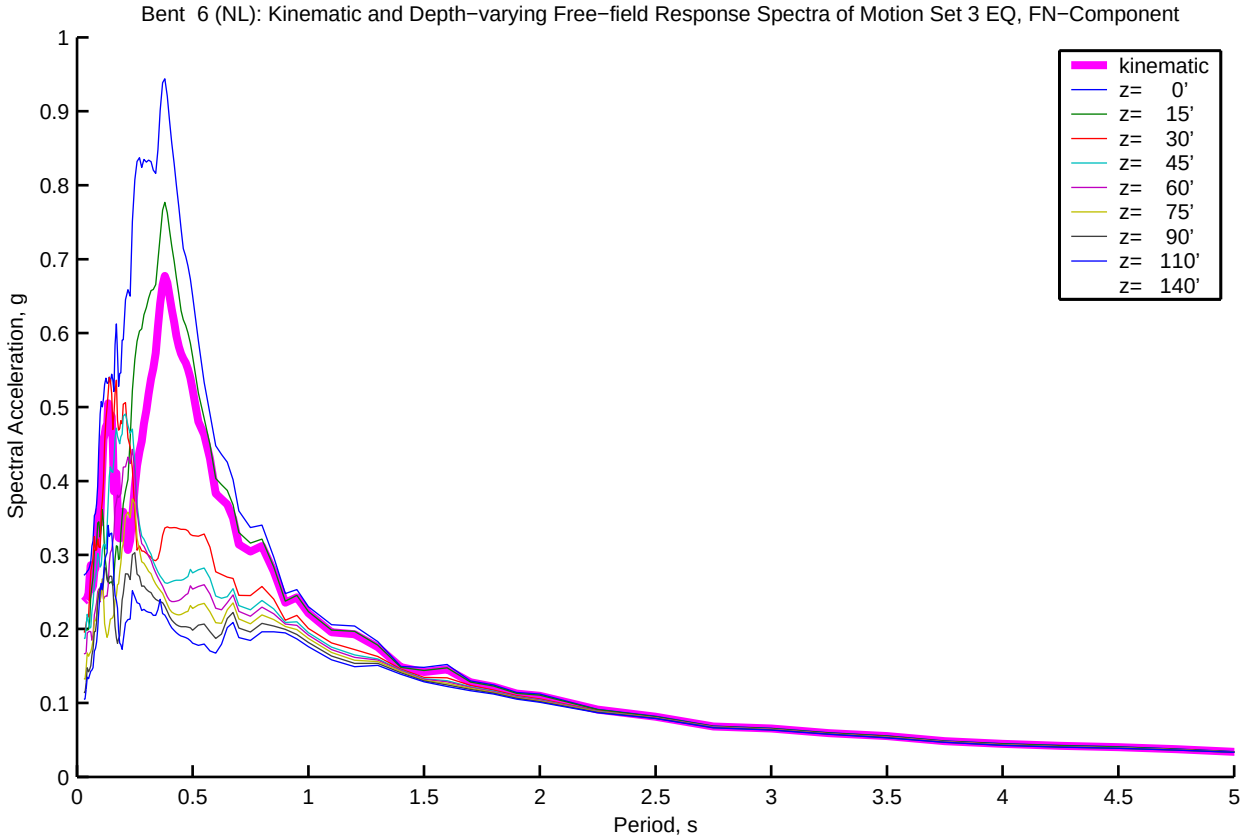

Bent 5 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'

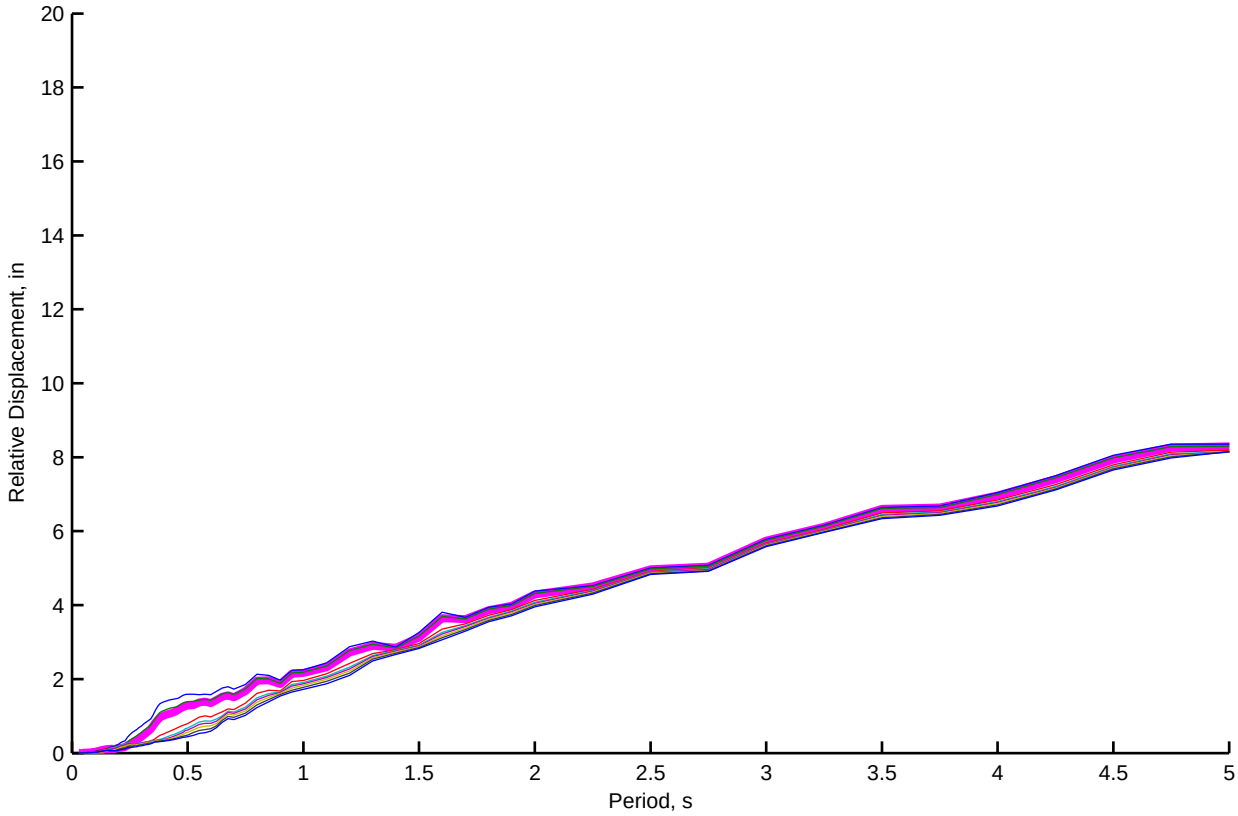

Relative Displacement, in
Period, s

Bent 6 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

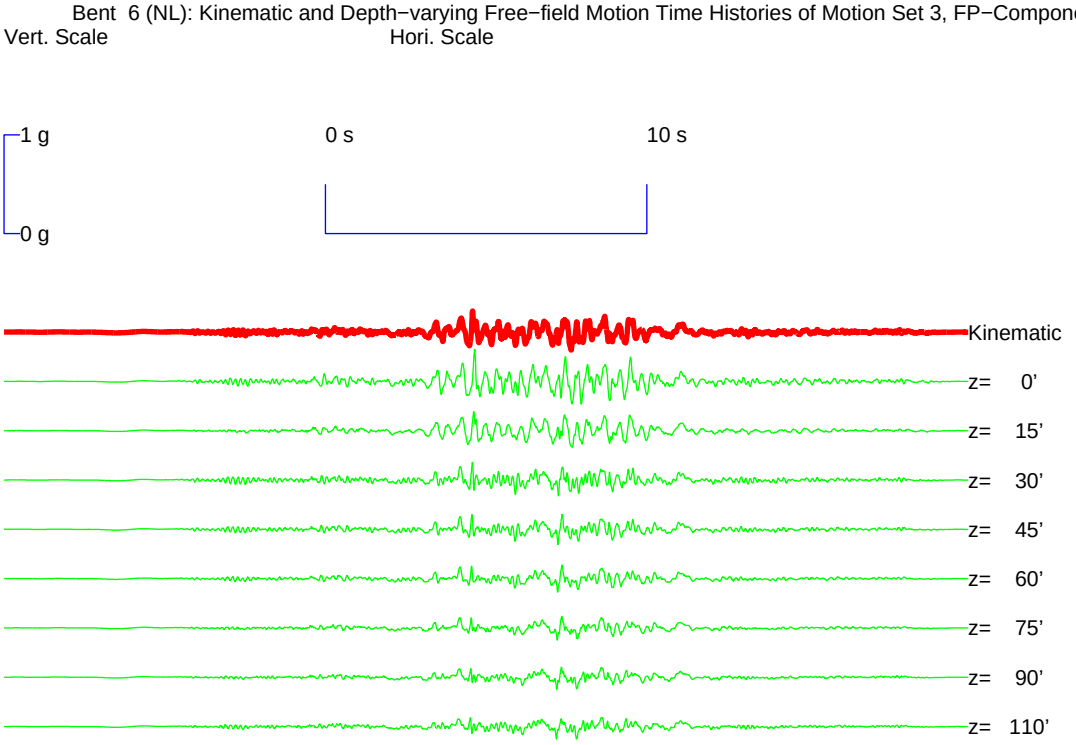


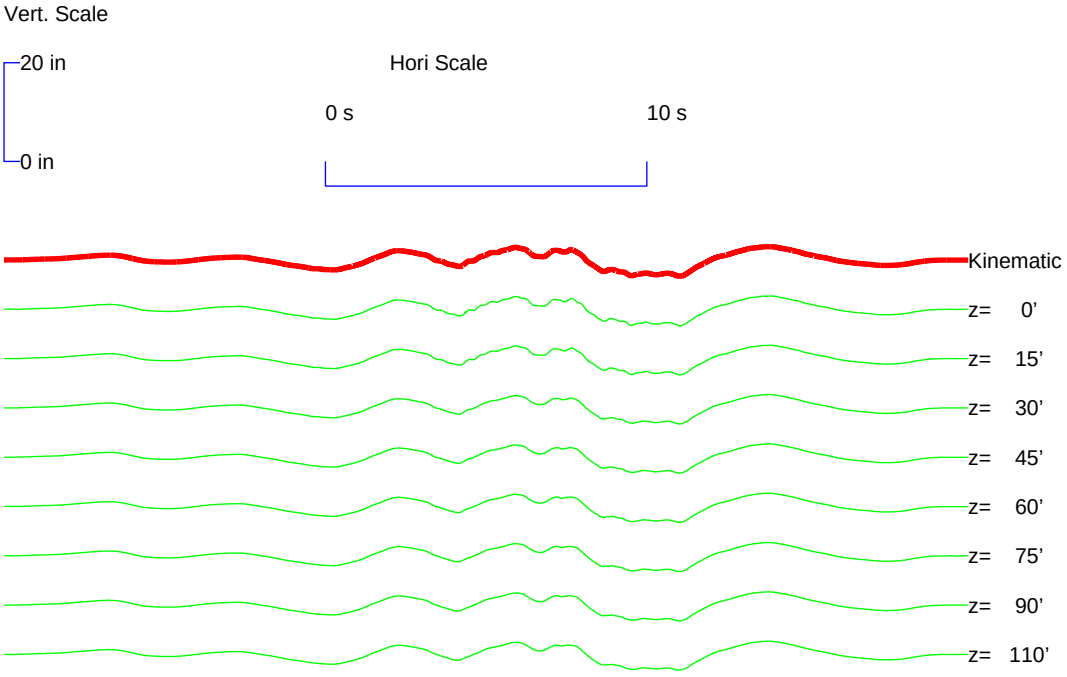



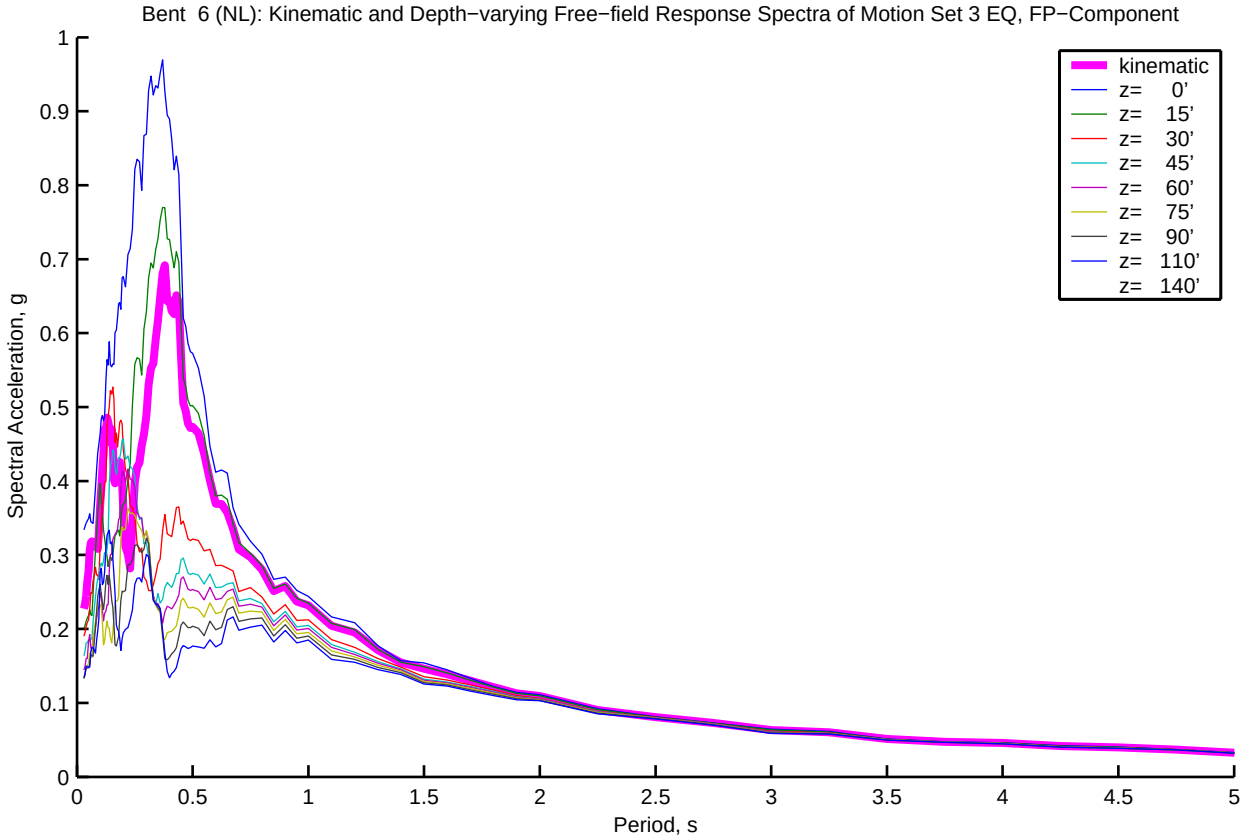

Bent 6 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'


Relative Displacement, in
Period, s

Bent 6 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component




Bent 6 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
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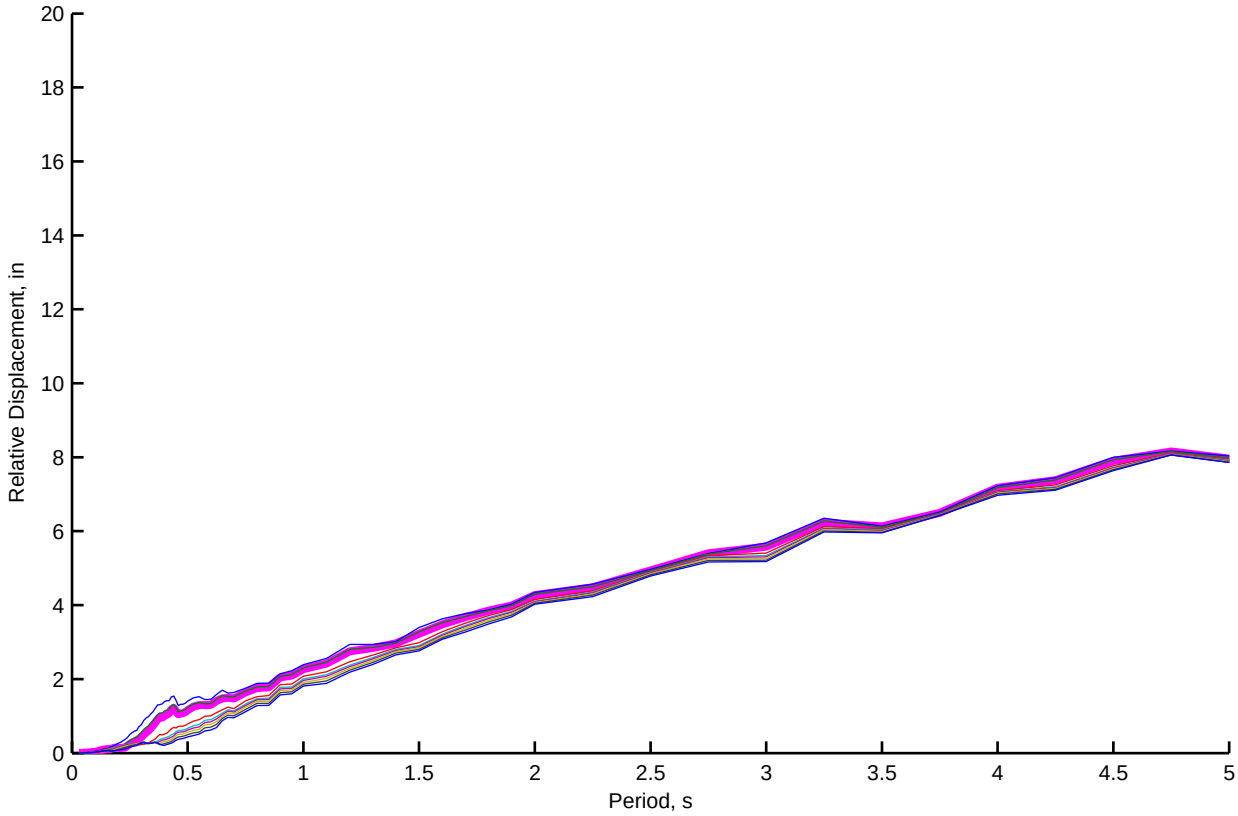
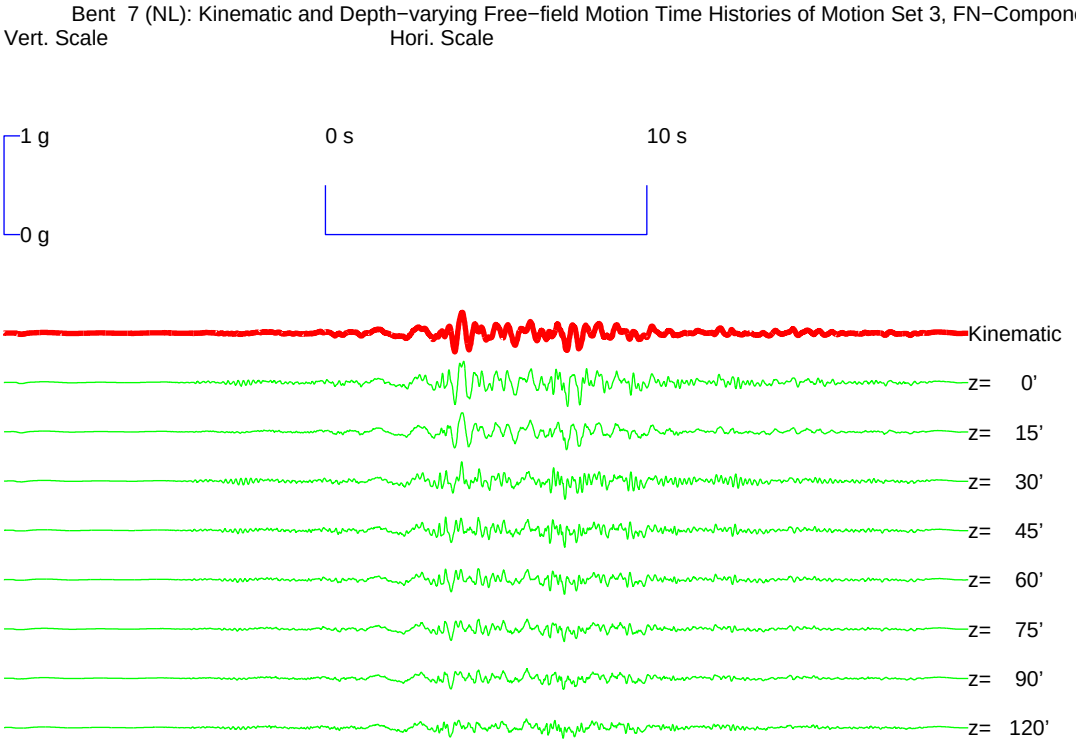
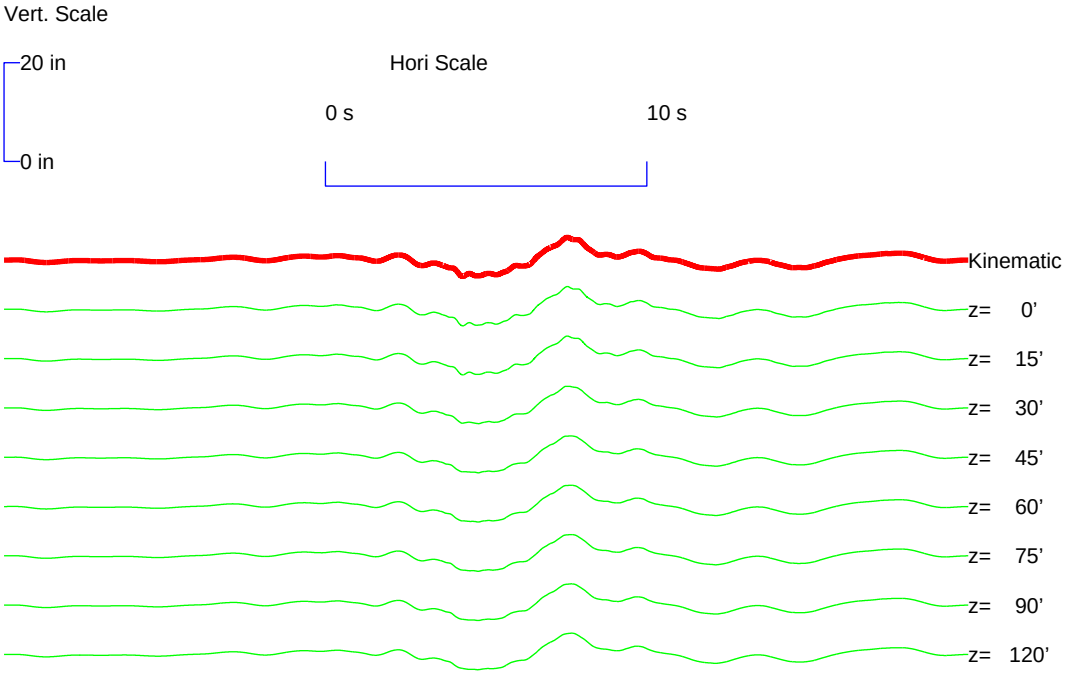
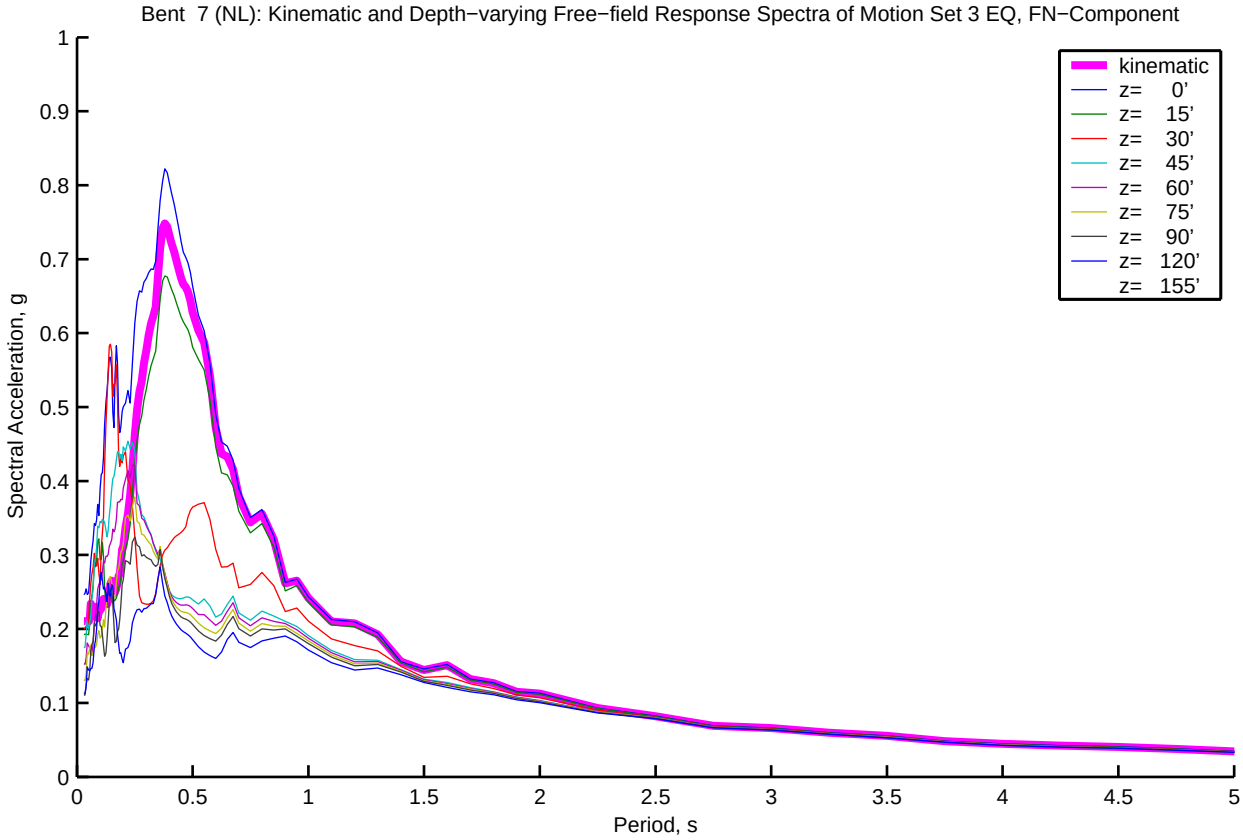
3.5
4
4.5
5

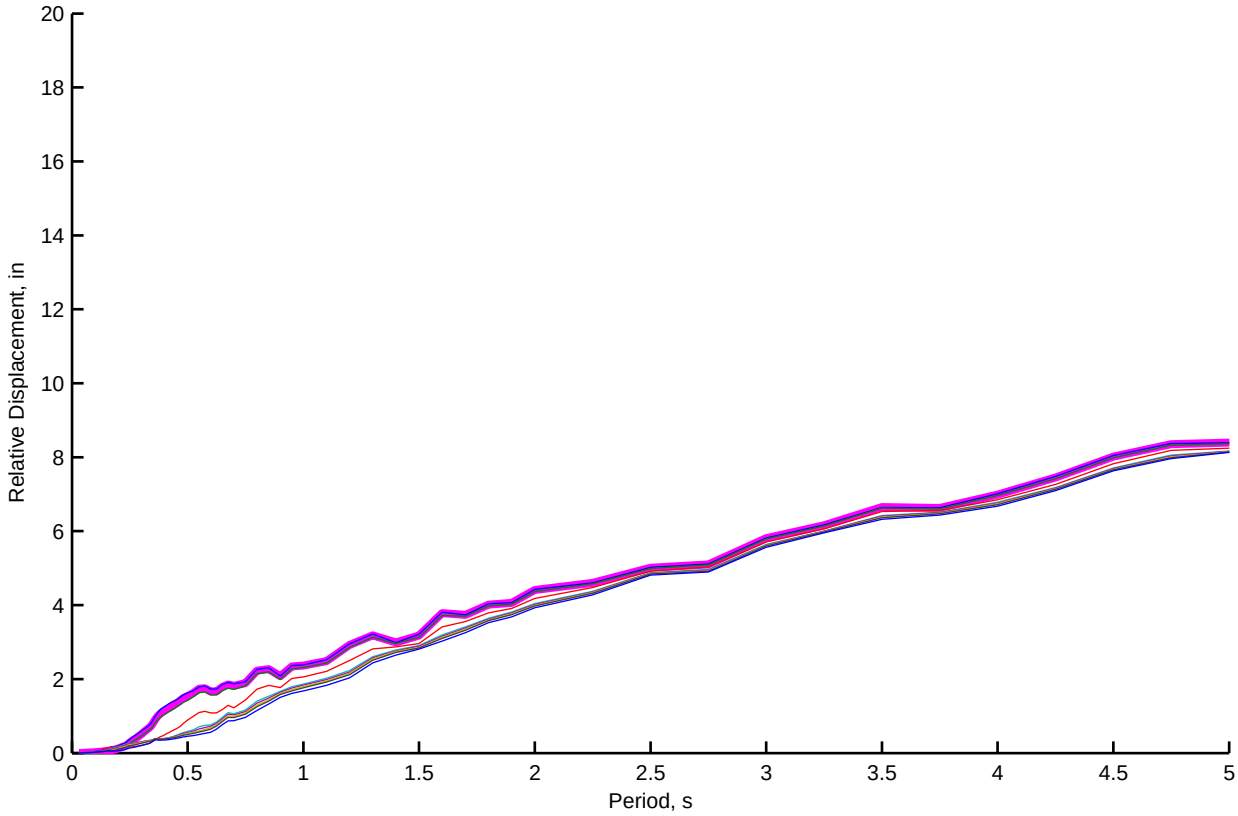

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

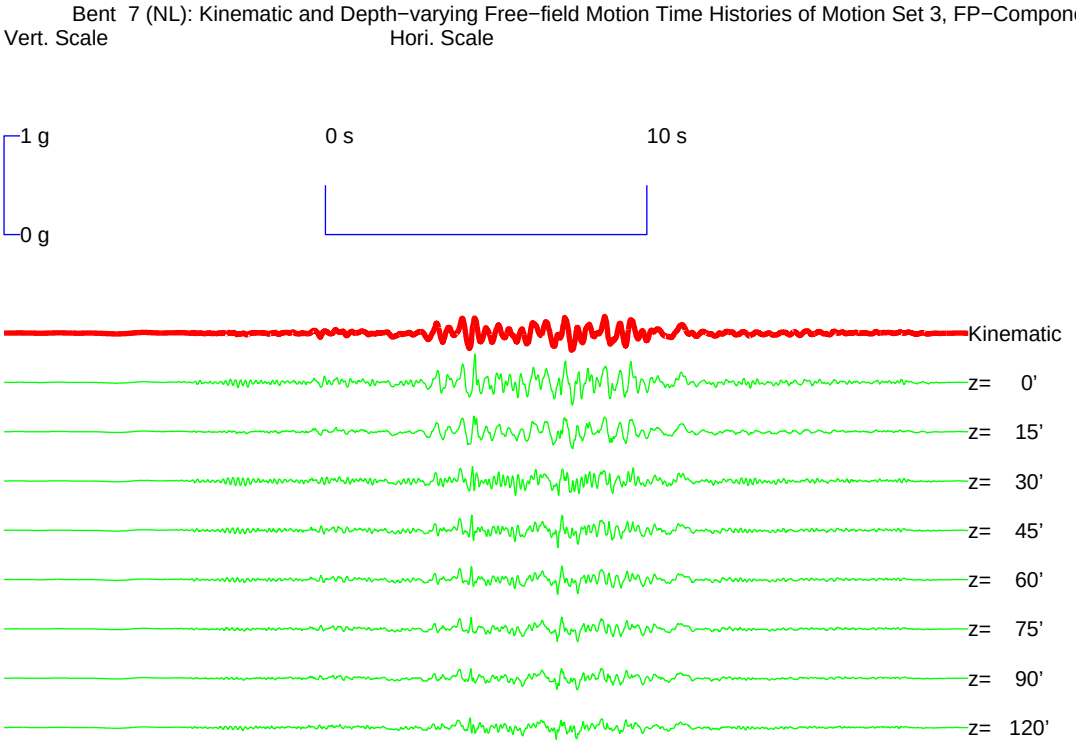


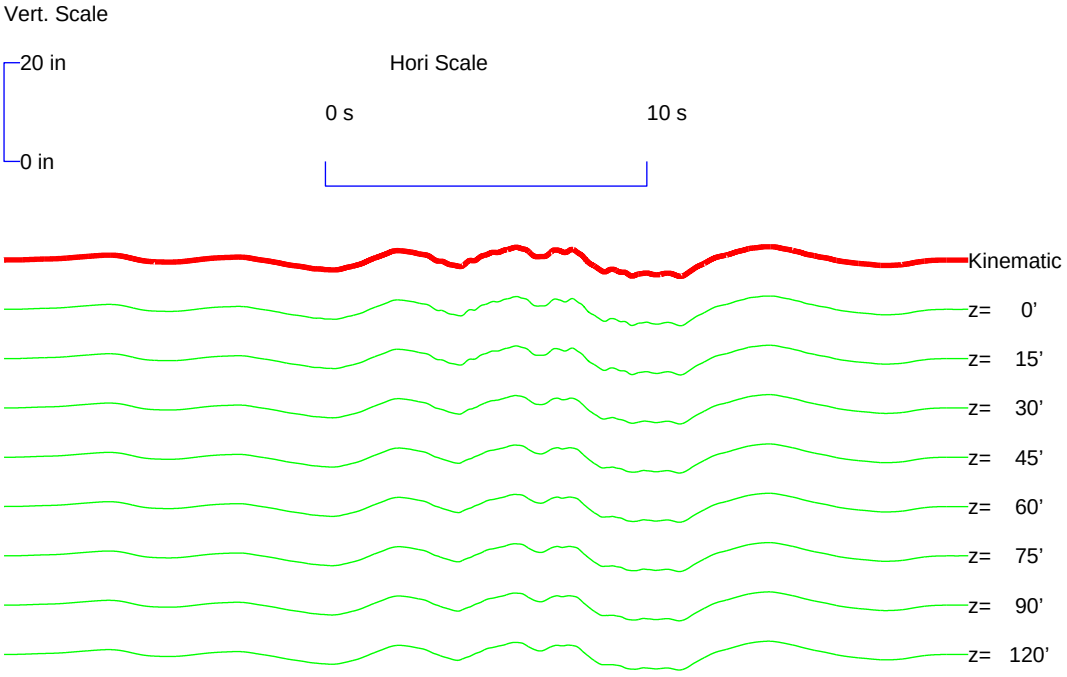



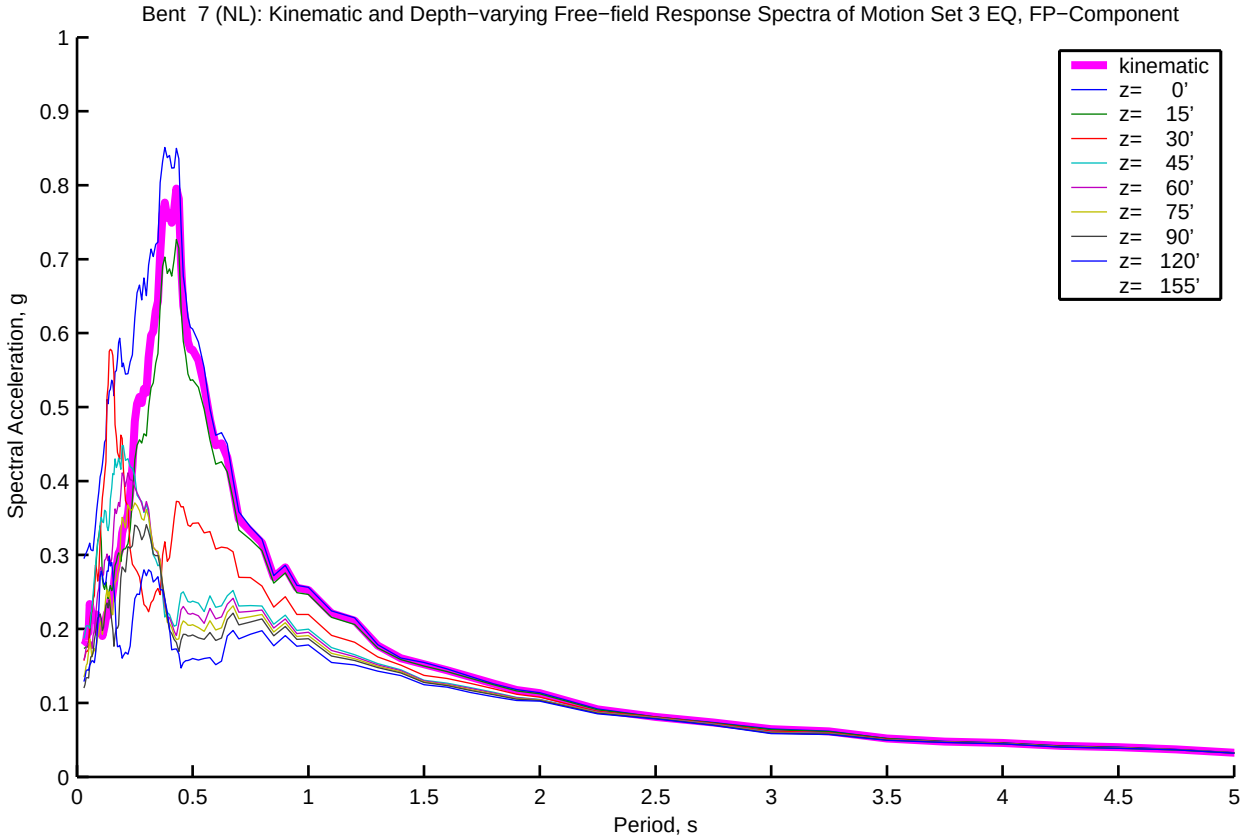

Bent 7 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

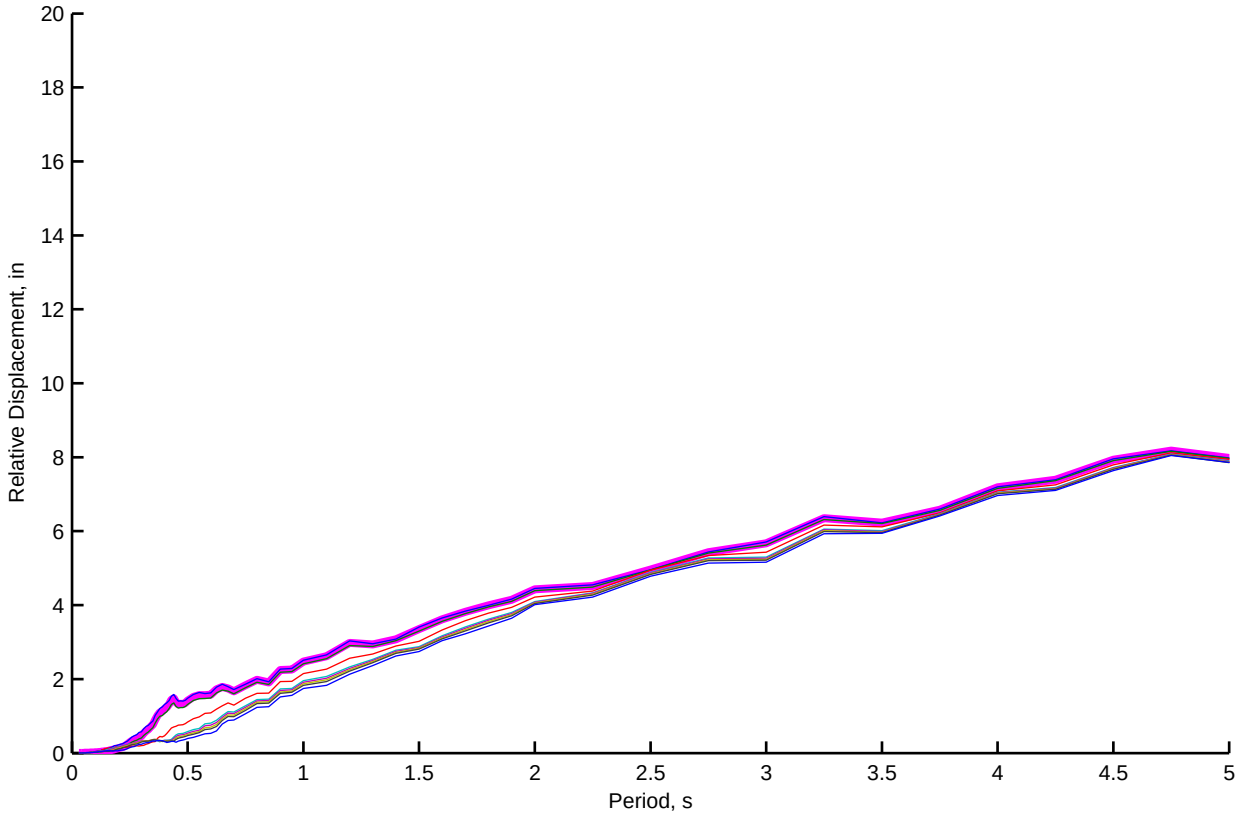

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

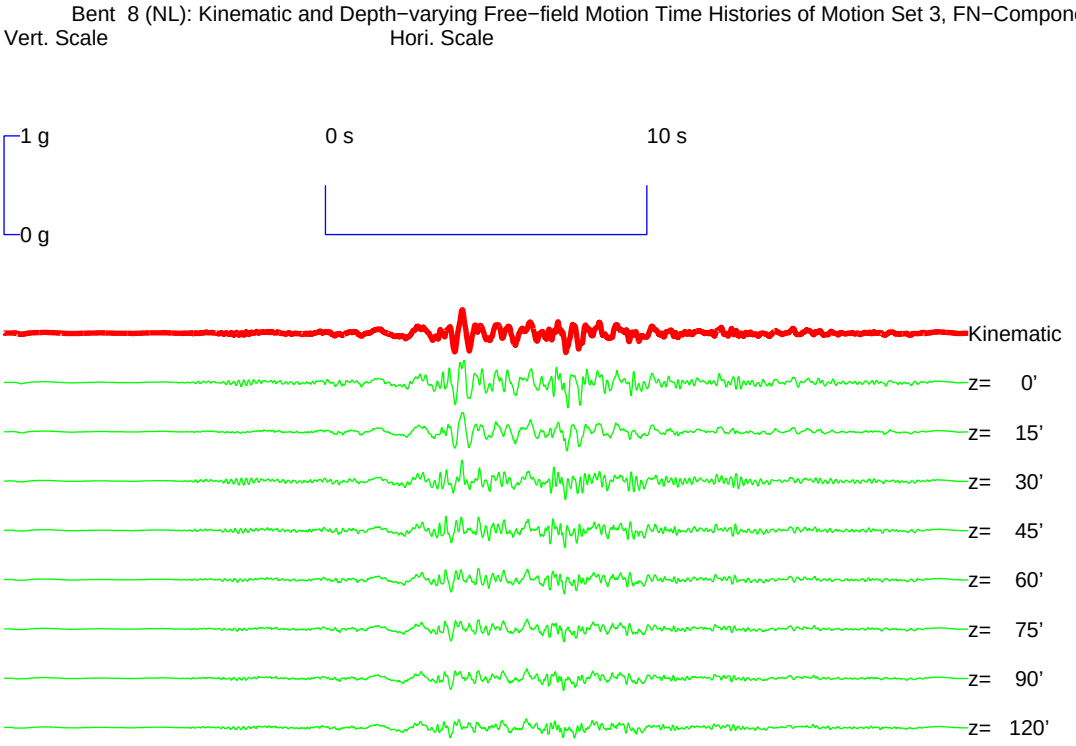


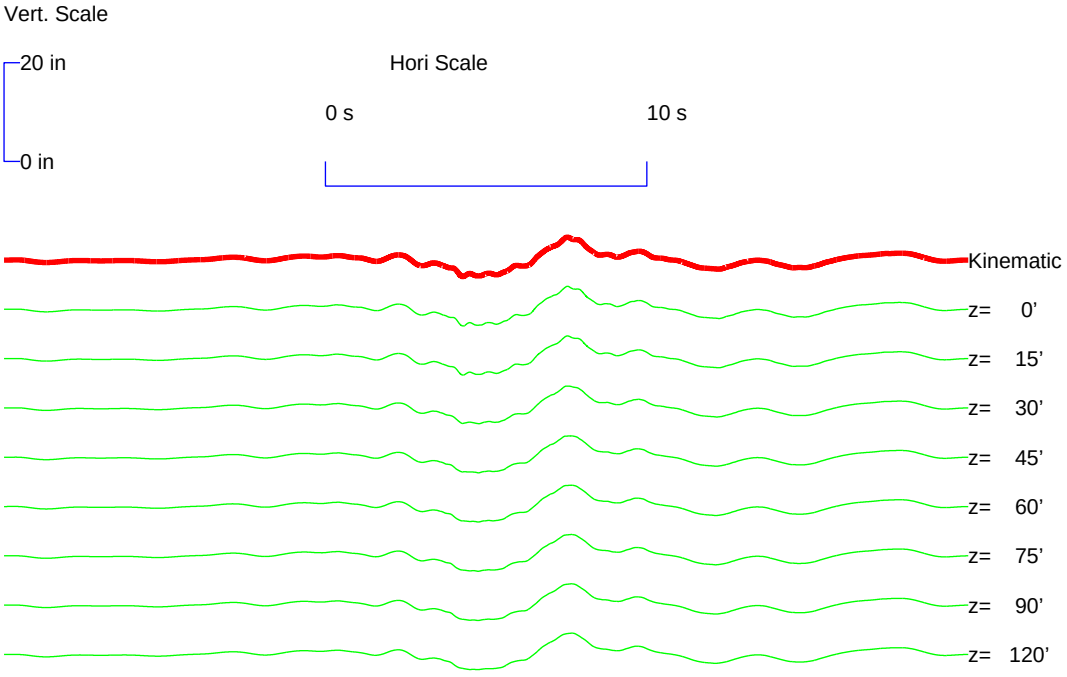



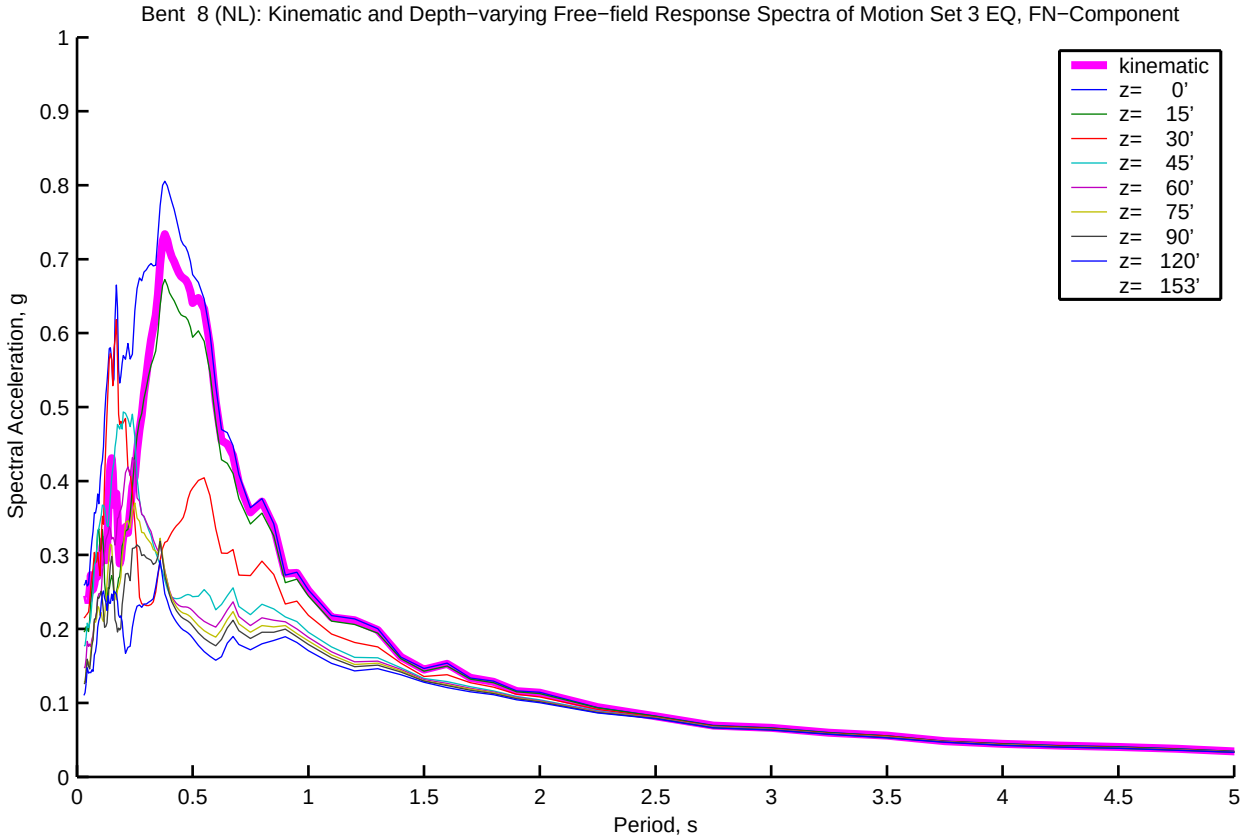

Bent 7 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'

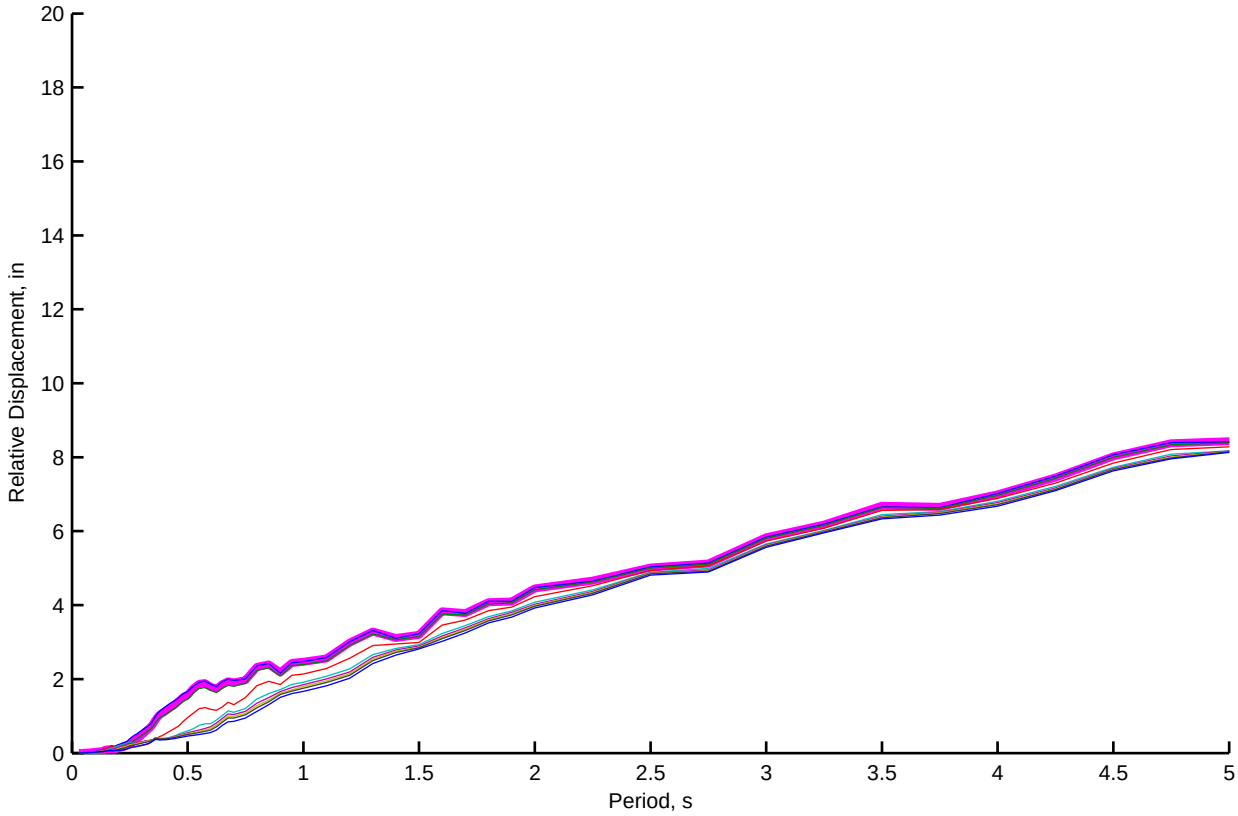

Relative Displacement, in
Period, s

Bent 8 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

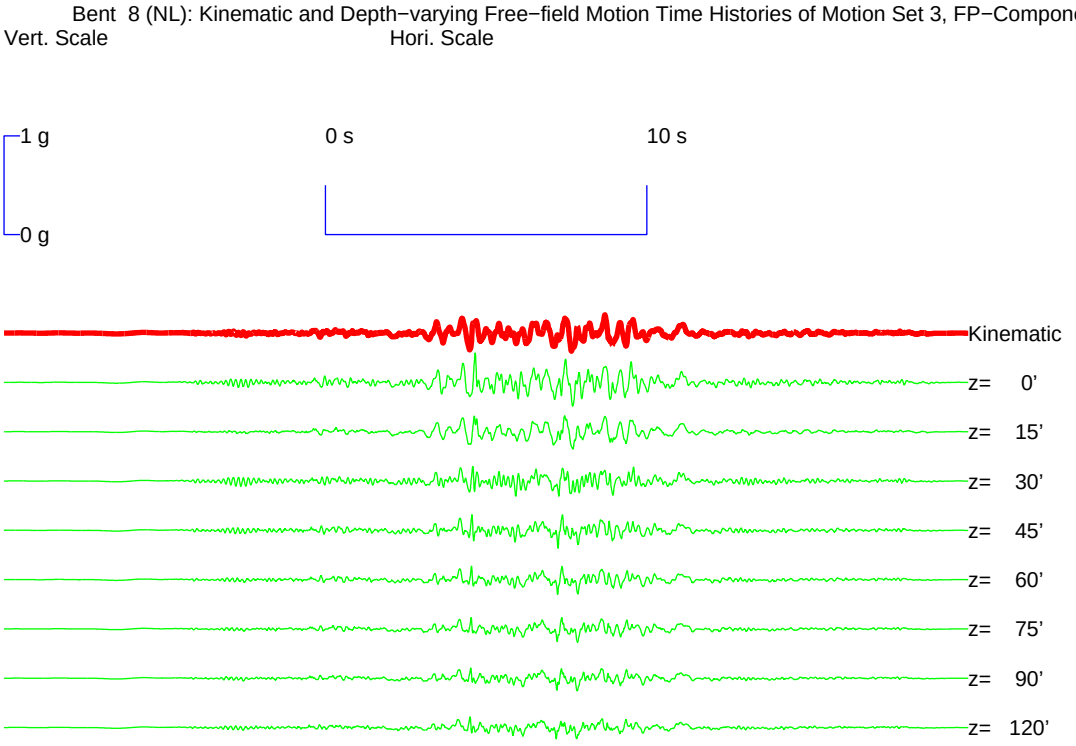


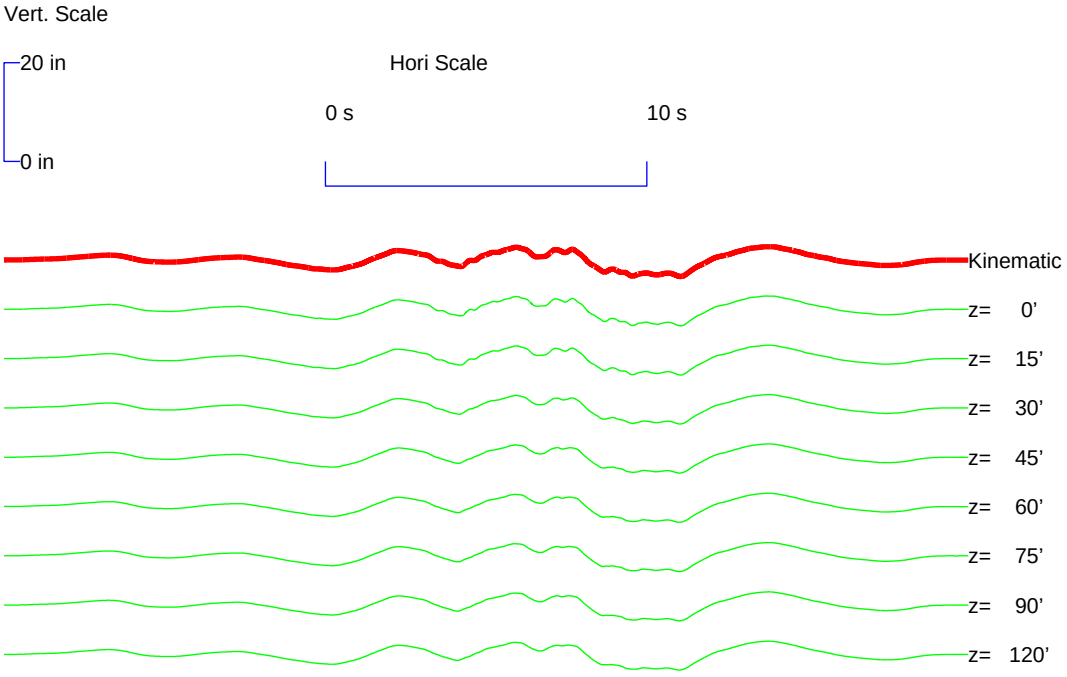



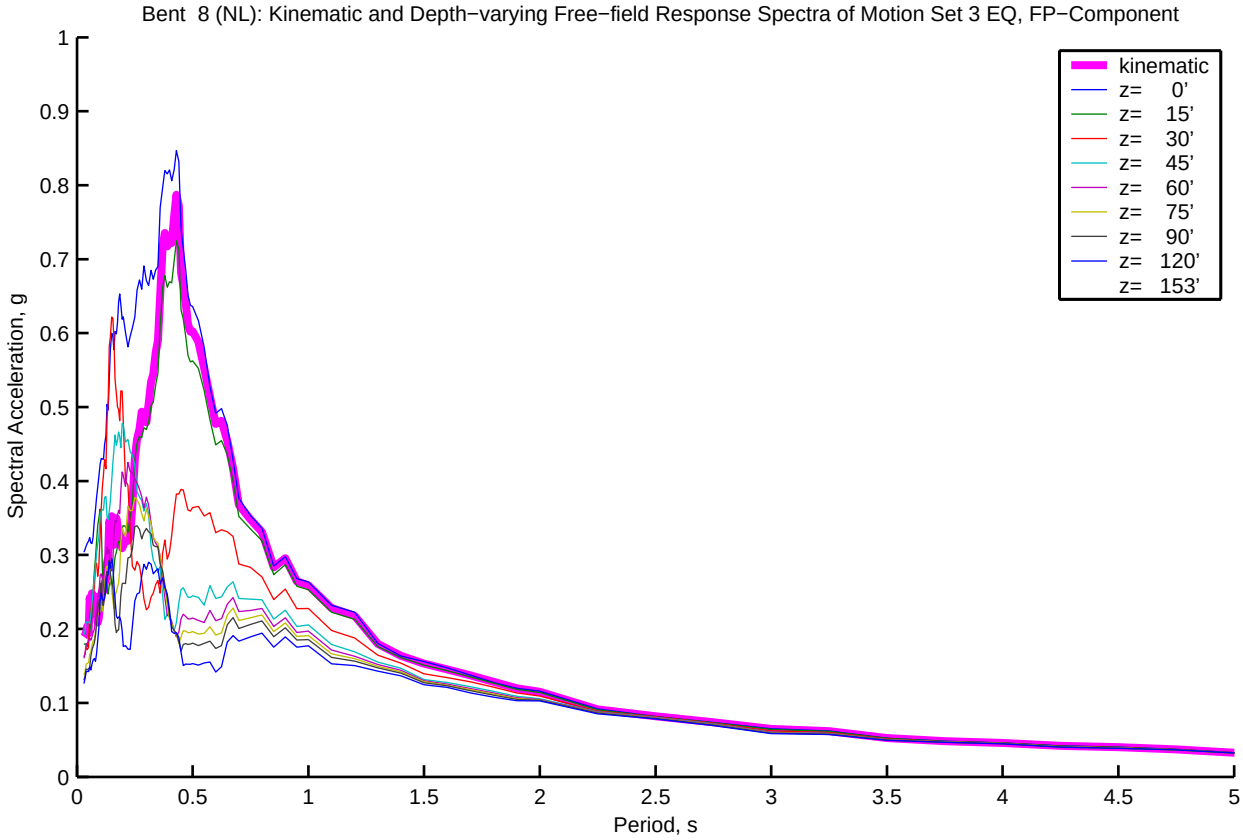

Bent 8 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

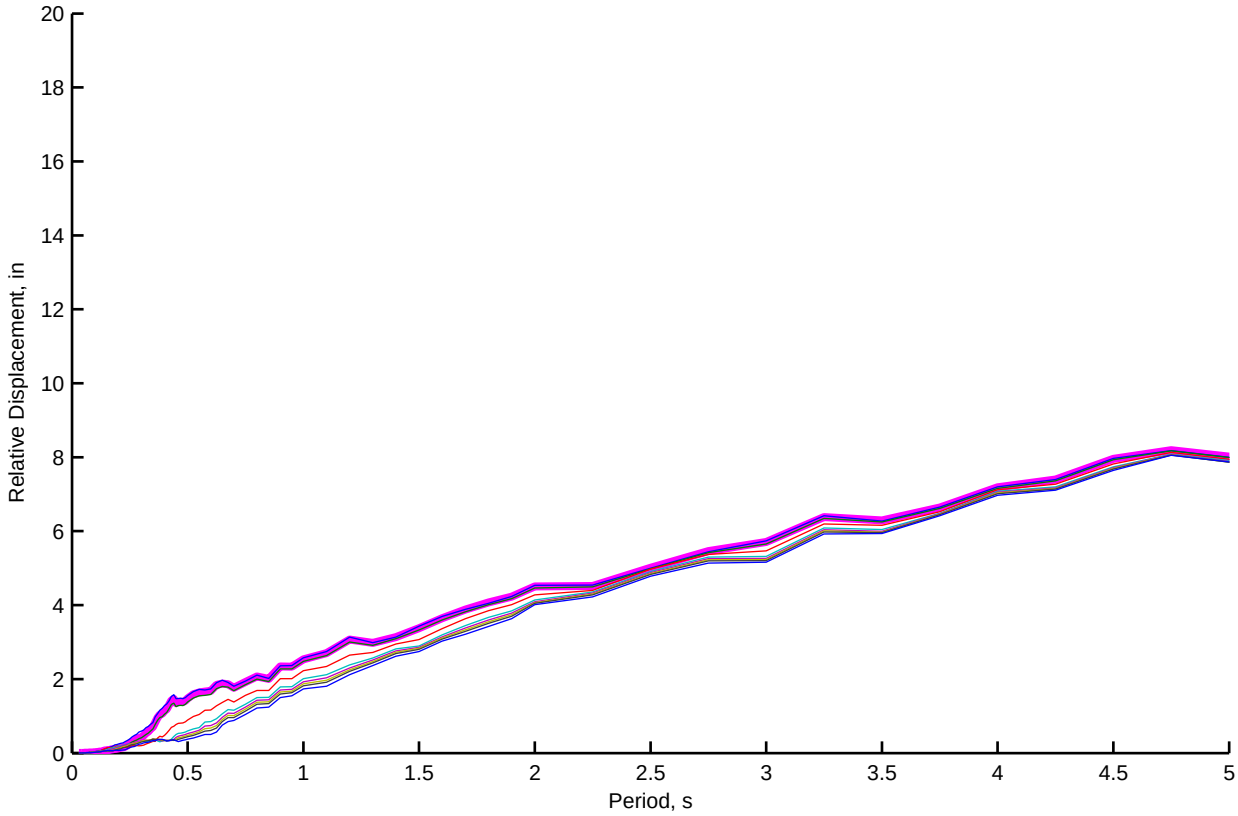

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

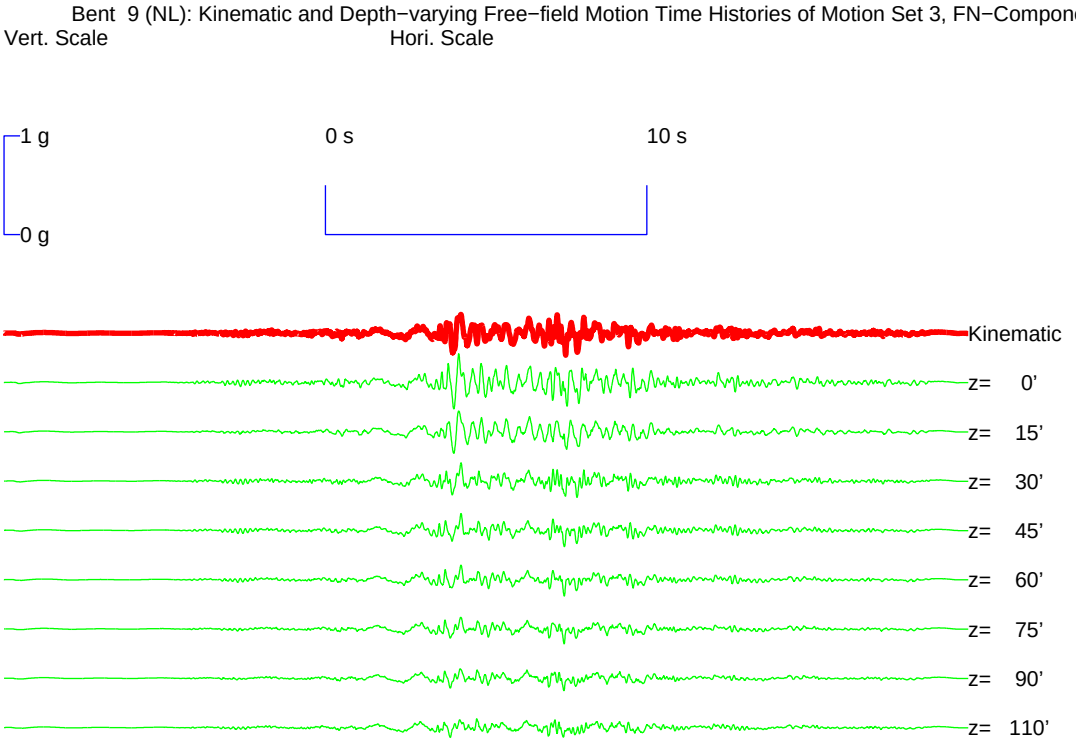


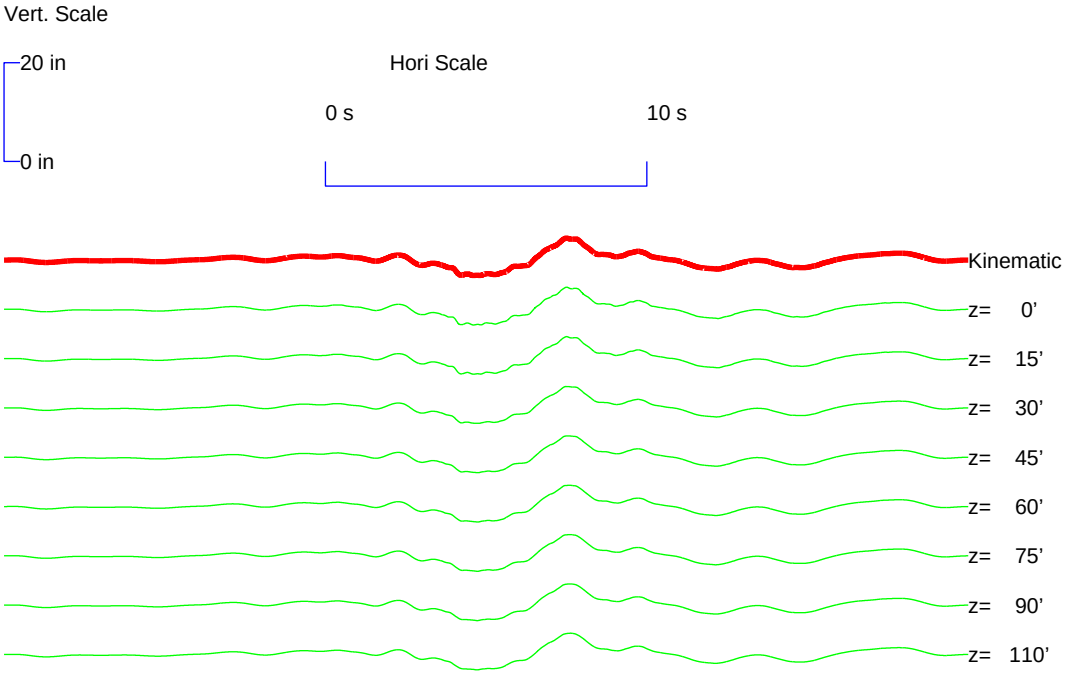



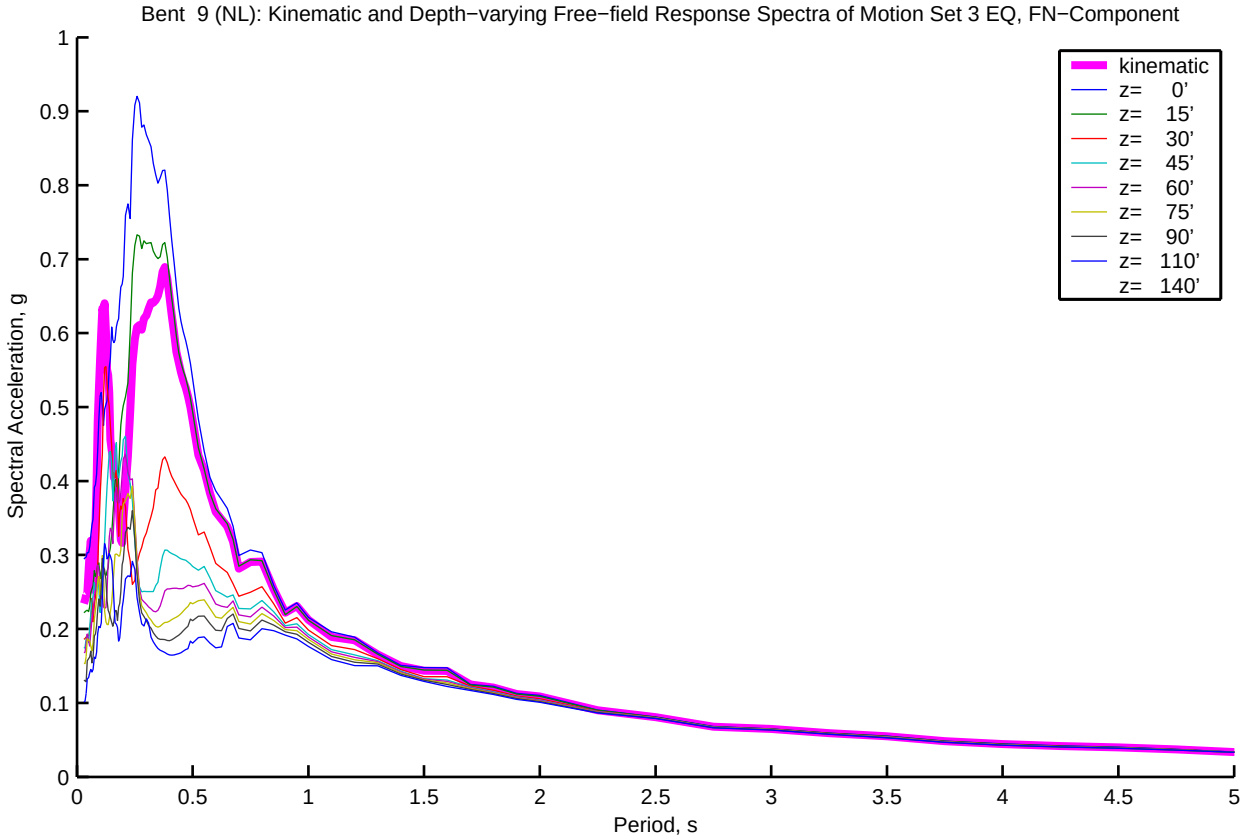

Bent 8 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

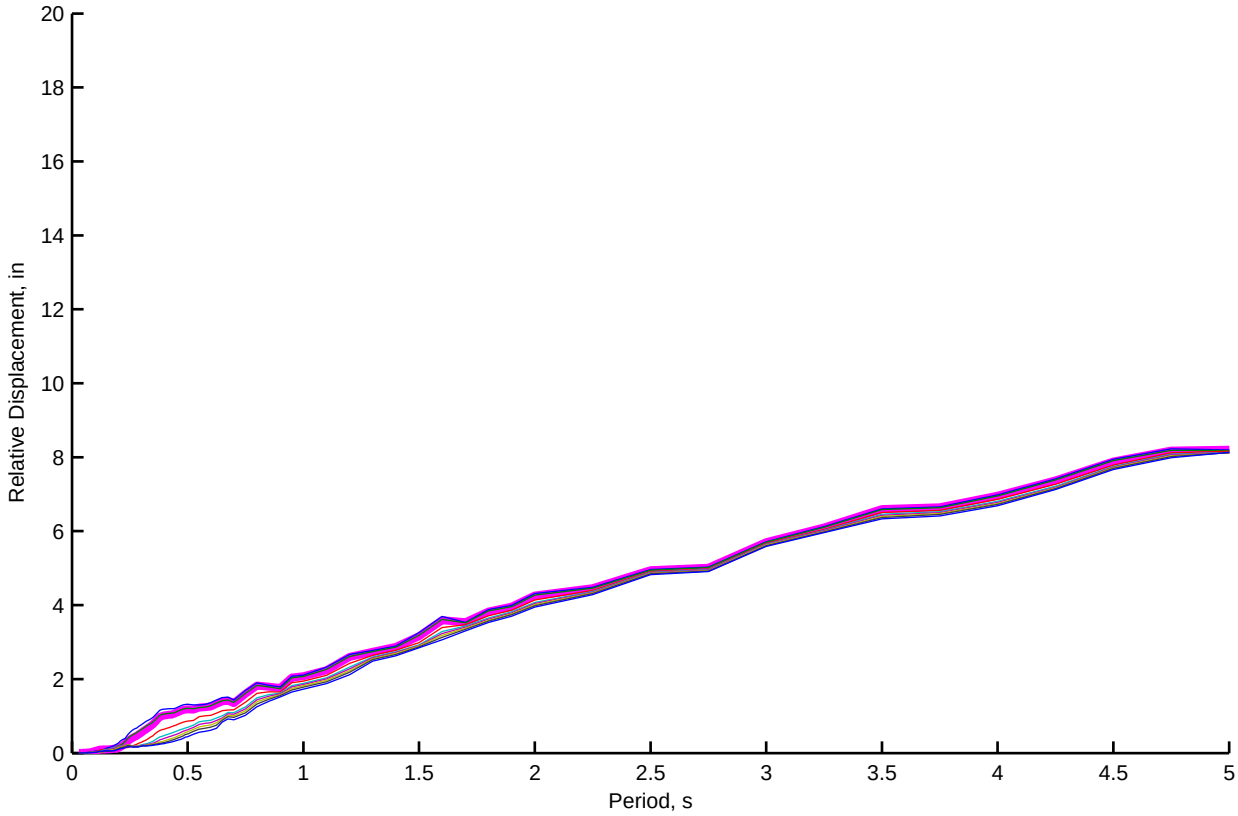

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 9 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

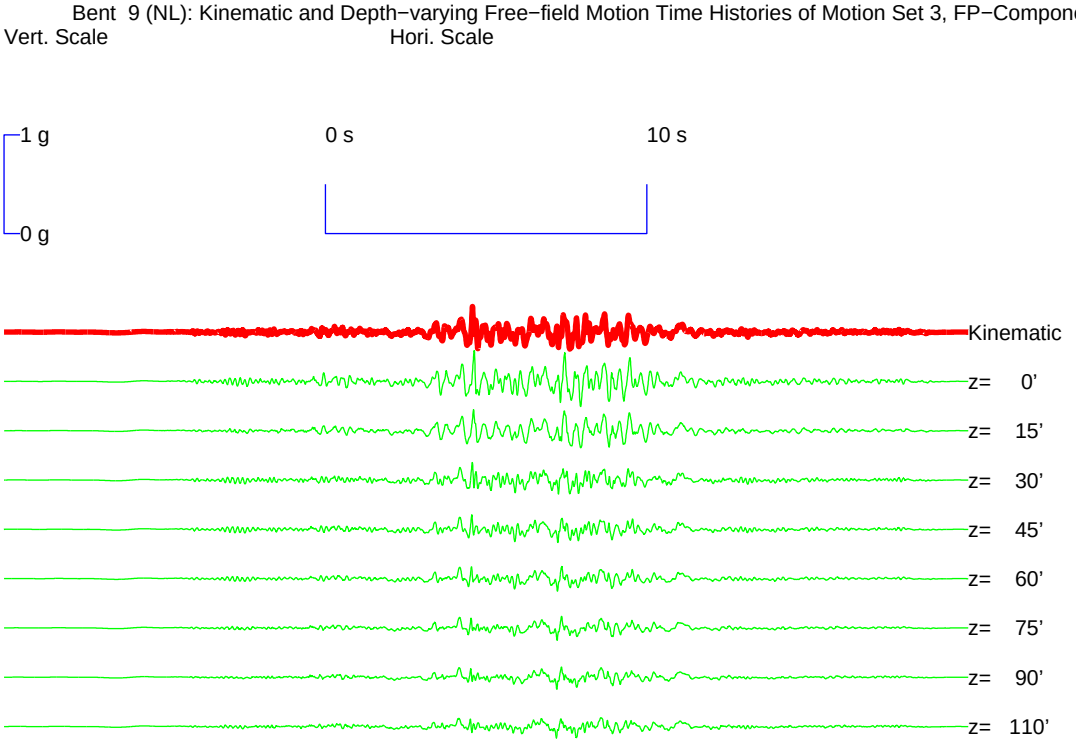


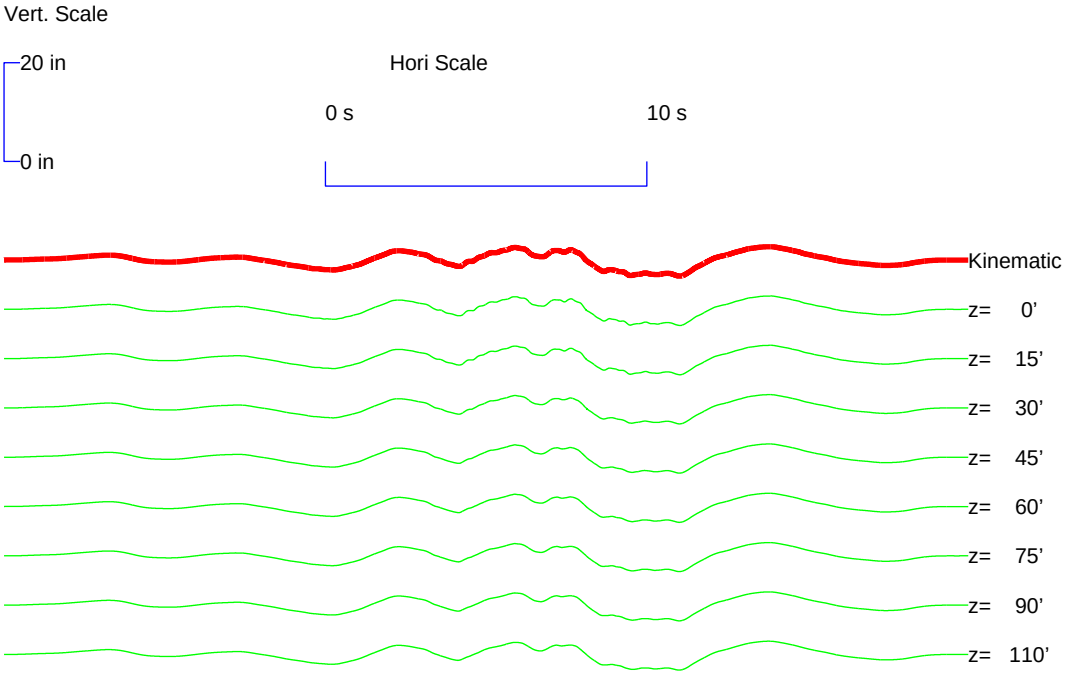



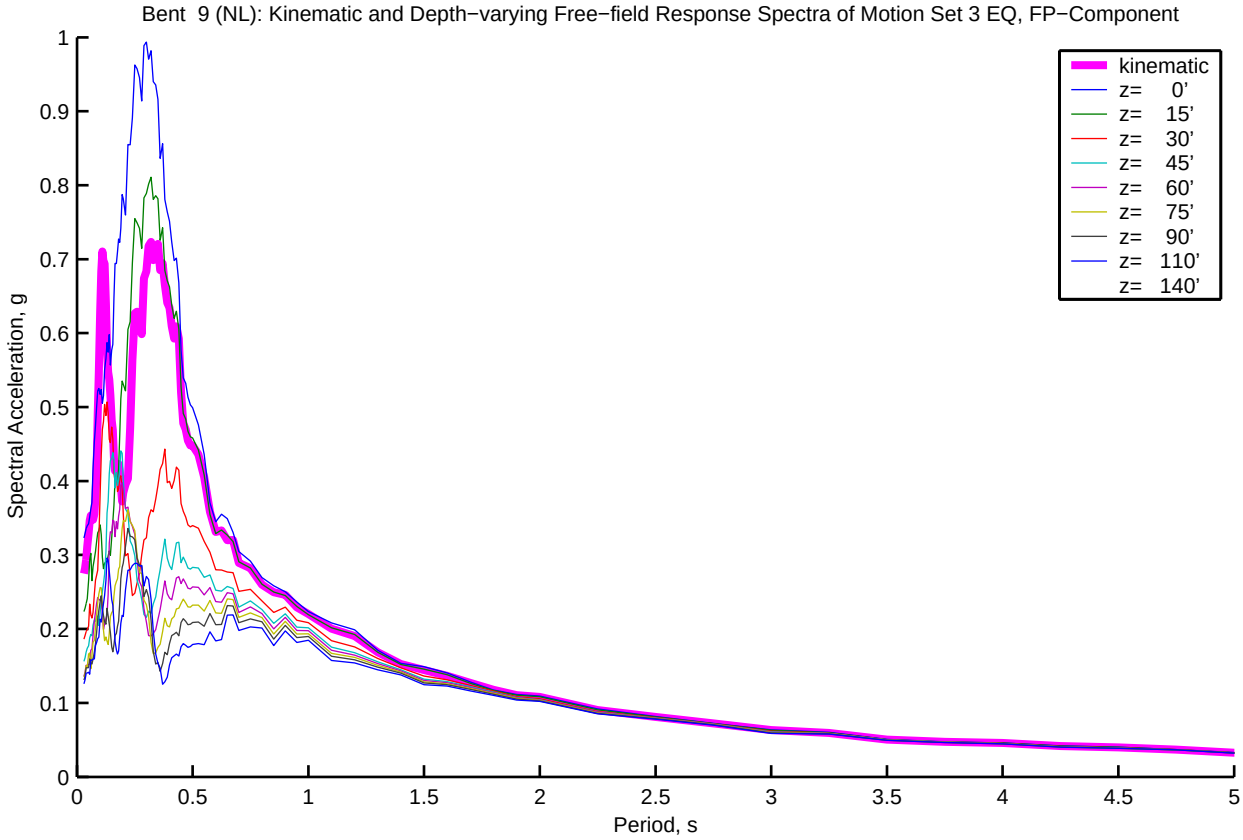

Bent 9 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

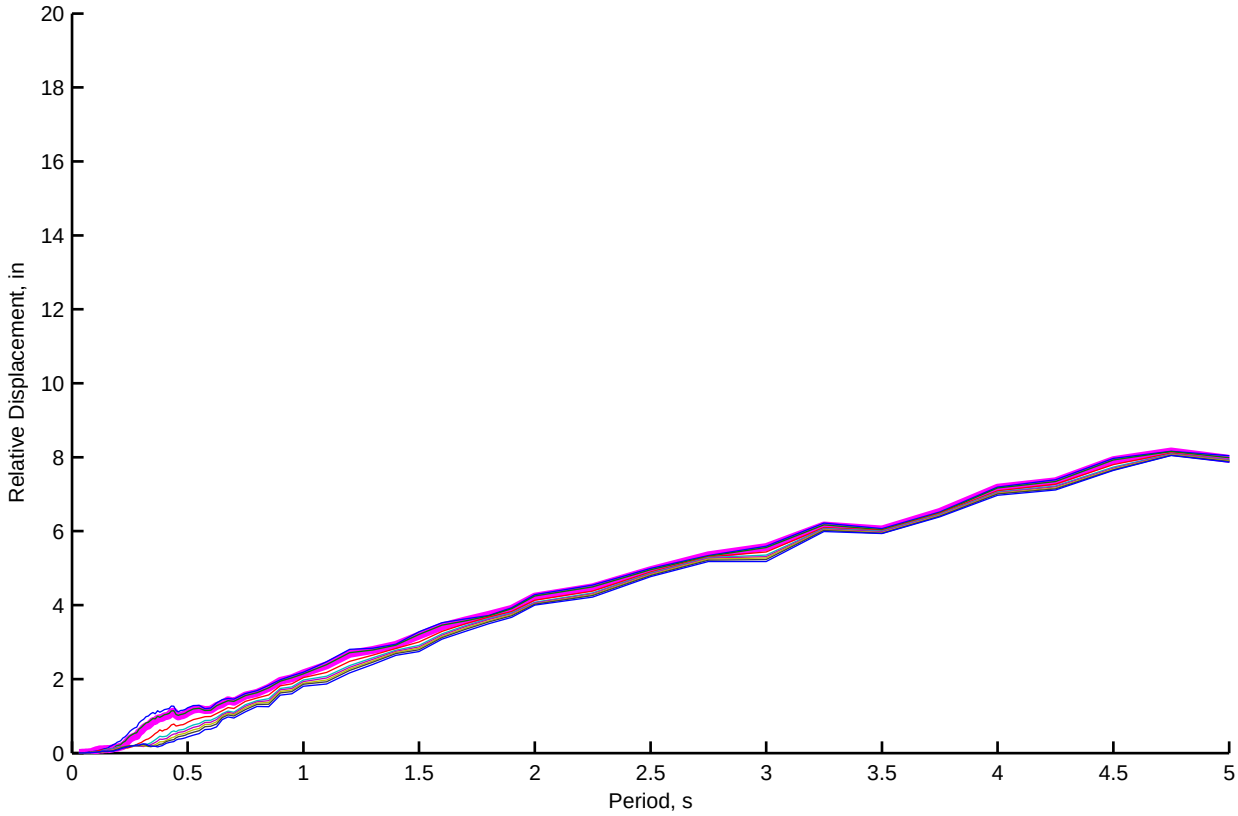

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 9 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

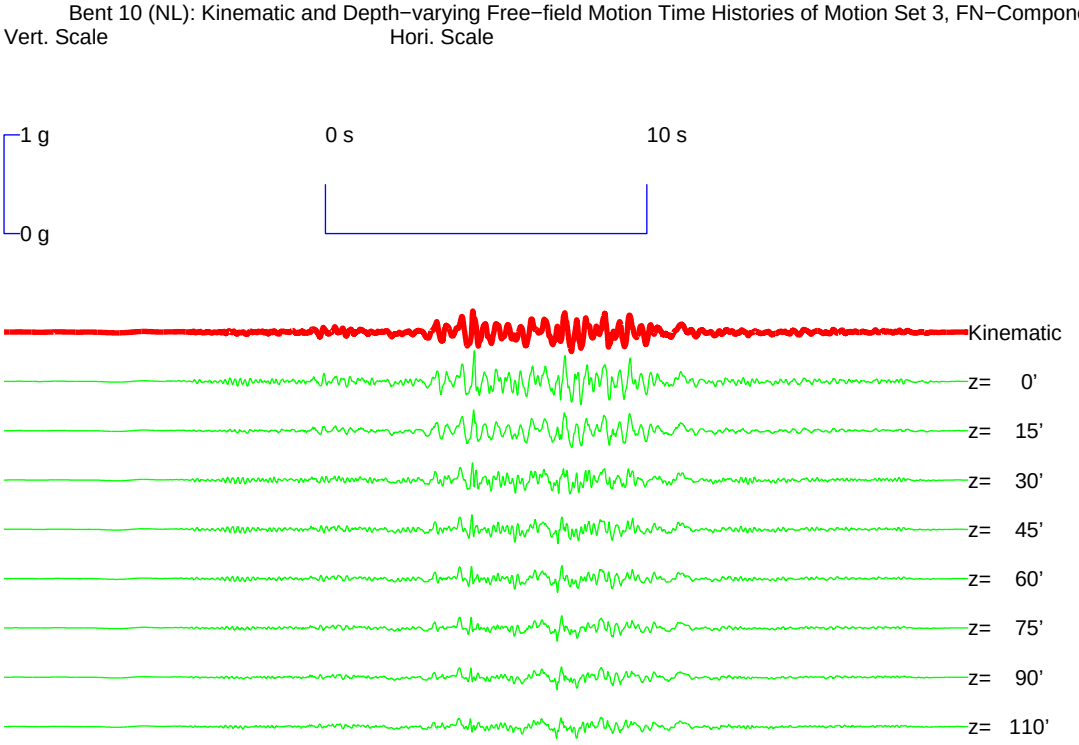


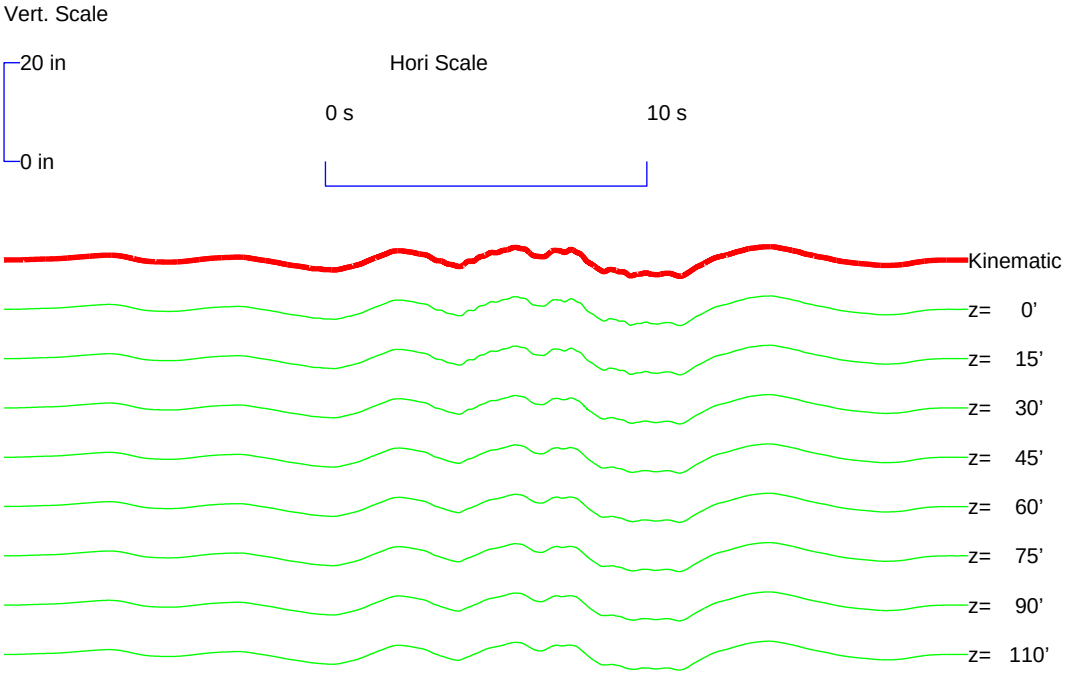



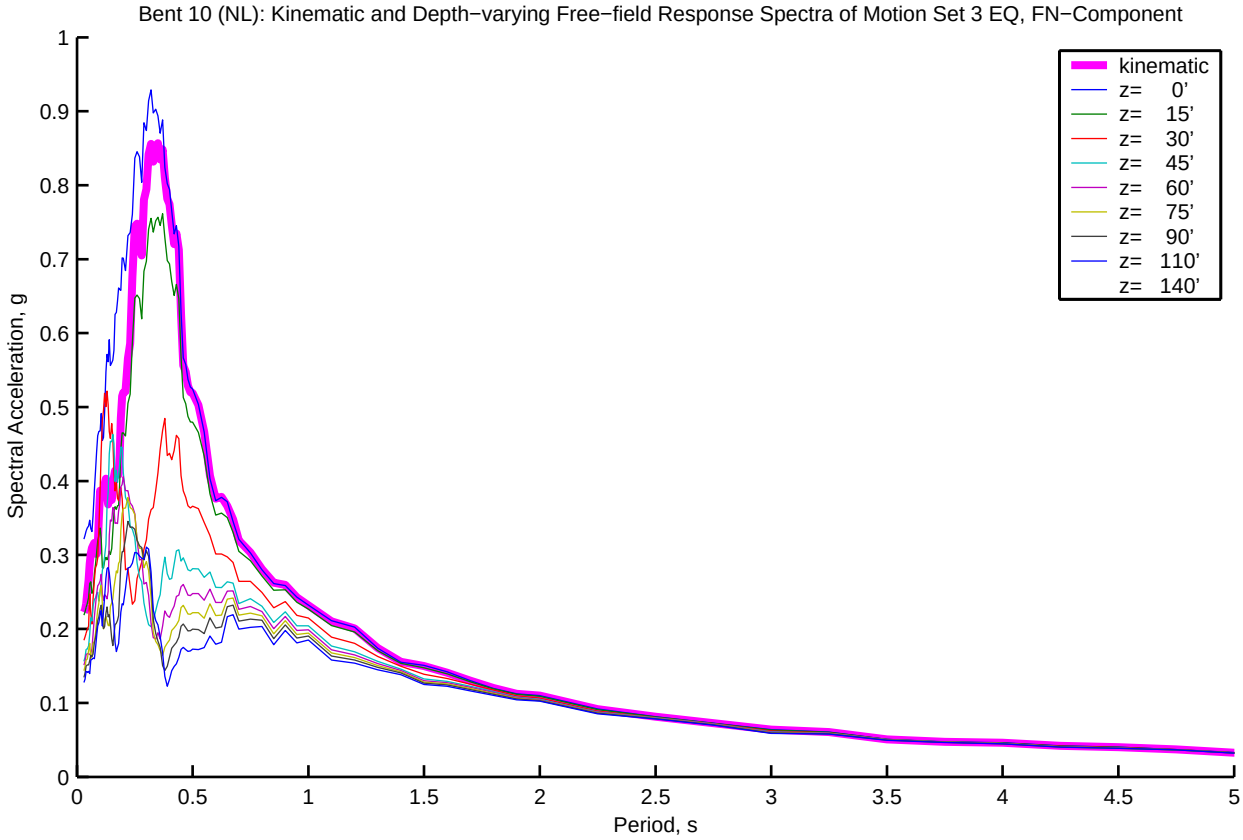

Bent 9 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

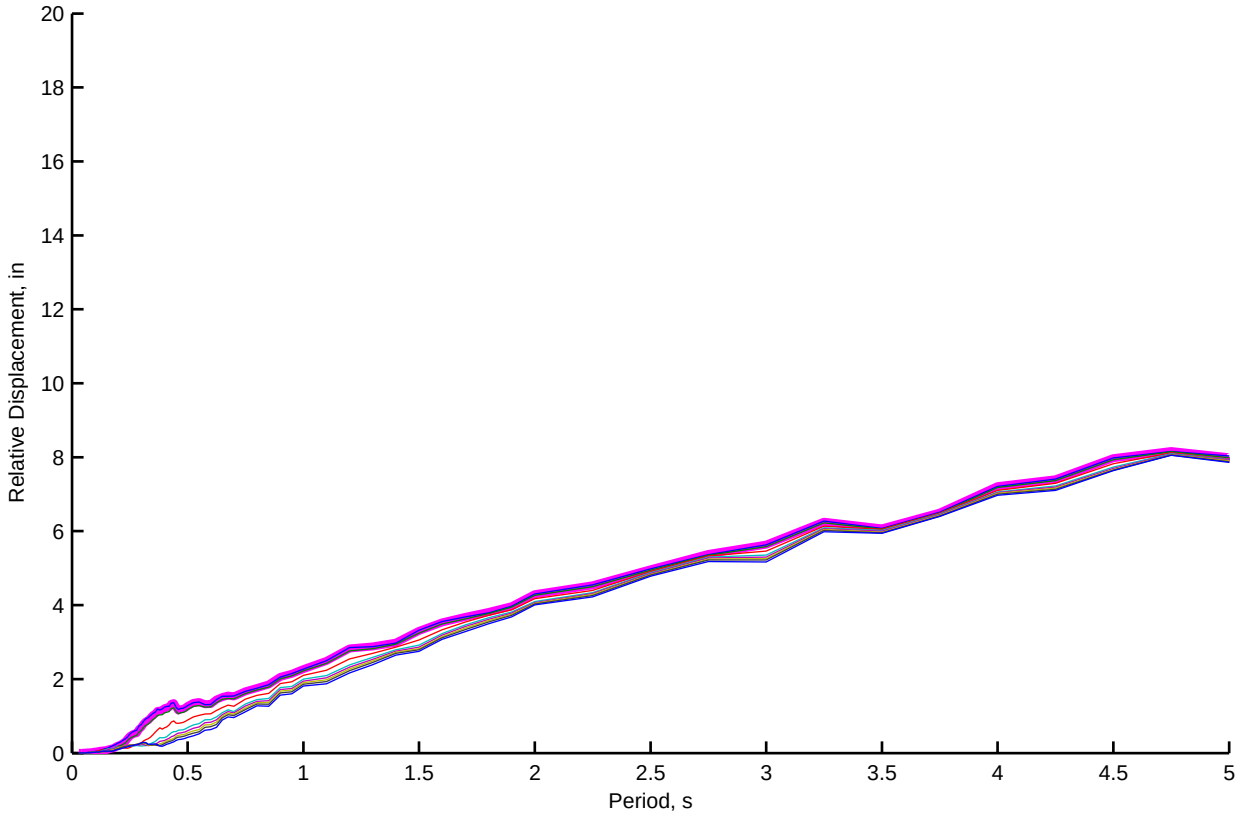

Relative Displacement, in
Period, s

Bent 10 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

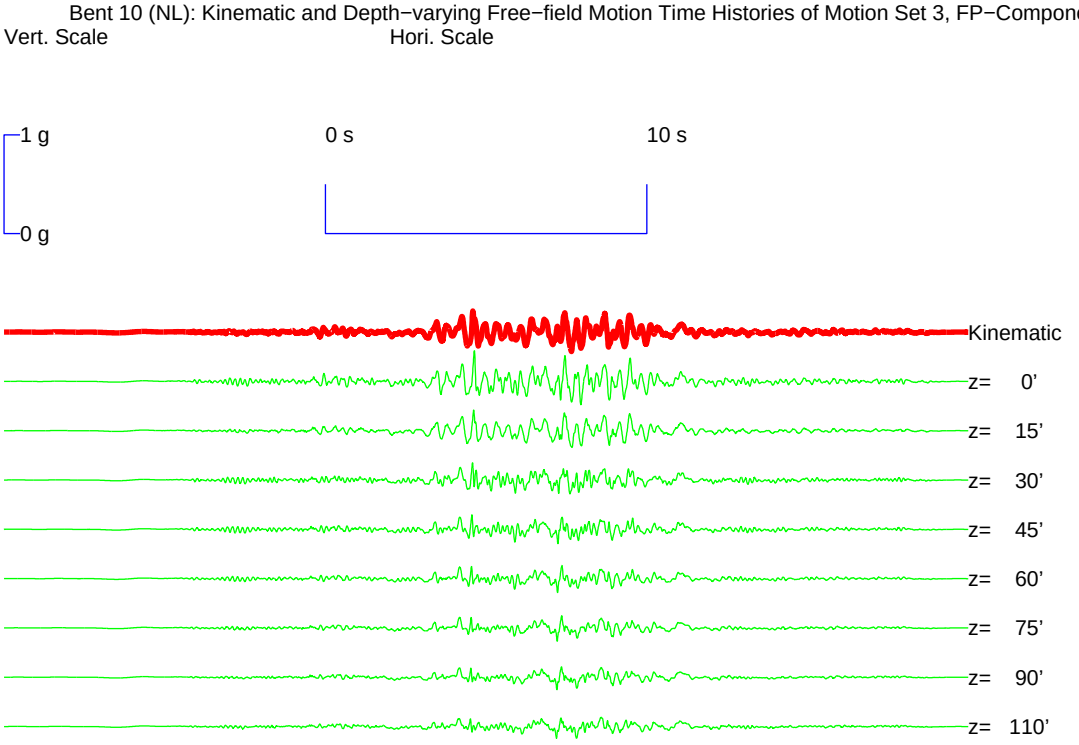


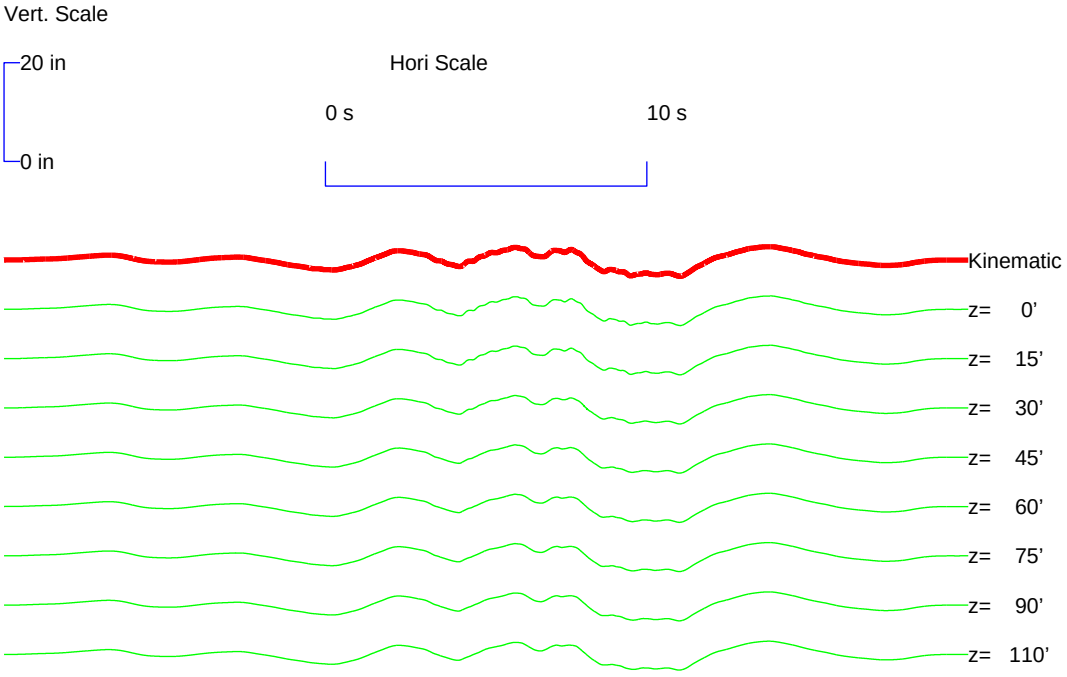



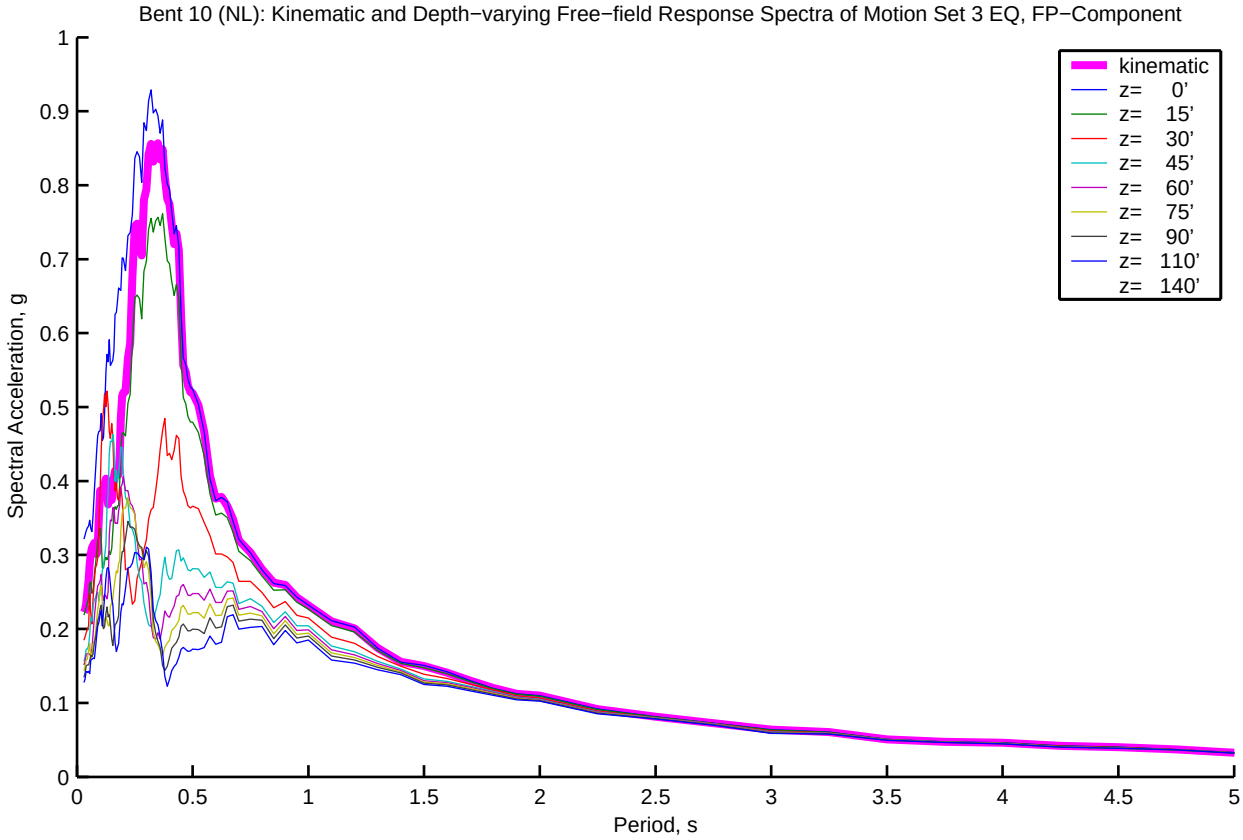

Bent 10 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

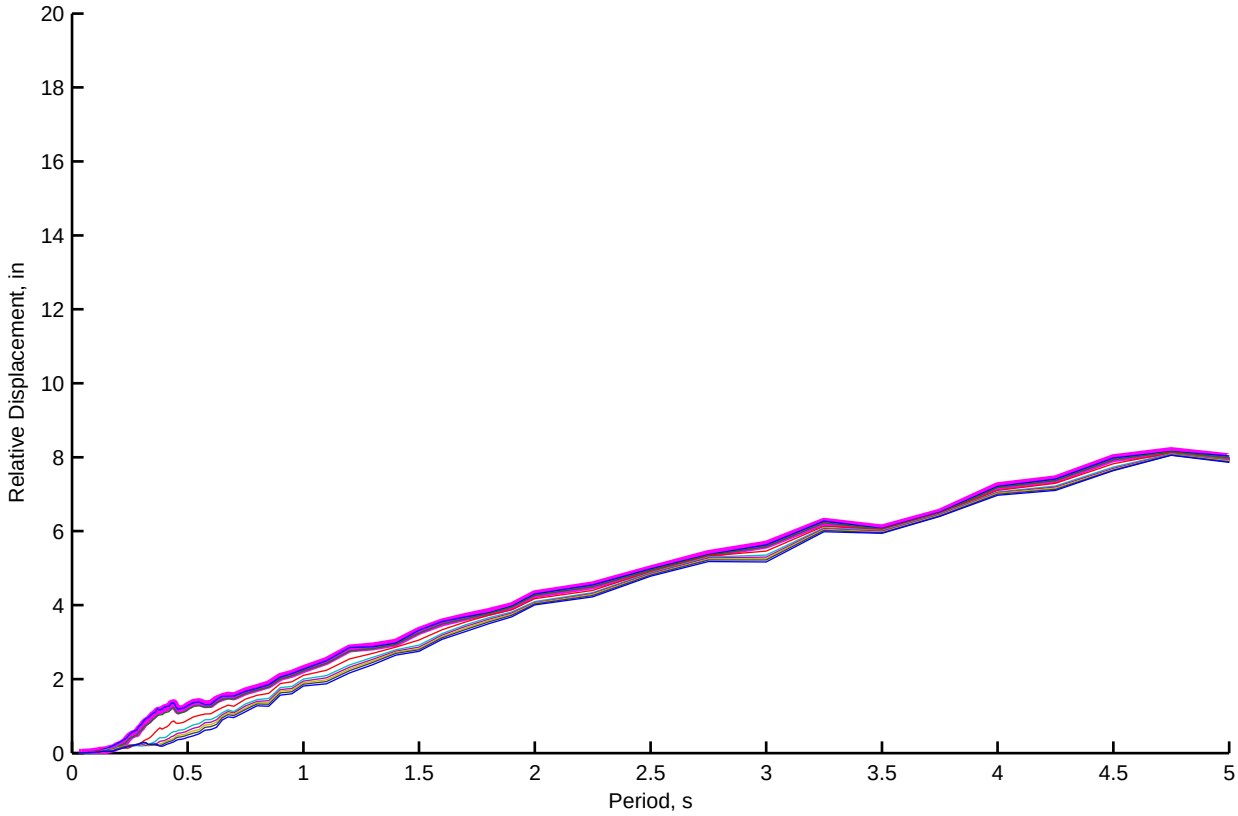

Relative Displacement, in
Period, s

Bent 10 (NL): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

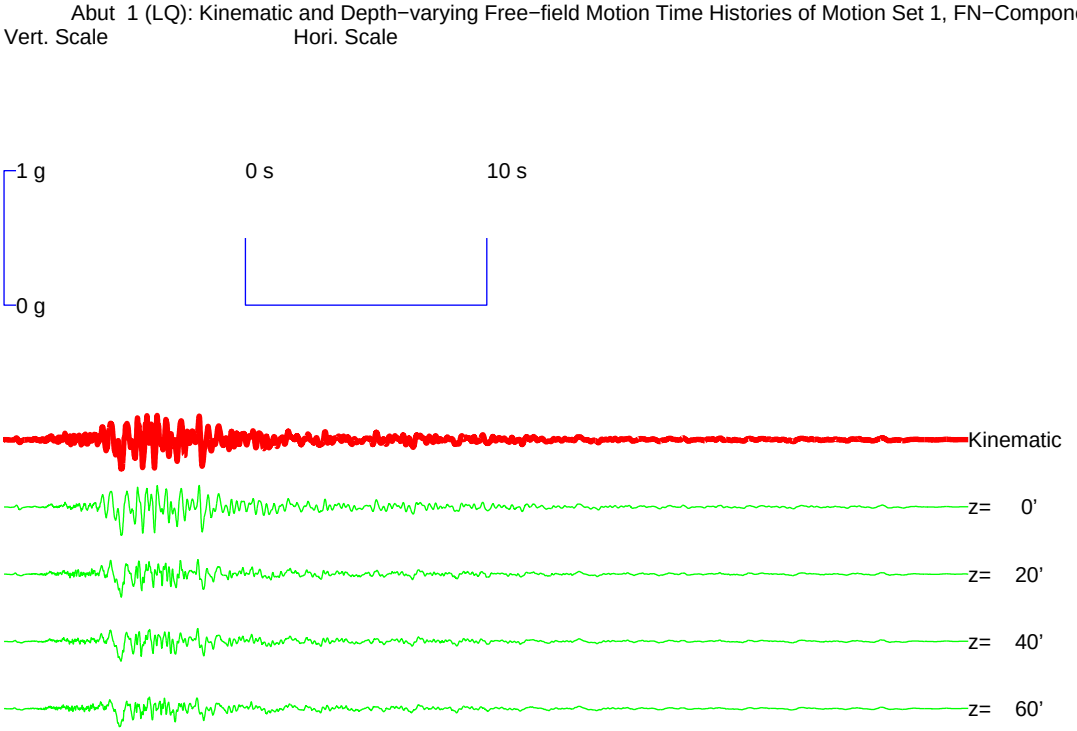


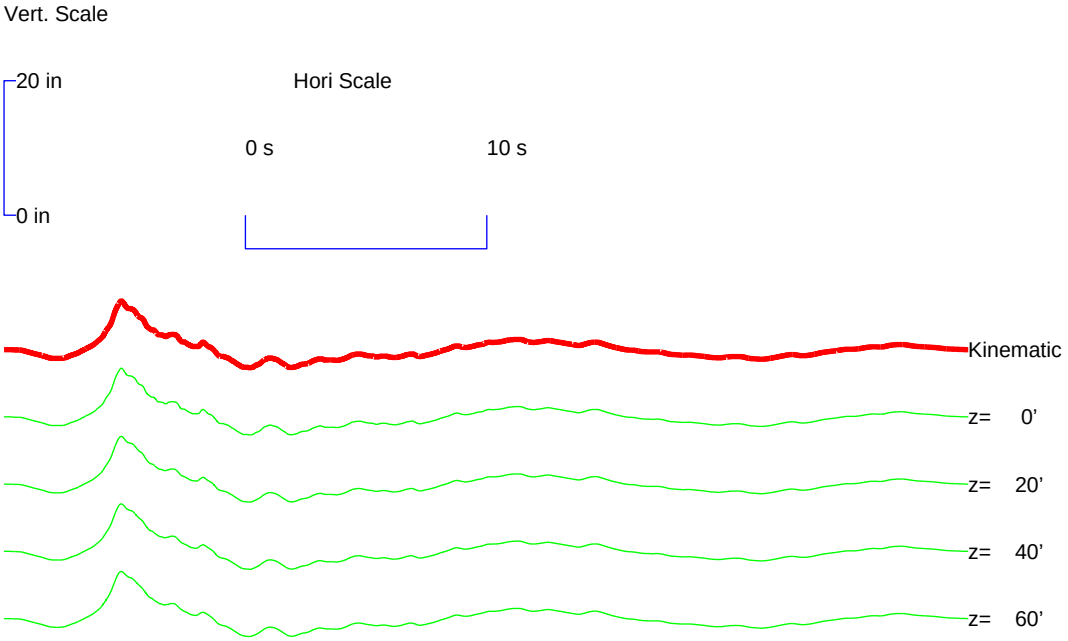



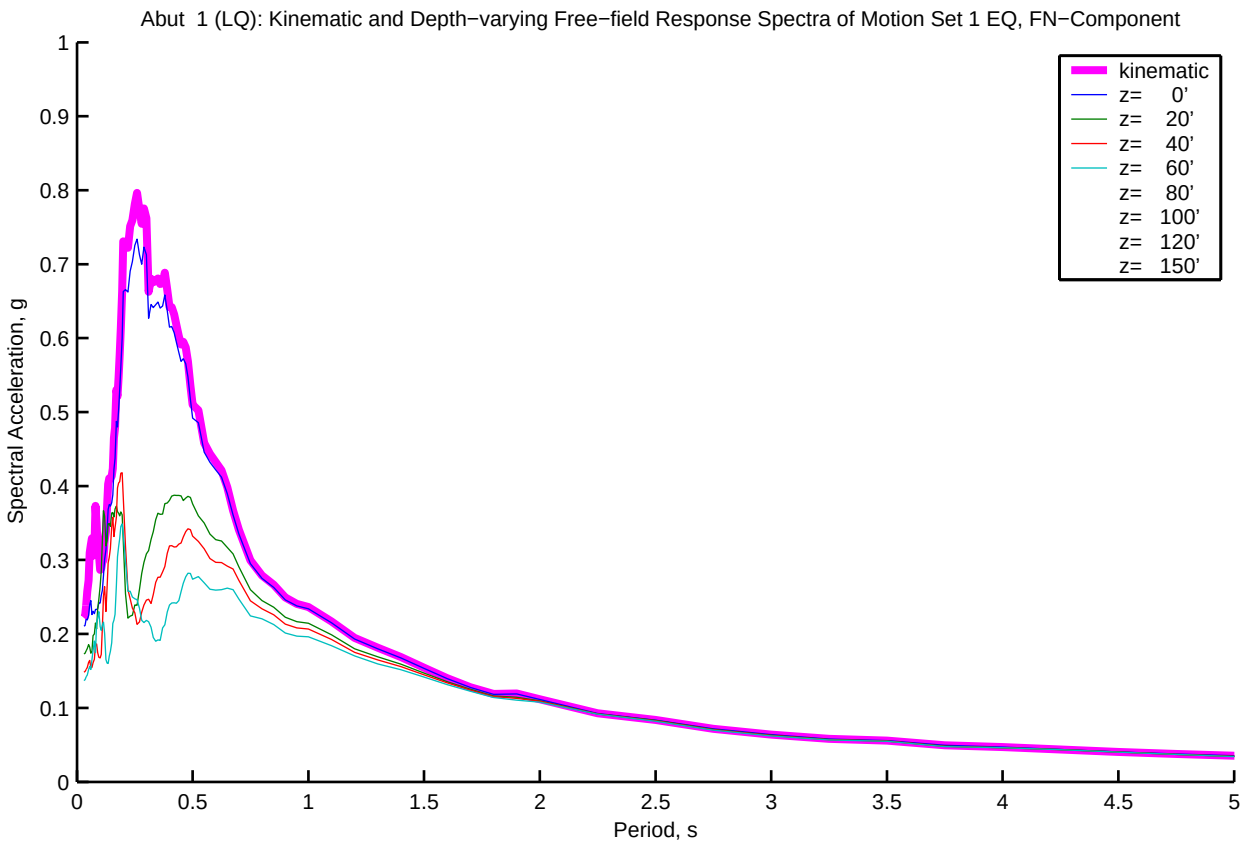

Bent 10 (NL): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

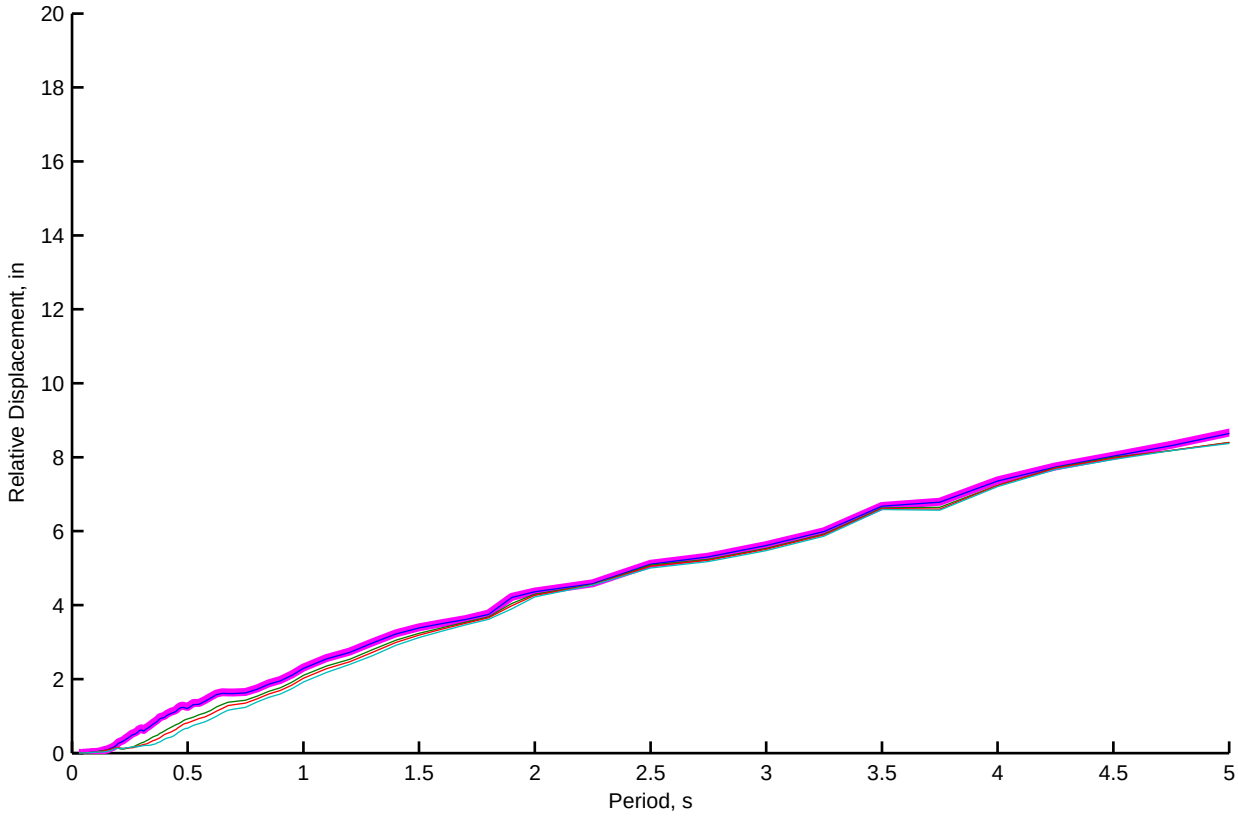

Relative Displacement, in
Period, s

Abut 1 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

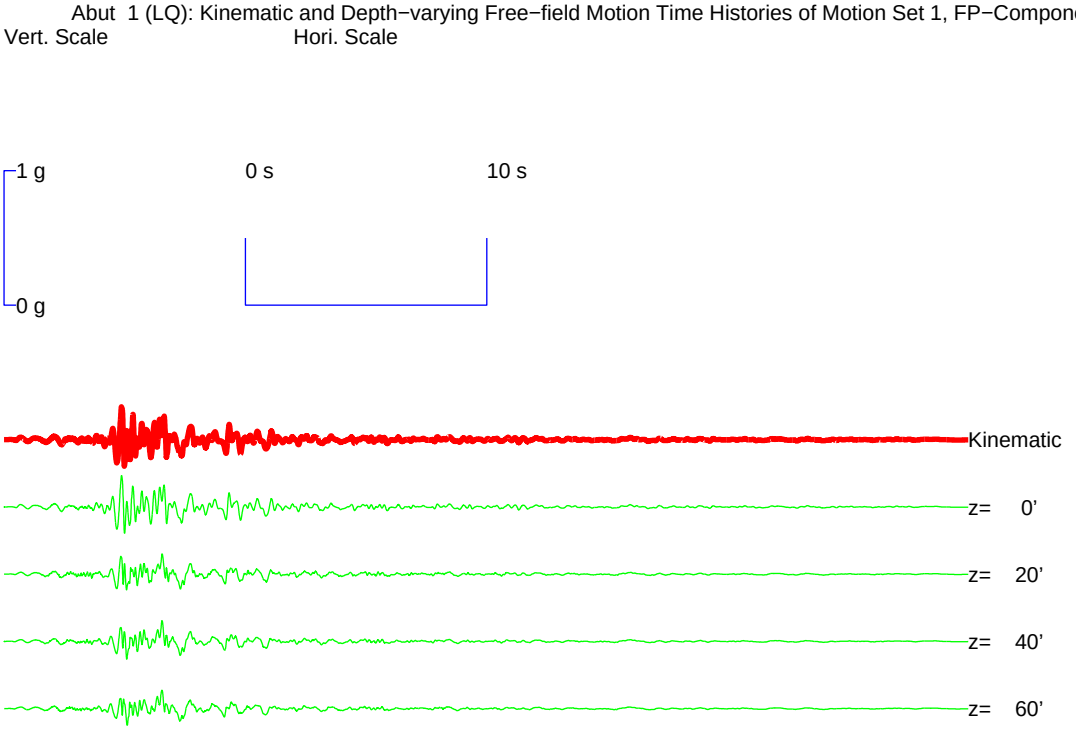


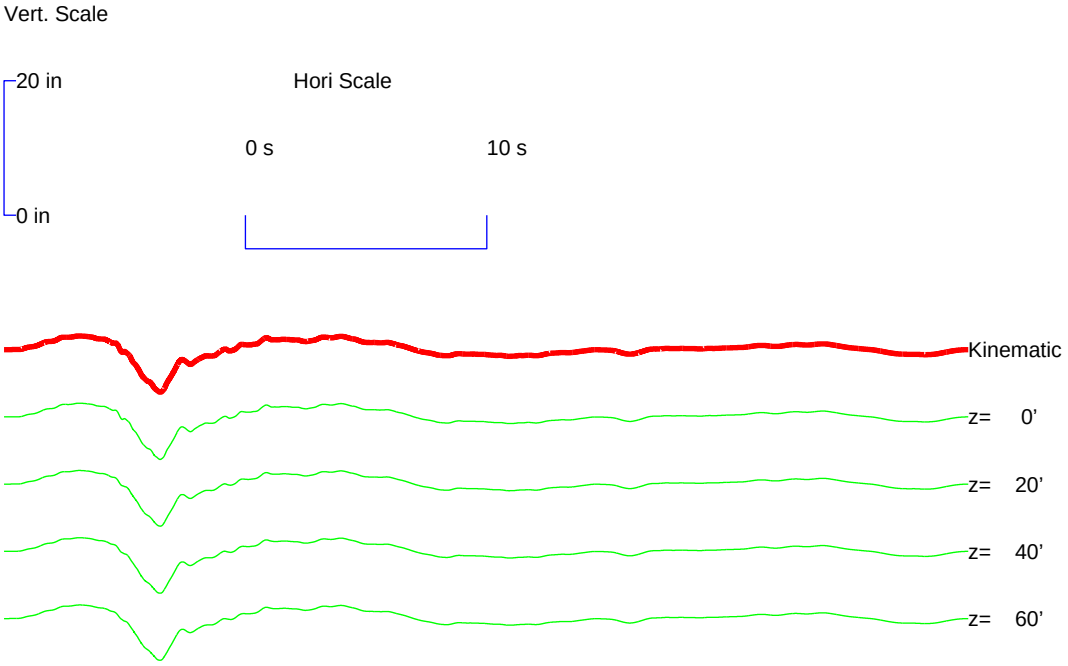



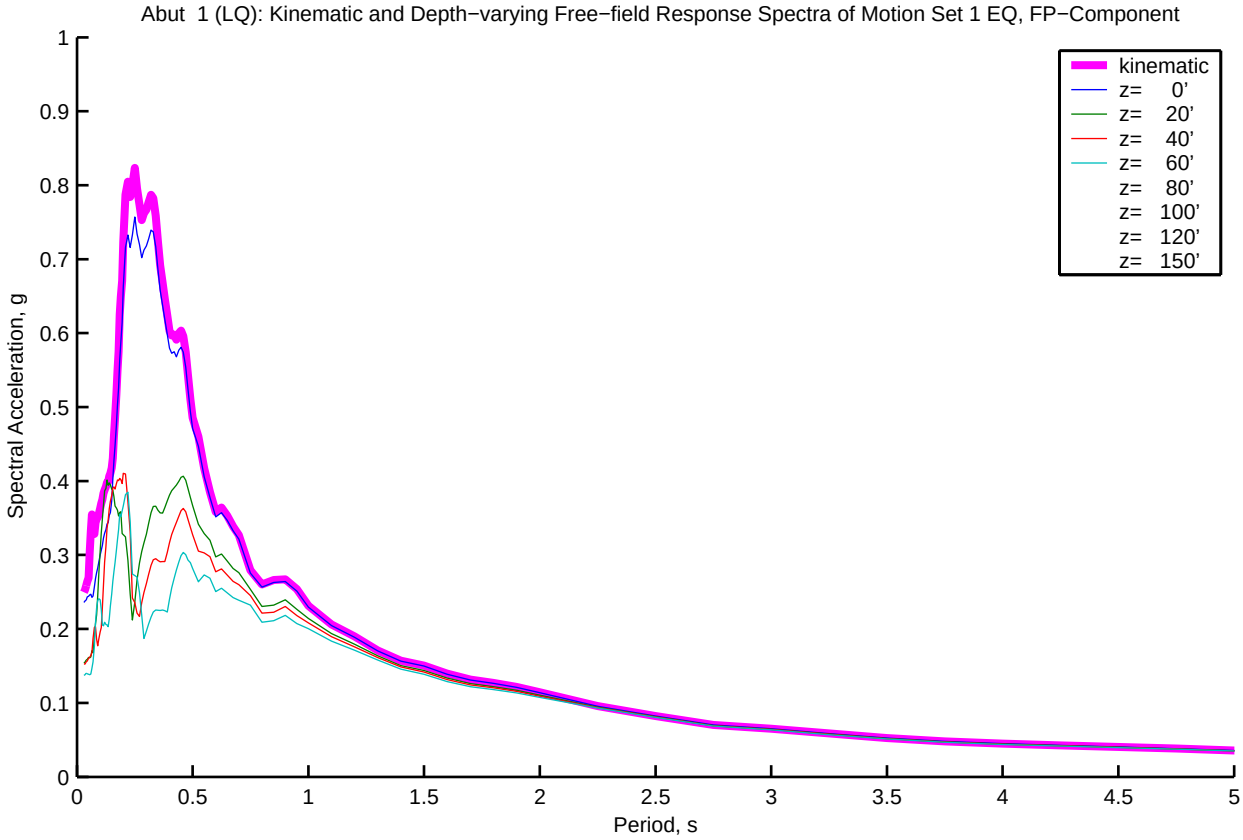

Abut 1 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

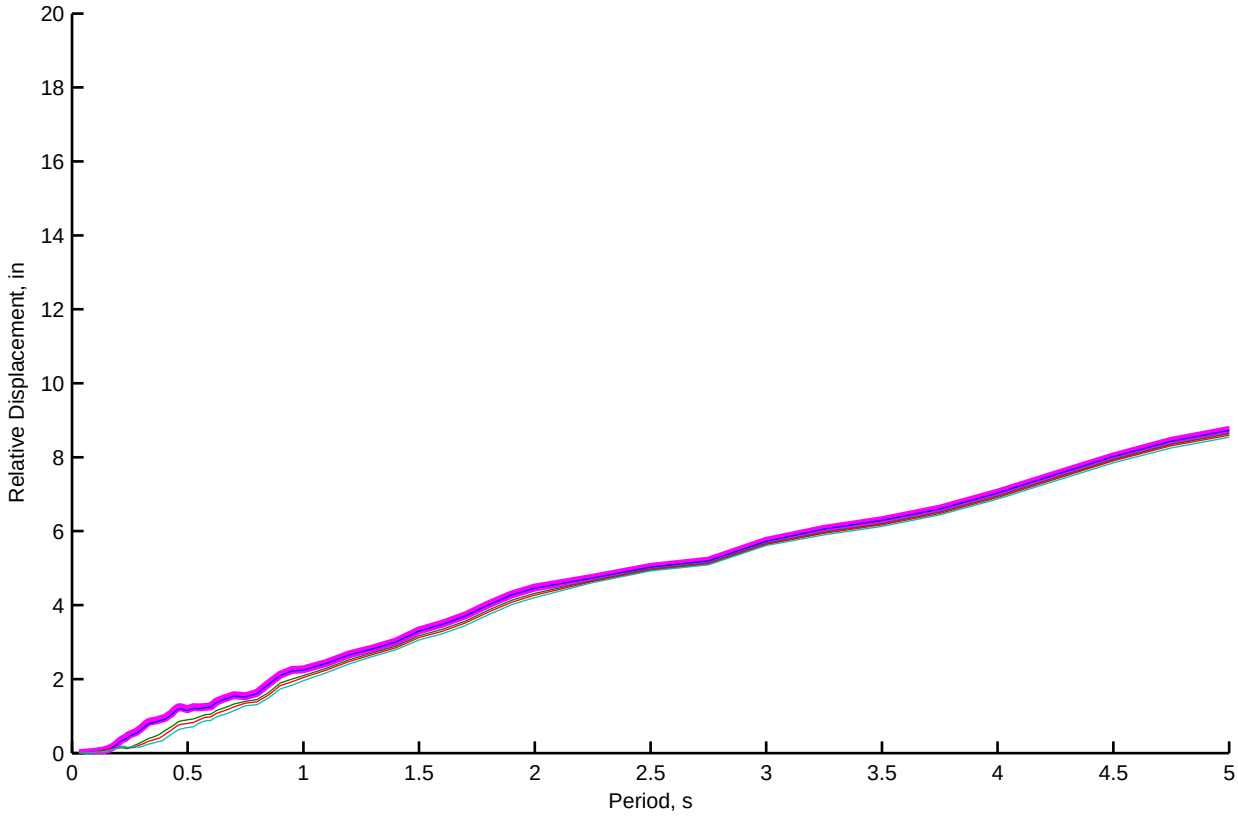

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 1 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

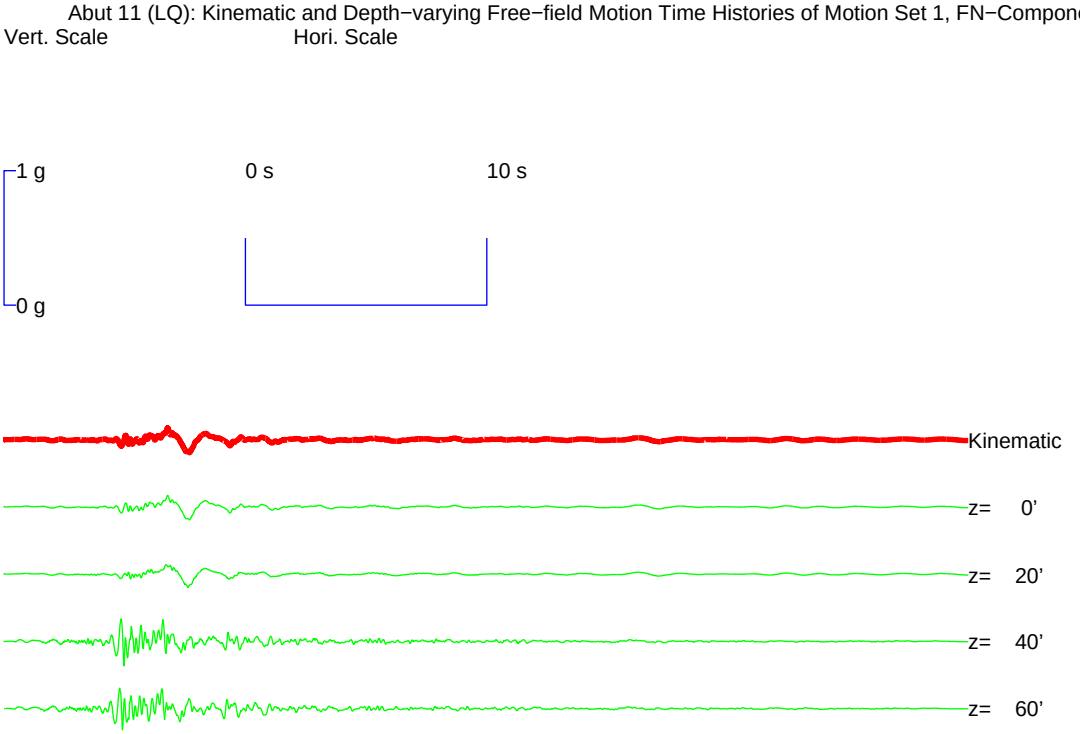


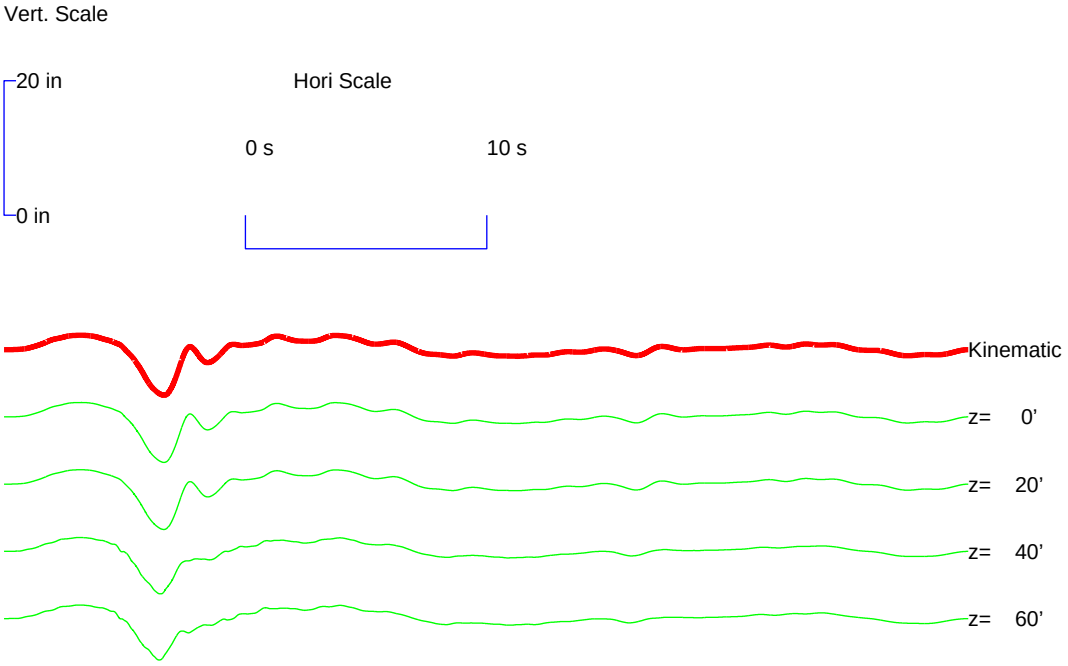



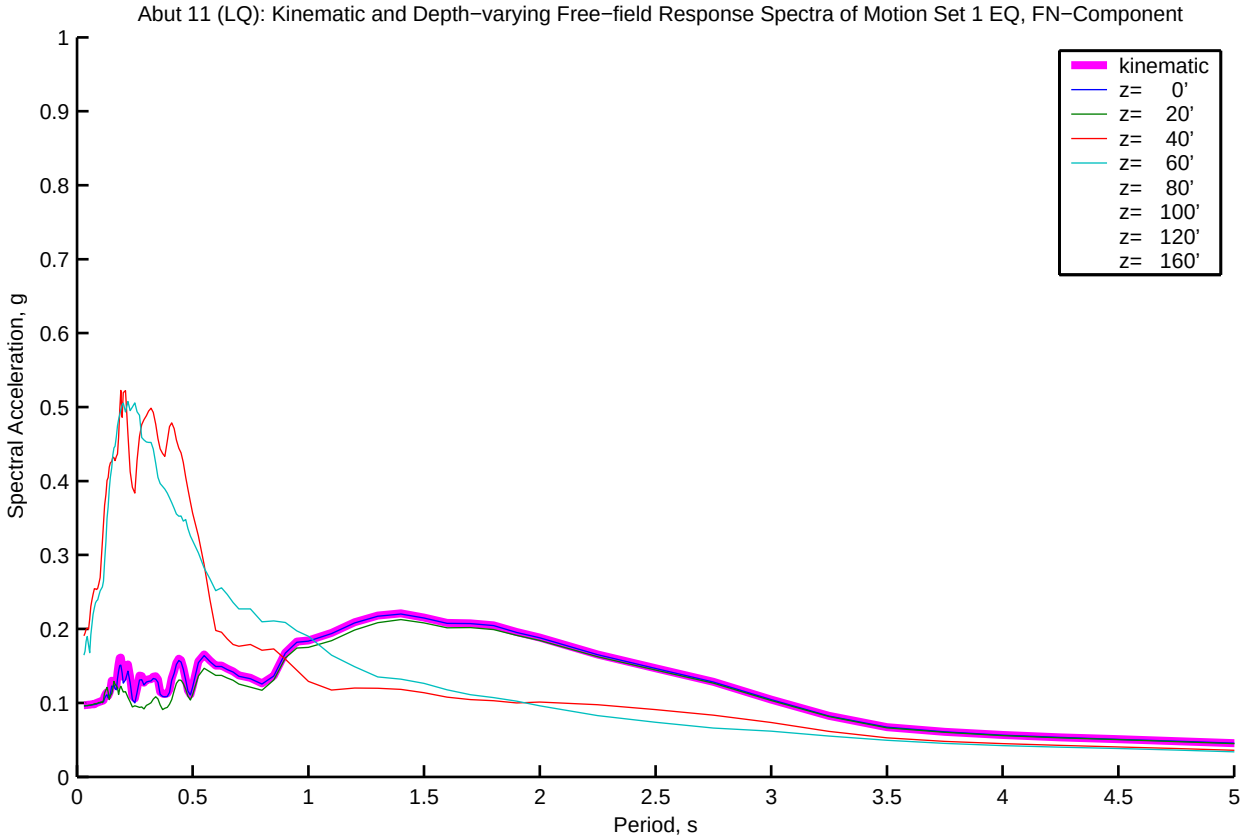

Abut 1 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

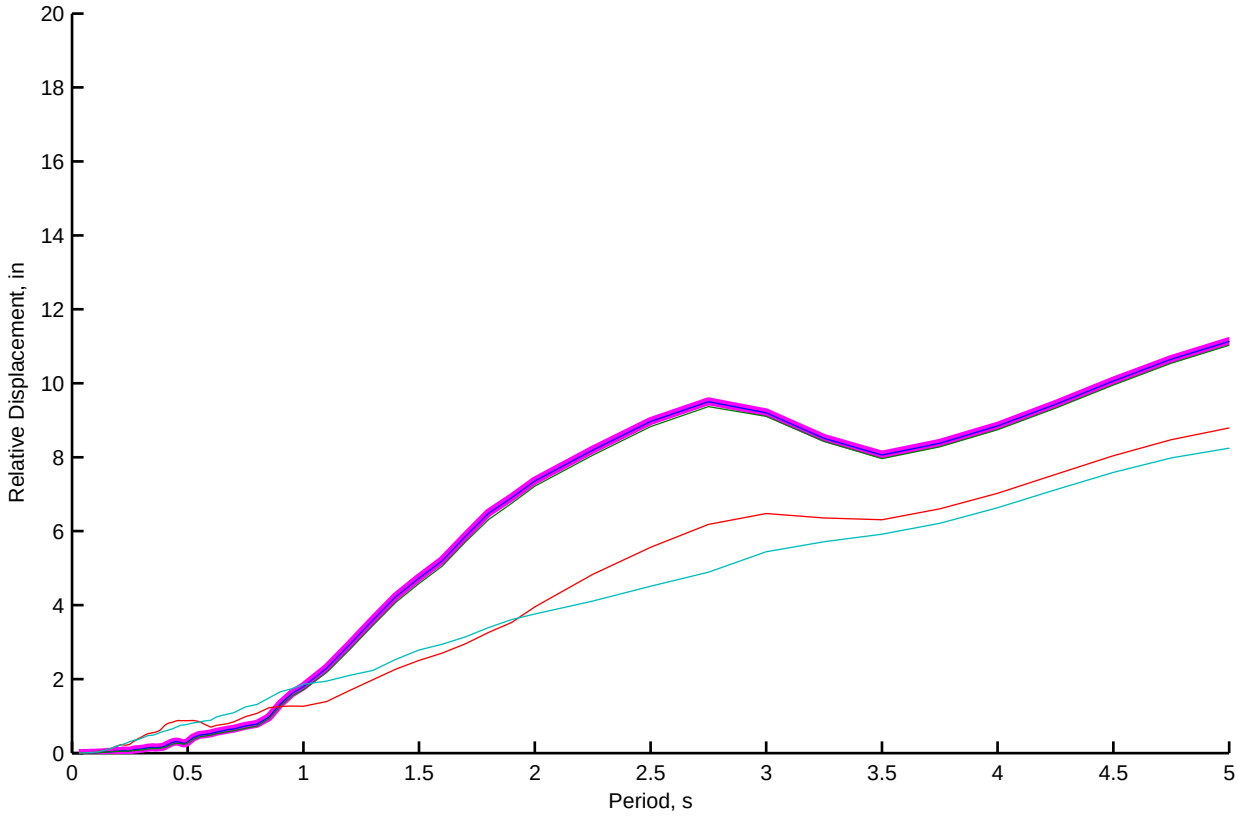

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

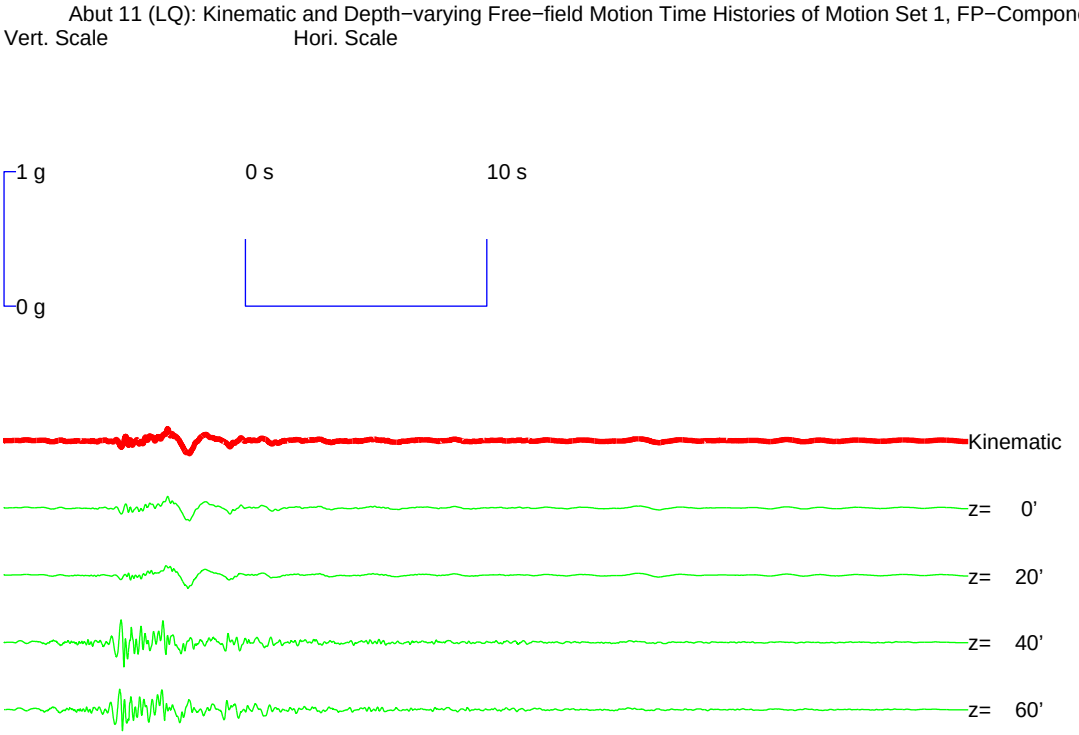


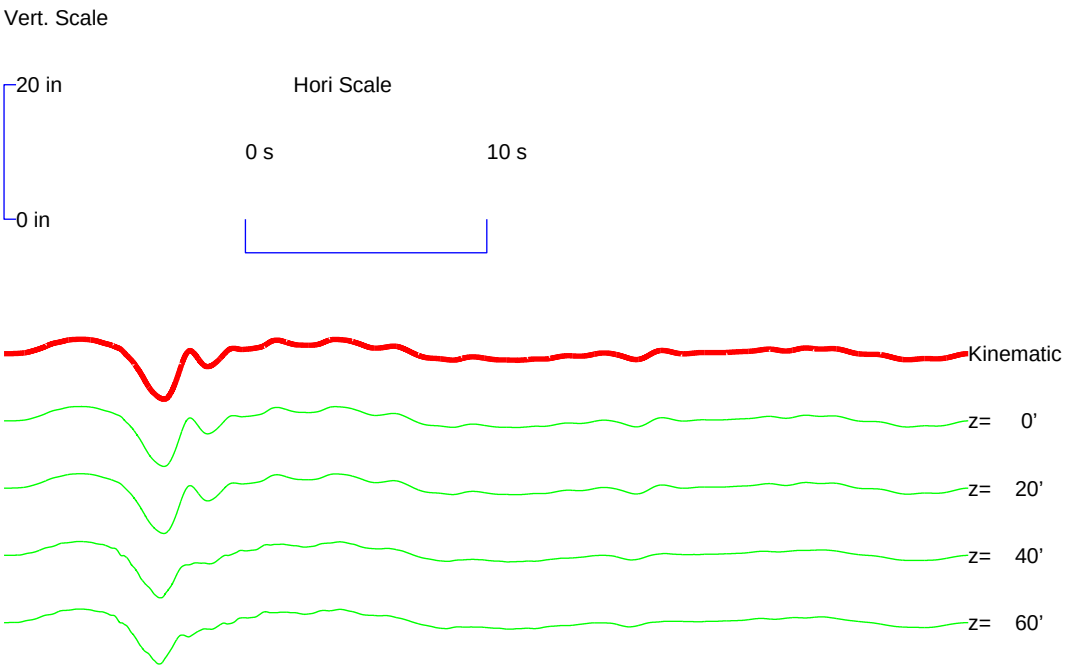



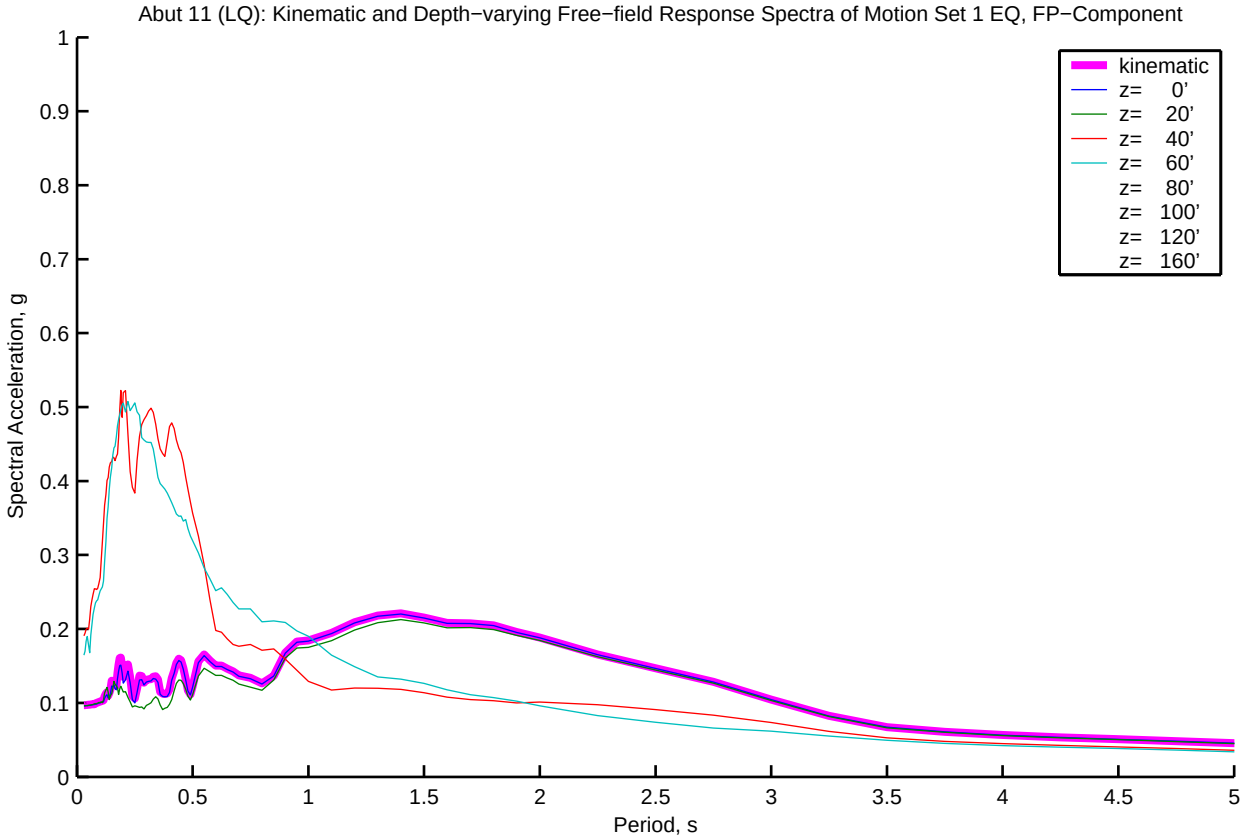

Abut 11 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

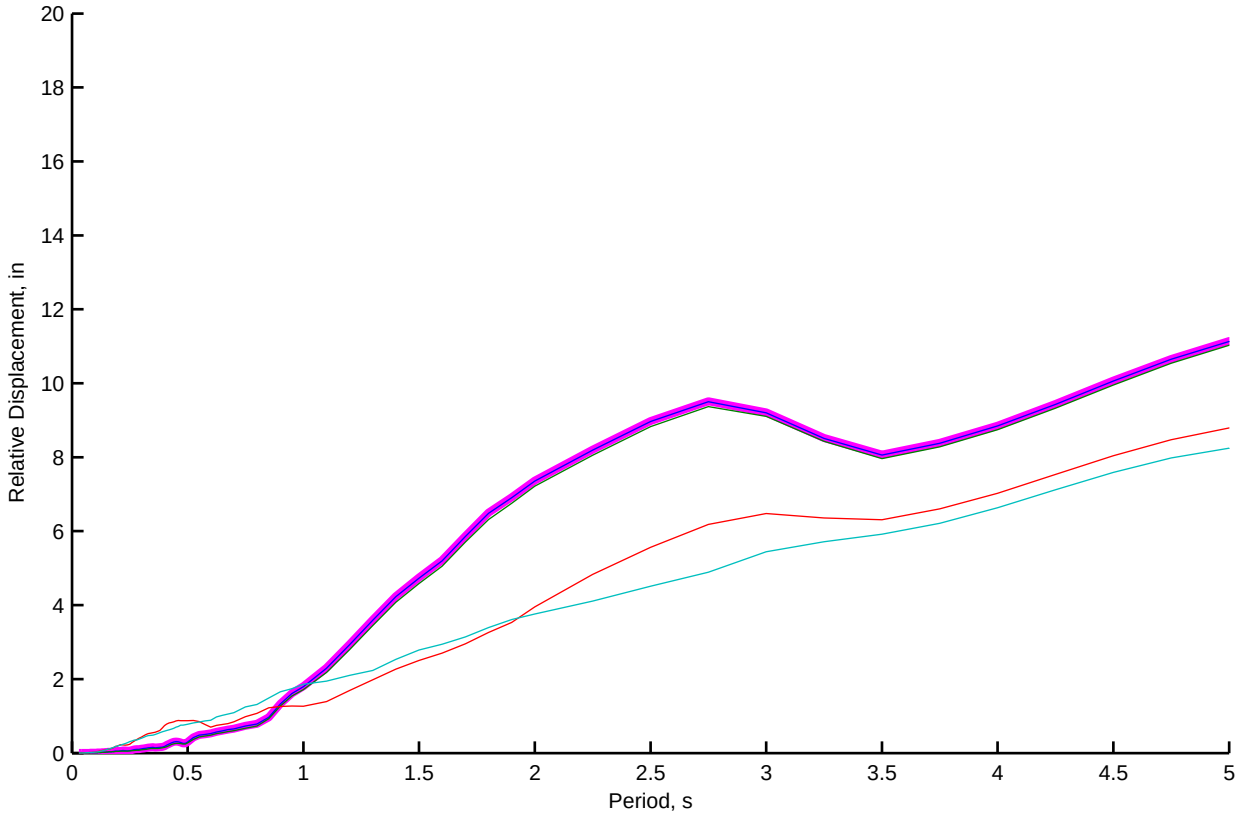

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component




Abut 11 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
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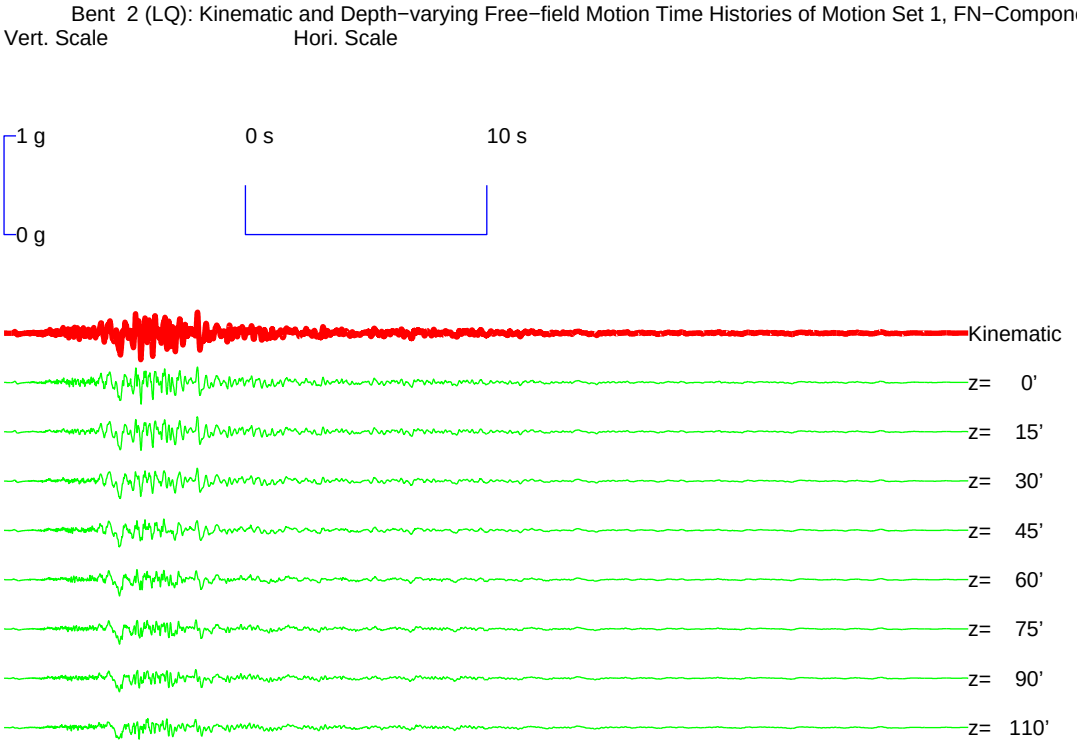
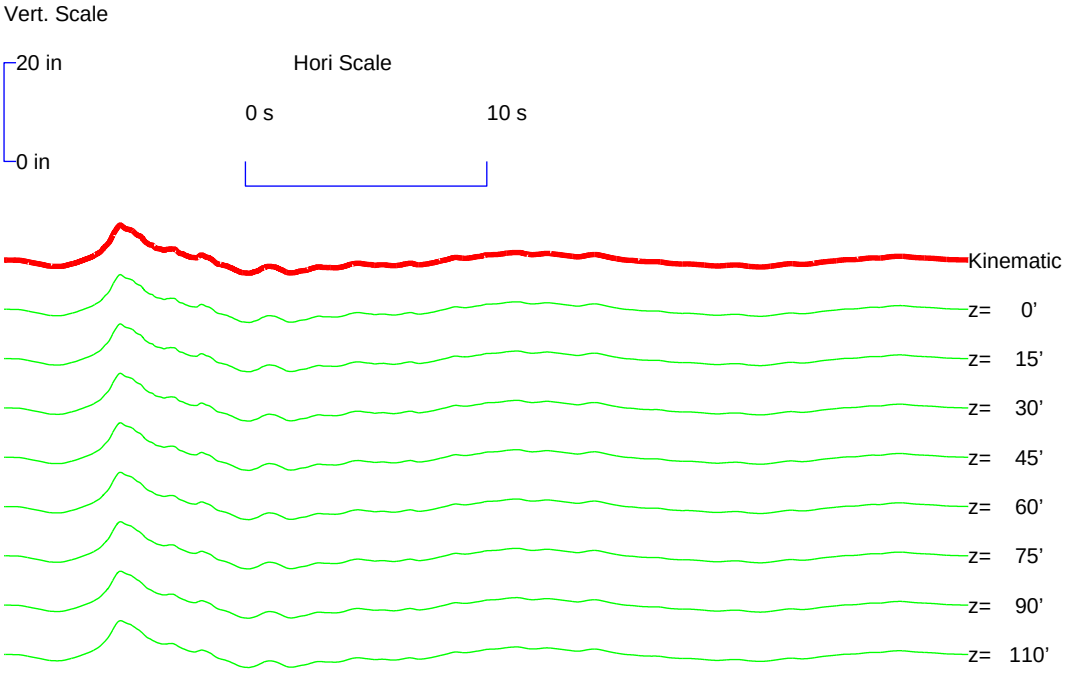
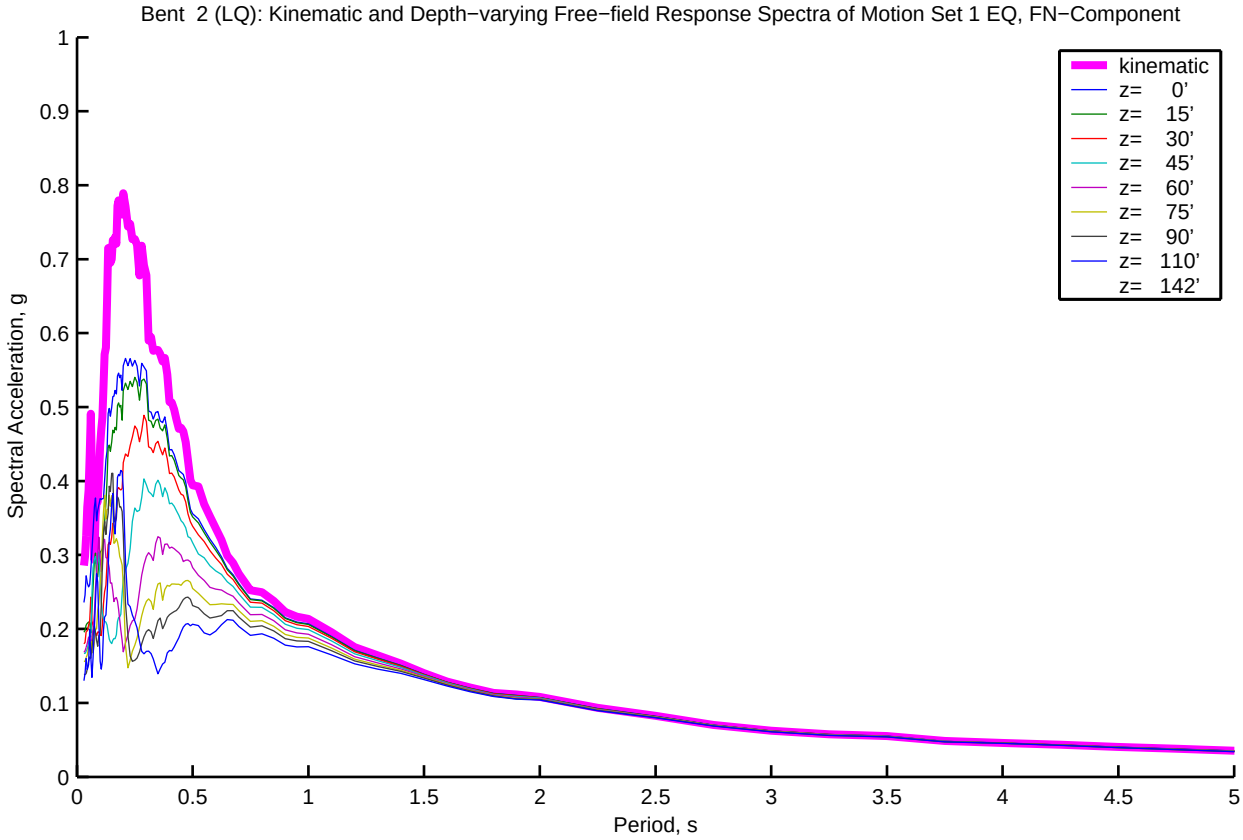
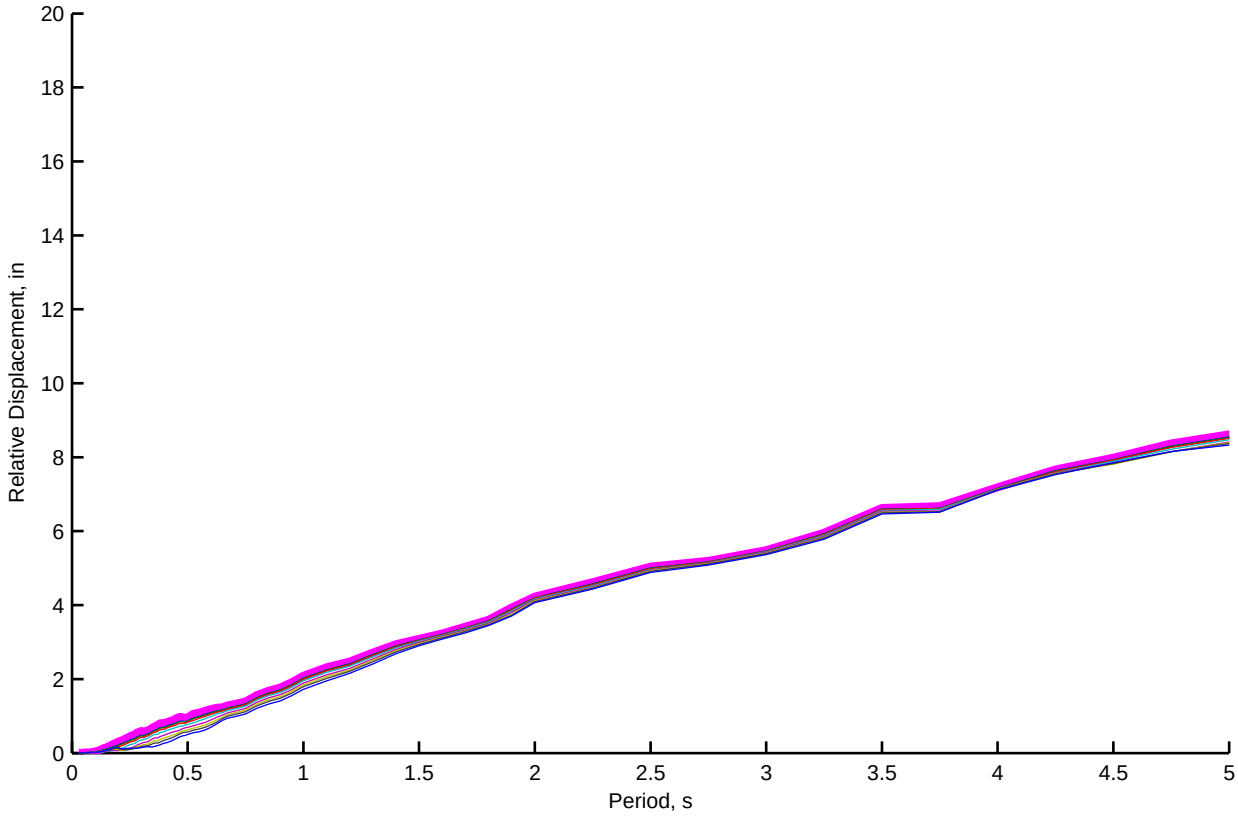
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

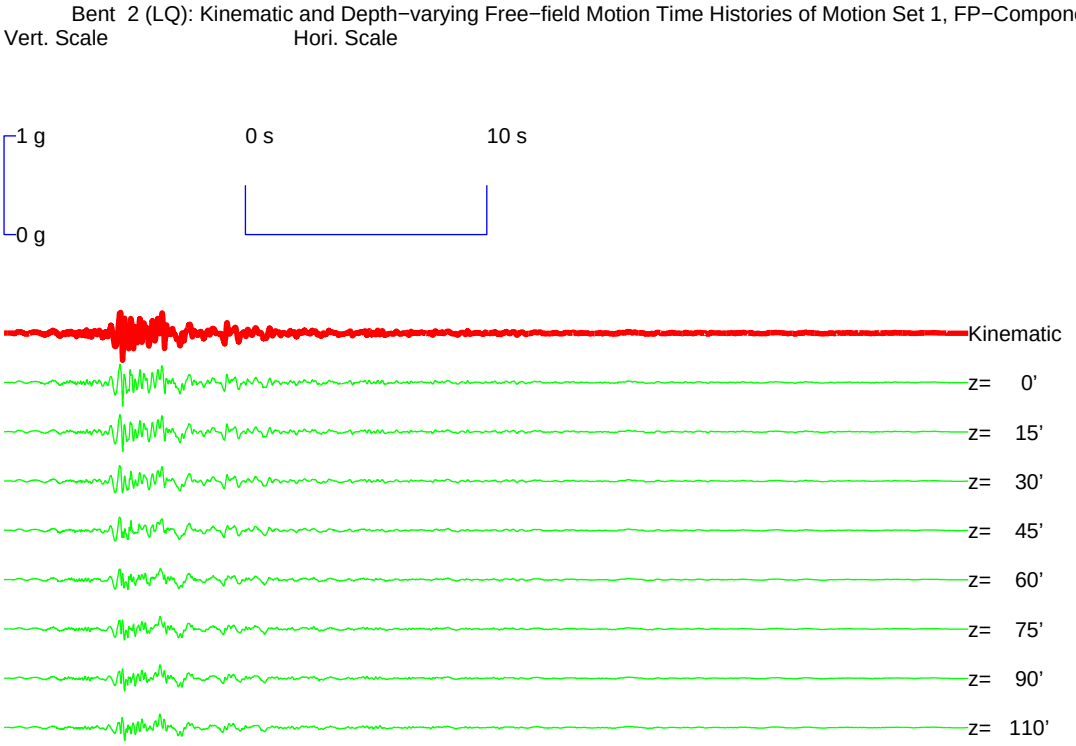


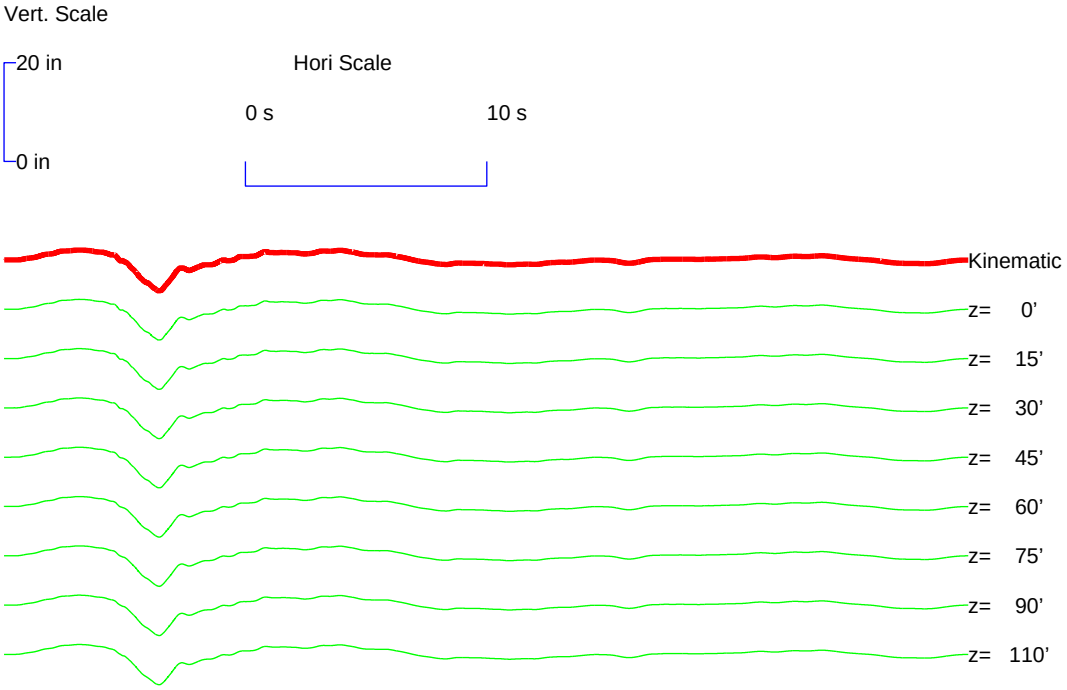



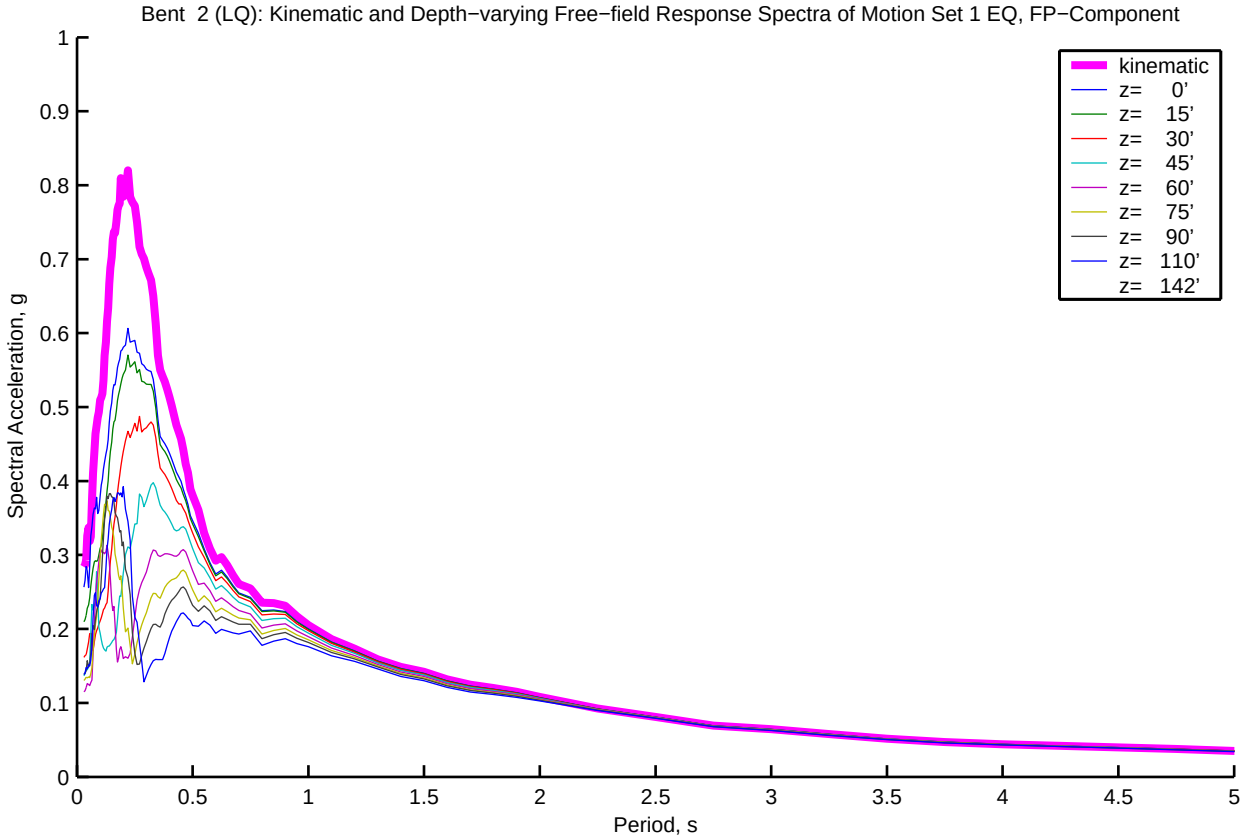

Bent 2 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

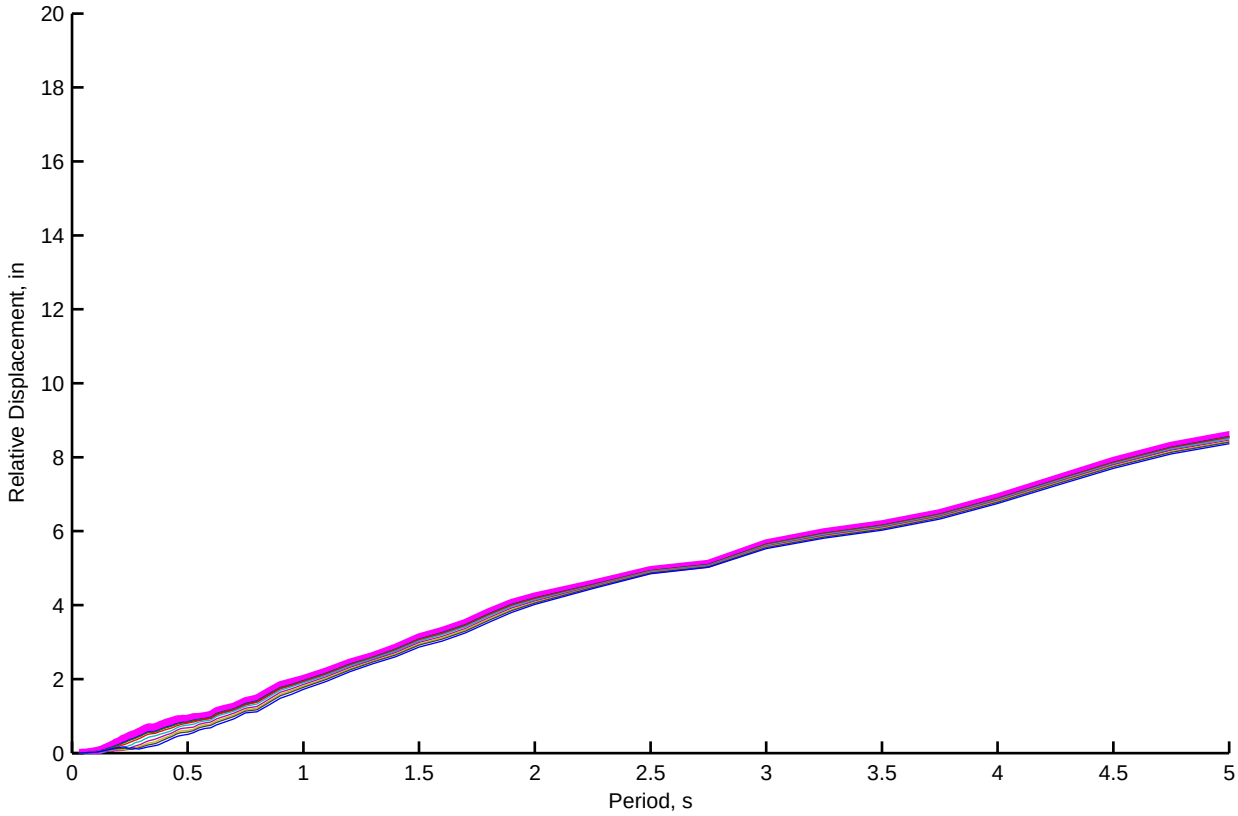

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

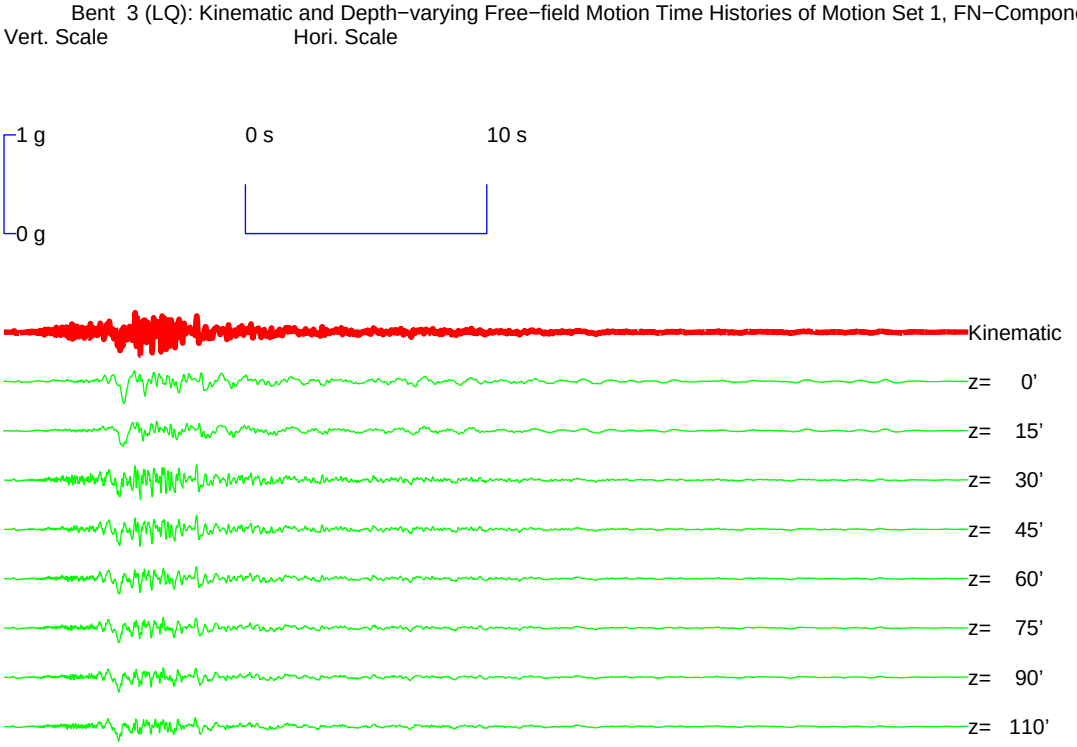


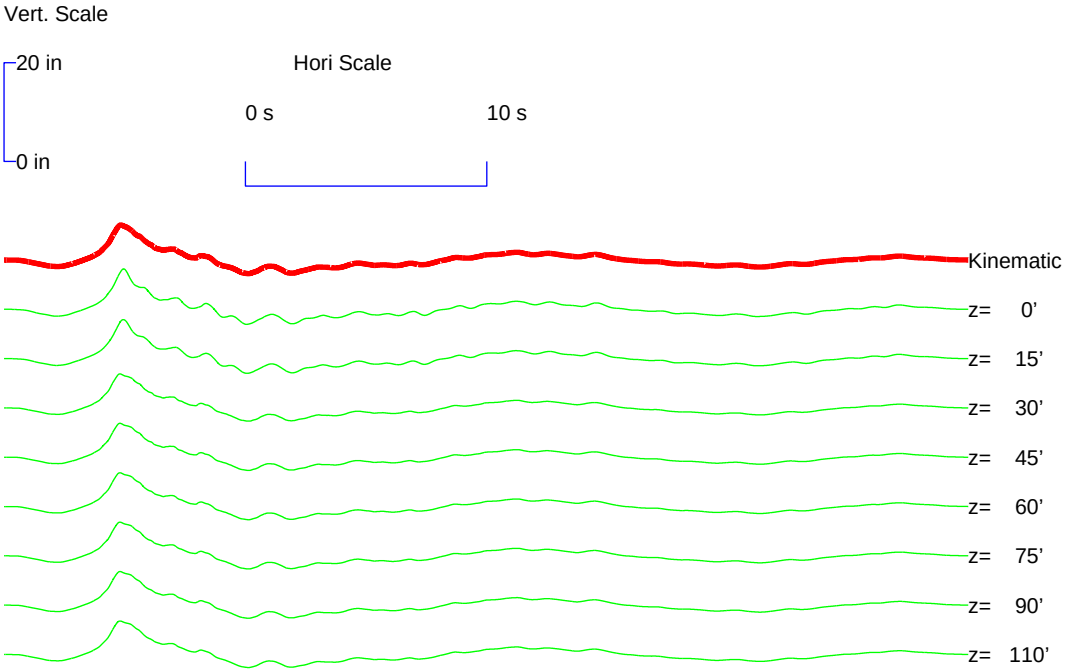



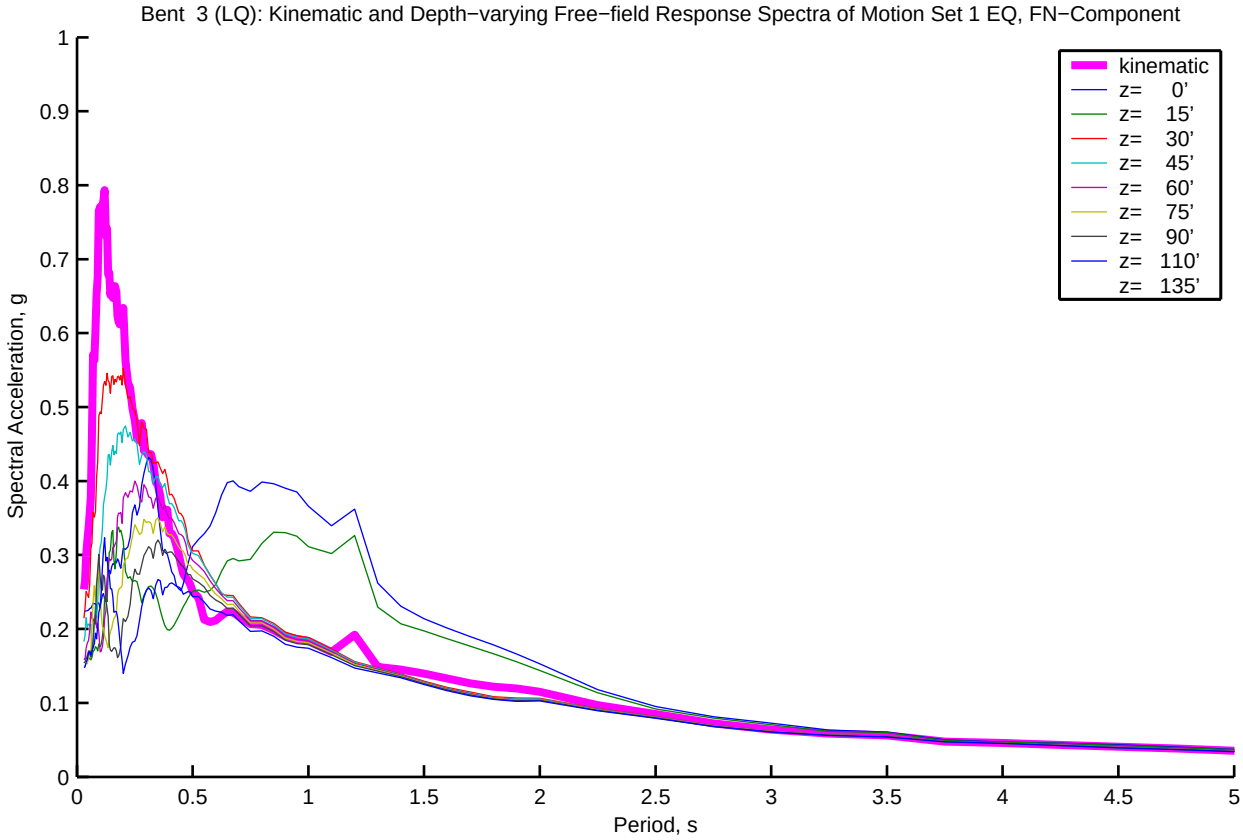

Bent 2 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

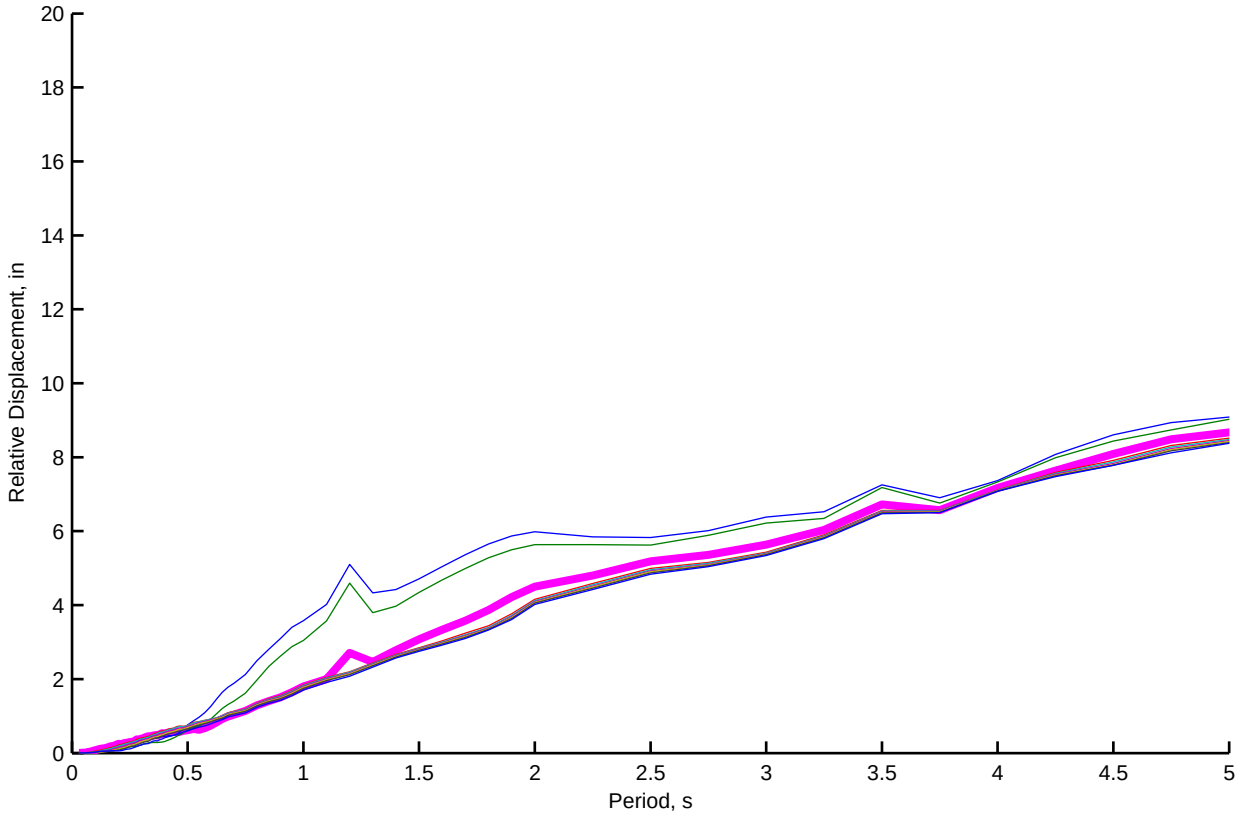

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 3 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component




Bent 3 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
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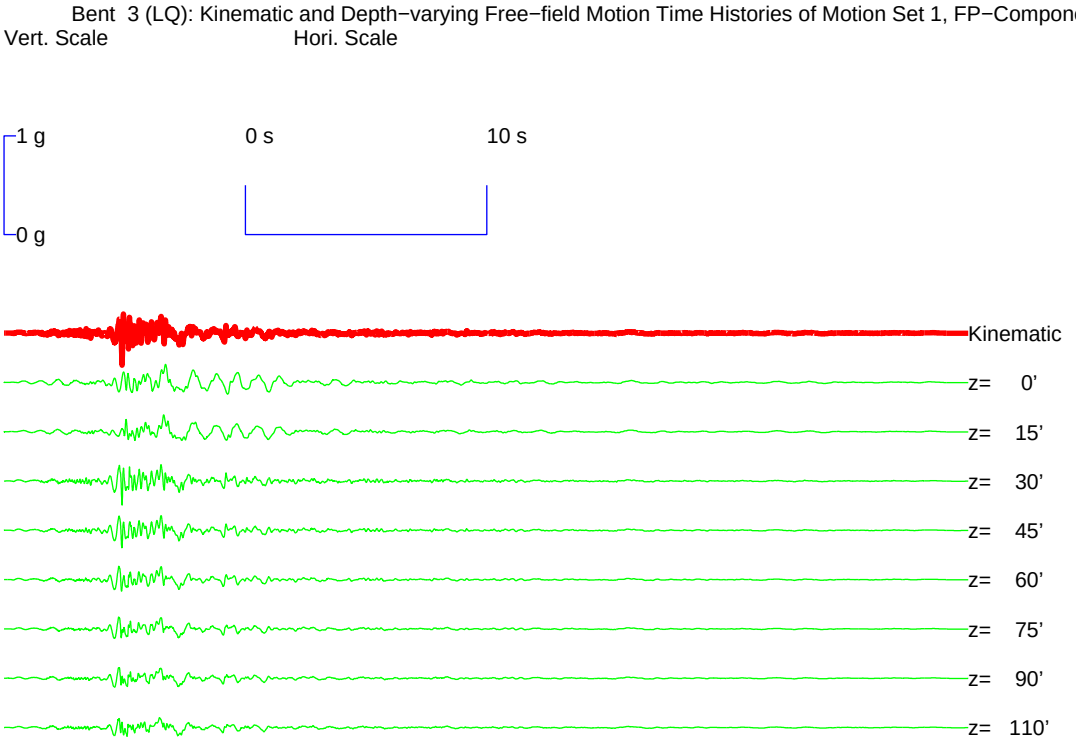
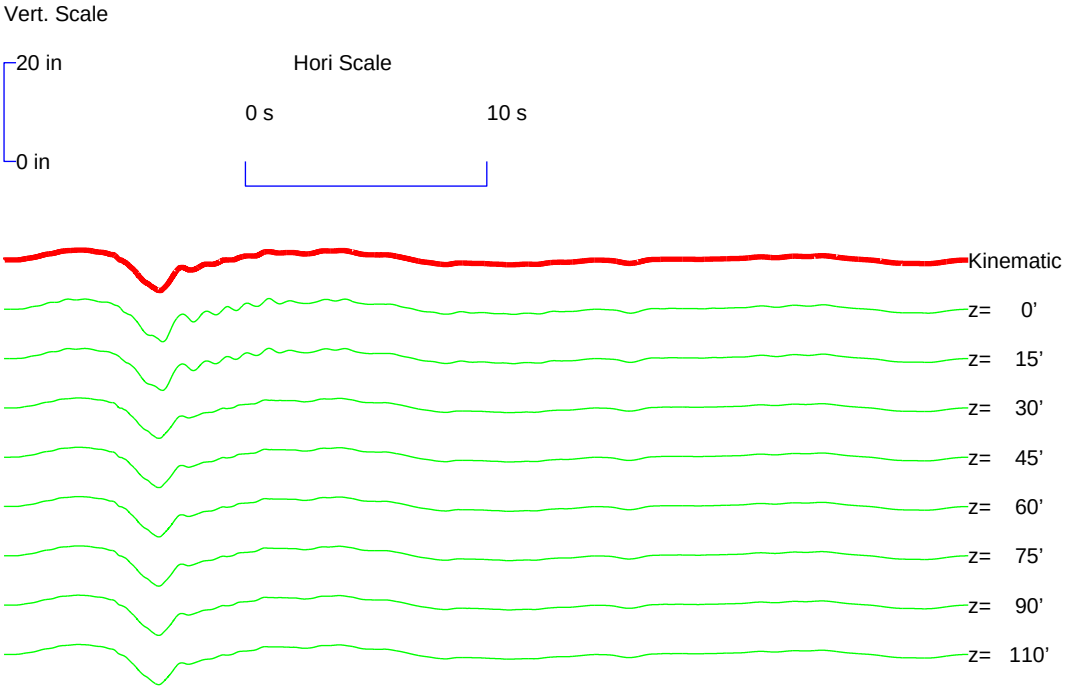
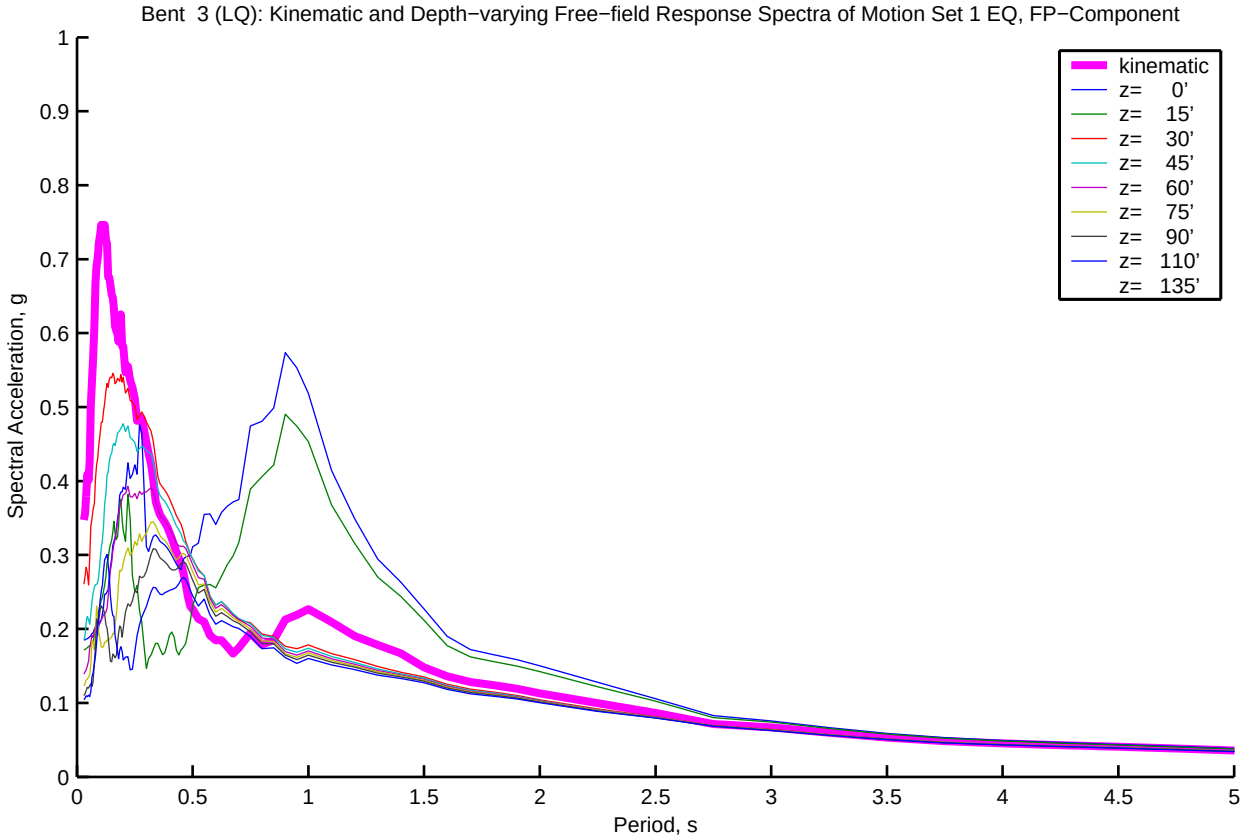
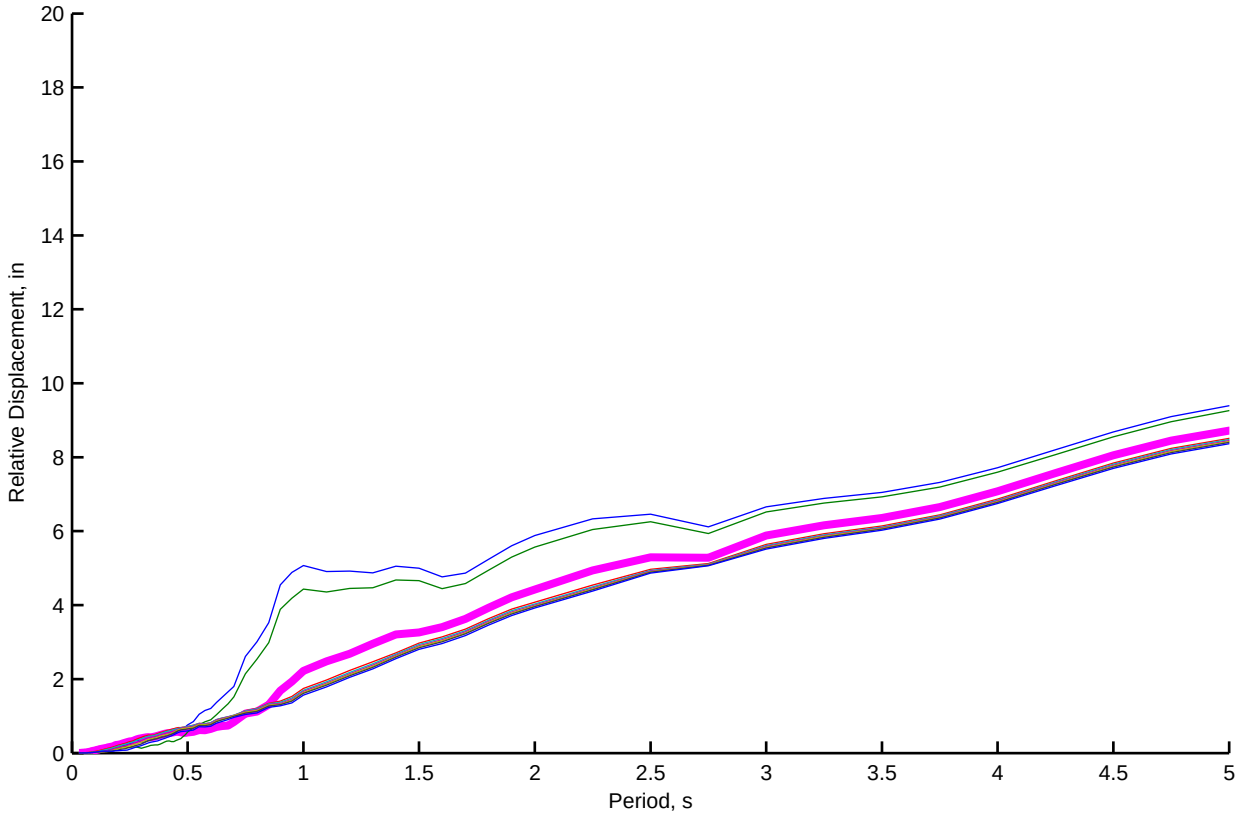
2.5
3
3.5
4
4.5
5

Bent 3 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component




Bent 3 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
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2.5
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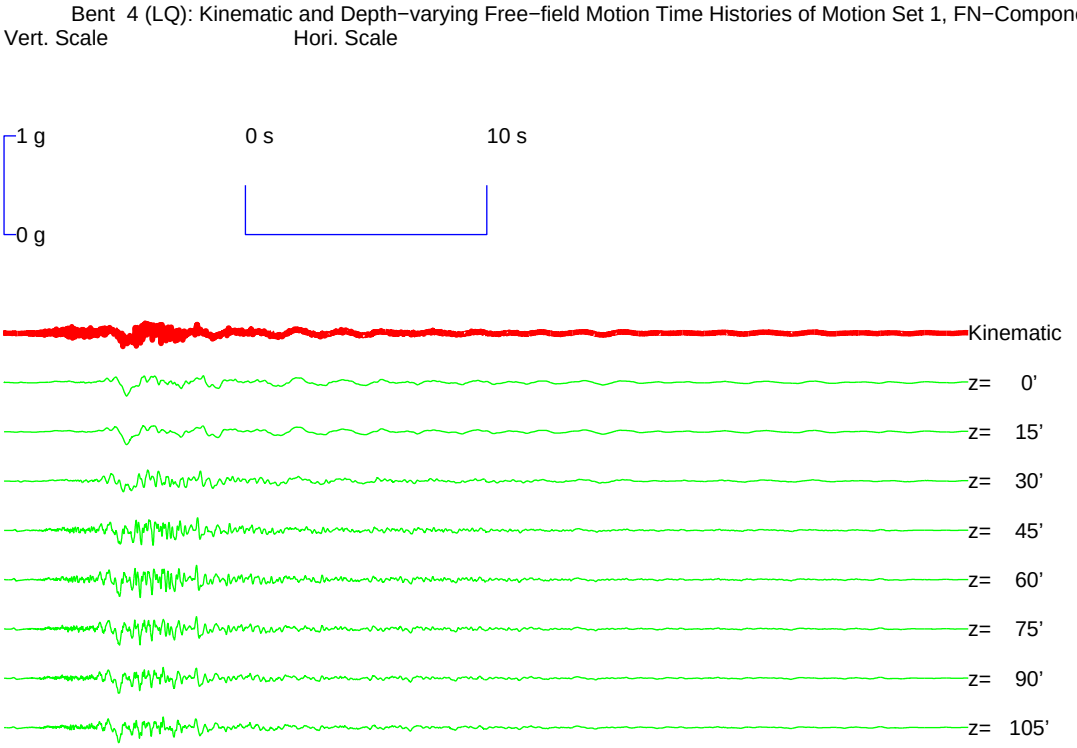
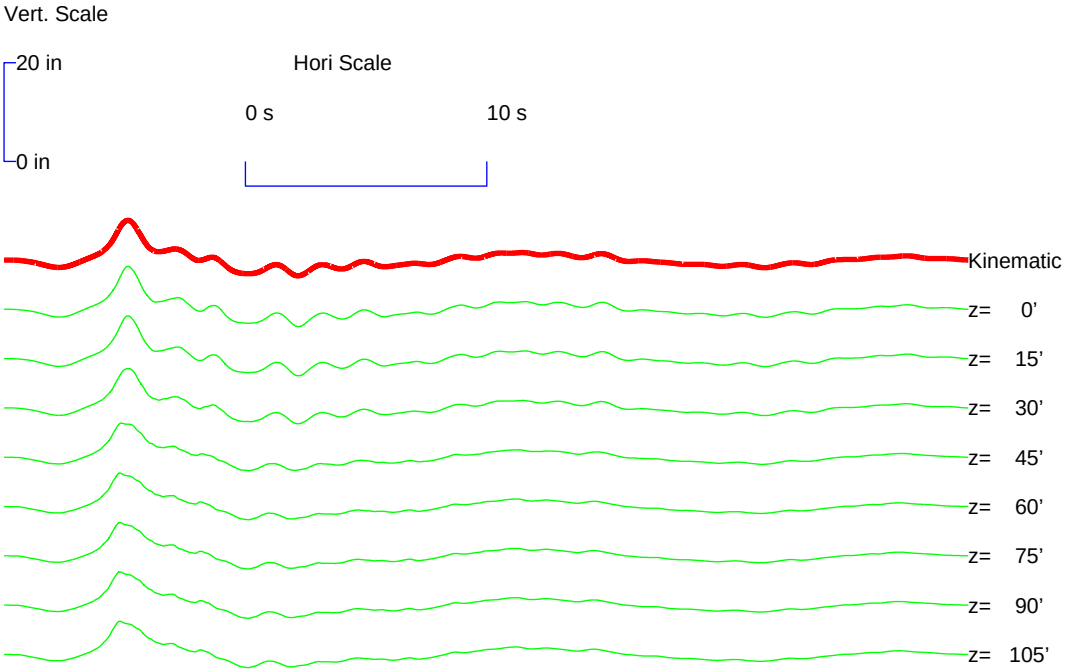
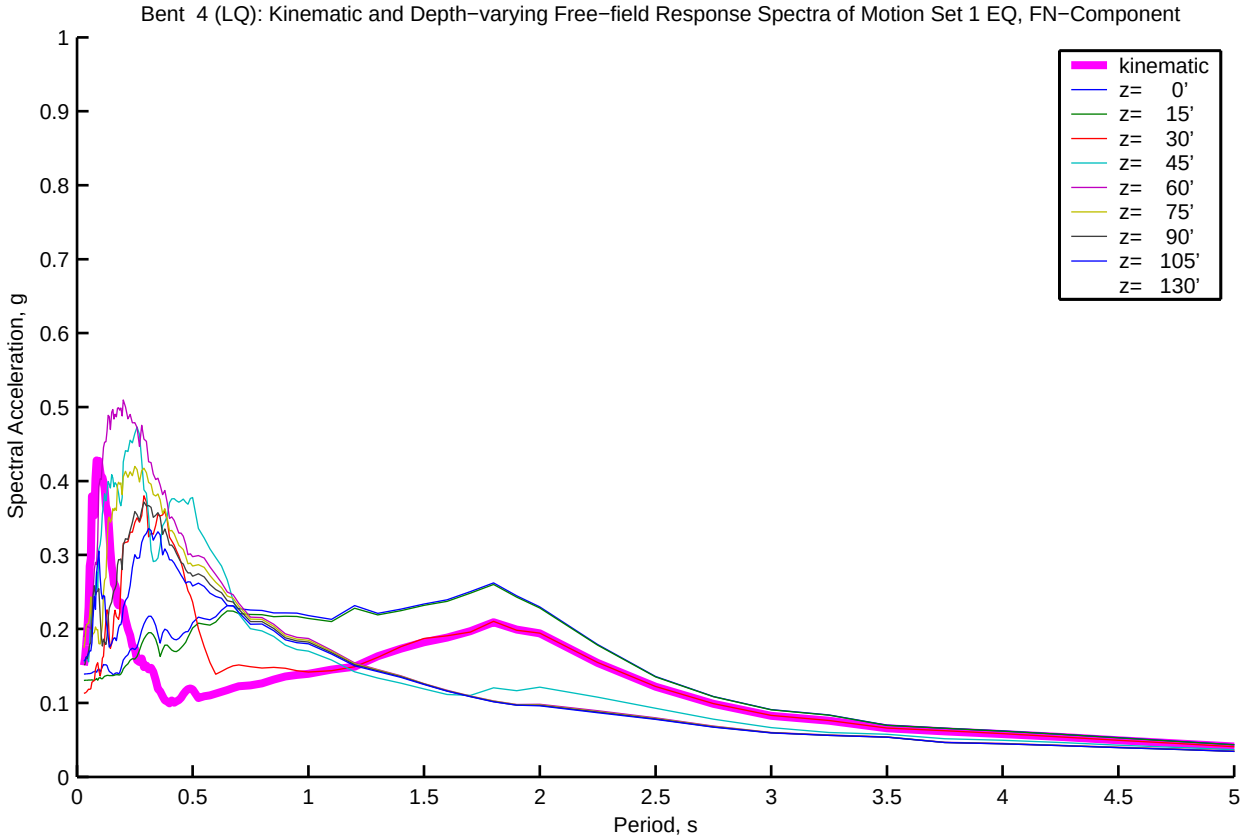
3.5
4
4.5
5

Bent 4 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component




Bent 4 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
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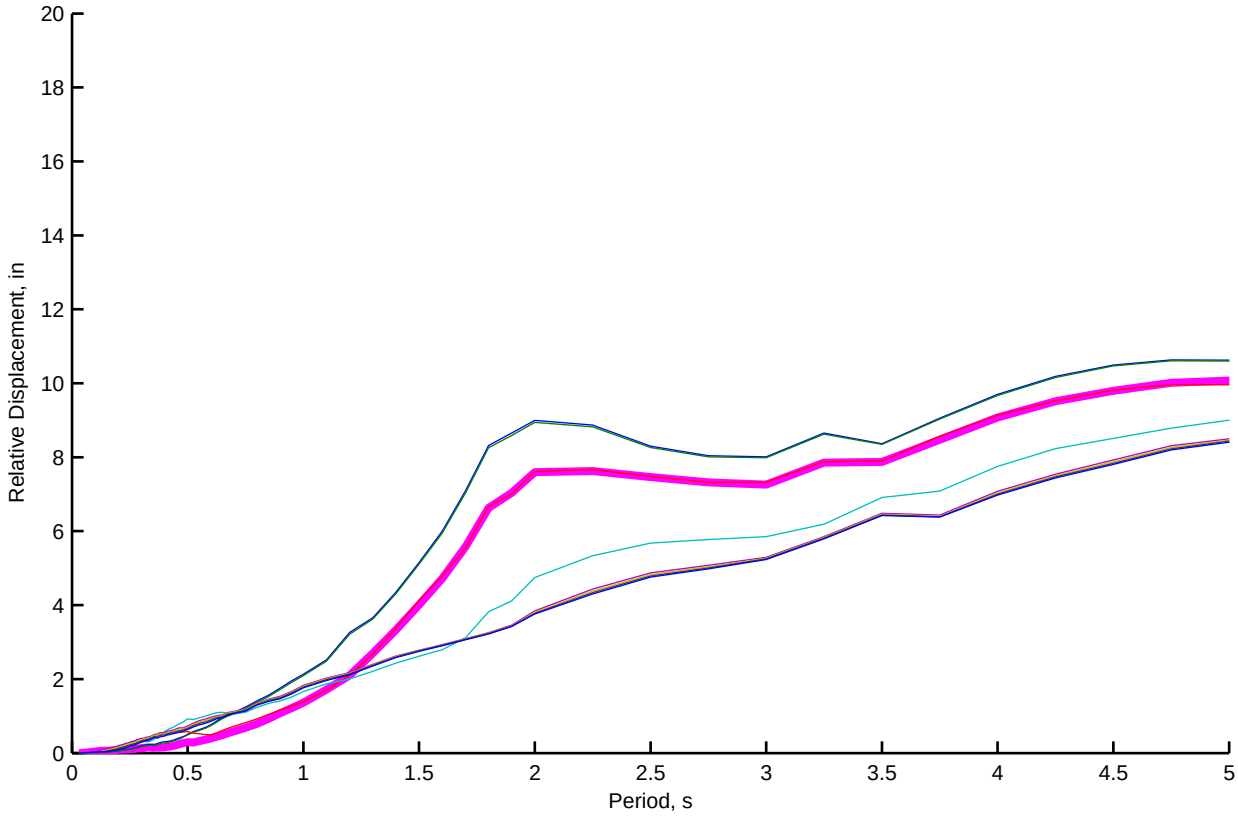
Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
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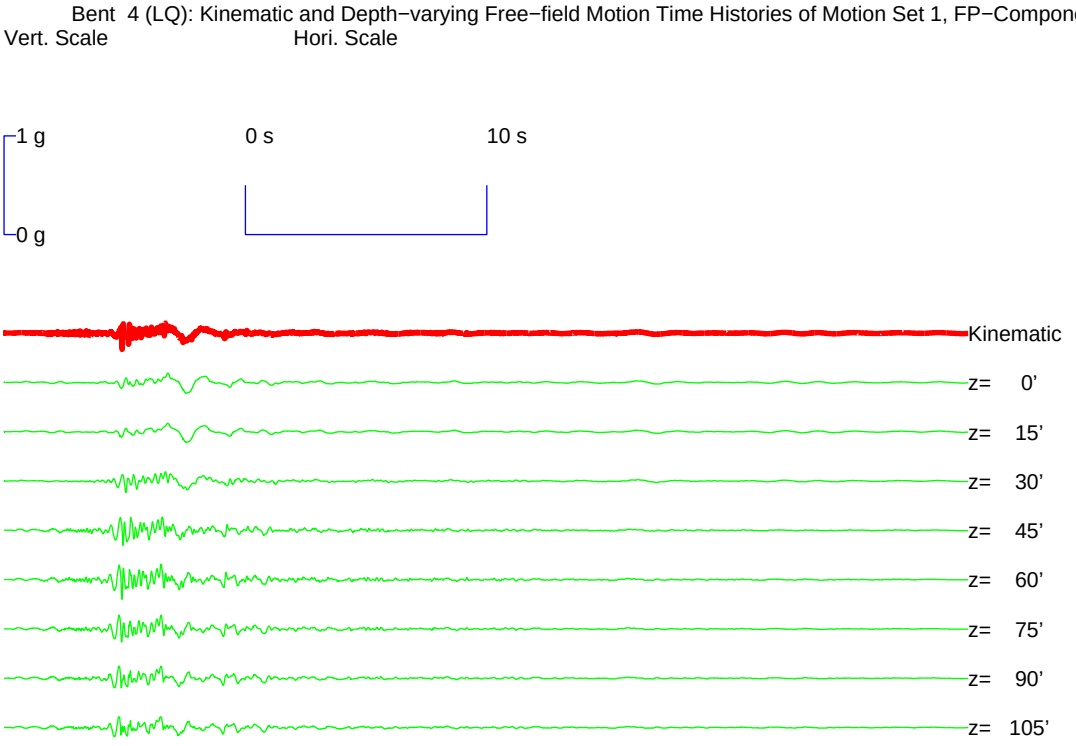
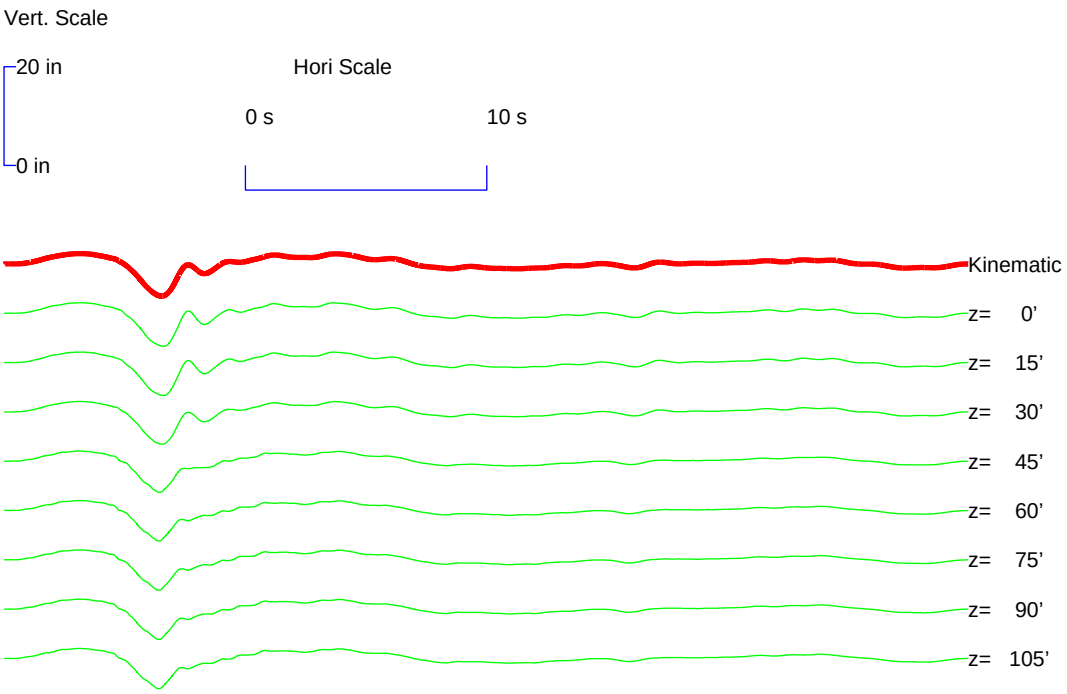
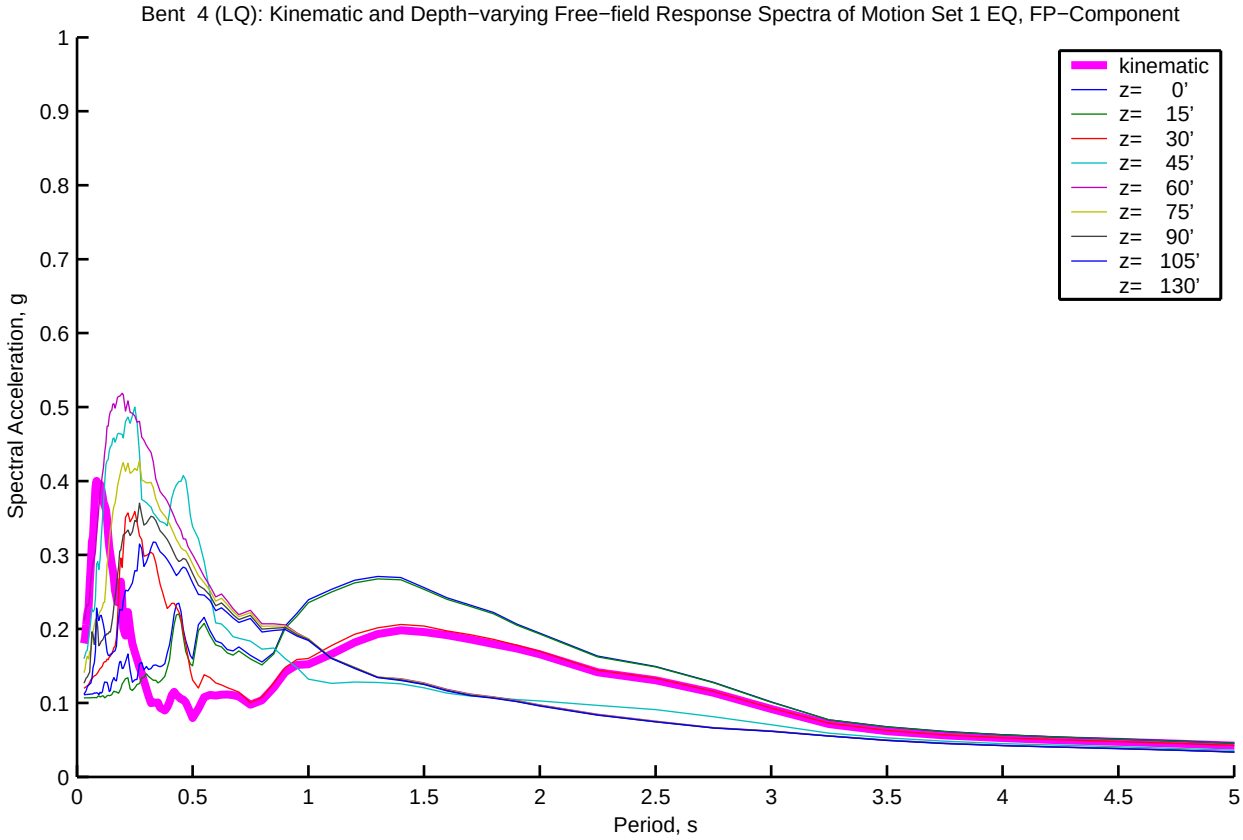
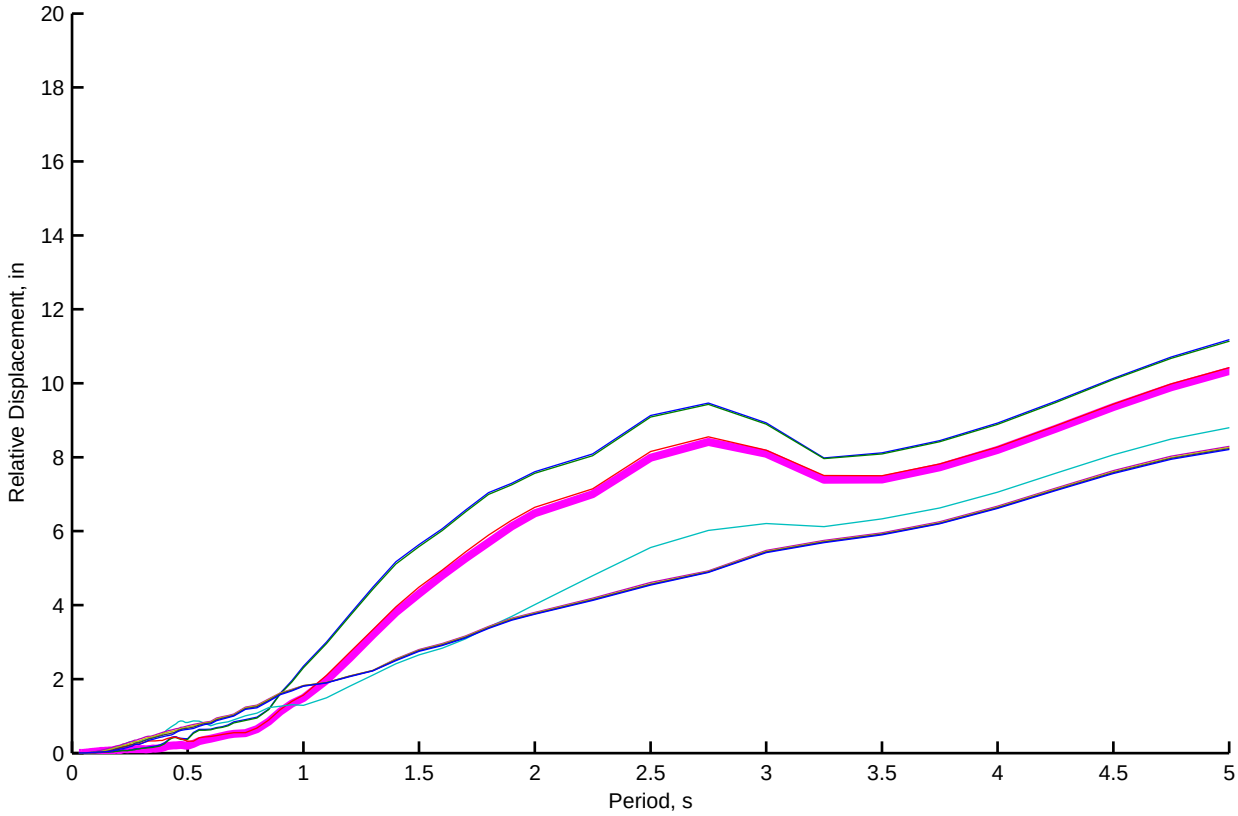
2.5
3
3.5
4
4.5
5

Bent 4 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

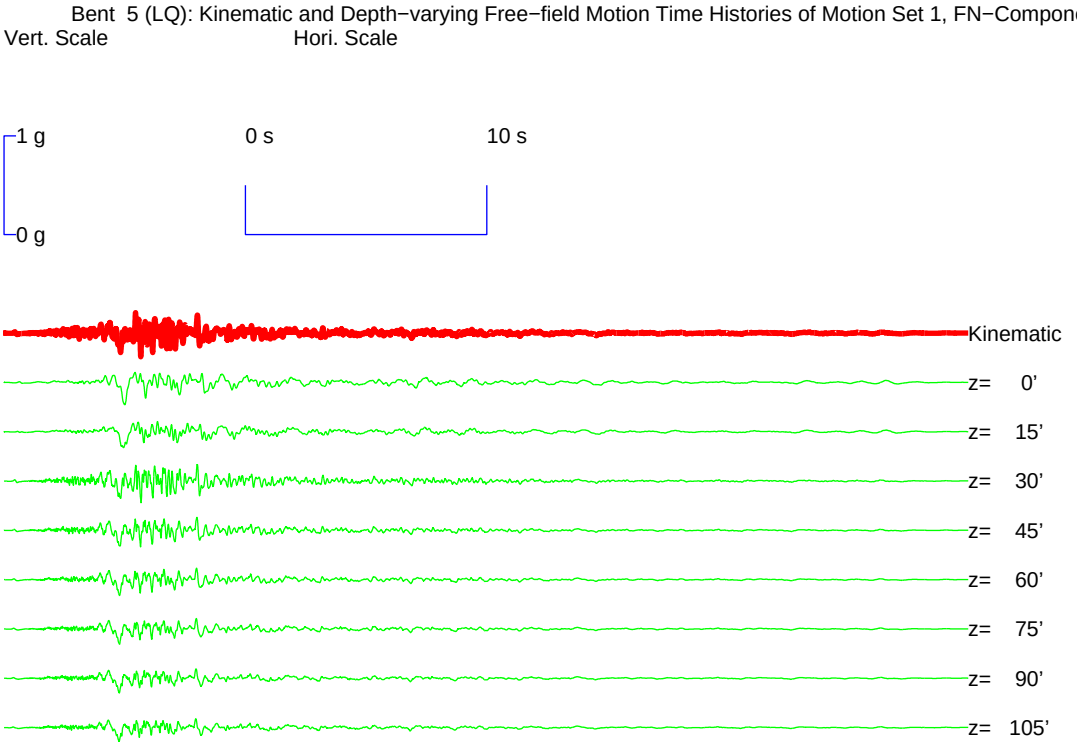


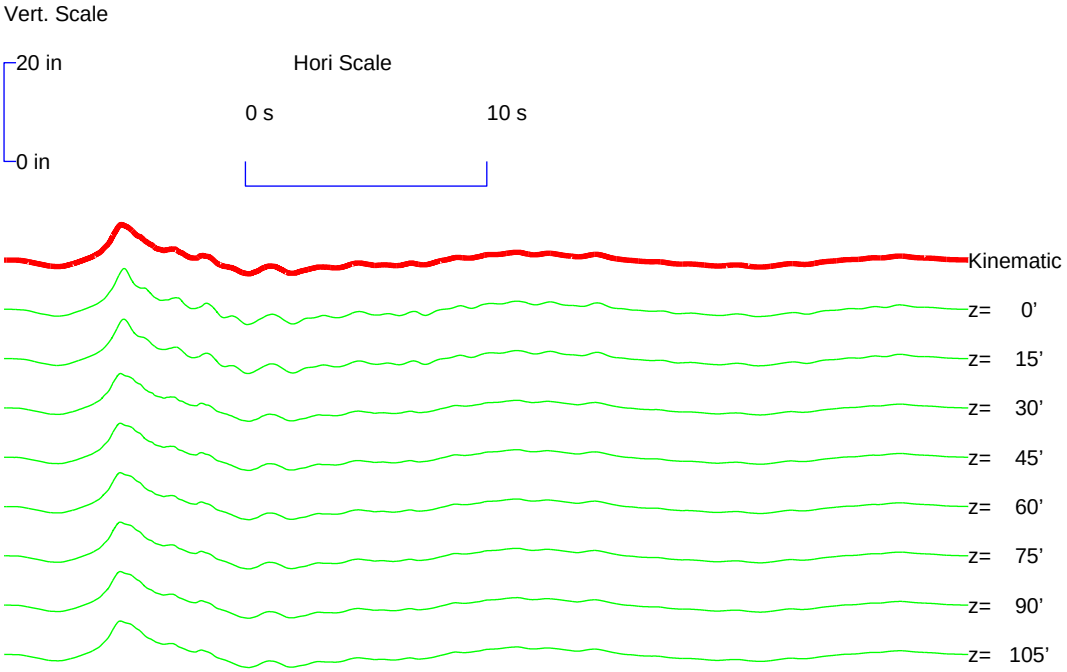



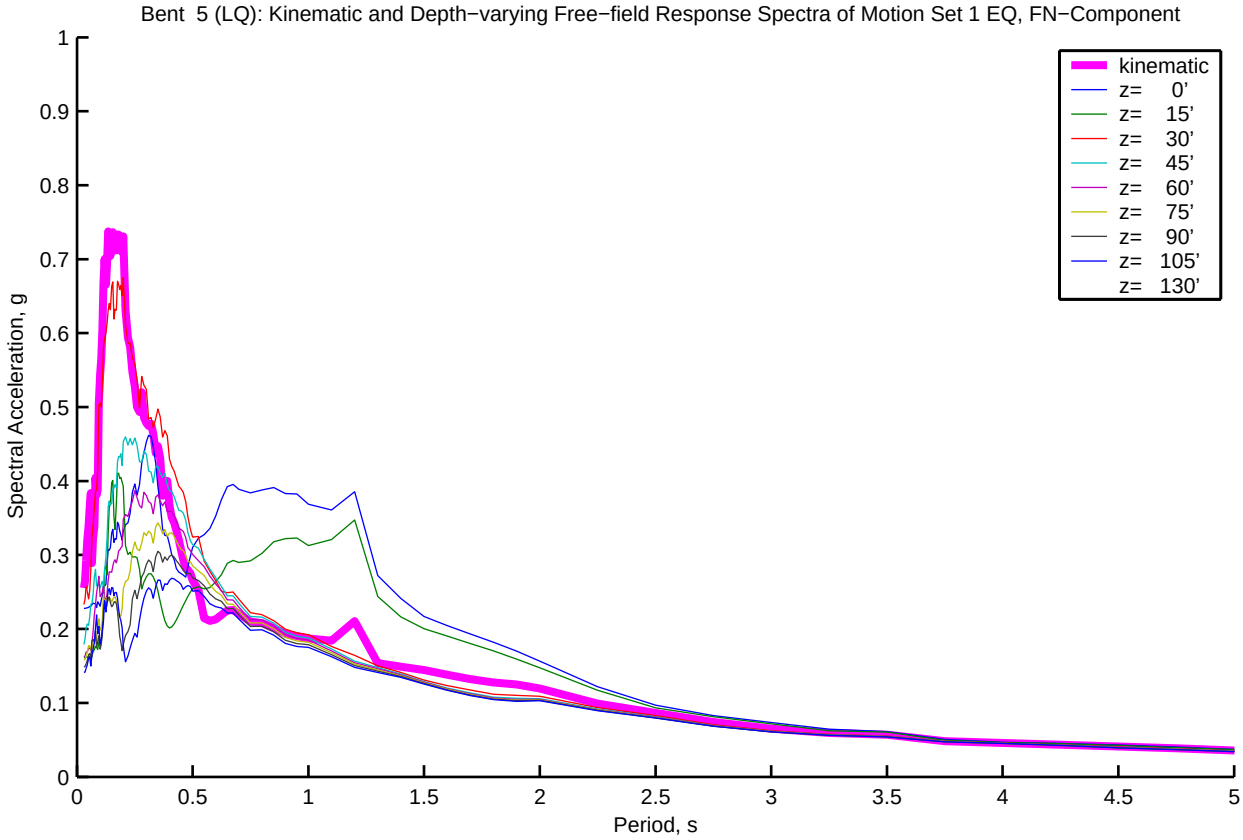

Bent 4 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

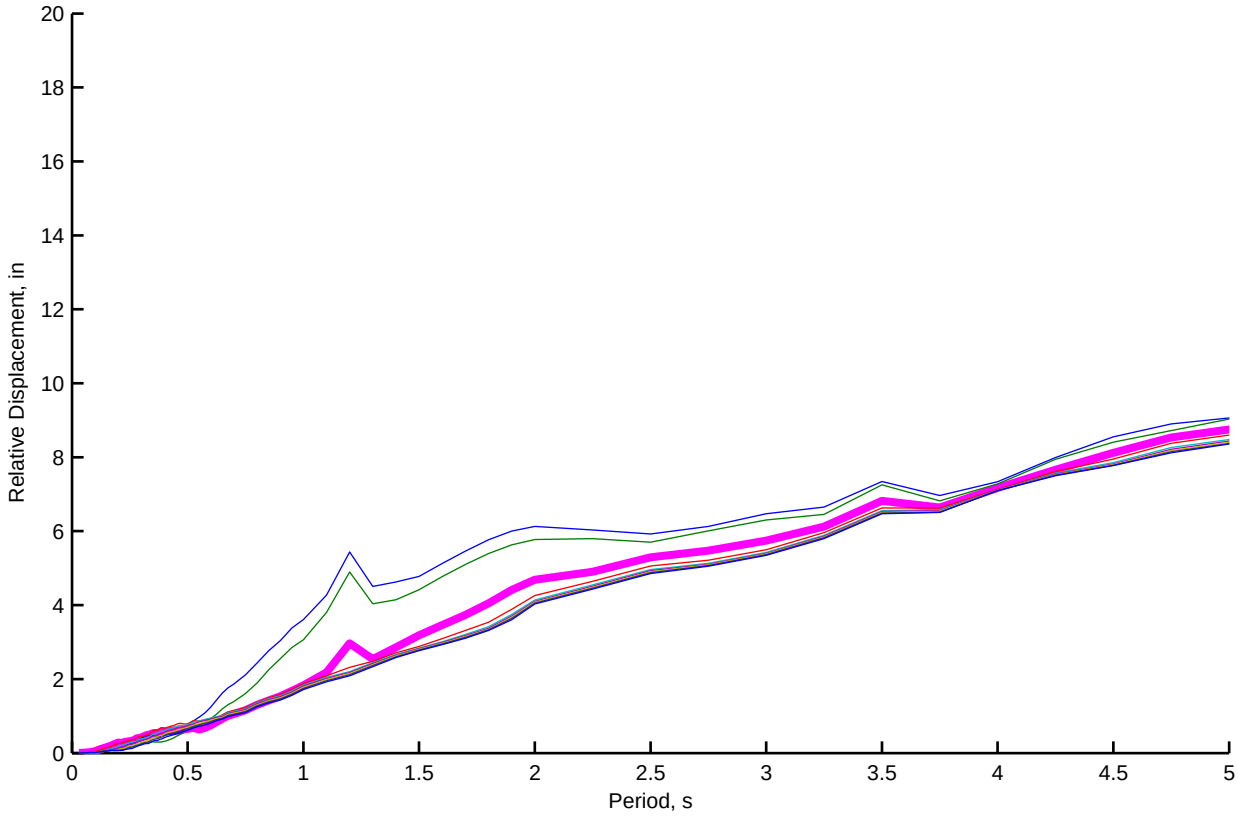

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 5 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

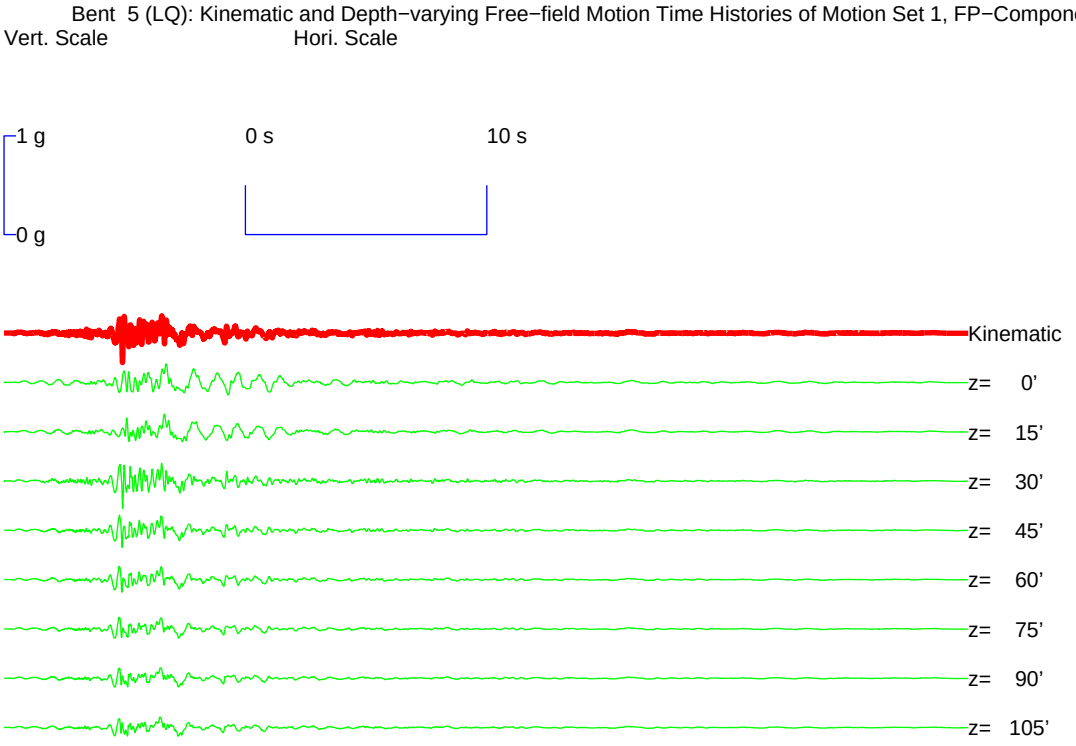


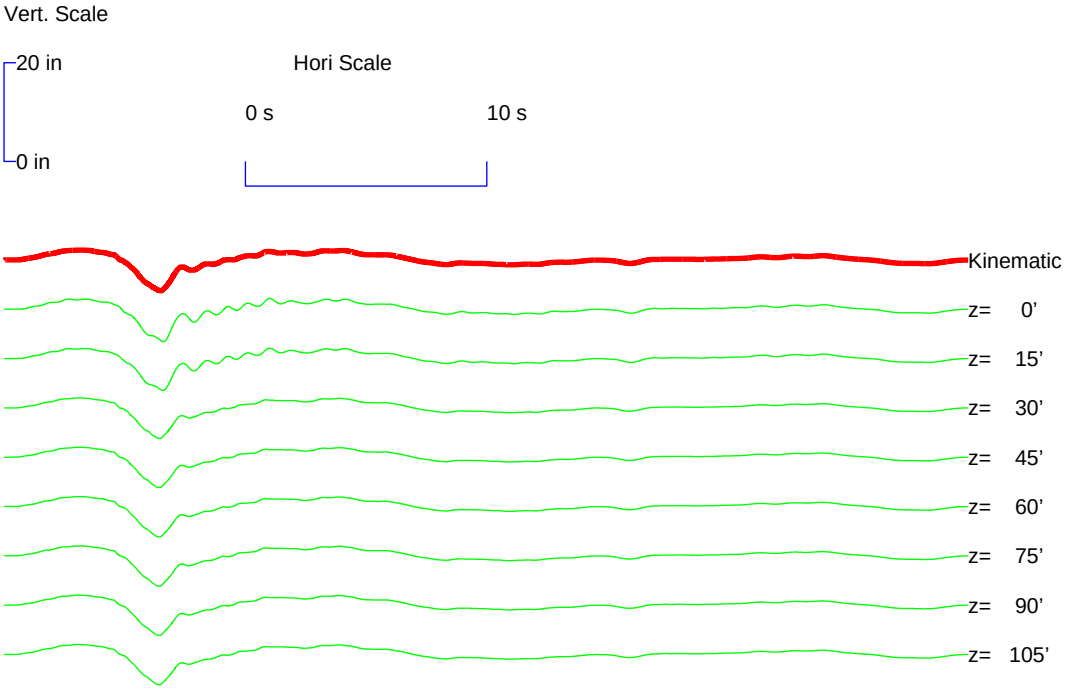



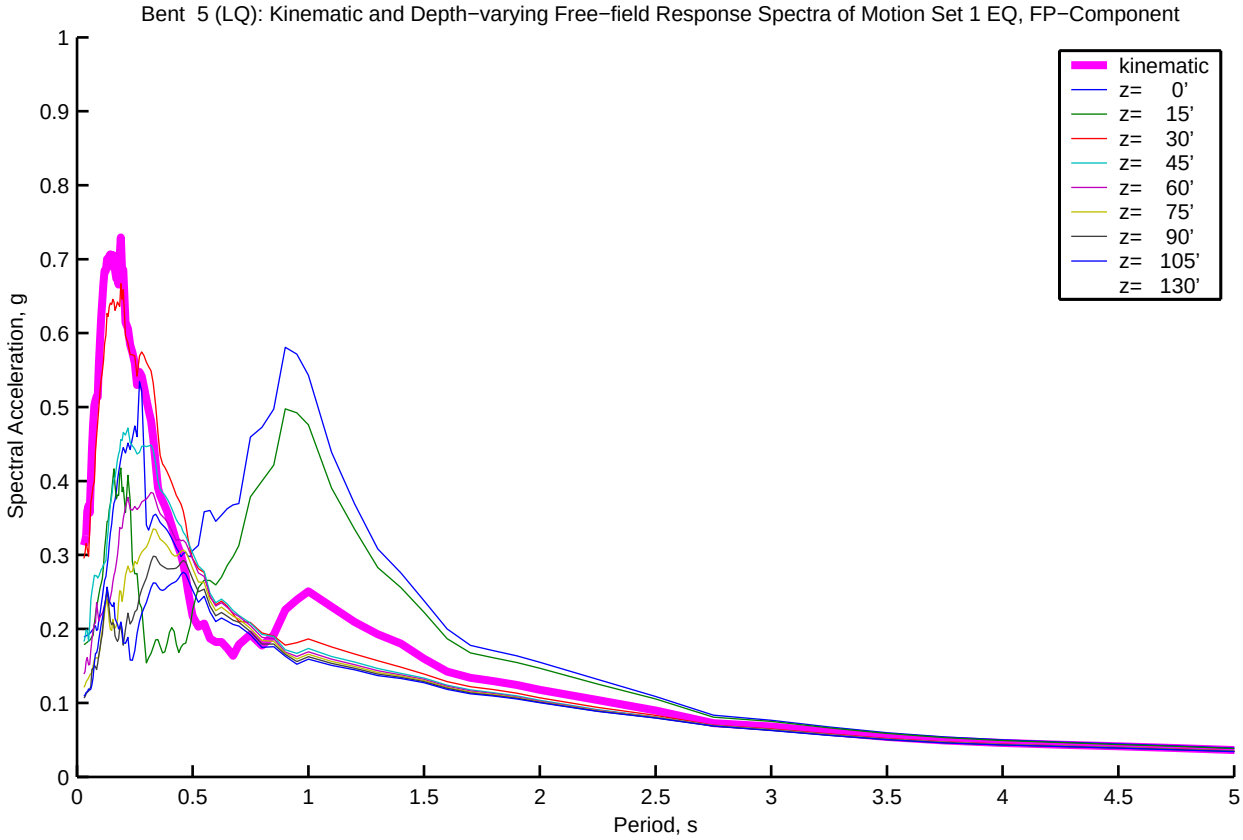

Bent 5 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

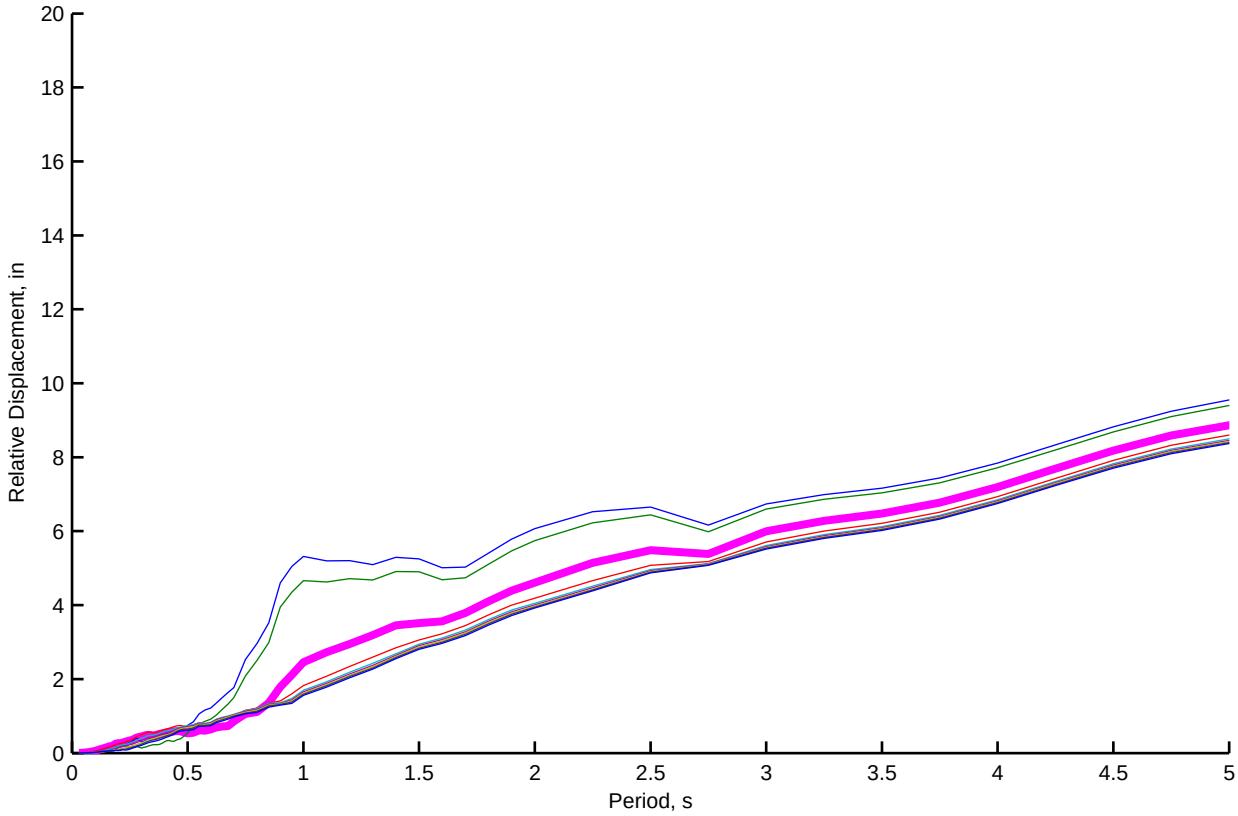

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 5 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

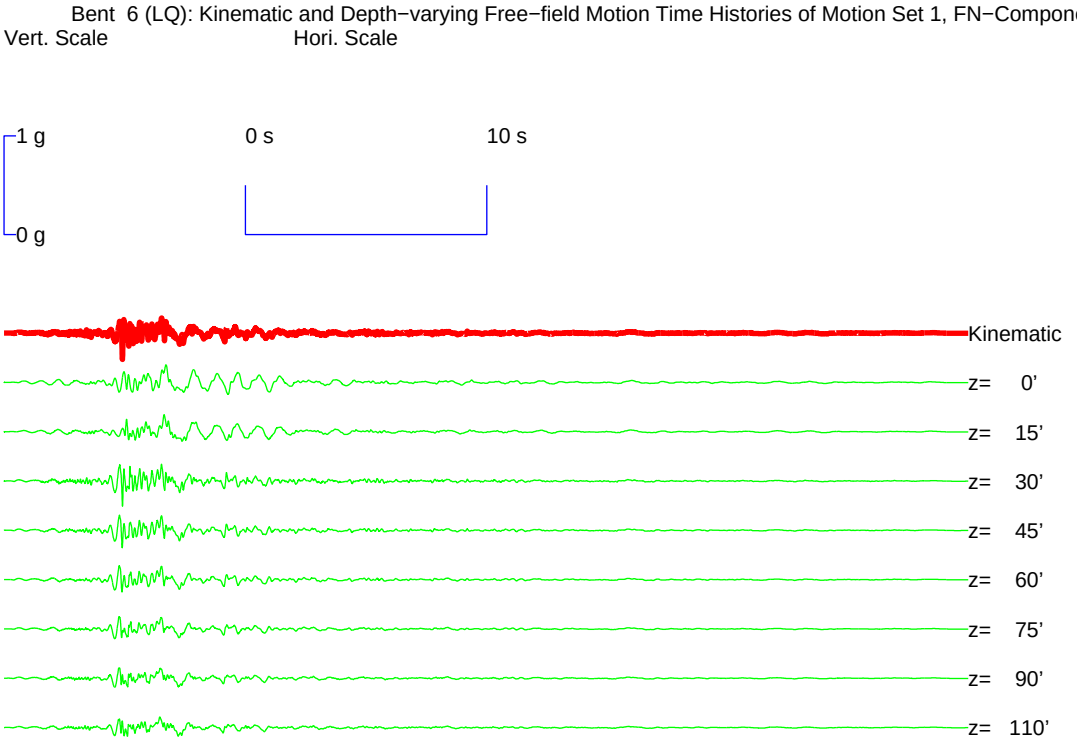


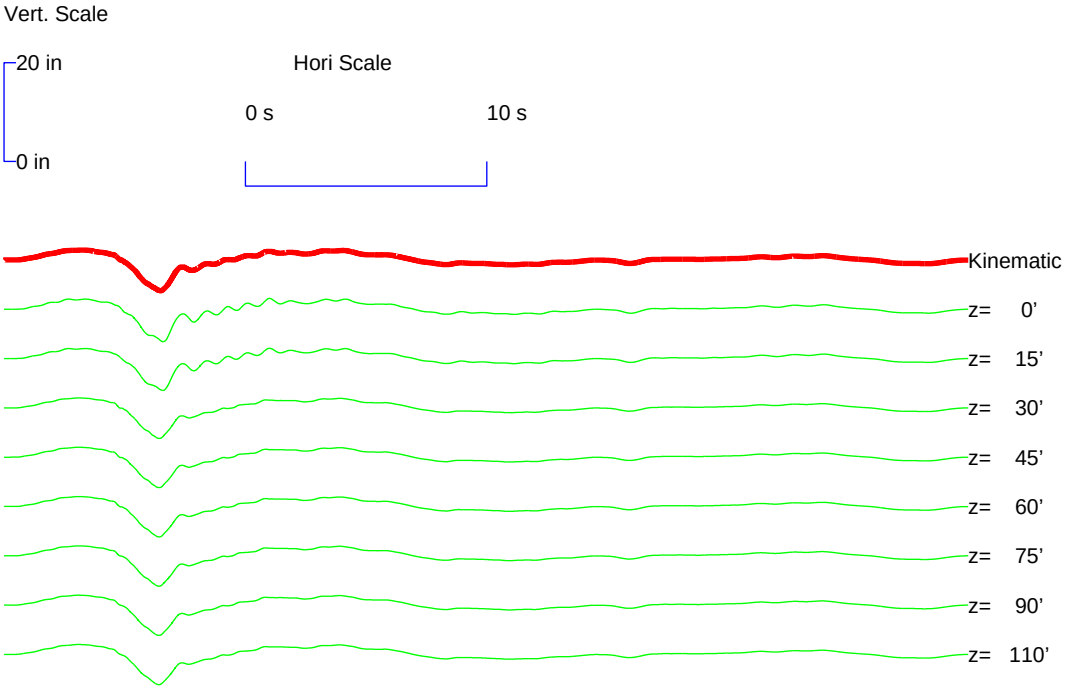



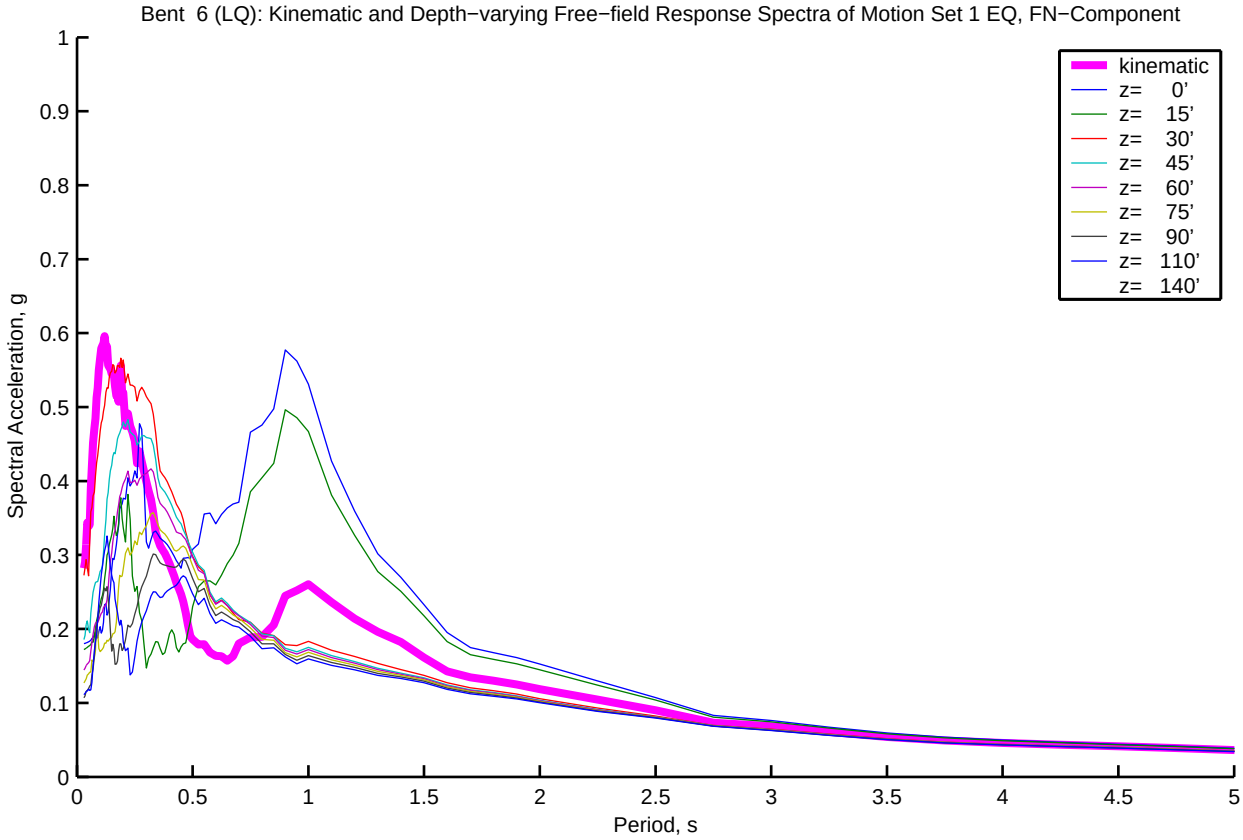

Bent 5 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 6 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component




Bent 6 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
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3.5
4
4.5
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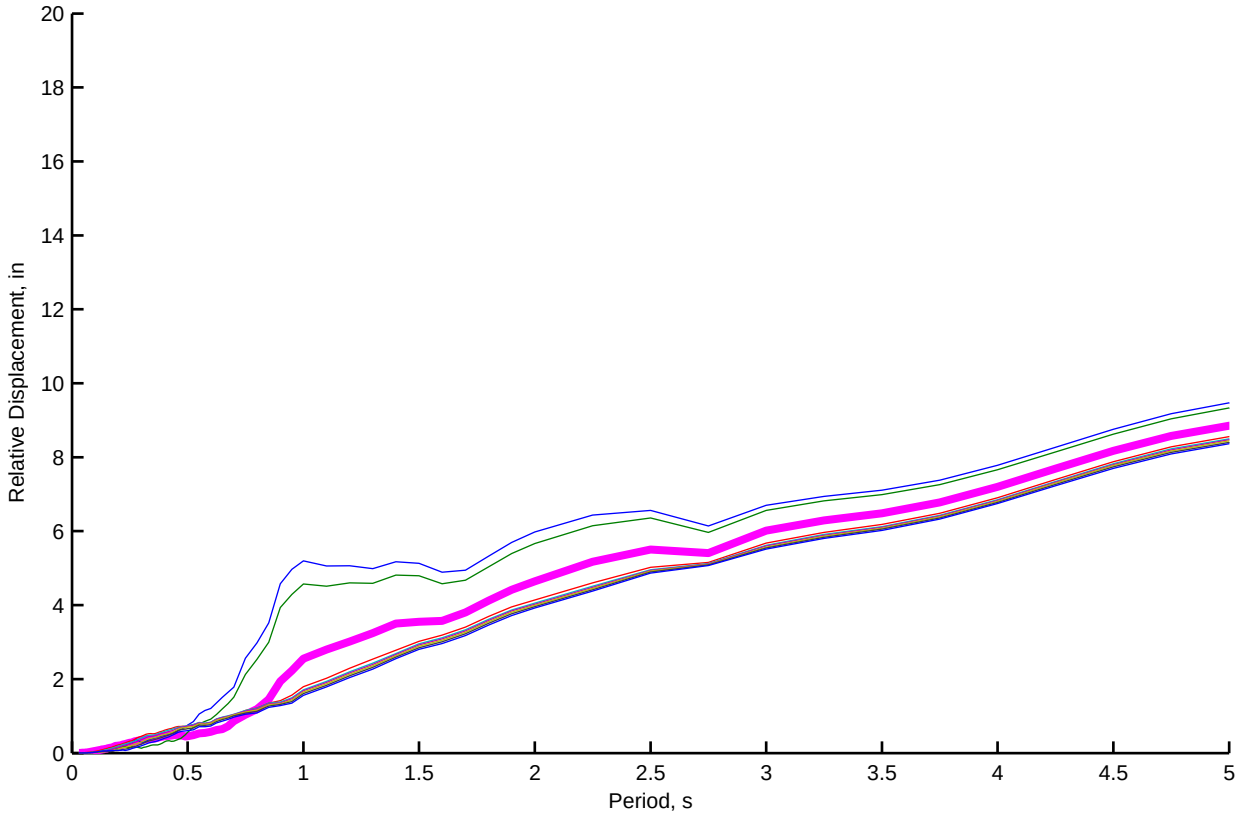
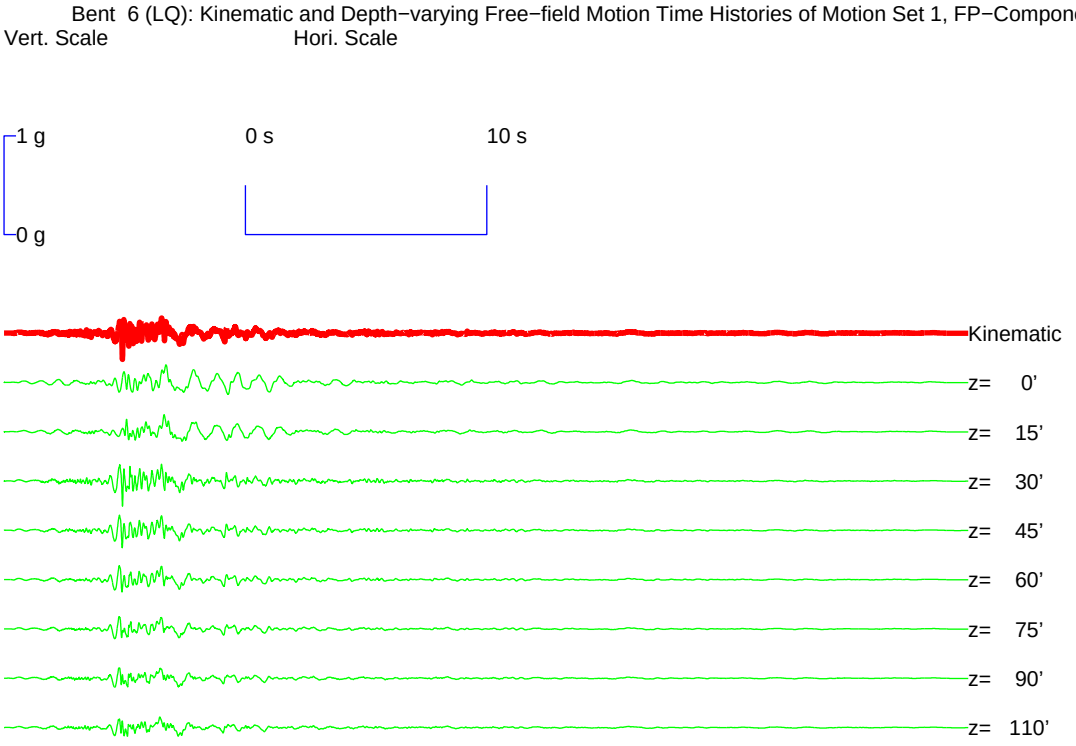
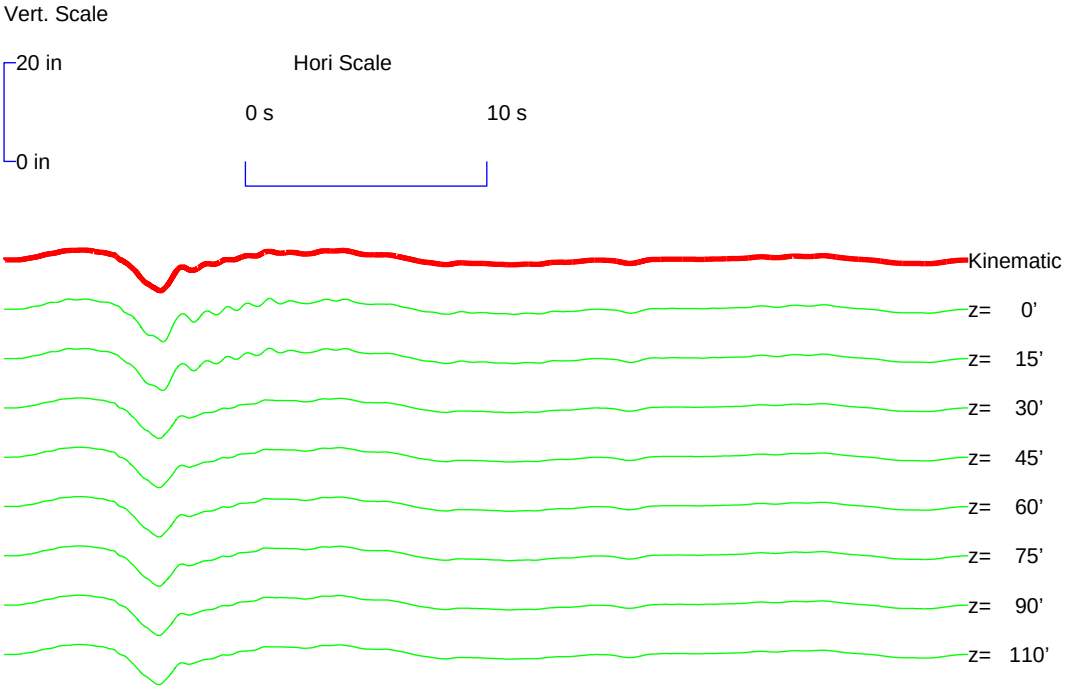
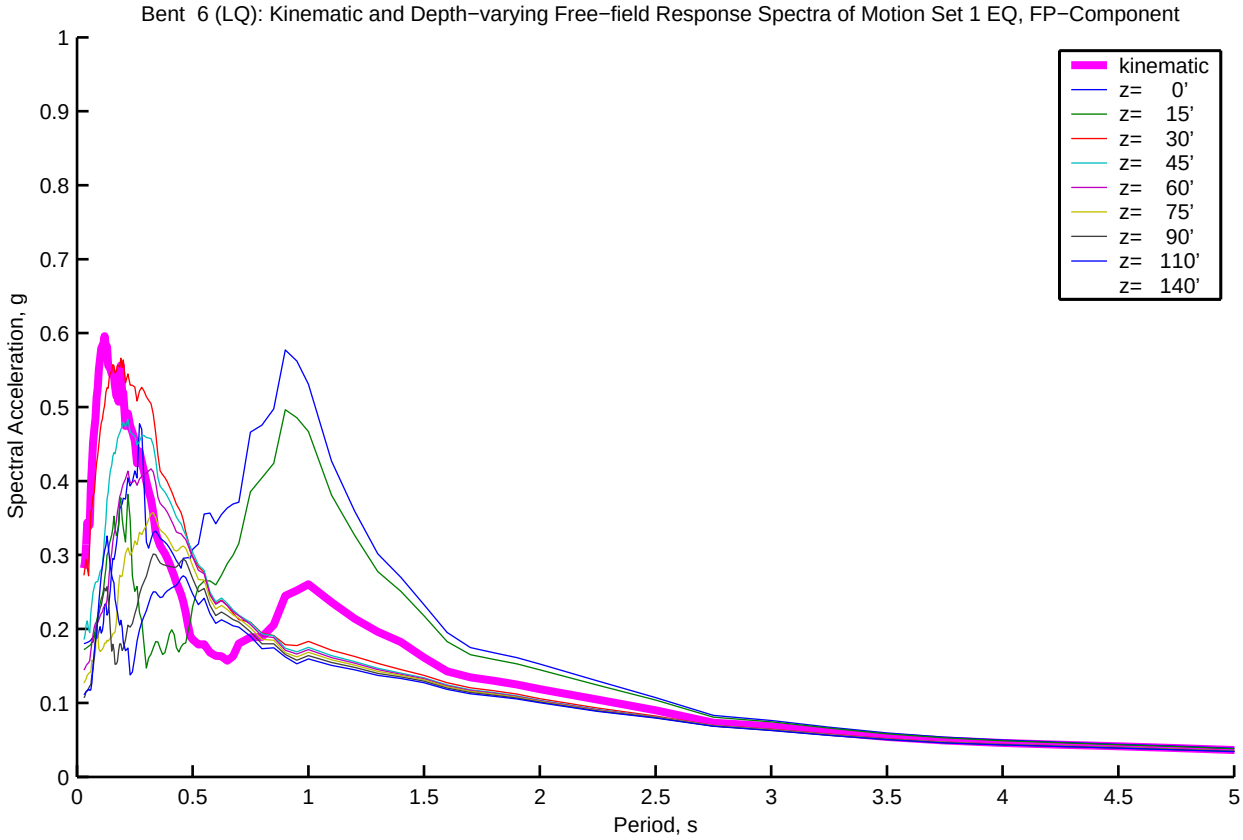
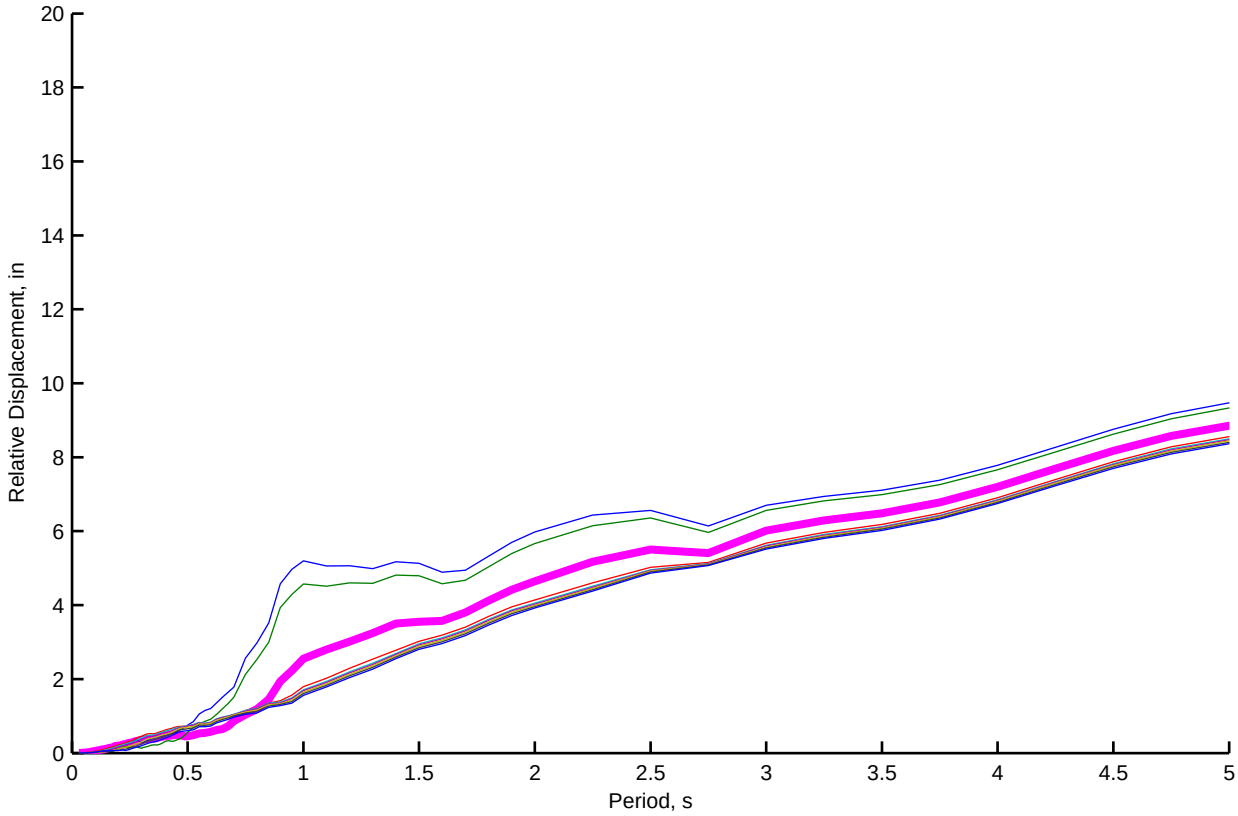

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 6 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

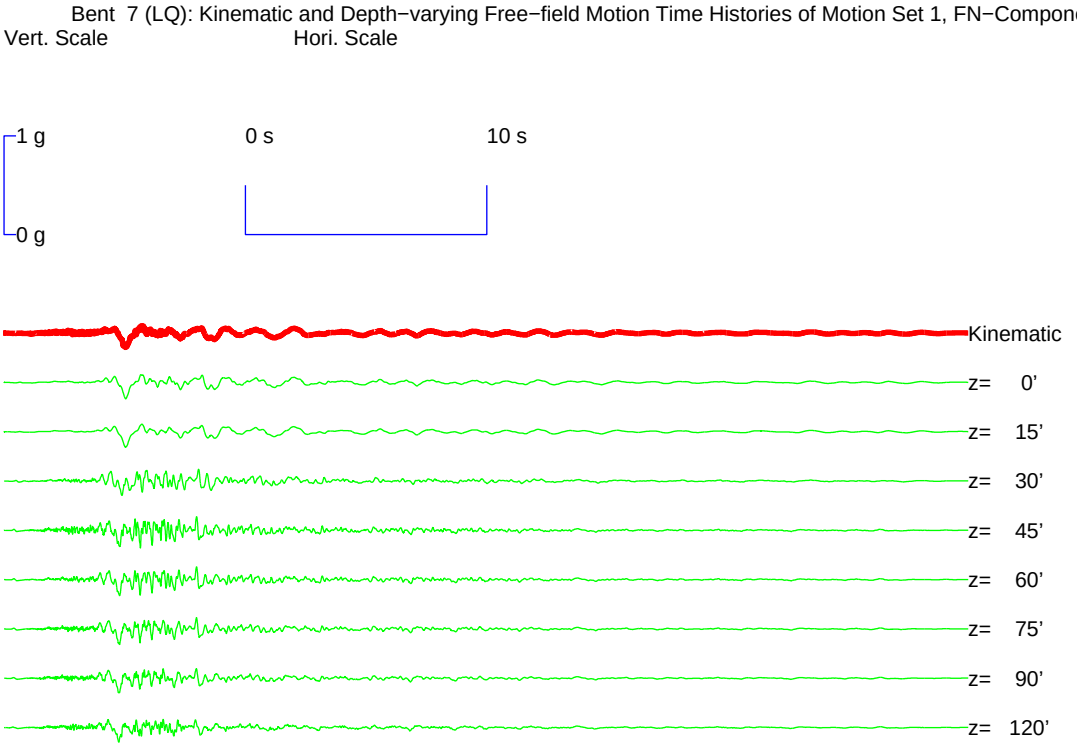


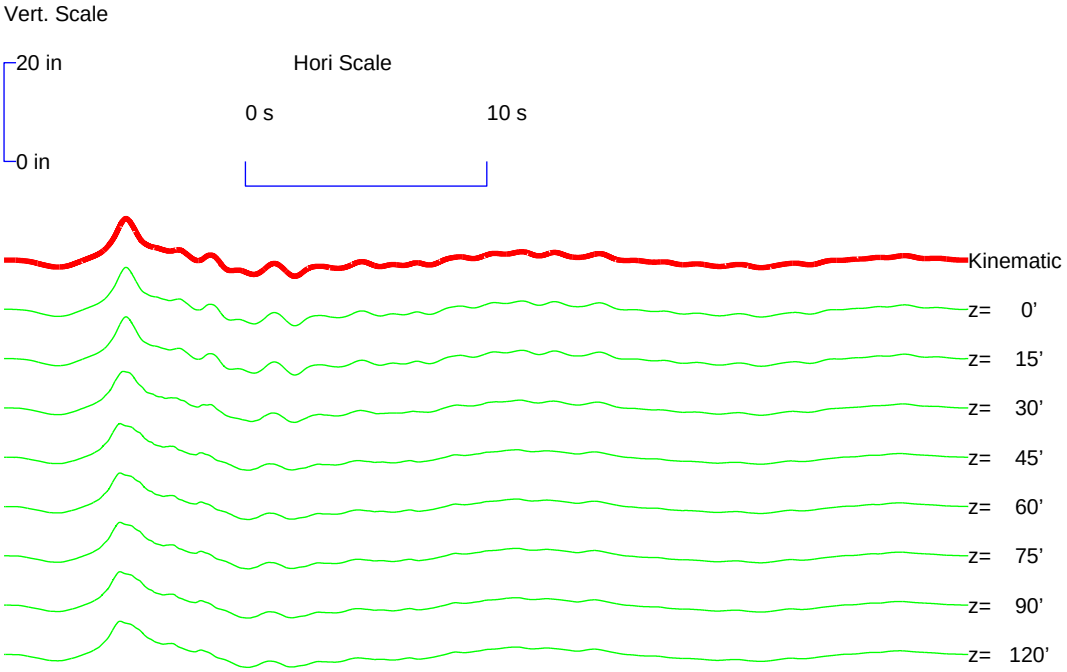



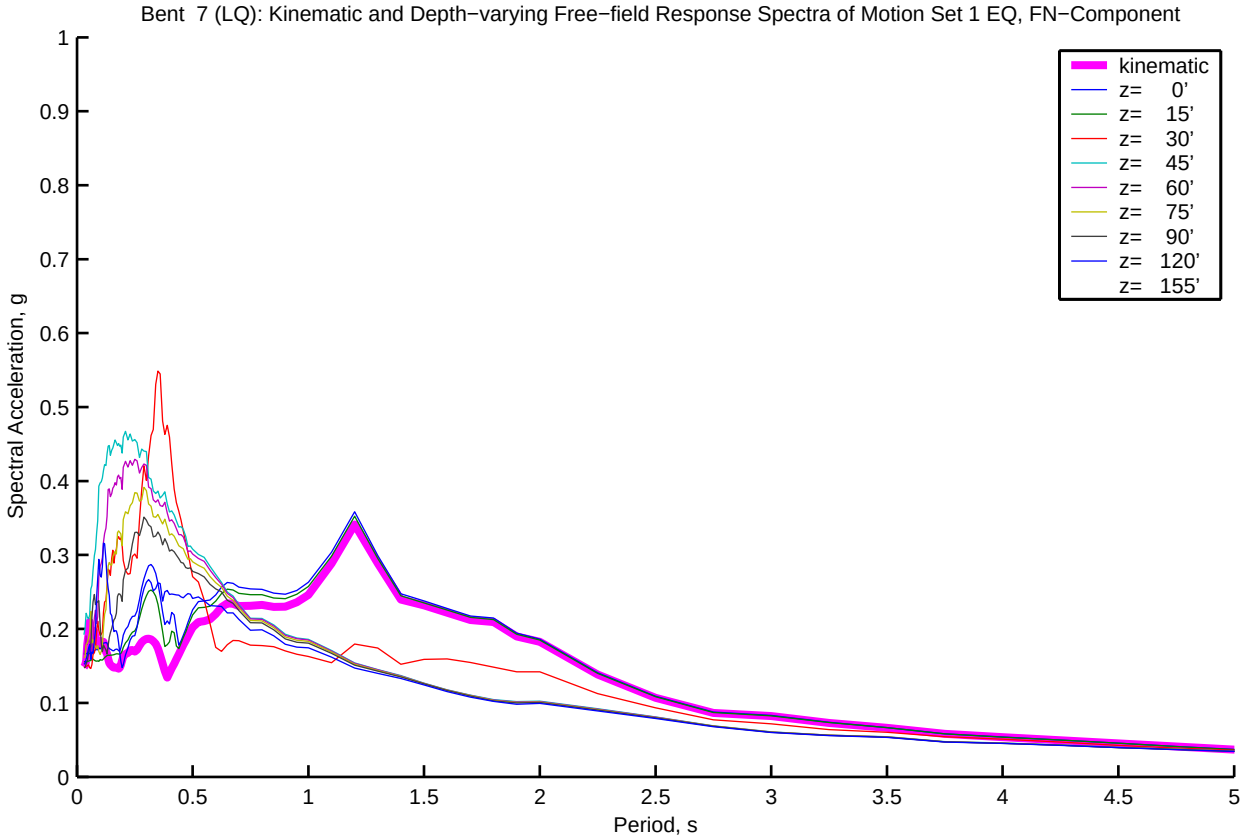

Bent 6 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

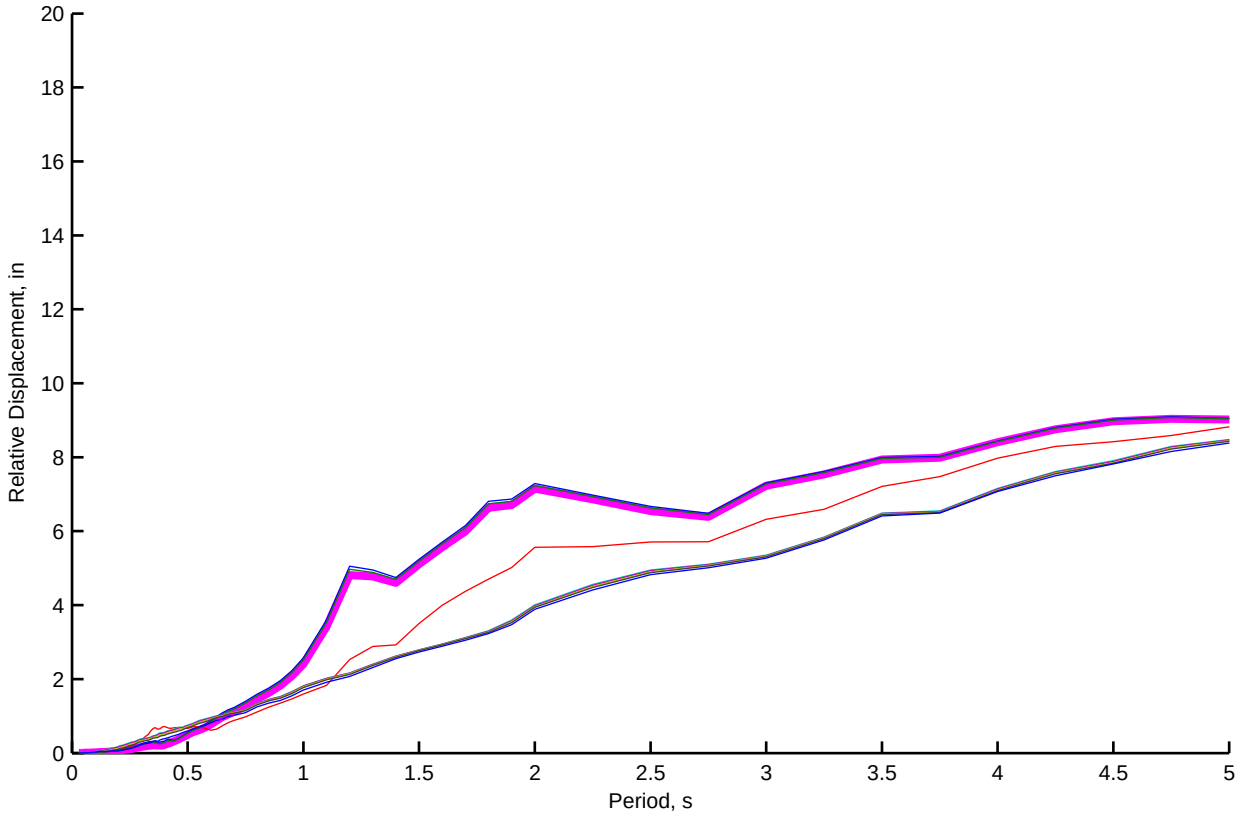

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

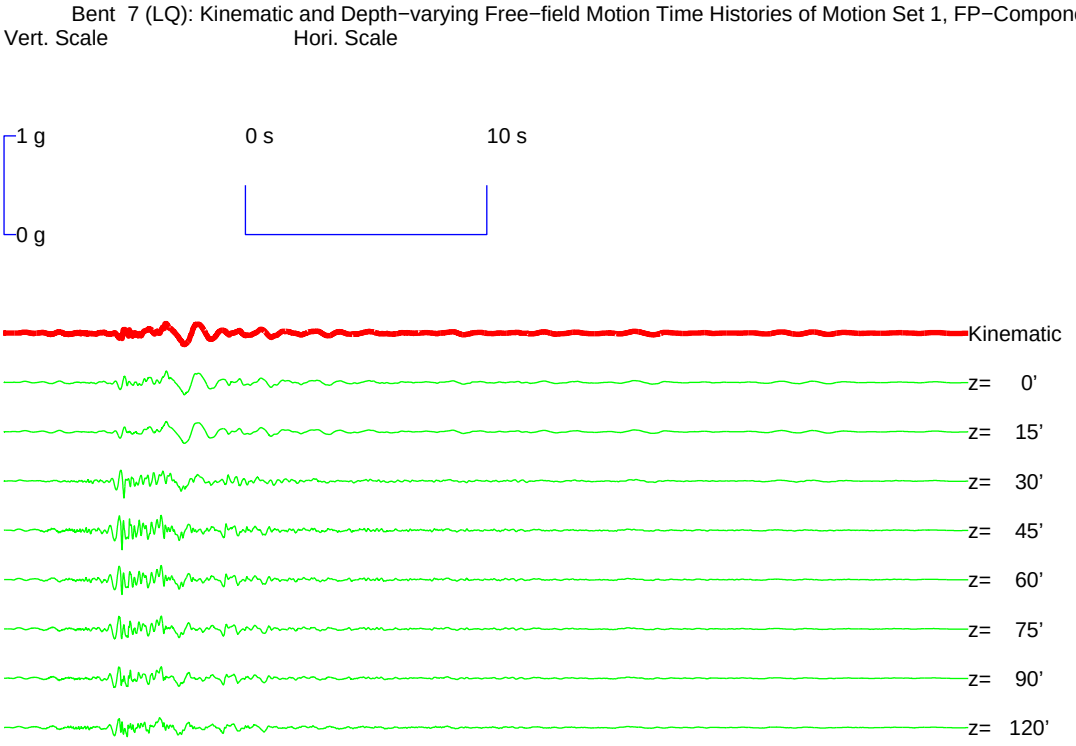


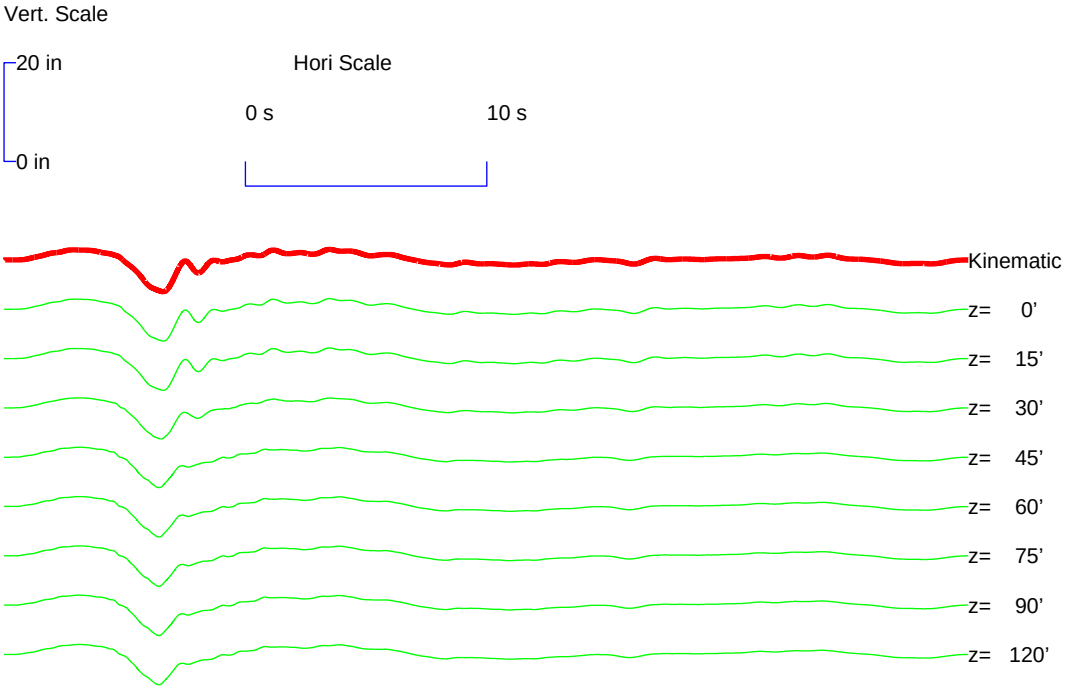



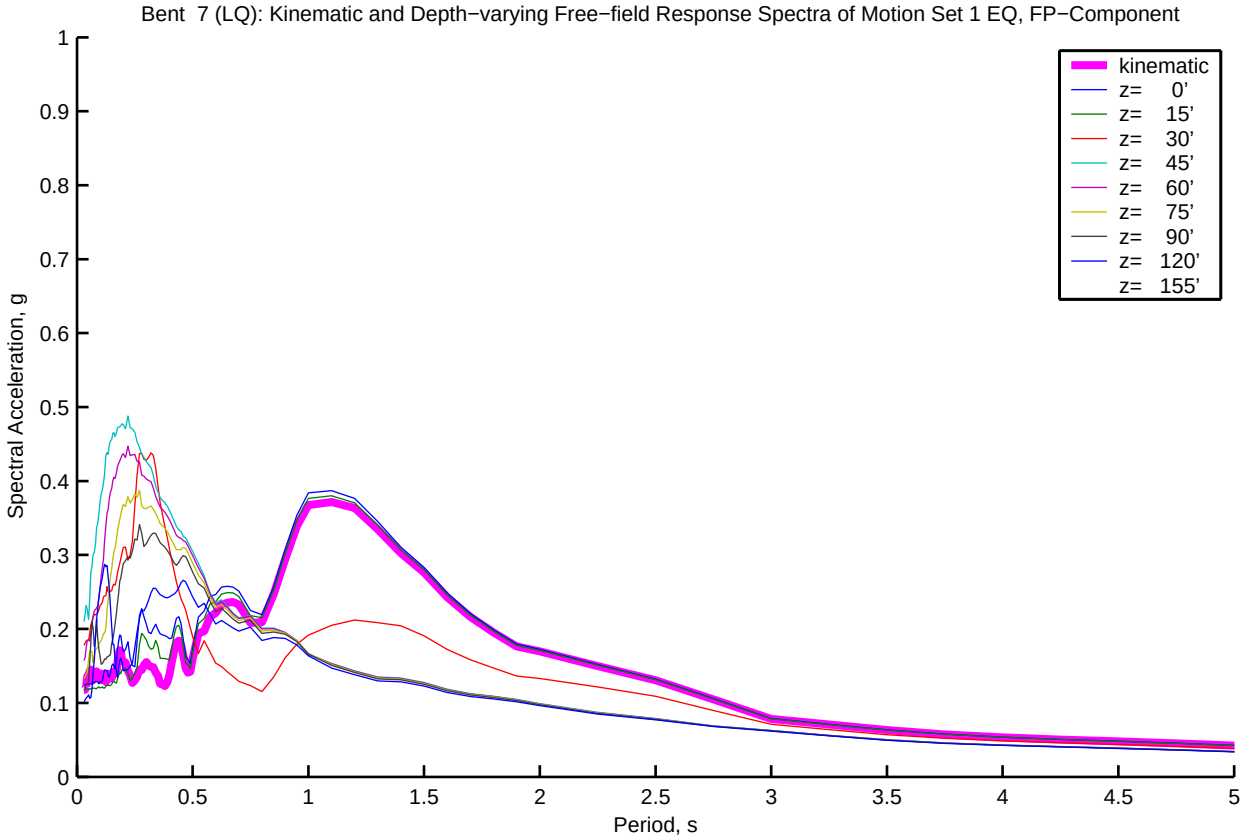

Bent 7 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

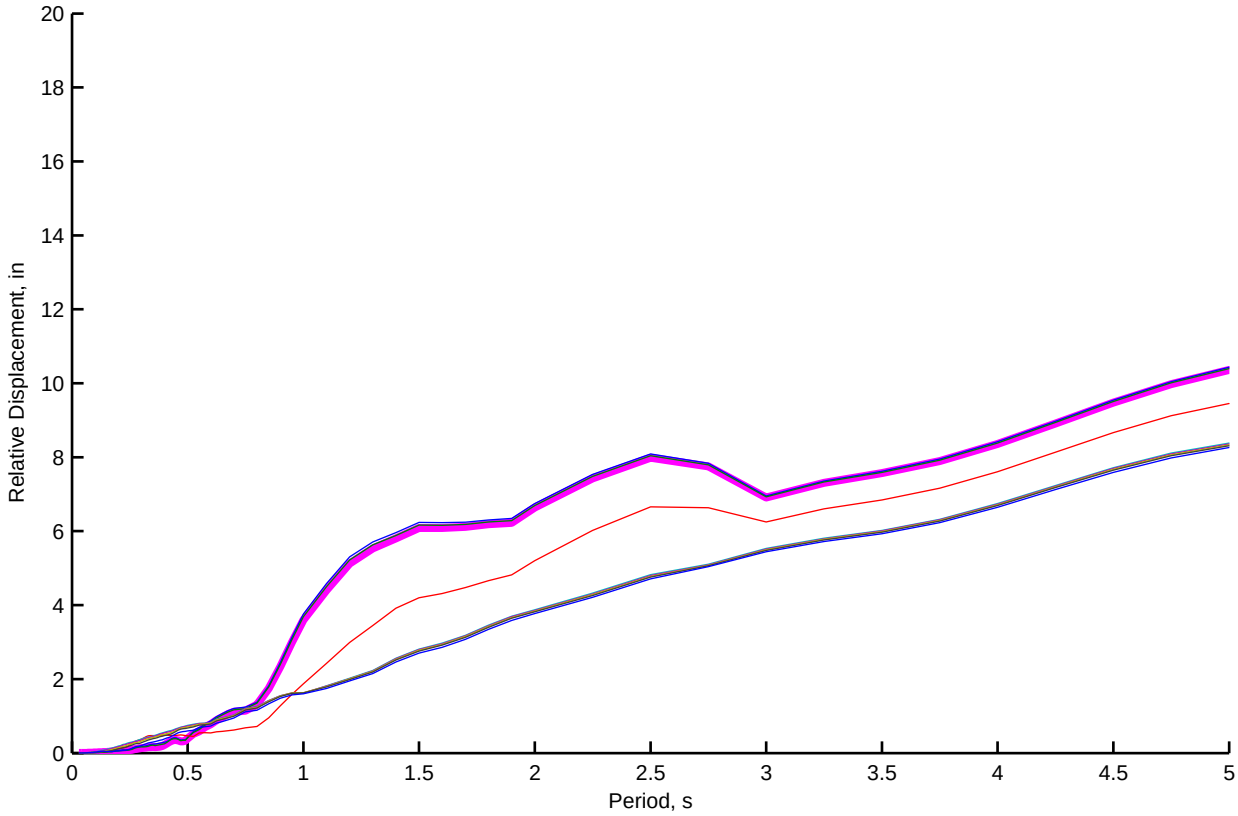

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

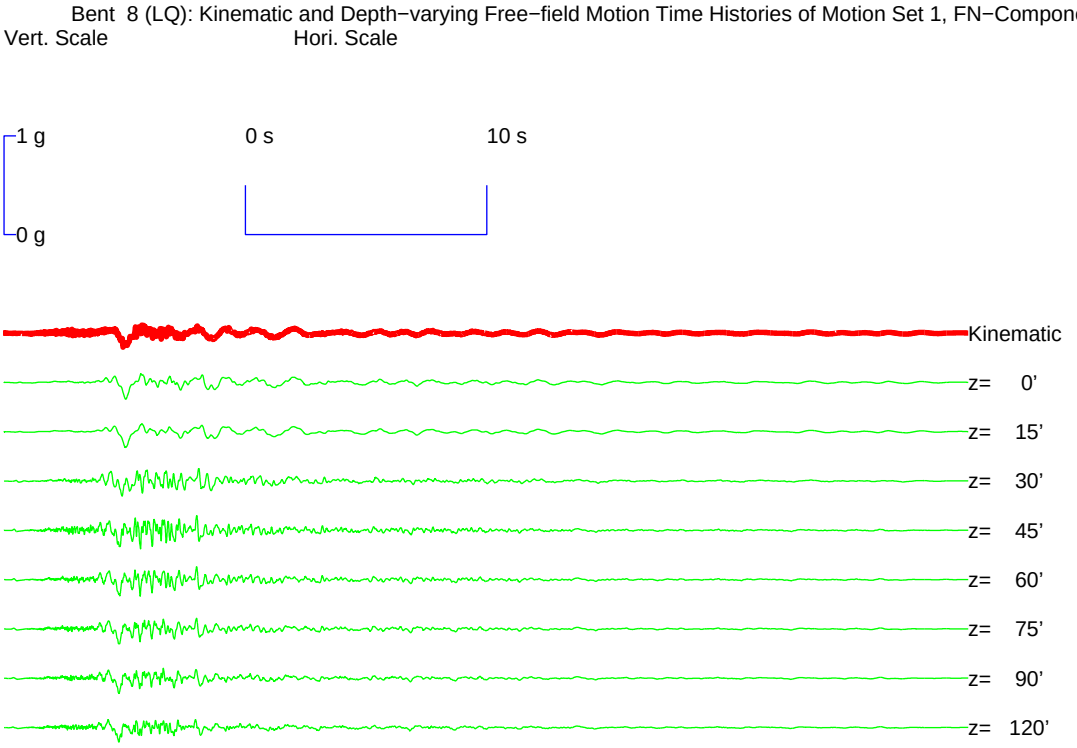


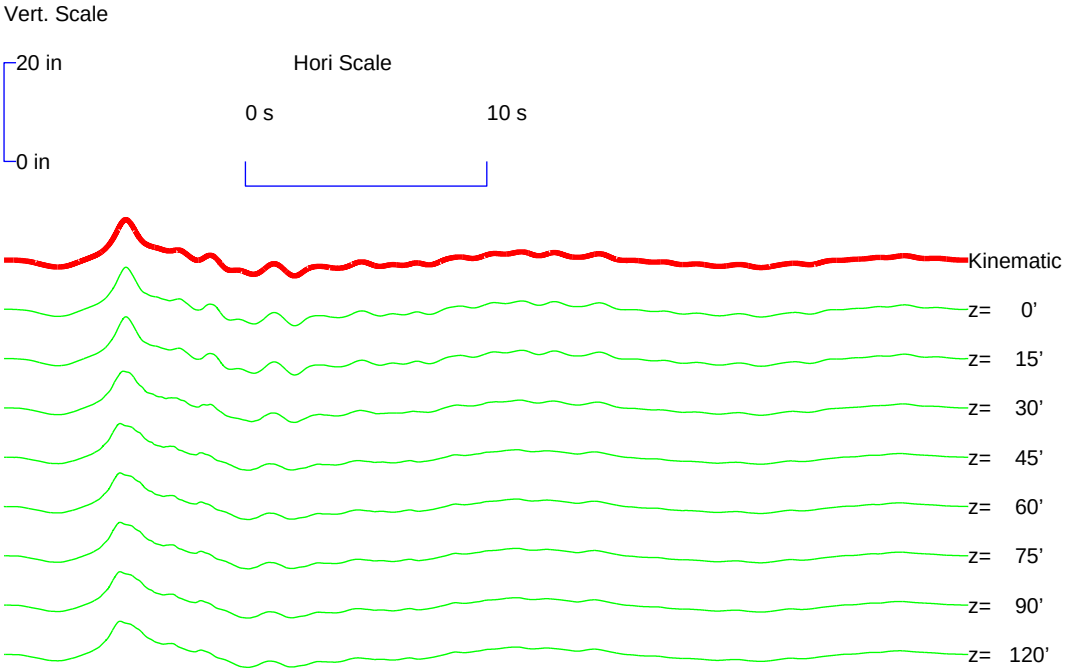



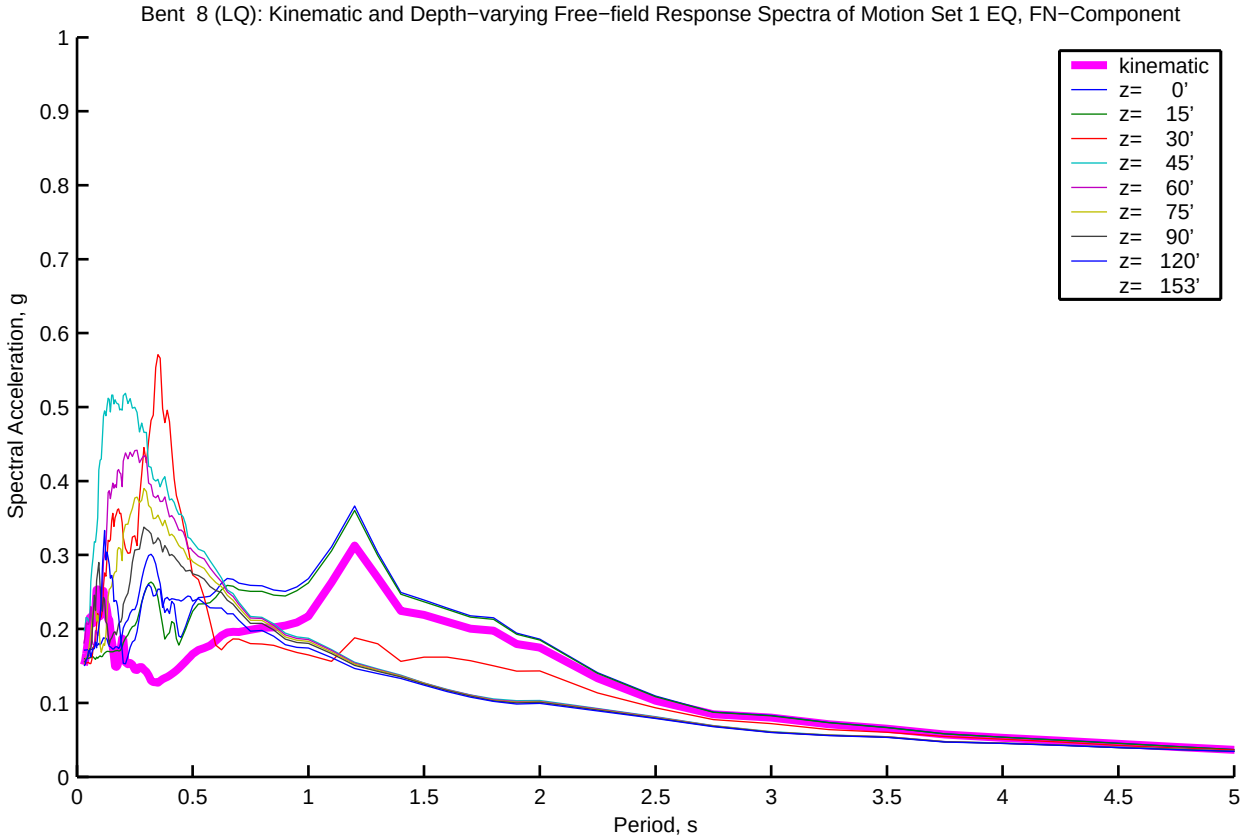

Bent 7 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

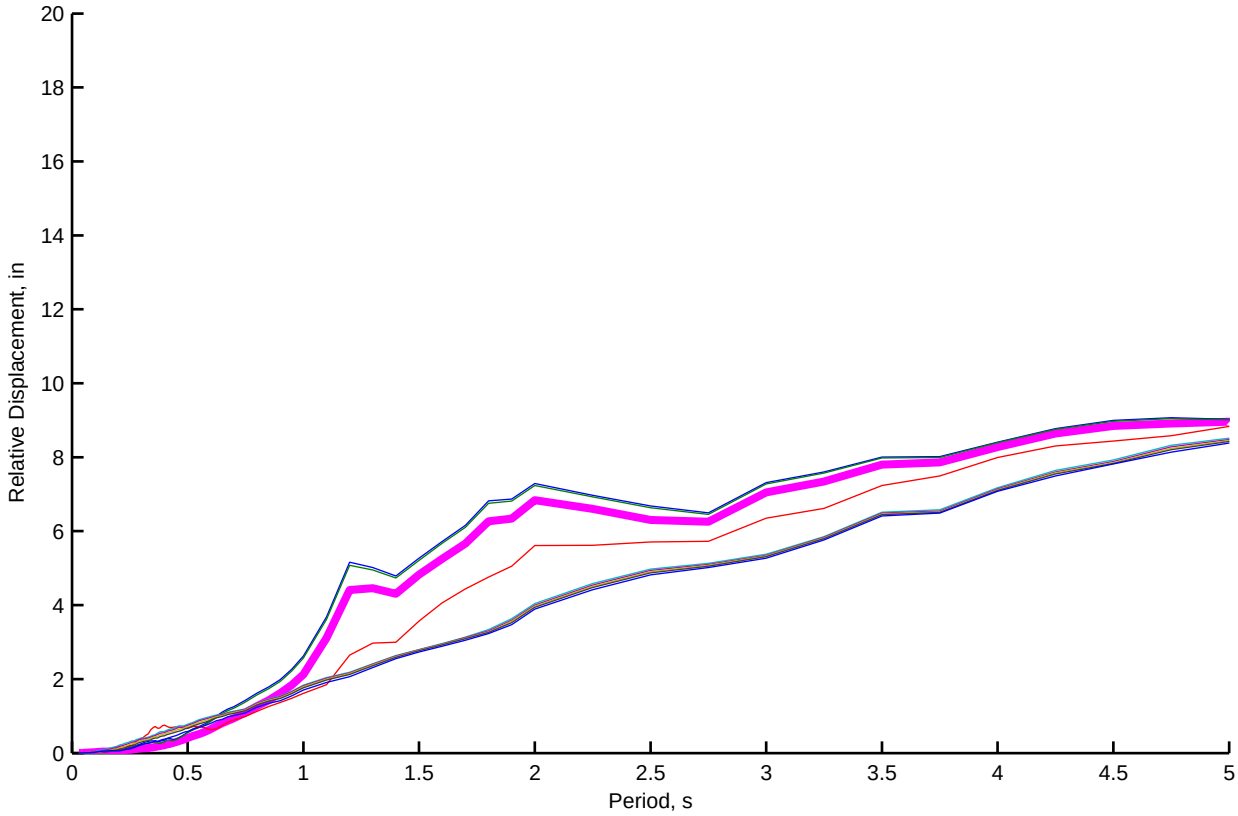

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

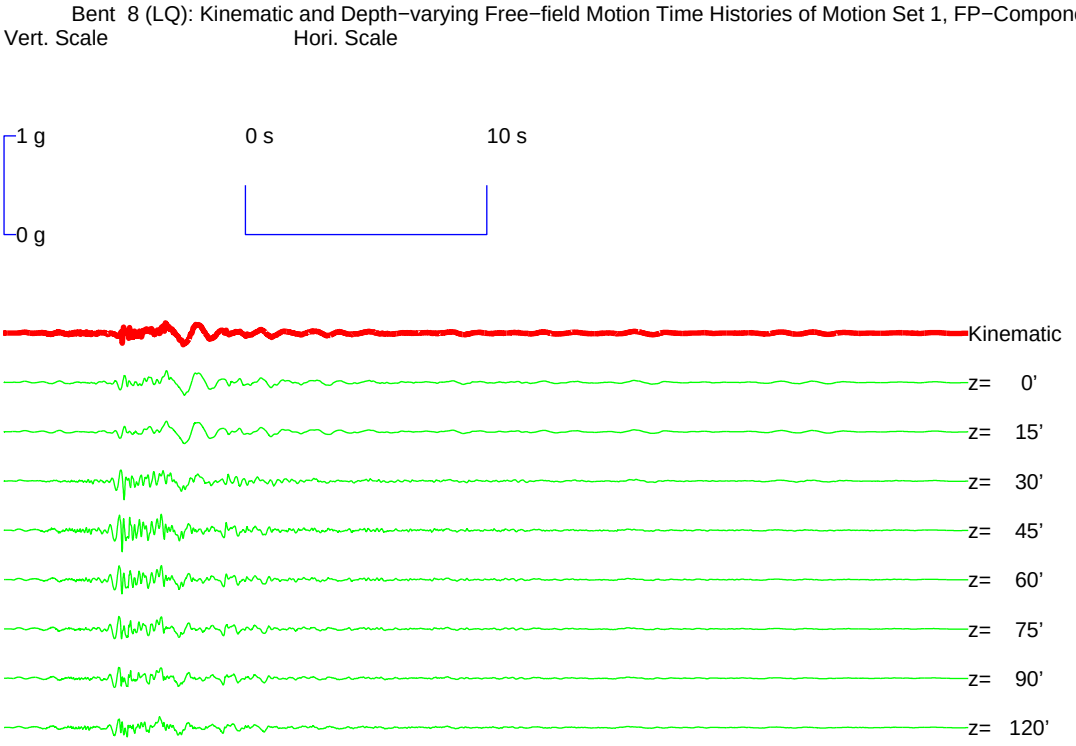


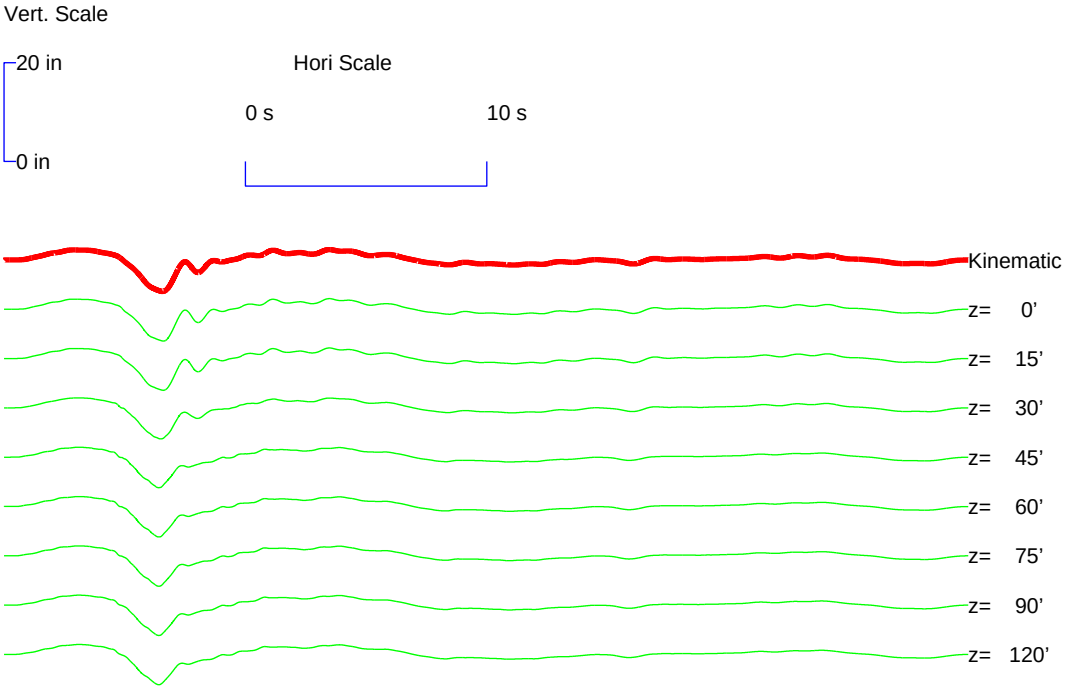



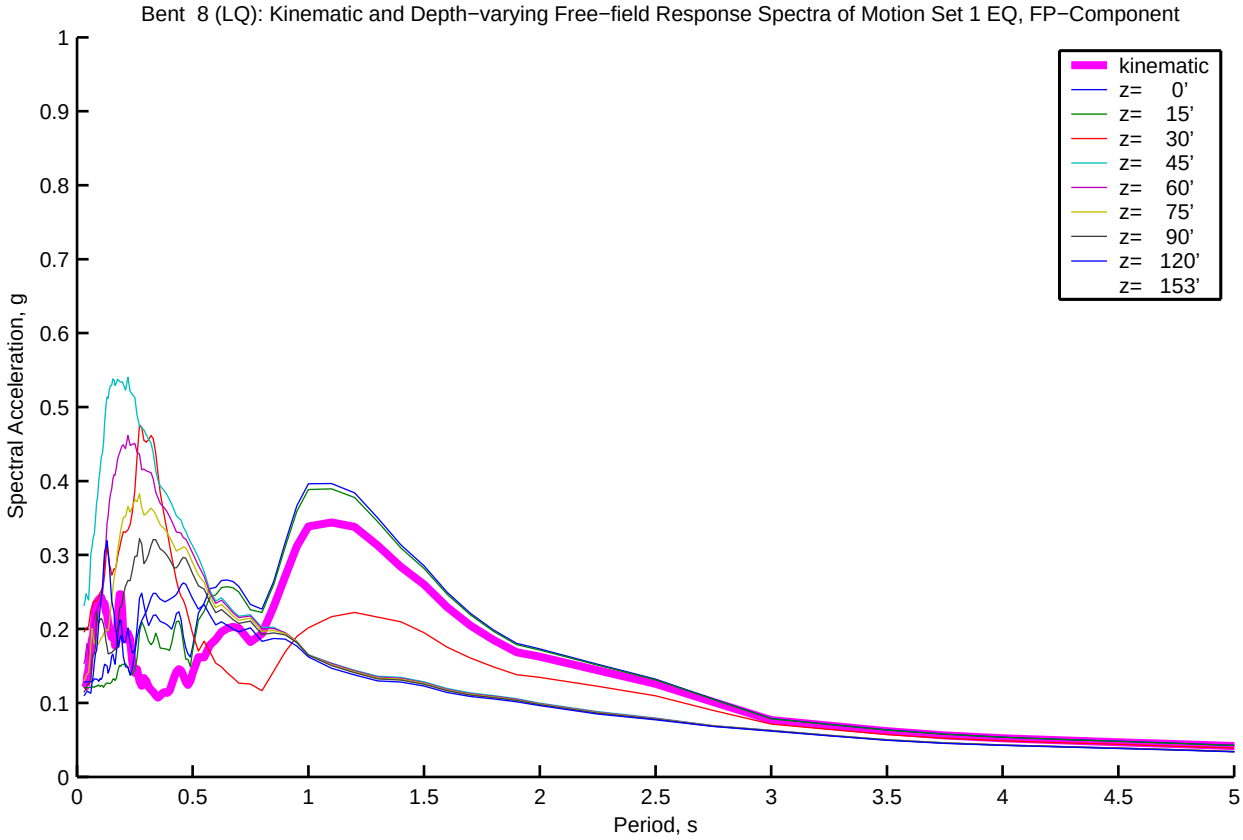

Bent 8 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

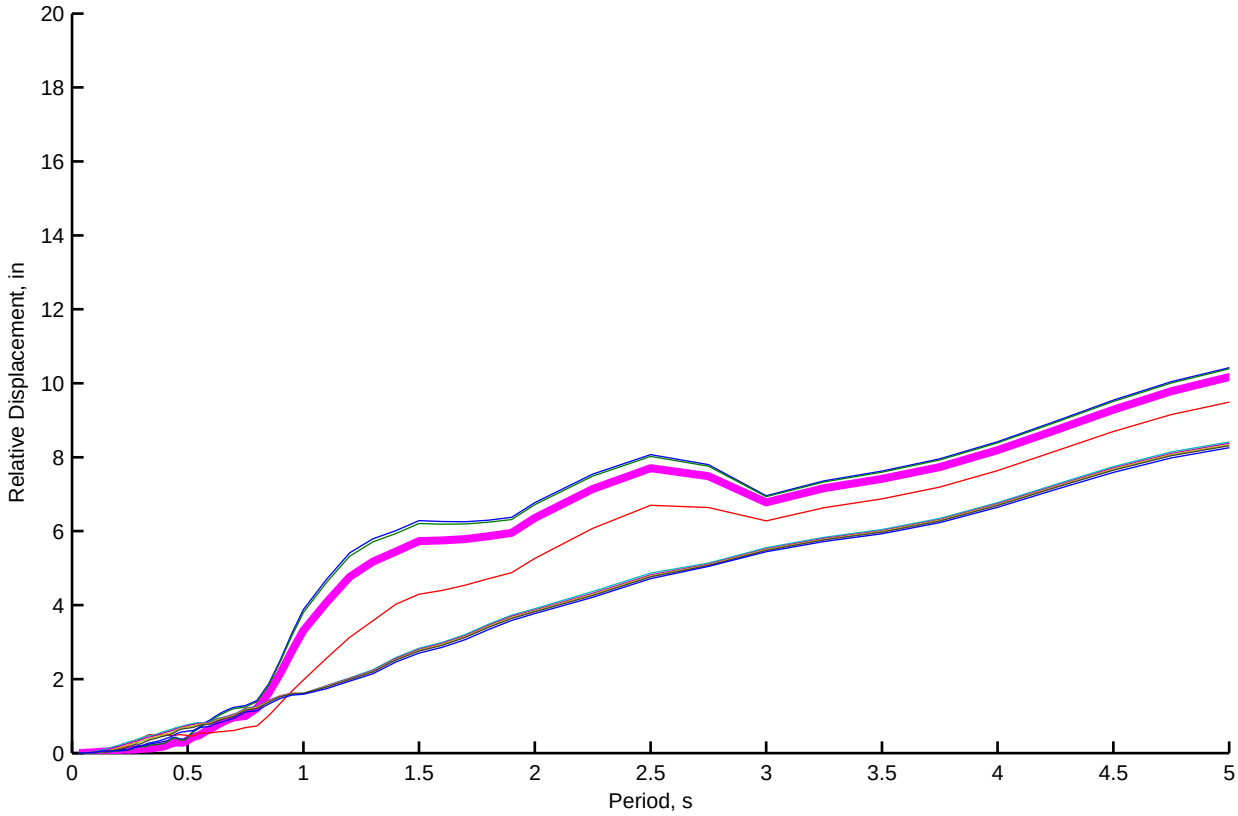

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

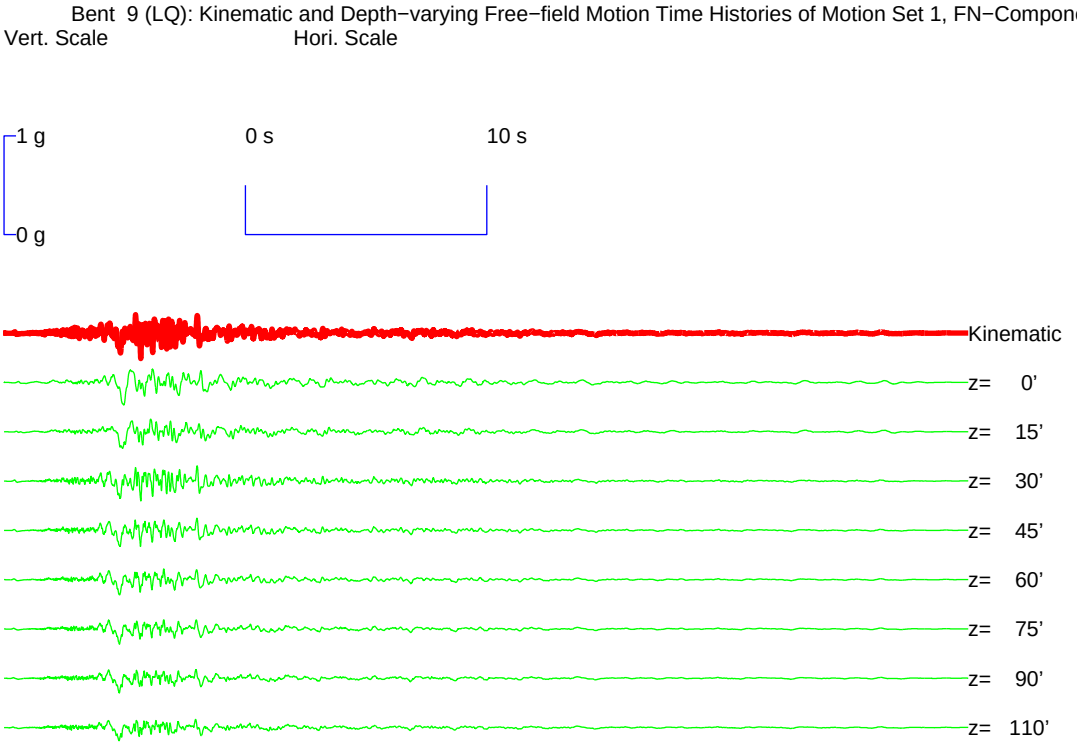


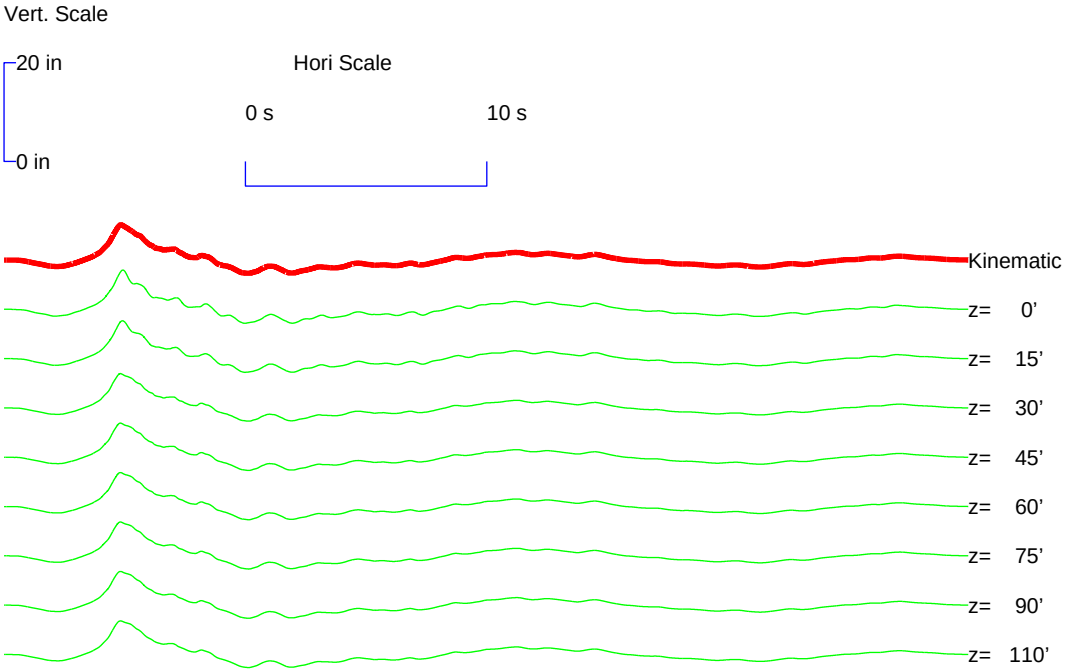



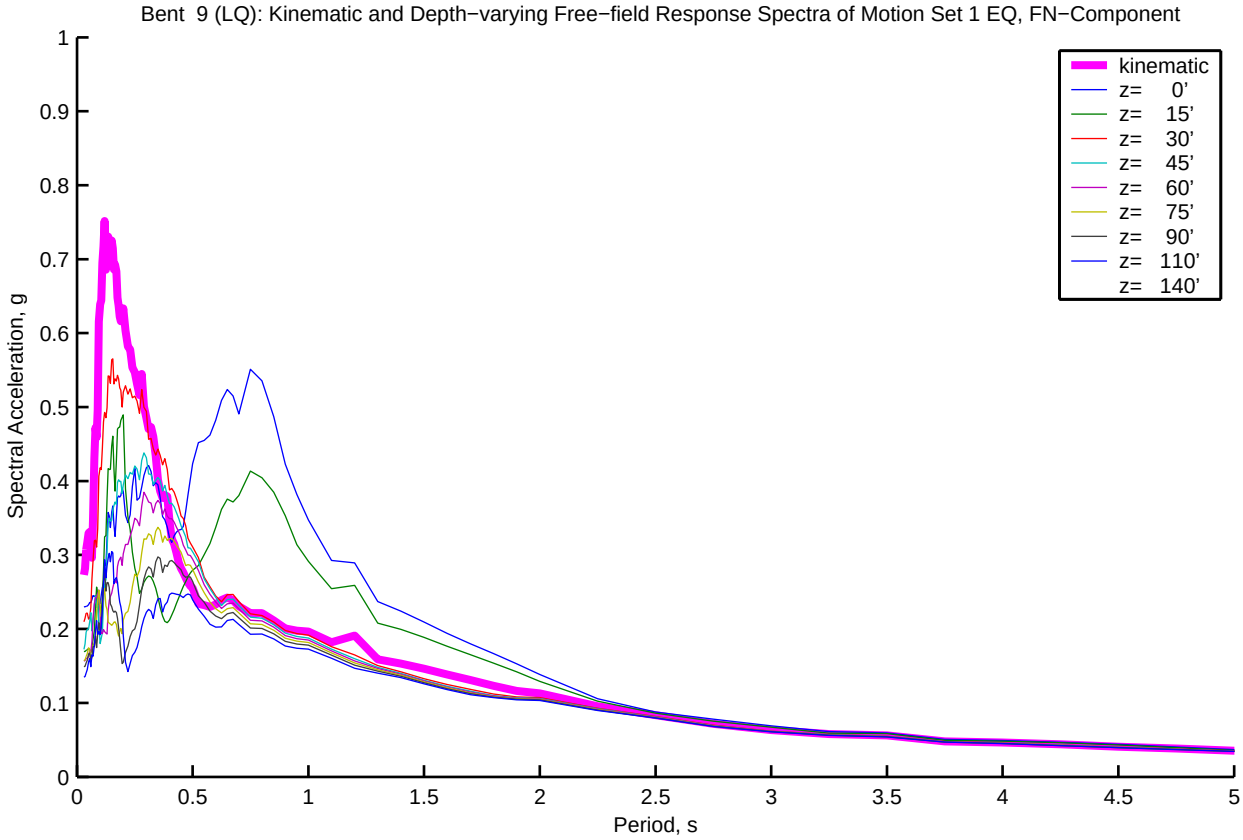

Bent 8 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

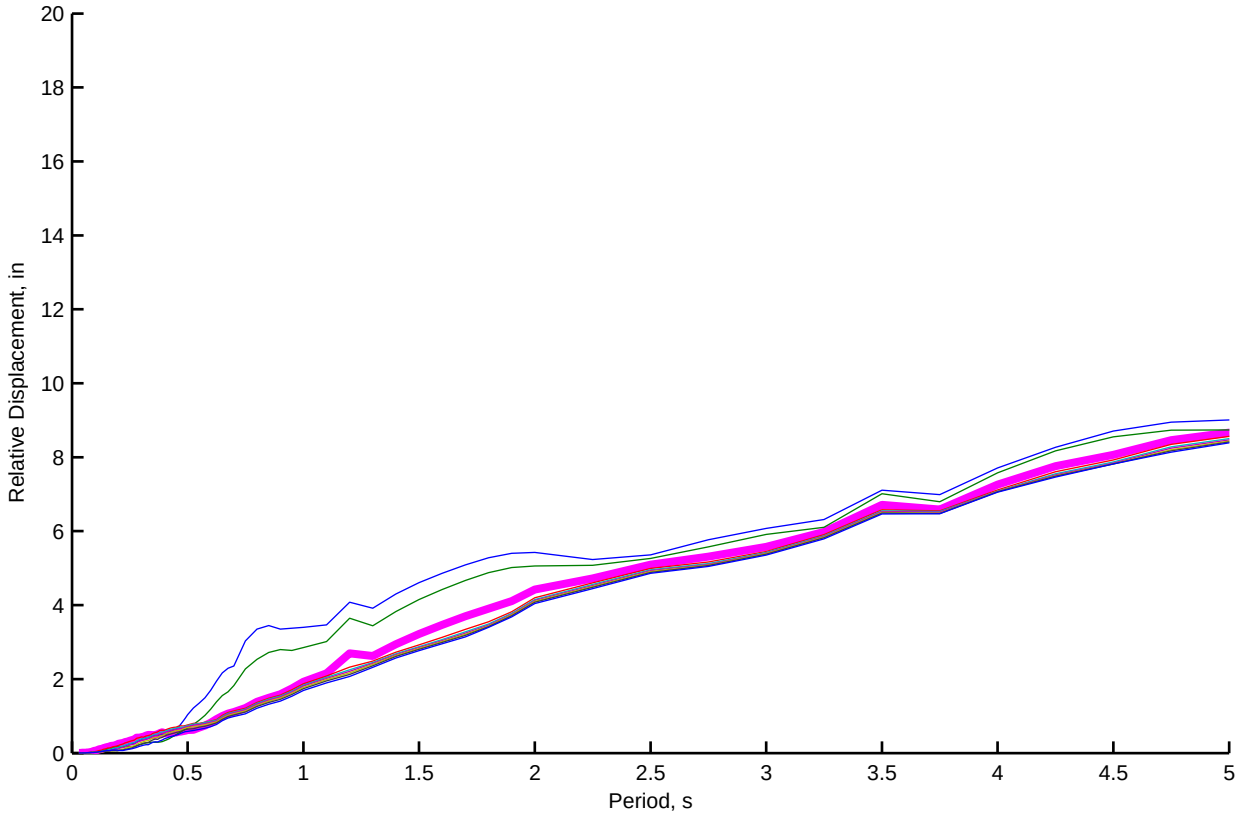

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 9 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

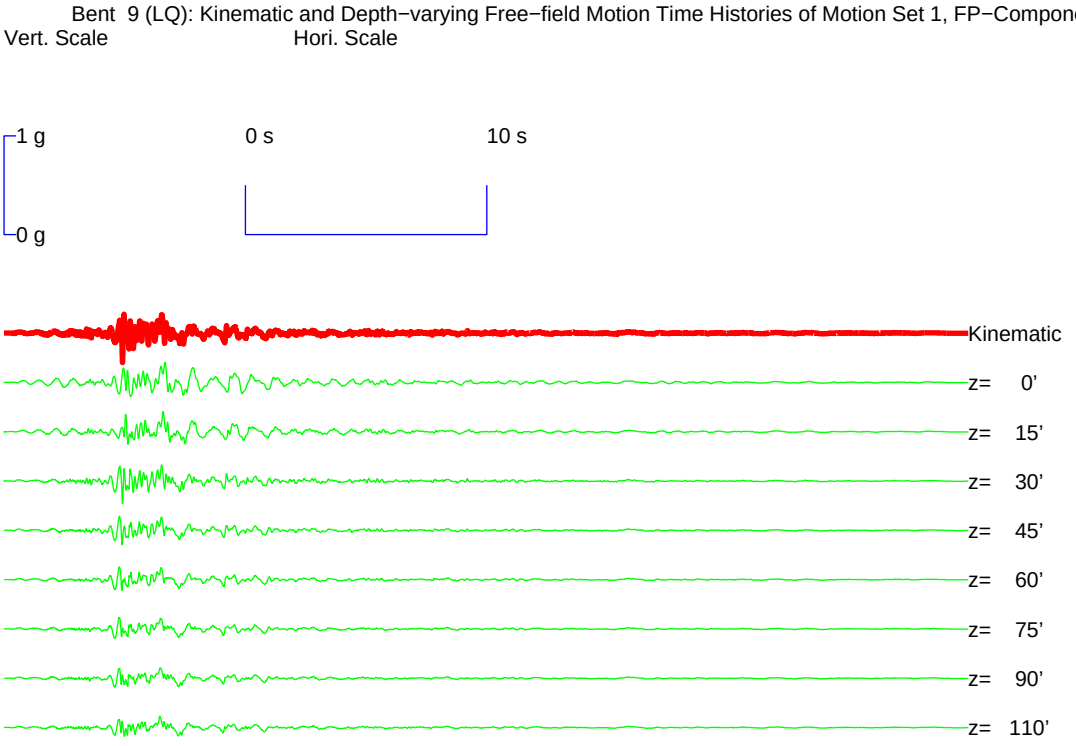


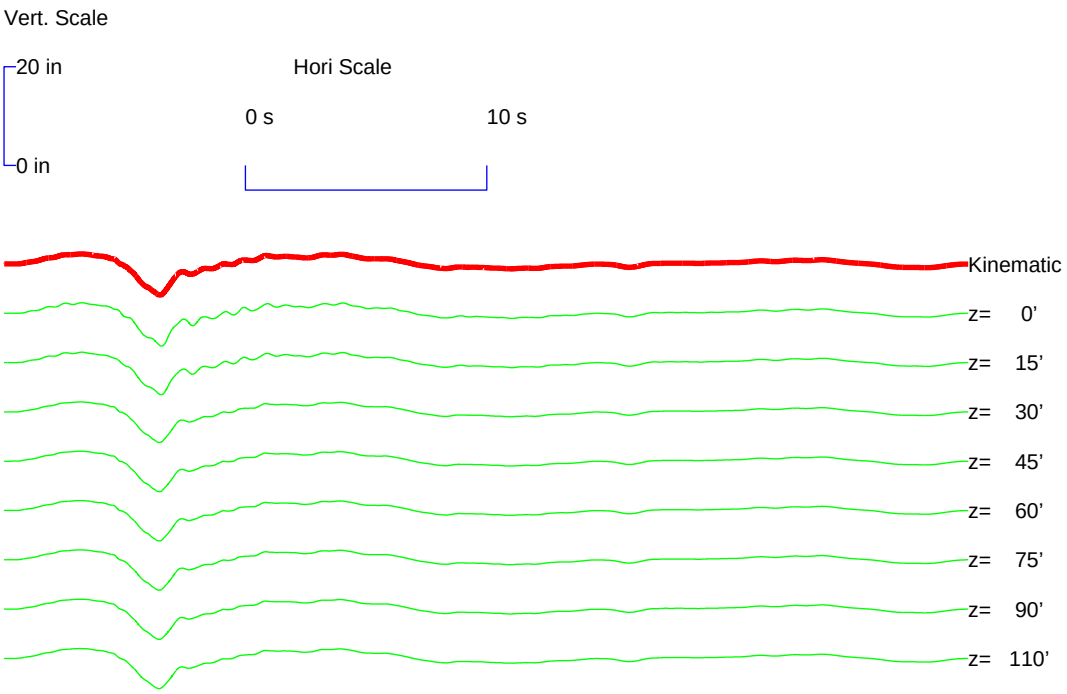



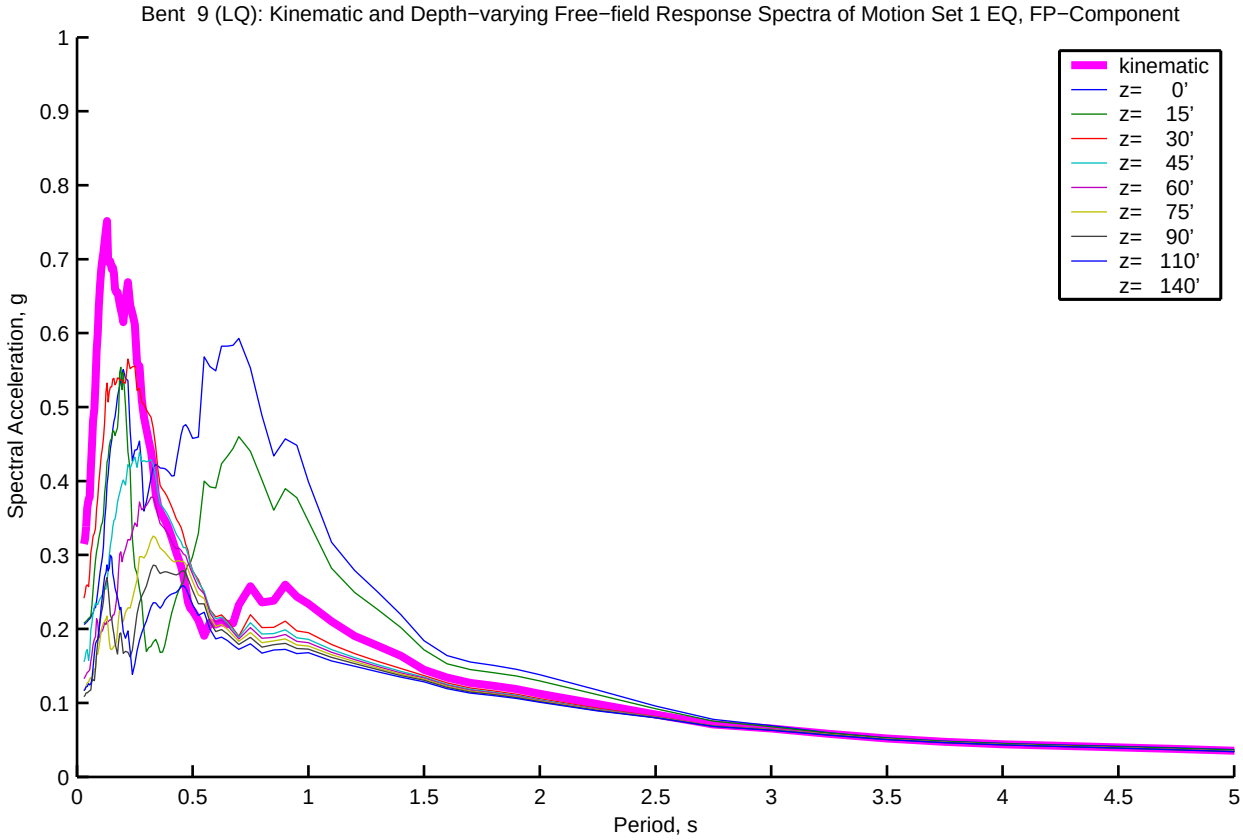

Bent 9 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

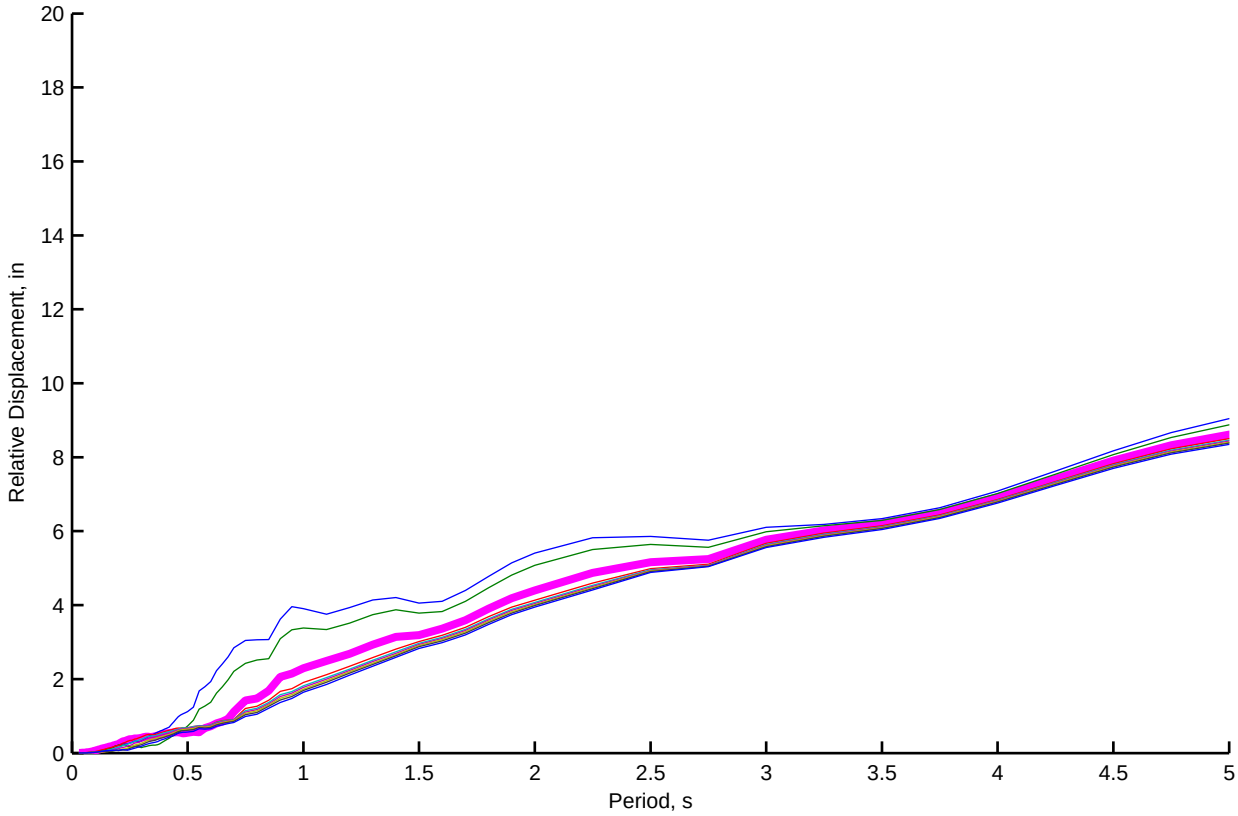

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 9 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

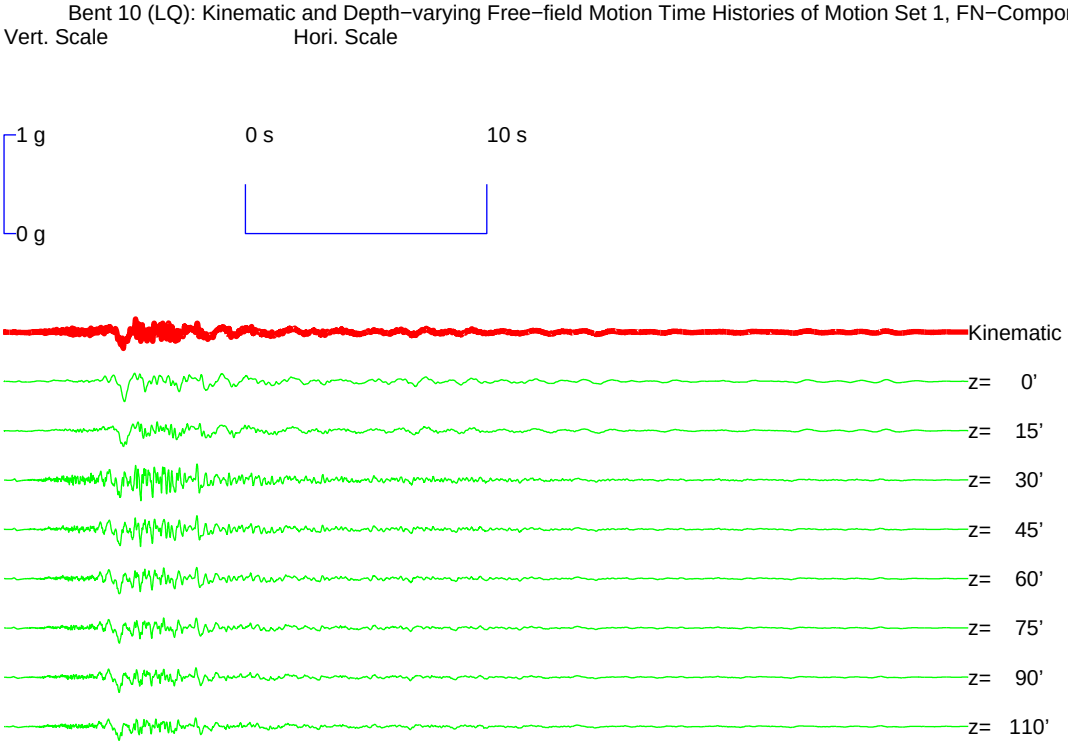


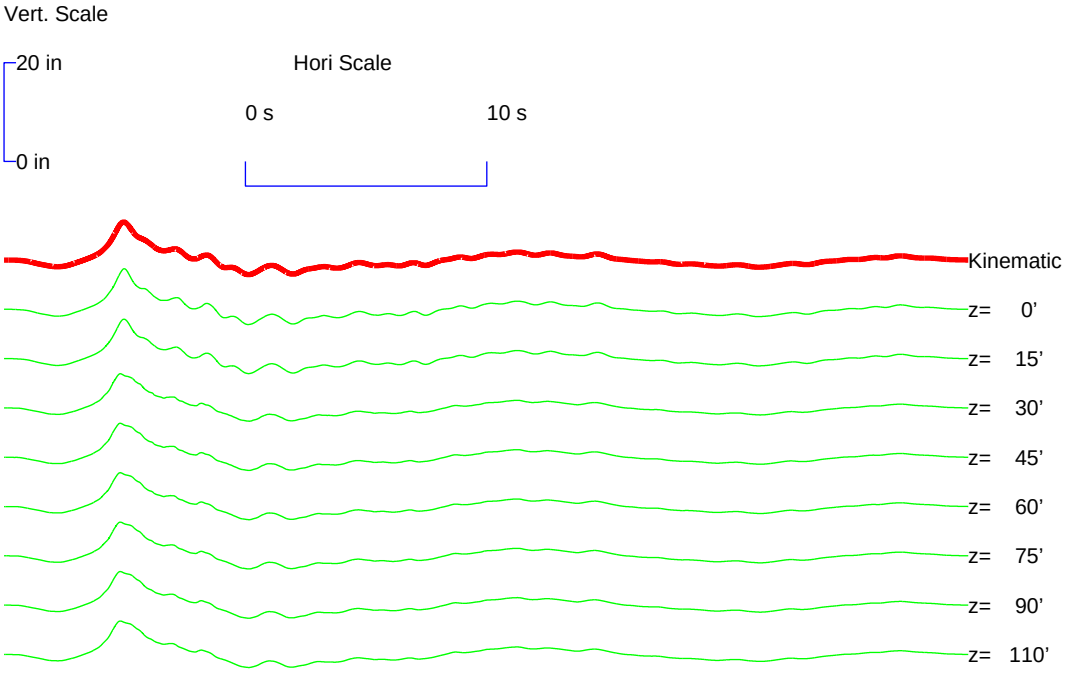



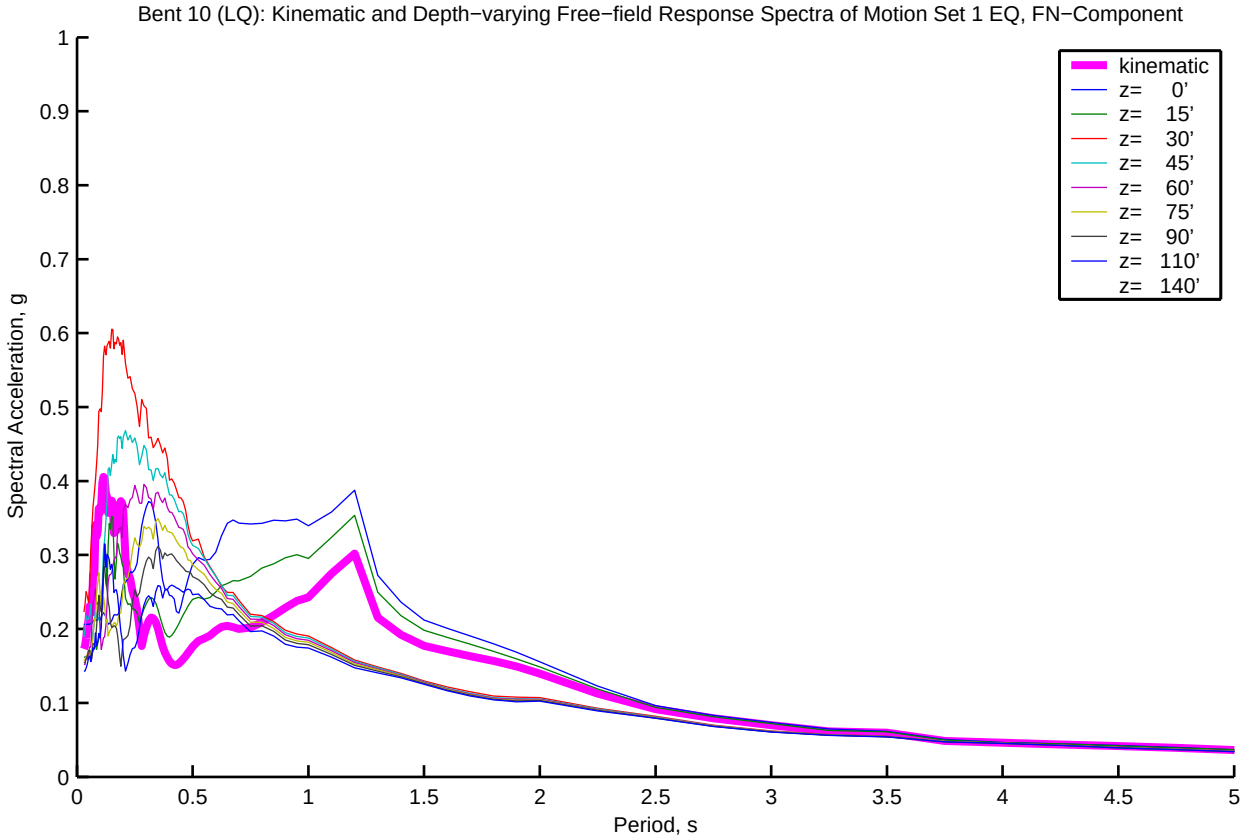

Bent 9 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

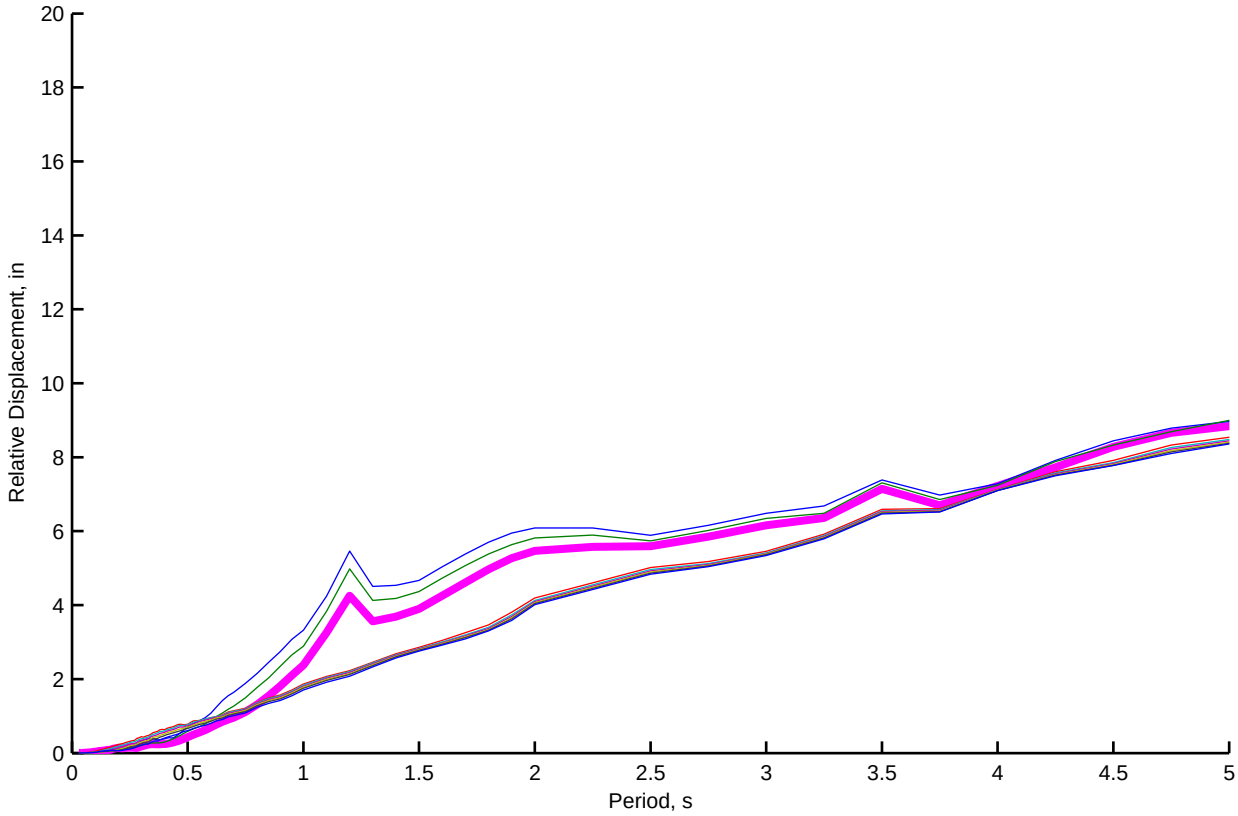

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 10 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FN−Component

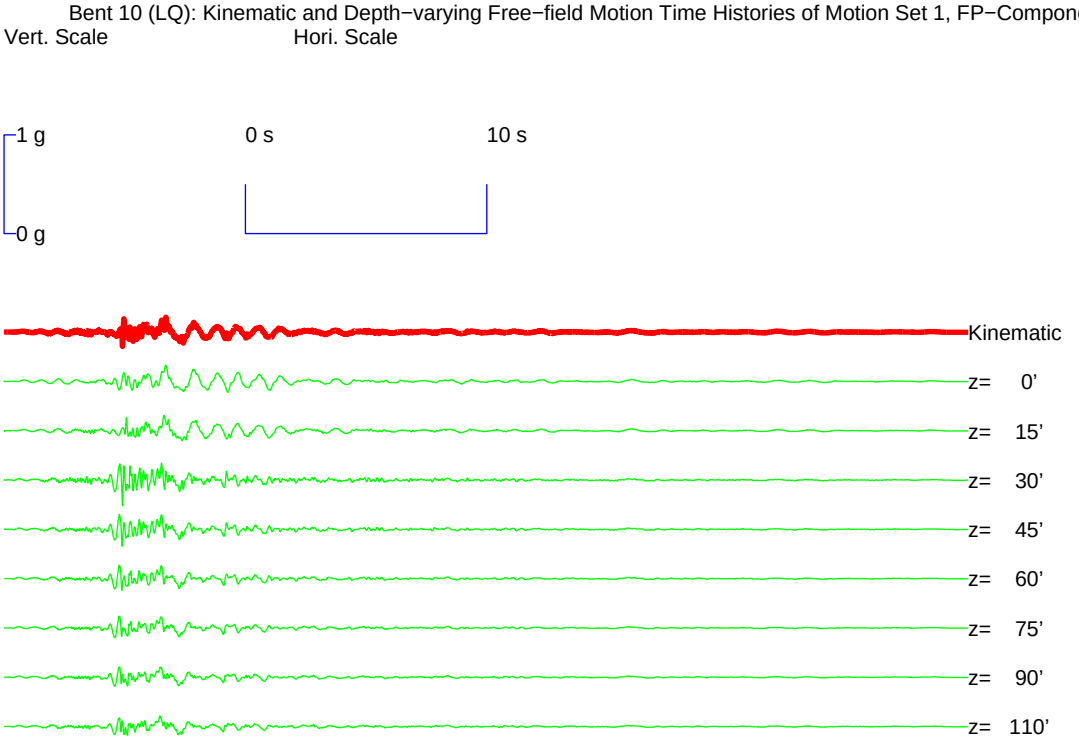


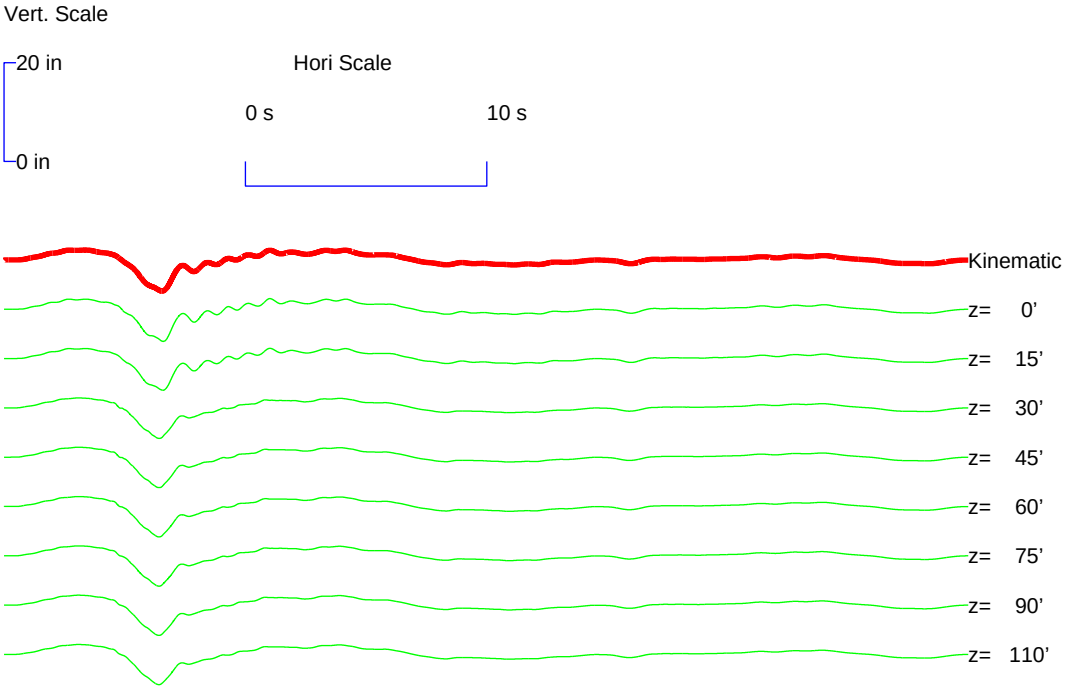



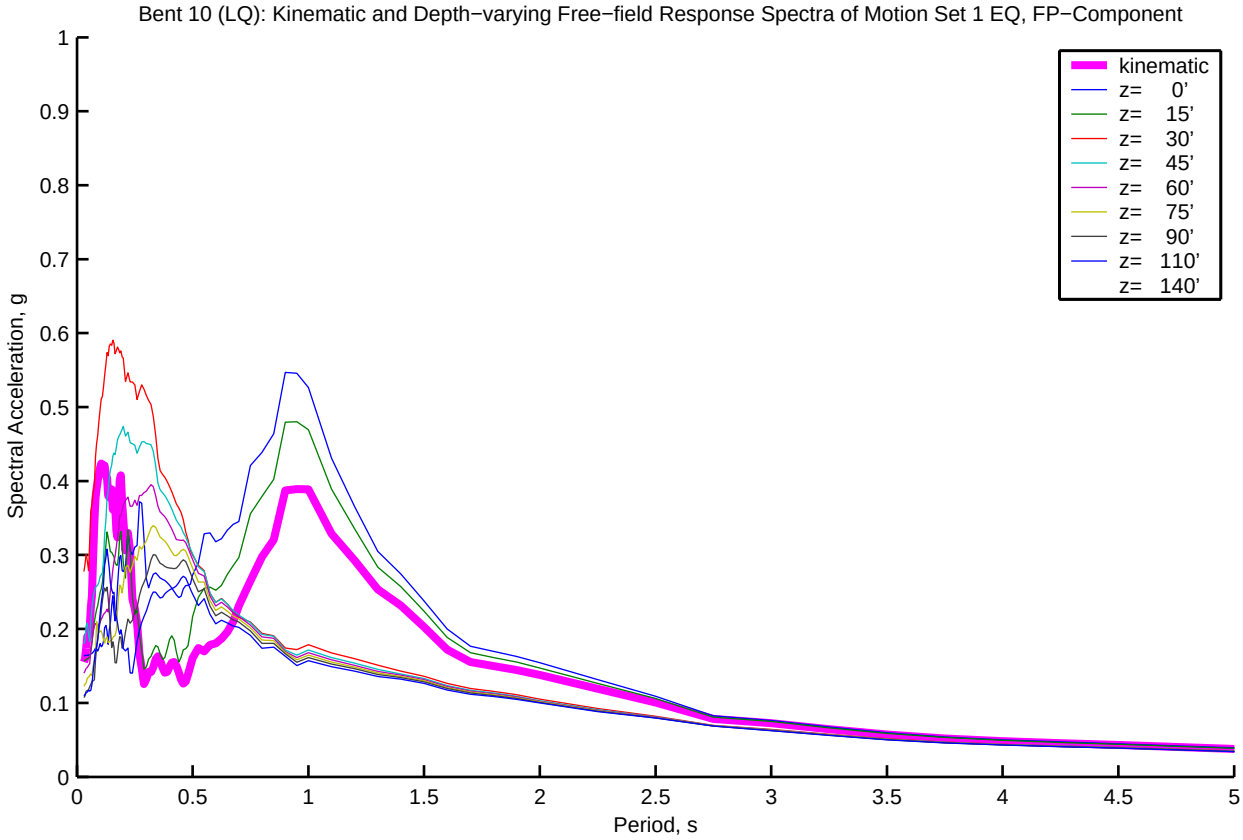

Bent 10 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

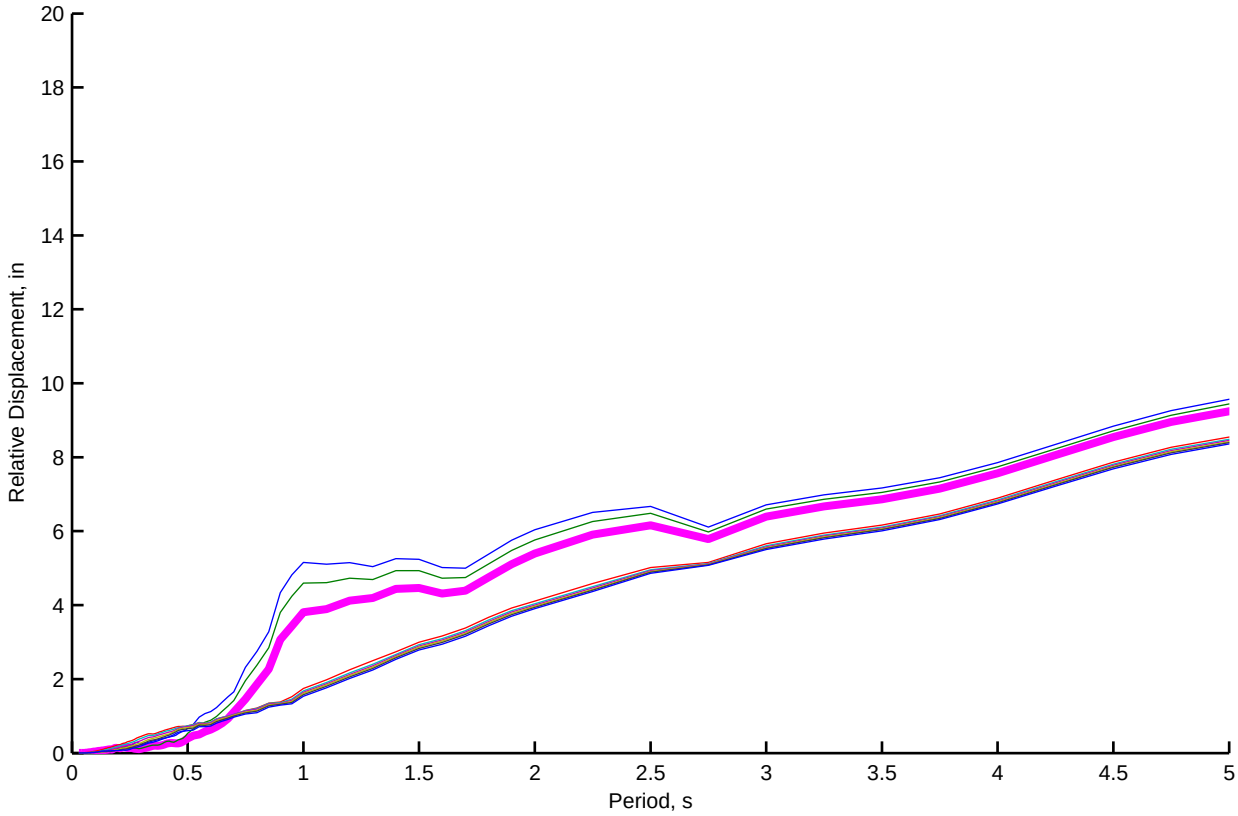

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 10 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 1, FP−Component

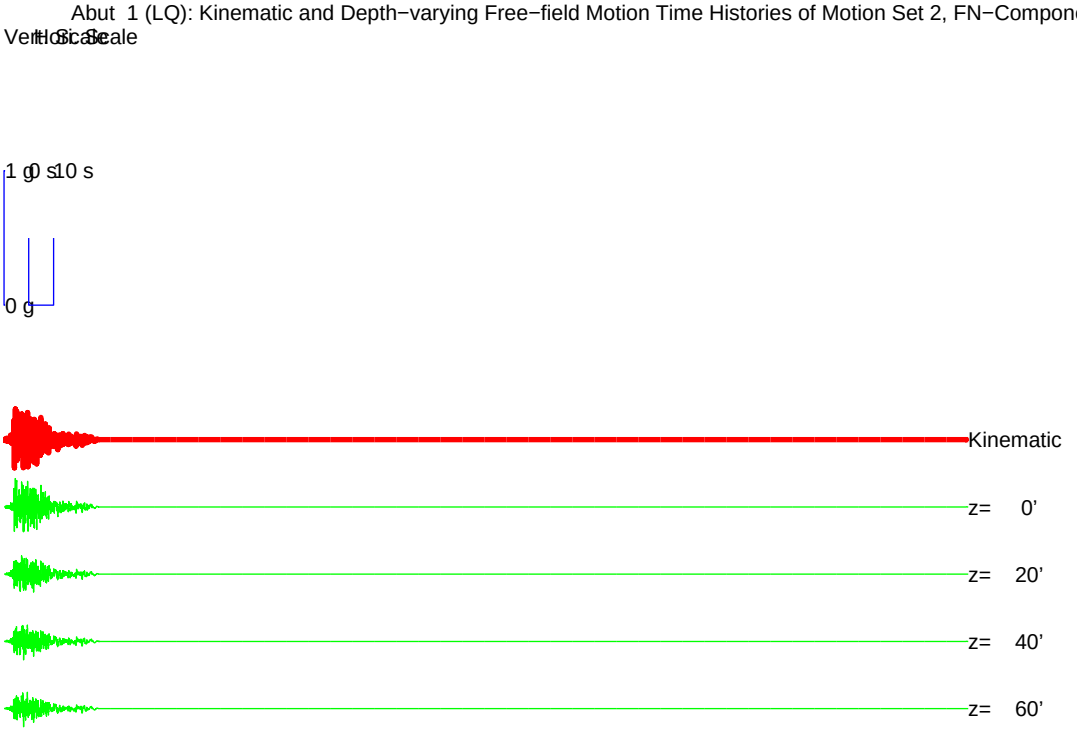


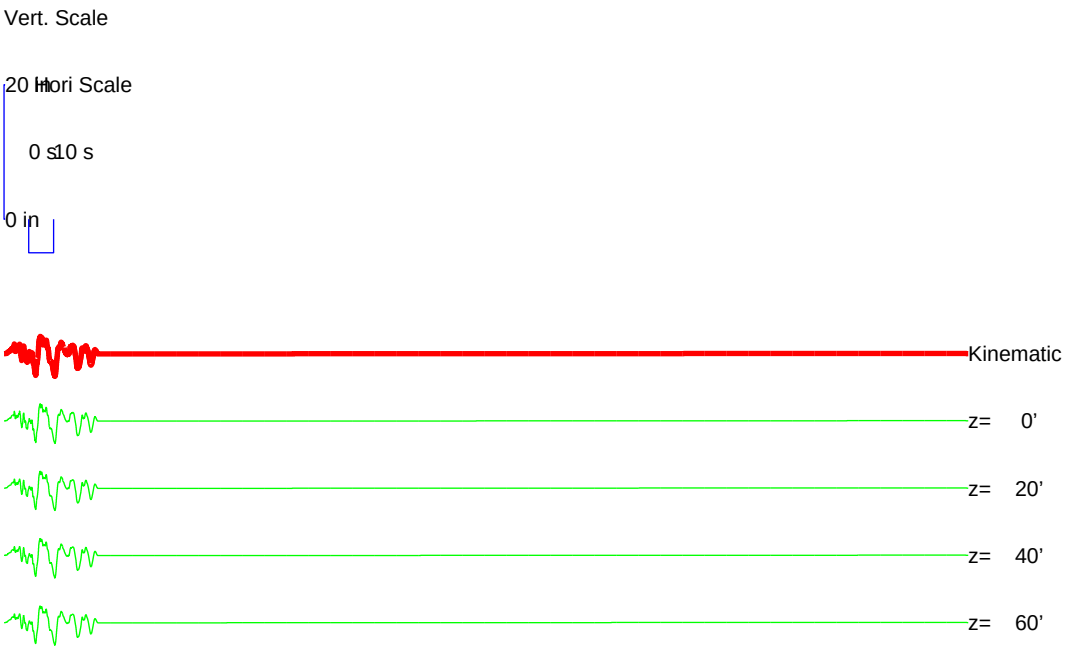



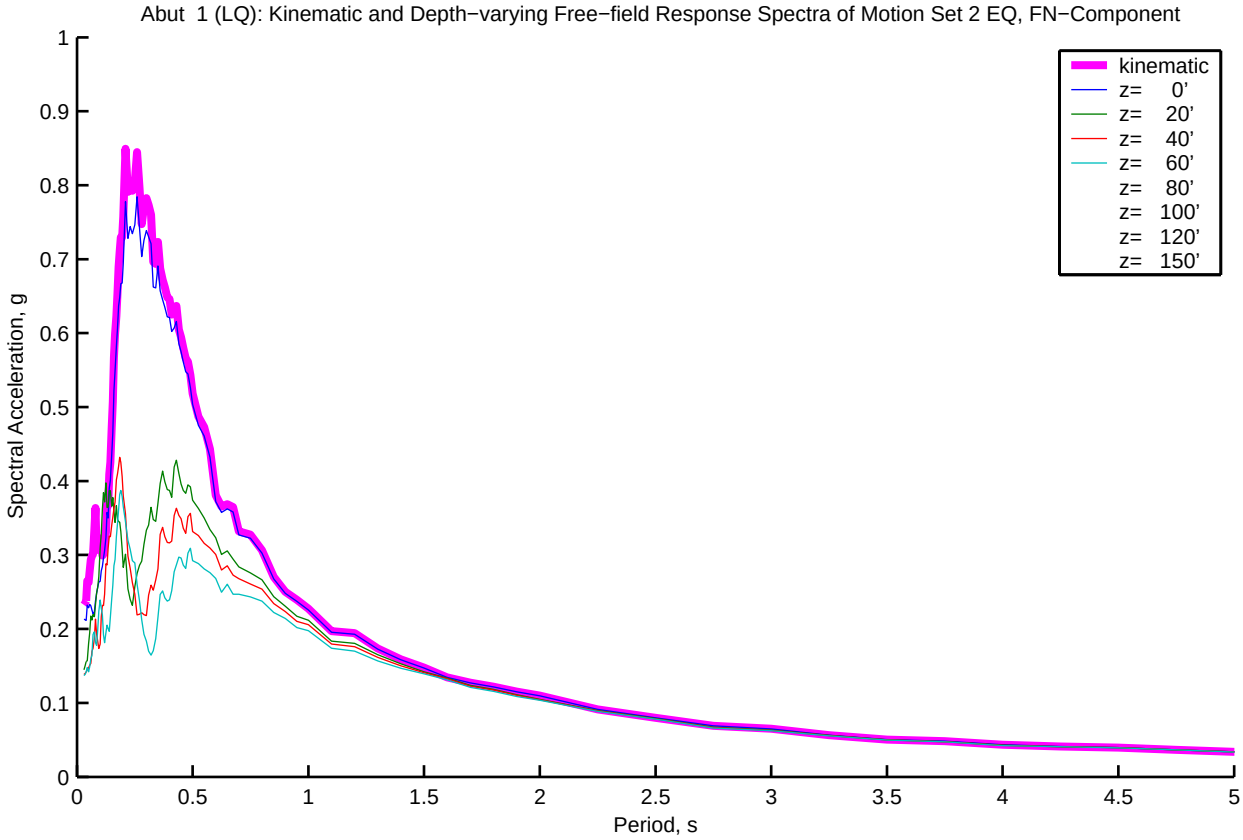

Bent 10 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 1 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

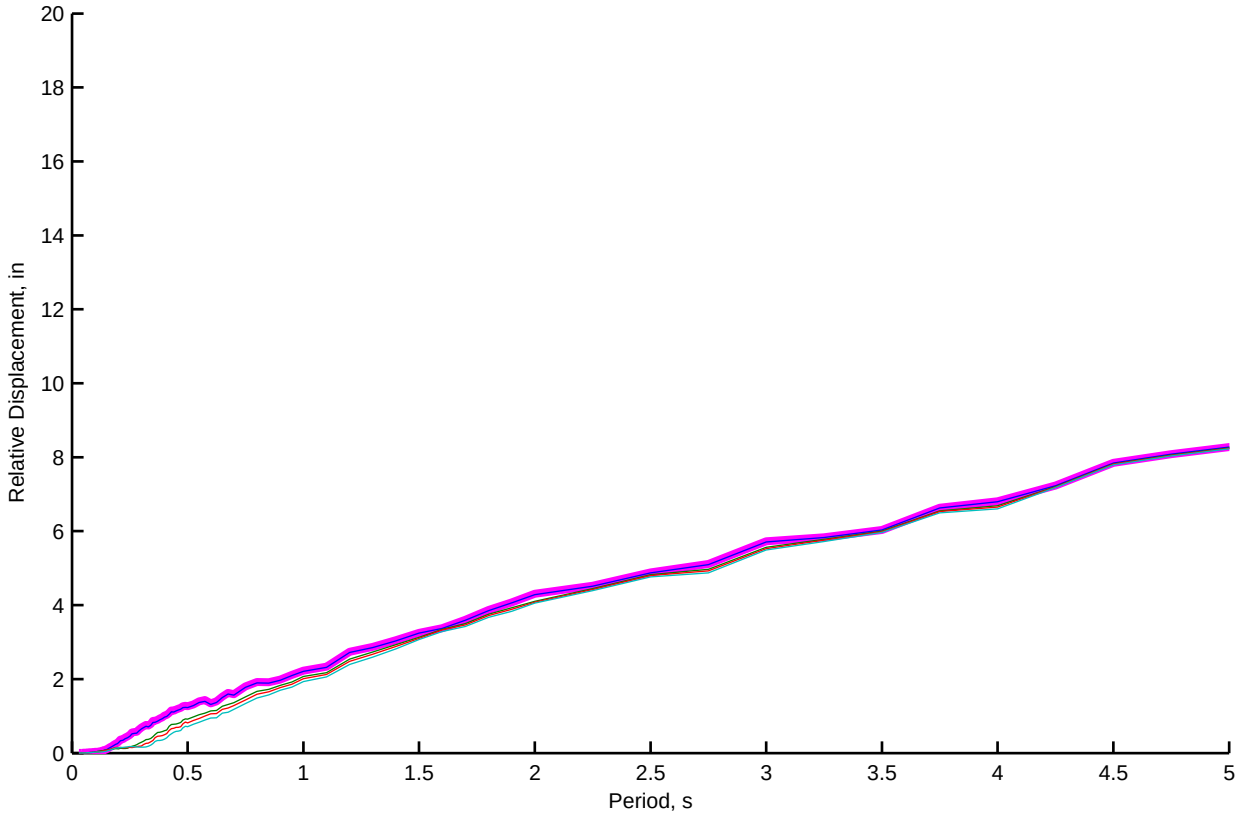

Relative Displacement, in
Period, s

Abut 1 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

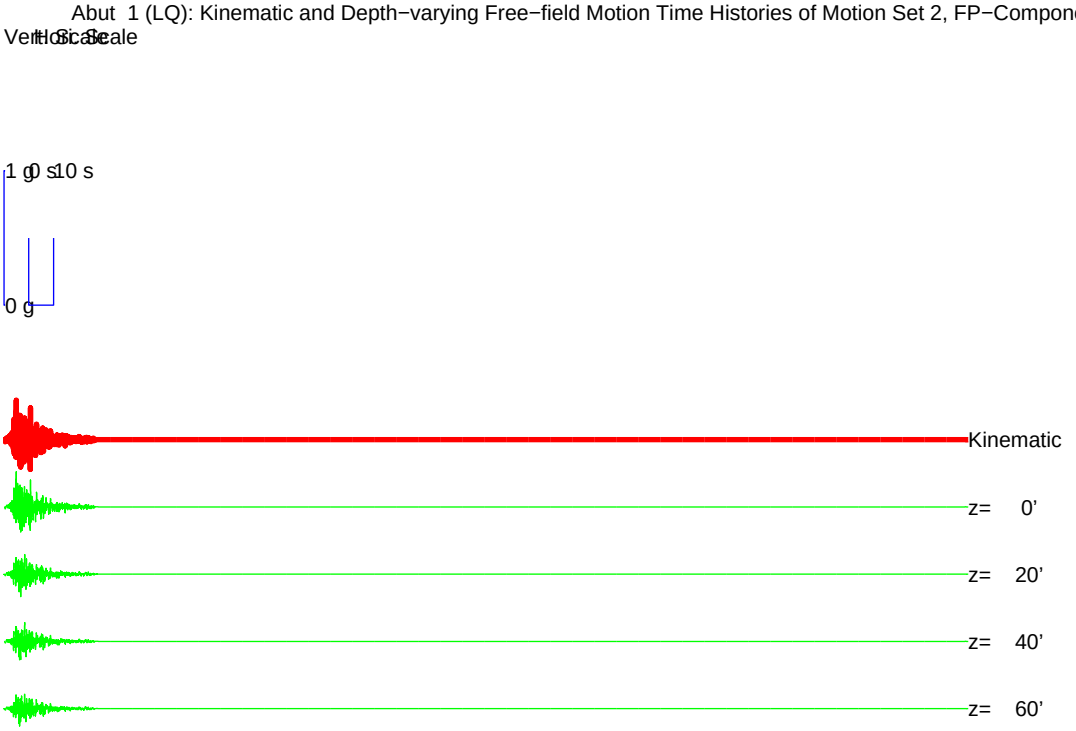


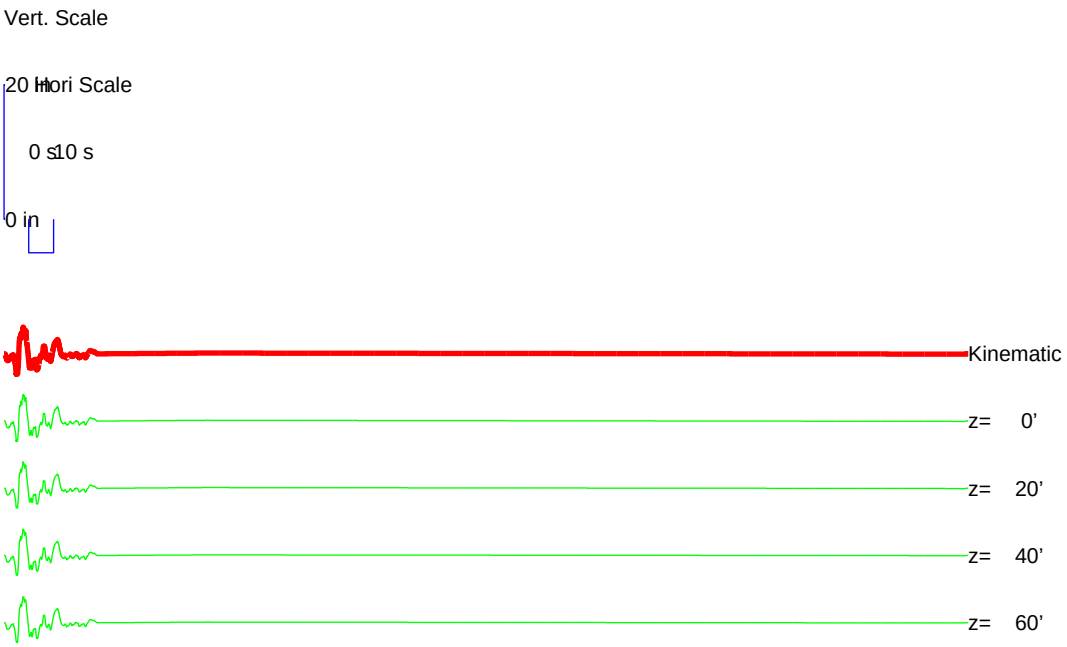



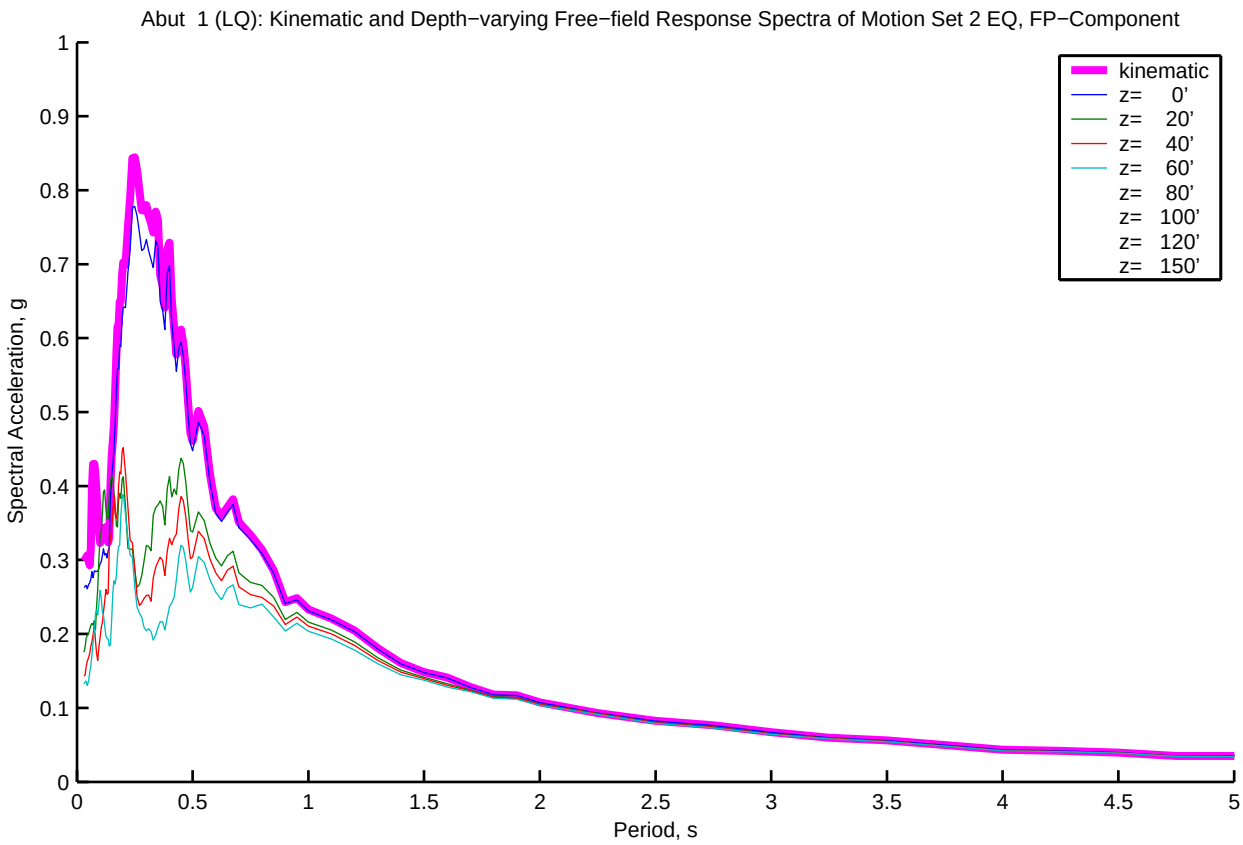

Abut 1 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

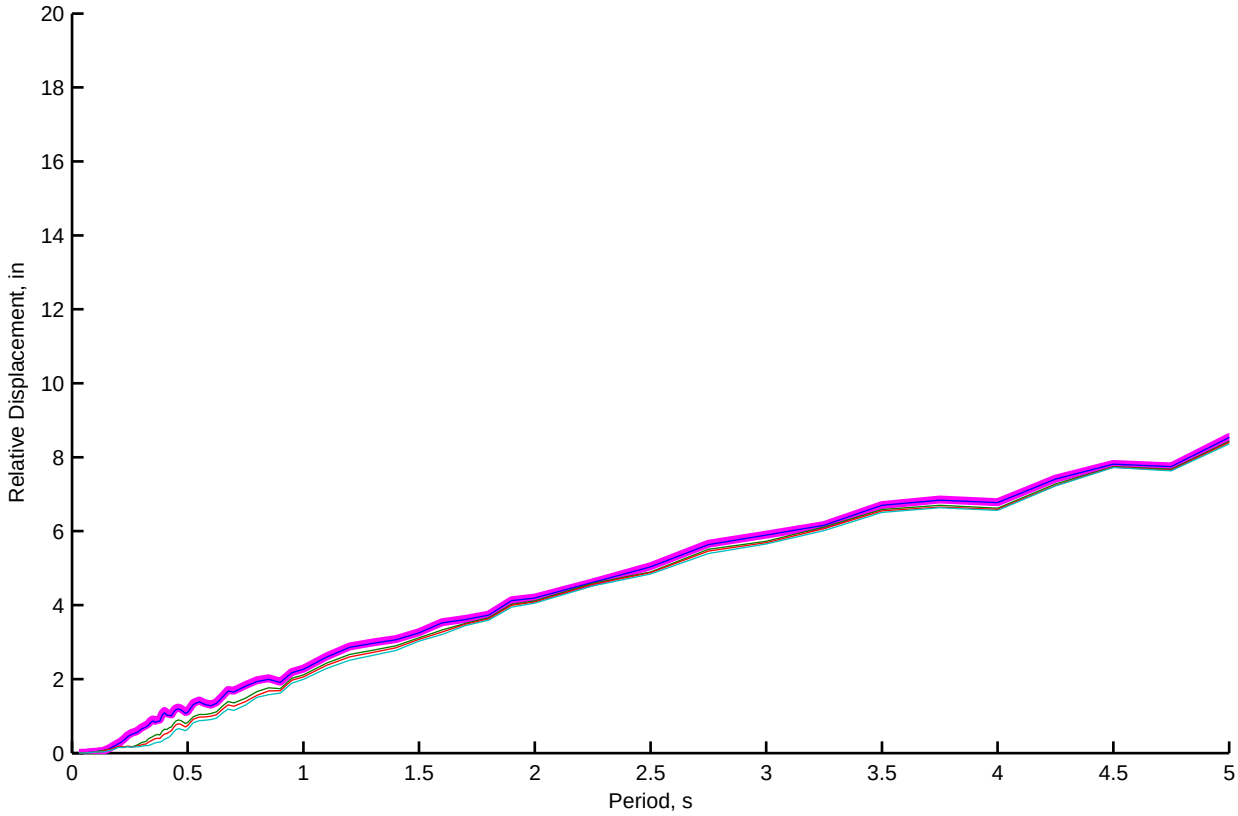

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 1 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

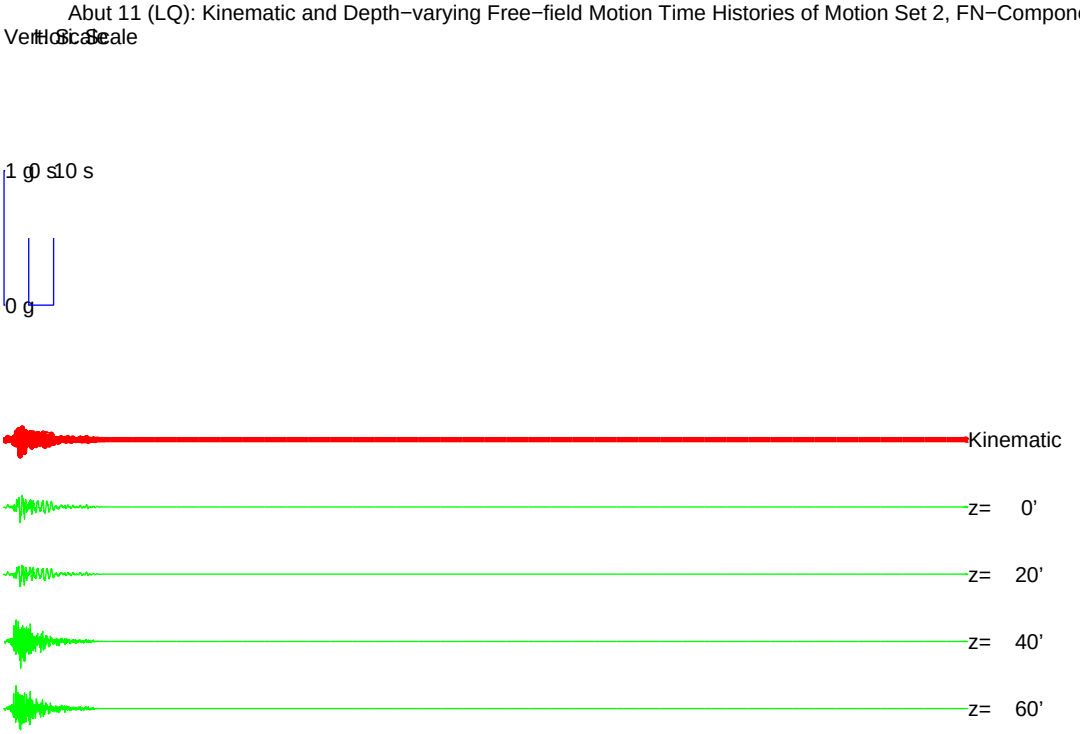


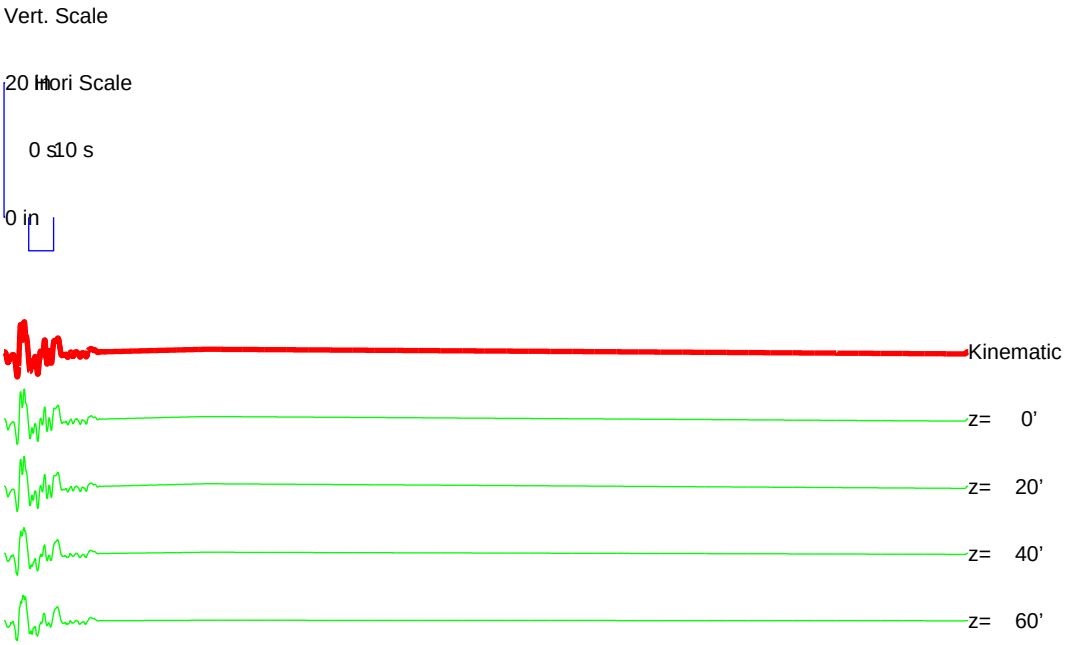



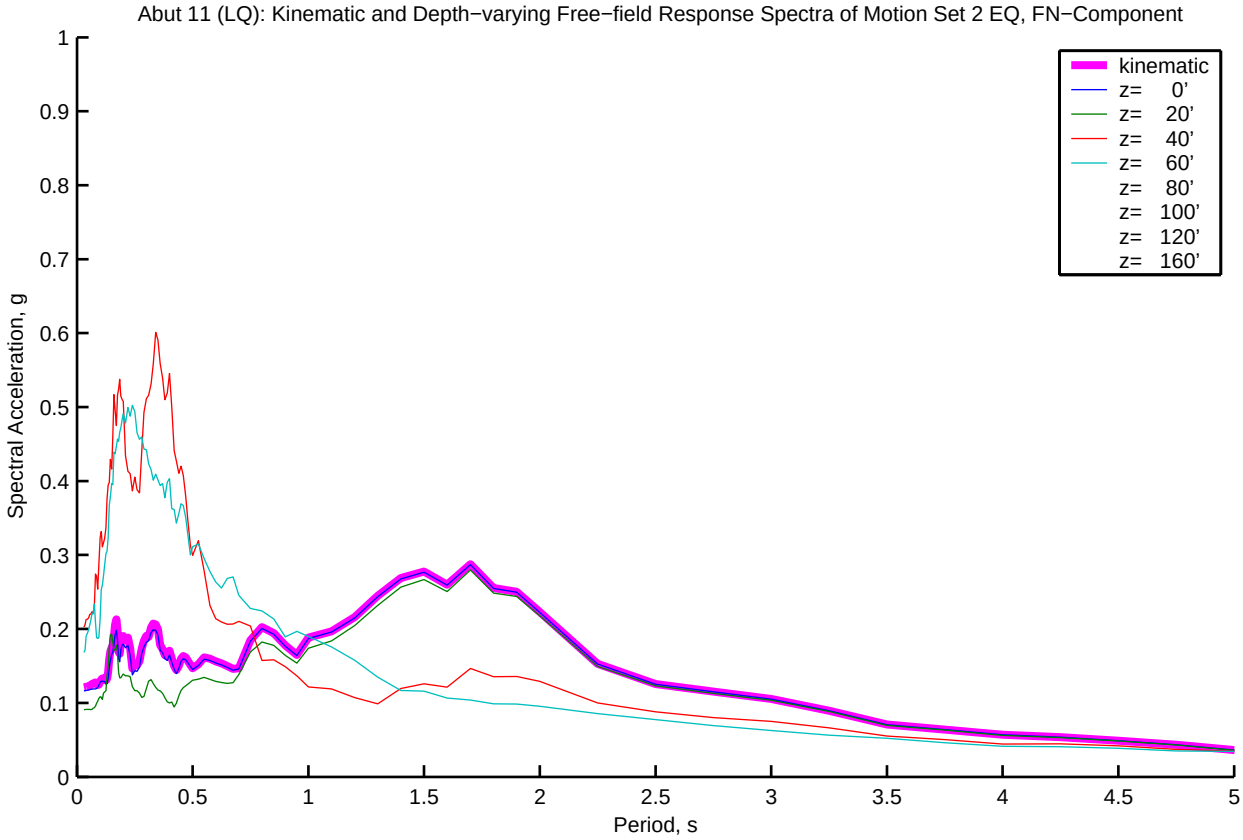

Abut 1 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

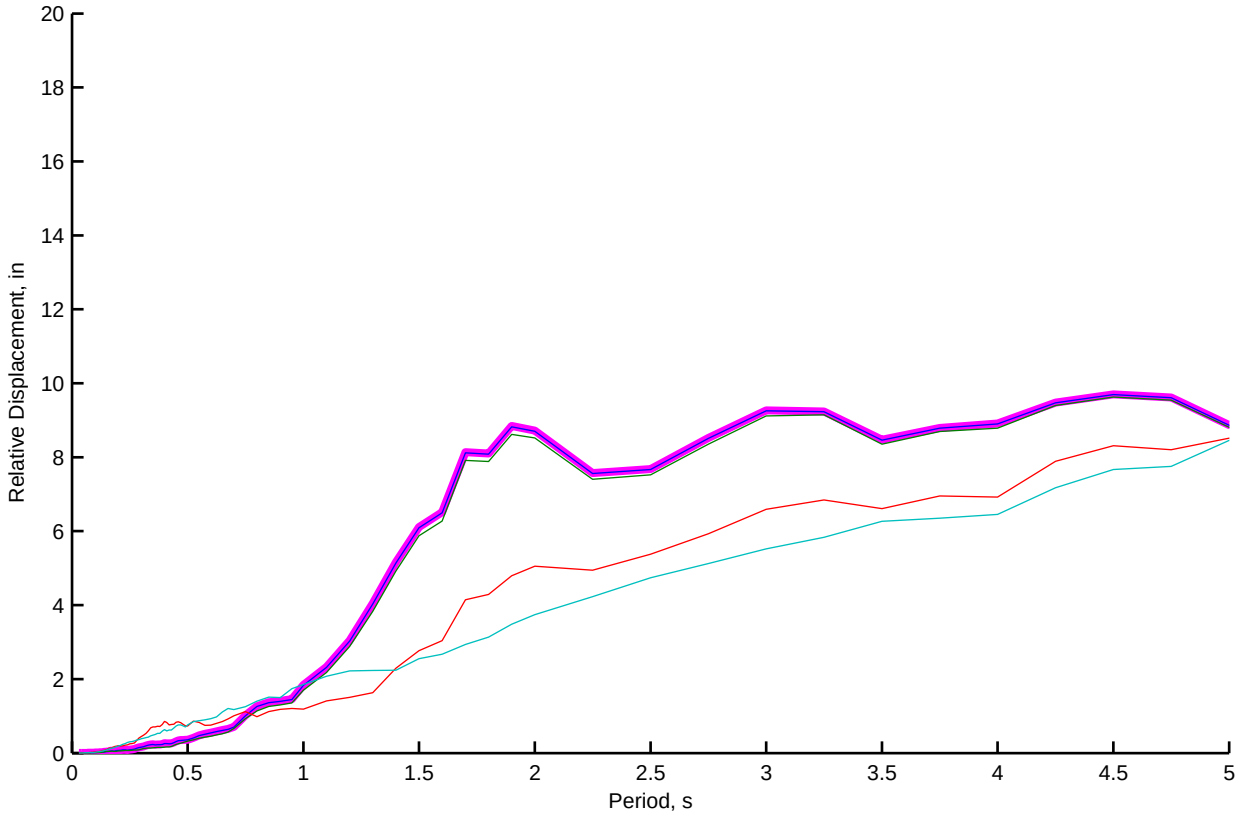

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

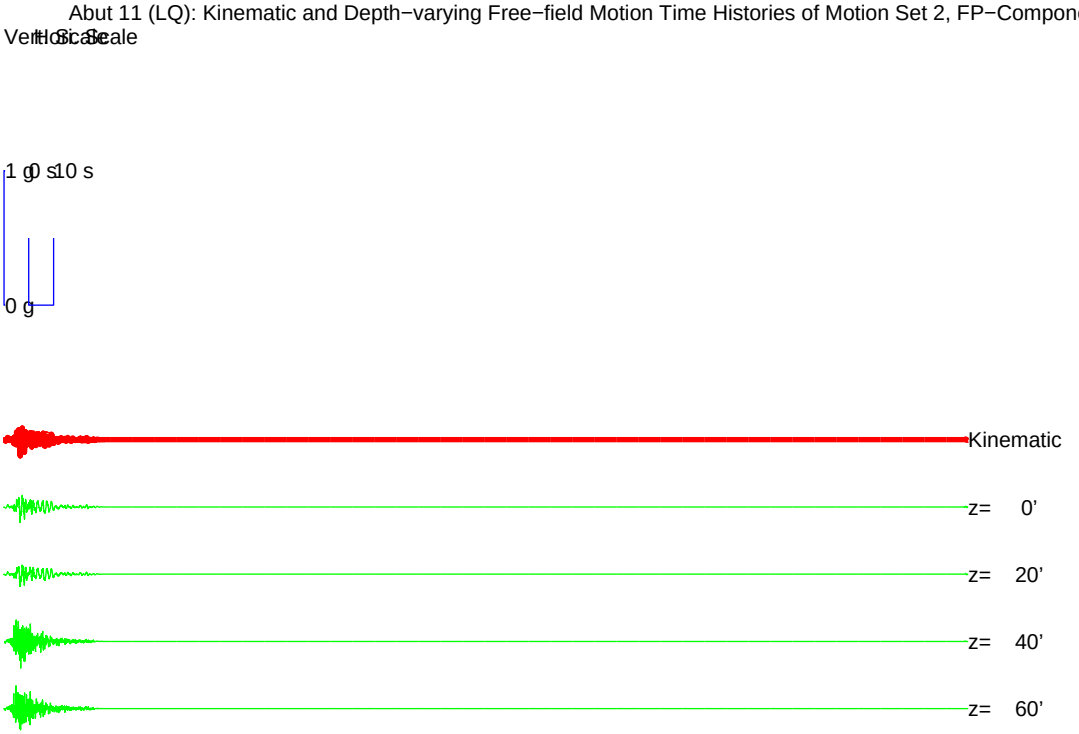


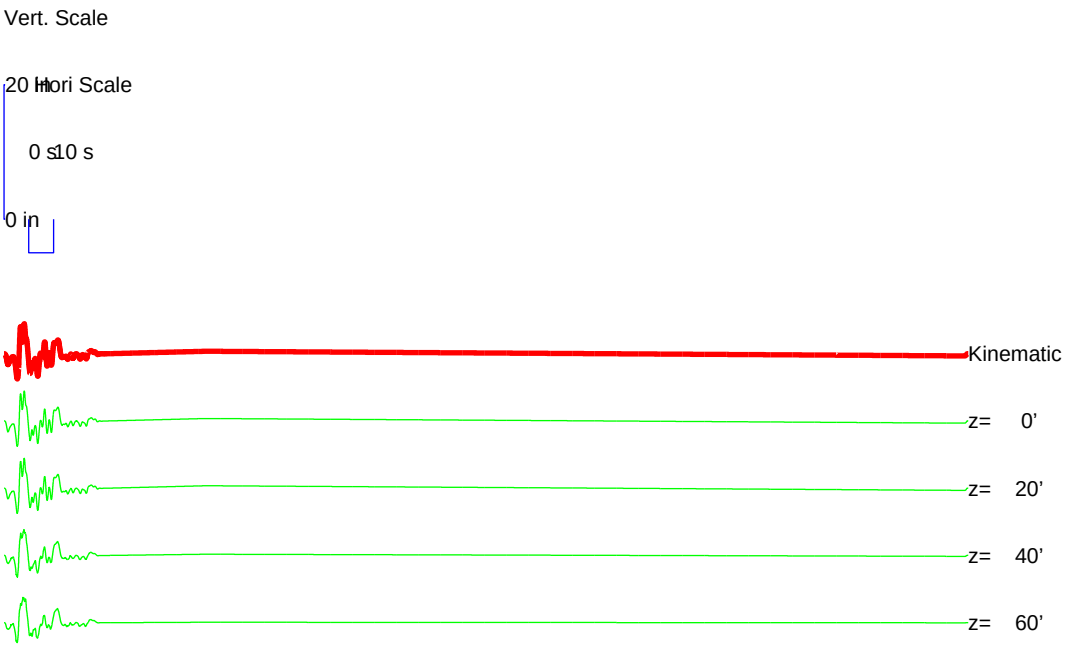



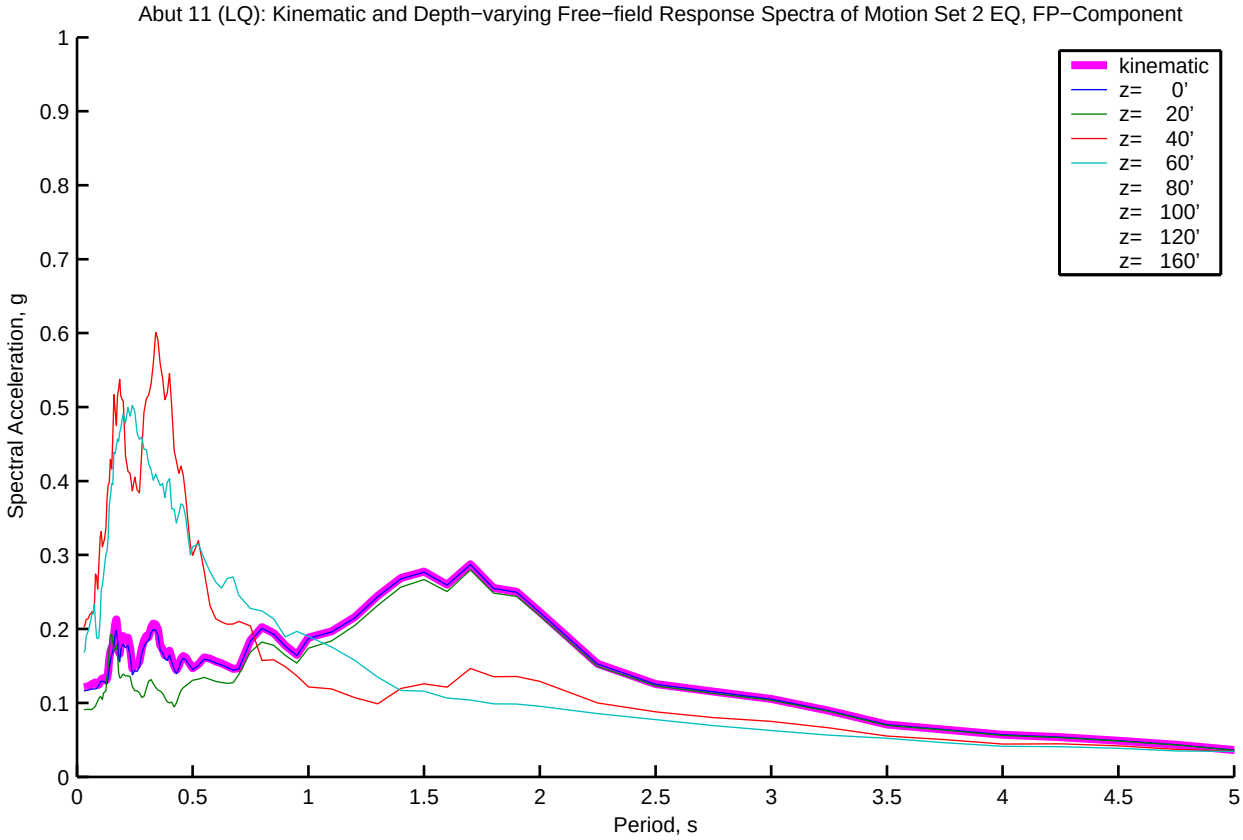

Abut 11 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

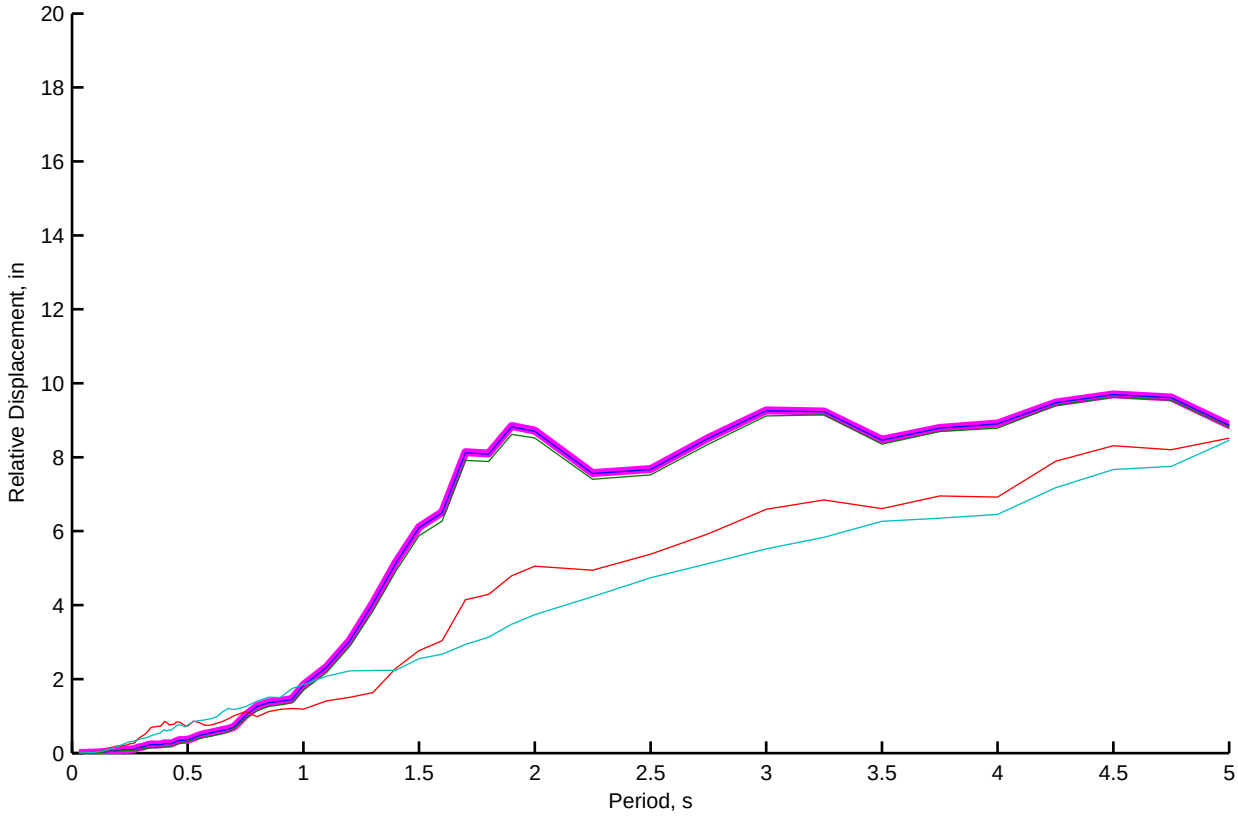

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

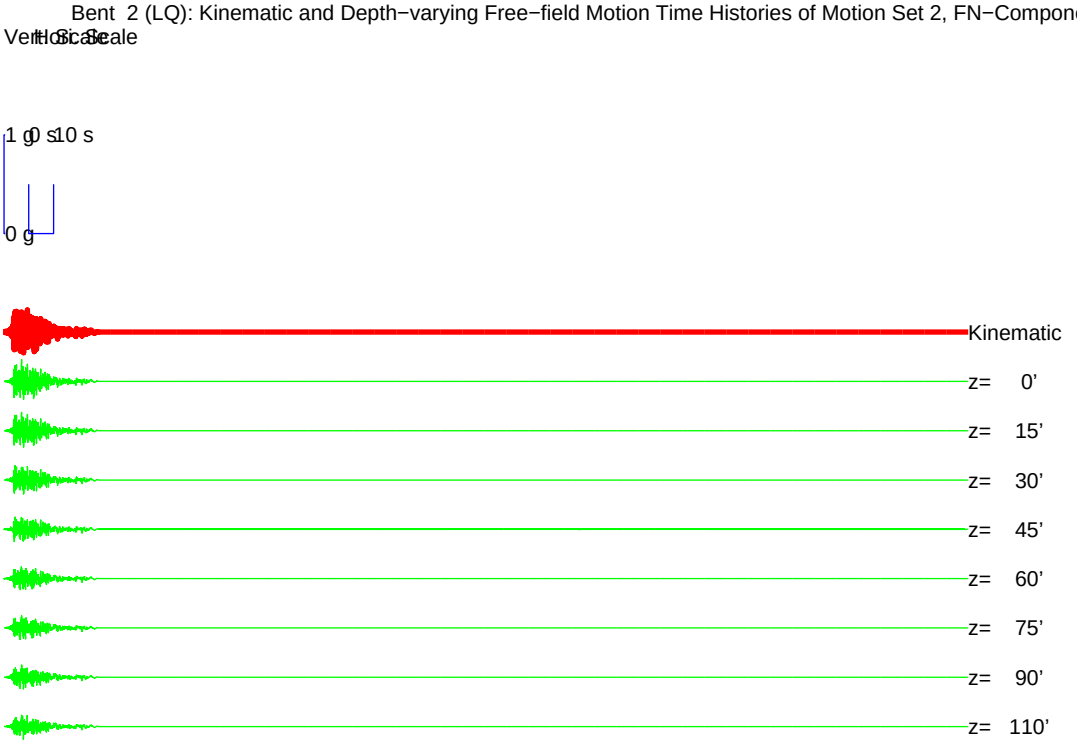


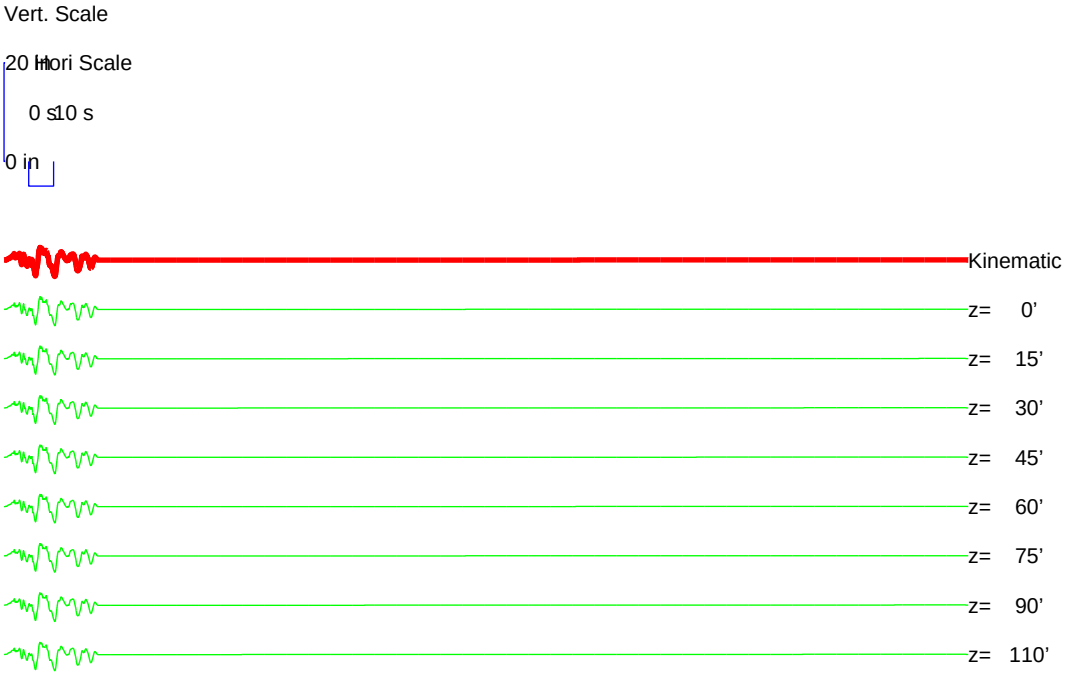



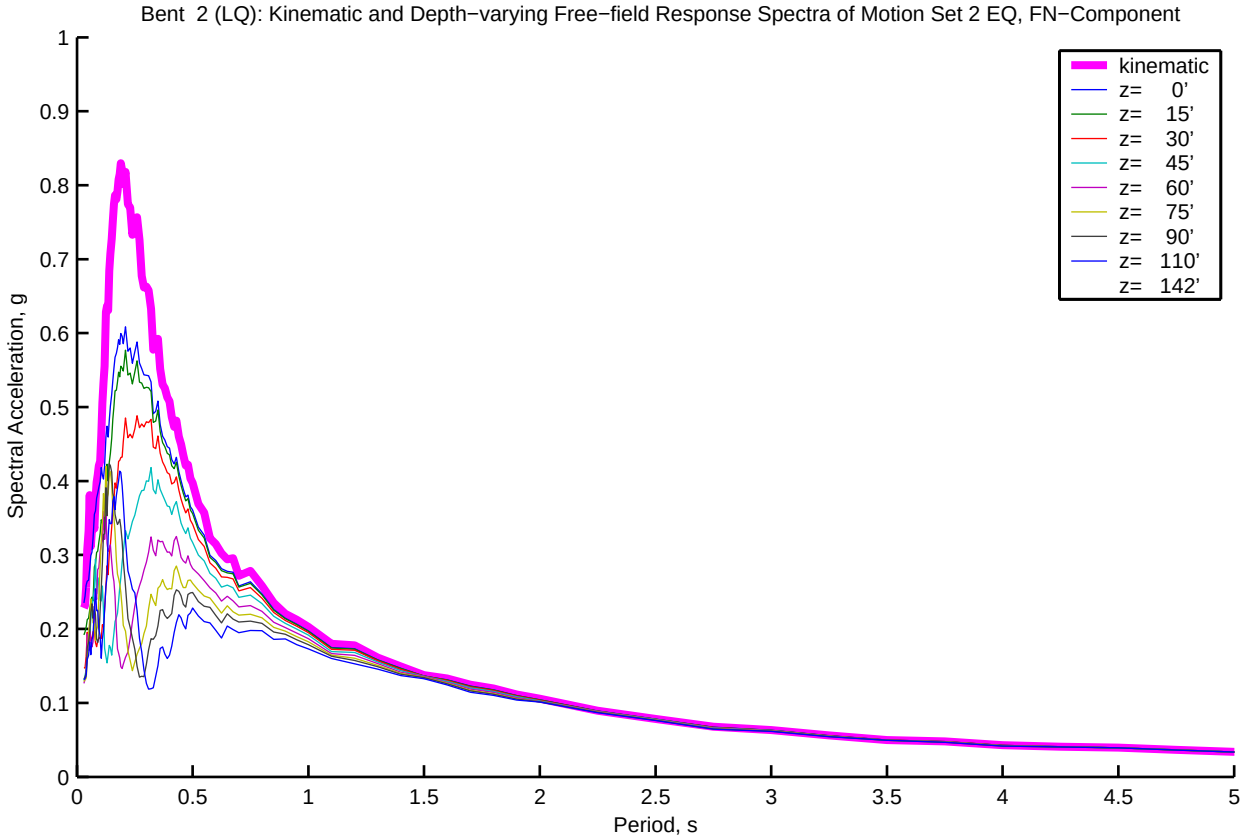

Abut 11 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

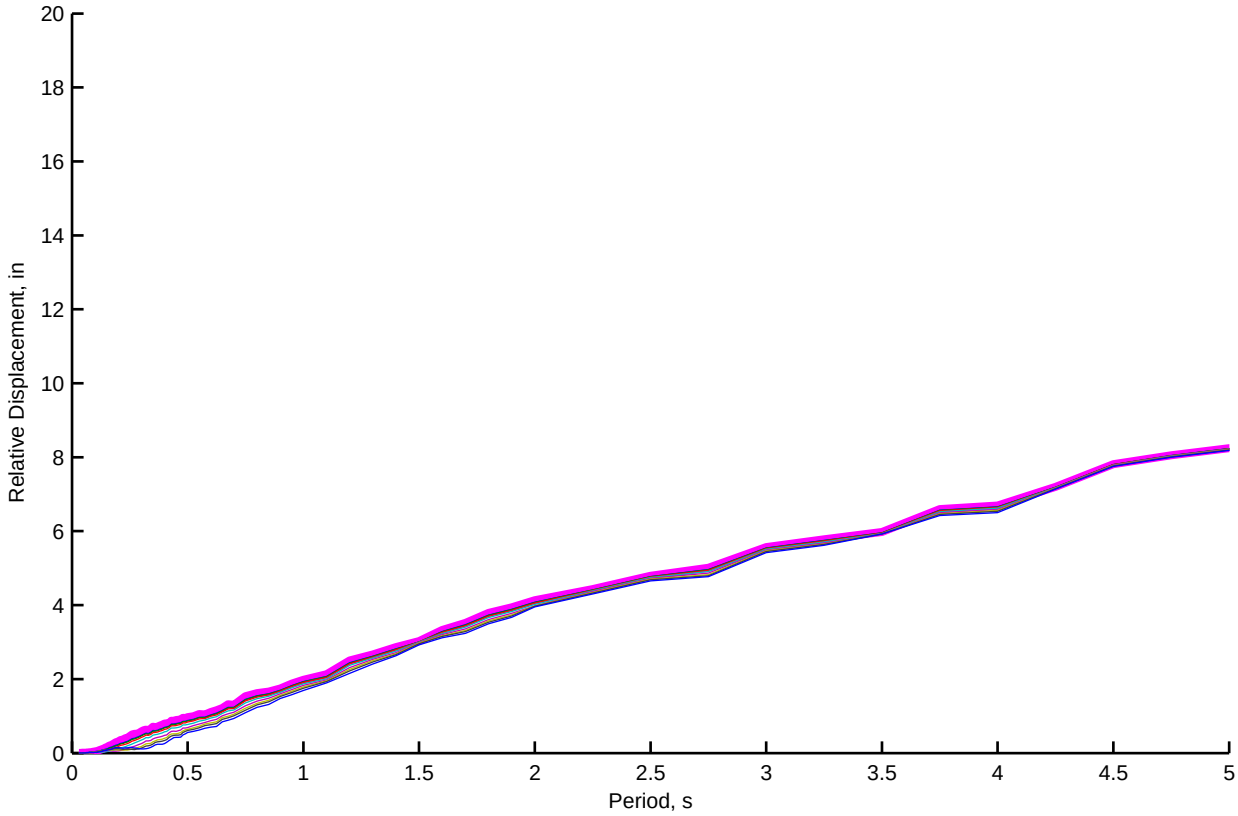

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

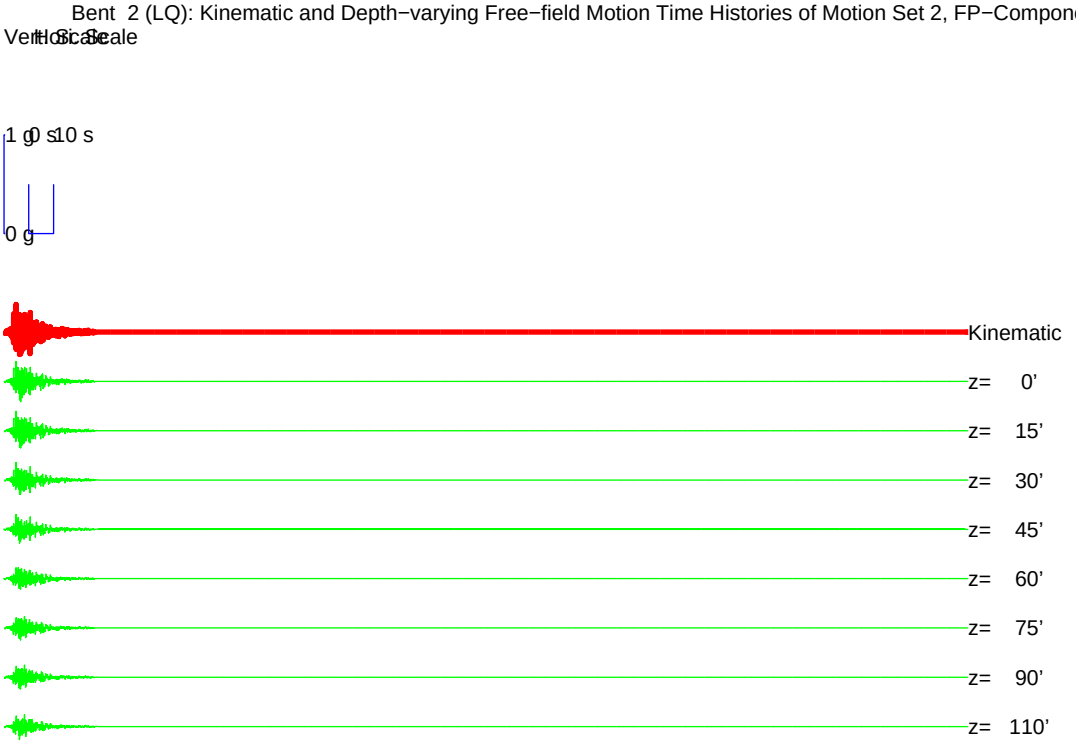


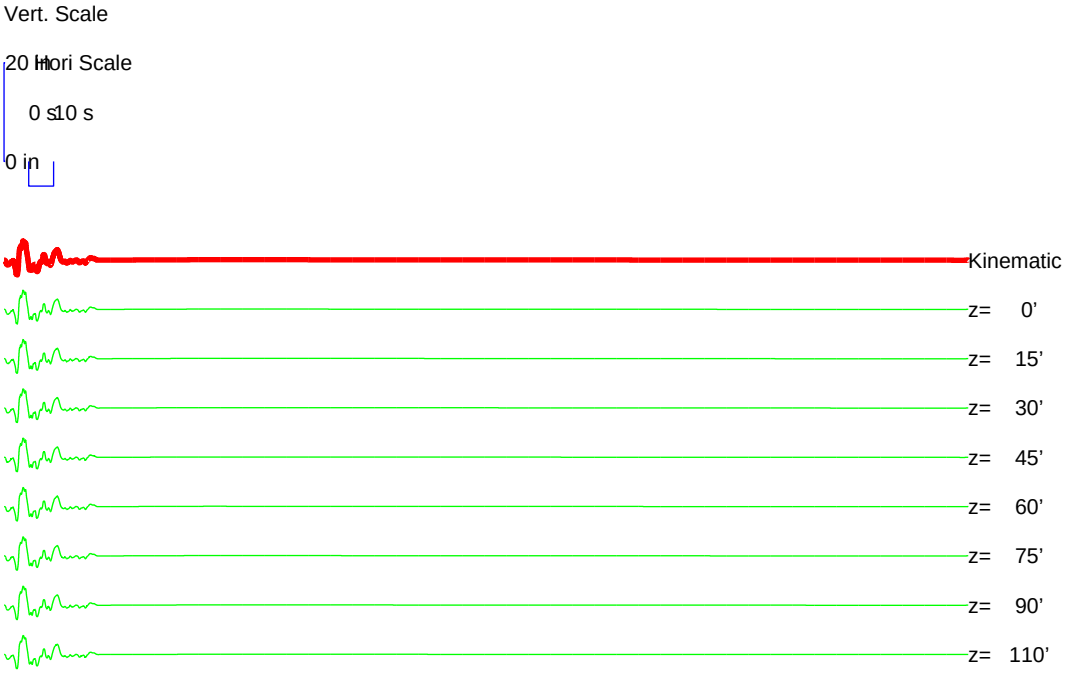



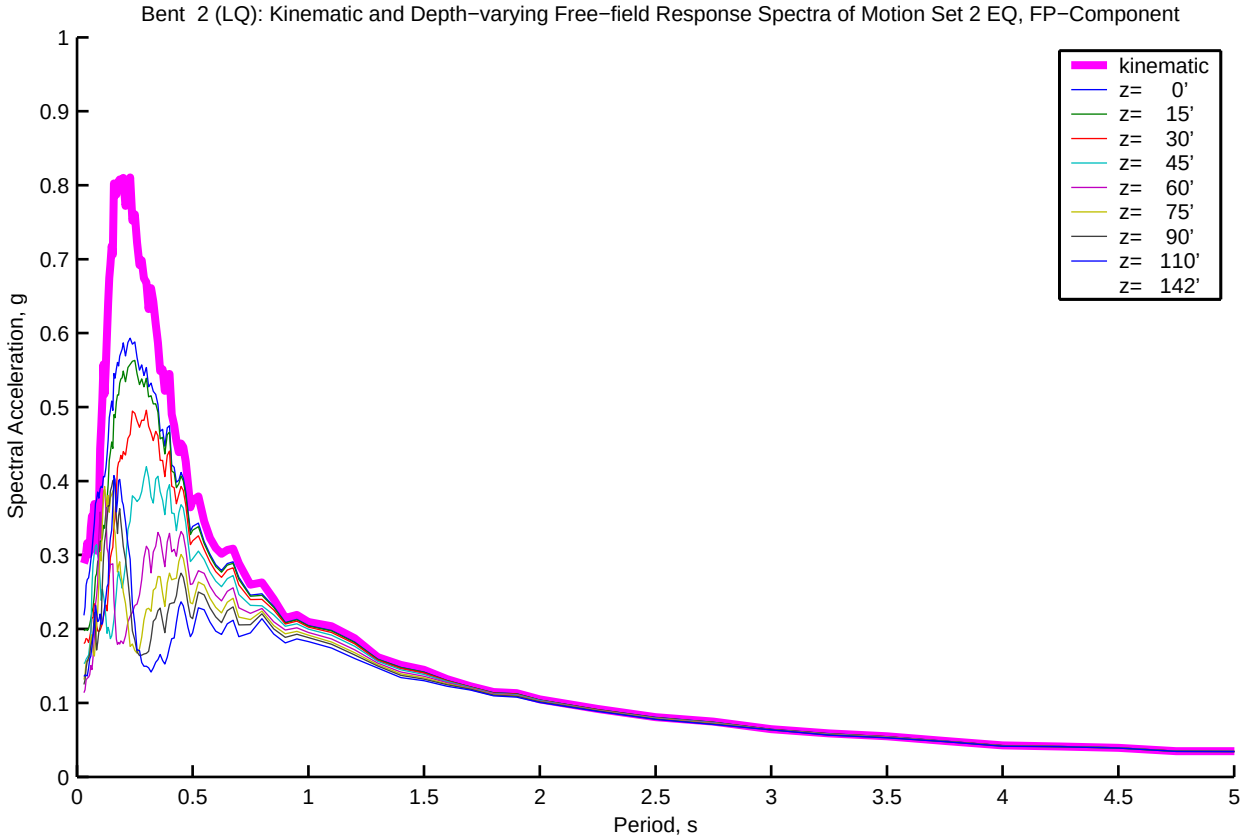

Bent 2 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

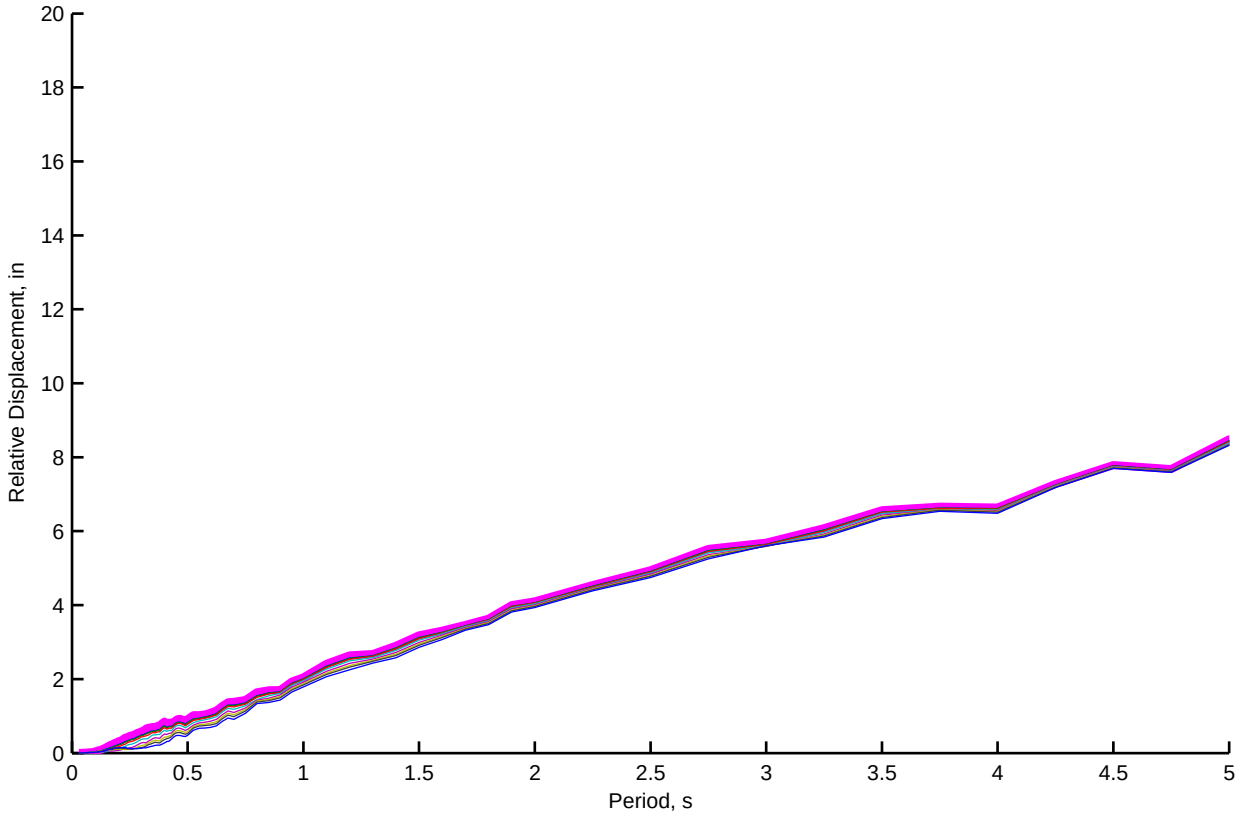

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

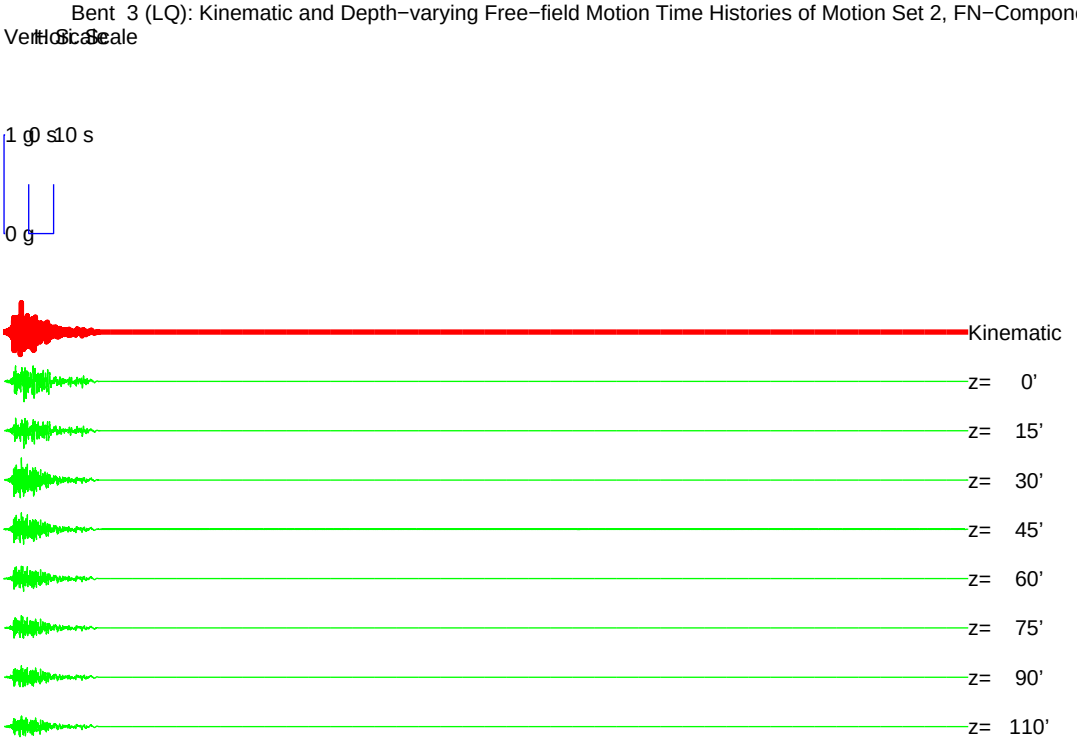


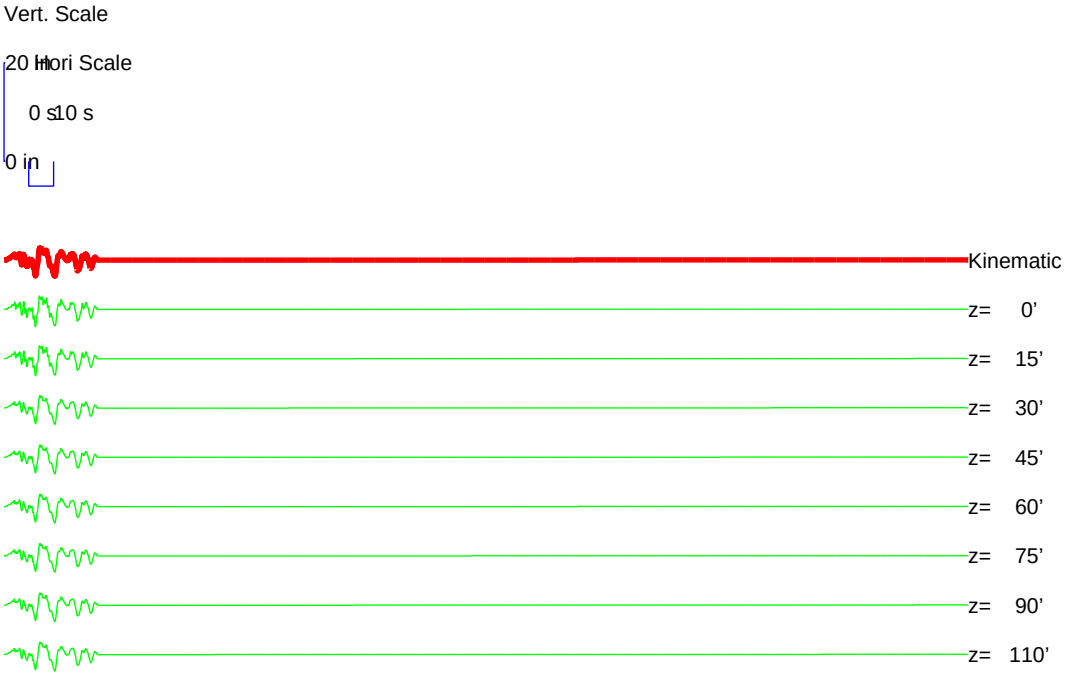



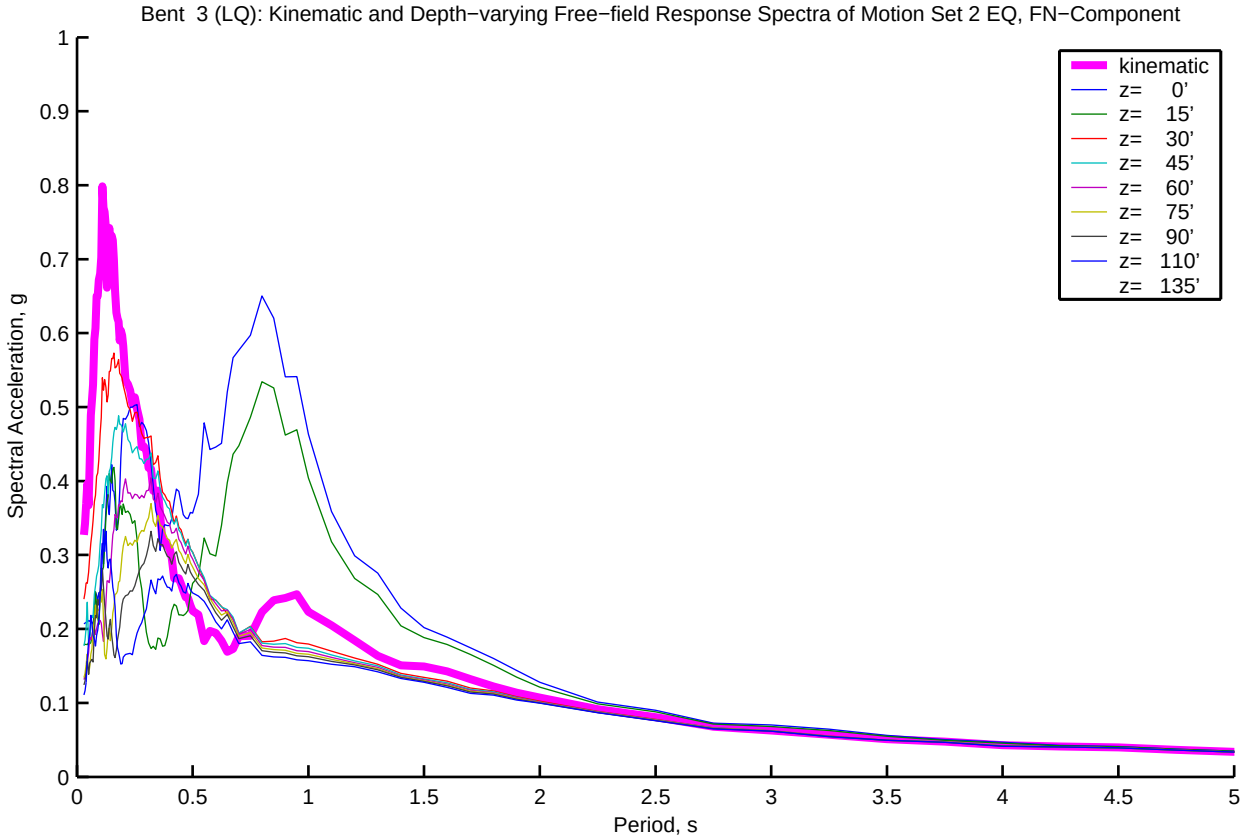

Bent 2 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

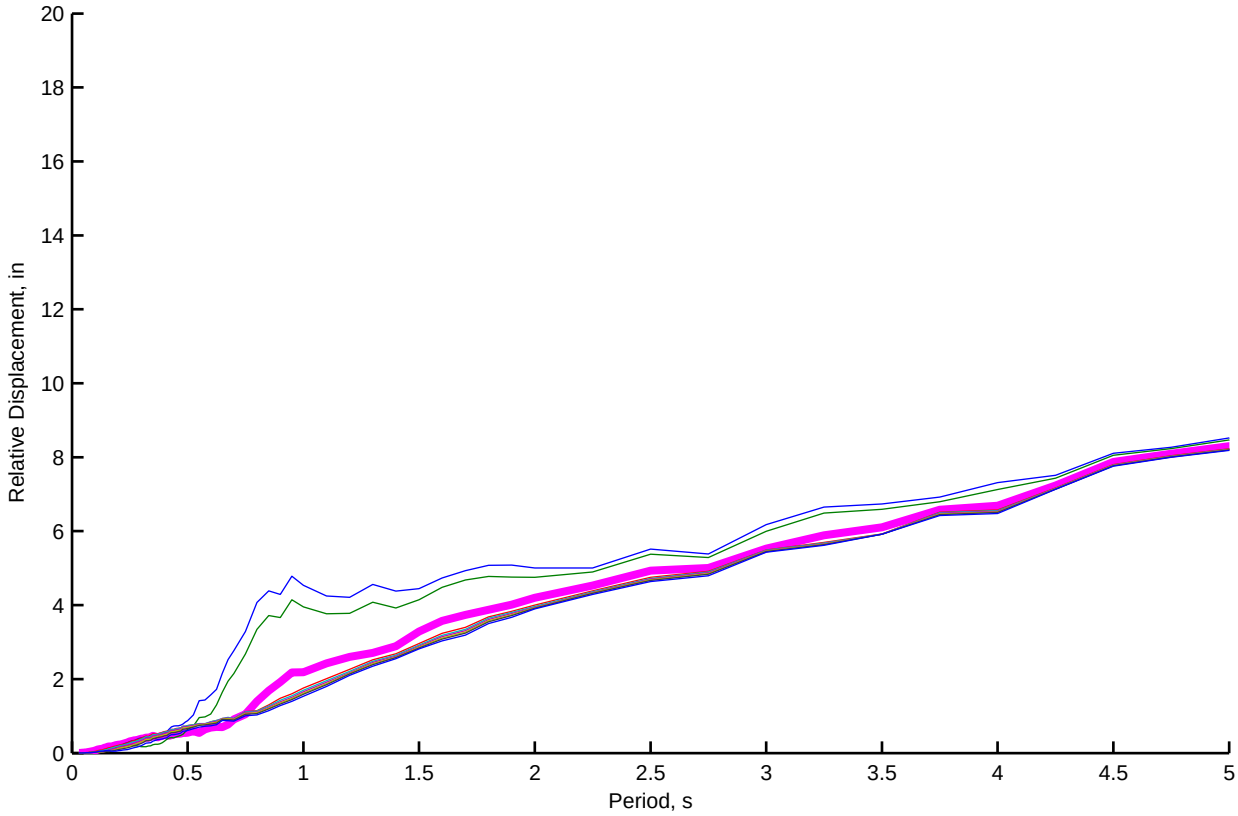

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 3 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

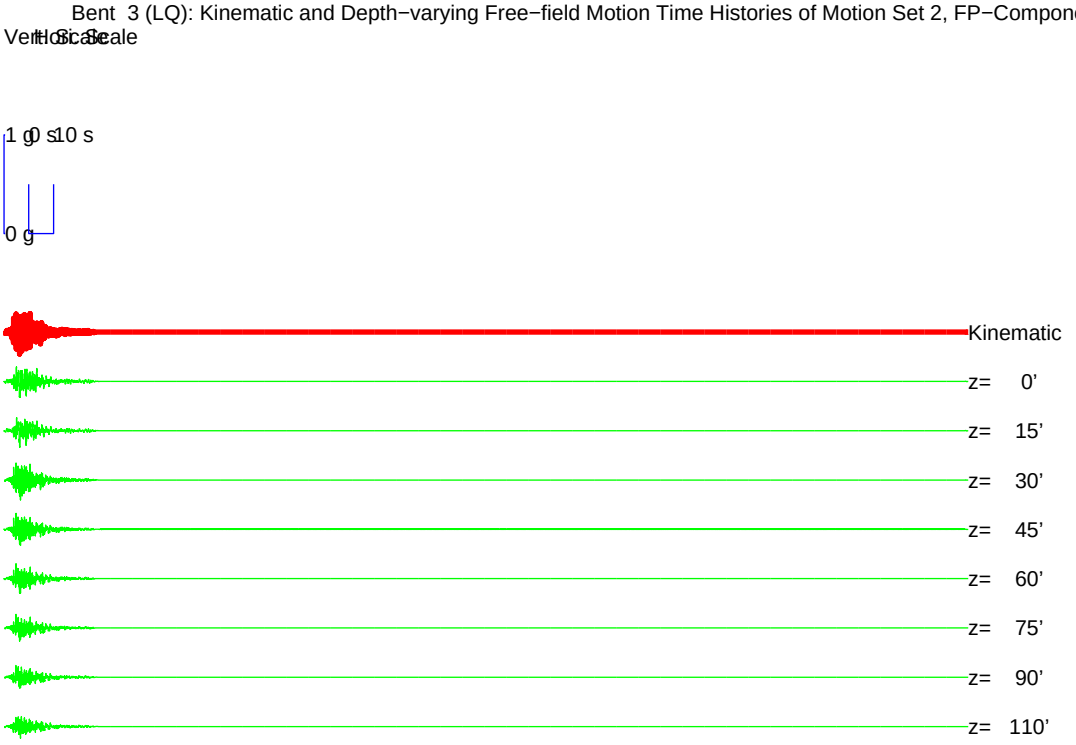


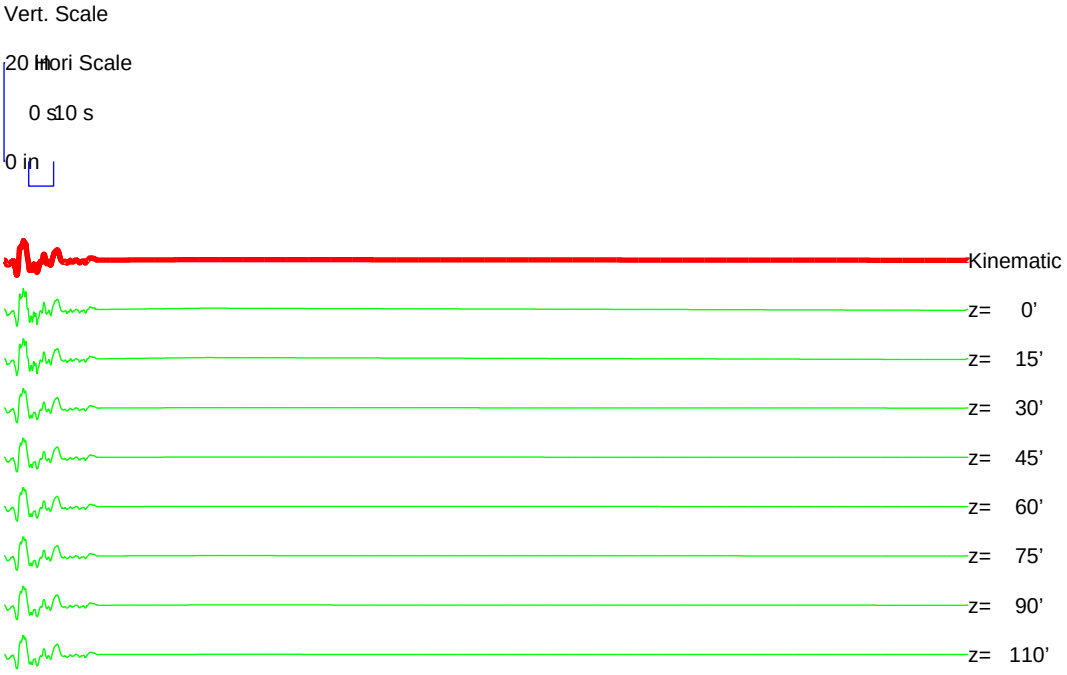



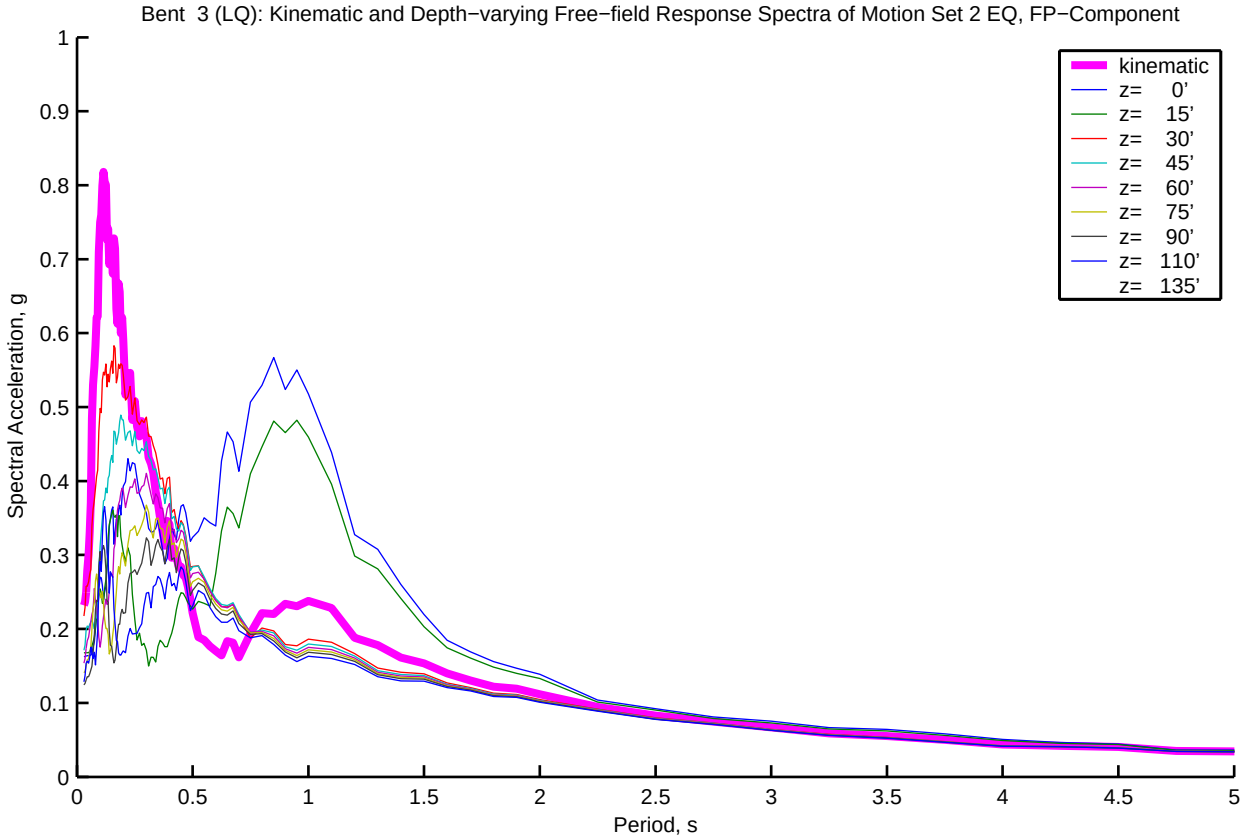

Bent 3 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

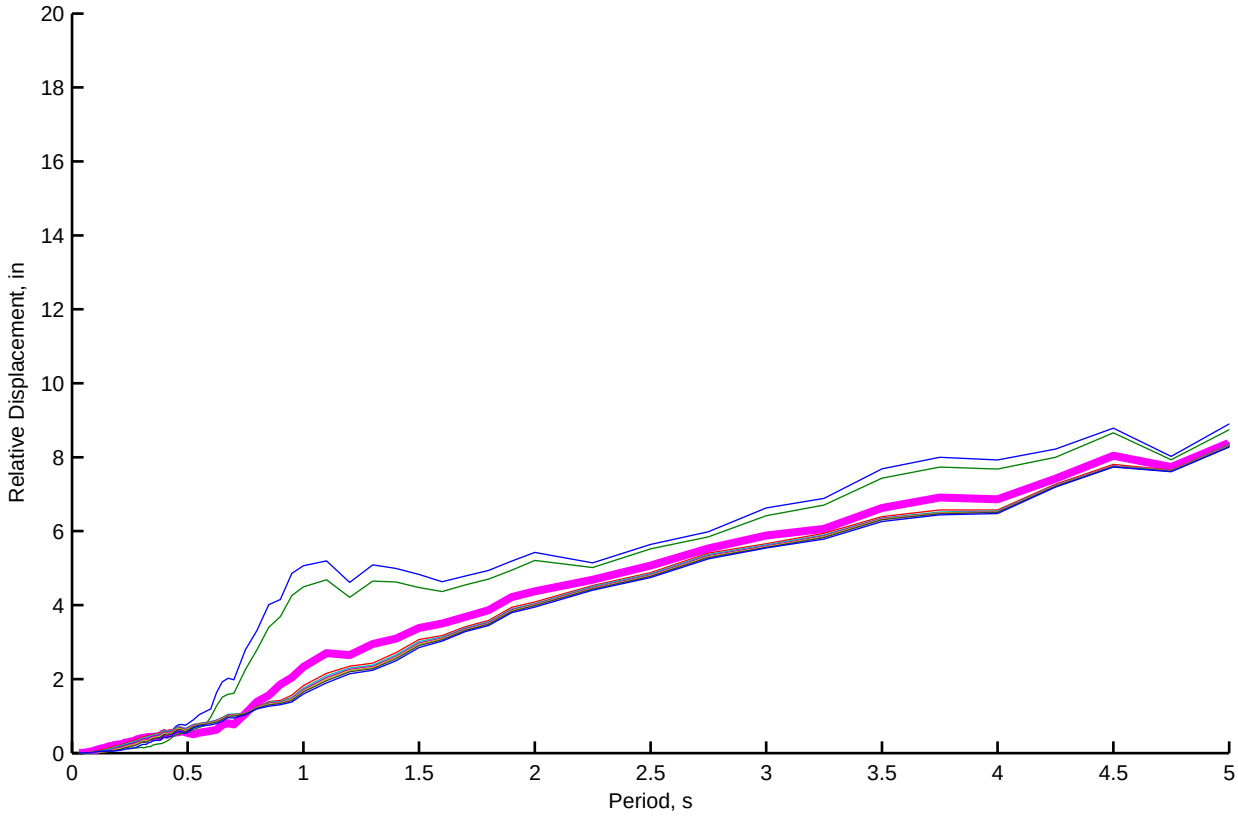

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 3 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

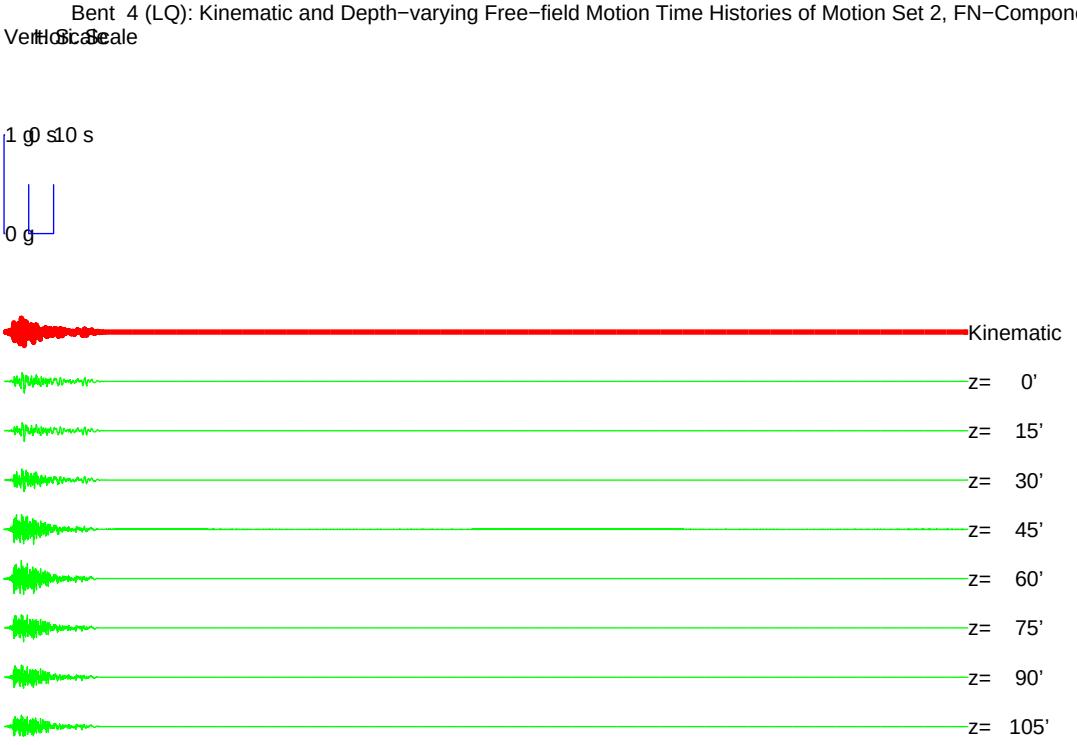


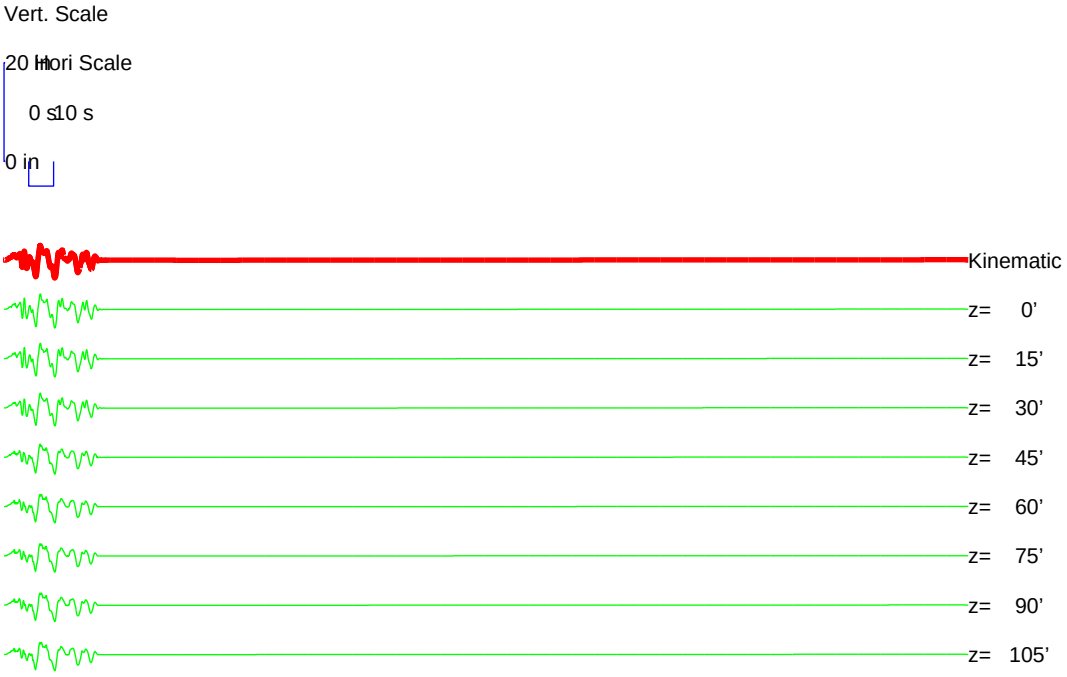



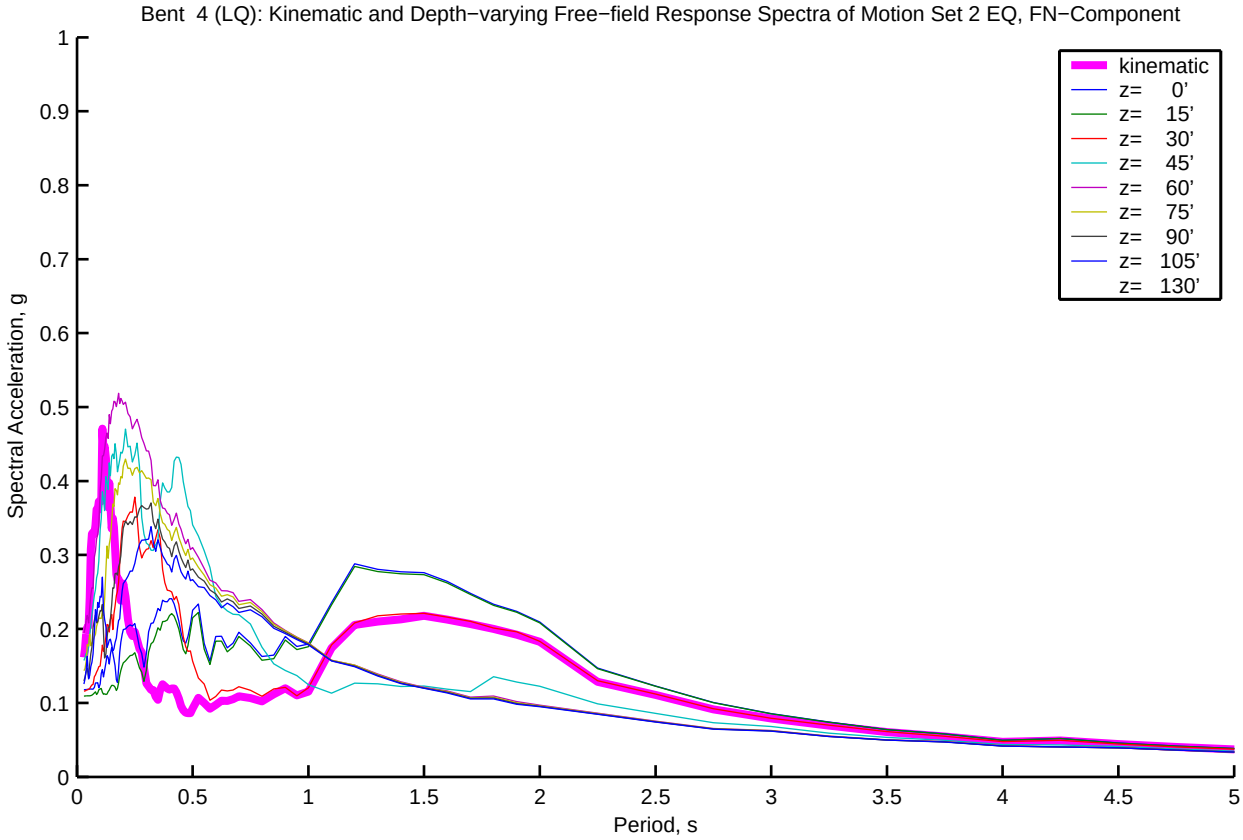

Bent 3 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

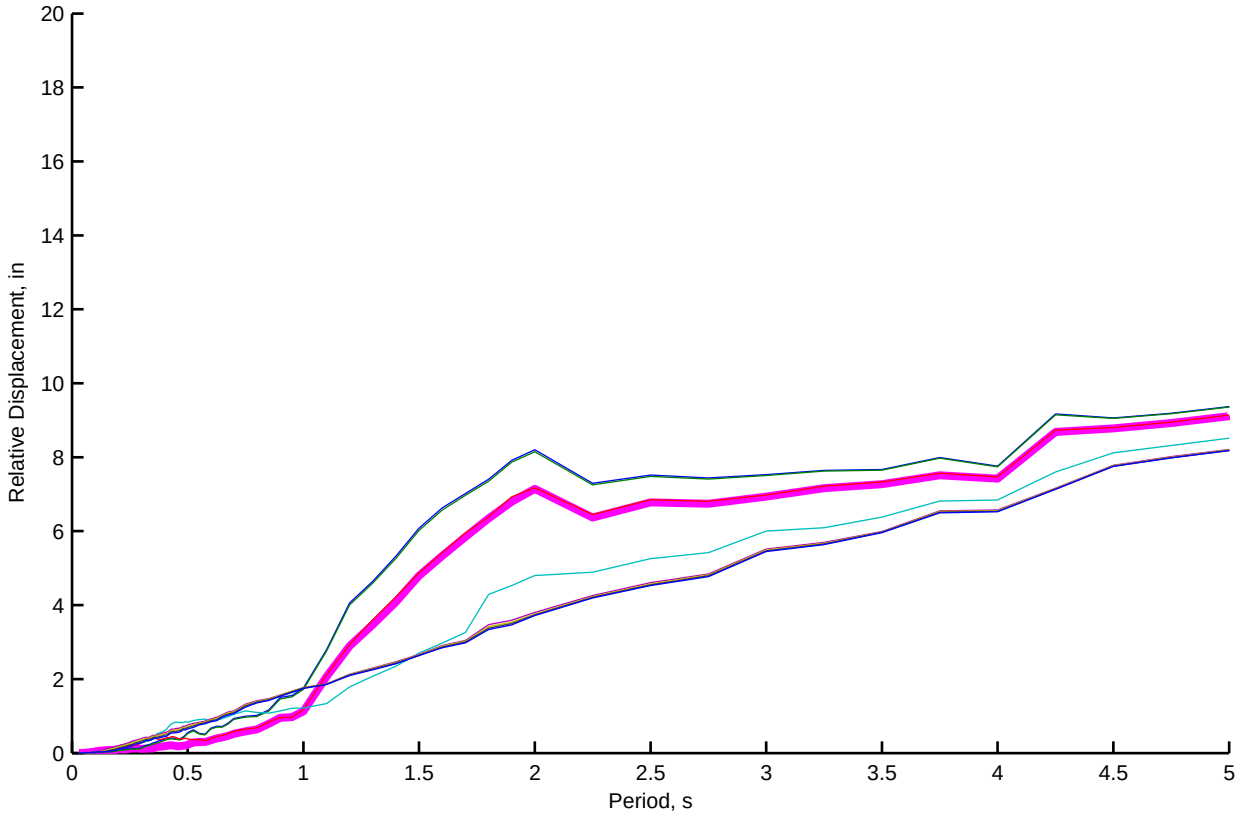

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 4 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

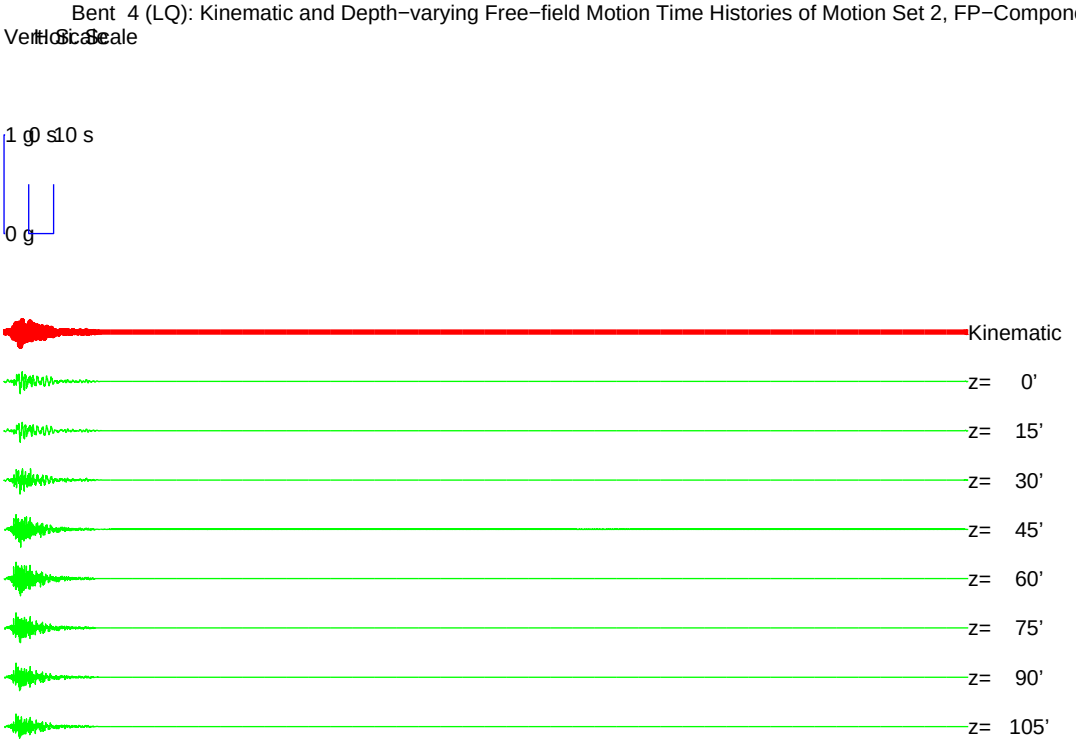


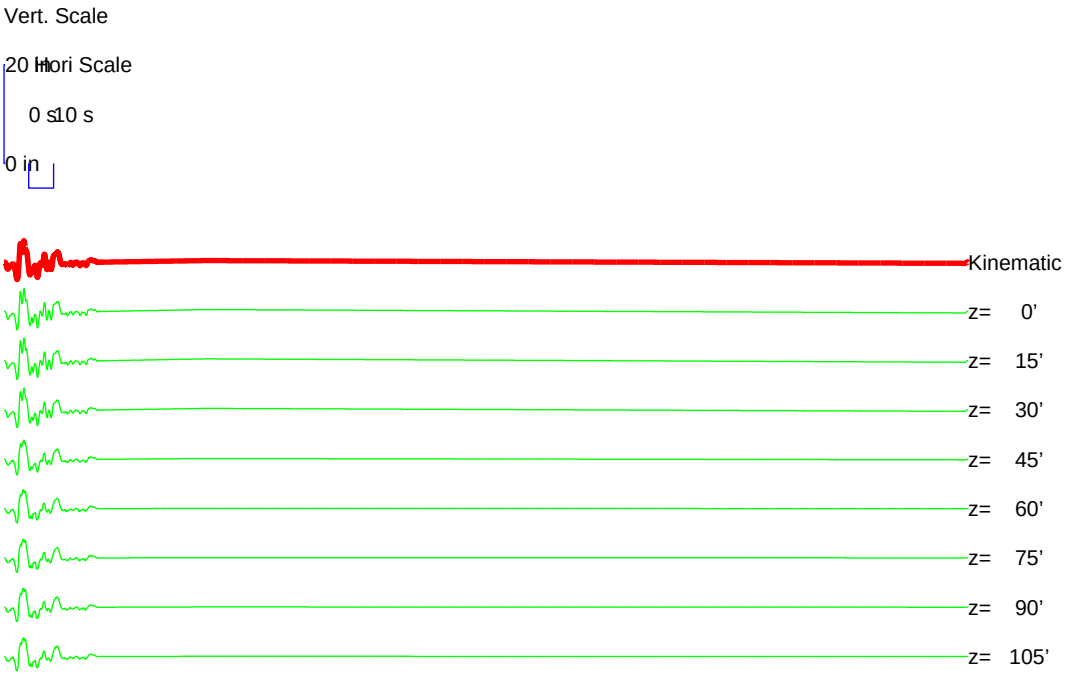



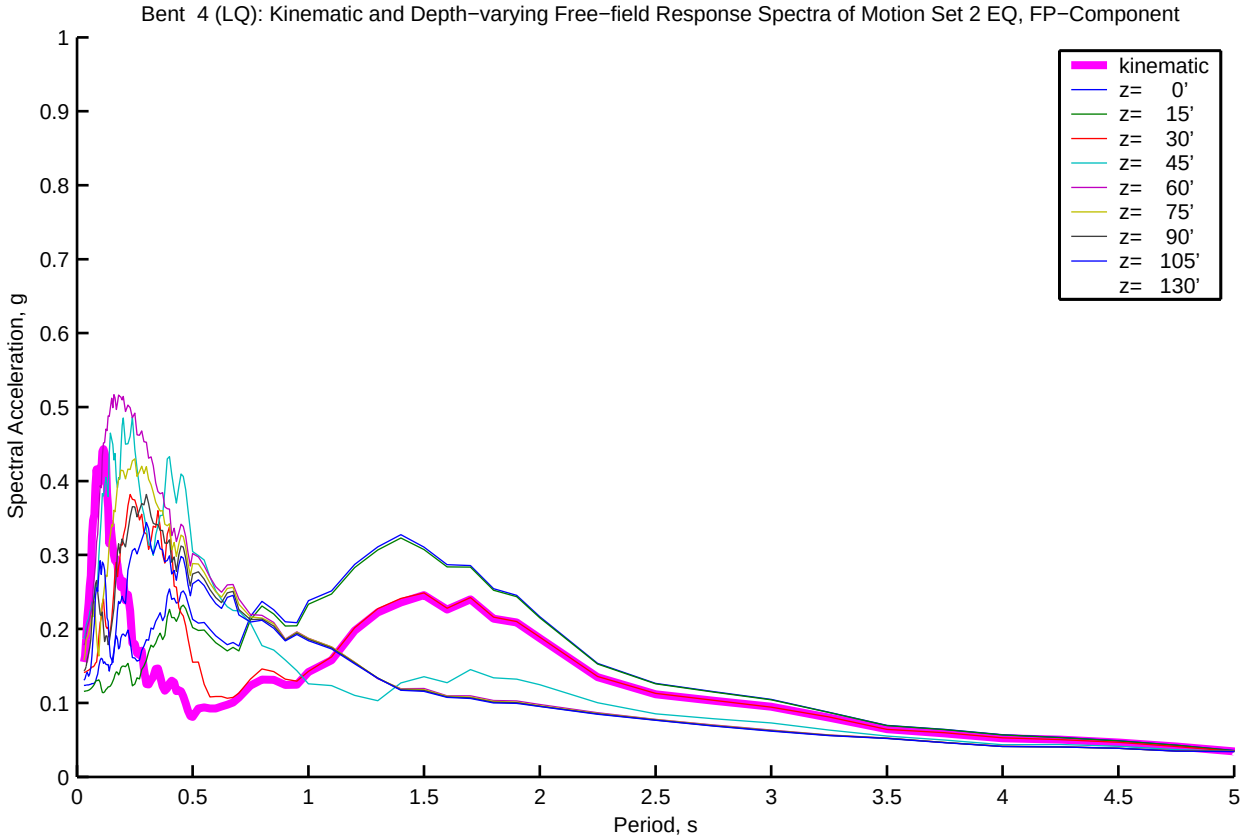

Bent 4 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

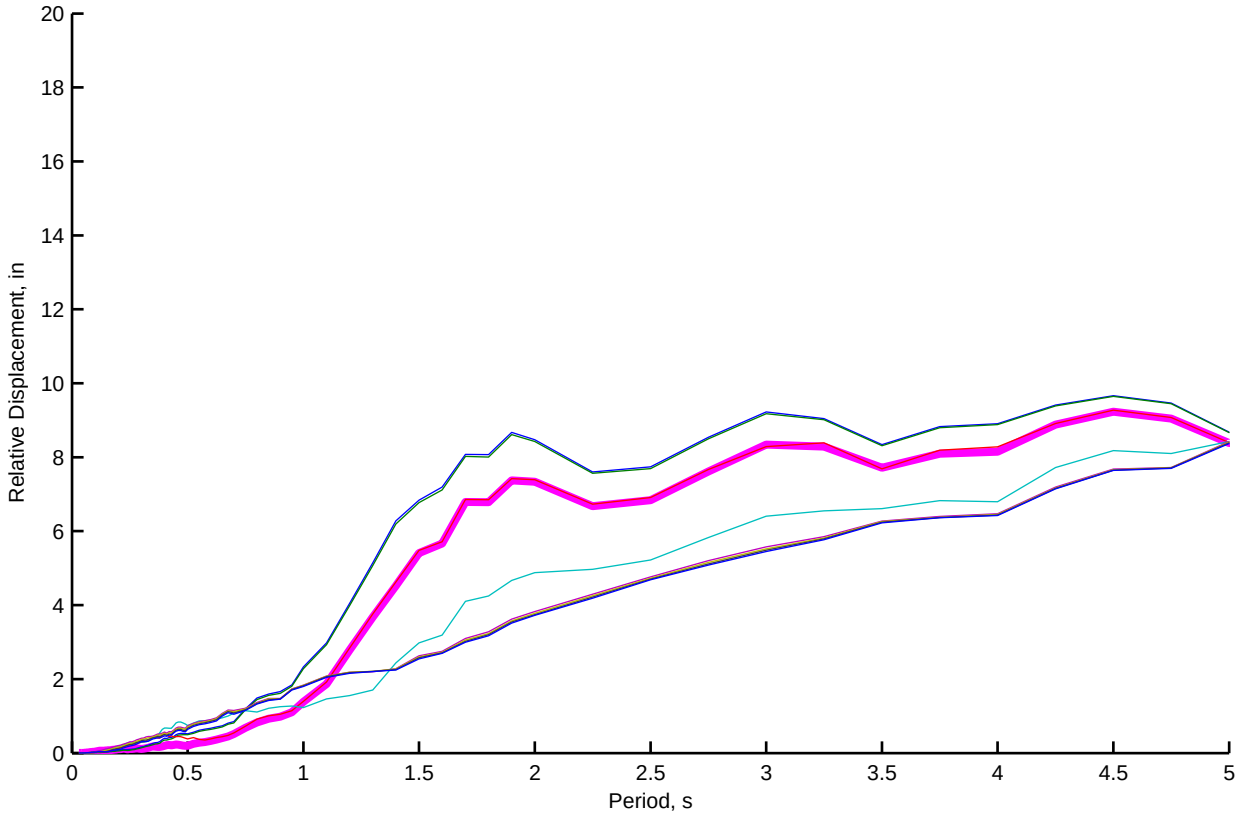

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 4 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

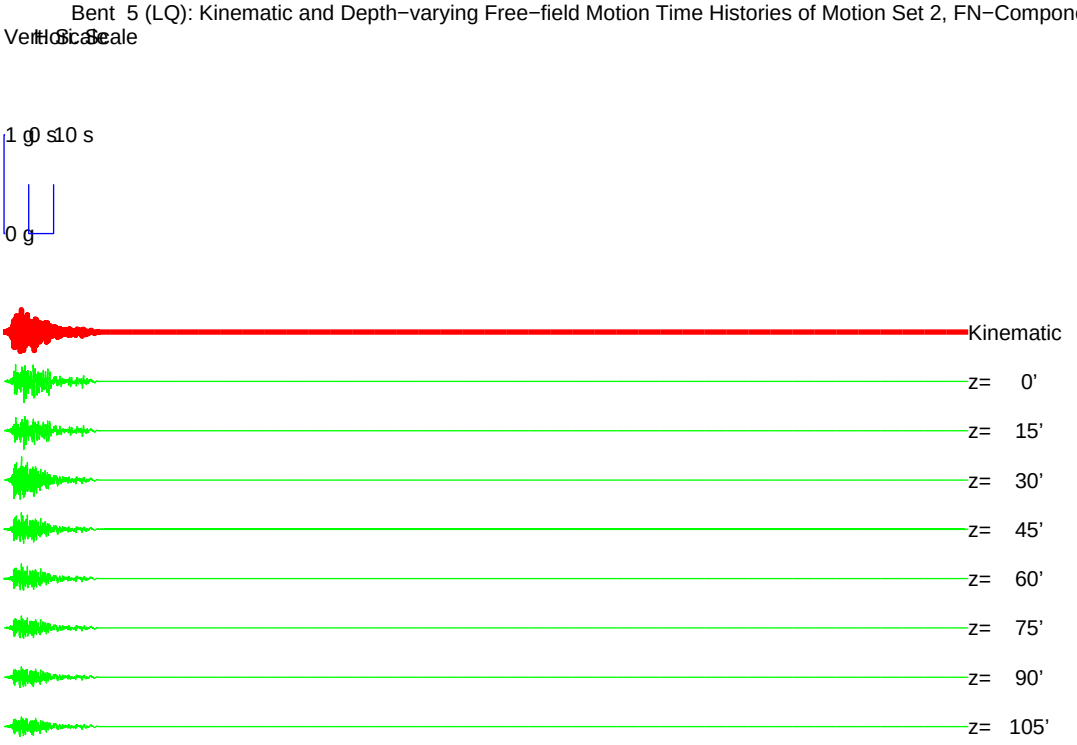


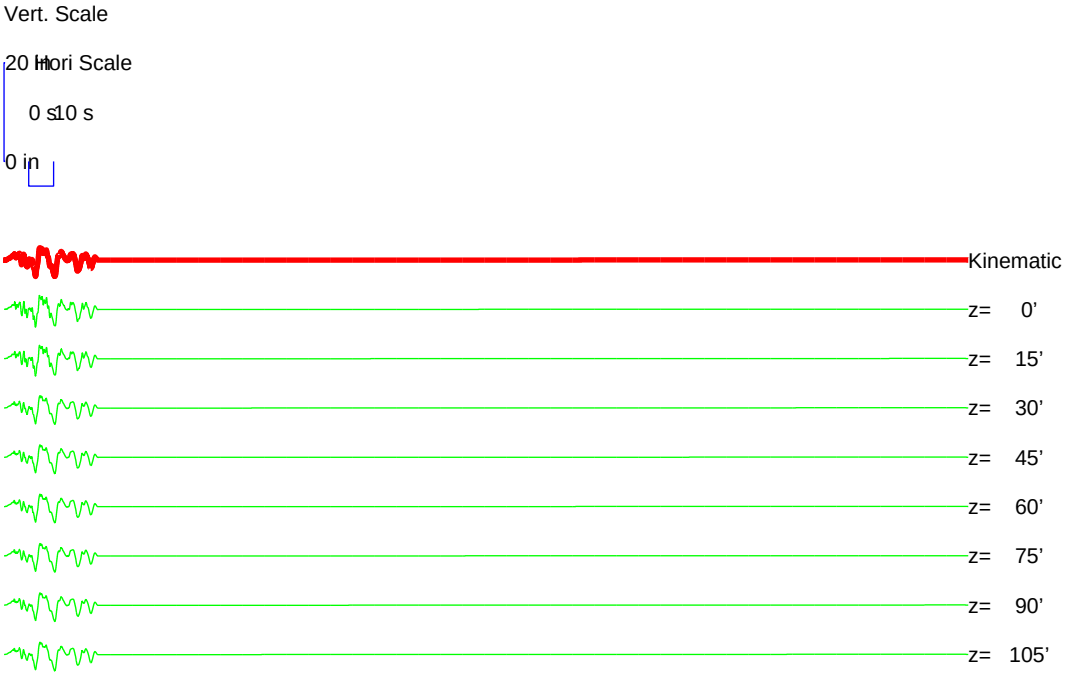



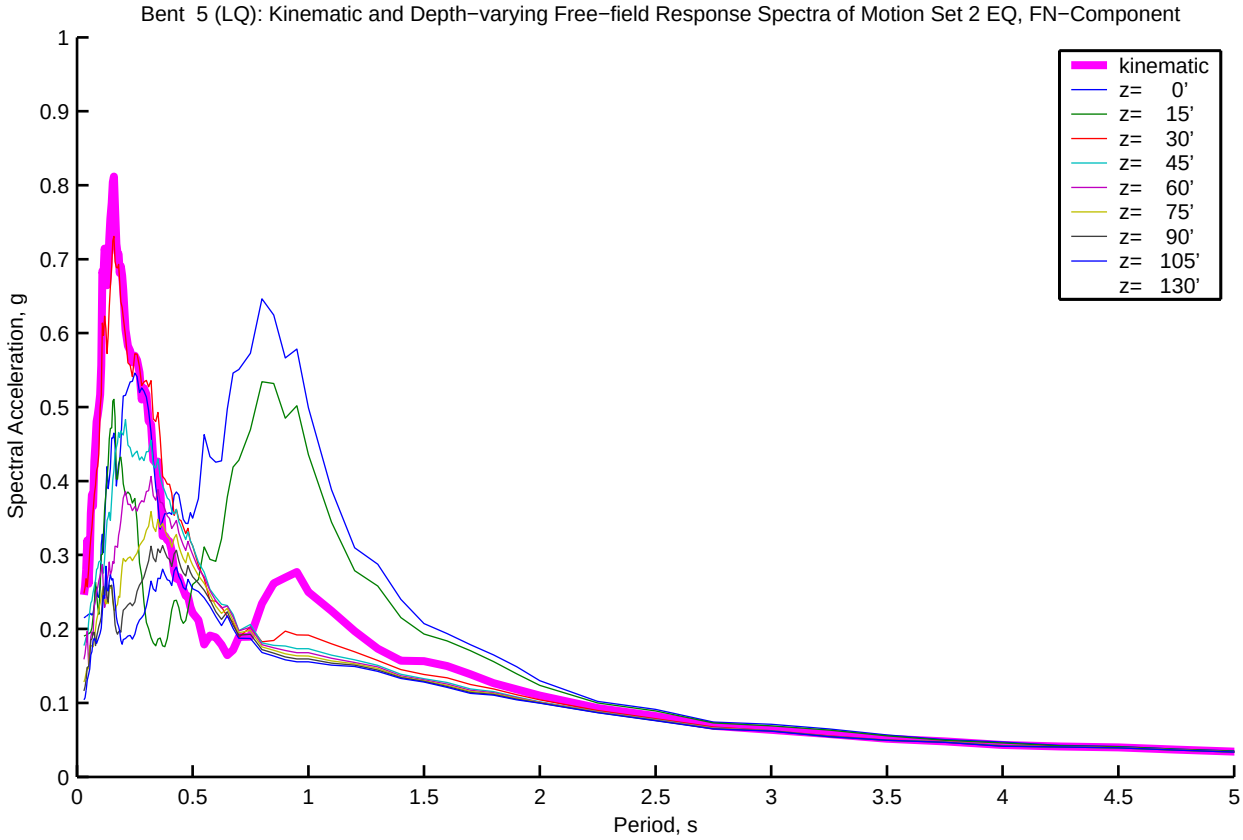

Bent 4 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

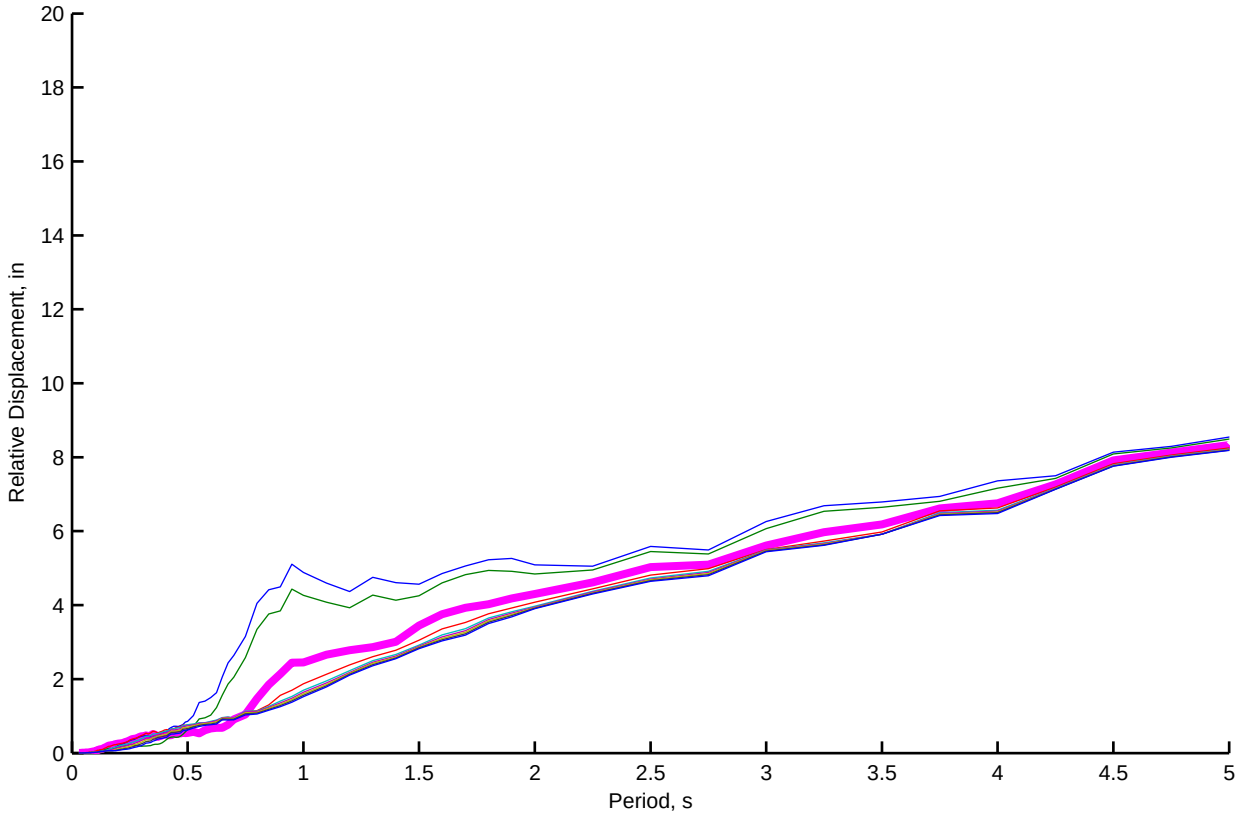

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 5 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

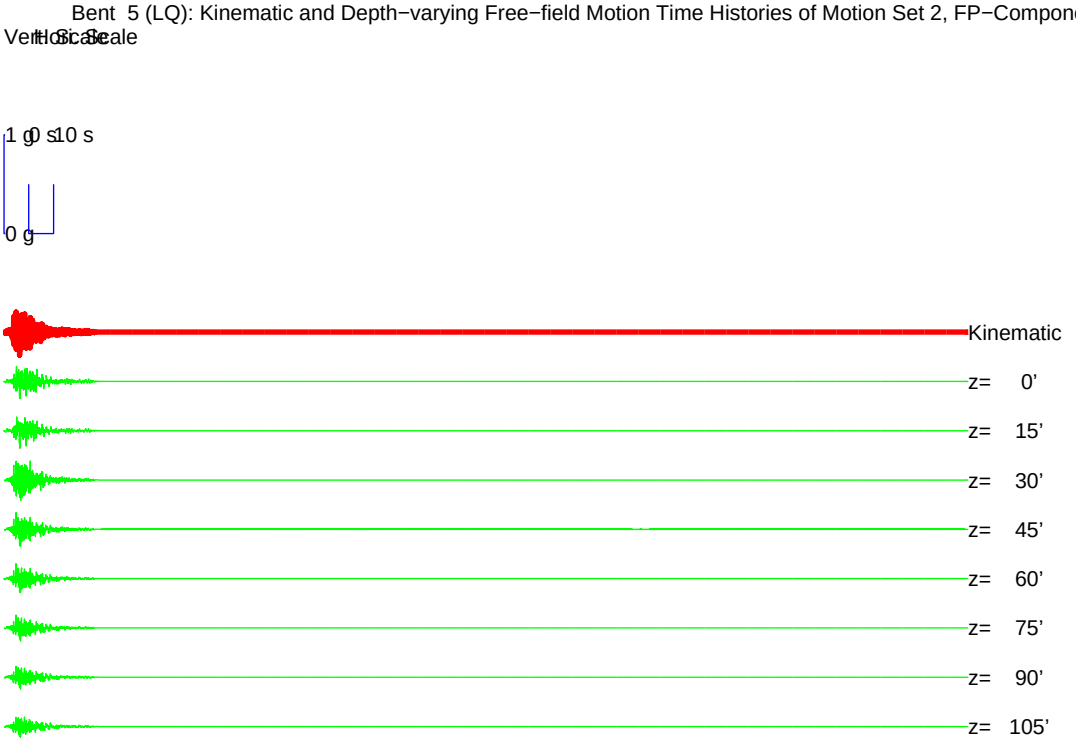


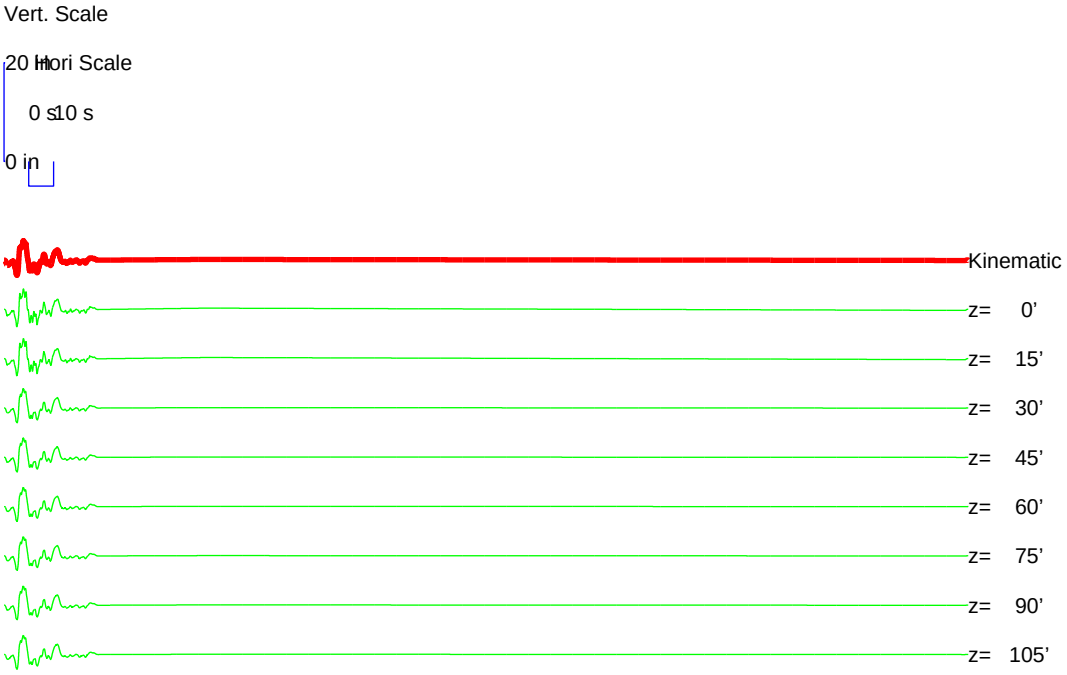



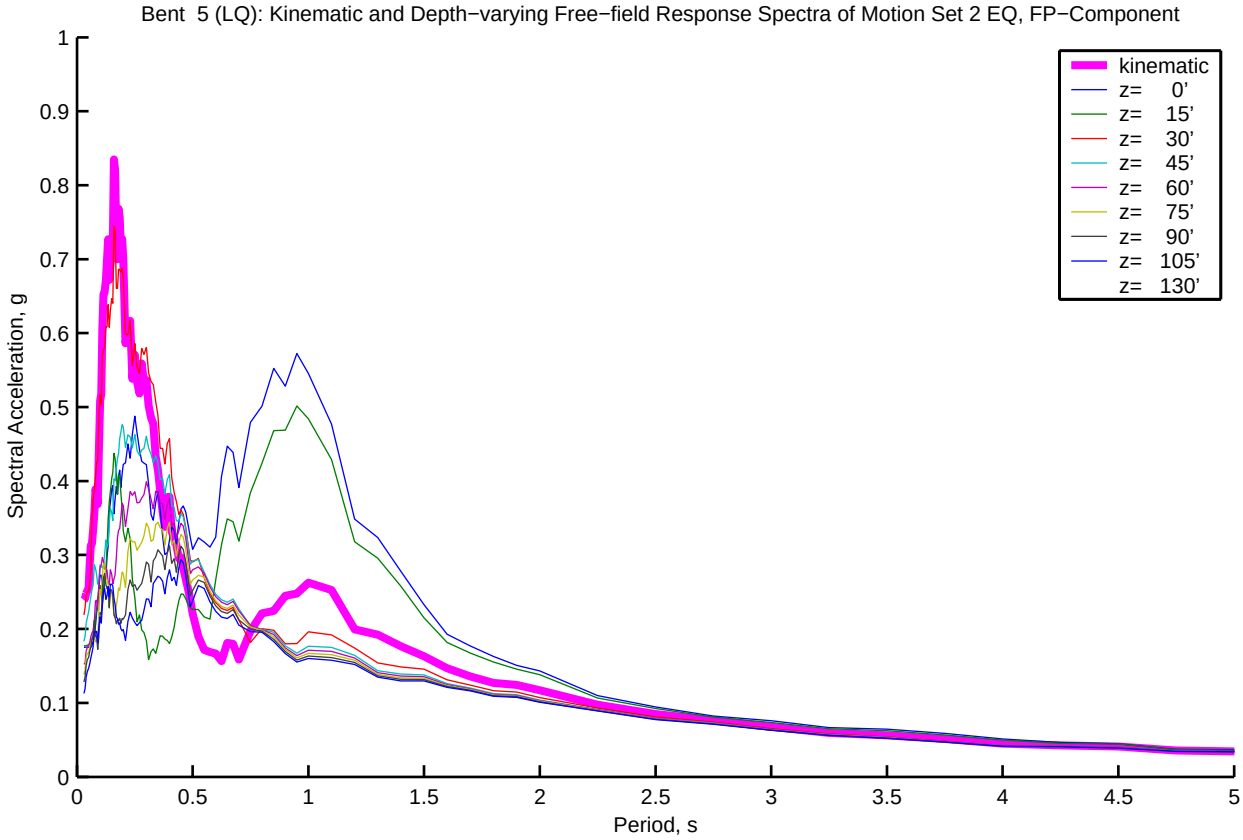

Bent 5 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

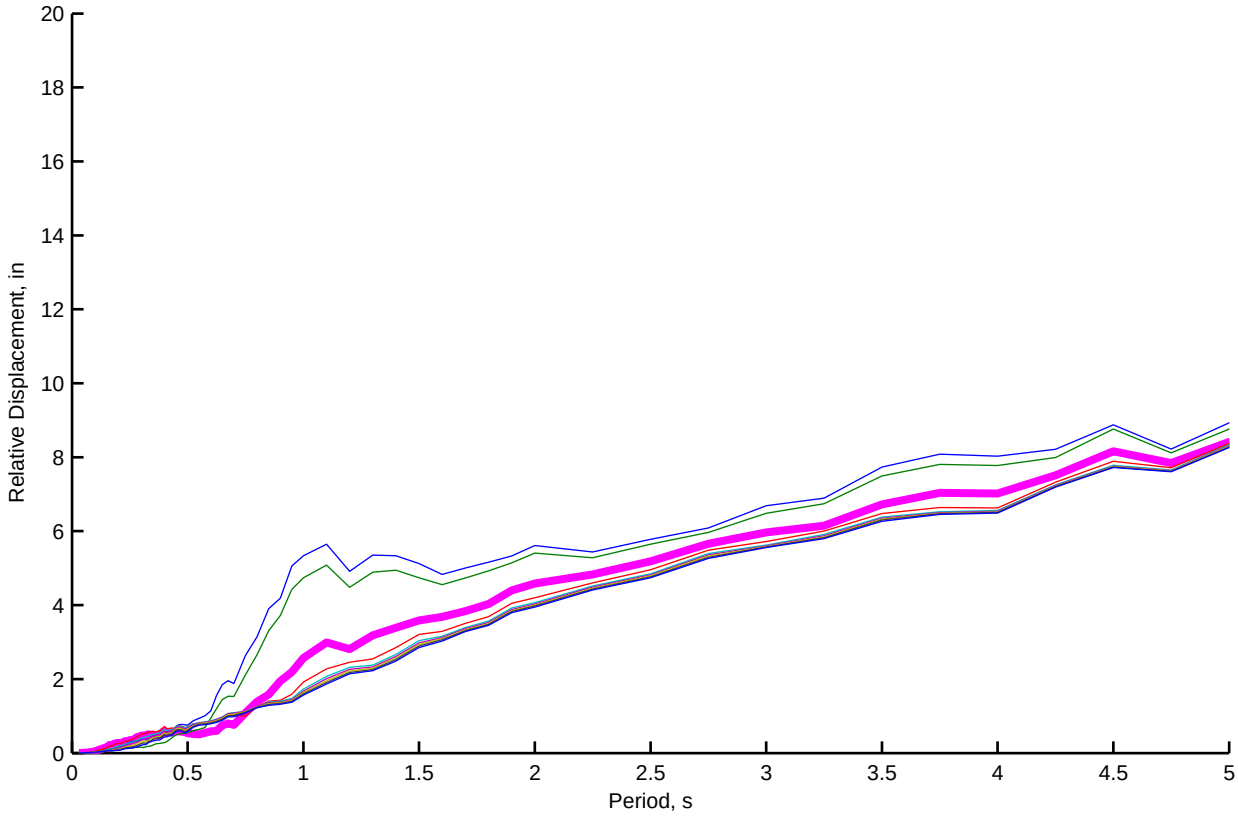

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 5 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

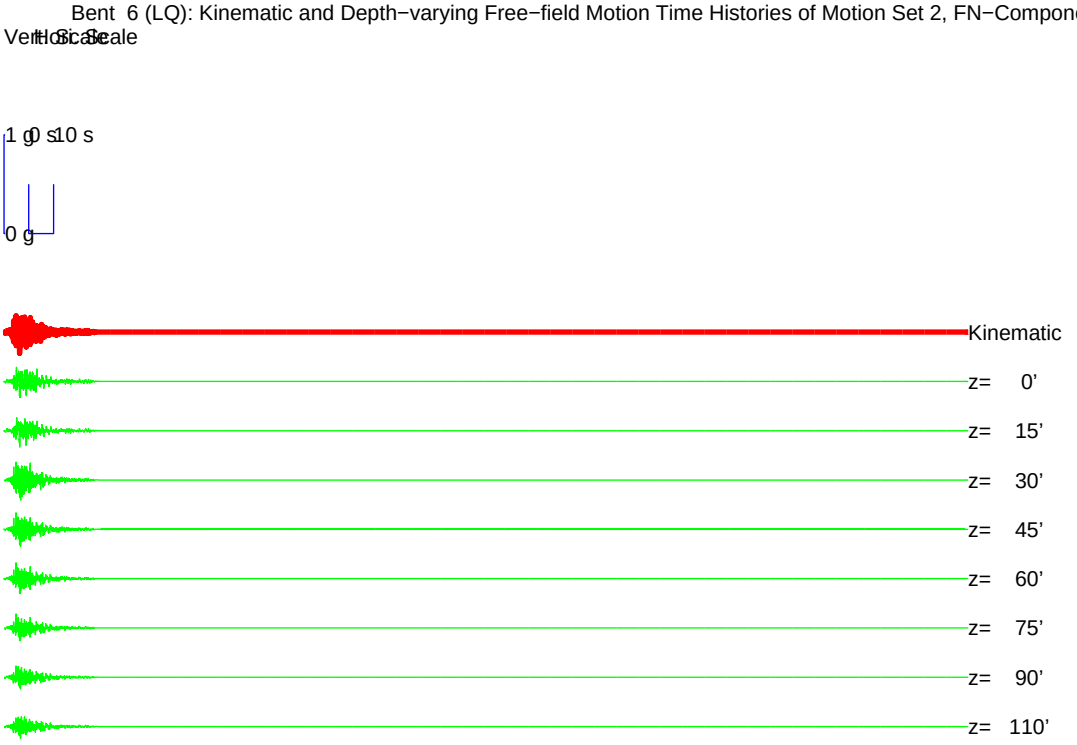


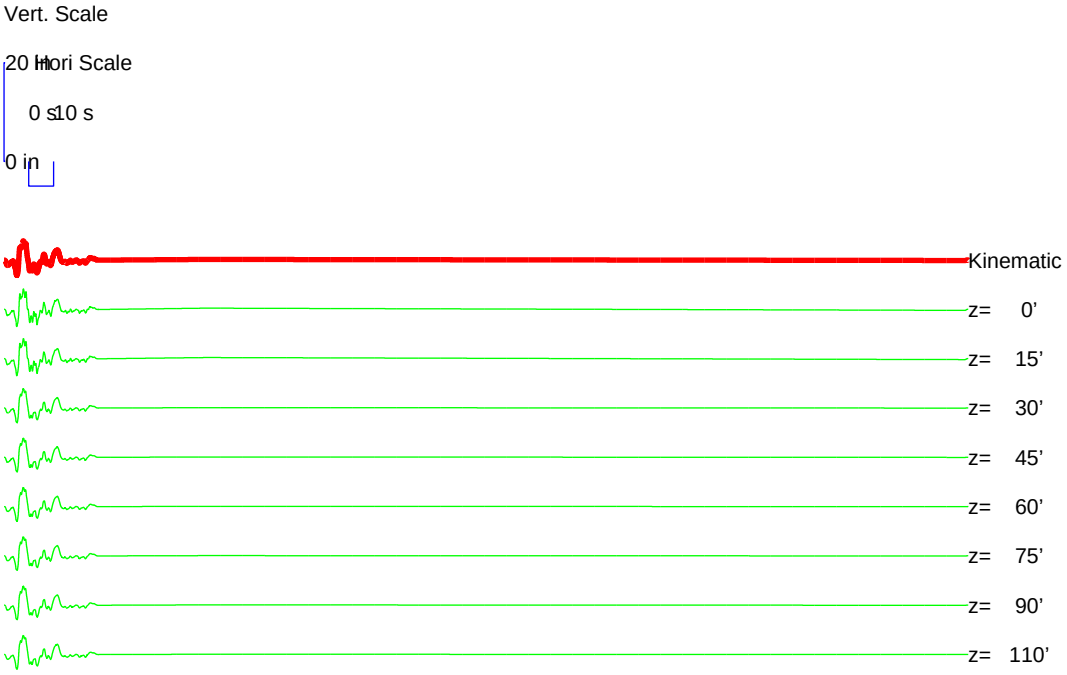



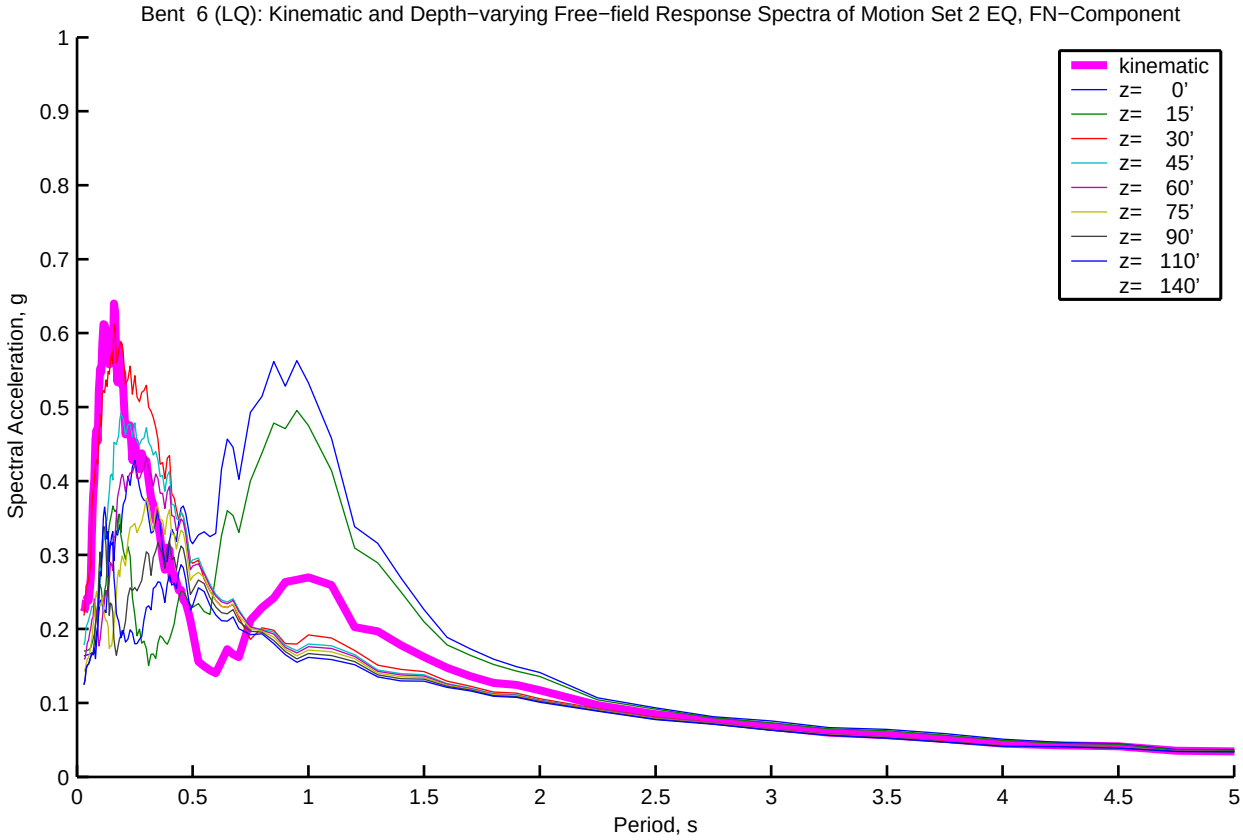

Bent 5 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'

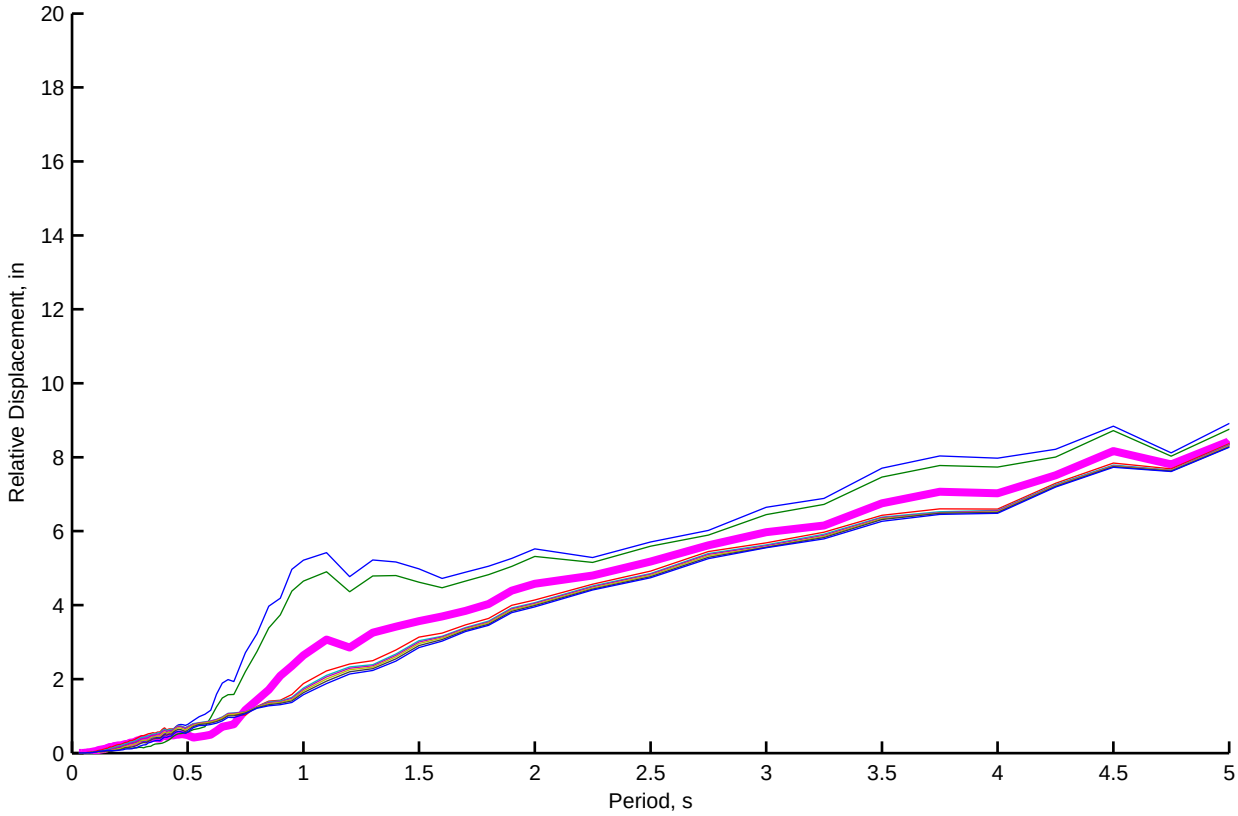

Relative Displacement, in
Period, s

Bent 6 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

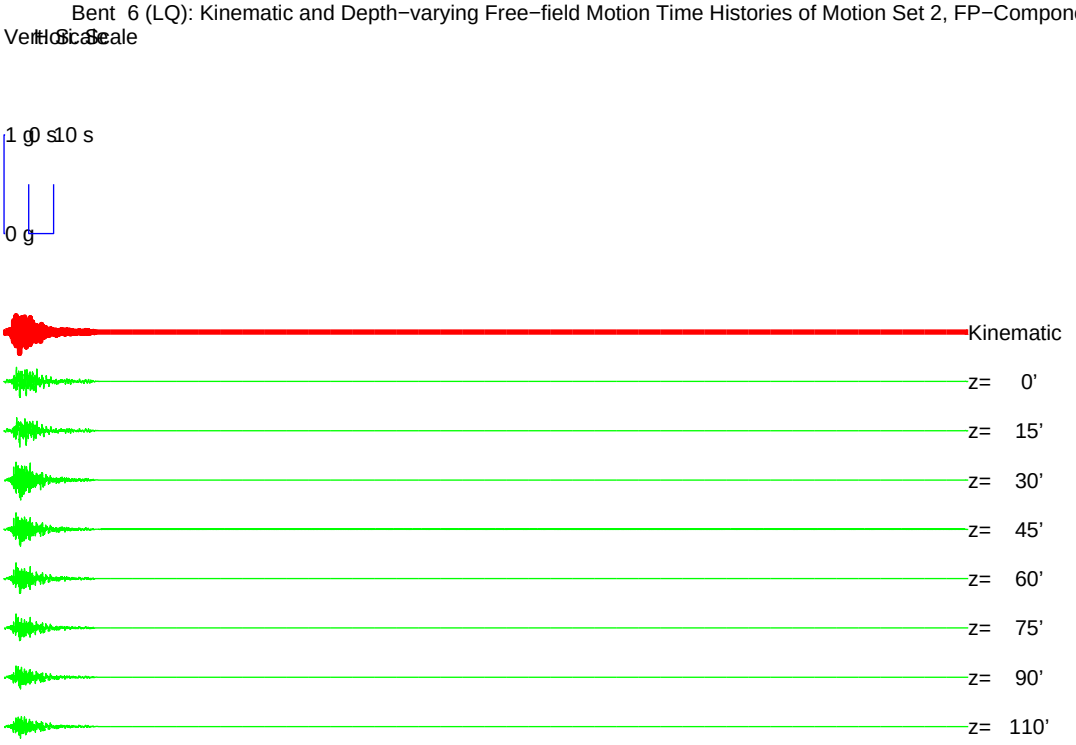


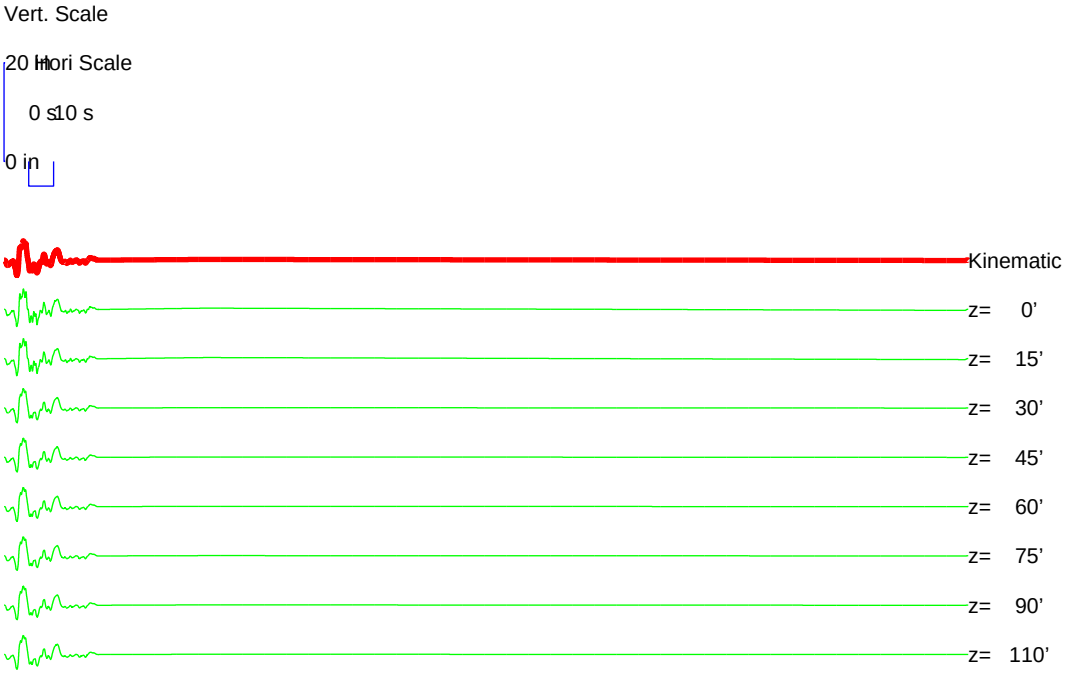



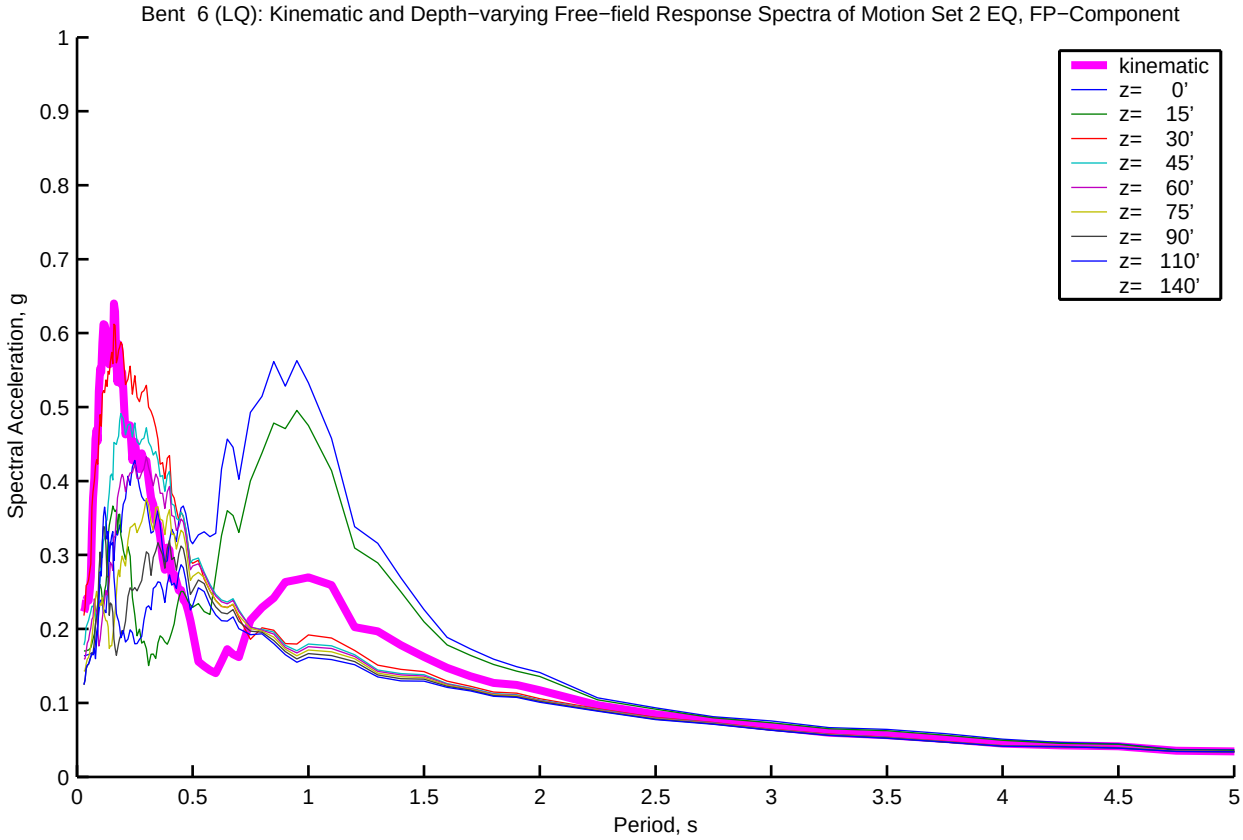

Bent 6 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

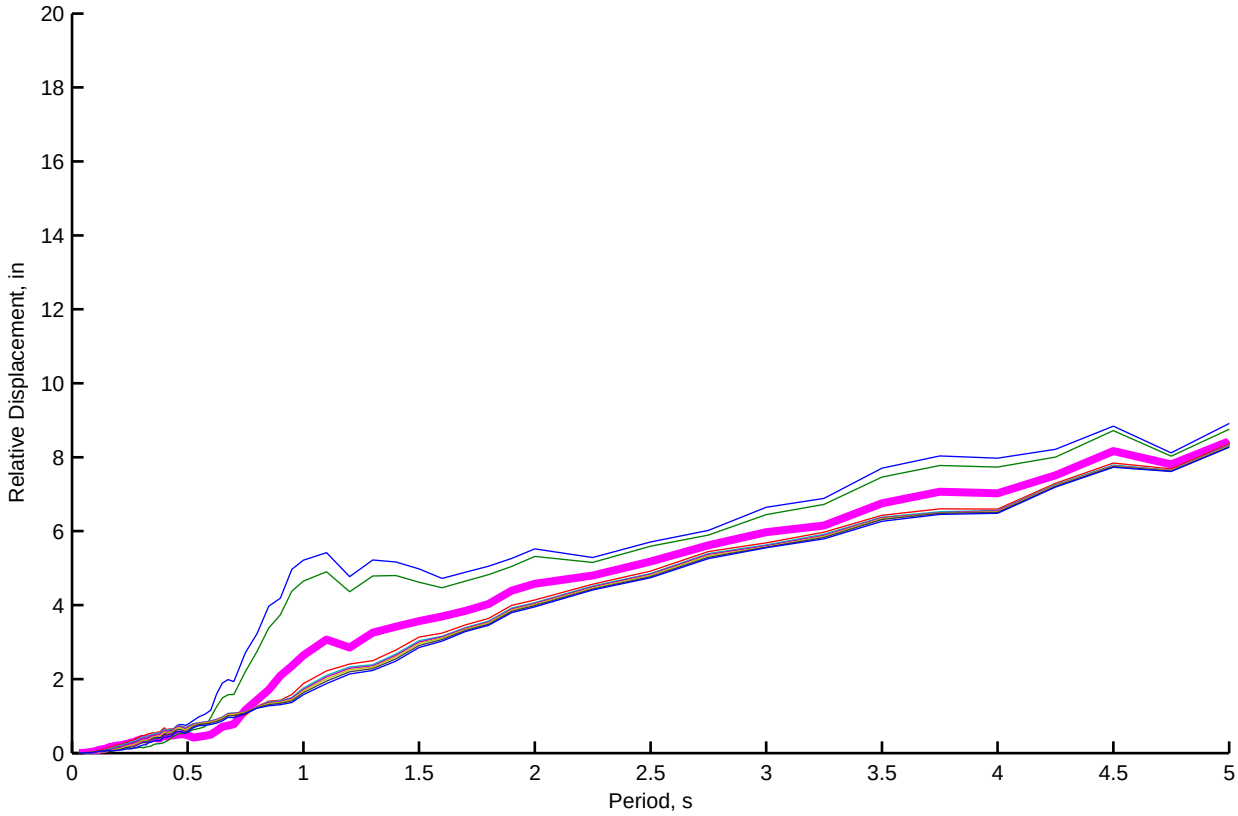

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 6 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

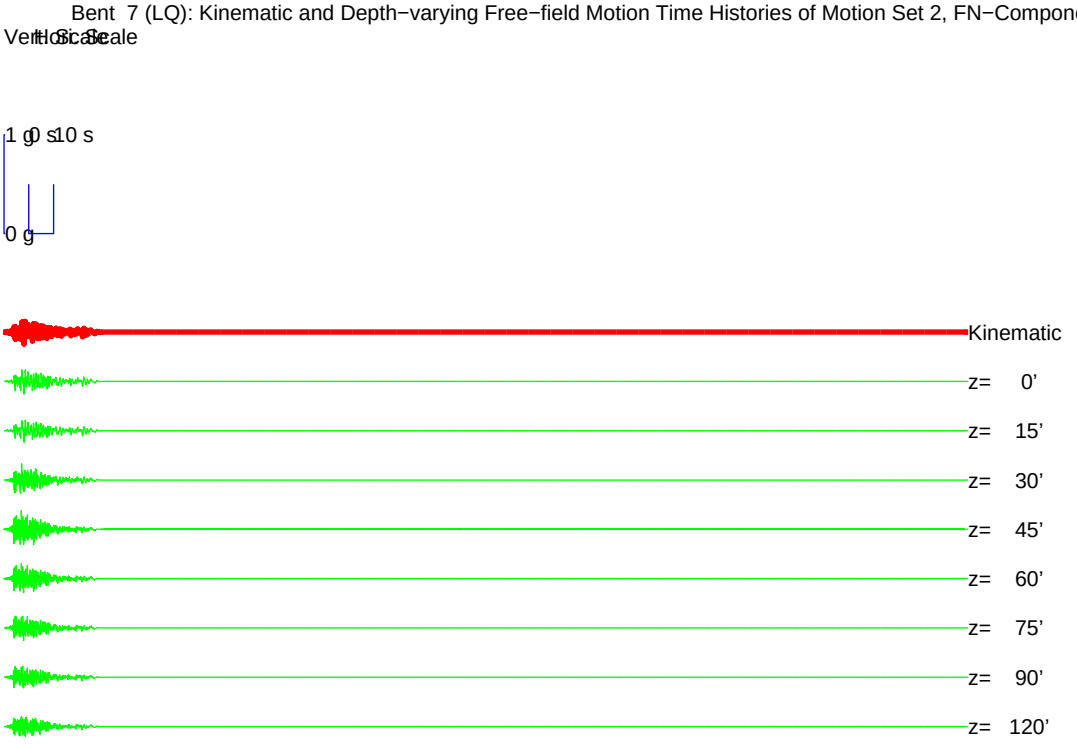


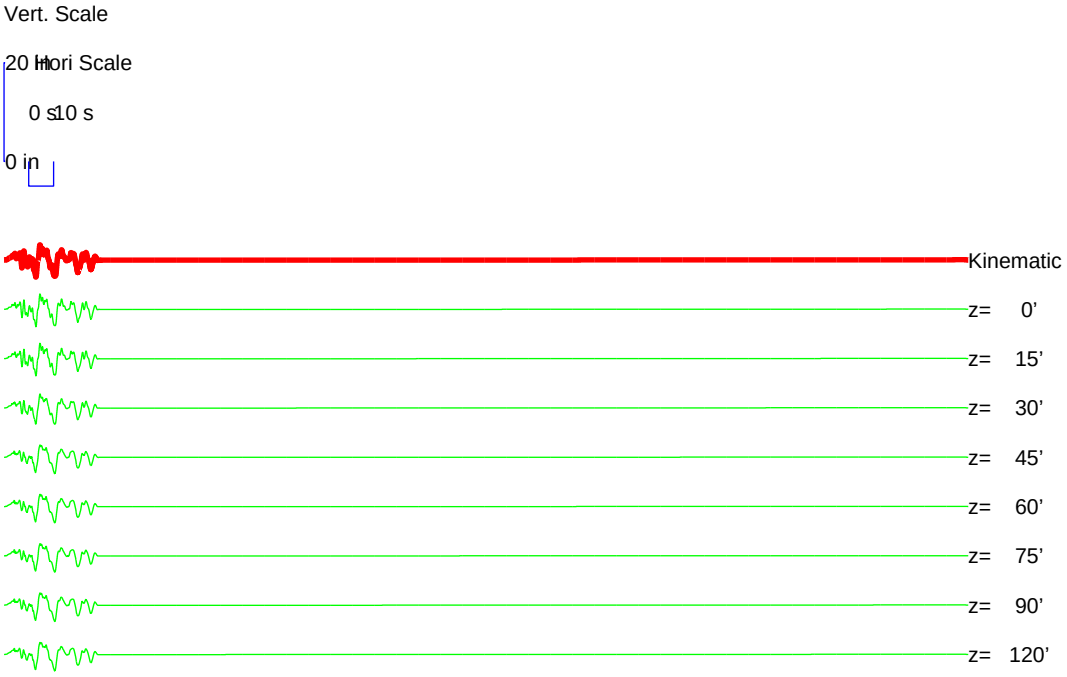



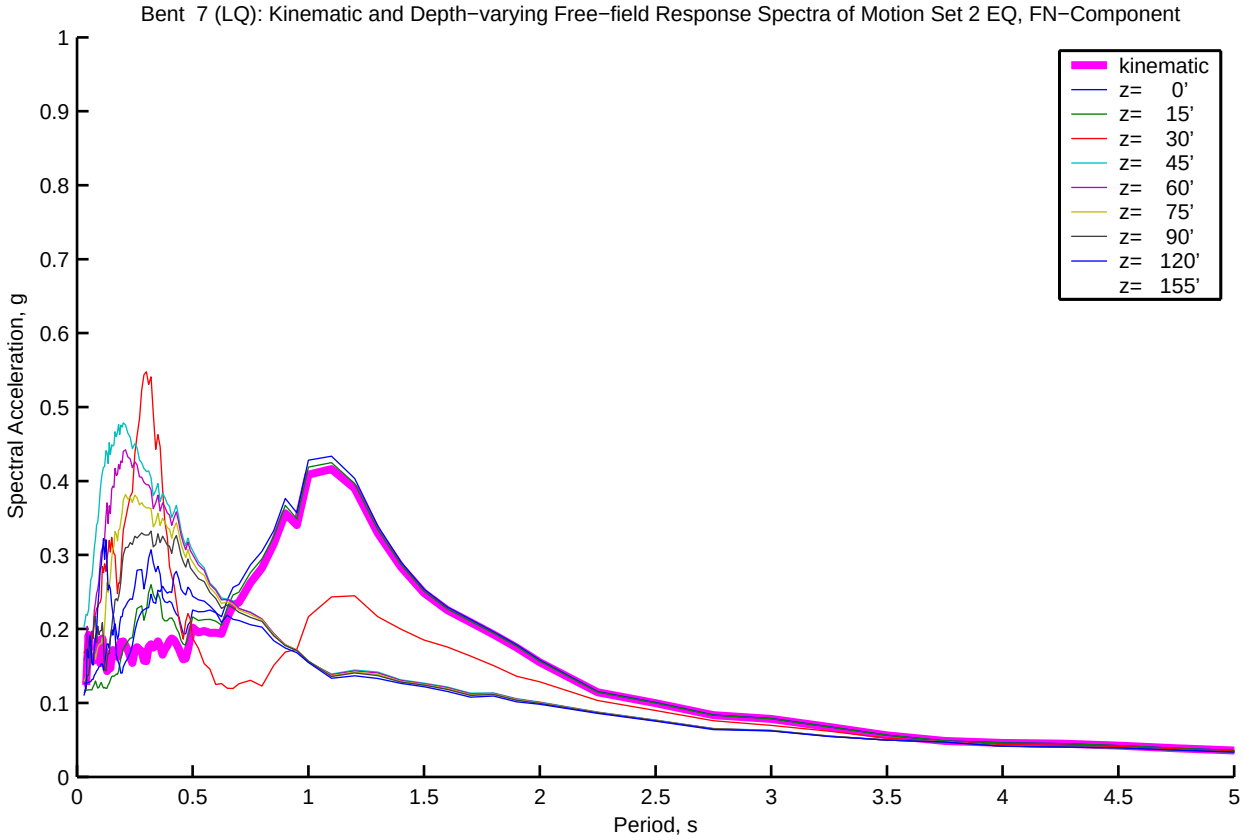

Bent 6 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

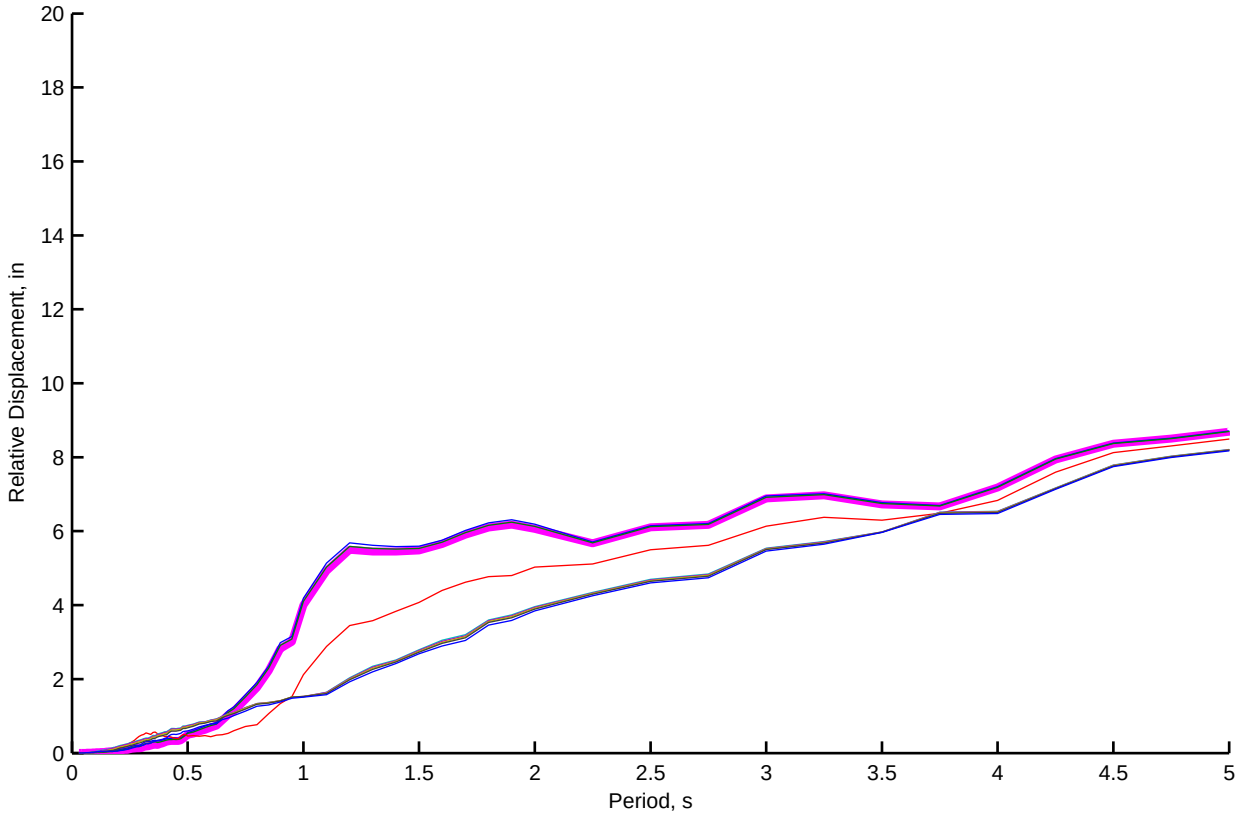

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

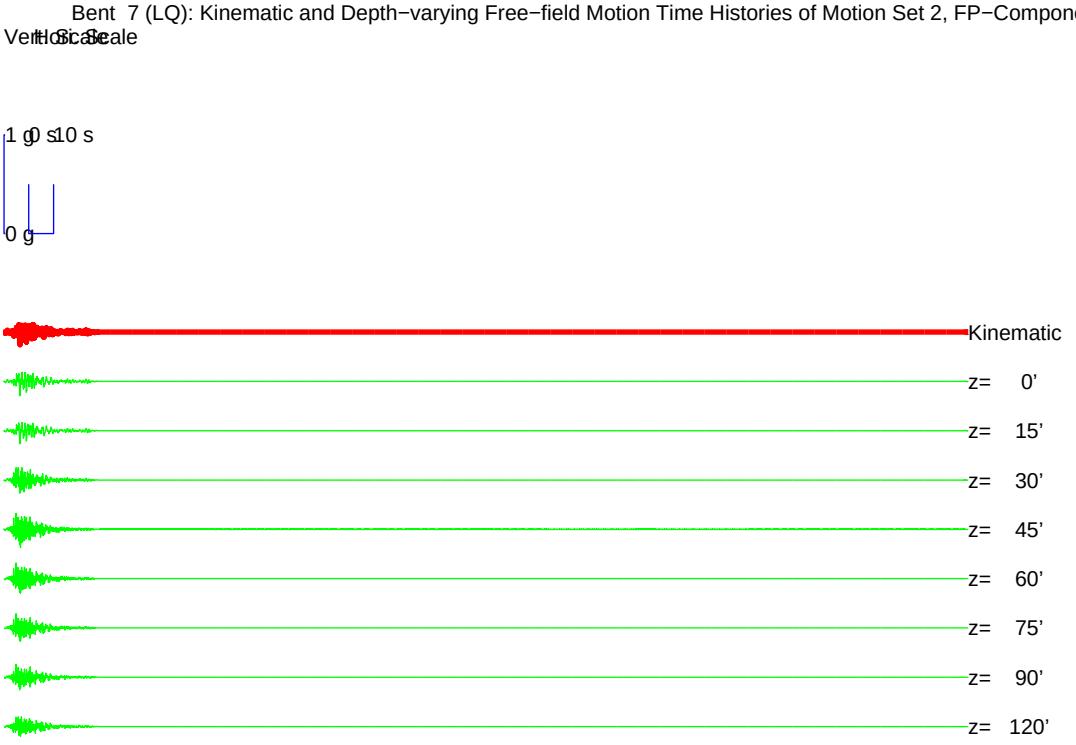


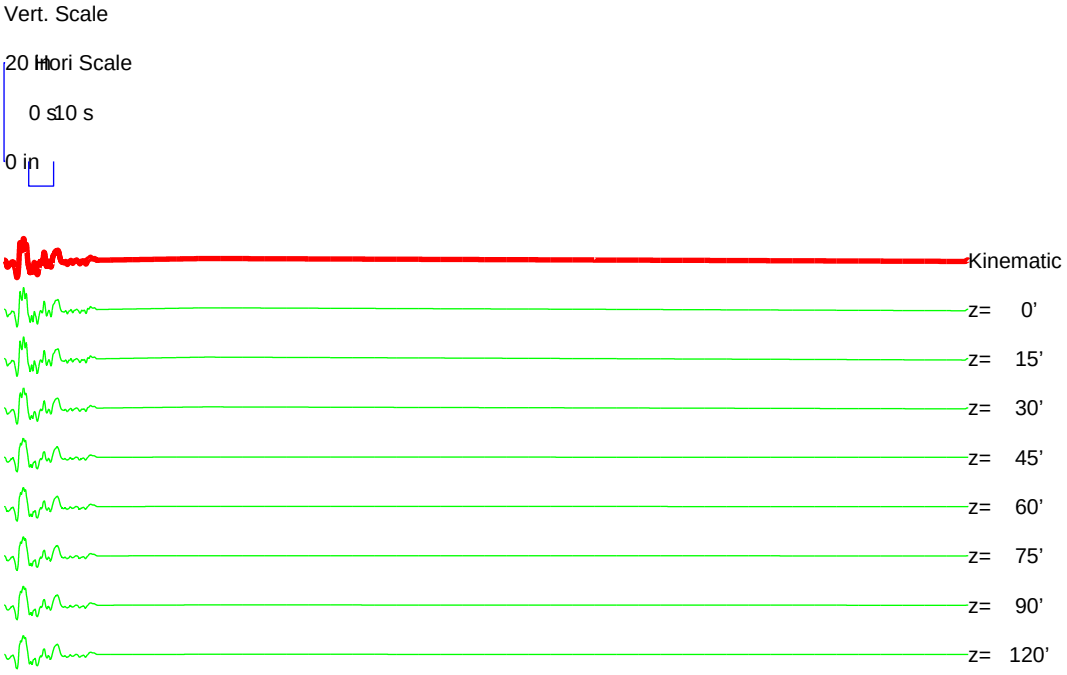



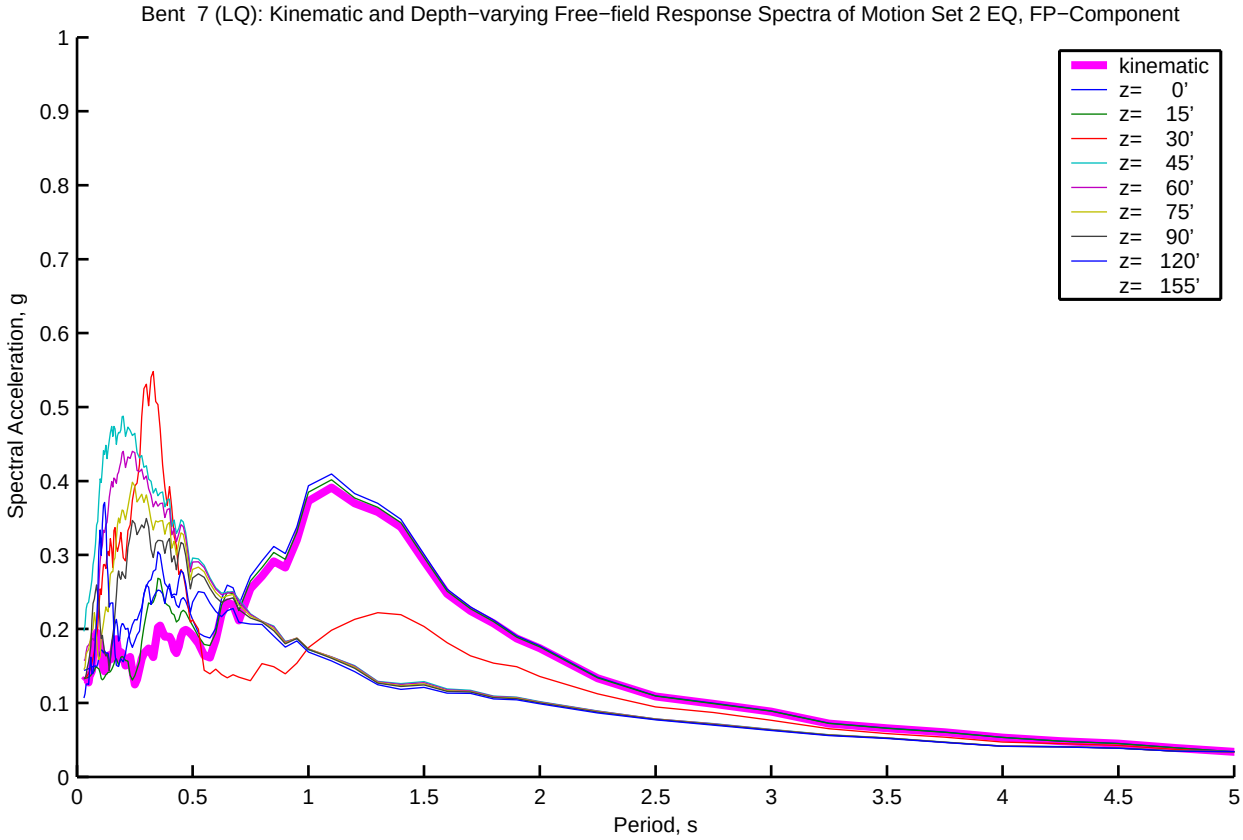

Bent 7 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

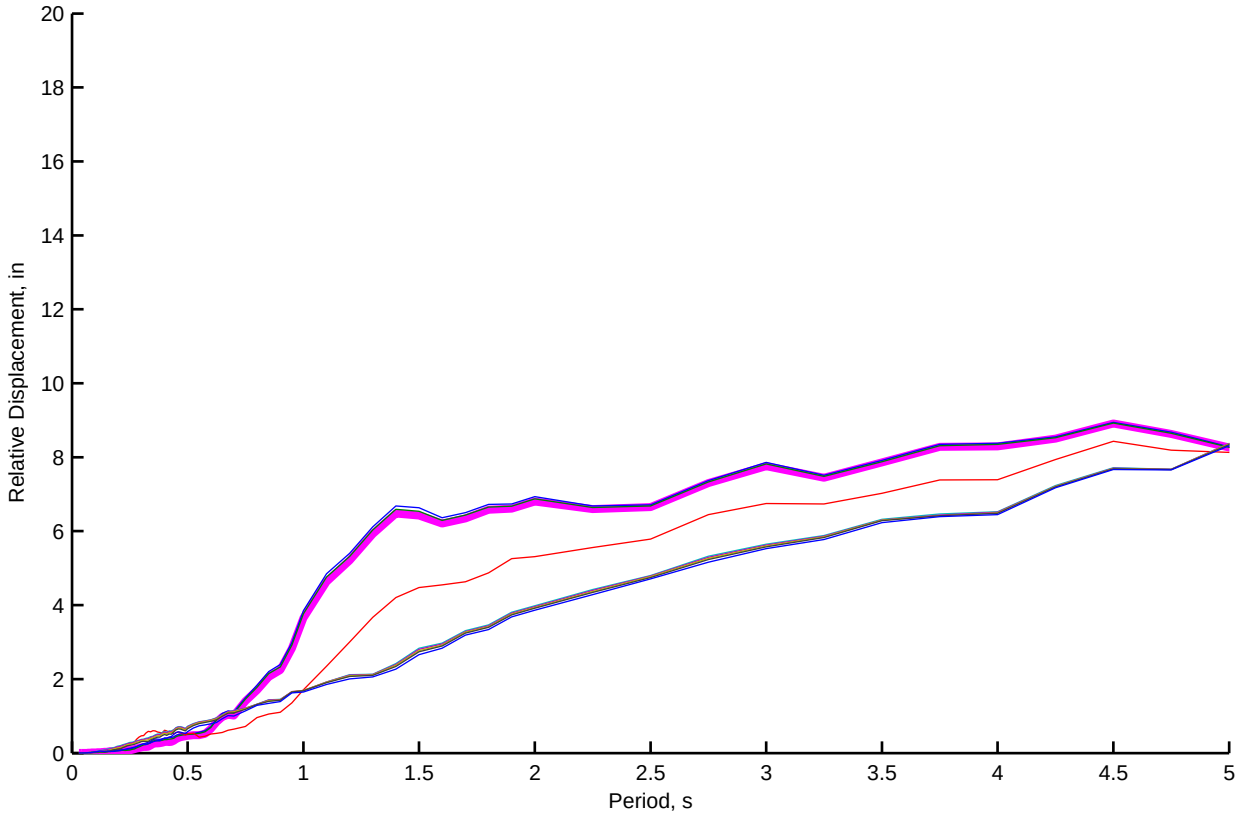

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

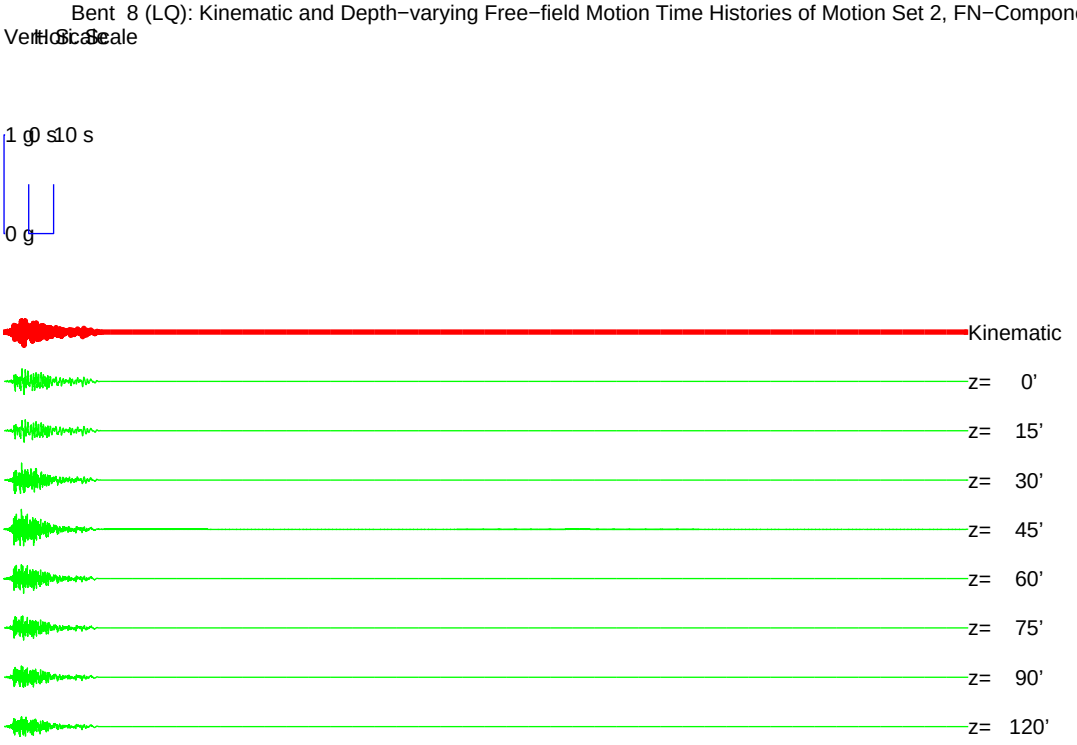


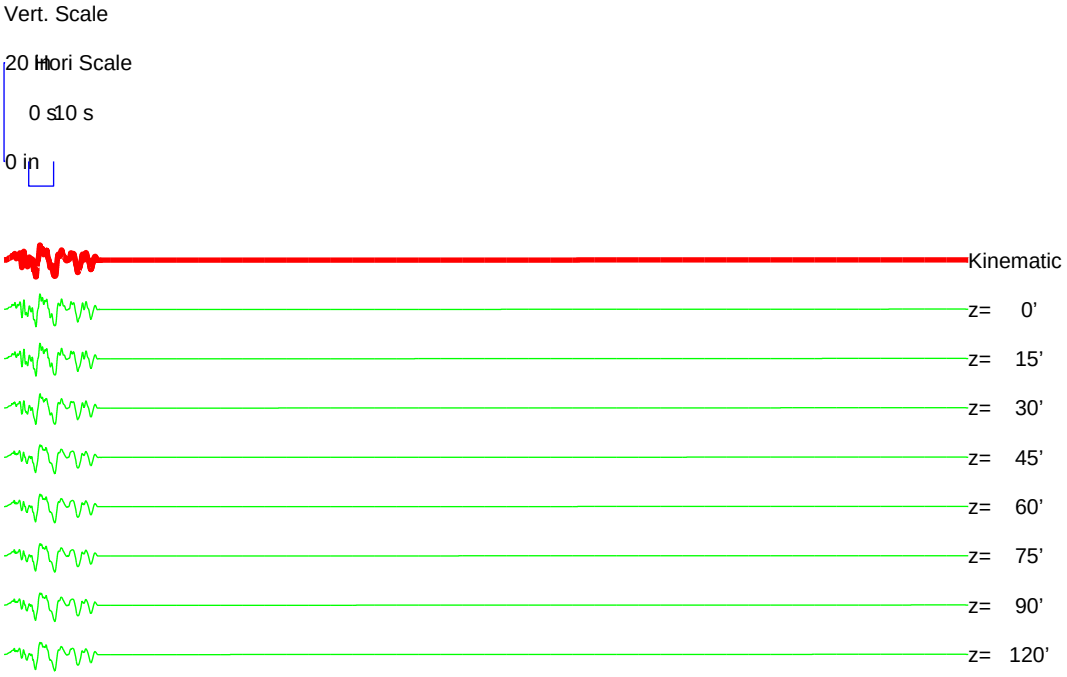



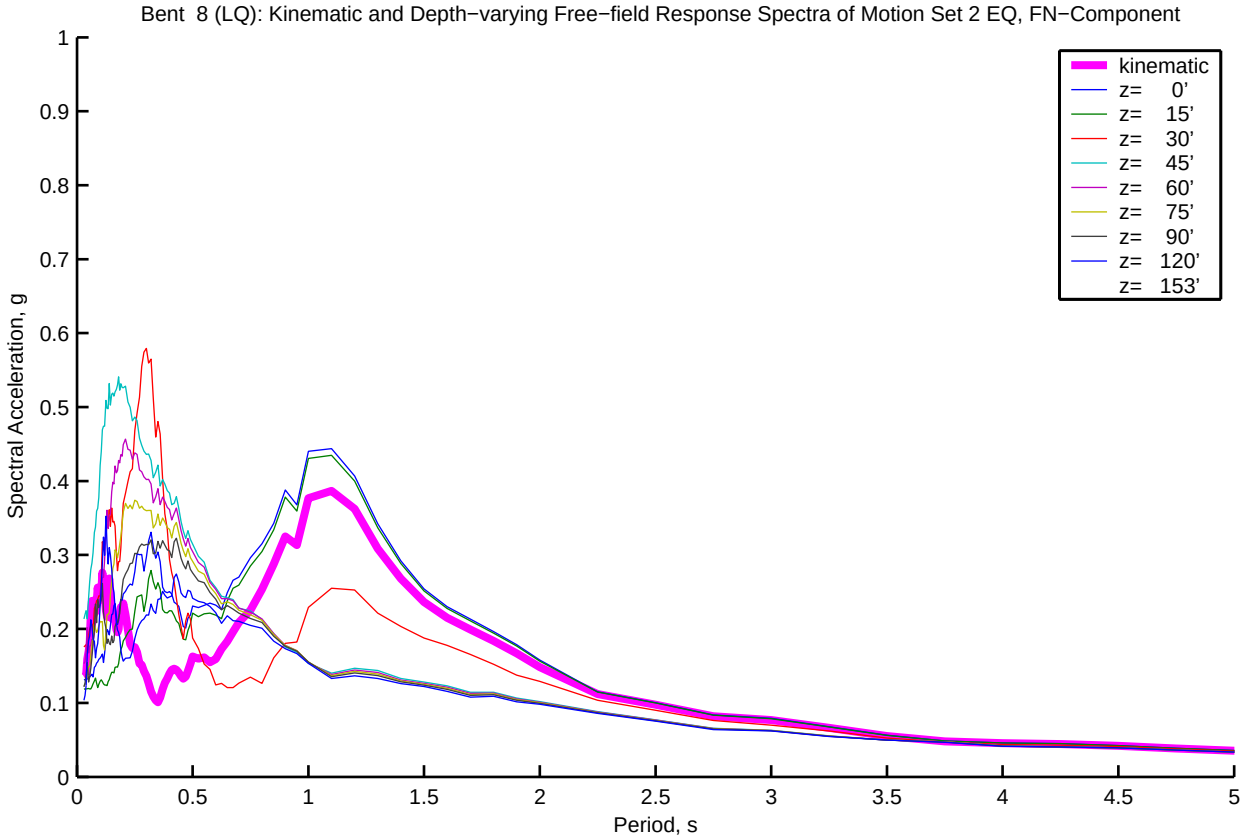

Bent 7 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

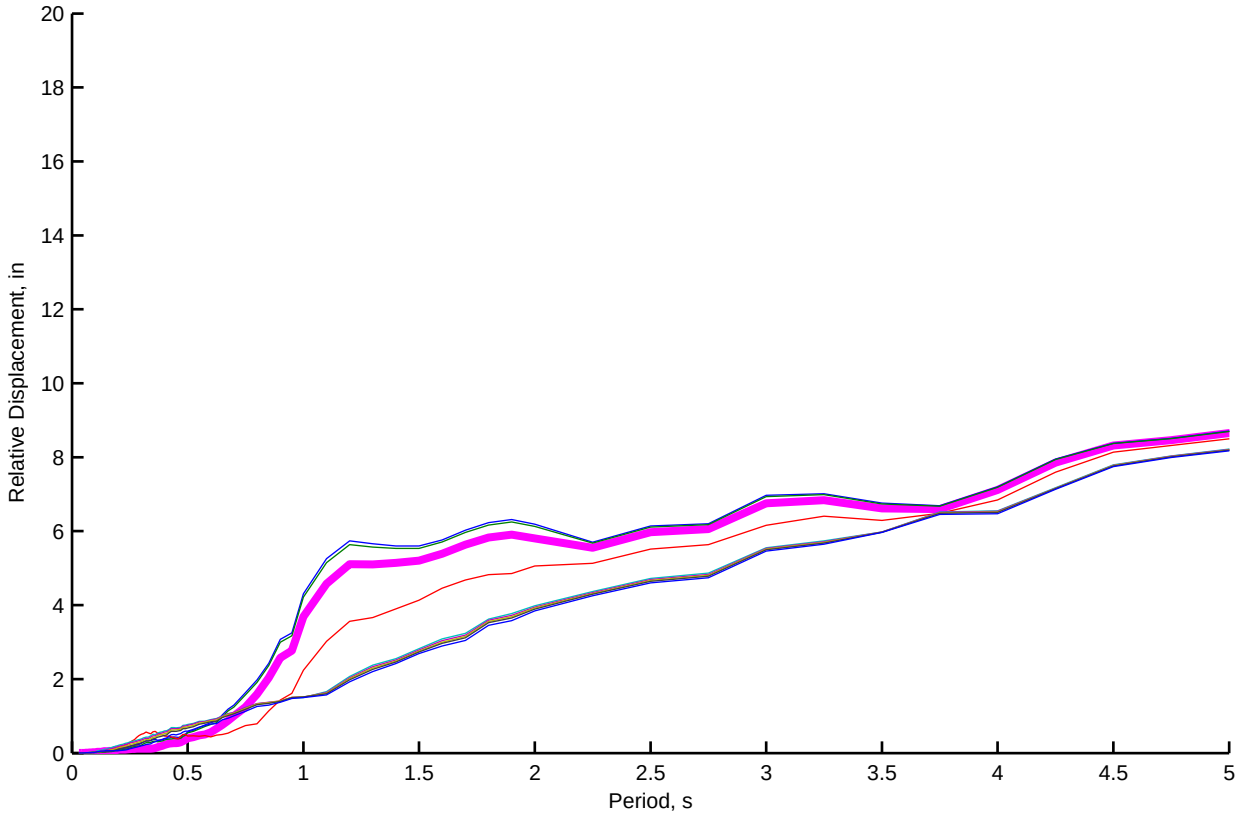

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

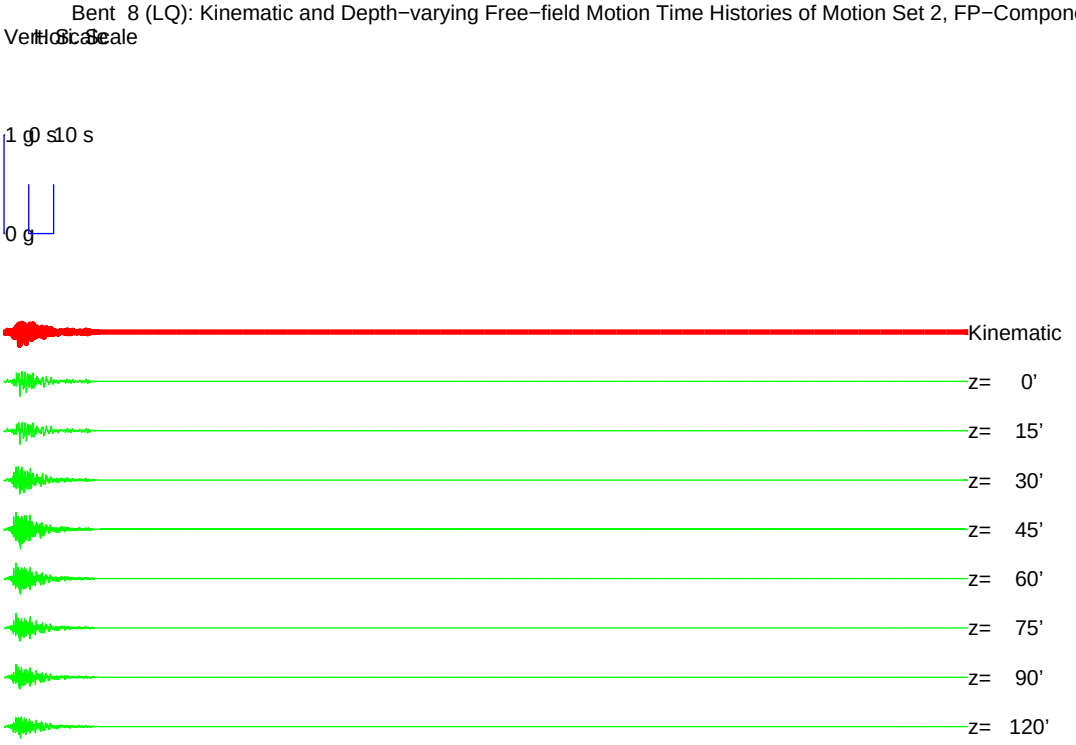


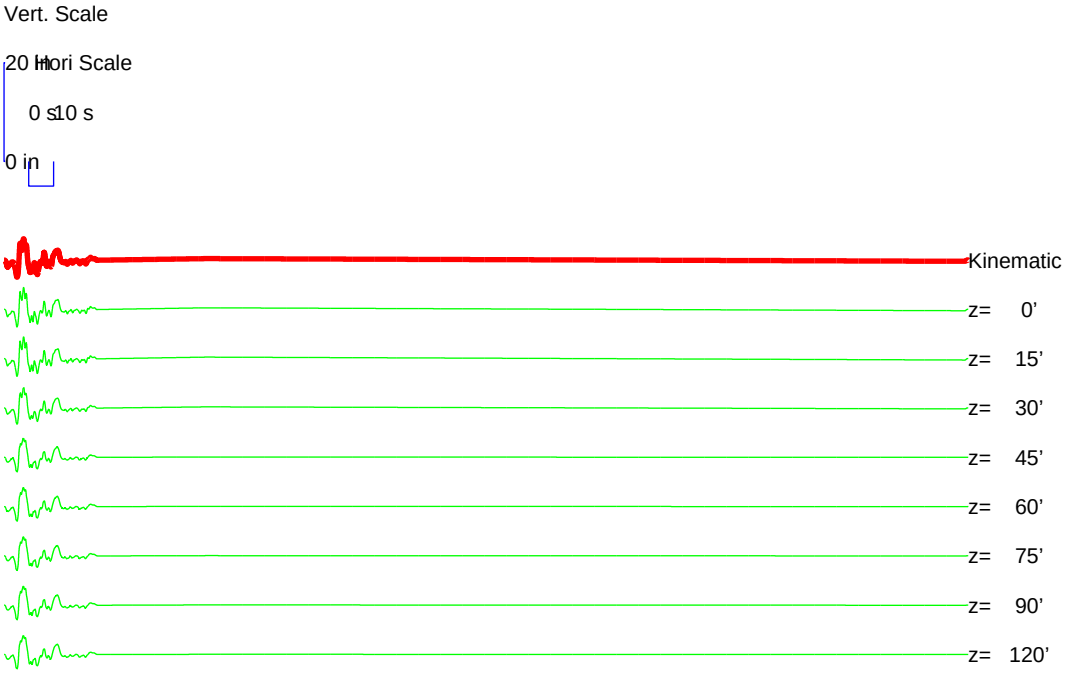



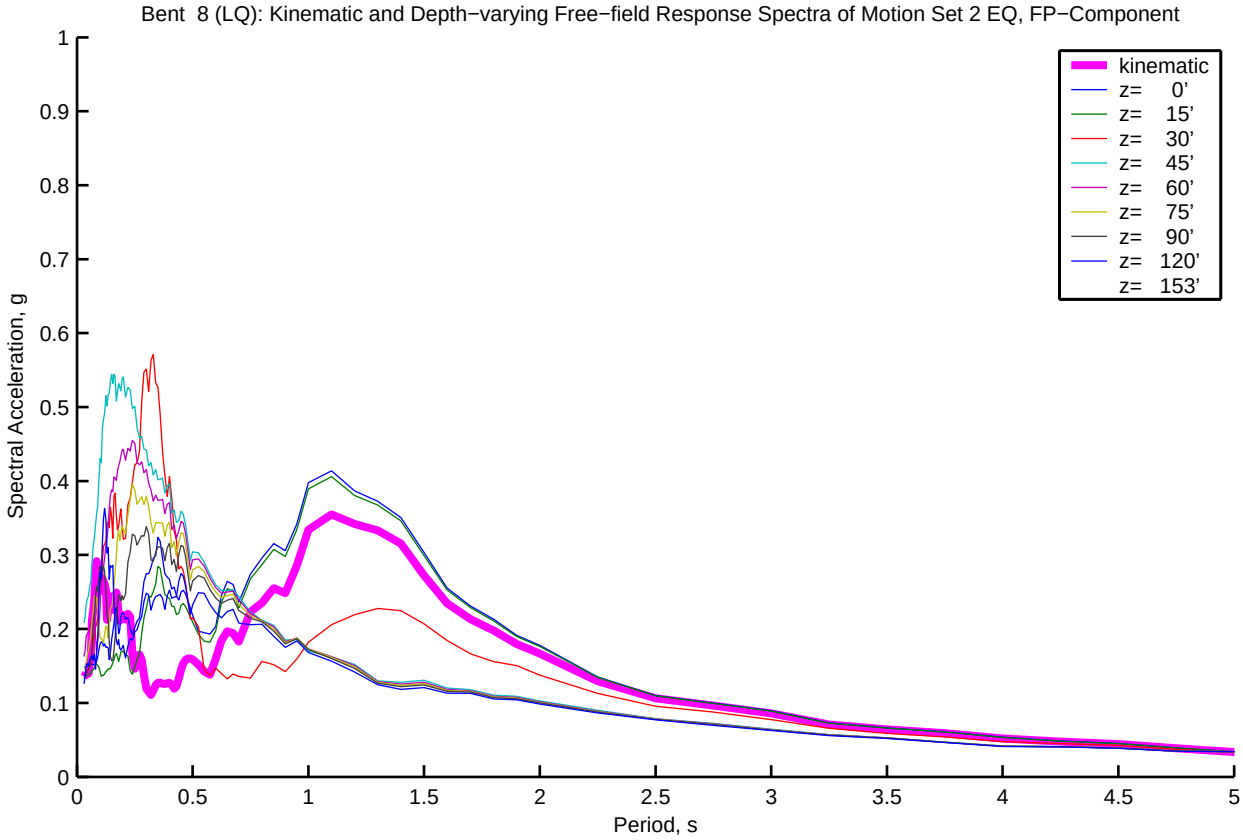

Bent 8 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

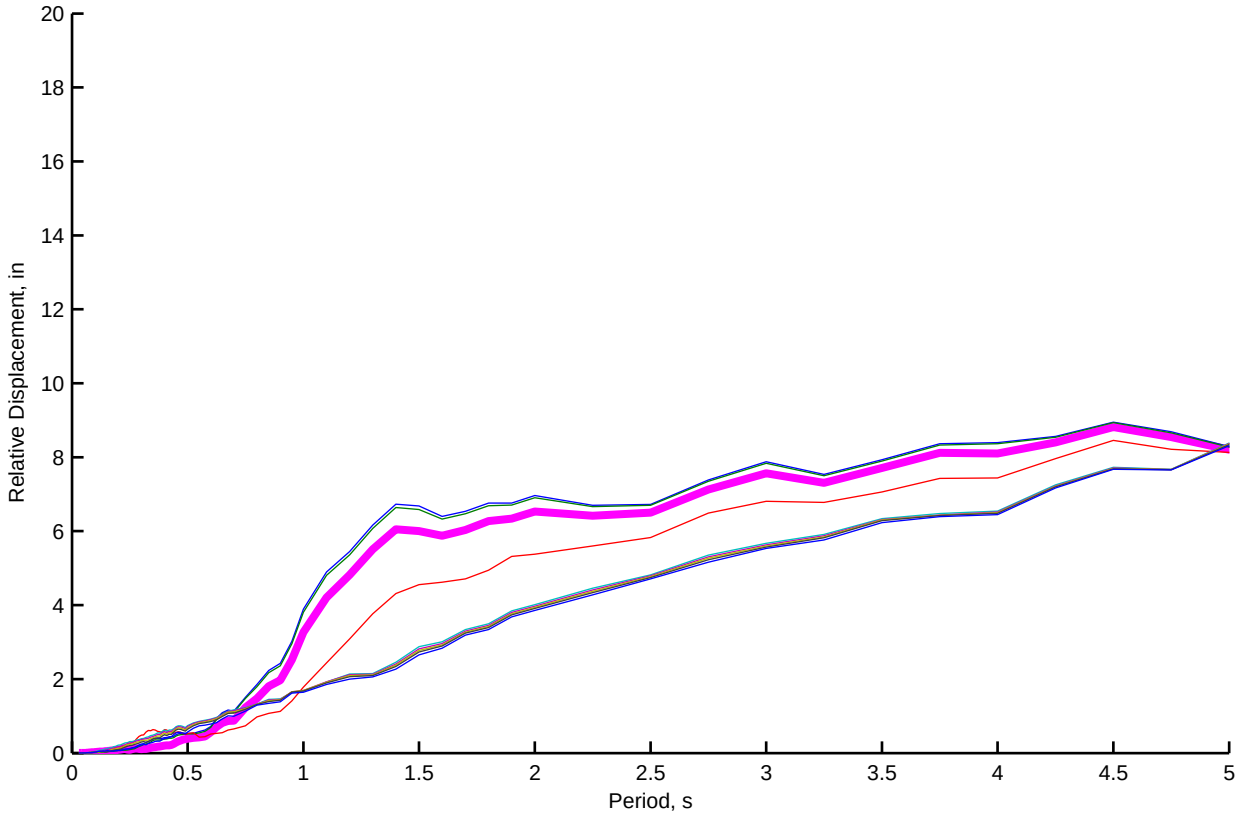

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

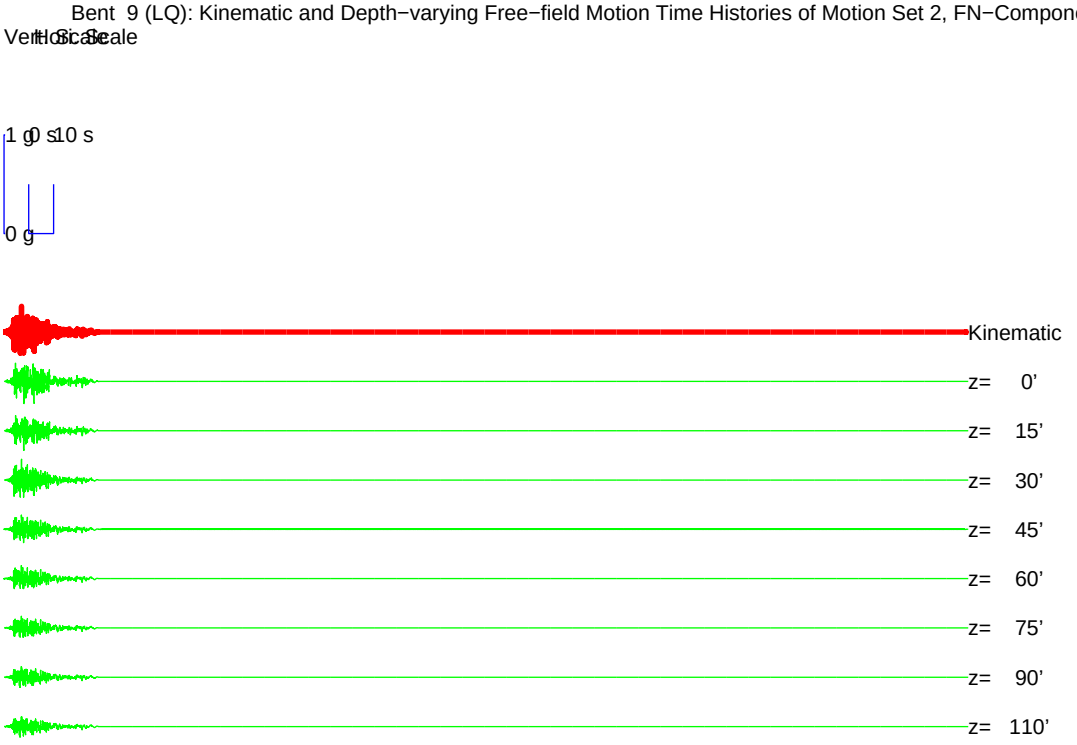


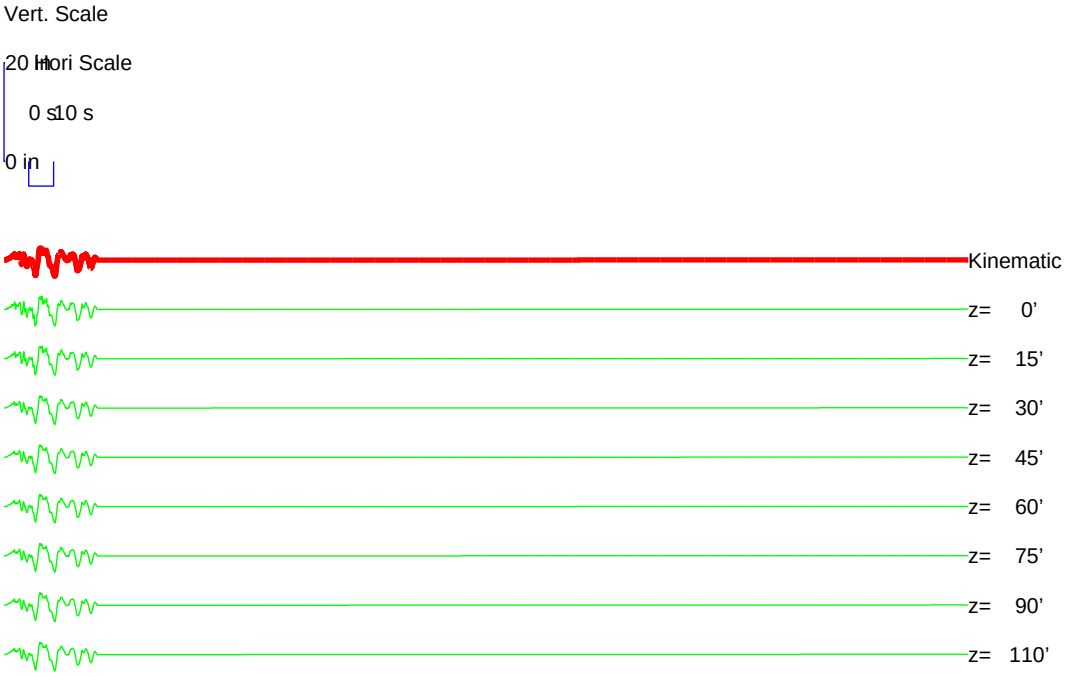



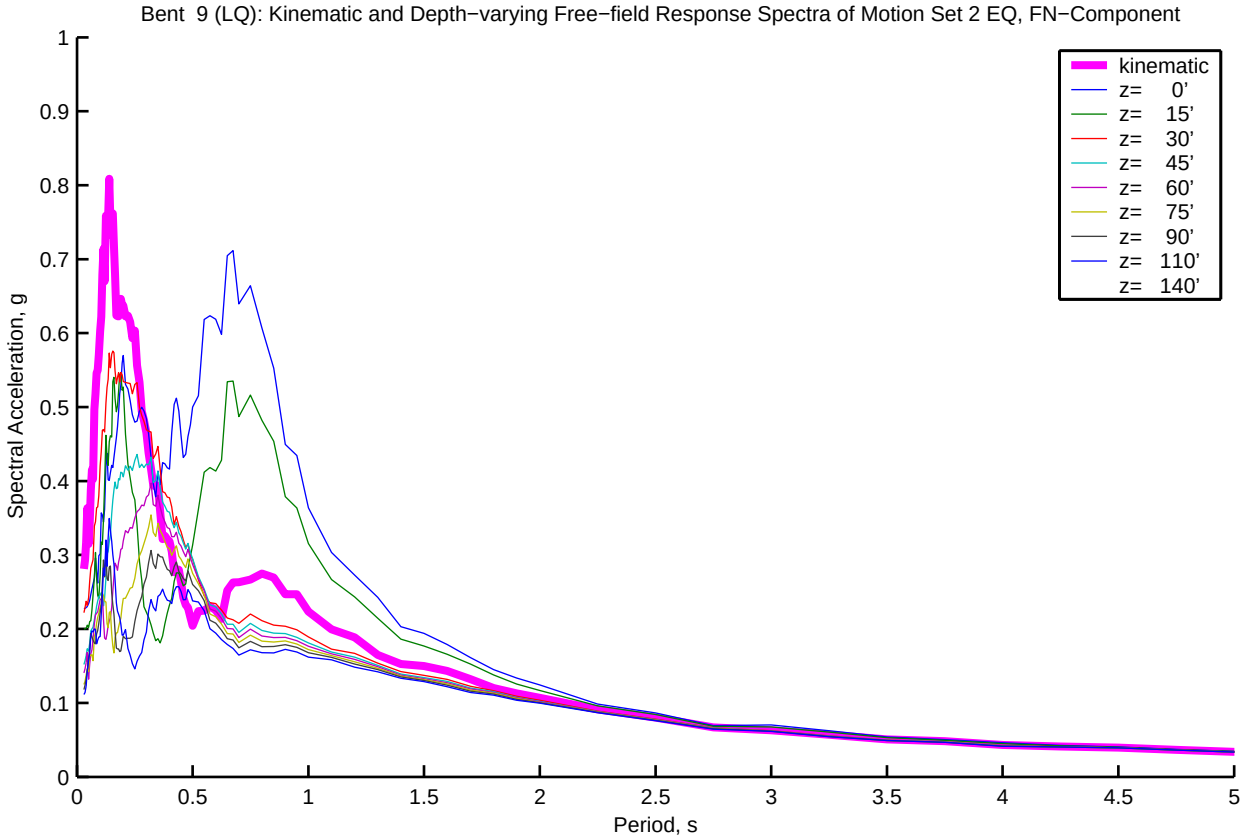

Bent 8 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

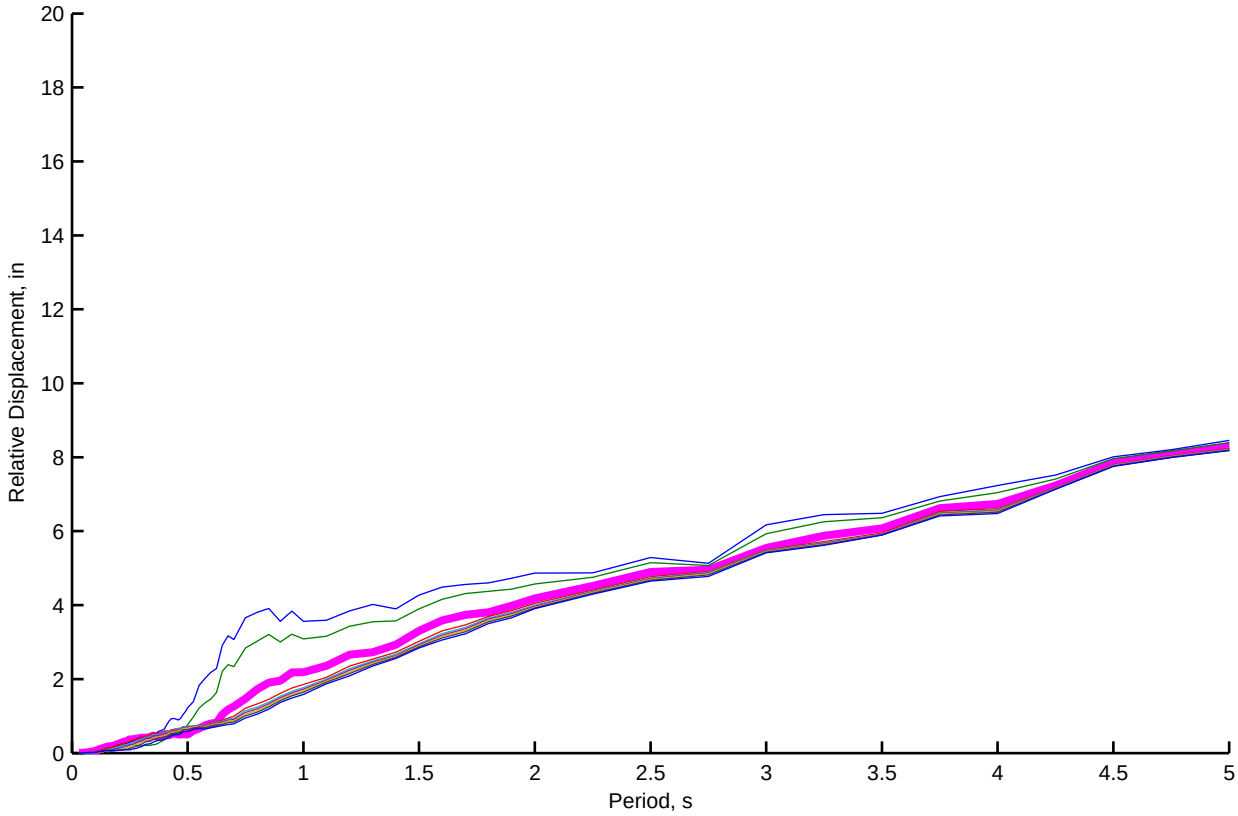

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 9 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

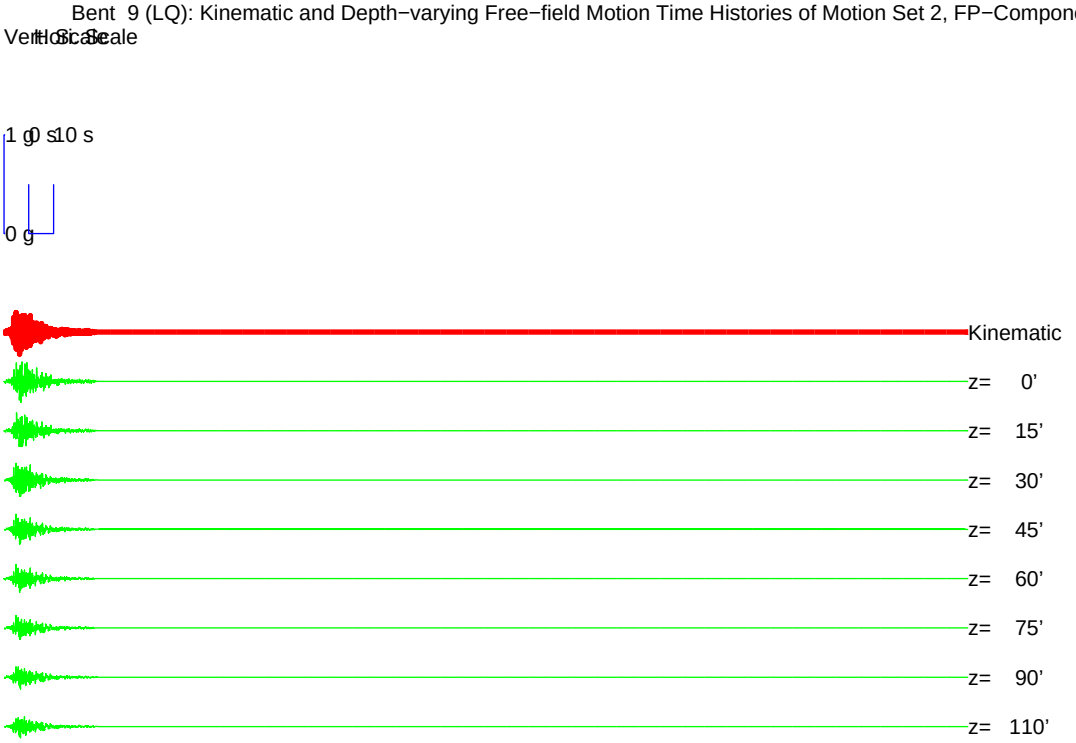


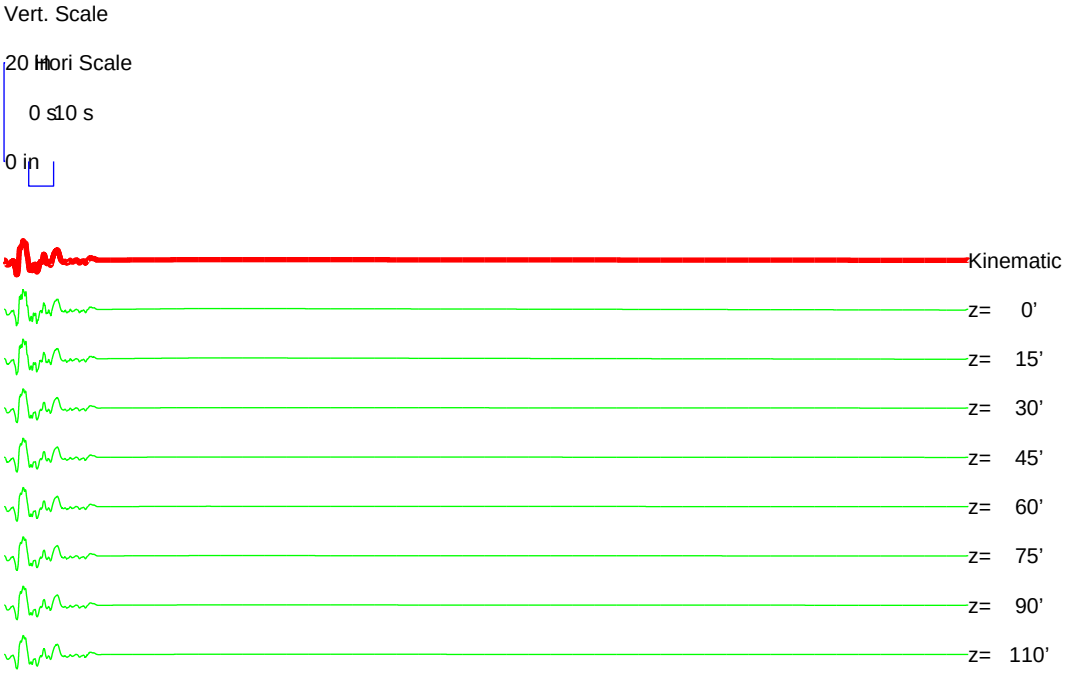



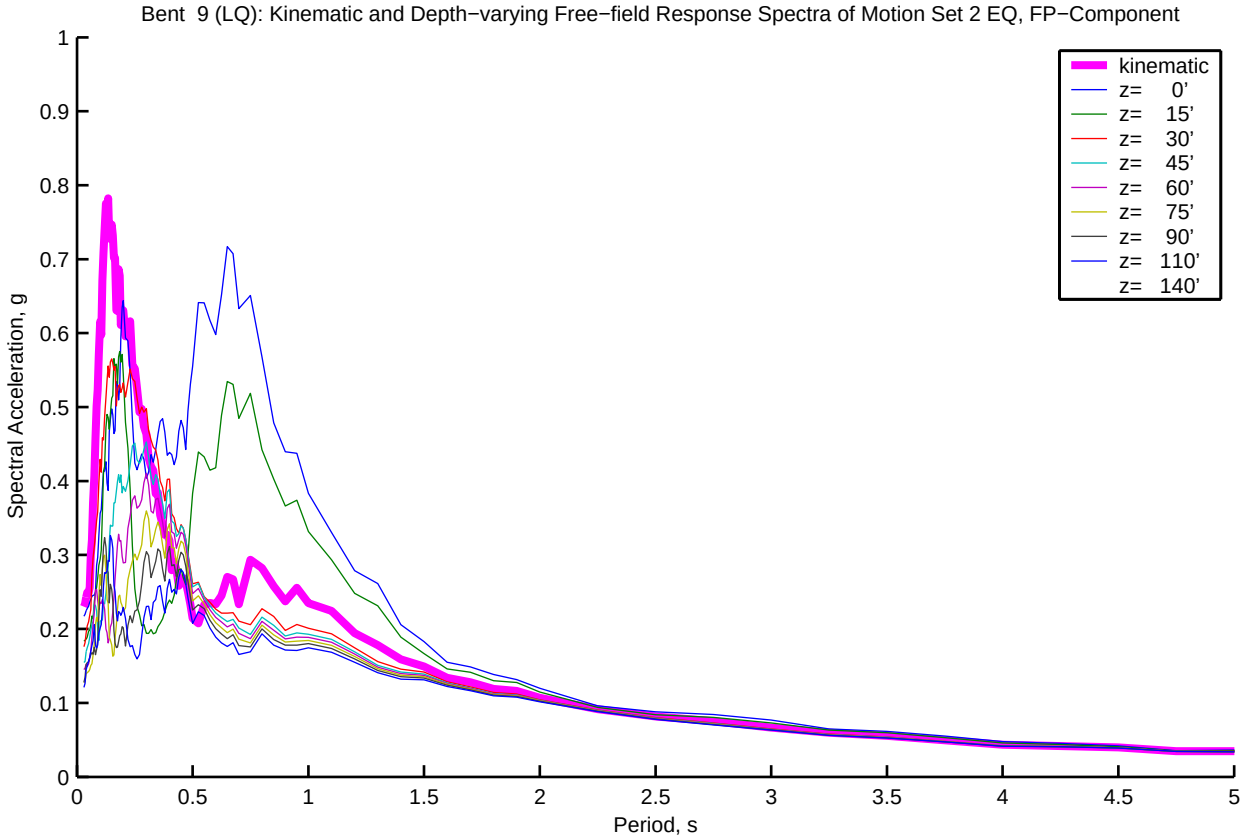

Bent 9 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

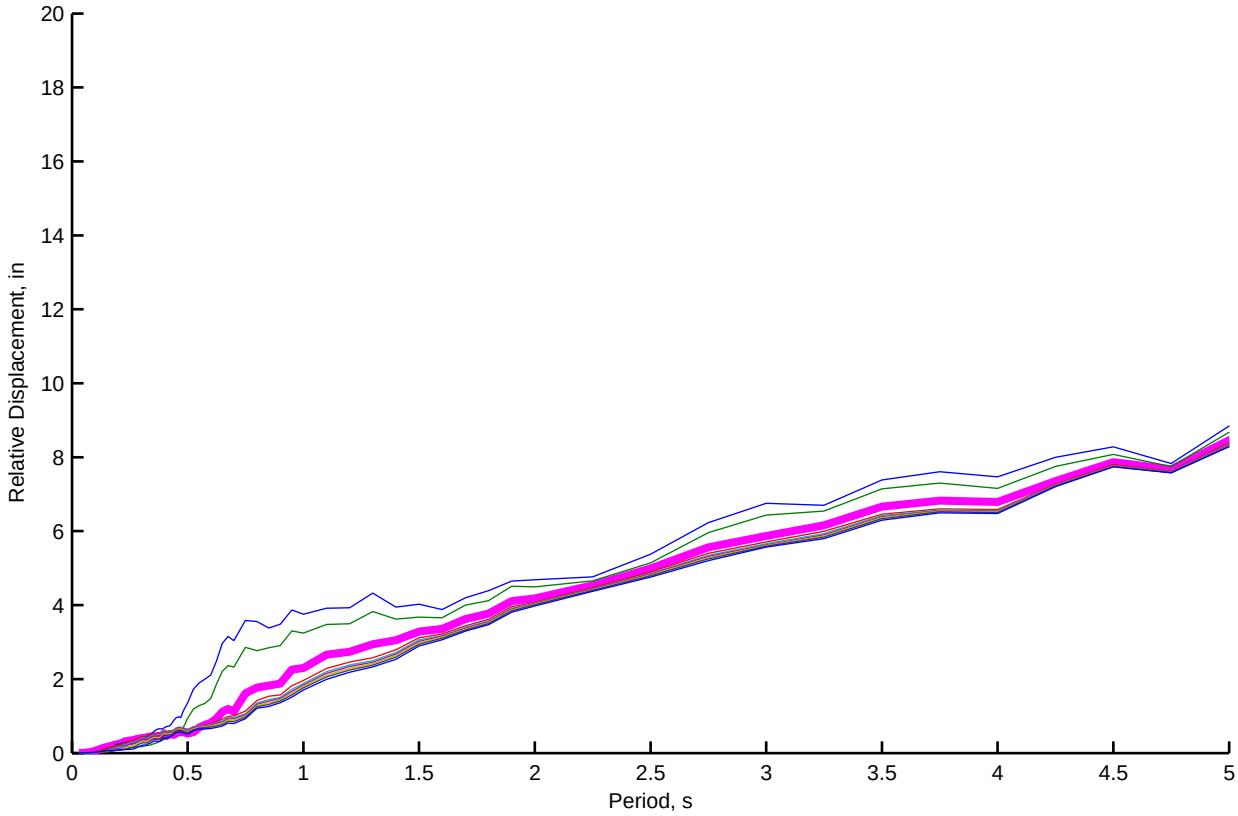

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 9 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

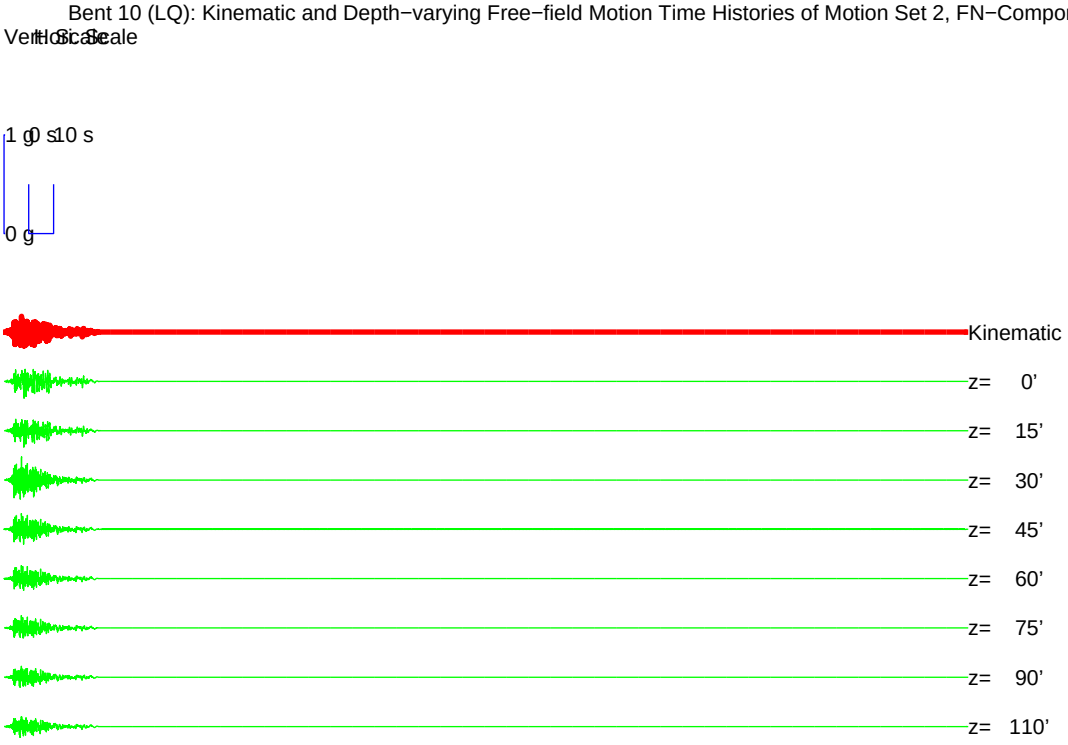


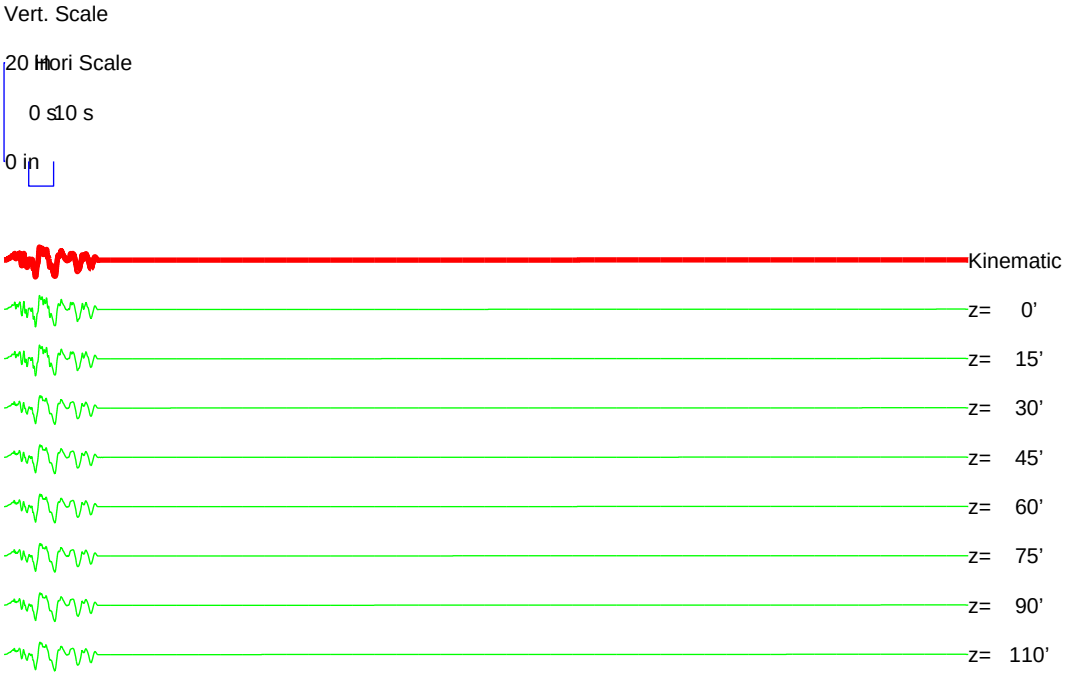



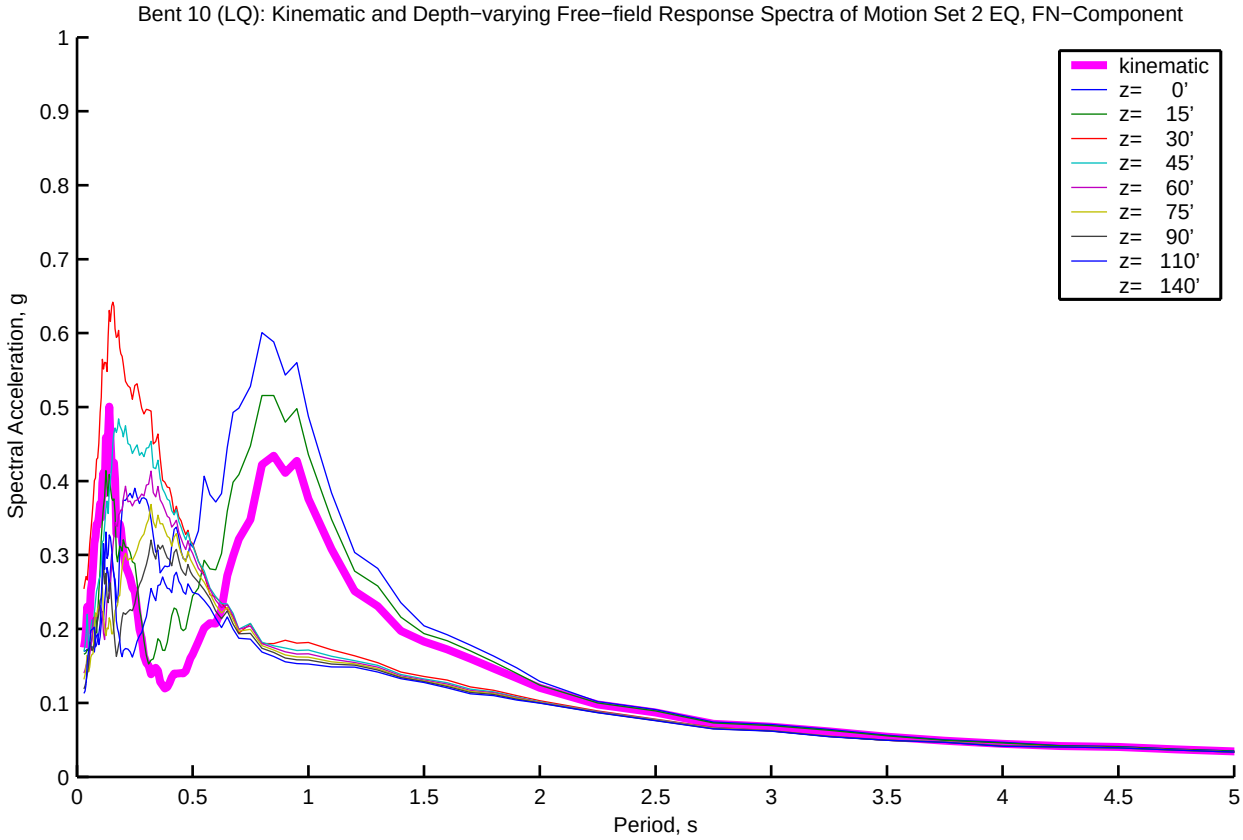

Bent 9 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

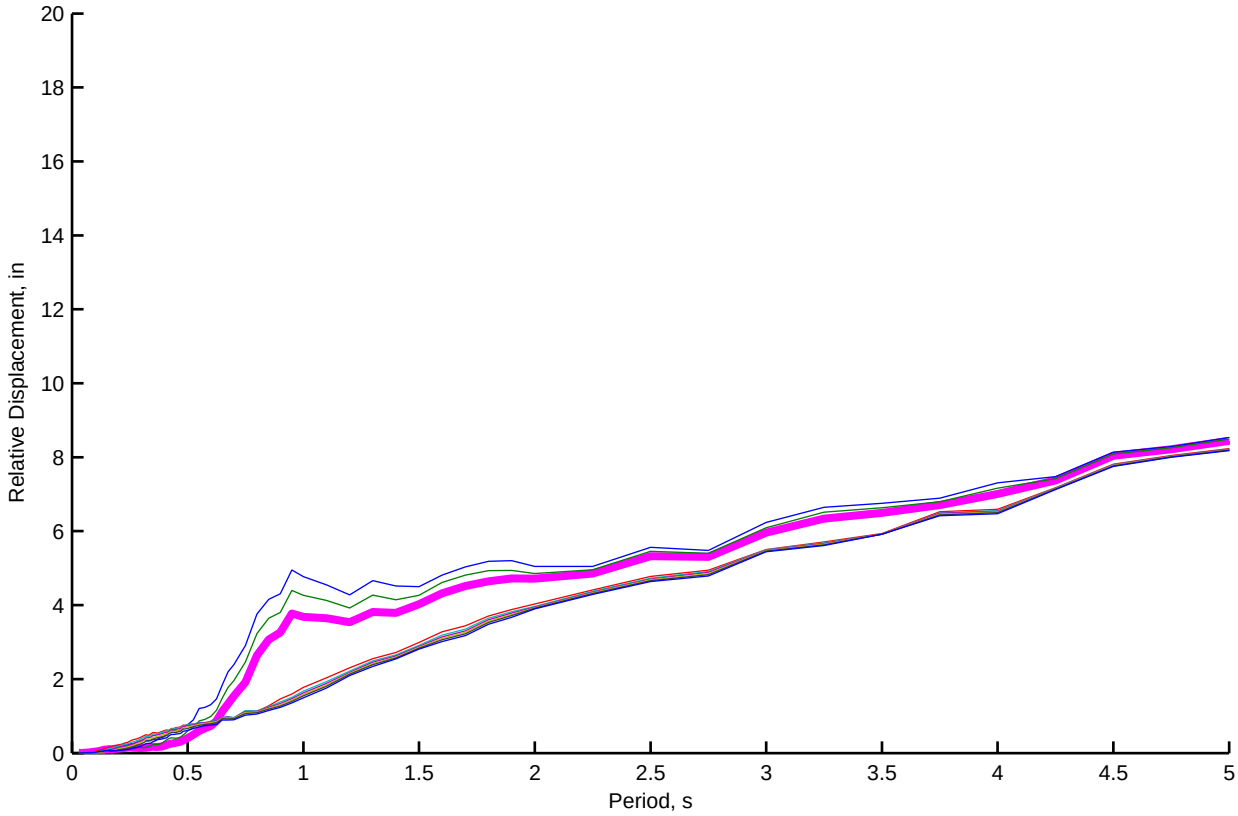

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 10 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FN−Component

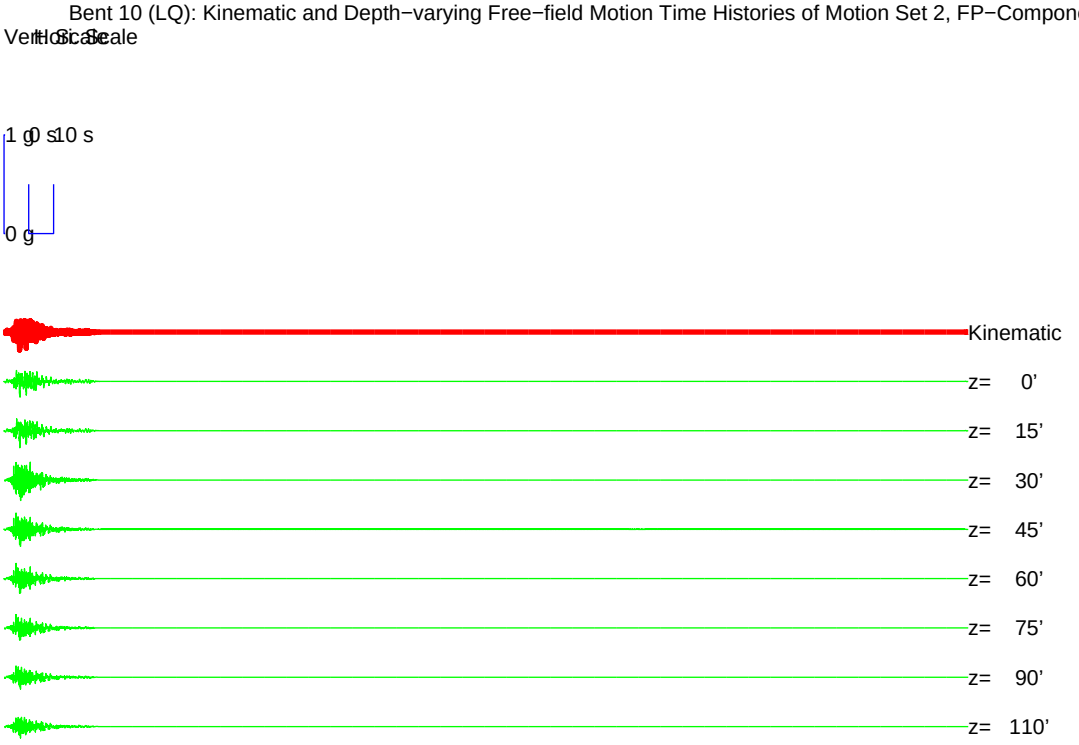


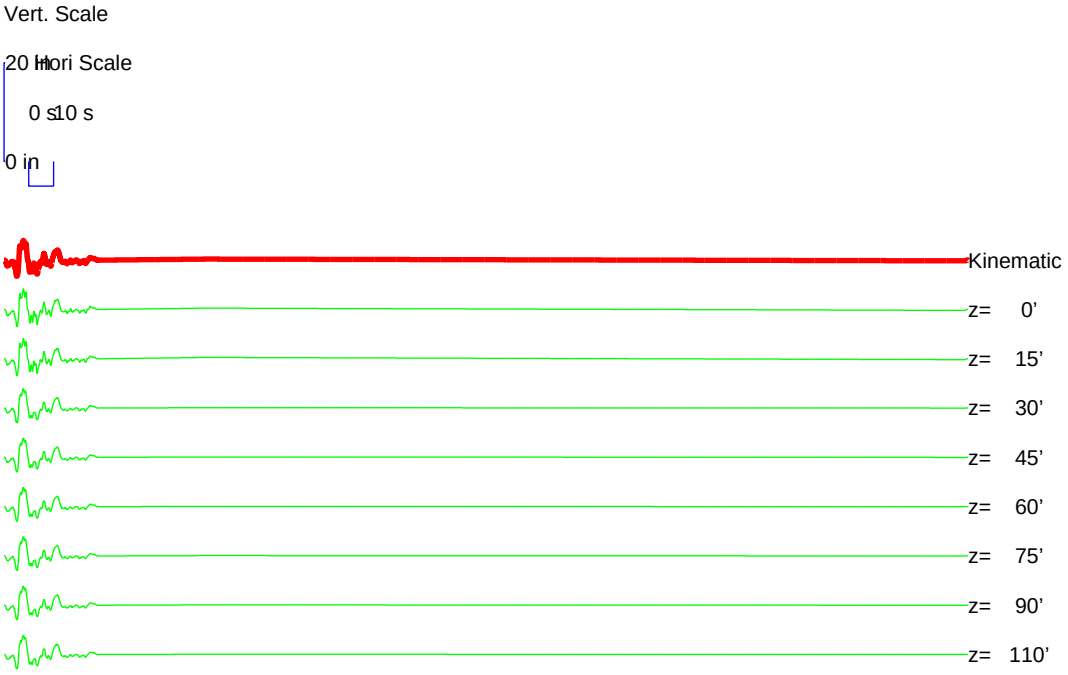



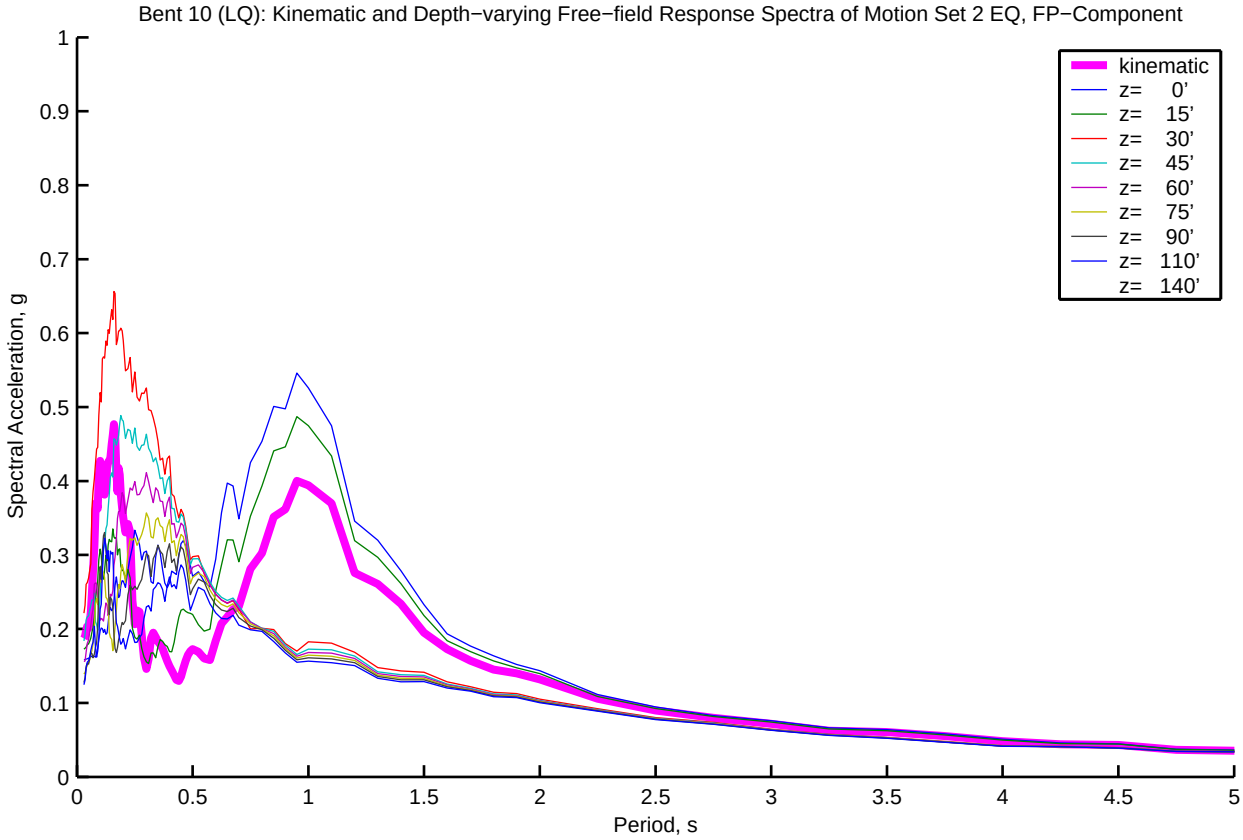

Bent 10 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

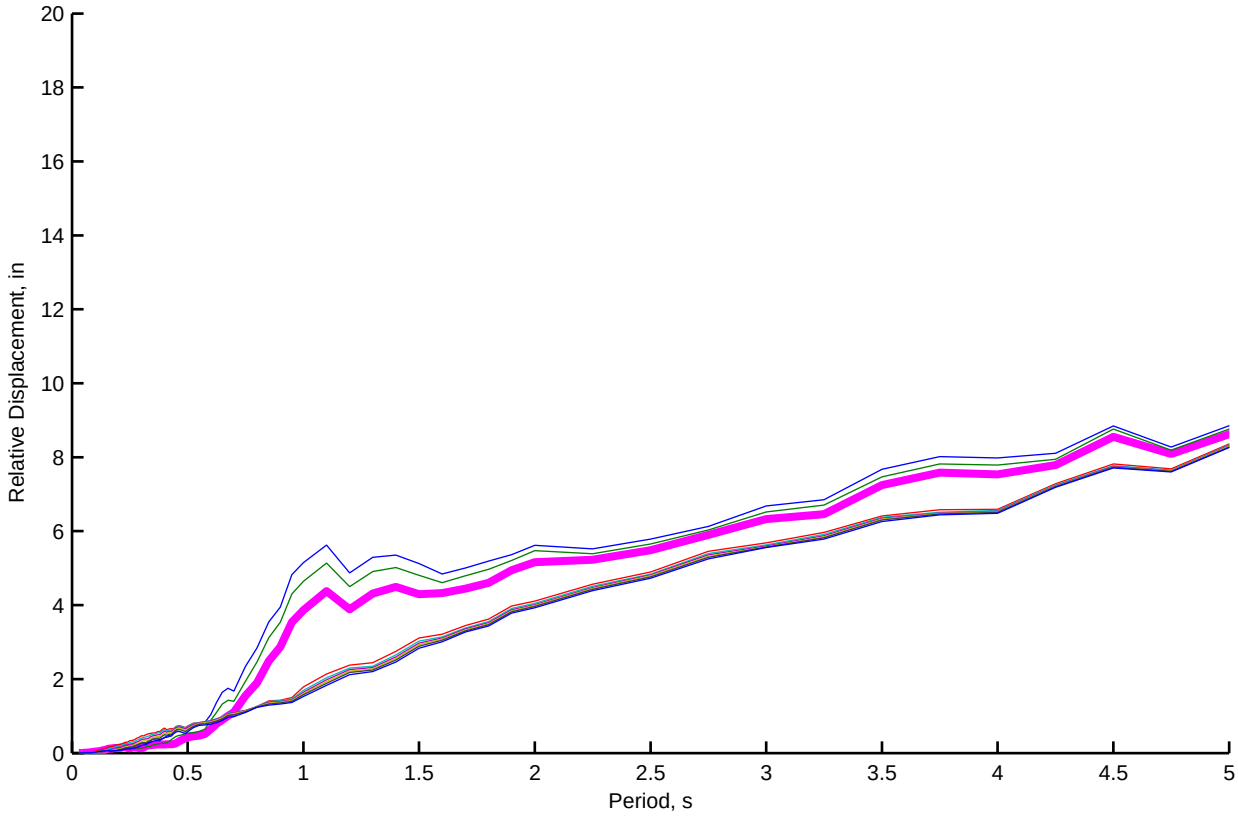

Relative Displacement, in
Period, s

Bent 10 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 2, FP−Component

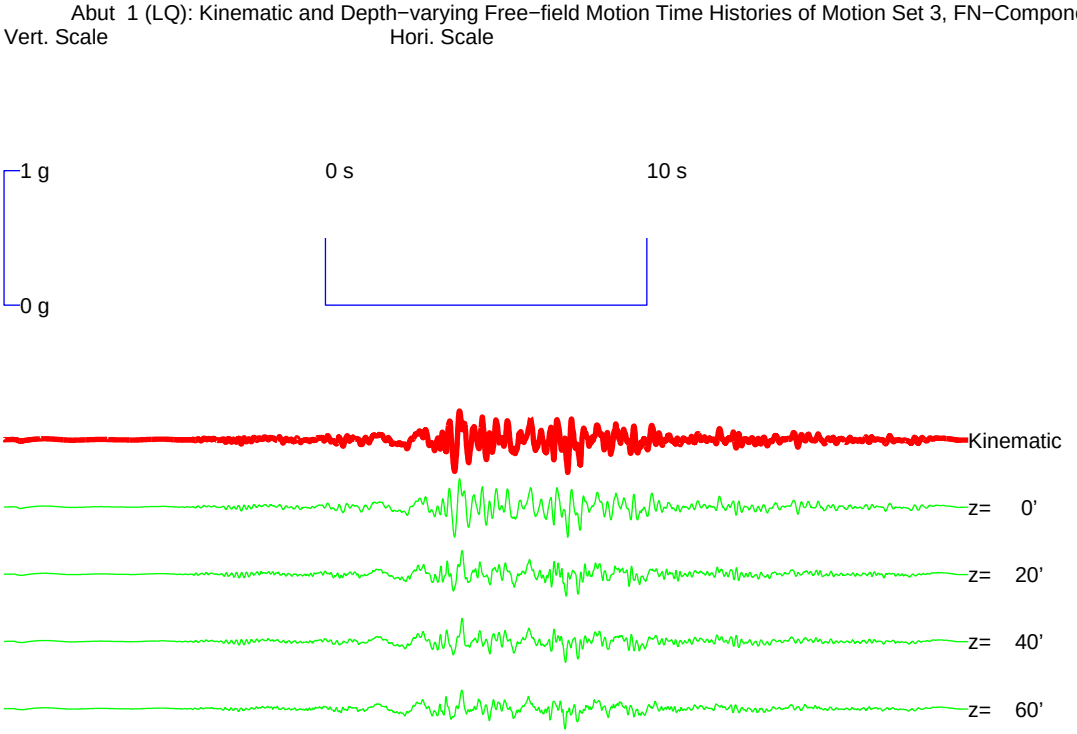


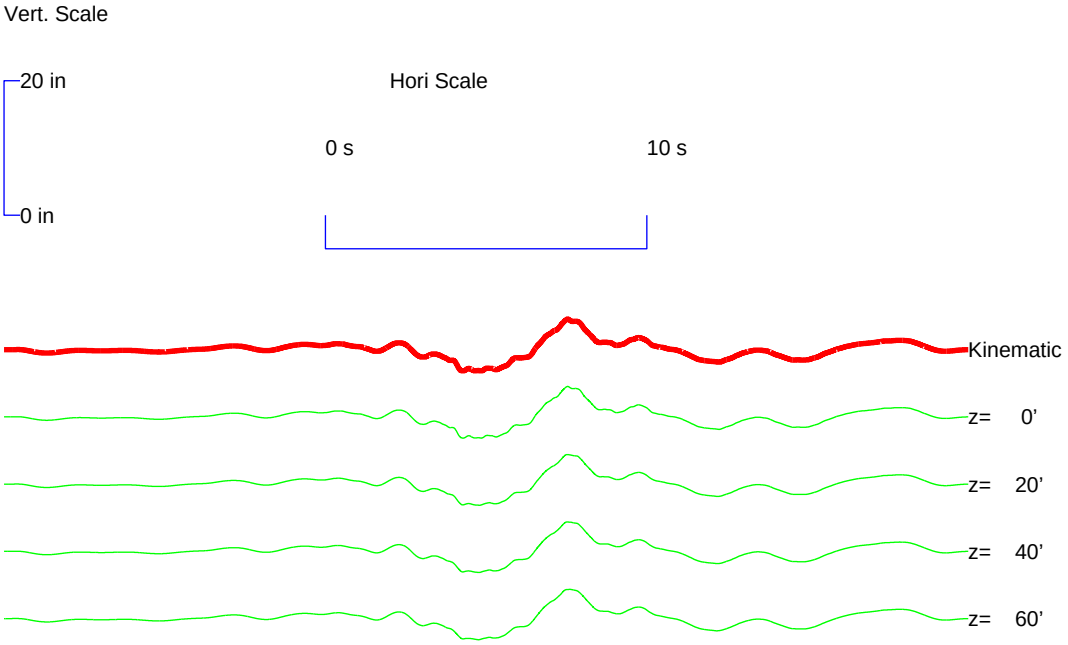



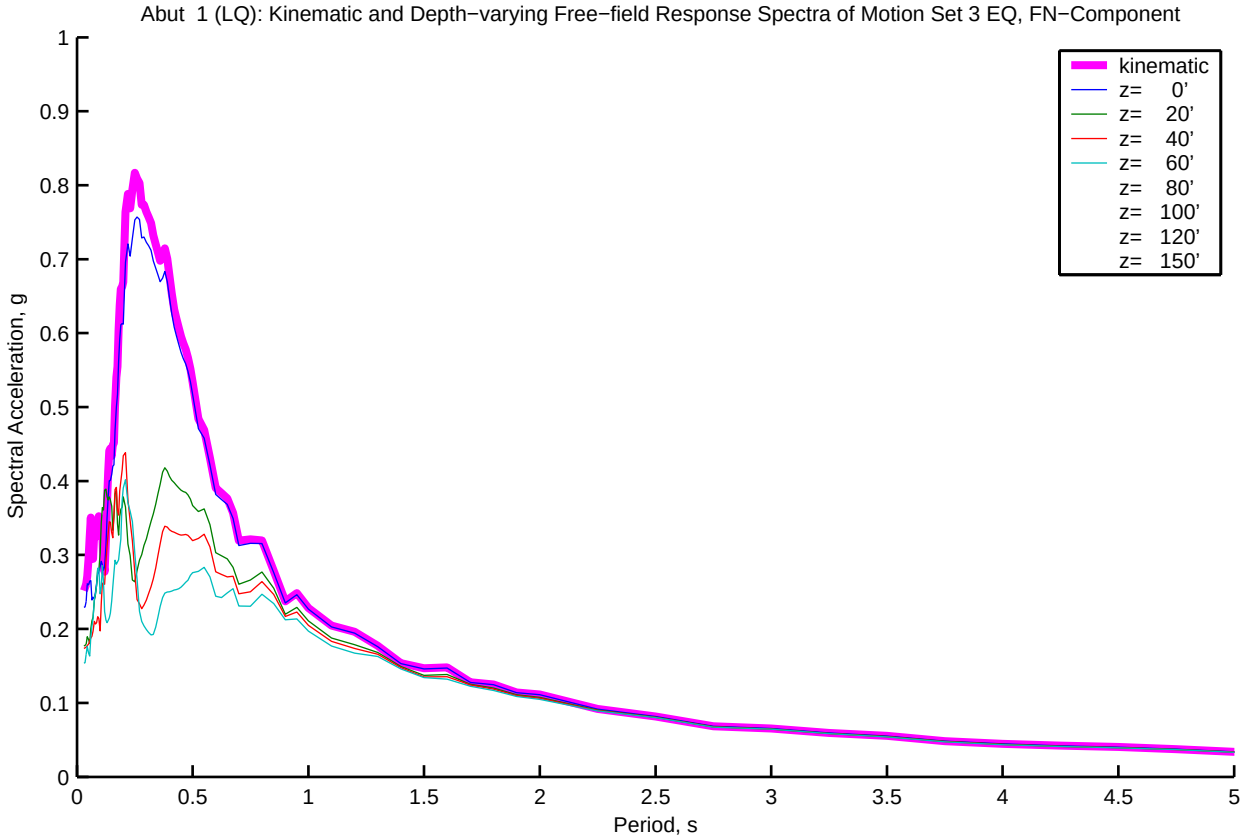

Bent 10 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 2 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'

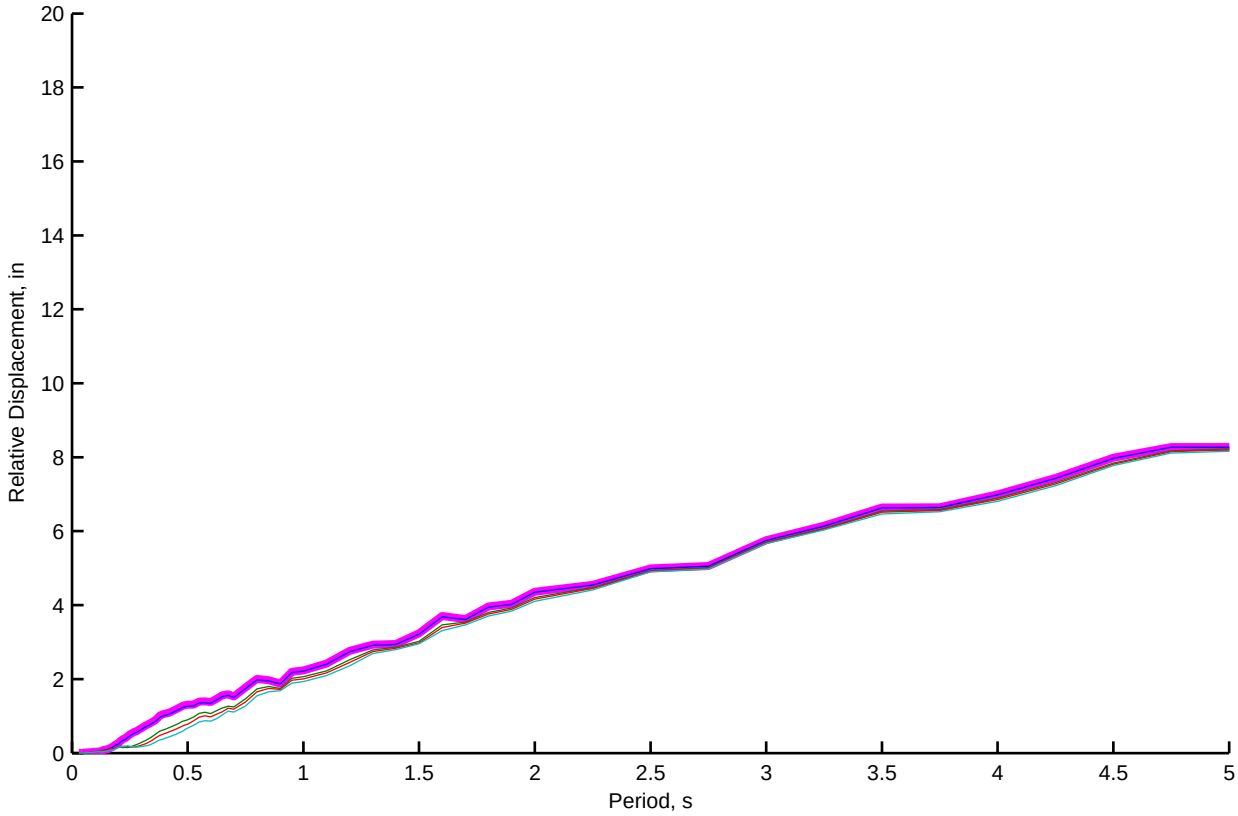

Relative Displacement, in
Period, s

Abut 1 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

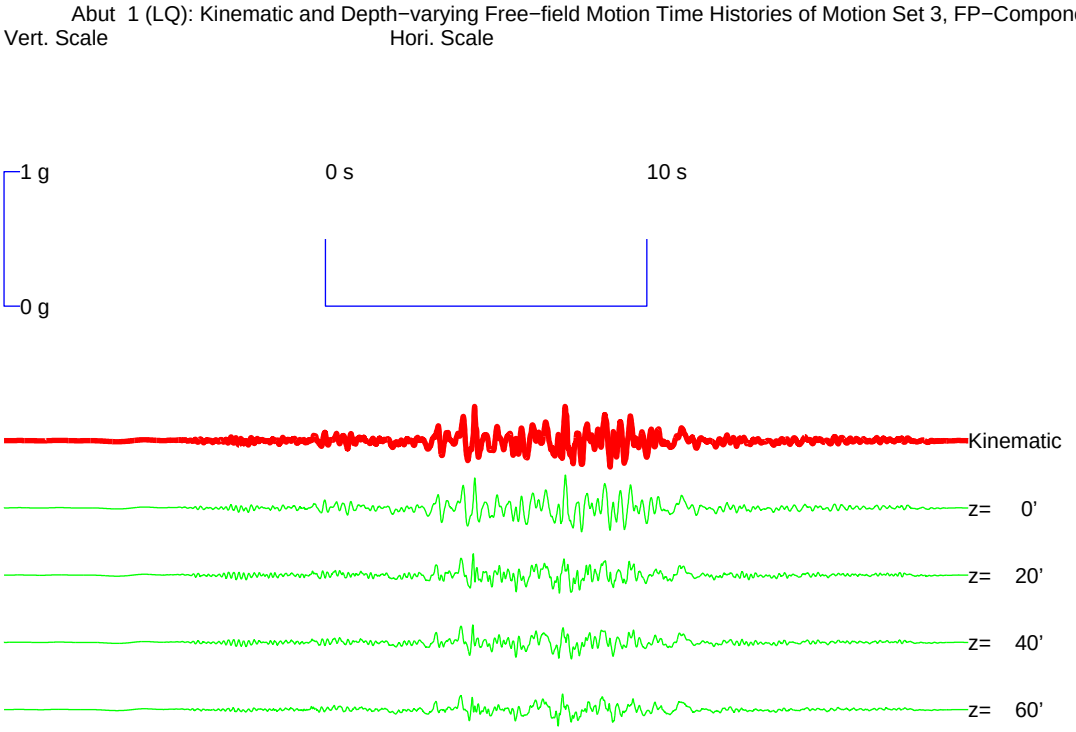


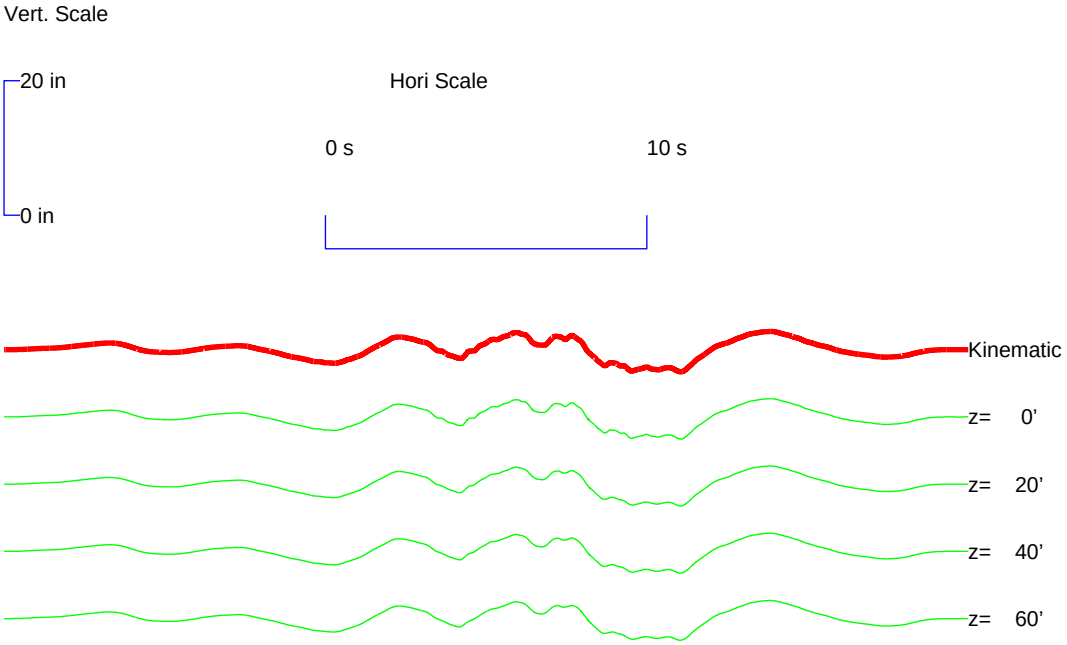



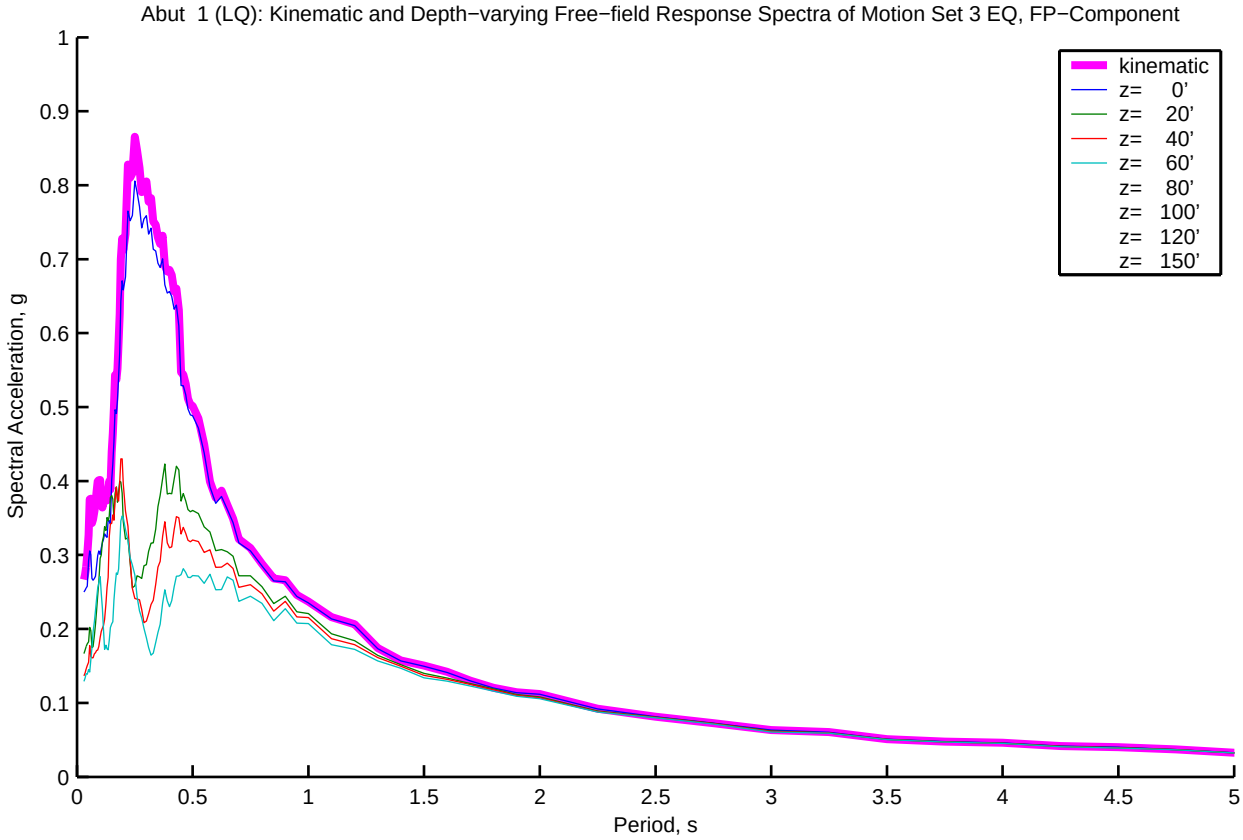

Abut 1 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

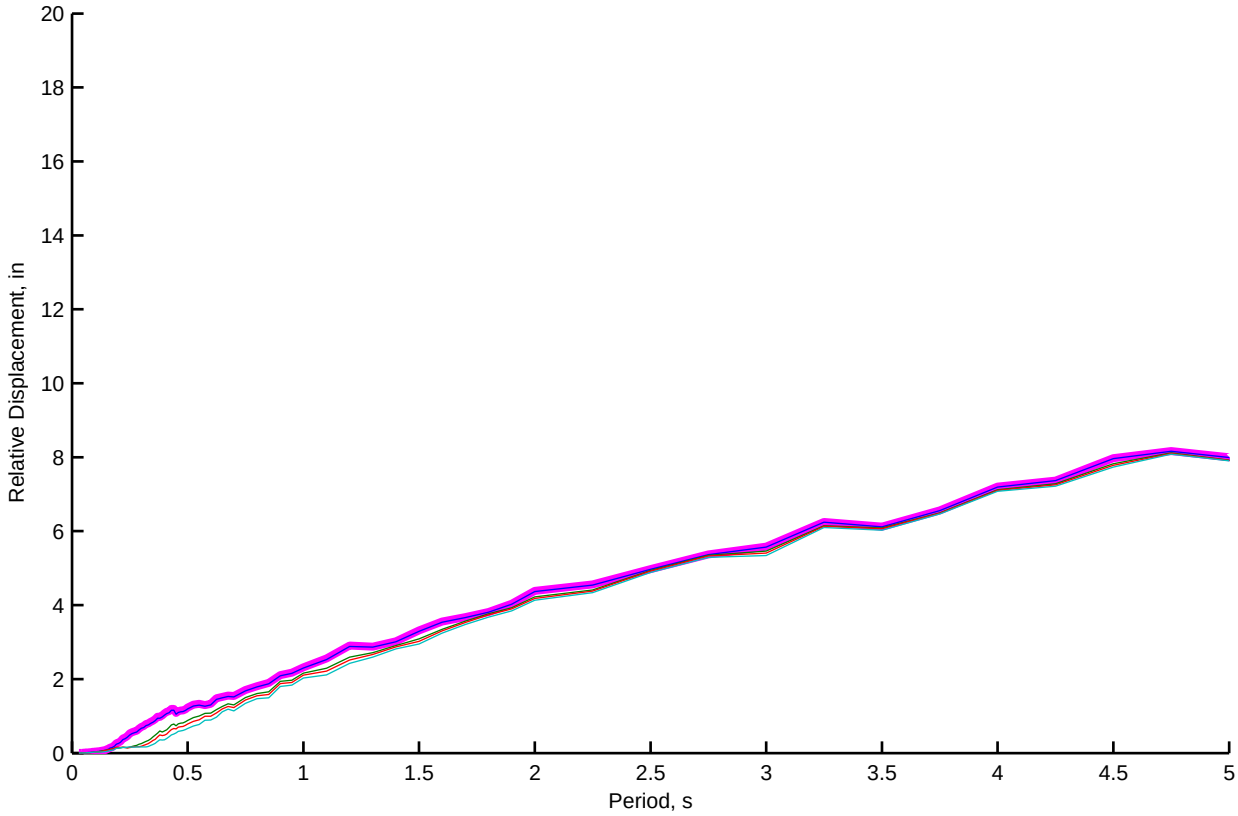

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 1 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

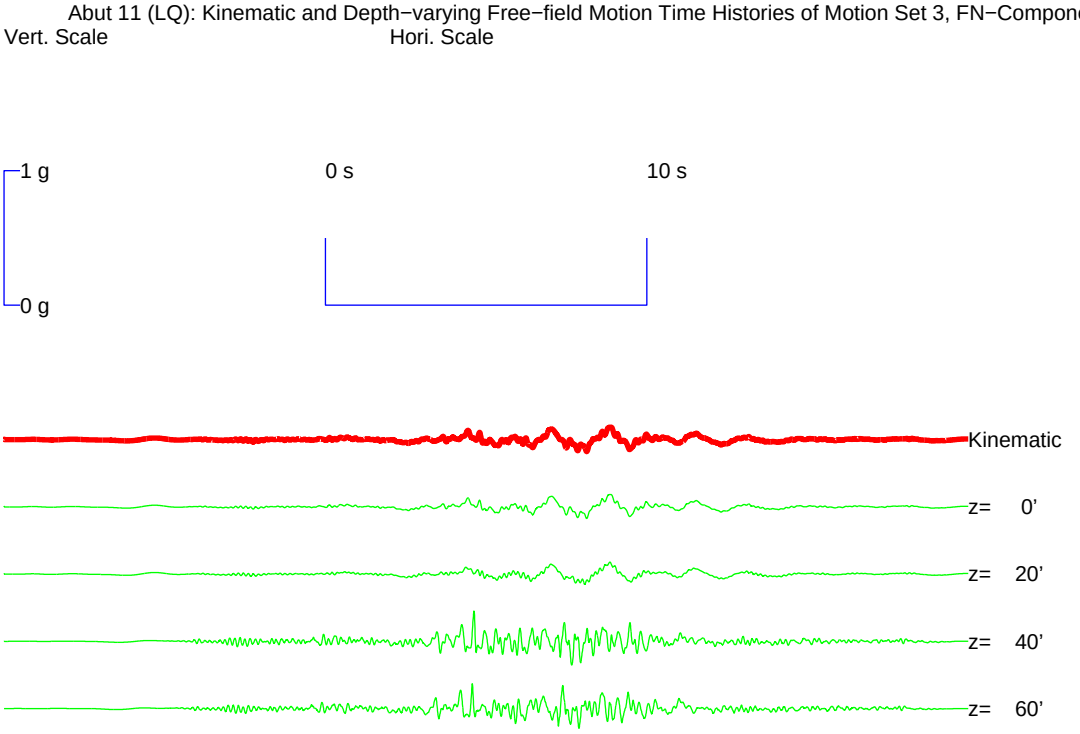


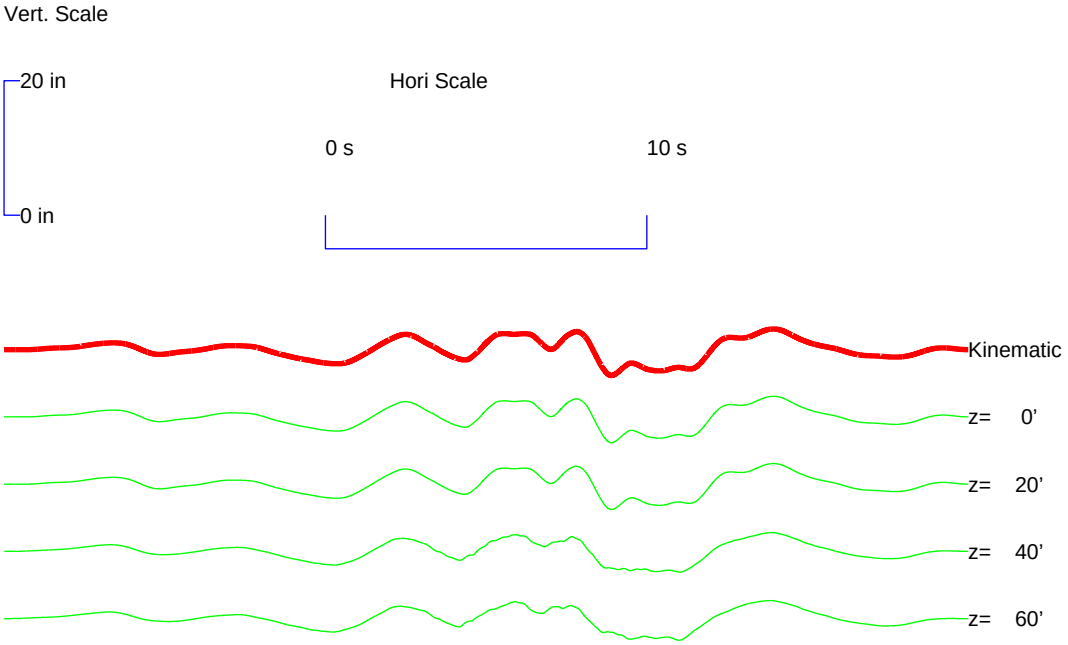



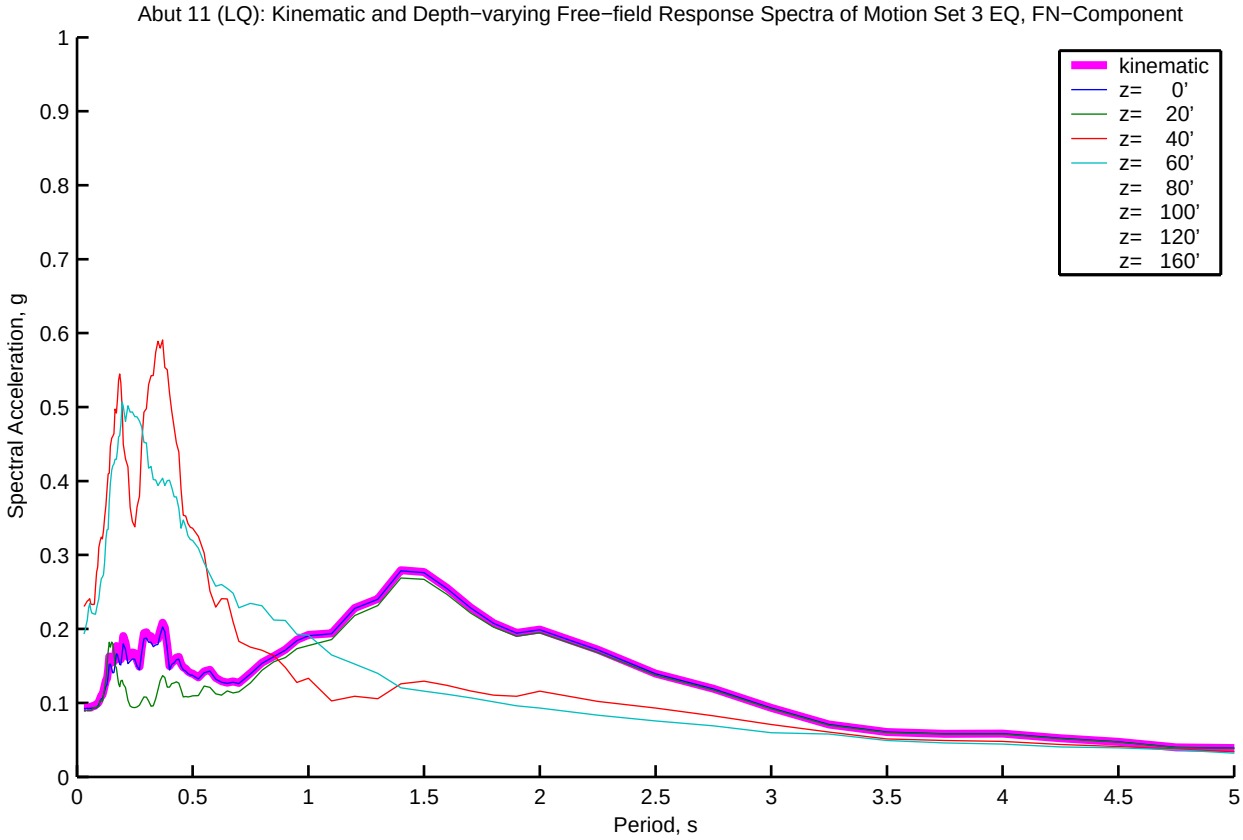

Abut 1 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 150'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

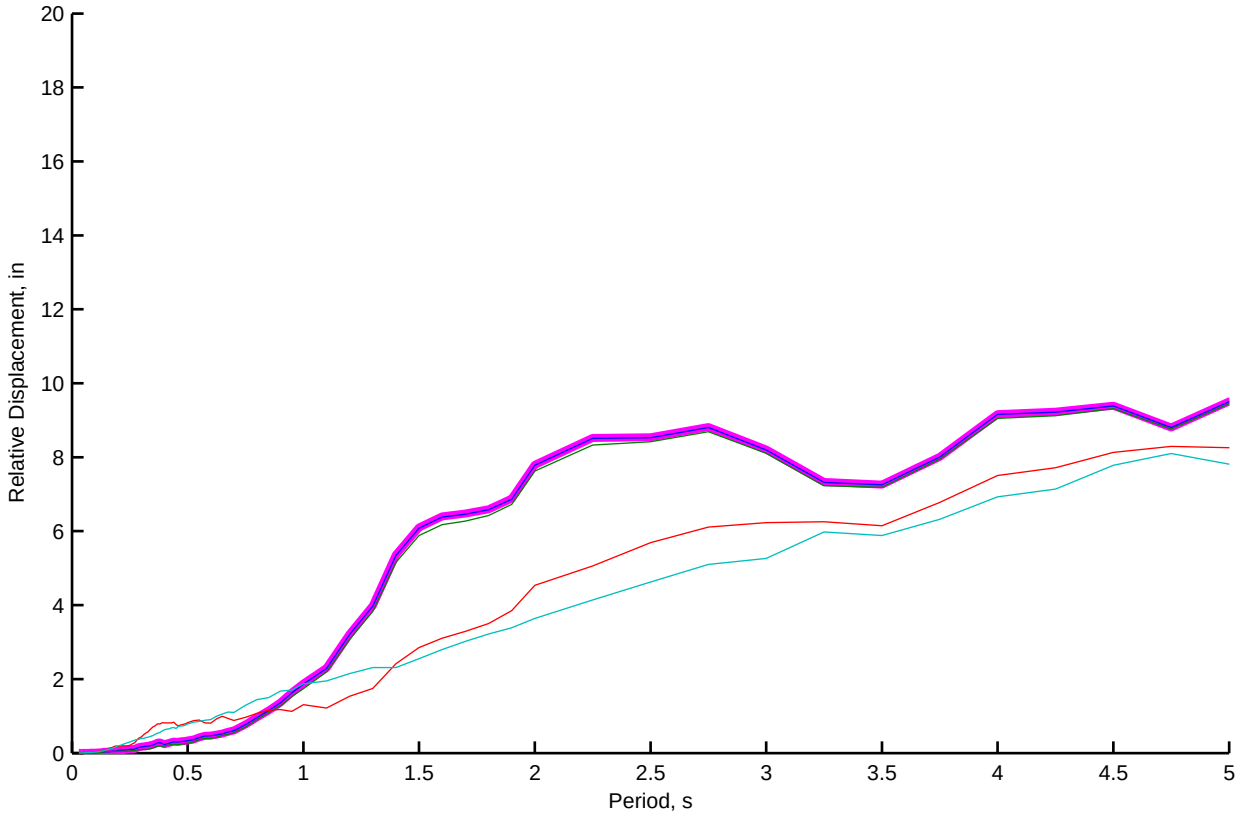

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

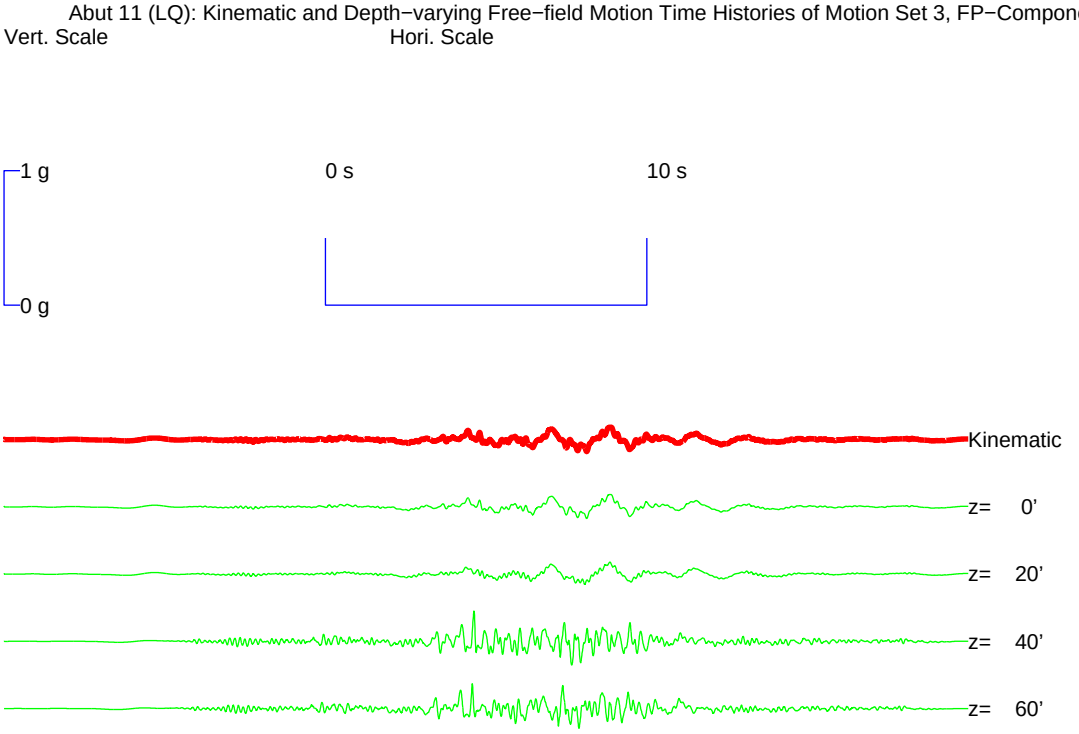


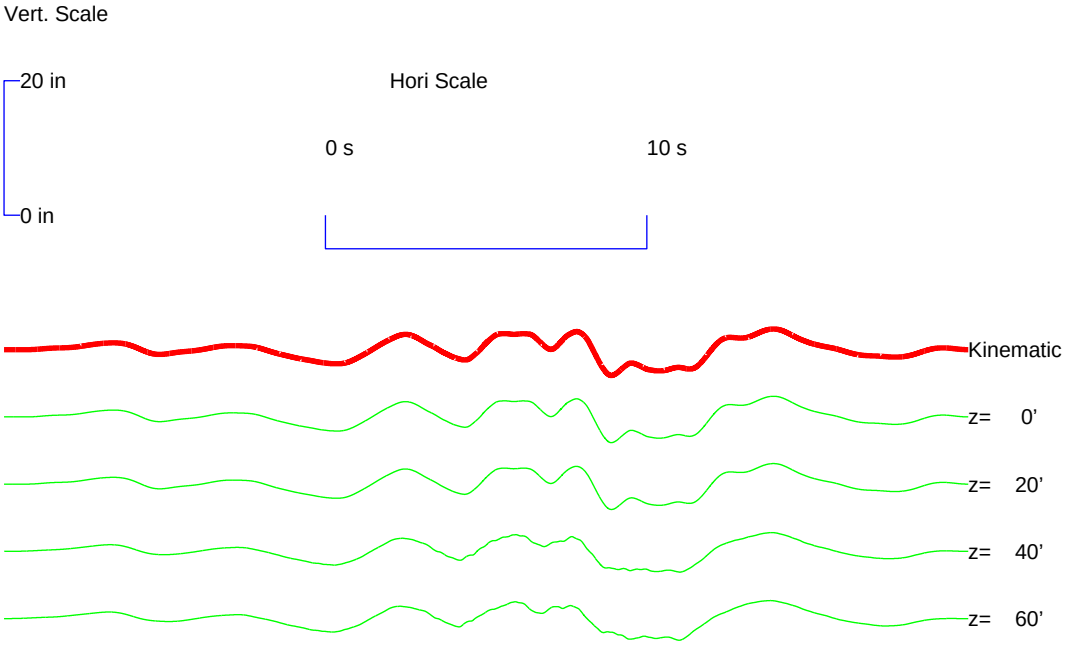



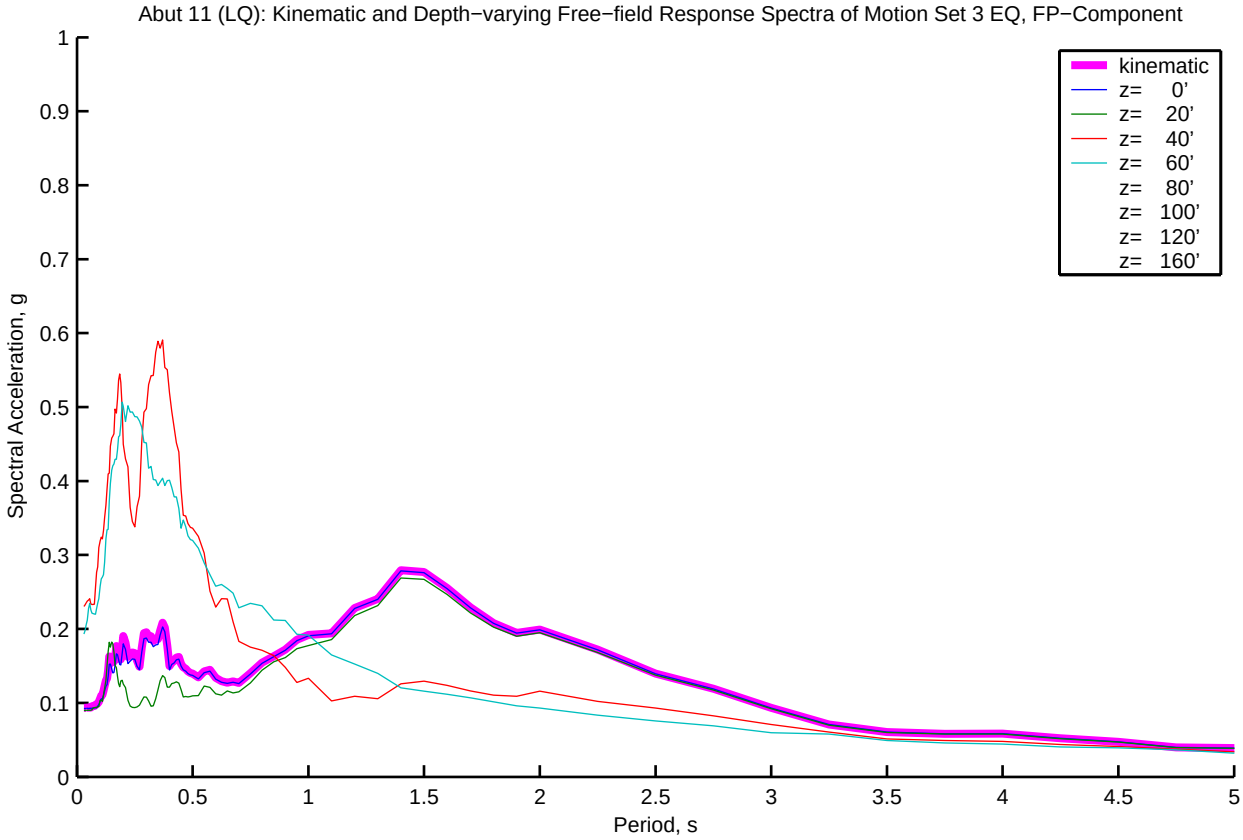

Abut 11 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

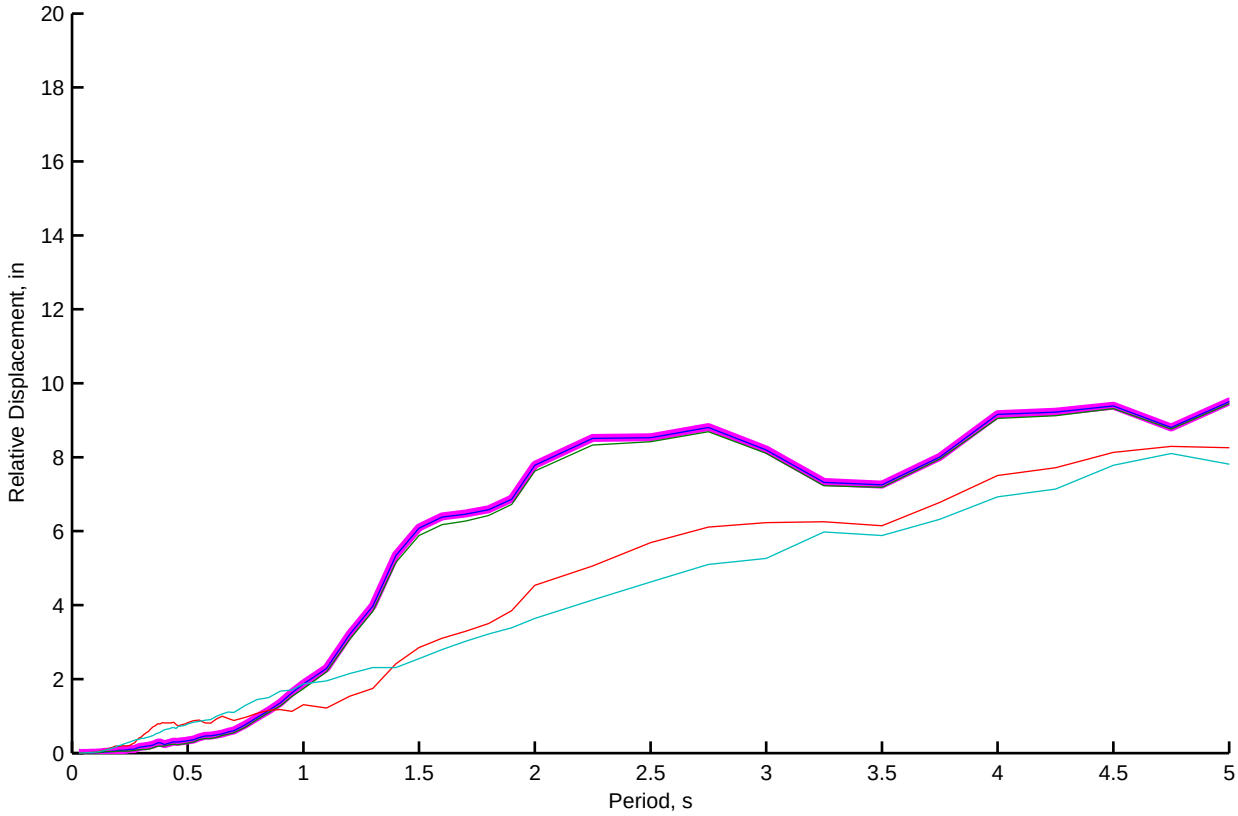

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Abut 11 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

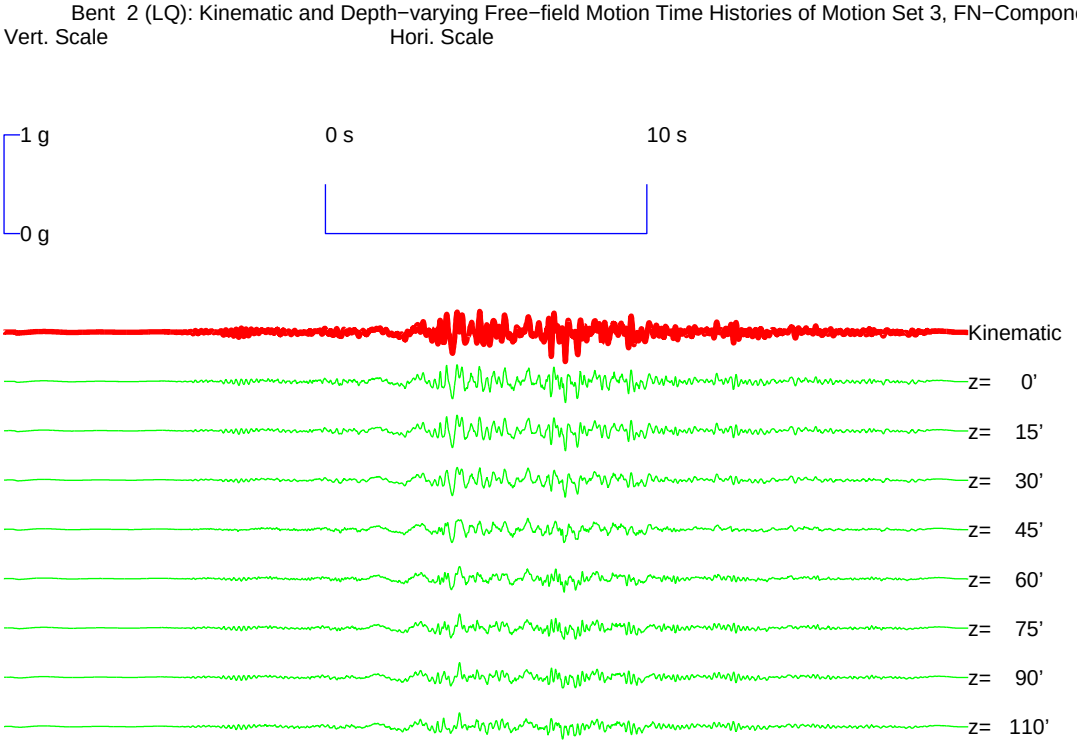


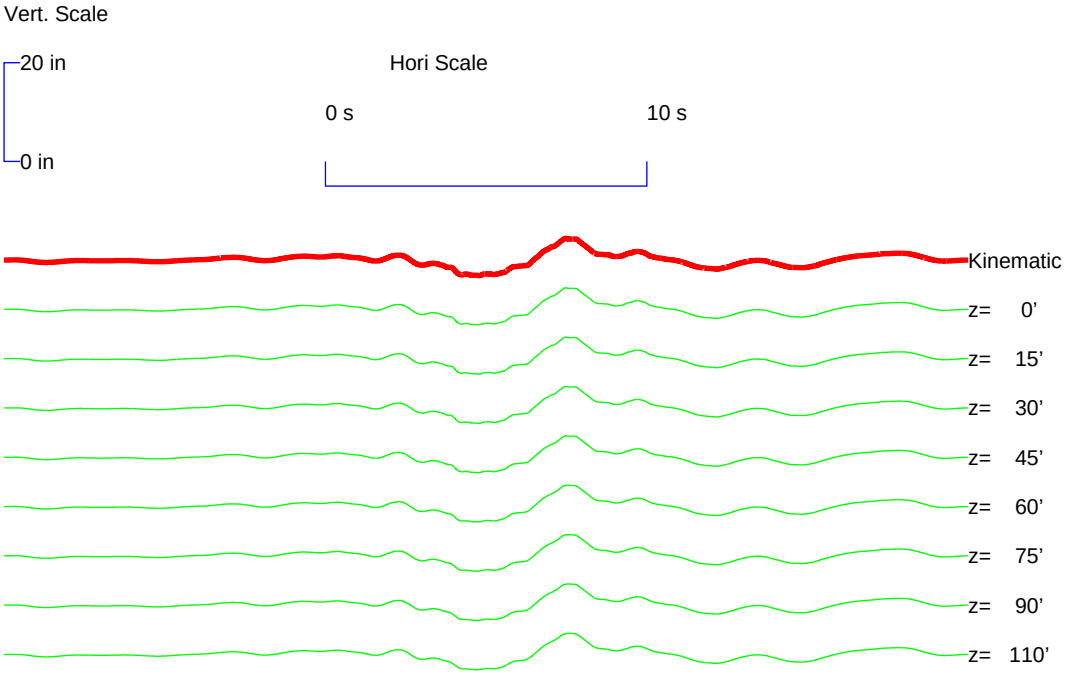



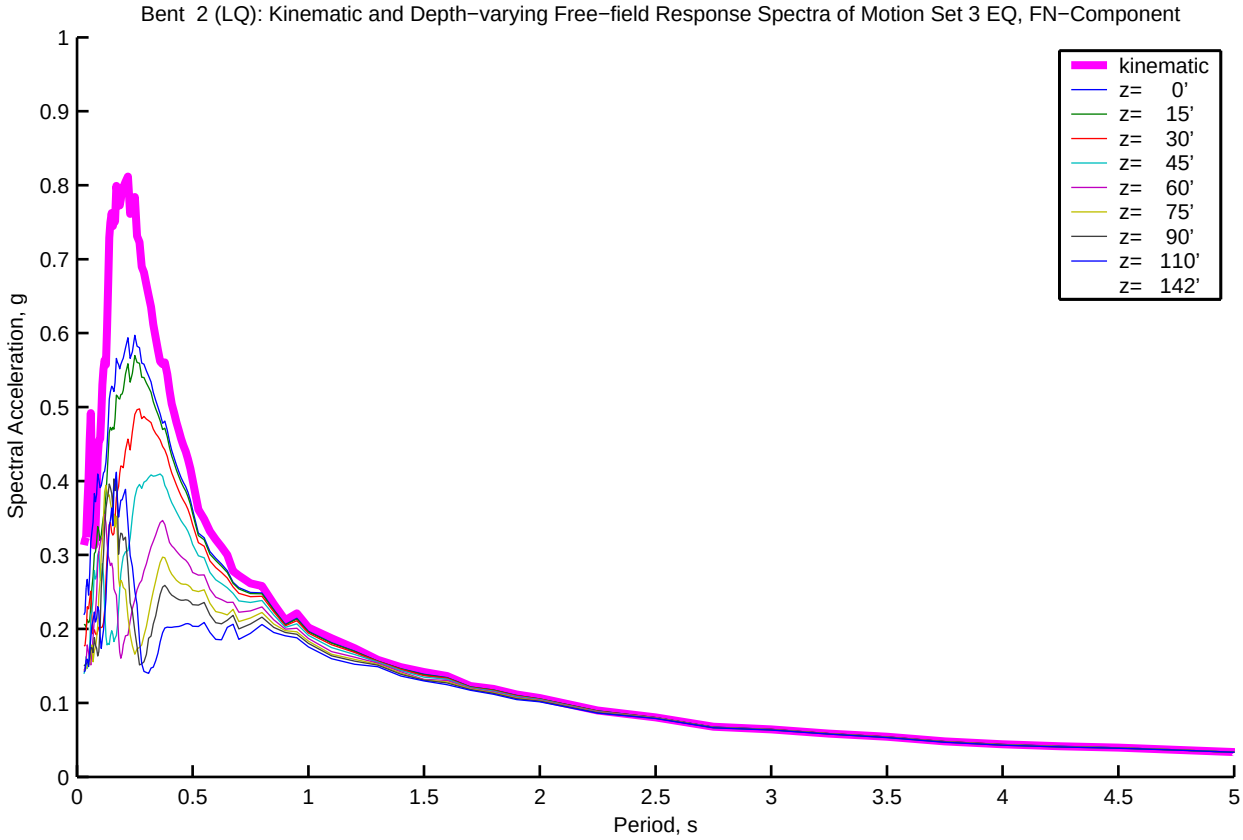

Abut 11 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 20'
z= 40'
z= 60'
z= 80'
z= 100'
z= 120'
z= 160'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

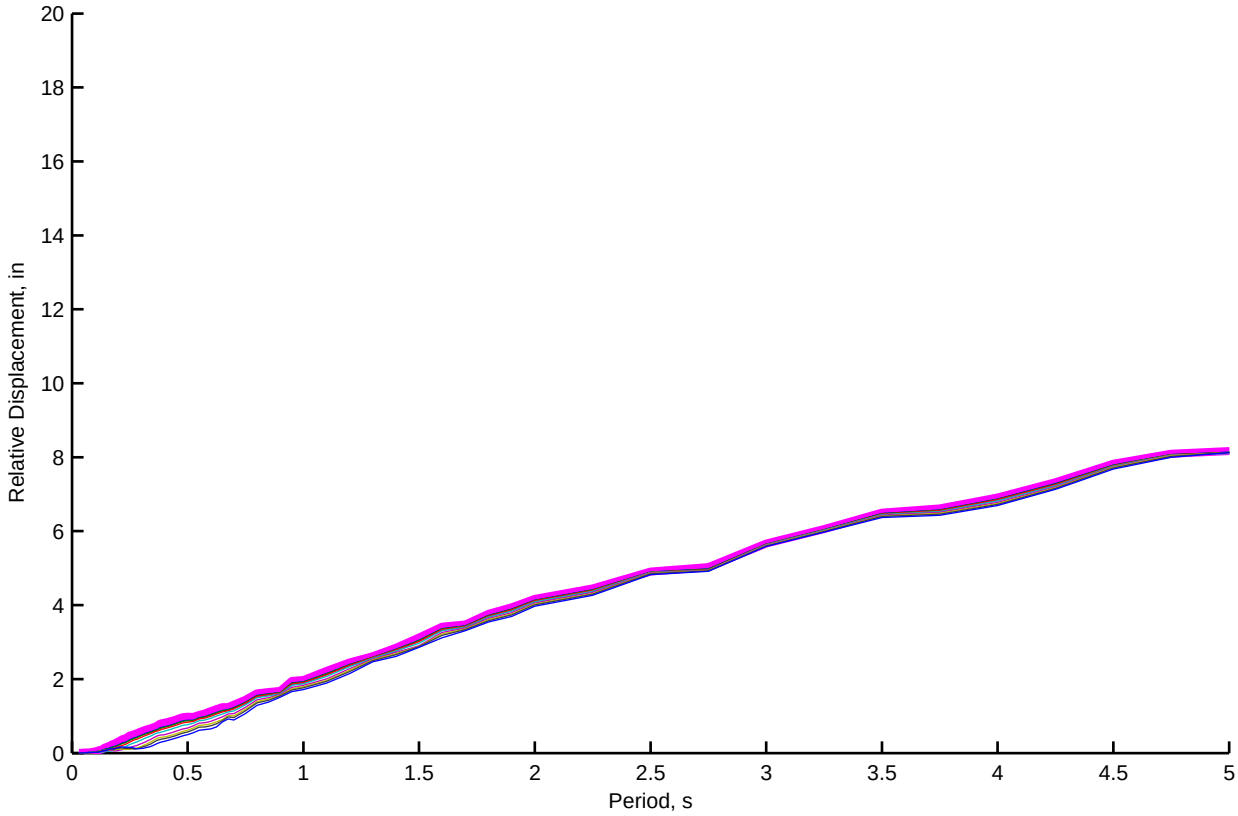

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

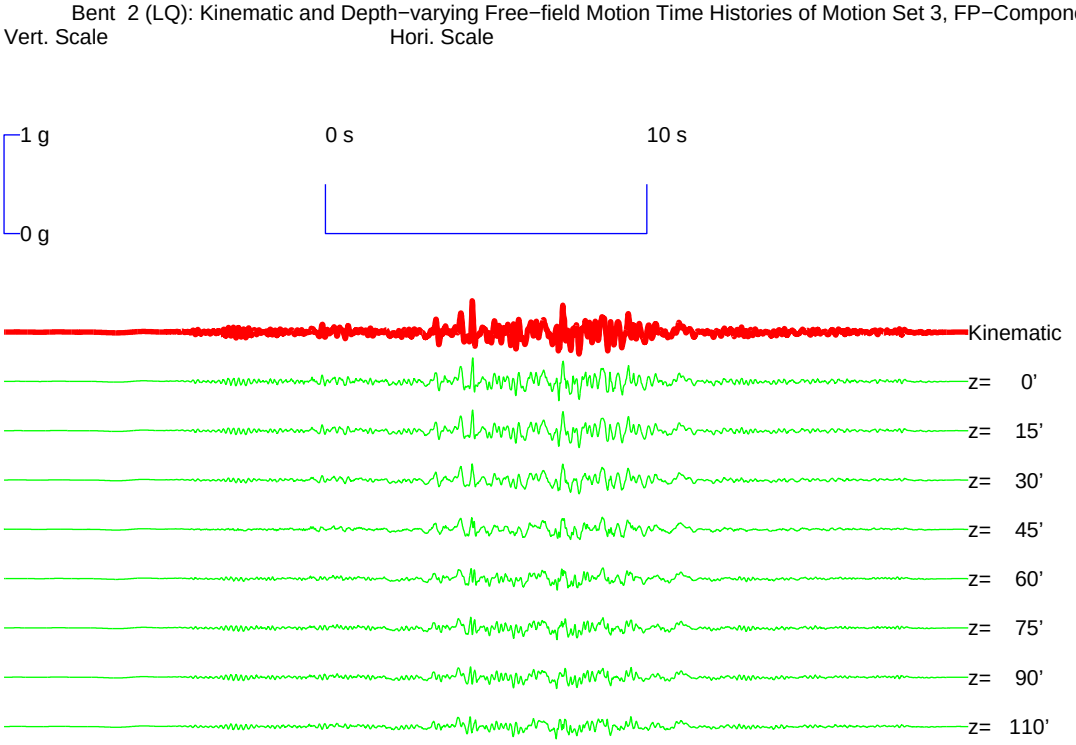


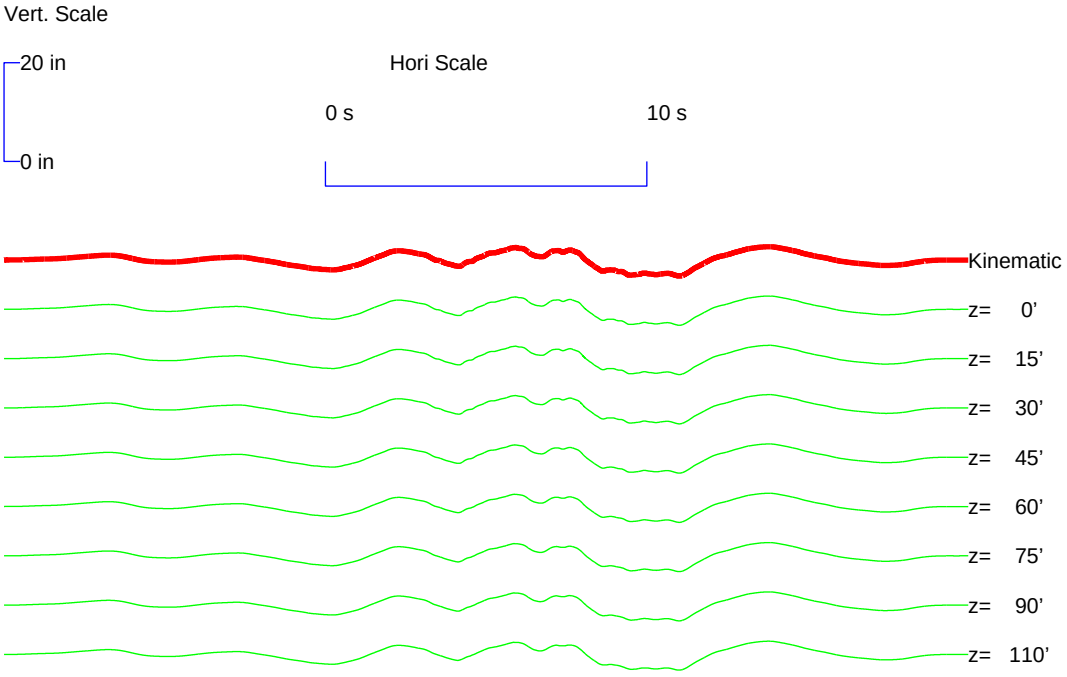



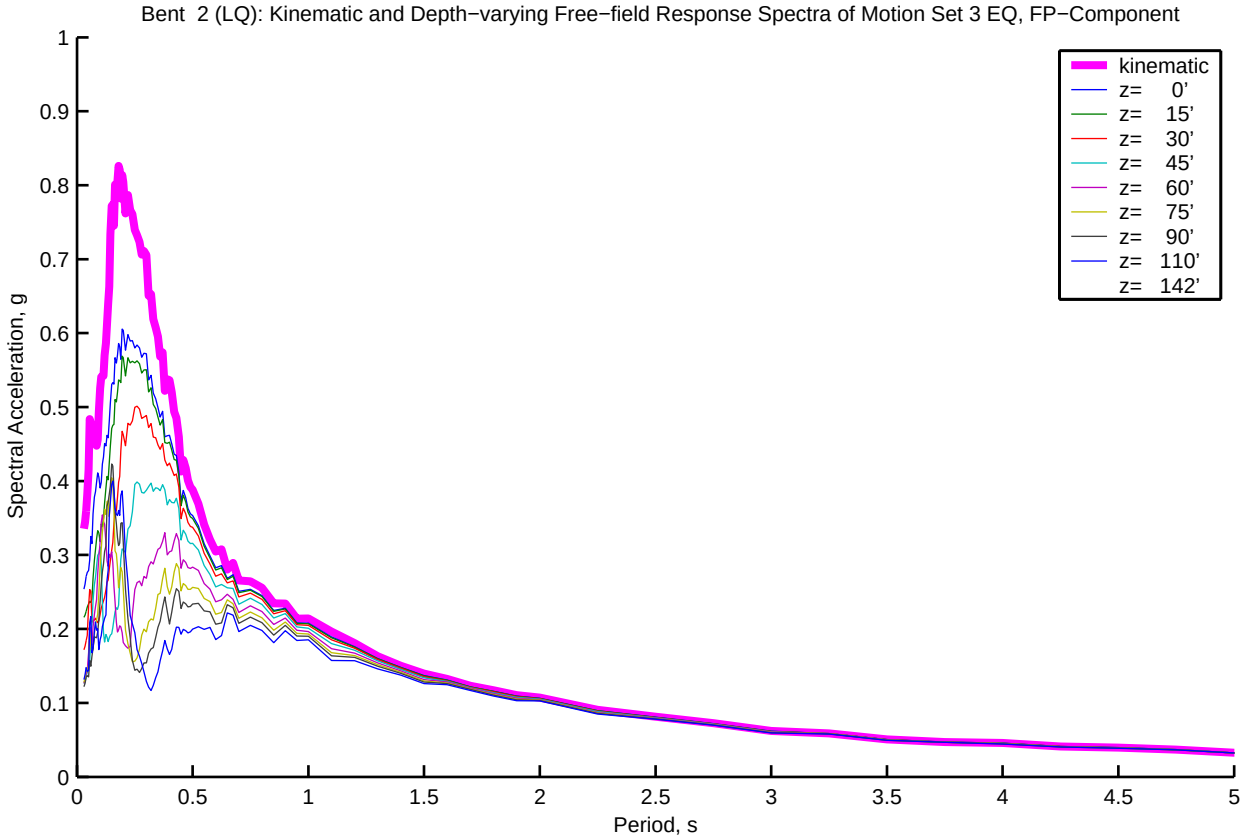

Bent 2 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

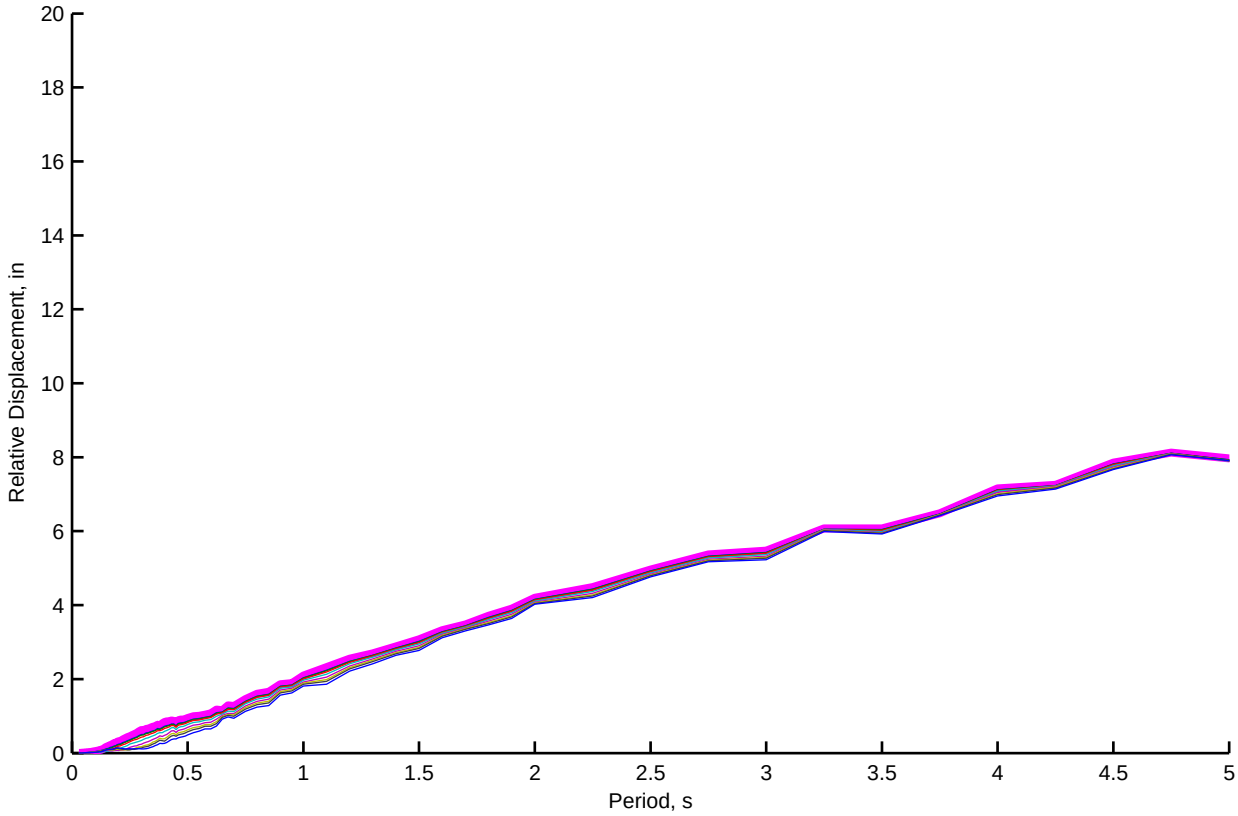

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 2 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

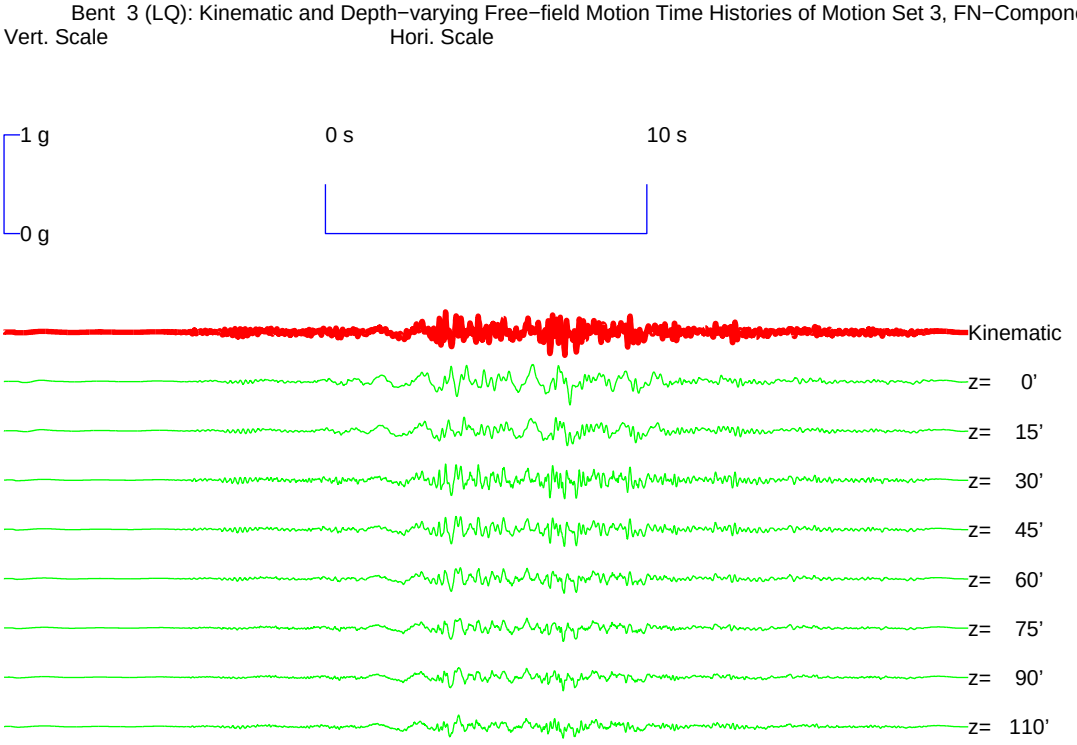


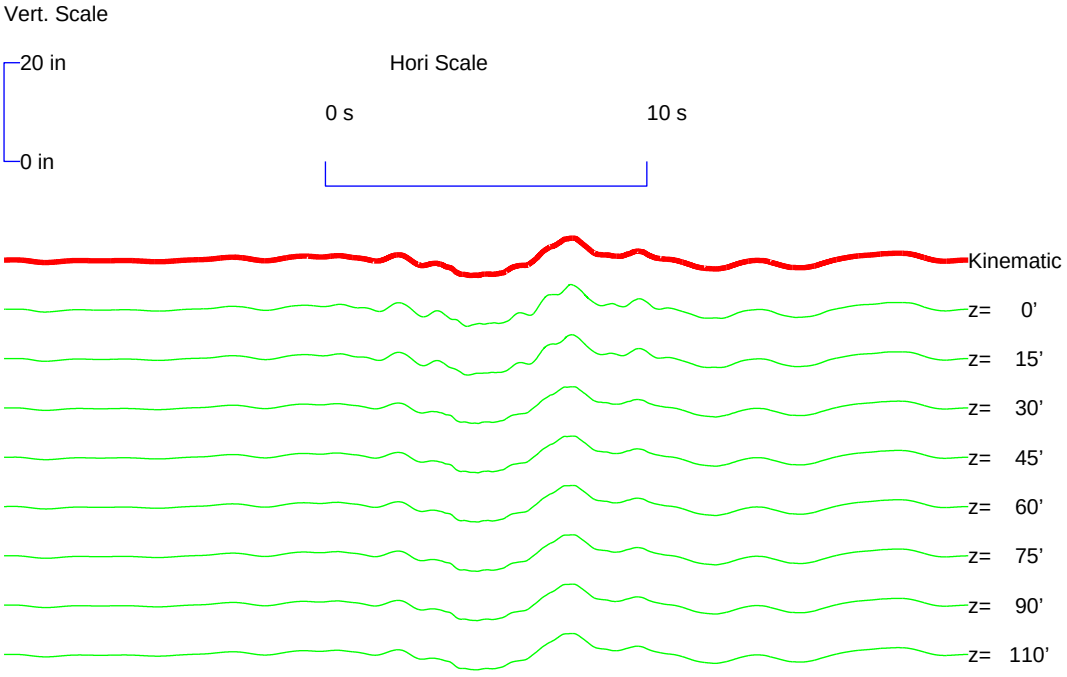



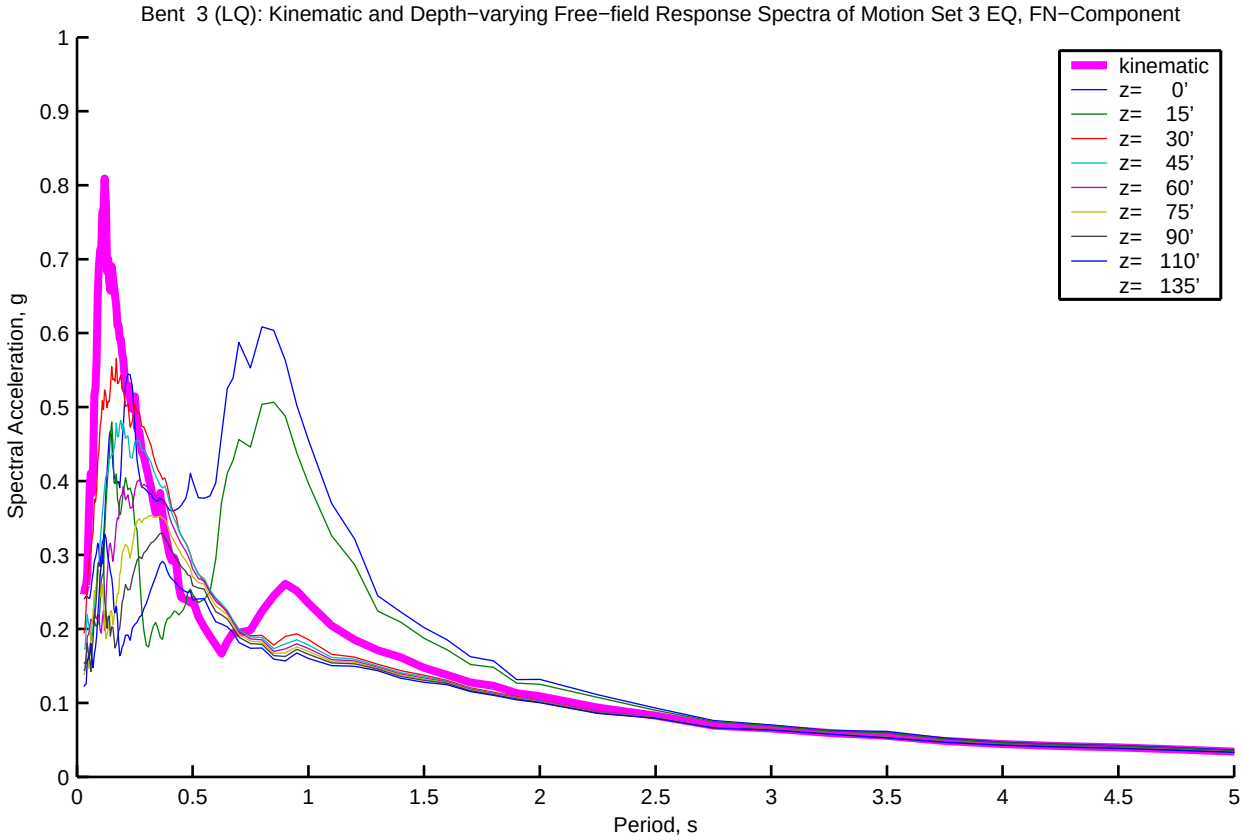

Bent 2 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 142'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

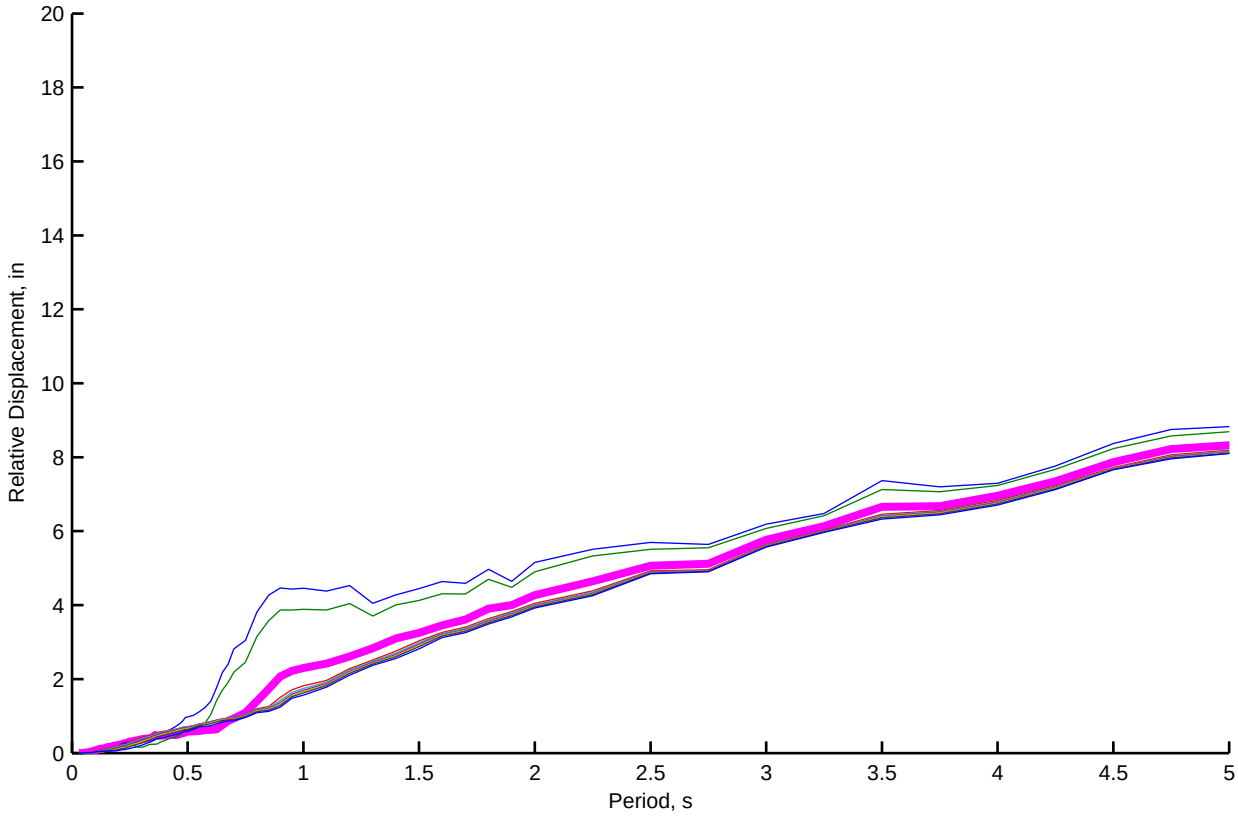

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 3 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

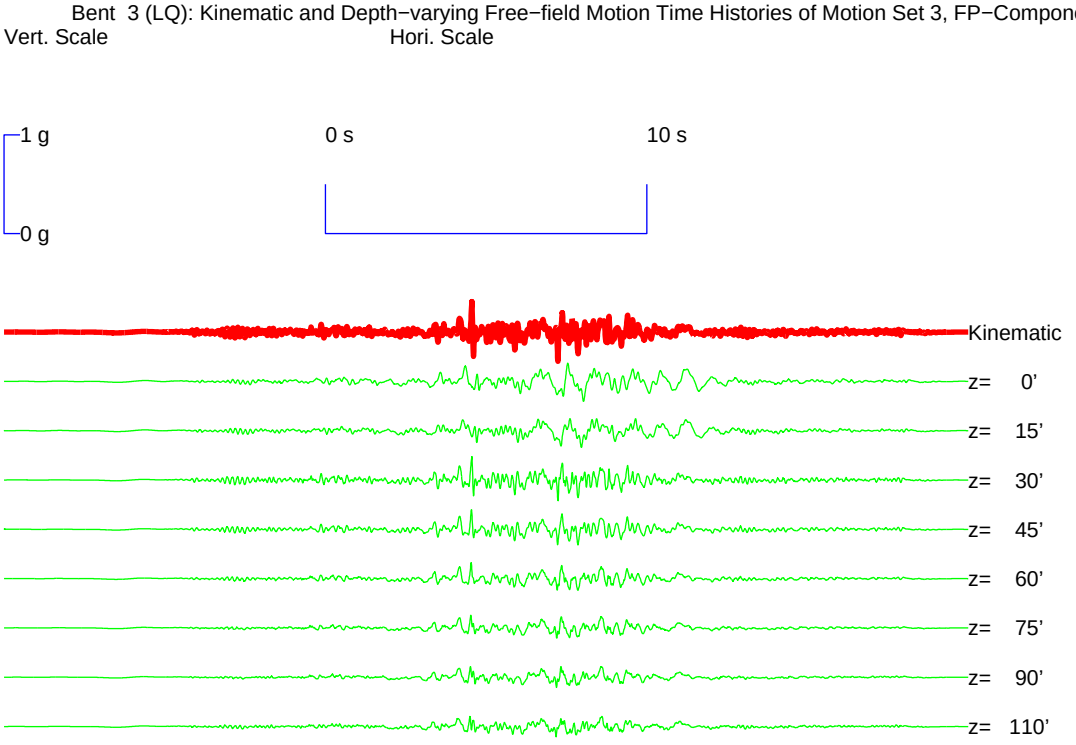


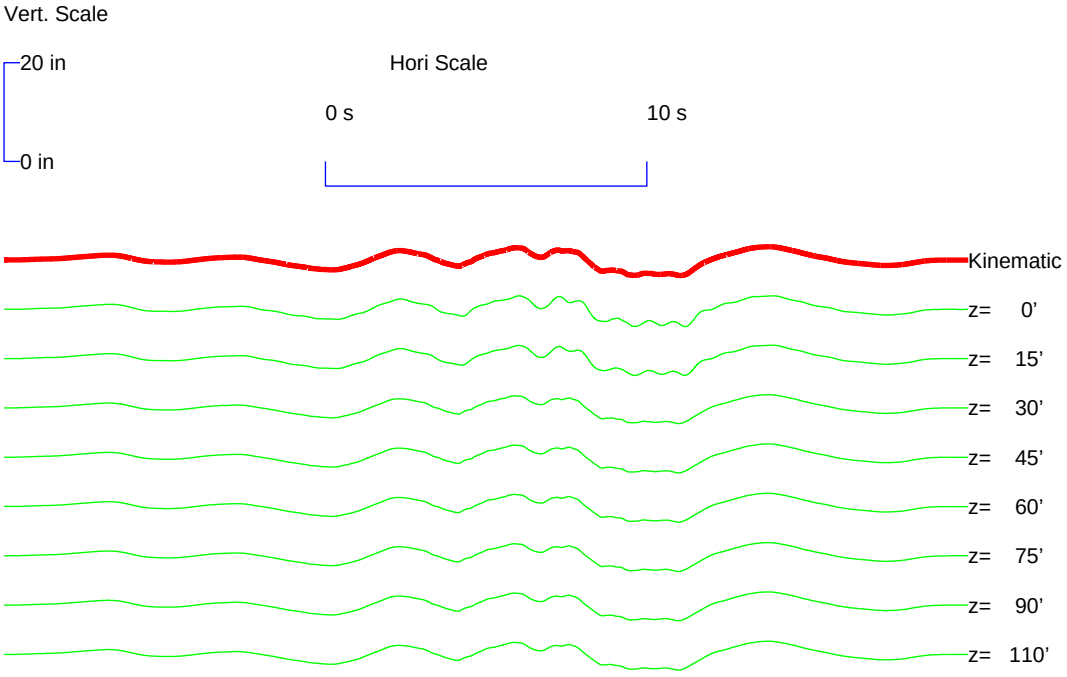



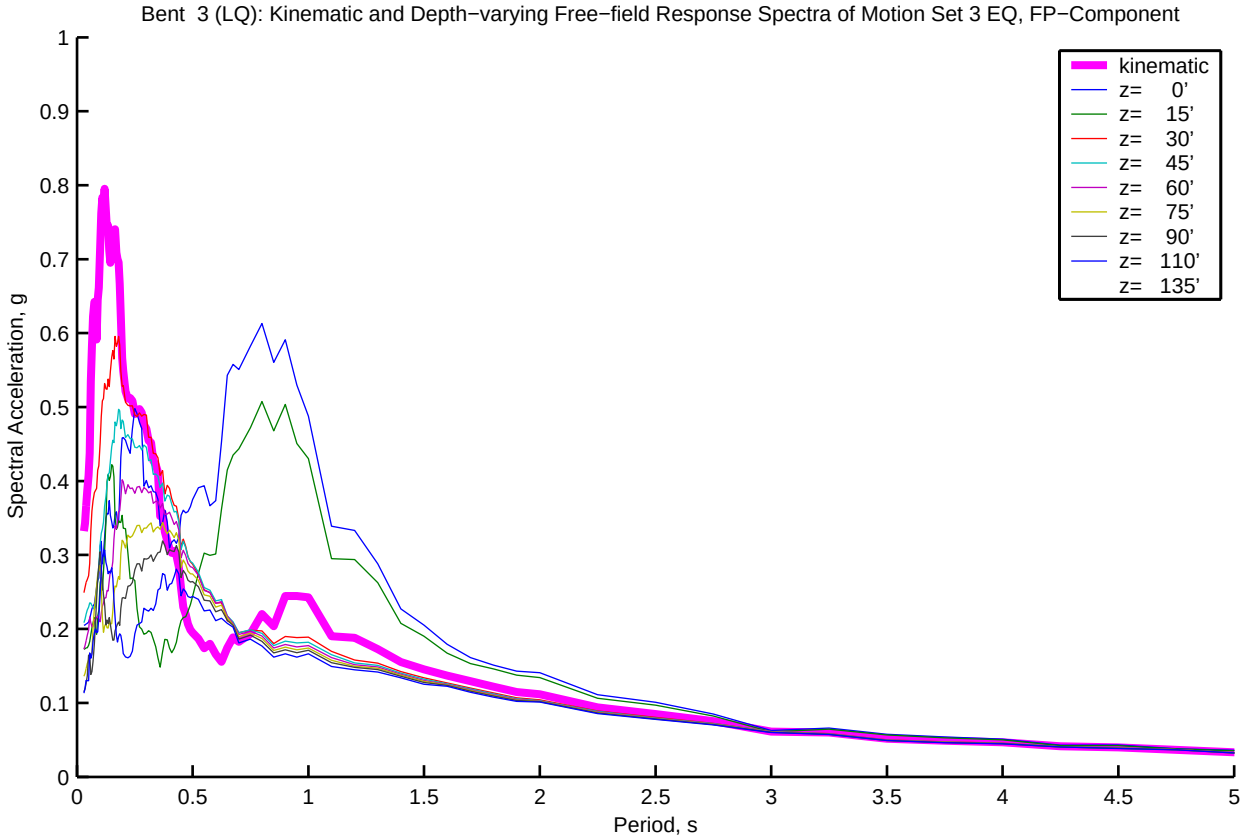

Bent 3 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

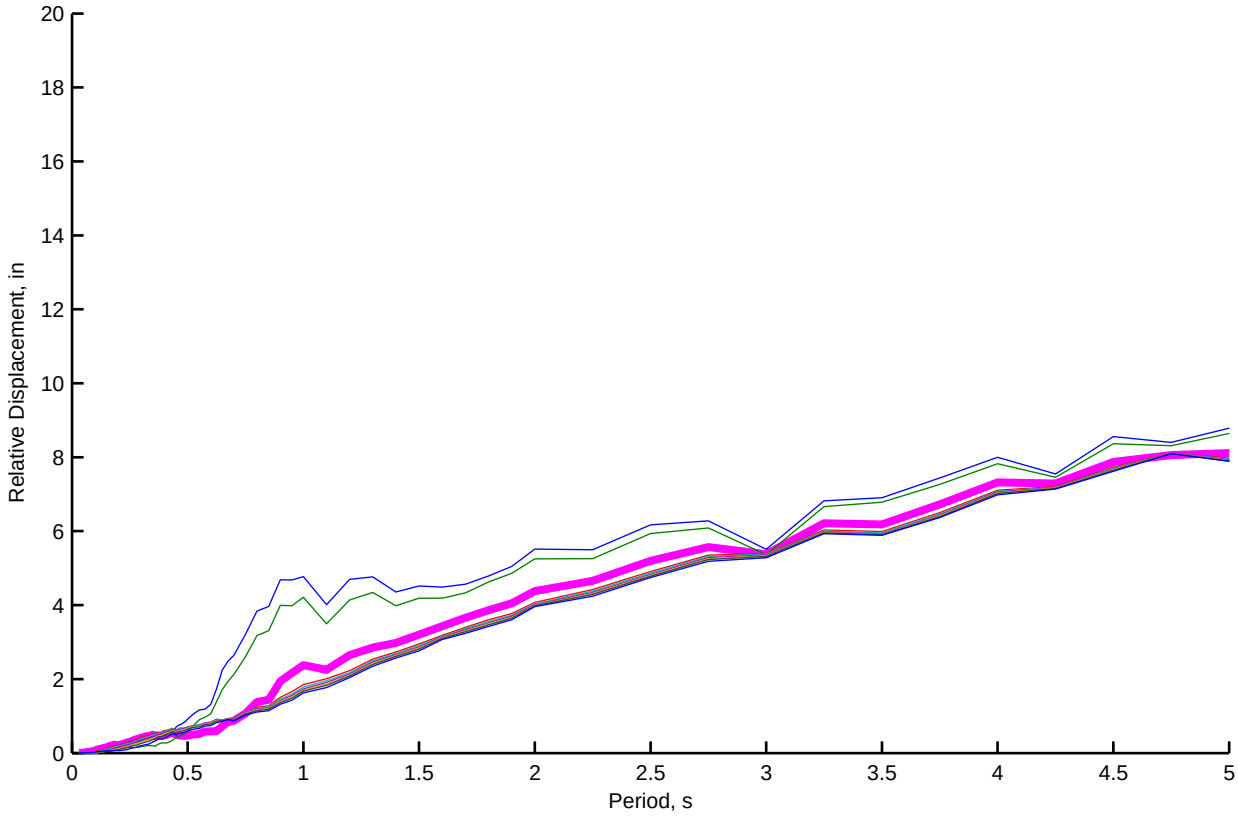

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 3 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component




Bent 3 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 135'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
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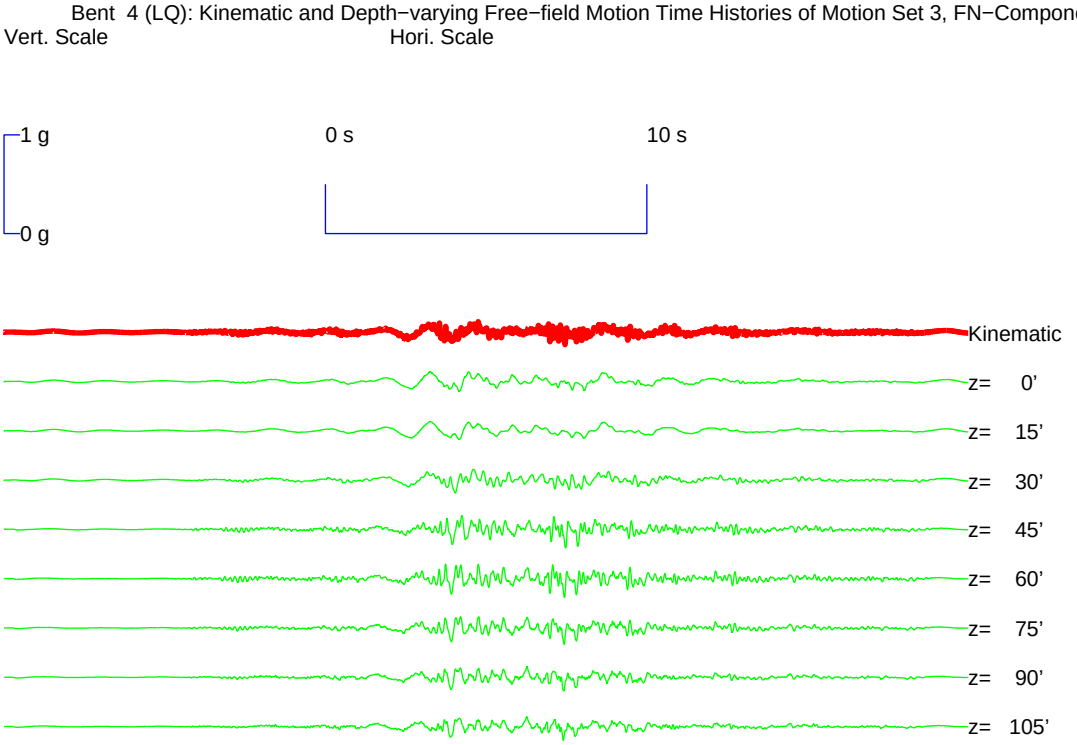
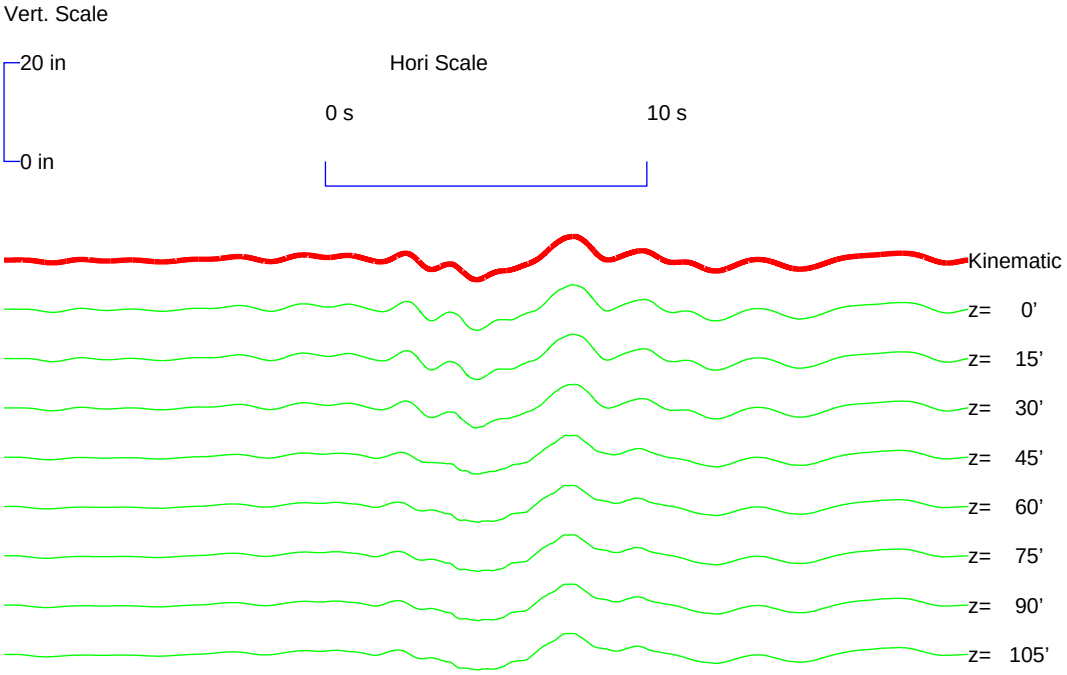
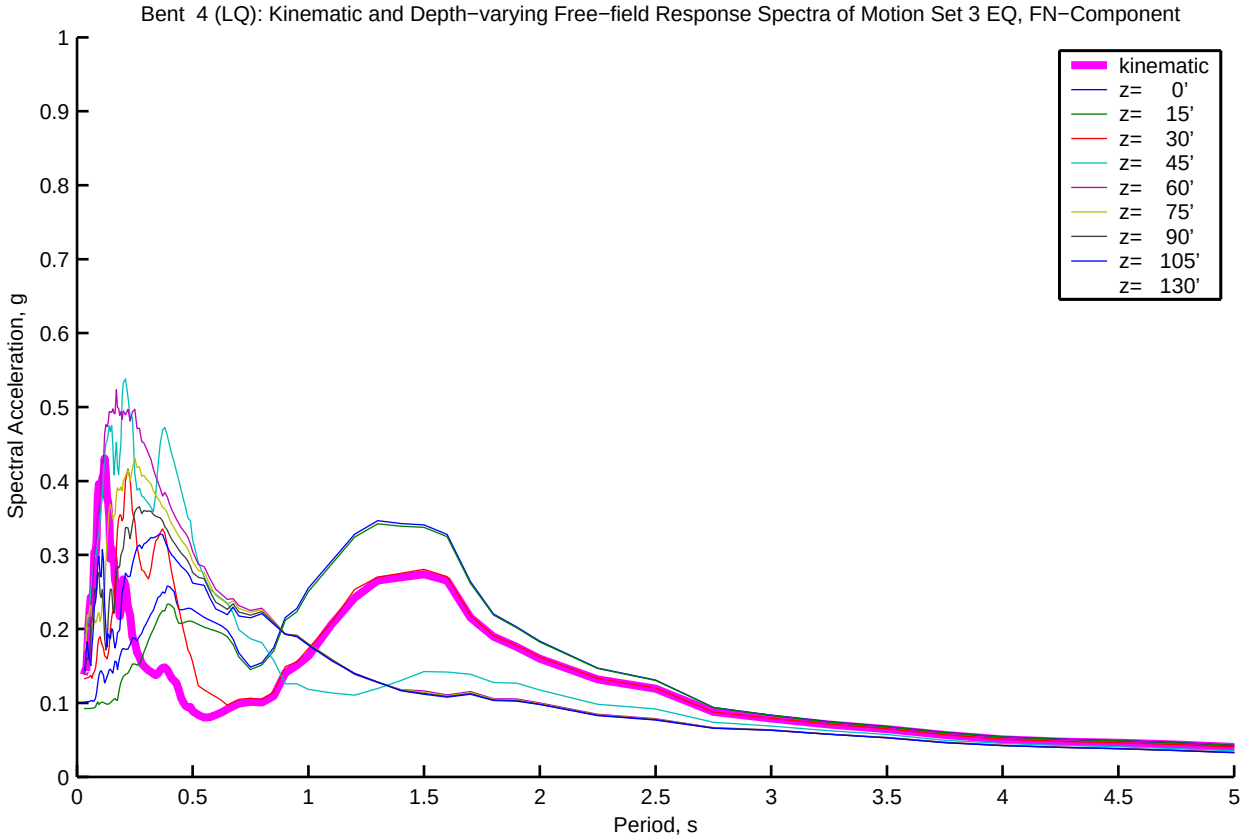
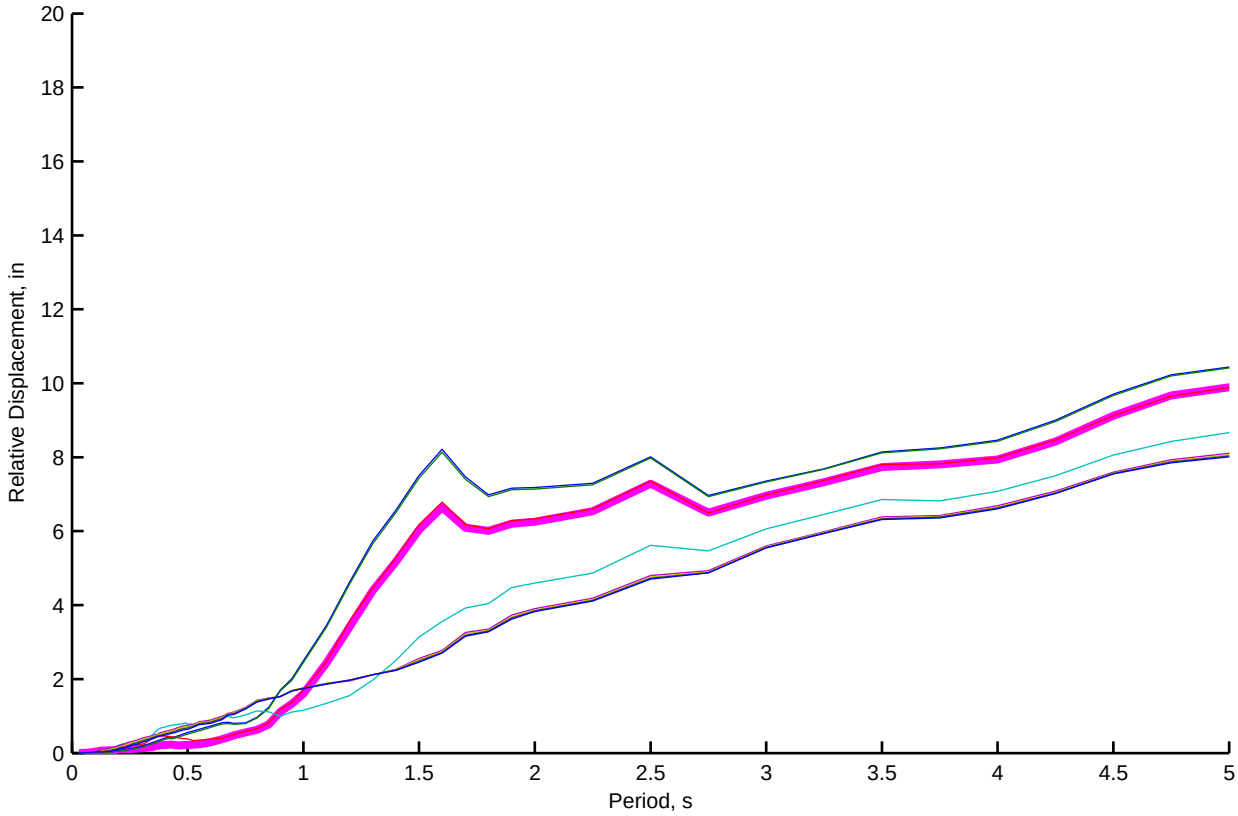
2.5
3
3.5
4
4.5
5

Bent 4 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component




Bent 4 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
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10
12
14
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18
20
0.5
1
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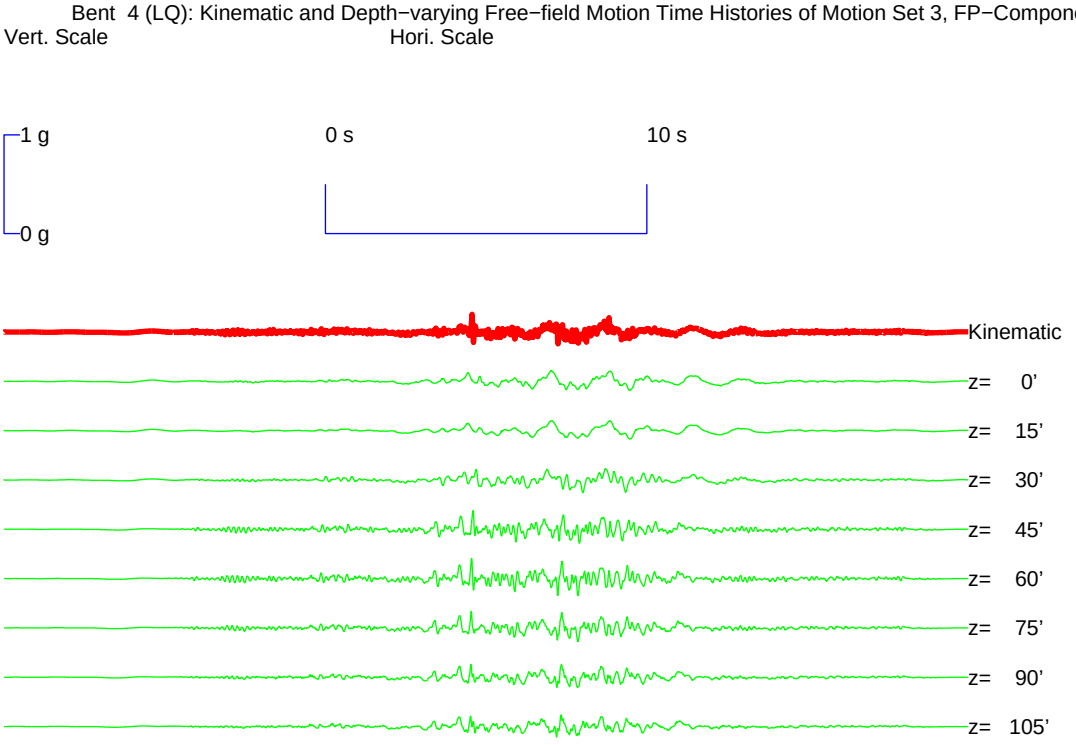
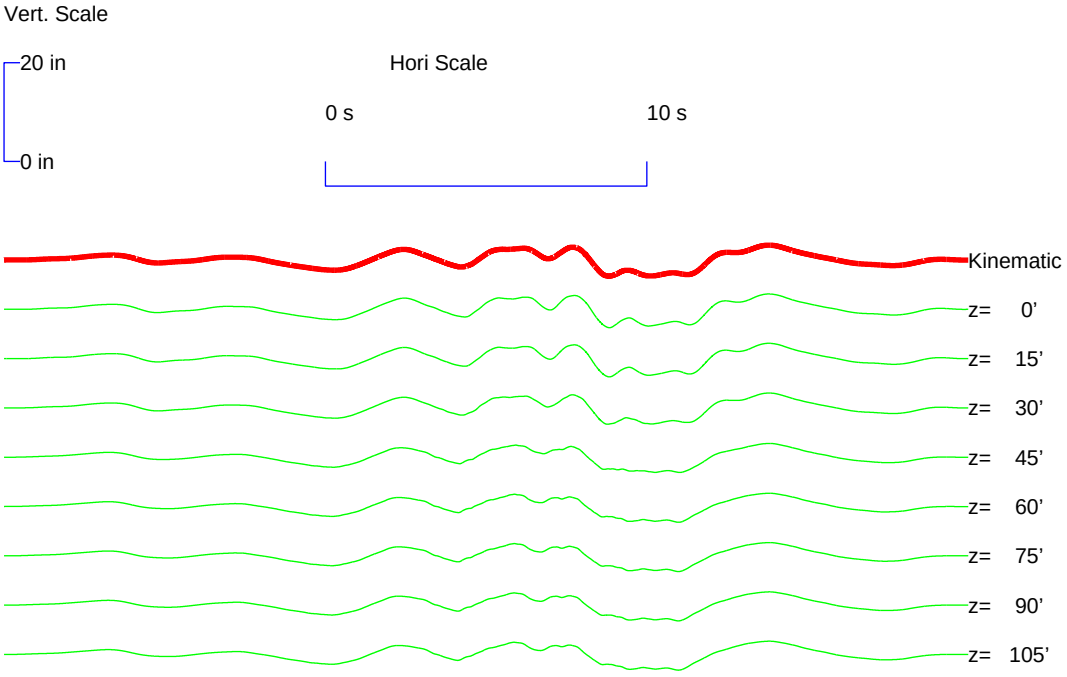
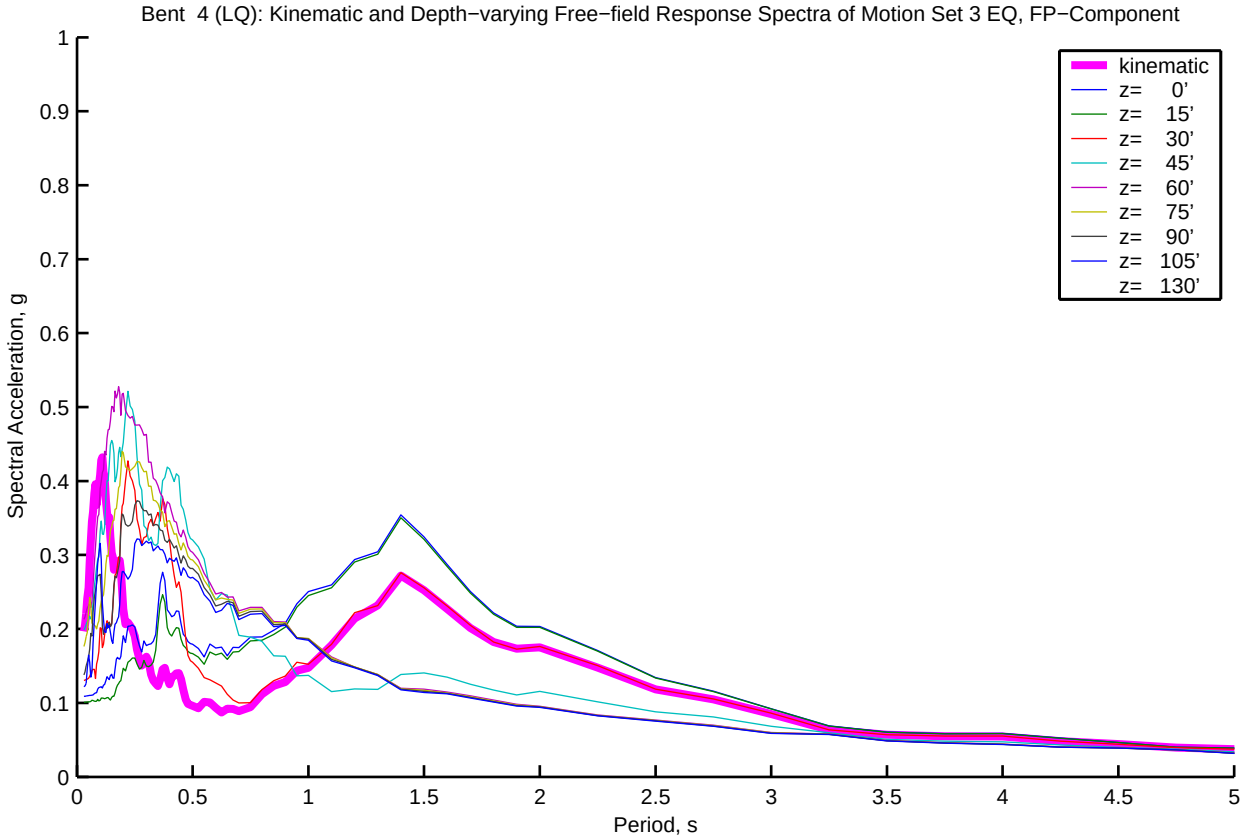
3
3.5
4
4.5
5

Bent 4 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component




Bent 4 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
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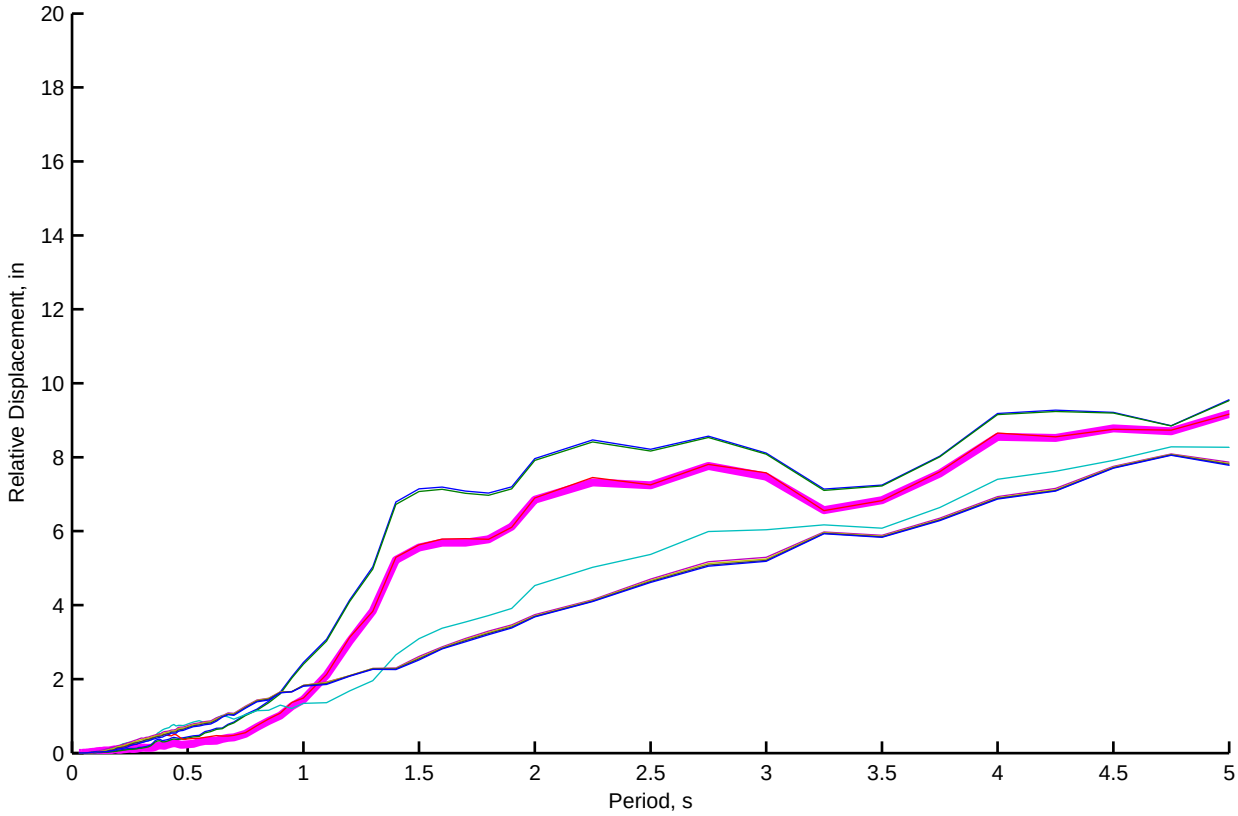
Relative Displacement, in
Period, s
0
2
4
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12
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0.5
1
1.5
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3
3.5
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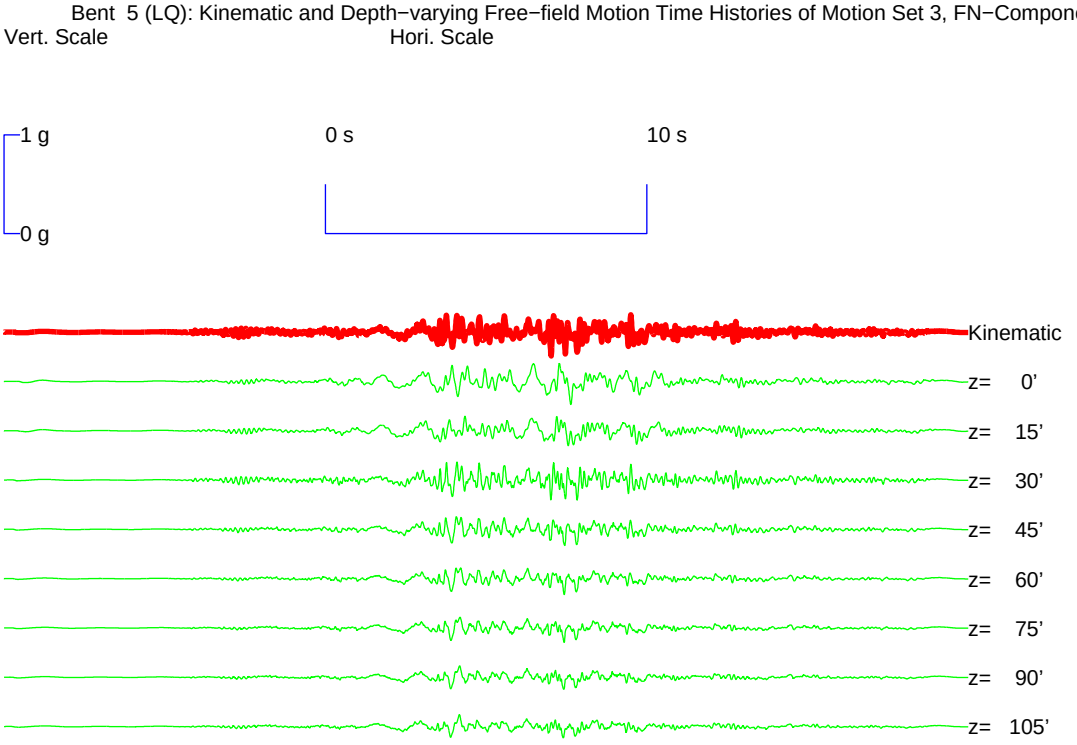
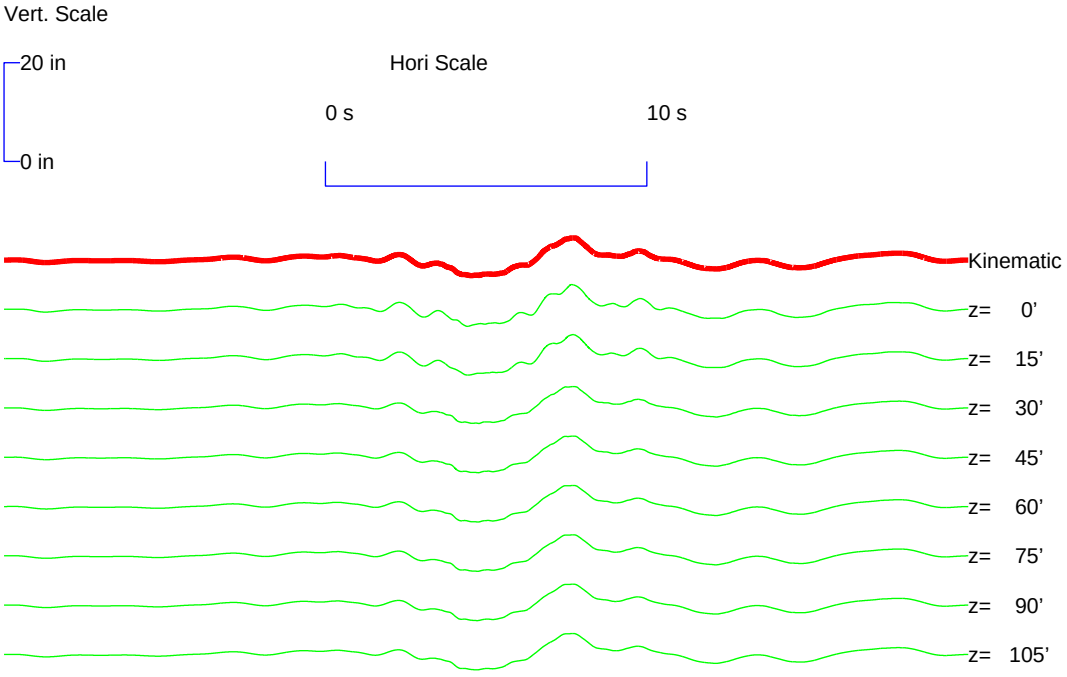
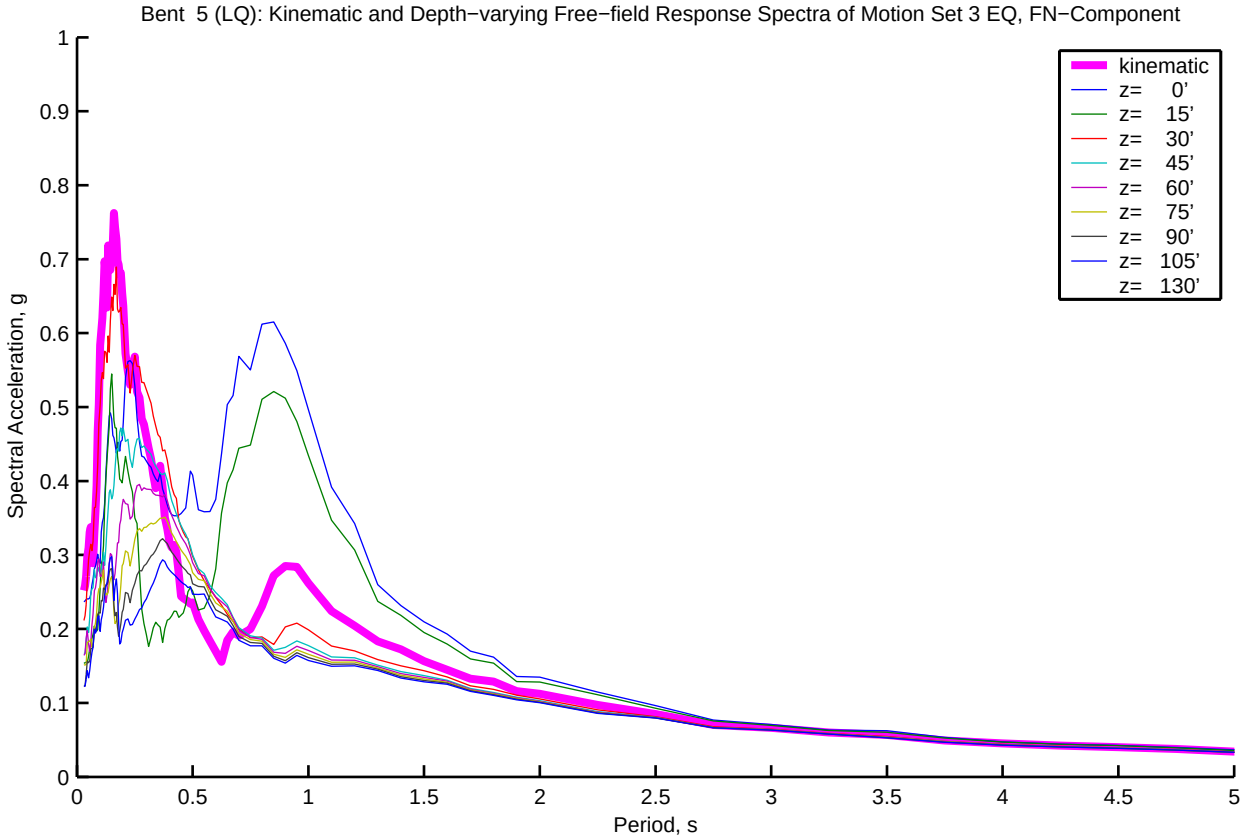
4.5
5

Bent 5 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component




Bent 5 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
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2.5
3
3.5
4
4.5
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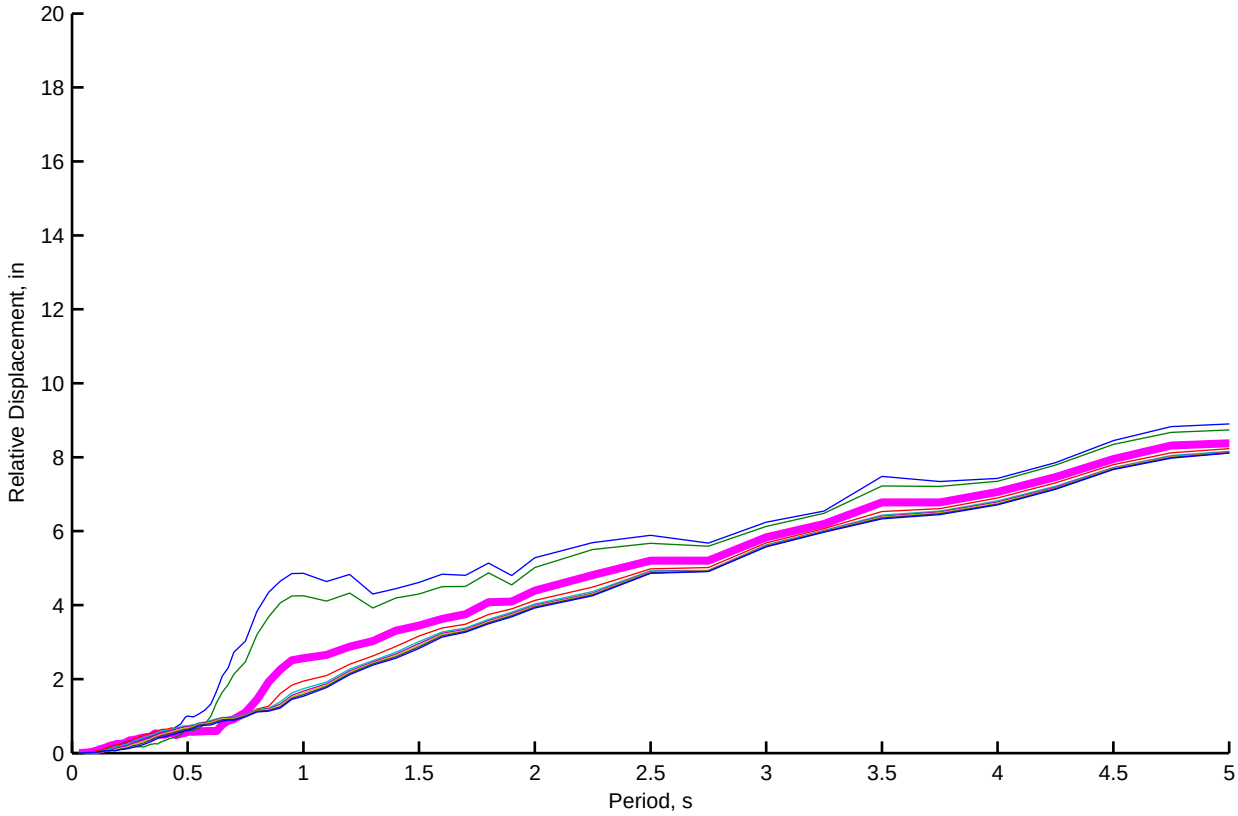
Relative Displacement, in
Period, s
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2
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0.5
1
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3.5
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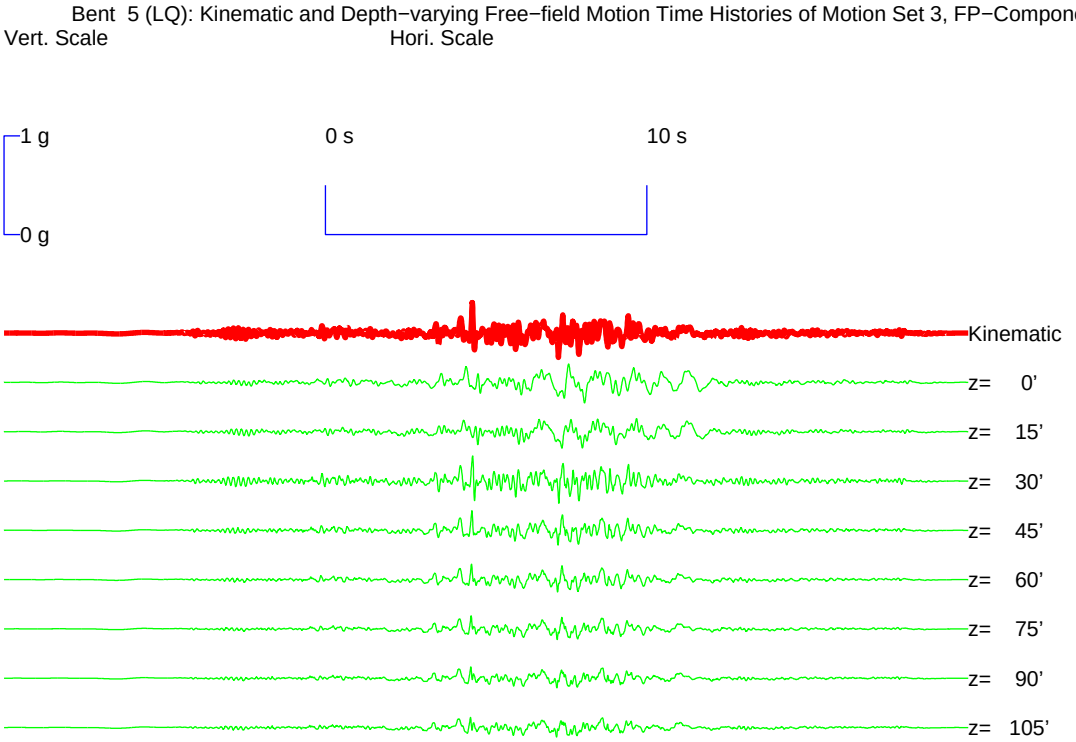
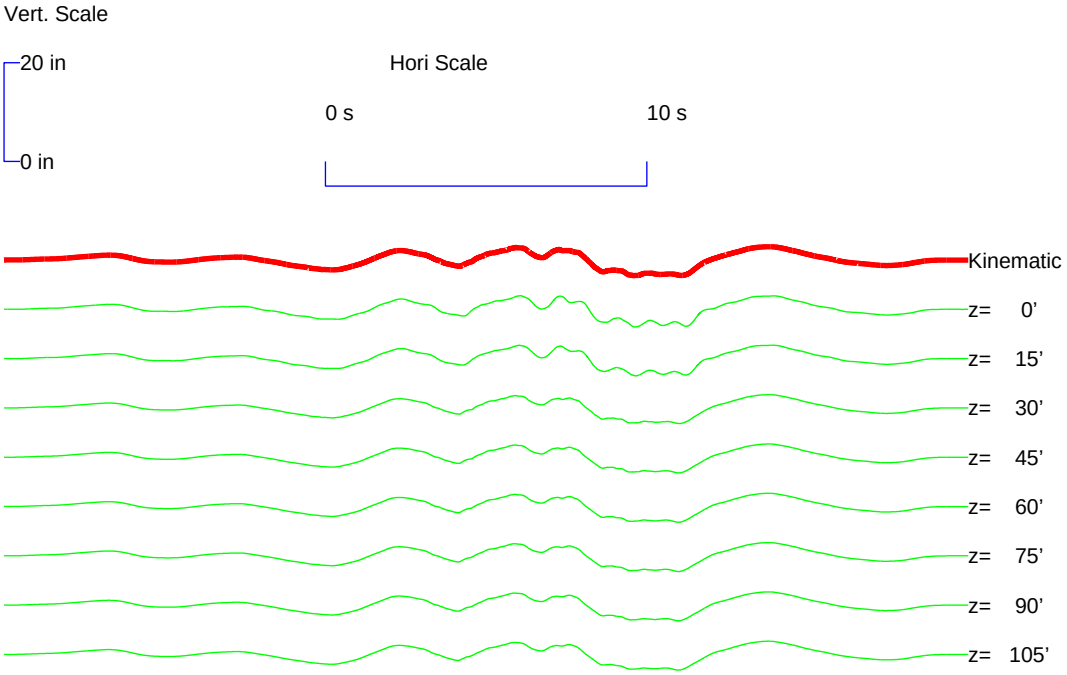
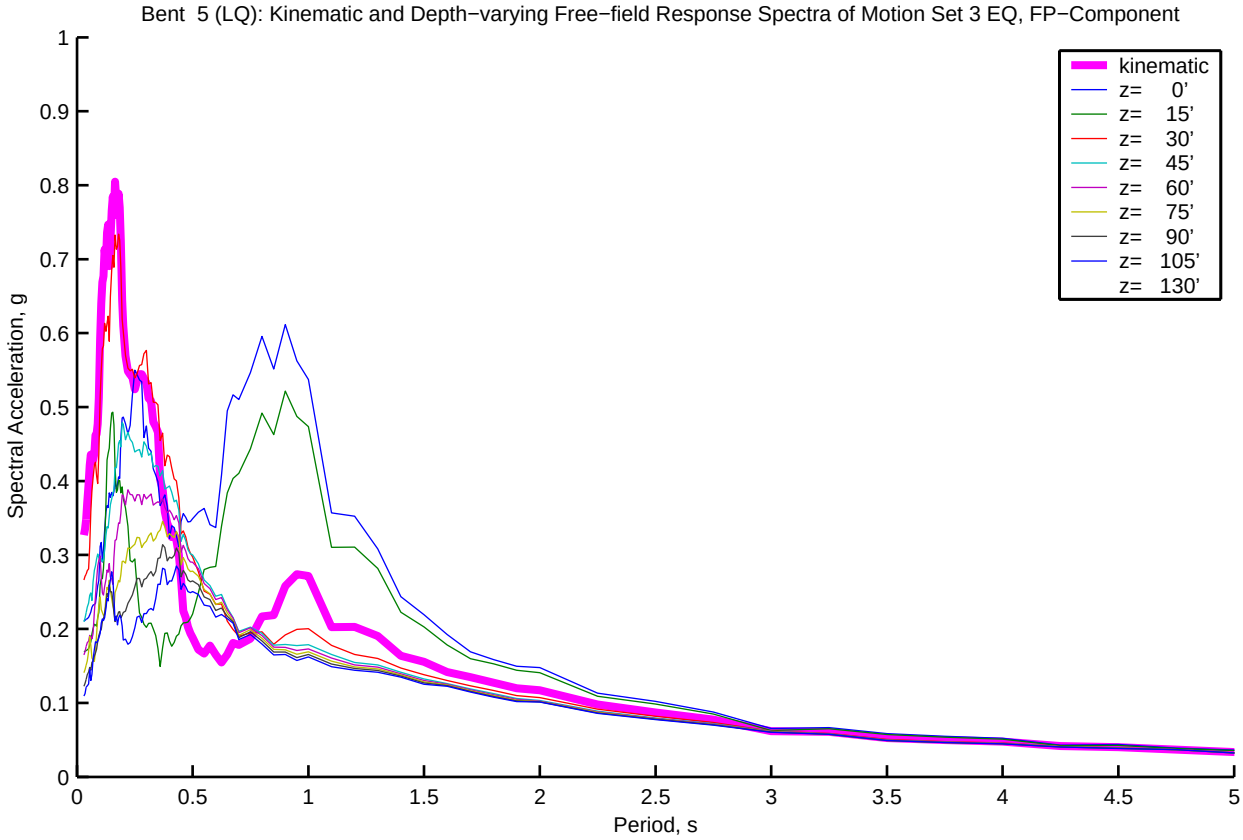
4.5
5

Bent 5 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component




Bent 5 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 105'
z= 130'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
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2.5
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3.5
4
4.5
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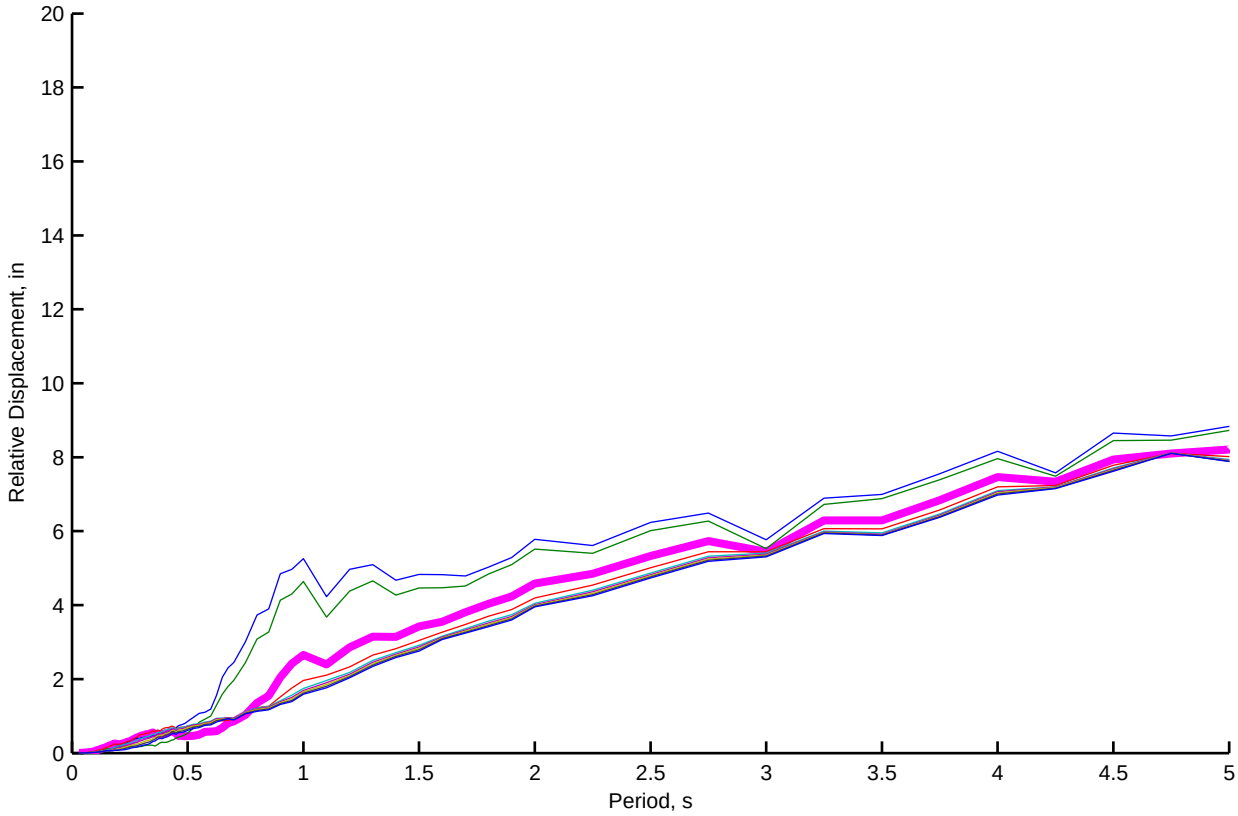
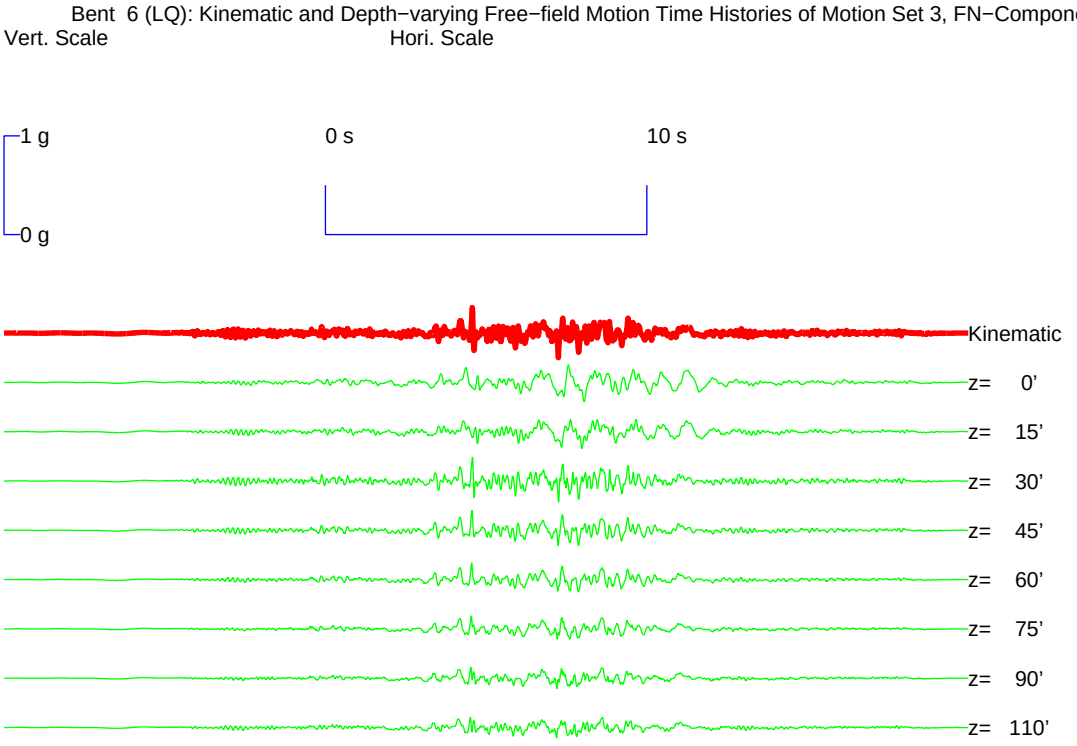
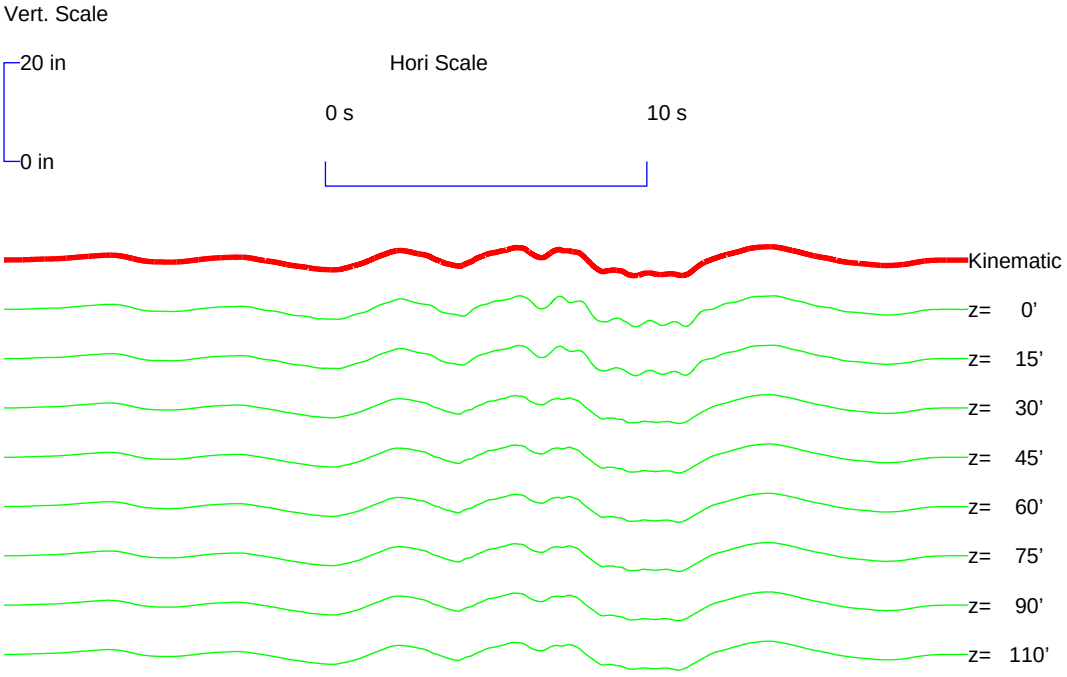
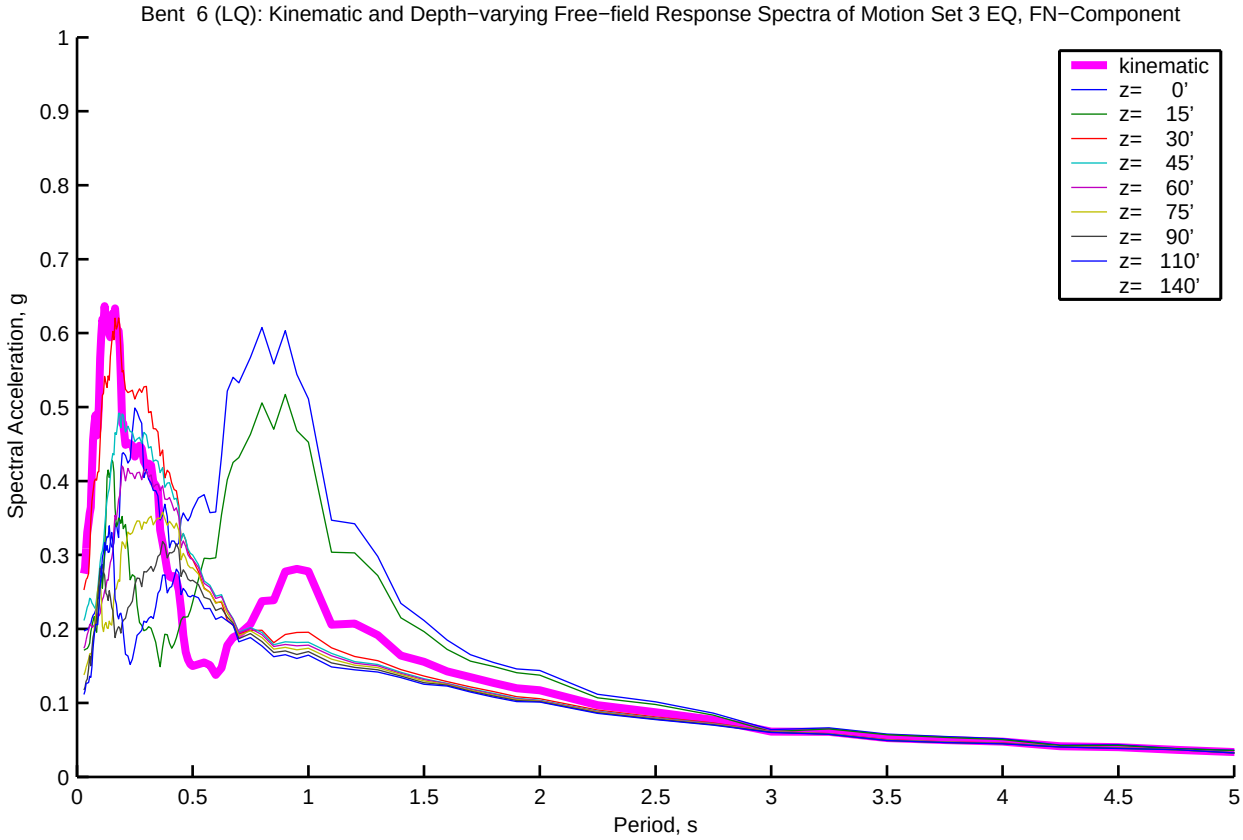
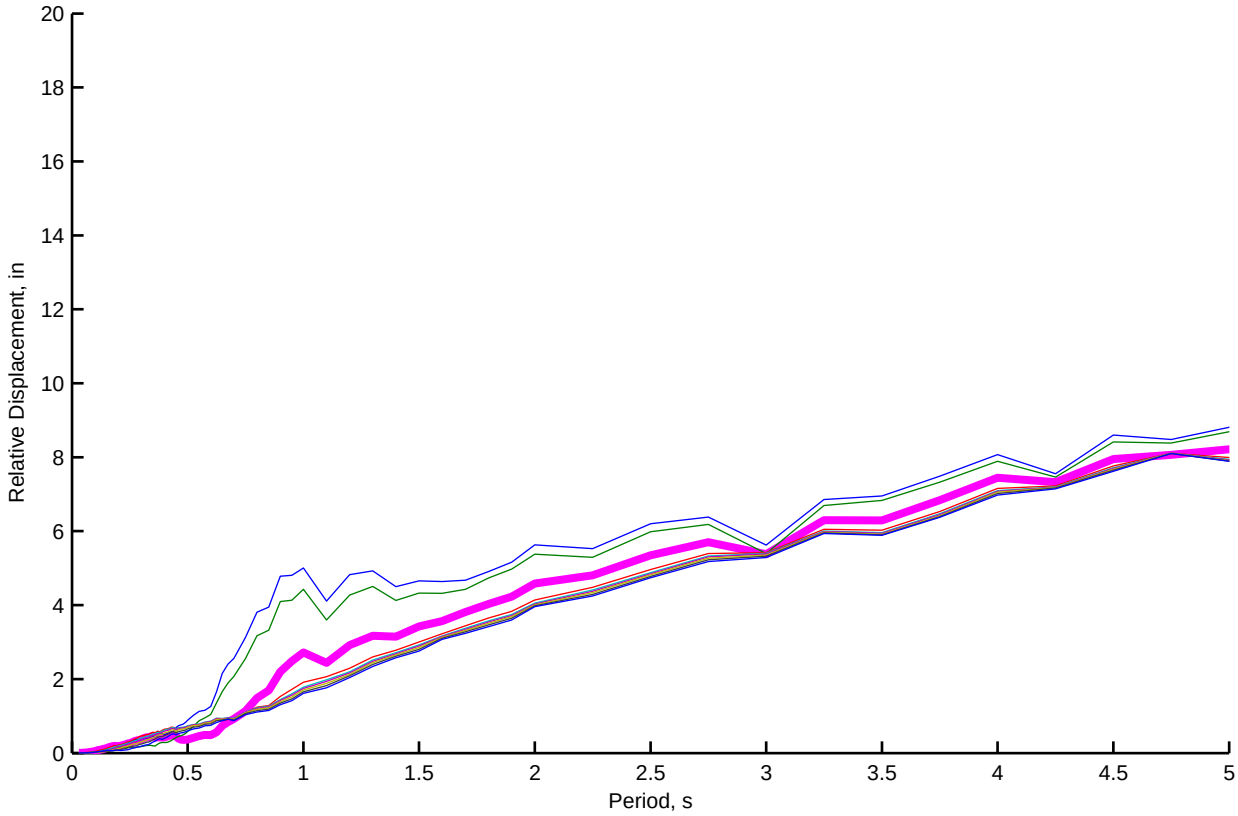

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 6 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

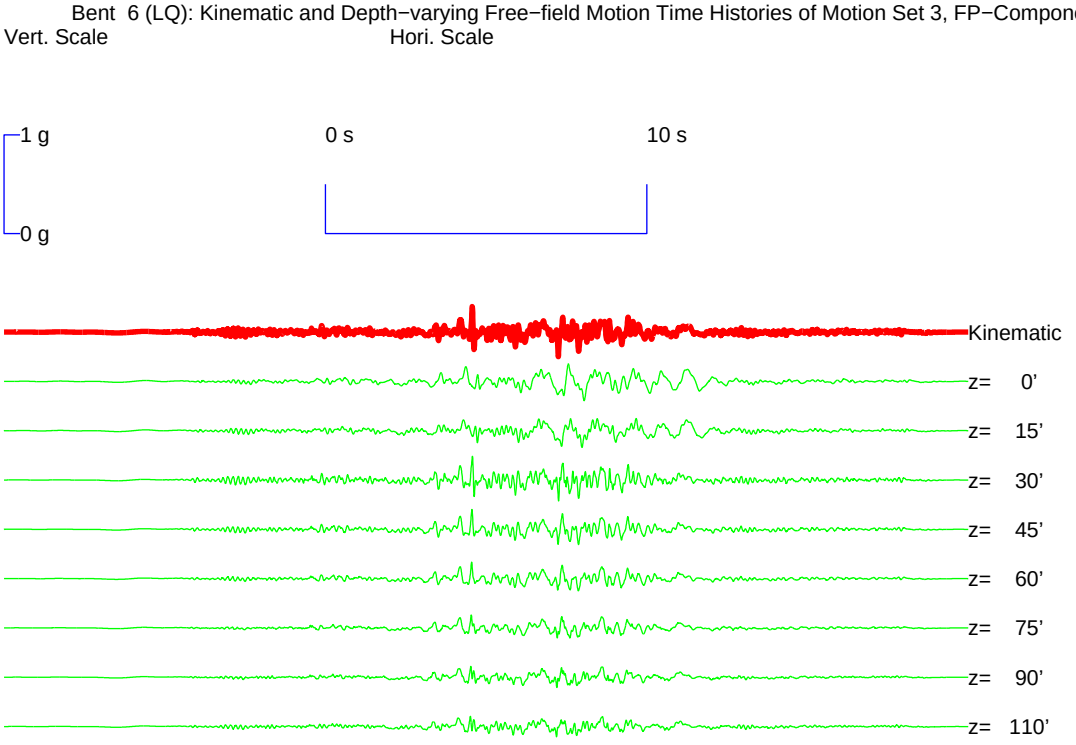


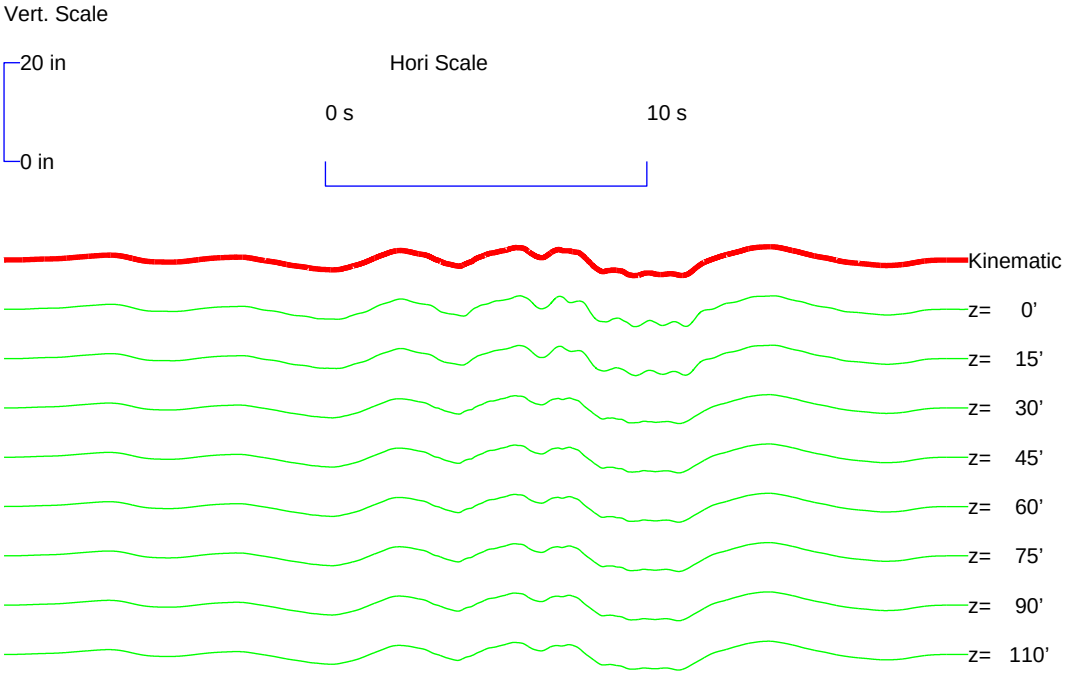



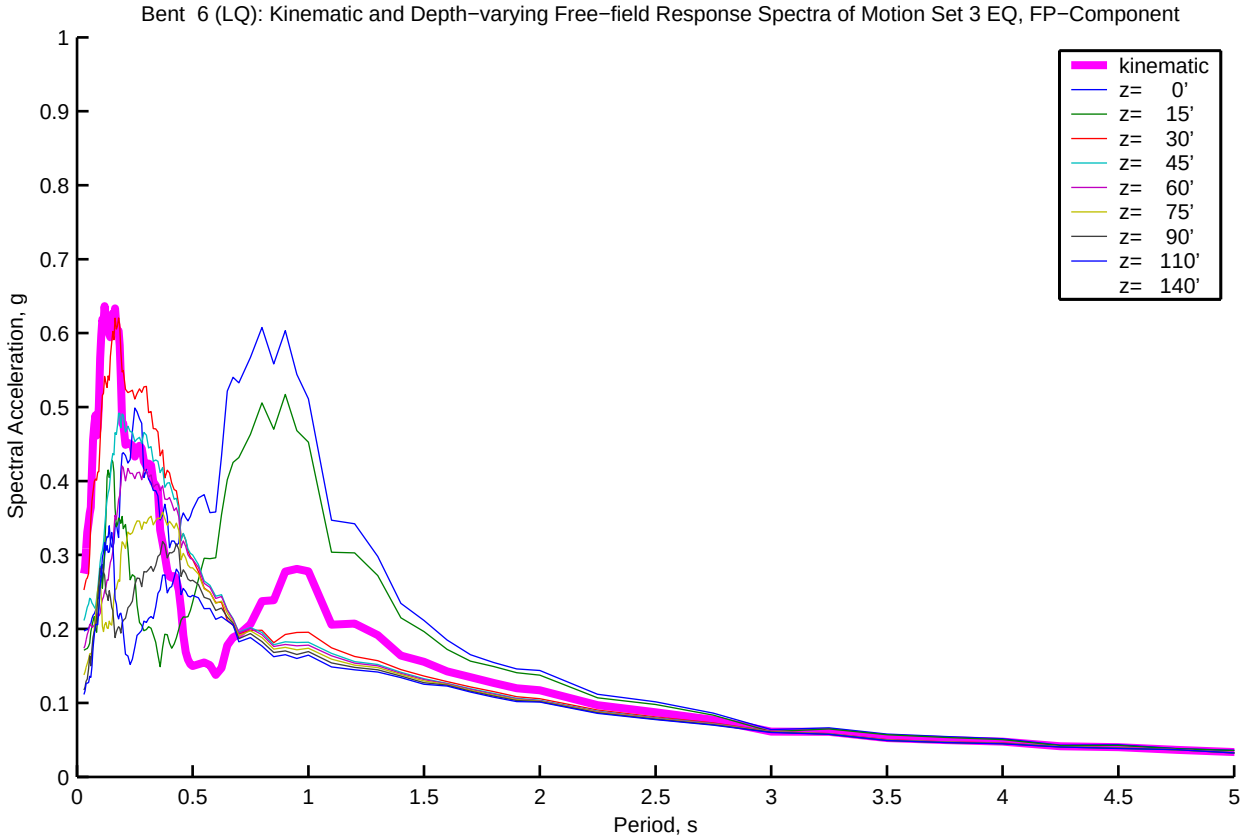

Bent 6 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

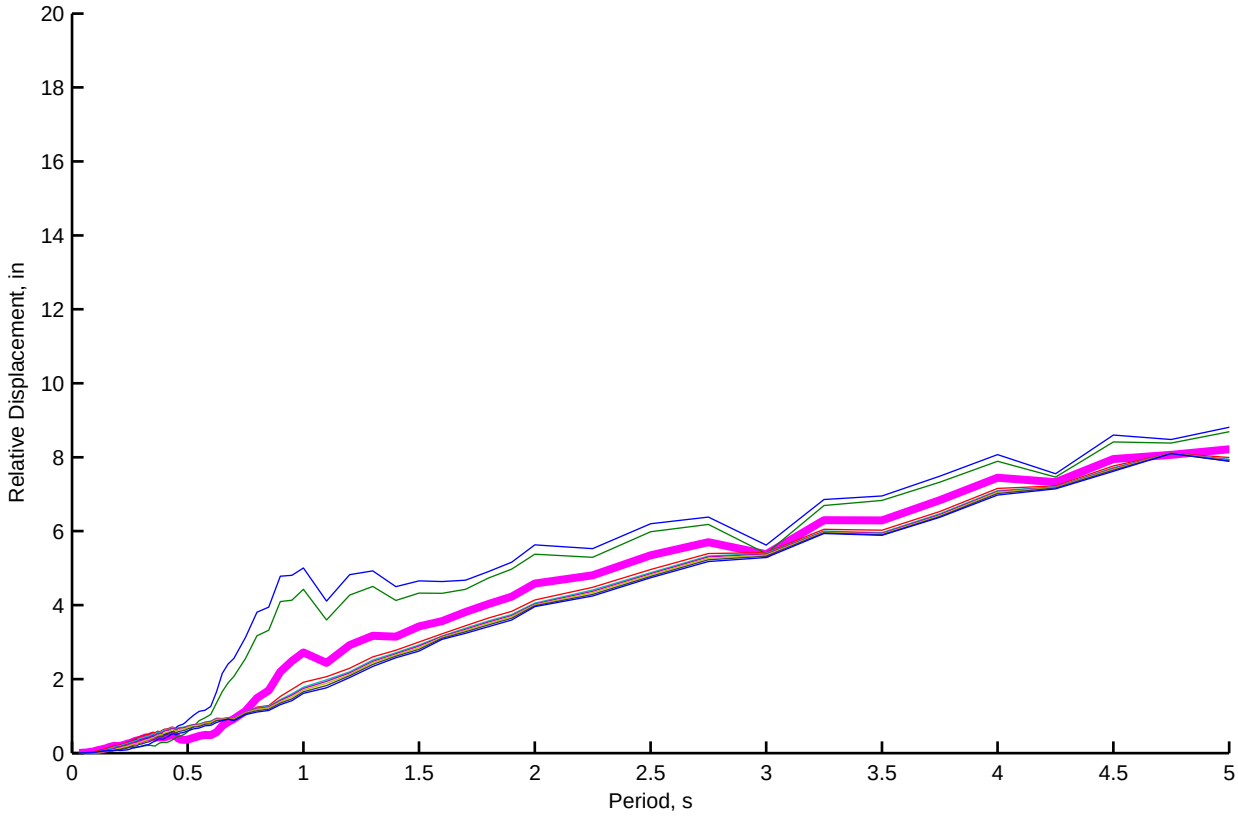

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 6 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

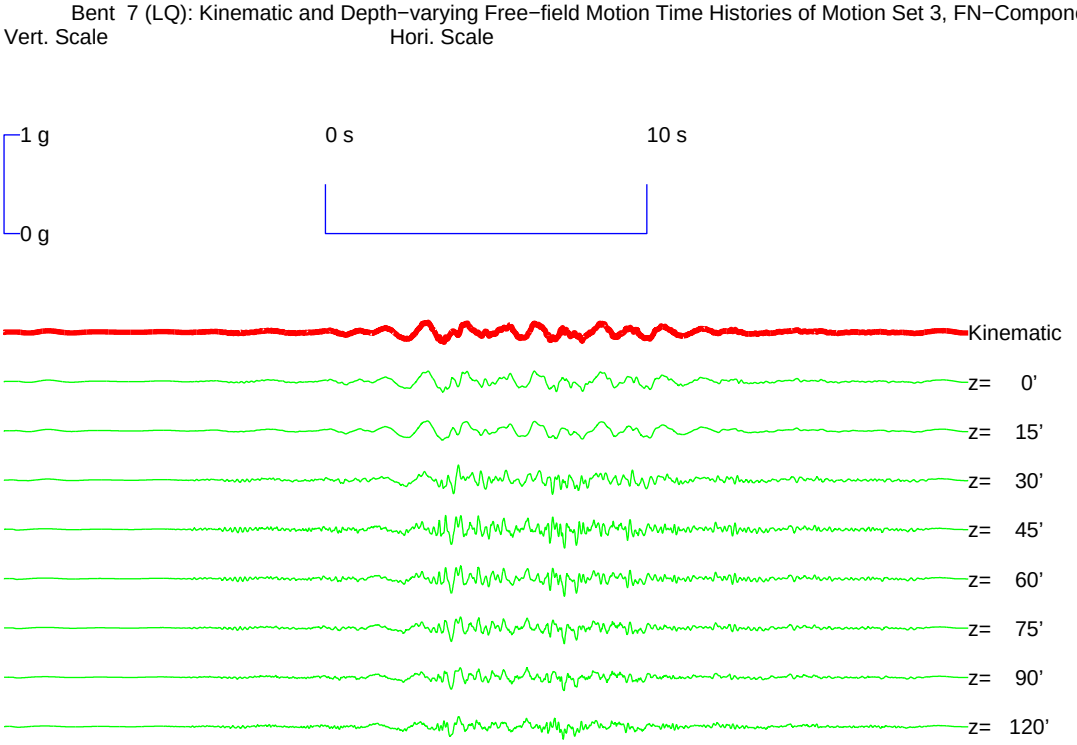


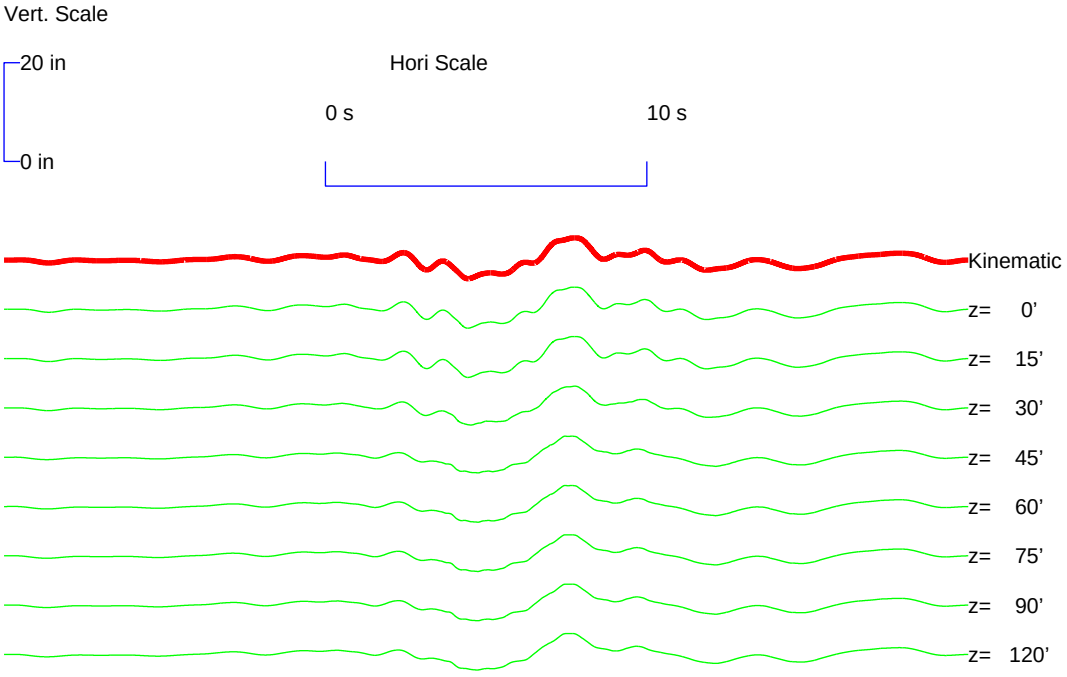



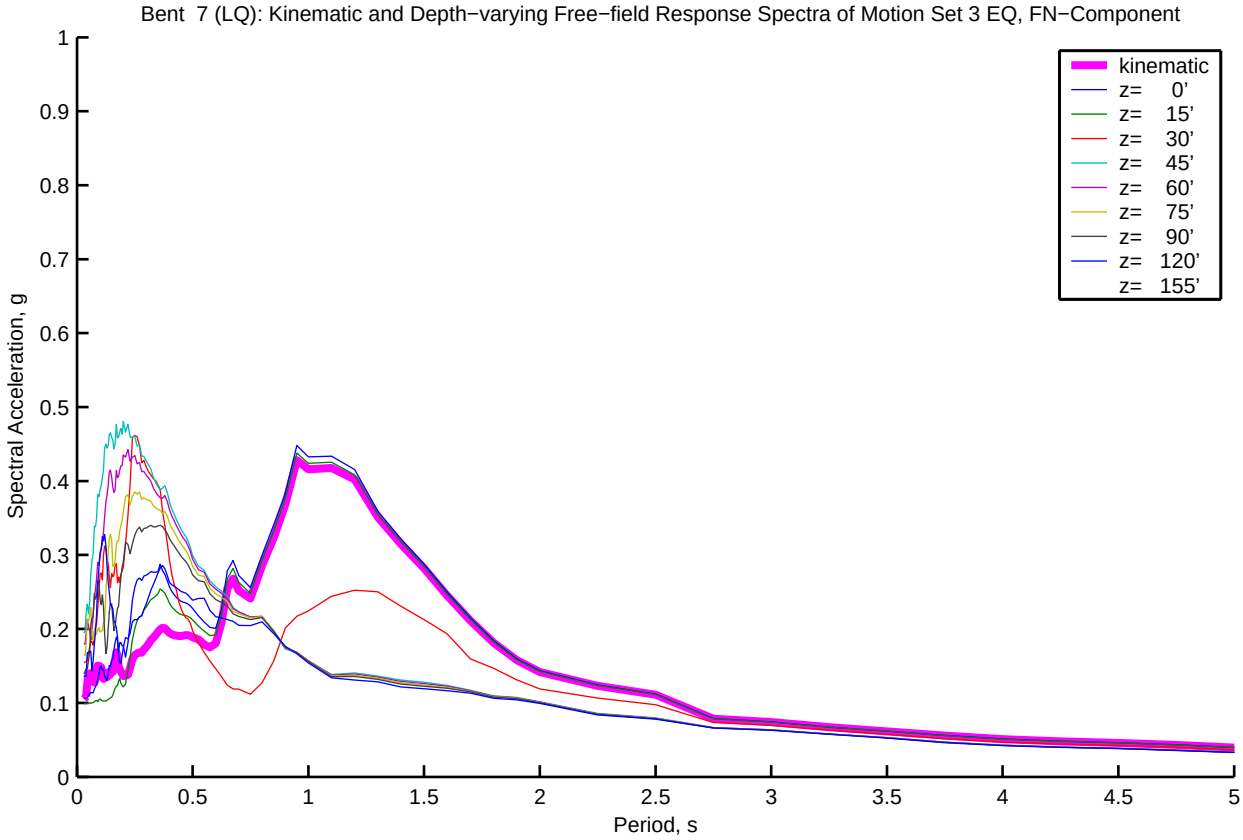

Bent 6 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

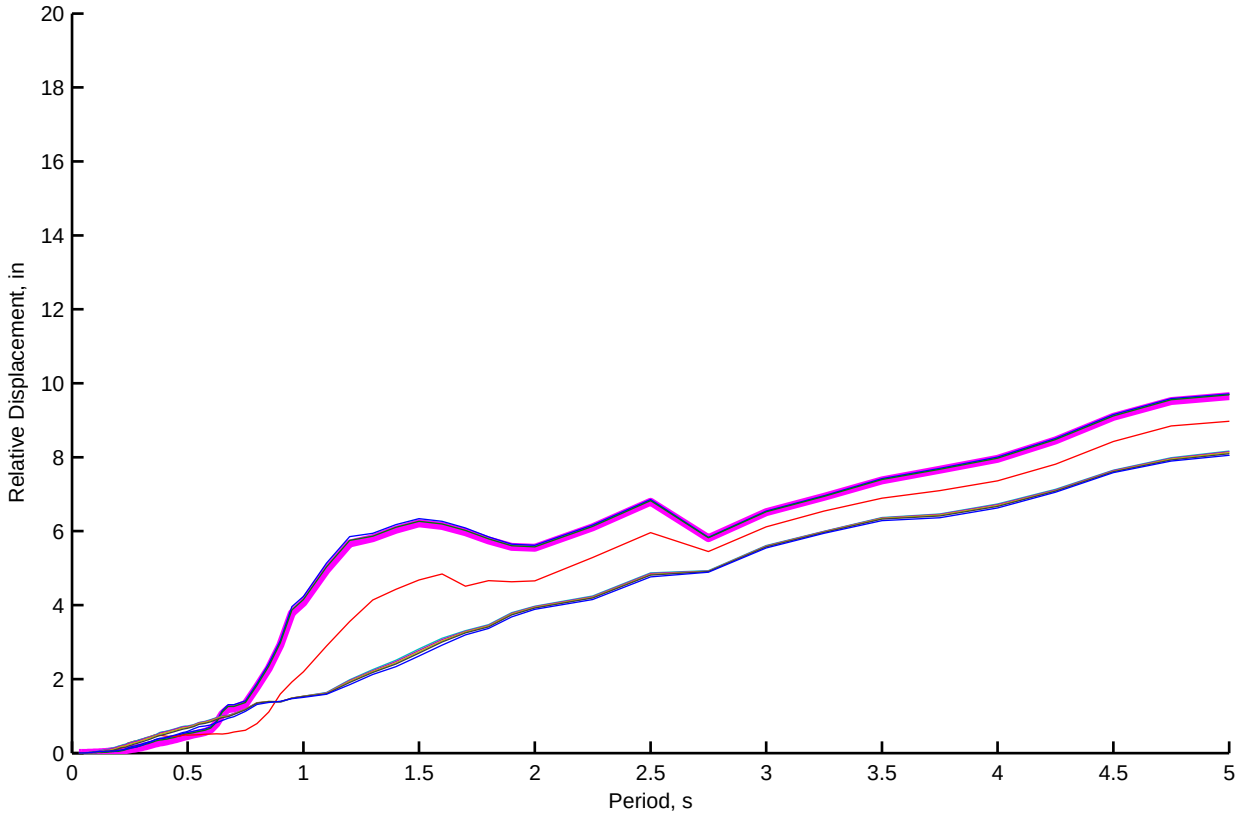

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

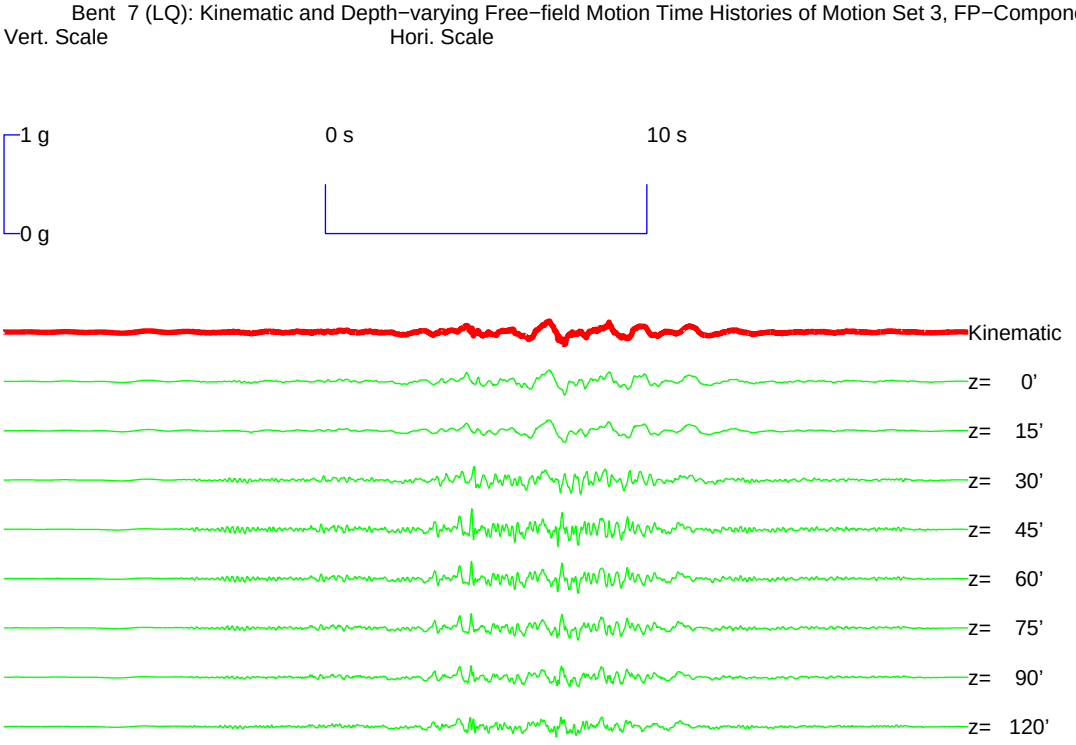


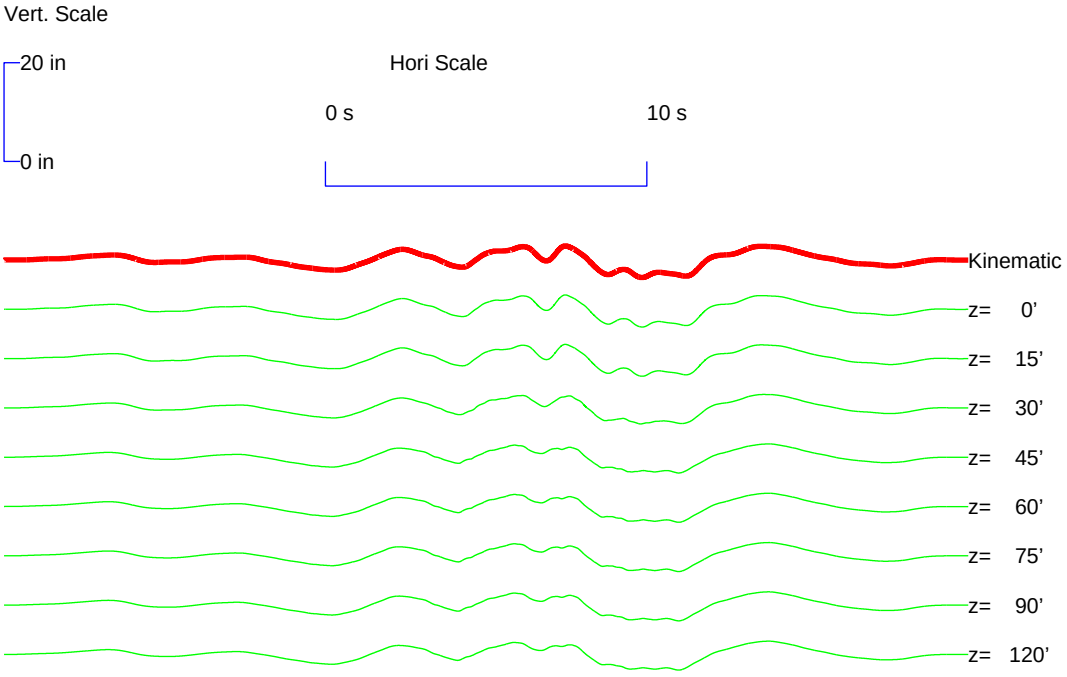



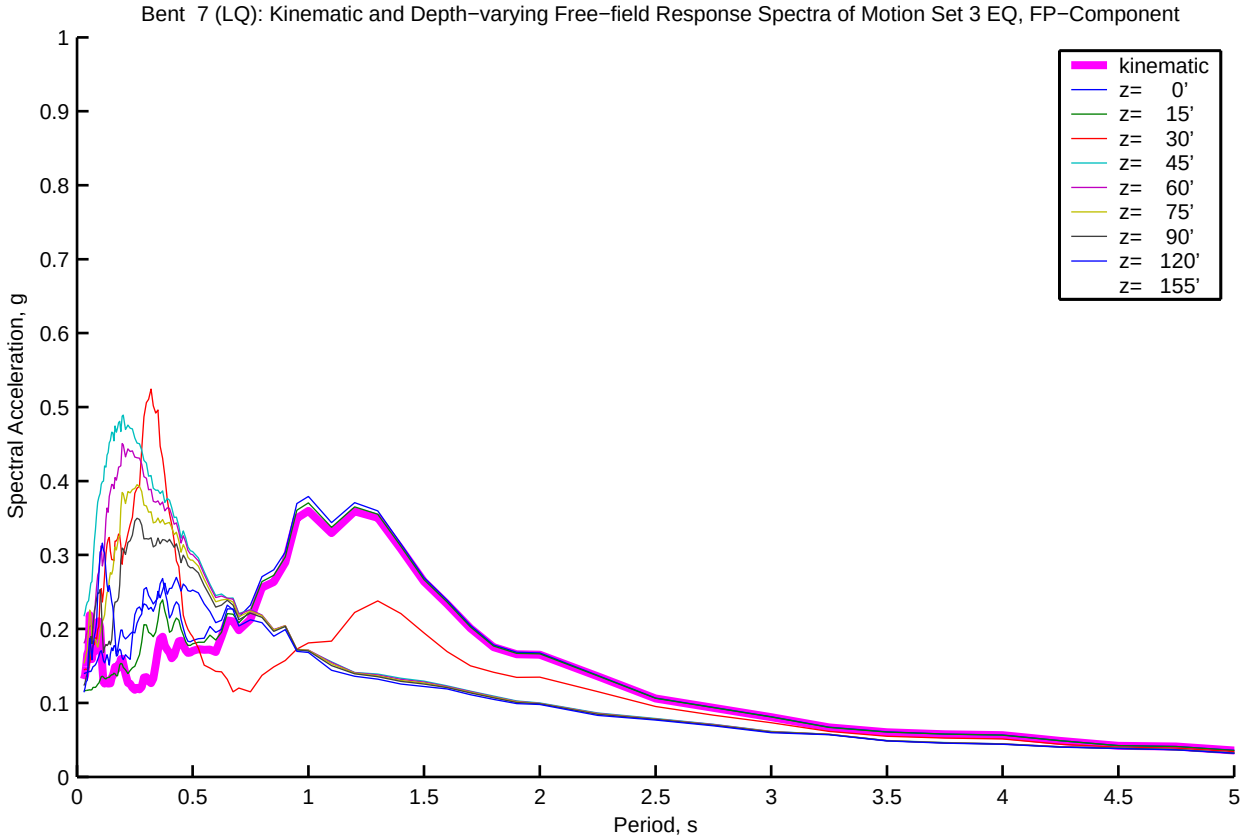

Bent 7 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

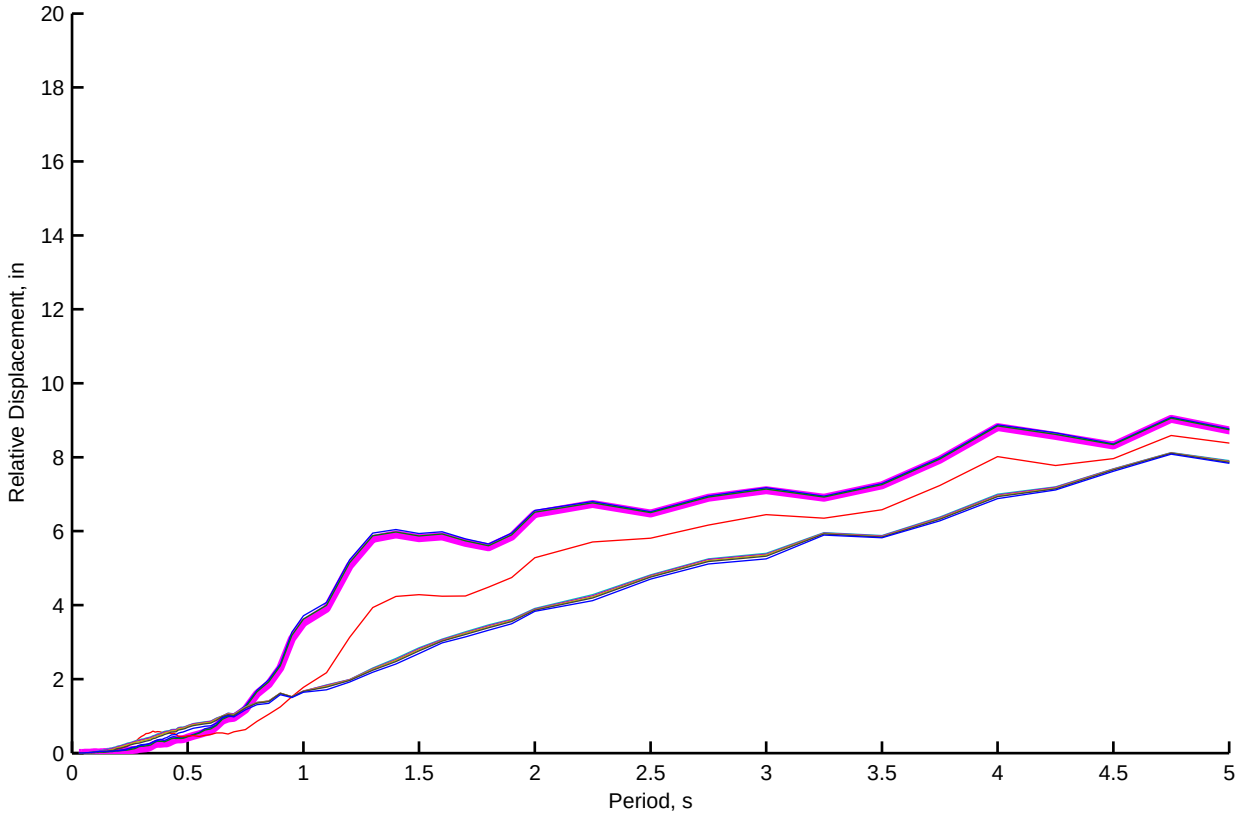

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 7 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

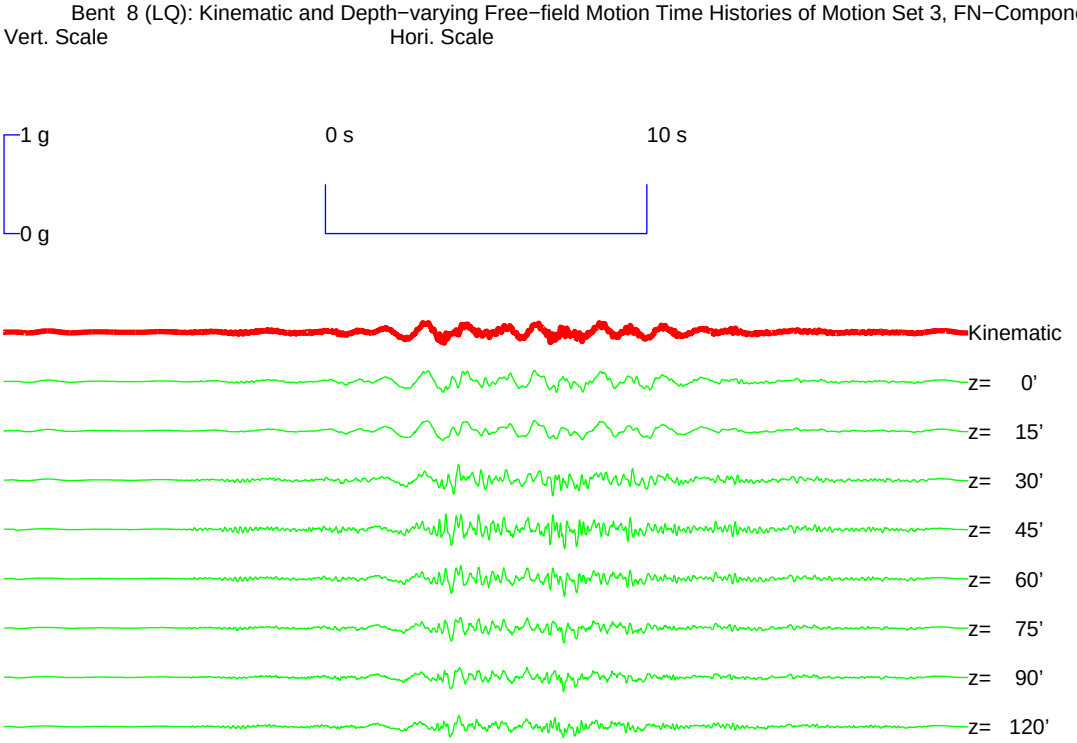


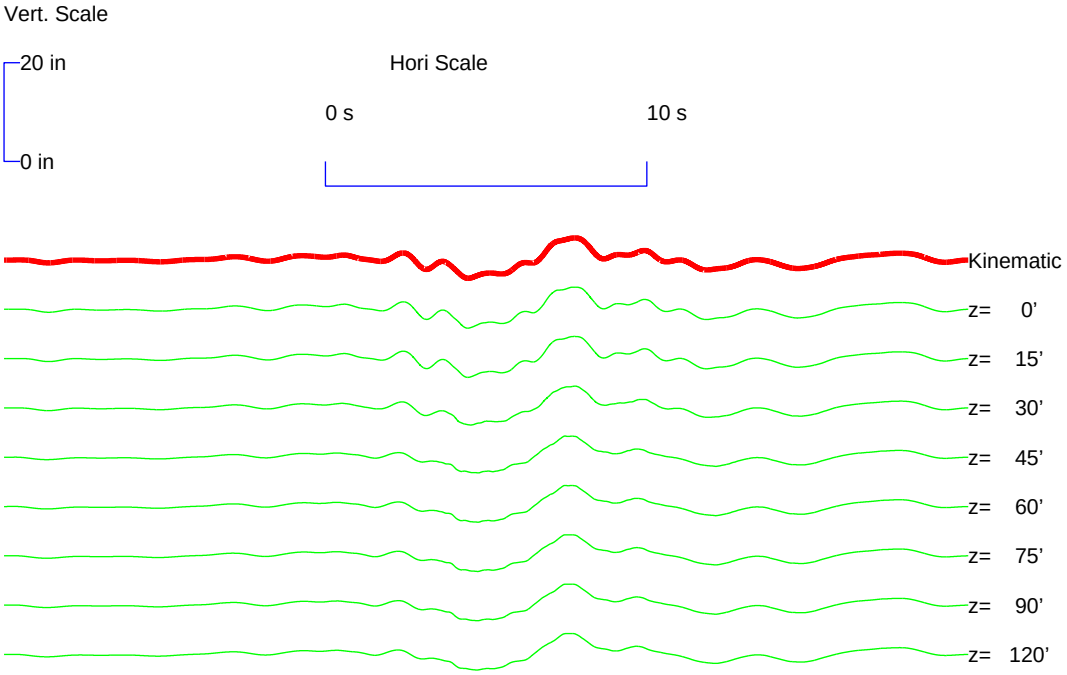



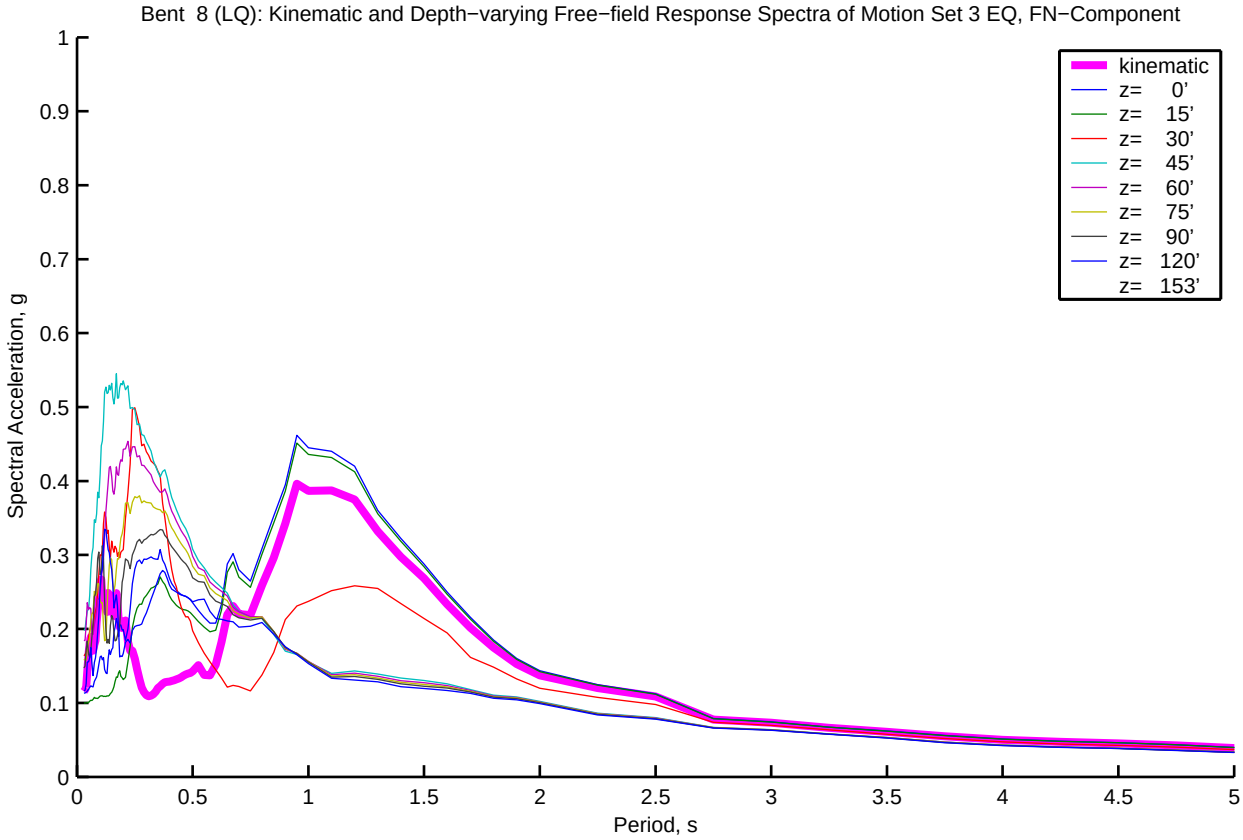

Bent 7 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 155'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

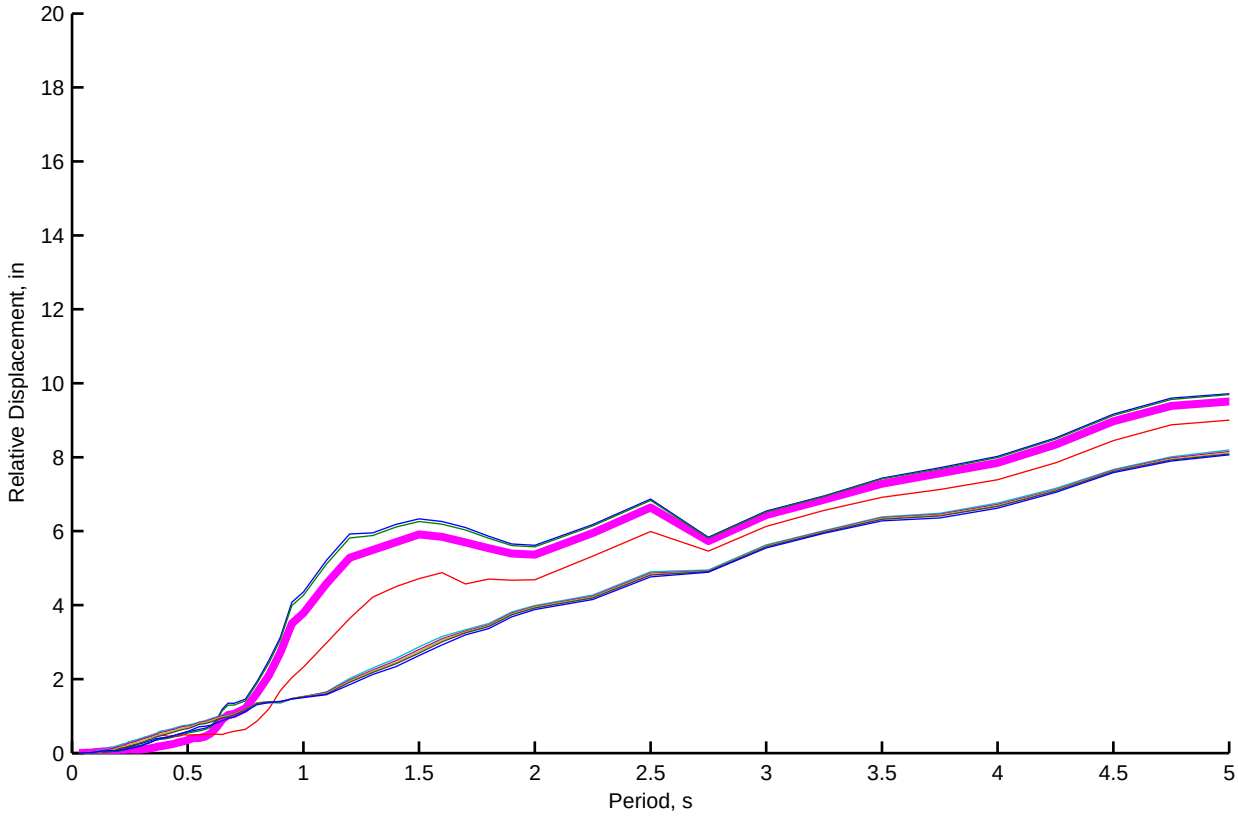

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

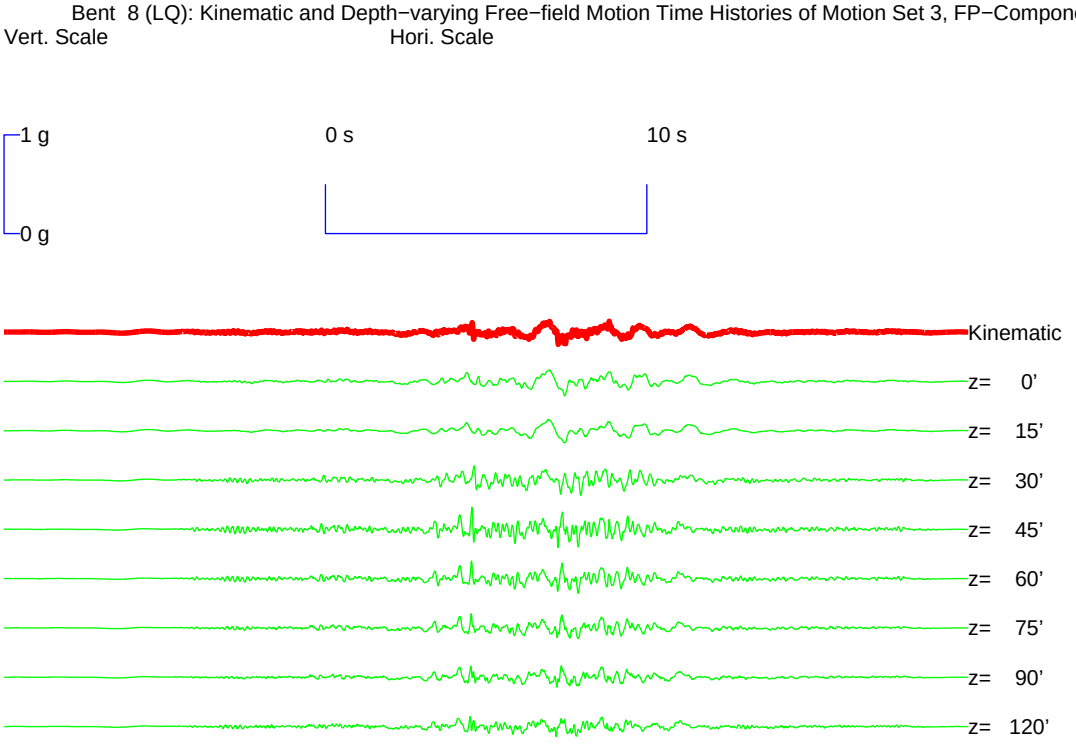


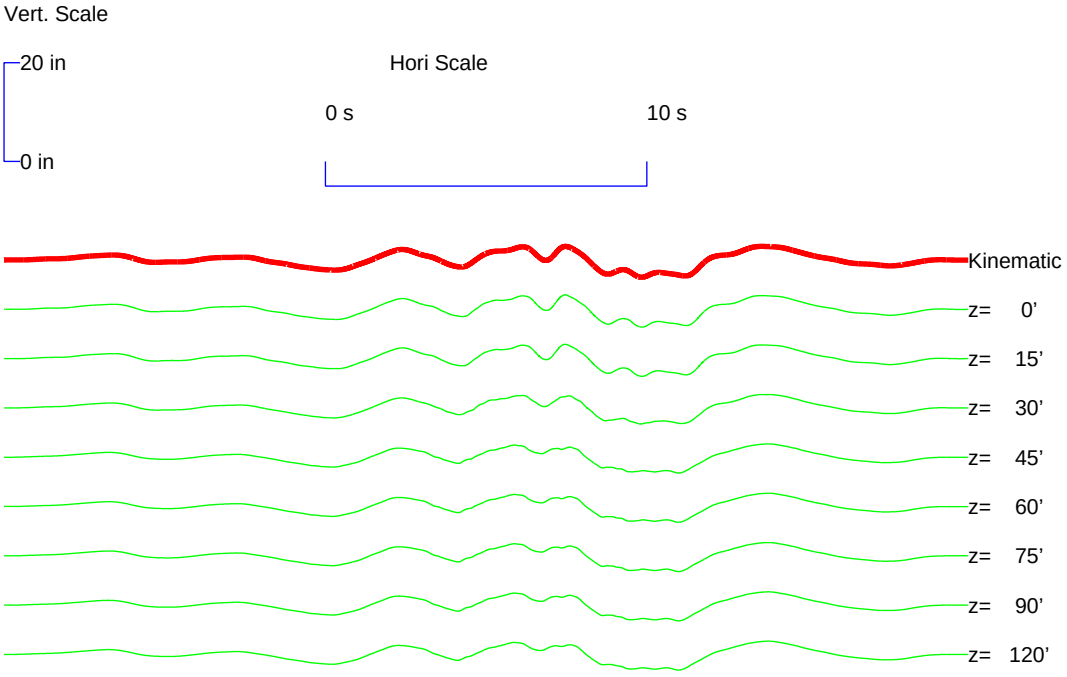



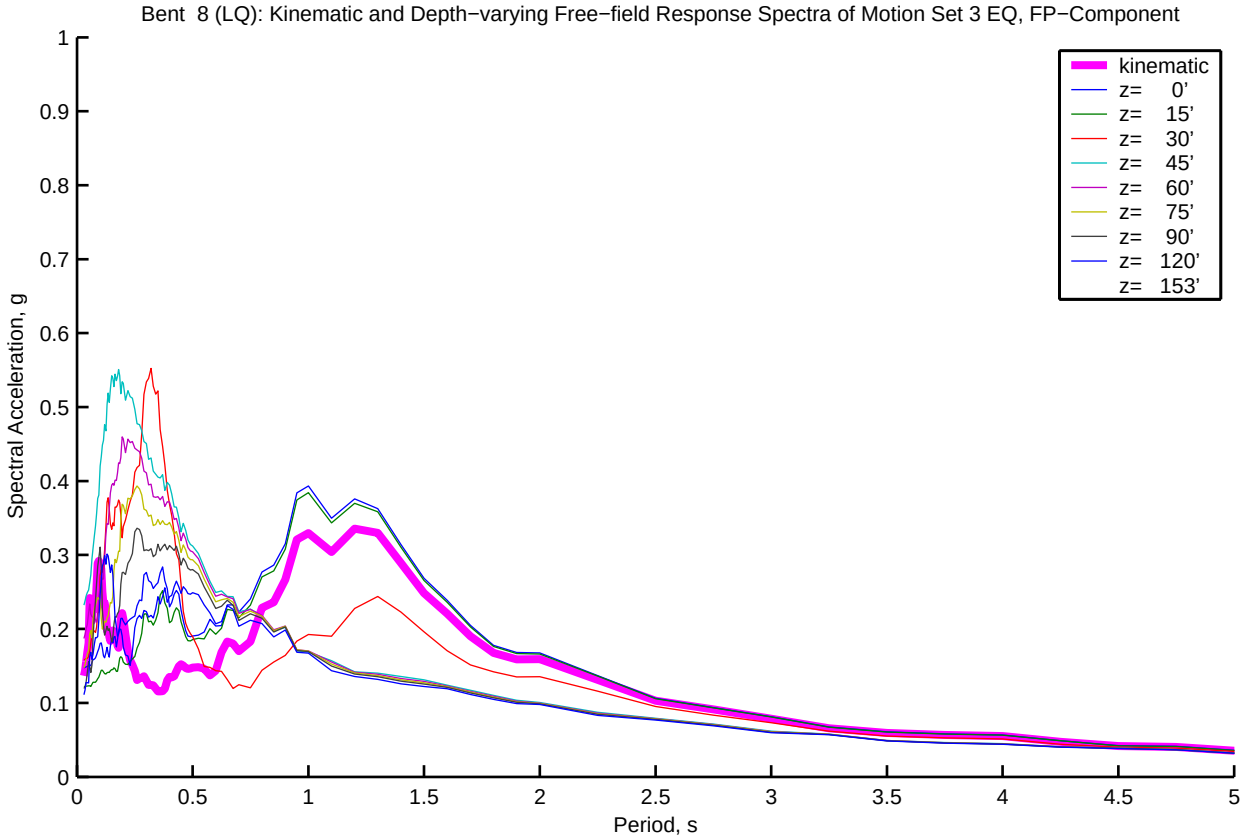

Bent 8 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

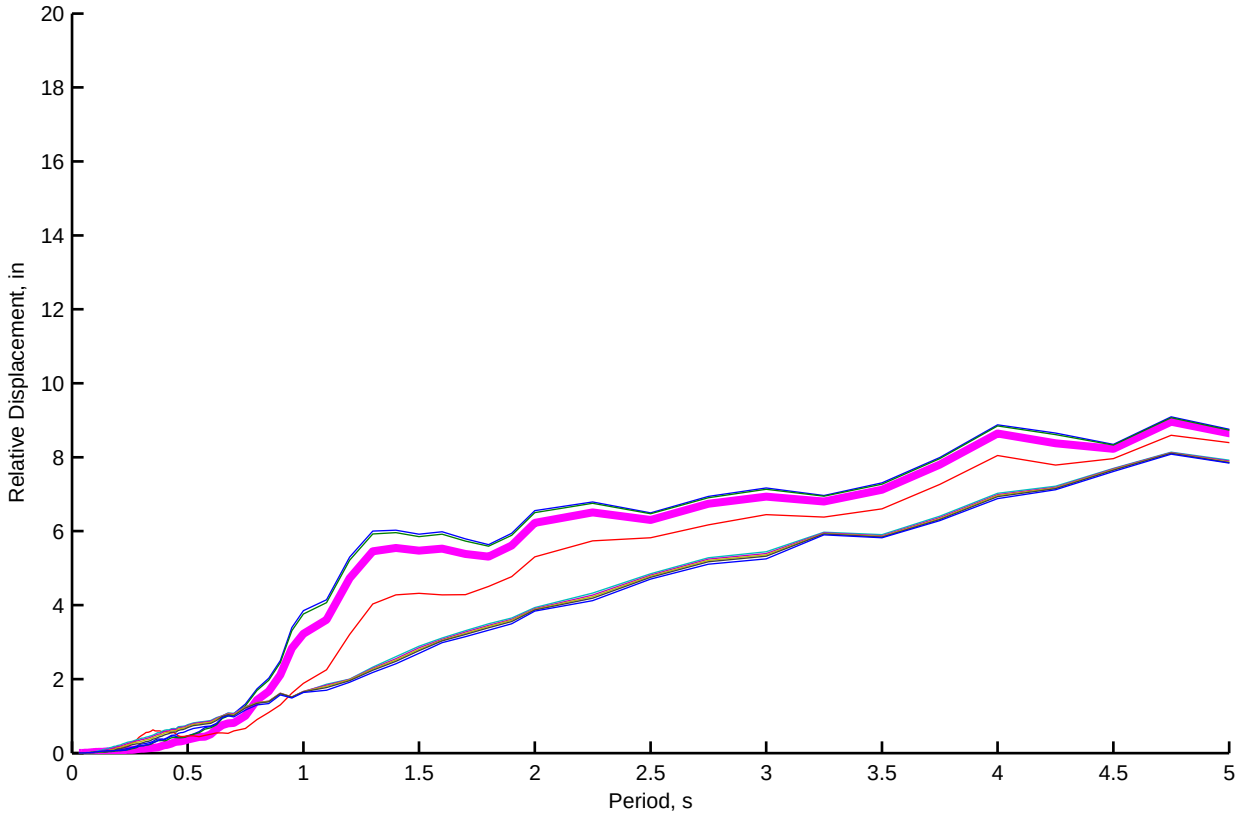

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 8 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

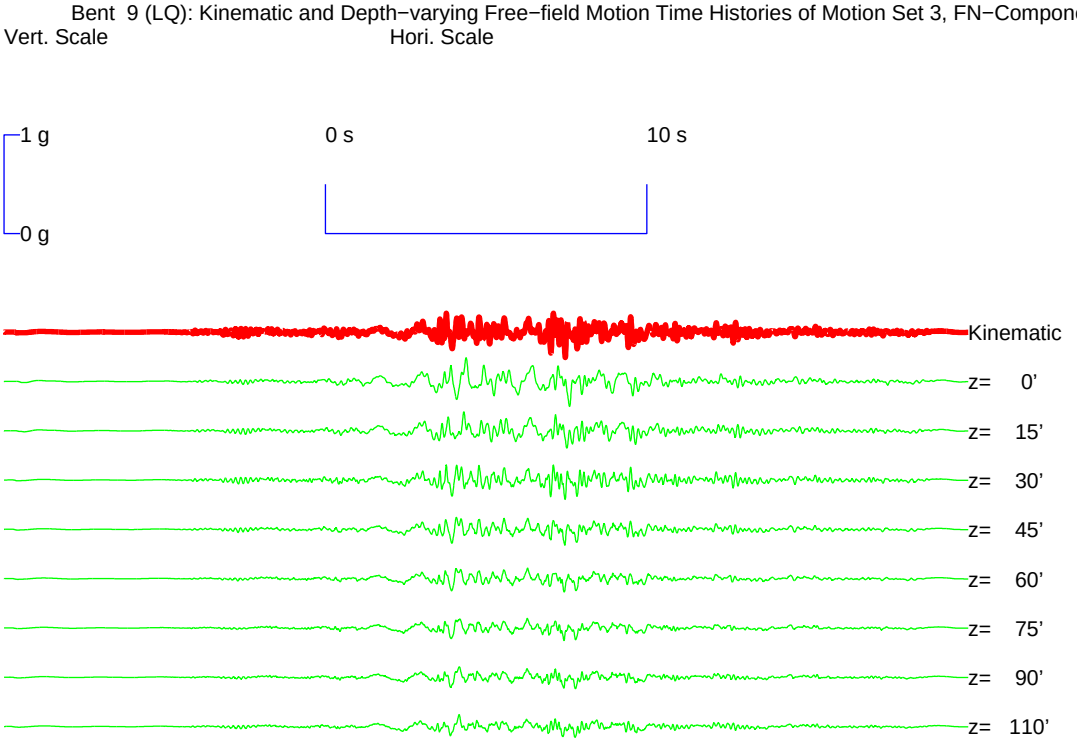


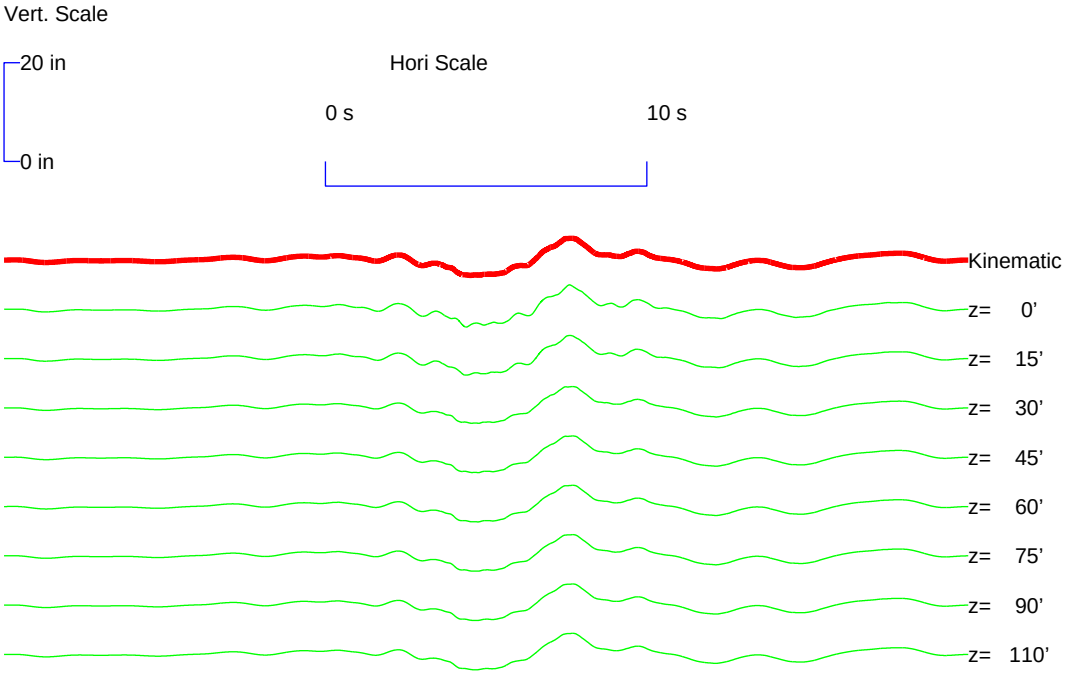



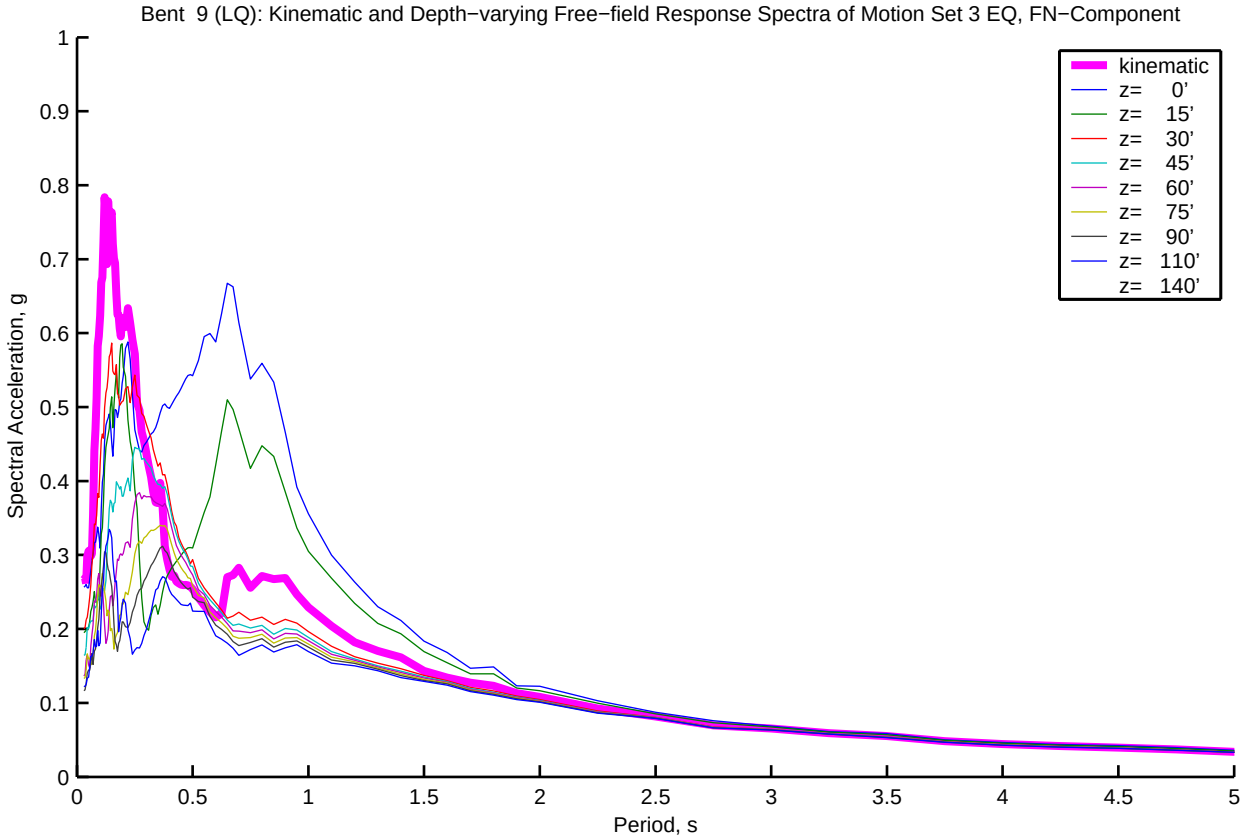

Bent 8 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 120'
z= 153'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

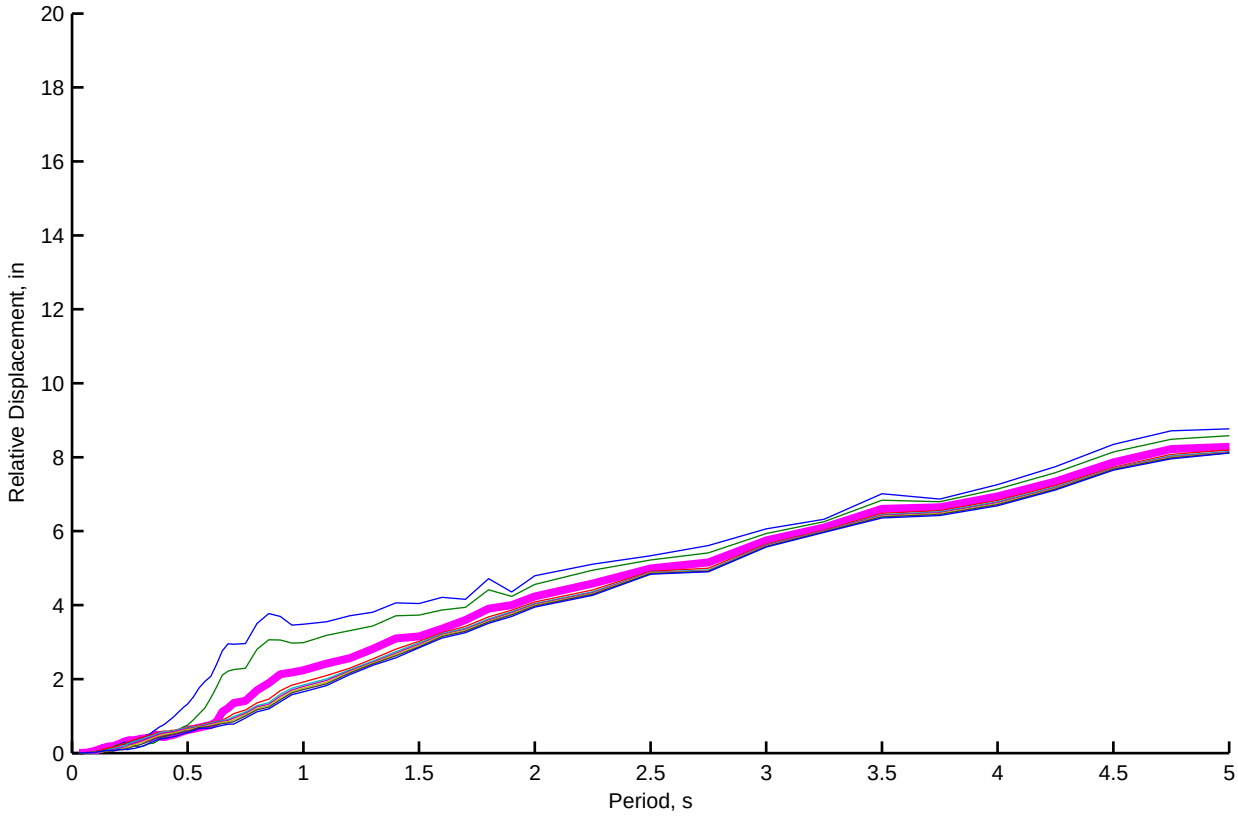

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 9 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component

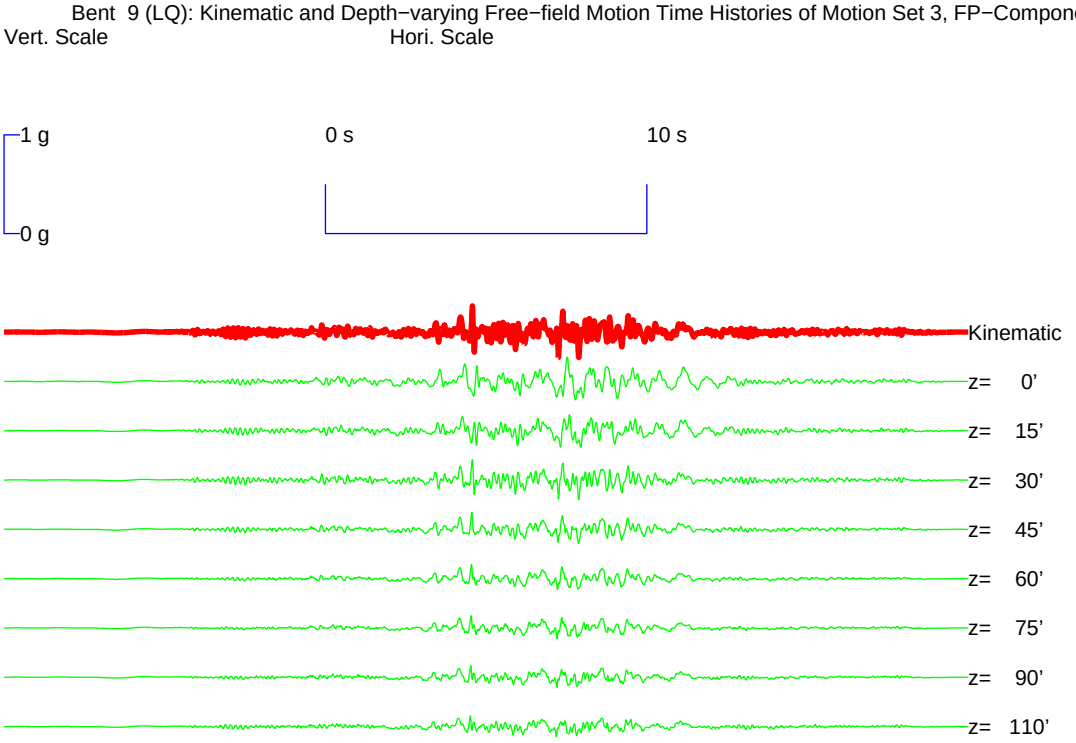


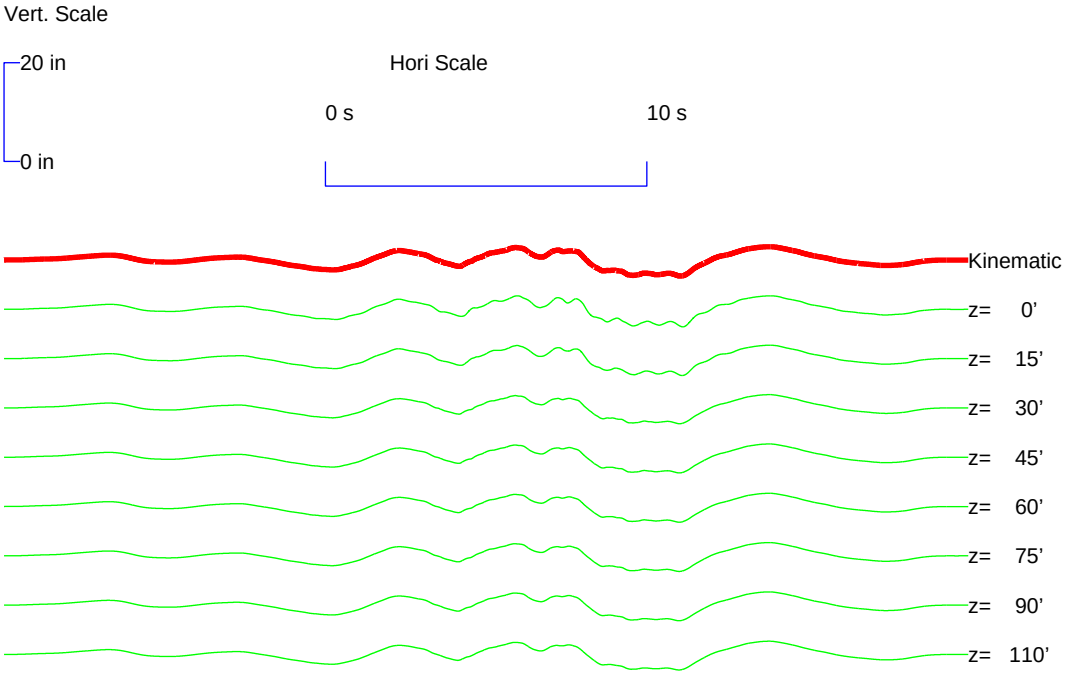



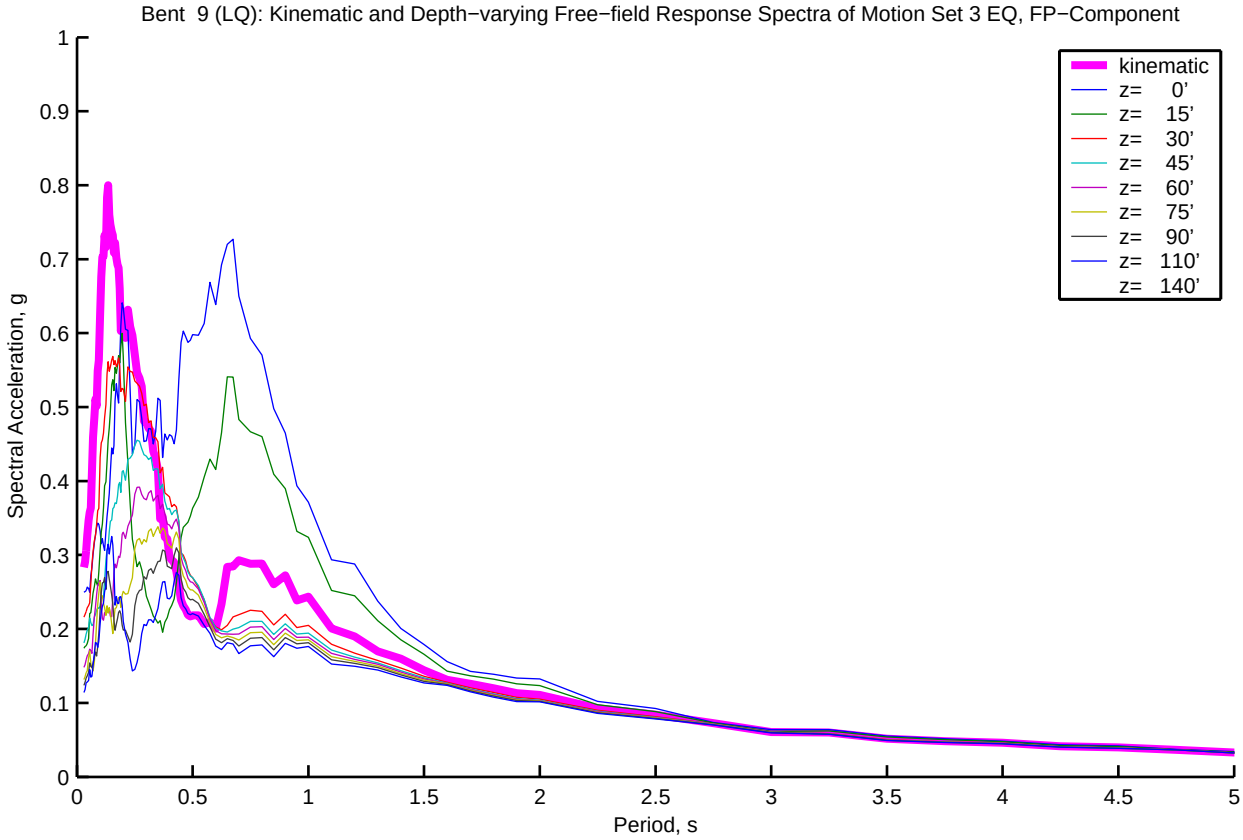

Bent 9 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

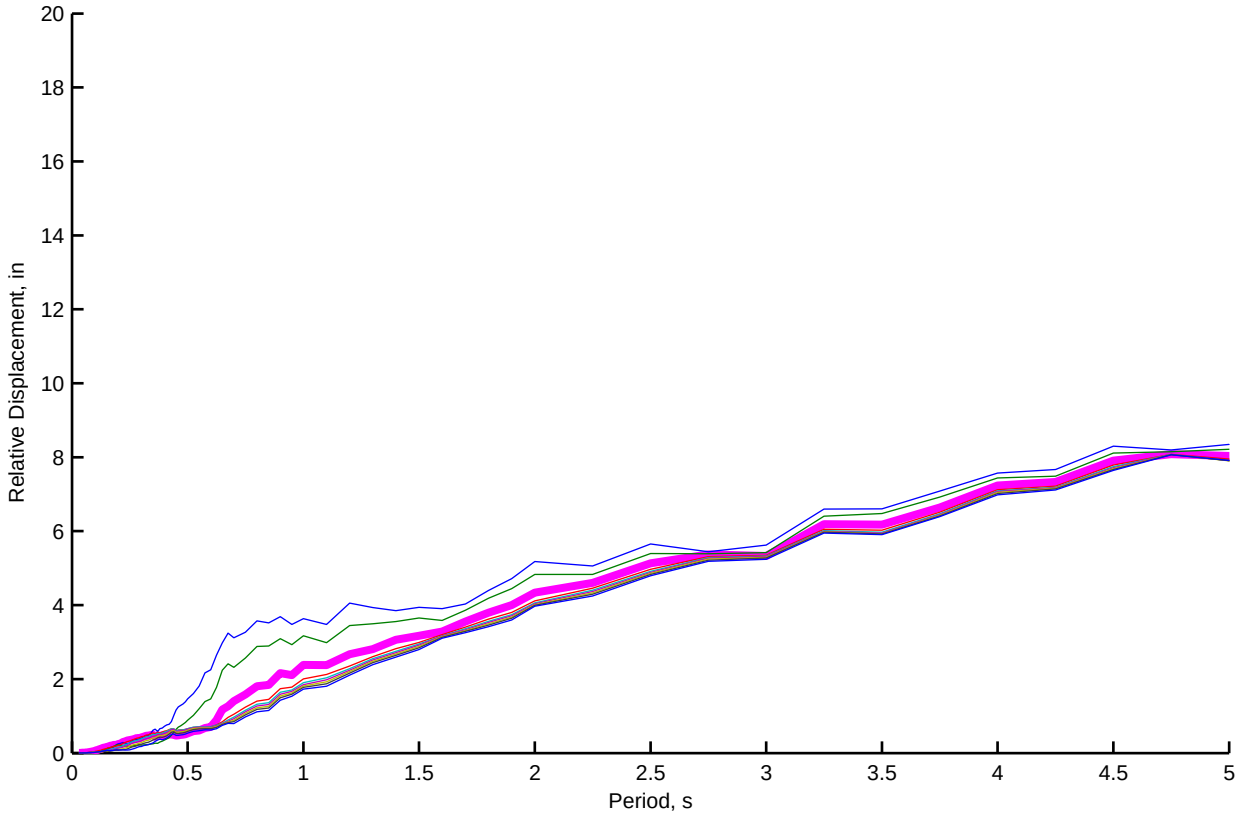

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 9 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component

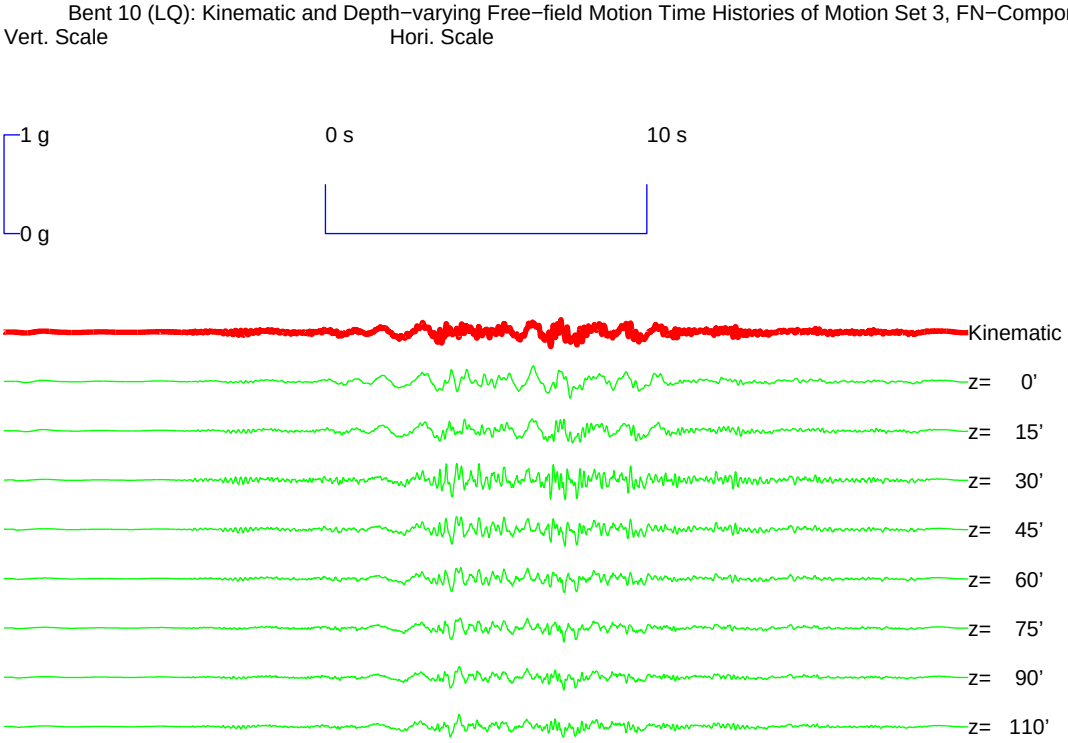


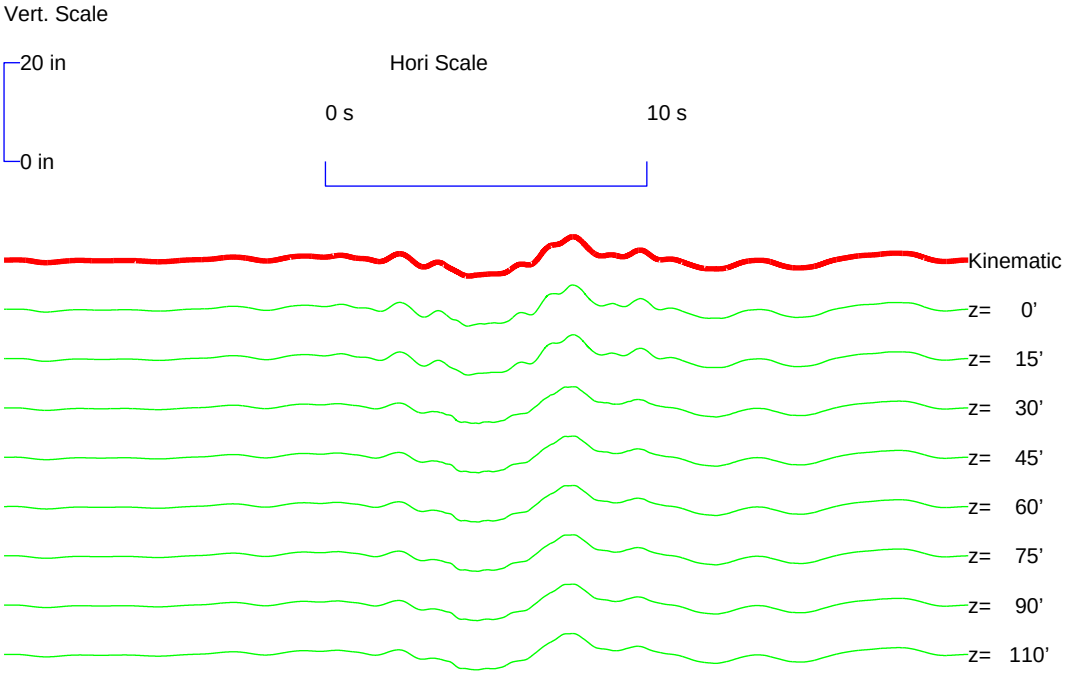



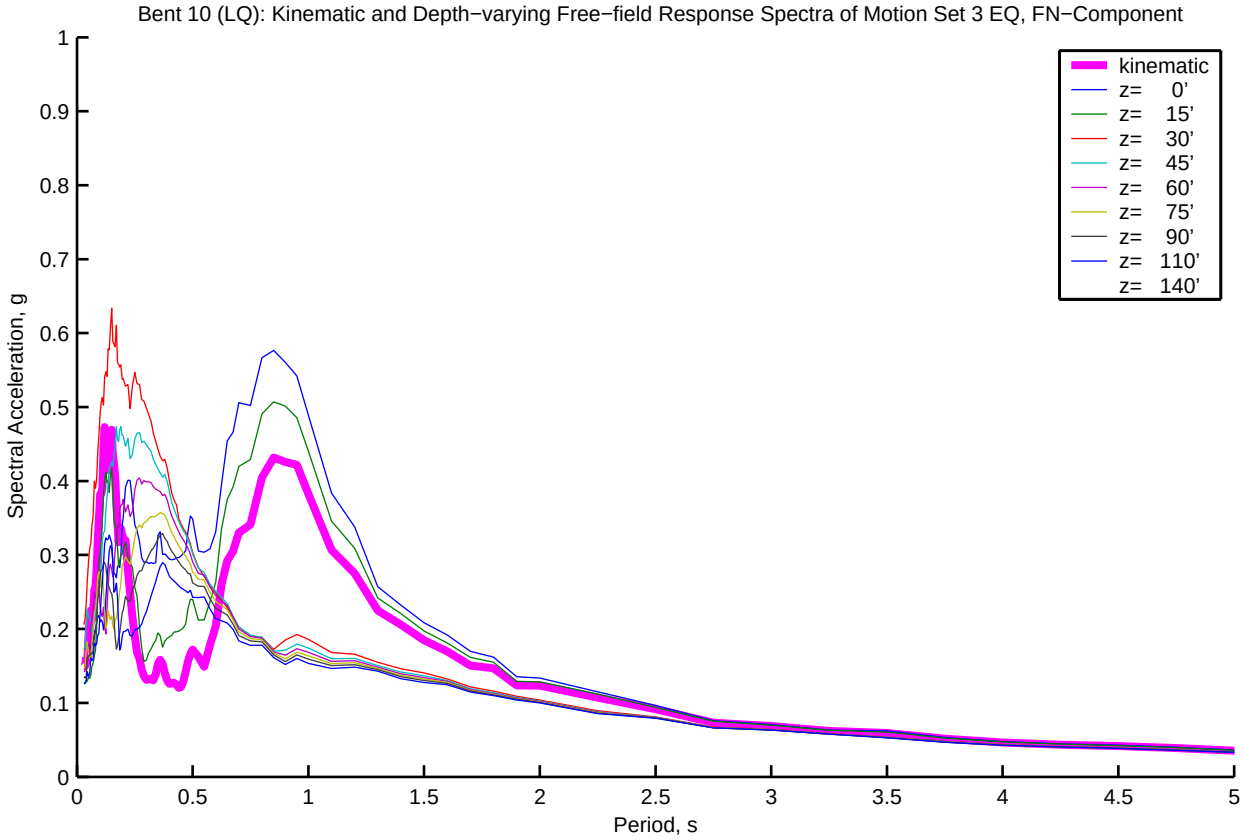

Bent 9 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5

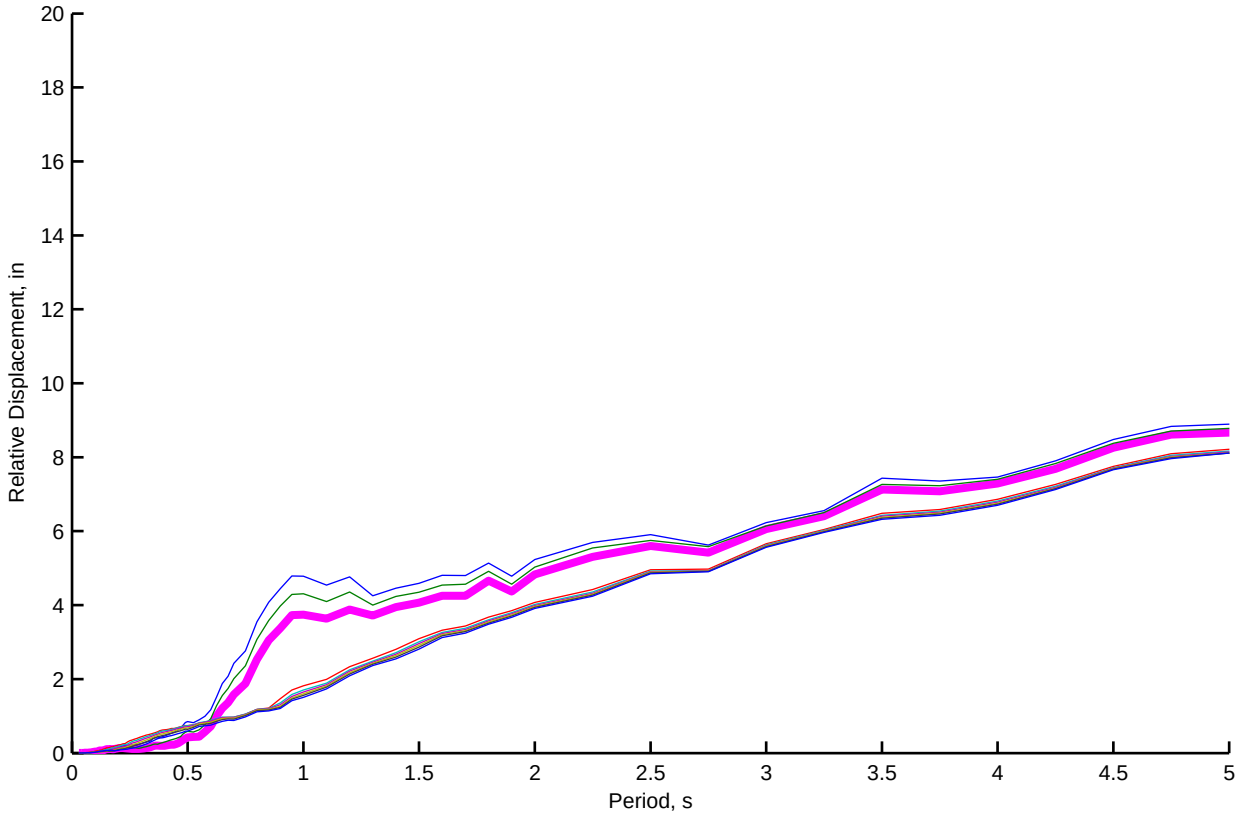

Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Bent 10 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FN−Component




Bent 10 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FN−Component
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'
Spectral Acceleration, g
Period, s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


Relative Displacement, in
Period, s
0
2
4
6
8
10
12
14
16
18
20
0.5
1
1.5
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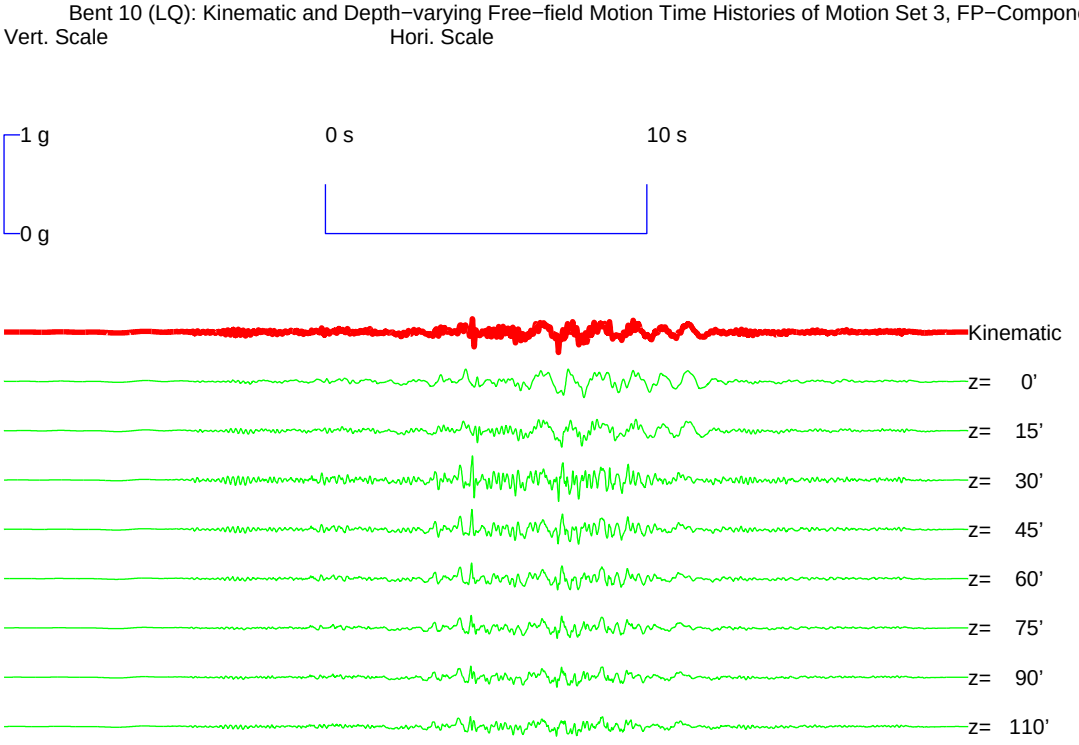
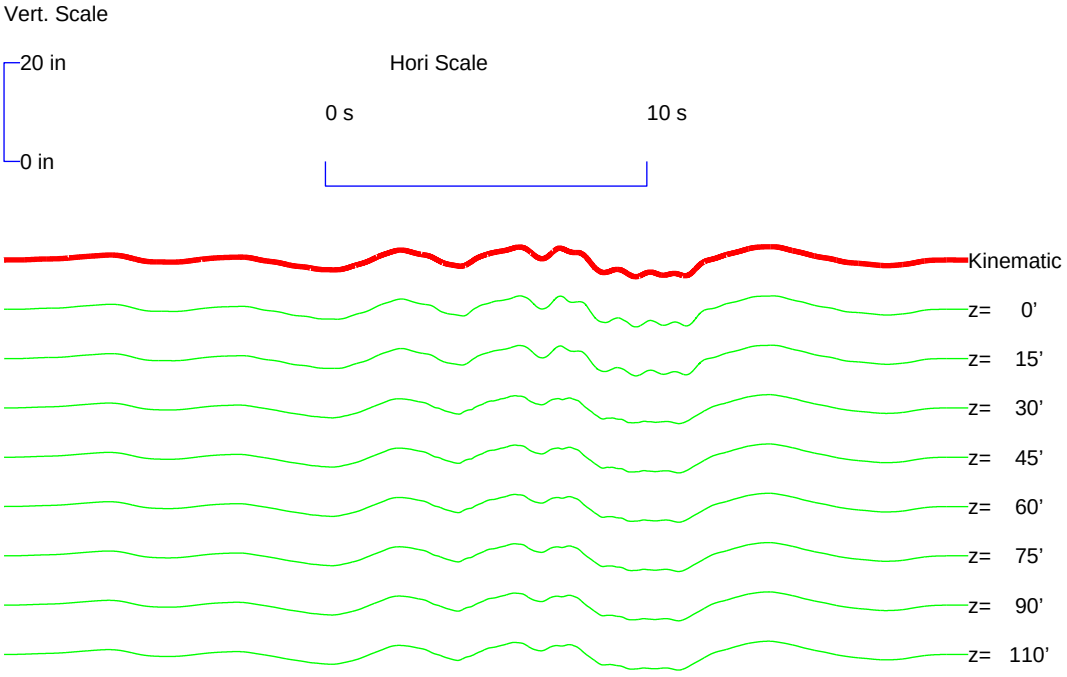
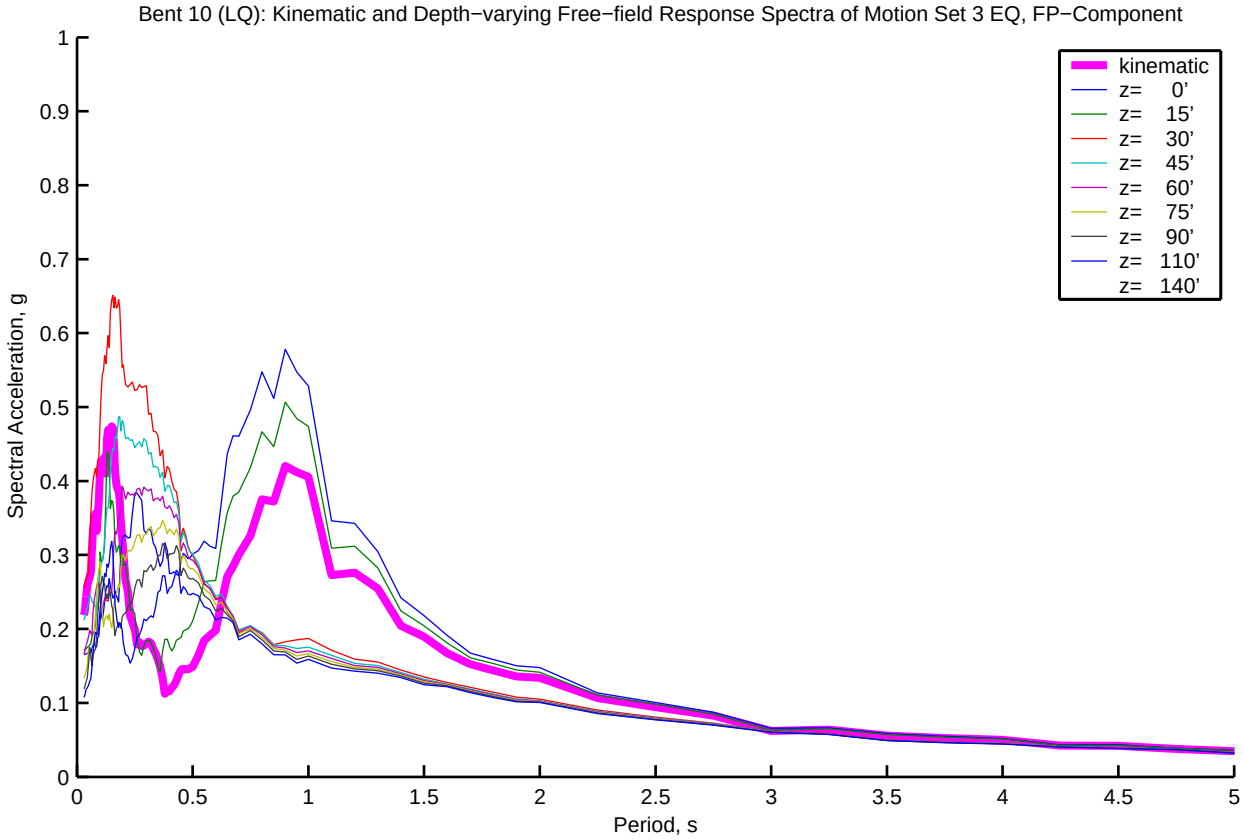
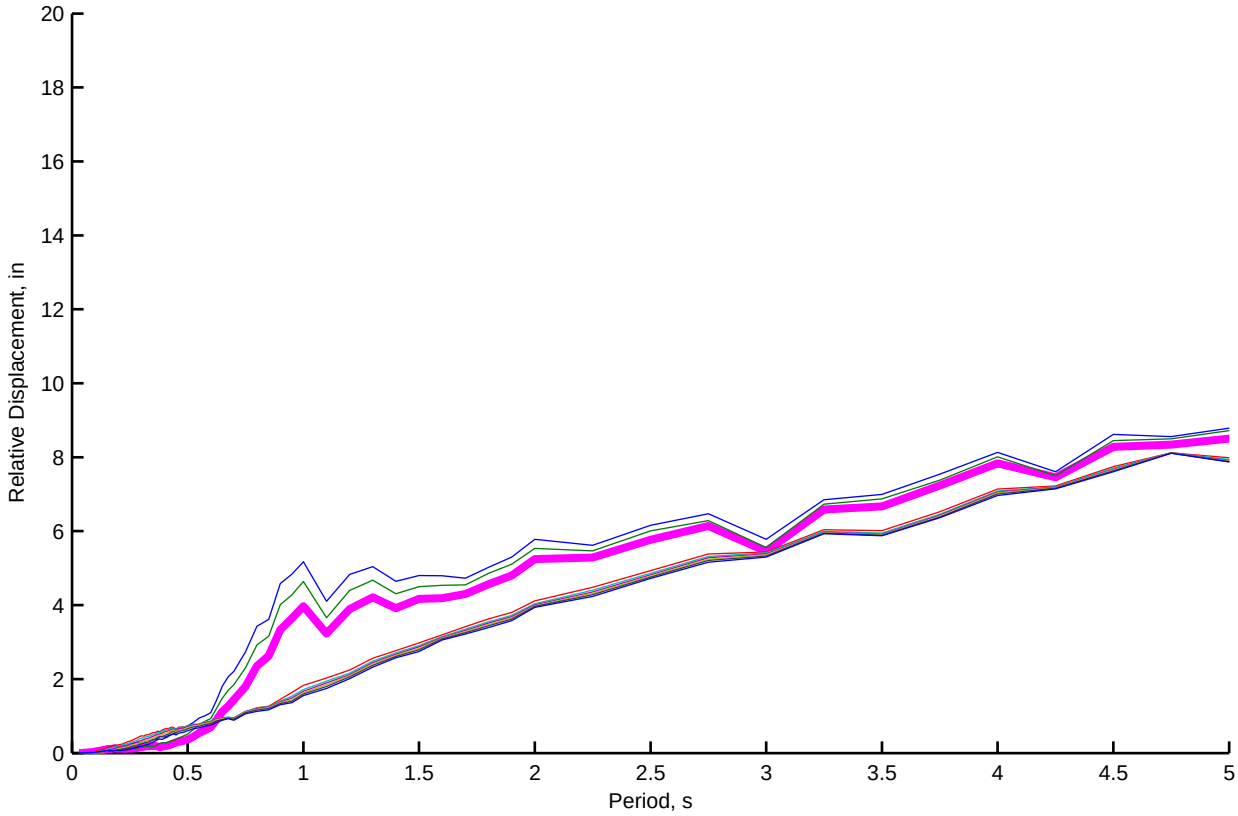
2.5
3
3.5
4
4.5
5

Bent 10 (LQ): Kinematic and Depth−varying Free−field Motion Time Histories of Motion Set 3, FP−Component




Bent 10 (LQ): Kinematic and Depth−varying Free−field Response Spectra of Motion Set 3 EQ, FP−Component
Spectral Acceleration, g
Period, s
kinematic
z= 0'
z= 15'
z= 30'
z= 45'
z= 60'
z= 75'
z= 90'
z= 110'
z= 140'


Relative Displacement, in
Period, s

# APPENDIX E

# ANALYSES AND CALCULATIONS

DRAFT

# Liquefaction and Lateral Spreading Analysis

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 12/26/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-001**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 86 | Present Ground El. | 85 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 25.0 | =Design Water Table Depth. | 44.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. I | 6.5 |
| $C_E$ | 1.43 | Future Ground El. | 85 | $C_B$ | 1.00 | 120 | 60 | =Design Water El. | 41 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 80 | SC | 26 | 2 | 2 | 40.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.00 | 0.67 | 0.99 | 0.30 | 0.15 | 34 | 46 | 1.00 | High N | 0.00 | LARGE | AboveWT |
| 10 | 75 | SC | 4 | 1 | 1 | 40.0 | 0.60 | 0.60 | 1.32 | 0.85 | 1.20 | 1.00 | 0.98 | 0.60 | 0.14 | 8 | 14 | 1.00 | 0.15 | 0.22 | 1.53 | AboveWT |
| 15 | 70 | SC | 4 | 2 | 2 | 40.0 | 0.90 | 0.90 | 1.08 | 0.85 | 1.00 | 0.67 | 0.97 | 0.90 | 0.14 | 3 | 9 | 1.00 | 0.11 | 0.15 | 1.07 | AboveWT |
| 20 | 65 | SC | 3 | 1 | 1 | 40.0 | 1.20 | 1.20 | 0.93 | 0.95 | 1.20 | 1.00 | 0.95 | 1.20 | 0.14 | 5 | 10 | 0.97 | 0.12 | 0.16 | 1.17 | AboveWT |
| 25 | 60 | CL | 4 | 2 | 2 | 60.0 | 1.50 | 1.50 | 0.83 | 0.95 | 1.00 | 0.67 | 0.94 | 1.50 | 0.14 | 3 | 9 | 0.93 | 0.10 | 0.14 | 0.98 | fines |
| 30 | 55 | SC | 3 | 1 | 1 | 40.0 | 1.80 | 1.80 | 0.76 | 1.00 | 1.20 | 1.00 | 0.93 | 1.64 | 0.15 | 4 | 10 | 0.91 | 0.11 | 0.15 | 0.97 | yes |
| 35 | 50 | SM | 15 | 2 | 2 | 30.0 | 2.10 | 2.10 | 0.71 | 1.00 | 1.00 | 0.67 | 0.89 | 1.79 | 0.15 | 10 | 16 | 0.89 | 0.17 | 0.22 | 1.45 | no |
| 40 | 45 | ML | 16 | 1 | 1 | 60.0 | 2.40 | 2.40 | 0.66 | 1.00 | 1.20 | 1.00 | 0.85 | 1.93 | 0.16 | 18 | 27 | 0.87 | 0.33 | 0.42 | 2.68 | fines |
| 45 | 40 | ML? | 1 | 2 | 2 | 60.0 | 2.70 | 2.67 | 0.63 | 1.00 | 1.00 | 0.67 | 0.81 | 2.08 | 0.15 | 1 | 6 | 0.87 | 0.08 | 0.10 | 0.63 | fines |
| 50 | 35 | ML | 18 | 1 | 1 | 75.0 | 3.00 | 2.81 | 0.61 | 1.00 | 1.20 | 1.00 | 0.77 | 2.22 | 0.15 | 19 | 28 | 0.86 | 0.36 | 0.44 | 2.90 | fines |
| 55 | 30 | ML | 100 | 2 | 2 | 75.0 | 3.30 | 2.96 | 0.59 | 1.00 | 1.00 | 0.67 | 0.73 | 2.36 | 0.15 | 57 | 73 | 0.85 | High N | 0.00 | LARGE | high N |
| 60 | 25 | CL | 52 | 1 | 1 | 95.0 | 3.60 | 3.10 | 0.58 | 1.00 | 1.20 | 1.00 | 0.69 | 2.51 | 0.15 | 52 | 67 | 0.84 | High N | 0.00 | LARGE | high N |
| 65 | 20 | ML | 24 | 2 | 2 | 90.0 | 3.90 | 3.24 | 0.57 | 1.00 | 1.00 | 0.67 | 0.64 | 2.65 | 0.14 | 13 | 21 | 0.83 | 0.22 | 0.27 | 1.90 | fines |
| 70 | 15 | SP | 31 | 1 | 1 | 5.0 | 4.20 | 3.39 | 0.56 | 1.00 | 1.20 | 1.00 | 0.60 | 2.80 | 0.13 | 30 | 30 | 0.82 | 0.44 | 0.52 | 3.88 | depth>50' |
| 80 | 5 | SP | 27 | 1 | 1 | 5.0 | 4.80 | 3.68 | 0.53 | 1.00 | 1.20 | 1.00 | 0.55 | 3.08 | 0.13 | 25 | 25 | 0.78 | 0.29 | 0.32 | 2.55 | depth>50' |
| 90 | -5 | SP/SM | 66 | 2 | 2 | 10.0 | 5.40 | 3.96 | 0.51 | 1.00 | 1.00 | 0.67 | 0.52 | 3.37 | 0.12 | 32 | 34 | 0.76 | High N | 0.00 | LARGE | high N |
| 100 | -15 | SP-SM | 50 | 1 | 1 | 10.0 | 6.00 | 4.25 | 0.50 | 0.95 | 1.20 | 1.00 | 0.50 | 3.66 | 0.12 | 40 | 42 | 0.74 | High N | 0.00 | LARGE | high N |
| 110 | -25 | SM | 67 | 2 | 2 | 40.0 | 6.60 | 4.54 | 0.48 | 0.95 | 1.00 | 0.67 | 0.50 | 3.95 | 0.12 | 29 | 40 | 0.73 | High N | 0.00 | LARGE | high N |
| 120 | -35 | CL | 68 | 1 | 1 | 80.0 | 7.20 | 4.83 | 0.46 | 0.95 | 1.20 | 1.00 | 0.50 | 4.24 | 0.13 | 52 | 67 | 0.71 | High N | 0.00 | LARGE | high N |
| 130 | -45 | CL | 100 | 2 | 2 | 95.0 | 7.80 | 5.12 | 0.45 | 0.95 | 1.00 | 0.67 | 0.50 | 4.52 | 0.13 | 41 | 54 | 0.70 | High N | 0.00 | LARGE | high N |
| 140 | -55 | CL | 39 | 1 | 1 | 95.0 | 8.40 | 5.40 | 0.44 | 0.95 | 1.20 | 1.00 | 0.50 | 4.81 | 0.13 | 28 | 39 | 0.68 | High N | 0.00 | LARGE | high N |
| 150 | -65 | CL | 100 | 2 | 2 | 95.0 | 9.00 | 5.69 | 0.43 | 0.95 | 1.00 | 0.67 | 0.50 | 5.10 | 0.13 | 39 | 52 | 0.67 | High N | 0.00 | LARGE | high N |
| 160 | -75 | MH | 25 | 1 | 1 | 90.0 | 9.60 | 5.98 | 0.42 | 0.95 | 1.20 | 1.00 | 0.50 | 5.39 | 0.13 | 17 | 25 | 0.66 | 0.30 | 0.29 | 2.19 | fines |
| 169 | -84 | RF | 100 | 1 | 1 | 2.0 | 10.14 | 6.24 | 0.41 | 0.95 | 1.20 | 1.00 | 0.50 | 5.65 | 0.13 | 67 | 67 | 0.66 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 12/26/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-004**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 86 | Present Ground El. | 55 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 0.0 | =Design Water Table Depth. | 10.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.43 | Future Ground El. | 55 | $C_B$ | 1.00 | 120 | 55 | =Design Water El. | 45 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 50 | SM | 8 | 1 | 1 | 25.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.20 | 1.00 | 0.99 | 0.14 | 0.30 | 19 | 25 | 1.00 | 0.29 | 0.43 | 1.40 | no |
| 10 | 45 | CL | 14 | 2 | 2 | 90.0 | 0.60 | 0.60 | 1.32 | 0.85 | 1.00 | 0.67 | 0.98 | 0.29 | 0.30 | 15 | 23 | 1.00 | 0.26 | 0.37 | 1.23 | fines |
| 15 | 40 | CL | 0.5 | 1 | 1 | 95.0 | 0.90 | 0.74 | 1.18 | 0.85 | 1.20 | 1.00 | 0.97 | 0.43 | 0.30 | 1 | 6 | 1.00 | 0.08 | 0.12 | 0.39 | fines |
| 20 | 35 | CL | 3 | 2 | 2 | 95.0 | 1.20 | 0.89 | 1.08 | 0.95 | 1.00 | 0.67 | 0.95 | 0.58 | 0.29 | 3 | 9 | 1.00 | 0.10 | 0.14 | 0.49 | fines |
| 25 | 30 | SP-SM | 2 | 1 | 1 | 15.0 | 1.50 | 1.03 | 1.01 | 0.95 | 1.20 | 1.00 | 0.94 | 0.72 | 0.29 | 3 | 6 | 1.00 | 0.08 | 0.11 | 0.39 | yes |
| 30 | 25 | SP-SM? | 10 | 2 | 2 | 20.0 | 1.80 | 1.18 | 0.94 | 1.00 | 1.00 | 0.67 | 0.93 | 0.86 | 0.29 | 9 | 13 | 1.00 | 0.14 | 0.21 | 0.72 | yes |
| 35 | 20 | SP-SM? | 5 | 1 | 1 | 20.0 | 2.10 | 1.32 | 0.89 | 1.00 | 1.20 | 1.00 | 0.89 | 1.01 | 0.27 | 8 | 12 | 1.00 | 0.13 | 0.19 | 0.69 | yes |
| 40 | 15 | SP/SM | 17 | 2 | 2 | 15.0 | 2.40 | 1.46 | 0.84 | 1.00 | 1.00 | 0.67 | 0.85 | 1.15 | 0.26 | 14 | 17 | 0.98 | 0.18 | 0.25 | 0.97 | yes |
| 45 | 10 | SP/SM | 10 | 1 | 1 | 15.0 | 2.70 | 1.61 | 0.81 | 1.00 | 1.20 | 1.00 | 0.81 | 1.30 | 0.25 | 14 | 17 | 0.96 | 0.18 | 0.25 | 1.01 | no |
| 50 | 5 | SP? | 32 | 2 | 2 | 10.0 | 3.00 | 1.75 | 0.77 | 1.00 | 1.00 | 0.67 | 0.77 | 1.44 | 0.24 | 24 | 25 | 0.94 | 0.29 | 0.39 | 1.67 | depth>50' |
| 55 | 0 | SP? | 14 | 1 | 1 | 20.0 | 3.30 | 1.90 | 0.74 | 1.00 | 1.20 | 1.00 | 0.73 | 1.58 | 0.22 | 18 | 23 | 0.92 | 0.26 | 0.34 | 1.51 | depth>50' |
| 60 | -5 | GP-GM? | 33 | 2 | 2 | 20.0 | 3.60 | 2.04 | 0.72 | 1.00 | 1.00 | 0.67 | 0.69 | 1.73 | 0.21 | 23 | 28 | 0.90 | 0.37 | 0.48 | 2.26 | depth>50' |
| 65 | -10 | ML | 31 | 1 | 1 | 95.0 | 3.90 | 2.18 | 0.69 | 1.00 | 1.20 | 1.00 | 0.64 | 1.87 | 0.20 | 37 | 49 | 0.88 | High N | 0.00 | LARGE | high N |
| 70 | -15 | ML | 61 | 2 | 2 | 95.0 | 4.20 | 2.33 | 0.67 | 1.00 | 1.00 | 0.67 | 0.60 | 2.02 | 0.19 | 39 | 52 | 0.88 | High N | 0.00 | LARGE | high N |
| 80 | -25 | SP-SM | 24 | 1 | 1 | 12.0 | 4.80 | 2.62 | 0.63 | 1.00 | 1.20 | 1.00 | 0.55 | 2.30 | 0.17 | 26 | 28 | 0.86 | 0.39 | 0.48 | 2.83 | depth>50' |
| 90 | -35 | CL | 100 | 2 | 2 | 93.0 | 5.40 | 2.90 | 0.60 | 1.00 | 1.00 | 0.67 | 0.52 | 2.59 | 0.16 | 57 | 74 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -45 | CL | 39 | 1 | 1 | 97.0 | 6.00 | 3.19 | 0.57 | 0.95 | 1.20 | 1.00 | 0.50 | 2.88 | 0.15 | 36 | 49 | 0.81 | High N | 0.00 | LARGE | high N |
| 110 | -55 | CL | 100 | 2 | 2 | 85.0 | 6.60 | 3.48 | 0.55 | 0.95 | 1.00 | 0.67 | 0.50 | 3.17 | 0.15 | 50 | 65 | 0.77 | High N | 0.00 | LARGE | high N |
| 120 | -65 | CL | 43 | 1 | 1 | 90.0 | 7.20 | 3.77 | 0.53 | 0.95 | 1.20 | 1.00 | 0.50 | 3.46 | 0.15 | 37 | 49 | 0.75 | High N | 0.00 | LARGE | high N |
| 130 | -75 | ML | 100 | 2 | 2 | 80.0 | 7.80 | 4.06 | 0.51 | 0.95 | 1.00 | 0.67 | 0.50 | 3.74 | 0.15 | 46 | 60 | 0.74 | High N | 0.00 | LARGE | high N |
| 140 | -85 | RF | 100 | 1 | 1 | 2.0 | 8.40 | 4.34 | 0.49 | 0.95 | 1.20 | 1.00 | 0.50 | 4.03 | 0.15 | 80 | 80 | 0.72 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-005**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 53 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 0.0 | =Design Water Table Depth. | 8.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 53 | $C_B$ | 1.00 | 120 | 53 | =Design Water El. | 45 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 48 | ML | 6 | 2 | 2 | 51.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.00 | 0.67 | 0.99 | 0.14 | 0.30 | 7 | 14 | 1.00 | 0.15 | 0.21 | 0.69 | fines |
| 10 | 43 | ML | 2 | 1 | 1 | 51.0 | 0.60 | 0.54 | 1.39 | 0.85 | 1.20 | 1.00 | 0.98 | 0.29 | 0.30 | 4 | 9 | 1.00 | 0.11 | 0.16 | 0.52 | fines |
| 15 | 38 | ML | 2 | 2 | 2 | 51.0 | 0.90 | 0.68 | 1.24 | 0.85 | 1.00 | 0.67 | 0.97 | 0.43 | 0.30 | 2 | 7 | 1.00 | 0.09 | 0.13 | 0.43 | fines |
| 20 | 33 | SM | 6 | 1 | 1 | 20.0 | 1.20 | 0.83 | 1.12 | 0.95 | 1.20 | 1.00 | 0.95 | 0.58 | 0.29 | 10 | 15 | 1.00 | 0.16 | 0.22 | 0.77 | yes |
| 25 | 28 | SP-SM | 16 | 2 | 2 | 11.0 | 1.50 | 0.97 | 1.04 | 0.95 | 1.00 | 0.67 | 0.94 | 0.72 | 0.29 | 14 | 15 | 1.00 | 0.16 | 0.24 | 0.82 | yes |
| 30 | 23 | SP-SM | 20 | 1 | 1 | 11.0 | 1.80 | 1.11 | 0.97 | 1.00 | 1.20 | 1.00 | 0.93 | 0.86 | 0.29 | 31 | 33 | 1.00 | High N | 0.00 | LARGE | high N |
| 35 | 18 | SP-SM | 21 | 2 | 2 | 11.0 | 2.10 | 1.26 | 0.91 | 1.00 | 1.00 | 0.67 | 0.89 | 1.01 | 0.27 | 17 | 18 | 1.00 | 0.20 | 0.28 | 1.04 | no |
| 40 | 13 | GP-GM | 24 | 1 | 1 | 7.0 | 2.40 | 1.40 | 0.86 | 1.00 | 1.20 | 1.00 | 0.85 | 1.15 | 0.26 | 33 | 33 | 0.98 | High N | 0.00 | LARGE | high N |
| 45 | 8 | GP | 100 | 2 | 2 | 4.0 | 2.70 | 1.55 | 0.82 | 1.00 | 1.00 | 0.67 | 0.81 | 1.30 | 0.25 | 72 | 72 | 0.96 | High N | 0.00 | LARGE | high N |
| 50 | 3 | GP | 36 | 1 | 1 | 4.0 | 3.00 | 1.69 | 0.79 | 1.00 | 1.20 | 1.00 | 0.77 | 1.44 | 0.24 | 45 | 45 | 0.94 | High N | 0.00 | LARGE | high N |
| 55 | -2 | SP-SM | 51 | 2 | 2 | 12.0 | 3.30 | 1.83 | 0.75 | 1.00 | 1.00 | 0.67 | 0.73 | 1.58 | 0.22 | 34 | 36 | 0.92 | High N | 0.00 | LARGE | high N |
| 60 | -7 | SM | 34 | 1 | 1 | 40.0 | 3.60 | 1.98 | 0.73 | 1.00 | 1.20 | 1.00 | 0.69 | 1.73 | 0.21 | 39 | 52 | 0.90 | High N | 0.00 | LARGE | high N |
| 65 | -12 | SM | 72 | 2 | 2 | 40.0 | 3.90 | 2.12 | 0.70 | 1.00 | 1.00 | 0.67 | 0.64 | 1.87 | 0.20 | 44 | 58 | 0.88 | High N | 0.00 | LARGE | high N |
| 70 | -17 | SM | 27 | 1 | 1 | 40.0 | 4.20 | 2.27 | 0.68 | 1.00 | 1.20 | 1.00 | 0.60 | 2.02 | 0.19 | 29 | 40 | 0.88 | High N | 0.00 | LARGE | high N |
| 80 | -27 | CL | 49 | 2 | 2 | 99.0 | 4.80 | 2.55 | 0.64 | 1.00 | 1.00 | 0.67 | 0.55 | 2.30 | 0.17 | 27 | 38 | 0.86 | High N | 0.00 | LARGE | high N |
| 90 | -37 | CL | 57 | 1 | 1 | 80.0 | 5.40 | 2.84 | 0.61 | 1.00 | 1.20 | 1.00 | 0.52 | 2.59 | 0.16 | 55 | 71 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -47 | CL | 100 | 2 | 2 | 80.0 | 6.00 | 3.13 | 0.58 | 0.95 | 1.00 | 0.67 | 0.50 | 2.88 | 0.15 | 48 | 63 | 0.81 | High N | 0.00 | LARGE | high N |
| 110 | -57 | SP-SM | 74 | 1 | 1 | 7.0 | 6.60 | 3.42 | 0.55 | 0.95 | 1.20 | 1.00 | 0.50 | 3.17 | 0.15 | 61 | 62 | 0.77 | High N | 0.00 | LARGE | high N |
| 120 | -67 | ML | 100 | 2 | 2 | 75.0 | 7.20 | 3.71 | 0.53 | 0.95 | 1.00 | 0.67 | 0.50 | 3.46 | 0.15 | 44 | 58 | 0.75 | High N | 0.00 | LARGE | high N |
| 130 | -77 | GM | 100 | 1 | 1 | 15.0 | 7.80 | 3.99 | 0.51 | 0.95 | 1.20 | 1.00 | 0.50 | 3.74 | 0.15 | 77 | 83 | 0.74 | High N | 0.00 | LARGE | high N |
| 140 | -87 | GM | 100 | 1 | 1 | 15.0 | 8.40 | 4.28 | 0.49 | 0.95 | 1.20 | 1.00 | 0.50 | 4.03 | 0.15 | 74 | 80 | 0.72 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-006**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 55 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 0.0 | =Design Water Table Depth. | 10.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 55 | $C_B$ | 1.00 | 120 | 55 | =Design Water El. | 45 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 50 | ML | 7 | 2 | 2 | 59.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.00 | 0.67 | 0.99 | 0.14 | 0.30 | 8 | 15 | 1.00 | 0.16 | 0.23 | 0.76 | fines |
| 10 | 45 | ML | 6 | 1 | 1 | 59.0 | 0.60 | 0.60 | 1.32 | 0.85 | 1.20 | 1.00 | 0.98 | 0.29 | 0.30 | 11 | 18 | 1.00 | 0.19 | 0.27 | 0.91 | fines |
| 15 | 40 | SP-SM | 13 | 2 | 2 | 10.0 | 0.90 | 0.74 | 1.18 | 0.85 | 1.00 | 0.67 | 0.97 | 0.43 | 0.30 | 11 | 13 | 1.00 | 0.14 | 0.20 | 0.66 | yes |
| 20 | 35 | SP-SM | 10 | 1 | 1 | 10.0 | 1.20 | 0.89 | 1.08 | 0.95 | 1.20 | 1.00 | 0.95 | 0.58 | 0.29 | 16 | 17 | 1.00 | 0.19 | 0.27 | 0.92 | yes |
| 25 | 30 | SM | 10 | 2 | 2 | 20.0 | 1.50 | 1.03 | 1.01 | 0.95 | 1.00 | 0.67 | 0.94 | 0.72 | 0.29 | 8 | 13 | 1.00 | 0.14 | 0.20 | 0.68 | yes |
| 30 | 25 | SP-SM | 16 | 1 | 1 | 12.0 | 1.80 | 1.18 | 0.94 | 1.00 | 1.20 | 1.00 | 0.93 | 0.86 | 0.29 | 24 | 26 | 1.00 | 0.32 | 0.46 | 1.59 | no |
| 35 | 20 | GW-GM | 46 | 1 | 1 | 9.0 | 2.10 | 1.32 | 0.89 | 1.00 | 1.20 | 1.00 | 0.89 | 1.01 | 0.27 | 65 | 66 | 1.00 | High N | 0.00 | LARGE | high N |
| 40 | 15 | GW-GM | 9 | 1 | 1 | 9.0 | 2.40 | 1.46 | 0.84 | 1.00 | 1.20 | 1.00 | 0.85 | 1.15 | 0.26 | 12 | 13 | 0.98 | 0.14 | 0.20 | 0.75 | yes |
| 45 | 10 | GW-GM | 66 | 1 | 1 | 9.0 | 2.70 | 1.61 | 0.81 | 1.00 | 1.20 | 1.00 | 0.81 | 1.30 | 0.25 | 84 | 86 | 0.96 | High N | 0.00 | LARGE | high N |
| 50 | 5 | CL | 40 | 2 | 2 | 60.0 | 3.00 | 1.75 | 0.77 | 1.00 | 1.00 | 0.67 | 0.77 | 1.44 | 0.24 | 27 | 37 | 0.94 | High N | 0.00 | LARGE | high N |
| 55 | 0 | CL | 31 | 1 | 1 | 60.0 | 3.30 | 1.90 | 0.74 | 1.00 | 1.20 | 1.00 | 0.73 | 1.58 | 0.22 | 36 | 49 | 0.92 | High N | 0.00 | LARGE | high N |
| 60 | -5 | MH | 48 | 2 | 2 | 95.0 | 3.60 | 2.04 | 0.72 | 1.00 | 1.00 | 0.67 | 0.69 | 1.73 | 0.21 | 30 | 41 | 0.90 | High N | 0.00 | LARGE | high N |
| 65 | -10 | MH | 38 | 1 | 1 | 95.0 | 3.90 | 2.18 | 0.69 | 1.00 | 1.20 | 1.00 | 0.64 | 1.87 | 0.20 | 42 | 55 | 0.88 | High N | 0.00 | LARGE | high N |
| 70 | -15 | CL | 53 | 2 | 2 | 80.0 | 4.20 | 2.33 | 0.67 | 1.00 | 1.00 | 0.67 | 0.60 | 2.02 | 0.19 | 31 | 42 | 0.88 | High N | 0.00 | LARGE | high N |
| 80 | -25 | CL | 44 | 1 | 1 | 80.0 | 4.80 | 2.62 | 0.63 | 1.00 | 1.20 | 1.00 | 0.55 | 2.30 | 0.17 | 44 | 58 | 0.86 | High N | 0.00 | LARGE | high N |
| 90 | -35 | SM | 100 | 2 | 2 | 25.0 | 5.40 | 2.90 | 0.60 | 1.00 | 1.00 | 0.67 | 0.52 | 2.59 | 0.16 | 53 | 63 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -45 | CL-ML | 100 | 1 | 1 | 60.0 | 6.00 | 3.19 | 0.57 | 0.95 | 1.20 | 1.00 | 0.50 | 2.88 | 0.15 | 86 | 108 | 0.81 | High N | 0.00 | LARGE | high N |
| 110 | -55 | SP-SM | 100 | 2 | 2 | 10.0 | 6.60 | 3.48 | 0.55 | 0.95 | 1.00 | 0.67 | 0.50 | 3.17 | 0.15 | 46 | 47 | 0.77 | High N | 0.00 | LARGE | high N |
| 120 | -65 | CL | 70 | 1 | 1 | 80.0 | 7.20 | 3.77 | 0.53 | 0.95 | 1.20 | 1.00 | 0.50 | 3.46 | 0.15 | 55 | 71 | 0.75 | High N | 0.00 | LARGE | high N |
| 130 | -75 | CL | 100 | 2 | 2 | 80.0 | 7.80 | 4.06 | 0.51 | 0.95 | 1.00 | 0.67 | 0.50 | 3.74 | 0.15 | 42 | 56 | 0.74 | High N | 0.00 | LARGE | high N |
| | | GW/GP | | | | | | | | | | | | | | | | | | | | |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-007**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 55 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 0.0 | =Design Water Table Depth. | 10.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 55 | $C_B$ | 1.00 | 120 | 55 | =Design Water El. | 45 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 50 | SM | 18 | 1 | 1 | 48.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.20 | 1.00 | 0.99 | 0.14 | 0.30 | 39 | 51 | 1.00 | High N | 0.00 | LARGE | high N |
| 10 | 45 | SM | 20 | 2 | 2 | 48.0 | 0.60 | 0.60 | 1.32 | 0.85 | 1.00 | 0.67 | 0.98 | 0.29 | 0.30 | 20 | 29 | 1.00 | 0.39 | 0.57 | 1.88 | no |
| 15 | 40 | ML | 2 | 1 | 1 | 70.0 | 0.90 | 0.74 | 1.18 | 0.85 | 1.20 | 1.00 | 0.97 | 0.43 | 0.30 | 3 | 9 | 1.00 | 0.10 | 0.15 | 0.50 | fines |
| 20 | 35 | ML | 4 | 2 | 2 | 70.0 | 1.20 | 0.89 | 1.08 | 0.95 | 1.00 | 0.67 | 0.95 | 0.58 | 0.29 | 4 | 9 | 1.00 | 0.11 | 0.15 | 0.53 | fines |
| 25 | 30 | ML | 3 | 1 | 1 | 67.0 | 1.50 | 1.03 | 1.01 | 0.95 | 1.20 | 1.00 | 0.94 | 0.72 | 0.29 | 5 | 10 | 1.00 | 0.12 | 0.17 | 0.58 | fines |
| 30 | 25 | CL | 13 | 2 | 2 | 90.0 | 1.80 | 1.18 | 0.94 | 1.00 | 1.00 | 0.67 | 0.93 | 0.86 | 0.29 | 11 | 18 | 1.00 | 0.19 | 0.27 | 0.96 | fines |
| 35 | 20 | SP-SM | 7 | 1 | 1 | 10.0 | 2.10 | 1.32 | 0.89 | 1.00 | 1.20 | 1.00 | 0.89 | 1.01 | 0.27 | 10 | 11 | 1.00 | 0.12 | 0.17 | 0.64 | yes |
| 40 | 15 | SP-SM | 30 | 2 | 2 | 10.0 | 2.40 | 1.46 | 0.84 | 1.00 | 1.00 | 0.67 | 0.85 | 1.15 | 0.26 | 22 | 24 | 0.98 | 0.27 | 0.38 | 1.44 | no |
| 45 | 10 | SP-SM | 52 | 1 | 1 | 10.0 | 2.70 | 1.61 | 0.81 | 1.00 | 1.20 | 1.00 | 0.81 | 1.30 | 0.25 | 66 | 69 | 0.96 | High N | 0.00 | LARGE | high N |
| 50 | 5 | SM | 62 | 2 | 2 | 24.0 | 3.00 | 1.75 | 0.77 | 1.00 | 1.00 | 0.67 | 0.77 | 1.44 | 0.24 | 42 | 51 | 0.94 | High N | 0.00 | LARGE | high N |
| 55 | 0 | ML | 48 | 1 | 1 | 95.0 | 3.30 | 1.90 | 0.74 | 1.00 | 1.20 | 1.00 | 0.73 | 1.58 | 0.22 | 56 | 73 | 0.92 | High N | 0.00 | LARGE | high N |
| 60 | -5 | ML | 69 | 2 | 2 | 95.0 | 3.60 | 2.04 | 0.72 | 1.00 | 1.00 | 0.67 | 0.69 | 1.73 | 0.21 | 43 | 57 | 0.90 | High N | 0.00 | LARGE | high N |
| 65 | -10 | CL-ML | 49 | 1 | 1 | 60.0 | 3.90 | 2.18 | 0.69 | 1.00 | 1.20 | 1.00 | 0.64 | 1.87 | 0.20 | 54 | 69 | 0.88 | High N | 0.00 | LARGE | high N |
| 70 | -15 | SM | 100 | 2 | 2 | 20.0 | 4.20 | 2.33 | 0.67 | 1.00 | 1.00 | 0.67 | 0.60 | 2.02 | 0.19 | 59 | 67 | 0.88 | High N | 0.00 | LARGE | high N |
| 80 | -25 | CL | 69 | 1 | 1 | 70.0 | 4.80 | 2.62 | 0.63 | 1.00 | 1.20 | 1.00 | 0.55 | 2.30 | 0.17 | 69 | 88 | 0.86 | High N | 0.00 | LARGE | high N |
| 90 | -35 | CL | 100 | 2 | 2 | 60.0 | 5.40 | 2.90 | 0.60 | 1.00 | 1.00 | 0.67 | 0.52 | 2.59 | 0.16 | 53 | 68 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -45 | SM | 68 | 1 | 1 | 20.0 | 6.00 | 3.19 | 0.57 | 0.95 | 1.20 | 1.00 | 0.50 | 2.88 | 0.15 | 58 | 67 | 0.81 | High N | 0.00 | LARGE | high N |
| 110 | -55 | SM | 100 | 2 | 2 | 15.0 | 6.60 | 3.48 | 0.55 | 0.95 | 1.00 | 0.67 | 0.50 | 3.17 | 0.15 | 46 | 50 | 0.77 | High N | 0.00 | LARGE | high N |
| 120 | -65 | CL-ML | 100 | 1 | 1 | 75.0 | 7.20 | 3.77 | 0.53 | 0.95 | 1.20 | 1.00 | 0.50 | 3.46 | 0.15 | 79 | 100 | 0.75 | High N | 0.00 | LARGE | high N |
| 130 | -75 | GP-GM | 100 | 1 | 1 | 10.0 | 7.80 | 4.06 | 0.51 | 0.95 | 1.20 | 1.00 | 0.50 | 3.74 | 0.15 | 76 | 79 | 0.74 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-008**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 53 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 0.0 | =Design Water Table Depth. | 8.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 53 | $C_B$ | 1.00 | 120 | 53 | =Design Water El. | 45 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 48 | ML | 11 | 2 | 2 | 80.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.00 | 0.67 | 0.99 | 0.14 | 0.30 | 13 | 21 | 1.00 | 0.22 | 0.32 | 1.07 | fines |
| 10 | 43 | SM | 10 | 1 | 1 | 40.0 | 0.60 | 0.54 | 1.39 | 0.85 | 1.20 | 1.00 | 0.98 | 0.29 | 0.30 | 19 | 27 | 1.00 | 0.35 | 0.51 | 1.69 | no |
| 15 | 38 | SM | 5 | 2 | 2 | 40.0 | 0.90 | 0.68 | 1.24 | 0.85 | 1.00 | 0.67 | 0.97 | 0.43 | 0.30 | 5 | 11 | 1.00 | 0.12 | 0.17 | 0.57 | yes |
| 20 | 33 | SP-SM | 8 | 1 | 1 | 10.0 | 1.20 | 0.83 | 1.12 | 0.95 | 1.20 | 1.00 | 0.95 | 0.58 | 0.29 | 14 | 15 | 1.00 | 0.16 | 0.23 | 0.77 | yes |
| 25 | 28 | SP-SM | 12 | 2 | 2 | 10.0 | 1.50 | 0.97 | 1.04 | 0.95 | 1.00 | 0.67 | 0.94 | 0.72 | 0.29 | 10 | 11 | 1.00 | 0.13 | 0.18 | 0.63 | yes |
| 30 | 23 | SP-SM | 14 | 1 | 1 | 10.0 | 1.80 | 1.11 | 0.97 | 1.00 | 1.20 | 1.00 | 0.93 | 0.86 | 0.29 | 21 | 23 | 1.00 | 0.25 | 0.36 | 1.28 | no |
| 35 | 18 | SP | 11 | 2 | 2 | 4.0 | 2.10 | 1.26 | 0.91 | 1.00 | 1.00 | 0.67 | 0.89 | 1.01 | 0.27 | 9 | 9 | 1.00 | 0.10 | 0.15 | 0.54 | yes |
| 40 | 13 | SP-SM | 68 | 1 | 1 | 15.0 | 2.40 | 1.40 | 0.86 | 1.00 | 1.20 | 1.00 | 0.85 | 1.15 | 0.26 | 93 | 100 | 0.98 | High N | 0.00 | LARGE | high N |
| 45 | 8 | CL | 31 | 1 | 1 | 80.0 | 2.70 | 1.55 | 0.82 | 1.00 | 1.20 | 1.00 | 0.81 | 1.30 | 0.25 | 40 | 53 | 0.96 | High N | 0.00 | LARGE | high N |
| 50 | 3 | SM | 72 | 2 | 2 | 27.0 | 3.00 | 1.69 | 0.79 | 1.00 | 1.00 | 0.67 | 0.77 | 1.44 | 0.24 | 50 | 61 | 0.94 | High N | 0.00 | LARGE | high N |
| 55 | -2 | ML | 100 | 2 | 2 | 80.0 | 3.30 | 1.83 | 0.75 | 1.00 | 1.00 | 0.67 | 0.73 | 1.58 | 0.22 | 66 | 84 | 0.92 | High N | 0.00 | LARGE | high N |
| 60 | -7 | SP-SM | 34 | 1 | 1 | 15.0 | 3.60 | 1.98 | 0.73 | 1.00 | 1.20 | 1.00 | 0.69 | 1.73 | 0.21 | 39 | 43 | 0.90 | High N | 0.00 | LARGE | high N |
| 65 | -12 | CL-ML | 100 | 2 | 2 | 90.0 | 3.90 | 2.12 | 0.70 | 1.00 | 1.00 | 0.67 | 0.64 | 1.87 | 0.20 | 62 | 79 | 0.88 | High N | 0.00 | LARGE | high N |
| 70 | -17 | CL-ML | 27 | 1 | 1 | 90.0 | 4.20 | 2.27 | 0.68 | 1.00 | 1.20 | 1.00 | 0.60 | 2.02 | 0.19 | 29 | 40 | 0.88 | High N | 0.00 | LARGE | high N |
| 80 | -27 | CL | 100 | 2 | 2 | 80.0 | 4.80 | 2.55 | 0.64 | 1.00 | 1.00 | 0.67 | 0.55 | 2.30 | 0.17 | 56 | 72 | 0.86 | High N | 0.00 | LARGE | high N |
| 90 | -37 | SP-SM | 100 | 1 | 1 | 15.0 | 5.40 | 2.84 | 0.61 | 1.00 | 1.20 | 1.00 | 0.52 | 2.59 | 0.16 | 96 | 103 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -47 | SM | 100 | 2 | 2 | 30.0 | 6.00 | 3.13 | 0.58 | 0.95 | 1.00 | 0.67 | 0.50 | 2.88 | 0.15 | 48 | 60 | 0.81 | High N | 0.00 | LARGE | high N |
| 110 | -57 | SP-SM | 58 | 1 | 1 | 15.0 | 6.60 | 3.42 | 0.55 | 0.95 | 1.20 | 1.00 | 0.50 | 3.17 | 0.15 | 48 | 53 | 0.77 | High N | 0.00 | LARGE | high N |
| 120 | -67 | ML | 59 | 1 | 1 | 70.0 | 7.20 | 3.71 | 0.53 | 0.95 | 1.20 | 1.00 | 0.50 | 3.46 | 0.15 | 47 | 61 | 0.75 | High N | 0.00 | LARGE | high N |
| 130 | -77 | SP | 100 | 1 | 1 | 5.0 | 7.80 | 3.99 | 0.51 | 0.95 | 1.20 | 1.00 | 0.50 | 3.74 | 0.15 | 77 | 77 | 0.74 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-009**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 51 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 0.0 | =Design Water Table Depth. | 6.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 51 | $C_B$ | 1.00 | 120 | 51 | =Design Water El. | 45 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 46 | CL | 7 | 1 | 1 | 80.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.20 | 1.00 | 0.99 | 0.14 | 0.30 | 15 | 23 | 1.00 | 0.26 | 0.37 | 1.22 | fines |
| 10 | 41 | SM | 14 | 2 | 2 | 40.0 | 0.60 | 0.48 | 1.48 | 0.85 | 1.00 | 0.67 | 0.98 | 0.29 | 0.30 | 15 | 24 | 1.00 | 0.27 | 0.38 | 1.28 | no |
| 15 | 36 | SM | 6 | 1 | 1 | 40.0 | 0.90 | 0.62 | 1.30 | 0.85 | 1.20 | 1.00 | 0.97 | 0.43 | 0.30 | 10 | 18 | 1.00 | 0.19 | 0.27 | 0.91 | yes |
| 20 | 31 | SM | 7 | 2 | 2 | 35.0 | 1.20 | 0.76 | 1.17 | 0.95 | 1.00 | 0.67 | 0.95 | 0.58 | 0.29 | 7 | 13 | 1.00 | 0.14 | 0.21 | 0.70 | yes |
| 25 | 26 | SP | 36 | 1 | 1 | 5.0 | 1.50 | 0.91 | 1.07 | 0.95 | 1.20 | 1.00 | 0.94 | 0.72 | 0.29 | 58 | 58 | 1.00 | High N | 0.00 | LARGE | high N |
| 30 | 21 | GP | 30 | 1 | 1 | 4.0 | 1.80 | 1.05 | 1.00 | 1.00 | 1.20 | 1.00 | 0.93 | 0.86 | 0.29 | 47 | 47 | 1.00 | High N | 0.00 | LARGE | high N |
| 35 | 16 | GP | 58 | 1 | 1 | 4.0 | 2.10 | 1.20 | 0.93 | 1.00 | 1.20 | 1.00 | 0.89 | 1.01 | 0.27 | 86 | 86 | 1.00 | High N | 0.00 | LARGE | high N |
| 40 | 11 | MH | 100 | 2 | 2 | 65.0 | 2.40 | 1.34 | 0.88 | 1.00 | 1.00 | 0.67 | 0.85 | 1.15 | 0.26 | 77 | 98 | 0.98 | High N | 0.00 | LARGE | high N |
| 45 | 6 | MH | 55 | 1 | 1 | 65.0 | 2.70 | 1.48 | 0.84 | 1.00 | 1.20 | 1.00 | 0.81 | 1.30 | 0.25 | 73 | 92 | 0.96 | High N | 0.00 | LARGE | high N |
| 50 | 1 | CL | 100 | 2 | 2 | 75.0 | 3.00 | 1.63 | 0.80 | 1.00 | 1.00 | 0.67 | 0.77 | 1.44 | 0.24 | 70 | 89 | 0.94 | High N | 0.00 | LARGE | high N |
| 55 | -4 | SM | 42 | 1 | 1 | 30.0 | 3.30 | 1.77 | 0.77 | 1.00 | 1.20 | 1.00 | 0.73 | 1.58 | 0.22 | 51 | 64 | 0.92 | High N | 0.00 | LARGE | high N |
| 60 | -9 | SP | 61 | 2 | 2 | 4.0 | 3.60 | 1.92 | 0.74 | 1.00 | 1.00 | 0.67 | 0.69 | 1.73 | 0.21 | 39 | 39 | 0.90 | High N | 0.00 | LARGE | high N |
| 65 | -14 | SP | 33 | 1 | 1 | 4.0 | 3.90 | 2.06 | 0.71 | 1.00 | 1.20 | 1.00 | 0.64 | 1.87 | 0.20 | 37 | 37 | 0.88 | High N | 0.00 | LARGE | high N |
| 70 | -19 | ML | 100 | 2 | 2 | 70.0 | 4.20 | 2.20 | 0.69 | 1.00 | 1.00 | 0.67 | 0.60 | 2.02 | 0.19 | 60 | 77 | 0.88 | High N | 0.00 | LARGE | high N |
| 80 | -29 | SM | 67 | 1 | 1 | 40.0 | 4.80 | 2.49 | 0.65 | 1.00 | 1.20 | 1.00 | 0.55 | 2.30 | 0.17 | 69 | 87 | 0.86 | High N | 0.00 | LARGE | high N |
| 90 | -39 | SM | 100 | 2 | 2 | 40.0 | 5.40 | 2.78 | 0.61 | 1.00 | 1.00 | 0.67 | 0.52 | 2.59 | 0.16 | 54 | 69 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -49 | SP-SM | 67 | 1 | 1 | 10.0 | 6.00 | 3.07 | 0.58 | 0.95 | 1.20 | 1.00 | 0.50 | 2.88 | 0.15 | 59 | 61 | 0.81 | High N | 0.00 | LARGE | high N |
| 110 | -59 | SW | 57 | 1 | 1 | 4.0 | 6.60 | 3.36 | 0.56 | 0.95 | 1.20 | 1.00 | 0.50 | 3.17 | 0.15 | 48 | 48 | 0.77 | High N | 0.00 | LARGE | high N |
| 120 | -69 | ML | 62 | 1 | 1 | 60.0 | 7.20 | 3.64 | 0.54 | 0.95 | 1.20 | 1.00 | 0.50 | 3.46 | 0.15 | 50 | 65 | 0.75 | High N | 0.00 | LARGE | high N |
| 130 | -79 | GM | 100 | 1 | 1 | 35.0 | 7.80 | 3.93 | 0.52 | 0.95 | 1.20 | 1.00 | 0.50 | 3.74 | 0.15 | 77 | 98 | 0.74 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-010**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 55 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 0.0 | =Design Water Table Depth. | 10.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 55 | $C_B$ | 1.00 | 120 | 55 | =Design Water El. | 45 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 50 | SM | 39 | 2 | 2 | 30.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.00 | 0.67 | 0.99 | 0.14 | 0.30 | 47 | 58 | 1.00 | High N | 0.00 | LARGE | high N |
| 10 | 45 | SM | 7 | 1 | 1 | 30.0 | 0.60 | 0.60 | 1.32 | 0.85 | 1.20 | 1.00 | 0.98 | 0.29 | 0.30 | 12 | 19 | 1.00 | 0.20 | 0.29 | 0.98 | yes |
| 15 | 40 | SM | 5 | 2 | 2 | 28.0 | 0.90 | 0.74 | 1.18 | 0.85 | 1.00 | 0.67 | 0.97 | 0.43 | 0.30 | 4 | 10 | 1.00 | 0.11 | 0.16 | 0.53 | yes |
| 20 | 35 | SM | 8 | 1 | 1 | 40.0 | 1.20 | 0.89 | 1.08 | 0.95 | 1.20 | 1.00 | 0.95 | 0.58 | 0.29 | 13 | 21 | 1.00 | 0.22 | 0.32 | 1.10 | no |
| 25 | 30 | SM | 20 | 2 | 2 | 20.0 | 1.50 | 1.03 | 1.01 | 0.95 | 1.00 | 0.67 | 0.94 | 0.72 | 0.29 | 17 | 22 | 1.00 | 0.24 | 0.34 | 1.18 | no |
| 30 | 25 | CL | 15 | 1 | 1 | 60.0 | 1.80 | 1.18 | 0.94 | 1.00 | 1.20 | 1.00 | 0.93 | 0.86 | 0.29 | 22 | 32 | 1.00 | High N | 0.00 | LARGE | high N |
| 35 | 20 | CL | 22 | 2 | 2 | 60.0 | 2.10 | 1.32 | 0.89 | 1.00 | 1.00 | 0.67 | 0.89 | 1.01 | 0.27 | 17 | 26 | 1.00 | 0.30 | 0.44 | 1.60 | fines |
| 40 | 15 | CL-ML | 30 | 1 | 1 | 85.0 | 2.40 | 1.46 | 0.84 | 1.00 | 1.20 | 1.00 | 0.85 | 1.15 | 0.26 | 40 | 53 | 0.98 | High N | 0.00 | LARGE | high N |
| 45 | 10 | ML | 100 | 2 | 2 | 65.0 | 2.70 | 1.61 | 0.81 | 1.00 | 1.00 | 0.67 | 0.81 | 1.30 | 0.25 | 71 | 90 | 0.96 | High N | 0.00 | LARGE | high N |
| 50 | 5 | SM | 100 | 2 | 2 | 40.0 | 3.00 | 1.75 | 0.77 | 1.00 | 1.00 | 0.67 | 0.77 | 1.44 | 0.24 | 68 | 86 | 0.94 | High N | 0.00 | LARGE | high N |
| 55 | 0 | ML | 52 | 1 | 1 | 85.0 | 3.30 | 1.90 | 0.74 | 1.00 | 1.20 | 1.00 | 0.73 | 1.58 | 0.22 | 61 | 78 | 0.92 | High N | 0.00 | LARGE | high N |
| 60 | -5 | SP-SM | 100 | 2 | 2 | 6.0 | 3.60 | 2.04 | 0.72 | 1.00 | 1.00 | 0.67 | 0.69 | 1.73 | 0.21 | 63 | 63 | 0.90 | High N | 0.00 | LARGE | high N |
| 65 | -10 | SM | 35 | 1 | 1 | 25.0 | 3.90 | 2.18 | 0.69 | 1.00 | 1.20 | 1.00 | 0.64 | 1.87 | 0.20 | 38 | 47 | 0.88 | High N | 0.00 | LARGE | high N |
| 70 | -15 | SP-SM | 48 | 2 | 2 | 6.0 | 4.20 | 2.33 | 0.67 | 1.00 | 1.00 | 0.67 | 0.60 | 2.02 | 0.19 | 28 | 28 | 0.88 | 0.38 | 0.48 | 2.61 | depth>50' |
| 80 | -25 | CL | 48 | 1 | 1 | 80.0 | 4.80 | 2.62 | 0.63 | 1.00 | 1.20 | 1.00 | 0.55 | 2.30 | 0.17 | 48 | 62 | 0.86 | High N | 0.00 | LARGE | high N |
| 90 | -35 | CH | 100 | 2 | 2 | 95.0 | 5.40 | 2.90 | 0.60 | 1.00 | 1.00 | 0.67 | 0.52 | 2.59 | 0.16 | 53 | 68 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -45 | ML | 42 | 1 | 1 | 70.0 | 6.00 | 3.19 | 0.57 | 0.95 | 1.20 | 1.00 | 0.50 | 2.88 | 0.15 | 36 | 48 | 0.81 | High N | 0.00 | LARGE | high N |
| 110 | -55 | SP-SM | 81 | 1 | 1 | 10.0 | 6.60 | 3.48 | 0.55 | 0.95 | 1.20 | 1.00 | 0.50 | 3.17 | 0.15 | 67 | 69 | 0.77 | High N | 0.00 | LARGE | high N |
| 120 | -65 | SP-SM | 56 | 1 | 1 | 10.0 | 7.20 | 3.77 | 0.53 | 0.95 | 1.20 | 1.00 | 0.50 | 3.46 | 0.15 | 44 | 46 | 0.75 | High N | 0.00 | LARGE | high N |
| 130 | -75 | GP-GM | 100 | 1 | 1 | 10.0 | 7.80 | 4.06 | 0.51 | 0.95 | 1.20 | 1.00 | 0.50 | 3.74 | 0.15 | 76 | 79 | 0.74 | High N | 0.00 | LARGE | high N |
| 140 | -85 | GP | 100 | 1 | 1 | 0.0 | 8.40 | 4.34 | 0.49 | 0.95 | 1.20 | 1.00 | 0.50 | 4.03 | 0.15 | 74 | 74 | 0.72 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-011**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 87 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 27.0 | =Design Water Table Depth. | 42.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 87 | $C_B$ | 1.00 | 120 | 60 | =Design Water El. | 45 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 82 | SM | 20 | 1 | 1 | 25.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.20 | 1.00 | 0.99 | 0.30 | 0.15 | 43 | 52 | 1.00 | High N | 0.00 | LARGE | AboveWT |
| 10 | 77 | CL | 28 | 2 | 2 | 54.0 | 0.60 | 0.60 | 1.32 | 0.85 | 1.00 | 0.67 | 0.98 | 0.60 | 0.14 | 28 | 38 | 1.00 | High N | 0.00 | LARGE | AboveWT |
| 15 | 72 | CL | 19 | 1 | 1 | 30.0 | 0.90 | 0.90 | 1.08 | 0.85 | 1.20 | 1.00 | 0.97 | 0.90 | 0.14 | 27 | 36 | 1.00 | High N | 0.00 | LARGE | AboveWT |
| 20 | 67 | ML | 29 | 2 | 2 | 60.0 | 1.20 | 1.20 | 0.93 | 0.95 | 1.00 | 0.67 | 0.95 | 1.20 | 0.14 | 23 | 32 | 0.97 | High N | 0.00 | LARGE | AboveWT |
| 25 | 62 | ML | 14 | 1 | 1 | 60.0 | 1.50 | 1.50 | 0.83 | 0.95 | 1.20 | 1.00 | 0.94 | 1.50 | 0.14 | 18 | 26 | 0.93 | 0.31 | 0.42 | 3.03 | AboveWT |
| 30 | 57 | SM | 27 | 2 | 2 | 30.0 | 1.80 | 1.80 | 0.76 | 1.00 | 1.00 | 0.67 | 0.93 | 1.71 | 0.14 | 18 | 26 | 0.90 | 0.30 | 0.39 | 2.72 | no |
| 35 | 52 | ML | 9 | 1 | 1 | 70.0 | 2.10 | 2.10 | 0.71 | 1.00 | 1.20 | 1.00 | 0.89 | 1.85 | 0.15 | 10 | 17 | 0.88 | 0.18 | 0.23 | 1.55 | fines |
| 40 | 47 | SM | 19 | 2 | 2 | 47.0 | 2.40 | 2.40 | 0.66 | 1.00 | 1.00 | 0.67 | 0.85 | 1.99 | 0.15 | 11 | 18 | 0.86 | 0.19 | 0.24 | 1.60 | no |
| 45 | 42 | SM | 19 | 1 | 1 | 35.0 | 2.70 | 2.61 | 0.63 | 1.00 | 1.20 | 1.00 | 0.81 | 2.14 | 0.15 | 19 | 28 | 0.87 | 0.36 | 0.45 | 3.02 | no |
| 50 | 37 | SM | 12 | 2 | 2 | 40.0 | 3.00 | 2.75 | 0.62 | 1.00 | 1.00 | 0.67 | 0.77 | 2.28 | 0.15 | 6 | 13 | 0.86 | 0.14 | 0.17 | 1.15 | depth>50' |
| 55 | 32 | GP | 100 | 1 | 1 | 5.0 | 3.30 | 2.89 | 0.60 | 1.00 | 1.20 | 1.00 | 0.73 | 2.43 | 0.15 | 95 | 95 | 0.85 | High N | 0.00 | LARGE | high N |
| 62 | 25.5 | SP | 40 | 2 | 2 | 5.0 | 3.69 | 3.08 | 0.58 | 1.00 | 1.00 | 0.67 | 0.67 | 2.61 | 0.14 | 20 | 20 | 0.83 | 0.22 | 0.26 | 1.88 | depth>50' |
| 65 | 22 | ML | 100 | 1 | 1 | 94.0 | 3.90 | 3.18 | 0.57 | 1.00 | 1.20 | 1.00 | 0.64 | 2.71 | 0.14 | 90 | 114 | 0.82 | High N | 0.00 | LARGE | high N |
| 70 | 17 | SM | 55 | 2 | 2 | 25.0 | 4.20 | 3.33 | 0.56 | 1.00 | 1.00 | 0.67 | 0.60 | 2.86 | 0.13 | 27 | 34 | 0.81 | High N | 0.00 | LARGE | high N |
| 80 | 7 | SM | 28 | 1 | 1 | 25.0 | 4.80 | 3.61 | 0.54 | 1.00 | 1.20 | 1.00 | 0.55 | 3.15 | 0.12 | 24 | 31 | 0.77 | High N | 0.00 | LARGE | high N |
| 90 | -3 | SM | 72 | 2 | 2 | 25.0 | 5.40 | 3.90 | 0.52 | 1.00 | 1.00 | 0.67 | 0.52 | 3.43 | 0.12 | 33 | 41 | 0.76 | High N | 0.00 | LARGE | high N |
| 100 | -13 | ML | 59 | 1 | 1 | 80.0 | 6.00 | 4.19 | 0.50 | 0.95 | 1.20 | 1.00 | 0.50 | 3.72 | 0.12 | 44 | 58 | 0.74 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-012**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 61 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 1.0 | =Design Water Table Depth. | 10.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 61 | $C_B$ | 1.00 | 120 | 60 | =Design Water El. | 51 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOI | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 56 | SC-SM | 13 | 2 | 2 | 38.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.00 | 0.67 | 0.99 | 0.18 | 0.25 | 16 | 24 | 1.00 | 0.27 | 0.38 | 1.54 | no |
| 10 | 51 | SC-SM | 6 | 1 | 1 | 38.0 | 0.60 | 0.60 | 1.32 | 0.85 | 1.20 | 1.00 | 0.98 | 0.32 | 0.27 | 11 | 18 | 1.00 | 0.19 | 0.27 | 1.01 | no |
| 17 | 44.5 | SC-SM | 100 | 1 | 1 | 38.0 | 0.99 | 0.79 | 1.15 | 0.95 | 1.20 | 1.00 | 0.96 | 0.51 | 0.28 | 173 | 212 | 1.00 | High N | 0.00 | LARGE | high N |
| 20 | 41 | SP-SM | 19 | 1 | 1 | 5.0 | 1.20 | 0.89 | 1.08 | 0.95 | 1.20 | 1.00 | 0.95 | 0.61 | 0.28 | 31 | 31 | 1.00 | High N | 0.00 | LARGE | high N |
| 25 | 36 | SP-SM | 89 | 2 | 2 | 5.0 | 1.50 | 1.03 | 1.01 | 0.95 | 1.00 | 0.67 | 0.94 | 0.75 | 0.28 | 75 | 75 | 1.00 | High N | 0.00 | LARGE | high N |
| 30 | 31 | SP-SM | 31 | 1 | 1 | 7.0 | 1.80 | 1.18 | 0.94 | 1.00 | 1.20 | 1.00 | 0.93 | 0.90 | 0.28 | 46 | 47 | 1.00 | High N | 0.00 | LARGE | high N |
| 35 | 26 | SP-SM | 46 | 2 | 2 | 7.0 | 2.10 | 1.32 | 0.89 | 1.00 | 1.00 | 0.67 | 0.89 | 1.04 | 0.27 | 36 | 36 | 0.99 | High N | 0.00 | LARGE | high N |
| 40 | 21 | SP-SM | 27 | 1 | 1 | 7.0 | 2.40 | 1.46 | 0.84 | 1.00 | 1.20 | 1.00 | 0.85 | 1.18 | 0.25 | 36 | 36 | 0.97 | High N | 0.00 | LARGE | high N |
| 45 | 16 | SP-SM | 75 | 2 | 2 | 7.0 | 2.70 | 1.61 | 0.81 | 1.00 | 1.00 | 0.67 | 0.81 | 1.33 | 0.24 | 53 | 54 | 0.95 | High N | 0.00 | LARGE | high N |
| 50 | 11 | ML | 36 | 1 | 1 | 85.0 | 3.00 | 1.75 | 0.77 | 1.00 | 1.20 | 1.00 | 0.77 | 1.47 | 0.23 | 44 | 58 | 0.93 | High N | 0.00 | LARGE | high N |
| 57 | 4.5 | SM | 43 | 2 | 2 | 40.0 | 3.39 | 1.94 | 0.73 | 1.00 | 1.00 | 0.67 | 0.71 | 1.66 | 0.22 | 28 | 38 | 0.91 | High N | 0.00 | LARGE | high N |
| 60 | 1 | ML | 21 | 1 | 1 | 80.0 | 3.60 | 2.04 | 0.72 | 1.00 | 1.20 | 1.00 | 0.69 | 1.76 | 0.21 | 24 | 33 | 0.89 | High N | 0.00 | LARGE | high N |
| 65 | -4 | SP-SM | 66 | 2 | 2 | 7.0 | 3.90 | 2.18 | 0.69 | 1.00 | 1.00 | 0.67 | 0.64 | 1.90 | 0.19 | 40 | 40 | 0.87 | High N | 0.00 | LARGE | high N |
| 70 | -9 | SW-SM | 43 | 1 | 1 | 7.0 | 4.20 | 2.33 | 0.67 | 1.00 | 1.20 | 1.00 | 0.60 | 2.05 | 0.18 | 45 | 46 | 0.88 | High N | 0.00 | LARGE | high N |
| 80 | -19 | SW-SM | 71 | 1 | 1 | 7.0 | 4.80 | 2.62 | 0.63 | 1.00 | 1.20 | 1.00 | 0.55 | 2.34 | 0.17 | 71 | 72 | 0.85 | High N | 0.00 | LARGE | high N |
| 90 | -29 | CL | 85 | 2 | 2 | 90.0 | 5.40 | 2.90 | 0.60 | 1.00 | 1.00 | 0.67 | 0.52 | 2.62 | 0.16 | 45 | 59 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -39 | CL | 100 | 2 | 2 | 90.0 | 6.00 | 3.19 | 0.57 | 0.95 | 1.00 | 0.67 | 0.50 | 2.91 | 0.15 | 48 | 62 | 0.81 | High N | 0.00 | LARGE | high N |

**5th Street Bridge, Yuba City** **EMI Project No.** **13-121** Version - 12/05

LIQUEFACTION ANALYSIS, ACC. = 0.227 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

**Calculated by:** **TC 10/31/2013**

**Checked by:** AZ 8/19/2016

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]$C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, $F_L$ is:
$F_L$ = CRR r / CSR i

**R-13-013**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emean (%) | 79 | Present Ground El. | 63 | Borehole Dia. (in) | 5 | Tot. Unit Wt. (pcf) | 3.0 | =Design Water Table Depth. | 12.0 | =Field Water Table Depth. | Acc. max = | 0.227 | g | Earthq. M | 6.5 |
| $C_E$ | 1.32 | Future Ground El. | 63 | $C_B$ | 1.00 | 120 | 60 | =Design Water El. | 51 | =Field Water El. | | | | Cm= | 1.44 |

| DEPTH OF SOIL SAMPLE (ft.) | EL. (ft.) | SOIL TYPE | FIELD BLOW COUNT N | SAMPLER TYPE 1=SPT =CA.MOD | SAMPLER LINED 1=UNLINED 2=LINED | EST. PERCENT OF FINES (%) | DESIGN TOTAL OVERBUR. PRESS. (tsf) | PRESENT EFFEC. OVERBUR. PRESS. (tsf) | $C_N$ | $C_R$ | $C_S$ | $C_{ST}$ | STRESS REDUC. COEFF. rd | DESIGN EFFEC. OVERBUR. PRESS. (tsf) | INDUCED CYCLIC STRESS RATIO | CORRECT BLOW COUNT N160 | (N1)60cs | K sigma | CYCLIC STRESS RATIO M=7.5 | CYCLIC STRESS RATIO verburd Cc Mag Corr | RESIST. FACTOR OF SAFETY ($F_L$) | RESIST. WILL IT LIQUEFY? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | | | - | - | | - | - | - | - | | | | - | - | - | - | | - | - | | - | - |
| 5 | 58 | ML | 7 | 1 | 1 | 93.0 | 0.30 | 0.30 | 1.70 | 0.80 | 1.20 | 1.00 | 0.99 | 0.24 | 0.18 | 15 | 23 | 1.00 | 0.26 | 0.37 | 2.02 | fines |
| 10 | 53 | SM | 22 | 2 | 2 | 39.0 | 0.60 | 0.60 | 1.32 | 0.85 | 1.00 | 0.67 | 0.98 | 0.38 | 0.23 | 22 | 31 | 1.00 | High N | 0.00 | LARGE | high N |
| 15 | 48 | SP | 21 | 1 | 1 | 3.0 | 0.90 | 0.81 | 1.14 | 0.85 | 1.20 | 1.00 | 0.97 | 0.53 | 0.24 | 32 | 32 | 1.00 | High N | 0.00 | LARGE | high N |
| 20 | 43 | SM | 44 | 2 | 2 | 15.0 | 1.20 | 0.95 | 1.05 | 0.95 | 1.00 | 0.67 | 0.95 | 0.67 | 0.25 | 38 | 43 | 1.00 | High N | 0.00 | LARGE | high N |
| 25 | 38 | ML | 31 | 1 | 1 | 75.0 | 1.50 | 1.09 | 0.98 | 0.95 | 1.20 | 1.00 | 0.94 | 0.81 | 0.26 | 45 | 60 | 1.00 | High N | 0.00 | LARGE | high N |
| 30 | 33 | SP-SM | 42 | 2 | 2 | 11.0 | 1.80 | 1.24 | 0.92 | 1.00 | 1.00 | 0.67 | 0.93 | 0.96 | 0.26 | 34 | 36 | 1.00 | High N | 0.00 | LARGE | high N |
| 35 | 28 | ML | 20 | 1 | 1 | 90.0 | 2.10 | 1.38 | 0.87 | 1.00 | 1.20 | 1.00 | 0.89 | 1.10 | 0.25 | 27 | 38 | 0.99 | High N | 0.00 | LARGE | high N |
| 40 | 23 | SM | 46 | 2 | 2 | 20.0 | 2.40 | 1.53 | 0.83 | 1.00 | 1.00 | 0.67 | 0.85 | 1.25 | 0.24 | 33 | 40 | 0.97 | High N | 0.00 | LARGE | high N |
| 45 | 18 | SP | 27 | 1 | 1 | 5.0 | 2.70 | 1.67 | 0.79 | 1.00 | 1.20 | 1.00 | 0.81 | 1.39 | 0.23 | 34 | 34 | 0.95 | High N | 0.00 | LARGE | high N |
| 50 | 13 | ML | 50 | 2 | 2 | 90.0 | 3.00 | 1.81 | 0.76 | 1.00 | 1.00 | 0.67 | 0.77 | 1.53 | 0.22 | 33 | 45 | 0.93 | High N | 0.00 | LARGE | high N |
| 55 | 8 | SP | 26 | 1 | 1 | 5.0 | 3.30 | 1.96 | 0.73 | 1.00 | 1.20 | 1.00 | 0.73 | 1.68 | 0.21 | 30 | 30 | 0.91 | 0.47 | 0.61 | 2.89 | depth>50' |
| 60 | 3 | ML | 56 | 2 | 2 | 95.0 | 3.60 | 2.10 | 0.70 | 1.00 | 1.00 | 0.67 | 0.69 | 1.82 | 0.20 | 35 | 47 | 0.88 | High N | 0.00 | LARGE | high N |
| 65 | -2 | SP-SM | 31 | 1 | 1 | 12.0 | 3.90 | 2.25 | 0.68 | 1.00 | 1.20 | 1.00 | 0.64 | 1.97 | 0.19 | 33 | 36 | 0.86 | High N | 0.00 | LARGE | high N |
| 70 | -7 | SP-SM | 36 | 1 | 1 | 10.0 | 4.20 | 2.39 | 0.66 | 1.00 | 1.20 | 1.00 | 0.60 | 2.11 | 0.18 | 38 | 39 | 0.87 | High N | 0.00 | LARGE | high N |
| 80 | -17 | SP | 52 | 1 | 1 | 5.0 | 4.80 | 2.68 | 0.62 | 1.00 | 1.20 | 1.00 | 0.55 | 2.40 | 0.16 | 51 | 51 | 0.85 | High N | 0.00 | LARGE | high N |
| 90 | -27 | CL | 65 | 1 | 1 | 95.0 | 5.40 | 2.97 | 0.59 | 1.00 | 1.20 | 1.00 | 0.52 | 2.69 | 0.16 | 61 | 78 | 0.83 | High N | 0.00 | LARGE | high N |
| 100 | -37 | CL | 66 | 1 | 1 | 95.0 | 6.00 | 3.25 | 0.57 | 0.95 | 1.20 | 1.00 | 0.50 | 2.97 | 0.15 | 56 | 72 | 0.80 | High N | 0.00 | LARGE | high N |

**Earth Mechanics, Inc.**
Geotechnical & Earthquake Engineering
17800 Newhope Street, Suite B
Fountain Valley, CA 92708

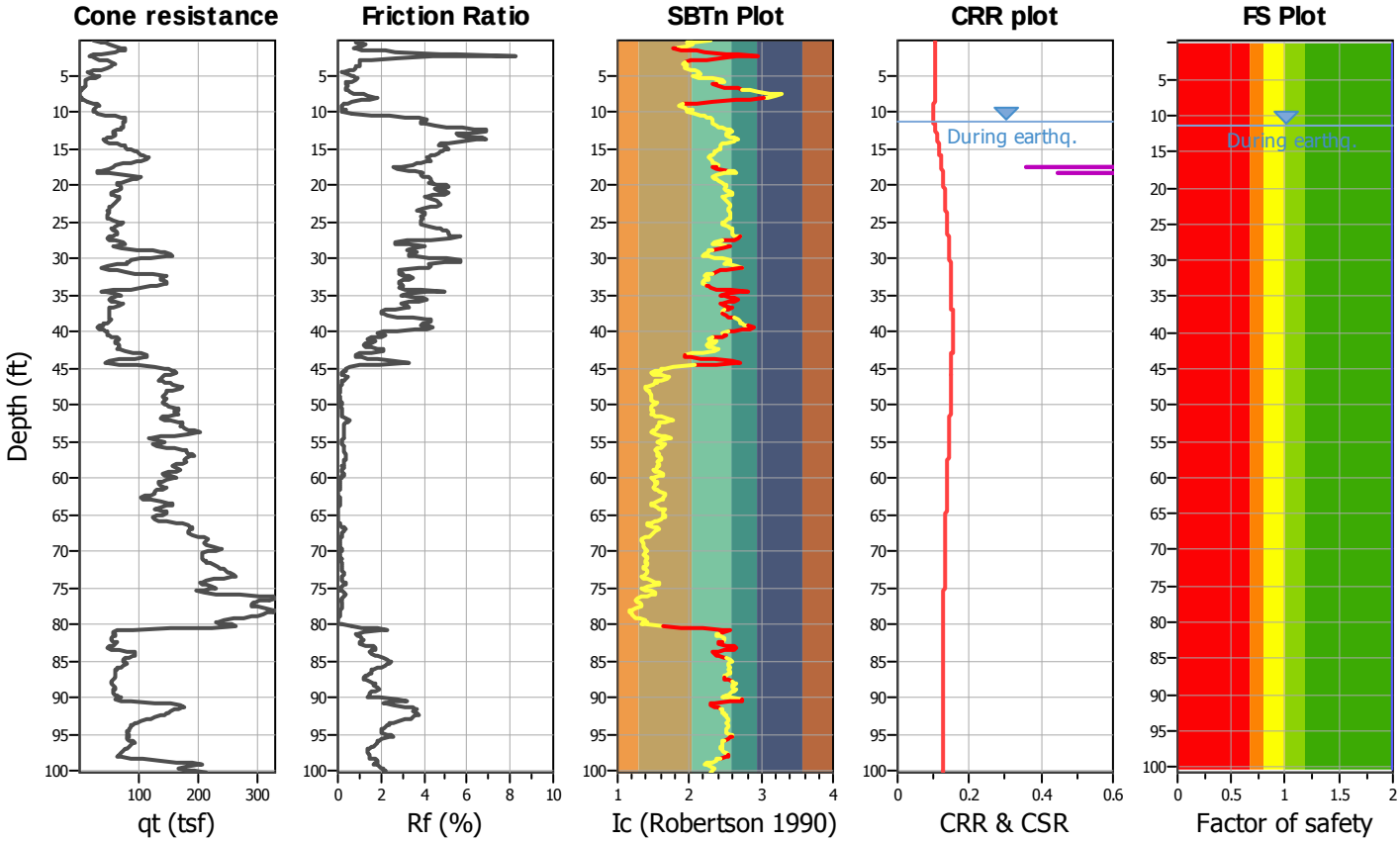
# LIQUEFACTION ANALYSIS REPORT

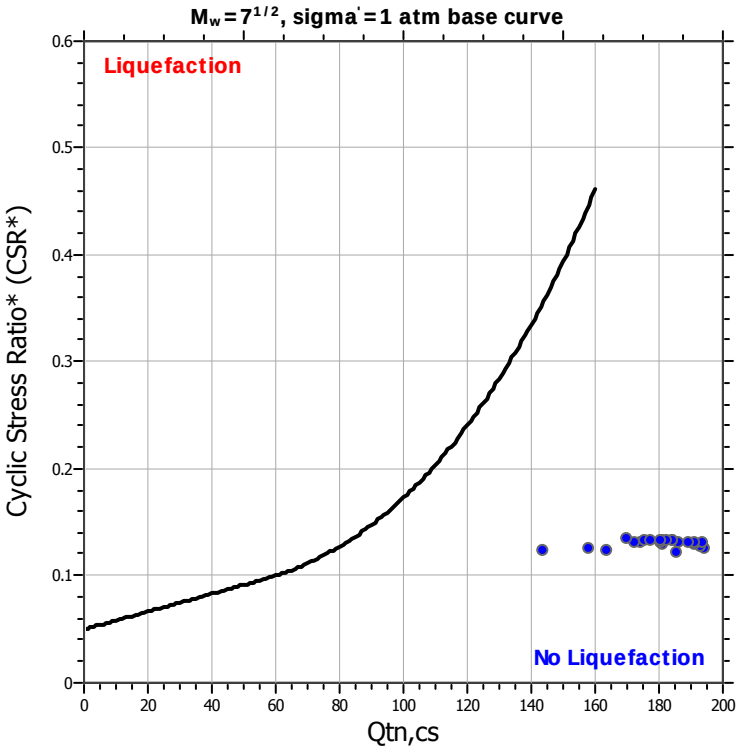
**Project title : 5th Street Bridge** **Location : Yuba City**

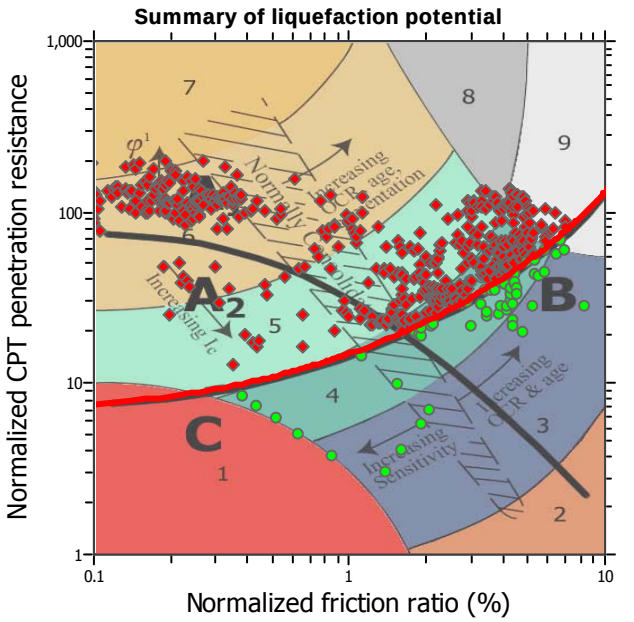
**CPT file : 066DE-CPT-01**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 11.38 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 11.38 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 22.86 ft |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.23 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

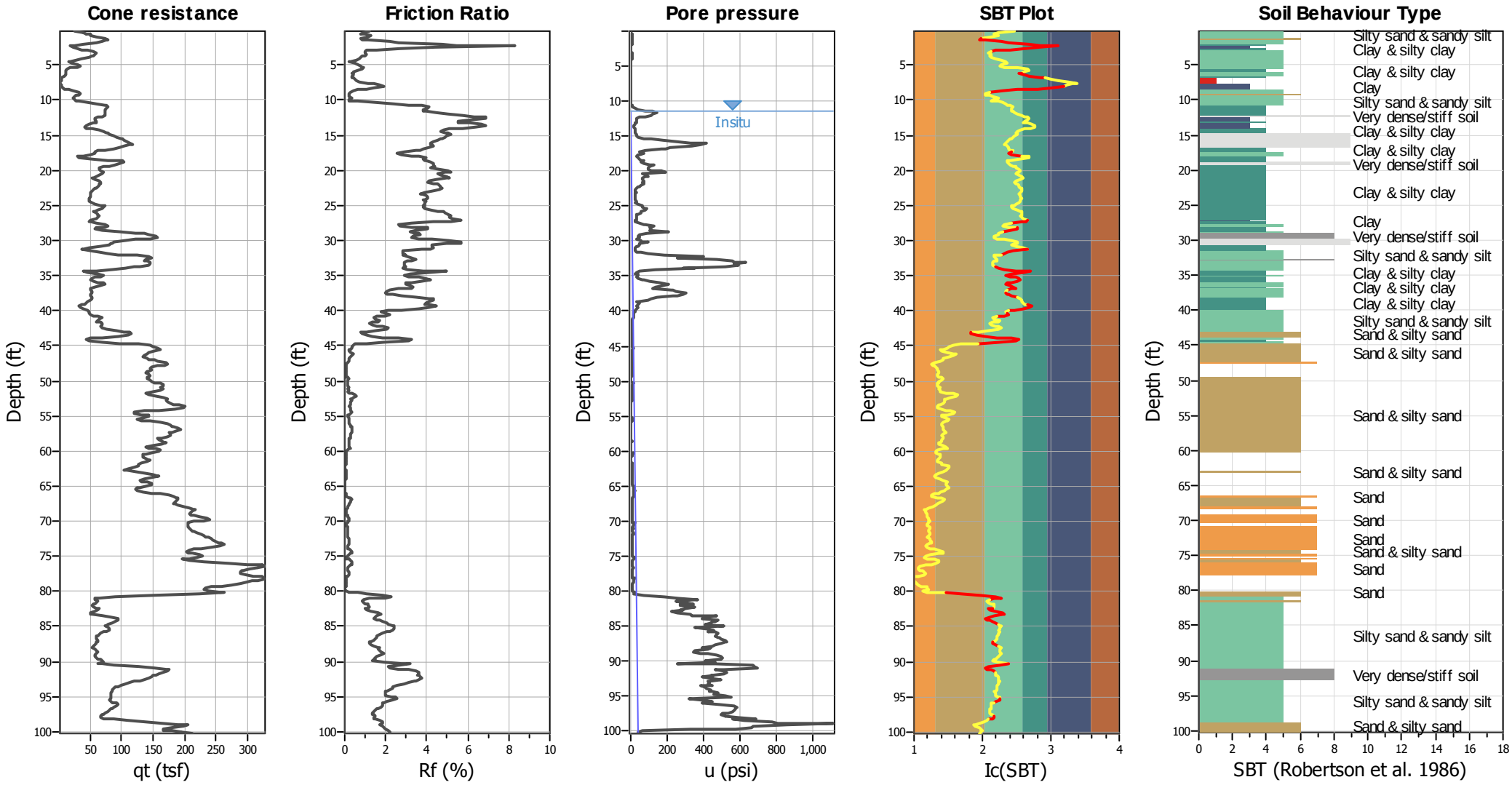



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots



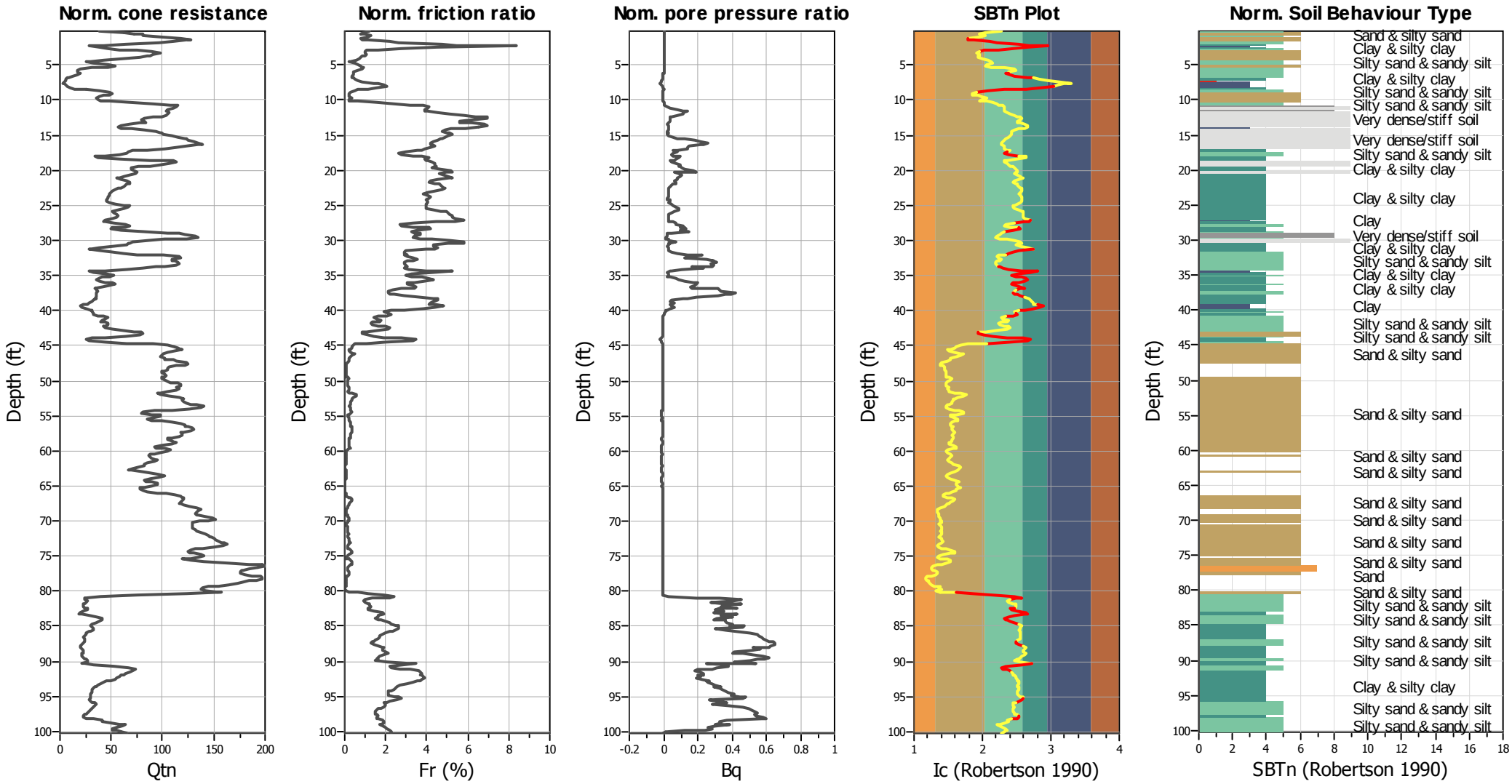

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 11.38 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 11.38 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## CPT basic interpretation plots (normalized)



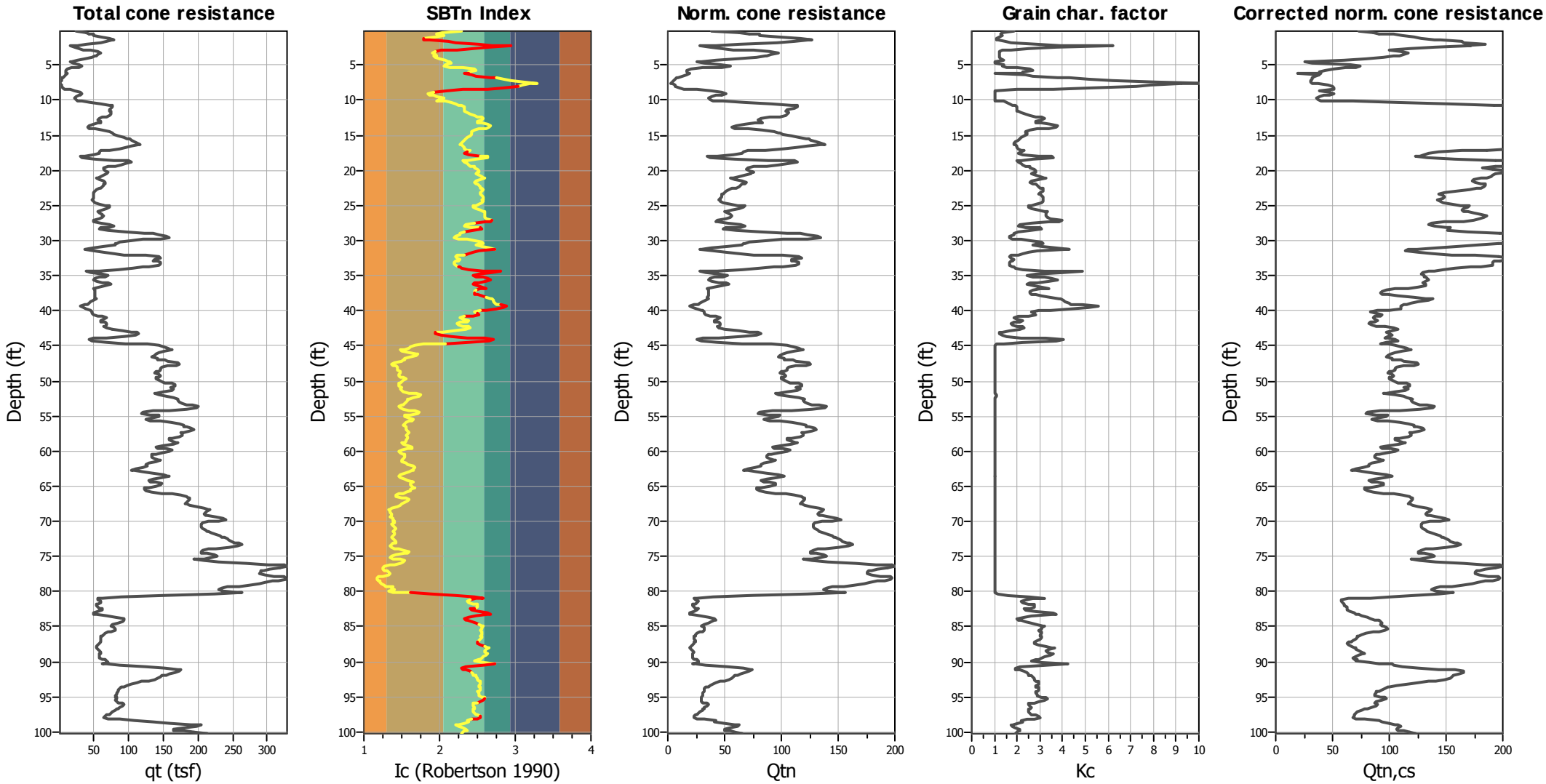

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 11.38 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 11.38 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

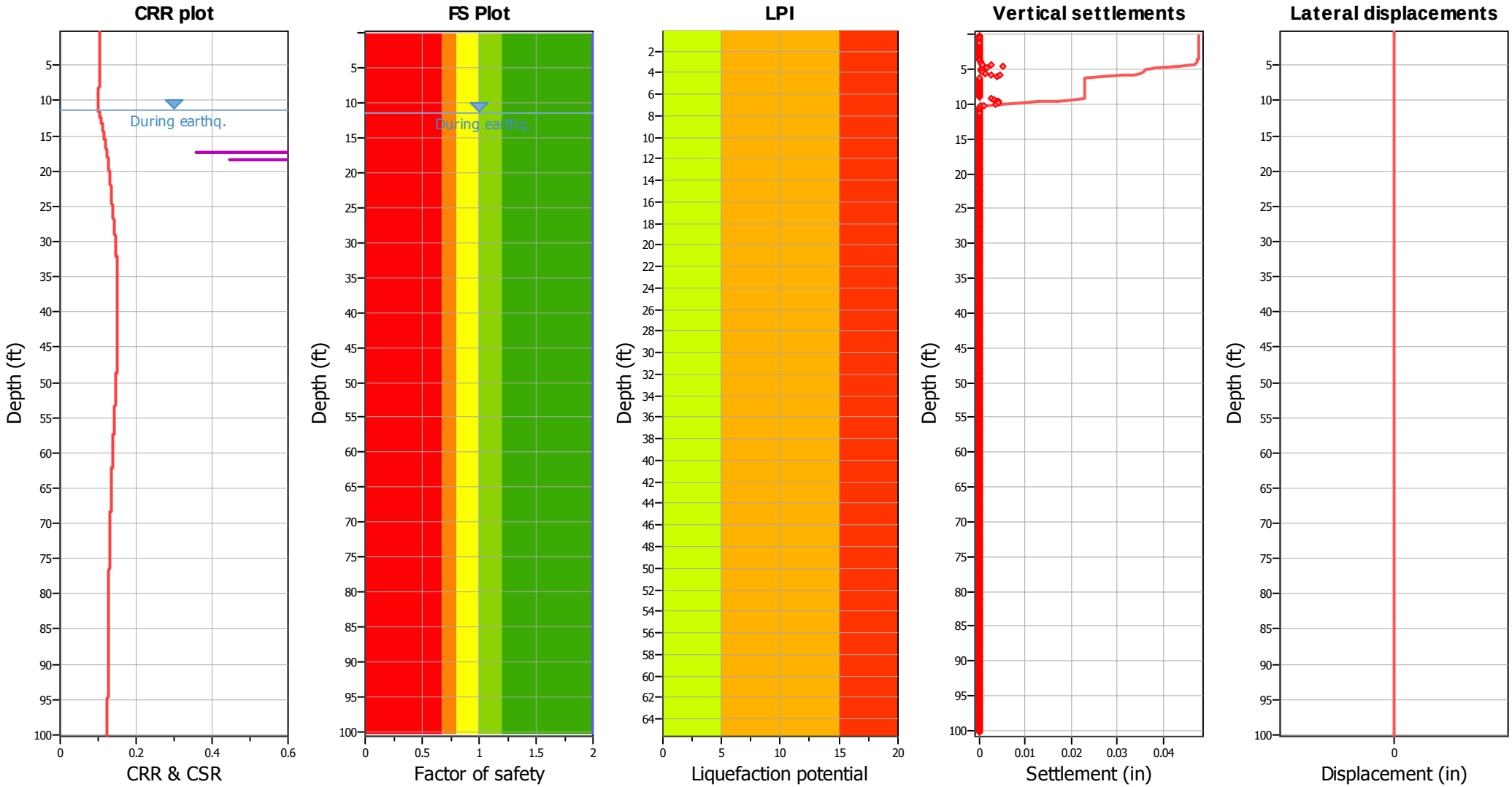
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 11.38 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 11.38 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 11.38 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 11.38 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

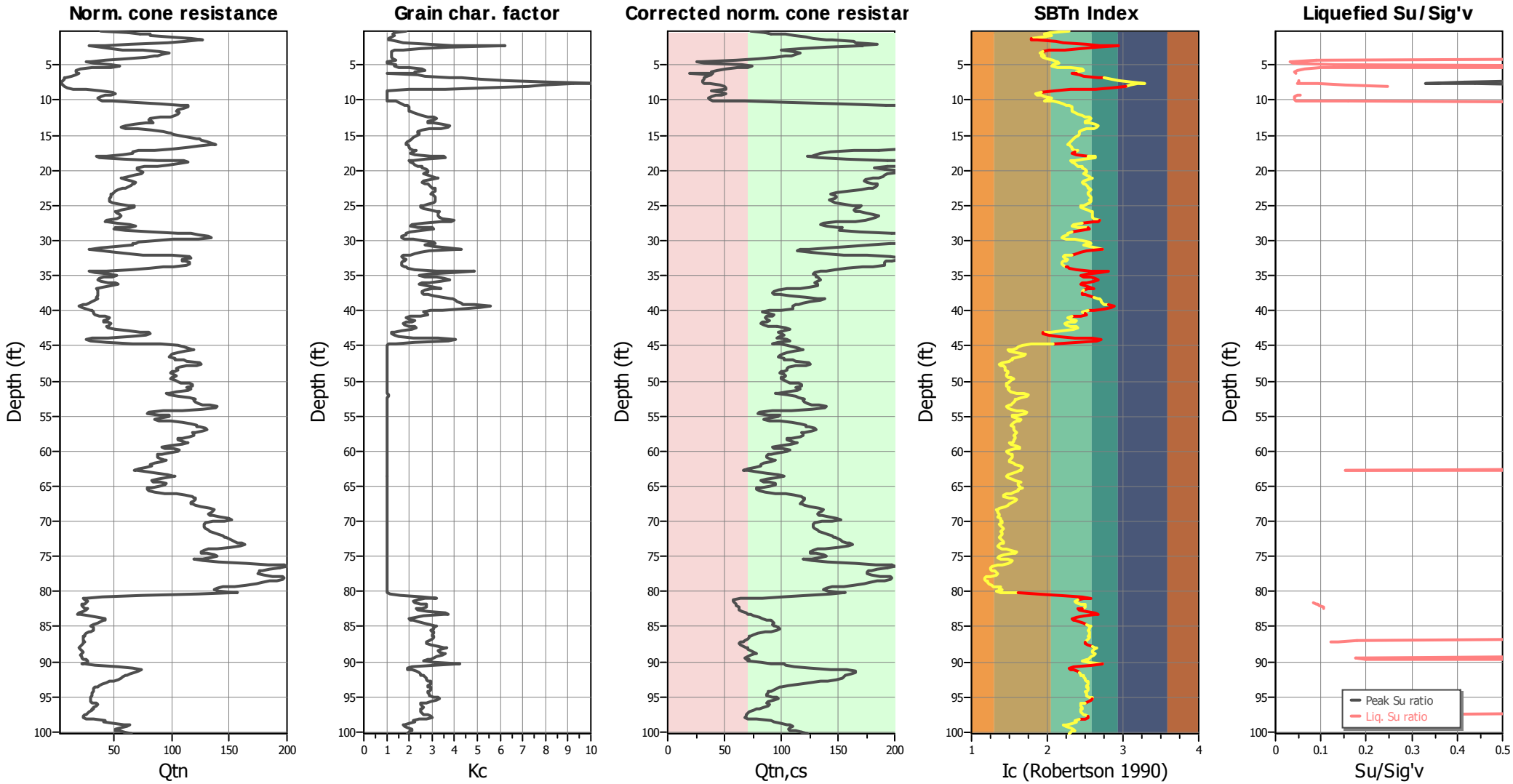
**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

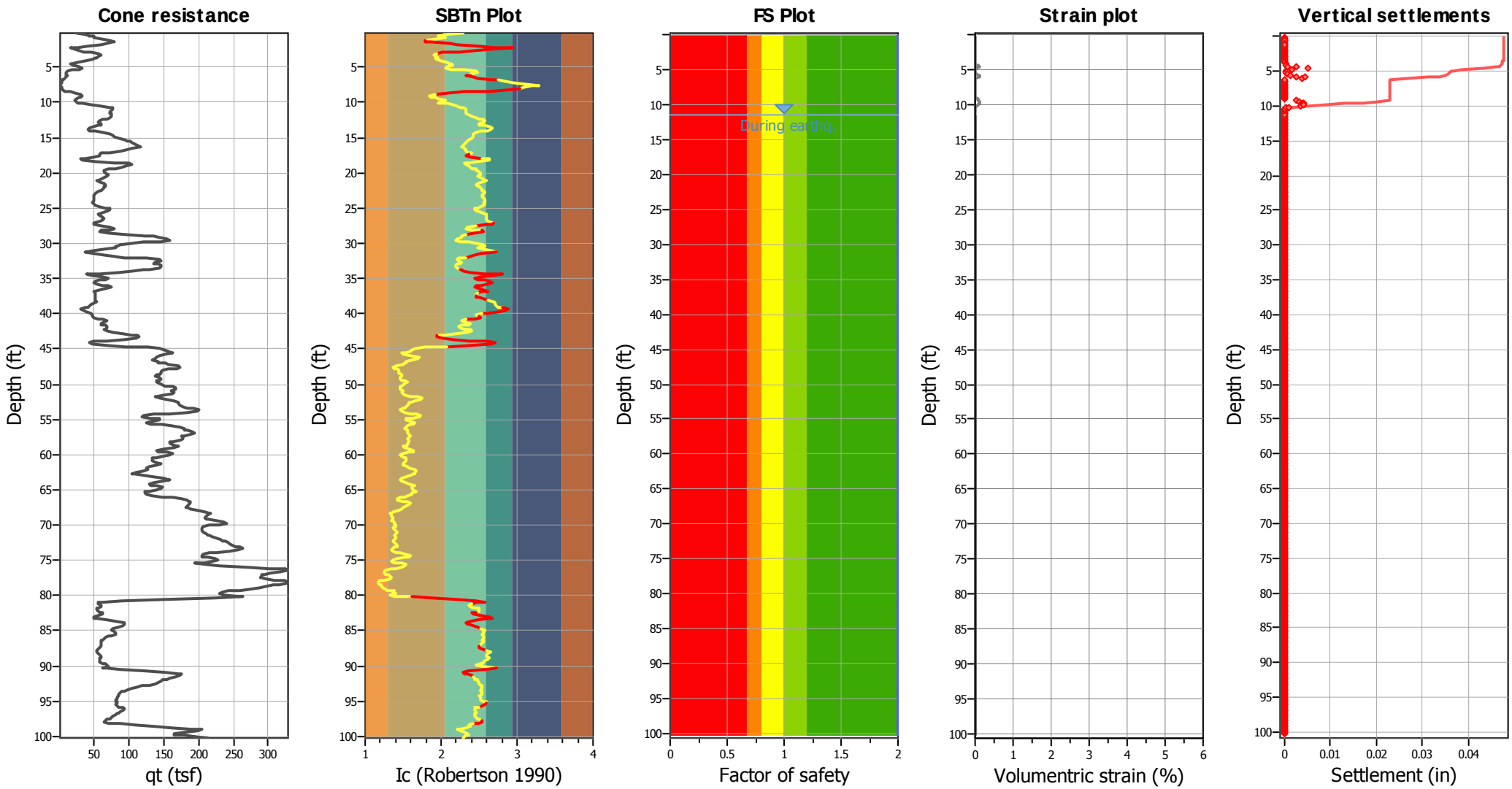
## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 11.38 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 11.38 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

## Estimation of post-earthquake settlements




**Abbreviations**

| | |
|---|---|
| $q_t$: | Total cone resistance (cone resistance $q_c$ corrected for pore water effects) |
| $I_c$: | Soil Behaviour Type Index |
| FS: | Calculated Factor of Safety against liquefaction |
| Volumentric strain: | Post-liquefaction volumentric strain |

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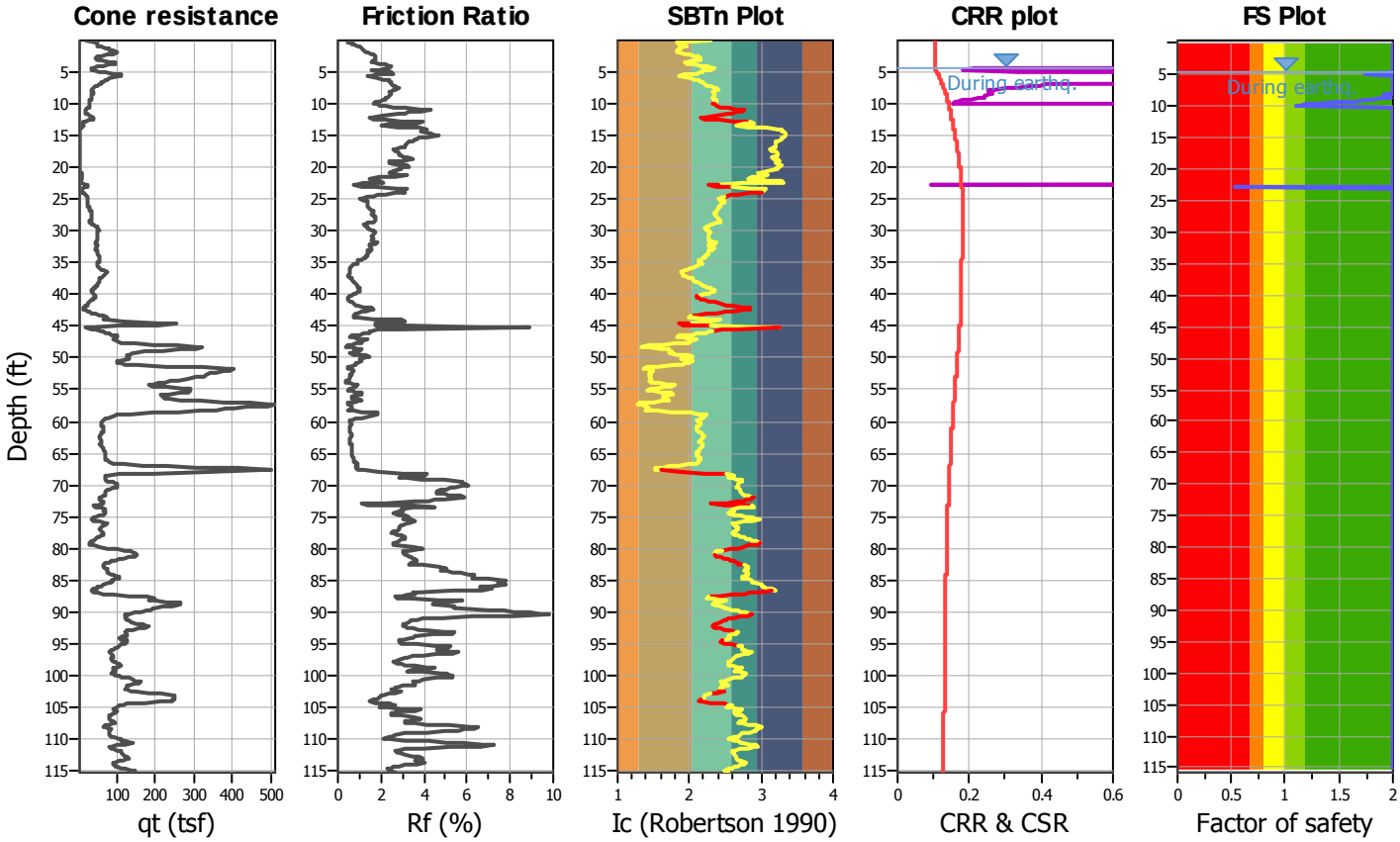
# LIQUEFACTION ANALYSIS REPORT

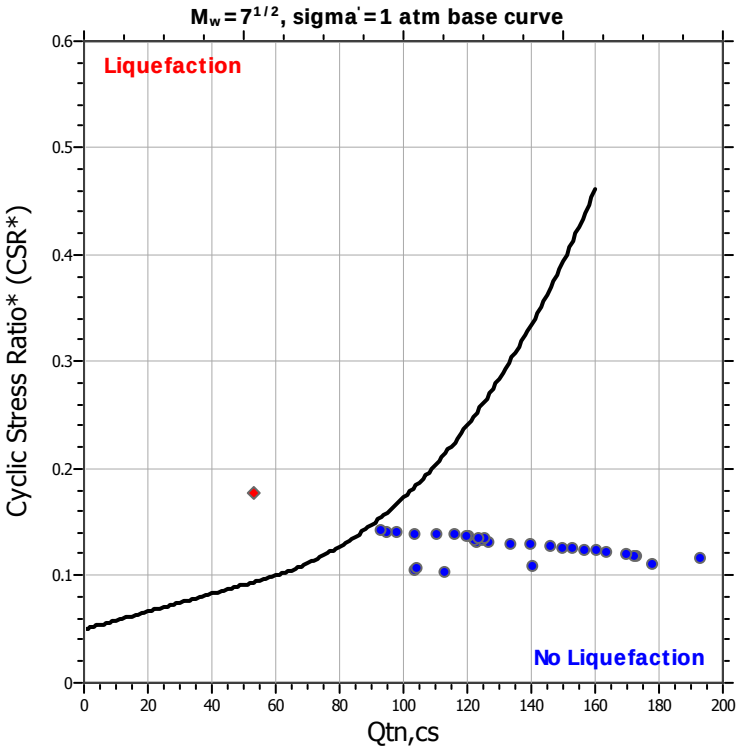
**Project title : 5th Street Bridge** **Location : Yuba City**

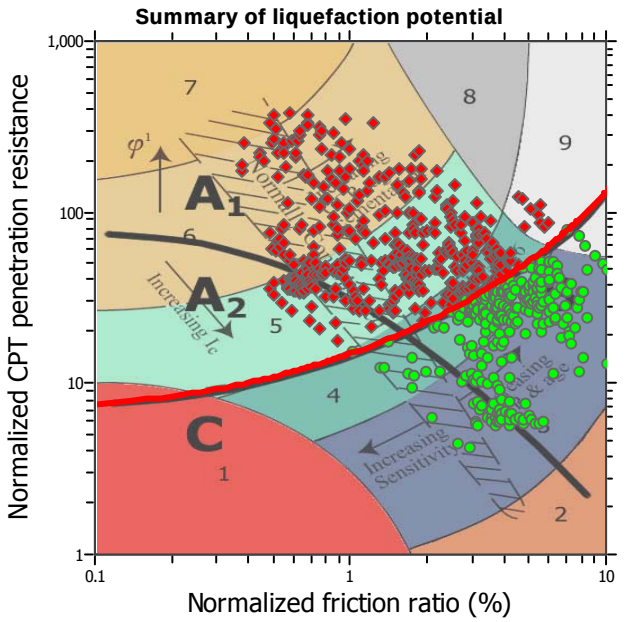
**CPT file : 066DE-CPT-02**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 4.59 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 4.59 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 22.86 ft |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.23 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

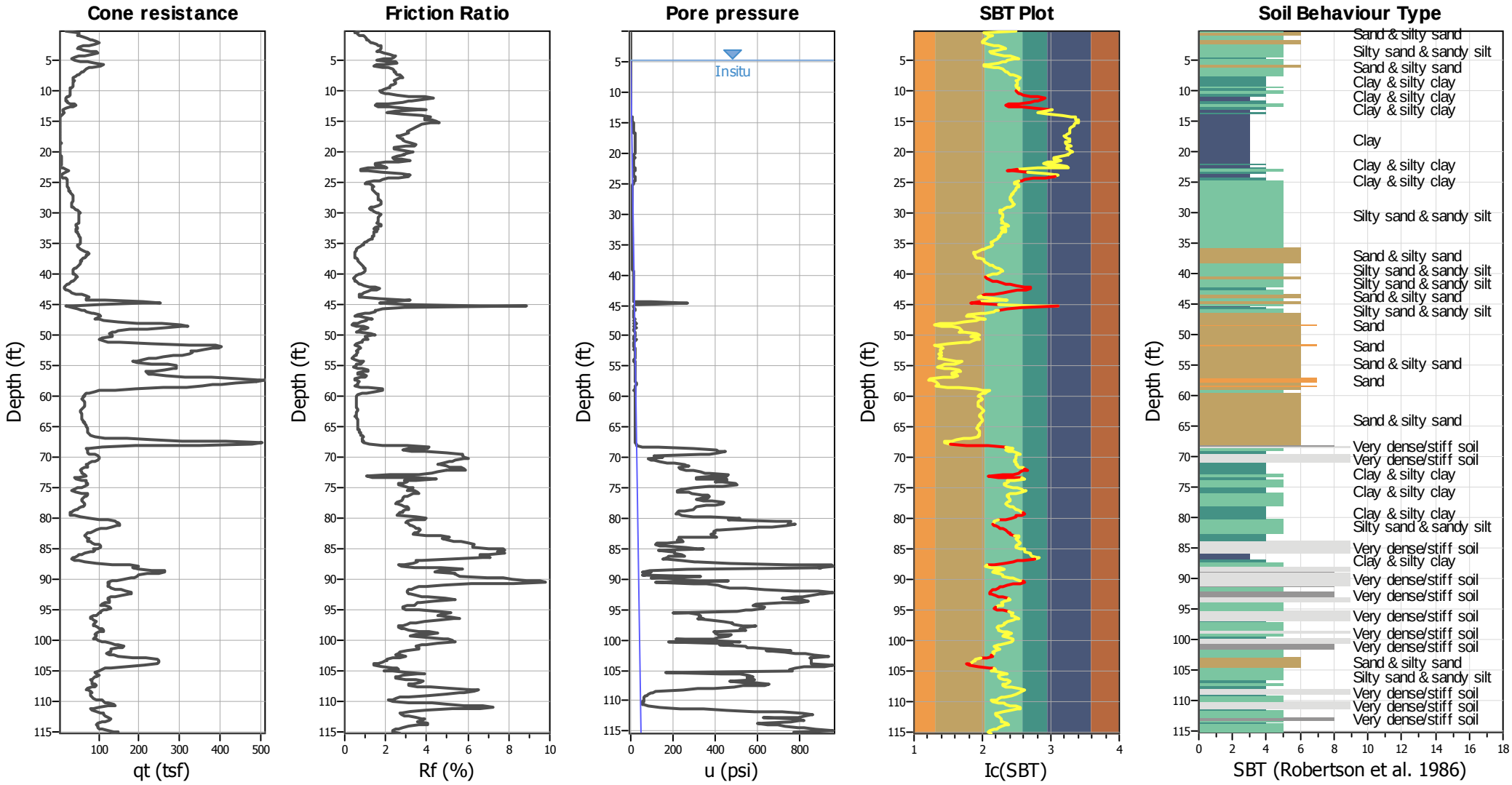



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots



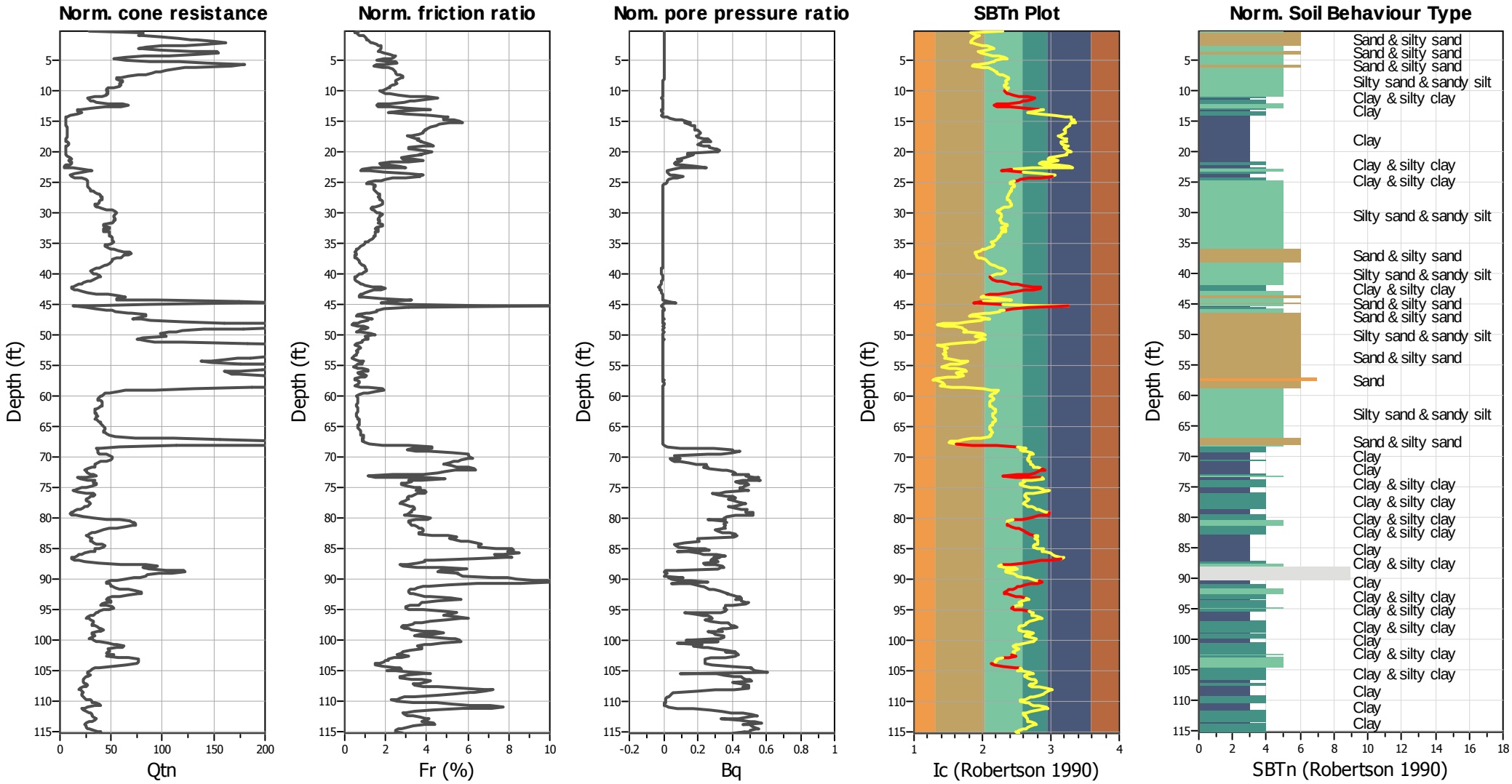

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## CPT basic interpretation plots (normalized)



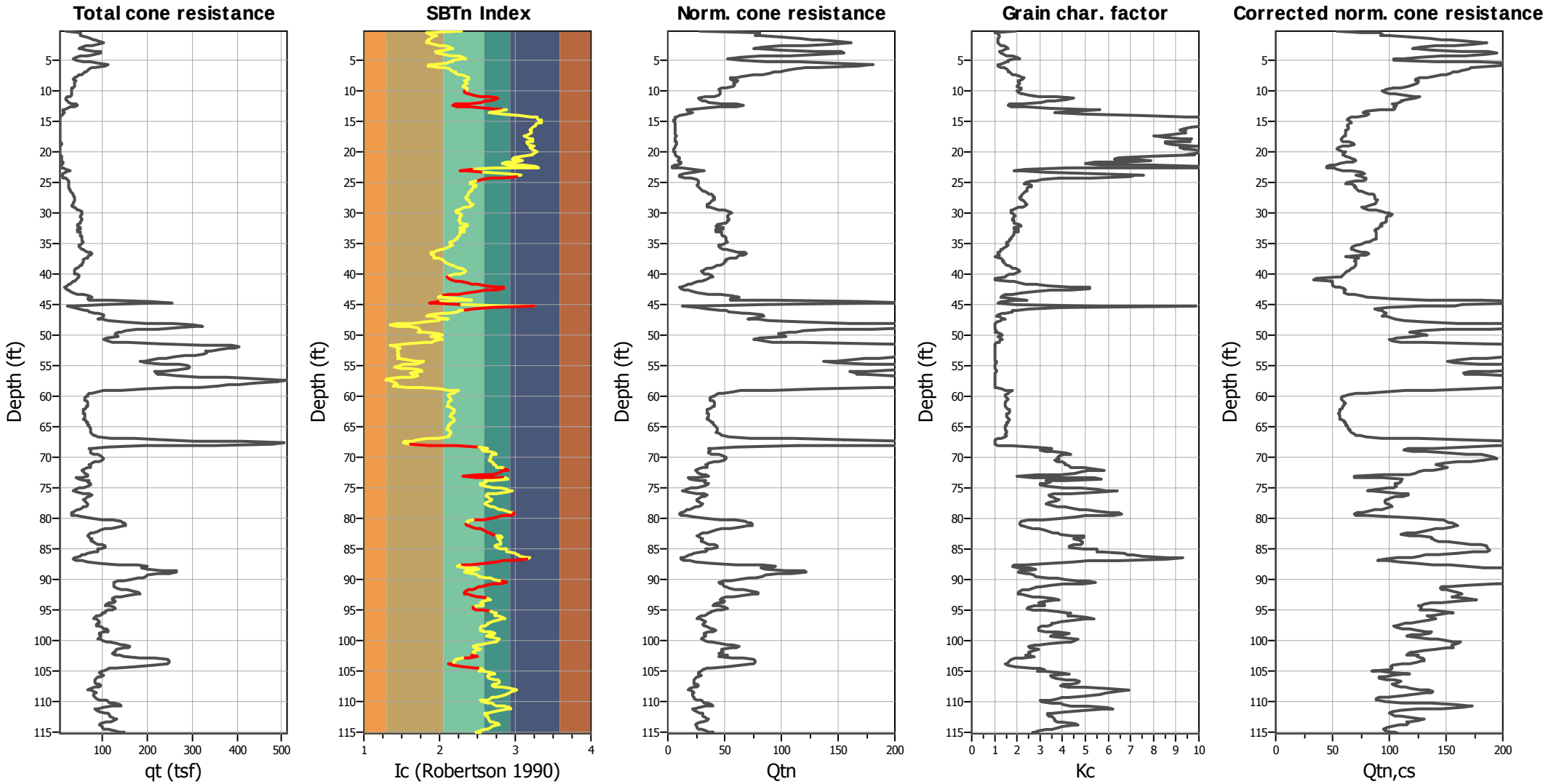

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

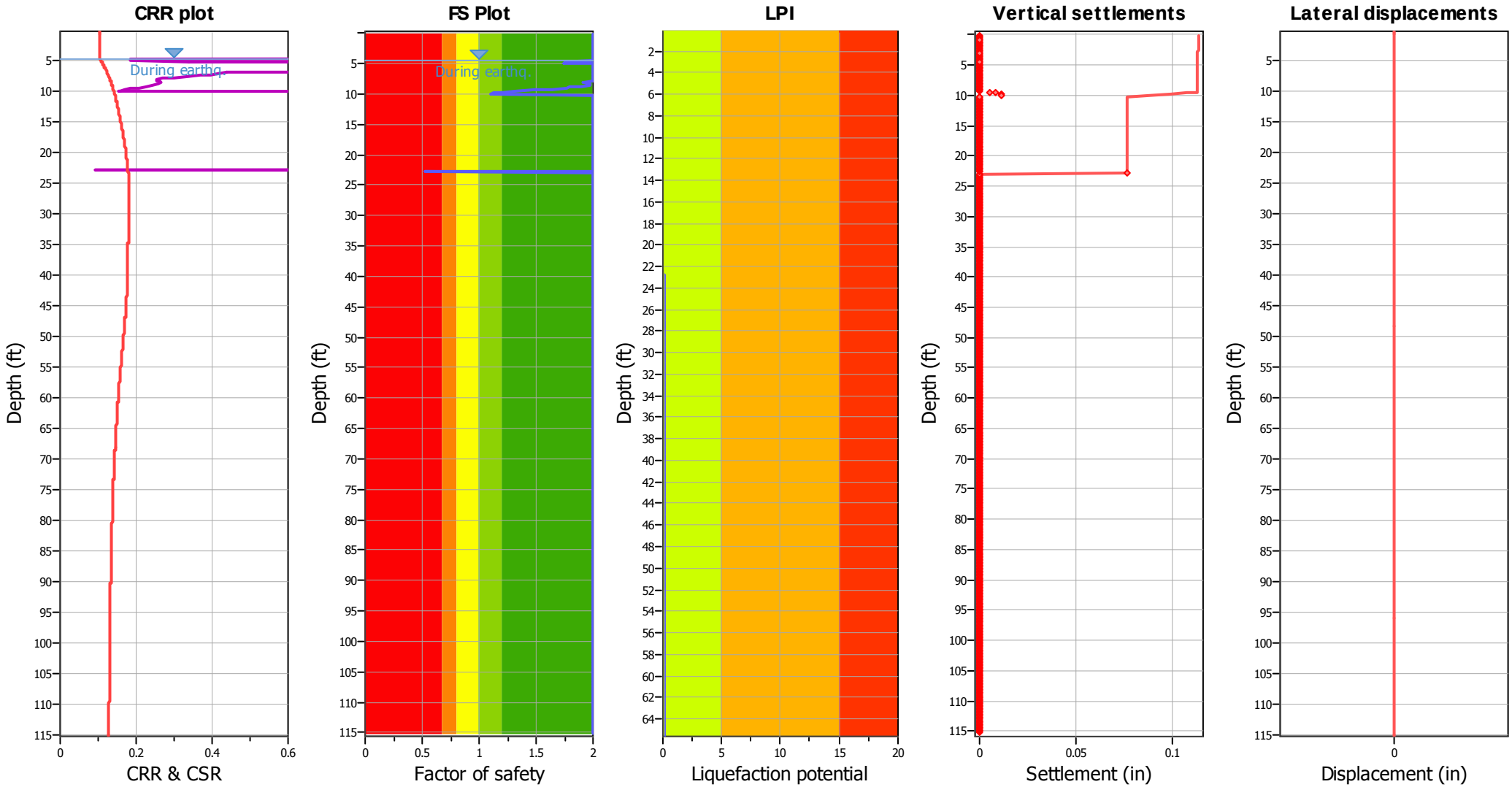
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

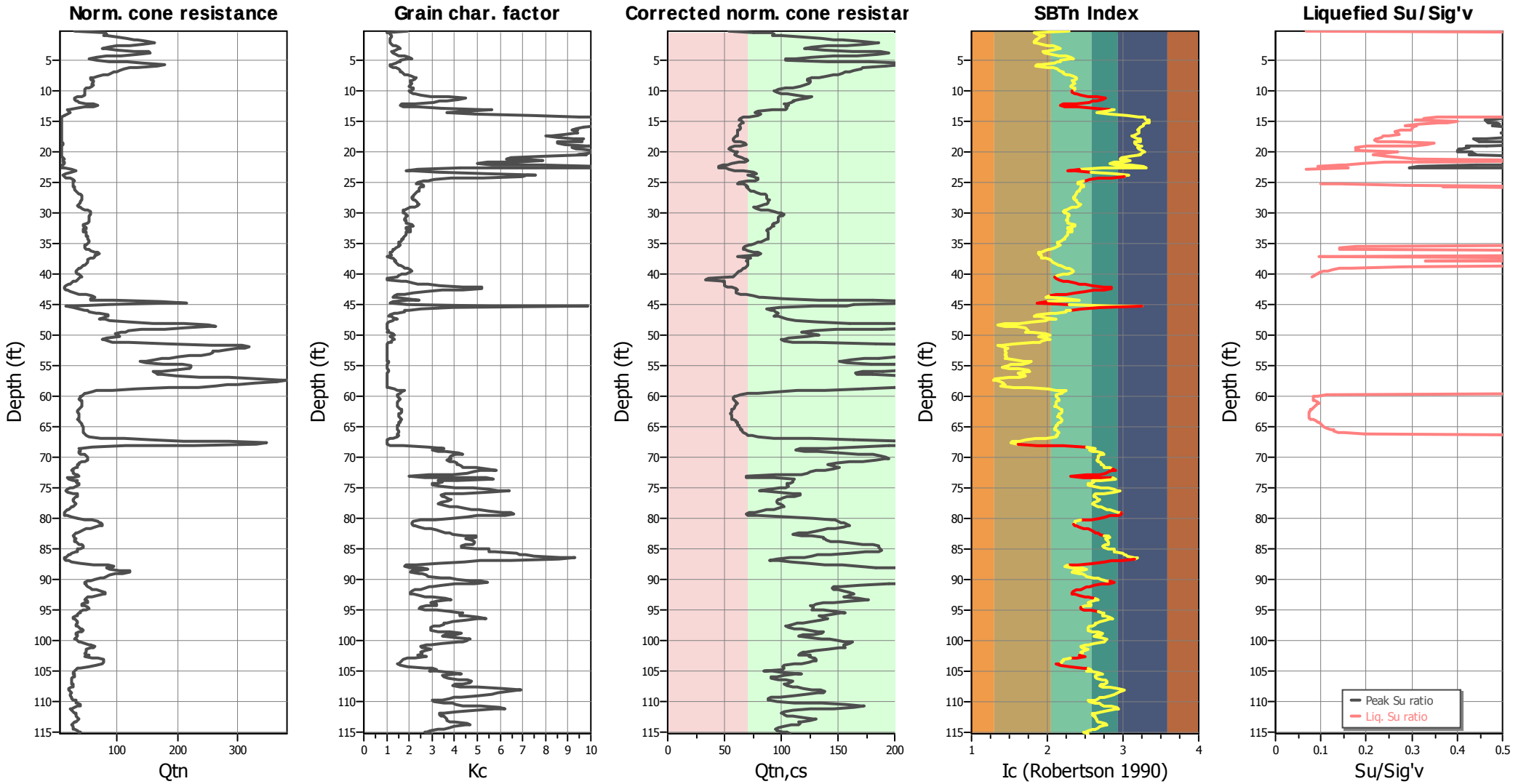
**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

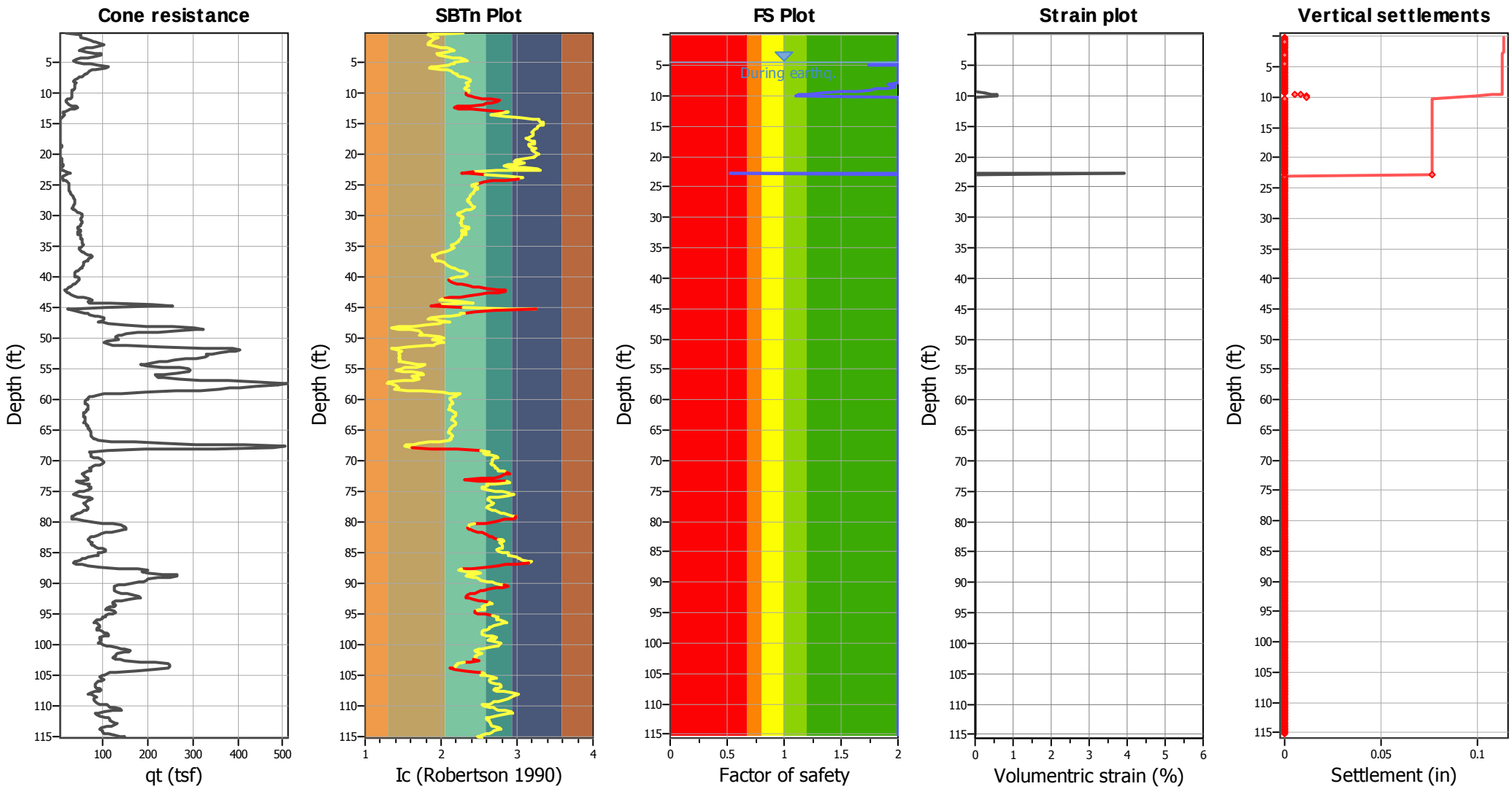
## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

## Estimation of post-earthquake settlements




**Abbreviations**

| | |
|---|---|
| $q_t$: | Total cone resistance (cone resistance $q_c$ corrected for pore water effects) |
| $I_c$: | Soil Behaviour Type Index |
| FS: | Calculated Factor of Safety against liquefaction |
| Volumentric strain: | Post-liquefaction volumentric strain |

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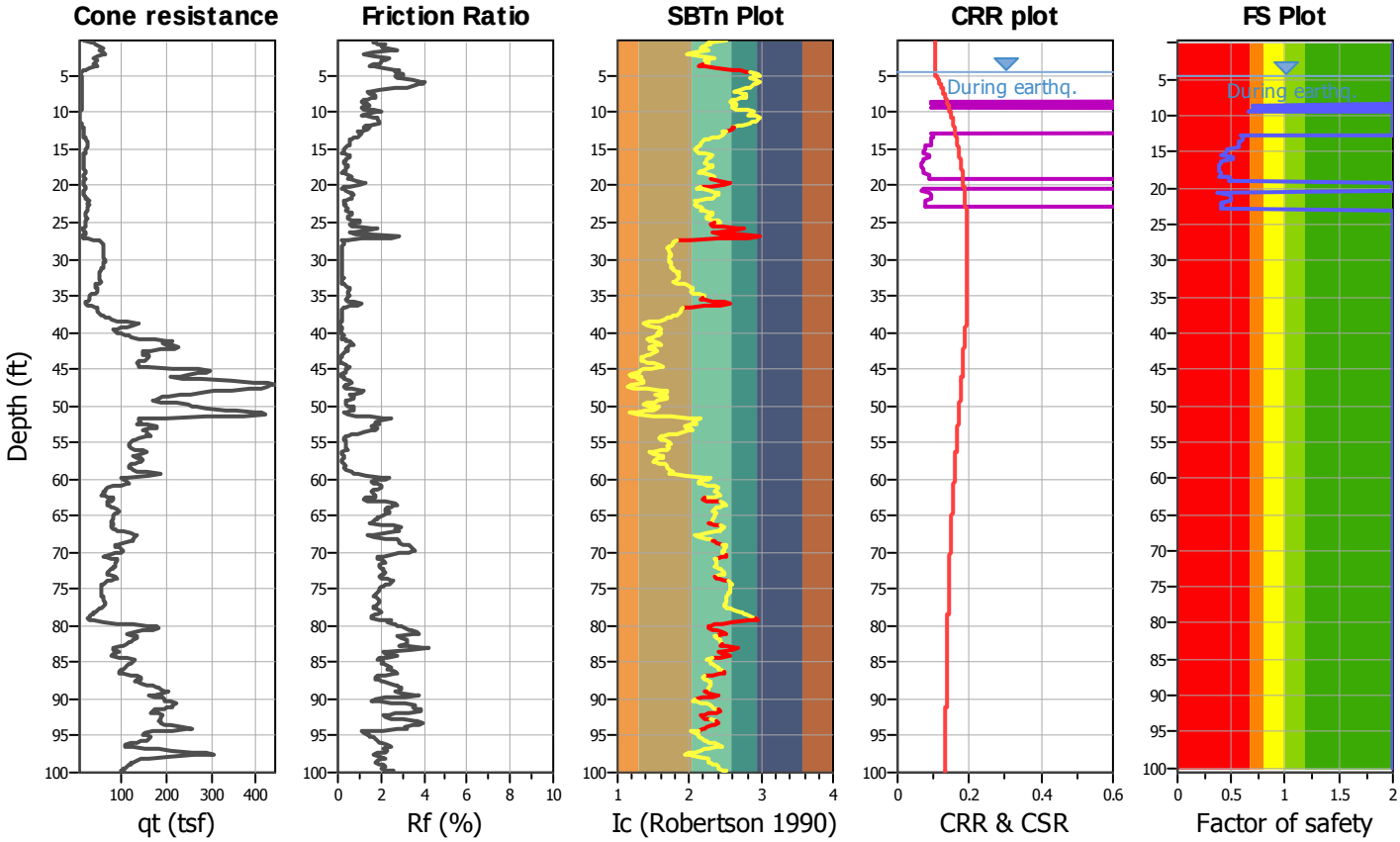
# LIQUEFACTION ANALYSIS REPORT

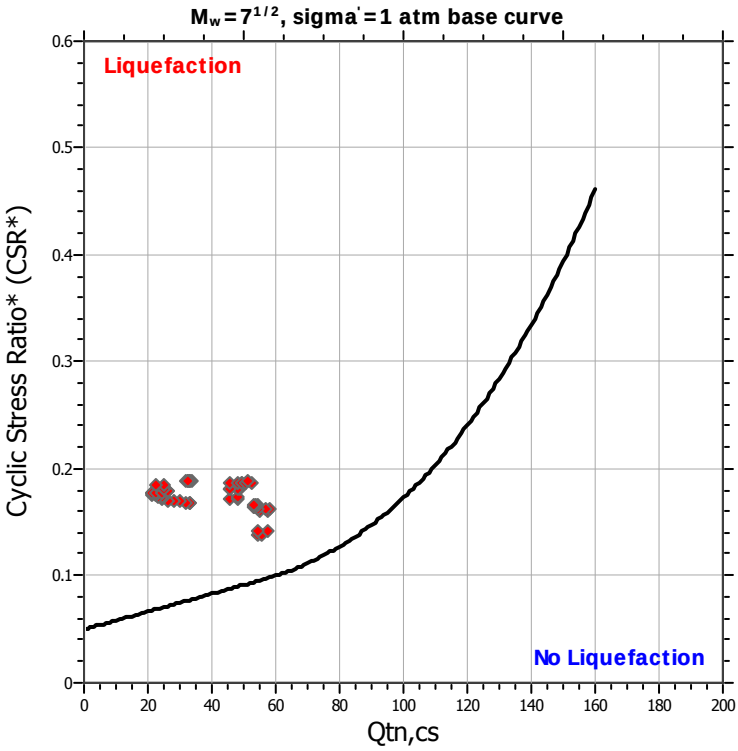
**Project title : 5th Street Bridge** **Location : Yuba City**

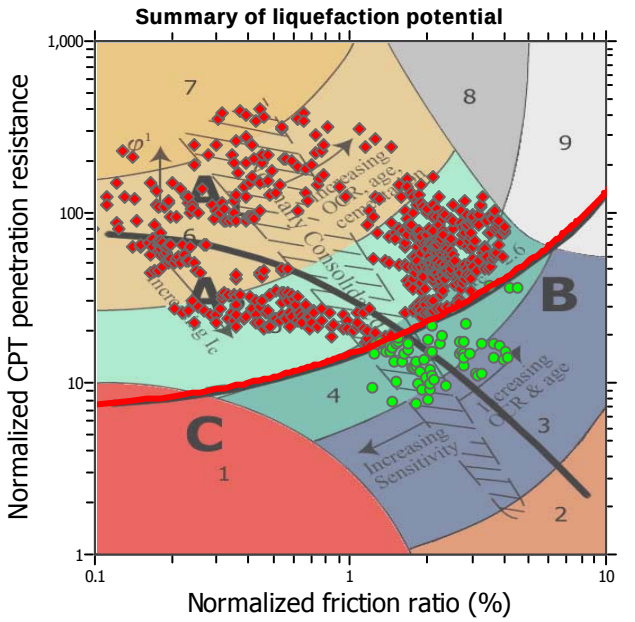
**CPT file : 066DE-CPT-03**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 4.59 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 4.59 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 22.86 ft |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.23 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

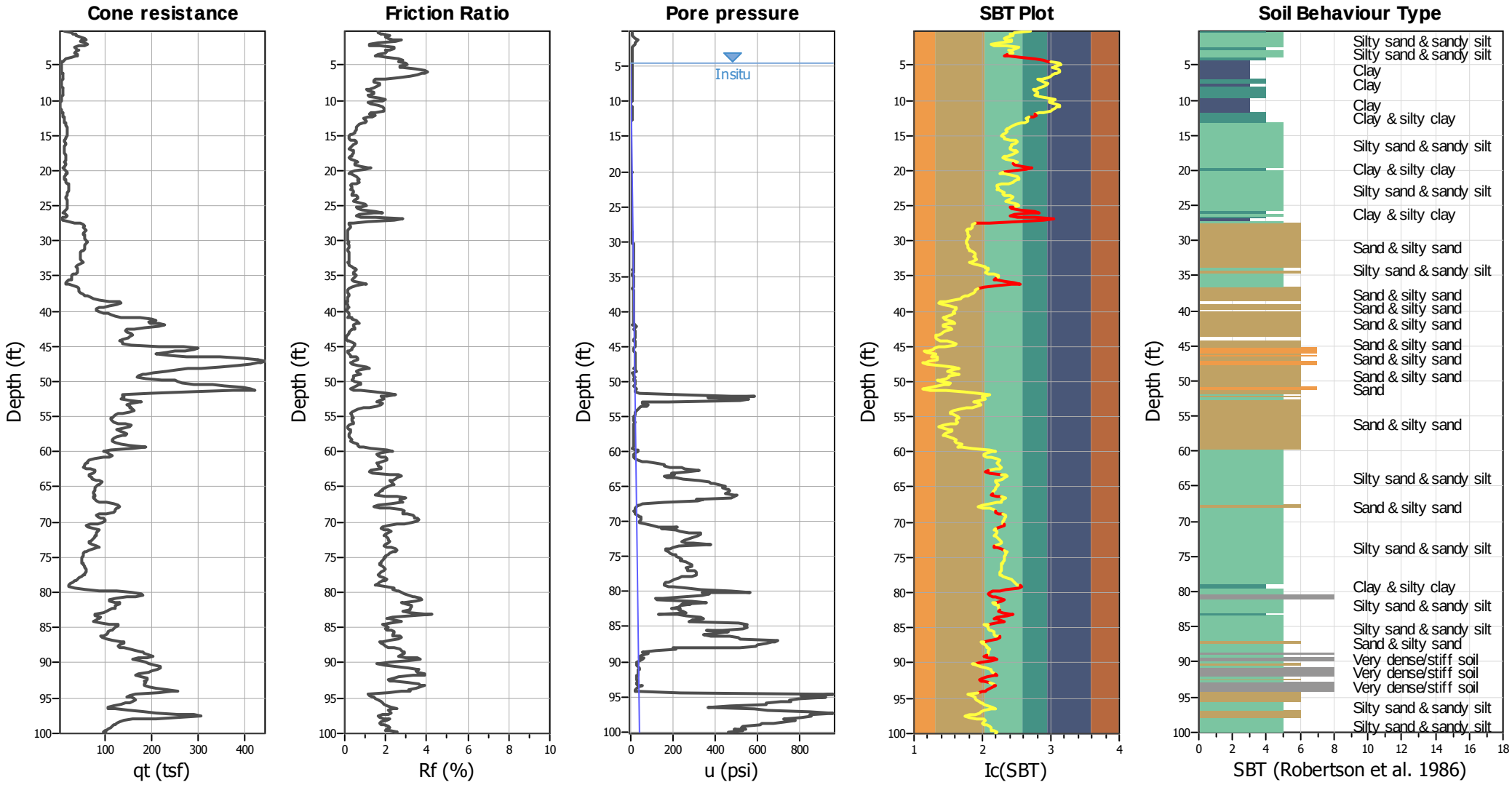



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots



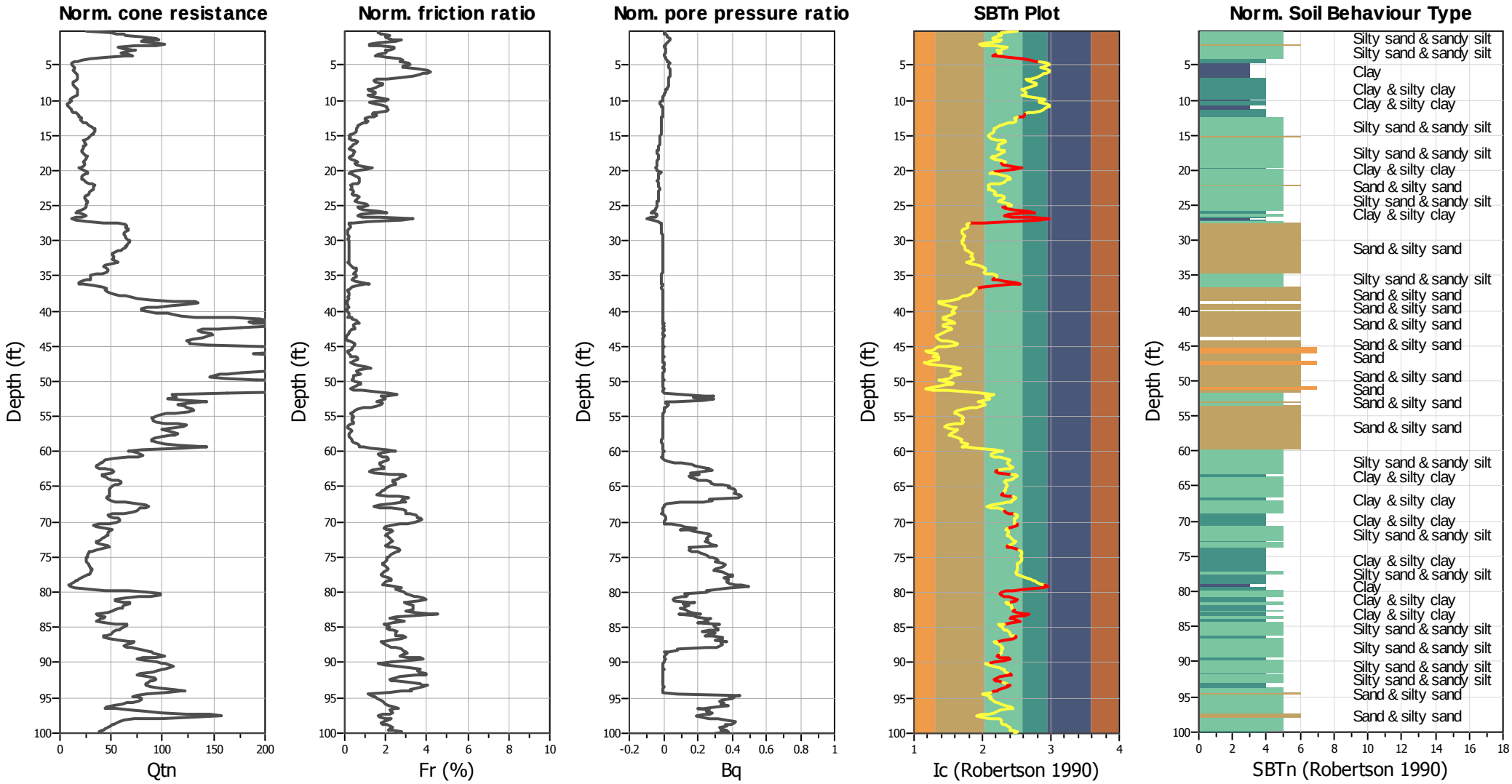

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## CPT basic interpretation plots (normalized)



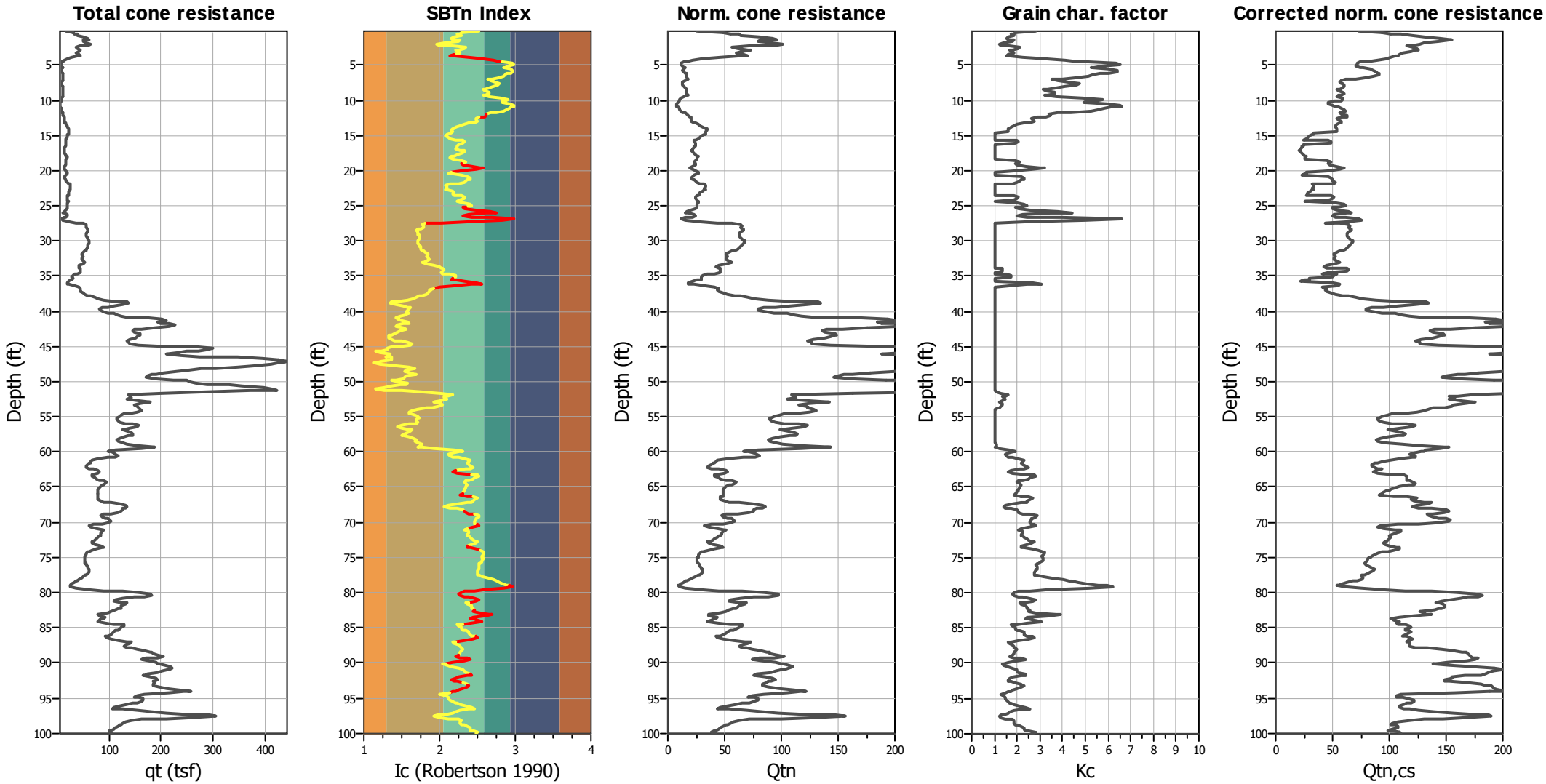

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

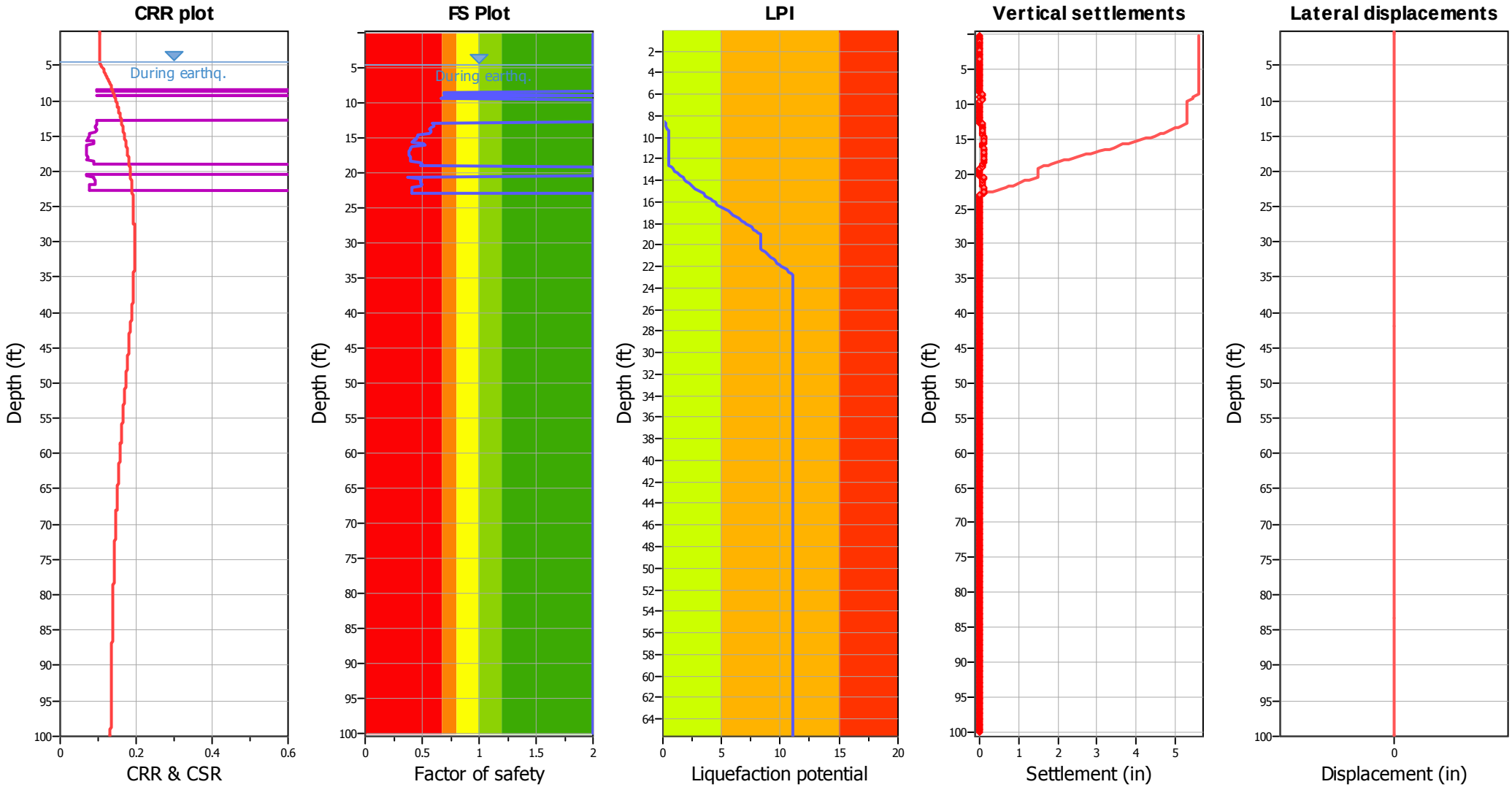
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

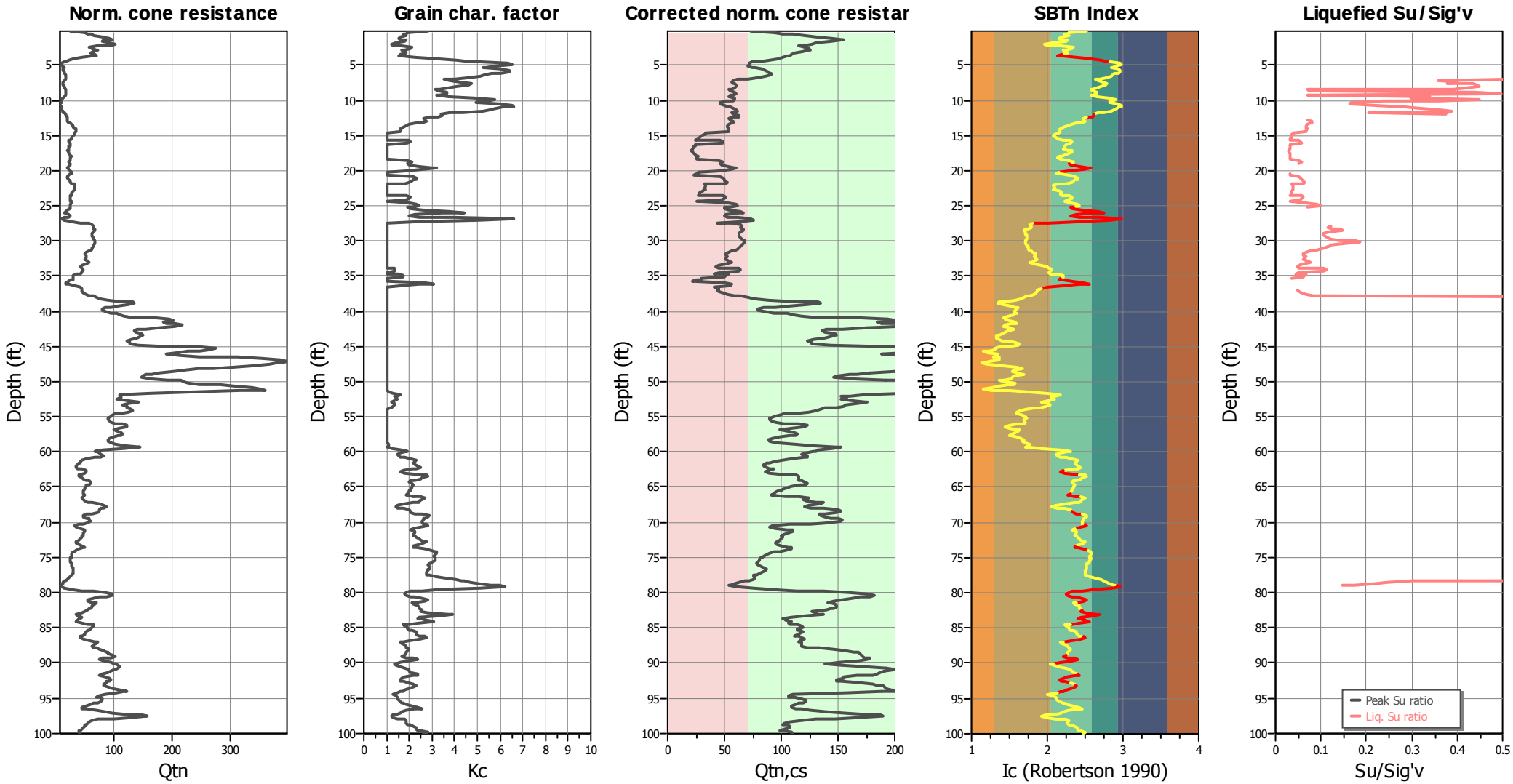
**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

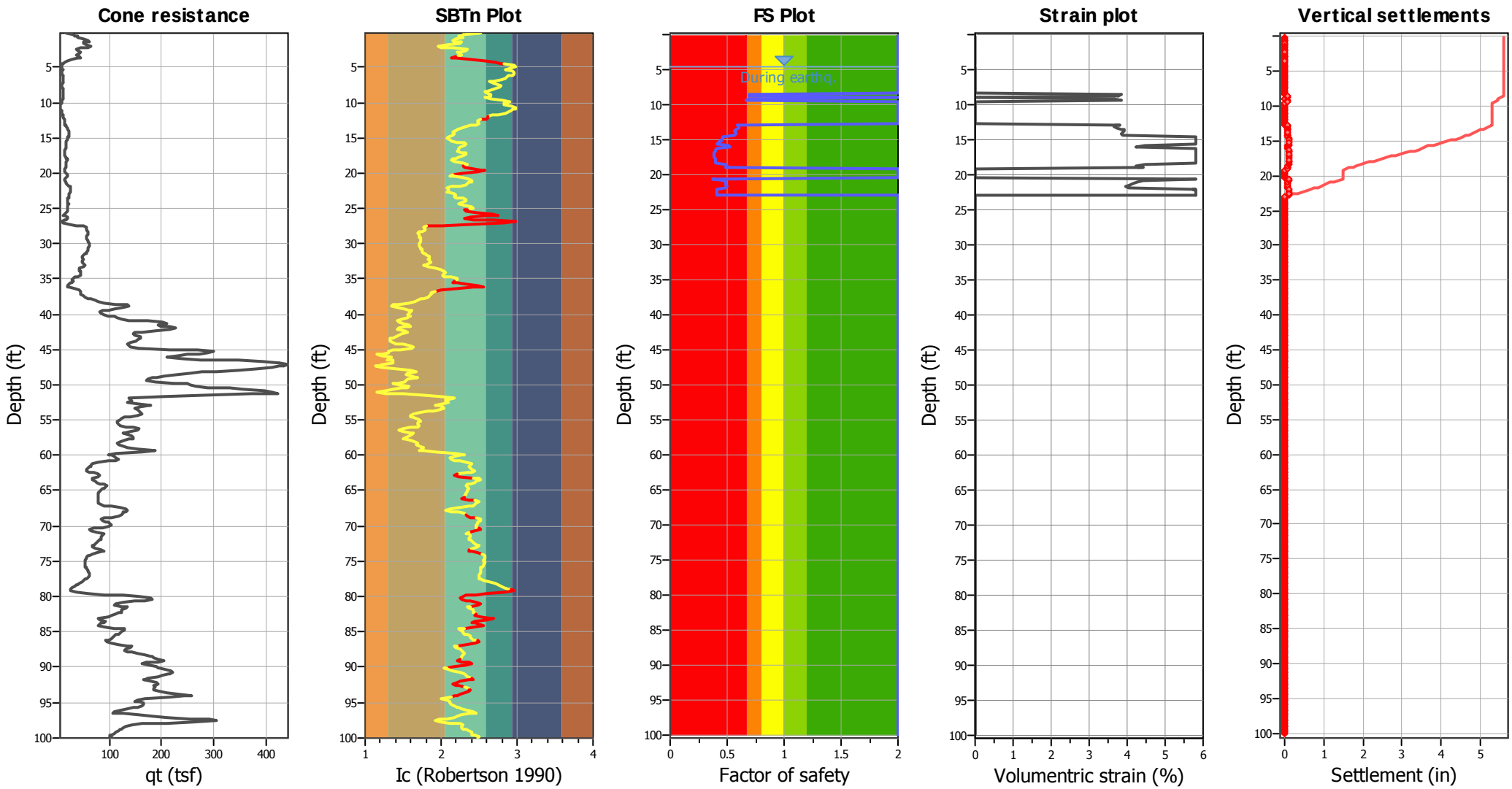
## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 4.59 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 4.59 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

## Estimation of post-earthquake settlements




**Abbreviations**

| | |
|---|---|
| $q_t$: | Total cone resistance (cone resistance $q_c$ corrected for pore water effects) |
| $I_c$: | Soil Behaviour Type Index |
| FS: | Calculated Factor of Safety against liquefaction |
| Volumentric strain: | Post-liquefaction volumentric strain |

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Fountain Valley, CA 92708

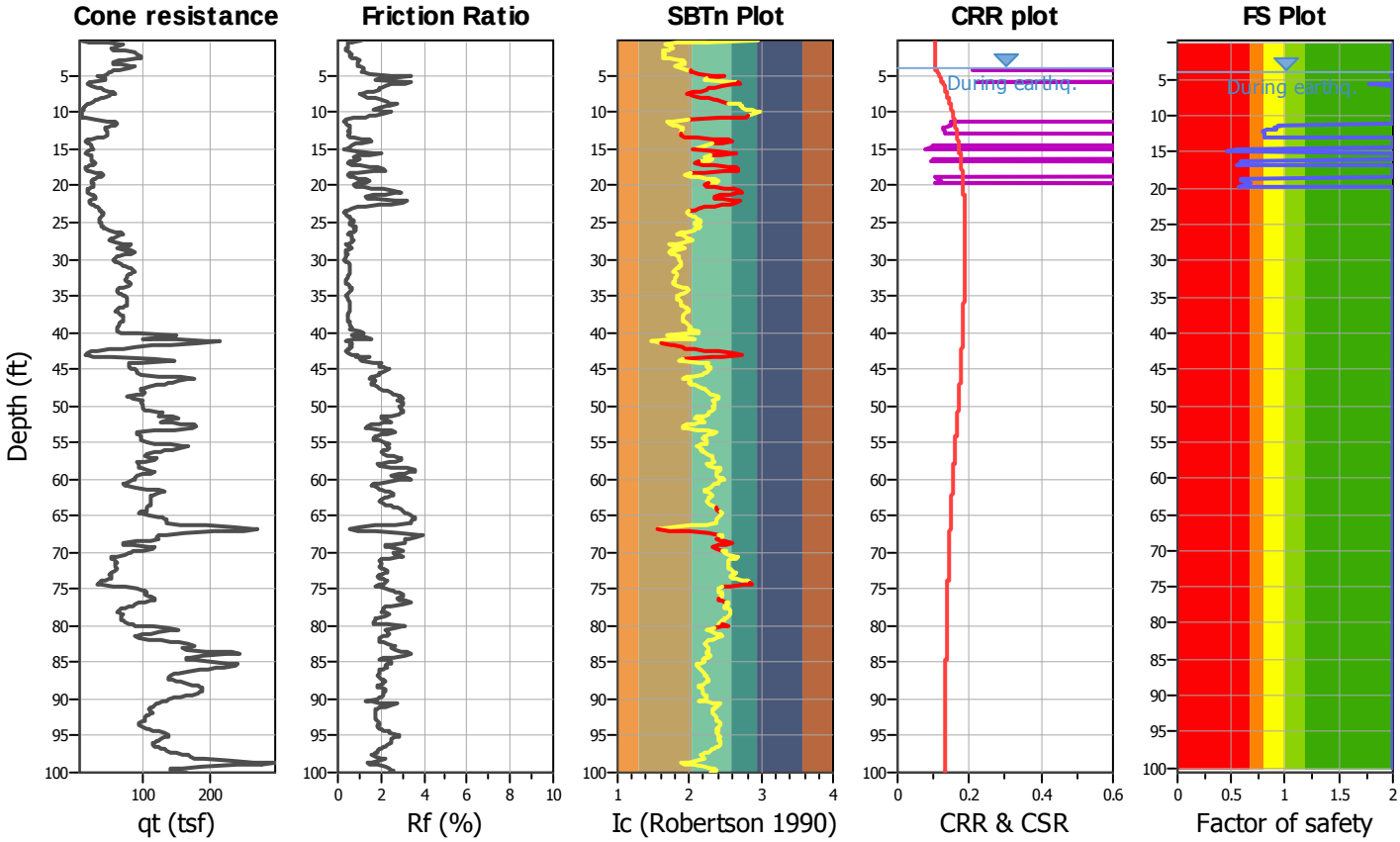
# LIQUEFACTION ANALYSIS REPORT

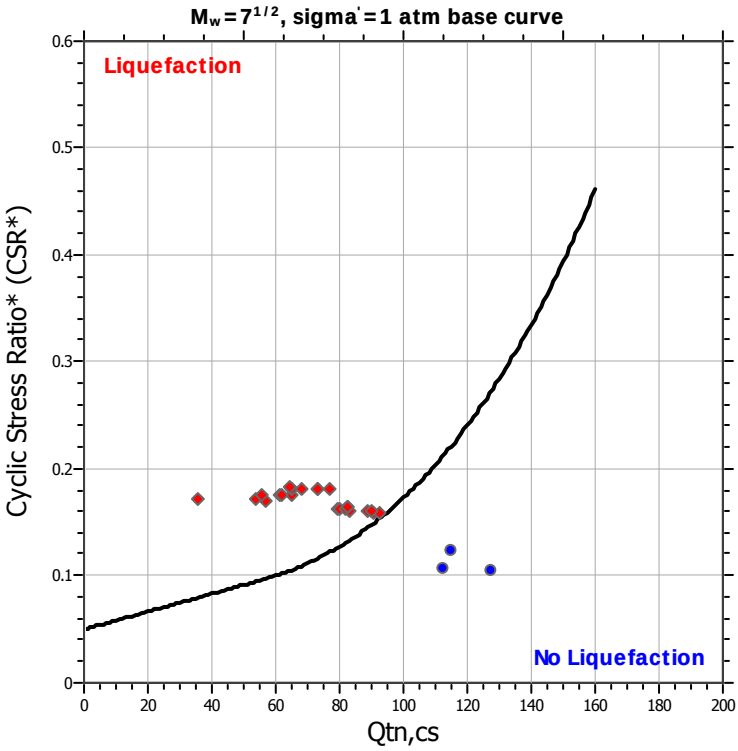
**Project title : 5th Street Bridge** **Location : Yuba City**

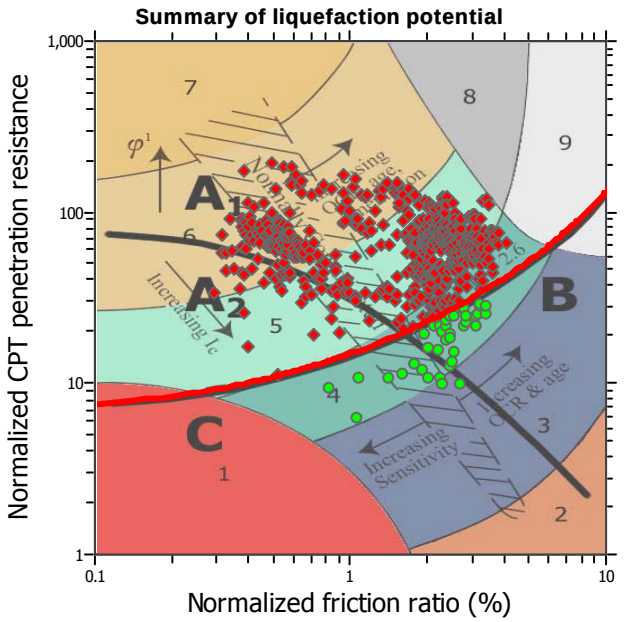
**CPT file : 066DE-CPT-04**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 3.94 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 3.94 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 22.86 ft |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.23 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

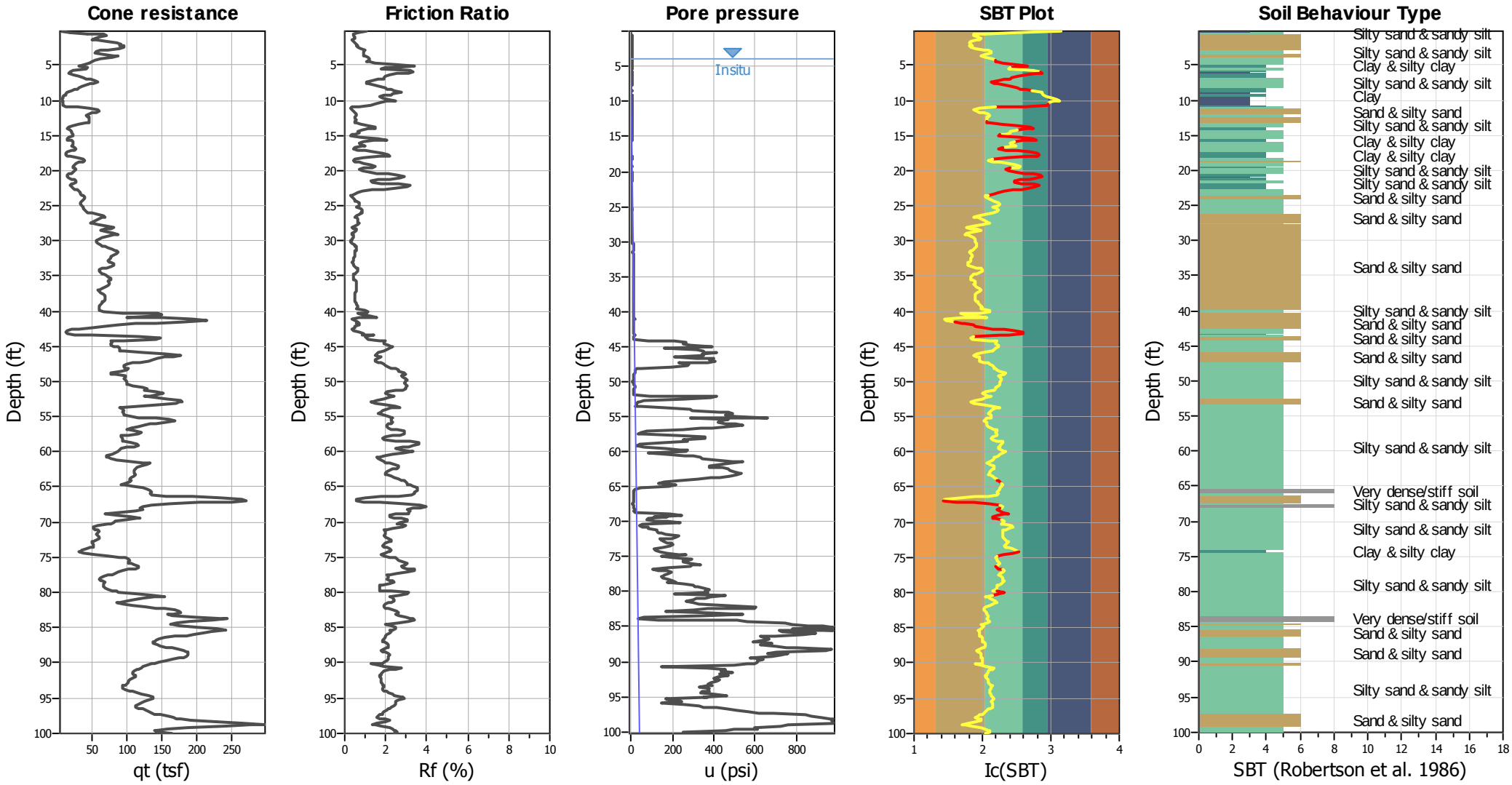



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots



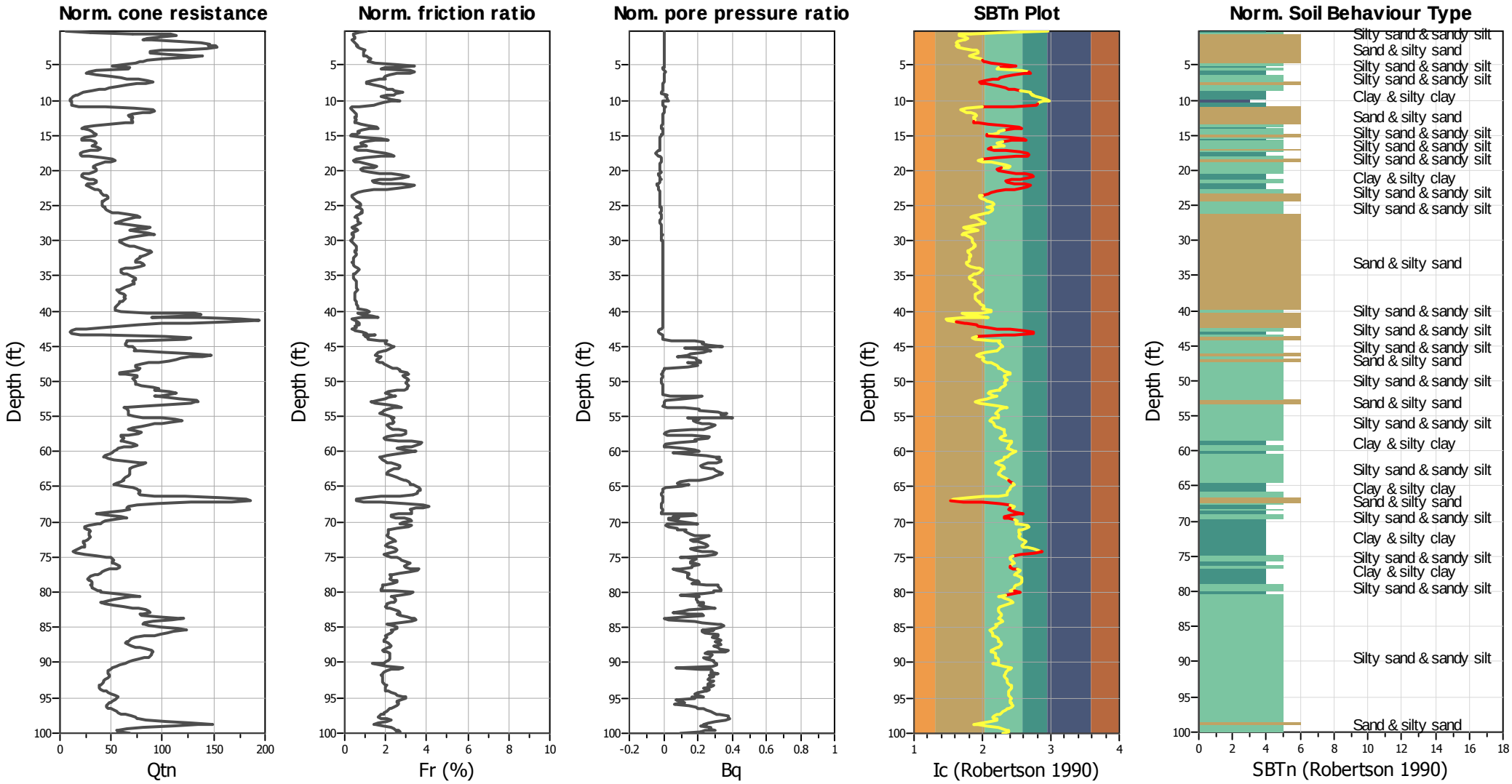

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.94 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.94 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## CPT basic interpretation plots (normalized)



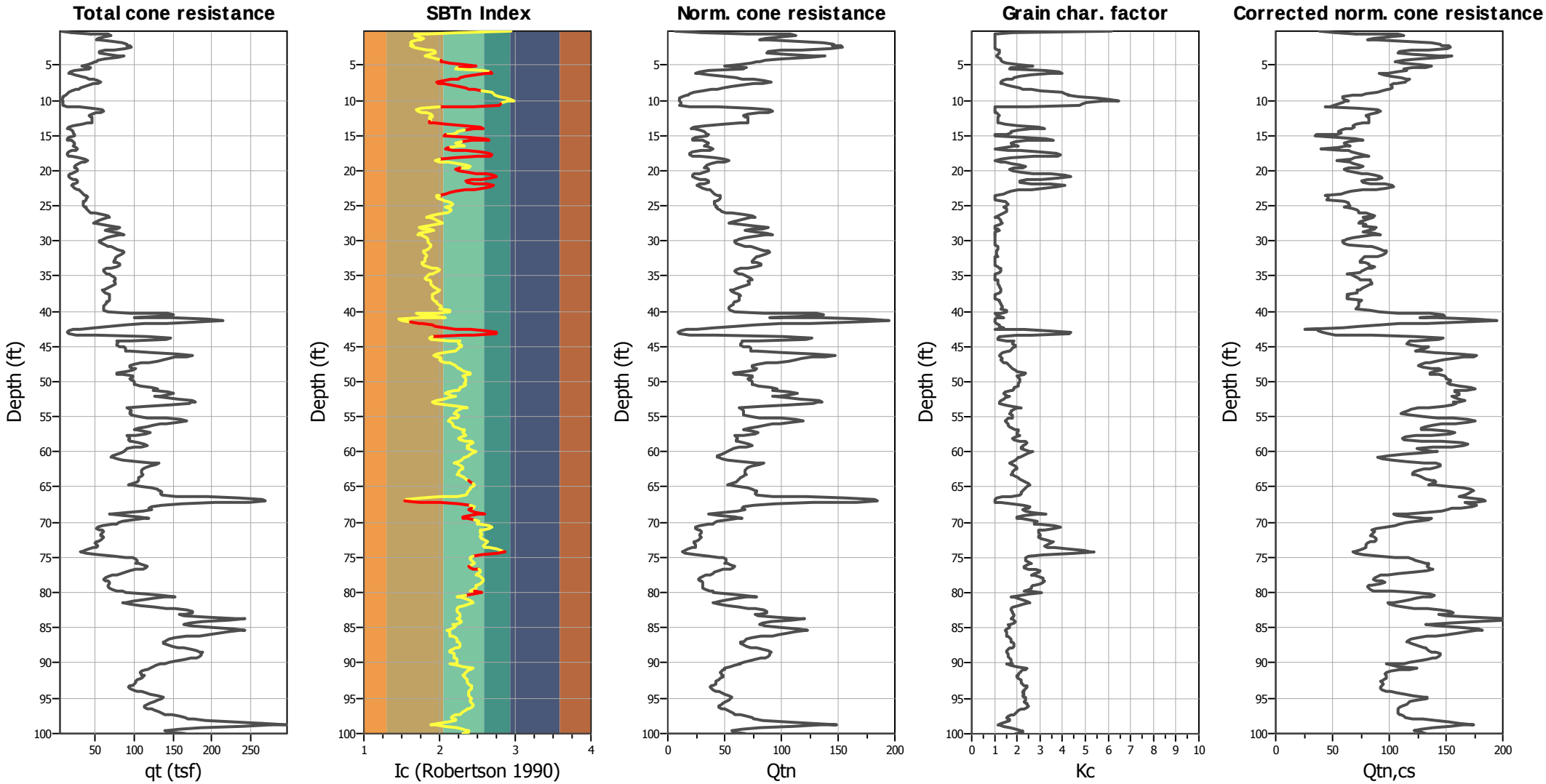

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.94 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.94 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

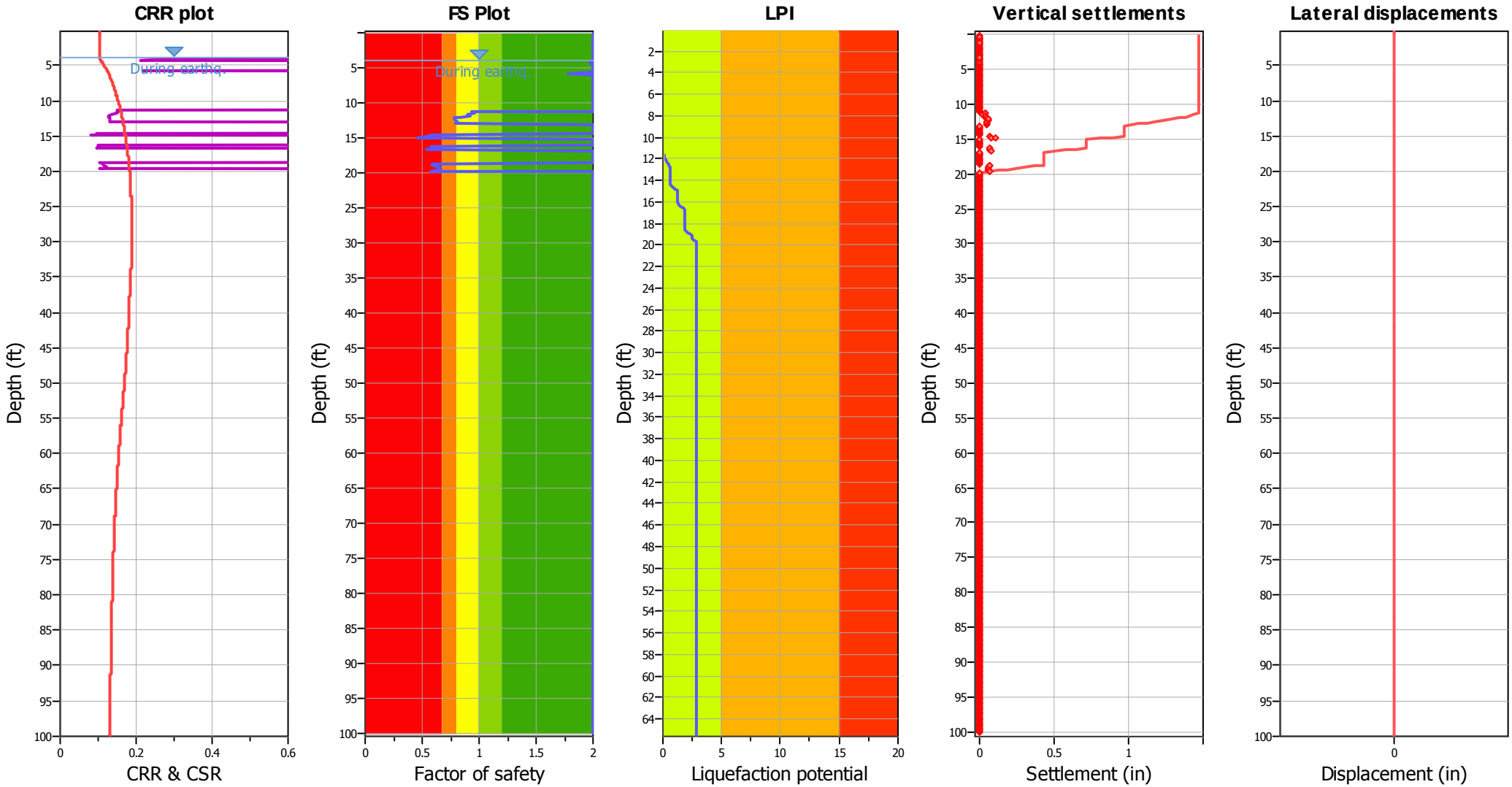
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.94 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.94 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.94 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.94 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

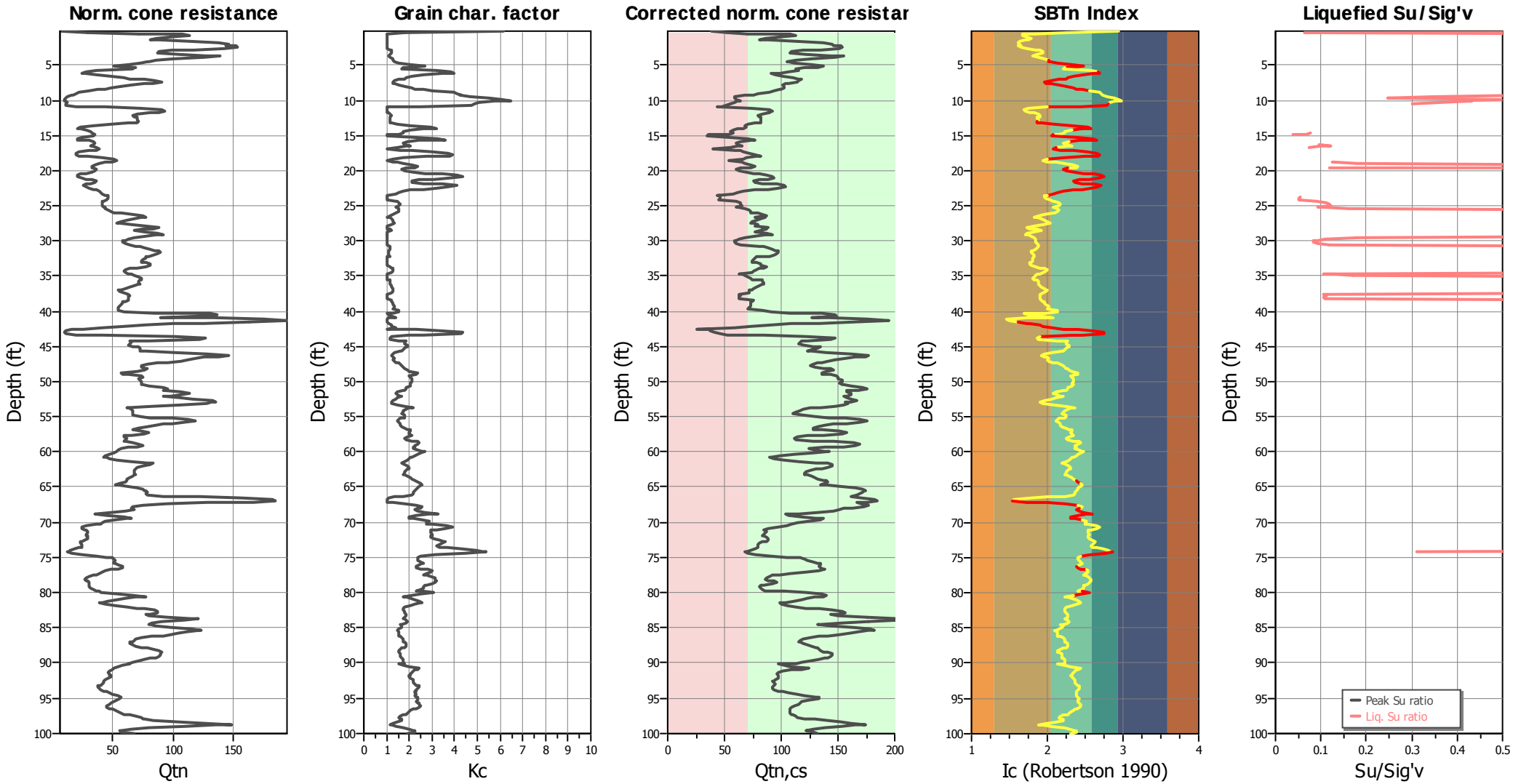
**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

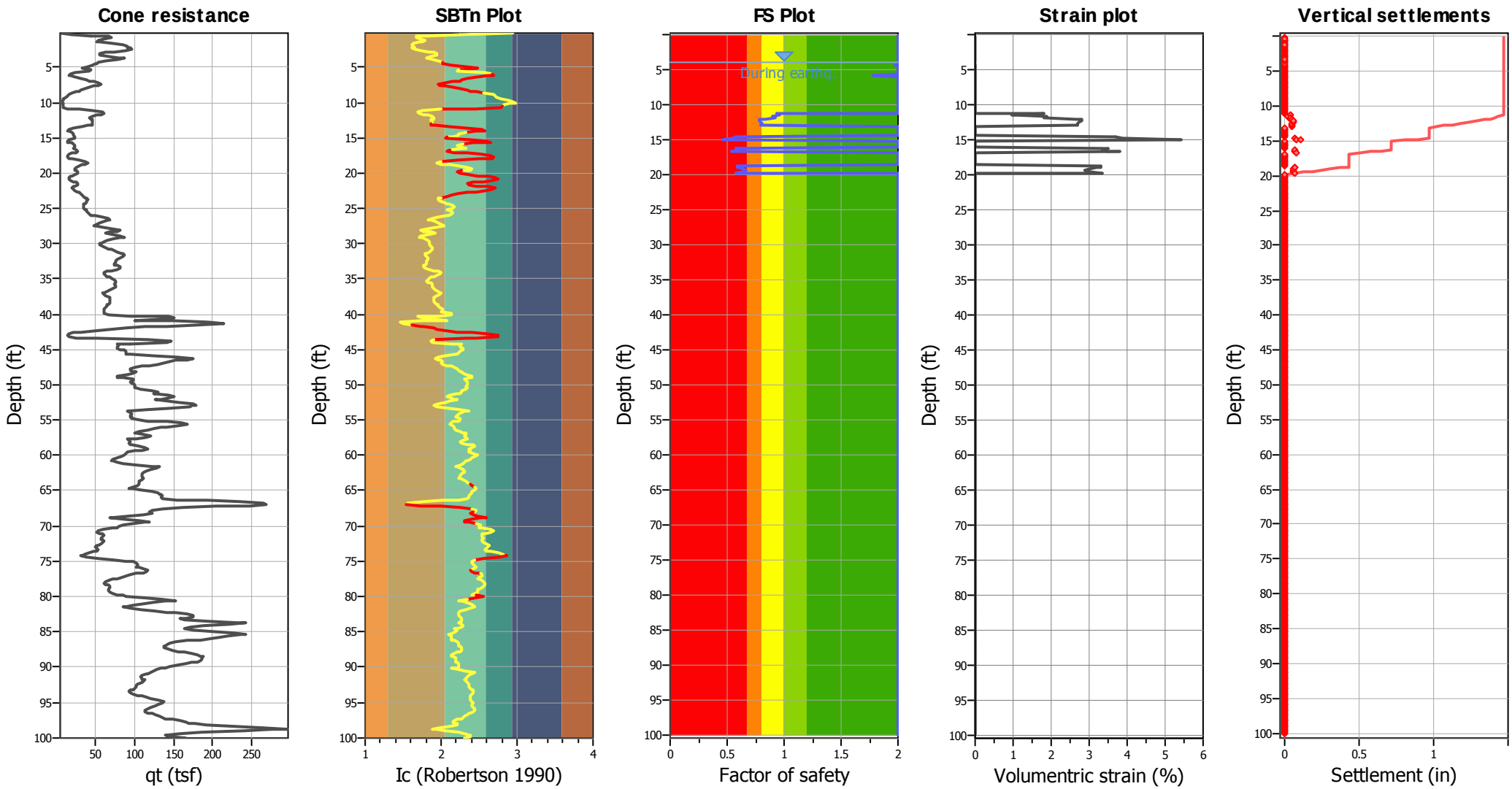
## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.94 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.94 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

## Estimation of post-earthquake settlements




**Abbreviations**

| | |
|---|---|
| $q_t$: | Total cone resistance (cone resistance $q_c$ corrected for pore water effects) |
| $I_c$: | Soil Behaviour Type Index |
| FS: | Calculated Factor of Safety against liquefaction |
| Volumentric strain: | Post-liquefaction volumentric strain |

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Fountain Valley, CA 92708

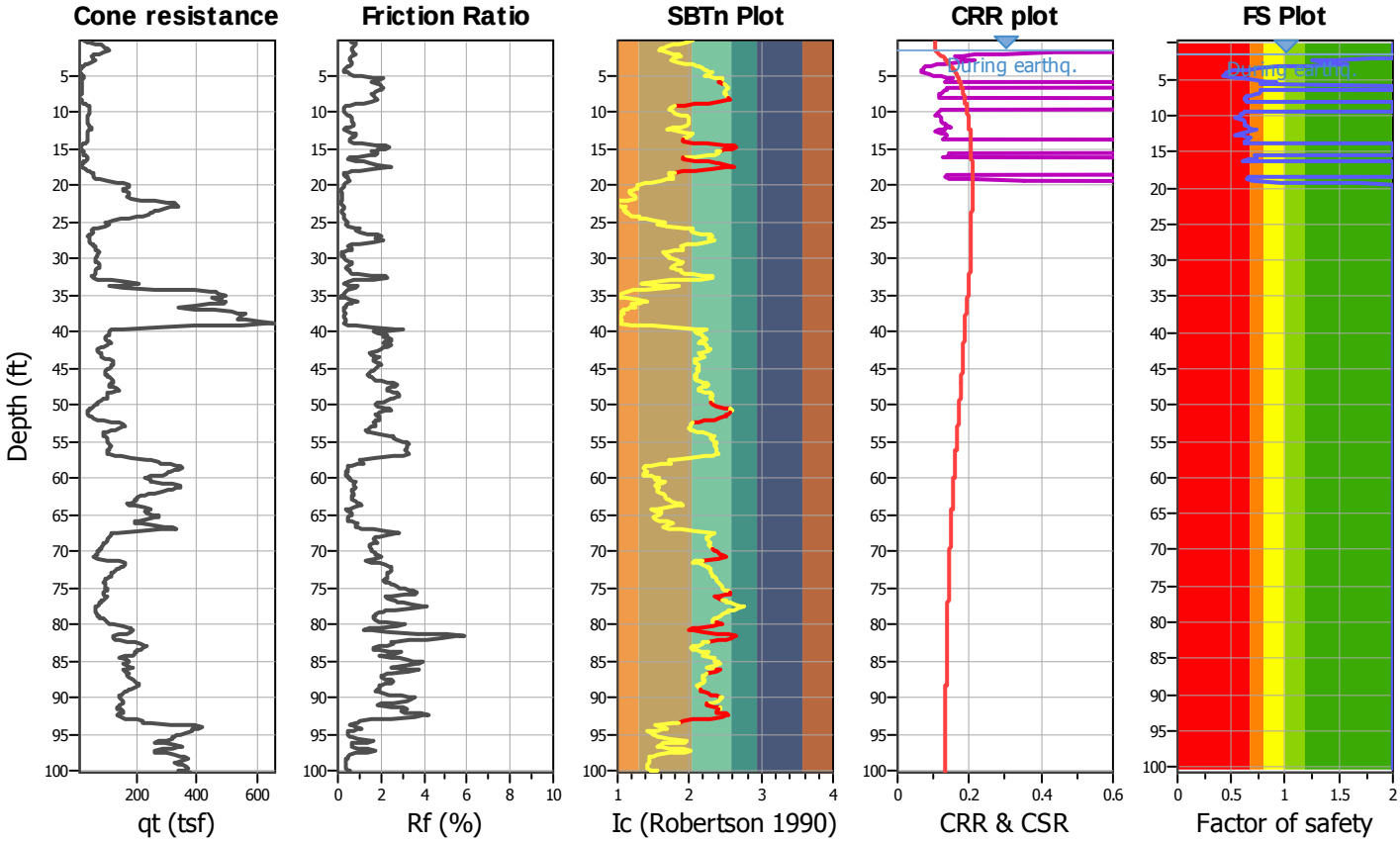
# LIQUEFACTION ANALYSIS REPORT

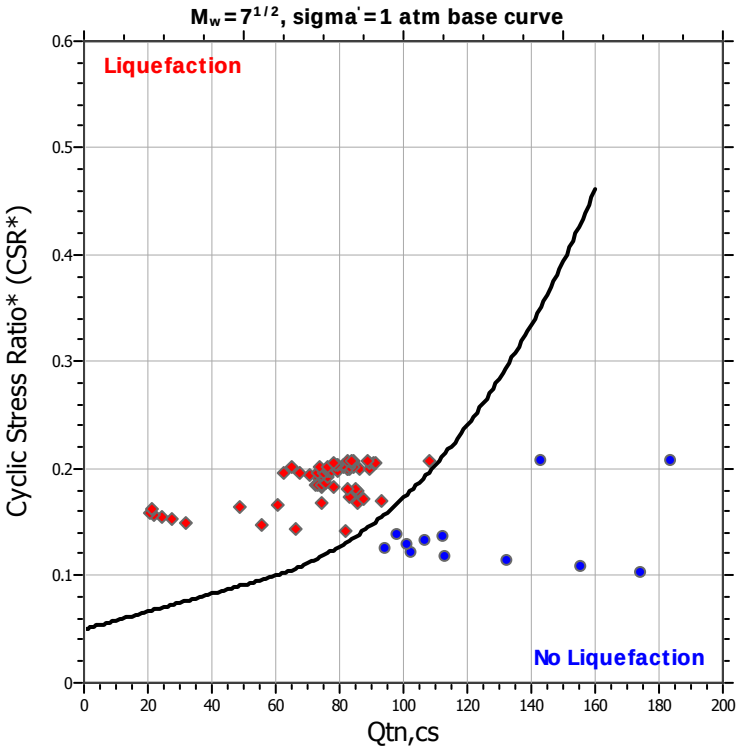
**Project title : 5th Street Bridge** **Location : Yuba City**

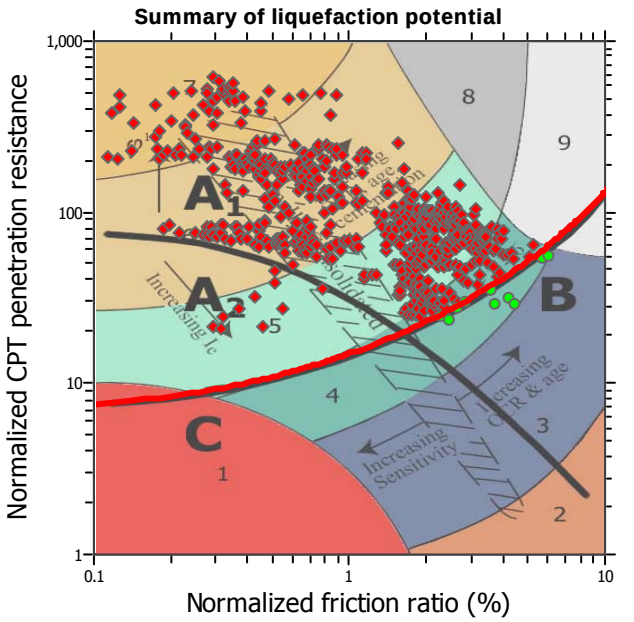
**CPT file : 066DE-CPT-05**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 1.64 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 1.64 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 22.86 ft |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.23 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

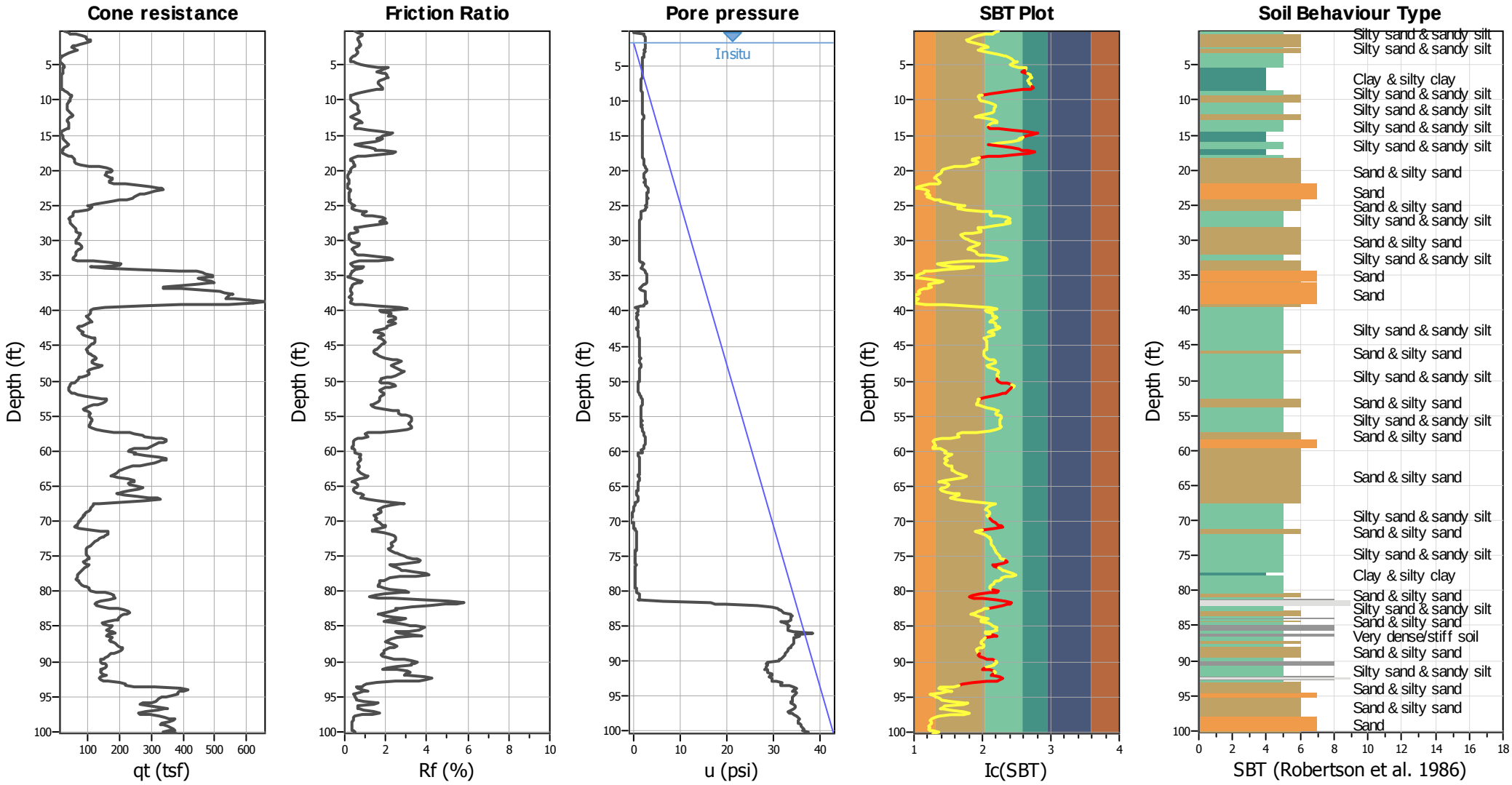



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots



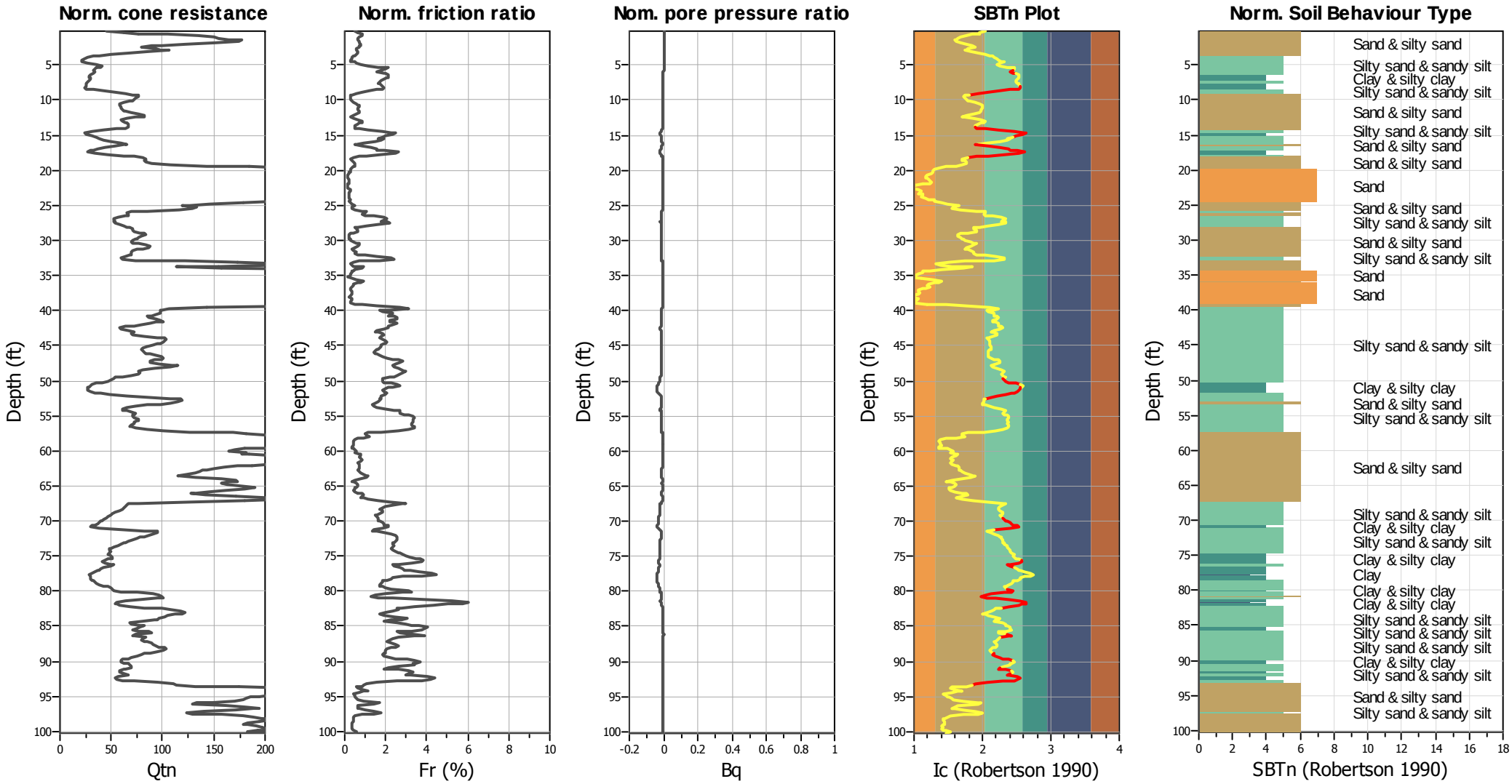

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.64 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 1.64 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBT legend**

| | | |
|---|---|---|
| 1. Sensitive fine grained | 4. Clayey silt to silty | 7. Gravely sand to sand |
| 2. Organic material | 5. Silty sand to sandy silt | 8. Very stiff sand to |
| 3. Clay to silty clay | 6. Clean sand to silty sand | 9. Very stiff fine grained |

## CPT basic interpretation plots (normalized)



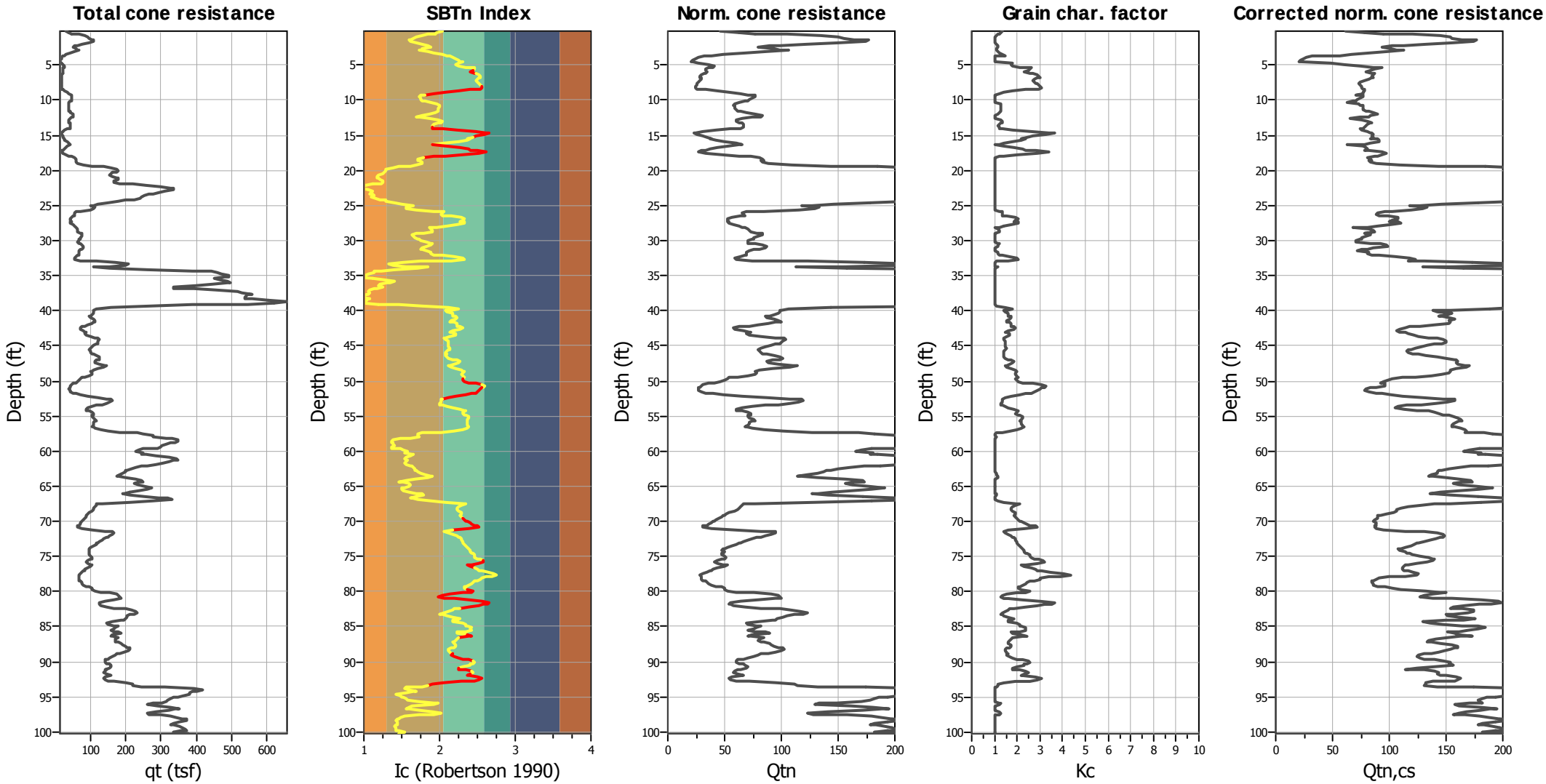

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.64 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 1.64 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

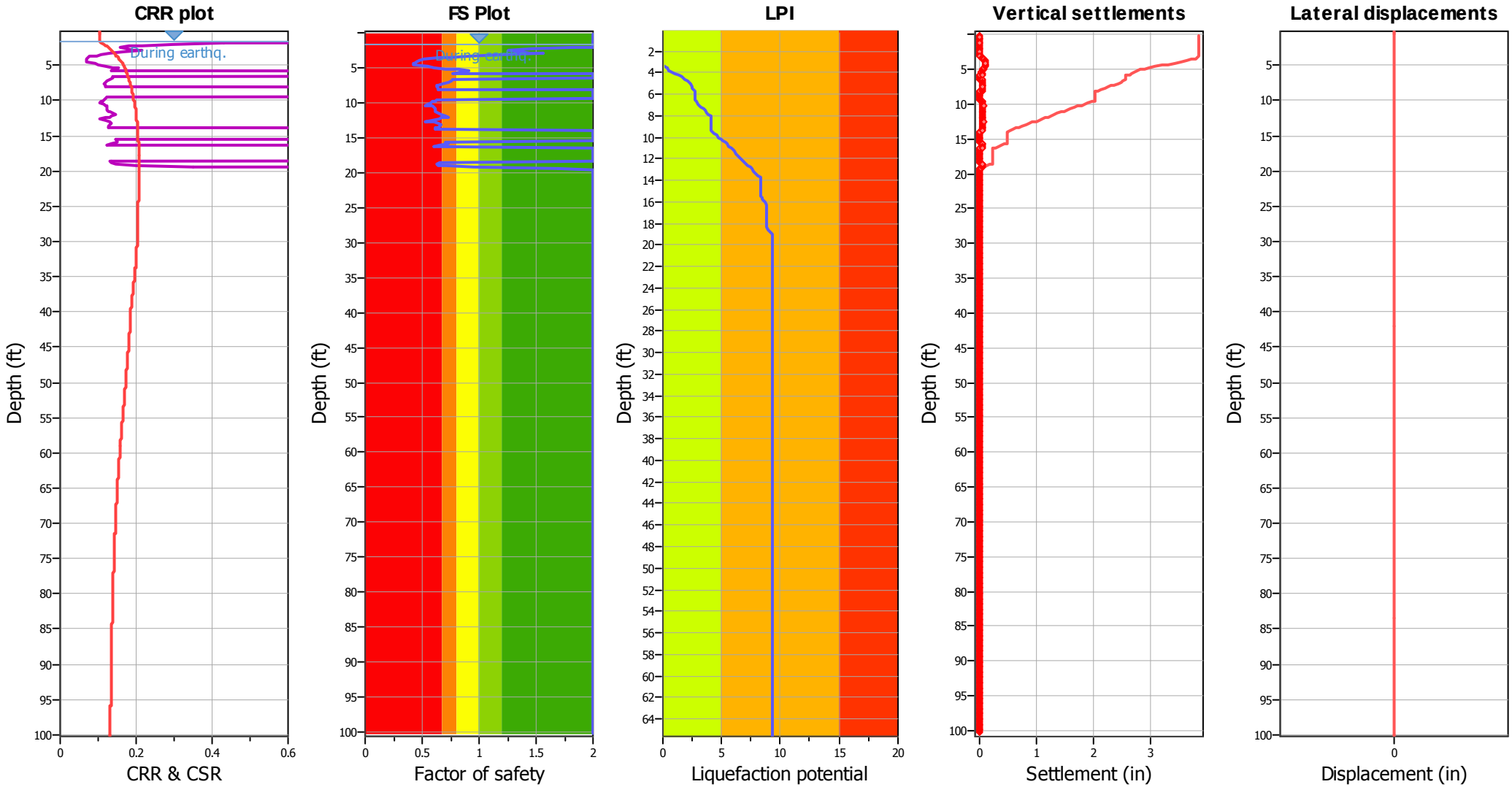
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.64 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 1.64 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

# Liquefaction analysis overall plots




**Input parameters and analysis data**

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.64 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 1.64 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

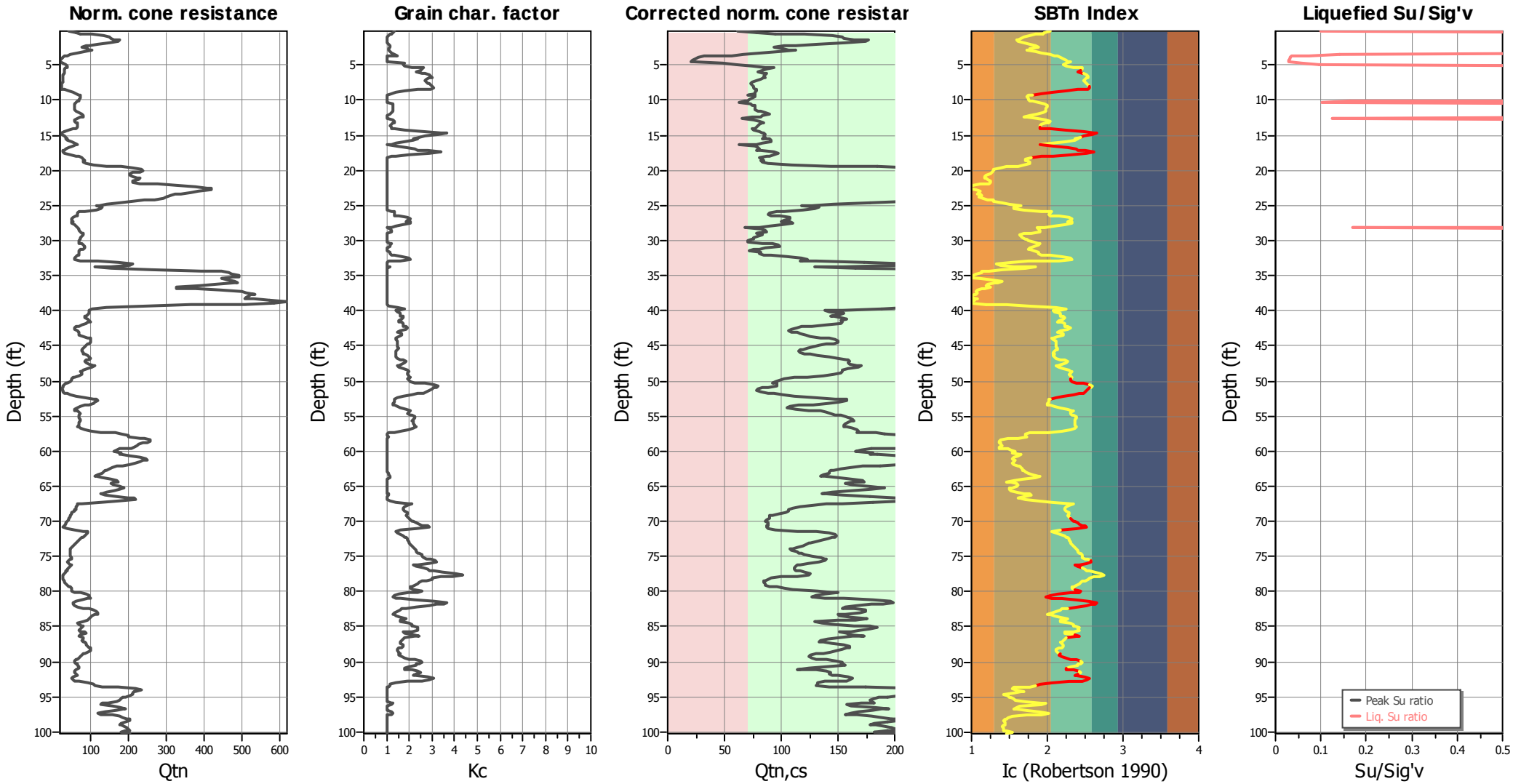
**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

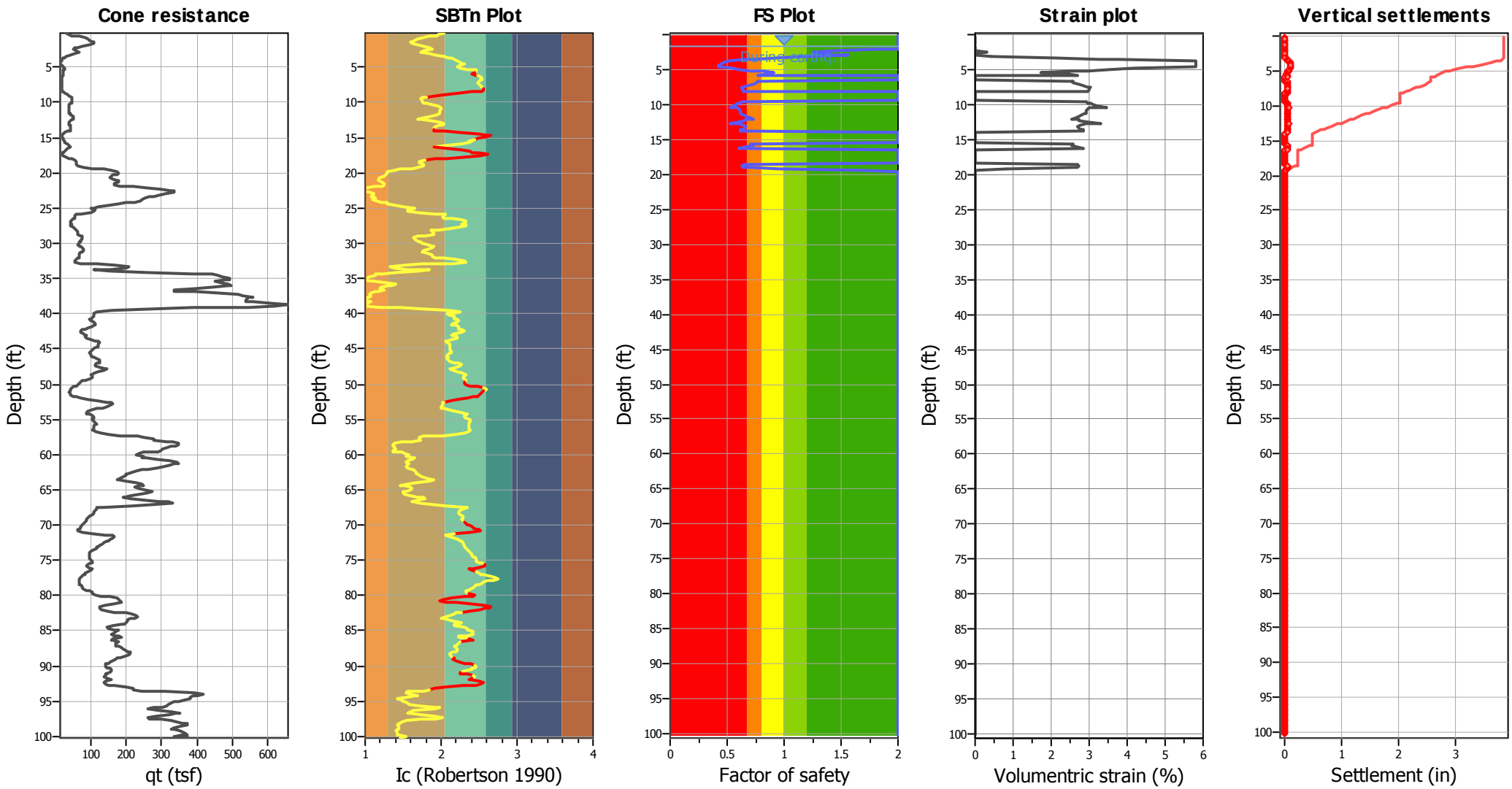
## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.64 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 1.64 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

## Estimation of post-earthquake settlements




**Abbreviations**

| | |
|---|---|
| $q_t$: | Total cone resistance (cone resistance $q_c$ corrected for pore water effects) |
| $I_c$: | Soil Behaviour Type Index |
| FS: | Calculated Factor of Safety against liquefaction |
| Volumentric strain: | Post-liquefaction volumentric strain |

**Earth Mechanics, Inc.**
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Fountain Valley, CA 92708

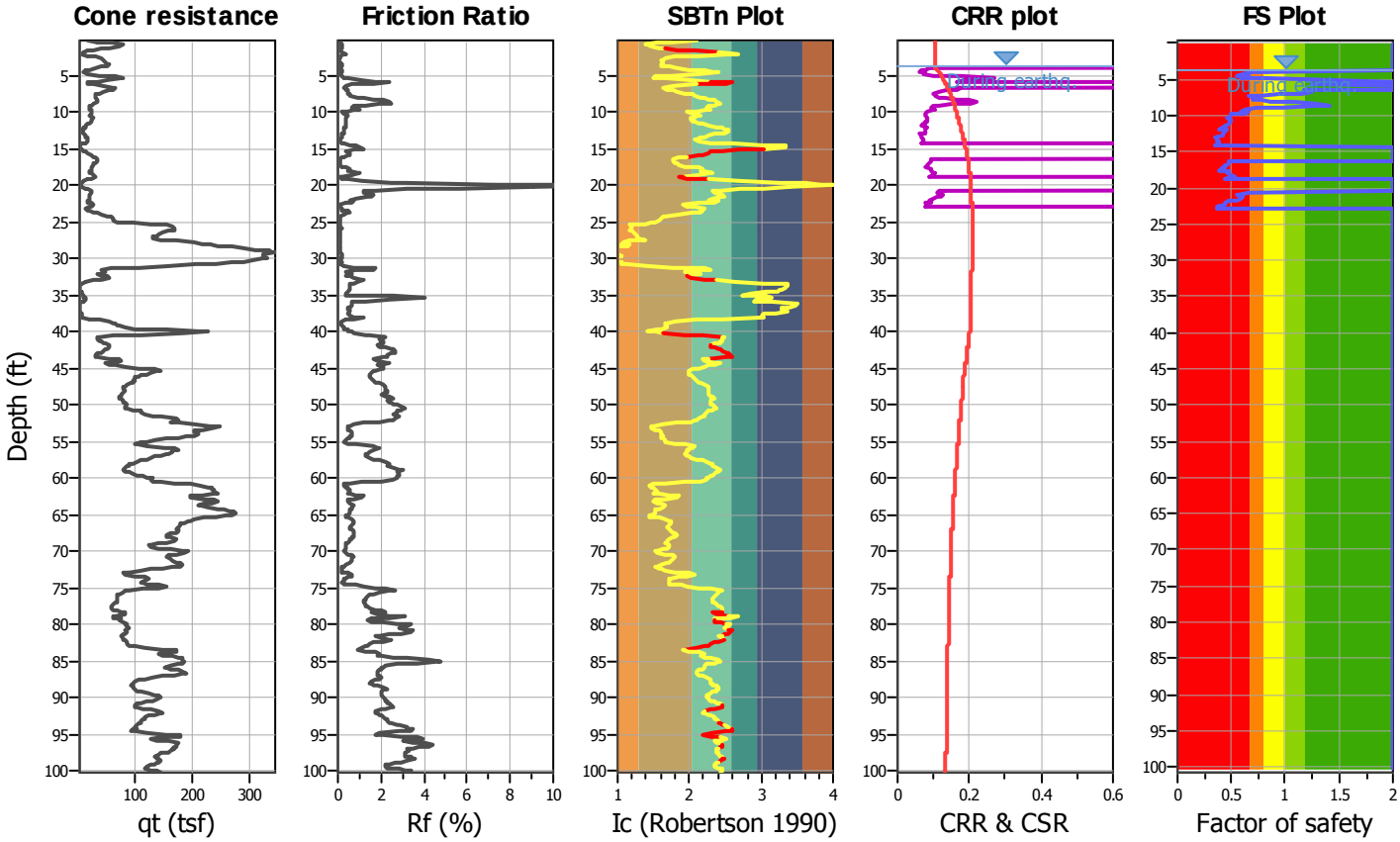
# LIQUEFACTION ANALYSIS REPORT

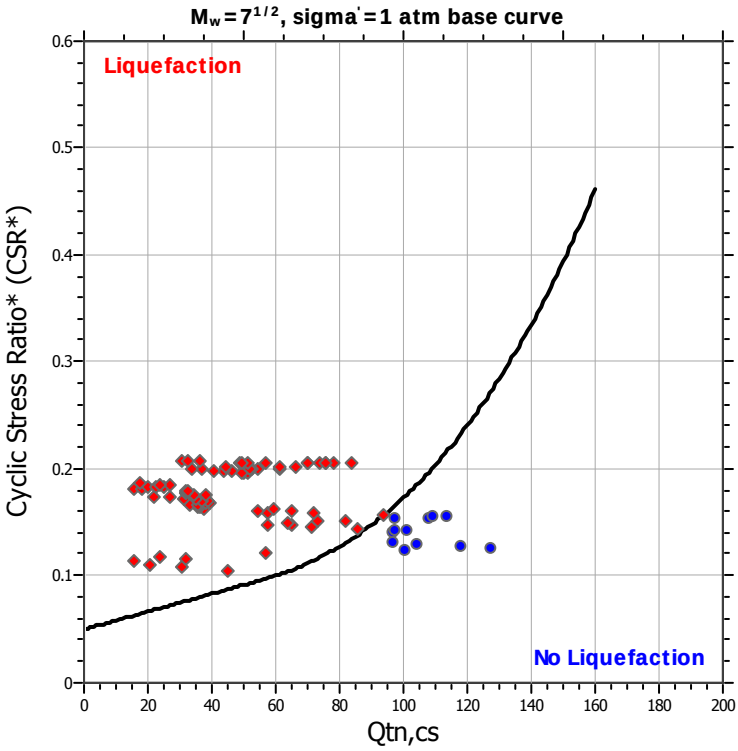
**Project title : 5th Street Bridge** **Location : Yuba City**

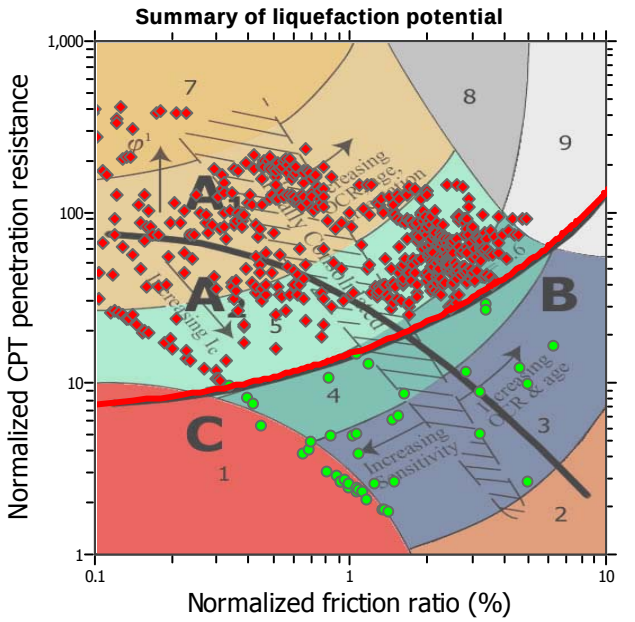
**CPT file : 066DE-CPT-06**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 3.81 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 3.81 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 22.86 ft |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.23 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

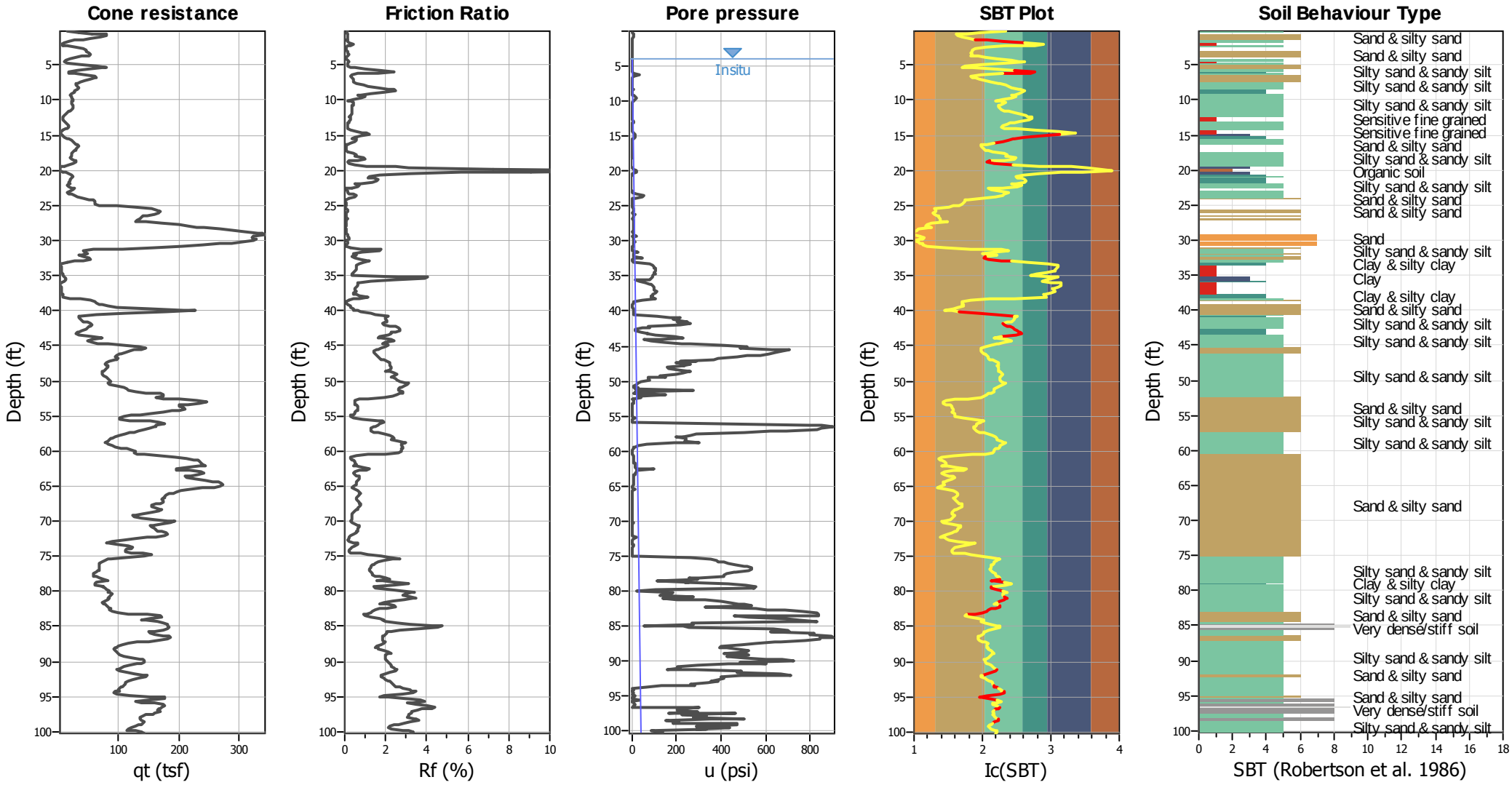



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots



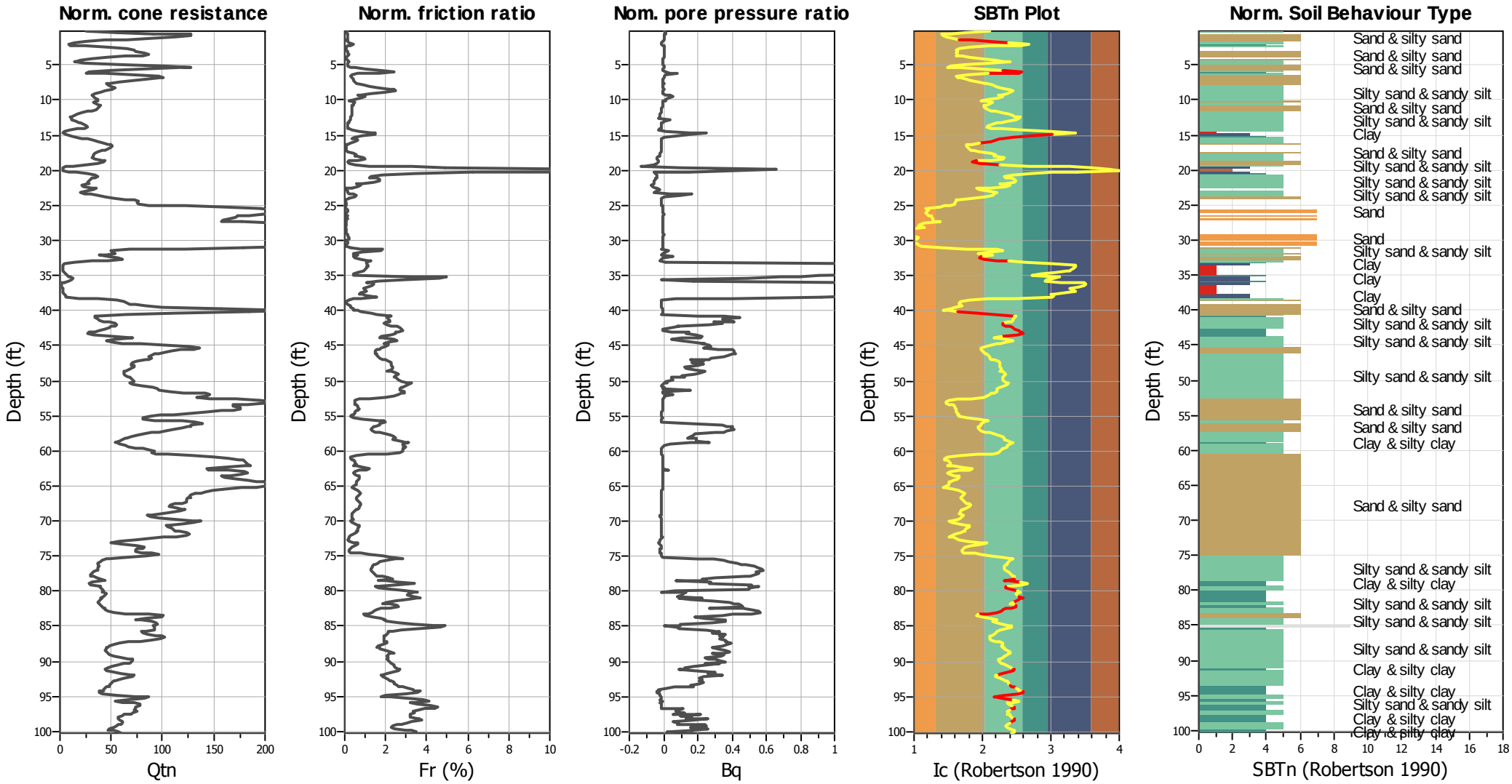

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.81 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.81 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## CPT basic interpretation plots (normalized)



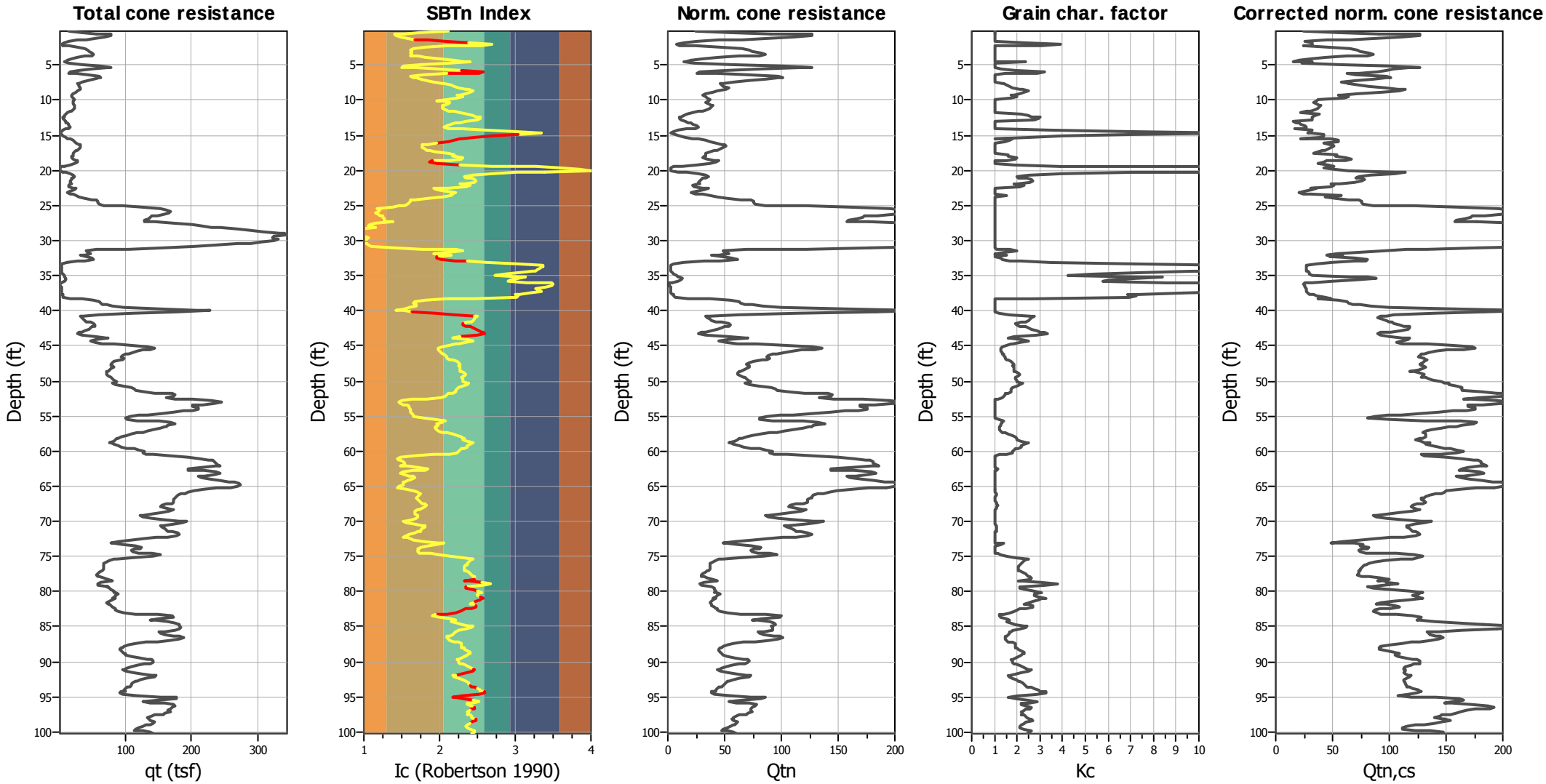

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.81 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.81 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

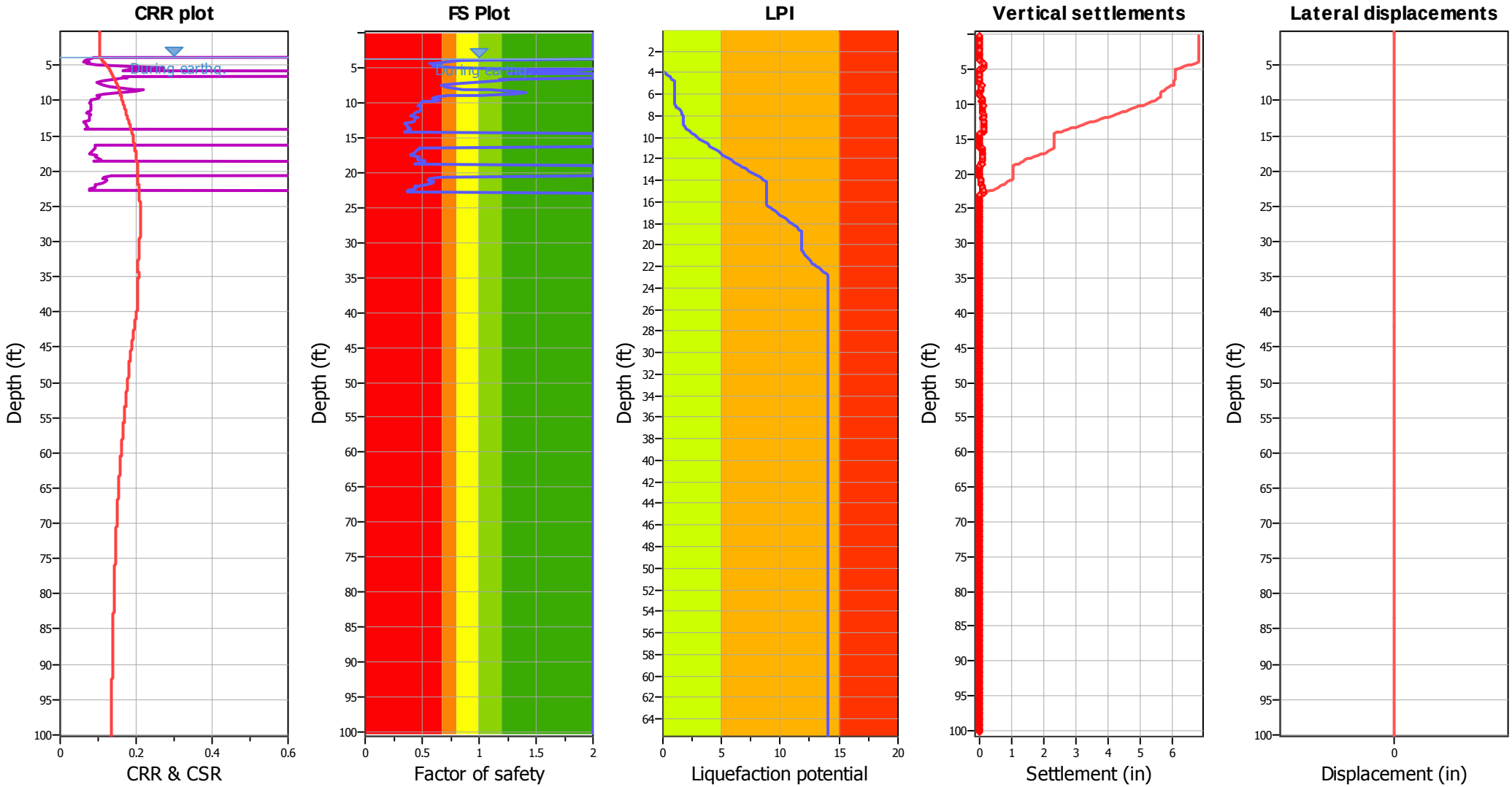
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.81 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.81 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.81 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.81 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

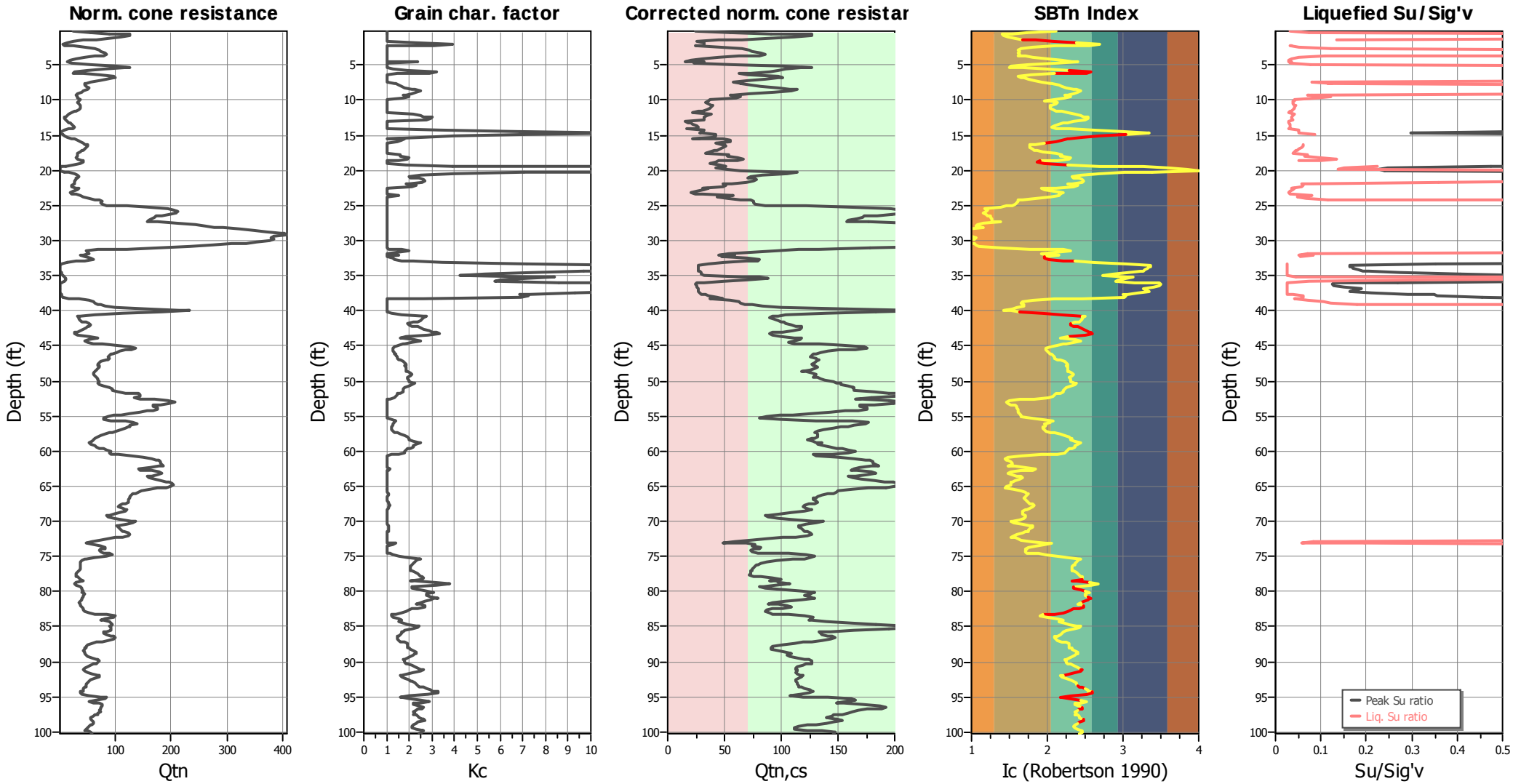
**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

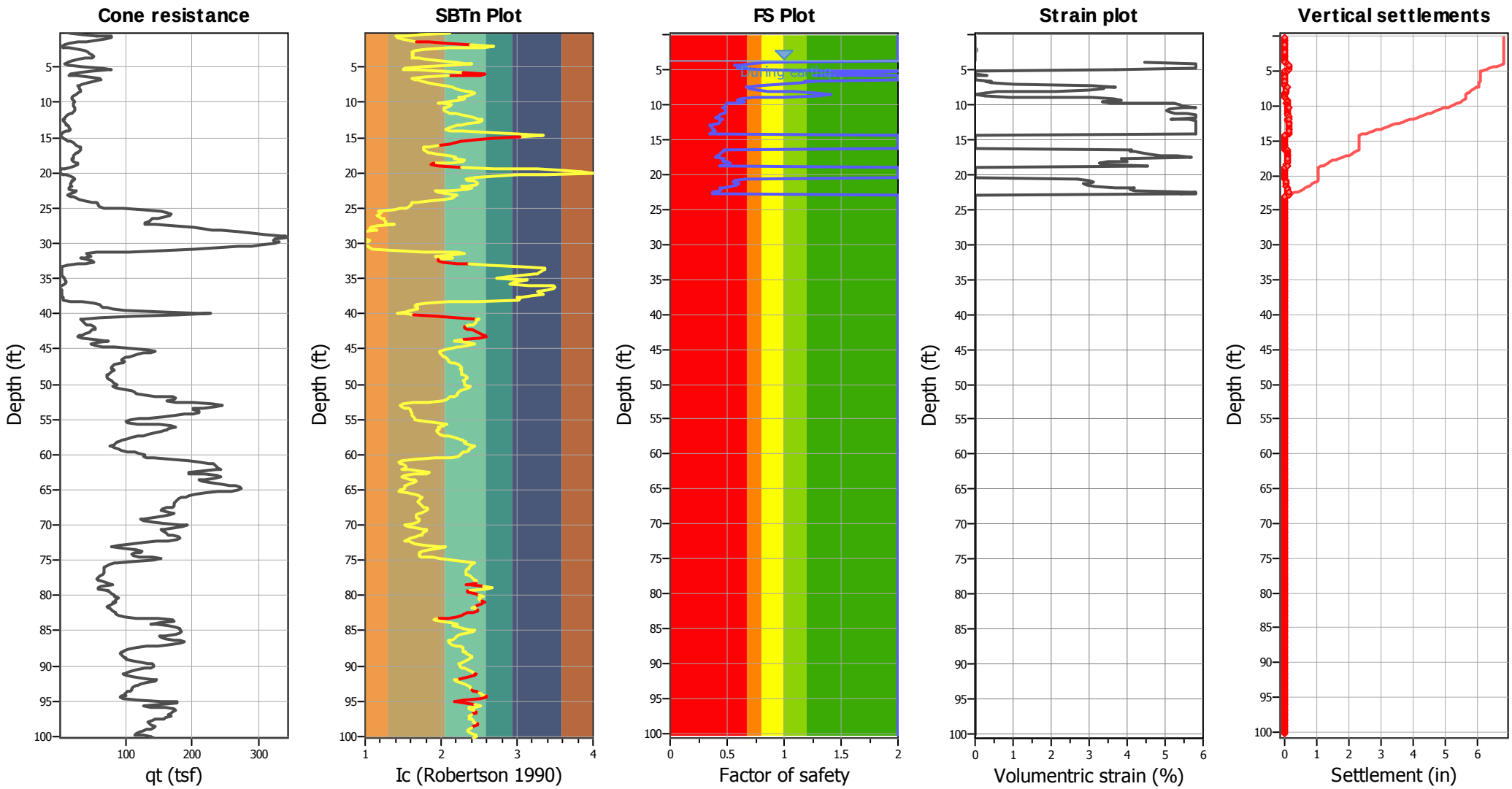
## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

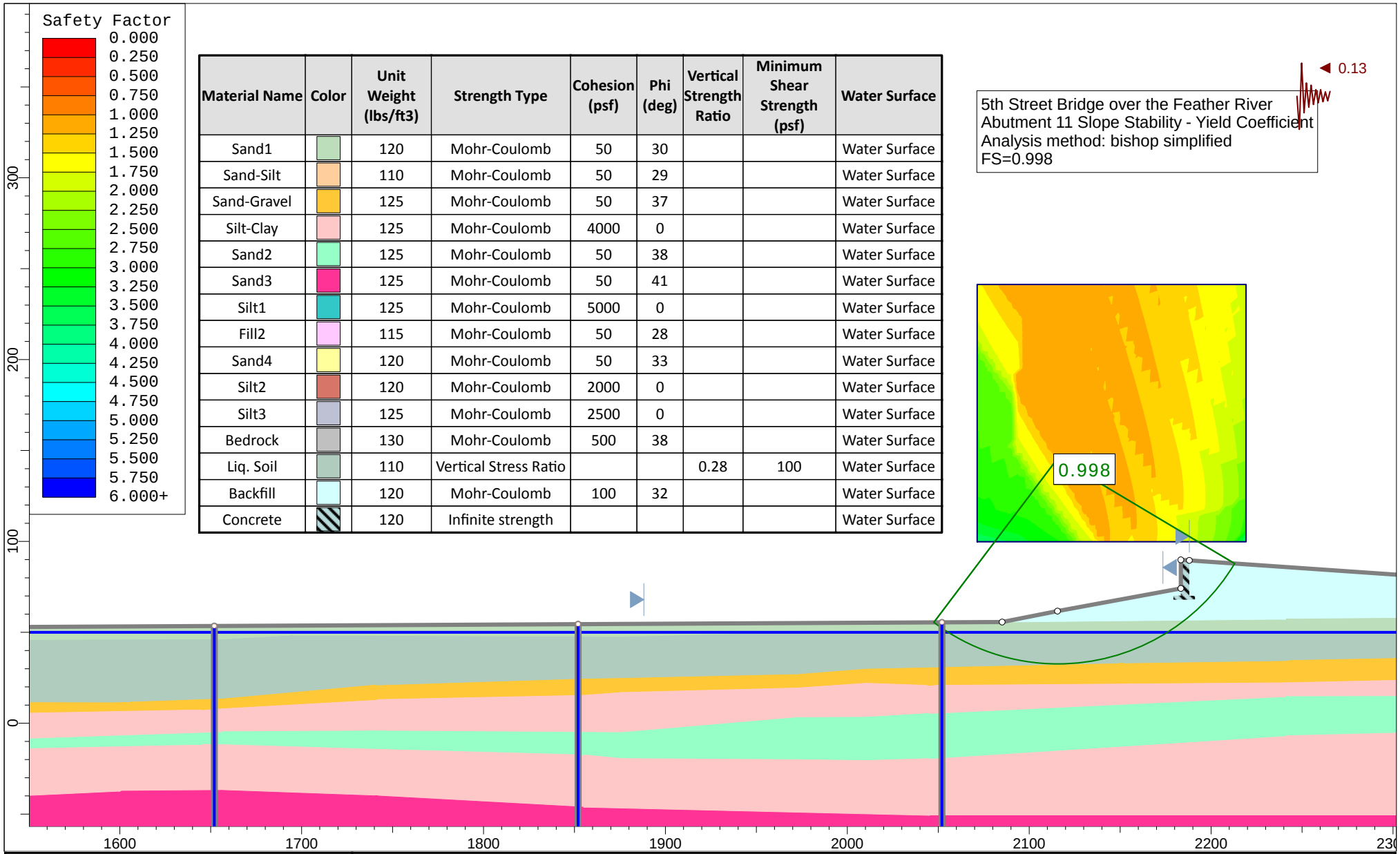
| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 3.81 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.23 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 3.81 ft | Fill height: | N/A | Limit depth: | 22.86 ft |

## Estimation of post-earthquake settlements




**Abbreviations**

| | |
|---|---|
| $q_t$: | Total cone resistance (cone resistance $q_c$ corrected for pore water effects) |
| $I_c$: | Soil Behaviour Type Index |
| FS: | Calculated Factor of Safety against liquefaction |
| Volumentric strain: | Post-liquefaction volumentric strain |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Vertical Strength Ratio | Minimum Shear Strength (psf) | Water Surface |
|---|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | | | Water Surface |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | | | Water Surface |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | | | Water Surface |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | | | Water Surface |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | | | Water Surface |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | | | Water Surface |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | | | Water Surface |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | | | Water Surface |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | | | Water Surface |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | | | Water Surface |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | | | Water Surface |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | | | Water Surface |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | 0.28 | 100 | Water Surface |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | | | Water Surface |
| Concrete | | 120 | Infinite strength | | | | | Water Surface |

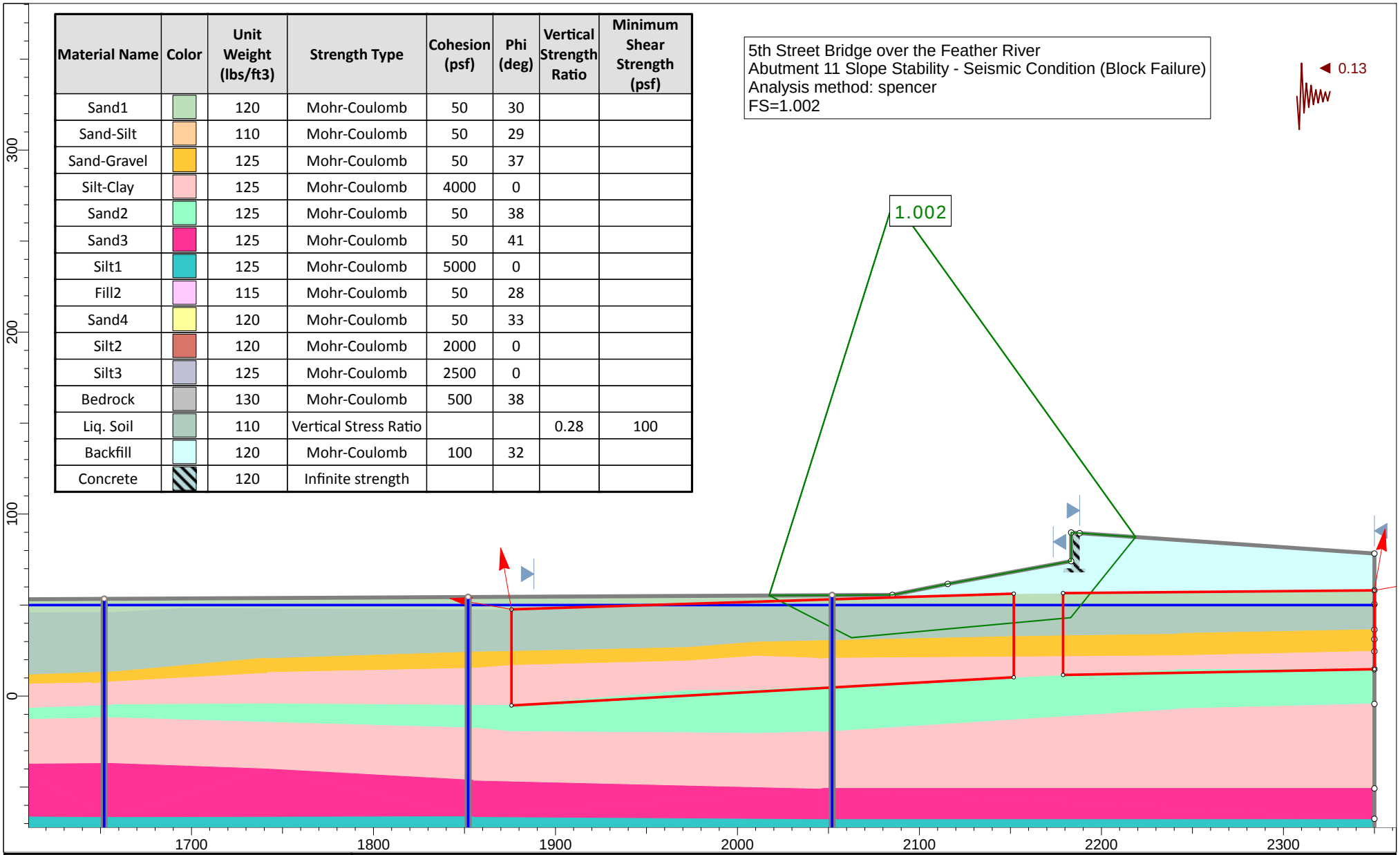
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | | | |
|---|---|---|---|
| Project | 5th Street Bridge over the Feather River | | |
| Analysis Description | Abutment 11 Slope Stability - Yield Coefficient | | |
| Drawn By | AZ | Scale 1:875 | Company |
| Date | | | File Name Abut 11 Yield Coeff circular.slim |

SLIDEINTERPRET 7.017

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Vertical Strength Ratio | Minimum Shear Strength (psf) |
|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | | |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | | |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | | |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | | |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | | |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | | |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | | |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | | |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | | |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | | |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | | |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | | |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | 0.28 | 100 |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | | |
| Concrete | | 120 | Infinite strength | | | | |

5th Street Bridge over the Feather River
Abutment 11 Slope Stability - Seismic Condition (Block Failure)
Analysis method: spencer
FS=1.002




Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | |
|---|---|
| Project | 5th Street Bridge over the Feather River |
| Analysis Description | Abutment 11 Slope Stability - Seismic Condition (Block Failure) |
| Drawn By | AZ |
| Scale | 1:875 |
| Company | |
| Date | |
| File Name | Abut 11 Yiled Acceleration Block.slim |

SLIDEINTERPRET 7.017

# Pile Axial and Settlement Design

# APILE Axial Analysis – 2nd Street OC, Abutments 1&2, Class 200

C:\Users\t.ke\Documents\13-121 - Dokken, 5th Street Bridge PSR PR\DFR\Analysis\20160322AP_abuts\PC200_2ndAb1.cpt

1

AXIALLY LOADING PILE ANALYSIS PROGRAM - APILEplus
VERSION 5.0 - (C) COPYRIGHT ENSOFT,INC.,1987-2008.

2nd Street OC, Abut1_2, NL, Class 200, 400kip

DESIGNER : EMI

DATE : 20160322

PILE PROPERTIES :

PERIMETER OF PILE WITH NONCIRCULAR SECTION= 54.40 IN.
TIP AREA OF PILE WITH NONCIRCULAR SECTION = 1.35 SQF
OUTSIDE DIAMETER OF CIRCULAR PILE = 0.00 IN.
INTERNAL DIAMETER OF CIRCULAR PILE = 0.00 IN.
PILE LENGTH = 100.00 FT.
MODULUS OF ELASTICITY = 0.477E+07 PSI

LENGTH OF SURFACE SECTION WITH ZERO SKIN FRICTION = 3.00 FT.
INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

| DEPTH FT. | SOIL TYPE | LATERAL EARTH PRESSURE | EFFECTIVE UNIT WEIGHT LB/CF | FRICTION ANGLE DEGREES | BEARING CAPACITY FACTOR |
|---|---|---|---|---|---|
| 0.00 | SAND | 0.52 | 110.00 | 29.00 | 14.00 |
| 10.00 | SAND | 0.52 | 110.00 | 29.00 | 14.00 |
| 10.00 | SAND | 0.52 | 47.60 | 29.00 | 14.00 |
| 15.00 | SAND | 0.52 | 47.60 | 29.00 | 14.00 |
| 15.00 | SAND | 0.46 | 57.60 | 33.00 | 32.00 |
| 25.00 | SAND | 0.46 | 57.60 | 33.00 | 32.00 |
| 25.00 | CLAY | 0.00 | 62.60 | 0.00 | 0.00 |
| 50.00 | CLAY | 0.00 | 62.60 | 0.00 | 0.00 |
| 50.00 | SAND | 0.44 | 62.60 | 34.00 | 40.00 |
| 85.00 | SAND | 0.44 | 62.60 | 34.00 | 40.00 |
| 85.00 | CLAY | 0.00 | 62.60 | 0.00 | 0.00 |
| 125.00 | CLAY | 0.00 | 62.60 | 0.00 | 0.00 |

| MAXIMUM UNIT FRICTION KSF | MAXIMUM UNIT BEARING KSF | UNDISTURB SHEAR STRENGTH KSF | REMOLDED SHEAR STRENGTH KSF | BLOW COUNT | UNIT SKIN FRICTION KSF | UNIT END BEARING KSF |
|---|---|---|---|---|---|---|
| 9999.00 | 99999.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9999.00 | 99999.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 2.50 | 1.25 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 2.50 | 1.25 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 4.00 | 2.00 | 0.00 | 0.00 | 0.00 |
| 9999.00 | 99999.00 | 4.00 | 2.00 | 0.00 | 0.00 | 0.00 |

1

**********
* COMPUTATION RESULT *
**********

| | ********** | ********** | ********** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | * FED. HWY. METHOD * | | | * ARMY CORPS METHOD * | | | * LAMBDA 2 METHOD * | | |
| | ********** | ********** | ********** | | | | | | |
| PILE PENETR-ATION | TOTAL SKIN FRIC | END BEARING | ULTIM CAPAC-ITY | TOTAL SKIN FRIC | END BEARING | ULTIM CAPAC-ITY | TOTAL SKIN FRIC | END BEARING | ULTIM CAPAC-ITY |
| FT. | KIP | KIP | KIP | KIP | KIP | KIP | KIP | KIP | KIP |
| 0.0 | 0.0 | 3.2 | 3.2 | 0.0 | 4.6 | 4.6 | 0.0 | 3.0 | 3.0 |
| 1.0 | 0.0 | 5.4 | 5.4 | 0.0 | 7.8 | 7.8 | 0.0 | 5.1 | 5.1 |
| 2.0 | 0.0 | 7.6 | 7.6 | 0.0 | 11.0 | 11.0 | 0.0 | 7.2 | 7.2 |
| 3.0 | 0.3 | 9.7 | 10.1 | 0.2 | 14.2 | 14.4 | 0.0 | 9.3 | 9.3 |
| 4.0 | 1.2 | 11.9 | 13.1 | 0.7 | 17.4 | 18.1 | 1.2 | 11.4 | 12.5 |
| 5.0 | 2.2 | 14.1 | 16.3 | 1.3 | 20.6 | 21.9 | 1.8 | 13.4 | 15.3 |
| 6.0 | 3.5 | 16.1 | 19.6 | 2.0 | 23.8 | 25.8 | 2.6 | 15.5 | 18.1 |
| 7.0 | 5.0 | 17.4 | 22.4 | 2.9 | 27.0 | 29.9 | 3.5 | 17.6 | 21.1 |
| 8.0 | 6.7 | 18.0 | 24.6 | 3.9 | 29.9 | 33.8 | 4.5 | 19.5 | 24.0 |
| 9.0 | 8.6 | 18.0 | 26.7 | 5.1 | 32.2 | 37.3 | 5.5 | 21.0 | 26.6 |
| 10.0 | 10.8 | 18.0 | 28.9 | 6.4 | 33.9 | 40.3 | 6.6 | 22.2 | 28.8 |
| 11.0 | 13.2 | 18.0 | 31.2 | 7.7 | 35.3 | 43.1 | 7.8 | 23.1 | 30.9 |
| 12.0 | 15.6 | 18.0 | 33.7 | 9.2 | 36.7 | 45.9 | 9.0 | 24.0 | 33.0 |
| 13.0 | 18.2 | 29.8 | 48.0 | 10.7 | 46.7 | 57.3 | 10.2 | 35.1 | 45.3 |
| 14.0 | 20.8 | 43.8 | 64.6 | 12.2 | 58.2 | 70.4 | 11.5 | 48.1 | 59.5 |
| 15.0 | 23.6 | 58.6 | 82.2 | 14.0 | 69.9 | 83.9 | 12.7 | 61.6 | 74.3 |
| 16.0 | 27.3 | 61.0 | 88.3 | 15.8 | 71.3 | 87.1 | 14.0 | 64.1 | 78.0 |
| 17.0 | 31.9 | 63.4 | 95.3 | 17.6 | 71.8 | 89.4 | 15.3 | 66.6 | 81.8 |
| 18.0 | 36.7 | 65.5 | 102.3 | 19.3 | 71.8 | 91.2 | 16.6 | 69.1 | 85.7 |
| 19.0 | 41.7 | 67.0 | 108.7 | 21.1 | 71.8 | 92.9 | 17.9 | 71.6 | 89.5 |
| 20.0 | 46.9 | 67.6 | 114.5 | 22.9 | 71.8 | 94.7 | 19.3 | 74.1 | 93.4 |
| 21.0 | 52.3 | 67.7 | 120.0 | 24.6 | 71.8 | 96.5 | 20.7 | 76.6 | 97.2 |
| 22.0 | 57.9 | 67.7 | 125.6 | 26.4 | 71.8 | 98.2 | 22.3 | 79.1 | 101.4 |
| 23.0 | 63.6 | 56.3 | 119.9 | 28.2 | 59.1 | 87.3 | 24.1 | 65.1 | 89.2 |
| 24.0 | 69.6 | 43.4 | 112.9 | 30.0 | 44.8 | 74.8 | 26.0 | 48.2 | 74.2 |
| 25.0 | 75.7 | 30.5 | 106.2 | 31.9 | 30.5 | 62.4 | 27.9 | 30.5 | 58.4 |
| 26.0 | 81.6 | 30.5 | 112.1 | 35.9 | 30.5 | 66.3 | 32.3 | 30.5 | 62.8 |
| 27.0 | 88.4 | 30.5 | 118.9 | 41.5 | 30.5 | 72.0 | 36.8 | 30.5 | 67.2 |
| 28.0 | 96.4 | 30.5 | 126.9 | 47.2 | 30.5 | 77.7 | 41.2 | 30.5 | 71.7 |
| 29.0 | 104.3 | 30.5 | 134.8 | 52.9 | 30.5 | 83.3 | 45.8 | 30.5 | 76.2 |
| 30.0 | 112.3 | 30.5 | 142.7 | 58.5 | 30.5 | 89.0 | 50.3 | 30.5 | 80.8 |
| 31.0 | 120.2 | 30.5 | 150.7 | 64.2 | 30.5 | 94.7 | 54.9 | 30.5 | 85.4 |
| 32.0 | 128.2 | 30.5 | 158.6 | 69.9 | 30.5 | 100.3 | 59.6 | 30.5 | 90.1 |
| 33.0 | 136.1 | 30.5 | 166.6 | 75.5 | 30.5 | 106.0 | 64.3 | 30.5 | 94.7 |
| 34.0 | 144.1 | 30.5 | 174.5 | 81.2 | 30.5 | 111.7 | 69.0 | 30.5 | 99.5 |
| 35.0 | 152.0 | 30.5 | 182.5 | 86.9 | 30.5 | 117.3 | 73.8 | 30.5 | 104.2 |
| 36.0 | 159.9 | 30.5 | 190.4 | 92.5 | 30.5 | 123.0 | 78.6 | 30.5 | 109.0 |
| 37.0 | 167.9 | 30.5 | 198.4 | 98.2 | 30.5 | 128.7 | 83.4 | 30.5 | 113.9 |
| 38.0 | 175.8 | 30.5 | 206.3 | 103.9 | 30.5 | 134.3 | 88.3 | 30.5 | 118.8 |
| 39.0 | 183.8 | 30.5 | 214.2 | 109.5 | 30.5 | 140.0 | 93.2 | 30.5 | 123.7 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 40.0 | 191.7 | 30.5 | 222.2 | 115.2 | 30.5 | 145.7 | 98.2 | 30.5 | 128.7 |
| 41.0 | 199.7 | 30.5 | 230.1 | 120.9 | 30.5 | 151.3 | 103.2 | 30.5 | 133.7 |
| 42.0 | 207.6 | 30.5 | 238.1 | 126.5 | 30.5 | 157.0 | 108.2 | 30.5 | 138.7 |
| 43.0 | 215.6 | 30.5 | 246.0 | 132.2 | 30.5 | 162.7 | 113.3 | 30.5 | 143.8 |
| 44.0 | 223.5 | 30.5 | 254.0 | 137.9 | 30.5 | 168.3 | 118.4 | 30.5 | 148.9 |
| 45.0 | 231.4 | 30.5 | 261.9 | 143.5 | 30.5 | 174.0 | 123.6 | 30.5 | 154.1 |
| 46.0 | 239.4 | 30.5 | 269.9 | 149.2 | 30.5 | 179.7 | 128.8 | 30.5 | 159.3 |
| 47.0 | 247.3 | 30.5 | 277.8 | 154.9 | 30.5 | 185.3 | 134.1 | 30.5 | 164.5 |
| 48.0 | 255.3 | 51.7 | 307.0 | 160.5 | 51.9 | 212.4 | 139.3 | 79.4 | 218.8 |
| 49.0 | 263.2 | 75.6 | 338.8 | 166.2 | 76.0 | 242.2 | 144.7 | 135.8 | 280.5 |
| 50.0 | 271.2 | 99.6 | 370.7 | 168.4 | 100.2 | 268.6 | 150.0 | 193.3 | 343.4 |
| 51.0 | 281.5 | 99.6 | 381.1 | 170.5 | 100.2 | 270.7 | 153.6 | 196.7 | 350.3 |
| 52.0 | 294.4 | 99.6 | 393.9 | 172.7 | 100.2 | 272.9 | 157.2 | 200.1 | 357.3 |
| 53.0 | 307.4 | 99.6 | 407.0 | 174.9 | 100.2 | 275.1 | 160.9 | 203.5 | 364.4 |
| 54.0 | 320.8 | 99.6 | 420.3 | 177.1 | 100.2 | 277.3 | 164.6 | 206.9 | 371.5 |
| 55.0 | 334.3 | 99.6 | 433.8 | 179.2 | 100.2 | 279.4 | 168.4 | 210.3 | 378.7 |
| 56.0 | 348.0 | 99.6 | 447.6 | 181.4 | 100.2 | 281.6 | 172.3 | 213.7 | 386.0 |
| 57.0 | 362.0 | 99.6 | 461.6 | 183.6 | 100.2 | 283.8 | 176.2 | 217.1 | 393.3 |
| 58.0 | 376.2 | 99.6 | 475.8 | 185.7 | 100.2 | 285.9 | 180.2 | 220.5 | 400.7 |
| 59.0 | 390.7 | 99.6 | 490.2 | 187.9 | 100.2 | 288.1 | 184.3 | 223.9 | 408.1 |
| 60.0 | 405.3 | 99.6 | 504.9 | 190.1 | 100.2 | 290.3 | 188.4 | 227.2 | 415.6 |
| 61.0 | 420.2 | 99.6 | 519.8 | 192.2 | 100.2 | 292.4 | 192.6 | 230.6 | 423.2 |
| 62.0 | 435.3 | 99.6 | 534.9 | 194.4 | 100.2 | 294.6 | 196.8 | 234.0 | 430.8 |
| 63.0 | 450.6 | 99.6 | 550.2 | 196.6 | 100.2 | 296.8 | 201.1 | 237.4 | 438.5 |
| 64.0 | 466.2 | 99.6 | 565.8 | 198.8 | 100.2 | 299.0 | 205.5 | 240.5 | 446.0 |
| 65.0 | 482.0 | 99.6 | 581.5 | 200.9 | 100.2 | 301.1 | 209.9 | 242.6 | 452.5 |
| 66.0 | 498.0 | 99.6 | 597.5 | 203.1 | 100.2 | 303.3 | 214.4 | 243.6 | 458.0 |
| 67.0 | 514.2 | 99.6 | 613.8 | 205.3 | 100.2 | 305.5 | 219.0 | 243.7 | 462.7 |
| 68.0 | 530.7 | 99.6 | 630.2 | 207.4 | 100.2 | 307.6 | 223.6 | 243.7 | 467.4 |
| 69.0 | 547.4 | 99.6 | 646.9 | 209.6 | 100.2 | 309.8 | 228.3 | 243.7 | 472.1 |
| 70.0 | 564.3 | 99.6 | 663.8 | 211.8 | 100.2 | 312.0 | 233.1 | 243.7 | 476.8 |
| 71.0 | 581.4 | 99.6 | 681.0 | 213.9 | 100.2 | 314.1 | 237.9 | 243.7 | 481.6 |
| 72.0 | 598.8 | 99.6 | 698.3 | 216.1 | 100.2 | 316.3 | 242.8 | 243.7 | 486.5 |
| 73.0 | 616.4 | 99.6 | 715.9 | 218.3 | 100.2 | 318.5 | 247.7 | 243.7 | 491.4 |
| 74.0 | 634.2 | 99.6 | 733.7 | 220.5 | 100.2 | 320.6 | 252.7 | 243.7 | 496.5 |
| 75.0 | 652.2 | 99.6 | 751.8 | 222.6 | 100.2 | 322.8 | 257.8 | 243.7 | 501.5 |
| 76.0 | 670.5 | 99.6 | 770.0 | 224.8 | 100.2 | 325.0 | 262.9 | 243.8 | 506.7 |
| 77.0 | 688.9 | 99.6 | 788.5 | 227.0 | 100.2 | 327.2 | 268.1 | 243.8 | 511.9 |
| 78.0 | 707.7 | 99.6 | 807.2 | 229.1 | 100.2 | 329.3 | 273.4 | 243.8 | 517.1 |
| 79.0 | 726.6 | 99.6 | 826.2 | 231.3 | 100.2 | 331.5 | 278.7 | 243.7 | 522.4 |
| 80.0 | 745.8 | 99.6 | 845.3 | 233.5 | 100.2 | 333.7 | 284.1 | 243.7 | 527.8 |
| 81.0 | 765.1 | 99.6 | 864.7 | 235.6 | 100.2 | 335.8 | 289.5 | 243.7 | 533.3 |
| 82.0 | 784.8 | 99.6 | 884.3 | 237.8 | 100.2 | 338.0 | 295.0 | 243.7 | 538.8 |
| 83.0 | 804.6 | 84.0 | 888.6 | 240.0 | 84.4 | 324.4 | 300.6 | 183.9 | 484.5 |
| 84.0 | 824.7 | 66.4 | 891.0 | 242.1 | 66.6 | 308.7 | 306.2 | 116.3 | 422.6 |
| 85.0 | 844.9 | 48.7 | 893.7 | 244.3 | 48.7 | 293.1 | 312.0 | 48.7 | 360.7 |
| 86.0 | 858.8 | 48.7 | 907.5 | 249.9 | 48.7 | 298.7 | 320.6 | 48.7 | 369.4 |
| 87.0 | 865.3 | 48.7 | 914.0 | 259.0 | 48.7 | 307.8 | 329.4 | 48.7 | 378.1 |
| 88.0 | 871.0 | 48.7 | 919.7 | 268.1 | 48.7 | 316.8 | 338.2 | 48.7 | 386.9 |
| 89.0 | 876.7 | 48.7 | 925.4 | 277.1 | 48.7 | 325.9 | 347.0 | 48.7 | 395.7 |
| 90.0 | 882.4 | 48.7 | 931.1 | 286.2 | 48.7 | 335.0 | 355.8 | 48.7 | 404.6 |
| 91.0 | 888.1 | 48.7 | 936.9 | 295.3 | 48.7 | 344.0 | 364.7 | 48.7 | 413.5 |
| 92.0 | 893.8 | 48.7 | 942.6 | 304.3 | 48.7 | 353.1 | 373.7 | 48.7 | 422.4 |
| 93.0 | 899.5 | 48.7 | 948.3 | 313.4 | 48.7 | 362.2 | 382.6 | 48.7 | 431.4 |
| 94.0 | 905.2 | 48.7 | 954.0 | 322.5 | 48.7 | 371.2 | 391.6 | 48.7 | 440.4 |
| 95.0 | 910.9 | 48.7 | 959.7 | 331.5 | 48.7 | 380.3 | 400.7 | 48.7 | 449.4 |
| 96.0 | 916.7 | 48.7 | 965.4 | 340.6 | 48.7 | 389.4 | 409.8 | 48.7 | 458.5 |
| 97.0 | 922.4 | 48.7 | 971.1 | 349.7 | 48.7 | 398.4 | 418.9 | 48.7 | 467.7 |
| 98.0 | 928.1 | 48.7 | 976.8 | 358.7 | 48.7 | 407.5 | 428.1 | 48.7 | 476.8 |
| 99.0 | 933.8 | 48.7 | 982.5 | 367.8 | 48.7 | 416.6 | 437.3 | 48.7 | 486.1 |
| 100.0 | 939.5 | 48.7 | 988.3 | 376.9 | 48.7 | 425.6 | 446.6 | 48.7 | 495.3 |

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*    API RP-2A (1994)    *
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| PILE PENETRATION FT. | TOTAL SKIN FRICTION KIP | END BEARING KIP | ULTIMATE CAPACITY KIP |
|---|---|---|---|
| 0.00 | 0.0 | 3.0 | 3.0 |
| 1.00 | 0.0 | 5.1 | 5.1 |
| 2.00 | 0.0 | 7.2 | 7.2 |
| 3.00 | 0.2 | 9.3 | 9.4 |
| 4.00 | 0.6 | 11.4 | 11.9 |
| 5.00 | 1.1 | 13.4 | 14.5 |
| 6.00 | 1.7 | 15.5 | 17.3 |
| 7.00 | 2.5 | 17.6 | 20.1 |
| 8.00 | 3.3 | 19.5 | 22.9 |
| 9.00 | 4.3 | 21.0 | 25.4 |
| 10.00 | 5.4 | 22.2 | 27.6 |
| 11.00 | 6.6 | 23.1 | 29.7 |
| 12.00 | 7.8 | 24.0 | 31.8 |
| 13.00 | 9.1 | 35.1 | 44.2 |
| 14.00 | 10.4 | 48.1 | 58.5 |
| 15.00 | 11.8 | 61.6 | 73.4 |
| 16.00 | 13.3 | 64.1 | 77.4 |
| 17.00 | 14.9 | 66.6 | 81.5 |
| 18.00 | 16.5 | 69.1 | 85.6 |
| 19.00 | 18.2 | 71.6 | 89.8 |
| 20.00 | 20.0 | 74.1 | 94.1 |
| 21.00 | 21.8 | 76.6 | 98.4 |
| 22.00 | 23.7 | 79.1 | 102.8 |
| 23.00 | 25.7 | 65.1 | 90.8 |
| 24.00 | 27.7 | 48.2 | 75.9 |
| 25.00 | 29.8 | 30.5 | 60.3 |
| 26.00 | 33.5 | 30.5 | 64.0 |
| 27.00 | 38.9 | 30.5 | 69.4 |
| 28.00 | 44.3 | 30.5 | 74.8 |
| 29.00 | 49.8 | 30.5 | 80.2 |
| 30.00 | 55.2 | 30.5 | 85.7 |
| 31.00 | 60.8 | 30.5 | 91.2 |
| 32.00 | 66.3 | 30.5 | 96.8 |
| 33.00 | 71.9 | 30.5 | 102.4 |
| 34.00 | 77.6 | 30.5 | 108.0 |
| 35.00 | 83.3 | 30.5 | 113.7 |
| 36.00 | 89.0 | 30.5 | 119.5 |
| 37.00 | 94.8 | 30.5 | 125.3 |
| 38.00 | 100.7 | 30.5 | 131.2 |
| 39.00 | 106.7 | 30.5 | 137.1 |
| 40.00 | 112.7 | 30.5 | 143.1 |
| 41.00 | 118.8 | 30.5 | 149.2 |
| 42.00 | 124.9 | 30.5 | 155.4 |
| 43.00 | 131.1 | 30.5 | 161.6 |
| 44.00 | 137.4 | 30.5 | 167.9 |
| 45.00 | 143.8 | 30.5 | 174.2 |
| 46.00 | 150.2 | 30.5 | 180.6 |
| 47.00 | 156.6 | 30.5 | 187.1 |
| 48.00 | 163.2 | 79.4 | 242.6 |
| 49.00 | 169.8 | 135.8 | 305.6 |
| 50.00 | 176.4 | 193.3 | 369.8 |
| 51.00 | 181.7 | 196.7 | 378.4 |
| 52.00 | 185.7 | 200.1 | 385.8 |
| 53.00 | 189.7 | 203.5 | 393.2 |
| 54.00 | 193.8 | 206.9 | 400.7 |
| 55.00 | 197.9 | 210.3 | 408.2 |
| 56.00 | 202.2 | 213.7 | 415.8 |
| 57.00 | 206.5 | 217.1 | 423.5 |
| 58.00 | 210.8 | 220.5 | 431.3 |
| 59.00 | 215.3 | 223.9 | 439.1 |
| 60.00 | 219.8 | 227.2 | 447.0 |

| | | | |
|---|---|---|---|
| 61.00 | 224.3 | 230.6 | 455.0 |
| 62.00 | 229.0 | 234.0 | 463.0 |
| 63.00 | 233.7 | 237.4 | 471.1 |
| 64.00 | 238.5 | 240.5 | 479.0 |
| 65.00 | 243.3 | 242.6 | 485.9 |
| 66.00 | 248.2 | 243.6 | 491.8 |
| 67.00 | 253.2 | 243.7 | 497.0 |
| 68.00 | 258.3 | 243.7 | 502.0 |
| 69.00 | 263.4 | 243.7 | 507.2 |
| 70.00 | 268.6 | 243.7 | 512.4 |
| 71.00 | 273.9 | 243.7 | 517.6 |
| 72.00 | 279.2 | 243.7 | 523.0 |
| 73.00 | 284.6 | 243.7 | 528.4 |
| 74.00 | 290.1 | 243.7 | 533.8 |
| 75.00 | 295.6 | 243.7 | 539.4 |
| 76.00 | 301.2 | 243.8 | 545.0 |
| 77.00 | 306.9 | 243.8 | 550.7 |
| 78.00 | 312.7 | 243.8 | 556.4 |
| 79.00 | 318.5 | 243.7 | 562.2 |
| 80.00 | 324.4 | 243.7 | 568.1 |
| 81.00 | 330.3 | 243.7 | 574.1 |
| 82.00 | 336.4 | 243.7 | 580.1 |
| 83.00 | 342.5 | 183.9 | 526.3 |
| 84.00 | 348.6 | 116.3 | 464.9 |
| 85.00 | 354.9 | 48.7 | 403.6 |
| 86.00 | 363.4 | 48.7 | 412.2 |
| 87.00 | 374.3 | 48.7 | 423.1 |
| 88.00 | 385.2 | 48.7 | 434.0 |
| 89.00 | 396.2 | 48.7 | 445.0 |
| 90.00 | 407.3 | 48.7 | 456.1 |
| 91.00 | 418.4 | 48.7 | 467.2 |
| 92.00 | 429.6 | 48.7 | 478.3 |
| 93.00 | 440.8 | 48.7 | 489.6 |
| 94.00 | 452.1 | 48.7 | 500.9 |
| 95.00 | 463.5 | 48.7 | 512.2 |
| 96.00 | 474.9 | 48.7 | 523.6 |
| 97.00 | 486.3 | 48.7 | 535.1 |
| 98.00 | 497.8 | 48.7 | 546.6 |
| 99.00 | 509.4 | 48.7 | 558.2 |
| 100.00 | 521.0 | 48.7 | 569.8 |

AN ASTERISK WILL BE PLACED IN THE END-BEARING COLUMN
IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

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**************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                      *
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| T-Z CURVE NO. | NO. OF POINTS | DEPTH TO CURVE FT. | LOAD TRANSFER PSI | PILE MOVEMENT IN. |
|---|---|---|---|---|
| 1 | 10 | 0.0000E+00 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.0000E+00 | 0.1732E-01 |
| | | | 0.0000E+00 | 0.3463E-01 |
| | | | 0.0000E+00 | 0.6926E-01 |
| | | | 0.0000E+00 | 0.1039E+00 |
| | | | 0.0000E+00 | 0.1385E+00 |
| | | | 0.0000E+00 | 0.1558E+00 |
| | | | 0.0000E+00 | 0.1732E+00 |

| | | | | |
|---|---|---|---|---|
| | | | 0.0000E+00 | 0.8658E+00 |
| | | | 0.0000E+00 | 0.1732E+01 |
| 2 | 10 | 0.5025E+01 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.9727E-01 | 0.1732E-01 |
| | | | 0.1945E+00 | 0.3463E-01 |
| | | | 0.3891E+00 | 0.6926E-01 |
| | | | 0.5836E+00 | 0.1039E+00 |
| | | | 0.7782E+00 | 0.1385E+00 |
| | | | 0.8754E+00 | 0.1558E+00 |
| | | | 0.9727E+00 | 0.1732E+00 |
| | | | 0.9727E+00 | 0.8658E+00 |
| | | | 0.9727E+00 | 0.1732E+01 |
| 3 | 10 | 0.9958E+01 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.1680E+00 | 0.1732E-01 |
| | | | 0.3360E+00 | 0.3463E-01 |
| | | | 0.6720E+00 | 0.6926E-01 |
| | | | 0.1008E+01 | 0.1039E+00 |
| | | | 0.1344E+01 | 0.1385E+00 |
| | | | 0.1512E+01 | 0.1558E+00 |
| | | | 0.1680E+01 | 0.1732E+00 |
| | | | 0.1680E+01 | 0.8658E+00 |
| | | | 0.1680E+01 | 0.1732E+01 |
| 4 | 10 | 0.1000E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.1807E+00 | 0.1732E-01 |
| | | | 0.3614E+00 | 0.3463E-01 |
| | | | 0.7227E+00 | 0.6926E-01 |
| | | | 0.1084E+01 | 0.1039E+00 |
| | | | 0.1445E+01 | 0.1385E+00 |
| | | | 0.1626E+01 | 0.1558E+00 |
| | | | 0.1807E+01 | 0.1732E+00 |
| | | | 0.1807E+01 | 0.8658E+00 |
| | | | 0.1807E+01 | 0.1732E+01 |
| 5 | 10 | 0.1253E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.1960E+00 | 0.1732E-01 |
| | | | 0.3920E+00 | 0.3463E-01 |
| | | | 0.7839E+00 | 0.6926E-01 |
| | | | 0.1176E+01 | 0.1039E+00 |
| | | | 0.1568E+01 | 0.1385E+00 |
| | | | 0.1764E+01 | 0.1558E+00 |
| | | | 0.1960E+01 | 0.1732E+00 |
| | | | 0.1960E+01 | 0.8658E+00 |
| | | | 0.1960E+01 | 0.1732E+01 |
| 6 | 10 | 0.1496E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.2113E+00 | 0.1732E-01 |
| | | | 0.4226E+00 | 0.3463E-01 |
| | | | 0.8452E+00 | 0.6926E-01 |
| | | | 0.1268E+01 | 0.1039E+00 |
| | | | 0.1690E+01 | 0.1385E+00 |
| | | | 0.1902E+01 | 0.1558E+00 |
| | | | 0.2113E+01 | 0.1732E+00 |
| | | | 0.2113E+01 | 0.8658E+00 |
| | | | 0.2113E+01 | 0.1732E+01 |
| 7 | 10 | 0.1500E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.2261E+00 | 0.1732E-01 |
| | | | 0.4522E+00 | 0.3463E-01 |
| | | | 0.9043E+00 | 0.6926E-01 |
| | | | 0.1356E+01 | 0.1039E+00 |
| | | | 0.1809E+01 | 0.1385E+00 |
| | | | 0.2035E+01 | 0.1558E+00 |
| | | | 0.2261E+01 | 0.1732E+00 |

| | | | | |
|---|---|---|---|---|
| | | | 0.2261E+01 | 0.8658E+00 |
| | | | 0.2261E+01 | 0.1732E+01 |
| 8 | 10 | 0.2002E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.2811E+00 | 0.1732E-01 |
| | | | 0.5621E+00 | 0.3463E-01 |
| | | | 0.1124E+01 | 0.6926E-01 |
| | | | 0.1686E+01 | 0.1039E+00 |
| | | | 0.2249E+01 | 0.1385E+00 |
| | | | 0.2530E+01 | 0.1558E+00 |
| | | | 0.2811E+01 | 0.1732E+00 |
| | | | 0.2811E+01 | 0.8658E+00 |
| | | | 0.2811E+01 | 0.1732E+01 |
| 9 | 10 | 0.2496E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.3202E+00 | 0.1732E-01 |
| | | | 0.6404E+00 | 0.3463E-01 |
| | | | 0.1281E+01 | 0.6926E-01 |
| | | | 0.1921E+01 | 0.1039E+00 |
| | | | 0.2562E+01 | 0.1385E+00 |
| | | | 0.2882E+01 | 0.1558E+00 |
| | | | 0.3202E+01 | 0.1732E+00 |
| | | | 0.3202E+01 | 0.8658E+00 |
| | | | 0.3202E+01 | 0.1732E+01 |
| 10 | 10 | 0.2500E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.1715E+01 | 0.2771E-01 |
| | | | 0.2859E+01 | 0.5368E-01 |
| | | | 0.4289E+01 | 0.9870E-01 |
| | | | 0.5146E+01 | 0.1385E+00 |
| | | | 0.5718E+01 | 0.1732E+00 |
| | | | 0.5146E+01 | 0.3463E+00 |
| | | | 0.5146E+01 | 0.5195E+00 |
| | | | 0.5146E+01 | 0.8658E+00 |
| | | | 0.5146E+01 | 0.3463E+01 |
| 11 | 10 | 0.3752E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.2705E+01 | 0.2771E-01 |
| | | | 0.4508E+01 | 0.5368E-01 |
| | | | 0.6761E+01 | 0.9870E-01 |
| | | | 0.8114E+01 | 0.1385E+00 |
| | | | 0.9015E+01 | 0.1732E+00 |
| | | | 0.8114E+01 | 0.3463E+00 |
| | | | 0.8114E+01 | 0.5195E+00 |
| | | | 0.8114E+01 | 0.8658E+00 |
| | | | 0.8114E+01 | 0.3463E+01 |
| 12 | 10 | 0.4996E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.3058E+01 | 0.2771E-01 |
| | | | 0.5097E+01 | 0.5368E-01 |
| | | | 0.7645E+01 | 0.9870E-01 |
| | | | 0.9174E+01 | 0.1385E+00 |
| | | | 0.1019E+02 | 0.1732E+00 |
| | | | 0.9174E+01 | 0.3463E+00 |
| | | | 0.9174E+01 | 0.5195E+00 |
| | | | 0.9174E+01 | 0.8658E+00 |
| | | | 0.9174E+01 | 0.3463E+01 |
| 13 | 10 | 0.5000E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.8119E+00 | 0.1732E-01 |
| | | | 0.1624E+01 | 0.3463E-01 |
| | | | 0.3248E+01 | 0.6926E-01 |
| | | | 0.4872E+01 | 0.1039E+00 |
| | | | 0.6495E+01 | 0.1385E+00 |
| | | | 0.7307E+01 | 0.1558E+00 |
| | | | 0.8119E+01 | 0.1732E+00 |

| | | | | |
|---|---|---|---|---|
| | | | 0.8119E+01 | 0.8658E+00 |
| | | | 0.8119E+01 | 0.1732E+01 |
| 14 | 10 | 0.6753E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.7748E+00 | 0.1732E-01 |
| | | | 0.1550E+01 | 0.3463E-01 |
| | | | 0.3099E+01 | 0.6926E-01 |
| | | | 0.4649E+01 | 0.1039E+00 |
| | | | 0.6198E+01 | 0.1385E+00 |
| | | | 0.6973E+01 | 0.1558E+00 |
| | | | 0.7748E+01 | 0.1732E+00 |
| | | | 0.7748E+01 | 0.8658E+00 |
| | | | 0.7748E+01 | 0.1732E+01 |
| 15 | 10 | 0.8496E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.9550E+00 | 0.1732E-01 |
| | | | 0.1910E+01 | 0.3463E-01 |
| | | | 0.3820E+01 | 0.6926E-01 |
| | | | 0.5730E+01 | 0.1039E+00 |
| | | | 0.7640E+01 | 0.1385E+00 |
| | | | 0.8595E+01 | 0.1558E+00 |
| | | | 0.9550E+01 | 0.1732E+00 |
| | | | 0.9550E+01 | 0.8658E+00 |
| | | | 0.9550E+01 | 0.1732E+01 |
| 16 | 10 | 0.8500E+02 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.3935E+01 | 0.2771E-01 |
| | | | 0.6558E+01 | 0.5368E-01 |
| | | | 0.9836E+01 | 0.9870E-01 |
| | | | 0.1180E+02 | 0.1385E+00 |
| | | | 0.1312E+02 | 0.1732E+00 |
| | | | 0.1180E+02 | 0.3463E+00 |
| | | | 0.1180E+02 | 0.5195E+00 |
| | | | 0.1180E+02 | 0.8658E+00 |
| | | | 0.1180E+02 | 0.3463E+01 |
| 17 | 10 | 0.1050E+03 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.5343E+01 | 0.2771E-01 |
| | | | 0.8905E+01 | 0.5368E-01 |
| | | | 0.1336E+02 | 0.9870E-01 |
| | | | 0.1603E+02 | 0.1385E+00 |
| | | | 0.1781E+02 | 0.1732E+00 |
| | | | 0.1603E+02 | 0.3463E+00 |
| | | | 0.1603E+02 | 0.5195E+00 |
| | | | 0.1603E+02 | 0.8658E+00 |
| | | | 0.1603E+02 | 0.3463E+01 |
| 18 | 10 | 0.1250E+03 | | |
| | | | 0.0000E+00 | 0.0000E+00 |
| | | | 0.5343E+01 | 0.2771E-01 |
| | | | 0.8905E+01 | 0.5368E-01 |
| | | | 0.1336E+02 | 0.9870E-01 |
| | | | 0.1603E+02 | 0.1385E+00 |
| | | | 0.1781E+02 | 0.1732E+00 |
| | | | 0.1603E+02 | 0.3463E+00 |
| | | | 0.1603E+02 | 0.5195E+00 |
| | | | 0.1603E+02 | 0.8658E+00 |
| | | | 0.1603E+02 | 0.3463E+01 |

| TIP LOAD KIP | TIP MOVEMENT IN. |
|---|---|
| 0.0000E+00 | 0.0000E+00 |
| 0.3047E+01 | 0.8658E-02 |
| 0.6094E+01 | 0.1732E-01 |

| | |
|---|---|
| 0.1219E+02 | 0.3463E-01 |
| 0.2437E+02 | 0.2251E+00 |
| 0.3656E+02 | 0.7273E+00 |
| 0.4387E+02 | 0.1264E+01 |
| 0.4875E+02 | 0.1732E+01 |
| 0.4875E+02 | 0.2597E+01 |
| 0.4875E+02 | 0.3463E+01 |

LOAD VERSUS SETTLEMENT CURVE
**********

| TOP LOAD KIP | TOP MOVEMENT IN. | TIP LOAD KIP | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.3765E+03 | 0.5277E+02 | 0.3519E-01 | 0.1000E-03 |
| 0.4188E+03 | 0.6250E+02 | 0.3519E+00 | 0.1000E-02 |
| 0.4466E+03 | 0.6918E+02 | 0.1760E+01 | 0.5000E-02 |
| 0.4588E+03 | 0.7218E+02 | 0.3519E+01 | 0.1000E-01 |
| 0.4856E+03 | 0.7889E+02 | 0.1317E+02 | 0.5000E-01 |
| 0.4925E+03 | 0.8067E+02 | 0.1637E+02 | 0.1000E+00 |
| 0.5064E+03 | 0.8458E+02 | 0.3105E+02 | 0.5000E+00 |
| 0.5156E+03 | 0.8740E+02 | 0.4028E+02 | 0.1000E+01 |
| 0.5241E+03 | 0.9053E+02 | 0.4875E+02 | 0.2000E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Abutment 1, 24” CIDH

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Abut 1, 24" CIDH (comp) NL

PROPOSED DEPTH = 90.0 FT
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NUMBER OF LAYERS = 7
---

WATER TABLE DEPTH = 24.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.995E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.140E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.995E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.290E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.140E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.839E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.290E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.240E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.839E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.240E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.657E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.390E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.200E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.390E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.200E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.590E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.463E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.590E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.940E+02

LAYER NO 6----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.940E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.134E+03

LAYER NO 7----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.134E+03

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.170E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 2.000 FT.
DIAMETER OF BASE = 2.000 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 3.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 4.524 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
---

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 4.0 | 0.47 | 1.25 | 0.00 | 1.25 | 1.25 | 1.25 | 3.82 |
| 5.0 | 0.58 | 3.56 | 0.00 | 3.56 | 3.56 | 3.56 | 6.12 |
| 6.0 | 0.70 | 5.87 | 0.00 | 5.87 | 5.87 | 5.87 | 8.41 |
| 7.0 | 0.81 | 8.51 | 0.00 | 8.51 | 8.51 | 8.51 | 10.45 |
| 8.0 | 0.93 | 11.46 | 0.00 | 11.46 | 11.46 | 11.46 | 12.32 |
| 9.0 | 1.05 | 14.72 | 0.00 | 14.72 | 14.72 | 14.72 | 14.05 |
| 10.0 | 1.16 | 18.26 | 0.00 | 18.26 | 18.26 | 18.26 | 15.69 |
| 11.0 | 1.28 | 22.08 | 0.00 | 22.08 | 22.08 | 22.08 | 17.25 |
| 12.0 | 1.40 | 26.16 | 0.00 | 26.16 | 26.16 | 26.16 | 18.73 |
| 13.0 | 1.51 | 30.51 | 0.00 | 30.51 | 30.51 | 30.51 | 20.17 |
| 14.0 | 1.63 | 35.10 | 0.00 | 35.10 | 35.10 | 35.10 | 21.55 |
| 15.0 | 1.75 | 39.95 | 0.00 | 39.95 | 39.95 | 39.95 | 22.89 |
| 16.0 | 1.86 | 45.05 | 0.00 | 45.05 | 45.05 | 45.05 | 24.20 |
| 17.0 | 1.98 | 50.39 | 0.00 | 50.39 | 50.39 | 50.39 | 25.47 |
| 18.0 | 2.09 | 55.95 | 0.00 | 55.95 | 55.95 | 55.95 | 26.71 |
| 19.0 | 2.21 | 61.74 | 0.00 | 61.74 | 61.74 | 61.74 | 27.92 |
| 20.0 | 2.33 | 67.73 | 0.00 | 67.73 | 67.73 | 67.73 | 29.10 |
| 21.0 | 2.44 | 73.94 | 5.99 | 79.92 | 79.92 | 79.92 | 32.70 |
| 22.0 | 2.56 | 80.34 | 13.17 | 93.51 | 93.51 | 93.51 | 36.52 |
| 23.0 | 2.68 | 86.93 | 16.76 | 103.69 | 103.69 | 103.69 | 38.74 |
| 24.0 | 2.79 | 93.70 | 16.76 | 110.46 | 110.46 | 110.46 | 39.55 |
| 25.0 | 2.91 | 100.51 | 16.76 | 117.27 | 117.27 | 117.27 | 40.31 |
| 26.0 | 3.03 | 107.36 | 16.76 | 124.12 | 124.12 | 124.12 | 41.02 |
| 27.0 | 3.14 | 114.24 | 16.76 | 131.00 | 131.00 | 131.00 | 41.69 |
| 28.0 | 3.26 | 121.15 | 16.76 | 137.91 | 137.91 | 137.91 | 42.33 |
| 29.0 | 3.37 | 128.09 | 16.76 | 144.85 | 144.85 | 144.85 | 42.92 |
| 30.0 | 3.49 | 135.06 | 16.76 | 151.82 | 151.82 | 151.82 | 43.49 |
| 31.0 | 3.61 | 142.05 | 16.76 | 158.81 | 158.81 | 158.81 | 44.02 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 32.0 | 3.72 | 149.06 | 16.76 | 165.82 | 165.82 | 165.82 | 44.53 |
| 33.0 | 3.84 | 156.09 | 16.76 | 172.85 | 172.85 | 172.85 | 45.01 |
| 34.0 | 3.96 | 163.14 | 16.76 | 179.90 | 179.90 | 179.90 | 45.47 |
| 35.0 | 4.07 | 170.20 | 16.76 | 186.96 | 186.96 | 186.96 | 45.90 |
| 36.0 | 4.19 | 177.27 | 20.87 | 198.14 | 198.14 | 198.14 | 47.30 |
| 37.0 | 4.31 | 184.35 | 25.81 | 210.16 | 210.16 | 210.16 | 48.81 |
| 38.0 | 4.42 | 191.43 | 28.28 | 219.71 | 219.71 | 219.71 | 49.69 |
| 39.0 | 4.54 | 198.52 | 28.28 | 226.80 | 226.80 | 226.80 | 49.97 |
| 40.0 | 4.65 | 201.98 | 28.28 | 230.26 | 230.26 | 230.26 | 49.47 |
| 41.0 | 4.77 | 205.43 | 28.28 | 233.71 | 233.71 | 233.71 | 48.98 |
| 42.0 | 4.89 | 208.89 | 28.28 | 237.17 | 237.17 | 237.17 | 48.52 |
| 43.0 | 5.00 | 212.35 | 28.28 | 240.62 | 240.62 | 240.62 | 48.09 |
| 44.0 | 5.12 | 215.80 | 28.28 | 244.08 | 244.08 | 244.08 | 47.67 |
| 45.0 | 5.24 | 219.26 | 28.28 | 247.54 | 247.54 | 247.54 | 47.27 |
| 46.0 | 5.35 | 222.71 | 28.28 | 250.99 | 250.99 | 250.99 | 46.89 |
| 47.0 | 5.47 | 226.17 | 28.28 | 254.45 | 254.45 | 254.45 | 46.52 |
| 48.0 | 5.59 | 229.63 | 28.28 | 257.91 | 257.91 | 257.91 | 46.17 |
| 49.0 | 5.70 | 233.08 | 28.28 | 261.36 | 261.36 | 261.36 | 45.84 |
| 50.0 | 5.82 | 236.54 | 28.28 | 264.82 | 264.82 | 264.82 | 45.51 |
| 51.0 | 5.93 | 240.00 | 28.28 | 268.27 | 268.27 | 268.27 | 45.20 |
| 52.0 | 6.05 | 243.45 | 28.28 | 271.73 | 271.73 | 271.73 | 44.90 |
| 53.0 | 6.17 | 246.91 | 28.28 | 275.19 | 275.19 | 275.19 | 44.62 |
| 54.0 | 6.28 | 250.36 | 28.28 | 278.64 | 278.64 | 278.64 | 44.34 |
| 55.0 | 6.40 | 253.82 | 28.28 | 282.10 | 282.10 | 282.10 | 44.08 |
| 56.0 | 6.52 | 257.28 | 30.15 | 287.43 | 287.43 | 287.43 | 44.11 |
| 57.0 | 6.63 | 260.73 | 32.40 | 293.13 | 293.13 | 293.13 | 44.19 |
| 58.0 | 6.75 | 264.19 | 33.52 | 297.71 | 297.71 | 297.71 | 44.11 |
| 59.0 | 6.87 | 267.65 | 33.52 | 301.16 | 301.16 | 301.16 | 43.86 |
| 60.0 | 6.98 | 274.42 | 33.52 | 307.94 | 307.94 | 307.94 | 44.10 |
| 61.0 | 7.10 | 281.16 | 33.52 | 314.68 | 314.68 | 314.68 | 44.33 |
| 62.0 | 7.21 | 287.85 | 33.52 | 321.37 | 321.37 | 321.37 | 44.54 |
| 63.0 | 7.33 | 294.50 | 33.52 | 328.02 | 328.02 | 328.02 | 44.74 |
| 64.0 | 7.45 | 301.09 | 33.52 | 334.61 | 334.61 | 334.61 | 44.93 |
| 65.0 | 7.56 | 307.64 | 33.52 | 341.16 | 341.16 | 341.16 | 45.10 |
| 66.0 | 7.68 | 314.13 | 33.52 | 347.65 | 347.65 | 347.65 | 45.26 |
| 67.0 | 7.80 | 320.57 | 33.52 | 354.09 | 354.09 | 354.09 | 45.41 |
| 68.0 | 7.91 | 326.95 | 33.52 | 360.47 | 360.47 | 360.47 | 45.55 |
| 69.0 | 8.03 | 333.27 | 33.52 | 366.79 | 366.79 | 366.79 | 45.68 |
| 70.0 | 8.15 | 339.52 | 33.52 | 373.04 | 373.04 | 373.04 | 45.80 |
| 71.0 | 8.26 | 345.72 | 33.52 | 379.24 | 379.24 | 379.24 | 45.90 |
| 72.0 | 8.38 | 351.84 | 33.52 | 385.36 | 385.36 | 385.36 | 45.99 |
| 73.0 | 8.50 | 357.90 | 33.52 | 391.42 | 391.42 | 391.42 | 46.08 |
| 74.0 | 8.61 | 363.89 | 33.52 | 397.40 | 397.40 | 397.40 | 46.15 |
| 75.0 | 8.73 | 369.80 | 33.52 | 403.32 | 403.32 | 403.32 | 46.21 |
| 76.0 | 8.84 | 375.64 | 33.52 | 409.15 | 409.15 | 409.15 | 46.26 |
| 77.0 | 8.96 | 381.40 | 33.52 | 414.91 | 414.91 | 414.91 | 46.30 |
| 78.0 | 9.08 | 387.08 | 33.52 | 420.60 | 420.60 | 420.60 | 46.34 |
| 79.0 | 9.19 | 392.68 | 33.52 | 426.19 | 426.19 | 426.19 | 46.36 |
| 80.0 | 9.31 | 398.19 | 33.52 | 431.71 | 431.71 | 431.71 | 46.37 |
| 81.0 | 9.43 | 403.62 | 33.52 | 437.14 | 437.14 | 437.14 | 46.38 |
| 82.0 | 9.54 | 408.96 | 33.52 | 442.48 | 442.48 | 442.48 | 46.37 |
| 83.0 | 9.66 | 414.21 | 33.52 | 447.73 | 447.73 | 447.73 | 46.36 |
| 84.0 | 9.78 | 419.37 | 33.52 | 452.89 | 452.89 | 452.89 | 46.33 |
| 85.0 | 9.89 | 424.44 | 33.52 | 457.96 | 457.96 | 457.96 | 46.30 |
| 86.0 | 10.01 | 429.45 | 33.52 | 462.97 | 462.97 | 462.97 | 46.26 |
| 87.0 | 10.12 | 434.50 | 33.52 | 468.02 | 468.02 | 468.02 | 46.23 |
| 88.0 | 10.24 | 439.61 | 33.52 | 473.13 | 473.13 | 473.13 | 46.20 |
| 89.0 | 10.36 | 444.77 | 33.52 | 478.29 | 478.29 | 478.29 | 46.18 |
| 90.0 | 10.47 | 449.97 | 33.52 | 483.49 | 483.49 | 483.49 | 46.16 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |

| | | | |
|---|---|---|---|
| 0.2151E+00 | 0.1184E-03 | 0.4888E-03 | 0.1000E-04 |
| 0.1075E+01 | 0.5920E-03 | 0.2444E-02 | 0.5000E-04 |
| 0.2151E+01 | 0.1184E-02 | 0.4888E-02 | 0.1000E-03 |
| 0.1052E+03 | 0.5922E-01 | 0.2444E+00 | 0.5000E-02 |
| 0.1476E+03 | 0.8633E-01 | 0.3666E+00 | 0.7500E-02 |
| 0.1816E+03 | 0.1105E+00 | 0.4888E+00 | 0.1000E-01 |
| 0.2921E+03 | 0.2086E+00 | 0.1222E+01 | 0.2500E-01 |
| 0.3675E+03 | 0.3027E+00 | 0.2444E+01 | 0.5000E-01 |
| 0.3957E+03 | 0.3571E+00 | 0.3666E+01 | 0.7500E-01 |
| 0.4130E+03 | 0.4009E+00 | 0.4888E+01 | 0.1000E+00 |
| 0.4403E+03 | 0.5855E+00 | 0.1196E+02 | 0.2500E+00 |
| 0.4415E+03 | 0.8409E+00 | 0.1929E+02 | 0.5000E+00 |
| 0.4440E+03 | 0.9696E+00 | 0.2208E+02 | 0.6250E+00 |
| 0.4474E+03 | 0.1131E+01 | 0.2575E+02 | 0.7813E+00 |
| 0.4549E+03 | 0.1560E+01 | 0.3402E+02 | 0.1200E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.4094E+00 | 0.1998E-03 | 0.6983E-03 | 0.1000E-04 |
| 0.2047E+01 | 0.9989E-03 | 0.3492E-02 | 0.5000E-04 |
| 0.4094E+01 | 0.1998E-02 | 0.6983E-02 | 0.1000E-03 |
| 0.1807E+03 | 0.9596E-01 | 0.3492E+00 | 0.5000E-02 |
| 0.2342E+03 | 0.1332E+00 | 0.5237E+00 | 0.7500E-02 |
| 0.2700E+03 | 0.1621E+00 | 0.6983E+00 | 0.1000E-01 |
| 0.3644E+03 | 0.2641E+00 | 0.1746E+01 | 0.2500E-01 |
| 0.4235E+03 | 0.3543E+00 | 0.3492E+01 | 0.5000E-01 |
| 0.4428E+03 | 0.4023E+00 | 0.5237E+01 | 0.7500E-01 |
| 0.4520E+03 | 0.4383E+00 | 0.6983E+01 | 0.1000E+00 |
| 0.4646E+03 | 0.6065E+00 | 0.1662E+02 | 0.2500E+00 |
| 0.4679E+03 | 0.8638E+00 | 0.2422E+02 | 0.5000E+00 |
| 0.4697E+03 | 0.9913E+00 | 0.2603E+02 | 0.6250E+00 |
| 0.4729E+03 | 0.1152E+01 | 0.2918E+02 | 0.7813E+00 |
| 0.4799E+03 | 0.1581E+01 | 0.3620E+02 | 0.1200E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.9548E-01 | 0.6333E-04 | 0.2793E-03 | 0.1000E-04 |
| 0.4774E+00 | 0.3166E-03 | 0.1397E-02 | 0.5000E-04 |
| 0.9548E+00 | 0.6333E-03 | 0.2793E-02 | 0.1000E-03 |
| 0.4822E+02 | 0.3186E-01 | 0.1397E+00 | 0.5000E-02 |
| 0.7134E+02 | 0.4766E-01 | 0.2095E+00 | 0.7500E-02 |
| 0.9308E+02 | 0.6301E-01 | 0.2793E+00 | 0.1000E-01 |
| 0.1940E+03 | 0.1430E+00 | 0.6983E+00 | 0.2500E-01 |
| 0.2919E+03 | 0.2398E+00 | 0.1397E+01 | 0.5000E-01 |
| 0.3414E+03 | 0.3073E+00 | 0.2095E+01 | 0.7500E-01 |
| 0.3711E+03 | 0.3612E+00 | 0.2793E+01 | 0.1000E+00 |
| 0.4151E+03 | 0.5636E+00 | 0.7290E+01 | 0.2500E+00 |
| 0.4150E+03 | 0.8180E+00 | 0.1436E+02 | 0.5000E+00 |
| 0.4183E+03 | 0.9479E+00 | 0.1813E+02 | 0.6250E+00 |
| 0.4219E+03 | 0.1110E+01 | 0.2232E+02 | 0.7813E+00 |
| 0.4299E+03 | 0.1540E+01 | 0.3184E+02 | 0.1200E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Bent 2, 118” CIDH (NL only)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 2, 11.8" CIDH (comp) NL

PROPOSED DEPTH = 125.0 FT
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NUMBER OF LAYERS = 4
---

WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
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FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.600E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.200E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.612E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.200E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03

MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.690E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.360E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.360E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.710E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.362E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.710E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.170E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 5.87 | 1215.33 | 1221.20 | 1221.20 | 1221.20 | 69.88 |
| 7.0 | 19.69 | 14.52 | 1215.33 | 1229.85 | 1229.85 | 1229.85 | 62.46 |
| 8.0 | 22.50 | 23.17 | 1215.33 | 1238.50 | 1238.50 | 1238.50 | 55.04 |
| 9.0 | 25.32 | 32.70 | 1215.33 | 1248.03 | 1248.03 | 1248.03 | 49.30 |
| 10.0 | 28.13 | 43.08 | 1215.33 | 1258.40 | 1258.40 | 1258.40 | 44.74 |
| 11.0 | 30.94 | 54.27 | 1215.33 | 1269.60 | 1269.60 | 1269.60 | 41.03 |
| 12.0 | 33.75 | 66.25 | 1215.33 | 1281.58 | 1281.58 | 1281.58 | 37.97 |
| 13.0 | 36.57 | 78.99 | 1215.33 | 1294.31 | 1294.31 | 1294.31 | 35.39 |
| 14.0 | 39.38 | 92.46 | 1215.33 | 1307.78 | 1307.78 | 1307.78 | 33.21 |
| 15.0 | 42.19 | 106.63 | 1215.33 | 1321.96 | 1321.96 | 1321.96 | 31.33 |
| 16.0 | 45.01 | 121.48 | 1215.33 | 1336.81 | 1336.81 | 1336.81 | 29.70 |
| 17.0 | 47.82 | 136.99 | 1215.33 | 1352.32 | 1352.32 | 1352.32 | 28.28 |
| 18.0 | 50.63 | 153.13 | 1194.52 | 1347.65 | 1347.65 | 1347.65 | 26.62 |
| 19.0 | 53.45 | 169.88 | 1172.67 | 1342.55 | 1342.55 | 1342.55 | 25.12 |
| 20.0 | 56.26 | 187.22 | 1149.79 | 1337.00 | 1337.00 | 1337.00 | 23.77 |
| 21.0 | 59.07 | 205.11 | 1125.86 | 1330.97 | 1330.97 | 1330.97 | 22.53 |
| 22.0 | 61.88 | 223.55 | 1100.89 | 1324.45 | 1324.45 | 1324.45 | 21.40 |
| 23.0 | 64.70 | 242.52 | 1074.89 | 1317.40 | 1317.40 | 1317.40 | 20.36 |
| 24.0 | 67.51 | 261.98 | 1047.84 | 1309.82 | 1309.82 | 1309.82 | 19.40 |
| 25.0 | 70.32 | 281.92 | 1019.75 | 1301.67 | 1301.67 | 1301.67 | 18.51 |
| 26.0 | 73.14 | 302.33 | 990.62 | 1292.95 | 1292.95 | 1292.95 | 17.68 |
| 27.0 | 75.95 | 323.18 | 962.53 | 1285.71 | 1285.71 | 1285.71 | 16.93 |
| 28.0 | 78.76 | 344.45 | 937.57 | 1282.02 | 1282.02 | 1282.02 | 16.28 |
| 29.0 | 81.57 | 366.13 | 915.72 | 1281.85 | 1281.85 | 1281.85 | 15.71 |
| 30.0 | 84.39 | 388.20 | 896.99 | 1285.19 | 1285.19 | 1285.19 | 15.23 |
| 31.0 | 87.20 | 410.63 | 881.39 | 1292.02 | 1292.02 | 1292.02 | 14.82 |
| 32.0 | 90.01 | 433.42 | 868.91 | 1302.32 | 1302.32 | 1302.32 | 14.47 |
| 33.0 | 92.83 | 456.53 | 859.54 | 1316.08 | 1316.08 | 1316.08 | 14.18 |
| 34.0 | 95.64 | 479.97 | 853.30 | 1333.27 | 1333.27 | 1333.27 | 13.94 |
| 35.0 | 98.45 | 503.71 | 850.18 | 1353.89 | 1353.89 | 1353.89 | 13.75 |
| 36.0 | 101.26 | 527.73 | 850.18 | 1377.91 | 1377.91 | 1377.91 | 13.61 |
| 37.0 | 104.08 | 559.31 | 850.18 | 1409.49 | 1409.49 | 1409.49 | 13.54 |
| 38.0 | 106.89 | 590.88 | 850.18 | 1441.06 | 1441.06 | 1441.06 | 13.48 |
| 39.0 | 109.70 | 622.46 | 850.18 | 1472.64 | 1472.64 | 1472.64 | 13.42 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 40.0 | 112.52 | 654.04 | 850.18 | 1504.22 | 1504.22 | 1504.22 | 13.37 |
| 41.0 | 115.33 | 685.62 | 850.18 | 1535.80 | 1535.80 | 1535.80 | 13.32 |
| 42.0 | 118.14 | 717.19 | 850.18 | 1567.37 | 1567.37 | 1567.37 | 13.27 |
| 43.0 | 120.95 | 748.77 | 850.18 | 1598.95 | 1598.95 | 1598.95 | 13.22 |
| 44.0 | 123.77 | 780.35 | 850.18 | 1630.53 | 1630.53 | 1630.53 | 13.17 |
| 45.0 | 126.58 | 811.92 | 850.18 | 1662.10 | 1662.10 | 1662.10 | 13.13 |
| 46.0 | 129.39 | 843.50 | 850.18 | 1693.68 | 1693.68 | 1693.68 | 13.09 |
| 47.0 | 132.21 | 875.08 | 850.18 | 1725.26 | 1725.26 | 1725.26 | 13.05 |
| 48.0 | 135.02 | 906.66 | 850.18 | 1756.84 | 1756.84 | 1756.84 | 13.01 |
| 49.0 | 137.83 | 938.23 | 850.18 | 1788.41 | 1788.41 | 1788.41 | 12.98 |
| 50.0 | 140.65 | 969.81 | 850.18 | 1819.99 | 1819.99 | 1819.99 | 12.94 |
| 51.0 | 143.46 | 1001.39 | 850.18 | 1851.57 | 1851.57 | 1851.57 | 12.91 |
| 52.0 | 146.27 | 1032.96 | 850.18 | 1883.15 | 1883.15 | 1883.15 | 12.87 |
| 53.0 | 149.08 | 1064.54 | 912.52 | 1977.06 | 1977.06 | 1977.06 | 13.26 |
| 54.0 | 151.90 | 1096.12 | 977.98 | 2074.10 | 2074.10 | 2074.10 | 13.65 |
| 55.0 | 154.71 | 1127.70 | 1046.56 | 2174.25 | 2174.25 | 2174.25 | 14.05 |
| 56.0 | 157.52 | 1159.27 | 1118.25 | 2277.52 | 2277.52 | 2277.52 | 14.46 |
| 57.0 | 160.34 | 1190.85 | 1193.06 | 2383.91 | 2383.91 | 2383.91 | 14.87 |
| 58.0 | 163.15 | 1222.43 | 1270.99 | 2493.41 | 2493.41 | 2493.41 | 15.28 |
| 59.0 | 165.96 | 1254.00 | 1352.03 | 2606.04 | 2606.04 | 2606.04 | 15.70 |
| 60.0 | 168.77 | 1285.58 | 1436.19 | 2721.77 | 2721.77 | 2721.77 | 16.13 |
| 61.0 | 171.59 | 1317.16 | 1523.47 | 2840.63 | 2840.63 | 2840.63 | 16.56 |
| 62.0 | 174.40 | 1348.74 | 1607.63 | 2956.37 | 2956.37 | 2956.37 | 16.95 |
| 63.0 | 177.21 | 1380.31 | 1682.44 | 3062.76 | 3062.76 | 3062.76 | 17.28 |
| 64.0 | 180.03 | 1411.89 | 1747.90 | 3159.79 | 3159.79 | 3159.79 | 17.55 |
| 65.0 | 182.84 | 1443.47 | 1804.01 | 3247.48 | 3247.48 | 3247.48 | 17.76 |
| 66.0 | 185.65 | 1475.04 | 1850.77 | 3325.81 | 3325.81 | 3325.81 | 17.91 |
| 67.0 | 188.46 | 1506.62 | 1888.17 | 3394.79 | 3394.79 | 3394.79 | 18.01 |
| 68.0 | 191.28 | 1538.20 | 1916.22 | 3454.42 | 3454.42 | 3454.42 | 18.06 |
| 69.0 | 194.09 | 1569.78 | 1934.93 | 3504.70 | 3504.70 | 3504.70 | 18.06 |
| 70.0 | 196.90 | 1601.35 | 1944.28 | 3545.63 | 3545.63 | 3545.63 | 18.01 |
| 71.0 | 199.72 | 1632.93 | 1944.28 | 3577.21 | 3577.21 | 3577.21 | 17.91 |
| 72.0 | 202.53 | 1657.64 | 1944.28 | 3601.92 | 3601.92 | 3601.92 | 17.78 |
| 73.0 | 205.34 | 1682.16 | 1944.28 | 3626.43 | 3626.43 | 3626.43 | 17.66 |
| 74.0 | 208.15 | 1706.47 | 1944.28 | 3650.75 | 3650.75 | 3650.75 | 17.54 |
| 75.0 | 210.97 | 1730.57 | 1944.28 | 3674.85 | 3674.85 | 3674.85 | 17.42 |
| 76.0 | 213.78 | 1754.44 | 1944.28 | 3698.72 | 3698.72 | 3698.72 | 17.30 |
| 77.0 | 216.59 | 1778.07 | 1944.28 | 3722.35 | 3722.35 | 3722.35 | 17.19 |
| 78.0 | 219.41 | 1801.45 | 1944.28 | 3745.72 | 3745.72 | 3745.72 | 17.07 |
| 79.0 | 222.22 | 1824.56 | 1944.28 | 3768.84 | 3768.84 | 3768.84 | 16.96 |
| 80.0 | 225.03 | 1847.39 | 1944.28 | 3791.67 | 3791.67 | 3791.67 | 16.85 |
| 81.0 | 227.85 | 1869.94 | 1944.28 | 3814.21 | 3814.21 | 3814.21 | 16.74 |
| 82.0 | 230.66 | 1892.18 | 1944.28 | 3836.46 | 3836.46 | 3836.46 | 16.63 |
| 83.0 | 233.47 | 1914.11 | 1944.28 | 3858.38 | 3858.38 | 3858.38 | 16.53 |
| 84.0 | 236.28 | 1935.71 | 1944.28 | 3879.99 | 3879.99 | 3879.99 | 16.42 |
| 85.0 | 239.10 | 1956.98 | 1944.28 | 3901.25 | 3901.25 | 3901.25 | 16.32 |
| 86.0 | 241.91 | 1978.06 | 1944.28 | 3922.33 | 3922.33 | 3922.33 | 16.21 |
| 87.0 | 244.72 | 1999.40 | 1944.28 | 3943.68 | 3943.68 | 3943.68 | 16.11 |
| 88.0 | 247.54 | 2021.00 | 1944.28 | 3965.28 | 3965.28 | 3965.28 | 16.02 |
| 89.0 | 250.35 | 2042.86 | 1944.28 | 3987.14 | 3987.14 | 3987.14 | 15.93 |
| 90.0 | 253.16 | 2064.99 | 1944.28 | 4009.27 | 4009.27 | 4009.27 | 15.84 |
| 91.0 | 255.97 | 2087.38 | 1944.28 | 4031.65 | 4031.65 | 4031.65 | 15.75 |
| 92.0 | 258.79 | 2110.02 | 1944.28 | 4054.30 | 4054.30 | 4054.30 | 15.67 |
| 93.0 | 261.60 | 2132.93 | 1944.28 | 4077.21 | 4077.21 | 4077.21 | 15.59 |
| 94.0 | 264.41 | 2156.10 | 1944.28 | 4100.38 | 4100.38 | 4100.38 | 15.51 |
| 95.0 | 267.23 | 2179.53 | 1944.28 | 4123.81 | 4123.81 | 4123.81 | 15.43 |
| 96.0 | 270.04 | 2203.22 | 1944.28 | 4147.50 | 4147.50 | 4147.50 | 15.36 |
| 97.0 | 272.85 | 2227.17 | 1944.28 | 4171.45 | 4171.45 | 4171.45 | 15.29 |
| 98.0 | 275.66 | 2251.39 | 1944.28 | 4195.67 | 4195.67 | 4195.67 | 15.22 |
| 99.0 | 278.48 | 2275.86 | 1944.28 | 4220.14 | 4220.14 | 4220.14 | 15.15 |
| 100.0 | 281.29 | 2300.60 | 1944.28 | 4244.88 | 4244.88 | 4244.88 | 15.09 |
| 101.0 | 284.10 | 2325.59 | 1944.28 | 4269.87 | 4269.87 | 4269.87 | 15.03 |
| 102.0 | 286.92 | 2350.85 | 1944.28 | 4295.13 | 4295.13 | 4295.13 | 14.97 |
| 103.0 | 289.73 | 2376.37 | 1944.28 | 4320.65 | 4320.65 | 4320.65 | 14.91 |
| 104.0 | 292.54 | 2402.15 | 1944.28 | 4346.43 | 4346.43 | 4346.43 | 14.86 |
| 105.0 | 295.35 | 2428.19 | 1944.28 | 4372.47 | 4372.47 | 4372.47 | 14.80 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 106.0 | 298.17 | 2454.49 | 1944.28 | 4398.77 | 4398.77 | 4398.77 | 14.75 |
| 107.0 | 300.98 | 2481.06 | 1944.28 | 4425.33 | 4425.33 | 4425.33 | 14.70 |
| 108.0 | 303.79 | 2507.88 | 1944.28 | 4452.16 | 4452.16 | 4452.16 | 14.66 |
| 109.0 | 306.61 | 2534.97 | 1944.28 | 4479.24 | 4479.24 | 4479.24 | 14.61 |
| 110.0 | 309.42 | 2562.31 | 1944.28 | 4506.59 | 4506.59 | 4506.59 | 14.56 |
| 111.0 | 312.23 | 2589.92 | 1944.28 | 4534.20 | 4534.20 | 4534.20 | 14.52 |
| 112.0 | 315.04 | 2617.79 | 1944.28 | 4562.06 | 4562.06 | 4562.06 | 14.48 |
| 113.0 | 317.86 | 2645.92 | 1944.28 | 4590.19 | 4590.19 | 4590.19 | 14.44 |
| 114.0 | 320.67 | 2674.31 | 1944.28 | 4618.58 | 4618.58 | 4618.58 | 14.40 |
| 115.0 | 323.48 | 2702.96 | 1944.28 | 4647.24 | 4647.24 | 4647.24 | 14.37 |
| 116.0 | 326.30 | 2731.87 | 1944.28 | 4676.15 | 4676.15 | 4676.15 | 14.33 |
| 117.0 | 329.11 | 2761.04 | 1944.28 | 4705.32 | 4705.32 | 4705.32 | 14.30 |
| 118.0 | 331.92 | 2790.48 | 1944.28 | 4734.76 | 4734.76 | 4734.76 | 14.26 |
| 119.0 | 334.74 | 2820.18 | 1944.28 | 4764.45 | 4764.45 | 4764.45 | 14.23 |
| 120.0 | 337.55 | 2850.13 | 1944.28 | 4794.41 | 4794.41 | 4794.41 | 14.20 |
| 121.0 | 340.36 | 2880.35 | 1944.28 | 4824.63 | 4824.63 | 4824.63 | 14.18 |
| 122.0 | 343.17 | 2910.83 | 1944.28 | 4855.11 | 4855.11 | 4855.11 | 14.15 |
| 123.0 | 345.99 | 2941.57 | 1944.28 | 4885.85 | 4885.85 | 4885.85 | 14.12 |
| 124.0 | 348.80 | 2972.57 | 1944.28 | 4916.85 | 4916.85 | 4916.85 | 14.10 |
| 125.0 | 351.61 | 3003.83 | 1944.28 | 4948.11 | 4948.11 | 4948.11 | 14.07 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1225E+00 | 0.1525E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6126E+00 | 0.7626E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1225E+01 | 0.1525E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6126E+02 | 0.7626E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.9189E+02 | 0.1144E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1225E+03 | 0.1525E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3063E+03 | 0.3813E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6133E+03 | 0.7628E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.9203E+03 | 0.1144E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1216E+04 | 0.1524E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2226E+04 | 0.3507E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2899E+04 | 0.6371E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3552E+04 | 0.1362E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.4014E+04 | 0.3174E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4737E+04 | 0.6182E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1790E+00 | 0.1751E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.8948E+00 | 0.8757E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1790E+01 | 0.1751E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.8948E+02 | 0.8757E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1342E+03 | 0.1314E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1790E+03 | 0.1751E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4479E+03 | 0.4380E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.8966E+03 | 0.8762E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1344E+04 | 0.1314E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1743E+04 | 0.1742E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2818E+04 | 0.3793E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3377E+04 | 0.6638E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3971E+04 | 0.1390E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4420E+04 | 0.3200E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.5042E+04 | 0.6200E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.7176E-01 | 0.1315E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3588E+00 | 0.6576E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.7176E+00 | 0.1315E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3588E+02 | 0.6576E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5382E+02 | 0.9864E-02 | 0.2472E+01 | 0.7500E-02 |
| 0.7176E+02 | 0.1315E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1794E+03 | 0.3288E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3589E+03 | 0.6576E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5386E+03 | 0.9865E-01 | 0.2472E+02 | 0.7500E-01 |
| 0.7175E+03 | 0.1315E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1560E+04 | 0.3197E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2381E+04 | 0.6092E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.3131E+04 | 0.1334E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3607E+04 | 0.3148E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4432E+04 | 0.6165E+01 | 0.1847E+04 | 0.5900E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Bent 3, 118” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 3, 118"CIDH (comp) NL

PROPOSED DEPTH = 125.0 FT
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NUMBER OF LAYERS = 4
---

WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
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FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.101E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.130E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.101E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.130E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.786E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.280E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.280E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.680E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.387E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.680E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION

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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.99 | 671.72 | 675.71 | 675.71 | 675.71 | 39.12 |
| 7.0 | 19.69 | 9.88 | 706.34 | 716.22 | 716.22 | 716.22 | 36.37 |
| 8.0 | 22.50 | 15.77 | 740.97 | 756.74 | 756.74 | 756.74 | 33.63 |
| 9.0 | 25.32 | 22.25 | 768.67 | 790.92 | 790.92 | 790.92 | 31.24 |
| 10.0 | 28.13 | 29.31 | 794.27 | 823.59 | 823.59 | 823.59 | 29.28 |
| 11.0 | 30.94 | 36.93 | 812.86 | 849.79 | 849.79 | 849.79 | 27.46 |
| 12.0 | 33.75 | 45.08 | 824.42 | 869.51 | 869.51 | 869.51 | 25.76 |
| 13.0 | 36.57 | 53.75 | 828.94 | 882.69 | 882.69 | 882.69 | 24.14 |
| 14.0 | 39.38 | 63.15 | 833.33 | 896.47 | 896.47 | 896.47 | 22.76 |
| 15.0 | 42.19 | 73.25 | 837.57 | 910.82 | 910.82 | 910.82 | 21.59 |
| 16.0 | 45.01 | 84.02 | 841.66 | 925.69 | 925.69 | 925.69 | 20.57 |
| 17.0 | 47.82 | 95.45 | 845.59 | 941.04 | 941.04 | 941.04 | 19.68 |
| 18.0 | 50.63 | 107.51 | 849.34 | 956.85 | 956.85 | 956.85 | 18.90 |
| 19.0 | 53.45 | 120.17 | 852.73 | 972.90 | 972.90 | 972.90 | 18.20 |
| 20.0 | 56.26 | 133.42 | 855.29 | 988.72 | 988.72 | 988.72 | 17.57 |
| 21.0 | 59.07 | 147.24 | 857.11 | 1004.34 | 1004.34 | 1004.34 | 17.00 |
| 22.0 | 61.88 | 161.59 | 858.23 | 1019.83 | 1019.83 | 1019.83 | 16.48 |
| 23.0 | 64.70 | 176.47 | 858.74 | 1035.21 | 1035.21 | 1035.21 | 16.00 |
| 24.0 | 67.51 | 191.86 | 858.68 | 1050.54 | 1050.54 | 1050.54 | 15.56 |
| 25.0 | 70.32 | 207.72 | 858.13 | 1065.85 | 1065.85 | 1065.85 | 15.16 |
| 26.0 | 73.14 | 224.05 | 857.15 | 1081.20 | 1081.20 | 1081.20 | 14.78 |
| 27.0 | 75.95 | 240.83 | 855.79 | 1096.62 | 1096.62 | 1096.62 | 14.44 |
| 28.0 | 78.76 | 258.04 | 854.09 | 1112.13 | 1112.13 | 1112.13 | 14.12 |
| 29.0 | 81.57 | 289.62 | 852.78 | 1142.40 | 1142.40 | 1142.40 | 14.00 |
| 30.0 | 84.39 | 321.19 | 851.80 | 1172.99 | 1172.99 | 1172.99 | 13.90 |
| 31.0 | 87.20 | 352.77 | 851.10 | 1203.87 | 1203.87 | 1203.87 | 13.81 |
| 32.0 | 90.01 | 384.35 | 850.64 | 1234.99 | 1234.99 | 1234.99 | 13.72 |
| 33.0 | 92.83 | 415.92 | 850.36 | 1266.29 | 1266.29 | 1266.29 | 13.64 |
| 34.0 | 95.64 | 447.50 | 850.23 | 1297.73 | 1297.73 | 1297.73 | 13.57 |
| 35.0 | 98.45 | 479.08 | 850.18 | 1329.26 | 1329.26 | 1329.26 | 13.50 |
| 36.0 | 101.26 | 510.66 | 850.18 | 1360.84 | 1360.84 | 1360.84 | 13.44 |
| 37.0 | 104.08 | 542.23 | 850.18 | 1392.41 | 1392.41 | 1392.41 | 13.38 |
| 38.0 | 106.89 | 573.81 | 850.18 | 1423.99 | 1423.99 | 1423.99 | 13.32 |
| 39.0 | 109.70 | 605.39 | 850.18 | 1455.57 | 1455.57 | 1455.57 | 13.27 |
| 40.0 | 112.52 | 636.97 | 850.18 | 1487.15 | 1487.15 | 1487.15 | 13.22 |
| 41.0 | 115.33 | 668.54 | 850.18 | 1518.72 | 1518.72 | 1518.72 | 13.17 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42.0 | 118.14 | 700.12 | 850.18 | 1550.30 | 1550.30 | 1550.30 | 13.12 |
| 43.0 | 120.95 | 731.70 | 850.18 | 1581.88 | 1581.88 | 1581.88 | 13.08 |
| 44.0 | 123.77 | 763.27 | 850.18 | 1613.45 | 1613.45 | 1613.45 | 13.04 |
| 45.0 | 126.58 | 794.85 | 850.18 | 1645.03 | 1645.03 | 1645.03 | 13.00 |
| 46.0 | 129.39 | 826.43 | 850.18 | 1676.61 | 1676.61 | 1676.61 | 12.96 |
| 47.0 | 132.21 | 858.01 | 850.18 | 1708.19 | 1708.19 | 1708.19 | 12.92 |
| 48.0 | 135.02 | 889.58 | 850.18 | 1739.76 | 1739.76 | 1739.76 | 12.89 |
| 49.0 | 137.83 | 921.16 | 850.18 | 1771.34 | 1771.34 | 1771.34 | 12.85 |
| 50.0 | 140.65 | 952.74 | 912.52 | 1865.26 | 1865.26 | 1865.26 | 13.26 |
| 51.0 | 143.46 | 984.31 | 977.98 | 1962.30 | 1962.30 | 1962.30 | 13.68 |
| 52.0 | 146.27 | 1015.89 | 1046.56 | 2062.45 | 2062.45 | 2062.45 | 14.10 |
| 53.0 | 149.08 | 1047.47 | 1118.25 | 2165.72 | 2165.72 | 2165.72 | 14.53 |
| 54.0 | 151.90 | 1079.05 | 1193.06 | 2272.11 | 2272.11 | 2272.11 | 14.96 |
| 55.0 | 154.71 | 1110.62 | 1270.99 | 2381.61 | 2381.61 | 2381.61 | 15.39 |
| 56.0 | 157.52 | 1142.20 | 1352.03 | 2494.23 | 2494.23 | 2494.23 | 15.83 |
| 57.0 | 160.34 | 1173.78 | 1436.19 | 2609.97 | 2609.97 | 2609.97 | 16.28 |
| 58.0 | 163.15 | 1205.35 | 1523.47 | 2728.83 | 2728.83 | 2728.83 | 16.73 |
| 59.0 | 165.96 | 1236.93 | 1607.63 | 2844.56 | 2844.56 | 2844.56 | 17.14 |
| 60.0 | 168.77 | 1268.51 | 1682.44 | 2950.95 | 2950.95 | 2950.95 | 17.48 |
| 61.0 | 171.59 | 1300.09 | 1747.90 | 3047.99 | 3047.99 | 3047.99 | 17.76 |
| 62.0 | 174.40 | 1331.66 | 1804.01 | 3135.67 | 3135.67 | 3135.67 | 17.98 |
| 63.0 | 177.21 | 1363.24 | 1850.77 | 3214.01 | 3214.01 | 3214.01 | 18.14 |
| 64.0 | 180.03 | 1394.82 | 1888.17 | 3282.99 | 3282.99 | 3282.99 | 18.24 |
| 65.0 | 182.84 | 1426.39 | 1916.22 | 3342.62 | 3342.62 | 3342.62 | 18.28 |
| 66.0 | 185.65 | 1457.97 | 1934.93 | 3392.90 | 3392.90 | 3392.90 | 18.28 |
| 67.0 | 188.46 | 1489.55 | 1944.28 | 3433.83 | 3433.83 | 3433.83 | 18.22 |
| 68.0 | 191.28 | 1521.13 | 1944.28 | 3465.40 | 3465.40 | 3465.40 | 18.12 |
| 69.0 | 194.09 | 1544.46 | 1944.28 | 3488.74 | 3488.74 | 3488.74 | 17.97 |
| 70.0 | 196.90 | 1567.68 | 1944.28 | 3511.96 | 3511.96 | 3511.96 | 17.84 |
| 71.0 | 199.72 | 1590.77 | 1944.28 | 3535.05 | 3535.05 | 3535.05 | 17.70 |
| 72.0 | 202.53 | 1613.73 | 1944.28 | 3558.01 | 3558.01 | 3558.01 | 17.57 |
| 73.0 | 205.34 | 1636.53 | 1944.28 | 3580.81 | 3580.81 | 3580.81 | 17.44 |
| 74.0 | 208.15 | 1659.18 | 1944.28 | 3603.45 | 3603.45 | 3603.45 | 17.31 |
| 75.0 | 210.97 | 1681.64 | 1944.28 | 3625.92 | 3625.92 | 3625.92 | 17.19 |
| 76.0 | 213.78 | 1703.91 | 1944.28 | 3648.19 | 3648.19 | 3648.19 | 17.07 |
| 77.0 | 216.59 | 1725.98 | 1944.28 | 3670.26 | 3670.26 | 3670.26 | 16.95 |
| 78.0 | 219.41 | 1747.84 | 1944.28 | 3692.12 | 3692.12 | 3692.12 | 16.83 |
| 79.0 | 222.22 | 1769.47 | 1944.28 | 3713.74 | 3713.74 | 3713.74 | 16.71 |
| 80.0 | 225.03 | 1790.85 | 1944.28 | 3735.13 | 3735.13 | 3735.13 | 16.60 |
| 81.0 | 227.85 | 1811.99 | 1944.28 | 3756.27 | 3756.27 | 3756.27 | 16.49 |
| 82.0 | 230.66 | 1832.86 | 1944.28 | 3777.14 | 3777.14 | 3777.14 | 16.38 |
| 83.0 | 233.47 | 1853.45 | 1944.28 | 3797.73 | 3797.73 | 3797.73 | 16.27 |
| 84.0 | 236.28 | 1873.76 | 1944.28 | 3818.03 | 3818.03 | 3818.03 | 16.16 |
| 85.0 | 239.10 | 1893.76 | 1944.28 | 3838.04 | 3838.04 | 3838.04 | 16.05 |
| 86.0 | 241.91 | 1913.61 | 1944.28 | 3857.88 | 3857.88 | 3857.88 | 15.95 |
| 87.0 | 244.72 | 1933.71 | 1944.28 | 3877.99 | 3877.99 | 3877.99 | 15.85 |
| 88.0 | 247.54 | 1954.08 | 1944.28 | 3898.36 | 3898.36 | 3898.36 | 15.75 |
| 89.0 | 250.35 | 1974.71 | 1944.28 | 3918.98 | 3918.98 | 3918.98 | 15.65 |
| 90.0 | 253.16 | 1995.59 | 1944.28 | 3939.87 | 3939.87 | 3939.87 | 15.56 |
| 91.0 | 255.97 | 2016.75 | 1944.28 | 3961.02 | 3961.02 | 3961.02 | 15.47 |
| 92.0 | 258.79 | 2038.16 | 1944.28 | 3982.43 | 3982.43 | 3982.43 | 15.39 |
| 93.0 | 261.60 | 2059.83 | 1944.28 | 4004.11 | 4004.11 | 4004.11 | 15.31 |
| 94.0 | 264.41 | 2081.76 | 1944.28 | 4026.04 | 4026.04 | 4026.04 | 15.23 |
| 95.0 | 267.23 | 2103.96 | 1944.28 | 4048.23 | 4048.23 | 4048.23 | 15.15 |
| 96.0 | 270.04 | 2126.41 | 1944.28 | 4070.69 | 4070.69 | 4070.69 | 15.07 |
| 97.0 | 272.85 | 2149.13 | 1944.28 | 4093.41 | 4093.41 | 4093.41 | 15.00 |
| 98.0 | 275.66 | 2172.11 | 1944.28 | 4116.38 | 4116.38 | 4116.38 | 14.93 |
| 99.0 | 278.48 | 2195.34 | 1944.28 | 4139.62 | 4139.62 | 4139.62 | 14.87 |
| 100.0 | 281.29 | 2218.84 | 1944.28 | 4163.12 | 4163.12 | 4163.12 | 14.80 |
| 101.0 | 284.10 | 2242.61 | 1944.28 | 4186.88 | 4186.88 | 4186.88 | 14.74 |
| 102.0 | 286.92 | 2266.63 | 1944.28 | 4210.90 | 4210.90 | 4210.90 | 14.68 |
| 103.0 | 289.73 | 2290.91 | 1944.28 | 4235.19 | 4235.19 | 4235.19 | 14.62 |
| 104.0 | 292.54 | 2315.45 | 1944.28 | 4259.73 | 4259.73 | 4259.73 | 14.56 |
| 105.0 | 295.35 | 2340.26 | 1944.28 | 4284.54 | 4284.54 | 4284.54 | 14.51 |
| 106.0 | 298.17 | 2365.33 | 1944.28 | 4309.60 | 4309.60 | 4309.60 | 14.45 |
| 107.0 | 300.98 | 2390.65 | 1944.28 | 4334.93 | 4334.93 | 4334.93 | 14.40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 108.0 | 303.79 | 2416.24 | 1944.28 | 4360.52 | 4360.52 | 4360.52 | 14.35 |
| 109.0 | 306.61 | 2442.09 | 1944.28 | 4386.37 | 4386.37 | 4386.37 | 14.31 |
| 110.0 | 309.42 | 2468.20 | 1944.28 | 4412.48 | 4412.48 | 4412.48 | 14.26 |
| 111.0 | 312.23 | 2494.57 | 1944.28 | 4438.85 | 4438.85 | 4438.85 | 14.22 |
| 112.0 | 315.04 | 2521.20 | 1944.28 | 4465.48 | 4465.48 | 4465.48 | 14.17 |
| 113.0 | 317.86 | 2548.10 | 1944.28 | 4492.38 | 4492.38 | 4492.38 | 14.13 |
| 114.0 | 320.67 | 2575.25 | 1944.28 | 4519.53 | 4519.53 | 4519.53 | 14.09 |
| 115.0 | 323.48 | 2602.67 | 1944.28 | 4546.95 | 4546.95 | 4546.95 | 14.06 |
| 116.0 | 326.30 | 2630.35 | 1944.28 | 4574.62 | 4574.62 | 4574.62 | 14.02 |
| 117.0 | 329.11 | 2658.28 | 1944.28 | 4602.56 | 4602.56 | 4602.56 | 13.98 |
| 118.0 | 331.92 | 2686.48 | 1944.28 | 4630.76 | 4630.76 | 4630.76 | 13.95 |
| 119.0 | 334.74 | 2714.94 | 1944.28 | 4659.22 | 4659.22 | 4659.22 | 13.92 |
| 120.0 | 337.55 | 2743.66 | 1944.28 | 4687.94 | 4687.94 | 4687.94 | 13.89 |
| 121.0 | 340.36 | 2772.65 | 1944.28 | 4716.92 | 4716.92 | 4716.92 | 13.86 |
| 122.0 | 343.17 | 2801.89 | 1944.28 | 4746.17 | 4746.17 | 4746.17 | 13.83 |
| 123.0 | 345.99 | 2831.39 | 1944.28 | 4775.67 | 4775.67 | 4775.67 | 13.80 |
| 124.0 | 348.80 | 2861.16 | 1944.28 | 4805.44 | 4805.44 | 4805.44 | 13.78 |
| 125.0 | 351.61 | 2891.18 | 1944.28 | 4835.46 | 4835.46 | 4835.46 | 13.75 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1214E+00 | 0.1511E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6070E+00 | 0.7556E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1214E+01 | 0.1511E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6070E+02 | 0.7556E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.9105E+02 | 0.1133E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1214E+03 | 0.1511E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3035E+03 | 0.3778E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6077E+03 | 0.7557E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.9118E+03 | 0.1134E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1204E+04 | 0.1509E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2179E+04 | 0.3476E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2816E+04 | 0.6329E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3442E+04 | 0.1357E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3890E+04 | 0.3169E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4614E+04 | 0.6177E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1783E+00 | 0.1733E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.8914E+00 | 0.8665E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1783E+01 | 0.1733E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.8914E+02 | 0.8665E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1337E+03 | 0.1300E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1783E+03 | 0.1733E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4462E+03 | 0.4334E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.8932E+03 | 0.8670E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1340E+04 | 0.1301E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1728E+04 | 0.1721E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2737E+04 | 0.3751E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3275E+04 | 0.6588E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3863E+04 | 0.1385E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4299E+04 | 0.3195E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4921E+04 | 0.6195E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.7041E-01 | 0.1306E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3520E+00 | 0.6528E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.7041E+00 | 0.1306E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3520E+02 | 0.6528E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5281E+02 | 0.9793E-02 | 0.2472E+01 | 0.7500E-02 |
| 0.7041E+02 | 0.1306E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1760E+03 | 0.3264E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3521E+03 | 0.6529E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5284E+03 | 0.9793E-01 | 0.2472E+02 | 0.7500E-01 |
| 0.7043E+03 | 0.1306E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1531E+04 | 0.3176E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2319E+04 | 0.6057E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.3022E+04 | 0.1329E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3481E+04 | 0.3143E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4307E+04 | 0.6160E+01 | 0.1847E+04 | 0.5900E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 3, 118"CIDH (comp) LQ

PROPOSED DEPTH = 125.0 FT
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NUMBER OF LAYERS = 4
---

WATER TABLE DEPTH = 0.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.600E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.759E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.130E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.101E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.130E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.786E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.280E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.280E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.680E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.387E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.680E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION

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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.40 | 690.94 | 694.34 | 694.34 | 694.34 | 40.09 |
| 7.0 | 19.69 | 6.80 | 720.80 | 727.60 | 727.60 | 727.60 | 36.95 |
| 8.0 | 22.50 | 10.20 | 750.66 | 760.85 | 760.85 | 760.85 | 33.81 |
| 9.0 | 25.32 | 13.59 | 774.51 | 788.11 | 788.11 | 788.11 | 31.13 |
| 10.0 | 28.13 | 16.99 | 797.21 | 814.21 | 814.21 | 814.21 | 28.95 |
| 11.0 | 30.94 | 20.39 | 813.85 | 834.24 | 834.24 | 834.24 | 26.96 |
| 12.0 | 33.75 | 23.79 | 824.42 | 848.21 | 848.21 | 848.21 | 25.13 |
| 13.0 | 36.57 | 27.19 | 828.94 | 856.13 | 856.13 | 856.13 | 23.41 |
| 14.0 | 39.38 | 36.58 | 833.33 | 869.91 | 869.91 | 869.91 | 22.09 |
| 15.0 | 42.19 | 46.68 | 837.57 | 884.25 | 884.25 | 884.25 | 20.96 |
| 16.0 | 45.01 | 57.46 | 841.66 | 899.12 | 899.12 | 899.12 | 19.98 |
| 17.0 | 47.82 | 68.89 | 845.59 | 914.48 | 914.48 | 914.48 | 19.12 |
| 18.0 | 50.63 | 80.94 | 849.34 | 930.29 | 930.29 | 930.29 | 18.37 |
| 19.0 | 53.45 | 93.61 | 852.73 | 946.34 | 946.34 | 946.34 | 17.71 |
| 20.0 | 56.26 | 106.86 | 855.29 | 962.15 | 962.15 | 962.15 | 17.10 |
| 21.0 | 59.07 | 120.67 | 857.11 | 977.78 | 977.78 | 977.78 | 16.55 |
| 22.0 | 61.88 | 135.03 | 858.23 | 993.26 | 993.26 | 993.26 | 16.05 |
| 23.0 | 64.70 | 149.91 | 858.74 | 1008.64 | 1008.64 | 1008.64 | 15.59 |
| 24.0 | 67.51 | 165.29 | 858.68 | 1023.97 | 1023.97 | 1023.97 | 15.17 |
| 25.0 | 70.32 | 181.16 | 858.13 | 1039.29 | 1039.29 | 1039.29 | 14.78 |
| 26.0 | 73.14 | 197.49 | 857.15 | 1054.64 | 1054.64 | 1054.64 | 14.42 |
| 27.0 | 75.95 | 214.27 | 855.79 | 1070.06 | 1070.06 | 1070.06 | 14.09 |
| 28.0 | 78.76 | 231.47 | 854.09 | 1085.57 | 1085.57 | 1085.57 | 13.78 |
| 29.0 | 81.57 | 263.05 | 852.78 | 1115.83 | 1115.83 | 1115.83 | 13.68 |
| 30.0 | 84.39 | 294.63 | 851.80 | 1146.43 | 1146.43 | 1146.43 | 13.59 |
| 31.0 | 87.20 | 326.21 | 851.10 | 1177.31 | 1177.31 | 1177.31 | 13.50 |
| 32.0 | 90.01 | 357.78 | 850.64 | 1208.42 | 1208.42 | 1208.42 | 13.43 |
| 33.0 | 92.83 | 389.36 | 850.36 | 1239.72 | 1239.72 | 1239.72 | 13.36 |
| 34.0 | 95.64 | 420.94 | 850.23 | 1271.16 | 1271.16 | 1271.16 | 13.29 |
| 35.0 | 98.45 | 452.51 | 850.18 | 1302.70 | 1302.70 | 1302.70 | 13.23 |
| 36.0 | 101.26 | 484.09 | 850.18 | 1334.27 | 1334.27 | 1334.27 | 13.18 |
| 37.0 | 104.08 | 515.67 | 850.18 | 1365.85 | 1365.85 | 1365.85 | 13.12 |
| 38.0 | 106.89 | 547.25 | 850.18 | 1397.43 | 1397.43 | 1397.43 | 13.07 |
| 39.0 | 109.70 | 578.82 | 850.18 | 1429.00 | 1429.00 | 1429.00 | 13.03 |
| 40.0 | 112.52 | 610.40 | 850.18 | 1460.58 | 1460.58 | 1460.58 | 12.98 |
| 41.0 | 115.33 | 641.98 | 850.18 | 1492.16 | 1492.16 | 1492.16 | 12.94 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42.0 | 118.14 | 673.56 | 850.18 | 1523.74 | 1523.74 | 1523.74 | 12.90 |
| 43.0 | 120.95 | 705.13 | 850.18 | 1555.31 | 1555.31 | 1555.31 | 12.86 |
| 44.0 | 123.77 | 736.71 | 850.18 | 1586.89 | 1586.89 | 1586.89 | 12.82 |
| 45.0 | 126.58 | 768.29 | 850.18 | 1618.47 | 1618.47 | 1618.47 | 12.79 |
| 46.0 | 129.39 | 799.86 | 850.18 | 1650.04 | 1650.04 | 1650.04 | 12.75 |
| 47.0 | 132.21 | 831.44 | 850.18 | 1681.62 | 1681.62 | 1681.62 | 12.72 |
| 48.0 | 135.02 | 863.02 | 850.18 | 1713.20 | 1713.20 | 1713.20 | 12.69 |
| 49.0 | 137.83 | 894.60 | 850.18 | 1744.78 | 1744.78 | 1744.78 | 12.66 |
| 50.0 | 140.65 | 926.17 | 912.52 | 1838.70 | 1838.70 | 1838.70 | 13.07 |
| 51.0 | 143.46 | 957.75 | 977.98 | 1935.73 | 1935.73 | 1935.73 | 13.49 |
| 52.0 | 146.27 | 989.33 | 1046.56 | 2035.88 | 2035.88 | 2035.88 | 13.92 |
| 53.0 | 149.08 | 1020.90 | 1118.25 | 2139.15 | 2139.15 | 2139.15 | 14.35 |
| 54.0 | 151.90 | 1052.48 | 1193.06 | 2245.54 | 2245.54 | 2245.54 | 14.78 |
| 55.0 | 154.71 | 1084.06 | 1270.99 | 2355.05 | 2355.05 | 2355.05 | 15.22 |
| 56.0 | 157.52 | 1115.64 | 1352.03 | 2467.67 | 2467.67 | 2467.67 | 15.67 |
| 57.0 | 160.34 | 1147.21 | 1436.19 | 2583.41 | 2583.41 | 2583.41 | 16.11 |
| 58.0 | 163.15 | 1178.79 | 1523.47 | 2702.26 | 2702.26 | 2702.26 | 16.56 |
| 59.0 | 165.96 | 1210.37 | 1607.63 | 2818.00 | 2818.00 | 2818.00 | 16.98 |
| 60.0 | 168.77 | 1241.94 | 1682.44 | 2924.39 | 2924.39 | 2924.39 | 17.33 |
| 61.0 | 171.59 | 1273.52 | 1747.90 | 3021.42 | 3021.42 | 3021.42 | 17.61 |
| 62.0 | 174.40 | 1305.10 | 1804.01 | 3109.11 | 3109.11 | 3109.11 | 17.83 |
| 63.0 | 177.21 | 1336.68 | 1850.77 | 3187.44 | 3187.44 | 3187.44 | 17.99 |
| 64.0 | 180.03 | 1368.25 | 1888.17 | 3256.42 | 3256.42 | 3256.42 | 18.09 |
| 65.0 | 182.84 | 1399.83 | 1916.22 | 3316.05 | 3316.05 | 3316.05 | 18.14 |
| 66.0 | 185.65 | 1431.41 | 1934.93 | 3366.33 | 3366.33 | 3366.33 | 18.13 |
| 67.0 | 188.46 | 1462.98 | 1944.28 | 3407.26 | 3407.26 | 3407.26 | 18.08 |
| 68.0 | 191.28 | 1494.56 | 1944.28 | 3438.84 | 3438.84 | 3438.84 | 17.98 |
| 69.0 | 194.09 | 1517.89 | 1944.28 | 3462.17 | 3462.17 | 3462.17 | 17.84 |
| 70.0 | 196.90 | 1541.11 | 1944.28 | 3485.39 | 3485.39 | 3485.39 | 17.70 |
| 71.0 | 199.72 | 1564.21 | 1944.28 | 3508.49 | 3508.49 | 3508.49 | 17.57 |
| 72.0 | 202.53 | 1587.17 | 1944.28 | 3531.44 | 3531.44 | 3531.44 | 17.44 |
| 73.0 | 205.34 | 1609.97 | 1944.28 | 3554.25 | 3554.25 | 3554.25 | 17.31 |
| 74.0 | 208.15 | 1632.61 | 1944.28 | 3576.89 | 3576.89 | 3576.89 | 17.18 |
| 75.0 | 210.97 | 1655.07 | 1944.28 | 3599.35 | 3599.35 | 3599.35 | 17.06 |
| 76.0 | 213.78 | 1677.35 | 1944.28 | 3621.63 | 3621.63 | 3621.63 | 16.94 |
| 77.0 | 216.59 | 1699.42 | 1944.28 | 3643.70 | 3643.70 | 3643.70 | 16.82 |
| 78.0 | 219.41 | 1721.27 | 1944.28 | 3665.55 | 3665.55 | 3665.55 | 16.71 |
| 79.0 | 222.22 | 1742.90 | 1944.28 | 3687.18 | 3687.18 | 3687.18 | 16.59 |
| 80.0 | 225.03 | 1764.29 | 1944.28 | 3708.57 | 3708.57 | 3708.57 | 16.48 |
| 81.0 | 227.85 | 1785.42 | 1944.28 | 3729.70 | 3729.70 | 3729.70 | 16.37 |
| 82.0 | 230.66 | 1806.29 | 1944.28 | 3750.57 | 3750.57 | 3750.57 | 16.26 |
| 83.0 | 233.47 | 1826.89 | 1944.28 | 3771.16 | 3771.16 | 3771.16 | 16.15 |
| 84.0 | 236.28 | 1847.19 | 1944.28 | 3791.47 | 3791.47 | 3791.47 | 16.05 |
| 85.0 | 239.10 | 1867.20 | 1944.28 | 3811.47 | 3811.47 | 3811.47 | 15.94 |
| 86.0 | 241.91 | 1887.04 | 1944.28 | 3831.32 | 3831.32 | 3831.32 | 15.84 |
| 87.0 | 244.72 | 1907.15 | 1944.28 | 3851.42 | 3851.42 | 3851.42 | 15.74 |
| 88.0 | 247.54 | 1927.51 | 1944.28 | 3871.79 | 3871.79 | 3871.79 | 15.64 |
| 89.0 | 250.35 | 1948.14 | 1944.28 | 3892.42 | 3892.42 | 3892.42 | 15.55 |
| 90.0 | 253.16 | 1969.03 | 1944.28 | 3913.31 | 3913.31 | 3913.31 | 15.46 |
| 91.0 | 255.97 | 1990.18 | 1944.28 | 3934.46 | 3934.46 | 3934.46 | 15.37 |
| 92.0 | 258.79 | 2011.59 | 1944.28 | 3955.87 | 3955.87 | 3955.87 | 15.29 |
| 93.0 | 261.60 | 2033.26 | 1944.28 | 3977.54 | 3977.54 | 3977.54 | 15.20 |
| 94.0 | 264.41 | 2055.20 | 1944.28 | 3999.48 | 3999.48 | 3999.48 | 15.13 |
| 95.0 | 267.23 | 2077.39 | 1944.28 | 4021.67 | 4021.67 | 4021.67 | 15.05 |
| 96.0 | 270.04 | 2099.85 | 1944.28 | 4044.13 | 4044.13 | 4044.13 | 14.98 |
| 97.0 | 272.85 | 2122.56 | 1944.28 | 4066.84 | 4066.84 | 4066.84 | 14.90 |
| 98.0 | 275.66 | 2145.54 | 1944.28 | 4089.82 | 4089.82 | 4089.82 | 14.84 |
| 99.0 | 278.48 | 2168.78 | 1944.28 | 4113.06 | 4113.06 | 4113.06 | 14.77 |
| 100.0 | 281.29 | 2192.28 | 1944.28 | 4136.56 | 4136.56 | 4136.56 | 14.71 |
| 101.0 | 284.10 | 2216.04 | 1944.28 | 4160.32 | 4160.32 | 4160.32 | 14.64 |
| 102.0 | 286.92 | 2240.06 | 1944.28 | 4184.34 | 4184.34 | 4184.34 | 14.58 |
| 103.0 | 289.73 | 2264.35 | 1944.28 | 4208.62 | 4208.62 | 4208.62 | 14.53 |
| 104.0 | 292.54 | 2288.89 | 1944.28 | 4233.17 | 4233.17 | 4233.17 | 14.47 |
| 105.0 | 295.35 | 2313.69 | 1944.28 | 4257.97 | 4257.97 | 4257.97 | 14.42 |
| 106.0 | 298.17 | 2338.76 | 1944.28 | 4283.04 | 4283.04 | 4283.04 | 14.36 |
| 107.0 | 300.98 | 2364.09 | 1944.28 | 4308.37 | 4308.37 | 4308.37 | 14.31 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 108.0 | 303.79 | 2389.68 | 1944.28 | 4333.95 | 4333.95 | 4333.95 | 14.27 |
| 109.0 | 306.61 | 2415.53 | 1944.28 | 4359.80 | 4359.80 | 4359.80 | 14.22 |
| 110.0 | 309.42 | 2441.64 | 1944.28 | 4385.91 | 4385.91 | 4385.91 | 14.17 |
| 111.0 | 312.23 | 2468.01 | 1944.28 | 4412.29 | 4412.29 | 4412.29 | 14.13 |
| 112.0 | 315.04 | 2494.64 | 1944.28 | 4438.92 | 4438.92 | 4438.92 | 14.09 |
| 113.0 | 317.86 | 2521.53 | 1944.28 | 4465.81 | 4465.81 | 4465.81 | 14.05 |
| 114.0 | 320.67 | 2548.69 | 1944.28 | 4492.97 | 4492.97 | 4492.97 | 14.01 |
| 115.0 | 323.48 | 2576.10 | 1944.28 | 4520.38 | 4520.38 | 4520.38 | 13.97 |
| 116.0 | 326.30 | 2603.78 | 1944.28 | 4548.06 | 4548.06 | 4548.06 | 13.94 |
| 117.0 | 329.11 | 2631.72 | 1944.28 | 4576.00 | 4576.00 | 4576.00 | 13.90 |
| 118.0 | 331.92 | 2659.92 | 1944.28 | 4604.20 | 4604.20 | 4604.20 | 13.87 |
| 119.0 | 334.74 | 2688.38 | 1944.28 | 4632.66 | 4632.66 | 4632.66 | 13.84 |
| 120.0 | 337.55 | 2717.10 | 1944.28 | 4661.38 | 4661.38 | 4661.38 | 13.81 |
| 121.0 | 340.36 | 2746.08 | 1944.28 | 4690.36 | 4690.36 | 4690.36 | 13.78 |
| 122.0 | 343.17 | 2775.32 | 1944.28 | 4719.60 | 4719.60 | 4719.60 | 13.75 |
| 123.0 | 345.99 | 2804.83 | 1944.28 | 4749.11 | 4749.11 | 4749.11 | 13.73 |
| 124.0 | 348.80 | 2834.59 | 1944.28 | 4778.87 | 4778.87 | 4778.87 | 13.70 |
| 125.0 | 351.61 | 2864.62 | 1944.28 | 4808.90 | 4808.90 | 4808.90 | 13.68 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1210E+00 | 0.1511E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6048E+00 | 0.7554E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1210E+01 | 0.1511E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6048E+02 | 0.7554E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.9071E+02 | 0.1133E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1210E+03 | 0.1511E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3024E+03 | 0.3777E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6055E+03 | 0.7556E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.9085E+03 | 0.1133E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1198E+04 | 0.1509E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2164E+04 | 0.3475E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2792E+04 | 0.6327E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3413E+04 | 0.1357E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3857E+04 | 0.3169E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4581E+04 | 0.6177E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1779E+00 | 0.1733E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.8894E+00 | 0.8663E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1779E+01 | 0.1733E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.8894E+02 | 0.8663E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1334E+03 | 0.1300E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1779E+03 | 0.1733E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4452E+03 | 0.4333E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.8912E+03 | 0.8668E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1336E+04 | 0.1300E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1719E+04 | 0.1721E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2713E+04 | 0.3749E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3246E+04 | 0.6586E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3833E+04 | 0.1384E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4266E+04 | 0.3195E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4888E+04 | 0.6195E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.6998E-01 | 0.1305E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3499E+00 | 0.6527E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.6998E+00 | 0.1305E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3499E+02 | 0.6527E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5248E+02 | 0.9790E-02 | 0.2472E+01 | 0.7500E-02 |
| 0.6998E+02 | 0.1305E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1749E+03 | 0.3263E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3500E+03 | 0.6527E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5252E+03 | 0.9791E-01 | 0.2472E+02 | 0.7500E-01 |
| 0.7000E+03 | 0.1306E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1522E+04 | 0.3175E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2300E+04 | 0.6056E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2992E+04 | 0.1329E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3448E+04 | 0.3143E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4274E+04 | 0.6160E+01 | 0.1847E+04 | 0.5900E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Bent 4, 118” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 4, 118"'CIDH (comp) NL

PROPOSED DEPTH = 135.0 FT
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NUMBER OF LAYERS = 4
---

WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.101E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.130E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.101E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.130E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.786E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.280E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.280E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.680E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.387E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.680E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION

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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.99 | 671.72 | 675.71 | 675.71 | 675.71 | 39.12 |
| 7.0 | 19.69 | 9.88 | 706.34 | 716.22 | 716.22 | 716.22 | 36.37 |
| 8.0 | 22.50 | 15.77 | 740.97 | 756.74 | 756.74 | 756.74 | 33.63 |
| 9.0 | 25.32 | 22.25 | 768.67 | 790.92 | 790.92 | 790.92 | 31.24 |
| 10.0 | 28.13 | 29.31 | 794.27 | 823.59 | 823.59 | 823.59 | 29.28 |
| 11.0 | 30.94 | 36.93 | 812.86 | 849.79 | 849.79 | 849.79 | 27.46 |
| 12.0 | 33.75 | 45.08 | 824.42 | 869.51 | 869.51 | 869.51 | 25.76 |
| 13.0 | 36.57 | 53.75 | 828.94 | 882.69 | 882.69 | 882.69 | 24.14 |
| 14.0 | 39.38 | 63.15 | 833.33 | 896.47 | 896.47 | 896.47 | 22.76 |
| 15.0 | 42.19 | 73.25 | 837.57 | 910.82 | 910.82 | 910.82 | 21.59 |
| 16.0 | 45.01 | 84.02 | 841.66 | 925.69 | 925.69 | 925.69 | 20.57 |
| 17.0 | 47.82 | 95.45 | 845.59 | 941.04 | 941.04 | 941.04 | 19.68 |
| 18.0 | 50.63 | 107.51 | 849.34 | 956.85 | 956.85 | 956.85 | 18.90 |
| 19.0 | 53.45 | 120.17 | 852.73 | 972.90 | 972.90 | 972.90 | 18.20 |
| 20.0 | 56.26 | 133.42 | 855.29 | 988.72 | 988.72 | 988.72 | 17.57 |
| 21.0 | 59.07 | 147.24 | 857.11 | 1004.34 | 1004.34 | 1004.34 | 17.00 |
| 22.0 | 61.88 | 161.59 | 858.23 | 1019.83 | 1019.83 | 1019.83 | 16.48 |
| 23.0 | 64.70 | 176.47 | 858.74 | 1035.21 | 1035.21 | 1035.21 | 16.00 |
| 24.0 | 67.51 | 191.86 | 858.68 | 1050.54 | 1050.54 | 1050.54 | 15.56 |
| 25.0 | 70.32 | 207.72 | 858.13 | 1065.85 | 1065.85 | 1065.85 | 15.16 |
| 26.0 | 73.14 | 224.05 | 857.15 | 1081.20 | 1081.20 | 1081.20 | 14.78 |
| 27.0 | 75.95 | 240.83 | 855.79 | 1096.62 | 1096.62 | 1096.62 | 14.44 |
| 28.0 | 78.76 | 258.04 | 854.09 | 1112.13 | 1112.13 | 1112.13 | 14.12 |
| 29.0 | 81.57 | 289.62 | 852.78 | 1142.40 | 1142.40 | 1142.40 | 14.00 |
| 30.0 | 84.39 | 321.19 | 851.80 | 1172.99 | 1172.99 | 1172.99 | 13.90 |
| 31.0 | 87.20 | 352.77 | 851.10 | 1203.87 | 1203.87 | 1203.87 | 13.81 |
| 32.0 | 90.01 | 384.35 | 850.64 | 1234.99 | 1234.99 | 1234.99 | 13.72 |
| 33.0 | 92.83 | 415.92 | 850.36 | 1266.29 | 1266.29 | 1266.29 | 13.64 |
| 34.0 | 95.64 | 447.50 | 850.23 | 1297.73 | 1297.73 | 1297.73 | 13.57 |
| 35.0 | 98.45 | 479.08 | 850.18 | 1329.26 | 1329.26 | 1329.26 | 13.50 |
| 36.0 | 101.26 | 510.66 | 850.18 | 1360.84 | 1360.84 | 1360.84 | 13.44 |
| 37.0 | 104.08 | 542.23 | 850.18 | 1392.41 | 1392.41 | 1392.41 | 13.38 |
| 38.0 | 106.89 | 573.81 | 850.18 | 1423.99 | 1423.99 | 1423.99 | 13.32 |
| 39.0 | 109.70 | 605.39 | 850.18 | 1455.57 | 1455.57 | 1455.57 | 13.27 |
| 40.0 | 112.52 | 636.97 | 850.18 | 1487.15 | 1487.15 | 1487.15 | 13.22 |
| 41.0 | 115.33 | 668.54 | 850.18 | 1518.72 | 1518.72 | 1518.72 | 13.17 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42.0 | 118.14 | 700.12 | 850.18 | 1550.30 | 1550.30 | 1550.30 | 13.12 |
| 43.0 | 120.95 | 731.70 | 850.18 | 1581.88 | 1581.88 | 1581.88 | 13.08 |
| 44.0 | 123.77 | 763.27 | 850.18 | 1613.45 | 1613.45 | 1613.45 | 13.04 |
| 45.0 | 126.58 | 794.85 | 850.18 | 1645.03 | 1645.03 | 1645.03 | 13.00 |
| 46.0 | 129.39 | 826.43 | 850.18 | 1676.61 | 1676.61 | 1676.61 | 12.96 |
| 47.0 | 132.21 | 858.01 | 850.18 | 1708.19 | 1708.19 | 1708.19 | 12.92 |
| 48.0 | 135.02 | 889.58 | 850.18 | 1739.76 | 1739.76 | 1739.76 | 12.89 |
| 49.0 | 137.83 | 921.16 | 850.18 | 1771.34 | 1771.34 | 1771.34 | 12.85 |
| 50.0 | 140.65 | 952.74 | 912.52 | 1865.26 | 1865.26 | 1865.26 | 13.26 |
| 51.0 | 143.46 | 984.31 | 977.98 | 1962.30 | 1962.30 | 1962.30 | 13.68 |
| 52.0 | 146.27 | 1015.89 | 1046.56 | 2062.45 | 2062.45 | 2062.45 | 14.10 |
| 53.0 | 149.08 | 1047.47 | 1118.25 | 2165.72 | 2165.72 | 2165.72 | 14.53 |
| 54.0 | 151.90 | 1079.05 | 1193.06 | 2272.11 | 2272.11 | 2272.11 | 14.96 |
| 55.0 | 154.71 | 1110.62 | 1270.99 | 2381.61 | 2381.61 | 2381.61 | 15.39 |
| 56.0 | 157.52 | 1142.20 | 1352.03 | 2494.23 | 2494.23 | 2494.23 | 15.83 |
| 57.0 | 160.34 | 1173.78 | 1436.19 | 2609.97 | 2609.97 | 2609.97 | 16.28 |
| 58.0 | 163.15 | 1205.35 | 1523.47 | 2728.83 | 2728.83 | 2728.83 | 16.73 |
| 59.0 | 165.96 | 1236.93 | 1607.63 | 2844.56 | 2844.56 | 2844.56 | 17.14 |
| 60.0 | 168.77 | 1268.51 | 1682.44 | 2950.95 | 2950.95 | 2950.95 | 17.48 |
| 61.0 | 171.59 | 1300.09 | 1747.90 | 3047.99 | 3047.99 | 3047.99 | 17.76 |
| 62.0 | 174.40 | 1331.66 | 1804.01 | 3135.67 | 3135.67 | 3135.67 | 17.98 |
| 63.0 | 177.21 | 1363.24 | 1850.77 | 3214.01 | 3214.01 | 3214.01 | 18.14 |
| 64.0 | 180.03 | 1394.82 | 1888.17 | 3282.99 | 3282.99 | 3282.99 | 18.24 |
| 65.0 | 182.84 | 1426.39 | 1916.22 | 3342.62 | 3342.62 | 3342.62 | 18.28 |
| 66.0 | 185.65 | 1457.97 | 1934.93 | 3392.90 | 3392.90 | 3392.90 | 18.28 |
| 67.0 | 188.46 | 1489.55 | 1944.28 | 3433.83 | 3433.83 | 3433.83 | 18.22 |
| 68.0 | 191.28 | 1521.13 | 1944.28 | 3465.40 | 3465.40 | 3465.40 | 18.12 |
| 69.0 | 194.09 | 1544.46 | 1944.28 | 3488.74 | 3488.74 | 3488.74 | 17.97 |
| 70.0 | 196.90 | 1567.68 | 1944.28 | 3511.96 | 3511.96 | 3511.96 | 17.84 |
| 71.0 | 199.72 | 1590.77 | 1944.28 | 3535.05 | 3535.05 | 3535.05 | 17.70 |
| 72.0 | 202.53 | 1613.73 | 1944.28 | 3558.01 | 3558.01 | 3558.01 | 17.57 |
| 73.0 | 205.34 | 1636.53 | 1944.28 | 3580.81 | 3580.81 | 3580.81 | 17.44 |
| 74.0 | 208.15 | 1659.18 | 1944.28 | 3603.45 | 3603.45 | 3603.45 | 17.31 |
| 75.0 | 210.97 | 1681.64 | 1944.28 | 3625.92 | 3625.92 | 3625.92 | 17.19 |
| 76.0 | 213.78 | 1703.91 | 1944.28 | 3648.19 | 3648.19 | 3648.19 | 17.07 |
| 77.0 | 216.59 | 1725.98 | 1944.28 | 3670.26 | 3670.26 | 3670.26 | 16.95 |
| 78.0 | 219.41 | 1747.84 | 1944.28 | 3692.12 | 3692.12 | 3692.12 | 16.83 |
| 79.0 | 222.22 | 1769.47 | 1944.28 | 3713.74 | 3713.74 | 3713.74 | 16.71 |
| 80.0 | 225.03 | 1790.85 | 1944.28 | 3735.13 | 3735.13 | 3735.13 | 16.60 |
| 81.0 | 227.85 | 1811.99 | 1944.28 | 3756.27 | 3756.27 | 3756.27 | 16.49 |
| 82.0 | 230.66 | 1832.86 | 1944.28 | 3777.14 | 3777.14 | 3777.14 | 16.38 |
| 83.0 | 233.47 | 1853.45 | 1944.28 | 3797.73 | 3797.73 | 3797.73 | 16.27 |
| 84.0 | 236.28 | 1873.76 | 1944.28 | 3818.03 | 3818.03 | 3818.03 | 16.16 |
| 85.0 | 239.10 | 1893.76 | 1944.28 | 3838.04 | 3838.04 | 3838.04 | 16.05 |
| 86.0 | 241.91 | 1913.61 | 1944.28 | 3857.88 | 3857.88 | 3857.88 | 15.95 |
| 87.0 | 244.72 | 1933.71 | 1944.28 | 3877.99 | 3877.99 | 3877.99 | 15.85 |
| 88.0 | 247.54 | 1954.08 | 1944.28 | 3898.36 | 3898.36 | 3898.36 | 15.75 |
| 89.0 | 250.35 | 1974.71 | 1944.28 | 3918.98 | 3918.98 | 3918.98 | 15.65 |
| 90.0 | 253.16 | 1995.59 | 1944.28 | 3939.87 | 3939.87 | 3939.87 | 15.56 |
| 91.0 | 255.97 | 2016.75 | 1944.28 | 3961.02 | 3961.02 | 3961.02 | 15.47 |
| 92.0 | 258.79 | 2038.16 | 1944.28 | 3982.43 | 3982.43 | 3982.43 | 15.39 |
| 93.0 | 261.60 | 2059.83 | 1944.28 | 4004.11 | 4004.11 | 4004.11 | 15.31 |
| 94.0 | 264.41 | 2081.76 | 1944.28 | 4026.04 | 4026.04 | 4026.04 | 15.23 |
| 95.0 | 267.23 | 2103.96 | 1944.28 | 4048.23 | 4048.23 | 4048.23 | 15.15 |
| 96.0 | 270.04 | 2126.41 | 1944.28 | 4070.69 | 4070.69 | 4070.69 | 15.07 |
| 97.0 | 272.85 | 2149.13 | 1944.28 | 4093.41 | 4093.41 | 4093.41 | 15.00 |
| 98.0 | 275.66 | 2172.11 | 1944.28 | 4116.38 | 4116.38 | 4116.38 | 14.93 |
| 99.0 | 278.48 | 2195.34 | 1944.28 | 4139.62 | 4139.62 | 4139.62 | 14.87 |
| 100.0 | 281.29 | 2218.84 | 1944.28 | 4163.12 | 4163.12 | 4163.12 | 14.80 |
| 101.0 | 284.10 | 2242.61 | 1944.28 | 4186.88 | 4186.88 | 4186.88 | 14.74 |
| 102.0 | 286.92 | 2266.63 | 1944.28 | 4210.90 | 4210.90 | 4210.90 | 14.68 |
| 103.0 | 289.73 | 2290.91 | 1944.28 | 4235.19 | 4235.19 | 4235.19 | 14.62 |
| 104.0 | 292.54 | 2315.45 | 1944.28 | 4259.73 | 4259.73 | 4259.73 | 14.56 |
| 105.0 | 295.35 | 2340.26 | 1944.28 | 4284.54 | 4284.54 | 4284.54 | 14.51 |
| 106.0 | 298.17 | 2365.33 | 1944.28 | 4309.60 | 4309.60 | 4309.60 | 14.45 |
| 107.0 | 300.98 | 2390.65 | 1944.28 | 4334.93 | 4334.93 | 4334.93 | 14.40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 108.0 | 303.79 | 2416.24 | 1944.28 | 4360.52 | 4360.52 | 4360.52 | 14.35 |
| 109.0 | 306.61 | 2442.09 | 1944.28 | 4386.37 | 4386.37 | 4386.37 | 14.31 |
| 110.0 | 309.42 | 2468.20 | 1944.28 | 4412.48 | 4412.48 | 4412.48 | 14.26 |
| 111.0 | 312.23 | 2494.57 | 1944.28 | 4438.85 | 4438.85 | 4438.85 | 14.22 |
| 112.0 | 315.04 | 2521.20 | 1944.28 | 4465.48 | 4465.48 | 4465.48 | 14.17 |
| 113.0 | 317.86 | 2548.10 | 1944.28 | 4492.38 | 4492.38 | 4492.38 | 14.13 |
| 114.0 | 320.67 | 2575.25 | 1944.28 | 4519.53 | 4519.53 | 4519.53 | 14.09 |
| 115.0 | 323.48 | 2602.67 | 1944.28 | 4546.95 | 4546.95 | 4546.95 | 14.06 |
| 116.0 | 326.30 | 2630.35 | 1944.28 | 4574.62 | 4574.62 | 4574.62 | 14.02 |
| 117.0 | 329.11 | 2658.28 | 1944.28 | 4602.56 | 4602.56 | 4602.56 | 13.98 |
| 118.0 | 331.92 | 2686.48 | 1944.28 | 4630.76 | 4630.76 | 4630.76 | 13.95 |
| 119.0 | 334.74 | 2714.94 | 1944.28 | 4659.22 | 4659.22 | 4659.22 | 13.92 |
| 120.0 | 337.55 | 2743.66 | 1944.28 | 4687.94 | 4687.94 | 4687.94 | 13.89 |
| 121.0 | 340.36 | 2772.65 | 1944.28 | 4716.92 | 4716.92 | 4716.92 | 13.86 |
| 122.0 | 343.17 | 2801.89 | 1944.28 | 4746.17 | 4746.17 | 4746.17 | 13.83 |
| 123.0 | 345.99 | 2831.39 | 1944.28 | 4775.67 | 4775.67 | 4775.67 | 13.80 |
| 124.0 | 348.80 | 2861.16 | 1944.28 | 4805.44 | 4805.44 | 4805.44 | 13.78 |
| 125.0 | 351.61 | 2891.18 | 1944.28 | 4835.46 | 4835.46 | 4835.46 | 13.75 |
| 126.0 | 354.43 | 2921.47 | 1944.28 | 4865.75 | 4865.75 | 4865.75 | 13.73 |
| 127.0 | 357.24 | 2952.02 | 1944.28 | 4896.30 | 4896.30 | 4896.30 | 13.71 |
| 128.0 | 360.05 | 2982.83 | 1944.28 | 4927.11 | 4927.11 | 4927.11 | 13.68 |
| 129.0 | 362.86 | 3013.90 | 1944.28 | 4958.18 | 4958.18 | 4958.18 | 13.66 |
| 130.0 | 365.68 | 3045.23 | 1944.28 | 4989.51 | 4989.51 | 4989.51 | 13.64 |
| 131.0 | 368.49 | 3076.83 | 1944.28 | 5021.10 | 5021.10 | 5021.10 | 13.63 |
| 132.0 | 371.30 | 3108.68 | 1944.28 | 5052.96 | 5052.96 | 5052.96 | 13.61 |
| 133.0 | 374.12 | 3140.79 | 1944.28 | 5085.07 | 5085.07 | 5085.07 | 13.59 |
| 134.0 | 376.93 | 3173.17 | 1944.28 | 5117.45 | 5117.45 | 5117.45 | 13.58 |
| 135.0 | 379.74 | 3205.81 | 1944.28 | 5150.08 | 5150.08 | 5150.08 | 13.56 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1355E+00 | 0.1609E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6774E+00 | 0.8044E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1355E+01 | 0.1609E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6774E+02 | 0.8044E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.1016E+03 | 0.1207E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1355E+03 | 0.1609E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3388E+03 | 0.4022E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6784E+03 | 0.8047E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.1018E+04 | 0.1207E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1331E+04 | 0.1604E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2414E+04 | 0.3663E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.3096E+04 | 0.6575E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3761E+04 | 0.1388E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.4210E+04 | 0.3204E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4933E+04 | 0.6216E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.2001E+00 | 0.1874E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.1000E+01 | 0.9369E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.2001E+01 | 0.1874E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.1000E+03 | 0.9369E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1500E+03 | 0.1405E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.2001E+03 | 0.1874E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.5009E+03 | 0.4686E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.1003E+04 | 0.9376E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1502E+04 | 0.1406E+00 | 0.6179E+02 | 0.7500E-01 |

| | | | |
|---|---|---|---|
| 0.1899E+04 | 0.1849E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.3020E+04 | 0.3989E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3601E+04 | 0.6881E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.4195E+04 | 0.1418E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4632E+04 | 0.3232E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.5255E+04 | 0.6236E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |
| 0.7838E-01 | 0.1365E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3919E+00 | 0.6827E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.7838E+00 | 0.1365E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3919E+02 | 0.6827E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5878E+02 | 0.1024E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.7838E+02 | 0.1365E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1959E+03 | 0.3413E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3921E+03 | 0.6827E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5883E+03 | 0.1024E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.7833E+03 | 0.1365E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1694E+04 | 0.3305E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2560E+04 | 0.6259E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.3326E+04 | 0.1357E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3787E+04 | 0.3175E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4611E+04 | 0.6197E+01 | 0.1847E+04 | 0.5900E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 4, 118'''CIDH (comp) LQ

PROPOSED DEPTH = 135.0 FT
---

NUMBER OF LAYERS = 4
---

WATER TABLE DEPTH = 0.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.600E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.759E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.130E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.101E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.130E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.786E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.280E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.280E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.680E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.387E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.680E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION

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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
---

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.40 | 690.94 | 694.34 | 694.34 | 694.34 | 40.09 |
| 7.0 | 19.69 | 6.80 | 720.80 | 727.60 | 727.60 | 727.60 | 36.95 |
| 8.0 | 22.50 | 10.20 | 750.66 | 760.85 | 760.85 | 760.85 | 33.81 |
| 9.0 | 25.32 | 13.59 | 774.51 | 788.11 | 788.11 | 788.11 | 31.13 |
| 10.0 | 28.13 | 16.99 | 797.21 | 814.21 | 814.21 | 814.21 | 28.95 |
| 11.0 | 30.94 | 20.39 | 813.85 | 834.24 | 834.24 | 834.24 | 26.96 |
| 12.0 | 33.75 | 23.79 | 824.42 | 848.21 | 848.21 | 848.21 | 25.13 |
| 13.0 | 36.57 | 27.19 | 828.94 | 856.13 | 856.13 | 856.13 | 23.41 |
| 14.0 | 39.38 | 36.58 | 833.33 | 869.91 | 869.91 | 869.91 | 22.09 |
| 15.0 | 42.19 | 46.68 | 837.57 | 884.25 | 884.25 | 884.25 | 20.96 |
| 16.0 | 45.01 | 57.46 | 841.66 | 899.12 | 899.12 | 899.12 | 19.98 |
| 17.0 | 47.82 | 68.89 | 845.59 | 914.48 | 914.48 | 914.48 | 19.12 |
| 18.0 | 50.63 | 80.94 | 849.34 | 930.29 | 930.29 | 930.29 | 18.37 |
| 19.0 | 53.45 | 93.61 | 852.73 | 946.34 | 946.34 | 946.34 | 17.71 |
| 20.0 | 56.26 | 106.86 | 855.29 | 962.15 | 962.15 | 962.15 | 17.10 |
| 21.0 | 59.07 | 120.67 | 857.11 | 977.78 | 977.78 | 977.78 | 16.55 |
| 22.0 | 61.88 | 135.03 | 858.23 | 993.26 | 993.26 | 993.26 | 16.05 |
| 23.0 | 64.70 | 149.91 | 858.74 | 1008.64 | 1008.64 | 1008.64 | 15.59 |
| 24.0 | 67.51 | 165.29 | 858.68 | 1023.97 | 1023.97 | 1023.97 | 15.17 |
| 25.0 | 70.32 | 181.16 | 858.13 | 1039.29 | 1039.29 | 1039.29 | 14.78 |
| 26.0 | 73.14 | 197.49 | 857.15 | 1054.64 | 1054.64 | 1054.64 | 14.42 |
| 27.0 | 75.95 | 214.27 | 855.79 | 1070.06 | 1070.06 | 1070.06 | 14.09 |
| 28.0 | 78.76 | 231.47 | 854.09 | 1085.57 | 1085.57 | 1085.57 | 13.78 |
| 29.0 | 81.57 | 263.05 | 852.78 | 1115.83 | 1115.83 | 1115.83 | 13.68 |
| 30.0 | 84.39 | 294.63 | 851.80 | 1146.43 | 1146.43 | 1146.43 | 13.59 |
| 31.0 | 87.20 | 326.21 | 851.10 | 1177.31 | 1177.31 | 1177.31 | 13.50 |
| 32.0 | 90.01 | 357.78 | 850.64 | 1208.42 | 1208.42 | 1208.42 | 13.43 |
| 33.0 | 92.83 | 389.36 | 850.36 | 1239.72 | 1239.72 | 1239.72 | 13.36 |
| 34.0 | 95.64 | 420.94 | 850.23 | 1271.16 | 1271.16 | 1271.16 | 13.29 |
| 35.0 | 98.45 | 452.51 | 850.18 | 1302.70 | 1302.70 | 1302.70 | 13.23 |
| 36.0 | 101.26 | 484.09 | 850.18 | 1334.27 | 1334.27 | 1334.27 | 13.18 |
| 37.0 | 104.08 | 515.67 | 850.18 | 1365.85 | 1365.85 | 1365.85 | 13.12 |
| 38.0 | 106.89 | 547.25 | 850.18 | 1397.43 | 1397.43 | 1397.43 | 13.07 |
| 39.0 | 109.70 | 578.82 | 850.18 | 1429.00 | 1429.00 | 1429.00 | 13.03 |
| 40.0 | 112.52 | 610.40 | 850.18 | 1460.58 | 1460.58 | 1460.58 | 12.98 |
| 41.0 | 115.33 | 641.98 | 850.18 | 1492.16 | 1492.16 | 1492.16 | 12.94 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42.0 | 118.14 | 673.56 | 850.18 | 1523.74 | 1523.74 | 1523.74 | 12.90 |
| 43.0 | 120.95 | 705.13 | 850.18 | 1555.31 | 1555.31 | 1555.31 | 12.86 |
| 44.0 | 123.77 | 736.71 | 850.18 | 1586.89 | 1586.89 | 1586.89 | 12.82 |
| 45.0 | 126.58 | 768.29 | 850.18 | 1618.47 | 1618.47 | 1618.47 | 12.79 |
| 46.0 | 129.39 | 799.86 | 850.18 | 1650.04 | 1650.04 | 1650.04 | 12.75 |
| 47.0 | 132.21 | 831.44 | 850.18 | 1681.62 | 1681.62 | 1681.62 | 12.72 |
| 48.0 | 135.02 | 863.02 | 850.18 | 1713.20 | 1713.20 | 1713.20 | 12.69 |
| 49.0 | 137.83 | 894.60 | 850.18 | 1744.78 | 1744.78 | 1744.78 | 12.66 |
| 50.0 | 140.65 | 926.17 | 912.52 | 1838.70 | 1838.70 | 1838.70 | 13.07 |
| 51.0 | 143.46 | 957.75 | 977.98 | 1935.73 | 1935.73 | 1935.73 | 13.49 |
| 52.0 | 146.27 | 989.33 | 1046.56 | 2035.88 | 2035.88 | 2035.88 | 13.92 |
| 53.0 | 149.08 | 1020.90 | 1118.25 | 2139.15 | 2139.15 | 2139.15 | 14.35 |
| 54.0 | 151.90 | 1052.48 | 1193.06 | 2245.54 | 2245.54 | 2245.54 | 14.78 |
| 55.0 | 154.71 | 1084.06 | 1270.99 | 2355.05 | 2355.05 | 2355.05 | 15.22 |
| 56.0 | 157.52 | 1115.64 | 1352.03 | 2467.67 | 2467.67 | 2467.67 | 15.67 |
| 57.0 | 160.34 | 1147.21 | 1436.19 | 2583.41 | 2583.41 | 2583.41 | 16.11 |
| 58.0 | 163.15 | 1178.79 | 1523.47 | 2702.26 | 2702.26 | 2702.26 | 16.56 |
| 59.0 | 165.96 | 1210.37 | 1607.63 | 2818.00 | 2818.00 | 2818.00 | 16.98 |
| 60.0 | 168.77 | 1241.94 | 1682.44 | 2924.39 | 2924.39 | 2924.39 | 17.33 |
| 61.0 | 171.59 | 1273.52 | 1747.90 | 3021.42 | 3021.42 | 3021.42 | 17.61 |
| 62.0 | 174.40 | 1305.10 | 1804.01 | 3109.11 | 3109.11 | 3109.11 | 17.83 |
| 63.0 | 177.21 | 1336.68 | 1850.77 | 3187.44 | 3187.44 | 3187.44 | 17.99 |
| 64.0 | 180.03 | 1368.25 | 1888.17 | 3256.42 | 3256.42 | 3256.42 | 18.09 |
| 65.0 | 182.84 | 1399.83 | 1916.22 | 3316.05 | 3316.05 | 3316.05 | 18.14 |
| 66.0 | 185.65 | 1431.41 | 1934.93 | 3366.33 | 3366.33 | 3366.33 | 18.13 |
| 67.0 | 188.46 | 1462.98 | 1944.28 | 3407.26 | 3407.26 | 3407.26 | 18.08 |
| 68.0 | 191.28 | 1494.56 | 1944.28 | 3438.84 | 3438.84 | 3438.84 | 17.98 |
| 69.0 | 194.09 | 1517.89 | 1944.28 | 3462.17 | 3462.17 | 3462.17 | 17.84 |
| 70.0 | 196.90 | 1541.11 | 1944.28 | 3485.39 | 3485.39 | 3485.39 | 17.70 |
| 71.0 | 199.72 | 1564.21 | 1944.28 | 3508.49 | 3508.49 | 3508.49 | 17.57 |
| 72.0 | 202.53 | 1587.17 | 1944.28 | 3531.44 | 3531.44 | 3531.44 | 17.44 |
| 73.0 | 205.34 | 1609.97 | 1944.28 | 3554.25 | 3554.25 | 3554.25 | 17.31 |
| 74.0 | 208.15 | 1632.61 | 1944.28 | 3576.89 | 3576.89 | 3576.89 | 17.18 |
| 75.0 | 210.97 | 1655.07 | 1944.28 | 3599.35 | 3599.35 | 3599.35 | 17.06 |
| 76.0 | 213.78 | 1677.35 | 1944.28 | 3621.63 | 3621.63 | 3621.63 | 16.94 |
| 77.0 | 216.59 | 1699.42 | 1944.28 | 3643.70 | 3643.70 | 3643.70 | 16.82 |
| 78.0 | 219.41 | 1721.27 | 1944.28 | 3665.55 | 3665.55 | 3665.55 | 16.71 |
| 79.0 | 222.22 | 1742.90 | 1944.28 | 3687.18 | 3687.18 | 3687.18 | 16.59 |
| 80.0 | 225.03 | 1764.29 | 1944.28 | 3708.57 | 3708.57 | 3708.57 | 16.48 |
| 81.0 | 227.85 | 1785.42 | 1944.28 | 3729.70 | 3729.70 | 3729.70 | 16.37 |
| 82.0 | 230.66 | 1806.29 | 1944.28 | 3750.57 | 3750.57 | 3750.57 | 16.26 |
| 83.0 | 233.47 | 1826.89 | 1944.28 | 3771.16 | 3771.16 | 3771.16 | 16.15 |
| 84.0 | 236.28 | 1847.19 | 1944.28 | 3791.47 | 3791.47 | 3791.47 | 16.05 |
| 85.0 | 239.10 | 1867.20 | 1944.28 | 3811.47 | 3811.47 | 3811.47 | 15.94 |
| 86.0 | 241.91 | 1887.04 | 1944.28 | 3831.32 | 3831.32 | 3831.32 | 15.84 |
| 87.0 | 244.72 | 1907.15 | 1944.28 | 3851.42 | 3851.42 | 3851.42 | 15.74 |
| 88.0 | 247.54 | 1927.51 | 1944.28 | 3871.79 | 3871.79 | 3871.79 | 15.64 |
| 89.0 | 250.35 | 1948.14 | 1944.28 | 3892.42 | 3892.42 | 3892.42 | 15.55 |
| 90.0 | 253.16 | 1969.03 | 1944.28 | 3913.31 | 3913.31 | 3913.31 | 15.46 |
| 91.0 | 255.97 | 1990.18 | 1944.28 | 3934.46 | 3934.46 | 3934.46 | 15.37 |
| 92.0 | 258.79 | 2011.59 | 1944.28 | 3955.87 | 3955.87 | 3955.87 | 15.29 |
| 93.0 | 261.60 | 2033.26 | 1944.28 | 3977.54 | 3977.54 | 3977.54 | 15.20 |
| 94.0 | 264.41 | 2055.20 | 1944.28 | 3999.48 | 3999.48 | 3999.48 | 15.13 |
| 95.0 | 267.23 | 2077.39 | 1944.28 | 4021.67 | 4021.67 | 4021.67 | 15.05 |
| 96.0 | 270.04 | 2099.85 | 1944.28 | 4044.13 | 4044.13 | 4044.13 | 14.98 |
| 97.0 | 272.85 | 2122.56 | 1944.28 | 4066.84 | 4066.84 | 4066.84 | 14.90 |
| 98.0 | 275.66 | 2145.54 | 1944.28 | 4089.82 | 4089.82 | 4089.82 | 14.84 |
| 99.0 | 278.48 | 2168.78 | 1944.28 | 4113.06 | 4113.06 | 4113.06 | 14.77 |
| 100.0 | 281.29 | 2192.28 | 1944.28 | 4136.56 | 4136.56 | 4136.56 | 14.71 |
| 101.0 | 284.10 | 2216.04 | 1944.28 | 4160.32 | 4160.32 | 4160.32 | 14.64 |
| 102.0 | 286.92 | 2240.06 | 1944.28 | 4184.34 | 4184.34 | 4184.34 | 14.58 |
| 103.0 | 289.73 | 2264.35 | 1944.28 | 4208.62 | 4208.62 | 4208.62 | 14.53 |
| 104.0 | 292.54 | 2288.89 | 1944.28 | 4233.17 | 4233.17 | 4233.17 | 14.47 |
| 105.0 | 295.35 | 2313.69 | 1944.28 | 4257.97 | 4257.97 | 4257.97 | 14.42 |
| 106.0 | 298.17 | 2338.76 | 1944.28 | 4283.04 | 4283.04 | 4283.04 | 14.36 |
| 107.0 | 300.98 | 2364.09 | 1944.28 | 4308.37 | 4308.37 | 4308.37 | 14.31 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 108.0 | 303.79 | 2389.68 | 1944.28 | 4333.95 | 4333.95 | 4333.95 | 14.27 |
| 109.0 | 306.61 | 2415.53 | 1944.28 | 4359.80 | 4359.80 | 4359.80 | 14.22 |
| 110.0 | 309.42 | 2441.64 | 1944.28 | 4385.91 | 4385.91 | 4385.91 | 14.17 |
| 111.0 | 312.23 | 2468.01 | 1944.28 | 4412.29 | 4412.29 | 4412.29 | 14.13 |
| 112.0 | 315.04 | 2494.64 | 1944.28 | 4438.92 | 4438.92 | 4438.92 | 14.09 |
| 113.0 | 317.86 | 2521.53 | 1944.28 | 4465.81 | 4465.81 | 4465.81 | 14.05 |
| 114.0 | 320.67 | 2548.69 | 1944.28 | 4492.97 | 4492.97 | 4492.97 | 14.01 |
| 115.0 | 323.48 | 2576.10 | 1944.28 | 4520.38 | 4520.38 | 4520.38 | 13.97 |
| 116.0 | 326.30 | 2603.78 | 1944.28 | 4548.06 | 4548.06 | 4548.06 | 13.94 |
| 117.0 | 329.11 | 2631.72 | 1944.28 | 4576.00 | 4576.00 | 4576.00 | 13.90 |
| 118.0 | 331.92 | 2659.92 | 1944.28 | 4604.20 | 4604.20 | 4604.20 | 13.87 |
| 119.0 | 334.74 | 2688.38 | 1944.28 | 4632.66 | 4632.66 | 4632.66 | 13.84 |
| 120.0 | 337.55 | 2717.10 | 1944.28 | 4661.38 | 4661.38 | 4661.38 | 13.81 |
| 121.0 | 340.36 | 2746.08 | 1944.28 | 4690.36 | 4690.36 | 4690.36 | 13.78 |
| 122.0 | 343.17 | 2775.32 | 1944.28 | 4719.60 | 4719.60 | 4719.60 | 13.75 |
| 123.0 | 345.99 | 2804.83 | 1944.28 | 4749.11 | 4749.11 | 4749.11 | 13.73 |
| 124.0 | 348.80 | 2834.59 | 1944.28 | 4778.87 | 4778.87 | 4778.87 | 13.70 |
| 125.0 | 351.61 | 2864.62 | 1944.28 | 4808.90 | 4808.90 | 4808.90 | 13.68 |
| 126.0 | 354.43 | 2894.91 | 1944.28 | 4839.19 | 4839.19 | 4839.19 | 13.65 |
| 127.0 | 357.24 | 2925.46 | 1944.28 | 4869.73 | 4869.73 | 4869.73 | 13.63 |
| 128.0 | 360.05 | 2956.27 | 1944.28 | 4900.54 | 4900.54 | 4900.54 | 13.61 |
| 129.0 | 362.86 | 2987.34 | 1944.28 | 4931.61 | 4931.61 | 4931.61 | 13.59 |
| 130.0 | 365.68 | 3018.67 | 1944.28 | 4962.95 | 4962.95 | 4962.95 | 13.57 |
| 131.0 | 368.49 | 3050.26 | 1944.28 | 4994.54 | 4994.54 | 4994.54 | 13.55 |
| 132.0 | 371.30 | 3082.11 | 1944.28 | 5026.39 | 5026.39 | 5026.39 | 13.54 |
| 133.0 | 374.12 | 3114.23 | 1944.28 | 5058.51 | 5058.51 | 5058.51 | 13.52 |
| 134.0 | 376.93 | 3146.61 | 1944.28 | 5090.88 | 5090.88 | 5090.88 | 13.51 |
| 135.0 | 379.74 | 3179.24 | 1944.28 | 5123.52 | 5123.52 | 5123.52 | 13.49 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1350E+00 | 0.1608E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6751E+00 | 0.8042E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1350E+01 | 0.1608E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6751E+02 | 0.8042E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.1013E+03 | 0.1206E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1350E+03 | 0.1608E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3377E+03 | 0.4021E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6761E+03 | 0.8045E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.1014E+04 | 0.1207E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1325E+04 | 0.1603E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2399E+04 | 0.3662E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.3072E+04 | 0.6574E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3731E+04 | 0.1388E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.4177E+04 | 0.3203E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4900E+04 | 0.6216E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1996E+00 | 0.1873E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.9982E+00 | 0.9367E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1996E+01 | 0.1873E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.9982E+02 | 0.9367E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1497E+03 | 0.1405E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1996E+03 | 0.1873E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4998E+03 | 0.4685E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.1000E+04 | 0.9373E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1498E+04 | 0.1406E+00 | 0.6179E+02 | 0.7500E-01 |

| | | | |
|---|---|---|---|
| 0.1889E+04 | 0.1849E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2995E+04 | 0.3987E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3572E+04 | 0.6880E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.4166E+04 | 0.1418E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4600E+04 | 0.3232E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.5222E+04 | 0.6236E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |
| 0.7793E-01 | 0.1365E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3897E+00 | 0.6825E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.7793E+00 | 0.1365E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3897E+02 | 0.6825E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5845E+02 | 0.1024E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.7793E+02 | 0.1365E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1948E+03 | 0.3413E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3898E+03 | 0.6825E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5850E+03 | 0.1024E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.7789E+03 | 0.1365E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1685E+04 | 0.3304E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2541E+04 | 0.6258E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.3296E+04 | 0.1357E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3754E+04 | 0.3175E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4578E+04 | 0.6197E+01 | 0.1847E+04 | 0.5900E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Bent 5, 118” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 5, 118"CIDH (comp) NL

PROPOSED DEPTH = 130.0 FT
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NUMBER OF LAYERS = 5
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WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
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FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.600E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.500E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.685E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.500E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.700E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.114E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03

MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.700E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.679E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.370E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.679E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.370E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.481E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.570E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.570E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.970E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.970E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 2.61 | 0.00 | 2.61 | 2.61 | 2.61 | 0.22 |
| 7.0 | 19.69 | 8.50 | 0.00 | 8.50 | 8.50 | 8.50 | 0.43 |
| 8.0 | 22.50 | 14.38 | 0.00 | 14.38 | 14.38 | 14.38 | 0.64 |
| 9.0 | 25.32 | 20.87 | 0.00 | 20.87 | 20.87 | 20.87 | 0.82 |
| 10.0 | 28.13 | 27.93 | 0.00 | 27.93 | 27.93 | 27.93 | 0.99 |
| 11.0 | 30.94 | 35.55 | 0.00 | 35.55 | 35.55 | 35.55 | 1.15 |
| 12.0 | 33.75 | 43.70 | 0.00 | 43.70 | 43.70 | 43.70 | 1.29 |
| 13.0 | 36.57 | 52.37 | 0.00 | 52.37 | 52.37 | 52.37 | 1.43 |
| 14.0 | 39.38 | 61.53 | 0.00 | 61.53 | 61.53 | 61.53 | 1.56 |
| 15.0 | 42.19 | 71.18 | 0.00 | 71.18 | 71.18 | 71.18 | 1.69 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16.0 | 45.01 | 81.29 | 0.00 | 81.29 | 81.29 | 81.29 | 1.81 |
| 17.0 | 47.82 | 91.84 | 0.00 | 91.84 | 91.84 | 91.84 | 1.92 |
| 18.0 | 50.63 | 102.82 | 0.00 | 102.82 | 102.82 | 102.82 | 2.03 |
| 19.0 | 53.45 | 114.22 | 46.17 | 160.39 | 160.39 | 160.39 | 3.00 |
| 20.0 | 56.26 | 126.02 | 94.64 | 220.66 | 220.66 | 220.66 | 3.92 |
| 21.0 | 59.07 | 138.20 | 145.42 | 283.62 | 283.62 | 283.62 | 4.80 |
| 22.0 | 61.88 | 150.75 | 198.51 | 349.26 | 349.26 | 349.26 | 5.64 |
| 23.0 | 64.70 | 163.65 | 253.91 | 417.56 | 417.56 | 417.56 | 6.45 |
| 24.0 | 67.51 | 176.90 | 311.62 | 488.52 | 488.52 | 488.52 | 7.24 |
| 25.0 | 70.32 | 190.47 | 371.64 | 562.11 | 562.11 | 562.11 | 7.99 |
| 26.0 | 73.14 | 204.35 | 433.96 | 638.32 | 638.32 | 638.32 | 8.73 |
| 27.0 | 75.95 | 218.54 | 498.60 | 717.14 | 717.14 | 717.14 | 9.44 |
| 28.0 | 78.76 | 233.02 | 560.92 | 793.94 | 793.94 | 793.94 | 10.08 |
| 29.0 | 81.57 | 247.77 | 616.32 | 864.09 | 864.09 | 864.09 | 10.59 |
| 30.0 | 84.39 | 262.79 | 664.79 | 927.58 | 927.58 | 927.58 | 10.99 |
| 31.0 | 87.20 | 278.05 | 706.34 | 984.40 | 984.40 | 984.40 | 11.29 |
| 32.0 | 90.01 | 293.56 | 740.97 | 1034.53 | 1034.53 | 1034.53 | 11.49 |
| 33.0 | 92.83 | 309.29 | 768.67 | 1077.96 | 1077.96 | 1077.96 | 11.61 |
| 34.0 | 95.64 | 325.24 | 789.44 | 1114.68 | 1114.68 | 1114.68 | 11.66 |
| 35.0 | 98.45 | 341.39 | 803.29 | 1144.69 | 1144.69 | 1144.69 | 11.63 |
| 36.0 | 101.26 | 357.74 | 810.22 | 1167.96 | 1167.96 | 1167.96 | 11.53 |
| 37.0 | 104.08 | 374.27 | 810.22 | 1184.49 | 1184.49 | 1184.49 | 11.38 |
| 38.0 | 106.89 | 391.12 | 810.22 | 1201.34 | 1201.34 | 1201.34 | 11.24 |
| 39.0 | 109.70 | 408.29 | 812.49 | 1220.78 | 1220.78 | 1220.78 | 11.13 |
| 40.0 | 112.52 | 425.75 | 814.89 | 1240.63 | 1240.63 | 1240.63 | 11.03 |
| 41.0 | 115.33 | 443.48 | 817.39 | 1260.87 | 1260.87 | 1260.87 | 10.93 |
| 42.0 | 118.14 | 461.48 | 820.01 | 1281.49 | 1281.49 | 1281.49 | 10.85 |
| 43.0 | 120.95 | 479.73 | 822.74 | 1302.48 | 1302.48 | 1302.48 | 10.77 |
| 44.0 | 123.77 | 498.22 | 825.59 | 1323.81 | 1323.81 | 1323.81 | 10.70 |
| 45.0 | 126.58 | 516.92 | 828.55 | 1345.47 | 1345.47 | 1345.47 | 10.63 |
| 46.0 | 129.39 | 535.83 | 831.62 | 1367.45 | 1367.45 | 1367.45 | 10.57 |
| 47.0 | 132.21 | 554.93 | 834.81 | 1389.74 | 1389.74 | 1389.74 | 10.51 |
| 48.0 | 135.02 | 574.21 | 837.88 | 1412.09 | 1412.09 | 1412.09 | 10.46 |
| 49.0 | 137.83 | 593.65 | 840.62 | 1434.26 | 1434.26 | 1434.26 | 10.41 |
| 50.0 | 140.65 | 613.24 | 843.01 | 1456.24 | 1456.24 | 1456.24 | 10.35 |
| 51.0 | 143.46 | 632.96 | 845.06 | 1478.02 | 1478.02 | 1478.02 | 10.30 |
| 52.0 | 146.27 | 652.81 | 846.77 | 1499.57 | 1499.57 | 1499.57 | 10.25 |
| 53.0 | 149.08 | 672.76 | 848.13 | 1520.89 | 1520.89 | 1520.89 | 10.20 |
| 54.0 | 151.90 | 692.81 | 849.16 | 1541.97 | 1541.97 | 1541.97 | 10.15 |
| 55.0 | 154.71 | 712.95 | 849.84 | 1562.79 | 1562.79 | 1562.79 | 10.10 |
| 56.0 | 157.52 | 733.15 | 850.18 | 1583.33 | 1583.33 | 1583.33 | 10.05 |
| 57.0 | 160.34 | 753.41 | 850.18 | 1603.60 | 1603.60 | 1603.60 | 10.00 |
| 58.0 | 163.15 | 784.99 | 850.18 | 1635.17 | 1635.17 | 1635.17 | 10.02 |
| 59.0 | 165.96 | 816.57 | 850.18 | 1666.75 | 1666.75 | 1666.75 | 10.04 |
| 60.0 | 168.77 | 848.15 | 850.18 | 1698.33 | 1698.33 | 1698.33 | 10.06 |
| 61.0 | 171.59 | 879.72 | 850.18 | 1729.90 | 1729.90 | 1729.90 | 10.08 |
| 62.0 | 174.40 | 911.30 | 850.18 | 1761.48 | 1761.48 | 1761.48 | 10.10 |
| 63.0 | 177.21 | 942.88 | 850.18 | 1793.06 | 1793.06 | 1793.06 | 10.12 |
| 64.0 | 180.03 | 974.45 | 850.18 | 1824.64 | 1824.64 | 1824.64 | 10.14 |
| 65.0 | 182.84 | 1006.03 | 850.18 | 1856.21 | 1856.21 | 1856.21 | 10.15 |
| 66.0 | 185.65 | 1037.61 | 850.18 | 1887.79 | 1887.79 | 1887.79 | 10.17 |
| 67.0 | 188.46 | 1069.19 | 850.18 | 1919.37 | 1919.37 | 1919.37 | 10.18 |
| 68.0 | 191.28 | 1100.76 | 850.18 | 1950.94 | 1950.94 | 1950.94 | 10.20 |
| 69.0 | 194.09 | 1132.34 | 850.18 | 1982.52 | 1982.52 | 1982.52 | 10.21 |
| 70.0 | 196.90 | 1163.92 | 850.18 | 2014.10 | 2014.10 | 2014.10 | 10.23 |
| 71.0 | 199.72 | 1195.49 | 850.18 | 2045.68 | 2045.68 | 2045.68 | 10.24 |
| 72.0 | 202.53 | 1227.07 | 850.18 | 2077.25 | 2077.25 | 2077.25 | 10.26 |
| 73.0 | 205.34 | 1258.65 | 850.18 | 2108.83 | 2108.83 | 2108.83 | 10.27 |
| 74.0 | 208.15 | 1290.23 | 850.18 | 2140.41 | 2140.41 | 2140.41 | 10.28 |
| 75.0 | 210.97 | 1321.80 | 850.18 | 2171.98 | 2171.98 | 2171.98 | 10.30 |
| 76.0 | 213.78 | 1353.38 | 850.18 | 2203.56 | 2203.56 | 2203.56 | 10.31 |
| 77.0 | 216.59 | 1384.96 | 850.18 | 2235.14 | 2235.14 | 2235.14 | 10.32 |
| 78.0 | 219.41 | 1416.54 | 850.18 | 2266.72 | 2266.72 | 2266.72 | 10.33 |
| 79.0 | 222.22 | 1448.11 | 912.52 | 2360.63 | 2360.63 | 2360.63 | 10.62 |
| 80.0 | 225.03 | 1479.69 | 977.98 | 2457.67 | 2457.67 | 2457.67 | 10.92 |
| 81.0 | 227.85 | 1511.27 | 1046.56 | 2557.82 | 2557.82 | 2557.82 | 11.23 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 82.0 | 230.66 | 1542.84 | 1118.25 | 2661.09 | 2661.09 | 2661.09 | 11.54 |
| 83.0 | 233.47 | 1574.42 | 1193.06 | 2767.48 | 2767.48 | 2767.48 | 11.85 |
| 84.0 | 236.28 | 1606.00 | 1270.99 | 2876.98 | 2876.98 | 2876.98 | 12.18 |
| 85.0 | 239.10 | 1637.58 | 1352.03 | 2989.61 | 2989.61 | 2989.61 | 12.50 |
| 86.0 | 241.91 | 1669.15 | 1436.19 | 3105.34 | 3105.34 | 3105.34 | 12.84 |
| 87.0 | 244.72 | 1700.73 | 1523.47 | 3224.20 | 3224.20 | 3224.20 | 13.17 |
| 88.0 | 247.54 | 1732.31 | 1607.63 | 3339.94 | 3339.94 | 3339.94 | 13.49 |
| 89.0 | 250.35 | 1763.88 | 1682.44 | 3446.33 | 3446.33 | 3446.33 | 13.77 |
| 90.0 | 253.16 | 1795.46 | 1747.90 | 3543.36 | 3543.36 | 3543.36 | 14.00 |
| 91.0 | 255.97 | 1827.04 | 1804.01 | 3631.05 | 3631.05 | 3631.05 | 14.19 |
| 92.0 | 258.79 | 1858.62 | 1850.77 | 3709.38 | 3709.38 | 3709.38 | 14.33 |
| 93.0 | 261.60 | 1890.19 | 1888.17 | 3778.36 | 3778.36 | 3778.36 | 14.44 |
| 94.0 | 264.41 | 1921.77 | 1916.22 | 3837.99 | 3837.99 | 3837.99 | 14.52 |
| 95.0 | 267.23 | 1953.35 | 1934.93 | 3888.27 | 3888.27 | 3888.27 | 14.55 |
| 96.0 | 270.04 | 1984.92 | 1944.28 | 3929.20 | 3929.20 | 3929.20 | 14.55 |
| 97.0 | 272.85 | 2016.50 | 1944.28 | 3960.78 | 3960.78 | 3960.78 | 14.52 |
| 98.0 | 275.66 | 2036.97 | 1944.28 | 3981.25 | 3981.25 | 3981.25 | 14.44 |
| 99.0 | 278.48 | 2057.70 | 1944.28 | 4001.97 | 4001.97 | 4001.97 | 14.37 |
| 100.0 | 281.29 | 2078.69 | 1944.28 | 4022.96 | 4022.96 | 4022.96 | 14.30 |
| 101.0 | 284.10 | 2099.94 | 1944.28 | 4044.21 | 4044.21 | 4044.21 | 14.24 |
| 102.0 | 286.92 | 2121.45 | 1944.28 | 4065.73 | 4065.73 | 4065.73 | 14.17 |
| 103.0 | 289.73 | 2143.22 | 1944.28 | 4087.50 | 4087.50 | 4087.50 | 14.11 |
| 104.0 | 292.54 | 2165.25 | 1944.28 | 4109.53 | 4109.53 | 4109.53 | 14.05 |
| 105.0 | 295.35 | 2187.55 | 1944.28 | 4131.83 | 4131.83 | 4131.83 | 13.99 |
| 106.0 | 298.17 | 2210.11 | 1944.28 | 4154.38 | 4154.38 | 4154.38 | 13.93 |
| 107.0 | 300.98 | 2232.92 | 1944.28 | 4177.20 | 4177.20 | 4177.20 | 13.88 |
| 108.0 | 303.79 | 2256.00 | 1944.28 | 4200.28 | 4200.28 | 4200.28 | 13.83 |
| 109.0 | 306.61 | 2279.34 | 1944.28 | 4223.62 | 4223.62 | 4223.62 | 13.78 |
| 110.0 | 309.42 | 2302.94 | 1944.28 | 4247.22 | 4247.22 | 4247.22 | 13.73 |
| 111.0 | 312.23 | 2326.80 | 1944.28 | 4271.08 | 4271.08 | 4271.08 | 13.68 |
| 112.0 | 315.04 | 2350.92 | 1944.28 | 4295.20 | 4295.20 | 4295.20 | 13.63 |
| 113.0 | 317.86 | 2375.31 | 1944.28 | 4319.58 | 4319.58 | 4319.58 | 13.59 |
| 114.0 | 320.67 | 2399.95 | 1944.28 | 4344.23 | 4344.23 | 4344.23 | 13.55 |
| 115.0 | 323.48 | 2424.86 | 1944.28 | 4369.13 | 4369.13 | 4369.13 | 13.51 |
| 116.0 | 326.30 | 2450.02 | 1944.28 | 4394.30 | 4394.30 | 4394.30 | 13.47 |
| 117.0 | 329.11 | 2475.45 | 1944.28 | 4419.73 | 4419.73 | 4419.73 | 13.43 |
| 118.0 | 331.92 | 2501.14 | 1944.28 | 4445.42 | 4445.42 | 4445.42 | 13.39 |
| 119.0 | 334.74 | 2527.09 | 1944.28 | 4471.37 | 4471.37 | 4471.37 | 13.36 |
| 120.0 | 337.55 | 2553.30 | 1944.28 | 4497.58 | 4497.58 | 4497.58 | 13.32 |
| 121.0 | 340.36 | 2579.77 | 1944.28 | 4524.05 | 4524.05 | 4524.05 | 13.29 |
| 122.0 | 343.17 | 2606.51 | 1944.28 | 4550.78 | 4550.78 | 4550.78 | 13.26 |
| 123.0 | 345.99 | 2633.50 | 1944.28 | 4577.78 | 4577.78 | 4577.78 | 13.23 |
| 124.0 | 348.80 | 2660.75 | 1944.28 | 4605.03 | 4605.03 | 4605.03 | 13.20 |
| 125.0 | 351.61 | 2688.27 | 1944.28 | 4632.55 | 4632.55 | 4632.55 | 13.18 |
| 126.0 | 354.43 | 2716.05 | 1944.28 | 4660.32 | 4660.32 | 4660.32 | 13.15 |
| 127.0 | 357.24 | 2744.09 | 1944.28 | 4688.36 | 4688.36 | 4688.36 | 13.12 |
| 128.0 | 360.05 | 2772.39 | 1944.28 | 4716.66 | 4716.66 | 4716.66 | 13.10 |
| 129.0 | 362.86 | 2800.95 | 1944.28 | 4745.22 | 4745.22 | 4745.22 | 13.08 |
| 130.0 | 365.68 | 2829.77 | 1944.28 | 4774.04 | 4774.04 | 4774.04 | 13.06 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1174E+00 | 0.1576E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.5872E+00 | 0.7878E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1174E+01 | 0.1576E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.5872E+02 | 0.7878E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.8808E+02 | 0.1182E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1174E+03 | 0.1576E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.2936E+03 | 0.3939E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.5879E+03 | 0.7880E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.8821E+03 | 0.1182E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1167E+04 | 0.1575E+00 | 0.5767E+02 | 0.1000E+00 |

| | | | |
|---|---|---|---|
| 0.2110E+04 | 0.3570E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2744E+04 | 0.6439E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3346E+04 | 0.1367E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3788E+04 | 0.3179E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4513E+04 | 0.6189E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1722E+00 | 0.1832E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.8609E+00 | 0.9162E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1722E+01 | 0.1832E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.8609E+02 | 0.9162E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1291E+03 | 0.1374E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1722E+03 | 0.1832E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4309E+03 | 0.4582E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.8626E+03 | 0.9168E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1292E+04 | 0.1375E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1689E+04 | 0.1826E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2673E+04 | 0.3866E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3179E+04 | 0.6699E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3761E+04 | 0.1397E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4194E+04 | 0.3207E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4816E+04 | 0.6209E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.6814E-01 | 0.1338E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3407E+00 | 0.6691E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.6814E+00 | 0.1338E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3407E+02 | 0.6691E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5111E+02 | 0.1004E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.6814E+02 | 0.1338E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1704E+03 | 0.3345E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3408E+03 | 0.6691E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5114E+03 | 0.1004E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.6812E+03 | 0.1338E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1484E+04 | 0.3246E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2255E+04 | 0.6153E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2930E+04 | 0.1338E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3383E+04 | 0.3151E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4209E+04 | 0.6170E+01 | 0.1847E+04 | 0.5900E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 5, 118"CIDH (comp) LQ

PROPOSED DEPTH = 130.0 FT
---

NUMBER OF LAYERS = 5
---

WATER TABLE DEPTH = 0.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.600E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.500E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.685E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.500E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.700E+01

LAYER NO 2----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.685E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11

DEPTH, FT = 0.700E+01

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.370E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.679E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.370E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.481E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.570E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.570E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.970E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.970E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 5.10 | 112.93 | 118.03 | 118.03 | 118.03 | 6.79 |
| 7.0 | 19.69 | 8.50 | 113.18 | 121.67 | 121.67 | 121.67 | 6.18 |
| 8.0 | 22.50 | 11.89 | 113.42 | 125.31 | 125.31 | 125.31 | 5.57 |
| 9.0 | 25.32 | 15.29 | 113.59 | 128.88 | 128.88 | 128.88 | 5.09 |
| 10.0 | 28.13 | 18.69 | 113.70 | 132.39 | 132.39 | 132.39 | 4.71 |
| 11.0 | 30.94 | 22.09 | 113.76 | 135.85 | 135.85 | 135.85 | 4.39 |
| 12.0 | 33.75 | 25.49 | 113.77 | 139.26 | 139.26 | 139.26 | 4.13 |
| 13.0 | 36.57 | 28.89 | 113.76 | 142.64 | 142.64 | 142.64 | 3.90 |
| 14.0 | 39.38 | 32.29 | 113.72 | 146.00 | 146.00 | 146.00 | 3.71 |
| 15.0 | 42.19 | 35.68 | 113.67 | 149.35 | 149.35 | 149.35 | 3.54 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16.0 | 45.01 | 39.08 | 113.61 | 152.70 | 152.70 | 152.70 | 3.39 |
| 17.0 | 47.82 | 42.48 | 113.56 | 156.04 | 156.04 | 156.04 | 3.26 |
| 18.0 | 50.63 | 45.88 | 113.51 | 159.39 | 159.39 | 159.39 | 3.15 |
| 19.0 | 53.45 | 49.28 | 153.18 | 202.46 | 202.46 | 202.46 | 3.79 |
| 20.0 | 56.26 | 52.68 | 194.84 | 247.52 | 247.52 | 247.52 | 4.40 |
| 21.0 | 59.07 | 56.07 | 238.49 | 294.56 | 294.56 | 294.56 | 4.99 |
| 22.0 | 61.88 | 59.47 | 284.13 | 343.60 | 343.60 | 343.60 | 5.55 |
| 23.0 | 64.70 | 62.87 | 331.76 | 394.63 | 394.63 | 394.63 | 6.10 |
| 24.0 | 67.51 | 66.27 | 381.37 | 447.65 | 447.65 | 447.65 | 6.63 |
| 25.0 | 70.32 | 69.67 | 432.98 | 502.65 | 502.65 | 502.65 | 7.15 |
| 26.0 | 73.14 | 73.07 | 486.58 | 559.65 | 559.65 | 559.65 | 7.65 |
| 27.0 | 75.95 | 76.47 | 542.17 | 618.63 | 618.63 | 618.63 | 8.15 |
| 28.0 | 78.76 | 79.86 | 595.77 | 675.64 | 675.64 | 675.64 | 8.58 |
| 29.0 | 81.57 | 83.26 | 643.42 | 726.69 | 726.69 | 726.69 | 8.91 |
| 30.0 | 84.39 | 86.66 | 685.12 | 771.78 | 771.78 | 771.78 | 9.15 |
| 31.0 | 87.20 | 90.06 | 720.86 | 810.92 | 810.92 | 810.92 | 9.30 |
| 32.0 | 90.01 | 93.46 | 750.64 | 844.10 | 844.10 | 844.10 | 9.38 |
| 33.0 | 92.83 | 96.86 | 774.47 | 871.33 | 871.33 | 871.33 | 9.39 |
| 34.0 | 95.64 | 100.26 | 792.34 | 892.60 | 892.60 | 892.60 | 9.33 |
| 35.0 | 98.45 | 103.65 | 804.26 | 907.91 | 907.91 | 907.91 | 9.22 |
| 36.0 | 101.26 | 107.05 | 810.22 | 917.27 | 917.27 | 917.27 | 9.06 |
| 37.0 | 104.08 | 110.45 | 810.22 | 920.67 | 920.67 | 920.67 | 8.85 |
| 38.0 | 106.89 | 127.30 | 810.22 | 937.52 | 937.52 | 937.52 | 8.77 |
| 39.0 | 109.70 | 144.47 | 812.49 | 956.96 | 956.96 | 956.96 | 8.72 |
| 40.0 | 112.52 | 161.93 | 814.89 | 976.81 | 976.81 | 976.81 | 8.68 |
| 41.0 | 115.33 | 179.67 | 817.39 | 997.06 | 997.06 | 997.06 | 8.65 |
| 42.0 | 118.14 | 197.67 | 820.01 | 1017.68 | 1017.68 | 1017.68 | 8.61 |
| 43.0 | 120.95 | 215.92 | 822.74 | 1038.66 | 1038.66 | 1038.66 | 8.59 |
| 44.0 | 123.77 | 234.40 | 825.59 | 1059.99 | 1059.99 | 1059.99 | 8.56 |
| 45.0 | 126.58 | 253.10 | 828.55 | 1081.65 | 1081.65 | 1081.65 | 8.55 |
| 46.0 | 129.39 | 272.01 | 831.62 | 1103.64 | 1103.64 | 1103.64 | 8.53 |
| 47.0 | 132.21 | 291.11 | 834.81 | 1125.92 | 1125.92 | 1125.92 | 8.52 |
| 48.0 | 135.02 | 310.39 | 837.88 | 1148.27 | 1148.27 | 1148.27 | 8.50 |
| 49.0 | 137.83 | 329.83 | 840.62 | 1170.45 | 1170.45 | 1170.45 | 8.49 |
| 50.0 | 140.65 | 349.42 | 843.01 | 1192.43 | 1192.43 | 1192.43 | 8.48 |
| 51.0 | 143.46 | 369.14 | 845.06 | 1214.20 | 1214.20 | 1214.20 | 8.46 |
| 52.0 | 146.27 | 388.99 | 846.77 | 1235.75 | 1235.75 | 1235.75 | 8.45 |
| 53.0 | 149.08 | 408.94 | 848.13 | 1257.08 | 1257.08 | 1257.08 | 8.43 |
| 54.0 | 151.90 | 429.00 | 849.16 | 1278.15 | 1278.15 | 1278.15 | 8.41 |
| 55.0 | 154.71 | 449.13 | 849.84 | 1298.97 | 1298.97 | 1298.97 | 8.40 |
| 56.0 | 157.52 | 469.33 | 850.18 | 1319.52 | 1319.52 | 1319.52 | 8.38 |
| 57.0 | 160.34 | 489.60 | 850.18 | 1339.78 | 1339.78 | 1339.78 | 8.36 |
| 58.0 | 163.15 | 521.17 | 850.18 | 1371.35 | 1371.35 | 1371.35 | 8.41 |
| 59.0 | 165.96 | 552.75 | 850.18 | 1402.93 | 1402.93 | 1402.93 | 8.45 |
| 60.0 | 168.77 | 584.33 | 850.18 | 1434.51 | 1434.51 | 1434.51 | 8.50 |
| 61.0 | 171.59 | 615.91 | 850.18 | 1466.09 | 1466.09 | 1466.09 | 8.54 |
| 62.0 | 174.40 | 647.48 | 850.18 | 1497.66 | 1497.66 | 1497.66 | 8.59 |
| 63.0 | 177.21 | 679.06 | 850.18 | 1529.24 | 1529.24 | 1529.24 | 8.63 |
| 64.0 | 180.03 | 710.64 | 850.18 | 1560.82 | 1560.82 | 1560.82 | 8.67 |
| 65.0 | 182.84 | 742.21 | 850.18 | 1592.39 | 1592.39 | 1592.39 | 8.71 |
| 66.0 | 185.65 | 773.79 | 850.18 | 1623.97 | 1623.97 | 1623.97 | 8.75 |
| 67.0 | 188.46 | 805.37 | 850.18 | 1655.55 | 1655.55 | 1655.55 | 8.78 |
| 68.0 | 191.28 | 836.95 | 850.18 | 1687.13 | 1687.13 | 1687.13 | 8.82 |
| 69.0 | 194.09 | 868.52 | 850.18 | 1718.70 | 1718.70 | 1718.70 | 8.86 |
| 70.0 | 196.90 | 900.10 | 850.18 | 1750.28 | 1750.28 | 1750.28 | 8.89 |
| 71.0 | 199.72 | 931.68 | 850.18 | 1781.86 | 1781.86 | 1781.86 | 8.92 |
| 72.0 | 202.53 | 963.25 | 850.18 | 1813.44 | 1813.44 | 1813.44 | 8.95 |
| 73.0 | 205.34 | 994.83 | 850.18 | 1845.01 | 1845.01 | 1845.01 | 8.99 |
| 74.0 | 208.15 | 1026.41 | 850.18 | 1876.59 | 1876.59 | 1876.59 | 9.02 |
| 75.0 | 210.97 | 1057.99 | 850.18 | 1908.17 | 1908.17 | 1908.17 | 9.04 |
| 76.0 | 213.78 | 1089.56 | 850.18 | 1939.74 | 1939.74 | 1939.74 | 9.07 |
| 77.0 | 216.59 | 1121.14 | 850.18 | 1971.32 | 1971.32 | 1971.32 | 9.10 |
| 78.0 | 219.41 | 1152.72 | 850.18 | 2002.90 | 2002.90 | 2002.90 | 9.13 |
| 79.0 | 222.22 | 1184.29 | 912.52 | 2096.82 | 2096.82 | 2096.82 | 9.44 |
| 80.0 | 225.03 | 1215.87 | 977.98 | 2193.85 | 2193.85 | 2193.85 | 9.75 |
| 81.0 | 227.85 | 1247.45 | 1046.56 | 2294.01 | 2294.01 | 2294.01 | 10.07 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 82.0 | 230.66 | 1279.03 | 1118.25 | 2397.28 | 2397.28 | 2397.28 | 10.39 |
| 83.0 | 233.47 | 1310.60 | 1193.06 | 2503.66 | 2503.66 | 2503.66 | 10.72 |
| 84.0 | 236.28 | 1342.18 | 1270.99 | 2613.17 | 2613.17 | 2613.17 | 11.06 |
| 85.0 | 239.10 | 1373.76 | 1352.03 | 2725.79 | 2725.79 | 2725.79 | 11.40 |
| 86.0 | 241.91 | 1405.33 | 1436.19 | 2841.53 | 2841.53 | 2841.53 | 11.75 |
| 87.0 | 244.72 | 1436.91 | 1523.47 | 2960.38 | 2960.38 | 2960.38 | 12.10 |
| 88.0 | 247.54 | 1468.49 | 1607.63 | 3076.12 | 3076.12 | 3076.12 | 12.43 |
| 89.0 | 250.35 | 1500.07 | 1682.44 | 3182.51 | 3182.51 | 3182.51 | 12.71 |
| 90.0 | 253.16 | 1531.64 | 1747.90 | 3279.54 | 3279.54 | 3279.54 | 12.95 |
| 91.0 | 255.97 | 1563.22 | 1804.01 | 3367.23 | 3367.23 | 3367.23 | 13.15 |
| 92.0 | 258.79 | 1594.80 | 1850.77 | 3445.56 | 3445.56 | 3445.56 | 13.31 |
| 93.0 | 261.60 | 1626.37 | 1888.17 | 3514.54 | 3514.54 | 3514.54 | 13.43 |
| 94.0 | 264.41 | 1657.95 | 1916.22 | 3574.18 | 3574.18 | 3574.18 | 13.52 |
| 95.0 | 267.23 | 1689.53 | 1934.93 | 3624.46 | 3624.46 | 3624.46 | 13.56 |
| 96.0 | 270.04 | 1721.11 | 1944.28 | 3665.38 | 3665.38 | 3665.38 | 13.57 |
| 97.0 | 272.85 | 1752.68 | 1944.28 | 3696.96 | 3696.96 | 3696.96 | 13.55 |
| 98.0 | 275.66 | 1773.15 | 1944.28 | 3717.43 | 3717.43 | 3717.43 | 13.49 |
| 99.0 | 278.48 | 1793.88 | 1944.28 | 3738.16 | 3738.16 | 3738.16 | 13.42 |
| 100.0 | 281.29 | 1814.87 | 1944.28 | 3759.15 | 3759.15 | 3759.15 | 13.36 |
| 101.0 | 284.10 | 1836.12 | 1944.28 | 3780.40 | 3780.40 | 3780.40 | 13.31 |
| 102.0 | 286.92 | 1857.63 | 1944.28 | 3801.91 | 3801.91 | 3801.91 | 13.25 |
| 103.0 | 289.73 | 1879.40 | 1944.28 | 3823.68 | 3823.68 | 3823.68 | 13.20 |
| 104.0 | 292.54 | 1901.44 | 1944.28 | 3845.71 | 3845.71 | 3845.71 | 13.15 |
| 105.0 | 295.35 | 1923.73 | 1944.28 | 3868.01 | 3868.01 | 3868.01 | 13.10 |
| 106.0 | 298.17 | 1946.29 | 1944.28 | 3890.57 | 3890.57 | 3890.57 | 13.05 |
| 107.0 | 300.98 | 1969.11 | 1944.28 | 3913.38 | 3913.38 | 3913.38 | 13.00 |
| 108.0 | 303.79 | 1992.18 | 1944.28 | 3936.46 | 3936.46 | 3936.46 | 12.96 |
| 109.0 | 306.61 | 2015.52 | 1944.28 | 3959.80 | 3959.80 | 3959.80 | 12.91 |
| 110.0 | 309.42 | 2039.12 | 1944.28 | 3983.40 | 3983.40 | 3983.40 | 12.87 |
| 111.0 | 312.23 | 2062.98 | 1944.28 | 4007.26 | 4007.26 | 4007.26 | 12.83 |
| 112.0 | 315.04 | 2087.11 | 1944.28 | 4031.38 | 4031.38 | 4031.38 | 12.80 |
| 113.0 | 317.86 | 2111.49 | 1944.28 | 4055.77 | 4055.77 | 4055.77 | 12.76 |
| 114.0 | 320.67 | 2136.13 | 1944.28 | 4080.41 | 4080.41 | 4080.41 | 12.72 |
| 115.0 | 323.48 | 2161.04 | 1944.28 | 4105.32 | 4105.32 | 4105.32 | 12.69 |
| 116.0 | 326.30 | 2186.21 | 1944.28 | 4130.48 | 4130.48 | 4130.48 | 12.66 |
| 117.0 | 329.11 | 2211.63 | 1944.28 | 4155.91 | 4155.91 | 4155.91 | 12.63 |
| 118.0 | 331.92 | 2237.32 | 1944.28 | 4181.60 | 4181.60 | 4181.60 | 12.60 |
| 119.0 | 334.74 | 2263.27 | 1944.28 | 4207.55 | 4207.55 | 4207.55 | 12.57 |
| 120.0 | 337.55 | 2289.48 | 1944.28 | 4233.76 | 4233.76 | 4233.76 | 12.54 |
| 121.0 | 340.36 | 2315.95 | 1944.28 | 4260.23 | 4260.23 | 4260.23 | 12.52 |
| 122.0 | 343.17 | 2342.69 | 1944.28 | 4286.96 | 4286.96 | 4286.96 | 12.49 |
| 123.0 | 345.99 | 2369.68 | 1944.28 | 4313.96 | 4313.96 | 4313.96 | 12.47 |
| 124.0 | 348.80 | 2396.94 | 1944.28 | 4341.21 | 4341.21 | 4341.21 | 12.45 |
| 125.0 | 351.61 | 2424.45 | 1944.28 | 4368.73 | 4368.73 | 4368.73 | 12.42 |
| 126.0 | 354.43 | 2452.23 | 1944.28 | 4396.51 | 4396.51 | 4396.51 | 12.40 |
| 127.0 | 357.24 | 2480.27 | 1944.28 | 4424.55 | 4424.55 | 4424.55 | 12.39 |
| 128.0 | 360.05 | 2508.57 | 1944.28 | 4452.84 | 4452.84 | 4452.84 | 12.37 |
| 129.0 | 362.86 | 2537.13 | 1944.28 | 4481.41 | 4481.41 | 4481.41 | 12.35 |
| 130.0 | 365.68 | 2565.95 | 1944.28 | 4510.23 | 4510.23 | 4510.23 | 12.33 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |
| 0.1093E+00 | 0.1562E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.5463E+00 | 0.7809E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1093E+01 | 0.1562E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.5463E+02 | 0.7809E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.8194E+02 | 0.1171E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1093E+03 | 0.1562E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.2731E+03 | 0.3905E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.5468E+03 | 0.7811E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.8205E+03 | 0.1172E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1085E+04 | 0.1561E+00 | 0.5767E+02 | 0.1000E+00 |

| | | | |
|---|---|---|---|
| 0.1948E+04 | 0.3543E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2524E+04 | 0.6403E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3091E+04 | 0.1363E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3525E+04 | 0.3175E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4250E+04 | 0.6185E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1606E+00 | 0.1813E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.8029E+00 | 0.9065E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1606E+01 | 0.1813E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.8029E+02 | 0.9065E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1204E+03 | 0.1360E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1606E+03 | 0.1813E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4018E+03 | 0.4533E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.8044E+03 | 0.9070E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1204E+04 | 0.1361E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1570E+04 | 0.1807E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2449E+04 | 0.3830E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.2924E+04 | 0.6657E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3500E+04 | 0.1393E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.3924E+04 | 0.3202E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4546E+04 | 0.6204E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.6289E-01 | 0.1329E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3145E+00 | 0.6647E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.6289E+00 | 0.1329E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3145E+02 | 0.6647E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.4717E+02 | 0.9971E-02 | 0.2472E+01 | 0.7500E-02 |
| 0.6289E+02 | 0.1329E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1572E+03 | 0.3324E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3145E+03 | 0.6647E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.4719E+03 | 0.9972E-01 | 0.2472E+02 | 0.7500E-01 |
| 0.6289E+03 | 0.1330E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1373E+04 | 0.3228E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2074E+04 | 0.6123E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2683E+04 | 0.1334E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3125E+04 | 0.3147E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.3954E+04 | 0.6166E+01 | 0.1847E+04 | 0.5900E+01 |

SHAFT Axial Analysis – 5th Street Bridge, Bent 6, 118” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 6, 118"CIDH (comp) NL

PROPOSED DEPTH = 125.0 FT
---

NUMBER OF LAYERS = 5
---

WATER TABLE DEPTH = 0.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.600E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.500E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.661E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.500E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.500E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03

MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.500E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.761E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.300E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.761E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.300E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.646E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.400E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.400E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.950E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.950E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
---

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.99 | 0.00 | 3.99 | 3.99 | 3.99 | 0.30 |
| 7.0 | 19.69 | 9.88 | 0.00 | 9.88 | 9.88 | 9.88 | 0.50 |
| 8.0 | 22.50 | 15.77 | 0.00 | 15.77 | 15.77 | 15.77 | 0.70 |
| 9.0 | 25.32 | 22.25 | 0.00 | 22.25 | 22.25 | 22.25 | 0.88 |
| 10.0 | 28.13 | 29.31 | 0.00 | 29.31 | 29.31 | 29.31 | 1.04 |
| 11.0 | 30.94 | 36.93 | 0.00 | 36.93 | 36.93 | 36.93 | 1.19 |
| 12.0 | 33.75 | 45.08 | 46.17 | 91.25 | 91.25 | 91.25 | 2.70 |
| 13.0 | 36.57 | 53.75 | 94.64 | 148.39 | 148.39 | 148.39 | 4.06 |
| 14.0 | 39.38 | 62.92 | 145.42 | 208.34 | 208.34 | 208.34 | 5.29 |
| 15.0 | 42.19 | 72.56 | 198.51 | 271.08 | 271.08 | 271.08 | 6.42 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16.0 | 45.01 | 82.67 | 253.91 | 336.59 | 336.59 | 336.59 | 7.48 |
| 17.0 | 47.82 | 93.23 | 311.62 | 404.85 | 404.85 | 404.85 | 8.47 |
| 18.0 | 50.63 | 104.21 | 371.64 | 475.85 | 475.85 | 475.85 | 9.40 |
| 19.0 | 53.45 | 115.61 | 433.96 | 549.57 | 549.57 | 549.57 | 10.28 |
| 20.0 | 56.26 | 127.40 | 498.60 | 626.00 | 626.00 | 626.00 | 11.13 |
| 21.0 | 59.07 | 139.58 | 560.92 | 700.50 | 700.50 | 700.50 | 11.86 |
| 22.0 | 61.88 | 152.13 | 618.60 | 770.73 | 770.73 | 770.73 | 12.45 |
| 23.0 | 64.70 | 165.04 | 669.46 | 834.50 | 834.50 | 834.50 | 12.90 |
| 24.0 | 67.51 | 178.28 | 713.52 | 891.80 | 891.80 | 891.80 | 13.21 |
| 25.0 | 70.32 | 191.85 | 750.76 | 942.61 | 942.61 | 942.61 | 13.40 |
| 26.0 | 73.14 | 205.74 | 781.19 | 986.93 | 986.93 | 986.93 | 13.49 |
| 27.0 | 75.95 | 219.93 | 804.81 | 1024.74 | 1024.74 | 1024.74 | 13.49 |
| 28.0 | 78.76 | 234.40 | 821.62 | 1056.03 | 1056.03 | 1056.03 | 13.41 |
| 29.0 | 81.57 | 249.16 | 831.62 | 1080.78 | 1080.78 | 1080.78 | 13.25 |
| 30.0 | 84.39 | 264.17 | 834.81 | 1098.98 | 1098.98 | 1098.98 | 13.02 |
| 31.0 | 87.20 | 279.61 | 837.88 | 1117.50 | 1117.50 | 1117.50 | 12.82 |
| 32.0 | 90.01 | 295.46 | 840.62 | 1136.08 | 1136.08 | 1136.08 | 12.62 |
| 33.0 | 92.83 | 311.70 | 843.01 | 1154.70 | 1154.70 | 1154.70 | 12.44 |
| 34.0 | 95.64 | 328.30 | 845.06 | 1173.36 | 1173.36 | 1173.36 | 12.27 |
| 35.0 | 98.45 | 345.27 | 846.77 | 1192.04 | 1192.04 | 1192.04 | 12.11 |
| 36.0 | 101.26 | 362.58 | 848.13 | 1210.71 | 1210.71 | 1210.71 | 11.96 |
| 37.0 | 104.08 | 380.21 | 849.16 | 1229.36 | 1229.36 | 1229.36 | 11.81 |
| 38.0 | 106.89 | 398.14 | 849.84 | 1247.98 | 1247.98 | 1247.98 | 11.68 |
| 39.0 | 109.70 | 416.37 | 850.18 | 1266.55 | 1266.55 | 1266.55 | 11.55 |
| 40.0 | 112.52 | 434.88 | 850.18 | 1285.06 | 1285.06 | 1285.06 | 11.42 |
| 41.0 | 115.33 | 466.46 | 850.18 | 1316.64 | 1316.64 | 1316.64 | 11.42 |
| 42.0 | 118.14 | 498.03 | 850.18 | 1348.21 | 1348.21 | 1348.21 | 11.41 |
| 43.0 | 120.95 | 529.61 | 850.18 | 1379.79 | 1379.79 | 1379.79 | 11.41 |
| 44.0 | 123.77 | 561.19 | 850.18 | 1411.37 | 1411.37 | 1411.37 | 11.40 |
| 45.0 | 126.58 | 592.77 | 850.18 | 1442.95 | 1442.95 | 1442.95 | 11.40 |
| 46.0 | 129.39 | 624.34 | 850.18 | 1474.52 | 1474.52 | 1474.52 | 11.40 |
| 47.0 | 132.21 | 655.92 | 850.18 | 1506.10 | 1506.10 | 1506.10 | 11.39 |
| 48.0 | 135.02 | 687.50 | 850.18 | 1537.68 | 1537.68 | 1537.68 | 11.39 |
| 49.0 | 137.83 | 719.07 | 850.18 | 1569.26 | 1569.26 | 1569.26 | 11.39 |
| 50.0 | 140.65 | 750.65 | 850.18 | 1600.83 | 1600.83 | 1600.83 | 11.38 |
| 51.0 | 143.46 | 782.23 | 850.18 | 1632.41 | 1632.41 | 1632.41 | 11.38 |
| 52.0 | 146.27 | 813.81 | 850.18 | 1663.99 | 1663.99 | 1663.99 | 11.38 |
| 53.0 | 149.08 | 845.38 | 850.18 | 1695.56 | 1695.56 | 1695.56 | 11.37 |
| 54.0 | 151.90 | 876.96 | 850.18 | 1727.14 | 1727.14 | 1727.14 | 11.37 |
| 55.0 | 154.71 | 908.54 | 850.18 | 1758.72 | 1758.72 | 1758.72 | 11.37 |
| 56.0 | 157.52 | 940.11 | 850.18 | 1790.30 | 1790.30 | 1790.30 | 11.37 |
| 57.0 | 160.34 | 971.69 | 850.18 | 1821.87 | 1821.87 | 1821.87 | 11.36 |
| 58.0 | 163.15 | 1003.27 | 850.18 | 1853.45 | 1853.45 | 1853.45 | 11.36 |
| 59.0 | 165.96 | 1034.85 | 850.18 | 1885.03 | 1885.03 | 1885.03 | 11.36 |
| 60.0 | 168.77 | 1066.42 | 850.18 | 1916.60 | 1916.60 | 1916.60 | 11.36 |
| 61.0 | 171.59 | 1098.00 | 850.18 | 1948.18 | 1948.18 | 1948.18 | 11.35 |
| 62.0 | 174.40 | 1129.58 | 850.18 | 1979.76 | 1979.76 | 1979.76 | 11.35 |
| 63.0 | 177.21 | 1161.16 | 850.18 | 2011.34 | 2011.34 | 2011.34 | 11.35 |
| 64.0 | 180.03 | 1192.73 | 850.18 | 2042.91 | 2042.91 | 2042.91 | 11.35 |
| 65.0 | 182.84 | 1224.31 | 850.18 | 2074.49 | 2074.49 | 2074.49 | 11.35 |
| 66.0 | 185.65 | 1255.89 | 850.18 | 2106.07 | 2106.07 | 2106.07 | 11.34 |
| 67.0 | 188.46 | 1287.46 | 850.18 | 2137.64 | 2137.64 | 2137.64 | 11.34 |
| 68.0 | 191.28 | 1319.04 | 850.18 | 2169.22 | 2169.22 | 2169.22 | 11.34 |
| 69.0 | 194.09 | 1350.62 | 850.18 | 2200.80 | 2200.80 | 2200.80 | 11.34 |
| 70.0 | 196.90 | 1382.20 | 850.18 | 2232.38 | 2232.38 | 2232.38 | 11.34 |
| 71.0 | 199.72 | 1413.77 | 850.18 | 2263.95 | 2263.95 | 2263.95 | 11.34 |
| 72.0 | 202.53 | 1445.35 | 850.18 | 2295.53 | 2295.53 | 2295.53 | 11.33 |
| 73.0 | 205.34 | 1476.93 | 850.18 | 2327.11 | 2327.11 | 2327.11 | 11.33 |
| 74.0 | 208.15 | 1508.50 | 850.18 | 2358.68 | 2358.68 | 2358.68 | 11.33 |
| 75.0 | 210.97 | 1540.08 | 850.18 | 2390.26 | 2390.26 | 2390.26 | 11.33 |
| 76.0 | 213.78 | 1571.66 | 850.18 | 2421.84 | 2421.84 | 2421.84 | 11.33 |
| 77.0 | 216.59 | 1603.24 | 912.52 | 2515.76 | 2515.76 | 2515.76 | 11.62 |
| 78.0 | 219.41 | 1634.81 | 977.98 | 2612.79 | 2612.79 | 2612.79 | 11.91 |
| 79.0 | 222.22 | 1666.39 | 1046.56 | 2712.95 | 2712.95 | 2712.95 | 12.21 |
| 80.0 | 225.03 | 1697.97 | 1118.25 | 2816.22 | 2816.22 | 2816.22 | 12.51 |
| 81.0 | 227.85 | 1729.54 | 1193.06 | 2922.60 | 2922.60 | 2922.60 | 12.83 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 82.0 | 230.66 | 1761.12 | 1270.99 | 3032.11 | 3032.11 | 3032.11 | 13.15 |
| 83.0 | 233.47 | 1792.70 | 1352.03 | 3144.73 | 3144.73 | 3144.73 | 13.47 |
| 84.0 | 236.28 | 1824.28 | 1436.19 | 3260.47 | 3260.47 | 3260.47 | 13.80 |
| 85.0 | 239.10 | 1855.85 | 1523.47 | 3379.32 | 3379.32 | 3379.32 | 14.13 |
| 86.0 | 241.91 | 1887.43 | 1607.63 | 3495.06 | 3495.06 | 3495.06 | 14.45 |
| 87.0 | 244.72 | 1919.01 | 1682.44 | 3601.45 | 3601.45 | 3601.45 | 14.72 |
| 88.0 | 247.54 | 1950.58 | 1747.90 | 3698.49 | 3698.49 | 3698.49 | 14.94 |
| 89.0 | 250.35 | 1982.16 | 1804.01 | 3786.17 | 3786.17 | 3786.17 | 15.12 |
| 90.0 | 253.16 | 2013.74 | 1850.77 | 3864.50 | 3864.50 | 3864.50 | 15.26 |
| 91.0 | 255.97 | 2045.32 | 1888.17 | 3933.49 | 3933.49 | 3933.49 | 15.37 |
| 92.0 | 258.79 | 2076.89 | 1916.22 | 3993.12 | 3993.12 | 3993.12 | 15.43 |
| 93.0 | 261.60 | 2108.47 | 1934.93 | 4043.40 | 4043.40 | 4043.40 | 15.46 |
| 94.0 | 264.41 | 2140.05 | 1944.28 | 4084.32 | 4084.32 | 4084.32 | 15.45 |
| 95.0 | 267.23 | 2171.62 | 1944.28 | 4115.90 | 4115.90 | 4115.90 | 15.40 |
| 96.0 | 270.04 | 2192.34 | 1944.28 | 4136.62 | 4136.62 | 4136.62 | 15.32 |
| 97.0 | 272.85 | 2213.32 | 1944.28 | 4157.60 | 4157.60 | 4157.60 | 15.24 |
| 98.0 | 275.66 | 2234.56 | 1944.28 | 4178.84 | 4178.84 | 4178.84 | 15.16 |
| 99.0 | 278.48 | 2256.06 | 1944.28 | 4200.34 | 4200.34 | 4200.34 | 15.08 |
| 100.0 | 281.29 | 2277.82 | 1944.28 | 4222.10 | 4222.10 | 4222.10 | 15.01 |
| 101.0 | 284.10 | 2299.85 | 1944.28 | 4244.12 | 4244.12 | 4244.12 | 14.94 |
| 102.0 | 286.92 | 2322.13 | 1944.28 | 4266.41 | 4266.41 | 4266.41 | 14.87 |
| 103.0 | 289.73 | 2344.67 | 1944.28 | 4288.95 | 4288.95 | 4288.95 | 14.80 |
| 104.0 | 292.54 | 2367.48 | 1944.28 | 4311.76 | 4311.76 | 4311.76 | 14.74 |
| 105.0 | 295.35 | 2390.55 | 1944.28 | 4334.83 | 4334.83 | 4334.83 | 14.68 |
| 106.0 | 298.17 | 2413.88 | 1944.28 | 4358.15 | 4358.15 | 4358.15 | 14.62 |
| 107.0 | 300.98 | 2437.47 | 1944.28 | 4381.74 | 4381.74 | 4381.74 | 14.56 |
| 108.0 | 303.79 | 2461.32 | 1944.28 | 4405.59 | 4405.59 | 4405.59 | 14.50 |
| 109.0 | 306.61 | 2485.43 | 1944.28 | 4429.71 | 4429.71 | 4429.71 | 14.45 |
| 110.0 | 309.42 | 2509.80 | 1944.28 | 4454.08 | 4454.08 | 4454.08 | 14.39 |
| 111.0 | 312.23 | 2534.43 | 1944.28 | 4478.71 | 4478.71 | 4478.71 | 14.34 |
| 112.0 | 315.04 | 2559.33 | 1944.28 | 4503.61 | 4503.61 | 4503.61 | 14.30 |
| 113.0 | 317.86 | 2584.48 | 1944.28 | 4528.76 | 4528.76 | 4528.76 | 14.25 |
| 114.0 | 320.67 | 2609.90 | 1944.28 | 4554.18 | 4554.18 | 4554.18 | 14.20 |
| 115.0 | 323.48 | 2635.58 | 1944.28 | 4579.86 | 4579.86 | 4579.86 | 14.16 |
| 116.0 | 326.30 | 2661.52 | 1944.28 | 4605.80 | 4605.80 | 4605.80 | 14.12 |
| 117.0 | 329.11 | 2687.72 | 1944.28 | 4632.00 | 4632.00 | 4632.00 | 14.07 |
| 118.0 | 331.92 | 2714.18 | 1944.28 | 4658.46 | 4658.46 | 4658.46 | 14.03 |
| 119.0 | 334.74 | 2740.90 | 1944.28 | 4685.18 | 4685.18 | 4685.18 | 14.00 |
| 120.0 | 337.55 | 2767.88 | 1944.28 | 4712.16 | 4712.16 | 4712.16 | 13.96 |
| 121.0 | 340.36 | 2795.13 | 1944.28 | 4739.41 | 4739.41 | 4739.41 | 13.92 |
| 122.0 | 343.17 | 2822.63 | 1944.28 | 4766.91 | 4766.91 | 4766.91 | 13.89 |
| 123.0 | 345.99 | 2850.40 | 1944.28 | 4794.68 | 4794.68 | 4794.68 | 13.86 |
| 124.0 | 348.80 | 2878.43 | 1944.28 | 4822.71 | 4822.71 | 4822.71 | 13.83 |
| 125.0 | 351.61 | 2906.72 | 1944.28 | 4850.99 | 4850.99 | 4850.99 | 13.80 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |
| 0.1283E+00 | 0.1584E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6417E+00 | 0.7920E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1283E+01 | 0.1584E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6417E+02 | 0.7920E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.9625E+02 | 0.1188E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1283E+03 | 0.1584E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3209E+03 | 0.3960E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6426E+03 | 0.7922E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.9641E+03 | 0.1188E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1273E+04 | 0.1582E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2234E+04 | 0.3560E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2851E+04 | 0.6405E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3414E+04 | 0.1361E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3809E+04 | 0.3169E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4535E+04 | 0.6177E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1906E+00 | 0.1853E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.9531E+00 | 0.9267E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1906E+01 | 0.1853E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.9531E+02 | 0.9267E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1430E+03 | 0.1390E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1906E+03 | 0.1853E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4772E+03 | 0.4635E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.9553E+03 | 0.9274E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1431E+04 | 0.1391E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1854E+04 | 0.1841E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2792E+04 | 0.3840E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3275E+04 | 0.6649E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3847E+04 | 0.1390E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4239E+04 | 0.3197E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4861E+04 | 0.6197E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.7284E-01 | 0.1337E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3642E+00 | 0.6687E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.7284E+00 | 0.1337E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3642E+02 | 0.6687E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5463E+02 | 0.1003E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.7284E+02 | 0.1337E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1821E+03 | 0.3343E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3643E+03 | 0.6687E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5467E+03 | 0.1003E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.7284E+03 | 0.1337E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1582E+04 | 0.3242E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2363E+04 | 0.6133E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2981E+04 | 0.1332E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3380E+04 | 0.3142E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4209E+04 | 0.6158E+01 | 0.1847E+04 | 0.5900E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 6, 118"CIDH (comp) LQ

PROPOSED DEPTH = 125.0 FT
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NUMBER OF LAYERS = 5
---

WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.600E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.500E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.661E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.500E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.500E+01

LAYER NO 2----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.661E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11

DEPTH, FT = 0.500E+01

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.300E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.761E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.300E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.646E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.400E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.400E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.950E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.950E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.40 | 115.99 | 119.39 | 119.39 | 119.39 | 6.87 |
| 7.0 | 19.69 | 6.80 | 116.56 | 123.35 | 123.35 | 123.35 | 6.26 |
| 8.0 | 22.50 | 10.20 | 117.12 | 127.32 | 127.32 | 127.32 | 5.66 |
| 9.0 | 25.32 | 13.59 | 117.61 | 131.21 | 131.21 | 131.21 | 5.18 |
| 10.0 | 28.13 | 16.99 | 118.03 | 135.02 | 135.02 | 135.02 | 4.80 |
| 11.0 | 30.94 | 20.39 | 118.39 | 138.79 | 138.79 | 138.79 | 4.49 |
| 12.0 | 33.75 | 23.79 | 158.01 | 181.80 | 181.80 | 181.80 | 5.39 |
| 13.0 | 36.57 | 27.19 | 199.55 | 226.74 | 226.74 | 226.74 | 6.20 |
| 14.0 | 39.38 | 30.59 | 243.01 | 273.60 | 273.60 | 273.60 | 6.95 |
| 15.0 | 42.19 | 33.98 | 288.41 | 322.39 | 322.39 | 322.39 | 7.64 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16.0 | 45.01 | 37.38 | 335.75 | 373.13 | 373.13 | 373.13 | 8.29 |
| 17.0 | 47.82 | 40.78 | 385.04 | 425.82 | 425.82 | 425.82 | 8.90 |
| 18.0 | 50.63 | 44.18 | 436.28 | 480.46 | 480.46 | 480.46 | 9.49 |
| 19.0 | 53.45 | 47.58 | 489.46 | 537.04 | 537.04 | 537.04 | 10.05 |
| 20.0 | 56.26 | 50.98 | 544.59 | 595.57 | 595.57 | 595.57 | 10.59 |
| 21.0 | 59.07 | 54.38 | 597.74 | 652.12 | 652.12 | 652.12 | 11.04 |
| 22.0 | 61.88 | 57.77 | 647.25 | 705.03 | 705.03 | 705.03 | 11.39 |
| 23.0 | 64.70 | 61.17 | 690.97 | 752.14 | 752.14 | 752.14 | 11.63 |
| 24.0 | 67.51 | 64.57 | 728.89 | 793.46 | 793.46 | 793.46 | 11.75 |
| 25.0 | 70.32 | 67.97 | 761.01 | 828.98 | 828.98 | 828.98 | 11.79 |
| 26.0 | 73.14 | 71.37 | 787.35 | 858.72 | 858.72 | 858.72 | 11.74 |
| 27.0 | 75.95 | 74.77 | 807.89 | 882.66 | 882.66 | 882.66 | 11.62 |
| 28.0 | 78.76 | 78.17 | 822.65 | 900.82 | 900.82 | 900.82 | 11.44 |
| 29.0 | 81.57 | 81.56 | 831.62 | 913.19 | 913.19 | 913.19 | 11.19 |
| 30.0 | 84.39 | 84.96 | 834.81 | 919.77 | 919.77 | 919.77 | 10.90 |
| 31.0 | 87.20 | 100.40 | 837.88 | 938.29 | 938.29 | 938.29 | 10.76 |
| 32.0 | 90.01 | 116.25 | 840.62 | 956.87 | 956.87 | 956.87 | 10.63 |
| 33.0 | 92.83 | 132.49 | 843.01 | 975.49 | 975.49 | 975.49 | 10.51 |
| 34.0 | 95.64 | 149.10 | 845.06 | 994.15 | 994.15 | 994.15 | 10.39 |
| 35.0 | 98.45 | 166.06 | 846.77 | 1012.83 | 1012.83 | 1012.83 | 10.29 |
| 36.0 | 101.26 | 183.37 | 848.13 | 1031.50 | 1031.50 | 1031.50 | 10.19 |
| 37.0 | 104.08 | 201.00 | 849.16 | 1050.15 | 1050.15 | 1050.15 | 10.09 |
| 38.0 | 106.89 | 218.93 | 849.84 | 1068.77 | 1068.77 | 1068.77 | 10.00 |
| 39.0 | 109.70 | 237.16 | 850.18 | 1087.34 | 1087.34 | 1087.34 | 9.91 |
| 40.0 | 112.52 | 255.67 | 850.18 | 1105.85 | 1105.85 | 1105.85 | 9.83 |
| 41.0 | 115.33 | 287.25 | 850.18 | 1137.43 | 1137.43 | 1137.43 | 9.86 |
| 42.0 | 118.14 | 318.82 | 850.18 | 1169.01 | 1169.01 | 1169.01 | 9.89 |
| 43.0 | 120.95 | 350.40 | 850.18 | 1200.58 | 1200.58 | 1200.58 | 9.93 |
| 44.0 | 123.77 | 381.98 | 850.18 | 1232.16 | 1232.16 | 1232.16 | 9.96 |
| 45.0 | 126.58 | 413.56 | 850.18 | 1263.74 | 1263.74 | 1263.74 | 9.98 |
| 46.0 | 129.39 | 445.13 | 850.18 | 1295.31 | 1295.31 | 1295.31 | 10.01 |
| 47.0 | 132.21 | 476.71 | 850.18 | 1326.89 | 1326.89 | 1326.89 | 10.04 |
| 48.0 | 135.02 | 508.29 | 850.18 | 1358.47 | 1358.47 | 1358.47 | 10.06 |
| 49.0 | 137.83 | 539.86 | 850.18 | 1390.05 | 1390.05 | 1390.05 | 10.09 |
| 50.0 | 140.65 | 571.44 | 850.18 | 1421.62 | 1421.62 | 1421.62 | 10.11 |
| 51.0 | 143.46 | 603.02 | 850.18 | 1453.20 | 1453.20 | 1453.20 | 10.13 |
| 52.0 | 146.27 | 634.60 | 850.18 | 1484.78 | 1484.78 | 1484.78 | 10.15 |
| 53.0 | 149.08 | 666.17 | 850.18 | 1516.35 | 1516.35 | 1516.35 | 10.17 |
| 54.0 | 151.90 | 697.75 | 850.18 | 1547.93 | 1547.93 | 1547.93 | 10.19 |
| 55.0 | 154.71 | 729.33 | 850.18 | 1579.51 | 1579.51 | 1579.51 | 10.21 |
| 56.0 | 157.52 | 760.91 | 850.18 | 1611.09 | 1611.09 | 1611.09 | 10.23 |
| 57.0 | 160.34 | 792.48 | 850.18 | 1642.66 | 1642.66 | 1642.66 | 10.25 |
| 58.0 | 163.15 | 824.06 | 850.18 | 1674.24 | 1674.24 | 1674.24 | 10.26 |
| 59.0 | 165.96 | 855.64 | 850.18 | 1705.82 | 1705.82 | 1705.82 | 10.28 |
| 60.0 | 168.77 | 887.21 | 850.18 | 1737.39 | 1737.39 | 1737.39 | 10.29 |
| 61.0 | 171.59 | 918.79 | 850.18 | 1768.97 | 1768.97 | 1768.97 | 10.31 |
| 62.0 | 174.40 | 950.37 | 850.18 | 1800.55 | 1800.55 | 1800.55 | 10.32 |
| 63.0 | 177.21 | 981.95 | 850.18 | 1832.13 | 1832.13 | 1832.13 | 10.34 |
| 64.0 | 180.03 | 1013.52 | 850.18 | 1863.70 | 1863.70 | 1863.70 | 10.35 |
| 65.0 | 182.84 | 1045.10 | 850.18 | 1895.28 | 1895.28 | 1895.28 | 10.37 |
| 66.0 | 185.65 | 1076.68 | 850.18 | 1926.86 | 1926.86 | 1926.86 | 10.38 |
| 67.0 | 188.46 | 1108.25 | 850.18 | 1958.44 | 1958.44 | 1958.44 | 10.39 |
| 68.0 | 191.28 | 1139.83 | 850.18 | 1990.01 | 1990.01 | 1990.01 | 10.40 |
| 69.0 | 194.09 | 1171.41 | 850.18 | 2021.59 | 2021.59 | 2021.59 | 10.42 |
| 70.0 | 196.90 | 1202.99 | 850.18 | 2053.17 | 2053.17 | 2053.17 | 10.43 |
| 71.0 | 199.72 | 1234.56 | 850.18 | 2084.74 | 2084.74 | 2084.74 | 10.44 |
| 72.0 | 202.53 | 1266.14 | 850.18 | 2116.32 | 2116.32 | 2116.32 | 10.45 |
| 73.0 | 205.34 | 1297.72 | 850.18 | 2147.90 | 2147.90 | 2147.90 | 10.46 |
| 74.0 | 208.15 | 1329.29 | 850.18 | 2179.48 | 2179.48 | 2179.48 | 10.47 |
| 75.0 | 210.97 | 1360.87 | 850.18 | 2211.05 | 2211.05 | 2211.05 | 10.48 |
| 76.0 | 213.78 | 1392.45 | 850.18 | 2242.63 | 2242.63 | 2242.63 | 10.49 |
| 77.0 | 216.59 | 1424.03 | 912.52 | 2336.55 | 2336.55 | 2336.55 | 10.79 |
| 78.0 | 219.41 | 1455.60 | 977.98 | 2433.58 | 2433.58 | 2433.58 | 11.09 |
| 79.0 | 222.22 | 1487.18 | 1046.56 | 2533.74 | 2533.74 | 2533.74 | 11.40 |
| 80.0 | 225.03 | 1518.76 | 1118.25 | 2637.01 | 2637.01 | 2637.01 | 11.72 |
| 81.0 | 227.85 | 1550.33 | 1193.06 | 2743.39 | 2743.39 | 2743.39 | 12.04 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 82.0 | 230.66 | 1581.91 | 1270.99 | 2852.90 | 2852.90 | 2852.90 | 12.37 |
| 83.0 | 233.47 | 1613.49 | 1352.03 | 2965.52 | 2965.52 | 2965.52 | 12.70 |
| 84.0 | 236.28 | 1645.07 | 1436.19 | 3081.26 | 3081.26 | 3081.26 | 13.04 |
| 85.0 | 239.10 | 1676.64 | 1523.47 | 3200.11 | 3200.11 | 3200.11 | 13.38 |
| 86.0 | 241.91 | 1708.22 | 1607.63 | 3315.85 | 3315.85 | 3315.85 | 13.71 |
| 87.0 | 244.72 | 1739.80 | 1682.44 | 3422.24 | 3422.24 | 3422.24 | 13.98 |
| 88.0 | 247.54 | 1771.37 | 1747.90 | 3519.28 | 3519.28 | 3519.28 | 14.22 |
| 89.0 | 250.35 | 1802.95 | 1804.01 | 3606.96 | 3606.96 | 3606.96 | 14.41 |
| 90.0 | 253.16 | 1834.53 | 1850.77 | 3685.29 | 3685.29 | 3685.29 | 14.56 |
| 91.0 | 255.97 | 1866.11 | 1888.17 | 3754.28 | 3754.28 | 3754.28 | 14.67 |
| 92.0 | 258.79 | 1897.68 | 1916.22 | 3813.91 | 3813.91 | 3813.91 | 14.74 |
| 93.0 | 261.60 | 1929.26 | 1934.93 | 3864.19 | 3864.19 | 3864.19 | 14.77 |
| 94.0 | 264.41 | 1960.84 | 1944.28 | 3905.11 | 3905.11 | 3905.11 | 14.77 |
| 95.0 | 267.23 | 1992.41 | 1944.28 | 3936.69 | 3936.69 | 3936.69 | 14.73 |
| 96.0 | 270.04 | 2013.13 | 1944.28 | 3957.41 | 3957.41 | 3957.41 | 14.65 |
| 97.0 | 272.85 | 2034.11 | 1944.28 | 3978.39 | 3978.39 | 3978.39 | 14.58 |
| 98.0 | 275.66 | 2055.35 | 1944.28 | 3999.63 | 3999.63 | 3999.63 | 14.51 |
| 99.0 | 278.48 | 2076.85 | 1944.28 | 4021.13 | 4021.13 | 4021.13 | 14.44 |
| 100.0 | 281.29 | 2098.61 | 1944.28 | 4042.89 | 4042.89 | 4042.89 | 14.37 |
| 101.0 | 284.10 | 2120.64 | 1944.28 | 4064.91 | 4064.91 | 4064.91 | 14.31 |
| 102.0 | 286.92 | 2142.92 | 1944.28 | 4087.20 | 4087.20 | 4087.20 | 14.25 |
| 103.0 | 289.73 | 2165.47 | 1944.28 | 4109.74 | 4109.74 | 4109.74 | 14.18 |
| 104.0 | 292.54 | 2188.27 | 1944.28 | 4132.55 | 4132.55 | 4132.55 | 14.13 |
| 105.0 | 295.35 | 2211.34 | 1944.28 | 4155.62 | 4155.62 | 4155.62 | 14.07 |
| 106.0 | 298.17 | 2234.67 | 1944.28 | 4178.94 | 4178.94 | 4178.94 | 14.02 |
| 107.0 | 300.98 | 2258.26 | 1944.28 | 4202.53 | 4202.53 | 4202.53 | 13.96 |
| 108.0 | 303.79 | 2282.11 | 1944.28 | 4226.38 | 4226.38 | 4226.38 | 13.91 |
| 109.0 | 306.61 | 2306.22 | 1944.28 | 4250.50 | 4250.50 | 4250.50 | 13.86 |
| 110.0 | 309.42 | 2330.59 | 1944.28 | 4274.87 | 4274.87 | 4274.87 | 13.82 |
| 111.0 | 312.23 | 2355.22 | 1944.28 | 4299.50 | 4299.50 | 4299.50 | 13.77 |
| 112.0 | 315.04 | 2380.12 | 1944.28 | 4324.40 | 4324.40 | 4324.40 | 13.73 |
| 113.0 | 317.86 | 2405.28 | 1944.28 | 4349.55 | 4349.55 | 4349.55 | 13.68 |
| 114.0 | 320.67 | 2430.69 | 1944.28 | 4374.97 | 4374.97 | 4374.97 | 13.64 |
| 115.0 | 323.48 | 2456.37 | 1944.28 | 4400.65 | 4400.65 | 4400.65 | 13.60 |
| 116.0 | 326.30 | 2482.31 | 1944.28 | 4426.59 | 4426.59 | 4426.59 | 13.57 |
| 117.0 | 329.11 | 2508.51 | 1944.28 | 4452.79 | 4452.79 | 4452.79 | 13.53 |
| 118.0 | 331.92 | 2534.97 | 1944.28 | 4479.25 | 4479.25 | 4479.25 | 13.49 |
| 119.0 | 334.74 | 2561.69 | 1944.28 | 4505.97 | 4505.97 | 4505.97 | 13.46 |
| 120.0 | 337.55 | 2588.68 | 1944.28 | 4532.95 | 4532.95 | 4532.95 | 13.43 |
| 121.0 | 340.36 | 2615.92 | 1944.28 | 4560.20 | 4560.20 | 4560.20 | 13.40 |
| 122.0 | 343.17 | 2643.43 | 1944.28 | 4587.70 | 4587.70 | 4587.70 | 13.37 |
| 123.0 | 345.99 | 2671.19 | 1944.28 | 4615.47 | 4615.47 | 4615.47 | 13.34 |
| 124.0 | 348.80 | 2699.22 | 1944.28 | 4643.50 | 4643.50 | 4643.50 | 13.31 |
| 125.0 | 351.61 | 2727.51 | 1944.28 | 4671.78 | 4671.78 | 4671.78 | 13.29 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1228E+00 | 0.1576E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6140E+00 | 0.7882E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1228E+01 | 0.1576E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6140E+02 | 0.7882E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.9211E+02 | 0.1182E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1228E+03 | 0.1576E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3070E+03 | 0.3941E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6148E+03 | 0.7884E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.9225E+03 | 0.1183E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1217E+04 | 0.1575E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2123E+04 | 0.3545E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2699E+04 | 0.6385E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3237E+04 | 0.1359E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3626E+04 | 0.3167E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4352E+04 | 0.6175E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1828E+00 | 0.1843E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.9142E+00 | 0.9213E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1828E+01 | 0.1843E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.9142E+02 | 0.9213E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1371E+03 | 0.1382E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1828E+03 | 0.1843E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4577E+03 | 0.4608E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.9163E+03 | 0.9220E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1372E+04 | 0.1383E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1772E+04 | 0.1830E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2637E+04 | 0.3819E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3099E+04 | 0.6625E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3666E+04 | 0.1387E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4051E+04 | 0.3194E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4673E+04 | 0.6194E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.6927E-01 | 0.1333E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3463E+00 | 0.6663E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.6927E+00 | 0.1333E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3463E+02 | 0.6663E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5195E+02 | 0.9994E-02 | 0.2472E+01 | 0.7500E-02 |
| 0.6927E+02 | 0.1333E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1732E+03 | 0.3331E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3464E+03 | 0.6663E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5198E+03 | 0.9995E-01 | 0.2472E+02 | 0.7500E-01 |
| 0.6928E+03 | 0.1333E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1506E+04 | 0.3232E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2239E+04 | 0.6117E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2809E+04 | 0.1330E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3200E+04 | 0.3139E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4031E+04 | 0.6156E+01 | 0.1847E+04 | 0.5900E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Bent 7, 118” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 7, 118"CIDH (comp) NL

PROPOSED DEPTH = 135.0 FT
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NUMBER OF LAYERS = 5
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WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
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FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
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SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.500E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.500E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.646E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.400E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.646E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.400E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.594E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.450E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.450E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.950E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.950E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.99 | 0.00 | 3.99 | 3.99 | 3.99 | 0.30 |
| 7.0 | 19.69 | 9.88 | 0.00 | 9.88 | 9.88 | 9.88 | 0.50 |
| 8.0 | 22.50 | 15.77 | 0.00 | 15.77 | 15.77 | 15.77 | 0.70 |
| 9.0 | 25.32 | 22.25 | 0.00 | 22.25 | 22.25 | 22.25 | 0.88 |
| 10.0 | 28.13 | 29.31 | 0.00 | 29.31 | 29.31 | 29.31 | 1.04 |
| 11.0 | 30.94 | 36.93 | 0.00 | 36.93 | 36.93 | 36.93 | 1.19 |
| 12.0 | 33.75 | 45.08 | 0.00 | 45.08 | 45.08 | 45.08 | 1.34 |
| 13.0 | 36.57 | 53.75 | 0.00 | 53.75 | 53.75 | 53.75 | 1.47 |
| 14.0 | 39.38 | 62.92 | 0.00 | 62.92 | 62.92 | 62.92 | 1.60 |
| 15.0 | 42.19 | 72.56 | 0.00 | 72.56 | 72.56 | 72.56 | 1.72 |
| 16.0 | 45.01 | 82.67 | 0.00 | 82.67 | 82.67 | 82.67 | 1.84 |
| 17.0 | 47.82 | 93.23 | 0.00 | 93.23 | 93.23 | 93.23 | 1.95 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18.0 | 50.63 | 104.21 | 0.00 | 104.21 | 104.21 | 104.21 | 2.06 |
| 19.0 | 53.45 | 115.61 | 0.00 | 115.61 | 115.61 | 115.61 | 2.16 |
| 20.0 | 56.26 | 127.40 | 0.00 | 127.40 | 127.40 | 127.40 | 2.26 |
| 21.0 | 59.07 | 139.58 | 0.00 | 139.58 | 139.58 | 139.58 | 2.36 |
| 22.0 | 61.88 | 152.13 | 69.25 | 221.38 | 221.38 | 221.38 | 3.58 |
| 23.0 | 64.70 | 165.04 | 141.96 | 307.00 | 307.00 | 307.00 | 4.75 |
| 24.0 | 67.51 | 178.28 | 218.14 | 396.42 | 396.42 | 396.42 | 5.87 |
| 25.0 | 70.32 | 191.85 | 297.77 | 489.63 | 489.63 | 489.63 | 6.96 |
| 26.0 | 73.14 | 205.74 | 380.87 | 586.61 | 586.61 | 586.61 | 8.02 |
| 27.0 | 75.95 | 219.93 | 446.63 | 666.55 | 666.55 | 666.55 | 8.78 |
| 28.0 | 78.76 | 234.40 | 514.80 | 749.21 | 749.21 | 749.21 | 9.51 |
| 29.0 | 81.57 | 249.16 | 585.40 | 834.56 | 834.56 | 834.56 | 10.23 |
| 30.0 | 84.39 | 264.17 | 658.43 | 922.60 | 922.60 | 922.60 | 10.93 |
| 31.0 | 87.20 | 279.44 | 726.95 | 1006.38 | 1006.38 | 1006.38 | 11.54 |
| 32.0 | 90.01 | 294.94 | 784.04 | 1078.98 | 1078.98 | 1078.98 | 11.99 |
| 33.0 | 92.83 | 310.68 | 829.70 | 1140.38 | 1140.38 | 1140.38 | 12.29 |
| 34.0 | 95.64 | 326.63 | 863.94 | 1190.56 | 1190.56 | 1190.56 | 12.45 |
| 35.0 | 98.45 | 342.78 | 886.75 | 1229.53 | 1229.53 | 1229.53 | 12.49 |
| 36.0 | 101.26 | 359.13 | 900.21 | 1259.33 | 1259.33 | 1259.33 | 12.44 |
| 37.0 | 104.08 | 375.65 | 906.40 | 1282.06 | 1282.06 | 1282.06 | 12.32 |
| 38.0 | 106.89 | 392.35 | 905.33 | 1297.69 | 1297.69 | 1297.69 | 12.14 |
| 39.0 | 109.70 | 409.21 | 896.99 | 1306.21 | 1306.21 | 1306.21 | 11.91 |
| 40.0 | 112.52 | 426.22 | 881.39 | 1307.61 | 1307.61 | 1307.61 | 11.62 |
| 41.0 | 115.33 | 443.57 | 868.91 | 1312.47 | 1312.47 | 1312.47 | 11.38 |
| 42.0 | 118.14 | 461.23 | 859.54 | 1320.77 | 1320.77 | 1320.77 | 11.18 |
| 43.0 | 120.95 | 479.20 | 853.30 | 1332.50 | 1332.50 | 1332.50 | 11.02 |
| 44.0 | 123.77 | 497.45 | 850.18 | 1347.63 | 1347.63 | 1347.63 | 10.89 |
| 45.0 | 126.58 | 515.97 | 850.18 | 1366.15 | 1366.15 | 1366.15 | 10.79 |
| 46.0 | 129.39 | 547.54 | 850.18 | 1397.72 | 1397.72 | 1397.72 | 10.80 |
| 47.0 | 132.21 | 579.12 | 850.18 | 1429.30 | 1429.30 | 1429.30 | 10.81 |
| 48.0 | 135.02 | 610.70 | 850.18 | 1460.88 | 1460.88 | 1460.88 | 10.82 |
| 49.0 | 137.83 | 642.28 | 850.18 | 1492.46 | 1492.46 | 1492.46 | 10.83 |
| 50.0 | 140.65 | 673.85 | 850.18 | 1524.03 | 1524.03 | 1524.03 | 10.84 |
| 51.0 | 143.46 | 705.43 | 850.18 | 1555.61 | 1555.61 | 1555.61 | 10.84 |
| 52.0 | 146.27 | 737.01 | 850.18 | 1587.19 | 1587.19 | 1587.19 | 10.85 |
| 53.0 | 149.08 | 768.58 | 850.18 | 1618.77 | 1618.77 | 1618.77 | 10.86 |
| 54.0 | 151.90 | 800.16 | 850.18 | 1650.34 | 1650.34 | 1650.34 | 10.86 |
| 55.0 | 154.71 | 831.74 | 850.18 | 1681.92 | 1681.92 | 1681.92 | 10.87 |
| 56.0 | 157.52 | 863.32 | 850.18 | 1713.50 | 1713.50 | 1713.50 | 10.88 |
| 57.0 | 160.34 | 894.89 | 850.18 | 1745.07 | 1745.07 | 1745.07 | 10.88 |
| 58.0 | 163.15 | 926.47 | 850.18 | 1776.65 | 1776.65 | 1776.65 | 10.89 |
| 59.0 | 165.96 | 958.05 | 850.18 | 1808.23 | 1808.23 | 1808.23 | 10.90 |
| 60.0 | 168.77 | 989.62 | 850.18 | 1839.81 | 1839.81 | 1839.81 | 10.90 |
| 61.0 | 171.59 | 1021.20 | 850.18 | 1871.38 | 1871.38 | 1871.38 | 10.91 |
| 62.0 | 174.40 | 1052.78 | 850.18 | 1902.96 | 1902.96 | 1902.96 | 10.91 |
| 63.0 | 177.21 | 1084.36 | 850.18 | 1934.54 | 1934.54 | 1934.54 | 10.92 |
| 64.0 | 180.03 | 1115.93 | 850.18 | 1966.11 | 1966.11 | 1966.11 | 10.92 |
| 65.0 | 182.84 | 1147.51 | 850.18 | 1997.69 | 1997.69 | 1997.69 | 10.93 |
| 66.0 | 185.65 | 1179.09 | 850.18 | 2029.27 | 2029.27 | 2029.27 | 10.93 |
| 67.0 | 188.46 | 1210.67 | 850.18 | 2060.85 | 2060.85 | 2060.85 | 10.93 |
| 68.0 | 191.28 | 1242.24 | 850.18 | 2092.42 | 2092.42 | 2092.42 | 10.94 |
| 69.0 | 194.09 | 1273.82 | 850.18 | 2124.00 | 2124.00 | 2124.00 | 10.94 |
| 70.0 | 196.90 | 1305.40 | 850.18 | 2155.58 | 2155.58 | 2155.58 | 10.95 |
| 71.0 | 199.72 | 1336.97 | 850.18 | 2187.15 | 2187.15 | 2187.15 | 10.95 |
| 72.0 | 202.53 | 1368.55 | 850.18 | 2218.73 | 2218.73 | 2218.73 | 10.96 |
| 73.0 | 205.34 | 1400.13 | 850.18 | 2250.31 | 2250.31 | 2250.31 | 10.96 |
| 74.0 | 208.15 | 1431.71 | 850.18 | 2281.89 | 2281.89 | 2281.89 | 10.96 |
| 75.0 | 210.97 | 1463.28 | 850.18 | 2313.46 | 2313.46 | 2313.46 | 10.97 |
| 76.0 | 213.78 | 1494.86 | 850.18 | 2345.04 | 2345.04 | 2345.04 | 10.97 |
| 77.0 | 216.59 | 1526.44 | 912.52 | 2438.96 | 2438.96 | 2438.96 | 11.26 |
| 78.0 | 219.41 | 1558.01 | 977.98 | 2535.99 | 2535.99 | 2535.99 | 11.56 |
| 79.0 | 222.22 | 1589.59 | 1046.56 | 2636.15 | 2636.15 | 2636.15 | 11.86 |
| 80.0 | 225.03 | 1621.17 | 1118.25 | 2739.42 | 2739.42 | 2739.42 | 12.17 |
| 81.0 | 227.85 | 1652.75 | 1193.06 | 2845.81 | 2845.81 | 2845.81 | 12.49 |
| 82.0 | 230.66 | 1684.32 | 1270.99 | 2955.31 | 2955.31 | 2955.31 | 12.81 |
| 83.0 | 233.47 | 1715.90 | 1352.03 | 3067.93 | 3067.93 | 3067.93 | 13.14 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 84.0 | 236.28 | 1747.48 | 1436.19 | 3183.67 | 3183.67 | 3183.67 | 13.47 |
| 85.0 | 239.10 | 1779.05 | 1523.47 | 3302.52 | 3302.52 | 3302.52 | 13.81 |
| 86.0 | 241.91 | 1810.63 | 1607.63 | 3418.26 | 3418.26 | 3418.26 | 14.13 |
| 87.0 | 244.72 | 1842.21 | 1682.44 | 3524.65 | 3524.65 | 3524.65 | 14.40 |
| 88.0 | 247.54 | 1873.79 | 1747.90 | 3621.69 | 3621.69 | 3621.69 | 14.63 |
| 89.0 | 250.35 | 1905.36 | 1804.01 | 3709.37 | 3709.37 | 3709.37 | 14.82 |
| 90.0 | 253.16 | 1936.94 | 1850.77 | 3787.70 | 3787.70 | 3787.70 | 14.96 |
| 91.0 | 255.97 | 1968.52 | 1888.17 | 3856.69 | 3856.69 | 3856.69 | 15.07 |
| 92.0 | 258.79 | 2000.09 | 1916.22 | 3916.32 | 3916.32 | 3916.32 | 15.13 |
| 93.0 | 261.60 | 2031.67 | 1934.93 | 3966.60 | 3966.60 | 3966.60 | 15.16 |
| 94.0 | 264.41 | 2063.25 | 1944.28 | 4007.53 | 4007.53 | 4007.53 | 15.16 |
| 95.0 | 267.23 | 2094.83 | 1944.28 | 4039.10 | 4039.10 | 4039.10 | 15.11 |
| 96.0 | 270.04 | 2114.96 | 1944.28 | 4059.24 | 4059.24 | 4059.24 | 15.03 |
| 97.0 | 272.85 | 2135.36 | 1944.28 | 4079.64 | 4079.64 | 4079.64 | 14.95 |
| 98.0 | 275.66 | 2156.02 | 1944.28 | 4100.30 | 4100.30 | 4100.30 | 14.87 |
| 99.0 | 278.48 | 2176.95 | 1944.28 | 4121.22 | 4121.22 | 4121.22 | 14.80 |
| 100.0 | 281.29 | 2198.13 | 1944.28 | 4142.41 | 4142.41 | 4142.41 | 14.73 |
| 101.0 | 284.10 | 2219.57 | 1944.28 | 4163.85 | 4163.85 | 4163.85 | 14.66 |
| 102.0 | 286.92 | 2241.28 | 1944.28 | 4185.55 | 4185.55 | 4185.55 | 14.59 |
| 103.0 | 289.73 | 2263.24 | 1944.28 | 4207.52 | 4207.52 | 4207.52 | 14.52 |
| 104.0 | 292.54 | 2285.47 | 1944.28 | 4229.75 | 4229.75 | 4229.75 | 14.46 |
| 105.0 | 295.35 | 2307.96 | 1944.28 | 4252.23 | 4252.23 | 4252.23 | 14.40 |
| 106.0 | 298.17 | 2330.71 | 1944.28 | 4274.98 | 4274.98 | 4274.98 | 14.34 |
| 107.0 | 300.98 | 2353.72 | 1944.28 | 4297.99 | 4297.99 | 4297.99 | 14.28 |
| 108.0 | 303.79 | 2376.99 | 1944.28 | 4321.26 | 4321.26 | 4321.26 | 14.22 |
| 109.0 | 306.61 | 2400.52 | 1944.28 | 4344.80 | 4344.80 | 4344.80 | 14.17 |
| 110.0 | 309.42 | 2424.31 | 1944.28 | 4368.59 | 4368.59 | 4368.59 | 14.12 |
| 111.0 | 312.23 | 2448.37 | 1944.28 | 4392.64 | 4392.64 | 4392.64 | 14.07 |
| 112.0 | 315.04 | 2472.68 | 1944.28 | 4416.96 | 4416.96 | 4416.96 | 14.02 |
| 113.0 | 317.86 | 2497.26 | 1944.28 | 4441.54 | 4441.54 | 4441.54 | 13.97 |
| 114.0 | 320.67 | 2522.10 | 1944.28 | 4466.37 | 4466.37 | 4466.37 | 13.93 |
| 115.0 | 323.48 | 2547.19 | 1944.28 | 4491.47 | 4491.47 | 4491.47 | 13.88 |
| 116.0 | 326.30 | 2572.55 | 1944.28 | 4516.83 | 4516.83 | 4516.83 | 13.84 |
| 117.0 | 329.11 | 2598.17 | 1944.28 | 4542.45 | 4542.45 | 4542.45 | 13.80 |
| 118.0 | 331.92 | 2624.06 | 1944.28 | 4568.33 | 4568.33 | 4568.33 | 13.76 |
| 119.0 | 334.74 | 2650.20 | 1944.28 | 4594.48 | 4594.48 | 4594.48 | 13.73 |
| 120.0 | 337.55 | 2676.60 | 1944.28 | 4620.88 | 4620.88 | 4620.88 | 13.69 |
| 121.0 | 340.36 | 2703.27 | 1944.28 | 4647.55 | 4647.55 | 4647.55 | 13.65 |
| 122.0 | 343.17 | 2730.19 | 1944.28 | 4674.47 | 4674.47 | 4674.47 | 13.62 |
| 123.0 | 345.99 | 2757.38 | 1944.28 | 4701.66 | 4701.66 | 4701.66 | 13.59 |
| 124.0 | 348.80 | 2784.83 | 1944.28 | 4729.11 | 4729.11 | 4729.11 | 13.56 |
| 125.0 | 351.61 | 2812.54 | 1944.28 | 4756.82 | 4756.82 | 4756.82 | 13.53 |
| 126.0 | 354.43 | 2840.51 | 1944.28 | 4784.79 | 4784.79 | 4784.79 | 13.50 |
| 127.0 | 357.24 | 2868.74 | 1944.28 | 4813.02 | 4813.02 | 4813.02 | 13.47 |
| 128.0 | 360.05 | 2897.23 | 1944.28 | 4841.51 | 4841.51 | 4841.51 | 13.45 |
| 129.0 | 362.86 | 2925.99 | 1944.28 | 4870.26 | 4870.26 | 4870.26 | 13.42 |
| 130.0 | 365.68 | 2955.00 | 1944.28 | 4899.28 | 4899.28 | 4899.28 | 13.40 |
| 131.0 | 368.49 | 2984.28 | 1944.28 | 4928.55 | 4928.55 | 4928.55 | 13.37 |
| 132.0 | 371.30 | 3013.81 | 1944.28 | 4958.09 | 4958.09 | 4958.09 | 13.35 |
| 133.0 | 374.12 | 3043.61 | 1944.28 | 4987.89 | 4987.89 | 4987.89 | 13.33 |
| 134.0 | 376.93 | 3073.67 | 1944.28 | 5017.95 | 5017.95 | 5017.95 | 13.31 |
| 135.0 | 379.74 | 3103.99 | 1944.28 | 5048.27 | 5048.27 | 5048.27 | 13.29 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1333E+00 | 0.1648E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6663E+00 | 0.8242E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1333E+01 | 0.1648E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6663E+02 | 0.8242E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.9994E+02 | 0.1236E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1333E+03 | 0.1648E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3332E+03 | 0.4121E-01 | 0.1442E+02 | 0.2500E-01 |

| | | | |
|---|---|---|---|
| 0.6672E+03 | 0.8245E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.1001E+04 | 0.1237E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1319E+04 | 0.1646E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2339E+04 | 0.3691E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2991E+04 | 0.6584E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3594E+04 | 0.1384E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.4007E+04 | 0.3197E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4732E+04 | 0.6210E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1975E+00 | 0.1944E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.9877E+00 | 0.9720E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1975E+01 | 0.1944E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.9877E+02 | 0.9720E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1482E+03 | 0.1458E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1975E+03 | 0.1944E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4946E+03 | 0.4862E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.9900E+03 | 0.9728E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1482E+04 | 0.1459E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1912E+04 | 0.1927E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2930E+04 | 0.4010E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3449E+04 | 0.6866E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.4029E+04 | 0.1416E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4437E+04 | 0.3227E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.5059E+04 | 0.6230E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.7619E-01 | 0.1378E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3810E+00 | 0.6892E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.7619E+00 | 0.1378E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3810E+02 | 0.6892E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5715E+02 | 0.1034E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.7619E+02 | 0.1378E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1905E+03 | 0.3446E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3811E+03 | 0.6892E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5719E+03 | 0.1034E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.7615E+03 | 0.1378E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1650E+04 | 0.3332E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2478E+04 | 0.6277E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.3158E+04 | 0.1353E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3578E+04 | 0.3167E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4405E+04 | 0.6189E+01 | 0.1847E+04 | 0.5900E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 7, 118"CIDH (comp) LQ

PROPOSED DEPTH = 135.0 FT
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NUMBER OF LAYERS = 5
---

WATER TABLE DEPTH = 0.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.500E+01

LAYER NO 2----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.661E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.500E+01

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.400E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.646E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.400E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.594E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.450E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.450E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.950E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.950E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.40 | 110.82 | 114.22 | 114.22 | 114.22 | 6.57 |
| 7.0 | 19.69 | 6.80 | 111.03 | 117.83 | 117.83 | 117.83 | 5.98 |
| 8.0 | 22.50 | 10.20 | 111.24 | 121.44 | 121.44 | 121.44 | 5.40 |
| 9.0 | 25.32 | 13.59 | 111.39 | 124.98 | 124.98 | 124.98 | 4.94 |
| 10.0 | 28.13 | 16.99 | 111.47 | 128.46 | 128.46 | 128.46 | 4.57 |
| 11.0 | 30.94 | 20.39 | 111.50 | 131.89 | 131.89 | 131.89 | 4.26 |
| 12.0 | 33.75 | 23.79 | 111.49 | 135.28 | 135.28 | 135.28 | 4.01 |
| 13.0 | 36.57 | 27.19 | 111.45 | 138.63 | 138.63 | 138.63 | 3.79 |
| 14.0 | 39.38 | 30.59 | 111.38 | 141.97 | 141.97 | 141.97 | 3.61 |
| 15.0 | 42.19 | 33.98 | 111.31 | 145.29 | 145.29 | 145.29 | 3.44 |
| 16.0 | 45.01 | 37.38 | 111.23 | 148.62 | 148.62 | 148.62 | 3.30 |
| 17.0 | 47.82 | 40.78 | 111.16 | 151.94 | 151.94 | 151.94 | 3.18 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18.0 | 50.63 | 44.18 | 111.08 | 155.26 | 155.26 | 155.26 | 3.07 |
| 19.0 | 53.45 | 47.58 | 111.07 | 158.64 | 158.64 | 158.64 | 2.97 |
| 20.0 | 56.26 | 50.98 | 111.10 | 162.08 | 162.08 | 162.08 | 2.88 |
| 21.0 | 59.07 | 54.38 | 111.20 | 165.57 | 165.57 | 165.57 | 2.80 |
| 22.0 | 61.88 | 57.77 | 174.11 | 231.88 | 231.88 | 231.88 | 3.75 |
| 23.0 | 64.70 | 61.17 | 240.17 | 301.34 | 301.34 | 301.34 | 4.66 |
| 24.0 | 67.51 | 64.57 | 309.39 | 373.96 | 373.96 | 373.96 | 5.54 |
| 25.0 | 70.32 | 67.97 | 381.75 | 449.72 | 449.72 | 449.72 | 6.40 |
| 26.0 | 73.14 | 71.37 | 457.27 | 528.64 | 528.64 | 528.64 | 7.23 |
| 27.0 | 75.95 | 74.77 | 515.14 | 589.91 | 589.91 | 589.91 | 7.77 |
| 28.0 | 78.76 | 78.17 | 575.12 | 653.28 | 653.28 | 653.28 | 8.29 |
| 29.0 | 81.57 | 81.56 | 637.19 | 718.75 | 718.75 | 718.75 | 8.81 |
| 30.0 | 84.39 | 84.96 | 701.35 | 786.31 | 786.31 | 786.31 | 9.32 |
| 31.0 | 87.20 | 88.36 | 761.31 | 849.67 | 849.67 | 849.67 | 9.74 |
| 32.0 | 90.01 | 91.76 | 810.79 | 902.55 | 902.55 | 902.55 | 10.03 |
| 33.0 | 92.83 | 95.16 | 849.79 | 944.95 | 944.95 | 944.95 | 10.18 |
| 34.0 | 95.64 | 98.56 | 878.31 | 976.86 | 976.86 | 976.86 | 10.21 |
| 35.0 | 98.45 | 101.95 | 896.35 | 998.30 | 998.30 | 998.30 | 10.14 |
| 36.0 | 101.26 | 105.35 | 905.98 | 1011.34 | 1011.34 | 1011.34 | 9.99 |
| 37.0 | 104.08 | 108.75 | 909.30 | 1018.05 | 1018.05 | 1018.05 | 9.78 |
| 38.0 | 106.89 | 112.15 | 906.30 | 1018.45 | 1018.45 | 1018.45 | 9.53 |
| 39.0 | 109.70 | 115.55 | 896.99 | 1012.54 | 1012.54 | 1012.54 | 9.23 |
| 40.0 | 112.52 | 118.95 | 881.39 | 1000.34 | 1000.34 | 1000.34 | 8.89 |
| 41.0 | 115.33 | 136.29 | 868.91 | 1005.20 | 1005.20 | 1005.20 | 8.72 |
| 42.0 | 118.14 | 153.96 | 859.54 | 1013.50 | 1013.50 | 1013.50 | 8.58 |
| 43.0 | 120.95 | 171.92 | 853.30 | 1025.22 | 1025.22 | 1025.22 | 8.48 |
| 44.0 | 123.77 | 190.17 | 850.18 | 1040.35 | 1040.35 | 1040.35 | 8.41 |
| 45.0 | 126.58 | 208.69 | 850.18 | 1058.87 | 1058.87 | 1058.87 | 8.37 |
| 46.0 | 129.39 | 240.27 | 850.18 | 1090.45 | 1090.45 | 1090.45 | 8.43 |
| 47.0 | 132.21 | 271.85 | 850.18 | 1122.03 | 1122.03 | 1122.03 | 8.49 |
| 48.0 | 135.02 | 303.42 | 850.18 | 1153.60 | 1153.60 | 1153.60 | 8.54 |
| 49.0 | 137.83 | 335.00 | 850.18 | 1185.18 | 1185.18 | 1185.18 | 8.60 |
| 50.0 | 140.65 | 366.58 | 850.18 | 1216.76 | 1216.76 | 1216.76 | 8.65 |
| 51.0 | 143.46 | 398.15 | 850.18 | 1248.33 | 1248.33 | 1248.33 | 8.70 |
| 52.0 | 146.27 | 429.73 | 850.18 | 1279.91 | 1279.91 | 1279.91 | 8.75 |
| 53.0 | 149.08 | 461.31 | 850.18 | 1311.49 | 1311.49 | 1311.49 | 8.80 |
| 54.0 | 151.90 | 492.89 | 850.18 | 1343.07 | 1343.07 | 1343.07 | 8.84 |
| 55.0 | 154.71 | 524.46 | 850.18 | 1374.64 | 1374.64 | 1374.64 | 8.89 |
| 56.0 | 157.52 | 556.04 | 850.18 | 1406.22 | 1406.22 | 1406.22 | 8.93 |
| 57.0 | 160.34 | 587.62 | 850.18 | 1437.80 | 1437.80 | 1437.80 | 8.97 |
| 58.0 | 163.15 | 619.19 | 850.18 | 1469.38 | 1469.38 | 1469.38 | 9.01 |
| 59.0 | 165.96 | 650.77 | 850.18 | 1500.95 | 1500.95 | 1500.95 | 9.04 |
| 60.0 | 168.77 | 682.35 | 850.18 | 1532.53 | 1532.53 | 1532.53 | 9.08 |
| 61.0 | 171.59 | 713.93 | 850.18 | 1564.11 | 1564.11 | 1564.11 | 9.12 |
| 62.0 | 174.40 | 745.50 | 850.18 | 1595.68 | 1595.68 | 1595.68 | 9.15 |
| 63.0 | 177.21 | 777.08 | 850.18 | 1627.26 | 1627.26 | 1627.26 | 9.18 |
| 64.0 | 180.03 | 808.66 | 850.18 | 1658.84 | 1658.84 | 1658.84 | 9.21 |
| 65.0 | 182.84 | 840.23 | 850.18 | 1690.42 | 1690.42 | 1690.42 | 9.25 |
| 66.0 | 185.65 | 871.81 | 850.18 | 1721.99 | 1721.99 | 1721.99 | 9.28 |
| 67.0 | 188.46 | 903.39 | 850.18 | 1753.57 | 1753.57 | 1753.57 | 9.30 |
| 68.0 | 191.28 | 934.97 | 850.18 | 1785.15 | 1785.15 | 1785.15 | 9.33 |
| 69.0 | 194.09 | 966.54 | 850.18 | 1816.72 | 1816.72 | 1816.72 | 9.36 |
| 70.0 | 196.90 | 998.12 | 850.18 | 1848.30 | 1848.30 | 1848.30 | 9.39 |
| 71.0 | 199.72 | 1029.70 | 850.18 | 1879.88 | 1879.88 | 1879.88 | 9.41 |
| 72.0 | 202.53 | 1061.28 | 850.18 | 1911.46 | 1911.46 | 1911.46 | 9.44 |
| 73.0 | 205.34 | 1092.85 | 850.18 | 1943.03 | 1943.03 | 1943.03 | 9.46 |
| 74.0 | 208.15 | 1124.43 | 850.18 | 1974.61 | 1974.61 | 1974.61 | 9.49 |
| 75.0 | 210.97 | 1156.01 | 850.18 | 2006.19 | 2006.19 | 2006.19 | 9.51 |
| 76.0 | 213.78 | 1187.58 | 850.18 | 2037.76 | 2037.76 | 2037.76 | 9.53 |
| 77.0 | 216.59 | 1219.16 | 912.52 | 2131.68 | 2131.68 | 2131.68 | 9.84 |
| 78.0 | 219.41 | 1250.74 | 977.98 | 2228.72 | 2228.72 | 2228.72 | 10.16 |
| 79.0 | 222.22 | 1282.32 | 1046.56 | 2328.87 | 2328.87 | 2328.87 | 10.48 |
| 80.0 | 225.03 | 1313.89 | 1118.25 | 2432.14 | 2432.14 | 2432.14 | 10.81 |
| 81.0 | 227.85 | 1345.47 | 1193.06 | 2538.53 | 2538.53 | 2538.53 | 11.14 |
| 82.0 | 230.66 | 1377.05 | 1270.99 | 2648.03 | 2648.03 | 2648.03 | 11.48 |
| 83.0 | 233.47 | 1408.62 | 1352.03 | 2760.66 | 2760.66 | 2760.66 | 11.82 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 84.0 | 236.28 | 1440.20 | 1436.19 | 2876.39 | 2876.39 | 2876.39 | 12.17 |
| 85.0 | 239.10 | 1471.78 | 1523.47 | 2995.25 | 2995.25 | 2995.25 | 12.53 |
| 86.0 | 241.91 | 1503.36 | 1607.63 | 3110.99 | 3110.99 | 3110.99 | 12.86 |
| 87.0 | 244.72 | 1534.93 | 1682.44 | 3217.38 | 3217.38 | 3217.38 | 13.15 |
| 88.0 | 247.54 | 1566.51 | 1747.90 | 3314.41 | 3314.41 | 3314.41 | 13.39 |
| 89.0 | 250.35 | 1598.09 | 1804.01 | 3402.10 | 3402.10 | 3402.10 | 13.59 |
| 90.0 | 253.16 | 1629.66 | 1850.77 | 3480.43 | 3480.43 | 3480.43 | 13.75 |
| 91.0 | 255.97 | 1661.24 | 1888.17 | 3549.41 | 3549.41 | 3549.41 | 13.87 |
| 92.0 | 258.79 | 1692.82 | 1916.22 | 3609.04 | 3609.04 | 3609.04 | 13.95 |
| 93.0 | 261.60 | 1724.40 | 1934.93 | 3659.32 | 3659.32 | 3659.32 | 13.99 |
| 94.0 | 264.41 | 1755.97 | 1944.28 | 3700.25 | 3700.25 | 3700.25 | 13.99 |
| 95.0 | 267.23 | 1787.55 | 1944.28 | 3731.83 | 3731.83 | 3731.83 | 13.97 |
| 96.0 | 270.04 | 1807.69 | 1944.28 | 3751.97 | 3751.97 | 3751.97 | 13.89 |
| 97.0 | 272.85 | 1828.09 | 1944.28 | 3772.36 | 3772.36 | 3772.36 | 13.83 |
| 98.0 | 275.66 | 1848.75 | 1944.28 | 3793.03 | 3793.03 | 3793.03 | 13.76 |
| 99.0 | 278.48 | 1869.67 | 1944.28 | 3813.95 | 3813.95 | 3813.95 | 13.70 |
| 100.0 | 281.29 | 1890.85 | 1944.28 | 3835.13 | 3835.13 | 3835.13 | 13.63 |
| 101.0 | 284.10 | 1912.30 | 1944.28 | 3856.57 | 3856.57 | 3856.57 | 13.57 |
| 102.0 | 286.92 | 1934.00 | 1944.28 | 3878.28 | 3878.28 | 3878.28 | 13.52 |
| 103.0 | 289.73 | 1955.97 | 1944.28 | 3900.24 | 3900.24 | 3900.24 | 13.46 |
| 104.0 | 292.54 | 1978.19 | 1944.28 | 3922.47 | 3922.47 | 3922.47 | 13.41 |
| 105.0 | 295.35 | 2000.68 | 1944.28 | 3944.96 | 3944.96 | 3944.96 | 13.36 |
| 106.0 | 298.17 | 2023.43 | 1944.28 | 3967.71 | 3967.71 | 3967.71 | 13.31 |
| 107.0 | 300.98 | 2046.44 | 1944.28 | 3990.72 | 3990.72 | 3990.72 | 13.26 |
| 108.0 | 303.79 | 2069.71 | 1944.28 | 4013.99 | 4013.99 | 4013.99 | 13.21 |
| 109.0 | 306.61 | 2093.24 | 1944.28 | 4037.52 | 4037.52 | 4037.52 | 13.17 |
| 110.0 | 309.42 | 2117.04 | 1944.28 | 4061.31 | 4061.31 | 4061.31 | 13.13 |
| 111.0 | 312.23 | 2141.09 | 1944.28 | 4085.37 | 4085.37 | 4085.37 | 13.08 |
| 112.0 | 315.04 | 2165.41 | 1944.28 | 4109.68 | 4109.68 | 4109.68 | 13.04 |
| 113.0 | 317.86 | 2189.98 | 1944.28 | 4134.26 | 4134.26 | 4134.26 | 13.01 |
| 114.0 | 320.67 | 2214.82 | 1944.28 | 4159.10 | 4159.10 | 4159.10 | 12.97 |
| 115.0 | 323.48 | 2239.92 | 1944.28 | 4184.20 | 4184.20 | 4184.20 | 12.93 |
| 116.0 | 326.30 | 2265.28 | 1944.28 | 4209.56 | 4209.56 | 4209.56 | 12.90 |
| 117.0 | 329.11 | 2290.90 | 1944.28 | 4235.18 | 4235.18 | 4235.18 | 12.87 |
| 118.0 | 331.92 | 2316.78 | 1944.28 | 4261.06 | 4261.06 | 4261.06 | 12.84 |
| 119.0 | 334.74 | 2342.92 | 1944.28 | 4287.20 | 4287.20 | 4287.20 | 12.81 |
| 120.0 | 337.55 | 2369.33 | 1944.28 | 4313.60 | 4313.60 | 4313.60 | 12.78 |
| 121.0 | 340.36 | 2395.99 | 1944.28 | 4340.27 | 4340.27 | 4340.27 | 12.75 |
| 122.0 | 343.17 | 2422.92 | 1944.28 | 4367.20 | 4367.20 | 4367.20 | 12.73 |
| 123.0 | 345.99 | 2450.11 | 1944.28 | 4394.38 | 4394.38 | 4394.38 | 12.70 |
| 124.0 | 348.80 | 2477.55 | 1944.28 | 4421.83 | 4421.83 | 4421.83 | 12.68 |
| 125.0 | 351.61 | 2505.26 | 1944.28 | 4449.54 | 4449.54 | 4449.54 | 12.65 |
| 126.0 | 354.43 | 2533.23 | 1944.28 | 4477.51 | 4477.51 | 4477.51 | 12.63 |
| 127.0 | 357.24 | 2561.46 | 1944.28 | 4505.74 | 4505.74 | 4505.74 | 12.61 |
| 128.0 | 360.05 | 2589.96 | 1944.28 | 4534.23 | 4534.23 | 4534.23 | 12.59 |
| 129.0 | 362.86 | 2618.71 | 1944.28 | 4562.99 | 4562.99 | 4562.99 | 12.57 |
| 130.0 | 365.68 | 2647.73 | 1944.28 | 4592.00 | 4592.00 | 4592.00 | 12.56 |
| 131.0 | 368.49 | 2677.00 | 1944.28 | 4621.28 | 4621.28 | 4621.28 | 12.54 |
| 132.0 | 371.30 | 2706.54 | 1944.28 | 4650.81 | 4650.81 | 4650.81 | 12.53 |
| 133.0 | 374.12 | 2736.34 | 1944.28 | 4680.61 | 4680.61 | 4680.61 | 12.51 |
| 134.0 | 376.93 | 2766.39 | 1944.28 | 4710.67 | 4710.67 | 4710.67 | 12.50 |
| 135.0 | 379.74 | 2796.71 | 1944.28 | 4740.99 | 4740.99 | 4740.99 | 12.48 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1234E+00 | 0.1631E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6169E+00 | 0.8155E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1234E+01 | 0.1631E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6169E+02 | 0.8155E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.9254E+02 | 0.1223E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1234E+03 | 0.1631E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3085E+03 | 0.4077E-01 | 0.1442E+02 | 0.2500E-01 |

| | | | |
|---|---|---|---|
| 0.6177E+03 | 0.8157E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.9268E+03 | 0.1224E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1220E+04 | 0.1628E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2147E+04 | 0.3657E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2732E+04 | 0.6539E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3294E+04 | 0.1379E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3698E+04 | 0.3192E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4424E+04 | 0.6204E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1835E+00 | 0.1919E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.9174E+00 | 0.9595E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1835E+01 | 0.1919E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.9174E+02 | 0.9595E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1376E+03 | 0.1439E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1835E+03 | 0.1919E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4593E+03 | 0.4799E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.9194E+03 | 0.9602E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1375E+04 | 0.1440E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1768E+04 | 0.1902E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2664E+04 | 0.3964E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3149E+04 | 0.6814E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3722E+04 | 0.1410E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4120E+04 | 0.3221E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4742E+04 | 0.6225E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.6993E-01 | 0.1367E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3496E+00 | 0.6837E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.6993E+00 | 0.1367E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3496E+02 | 0.6837E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5245E+02 | 0.1026E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.6993E+02 | 0.1367E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1748E+03 | 0.3418E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3497E+03 | 0.6837E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5248E+03 | 0.1026E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.6993E+03 | 0.1368E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1519E+04 | 0.3309E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2264E+04 | 0.6240E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2867E+04 | 0.1348E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3276E+04 | 0.3162E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4105E+04 | 0.6184E+01 | 0.1847E+04 | 0.5900E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Bent 8, 118” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 8, 118"CIDH (comp) NL

PROPOSED DEPTH = 130.0 FT
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NUMBER OF LAYERS = 5
---

WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.679E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.370E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.679E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.370E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.625E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.420E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.420E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.820E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.278E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.820E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
---

DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.99 | 0.00 | 3.99 | 3.99 | 3.99 | 0.30 |
| 7.0 | 19.69 | 9.88 | 0.00 | 9.88 | 9.88 | 9.88 | 0.50 |
| 8.0 | 22.50 | 15.77 | 0.00 | 15.77 | 15.77 | 15.77 | 0.70 |
| 9.0 | 25.32 | 22.25 | 0.00 | 22.25 | 22.25 | 22.25 | 0.88 |
| 10.0 | 28.13 | 29.31 | 0.00 | 29.31 | 29.31 | 29.31 | 1.04 |
| 11.0 | 30.94 | 36.93 | 0.00 | 36.93 | 36.93 | 36.93 | 1.19 |
| 12.0 | 33.75 | 45.08 | 0.00 | 45.08 | 45.08 | 45.08 | 1.34 |
| 13.0 | 36.57 | 53.75 | 0.00 | 53.75 | 53.75 | 53.75 | 1.47 |
| 14.0 | 39.38 | 62.92 | 0.00 | 62.92 | 62.92 | 62.92 | 1.60 |
| 15.0 | 42.19 | 72.56 | 0.00 | 72.56 | 72.56 | 72.56 | 1.72 |
| 16.0 | 45.01 | 82.67 | 0.00 | 82.67 | 82.67 | 82.67 | 1.84 |
| 17.0 | 47.82 | 93.23 | 0.00 | 93.23 | 93.23 | 93.23 | 1.95 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18.0 | 50.63 | 104.21 | 0.00 | 104.21 | 104.21 | 104.21 | 2.06 |
| 19.0 | 53.45 | 115.61 | 69.25 | 184.86 | 184.86 | 184.86 | 3.46 |
| 20.0 | 56.26 | 127.40 | 141.96 | 269.36 | 269.36 | 269.36 | 4.79 |
| 21.0 | 59.07 | 139.58 | 218.14 | 357.72 | 357.72 | 357.72 | 6.06 |
| 22.0 | 61.88 | 152.13 | 297.77 | 449.90 | 449.90 | 449.90 | 7.27 |
| 23.0 | 64.70 | 165.04 | 380.87 | 545.91 | 545.91 | 545.91 | 8.44 |
| 24.0 | 67.51 | 178.28 | 446.63 | 624.91 | 624.91 | 624.91 | 9.26 |
| 25.0 | 70.32 | 191.85 | 514.80 | 706.66 | 706.66 | 706.66 | 10.05 |
| 26.0 | 73.14 | 205.74 | 585.40 | 791.14 | 791.14 | 791.14 | 10.82 |
| 27.0 | 75.95 | 219.93 | 658.43 | 878.35 | 878.35 | 878.35 | 11.57 |
| 28.0 | 78.76 | 234.40 | 726.95 | 961.35 | 961.35 | 961.35 | 12.21 |
| 29.0 | 81.57 | 249.16 | 784.04 | 1033.19 | 1033.19 | 1033.19 | 12.67 |
| 30.0 | 84.39 | 264.17 | 829.70 | 1093.87 | 1093.87 | 1093.87 | 12.96 |
| 31.0 | 87.20 | 279.44 | 863.94 | 1143.38 | 1143.38 | 1143.38 | 13.11 |
| 32.0 | 90.01 | 294.94 | 886.75 | 1181.69 | 1181.69 | 1181.69 | 13.13 |
| 33.0 | 92.83 | 310.68 | 900.21 | 1210.89 | 1210.89 | 1210.89 | 13.04 |
| 34.0 | 95.64 | 326.63 | 906.40 | 1233.03 | 1233.03 | 1233.03 | 12.89 |
| 35.0 | 98.45 | 342.78 | 905.33 | 1248.11 | 1248.11 | 1248.11 | 12.68 |
| 36.0 | 101.26 | 359.13 | 896.99 | 1256.12 | 1256.12 | 1256.12 | 12.40 |
| 37.0 | 104.08 | 375.65 | 881.39 | 1257.04 | 1257.04 | 1257.04 | 12.08 |
| 38.0 | 106.89 | 392.56 | 868.91 | 1261.47 | 1261.47 | 1261.47 | 11.80 |
| 39.0 | 109.70 | 409.83 | 859.54 | 1269.37 | 1269.37 | 1269.37 | 11.57 |
| 40.0 | 112.52 | 427.43 | 853.30 | 1280.74 | 1280.74 | 1280.74 | 11.38 |
| 41.0 | 115.33 | 445.37 | 850.18 | 1295.55 | 1295.55 | 1295.55 | 11.23 |
| 42.0 | 118.14 | 463.61 | 850.18 | 1313.79 | 1313.79 | 1313.79 | 11.12 |
| 43.0 | 120.95 | 495.19 | 850.18 | 1345.37 | 1345.37 | 1345.37 | 11.12 |
| 44.0 | 123.77 | 526.76 | 850.18 | 1376.95 | 1376.95 | 1376.95 | 11.13 |
| 45.0 | 126.58 | 558.34 | 850.18 | 1408.52 | 1408.52 | 1408.52 | 11.13 |
| 46.0 | 129.39 | 589.92 | 850.18 | 1440.10 | 1440.10 | 1440.10 | 11.13 |
| 47.0 | 132.21 | 621.50 | 850.18 | 1471.68 | 1471.68 | 1471.68 | 11.13 |
| 48.0 | 135.02 | 653.07 | 850.18 | 1503.25 | 1503.25 | 1503.25 | 11.13 |
| 49.0 | 137.83 | 684.65 | 850.18 | 1534.83 | 1534.83 | 1534.83 | 11.14 |
| 50.0 | 140.65 | 716.23 | 850.18 | 1566.41 | 1566.41 | 1566.41 | 11.14 |
| 51.0 | 143.46 | 747.81 | 850.18 | 1597.99 | 1597.99 | 1597.99 | 11.14 |
| 52.0 | 146.27 | 779.38 | 850.18 | 1629.56 | 1629.56 | 1629.56 | 11.14 |
| 53.0 | 149.08 | 810.96 | 850.18 | 1661.14 | 1661.14 | 1661.14 | 11.14 |
| 54.0 | 151.90 | 842.54 | 850.18 | 1692.72 | 1692.72 | 1692.72 | 11.14 |
| 55.0 | 154.71 | 874.11 | 850.18 | 1724.29 | 1724.29 | 1724.29 | 11.15 |
| 56.0 | 157.52 | 905.69 | 850.18 | 1755.87 | 1755.87 | 1755.87 | 11.15 |
| 57.0 | 160.34 | 937.27 | 850.18 | 1787.45 | 1787.45 | 1787.45 | 11.15 |
| 58.0 | 163.15 | 968.85 | 850.18 | 1819.03 | 1819.03 | 1819.03 | 11.15 |
| 59.0 | 165.96 | 1000.42 | 850.18 | 1850.60 | 1850.60 | 1850.60 | 11.15 |
| 60.0 | 168.77 | 1032.00 | 850.18 | 1882.18 | 1882.18 | 1882.18 | 11.15 |
| 61.0 | 171.59 | 1063.58 | 850.18 | 1913.76 | 1913.76 | 1913.76 | 11.15 |
| 62.0 | 174.40 | 1095.15 | 850.18 | 1945.34 | 1945.34 | 1945.34 | 11.15 |
| 63.0 | 177.21 | 1126.73 | 850.18 | 1976.91 | 1976.91 | 1976.91 | 11.16 |
| 64.0 | 180.03 | 1158.31 | 912.52 | 2070.83 | 2070.83 | 2070.83 | 11.50 |
| 65.0 | 182.84 | 1189.89 | 977.98 | 2167.87 | 2167.87 | 2167.87 | 11.86 |
| 66.0 | 185.65 | 1221.46 | 1046.56 | 2268.02 | 2268.02 | 2268.02 | 12.22 |
| 67.0 | 188.46 | 1253.04 | 1118.25 | 2371.29 | 2371.29 | 2371.29 | 12.58 |
| 68.0 | 191.28 | 1284.62 | 1193.06 | 2477.68 | 2477.68 | 2477.68 | 12.95 |
| 69.0 | 194.09 | 1316.19 | 1270.99 | 2587.18 | 2587.18 | 2587.18 | 13.33 |
| 70.0 | 196.90 | 1347.77 | 1352.03 | 2699.80 | 2699.80 | 2699.80 | 13.71 |
| 71.0 | 199.72 | 1379.35 | 1436.19 | 2815.54 | 2815.54 | 2815.54 | 14.10 |
| 72.0 | 202.53 | 1410.93 | 1523.47 | 2934.40 | 2934.40 | 2934.40 | 14.49 |
| 73.0 | 205.34 | 1442.50 | 1607.63 | 3050.14 | 3050.14 | 3050.14 | 14.85 |
| 74.0 | 208.15 | 1474.08 | 1682.44 | 3156.52 | 3156.52 | 3156.52 | 15.16 |
| 75.0 | 210.97 | 1505.66 | 1747.90 | 3253.56 | 3253.56 | 3253.56 | 15.42 |
| 76.0 | 213.78 | 1537.23 | 1804.01 | 3341.24 | 3341.24 | 3341.24 | 15.63 |
| 77.0 | 216.59 | 1568.81 | 1850.77 | 3419.58 | 3419.58 | 3419.58 | 15.79 |
| 78.0 | 219.41 | 1600.39 | 1888.17 | 3488.56 | 3488.56 | 3488.56 | 15.90 |
| 79.0 | 222.22 | 1631.97 | 1916.22 | 3548.19 | 3548.19 | 3548.19 | 15.97 |
| 80.0 | 225.03 | 1663.54 | 1934.93 | 3598.47 | 3598.47 | 3598.47 | 15.99 |
| 81.0 | 227.85 | 1695.12 | 1944.28 | 3639.40 | 3639.40 | 3639.40 | 15.97 |
| 82.0 | 230.66 | 1726.70 | 1944.28 | 3670.97 | 3670.97 | 3670.97 | 15.92 |
| 83.0 | 233.47 | 1745.31 | 1944.28 | 3689.59 | 3689.59 | 3689.59 | 15.80 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 84.0 | 236.28 | 1763.69 | 1944.28 | 3707.96 | 3707.96 | 3707.96 | 15.69 |
| 85.0 | 239.10 | 1781.82 | 1944.28 | 3726.09 | 3726.09 | 3726.09 | 15.58 |
| 86.0 | 241.91 | 1799.83 | 1944.28 | 3744.10 | 3744.10 | 3744.10 | 15.48 |
| 87.0 | 244.72 | 1818.10 | 1944.28 | 3762.38 | 3762.38 | 3762.38 | 15.37 |
| 88.0 | 247.54 | 1836.63 | 1944.28 | 3780.91 | 3780.91 | 3780.91 | 15.27 |
| 89.0 | 250.35 | 1855.42 | 1944.28 | 3799.70 | 3799.70 | 3799.70 | 15.18 |
| 90.0 | 253.16 | 1874.48 | 1944.28 | 3818.76 | 3818.76 | 3818.76 | 15.08 |
| 91.0 | 255.97 | 1893.79 | 1944.28 | 3838.07 | 3838.07 | 3838.07 | 14.99 |
| 92.0 | 258.79 | 1913.37 | 1944.28 | 3857.65 | 3857.65 | 3857.65 | 14.91 |
| 93.0 | 261.60 | 1933.21 | 1944.28 | 3877.49 | 3877.49 | 3877.49 | 14.82 |
| 94.0 | 264.41 | 1953.31 | 1944.28 | 3897.59 | 3897.59 | 3897.59 | 14.74 |
| 95.0 | 267.23 | 1973.67 | 1944.28 | 3917.95 | 3917.95 | 3917.95 | 14.66 |
| 96.0 | 270.04 | 1994.29 | 1944.28 | 3938.57 | 3938.57 | 3938.57 | 14.59 |
| 97.0 | 272.85 | 2015.17 | 1944.28 | 3959.45 | 3959.45 | 3959.45 | 14.51 |
| 98.0 | 275.66 | 2036.31 | 1944.28 | 3980.59 | 3980.59 | 3980.59 | 14.44 |
| 99.0 | 278.48 | 2057.72 | 1944.28 | 4002.00 | 4002.00 | 4002.00 | 14.37 |
| 100.0 | 281.29 | 2079.38 | 1944.28 | 4023.66 | 4023.66 | 4023.66 | 14.30 |
| 101.0 | 284.10 | 2101.31 | 1944.28 | 4045.59 | 4045.59 | 4045.59 | 14.24 |
| 102.0 | 286.92 | 2123.50 | 1944.28 | 4067.78 | 4067.78 | 4067.78 | 14.18 |
| 103.0 | 289.73 | 2145.95 | 1944.28 | 4090.22 | 4090.22 | 4090.22 | 14.12 |
| 104.0 | 292.54 | 2168.66 | 1944.28 | 4112.93 | 4112.93 | 4112.93 | 14.06 |
| 105.0 | 295.35 | 2191.63 | 1944.28 | 4135.90 | 4135.90 | 4135.90 | 14.00 |
| 106.0 | 298.17 | 2214.86 | 1944.28 | 4159.14 | 4159.14 | 4159.14 | 13.95 |
| 107.0 | 300.98 | 2238.35 | 1944.28 | 4182.63 | 4182.63 | 4182.63 | 13.90 |
| 108.0 | 303.79 | 2262.11 | 1944.28 | 4206.38 | 4206.38 | 4206.38 | 13.85 |
| 109.0 | 306.61 | 2286.12 | 1944.28 | 4230.40 | 4230.40 | 4230.40 | 13.80 |
| 110.0 | 309.42 | 2310.40 | 1944.28 | 4254.67 | 4254.67 | 4254.67 | 13.75 |
| 111.0 | 312.23 | 2334.93 | 1944.28 | 4279.21 | 4279.21 | 4279.21 | 13.71 |
| 112.0 | 315.04 | 2359.73 | 1944.28 | 4304.01 | 4304.01 | 4304.01 | 13.66 |
| 113.0 | 317.86 | 2384.79 | 1944.28 | 4329.07 | 4329.07 | 4329.07 | 13.62 |
| 114.0 | 320.67 | 2410.11 | 1944.28 | 4354.39 | 4354.39 | 4354.39 | 13.58 |
| 115.0 | 323.48 | 2435.69 | 1944.28 | 4379.97 | 4379.97 | 4379.97 | 13.54 |
| 116.0 | 326.30 | 2461.53 | 1944.28 | 4405.81 | 4405.81 | 4405.81 | 13.50 |
| 117.0 | 329.11 | 2487.64 | 1944.28 | 4431.92 | 4431.92 | 4431.92 | 13.47 |
| 118.0 | 331.92 | 2514.00 | 1944.28 | 4458.28 | 4458.28 | 4458.28 | 13.43 |
| 119.0 | 334.74 | 2540.63 | 1944.28 | 4484.91 | 4484.91 | 4484.91 | 13.40 |
| 120.0 | 337.55 | 2567.51 | 1944.28 | 4511.79 | 4511.79 | 4511.79 | 13.37 |
| 121.0 | 340.36 | 2594.66 | 1944.28 | 4538.94 | 4538.94 | 4538.94 | 13.34 |
| 122.0 | 343.17 | 2622.07 | 1944.28 | 4566.35 | 4566.35 | 4566.35 | 13.31 |
| 123.0 | 345.99 | 2649.74 | 1944.28 | 4594.02 | 4594.02 | 4594.02 | 13.28 |
| 124.0 | 348.80 | 2677.67 | 1944.28 | 4621.95 | 4621.95 | 4621.95 | 13.25 |
| 125.0 | 351.61 | 2705.86 | 1944.28 | 4650.14 | 4650.14 | 4650.14 | 13.23 |
| 126.0 | 354.43 | 2734.32 | 1944.28 | 4678.59 | 4678.59 | 4678.59 | 13.20 |
| 127.0 | 357.24 | 2763.03 | 1944.28 | 4707.31 | 4707.31 | 4707.31 | 13.18 |
| 128.0 | 360.05 | 2792.01 | 1944.28 | 4736.28 | 4736.28 | 4736.28 | 13.15 |
| 129.0 | 362.86 | 2821.24 | 1944.28 | 4765.52 | 4765.52 | 4765.52 | 13.13 |
| 130.0 | 365.68 | 2850.74 | 1944.28 | 4795.02 | 4795.02 | 4795.02 | 13.11 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1184E+00 | 0.1549E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.5919E+00 | 0.7745E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1184E+01 | 0.1549E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.5919E+02 | 0.7745E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.8879E+02 | 0.1162E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1184E+03 | 0.1549E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.2960E+03 | 0.3873E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.5926E+03 | 0.7747E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.8892E+03 | 0.1162E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1177E+04 | 0.1548E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2127E+04 | 0.3534E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2757E+04 | 0.6399E+00 | 0.2884E+03 | 0.5000E+00 |

| | | | |
|---|---|---|---|
| 0.3369E+04 | 0.1365E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3815E+04 | 0.3177E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4540E+04 | 0.6188E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1737E+00 | 0.1791E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.8684E+00 | 0.8956E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1737E+01 | 0.1791E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.8684E+02 | 0.8956E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1303E+03 | 0.1343E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1737E+03 | 0.1791E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4347E+03 | 0.4479E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.8701E+03 | 0.8961E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1305E+04 | 0.1344E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1697E+04 | 0.1782E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2682E+04 | 0.3822E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3202E+04 | 0.6663E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3786E+04 | 0.1394E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4221E+04 | 0.3205E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4843E+04 | 0.6206E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.6869E-01 | 0.1325E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3434E+00 | 0.6627E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.6869E+00 | 0.1325E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3434E+02 | 0.6627E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5151E+02 | 0.9940E-02 | 0.2472E+01 | 0.7500E-02 |
| 0.6869E+02 | 0.1325E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1717E+03 | 0.3313E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3435E+03 | 0.6627E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5155E+03 | 0.9941E-01 | 0.2472E+02 | 0.7500E-01 |
| 0.6868E+03 | 0.1325E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1495E+04 | 0.3218E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2268E+04 | 0.6117E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2952E+04 | 0.1336E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3410E+04 | 0.3150E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4236E+04 | 0.6169E+01 | 0.1847E+04 | 0.5900E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 8, 118"CIDH (comp) LQ

PROPOSED DEPTH = 130.0 FT
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NUMBER OF LAYERS = 5
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WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
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FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
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SOIL INFORMATION
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LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+01

LAYER NO 2----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.624E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+01

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.370E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.679E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.370E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.625E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.420E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.420E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.820E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.278E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.820E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.40 | 110.88 | 114.28 | 114.28 | 114.28 | 6.58 |
| 7.0 | 19.69 | 6.80 | 111.24 | 118.04 | 118.04 | 118.04 | 5.99 |
| 8.0 | 22.50 | 10.20 | 111.60 | 121.79 | 121.79 | 121.79 | 5.41 |
| 9.0 | 25.32 | 13.59 | 111.89 | 125.48 | 125.48 | 125.48 | 4.96 |
| 10.0 | 28.13 | 16.99 | 112.11 | 129.11 | 129.11 | 129.11 | 4.59 |
| 11.0 | 30.94 | 20.39 | 112.29 | 132.68 | 132.68 | 132.68 | 4.29 |
| 12.0 | 33.75 | 23.79 | 112.42 | 136.21 | 136.21 | 136.21 | 4.04 |
| 13.0 | 36.57 | 27.19 | 112.51 | 139.70 | 139.70 | 139.70 | 3.82 |
| 14.0 | 39.38 | 30.59 | 112.59 | 143.17 | 143.17 | 143.17 | 3.64 |
| 15.0 | 42.19 | 33.98 | 112.65 | 146.63 | 146.63 | 146.63 | 3.48 |
| 16.0 | 45.01 | 37.38 | 112.70 | 150.08 | 150.08 | 150.08 | 3.33 |
| 17.0 | 47.82 | 40.78 | 112.75 | 153.54 | 153.54 | 153.54 | 3.21 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18.0 | 50.63 | 44.18 | 112.81 | 156.99 | 156.99 | 156.99 | 3.10 |
| 19.0 | 53.45 | 47.58 | 175.66 | 223.24 | 223.24 | 223.24 | 4.18 |
| 20.0 | 56.26 | 50.98 | 241.64 | 292.62 | 292.62 | 292.62 | 5.20 |
| 21.0 | 59.07 | 54.38 | 310.77 | 365.14 | 365.14 | 365.14 | 6.18 |
| 22.0 | 61.88 | 57.77 | 383.03 | 440.80 | 440.80 | 440.80 | 7.12 |
| 23.0 | 64.70 | 61.17 | 458.42 | 519.60 | 519.60 | 519.60 | 8.03 |
| 24.0 | 67.51 | 64.57 | 516.15 | 580.72 | 580.72 | 580.72 | 8.60 |
| 25.0 | 70.32 | 67.97 | 575.97 | 643.94 | 643.94 | 643.94 | 9.16 |
| 26.0 | 73.14 | 71.37 | 637.89 | 709.26 | 709.26 | 709.26 | 9.70 |
| 27.0 | 75.95 | 74.77 | 701.90 | 776.67 | 776.67 | 776.67 | 10.23 |
| 28.0 | 78.76 | 78.17 | 761.73 | 839.90 | 839.90 | 839.90 | 10.66 |
| 29.0 | 81.57 | 81.56 | 811.10 | 892.66 | 892.66 | 892.66 | 10.94 |
| 30.0 | 84.39 | 84.96 | 850.00 | 934.96 | 934.96 | 934.96 | 11.08 |
| 31.0 | 87.20 | 88.36 | 878.44 | 966.80 | 966.80 | 966.80 | 11.09 |
| 32.0 | 90.01 | 91.76 | 896.42 | 988.17 | 988.17 | 988.17 | 10.98 |
| 33.0 | 92.83 | 95.16 | 906.01 | 1001.17 | 1001.17 | 1001.17 | 10.79 |
| 34.0 | 95.64 | 98.56 | 909.30 | 1007.86 | 1007.86 | 1007.86 | 10.54 |
| 35.0 | 98.45 | 101.95 | 906.30 | 1008.25 | 1008.25 | 1008.25 | 10.24 |
| 36.0 | 101.26 | 105.35 | 896.99 | 1002.35 | 1002.35 | 1002.35 | 9.90 |
| 37.0 | 104.08 | 108.75 | 881.39 | 990.14 | 990.14 | 990.14 | 9.51 |
| 38.0 | 106.89 | 125.66 | 868.91 | 994.56 | 994.56 | 994.56 | 9.30 |
| 39.0 | 109.70 | 142.92 | 859.54 | 1002.47 | 1002.47 | 1002.47 | 9.14 |
| 40.0 | 112.52 | 160.53 | 853.30 | 1013.83 | 1013.83 | 1013.83 | 9.01 |
| 41.0 | 115.33 | 178.47 | 850.18 | 1028.65 | 1028.65 | 1028.65 | 8.92 |
| 42.0 | 118.14 | 196.71 | 850.18 | 1046.89 | 1046.89 | 1046.89 | 8.86 |
| 43.0 | 120.95 | 228.29 | 850.18 | 1078.47 | 1078.47 | 1078.47 | 8.92 |
| 44.0 | 123.77 | 259.86 | 850.18 | 1110.04 | 1110.04 | 1110.04 | 8.97 |
| 45.0 | 126.58 | 291.44 | 850.18 | 1141.62 | 1141.62 | 1141.62 | 9.02 |
| 46.0 | 129.39 | 323.02 | 850.18 | 1173.20 | 1173.20 | 1173.20 | 9.07 |
| 47.0 | 132.21 | 354.59 | 850.18 | 1204.77 | 1204.77 | 1204.77 | 9.11 |
| 48.0 | 135.02 | 386.17 | 850.18 | 1236.35 | 1236.35 | 1236.35 | 9.16 |
| 49.0 | 137.83 | 417.75 | 850.18 | 1267.93 | 1267.93 | 1267.93 | 9.20 |
| 50.0 | 140.65 | 449.33 | 850.18 | 1299.51 | 1299.51 | 1299.51 | 9.24 |
| 51.0 | 143.46 | 480.90 | 850.18 | 1331.08 | 1331.08 | 1331.08 | 9.28 |
| 52.0 | 146.27 | 512.48 | 850.18 | 1362.66 | 1362.66 | 1362.66 | 9.32 |
| 53.0 | 149.08 | 544.06 | 850.18 | 1394.24 | 1394.24 | 1394.24 | 9.35 |
| 54.0 | 151.90 | 575.63 | 850.18 | 1425.81 | 1425.81 | 1425.81 | 9.39 |
| 55.0 | 154.71 | 607.21 | 850.18 | 1457.39 | 1457.39 | 1457.39 | 9.42 |
| 56.0 | 157.52 | 638.79 | 850.18 | 1488.97 | 1488.97 | 1488.97 | 9.45 |
| 57.0 | 160.34 | 670.37 | 850.18 | 1520.55 | 1520.55 | 1520.55 | 9.48 |
| 58.0 | 163.15 | 701.94 | 850.18 | 1552.12 | 1552.12 | 1552.12 | 9.51 |
| 59.0 | 165.96 | 733.52 | 850.18 | 1583.70 | 1583.70 | 1583.70 | 9.54 |
| 60.0 | 168.77 | 765.10 | 850.18 | 1615.28 | 1615.28 | 1615.28 | 9.57 |
| 61.0 | 171.59 | 796.67 | 850.18 | 1646.86 | 1646.86 | 1646.86 | 9.60 |
| 62.0 | 174.40 | 828.25 | 850.18 | 1678.43 | 1678.43 | 1678.43 | 9.62 |
| 63.0 | 177.21 | 859.83 | 850.18 | 1710.01 | 1710.01 | 1710.01 | 9.65 |
| 64.0 | 180.03 | 891.41 | 912.52 | 1803.93 | 1803.93 | 1803.93 | 10.02 |
| 65.0 | 182.84 | 922.98 | 977.98 | 1900.96 | 1900.96 | 1900.96 | 10.40 |
| 66.0 | 185.65 | 954.56 | 1046.56 | 2001.12 | 2001.12 | 2001.12 | 10.78 |
| 67.0 | 188.46 | 986.14 | 1118.25 | 2104.39 | 2104.39 | 2104.39 | 11.17 |
| 68.0 | 191.28 | 1017.72 | 1193.06 | 2210.77 | 2210.77 | 2210.77 | 11.56 |
| 69.0 | 194.09 | 1049.29 | 1270.99 | 2320.28 | 2320.28 | 2320.28 | 11.95 |
| 70.0 | 196.90 | 1080.87 | 1352.03 | 2432.90 | 2432.90 | 2432.90 | 12.36 |
| 71.0 | 199.72 | 1112.45 | 1436.19 | 2548.64 | 2548.64 | 2548.64 | 12.76 |
| 72.0 | 202.53 | 1144.02 | 1523.47 | 2667.49 | 2667.49 | 2667.49 | 13.17 |
| 73.0 | 205.34 | 1175.60 | 1607.63 | 2783.23 | 2783.23 | 2783.23 | 13.55 |
| 74.0 | 208.15 | 1207.18 | 1682.44 | 2889.62 | 2889.62 | 2889.62 | 13.88 |
| 75.0 | 210.97 | 1238.76 | 1747.90 | 2986.66 | 2986.66 | 2986.66 | 14.16 |
| 76.0 | 213.78 | 1270.33 | 1804.01 | 3074.34 | 3074.34 | 3074.34 | 14.38 |
| 77.0 | 216.59 | 1301.91 | 1850.77 | 3152.67 | 3152.67 | 3152.67 | 14.56 |
| 78.0 | 219.41 | 1333.49 | 1888.17 | 3221.66 | 3221.66 | 3221.66 | 14.68 |
| 79.0 | 222.22 | 1365.06 | 1916.22 | 3281.29 | 3281.29 | 3281.29 | 14.77 |
| 80.0 | 225.03 | 1396.64 | 1934.93 | 3331.57 | 3331.57 | 3331.57 | 14.80 |
| 81.0 | 227.85 | 1428.22 | 1944.28 | 3372.50 | 3372.50 | 3372.50 | 14.80 |
| 82.0 | 230.66 | 1459.80 | 1944.28 | 3404.07 | 3404.07 | 3404.07 | 14.76 |
| 83.0 | 233.47 | 1478.41 | 1944.28 | 3422.68 | 3422.68 | 3422.68 | 14.66 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 84.0 | 236.28 | 1496.78 | 1944.28 | 3441.06 | 3441.06 | 3441.06 | 14.56 |
| 85.0 | 239.10 | 1514.91 | 1944.28 | 3459.19 | 3459.19 | 3459.19 | 14.47 |
| 86.0 | 241.91 | 1532.92 | 1944.28 | 3477.20 | 3477.20 | 3477.20 | 14.37 |
| 87.0 | 244.72 | 1551.20 | 1944.28 | 3495.47 | 3495.47 | 3495.47 | 14.28 |
| 88.0 | 247.54 | 1569.73 | 1944.28 | 3514.01 | 3514.01 | 3514.01 | 14.20 |
| 89.0 | 250.35 | 1588.52 | 1944.28 | 3532.80 | 3532.80 | 3532.80 | 14.11 |
| 90.0 | 253.16 | 1607.58 | 1944.28 | 3551.85 | 3551.85 | 3551.85 | 14.03 |
| 91.0 | 255.97 | 1626.89 | 1944.28 | 3571.17 | 3571.17 | 3571.17 | 13.95 |
| 92.0 | 258.79 | 1646.47 | 1944.28 | 3590.75 | 3590.75 | 3590.75 | 13.88 |
| 93.0 | 261.60 | 1666.31 | 1944.28 | 3610.58 | 3610.58 | 3610.58 | 13.80 |
| 94.0 | 264.41 | 1686.41 | 1944.28 | 3630.68 | 3630.68 | 3630.68 | 13.73 |
| 95.0 | 267.23 | 1706.77 | 1944.28 | 3651.04 | 3651.04 | 3651.04 | 13.66 |
| 96.0 | 270.04 | 1727.39 | 1944.28 | 3671.66 | 3671.66 | 3671.66 | 13.60 |
| 97.0 | 272.85 | 1748.27 | 1944.28 | 3692.55 | 3692.55 | 3692.55 | 13.53 |
| 98.0 | 275.66 | 1769.41 | 1944.28 | 3713.69 | 3713.69 | 3713.69 | 13.47 |
| 99.0 | 278.48 | 1790.82 | 1944.28 | 3735.09 | 3735.09 | 3735.09 | 13.41 |
| 100.0 | 281.29 | 1812.48 | 1944.28 | 3756.76 | 3756.76 | 3756.76 | 13.36 |
| 101.0 | 284.10 | 1834.41 | 1944.28 | 3778.69 | 3778.69 | 3778.69 | 13.30 |
| 102.0 | 286.92 | 1856.60 | 1944.28 | 3800.87 | 3800.87 | 3800.87 | 13.25 |
| 103.0 | 289.73 | 1879.04 | 1944.28 | 3823.32 | 3823.32 | 3823.32 | 13.20 |
| 104.0 | 292.54 | 1901.75 | 1944.28 | 3846.03 | 3846.03 | 3846.03 | 13.15 |
| 105.0 | 295.35 | 1924.72 | 1944.28 | 3869.00 | 3869.00 | 3869.00 | 13.10 |
| 106.0 | 298.17 | 1947.96 | 1944.28 | 3892.23 | 3892.23 | 3892.23 | 13.05 |
| 107.0 | 300.98 | 1971.45 | 1944.28 | 3915.73 | 3915.73 | 3915.73 | 13.01 |
| 108.0 | 303.79 | 1995.20 | 1944.28 | 3939.48 | 3939.48 | 3939.48 | 12.97 |
| 109.0 | 306.61 | 2019.22 | 1944.28 | 3963.50 | 3963.50 | 3963.50 | 12.93 |
| 110.0 | 309.42 | 2043.49 | 1944.28 | 3987.77 | 3987.77 | 3987.77 | 12.89 |
| 111.0 | 312.23 | 2068.03 | 1944.28 | 4012.31 | 4012.31 | 4012.31 | 12.85 |
| 112.0 | 315.04 | 2092.83 | 1944.28 | 4037.11 | 4037.11 | 4037.11 | 12.81 |
| 113.0 | 317.86 | 2117.89 | 1944.28 | 4062.17 | 4062.17 | 4062.17 | 12.78 |
| 114.0 | 320.67 | 2143.21 | 1944.28 | 4087.49 | 4087.49 | 4087.49 | 12.75 |
| 115.0 | 323.48 | 2168.79 | 1944.28 | 4113.07 | 4113.07 | 4113.07 | 12.71 |
| 116.0 | 326.30 | 2194.63 | 1944.28 | 4138.91 | 4138.91 | 4138.91 | 12.68 |
| 117.0 | 329.11 | 2220.74 | 1944.28 | 4165.01 | 4165.01 | 4165.01 | 12.66 |
| 118.0 | 331.92 | 2247.10 | 1944.28 | 4191.38 | 4191.38 | 4191.38 | 12.63 |
| 119.0 | 334.74 | 2273.73 | 1944.28 | 4218.00 | 4218.00 | 4218.00 | 12.60 |
| 120.0 | 337.55 | 2300.61 | 1944.28 | 4244.89 | 4244.89 | 4244.89 | 12.58 |
| 121.0 | 340.36 | 2327.76 | 1944.28 | 4272.04 | 4272.04 | 4272.04 | 12.55 |
| 122.0 | 343.17 | 2355.17 | 1944.28 | 4299.45 | 4299.45 | 4299.45 | 12.53 |
| 123.0 | 345.99 | 2382.84 | 1944.28 | 4327.12 | 4327.12 | 4327.12 | 12.51 |
| 124.0 | 348.80 | 2410.77 | 1944.28 | 4355.05 | 4355.05 | 4355.05 | 12.49 |
| 125.0 | 351.61 | 2438.96 | 1944.28 | 4383.24 | 4383.24 | 4383.24 | 12.47 |
| 126.0 | 354.43 | 2467.41 | 1944.28 | 4411.69 | 4411.69 | 4411.69 | 12.45 |
| 127.0 | 357.24 | 2496.13 | 1944.28 | 4440.41 | 4440.41 | 4440.41 | 12.43 |
| 128.0 | 360.05 | 2525.10 | 1944.28 | 4469.38 | 4469.38 | 4469.38 | 12.41 |
| 129.0 | 362.86 | 2554.34 | 1944.28 | 4498.62 | 4498.62 | 4498.62 | 12.40 |
| 130.0 | 365.68 | 2583.84 | 1944.28 | 4528.11 | 4528.11 | 4528.11 | 12.38 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1102E+00 | 0.1536E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.5511E+00 | 0.7678E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1102E+01 | 0.1536E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.5511E+02 | 0.7678E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.8267E+02 | 0.1152E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1102E+03 | 0.1536E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.2756E+03 | 0.3839E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.5517E+03 | 0.7680E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.8278E+03 | 0.1152E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1095E+04 | 0.1534E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.1962E+04 | 0.3508E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2531E+04 | 0.6363E+00 | 0.2884E+03 | 0.5000E+00 |

| | | | |
|---|---|---|---|
| 0.3106E+04 | 0.1360E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3543E+04 | 0.3173E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4268E+04 | 0.6184E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1623E+00 | 0.1772E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.8114E+00 | 0.8861E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1623E+01 | 0.1772E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.8114E+02 | 0.8861E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1217E+03 | 0.1329E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1623E+03 | 0.1772E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4061E+03 | 0.4431E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.8130E+03 | 0.8866E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1218E+04 | 0.1330E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1579E+04 | 0.1763E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2453E+04 | 0.3785E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.2939E+04 | 0.6621E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3516E+04 | 0.1389E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.3942E+04 | 0.3200E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4564E+04 | 0.6202E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.6337E-01 | 0.1317E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3169E+00 | 0.6583E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.6337E+00 | 0.1317E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3169E+02 | 0.6583E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.4753E+02 | 0.9875E-02 | 0.2472E+01 | 0.7500E-02 |
| 0.6337E+02 | 0.1317E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1584E+03 | 0.3292E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3169E+03 | 0.6583E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.4756E+03 | 0.9876E-01 | 0.2472E+02 | 0.7500E-01 |
| 0.6339E+03 | 0.1317E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1382E+04 | 0.3200E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2082E+04 | 0.6087E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2697E+04 | 0.1332E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3143E+04 | 0.3146E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.3972E+04 | 0.6165E+01 | 0.1847E+04 | 0.5900E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Bent 9, 118” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 9, 118"CIDH (comp) NL

PROPOSED DEPTH = 125.0 FT
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NUMBER OF LAYERS = 5
---

WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
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FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.812E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.260E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.812E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.260E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.690E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.360E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.360E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.960E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.960E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.99 | -69.25 | -65.25 | -65.25 | -65.25 | -2.77 |
| 7.0 | 19.69 | 9.88 | 0.00 | 9.88 | 9.88 | 9.88 | 0.50 |
| 8.0 | 22.50 | 15.77 | 69.25 | 85.02 | 85.02 | 85.02 | 3.78 |
| 9.0 | 25.32 | 22.25 | 141.96 | 164.21 | 164.21 | 164.21 | 6.49 |
| 10.0 | 28.13 | 29.31 | 218.14 | 247.45 | 247.45 | 247.45 | 8.80 |
| 11.0 | 30.94 | 36.93 | 297.77 | 334.70 | 334.70 | 334.70 | 10.82 |
| 12.0 | 33.75 | 45.08 | 380.87 | 425.96 | 425.96 | 425.96 | 12.62 |
| 13.0 | 36.57 | 53.75 | 467.43 | 521.19 | 521.19 | 521.19 | 14.25 |
| 14.0 | 39.38 | 62.92 | 557.46 | 620.38 | 620.38 | 620.38 | 15.75 |
| 15.0 | 42.19 | 72.56 | 650.94 | 723.51 | 723.51 | 723.51 | 17.15 |
| 16.0 | 45.01 | 82.67 | 747.89 | 830.56 | 830.56 | 830.56 | 18.45 |
| 17.0 | 47.82 | 93.23 | 841.38 | 934.60 | 934.60 | 934.60 | 19.54 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18.0 | 50.63 | 104.21 | 903.67 | 1007.88 | 1007.88 | 1007.88 | 19.91 |
| 19.0 | 53.45 | 115.61 | 954.54 | 1070.14 | 1070.14 | 1070.14 | 20.02 |
| 20.0 | 56.26 | 127.40 | 993.98 | 1121.38 | 1121.38 | 1121.38 | 19.93 |
| 21.0 | 59.07 | 139.58 | 1021.99 | 1161.57 | 1161.57 | 1161.57 | 19.66 |
| 22.0 | 61.88 | 152.13 | 1038.57 | 1190.70 | 1190.70 | 1190.70 | 19.24 |
| 23.0 | 64.70 | 165.04 | 1043.72 | 1208.76 | 1208.76 | 1208.76 | 18.68 |
| 24.0 | 67.51 | 178.28 | 1037.45 | 1215.73 | 1215.73 | 1215.73 | 18.01 |
| 25.0 | 70.32 | 191.85 | 1019.75 | 1211.60 | 1211.60 | 1211.60 | 17.23 |
| 26.0 | 73.14 | 205.74 | 990.62 | 1196.36 | 1196.36 | 1196.36 | 16.36 |
| 27.0 | 75.95 | 220.17 | 962.53 | 1182.71 | 1182.71 | 1182.71 | 15.57 |
| 28.0 | 78.76 | 235.14 | 937.57 | 1172.70 | 1172.70 | 1172.70 | 14.89 |
| 29.0 | 81.57 | 250.60 | 915.72 | 1166.32 | 1166.32 | 1166.32 | 14.30 |
| 30.0 | 84.39 | 266.56 | 896.99 | 1163.55 | 1163.55 | 1163.55 | 13.79 |
| 31.0 | 87.20 | 282.98 | 881.39 | 1164.37 | 1164.37 | 1164.37 | 13.35 |
| 32.0 | 90.01 | 299.85 | 868.91 | 1168.76 | 1168.76 | 1168.76 | 12.98 |
| 33.0 | 92.83 | 317.15 | 859.54 | 1176.70 | 1176.70 | 1176.70 | 12.68 |
| 34.0 | 95.64 | 334.86 | 853.30 | 1188.17 | 1188.17 | 1188.17 | 12.42 |
| 35.0 | 98.45 | 352.97 | 850.18 | 1203.15 | 1203.15 | 1203.15 | 12.22 |
| 36.0 | 101.26 | 371.45 | 850.18 | 1221.63 | 1221.63 | 1221.63 | 12.06 |
| 37.0 | 104.08 | 403.02 | 850.18 | 1253.20 | 1253.20 | 1253.20 | 12.04 |
| 38.0 | 106.89 | 434.60 | 850.18 | 1284.78 | 1284.78 | 1284.78 | 12.02 |
| 39.0 | 109.70 | 466.18 | 850.18 | 1316.36 | 1316.36 | 1316.36 | 12.00 |
| 40.0 | 112.52 | 497.75 | 850.18 | 1347.94 | 1347.94 | 1347.94 | 11.98 |
| 41.0 | 115.33 | 529.33 | 850.18 | 1379.51 | 1379.51 | 1379.51 | 11.96 |
| 42.0 | 118.14 | 560.91 | 850.18 | 1411.09 | 1411.09 | 1411.09 | 11.94 |
| 43.0 | 120.95 | 592.49 | 850.18 | 1442.67 | 1442.67 | 1442.67 | 11.93 |
| 44.0 | 123.77 | 624.06 | 850.18 | 1474.24 | 1474.24 | 1474.24 | 11.91 |
| 45.0 | 126.58 | 655.64 | 850.18 | 1505.82 | 1505.82 | 1505.82 | 11.90 |
| 46.0 | 129.39 | 687.22 | 850.18 | 1537.40 | 1537.40 | 1537.40 | 11.88 |
| 47.0 | 132.21 | 718.79 | 850.18 | 1568.98 | 1568.98 | 1568.98 | 11.87 |
| 48.0 | 135.02 | 750.37 | 850.18 | 1600.55 | 1600.55 | 1600.55 | 11.85 |
| 49.0 | 137.83 | 781.95 | 850.18 | 1632.13 | 1632.13 | 1632.13 | 11.84 |
| 50.0 | 140.65 | 813.53 | 850.18 | 1663.71 | 1663.71 | 1663.71 | 11.83 |
| 51.0 | 143.46 | 845.10 | 850.18 | 1695.28 | 1695.28 | 1695.28 | 11.82 |
| 52.0 | 146.27 | 876.68 | 850.18 | 1726.86 | 1726.86 | 1726.86 | 11.81 |
| 53.0 | 149.08 | 908.26 | 850.18 | 1758.44 | 1758.44 | 1758.44 | 11.79 |
| 54.0 | 151.90 | 939.84 | 850.18 | 1790.02 | 1790.02 | 1790.02 | 11.78 |
| 55.0 | 154.71 | 971.41 | 850.18 | 1821.59 | 1821.59 | 1821.59 | 11.77 |
| 56.0 | 157.52 | 1002.99 | 850.18 | 1853.17 | 1853.17 | 1853.17 | 11.76 |
| 57.0 | 160.34 | 1034.57 | 850.18 | 1884.75 | 1884.75 | 1884.75 | 11.76 |
| 58.0 | 163.15 | 1066.14 | 850.18 | 1916.32 | 1916.32 | 1916.32 | 11.75 |
| 59.0 | 165.96 | 1097.72 | 850.18 | 1947.90 | 1947.90 | 1947.90 | 11.74 |
| 60.0 | 168.77 | 1129.30 | 850.18 | 1979.48 | 1979.48 | 1979.48 | 11.73 |
| 61.0 | 171.59 | 1160.88 | 850.18 | 2011.06 | 2011.06 | 2011.06 | 11.72 |
| 62.0 | 174.40 | 1192.45 | 850.18 | 2042.63 | 2042.63 | 2042.63 | 11.71 |
| 63.0 | 177.21 | 1224.03 | 850.18 | 2074.21 | 2074.21 | 2074.21 | 11.70 |
| 64.0 | 180.03 | 1255.61 | 850.18 | 2105.79 | 2105.79 | 2105.79 | 11.70 |
| 65.0 | 182.84 | 1287.18 | 850.18 | 2137.36 | 2137.36 | 2137.36 | 11.69 |
| 66.0 | 185.65 | 1318.76 | 850.18 | 2168.94 | 2168.94 | 2168.94 | 11.68 |
| 67.0 | 188.46 | 1350.34 | 850.18 | 2200.52 | 2200.52 | 2200.52 | 11.68 |
| 68.0 | 191.28 | 1381.92 | 850.18 | 2232.10 | 2232.10 | 2232.10 | 11.67 |
| 69.0 | 194.09 | 1413.49 | 850.18 | 2263.67 | 2263.67 | 2263.67 | 11.66 |
| 70.0 | 196.90 | 1445.07 | 850.18 | 2295.25 | 2295.25 | 2295.25 | 11.66 |
| 71.0 | 199.72 | 1476.65 | 850.18 | 2326.83 | 2326.83 | 2326.83 | 11.65 |
| 72.0 | 202.53 | 1508.22 | 850.18 | 2358.40 | 2358.40 | 2358.40 | 11.64 |
| 73.0 | 205.34 | 1539.80 | 850.18 | 2389.98 | 2389.98 | 2389.98 | 11.64 |
| 74.0 | 208.15 | 1571.38 | 850.18 | 2421.56 | 2421.56 | 2421.56 | 11.63 |
| 75.0 | 210.97 | 1602.96 | 850.18 | 2453.14 | 2453.14 | 2453.14 | 11.63 |
| 76.0 | 213.78 | 1634.53 | 850.18 | 2484.71 | 2484.71 | 2484.71 | 11.62 |
| 77.0 | 216.59 | 1666.11 | 850.18 | 2516.29 | 2516.29 | 2516.29 | 11.62 |
| 78.0 | 219.41 | 1697.69 | 912.52 | 2610.21 | 2610.21 | 2610.21 | 11.90 |
| 79.0 | 222.22 | 1729.26 | 977.98 | 2707.25 | 2707.25 | 2707.25 | 12.18 |
| 80.0 | 225.03 | 1760.84 | 1046.56 | 2807.40 | 2807.40 | 2807.40 | 12.48 |
| 81.0 | 227.85 | 1792.42 | 1118.25 | 2910.67 | 2910.67 | 2910.67 | 12.77 |
| 82.0 | 230.66 | 1824.00 | 1193.06 | 3017.06 | 3017.06 | 3017.06 | 13.08 |
| 83.0 | 233.47 | 1855.57 | 1270.99 | 3126.56 | 3126.56 | 3126.56 | 13.39 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 84.0 | 236.28 | 1887.15 | 1352.03 | 3239.18 | 3239.18 | 3239.18 | 13.71 |
| 85.0 | 239.10 | 1918.73 | 1436.19 | 3354.92 | 3354.92 | 3354.92 | 14.03 |
| 86.0 | 241.91 | 1950.30 | 1523.47 | 3473.78 | 3473.78 | 3473.78 | 14.36 |
| 87.0 | 244.72 | 1981.88 | 1607.63 | 3589.51 | 3589.51 | 3589.51 | 14.67 |
| 88.0 | 247.54 | 2013.46 | 1682.44 | 3695.90 | 3695.90 | 3695.90 | 14.93 |
| 89.0 | 250.35 | 2045.04 | 1747.90 | 3792.94 | 3792.94 | 3792.94 | 15.15 |
| 90.0 | 253.16 | 2076.61 | 1804.01 | 3880.62 | 3880.62 | 3880.62 | 15.33 |
| 91.0 | 255.97 | 2108.19 | 1850.77 | 3958.96 | 3958.96 | 3958.96 | 15.47 |
| 92.0 | 258.79 | 2139.77 | 1888.17 | 4027.94 | 4027.94 | 4027.94 | 15.56 |
| 93.0 | 261.60 | 2171.34 | 1916.22 | 4087.57 | 4087.57 | 4087.57 | 15.63 |
| 94.0 | 264.41 | 2202.92 | 1934.93 | 4137.85 | 4137.85 | 4137.85 | 15.65 |
| 95.0 | 267.23 | 2234.50 | 1944.28 | 4178.78 | 4178.78 | 4178.78 | 15.64 |
| 96.0 | 270.04 | 2266.08 | 1944.28 | 4210.35 | 4210.35 | 4210.35 | 15.59 |
| 97.0 | 272.85 | 2287.54 | 1944.28 | 4231.81 | 4231.81 | 4231.81 | 15.51 |
| 98.0 | 275.66 | 2309.26 | 1944.28 | 4253.54 | 4253.54 | 4253.54 | 15.43 |
| 99.0 | 278.48 | 2331.24 | 1944.28 | 4275.52 | 4275.52 | 4275.52 | 15.35 |
| 100.0 | 281.29 | 2353.49 | 1944.28 | 4297.77 | 4297.77 | 4297.77 | 15.28 |
| 101.0 | 284.10 | 2375.99 | 1944.28 | 4320.27 | 4320.27 | 4320.27 | 15.21 |
| 102.0 | 286.92 | 2398.76 | 1944.28 | 4343.04 | 4343.04 | 4343.04 | 15.14 |
| 103.0 | 289.73 | 2421.79 | 1944.28 | 4366.07 | 4366.07 | 4366.07 | 15.07 |
| 104.0 | 292.54 | 2445.08 | 1944.28 | 4389.35 | 4389.35 | 4389.35 | 15.00 |
| 105.0 | 295.35 | 2468.63 | 1944.28 | 4412.90 | 4412.90 | 4412.90 | 14.94 |
| 106.0 | 298.17 | 2492.44 | 1944.28 | 4436.72 | 4436.72 | 4436.72 | 14.88 |
| 107.0 | 300.98 | 2516.51 | 1944.28 | 4460.79 | 4460.79 | 4460.79 | 14.82 |
| 108.0 | 303.79 | 2540.84 | 1944.28 | 4485.12 | 4485.12 | 4485.12 | 14.76 |
| 109.0 | 306.61 | 2565.44 | 1944.28 | 4509.71 | 4509.71 | 4509.71 | 14.71 |
| 110.0 | 309.42 | 2590.29 | 1944.28 | 4534.57 | 4534.57 | 4534.57 | 14.66 |
| 111.0 | 312.23 | 2615.41 | 1944.28 | 4559.69 | 4559.69 | 4559.69 | 14.60 |
| 112.0 | 315.04 | 2640.79 | 1944.28 | 4585.06 | 4585.06 | 4585.06 | 14.55 |
| 113.0 | 317.86 | 2666.43 | 1944.28 | 4610.70 | 4610.70 | 4610.70 | 14.51 |
| 114.0 | 320.67 | 2692.32 | 1944.28 | 4636.60 | 4636.60 | 4636.60 | 14.46 |
| 115.0 | 323.48 | 2718.49 | 1944.28 | 4662.76 | 4662.76 | 4662.76 | 14.41 |
| 116.0 | 326.30 | 2744.91 | 1944.28 | 4689.18 | 4689.18 | 4689.18 | 14.37 |
| 117.0 | 329.11 | 2771.59 | 1944.28 | 4715.87 | 4715.87 | 4715.87 | 14.33 |
| 118.0 | 331.92 | 2798.53 | 1944.28 | 4742.81 | 4742.81 | 4742.81 | 14.29 |
| 119.0 | 334.74 | 2825.74 | 1944.28 | 4770.02 | 4770.02 | 4770.02 | 14.25 |
| 120.0 | 337.55 | 2853.20 | 1944.28 | 4797.48 | 4797.48 | 4797.48 | 14.21 |
| 121.0 | 340.36 | 2880.93 | 1944.28 | 4825.21 | 4825.21 | 4825.21 | 14.18 |
| 122.0 | 343.17 | 2908.92 | 1944.28 | 4853.20 | 4853.20 | 4853.20 | 14.14 |
| 123.0 | 345.99 | 2937.17 | 1944.28 | 4881.45 | 4881.45 | 4881.45 | 14.11 |
| 124.0 | 348.80 | 2965.68 | 1944.28 | 4909.96 | 4909.96 | 4909.96 | 14.08 |
| 125.0 | 351.61 | 2994.45 | 1944.28 | 4938.73 | 4938.73 | 4938.73 | 14.05 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1343E+00 | 0.1604E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6717E+00 | 0.8021E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1343E+01 | 0.1604E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6717E+02 | 0.8021E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.1008E+03 | 0.1203E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1343E+03 | 0.1604E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3360E+03 | 0.4011E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6727E+03 | 0.8024E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.1009E+04 | 0.1204E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1330E+04 | 0.1602E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2316E+04 | 0.3588E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2937E+04 | 0.6436E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3495E+04 | 0.1364E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3876E+04 | 0.3172E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4602E+04 | 0.6180E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.2004E+00 | 0.1886E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.1002E+01 | 0.9430E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.2004E+01 | 0.1886E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.1002E+03 | 0.9430E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1503E+03 | 0.1414E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.2004E+03 | 0.1886E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.5018E+03 | 0.4717E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.1004E+04 | 0.9437E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1505E+04 | 0.1416E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1939E+04 | 0.1870E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2883E+04 | 0.3873E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3366E+04 | 0.6682E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3936E+04 | 0.1393E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4315E+04 | 0.3200E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4937E+04 | 0.6199E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.7578E-01 | 0.1348E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3789E+00 | 0.6738E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.7578E+00 | 0.1348E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3789E+02 | 0.6738E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5684E+02 | 0.1011E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.7578E+02 | 0.1348E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1895E+03 | 0.3369E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3791E+03 | 0.6738E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5688E+03 | 0.1011E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.7578E+03 | 0.1348E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1643E+04 | 0.3264E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2442E+04 | 0.6162E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.3054E+04 | 0.1335E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3436E+04 | 0.3144E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4266E+04 | 0.6160E+01 | 0.1847E+04 | 0.5900E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 9, 118"CIDH (comp) LQ

PROPOSED DEPTH = 125.0 FT
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NUMBER OF LAYERS = 5
---

WATER TABLE DEPTH = 0.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+01

LAYER NO 2----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.612E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+01

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.260E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.812E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.260E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.690E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.360E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.360E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.960E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.960E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.40 | 57.15 | 60.55 | 60.55 | 60.55 | 4.30 |
| 7.0 | 19.69 | 6.80 | 120.10 | 126.90 | 126.90 | 126.90 | 6.44 |
| 8.0 | 22.50 | 10.20 | 183.05 | 193.24 | 193.24 | 193.24 | 8.59 |
| 9.0 | 25.32 | 13.59 | 248.99 | 262.59 | 262.59 | 262.59 | 10.37 |
| 10.0 | 28.13 | 16.99 | 317.94 | 334.94 | 334.94 | 334.94 | 11.91 |
| 11.0 | 30.94 | 20.39 | 389.91 | 410.30 | 410.30 | 410.30 | 13.26 |
| 12.0 | 33.75 | 23.79 | 464.91 | 488.70 | 488.70 | 488.70 | 14.48 |
| 13.0 | 36.57 | 27.19 | 542.94 | 570.13 | 570.13 | 570.13 | 15.59 |
| 14.0 | 39.38 | 30.59 | 624.01 | 654.60 | 654.60 | 654.60 | 16.62 |
| 15.0 | 42.19 | 33.98 | 708.14 | 742.13 | 742.13 | 742.13 | 17.59 |
| 16.0 | 45.01 | 37.38 | 795.33 | 832.72 | 832.72 | 832.72 | 18.50 |
| 17.0 | 47.82 | 40.78 | 879.38 | 920.16 | 920.16 | 920.16 | 19.24 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18.0 | 50.63 | 44.18 | 933.27 | 977.45 | 977.45 | 977.45 | 19.30 |
| 19.0 | 53.45 | 47.58 | 976.76 | 1024.34 | 1024.34 | 1024.34 | 19.17 |
| 20.0 | 56.26 | 50.98 | 1009.87 | 1060.85 | 1060.85 | 1060.85 | 18.86 |
| 21.0 | 59.07 | 54.38 | 1032.60 | 1086.97 | 1086.97 | 1086.97 | 18.40 |
| 22.0 | 61.88 | 57.77 | 1044.94 | 1102.72 | 1102.72 | 1102.72 | 17.82 |
| 23.0 | 64.70 | 61.17 | 1046.91 | 1108.09 | 1108.09 | 1108.09 | 17.13 |
| 24.0 | 67.51 | 64.57 | 1038.51 | 1103.09 | 1103.09 | 1103.09 | 16.34 |
| 25.0 | 70.32 | 67.97 | 1019.75 | 1087.72 | 1087.72 | 1087.72 | 15.47 |
| 26.0 | 73.14 | 71.37 | 990.62 | 1061.99 | 1061.99 | 1061.99 | 14.52 |
| 27.0 | 75.95 | 85.80 | 962.53 | 1048.34 | 1048.34 | 1048.34 | 13.80 |
| 28.0 | 78.76 | 100.76 | 937.57 | 1038.33 | 1038.33 | 1038.33 | 13.18 |
| 29.0 | 81.57 | 116.23 | 915.72 | 1031.95 | 1031.95 | 1031.95 | 12.65 |
| 30.0 | 84.39 | 132.19 | 896.99 | 1029.18 | 1029.18 | 1029.18 | 12.20 |
| 31.0 | 87.20 | 148.61 | 881.39 | 1030.00 | 1030.00 | 1030.00 | 11.81 |
| 32.0 | 90.01 | 165.48 | 868.91 | 1034.39 | 1034.39 | 1034.39 | 11.49 |
| 33.0 | 92.83 | 182.78 | 859.54 | 1042.32 | 1042.32 | 1042.32 | 11.23 |
| 34.0 | 95.64 | 200.49 | 853.30 | 1053.79 | 1053.79 | 1053.79 | 11.02 |
| 35.0 | 98.45 | 218.60 | 850.18 | 1068.78 | 1068.78 | 1068.78 | 10.86 |
| 36.0 | 101.26 | 237.07 | 850.18 | 1087.25 | 1087.25 | 1087.25 | 10.74 |
| 37.0 | 104.08 | 268.65 | 850.18 | 1118.83 | 1118.83 | 1118.83 | 10.75 |
| 38.0 | 106.89 | 300.23 | 850.18 | 1150.41 | 1150.41 | 1150.41 | 10.76 |
| 39.0 | 109.70 | 331.81 | 850.18 | 1181.99 | 1181.99 | 1181.99 | 10.77 |
| 40.0 | 112.52 | 363.38 | 850.18 | 1213.56 | 1213.56 | 1213.56 | 10.79 |
| 41.0 | 115.33 | 394.96 | 850.18 | 1245.14 | 1245.14 | 1245.14 | 10.80 |
| 42.0 | 118.14 | 426.54 | 850.18 | 1276.72 | 1276.72 | 1276.72 | 10.81 |
| 43.0 | 120.95 | 458.11 | 850.18 | 1308.29 | 1308.29 | 1308.29 | 10.82 |
| 44.0 | 123.77 | 489.69 | 850.18 | 1339.87 | 1339.87 | 1339.87 | 10.83 |
| 45.0 | 126.58 | 521.27 | 850.18 | 1371.45 | 1371.45 | 1371.45 | 10.83 |
| 46.0 | 129.39 | 552.85 | 850.18 | 1403.03 | 1403.03 | 1403.03 | 10.84 |
| 47.0 | 132.21 | 584.42 | 850.18 | 1434.60 | 1434.60 | 1434.60 | 10.85 |
| 48.0 | 135.02 | 616.00 | 850.18 | 1466.18 | 1466.18 | 1466.18 | 10.86 |
| 49.0 | 137.83 | 647.58 | 850.18 | 1497.76 | 1497.76 | 1497.76 | 10.87 |
| 50.0 | 140.65 | 679.15 | 850.18 | 1529.34 | 1529.34 | 1529.34 | 10.87 |
| 51.0 | 143.46 | 710.73 | 850.18 | 1560.91 | 1560.91 | 1560.91 | 10.88 |
| 52.0 | 146.27 | 742.31 | 850.18 | 1592.49 | 1592.49 | 1592.49 | 10.89 |
| 53.0 | 149.08 | 773.89 | 850.18 | 1624.07 | 1624.07 | 1624.07 | 10.89 |
| 54.0 | 151.90 | 805.46 | 850.18 | 1655.64 | 1655.64 | 1655.64 | 10.90 |
| 55.0 | 154.71 | 837.04 | 850.18 | 1687.22 | 1687.22 | 1687.22 | 10.91 |
| 56.0 | 157.52 | 868.62 | 850.18 | 1718.80 | 1718.80 | 1718.80 | 10.91 |
| 57.0 | 160.34 | 900.19 | 850.18 | 1750.38 | 1750.38 | 1750.38 | 10.92 |
| 58.0 | 163.15 | 931.77 | 850.18 | 1781.95 | 1781.95 | 1781.95 | 10.92 |
| 59.0 | 165.96 | 963.35 | 850.18 | 1813.53 | 1813.53 | 1813.53 | 10.93 |
| 60.0 | 168.77 | 994.93 | 850.18 | 1845.11 | 1845.11 | 1845.11 | 10.93 |
| 61.0 | 171.59 | 1026.50 | 850.18 | 1876.68 | 1876.68 | 1876.68 | 10.94 |
| 62.0 | 174.40 | 1058.08 | 850.18 | 1908.26 | 1908.26 | 1908.26 | 10.94 |
| 63.0 | 177.21 | 1089.66 | 850.18 | 1939.84 | 1939.84 | 1939.84 | 10.95 |
| 64.0 | 180.03 | 1121.24 | 850.18 | 1971.42 | 1971.42 | 1971.42 | 10.95 |
| 65.0 | 182.84 | 1152.81 | 850.18 | 2002.99 | 2002.99 | 2002.99 | 10.95 |
| 66.0 | 185.65 | 1184.39 | 850.18 | 2034.57 | 2034.57 | 2034.57 | 10.96 |
| 67.0 | 188.46 | 1215.97 | 850.18 | 2066.15 | 2066.15 | 2066.15 | 10.96 |
| 68.0 | 191.28 | 1247.54 | 850.18 | 2097.72 | 2097.72 | 2097.72 | 10.97 |
| 69.0 | 194.09 | 1279.12 | 850.18 | 2129.30 | 2129.30 | 2129.30 | 10.97 |
| 70.0 | 196.90 | 1310.70 | 850.18 | 2160.88 | 2160.88 | 2160.88 | 10.97 |
| 71.0 | 199.72 | 1342.28 | 850.18 | 2192.46 | 2192.46 | 2192.46 | 10.98 |
| 72.0 | 202.53 | 1373.85 | 850.18 | 2224.03 | 2224.03 | 2224.03 | 10.98 |
| 73.0 | 205.34 | 1405.43 | 850.18 | 2255.61 | 2255.61 | 2255.61 | 10.98 |
| 74.0 | 208.15 | 1437.01 | 850.18 | 2287.19 | 2287.19 | 2287.19 | 10.99 |
| 75.0 | 210.97 | 1468.58 | 850.18 | 2318.76 | 2318.76 | 2318.76 | 10.99 |
| 76.0 | 213.78 | 1500.16 | 850.18 | 2350.34 | 2350.34 | 2350.34 | 10.99 |
| 77.0 | 216.59 | 1531.74 | 850.18 | 2381.92 | 2381.92 | 2381.92 | 11.00 |
| 78.0 | 219.41 | 1563.32 | 912.52 | 2475.84 | 2475.84 | 2475.84 | 11.28 |
| 79.0 | 222.22 | 1594.89 | 977.98 | 2572.87 | 2572.87 | 2572.87 | 11.58 |
| 80.0 | 225.03 | 1626.47 | 1046.56 | 2673.03 | 2673.03 | 2673.03 | 11.88 |
| 81.0 | 227.85 | 1658.05 | 1118.25 | 2776.30 | 2776.30 | 2776.30 | 12.19 |
| 82.0 | 230.66 | 1689.62 | 1193.06 | 2882.68 | 2882.68 | 2882.68 | 12.50 |
| 83.0 | 233.47 | 1721.20 | 1270.99 | 2992.19 | 2992.19 | 2992.19 | 12.82 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 84.0 | 236.28 | 1752.78 | 1352.03 | 3104.81 | 3104.81 | 3104.81 | 13.14 |
| 85.0 | 239.10 | 1784.36 | 1436.19 | 3220.55 | 3220.55 | 3220.55 | 13.47 |
| 86.0 | 241.91 | 1815.93 | 1523.47 | 3339.40 | 3339.40 | 3339.40 | 13.80 |
| 87.0 | 244.72 | 1847.51 | 1607.63 | 3455.14 | 3455.14 | 3455.14 | 14.12 |
| 88.0 | 247.54 | 1879.09 | 1682.44 | 3561.53 | 3561.53 | 3561.53 | 14.39 |
| 89.0 | 250.35 | 1910.66 | 1747.90 | 3658.56 | 3658.56 | 3658.56 | 14.61 |
| 90.0 | 253.16 | 1942.24 | 1804.01 | 3746.25 | 3746.25 | 3746.25 | 14.80 |
| 91.0 | 255.97 | 1973.82 | 1850.77 | 3824.58 | 3824.58 | 3824.58 | 14.94 |
| 92.0 | 258.79 | 2005.40 | 1888.17 | 3893.57 | 3893.57 | 3893.57 | 15.05 |
| 93.0 | 261.60 | 2036.97 | 1916.22 | 3953.20 | 3953.20 | 3953.20 | 15.11 |
| 94.0 | 264.41 | 2068.55 | 1934.93 | 4003.48 | 4003.48 | 4003.48 | 15.14 |
| 95.0 | 267.23 | 2100.13 | 1944.28 | 4044.40 | 4044.40 | 4044.40 | 15.13 |
| 96.0 | 270.04 | 2131.70 | 1944.28 | 4075.98 | 4075.98 | 4075.98 | 15.09 |
| 97.0 | 272.85 | 2153.17 | 1944.28 | 4097.44 | 4097.44 | 4097.44 | 15.02 |
| 98.0 | 275.66 | 2174.89 | 1944.28 | 4119.17 | 4119.17 | 4119.17 | 14.94 |
| 99.0 | 278.48 | 2196.87 | 1944.28 | 4141.15 | 4141.15 | 4141.15 | 14.87 |
| 100.0 | 281.29 | 2219.12 | 1944.28 | 4163.39 | 4163.39 | 4163.39 | 14.80 |
| 101.0 | 284.10 | 2241.62 | 1944.28 | 4185.90 | 4185.90 | 4185.90 | 14.73 |
| 102.0 | 286.92 | 2264.39 | 1944.28 | 4208.67 | 4208.67 | 4208.67 | 14.67 |
| 103.0 | 289.73 | 2287.42 | 1944.28 | 4231.69 | 4231.69 | 4231.69 | 14.61 |
| 104.0 | 292.54 | 2310.71 | 1944.28 | 4254.98 | 4254.98 | 4254.98 | 14.54 |
| 105.0 | 295.35 | 2334.26 | 1944.28 | 4278.53 | 4278.53 | 4278.53 | 14.49 |
| 106.0 | 298.17 | 2358.07 | 1944.28 | 4302.34 | 4302.34 | 4302.34 | 14.43 |
| 107.0 | 300.98 | 2382.14 | 1944.28 | 4326.42 | 4326.42 | 4326.42 | 14.37 |
| 108.0 | 303.79 | 2406.47 | 1944.28 | 4350.75 | 4350.75 | 4350.75 | 14.32 |
| 109.0 | 306.61 | 2431.07 | 1944.28 | 4375.34 | 4375.34 | 4375.34 | 14.27 |
| 110.0 | 309.42 | 2455.92 | 1944.28 | 4400.20 | 4400.20 | 4400.20 | 14.22 |
| 111.0 | 312.23 | 2481.04 | 1944.28 | 4425.31 | 4425.31 | 4425.31 | 14.17 |
| 112.0 | 315.04 | 2506.41 | 1944.28 | 4450.69 | 4450.69 | 4450.69 | 14.13 |
| 113.0 | 317.86 | 2532.05 | 1944.28 | 4476.33 | 4476.33 | 4476.33 | 14.08 |
| 114.0 | 320.67 | 2557.95 | 1944.28 | 4502.23 | 4502.23 | 4502.23 | 14.04 |
| 115.0 | 323.48 | 2584.11 | 1944.28 | 4528.39 | 4528.39 | 4528.39 | 14.00 |
| 116.0 | 326.30 | 2610.54 | 1944.28 | 4554.81 | 4554.81 | 4554.81 | 13.96 |
| 117.0 | 329.11 | 2637.22 | 1944.28 | 4581.50 | 4581.50 | 4581.50 | 13.92 |
| 118.0 | 331.92 | 2664.16 | 1944.28 | 4608.44 | 4608.44 | 4608.44 | 13.88 |
| 119.0 | 334.74 | 2691.37 | 1944.28 | 4635.64 | 4635.64 | 4635.64 | 13.85 |
| 120.0 | 337.55 | 2718.83 | 1944.28 | 4663.11 | 4663.11 | 4663.11 | 13.81 |
| 121.0 | 340.36 | 2746.56 | 1944.28 | 4690.84 | 4690.84 | 4690.84 | 13.78 |
| 122.0 | 343.17 | 2774.55 | 1944.28 | 4718.82 | 4718.82 | 4718.82 | 13.75 |
| 123.0 | 345.99 | 2802.80 | 1944.28 | 4747.07 | 4747.07 | 4747.07 | 13.72 |
| 124.0 | 348.80 | 2831.31 | 1944.28 | 4775.58 | 4775.58 | 4775.58 | 13.69 |
| 125.0 | 351.61 | 2860.08 | 1944.28 | 4804.36 | 4804.36 | 4804.36 | 13.66 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1304E+00 | 0.1599E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.6520E+00 | 0.7997E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1304E+01 | 0.1599E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.6520E+02 | 0.7997E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.9780E+02 | 0.1199E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1304E+03 | 0.1599E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3261E+03 | 0.3998E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.6529E+03 | 0.7999E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.9796E+03 | 0.1200E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1290E+04 | 0.1597E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2234E+04 | 0.3579E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.2822E+04 | 0.6423E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3360E+04 | 0.1362E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3734E+04 | 0.3170E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4461E+04 | 0.6178E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1950E+00 | 0.1879E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.9750E+00 | 0.9395E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.1950E+01 | 0.1879E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.9750E+02 | 0.9395E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1462E+03 | 0.1409E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.1950E+03 | 0.1879E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.4882E+03 | 0.4699E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.9773E+03 | 0.9403E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1463E+04 | 0.1410E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.1879E+04 | 0.1863E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.2766E+04 | 0.3859E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3232E+04 | 0.6666E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.3799E+04 | 0.1391E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4171E+04 | 0.3198E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.4794E+04 | 0.6198E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.7315E-01 | 0.1344E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.3657E+00 | 0.6722E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.7315E+00 | 0.1344E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.3657E+02 | 0.6722E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.5486E+02 | 0.1008E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.7315E+02 | 0.1344E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.1829E+03 | 0.3361E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.3659E+03 | 0.6722E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.5490E+03 | 0.1008E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.7316E+03 | 0.1344E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1587E+04 | 0.3257E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2349E+04 | 0.6151E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.2922E+04 | 0.1333E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3297E+04 | 0.3142E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4128E+04 | 0.6159E+01 | 0.1847E+04 | 0.5900E+01 |

# SHAFT Axial Analysis – 5th Street Bridge, Bent 10, 118” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 10, 118"IDH (comp) NL

PROPOSED DEPTH = 125.0 FT
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NUMBER OF LAYERS = 4
---

WATER TABLE DEPTH = 0.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.960E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.160E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.960E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.160E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.812E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.260E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.260E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.960E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.960E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION

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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.99 | 224.16 | 228.16 | 228.16 | 228.16 | 13.83 |
| 7.0 | 19.69 | 9.88 | 280.46 | 290.34 | 290.34 | 290.34 | 14.75 |
| 8.0 | 22.50 | 15.77 | 336.76 | 352.52 | 352.52 | 352.52 | 15.67 |
| 9.0 | 25.32 | 22.25 | 390.68 | 412.93 | 412.93 | 412.93 | 16.31 |
| 10.0 | 28.13 | 29.31 | 442.21 | 471.52 | 471.52 | 471.52 | 16.76 |
| 11.0 | 30.94 | 36.93 | 491.34 | 528.27 | 528.27 | 528.27 | 17.07 |
| 12.0 | 33.75 | 45.08 | 538.06 | 583.14 | 583.14 | 583.14 | 17.28 |
| 13.0 | 36.57 | 53.75 | 582.35 | 636.10 | 636.10 | 636.10 | 17.40 |
| 14.0 | 39.38 | 62.92 | 624.20 | 687.12 | 687.12 | 687.12 | 17.45 |
| 15.0 | 42.19 | 72.56 | 663.61 | 736.17 | 736.17 | 736.17 | 17.45 |
| 16.0 | 45.01 | 82.67 | 700.55 | 783.22 | 783.22 | 783.22 | 17.40 |
| 17.0 | 47.82 | 93.44 | 735.62 | 829.07 | 829.07 | 829.07 | 17.34 |
| 18.0 | 50.63 | 104.86 | 765.99 | 870.85 | 870.85 | 870.85 | 17.20 |
| 19.0 | 53.45 | 116.89 | 792.01 | 908.90 | 908.90 | 908.90 | 17.01 |
| 20.0 | 56.26 | 129.52 | 813.75 | 943.26 | 943.26 | 943.26 | 16.77 |
| 21.0 | 59.07 | 142.72 | 831.27 | 973.99 | 973.99 | 973.99 | 16.49 |
| 22.0 | 61.88 | 156.47 | 844.64 | 1001.11 | 1001.11 | 1001.11 | 16.18 |
| 23.0 | 64.70 | 170.76 | 853.93 | 1024.69 | 1024.69 | 1024.69 | 15.84 |
| 24.0 | 67.51 | 185.56 | 859.20 | 1044.76 | 1044.76 | 1044.76 | 15.48 |
| 25.0 | 70.32 | 200.85 | 860.51 | 1061.36 | 1061.36 | 1061.36 | 15.09 |
| 26.0 | 73.14 | 216.62 | 857.92 | 1074.54 | 1074.54 | 1074.54 | 14.69 |
| 27.0 | 75.95 | 248.19 | 855.79 | 1103.99 | 1103.99 | 1103.99 | 14.54 |
| 28.0 | 78.76 | 279.77 | 854.09 | 1133.87 | 1133.87 | 1133.87 | 14.40 |
| 29.0 | 81.57 | 311.35 | 852.78 | 1164.13 | 1164.13 | 1164.13 | 14.27 |
| 30.0 | 84.39 | 342.93 | 851.80 | 1194.73 | 1194.73 | 1194.73 | 14.16 |
| 31.0 | 87.20 | 374.50 | 851.10 | 1225.61 | 1225.61 | 1225.61 | 14.06 |
| 32.0 | 90.01 | 406.08 | 850.64 | 1256.72 | 1256.72 | 1256.72 | 13.96 |
| 33.0 | 92.83 | 437.66 | 850.36 | 1288.02 | 1288.02 | 1288.02 | 13.88 |
| 34.0 | 95.64 | 469.23 | 850.23 | 1319.46 | 1319.46 | 1319.46 | 13.80 |
| 35.0 | 98.45 | 500.81 | 850.18 | 1350.99 | 1350.99 | 1350.99 | 13.72 |
| 36.0 | 101.26 | 532.39 | 850.18 | 1382.57 | 1382.57 | 1382.57 | 13.65 |
| 37.0 | 104.08 | 563.97 | 850.18 | 1414.15 | 1414.15 | 1414.15 | 13.59 |
| 38.0 | 106.89 | 595.54 | 850.18 | 1445.72 | 1445.72 | 1445.72 | 13.53 |
| 39.0 | 109.70 | 627.12 | 850.18 | 1477.30 | 1477.30 | 1477.30 | 13.47 |
| 40.0 | 112.52 | 658.70 | 850.18 | 1508.88 | 1508.88 | 1508.88 | 13.41 |
| 41.0 | 115.33 | 690.28 | 850.18 | 1540.46 | 1540.46 | 1540.46 | 13.36 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42.0 | 118.14 | 721.85 | 850.18 | 1572.03 | 1572.03 | 1572.03 | 13.31 |
| 43.0 | 120.95 | 753.43 | 850.18 | 1603.61 | 1603.61 | 1603.61 | 13.26 |
| 44.0 | 123.77 | 785.01 | 850.18 | 1635.19 | 1635.19 | 1635.19 | 13.21 |
| 45.0 | 126.58 | 816.58 | 850.18 | 1666.76 | 1666.76 | 1666.76 | 13.17 |
| 46.0 | 129.39 | 848.16 | 850.18 | 1698.34 | 1698.34 | 1698.34 | 13.13 |
| 47.0 | 132.21 | 879.74 | 850.18 | 1729.92 | 1729.92 | 1729.92 | 13.08 |
| 48.0 | 135.02 | 911.32 | 850.18 | 1761.50 | 1761.50 | 1761.50 | 13.05 |
| 49.0 | 137.83 | 942.89 | 850.18 | 1793.07 | 1793.07 | 1793.07 | 13.01 |
| 50.0 | 140.65 | 974.47 | 850.18 | 1824.65 | 1824.65 | 1824.65 | 12.97 |
| 51.0 | 143.46 | 1006.05 | 850.18 | 1856.23 | 1856.23 | 1856.23 | 12.94 |
| 52.0 | 146.27 | 1037.62 | 850.18 | 1887.81 | 1887.81 | 1887.81 | 12.91 |
| 53.0 | 149.08 | 1069.20 | 850.18 | 1919.38 | 1919.38 | 1919.38 | 12.87 |
| 54.0 | 151.90 | 1100.78 | 850.18 | 1950.96 | 1950.96 | 1950.96 | 12.84 |
| 55.0 | 154.71 | 1132.36 | 850.18 | 1982.54 | 1982.54 | 1982.54 | 12.81 |
| 56.0 | 157.52 | 1163.93 | 850.18 | 2014.11 | 2014.11 | 2014.11 | 12.79 |
| 57.0 | 160.34 | 1195.51 | 850.18 | 2045.69 | 2045.69 | 2045.69 | 12.76 |
| 58.0 | 163.15 | 1227.09 | 850.18 | 2077.27 | 2077.27 | 2077.27 | 12.73 |
| 59.0 | 165.96 | 1258.66 | 850.18 | 2108.85 | 2108.85 | 2108.85 | 12.71 |
| 60.0 | 168.77 | 1290.24 | 850.18 | 2140.42 | 2140.42 | 2140.42 | 12.68 |
| 61.0 | 171.59 | 1321.82 | 850.18 | 2172.00 | 2172.00 | 2172.00 | 12.66 |
| 62.0 | 174.40 | 1353.40 | 850.18 | 2203.58 | 2203.58 | 2203.58 | 12.64 |
| 63.0 | 177.21 | 1384.97 | 850.18 | 2235.15 | 2235.15 | 2235.15 | 12.61 |
| 64.0 | 180.03 | 1416.55 | 850.18 | 2266.73 | 2266.73 | 2266.73 | 12.59 |
| 65.0 | 182.84 | 1448.13 | 850.18 | 2298.31 | 2298.31 | 2298.31 | 12.57 |
| 66.0 | 185.65 | 1479.70 | 850.18 | 2329.89 | 2329.89 | 2329.89 | 12.55 |
| 67.0 | 188.46 | 1511.28 | 850.18 | 2361.46 | 2361.46 | 2361.46 | 12.53 |
| 68.0 | 191.28 | 1542.86 | 850.18 | 2393.04 | 2393.04 | 2393.04 | 12.51 |
| 69.0 | 194.09 | 1574.44 | 850.18 | 2424.62 | 2424.62 | 2424.62 | 12.49 |
| 70.0 | 196.90 | 1606.01 | 850.18 | 2456.19 | 2456.19 | 2456.19 | 12.47 |
| 71.0 | 199.72 | 1637.59 | 850.18 | 2487.77 | 2487.77 | 2487.77 | 12.46 |
| 72.0 | 202.53 | 1669.17 | 850.18 | 2519.35 | 2519.35 | 2519.35 | 12.44 |
| 73.0 | 205.34 | 1700.74 | 850.18 | 2550.93 | 2550.93 | 2550.93 | 12.42 |
| 74.0 | 208.15 | 1732.32 | 850.18 | 2582.50 | 2582.50 | 2582.50 | 12.41 |
| 75.0 | 210.97 | 1763.90 | 850.18 | 2614.08 | 2614.08 | 2614.08 | 12.39 |
| 76.0 | 213.78 | 1795.48 | 850.18 | 2645.66 | 2645.66 | 2645.66 | 12.38 |
| 77.0 | 216.59 | 1827.05 | 850.18 | 2677.23 | 2677.23 | 2677.23 | 12.36 |
| 78.0 | 219.41 | 1858.63 | 912.52 | 2771.15 | 2771.15 | 2771.15 | 12.63 |
| 79.0 | 222.22 | 1890.21 | 977.98 | 2868.19 | 2868.19 | 2868.19 | 12.91 |
| 80.0 | 225.03 | 1921.78 | 1046.56 | 2968.34 | 2968.34 | 2968.34 | 13.19 |
| 81.0 | 227.85 | 1953.36 | 1118.25 | 3071.61 | 3071.61 | 3071.61 | 13.48 |
| 82.0 | 230.66 | 1984.94 | 1193.06 | 3178.00 | 3178.00 | 3178.00 | 13.78 |
| 83.0 | 233.47 | 2016.52 | 1270.99 | 3287.50 | 3287.50 | 3287.50 | 14.08 |
| 84.0 | 236.28 | 2048.09 | 1352.03 | 3400.13 | 3400.13 | 3400.13 | 14.39 |
| 85.0 | 239.10 | 2079.67 | 1436.19 | 3515.86 | 3515.86 | 3515.86 | 14.70 |
| 86.0 | 241.91 | 2111.25 | 1523.47 | 3634.72 | 3634.72 | 3634.72 | 15.03 |
| 87.0 | 244.72 | 2142.82 | 1607.63 | 3750.46 | 3750.46 | 3750.46 | 15.33 |
| 88.0 | 247.54 | 2174.40 | 1682.44 | 3856.84 | 3856.84 | 3856.84 | 15.58 |
| 89.0 | 250.35 | 2205.98 | 1747.90 | 3953.88 | 3953.88 | 3953.88 | 15.79 |
| 90.0 | 253.16 | 2237.56 | 1804.01 | 4041.57 | 4041.57 | 4041.57 | 15.96 |
| 91.0 | 255.97 | 2269.13 | 1850.77 | 4119.90 | 4119.90 | 4119.90 | 16.09 |
| 92.0 | 258.79 | 2300.71 | 1888.17 | 4188.88 | 4188.88 | 4188.88 | 16.19 |
| 93.0 | 261.60 | 2332.29 | 1916.22 | 4248.51 | 4248.51 | 4248.51 | 16.24 |
| 94.0 | 264.41 | 2363.86 | 1934.93 | 4298.79 | 4298.79 | 4298.79 | 16.26 |
| 95.0 | 267.23 | 2395.44 | 1944.28 | 4339.72 | 4339.72 | 4339.72 | 16.24 |
| 96.0 | 270.04 | 2427.02 | 1944.28 | 4371.30 | 4371.30 | 4371.30 | 16.19 |
| 97.0 | 272.85 | 2449.06 | 1944.28 | 4393.34 | 4393.34 | 4393.34 | 16.10 |
| 98.0 | 275.66 | 2471.36 | 1944.28 | 4415.64 | 4415.64 | 4415.64 | 16.02 |
| 99.0 | 278.48 | 2493.92 | 1944.28 | 4438.20 | 4438.20 | 4438.20 | 15.94 |
| 100.0 | 281.29 | 2516.75 | 1944.28 | 4461.03 | 4461.03 | 4461.03 | 15.86 |
| 101.0 | 284.10 | 2539.83 | 1944.28 | 4484.11 | 4484.11 | 4484.11 | 15.78 |
| 102.0 | 286.92 | 2563.18 | 1944.28 | 4507.46 | 4507.46 | 4507.46 | 15.71 |
| 103.0 | 289.73 | 2586.79 | 1944.28 | 4531.06 | 4531.06 | 4531.06 | 15.64 |
| 104.0 | 292.54 | 2610.65 | 1944.28 | 4554.93 | 4554.93 | 4554.93 | 15.57 |
| 105.0 | 295.35 | 2634.78 | 1944.28 | 4579.06 | 4579.06 | 4579.06 | 15.50 |
| 106.0 | 298.17 | 2659.17 | 1944.28 | 4603.45 | 4603.45 | 4603.45 | 15.44 |
| 107.0 | 300.98 | 2683.83 | 1944.28 | 4628.10 | 4628.10 | 4628.10 | 15.38 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 108.0 | 303.79 | 2708.74 | 1944.28 | 4653.02 | 4653.02 | 4653.02 | 15.32 |
| 109.0 | 306.61 | 2733.91 | 1944.28 | 4678.19 | 4678.19 | 4678.19 | 15.26 |
| 110.0 | 309.42 | 2759.35 | 1944.28 | 4703.62 | 4703.62 | 4703.62 | 15.20 |
| 111.0 | 312.23 | 2785.04 | 1944.28 | 4729.32 | 4729.32 | 4729.32 | 15.15 |
| 112.0 | 315.04 | 2811.00 | 1944.28 | 4755.28 | 4755.28 | 4755.28 | 15.09 |
| 113.0 | 317.86 | 2837.22 | 1944.28 | 4781.49 | 4781.49 | 4781.49 | 15.04 |
| 114.0 | 320.67 | 2863.70 | 1944.28 | 4807.97 | 4807.97 | 4807.97 | 14.99 |
| 115.0 | 323.48 | 2890.44 | 1944.28 | 4834.71 | 4834.71 | 4834.71 | 14.95 |
| 116.0 | 326.30 | 2917.44 | 1944.28 | 4861.71 | 4861.71 | 4861.71 | 14.90 |
| 117.0 | 329.11 | 2944.70 | 1944.28 | 4888.98 | 4888.98 | 4888.98 | 14.86 |
| 118.0 | 331.92 | 2972.22 | 1944.28 | 4916.50 | 4916.50 | 4916.50 | 14.81 |
| 119.0 | 334.74 | 3000.01 | 1944.28 | 4944.28 | 4944.28 | 4944.28 | 14.77 |
| 120.0 | 337.55 | 3028.05 | 1944.28 | 4972.33 | 4972.33 | 4972.33 | 14.73 |
| 121.0 | 340.36 | 3056.36 | 1944.28 | 5000.63 | 5000.63 | 5000.63 | 14.69 |
| 122.0 | 343.17 | 3084.92 | 1944.28 | 5029.20 | 5029.20 | 5029.20 | 14.65 |
| 123.0 | 345.99 | 3113.75 | 1944.28 | 5058.03 | 5058.03 | 5058.03 | 14.62 |
| 124.0 | 348.80 | 3142.84 | 1944.28 | 5087.12 | 5087.12 | 5087.12 | 14.58 |
| 125.0 | 351.61 | 3172.19 | 1944.28 | 5116.47 | 5116.47 | 5116.47 | 14.55 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |
| 0.1475E+00 | 0.1633E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.7375E+00 | 0.8165E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1475E+01 | 0.1633E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.7375E+02 | 0.8165E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.1106E+03 | 0.1225E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1475E+03 | 0.1633E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3690E+03 | 0.4083E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.7388E+03 | 0.8168E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.1108E+04 | 0.1225E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1450E+04 | 0.1628E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2489E+04 | 0.3628E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.3111E+04 | 0.6477E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3657E+04 | 0.1368E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.4008E+04 | 0.3175E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4734E+04 | 0.6183E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |
| 0.2224E+00 | 0.1933E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.1112E+01 | 0.9666E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.2224E+01 | 0.1933E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.1112E+03 | 0.9666E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1668E+03 | 0.1450E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.2224E+03 | 0.1933E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.5570E+03 | 0.4835E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.1115E+04 | 0.9674E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1670E+04 | 0.1451E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.2115E+04 | 0.1909E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.3066E+04 | 0.3915E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3550E+04 | 0.6726E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.4116E+04 | 0.1397E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4468E+04 | 0.3203E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.5091E+04 | 0.6203E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |
| 0.8205E-01 | 0.1362E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.4102E+00 | 0.6808E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.8205E+00 | 0.1362E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.4102E+02 | 0.6808E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.6154E+02 | 0.1021E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.8205E+02 | 0.1362E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.2051E+03 | 0.3404E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.4105E+03 | 0.6808E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.6159E+03 | 0.1021E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.8203E+03 | 0.1362E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1771E+04 | 0.3293E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2605E+04 | 0.6199E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.3199E+04 | 0.1338E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3547E+04 | 0.3147E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4378E+04 | 0.6163E+01 | 0.1847E+04 | 0.5900E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Bent 10, 118"IDH (comp) LQ

PROPOSED DEPTH = 125.0 FT
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NUMBER OF LAYERS = 4
---

WATER TABLE DEPTH = 0.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.600E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.795E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.160E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.960E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.160E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.812E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.260E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.260E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.960E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.960E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.200E+03

DRILLED SHAFT INFORMATION

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DIAMETER OF STEM = 9.833 FT.
DIAMETER OF BASE = 9.833 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 5.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 109.366 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 6.0 | 16.88 | 3.40 | 267.82 | 271.22 | 271.22 | 271.22 | 16.15 |
| 7.0 | 19.69 | 6.80 | 316.30 | 323.09 | 323.09 | 323.09 | 16.41 |
| 8.0 | 22.50 | 10.20 | 364.78 | 374.97 | 374.97 | 374.97 | 16.66 |
| 9.0 | 25.32 | 13.59 | 411.80 | 425.40 | 425.40 | 425.40 | 16.80 |
| 10.0 | 28.13 | 16.99 | 457.38 | 474.37 | 474.37 | 474.37 | 16.86 |
| 11.0 | 30.94 | 20.39 | 501.51 | 521.90 | 521.90 | 521.90 | 16.87 |
| 12.0 | 33.75 | 23.79 | 544.19 | 567.98 | 567.98 | 567.98 | 16.83 |
| 13.0 | 36.57 | 27.19 | 585.43 | 612.62 | 612.62 | 612.62 | 16.75 |
| 14.0 | 39.38 | 30.59 | 625.24 | 655.82 | 655.82 | 655.82 | 16.65 |
| 15.0 | 42.19 | 33.98 | 663.61 | 697.59 | 697.59 | 697.59 | 16.53 |
| 16.0 | 45.01 | 37.38 | 700.55 | 737.94 | 737.94 | 737.94 | 16.40 |
| 17.0 | 47.82 | 48.16 | 735.62 | 783.78 | 783.78 | 783.78 | 16.39 |
| 18.0 | 50.63 | 59.57 | 765.99 | 825.56 | 825.56 | 825.56 | 16.31 |
| 19.0 | 53.45 | 71.60 | 792.01 | 863.61 | 863.61 | 863.61 | 16.16 |
| 20.0 | 56.26 | 84.23 | 813.75 | 897.98 | 897.98 | 897.98 | 15.96 |
| 21.0 | 59.07 | 97.43 | 831.27 | 928.70 | 928.70 | 928.70 | 15.72 |
| 22.0 | 61.88 | 111.18 | 844.64 | 955.83 | 955.83 | 955.83 | 15.45 |
| 23.0 | 64.70 | 125.47 | 853.93 | 979.40 | 979.40 | 979.40 | 15.14 |
| 24.0 | 67.51 | 140.27 | 859.20 | 999.47 | 999.47 | 999.47 | 14.80 |
| 25.0 | 70.32 | 155.56 | 860.51 | 1016.07 | 1016.07 | 1016.07 | 14.45 |
| 26.0 | 73.14 | 171.33 | 857.92 | 1029.25 | 1029.25 | 1029.25 | 14.07 |
| 27.0 | 75.95 | 202.91 | 855.79 | 1058.70 | 1058.70 | 1058.70 | 13.94 |
| 28.0 | 78.76 | 234.48 | 854.09 | 1088.58 | 1088.58 | 1088.58 | 13.82 |
| 29.0 | 81.57 | 266.06 | 852.78 | 1118.84 | 1118.84 | 1118.84 | 13.72 |
| 30.0 | 84.39 | 297.64 | 851.80 | 1149.44 | 1149.44 | 1149.44 | 13.62 |
| 31.0 | 87.20 | 329.21 | 851.10 | 1180.32 | 1180.32 | 1180.32 | 13.54 |
| 32.0 | 90.01 | 360.79 | 850.64 | 1211.43 | 1211.43 | 1211.43 | 13.46 |
| 33.0 | 92.83 | 392.37 | 850.36 | 1242.73 | 1242.73 | 1242.73 | 13.39 |
| 34.0 | 95.64 | 423.95 | 850.23 | 1274.17 | 1274.17 | 1274.17 | 13.32 |
| 35.0 | 98.45 | 455.52 | 850.18 | 1305.70 | 1305.70 | 1305.70 | 13.26 |
| 36.0 | 101.26 | 487.10 | 850.18 | 1337.28 | 1337.28 | 1337.28 | 13.21 |
| 37.0 | 104.08 | 518.68 | 850.18 | 1368.86 | 1368.86 | 1368.86 | 13.15 |
| 38.0 | 106.89 | 550.26 | 850.18 | 1400.44 | 1400.44 | 1400.44 | 13.10 |
| 39.0 | 109.70 | 581.83 | 850.18 | 1432.01 | 1432.01 | 1432.01 | 13.05 |
| 40.0 | 112.52 | 613.41 | 850.18 | 1463.59 | 1463.59 | 1463.59 | 13.01 |
| 41.0 | 115.33 | 644.99 | 850.18 | 1495.17 | 1495.17 | 1495.17 | 12.96 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42.0 | 118.14 | 676.56 | 850.18 | 1526.74 | 1526.74 | 1526.74 | 12.92 |
| 43.0 | 120.95 | 708.14 | 850.18 | 1558.32 | 1558.32 | 1558.32 | 12.88 |
| 44.0 | 123.77 | 739.72 | 850.18 | 1589.90 | 1589.90 | 1589.90 | 12.85 |
| 45.0 | 126.58 | 771.30 | 850.18 | 1621.48 | 1621.48 | 1621.48 | 12.81 |
| 46.0 | 129.39 | 802.87 | 850.18 | 1653.05 | 1653.05 | 1653.05 | 12.78 |
| 47.0 | 132.21 | 834.45 | 850.18 | 1684.63 | 1684.63 | 1684.63 | 12.74 |
| 48.0 | 135.02 | 866.03 | 850.18 | 1716.21 | 1716.21 | 1716.21 | 12.71 |
| 49.0 | 137.83 | 897.60 | 850.18 | 1747.79 | 1747.79 | 1747.79 | 12.68 |
| 50.0 | 140.65 | 929.18 | 850.18 | 1779.36 | 1779.36 | 1779.36 | 12.65 |
| 51.0 | 143.46 | 960.76 | 850.18 | 1810.94 | 1810.94 | 1810.94 | 12.62 |
| 52.0 | 146.27 | 992.34 | 850.18 | 1842.52 | 1842.52 | 1842.52 | 12.60 |
| 53.0 | 149.08 | 1023.91 | 850.18 | 1874.09 | 1874.09 | 1874.09 | 12.57 |
| 54.0 | 151.90 | 1055.49 | 850.18 | 1905.67 | 1905.67 | 1905.67 | 12.55 |
| 55.0 | 154.71 | 1087.07 | 850.18 | 1937.25 | 1937.25 | 1937.25 | 12.52 |
| 56.0 | 157.52 | 1118.64 | 850.18 | 1968.83 | 1968.83 | 1968.83 | 12.50 |
| 57.0 | 160.34 | 1150.22 | 850.18 | 2000.40 | 2000.40 | 2000.40 | 12.48 |
| 58.0 | 163.15 | 1181.80 | 850.18 | 2031.98 | 2031.98 | 2031.98 | 12.45 |
| 59.0 | 165.96 | 1213.38 | 850.18 | 2063.56 | 2063.56 | 2063.56 | 12.43 |
| 60.0 | 168.77 | 1244.95 | 850.18 | 2095.13 | 2095.13 | 2095.13 | 12.41 |
| 61.0 | 171.59 | 1276.53 | 850.18 | 2126.71 | 2126.71 | 2126.71 | 12.39 |
| 62.0 | 174.40 | 1308.11 | 850.18 | 2158.29 | 2158.29 | 2158.29 | 12.38 |
| 63.0 | 177.21 | 1339.68 | 850.18 | 2189.87 | 2189.87 | 2189.87 | 12.36 |
| 64.0 | 180.03 | 1371.26 | 850.18 | 2221.44 | 2221.44 | 2221.44 | 12.34 |
| 65.0 | 182.84 | 1402.84 | 850.18 | 2253.02 | 2253.02 | 2253.02 | 12.32 |
| 66.0 | 185.65 | 1434.42 | 850.18 | 2284.60 | 2284.60 | 2284.60 | 12.31 |
| 67.0 | 188.46 | 1465.99 | 850.18 | 2316.17 | 2316.17 | 2316.17 | 12.29 |
| 68.0 | 191.28 | 1497.57 | 850.18 | 2347.75 | 2347.75 | 2347.75 | 12.27 |
| 69.0 | 194.09 | 1529.15 | 850.18 | 2379.33 | 2379.33 | 2379.33 | 12.26 |
| 70.0 | 196.90 | 1560.72 | 850.18 | 2410.91 | 2410.91 | 2410.91 | 12.24 |
| 71.0 | 199.72 | 1592.30 | 850.18 | 2442.48 | 2442.48 | 2442.48 | 12.23 |
| 72.0 | 202.53 | 1623.88 | 850.18 | 2474.06 | 2474.06 | 2474.06 | 12.22 |
| 73.0 | 205.34 | 1655.46 | 850.18 | 2505.64 | 2505.64 | 2505.64 | 12.20 |
| 74.0 | 208.15 | 1687.03 | 850.18 | 2537.21 | 2537.21 | 2537.21 | 12.19 |
| 75.0 | 210.97 | 1718.61 | 850.18 | 2568.79 | 2568.79 | 2568.79 | 12.18 |
| 76.0 | 213.78 | 1750.19 | 850.18 | 2600.37 | 2600.37 | 2600.37 | 12.16 |
| 77.0 | 216.59 | 1781.77 | 850.18 | 2631.95 | 2631.95 | 2631.95 | 12.15 |
| 78.0 | 219.41 | 1813.34 | 912.52 | 2725.86 | 2725.86 | 2725.86 | 12.42 |
| 79.0 | 222.22 | 1844.92 | 977.98 | 2822.90 | 2822.90 | 2822.90 | 12.70 |
| 80.0 | 225.03 | 1876.50 | 1046.56 | 2923.05 | 2923.05 | 2923.05 | 12.99 |
| 81.0 | 227.85 | 1908.07 | 1118.25 | 3026.32 | 3026.32 | 3026.32 | 13.28 |
| 82.0 | 230.66 | 1939.65 | 1193.06 | 3132.71 | 3132.71 | 3132.71 | 13.58 |
| 83.0 | 233.47 | 1971.23 | 1270.99 | 3242.21 | 3242.21 | 3242.21 | 13.89 |
| 84.0 | 236.28 | 2002.81 | 1352.03 | 3354.84 | 3354.84 | 3354.84 | 14.20 |
| 85.0 | 239.10 | 2034.38 | 1436.19 | 3470.57 | 3470.57 | 3470.57 | 14.52 |
| 86.0 | 241.91 | 2065.96 | 1523.47 | 3589.43 | 3589.43 | 3589.43 | 14.84 |
| 87.0 | 244.72 | 2097.54 | 1607.63 | 3705.17 | 3705.17 | 3705.17 | 15.14 |
| 88.0 | 247.54 | 2129.11 | 1682.44 | 3811.56 | 3811.56 | 3811.56 | 15.40 |
| 89.0 | 250.35 | 2160.69 | 1747.90 | 3908.59 | 3908.59 | 3908.59 | 15.61 |
| 90.0 | 253.16 | 2192.27 | 1804.01 | 3996.28 | 3996.28 | 3996.28 | 15.79 |
| 91.0 | 255.97 | 2223.85 | 1850.77 | 4074.61 | 4074.61 | 4074.61 | 15.92 |
| 92.0 | 258.79 | 2255.42 | 1888.17 | 4143.59 | 4143.59 | 4143.59 | 16.01 |
| 93.0 | 261.60 | 2287.00 | 1916.22 | 4203.22 | 4203.22 | 4203.22 | 16.07 |
| 94.0 | 264.41 | 2318.58 | 1934.93 | 4253.50 | 4253.50 | 4253.50 | 16.09 |
| 95.0 | 267.23 | 2350.15 | 1944.28 | 4294.43 | 4294.43 | 4294.43 | 16.07 |
| 96.0 | 270.04 | 2381.73 | 1944.28 | 4326.01 | 4326.01 | 4326.01 | 16.02 |
| 97.0 | 272.85 | 2403.77 | 1944.28 | 4348.05 | 4348.05 | 4348.05 | 15.94 |
| 98.0 | 275.66 | 2426.07 | 1944.28 | 4370.35 | 4370.35 | 4370.35 | 15.85 |
| 99.0 | 278.48 | 2448.64 | 1944.28 | 4392.91 | 4392.91 | 4392.91 | 15.77 |
| 100.0 | 281.29 | 2471.46 | 1944.28 | 4415.74 | 4415.74 | 4415.74 | 15.70 |
| 101.0 | 284.10 | 2494.55 | 1944.28 | 4438.82 | 4438.82 | 4438.82 | 15.62 |
| 102.0 | 286.92 | 2517.89 | 1944.28 | 4462.17 | 4462.17 | 4462.17 | 15.55 |
| 103.0 | 289.73 | 2541.50 | 1944.28 | 4485.78 | 4485.78 | 4485.78 | 15.48 |
| 104.0 | 292.54 | 2565.37 | 1944.28 | 4509.64 | 4509.64 | 4509.64 | 15.42 |
| 105.0 | 295.35 | 2589.50 | 1944.28 | 4533.77 | 4533.77 | 4533.77 | 15.35 |
| 106.0 | 298.17 | 2613.89 | 1944.28 | 4558.16 | 4558.16 | 4558.16 | 15.29 |
| 107.0 | 300.98 | 2638.54 | 1944.28 | 4582.81 | 4582.81 | 4582.81 | 15.23 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 108.0 | 303.79 | 2663.45 | 1944.28 | 4607.73 | 4607.73 | 4607.73 | 15.17 |
| 109.0 | 306.61 | 2688.62 | 1944.28 | 4632.90 | 4632.90 | 4632.90 | 15.11 |
| 110.0 | 309.42 | 2714.06 | 1944.28 | 4658.34 | 4658.34 | 4658.34 | 15.06 |
| 111.0 | 312.23 | 2739.75 | 1944.28 | 4684.03 | 4684.03 | 4684.03 | 15.00 |
| 112.0 | 315.04 | 2765.71 | 1944.28 | 4709.99 | 4709.99 | 4709.99 | 14.95 |
| 113.0 | 317.86 | 2791.93 | 1944.28 | 4736.21 | 4736.21 | 4736.21 | 14.90 |
| 114.0 | 320.67 | 2818.41 | 1944.28 | 4762.68 | 4762.68 | 4762.68 | 14.85 |
| 115.0 | 323.48 | 2845.15 | 1944.28 | 4789.42 | 4789.42 | 4789.42 | 14.81 |
| 116.0 | 326.30 | 2872.15 | 1944.28 | 4816.43 | 4816.43 | 4816.43 | 14.76 |
| 117.0 | 329.11 | 2899.41 | 1944.28 | 4843.69 | 4843.69 | 4843.69 | 14.72 |
| 118.0 | 331.92 | 2926.93 | 1944.28 | 4871.21 | 4871.21 | 4871.21 | 14.68 |
| 119.0 | 334.74 | 2954.72 | 1944.28 | 4898.99 | 4898.99 | 4898.99 | 14.64 |
| 120.0 | 337.55 | 2982.76 | 1944.28 | 4927.04 | 4927.04 | 4927.04 | 14.60 |
| 121.0 | 340.36 | 3011.07 | 1944.28 | 4955.35 | 4955.35 | 4955.35 | 14.56 |
| 122.0 | 343.17 | 3039.64 | 1944.28 | 4983.91 | 4983.91 | 4983.91 | 14.52 |
| 123.0 | 345.99 | 3068.46 | 1944.28 | 5012.74 | 5012.74 | 5012.74 | 14.49 |
| 124.0 | 348.80 | 3097.55 | 1944.28 | 5041.83 | 5041.83 | 5041.83 | 14.45 |
| 125.0 | 351.61 | 3126.90 | 1944.28 | 5071.18 | 5071.18 | 5071.18 | 14.42 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1465E+00 | 0.1632E-04 | 0.5767E-02 | 0.1000E-04 |
| 0.7324E+00 | 0.8160E-04 | 0.2884E-01 | 0.5000E-04 |
| 0.1465E+01 | 0.1632E-03 | 0.5767E-01 | 0.1000E-03 |
| 0.7324E+02 | 0.8160E-02 | 0.2884E+01 | 0.5000E-02 |
| 0.1099E+03 | 0.1224E-01 | 0.4325E+01 | 0.7500E-02 |
| 0.1465E+03 | 0.1632E-01 | 0.5767E+01 | 0.1000E-01 |
| 0.3664E+03 | 0.4080E-01 | 0.1442E+02 | 0.2500E-01 |
| 0.7336E+03 | 0.8163E-01 | 0.2884E+02 | 0.5000E-01 |
| 0.1101E+04 | 0.1225E+00 | 0.4325E+02 | 0.7500E-01 |
| 0.1438E+04 | 0.1627E+00 | 0.5767E+02 | 0.1000E+00 |
| 0.2463E+04 | 0.3626E+00 | 0.1442E+03 | 0.2500E+00 |
| 0.3071E+04 | 0.6474E+00 | 0.2884E+03 | 0.5000E+00 |
| 0.3609E+04 | 0.1367E+01 | 0.6708E+03 | 0.1180E+01 |
| 0.3956E+04 | 0.3175E+01 | 0.1244E+04 | 0.2950E+01 |
| 0.4682E+04 | 0.6183E+01 | 0.1973E+04 | 0.5900E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.2212E+00 | 0.1932E-04 | 0.8239E-02 | 0.1000E-04 |
| 0.1106E+01 | 0.9660E-04 | 0.4119E-01 | 0.5000E-04 |
| 0.2212E+01 | 0.1932E-03 | 0.8239E-01 | 0.1000E-03 |
| 0.1106E+03 | 0.9660E-02 | 0.4119E+01 | 0.5000E-02 |
| 0.1659E+03 | 0.1449E-01 | 0.6179E+01 | 0.7500E-02 |
| 0.2212E+03 | 0.1932E-01 | 0.8239E+01 | 0.1000E-01 |
| 0.5539E+03 | 0.4832E-01 | 0.2060E+02 | 0.2500E-01 |
| 0.1109E+04 | 0.9668E-01 | 0.4119E+02 | 0.5000E-01 |
| 0.1659E+04 | 0.1450E+00 | 0.6179E+02 | 0.7500E-01 |
| 0.2097E+04 | 0.1907E+00 | 0.8239E+02 | 0.1000E+00 |
| 0.3026E+04 | 0.3912E+00 | 0.2060E+03 | 0.2500E+00 |
| 0.3503E+04 | 0.6722E+00 | 0.4119E+03 | 0.5000E+00 |
| 0.4067E+04 | 0.1397E+01 | 0.9333E+03 | 0.1180E+01 |
| 0.4416E+04 | 0.3203E+01 | 0.1478E+04 | 0.2950E+01 |
| 0.5038E+04 | 0.6203E+01 | 0.2100E+04 | 0.5900E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.8124E-01 | 0.1361E-04 | 0.3295E-02 | 0.1000E-04 |
| 0.4062E+00 | 0.6804E-04 | 0.1648E-01 | 0.5000E-04 |
| 0.8124E+00 | 0.1361E-03 | 0.3295E-01 | 0.1000E-03 |
| 0.4062E+02 | 0.6804E-02 | 0.1648E+01 | 0.5000E-02 |
| 0.6093E+02 | 0.1021E-01 | 0.2472E+01 | 0.7500E-02 |
| 0.8124E+02 | 0.1361E-01 | 0.3295E+01 | 0.1000E-01 |
| 0.2031E+03 | 0.3402E-01 | 0.8239E+01 | 0.2500E-01 |
| 0.4064E+03 | 0.6805E-01 | 0.1648E+02 | 0.5000E-01 |
| 0.6098E+03 | 0.1021E+00 | 0.2472E+02 | 0.7500E-01 |
| 0.8122E+03 | 0.1361E+00 | 0.3295E+02 | 0.1000E+00 |
| 0.1754E+04 | 0.3291E+00 | 0.8239E+02 | 0.2500E+00 |
| 0.2573E+04 | 0.6197E+00 | 0.1648E+03 | 0.5000E+00 |
| 0.3152E+04 | 0.1338E+01 | 0.4083E+03 | 0.1180E+01 |
| 0.3495E+04 | 0.3146E+01 | 0.1011E+04 | 0.2950E+01 |
| 0.4326E+04 | 0.6163E+01 | 0.1847E+04 | 0.5900E+01 |

SHAFT Axial Analysis – 5th Street Bridge, Abutment 11, 24” CIDH (NL and LQ)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Abut 11, 24" CIDH, NL (comp)

PROPOSED DEPTH = 90.0 FT
---

NUMBER OF LAYERS = 7
---

WATER TABLE DEPTH = 17.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.107E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.107E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.977E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.150E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.977E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.150E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.943E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.170E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.943E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.170E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.701E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.350E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.701E+00

UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.350E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.594E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.450E+02

LAYER NO 6----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.450E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.115E+03

LAYER NO 7----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.115E+03

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11

DEPTH, FT = 0.167E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 2.000 FT.
DIAMETER OF BASE = 2.000 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 3.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 4.524 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 4.0 | 0.47 | 1.30 | 5.99 | 7.29 | 7.29 | 7.29 | 16.49 |
| 5.0 | 0.58 | 3.73 | 6.82 | 10.55 | 10.55 | 10.55 | 18.14 |
| 6.0 | 0.70 | 6.15 | 7.66 | 13.82 | 13.82 | 13.82 | 19.79 |
| 7.0 | 0.81 | 8.92 | 5.21 | 14.13 | 14.13 | 14.13 | 17.34 |
| 8.0 | 0.93 | 12.01 | 1.80 | 13.81 | 13.81 | 13.81 | 14.83 |
| 9.0 | 1.05 | 15.42 | 0.00 | 15.42 | 15.42 | 15.42 | 14.72 |
| 10.0 | 1.16 | 19.13 | 0.00 | 19.13 | 19.13 | 19.13 | 16.44 |
| 11.0 | 1.28 | 23.13 | 0.00 | 23.13 | 23.13 | 23.13 | 18.07 |
| 12.0 | 1.40 | 27.41 | 0.00 | 27.41 | 27.41 | 27.41 | 19.63 |
| 13.0 | 1.51 | 31.96 | 0.00 | 31.96 | 31.96 | 31.96 | 21.13 |
| 14.0 | 1.63 | 36.77 | 0.00 | 36.77 | 36.77 | 36.77 | 22.57 |
| 15.0 | 1.75 | 41.84 | 0.00 | 41.84 | 41.84 | 41.84 | 23.97 |
| 16.0 | 1.86 | 47.13 | 0.00 | 47.13 | 47.13 | 47.13 | 25.31 |
| 17.0 | 1.98 | 52.65 | 0.00 | 52.65 | 52.65 | 52.65 | 26.61 |
| 18.0 | 2.09 | 58.19 | 0.00 | 58.19 | 58.19 | 58.19 | 27.78 |
| 19.0 | 2.21 | 63.76 | 0.00 | 63.76 | 63.76 | 63.76 | 28.84 |
| 20.0 | 2.33 | 69.36 | 0.00 | 69.36 | 69.36 | 69.36 | 29.80 |
| 21.0 | 2.44 | 74.98 | 0.00 | 74.98 | 74.98 | 74.98 | 30.68 |
| 22.0 | 2.56 | 80.63 | 0.00 | 80.63 | 80.63 | 80.63 | 31.49 |
| 23.0 | 2.68 | 86.29 | 0.00 | 86.29 | 86.29 | 86.29 | 32.24 |
| 24.0 | 2.79 | 91.98 | 0.00 | 91.98 | 91.98 | 91.98 | 32.93 |
| 25.0 | 2.91 | 97.69 | 0.00 | 97.69 | 97.69 | 97.69 | 33.58 |
| 26.0 | 3.03 | 103.41 | 0.00 | 103.41 | 103.41 | 103.41 | 34.18 |
| 27.0 | 3.14 | 109.14 | 0.00 | 109.14 | 109.14 | 109.14 | 34.74 |
| 28.0 | 3.26 | 114.89 | 0.00 | 114.89 | 114.89 | 114.89 | 35.26 |
| 29.0 | 3.37 | 120.65 | 0.00 | 120.65 | 120.65 | 120.65 | 35.75 |
| 30.0 | 3.49 | 126.42 | 0.00 | 126.42 | 126.42 | 126.42 | 36.21 |
| 31.0 | 3.61 | 132.19 | 0.00 | 132.19 | 132.19 | 132.19 | 36.64 |
| 32.0 | 3.72 | 137.98 | 5.99 | 143.96 | 143.96 | 143.96 | 38.66 |
| 33.0 | 3.84 | 143.76 | 13.17 | 156.93 | 156.93 | 156.93 | 40.86 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 34.0 | 3.96 | 149.55 | 16.76 | 166.31 | 166.31 | 166.31 | 42.03 |
| 35.0 | 4.07 | 155.34 | 16.76 | 172.10 | 172.10 | 172.10 | 42.25 |
| 36.0 | 4.19 | 161.16 | 16.76 | 177.92 | 177.92 | 177.92 | 42.47 |
| 37.0 | 4.31 | 167.01 | 16.76 | 183.76 | 183.76 | 183.76 | 42.68 |
| 38.0 | 4.42 | 172.88 | 16.76 | 189.64 | 189.64 | 189.64 | 42.88 |
| 39.0 | 4.54 | 178.78 | 16.76 | 195.54 | 195.54 | 195.54 | 43.08 |
| 40.0 | 4.65 | 184.69 | 16.76 | 201.45 | 201.45 | 201.45 | 43.28 |
| 41.0 | 4.77 | 190.63 | 16.76 | 207.39 | 207.39 | 207.39 | 43.47 |
| 42.0 | 4.89 | 196.58 | 30.97 | 227.55 | 227.55 | 227.55 | 46.56 |
| 43.0 | 5.00 | 202.55 | 48.03 | 250.57 | 250.57 | 250.57 | 50.08 |
| 44.0 | 5.12 | 208.52 | 56.56 | 265.08 | 265.08 | 265.08 | 51.77 |
| 45.0 | 5.24 | 214.50 | 56.56 | 271.06 | 271.06 | 271.06 | 51.76 |
| 46.0 | 5.35 | 220.92 | 56.56 | 277.48 | 277.48 | 277.48 | 51.84 |
| 47.0 | 5.47 | 227.35 | 56.56 | 283.90 | 283.90 | 283.90 | 51.91 |
| 48.0 | 5.59 | 233.77 | 56.56 | 290.33 | 290.33 | 290.33 | 51.98 |
| 49.0 | 5.70 | 240.19 | 56.56 | 296.75 | 296.75 | 296.75 | 52.04 |
| 50.0 | 5.82 | 246.61 | 56.56 | 303.17 | 303.17 | 303.17 | 52.10 |
| 51.0 | 5.93 | 253.04 | 56.56 | 309.59 | 309.59 | 309.59 | 52.16 |
| 52.0 | 6.05 | 259.46 | 56.56 | 316.02 | 316.02 | 316.02 | 52.22 |
| 53.0 | 6.17 | 265.88 | 56.56 | 322.44 | 322.44 | 322.44 | 52.28 |
| 54.0 | 6.28 | 272.31 | 56.56 | 328.86 | 328.86 | 328.86 | 52.33 |
| 55.0 | 6.40 | 278.73 | 56.56 | 335.28 | 335.28 | 335.28 | 52.39 |
| 56.0 | 6.52 | 285.15 | 56.56 | 341.71 | 341.71 | 341.71 | 52.44 |
| 57.0 | 6.63 | 291.57 | 56.56 | 348.13 | 348.13 | 348.13 | 52.48 |
| 58.0 | 6.75 | 298.00 | 56.56 | 354.55 | 354.55 | 354.55 | 52.53 |
| 59.0 | 6.87 | 304.42 | 56.56 | 360.97 | 360.97 | 360.97 | 52.58 |
| 60.0 | 6.98 | 310.84 | 56.56 | 367.40 | 367.40 | 367.40 | 52.62 |
| 61.0 | 7.10 | 317.26 | 56.56 | 373.82 | 373.82 | 373.82 | 52.66 |
| 62.0 | 7.21 | 323.69 | 56.56 | 380.24 | 380.24 | 380.24 | 52.70 |
| 63.0 | 7.33 | 330.11 | 56.56 | 386.67 | 386.67 | 386.67 | 52.74 |
| 64.0 | 7.45 | 336.53 | 56.56 | 393.09 | 393.09 | 393.09 | 52.78 |
| 65.0 | 7.56 | 342.96 | 56.56 | 399.51 | 399.51 | 399.51 | 52.82 |
| 66.0 | 7.68 | 349.38 | 56.56 | 405.93 | 405.93 | 405.93 | 52.85 |
| 67.0 | 7.80 | 355.80 | 56.56 | 412.36 | 412.36 | 412.36 | 52.89 |
| 68.0 | 7.91 | 362.22 | 56.56 | 418.78 | 418.78 | 418.78 | 52.92 |
| 69.0 | 8.03 | 368.65 | 56.56 | 425.20 | 425.20 | 425.20 | 52.95 |
| 70.0 | 8.15 | 375.07 | 56.56 | 431.62 | 431.62 | 431.62 | 52.99 |
| 71.0 | 8.26 | 381.49 | 56.56 | 438.05 | 438.05 | 438.05 | 53.02 |
| 72.0 | 8.38 | 387.91 | 56.56 | 444.47 | 444.47 | 444.47 | 53.05 |
| 73.0 | 8.50 | 394.34 | 56.56 | 450.89 | 450.89 | 450.89 | 53.08 |
| 74.0 | 8.61 | 400.76 | 56.56 | 457.32 | 457.32 | 457.32 | 53.11 |
| 75.0 | 8.73 | 407.18 | 56.56 | 463.74 | 463.74 | 463.74 | 53.13 |
| 76.0 | 8.84 | 413.60 | 56.56 | 470.16 | 470.16 | 470.16 | 53.16 |
| 77.0 | 8.96 | 420.03 | 56.56 | 476.58 | 476.58 | 476.58 | 53.19 |
| 78.0 | 9.08 | 426.45 | 56.56 | 483.01 | 483.01 | 483.01 | 53.21 |
| 79.0 | 9.19 | 432.87 | 56.56 | 489.43 | 489.43 | 489.43 | 53.24 |
| 80.0 | 9.31 | 439.30 | 56.56 | 495.85 | 495.85 | 495.85 | 53.26 |
| 81.0 | 9.43 | 445.72 | 56.56 | 502.27 | 502.27 | 502.27 | 53.29 |
| 82.0 | 9.54 | 452.14 | 56.56 | 508.70 | 508.70 | 508.70 | 53.31 |
| 83.0 | 9.66 | 458.56 | 56.56 | 515.12 | 515.12 | 515.12 | 53.33 |
| 84.0 | 9.78 | 464.99 | 56.56 | 521.54 | 521.54 | 521.54 | 53.35 |
| 85.0 | 9.89 | 471.41 | 56.56 | 527.97 | 527.97 | 527.97 | 53.38 |
| 86.0 | 10.01 | 477.83 | 56.56 | 534.39 | 534.39 | 534.39 | 53.40 |
| 87.0 | 10.12 | 484.25 | 56.56 | 540.81 | 540.81 | 540.81 | 53.42 |
| 88.0 | 10.24 | 490.68 | 56.56 | 547.23 | 547.23 | 547.23 | 53.44 |
| 89.0 | 10.36 | 497.10 | 56.56 | 553.66 | 553.66 | 553.66 | 53.46 |
| 90.0 | 10.47 | 503.52 | 56.56 | 560.08 | 560.08 | 560.08 | 53.48 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.3873E+00 | 0.2118E-03 | 0.8248E-03 | 0.1000E-04 |
| 0.1936E+01 | 0.1059E-02 | 0.4124E-02 | 0.5000E-04 |

| | | | |
|---|---|---|---|
| 0.3873E+01 | 0.2118E-02 | 0.8248E-02 | 0.1000E-03 |
| 0.1716E+03 | 0.1021E+00 | 0.4124E+00 | 0.5000E-02 |
| 0.2272E+03 | 0.1437E+00 | 0.6186E+00 | 0.7500E-02 |
| 0.2682E+03 | 0.1778E+00 | 0.8248E+00 | 0.1000E-01 |
| 0.3896E+03 | 0.3010E+00 | 0.2062E+01 | 0.2500E-01 |
| 0.4522E+03 | 0.3908E+00 | 0.4124E+01 | 0.5000E-01 |
| 0.4764E+03 | 0.4439E+00 | 0.6186E+01 | 0.7500E-01 |
| 0.4829E+03 | 0.4763E+00 | 0.8248E+01 | 0.1000E+00 |
| 0.4929E+03 | 0.6423E+00 | 0.2017E+02 | 0.2500E+00 |
| 0.4791E+03 | 0.8817E+00 | 0.3254E+02 | 0.5000E+00 |
| 0.4836E+03 | 0.1013E+01 | 0.3726E+02 | 0.6250E+00 |
| 0.4897E+03 | 0.1178E+01 | 0.4345E+02 | 0.7813E+00 |
| 0.5031E+03 | 0.1616E+01 | 0.5740E+02 | 0.1200E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.8563E+00 | 0.4169E-03 | 0.1178E-02 | 0.1000E-04 |
| 0.4282E+01 | 0.2085E-02 | 0.5891E-02 | 0.5000E-04 |
| 0.8563E+01 | 0.4169E-02 | 0.1178E-01 | 0.1000E-03 |
| 0.2880E+03 | 0.1750E+00 | 0.5891E+00 | 0.5000E-02 |
| 0.3443E+03 | 0.2260E+00 | 0.8837E+00 | 0.7500E-02 |
| 0.3810E+03 | 0.2637E+00 | 0.1178E+01 | 0.1000E-01 |
| 0.4704E+03 | 0.3769E+00 | 0.2946E+01 | 0.2500E-01 |
| 0.5000E+03 | 0.4369E+00 | 0.5891E+01 | 0.5000E-01 |
| 0.5106E+03 | 0.4748E+00 | 0.8837E+01 | 0.7500E-01 |
| 0.5174E+03 | 0.5085E+00 | 0.1178E+02 | 0.1000E+00 |
| 0.5294E+03 | 0.6779E+00 | 0.2804E+02 | 0.2500E+00 |
| 0.5207E+03 | 0.9225E+00 | 0.4086E+02 | 0.5000E+00 |
| 0.5237E+03 | 0.1052E+01 | 0.4393E+02 | 0.6250E+00 |
| 0.5291E+03 | 0.1215E+01 | 0.4924E+02 | 0.7813E+00 |
| 0.5409E+03 | 0.1651E+01 | 0.6108E+02 | 0.1200E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1416E+00 | 0.9238E-04 | 0.4713E-03 | 0.1000E-04 |
| 0.7079E+00 | 0.4619E-03 | 0.2357E-02 | 0.5000E-04 |
| 0.1416E+01 | 0.9238E-03 | 0.4713E-02 | 0.1000E-03 |
| 0.7082E+02 | 0.4649E-01 | 0.2357E+00 | 0.5000E-02 |
| 0.1033E+03 | 0.6905E-01 | 0.3535E+00 | 0.7500E-02 |
| 0.1331E+03 | 0.9074E-01 | 0.4713E+00 | 0.1000E-01 |
| 0.2634E+03 | 0.1987E+00 | 0.1178E+01 | 0.2500E-01 |
| 0.3741E+03 | 0.3179E+00 | 0.2357E+01 | 0.5000E-01 |
| 0.4213E+03 | 0.3896E+00 | 0.3535E+01 | 0.7500E-01 |
| 0.4423E+03 | 0.4368E+00 | 0.4713E+01 | 0.1000E+00 |
| 0.4551E+03 | 0.6056E+00 | 0.1230E+02 | 0.2500E+00 |
| 0.4375E+03 | 0.8409E+00 | 0.2422E+02 | 0.5000E+00 |
| 0.4436E+03 | 0.9746E+00 | 0.3059E+02 | 0.6250E+00 |
| 0.4503E+03 | 0.1141E+01 | 0.3766E+02 | 0.7813E+00 |
| 0.4654E+03 | 0.1581E+01 | 0.5373E+02 | 0.1200E+01 |

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

5th Street Bridge, Abut 11, 24" CIDH, LQ (comp)

PROPOSED DEPTH = 90.0 FT
---

NUMBER OF LAYERS = 7
---

WATER TABLE DEPTH = 17.0 FT.
---

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00
---
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00
---

SOIL INFORMATION
---

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.107E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.107E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.977E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.110E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.150E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.977E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.150E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.943E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.170E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.170E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+03
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.105E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.350E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.701E+00

UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.350E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.594E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.450E+02

LAYER NO 6----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.450E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.511E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.115E+03

LAYER NO 7----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.115E+03

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11

DEPTH, FT = 0.167E+03

DRILLED SHAFT INFORMATION
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DIAMETER OF STEM = 2.000 FT.
DIAMETER OF BASE = 2.000 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 3.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 4.524 SQ.IN.
ELASTIC MODULUS, Ec = 0.342E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS
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QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

| LENGTH (FEET) | VOLUME (CU.YDS) | QS (TONS) | QB (TONS) | QU (TONS) | QBD (TONS) | QDN (TONS) | QU/VOLUME (TONS/CU.YDS) |
|---|---|---|---|---|---|---|---|
| 4.0 | 0.47 | 1.30 | 5.99 | 7.29 | 7.29 | 7.29 | 16.49 |
| 5.0 | 0.58 | 3.73 | 6.82 | 10.55 | 10.55 | 10.55 | 18.14 |
| 6.0 | 0.70 | 6.15 | 7.66 | 13.82 | 13.82 | 13.82 | 19.79 |
| 7.0 | 0.81 | 8.92 | 5.21 | 14.13 | 14.13 | 14.13 | 17.34 |
| 8.0 | 0.93 | 12.01 | 1.80 | 13.81 | 13.81 | 13.81 | 14.83 |
| 9.0 | 1.05 | 15.42 | 0.00 | 15.42 | 15.42 | 15.42 | 14.72 |
| 10.0 | 1.16 | 19.13 | 0.00 | 19.13 | 19.13 | 19.13 | 16.44 |
| 11.0 | 1.28 | 23.13 | 0.00 | 23.13 | 23.13 | 23.13 | 18.07 |
| 12.0 | 1.40 | 27.41 | 0.00 | 27.41 | 27.41 | 27.41 | 19.63 |
| 13.0 | 1.51 | 31.96 | 0.00 | 31.96 | 31.96 | 31.96 | 21.13 |
| 14.0 | 1.63 | 36.77 | 2.02 | 38.79 | 38.79 | 38.79 | 23.81 |
| 15.0 | 1.75 | 41.84 | 4.44 | 46.28 | 46.28 | 46.28 | 26.52 |
| 16.0 | 1.86 | 47.13 | 5.66 | 52.79 | 52.79 | 52.79 | 28.35 |
| 17.0 | 1.98 | 52.65 | 5.66 | 58.30 | 58.30 | 58.30 | 29.47 |
| 18.0 | 2.09 | 53.34 | 5.66 | 58.99 | 58.99 | 58.99 | 28.16 |
| 19.0 | 2.21 | 54.03 | 5.66 | 59.69 | 59.69 | 59.69 | 26.99 |
| 20.0 | 2.33 | 54.72 | 5.66 | 60.38 | 60.38 | 60.38 | 25.94 |
| 21.0 | 2.44 | 55.41 | 5.66 | 61.07 | 61.07 | 61.07 | 24.99 |
| 22.0 | 2.56 | 56.10 | 5.66 | 61.76 | 61.76 | 61.76 | 24.12 |
| 23.0 | 2.68 | 56.79 | 5.66 | 62.45 | 62.45 | 62.45 | 23.33 |
| 24.0 | 2.79 | 57.49 | 5.66 | 63.14 | 63.14 | 63.14 | 22.61 |
| 25.0 | 2.91 | 58.18 | 5.66 | 63.83 | 63.83 | 63.83 | 21.94 |
| 26.0 | 3.03 | 58.87 | 5.66 | 64.52 | 64.52 | 64.52 | 21.33 |
| 27.0 | 3.14 | 59.56 | 5.66 | 65.22 | 65.22 | 65.22 | 20.76 |
| 28.0 | 3.26 | 60.25 | 5.66 | 65.91 | 65.91 | 65.91 | 20.23 |
| 29.0 | 3.37 | 60.94 | 5.66 | 66.60 | 66.60 | 66.60 | 19.73 |
| 30.0 | 3.49 | 61.63 | 5.66 | 67.29 | 67.29 | 67.29 | 19.27 |
| 31.0 | 3.61 | 62.32 | 5.66 | 67.98 | 67.98 | 67.98 | 18.84 |
| 32.0 | 3.72 | 63.02 | 9.62 | 72.64 | 72.64 | 72.64 | 19.51 |
| 33.0 | 3.84 | 63.71 | 14.38 | 78.09 | 78.09 | 78.09 | 20.33 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 34.0 | 3.96 | 64.40 | 16.76 | 81.16 | 81.16 | 81.16 | 20.51 |
| 35.0 | 4.07 | 65.09 | 16.76 | 81.85 | 81.85 | 81.85 | 20.10 |
| 36.0 | 4.19 | 70.91 | 16.76 | 87.67 | 87.67 | 87.67 | 20.93 |
| 37.0 | 4.31 | 76.76 | 16.76 | 93.52 | 93.52 | 93.52 | 21.72 |
| 38.0 | 4.42 | 82.63 | 16.76 | 99.39 | 99.39 | 99.39 | 22.48 |
| 39.0 | 4.54 | 88.53 | 16.76 | 105.29 | 105.29 | 105.29 | 23.20 |
| 40.0 | 4.65 | 94.45 | 16.76 | 111.21 | 111.21 | 111.21 | 23.89 |
| 41.0 | 4.77 | 100.38 | 16.76 | 117.14 | 117.14 | 117.14 | 24.55 |
| 42.0 | 4.89 | 106.33 | 30.97 | 137.31 | 137.31 | 137.31 | 28.09 |
| 43.0 | 5.00 | 112.30 | 48.03 | 160.33 | 160.33 | 160.33 | 32.04 |
| 44.0 | 5.12 | 118.27 | 56.56 | 174.83 | 174.83 | 174.83 | 34.14 |
| 45.0 | 5.24 | 124.25 | 56.56 | 180.81 | 180.81 | 180.81 | 34.53 |
| 46.0 | 5.35 | 130.68 | 56.56 | 187.23 | 187.23 | 187.23 | 34.98 |
| 47.0 | 5.47 | 137.10 | 56.56 | 193.65 | 193.65 | 193.65 | 35.41 |
| 48.0 | 5.59 | 143.52 | 56.56 | 200.08 | 200.08 | 200.08 | 35.82 |
| 49.0 | 5.70 | 149.94 | 56.56 | 206.50 | 206.50 | 206.50 | 36.21 |
| 50.0 | 5.82 | 156.37 | 56.56 | 212.92 | 212.92 | 212.92 | 36.59 |
| 51.0 | 5.93 | 162.79 | 56.56 | 219.35 | 219.35 | 219.35 | 36.96 |
| 52.0 | 6.05 | 169.21 | 56.56 | 225.77 | 225.77 | 225.77 | 37.31 |
| 53.0 | 6.17 | 175.63 | 56.56 | 232.19 | 232.19 | 232.19 | 37.65 |
| 54.0 | 6.28 | 182.06 | 56.56 | 238.61 | 238.61 | 238.61 | 37.97 |
| 55.0 | 6.40 | 188.48 | 56.56 | 245.04 | 245.04 | 245.04 | 38.28 |
| 56.0 | 6.52 | 194.90 | 56.56 | 251.46 | 251.46 | 251.46 | 38.59 |
| 57.0 | 6.63 | 201.33 | 56.56 | 257.88 | 257.88 | 257.88 | 38.88 |
| 58.0 | 6.75 | 207.75 | 56.56 | 264.30 | 264.30 | 264.30 | 39.16 |
| 59.0 | 6.87 | 214.17 | 56.56 | 270.73 | 270.73 | 270.73 | 39.43 |
| 60.0 | 6.98 | 220.59 | 56.56 | 277.15 | 277.15 | 277.15 | 39.69 |
| 61.0 | 7.10 | 227.02 | 56.56 | 283.57 | 283.57 | 283.57 | 39.95 |
| 62.0 | 7.21 | 233.44 | 56.56 | 290.00 | 290.00 | 290.00 | 40.19 |
| 63.0 | 7.33 | 239.86 | 56.56 | 296.42 | 296.42 | 296.42 | 40.43 |
| 64.0 | 7.45 | 246.28 | 56.56 | 302.84 | 302.84 | 302.84 | 40.66 |
| 65.0 | 7.56 | 252.71 | 56.56 | 309.26 | 309.26 | 309.26 | 40.89 |
| 66.0 | 7.68 | 259.13 | 56.56 | 315.69 | 315.69 | 315.69 | 41.10 |
| 67.0 | 7.80 | 265.55 | 56.56 | 322.11 | 322.11 | 322.11 | 41.31 |
| 68.0 | 7.91 | 271.98 | 56.56 | 328.53 | 328.53 | 328.53 | 41.52 |
| 69.0 | 8.03 | 278.40 | 56.56 | 334.95 | 334.95 | 334.95 | 41.72 |
| 70.0 | 8.15 | 284.82 | 56.56 | 341.38 | 341.38 | 341.38 | 41.91 |
| 71.0 | 8.26 | 291.24 | 56.56 | 347.80 | 347.80 | 347.80 | 42.09 |
| 72.0 | 8.38 | 297.67 | 56.56 | 354.22 | 354.22 | 354.22 | 42.28 |
| 73.0 | 8.50 | 304.09 | 56.56 | 360.64 | 360.64 | 360.64 | 42.45 |
| 74.0 | 8.61 | 310.51 | 56.56 | 367.07 | 367.07 | 367.07 | 42.63 |
| 75.0 | 8.73 | 316.93 | 56.56 | 373.49 | 373.49 | 373.49 | 42.79 |
| 76.0 | 8.84 | 323.36 | 56.56 | 379.91 | 379.91 | 379.91 | 42.96 |
| 77.0 | 8.96 | 329.78 | 56.56 | 386.34 | 386.34 | 386.34 | 43.12 |
| 78.0 | 9.08 | 336.20 | 56.56 | 392.76 | 392.76 | 392.76 | 43.27 |
| 79.0 | 9.19 | 342.62 | 56.56 | 399.18 | 399.18 | 399.18 | 43.42 |
| 80.0 | 9.31 | 349.05 | 56.56 | 405.60 | 405.60 | 405.60 | 43.57 |
| 81.0 | 9.43 | 355.47 | 56.56 | 412.03 | 412.03 | 412.03 | 43.71 |
| 82.0 | 9.54 | 361.89 | 56.56 | 418.45 | 418.45 | 418.45 | 43.85 |
| 83.0 | 9.66 | 368.32 | 56.56 | 424.87 | 424.87 | 424.87 | 43.99 |
| 84.0 | 9.78 | 374.74 | 56.56 | 431.29 | 431.29 | 431.29 | 44.12 |
| 85.0 | 9.89 | 381.16 | 56.56 | 437.72 | 437.72 | 437.72 | 44.25 |
| 86.0 | 10.01 | 387.58 | 56.56 | 444.14 | 444.14 | 444.14 | 44.38 |
| 87.0 | 10.12 | 394.01 | 56.56 | 450.56 | 450.56 | 450.56 | 44.50 |
| 88.0 | 10.24 | 400.43 | 56.56 | 456.99 | 456.99 | 456.99 | 44.62 |
| 89.0 | 10.36 | 406.85 | 56.56 | 463.41 | 463.41 | 463.41 | 44.74 |
| 90.0 | 10.47 | 413.27 | 56.56 | 469.83 | 469.83 | 469.83 | 44.86 |

RESULT FROM TREND (AVERAGED) LINE

| TOP LOAD | TOP MOVEMENT | TIP LOAD | TIP MOVEMENT |
|---|---|---|---|
| ton | IN. | ton | IN. |
| 0.2708E+00 | 0.1697E-03 | 0.8248E-03 | 0.1000E-04 |
| 0.1354E+01 | 0.8484E-03 | 0.4124E-02 | 0.5000E-04 |

| | | | |
|---|---|---|---|
| 0.2708E+01 | 0.1697E-02 | 0.8248E-02 | 0.1000E-03 |
| 0.1232E+03 | 0.8330E-01 | 0.4124E+00 | 0.5000E-02 |
| 0.1668E+03 | 0.1198E+00 | 0.6186E+00 | 0.7500E-02 |
| 0.2011E+03 | 0.1509E+00 | 0.8248E+00 | 0.1000E-01 |
| 0.3073E+03 | 0.2674E+00 | 0.2062E+01 | 0.2500E-01 |
| 0.3662E+03 | 0.3554E+00 | 0.4124E+01 | 0.5000E-01 |
| 0.3896E+03 | 0.4081E+00 | 0.6186E+01 | 0.7500E-01 |
| 0.3958E+03 | 0.4403E+00 | 0.8248E+01 | 0.1000E+00 |
| 0.4052E+03 | 0.6061E+00 | 0.2017E+02 | 0.2500E+00 |
| 0.3912E+03 | 0.8455E+00 | 0.3254E+02 | 0.5000E+00 |
| 0.3958E+03 | 0.9770E+00 | 0.3726E+02 | 0.6250E+00 |
| 0.4019E+03 | 0.1142E+01 | 0.4345E+02 | 0.7813E+00 |
| 0.4156E+03 | 0.1580E+01 | 0.5740E+02 | 0.1200E+01 |

RESULT FROM UPPER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.5777E+00 | 0.3194E-03 | 0.1178E-02 | 0.1000E-04 |
| 0.2889E+01 | 0.1597E-02 | 0.5891E-02 | 0.5000E-04 |
| 0.5777E+01 | 0.3194E-02 | 0.1178E-01 | 0.1000E-03 |
| 0.2088E+03 | 0.1430E+00 | 0.5891E+00 | 0.5000E-02 |
| 0.2593E+03 | 0.1912E+00 | 0.8837E+00 | 0.7500E-02 |
| 0.2935E+03 | 0.2278E+00 | 0.1178E+01 | 0.1000E-01 |
| 0.3805E+03 | 0.3399E+00 | 0.2946E+01 | 0.2500E-01 |
| 0.4100E+03 | 0.3998E+00 | 0.5891E+01 | 0.5000E-01 |
| 0.4205E+03 | 0.4377E+00 | 0.8837E+01 | 0.7500E-01 |
| 0.4272E+03 | 0.4713E+00 | 0.1178E+02 | 0.1000E+00 |
| 0.4384E+03 | 0.6404E+00 | 0.2804E+02 | 0.2500E+00 |
| 0.4296E+03 | 0.8850E+00 | 0.4086E+02 | 0.5000E+00 |
| 0.4327E+03 | 0.1014E+01 | 0.4393E+02 | 0.6250E+00 |
| 0.4380E+03 | 0.1178E+01 | 0.4924E+02 | 0.7813E+00 |
| 0.4498E+03 | 0.1613E+01 | 0.6108E+02 | 0.1200E+01 |

RESULT FROM LOWER-BOUND LINE

| TOP LOAD ton | TOP MOVEMENT IN. | TIP LOAD ton | TIP MOVEMENT IN. |
|---|---|---|---|
| 0.1029E+00 | 0.7785E-04 | 0.4713E-03 | 0.1000E-04 |
| 0.5144E+00 | 0.3892E-03 | 0.2357E-02 | 0.5000E-04 |
| 0.1029E+01 | 0.7785E-03 | 0.4713E-02 | 0.1000E-03 |
| 0.5149E+02 | 0.3915E-01 | 0.2357E+00 | 0.5000E-02 |
| 0.7589E+02 | 0.5854E-01 | 0.3535E+00 | 0.7500E-02 |
| 0.9854E+02 | 0.7739E-01 | 0.4713E+00 | 0.1000E-01 |
| 0.2023E+03 | 0.1744E+00 | 0.1178E+01 | 0.2500E-01 |
| 0.2952E+03 | 0.2857E+00 | 0.2357E+01 | 0.5000E-01 |
| 0.3386E+03 | 0.3556E+00 | 0.3535E+01 | 0.7500E-01 |
| 0.3585E+03 | 0.4023E+00 | 0.4713E+01 | 0.1000E+00 |
| 0.3705E+03 | 0.5708E+00 | 0.1230E+02 | 0.2500E+00 |
| 0.3528E+03 | 0.8060E+00 | 0.2422E+02 | 0.5000E+00 |
| 0.3590E+03 | 0.9398E+00 | 0.3059E+02 | 0.6250E+00 |
| 0.3659E+03 | 0.1106E+01 | 0.3766E+02 | 0.7813E+00 |
| 0.3815E+03 | 0.1547E+01 | 0.5373E+02 | 0.1200E+01 |

## Driven Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 2nd Street OC (Replace) **Location:** Abut 1
**DONE BY:** TK **DATE:** 04/28/16 **CHECKED BY:** AZ **DATE:** 04/28/16

Finish Grade Elevation = 60 ft
Cut Off Elevation = 60 ft
Pile type: Class 200, 14" PPC
Pre-liquefaction Condition(only)

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.4 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 0 | Sand | 1.00 |
| (2) | 0 | 15 | Sand | 1.00 |
| (3) | 15 | 25 | Sand | 1.00 |
| (4) | 25 | 50 | Clay | 1.00 |
| (5) | 50 | 85 | Sand | 1.00 |
| (6) | 85 | 125 | Clay | 1.00 |
| (7) | 125 | 160 | Sand | 1.00 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 1.00
Axial Group Reduction Factor (η) for Clayey Materials= 1.00

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 60 ' for Liq. settlement=0.1"
0 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (kips) | End Bearing (kips) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 60 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 58 | 2 | 0 | 5 | 1.00 | 0 | 2 | **2** | 0 | 0 | 4 | **4** |
| 57 | 3 | 0 | 6 | 1.00 | 0 | 3 | **3** | 0 | 0 | 5 | **5** |
| 56 | 4 | 1 | 8 | 1.00 | 0 | 3 | **4** | 1 | 1 | 6 | **7** |
| 55 | 5 | 1 | 9 | 1.00 | 1 | 4 | **5** | 1 | 1 | 7 | **9** |
| 54 | 6 | 2 | 11 | 1.00 | 1 | 4 | **6** | 2 | 2 | 8 | **10** |
| 53 | 7 | 3 | 12 | 1.00 | 2 | 5 | **7** | 3 | 3 | 10 | **12** |
| 52 | 8 | 3 | 13 | 1.00 | 2 | 5 | **8** | 3 | 3 | 11 | **14** |
| 51 | 9 | 4 | 15 | 1.00 | 3 | 6 | **9** | 4 | 4 | 12 | **16** |
| 50 | 10 | 5 | 16 | 1.00 | 4 | 7 | **10** | 5 | 5 | 13 | **18** |
| 49 | 11 | 6 | 18 | 1.00 | 4 | 7 | **12** | 6 | 6 | 14 | **21** |
| 48 | 12 | 8 | 22 | 1.00 | 5 | 9 | **14** | 8 | 8 | 17 | **25** |
| 47 | 13 | 9 | 26 | 1.00 | 6 | 10 | **17** | 9 | 9 | 21 | **30** |
| 46 | 14 | 10 | 31 | 1.00 | 7 | 12 | **20** | 10 | 10 | 25 | **35** |
| 45 | 15 | 12 | 33 | 1.00 | 8 | 13 | **22** | 12 | 12 | 26 | **38** |
| 44 | 16 | 14 | 35 | 1.00 | 10 | 14 | **24** | 14 | 14 | 28 | **42** |
| 43 | 17 | 16 | 37 | 1.00 | 11 | 15 | **26** | 16 | 16 | 30 | **45** |
| 42 | 18 | 18 | 39 | 1.00 | 12 | 16 | **28** | 18 | 18 | 31 | **49** |
| 41 | 19 | 20 | 41 | 1.00 | 14 | 17 | **30** | 20 | 20 | 33 | **53** |
| 40 | 20 | 22 | 43 | 1.00 | 15 | 17 | **33** | 22 | 22 | 35 | **56** |
| 39 | 21 | 24 | 46 | 1.00 | 17 | 18 | **35** | 24 | 24 | 36 | **60** |
| 38 | 22 | 26 | 60 | 1.00 | 18 | 24 | **43** | 26 | 26 | 48 | **75** |
| 37 | 23 | 29 | 77 | 1.00 | 20 | 31 | **51** | 29 | 29 | 62 | **90** |
| 36 | 24 | 32 | 93 | 1.00 | 22 | 37 | **59** | 32 | 32 | 75 | **106** |
| 35 | 25 | 34 | 95 | 1.00 | 24 | 38 | **62** | 34 | 34 | 76 | **111** |
| 34 | 26 | 37 | 98 | 1.00 | 26 | 39 | **65** | 37 | 37 | 78 | **115** |
| 33 | 27 | 40 | 100 | 1.00 | 28 | 40 | **68** | 40 | 40 | 80 | **120** |
| 32 | 28 | 43 | 102 | 1.00 | 30 | 41 | **71** | 43 | 43 | 81 | **124** |
| 31 | 29 | 46 | 104 | 1.00 | 32 | 41 | **74** | 46 | 46 | 83 | **129** |
| 30 | 30 | 49 | 106 | 1.00 | 35 | 42 | **77** | 49 | 49 | 84 | **134** |
| 29 | 31 | 53 | 108 | 1.00 | 37 | 43 | **80** | 53 | 53 | 86 | **139** |
| 28 | 32 | 56 | 110 | 1.00 | 39 | 44 | **83** | 56 | 56 | 88 | **143** |
| 27 | 33 | 59 | 112 | 1.00 | 41 | 45 | **86** | 59 | 59 | 89 | **149** |
| 26 | 34 | 63 | 114 | 1.00 | 44 | 45 | **89** | 63 | 63 | 91 | **153** |
| 25 | 35 | 66 | 116 | 1.00 | 46 | 46 | **92** | 66 | 66 | 93 | **159** |
| 24 | 36 | 70 | 118 | 1.00 | 49 | 47 | **96** | 70 | 70 | 94 | **164** |
| 23 | 37 | 73 | 90 | 1.00 | 51 | 36 | **87** | 73 | 73 | 72 | **145** |
| 22 | 38 | 77 | 58 | 1.00 | 54 | 23 | **77** | 77 | 77 | 46 | **123** |
| 21 | 39 | 80 | 24 | 1.00 | 56 | 10 | **66** | 80 | 80 | 20 | **100** |
| 20 | 40 | 85 | 24 | 1.00 | 60 | 10 | **69** | 85 | 85 | 20 | **105** |
| 19 | 41 | 91 | 24 | 1.00 | 64 | 10 | **74** | 91 | 91 | 20 | **111** |
| 18 | 42 | 97 | 24 | 1.00 | 68 | 10 | **78** | 97 | 97 | 20 | **117** |
| 17 | 43 | 104 | 24 | 1.00 | 72 | 10 | **82** | 104 | 104 | 20 | **123** | Strength T. (62,66k) |
| 16 | 44 | 110 | 24 | 1.00 | 77 | 10 | **87** | 110 | 110 | 20 | **129** |
| 15 | 45 | 116 | 24 | 1.00 | 81 | 10 | **91** | 116 | 116 | 20 | **135** | Strength T. (78k) |
| 14 | 46 | 122 | 24 | 1.00 | 86 | 10 | **95** | 122 | 122 | 20 | **142** |
| 13 | 47 | 129 | 24 | 1.00 | 90 | 10 | **100** | 129 | 129 | 20 | **148** |
| 12 | 48 | 135 | 24 | 1.00 | 94 | 10 | **104** | 135 | 135 | 20 | **154** |
| 11 | 49 | 141 | 24 | 1.00 | 99 | 10 | **109** | 141 | 141 | 20 | **161** |
| 10 | 50 | 148 | 24 | 1.00 | 103 | 10 | **113** | 148 | 148 | 20 | **167** |
| 9 | 51 | 154 | 24 | 1.00 | 108 | 10 | **118** | 154 | 154 | 20 | **174** |
| 8 | 52 | 161 | 24 | 1.00 | 113 | 10 | **122** | 161 | 161 | 20 | **180** |
| 7 | 53 | 168 | 24 | 1.00 | 117 | 10 | **127** | 168 | 168 | 20 | **187** |
| 6 | 54 | 174 | 24 | 1.00 | 122 | 10 | **132** | 174 | 174 | 20 | **194** |
| 5 | 55 | 181 | 24 | 1.00 | 127 | 10 | **136** | 181 | 181 | 20 | **201** |
| 4 | 56 | 188 | 24 | 1.00 | 131 | 10 | **141** | 188 | 188 | 20 | **207** | Strength RW (140k) |
| 3 | 57 | 195 | 92 | 1.00 | 136 | 37 | **173** | 195 | 195 | 73 | **268** | use EL +4' |
| 2 | 58 | 201 | 168 | 1.00 | 141 | 67 | **208** | 201 | 201 | 134 | **336** | Extreme (300k) |
| 1 | 59 | 208 | 244 | 1.00 | 146 | 97 | **243** | 208 | 208 | 195 | **403** | Use El +0' |
| 0 | 60 | 214 | 244 | 1.00 | 150 | 97 | **248** | 214 | 214 | 195 | **409** |
| -1 | 61 | 220 | 244 | 1.00 | 154 | 97 | **251** | 220 | 220 | 195 | **415** |
| -2 | 62 | 225 | 244 | 1.00 | 158 | 97 | **255** | 225 | 225 | 195 | **420** |
| -3 | 63 | 231 | 244 | 1.00 | 161 | 97 | **259** | 231 | 231 | 195 | **425** |
| -4 | 64 | 236 | 244 | 1.00 | 165 | 97 | **263** | 236 | 236 | 195 | **431** | a1R Strength (263k) |
| -5 | 65 | 242 | 244 | 1.00 | 169 | 97 | **267** | 242 | 242 | 195 | **437** | a2R Strength (266k) |
| -6 | 66 | 247 | 244 | 1.00 | 173 | 97 | **271** | 247 | 247 | 195 | **442** |
| -7 | 67 | 253 | 244 | 1.00 | 177 | 97 | **275** | 253 | 253 | 195 | **448** |
| -8 | 68 | 259 | 244 | 1.00 | 181 | 97 | **279** | 259 | 259 | 195 | **454** | a1L Strength (276k) |
| -9 | 69 | 265 | 244 | 1.00 | 185 | 97 | **283** | 265 | 265 | 195 | **459** | a2L Strength (280k) |
| -10 | 70 | 270 | 244 | 1.00 | 189 | 97 | **287** | 270 | 270 | 195 | **465** |
| -11 | 71 | 276 | 244 | 1.00 | 193 | 97 | **291** | 276 | 276 | 195 | **471** |
| -12 | 72 | 282 | 244 | 1.00 | 198 | 97 | **295** | 282 | 282 | 195 | **477** |
| -13 | 73 | 289 | 244 | 1.00 | 202 | 97 | **299** | 289 | 289 | 195 | **483** |
| -14 | 74 | 295 | 244 | 1.00 | 206 | 97 | **304** | 295 | 295 | 195 | **490** |
| -15 | 75 | 301 | 244 | 1.00 | 211 | 97 | **308** | 301 | 301 | 195 | **496** |
| -16 | 76 | 307 | 244 | 1.00 | 215 | 97 | **313** | 307 | 307 | 195 | **502** |
| -17 | 77 | 314 | 244 | 1.00 | 220 | 97 | **317** | 314 | 314 | 195 | **509** |
| -18 | 78 | 320 | 244 | 1.00 | 224 | 97 | **322** | 320 | 320 | 195 | **515** |
| -19 | 79 | 327 | 244 | 1.00 | 229 | 97 | **326** | 327 | 327 | 195 | **522** |
| -20 | 80 | 333 | 244 | 1.00 | 233 | 97 | **331** | 333 | 333 | 195 | **528** |
| -21 | 81 | 340 | 244 | 1.00 | 238 | 97 | **335** | 340 | 340 | 195 | **535** |
| -22 | 82 | 347 | 244 | 1.00 | 243 | 97 | **340** | 347 | 347 | 195 | **542** |
| -23 | 83 | 354 | 244 | 1.00 | 247 | 97 | **345** | 354 | 354 | 195 | **548** |

## Driven Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 2nd Street OC (Replace) **Location:** Abut 1
**DONE BY:** TK **DATE:** 04/28/16 **CHECKED BY:** AZ **DATE:** 04/28/16

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -24 | 84 | 360 | 244 | 1.00 | 252 | 97 | **350** | 360 | 360 | 195 | **555** |
| -25 | 85 | 367 | 244 | 1.00 | 257 | 97 | **355** | 367 | 367 | 195 | **562** |
| -26 | 86 | 374 | 244 | 1.00 | 262 | 97 | **359** | 374 | 374 | 195 | **569** |
| -27 | 87 | 381 | 244 | 1.00 | 267 | 97 | **364** | 381 | 381 | 195 | **576** |
| -28 | 88 | 389 | 244 | 1.00 | 272 | 97 | **370** | 389 | 389 | 195 | **584** |
| -29 | 89 | 396 | 244 | 1.00 | 277 | 97 | **375** | 396 | 396 | 195 | **591** |
| -30 | 90 | 403 | 244 | 1.00 | 282 | 97 | **380** | 403 | 403 | 195 | **598** |
| -31 | 91 | 411 | 244 | 1.00 | 287 | 97 | **385** | 411 | 411 | 195 | **605** |
| -32 | 92 | 418 | 184 | 1.00 | 293 | 74 | **366** | 418 | 418 | 147 | **565** |
| -33 | 93 | 425 | 116 | 1.00 | 298 | 47 | **344** | 425 | 425 | 93 | **518** |
| -34 | 94 | 433 | 49 | 1.00 | 303 | 19 | **323** | 433 | 433 | 39 | **472** |
| -35 | 95 | 443 | 49 | 1.00 | 310 | 19 | **329** | 443 | 443 | 39 | **482** |
| -36 | 96 | 455 | 49 | 1.00 | 318 | 19 | **338** | 455 | 455 | 39 | **494** |
| -37 | 97 | 467 | 49 | 1.00 | 327 | 19 | **346** | 467 | 467 | 39 | **506** |
| -38 | 98 | 479 | 49 | 1.00 | 335 | 19 | **355** | 479 | 479 | 39 | **518** |
| -39 | 99 | 491 | 49 | 1.00 | 344 | 19 | **363** | 491 | 491 | 39 | **530** |
| -40 | 100 | 503 | 49 | 1.00 | 352 | 19 | **372** | 503 | 503 | 39 | **542** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Abut 1
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 74 ft
Cut Off Elevation = 74 ft
Pile type: 24'"-diameter CIDH
Pre-liquefaction Condition(only)

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.0 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 39 | Sand | 1.00 |
| (2) | 39 | 59 | Clay | 1.00 |
| (3) | 59 | 94 | Sand | 1.00 |
| (4) | 94 | 134 | Clay | 1.00 |
| (5) | 94 | 150 | sand | 1.00 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 1.00
Axial Group Reduction Factor (η) for Clayey Materials= 1.00
Reduction for top 20 feet casing= 0.40

Skin Resistance above neutral axis (refere (=>Pile Length)
minus @ Ele.= 74 ' for Liq. settlement=0.1"
0 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 74 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 70 | 4 | 1 | 0 | 0.40 | 1 | 0 | **1** | 1 | 1 | 0 | **1** | |
| 69 | 5 | 4 | 0 | 0.40 | 2 | 0 | **2** | 3 | 3 | 0 | **3** | |
| 68 | 6 | 6 | 0 | 0.40 | 3 | 0 | **3** | 5 | 5 | 0 | **5** | |
| 67 | 7 | 9 | 0 | 0.40 | 5 | 0 | **5** | 7 | 7 | 0 | **7** | |
| 66 | 8 | 11 | 0 | 0.40 | 6 | 0 | **6** | 9 | 9 | 0 | **9** | |
| 65 | 9 | 15 | 0 | 0.40 | 8 | 0 | **8** | 12 | 12 | 0 | **12** | |
| 64 | 10 | 18 | 0 | 0.40 | 10 | 0 | **10** | 15 | 15 | 0 | **15** | |
| 63 | 11 | 22 | 0 | 0.40 | 12 | 0 | **12** | 18 | 18 | 0 | **18** | |
| 62 | 12 | 26 | 0 | 0.40 | 15 | 0 | **15** | 21 | 21 | 0 | **21** | |
| 61 | 13 | 31 | 0 | 0.40 | 17 | 0 | **17** | 24 | 24 | 0 | **24** | |
| 60 | 14 | 35 | 0 | 0.40 | 20 | 0 | **20** | 28 | 28 | 0 | **28** | |
| 59 | 15 | 40 | 0 | 0.40 | 22 | 0 | **22** | 32 | 32 | 0 | **32** | |
| 58 | 16 | 45 | 0 | 0.40 | 25 | 0 | **25** | 36 | 36 | 0 | **36** | |
| 57 | 17 | 50 | 0 | 0.40 | 28 | 0 | **28** | 40 | 40 | 0 | **40** | |
| 56 | 18 | 56 | 0 | 0.40 | 31 | 0 | **31** | 45 | 45 | 0 | **45** | |
| 55 | 19 | 62 | 0 | 0.40 | 35 | 0 | **35** | 49 | 49 | 0 | **49** | |
| 54 | 20 | 68 | 0 | 0.40 | 38 | 0 | **38** | 54 | 54 | 0 | **54** | |
| 53 | 21 | 74 | 6 | 1.00 | 47 | 0 | **47** | 67 | 67 | 10 | **76** | |
| 52 | 22 | 80 | 13 | 1.00 | 56 | 0 | **56** | 79 | 79 | 21 | **100** | |
| 51 | 23 | 87 | 17 | 1.00 | 65 | 0 | **65** | 93 | 93 | 27 | **119** | |
| 50 | 24 | 94 | 17 | 1.00 | 74 | 0 | **74** | 106 | 106 | 27 | **133** | |
| 49 | 25 | 101 | 17 | 1.00 | 84 | 0 | **84** | 120 | 120 | 27 | **147** | |
| 48 | 26 | 107 | 17 | 1.00 | 93 | 0 | **93** | 133 | 133 | 27 | **160** | |
| 47 | 27 | 114 | 17 | 1.00 | 103 | 0 | **103** | 147 | 147 | 27 | **174** | |
| 46 | 28 | 121 | 17 | 1.00 | 113 | 0 | **113** | 161 | 161 | 27 | **188** | ?Extreme (200k)? |
| 45 | 29 | 128 | 17 | 1.00 | 122 | 0 | **122** | 175 | 175 | 27 | **202** | Use El +41' |
| 44 | 30 | 135 | 17 | 1.00 | 132 | 0 | **132** | 189 | 189 | 27 | **216** | |
| 43 | 31 | 142 | 17 | 1.00 | 142 | 0 | **142** | 203 | 203 | 27 | **230** | Strength RW (140k) |
| 42 | 32 | 149 | 17 | 1.00 | 152 | 0 | **152** | 217 | 217 | 27 | **244** | use EL +41' |
| 41 | 33 | 156 | 17 | 1.00 | 162 | 0 | **162** | 231 | 231 | 27 | **258** | |
| 40 | 34 | 163 | 17 | 1.00 | 172 | 0 | **172** | 245 | 245 | 27 | **272** | |
| 39 | 35 | 170 | 17 | 1.00 | 181 | 0 | **181** | 259 | 259 | 27 | **286** | |
| 38 | 36 | 177 | 21 | 1.00 | 191 | 0 | **191** | 273 | 273 | 33 | **307** | |
| 37 | 37 | 184 | 26 | 1.00 | 201 | 0 | **201** | 287 | 287 | 41 | **329** | |
| 36 | 38 | 191 | 28 | 1.00 | 211 | 0 | **211** | 302 | 302 | 45 | **347** | |
| 35 | 39 | 199 | 28 | 1.00 | 221 | 0 | **221** | 316 | 316 | 45 | **361** | |
| 34 | 40 | 202 | 28 | 1.00 | 226 | 0 | **226** | 323 | 323 | 45 | **368** | |
| 33 | 41 | 205 | 28 | 1.00 | 231 | 0 | **231** | 330 | 330 | 45 | **375** | |
| 32 | 42 | 209 | 28 | 1.00 | 236 | 0 | **236** | 337 | 337 | 45 | **382** | |
| 31 | 43 | 212 | 28 | 1.00 | 240 | 0 | **240** | 343 | 343 | 45 | **389** | |
| 30 | 44 | 216 | 28 | 1.00 | 245 | 0 | **245** | 350 | 350 | 45 | **396** | |
| 29 | 45 | 219 | 28 | 1.00 | 250 | 0 | **250** | 357 | 357 | 45 | **402** | |
| 28 | 46 | 223 | 28 | 1.00 | 255 | 0 | **255** | 364 | 364 | 45 | **409** | |
| 27 | 47 | 226 | 28 | 1.00 | 260 | 0 | **260** | 371 | 371 | 45 | **416** | |
| 26 | 48 | 230 | 28 | 1.00 | 265 | 0 | **265** | 378 | 378 | 45 | **423** | |
| 25 | 49 | 233 | 28 | 1.00 | 269 | 0 | **269** | 385 | 385 | 45 | **430** | Strength (267k) |
| 24 | 50 | 237 | 28 | 1.00 | 274 | 0 | **274** | 392 | 392 | 45 | **437** | use EL+23' |
| 23 | 51 | 240 | 28 | 1.00 | 279 | 0 | **279** | 399 | 399 | 45 | **444** | |
| 22 | 52 | 243 | 28 | 1.00 | 284 | 0 | **284** | 406 | 406 | 45 | **451** | |
| 21 | 53 | 247 | 28 | 1.00 | 289 | 0 | **289** | 413 | 413 | 45 | **458** | |
| 20 | 54 | 250 | 28 | 1.00 | 294 | 0 | **294** | 419 | 419 | 45 | **465** | |
| 19 | 55 | 254 | 28 | 1.00 | 298 | 0 | **298** | 426 | 426 | 45 | **472** | |
| 18 | 56 | 257 | 30 | 1.00 | 303 | 0 | **303** | 433 | 433 | 48 | **482** | |
| 17 | 57 | 261 | 32 | 1.00 | 308 | 0 | **308** | 440 | 440 | 52 | **492** | |
| 16 | 58 | 264 | 34 | 1.00 | 313 | 0 | **313** | 447 | 447 | 54 | **501** | |
| 15 | 59 | 268 | 34 | 1.00 | 318 | 0 | **318** | 454 | 454 | 54 | **508** | |
| 14 | 60 | 274 | 34 | 1.00 | 327 | 0 | **327** | 468 | 468 | 54 | **521** | |
| 13 | 61 | 281 | 34 | 1.00 | 337 | 0 | **337** | 481 | 481 | 54 | **535** | |
| 12 | 62 | 288 | 34 | 1.00 | 346 | 0 | **346** | 494 | 494 | 54 | **548** | |
| 11 | 63 | 295 | 34 | 1.00 | 355 | 0 | **355** | 508 | 508 | 54 | **561** | |
| 10 | 64 | 301 | 34 | 1.00 | 365 | 0 | **365** | 521 | 521 | 54 | **575** | |
| 9 | 65 | 308 | 34 | 1.00 | 374 | 0 | **374** | 534 | 534 | 54 | **588** | |
| 8 | 66 | 314 | 34 | 1.00 | 383 | 0 | **383** | 547 | 547 | 54 | **601** | |
| 7 | 67 | 321 | 34 | 1.00 | 392 | 0 | **392** | 560 | 560 | 54 | **613** | |
| 6 | 68 | 327 | 34 | 1.00 | 401 | 0 | **401** | 573 | 573 | 54 | **626** | |
| 5 | 69 | 333 | 34 | 1.00 | 410 | 0 | **410** | 585 | 585 | 54 | **639** | |
| 4 | 70 | 340 | 34 | 1.00 | 418 | 0 | **418** | 598 | 598 | 54 | **651** | |
| 3 | 71 | 346 | 34 | 1.00 | 427 | 0 | **427** | 610 | 610 | 54 | **664** | |
| 2 | 72 | 352 | 34 | 1.00 | 436 | 0 | **436** | 622 | 622 | 54 | **676** | |
| 1 | 73 | 358 | 34 | 1.00 | 444 | 0 | **444** | 635 | 635 | 54 | **688** | |
| 0 | 74 | 364 | 34 | 1.00 | 453 | 0 | **453** | 647 | 647 | 54 | **700** | |
| -1 | 75 | 370 | 34 | 1.00 | 461 | 0 | **461** | 658 | 658 | 54 | **712** | |
| -2 | 76 | 376 | 34 | 1.00 | 469 | 0 | **469** | 670 | 670 | 54 | **724** | |
| -3 | 77 | 381 | 34 | 1.00 | 477 | 0 | **477** | 682 | 682 | 54 | **735** | |
| -4 | 78 | 387 | 34 | 1.00 | 485 | 0 | **485** | 693 | 693 | 54 | **747** | |
| -5 | 79 | 393 | 34 | 1.00 | 493 | 0 | **493** | 704 | 704 | 54 | **758** | |
| -6 | 80 | 398 | 34 | 1.00 | 501 | 0 | **501** | 715 | 715 | 54 | **769** | |
| -7 | 81 | 404 | 34 | 1.00 | 508 | 0 | **508** | 726 | 726 | 54 | **780** | |
| -8 | 82 | 409 | 34 | 1.00 | 516 | 0 | **516** | 737 | 737 | 54 | **790** | |
| -9 | 83 | 414 | 34 | 1.00 | 523 | 0 | **523** | 747 | 747 | 54 | **801** | |
| -10 | 84 | 419 | 34 | 1.00 | 530 | 0 | **530** | 757 | 757 | 54 | **811** | |
| -11 | 85 | 424 | 34 | 1.00 | 537 | 0 | **537** | 768 | 768 | 54 | **821** | |
| -12 | 86 | 429 | 34 | 1.00 | 544 | 0 | **544** | 778 | 778 | 54 | **831** | |
| -13 | 87 | 435 | 34 | 1.00 | 551 | 0 | **551** | 788 | 788 | 54 | **841** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Abut 1
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -14 | 88 | 440 | 34 | 1.00 | 559 | 0 | **559** | 798 | 798 | 54 | **852** |
| -15 | 89 | 445 | 34 | 1.00 | 566 | 0 | **566** | 808 | 808 | 54 | **862** |
| | 90 | 450 | 34 | 1.00 | 573 | 0 | **573** | 819 | 819 | 54 | **872** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 2
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 18 ft
Cut Off Elevation = 13 ft

Pile type: 118'"-diameter CIDH

Pre-liquefaction Condition(only)

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 1 | Clay | 0.88 |
| (2) | 1 | 36 | Sand | 0.88 |
| (3) | 36 | 71 | Clay | 0.88 |
| (4) | 71 | 150 | sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (refere (=>Pile Length)
minus @ Ele.= 18 ' for Liq. settlement=0.1"
0 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 18 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 12 | 6 | 6 | 1215 | 0.88 | 7 | 428 | **435** | 10 | 10 | 1711 | **1722** | |
| 11 | 7 | 15 | 1215 | 0.88 | 18 | 428 | **446** | 26 | 26 | 1711 | **1737** | |
| 10 | 8 | 23 | 1215 | 0.88 | 29 | 428 | **456** | 41 | 41 | 1711 | **1752** | |
| 9 | 9 | 33 | 1215 | 0.88 | 40 | 428 | **468** | 58 | 58 | 1711 | **1769** | |
| 8 | 10 | 43 | 1215 | 0.88 | 53 | 428 | **481** | 76 | 76 | 1711 | **1787** | |
| 7 | 11 | 54 | 1215 | 0.88 | 67 | 428 | **495** | 96 | 96 | 1711 | **1807** | Extreme (1503k)* |
| 6 | 12 | 66 | 1215 | 0.88 | 82 | 428 | **509** | 117 | 117 | 1711 | **1828** | Use El +2' |
| 5 | 13 | 79 | 1215 | 0.88 | 97 | 428 | **525** | 139 | 139 | 1711 | **1850** | |
| 4 | 14 | 92 | 1215 | 0.88 | 114 | 428 | **542** | 163 | 163 | 1711 | **1874** | |
| 3 | 15 | 107 | 1215 | 0.88 | 131 | 428 | **559** | 188 | 188 | 1711 | **1899** | |
| 2 | 16 | 121 | 1215 | 0.88 | 150 | 428 | **577** | 214 | 214 | 1711 | **1925** | |
| 1 | 17 | 137 | 1215 | 0.88 | 169 | 428 | **597** | 241 | 241 | 1711 | **1952** | |
| 0 | 18 | 153 | 1195 | 0.88 | 189 | 420 | **609** | 270 | 270 | 1682 | **1951** | |
| -1 | 19 | 170 | 1173 | 0.88 | 209 | 413 | **622** | 299 | 299 | 1651 | **1950** | |
| -2 | 20 | 187 | 1150 | 0.88 | 231 | 405 | **635** | 330 | 330 | 1619 | **1948** | |
| -3 | 21 | 205 | 1126 | 0.88 | 253 | 396 | **649** | 361 | 361 | 1585 | **1946** | |
| -4 | 22 | 224 | 1101 | 0.88 | 275 | 388 | **663** | 393 | 393 | 1550 | **1944** | |
| -5 | 23 | 243 | 1075 | 0.88 | 299 | 378 | **677** | 427 | 427 | 1513 | **1940** | |
| -6 | 24 | 262 | 1048 | 0.88 | 323 | 369 | **692** | 461 | 461 | 1475 | **1936** | |
| -7 | 25 | 282 | 1020 | 0.88 | 347 | 359 | **706** | 496 | 496 | 1436 | **1932** | |
| -8 | 26 | 302 | 991 | 0.88 | 372 | 349 | **721** | 532 | 532 | 1395 | **1927** | |
| -9 | 27 | 323 | 963 | 0.88 | 398 | 339 | **737** | 569 | 569 | 1355 | **1924** | |
| -10 | 28 | 344 | 938 | 0.88 | 424 | 330 | **754** | 606 | 606 | 1320 | **1926** | |
| -11 | 29 | 366 | 916 | 0.88 | 451 | 322 | **773** | 644 | 644 | 1289 | **1934** | |
| -12 | 30 | 388 | 897 | 0.88 | 478 | 316 | **794** | 683 | 683 | 1263 | **1946** | |
| -13 | 31 | 411 | 881 | 0.88 | 506 | 310 | **816** | 723 | 723 | 1241 | **1964** | |
| -14 | 32 | 433 | 869 | 0.88 | 534 | 306 | **840** | 763 | 763 | 1223 | **1986** | |
| -15 | 33 | 457 | 860 | 0.88 | 562 | 303 | **865** | 803 | 803 | 1210 | **2014** | |
| -16 | 34 | 480 | 853 | 0.88 | 591 | 300 | **892** | 845 | 845 | 1201 | **2046** | |
| -17 | 35 | 504 | 850 | 0.88 | 621 | 299 | **920** | 887 | 887 | 1197 | **2084** | |
| -18 | 36 | 528 | 850 | 0.88 | 650 | 299 | **949** | 929 | 929 | 1197 | **2126** | |
| -19 | 37 | 559 | 850 | 0.88 | 689 | 299 | **988** | 984 | 984 | 1197 | **2181** | |
| -20 | 38 | 591 | 850 | 0.88 | 728 | 299 | **1027** | 1040 | 1040 | 1197 | **2237** | |
| -21 | 39 | 622 | 850 | 0.88 | 767 | 299 | **1066** | 1096 | 1096 | 1197 | **2293** | |
| -22 | 40 | 654 | 850 | 0.88 | 806 | 299 | **1105** | 1151 | 1151 | 1197 | **2348** | |
| -23 | 41 | 686 | 850 | 0.88 | 845 | 299 | **1144** | 1207 | 1207 | 1197 | **2404** | |
| -24 | 42 | 717 | 850 | 0.88 | 884 | 299 | **1183** | 1262 | 1262 | 1197 | **2459** | |
| -25 | 43 | 749 | 850 | 0.88 | 922 | 299 | **1222** | 1318 | 1318 | 1197 | **2515** | |
| -26 | 44 | 780 | 850 | 0.88 | 961 | 299 | **1261** | 1373 | 1373 | 1197 | **2570** | |
| -27 | 45 | 812 | 850 | 0.88 | 1000 | 299 | **1300** | 1429 | 1429 | 1197 | **2626** | |
| -28 | 46 | 844 | 850 | 0.88 | 1039 | 299 | **1338** | 1485 | 1485 | 1197 | **2682** | |
| -29 | 47 | 875 | 850 | 0.88 | 1078 | 299 | **1377** | 1540 | 1540 | 1197 | **2737** | |
| -30 | 48 | 907 | 850 | 0.88 | 1117 | 299 | **1416** | 1596 | 1596 | 1197 | **2793** | |
| -31 | 49 | 938 | 850 | 0.88 | 1156 | 299 | **1455** | 1651 | 1651 | 1197 | **2848** | |
| -32 | 50 | 970 | 850 | 0.88 | 1195 | 299 | **1494** | 1707 | 1707 | 1197 | **2904** | |
| -33 | 51 | 1001 | 850 | 0.88 | 1234 | 299 | **1533** | 1762 | 1762 | 1197 | **2959** | |
| -34 | 52 | 1033 | 850 | 0.88 | 1273 | 299 | **1572** | 1818 | 1818 | 1197 | **3015** | |
| -35 | 53 | 1065 | 913 | 0.88 | 1312 | 321 | **1633** | 1874 | 1874 | 1285 | **3158** | |
| -36 | 54 | 1096 | 978 | 0.88 | 1350 | 344 | **1695** | 1929 | 1929 | 1377 | **3306** | |
| -37 | 55 | 1128 | 1047 | 0.88 | 1389 | 368 | **1758** | 1985 | 1985 | 1474 | **3458** | |
| -38 | 56 | 1159 | 1118 | 0.88 | 1428 | 394 | **1822** | 2040 | 2040 | 1574 | **3615** | |
| -39 | 57 | 1191 | 1193 | 0.88 | 1467 | 420 | **1887** | 2096 | 2096 | 1680 | **3776** | |
| -40 | 58 | 1222 | 1271 | 0.88 | 1506 | 447 | **1953** | 2151 | 2151 | 1790 | **3941** | |
| -41 | 59 | 1254 | 1352 | 0.88 | 1545 | 476 | **2021** | 2207 | 2207 | 1904 | **4111** | |
| -42 | 60 | 1286 | 1436 | 0.88 | 1584 | 506 | **2089** | 2263 | 2263 | 2022 | **4285** | |
| -43 | 61 | 1317 | 1523 | 0.88 | 1623 | 536 | **2159** | 2318 | 2318 | 2145 | **4463** | |
| -44 | 62 | 1349 | 1608 | 0.88 | 1662 | 566 | **2228** | 2374 | 2374 | 2264 | **4637** | |
| -45 | 63 | 1380 | 1682 | 0.88 | 1701 | 592 | **2293** | 2429 | 2429 | 2369 | **4798** | |
| -46 | 64 | 1412 | 1748 | 0.88 | 1739 | 615 | **2355** | 2485 | 2485 | 2461 | **4946** | |
| -47 | 65 | 1443 | 1804 | 0.88 | 1778 | 635 | **2413** | 2541 | 2541 | 2540 | **5081** | |
| -48 | 66 | 1475 | 1851 | 0.88 | 1817 | 651 | **2469** | 2596 | 2596 | 2606 | **5202** | |
| -49 | 67 | 1507 | 1888 | 0.88 | 1856 | 665 | **2521** | 2652 | 2652 | 2659 | **5310** | |
| -50 | 68 | 1538 | 1916 | 0.88 | 1895 | 675 | **2570** | 2707 | 2707 | 2698 | **5405** | |
| -51 | 69 | 1570 | 1935 | 0.88 | 1934 | 681 | **2615** | 2763 | 2763 | 2724 | **5487** | |
| -52 | 70 | 1601 | 1944 | 0.88 | 1973 | 684 | **2657** | 2818 | 2818 | 2738 | **5556** | |
| -53 | 71 | 1633 | 1944 | 0.88 | 2012 | 684 | **2696** | 2874 | 2874 | 2738 | **5612** | |
| -54 | 72 | 1658 | 1944 | 0.88 | 2042 | 684 | **2727** | 2917 | 2917 | 2738 | **5655** | |
| -55 | 73 | 1682 | 1944 | 0.88 | 2072 | 684 | **2757** | 2961 | 2961 | 2738 | **5698** | |
| -56 | 74 | 1706 | 1944 | 0.88 | 2102 | 684 | **2787** | 3003 | 3003 | 2738 | **5741** | |
| -57 | 75 | 1731 | 1944 | 0.88 | 2132 | 684 | **2816** | 3046 | 3046 | 2738 | **5783** | |
| -58 | 76 | 1754 | 1944 | 0.88 | 2161 | 684 | **2846** | 3088 | 3088 | 2738 | **5825** | |
| -59 | 77 | 1778 | 1944 | 0.88 | 2191 | 684 | **2875** | 3129 | 3129 | 2738 | **5867** | |
| -60 | 78 | 1801 | 1944 | 0.88 | 2219 | 684 | **2904** | 3171 | 3171 | 2738 | **5908** | |
| -61 | 79 | 1825 | 1944 | 0.88 | 2248 | 684 | **2932** | 3211 | 3211 | 2738 | **5949** | |
| -62 | 80 | 1847 | 1944 | 0.88 | 2276 | 684 | **2960** | 3251 | 3251 | 2738 | **5989** | |
| -63 | 81 | 1870 | 1944 | 0.88 | 2304 | 684 | **2988** | 3291 | 3291 | 2738 | **6029** | |
| -64 | 82 | 1892 | 1944 | 0.88 | 2331 | 684 | **3016** | 3330 | 3330 | 2738 | **6068** | |
| -65 | 83 | 1914 | 1944 | 0.88 | 2358 | 684 | **3043** | 3369 | 3369 | 2738 | **6106** | |
| -66 | 84 | 1936 | 1944 | 0.88 | 2385 | 684 | **3069** | 3407 | 3407 | 2738 | **6144** | |
| -67 | 85 | 1957 | 1944 | 0.88 | 2411 | 684 | **3095** | 3444 | 3444 | 2738 | **6182** | |
| -68 | 86 | 1978 | 1944 | 0.88 | 2437 | 684 | **3121** | 3481 | 3481 | 2738 | **6219** | |
| -69 | 87 | 1999 | 1944 | 0.88 | 2463 | 684 | **3148** | 3519 | 3519 | 2738 | **6256** | |
| -70 | 88 | 2021 | 1944 | 0.88 | 2490 | 684 | **3174** | 3557 | 3557 | 2738 | **6295** | |
| -71 | 89 | 2043 | 1944 | 0.88 | 2517 | 684 | **3201** | 3595 | 3595 | 2738 | **6333** | |
| -72 | 90 | 2065 | 1944 | 0.88 | 2544 | 684 | **3228** | 3634 | 3634 | 2738 | **6372** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 2
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -73 | 91 | 2087 | 1944 | 0.88 | 2572 | 684 | **3256** | 3674 | 3674 | 2738 | **6411** | |
| -74 | 92 | 2110 | 1944 | 0.88 | 2600 | 684 | **3284** | 3714 | 3714 | 2738 | **6451** | |
| -75 | 93 | 2133 | 1944 | 0.88 | 2628 | 684 | **3312** | 3754 | 3754 | 2738 | **6492** | |
| -76 | 94 | 2156 | 1944 | 0.88 | 2656 | 684 | **3341** | 3795 | 3795 | 2738 | **6532** | |
| -77 | 95 | 2180 | 1944 | 0.88 | 2685 | 684 | **3370** | 3836 | 3836 | 2738 | **6574** | |
| -78 | 96 | 2203 | 1944 | 0.88 | 2714 | 684 | **3399** | 3878 | 3878 | 2738 | **6615** | |
| -79 | 97 | 2227 | 1944 | 0.88 | 2744 | 684 | **3428** | 3920 | 3920 | 2738 | **6657** | |
| -80 | 98 | 2251 | 1944 | 0.88 | 2774 | 684 | **3458** | 3962 | 3962 | 2738 | **6700** | |
| -81 | 99 | 2276 | 1944 | 0.88 | 2804 | 684 | **3488** | 4006 | 4006 | 2738 | **6743** | |
| -82 | 100 | 2301 | 1944 | 0.88 | 2834 | 684 | **3519** | 4049 | 4049 | 2738 | **6787** | |
| -83 | 101 | 2326 | 1944 | 0.88 | 2865 | 684 | **3550** | 4093 | 4093 | 2738 | **6831** | |
| -84 | 102 | 2351 | 1944 | 0.88 | 2896 | 684 | **3581** | 4137 | 4137 | 2738 | **6875** | |
| -85 | 103 | 2376 | 1944 | 0.88 | 2928 | 684 | **3612** | 4182 | 4182 | 2738 | **6920** | |
| -86 | 104 | 2402 | 1944 | 0.88 | 2959 | 684 | **3644** | 4228 | 4228 | 2738 | **6965** | |
| -87 | 105 | 2428 | 1944 | 0.88 | 2992 | 684 | **3676** | 4274 | 4274 | 2738 | **7011** | |
| -88 | 106 | 2454 | 1944 | 0.88 | 3024 | 684 | **3708** | 4320 | 4320 | 2738 | **7057** | |
| -89 | 107 | 2481 | 1944 | 0.88 | 3057 | 684 | **3741** | 4367 | 4367 | 2738 | **7104** | |
| -90 | 108 | 2508 | 1944 | 0.88 | 3090 | 684 | **3774** | 4414 | 4414 | 2738 | **7151** | |
| -91 | 109 | 2535 | 1944 | 0.88 | 3123 | 684 | **3807** | 4462 | 4462 | 2738 | **7199** | |
| -92 | 110 | 2562 | 1944 | 0.88 | 3157 | 684 | **3841** | 4510 | 4510 | 2738 | **7247** | |
| -93 | 111 | 2590 | 1944 | 0.88 | 3191 | 684 | **3875** | 4558 | 4558 | 2738 | **7296** | |
| -94 | 112 | 2618 | 1944 | 0.88 | 3225 | 684 | **3910** | 4607 | 4607 | 2738 | **7345** | |
| -95 | 113 | 2646 | 1944 | 0.88 | 3260 | 684 | **3944** | 4657 | 4657 | 2738 | **7394** | |
| -96 | 114 | 2674 | 1944 | 0.88 | 3295 | 684 | **3979** | 4707 | 4707 | 2738 | **7444** | |
| -97 | 115 | 2703 | 1944 | 0.88 | 3330 | 684 | **4014** | 4757 | 4757 | 2738 | **7495** | |
| -98 | 116 | 2732 | 1944 | 0.88 | 3366 | 684 | **4050** | 4808 | 4808 | 2738 | **7546** | |
| -99 | 117 | 2761 | 1944 | 0.88 | 3402 | 684 | **4086** | 4859 | 4859 | 2738 | **7597** | |
| -100 | 118 | 2790 | 1944 | 0.88 | 3438 | 684 | **4122** | 4911 | 4911 | 2738 | **7649** | Strength (4101k) |
| -101 | 119 | 2820 | 1944 | 0.88 | 3474 | 684 | **4159** | 4964 | 4964 | 2738 | **7701** | use EL-102' |
| -102 | 120 | 2850 | 1944 | 0.88 | 3511 | 684 | **4196** | 5016 | 5016 | 2738 | **7754** | |
| -103 | 121 | 2880 | 1944 | 0.88 | 3549 | 684 | **4233** | 5069 | 5069 | 2738 | **7807** | |
| -104 | 122 | 2911 | 1944 | 0.88 | 3586 | 684 | **4271** | 5123 | 5123 | 2738 | **7861** | |
| -105 | 123 | 2942 | 1944 | 0.88 | 3624 | 684 | **4308** | 5177 | 5177 | 2738 | **7915** | |
| -106 | 124 | 2973 | 1944 | 0.88 | 3662 | 684 | **4347** | 5232 | 5232 | 2738 | **7969** | |
| -107 | 125 | 3004 | 1944 | 0.88 | 3701 | 684 | **4385** | 5287 | 5287 | 2738 | **8024** | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 3
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 18 ft
Cut Off Elevation = 13 ft
Pile type: 118'"-diameter CIDH
Pre-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 13 | Sand | 0.88 |
| (2) | 13 | 28 | Sand | 0.88 |
| (3) | 28 | 68 | Clay | 0.88 |
| (4) | 68 | 150 | Sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 18 ' for Liq. settlement=0.1"
0 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 18 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 12 | 6 | 4 | 672 | 0.88 | 5 | 236 | **241** | 7 | 7 | 946 | **953** |
| 11 | 7 | 10 | 706 | 0.88 | 12 | 249 | **261** | 17 | 17 | 995 | **1012** |
| 10 | 8 | 16 | 741 | 0.88 | 19 | 261 | **280** | 28 | 28 | 1043 | **1071** |
| 9 | 9 | 22 | 769 | 0.88 | 27 | 271 | **298** | 39 | 39 | 1082 | **1121** |
| 8 | 10 | 29 | 794 | 0.88 | 36 | 280 | **316** | 52 | 52 | 1118 | **1170** |
| 7 | 11 | 37 | 813 | 0.88 | 45 | 286 | **332** | 65 | 65 | 1145 | **1210** |
| 6 | 12 | 45 | 824 | 0.88 | 56 | 290 | **346** | 79 | 79 | 1161 | **1240** |
| 5 | 13 | 54 | 829 | 0.88 | 66 | 292 | **358** | 95 | 95 | 1167 | **1262** |
| 4 | 14 | 63 | 833 | 0.88 | 78 | 293 | **371** | 111 | 111 | 1173 | **1284** |
| 3 | 15 | 73 | 838 | 0.88 | 90 | 295 | **385** | 129 | 129 | 1179 | **1308** |
| 2 | 16 | 84 | 842 | 0.88 | 104 | 296 | **400** | 148 | 148 | 1185 | **1333** |
| 1 | 17 | 95 | 846 | 0.88 | 118 | 298 | **415** | 168 | 168 | 1191 | **1359** |
| 0 | 18 | 108 | 849 | 0.88 | 132 | 299 | **431** | 189 | 189 | 1196 | **1385** |
| -1 | 19 | 120 | 853 | 0.88 | 148 | 300 | **448** | 211 | 211 | 1201 | **1412** |
| -2 | 20 | 133 | 855 | 0.88 | 164 | 301 | **465** | 235 | 235 | 1204 | **1439** |
| -3 | 21 | 147 | 857 | 0.88 | 181 | 302 | **483** | 259 | 259 | 1207 | **1466** |
| -4 | 22 | 162 | 858 | 0.88 | 199 | 302 | **501** | 284 | 284 | 1208 | **1493** |
| -5 | 23 | 176 | 859 | 0.88 | 217 | 302 | **520** | 311 | 311 | 1209 | **1520** |
| -6 | 24 | 192 | 859 | 0.88 | 236 | 302 | **539** | 338 | 338 | 1209 | **1547** |
| -7 | 25 | 208 | 858 | 0.88 | 256 | 302 | **558** | 366 | 366 | 1208 | **1574** |
| -8 | 26 | 224 | 857 | 0.88 | 276 | 302 | **578** | 394 | 394 | 1207 | **1601** |
| -9 | 27 | 241 | 856 | 0.88 | 297 | 301 | **598** | 424 | 424 | 1205 | **1629** |
| -10 | 28 | 258 | 854 | 0.88 | 318 | 301 | **619** | 454 | 454 | 1203 | **1657** |
| -11 | 29 | 290 | 853 | 0.88 | 357 | 300 | **657** | 510 | 510 | 1201 | **1710** |
| -12 | 30 | 321 | 852 | 0.88 | 396 | 300 | **696** | 565 | 565 | 1199 | **1765** |
| -13 | 31 | 353 | 851 | 0.88 | 435 | 300 | **734** | 621 | 621 | 1198 | **1819** |
| -14 | 32 | 384 | 851 | 0.88 | 474 | 299 | **773** | 676 | 676 | 1198 | **1874** |
| -15 | 33 | 416 | 850 | 0.88 | 512 | 299 | **812** | 732 | 732 | 1197 | **1929** |
| -16 | 34 | 448 | 850 | 0.88 | 551 | 299 | **851** | 788 | 788 | 1197 | **1985** |
| -17 | 35 | 479 | 850 | 0.88 | 590 | 299 | **889** | 843 | 843 | 1197 | **2040** |
| -18 | 36 | 511 | 850 | 0.88 | 629 | 299 | **928** | 899 | 899 | 1197 | **2096** |
| -19 | 37 | 542 | 850 | 0.88 | 668 | 299 | **967** | 954 | 954 | 1197 | **2151** |
| -20 | 38 | 574 | 850 | 0.88 | 707 | 299 | **1006** | 1010 | 1010 | 1197 | **2207** |
| -21 | 39 | 605 | 850 | 0.88 | 746 | 299 | **1045** | 1065 | 1065 | 1197 | **2263** |
| -22 | 40 | 637 | 850 | 0.88 | 785 | 299 | **1084** | 1121 | 1121 | 1197 | **2318** |
| -23 | 41 | 669 | 850 | 0.88 | 824 | 299 | **1123** | 1177 | 1177 | 1197 | **2374** |
| -24 | 42 | 700 | 850 | 0.88 | 863 | 299 | **1162** | 1232 | 1232 | 1197 | **2429** |
| -25 | 43 | 732 | 850 | 0.88 | 901 | 299 | **1201** | 1288 | 1288 | 1197 | **2485** |
| -26 | 44 | 763 | 850 | 0.88 | 940 | 299 | **1240** | 1343 | 1343 | 1197 | **2540** |
| -27 | 45 | 795 | 850 | 0.88 | 979 | 299 | **1279** | 1399 | 1399 | 1197 | **2596** |
| -28 | 46 | 826 | 850 | 0.88 | 1018 | 299 | **1317** | 1455 | 1455 | 1197 | **2652** |
| -29 | 47 | 858 | 850 | 0.88 | 1057 | 299 | **1356** | 1510 | 1510 | 1197 | **2707** |
| -30 | 48 | 890 | 850 | 0.88 | 1096 | 299 | **1395** | 1566 | 1566 | 1197 | **2763** |
| -31 | 49 | 921 | 850 | 0.88 | 1135 | 299 | **1434** | 1621 | 1621 | 1197 | **2818** |
| -32 | 50 | 953 | 913 | 0.88 | 1174 | 321 | **1495** | 1677 | 1677 | 1285 | **2962** |
| -33 | 51 | 984 | 978 | 0.88 | 1213 | 344 | **1557** | 1732 | 1732 | 1377 | **3109** |
| -34 | 52 | 1016 | 1047 | 0.88 | 1252 | 368 | **1620** | 1788 | 1788 | 1474 | **3262** |
| -35 | 53 | 1047 | 1118 | 0.88 | 1290 | 394 | **1684** | 1844 | 1844 | 1574 | **3418** |
| -36 | 54 | 1079 | 1193 | 0.88 | 1329 | 420 | **1749** | 1899 | 1899 | 1680 | **3579** |
| -37 | 55 | 1111 | 1271 | 0.88 | 1368 | 447 | **1816** | 1955 | 1955 | 1790 | **3744** |
| -38 | 56 | 1142 | 1352 | 0.88 | 1407 | 476 | **1883** | 2010 | 2010 | 1904 | **3914** |
| -39 | 57 | 1174 | 1436 | 0.88 | 1446 | 506 | **1952** | 2066 | 2066 | 2022 | **4088** |
| -40 | 58 | 1205 | 1523 | 0.88 | 1485 | 536 | **2021** | 2121 | 2121 | 2145 | **4266** |
| -41 | 59 | 1237 | 1608 | 0.88 | 1524 | 566 | **2090** | 2177 | 2177 | 2264 | **4441** |
| -42 | 60 | 1269 | 1682 | 0.88 | 1563 | 592 | **2155** | 2233 | 2233 | 2369 | **4601** |
| -43 | 61 | 1300 | 1748 | 0.88 | 1602 | 615 | **2217** | 2288 | 2288 | 2461 | **4749** |
| -44 | 62 | 1332 | 1804 | 0.88 | 1641 | 635 | **2276** | 2344 | 2344 | 2540 | **4884** |
| -45 | 63 | 1363 | 1851 | 0.88 | 1680 | 651 | **2331** | 2399 | 2399 | 2606 | **5005** |
| -46 | 64 | 1395 | 1888 | 0.88 | 1718 | 665 | **2383** | 2455 | 2455 | 2659 | **5113** |
| -47 | 65 | 1426 | 1916 | 0.88 | 1757 | 675 | **2432** | 2510 | 2510 | 2698 | **5208** |
| -48 | 66 | 1458 | 1935 | 0.88 | 1796 | 681 | **2477** | 2566 | 2566 | 2724 | **5290** |
| -49 | 67 | 1490 | 1944 | 0.88 | 1835 | 684 | **2520** | 2622 | 2622 | 2738 | **5359** |
| -50 | 68 | 1521 | 1944 | 0.88 | 1874 | 684 | **2558** | 2677 | 2677 | 2738 | **5415** |
| -51 | 69 | 1544 | 1944 | 0.88 | 1903 | 684 | **2587** | 2718 | 2718 | 2738 | **5456** |
| -52 | 70 | 1568 | 1944 | 0.88 | 1931 | 684 | **2616** | 2759 | 2759 | 2738 | **5497** |
| -53 | 71 | 1591 | 1944 | 0.88 | 1960 | 684 | **2644** | 2800 | 2800 | 2738 | **5537** |
| -54 | 72 | 1614 | 1944 | 0.88 | 1988 | 684 | **2673** | 2840 | 2840 | 2738 | **5578** |
| -55 | 73 | 1637 | 1944 | 0.88 | 2016 | 684 | **2701** | 2880 | 2880 | 2738 | **5618** |
| -56 | 74 | 1659 | 1944 | 0.88 | 2044 | 684 | **2728** | 2920 | 2920 | 2738 | **5658** |
| -57 | 75 | 1682 | 1944 | 0.88 | 2072 | 684 | **2756** | 2960 | 2960 | 2738 | **5697** |
| -58 | 76 | 1704 | 1944 | 0.88 | 2099 | 684 | **2784** | 2999 | 2999 | 2738 | **5736** |
| -59 | 77 | 1726 | 1944 | 0.88 | 2126 | 684 | **2811** | 3038 | 3038 | 2738 | **5775** |
| -60 | 78 | 1748 | 1944 | 0.88 | 2153 | 684 | **2838** | 3076 | 3076 | 2738 | **5814** |
| -61 | 79 | 1769 | 1944 | 0.88 | 2180 | 684 | **2864** | 3114 | 3114 | 2738 | **5852** |
| -62 | 80 | 1791 | 1944 | 0.88 | 2206 | 684 | **2891** | 3152 | 3152 | 2738 | **5889** |
| -63 | 81 | 1812 | 1944 | 0.88 | 2232 | 684 | **2917** | 3189 | 3189 | 2738 | **5927** |
| -64 | 82 | 1833 | 1944 | 0.88 | 2258 | 684 | **2942** | 3226 | 3226 | 2738 | **5963** |
| -65 | 83 | 1853 | 1944 | 0.88 | 2283 | 684 | **2968** | 3262 | 3262 | 2738 | **6000** |
| -66 | 84 | 1874 | 1944 | 0.88 | 2308 | 684 | **2993** | 3298 | 3298 | 2738 | **6035** |
| -67 | 85 | 1894 | 1944 | 0.88 | 2333 | 684 | **3017** | 3333 | 3333 | 2738 | **6071** |
| -68 | 86 | 1914 | 1944 | 0.88 | 2358 | 684 | **3042** | 3368 | 3368 | 2738 | **6105** |
| -69 | 87 | 1934 | 1944 | 0.88 | 2382 | 684 | **3067** | 3403 | 3403 | 2738 | **6141** |
| -70 | 88 | 1954 | 1944 | 0.88 | 2407 | 684 | **3092** | 3439 | 3439 | 2738 | **6177** |
| -71 | 89 | 1975 | 1944 | 0.88 | 2433 | 684 | **3117** | 3475 | 3475 | 2738 | **6213** |
| -72 | 90 | 1996 | 1944 | 0.88 | 2459 | 684 | **3143** | 3512 | 3512 | 2738 | **6250** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 3
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -73 | 91 | 2017 | 1944 | 0.88 | 2485 | 684 | **3169** | 3549 | 3549 | 2738 | **6287** | |
| -74 | 92 | 2038 | 1944 | 0.88 | 2511 | 684 | **3195** | 3587 | 3587 | 2738 | **6325** | |
| -75 | 93 | 2060 | 1944 | 0.88 | 2538 | 684 | **3222** | 3625 | 3625 | 2738 | **6363** | |
| -76 | 94 | 2082 | 1944 | 0.88 | 2565 | 684 | **3249** | 3664 | 3664 | 2738 | **6401** | |
| -77 | 95 | 2104 | 1944 | 0.88 | 2592 | 684 | **3276** | 3703 | 3703 | 2738 | **6441** | |
| -78 | 96 | 2126 | 1944 | 0.88 | 2620 | 684 | **3304** | 3742 | 3742 | 2738 | **6480** | |
| -79 | 97 | 2149 | 1944 | 0.88 | 2648 | 684 | **3332** | 3782 | 3782 | 2738 | **6520** | |
| -80 | 98 | 2172 | 1944 | 0.88 | 2676 | 684 | **3360** | 3823 | 3823 | 2738 | **6560** | |
| -81 | 99 | 2195 | 1944 | 0.88 | 2705 | 684 | **3389** | 3864 | 3864 | 2738 | **6601** | |
| -82 | 100 | 2219 | 1944 | 0.88 | 2734 | 684 | **3418** | 3905 | 3905 | 2738 | **6643** | |
| -83 | 101 | 2243 | 1944 | 0.88 | 2763 | 684 | **3447** | 3947 | 3947 | 2738 | **6685** | |
| -84 | 102 | 2267 | 1944 | 0.88 | 2792 | 684 | **3477** | 3989 | 3989 | 2738 | **6727** | |
| -85 | 103 | 2291 | 1944 | 0.88 | 2822 | 684 | **3507** | 4032 | 4032 | 2738 | **6770** | |
| -86 | 104 | 2315 | 1944 | 0.88 | 2853 | 684 | **3537** | 4075 | 4075 | 2738 | **6813** | |
| -87 | 105 | 2340 | 1944 | 0.88 | 2883 | 684 | **3568** | 4119 | 4119 | 2738 | **6856** | |
| -88 | 106 | 2365 | 1944 | 0.88 | 2914 | 684 | **3598** | 4163 | 4163 | 2738 | **6901** | |
| -89 | 107 | 2391 | 1944 | 0.88 | 2945 | 684 | **3630** | 4208 | 4208 | 2738 | **6945** | |
| -90 | 108 | 2416 | 1944 | 0.88 | 2977 | 684 | **3661** | 4253 | 4253 | 2738 | **6990** | |
| -91 | 109 | 2442 | 1944 | 0.88 | 3009 | 684 | **3693** | 4298 | 4298 | 2738 | **7036** | |
| -92 | 110 | 2468 | 1944 | 0.88 | 3041 | 684 | **3725** | 4344 | 4344 | 2738 | **7082** | |
| -93 | 111 | 2495 | 1944 | 0.88 | 3073 | 684 | **3758** | 4390 | 4390 | 2738 | **7128** | |
| -94 | 112 | 2521 | 1944 | 0.88 | 3106 | 684 | **3791** | 4437 | 4437 | 2738 | **7175** | |
| -95 | 113 | 2548 | 1944 | 0.88 | 3139 | 684 | **3824** | 4485 | 4485 | 2738 | **7222** | |
| -96 | 114 | 2575 | 1944 | 0.88 | 3173 | 684 | **3857** | 4532 | 4532 | 2738 | **7270** | |
| -97 | 115 | 2603 | 1944 | 0.88 | 3206 | 684 | **3891** | 4581 | 4581 | 2738 | **7318** | |
| -98 | 116 | 2630 | 1944 | 0.88 | 3241 | 684 | **3925** | 4629 | 4629 | 2738 | **7367** | |
| -99 | 117 | 2658 | 1944 | 0.88 | 3275 | 684 | **3959** | 4679 | 4679 | 2738 | **7416** | |
| -100 | 118 | 2686 | 1944 | 0.88 | 3310 | 684 | **3994** | 4728 | 4728 | 2738 | **7466** | |
| -101 | 119 | 2715 | 1944 | 0.88 | 3345 | 684 | **4029** | 4778 | 4778 | 2738 | **7516** | |
| -102 | 120 | 2744 | 1944 | 0.88 | 3380 | 684 | **4065** | 4829 | 4829 | 2738 | **7566** | |
| -103 | 121 | 2773 | 1944 | 0.88 | 3416 | 684 | **4100** | 4880 | 4880 | 2738 | **7617** | |
| -104 | 122 | 2802 | 1944 | 0.88 | 3452 | 684 | **4136** | 4931 | 4931 | 2738 | **7669** | |
| -105 | 123 | 2831 | 1944 | 0.88 | 3488 | 684 | **4173** | 4983 | 4983 | 2738 | **7721** | |
| -106 | 124 | 2861 | 1944 | 0.88 | 3525 | 684 | **4209** | 5036 | 5036 | 2738 | **7773** | Strength (4245k) |
| -107 | 125 | 2891 | 1944 | 0.88 | 3562 | 684 | **4246** | 5088 | 5088 | 2738 | **7826** | use EL-108' |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 3
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 18 ft
Cut Off Elevation = 13 ft

Pile type: 118'"-diameter CIDH

Post-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 13 | Clay | 0.88 |
| (2) | 13 | 28 | Sand | 0.88 |
| (3) | 28 | 68 | Clay | 0.88 |
| (4) | 68 | 150 | Sand | 0.88 |

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 18 ' for Liq. settlement=0.1"
0 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 18 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 12 | 6 | 3 | 691 | 0.88 | 4 | 243 | **247** | 6 | 6 | 973 | **979** | |
| 11 | 7 | 7 | 721 | 0.88 | 8 | 254 | **262** | 12 | 12 | 1015 | **1027** | |
| 10 | 8 | 10 | 751 | 0.88 | 13 | 264 | **277** | 18 | 18 | 1057 | **1075** | |
| 9 | 9 | 14 | 775 | 0.88 | 17 | 273 | **289** | 24 | 24 | 1091 | **1114** | |
| 8 | 10 | 17 | 797 | 0.88 | 21 | 281 | **302** | 30 | 30 | 1122 | **1152** | |
| 7 | 11 | 20 | 814 | 0.88 | 25 | 286 | **312** | 36 | 36 | 1146 | **1182** | |
| 6 | 12 | 24 | 824 | 0.88 | 29 | 290 | **320** | 42 | 42 | 1161 | **1203** | |
| 5 | 13 | 27 | 829 | 0.88 | 33 | 292 | **325** | 48 | 48 | 1167 | **1215** | |
| 4 | 14 | 37 | 833 | 0.88 | 45 | 293 | **338** | 64 | 64 | 1173 | **1238** | |
| 3 | 15 | 47 | 838 | 0.88 | 58 | 295 | **352** | 82 | 82 | 1179 | **1261** | |
| 2 | 16 | 57 | 842 | 0.88 | 71 | 296 | **367** | 101 | 101 | 1185 | **1286** | |
| 1 | 17 | 69 | 846 | 0.88 | 85 | 298 | **383** | 121 | 121 | 1191 | **1312** | |
| 0 | 18 | 81 | 849 | 0.88 | 100 | 299 | **399** | 142 | 142 | 1196 | **1338** | |
| -1 | 19 | 94 | 853 | 0.88 | 115 | 300 | **415** | 165 | 165 | 1201 | **1365** | |
| -2 | 20 | 107 | 855 | 0.88 | 132 | 301 | **433** | 188 | 188 | 1204 | **1392** | |
| -3 | 21 | 121 | 857 | 0.88 | 149 | 302 | **450** | 212 | 212 | 1207 | **1419** | |
| -4 | 22 | 135 | 858 | 0.88 | 166 | 302 | **468** | 238 | 238 | 1208 | **1446** | |
| -5 | 23 | 150 | 859 | 0.88 | 185 | 302 | **487** | 264 | 264 | 1209 | **1473** | |
| -6 | 24 | 165 | 859 | 0.88 | 204 | 302 | **506** | 291 | 291 | 1209 | **1500** | |
| -7 | 25 | 181 | 858 | 0.88 | 223 | 302 | **525** | 319 | 319 | 1208 | **1527** | |
| -8 | 26 | 197 | 857 | 0.88 | 243 | 302 | **545** | 348 | 348 | 1207 | **1554** | |
| -9 | 27 | 214 | 856 | 0.88 | 264 | 301 | **565** | 377 | 377 | 1205 | **1582** | |
| -10 | 28 | 231 | 854 | 0.88 | 285 | 301 | **586** | 407 | 407 | 1203 | **1610** | Extreme (1599k)* |
| -11 | 29 | 263 | 853 | 0.88 | 324 | 300 | **624** | 463 | 463 | 1201 | **1664** | Use El-15 |
| -12 | 30 | 295 | 852 | 0.88 | 363 | 300 | **663** | 519 | 519 | 1199 | **1718** | |
| -13 | 31 | 326 | 851 | 0.88 | 402 | 300 | **701** | 574 | 574 | 1198 | **1772** | |
| -14 | 32 | 358 | 851 | 0.88 | 441 | 299 | **740** | 630 | 630 | 1198 | **1827** | |
| -15 | 33 | 389 | 850 | 0.88 | 480 | 299 | **779** | 685 | 685 | 1197 | **1883** | |
| -16 | 34 | 421 | 850 | 0.88 | 519 | 299 | **818** | 741 | 741 | 1197 | **1938** | |
| -17 | 35 | 453 | 850 | 0.88 | 557 | 299 | **857** | 796 | 796 | 1197 | **1993** | |
| -18 | 36 | 484 | 850 | 0.88 | 596 | 299 | **896** | 852 | 852 | 1197 | **2049** | |
| -19 | 37 | 516 | 850 | 0.88 | 635 | 299 | **935** | 908 | 908 | 1197 | **2105** | |
| -20 | 38 | 547 | 850 | 0.88 | 674 | 299 | **973** | 963 | 963 | 1197 | **2160** | |
| -21 | 39 | 579 | 850 | 0.88 | 713 | 299 | **1012** | 1019 | 1019 | 1197 | **2216** | |
| -22 | 40 | 610 | 850 | 0.88 | 752 | 299 | **1051** | 1074 | 1074 | 1197 | **2271** | |
| -23 | 41 | 642 | 850 | 0.88 | 791 | 299 | **1090** | 1130 | 1130 | 1197 | **2327** | |
| -24 | 42 | 674 | 850 | 0.88 | 830 | 299 | **1129** | 1185 | 1185 | 1197 | **2383** | |
| -25 | 43 | 705 | 850 | 0.88 | 869 | 299 | **1168** | 1241 | 1241 | 1197 | **2438** | |
| -26 | 44 | 737 | 850 | 0.88 | 908 | 299 | **1207** | 1297 | 1297 | 1197 | **2494** | |
| -27 | 45 | 768 | 850 | 0.88 | 947 | 299 | **1246** | 1352 | 1352 | 1197 | **2549** | |
| -28 | 46 | 800 | 850 | 0.88 | 985 | 299 | **1285** | 1408 | 1408 | 1197 | **2605** | |
| -29 | 47 | 831 | 850 | 0.88 | 1024 | 299 | **1324** | 1463 | 1463 | 1197 | **2660** | |
| -30 | 48 | 863 | 850 | 0.88 | 1063 | 299 | **1363** | 1519 | 1519 | 1197 | **2716** | |
| -31 | 49 | 895 | 850 | 0.88 | 1102 | 299 | **1401** | 1574 | 1574 | 1197 | **2772** | |
| -32 | 50 | 926 | 913 | 0.88 | 1141 | 321 | **1462** | 1630 | 1630 | 1285 | **2915** | |
| -33 | 51 | 958 | 978 | 0.88 | 1180 | 344 | **1524** | 1686 | 1686 | 1377 | **3063** | |
| -34 | 52 | 989 | 1047 | 0.88 | 1219 | 368 | **1587** | 1741 | 1741 | 1474 | **3215** | |
| -35 | 53 | 1021 | 1118 | 0.88 | 1258 | 394 | **1651** | 1797 | 1797 | 1574 | **3371** | |
| -36 | 54 | 1052 | 1193 | 0.88 | 1297 | 420 | **1717** | 1852 | 1852 | 1680 | **3532** | |
| -37 | 55 | 1084 | 1271 | 0.88 | 1336 | 447 | **1783** | 1908 | 1908 | 1790 | **3697** | |
| -38 | 56 | 1116 | 1352 | 0.88 | 1374 | 476 | **1850** | 1964 | 1964 | 1904 | **3867** | |
| -39 | 57 | 1147 | 1436 | 0.88 | 1413 | 506 | **1919** | 2019 | 2019 | 2022 | **4041** | |
| -40 | 58 | 1179 | 1523 | 0.88 | 1452 | 536 | **1989** | 2075 | 2075 | 2145 | **4220** | |
| -41 | 59 | 1210 | 1608 | 0.88 | 1491 | 566 | **2057** | 2130 | 2130 | 2264 | **4394** | |
| -42 | 60 | 1242 | 1682 | 0.88 | 1530 | 592 | **2122** | 2186 | 2186 | 2369 | **4555** | |
| -43 | 61 | 1274 | 1748 | 0.88 | 1569 | 615 | **2184** | 2241 | 2241 | 2461 | **4702** | |
| -44 | 62 | 1305 | 1804 | 0.88 | 1608 | 635 | **2243** | 2297 | 2297 | 2540 | **4837** | |
| -45 | 63 | 1337 | 1851 | 0.88 | 1647 | 651 | **2298** | 2353 | 2353 | 2606 | **4958** | |
| -46 | 64 | 1368 | 1888 | 0.88 | 1686 | 665 | **2350** | 2408 | 2408 | 2659 | **5067** | |
| -47 | 65 | 1400 | 1916 | 0.88 | 1725 | 675 | **2399** | 2464 | 2464 | 2698 | **5162** | |
| -48 | 66 | 1431 | 1935 | 0.88 | 1763 | 681 | **2445** | 2519 | 2519 | 2724 | **5244** | |
| -49 | 67 | 1463 | 1944 | 0.88 | 1802 | 684 | **2487** | 2575 | 2575 | 2738 | **5312** | |
| -50 | 68 | 1495 | 1944 | 0.88 | 1841 | 684 | **2526** | 2630 | 2630 | 2738 | **5368** | |
| -51 | 69 | 1518 | 1944 | 0.88 | 1870 | 684 | **2554** | 2671 | 2671 | 2738 | **5409** | |
| -52 | 70 | 1541 | 1944 | 0.88 | 1899 | 684 | **2583** | 2712 | 2712 | 2738 | **5450** | |
| -53 | 71 | 1564 | 1944 | 0.88 | 1927 | 684 | **2611** | 2753 | 2753 | 2738 | **5491** | |
| -54 | 72 | 1587 | 1944 | 0.88 | 1955 | 684 | **2640** | 2793 | 2793 | 2738 | **5531** | |
| -55 | 73 | 1610 | 1944 | 0.88 | 1983 | 684 | **2668** | 2834 | 2834 | 2738 | **5571** | |
| -56 | 74 | 1633 | 1944 | 0.88 | 2011 | 684 | **2696** | 2873 | 2873 | 2738 | **5611** | |
| -57 | 75 | 1655 | 1944 | 0.88 | 2039 | 684 | **2723** | 2913 | 2913 | 2738 | **5650** | |
| -58 | 76 | 1677 | 1944 | 0.88 | 2066 | 684 | **2751** | 2952 | 2952 | 2738 | **5690** | |
| -59 | 77 | 1699 | 1944 | 0.88 | 2094 | 684 | **2778** | 2991 | 2991 | 2738 | **5729** | |
| -60 | 78 | 1721 | 1944 | 0.88 | 2121 | 684 | **2805** | 3029 | 3029 | 2738 | **5767** | |
| -61 | 79 | 1743 | 1944 | 0.88 | 2147 | 684 | **2832** | 3068 | 3068 | 2738 | **5805** | |
| -62 | 80 | 1764 | 1944 | 0.88 | 2174 | 684 | **2858** | 3105 | 3105 | 2738 | **5843** | |
| -63 | 81 | 1785 | 1944 | 0.88 | 2200 | 684 | **2884** | 3142 | 3142 | 2738 | **5880** | |
| -64 | 82 | 1806 | 1944 | 0.88 | 2225 | 684 | **2910** | 3179 | 3179 | 2738 | **5917** | |
| -65 | 83 | 1827 | 1944 | 0.88 | 2251 | 684 | **2935** | 3215 | 3215 | 2738 | **5953** | |
| -66 | 84 | 1847 | 1944 | 0.88 | 2276 | 684 | **2960** | 3251 | 3251 | 2738 | **5989** | |
| -67 | 85 | 1867 | 1944 | 0.88 | 2300 | 684 | **2985** | 3286 | 3286 | 2738 | **6024** | |
| -68 | 86 | 1887 | 1944 | 0.88 | 2325 | 684 | **3009** | 3321 | 3321 | 2738 | **6059** | |
| -69 | 87 | 1907 | 1944 | 0.88 | 2350 | 684 | **3034** | 3357 | 3357 | 2738 | **6094** | |
| -70 | 88 | 1928 | 1944 | 0.88 | 2375 | 684 | **3059** | 3392 | 3392 | 2738 | **6130** | |
| -71 | 89 | 1948 | 1944 | 0.88 | 2400 | 684 | **3084** | 3429 | 3429 | 2738 | **6166** | |
| -72 | 90 | 1969 | 1944 | 0.88 | 2426 | 684 | **3110** | 3465 | 3465 | 2738 | **6203** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 3
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -73 | 91 | 1990 | 1944 | 0.88 | 2452 | 684 | **3136** | 3503 | 3503 | 2738 | **6240** |
| -74 | 92 | 2012 | 1944 | 0.88 | 2478 | 684 | **3163** | 3540 | 3540 | 2738 | **6278** |
| -75 | 93 | 2033 | 1944 | 0.88 | 2505 | 684 | **3189** | 3579 | 3579 | 2738 | **6316** |
| -76 | 94 | 2055 | 1944 | 0.88 | 2532 | 684 | **3216** | 3617 | 3617 | 2738 | **6355** |
| -77 | 95 | 2077 | 1944 | 0.88 | 2559 | 684 | **3244** | 3656 | 3656 | 2738 | **6394** |
| -78 | 96 | 2100 | 1944 | 0.88 | 2587 | 684 | **3271** | 3696 | 3696 | 2738 | **6433** |
| -79 | 97 | 2123 | 1944 | 0.88 | 2615 | 684 | **3299** | 3736 | 3736 | 2738 | **6473** |
| -80 | 98 | 2146 | 1944 | 0.88 | 2643 | 684 | **3328** | 3776 | 3776 | 2738 | **6514** |
| -81 | 99 | 2169 | 1944 | 0.88 | 2672 | 684 | **3356** | 3817 | 3817 | 2738 | **6555** |
| -82 | 100 | 2192 | 1944 | 0.88 | 2701 | 684 | **3385** | 3858 | 3858 | 2738 | **6596** |
| -83 | 101 | 2216 | 1944 | 0.88 | 2730 | 684 | **3415** | 3900 | 3900 | 2738 | **6638** |
| -84 | 102 | 2240 | 1944 | 0.88 | 2760 | 684 | **3444** | 3943 | 3943 | 2738 | **6680** |
| -85 | 103 | 2264 | 1944 | 0.88 | 2790 | 684 | **3474** | 3985 | 3985 | 2738 | **6723** |
| -86 | 104 | 2289 | 1944 | 0.88 | 2820 | 684 | **3504** | 4028 | 4028 | 2738 | **6766** |
| -87 | 105 | 2314 | 1944 | 0.88 | 2850 | 684 | **3535** | 4072 | 4072 | 2738 | **6810** |
| -88 | 106 | 2339 | 1944 | 0.88 | 2881 | 684 | **3566** | 4116 | 4116 | 2738 | **6854** |
| -89 | 107 | 2364 | 1944 | 0.88 | 2913 | 684 | **3597** | 4161 | 4161 | 2738 | **6898** |
| -90 | 108 | 2390 | 1944 | 0.88 | 2944 | 684 | **3628** | 4206 | 4206 | 2738 | **6943** |
| -91 | 109 | 2416 | 1944 | 0.88 | 2976 | 684 | **3660** | 4251 | 4251 | 2738 | **6989** |
| -92 | 110 | 2442 | 1944 | 0.88 | 3008 | 684 | **3692** | 4297 | 4297 | 2738 | **7035** |
| -93 | 111 | 2468 | 1944 | 0.88 | 3041 | 684 | **3725** | 4344 | 4344 | 2738 | **7081** |
| -94 | 112 | 2495 | 1944 | 0.88 | 3073 | 684 | **3758** | 4391 | 4391 | 2738 | **7128** |
| -95 | 113 | 2522 | 1944 | 0.88 | 3107 | 684 | **3791** | 4438 | 4438 | 2738 | **7175** |
| -96 | 114 | 2549 | 1944 | 0.88 | 3140 | 684 | **3824** | 4486 | 4486 | 2738 | **7223** |
| -97 | 115 | 2576 | 1944 | 0.88 | 3174 | 684 | **3858** | 4534 | 4534 | 2738 | **7271** |
| -98 | 116 | 2604 | 1944 | 0.88 | 3208 | 684 | **3892** | 4583 | 4583 | 2738 | **7320** |
| -99 | 117 | 2632 | 1944 | 0.88 | 3242 | 684 | **3927** | 4632 | 4632 | 2738 | **7369** |
| -100 | 118 | 2660 | 1944 | 0.88 | 3277 | 684 | **3961** | 4681 | 4681 | 2738 | **7419** |
| -101 | 119 | 2688 | 1944 | 0.88 | 3312 | 684 | **3996** | 4732 | 4732 | 2738 | **7469** |
| -102 | 120 | 2717 | 1944 | 0.88 | 3347 | 684 | **4032** | 4782 | 4782 | 2738 | **7520** |
| -103 | 121 | 2746 | 1944 | 0.88 | 3383 | 684 | **4068** | 4833 | 4833 | 2738 | **7571** |
| -104 | 122 | 2775 | 1944 | 0.88 | 3419 | 684 | **4104** | 4885 | 4885 | 2738 | **7622** |
| -105 | 123 | 2805 | 1944 | 0.88 | 3456 | 684 | **4140** | 4937 | 4937 | 2738 | **7674** |
| -106 | 124 | 2835 | 1944 | 0.88 | 3492 | 684 | **4177** | 4989 | 4989 | 2738 | **7726** |
| -107 | 125 | 2865 | 1944 | 0.88 | 3529 | 684 | **4214** | 5042 | 5042 | 2738 | **7779** |
| 18 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
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## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 4
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 18 ft
Cut Off Elevation = 13 ft
Pile type: 118"-diameter CIDH
Pre-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 13 | Sand | 0.88 |
| (2) | 13 | 28 | Sand | 0.88 |
| (3) | 28 | 68 | Clay | 0.88 |
| (4) | 68 | 150 | Sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 18 ' for Liq. settlement=0.1"
0 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 18 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 12 | 6 | 4 | 672 | 0.88 | 5 | 236 | **241** | 7 | 7 | 946 | **953** |
| 11 | 7 | 10 | 706 | 0.88 | 12 | 249 | **261** | 17 | 17 | 995 | **1012** |
| 10 | 8 | 16 | 741 | 0.88 | 19 | 261 | **280** | 28 | 28 | 1043 | **1071** |
| 9 | 9 | 22 | 769 | 0.88 | 27 | 271 | **298** | 39 | 39 | 1082 | **1121** |
| 8 | 10 | 29 | 794 | 0.88 | 36 | 280 | **316** | 52 | 52 | 1118 | **1170** |
| 7 | 11 | 37 | 813 | 0.88 | 45 | 286 | **332** | 65 | 65 | 1145 | **1210** |
| 6 | 12 | 45 | 824 | 0.88 | 56 | 290 | **346** | 79 | 79 | 1161 | **1240** |
| 5 | 13 | 54 | 829 | 0.88 | 66 | 292 | **358** | 95 | 95 | 1167 | **1262** |
| 4 | 14 | 63 | 833 | 0.88 | 78 | 293 | **371** | 111 | 111 | 1173 | **1284** |
| 3 | 15 | 73 | 838 | 0.88 | 90 | 295 | **385** | 129 | 129 | 1179 | **1308** |
| 2 | 16 | 84 | 842 | 0.88 | 104 | 296 | **400** | 148 | 148 | 1185 | **1333** |
| 1 | 17 | 95 | 846 | 0.88 | 118 | 298 | **415** | 168 | 168 | 1191 | **1359** |
| 0 | 18 | 108 | 849 | 0.88 | 132 | 299 | **431** | 189 | 189 | 1196 | **1385** |
| -1 | 19 | 120 | 853 | 0.88 | 148 | 300 | **448** | 211 | 211 | 1201 | **1412** |
| -2 | 20 | 133 | 855 | 0.88 | 164 | 301 | **465** | 235 | 235 | 1204 | **1439** |
| -3 | 21 | 147 | 857 | 0.88 | 181 | 302 | **483** | 259 | 259 | 1207 | **1466** |
| -4 | 22 | 162 | 858 | 0.88 | 199 | 302 | **501** | 284 | 284 | 1208 | **1493** |
| -5 | 23 | 176 | 859 | 0.88 | 217 | 302 | **520** | 311 | 311 | 1209 | **1520** |
| -6 | 24 | 192 | 859 | 0.88 | 236 | 302 | **539** | 338 | 338 | 1209 | **1547** |
| -7 | 25 | 208 | 858 | 0.88 | 256 | 302 | **558** | 366 | 366 | 1208 | **1574** |
| -8 | 26 | 224 | 857 | 0.88 | 276 | 302 | **578** | 394 | 394 | 1207 | **1601** |
| -9 | 27 | 241 | 856 | 0.88 | 297 | 301 | **598** | 424 | 424 | 1205 | **1629** |
| -10 | 28 | 258 | 854 | 0.88 | 318 | 301 | **619** | 454 | 454 | 1203 | **1657** |
| -11 | 29 | 290 | 853 | 0.88 | 357 | 300 | **657** | 510 | 510 | 1201 | **1710** |
| -12 | 30 | 321 | 852 | 0.88 | 396 | 300 | **696** | 565 | 565 | 1199 | **1765** |
| -13 | 31 | 353 | 851 | 0.88 | 435 | 300 | **734** | 621 | 621 | 1198 | **1819** |
| -14 | 32 | 384 | 851 | 0.88 | 474 | 299 | **773** | 676 | 676 | 1198 | **1874** |
| -15 | 33 | 416 | 850 | 0.88 | 512 | 299 | **812** | 732 | 732 | 1197 | **1929** |
| -16 | 34 | 448 | 850 | 0.88 | 551 | 299 | **851** | 788 | 788 | 1197 | **1985** |
| -17 | 35 | 479 | 850 | 0.88 | 590 | 299 | **889** | 843 | 843 | 1197 | **2040** |
| -18 | 36 | 511 | 850 | 0.88 | 629 | 299 | **928** | 899 | 899 | 1197 | **2096** |
| -19 | 37 | 542 | 850 | 0.88 | 668 | 299 | **967** | 954 | 954 | 1197 | **2151** |
| -20 | 38 | 574 | 850 | 0.88 | 707 | 299 | **1006** | 1010 | 1010 | 1197 | **2207** |
| -21 | 39 | 605 | 850 | 0.88 | 746 | 299 | **1045** | 1065 | 1065 | 1197 | **2263** |
| -22 | 40 | 637 | 850 | 0.88 | 785 | 299 | **1084** | 1121 | 1121 | 1197 | **2318** |
| -23 | 41 | 669 | 850 | 0.88 | 824 | 299 | **1123** | 1177 | 1177 | 1197 | **2374** |
| -24 | 42 | 700 | 850 | 0.88 | 863 | 299 | **1162** | 1232 | 1232 | 1197 | **2429** |
| -25 | 43 | 732 | 850 | 0.88 | 901 | 299 | **1201** | 1288 | 1288 | 1197 | **2485** |
| -26 | 44 | 763 | 850 | 0.88 | 940 | 299 | **1240** | 1343 | 1343 | 1197 | **2540** |
| -27 | 45 | 795 | 850 | 0.88 | 979 | 299 | **1279** | 1399 | 1399 | 1197 | **2596** |
| -28 | 46 | 826 | 850 | 0.88 | 1018 | 299 | **1317** | 1455 | 1455 | 1197 | **2652** |
| -29 | 47 | 858 | 850 | 0.88 | 1057 | 299 | **1356** | 1510 | 1510 | 1197 | **2707** |
| -30 | 48 | 890 | 850 | 0.88 | 1096 | 299 | **1395** | 1566 | 1566 | 1197 | **2763** |
| -31 | 49 | 921 | 850 | 0.88 | 1135 | 299 | **1434** | 1621 | 1621 | 1197 | **2818** |
| -32 | 50 | 953 | 913 | 0.88 | 1174 | 321 | **1495** | 1677 | 1677 | 1285 | **2962** |
| -33 | 51 | 984 | 978 | 0.88 | 1213 | 344 | **1557** | 1732 | 1732 | 1377 | **3109** |
| -34 | 52 | 1016 | 1047 | 0.88 | 1252 | 368 | **1620** | 1788 | 1788 | 1474 | **3262** |
| -35 | 53 | 1047 | 1118 | 0.88 | 1290 | 394 | **1684** | 1844 | 1844 | 1574 | **3418** |
| -36 | 54 | 1079 | 1193 | 0.88 | 1329 | 420 | **1749** | 1899 | 1899 | 1680 | **3579** |
| -37 | 55 | 1111 | 1271 | 0.88 | 1368 | 447 | **1816** | 1955 | 1955 | 1790 | **3744** |
| -38 | 56 | 1142 | 1352 | 0.88 | 1407 | 476 | **1883** | 2010 | 2010 | 1904 | **3914** |
| -39 | 57 | 1174 | 1436 | 0.88 | 1446 | 506 | **1952** | 2066 | 2066 | 2022 | **4088** |
| -40 | 58 | 1205 | 1523 | 0.88 | 1485 | 536 | **2021** | 2121 | 2121 | 2145 | **4266** |
| -41 | 59 | 1237 | 1608 | 0.88 | 1524 | 566 | **2090** | 2177 | 2177 | 2264 | **4441** |
| -42 | 60 | 1269 | 1682 | 0.88 | 1563 | 592 | **2155** | 2233 | 2233 | 2369 | **4601** |
| -43 | 61 | 1300 | 1748 | 0.88 | 1602 | 615 | **2217** | 2288 | 2288 | 2461 | **4749** |
| -44 | 62 | 1332 | 1804 | 0.88 | 1641 | 635 | **2276** | 2344 | 2344 | 2540 | **4884** |
| -45 | 63 | 1363 | 1851 | 0.88 | 1680 | 651 | **2331** | 2399 | 2399 | 2606 | **5005** |
| -46 | 64 | 1395 | 1888 | 0.88 | 1718 | 665 | **2383** | 2455 | 2455 | 2659 | **5113** |
| -47 | 65 | 1426 | 1916 | 0.88 | 1757 | 675 | **2432** | 2510 | 2510 | 2698 | **5208** |
| -48 | 66 | 1458 | 1935 | 0.88 | 1796 | 681 | **2477** | 2566 | 2566 | 2724 | **5290** |
| -49 | 67 | 1490 | 1944 | 0.88 | 1835 | 684 | **2520** | 2622 | 2622 | 2738 | **5359** |
| -50 | 68 | 1521 | 1944 | 0.88 | 1874 | 684 | **2558** | 2677 | 2677 | 2738 | **5415** |
| -51 | 69 | 1544 | 1944 | 0.88 | 1903 | 684 | **2587** | 2718 | 2718 | 2738 | **5456** |
| -52 | 70 | 1568 | 1944 | 0.88 | 1931 | 684 | **2616** | 2759 | 2759 | 2738 | **5497** |
| -53 | 71 | 1591 | 1944 | 0.88 | 1960 | 684 | **2644** | 2800 | 2800 | 2738 | **5537** |
| -54 | 72 | 1614 | 1944 | 0.88 | 1988 | 684 | **2673** | 2840 | 2840 | 2738 | **5578** |
| -55 | 73 | 1637 | 1944 | 0.88 | 2016 | 684 | **2701** | 2880 | 2880 | 2738 | **5618** |
| -56 | 74 | 1659 | 1944 | 0.88 | 2044 | 684 | **2728** | 2920 | 2920 | 2738 | **5658** |
| -57 | 75 | 1682 | 1944 | 0.88 | 2072 | 684 | **2756** | 2960 | 2960 | 2738 | **5697** |
| -58 | 76 | 1704 | 1944 | 0.88 | 2099 | 684 | **2784** | 2999 | 2999 | 2738 | **5736** |
| -59 | 77 | 1726 | 1944 | 0.88 | 2126 | 684 | **2811** | 3038 | 3038 | 2738 | **5775** |
| -60 | 78 | 1748 | 1944 | 0.88 | 2153 | 684 | **2838** | 3076 | 3076 | 2738 | **5814** |
| -61 | 79 | 1769 | 1944 | 0.88 | 2180 | 684 | **2864** | 3114 | 3114 | 2738 | **5852** |
| -62 | 80 | 1791 | 1944 | 0.88 | 2206 | 684 | **2891** | 3152 | 3152 | 2738 | **5889** |
| -63 | 81 | 1812 | 1944 | 0.88 | 2232 | 684 | **2917** | 3189 | 3189 | 2738 | **5927** |
| -64 | 82 | 1833 | 1944 | 0.88 | 2258 | 684 | **2942** | 3226 | 3226 | 2738 | **5963** |
| -65 | 83 | 1853 | 1944 | 0.88 | 2283 | 684 | **2968** | 3262 | 3262 | 2738 | **6000** |
| -66 | 84 | 1874 | 1944 | 0.88 | 2308 | 684 | **2993** | 3298 | 3298 | 2738 | **6035** |
| -67 | 85 | 1894 | 1944 | 0.88 | 2333 | 684 | **3017** | 3333 | 3333 | 2738 | **6071** |
| -68 | 86 | 1914 | 1944 | 0.88 | 2358 | 684 | **3042** | 3368 | 3368 | 2738 | **6105** |
| -69 | 87 | 1934 | 1944 | 0.88 | 2382 | 684 | **3067** | 3403 | 3403 | 2738 | **6141** |
| -70 | 88 | 1954 | 1944 | 0.88 | 2407 | 684 | **3092** | 3439 | 3439 | 2738 | **6177** |
| -71 | 89 | 1975 | 1944 | 0.88 | 2433 | 684 | **3117** | 3475 | 3475 | 2738 | **6213** |
| -72 | 90 | 1996 | 1944 | 0.88 | 2459 | 684 | **3143** | 3512 | 3512 | 2738 | **6250** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 4
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -73 | 91 | 2017 | 1944 | 0.88 | 2485 | 684 | **3169** | 3549 | 3549 | 2738 | **6287** | |
| -74 | 92 | 2038 | 1944 | 0.88 | 2511 | 684 | **3195** | 3587 | 3587 | 2738 | **6325** | |
| -75 | 93 | 2060 | 1944 | 0.88 | 2538 | 684 | **3222** | 3625 | 3625 | 2738 | **6363** | |
| -76 | 94 | 2082 | 1944 | 0.88 | 2565 | 684 | **3249** | 3664 | 3664 | 2738 | **6401** | |
| -77 | 95 | 2104 | 1944 | 0.88 | 2592 | 684 | **3276** | 3703 | 3703 | 2738 | **6441** | |
| -78 | 96 | 2126 | 1944 | 0.88 | 2620 | 684 | **3304** | 3742 | 3742 | 2738 | **6480** | |
| -79 | 97 | 2149 | 1944 | 0.88 | 2648 | 684 | **3332** | 3782 | 3782 | 2738 | **6520** | |
| -80 | 98 | 2172 | 1944 | 0.88 | 2676 | 684 | **3360** | 3823 | 3823 | 2738 | **6560** | |
| -81 | 99 | 2195 | 1944 | 0.88 | 2705 | 684 | **3389** | 3864 | 3864 | 2738 | **6601** | |
| -82 | 100 | 2219 | 1944 | 0.88 | 2734 | 684 | **3418** | 3905 | 3905 | 2738 | **6643** | |
| -83 | 101 | 2243 | 1944 | 0.88 | 2763 | 684 | **3447** | 3947 | 3947 | 2738 | **6685** | |
| -84 | 102 | 2267 | 1944 | 0.88 | 2792 | 684 | **3477** | 3989 | 3989 | 2738 | **6727** | |
| -85 | 103 | 2291 | 1944 | 0.88 | 2822 | 684 | **3507** | 4032 | 4032 | 2738 | **6770** | |
| -86 | 104 | 2315 | 1944 | 0.88 | 2853 | 684 | **3537** | 4075 | 4075 | 2738 | **6813** | |
| -87 | 105 | 2340 | 1944 | 0.88 | 2883 | 684 | **3568** | 4119 | 4119 | 2738 | **6856** | |
| -88 | 106 | 2365 | 1944 | 0.88 | 2914 | 684 | **3598** | 4163 | 4163 | 2738 | **6901** | |
| -89 | 107 | 2391 | 1944 | 0.88 | 2945 | 684 | **3630** | 4208 | 4208 | 2738 | **6945** | |
| -90 | 108 | 2416 | 1944 | 0.88 | 2977 | 684 | **3661** | 4253 | 4253 | 2738 | **6990** | |
| -91 | 109 | 2442 | 1944 | 0.88 | 3009 | 684 | **3693** | 4298 | 4298 | 2738 | **7036** | |
| -92 | 110 | 2468 | 1944 | 0.88 | 3041 | 684 | **3725** | 4344 | 4344 | 2738 | **7082** | |
| -93 | 111 | 2495 | 1944 | 0.88 | 3073 | 684 | **3758** | 4390 | 4390 | 2738 | **7128** | |
| -94 | 112 | 2521 | 1944 | 0.88 | 3106 | 684 | **3791** | 4437 | 4437 | 2738 | **7175** | |
| -95 | 113 | 2548 | 1944 | 0.88 | 3139 | 684 | **3824** | 4485 | 4485 | 2738 | **7222** | |
| -96 | 114 | 2575 | 1944 | 0.88 | 3173 | 684 | **3857** | 4532 | 4532 | 2738 | **7270** | |
| -97 | 115 | 2603 | 1944 | 0.88 | 3206 | 684 | **3891** | 4581 | 4581 | 2738 | **7318** | |
| -98 | 116 | 2630 | 1944 | 0.88 | 3241 | 684 | **3925** | 4629 | 4629 | 2738 | **7367** | |
| -99 | 117 | 2658 | 1944 | 0.88 | 3275 | 684 | **3959** | 4679 | 4679 | 2738 | **7416** | |
| -100 | 118 | 2686 | 1944 | 0.88 | 3310 | 684 | **3994** | 4728 | 4728 | 2738 | **7466** | |
| -101 | 119 | 2715 | 1944 | 0.88 | 3345 | 684 | **4029** | 4778 | 4778 | 2738 | **7516** | |
| -102 | 120 | 2744 | 1944 | 0.88 | 3380 | 684 | **4065** | 4829 | 4829 | 2738 | **7566** | |
| -103 | 121 | 2773 | 1944 | 0.88 | 3416 | 684 | **4100** | 4880 | 4880 | 2738 | **7617** | |
| -104 | 122 | 2802 | 1944 | 0.88 | 3452 | 684 | **4136** | 4931 | 4931 | 2738 | **7669** | |
| -105 | 123 | 2831 | 1944 | 0.88 | 3488 | 684 | **4173** | 4983 | 4983 | 2738 | **7721** | |
| -106 | 124 | 2861 | 1944 | 0.88 | 3525 | 684 | **4209** | 5036 | 5036 | 2738 | **7773** | |
| -107 | 125 | 2891 | 1944 | 0.88 | 3562 | 684 | **4246** | 5088 | 5088 | 2738 | **7826** | |
| -108 | 126 | 2921 | 1944 | 0.88 | 3599 | 684 | **4284** | 5142 | 5142 | 2738 | **7879** | |
| -109 | 127 | 2952 | 1944 | 0.88 | 3637 | 684 | **4321** | 5196 | 5196 | 2738 | **7933** | |
| -110 | 128 | 2983 | 1944 | 0.88 | 3675 | 684 | **4359** | 5250 | 5250 | 2738 | **7987** | |
| -111 | 129 | 3014 | 1944 | 0.88 | 3713 | 684 | **4398** | 5304 | 5304 | 2738 | **8042** | |
| -112 | 130 | 3045 | 1944 | 0.88 | 3752 | 684 | **4436** | 5360 | 5360 | 2738 | **8097** | |
| -113 | 131 | 3077 | 1944 | 0.88 | 3791 | 684 | **4475** | 5415 | 5415 | 2738 | **8153** | |
| -114 | 132 | 3109 | 1944 | 0.88 | 3830 | 684 | **4514** | 5471 | 5471 | 2738 | **8209** | Strength (4514k) |
| -115 | 133 | 3141 | 1944 | 0.88 | 3869 | 684 | **4554** | 5528 | 5528 | 2738 | **8265** | use EL-116' |
| -116 | 134 | 3173 | 1944 | 0.88 | 3909 | 684 | **4594** | 5585 | 5585 | 2738 | **8322** | |
| -117 | 135 | 3206 | 1944 | 0.88 | 3950 | 684 | **4634** | 5642 | 5642 | 2738 | **8380** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 4
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 18 ft
Cut Off Elevation = 13 ft

Pile type: 118"-diameter CIDH

Post-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 13 | Clay | 0.88 |
| (2) | 13 | 28 | Sand | 0.88 |
| (3) | 28 | 68 | Clay | 0.88 |
| (4) | 68 | 150 | Sand | 0.88 |

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 18 ' for Liq. settlement=0.1"
0 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 18 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 12 | 6 | 3 | 691 | 0.88 | 4 | 243 | **247** | 6 | 6 | 973 | **979** | |
| 11 | 7 | 7 | 721 | 0.88 | 8 | 254 | **262** | 12 | 12 | 1015 | **1027** | |
| 10 | 8 | 10 | 751 | 0.88 | 13 | 264 | **277** | 18 | 18 | 1057 | **1075** | |
| 9 | 9 | 14 | 775 | 0.88 | 17 | 273 | **289** | 24 | 24 | 1091 | **1114** | |
| 8 | 10 | 17 | 797 | 0.88 | 21 | 281 | **302** | 30 | 30 | 1122 | **1152** | |
| 7 | 11 | 20 | 814 | 0.88 | 25 | 286 | **312** | 36 | 36 | 1146 | **1182** | |
| 6 | 12 | 24 | 824 | 0.88 | 29 | 290 | **320** | 42 | 42 | 1161 | **1203** | |
| 5 | 13 | 27 | 829 | 0.88 | 33 | 292 | **325** | 48 | 48 | 1167 | **1215** | |
| 4 | 14 | 37 | 833 | 0.88 | 45 | 293 | **338** | 64 | 64 | 1173 | **1238** | |
| 3 | 15 | 47 | 838 | 0.88 | 58 | 295 | **352** | 82 | 82 | 1179 | **1261** | |
| 2 | 16 | 57 | 842 | 0.88 | 71 | 296 | **367** | 101 | 101 | 1185 | **1286** | |
| 1 | 17 | 69 | 846 | 0.88 | 85 | 298 | **383** | 121 | 121 | 1191 | **1312** | |
| 0 | 18 | 81 | 849 | 0.88 | 100 | 299 | **399** | 142 | 142 | 1196 | **1338** | |
| -1 | 19 | 94 | 853 | 0.88 | 115 | 300 | **415** | 165 | 165 | 1201 | **1365** | |
| -2 | 20 | 107 | 855 | 0.88 | 132 | 301 | **433** | 188 | 188 | 1204 | **1392** | |
| -3 | 21 | 121 | 857 | 0.88 | 149 | 302 | **450** | 212 | 212 | 1207 | **1419** | |
| -4 | 22 | 135 | 858 | 0.88 | 166 | 302 | **468** | 238 | 238 | 1208 | **1446** | |
| -5 | 23 | 150 | 859 | 0.88 | 185 | 302 | **487** | 264 | 264 | 1209 | **1473** | |
| -6 | 24 | 165 | 859 | 0.88 | 204 | 302 | **506** | 291 | 291 | 1209 | **1500** | |
| -7 | 25 | 181 | 858 | 0.88 | 223 | 302 | **525** | 319 | 319 | 1208 | **1527** | |
| -8 | 26 | 197 | 857 | 0.88 | 243 | 302 | **545** | 348 | 348 | 1207 | **1554** | |
| -9 | 27 | 214 | 856 | 0.88 | 264 | 301 | **565** | 377 | 377 | 1205 | **1582** | |
| -10 | 28 | 231 | 854 | 0.88 | 285 | 301 | **586** | 407 | 407 | 1203 | **1610** | |
| -11 | 29 | 263 | 853 | 0.88 | 324 | 300 | **624** | 463 | 463 | 1201 | **1664** | |
| -12 | 30 | 295 | 852 | 0.88 | 363 | 300 | **663** | 519 | 519 | 1199 | **1718** | |
| -13 | 31 | 326 | 851 | 0.88 | 402 | 300 | **701** | 574 | 574 | 1198 | **1772** | |
| -14 | 32 | 358 | 851 | 0.88 | 441 | 299 | **740** | 630 | 630 | 1198 | **1827** | |
| -15 | 33 | 389 | 850 | 0.88 | 480 | 299 | **779** | 685 | 685 | 1197 | **1883** | |
| -16 | 34 | 421 | 850 | 0.88 | 519 | 299 | **818** | 741 | 741 | 1197 | **1938** | |
| -17 | 35 | 453 | 850 | 0.88 | 557 | 299 | **857** | 796 | 796 | 1197 | **1993** | Extreme (1945k)* |
| -18 | 36 | 484 | 850 | 0.88 | 596 | 299 | **896** | 852 | 852 | 1197 | **2049** | Use El-22 |
| -19 | 37 | 516 | 850 | 0.88 | 635 | 299 | **935** | 908 | 908 | 1197 | **2105** | |
| -20 | 38 | 547 | 850 | 0.88 | 674 | 299 | **973** | 963 | 963 | 1197 | **2160** | |
| -21 | 39 | 579 | 850 | 0.88 | 713 | 299 | **1012** | 1019 | 1019 | 1197 | **2216** | |
| -22 | 40 | 610 | 850 | 0.88 | 752 | 299 | **1051** | 1074 | 1074 | 1197 | **2271** | |
| -23 | 41 | 642 | 850 | 0.88 | 791 | 299 | **1090** | 1130 | 1130 | 1197 | **2327** | |
| -24 | 42 | 674 | 850 | 0.88 | 830 | 299 | **1129** | 1185 | 1185 | 1197 | **2383** | |
| -25 | 43 | 705 | 850 | 0.88 | 869 | 299 | **1168** | 1241 | 1241 | 1197 | **2438** | |
| -26 | 44 | 737 | 850 | 0.88 | 908 | 299 | **1207** | 1297 | 1297 | 1197 | **2494** | |
| -27 | 45 | 768 | 850 | 0.88 | 947 | 299 | **1246** | 1352 | 1352 | 1197 | **2549** | |
| -28 | 46 | 800 | 850 | 0.88 | 985 | 299 | **1285** | 1408 | 1408 | 1197 | **2605** | |
| -29 | 47 | 831 | 850 | 0.88 | 1024 | 299 | **1324** | 1463 | 1463 | 1197 | **2660** | |
| -30 | 48 | 863 | 850 | 0.88 | 1063 | 299 | **1363** | 1519 | 1519 | 1197 | **2716** | |
| -31 | 49 | 895 | 850 | 0.88 | 1102 | 299 | **1401** | 1574 | 1574 | 1197 | **2772** | |
| -32 | 50 | 926 | 913 | 0.88 | 1141 | 321 | **1462** | 1630 | 1630 | 1285 | **2915** | |
| -33 | 51 | 958 | 978 | 0.88 | 1180 | 344 | **1524** | 1686 | 1686 | 1377 | **3063** | |
| -34 | 52 | 989 | 1047 | 0.88 | 1219 | 368 | **1587** | 1741 | 1741 | 1474 | **3215** | |
| -35 | 53 | 1021 | 1118 | 0.88 | 1258 | 394 | **1651** | 1797 | 1797 | 1574 | **3371** | |
| -36 | 54 | 1052 | 1193 | 0.88 | 1297 | 420 | **1717** | 1852 | 1852 | 1680 | **3532** | |
| -37 | 55 | 1084 | 1271 | 0.88 | 1336 | 447 | **1783** | 1908 | 1908 | 1790 | **3697** | |
| -38 | 56 | 1116 | 1352 | 0.88 | 1374 | 476 | **1850** | 1964 | 1964 | 1904 | **3867** | |
| -39 | 57 | 1147 | 1436 | 0.88 | 1413 | 506 | **1919** | 2019 | 2019 | 2022 | **4041** | |
| -40 | 58 | 1179 | 1523 | 0.88 | 1452 | 536 | **1989** | 2075 | 2075 | 2145 | **4220** | |
| -41 | 59 | 1210 | 1608 | 0.88 | 1491 | 566 | **2057** | 2130 | 2130 | 2264 | **4394** | |
| -42 | 60 | 1242 | 1682 | 0.88 | 1530 | 592 | **2122** | 2186 | 2186 | 2369 | **4555** | |
| -43 | 61 | 1274 | 1748 | 0.88 | 1569 | 615 | **2184** | 2241 | 2241 | 2461 | **4702** | |
| -44 | 62 | 1305 | 1804 | 0.88 | 1608 | 635 | **2243** | 2297 | 2297 | 2540 | **4837** | |
| -45 | 63 | 1337 | 1851 | 0.88 | 1647 | 651 | **2298** | 2353 | 2353 | 2606 | **4958** | |
| -46 | 64 | 1368 | 1888 | 0.88 | 1686 | 665 | **2350** | 2408 | 2408 | 2659 | **5067** | |
| -47 | 65 | 1400 | 1916 | 0.88 | 1725 | 675 | **2399** | 2464 | 2464 | 2698 | **5162** | |
| -48 | 66 | 1431 | 1935 | 0.88 | 1763 | 681 | **2445** | 2519 | 2519 | 2724 | **5244** | |
| -49 | 67 | 1463 | 1944 | 0.88 | 1802 | 684 | **2487** | 2575 | 2575 | 2738 | **5312** | |
| -50 | 68 | 1495 | 1944 | 0.88 | 1841 | 684 | **2526** | 2630 | 2630 | 2738 | **5368** | |
| -51 | 69 | 1518 | 1944 | 0.88 | 1870 | 684 | **2554** | 2671 | 2671 | 2738 | **5409** | |
| -52 | 70 | 1541 | 1944 | 0.88 | 1899 | 684 | **2583** | 2712 | 2712 | 2738 | **5450** | |
| -53 | 71 | 1564 | 1944 | 0.88 | 1927 | 684 | **2611** | 2753 | 2753 | 2738 | **5491** | |
| -54 | 72 | 1587 | 1944 | 0.88 | 1955 | 684 | **2640** | 2793 | 2793 | 2738 | **5531** | |
| -55 | 73 | 1610 | 1944 | 0.88 | 1983 | 684 | **2668** | 2834 | 2834 | 2738 | **5571** | |
| -56 | 74 | 1633 | 1944 | 0.88 | 2011 | 684 | **2696** | 2873 | 2873 | 2738 | **5611** | |
| -57 | 75 | 1655 | 1944 | 0.88 | 2039 | 684 | **2723** | 2913 | 2913 | 2738 | **5650** | |
| -58 | 76 | 1677 | 1944 | 0.88 | 2066 | 684 | **2751** | 2952 | 2952 | 2738 | **5690** | |
| -59 | 77 | 1699 | 1944 | 0.88 | 2094 | 684 | **2778** | 2991 | 2991 | 2738 | **5729** | |
| -60 | 78 | 1721 | 1944 | 0.88 | 2121 | 684 | **2805** | 3029 | 3029 | 2738 | **5767** | |
| -61 | 79 | 1743 | 1944 | 0.88 | 2147 | 684 | **2832** | 3068 | 3068 | 2738 | **5805** | |
| -62 | 80 | 1764 | 1944 | 0.88 | 2174 | 684 | **2858** | 3105 | 3105 | 2738 | **5843** | |
| -63 | 81 | 1785 | 1944 | 0.88 | 2200 | 684 | **2884** | 3142 | 3142 | 2738 | **5880** | |
| -64 | 82 | 1806 | 1944 | 0.88 | 2225 | 684 | **2910** | 3179 | 3179 | 2738 | **5917** | |
| -65 | 83 | 1827 | 1944 | 0.88 | 2251 | 684 | **2935** | 3215 | 3215 | 2738 | **5953** | |
| -66 | 84 | 1847 | 1944 | 0.88 | 2276 | 684 | **2960** | 3251 | 3251 | 2738 | **5989** | |
| -67 | 85 | 1867 | 1944 | 0.88 | 2300 | 684 | **2985** | 3286 | 3286 | 2738 | **6024** | |
| -68 | 86 | 1887 | 1944 | 0.88 | 2325 | 684 | **3009** | 3321 | 3321 | 2738 | **6059** | |
| -69 | 87 | 1907 | 1944 | 0.88 | 2350 | 684 | **3034** | 3357 | 3357 | 2738 | **6094** | |
| -70 | 88 | 1928 | 1944 | 0.88 | 2375 | 684 | **3059** | 3392 | 3392 | 2738 | **6130** | |
| -71 | 89 | 1948 | 1944 | 0.88 | 2400 | 684 | **3084** | 3429 | 3429 | 2738 | **6166** | |
| -72 | 90 | 1969 | 1944 | 0.88 | 2426 | 684 | **3110** | 3465 | 3465 | 2738 | **6203** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 4
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -73 | 91 | 1990 | 1944 | 0.88 | 2452 | 684 | **3136** | 3503 | 3503 | 2738 | **6240** |
| -74 | 92 | 2012 | 1944 | 0.88 | 2478 | 684 | **3163** | 3540 | 3540 | 2738 | **6278** |
| -75 | 93 | 2033 | 1944 | 0.88 | 2505 | 684 | **3189** | 3579 | 3579 | 2738 | **6316** |
| -76 | 94 | 2055 | 1944 | 0.88 | 2532 | 684 | **3216** | 3617 | 3617 | 2738 | **6355** |
| -77 | 95 | 2077 | 1944 | 0.88 | 2559 | 684 | **3244** | 3656 | 3656 | 2738 | **6394** |
| -78 | 96 | 2100 | 1944 | 0.88 | 2587 | 684 | **3271** | 3696 | 3696 | 2738 | **6433** |
| -79 | 97 | 2123 | 1944 | 0.88 | 2615 | 684 | **3299** | 3736 | 3736 | 2738 | **6473** |
| -80 | 98 | 2146 | 1944 | 0.88 | 2643 | 684 | **3328** | 3776 | 3776 | 2738 | **6514** |
| -81 | 99 | 2169 | 1944 | 0.88 | 2672 | 684 | **3356** | 3817 | 3817 | 2738 | **6555** |
| -82 | 100 | 2192 | 1944 | 0.88 | 2701 | 684 | **3385** | 3858 | 3858 | 2738 | **6596** |
| -83 | 101 | 2216 | 1944 | 0.88 | 2730 | 684 | **3415** | 3900 | 3900 | 2738 | **6638** |
| -84 | 102 | 2240 | 1944 | 0.88 | 2760 | 684 | **3444** | 3943 | 3943 | 2738 | **6680** |
| -85 | 103 | 2264 | 1944 | 0.88 | 2790 | 684 | **3474** | 3985 | 3985 | 2738 | **6723** |
| -86 | 104 | 2289 | 1944 | 0.88 | 2820 | 684 | **3504** | 4028 | 4028 | 2738 | **6766** |
| -87 | 105 | 2314 | 1944 | 0.88 | 2850 | 684 | **3535** | 4072 | 4072 | 2738 | **6810** |
| -88 | 106 | 2339 | 1944 | 0.88 | 2881 | 684 | **3566** | 4116 | 4116 | 2738 | **6854** |
| -89 | 107 | 2364 | 1944 | 0.88 | 2913 | 684 | **3597** | 4161 | 4161 | 2738 | **6898** |
| -90 | 108 | 2390 | 1944 | 0.88 | 2944 | 684 | **3628** | 4206 | 4206 | 2738 | **6943** |
| -91 | 109 | 2416 | 1944 | 0.88 | 2976 | 684 | **3660** | 4251 | 4251 | 2738 | **6989** |
| -92 | 110 | 2442 | 1944 | 0.88 | 3008 | 684 | **3692** | 4297 | 4297 | 2738 | **7035** |
| -93 | 111 | 2468 | 1944 | 0.88 | 3041 | 684 | **3725** | 4344 | 4344 | 2738 | **7081** |
| -94 | 112 | 2495 | 1944 | 0.88 | 3073 | 684 | **3758** | 4391 | 4391 | 2738 | **7128** |
| -95 | 113 | 2522 | 1944 | 0.88 | 3107 | 684 | **3791** | 4438 | 4438 | 2738 | **7175** |
| -96 | 114 | 2549 | 1944 | 0.88 | 3140 | 684 | **3824** | 4486 | 4486 | 2738 | **7223** |
| -97 | 115 | 2576 | 1944 | 0.88 | 3174 | 684 | **3858** | 4534 | 4534 | 2738 | **7271** |
| -98 | 116 | 2604 | 1944 | 0.88 | 3208 | 684 | **3892** | 4583 | 4583 | 2738 | **7320** |
| -99 | 117 | 2632 | 1944 | 0.88 | 3242 | 684 | **3927** | 4632 | 4632 | 2738 | **7369** |
| -100 | 118 | 2660 | 1944 | 0.88 | 3277 | 684 | **3961** | 4681 | 4681 | 2738 | **7419** |
| -101 | 119 | 2688 | 1944 | 0.88 | 3312 | 684 | **3996** | 4732 | 4732 | 2738 | **7469** |
| -102 | 120 | 2717 | 1944 | 0.88 | 3347 | 684 | **4032** | 4782 | 4782 | 2738 | **7520** |
| -103 | 121 | 2746 | 1944 | 0.88 | 3383 | 684 | **4068** | 4833 | 4833 | 2738 | **7571** |
| -104 | 122 | 2775 | 1944 | 0.88 | 3419 | 684 | **4104** | 4885 | 4885 | 2738 | **7622** |
| -105 | 123 | 2805 | 1944 | 0.88 | 3456 | 684 | **4140** | 4937 | 4937 | 2738 | **7674** |
| -106 | 124 | 2835 | 1944 | 0.88 | 3492 | 684 | **4177** | 4989 | 4989 | 2738 | **7726** |
| -107 | 125 | 2865 | 1944 | 0.88 | 3529 | 684 | **4214** | 5042 | 5042 | 2738 | **7779** |
| -108 | 126 | 2895 | 1944 | 0.88 | 3567 | 684 | **4251** | 5095 | 5095 | 2738 | **7833** |
| -109 | 127 | 2925 | 1944 | 0.88 | 3604 | 684 | **4289** | 5149 | 5149 | 2738 | **7886** |
| -110 | 128 | 2956 | 1944 | 0.88 | 3642 | 684 | **4327** | 5203 | 5203 | 2738 | **7941** |
| -111 | 129 | 2987 | 1944 | 0.88 | 3680 | 684 | **4365** | 5258 | 5258 | 2738 | **7995** |
| -112 | 130 | 3019 | 1944 | 0.88 | 3719 | 684 | **4403** | 5313 | 5313 | 2738 | **8050** |
| -113 | 131 | 3050 | 1944 | 0.88 | 3758 | 684 | **4442** | 5368 | 5368 | 2738 | **8106** |
| -114 | 132 | 3082 | 1944 | 0.88 | 3797 | 684 | **4482** | 5425 | 5425 | 2738 | **8162** |
| -115 | 133 | 3114 | 1944 | 0.88 | 3837 | 684 | **4521** | 5481 | 5481 | 2738 | **8219** |
| -116 | 134 | 3147 | 1944 | 0.88 | 3877 | 684 | **4561** | 5538 | 5538 | 2738 | **8276** |
| -117 | 135 | 3179 | 1944 | 0.88 | 3917 | 684 | **4601** | 5595 | 5595 | 2738 | **8333** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 5
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft
Pile type: 118"'-diameter CIDH
Pre-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 7 | Sand | 0.88 |
| (2) | 7 | 37 | Sand | 0.88 |
| (3) | 37 | 57 | Sand | 0.88 |
| (4) | 57 | 97 | Clay | 0.88 |
| (5) | 97 | 170 | Sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
222 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 44 | 6 | 3 | 0 | 0.88 | 3 | 0 | **3** | 5 | 0 | 0 | **0** |
| 43 | 7 | 9 | 0 | 0.88 | 10 | 0 | **10** | 15 | 0 | 0 | **0** |
| 42 | 8 | 14 | 0 | 0.88 | 18 | 0 | **18** | 25 | 0 | 0 | **0** |
| 41 | 9 | 21 | 0 | 0.88 | 26 | 0 | **26** | 37 | 0 | 0 | **0** |
| 40 | 10 | 28 | 0 | 0.88 | 34 | 0 | **34** | 49 | 0 | 0 | **0** |
| 39 | 11 | 36 | 0 | 0.88 | 44 | 0 | **44** | 63 | 0 | 0 | **0** |
| 38 | 12 | 44 | 0 | 0.88 | 54 | 0 | **54** | 77 | 0 | 0 | **0** |
| 37 | 13 | 52 | 0 | 0.88 | 65 | 0 | **65** | 92 | 0 | 0 | **0** |
| 36 | 14 | 62 | 0 | 0.88 | 76 | 0 | **76** | 108 | 0 | 0 | **0** |
| 35 | 15 | 71 | 0 | 0.88 | 88 | 0 | **88** | 125 | 0 | 0 | **0** |
| 34 | 16 | 81 | 0 | 0.88 | 100 | 0 | **100** | 143 | 0 | 0 | **0** |
| 33 | 17 | 92 | 0 | 0.88 | 113 | 0 | **113** | 162 | 0 | 0 | **0** |
| 32 | 18 | 103 | 0 | 0.88 | 127 | 0 | **127** | 181 | 0 | 0 | **0** |
| 31 | 19 | 114 | 46 | 0.88 | 141 | 16 | **157** | 201 | 0 | 65 | **65** |
| 30 | 20 | 126 | 95 | 0.88 | 155 | 33 | **189** | 222 | 0 | 133 | **133** |
| 29 | 21 | 138 | 145 | 0.88 | 170 | 51 | **221** | 243 | 21 | 205 | **226** |
| 28 | 22 | 151 | 199 | 0.88 | 186 | 70 | **256** | 265 | 44 | 280 | **323** |
| 27 | 23 | 164 | 254 | 0.88 | 202 | 89 | **291** | 288 | 66 | 358 | **424** |
| 26 | 24 | 177 | 312 | 0.88 | 218 | 110 | **328** | 311 | 90 | 439 | **528** |
| 25 | 25 | 190 | 372 | 0.88 | 235 | 131 | **365** | 335 | 113 | 523 | **637** |
| 24 | 26 | 204 | 434 | 0.88 | 252 | 153 | **405** | 360 | 138 | 611 | **749** |
| 23 | 27 | 219 | 499 | 0.88 | 269 | 176 | **445** | 385 | 163 | 702 | **865** |
| 22 | 28 | 233 | 561 | 0.88 | 287 | 197 | **485** | 410 | 188 | 790 | **978** |
| 21 | 29 | 248 | 616 | 0.88 | 305 | 217 | **522** | 436 | 214 | 868 | **1082** |
| 20 | 30 | 263 | 665 | 0.88 | 324 | 234 | **558** | 463 | 241 | 936 | **1177** |
| 19 | 31 | 278 | 706 | 0.88 | 343 | 249 | **591** | 489 | 268 | 995 | **1262** |
| 18 | 32 | 294 | 741 | 0.88 | 362 | 261 | **622** | 517 | 295 | 1043 | **1338** |
| 17 | 33 | 309 | 769 | 0.88 | 381 | 271 | **652** | 544 | 323 | 1082 | **1405** |
| 16 | 34 | 325 | 789 | 0.88 | 401 | 278 | **679** | 572 | 351 | 1112 | **1462** |
| 15 | 35 | 341 | 803 | 0.88 | 421 | 283 | **703** | 601 | 379 | 1131 | **1510** |
| 14 | 36 | 358 | 810 | 0.88 | 441 | 285 | **726** | 630 | 408 | 1141 | **1549** |
| 13 | 37 | 374 | 810 | 0.88 | 461 | 285 | **746** | 659 | 437 | 1141 | **1578** |
| 12 | 38 | 391 | 810 | 0.88 | 482 | 285 | **767** | 688 | 467 | 1141 | **1607** |
| 11 | 39 | 408 | 812 | 0.88 | 503 | 286 | **789** | 719 | 497 | 1144 | **1641** |
| 10 | 40 | 426 | 815 | 0.88 | 525 | 287 | **811** | 749 | 528 | 1147 | **1675** |
| 9 | 41 | 443 | 817 | 0.88 | 546 | 288 | **834** | 781 | 559 | 1151 | **1710** |
| 8 | 42 | 461 | 820 | 0.88 | 569 | 289 | **857** | 812 | 590 | 1155 | **1745** |
| 7 | 43 | 480 | 823 | 0.88 | 591 | 290 | **881** | 844 | 623 | 1158 | **1781** |
| 6 | 44 | 498 | 826 | 0.88 | 614 | 291 | **904** | 877 | 655 | 1162 | **1818** |
| 5 | 45 | 517 | 829 | 0.88 | 637 | 292 | **928** | 910 | 688 | 1167 | **1855** |
| 4 | 46 | 536 | 832 | 0.88 | 660 | 293 | **953** | 943 | 721 | 1171 | **1892** |
| 3 | 47 | 555 | 835 | 0.88 | 684 | 294 | **978** | 977 | 755 | 1175 | **1930** |
| 2 | 48 | 574 | 838 | 0.88 | 707 | 295 | **1002** | 1011 | 789 | 1180 | **1969** |
| 1 | 49 | 594 | 841 | 0.88 | 731 | 296 | **1027** | 1045 | 823 | 1184 | **2007** |
| 0 | 50 | 613 | 843 | 0.88 | 756 | 297 | **1052** | 1079 | 858 | 1187 | **2044** |
| -1 | 51 | 633 | 845 | 0.88 | 780 | 297 | **1077** | 1114 | 892 | 1190 | **2082** |
| -2 | 52 | 653 | 847 | 0.88 | 804 | 298 | **1102** | 1149 | 927 | 1192 | **2119** |
| -3 | 53 | 673 | 848 | 0.88 | 829 | 299 | **1127** | 1184 | 962 | 1194 | **2156** |
| -4 | 54 | 693 | 849 | 0.88 | 854 | 299 | **1152** | 1219 | 998 | 1196 | **2193** |
| -5 | 55 | 713 | 850 | 0.88 | 878 | 299 | **1177** | 1255 | 1033 | 1197 | **2230** |
| -6 | 56 | 733 | 850 | 0.88 | 903 | 299 | **1203** | 1290 | 1069 | 1197 | **2266** |
| -7 | 57 | 753 | 850 | 0.88 | 928 | 299 | **1227** | 1326 | 1104 | 1197 | **2301** |
| -8 | 58 | 785 | 850 | 0.88 | 967 | 299 | **1266** | 1382 | 1160 | 1197 | **2357** |
| -9 | 59 | 817 | 850 | 0.88 | 1006 | 299 | **1305** | 1437 | 1215 | 1197 | **2412** |
| -10 | 60 | 848 | 850 | 0.88 | 1045 | 299 | **1344** | 1493 | 1271 | 1197 | **2468** |
| -11 | 61 | 880 | 850 | 0.88 | 1084 | 299 | **1383** | 1548 | 1327 | 1197 | **2524** |
| -12 | 62 | 911 | 850 | 0.88 | 1123 | 299 | **1422** | 1604 | 1382 | 1197 | **2579** |
| -13 | 63 | 943 | 850 | 0.88 | 1162 | 299 | **1461** | 1659 | 1438 | 1197 | **2635** |
| -14 | 64 | 974 | 850 | 0.88 | 1201 | 299 | **1500** | 1715 | 1493 | 1197 | **2690** |
| -15 | 65 | 1006 | 850 | 0.88 | 1239 | 299 | **1539** | 1771 | 1549 | 1197 | **2746** |
| -16 | 66 | 1038 | 850 | 0.88 | 1278 | 299 | **1578** | 1826 | 1604 | 1197 | **2801** |
| -17 | 67 | 1069 | 850 | 0.88 | 1317 | 299 | **1617** | 1882 | 1660 | 1197 | **2857** |
| -18 | 68 | 1101 | 850 | 0.88 | 1356 | 299 | **1655** | 1937 | 1716 | 1197 | **2913** |
| -19 | 69 | 1132 | 850 | 0.88 | 1395 | 299 | **1694** | 1993 | 1771 | 1197 | **2968** |
| -20 | 70 | 1164 | 850 | 0.88 | 1434 | 299 | **1733** | 2048 | 1827 | 1197 | **3024** |
| -21 | 71 | 1195 | 850 | 0.88 | 1473 | 299 | **1772** | 2104 | 1882 | 1197 | **3079** |
| -22 | 72 | 1227 | 850 | 0.88 | 1512 | 299 | **1811** | 2160 | 1938 | 1197 | **3135** |
| -23 | 73 | 1259 | 850 | 0.88 | 1551 | 299 | **1850** | 2215 | 1993 | 1197 | **3190** |
| -24 | 74 | 1290 | 850 | 0.88 | 1590 | 299 | **1889** | 2271 | 2049 | 1197 | **3246** |
| -25 | 75 | 1322 | 850 | 0.88 | 1628 | 299 | **1928** | 2326 | 2105 | 1197 | **3302** |
| -26 | 76 | 1353 | 850 | 0.88 | 1667 | 299 | **1967** | 2382 | 2160 | 1197 | **3357** |
| -27 | 77 | 1385 | 850 | 0.88 | 1706 | 299 | **2006** | 2438 | 2216 | 1197 | **3413** |
| -28 | 78 | 1417 | 850 | 0.88 | 1745 | 299 | **2044** | 2493 | 2271 | 1197 | **3468** |
| -29 | 79 | 1448 | 913 | 0.88 | 1784 | 321 | **2105** | 2549 | 2327 | 1285 | **3612** |
| -30 | 80 | 1480 | 978 | 0.88 | 1823 | 344 | **2167** | 2604 | 2382 | 1377 | **3759** |
| -31 | 81 | 1511 | 1047 | 0.88 | 1862 | 368 | **2230** | 2660 | 2438 | 1474 | **3912** |
| -32 | 82 | 1543 | 1118 | 0.88 | 1901 | 394 | **2294** | 2715 | 2494 | 1574 | **4068** |
| -33 | 83 | 1574 | 1193 | 0.88 | 1940 | 420 | **2360** | 2771 | 2549 | 1680 | **4229** |
| -34 | 84 | 1606 | 1271 | 0.88 | 1979 | 447 | **2426** | 2827 | 2605 | 1790 | **4394** |
| -35 | 85 | 1638 | 1352 | 0.88 | 2017 | 476 | **2493** | 2882 | 2660 | 1904 | **4564** |
| -36 | 86 | 1669 | 1436 | 0.88 | 2056 | 506 | **2562** | 2938 | 2716 | 2022 | **4738** |
| -37 | 87 | 1701 | 1523 | 0.88 | 2095 | 536 | **2632** | 2993 | 2771 | 2145 | **4917** |
| -38 | 88 | 1732 | 1608 | 0.88 | 2134 | 566 | **2700** | 3049 | 2827 | 2264 | **5091** |
| -39 | 89 | 1764 | 1682 | 0.88 | 2173 | 592 | **2765** | 3104 | 2883 | 2369 | **5252** |
| -40 | 90 | 1795 | 1748 | 0.88 | 2212 | 615 | **2827** | 3160 | 2938 | 2461 | **5399** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 5
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 1827 | 1804 | 0.88 | 2251 | 635 | **2886** | 3216 | 2994 | 2540 | **5534** | |
| -42 | 92 | 1859 | 1851 | 0.88 | 2290 | 651 | **2941** | 3271 | 3049 | 2606 | **5655** | |
| -43 | 93 | 1890 | 1888 | 0.88 | 2329 | 665 | **2993** | 3327 | 3105 | 2659 | **5763** | |
| -44 | 94 | 1922 | 1916 | 0.88 | 2368 | 675 | **3042** | 3382 | 3161 | 2698 | **5859** | |
| -45 | 95 | 1953 | 1935 | 0.88 | 2407 | 681 | **3088** | 3438 | 3216 | 2724 | **5940** | |
| -46 | 96 | 1985 | 1944 | 0.88 | 2445 | 684 | **3130** | 3493 | 3272 | 2738 | **6009** | |
| -47 | 97 | 2017 | 1944 | 0.88 | 2484 | 684 | **3169** | 3549 | 3327 | 2738 | **6065** | |
| -48 | 98 | 2037 | 1944 | 0.88 | 2510 | 684 | **3194** | 3585 | 3363 | 2738 | **6101** | |
| -49 | 99 | 2058 | 1944 | 0.88 | 2535 | 684 | **3219** | 3622 | 3400 | 2738 | **6137** | |
| -50 | 100 | 2079 | 1944 | 0.88 | 2561 | 684 | **3245** | 3658 | 3437 | 2738 | **6174** | |
| -51 | 101 | 2100 | 1944 | 0.88 | 2587 | 684 | **3272** | 3696 | 3474 | 2738 | **6212** | |
| -52 | 102 | 2121 | 1944 | 0.88 | 2614 | 684 | **3298** | 3734 | 3512 | 2738 | **6250** | |
| -53 | 103 | 2143 | 1944 | 0.88 | 2640 | 684 | **3325** | 3772 | 3550 | 2738 | **6288** | |
| -54 | 104 | 2165 | 1944 | 0.88 | 2668 | 684 | **3352** | 3811 | 3589 | 2738 | **6327** | |
| -55 | 105 | 2188 | 1944 | 0.88 | 2695 | 684 | **3379** | 3850 | 3628 | 2738 | **6366** | |
| -56 | 106 | 2210 | 1944 | 0.88 | 2723 | 684 | **3407** | 3890 | 3668 | 2738 | **6406** | |
| -57 | 107 | 2233 | 1944 | 0.88 | 2751 | 684 | **3435** | 3930 | 3708 | 2738 | **6446** | |
| -58 | 108 | 2256 | 1944 | 0.88 | 2779 | 684 | **3464** | 3971 | 3749 | 2738 | **6486** | |
| -59 | 109 | 2279 | 1944 | 0.88 | 2808 | 684 | **3493** | 4012 | 3790 | 2738 | **6527** | |
| -60 | 110 | 2303 | 1944 | 0.88 | 2837 | 684 | **3522** | 4053 | 3831 | 2738 | **6569** | |
| -61 | 111 | 2327 | 1944 | 0.88 | 2867 | 684 | **3551** | 4095 | 3873 | 2738 | **6611** | |
| -62 | 112 | 2351 | 1944 | 0.88 | 2896 | 684 | **3581** | 4138 | 3916 | 2738 | **6653** | |
| -63 | 113 | 2375 | 1944 | 0.88 | 2926 | 684 | **3611** | 4181 | 3959 | 2738 | **6696** | |
| -64 | 114 | 2400 | 1944 | 0.88 | 2957 | 684 | **3641** | 4224 | 4002 | 2738 | **6740** | |
| -65 | 115 | 2425 | 1944 | 0.88 | 2987 | 684 | **3672** | 4268 | 4046 | 2738 | **6784** | |
| -66 | 116 | 2450 | 1944 | 0.88 | 3018 | 684 | **3703** | 4312 | 4090 | 2738 | **6828** | |
| -67 | 117 | 2475 | 1944 | 0.88 | 3050 | 684 | **3734** | 4357 | 4135 | 2738 | **6873** | |
| -68 | 118 | 2501 | 1944 | 0.88 | 3081 | 684 | **3766** | 4402 | 4180 | 2738 | **6918** | |
| -69 | 119 | 2527 | 1944 | 0.88 | 3113 | 684 | **3798** | 4448 | 4226 | 2738 | **6963** | |
| -70 | 120 | 2553 | 1944 | 0.88 | 3146 | 684 | **3830** | 4494 | 4272 | 2738 | **7010** | |
| -71 | 121 | 2580 | 1944 | 0.88 | 3178 | 684 | **3863** | 4540 | 4319 | 2738 | **7056** | |
| -72 | 122 | 2607 | 1944 | 0.88 | 3211 | 684 | **3896** | 4587 | 4366 | 2738 | **7103** | |
| -73 | 123 | 2634 | 1944 | 0.88 | 3244 | 684 | **3929** | 4635 | 4413 | 2738 | **7151** | |
| -74 | 124 | 2661 | 1944 | 0.88 | 3278 | 684 | **3962** | 4683 | 4461 | 2738 | **7199** | |
| -75 | 125 | 2688 | 1944 | 0.88 | 3312 | 684 | **3996** | 4731 | 4510 | 2738 | **7247** | |
| -76 | 126 | 2716 | 1944 | 0.88 | 3346 | 684 | **4031** | 4780 | 4558 | 2738 | **7296** | |
| -77 | 127 | 2744 | 1944 | 0.88 | 3381 | 684 | **4065** | 4830 | 4608 | 2738 | **7345** | Strength (4059k) |
| -78 | 128 | 2772 | 1944 | 0.88 | 3416 | 684 | **4100** | 4879 | 4658 | 2738 | **7395** | use EL-79' |
| -79 | 129 | 2801 | 1944 | 0.88 | 3451 | 684 | **4135** | 4930 | 4708 | 2738 | **7445** | |
| -80 | 130 | 2830 | 1944 | 0.88 | 3486 | 684 | **4171** | 4980 | 4759 | 2738 | **7496** | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 5
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft
Pile type: 118'"-diameter CIDH
Post-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 7 | Sand | 0.88 |
| (2) | 7 | 37 | Clay | 0.88 |
| (3) | 37 | 57 | Sand | 0.88 |
| (4) | 57 | 97 | Clay | 0.88 |
| (5) | 97 | 170 | Sand | 0.88 |

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
93 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 44 | 6 | 5 | 113 | 0.88 | 6 | 40 | **46** | 9 | 0 | 159 | **159** | |
| 43 | 7 | 9 | 113 | 0.88 | 10 | 40 | **50** | 15 | 0 | 159 | **159** | |
| 42 | 8 | 12 | 113 | 0.88 | 15 | 40 | **55** | 21 | 0 | 160 | **160** | |
| 41 | 9 | 15 | 114 | 0.88 | 19 | 40 | **59** | 27 | 0 | 160 | **160** | |
| 40 | 10 | 19 | 114 | 0.88 | 23 | 40 | **63** | 33 | 0 | 160 | **160** | |
| 39 | 11 | 22 | 114 | 0.88 | 27 | 40 | **67** | 39 | 0 | 160 | **160** | |
| 38 | 12 | 25 | 114 | 0.88 | 31 | 40 | **71** | 45 | 0 | 160 | **160** | |
| 37 | 13 | 29 | 114 | 0.88 | 36 | 40 | **76** | 51 | 0 | 160 | **160** | |
| 36 | 14 | 32 | 114 | 0.88 | 40 | 40 | **80** | 57 | 0 | 160 | **160** | |
| 35 | 15 | 36 | 114 | 0.88 | 44 | 40 | **84** | 63 | 0 | 160 | **160** | |
| 34 | 16 | 39 | 114 | 0.88 | 48 | 40 | **88** | 69 | 0 | 160 | **160** | |
| 33 | 17 | 42 | 114 | 0.88 | 52 | 40 | **92** | 75 | 0 | 160 | **160** | |
| 32 | 18 | 46 | 114 | 0.88 | 57 | 40 | **96** | 81 | 0 | 160 | **160** | |
| 31 | 19 | 49 | 153 | 0.88 | 61 | 54 | **115** | 87 | 0 | 216 | **216** | |
| 30 | 20 | 53 | 195 | 0.88 | 65 | 69 | **133** | 93 | 0 | 274 | **274** | |
| 29 | 21 | 56 | 238 | 0.88 | 69 | 84 | **153** | 99 | 6 | 336 | **342** | |
| 28 | 22 | 59 | 284 | 0.88 | 73 | 100 | **173** | 105 | 12 | 400 | **412** | |
| 27 | 23 | 63 | 332 | 0.88 | 77 | 117 | **194** | 111 | 18 | 467 | **485** | |
| 26 | 24 | 66 | 381 | 0.88 | 82 | 134 | **216** | 117 | 24 | 537 | **561** | |
| 25 | 25 | 70 | 433 | 0.88 | 86 | 152 | **238** | 123 | 30 | 610 | **640** | |
| 24 | 26 | 73 | 487 | 0.88 | 90 | 171 | **261** | 129 | 36 | 685 | **721** | |
| 23 | 27 | 76 | 542 | 0.88 | 94 | 191 | **285** | 135 | 42 | 763 | **805** | |
| 22 | 28 | 80 | 596 | 0.88 | 98 | 210 | **308** | 141 | 48 | 839 | **887** | |
| 21 | 29 | 83 | 643 | 0.88 | 103 | 226 | **329** | 147 | 54 | 906 | **960** | |
| 20 | 30 | 87 | 685 | 0.88 | 107 | 241 | **348** | 153 | 60 | 965 | **1024** | |
| 19 | 31 | 90 | 721 | 0.88 | 111 | 254 | **365** | 159 | 66 | 1015 | **1081** | |
| 18 | 32 | 93 | 751 | 0.88 | 115 | 264 | **379** | 164 | 72 | 1057 | **1129** | |
| 17 | 33 | 97 | 774 | 0.88 | 119 | 273 | **392** | 170 | 78 | 1090 | **1168** | |
| 16 | 34 | 100 | 792 | 0.88 | 124 | 279 | **402** | 176 | 84 | 1116 | **1199** | |
| 15 | 35 | 104 | 804 | 0.88 | 128 | 283 | **411** | 182 | 90 | 1132 | **1222** | |
| 14 | 36 | 107 | 810 | 0.88 | 132 | 285 | **417** | 188 | 96 | 1141 | **1236** | |
| 13 | 37 | 110 | 810 | 0.88 | 136 | 285 | **421** | 194 | 102 | 1141 | **1242** | |
| 12 | 38 | 127 | 810 | 0.88 | 157 | 285 | **442** | 224 | 131 | 1141 | **1272** | |
| 11 | 39 | 144 | 812 | 0.88 | 178 | 286 | **464** | 254 | 162 | 1144 | **1306** | |
| 10 | 40 | 162 | 815 | 0.88 | 199 | 287 | **486** | 285 | 192 | 1147 | **1340** | |
| 9 | 41 | 180 | 817 | 0.88 | 221 | 288 | **509** | 316 | 224 | 1151 | **1374** | |
| 8 | 42 | 198 | 820 | 0.88 | 244 | 289 | **532** | 348 | 255 | 1155 | **1410** | |
| 7 | 43 | 216 | 823 | 0.88 | 266 | 290 | **556** | 380 | 287 | 1158 | **1446** | |
| 6 | 44 | 234 | 826 | 0.88 | 289 | 291 | **579** | 413 | 320 | 1162 | **1482** | |
| 5 | 45 | 253 | 829 | 0.88 | 312 | 292 | **603** | 445 | 353 | 1167 | **1519** | |
| 4 | 46 | 272 | 832 | 0.88 | 335 | 293 | **628** | 479 | 386 | 1171 | **1557** | Extreme (1551k)* |
| 3 | 47 | 291 | 835 | 0.88 | 359 | 294 | **653** | 512 | 420 | 1175 | **1595** | Use El-1' |
| 2 | 48 | 310 | 838 | 0.88 | 382 | 295 | **677** | 546 | 454 | 1180 | **1633** | |
| 1 | 49 | 330 | 841 | 0.88 | 406 | 296 | **702** | 581 | 488 | 1184 | **1671** | |
| 0 | 50 | 349 | 843 | 0.88 | 430 | 297 | **727** | 615 | 522 | 1187 | **1709** | |
| -1 | 51 | 369 | 845 | 0.88 | 455 | 297 | **752** | 650 | 557 | 1190 | **1747** | |
| -2 | 52 | 389 | 847 | 0.88 | 479 | 298 | **777** | 685 | 592 | 1192 | **1784** | |
| -3 | 53 | 409 | 848 | 0.88 | 504 | 299 | **802** | 720 | 627 | 1194 | **1821** | |
| -4 | 54 | 429 | 849 | 0.88 | 529 | 299 | **827** | 755 | 662 | 1196 | **1858** | |
| -5 | 55 | 449 | 850 | 0.88 | 553 | 299 | **852** | 790 | 698 | 1197 | **1894** | |
| -6 | 56 | 469 | 850 | 0.88 | 578 | 299 | **877** | 826 | 733 | 1197 | **1930** | |
| -7 | 57 | 490 | 850 | 0.88 | 603 | 299 | **902** | 862 | 769 | 1197 | **1966** | |
| -8 | 58 | 521 | 850 | 0.88 | 642 | 299 | **941** | 917 | 825 | 1197 | **2022** | |
| -9 | 59 | 553 | 850 | 0.88 | 681 | 299 | **980** | 973 | 880 | 1197 | **2077** | |
| -10 | 60 | 584 | 850 | 0.88 | 720 | 299 | **1019** | 1028 | 936 | 1197 | **2133** | |
| -11 | 61 | 616 | 850 | 0.88 | 759 | 299 | **1058** | 1084 | 991 | 1197 | **2188** | |
| -12 | 62 | 647 | 850 | 0.88 | 798 | 299 | **1097** | 1140 | 1047 | 1197 | **2244** | |
| -13 | 63 | 679 | 850 | 0.88 | 837 | 299 | **1136** | 1195 | 1102 | 1197 | **2299** | |
| -14 | 64 | 711 | 850 | 0.88 | 876 | 299 | **1175** | 1251 | 1158 | 1197 | **2355** | |
| -15 | 65 | 742 | 850 | 0.88 | 914 | 299 | **1214** | 1306 | 1214 | 1197 | **2411** | |
| -16 | 66 | 774 | 850 | 0.88 | 953 | 299 | **1253** | 1362 | 1269 | 1197 | **2466** | |
| -17 | 67 | 805 | 850 | 0.88 | 992 | 299 | **1291** | 1417 | 1325 | 1197 | **2522** | |
| -18 | 68 | 837 | 850 | 0.88 | 1031 | 299 | **1330** | 1473 | 1380 | 1197 | **2577** | |
| -19 | 69 | 869 | 850 | 0.88 | 1070 | 299 | **1369** | 1529 | 1436 | 1197 | **2633** | |
| -20 | 70 | 900 | 850 | 0.88 | 1109 | 299 | **1408** | 1584 | 1491 | 1197 | **2689** | |
| -21 | 71 | 932 | 850 | 0.88 | 1148 | 299 | **1447** | 1640 | 1547 | 1197 | **2744** | |
| -22 | 72 | 963 | 850 | 0.88 | 1187 | 299 | **1486** | 1695 | 1603 | 1197 | **2800** | |
| -23 | 73 | 995 | 850 | 0.88 | 1226 | 299 | **1525** | 1751 | 1658 | 1197 | **2855** | |
| -24 | 74 | 1026 | 850 | 0.88 | 1265 | 299 | **1564** | 1806 | 1714 | 1197 | **2911** | |
| -25 | 75 | 1058 | 850 | 0.88 | 1303 | 299 | **1603** | 1862 | 1769 | 1197 | **2966** | |
| -26 | 76 | 1090 | 850 | 0.88 | 1342 | 299 | **1642** | 1918 | 1825 | 1197 | **3022** | |
| -27 | 77 | 1121 | 850 | 0.88 | 1381 | 299 | **1681** | 1973 | 1880 | 1197 | **3078** | |
| -28 | 78 | 1153 | 850 | 0.88 | 1420 | 299 | **1719** | 2029 | 1936 | 1197 | **3133** | |
| -29 | 79 | 1184 | 913 | 0.88 | 1459 | 321 | **1780** | 2084 | 1992 | 1285 | **3276** | |
| -30 | 80 | 1216 | 978 | 0.88 | 1498 | 344 | **1842** | 2140 | 2047 | 1377 | **3424** | |
| -31 | 81 | 1247 | 1047 | 0.88 | 1537 | 368 | **1905** | 2196 | 2103 | 1474 | **3576** | |
| -32 | 82 | 1279 | 1118 | 0.88 | 1576 | 394 | **1969** | 2251 | 2158 | 1574 | **3733** | |
| -33 | 83 | 1311 | 1193 | 0.88 | 1615 | 420 | **2035** | 2307 | 2214 | 1680 | **3894** | |
| -34 | 84 | 1342 | 1271 | 0.88 | 1654 | 447 | **2101** | 2362 | 2270 | 1790 | **4059** | |
| -35 | 85 | 1374 | 1352 | 0.88 | 1692 | 476 | **2168** | 2418 | 2325 | 1904 | **4229** | |
| -36 | 86 | 1405 | 1436 | 0.88 | 1731 | 506 | **2237** | 2473 | 2381 | 2022 | **4403** | |
| -37 | 87 | 1437 | 1523 | 0.88 | 1770 | 536 | **2307** | 2529 | 2436 | 2145 | **4581** | |
| -38 | 88 | 1468 | 1608 | 0.88 | 1809 | 566 | **2375** | 2585 | 2492 | 2264 | **4755** | |
| -39 | 89 | 1500 | 1682 | 0.88 | 1848 | 592 | **2440** | 2640 | 2547 | 2369 | **4916** | |
| -40 | 90 | 1532 | 1748 | 0.88 | 1887 | 615 | **2502** | 2696 | 2603 | 2461 | **5064** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 5
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 1563 | 1804 | 0.88 | 1926 | 635 | **2561** | 2751 | 2659 | 2540 | **5199** | |
| -42 | 92 | 1595 | 1851 | 0.88 | 1965 | 651 | **2616** | 2807 | 2714 | 2606 | **5320** | |
| -43 | 93 | 1626 | 1888 | 0.88 | 2004 | 665 | **2668** | 2862 | 2770 | 2659 | **5428** | |
| -44 | 94 | 1658 | 1916 | 0.88 | 2043 | 675 | **2717** | 2918 | 2825 | 2698 | **5523** | |
| -45 | 95 | 1690 | 1935 | 0.88 | 2082 | 681 | **2763** | 2974 | 2881 | 2724 | **5605** | |
| -46 | 96 | 1721 | 1944 | 0.88 | 2120 | 684 | **2805** | 3029 | 2936 | 2738 | **5674** | |
| -47 | 97 | 1753 | 1944 | 0.88 | 2159 | 684 | **2844** | 3085 | 2992 | 2738 | **5730** | |
| -48 | 98 | 1773 | 1944 | 0.88 | 2185 | 684 | **2869** | 3121 | 3028 | 2738 | **5766** | |
| -49 | 99 | 1794 | 1944 | 0.88 | 2210 | 684 | **2894** | 3157 | 3065 | 2738 | **5802** | |
| -50 | 100 | 1815 | 1944 | 0.88 | 2236 | 684 | **2920** | 3194 | 3101 | 2738 | **5839** | |
| -51 | 101 | 1836 | 1944 | 0.88 | 2262 | 684 | **2946** | 3232 | 3139 | 2738 | **5876** | |
| -52 | 102 | 1858 | 1944 | 0.88 | 2289 | 684 | **2973** | 3269 | 3177 | 2738 | **5914** | |
| -53 | 103 | 1879 | 1944 | 0.88 | 2315 | 684 | **3000** | 3308 | 3215 | 2738 | **5953** | |
| -54 | 104 | 1901 | 1944 | 0.88 | 2343 | 684 | **3027** | 3347 | 3254 | 2738 | **5991** | |
| -55 | 105 | 1924 | 1944 | 0.88 | 2370 | 684 | **3054** | 3386 | 3293 | 2738 | **6031** | |
| -56 | 106 | 1946 | 1944 | 0.88 | 2398 | 684 | **3082** | 3425 | 3333 | 2738 | **6070** | |
| -57 | 107 | 1969 | 1944 | 0.88 | 2426 | 684 | **3110** | 3466 | 3373 | 2738 | **6110** | |
| -58 | 108 | 1992 | 1944 | 0.88 | 2454 | 684 | **3139** | 3506 | 3414 | 2738 | **6151** | |
| -59 | 109 | 2016 | 1944 | 0.88 | 2483 | 684 | **3168** | 3547 | 3455 | 2738 | **6192** | |
| -60 | 110 | 2039 | 1944 | 0.88 | 2512 | 684 | **3197** | 3589 | 3496 | 2738 | **6234** | |
| -61 | 111 | 2063 | 1944 | 0.88 | 2542 | 684 | **3226** | 3631 | 3538 | 2738 | **6276** | |
| -62 | 112 | 2087 | 1944 | 0.88 | 2571 | 684 | **3256** | 3673 | 3581 | 2738 | **6318** | |
| -63 | 113 | 2111 | 1944 | 0.88 | 2601 | 684 | **3286** | 3716 | 3624 | 2738 | **6361** | |
| -64 | 114 | 2136 | 1944 | 0.88 | 2632 | 684 | **3316** | 3760 | 3667 | 2738 | **6404** | |
| -65 | 115 | 2161 | 1944 | 0.88 | 2662 | 684 | **3347** | 3803 | 3711 | 2738 | **6448** | |
| -66 | 116 | 2186 | 1944 | 0.88 | 2693 | 684 | **3378** | 3848 | 3755 | 2738 | **6493** | |
| -67 | 117 | 2212 | 1944 | 0.88 | 2725 | 684 | **3409** | 3892 | 3800 | 2738 | **6537** | |
| -68 | 118 | 2237 | 1944 | 0.88 | 2756 | 684 | **3441** | 3938 | 3845 | 2738 | **6583** | |
| -69 | 119 | 2263 | 1944 | 0.88 | 2788 | 684 | **3473** | 3983 | 3891 | 2738 | **6628** | |
| -70 | 120 | 2289 | 1944 | 0.88 | 2821 | 684 | **3505** | 4029 | 3937 | 2738 | **6674** | |
| -71 | 121 | 2316 | 1944 | 0.88 | 2853 | 684 | **3538** | 4076 | 3983 | 2738 | **6721** | |
| -72 | 122 | 2343 | 1944 | 0.88 | 2886 | 684 | **3571** | 4123 | 4030 | 2738 | **6768** | |
| -73 | 123 | 2370 | 1944 | 0.88 | 2919 | 684 | **3604** | 4171 | 4078 | 2738 | **6815** | |
| -74 | 124 | 2397 | 1944 | 0.88 | 2953 | 684 | **3637** | 4219 | 4126 | 2738 | **6863** | |
| -75 | 125 | 2424 | 1944 | 0.88 | 2987 | 684 | **3671** | 4267 | 4174 | 2738 | **6912** | |
| -76 | 126 | 2452 | 1944 | | | | | | | | | |
| -77 | 127 | 2480 | 1944 | | | | | | | | | |
| -78 | 128 | 2509 | 1944 | | | | | | | | | |
| -79 | 129 | 2537 | 1944 | | | | | | | | | |
| -80 | 130 | 2566 | 1944 | | | | | | | | | Strength (4716k) |
| 50 | | | | | | | | | | | | use EL-81' |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 6
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft
Pile type: 118"'-diameter CIDH
Pre-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 5 | Clay | 0.88 |
| (2) | 5 | 30 | Sand | 0.88 |
| (3) | 30 | 40 | Sand | 0.88 |
| (4) | 40 | 95 | Clay | 0.88 |
| (5) | 95 | 170 | Sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
224 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 44 | 6 | 4 | 0 | 0.88 | 5 | 0 | **5** | 7 | 0 | 0 | **0** |
| 43 | 7 | 10 | 0 | 0.88 | 12 | 0 | **12** | 17 | 0 | 0 | **0** |
| 42 | 8 | 16 | 0 | 0.88 | 19 | 0 | **19** | 28 | 0 | 0 | **0** |
| 41 | 9 | 22 | 0 | 0.88 | 27 | 0 | **27** | 39 | 0 | 0 | **0** |
| 40 | 10 | 29 | 0 | 0.88 | 36 | 0 | **36** | 52 | 0 | 0 | **0** |
| 39 | 11 | 37 | 0 | 0.88 | 45 | 0 | **45** | 65 | 0 | 0 | **0** |
| 38 | 12 | 45 | 46 | 0.88 | 56 | 16 | **72** | 79 | 0 | 65 | **65** |
| 37 | 13 | 54 | 95 | 0.88 | 66 | 33 | **100** | 95 | 0 | 133 | **133** |
| 36 | 14 | 63 | 145 | 0.88 | 78 | 51 | **129** | 111 | 0 | 205 | **205** |
| 35 | 15 | 73 | 199 | 0.88 | 89 | 70 | **159** | 128 | 0 | 280 | **280** |
| 34 | 16 | 83 | 254 | 0.88 | 102 | 89 | **191** | 145 | 0 | 358 | **358** |
| 33 | 17 | 93 | 312 | 0.88 | 115 | 110 | **225** | 164 | 0 | 439 | **439** |
| 32 | 18 | 104 | 372 | 0.88 | 128 | 131 | **259** | 183 | 0 | 523 | **523** |
| 31 | 19 | 116 | 434 | 0.88 | 142 | 153 | **295** | 203 | 0 | 611 | **611** |
| 30 | 20 | 127 | 499 | 0.88 | 157 | 176 | **332** | 224 | 0 | 702 | **702** |
| 29 | 21 | 140 | 561 | 0.88 | 172 | 197 | **369** | 246 | 21 | 790 | **811** |
| 28 | 22 | 152 | 619 | 0.88 | 187 | 218 | **405** | 268 | 44 | 871 | **915** |
| 27 | 23 | 165 | 669 | 0.88 | 203 | 236 | **439** | 290 | 66 | 943 | **1009** |
| 26 | 24 | 178 | 714 | 0.88 | 220 | 251 | **471** | 314 | 90 | 1005 | **1094** |
| 25 | 25 | 192 | 751 | 0.88 | 236 | 264 | **501** | 338 | 113 | 1057 | **1171** |
| 24 | 26 | 206 | 781 | 0.88 | 253 | 275 | **528** | 362 | 138 | 1100 | **1238** |
| 23 | 27 | 220 | 805 | 0.88 | 271 | 283 | **554** | 387 | 163 | 1133 | **1296** |
| 22 | 28 | 234 | 822 | 0.88 | 289 | 289 | **578** | 413 | 188 | 1157 | **1345** |
| 21 | 29 | 249 | 832 | 0.88 | 307 | 293 | **600** | 439 | 214 | 1171 | **1385** |
| 20 | 30 | 264 | 835 | 0.88 | 325 | 294 | **619** | 465 | 241 | 1175 | **1416** |
| 19 | 31 | 280 | 838 | 0.88 | 344 | 295 | **639** | 492 | 268 | 1180 | **1448** |
| 18 | 32 | 295 | 841 | 0.88 | 364 | 296 | **660** | 520 | 296 | 1184 | **1479** |
| 17 | 33 | 312 | 843 | 0.88 | 384 | 297 | **681** | 549 | 324 | 1187 | **1511** |
| 16 | 34 | 328 | 845 | 0.88 | 404 | 297 | **702** | 578 | 354 | 1190 | **1543** |
| 15 | 35 | 345 | 847 | 0.88 | 425 | 298 | **723** | 608 | 383 | 1192 | **1576** |
| 14 | 36 | 363 | 848 | 0.88 | 447 | 299 | **745** | 638 | 414 | 1194 | **1608** |
| 13 | 37 | 380 | 849 | 0.88 | 468 | 299 | **767** | 669 | 445 | 1196 | **1641** |
| 12 | 38 | 398 | 850 | 0.88 | 491 | 299 | **790** | 701 | 477 | 1197 | **1673** |
| 11 | 39 | 416 | 850 | 0.88 | 513 | 299 | **812** | 733 | 509 | 1197 | **1706** |
| 10 | 40 | 435 | 850 | 0.88 | 536 | 299 | **835** | 765 | 541 | 1197 | **1738** |
| 9 | 41 | 466 | 850 | 0.88 | 575 | 299 | **874** | 821 | 597 | 1197 | **1794** |
| 8 | 42 | 498 | 850 | 0.88 | 614 | 299 | **913** | 877 | 652 | 1197 | **1849** |
| 7 | 43 | 530 | 850 | 0.88 | 652 | 299 | **952** | 932 | 708 | 1197 | **1905** |
| 6 | 44 | 561 | 850 | 0.88 | 691 | 299 | **991** | 988 | 763 | 1197 | **1961** |
| 5 | 45 | 593 | 850 | 0.88 | 730 | 299 | **1030** | 1043 | 819 | 1197 | **2016** |
| 4 | 46 | 624 | 850 | 0.88 | 769 | 299 | **1068** | 1099 | 875 | 1197 | **2072** |
| 3 | 47 | 656 | 850 | 0.88 | 808 | 299 | **1107** | 1154 | 930 | 1197 | **2127** |
| 2 | 48 | 688 | 850 | 0.88 | 847 | 299 | **1146** | 1210 | 986 | 1197 | **2183** |
| 1 | 49 | 719 | 850 | 0.88 | 886 | 299 | **1185** | 1266 | 1041 | 1197 | **2238** |
| 0 | 50 | 751 | 850 | 0.88 | 925 | 299 | **1224** | 1321 | 1097 | 1197 | **2294** |
| -1 | 51 | 782 | 850 | 0.88 | 964 | 299 | **1263** | 1377 | 1153 | 1197 | **2350** |
| -2 | 52 | 814 | 850 | 0.88 | 1003 | 299 | **1302** | 1432 | 1208 | 1197 | **2405** |
| -3 | 53 | 845 | 850 | 0.88 | 1042 | 299 | **1341** | 1488 | 1264 | 1197 | **2461** |
| -4 | 54 | 877 | 850 | 0.88 | 1080 | 299 | **1380** | 1543 | 1319 | 1197 | **2516** |
| -5 | 55 | 909 | 850 | 0.88 | 1119 | 299 | **1419** | 1599 | 1375 | 1197 | **2572** |
| -6 | 56 | 940 | 850 | 0.88 | 1158 | 299 | **1457** | 1655 | 1430 | 1197 | **2627** |
| -7 | 57 | 972 | 850 | 0.88 | 1197 | 299 | **1496** | 1710 | 1486 | 1197 | **2683** |
| -8 | 58 | 1003 | 850 | 0.88 | 1236 | 299 | **1535** | 1766 | 1542 | 1197 | **2739** |
| -9 | 59 | 1035 | 850 | 0.88 | 1275 | 299 | **1574** | 1821 | 1597 | 1197 | **2794** |
| -10 | 60 | 1066 | 850 | 0.88 | 1314 | 299 | **1613** | 1877 | 1653 | 1197 | **2850** |
| -11 | 61 | 1098 | 850 | 0.88 | 1353 | 299 | **1652** | 1932 | 1708 | 1197 | **2905** |
| -12 | 62 | 1130 | 850 | 0.88 | 1392 | 299 | **1691** | 1988 | 1764 | 1197 | **2961** |
| -13 | 63 | 1161 | 850 | 0.88 | 1431 | 299 | **1730** | 2044 | 1819 | 1197 | **3016** |
| -14 | 64 | 1193 | 850 | 0.88 | 1469 | 299 | **1769** | 2099 | 1875 | 1197 | **3072** |
| -15 | 65 | 1224 | 850 | 0.88 | 1508 | 299 | **1808** | 2155 | 1931 | 1197 | **3128** |
| -16 | 66 | 1256 | 850 | 0.88 | 1547 | 299 | **1847** | 2210 | 1986 | 1197 | **3183** |
| -17 | 67 | 1287 | 850 | 0.88 | 1586 | 299 | **1885** | 2266 | 2042 | 1197 | **3239** |
| -18 | 68 | 1319 | 850 | 0.88 | 1625 | 299 | **1924** | 2322 | 2097 | 1197 | **3294** |
| -19 | 69 | 1351 | 850 | 0.88 | 1664 | 299 | **1963** | 2377 | 2153 | 1197 | **3350** |
| -20 | 70 | 1382 | 850 | 0.88 | 1703 | 299 | **2002** | 2433 | 2208 | 1197 | **3406** |
| -21 | 71 | 1414 | 850 | 0.88 | 1742 | 299 | **2041** | 2488 | 2264 | 1197 | **3461** |
| -22 | 72 | 1445 | 850 | 0.88 | 1781 | 299 | **2080** | 2544 | 2320 | 1197 | **3517** |
| -23 | 73 | 1477 | 850 | 0.88 | 1820 | 299 | **2119** | 2599 | 2375 | 1197 | **3572** |
| -24 | 74 | 1509 | 850 | 0.88 | 1858 | 299 | **2158** | 2655 | 2431 | 1197 | **3628** |
| -25 | 75 | 1540 | 850 | 0.88 | 1897 | 299 | **2197** | 2711 | 2486 | 1197 | **3683** |
| -26 | 76 | 1572 | 850 | 0.88 | 1936 | 299 | **2236** | 2766 | 2542 | 1197 | **3739** |
| -27 | 77 | 1603 | 913 | 0.88 | 1975 | 321 | **2296** | 2822 | 2597 | 1285 | **3882** |
| -28 | 78 | 1635 | 978 | 0.88 | 2014 | 344 | **2358** | 2877 | 2653 | 1377 | **4030** |
| -29 | 79 | 1666 | 1047 | 0.88 | 2053 | 368 | **2421** | 2933 | 2709 | 1474 | **4182** |
| -30 | 80 | 1698 | 1118 | 0.88 | 2092 | 394 | **2486** | 2988 | 2764 | 1574 | **4339** |
| -31 | 81 | 1730 | 1193 | 0.88 | 2131 | 420 | **2551** | 3044 | 2820 | 1680 | **4500** |
| -32 | 82 | 1761 | 1271 | 0.88 | 2170 | 447 | **2617** | 3100 | 2875 | 1790 | **4665** |
| -33 | 83 | 1793 | 1352 | 0.88 | 2209 | 476 | **2685** | 3155 | 2931 | 1904 | **4835** |
| -34 | 84 | 1824 | 1436 | 0.88 | 2248 | 506 | **2753** | 3211 | 2987 | 2022 | **5009** |
| -35 | 85 | 1856 | 1523 | 0.88 | 2286 | 536 | **2823** | 3266 | 3042 | 2145 | **5187** |
| -36 | 86 | 1887 | 1608 | 0.88 | 2325 | 566 | **2891** | 3322 | 3098 | 2264 | **5361** |
| -37 | 87 | 1919 | 1682 | 0.88 | 2364 | 592 | **2956** | 3377 | 3153 | 2369 | **5522** |
| -38 | 88 | 1951 | 1748 | 0.88 | 2403 | 615 | **3018** | 3433 | 3209 | 2461 | **5670** |
| -39 | 89 | 1982 | 1804 | 0.88 | 2442 | 635 | **3077** | 3489 | 3264 | 2540 | **5804** |
| -40 | 90 | 2014 | 1851 | 0.88 | 2481 | 651 | **3132** | 3544 | 3320 | 2606 | **5926** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 6
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 2045 | 1888 | 0.88 | 2520 | 665 | **3184** | 3600 | 3376 | 2659 | **6034** | |
| -42 | 92 | 2077 | 1916 | 0.88 | 2559 | 675 | **3233** | 3655 | 3431 | 2698 | **6129** | |
| -43 | 93 | 2108 | 1935 | 0.88 | 2598 | 681 | **3279** | 3711 | 3487 | 2724 | **6211** | |
| -44 | 94 | 2140 | 1944 | 0.88 | 2637 | 684 | **3321** | 3766 | 3542 | 2738 | **6280** | |
| -45 | 95 | 2172 | 1944 | 0.88 | 2675 | 684 | **3360** | 3822 | 3598 | 2738 | **6335** | |
| -46 | 96 | 2192 | 1944 | 0.88 | 2701 | 684 | **3385** | 3859 | 3634 | 2738 | **6372** | |
| -47 | 97 | 2213 | 1944 | 0.88 | 2727 | 684 | **3411** | 3895 | 3671 | 2738 | **6409** | |
| -48 | 98 | 2235 | 1944 | 0.88 | 2753 | 684 | **3437** | 3933 | 3709 | 2738 | **6446** | |
| -49 | 99 | 2256 | 1944 | 0.88 | 2779 | 684 | **3464** | 3971 | 3746 | 2738 | **6484** | |
| -50 | 100 | 2278 | 1944 | 0.88 | 2806 | 684 | **3491** | 4009 | 3785 | 2738 | **6522** | |
| -51 | 101 | 2300 | 1944 | 0.88 | 2833 | 684 | **3518** | 4048 | 3824 | 2738 | **6561** | |
| -52 | 102 | 2322 | 1944 | 0.88 | 2861 | 684 | **3545** | 4087 | 3863 | 2738 | **6600** | |
| -53 | 103 | 2345 | 1944 | 0.88 | 2889 | 684 | **3573** | 4127 | 3902 | 2738 | **6640** | |
| -54 | 104 | 2367 | 1944 | 0.88 | 2917 | 684 | **3601** | 4167 | 3943 | 2738 | **6680** | |
| -55 | 105 | 2391 | 1944 | 0.88 | 2945 | 684 | **3630** | 4207 | 3983 | 2738 | **6721** | |
| -56 | 106 | 2414 | 1944 | 0.88 | 2974 | 684 | **3658** | 4248 | 4024 | 2738 | **6762** | |
| -57 | 107 | 2437 | 1944 | 0.88 | 3003 | 684 | **3687** | 4290 | 4066 | 2738 | **6803** | |
| -58 | 108 | 2461 | 1944 | 0.88 | 3032 | 684 | **3717** | 4332 | 4108 | 2738 | **6845** | |
| -59 | 109 | 2485 | 1944 | 0.88 | 3062 | 684 | **3746** | 4374 | 4150 | 2738 | **6888** | |
| -60 | 110 | 2510 | 1944 | 0.88 | 3092 | 684 | **3776** | 4417 | 4193 | 2738 | **6931** | |
| -61 | 111 | 2534 | 1944 | 0.88 | 3122 | 684 | **3807** | 4461 | 4236 | 2738 | **6974** | |
| -62 | 112 | 2559 | 1944 | 0.88 | 3153 | 684 | **3837** | 4504 | 4280 | 2738 | **7018** | |
| -63 | 113 | 2584 | 1944 | 0.88 | 3184 | 684 | **3868** | 4549 | 4324 | 2738 | **7062** | |
| -64 | 114 | 2610 | 1944 | 0.88 | 3215 | 684 | **3900** | 4593 | 4369 | 2738 | **7107** | |
| -65 | 115 | 2636 | 1944 | 0.88 | 3247 | 684 | **3931** | 4639 | 4414 | 2738 | **7152** | |
| -66 | 116 | 2662 | 1944 | 0.88 | 3279 | 684 | **3963** | 4684 | 4460 | 2738 | **7198** | |
| -67 | 117 | 2688 | 1944 | 0.88 | 3311 | 684 | **3996** | 4730 | 4506 | 2738 | **7244** | Strength (3997k) |
| -68 | 118 | 2714 | 1944 | 0.88 | 3344 | 684 | **4028** | 4777 | 4553 | 2738 | **7290** | use EL-68' |
| -69 | 119 | 2741 | 1944 | 0.88 | 3377 | 684 | **4061** | 4824 | 4600 | 2738 | **7337** | |
| -70 | 120 | 2768 | 1944 | 0.88 | 3410 | 684 | **4094** | 4871 | 4647 | 2738 | **7385** | |
| -71 | 121 | 2795 | 1944 | 0.88 | 3444 | 684 | **4128** | 4919 | 4695 | 2738 | **7433** | |
| -72 | 122 | 2823 | 1944 | 0.88 | 3477 | 684 | **4162** | 4968 | 4744 | 2738 | **7481** | |
| -73 | 123 | 2850 | 1944 | 0.88 | 3512 | 684 | **4196** | 5017 | 4792 | 2738 | **7530** | |
| -74 | 124 | 2878 | 1944 | 0.88 | 3546 | 684 | **4231** | 5066 | 4842 | 2738 | **7579** | |
| -75 | 125 | 2907 | 1944 | 0.88 | 3581 | 684 | **4265** | 5116 | 4892 | 2738 | **7629** | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 6
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft

Pile type: 118'"-diameter CIDH

Post-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 5 | Clay | 0.88 |
| (2) | 5 | 30 | Clay | 0.88 |
| (3) | 30 | 40 | Sand | 0.88 |
| (4) | 40 | 95 | Clay | 0.88 |
| (5) | 95 | 170 | Sand | 0.88 |

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
90 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 44 | 6 | 3 | 116 | 0.88 | 4 | 41 | **45** | 6 | 0 | 163 | **163** | |
| 43 | 7 | 7 | 117 | 0.88 | 8 | 41 | **49** | 12 | 0 | 164 | **164** | |
| 42 | 8 | 10 | 117 | 0.88 | 13 | 41 | **54** | 18 | 0 | 165 | **165** | |
| 41 | 9 | 14 | 118 | 0.88 | 17 | 41 | **58** | 24 | 0 | 166 | **166** | |
| 40 | 10 | 17 | 118 | 0.88 | 21 | 42 | **62** | 30 | 0 | 166 | **166** | |
| 39 | 11 | 20 | 118 | 0.88 | 25 | 42 | **67** | 36 | 0 | 167 | **167** | |
| 38 | 12 | 24 | 158 | 0.88 | 29 | 56 | **85** | 42 | 0 | 222 | **222** | |
| 37 | 13 | 27 | 200 | 0.88 | 33 | 70 | **104** | 48 | 0 | 281 | **281** | |
| 36 | 14 | 31 | 243 | 0.88 | 38 | 86 | **123** | 54 | 0 | 342 | **342** | |
| 35 | 15 | 34 | 288 | 0.88 | 42 | 102 | **143** | 60 | 0 | 406 | **406** | |
| 34 | 16 | 37 | 336 | 0.88 | 46 | 118 | **164** | 66 | 0 | 473 | **473** | |
| 33 | 17 | 41 | 385 | 0.88 | 50 | 136 | **186** | 72 | 0 | 542 | **542** | |
| 32 | 18 | 44 | 436 | 0.88 | 54 | 154 | **208** | 78 | 0 | 614 | **614** | |
| 31 | 19 | 48 | 489 | 0.88 | 59 | 172 | **231** | 84 | 0 | 689 | **689** | |
| 30 | 20 | 51 | 545 | 0.88 | 63 | 192 | **255** | 90 | 0 | 767 | **767** | |
| 29 | 21 | 54 | 598 | 0.88 | 67 | 210 | **277** | 96 | 6 | 842 | **848** | |
| 28 | 22 | 58 | 647 | 0.88 | 71 | 228 | **299** | 102 | 12 | 911 | **923** | |
| 27 | 23 | 61 | 691 | 0.88 | 75 | 243 | **319** | 108 | 18 | 973 | **991** | |
| 26 | 24 | 65 | 729 | 0.88 | 80 | 257 | **336** | 114 | 24 | 1026 | **1050** | |
| 25 | 25 | 68 | 761 | 0.88 | 84 | 268 | **352** | 120 | 30 | 1072 | **1101** | |
| 24 | 26 | 71 | 787 | 0.88 | 88 | 277 | **365** | 126 | 36 | 1109 | **1144** | |
| 23 | 27 | 75 | 808 | 0.88 | 92 | 284 | **376** | 132 | 42 | 1138 | **1179** | |
| 22 | 28 | 78 | 823 | 0.88 | 96 | 290 | **386** | 138 | 48 | 1158 | **1206** | |
| 21 | 29 | 82 | 832 | 0.88 | 100 | 293 | **393** | 144 | 54 | 1171 | **1225** | |
| 20 | 30 | 85 | 835 | 0.88 | 105 | 294 | **399** | 150 | 60 | 1175 | **1235** | |
| 19 | 31 | 100 | 838 | 0.88 | 124 | 295 | **419** | 177 | 87 | 1180 | **1267** | |
| 18 | 32 | 116 | 841 | 0.88 | 143 | 296 | **439** | 205 | 115 | 1184 | **1298** | |
| 17 | 33 | 132 | 843 | 0.88 | 163 | 297 | **460** | 233 | 143 | 1187 | **1330** | |
| 16 | 34 | 149 | 845 | 0.88 | 184 | 297 | **481** | 262 | 173 | 1190 | **1363** | |
| 15 | 35 | 166 | 847 | 0.88 | 205 | 298 | **503** | 292 | 203 | 1192 | **1395** | |
| 14 | 36 | 183 | 848 | 0.88 | 226 | 299 | **524** | 323 | 233 | 1194 | **1427** | |
| 13 | 37 | 201 | 849 | 0.88 | 248 | 299 | **547** | 354 | 264 | 1196 | **1460** | |
| 12 | 38 | 219 | 850 | 0.88 | 270 | 299 | **569** | 385 | 296 | 1197 | **1492** | |
| 11 | 39 | 237 | 850 | 0.88 | 292 | 299 | **591** | 417 | 328 | 1197 | **1525** | |
| 10 | 40 | 256 | 850 | 0.88 | 315 | 299 | **614** | 450 | 360 | 1197 | **1557** | |
| 9 | 41 | 287 | 850 | 0.88 | 354 | 299 | **653** | 506 | 416 | 1197 | **1613** | |
| 8 | 42 | 319 | 850 | 0.88 | 393 | 299 | **692** | 561 | 471 | 1197 | **1668** | Extreme (1638k)* |
| 7 | 43 | 350 | 850 | 0.88 | 432 | 299 | **731** | 617 | 527 | 1197 | **1724** | Use El+3' |
| 6 | 44 | 382 | 850 | 0.88 | 471 | 299 | **770** | 672 | 583 | 1197 | **1780** | |
| 5 | 45 | 414 | 850 | 0.88 | 510 | 299 | **809** | 728 | 638 | 1197 | **1835** | |
| 4 | 46 | 445 | 850 | 0.88 | 548 | 299 | **848** | 783 | 694 | 1197 | **1891** | |
| 3 | 47 | 477 | 850 | 0.88 | 587 | 299 | **887** | 839 | 749 | 1197 | **1946** | |
| 2 | 48 | 508 | 850 | 0.88 | 626 | 299 | **925** | 895 | 805 | 1197 | **2002** | |
| 1 | 49 | 540 | 850 | 0.88 | 665 | 299 | **964** | 950 | 860 | 1197 | **2057** | |
| 0 | 50 | 571 | 850 | 0.88 | 704 | 299 | **1003** | 1006 | 916 | 1197 | **2113** | |
| -1 | 51 | 603 | 850 | 0.88 | 743 | 299 | **1042** | 1061 | 972 | 1197 | **2169** | |
| -2 | 52 | 635 | 850 | 0.88 | 782 | 299 | **1081** | 1117 | 1027 | 1197 | **2224** | |
| -3 | 53 | 666 | 850 | 0.88 | 821 | 299 | **1120** | 1172 | 1083 | 1197 | **2280** | |
| -4 | 54 | 698 | 850 | 0.88 | 860 | 299 | **1159** | 1228 | 1138 | 1197 | **2335** | |
| -5 | 55 | 729 | 850 | 0.88 | 899 | 299 | **1198** | 1284 | 1194 | 1197 | **2391** | |
| -6 | 56 | 761 | 850 | 0.88 | 937 | 299 | **1237** | 1339 | 1249 | 1197 | **2447** | |
| -7 | 57 | 792 | 850 | 0.88 | 976 | 299 | **1276** | 1395 | 1305 | 1197 | **2502** | |
| -8 | 58 | 824 | 850 | 0.88 | 1015 | 299 | **1315** | 1450 | 1361 | 1197 | **2558** | |
| -9 | 59 | 856 | 850 | 0.88 | 1054 | 299 | **1353** | 1506 | 1416 | 1197 | **2613** | |
| -10 | 60 | 887 | 850 | 0.88 | 1093 | 299 | **1392** | 1561 | 1472 | 1197 | **2669** | |
| -11 | 61 | 919 | 850 | 0.88 | 1132 | 299 | **1431** | 1617 | 1527 | 1197 | **2724** | |
| -12 | 62 | 950 | 850 | 0.88 | 1171 | 299 | **1470** | 1673 | 1583 | 1197 | **2780** | |
| -13 | 63 | 982 | 850 | 0.88 | 1210 | 299 | **1509** | 1728 | 1639 | 1197 | **2836** | |
| -14 | 64 | 1014 | 850 | 0.88 | 1249 | 299 | **1548** | 1784 | 1694 | 1197 | **2891** | |
| -15 | 65 | 1045 | 850 | 0.88 | 1288 | 299 | **1587** | 1839 | 1750 | 1197 | **2947** | |
| -16 | 66 | 1077 | 850 | 0.88 | 1326 | 299 | **1626** | 1895 | 1805 | 1197 | **3002** | |
| -17 | 67 | 1108 | 850 | 0.88 | 1365 | 299 | **1665** | 1951 | 1861 | 1197 | **3058** | |
| -18 | 68 | 1140 | 850 | 0.88 | 1404 | 299 | **1704** | 2006 | 1916 | 1197 | **3113** | |
| -19 | 69 | 1171 | 850 | 0.88 | 1443 | 299 | **1742** | 2062 | 1972 | 1197 | **3169** | |
| -20 | 70 | 1203 | 850 | 0.88 | 1482 | 299 | **1781** | 2117 | 2028 | 1197 | **3225** | |
| -21 | 71 | 1235 | 850 | 0.88 | 1521 | 299 | **1820** | 2173 | 2083 | 1197 | **3280** | |
| -22 | 72 | 1266 | 850 | 0.88 | 1560 | 299 | **1859** | 2228 | 2139 | 1197 | **3336** | |
| -23 | 73 | 1298 | 850 | 0.88 | 1599 | 299 | **1898** | 2284 | 2194 | 1197 | **3391** | |
| -24 | 74 | 1329 | 850 | 0.88 | 1638 | 299 | **1937** | 2340 | 2250 | 1197 | **3447** | |
| -25 | 75 | 1361 | 850 | 0.88 | 1677 | 299 | **1976** | 2395 | 2305 | 1197 | **3502** | |
| -26 | 76 | 1392 | 850 | 0.88 | 1715 | 299 | **2015** | 2451 | 2361 | 1197 | **3558** | |
| -27 | 77 | 1424 | 913 | 0.88 | 1754 | 321 | **2076** | 2506 | 2417 | 1285 | **3701** | |
| -28 | 78 | 1456 | 978 | 0.88 | 1793 | 344 | **2138** | 2562 | 2472 | 1377 | **3849** | |
| -29 | 79 | 1487 | 1047 | 0.88 | 1832 | 368 | **2201** | 2617 | 2528 | 1474 | **4001** | |
| -30 | 80 | 1519 | 1118 | 0.88 | 1871 | 394 | **2265** | 2673 | 2583 | 1574 | **4158** | |
| -31 | 81 | 1550 | 1193 | 0.88 | 1910 | 420 | **2330** | 2729 | 2639 | 1680 | **4319** | |
| -32 | 82 | 1582 | 1271 | 0.88 | 1949 | 447 | **2396** | 2784 | 2694 | 1790 | **4484** | |
| -33 | 83 | 1613 | 1352 | 0.88 | 1988 | 476 | **2464** | 2840 | 2750 | 1904 | **4654** | |
| -34 | 84 | 1645 | 1436 | 0.88 | 2027 | 506 | **2532** | 2895 | 2806 | 2022 | **4828** | |
| -35 | 85 | 1677 | 1523 | 0.88 | 2066 | 536 | **2602** | 2951 | 2861 | 2145 | **5006** | |
| -36 | 86 | 1708 | 1608 | 0.88 | 2105 | 566 | **2670** | 3006 | 2917 | 2264 | **5180** | |
| -37 | 87 | 1740 | 1682 | 0.88 | 2143 | 592 | **2736** | 3062 | 2972 | 2369 | **5341** | |
| -38 | 88 | 1771 | 1748 | 0.88 | 2182 | 615 | **2798** | 3118 | 3028 | 2461 | **5489** | |
| -39 | 89 | 1803 | 1804 | 0.88 | 2221 | 635 | **2856** | 3173 | 3083 | 2540 | **5624** | |
| -40 | 90 | 1835 | 1851 | 0.88 | 2260 | 651 | **2912** | 3229 | 3139 | 2606 | **5745** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 6
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 1866 | 1888 | 0.88 | 2299 | 665 | **2964** | 3284 | 3195 | 2659 | **5853** | |
| -42 | 92 | 1898 | 1916 | 0.88 | 2338 | 675 | **3012** | 3340 | 3250 | 2698 | **5948** | |
| -43 | 93 | 1929 | 1935 | 0.88 | 2377 | 681 | **3058** | 3395 | 3306 | 2724 | **6030** | |
| -44 | 94 | 1961 | 1944 | 0.88 | 2416 | 684 | **3100** | 3451 | 3361 | 2738 | **6099** | |
| -45 | 95 | 1992 | 1944 | 0.88 | 2455 | 684 | **3139** | 3507 | 3417 | 2738 | **6154** | |
| -46 | 96 | 2013 | 1944 | 0.88 | 2480 | 684 | **3165** | 3543 | 3453 | 2738 | **6191** | |
| -47 | 97 | 2034 | 1944 | 0.88 | 2506 | 684 | **3190** | 3580 | 3490 | 2738 | **6228** | |
| -48 | 98 | 2055 | 1944 | 0.88 | 2532 | 684 | **3217** | 3617 | 3528 | 2738 | **6265** | |
| -49 | 99 | 2077 | 1944 | 0.88 | 2559 | 684 | **3243** | 3655 | 3566 | 2738 | **6303** | |
| -50 | 100 | 2099 | 1944 | 0.88 | 2585 | 684 | **3270** | 3694 | 3604 | 2738 | **6341** | |
| -51 | 101 | 2121 | 1944 | 0.88 | 2613 | 684 | **3297** | 3732 | 3643 | 2738 | **6380** | |
| -52 | 102 | 2143 | 1944 | 0.88 | 2640 | 684 | **3324** | 3772 | 3682 | 2738 | **6419** | |
| -53 | 103 | 2165 | 1944 | 0.88 | 2668 | 684 | **3352** | 3811 | 3722 | 2738 | **6459** | |
| -54 | 104 | 2188 | 1944 | 0.88 | 2696 | 684 | **3380** | 3851 | 3762 | 2738 | **6499** | |
| -55 | 105 | 2211 | 1944 | 0.88 | 2724 | 684 | **3409** | 3892 | 3802 | 2738 | **6540** | |
| -56 | 106 | 2235 | 1944 | 0.88 | 2753 | 684 | **3438** | 3933 | 3843 | 2738 | **6581** | |
| -57 | 107 | 2258 | 1944 | 0.88 | 2782 | 684 | **3467** | 3975 | 3885 | 2738 | **6622** | |
| -58 | 108 | 2282 | 1944 | 0.88 | 2812 | 684 | **3496** | 4017 | 3927 | 2738 | **6664** | |
| -59 | 109 | 2306 | 1944 | 0.88 | 2841 | 684 | **3526** | 4059 | 3969 | 2738 | **6707** | |
| -60 | 110 | 2331 | 1944 | 0.88 | 2871 | 684 | **3556** | 4102 | 4012 | 2738 | **6750** | |
| -61 | 111 | 2355 | 1944 | 0.88 | 2902 | 684 | **3586** | 4145 | 4055 | 2738 | **6793** | |
| -62 | 112 | 2380 | 1944 | 0.88 | 2932 | 684 | **3617** | 4189 | 4099 | 2738 | **6837** | |
| -63 | 113 | 2405 | 1944 | 0.88 | 2963 | 684 | **3648** | 4233 | 4144 | 2738 | **6881** | |
| -64 | 114 | 2431 | 1944 | 0.88 | 2995 | 684 | **3679** | 4278 | 4188 | 2738 | **6926** | |
| -65 | 115 | 2456 | 1944 | 0.88 | 3026 | 684 | **3711** | 4323 | 4233 | 2738 | **6971** | |
| -66 | 116 | 2482 | 1944 | 0.88 | 3058 | 684 | **3743** | 4369 | 4279 | 2738 | **7017** | |
| -67 | 117 | 2509 | 1944 | 0.88 | 3090 | 684 | **3775** | 4415 | 4325 | 2738 | **7063** | |
| -68 | 118 | 2535 | 1944 | 0.88 | 3123 | 684 | **3807** | 4462 | 4372 | 2738 | **7109** | |
| -69 | 119 | 2562 | 1944 | 0.88 | 3156 | 684 | **3840** | 4509 | 4419 | 2738 | **7156** | |
| -70 | 120 | 2589 | 1944 | 0.88 | 3189 | 684 | **3874** | 4556 | 4466 | 2738 | **7204** | |
| -71 | 121 | 2616 | 1944 | 0.88 | 3223 | 684 | **3907** | 4604 | 4514 | 2738 | **7252** | |
| -72 | 122 | 2643 | 1944 | 0.88 | 3257 | 684 | **3941** | 4652 | 4563 | 2738 | **7300** | |
| -73 | 123 | 2671 | 1944 | 0.88 | 3291 | 684 | **3975** | 4701 | 4612 | 2738 | **7349** | |
| -74 | 124 | 2699 | 1944 | 0.88 | 3325 | 684 | **4010** | 4751 | 4661 | 2738 | **7398** | |
| -75 | 125 | 2728 | 1944 | 0.88 | 3360 | 684 | **4045** | 4800 | 4711 | 2738 | **7448** | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | Strength (4716k) |
| 50 | | | | | | | | | | | | use EL-81' |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 7
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft
Pile type: 118"'-diameter CIDH
Pre-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 5 | Sand | 0.88 |
| (2) | 5 | 40 | Sand | 0.88 |
| (3) | 40 | 45 | Sand | 0.88 |
| (4) | 45 | 95 | Clay | 0.88 |
| (5) | 95 | 170 | Sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
224 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 44 | 6 | 4 | 0 | 0.88 | 5 | 0 | **5** | 7 | 0 | 0 | **0** |
| 43 | 7 | 10 | 0 | 0.88 | 12 | 0 | **12** | 17 | 0 | 0 | **0** |
| 42 | 8 | 16 | 0 | 0.88 | 19 | 0 | **19** | 28 | 0 | 0 | **0** |
| 41 | 9 | 22 | 0 | 0.88 | 27 | 0 | **27** | 39 | 0 | 0 | **0** |
| 40 | 10 | 29 | 0 | 0.88 | 36 | 0 | **36** | 52 | 0 | 0 | **0** |
| 39 | 11 | 37 | 0 | 0.88 | 45 | 0 | **45** | 65 | 0 | 0 | **0** |
| 38 | 12 | 45 | 0 | 0.88 | 56 | 0 | **56** | 79 | 0 | 0 | **0** |
| 37 | 13 | 54 | 0 | 0.88 | 66 | 0 | **66** | 95 | 0 | 0 | **0** |
| 36 | 14 | 63 | 0 | 0.88 | 78 | 0 | **78** | 111 | 0 | 0 | **0** |
| 35 | 15 | 73 | 0 | 0.88 | 89 | 0 | **89** | 128 | 0 | 0 | **0** |
| 34 | 16 | 83 | 0 | 0.88 | 102 | 0 | **102** | 145 | 0 | 0 | **0** |
| 33 | 17 | 93 | 0 | 0.88 | 115 | 0 | **115** | 164 | 0 | 0 | **0** |
| 32 | 18 | 104 | 0 | 0.88 | 128 | 0 | **128** | 183 | 0 | 0 | **0** |
| 31 | 19 | 116 | 0 | 0.88 | 142 | 0 | **142** | 203 | 0 | 0 | **0** |
| 30 | 20 | 127 | 0 | 0.88 | 157 | 0 | **157** | 224 | 0 | 0 | **0** |
| 29 | 21 | 140 | 0 | 0.88 | 172 | 0 | **172** | 246 | 21 | 0 | **21** |
| 28 | 22 | 152 | 69 | 0.88 | 187 | 24 | **212** | 268 | 44 | 98 | **141** |
| 27 | 23 | 165 | 142 | 0.88 | 203 | 50 | **253** | 290 | 66 | 200 | **266** |
| 26 | 24 | 178 | 218 | 0.88 | 220 | 77 | **296** | 314 | 90 | 307 | **397** |
| 25 | 25 | 192 | 298 | 0.88 | 236 | 105 | **341** | 338 | 113 | 419 | **533** |
| 24 | 26 | 206 | 381 | 0.88 | 253 | 134 | **388** | 362 | 138 | 536 | **674** |
| 23 | 27 | 220 | 447 | 0.88 | 271 | 157 | **428** | 387 | 163 | 629 | **792** |
| 22 | 28 | 234 | 515 | 0.88 | 289 | 181 | **470** | 413 | 188 | 725 | **913** |
| 21 | 29 | 249 | 585 | 0.88 | 307 | 206 | **513** | 439 | 214 | 824 | **1039** |
| 20 | 30 | 264 | 658 | 0.88 | 325 | 232 | **557** | 465 | 241 | 927 | **1168** |
| 19 | 31 | 279 | 727 | 0.88 | 344 | 256 | **600** | 492 | 268 | 1024 | **1291** |
| 18 | 32 | 295 | 784 | 0.88 | 363 | 276 | **639** | 519 | 295 | 1104 | **1399** |
| 17 | 33 | 311 | 830 | 0.88 | 383 | 292 | **675** | 547 | 323 | 1168 | **1491** |
| 16 | 34 | 327 | 864 | 0.88 | 402 | 304 | **707** | 575 | 351 | 1216 | **1567** |
| 15 | 35 | 343 | 887 | 0.88 | 422 | 312 | **734** | 603 | 379 | 1249 | **1628** |
| 14 | 36 | 359 | 900 | 0.88 | 442 | 317 | **759** | 632 | 408 | 1267 | **1675** |
| 13 | 37 | 376 | 906 | 0.88 | 463 | 319 | **782** | 661 | 437 | 1276 | **1713** |
| 12 | 38 | 392 | 905 | 0.88 | 483 | 319 | **802** | 691 | 466 | 1275 | **1741** |
| 11 | 39 | 409 | 897 | 0.88 | 504 | 316 | **820** | 720 | 496 | 1263 | **1759** |
| 10 | 40 | 426 | 881 | 0.88 | 525 | 310 | **835** | 750 | 526 | 1241 | **1767** |
| 9 | 41 | 444 | 869 | 0.88 | 546 | 306 | **852** | 781 | 556 | 1223 | **1780** |
| 8 | 42 | 461 | 860 | 0.88 | 568 | 303 | **871** | 812 | 588 | 1210 | **1798** |
| 7 | 43 | 479 | 853 | 0.88 | 590 | 300 | **891** | 843 | 619 | 1201 | **1821** |
| 6 | 44 | 497 | 850 | 0.88 | 613 | 299 | **912** | 876 | 651 | 1197 | **1848** |
| 5 | 45 | 516 | 850 | 0.88 | 636 | 299 | **935** | 908 | 684 | 1197 | **1881** |
| 4 | 46 | 548 | 850 | 0.88 | 675 | 299 | **974** | 964 | 739 | 1197 | **1936** |
| 3 | 47 | 579 | 850 | 0.88 | 713 | 299 | **1013** | 1019 | 795 | 1197 | **1992** |
| 2 | 48 | 611 | 850 | 0.88 | 752 | 299 | **1052** | 1075 | 851 | 1197 | **2048** |
| 1 | 49 | 642 | 850 | 0.88 | 791 | 299 | **1091** | 1130 | 906 | 1197 | **2103** |
| 0 | 50 | 674 | 850 | 0.88 | 830 | 299 | **1129** | 1186 | 962 | 1197 | **2159** |
| -1 | 51 | 705 | 850 | 0.88 | 869 | 299 | **1168** | 1242 | 1017 | 1197 | **2214** |
| -2 | 52 | 737 | 850 | 0.88 | 908 | 299 | **1207** | 1297 | 1073 | 1197 | **2270** |
| -3 | 53 | 769 | 850 | 0.88 | 947 | 299 | **1246** | 1353 | 1128 | 1197 | **2326** |
| -4 | 54 | 800 | 850 | 0.88 | 986 | 299 | **1285** | 1408 | 1184 | 1197 | **2381** |
| -5 | 55 | 832 | 850 | 0.88 | 1025 | 299 | **1324** | 1464 | 1240 | 1197 | **2437** |
| -6 | 56 | 863 | 850 | 0.88 | 1064 | 299 | **1363** | 1519 | 1295 | 1197 | **2492** |
| -7 | 57 | 895 | 850 | 0.88 | 1103 | 299 | **1402** | 1575 | 1351 | 1197 | **2548** |
| -8 | 58 | 926 | 850 | 0.88 | 1141 | 299 | **1441** | 1631 | 1406 | 1197 | **2603** |
| -9 | 59 | 958 | 850 | 0.88 | 1180 | 299 | **1480** | 1686 | 1462 | 1197 | **2659** |
| -10 | 60 | 990 | 850 | 0.88 | 1219 | 299 | **1518** | 1742 | 1518 | 1197 | **2715** |
| -11 | 61 | 1021 | 850 | 0.88 | 1258 | 299 | **1557** | 1797 | 1573 | 1197 | **2770** |
| -12 | 62 | 1053 | 850 | 0.88 | 1297 | 299 | **1596** | 1853 | 1629 | 1197 | **2826** |
| -13 | 63 | 1084 | 850 | 0.88 | 1336 | 299 | **1635** | 1908 | 1684 | 1197 | **2881** |
| -14 | 64 | 1116 | 850 | 0.88 | 1375 | 299 | **1674** | 1964 | 1740 | 1197 | **2937** |
| -15 | 65 | 1148 | 850 | 0.88 | 1414 | 299 | **1713** | 2020 | 1795 | 1197 | **2992** |
| -16 | 66 | 1179 | 850 | 0.88 | 1453 | 299 | **1752** | 2075 | 1851 | 1197 | **3048** |
| -17 | 67 | 1211 | 850 | 0.88 | 1492 | 299 | **1791** | 2131 | 1907 | 1197 | **3104** |
| -18 | 68 | 1242 | 850 | 0.88 | 1530 | 299 | **1830** | 2186 | 1962 | 1197 | **3159** |
| -19 | 69 | 1274 | 850 | 0.88 | 1569 | 299 | **1869** | 2242 | 2018 | 1197 | **3215** |
| -20 | 70 | 1305 | 850 | 0.88 | 1608 | 299 | **1908** | 2298 | 2073 | 1197 | **3270** |
| -21 | 71 | 1337 | 850 | 0.88 | 1647 | 299 | **1946** | 2353 | 2129 | 1197 | **3326** |
| -22 | 72 | 1369 | 850 | 0.88 | 1686 | 299 | **1985** | 2409 | 2184 | 1197 | **3381** |
| -23 | 73 | 1400 | 850 | 0.88 | 1725 | 299 | **2024** | 2464 | 2240 | 1197 | **3437** |
| -24 | 74 | 1432 | 850 | 0.88 | 1764 | 299 | **2063** | 2520 | 2296 | 1197 | **3493** |
| -25 | 75 | 1463 | 850 | 0.88 | 1803 | 299 | **2102** | 2575 | 2351 | 1197 | **3548** |
| -26 | 76 | 1495 | 850 | 0.88 | 1842 | 299 | **2141** | 2631 | 2407 | 1197 | **3604** |
| -27 | 77 | 1526 | 913 | 0.88 | 1881 | 321 | **2202** | 2687 | 2462 | 1285 | **3747** |
| -28 | 78 | 1558 | 978 | 0.88 | 1919 | 344 | **2264** | 2742 | 2518 | 1377 | **3895** |
| -29 | 79 | 1590 | 1047 | 0.88 | 1958 | 368 | **2327** | 2798 | 2573 | 1474 | **4047** |
| -30 | 80 | 1621 | 1118 | 0.88 | 1997 | 394 | **2391** | 2853 | 2629 | 1574 | **4204** |
| -31 | 81 | 1653 | 1193 | 0.88 | 2036 | 420 | **2456** | 2909 | 2685 | 1680 | **4364** |
| -32 | 82 | 1684 | 1271 | 0.88 | 2075 | 447 | **2522** | 2964 | 2740 | 1790 | **4530** |
| -33 | 83 | 1716 | 1352 | 0.88 | 2114 | 476 | **2590** | 3020 | 2796 | 1904 | **4699** |
| -34 | 84 | 1747 | 1436 | 0.88 | 2153 | 506 | **2658** | 3076 | 2851 | 2022 | **4873** |
| -35 | 85 | 1779 | 1523 | 0.88 | 2192 | 536 | **2728** | 3131 | 2907 | 2145 | **5052** |
| -36 | 86 | 1811 | 1608 | 0.88 | 2231 | 566 | **2797** | 3187 | 2962 | 2264 | **5226** |
| -37 | 87 | 1842 | 1682 | 0.88 | 2270 | 592 | **2862** | 3242 | 3018 | 2369 | **5387** |
| -38 | 88 | 1874 | 1748 | 0.88 | 2309 | 615 | **2924** | 3298 | 3074 | 2461 | **5535** |
| -39 | 89 | 1905 | 1804 | 0.88 | 2347 | 635 | **2982** | 3353 | 3129 | 2540 | **5669** |
| -40 | 90 | 1937 | 1851 | 0.88 | 2386 | 651 | **3038** | 3409 | 3185 | 2606 | **5791** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 7
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 1969 | 1888 | 0.88 | 2425 | 665 | **3090** | 3465 | 3240 | 2659 | **5899** | |
| -42 | 92 | 2000 | 1916 | 0.88 | 2464 | 675 | **3139** | 3520 | 3296 | 2698 | **5994** | |
| -43 | 93 | 2032 | 1935 | 0.88 | 2503 | 681 | **3184** | 3576 | 3352 | 2724 | **6076** | |
| -44 | 94 | 2063 | 1944 | 0.88 | 2542 | 684 | **3226** | 3631 | 3407 | 2738 | **6145** | |
| -45 | 95 | 2095 | 1944 | 0.88 | 2581 | 684 | **3265** | 3687 | 3463 | 2738 | **6200** | |
| -46 | 96 | 2115 | 1944 | 0.88 | 2606 | 684 | **3290** | 3722 | 3498 | 2738 | **6236** | |
| -47 | 97 | 2135 | 1944 | 0.88 | 2631 | 684 | **3315** | 3758 | 3534 | 2738 | **6272** | |
| -48 | 98 | 2156 | 1944 | 0.88 | 2656 | 684 | **3341** | 3795 | 3570 | 2738 | **6308** | |
| -49 | 99 | 2177 | 1944 | 0.88 | 2682 | 684 | **3366** | 3831 | 3607 | 2738 | **6345** | |
| -50 | 100 | 2198 | 1944 | 0.88 | 2708 | 684 | **3392** | 3869 | 3644 | 2738 | **6382** | |
| -51 | 101 | 2220 | 1944 | 0.88 | 2735 | 684 | **3419** | 3906 | 3682 | 2738 | **6420** | |
| -52 | 102 | 2241 | 1944 | 0.88 | 2761 | 684 | **3446** | 3945 | 3720 | 2738 | **6458** | |
| -53 | 103 | 2263 | 1944 | 0.88 | 2788 | 684 | **3473** | 3983 | 3759 | 2738 | **6497** | |
| -54 | 104 | 2285 | 1944 | 0.88 | 2816 | 684 | **3500** | 4022 | 3798 | 2738 | **6536** | |
| -55 | 105 | 2308 | 1944 | 0.88 | 2843 | 684 | **3528** | 4062 | 3838 | 2738 | **6575** | |
| -56 | 106 | 2331 | 1944 | 0.88 | 2871 | 684 | **3556** | 4102 | 3878 | 2738 | **6615** | |
| -57 | 107 | 2354 | 1944 | 0.88 | 2900 | 684 | **3584** | 4143 | 3918 | 2738 | **6656** | |
| -58 | 108 | 2377 | 1944 | 0.88 | 2928 | 684 | **3613** | 4184 | 3959 | 2738 | **6697** | |
| -59 | 109 | 2401 | 1944 | 0.88 | 2957 | 684 | **3642** | 4225 | 4001 | 2738 | **6738** | |
| -60 | 110 | 2424 | 1944 | 0.88 | 2987 | 684 | **3671** | 4267 | 4043 | 2738 | **6780** | |
| -61 | 111 | 2448 | 1944 | 0.88 | 3016 | 684 | **3701** | 4309 | 4085 | 2738 | **6822** | |
| -62 | 112 | 2473 | 1944 | 0.88 | 3046 | 684 | **3731** | 4352 | 4128 | 2738 | **6865** | |
| -63 | 113 | 2497 | 1944 | 0.88 | 3077 | 684 | **3761** | 4395 | 4171 | 2738 | **6908** | |
| -64 | 114 | 2522 | 1944 | 0.88 | 3107 | 684 | **3792** | 4439 | 4215 | 2738 | **6952** | |
| -65 | 115 | 2547 | 1944 | 0.88 | 3138 | 684 | **3823** | 4483 | 4259 | 2738 | **6996** | |
| -66 | 116 | 2573 | 1944 | 0.88 | 3169 | 684 | **3854** | 4528 | 4303 | 2738 | **7041** | |
| -67 | 117 | 2598 | 1944 | 0.88 | 3201 | 684 | **3885** | 4573 | 4349 | 2738 | **7086** | |
| -68 | 118 | 2624 | 1944 | 0.88 | 3233 | 684 | **3917** | 4618 | 4394 | 2738 | **7132** | |
| -69 | 119 | 2650 | 1944 | 0.88 | 3265 | 684 | **3949** | 4664 | 4440 | 2738 | **7178** | |
| -70 | 120 | 2677 | 1944 | 0.88 | 3298 | 684 | **3982** | 4711 | 4487 | 2738 | **7224** | |
| -71 | 121 | 2703 | 1944 | 0.88 | 3330 | 684 | **4015** | 4758 | 4534 | 2738 | **7271** | |
| -72 | 122 | 2730 | 1944 | 0.88 | 3364 | 684 | **4048** | 4805 | 4581 | 2738 | **7318** | |
| -73 | 123 | 2757 | 1944 | 0.88 | 3397 | 684 | **4081** | 4853 | 4629 | 2738 | **7366** | |
| -74 | 124 | 2785 | 1944 | 0.88 | 3431 | 684 | **4115** | 4901 | 4677 | 2738 | **7415** | |
| -75 | 125 | 2813 | 1944 | 0.88 | 3465 | 684 | **4149** | 4950 | 4726 | 2738 | **7463** | |
| -76 | 126 | 2841 | 1944 | 0.88 | 3500 | 684 | **4184** | 4999 | 4775 | 2738 | **7513** | |
| -77 | 127 | 2869 | 1944 | 0.88 | 3534 | 684 | **4219** | 5049 | 4825 | 2738 | **7562** | |
| -78 | 128 | 2897 | 1944 | 0.88 | 3569 | 684 | **4254** | 5099 | 4875 | 2738 | **7612** | |
| -79 | 129 | 2926 | 1944 | 0.88 | 3605 | 684 | **4289** | 5150 | 4926 | 2738 | **7663** | |
| -80 | 130 | 2955 | 1944 | 0.88 | 3641 | 684 | **4325** | 5201 | 4977 | 2738 | **7714** | Strength (4314k) |
| -81 | 131 | 2984 | 1944 | 0.88 | 3677 | 684 | **4361** | 5252 | 5028 | 2738 | **7766** | use EL-82' |
| -82 | 132 | 3014 | 1944 | 0.88 | 3713 | 684 | **4397** | 5304 | 5080 | 2738 | **7818** | |
| -83 | 133 | 3044 | 1944 | 0.88 | 3750 | 684 | **4434** | 5357 | 5133 | 2738 | **7870** | |
| -84 | 134 | 3074 | 1944 | 0.88 | 3787 | 684 | **4471** | 5410 | 5185 | 2738 | **7923** | |
| -85 | 135 | 3104 | 1944 | 0.88 | 3824 | 684 | **4509** | 5463 | 5239 | 2738 | **7976** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 7
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft
Pile type: 118'"-diameter CIDH
Post-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 5 | Sand | 0.88 |
| (2) | 5 | 40 | Clay | 0.88 |
| (3) | 40 | 45 | Sand | 0.88 |
| (4) | 45 | 95 | Clay | 0.88 |
| (5) | 95 | 170 | Sand | 0.88 |

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
90 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 44 | 6 | 3 | 111 | 0.88 | 4 | 39 | **43** | 6 | 0 | 156 | **156** | |
| 43 | 7 | 7 | 111 | 0.88 | 8 | 39 | **47** | 12 | 0 | 156 | **156** | |
| 42 | 8 | 10 | 111 | 0.88 | 13 | 39 | **52** | 18 | 0 | 157 | **157** | |
| 41 | 9 | 14 | 111 | 0.88 | 17 | 39 | **56** | 24 | 0 | 157 | **157** | |
| 40 | 10 | 17 | 111 | 0.88 | 21 | 39 | **60** | 30 | 0 | 157 | **157** | |
| 39 | 11 | 20 | 112 | 0.88 | 25 | 39 | **64** | 36 | 0 | 157 | **157** | |
| 38 | 12 | 24 | 111 | 0.88 | 29 | 39 | **69** | 42 | 0 | 157 | **157** | |
| 37 | 13 | 27 | 111 | 0.88 | 33 | 39 | **73** | 48 | 0 | 157 | **157** | |
| 36 | 14 | 31 | 111 | 0.88 | 38 | 39 | **77** | 54 | 0 | 157 | **157** | |
| 35 | 15 | 34 | 111 | 0.88 | 42 | 39 | **81** | 60 | 0 | 157 | **157** | |
| 34 | 16 | 37 | 111 | 0.88 | 46 | 39 | **85** | 66 | 0 | 157 | **157** | |
| 33 | 17 | 41 | 111 | 0.88 | 50 | 39 | **89** | 72 | 0 | 157 | **157** | |
| 32 | 18 | 44 | 111 | 0.88 | 54 | 39 | **94** | 78 | 0 | 156 | **156** | |
| 31 | 19 | 48 | 111 | 0.88 | 59 | 39 | **98** | 84 | 0 | 156 | **156** | |
| 30 | 20 | 51 | 111 | 0.88 | 63 | 39 | **102** | 90 | 0 | 156 | **156** | |
| 29 | 21 | 54 | 111 | 0.88 | 67 | 39 | **106** | 96 | 6 | 157 | **163** | |
| 28 | 22 | 58 | 174 | 0.88 | 71 | 61 | **132** | 102 | 12 | 245 | **257** | |
| 27 | 23 | 61 | 240 | 0.88 | 75 | 85 | **160** | 108 | 18 | 338 | **356** | |
| 26 | 24 | 65 | 309 | 0.88 | 80 | 109 | **188** | 114 | 24 | 436 | **460** | |
| 25 | 25 | 68 | 382 | 0.88 | 84 | 134 | **218** | 120 | 30 | 538 | **567** | |
| 24 | 26 | 71 | 457 | 0.88 | 88 | 161 | **249** | 126 | 36 | 644 | **680** | |
| 23 | 27 | 75 | 515 | 0.88 | 92 | 181 | **273** | 132 | 42 | 725 | **767** | |
| 22 | 28 | 78 | 575 | 0.88 | 96 | 202 | **299** | 138 | 48 | 810 | **858** | |
| 21 | 29 | 82 | 637 | 0.88 | 100 | 224 | **325** | 144 | 54 | 897 | **951** | |
| 20 | 30 | 85 | 701 | 0.88 | 105 | 247 | **352** | 150 | 60 | 988 | **1047** | |
| 19 | 31 | 88 | 761 | 0.88 | 109 | 268 | **377** | 156 | 66 | 1072 | **1138** | |
| 18 | 32 | 92 | 811 | 0.88 | 113 | 285 | **398** | 161 | 72 | 1142 | **1213** | |
| 17 | 33 | 95 | 850 | 0.88 | 117 | 299 | **416** | 167 | 78 | 1197 | **1274** | |
| 16 | 34 | 99 | 878 | 0.88 | 121 | 309 | **431** | 173 | 84 | 1237 | **1320** | |
| 15 | 35 | 102 | 896 | 0.88 | 126 | 316 | **441** | 179 | 90 | 1262 | **1352** | |
| 14 | 36 | 105 | 906 | 0.88 | 130 | 319 | **449** | 185 | 96 | 1276 | **1371** | |
| 13 | 37 | 109 | 909 | 0.88 | 134 | 320 | **454** | 191 | 102 | 1280 | **1382** | |
| 12 | 38 | 112 | 906 | 0.88 | 138 | 319 | **457** | 197 | 108 | 1276 | **1384** | |
| 11 | 39 | 116 | 897 | 0.88 | 142 | 316 | **458** | 203 | 114 | 1263 | **1377** | |
| 10 | 40 | 119 | 881 | 0.88 | 147 | 310 | **457** | 209 | 120 | 1241 | **1361** | |
| 9 | 41 | 136 | 869 | 0.88 | 168 | 306 | **474** | 240 | 150 | 1223 | **1374** | |
| 8 | 42 | 154 | 860 | 0.88 | 190 | 303 | **492** | 271 | 181 | 1210 | **1391** | |
| 7 | 43 | 172 | 853 | 0.88 | 212 | 300 | **512** | 303 | 213 | 1201 | **1414** | |
| 6 | 44 | 190 | 850 | 0.88 | 234 | 299 | **534** | 335 | 245 | 1197 | **1442** | |
| 5 | 45 | 209 | 850 | 0.88 | 257 | 299 | **556** | 367 | 278 | 1197 | **1475** | |
| 4 | 46 | 240 | 850 | 0.88 | 296 | 299 | **595** | 423 | 333 | 1197 | **1530** | |
| 3 | 47 | 272 | 850 | 0.88 | 335 | 299 | **634** | 478 | 389 | 1197 | **1586** | |
| 2 | 48 | 303 | 850 | 0.88 | 374 | 299 | **673** | 534 | 444 | 1197 | **1641** | |
| 1 | 49 | 335 | 850 | 0.88 | 413 | 299 | **712** | 590 | 500 | 1197 | **1697** | |
| 0 | 50 | 367 | 850 | 0.88 | 452 | 299 | **751** | 645 | 555 | 1197 | **1753** | Extreme (1723k)* |
| -1 | 51 | 398 | 850 | 0.88 | 491 | 299 | **790** | 701 | 611 | 1197 | **1808** | Use El -5' |
| -2 | 52 | 430 | 850 | 0.88 | 529 | 299 | **829** | 756 | 667 | 1197 | **1864** | |
| -3 | 53 | 461 | 850 | 0.88 | 568 | 299 | **868** | 812 | 722 | 1197 | **1919** | |
| -4 | 54 | 493 | 850 | 0.88 | 607 | 299 | **907** | 867 | 778 | 1197 | **1975** | |
| -5 | 55 | 524 | 850 | 0.88 | 646 | 299 | **945** | 923 | 833 | 1197 | **2030** | |
| -6 | 56 | 556 | 850 | 0.88 | 685 | 299 | **984** | 979 | 889 | 1197 | **2086** | |
| -7 | 57 | 588 | 850 | 0.88 | 724 | 299 | **1023** | 1034 | 944 | 1197 | **2142** | |
| -8 | 58 | 619 | 850 | 0.88 | 763 | 299 | **1062** | 1090 | 1000 | 1197 | **2197** | |
| -9 | 59 | 651 | 850 | 0.88 | 802 | 299 | **1101** | 1145 | 1056 | 1197 | **2253** | |
| -10 | 60 | 682 | 850 | 0.88 | 841 | 299 | **1140** | 1201 | 1111 | 1197 | **2308** | |
| -11 | 61 | 714 | 850 | 0.88 | 880 | 299 | **1179** | 1257 | 1167 | 1197 | **2364** | |
| -12 | 62 | 746 | 850 | 0.88 | 918 | 299 | **1218** | 1312 | 1222 | 1197 | **2419** | |
| -13 | 63 | 777 | 850 | 0.88 | 957 | 299 | **1257** | 1368 | 1278 | 1197 | **2475** | |
| -14 | 64 | 809 | 850 | 0.88 | 996 | 299 | **1296** | 1423 | 1334 | 1197 | **2531** | |
| -15 | 65 | 840 | 850 | 0.88 | 1035 | 299 | **1334** | 1479 | 1389 | 1197 | **2586** | |
| -16 | 66 | 872 | 850 | 0.88 | 1074 | 299 | **1373** | 1534 | 1445 | 1197 | **2642** | |
| -17 | 67 | 903 | 850 | 0.88 | 1113 | 299 | **1412** | 1590 | 1500 | 1197 | **2697** | |
| -18 | 68 | 935 | 850 | 0.88 | 1152 | 299 | **1451** | 1646 | 1556 | 1197 | **2753** | |
| -19 | 69 | 967 | 850 | 0.88 | 1191 | 299 | **1490** | 1701 | 1611 | 1197 | **2808** | |
| -20 | 70 | 998 | 850 | 0.88 | 1230 | 299 | **1529** | 1757 | 1667 | 1197 | **2864** | |
| -21 | 71 | 1030 | 850 | 0.88 | 1269 | 299 | **1568** | 1812 | 1723 | 1197 | **2920** | |
| -22 | 72 | 1061 | 850 | 0.88 | 1307 | 299 | **1607** | 1868 | 1778 | 1197 | **2975** | |
| -23 | 73 | 1093 | 850 | 0.88 | 1346 | 299 | **1646** | 1923 | 1834 | 1197 | **3031** | |
| -24 | 74 | 1124 | 850 | 0.88 | 1385 | 299 | **1685** | 1979 | 1889 | 1197 | **3086** | |
| -25 | 75 | 1156 | 850 | 0.88 | 1424 | 299 | **1723** | 2035 | 1945 | 1197 | **3142** | |
| -26 | 76 | 1188 | 850 | 0.88 | 1463 | 299 | **1762** | 2090 | 2000 | 1197 | **3197** | |
| -27 | 77 | 1219 | 913 | 0.88 | 1502 | 321 | **1823** | 2146 | 2056 | 1285 | **3341** | |
| -28 | 78 | 1251 | 978 | 0.88 | 1541 | 344 | **1885** | 2201 | 2112 | 1377 | **3489** | |
| -29 | 79 | 1282 | 1047 | 0.88 | 1580 | 368 | **1948** | 2257 | 2167 | 1474 | **3641** | |
| -30 | 80 | 1314 | 1118 | 0.88 | 1619 | 394 | **2012** | 2312 | 2223 | 1574 | **3797** | |
| -31 | 81 | 1345 | 1193 | 0.88 | 1658 | 420 | **2078** | 2368 | 2278 | 1680 | **3958** | |
| -32 | 82 | 1377 | 1271 | 0.88 | 1697 | 447 | **2144** | 2424 | 2334 | 1790 | **4123** | |
| -33 | 83 | 1409 | 1352 | 0.88 | 1735 | 476 | **2211** | 2479 | 2389 | 1904 | **4293** | |
| -34 | 84 | 1440 | 1436 | 0.88 | 1774 | 506 | **2280** | 2535 | 2445 | 2022 | **4467** | |
| -35 | 85 | 1472 | 1523 | 0.88 | 1813 | 536 | **2349** | 2590 | 2501 | 2145 | **4646** | |
| -36 | 86 | 1503 | 1608 | 0.88 | 1852 | 566 | **2418** | 2646 | 2556 | 2264 | **4820** | |
| -37 | 87 | 1535 | 1682 | 0.88 | 1891 | 592 | **2483** | 2701 | 2612 | 2369 | **4981** | |
| -38 | 88 | 1567 | 1748 | 0.88 | 1930 | 615 | **2545** | 2757 | 2667 | 2461 | **5128** | |
| -39 | 89 | 1598 | 1804 | 0.88 | 1969 | 635 | **2604** | 2813 | 2723 | 2540 | **5263** | |
| -40 | 90 | 1630 | 1851 | 0.88 | 2008 | 651 | **2659** | 2868 | 2778 | 2606 | **5384** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 7
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 1661 | 1888 | 0.88 | 2047 | 665 | **2711** | 2924 | 2834 | 2659 | **5493** | |
| -42 | 92 | 1693 | 1916 | 0.88 | 2086 | 675 | **2760** | 2979 | 2890 | 2698 | **5588** | |
| -43 | 93 | 1724 | 1935 | 0.88 | 2124 | 681 | **2806** | 3035 | 2945 | 2724 | **5670** | |
| -44 | 94 | 1756 | 1944 | 0.88 | 2163 | 684 | **2848** | 3091 | 3001 | 2738 | **5738** | |
| -45 | 95 | 1788 | 1944 | 0.88 | 2202 | 684 | **2887** | 3146 | 3056 | 2738 | **5794** | |
| -46 | 96 | 1808 | 1944 | 0.88 | 2227 | 684 | **2911** | 3182 | 3092 | 2738 | **5829** | |
| -47 | 97 | 1828 | 1944 | 0.88 | 2252 | 684 | **2937** | 3217 | 3128 | 2738 | **5865** | |
| -48 | 98 | 1849 | 1944 | 0.88 | 2278 | 684 | **2962** | 3254 | 3164 | 2738 | **5902** | |
| -49 | 99 | 1870 | 1944 | 0.88 | 2303 | 684 | **2988** | 3291 | 3201 | 2738 | **5938** | |
| -50 | 100 | 1891 | 1944 | 0.88 | 2330 | 684 | **3014** | 3328 | 3238 | 2738 | **5976** | |
| -51 | 101 | 1912 | 1944 | 0.88 | 2356 | 684 | **3040** | 3366 | 3276 | 2738 | **6013** | |
| -52 | 102 | 1934 | 1944 | 0.88 | 2383 | 684 | **3067** | 3404 | 3314 | 2738 | **6052** | |
| -53 | 103 | 1956 | 1944 | 0.88 | 2410 | 684 | **3094** | 3443 | 3353 | 2738 | **6090** | |
| -54 | 104 | 1978 | 1944 | 0.88 | 2437 | 684 | **3122** | 3482 | 3392 | 2738 | **6129** | |
| -55 | 105 | 2001 | 1944 | 0.88 | 2465 | 684 | **3149** | 3521 | 3431 | 2738 | **6169** | |
| -56 | 106 | 2023 | 1944 | 0.88 | 2493 | 684 | **3177** | 3561 | 3472 | 2738 | **6209** | |
| -57 | 107 | 2046 | 1944 | 0.88 | 2521 | 684 | **3206** | 3602 | 3512 | 2738 | **6250** | |
| -58 | 108 | 2070 | 1944 | 0.88 | 2550 | 684 | **3234** | 3643 | 3553 | 2738 | **6291** | |
| -59 | 109 | 2093 | 1944 | 0.88 | 2579 | 684 | **3263** | 3684 | 3594 | 2738 | **6332** | |
| -60 | 110 | 2117 | 1944 | 0.88 | 2608 | 684 | **3293** | 3726 | 3636 | 2738 | **6374** | |
| -61 | 111 | 2141 | 1944 | 0.88 | 2638 | 684 | **3322** | 3768 | 3679 | 2738 | **6416** | |
| -62 | 112 | 2165 | 1944 | 0.88 | 2668 | 684 | **3352** | 3811 | 3721 | 2738 | **6459** | |
| -63 | 113 | 2190 | 1944 | 0.88 | 2698 | 684 | **3382** | 3854 | 3765 | 2738 | **6502** | |
| -64 | 114 | 2215 | 1944 | 0.88 | 2729 | 684 | **3413** | 3898 | 3808 | 2738 | **6546** | |
| -65 | 115 | 2240 | 1944 | 0.88 | 2760 | 684 | **3444** | 3942 | 3853 | 2738 | **6590** | |
| -66 | 116 | 2265 | 1944 | 0.88 | 2791 | 684 | **3475** | 3987 | 3897 | 2738 | **6635** | |
| -67 | 117 | 2291 | 1944 | 0.88 | 2822 | 684 | **3507** | 4032 | 3942 | 2738 | **6680** | |
| -68 | 118 | 2317 | 1944 | 0.88 | 2854 | 684 | **3539** | 4078 | 3988 | 2738 | **6725** | |
| -69 | 119 | 2343 | 1944 | 0.88 | 2886 | 684 | **3571** | 4124 | 4034 | 2738 | **6771** | |
| -70 | 120 | 2369 | 1944 | 0.88 | 2919 | 684 | **3603** | 4170 | 4080 | 2738 | **6818** | |
| -71 | 121 | 2396 | 1944 | 0.88 | 2952 | 684 | **3636** | 4217 | 4127 | 2738 | **6865** | |
| -72 | 122 | 2423 | 1944 | 0.88 | 2985 | 684 | **3669** | 4264 | 4175 | 2738 | **6912** | |
| -73 | 123 | 2450 | 1944 | 0.88 | 3019 | 684 | **3703** | 4312 | 4222 | 2738 | **6960** | |
| -74 | 124 | 2478 | 1944 | 0.88 | 3052 | 684 | **3737** | 4360 | 4271 | 2738 | **7008** | |
| -75 | 125 | 2505 | 1944 | 0.88 | 3086 | 684 | **3771** | 4409 | 4320 | 2738 | **7057** | |
| -76 | 126 | 2533 | 1944 | | | | | | | | | |
| -77 | 127 | 2561 | 1944 | | | | | | | | | |
| -78 | 128 | 2590 | 1944 | | | | | | | | | |
| -79 | 129 | 2619 | 1944 | | | | | | | | | |
| -80 | 130 | 2648 | 1944 | | | | | | | | | Strength (4716k) |
| -81 | 131 | 2677 | 1944 | | | | | | | | | use EL-81' |
| -82 | 132 | 2707 | 1944 | | | | | | | | | |
| -83 | 133 | 2736 | 1944 | | | | | | | | | |
| -84 | 134 | 2766 | 1944 | | | | | | | | | |
| -85 | 135 | 2797 | 1944 | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 8
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft
Pile type: 118"'-diameter CIDH
Pre-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 2 | Sand | 0.88 |
| (2) | 2 | 37 | Sand | 0.88 |
| (3) | 37 | 42 | Sand | 0.88 |
| (4) | 42 | 82 | Clay | 0.88 |
| (5) | 82 | 170 | Sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
224 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 44 | 6 | 4 | 0 | 0.88 | 5 | 0 | **5** | 7 | 0 | 0 | **0** |
| 43 | 7 | 10 | 0 | 0.88 | 12 | 0 | **12** | 17 | 0 | 0 | **0** |
| 42 | 8 | 16 | 0 | 0.88 | 19 | 0 | **19** | 28 | 0 | 0 | **0** |
| 41 | 9 | 22 | 0 | 0.88 | 27 | 0 | **27** | 39 | 0 | 0 | **0** |
| 40 | 10 | 29 | 0 | 0.88 | 36 | 0 | **36** | 52 | 0 | 0 | **0** |
| 39 | 11 | 37 | 0 | 0.88 | 45 | 0 | **45** | 65 | 0 | 0 | **0** |
| 38 | 12 | 45 | 0 | 0.88 | 56 | 0 | **56** | 79 | 0 | 0 | **0** |
| 37 | 13 | 54 | 0 | 0.88 | 66 | 0 | **66** | 95 | 0 | 0 | **0** |
| 36 | 14 | 63 | 0 | 0.88 | 78 | 0 | **78** | 111 | 0 | 0 | **0** |
| 35 | 15 | 73 | 0 | 0.88 | 89 | 0 | **89** | 128 | 0 | 0 | **0** |
| 34 | 16 | 83 | 0 | 0.88 | 102 | 0 | **102** | 145 | 0 | 0 | **0** |
| 33 | 17 | 93 | 0 | 0.88 | 115 | 0 | **115** | 164 | 0 | 0 | **0** |
| 32 | 18 | 104 | 0 | 0.88 | 128 | 0 | **128** | 183 | 0 | 0 | **0** |
| 31 | 19 | 116 | 69 | 0.88 | 142 | 24 | **167** | 203 | 0 | 98 | **98** |
| 30 | 20 | 127 | 142 | 0.88 | 157 | 50 | **207** | 224 | 0 | 200 | **200** |
| 29 | 21 | 140 | 218 | 0.88 | 172 | 77 | **249** | 246 | 21 | 307 | **329** |
| 28 | 22 | 152 | 298 | 0.88 | 187 | 105 | **292** | 268 | 44 | 419 | **463** |
| 27 | 23 | 165 | 381 | 0.88 | 203 | 134 | **337** | 290 | 66 | 536 | **603** |
| 26 | 24 | 178 | 447 | 0.88 | 220 | 157 | **377** | 314 | 90 | 629 | **718** |
| 25 | 25 | 192 | 515 | 0.88 | 236 | 181 | **418** | 338 | 113 | 725 | **838** |
| 24 | 26 | 206 | 585 | 0.88 | 253 | 206 | **460** | 362 | 138 | 824 | **962** |
| 23 | 27 | 220 | 658 | 0.88 | 271 | 232 | **503** | 387 | 163 | 927 | **1090** |
| 22 | 28 | 234 | 727 | 0.88 | 289 | 256 | **545** | 413 | 188 | 1024 | **1212** |
| 21 | 29 | 249 | 784 | 0.88 | 307 | 276 | **583** | 439 | 214 | 1104 | **1318** |
| 20 | 30 | 264 | 830 | 0.88 | 325 | 292 | **618** | 465 | 241 | 1168 | **1409** |
| 19 | 31 | 279 | 864 | 0.88 | 344 | 304 | **648** | 492 | 268 | 1216 | **1484** |
| 18 | 32 | 295 | 887 | 0.88 | 363 | 312 | **676** | 519 | 295 | 1249 | **1543** |
| 17 | 33 | 311 | 900 | 0.88 | 383 | 317 | **700** | 547 | 323 | 1267 | **1590** |
| 16 | 34 | 327 | 906 | 0.88 | 402 | 319 | **721** | 575 | 351 | 1276 | **1627** |
| 15 | 35 | 343 | 905 | 0.88 | 422 | 319 | **741** | 603 | 379 | 1275 | **1654** |
| 14 | 36 | 359 | 897 | 0.88 | 442 | 316 | **758** | 632 | 408 | 1263 | **1671** |
| 13 | 37 | 376 | 881 | 0.88 | 463 | 310 | **773** | 661 | 437 | 1241 | **1678** |
| 12 | 38 | 393 | 869 | 0.88 | 484 | 306 | **789** | 691 | 467 | 1223 | **1690** |
| 11 | 39 | 410 | 860 | 0.88 | 505 | 303 | **807** | 721 | 497 | 1210 | **1707** |
| 10 | 40 | 427 | 853 | 0.88 | 527 | 300 | **827** | 752 | 528 | 1201 | **1729** |
| 9 | 41 | 445 | 850 | 0.88 | 549 | 299 | **848** | 784 | 560 | 1197 | **1757** |
| 8 | 42 | 464 | 850 | 0.88 | 571 | 299 | **870** | 816 | 592 | 1197 | **1789** |
| 7 | 43 | 495 | 850 | 0.88 | 610 | 299 | **909** | 872 | 647 | 1197 | **1844** |
| 6 | 44 | 527 | 850 | 0.88 | 649 | 299 | **948** | 927 | 703 | 1197 | **1900** |
| 5 | 45 | 558 | 850 | 0.88 | 688 | 299 | **987** | 983 | 758 | 1197 | **1956** |
| 4 | 46 | 590 | 850 | 0.88 | 727 | 299 | **1026** | 1038 | 814 | 1197 | **2011** |
| 3 | 47 | 622 | 850 | 0.88 | 766 | 299 | **1065** | 1094 | 870 | 1197 | **2067** |
| 2 | 48 | 653 | 850 | 0.88 | 805 | 299 | **1104** | 1149 | 925 | 1197 | **2122** |
| 1 | 49 | 685 | 850 | 0.88 | 843 | 299 | **1143** | 1205 | 981 | 1197 | **2178** |
| 0 | 50 | 716 | 850 | 0.88 | 882 | 299 | **1182** | 1261 | 1036 | 1197 | **2233** |
| -1 | 51 | 748 | 850 | 0.88 | 921 | 299 | **1221** | 1316 | 1092 | 1197 | **2289** |
| -2 | 52 | 779 | 850 | 0.88 | 960 | 299 | **1259** | 1372 | 1147 | 1197 | **2345** |
| -3 | 53 | 811 | 850 | 0.88 | 999 | 299 | **1298** | 1427 | 1203 | 1197 | **2400** |
| -4 | 54 | 843 | 850 | 0.88 | 1038 | 299 | **1337** | 1483 | 1259 | 1197 | **2456** |
| -5 | 55 | 874 | 850 | 0.88 | 1077 | 299 | **1376** | 1538 | 1314 | 1197 | **2511** |
| -6 | 56 | 906 | 850 | 0.88 | 1116 | 299 | **1415** | 1594 | 1370 | 1197 | **2567** |
| -7 | 57 | 937 | 850 | 0.88 | 1155 | 299 | **1454** | 1650 | 1425 | 1197 | **2622** |
| -8 | 58 | 969 | 850 | 0.88 | 1194 | 299 | **1493** | 1705 | 1481 | 1197 | **2678** |
| -9 | 59 | 1000 | 850 | 0.88 | 1233 | 299 | **1532** | 1761 | 1537 | 1197 | **2734** |
| -10 | 60 | 1032 | 850 | 0.88 | 1271 | 299 | **1571** | 1816 | 1592 | 1197 | **2789** |
| -11 | 61 | 1064 | 850 | 0.88 | 1310 | 299 | **1610** | 1872 | 1648 | 1197 | **2845** |
| -12 | 62 | 1095 | 850 | 0.88 | 1349 | 299 | **1648** | 1927 | 1703 | 1197 | **2900** |
| -13 | 63 | 1127 | 850 | 0.88 | 1388 | 299 | **1687** | 1983 | 1759 | 1197 | **2956** |
| -14 | 64 | 1158 | 913 | 0.88 | 1427 | 321 | **1748** | 2039 | 1814 | 1285 | **3099** |
| -15 | 65 | 1190 | 978 | 0.88 | 1466 | 344 | **1810** | 2094 | 1870 | 1377 | **3247** |
| -16 | 66 | 1221 | 1047 | 0.88 | 1505 | 368 | **1873** | 2150 | 1926 | 1474 | **3399** |
| -17 | 67 | 1253 | 1118 | 0.88 | 1544 | 394 | **1937** | 2205 | 1981 | 1574 | **3556** |
| -18 | 68 | 1285 | 1193 | 0.88 | 1583 | 420 | **2003** | 2261 | 2037 | 1680 | **3717** |
| -19 | 69 | 1316 | 1271 | 0.88 | 1622 | 447 | **2069** | 2316 | 2092 | 1790 | **3882** |
| -20 | 70 | 1348 | 1352 | 0.88 | 1660 | 476 | **2136** | 2372 | 2148 | 1904 | **4052** |
| -21 | 71 | 1379 | 1436 | 0.88 | 1699 | 506 | **2205** | 2428 | 2203 | 2022 | **4226** |
| -22 | 72 | 1411 | 1523 | 0.88 | 1738 | 536 | **2275** | 2483 | 2259 | 2145 | **4404** |
| -23 | 73 | 1443 | 1608 | 0.88 | 1777 | 566 | **2343** | 2539 | 2315 | 2264 | **4578** |
| -24 | 74 | 1474 | 1682 | 0.88 | 1816 | 592 | **2408** | 2594 | 2370 | 2369 | **4739** |
| -25 | 75 | 1506 | 1748 | 0.88 | 1855 | 615 | **2470** | 2650 | 2426 | 2461 | **4887** |
| -26 | 76 | 1537 | 1804 | 0.88 | 1894 | 635 | **2529** | 2706 | 2481 | 2540 | **5021** |
| -27 | 77 | 1569 | 1851 | 0.88 | 1933 | 651 | **2584** | 2761 | 2537 | 2606 | **5143** |
| -28 | 78 | 1600 | 1888 | 0.88 | 1972 | 665 | **2636** | 2817 | 2592 | 2659 | **5251** |
| -29 | 79 | 1632 | 1916 | 0.88 | 2011 | 675 | **2685** | 2872 | 2648 | 2698 | **5346** |
| -30 | 80 | 1664 | 1935 | 0.88 | 2049 | 681 | **2731** | 2928 | 2704 | 2724 | **5428** |
| -31 | 81 | 1695 | 1944 | 0.88 | 2088 | 684 | **2773** | 2983 | 2759 | 2738 | **5497** |
| -32 | 82 | 1727 | 1944 | 0.88 | 2127 | 684 | **2812** | 3039 | 2815 | 2738 | **5552** |
| -33 | 83 | 1745 | 1944 | 0.88 | 2150 | 684 | **2835** | 3072 | 2848 | 2738 | **5585** |
| -34 | 84 | 1764 | 1944 | 0.88 | 2173 | 684 | **2857** | 3104 | 2880 | 2738 | **5617** |
| -35 | 85 | 1782 | 1944 | 0.88 | 2195 | 684 | **2880** | 3136 | 2912 | 2738 | **5649** |
| -36 | 86 | 1800 | 1944 | 0.88 | 2217 | 684 | **2902** | 3168 | 2943 | 2738 | **5681** |
| -37 | 87 | 1818 | 1944 | 0.88 | 2240 | 684 | **2924** | 3200 | 2976 | 2738 | **5713** |
| -38 | 88 | 1837 | 1944 | 0.88 | 2263 | 684 | **2947** | 3232 | 3008 | 2738 | **5746** |
| -39 | 89 | 1855 | 1944 | 0.88 | 2286 | 684 | **2970** | 3266 | 3041 | 2738 | **5779** |
| -40 | 90 | 1874 | 1944 | 0.88 | 2309 | 684 | **2994** | 3299 | 3075 | 2738 | **5812** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 8
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 1894 | 1944 | 0.88 | 2333 | 684 | **3018** | 3333 | 3109 | 2738 | **5846** | |
| -42 | 92 | 1913 | 1944 | 0.88 | 2357 | 684 | **3042** | 3368 | 3143 | 2738 | **5881** | |
| -43 | 93 | 1933 | 1944 | 0.88 | 2382 | 684 | **3066** | 3402 | 3178 | 2738 | **5916** | |
| -44 | 94 | 1953 | 1944 | 0.88 | 2406 | 684 | **3091** | 3438 | 3214 | 2738 | **5951** | |
| -45 | 95 | 1974 | 1944 | 0.88 | 2432 | 684 | **3116** | 3474 | 3249 | 2738 | **5987** | |
| -46 | 96 | 1994 | 1944 | 0.88 | 2457 | 684 | **3141** | 3510 | 3286 | 2738 | **6023** | |
| -47 | 97 | 2015 | 1944 | 0.88 | 2483 | 684 | **3167** | 3547 | 3322 | 2738 | **6060** | |
| -48 | 98 | 2036 | 1944 | 0.88 | 2509 | 684 | **3193** | 3584 | 3360 | 2738 | **6097** | |
| -49 | 99 | 2058 | 1944 | 0.88 | 2535 | 684 | **3219** | 3622 | 3397 | 2738 | **6135** | |
| -50 | 100 | 2079 | 1944 | 0.88 | 2562 | 684 | **3246** | 3660 | 3435 | 2738 | **6173** | |
| -51 | 101 | 2101 | 1944 | 0.88 | 2589 | 684 | **3273** | 3698 | 3474 | 2738 | **6212** | |
| -52 | 102 | 2124 | 1944 | 0.88 | 2616 | 684 | **3301** | 3737 | 3513 | 2738 | **6251** | |
| -53 | 103 | 2146 | 1944 | 0.88 | 2644 | 684 | **3328** | 3777 | 3553 | 2738 | **6290** | |
| -54 | 104 | 2169 | 1944 | 0.88 | 2672 | 684 | **3356** | 3817 | 3593 | 2738 | **6330** | |
| -55 | 105 | 2192 | 1944 | 0.88 | 2700 | 684 | **3384** | 3857 | 3633 | 2738 | **6371** | |
| -56 | 106 | 2215 | 1944 | 0.88 | 2729 | 684 | **3413** | 3898 | 3674 | 2738 | **6411** | |
| -57 | 107 | 2238 | 1944 | 0.88 | 2758 | 684 | **3442** | 3939 | 3715 | 2738 | **6453** | |
| -58 | 108 | 2262 | 1944 | 0.88 | 2787 | 684 | **3471** | 3981 | 3757 | 2738 | **6495** | |
| -59 | 109 | 2286 | 1944 | 0.88 | 2816 | 684 | **3501** | 4024 | 3799 | 2738 | **6537** | |
| -60 | 110 | 2310 | 1944 | 0.88 | 2846 | 684 | **3531** | 4066 | 3842 | 2738 | **6580** | |
| -61 | 111 | 2335 | 1944 | 0.88 | 2877 | 684 | **3561** | 4109 | 3885 | 2738 | **6623** | |
| -62 | 112 | 2360 | 1944 | 0.88 | 2907 | 684 | **3592** | 4153 | 3929 | 2738 | **6666** | |
| -63 | 113 | 2385 | 1944 | 0.88 | 2938 | 684 | **3622** | 4197 | 3973 | 2738 | **6711** | |
| -64 | 114 | 2410 | 1944 | 0.88 | 2969 | 684 | **3654** | 4242 | 4018 | 2738 | **6755** | |
| -65 | 115 | 2436 | 1944 | 0.88 | 3001 | 684 | **3685** | 4287 | 4063 | 2738 | **6800** | |
| -66 | 116 | 2462 | 1944 | 0.88 | 3033 | 684 | **3717** | 4332 | 4108 | 2738 | **6846** | |
| -67 | 117 | 2488 | 1944 | 0.88 | 3065 | 684 | **3749** | 4378 | 4154 | 2738 | **6892** | |
| -68 | 118 | 2514 | 1944 | 0.88 | 3097 | 684 | **3782** | 4425 | 4200 | 2738 | **6938** | |
| -69 | 119 | 2541 | 1944 | 0.88 | 3130 | 684 | **3814** | 4472 | 4247 | 2738 | **6985** | |
| -70 | 120 | 2568 | 1944 | 0.88 | 3163 | 684 | **3848** | 4519 | 4295 | 2738 | **7032** | |
| -71 | 121 | 2595 | 1944 | 0.88 | 3197 | 684 | **3881** | 4567 | 4342 | 2738 | **7080** | |
| -72 | 122 | 2622 | 1944 | 0.88 | 3230 | 684 | **3915** | 4615 | 4391 | 2738 | **7128** | |
| -73 | 123 | 2650 | 1944 | 0.88 | 3264 | 684 | **3949** | 4664 | 4439 | 2738 | **7177** | |
| -74 | 124 | 2678 | 1944 | 0.88 | 3299 | 684 | **3983** | 4713 | 4488 | 2738 | **7226** | |
| -75 | 125 | 2706 | 1944 | 0.88 | 3334 | 684 | **4018** | 4762 | 4538 | 2738 | **7276** | |
| -76 | 126 | 2734 | 1944 | 0.88 | 3369 | 684 | **4053** | 4812 | 4588 | 2738 | **7326** | Strength (4051k) |
| -77 | 127 | 2763 | 1944 | 0.88 | 3404 | 684 | **4088** | 4863 | 4639 | 2738 | **7376** | use EL-78' |
| -78 | 128 | 2792 | 1944 | 0.88 | 3440 | 684 | **4124** | 4914 | 4690 | 2738 | **7427** | |
| -79 | 129 | 2821 | 1944 | 0.88 | 3476 | 684 | **4160** | 4965 | 4741 | 2738 | **7479** | |
| -80 | 130 | 2851 | 1944 | 0.88 | 3512 | 684 | **4196** | 5017 | 4793 | 2738 | **7531** | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 8
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft
Pile type: 118'"-diameter CIDH
Post-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 2 | Sand | 0.88 |
| (2) | 2 | 37 | Clay | 0.88 |
| (3) | 37 | 42 | Sand | 0.88 |
| (4) | 42 | 82 | Clay | 0.88 |
| (5) | 82 | 170 | Sand | 0.88 |

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
90 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 44 | 6 | 3 | 111 | 0.88 | 4 | 39 | **43** | 6 | 0 | 156 | **156** | |
| 43 | 7 | 7 | 111 | 0.88 | 8 | 39 | **48** | 12 | 0 | 157 | **157** | |
| 42 | 8 | 10 | 112 | 0.88 | 13 | 39 | **52** | 18 | 0 | 157 | **157** | |
| 41 | 9 | 14 | 112 | 0.88 | 17 | 39 | **56** | 24 | 0 | 158 | **158** | |
| 40 | 10 | 17 | 112 | 0.88 | 21 | 39 | **60** | 30 | 0 | 158 | **158** | |
| 39 | 11 | 20 | 112 | 0.88 | 25 | 40 | **65** | 36 | 0 | 158 | **158** | |
| 38 | 12 | 24 | 112 | 0.88 | 29 | 40 | **69** | 42 | 0 | 158 | **158** | |
| 37 | 13 | 27 | 113 | 0.88 | 33 | 40 | **73** | 48 | 0 | 158 | **158** | |
| 36 | 14 | 31 | 113 | 0.88 | 38 | 40 | **77** | 54 | 0 | 159 | **159** | |
| 35 | 15 | 34 | 113 | 0.88 | 42 | 40 | **82** | 60 | 0 | 159 | **159** | |
| 34 | 16 | 37 | 113 | 0.88 | 46 | 40 | **86** | 66 | 0 | 159 | **159** | |
| 33 | 17 | 41 | 113 | 0.88 | 50 | 40 | **90** | 72 | 0 | 159 | **159** | |
| 32 | 18 | 44 | 113 | 0.88 | 54 | 40 | **94** | 78 | 0 | 159 | **159** | |
| 31 | 19 | 48 | 176 | 0.88 | 59 | 62 | **120** | 84 | 0 | 247 | **247** | |
| 30 | 20 | 51 | 242 | 0.88 | 63 | 85 | **148** | 90 | 0 | 340 | **340** | |
| 29 | 21 | 54 | 311 | 0.88 | 67 | 109 | **176** | 96 | 6 | 438 | **444** | |
| 28 | 22 | 58 | 383 | 0.88 | 71 | 135 | **206** | 102 | 12 | 539 | **551** | |
| 27 | 23 | 61 | 458 | 0.88 | 75 | 161 | **237** | 108 | 18 | 645 | **663** | |
| 26 | 24 | 65 | 516 | 0.88 | 80 | 182 | **261** | 114 | 24 | 727 | **751** | |
| 25 | 25 | 68 | 576 | 0.88 | 84 | 203 | **286** | 120 | 30 | 811 | **841** | |
| 24 | 26 | 71 | 638 | 0.88 | 88 | 225 | **312** | 126 | 36 | 898 | **934** | |
| 23 | 27 | 75 | 702 | 0.88 | 92 | 247 | **339** | 132 | 42 | 988 | **1030** | |
| 22 | 28 | 78 | 762 | 0.88 | 96 | 268 | **364** | 138 | 48 | 1073 | **1120** | |
| 21 | 29 | 82 | 811 | 0.88 | 100 | 286 | **386** | 144 | 54 | 1142 | **1196** | |
| 20 | 30 | 85 | 850 | 0.88 | 105 | 299 | **404** | 150 | 60 | 1197 | **1257** | |
| 19 | 31 | 88 | 878 | 0.88 | 109 | 309 | **418** | 156 | 66 | 1237 | **1303** | |
| 18 | 32 | 92 | 896 | 0.88 | 113 | 316 | **429** | 161 | 72 | 1262 | **1334** | |
| 17 | 33 | 95 | 906 | 0.88 | 117 | 319 | **436** | 167 | 78 | 1276 | **1353** | |
| 16 | 34 | 99 | 909 | 0.88 | 121 | 320 | **441** | 173 | 84 | 1280 | **1364** | |
| 15 | 35 | 102 | 906 | 0.88 | 126 | 319 | **445** | 179 | 90 | 1276 | **1366** | |
| 14 | 36 | 105 | 897 | 0.88 | 130 | 316 | **446** | 185 | 96 | 1263 | **1359** | |
| 13 | 37 | 109 | 881 | 0.88 | 134 | 310 | **444** | 191 | 102 | 1241 | **1343** | |
| 12 | 38 | 126 | 869 | 0.88 | 155 | 306 | **461** | 221 | 131 | 1223 | **1355** | |
| 11 | 39 | 143 | 860 | 0.88 | 176 | 303 | **479** | 252 | 162 | 1210 | **1372** | |
| 10 | 40 | 161 | 853 | 0.88 | 198 | 300 | **498** | 283 | 193 | 1201 | **1394** | |
| 9 | 41 | 178 | 850 | 0.88 | 220 | 299 | **519** | 314 | 224 | 1197 | **1421** | |
| 8 | 42 | 197 | 850 | 0.88 | 242 | 299 | **542** | 346 | 256 | 1197 | **1454** | |
| 7 | 43 | 228 | 850 | 0.88 | 281 | 299 | **581** | 402 | 312 | 1197 | **1509** | |
| 6 | 44 | 260 | 850 | 0.88 | 320 | 299 | **619** | 457 | 368 | 1197 | **1565** | Extreme (1550k)* |
| 5 | 45 | 291 | 850 | 0.88 | 359 | 299 | **658** | 513 | 423 | 1197 | **1620** | Use El +1' |
| 4 | 46 | 323 | 850 | 0.88 | 398 | 299 | **697** | 569 | 479 | 1197 | **1676** | |
| 3 | 47 | 355 | 850 | 0.88 | 437 | 299 | **736** | 624 | 534 | 1197 | **1731** | |
| 2 | 48 | 386 | 850 | 0.88 | 476 | 299 | **775** | 680 | 590 | 1197 | **1787** | |
| 1 | 49 | 418 | 850 | 0.88 | 515 | 299 | **814** | 735 | 646 | 1197 | **1843** | |
| 0 | 50 | 449 | 850 | 0.88 | 554 | 299 | **853** | 791 | 701 | 1197 | **1898** | |
| -1 | 51 | 481 | 850 | 0.88 | 592 | 299 | **892** | 846 | 757 | 1197 | **1954** | |
| -2 | 52 | 512 | 850 | 0.88 | 631 | 299 | **931** | 902 | 812 | 1197 | **2009** | |
| -3 | 53 | 544 | 850 | 0.88 | 670 | 299 | **970** | 958 | 868 | 1197 | **2065** | |
| -4 | 54 | 576 | 850 | 0.88 | 709 | 299 | **1008** | 1013 | 923 | 1197 | **2120** | |
| -5 | 55 | 607 | 850 | 0.88 | 748 | 299 | **1047** | 1069 | 979 | 1197 | **2176** | |
| -6 | 56 | 639 | 850 | 0.88 | 787 | 299 | **1086** | 1124 | 1035 | 1197 | **2232** | |
| -7 | 57 | 670 | 850 | 0.88 | 826 | 299 | **1125** | 1180 | 1090 | 1197 | **2287** | |
| -8 | 58 | 702 | 850 | 0.88 | 865 | 299 | **1164** | 1235 | 1146 | 1197 | **2343** | |
| -9 | 59 | 734 | 850 | 0.88 | 904 | 299 | **1203** | 1291 | 1201 | 1197 | **2398** | |
| -10 | 60 | 765 | 850 | 0.88 | 943 | 299 | **1242** | 1347 | 1257 | 1197 | **2454** | |
| -11 | 61 | 797 | 850 | 0.88 | 981 | 299 | **1281** | 1402 | 1312 | 1197 | **2509** | |
| -12 | 62 | 828 | 850 | 0.88 | 1020 | 299 | **1320** | 1458 | 1368 | 1197 | **2565** | |
| -13 | 63 | 860 | 850 | 0.88 | 1059 | 299 | **1359** | 1513 | 1424 | 1197 | **2621** | |
| -14 | 64 | 891 | 913 | 0.88 | 1098 | 321 | **1419** | 1569 | 1479 | 1285 | **2764** | |
| -15 | 65 | 923 | 978 | 0.88 | 1137 | 344 | **1481** | 1624 | 1535 | 1377 | **2912** | |
| -16 | 66 | 955 | 1047 | 0.88 | 1176 | 368 | **1544** | 1680 | 1590 | 1474 | **3064** | |
| -17 | 67 | 986 | 1118 | 0.88 | 1215 | 394 | **1609** | 1736 | 1646 | 1574 | **3220** | |
| -18 | 68 | 1018 | 1193 | 0.88 | 1254 | 420 | **1674** | 1791 | 1701 | 1680 | **3381** | |
| -19 | 69 | 1049 | 1271 | 0.88 | 1293 | 447 | **1740** | 1847 | 1757 | 1790 | **3547** | |
| -20 | 70 | 1081 | 1352 | 0.88 | 1332 | 476 | **1808** | 1902 | 1813 | 1904 | **3716** | |
| -21 | 71 | 1112 | 1436 | 0.88 | 1371 | 506 | **1876** | 1958 | 1868 | 2022 | **3890** | |
| -22 | 72 | 1144 | 1523 | 0.88 | 1409 | 536 | **1946** | 2013 | 1924 | 2145 | **4069** | |
| -23 | 73 | 1176 | 1608 | 0.88 | 1448 | 566 | **2014** | 2069 | 1979 | 2264 | **4243** | |
| -24 | 74 | 1207 | 1682 | 0.88 | 1487 | 592 | **2079** | 2125 | 2035 | 2369 | **4404** | |
| -25 | 75 | 1239 | 1748 | 0.88 | 1526 | 615 | **2141** | 2180 | 2090 | 2461 | **4552** | |
| -26 | 76 | 1270 | 1804 | 0.88 | 1565 | 635 | **2200** | 2236 | 2146 | 2540 | **4686** | |
| -27 | 77 | 1302 | 1851 | 0.88 | 1604 | 651 | **2255** | 2291 | 2202 | 2606 | **4808** | |
| -28 | 78 | 1333 | 1888 | 0.88 | 1643 | 665 | **2307** | 2347 | 2257 | 2659 | **4916** | |
| -29 | 79 | 1365 | 1916 | 0.88 | 1682 | 675 | **2356** | 2403 | 2313 | 2698 | **5011** | |
| -30 | 80 | 1397 | 1935 | 0.88 | 1721 | 681 | **2402** | 2458 | 2368 | 2724 | **5093** | |
| -31 | 81 | 1428 | 1944 | 0.88 | 1760 | 684 | **2444** | 2514 | 2424 | 2738 | **5161** | |
| -32 | 82 | 1460 | 1944 | 0.88 | 1798 | 684 | **2483** | 2569 | 2480 | 2738 | **5217** | |
| -33 | 83 | 1478 | 1944 | 0.88 | 1821 | 684 | **2506** | 2602 | 2512 | 2738 | **5250** | |
| -34 | 84 | 1497 | 1944 | 0.88 | 1844 | 684 | **2528** | 2634 | 2545 | 2738 | **5282** | |
| -35 | 85 | 1515 | 1944 | 0.88 | 1866 | 684 | **2551** | 2666 | 2577 | 2738 | **5314** | |
| -36 | 86 | 1533 | 1944 | 0.88 | 1889 | 684 | **2573** | 2698 | 2608 | 2738 | **5346** | |
| -37 | 87 | 1551 | 1944 | 0.88 | 1911 | 684 | **2595** | 2730 | 2640 | 2738 | **5378** | |
| -38 | 88 | 1570 | 1944 | 0.88 | 1934 | 684 | **2618** | 2763 | 2673 | 2738 | **5411** | |
| -39 | 89 | 1589 | 1944 | 0.88 | 1957 | 684 | **2641** | 2796 | 2706 | 2738 | **5444** | |
| -40 | 90 | 1608 | 1944 | 0.88 | 1981 | 684 | **2665** | 2829 | 2740 | 2738 | **5477** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 8
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 1627 | 1944 | 0.88 | 2004 | 684 | **2689** | 2863 | 2774 | 2738 | **5511** | |
| -42 | 92 | 1646 | 1944 | 0.88 | 2028 | 684 | **2713** | 2898 | 2808 | 2738 | **5546** | |
| -43 | 93 | 1666 | 1944 | 0.88 | 2053 | 684 | **2737** | 2933 | 2843 | 2738 | **5581** | |
| -44 | 94 | 1686 | 1944 | 0.88 | 2078 | 684 | **2762** | 2968 | 2878 | 2738 | **5616** | |
| -45 | 95 | 1707 | 1944 | 0.88 | 2103 | 684 | **2787** | 3004 | 2914 | 2738 | **5652** | |
| -46 | 96 | 1727 | 1944 | 0.88 | 2128 | 684 | **2813** | 3040 | 2950 | 2738 | **5688** | |
| -47 | 97 | 1748 | 1944 | 0.88 | 2154 | 684 | **2838** | 3077 | 2987 | 2738 | **5725** | |
| -48 | 98 | 1769 | 1944 | 0.88 | 2180 | 684 | **2864** | 3114 | 3024 | 2738 | **5762** | |
| -49 | 99 | 1791 | 1944 | 0.88 | 2206 | 684 | **2891** | 3152 | 3062 | 2738 | **5800** | |
| -50 | 100 | 1812 | 1944 | 0.88 | 2233 | 684 | **2917** | 3190 | 3100 | 2738 | **5838** | |
| -51 | 101 | 1834 | 1944 | 0.88 | 2260 | 684 | **2944** | 3229 | 3139 | 2738 | **5876** | |
| -52 | 102 | 1857 | 1944 | 0.88 | 2287 | 684 | **2972** | 3268 | 3178 | 2738 | **5915** | |
| -53 | 103 | 1879 | 1944 | 0.88 | 2315 | 684 | **2999** | 3307 | 3217 | 2738 | **5955** | |
| -54 | 104 | 1902 | 1944 | 0.88 | 2343 | 684 | **3027** | 3347 | 3257 | 2738 | **5995** | |
| -55 | 105 | 1925 | 1944 | 0.88 | 2371 | 684 | **3056** | 3388 | 3298 | 2738 | **6035** | |
| -56 | 106 | 1948 | 1944 | 0.88 | 2400 | 684 | **3084** | 3428 | 3339 | 2738 | **6076** | |
| -57 | 107 | 1971 | 1944 | 0.88 | 2429 | 684 | **3113** | 3470 | 3380 | 2738 | **6118** | |
| -58 | 108 | 1995 | 1944 | 0.88 | 2458 | 684 | **3142** | 3512 | 3422 | 2738 | **6159** | |
| -59 | 109 | 2019 | 1944 | 0.88 | 2488 | 684 | **3172** | 3554 | 3464 | 2738 | **6202** | |
| -60 | 110 | 2043 | 1944 | 0.88 | 2518 | 684 | **3202** | 3597 | 3507 | 2738 | **6244** | |
| -61 | 111 | 2068 | 1944 | 0.88 | 2548 | 684 | **3232** | 3640 | 3550 | 2738 | **6288** | |
| -62 | 112 | 2093 | 1944 | 0.88 | 2578 | 684 | **3263** | 3683 | 3594 | 2738 | **6331** | |
| -63 | 113 | 2118 | 1944 | 0.88 | 2609 | 684 | **3294** | 3727 | 3638 | 2738 | **6375** | |
| -64 | 114 | 2143 | 1944 | 0.88 | 2640 | 684 | **3325** | 3772 | 3682 | 2738 | **6420** | |
| -65 | 115 | 2169 | 1944 | 0.88 | 2672 | 684 | **3356** | 3817 | 3727 | 2738 | **6465** | |
| -66 | 116 | 2195 | 1944 | 0.88 | 2704 | 684 | **3388** | 3863 | 3773 | 2738 | **6510** | |
| -67 | 117 | 2221 | 1944 | 0.88 | 2736 | 684 | **3420** | 3909 | 3819 | 2738 | **6556** | |
| -68 | 118 | 2247 | 1944 | 0.88 | 2768 | 684 | **3453** | 3955 | 3865 | 2738 | **6603** | |
| -69 | 119 | 2274 | 1944 | 0.88 | 2801 | 684 | **3486** | 4002 | 3912 | 2738 | **6650** | |
| -70 | 120 | 2301 | 1944 | 0.88 | 2834 | 684 | **3519** | 4049 | 3959 | 2738 | **6697** | |
| -71 | 121 | 2328 | 1944 | 0.88 | 2868 | 684 | **3552** | 4097 | 4007 | 2738 | **6745** | |
| -72 | 122 | 2355 | 1944 | 0.88 | 2902 | 684 | **3586** | 4145 | 4055 | 2738 | **6793** | |
| -73 | 123 | 2383 | 1944 | 0.88 | 2936 | 684 | **3620** | 4194 | 4104 | 2738 | **6842** | |
| -74 | 124 | 2411 | 1944 | 0.88 | 2970 | 684 | **3654** | 4243 | 4153 | 2738 | **6891** | |
| -75 | 125 | 2439 | 1944 | 0.88 | 3005 | 684 | **3689** | 4293 | 4203 | 2738 | **6940** | |
| -76 | 126 | 2467 | 1944 | | | | | | | | | |
| -77 | 127 | 2496 | 1944 | | | | | | | | | |
| -78 | 128 | 2525 | 1944 | | | | | | | | | |
| -79 | 129 | 2554 | 1944 | | | | | | | | | |
| -80 | 130 | 2584 | 1944 | | | | | | | | | Strength (4716k) |
| 50 | | | | | | | | | | | | use EL-81' |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 9
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft

Pile type: 118"'-diameter CIDH

Pre-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 1 | Sand | 0.88 |
| (2) | 1 | 26 | Sand | 0.88 |
| (3) | 26 | 36 | Sand | 0.88 |
| (4) | 36 | 96 | Clay | 0.88 |
| (5) | 96 | 170 | Sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
224 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 44 | 6 | 4 | -69 | 0.88 | 5 | -24 | **-19** | 7 | 0 | -98 | **-98** |
| 43 | 7 | 10 | 0 | 0.88 | 12 | 0 | **12** | 17 | 0 | 0 | **0** |
| 42 | 8 | 16 | 69 | 0.88 | 19 | 24 | **44** | 28 | 0 | 98 | **98** |
| 41 | 9 | 22 | 142 | 0.88 | 27 | 50 | **77** | 39 | 0 | 200 | **200** |
| 40 | 10 | 29 | 218 | 0.88 | 36 | 77 | **113** | 52 | 0 | 307 | **307** |
| 39 | 11 | 37 | 298 | 0.88 | 45 | 105 | **150** | 65 | 0 | 419 | **419** |
| 38 | 12 | 45 | 381 | 0.88 | 56 | 134 | **190** | 79 | 0 | 536 | **536** |
| 37 | 13 | 54 | 467 | 0.88 | 66 | 165 | **231** | 95 | 0 | 658 | **658** |
| 36 | 14 | 63 | 557 | 0.88 | 78 | 196 | **274** | 111 | 0 | 785 | **785** |
| 35 | 15 | 73 | 651 | 0.88 | 89 | 229 | **319** | 128 | 0 | 917 | **917** |
| 34 | 16 | 83 | 748 | 0.88 | 102 | 263 | **365** | 145 | 0 | 1053 | **1053** |
| 33 | 17 | 93 | 841 | 0.88 | 115 | 296 | **411** | 164 | 0 | 1185 | **1185** |
| 32 | 18 | 104 | 904 | 0.88 | 128 | 318 | **446** | 183 | 0 | 1272 | **1272** |
| 31 | 19 | 116 | 955 | 0.88 | 142 | 336 | **478** | 203 | 0 | 1344 | **1344** |
| 30 | 20 | 127 | 994 | 0.88 | 157 | 350 | **507** | 224 | 0 | 1400 | **1400** |
| 29 | 21 | 140 | 1022 | 0.88 | 172 | 360 | **532** | 246 | 21 | 1439 | **1460** |
| 28 | 22 | 152 | 1039 | 0.88 | 187 | 366 | **553** | 268 | 44 | 1462 | **1506** |
| 27 | 23 | 165 | 1044 | 0.88 | 203 | 367 | **571** | 290 | 66 | 1470 | **1536** |
| 26 | 24 | 178 | 1037 | 0.88 | 220 | 365 | **585** | 314 | 90 | 1461 | **1550** |
| 25 | 25 | 192 | 1020 | 0.88 | 236 | 359 | **595** | 338 | 113 | 1436 | **1549** |
| 24 | 26 | 206 | 991 | 0.88 | 253 | 349 | **602** | 362 | 138 | 1395 | **1533** |
| 23 | 27 | 220 | 963 | 0.88 | 271 | 339 | **610** | 387 | 163 | 1355 | **1519** |
| 22 | 28 | 235 | 938 | 0.88 | 290 | 330 | **620** | 414 | 190 | 1320 | **1510** |
| 21 | 29 | 251 | 916 | 0.88 | 309 | 322 | **631** | 441 | 217 | 1289 | **1506** |
| 20 | 30 | 267 | 897 | 0.88 | 328 | 316 | **644** | 469 | 245 | 1263 | **1508** |
| 19 | 31 | 283 | 881 | 0.88 | 349 | 310 | **659** | 498 | 274 | 1241 | **1515** |
| 18 | 32 | 300 | 869 | 0.88 | 369 | 306 | **675** | 528 | 304 | 1223 | **1527** |
| 17 | 33 | 317 | 860 | 0.88 | 391 | 303 | **693** | 558 | 334 | 1210 | **1544** |
| 16 | 34 | 335 | 853 | 0.88 | 413 | 300 | **713** | 589 | 365 | 1201 | **1567** |
| 15 | 35 | 353 | 850 | 0.88 | 435 | 299 | **734** | 621 | 397 | 1197 | **1594** |
| 14 | 36 | 371 | 850 | 0.88 | 458 | 299 | **757** | 654 | 430 | 1197 | **1627** |
| 13 | 37 | 403 | 850 | 0.88 | 497 | 299 | **796** | 709 | 485 | 1197 | **1682** |
| 12 | 38 | 435 | 850 | 0.88 | 535 | 299 | **835** | 765 | 541 | 1197 | **1738** |
| 11 | 39 | 466 | 850 | 0.88 | 574 | 299 | **874** | 820 | 596 | 1197 | **1793** |
| 10 | 40 | 498 | 850 | 0.88 | 613 | 299 | **912** | 876 | 652 | 1197 | **1849** |
| 9 | 41 | 529 | 850 | 0.88 | 652 | 299 | **951** | 932 | 707 | 1197 | **1904** |
| 8 | 42 | 561 | 850 | 0.88 | 691 | 299 | **990** | 987 | 763 | 1197 | **1960** |
| 7 | 43 | 592 | 850 | 0.88 | 730 | 299 | **1029** | 1043 | 819 | 1197 | **2016** |
| 6 | 44 | 624 | 850 | 0.88 | 769 | 299 | **1068** | 1098 | 874 | 1197 | **2071** |
| 5 | 45 | 656 | 850 | 0.88 | 808 | 299 | **1107** | 1154 | 930 | 1197 | **2127** |
| 4 | 46 | 687 | 850 | 0.88 | 847 | 299 | **1146** | 1210 | 985 | 1197 | **2182** |
| 3 | 47 | 719 | 850 | 0.88 | 886 | 299 | **1185** | 1265 | 1041 | 1197 | **2238** |
| 2 | 48 | 750 | 850 | 0.88 | 924 | 299 | **1224** | 1321 | 1096 | 1197 | **2293** |
| 1 | 49 | 782 | 850 | 0.88 | 963 | 299 | **1263** | 1376 | 1152 | 1197 | **2349** |
| 0 | 50 | 814 | 850 | 0.88 | 1002 | 299 | **1302** | 1432 | 1208 | 1197 | **2405** |
| -1 | 51 | 845 | 850 | 0.88 | 1041 | 299 | **1340** | 1487 | 1263 | 1197 | **2460** |
| -2 | 52 | 877 | 850 | 0.88 | 1080 | 299 | **1379** | 1543 | 1319 | 1197 | **2516** |
| -3 | 53 | 908 | 850 | 0.88 | 1119 | 299 | **1418** | 1599 | 1374 | 1197 | **2571** |
| -4 | 54 | 940 | 850 | 0.88 | 1158 | 299 | **1457** | 1654 | 1430 | 1197 | **2627** |
| -5 | 55 | 971 | 850 | 0.88 | 1197 | 299 | **1496** | 1710 | 1485 | 1197 | **2683** |
| -6 | 56 | 1003 | 850 | 0.88 | 1236 | 299 | **1535** | 1765 | 1541 | 1197 | **2738** |
| -7 | 57 | 1035 | 850 | 0.88 | 1275 | 299 | **1574** | 1821 | 1597 | 1197 | **2794** |
| -8 | 58 | 1066 | 850 | 0.88 | 1313 | 299 | **1613** | 1876 | 1652 | 1197 | **2849** |
| -9 | 59 | 1098 | 850 | 0.88 | 1352 | 299 | **1652** | 1932 | 1708 | 1197 | **2905** |
| -10 | 60 | 1129 | 850 | 0.88 | 1391 | 299 | **1691** | 1988 | 1763 | 1197 | **2960** |
| -11 | 61 | 1161 | 850 | 0.88 | 1430 | 299 | **1729** | 2043 | 1819 | 1197 | **3016** |
| -12 | 62 | 1192 | 850 | 0.88 | 1469 | 299 | **1768** | 2099 | 1874 | 1197 | **3072** |
| -13 | 63 | 1224 | 850 | 0.88 | 1508 | 299 | **1807** | 2154 | 1930 | 1197 | **3127** |
| -14 | 64 | 1256 | 850 | 0.88 | 1547 | 299 | **1846** | 2210 | 1986 | 1197 | **3183** |
| -15 | 65 | 1287 | 850 | 0.88 | 1586 | 299 | **1885** | 2265 | 2041 | 1197 | **3238** |
| -16 | 66 | 1319 | 850 | 0.88 | 1625 | 299 | **1924** | 2321 | 2097 | 1197 | **3294** |
| -17 | 67 | 1350 | 850 | 0.88 | 1664 | 299 | **1963** | 2377 | 2152 | 1197 | **3349** |
| -18 | 68 | 1382 | 850 | 0.88 | 1703 | 299 | **2002** | 2432 | 2208 | 1197 | **3405** |
| -19 | 69 | 1413 | 850 | 0.88 | 1741 | 299 | **2041** | 2488 | 2264 | 1197 | **3461** |
| -20 | 70 | 1445 | 850 | 0.88 | 1780 | 299 | **2080** | 2543 | 2319 | 1197 | **3516** |
| -21 | 71 | 1477 | 850 | 0.88 | 1819 | 299 | **2118** | 2599 | 2375 | 1197 | **3572** |
| -22 | 72 | 1508 | 850 | 0.88 | 1858 | 299 | **2157** | 2654 | 2430 | 1197 | **3627** |
| -23 | 73 | 1540 | 850 | 0.88 | 1897 | 299 | **2196** | 2710 | 2486 | 1197 | **3683** |
| -24 | 74 | 1571 | 850 | 0.88 | 1936 | 299 | **2235** | 2766 | 2541 | 1197 | **3738** |
| -25 | 75 | 1603 | 850 | 0.88 | 1975 | 299 | **2274** | 2821 | 2597 | 1197 | **3794** |
| -26 | 76 | 1635 | 850 | 0.88 | 2014 | 299 | **2313** | 2877 | 2653 | 1197 | **3850** |
| -27 | 77 | 1666 | 850 | 0.88 | 2053 | 299 | **2352** | 2932 | 2708 | 1197 | **3905** |
| -28 | 78 | 1698 | 913 | 0.88 | 2092 | 321 | **2413** | 2988 | 2764 | 1285 | **4049** |
| -29 | 79 | 1729 | 978 | 0.88 | 2130 | 344 | **2475** | 3043 | 2819 | 1377 | **4196** |
| -30 | 80 | 1761 | 1047 | 0.88 | 2169 | 368 | **2538** | 3099 | 2875 | 1474 | **4348** |
| -31 | 81 | 1792 | 1118 | 0.88 | 2208 | 394 | **2602** | 3155 | 2930 | 1574 | **4505** |
| -32 | 82 | 1824 | 1193 | 0.88 | 2247 | 420 | **2667** | 3210 | 2986 | 1680 | **4666** |
| -33 | 83 | 1856 | 1271 | 0.88 | 2286 | 447 | **2733** | 3266 | 3042 | 1790 | **4831** |
| -34 | 84 | 1887 | 1352 | 0.88 | 2325 | 476 | **2801** | 3321 | 3097 | 1904 | **5001** |
| -35 | 85 | 1919 | 1436 | 0.88 | 2364 | 506 | **2869** | 3377 | 3153 | 2022 | **5175** |
| -36 | 86 | 1950 | 1523 | 0.88 | 2403 | 536 | **2939** | 3433 | 3208 | 2145 | **5353** |
| -37 | 87 | 1982 | 1608 | 0.88 | 2442 | 566 | **3008** | 3488 | 3264 | 2264 | **5527** |
| -38 | 88 | 2013 | 1682 | 0.88 | 2481 | 592 | **3073** | 3544 | 3319 | 2369 | **5688** |
| -39 | 89 | 2045 | 1748 | 0.88 | 2519 | 615 | **3135** | 3599 | 3375 | 2461 | **5836** |
| -40 | 90 | 2077 | 1804 | 0.88 | 2558 | 635 | **3193** | 3655 | 3431 | 2540 | **5971** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 9
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 2108 | 1851 | 0.88 | 2597 | 651 | **3249** | 3710 | 3486 | 2606 | **6092** | |
| -42 | 92 | 2140 | 1888 | 0.88 | 2636 | 665 | **3301** | 3766 | 3542 | 2659 | **6200** | |
| -43 | 93 | 2171 | 1916 | 0.88 | 2675 | 675 | **3350** | 3822 | 3597 | 2698 | **6295** | |
| -44 | 94 | 2203 | 1935 | 0.88 | 2714 | 681 | **3395** | 3877 | 3653 | 2724 | **6377** | |
| -45 | 95 | 2235 | 1944 | 0.88 | 2753 | 684 | **3437** | 3933 | 3708 | 2738 | **6446** | |
| -46 | 96 | 2266 | 1944 | 0.88 | 2792 | 684 | **3476** | 3988 | 3764 | 2738 | **6502** | |
| -47 | 97 | 2288 | 1944 | 0.88 | 2818 | 684 | **3503** | 4026 | 3802 | 2738 | **6539** | |
| -48 | 98 | 2309 | 1944 | 0.88 | 2845 | 684 | **3529** | 4064 | 3840 | 2738 | **6578** | |
| -49 | 99 | 2331 | 1944 | 0.88 | 2872 | 684 | **3556** | 4103 | 3879 | 2738 | **6616** | |
| -50 | 100 | 2353 | 1944 | 0.88 | 2899 | 684 | **3584** | 4142 | 3918 | 2738 | **6655** | |
| -51 | 101 | 2376 | 1944 | 0.88 | 2927 | 684 | **3612** | 4182 | 3958 | 2738 | **6695** | |
| -52 | 102 | 2399 | 1944 | 0.88 | 2955 | 684 | **3640** | 4222 | 3998 | 2738 | **6735** | |
| -53 | 103 | 2422 | 1944 | 0.88 | 2984 | 684 | **3668** | 4262 | 4038 | 2738 | **6776** | |
| -54 | 104 | 2445 | 1944 | 0.88 | 3012 | 684 | **3697** | 4303 | 4079 | 2738 | **6817** | |
| -55 | 105 | 2469 | 1944 | 0.88 | 3041 | 684 | **3726** | 4345 | 4121 | 2738 | **6858** | |
| -56 | 106 | 2492 | 1944 | 0.88 | 3071 | 684 | **3755** | 4387 | 4162 | 2738 | **6900** | |
| -57 | 107 | 2517 | 1944 | 0.88 | 3100 | 684 | **3785** | 4429 | 4205 | 2738 | **6942** | |
| -58 | 108 | 2541 | 1944 | 0.88 | 3130 | 684 | **3815** | 4472 | 4248 | 2738 | **6985** | |
| -59 | 109 | 2565 | 1944 | 0.88 | 3161 | 684 | **3845** | 4515 | 4291 | 2738 | **7028** | |
| -60 | 110 | 2590 | 1944 | 0.88 | 3191 | 684 | **3876** | 4559 | 4335 | 2738 | **7072** | |
| -61 | 111 | 2615 | 1944 | 0.88 | 3222 | 684 | **3907** | 4603 | 4379 | 2738 | **7116** | |
| -62 | 112 | 2641 | 1944 | 0.88 | 3253 | 684 | **3938** | 4648 | 4424 | 2738 | **7161** | |
| -63 | 113 | 2666 | 1944 | 0.88 | 3285 | 684 | **3969** | 4693 | 4469 | 2738 | **7206** | |
| -64 | 114 | 2692 | 1944 | 0.88 | 3317 | 684 | **4001** | 4738 | 4514 | 2738 | **7252** | |
| -65 | 115 | 2718 | 1944 | 0.88 | 3349 | 684 | **4034** | 4785 | 4560 | 2738 | **7298** | Strength (4006k) |
| -66 | 116 | 2745 | 1944 | 0.88 | 3382 | 684 | **4066** | 4831 | 4607 | 2738 | **7344** | use EL-67' |
| -67 | 117 | 2772 | 1944 | 0.88 | 3415 | 684 | **4099** | 4878 | 4654 | 2738 | **7391** | |
| -68 | 118 | 2799 | 1944 | 0.88 | 3448 | 684 | **4132** | 4925 | 4701 | 2738 | **7439** | |
| -69 | 119 | 2826 | 1944 | 0.88 | 3481 | 684 | **4166** | 4973 | 4749 | 2738 | **7487** | |
| -70 | 120 | 2853 | 1944 | 0.88 | 3515 | 684 | **4200** | 5022 | 4797 | 2738 | **7535** | |
| -71 | 121 | 2881 | 1944 | 0.88 | 3549 | 684 | **4234** | 5070 | 4846 | 2738 | **7584** | |
| -72 | 122 | 2909 | 1944 | 0.88 | 3584 | 684 | **4268** | 5120 | 4895 | 2738 | **7633** | |
| -73 | 123 | 2937 | 1944 | 0.88 | 3619 | 684 | **4303** | 5169 | 4945 | 2738 | **7683** | |
| -74 | 124 | 2966 | 1944 | 0.88 | 3654 | 684 | **4338** | 5220 | 4995 | 2738 | **7733** | |
| -75 | 125 | 2994 | 1944 | 0.88 | 3689 | 684 | **4374** | 5270 | 5046 | 2738 | **7784** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 9
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 50 ft
Cut Off Elevation = 45 ft
Pile type: 118'"-diameter CIDH
Post-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 1 | Sand | 0.88 |
| (2) | 1 | 26 | Clay | 0.88 |
| (3) | 26 | 36 | Sand | 0.88 |
| (4) | 36 | 96 | Clay | 0.88 |
| (5) | 96 | 170 | Sand | 0.88 |

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
90 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 50 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 44 | 6 | 3 | 57 | 0.88 | 4 | 20 | **24** | 6 | 0 | 80 | **80** | |
| 43 | 7 | 7 | 120 | 0.88 | 8 | 42 | **51** | 12 | 0 | 169 | **169** | |
| 42 | 8 | 10 | 183 | 0.88 | 13 | 64 | **77** | 18 | 0 | 258 | **258** | |
| 41 | 9 | 14 | 249 | 0.88 | 17 | 88 | **104** | 24 | 0 | 351 | **351** | |
| 40 | 10 | 17 | 318 | 0.88 | 21 | 112 | **133** | 30 | 0 | 448 | **448** | |
| 39 | 11 | 20 | 390 | 0.88 | 25 | 137 | **162** | 36 | 0 | 549 | **549** | |
| 38 | 12 | 24 | 465 | 0.88 | 29 | 164 | **193** | 42 | 0 | 655 | **655** | |
| 37 | 13 | 27 | 543 | 0.88 | 33 | 191 | **225** | 48 | 0 | 764 | **764** | |
| 36 | 14 | 31 | 624 | 0.88 | 38 | 220 | **257** | 54 | 0 | 879 | **879** | |
| 35 | 15 | 34 | 708 | 0.88 | 42 | 249 | **291** | 60 | 0 | 997 | **997** | |
| 34 | 16 | 37 | 795 | 0.88 | 46 | 280 | **326** | 66 | 0 | 1120 | **1120** | |
| 33 | 17 | 41 | 879 | 0.88 | 50 | 310 | **360** | 72 | 0 | 1238 | **1238** | |
| 32 | 18 | 44 | 933 | 0.88 | 54 | 329 | **383** | 78 | 0 | 1314 | **1314** | |
| 31 | 19 | 48 | 977 | 0.88 | 59 | 344 | **402** | 84 | 0 | 1375 | **1375** | |
| 30 | 20 | 51 | 1010 | 0.88 | 63 | 355 | **418** | 90 | 0 | 1422 | **1422** | |
| 29 | 21 | 54 | 1033 | 0.88 | 67 | 363 | **430** | 96 | 6 | 1454 | **1460** | |
| 28 | 22 | 58 | 1045 | 0.88 | 71 | 368 | **439** | 102 | 12 | 1471 | **1483** | |
| 27 | 23 | 61 | 1047 | 0.88 | 75 | 369 | **444** | 108 | 18 | 1474 | **1492** | |
| 26 | 24 | 65 | 1039 | 0.88 | 80 | 366 | **445** | 114 | 24 | 1462 | **1486** | |
| 25 | 25 | 68 | 1020 | 0.88 | 84 | 359 | **443** | 120 | 30 | 1436 | **1466** | |
| 24 | 26 | 71 | 991 | 0.88 | 88 | 349 | **437** | 126 | 36 | 1395 | **1431** | |
| 23 | 27 | 86 | 963 | 0.88 | 106 | 339 | **445** | 151 | 61 | 1355 | **1417** | |
| 22 | 28 | 101 | 938 | 0.88 | 124 | 330 | **454** | 177 | 88 | 1320 | **1408** | |
| 21 | 29 | 116 | 916 | 0.88 | 143 | 322 | **466** | 205 | 115 | 1289 | **1404** | |
| 20 | 30 | 132 | 897 | 0.88 | 163 | 316 | **479** | 233 | 143 | 1263 | **1406** | |
| 19 | 31 | 149 | 881 | 0.88 | 183 | 310 | **493** | 262 | 172 | 1241 | **1413** | |
| 18 | 32 | 165 | 869 | 0.88 | 204 | 306 | **510** | 291 | 202 | 1223 | **1425** | |
| 17 | 33 | 183 | 860 | 0.88 | 225 | 303 | **528** | 322 | 232 | 1210 | **1442** | |
| 16 | 34 | 200 | 853 | 0.88 | 247 | 300 | **547** | 353 | 263 | 1201 | **1465** | |
| 15 | 35 | 219 | 850 | 0.88 | 269 | 299 | **569** | 385 | 295 | 1197 | **1492** | |
| 14 | 36 | 237 | 850 | 0.88 | 292 | 299 | **591** | 417 | 328 | 1197 | **1525** | |
| 13 | 37 | 269 | 850 | 0.88 | 331 | 299 | **630** | 473 | 383 | 1197 | **1580** | Extreme (1569k)* |
| 12 | 38 | 300 | 850 | 0.88 | 370 | 299 | **669** | 528 | 439 | 1197 | **1636** | Use El +8' |
| 11 | 39 | 332 | 850 | 0.88 | 409 | 299 | **708** | 584 | 494 | 1197 | **1691** | |
| 10 | 40 | 363 | 850 | 0.88 | 448 | 299 | **747** | 640 | 550 | 1197 | **1747** | |
| 9 | 41 | 395 | 850 | 0.88 | 487 | 299 | **786** | 695 | 605 | 1197 | **1802** | |
| 8 | 42 | 427 | 850 | 0.88 | 525 | 299 | **825** | 751 | 661 | 1197 | **1858** | |
| 7 | 43 | 458 | 850 | 0.88 | 564 | 299 | **864** | 806 | 717 | 1197 | **1914** | |
| 6 | 44 | 490 | 850 | 0.88 | 603 | 299 | **903** | 862 | 772 | 1197 | **1969** | |
| 5 | 45 | 521 | 850 | 0.88 | 642 | 299 | **941** | 917 | 828 | 1197 | **2025** | |
| 4 | 46 | 553 | 850 | 0.88 | 681 | 299 | **980** | 973 | 883 | 1197 | **2080** | |
| 3 | 47 | 584 | 850 | 0.88 | 720 | 299 | **1019** | 1029 | 939 | 1197 | **2136** | |
| 2 | 48 | 616 | 850 | 0.88 | 759 | 299 | **1058** | 1084 | 994 | 1197 | **2191** | |
| 1 | 49 | 648 | 850 | 0.88 | 798 | 299 | **1097** | 1140 | 1050 | 1197 | **2247** | |
| 0 | 50 | 679 | 850 | 0.88 | 837 | 299 | **1136** | 1195 | 1106 | 1197 | **2303** | |
| -1 | 51 | 711 | 850 | 0.88 | 876 | 299 | **1175** | 1251 | 1161 | 1197 | **2358** | |
| -2 | 52 | 742 | 850 | 0.88 | 915 | 299 | **1214** | 1306 | 1217 | 1197 | **2414** | |
| -3 | 53 | 774 | 850 | 0.88 | 953 | 299 | **1253** | 1362 | 1272 | 1197 | **2469** | |
| -4 | 54 | 805 | 850 | 0.88 | 992 | 299 | **1292** | 1418 | 1328 | 1197 | **2525** | |
| -5 | 55 | 837 | 850 | 0.88 | 1031 | 299 | **1330** | 1473 | 1383 | 1197 | **2581** | |
| -6 | 56 | 869 | 850 | 0.88 | 1070 | 299 | **1369** | 1529 | 1439 | 1197 | **2636** | |
| -7 | 57 | 900 | 850 | 0.88 | 1109 | 299 | **1408** | 1584 | 1495 | 1197 | **2692** | |
| -8 | 58 | 932 | 850 | 0.88 | 1148 | 299 | **1447** | 1640 | 1550 | 1197 | **2747** | |
| -9 | 59 | 963 | 850 | 0.88 | 1187 | 299 | **1486** | 1695 | 1606 | 1197 | **2803** | |
| -10 | 60 | 995 | 850 | 0.88 | 1226 | 299 | **1525** | 1751 | 1661 | 1197 | **2858** | |
| -11 | 61 | 1027 | 850 | 0.88 | 1265 | 299 | **1564** | 1807 | 1717 | 1197 | **2914** | |
| -12 | 62 | 1058 | 850 | 0.88 | 1304 | 299 | **1603** | 1862 | 1772 | 1197 | **2970** | |
| -13 | 63 | 1090 | 850 | 0.88 | 1342 | 299 | **1642** | 1918 | 1828 | 1197 | **3025** | |
| -14 | 64 | 1121 | 850 | 0.88 | 1381 | 299 | **1681** | 1973 | 1884 | 1197 | **3081** | |
| -15 | 65 | 1153 | 850 | 0.88 | 1420 | 299 | **1720** | 2029 | 1939 | 1197 | **3136** | |
| -16 | 66 | 1184 | 850 | 0.88 | 1459 | 299 | **1758** | 2085 | 1995 | 1197 | **3192** | |
| -17 | 67 | 1216 | 850 | 0.88 | 1498 | 299 | **1797** | 2140 | 2050 | 1197 | **3247** | |
| -18 | 68 | 1248 | 850 | 0.88 | 1537 | 299 | **1836** | 2196 | 2106 | 1197 | **3303** | |
| -19 | 69 | 1279 | 850 | 0.88 | 1576 | 299 | **1875** | 2251 | 2162 | 1197 | **3359** | |
| -20 | 70 | 1311 | 850 | 0.88 | 1615 | 299 | **1914** | 2307 | 2217 | 1197 | **3414** | |
| -21 | 71 | 1342 | 850 | 0.88 | 1654 | 299 | **1953** | 2362 | 2273 | 1197 | **3470** | |
| -22 | 72 | 1374 | 850 | 0.88 | 1693 | 299 | **1992** | 2418 | 2328 | 1197 | **3525** | |
| -23 | 73 | 1405 | 850 | 0.88 | 1731 | 299 | **2031** | 2474 | 2384 | 1197 | **3581** | |
| -24 | 74 | 1437 | 850 | 0.88 | 1770 | 299 | **2070** | 2529 | 2439 | 1197 | **3636** | |
| -25 | 75 | 1469 | 850 | 0.88 | 1809 | 299 | **2109** | 2585 | 2495 | 1197 | **3692** | |
| -26 | 76 | 1500 | 850 | 0.88 | 1848 | 299 | **2147** | 2640 | 2551 | 1197 | **3748** | |
| -27 | 77 | 1532 | 850 | 0.88 | 1887 | 299 | **2186** | 2696 | 2606 | 1197 | **3803** | |
| -28 | 78 | 1563 | 913 | 0.88 | 1926 | 321 | **2247** | 2751 | 2662 | 1285 | **3947** | |
| -29 | 79 | 1595 | 978 | 0.88 | 1965 | 344 | **2309** | 2807 | 2717 | 1377 | **4094** | |
| -30 | 80 | 1626 | 1047 | 0.88 | 2004 | 368 | **2372** | 2863 | 2773 | 1474 | **4246** | |
| -31 | 81 | 1658 | 1118 | 0.88 | 2043 | 394 | **2436** | 2918 | 2828 | 1574 | **4403** | |
| -32 | 82 | 1690 | 1193 | 0.88 | 2082 | 420 | **2502** | 2974 | 2884 | 1680 | **4564** | |
| -33 | 83 | 1721 | 1271 | 0.88 | 2121 | 447 | **2568** | 3029 | 2940 | 1790 | **4729** | |
| -34 | 84 | 1753 | 1352 | 0.88 | 2159 | 476 | **2635** | 3085 | 2995 | 1904 | **4899** | |
| -35 | 85 | 1784 | 1436 | 0.88 | 2198 | 506 | **2704** | 3140 | 3051 | 2022 | **5073** | |
| -36 | 86 | 1816 | 1523 | 0.88 | 2237 | 536 | **2773** | 3196 | 3106 | 2145 | **5251** | |
| -37 | 87 | 1848 | 1608 | 0.88 | 2276 | 566 | **2842** | 3252 | 3162 | 2264 | **5425** | |
| -38 | 88 | 1879 | 1682 | 0.88 | 2315 | 592 | **2907** | 3307 | 3217 | 2369 | **5586** | |
| -39 | 89 | 1911 | 1748 | 0.88 | 2354 | 615 | **2969** | 3363 | 3273 | 2461 | **5734** | |
| -40 | 90 | 1942 | 1804 | 0.88 | 2393 | 635 | **3028** | 3418 | 3329 | 2540 | **5869** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 9
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -41 | 91 | 1974 | 1851 | 0.88 | 2432 | 651 | **3083** | 3474 | 3384 | 2606 | **5990** | |
| -42 | 92 | 2005 | 1888 | 0.88 | 2471 | 665 | **3135** | 3530 | 3440 | 2659 | **6098** | |
| -43 | 93 | 2037 | 1916 | 0.88 | 2510 | 675 | **3184** | 3585 | 3495 | 2698 | **6193** | |
| -44 | 94 | 2069 | 1935 | 0.88 | 2548 | 681 | **3230** | 3641 | 3551 | 2724 | **6275** | |
| -45 | 95 | 2100 | 1944 | 0.88 | 2587 | 684 | **3272** | 3696 | 3607 | 2738 | **6344** | |
| -46 | 96 | 2132 | 1944 | 0.88 | 2626 | 684 | **3311** | 3752 | 3662 | 2738 | **6400** | |
| -47 | 97 | 2153 | 1944 | 0.88 | 2653 | 684 | **3337** | 3790 | 3700 | 2738 | **6437** | |
| -48 | 98 | 2175 | 1944 | 0.88 | 2679 | 684 | **3364** | 3828 | 3738 | 2738 | **6476** | |
| -49 | 99 | 2197 | 1944 | 0.88 | 2707 | 684 | **3391** | 3866 | 3777 | 2738 | **6514** | |
| -50 | 100 | 2219 | 1944 | 0.88 | 2734 | 684 | **3418** | 3906 | 3816 | 2738 | **6553** | |
| -51 | 101 | 2242 | 1944 | 0.88 | 2762 | 684 | **3446** | 3945 | 3856 | 2738 | **6593** | |
| -52 | 102 | 2264 | 1944 | 0.88 | 2790 | 684 | **3474** | 3985 | 3896 | 2738 | **6633** | |
| -53 | 103 | 2287 | 1944 | 0.88 | 2818 | 684 | **3502** | 4026 | 3936 | 2738 | **6674** | |
| -54 | 104 | 2311 | 1944 | 0.88 | 2847 | 684 | **3531** | 4067 | 3977 | 2738 | **6715** | |
| -55 | 105 | 2334 | 1944 | 0.88 | 2876 | 684 | **3560** | 4108 | 4019 | 2738 | **6756** | |
| -56 | 106 | 2358 | 1944 | 0.88 | 2905 | 684 | **3590** | 4150 | 4060 | 2738 | **6798** | |
| -57 | 107 | 2382 | 1944 | 0.88 | 2935 | 684 | **3619** | 4193 | 4103 | 2738 | **6840** | |
| -58 | 108 | 2406 | 1944 | 0.88 | 2965 | 684 | **3649** | 4235 | 4146 | 2738 | **6883** | |
| -59 | 109 | 2431 | 1944 | 0.88 | 2995 | 684 | **3679** | 4279 | 4189 | 2738 | **6927** | |
| -60 | 110 | 2456 | 1944 | 0.88 | 3026 | 684 | **3710** | 4322 | 4233 | 2738 | **6970** | |
| -61 | 111 | 2481 | 1944 | 0.88 | 3057 | 684 | **3741** | 4367 | 4277 | 2738 | **7014** | |
| -62 | 112 | 2506 | 1944 | 0.88 | 3088 | 684 | **3772** | 4411 | 4322 | 2738 | **7059** | |
| -63 | 113 | 2532 | 1944 | 0.88 | 3119 | 684 | **3804** | 4456 | 4367 | 2738 | **7104** | |
| -64 | 114 | 2558 | 1944 | 0.88 | 3151 | 684 | **3836** | 4502 | 4412 | 2738 | **7150** | |
| -65 | 115 | 2584 | 1944 | 0.88 | 3184 | 684 | **3868** | 4548 | 4458 | 2738 | **7196** | |
| -66 | 116 | 2611 | 1944 | 0.88 | 3216 | 684 | **3901** | 4595 | 4505 | 2738 | **7242** | |
| -67 | 117 | 2637 | 1944 | 0.88 | 3249 | 684 | **3933** | 4642 | 4552 | 2738 | **7289** | |
| -68 | 118 | 2664 | 1944 | 0.88 | 3282 | 684 | **3967** | 4689 | 4599 | 2738 | **7337** | |
| -69 | 119 | 2691 | 1944 | 0.88 | 3316 | 684 | **4000** | 4737 | 4647 | 2738 | **7385** | |
| -70 | 120 | 2719 | 1944 | 0.88 | 3350 | 684 | **4034** | 4785 | 4695 | 2738 | **7433** | |
| -71 | 121 | 2747 | 1944 | 0.88 | 3384 | 684 | **4068** | 4834 | 4744 | 2738 | **7482** | |
| -72 | 122 | 2775 | 1944 | 0.88 | 3418 | 684 | **4103** | 4883 | 4793 | 2738 | **7531** | |
| -73 | 123 | 2803 | 1944 | 0.88 | 3453 | 684 | **4137** | 4933 | 4843 | 2738 | **7581** | |
| -74 | 124 | 2831 | 1944 | 0.88 | 3488 | 684 | **4173** | 4983 | 4893 | 2738 | **7631** | Strength (4600k) |
| -75 | 125 | 2860 | 1944 | 0.88 | 3524 | 684 | **4208** | 5034 | 4944 | 2738 | **7682** | Use EL-76' |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 10
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 46 ft
Cut Off Elevation = 41 ft

Pile type: 118"-diameter CIDH

Pre-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 16 | Sand | 0.88 |
| (2) | 16 | 26 | Sand | 0.88 |
| (3) | 26 | 96 | Clay | 0.88 |
| (4) | 96 | 166 | Sand | 0.88 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
145 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) |
| 46 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** |
| 40 | 6 | 4 | 224 | 0.88 | 5 | 79 | **84** | 7 | 0 | 316 | **316** |
| 39 | 7 | 10 | 280 | 0.88 | 12 | 99 | **111** | 17 | 0 | 395 | **395** |
| 38 | 8 | 16 | 337 | 0.88 | 19 | 119 | **138** | 28 | 0 | 474 | **474** |
| 37 | 9 | 22 | 391 | 0.88 | 27 | 138 | **165** | 39 | 0 | 550 | **550** |
| 36 | 10 | 29 | 442 | 0.88 | 36 | 156 | **192** | 52 | 0 | 623 | **623** |
| 35 | 11 | 37 | 491 | 0.88 | 45 | 173 | **218** | 65 | 0 | 692 | **692** |
| 34 | 12 | 45 | 538 | 0.88 | 56 | 189 | **245** | 79 | 0 | 758 | **758** |
| 33 | 13 | 54 | 582 | 0.88 | 66 | 205 | **271** | 95 | 0 | 820 | **820** |
| 32 | 14 | 63 | 624 | 0.88 | 78 | 220 | **297** | 111 | 0 | 879 | **879** |
| 31 | 15 | 73 | 664 | 0.88 | 89 | 234 | **323** | 128 | 0 | 934 | **934** |
| 30 | 16 | 83 | 701 | 0.88 | 102 | 247 | **348** | 145 | 0 | 986 | **986** |
| 29 | 17 | 93 | 736 | 0.88 | 115 | 259 | **374** | 164 | 19 | 1036 | **1055** |
| 28 | 18 | 105 | 766 | 0.88 | 129 | 270 | **399** | 185 | 39 | 1079 | **1118** |
| 27 | 19 | 117 | 792 | 0.88 | 144 | 279 | **423** | 206 | 60 | 1115 | **1175** |
| 26 | 20 | 130 | 814 | 0.88 | 160 | 286 | **446** | 228 | 82 | 1146 | **1228** |
| 25 | 21 | 143 | 831 | 0.88 | 176 | 293 | **468** | 251 | 106 | 1170 | **1276** |
| 24 | 22 | 156 | 845 | 0.88 | 193 | 297 | **490** | 275 | 130 | 1189 | **1319** |
| 23 | 23 | 171 | 854 | 0.88 | 210 | 301 | **511** | 301 | 155 | 1202 | **1357** |
| 22 | 24 | 186 | 859 | 0.88 | 229 | 302 | **531** | 327 | 181 | 1210 | **1391** |
| 21 | 25 | 201 | 861 | 0.88 | 247 | 303 | **550** | 353 | 208 | 1212 | **1420** |
| 20 | 26 | 217 | 858 | 0.88 | 267 | 302 | **569** | 381 | 236 | 1208 | **1444** |
| 19 | 27 | 248 | 856 | 0.88 | 306 | 301 | **607** | 437 | 291 | 1205 | **1496** |
| 18 | 28 | 280 | 854 | 0.88 | 345 | 301 | **645** | 492 | 347 | 1203 | **1549** |
| 17 | 29 | 311 | 853 | 0.88 | 384 | 300 | **684** | 548 | 402 | 1201 | **1603** |
| 16 | 30 | 343 | 852 | 0.88 | 422 | 300 | **722** | 604 | 458 | 1199 | **1657** |
| 15 | 31 | 375 | 851 | 0.88 | 461 | 300 | **761** | 659 | 514 | 1198 | **1712** |
| 14 | 32 | 406 | 851 | 0.88 | 500 | 299 | **800** | 715 | 569 | 1198 | **1767** |
| 13 | 33 | 438 | 850 | 0.88 | 539 | 299 | **839** | 770 | 625 | 1197 | **1822** |
| 12 | 34 | 469 | 850 | 0.88 | 578 | 299 | **877** | 826 | 680 | 1197 | **1877** |
| 11 | 35 | 501 | 850 | 0.88 | 617 | 299 | **916** | 881 | 736 | 1197 | **1933** |
| 10 | 36 | 532 | 850 | 0.88 | 656 | 299 | **955** | 937 | 792 | 1197 | **1989** |
| 9 | 37 | 564 | 850 | 0.88 | 695 | 299 | **994** | 993 | 847 | 1197 | **2044** |
| 8 | 38 | 596 | 850 | 0.88 | 734 | 299 | **1033** | 1048 | 903 | 1197 | **2100** |
| 7 | 39 | 627 | 850 | 0.88 | 773 | 299 | **1072** | 1104 | 958 | 1197 | **2155** |
| 6 | 40 | 659 | 850 | 0.88 | 812 | 299 | **1111** | 1159 | 1014 | 1197 | **2211** |
| 5 | 41 | 690 | 850 | 0.88 | 850 | 299 | **1150** | 1215 | 1069 | 1197 | **2266** |
| 4 | 42 | 722 | 850 | 0.88 | 889 | 299 | **1189** | 1270 | 1125 | 1197 | **2322** |
| 3 | 43 | 753 | 850 | 0.88 | 928 | 299 | **1227** | 1326 | 1181 | 1197 | **2378** |
| 2 | 44 | 785 | 850 | 0.88 | 967 | 299 | **1266** | 1382 | 1236 | 1197 | **2433** |
| 1 | 45 | 817 | 850 | 0.88 | 1006 | 299 | **1305** | 1437 | 1292 | 1197 | **2489** |
| 0 | 46 | 848 | 850 | 0.88 | 1045 | 299 | **1344** | 1493 | 1347 | 1197 | **2544** |
| -1 | 47 | 880 | 850 | 0.88 | 1084 | 299 | **1383** | 1548 | 1403 | 1197 | **2600** |
| -2 | 48 | 911 | 850 | 0.88 | 1123 | 299 | **1422** | 1604 | 1458 | 1197 | **2655** |
| -3 | 49 | 943 | 850 | 0.88 | 1162 | 299 | **1461** | 1659 | 1514 | 1197 | **2711** |
| -4 | 50 | 974 | 850 | 0.88 | 1201 | 299 | **1500** | 1715 | 1570 | 1197 | **2767** |
| -5 | 51 | 1006 | 850 | 0.88 | 1239 | 299 | **1539** | 1771 | 1625 | 1197 | **2822** |
| -6 | 52 | 1038 | 850 | 0.88 | 1278 | 299 | **1578** | 1826 | 1681 | 1197 | **2878** |
| -7 | 53 | 1069 | 850 | 0.88 | 1317 | 299 | **1617** | 1882 | 1736 | 1197 | **2933** |
| -8 | 54 | 1101 | 850 | 0.88 | 1356 | 299 | **1655** | 1937 | 1792 | 1197 | **2989** |
| -9 | 55 | 1132 | 850 | 0.88 | 1395 | 299 | **1694** | 1993 | 1847 | 1197 | **3045** |
| -10 | 56 | 1164 | 850 | 0.88 | 1434 | 299 | **1733** | 2049 | 1903 | 1197 | **3100** |
| -11 | 57 | 1196 | 850 | 0.88 | 1473 | 299 | **1772** | 2104 | 1959 | 1197 | **3156** |
| -12 | 58 | 1227 | 850 | 0.88 | 1512 | 299 | **1811** | 2160 | 2014 | 1197 | **3211** |
| -13 | 59 | 1259 | 850 | 0.88 | 1551 | 299 | **1850** | 2215 | 2070 | 1197 | **3267** |
| -14 | 60 | 1290 | 850 | 0.88 | 1590 | 299 | **1889** | 2271 | 2125 | 1197 | **3322** |
| -15 | 61 | 1322 | 850 | 0.88 | 1628 | 299 | **1928** | 2326 | 2181 | 1197 | **3378** |
| -16 | 62 | 1353 | 850 | 0.88 | 1667 | 299 | **1967** | 2382 | 2236 | 1197 | **3434** |
| -17 | 63 | 1385 | 850 | 0.88 | 1706 | 299 | **2006** | 2438 | 2292 | 1197 | **3489** |
| -18 | 64 | 1417 | 850 | 0.88 | 1745 | 299 | **2044** | 2493 | 2348 | 1197 | **3545** |
| -19 | 65 | 1448 | 850 | 0.88 | 1784 | 299 | **2083** | 2549 | 2403 | 1197 | **3600** |
| -20 | 66 | 1480 | 850 | 0.88 | 1823 | 299 | **2122** | 2604 | 2459 | 1197 | **3656** |
| -21 | 67 | 1511 | 850 | 0.88 | 1862 | 299 | **2161** | 2660 | 2514 | 1197 | **3711** |
| -22 | 68 | 1543 | 850 | 0.88 | 1901 | 299 | **2200** | 2715 | 2570 | 1197 | **3767** |
| -23 | 69 | 1574 | 850 | 0.88 | 1940 | 299 | **2239** | 2771 | 2626 | 1197 | **3823** |
| -24 | 70 | 1606 | 850 | 0.88 | 1979 | 299 | **2278** | 2827 | 2681 | 1197 | **3878** |
| -25 | 71 | 1638 | 850 | 0.88 | 2018 | 299 | **2317** | 2882 | 2737 | 1197 | **3934** |
| -26 | 72 | 1669 | 850 | 0.88 | 2056 | 299 | **2356** | 2938 | 2792 | 1197 | **3989** |
| -27 | 73 | 1701 | 850 | 0.88 | 2095 | 299 | **2395** | 2993 | 2848 | 1197 | **4045** |
| -28 | 74 | 1732 | 850 | 0.88 | 2134 | 299 | **2433** | 3049 | 2903 | 1197 | **4100** |
| -29 | 75 | 1764 | 850 | 0.88 | 2173 | 299 | **2472** | 3104 | 2959 | 1197 | **4156** |
| -30 | 76 | 1795 | 850 | 0.88 | 2212 | 299 | **2511** | 3160 | 3015 | 1197 | **4212** |
| -31 | 77 | 1827 | 850 | 0.88 | 2251 | 299 | **2550** | 3216 | 3070 | 1197 | **4267** |
| -32 | 78 | 1859 | 913 | 0.88 | 2290 | 321 | **2611** | 3271 | 3126 | 1285 | **4411** |
| -33 | 79 | 1890 | 978 | 0.88 | 2329 | 344 | **2673** | 3327 | 3181 | 1377 | **4558** |
| -34 | 80 | 1922 | 1047 | 0.88 | 2368 | 368 | **2736** | 3382 | 3237 | 1474 | **4710** |
| -35 | 81 | 1953 | 1118 | 0.88 | 2407 | 394 | **2800** | 3438 | 3292 | 1574 | **4867** |
| -36 | 82 | 1985 | 1193 | 0.88 | 2445 | 420 | **2865** | 3493 | 3348 | 1680 | **5028** |
| -37 | 83 | 2017 | 1271 | 0.88 | 2484 | 447 | **2932** | 3549 | 3404 | 1790 | **5193** |
| -38 | 84 | 2048 | 1352 | 0.88 | 2523 | 476 | **2999** | 3605 | 3459 | 1904 | **5363** |
| -39 | 85 | 2080 | 1436 | 0.88 | 2562 | 506 | **3068** | 3660 | 3515 | 2022 | **5537** |
| -40 | 86 | 2111 | 1523 | 0.88 | 2601 | 536 | **3137** | 3716 | 3570 | 2145 | **5715** |
| -41 | 87 | 2143 | 1608 | 0.88 | 2640 | 566 | **3206** | 3771 | 3626 | 2264 | **5889** |
| -42 | 88 | 2174 | 1682 | 0.88 | 2679 | 592 | **3271** | 3827 | 3681 | 2369 | **6050** |
| -43 | 89 | 2206 | 1748 | 0.88 | 2718 | 615 | **3333** | 3883 | 3737 | 2461 | **6198** |
| -44 | 90 | 2238 | 1804 | 0.88 | 2757 | 635 | **3392** | 3938 | 3793 | 2540 | **6333** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 10
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -45 | 91 | 2269 | 1851 | 0.88 | 2796 | 651 | **3447** | 3994 | 3848 | 2606 | **6454** | |
| -46 | 92 | 2301 | 1888 | 0.88 | 2834 | 665 | **3499** | 4049 | 3904 | 2659 | **6562** | |
| -47 | 93 | 2332 | 1916 | 0.88 | 2873 | 675 | **3548** | 4105 | 3959 | 2698 | **6657** | |
| -48 | 94 | 2364 | 1935 | 0.88 | 2912 | 681 | **3593** | 4160 | 4015 | 2724 | **6739** | |
| -49 | 95 | 2395 | 1944 | 0.88 | 2951 | 684 | **3636** | 4216 | 4070 | 2738 | **6808** | |
| -50 | 96 | 2427 | 1944 | 0.88 | 2990 | 684 | **3674** | 4272 | 4126 | 2738 | **6864** | |
| -51 | 97 | 2449 | 1944 | 0.88 | 3017 | 684 | **3702** | 4310 | 4165 | 2738 | **6902** | |
| -52 | 98 | 2471 | 1944 | 0.88 | 3045 | 684 | **3729** | 4350 | 4204 | 2738 | **6942** | |
| -53 | 99 | 2494 | 1944 | 0.88 | 3073 | 684 | **3757** | 4389 | 4244 | 2738 | **6981** | |
| -54 | 100 | 2517 | 1944 | 0.88 | 3101 | 684 | **3785** | 4429 | 4284 | 2738 | **7022** | |
| -55 | 101 | 2540 | 1944 | 0.88 | 3129 | 684 | **3813** | 4470 | 4325 | 2738 | **7062** | Strength (3807k) |
| -56 | 102 | 2563 | 1944 | 0.88 | 3158 | 684 | **3842** | 4511 | 4366 | 2738 | **7103** | use EL-57' |
| -57 | 103 | 2587 | 1944 | 0.88 | 3187 | 684 | **3871** | 4553 | 4407 | 2738 | **7145** | |
| -58 | 104 | 2611 | 1944 | 0.88 | 3216 | 684 | **3901** | 4595 | 4449 | 2738 | **7187** | |
| -59 | 105 | 2635 | 1944 | 0.88 | 3246 | 684 | **3930** | 4637 | 4492 | 2738 | **7229** | |
| -60 | 106 | 2659 | 1944 | 0.88 | 3276 | 684 | **3960** | 4680 | 4535 | 2738 | **7272** | |
| -61 | 107 | 2684 | 1944 | 0.88 | 3306 | 684 | **3991** | 4724 | 4578 | 2738 | **7316** | |
| -62 | 108 | 2709 | 1944 | 0.88 | 3337 | 684 | **4022** | 4767 | 4622 | 2738 | **7359** | |
| -63 | 109 | 2734 | 1944 | 0.88 | 3368 | 684 | **4053** | 4812 | 4666 | 2738 | **7404** | |
| -64 | 110 | 2759 | 1944 | 0.88 | 3400 | 684 | **4084** | 4856 | 4711 | 2738 | **7449** | |
| -65 | 111 | 2785 | 1944 | 0.88 | 3431 | 684 | **4116** | 4902 | 4756 | 2738 | **7494** | |
| -66 | 112 | 2811 | 1944 | 0.88 | 3463 | 684 | **4148** | 4947 | 4802 | 2738 | **7539** | |
| -67 | 113 | 2837 | 1944 | 0.88 | 3495 | 684 | **4180** | 4994 | 4848 | 2738 | **7586** | |
| -68 | 114 | 2864 | 1944 | 0.88 | 3528 | 684 | **4212** | 5040 | 4895 | 2738 | **7632** | |
| -69 | 115 | 2890 | 1944 | 0.88 | 3561 | 684 | **4245** | 5087 | 4942 | 2738 | **7679** | |
| -70 | 116 | 2917 | 1944 | 0.88 | 3594 | 684 | **4279** | 5135 | 4989 | 2738 | **7727** | |
| -71 | 117 | 2945 | 1944 | 0.88 | 3628 | 684 | **4312** | 5183 | 5037 | 2738 | **7775** | |
| -72 | 118 | 2972 | 1944 | 0.88 | 3662 | 684 | **4346** | 5231 | 5086 | 2738 | **7823** | |
| -73 | 119 | 3000 | 1944 | 0.88 | 3696 | 684 | **4380** | 5280 | 5135 | 2738 | **7872** | |
| -74 | 120 | 3028 | 1944 | 0.88 | 3731 | 684 | **4415** | 5329 | 5184 | 2738 | **7921** | |
| -75 | 121 | 3056 | 1944 | 0.88 | 3765 | 684 | **4450** | 5379 | 5234 | 2738 | **7971** | |
| -76 | 122 | 3085 | 1944 | 0.88 | 3801 | 684 | **4485** | 5429 | 5284 | 2738 | **8022** | |
| -77 | 123 | 3114 | 1944 | 0.88 | 3836 | 684 | **4521** | 5480 | 5335 | 2738 | **8072** | |
| -78 | 124 | 3143 | 1944 | 0.88 | 3872 | 684 | **4556** | 5531 | 5386 | 2738 | **8123** | |
| -79 | 125 | 3172 | 1944 | 0.88 | 3908 | 684 | **4593** | 5583 | 5438 | 2738 | **8175** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 10
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

Finish Grade Elevation = 46 ft
Cut Off Elevation = 41 ft

Pile type: 118"-diameter CIDH

Post-liquefaction Condition

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.2 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 16 | Clay | 0.88 |
| (2) | 16 | 26 | Sand | 0.88 |
| (3) | 26 | 96 | Clay | 0.88 |
| (4) | 96 | 166 | Sand | 0.88 |

Axial Group Reduction Factor (η) for Sandy Materials= 0.88
Axial Group Reduction Factor (η) for Clayey Materials= 0.88

Skin Resistance above neutral axis (=>Pile Length)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
66 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 46 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 40 | 6 | 3 | 268 | 0.88 | 4 | 94 | **98** | 6 | 0 | 377 | **377** | |
| 39 | 7 | 7 | 316 | 0.88 | 8 | 111 | **120** | 12 | 0 | 445 | **445** | |
| 38 | 8 | 10 | 365 | 0.88 | 13 | 128 | **141** | 18 | 0 | 514 | **514** | |
| 37 | 9 | 14 | 412 | 0.88 | 17 | 145 | **162** | 24 | 0 | 580 | **580** | |
| 36 | 10 | 17 | 457 | 0.88 | 21 | 161 | **182** | 30 | 0 | 644 | **644** | |
| 35 | 11 | 20 | 502 | 0.88 | 25 | 177 | **202** | 36 | 0 | 706 | **706** | |
| 34 | 12 | 24 | 544 | 0.88 | 29 | 192 | **221** | 42 | 0 | 766 | **766** | |
| 33 | 13 | 27 | 585 | 0.88 | 33 | 206 | **240** | 48 | 0 | 824 | **824** | |
| 32 | 14 | 31 | 625 | 0.88 | 38 | 220 | **258** | 54 | 0 | 880 | **880** | |
| 31 | 15 | 34 | 664 | 0.88 | 42 | 234 | **275** | 60 | 0 | 934 | **934** | |
| 30 | 16 | 37 | 701 | 0.88 | 46 | 247 | **293** | 66 | 0 | 986 | **986** | |
| 29 | 17 | 48 | 736 | 0.88 | 59 | 259 | **318** | 85 | 19 | 1036 | **1055** | |
| 28 | 18 | 60 | 766 | 0.88 | 73 | 270 | **343** | 105 | 39 | 1079 | **1118** | |
| 27 | 19 | 72 | 792 | 0.88 | 88 | 279 | **367** | 126 | 60 | 1115 | **1175** | |
| 26 | 20 | 84 | 814 | 0.88 | 104 | 286 | **390** | 148 | 82 | 1146 | **1228** | |
| 25 | 21 | 97 | 831 | 0.88 | 120 | 293 | **413** | 171 | 106 | 1170 | **1276** | |
| 24 | 22 | 111 | 845 | 0.88 | 137 | 297 | **434** | 196 | 130 | 1189 | **1319** | |
| 23 | 23 | 125 | 854 | 0.88 | 155 | 301 | **455** | 221 | 155 | 1202 | **1357** | |
| 22 | 24 | 140 | 859 | 0.88 | 173 | 302 | **475** | 247 | 181 | 1210 | **1391** | |
| 21 | 25 | 156 | 861 | 0.88 | 192 | 303 | **495** | 274 | 208 | 1212 | **1420** | |
| 20 | 26 | 171 | 858 | 0.88 | 211 | 302 | **513** | 302 | 236 | 1208 | **1444** | |
| 19 | 27 | 203 | 856 | 0.88 | 250 | 301 | **551** | 357 | 291 | 1205 | **1496** | |
| 18 | 28 | 234 | 854 | 0.88 | 289 | 301 | **590** | 413 | 347 | 1203 | **1549** | |
| 17 | 29 | 266 | 853 | 0.88 | 328 | 300 | **628** | 468 | 402 | 1201 | **1603** | |
| 16 | 30 | 298 | 852 | 0.88 | 367 | 300 | **667** | 524 | 458 | 1199 | **1657** | |
| 15 | 31 | 329 | 851 | 0.88 | 406 | 300 | **705** | 579 | 514 | 1198 | **1712** | |
| 14 | 32 | 361 | 851 | 0.88 | 444 | 299 | **744** | 635 | 569 | 1198 | **1767** | |
| 13 | 33 | 392 | 850 | 0.88 | 483 | 299 | **783** | 691 | 625 | 1197 | **1822** | |
| 12 | 34 | 424 | 850 | 0.88 | 522 | 299 | **822** | 746 | 680 | 1197 | **1877** | Extreme (1843k) |
| 11 | 35 | 456 | 850 | 0.88 | 561 | 299 | **860** | 802 | 736 | 1197 | **1933** | Use El +7' |
| 10 | 36 | 487 | 850 | 0.88 | 600 | 299 | **899** | 857 | 792 | 1197 | **1989** | |
| 9 | 37 | 519 | 850 | 0.88 | 639 | 299 | **938** | 913 | 847 | 1197 | **2044** | |
| 8 | 38 | 550 | 850 | 0.88 | 678 | 299 | **977** | 968 | 903 | 1197 | **2100** | |
| 7 | 39 | 582 | 850 | 0.88 | 717 | 299 | **1016** | 1024 | 958 | 1197 | **2155** | |
| 6 | 40 | 613 | 850 | 0.88 | 756 | 299 | **1055** | 1080 | 1014 | 1197 | **2211** | |
| 5 | 41 | 645 | 850 | 0.88 | 795 | 299 | **1094** | 1135 | 1069 | 1197 | **2266** | |
| 4 | 42 | 677 | 850 | 0.88 | 834 | 299 | **1133** | 1191 | 1125 | 1197 | **2322** | |
| 3 | 43 | 708 | 850 | 0.88 | 872 | 299 | **1172** | 1246 | 1181 | 1197 | **2378** | |
| 2 | 44 | 740 | 850 | 0.88 | 911 | 299 | **1211** | 1302 | 1236 | 1197 | **2433** | |
| 1 | 45 | 771 | 850 | 0.88 | 950 | 299 | **1250** | 1357 | 1292 | 1197 | **2489** | |
| 0 | 46 | 803 | 850 | 0.88 | 989 | 299 | **1288** | 1413 | 1347 | 1197 | **2544** | |
| -1 | 47 | 834 | 850 | 0.88 | 1028 | 299 | **1327** | 1469 | 1403 | 1197 | **2600** | |
| -2 | 48 | 866 | 850 | 0.88 | 1067 | 299 | **1366** | 1524 | 1458 | 1197 | **2655** | |
| -3 | 49 | 898 | 850 | 0.88 | 1106 | 299 | **1405** | 1580 | 1514 | 1197 | **2711** | |
| -4 | 50 | 929 | 850 | 0.88 | 1145 | 299 | **1444** | 1635 | 1570 | 1197 | **2767** | |
| -5 | 51 | 961 | 850 | 0.88 | 1184 | 299 | **1483** | 1691 | 1625 | 1197 | **2822** | |
| -6 | 52 | 992 | 850 | 0.88 | 1223 | 299 | **1522** | 1747 | 1681 | 1197 | **2878** | |
| -7 | 53 | 1024 | 850 | 0.88 | 1261 | 299 | **1561** | 1802 | 1736 | 1197 | **2933** | |
| -8 | 54 | 1055 | 850 | 0.88 | 1300 | 299 | **1600** | 1858 | 1792 | 1197 | **2989** | |
| -9 | 55 | 1087 | 850 | 0.88 | 1339 | 299 | **1639** | 1913 | 1847 | 1197 | **3045** | |
| -10 | 56 | 1119 | 850 | 0.88 | 1378 | 299 | **1677** | 1969 | 1903 | 1197 | **3100** | |
| -11 | 57 | 1150 | 850 | 0.88 | 1417 | 299 | **1716** | 2024 | 1959 | 1197 | **3156** | |
| -12 | 58 | 1182 | 850 | 0.88 | 1456 | 299 | **1755** | 2080 | 2014 | 1197 | **3211** | |
| -13 | 59 | 1213 | 850 | 0.88 | 1495 | 299 | **1794** | 2136 | 2070 | 1197 | **3267** | |
| -14 | 60 | 1245 | 850 | 0.88 | 1534 | 299 | **1833** | 2191 | 2125 | 1197 | **3322** | |
| -15 | 61 | 1277 | 850 | 0.88 | 1573 | 299 | **1872** | 2247 | 2181 | 1197 | **3378** | |
| -16 | 62 | 1308 | 850 | 0.88 | 1612 | 299 | **1911** | 2302 | 2236 | 1197 | **3434** | |
| -17 | 63 | 1340 | 850 | 0.88 | 1650 | 299 | **1950** | 2358 | 2292 | 1197 | **3489** | |
| -18 | 64 | 1371 | 850 | 0.88 | 1689 | 299 | **1989** | 2413 | 2348 | 1197 | **3545** | |
| -19 | 65 | 1403 | 850 | 0.88 | 1728 | 299 | **2028** | 2469 | 2403 | 1197 | **3600** | |
| -20 | 66 | 1434 | 850 | 0.88 | 1767 | 299 | **2066** | 2525 | 2459 | 1197 | **3656** | |
| -21 | 67 | 1466 | 850 | 0.88 | 1806 | 299 | **2105** | 2580 | 2514 | 1197 | **3711** | |
| -22 | 68 | 1498 | 850 | 0.88 | 1845 | 299 | **2144** | 2636 | 2570 | 1197 | **3767** | |
| -23 | 69 | 1529 | 850 | 0.88 | 1884 | 299 | **2183** | 2691 | 2626 | 1197 | **3823** | |
| -24 | 70 | 1561 | 850 | 0.88 | 1923 | 299 | **2222** | 2747 | 2681 | 1197 | **3878** | |
| -25 | 71 | 1592 | 850 | 0.88 | 1962 | 299 | **2261** | 2802 | 2737 | 1197 | **3934** | |
| -26 | 72 | 1624 | 850 | 0.88 | 2001 | 299 | **2300** | 2858 | 2792 | 1197 | **3989** | |
| -27 | 73 | 1655 | 850 | 0.88 | 2040 | 299 | **2339** | 2914 | 2848 | 1197 | **4045** | |
| -28 | 74 | 1687 | 850 | 0.88 | 2078 | 299 | **2378** | 2969 | 2903 | 1197 | **4100** | |
| -29 | 75 | 1719 | 850 | 0.88 | 2117 | 299 | **2417** | 3025 | 2959 | 1197 | **4156** | |
| -30 | 76 | 1750 | 850 | 0.88 | 2156 | 299 | **2455** | 3080 | 3015 | 1197 | **4212** | |
| -31 | 77 | 1782 | 850 | 0.88 | 2195 | 299 | **2494** | 3136 | 3070 | 1197 | **4267** | |
| -32 | 78 | 1813 | 913 | 0.88 | 2234 | 321 | **2555** | 3191 | 3126 | 1285 | **4411** | |
| -33 | 79 | 1845 | 978 | 0.88 | 2273 | 344 | **2617** | 3247 | 3181 | 1377 | **4558** | |
| -34 | 80 | 1877 | 1047 | 0.88 | 2312 | 368 | **2680** | 3303 | 3237 | 1474 | **4710** | |
| -35 | 81 | 1908 | 1118 | 0.88 | 2351 | 394 | **2744** | 3358 | 3292 | 1574 | **4867** | |
| -36 | 82 | 1940 | 1193 | 0.88 | 2390 | 420 | **2810** | 3414 | 3348 | 1680 | **5028** | |
| -37 | 83 | 1971 | 1271 | 0.88 | 2429 | 447 | **2876** | 3469 | 3404 | 1790 | **5193** | |
| -38 | 84 | 2003 | 1352 | 0.88 | 2467 | 476 | **2943** | 3525 | 3459 | 1904 | **5363** | |
| -39 | 85 | 2034 | 1436 | 0.88 | 2506 | 506 | **3012** | 3581 | 3515 | 2022 | **5537** | |
| -40 | 86 | 2066 | 1523 | 0.88 | 2545 | 536 | **3082** | 3636 | 3570 | 2145 | **5715** | |
| -41 | 87 | 2098 | 1608 | 0.88 | 2584 | 566 | **3150** | 3692 | 3626 | 2264 | **5889** | |
| -42 | 88 | 2129 | 1682 | 0.88 | 2623 | 592 | **3215** | 3747 | 3681 | 2369 | **6050** | |
| -43 | 89 | 2161 | 1748 | 0.88 | 2662 | 615 | **3277** | 3803 | 3737 | 2461 | **6198** | |
| -44 | 90 | 2192 | 1804 | 0.88 | 2701 | 635 | **3336** | 3858 | 3793 | 2540 | **6333** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Bent 10
**DONE BY:** TK **DATE:** 09/27/16 **CHECKED BY:** AZ **DATE:** 09/27/16

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -45 | 91 | 2224 | 1851 | 0.88 | 2740 | 651 | **3391** | 3914 | 3848 | 2606 | **6454** |
| -46 | 92 | 2255 | 1888 | 0.88 | 2779 | 665 | **3443** | 3970 | 3904 | 2659 | **6562** |
| -47 | 93 | 2287 | 1916 | 0.88 | 2818 | 675 | **3492** | 4025 | 3959 | 2698 | **6657** |
| -48 | 94 | 2319 | 1935 | 0.88 | 2856 | 681 | **3538** | 4081 | 4015 | 2724 | **6739** |
| -49 | 95 | 2350 | 1944 | 0.88 | 2895 | 684 | **3580** | 4136 | 4070 | 2738 | **6808** |
| -50 | 96 | 2382 | 1944 | 0.88 | 2934 | 684 | **3619** | 4192 | 4126 | 2738 | **6864** |
| -51 | 97 | 2404 | 1944 | 0.88 | 2961 | 684 | **3646** | 4231 | 4165 | 2738 | **6902** |
| -52 | 98 | 2426 | 1944 | 0.88 | 2989 | 684 | **3673** | 4270 | 4204 | 2738 | **6942** |
| -53 | 99 | 2449 | 1944 | 0.88 | 3017 | 684 | **3701** | 4310 | 4244 | 2738 | **6981** |
| -54 | 100 | 2471 | 1944 | 0.88 | 3045 | 684 | **3729** | 4350 | 4284 | 2738 | **7022** |
| -55 | 101 | 2495 | 1944 | 0.88 | 3073 | 684 | **3758** | 4390 | 4325 | 2738 | **7062** |
| -56 | 102 | 2518 | 1944 | 0.88 | 3102 | 684 | **3786** | 4431 | 4366 | 2738 | **7103** |
| -57 | 103 | 2542 | 1944 | 0.88 | 3131 | 684 | **3816** | 4473 | 4407 | 2738 | **7145** |
| -58 | 104 | 2565 | 1944 | 0.88 | 3161 | 684 | **3845** | 4515 | 4449 | 2738 | **7187** |
| -59 | 105 | 2590 | 1944 | 0.88 | 3190 | 684 | **3875** | 4558 | 4492 | 2738 | **7229** |
| -60 | 106 | 2614 | 1944 | 0.88 | 3220 | 684 | **3905** | 4600 | 4535 | 2738 | **7272** |
| -61 | 107 | 2639 | 1944 | 0.88 | 3251 | 684 | **3935** | 4644 | 4578 | 2738 | **7316** |
| -62 | 108 | 2663 | 1944 | 0.88 | 3281 | 684 | **3966** | 4688 | 4622 | 2738 | **7359** |
| -63 | 109 | 2689 | 1944 | 0.88 | 3312 | 684 | **3997** | 4732 | 4666 | 2738 | **7404** |
| -64 | 110 | 2714 | 1944 | 0.88 | 3344 | 684 | **4028** | 4777 | 4711 | 2738 | **7449** |
| -65 | 111 | 2740 | 1944 | 0.88 | 3375 | 684 | **4060** | 4822 | 4756 | 2738 | **7494** |
| -66 | 112 | 2766 | 1944 | 0.88 | 3407 | 684 | **4092** | 4868 | 4802 | 2738 | **7539** |
| -67 | 113 | 2792 | 1944 | 0.88 | 3440 | 684 | **4124** | 4914 | 4848 | 2738 | **7586** |
| -68 | 114 | 2818 | 1944 | 0.88 | 3472 | 684 | **4157** | 4960 | 4895 | 2738 | **7632** |
| -69 | 115 | 2845 | 1944 | 0.88 | 3505 | 684 | **4190** | 5007 | 4942 | 2738 | **7679** |
| -70 | 116 | 2872 | 1944 | 0.88 | 3538 | 684 | **4223** | 5055 | 4989 | 2738 | **7727** |
| -71 | 117 | 2899 | 1944 | 0.88 | 3572 | 684 | **4256** | 5103 | 5037 | 2738 | **7775** |
| -72 | 118 | 2927 | 1944 | 0.88 | 3606 | 684 | **4290** | 5151 | 5086 | 2738 | **7823** |
| -73 | 119 | 2955 | 1944 | 0.88 | 3640 | 684 | **4325** | 5200 | 5135 | 2738 | **7872** |
| -74 | 120 | 2983 | 1944 | 0.88 | 3675 | 684 | **4359** | 5250 | 5184 | 2738 | **7921** |
| -75 | 121 | 3011 | 1944 | 0.88 | 3710 | 684 | **4394** | 5299 | 5234 | 2738 | **7971** |
| -76 | 122 | 3040 | 1944 | 0.88 | 3745 | 684 | **4429** | 5350 | 5284 | 2738 | **8022** |
| -77 | 123 | 3068 | 1944 | 0.88 | 3780 | 684 | **4465** | 5400 | 5335 | 2738 | **8072** |
| -78 | 124 | 3098 | 1944 | 0.88 | 3816 | 684 | **4501** | 5452 | 5386 | 2738 | **8123** |
| -79 | 125 | 3127 | 1944 | 0.88 | 3852 | 684 | **4537** | 5503 | 5438 | 2738 | **8175** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Abut 11
**DONE BY:** TK **DATE:** 08/03/16 **CHECKED BY:** AZ **DATE:** 08/03/16

Finish Grade Elevation = 67 ft
Cut Off Elevation = 67 ft
Pile type: 24'"-diameter CIDH
Pre-liquefaction Condition(only)

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.0 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 10 | Sand | 1.00 |
| (2) | 10 | 15 | Sand | 1.00 |
| (3) | 15 | 17 | Sand | 1.00 |
| (4) | 17 | 35 | Sand | 1.00 |
| (5) | 35 | 45 | Sand | 1.00 |
| (6) | 45 | 115 | Clay | 1.00 |
| (7) | 115 | 167 | Sand | 1.00 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 1.00
Axial Group Reduction Factor (η) for Clayey Materials= 1.00
Reduction for top 20 feet casing= 0.40

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
251 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 67 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 63 | 4 | 1 | 6 | 0.40 | 1 | 0 | **1** | 1 | 0 | 4 | **4** | |
| 62 | 5 | 4 | 7 | 0.40 | 2 | 0 | **2** | 3 | 0 | 4 | **4** | |
| 61 | 6 | 6 | 8 | 0.40 | 3 | 0 | **3** | 5 | 0 | 5 | **5** | |
| 60 | 7 | 9 | 5 | 0.40 | 5 | 0 | **5** | 7 | 0 | 3 | **3** | |
| 59 | 8 | 12 | 2 | 0.40 | 7 | 0 | **7** | 10 | 0 | 1 | **1** | |
| 58 | 9 | 15 | 0 | 0.40 | 9 | 0 | **9** | 12 | 0 | 0 | **0** | |
| 57 | 10 | 19 | 0 | 0.40 | 11 | 0 | **11** | 15 | 0 | 0 | **0** | |
| 56 | 11 | 23 | 0 | 0.40 | 13 | 0 | **13** | 19 | 0 | 0 | **0** | |
| 55 | 12 | 27 | 0 | 0.40 | 15 | 0 | **15** | 22 | 0 | 0 | **0** | |
| 54 | 13 | 32 | 0 | 0.40 | 18 | 0 | **18** | 26 | 0 | 0 | **0** | |
| 53 | 14 | 37 | 0 | 0.40 | 21 | 0 | **21** | 29 | 0 | 0 | **0** | |
| 52 | 15 | 42 | 0 | 0.40 | 23 | 0 | **23** | 33 | 0 | 0 | **0** | |
| 51 | 16 | 47 | 0 | 0.40 | 26 | 0 | **26** | 38 | 0 | 0 | **0** | |
| 50 | 17 | 53 | 0 | 0.40 | 29 | 0 | **29** | 42 | 0 | 0 | **0** | |
| 49 | 18 | 58 | 0 | 0.40 | 33 | 0 | **33** | 47 | 0 | 0 | **0** | |
| 48 | 19 | 64 | 0 | 0.40 | 36 | 0 | **36** | 51 | 0 | 0 | **0** | |
| 47 | 20 | 69 | 0 | 0.40 | 39 | 0 | **39** | 55 | 0 | 0 | **0** | |
| 46 | 21 | 75 | 0 | 1.00 | 47 | 0 | **47** | 67 | 0 | 0 | **0** | |
| 45 | 22 | 81 | 0 | 1.00 | 55 | 0 | **55** | 78 | 0 | 0 | **0** | Strength T (52k) |
| 44 | 23 | 86 | 0 | 1.00 | 63 | 0 | **63** | 89 | 0 | 0 | **0** | use EL +40' |
| 43 | 24 | 92 | 0 | 1.00 | 71 | 0 | **71** | 101 | 0 | 0 | **0** | |
| 42 | 25 | 98 | 0 | 1.00 | 79 | 0 | **79** | 112 | 0 | 0 | **0** | |
| 41 | 26 | 103 | 0 | 1.00 | 87 | 0 | **87** | 124 | 0 | 0 | **0** | |
| 40 | 27 | 109 | 0 | 1.00 | 95 | 0 | **95** | 135 | 0 | 0 | **0** | |
| 39 | 28 | 115 | 0 | 1.00 | 103 | 0 | **103** | 147 | 0 | 0 | **0** | |
| 38 | 29 | 121 | 0 | 1.00 | 111 | 0 | **111** | 158 | 0 | 0 | **0** | |
| 37 | 30 | 126 | 0 | 1.00 | 119 | 0 | **119** | 170 | 0 | 0 | **0** | |
| 36 | 31 | 132 | 0 | 1.00 | 127 | 0 | **127** | 181 | 0 | 0 | **0** | |
| 35 | 32 | 138 | 6 | 1.00 | 135 | 0 | **135** | 193 | 0 | 10 | **10** | |
| 34 | 33 | 144 | 13 | 1.00 | 143 | 0 | **143** | 204 | 0 | 21 | **21** | Strength RW (140k) |
| 33 | 34 | 150 | 17 | 1.00 | 151 | 0 | **151** | 216 | 0 | 27 | **27** | use EL +20' |
| 32 | 35 | 155 | 17 | 1.00 | 159 | 0 | **159** | 227 | 0 | 27 | **27** | |
| 31 | 36 | 161 | 17 | 1.00 | 167 | 0 | **167** | 239 | 0 | 27 | **27** | |
| 30 | 37 | 167 | 17 | 1.00 | 176 | 0 | **176** | 251 | 0 | 27 | **27** | |
| 29 | 38 | 173 | 17 | 1.00 | 184 | 0 | **184** | 263 | 12 | 27 | **39** | |
| 28 | 39 | 179 | 17 | 1.00 | 192 | 0 | **192** | 274 | 24 | 27 | **50** | |
| 27 | 40 | 185 | 17 | 1.00 | 200 | 0 | **200** | 286 | 35 | 27 | **62** | |
| 26 | 41 | 191 | 17 | 1.00 | 209 | 0 | **209** | 298 | 47 | 27 | **74** | |
| 25 | 42 | 197 | 31 | 1.00 | 217 | 0 | **217** | 310 | 59 | 50 | **109** | |
| 24 | 43 | 203 | 48 | 1.00 | 225 | 0 | **225** | 322 | 71 | 77 | **148** | |
| 23 | 44 | 209 | 57 | 1.00 | 234 | 0 | **234** | 334 | 83 | 90 | **174** | |
| 22 | 45 | 215 | 57 | 1.00 | 242 | 0 | **242** | 346 | 95 | 90 | **185** | |
| 21 | 46 | 221 | 57 | 1.00 | 251 | 0 | **251** | 359 | 108 | 90 | **198** | |
| 20 | 47 | 227 | 57 | 1.00 | 260 | 0 | **260** | 371 | 121 | 90 | **211** | |
| 19 | 48 | 234 | 57 | 1.00 | 269 | 0 | **269** | 384 | 134 | 90 | **224** | |
| 18 | 49 | 240 | 57 | 1.00 | 278 | 0 | **278** | 397 | 146 | 90 | **237** | |
| 17 | 50 | 247 | 57 | 1.00 | 287 | 0 | **287** | 410 | 159 | 90 | **250** | |
| 16 | 51 | 253 | 57 | 1.00 | 296 | 0 | **296** | 423 | 172 | 90 | **263** | |
| 15 | 52 | 259 | 57 | 1.00 | 305 | 0 | **305** | 436 | 185 | 90 | **275** | |
| 14 | 53 | 266 | 57 | 1.00 | 314 | 0 | **314** | 449 | 198 | 90 | **288** | |
| 13 | 54 | 272 | 57 | 1.00 | 323 | 0 | **323** | 461 | 211 | 90 | **301** | |
| 12 | 55 | 279 | 57 | 1.00 | 332 | 0 | **332** | 474 | 223 | 90 | **314** | |
| 11 | 56 | 285 | 57 | 1.00 | 341 | 0 | **341** | 487 | 236 | 90 | **327** | |
| 10 | 57 | 292 | 57 | 1.00 | 350 | 0 | **350** | 500 | 249 | 90 | **340** | Strength (345k) |
| 9 | 58 | 298 | 57 | 1.00 | 359 | 0 | **359** | 513 | 262 | 90 | **352** | use EL +8' |
| 8 | 59 | 304 | 57 | 1.00 | 368 | 0 | **368** | 526 | 275 | 90 | **365** | |
| 7 | 60 | 311 | 57 | 1.00 | 377 | 0 | **377** | 538 | 288 | 90 | **378** | |
| 6 | 61 | 317 | 57 | 1.00 | 386 | 0 | **386** | 551 | 301 | 90 | **391** | |
| 5 | 62 | 324 | 57 | 1.00 | 395 | 0 | **395** | 564 | 313 | 90 | **404** | |
| 4 | 63 | 330 | 57 | 1.00 | 404 | 0 | **404** | 577 | 326 | 90 | **417** | |
| 3 | 64 | 337 | 57 | 1.00 | 413 | 0 | **413** | 590 | 339 | 90 | **430** | |
| 2 | 65 | 343 | 57 | 1.00 | 422 | 0 | **422** | 603 | 352 | 90 | **442** | |
| 1 | 66 | 349 | 57 | 1.00 | 431 | 0 | **431** | 616 | 365 | 90 | **455** | |
| 0 | 67 | 356 | 57 | 1.00 | 440 | 0 | **440** | 628 | 378 | 90 | **468** | |
| -1 | 68 | 362 | 57 | 1.00 | 449 | 0 | **449** | 641 | 390 | 90 | **481** | |
| -2 | 69 | 369 | 57 | 1.00 | 458 | 0 | **458** | 654 | 403 | 90 | **494** | |
| -3 | 70 | 375 | 57 | 1.00 | 467 | 0 | **467** | 667 | 416 | 90 | **507** | |
| -4 | 71 | 381 | 57 | 1.00 | 476 | 0 | **476** | 680 | 429 | 90 | **519** | |
| -5 | 72 | 388 | 57 | 1.00 | 485 | 0 | **485** | 693 | 442 | 90 | **532** | |
| -6 | 73 | 394 | 57 | 1.00 | 494 | 0 | **494** | 705 | 455 | 90 | **545** | |
| -7 | 74 | 401 | 57 | 1.00 | 503 | 0 | **503** | 718 | 468 | 90 | **558** | |
| -8 | 75 | 407 | 57 | 1.00 | 512 | 0 | **512** | 731 | 480 | 90 | **571** | |
| -9 | 76 | 414 | 57 | 1.00 | 521 | 0 | **521** | 744 | 493 | 90 | **584** | |
| -10 | 77 | 420 | 57 | 1.00 | 530 | 0 | **530** | 757 | 506 | 90 | **597** | |
| -11 | 78 | 426 | 57 | 1.00 | 539 | 0 | **539** | 770 | 519 | 90 | **609** | |
| -12 | 79 | 433 | 57 | 1.00 | 548 | 0 | **548** | 783 | 532 | 90 | **622** | |
| -13 | 80 | 439 | 57 | 1.00 | 557 | 0 | **557** | 795 | 545 | 90 | **635** | |
| -14 | 81 | 446 | 57 | 1.00 | 566 | 0 | **566** | 808 | 557 | 90 | **648** | |
| -15 | 82 | 452 | 57 | 1.00 | 575 | 0 | **575** | 821 | 570 | 90 | **661** | |
| -16 | 83 | 459 | 57 | 1.00 | 584 | 0 | **584** | 834 | 583 | 90 | **674** | |
| -17 | 84 | 465 | 57 | 1.00 | 593 | 0 | **593** | 847 | 596 | 90 | **686** | |
| -18 | 85 | 471 | 57 | 1.00 | 602 | 0 | **602** | 860 | 609 | 90 | **699** | |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Abut 11
**DONE BY:** TK **DATE:** 08/03/16 **CHECKED BY:** AZ **DATE:** 08/03/16

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -19 | 86 | 478 | 57 | 1.00 | 611 | 0 | **611** | 872 | 622 | 90 | **712** |
| -20 | 87 | 484 | 57 | 1.00 | 620 | 0 | **620** | 885 | 634 | 90 | **725** |
| -21 | 88 | 491 | 57 | 1.00 | 629 | 0 | **629** | 898 | 647 | 90 | **738** |
| -22 | 89 | 497 | 57 | 1.00 | 638 | 0 | **638** | 911 | 660 | 90 | **751** |
| -23 | 90 | 504 | 57 | 1.00 | 647 | 0 | **647** | 924 | 673 | 90 | **764** |

## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Abut 11
**DONE BY:** TK **DATE:** 08/03/16 **CHECKED BY:** AZ **DATE:** 08/03/16

Finish Grade Elevation = 67 ft
Cut Off Elevation = 67 ft
Pile type: 24'"-diameter CIDH
Post-liquefaction Condition(only)

| | Strength Limit State | Extreme Limit State |
|---|---|---|
| Resistance Factor for Skin Friction = | 0.7 | 1.0 |
| Resistance Factor for Base Bearing = | 0.0 | 0.8 |

| Soil Layer | Top (ft) | Bottom (ft) | Soil Type | η |
|---|---|---|---|---|
| (1) | 0 | 10 | Sand | 1.00 |
| (2) | 10 | 15 | Sand | 1.00 |
| (3) | 15 | 17 | Sand | 1.00 |
| (4) | 17 | 35 | Clay | 1.00 |
| (5) | 35 | 45 | Sand | 1.00 |
| (6) | 45 | 115 | Clay | 1.00 |
| (7) | 115 | 167 | Sand | 1.00 |

(=>Pile Length)

Axial Group Reduction Factor (η) for Sandy Materials= 1.00
Axial Group Reduction Factor (η) for Clayey Materials= 1.00
Reduction for top 20 feet casing= 0.40

Skin Resistance above neutral axis (reference only)
minus @ Ele.= 30 ' for Liq. settlement=0.1"
88 kips

| Depths and Elevations | | Unfactored Pile Capacity From SHAFT Results | | Group Reduction Factor | Factored Pile Capacity for Strength Limit State | | | Factored Pile Capacity for Extreme Limit State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation (ft) | Depth, z (ft) | Skin Friction (tons) | End Bearing (tons) | η | $Q_s$ (kips) | $Q_b$ (kips) | $Q_{total}$ (kips) | $Q_{s,f}$ (kips) | $Q_{s,f**}$ (kips) | $Q_{b,f}$ (kips) | $Q_{total,f}$ (kips) | |
| 67 | 0 | 0 | 0 | | 0 | 0 | **0** | 0 | | 0 | **0** | |
| 63 | 4 | 1 | 6 | 0.40 | 1 | 0 | **1** | 1 | 0 | 4 | **4** | |
| 62 | 5 | 4 | 7 | 0.40 | 2 | 0 | **2** | 3 | 0 | 4 | **4** | |
| 61 | 6 | 6 | 8 | 0.40 | 3 | 0 | **3** | 5 | 0 | 5 | **5** | |
| 60 | 7 | 9 | 5 | 0.40 | 5 | 0 | **5** | 7 | 0 | 3 | **3** | |
| 59 | 8 | 12 | 2 | 0.40 | 7 | 0 | **7** | 10 | 0 | 1 | **1** | |
| 58 | 9 | 15 | 0 | 0.40 | 9 | 0 | **9** | 12 | 0 | 0 | **0** | |
| 57 | 10 | 19 | 0 | 0.40 | 11 | 0 | **11** | 15 | 0 | 0 | **0** | |
| 56 | 11 | 23 | 0 | 0.40 | 13 | 0 | **13** | 19 | 0 | 0 | **0** | |
| 55 | 12 | 27 | 0 | 0.40 | 15 | 0 | **15** | 22 | 0 | 0 | **0** | |
| 54 | 13 | 32 | 0 | 0.40 | 18 | 0 | **18** | 26 | 0 | 0 | **0** | |
| 53 | 14 | 37 | 2 | 0.40 | 21 | 0 | **21** | 29 | 0 | 1 | **1** | |
| 52 | 15 | 42 | 4 | 0.40 | 23 | 0 | **23** | 33 | 0 | 3 | **3** | |
| 51 | 16 | 47 | 6 | 0.40 | 26 | 0 | **26** | 38 | 0 | 4 | **4** | |
| 50 | 17 | 53 | 6 | 0.40 | 29 | 0 | **29** | 42 | 0 | 4 | **4** | |
| 49 | 18 | 53 | 6 | 0.40 | 30 | 0 | **30** | 43 | 0 | 4 | **4** | |
| 48 | 19 | 54 | 6 | 0.40 | 30 | 0 | **30** | 43 | 0 | 4 | **4** | |
| 47 | 20 | 55 | 6 | 0.40 | 31 | 0 | **31** | 44 | 0 | 4 | **4** | |
| 46 | 21 | 55 | 6 | 1.00 | 32 | 0 | **32** | 45 | 0 | 9 | **9** | |
| 45 | 22 | 56 | 6 | 1.00 | 33 | 0 | **33** | 47 | 0 | 9 | **9** | |
| 44 | 23 | 57 | 6 | 1.00 | 34 | 0 | **34** | 48 | 0 | 9 | **9** | |
| 43 | 24 | 57 | 6 | 1.00 | 35 | 0 | **35** | 49 | 0 | 9 | **9** | |
| 42 | 25 | 58 | 6 | 1.00 | 35 | 0 | **35** | 51 | 0 | 9 | **9** | |
| 41 | 26 | 59 | 6 | 1.00 | 36 | 0 | **36** | 52 | 0 | 9 | **9** | |
| 40 | 27 | 60 | 6 | 1.00 | 37 | 0 | **37** | 53 | 0 | 9 | **9** | |
| 39 | 28 | 60 | 6 | 1.00 | 38 | 0 | **38** | 55 | 0 | 9 | **9** | |
| 38 | 29 | 61 | 6 | 1.00 | 39 | 0 | **39** | 56 | 0 | 9 | **9** | |
| 37 | 30 | 62 | 6 | 1.00 | 40 | 0 | **40** | 58 | 0 | 9 | **9** | |
| 36 | 31 | 62 | 6 | 1.00 | 41 | 0 | **41** | 59 | 0 | 9 | **9** | |
| 35 | 32 | 63 | 10 | 1.00 | 42 | 0 | **42** | 60 | 0 | 15 | **15** | |
| 34 | 33 | 64 | 14 | 1.00 | 43 | 0 | **43** | 62 | 0 | 23 | **23** | |
| 33 | 34 | 64 | 17 | 1.00 | 44 | 0 | **44** | 63 | 0 | 27 | **27** | |
| 32 | 35 | 65 | 17 | 1.00 | 45 | 0 | **45** | 65 | 0 | 27 | **27** | |
| 31 | 36 | 71 | 17 | 1.00 | 53 | 0 | **53** | 76 | 0 | 27 | **27** | |
| 30 | 37 | 77 | 17 | 1.00 | 61 | 0 | **61** | 88 | 0 | 27 | **27** | |
| 29 | 38 | 83 | 17 | 1.00 | 70 | 0 | **70** | 100 | 12 | 27 | **39** | |
| 28 | 39 | 89 | 17 | 1.00 | 78 | 0 | **78** | 111 | 24 | 27 | **50** | |
| 27 | 40 | 94 | 17 | 1.00 | 86 | 0 | **86** | 123 | 35 | 27 | **62** | |
| 26 | 41 | 100 | 17 | 1.00 | 95 | 0 | **95** | 135 | 47 | 27 | **74** | |
| 25 | 42 | 106 | 31 | 1.00 | 103 | 0 | **103** | 147 | 59 | 50 | **109** | |
| 24 | 43 | 112 | 48 | 1.00 | 111 | 0 | **111** | 159 | 71 | 77 | **148** | |
| 23 | 44 | 118 | 57 | 1.00 | 120 | 0 | **120** | 171 | 83 | 90 | **174** | |
| 22 | 45 | 124 | 57 | 1.00 | 128 | 0 | **128** | 183 | 95 | 90 | **185** | |
| 21 | 46 | 131 | 57 | 1.00 | 137 | 0 | **137** | 196 | 108 | 90 | **198** | |
| 20 | 47 | 137 | 57 | 1.00 | 146 | 0 | **146** | 209 | 121 | 90 | **211** | |
| 19 | 48 | 144 | 57 | 1.00 | 155 | 0 | **155** | 221 | 134 | 90 | **224** | |
| 18 | 49 | 150 | 57 | 1.00 | 164 | 0 | **164** | 234 | 146 | 90 | **237** | |
| 17 | 50 | 156 | 57 | 1.00 | 173 | 0 | **173** | 247 | 159 | 90 | **250** | ?Extreme (250k)? |
| 16 | 51 | 163 | 57 | 1.00 | 182 | 0 | **182** | 260 | 172 | 90 | **263** | use EL +15' |
| 15 | 52 | 169 | 57 | 1.00 | 191 | 0 | **191** | 273 | 185 | 90 | **275** | |
| 14 | 53 | 176 | 57 | 1.00 | 200 | 0 | **200** | 286 | 198 | 90 | **288** | |
| 13 | 54 | 182 | 57 | 1.00 | 209 | 0 | **209** | 298 | 211 | 90 | **301** | |
| 12 | 55 | 188 | 57 | 1.00 | 218 | 0 | **218** | 311 | 223 | 90 | **314** | |
| 11 | 56 | 195 | 57 | 1.00 | 227 | 0 | **227** | 324 | 236 | 90 | **327** | |
| 10 | 57 | 201 | 57 | 1.00 | 236 | 0 | **236** | 337 | 249 | 90 | **340** | |
| 9 | 58 | 208 | 57 | 1.00 | 245 | 0 | **245** | 350 | 262 | 90 | **352** | |
| 8 | 59 | 214 | 57 | 1.00 | 254 | 0 | **254** | 363 | 275 | 90 | **365** | |
| 7 | 60 | 221 | 57 | 1.00 | 263 | 0 | **263** | 376 | 288 | 90 | **378** | |
| 6 | 61 | 227 | 57 | 1.00 | 272 | 0 | **272** | 388 | 301 | 90 | **391** | |
| 5 | 62 | 233 | 57 | 1.00 | 281 | 0 | **281** | 401 | 313 | 90 | **404** | |
| 4 | 63 | 240 | 57 | 1.00 | 290 | 0 | **290** | 414 | 326 | 90 | **417** | |
| 3 | 64 | 246 | 57 | 1.00 | 299 | 0 | **299** | 427 | 339 | 90 | **430** | |
| 2 | 65 | 253 | 57 | 1.00 | 308 | 0 | **308** | 440 | 352 | 90 | **442** | |
| 1 | 66 | 259 | 57 | 1.00 | 317 | 0 | **317** | 453 | 365 | 90 | **455** | |
| 0 | 67 | 266 | 57 | 1.00 | 326 | 0 | **326** | 465 | 378 | 90 | **468** | |
| -1 | 68 | 272 | 57 | 1.00 | 335 | 0 | **335** | 478 | 390 | 90 | **481** | |
| -2 | 69 | 278 | 57 | 1.00 | 344 | 0 | **344** | 491 | 403 | 90 | **494** | |
| -3 | 70 | 285 | 57 | 1.00 | 353 | 0 | **353** | 504 | 416 | 90 | **507** | |
| -4 | 71 | 291 | 57 | 1.00 | 362 | 0 | **362** | 517 | 429 | 90 | **519** | |
| -5 | 72 | 298 | 57 | 1.00 | 371 | 0 | **371** | 530 | 442 | 90 | **532** | |
| -6 | 73 | 304 | 57 | 1.00 | 380 | 0 | **380** | 543 | 455 | 90 | **545** | |
| -7 | 74 | 311 | 57 | 1.00 | 389 | 0 | **389** | 555 | 468 | 90 | **558** | |
| -8 | 75 | 317 | 57 | 1.00 | 398 | 0 | **398** | 568 | 480 | 90 | **571** | |
| -9 | 76 | 323 | 57 | 1.00 | 407 | 0 | **407** | 581 | 493 | 90 | **584** | |
| -10 | 77 | 330 | 57 | 1.00 | 416 | 0 | **416** | 594 | 506 | 90 | **597** | |
| -11 | 78 | 336 | 57 | 1.00 | 425 | 0 | **425** | 607 | 519 | 90 | **609** | |
| -12 | 79 | 343 | 57 | 1.00 | 434 | 0 | **434** | 620 | 532 | 90 | **622** | |
| -13 | 80 | 349 | 57 | 1.00 | 443 | 0 | **443** | 632 | 545 | 90 | **635** | |
| -14 | 81 | 355 | 57 | 1.00 | 452 | 0 | **452** | 645 | 557 | 90 | **648** | |
| -15 | 82 | 362 | 57 | 1.00 | 461 | 0 | **461** | 658 | 570 | 90 | **661** | |
| -16 | 83 | 368 | 57 | 1.00 | 470 | 0 | **470** | 671 | 583 | 90 | **674** | |
| -17 | 84 | 375 | 57 | 1.00 | 479 | 0 | **479** | 684 | 596 | 90 | **686** | |
| -18 | 85 | 381 | 57 | 1.00 | 488 | 0 | **488** | 697 | 609 | 90 | **699** | |

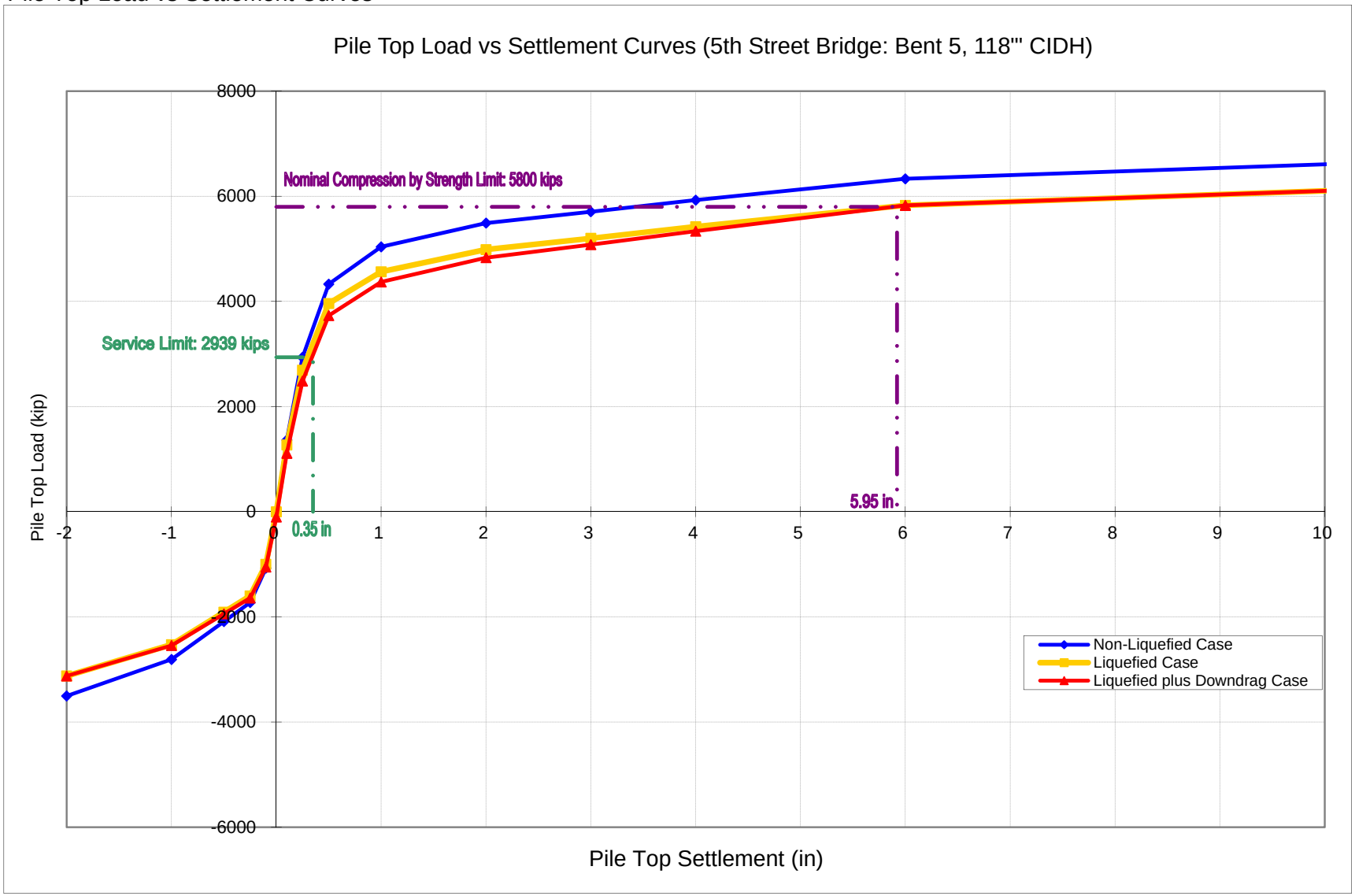
## Drilled SHAFT Pile Capacity

**PROJECT:** 13-121 - Dokken, 5th Street Bridge PSR PR
**PROJECT NO.:** 13-121
**Bridge Name:** 5th Street Bridge (Replace) **Location:** Abut 11
**DONE BY:** TK **DATE:** 08/03/16 **CHECKED BY:** AZ **DATE:** 08/03/16

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -19 | 86 | 388 | 57 | 1.00 | 497 | 0 | **497** | 709 | 622 | 90 | **712** |
| -20 | 87 | 394 | 57 | 1.00 | 506 | 0 | **506** | 722 | 635 | 90 | **725** |
| -21 | 88 | 400 | 57 | 1.00 | 515 | 0 | **515** | 735 | 647 | 90 | **738** |
| -22 | 89 | 407 | 57 | 1.00 | 524 | 0 | **524** | 748 | 660 | 90 | **751** |
| -23 | 90 | 413 | 57 | 1.00 | 533 | 0 | **533** | 761 | 673 | 90 | **764** |

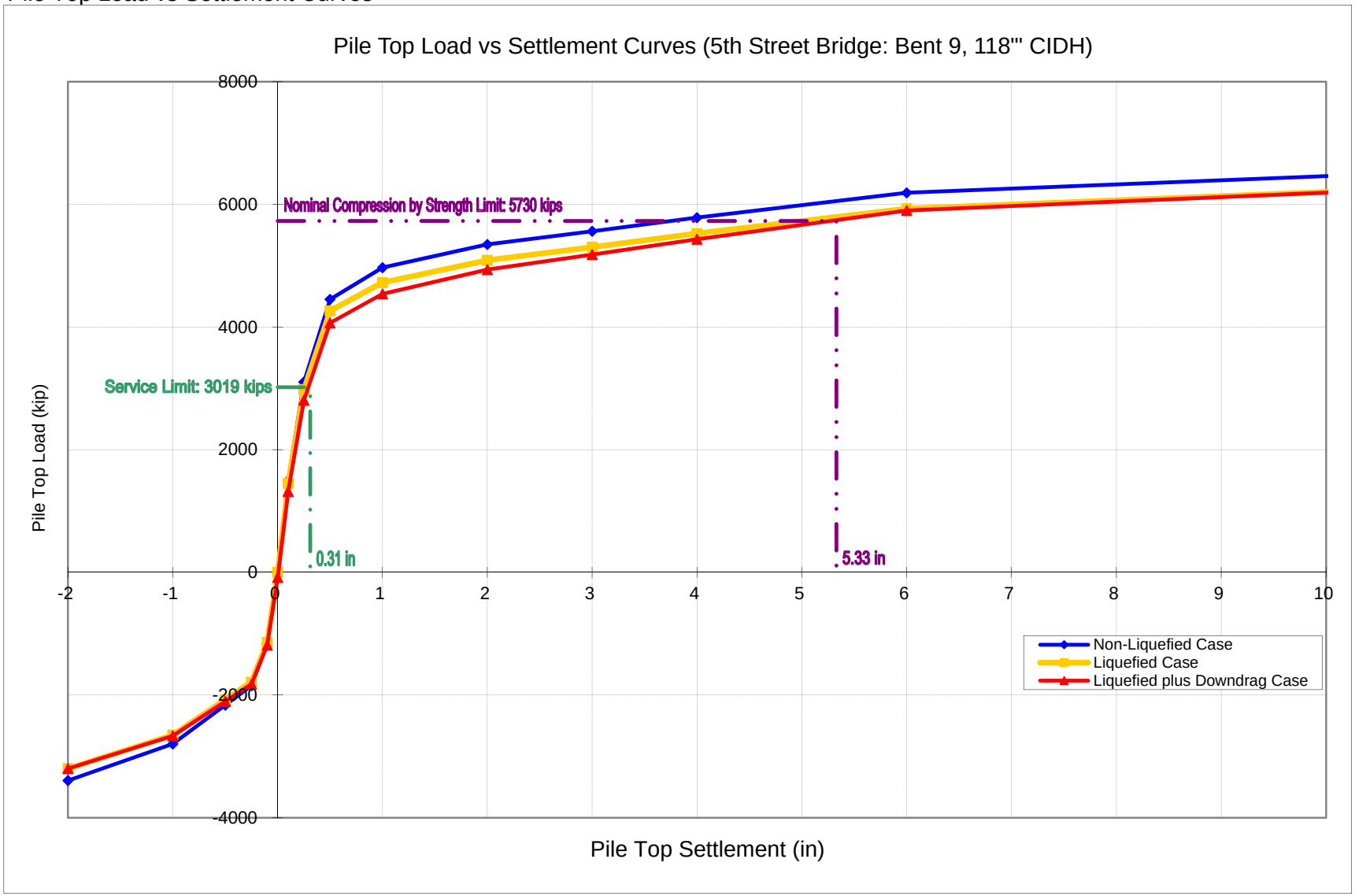
# BMCOL 76 Displacement-based Downdrag Analysis
# (Bent 5 and Bent 9)

Pile Top Load vs Settlement Curves




Note: The above curves were developed by the axial mode of BMCOL program using the tz-curves derived from SHAFT.

Pile Top Load vs Settlement Curves

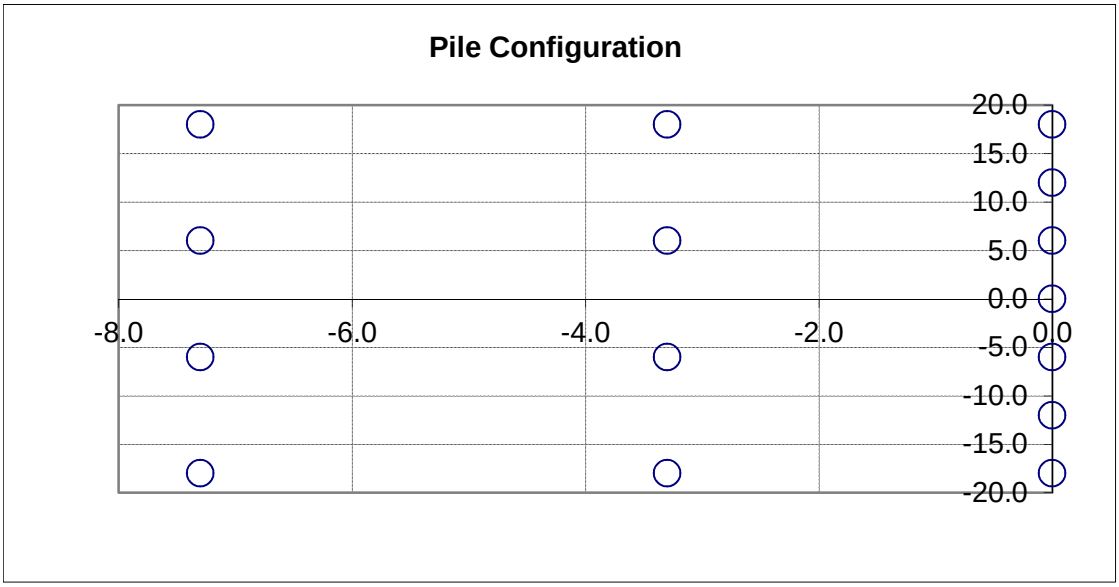



Note: The above curves were developed by the axial mode of BMCOL program using the tz-curves derived from SHAFT.

# Pile Lateral Design

**Project:** 2nd Street OC, Abut 1M
**By:** TK

## Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)




**Pile Dia.:** 1.17
**No. of Piles:** 15

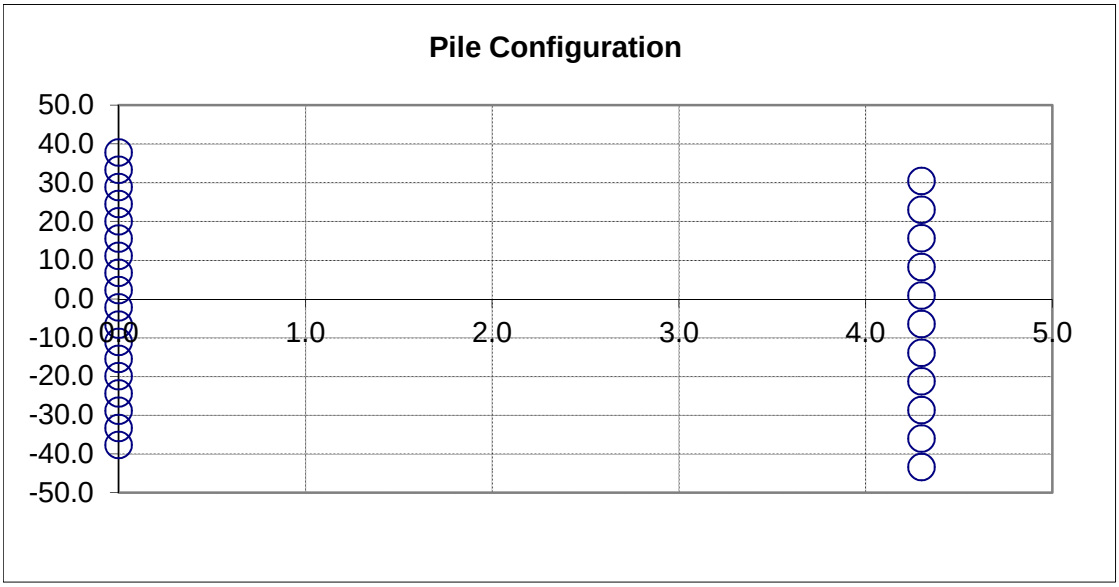
6 SP

| | X-Dir | Y-Dir |
|---|---|---|
| Group Efficiency | 0.821 | 0.882 |

| Pile No. | X | Y | Reduction Factors in X-dir | Reduction Factors in Y-dir |
|---|---|---|---|---|
| 1 | 0.000 | -18.00 | 0.917 | 0.815 |
| 2 | 0.000 | -12.00 | 1.000 | 0.854 |
| 3 | 0.000 | -6.00 | 0.917 | 0.815 |
| 4 | 0.000 | 0.00 | 1.000 | 0.854 |
| 5 | 0.000 | 6.00 | 0.917 | 0.815 |
| 6 | 0.000 | 12.00 | 1.000 | 0.854 |
| 7 | 0.000 | 18.00 | 0.917 | 0.911 |
| 8 | -3.300 | -18.00 | 0.678 | 0.847 |
| 9 | -3.300 | -6.00 | 0.669 | 0.847 |
| 10 | -3.300 | 6.00 | 0.669 | 0.847 |
| 11 | -3.300 | 18.00 | 0.678 | 0.887 |
| 12 | -7.300 | -18.00 | 0.739 | 0.973 |
| 13 | -7.300 | -6.00 | 0.739 | 0.973 |
| 14 | -7.300 | 6.00 | 0.739 | 0.973 |
| 15 | -7.300 | 18.00 | 0.739 | 0.973 |

**Project:** 2nd Street OC, Abut 2R
**By:** TK

## Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)




**Pile Dia.:** 1.17 4.44 SP
**No. of Piles:** 29

| | X-Dir | Y-Dir |
|---|---|---|
| Group Efficiency | 0.899 | 0.838 |

| Pile No. | X | Y | Reduction Factors in X-dir | Reduction Factors in Y-dir |
|---|---|---|---|---|
| 1 | 0.000 | -37.74 | 0.824 | 0.779 |
| 2 | 0.000 | -33.30 | 0.855 | 0.754 |
| 3 | 0.000 | -28.86 | 0.789 | 0.788 |
| 4 | 0.000 | -24.42 | 0.861 | 0.753 |
| 5 | 0.000 | -19.98 | 0.812 | 0.774 |
| 6 | 0.000 | -15.54 | 0.822 | 0.773 |
| 7 | 0.000 | -11.10 | 0.856 | 0.753 |
| 8 | 0.000 | -6.66 | 0.788 | 0.788 |
| 9 | 0.000 | -2.22 | 0.860 | 0.753 |
| 10 | 0.000 | 2.22 | 0.814 | 0.773 |
| 11 | 0.000 | 6.66 | 0.820 | 0.774 |
| 12 | 0.000 | 11.10 | 0.857 | 0.753 |
| 13 | 0.000 | 15.54 | 0.788 | 0.788 |
| 14 | 0.000 | 19.98 | 0.859 | 0.754 |
| 15 | 0.000 | 24.42 | 0.816 | 0.772 |
| 16 | 0.000 | 28.86 | 0.818 | 0.775 |
| 17 | 0.000 | 33.30 | 0.899 | 0.790 |
| 18 | 0.000 | 37.74 | 1.000 | 0.991 |
| 19 | 4.300 | 30.36 | 0.998 | 0.954 |
| 20 | 4.300 | 22.98 | 0.997 | 0.927 |
| 21 | 4.300 | 15.60 | 0.983 | 0.918 |
| 22 | 4.300 | 8.22 | 0.999 | 0.924 |
| 23 | 4.300 | 0.84 | 0.996 | 0.927 |
| 24 | 4.300 | -6.54 | 0.983 | 0.918 |
| 25 | 4.300 | -13.92 | 1.000 | 0.925 |
| 26 | 4.300 | -21.30 | 0.995 | 0.927 |
| 27 | 4.300 | -28.68 | 0.983 | 0.917 |
| 28 | 4.300 | -36.06 | 1.000 | 0.925 |

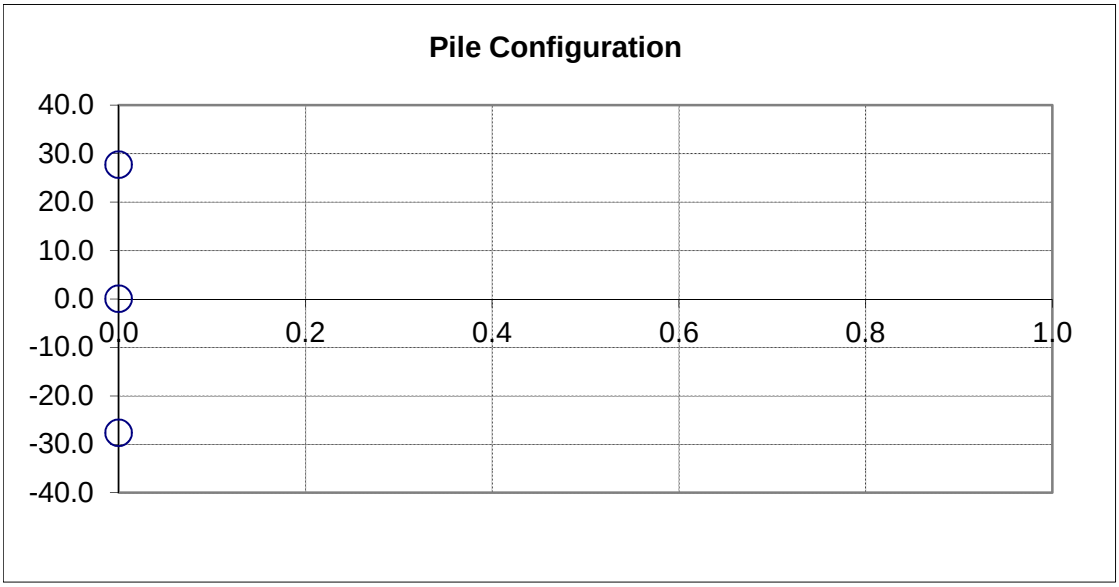
| | | |
|---|---|---|
| 29 | 4.300 | -43.44 |

| | |
|---|---|
| 1.000 | 0.940 |

**Project:** 5th Street Relacement Bridge, Bent 2

**By:** TC

## Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)




**Pile Dia.:** 9.83

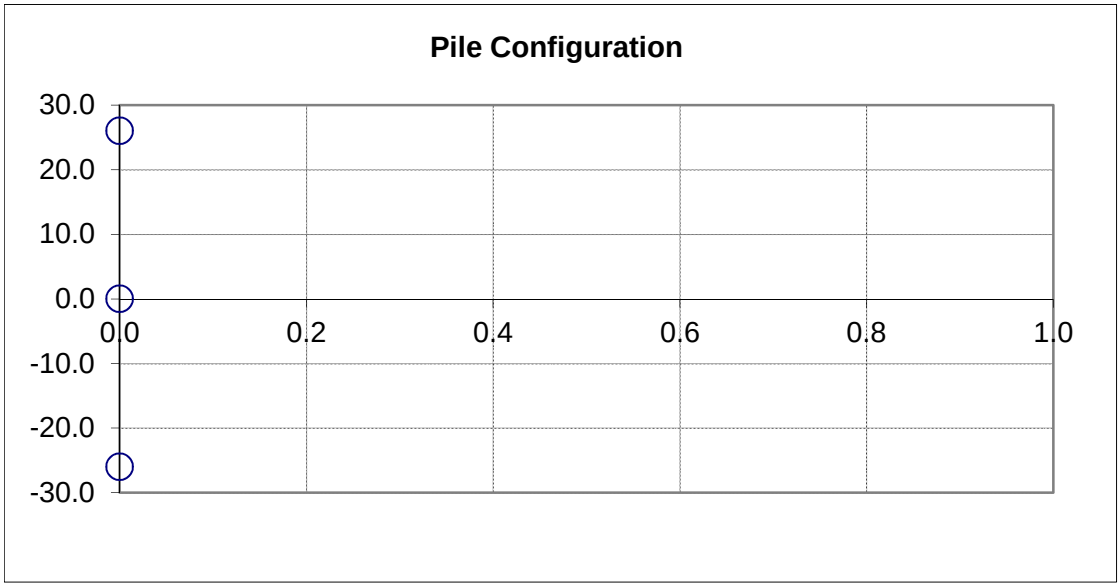
**No. of Piles:** 3

| | X-Dir | Y-Dir |
|---|---|---|
| **Group Efficiency** | 0.882 | 0.742 |

| Pile No. | X | Y | Reduction Factors in X-dir | Reduction Factors in Y-dir |
|---|---|---|---|---|
| 1 | 0.000 | -27.670 | 0.910 | 0.658 |
| 2 | 0.000 | 0.000 | 0.828 | 0.651 |
| 3 | 0.000 | 27.670 | 0.910 | 0.916 |

**Project:** 5th Street Relacement Bridge, Bents 3 to 10
**By:** TC

## Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)




**Pile Dia.:** 9.83
**No. of Piles:** 3

| | X-Dir | Y-Dir |
|---|---|---|
| **Group Efficiency** | 0.858 | 0.718 |

| Pile No. | X | Y | Reduction Factors in X-dir | Reduction Factors in Y-dir |
|---|---|---|---|---|
| 1 | 0.000 | -26.000 | 0.891 | 0.628 |
| 2 | 0.000 | 0.000 | 0.793 | 0.626 |
| 3 | 0.000 | 26.000 | 0.891 | 0.901 |

# LPILE Lateral Analysis – 2nd Street OC, Abutments 1, Class 200

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

TC
EMI

---
Files Used for Analysis
---

Path to file locations: C:\Users\t.ke\Documents\13-121 - Dokken, 5th Street Bridge PSR PR\DFR\Analysis\20160923_2nd_LP\
Name of input data file: Ab1.lpd
Name of output file: Ab1.lpo
Name of plot output file: Ab1.lpp
Name of runtime file: Ab1.lpr

---
Time and Date of Analysis
---

Date: September 27, 2016 Time: 12:00:42

---
Problem Title
---

2th Street OC, Abut 1, Class 200 (pm_avg=0.85)

---
Program Options
---

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 300
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 20

---

Pile Structural Properties and Geometry

---

Pile Length = 840.00 in

Depth of ground surface below top of pile = -24.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

| Point No. | Point Depth in | Pile Diameter in | Moment of Inertia in**4 | Pile Area Sq.in | Modulus of Elasticity lbs/Sq.in |
|---|---|---|---|---|---|
| 1 | 0.0000 | 14.00000000 | 1601.0000 | 196.0000 | 4770000. |
| 2 | 840.0000 | 14.00000000 | 1601.0000 | 196.0000 | 4770000. |

---

Soil and Rock Layering Information

---

The soil profile is modelled using 7 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = -24.000 in
Distance from top of pile to bottom of layer = 120.000 in
p-y subgrade modulus k for top of soil layer = 15.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 15.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 120.000 in
Distance from top of pile to bottom of layer = 180.000 in
p-y subgrade modulus k for top of soil layer = 15.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 15.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 300.000 in
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 300.000 in
Distance from top of pile to bottom of layer = 600.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 600.000 in
Distance from top of pile to bottom of layer = 1020.000 in
p-y subgrade modulus k for top of soil layer = 70.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 70.000 lbs/in**3

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 1020.000 in
Distance from top of pile to bottom of layer = 1500.000 in

Layer 7 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 1500.000 in
Distance from top of pile to bottom of layer = 1900.000 in
p-y subgrade modulus k for top of soil layer = 118.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 118.000 lbs/in**3

(Depth of lowest layer extends 1060.00 in below pile tip)

---

Effective Unit Weight of Soil vs. Depth

---

Effective unit weight of soil with depth defined using 14 points

| Point No. | Depth X in | Eff. Unit Weight lbs/in**3 |
|---|---|---|
| 1 | -24.00 | 0.06366 |
| 2 | 120.00 | 0.06366 |
| 3 | 120.00 | 0.02755 |
| 4 | 180.00 | 0.02755 |
| 5 | 180.00 | 0.03333 |
| 6 | 300.00 | 0.03333 |
| 7 | 300.00 | 0.03623 |
| 8 | 600.00 | 0.03623 |
| 9 | 600.00 | 0.03623 |
| 10 | 1020.00 | 0.03623 |
| 11 | 1020.00 | 0.03623 |
| 12 | 1500.00 | 0.03623 |
| 13 | 1500.00 | 0.03912 |
| 14 | 1900.00 | 0.03912 |

---

Shear Strength of Soils

---

Shear strength parameters with depth defined using 14 points

| Point No. | Depth X in | Cohesion c lbs/in**2 | Angle of Friction Deg. | E50 or k_rm | RQD % |
|---|---|---|---|---|---|
| 1 | -24.000 | 0.00000 | 29.00 | ------ | ------ |
| 2 | 120.000 | 0.00000 | 29.00 | ------ | ------ |
| 3 | 120.000 | 0.00000 | 29.00 | ------ | ------ |
| 4 | 180.000 | 0.00000 | 29.00 | ------ | ------ |
| 5 | 180.000 | 0.00000 | 33.00 | ------ | ------ |
| 6 | 300.000 | 0.00000 | 33.00 | ------ | ------ |
| 7 | 300.000 | 17.36110 | 0.00 | 0.00800 | 0.0 |
| 8 | 600.000 | 17.36110 | 0.00 | 0.00800 | 0.0 |
| 9 | 600.000 | 0.00000 | 34.00 | ------ | ------ |
| 10 | 1020.000 | 0.00000 | 34.00 | ------ | ------ |
| 11 | 1020.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 12 | 1500.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 13 | 1500.000 | 0.00000 | 38.00 | ------ | ------ |
| 14 | 1900.000 | 0.00000 | 38.00 | ------ | ------ |

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

---

p-y Modification Factors

---

Distribution of p-y multipliers with depth defined using 2 points

| Point No. | Depth X in | p-mult | y-mult |
|---|---|---|---|
| 1 | 0.000 | 0.8500 | 1.0000 |
| 2 | 840.000 | 0.8500 | 1.0000 |

---

Loading Type

---

Static loading criteria was used for computation of p-y curves.

---

Pile-head Loading and Pile-head Fixity Conditions

---

Number of loads specified = 4

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.250 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.500 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 1.000 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 2.000 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 0.250000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.250000 | 0.0000 | 5427.0413 | -0.0032990 | 2040.8163 | -71.3864 | 399.7637 |
| 56.000 | 0.086248 | 225759. | 143.8468 | -0.0022702 | 3027.8965 | -87.4906 | 2840.3291 |
| 112.000 | 0.004978 | 170103. | -2527.9854 | -0.0007061 | 2784.5529 | -8.6314 | 4855.1632 |
| 168.000 | -0.008557 | 43198.0044 | -1953.5600 | 6.4798E-05 | 2229.6896 | 18.3694 | 6010.8484 |
| 224.000 | -0.002143 | -15946.6771 | -64.1052 | 9.1835E-05 | 2110.5395 | 20.5426 | 26836.4320 |
| 280.000 | 9.67E-05 | -5258.0169 | 275.7663 | 2.6867E-06 | 2063.8058 | -1.2024 | 34833.5157 |
| 336.000 | -3.89E-06 | 214.7160 | -34.3875 | 6.0862E-08 | 2041.7551 | 2.7035 | 1944992. |
| 392.000 | 1.01E-07 | 0.5120627 | 0.4758733 | -7.4138E-09 | 2040.8186 | -0.0701976 | 1944992. |
| 448.000 | -1.48E-09 | -0.1087297 | -3.6911E-05 | 2.0562E-10 | 2040.8168 | 0.0010284 | 1944992. |
| 504.000 | 2.67E-12 | 0.0031799 | -0.0002043 | -3.2305E-12 | 2040.8163 | -1.8579E-06 | 1944992. |
| 560.000 | 5.59E-13 | -5.2572E-05 | 6.3883E-06 | 1.2417E-14 | 2040.8163 | -3.8802E-07 | 1944992. |
| 616.000 | -1.19E-13 | 1.8678E-06 | -9.1429E-08 | -9.7344E-16 | 2040.8163 | 2.1289E-09 | 49949.2070 |
| 672.000 | -3.00E-14 | -3.1920E-07 | -1.7673E-09 | 1.5902E-15 | 2040.8163 | 6.3420E-10 | 59278.8070 |
| 728.000 | 4.54E-15 | -6.7917E-08 | 4.2476E-09 | -1.6415E-18 | 2040.8163 | -1.3096E-10 | 80715.7730 |
| 784.000 | 5.85E-16 | 1.3596E-08 | -2.0747E-10 | -4.7760E-17 | 2040.8163 | -1.9155E-11 | 91691.7730 |
| 840.000 | -4.17E-16 | 0.0000 | 0.0000 | -6.6478E-18 | 2040.8163 | 1.5296E-11 | 51333.8865 |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.25000000 in
Computed slope at pile head = -0.00329896
Maximum bending moment = 231577.82896 lbs-in
Maximum shear force = 5427.04131 lbs
Depth of maximum bending moment = 67.20000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 5
Number of zero deflection points = 11

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 0.500000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.500000 | 0.0000 | 10067.2899 | -0.0065275 | 2040.8163 | -119.9940 | 335.9832 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 56.000 | 0.174773 | 443102. | 480.2415 | -0.0045373 | 3978.1773 | -174.3321 | 2792.9409 |
| 112.000 | 0.011368 | 340256. | -4980.4762 | -0.0014356 | 3528.5086 | -19.7114 | 4855.0082 |
| 168.000 | -0.016787 | 88406.5285 | -3912.8472 | 0.0001166 | 2427.3533 | 36.0350 | 6010.4913 |
| 224.000 | -0.004321 | -31020.7619 | -156.4093 | 0.0001823 | 2176.4474 | 41.4087 | 26835.5610 |
| 280.000 | 0.000176 | -10591.2891 | 544.5850 | 6.1854E-06 | 2087.1243 | -2.1911 | 34833.5142 |
| 336.000 | -7.39E-06 | 427.0016 | -66.6129 | 9.7014E-08 | 2042.6833 | 5.1328 | 1944992. |
| 392.000 | 1.95E-07 | 0.6689272 | 0.9426365 | -1.4034E-08 | 2040.8193 | -0.1358004 | 1944992. |
| 448.000 | -2.92E-09 | -0.2052995 | -0.0007224 | 3.9709E-10 | 2040.8172 | 0.0020315 | 1944992. |
| 504.000 | 7.06E-12 | 0.0061328 | -0.0003844 | -6.3610E-12 | 2040.8164 | -4.9071E-06 | 1944992. |
| 560.000 | 1.05E-12 | -0.0001033 | 1.2301E-05 | 2.7804E-14 | 2040.8163 | -7.2766E-07 | 1944992. |
| 616.000 | -2.29E-13 | 3.6331E-06 | -1.7688E-07 | -1.9820E-15 | 2040.8163 | 4.0868E-09 | 49949.2070 |
| 672.000 | -5.85E-14 | -6.1240E-07 | -3.5909E-09 | 3.0730E-15 | 2040.8163 | 1.2376E-09 | 59278.8070 |
| 728.000 | 8.66E-15 | -1.3292E-07 | 8.2065E-09 | 4.0794E-18 | 2040.8163 | -2.4965E-10 | 80715.7730 |
| 784.000 | 1.15E-15 | 2.6016E-08 | -3.8293E-10 | -9.2514E-17 | 2040.8163 | -3.7763E-11 | 91691.7730 |
| 840.000 | -8.12E-16 | 0.0000 | 0.0000 | -1.3380E-17 | 2040.8163 | 2.9757E-11 | 51333.8865 |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.50000000 in
Computed slope at pile head = -0.00652746
Maximum bending moment = 456896.67568 lbs-in
Maximum shear force = 10067.28989 lbs
Depth of maximum bending moment = 67.20000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 5
Number of zero deflection points = 11

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 1.000000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 1.000000 | 0.0000 | 16803.8955 | -0.0126965 | 2040.8163 | -156.2052 | 218.6873 |
| 56.000 | 0.361689 | 840143. | 1912.1764 | -0.0090489 | 5714.1449 | -336.8241 | 2607.5097 |
| 112.000 | 0.030471 | 680060. | -9535.5112 | -0.0029970 | 5014.2213 | -52.8222 | 4853.8222 |
| 168.000 | -0.031745 | 187678. | -7848.5341 | 0.0001614 | 2861.3944 | 68.1297 | 6009.2487 |
| 224.000 | -0.008820 | -57181.7316 | -467.7147 | 0.0003567 | 2290.8301 | 84.5184 | 26831.9025 |
| 280.000 | 0.000257 | -21577.3580 | 1049.9278 | 1.6829E-05 | 2135.1583 | -3.2014 | 34833.5117 |
| 336.000 | -1.26E-05 | 839.8415 | -121.2027 | 5.7840E-08 | 2044.4883 | 8.7470 | 1944992. |
| 392.000 | 3.54E-07 | -0.6185043 | 1.8334 | -2.3674E-08 | 2040.8190 | -0.2460608 | 1944992. |
| 448.000 | -5.64E-09 | -0.3432898 | -0.0050136 | 7.1555E-10 | 2040.8178 | 0.0039198 | 1944992. |
| 504.000 | 2.36E-11 | 0.0110050 | -0.0006348 | -1.2160E-11 | 2040.8164 | -1.6363E-05 | 1944992. |
| 560.000 | 1.71E-12 | -0.0001962 | 2.1960E-05 | 7.1908E-14 | 2040.8163 | -1.1876E-06 | 1944992. |
| 616.000 | -4.05E-13 | 6.6985E-06 | -3.2040E-07 | -4.1489E-15 | 2040.8163 | 7.2242E-09 | 49949.2070 |
| 672.000 | -1.08E-13 | -1.0805E-06 | -7.8626E-09 | 5.5795E-15 | 2040.8163 | 2.2809E-09 | 59278.8070 |
| 728.000 | 1.67E-14 | -2.5739E-07 | 1.4720E-08 | 3.9072E-17 | 2040.8163 | -4.0854E-10 | 68608.4070 |
| 784.000 | 2.52E-15 | 5.0290E-08 | -6.2008E-10 | -1.8840E-16 | 2040.8163 | -8.2446E-11 | 91691.7730 |
| 840.000 | -1.68E-15 | 0.0000 | 0.0000 | -3.1490E-17 | 2040.8163 | 6.1677E-11 | 51333.8865 |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection = 1.00000000 in
Computed slope at pile head = -0.01269652
Maximum bending moment = 881598.15396 lbs-in
Maximum shear force = 16803.89552 lbs
Depth of maximum bending moment = 72.80000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 6
Number of zero deflection points = 11

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 4

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 2.000000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 2.000 | 0.0000 | 25205.5680 | -0.0241323 | 2040.8163 | -163.6572 | 114.5601 |
| 56.000 | 0.769822 | 1498784. | 6501.8302 | -0.0179259 | 8593.9013 | -558.6341 | 2031.8653 |
| 112.000 | 0.092357 | 1351549. | -17232.9373 | -0.0064806 | 7950.1505 | -159.7313 | 4842.5779 |
| 168.000 | -0.055702 | 418146. | -15710.4236 | 2.6709E-05 | 3869.0641 | 119.4738 | 6005.6661 |
| 224.000 | -0.018299 | -93840.4670 | -1569.2915 | 0.0006782 | 2451.1119 | 175.2475 | 26816.0103 |
| 280.000 | 0.000136 | -44706.3540 | 1923.4825 | 5.1958E-05 | 2236.2845 | -1.6906 | 34833.5151 |
| 336.000 | -1.65E-05 | 1690.0834 | -199.3062 | -4.8790E-07 | 2048.2058 | 11.4749 | 1944992. |
| 392.000 | 5.75E-07 | -10.0347 | 3.5958 | -2.9790E-08 | 2040.8602 | -0.3995675 | 1944992. |
| 448.000 | -1.09E-08 | -0.4158809 | -0.0264171 | 1.1425E-09 | 2040.8181 | 0.0075435 | 1944992. |
| 504.000 | 9.13E-11 | 0.0173415 | -0.0007263 | -2.2874E-11 | 2040.8164 | -6.3429E-05 | 1944992. |
| 560.000 | 1.85E-12 | -0.0003630 | 3.4041E-05 | 2.2297E-13 | 2040.8163 | -1.2832E-06 | 1944992. |
| 616.000 | -6.07E-13 | 1.1447E-05 | -5.2009E-07 | -9.4790E-15 | 2040.8163 | 1.0836E-08 | 49949.2070 |
| 672.000 | -1.84E-13 | -1.6299E-06 | -1.9851E-08 | 9.0628E-15 | 2040.8163 | 3.9022E-09 | 59278.8070 |
| 728.000 | 2.58E-14 | -4.4424E-07 | 2.4052E-08 | 1.7519E-16 | 2040.8163 | -6.3232E-10 | 68608.4070 |
| 784.000 | 4.78E-15 | 7.7715E-08 | -5.9005E-10 | -3.2048E-16 | 2040.8163 | -1.5637E-10 | 91691.7730 |
| 840.000 | -2.95E-15 | 0.0000 | 0.0000 | -6.5902E-17 | 2040.8163 | 1.0805E-10 | 51333.8865 |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 4:

Pile-head deflection = 2.00000000 in
Computed slope at pile head = -0.02413226
Maximum bending moment = 1643007. lbs-in
Maximum shear force = 25205.56803 lbs
Depth of maximum bending moment = 78.40000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 7
Number of zero deflection points = 11

---

Summary of Pile Response(s)

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Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

| Load Type | Pile-Head Condition 1 | Pile-Head Condition 2 | Axial Load lbs | Pile-Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|---|---|---|
| 4 | y= 0.250000 | M= 0.000 | 400000. | 0.2500000 | 231578. | 5427.0413 |
| 4 | y= 0.500000 | M= 0.000 | 400000. | 0.5000000 | 456897. | 10067.2899 |
| 4 | y= 1.000000 | M= 0.000 | 400000. | 1.0000000 | 881598. | 16803.8955 |
| 4 | y= 2.000 | M= 0.000 | 400000. | 2.0000 | 1643007. | 25205.5680 |

---

Pile-head Deflection vs. Pile Length

---

Boundary Condition Type 4, Deflection and Moment

Deflection = 0.25000 in
Moment = 0. in-lbs
Axial Load = 400000. lbs

| Pile Length in | Pile Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|
| 840.000 | 0.25000000 | 231577.82896 | 5427.04131 |
| 798.000 | 0.25000000 | 231602.01487 | 5428.24394 |
| 756.000 | 0.25000000 | 231583.89215 | 5427.34743 |
| 714.000 | 0.25000000 | 231606.28474 | 5428.50245 |
| 672.000 | 0.25000000 | 231596.99345 | 5427.91030 |
| 630.000 | 0.25000000 | 231636.95091 | 5428.67126 |
| 588.000 | 0.25000000 | 231626.76403 | 5429.30911 |
| 546.000 | 0.25000000 | 231652.01894 | 5429.06256 |
| 504.000 | 0.25000000 | 231586.30185 | 5428.13460 |
| 462.000 | 0.25000000 | 231642.25197 | 5429.39954 |

The analysis ended normally.

# LPILE Lateral Analysis – 2nd Street OC, Abutments 2, Class 200

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

TC
EMI

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Files Used for Analysis
---

Path to file locations: C:\Users\t.ke\Documents\13-121 - Dokken, 5th Street Bridge PSR PR\DFR\Analysis\20160923_2nd_LP\
Name of input data file: Ab2.lpd
Name of output file: Ab2.lpo
Name of plot output file: Ab2.lpp
Name of runtime file: Ab2.lpr

---
Time and Date of Analysis
---

Date: September 27, 2016 Time: 12:03:07

---
Problem Title
---

2th Street OC, Abut 2, Class 200 (pm_avg=0.87)

---
Program Options
---

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 300
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 20

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Pile Structural Properties and Geometry

---

Pile Length = 840.00 in

Depth of ground surface below top of pile = -24.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

| Point No. | Point Depth in | Pile Diameter in | Moment of Inertia in**4 | Pile Area Sq.in | Modulus of Elasticity lbs/Sq.in |
|---|---|---|---|---|---|
| 1 | 0.0000 | 14.00000000 | 1601.0000 | 196.0000 | 4770000. |
| 2 | 840.0000 | 14.00000000 | 1601.0000 | 196.0000 | 4770000. |

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Soil and Rock Layering Information

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The soil profile is modelled using 7 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = -24.000 in
Distance from top of pile to bottom of layer = 120.000 in
p-y subgrade modulus k for top of soil layer = 15.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 15.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 120.000 in
Distance from top of pile to bottom of layer = 180.000 in
p-y subgrade modulus k for top of soil layer = 15.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 15.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 300.000 in
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 300.000 in
Distance from top of pile to bottom of layer = 600.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 600.000 in
Distance from top of pile to bottom of layer = 1020.000 in
p-y subgrade modulus k for top of soil layer = 70.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 70.000 lbs/in**3

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 1020.000 in
Distance from top of pile to bottom of layer = 1500.000 in

Layer 7 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 1500.000 in
Distance from top of pile to bottom of layer = 1900.000 in
p-y subgrade modulus k for top of soil layer = 118.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 118.000 lbs/in**3

(Depth of lowest layer extends 1060.00 in below pile tip)

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Effective Unit Weight of Soil vs. Depth

---

Effective unit weight of soil with depth defined using 14 points

| Point No. | Depth X in | Eff. Unit Weight lbs/in**3 |
|---|---|---|
| 1 | -24.00 | 0.06366 |
| 2 | 120.00 | 0.06366 |
| 3 | 120.00 | 0.02755 |
| 4 | 180.00 | 0.02755 |
| 5 | 180.00 | 0.03333 |
| 6 | 300.00 | 0.03333 |
| 7 | 300.00 | 0.03623 |
| 8 | 600.00 | 0.03623 |
| 9 | 600.00 | 0.03623 |
| 10 | 1020.00 | 0.03623 |
| 11 | 1020.00 | 0.03623 |
| 12 | 1500.00 | 0.03623 |
| 13 | 1500.00 | 0.03912 |
| 14 | 1900.00 | 0.03912 |

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Shear Strength of Soils

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Shear strength parameters with depth defined using 14 points

| Point No. | Depth X in | Cohesion c lbs/in**2 | Angle of Friction Deg. | E50 or k_rm | RQD % |
|---|---|---|---|---|---|
| 1 | -24.000 | 0.00000 | 29.00 | ------ | ------ |
| 2 | 120.000 | 0.00000 | 29.00 | ------ | ------ |
| 3 | 120.000 | 0.00000 | 29.00 | ------ | ------ |
| 4 | 180.000 | 0.00000 | 29.00 | ------ | ------ |
| 5 | 180.000 | 0.00000 | 33.00 | ------ | ------ |
| 6 | 300.000 | 0.00000 | 33.00 | ------ | ------ |
| 7 | 300.000 | 17.36110 | 0.00 | 0.00800 | 0.0 |
| 8 | 600.000 | 17.36110 | 0.00 | 0.00800 | 0.0 |
| 9 | 600.000 | 0.00000 | 34.00 | ------ | ------ |
| 10 | 1020.000 | 0.00000 | 34.00 | ------ | ------ |
| 11 | 1020.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 12 | 1500.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 13 | 1500.000 | 0.00000 | 38.00 | ------ | ------ |
| 14 | 1900.000 | 0.00000 | 38.00 | ------ | ------ |

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

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p-y Modification Factors

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Distribution of p-y multipliers with depth defined using 2 points

| Point No. | Depth X in | p-mult | y-mult |
|---|---|---|---|
| 1 | 0.000 | 0.8700 | 1.0000 |
| 2 | 840.000 | 0.8700 | 1.0000 |

---

Loading Type

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Static loading criteria was used for computation of p-y curves.

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Pile-head Loading and Pile-head Fixity Conditions

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Number of loads specified = 4

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.250 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.500 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 1.000 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 2.000 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 0.250000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.250000 | 0.0000 | 5521.0044 | -0.0033147 | 2040.8163 | -73.0661 | 409.1699 |
| 56.000 | 0.085643 | 228128. | 128.4717 | -0.0022732 | 3038.2519 | -88.9271 | 2907.3834 |
| 112.000 | 0.004578 | 170439. | -2563.4646 | -0.0006984 | 2786.0199 | -8.1254 | 4969.4082 |
| 168.000 | -0.008572 | 42315.4328 | -1956.4500 | 6.9315E-05 | 2225.8307 | 18.8345 | 6152.2797 |
| 224.000 | -0.002074 | -16263.3144 | -47.5152 | 9.1083E-05 | 2111.9239 | 20.3478 | 27467.8959 |
| 280.000 | 0.000108 | -5091.9676 | 276.1437 | 1.9798E-06 | 2063.0798 | -1.3810 | 35653.1277 |
| 336.000 | -4.13E-06 | 212.1432 | -35.4055 | 7.9509E-08 | 2041.7439 | 2.8675 | 1944992. |
| 392.000 | 1.04E-07 | 0.7877809 | 0.4731751 | -7.8973E-09 | 2040.8198 | -0.0724219 | 1944992. |
| 448.000 | -1.48E-09 | -0.1162431 | 0.0004871 | 2.1269E-10 | 2040.8168 | 0.0010271 | 1944992. |
| 504.000 | 1.23E-12 | 0.0032959 | -0.0002195 | -3.2430E-12 | 2040.8163 | -8.5762E-07 | 1944992. |
| 560.000 | 6.03E-13 | -5.2960E-05 | 6.6373E-06 | 9.7570E-15 | 2040.8163 | -4.1885E-07 | 1944992. |
| 616.000 | -1.24E-13 | 1.9053E-06 | -9.4920E-08 | -8.9300E-16 | 2040.8163 | 2.2587E-09 | 51124.4825 |
| 672.000 | -2.97E-14 | -3.3451E-07 | -1.3389E-09 | 1.6177E-15 | 2040.8163 | 6.4400E-10 | 60673.6025 |
| 728.000 | 4.74E-15 | -6.6826E-08 | 4.3021E-09 | -1.0013E-17 | 2040.8163 | -1.3651E-10 | 80715.7730 |
| 784.000 | 5.66E-16 | 1.4059E-08 | -2.3076E-10 | -4.8096E-17 | 2040.8163 | -1.8533E-11 | 91691.7730 |
| 840.000 | -4.16E-16 | 0.0000 | 0.0000 | -6.1151E-18 | 2040.8163 | 1.5256E-11 | 51333.8865 |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.25000000 in
Computed slope at pile head = -0.00331471
Maximum bending moment = 233698.61454 lbs-in
Maximum shear force = 5521.00440 lbs
Depth of maximum bending moment = 67.20000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 5
Number of zero deflection points = 11

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 0.500000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.500000 | 0.0000 | 10241.1308 | -0.0065584 | 2040.8163 | -122.8174 | 343.8886 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 56.000 | 0.173570 | 447780. | 453.2341 | -0.0045435 | 3998.6307 | -177.2598 | 2859.5191 |
| 112.000 | 0.010562 | 340977. | -5051.3115 | -0.0014204 | 3531.6607 | -18.7448 | 4969.2705 |
| 168.000 | -0.016824 | 86658.4747 | -3919.5241 | 0.0001257 | 2419.7103 | 36.9650 | 6151.9124 |
| 224.000 | -0.004183 | -31670.9472 | -123.2629 | 0.0001809 | 2179.2902 | 41.0363 | 27467.0599 |
| 280.000 | 0.000200 | -10262.9437 | 545.6928 | 4.7599E-06 | 2085.6887 | -2.5483 | 35653.1257 |
| 336.000 | -7.87E-06 | 422.1255 | -68.7232 | 1.3481E-07 | 2042.6620 | 5.4686 | 1944992. |
| 392.000 | 2.02E-07 | 1.2271 | 0.9379024 | -1.5023E-08 | 2040.8217 | -0.1404038 | 1944992. |
| 448.000 | -2.92E-09 | -0.2206543 | 0.0003369 | 4.1170E-10 | 2040.8173 | 0.0020305 | 1944992. |
| 504.000 | 4.16E-12 | 0.0063721 | -0.0004155 | -6.3911E-12 | 2040.8164 | -2.8877E-06 | 1944992. |
| 560.000 | 1.14E-12 | -0.0001042 | 1.2814E-05 | 2.2446E-14 | 2040.8163 | -7.9057E-07 | 1944992. |
| 616.000 | -2.38E-13 | 3.7125E-06 | -1.8402E-07 | -1.8234E-15 | 2040.8163 | 4.3487E-09 | 51124.4825 |
| 672.000 | -5.81E-14 | -6.4389E-07 | -2.7661E-09 | 3.1336E-15 | 2040.8163 | 1.2583E-09 | 60673.6025 |
| 728.000 | 9.07E-15 | -1.3091E-07 | 8.3331E-09 | -1.3129E-17 | 2040.8163 | -2.6151E-10 | 80715.7730 |
| 784.000 | 1.12E-15 | 2.7015E-08 | -4.3149E-10 | -9.3368E-17 | 2040.8163 | -3.6549E-11 | 91691.7730 |
| 840.000 | -8.11E-16 | 0.0000 | 0.0000 | -1.2309E-17 | 2040.8163 | 2.9728E-11 | 51333.8865 |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.50000000 in
Computed slope at pile head = -0.00655837
Maximum bending moment = 461118.66229 lbs-in
Maximum shear force = 10241.13083 lbs
Depth of maximum bending moment = 67.20000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 5
Number of zero deflection points = 11

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 1.000000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 1.000000 | 0.0000 | 17092.0797 | -0.0127555 | 2040.8163 | -159.8806 | 223.8329 |
| 56.000 | 0.359331 | 849162. | 1878.3858 | -0.0090628 | 5753.5777 | -342.8826 | 2671.8277 |
| 112.000 | 0.028821 | 681770. | -9676.3784 | -0.0029674 | 5021.6973 | -51.1383 | 4968.1784 |
| 168.000 | -0.031861 | 184276. | -7866.7438 | 0.0001803 | 2846.5201 | 69.9870 | 6150.6299 |
| 224.000 | -0.008551 | -58574.4223 | -401.6382 | 0.0003543 | 2296.9194 | 83.8678 | 27463.5375 |
| 280.000 | 0.000308 | -20941.6986 | 1054.0840 | 1.3915E-05 | 2132.3790 | -3.9160 | 35653.1218 |
| 336.000 | -1.36E-05 | 831.5774 | -125.8292 | 1.3612E-07 | 2044.4522 | 9.4604 | 1944992. |
| 392.000 | 3.69E-07 | 0.5344567 | 1.8276 | -2.5771E-08 | 2040.8187 | -0.2561130 | 1944992. |
| 448.000 | -5.65E-09 | -0.3757856 | -0.0028340 | 7.4732E-10 | 2040.8180 | 0.0039262 | 1944992. |
| 504.000 | 1.76E-11 | 0.0115236 | -0.0007005 | -1.2248E-11 | 2040.8164 | -1.2222E-05 | 1944992. |
| 560.000 | 1.90E-12 | -0.0001984 | 2.3069E-05 | 6.0984E-14 | 2040.8163 | -1.3203E-06 | 1944992. |
| 616.000 | -4.25E-13 | 6.8804E-06 | -3.3558E-07 | -3.8453E-15 | 2040.8163 | 7.7609E-09 | 51124.4825 |
| 672.000 | -1.08E-13 | -1.1477E-06 | -6.3444E-09 | 5.7299E-15 | 2040.8163 | 2.3298E-09 | 60673.6025 |
| 728.000 | 1.75E-14 | -2.5402E-07 | 1.5127E-08 | 1.7190E-18 | 2040.8163 | -4.3968E-10 | 70222.7225 |
| 784.000 | 2.42E-15 | 5.2382E-08 | -7.3133E-10 | -1.8943E-16 | 2040.8163 | -7.9153E-11 | 91691.7730 |
| 840.000 | -1.67E-15 | 0.0000 | 0.0000 | -2.8798E-17 | 2040.8163 | 6.1286E-11 | 51333.8865 |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection = 1.00000000 in
Computed slope at pile head = -0.01275546
Maximum bending moment = 889537.39498 lbs-in
Maximum shear force = 17092.07968 lbs
Depth of maximum bending moment = 70.00000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 6
Number of zero deflection points = 11

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 4

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 2.000000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 2.000 | 0.0000 | 25637.0499 | -0.0242410 | 2040.8163 | -167.5080 | 117.2556 |
| 56.000 | 0.765274 | 1515346. | 6507.5458 | -0.0179584 | 8666.3134 | -570.1940 | 2086.2363 |
| 112.000 | 0.088898 | 1356013. | -17510.1856 | -0.0064251 | 7969.6688 | -157.3959 | 4957.4679 |
| 168.000 | -0.056103 | 411732. | -15766.0068 | 6.6931E-05 | 3841.0166 | 123.1635 | 6146.8975 |
| 224.000 | -0.017784 | -96995.3270 | -1438.3089 | 0.0006751 | 2464.9058 | 174.3303 | 27448.1504 |
| 280.000 | 0.000247 | -43540.2667 | 1938.8313 | 4.5900E-05 | 2231.1860 | -3.1470 | 35653.1241 |
| 336.000 | -1.89E-05 | 1691.0621 | -211.3066 | -3.2716E-07 | 2048.2101 | 13.1144 | 1944992. |
| 392.000 | 6.12E-07 | -7.6982 | 3.6229 | -3.4565E-08 | 2040.8500 | -0.4252744 | 1944992. |
| 448.000 | -1.10E-08 | -0.4893896 | -0.0220814 | 1.2224E-09 | 2040.8185 | 0.0076397 | 1944992. |
| 504.000 | 7.97E-11 | 0.0186319 | -0.0008736 | -2.3312E-11 | 2040.8164 | -5.5338E-05 | 1944992. |
| 560.000 | 2.27E-12 | -0.0003717 | 3.6766E-05 | 2.0224E-13 | 2040.8163 | -1.5788E-06 | 1944992. |
| 616.000 | -6.58E-13 | 1.1969E-05 | -5.5702E-07 | -8.9950E-15 | 2040.8163 | 1.2019E-08 | 51124.4825 |
| 672.000 | -1.87E-13 | -1.7887E-06 | -1.7258E-08 | 9.5176E-15 | 2040.8163 | 4.0628E-09 | 60673.6025 |
| 728.000 | 2.78E-14 | -4.4662E-07 | 2.5225E-08 | 1.1023E-16 | 2040.8163 | -6.9760E-10 | 70222.7225 |
| 784.000 | 4.64E-15 | 8.3100E-08 | -8.2447E-10 | -3.2727E-16 | 2040.8163 | -1.5198E-10 | 91691.7730 |
| 840.000 | -2.97E-15 | 0.0000 | 0.0000 | -6.1406E-17 | 2040.8163 | 1.0884E-10 | 51333.8865 |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 4:

Pile-head deflection = 2.00000000 in
Computed slope at pile head = -0.02424105
Maximum bending moment = 1657121. lbs-in
Maximum shear force = 25637.04992 lbs
Depth of maximum bending moment = 78.40000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 7
Number of zero deflection points = 11

---

Summary of Pile Response(s)

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Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

| Load Type | Pile-Head Condition 1 | Pile-Head Condition 2 | Axial Load lbs | Pile-Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|---|---|---|
| 4 | y= 0.250000 | M= 0.000 | 400000. | 0.2500000 | 233699. | 5521.0044 |
| 4 | y= 0.500000 | M= 0.000 | 400000. | 0.5000000 | 461119. | 10241.1308 |
| 4 | y= 1.000000 | M= 0.000 | 400000. | 1.0000000 | 889537. | 17092.0797 |
| 4 | y= 2.000 | M= 0.000 | 400000. | 2.0000 | 1657121. | 25637.0499 |

---

Pile-head Deflection vs. Pile Length

---

Boundary Condition Type 4, Deflection and Moment

Deflection = 0.25000 in
Moment = 0. in-lbs
Axial Load = 400000. lbs

| Pile Length in | Pile Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|
| 840.000 | 0.25000000 | 233698.61454 | 5521.00440 |
| 798.000 | 0.25000000 | 233743.93934 | 5522.23168 |
| 756.000 | 0.25000000 | 233680.28691 | 5521.31586 |
| 714.000 | 0.25000000 | 233744.23242 | 5522.49291 |
| 672.000 | 0.25000000 | 233718.17693 | 5521.89187 |
| 630.000 | 0.25000000 | 233758.97649 | 5522.66654 |
| 588.000 | 0.25000000 | 233765.22438 | 5523.31510 |
| 546.000 | 0.25000000 | 233770.74409 | 5523.06072 |
| 504.000 | 0.25000000 | 233707.17713 | 5522.12227 |
| 462.000 | 0.25000000 | 233748.44545 | 5523.40515 |

The analysis ended normally.

# LPILE Lateral Analysis – 2nd Street OC, Abutments 2, North Wingwalls, Class 200

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

TC
EMI

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Files Used for Analysis
---

Path to file locations: C:\Users\t.ke\Documents\13-121 - Dokken, 5th Street Bridge PSR PR\DFR\Analysis\20160927Abut_wingwal_piles_LP\2nd_Abut2\
Name of input data file: Ab2.lpd
Name of output file: Ab2.lpo
Name of plot output file: Ab2.lpp
Name of runtime file: Ab2.lpr

---
Time and Date of Analysis
---

Date: September 27, 2016 Time: 16:56:46

---
Problem Title
---

2th Street OC, Abut 2N RW, Class 200 (pm_avg=0.6

---
Program Options
---

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 300
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 20

---

Pile Structural Properties and Geometry

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Pile Length = 600.00 in

Depth of ground surface below top of pile = -24.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

| Point No. | Point Depth in | Pile Diameter in | Moment of Inertia in**4 | Pile Area Sq.in | Modulus of Elasticity lbs/Sq.in |
|---|---|---|---|---|---|
| 1 | 0.0000 | 14.00000000 | 1601.0000 | 196.0000 | 4770000. |
| 2 | 840.0000 | 14.00000000 | 1601.0000 | 196.0000 | 4770000. |

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Soil and Rock Layering Information

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The soil profile is modelled using 7 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = -24.000 in
Distance from top of pile to bottom of layer = 120.000 in
p-y subgrade modulus k for top of soil layer = 15.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 15.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 120.000 in
Distance from top of pile to bottom of layer = 180.000 in
p-y subgrade modulus k for top of soil layer = 15.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 15.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 300.000 in
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 300.000 in
Distance from top of pile to bottom of layer = 600.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 600.000 in
Distance from top of pile to bottom of layer = 1020.000 in
p-y subgrade modulus k for top of soil layer = 70.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 70.000 lbs/in**3

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 1020.000 in
Distance from top of pile to bottom of layer = 1500.000 in

Layer 7 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 1500.000 in
Distance from top of pile to bottom of layer = 1900.000 in
p-y subgrade modulus k for top of soil layer = 118.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 118.000 lbs/in**3

(Depth of lowest layer extends 1300.00 in below pile tip)

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Effective Unit Weight of Soil vs. Depth

---

Effective unit weight of soil with depth defined using 14 points

| Point No. | Depth X in | Eff. Unit Weight lbs/in**3 |
|---|---|---|
| 1 | -24.00 | 0.06366 |
| 2 | 120.00 | 0.06366 |
| 3 | 120.00 | 0.02755 |
| 4 | 180.00 | 0.02755 |
| 5 | 180.00 | 0.03333 |
| 6 | 300.00 | 0.03333 |
| 7 | 300.00 | 0.03623 |
| 8 | 600.00 | 0.03623 |
| 9 | 600.00 | 0.03623 |
| 10 | 1020.00 | 0.03623 |
| 11 | 1020.00 | 0.03623 |
| 12 | 1500.00 | 0.03623 |
| 13 | 1500.00 | 0.03912 |
| 14 | 1900.00 | 0.03912 |

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Shear Strength of Soils

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Shear strength parameters with depth defined using 14 points

| Point No. | Depth X in | Cohesion c lbs/in**2 | Angle of Friction Deg. | E50 or k_rm | RQD % |
|---|---|---|---|---|---|
| 1 | -24.000 | 0.00000 | 29.00 | ------ | ------ |
| 2 | 120.000 | 0.00000 | 29.00 | ------ | ------ |
| 3 | 120.000 | 0.00000 | 29.00 | ------ | ------ |
| 4 | 180.000 | 0.00000 | 29.00 | ------ | ------ |
| 5 | 180.000 | 0.00000 | 33.00 | ------ | ------ |
| 6 | 300.000 | 0.00000 | 33.00 | ------ | ------ |
| 7 | 300.000 | 17.36110 | 0.00 | 0.00800 | 0.0 |
| 8 | 600.000 | 17.36110 | 0.00 | 0.00800 | 0.0 |
| 9 | 600.000 | 0.00000 | 34.00 | ------ | ------ |
| 10 | 1020.000 | 0.00000 | 34.00 | ------ | ------ |
| 11 | 1020.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 12 | 1500.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 13 | 1500.000 | 0.00000 | 38.00 | ------ | ------ |
| 14 | 1900.000 | 0.00000 | 38.00 | ------ | ------ |

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

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p-y Modification Factors

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Distribution of p-y multipliers with depth defined using 2 points

| Point No. | Depth X in | p-mult | y-mult |
|---|---|---|---|
| 1 | 0.000 | 0.6000 | 1.0000 |
| 2 | 600.000 | 0.6000 | 1.0000 |

---

Loading Type

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Static loading criteria was used for computation of p-y curves.

---

Pile-head Loading and Pile-head Fixity Conditions

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Number of loads specified = 4

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.250 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.500 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 1.000 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 2.000 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 0.250000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.250000 | 0.0000 | 4190.2972 | -0.0030714 | 2040.8163 | -50.3904 | 201.5615 |
| 40.000 | 0.133841 | 163168. | 1470.0423 | -0.0025926 | 2754.2294 | -75.6731 | 1130.7873 |
| 80.000 | 0.049586 | 200601. | -1080.8834 | -0.0015880 | 2917.8972 | -46.3570 | 1869.7780 |
| 120.000 | 0.005785 | 148763. | -2122.2460 | -0.0006485 | 2691.2496 | -6.2710 | 2168.0038 |
| 160.000 | -0.007286 | 69840.5053 | -1972.4049 | -7.4799E-05 | 2346.1777 | 10.5203 | 2887.9856 |
| 200.000 | -0.005521 | 5427.8537 | -957.4173 | 0.0001053 | 2064.5484 | 34.3282 | 12435.1540 |
| 240.000 | -0.001711 | -12498.8252 | -8.3750 | 6.9978E-05 | 2095.4645 | 13.1019 | 15316.0201 |
| 280.000 | -0.000127 | -7122.6076 | 228.8595 | 1.4238E-05 | 2071.9583 | 1.1510 | 18196.1052 |
| 320.000 | 8.96E-06 | 82.0355 | 39.4583 | -6.9502E-07 | 2041.1750 | -6.2252 | 1389280. |
| 360.000 | -5.52E-07 | 10.4767 | -3.5003 | 2.8010E-08 | 2040.8621 | 0.3835911 | 1389280. |
| 400.000 | 2.90E-08 | -1.5549 | 0.2531418 | -5.1493E-10 | 2040.8231 | -0.0201688 | 1389280. |
| 440.000 | -1.20E-09 | 0.1405415 | -0.0157315 | -5.1213E-11 | 2040.8169 | 0.0008363 | 1389280. |
| 480.000 | 2.55E-11 | -0.0102811 | 0.0008358 | 8.0546E-12 | 2040.8164 | -1.7693E-05 | 1389280. |
| 520.000 | 1.81E-12 | 0.0006454 | -3.5306E-05 | -7.4020E-13 | 2040.8163 | -1.2571E-06 | 1389280. |
| 560.000 | -3.12E-13 | -3.4631E-05 | 8.0855E-07 | 5.4829E-14 | 2040.8163 | 2.1705E-07 | 1389280. |
| 600.000 | 1.82E-14 | 0.0000 | 0.0000 | -5.6732E-15 | 2040.8163 | -1.2623E-08 | 694640. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.25000000 in
Computed slope at pile head = -0.00307137
Maximum bending moment = 202263.43984 lbs-in
Maximum shear force = 4190.29715 lbs
Depth of maximum bending moment = 72.00000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 5
Number of zero deflection points = 8

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 0.500000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.500000 | 0.0000 | 7777.0793 | -0.0060805 | 2040.8163 | -84.7016 | 169.4033 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 40.000 | 0.269573 | 316972. | 3023.2749 | -0.0051607 | 3426.7034 | -144.4080 | 1071.3847 |
| 80.000 | 0.101221 | 397121. | -2031.2836 | -0.0031877 | 3777.1357 | -94.2765 | 1862.7824 |
| 120.000 | 0.012894 | 297513. | -4186.3968 | -0.0013180 | 3341.6210 | -13.9764 | 2167.8953 |
| 160.000 | -0.014019 | 141301. | -3932.3210 | -0.0001657 | 2658.6203 | 20.2432 | 2887.8623 |
| 200.000 | -0.010949 | 12510.5782 | -1936.7827 | 0.0002038 | 2095.5159 | 68.0625 | 12432.3634 |
| 240.000 | -0.003460 | -24316.1057 | -40.2111 | 0.0001393 | 2147.1328 | 26.4948 | 15315.7554 |
| 280.000 | -0.000273 | -14266.1171 | 445.5909 | 2.9384E-05 | 2103.1916 | 2.4861 | 18196.1031 |
| 320.000 | 1.85E-05 | 68.7710 | 88.5174 | -1.3407E-06 | 2041.1170 | -12.8703 | 1389280. |
| 360.000 | -1.11E-06 | 27.5637 | -7.4798 | 5.0047E-08 | 2040.9368 | 0.7705422 | 1389280. |
| 400.000 | 5.62E-08 | -3.5051 | 0.5242219 | -5.2613E-10 | 2040.8317 | -0.0390590 | 1389280. |
| 440.000 | -2.17E-09 | 0.3010864 | -0.0316566 | -1.3768E-10 | 2040.8176 | 0.0015093 | 1389280. |
| 480.000 | 3.07E-11 | -0.0213326 | 0.0016228 | 1.8236E-11 | 2040.8164 | -2.1340E-05 | 1389280. |
| 520.000 | 5.05E-12 | 0.0013014 | -6.4126E-05 | -1.5892E-12 | 2040.8163 | -3.5105E-06 | 1389280. |
| 560.000 | -7.13E-13 | -6.7435E-05 | 1.0551E-06 | 1.1390E-13 | 2040.8163 | 4.9546E-07 | 1389280. |
| 600.000 | 5.25E-14 | 0.0000 | 0.0000 | -1.0376E-14 | 2040.8163 | -3.6434E-08 | 694640. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.50000000 in
Computed slope at pile head = -0.00608055
Maximum bending moment = 399521.87990 lbs-in
Maximum shear force = 7777.07934 lbs
Depth of maximum bending moment = 74.00000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 5
Number of zero deflection points = 8

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 1.000000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 1.000000 | 0.0000 | 12997.7287 | -0.0118432 | 2040.8163 | -110.2625 | 110.2625 |
| 40.000 | 0.549112 | 585485. | 6277.2750 | -0.0101832 | 4600.7118 | -243.5768 | 887.1666 |
| 80.000 | 0.213547 | 771083. | -3353.2050 | -0.0064333 | 5412.1963 | -195.5870 | 1831.7929 |
| 120.000 | 0.033061 | 594363. | -8044.2490 | -0.0027499 | 4639.5290 | -35.8235 | 2167.1381 |
| 160.000 | -0.024973 | 291257. | -7787.9018 | -0.0004197 | 3314.2710 | 36.0541 | 2887.4955 |
| 200.000 | -0.021366 | 34128.2526 | -3990.9664 | 0.0003697 | 2190.0342 | 132.7048 | 12421.8695 |
| 240.000 | -0.007124 | -44829.0393 | -209.8371 | 0.0002749 | 2236.8209 | 54.5492 | 15314.6204 |
| 280.000 | -0.000658 | -28623.3113 | 823.4805 | 6.3725E-05 | 2165.9651 | 5.9836 | 18196.0900 |
| 320.000 | 4.04E-05 | -388.5947 | 229.8768 | -2.4070E-06 | 2042.5154 | -28.0363 | 1389280. |
| 360.000 | -2.24E-06 | 91.5663 | -17.5923 | 6.7042E-08 | 2041.2167 | 1.5583 | 1389280. |
| 400.000 | 1.02E-07 | -9.1859 | 1.1466 | 1.7291E-09 | 2040.8565 | -0.0709938 | 1389280. |
| 440.000 | -3.04E-09 | 0.7120716 | -0.0643285 | -4.6974E-10 | 2040.8194 | 0.0021148 | 1389280. |
| 480.000 | -5.02E-11 | -0.0468813 | 0.0029737 | 4.8178E-11 | 2040.8165 | 3.4886E-05 | 1389280. |
| 520.000 | 1.80E-11 | 0.0026592 | -9.2343E-05 | -3.7765E-12 | 2040.8163 | -1.2514E-05 | 1389280. |
| 560.000 | -1.91E-12 | -0.0001247 | -9.9368E-07 | 2.5100E-13 | 2040.8163 | 1.3287E-06 | 1389280. |
| 600.000 | 1.94E-13 | 0.0000 | 0.0000 | -1.5379E-14 | 2040.8163 | -1.3456E-07 | 694640. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection = 1.00000000 in
Computed slope at pile head = -0.01184324
Maximum bending moment = 772285.25811 lbs-in
Maximum shear force = 12997.72874 lbs
Depth of maximum bending moment = 76.00000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 6
Number of zero deflection points = 8

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 4

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 2.000000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 2.000 | 0.0000 | 19484.6116 | -0.0225549 | 2040.8163 | -115.5228 | 57.7614 |
| 40.000 | 1.136 | 1002809. | 11998.3668 | -0.0197836 | 6425.3655 | -313.0650 | 551.4083 |
| 80.000 | 0.471081 | 1441568. | -3968.5258 | -0.0130502 | 8343.7353 | -399.0152 | 1694.0404 |
| 120.000 | 0.095880 | 1180578. | -14657.8891 | -0.0059458 | 7202.6203 | -103.5769 | 2160.5475 |
| 160.000 | -0.037057 | 615680. | -15186.4331 | -0.0012010 | 4732.7331 | 53.4895 | 2886.8519 |
| 200.000 | -0.040358 | 105669. | -8431.9300 | 0.0005795 | 2502.8281 | 249.9254 | 12385.4924 |
| 240.000 | -0.015038 | -73536.2885 | -954.3241 | 0.0005323 | 2362.3366 | 115.1084 | 15309.4896 |
| 280.000 | -0.001771 | -57396.6304 | 1359.7412 | 0.0001475 | 2291.7697 | 16.1131 | 18195.9915 |
| 320.000 | 9.41E-05 | -2955.3302 | 676.9960 | -3.6570E-06 | 2053.7378 | -65.3668 | 1389280. |
| 360.000 | -4.57E-06 | 333.4711 | -45.9590 | -3.4785E-09 | 2042.2744 | 3.1757 | 1389280. |
| 400.000 | 1.61E-07 | -27.3188 | 2.6908 | 1.4975E-08 | 2040.9358 | -0.1118884 | 1389280. |
| 440.000 | -6.71E-10 | 1.8741 | -0.1323544 | -1.7416E-09 | 2040.8245 | 0.0004660 | 1389280. |
| 480.000 | -5.63E-10 | -0.1108685 | 0.0047967 | 1.4451E-10 | 2040.8168 | 0.0003911 | 1389280. |
| 520.000 | 6.87E-11 | 0.0055312 | -3.5083E-05 | -1.0002E-11 | 2040.8164 | -4.7700E-05 | 1389280. |
| 560.000 | -5.83E-12 | -0.0002060 | -1.4847E-05 | 5.9622E-13 | 2040.8163 | 4.0474E-06 | 1389280. |
| 600.000 | 7.54E-13 | 0.0000 | 0.0000 | -8.3577E-15 | 2040.8163 | -5.2381E-07 | 694640. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 4:

Pile-head deflection = 2.00000000 in
Computed slope at pile head = -0.02255493
Maximum bending moment = 1443122. lbs-in
Maximum shear force = 19484.61157 lbs
Depth of maximum bending moment = 82.00000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 7
Number of zero deflection points = 8

---

Summary of Pile Response(s)

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Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

| Load Type | Pile-Head Condition 1 | Pile-Head Condition 2 | Axial Load lbs | Pile-Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|---|---|---|
| 4 | y= 0.250000 | M= 0.000 | 400000. | 0.2500000 | 202263. | 4190.2972 |
| 4 | y= 0.500000 | M= 0.000 | 400000. | 0.5000000 | 399522. | 7777.0793 |
| 4 | y= 1.000000 | M= 0.000 | 400000. | 1.0000000 | 772285. | 12997.7287 |
| 4 | y= 2.000 | M= 0.000 | 400000. | 2.0000 | 1443122. | 19484.6116 |

---

Pile-head Deflection vs. Pile Length

---

Boundary Condition Type 4, Deflection and Moment

Deflection = 0.25000 in
Moment = 0. in-lbs
Axial Load = 400000. lbs

| Pile Length in | Pile Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|
| 600.000 | 0.25000000 | 202263.43984 | 4190.29715 |
| 570.000 | 0.25000000 | 202164.39566 | 4188.11466 |
| 540.000 | 0.25000000 | 202109.70165 | 4186.93659 |
| 510.000 | 0.25000000 | 202164.99294 | 4188.37664 |
| 480.000 | 0.25000000 | 202133.80953 | 4187.70647 |
| 450.000 | 0.25000000 | 202260.28983 | 4190.39695 |
| 420.000 | 0.25000000 | 202154.49197 | 4187.99160 |
| 390.000 | 0.25000000 | 202154.66770 | 4187.99542 |
| 360.000 | 0.25000000 | 202158.43599 | 4188.52288 |
| 330.000 | 0.25000000 | 202163.71333 | 4188.28432 |

The analysis ended normally.

LPILE Lateral Analysis – 5th Street Bridge, Abutment 1, 24” CIDH

# LPILE Lateral Analysis – 5th Street Bridge, Abutment 11, 24” CIDH

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

TC
EMI

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Files Used for Analysis
---

Path to file locations: C:\Users\t.ke\Documents\13-121 - Dokken, 5th Street Bridge PSR PR\DFR\Analysis\20160707LP_5th_Abut11_CIDH_SP_3D\24inCIDH_pm_85\
Name of input data file: P11.lpd
Name of output file: P11.lpo
Name of plot output file: P11.lpp
Name of runtime file: P11.lpr

---
Time and Date of Analysis
---

Date: September 28, 2016 Time: 12:20:23

---
Problem Title
---

5th Street Bridge, Abut 11, 24"CIDH (pm_avg=0.85), LQ, P.fixed

---
Program Options
---

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 300
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 20

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Pile Structural Properties and Geometry

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Pile Length = 960.00 in

Depth of ground surface below top of pile = 0.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 6 points

| Point No. | Point Depth in | Pile Diameter in | Moment of Inertia in**4 | Pile Area Sq.in | Modulus of Elasticity lbs/Sq.in |
|---|---|---|---|---|---|
| 1 | 0.0000 | 24.00000000 | 8143.0000 | 452.0000 | 3420000. |
| 2 | 24.0000 | 24.00000000 | 8143.0000 | 452.0000 | 3420000. |
| 3 | 24.0000 | 24.00000000 | 27179.0000 | 452.0000 | 3420000. |
| 4 | 264.0000 | 24.00000000 | 27179.0000 | 452.0000 | 3420000. |
| 5 | 264.0000 | 24.00000000 | 8143.0000 | 452.0000 | 3420000. |
| 6 | 960.0000 | 24.00000000 | 8143.0000 | 452.0000 | 3420000. |

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Soil and Rock Layering Information

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The soil profile is modelled using 7 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 0.000 in
Distance from top of pile to bottom of layer = 108.000 in
p-y subgrade modulus k for top of soil layer = 70.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 70.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 108.000 in
Distance from top of pile to bottom of layer = 168.000 in
p-y subgrade modulus k for top of soil layer = 45.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 45.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 168.000 in
Distance from top of pile to bottom of layer = 192.000 in
p-y subgrade modulus k for top of soil layer = 10.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 10.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 192.000 in
Distance from top of pile to bottom of layer = 408.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 408.000 in
Distance from top of pile to bottom of layer = 528.000 in
p-y subgrade modulus k for top of soil layer = 50.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 50.000 lbs/in**3

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 528.000 in
Distance from top of pile to bottom of layer = 1368.000 in

Layer 7 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 1368.000 in
Distance from top of pile to bottom of layer = 1992.000 in
p-y subgrade modulus k for top of soil layer = 118.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 118.000 lbs/in**3

(Depth of lowest layer extends 1032.00 in below pile tip)

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Effective Unit Weight of Soil vs. Depth

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Effective unit weight of soil with depth defined using 14 points

| Point No. | Depth X in | Eff. Unit Weight lbs/in**3 |
|---|---|---|
| 1 | 0.00 | 0.06366 |
| 2 | 108.00 | 0.06266 |
| 3 | 108.00 | 0.06366 |
| 4 | 168.00 | 0.06366 |
| 5 | 168.00 | 0.06076 |
| 6 | 192.00 | 0.06076 |
| 7 | 192.00 | 0.02466 |
| 8 | 408.00 | 0.02466 |
| 9 | 408.00 | 0.03333 |
| 10 | 528.00 | 0.03333 |
| 11 | 528.00 | 0.03623 |
| 12 | 1368.00 | 0.03623 |
| 13 | 1368.00 | 0.03912 |
| 14 | 1992.00 | 0.03912 |

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Shear Strength of Soils

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Shear strength parameters with depth defined using 14 points

| Point No. | Depth X in | Cohesion c lbs/in**2 | Angle of Friction Deg. | E50 or k_rm | RQD % |
|---|---|---|---|---|---|
| 1 | 0.000 | 0.00000 | 32.00 | ------ | ------ |
| 2 | 108.000 | 0.00000 | 32.00 | ------ | ------ |
| 3 | 108.000 | 0.00000 | 30.00 | ------ | ------ |
| 4 | 168.000 | 0.00000 | 30.00 | ------ | ------ |
| 5 | 168.000 | 0.00000 | 28.00 | ------ | ------ |
| 6 | 192.000 | 0.00000 | 28.00 | ------ | ------ |
| 7 | 192.000 | 2.77780 | 0.00 | 0.01500 | 0.0 |
| 8 | 408.000 | 2.77780 | 0.00 | 0.01500 | 0.0 |
| 9 | 408.000 | 0.00000 | 32.00 | ------ | ------ |
| 10 | 528.000 | 0.00000 | 32.00 | ------ | ------ |
| 11 | 528.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 12 | 1368.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |

| | | | | | |
|---|---|---|---|---|---|
| 13 | 1368.000 | 0.00000 | 38.00 | ------ | ------ |
| 14 | 1992.000 | 0.00000 | 38.00 | ------ | ------ |

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

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p-y Modification Factors

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Distribution of p-y multipliers with depth defined using 2 points

| Point No. | Depth X in | p-mult | y-mult |
|---|---|---|---|
| 1 | 0.000 | 0.8500 | 1.0000 |
| 2 | 960.000 | 0.8500 | 1.0000 |

---

Loading Type

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Static loading criteria was used for computation of p-y curves.

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Pile-head Loading and Pile-head Fixity Conditions

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Number of loads specified = 5

Load Case Number 1

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.250 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 500000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.400 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 500000.000 lbs

Load Case Number 3

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.500 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 500000.000 lbs

Load Case Number 4

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 1.000 in

Slope at pile head = 0.000 in/in
Axial load at pile head = 500000.000 lbs

Load Case Number 5

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 2.000 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 500000.000 lbs

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

---

Pile-head boundary conditions are Displacement and Slope (Pile-head Condition Type 5)
Specified deflection at pile head = 0.250000 in
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 500000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.250000 | -2465758. | 48967.7644 | 0.0000 | 4739.8799 | 0.0000 | 0.0000 |
| 64.000 | 0.157245 | 271870. | 29770.9228 | -0.0018217 | 1226.2300 | -478.5140 | 9737.9476 |
| 128.000 | 0.057100 | 1182158. | -45.0359 | -0.0012051 | 1628.1380 | -287.5365 | 16114.0651 |
| 192.000 | 0.004471 | 813274. | -8806.5033 | -0.0004850 | 1465.2694 | -43.4837 | 31122.5374 |
| 256.000 | -0.012678 | 302243. | -6450.6410 | -0.0001105 | 1239.6404 | 61.6099 | 15550.6491 |
| 320.000 | -0.009402 | 15684.6285 | -2521.8505 | 0.0001521 | 1129.3085 | 55.7772 | 18983.4963 |
| 384.000 | -0.001285 | -51321.8088 | 266.3878 | 7.6386E-05 | 1181.8255 | 28.7740 | 71627.2063 |
| 448.000 | 0.000648 | -14463.2659 | 495.4551 | -7.4433E-07 | 1127.5086 | -7.3582 | 36338.1778 |
| 512.000 | 0.000143 | 4585.8079 | 154.7658 | -7.8648E-06 | 1112.9526 | -2.0073 | 45042.1963 |
| 576.000 | -3.21E-06 | -225.9837 | -21.9639 | 2.5533E-07 | 1106.5277 | 4.0180 | 4000003. |
| 640.000 | 5.11E-08 | 12.4075 | -0.1567963 | -6.8199E-09 | 1106.2130 | -0.0638990 | 4000003. |
| 704.000 | -2.06E-10 | -0.3804899 | 0.0196136 | 1.3093E-10 | 1106.1953 | 0.0002570 | 4000003. |
| 768.000 | -2.20E-11 | 0.0084008 | -0.0007210 | -1.3694E-12 | 1106.1947 | 2.7443E-05 | 4000003. |
| 832.000 | 1.03E-12 | -0.0001219 | 1.8245E-05 | -2.1227E-14 | 1106.1947 | -1.2930E-06 | 4000003. |
| 896.000 | -2.99E-14 | 5.4118E-08 | -3.2750E-07 | 1.6989E-15 | 1106.1947 | 3.7333E-08 | 4000003. |
| 960.000 | 5.01E-16 | 0.0000 | 0.0000 | -8.6980E-17 | 1106.1947 | -6.2632E-10 | 2000002. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.25000000 in
Computed slope at pile head = -0.00000901
Maximum bending moment = -2465758. lbs-in
Maximum shear force = 48967.76435 lbs
Depth of maximum bending moment = 0.00000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 14
Number of zero deflection points = 10

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

---

Pile-head boundary conditions are Displacement and Slope (Pile-head Condition Type 5)
Specified deflection at pile head = 0.400000 in
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 500000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.400000 | -3735840. | 69991.7279 | 0.0000 | 6611.5472 | 0.0000 | 0.0000 |
| 64.000 | 0.256412 | 261379. | 45705.0777 | -0.0028592 | 1221.5980 | -602.5434 | 7519.7028 |
| 128.000 | 0.095923 | 1782803. | 1665.2833 | -0.0019826 | 1893.3333 | -477.2384 | 15920.6922 |
| 192.000 | 0.006540 | 1276114. | -12998.9010 | -0.0008738 | 1669.6211 | -49.3703 | 24155.1727 |
| 256.000 | -0.027114 | 530905. | -9728.2444 | -0.0002645 | 1340.5984 | 79.3606 | 9366.1089 |
| 320.000 | -0.024100 | 73708.8173 | -4551.6338 | 0.0002705 | 1214.8163 | 76.3071 | 10131.8724 |
| 384.000 | -0.006906 | -85265.1775 | -427.9825 | 0.0002062 | 1231.8464 | 50.3186 | 23317.0107 |
| 448.000 | 0.000270 | -48718.6010 | 1018.2017 | 3.3859E-05 | 1177.9893 | -3.0666 | 36338.1938 |
| 512.000 | 0.000286 | 2765.5585 | 593.2478 | -1.3530E-05 | 1110.2702 | -4.0294 | 45042.1938 |
| 576.000 | -6.98E-06 | -287.2156 | -59.3673 | 4.9066E-07 | 1106.6179 | 8.7235 | 4000003. |
| 640.000 | 1.25E-07 | 22.7106 | 0.0547138 | -1.4288E-08 | 1106.2282 | -0.1562555 | 4000003. |
| 704.000 | -1.03E-09 | -0.7718587 | 0.0331410 | 3.0072E-10 | 1106.1958 | 0.0012857 | 4000003. |
| 768.000 | -3.18E-11 | 0.0185086 | -0.0014090 | -3.9658E-12 | 1106.1947 | 3.9812E-05 | 4000003. |
| 832.000 | 1.94E-12 | -0.0003083 | 3.8748E-05 | -1.4677E-14 | 1106.1947 | -2.4203E-06 | 4000003. |
| 896.000 | -6.14E-14 | 1.7631E-06 | -7.6850E-07 | 2.9750E-15 | 1106.1947 | 7.6786E-08 | 4000003. |
| 960.000 | 1.62E-15 | 0.0000 | 0.0000 | -1.3651E-16 | 1106.1947 | -2.0268E-09 | 2000002. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.40000000 in
Computed slope at pile head = -0.00001288
Maximum bending moment = -3735840. lbs-in
Maximum shear force = 69991.72792 lbs
Depth of maximum bending moment = 0.00000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 16
Number of zero deflection points = 10

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

---

Pile-head boundary conditions are Displacement and Slope (Pile-head Condition Type 5)
Specified deflection at pile head = 0.500000 in
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 500000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.500000 | -4501018. | 81147.8797 | 0.0000 | 7739.1569 | 0.0000 | 0.0000 |
| 64.000 | 0.324643 | 192353. | 55280.5777 | -0.0035221 | 1191.1218 | -639.2163 | 6300.7402 |
| 128.000 | 0.124265 | 2139700. | 3634.9010 | -0.0025161 | 2050.9092 | -610.5877 | 15723.4764 |
| 192.000 | 0.008770 | 1577306. | -15408.9388 | -0.0011641 | 1802.6025 | -54.4496 | 19866.4711 |
| 256.000 | -0.037887 | 691997. | -11772.9438 | -0.0003968 | 1411.7234 | 88.7175 | 7493.3237 |
| 320.000 | -0.036246 | 125488. | -5926.0555 | 0.0003451 | 1291.1210 | 87.4191 | 7717.8614 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 384.000 | -0.012420 | -101941. | -1092.0573 | 0.0003125 | 1256.4204 | 61.1781 | 15763.0765 |
| 448.000 | -0.000451 | -79094.8095 | 1350.3992 | 7.1884E-05 | 1222.7534 | 5.1233 | 36338.1878 |
| 512.000 | 0.000374 | -1408.4541 | 996.5951 | -1.5937E-05 | 1108.2703 | -5.2711 | 45042.1914 |
| 576.000 | -9.54E-06 | -245.8321 | -89.5846 | 6.2477E-07 | 1106.5570 | 11.9251 | 4000003. |
| 640.000 | 1.81E-07 | 27.9948 | 0.3599315 | -1.9158E-08 | 1106.2359 | -0.2262469 | 4000003. |
| 704.000 | -1.83E-09 | -1.0160 | 0.0384900 | 4.2295E-10 | 1106.1962 | 0.0022827 | 4000003. |
| 768.000 | -3.21E-11 | 0.0254959 | -0.0018132 | -6.1376E-12 | 1106.1947 | 4.0156E-05 | 4000003. |
| 832.000 | 2.42E-12 | -0.0004528 | 5.2344E-05 | 2.6024E-15 | 1106.1947 | -3.0294E-06 | 4000003. |
| 896.000 | -8.15E-14 | 3.5976E-06 | -1.0920E-06 | 3.5521E-15 | 1106.1947 | 1.0189E-07 | 4000003. |
| 960.000 | 2.60E-15 | 0.0000 | 0.0000 | -1.4884E-16 | 1106.1947 | -3.2519E-09 | 2000002. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection = 0.50000000 in
Computed slope at pile head = -0.00001493
Maximum bending moment = -4501018. lbs-in
Maximum shear force = 81147.87970 lbs
Depth of maximum bending moment = 0.00000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 16
Number of zero deflection points = 10

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 4

---

Pile-head boundary conditions are Displacement and Slope (Pile-head Condition Type 5)
Specified deflection at pile head = 1.000000 in
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 500000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 1.000000 | -7762857. | 120724. | 0.0000 | 12545.9932 | 0.0000 | 0.0000 |
| 64.000 | 0.682970 | -498674. | 93293.8620 | -0.0065622 | 1326.3678 | -671.8068 | 3147.6971 |
| 128.000 | 0.290441 | 3535949. | 19956.0036 | -0.0052338 | 2667.3774 | -1259.8524 | 13880.6945 |
| 192.000 | 0.035370 | 2993925. | -24596.7587 | -0.0028131 | 2428.0647 | -86.6879 | 7842.8874 |
| 256.000 | -0.089813 | 1531794. | -20843.7093 | -0.0012690 | 1782.5082 | 118.2869 | 4214.4973 |
| 320.000 | -0.104948 | 461425. | -12784.3206 | 0.0006420 | 1786.1770 | 124.5880 | 3798.8653 |
| 384.000 | -0.047560 | -146022. | -5613.5534 | 0.0009180 | 1321.3811 | 95.6984 | 6438.9004 |
| 448.000 | -0.006218 | -262004. | 2866.2151 | 0.0003279 | 1492.2990 | 70.6065 | 36336.4164 |
| 512.000 | 0.000761 | -35984.6879 | 3478.8917 | -2.0780E-05 | 1159.2238 | -10.7138 | 45042.1735 |
| 576.000 | -2.21E-05 | 356.2941 | -260.6530 | 1.1573E-06 | 1106.7197 | 27.6212 | 4000003. |
| 640.000 | 4.83E-07 | 45.6039 | 2.6318 | -4.2014E-08 | 1106.2619 | -0.6037775 | 4000003. |
| 704.000 | -6.88E-09 | -2.1065 | 0.0461824 | 1.0545E-09 | 1106.1978 | 0.0085989 | 4000003. |
| 768.000 | -2.43E-12 | 0.0602806 | -0.0034879 | -1.8733E-11 | 1106.1948 | 3.0420E-06 | 4000003. |
| 832.000 | 4.20E-12 | -0.0012469 | 0.0001173 | 1.4896E-13 | 1106.1947 | -5.2557E-06 | 4000003. |
| 896.000 | -1.73E-13 | 1.5821E-05 | -2.7907E-06 | 4.9808E-15 | 1106.1947 | 2.1656E-07 | 4000003. |
| 960.000 | 8.45E-15 | 0.0000 | 0.0000 | -1.0658E-16 | 1106.1947 | -1.0567E-08 | 2000002. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 4:

Pile-head deflection = 1.00000000 in
Computed slope at pile head = -0.00002222
Maximum bending moment = -7762857. lbs-in
Maximum shear force = 120723.74655 lbs
Depth of maximum bending moment = 0.00000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 15
Number of zero deflection points = 10

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 5

---

Pile-head boundary conditions are Displacement and Slope (Pile-head Condition Type 5)
Specified deflection at pile head = 2.000000 in
Specified slope at pile head = 0.000E+00 in/in
Specified axial load at pile head = 500000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 2.000 | -1.2857E+07 | 170851. | 0.0000 | 20053.2703 | 0.0000 | 0.0000 |
| 64.000 | 1.452 | -2270386. | 143379. | -0.0116425 | 2108.6094 | -672.3942 | 1481.5533 |
| 128.000 | 0.720213 | 5019762. | 59446.8146 | -0.0103843 | 3322.5068 | -1925.4561 | 8555.0554 |
| 192.000 | 0.181034 | 5285594. | -34371.2831 | -0.0064558 | 3439.8761 | -149.4071 | 2640.9565 |
| 256.000 | -0.131331 | 3106001. | -34726.6557 | -0.0035603 | 2477.5478 | 134.2572 | 3271.2963 |
| 320.000 | -0.215632 | 1232874. | -24889.2701 | 0.0007327 | 2923.0294 | 158.3837 | 2350.4323 |
| 384.000 | -0.114140 | -101108. | -15539.2474 | 0.0019256 | 1255.1938 | 128.1205 | 3591.9450 |
| 448.000 | -0.019303 | -587815. | 4568.4892 | 0.0008412 | 1972.4337 | 219.1004 | 36321.0399 |
| 512.000 | 0.001320 | -120796. | 7882.0333 | -1.0882E-05 | 1284.2067 | -18.5737 | 45042.1262 |
| 576.000 | -4.45E-05 | 3298.7406 | -672.6003 | 1.5197E-06 | 1111.0559 | 55.5635 | 4000003. |
| 640.000 | 1.15E-06 | 38.0773 | 10.3096 | -7.7933E-08 | 1106.2508 | -1.4370 | 4000003. |
| 704.000 | -2.12E-08 | -3.5491 | -0.0269502 | 2.3301E-09 | 1106.1999 | 0.0265348 | 4000003. |
| 768.000 | 1.96E-10 | 0.1246831 | -0.0050305 | -5.0282E-11 | 1106.1949 | -0.0002448 | 4000003. |
| 832.000 | 4.53E-12 | -0.0030611 | 0.0002250 | 6.9833E-13 | 1106.1947 | -5.6605E-06 | 4000003. |
| 896.000 | -3.05E-13 | 5.2713E-05 | -6.3430E-06 | 9.6403E-16 | 1106.1947 | 3.8145E-07 | 4000003. |
| 960.000 | 2.38E-14 | 0.0000 | 0.0000 | 4.4989E-16 | 1106.1947 | -2.9723E-08 | 2000002. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 5:

Pile-head deflection = 2.00000000 in
Computed slope at pile head = -0.00003147
Maximum bending moment = -12857170. lbs-in
Maximum shear force = 170851.42448 lbs
Depth of maximum bending moment = 0.00000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 14
Number of zero deflection points = 10

---

Summary of Pile Response(s)

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Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

| Load Type | Pile-Head Condition 1 | Pile-Head Condition 2 | Axial Load lbs | Pile-Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|---|---|---|
| 5 | y= 0.250000 | S= 0.000 | 500000. | 0.2500000 | -2465758. | 48967.7644 |
| 5 | y= 0.400000 | S= 0.000 | 500000. | 0.4000000 | -3735840. | 69991.7279 |
| 5 | y= 0.500000 | S= 0.000 | 500000. | 0.5000000 | -4501018. | 81147.8797 |
| 5 | y= 1.000000 | S= 0.000 | 500000. | 1.0000000 | -7762857. | 120724. |
| 5 | y= 2.000 | S= 0.000 | 500000. | 2.0000 | -1.2857E+07 | 170851. |

---

Pile-head Deflection vs. Pile Length

---

Boundary Condition Type 5, Deflection and Slope

Deflection = 0.25000 in
Slope = 0.00000
Axial Load = 500000. lbs

| Pile Length in | Pile Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|
| 960.000 | 0.25000000 | -2465758. | 48967.76435 |
| 912.000 | 0.25000000 | -2498840. | 49221.19786 |
| 864.000 | 0.25000000 | -2456644. | 48930.10924 |
| 816.000 | 0.25000000 | -2489037. | 49136.33843 |
| 768.000 | 0.25000000 | -2463098. | 49009.23919 |
| 720.000 | 0.25000000 | -2489025. | 49025.04151 |
| 672.000 | 0.25000000 | -2483487. | 49129.09734 |
| 624.000 | 0.25000000 | -2467726. | 48955.89040 |
| 576.000 | 0.25000000 | -2470659. | 49033.92349 |
| 528.000 | 0.25000000 | -2476145. | 49067.06898 |

The analysis ended normally.

# LPILE Lateral Analysis – 5th Street Bridge, Abutment 11, Wingwalls, 24” CIDH

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

TC
EMI

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Files Used for Analysis
---

Path to file locations: C:\Users\t.ke\Documents\13-121 - Dokken, 5th Street Bridge PSR PR\DFR\Analysis\20160927Abut_wingwal_piles_LP_pin\5th_Anut11\
Name of input data file: P11.lpd
Name of output file: P11.lpo
Name of plot output file: P11.lpp
Name of runtime file: P11.lpr

---
Time and Date of Analysis
---

Date: September 27, 2016 Time: 17:10:21

---
Problem Title
---

5th Street Bridge, Abut 11NS RW, 24"CIDH (pm_avg=0.60), LQ

---
Program Options
---

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 300
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 20

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Pile Structural Properties and Geometry

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Pile Length = 720.00 in

Depth of ground surface below top of pile = -24.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

| Point No. | Point Depth in | Pile Diameter in | Moment of Inertia in**4 | Pile Area Sq.in | Modulus of Elasticity lbs/Sq.in |
|---|---|---|---|---|---|
| 1 | 0.0000 | 24.00000000 | 8143.0000 | 452.0000 | 3420000. |
| 2 | 960.0000 | 24.00000000 | 8143.0000 | 452.0000 | 3420000. |

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Soil and Rock Layering Information

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The soil profile is modelled using 7 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = -24.000 in
Distance from top of pile to bottom of layer = 108.000 in
p-y subgrade modulus k for top of soil layer = 70.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 70.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 108.000 in
Distance from top of pile to bottom of layer = 168.000 in
p-y subgrade modulus k for top of soil layer = 45.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 45.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 168.000 in
Distance from top of pile to bottom of layer = 192.000 in
p-y subgrade modulus k for top of soil layer = 10.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 10.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 192.000 in
Distance from top of pile to bottom of layer = 408.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 408.000 in
Distance from top of pile to bottom of layer = 528.000 in
p-y subgrade modulus k for top of soil layer = 50.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 50.000 lbs/in**3

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 528.000 in
Distance from top of pile to bottom of layer = 1368.000 in

Layer 7 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 1368.000 in
Distance from top of pile to bottom of layer = 1992.000 in
p-y subgrade modulus k for top of soil layer = 118.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 118.000 lbs/in**3

(Depth of lowest layer extends 1272.00 in below pile tip)

---

Effective Unit Weight of Soil vs. Depth

---

Effective unit weight of soil with depth defined using 14 points

| Point No. | Depth X in | Eff. Unit Weight lbs/in**3 |
|---|---|---|
| 1 | -24.00 | 0.06366 |
| 2 | 108.00 | 0.06266 |
| 3 | 108.00 | 0.06366 |
| 4 | 168.00 | 0.06366 |
| 5 | 168.00 | 0.06076 |
| 6 | 192.00 | 0.06076 |
| 7 | 192.00 | 0.02466 |
| 8 | 408.00 | 0.02466 |
| 9 | 408.00 | 0.03333 |
| 10 | 528.00 | 0.03333 |
| 11 | 528.00 | 0.03623 |
| 12 | 1368.00 | 0.03623 |
| 13 | 1368.00 | 0.03912 |
| 14 | 1992.00 | 0.03912 |

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Shear Strength of Soils

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Shear strength parameters with depth defined using 14 points

| Point No. | Depth X in | Cohesion c lbs/in**2 | Angle of Friction Deg. | E50 or k_rm | RQD % |
|---|---|---|---|---|---|
| 1 | -24.000 | 0.00000 | 32.00 | ------ | ------ |
| 2 | 108.000 | 0.00000 | 32.00 | ------ | ------ |
| 3 | 108.000 | 0.00000 | 30.00 | ------ | ------ |
| 4 | 168.000 | 0.00000 | 30.00 | ------ | ------ |
| 5 | 168.000 | 0.00000 | 28.00 | ------ | ------ |
| 6 | 192.000 | 0.00000 | 28.00 | ------ | ------ |
| 7 | 192.000 | 2.77780 | 0.00 | 0.01500 | 0.0 |
| 8 | 408.000 | 2.77780 | 0.00 | 0.01500 | 0.0 |
| 9 | 408.000 | 0.00000 | 32.00 | ------ | ------ |
| 10 | 528.000 | 0.00000 | 32.00 | ------ | ------ |
| 11 | 528.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 12 | 1368.000 | 27.77780 | 0.00 | 0.00500 | 0.0 |
| 13 | 1368.000 | 0.00000 | 38.00 | ------ | ------ |
| 14 | 1992.000 | 0.00000 | 38.00 | ------ | ------ |

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

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p-y Modification Factors

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Distribution of p-y multipliers with depth defined using 2 points

| Point No. | Depth X in | p-mult | y-mult |
|---|---|---|---|
| 1 | 0.000 | 0.6000 | 1.0000 |
| 2 | 720.000 | 0.6000 | 1.0000 |

---

Loading Type

---

Static loading criteria was used for computation of p-y curves.

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Pile-head Loading and Pile-head Fixity Conditions

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Number of loads specified = 4

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.250 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.500 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 1.000 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

Load Case Number 4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 2.000 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 400000.000 lbs

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 0.250000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.250000 | 0.0000 | 18966.3894 | -0.0031124 | 884.9558 | -192.1659 | 922.3962 |
| 48.000 | 0.112007 | 662190. | 5529.0775 | -0.0024450 | 1860.7981 | -304.7328 | 6529.5598 |
| 96.000 | 0.023995 | 660077. | -5526.1713 | -0.0012249 | 1857.6833 | -120.6371 | 12066.4662 |
| 144.000 | -0.011450 | 359754. | -6192.9190 | -0.0003405 | 1415.1105 | 56.0692 | 11752.5726 |
| 192.000 | -0.016422 | 132353. | -3896.2961 | 6.8709E-05 | 1079.9991 | 47.3975 | 6926.9557 |
| 240.000 | -0.009883 | -4784.9500 | -1768.7906 | 0.0001642 | 892.0071 | 40.0274 | 9720.5974 |
| 288.000 | -0.003107 | -50795.7234 | -138.4099 | 0.0001049 | 959.8113 | 27.2424 | 21040.5283 |
| 336.000 | -9.37E-05 | -33128.1593 | 787.4945 | 2.5912E-05 | 933.7753 | 4.7508 | 121645. |
| 384.000 | 0.000265 | -3763.1967 | 312.5079 | -2.3161E-06 | 890.5014 | -13.4337 | 121645. |
| 432.000 | 0.000115 | 930.0629 | 14.5379 | -2.8132E-06 | 886.3263 | -0.9544159 | 19986.3271 |
| 480.000 | 2.21E-05 | 896.2106 | -11.5125 | -1.0582E-06 | 886.2765 | -0.2161002 | 23442.3274 |
| 528.000 | -1.35E-07 | 230.0142 | -14.7168 | -6.3962E-08 | 885.2947 | 0.1685886 | 3000002. |
| 576.000 | -1.96E-08 | -13.8611 | 0.5868180 | 5.4506E-09 | 884.9762 | 0.0244604 | 3000002. |
| 624.000 | 2.78E-09 | 0.7205418 | -0.0113840 | -3.8506E-10 | 884.9568 | -0.0034779 | 3000002. |
| 672.000 | -2.47E-10 | -0.0300603 | -0.0009261 | 2.3621E-11 | 884.9558 | 0.0003091 | 3000002. |
| 720.000 | 2.81E-11 | 0.0000 | 0.0000 | -8.9161E-13 | 884.9558 | -3.5093E-05 | 1500001. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.25000000 in
Computed slope at pile head = -0.00311236
Maximum bending moment = 732062.05084 lbs-in
Maximum shear force = 18966.38938 lbs
Depth of maximum bending moment = 69.60000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 13
Number of zero deflection points = 6

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 0.500000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.500000 | 0.0000 | 30901.9992 | -0.0059674 | 884.9558 | -243.5240 | 584.4575 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 48.000 | 0.232937 | 1174064. | 11954.7951 | -0.0048192 | 2615.1251 | -485.6410 | 5003.6550 |
| 96.000 | 0.055243 | 1262684. | -9369.1430 | -0.0025618 | 2745.7203 | -274.8663 | 11941.4036 |
| 144.000 | -0.022478 | 718196. | -11577.3459 | -0.0008378 | 1943.3311 | 110.0196 | 11747.1517 |
| 192.000 | -0.039395 | 311883. | -6704.7858 | 1.7701E-05 | 1344.5654 | 63.4401 | 3864.8774 |
| 240.000 | -0.029605 | 57924.6192 | -3760.8948 | 0.0003169 | 970.3169 | 57.6805 | 4675.9887 |
| 288.000 | -0.014127 | -66683.0067 | -1274.7590 | 0.0002922 | 983.2237 | 45.0791 | 7658.4691 |
| 336.000 | -0.003439 | -86300.2437 | 499.7398 | 0.0001477 | 1012.1328 | 28.1588 | 19652.4280 |
| 384.000 | 0.000570 | -41716.0977 | 1021.9213 | 3.2761E-05 | 946.4310 | -15.4324 | 65006.1034 |
| 432.000 | 0.000957 | -9770.2422 | 422.7666 | -7.5798E-06 | 899.3538 | -7.9720 | 19986.3071 |
| 480.000 | 0.000412 | 2745.6505 | 122.4775 | -1.1561E-05 | 889.0019 | -4.0266 | 23442.3239 |
| 528.000 | 2.97E-05 | 5829.1703 | -14.2636 | -3.5291E-06 | 893.5460 | -37.1152 | 3000002. |
| 576.000 | -2.41E-06 | -214.1011 | -13.7954 | 2.0579E-07 | 885.2713 | 3.0154 | 3000002. |
| 624.000 | 1.65E-07 | 2.3873 | 1.6510 | -1.0260E-08 | 884.9593 | -0.2063893 | 3000002. |
| 672.000 | -9.92E-09 | 0.5470432 | -0.1371157 | 3.9244E-10 | 884.9566 | 0.0124037 | 3000002. |
| 720.000 | 1.78E-09 | 0.0000 | 0.0000 | 8.9479E-11 | 884.9558 | -0.0022236 | 1500001. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.50000000 in
Computed slope at pile head = -0.00596735
Maximum bending moment = 1358490. lbs-in
Maximum shear force = 30901.99921 lbs
Depth of maximum bending moment = 74.40000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 15
Number of zero deflection points = 6

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 1.000000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 1.000000 | 0.0000 | 44113.6136 | -0.0110691 | 884.9558 | -252.5432 | 303.0519 |
| 48.000 | 0.497950 | 1872191. | 23499.4241 | -0.0093064 | 3643.9254 | -572.7848 | 2760.6832 |
| 96.000 | 0.141056 | 2313960. | -11986.4414 | -0.0054351 | 4294.9417 | -656.3008 | 11166.6506 |
| 144.000 | -0.034418 | 1438100. | -20766.6526 | -0.0021381 | 3004.2239 | 168.3251 | 11737.3233 |
| 192.000 | -0.088942 | 724381. | -11550.3597 | -0.0003363 | 1952.4455 | 83.2220 | 2245.6653 |
| 240.000 | -0.082064 | 263473. | -7558.5237 | 0.0004898 | 1273.2246 | 81.0204 | 2369.4846 |
| 288.000 | -0.052171 | -21663.3864 | -3915.6545 | 0.0006736 | 916.8802 | 69.6681 | 3204.9314 |
| 336.000 | -0.022965 | -147008. | -954.4372 | 0.0005073 | 1101.5948 | 53.0007 | 5538.9672 |
| 384.000 | -0.005051 | -146495. | 1106.2388 | 0.0002395 | 1100.8394 | 32.0033 | 15206.3347 |
| 432.000 | 0.001269 | -74050.7148 | 1610.0749 | 4.5412E-05 | 994.0812 | -10.5648 | 19986.2917 |
| 480.000 | 0.001339 | -12875.4951 | 924.0182 | -2.4804E-05 | 903.9298 | -13.0757 | 23442.2909 |
| 528.000 | 0.000147 | 21339.6741 | 359.6623 | -1.5110E-05 | 916.4031 | -183.3965 | 3000002. |
| 576.000 | -1.10E-05 | -626.2784 | -83.4200 | 8.3107E-07 | 885.8787 | 13.7896 | 3000002. |
| 624.000 | 7.13E-07 | -9.4868 | 8.2712 | -3.8134E-08 | 884.9697 | -0.8913415 | 3000002. |
| 672.000 | -4.05E-08 | 3.5055 | -0.6324530 | 1.1999E-09 | 884.9609 | 0.0506551 | 3000002. |
| 720.000 | 7.74E-09 | 0.0000 | 0.0000 | 4.5626E-10 | 884.9558 | -0.0096722 | 1500001. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection = 1.00000000 in
Computed slope at pile head = -0.01106911
Maximum bending moment = 2378308. lbs-in
Maximum shear force = 44113.61358 lbs
Depth of maximum bending moment = 84.00000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 17
Number of zero deflection points = 6

---

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 4

---

Pile-head boundary conditions are Displacement and Moment (Pile-head Condition Type 4)
Specified deflection at pile head = 2.000000 in
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 400000.000 lbs

| Depth X in | Deflect. y in | Moment M lbs-in | Shear V lbs | Slope S Rad. | Total Stress lbs/in**2 | Soil Res. p lbs/in | Es*h F/L lbs/in |
|---|---|---|---|---|---|---|---|
| 0.000 | 2.000 | 0.0000 | 59131.6984 | -0.0201001 | 884.9558 | -252.7165 | 151.6299 |
| 48.000 | 1.077 | 2760494. | 38448.4325 | -0.0175694 | 4952.9811 | -579.1232 | 1290.8404 |
| 96.000 | 0.371569 | 3945949. | -6450.9695 | -0.0114623 | 6699.9364 | -1225.5271 | 7915.8041 |
| 144.000 | -0.025221 | 2842074. | -34371.7090 | -0.0054056 | 5073.2018 | 123.4260 | 11745.2580 |
| 192.000 | -0.186168 | 1636583. | -19838.8154 | -0.0016449 | 3296.7203 | 106.4560 | 1372.3884 |
| 240.000 | -0.209392 | 819684. | -14553.6641 | 0.0004412 | 2092.8898 | 110.7112 | 1268.9460 |
| 288.000 | -0.163242 | 227715. | -9414.0731 | 0.0013108 | 1220.5294 | 101.8954 | 1498.0716 |
| 336.000 | -0.096697 | -139057. | -4890.4751 | 0.0013562 | 1089.8789 | 85.5767 | 2123.9998 |
| 384.000 | -0.040272 | -305623. | -1283.5992 | 0.0009470 | 1335.3389 | 63.9096 | 3808.6525 |
| 432.000 | -0.007999 | -290520. | 2861.4582 | 0.0004011 | 1313.0833 | 66.6101 | 19984.9118 |
| 480.000 | 0.001381 | -123526. | 3615.9174 | 3.8845E-05 | 1066.9911 | -13.4930 | 23442.2886 |
| 528.000 | 0.000406 | 34213.9737 | 2424.9276 | -3.4059E-05 | 935.3755 | -507.2992 | 3000002. |
| 576.000 | -2.76E-05 | -297.2895 | -281.4604 | 1.6811E-06 | 885.3939 | 34.4524 | 3000002. |
| 624.000 | 1.63E-06 | -96.9999 | 23.2549 | -6.3723E-08 | 885.0987 | -2.0384 | 3000002. |
| 672.000 | -8.38E-08 | 12.3646 | -1.5996 | 8.6150E-10 | 884.9740 | 0.1047620 | 3000002. |
| 720.000 | 1.79E-08 | 0.0000 | 0.0000 | 1.3090E-09 | 884.9558 | -0.0223824 | 1500001. |

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 4:

Pile-head deflection = 2.00000000 in
Computed slope at pile head = -0.02010012
Maximum bending moment = 3946735. lbs-in
Maximum shear force = 59131.69836 lbs
Depth of maximum bending moment = 93.60000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 14
Number of zero deflection points = 6

---

Summary of Pile Response(s)

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Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

| Load Type | Pile-Head Condition 1 | Pile-Head Condition 2 | Axial Load lbs | Pile-Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|---|---|---|
| 4 | y= 0.250000 | M= 0.000 | 400000. | 0.2500000 | 732062. | 18966.3894 |
| 4 | y= 0.500000 | M= 0.000 | 400000. | 0.5000000 | 1358490. | 30901.9992 |
| 4 | y= 1.000000 | M= 0.000 | 400000. | 1.0000000 | 2378308. | 44113.6136 |
| 4 | y= 2.000 | M= 0.000 | 400000. | 2.0000 | 3946735. | 59131.6984 |

---

Pile-head Deflection vs. Pile Length

---

Boundary Condition Type 4, Deflection and Moment

Deflection = 0.25000 in
Moment = 0. in-lbs
Axial Load = 400000. lbs

| Pile Length in | Pile Head Deflection in | Maximum Moment in-lbs | Maximum Shear lbs |
|---|---|---|---|
| 720.000 | 0.25000000 | 732062.05084 | 18966.38938 |
| 684.000 | 0.25000000 | 732607.74232 | 18974.64307 |
| 648.000 | 0.25000000 | 732742.21962 | 18978.13212 |
| 612.000 | 0.25000000 | 732575.19977 | 18977.38091 |
| 576.000 | 0.25000000 | 732933.44984 | 18982.15392 |
| 540.000 | 0.25000000 | 732596.01886 | 18976.48948 |
| 504.000 | 0.25000000 | 733076.60382 | 18984.40889 |
| 468.000 | 0.25000000 | 732703.41488 | 18977.74435 |
| 432.000 | 0.25000000 | 732609.71391 | 18977.64536 |
| 396.000 | 0.25000000 | 732785.13692 | 18981.08030 |

The analysis ended normally.

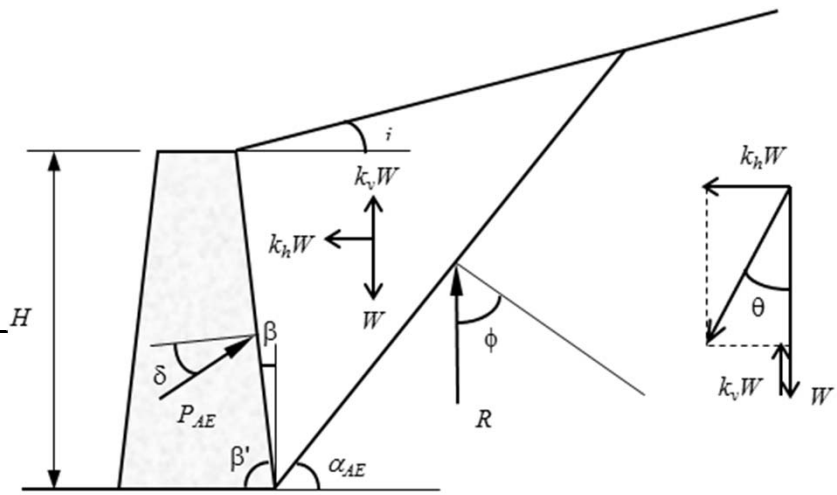
# Lateral Earth Pressures and Slope Stability

## Active Earth Pressure (Coulomb and Mononobe-Okabe Methods)

| | | | | | |
|---|---|---|---|---|---|
| Project: | 5th Street Bridge | Project Number: | 13-121 | | |
| Location: | Yuba City | Calculations by: | AZ | Date: | 9/12/2016 |
| | | Checked by: | TK | Date: | 9/12/2016 |

($k_h$ = 1/2 PGA of 0.24 g)

| | | |
|---|---|---|
| $\phi$ = | 34 | deg |
| $k_h$ = | 0.120 | |
| $k_v$ = | 0 | |
| $\beta$ = | 0 | deg |
| $i$ = | 0 | deg |
| $H$ = | 25 | ft |
| $\gamma$ = | 125 | pcf |
| $\delta$ = | 0 | deg |
| $\beta'$ = | 90 | deg |
| $\theta$ = | 6.843 | deg |




Active Earth Pressure :

Static (Coulumb):

| | | |
|---|---|---|
| $K_A$ = | 0.283 | |
| $P_A$ = | 11,044 | lbs |
| $K_{AH}$ = | 0.283 | |
| $P_{AH}$ = | 11,044 | lbs |
| $EFP$ = | 35.3 | pcf |

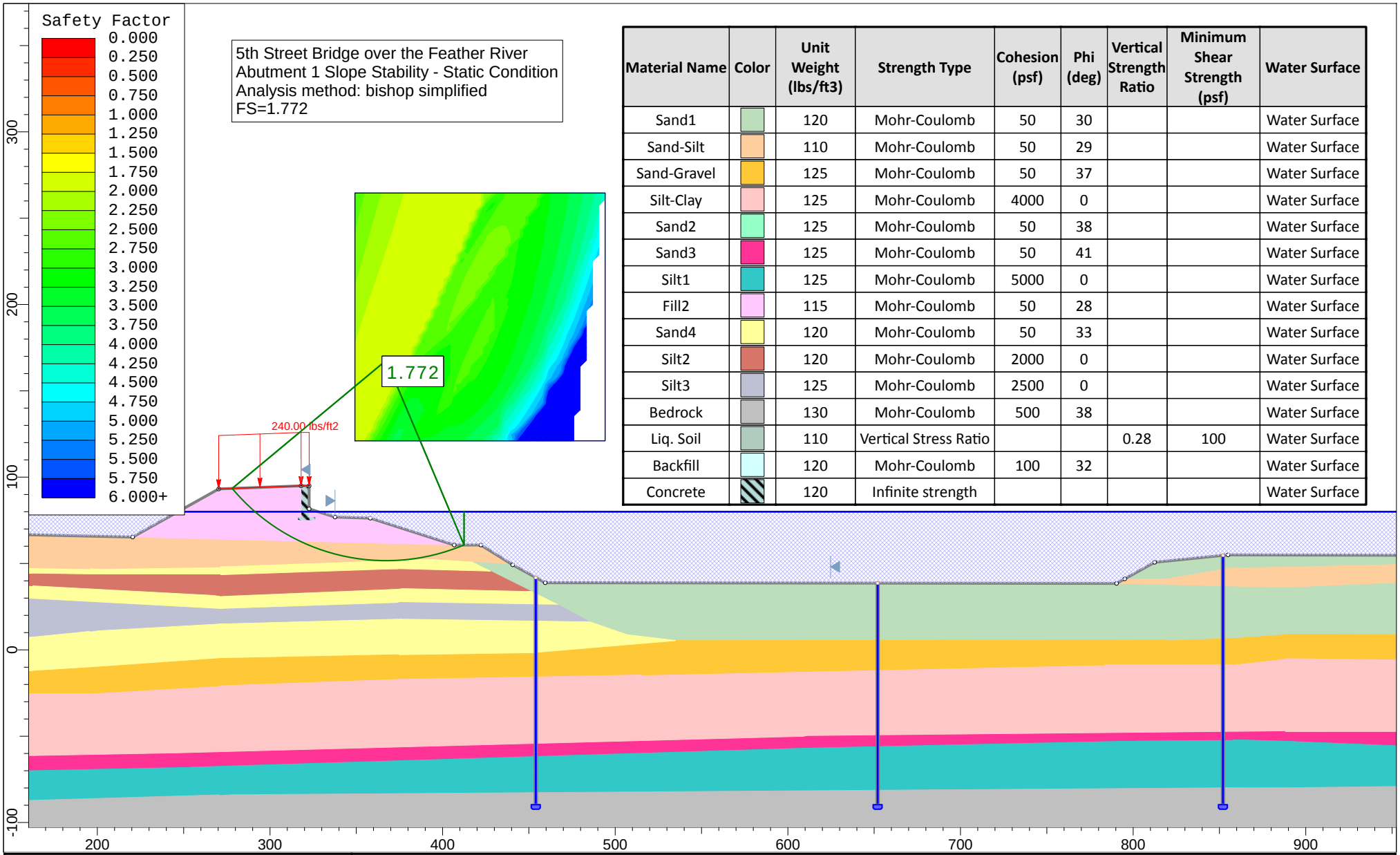
Seismic (Mononobe-Okabe):

| | | |
|---|---|---|
| $K_{AE}$ = | 0.354 | |
| $P_{AE}$ = | 13,813 | lbs |
| $K_{AEH}$ = | 0.354 | |
| $P_{AEH}$ = | 13,813 | lbs |
| $EFP_E$ = | 44.2 | pcf |
| $\Delta EFP_E$ = | 8.9 | pcf |

Approximate Failure Plane Angle:

Static: $\alpha_A$ = 62 degrees

Seismic: $\alpha_{AE}$ = 57 degrees

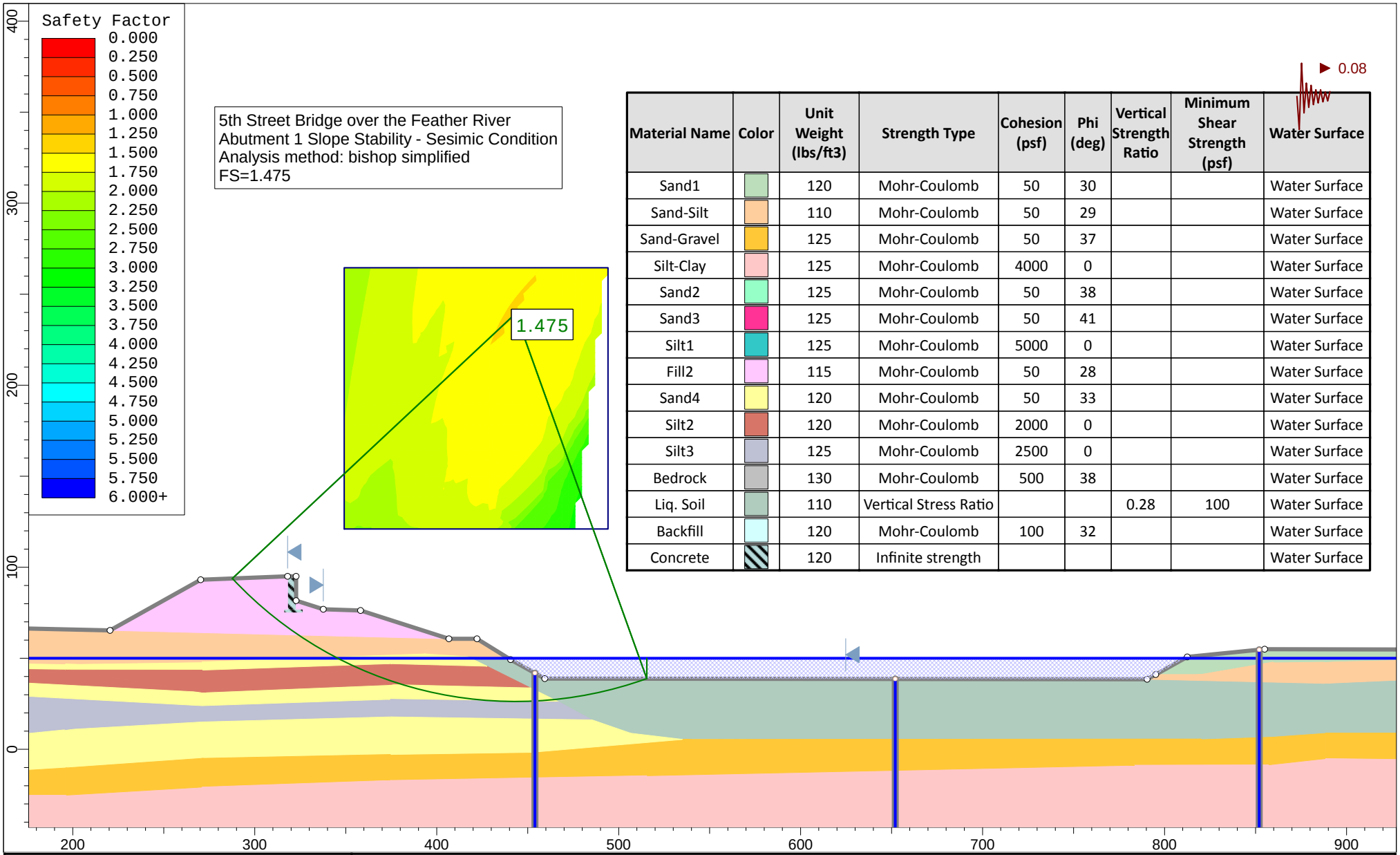



| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Vertical Strength Ratio | Minimum Shear Strength (psf) | Water Surface |
|---|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | | | Water Surface |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | | | Water Surface |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | | | Water Surface |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | | | Water Surface |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | | | Water Surface |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | | | Water Surface |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | | | Water Surface |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | | | Water Surface |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | | | Water Surface |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | | | Water Surface |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | | | Water Surface |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | | | Water Surface |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | 0.28 | 100 | Water Surface |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | | | Water Surface |
| Concrete | | 120 | Infinite strength | | | | | Water Surface |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | |
|---|---|
| Project | 5th Street Bridge over the Feather River |
| Analysis Description | Abutment 1 Slope Stability - Static Condition |
| Drawn By | AZ |
| Scale | 1:922 |
| Company | |
| Date | |
| File Name | Abut 1 circular.slim |

SLIDEINTERPRET 7.017

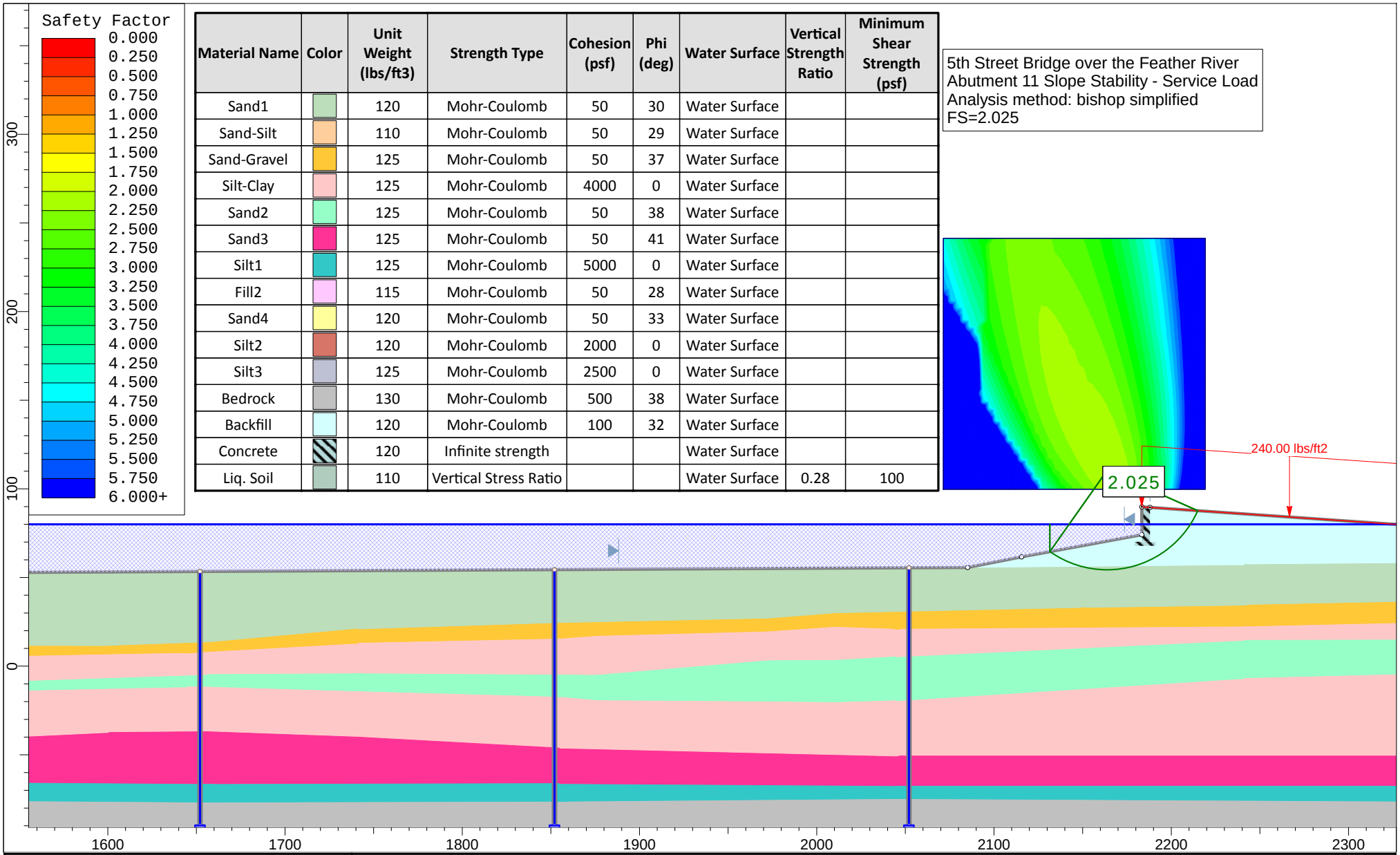



| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Vertical Strength Ratio | Minimum Shear Strength (psf) | Water Surface |
|---|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | | | Water Surface |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | | | Water Surface |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | | | Water Surface |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | | | Water Surface |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | | | Water Surface |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | | | Water Surface |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | | | Water Surface |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | | | Water Surface |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | | | Water Surface |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | | | Water Surface |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | | | Water Surface |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | | | Water Surface |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | 0.28 | 100 | Water Surface |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | | | Water Surface |
| Concrete | | 120 | Infinite strength | | | | | Water Surface |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | | | |
|---|---|---|---|
| Project | 5th Street Bridge over the Feather River | | |
| Analysis Description | Abutment 1 Slope Stability - Sesimic Condition | | |
| Drawn By | AZ | Scale 1:875 | Company |
| Date | | | File Name Abut 1 EQ circular.slim |

SLIDEINTERPRET 7.017



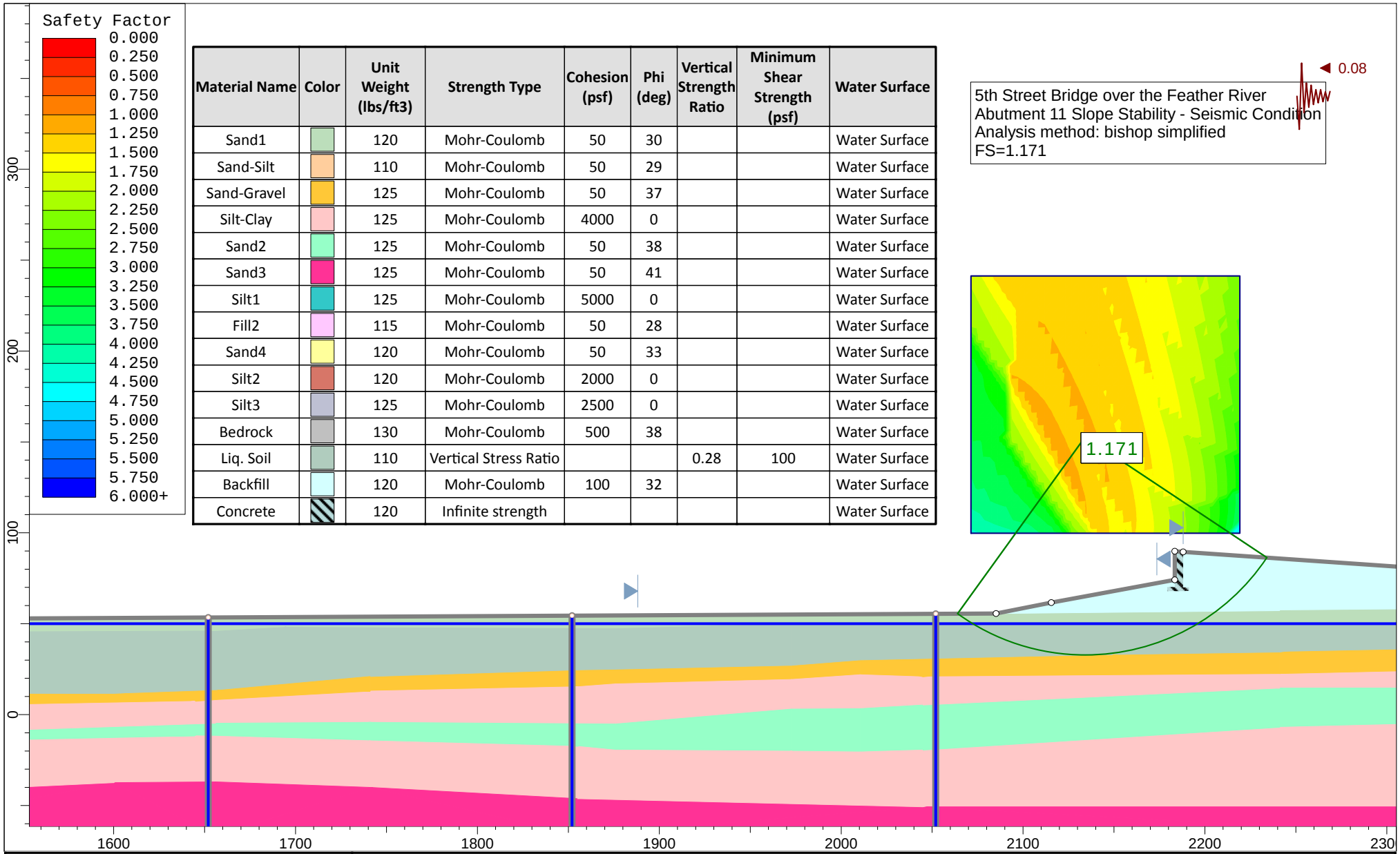

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Vertical Strength Ratio | Minimum Shear Strength (psf) |
|---|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | Water Surface | | |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | Water Surface | | |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | Water Surface | | |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | Water Surface | | |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | Water Surface | | |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | Water Surface | | |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | Water Surface | | |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | Water Surface | | |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | Water Surface | | |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | Water Surface | | |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | Water Surface | | |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | Water Surface | | |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | Water Surface | | |
| Concrete | | 120 | Infinite strength | | | Water Surface | | |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | Water Surface | 0.28 | 100 |

5th Street Bridge over the Feather River
Abutment 11 Slope Stability - Service Load
Analysis method: bishop simplified
FS=2.025

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | | | |
|---|---|---|---|
| Project | 5th Street Bridge over the Feather River | | |
| Analysis Description | Abutment 11 Slope Stability - Service Load | | |
| Drawn By: AZ | Scale: 1:898 | Company | |
| Date | | File Name: Abut 11 static circular.slim | |

SLIDEINTERPRET 7.017

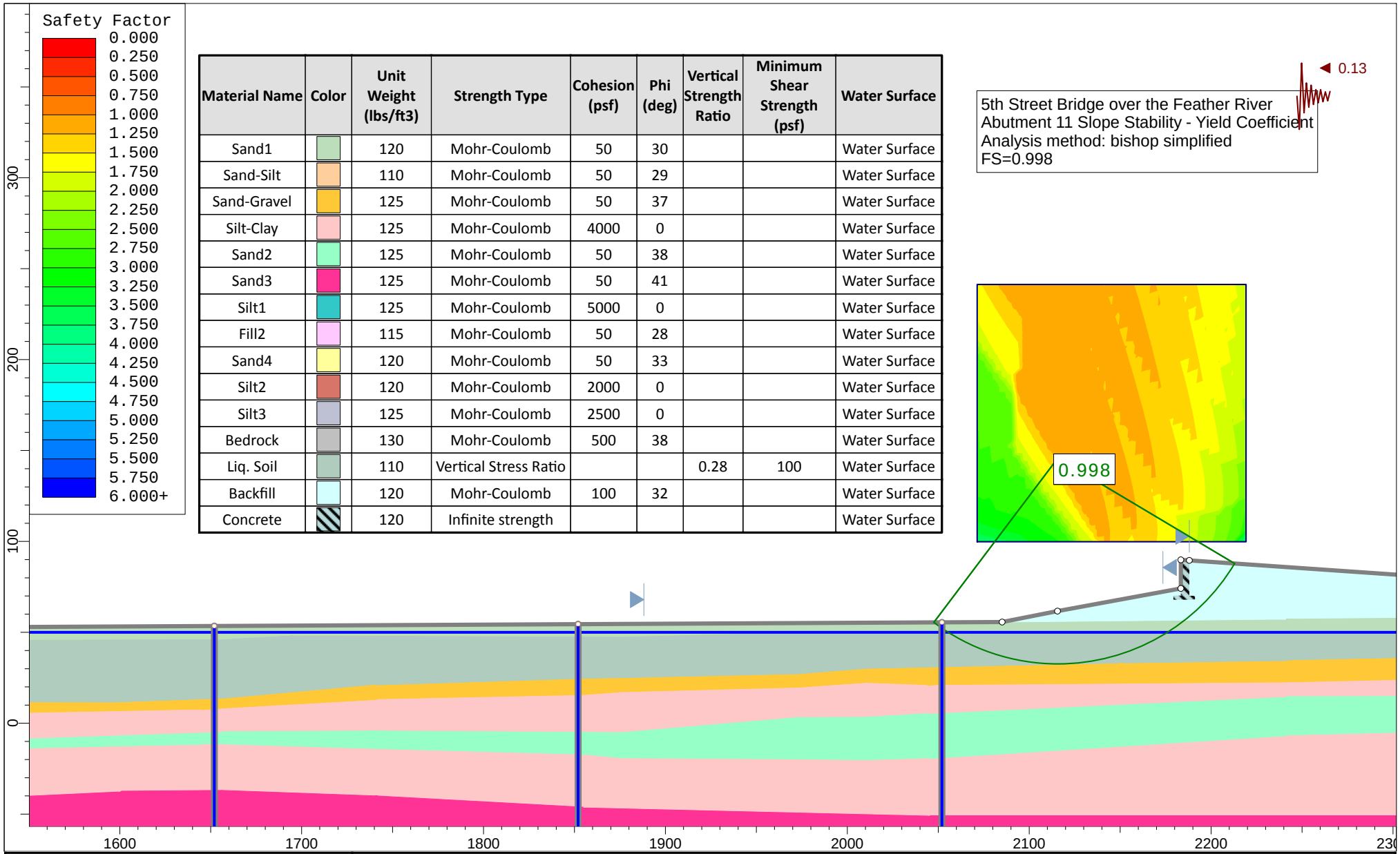



| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Vertical Strength Ratio | Minimum Shear Strength (psf) | Water Surface |
|---|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | | | Water Surface |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | | | Water Surface |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | | | Water Surface |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | | | Water Surface |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | | | Water Surface |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | | | Water Surface |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | | | Water Surface |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | | | Water Surface |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | | | Water Surface |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | | | Water Surface |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | | | Water Surface |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | | | Water Surface |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | 0.28 | 100 | Water Surface |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | | | Water Surface |
| Concrete | | 120 | Infinite strength | | | | | Water Surface |

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | | | |
|---|---|---|---|
| Project | 5th Street Bridge over the Feather River | | |
| Analysis Description | Abutment 11 Slope Stability - Seismic Condition | | |
| Drawn By | AZ | Scale 1:875 | Company |
| Date | | | File Name Abut 11 EQ circular.slim |

SLIDEINTERPRET 7.017




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Vertical Strength Ratio | Minimum Shear Strength (psf) | Water Surface |
|---|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | | | Water Surface |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | | | Water Surface |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | | | Water Surface |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | | | Water Surface |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | | | Water Surface |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | | | Water Surface |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | | | Water Surface |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | | | Water Surface |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | | | Water Surface |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | | | Water Surface |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | | | Water Surface |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | | | Water Surface |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | 0.28 | 100 | Water Surface |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | | | Water Surface |
| Concrete | | 120 | Infinite strength | | | | | Water Surface |

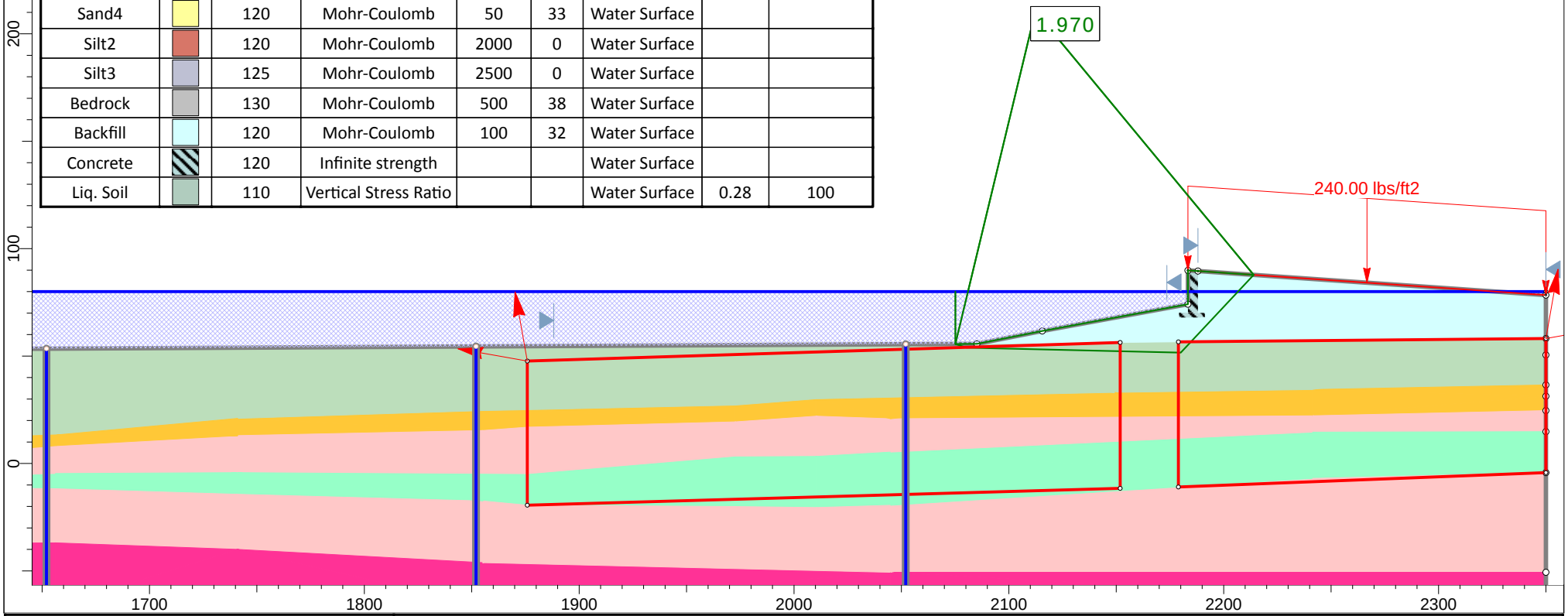
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | | | |
|---|---|---|---|
| Project | 5th Street Bridge over the Feather River | | |
| Analysis Description | Abutment 11 Slope Stability - Yield Coefficient | | |
| Drawn By | AZ | Scale 1:875 | Company |
| Date | | | File Name Abut 11 Yield Coeff circular.slim |

SLIDEINTERPRET 7.017

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Vertical Strength Ratio | Minimum Shear Strength (psf) |
|---|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | Water Surface | | |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | Water Surface | | |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | Water Surface | | |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | Water Surface | | |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | Water Surface | | |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | Water Surface | | |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | Water Surface | | |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | Water Surface | | |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | Water Surface | | |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | Water Surface | | |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | Water Surface | | |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | Water Surface | | |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | Water Surface | | |
| Concrete | | 120 | Infinite strength | | | Water Surface | | |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | Water Surface | 0.28 | 100 |

5th Street Bridge over the Feather River
Abutment 11 Slope Stability - Service Load (Block Failure)
Analysis method: spencer
FS=1.970



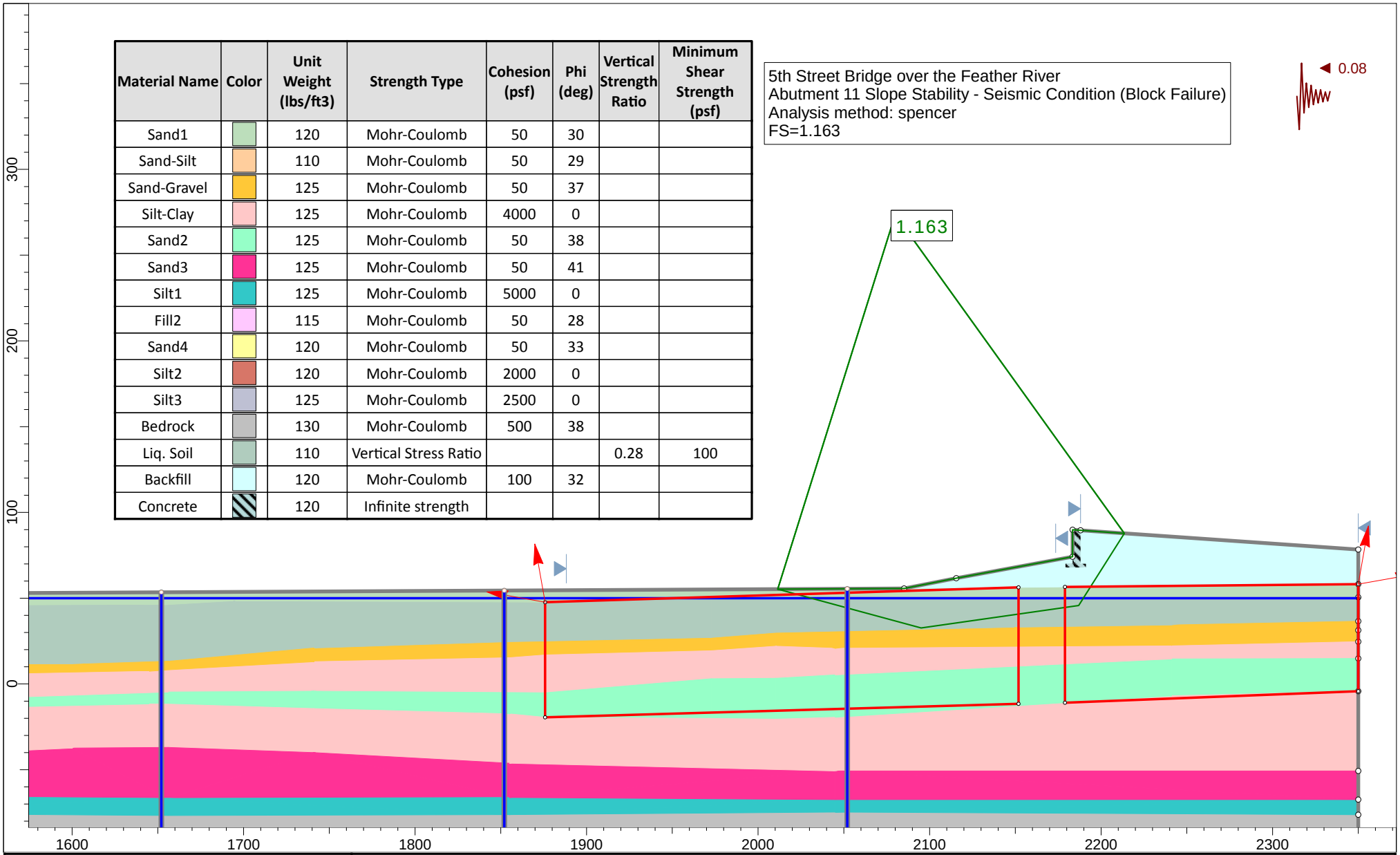

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | |
|---|---|
| Project | 5th Street Bridge over the Feather River |
| Analysis Description | Abutment 11 Slope Stability - Service Load (Block Failure) |
| Drawn By | AZ |
| Scale | 1:830 |
| Company | |
| Date | |
| File Name | Abut 11 static block.slim |

SLIDEINTERPRET 7.017

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Vertical Strength Ratio | Minimum Shear Strength (psf) |
|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | | |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | | |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | | |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | | |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | | |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | | |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | | |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | | |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | | |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | | |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | | |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | | |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | 0.28 | 100 |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | | |
| Concrete | | 120 | Infinite strength | | | | |

5th Street Bridge over the Feather River
Abutment 11 Slope Stability - Seismic Condition (Block Failure)
Analysis method: spencer
FS=1.163



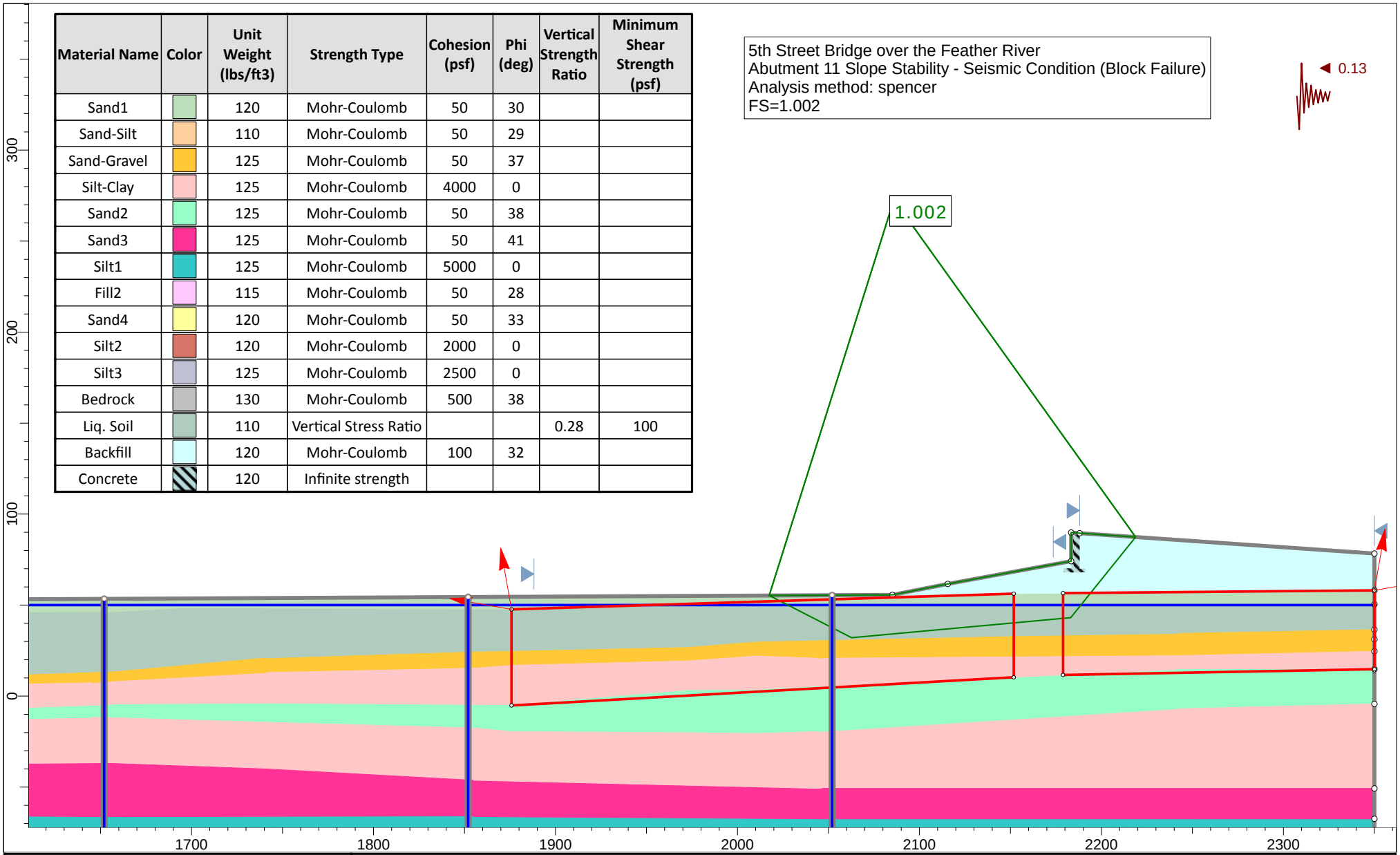

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | |
|---|---|
| Project | 5th Street Bridge over the Feather River |
| Analysis Description | Abutment 11 Slope Stability - Seismic Condition (Block Failure) |
| Drawn By | AZ |
| Scale | 1:928 |
| Company | |
| Date | |
| File Name | Abut 11 seismic block.slim |

SLIDEINTERPRET 7.017

| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Vertical Strength Ratio | Minimum Shear Strength (psf) |
|---|---|---|---|---|---|---|---|
| Sand1 | | 120 | Mohr-Coulomb | 50 | 30 | | |
| Sand-Silt | | 110 | Mohr-Coulomb | 50 | 29 | | |
| Sand-Gravel | | 125 | Mohr-Coulomb | 50 | 37 | | |
| Silt-Clay | | 125 | Mohr-Coulomb | 4000 | 0 | | |
| Sand2 | | 125 | Mohr-Coulomb | 50 | 38 | | |
| Sand3 | | 125 | Mohr-Coulomb | 50 | 41 | | |
| Silt1 | | 125 | Mohr-Coulomb | 5000 | 0 | | |
| Fill2 | | 115 | Mohr-Coulomb | 50 | 28 | | |
| Sand4 | | 120 | Mohr-Coulomb | 50 | 33 | | |
| Silt2 | | 120 | Mohr-Coulomb | 2000 | 0 | | |
| Silt3 | | 125 | Mohr-Coulomb | 2500 | 0 | | |
| Bedrock | | 130 | Mohr-Coulomb | 500 | 38 | | |
| Liq. Soil | | 110 | Vertical Stress Ratio | | | 0.28 | 100 |
| Backfill | | 120 | Mohr-Coulomb | 100 | 32 | | |
| Concrete | | 120 | Infinite strength | | | | |

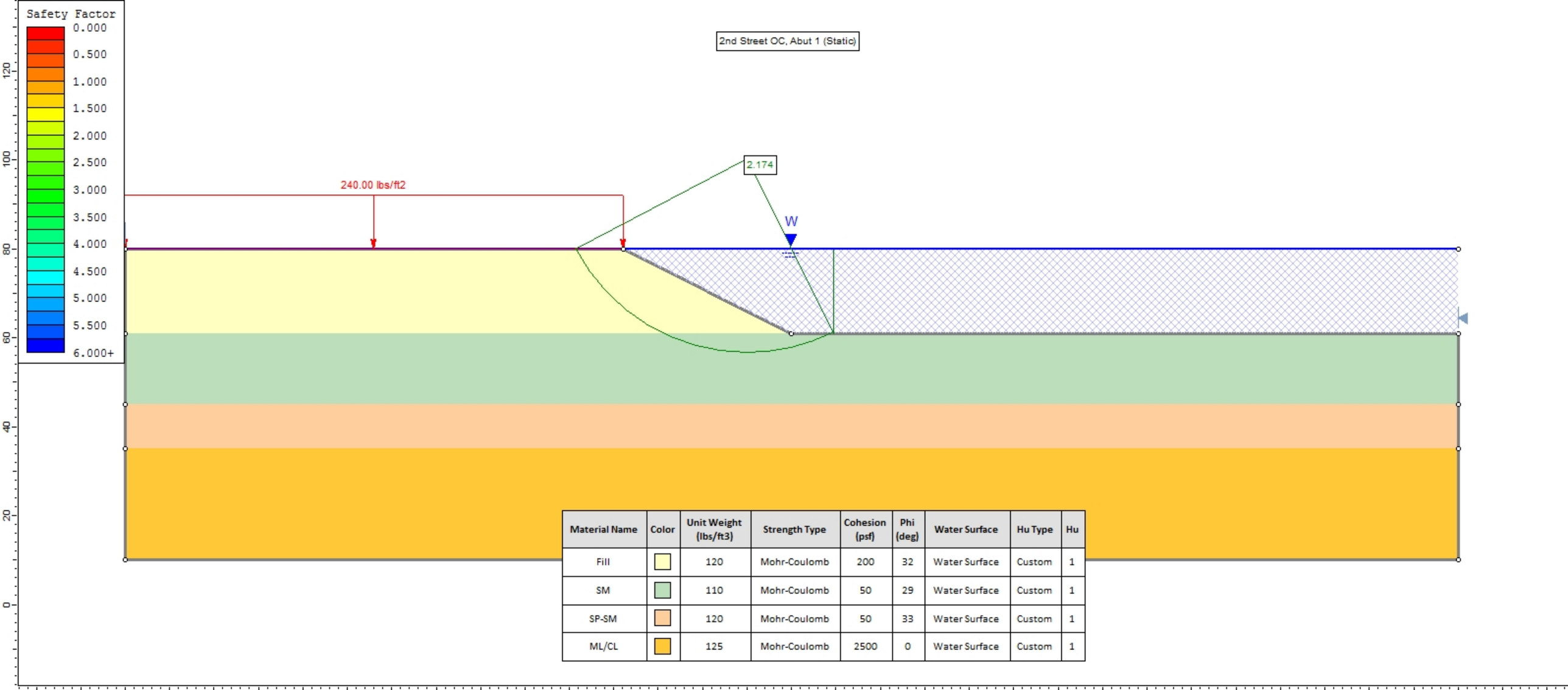
5th Street Bridge over the Feather River
Abutment 11 Slope Stability - Seismic Condition (Block Failure)
Analysis method: spencer
FS=1.002



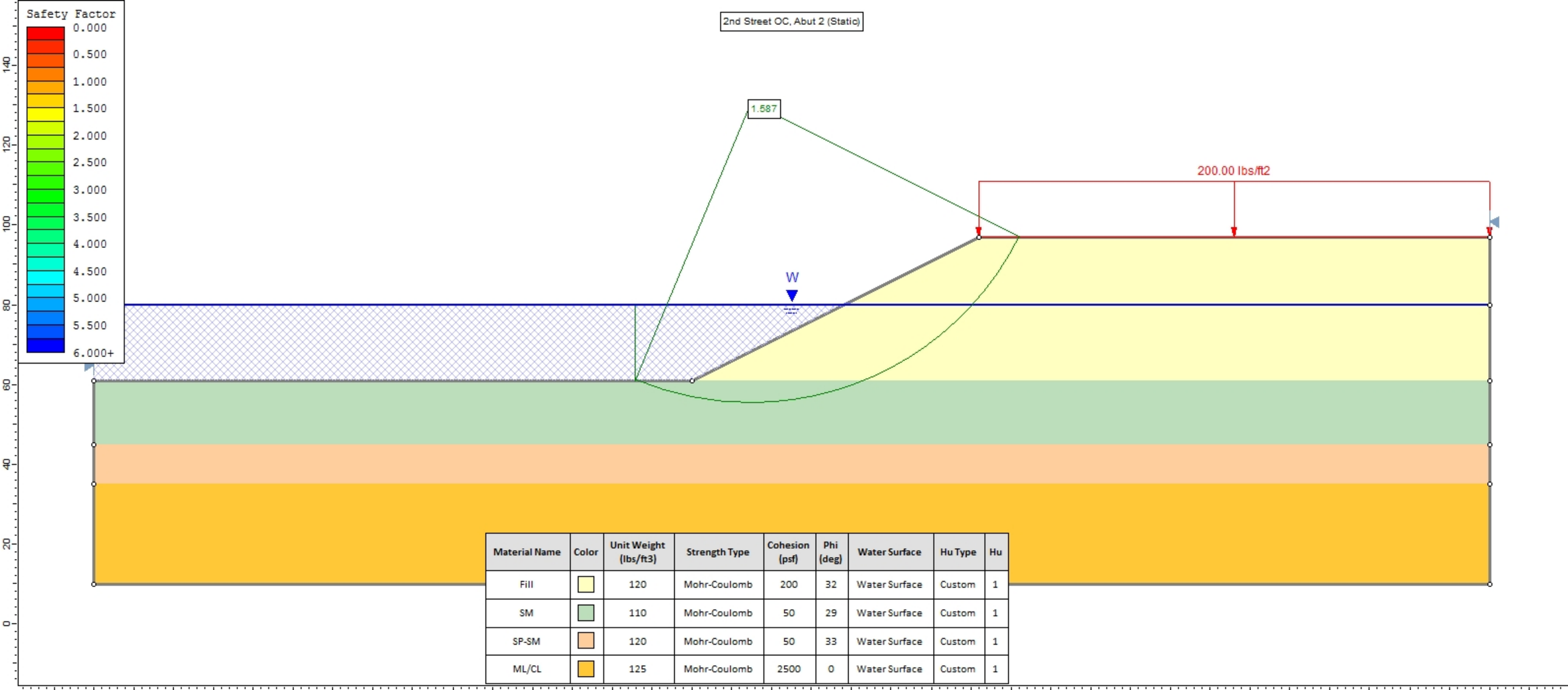

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

| | |
|---|---|
| Project | 5th Street Bridge over the Feather River |
| Analysis Description | Abutment 11 Slope Stability - Seismic Condition (Block Failure) |
| Drawn By | AZ |
| Scale | 1:875 |
| Company | |
| Date | |
| File Name | Abut 11 Yiled Acceleration Block.slim |

SLIDEINTERPRET 7.017




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Fill | | 120 | Mohr-Coulomb | 200 | 32 | Water Surface | Custom | 1 |
| SM | | 110 | Mohr-Coulomb | 50 | 29 | Water Surface | Custom | 1 |
| SP-SM | | 120 | Mohr-Coulomb | 50 | 33 | Water Surface | Custom | 1 |
| ML/CL | | 125 | Mohr-Coulomb | 2500 | 0 | Water Surface | Custom | 1 |

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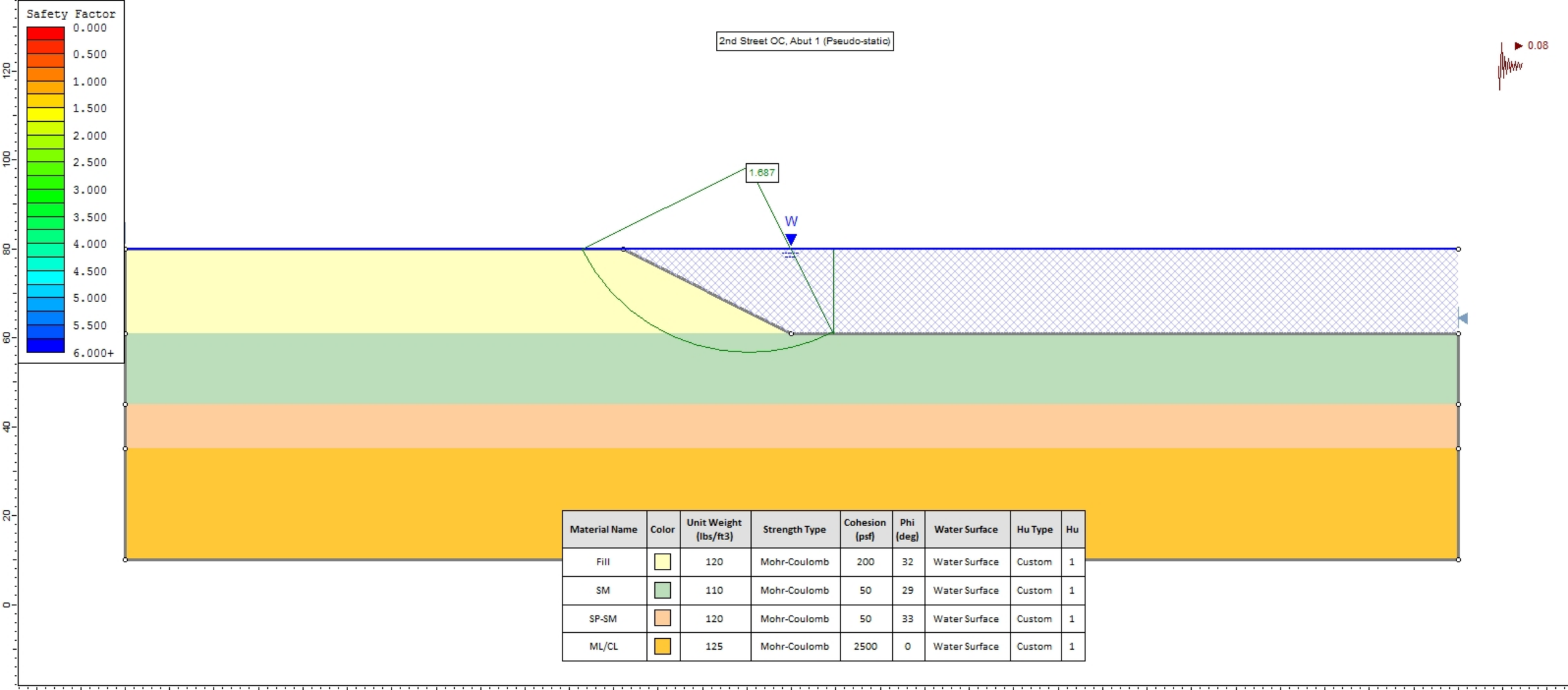
| Fill | | 120 | Mohr-Coulomb | 200 | 32 | Water Surface | Custom | 1 |
| SM | | 110 | Mohr-Coulomb | 50 | 29 | Water Surface | Custom | 1 |
| SP-SM | | 120 | Mohr-Coulomb | 50 | 33 | Water Surface | Custom | 1 |
| ML/CL | | 125 | Mohr-Coulomb | 2500 | 0 | Water Surface | Custom | 1 |

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| Fill | | 120 | Mohr-Coulomb | 200 | 32 | Water Surface | Custom | 1 |
| SM | | 110 | Mohr-Coulomb | 50 | 29 | Water Surface | Custom | 1 |
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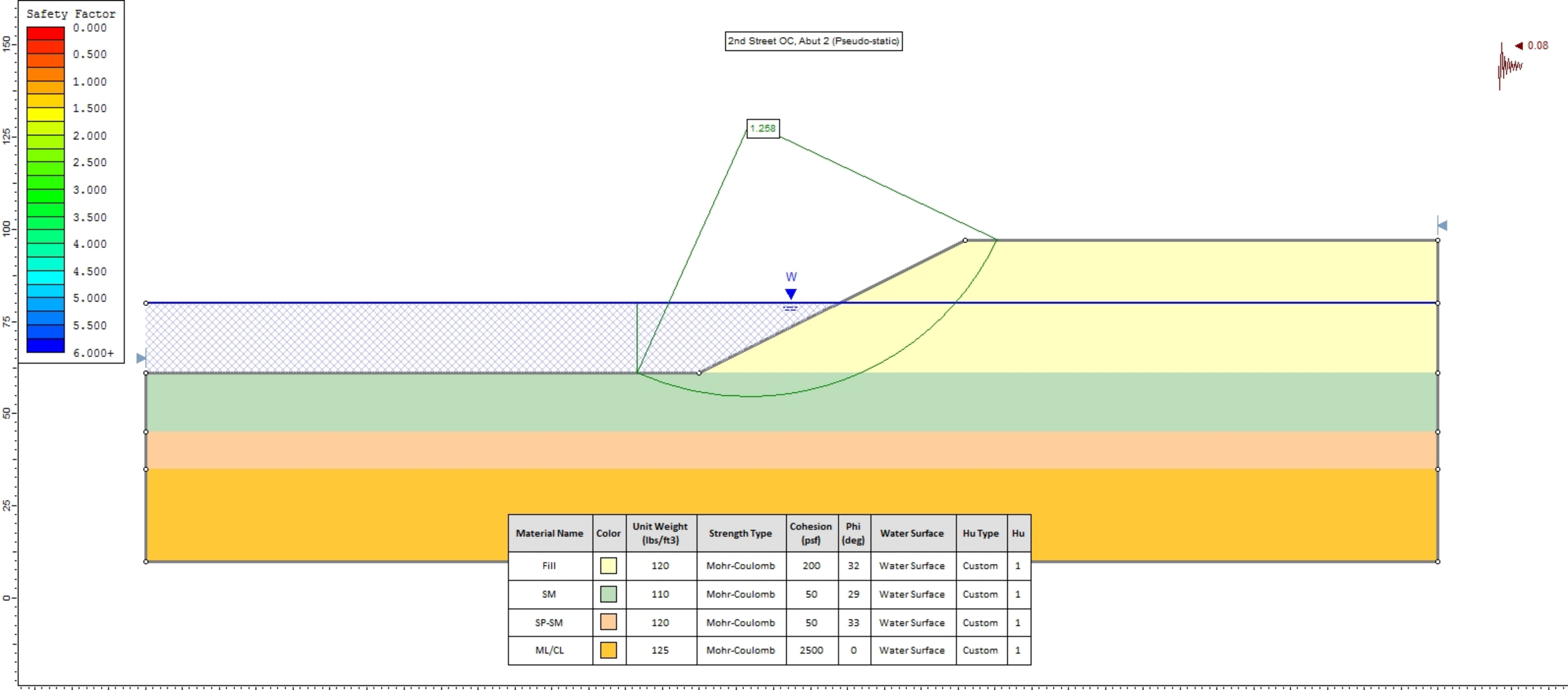
| ML/CL | | 125 | Mohr-Coulomb | 2500 | 0 | Water Surface | Custom | 1 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Fill | | 120 | Mohr-Coulomb | 200 | 32 | Water Surface | Custom | 1 |
| SM | | 110 | Mohr-Coulomb | 50 | 29 | Water Surface | Custom | 1 |
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