November 10, 2026

Mr. Erik Scott, P.E.
Kentucky Transportation Cabinet
Division of Structural Design
Geotechnical Branch
1236 Wilkinson Boulevard
Frankfort, KY 40601-1200

**RE: Geotechnical Roadway Report**
**US-51 Cairo Bridge Replacement**
**Kentucky Roadway Approach**
**Ballard County**
**Item No.: 01-1140.20**
**Project ID: R-015-2025**

# Introduction

An abbreviated geotechnical roadway report has been completed for the Kentucky roadway section of the US-51 Cairo Bridge Replacement project. The purpose of this project is to meet the transportation needs of the region while improving the reliability of the connection between Kentucky and Illinois. This roadway section is in Ballard County, Kentucky approximately 4 miles northwest of downtown Wickliffe, Kentucky. A Project Location Map is provided within Attachment A.

This geotechnical roadway report summarizes the results of the analysis performed along the Kentucky Roadway and at the Kentucky Bridge Abutment. The evaluation includes geotechnical site characterization, geologic interpretation, seismic ground motion analysis, slope stability, and settlement for the proposed US-51 improvements. Various embankment materials were considered for the approach embankment as the KYTC Geotechnical Office suggested the use of on-site materials as approach embankment. However, the design team and KYTC District 1 preferred the approach embankment to be constructed out of rock materials to alleviate concerns of long-term settlement, stability, and embankment degradation over time due to fluctuation of the river levels.

# Geology

The existing US-51 bridge is situated southeast of the town of Cairo, Illinois, crossing the Ohio River, connecting Illinois to Kentucky. Physiographically, the surrounding area is located on the northern tip of the Mississippi Embayment, a wedge-shaped region of topographically low relief comprising 100,000 square miles within the Gulf Coastal Plain extending from the southern tip of Illinois, southward to the Gulf of Mexico.

The Embayment is an artifact of a failed continental rift that originated from a subsurface system of predominantly northeast to southwest-trending normal faults known as the Reelfoot Rift. The rift is considered active to this day and is the primary cause of earthquake activity within the New Madrid

Seismic Zone. Beginning during the Mesozoic era, the rift was gradually infilled with marine and deltaic sediments, creating the Embayment feature as seen today.

The site is located near the confluence of the Mississippi and Ohio rivers, which today produces alluvial sediments of primarily clayey deposits with intermittent and discontinuous sand layers grading with depth to gravels. The most recent deposited alluvium is stratigraphically designated as Cahokian (Wisconsin-stage Glacial Period, Holocene) (Wright, 1964), the base of which – based on boring interpretations – is believed to lie between 200 to 240 feet elevation.

The Cahokian sediments are supported by Eocene deposits of the Claiborne and Wilcox formations, undivided. The Claiborne and Wilcox Formations consist of white to yellow, orange and reddish brown, fine to coarse-grained poorly sorted sand, silt, and clay. Based on borehole data, utilizing subsurface data from across the project site, the base of the Claiborne and Wilcox Formations is interpreted at approximately -15 to -35 feet elevation where the top of the Porters Creek Formation (Paleocene) is encountered.

The Porters Creek Formation is composed of a dark gray to dark olive-gray stiff and massive conchoidally-fractured clay with thin laminae of light gray micaceous fine-grained silt and sand. The base of the Porters Creek Formation was not encountered in advanced borings; however, based on published geologic maps, these deposits are believed to extend to approximately -200-ft elevation, where undivided marine Cretaceous deposits of the Owl Creek, McNairy, and Post Creek Formations lie, composed of similar fine quartz-rich sands, micaceous and glauconitic silts and clays (Fisk, 1944).

Cretaceous deposits are believed to extend to approximately -225-ft elevation, where the Devonian New Harmony Group is believed to lie, extending to an elevation of greater than -800-ft. The upper portion of the New Harmony Group is composed primarily of white to light gray chert cobbles to approximately -500-ft elevation, where a dark gray siliceous and argillaceous limestone was encountered in historic boreholes (greater than 800-ft depth) (Nelson, W.J. 2008).

In general, based on subsurface data obtained across the project site, the soil profile at the boring locations consisted of up to 20 feet of silty clay to silty sand with intermittent lenses of sand and silt soils overlying cohesionless soils that generally consisted of clean to silty sands and gravels that extended to the Porters Creek Formation layer generally encountered at elevations ranging from -15 to -35 ft.

# Seismic Hazard

Structural and elevation contours indicate that the geologic formations are sub-horizontally bedded. Two sub-parallel unnamed faults trending east to west are located approximately 0.5 miles north of the northern project limits. The faults are not known to be active in recent geologic time.

The project area could be affected by seismic events associated with the New Madrid Seismic Zone, which lies within the north-central Mississippi River Valley extending from northeast Arkansas, southeast Missouri, western Tennessee, western Kentucky, and southern Illinois. The New Madrid Seismic Zone is the most seismically active region in the United States east of the Rocky Mountains.

# Drilling and Sampling

The subsurface investigation was performed by Terracon under HDR's guidance and supervision in April 2021 and May, November, and December of 2025. A total of twelve (12) soil borings (117 through 126, B-2046, and B-6) were advanced by CME-55, Mobile B-57 and Geoprobe 3230DT model drill rigs utilizing hollow stem augers. Boring B-2046 utilized 4" casing below a depth of 8-feet. B-6 utilized mud rotary techniques below a depth of 10 feet. The CME-55, Mobile B-57, and Geoprobe 3230DT drills each had a hammer energy transfer ratio (ETR) of 89.4%, 83.8%, and 93.6%, respectively. In general, split-spoon or undisturbed samples were conducted at 5-foot intervals until the proposed boring depth was reached. Boring B-2046 was sampled at 10-foot intervals at depths below 100 feet. Pavement cores were collected at two (2) borings (124P and 126). Additionally, the investigation included advancing three hand auger borings (120A, 121A, and 122A) to allow for the collection of bulk samples from each location. One (1) Seismic Piezocone Penetration Test (SCPTu) (CPT-6) was drilled near the bridge abutment.

Excluding the pavement core at boring 126 and the hand auger borings, the roadway borings were drilled beginning at existing grade and advanced to termination depths ranging from 25.0 feet to 152.0 feet, corresponding to elevations of 161.8 feet to 301.4 feet above mean sea level (ft. AMSL). It should be noted that boring refusal was not encountered within the borings. The final typed driller's subsurface logs are included in Attachment C and summarized in Table 1 below.

**Table 1. Boring Summary**

| Boring No. | Alignment | Station | Offset (ft.) | Surface Elevation (ft. AMSL) | Depth (ft.) | Type |
|---|---|---|---|---|---|---|
| 117 | US-51 | 2096+50 | 110 Lt. | 302.9 | 41.5 | SPT/ST |
| 118 | US-51 | 2095+86 | 48 Rt. | 327.6 | 65.0 | SPT/ST |
| 119 | US-51 | 2096+50 | 200 Rt. | 304.9 | 51.5 | SPT/ST |
| 120 | US-51 | 2097+73 | CL | 308.8 | 25.0 | SPT/ST |
| 120A | US-51 | 2097+72 | CL | 308.8 | 8.0 | Bulk |
| 121 | US-51 | 2101+73 | CL | 304.7 | 25.0 | SPT/ST |
| 121A | US-51 | 2101+72 | CL | 304.7 | 8.0 | Bulk |
| 122 | US-51 | 2105+73 | CL | 302.7 | 26.5 | SPT/ST |
| 122A | US-51 | 2105+72 | CL | 302.7 | 8.0 | Bulk |
| 123 | US-51 | 2107+50 | 10 Rt. | 308.8 | 60.0 | SPT/ST |
| 124P | US-51 | 2117+73 | 5 Rt. | 326.4 | 25.0 | Pavement Core/SPT/ST |
| 125 | US-51 | 2118+50 | 5 Rt. | 324.5 | 50.0 | SPT/ST |
| 126[1] | US-51 | 2126+64 | CL | 328.4 | 1.4 | Pavement Core |
| 126A | US-51 | 2126+60 | 35 Rt. | 324.4 | 70.0 | SPT/ST |
| B-2046[2] | US-51 | 2093+73 | 12 Lt. | 314.3 | 150.0 | SPT/ST/PT |
| B-6[2] | US-51 | 2093+67 | 7 Rt. | 313.8 | 152.0 | SPT/ST/PT |
| CPT-6[2] | US-51 | 2093+79 | 19 Lt. | 314.6 | 68.8 | CPT |

Notes:
(1) 126 terminated at 1.4' due to encountering rebar below pavement. Offset boring 126A moved from pavement to clear rebar.
(2) Borings and CPT Sounding advanced for the KY Bridge Abutment.

Pavement cores were collected near the beginning and end of the proposed widening to obtain existing pavement structure information as well as subgrade soil characteristics by collecting undisturbed and disturbed soil samples. The pavement core boring summary is presented in Table 2 below and the pavement core photographic logs are included in Attachment C with the corresponding driller's subsurface log.

**Table 2. Pavement Core Summary**

| Boring No. | Alignment | Station | Offset (ft.) | Asphalt Thickness (ft.) | Concrete Thickness (ft.) | Approximate Total Pavement Thickness (ft.) |
|---|---|---|---|---|---|---|
| 124P | US-51 | 2117+73 | 5 Rt. | 0.9 | 0.6 | 1.5 |
| 126[1] | US-51 | 2126+64 | CL | 0.2 | 1.1 | 1.3 |

Notes:
(1) 126 terminated at 1.4' due to encountering rebar below concrete pavement.

# Groundwater Levels

Groundwater was encountered during drilling at depths ranging from approximately 5.0 to 44.0 feet below existing ground surface (bgs), corresponding to groundwater elevations ranging from approximately 282.9 to 303.8 feet above mean sea level (AMSL). Additionally, borings 119 and 123 were converted to observation wells upon completion of drilling to allow for collection of delayed groundwater level measurements after groundwater conditions had stabilized. Delayed groundwater level measurements were collected on January 13, 2026, at depths ranging from approximately 18.4 to 19.3 feet bgs, corresponding to elevations ranging from approximately 285.6 to 290.4 feet AMSL. The measured groundwater depths are summarized in Table 3. Groundwater conditions at the site are expected to fluctuate seasonally and in response to changes in the Ohio River.

The Ohio River water surface elevations provided by the design team indicate a normal pool elevation of 300.0 feet AMSL and a maximum flood elevation of 331.9 feet AMSL, as summarized in Table 4. Because the measured groundwater elevations are influenced by river stage and represent only the conditions observed during drilling, a design groundwater elevation of 300.0 feet AMSL was adopted for the geotechnical analyses. The analyses also consider conditions during a sudden reduction in the Ohio River water surface elevation from the maximum flood elevation of 331.9 feet AMSL to the normal pool elevation.

**Table 3. Groundwater Table Summary**

| Test Hole No. | Initial Reading[1] | | Delayed Reading[1] | |
|---|---|---|---|---|
| | Groundwater Depth (ft.) | Approximate Groundwater Elevation (ft. AMSL) | Groundwater Depth (ft.) | Approximate Groundwater Elevation (ft. AMSL) |
| 117 | 20.0 | 282.9 | N/A | N/A |
| 118 | 44.0 | 283.6 | N/A | N/A |
| 119 | 20.0 | 284.9 | 19.3 | 285.6 |
| 120 | 5.0 | 303.8 | N/A | N/A |
| 121 | 8.0 | 296.7 | N/A | N/A |
| 122 | 18.0 | 284.7 | N/A | N/A |
| 123 | 18.0 | 290.8 | 18.4 | 290.4 |
| 124P | Dry | Dry | N/A | N/A |
| 125 | 22.0 | 302.5 | N/A | N/A |
| 126A | 28.0 | 296.4 | N/A | N/A |

Notes:
(1) Initial groundwater readings were obtained during drilling. Delayed groundwater readings were obtained on January 13, 2026 from borings 119 and 123 which were converted to observation wells upon completion of drilling.

Water surface elevations, as provided by members of the design team, and the corresponding river condition are presented below in Table 4.

**Table 4. Ohio River Water Surface Elevations**

| River Condition | Water Surface Elevation, (ft. AMSL) |
|---|---|
| Normal Pool | 300.0 |
| Maximum Flood | 331.9 |

# Laboratory Testing

Laboratory testing was performed on representative bulk, disturbed, and undisturbed soil samples to characterize the engineering properties of the subsurface materials encountered along the proposed roadway alignment. The testing program included soil classification, index property, strength, and compaction testing to support the geotechnical evaluation and design recommendations presented herein.

Soil classification testing included natural moisture content, grain size analysis, and Atterberg Limits testing. The laboratory results indicate the subsurface materials range from silts and clays (ML, MH, CL, and CL-ML) to sands and gravels (SM, SC, SP, SP-SM, SC-SM SW, GP, and GP-GM), with AASHTO classifications ranging from A-1-a to A-7-6. Plasticity indices ranged from non-plastic (NP) to 23, natural moisture contents ranged from 4 to 65 percent, and fines contents ranged from 3 to 100 percent, reflecting the variable alluvial deposits encountered across the project.

Engineering property testing consisted of fifteen (15) unconsolidated-undrained (UU) triaxial compression tests and twenty-one (21) unconfined compressive strength (UC) tests performed on selected undisturbed samples to evaluate the strength characteristics of the cohesive soils. Additionally, nine (9) one-dimensional consolidation tests [ASTM D2435] were performed to evaluate the compressibility characteristics of the cohesive soils, and seven (7) consolidated-undrained (CU) triaxial compression tests [ASTM D4767] were performed to evaluate their shear strength characteristics.

California Bearing Ratio (CBR) [KM 64-501-02] and Standard Proctor [KM 64-511-03] compaction tests were performed on the three (3) bulk samples collected along the alignment to evaluate subgrade support characteristics and compaction properties. A summary of the CBR and Proctor test results is presented in Table 5, while the complete laboratory testing results are included in Attachment D.

**Table 5. CBR and Proctor Test Results**

| Boring No. | Alignment | Station | Offset (ft.) | CBR | Proctor Test | |
|---|---|---|---|---|---|---|
| | | | | | Maximum Dry Unit Weight (pcf) | Optimum Moisture Content (%) |
| 120A | US-51 | 2097+73 | CL | 6.3 | 96.4 | 25.4 |
| 121A | US-51 | 2101+73 | CL | 5.3 | 96.4 | 20.3 |
| 122A | US-51 | 2105+73 | CL | 5.0 | 107.2 | 20.2 |

The full laboratory testing results are included in Attachment D.

# Seismic Conditions

## Response Spectra

Terracon performed the site response analyses and seismic ground motion characterization necessary for the liquefaction and seismic deformation at the Kentucky abutment. Site response analysis was performed using equivalent linear and nonlinear total stress methods with SHAKE2000 and DEEPSOIL, and AASHTO limiting response spectra were developed using the USGS Uniform Hazard Tool. A ground motion study (GMS), which included a probabilistic seismic hazard analysis (PSHA), was performed to develop a uniform hazard spectrum using site-specific time histories. The PSHA characterizes the seismic hazard at the pier locations, incorporating regional seismicity, ground motion attenuation relationships, and site-specific conditions. The full results of Terracon's ground motion study may be viewed in their Tech Memo dated March 23rd, 2026.

## Basis of Seismic Hazard and Design Parameters

The liquefaction and seismic deformation analysis was conducted at The Kentucky abutment utilizing the results of the subsurface site investigation and Terracon's site response analysis and GMS. The GMS utilized the 2018 USGS National Seismic Hazard Model to develop Uniform Hazard Response

Spectra (UHRS) at the base of the soil profile (Site Class C, Vs30 = 1500 ft/s). These spectra were generated for two primary hazard levels:

- 7% probability of exceedance in 75 years (approx. 1,033-year return period)
- 50% probability of exceedance in 75 years (approx. 110-year return period)

The moment magnitudes for liquefaction triggering identified for use in the analyses were:

- M = 5.98 for the 110-year event (Also referred to herein as the “100-year event”)
- M = 6.99 for the 1,033-year event (Also referred to herein as the “1,000-year event”)

Based on the AASHTO Bridge Design Specifications, the final design response spectrum was adjusted accordingly where site-specific spectral accelerations fell below 2/3 of the AASHTO uniform hazard values. The seismic conditions utilized in the analyses at the Kentucky abutment are summarized in Table 6 below.

**Table 6. Summary of Seismic Parameters for Analysis at Kentucky Abutment**

| Design Event | Earthquake Magnitude | Distance (km) | Ground Surface – Design $PGA_m$ (g) |
|---|---|---|---|
| 50% PE in 75 yrs (~100-yr) | 5.98 | 127 | 0.078 |
| 7% PE in 75 yrs (~1000-yr) | 6.99 | 15 | 0.48 |

# Engineering Analysis

## General

Although other embankment material types were considered, the roadway embankments shall be constructed using rock materials to protect the embankment against fluctuating river conditions, consistent with the recommendations and preferences of the design team and KYTC District 1. Furthermore, a granular pile core is recommended within the proposed rock fill embankment at the Kentucky abutment to facilitate pile drivability of the piles at the Kentucky abutment. The pile core should consist of durable structure granular backfill and be constructed in accordance with KYTC Standard Drawings RGX-100 and RGX-105, to the limits and extents shown therein. Coordination efforts with the structural design team will be required to facilitate the sequence of construction and the final foundation recommendations at the Kentucky abutment.

The following sections present the results of the liquefaction analysis and the resulting seismic settlement and lateral displacement analyses, static settlement analyses, and global stability analyses. Due to the seismic conditions for this project, large vertical and lateral displacements are anticipated due to the significant depths of liquefiable soils. Thus, ground improvement is required at the Kentucky abutment to mitigate these large deformations and details regarding these improvements are included herein.

## Liquefaction Analysis, Settlement, & Lateral Displacement

Liquefaction susceptibility analyses and the resulting vertical settlements and lateral displacements were evaluated at the Kentucky abutment using data from each SPT boring and SCPTu sounding. The primary inputs for the liquefaction analysis included normalized SCPTu cone resistances, shear wave velocity, SPT N-values, and laboratory soil classification test results (plasticity and gradation), supplemented by site-specific ground motions and response spectra developed through the GMS. Cyclic Resistance Ratio (CRR) values were calculated and compared to Cyclic Stress Ratio (CSR) values to estimate the factor of safety against liquefaction, with a triggering threshold defined as a factor of safety of 1.1 per Section 6.3.4 of FHWA-NHI-11-032: Seismic Design – Geotechnical Features.

**Seismic Soil Profiles and Residual Strength Estimation**

To perform geotechnical analyses evaluating liquefied soil conditions, residual shear strengths were estimated for discrete soil layers identified as potentially liquefiable, designated as “PL” layers. For the SPT-based analyses, these estimates were developed using methods from Idriss and Boulanger (2007), Olsen and Johnson (2008), and Kramer and Wang (2015), which rely primarily on corrected SPT blow counts and effective overburden stress. For SCPTu-based methods, the estimated residual shear strengths were developed using Youd et al. (2001), Olsen and Johnson (2008), and Idriss and Boulanger (2008) which rely primarily on the normalized cone resistance.

It should be noted that for the Kentucky abutment liquefaction analysis, the preliminary phase boring and CPT (B-6, and CPT-6, respectively) were used to further define the residual shear strengths of the potentially liquefiable soils. A graphical summary of the PL layers and their associated residual shear strengths is provided in Attachment F.

**Seismic Settlement and Lateral Displacement Results**

The estimated vertical settlements and lateral displacements are based on screening methods from Robertson (1998, 2009) for CPT data and Idriss and Boulanger (2008) for SPT data. The range in vertical settlements and lateral displacements due to liquefaction, are without mitigation measures and do not consider soil-structure interaction effects from the abutment piles. These estimates are derived from empirical correlations and should be considered approximate; lateral spreading predictions represent a rough order-of-magnitude, especially for larger calculated displacements. Ground improvement techniques are recommended to mitigate liquefaction during the 1000-yr return period and are discussed further in the report.

The results of the liquefaction analyses for the 1000-yr return period are summarized in Table 7 and presented graphically in Attachment F. Liquefaction analysis of the 100-yr return period indicated the soils would not be susceptible to liquefaction at this location. The results presented below reflect existing site conditions and do not account for the effects of any ground improvement measures.

**Table 7. Liquefaction Analysis Results for the 1000-Year Return Period**

| Location | Boring Elevation (ft. AMSL) | Bottom of Liquefaction Elevation (ft. AMSL) | Bottom of Liquefaction Depth (ft. Below Top of Boring (bgs) | Estimated Seismic Settlement (in.) | Estimated Lateral Spread Displacement (ft.) |
|---|---|---|---|---|---|
| B-2046 | 314.3 | 245.0 | 69.3 | 11.1 | 9.0 |
| B-6 | 313.8 | 239.0 | 74.8 | 32.9 | 21.0 |
| CPT-6 | 314.6 | 247.2 | 67.4 | 14.0 | 10.7 |

As previously stated, the analysis indicates that for the 1,000-yr return period event, there is significant potential for liquefaction of foundation soils across the abutment of the bridge.

## Static Settlement

Preliminary settlement analyses were performed utilizing the *Rocscience* software Settle3 to estimate the magnitude and time-rate of settlement which may affect roadway surfaces and impact foundation designs. The settlement analyses includes primary and secondary consolidation of the cohesive soils. Settlement parameters for cohesive foundation soils were derived from consolidation testing. In addition, published empirical relationships correlating natural moisture content and index testing (Atterberg limits) to consolidation parameters were considered.

The analyses evaluated the effects of staged construction on the expected settlement of the new embankments. The general construction sequence for the approach embankment and ensuing settlement analyses was considered in the following manner:

1. Estimate settlement due to the construction of the temporary embankment, constructed as part of the advanced letting;
2. Determine the additional settlement due to construction of embankment to final grade following an approximate time period of two years (the estimated timeframe that the temporary embankment will remain in place during bridge construction).

By constructing a portion of the approach embankment during bridge construction, settlement may begin during this advanced letting period, ultimately reducing the total amount of settlement observed from the time the embankment material is constructed to final grade.

Table 8 below provides the results of the Service Limit State settlement analysis for the embankment constructed to the temporary fill grade, including the estimated settlement after the approximately two-year advanced letting period and the estimated time for 50 and 90 percent of primary consolidation settlement to occur.

**Table 8. Results of Roadway Embankment Settlement Analysis for Temporary Grade**

| Station | Alignment | Temporary Embankment Height (feet) | Estimated Settlement at End of Advanced Letting Period (inches)[1] | | | | Estimated Time for Consol. Settlement (months) | |
|---|---|---|---|---|---|---|---|---|
| | | | Immed. | Consol. | Sec. | Total | Time to 50% | Time to 90% |
| 2094+00 | US-51 | 22.9 | 3.4 | 11.5 | 0.0 | 14.9 | 1 | 2 |
| 2096+50 | US-51 | 23.2 | 6.2 | 11.9 | 0.0 | 18.1 | 1 | 2 |
| 2107+50 | US-51 | 21.3 | 2.7 | 19.3 | 0.2 | 22.2 | 2 | 5 |

Notes:
(1) A two-year duration was assumed for the advanced letting period prior to placement of additional fill to final grade.

As mentioned, settlement analyses for the embankment constructed to final grade were performed to estimate the total settlement expected through completion of the staged embankment construction (and for the design life of the approach embankment). Table 9 below provides the results of the settlement analyses at final grade, including the estimated settlement remaining following the advanced letting period.

**Table 9. Results of Roadway Embankment Settlement Analysis for Final Grade**

| Station | Alignment | Additional Fill Height to Final Grade (feet)[1] | Final Embankment Height (feet)[2] | Estimated Settlement at Final Grade (inches)[3] | | | | Settlement Remaining After Advanced Letting (inches) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Immed. | Consol. | Sec. | Total | Consol. | Total |
| 2094+00 | US-51 | 3.2 | 26.1 | 3.4 | 12.8 | 0.3 | 16.5 | 1.3 | 1.6 |
| 2096+50 | US-51 | 4.0 | 27.2 | 7.8 | 12.9 | 0.4 | 21.1 | 1.0 | 3.0 |
| 2107+50 | US-51 | 6.0 | 27.3 | 3.2 | 22.3 | 0.8 | 26.3 | 3.0 | 4.1 |

Notes:
(1) Fill required to construct the embankments to final grade from the temporary grade constructed during the advanced letting.
(2) Measured from the top of the roadway to the bottom of the embankment.
(3) Includes settlements in Table 8 occurring during the advanced letting period.

As indicated by the results above, the current project schedule with the advanced letting provides an opportunity for a substantial portion of the estimated settlement at final grade presented in Table 9 to occur prior to completion of the bridge and roadway surfacing. More than 85 percent of the estimated primary consolidation settlement is expected to occur during the approximately two-year advanced letting period.

### Ground Improvement and Differential Settlement

The static settlement estimates presented above do not account for ground improvement measures at the approach embankments. Ground improvements consisting of a column supported embankment supported by reinforced cementitious rigid inclusions (refer to the subsequent section, “Ground Improvement”) will be required within approximately 100 feet of the bridge abutment, at a minimum, to mitigate liquefaction and satisfy the required global stability factors of safety, specifically for the

Extreme Event Limit State (seismic) loading condition. Station 2094+00 is located within the ground improvement zone, where total settlement is expected to be reduced to approximately 1 inch or less.

Consequently, a transition will occur between the ground improved embankment and the adjacent embankment founded on existing soils, introducing the potential for differential settlement. The improved portion of the embankment is expected to experience significantly less settlement than areas outside the limits of the ground improvement zone. Due to the staged construction sequence of the embankment, the potential for differential settlement is reduced at the transition by allowing most of the anticipated settlement to occur during the approximately two-year advanced letting period. The current settlement analyses indicate that approximately 1 to 3 inches of primary consolidation settlement and up to approximately 4 inches of total settlement are expected to remain following the advanced letting period (Refer to results in Table 9).

**Settlement Platforms**

Settlement performance should be monitored and verified during construction through instrumentation. Settlement platforms should be installed at the approach embankment in accordance with the current Standard Specifications and Standard Drawings at the locations shown on the Contract Drawings. At a minimum, one settlement platform should be installed within the ground improvement zone on top of the load transfer platform, and one immediately up station of the ground improvement zone. Three additional settlement platforms should be installed throughout the untreated portions of the embankment. Settlement measurements should be collected throughout construction to evaluate trends and determine the quantity of additional embankment fill required to restore the embankment to final grade before placement of the roadway surface. Based on the results of settlement readings, the Department will determine if settlement has completed sufficiently to proceed with construction of permanent drainage structures and final paving operations.

## Global Stability

Based on the previously established static and seismic parameters, preliminary global stability analyses of potential deep-seated failure surfaces were performed using the computer program SLOPE/W (GeoStudio, 2025) using the Spencer Method. Circular failure planes for the proposed approach embankments and spill-through slopes were evaluated at the Service Limit State for short-term (total stress) and long-term (effective stress) conditions. Additionally, the Extreme Event Limit State for seismic (total stress) and rapid drawdown (total stress) conditions were also evaluated. All global stability analyses used the grid and radius slip surface option.

Seismic stability analyses were performed using both the 100-year and 1000-year pseudo-static conditions. Additionally, temporary slopes will be constructed to facilitate the construction of the proposed roadway to the finished grade. Table 10 and Table 11 below provide the results of the global stability analyses performed for the short term, long term, rapid drawdown, and seismic (pseudo-static) cases for the temporary roadway embankment geometry and final roadway embankment geometry, respectively. The results presented below reflect conditions without consideration of any ground improvement measures. These analyses were performed to identify potential slope instability

and evaluate the need for ground improvements or other mitigation measures, particularly at the bridge abutment and other critical structures.

It should be noted that for the temporary condition, STA 2094+00 will incorporate construction staging techniques due to the ground improvement required at this location and isn't the most critical station location during the temporary phase for this project; thus, to evaluate the stability of the bridge approach embankment, STA 2094+50 was selected and results shown in Table 10.

**Table 10. Results of Temporary Roadway Global Stability Analysis**

| Station | Alignment | Slope | Factor of Safety | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Short Term | | Long Term | | Rapid Drawdown | | Pseudo-Static 100-Year | | Pseudo-Static 1000-Year | |
| | | | Calc. | Min. Req. | Calc. | Min. Req.[1] | Calc. | Min. Req. | Calc. | Min. Req. | Calc. | Min. Req. |
| 2094+50 | US-51 | 2H:1V | 1.4 | 1.3 | 1.6 | 1.6 | 1.2 | 1.0 | 1.2 | 1.1 | 0.9 | 1.1 |
| 2096+50 | US-51 | 2H:1V | 1.5 | 1.3 | 1.7 | 1.5 | 1.3 | 1.0 | 1.2 | 1.1 | 0.8 | 1.1 |
| 2107+50 | US-51 | 2H:1V | 1.6 | 1.3 | 1.7 | 1.5 | 1.4 | 1.0 | 1.2 | 1.1 | 0.8 | 1.1 |
| 2118+50 | US-51 | 2H:1V | 2.2 | 1.3 | 2.0 | 1.5 | 1.8 | 1.0 | 1.8 | 1.1 | 1.3 | 1.1 |

Notes:
(1) At Station 2094+50, the minimum required factor of safety corresponds to the KYTC Geotechnical Guidance Manual bridge approach slope criterion (FSmin = 1.6). Elsewhere, the roadway embankment criterion governs (FSmin = 1.5).

**Table 11. Results of Final Grade Roadway Global Stability Analysis**

| Station | Alignment | Slope | Factor of Safety | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Short Term | | Long Term | | Rapid Drawdown | | Pseudo-Static | | | |
| | | | | | | | | | 100-Year | | 1000-Year | |
| | | | Calc. | Min. Req. | Calc. | Min. Req.[2] | Calc. | Min. Req. | Calc. | Min. Req. | Calc. | Min. Req. |
| KY Abut. Spill-Through[1] | US-51 | 4H:1V | 1.5 | 1.3 | 2.1 | 1.6 | 1.4 | 1.0 | 1.2 | 1.1 | 0.5 | 1.1 |
| 2094+00[1] | US-51 | 3H:1V | 1.5 | 1.3 | 2.3 | 1.6 | 1.4 | 1.0 | 1.2 | 1.1 | 0.6 | 1.1 |
| 2096+50 LT | US-51 | 3H:1V | 2.1 | 1.3 | 2.6 | 1.5 | 2.0 | 1.0 | 1.5 | 1.1 | 0.8 | 1.1 |
| 2096+50 RT | US-51 | 3H:1V | 2.0 | 1.3 | 2.2 | 1.5 | 1.7 | 1.0 | 1.6 | 1.1 | 1.0 | 1.1 |
| 2107+50 | US-51 | 3H:1V | 1.5 | 1.3 | 2.2 | 1.5 | 1.5 | 1.0 | 1.2 | 1.1 | 0.8 | 1.1 |
| 2118+50 | US-51 | 3H:1V | 2.5 | 1.3 | 2.1 | 1.5 | 1.8 | 1.0 | 2.0 | 1.1 | 1.3 | 1.1 |
| 2126+50 | US-51 | 3H:1V | 1.4 | 1.3 | 1.8 | 1.5 | 1.2 | 1.0 | 1.1 | 1.1 | 0.7 | 1.1 |

Notes:
(1) These locations were analyzed without a reduction in the PGA for the 1,000-yr event; Newmark displacement analyses were performed. Other locations shown were analyzed with ½ PGA.
(2) At Station 2094+00 and the spill-through slope, the minimum required factor of safety corresponds to the KYTC Geotechnical Guidance Manual bridge approach slope criterion (FSmin = 1.6). Elsewhere, the roadway embankment criterion governs (FSmin = 1.5).

The results of the analysis indicate that the global stability design requirements for short-term, long-term, seismic and rapid drawdown cases are satisfied for all temporary and final roadway embankment geometries except for the pseudo-static analysis for the 1,000-yr seismic event. According to FHWA-NHI-11-032: Seismic Design for Geotechnical Features, 1-2 inches of displacement may be assumed when a Factor of Safety of 1.1 is achieved with ½ of the PGA value. The analysis for the temporary condition embankment geometry, used ½ PGA values for the 1,000-yr event; thus, results indicate that temporary slopes may experience displacements greater than a few inches during a 1000-yr seismic event.

To gage lateral deformations for the final embankment geometry and impacts to the bridge abutment (assumed to be within a 100-ft zone from the beginning of the bridge), as well as one location outside of the 100-ft zone, a simplified Newmark displacement analysis was performed. This analysis was performed in accordance with the guidance in Chapter 6 of *LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations* (Geotechnical Engineering Circular No. 3, FHWA–NHI-11-032, 2011). The results of the Newmark displacement analysis at critical locations are included in Attachment G.

For the locations near the abutment, the analysis indicates a seismic yield horizontal acceleration of 0.15g, corresponding to an estimated displacement of approximately 22.0-in at both the Kentucky abutment spill-through slope and at STA 2094+00, which is considered unacceptable for bridge approach embankments. Thus, solely based on the inertial displacements, ground improvements would be required; however, the lateral spread displacement analysis, discussed in the following section, reaffirms the requirement for ground improvement.

For the location outside of the 100-ft zone, the analysis indicates a seismic yield horizontal acceleration of 0.21g, corresponding to an estimated displacement of approximately 8.0-in at STA 2096+50 (left bank). This location was considered generally representative of the cross sections analyzed outside the ground improvement zone, as the pseudo-static slope stability results for the 1,000-year seismic event varied only marginally among these locations. A liquefaction analysis was not performed for the roadway embankment outside of the critical 100-ft zone; thus, the approximate magnitude of displacement mentioned above is solely based on the inertial displacement. The estimated displacement is valid only if the underlying soils do not experience liquefaction. If unidentified liquefiable soils are present between exploration locations, lateral spreading or flow slide movements on the order of multiple feet could occur.

**Lateral Spreading Displacement Evaluation**

Evaluation of the lateral spreading displacements was performed at the Kentucky abutment using block-specified search methods. This analysis was performed for the Extreme Event Limit State at each “Post-Liquefied” (PL) layer identified in the seismic evaluation. Table 12 below provides the top and bottom elevations of the PL layers at the Kentucky abutment.

**Table 12. 1000-yr PL Layer Elevations**

| Station | 1000-yr PL Elevations (ft. AMSL) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PL1 | | PL2 | | PL3 | | PL4 | |
| | Top | Bot. | Top | Bot. | Top | Bot. | Top | Bot. |
| 2094+00 | 294.0 | 287.0 | 287.0 | 257.5 | 257.5 | 246.0 | 246.0 | 239.0 |

Table 13 presents the results of this analysis for the proposed embankments at the abutment spill-through and cross-section using ½ PGA values for the 1,000-yr event, targeting 1-2 inches of displacement.

**Table 13. Lateral Spread Stability Results**

| Station | Lateral Spread Stability Analysis Factor of Safety (1000-yr) | | | | Minimum Required[1] |
|---|---|---|---|---|---|
| | PL1 | PL2 | PL3 | PL4 | |
| KY Abut. Spill-Through | 0.5 | 0.4 | 0.4 | 0.4 | 1.1 |
| 2094+00 | 0.5 | 0.3 | 0.3 | 0.3 | |

Notes:
(1) The minimum factor of safety when evaluating stability at ½ PGA, which assumes 1-2 inches of displacement, is equal to 1.1. See FHWA-NHI-11-032 for more information.

The results indicate that the stability requirements are not satisfied for either the abutment spill-through slope or the cross-section side slopes. Furthermore, the results indicate that flow failures should be expected with large lateral displacements on the order of tens of feet.

Therefore, ground improvement is required to mitigate liquefaction. Displacement rigid inclusions have been selected as the ground improvement measure for liquefaction mitigation. Consequently, the approach embankments will function as column-supported embankments and will transfer loads to the rigid inclusion system. The column supported embankment configuration is, therefore, a result of the selected liquefaction mitigation rather than the primary objective for the ground improvement program. Further details regarding the rigid inclusion system and the resulting column-supported embankment are provided later in the Report.

## Ground Improvement

To satisfy global stability factor of safety requirements for the Pseudo-Static and wedge analyses, we recommend rigid inclusions for liquefaction mitigation and construction of a Column Supported Embankment (CSE) beginning at the Kentucky abutment to approximately STA 2094+35 (or 100-ft beyond the location of the abutment). Ground improvements will be constructed ahead of the approach embankments under the project's advance letting. Temporary support systems, shoring, and/or staged construction will be required to facilitate installation of the ground improvement system while avoiding disturbance to existing geotechnical and structural features.

### Column Supported Embankment

In general, CSE consists of vertical columns designed to transfer embankment loads to stiffer soils. A load-transfer platform (LTP) composed of granular materials consistent with a Dense Graded

Aggregate (DGA) gradation and layers of geosynthetic reinforcement are typically constructed above the columns and below the embankment fill.

The load transfer platform minimum thickness shall be 2-ft with Fabric-Geotextile Class 1 (Separation) along the sides, base, and top of the platform. Additionally, three layers of biaxial geogrid shall be installed within the load transfer platform above the pile caps, beginning 6-inches above the top of the pile cap and continuing thereafter at 6-inch vertical intervals. The geogrid shall meet the minimum properties provided in the table below. An example CSE section view illustrating the geotextile fabric and geogrid configuration within the LTP is provided in Appendix A of Special Note D: Ground Improvement.

**Table 14. Geosynthetic Reinforcement Requirements**

| Property | Requirement | |
|---|---|---|
| | Machine Direction (MD) | Cross Machine Direction (XMD) |
| Tensile Strength @ 5% Strain | 800 lbf/ft | 1,350 lbf/ft |
| Ultimate Tensile Strength | 1,300 lbf/ft | 1,990 lbf/ft |
| Flexural Stiffness | 750,000 mg-cm | |

Additionally, to assist in the stress distribution of the proposed embankment loads, concrete pile caps are required to be constructed at the base of the LTP and at the top of each column. The following are the required dimensions for each concrete cap:

- Width: 2.5-ft
- Length: 2.5-ft
- Thickness: 2.0-ft

**Displacement Based Rigid Inclusions**

Displacement rigid inclusions (hereafter referred to as rigid inclusions) are cementitious columns that are significantly stiffer than surrounding soils and are constructed using an auger drilling tool with a sacrificial tip so that concrete or grout may be injected into the hole upon reaching the required depth. For this project, a displacement-based technique is required during construction. The displacement-based technique utilizes a drilling tool that laterally displaces soils as the auger advances. This is required so that the relative density of granular soil is increased such that liquefaction doesn't occur in between the rigid inclusions.

A verification test program (refer to Contract Special Note D) is required, in which the rigid inclusions will be constructed at various layouts in a predetermined test area to evaluate the effectiveness of the displacement tool. Placement of the LTP may not commence until the verification test program has been completed and the results demonstrate the rigid inclusion system provides sufficient improvement to satisfy the performance requirements necessary to mitigate liquefaction. The stability analyses indicate that satisfactory results are only achieved if liquefaction in between columns is fully mitigated.

Table 15 below provides the results of the global stability analyses performed for the proposed column supported embankment and using the nominal shear resistance of the rigid inclusions. Load conditions that satisfy the required factors of safety without ground improvement near the abutment are not presented in Table 15, as the proposed improvements will result in an increased factor of safety. As such, only the results at the Extreme Event Limit State for the 1,000-year seismic return period are included in Table 15.

**Table 15. Global Stability Results at Extreme Event Limit State**

| Station | Pseudo-Static (1000-yr) | Global Stability Analysis Factor of Safety (1000-yr)[1] | | | | Minimum Required[2] |
|---|---|---|---|---|---|---|
| | | PL1 | PL2 | PL3 | PL4 | |
| KY Abut. Spill-Through | 1.3 | 1.4 | 2.8 | 2.4 | 2.4 | 1.1 |
| 2094+00 | 1.2 | 1.2 | 1.2 | 1.1 | 1.5 | |

Notes:
(1) Factor of safety with ground improvements.
(2) A minimum factor of safety of 1.1 is required based on FHWA Design Guidance when ½ PGA values are used to reasonably assume 1-2 inches of lateral displacement.

**Newmark's Displacement Analysis & Soil-Structure Interaction**

To evaluate the permanent lateral displacement due to liquefaction, while incorporating the displacement-based shear resistance from the rigid inclusions, the Caltrans Memo-To-Designers (MTD) 20-15 methodology was used. This method incorporates a limit equilibrium based pseudo-static analysis and a soil-foundation interaction analysis to determine the lateral spreading demand and the displacement-dependent lateral resistance of the rigid inclusions, respectively. Using both analyses, the resulting permanent displacement can be estimated.

For this project, the critical location for analysis was determined to be at STA 2094+00 since the lowest factors of safety from the global stability analysis were occurring here as well as the fact that the bridge abutment piles will not be contributing to the total horizontal shear resistance at this location. The Newmark Displacement Analysis was performed at the critical failure surface incorporating the total shear resistance from 18-inch-diameter rigid inclusions constructed on a 5-foot center-to-center spacing and penetrating to a minimum depth of 75-feet below ground surface (approximate tip elevation of 226.0 feet). The total shear resistance was determined through the soil-foundation interaction analysis. The rigid inclusions are constructed with grout/concrete having a minimum compressive strength of 4 ksi. A portion of rigid inclusions will require reinforcement consisting of four #11 Grade 60 longitudinal bars confined by a #4 spiral at a 4-inch pitch within the designated zone shown in the Special Note for Ground Improvement (Note D).

The analysis concluded that a permanent deformation of approximately 7 inches may be assumed at this location which is less than the limiting lateral spread displacement from Table 3.2-4 in the AASHTO Guidelines for Performance-Based Seismic Design of Highway Bridges. This estimated deformation considers the interaction between the liquefaction-induced lateral spreading demand and the displacement-dependent resistance provided by the rigid inclusions. Additionally, structural

analyses indicate that the strength limits of the rigid inclusions aren't exceeded at this amount of displacement. The results of this analysis may be viewed in Attachment H.

# Geotechnical Recommendations

1. Clearing and grubbing of roadway areas shall be completed in accordance with the requirements of Section 202 of the current Kentucky Department of Highways Standard Specifications for Road and Bridge Construction.
2. Removal of existing structures at the locations shown in these drawings and removal of other obstructions, when approved by the Department, shall be performed in accordance with Section 203 of the current Kentucky Department of Highways Standard Specifications for Road and Bridge Construction.
3. The Contractor shall be responsible for conducting all operations necessary to excavate existing embankment fill within the limits of disturbance to the extents required for construction of the ground improvement system. These operations shall be incidental to Roadway Excavation or Embankment-in-Place, and no additional compensation shall be made for this work.
4. Ground Improvement shall be constructed in accordance with "Special Note D: Ground Improvement". Construct ground improvement within the following station interval before any of the embankments are constructed. Do not install ground improvement elements within the footprint of the existing bridge abutment or within the limits of the existing pile foundations, in accordance with Special Note D.

   US-51
   2093+00 to 2094+35

5. The Contractor shall construct a Load Transfer Platform spanning the limits for ground improvement construction shown in the plans. The Load Transfer Platform shall consist of materials conforming to Dense Graded Aggregate per Section 805 of the Current KYTC Standard Specifications and reinforced with three (3) layers of geosynthetic reinforcement (geogrid) conforming the strength requirements shown in "Special Note D: Ground Improvement". The Load Transfer Platform shall be underlain with Fabric-Geotextile, Class 1 (Separation). Refer to the current KYTC Standard Specifications Section 214 and Section 843 for Geotextile Construction and Geotextile Fabrics.
6. The Contractor is responsible for the design, construction, and maintenance of all temporary works (e.g., shoring, sheet piling) required for the installation of the ground improvement system. The design shall be reviewed and approved by the Engineer prior to installing any temporary work systems. Any temporary construction slopes or temporary work features shown on these Drawings are for general guidance only. The temporary works system shall designed, constructed and established in a manner that remains safe and stable for the duration of the work, implementing any necessary measures to maintain the excavations and protect existing geotechnical and structural features within and adjacent to the disturbed limits. These operations shall be incidental to roadway excavation. No additional compensation shall be made for this work.

7. Remove all temporary sheeting or shoring upon completion of the substructure work, unless otherwise directed by the Engineer or shown on the Contract Drawings. Sheet piles installed between station 2094+04.45 and 2095+00 shall remain in place post-construction in accordance with the Contract Cross Sections. Leave portions of other temporary sheeting or shoring in place only with prior written permission of the Engineer. Temporary structures shall be in accordance with Section 600 of the current Kentucky Department of Highways Standard Specifications for Road and Bridge Construction.

8. All water wells or cisterns, septic tanks, catch basins, manholes, etc., that may be encountered within the limits of the construction, whether shown on plans or not, shall be plugged and/or capped in accordance with Section 708 of the current Kentucky Department of Highways Standard Specifications for Road and Bridge Construction.

9. Excavation of surface ditches and channel changes adjacent to embankment areas shall be performed prior to the placement of the adjacent embankments.

10. Foundation embankment benches shall be placed in accordance with Standard Drawing RGX-010-04 at the approximate locations listed below and/or as directed by the Engineer. Contrary to Standard Drawing RGX-010, the typical rise height for benching into soil/earth slopes shall be 4 to 6 feet. Benches in soil/earth slopes shall be constructed one at a time beginning with the lowest bench and each bench shall be backfilled prior to excavation of the next bench:

    US-51
    2094+00 to 2123+25

11. Class 1 (Separation) Geotextile Fabric is required in accordance with Special Note D. Additionally, where saturated, soft foundation areas, and/or drainage swales are present within the embankment foundation limits, Class 1 (Separation) Geotextile Fabric shall also be placed beneath the embankment at the interface of the granular embankment and existing ground line. The actual locations within the foundation limits that require separation Geotextile Fabric will be determined by the Engineer during construction. Refer to the current Standard Specifications Section 214 and Section 843 for Geotextile Construction and Geotextile Fabrics.

12. In accordance with Section 214.03.03 of the KYTC Standard Specifications, the drop height of the lowest 2 feet of granular embankment and/or Load Transfer Platform shall be limited to 3 feet to avoid damaging the Separation Geotextile Fabric. Refer to the current KYTC Standard Specifications Section 214 and Section 843 for Geotextile Construction and Geotextile Fabrics. This work shall be done as shown on the project cross-sections, project Special Notes, and as directed by the Engineer.

13. Some of the soil horizons and slopes on the project are subject to erosion. Necessary procedures in accordance with Sections 212 and 213 of the current KYTC Standard Specifications shall be followed on construction.

14. All embankment materials placed above the existing ground line and within the limits shown on the plans shall be constructed of Granular Embankment meeting the requirements of Section 805.10 of the current KYTC Standard Specifications. This requirement includes embankment materials placed above the Load Transfer Platform. The embankment shall be constructed by end-

dumping and grading the material (in accordance with Section 805 of the KYTC Standard Specifications). Within the limits of the Load Transfer Platform, place Granular Embankment in a manner to avoid damage or displacement of the Load Transfer Platform. As per Section 805.03.04 of the KYTC Standard Specifications, the granular embankment shall be non-erodible and stable material and is required to be quarry-processed limestone. Do not extend the construction berm beyond the proposed roadway embankment toe.

15. The Contractor is responsible for conducting any operations necessary to excavate the cut areas to the required typical sections. These operations shall be incidental to Embankment in Place.

16. Excess material shall be deposited on a permitted site. All work associated with excess material placement shall conform to Section 205 of the current KYTC Standard Specifications and all applicable plan notes and bid documents. The Contractor will be responsible for identifying a site, preparing plans for the site and submitting them to the Cabinet for review. Additionally, the Contractor is also responsible for geotechnical investigations and analysis of the proposed excess material storage area, including any necessary stability and settlement analyses. Ensure all work is performed by a KYTC prequalified geotechnical consultant and is in accordance with the Department's Geotechnical Manual. All work shall be subject to review by the Cabinet.

17. If a spring with a defined area of water flow is encountered during construction, install a spring box with a pipe outlet at the toe of the slope, as determined by the Engineer.

18. Both a pile load testing program, which includes the approach span pile load tests, and ground improvements are included in the advance letting Contract Documents. Ground improvement verification testing, including pre- and post-installation SCPT/SPT testing of pre-production rigid inclusion test sections, will be completed as part of the Advanced Letting. Coordination between the load testing contractor and the ground improvement contractor and their subcontractors will be required due to the proximity of the work to the bridge abutments. Refer to the "Special Note for Pile Load Testing Program" for specific details, locations, and required coordination with roadway construction.

19. Construct a granular pile core at the Kentucky Abutment prior to the installation of piling in accordance with KYTC Special Provision No. 69 and KYTC Standard Drawings RGX-100 and RGX-105. Where conflicts exist between the Contract Drawings, Special Provision, and Standard Drawings, the Contract Drawings shall govern. The pile core shall consist of Structure Granular Backfill meeting the requirements of Section 805.11 of the KYTC Standard Specifications and shall extend to the limits and extents shown on the applicable Standard or Contract Drawings. No rock fragments larger than 4 inches in any dimension are permitted within the pile core. Measurement and payment for the granular pile core shall be in accordance with KYTC Special Provision No. 69. Pile core will be measured and paid under roadway excavation or embankment-in-place.

20. Provide an 8-inch perforated underdrain within the granular pile core in accordance with Special Provision No. 69 and KYTC Standard Drawings RGX-100 and RGX-105. Install the underdrain to the lines, grades, limits, and outlet headwall configuration shown on the Contract Drawings. Where the pile core is located within the limits of the ground improvements, install the underdrain at the elevation of the top of the load transfer platform; otherwise, install the underdrain at the original ground elevation. Wrap the perforated pipe with a filter fabric of the type recommended by the pipe

manufacturer. The Department considers the 8-inch perforated underdrain pipe incidental to the Pile Core.

21. Settlement platforms (Standard Drawing RGX 015) shall be furnished and installed by the Contractor at the left shoulder, outside the proposed guardrail, at the approximate locations below. The exact locations shall be determined by the Engineer and a representative of the Department's Geotechnical Services Branch. The settlement platforms within the limits of the ground improvement shall be constructed after the load-transfer platform (LTP). Settlement platforms shall be constructed as early as practical.

    Contact the Geotechnical Services Branch approximately one (1) week prior to the installation of the settlement platforms. The platforms shall be installed in accordance with Section 216 of the current Standard Specifications. The Geotechnical Services Branch will provide the necessary forms for recording measurements. Readings shall be obtained using a benchmark and level; use of GPS survey equipment will not be permitted. Fill elevation readings shall also be obtained with each settlement platform reading. These shall be at the current fill surface within three (3) feet of the settlement platform pipe.

    Based on the results of settlement readings, the Engineer and Geotechnical Services Branch will determine if settlement has completed sufficiently to proceed with construction of permanent drainage structures and final paving operations. Settlement platforms destroyed by the Contractor shall be replaced at the Contractor's expense. Platforms shall be left in place for future readings after project construction has been completed.

    <u>Settlement Platform Location</u>
    Station 2094+10, 32’ Lt.
    Station 2094+50, 31’ Lt.
    Station 2096+00, 31’ Lt.
    Station 2099+50, 53’ Lt.
    Station 2105+50, 53’ Lt.

22. As directed by the Engineer, existing bituminous concrete located at a distance greater than 3 feet below the proposed subgrade elevation within the limits of new roadway embankments, shall be scarified or broken until all cleavage planes are destroyed, or the pavement shall be removed entirely as conditions demand. This shall be performed in compliance with Section 206 of the Standard Specifications for Road and Bridge Construction.

23. In areas where pavement is not to be overlaid, existing bituminous concrete located at a distance less than three feet below the proposed subgrade elevation within the limits of new roadway embankments, shall be removed entirely. This shall be performed in compliance with Section 206 of the Standard Specifications for Road and Bridge Construction.

# Design Recommendations

1. An average soil shrinkage value of two (2) percent is estimated for this project. This value should be applied to the formula for calculating the Apparent Shrinkage as outlined in the Design Manual.
2. Because the Kentucky approach embankments will be constructed from rock fill, the project should be designed for a minimum 2-foot-thick rock roadbed. This design recommendation applies to the US-62 mainline and all ancillary approach and access roads. Where the proposed finished grades are near existing ground elevations, undercutting existing soils will be required to accommodate the minimum 2-foot-thick rock roadbed. A CBR design value of 11 is recommended for pavement design. In accordance with Section 207 of the Standard Specifications, rock embankment fill should be leveled using dense grade aggregate (DGA) or crushed stone base to achieve the required subgrade tolerance prior to construction of overlying pavement section. The DGA or crushed stone base leveling material is intended to provide the required grade and should not be considered a structural layer in the pavement design.

Please contact HDR Inc. for further recommendations or for any additional questions that arise pertaining to this project, at (859) 629-4800.

Sincerely,

HDR ENGINEERING, Inc.

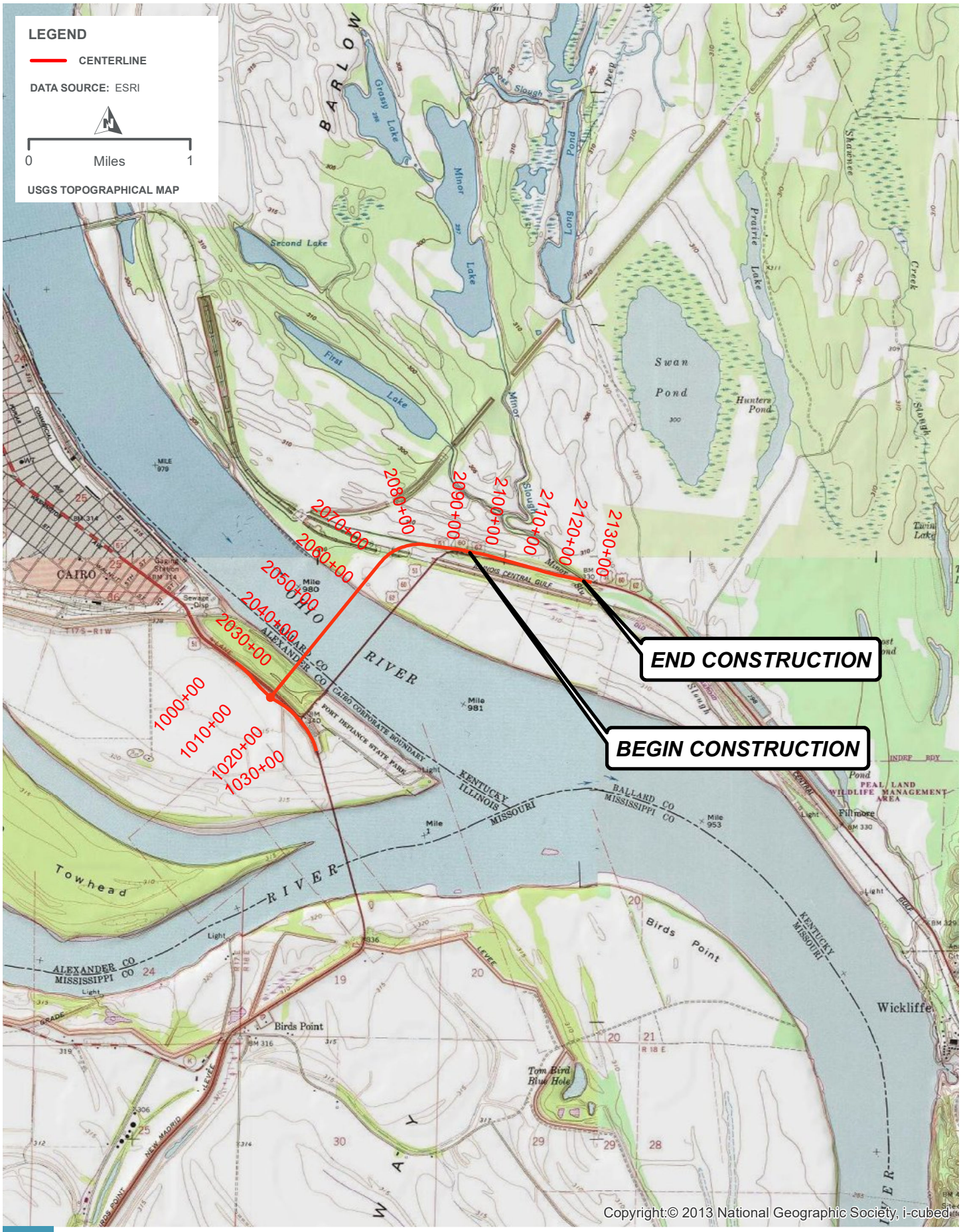
**Attachments:**

- **Attachment A: Project Location Map and Coordinate Data Sheet**
- **Attachment B: Geotechnical Notes and Soil Profile**
- **Attachment C: Driller Logs**
- **Attachment D: Laboratory Data**
- **Attachment E: Soil Parameters**
- **Attachment F: Liquefaction**
- **Attachment G: Slope Stability Results**
- **Attachment H: Newmark's Displacement Analysis Method Results**
- **Attachment I: Settlement Results**

# Attachment A: Project Location Map and Coordinate Data Sheet

hdrinc.com

333 West Vine Street, Suite 1400, Lexington, KY 40507-1681
(859) 629-4800




# US-51 ROADWAY IMPROVEMENTS

## BALLARD COUNTY - KENTUCKY

SITE VICINITY MAP

SUBSURFACE INVESTIGATION

**COORDINATE DATA SUBMISSION FORM**

**KYTC DIVISION OF STRUCTURAL DESIGN -- GEOTECHNICAL BRANCH**

**County** Alexander Co., IL / Ballard Co., KY **Date** 11/11/2025

**Road Number** US 51

**Survey Crew / Consultant** Civil Design, Inc.

**Contact Person** Dennis Kononov

**Item #** 1-1140.20

**Mars #**

**Project #**

**Notes:**

**Elevation Datum** (circle one) **NAVD88** **Assumed**

| HOLE NUMBER | LATITUDE (Decimal Degrees) | LONGITUDE (Decimal Degrees) | HOLE NUMBER | STATION | OFFSET | ELEVATION (ft) |
|---|---|---|---|---|---|---|
| B-2046 | 37.00065954 | 89.13786839 | B-2046 | 2093+73 | 12' LT | 314.31 |
| 117 | 37.00080292 | -89.13687147 | 117 | 2096+50 | 110' LT | 302.91 |
| 118 | 37.00040661 | -89.13717965 | 118 | 2095+86 | 48' RT | 327.61 |
| 119 | 36.99996453 | -89.13705626 | 119 | 2096+50 | 200' RT | 304.93 |
| 120 | 37.00044445 | -89.13652278 | 120 | 2097+73 | CL | 308.81 |
| 120A | 37.00044445 | -89.13652278 | 120A | 2097+72 | CL | 308.81 |
| 121 | 37.00021696 | -89.13518287 | 121 | 2101+73 | CL | 304.71 |
| 121A | 37.00021696 | -89.13518287 | 121A | 2101+72 | CL | 304.71 |
| 122 | 36.99994323 | -89.13385645 | 122 | 2105+73 | CL | 302.73 |
| 122A | 36.99994323 | -89.13385645 | 122A | 2105+72 | CL | 302.73 |
| 123 | 36.99978089 | -89.13328424 | 123 | 2107+50 | 10' RT | 308.78 |
| 124P | 36.99900122 | -89.12991857 | 124P | 2117+73 | 5' RT | 326.42 |
| 125 | 36.99898518 | -89.12965077 | 125 | 2118+50 | 5' RT | 324.52 |
| 126 | 36.998456 | -89.126944 | 126 | 2126+64 | CL | 328.40 |
| 126A | 36.99836521 | -89.1269815 | 126A | 2126+60 | 35' RT | 324.41 |
| B-6 | 37.000609 | -89.137896 | B-6 | 2093+67 | 7' RT | 313.80 |
| CPT-6 | 37.00067495 | -89.13784445 | CPT-6 | 2093+78 | 19' LT | 314.59 |

# Attachment B: Geotechnical Notes and Soil Profile

# GEOTECHNICAL SYMBOLS

## AASHTO Classification of Soils and Soil-Aggregate Mixtures

| General Classification | Granular Materials (35% or less passing 0.075 mm) | | | | | | | Silt-Clay Materials (More than 35% passing 0.075 mm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Group Classification | A-1 | | A-3 | A-2 | | | | A-4 | A-5 | A-6 | A-7 |
| | A-1-a | A-1-b | | A-2-4 | A-2-5 | A-2-6 | A-2-7 | | | | A-7-5 A-7-6 |
| Sieve Analysis, Percent Passing | | | | | | | | | | | |
| 2.00 mm (No. 10) | 50 max | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - |
| 0.425 mm (No. 40) | 30 max | 50 max | 51 min | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - |
| 0.075 mm (No. 200) | 15 max | 25 max | 10 max | 35 max | 35 max | 35 max | 35 max | 36 min | 36 min | 36 min | 36 min |
| Characteristics of Fraction Passing 0.425 mm (No. 40) | | | | | | | | | | | |
| Liquid Limit | - - - | | - - - | 40 max | 41 min | 40 max | 41 min | 40 max | 41 min | 40 max | 41 min |
| Plasticity Index | 6 max | | N.P. | 10 max | 10 max | 11 min | 11 min | 10 max | 10 max | 11 min | 11 min |

| | |
|---|---|
| AI | Activity Index |
| LI | Liquidity Index |
| S+C | Silt + Clay (% finer than No.200 Sieve) |
| ○ | Rockline Soundings |
| ◒ | Disturbed Sample Boring |
| ◎ | Undisturbed Sample Boring |
| ⊙ | Undisturbed Sample Boring & Rock Core |
| ● | Rock Core |
| ⌖ | Slope Inclinometer Installation |
| | typical applications: ⌖ ◒ ◎ ⊙ ● |
| OW | Observation Well |
| ➡ | Approximate Footing Elevation |
| ▼ (Date) | Water Elevation |

| | |
|---|---|
| VS (psf) | Field Vane Shear Strength |
| ■ | Thin-walled Tube Sample |
| < | Standard Penetration Test Sample |
| N | Penetration Resistance |
| Qu (psf) | Unconfined Compressive Strength |
| UU (psf) | Unconsolidated Undrained Triaxial Strength |
| w% | Moisture Content |
| KY RQD | Rock Quality Designation (Kentucky Method) |
| STD RQD | Rock Quality Designation (Standard Method) |
| SDI(JS) | Slake Durability Index (Jar Slake Test) |
| REC | Core Recovery |
| $\phi$ | Angle of Internal Friction (Total Stress) |
| $\bar{\phi}$ | Angle of Internal Friction (Effective Stress) |
| c (psf) | Cohesion (Total Stress) |
| $\bar{c}$ (psf) | Cohesion (Effective Stress) |
| $\gamma$ (pcf) | Total Unit Weight |
| RDZ | Rock Disintegration Zone |
| OB | Overburden Bench |
| IB | Intermediate Bench |
| R | Refusal |
| NR | Refusal Not Encountered |

## Unified Soil Classifications

| MAJOR DIVISIONS | | SYMBOL | NAME |
|---|---|---|---|
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | GW | Well-graded gravels or gravel-sand mixtures, little or no fines. |
| | | GP | Poorly graded gravels or gravel-sand mixtures, little or no fines. |
| | | GM | Silty gravels, gravel-sand-silt mixtures. |
| | | GC | Clayey gravels, gravel-sand-clay mixtures. |
| | SAND AND SANDY SOILS | SW | Well graded sands or gravelly sands, little or no fines. |
| | | SP | Poorly graded sands or gravelly sands, little or no fines. |
| | | SM | Silty sands, sand-silt mixtures. |
| | | SC | Clayey sands, sand-clay mixtures. |
| FINE GRAINED SOILS | SILTS AND CLAYS LL IS LESS THAN 50 | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity. |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays silty clays, lean clays. |
| | | ML-CL | Silty clay-silty clay with sand and or gravel, sandy silty clay, sandy silty clay with gravel, gravelly silty clay, gravelly silty clay with sand |
| | SILTS AND CLAYS LL IS GREATER THAN 50 | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts. |
| | | CH | Inorganic clays of high plasticity, fat clays. |

## Unified Soil Classifications - Continued

| MAJOR DIVISIONS | | SYMBOL | NAME |
|---|---|---|---|
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | GP-GC | Poorly graded gravel with clay (or silty clay), poorly graded gravel with clay and sand (or silty clay & sand) |
| | | GP-GM | Poorly graded gravel with silt, poorly graded gravel with silt and sand |
| | | GW-GC | Well graded gravel with clay (or silty clay), well graded gravel with clay and sand (or silty clay and sand) |
| | | GW-GM | Well graded gravel with silt, well graded gravel with silt and sand |
| | | GC-GM | Silty clayey gravel, silty clayey gravel with sand |
| | SAND AND SANDY SOILS | SW-SC | Well graded sand with clay (or silty clay), well graded sand with clay and gravel (or silty clay & gravel) |
| | | SP-SC | Poorly graded sand with clay (or silty clay), poorly graded sand with clay and gravel (or silty clay and gravel) |
| | | SP-SM | Poorly graded sand with silt, poorly graded sand with silt and gravel |
| | | SC-SM | Silty clayey sand, silty clayey sand with gravel |
| | | SW-SM | Well graded sand with silt, well graded sand with silt and gravel |
| UNCLASSIFIED MATERIAL | | OH | Organic (High Plasticity) |
| | | OL | Organic (Low Plasticity) |

| | |
|---|---|
| LIMESTONE | TALUS, MINE WASTE, FILL MATERIAL, BOULDERS, & ETC. |
| SANDSTONE | COAL |
| DURABLE SHALE (SDI ≥ 95) | DOLOMITE |
| NONDURABLE SHALE (SDI < 95) | LIMESTONE (ARGILLACEOUS) |
| GRANULAR EMBANKMENT | SLOPE PROTECTION |
| STRUCTURE GRANULAR BACKFILL | |

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
TEAM KENTUCKY TRANSPORTATION CABINET

GEOTECHNICAL SYMBOLS

ITEM NO. 1-1140.20 COUNTY OF BALLARD
SHEET NO. R45

# GEOTECHNICAL RECOMMENDATIONS

1. CLEARING AND GRUBBING OF ROADWAY AREAS SHALL BE COMPLETED IN ACCORDANCE WITH THE REQUIREMENTS OF SECTION 202 OF THE CURRENT KENTUCKY DEPARTMENT OF HIGHWAYS STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.

2. REMOVAL OF EXISTING STRUCTURES AT THE LOCATIONS SHOWN IN THESE DRAWINGS AND REMOVAL OF OTHER OBSTRUCTIONS, WHEN APPROVED BY THE DEPARTMENT, SHALL BE PERFORMED IN ACCORDANCE WITH SECTION 203 OF THE CURRENT KENTUCKY DEPARTMENT OF HIGHWAYS STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.

3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONDUCTING ALL OPERATIONS NECESSARY TO EXCAVATE EXISTING EMBANKMENT FILL WITHIN THE LIMITS OF DISTURBANCE TO THE EXTENTS REQUIRED FOR CONSTRUCTION OF THE GROUND IMPROVEMENT SYSTEM. THESE OPERATIONS SHALL BE INCIDENTAL TO ROADWAY EXCAVATION OR EMBANKMENT-IN-PLACE, AND NO ADDITIONAL COMPENSATION SHALL BE MADE FOR THIS WORK.

4. GROUND IMPROVEMENT SHALL BE CONSTRUCTED IN ACCORDANCE WITH “SPECIAL NOTE D: GROUND IMPROVEMENT”. CONSTRUCT GROUND IMPROVEMENT WITHIN THE FOLLOWING STATION INTERVAL BEFORE ANY OF THE EMBANKMENTS ARE CONSTRUCTED. DO NOT INSTALL GROUND IMPROVEMENT ELEMENTS WITHIN THE FOOTPRINT OF THE EXISTING BRIDGE ABUTMENT OR WITHIN THE LIMITS OF THE EXISTING PILE FOUNDATIONS, IN ACCORDANCE WITH SPECIAL NOTE D.

US-51
2093+00 TO 2094+35

5. THE CONTRACTOR SHALL CONSTRUCT A LOAD TRANSFER PLATFORM SPANNING THE LIMITS FOR GROUND IMPROVEMENT CONSTRUCTION SHOWN IN THE PLANS. THE LOAD TRANSFER PLATFORM SHALL CONSIST OF MATERIALS CONFORMING TO DENSE GRADED AGGREGATE PER SECTION 805 OF THE CURRENT KYTC STANDARD SPECIFICATIONS AND REINFORCED WITH THREE (3) LAYERS OF GEOSYNTHETIC REINFORCEMENT (GEOGRID) CONFORMING THE STRENGTH REQUIREMENTS SHOWN IN “SPECIAL NOTE D: GROUND IMPROVEMENT”. THE LOAD TRANSFER PLATFORM SHALL BE OVERLAIN WITH FABRIC-GEOTEXTILE, CLASS 1 (SEPARATION). REFER TO COLUMN SUPPORTED EMBANKMENT SYSTEM SHEET IN SPECIAL NOTE D, APPENDIX A FOR DETAILED REQUIREMENTS. REFER TO THE CURRENT KYTC STANDARD SPECIFICATIONS SECTION 214 AND SECTION 843 FOR GEOTEXTILE CONSTRUCTION AND GEOTEXTILE FABRICS.

6. THE CONTRACTOR IS RESPONSIBLE FOR THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF ALL TEMPORARY WORKS (E.G., SHORING, SHEET PILING) REQUIRED FOR THE INSTALLATION OF THE GROUND IMPROVEMENT SYSTEM. THE DESIGN SHALL BE REVIEWED AND APPROVED BY THE ENGINEER PRIOR TO INSTALLING ANY TEMPORARY WORK SYSTEMS. ANY TEMPORARY CONSTRUCTION SLOPES OR TEMPORARY WORK FEATURES SHOWN ON THESE DRAWINGS ARE FOR GENERAL GUIDANCE ONLY. THE TEMPORARY WORKS SYSTEM SHALL BE DESIGNED, CONSTRUCTED AND ESTABLISHED IN A MANNER THAT REMAINS SAFE AND STABLE FOR THE DURATION OF THE WORK, IMPLEMENTING ANY NECESSARY MEASURES TO MAINTAIN THE EXCAVATIONS AND PROTECT EXISTING GEOTECHNICAL AND STRUCTURAL FEATURES WITHIN AND ADJACENT TO THE DISTURBED LIMITS. THESE OPERATIONS SHALL BE INCIDENTAL TO ROADWAY EXCAVATION. NO ADDITIONAL COMPENSATION SHALL BE MADE FOR THIS WORK.

7. REMOVE ALL TEMPORARY SHEETING OR SHORING UPON COMPLETION OF THE SUBSTRUCTURE WORK, UNLESS OTHERWISE DIRECTED BY THE ENGINEER OR SHOWN ON THE CONTRACT DRAWINGS. SHEET PILES INSTALLED BETWEEN STATION 2094+04.45 AND 2095+00 SHALL REMAIN IN PLACE POST-CONSTRUCTION IN ACCORDANCE WITH THE CONTRACT CROSS SECTIONS. LEAVE PORTIONS OF OTHER TEMPORARY SHEETING OR SHORING IN PLACE ONLY WITH PRIOR WRITTEN PERMISSION OF THE ENGINEER. TEMPORARY STRUCTURES SHALL BE IN ACCORDANCE WITH SECTION 600 OF THE CURRENT KENTUCKY DEPARTMENT OF HIGHWAYS STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.

8. ALL WATER WELLS OR CISTERNS, SEPTIC TANKS, CATCH BASINS, MANHOLES, ETC., THAT MAY BE ENCOUNTERED WITHIN THE LIMITS OF THE CONSTRUCTION, WHETHER SHOWN ON PLANS OR NOT, SHALL BE PLUGGED AND/OR CAPPED IN ACCORDANCE WITH SECTION 708 OF THE CURRENT KENTUCKY DEPARTMENT OF HIGHWAYS STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.

9. EXCAVATION OF SURFACE DITCHES AND CHANNEL CHANGES ADJACENT TO EMBANKMENT AREAS SHALL BE PERFORMED PRIOR TO THE PLACEMENT OF THE ADJACENT EMBANKMENTS.

10. FOUNDATION EMBANKMENT BENCHES SHALL BE PLACED IN ACCORDANCE WITH STANDARD DRAWING RGX-010-04 AT THE APPROXIMATE LOCATIONS LISTED BELOW AND/OR AS DIRECTED BY THE ENGINEER. CONTRARY TO STANDARD DRAWING RGX-010, THE TYPICAL RISE HEIGHT FOR BENCHING INTO SOIL/EARTH SLOPES SHALL BE 4 TO 6 FEET. BENCHES IN SOIL/EARTH SLOPES SHALL BE CONSTRUCTED ONE AT A TIME BEGINNING WITH THE LOWEST BENCH AND EACH BENCH SHALL BE BACKFILLED PRIOR TO EXCAVATION OF THE NEXT BENCH:

US-51
2094+65 to 2123+25

11. CLASS 1 (SEPARATION) GEOTEXTILE FABRIC IS REQUIRED IN ACCORDANCE WITH SPECIAL NOTE D. ADDITIONALLY, WHERE SATURATED, SOFT FOUNDATION AREAS, AND/OR DRAINAGE SWALES ARE PRESENT WITHIN THE EMBANKMENT FOUNDATION LIMITS, CLASS 1 (SEPARATION) GEOTEXTILE FABRIC SHALL ALSO BE PLACED BENEATH THE EMBANKMENT AT THE INTERFACE OF THE GRANULAR EMBANKMENT AND EXISTING GROUND LINE. THE ACTUAL LOCATIONS WITHIN THE FOUNDATION LIMITS THAT REQUIRE SEPARATION GEOTEXTILE FABRIC WILL BE DETERMINED BY THE ENGINEER DURING CONSTRUCTION. REFER TO THE CURRENT STANDARD SPECIFICATIONS SECTION 214 AND SECTION 843 FOR GEOTEXTILE CONSTRUCTION AND GEOTEXTILE FABRICS.

12. IN ACCORDANCE WITH SECTION 214.03.03 OF THE KYTC STANDARD SPECIFICATIONS, THE DROP HEIGHT OF THE LOWEST 2 FEET OF GRANULAR EMBANKMENT AND/OR LOAD TRANSFER PLATFORM SHALL BE LIMITED TO 3 FEET TO AVOID DAMAGING THE SEPARATION GEOTEXTILE FABRIC. REFER TO THE CURRENT KYTC STANDARD SPECIFICATIONS SECTION 214 AND SECTION 843 FOR GEOTEXTILE CONSTRUCTION AND GEOTEXTILE FABRICS. THIS WORK SHALL BE DONE AS SHOWN ON THE PROJECT CROSS-SECTIONS, PROJECT SPECIAL NOTES, AND AS DIRECTED BY THE ENGINEER.

13. SOME OF THE SOIL HORIZONS AND SLOPES ON THE PROJECT ARE SUBJECT TO EROSION. NECESSARY PROCEDURES IN ACCORDANCE WITH SECTIONS 212 AND 213 OF THE CURRENT KYTC STANDARD SPECIFICATIONS SHALL BE FOLLOWED ON CONSTRUCTION.

14. ALL EMBANKMENT MATERIALS PLACED ABOVE THE EXISTING GROUND LINE AND WITHIN THE LIMITS SHOWN ON THE PLANS SHALL BE CONSTRUCTED OF GRANULAR EMBANKMENT MEETING THE REQUIREMENTS OF SECTION 805.10 OF THE CURRENT KYTC STANDARD SPECIFICATIONS. THIS REQUIREMENT INCLUDES EMBANKMENT MATERIALS PLACED ABOVE THE LOAD TRANSFER PLATFORM. THE EMBANKMENT SHALL BE CONSTRUCTED BY END-DUMPING AND GRADING THE MATERIAL (IN ACCORDANCE WITH SECTION 805 OF THE KYTC STANDARD SPECIFICATIONS). WITHIN THE LIMITS OF THE LOAD TRANSFER PLATFORM, PLACE GRANULAR EMBANKMENT IN A MANNER TO AVOID DAMAGE OR DISPLACEMENT OF THE LOAD TRANSFER PLATFORM. AS PER SECTION 805.03.04 OF THE KYTC STANDARD SPECIFICATIONS, THE GRANULAR EMBANKMENT SHALL BE NON-ERODIBLE AND STABLE MATERIAL AND IS REQUIRED TO BE QUARRY-PROCESSED LIMESTONE. DO NOT EXTEND THE CONSTRUCTION BERM BEYOND THE PROPOSED ROADWAY EMBANKMENT TOE.

15. THE CONTRACTOR IS RESPONSIBLE FOR CONDUCTING ANY OPERATIONS NECESSARY TO EXCAVATE THE CUT AREAS TO THE REQUIRED TYPICAL SECTIONS. THESE OPERATIONS SHALL BE INCIDENTAL TO EMBANKMENT IN PLACE.

16. EXCESS MATERIAL SHALL BE DEPOSITED ON A PERMITTED SITE. ALL WORK ASSOCIATED WITH EXCESS MATERIAL PLACEMENT SHALL CONFORM TO SECTION 205 OF THE CURRENT KYTC STANDARD SPECIFICATIONS AND ALL APPLICABLE PLAN NOTES AND BID DOCUMENTS. THE CONTRACTOR WILL BE RESPONSIBLE FOR IDENTIFYING A SITE, PREPARING PLANS FOR THE SITE AND SUBMITTING THEM TO THE CABINET FOR REVIEW. ADDITIONALLY, THE CONTRACTOR IS ALSO RESPONSIBLE FOR GEOTECHNICAL INVESTIGATIONS AND ANALYSIS OF THE PROPOSED EXCESS MATERIAL STORAGE AREA, INCLUDING ANY NECESSARY STABILITY AND SETTLEMENT ANALYSES. ENSURE ALL WORK IS PERFORMED BY A KYTC PREQUALIFIED GEOTECHNICAL CONSULTANT AND IS IN ACCORDANCE WITH THE DEPARTMENT'S GEOTECHNICAL MANUAL. ALL WORK SHALL BE SUBJECT TO REVIEW BY THE CABINET.

17. IF A SPRING WITH A DEFINED AREA OF WATER FLOW IS ENCOUNTERED DURING CONSTRUCTION, INSTALL A SPRING BOX WITH A PIPE OUTLET AT THE TOE OF THE SLOPE, AS DETERMINED BY THE ENGINEER.

18. BOTH A PILE LOAD TESTING PROGRAM, WHICH INCLUDES THE APPROACH SPAN PILE LOAD TESTS, AND GROUND IMPROVEMENTS ARE INCLUDED IN THE ADVANCE LETTING CONTRACT DOCUMENTS. GROUND IMPROVEMENT VERIFICATION TESTING, INCLUDING PRE- AND POST-INSTALLATION SCPT/SPT TESTING OF PRE-PRODUCTION RIGID INCLUSION TEST SECTIONS, WILL BE COMPLETED AS PART OF THE ADVANCED LETTING. COORDINATION BETWEEN THE LOAD TESTING CONTRACTOR AND THE GROUND IMPROVEMENT CONTRACTOR AND THEIR SUBCONTRACTORS WILL BE REQUIRED DUE TO THE PROXIMITY OF THE WORK TO THE BRIDGE ABUTMENTS. REFER TO THE "SPECIAL NOTE FOR PILE LOAD TESTING PROGRAM" FOR SPECIFIC DETAILS, LOCATIONS, AND REQUIRED COORDINATION WITH ROADWAY CONSTRUCTION.

19. CONSTRUCT A GRANULAR PILE CORE AT THE KENTUCKY ABUTMENT PRIOR TO THE INSTALLATION OF PILING IN ACCORDANCE WITH KYTC SPECIAL PROVISION NO. 69 AND KYTC STANDARD DRAWINGS RGX-100 AND RGX-105. WHERE CONFLICTS EXIST BETWEEN THE CONTRACT DRAWINGS, SPECIAL PROVISION, AND STANDARD DRAWINGS, THE CONTRACT DRAWINGS SHALL GOVERN. THE PILE CORE SHALL CONSIST OF STRUCTURE GRANULAR BACKFILL MEETING THE REQUIREMENTS OF SECTION 805.11 OF THE KYTC STANDARD SPECIFICATIONS AND SHALL EXTEND TO THE LIMITS AND EXTENTS SHOWN ON THE APPLICABLE STANDARD OR CONTRACT DRAWINGS. NO ROCK FRAGMENTS LARGER THAN 4 INCHES IN ANY DIMENSION ARE PERMITTED WITHIN THE PILE CORE. MEASUREMENT AND PAYMENT FOR THE GRANULAR PILE CORE SHALL BE IN ACCORDANCE WITH KYTC SPECIAL PROVISION NO. 69. PILE CORE WILL BE MEASURED AND PAID UNDER ROADWAY EXCAVATION OR EMBANKMENT-IN-PLACE.

20. PROVIDE AN 8-INCH PERFORATED UNDERDRAIN WITHIN THE GRANULAR PILE CORE IN ACCORDANCE WITH SPECIAL PROVISION NO. 69 AND KYTC STANDARD DRAWINGS RGX-100 AND RGX-105. INSTALL THE UNDERDRAIN TO THE LINES, GRADES, LIMITS, AND OUTLET HEADWALL CONFIGURATION SHOWN ON THE CONTRACT DRAWINGS. WHERE THE PILE CORE IS LOCATED WITHIN THE LIMITS OF THE GROUND IMPROVEMENTS, INSTALL THE UNDERDRAIN AT THE ELEVATION OF THE TOP OF THE LOAD TRANSFER PLATFORM; OTHERWISE, INSTALL THE UNDERDRAIN AT THE ORIGINAL GROUND ELEVATION. WRAP THE PERFORATED PIPE WITH A FILTER FABRIC OF THE TYPE RECOMMENDED BY THE PIPE MANUFACTURER. THE DEPARTMENT CONSIDERS THE 8-INCH PERFORATED UNDERDRAIN PIPE INCIDENTAL TO THE PILE CORE.

21. SETTLEMENT PLATFORMS (STANDARD DRAWING RGX 015) SHALL BE FURNISHED AND INSTALLED BY THE CONTRACTOR AT THE LEFT SHOULDER, OUTSIDE THE PROPOSED GUARDRAIL, AT THE APPROXIMATE LOCATIONS BELOW. THE EXACT LOCATIONS SHALL BE DETERMINED BY THE ENGINEER AND A REPRESENTATIVE OF THE DEPARTMENT'S GEOTECHNICAL SERVICES BRANCH. THE SETTLEMENT PLATFORMS WITHIN THE LIMITS OF THE GROUND IMPROVEMENT SHALL BE CONSTRUCTED AFTER THE LOAD-TRANSFER PLATFORM (LTP). SETTLEMENT PLATFORMS SHALL BE CONSTRUCTED AS EARLY AS PRACTICAL.
CONTACT THE GEOTECHNICAL SERVICES BRANCH APPROXIMATELY ONE (1) WEEK PRIOR TO THE INSTALLATION OF THE SETTLEMENT PLATFORMS. THE PLATFORMS SHALL BE INSTALLED IN ACCORDANCE WITH SECTION 216 OF THE CURRENT STANDARD SPECIFICATIONS. THE GEOTECHNICAL SERVICES BRANCH WILL PROVIDE THE NECESSARY FORMS FOR RECORDING MEASUREMENTS. READINGS SHALL BE OBTAINED USING A BENCHMARK AND LEVEL; USE OF GPS SURVEY EQUIPMENT WILL NOT BE PERMITTED. FILL ELEVATION READINGS SHALL ALSO BE OBTAINED WITH EACH SETTLEMENT PLATFORM READING. THESE SHALL BE AT THE CURRENT FILL SURFACE WITHIN THREE (3) FEET OF THE SETTLEMENT PLATFORM PIPE.
BASED ON THE RESULTS OF SETTLEMENT READINGS, THE ENGINEER AND GEOTECHNICAL SERVICES BRANCH WILL DETERMINE IF SETTLEMENT HAS COMPLETED SUFFICIENTLY TO PROCEED WITH CONSTRUCTION OF PERMANENT DRAINAGE STRUCTURES AND FINAL PAVING OPERATIONS. SETTLEMENT PLATFORMS DESTROYED BY THE CONTRACTOR SHALL BE REPLACED AT THE CONTRACTOR'S EXPENSE. PLATFORMS SHALL BE LEFT IN PLACE FOR FUTURE READINGS AFTER PROJECT CONSTRUCTION HAS BEEN COMPLETED.

SETTLEMENT PLATFORM LOCATION
STATION 2094+10, 32' LT.
STATION 2094+50, 31' LT.
STATION 2096+00, 31' LT.
STATION 2099+50, 53' LT.
STATION 2105+50, 53' LT.

22. AS DIRECTED BY THE ENGINEER, EXISTING BITUMINOUS CONCRETE LOCATED AT A DISTANCE GREATER THAN 3 FEET BELOW THE PROPOSED SUBGRADE ELEVATION WITHIN THE LIMITS OF NEW ROADWAY EMBANKMENTS, SHALL BE SCARIFIED OR BROKEN UNTIL ALL CLEAVAGE PLANES ARE DESTROYED, OR THE PAVEMENT SHALL BE REMOVED ENTIRELY AS CONDITIONS DEMAND. THIS SHALL BE PERFORMED IN COMPLIANCE WITH SECTION 206 OF THE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.

23. IN AREAS WHERE PAVEMENT IS NOT TO BE OVERLAID, EXISTING BITUMINOUS CONCRETE LOCATED AT A DISTANCE LESS THAN THREE FEET BELOW THE PROPOSED SUBGRADE ELEVATION WITHIN THE LIMITS OF NEW ROADWAY EMBANKMENTS, SHALL BE REMOVED ENTIRELY. THIS SHALL BE PERFORMED IN COMPLIANCE WITH SECTION 206 OF THE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.




## BASIS OF ELEVATIONS

Elevations were derived from GPS methods and are adjusted to the NAVD88 Vertical Datum. Geoid model used was Geoid12B.

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

TEAM KENTUCKY
TRANSPORTATION CABINET

DRAWING TITLE: US-51 SOIL PROFILE

0′ 100′ 200′ 400′
HORIZONTAL SCALE: 1"=100′

0′ 10′ 20′ 40′
VERTICAL SCALE: 1"=10′

STA. 2040+00.00 TO STA. 2070+00.00

ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R48

OpenRoads Designer v23.00.01.11
USER: TLYNN
FILE NAME: C:\PWV8I-LOCAL\BAKER_PROJECTS\WESLEY.SHUECRAFT\D0757077\01_1140_00_GEO_KY PROFILE.DGN

REFER TO GEOTECHNICAL NOTE 4 & 5
FOR STA. 2093+00 TO STA. 2094+35

REFER TO GEOTECHNICAL NOTE 10 FOR
STA. 2094+00 TO STA. 2123+25

REFER TO GEOTECHNICAL NOTE 7 FOR
STA. 2094+04.45 TO STA. 2095+00 RT.

REFER TO SECTION STATION 2094+00
FOR EMBANKMENT STABILITY

REFER TO SECTION STATION 2096+50
FOR EMBANKMENT STABILITY

REFER TO SECTION STATION 2097+50
FOR EMBANKMENT STABILITY

REFER TO GEOTECHNICAL NOTE 21 FOR
STA. 2094+10 LT.
STA. 2094+50 LT.
STA. 2096+00 LT.
STA. 2099+50 LT.

-0.65%

-2.00%

120A
CL

W%
23
1
NR

| | | |
|---|---|---|
| SAMPLE NO. | | 1 |
| STATION | | 2097+72 |
| OFFSET | | CL |
| DEPTH | | 0.0'-8.0' |
| COMPOSITION OF TOTAL SAMPLE | GRAVEL (- 3" + NO. 10) | 0.0 |
| | SAND (- NO 10 + NO. 200) | 4.5 |
| | SILT (- 0.075 mm + 0.002 mm) | 74.2 |
| | CLAY (- 0.002 mm) | 21.3 |
| LIQUID LIMIT | | 42 |
| PLASTIC LIMIT | | 22 |
| PLASTICITY INDEX | | 20 |
| ACTIVITY INDEX | | 0.94 |
| SPECIFIC GRAVITY | | 2.717 |
| AASHTO CLASSIFICATION | | A-7-6(21) |
| UNIFIED CLASSIFICATION | | CL |
| CALIFORNIA BEARING RATIO | | 6.3 |
| MAXIMUM DRY DENSITY (pcf) | | 96.3 |
| OPTIMUM MOISTURE (%) | | 25.4 |
| % +4.75mm MATERIAL IN CBR & MOISTURE-DENSITY TESTS | | - |

410 400 390 380 370 360 350 340 330 320 310 300 290 280 270 260 250

2071+00 2072+00 2073+00 2074+00 2075+00 2076+00 2077+00 2078+00 2079+00 2080+00 2081+00 2082+00 2083+00 2084+00 2085+00 2086+00 2087+00 2088+00 2089+00 2090+00 2091+00 2092+00 2093+00 2094+00 2095+00 2096+00 2097+00 2098+00 2099+00 2100+00

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
TEAM KENTUCKY TRANSPORTATION CABINET

DRAWING TITLE: US-51 SOIL PROFILE

0′ 100′ 200′ 400′
HORIZONTAL SCALE: 1"=100′

0′ 10′ 20′ 40′
VERTICAL SCALE: 1"=10′

STA. 2070+00.00 TO STA. 2100+00.00

ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R49

OpenRoads Designer v23.00.01.11
USER: TLYNN
FILE NAME: C:\PWV8I-LOCAL\BAKER_PROJECTS\TAMARA.LYNN\D0757077\01_1140_00_GEO_KY PROFILE.DGN

REFER TO SECTION STATION 2101+50
FOR EMBANKMENT STABILITY

REFER TO GEOTECHNICAL NOTE 10 FOR
FOR STA. 2094+00 TO STA. 2123+25

REFER TO SECTION STATION 2105+50
FOR EMBANKMENT STABILITY

REFER TO SECTION STATION 2118+50
FOR EMBANKMENT STABILITY

REFER TO GEOTECHNICAL NOTE 21 FOR
FOR STA. 2105+50 LT.

REFER TO SECTION STATION 2126+50
FOR EMBANKMENT STABILITY

REFER TO SECTION STATION 2107+50
FOR EMBANKMENT STABILITY

0.00%

121A
CL

W%

39

NR

2

122A
CL

W%

40

NR

3

STA. 2126+63.92
END CONST.

| SAMPLE NO. | | 2 | 3 |
|---|---|---|---|
| STATION | | 2101+72 | 2105+72 |
| OFFSET | | CL | CL |
| DEPTH | | 0.0'-8.0' | 0.0'-8.0' |
| COMPOSITION OF TOTAL SAMPLE | GRAVEL (- 3" + NO. 10) | 0.0 | 0.4 |
| | SAND (- NO 10 + NO. 200) | 7.4 | 12.7 |
| | SILT (- 0.075 mm + 0.002 mm) | 66.5 | 56.2 |
| | CLAY (- 0.002 mm) | 26.1 | 30.6 |
| LIQUID LIMIT | | 46 | 42 |
| PLASTIC LIMIT | | 28 | 25 |
| PLASTICITY INDEX | | 18 | 17 |
| ACTIVITY INDEX | | 0.69 | 0.56 |
| SPECIFIC GRAVITY | | 2.562 | 2.708 |
| AASHTO CLASSIFICATION | | A-7-6(20) | A-7-6(16) |
| UNIFIED CLASSIFICATION | | ML | CL |
| CALIFORNIA BEARING RATIO | | 5.3 | 5.0 |
| MAXIMUM DRY DENSITY (pcf) | | 96.4 | 107.2 |
| OPTIMUM MOISTURE (%) | | 20.3 | 20.2 |
| % +4.75mm MATERIAL IN CBR & MOISTURE-DENSITY TESTS | | - | - |

390 380 370 360 350 340 330 320 310 300 290 280 270 260 250 240 230

2101+00 2102+00 2103+00 2104+00 2105+00 2106+00 2107+00 2108+00 2109+00 2110+00 2111+00 2112+00 2113+00 2114+00 2115+00 2116+00 2117+00 2118+00 2119+00 2120+00 2121+00 2122+00 2123+00 2124+00 2125+00 2126+00

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

TEAM KENTUCKY
TRANSPORTATION CABINET

DRAWING TITLE: US-51 SOIL PROFILE

0′ 100′ 200′ 400′
HORIZONTAL SCALE: 1"=100′

0′ 10′ 20′ 40′
VERTICAL SCALE: 1"=10′

STA. 2100+00.00 TO STA. 2126+63.92

ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R50

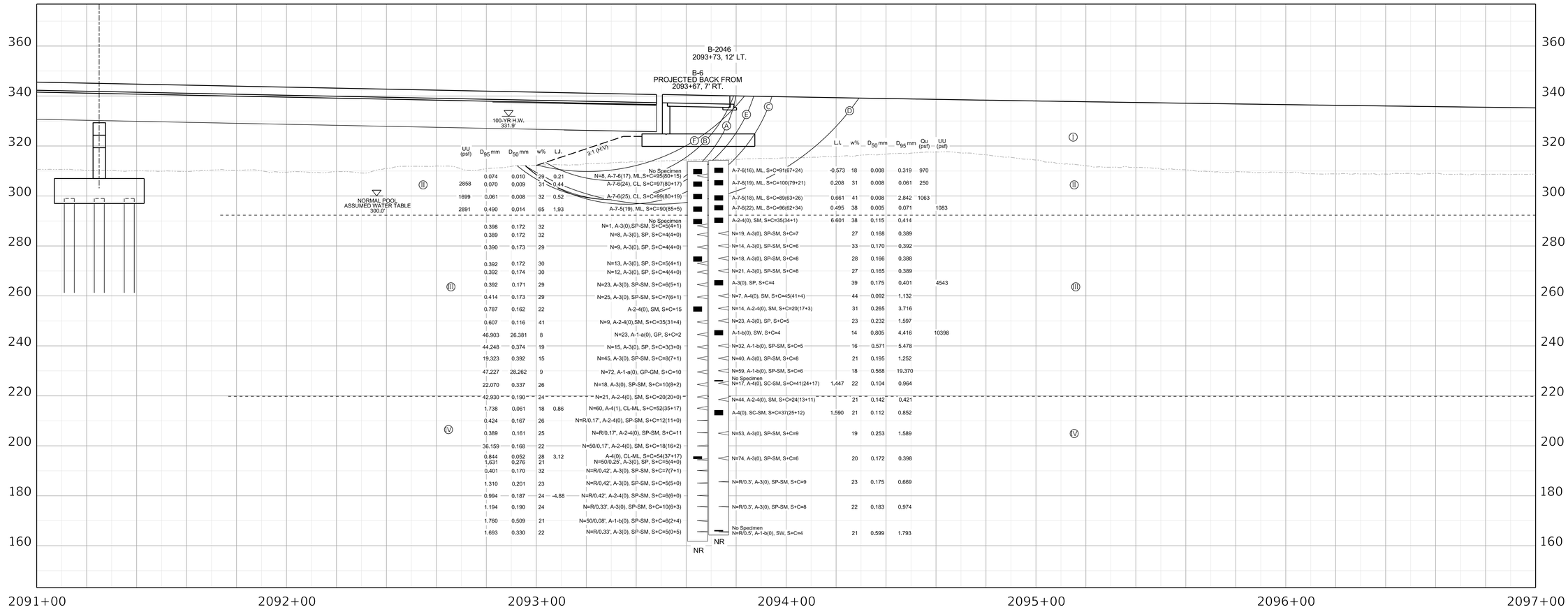
OpenRoads Designer v23.00.01.11
USER: TLYNN
FILE NAME: C:\PWV8I-LOCAL\BAKER_PROJECTS\TAMARA.LYNN\D0757077\01_1140_00_GEO_KY PROFILE.DGN

| FACTORS OF SAFETY | | |
|---|---|---|
| SHORT TERM | A | 1.5 |
| LONG TERM | B | 2.1 |
| SEISMIC 100 YR | C | 1.2 |
| SEISMIC 1000 YR | D | 0.5 |
| RAPID DRAWDOWN | E | 1.4 |
| SEISMIC 1000-YR (1/2 PGA) | F | 1.3* |

* FACTOR OF SAFETY INCLUDES THE EFFECTS FROM GROUND IMPROVEMENTS CONSISTING OF A COLUMN-SUPPORTED EMBANKMENT WITH REINFORCED CEMENTITIOUS RIGID INCLUSIONS.

** RESULTS ARE BASED ON NORMAL POOL CONDITIONS WITH AN ASSUMED GROUNDWATER ELEVATION OF 300 FEET. RAPID DRAWDOWN LOADING ASSUMES DRAWDOWN FROM THE 100-YEAR HIGH-WATER ELEVATION (ELEV. 331.9 FT) TO NORMAL POOL.

| ASSUMED SOIL STRENGTH PARAMETERS | | | | |
|---|---|---|---|---|
| SOIL | I | II | III | IV |
| SHORT TERM | c = 0 PSF<br>Φ = 38°<br>γ = 125 PCF | c = 800 PSF<br>Φ = 0°<br>γ = 115 PCF | c = 0 PSF<br>Φ = 32°<br>γ = 130 PCF | c = 0 PSF<br>Φ = 36°<br>γ = 130 PCF |
| LONG TERM | c' = 0 PSF<br>Φ' = 38°<br>γ = 125 PCF | c' = 80 PSF<br>Φ' = 28°<br>γ = 115 PCF | c' = 0 PSF<br>Φ' = 32°<br>γ = 130 PCF | c' = 0 PSF<br>Φ' = 36°<br>γ = 130 PCF |




NOTE:
SUPERSTRUCTURE AND SUBSTRUCTURE SUBJECT TO CHANGE

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
TEAM KENTUCKY TRANSPORTATION CABINET

DRAWING TITLE: SPILL-THROUGH STABILITY PROFILE

0' 20' 40' 80'
HORIZONTAL SCALE: 1"=20'

0' 20' 40' 80'
VERTICAL SCALE: 1"=20'

STA. 2091+00.00 - STA. 2097+00.00

ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R51

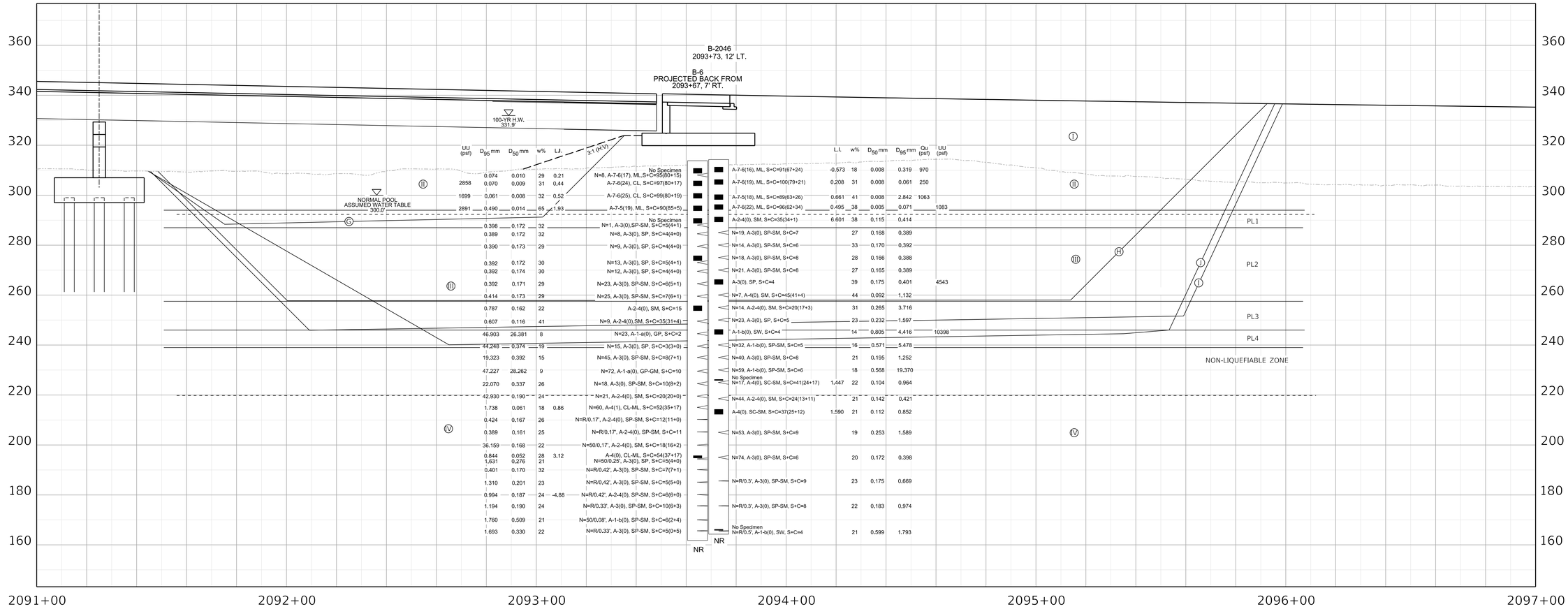
| ASSUMED SOIL STRENGTH PARAMETERS | | | | |
|---|---|---|---|---|
| SOIL | I | II | III | IV |
| SHORT TERM | c = 0 PSF<br>Φ = 38°<br>ɣ = 125 PCF | c = 800 PSF<br>Φ = 0°<br>ɣ = 115 PCF | c = 0 PSF<br>Φ = 32°<br>ɣ = 130 PCF | c = 0 PSF<br>Φ = 36°<br>ɣ = 130 PCF |
| LONG TERM | c̄ = 0 PSF<br>Φ̄ = 38°<br>ɣ = 125 PCF | c̄ = 80 PSF<br>Φ̄ = 28°<br>ɣ = 115 PCF | c̄ = 0 PSF<br>Φ̄ = 32°<br>ɣ = 130 PCF | c̄ = 0 PSF<br>Φ̄ = 36°<br>ɣ = 130 PCF |

| ASSUMED SOIL STRENGTH PARAMETERS FOR LIQUEFIED SOILS | | | | |
|---|---|---|---|---|
| SOIL | PL-1 | PL-2 | PL-3 | PL-4 |
| SHORT TERM | $S_r$ = 150 PSF<br>ɣ = 120 PCF | $S_r$ = 350 PSF<br>ɣ = 130 PCF | $S_r$ = 500 PSF<br>ɣ = 130 PCF | $S_r$ = 700 PSF<br>ɣ = 130 PCF |

| FACTORS OF SAFETY - 1000 YEAR EVENT | | |
|---|---|---|
| LIQUEFACTION ZONE PL1 | G | 1.4 |
| LIQUEFACTION ZONE PL2 | H | 2.8 |
| LIQUEFACTION ZONE PL3 | I | 2.4 |
| LIQUEFACTION ZONE PL4 | J | 2.4 |

* FACTOR OF SAFETY INCLUDES THE EFFECTS FROM GROUND IMPROVEMENTS CONSISTING OF A COLUMN-SUPPORTED EMBANKMENT WITH REINFORCED CEMENTITIOUS RIGID INCLUSIONS.

**RESULTS ARE BASED ON NORMAL POOL CONDITIONS WITH AN ASSUMED GROUNDWATER ELEVATION OF 300 FT.




NOTE:
SUPERSTRUCTURE AND SUBSTRUCTURE SUBJECT TO CHANGE

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
TEAM KENTUCKY TRANSPORTATION CABINET

DRAWING TITLE: AFTER SEIZMIC EVENT WEDGE ANALYSIS

0′ 20′ 40′ 80′
HORIZONTAL SCALE: 1"=20′

0′ 20′ 40′ 80′
VERTICAL SCALE: 1"=20′

STA. 2091+00.00 - STA. 2097+00.00

ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R52

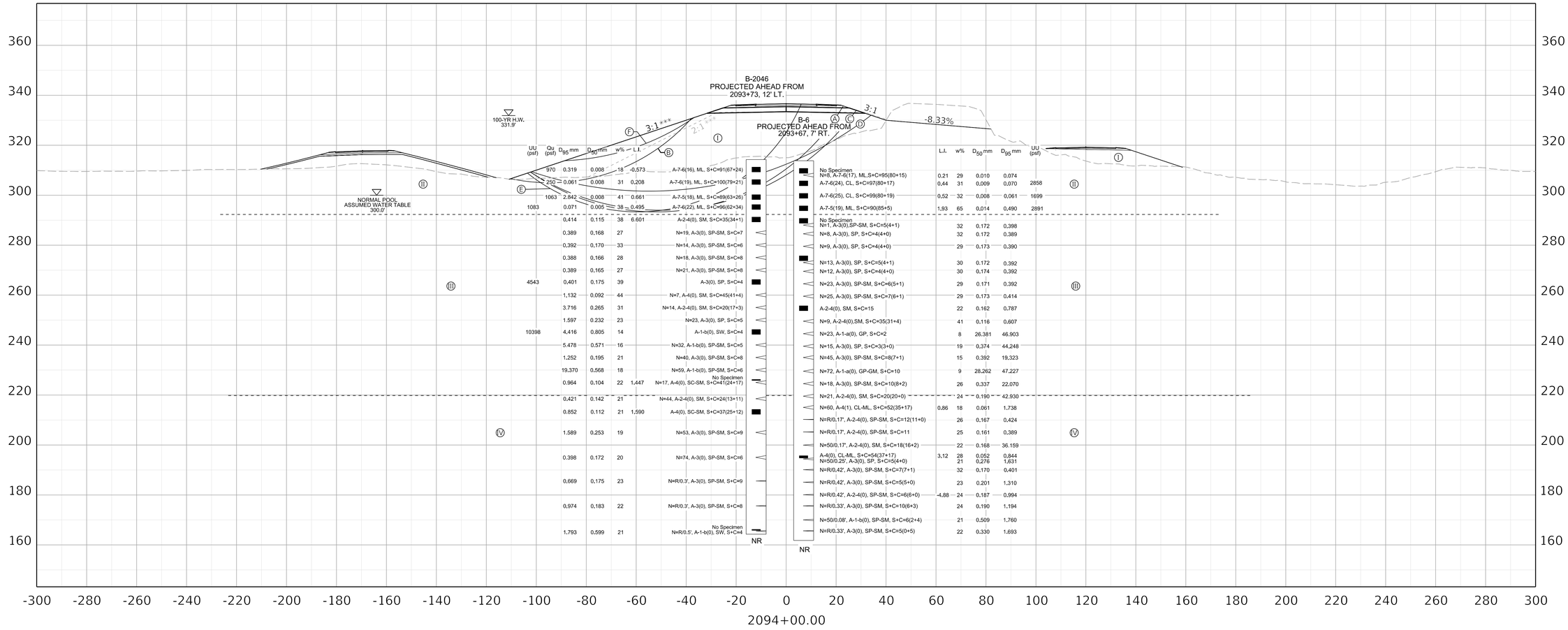
| FACTORS OF SAFETY** | | |
|---|---|---|
| SHORT TERM | A | 1.5 |
| LONG TERM | B | 2.3 |
| SEISMIC 100 YR | C | 1.2 |
| SEISMIC 1000 YR | D | 0.6 |
| RAPID DRAWDOWN | E | 1.4 |
| SEISMIC 1000 YR ½ PGA | F | 1.2* |

* FACTOR OF SAFETY INCLUDES THE EFFECTS FROM GROUND IMPROVEMENTS CONSISTING OF A COLUMN-SUPPORTED EMBANKMENT WITH REINFORCED CEMENTITIOUS RIGID INCLUSIONS.

**RESULTS ARE BASED ON NORMAL POOL CONDITIONS WITH AN ASSUMED GROUNDWATER ELEVATION OF 300 FEET. RAPID DRAWDOWN LOADING ASSUMES DRAWDOWN FROM THE 100-YEAR HIGH-WATER ELEVATION (ELEV. 331.9 FT) TO NORMAL POOL.

***2H:1V SLOPES REPRESENT ADVANCE LETTING (PHASE 1) CONSTRUCTION. FINAL 3H:1V SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS.

| ASSUMED SOIL STRENGTH PARAMETERS | | | | |
|---|---|---|---|---|
| SOIL | I | II | III | IV |
| SHORT TERM | c = 0 PSF<br>Φ = 38°<br>γ = 125 PCF | c = 800 PSF<br>Φ = 0°<br>γ = 115 PCF | c = 0 PSF<br>Φ = 32°<br>γ = 130 PCF | c = 0 PSF<br>Φ = 36°<br>γ = 130 PCF |
| LONG TERM | $\bar{c}$ = 0 PSF<br>$\bar{\Phi}$ = 38°<br>γ = 125 PCF | $\bar{c}$ = 80 PSF<br>$\bar{\Phi}$ = 28°<br>γ = 115 PCF | $\bar{c}$ = 0 PSF<br>$\bar{\Phi}$ = 32°<br>γ = 130 PCF | $\bar{c}$ = 0 PSF<br>$\bar{\Phi}$ = 36°<br>γ = 130 PCF |




COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
TEAM KENTUCKY TRANSPORTATION CABINET

DRAWING TITLE: EMBANKMENT STABILITY SECTION

HORIZONTAL SCALE: 1"=20'
VERTICAL SCALE: 1"=20'

STA. 2094+00.00

ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R53

OpenRoads Designer v23.00.01.11
USER: TLYNN
FILE NAME: C:\PWV8I-LOCAL\BAKER_PROJECTS\TYLER VALINE\D0757077\01_1140_00_GEO_KY CROSS SECTIONS.DGN

| ASSUMED SOIL STRENGTH PARAMETERS | | | | |
|---|---|---|---|---|
| SOIL | I | II | III | IV |
| SHORT TERM | c = 0 PSF<br>Φ = 38°<br>γ = 125 PCF | c = 800 PSF<br>Φ = 0°<br>γ = 115 PCF | c = 0 PSF<br>Φ = 32°<br>γ = 130 PCF | c = 0 PSF<br>Φ = 36°<br>γ = 130 PCF |
| LONG TERM | c' = 0 PSF<br>Φ' = 38°<br>γ = 125 PCF | c' = 80 PSF<br>Φ' = 28°<br>γ = 115 PCF | c' = 0 PSF<br>Φ' = 32°<br>γ = 130 PCF | c' = 0 PSF<br>Φ' = 36°<br>γ = 130 PCF |

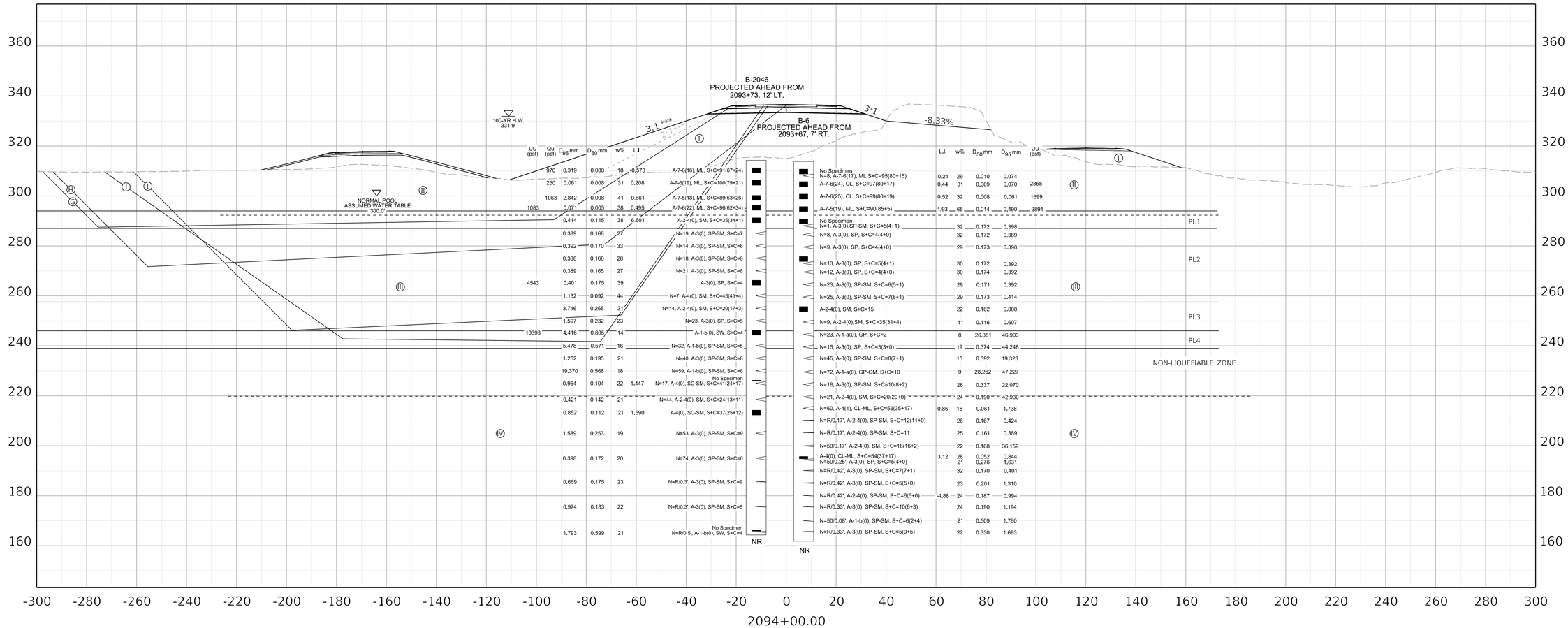
| ASSUMED SOIL STRENGTH PARAMETERS FOR LIQUEFIED SOILS | | | | |
|---|---|---|---|---|
| SOIL | PL-1 | PL-2 | PL-3 | PL-4 |
| SHORT TERM | $S_r$ = 150 PSF<br>γ = 115 PCF | $S_r$ = 350 PSF<br>γ = 130 PCF | $S_r$ = 500 PSF<br>γ = 130 PCF | $S_r$ = 700 PSF<br>γ = 130 PCF |

| FACTORS OF SAFETY - 1000 YEAR EVENT | | |
|---|---|---|
| LIQUEFACTION ZONE PL1 | G | 2.2 |
| LIQUEFACTION ZONE PL2 | H | 1.2 |
| LIQUEFACTION ZONE PL3 | I | 1.4 |
| LIQUEFACTION ZONE PL4 | J | 1.5 |

* FACTOR OF SAFETY INCLUDES THE EFFECTS FROM GROUND IMPROVEMENTS CONSISTING OF A COLUMN-SUPPORTED EMBANKMENT WITH REINFORCED CEMENTITIOUS RIGID INCLUSIONS.

**RESULTS ARE BASED ON NORMAL POOL CONDITIONS WITH AN ASSUMED GROUNDWATER ELEVATION OF 300 FEET.

***2H:1V SLOPES REPRESENT ADVANCE LETTING (PHASE 1) CONSTRUCTION. FINAL 3H:1V SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS.




COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

TEAM KENTUCKY TRANSPORTATION CABINET

DRAWING TITLE: AFTER SEISMIC EVENT WEDGE ANALYSIS

0' 20' 40' 80'
HORIZONTAL SCALE: 1"=20'

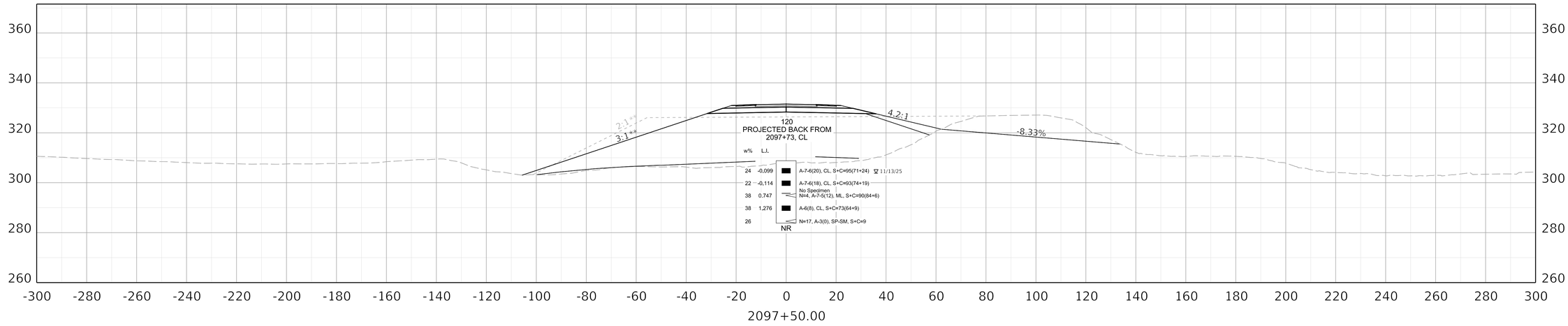
0' 20' 40' 80'
VERTICAL SCALE: 1"=20'

STA. 2094+00.00

ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R54

OpenRoads Designer v23.00.01.11
USER: TLYNN
FILE NAME: C:\PWV8I-LOCAL\BAKER_PROJECTS\TAMARA.LYNN\D0728257\01_1140_00_GEO_KY CROSS SECTIONS.DGN

**2H:1V SLOPES REPRESENT ADVANCE LETTING (PHASE 1) CONSTRUCTION. FINAL 3H:1V SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS.



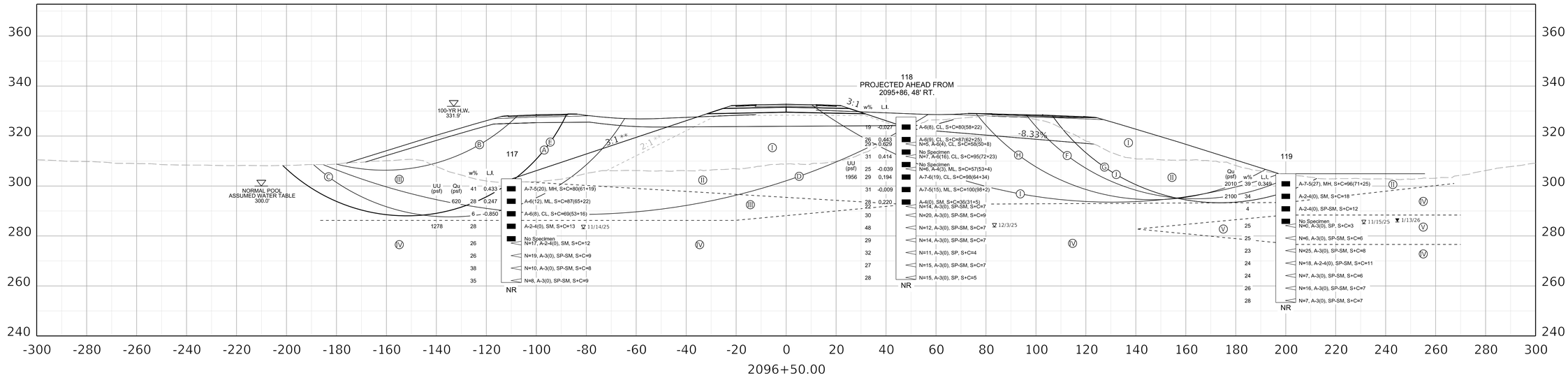

| FACTORS OF SAFETY | | |
|---|---|---|
| SHORT TERM | A | 2.1 |
| LONG TERM | B | 2.6 |
| SEISMIC 100 YR | C | 1.5 |
| SEISMIC 1000 YR | D | 0.8 |
| RAPID DRAWDOWN | E | 2.0 |
| SHORT TERM | F | 2.0 |
| LONG TERM | G | 2.2 |
| SEISMIC 100 YR | H | 1.6 |
| SEISMIC 1000 YR | I | 1.0 |
| RAPID DRAWDOWN | J | 1.7 |

| ASSUMED SOIL STRENGTH PARAMETERS | | | | | |
|---|---|---|---|---|---|
| SOIL | I | II | III | IV | V |
| SHORT TERM | c = 0 PSF<br>Φ = 38°<br>ɣ = 125 PCF | c = 900 PSF<br>Φ = 0°<br>ɣ = 120 PCF | c = 800 PSF<br>Φ = 0°<br>ɣ = 120 PCF | c = 0 PSF<br>Φ = 32°<br>ɣ = 130 PCF | c = 0 PSF<br>Φ = 28°<br>ɣ = 125 PCF |
| LONG TERM | c̄ = 0 PSF<br>Φ̄ = 38°<br>ɣ = 125 PCF | c̄ = 90 PSF<br>Φ̄ = 26°<br>ɣ = 120 PCF | c̄ = 80 PSF<br>Φ̄ = 26°<br>ɣ = 120 PCF | c̄ = 0 PSF<br>Φ̄ = 32°<br>ɣ = 130 PCF | c̄ = 0 PSF<br>Φ̄ = 28°<br>ɣ = 125 PCF |

| SUMMARY OF OBSERVATION WELL DATA | | | | | |
|---|---|---|---|---|---|
| BORING | STATION | OFFSET | DATE | STATIC DEPTH (FEET) | STATIC ELEV. (FEET) |
| 119 | 2096+50 | 200' RT. | 1/13/2026 | 19.3 | 285.63 |

*RESULTS ARE BASED ON NORMAL POOL CONDITIONS WITH AN ASSUMED GROUNDWATER ELEVATION OF 300 FEET. RAPID DRAWDOWN LOADING ASSUMES DRAWDOWN FROM THE 100-YEAR HIGH-WATER ELEVATION (ELEV. 331.9 FT) TO NORMAL POOL.

**2H:1V SLOPES REPRESENT ADVANCE LETTING (PHASE 1) CONSTRUCTION. FINAL 3H:1V SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS.




COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

TEAM KENTUCKY TRANSPORTATION CABINET

DRAWING TITLE: EMBANKMENT STABILITY SECTION

HORIZONTAL SCALE: 1"=20' (0' 20' 40' 80')

VERTICAL SCALE: 1"=20' (0' 20' 40' 80')

STA. 2096+50.00 TO 2097+50.00

ITEM NO. 1-1140.20

COUNTY OF BALLARD

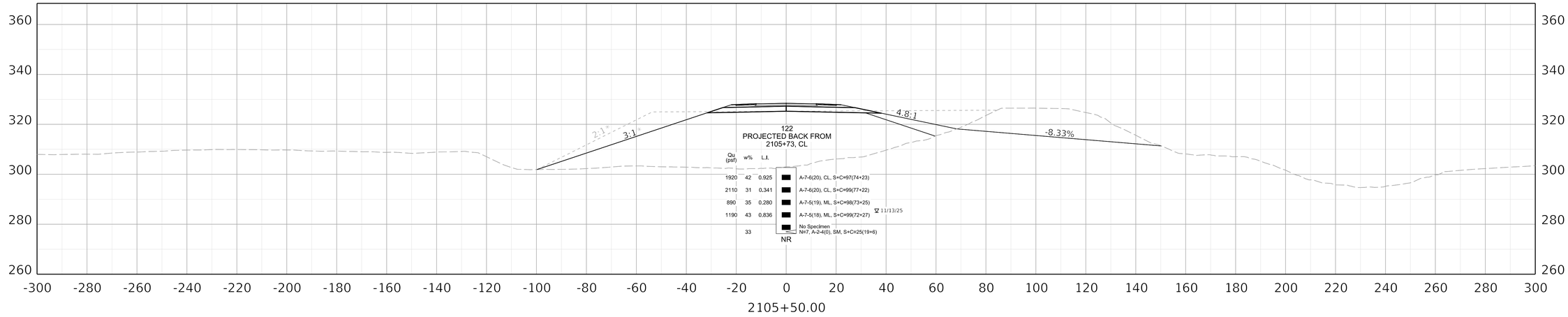
SHEET NO. R55

OpenRoads Designer v23.00.01.11

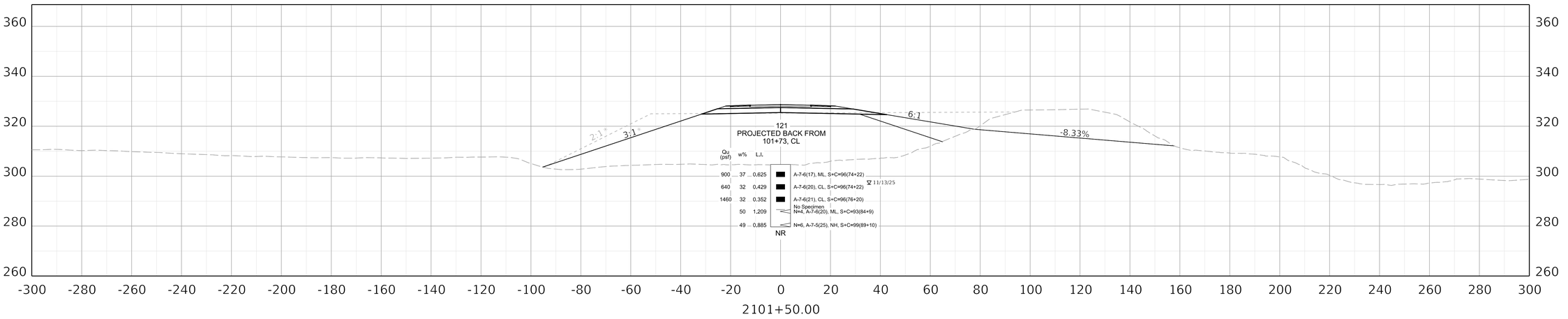
USER: tvaline

FILE NAME: C:\PWV8I-LOCAL\BAKER_PROJECTS\TAMARA.LYNN\D0757077\01_1140_00_GEO_KY CROSS SECTIONS.DGN

*2H:1V SLOPES REPRESENT ADVANCE LETTING (PHASE 1) CONSTRUCTION. FINAL 3H:1V SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS.




*2H:1V SLOPES REPRESENT ADVANCE LETTING (PHASE 1) CONSTRUCTION. FINAL 3H:1V SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS.




COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

TEAM KENTUCKY
TRANSPORTATION CABINET

DRAWING TITLE: EMBANKMENT STABILITY SECTION

0′ 20′ 40′ 80′
HORIZONTAL SCALE: 1"=20′

0′ 20′ 40′ 80′
VERTICAL SCALE: 1"=20′

STA. 2101+50.00 TO 2105+50.00

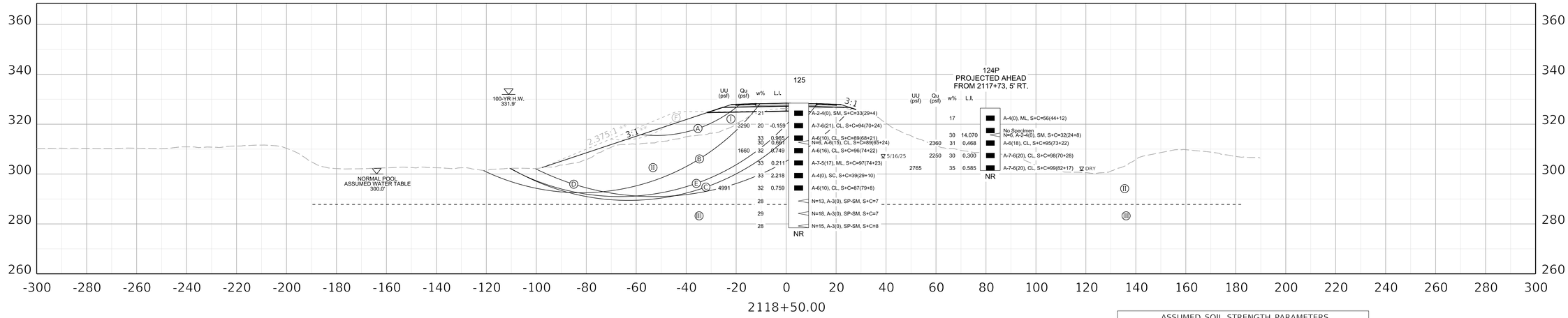
ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R56

*RESULTS ARE BASED ON NORMAL POOL CONDITIONS WITH AN ASSUMED GROUNDWATER ELEVATION OF 300 FEET. RAPID DRAWDOWN LOADING ASSUMES DRAWDOWN FROM THE 100-YEAR HIGH-WATER ELEVATION (ELEV. 331.9 FT) TO NORMAL POOL.

**2H:1V SLOPES REPRESENT ADVANCE LETTING (PHASE 1) CONSTRUCTION. FINAL 3H:1V SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS.

| FACTORS OF SAFETY | | |
|---|---|---|
| SHORT TERM | A | 2.5 |
| LONG TERM | B | 2.1 |
| SEISMIC 100 YR | C | 2.0 |
| SEISMIC 1000 YR | D | 1.3 |
| RAPID DRAWDOWN | E | 1.8 |
| TEMPORARY 1000 YR | F | 1.3 |

| ASSUMED SOIL STRENGTH PARAMETERS | | | |
|---|---|---|---|
| SOIL | I | II | III |
| SHORT TERM | c = 0 PSF<br>Φ = 38°<br>γ = 125 PCF | c = 1200 PSF<br>Φ = 0°<br>γ = 120 PCF | c = 0 PSF<br>Φ = 32°<br>γ = 125 PCF |
| LONG TERM | c̄ = 0 PSF<br>Φ̄ = 38°<br>γ = 125 PCF | c̄ = 120 PSF<br>Φ̄ = 28°<br>γ = 120 PCF | c̄ = 0 PSF<br>Φ̄ = 32°<br>γ = 125 PCF |



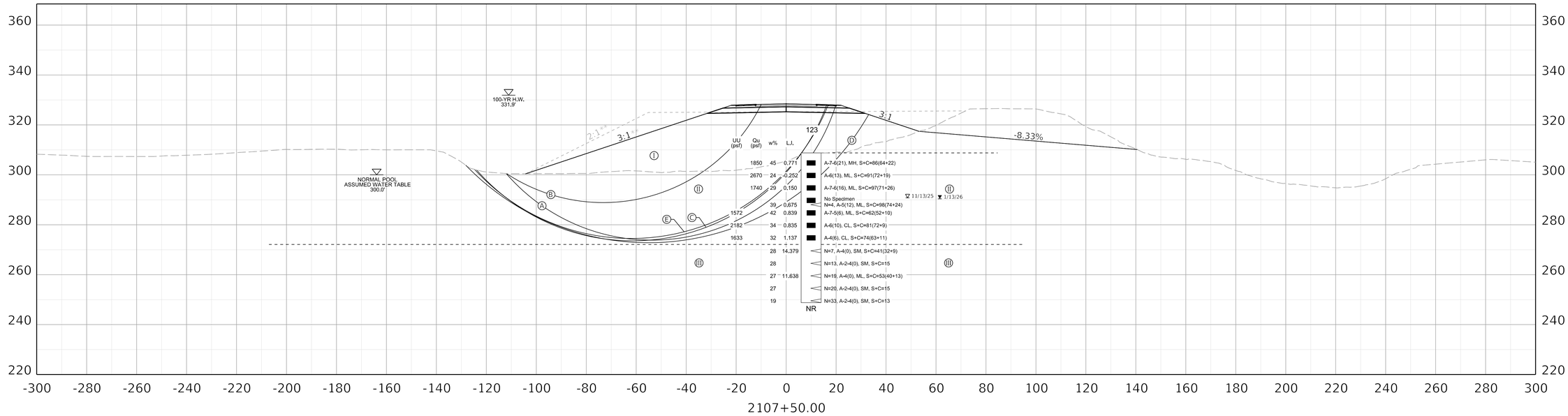

*RESULTS ARE BASED ON NORMAL POOL CONDITIONS WITH AN ASSUMED GROUNDWATER ELEVATION OF 300 FEET. RAPID DRAWDOWN LOADING ASSUMES DRAWDOWN FROM THE 100-YEAR HIGH-WATER ELEVATION (ELEV. 331.9 FT) TO NORMAL POOL.

**2H:1V SLOPES REPRESENT ADVANCE LETTING (PHASE 1) CONSTRUCTION. FINAL 3H:1V SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS.

| SUMMARY OF OBSERVATION WELL DATA | | | | | |
|---|---|---|---|---|---|
| BORING | STATION | OFFSET | DATE | STATIC DEPTH (FEET) | STATIC ELEV. (FEET) |
| 123 | 2107+50 | 10' RT. | 1/13/2026 | 18.4 | 290.38 |

| FACTORS OF SAFETY | | |
|---|---|---|
| SHORT TERM | A | 1.5 |
| LONG TERM | B | 2.2 |
| SEISMIC 100 YR | C | 1.2 |
| SEISMIC 1000 YR | D | 0.8 |
| RAPID DRAWDOWN | E | 1.5 |

| ASSUMED SOIL STRENGTH PARAMETERS | | | |
|---|---|---|---|
| SOIL | I | II | III |
| SHORT TERM | c = 0 PSF<br>Φ = 38°<br>γ = 125 PCF | c = 900 PSF<br>Φ = 0°<br>γ = 115 PCF | c = 0 PSF<br>Φ = 32°<br>γ = 120 PCF |
| LONG TERM | c̄ = 0 PSF<br>Φ̄ = 38°<br>γ = 125 PCF | c̄ = 90 PSF<br>Φ̄ = 28°<br>γ = 115 PCF | c̄ = 0 PSF<br>Φ̄ = 32°<br>γ = 120 PCF |




COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

TEAM KENTUCKY TRANSPORTATION CABINET

DRAWING TITLE: EMBANKMENT STABILITY SECTION

HORIZONTAL SCALE: 1"=20'

VERTICAL SCALE: 1"=20'

STA. 2107+50.00 TO 2118+50.00

ITEM NO. 1-1140.20

COUNTY OF BALLARD

SHEET NO. R57

OpenRoads Designer v23.00.01.11

USER: TLYNN

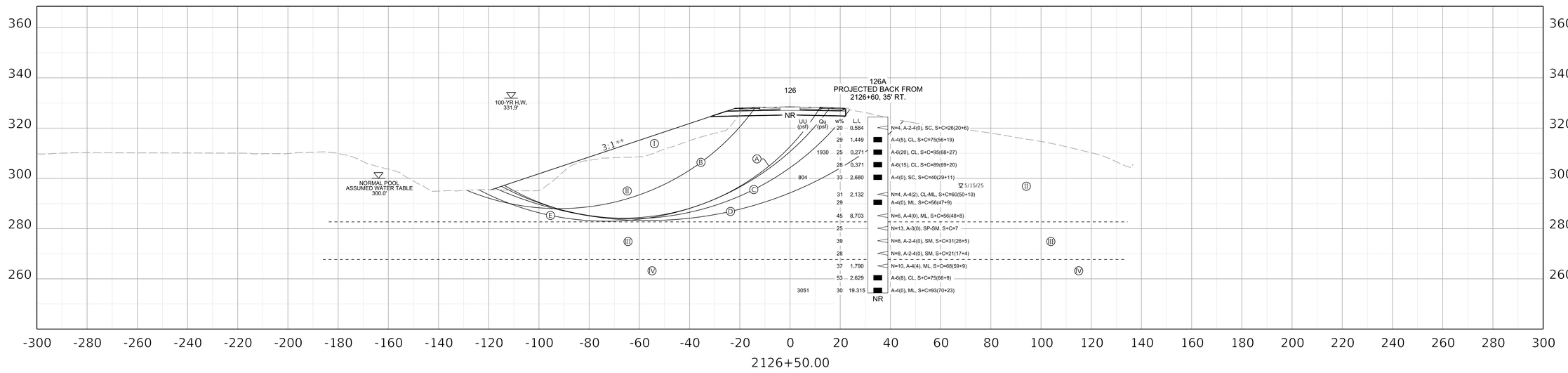
FILE NAME: C:\PWV8I-LOCAL\BAKER_PROJECTS\TYLER VALINE\D0757077\01_1140_00_GEO_KY CROSS SECTIONS.DGN

*RESULTS ARE BASED ON NORMAL POOL CONDITIONS WITH AN ASSUMED GROUNDWATER ELEVATION OF 300 FEET. RAPID DRAWDOWN LOADING ASSUMES DRAWDOWN FROM THE 100-YEAR HIGH-WATER ELEVATION (ELEV. 331.9 FT) TO NORMAL POOL.

**EMBANKMENT SLOPES WILL BE CONSTRUCTED, BY OTHERS, AS PART OF THE FINAL (PHASE 2) IMPROVEMENTS

| FACTORS OF SAFETY | | |
|---|---|---|
| SHORT TERM | A | 1.4 |
| LONG TERM | B | 1.8 |
| SEISMIC 100 YR | C | 1.1 |
| SEISMIC 1000 YR | D | 0.7 |
| RAPID DRAWDOWN | E | 1.2 |

| ASSUMED SOIL STRENGTH PARAMETERS | | | | |
|---|---|---|---|---|
| SOIL | I | II | III | IV |
| SHORT TERM | c = 0 PSF<br>Φ = 38°<br>γ = 125 PCF | c = 800 PSF<br>Φ = 0°<br>γ = 120 PCF | c = 0 PSF<br>Φ = 30°<br>γ = 125 PCF | c = 1450 PSF<br>Φ = 0°<br>γ = 120 PCF |
| LONG TERM | c' = 0 PSF<br>Φ' = 38°<br>γ = 125 PCF | c' = 80 PSF<br>Φ' = 28°<br>γ = 120 PCF | c' = 0 PSF<br>Φ' = 30°<br>γ = 125 PCF | c' = 145 PSF<br>Φ' = 30°<br>γ = 120 PCF |




COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
TEAM KENTUCKY TRANSPORTATION CABINET

DRAWING TITLE: EMBANKMENT STABILITY SECTION

0' 20' 40' 80'
HORIZONTAL SCALE: 1"=20'

0' 20' 40' 80'
VERTICAL SCALE: 1"=20'

STA. 2126+50.00

ITEM NO. 1-1140.20
COUNTY OF BALLARD
SHEET NO. R58

# Attachment C: Driller Logs

hdrinc.com

333 West Vine Street, Suite 1400, Lexington, KY 40507-1681
(859) 629-4800

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 3/2/26



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***117*** | Immediate Water Depth ***20.0 (11/14/25)*** | Start Date ***11/14/2025*** | Hole Type ***sample*** |
| Surface Elevation ***302.9'*** | Static Water Depth ***NA*** | End Date ***11/14/2025*** | Rig_Number ***3230 / 448*** |
| Total Depth ***41.5'*** | Driller ***J. Williams*** | Latitude(83) ***37.000803*** | |
| Location ***2096+50.00 110.0' Lt.*** | | Longitude(83) ***-89.136871*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. | Depth (ft) Run (ft) | Rec. (ft) Rec (ft) | SPT Blows Rec (%) | Sample Type SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 5 | | Soft, brown, clay. | ST-1 | 3.0-5.0 | 1.0 | | ST | |
| | | | | | | | | |
| 10 292.9 | 10.0 | | ST-2 | 8.0-10.0 | 2.0 | | ST | **Trace amounts of Silt @ 8** |
| | | | | | | | | |
| 15 | | | ST-3 | 13.0-15.0 | 1.8 | | ST | |
| | | | | | | | | |
| 20 | | | ST-4 | 18.0-20.0 | 1.6 | | ST | |
| | | | | | | | | **No mud added before ground water encountered @ 20** |
| 25 | | | ST-5 | 23.0-25.0 | 0.0 | | ST | |
| | | Loose to medium dense, gray, sand. | SS-1 | 25.0-26.5 | 1.5 | 3-7-10 | SPT | |
| 30 | | | | | | | | |
| | | | SS-2 | 30.0-31.5 | 1.5 | 3-7-12 | SPT | |
| 35 | | | | | | | | |
| | | | SS-3 | 35.0-36.5 | 1.5 | 7-5-5 | SPT | |
| 40 | | | | | | | | |
| 261.4 | 41.5 | | SS-4 | 40.0-41.5 | 1.3 | 4-4-4 | SPT | |
| 45 | | (Bottom of Hole 41.5')<br>(No Refusal) | | | | | | |
| 50 | | Boring location in farmer's field north of E. Cairo road | | | | | | |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***118*** | Immediate Water Depth ***44.0 (12/03/25)*** | Start Date ***12/03/2025*** | Hole Type ***sample*** |
| Surface Elevation ***327.6'*** | Static Water Depth ***NA*** | End Date ***12/03/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***65.0'*** | Driller ***J. Silcox*** | Latitude(83) ***37.000407*** | |
| Location ***2095+86.00 48.0' Rt.*** | | Longitude(83) ***-89.137180*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 327.4 | 0.2 | Asphalt. | | | | | | |
| 326.6 | 1.0 | Very loose, gravel with brown clay. | | | | | | |
| | | | ST-1 | 3.0-5.0 | 1.8 | | ST | |
| | | Soft, brown, clay. | | | | | | |
| | | | ST-2 | 8.0-10.0 | 0.7 | | ST | |
| | | | SS-1 | 10.0-11.5 | 1.3 | 2-2-3 | SPT | |
| 314.6 | 13.0 | | | | | | | |
| | | | ST-3 | 13.0-15.0 | 0.0 | | ST | |
| | | | SS-2 | 15.0-16.5 | 1.2 | 2-3-4 | SPT | |
| | | | | | | | | |
| | | | ST-4 | 18.0-20.0 | 0.0 | | ST | |
| | | Soft, gray, clay. | SS-3 | 20.0-21.5 | 0.9 | 2-3-3 | SPT | |
| | | | | | | | | |
| | | | ST-5 | 23.0-25.0 | 1.2 | | ST | |
| 299.6 | 28.0 | | | | | | | |
| | | | ST-6 | 28.0-30.0 | 1.8 | | ST | |
| | | Soft, black and brown, clay. | | | | | | |
| 292.6 | 35.0 | | ST-7 | 33.0-35.0 | 0.5 | | ST | |
| | | | SS-4 | 35.0-36.5 | 0.7 | 6-6-8 | SPT | |
| | | | | | | | | |
| | | | SS-5 | 38.5-40.0 | 0.8 | 8-9-11 | SPT | |
| | | Stiff to very stiff, brown, sandy clay. | | | | | | |
| 282.6 | 45.0 | | SS-6 | 43.5-45.0 | 0.7 | 4-5-7 | SPT | |
| | | Medium dense, brown, wet, sand. | | | | | | |
| | | | SS-7 | 48.5-50.0 | 1.0 | 7-6-8 | SPT | |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***118*** | Immediate Water Depth ***44.0 (12/03/25)*** | Start Date ***12/03/2025*** | Hole Type ***sample*** |
| Surface Elevation ***327.6'*** | Static Water Depth ***NA*** | End Date ***12/03/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***65.0'*** | Driller ***J. Silcox*** | Latitude(83) ***37.000407*** | |
| Location ***2095+86.00 48.0' Rt.*** | | Longitude(83) ***-89.137180*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 55 | | | SS-8 | 53.5-55.0 | 0.8 | 5-5-6 | SPT | 55 |
| | | Medium dense, brown, wet, sand. | | | | | | |
| 60 | | | SS-9 | 58.5-60.0 | 1.2 | 6-8-7 | SPT | 60 |
| | | | | | | | | |
| 65 262.6 | 65.0 | | SS-10 | 63.5-65.0 | 1.0 | 5-7-8 | SPT | 65 |
| 70 | | (Bottom of Hole 65.0')<br>(No Refusal) | | | | | | 70 |
| | | Boring located in asphaltic pavement at the intersection of E. Cairo Road and US 51 | | | | | | |
| 75 | | | | | | | | 75 |
| 80 | | | | | | | | 80 |
| 85 | | | | | | | | 85 |
| 90 | | | | | | | | 90 |
| 95 | | | | | | | | 95 |
| 100 | | | | | | | | 100 |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***119*** | Immediate Water Depth ***20.0 (11/15/25)*** | Start Date ***11/15/2025*** | Hole Type ***sample*** |
| Surface Elevation ***304.9'*** | Static Water Depth ***NA*** | End Date ***11/15/2025*** | Rig_Number ***3230 / 448*** |
| Total Depth ***51.5'*** | Driller ***J. Williams*** | Latitude(83) ***36.999965*** | |
| Location ***2096+50.00 200.0' Rt.*** | | Longitude(83) ***-89.137056*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Soft, brown, clay. | | | | | | |
| 5 299.9 | 5.0 | | ST-1 | 3.0-5.0 | 1.0 | | ST | |
| | | Loose, brown, sand. | | | | | | |
| 10 294.9 | 10.0 | | ST-2 | 8.0-10.0 | 1.5 | | ST | |
| | | | | | | | | |
| 15 | | Loose, blonde, sand. | ST-3 | 13.0-15.0 | 1.7 | | ST | |
| | | | | | | | | |
| 20 284.9 | 20.0 | | ST-4 | 18.0-20.0 | 0.0 | | ST | |
| | | | SS-1 | 20.0-21.5 | 1.4 | 0-0-0 | SPT | **No mud added before ground water encountered @ 20** |
| 25 | | | | | | | | |
| | | | SS-2 | 25.0-26.5 | 1.5 | 3-2-4 | SPT | |
| 30 | | | | | | | | |
| | | | SS-3 | 30.0-31.5 | 1.5 | 8-11-14 | SPT | |
| 35 | | Loose to medium dense, brown, sand. | | | | | | |
| | | | SS-4 | 35.0-36.5 | 1.5 | 5-7-11 | SPT | |
| 40 | | | | | | | | |
| | | | SS-5 | 40.0-41.5 | 1.5 | 3-3-4 | SPT | |
| 45 | | | | | | | | |
| | | | SS-6 | 45.0-46.5 | 1.5 | 3-7-9 | SPT | |
| 50 | | | | | | | | |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| | | |
|---|---|---|
| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***119*** | Immediate Water Depth ***20.0 (11/15/25)*** | Start Date ***11/15/2025*** | Hole Type ***sample*** |
| Surface Elevation ***304.9'*** | Static Water Depth ***NA*** | End Date ***11/15/2025*** | Rig_Number ***3230 / 448*** |
| Total Depth ***51.5'*** | Driller ***J. Williams*** | Latitude(83) ***36.999965*** | |
| Location ***2096+50.00 200.0' Rt.*** | | Longitude(83) ***-89.137056*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 253.4 | 51.5 | Loose to medium dense, brown, sand. | SS-7 | 50.0-51.5 | 1.5 | 3-2-5 | SPT | |
| | | (Bottom of Hole 51.5')<br>(No Refusal)<br><br>Boring location in wetlands area on the south side of E. Cairo road<br>Observation well set | | | | | | |

55 60 65 70 75 80 85 90 95 100

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 3/2/26



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***120*** | Immediate Water Depth ***5.0 (11/13/25)*** | Start Date ***11/13/2025*** | Hole Type ***sample*** |
| Surface Elevation ***308.8'*** | Static Water Depth ***NA*** | End Date ***11/13/2025*** | Rig_Number ***3230 / 448*** |
| Total Depth ***25.0'*** | Driller ***J. Williams*** | Latitude(83) ***37.000444*** | |
| Location ***2097+73.00 CL*** | | Longitude(83) ***-89.136523*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. (Std/Ky RQD) | Depth (ft) Run (ft) | Rec. (ft) Rec (ft) | SPT Blows Rec (%) | Sample Type SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 5 | | Soft, brown, silty clay. | ST-1 | 3.0-5.0 | 1.8 | | ST | 5 |
| | | | | | | | | |
| 10 298.8 | 10.0 | | ST-2 | 8.0-10.0 | 2.0 | | ST | 10 |
| | | | | | | | | |
| 15 | | Soft, brown, sandy clay. | ST-3<br>SS-1 | 13.0-13.2<br>13.2-14.7 | 0.2<br>1.3 | 2-2-2 | ST<br>SPT | 15 |
| | | | | | | | | |
| 20 288.8 | 20.0 | | ST-4 | 18.0-20.0 | 2.0 | | ST | 20 |
| | | Medium dense, gray, sand. | | | | | | |
| 25 283.8 | 25.0 | | SS-2 | 23.5-25.0 | 1.5 | 6-8-9 | SPT | 25 |
| 30 | | (Bottom of Hole 25.0')<br>(No Refusal)<br><br>Boring location in area logged by land owner | | | | | | 30 |
| 35 | | | | | | | | 35 |
| 40 | | | | | | | | 40 |
| 45 | | | | | | | | 45 |
| 50 | | | | | | | | 50 |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 8/5/26



| | | |
|---|---|---|
| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
| Item Number: ***01-1140.00*** | | Project Manager: |

| | | | |
|---|---|---|---|
| Hole Number ***120A*** | Immediate Water Depth ***(03/26/26)*** | Start Date ***03/26/2026*** | Hole Type ***fill profile*** |
| Surface Elevation ***308.8'*** | Static Water Depth ***NA*** | End Date ***03/26/2026*** | Rig_Number |
| Total Depth ***8.0'*** | Driller ***G. Darnall*** | Latitude(83) ***37.000444*** | |
| Location ***2097+72.00 CL*** | | Longitude(83) ***-89.136523*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. Std/Ky RQD | Depth (ft) Run (ft) | Rec. (ft) Rec (ft) | SPT Blows Rec (%) | Sample Type SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Brown, silty clay<br>Bag #1 | | | | | NMC #1<br>@ 2' | |
| | | (Bottom of Hole 8.0')<br>(No Refusal) | | | | | | |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 3/2/26



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***121*** | Immediate Water Depth ***8.0 (11/13/25)*** | Start Date ***11/13/2025*** | Hole Type ***sample*** |
| Surface Elevation ***304.7'*** | Static Water Depth ***NA*** | End Date ***11/13/2025*** | Rig_Number ***3230 / 448*** |
| Total Depth ***25.0'*** | Driller ***J. Williams*** | Latitude(83) ***37.000217*** | |
| Location ***2101+73.00 CL*** | | Longitude(83) ***-89.135183*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | Soft, brown, silty fat clay. | ST-1 | 3.0-5.0 | 1.1 | | ST | |
| | | | | | | | | |
| 294.7 | 10.0 | | ST-2 | 8.0-10.0 | 2.0 | | ST | |
| | | Soft, gray, silty clay. | ST-3 | 13.0-15.0 | 2.0 | | ST | |
| | | | | | | | | |
| 285.1 | 19.6 | | ST-4 | 18.0-18.1 | 0.1 | 0-2-2 | ST | |
| | | | SS-1 | 18.1-19.6 | 1.5 | | SPT | |
| | | Soft, gray, silty fat clay. | | | | | | |
| 279.7 | 25.0 | | SS-2 | 23.5-25.0 | 1.5 | 2-3-3 | SPT | |
| | | (Bottom of Hole 25.0')<br>(No Refusal)<br><br>Boring location in area logged by land owner | | | | | | |

Drilling Firm: Terracon
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Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| | | |
|---|---|---|
| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
| Item Number: ***01-1140.00*** | | Project Manager: |

| | | | |
|---|---|---|---|
| Hole Number ***121A*** | Immediate Water Depth ***3.1 (03/26/26)*** | Start Date ***03/26/2026*** | Hole Type ***fill profile*** |
| Surface Elevation ***304.7'*** | Static Water Depth ***NA*** | End Date ***03/26/2026*** | Rig_Number |
| Total Depth ***8.0'*** | Driller ***G. Darnall*** | Latitude(83) ***37.000217*** | |
| Location ***2101+72.00 CL*** | | Longitude(83) ***-89.135183*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | NMC #1 @ 2' | |
| 5 | | Brown, silty clay<br>Bag #2 | | | | | | 5 |
| 10 | | (Bottom of Hole 8.0')<br>(No Refusal) | | | | | | 10 |
| 15 | | | | | | | | 15 |
| 20 | | | | | | | | 20 |
| 25 | | | | | | | | 25 |
| 30 | | | | | | | | 30 |
| 35 | | | | | | | | 35 |
| 40 | | | | | | | | 40 |
| 45 | | | | | | | | 45 |
| 50 | | | | | | | | 50 |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***122*** | Immediate Water Depth ***18.0 (11/13/25)*** | Start Date ***11/13/2025*** | Hole Type ***sample*** |
| Surface Elevation ***302.7'*** | Static Water Depth ***NA*** | End Date ***11/13/2025*** | Rig_Number ***3230 / 448*** |
| Total Depth ***26.5'*** | Driller ***J. Williams*** | Latitude(83) ***36.999943*** | |
| Location ***2105+73.00 CL*** | | Longitude(83) ***-89.133856*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Soft, brown, clay. | | | | | | |
| 297.7 | 5.0 | | ST-1 | 3.0-5.0 | 1.3 | | ST | |
| | | | | | | | | |
| | | | ST-2 | 8.0-10.0 | 1.2 | | ST | |
| | | | | | | | | |
| | | Soft, gray, clay. | ST-3 | 13.0-15.0 | 1.8 | | ST | |
| | | | | | | | | |
| | | | ST-4 | 18.0-20.0 | 1.7 | | ST | |
| | | | | | | | | |
| 277.7 | 25.0 | | ST-5 | 23.0-25.0 | 0.0 | | ST | |
| 276.2 | 26.5 | Loose, gray, sand. | SS-1 | 25.0-26.5 | 1.5 | 2-3-4 | SPT | |
| | | (Bottom of Hole 26.5')<br>(No Refusal)<br><br>Boring location in area logged by land owner | | | | | | |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 8/5/26



| | | |
|---|---|---|
| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***122A*** | Immediate Water Depth ***(03/26/26)*** | Start Date ***03/26/2026*** | Hole Type ***fill profile*** |
| Surface Elevation ***302.7'*** | Static Water Depth ***NA*** | End Date ***03/26/2026*** | Rig_Number |
| Total Depth ***8.0'*** | Driller ***G. Darnall*** | Latitude(83) ***36.999943*** | |
| Location ***2105+72.00 CL*** | | Longitude(83) ***-89.133856*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Brown, clay<br>Bag #3 | | | | | NMC #1<br>@ 2' | |
| | | (Bottom of Hole 8.0')<br>(No Refusal) | | | | | | |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***123*** | Immediate Water Depth ***18.0 (11/13/25)*** | Start Date ***11/13/2025*** | Hole Type ***sample*** |
| Surface Elevation ***308.8'*** | Static Water Depth ***NA*** | End Date ***11/13/2025*** | Rig_Number ***3230 / 448*** |
| Total Depth ***60.0'*** | Driller ***J. Williams*** | Latitude(83) ***36.999781*** | |
| Location ***2107+50.00 10.0' Rt.*** | | Longitude(83) ***-89.133284*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | ST-1 | 3.0-5.0 | 2.0 | | ST | |
| | | Soft, brown, silty clay. | | | | | | |
| | | | | | | | | |
| 298.8 | 10.0 | | ST-2 | 8.0-10.0 | 2.0 | | ST | |
| | | | | | | | | |
| | | | ST-3 | 13.0-15.0 | 1.8 | | ST | |
| | | | | | | | | |
| | | | ST-4 | 18.0-20.0 | 0.0 | | ST | |
| | | Soft, gray, silty clay. | SS-1 | 20.0-21.5 | 1.5 | 1-2-2 | SPT | |
| | | | | | | | | |
| | | | ST-5 | 23.0-25.0 | 2.0 | | ST | **Trace sand @ 23** |
| | | | | | | | | |
| 278.8 | 30.0 | | ST-6 | 28.0-30.0 | 2.0 | | ST | **Drilling mud added @ 30** |
| | | | | | | | | |
| | | | ST-7 | 33.0-35.0 | 2.0 | | ST | |
| | | | | | | | | |
| | | | SS-2 | 38.5-40.0 | 1.3 | 3-3-4 | SPT | |
| | | Loose, gray, sand. | | | | | | |
| | | | | | | | | |
| | | | SS-3 | 43.5-45.0 | 1.5 | 2-4-9 | SPT | |
| | | | | | | | | |
| 258.8 | 50.0 | | SS-4 | 48.5-50.0 | 1.5 | 6-8-11 | SPT | **Trace silt @ 48** |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***123*** | Immediate Water Depth ***18.0 (11/13/25)*** | Start Date ***11/13/2025*** | Hole Type ***sample*** |
| Surface Elevation ***308.8'*** | Static Water Depth ***NA*** | End Date ***11/13/2025*** | Rig_Number ***3230 / 448*** |
| Total Depth ***60.0'*** | Driller ***J. Williams*** | Latitude(83) ***36.999781*** | |
| Location ***2107+50.00 10.0' Rt.*** | | Longitude(83) ***-89.133284*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 55 | | Loose to medium dense, gray, sand with gravel. | SS-5 | 53.5-55.0 | 1.5 | 7-10-10 | SPT | 55 |
| 60 248.8 | 60.0 | | SS-6 | 58.5-60.0 | 1.5 | 8-16-17 | SPT | 60 |
| 65 | | (Bottom of Hole 60.0')<br>(No Refusal)<br><br>Boring location in area logged by land owner<br>Observation well set | | | | | | 65 |
| 70 | | | | | | | | 70 |
| 75 | | | | | | | | 75 |
| 80 | | | | | | | | 80 |
| 85 | | | | | | | | 85 |
| 90 | | | | | | | | 90 |
| 95 | | | | | | | | 95 |
| 100 | | | | | | | | 100 |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 3/2/26



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***124P*** | Immediate Water Depth ***(05/15/25)*** | Start Date ***05/14/2025*** | Hole Type ***sample*** |
| Surface Elevation ***326.4'*** | Static Water Depth ***NA*** | End Date ***05/14/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***25.0'*** | Driller ***J. Silcox*** | Latitude(83) ***36.999001*** | |
| Location ***2117+73.00 5.0' Rt.*** | | Longitude(83) ***-89.129919*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 325.5 | 0.9 | Asphatic concrete. | | | | | | |
| 324.9 | 1.5 | Portland concrete. | | | | | | |
| | | | ST-1 | 3.0-5.0 | 0.8 | | ST | |
| | | | ST-2 | 8.0-10.0 | 0.0 | | ST | |
| | | | SS-3 | 10.0-11.5 | 1.2 | 2-3-3 | SPT | |
| | | Brown, sandy clay. | ST-4 | 13.0-15.0 | 2.0 | | ST | |
| | | | ST-5 | 18.0-20.0 | 2.0 | | ST | |
| 301.4 | 25.0 | | ST-6 | 23.0-25.0 | 2.0 | | ST | |
| | | (Bottom of Hole 25.0')<br>(No Refusal) | | | | | | |



B-124P Total Length- 1.55’

S-.09’
B-.25’
B-.28’
B-.32’
C-.61’

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***125*** | Immediate Water Depth ***22.0 (05/16/25)*** | Start Date ***05/16/2025*** | Hole Type ***sample*** |
| Surface Elevation ***324.5'*** | Static Water Depth ***NA*** | End Date ***05/16/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***50.0'*** | Driller ***J. Silcox*** | Latitude(83) ***36.998985*** | |
| Location ***2118+50.00 5.0' Rt.*** | | Longitude(83) ***-89.129651*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | ST-1 | 3.0-5.0 | 1.0 | | ST | |
| | | Soft to stiff, brown, sandy clay. | | | | | | |
| | | | ST-2 | 8.0-10.0 | 1.3 | | ST | |
| | | | | | | | | |
| 309.5 | 15.0 | | ST-3 | 13.0-15.0 | 1.0 | | ST | |
| | | Loose, brown, sand. | SS-4 | 15.0-16.5 | 1.3 | 2-3-3 | SPT | |
| 306.5 | 18.0 | | | | | | | |
| | | | ST-5 | 18.0-20.0 | 1.5 | | ST | |
| | | | | | | | | |
| | | | ST-6 | 23.0-25.0 | 2.0 | | ST | |
| | | Soft to medium stiff, brown, sandy clay. | | | | | | |
| | | | ST-7 | 28.0-30.0 | 1.8 | | ST | |
| | | | | | | | | |
| | | | ST-8 | 33.0-35.0 | 2.0 | | ST | |
| 286.5 | 38.0 | | | | | | | |
| | | | SS-9 | 38.5-40.0 | 1.3 | 4-5-8 | SPT | |
| | | Medium dense, brown, sand. | | | | | | |
| | | | SS-10 | 43.5-45.0 | 1.3 | 8-10-8 | SPT | |
| | | | | | | | | |
| 274.5 | 50.0 | | SS-11 | 48.5-50.0 | 1.3 | 5-5-10 | SPT | |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 3/2/26



| | | |
|---|---|---|
| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***125*** | Immediate Water Depth ***22.0 (05/16/25)*** | Start Date ***05/16/2025*** | Hole Type ***sample*** |
| Surface Elevation ***324.5'*** | Static Water Depth ***NA*** | End Date ***05/16/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***50.0'*** | Driller ***J. Silcox*** | Latitude(83) ***36.998985*** | |
| Location ***2118+50.00 5.0' Rt.*** | | Longitude(83) ***-89.129651*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | (Bottom of Hole 50.0')<br>(No Refusal) | | | | | | |

55 60 65 70 75 80 85 90 95 100

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 11/2/26



| | | |
|---|---|---|
| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
| Item Number: ***01-1140.00*** | | Project Manager: |

| | | | |
|---|---|---|---|
| Hole Number ***126*** | Immediate Water Depth ***(05/15/25)*** | Start Date ***05/15/2025*** | Hole Type ***sample*** |
| Surface Elevation ***328.4'*** | Static Water Depth ***NA*** | End Date ***05/15/2025*** | Rig_Number |
| Total Depth ***1.3'*** | Driller ***J. Silcox*** | Latitude(83) ***36.998456*** | |
| Location ***2126+64.00 CL*** | | Longitude(83) ***-89.126944*** | |

| Lithology Elevation | Lithology Depth | Description | Sample No. | Depth (ft) | Rec. (ft) | SPT Blows | Sample Type | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Overburden | | | | | | |
| 328.2 | 0.2 | Blacktop. | | | | | | |
| 327.1 | 1.3 | Concrete (Encountered Rebar bottom of Pavement). | | | | | | |
| | | Rock Core | Std/Ky RQD | Run (ft) | Rec (ft) | Rec (%) | SDI (JS) | |
| | | (Bottom of Hole 1.3')<br>(Refusal @ 1.3) | | | | | | |
| | | Rebar encountered at about 12 inches (1.0 ft) | | | | | | |



B-126 Total Length- 1.3’

S-.1’

B-.1’

C-1.1’

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***126A*** | Immediate Water Depth ***28.0 (05/15/25)*** | Start Date ***05/15/2025*** | Hole Type ***sample*** |
| Surface Elevation ***324.4'*** | Static Water Depth ***NA*** | End Date ***05/15/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***70.0'*** | Driller ***J. Silcox*** | Latitude(83) ***36.998365*** | |
| Location ***2126+60.00 35.0' Rt.*** | | Longitude(83) ***-89.126982*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. | Depth (ft) Run (ft) | Rec. (ft) Rec (ft) | SPT Blows Rec (%) | Sample Type SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 5 | | | SS-1 | 3.5-5.0 | 0.8 | 1-2-2 | SPT | 5 |
| | | | | | | | | |
| 10 | | | ST-2 | 8.0-10.0 | 2.0 | | ST | 10 |
| | | | | | | | | |
| | | Brown, clay. | | | | | | |
| 15 | | | ST-3 | 13.0-15.0 | 1.9 | | ST | 15 |
| | | | | | | | | |
| 20 | | | ST-4 | 18.0-20.0 | 1.3 | | ST | 20 |
| | | | | | | | | |
| 25 | | | ST-5 | 23.0-25.0 | 2.0 | | ST | 25 |
| 298.4 | 26.0 | | | | | | | |
| | | | | | | | | |
| 30 | | | SS-6 | 30.0-31.5 | 1.5 | 1-2-2 | SPT | 30 |
| | | | | | | | | |
| 35 | | | ST-7 | 33.0-35.0 | 2.0 | | ST | 35 |
| | | | | | | | | |
| | | Medium stiff to stiff, brown, sandy clay. | | | | | | |
| 40 | | | SS-8 | 38.5-40.0 | 1.5 | 2-3-3 | SPT | 40 |
| | | | | | | | | |
| 45 | | | SS-9 | 43.5-45.0 | 1.5 | 4-6-7 | SPT | 45 |
| | | | | | | | | |
| 50 | | | SS-10 | 48.5-50.0 | 1.5 | 5-4-4 | SPT | 50 |

# DRILLER'S SUBSURFACE LOG



| Project ID: ***R-015-2025*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Roadway Roadway*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***126A*** | Immediate Water Depth ***28.0 (05/15/25)*** | Start Date ***05/15/2025*** | Hole Type ***sample*** |
| Surface Elevation ***324.4'*** | Static Water Depth ***NA*** | End Date ***05/15/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***70.0'*** | Driller ***J. Silcox*** | Latitude(83) ***36.998365*** | |
| Location ***2126+60.00 35.0' Rt.*** | | Longitude(83) ***-89.126982*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 55 | | Medium stiff to stiff, brown, sandy clay. | SS-11 | 53.5-55.0 | 1.5 | 3-4-4 | SPT | 55 |
| | | | | | | | | |
| 60 264.4 | 60.0 | | SS-12 | 58.5-60.0 | 1.5 | 3-4-6 | SPT | 60 |
| | | | | | | | | |
| 65 | | Brown, clay. | ST-13 | 63.0-65.0 | 0.6 | | ST | 65 |
| | | | | | | | | |
| 70 254.4 | 70.0 | | ST-14 | 68.0-70.0 | 0.8 | | ST | 70 |
| 75 | | (Bottom of Hole 70.0')<br>(No Refusal) | | | | | | 75 |
| 80 | | | | | | | | 80 |
| 85 | | | | | | | | 85 |
| 90 | | | | | | | | 90 |
| 95 | | | | | | | | 95 |
| 100 | | | | | | | | 100 |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| | | |
|---|---|---|
| Project ID: ***S-033-2024*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Structure State Bridge*** |
| Item Number: ***01-1140.00*** | ***Ohio River*** | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***B-2046*** | Immediate Water Depth ***NA*** | Start Date ***07/18/2025*** | Hole Type ***sample*** |
| Surface Elevation ***314.3'*** | Static Water Depth ***NA*** | End Date ***07/19/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***150.0'*** | Driller ***J. Silcox*** | Latitude(83) ***37.000660*** | |
| Location ***2093+73.00 12.0' Lt.*** | | Longitude(83) ***-89.137868*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | ST-1 | 3.0-5.0 | 1.2 | | ST | |
| | | | | | | | | |
| | | | ST-2 | 8.0-10.0 | 2.0 | | ST | |
| | | Brown gray, silty clay. | | | | | | |
| | | | ST-3 | 14.0-16.0 | 1.3 | | ST | |
| | | | | | | | | |
| | | | ST-4 | 18.0-20.0 | 2.0 | | ST | **Continued on 7/19/2025 @ 18** |
| 292.8 | 21.5 | | | | | | | |
| | | Gray, sand with clay. | ST-5 | 23.0-25.0 | 1.8 | | ST | |
| 287.3 | 27.0 | | | | | | | |
| | | | SS-1 | 28.5-30.0 | 1.3 | 5-8-11 | SPT | |
| | | | | | | | | |
| | | | SS-2 | 33.5-35.0 | 1.5 | 5-7-7 | SPT | |
| | | | | | | | | |
| | | Loose to dense, gray, sand. | SS-3 | 38.5-40.0 | 1.3 | 6-7-11 | SPT | |
| | | | | | | | | |
| | | | SS-4 | 43.5-45.0 | 1.3 | 6-10-11 | SPT | |
| | | | | | | | | |
| | | | PT-1 | 48.0-50.0 | 1.0 | | ST | |

# DRILLER'S SUBSURFACE LOG

| | | |
|---|---|---|
| Project ID: ***S-033-2024*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Structure State Bridge*** |
| Item Number: ***01-1140.00*** | ***Ohio River*** | Project Manager: |

| | | | |
|---|---|---|---|
| Hole Number ***B-2046*** | Immediate Water Depth ***NA*** | Start Date ***07/18/2025*** | Hole Type ***sample*** |
| Surface Elevation ***314.3'*** | Static Water Depth ***NA*** | End Date ***07/19/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***150.0'*** | Driller ***J. Silcox*** | Latitude(83) ***37.000660*** | |
| Location ***2093+73.00 12.0' Lt.*** | | Longitude(83) ***-89.137868*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 55 | | | SS-5 | 53.5-55.0 | 1.5 | 1-3-4 | SPT | 55 |
| 60 | | | SS-6 | 58.5-60.0 | 1.3 | 4-7-7 | SPT | 60 |
| 65 | | | SS-7 | 63.5-65.0 | 1.3 | 9-8-15 | SPT | 65 |
| | | Loose to dense, gray, sand. | | | | | | |
| 70 | | | PT-2 | 68.0-70.0 | 1.0 | | ST | 70 |
| 75 | | | SS-8 | 73.5-75.0 | 1.3 | 13-14-18 | SPT | 75 |
| 80 | | | SS-9 | 78.5-80.0 | 1.0 | 16-18-22 | SPT | 80 |
| 232.3 | 82.0 | | | | | | | |
| 85 | | Very dense, gray, sand with gravel. | SS-10 | 83.5-85.0 | 0.7 | 13-19-40 | SPT | 85 |
| 225.8 | 88.5 | | PT-3 | 88.0-88.5 | 0.0 | | ST | |
| 90 | | | SS-11 | 88.5-90.0 | 1.3 | 9-8-9 | SPT | 90 |
| 95 | | Medium dense to dense, white, silty, sandy clay. | SS-12 | 95.0-96.5 | 1.0 | 15-19-25 | SPT | 95 |
| 215.8 | 98.5 | | | | | | | |
| 100 | | Very dense, white, sandy clay. | | | | | | 100 |

# DRILLER'S SUBSURFACE LOG

| | | |
|---|---|---|
| Project ID: ***S-033-2024*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Structure State Bridge*** |
| Item Number: ***01-1140.00*** | ***Ohio River*** | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***B-2046*** | Immediate Water Depth ***NA*** | Start Date ***07/18/2025*** | Hole Type ***sample*** |
| Surface Elevation ***314.3'*** | Static Water Depth ***NA*** | End Date ***07/19/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***150.0'*** | Driller ***J. Silcox*** | Latitude(83) ***37.000660*** | |
| Location ***2093+73.00 12.0' Lt.*** | | Longitude(83) ***-89.137868*** | |

| Lithology Elevation | Lithology Depth | Description | Sample No. | Depth (ft) | Rec. (ft) | SPT Blows | Sample Type | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Overburden | | | | | | |
| | | | PT-4 | 100.0-102.0 | 2.0 | | ST | |
| 105 | | Very dense, white, sandy clay. | | | | | | 105 |
| 110 | | | SS-13 | 108.5-110.0 | 1.3 | 22-28-25 | SPT | 110 |
| 200.3 | 114.0 | | | | | | | |
| 115 | | | | | | | | 115 |
| 120 | | | SS-14 | 118.5-120.0 | 1.5 | 19-31-43 | SPT | 120 |
| 125 | | | | | | | | 125 |
| 130 | | | SS-15 | 128.5-128.8 | 0.3 | 50/0.33' | SPT | 130 |
| 135 | | Very dense, brown white, sand. | | | | | | 135 |
| 140 | | | SS-16 | 138.5-138.8 | 0.3 | 50/0.33' | SPT | 140 |
| 145 | | | | | | | | 145 |
| | | | PT-5 | 148.0-148.5 | 0.0 | 50/0.50' | ST | |
| 150164.3 | 150.0 | | SS-17 | 148.5-149.0 | 0.5 | | SPT | 150 |

Rock Core

Std/Ky RQD | Run (ft) | Rec (ft) | Rec (%) | SDI (JS)

# DRILLER'S SUBSURFACE LOG



| | | |
|---|---|---|
| Project ID: ***S-033-2024*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Structure State Bridge*** |
| Item Number: ***01-1140.00*** | ***Ohio River*** | Project Manager: - |

| | | | |
|---|---|---|---|
| Hole Number ***B-2046*** | Immediate Water Depth ***NA*** | Start Date ***07/18/2025*** | Hole Type ***sample*** |
| Surface Elevation ***314.3'*** | Static Water Depth ***NA*** | End Date ***07/19/2025*** | Rig_Number ***B-57 / 1287*** |
| Total Depth ***150.0'*** | Driller ***J. Silcox*** | Latitude(83) ***37.000660*** | |
| Location ***2093+73.00 12.0' Lt.*** | | Longitude(83) ***-89.137868*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 155 | | (Bottom of Hole 150.0')<br>(No Refusal) | | | | | | 155 |
| | | 3 1/4" HSA to 8 ft<br>6" Casing to 8 ft<br>4" Casing to Termination Depth | | | | | | |
| 160 | | Boring located north of E. Cairo Road | | | | | | 160 |
| 165 | | | | | | | | 165 |
| 170 | | | | | | | | 170 |
| 175 | | | | | | | | 175 |
| 180 | | | | | | | | 180 |
| 185 | | | | | | | | 185 |
| 190 | | | | | | | | 190 |
| 195 | | | | | | | | 195 |
| 200 | | | | | | | | 200 |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG



| Project ID: ***S-040-2021*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Structure State Bridge*** |
|---|---|---|
| Item Number: ***01-1140.00*** | | Project Manager: ***Eric Scott*** |

| | | | |
|---|---|---|---|
| Hole Number ***B-6*** | Immediate Water Depth ***NA*** | Start Date ***04/13/2021*** | Hole Type ***sample*** |
| Surface Elevation ***313.8'*** | Static Water Depth ***NA*** | End Date ***04/17/2021*** | Rig_Number ***642*** |
| Total Depth ***152.0'*** | Driller ***K. Hayslip*** | Latitude(83) ***37.000609*** | |
| Location ***2093+67.00 7.0' Rt.*** | | Longitude(83) ***-89.137896*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 311.8 | 2.0 | Silt, sand, and gravel (gravel roadbed). | | | | | | |
| | | Medium stiff, brown, moist, silty clay. | ST-1 | 3.0-5.0 | 0.0 | | ST | **Pushed Shelby Tube with HSA Drilling, no recovery @ 3** |
| | | | SPT-1 | 5.0-6.5 | 1.5 | 2-4-4 | SPT | |
| 305.8 | 8.0 | | | | | | | **Pushed Shelby Tube with HSA Drilling @ 8 Begin Mud Rotary Drilling @ 10** |
| | | Medium stiff, dark gray, moist, silty clay. | ST-2 | 8.0-10.0 | 1.8 | | ST | |
| | | | ST-3 | 13.0-15.0 | 1.8 | | ST | |
| | | | ST-4 | 18.0-20.0 | 2.0 | | ST | |
| 291.8 | 22.0 | | | | | | | |
| | | Loose to medium dense, gray and brown, wet, sand (clay layer at 64 feet). | ST-5 | 23.0-25.0 | 0.0 | | ST | **Pushed Shelby Tube no recovery @ 23** |
| | | | SPT-2 | 25.0-26.5 | 0.7 | 2-1-0 | SPT | |
| | | | SPT-3 | 28.5-30.0 | 1.5 | 3-4-4 | SPT | |
| | | | SPT-4 | 33.5-35.0 | 1.3 | 4-4-5 | SPT | |
| | | | PT-6 | 38.0-40.0 | 0.0 | | ST | **SPT sample from 38.5 ft to 40.0 ft @ 38.5 continued on 04.15.2021 @ 40** |
| | | | SPT-5 | 40.0-41.5 | 1.5 | 4-6-7 | SPT | |
| | | | SPT-6 | 43.5-45.0 | 0.9 | 4-5-7 | SPT | |
| | | | SPT-7 | 48.5-50.0 | 1.5 | 6-10-13 | SPT | |

# DRILLER'S SUBSURFACE LOG



| | | |
|---|---|---|
| Project ID: ***S-040-2021*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Structure State Bridge*** |
| Item Number: ***01-1140.00*** | | Project Manager: ***Eric Scott*** |

| | | | |
|---|---|---|---|
| Hole Number ***B-6*** | Immediate Water Depth ***NA*** | Start Date ***04/13/2021*** | Hole Type ***sample*** |
| Surface Elevation ***313.8'*** | Static Water Depth ***NA*** | End Date ***04/17/2021*** | Rig_Number ***642*** |
| Total Depth ***152.0'*** | Driller ***K. Hayslip*** | Latitude(83) ***37.000609*** | |
| Location ***2093+67.00 7.0' Rt.*** | | Longitude(83) ***-89.137896*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 55 | | | SPT-8 | 53.5-55.0 | 1.5 | 9-12-13 | SPT | 55 |
| | | | | | | | | |
| 60 | | Loose to medium dense, gray and brown, wet, sand (clay layer at 64 feet). | PT-7 | 58.0-60.0 | 1.2 | | ST | 60 |
| | | | | | | | | |
| 65 | | | SPT-9 | 63.5-65.0 | 1.5 | 4-4-5 | SPT | 65 |
| 245.8 | 68.0 | | | | | | | |
| 70 | | | SPT-10 | 68.5-70.0 | 0.1 | 9-13-10 | SPT | 70 |
| | | | | | | | | |
| 75 | | | SPT-11 | 73.5-75.0 | 0.7 | 9-7-8 | SPT | 75 |
| | | Medium dense to dense, gray, wet, sand (medium coarse, with some gravel and few cobbles). | PT-8 | 78.0-78.0 | 0.0 | 12-20-25 | ST | **Piston Tube Refusal @ 78 continued on 04.16.2021 @ 80** |
| 80 | | | SPT-12 | 78.0-79.5 | 0.6 | | SPT | 80 |
| | | | | | | | | |
| 85 | | | SPT-13 | 83.5-85.0 | 0.1 | 11-30-42 | SPT | 85 |
| 226.8 | 87.0 | | | | | | | |
| 90 | | | SPT-14 | 88.5-90.0 | 0.3 | 7-11-7 | SPT | 90 |
| | | Medium dense, white to gray, wet, sand (medium coarse). | | | | | | |
| 95 | | | SPT-15 | 93.5-95.0 | 0.3 | 7-9-12 | SPT | 95 |
| 216.8 | 97.0 | | | | | | | |
| | | Dense to very dense, white and gray, wet, sand (medium coarse). | PT-9 | 98.0-98.0 | 0.0 | 8-24-36 | ST | **Piston Tube Refusal @ 98** |
| 100 | | | SPT-16 | 98.0-99.5 | 1.0 | | SPT | 100 |

# DRILLER'S SUBSURFACE LOG



| | | |
|---|---|---|
| Project ID: ***S-040-2021*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Structure State Bridge*** |
| Item Number: ***01-1140.00*** | | Project Manager: ***Eric Scott*** |

| | | | |
|---|---|---|---|
| Hole Number ***B-6*** | Immediate Water Depth ***NA*** | Start Date ***04/13/2021*** | Hole Type ***sample*** |
| Surface Elevation ***313.8'*** | Static Water Depth ***NA*** | End Date ***04/17/2021*** | Rig_Number ***642*** |
| Total Depth ***152.0'*** | Driller ***K. Hayslip*** | Latitude(83) ***37.000609*** | |
| Location ***2093+67.00 7.0' Rt.*** | | Longitude(83) ***-89.137896*** | |

| Lithology Elevation | Lithology Depth | Description | Sample No. | Depth (ft) | Rec. (ft) | SPT Blows | Sample Type | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Overburden | | | | | | |
| | | Rock Core | Std/Ky RQD | Run (ft) | Rec (ft) | Rec (%) | SDI (JS) | |
| 105 | | | SPT-17 | 103.5-103.7 | 0.2 | 50/0.17' | SPT | 105 |
| 110 | | | SPT-18 | 108.5-108.7 | 0.2 | 50/0.17' | SPT | 110 |
| 115 | | | SPT-19 | 113.5-114.2 | 0.7 | 26-50/0.17' | SPT | 115 |
| 120 | | | PT-10 | 118.0-119.0 | 1.0 | | ST | 120 |
| | | | SPT-20 | 119.0-119.8 | 0.8 | 10-50/0.25' | SPT | |
| 125 | | Dense to very dense, white and gray, wet, sand (medium coarse). | SPT-21 | 123.5-123.9 | 0.3 | 50/0.42' | SPT | **continued on 04.17.2021 @ 123.5** 125 |
| 130 | | | SPT-22 | 128.5-128.9 | 0.3 | 50/0.42' | SPT | 130 |
| 135 | | | SPT-23 | 133.5-133.9 | 0.3 | 50/0.42' | SPT | 135 |
| 140 | | | PT-11 | 138.0-138.0 | 0.0 | 50/0.33' | ST | **Piston Tube Refusal @ 138** |
| | | | SPT-24 | 138.0-138.3 | 0.3 | | SPT | 140 |
| 145 | | | SPT-25 | 143.5-144.1 | 0.5 | 40-50/0.08' | SPT | 145 |
| 150 | | | PT-12 | 148.0-148.0 | 0.0 | 50/0.33' | ST | **Piston Tube Refusal @** |
| | | | SPT-26 | 148.0-148.3 | 0.3 | | SPT | 150 |

Drilling Firm: Terracon
For: Division of Structural Design
Geotechnical Branch

# DRILLER'S SUBSURFACE LOG

Printed: 3/18/26



| | | |
|---|---|---|
| Project ID: ***S-040-2021*** Item Number: ***01-1140.00*** | ***Ballard - US-51 MP 7.3-8.3*** | Project Type: ***Structure State Bridge*** Project Manager: ***Eric Scott*** |

| | | | |
|---|---|---|---|
| Hole Number ***B-6*** | Immediate Water Depth ***NA*** | Start Date ***04/13/2021*** | Hole Type ***sample*** |
| Surface Elevation ***313.8'*** | Static Water Depth ***NA*** | End Date ***04/17/2021*** | Rig_Number ***642*** |
| Total Depth ***152.0'*** | Driller ***K. Hayslip*** | Latitude(83) ***37.000609*** | |
| Location ***2093+67.00 7.0' Rt.*** | | Longitude(83) ***-89.137896*** | |

| Lithology Elevation | Lithology Depth | Description (Overburden / Rock Core) | Sample No. / Std/Ky RQD | Depth (ft) / Run (ft) | Rec. (ft) / Rec (ft) | SPT Blows / Rec (%) | Sample Type / SDI (JS) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 161.8 | 152.0 | Dense to very dense, white and gray, wet, sand (medium coarse). | | | | | | **148 boring extended 2.0 ft to facilitate downhole seismic testing @ 150** |
| | | (Bottom of Hole 152.0') (No Refusal) | | | | | | |
| | | gravel parking lot | | | | | | |

155 160 165 170 175 180 185 190 195 200

# CPT LOG NO. CPT-6



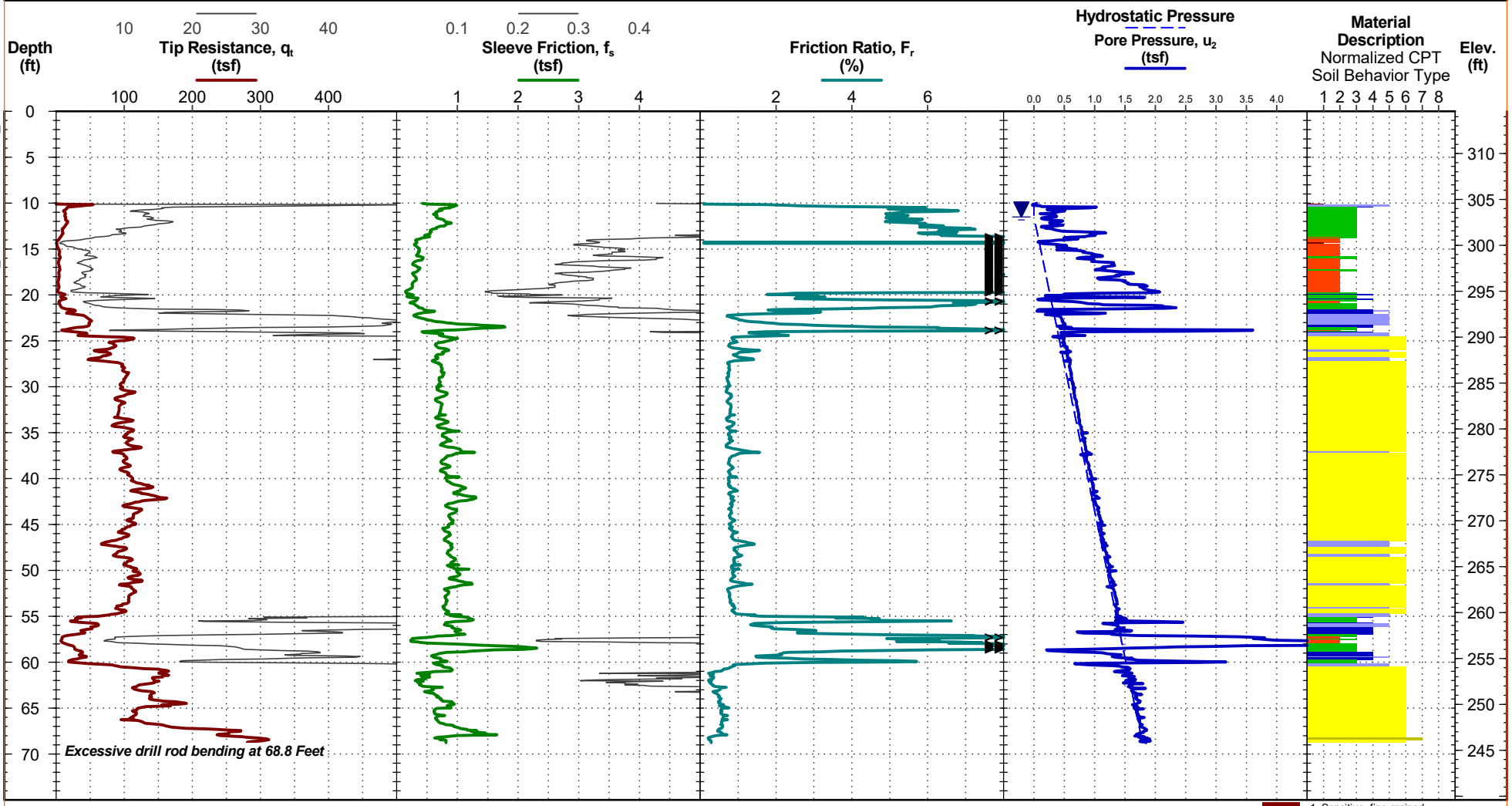
**PROJECT:** US-51 Bridge Replacement over Ohio River

**CLIENT:** Michael Baker International LLC
Louisville, KY

**TEST LOCATION:** See Exploration Plan

Surface Elev.: 314.592 ft
Latitude: 37.00067495°
Longitude: -89.13784445°

**SITE:** US51
Wicliffe, KY




Augered to 10 feet prior to initiating push
Hand advancement from 67.5 to 68.77 feet
See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
Elevations were provided by others.

CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

**WATER LEVEL OBSERVATION**
11.5 ft estimated water depth
(used in normalizations and correlations; See Supporting Information)

Probe no. 4342 with net area ratio of .84
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 8/3/2020
Tip and sleeve areas of 10 $cm^2$ and 150 $cm^2$
Ring friction reducer with O.D. of 1.875 in

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

CPT Started: 4/20/2021
CPT Completed: 4/20/2021
Rig: CME 55X
Operator: kyle
Project No.: 57205041

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CPT REPORT 57205041 US-51 BRIDGE REPL_CPT.GPJ TERRACON_DATATEMPLATE.GDT 11/20/21

**TERRACON**
611 Lunken Park Drive
Cincinnati, OH 45226
9-Dec-21

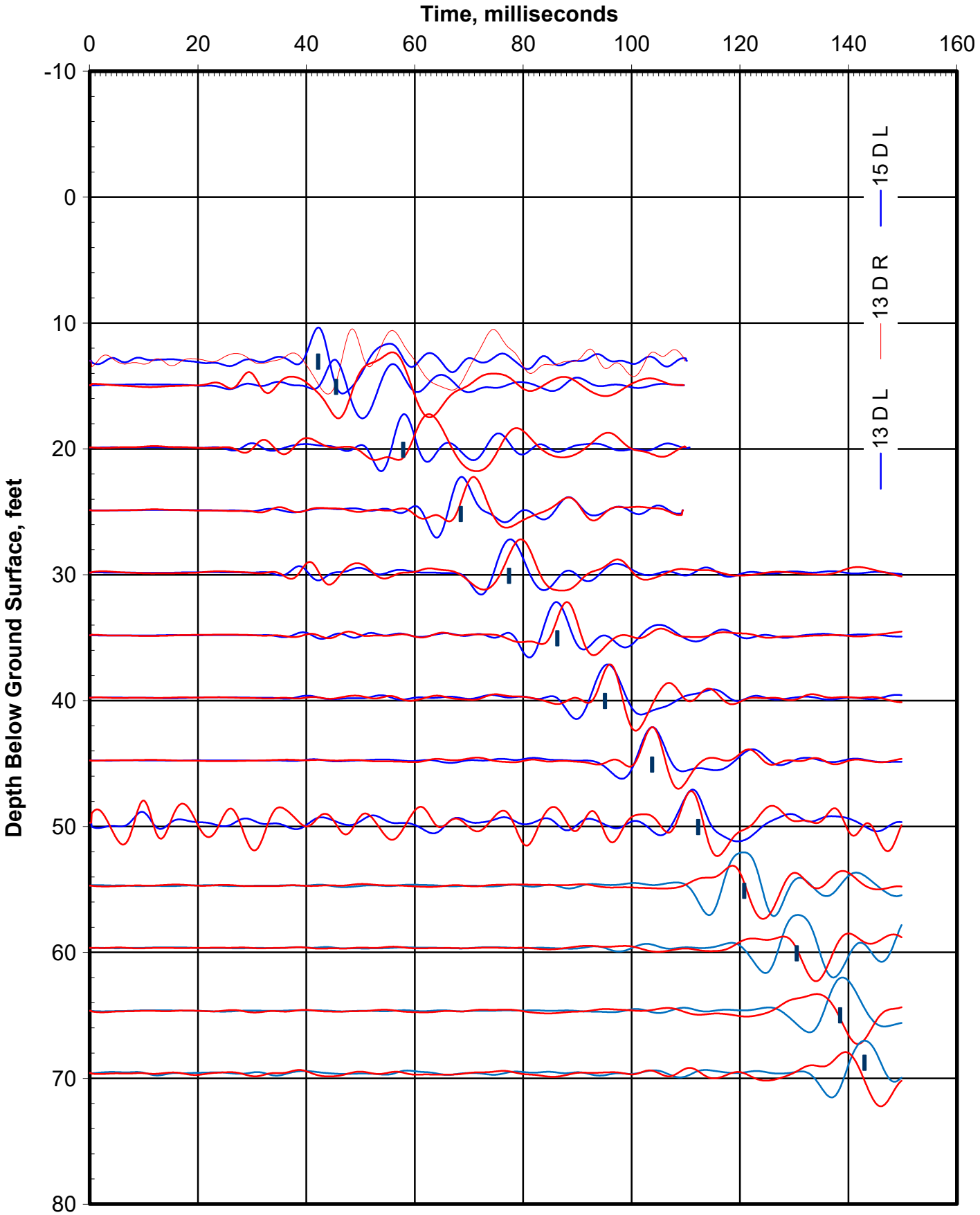
Michael Baker International LLC
US 51 Bridge Replacement over Ohio River
Ballard County, KY
Project No. 57205041
KYTC Project ID: S-040-2021

## SHEAR WAVE VELOCITY MEASUREMENTS
## DOWNHOLE SEISMIC TEST - CPT-6

| | | |
|---|---|---|
| **Test Date(s):** | 04/20/21 | |
| **Operator:** | DSB / KH | |
| **Weather:** | Fair 71° | |
| **Source:** | 12-lb Sledge Hammer / Strike Plates | |
| **Downhole Receiver:** | Geotech AB Triaxial Accelerometer | |
| **Recording Equipment:** | SCPT-Log | |
| **Borehole Information:** | CPT Sounding | |
| **Method of Installation:** | CME 55X | |
| **Casing Diameter** | 1.4-inch-diameter Rod | |
| **Clamp Method:** | N/A | |
| **Ground Surface Elevation @ Seismic Source, $E_S$:** | 314.6 | ft |
| **Source Horizontal Offset, X:** | 10.0 | ft |
| **Pipe Stickup:** | 0.00 | ft |
| **Receiver Offset from Reference Point:** | 0.5 | ft |
| **Ground Surface Elevation @ Borehole, $E_G$:** | 314.6 | ft |

FMDSM

| *Recorded Geophone Depth (ft)* | *Corrected Geophone Depth (ft)* | *Receiver Depth, $D_G$ (ft)* | *Receiver Elevation (ft)* | *Source Slant Distance, (ft)* | *Reference Shear Wave Arrival, $T_R$ (milliseconds)* | *Average Shear Wave Velocity (ft/sec)* | *Interval Shear Wave Velocity, $V_S$ (ft/sec)* |
|---|---|---|---|---|---|---|---|
| 13.1 | 13.1 | 12.6 | 302.0 | 16.06 | 42.20 | 408 | |
| | | | | | | | 484 |
| 15.1 | 15.1 | 14.6 | 300.0 | 17.68 | 45.50 | 414 | |
| | | | | | | | 364 |
| 20.1 | 20.1 | 19.6 | 295.0 | 21.98 | 57.90 | 399 | |
| | | | | | | | 435 |
| 25.2 | 25.2 | 24.7 | 289.9 | 26.63 | 68.50 | 405 | |
| | | | | | | | 504 |
| 30.1 | 30.1 | 29.6 | 285.0 | 31.23 | 77.40 | 419 | |
| | | | | | | | 526 |
| 35.1 | 35.1 | 34.6 | 280.0 | 35.98 | 86.30 | 431 | |
| | | | | | | | 531 |
| 40.0 | 40.0 | 39.5 | 275.1 | 40.78 | 95.10 | 442 | |
| | | | | | | | 563 |
| 45.1 | 45.1 | 44.6 | 270.0 | 45.69 | 103.80 | 452 | |
| | | | | | | | 570 |
| 50.1 | 50.1 | 49.6 | 265.0 | 50.55 | 112.30 | 462 | |
| | | | | | | | 574 |
| 55.1 | 55.1 | 54.6 | 260.0 | 55.52 | 120.80 | 471 | |
| | | | | | | | 507 |
| 60.1 | 60.1 | 59.6 | 255.0 | 60.41 | 130.50 | 473 | |
| | | | | | | | 601 |
| 65.0 | 65.0 | 64.5 | 250.1 | 65.27 | 138.50 | 481 | |
| | | | | | | | 821 |
| 68.8 | 68.8 | 68.3 | 246.3 | 69.00 | 143.00 | 492 | |
| | | | | | | | |
| Average | | | | | | | 494 |

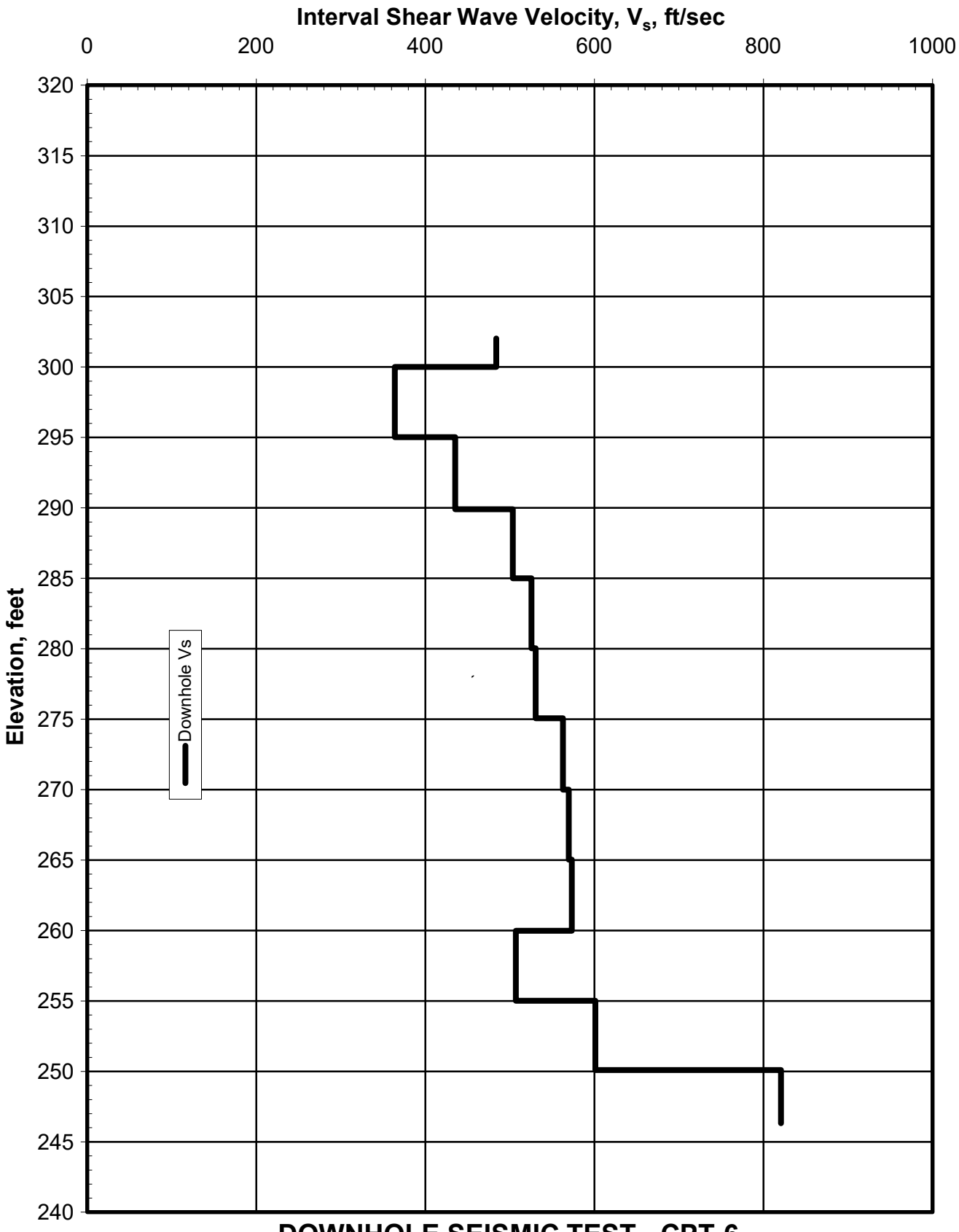



# DOWNHOLE SEISMIC TEST - CPT-6

## SHEAR WAVE ARRIVALS PROFILE

**Michael Baker International LLC**

**US 51 Bridge Replacement over Ohio River**




**DOWNHOLE SEISMIC TEST - CPT-6**

**SHEAR WAVE VELOCITY PROFILE**

**Michael Baker International LLC**

**US 51 Bridge Replacement over Ohio River**

# Attachment D: Laboratory Data

hdrinc.com

333 West Vine Street, Suite 1400, Lexington, KY 40507-1681
(859) 629-4800

US-51 Cairo
Ballard County, KY
Roadway Laboratory

| Boring Number | Sample Number | Sample Depth (ft.) | | Elevation at Bottom of Sample | Natural Moisture Content (%) | (%) Passing No. 200 | Atterberg Limits | | AASHTO Classification | ASTM Classification | N-Count | N-60 | Standard Proctor | | CBR | Consolidation | | | | | Triaxal Compression (UU/UC) | | Consolidated Undrained Triaxial Test (CU) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Liquid Limit | Plasticity Index | | | | | MDD (pcf) | OMC (%) | | Overburden Pressure (tsf) | Pc (tsf) | OCR | Cc | Cr | c (psf) | γ (pcf) | c (psf) | Ø (deg) | c' (psf) | Ø' (deg) |
| 117 | ST-1 | 3 | 5 | 297.9 | 40.5 | 80 | 53 | 22 | A-7-5 (20) | MH | - | - | | | | 0.26 | 2.07 | 7.96 | 0.42 | 0.01 | | | | | | |
| | ST-2 | 8 | 10 | 292.9 | 28.2 | 86 | 38 | 13 | A-6 (12) | ML | - | - | | | | | | | | | 310 | 111.9 | | | | |
| | ST-3 | 14 | 16 | 286.9 | 6.1 | 69 | 32 | 14 | A-6 (8) | CL | - | - | | | | | | | | | | | | | | |
| | ST-4 | 18 | 20 | 282.9 | 28.0 | 13 | 0 | 0 | A-2-4 (0) | SM | - | - | | | | | | | | | 639 | 130.2 | | | | |
| | ST-5 | 23 | 25 | 277.9 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-1 | 25 | 26.5 | 276.4 | 26.5 | 12 | 0 | 0 | A-2-4 (0) | SM | 17 | 27 | | | | | | | | | | | | | | |
| | SS-2 | 30 | 31.5 | 271.4 | 25.9 | 9 | 0 | 0 | A-3 (0) | SP-SM | 19 | 30 | | | | | | | | | | | | | | |
| | SS-3 | 35 | 36.5 | 266.4 | 37.7 | 8 | 0 | 0 | A-3 (0) | SP-SM | 10 | 16 | | | | | | | | | | | | | | |
| | SS-4 | 40 | 41.5 | 261.4 | 35.3 | 9 | 0 | 0 | A-3 (0) | SP-SM | 8 | 12 | | | | | | | | | | | | | | |
| 118 | ST-1 | 3 | 5 | 322.6 | 18.7 | 80 | 31 | 12 | A-6 (8) | CL | - | - | | | | | | | | | | | 345.6 | 14.2 | 475.2 | 24.6 |
| | ST-2 | 8 | 10 | 317.6 | 25.9 | 87 | 32 | 11 | A-6 (9) | CL | - | - | | | | | | | | | | | | | | |
| | SS-1 | 10 | 11.5 | 316.1 | 28.6 | 57 | 33 | 12 | A-6 (4) | CL | 5 | 7 | | | | | | | | | | | | | | |
| | ST-3 | 13 | 15 | 312.6 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-2 | 15 | 16.5 | 311.1 | 31.2 | 95 | 40 | 15 | A-6 (16) | CL | 7 | 10 | | | | | | | | | | | | | | |
| | ST-4 | 18 | 20 | 307.6 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-3 | 20 | 21.5 | 306.1 | 24.6 | 57 | 34 | 9 | A-4 (3) | ML | 6 | 8 | | | | | | | | | | | | | | |
| | ST-5 | 23 | 25 | 302.6 | 29.3 | 98 | 43 | 17 | A-7-6 (19) | CL | - | - | | | | | | | | | 978 | 118.3 | 345.6 | 14.2 | 475.2 | 24.6 |
| | ST-6 | 28 | 30 | 297.6 | 30.9 | 100 | 42 | 11 | A-7-5 (15) | ML | - | - | | | | 1.73 | 1.97 | 1.14 | 0.33 | 0.03 | | | 345.6 | 14.2 | 475.2 | 24.6 |
| | ST-7 | 33 | 35 | 292.6 | 27.5 | 36 | 33 | 7 | A-4 (0) | SM | - | - | | | | | | | | | | | | | | |
| | SS-4 | 35 | 36.5 | 291.1 | 21.6 | 7 | 0 | 0 | A-3 (0) | SP-SM | 14 | 20 | | | | | | | | | | | | | | |
| | SS-5 | 38.5 | 40 | 287.6 | 29.8 | 9 | 0 | 0 | A-3 (0) | SP-SM | 20 | 28 | | | | | | | | | | | | | | |
| | SS-6 | 43.5 | 45 | 282.6 | 48.3 | 7 | 0 | 0 | A-3 (0) | SP-SM | 12 | 17 | | | | | | | | | | | | | | |
| | SS-7 | 48.5 | 50 | 277.6 | 29.3 | 7 | 0 | 0 | A-3 (0) | SP-SM | 14 | 20 | | | | | | | | | | | | | | |
| | SS-8 | 53.5 | 55 | 272.6 | 31.8 | 4 | 0 | 0 | A-3 (0) | SP | 11 | 15 | | | | | | | | | | | | | | |
| | SS-9 | 58.5 | 60 | 267.6 | 27.2 | 6 | 0 | 0 | A-3 (0) | SP-SM | 15 | 21 | | | | | | | | | | | | | | |
| | SS-10 | 63.5 | 65 | 262.6 | 27.5 | 5 | 0 | 0 | A-3 (0) | SP | 15 | 21 | | | | | | | | | | | | | | |
| 119 | ST-1 | 3 | 5 | 299.9 | 39.0 | 96 | 54 | 23 | A-7-5 (27) | MH | - | - | | | | | | | | | 1005 | 112.3 | | | | |
| | ST-2 | 8 | 10 | 294.9 | 33.7 | 18 | 0 | 0 | A-2-4 (0) | SM | - | - | | | | | | | | | 1065 | 115.6 | | | | |
| | ST-3 | 13 | 15 | 289.9 | 4.1 | 12 | 0 | 0 | A-2-4 (0) | SP-SM | - | - | | | | | | | | | | | | | | |
| | ST-4 | 18 | 20 | 284.9 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-1 | 20 | 21.5 | 283.4 | 24.8 | 3 | 0 | 0 | A-3 (0) | SP | 0 | 0 | | | | | | | | | | | | | | |
| | SS-2 | 25 | 26.5 | 278.4 | 25.3 | 6 | 0 | 0 | A-3 (0) | SP-SM | 6 | 9 | | | | | | | | | | | | | | |
| | SS-3 | 30 | 31.5 | 273.4 | 22.6 | 8 | 0 | 0 | A-3 (0) | SP-SM | 25 | 39 | | | | | | | | | | | | | | |
| | SS-4 | 35 | 36.5 | 268.4 | 23.9 | 11 | 0 | 0 | A-2-4 (0) | SP-SM | 18 | 28 | | | | | | | | | | | | | | |
| | SS-5 | 40 | 41.5 | 263.4 | 23.8 | 6 | 0 | 0 | A-3 (0) | SP-SM | 7 | 11 | | | | | | | | | | | | | | |
| | SS-6 | 45 | 46.5 | 258.4 | 26.3 | 7 | 0 | 0 | A-3 (0) | SP-SM | 16 | 25 | | | | | | | | | | | | | | |
| | SS-7 | 50 | 51.5 | 253.4 | 28.3 | 7 | 0 | 0 | A-3 (0) | SP-SM | 7 | 11 | | | | | | | | | | | | | | |
| 120A | Bag-1 | 0 | 8 | 300.8 | | | | | | | | | 96.4 | 25.4 | 6.3 | | | | | | | | | | | |
| 120 | ST-1 | 3 | 5 | 303.8 | 24.2 | 95 | 44 | 18 | A-7-6 (20) | CL | - | - | | | | | | | | | | | 460.8 | 11.5 | 432 | 19.9 |
| | ST-2 | 8 | 10 | 298.8 | 21.9 | 93 | 42 | 18 | A-7-6 (18) | CL | - | - | | | | | | | | | | | 460.8 | 11.5 | 432 | 19.9 |
| | ST-3 | 13 | 13.2 | 295.6 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-1 | 13.2 | 14.7 | 294.1 | 38.2 | 90 | 41 | 11 | A-7-5 (12) | ML | 4 | 6 | | | | | | | | | | | | | | |
| | ST-4 | 18 | 20 | 288.8 | 38.3 | 73 | 35 | 12 | A-6 (8) | CL | - | - | | | | | | | | | | | 460.8 | 11.5 | 432 | 19.9 |
| | SS-2 | 23.5 | 25 | 283.8 | 25.9 | 9 | 0 | 0 | A-3 (0) | SP-SM | 17 | 27 | | | | | | | | | | | | | | |
| 121A | Bag-1 | 0 | 8 | 296.7 | | | | | | | | | 96.4 | 20.3 | 5.3 | | | | | | | | | | | |
| 121 | ST-1 | 3 | 5 | 299.7 | 37.4 | 96 | 43 | 15 | A-7-6 (17) | ML | - | - | | | | | | | | | 450 | 113.8 | 504 | 10 | 590.4 | 19.7 |
| | ST-2 | 8 | 10 | 294.7 | 32.2 | 96 | 43 | 19 | A-7-6 (20) | CL | - | - | | | | | | | | | 320 | 119.9 | 504 | 10 | 590.4 | 19.7 |
| | ST-3 | 13 | 15 | 289.7 | 31.7 | 96 | 44 | 19 | A-7-6 (21) | CL | - | - | | | | | | | | | 730 | 111.4 | 504 | 10 | 590.4 | 19.7 |
| | ST-4 | 18 | 18.1 | 286.6 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-1 | 18.1 | 19.6 | 285.1 | 49.8 | 93 | 46 | 18 | A-7-6 (20) | ML | 4 | 6 | | | | | | | | | | | | | | |
| | SS-2 | 23.5 | 25 | 279.7 | 48.6 | 98 | 51 | 21 | A-7-5 (25) | MH | 6 | 9 | | | | | | | | | | | | | | |

US-51 Cairo
Ballard County, KY
Roadway Laboratory

| Boring Number | Sample Number | Sample Depth (ft.) | | Elevation at Bottom of Sample | Natural Moisture Content (%) | (%) Passing No. 200 | Atterberg Limits | | AASHTO Classification | ASTM Classification | N-Count | N-60 | Standard Proctor | | CBR | Consolidation | | | | | Triaxal Compression (UU/UC) | | Consolidated Undrained Triaxial Test (CU) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Liquid Limit | Plasticity Index | | | | | MDD (pcf) | OMC (%) | | Overburden Pressure (tsf) | Pc (tsf) | OCR | Cc | Cr | c (psf) | γ (pcf) | c (psf) | Ø (deg) | c' (psf) | Ø' (deg) |
| 122A | Bag-1 | 0 | 8 | 294.7 | | | | | | | | | 107.2 | 20.2 | 5 | | | | | | | | | | | |
| 122 | ST-1 | 3 | 5 | 297.7 | 41.6 | 97 | 43 | 18 | A-7-6 (20) | CL | - | - | | | | | | | | | 960 | 113.9 | | | | |
| | ST-2 | 8 | 10 | 292.7 | 31.1 | 99 | 43 | 18 | A-7-6 (20) | CL | - | - | | | | | | | | | 1055 | 115.4 | 633.6 | 9 | 1094.4 | 6.9 |
| | ST-3 | 13 | 15 | 287.7 | 35.2 | 98 | 46 | 15 | A-7-5 (19) | ML | - | - | | | | | | | | | 465 | 112.0 | | | | |
| | ST-4 | 18 | 20 | 282.7 | 42.7 | 99 | 45 | 14 | A-7-5 (18) | ML | - | - | | | | | | | | | 595 | 94.5 | | | | |
| | ST-5 | 23 | 25 | 277.7 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-1 | 25 | 26.5 | 276.2 | 32.8 | 25 | 19 | 0 | A-2-4 (0) | SM | 7 | 11 | | | | | | | | | | | | | | |
| 123 | ST-1 | 3 | 5 | 303.8 | 45.2 | 86 | 50 | 21 | A-7-6 (21) | MH | - | - | | | | | | | | | 925 | 117.1 | | | | |
| | ST-2 | 8 | 10 | 298.8 | 23.7 | 91 | 40 | 13 | A-6 (13) | ML | - | - | | | | 0.59 | 1.78 | 3.02 | 0.22 | 0.03 | 1335 | 123.4 | | | | |
| | ST-3 | 13 | 15 | 293.8 | 29.1 | 97 | 41 | 14 | A-7-6 (16) | ML | - | - | | | | | | | | | 870 | 117.5 | | | | |
| | ST-4 | 18 | 20 | 288.8 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-1 | 20 | 21.5 | 287.3 | 39.1 | 98 | 42 | 9 | A-5 (12) | ML | 4 | 6 | | | | | | | | | | | | | | |
| | ST-5 | 23 | 25 | 283.8 | 42.2 | 62 | 44 | 11 | A-7-5 (6) | ML | - | - | | | | | | | | | 786 | 106.8 | 273.6 | 15.6 | 1195.2 | 22.2 |
| | ST-6 | 28 | 30 | 278.8 | 33.9 | 81 | 36 | 13 | A-6 (10) | CL | - | - | | | | 1.76 | 6.3 | 3.58 | 0.29 | 0.03 | 1091 | 108.5 | | | | |
| | ST-7 | 33 | 35 | 273.8 | 32.4 | 74 | 31 | 10 | A-4 (6) | CL | - | - | | | | | | | | | 816 | 120.7 | | | | |
| | SS-2 | 38.5 | 40 | 268.8 | 28.4 | 41 | 15 | 1 | A-4 (0) | SM | 7 | 11 | | | | | | | | | | | | | | |
| | SS-3 | 43.5 | 45 | 263.8 | 28.0 | 15 | 0 | 0 | A-2-4 (0) | SM | 13 | 20 | | | | | | | | | | | | | | |
| | SS-4 | 48.5 | 50 | 258.8 | 26.6 | 53 | 16 | 1 | A-4 (0) | ML | 19 | 30 | | | | | | | | | | | | | | |
| | SS-5 | 53.5 | 55 | 253.8 | 26.7 | 15 | 0 | 0 | A-2-4 (0) | SM | 20 | 31 | | | | | | | | | | | | | | |
| | SS-6 | 58.5 | 60 | 248.8 | 18.9 | 13 | 0 | 0 | A-2-4 (0) | SM | 33 | 51 | | | | | | | | | | | | | | |
| 124P | ST-1 | 3 | 5 | 321.4 | 16.6 | 56 | 18 | 0 | A-4 (0) | ML | - | - | | | | | | | | | | | | | | |
| | ST-2 | 8 | 10 | 316.4 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-3 | 10 | 11.5 | 314.9 | 30.1 | 32 | 17 | 1 | A-2-4 (0) | SM | 6 | 8 | | | | | | | | | | | | | | |
| | ST-4 | 13 | 15 | 311.4 | 31.0 | 95 | 40 | 17 | A-6 (18) | CL | - | - | | | | 0.89 | 2.83 | 3.19 | 0.21 | 0.01 | 1180 | 121.8 | | | | |
| | ST-5 | 18 | 20 | 306.4 | 30.4 | 98 | 43 | 18 | A-7-6 (20) | CL | - | - | | | | | | | | | 1125 | 118.7 | | | | |
| | ST-6 | 23 | 25 | 301.4 | 34.5 | 99 | 42 | 18 | A-7-6 (20) | CL | - | - | | | | | | | | | 1382 | 121.7 | | | | |
| 125 | ST-1 | 3 | 5 | 319.5 | 21.0 | 33 | 20 | 0 | A-2-4 (0) | SM | - | - | | | | | | | | | | | | | | |
| | ST-2 | 8 | 10 | 314.5 | 19.8 | 94 | 43 | 20 | A-7-6 (21) | CL | - | - | | | | | | | | | 1645 | 119.1 | | | | |
| | ST-3 | 13 | 15.0 | 309.5 | 32.6 | 89 | 33 | 12 | A-6 (10) | CL | - | - | | | | | | | | | | | | | | |
| | SS-4 | 15 | 16.5 | 308.0 | 30.2 | 89 | 36 | 17 | A-6 (15) | CL | 6 | 8 | | | | | | | | | | | | | | |
| | ST-5 | 18 | 20 | 304.5 | 32.0 | 96 | 36 | 16 | A-6 (16) | CL | - | - | | | | | | | | | 830 | 120.5 | | | | |
| | ST-6 | 23 | 25 | 299.5 | 33.0 | 97 | 44 | 14 | A-7-5 (17) | ML | - | - | | | | 1.49 | 4.17 | 2.8 | 0.29 | 0.05 | | | | | | |
| | ST-7 | 28 | 30 | 294.5 | 32.7 | 39 | 23 | 8 | A-4 (0) | SC | - | - | | | | | | | | | | | | | | |
| | ST-8 | 33 | 35 | 289.5 | 32.3 | 87 | 35 | 11 | A-6 (10) | CL | - | - | | | | | | | | | 2495 | 125.4 | | | | |
| | SS-9 | 38.5 | 40 | 284.5 | 27.9 | 7 | 0 | 0 | A-3 (0) | SP-SM | 13 | 18 | | | | | | | | | | | | | | |
| | SS-10 | 43.5 | 45.0 | 279.5 | 29.0 | 7 | 0 | 0 | A-3 (0) | SP-SM | 18 | 25 | | | | | | | | | | | | | | |
| | SS-11 | 48.5 | 50.0 | 274.5 | 27.6 | 8 | 0 | 0 | A-3 (0) | SP-SM | 15 | 21 | | | | | | | | | | | | | | |
| 126A | SS-1 | 3.5 | 5 | 319.4 | 19.7 | 26 | 23 | 8 | A-2-4 (0) | SC | 4 | 6 | | | | | | | | | | | | | | |
| | ST-2 | 8.0 | 10 | 314.4 | 29.5 | 75 | 25 | 10 | A-4 (5) | CL | - | - | | | | 0.5 | 1.49 | 3.01 | 0.22 | 0.01 | | | 892.8 | 8.3 | 316.8 | 24.6 |
| | ST-3 | 13.0 | 15 | 309.4 | 25.4 | 95 | 40 | 20 | A-6 (20) | CL | - | - | | | | | | | | | 965 | 118.7 | | | | |
| | ST-4 | 18 | 20 | 304.4 | 27.9 | 89 | 38 | 16 | A-6 (15) | CL | - | - | | | | | | | | | | | 892.8 | 8.3 | 316.8 | 24.6 |
| | ST-5 | 23 | 25 | 299.4 | 33.4 | 40 | 20 | 8 | A-4 (0) | SC | - | - | | | | | | | | | 402 | 124.0 | | | | |
| | SS-6 | 30 | 31.5 | 292.9 | 30.9 | 60 | 23 | 7 | A-4 (2) | CL-ML | 4 | 6 | | | | | | | | | | | | | | |
| | ST-7 | 33 | 35 | 289.4 | 29.4 | 56 | 22 | 0 | A-4 (0) | ML | - | - | | | | | | | | | | | 892.8 | 8.3 | 316.8 | 24.6 |
| | SS-8 | 38.5 | 40 | 284.4 | 45.1 | 56 | 22 | 3 | A-4 (0) | ML | 6 | 8 | | | | | | | | | | | | | | |
| | SS-9 | 43.5 | 45 | 279.4 | 24.9 | 7 | 0 | 0 | A-3 (0) | SP-SM | 13 | 18 | | | | | | | | | | | | | | |
| | SS-10 | 48.5 | 50 | 274.4 | 38.8 | 31 | 17 | 0 | A-2-4 (0) | SM | 8 | 11 | | | | | | | | | | | | | | |
| | SS-11 | 53.5 | 55 | 269.4 | 28.3 | 21 | 16 | 0 | A-2-4 (0) | SM | 8 | 11 | | | | | | | | | | | | | | |
| | SS-12 | 58.5 | 60 | 264.4 | 37.3 | 68 | 31 | 8 | A-4 (4) | ML | 10 | 14 | | | | | | | | | | | | | | |
| | ST-13 | 63 | 65 | 259.4 | 53.2 | 75 | 32 | 13 | A-6 (8) | CL | - | - | | | | | | | | | | | | | | |
| | ST-14 | 68 | 70 | 254.4 | 30.3 | 93 | 12 | 1 | A-4 (0) | ML | - | - | | | | | | | | | 1526 | 120.3 | | | | |

US-51 Cairo
Ballard County, KY
Roadway Laboratory

| Boring Number | Sample Number | Sample Depth (ft.) | | Elevation at Bottom of Sample | Natural Moisture Content (%) | (%) Passing No. 200 | Atterberg Limits | | AASHTO Classification | ASTM Classification | N-Count | N-60 | Standard Proctor | | CBR | Consolidation | | | | | Triaxal Compression (UU/UC) | | Consolidated Undrained Triaxial Test (CU) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Liquid Limit | Plasticity Index | | | | | MDD (pcf) | OMC (%) | | Overburden Pressure (tsf) | Pc (tsf) | OCR | Cc | Cr | c (psf) | γ (pcf) | c (psf) | Ø (deg) | c' (psf) | Ø' (deg) |
| B-2046 | ST-1 | 3 | 5 | 309.3 | 18.4 | 91 | 42 | 15 | A-7-6 (16) | ML | - | - | | | | | | | | | 485 | 114.8 | | | | |
| | ST-2 | 8 | 10 | 304.3 | 31.3 | 100 | 44 | 16 | A-7-6 (19) | ML | - | - | | | | | | | | | 125 | 119.6 | | | | |
| | ST-3 | 14 | 16 | 298.3 | 41.2 | 89 | 47 | 17 | A-7-5 (18) | ML | - | - | | | | | | | | | 645 | 114.4 | | | | |
| | ST-4 | 18 | 20 | 294.3 | 38.4 | 96 | 48 | 19 | A-7-6 (22) | ML | - | - | | | | | | | | | 541 | 115.9 | | | | |
| | ST-5 | 23 | 25 | 289.3 | 37.8 | 35 | 21 | 3 | A-2-4 (0) | SM | - | - | | | | | | | | | | | | | | |
| | SS-1 | 28.5 | 30 | 284.3 | 27.3 | 7 | 0 | 0 | A-3 (0) | SP-SM | 19 | 27 | | | | | | | | | | | | | | |
| | SS-2 | 33.5 | 35 | 279.3 | 32.6 | 6 | 0 | 0 | A-3 (0) | SP-SM | 14 | 20 | | | | | | | | | | | | | | |
| | SS-3 | 38.5 | 40 | 274.3 | 27.7 | 8 | 0 | 0 | A-3 (0) | SP-SM | 18 | 25 | | | | | | | | | | | | | | |
| | SS-4 | 43.5 | 45 | 269.3 | 27.0 | 8 | 0 | 0 | A-3 (0) | SP-SM | 21 | 29 | | | | | | | | | | | | | | |
| | PT-1 | 48 | 50 | 264.3 | 38.6 | 4 | 0 | 0 | A-3 (0) | SP | - | - | | | | | | | | | 2271 | 136.8 | | | | |
| | SS-5 | 53.5 | 55 | 259.3 | 43.7 | 45 | 19 | 0 | A-4 (0) | SM | 7 | 10 | | | | | | | | | | | | | | |
| | SS-6 | 58.5 | 60 | 254.3 | 30.5 | 20 | 17 | 17 | A-2-4 (0) | SM | 14 | 20 | | | | | | | | | | | | | | |
| | SS-7 | 63.5 | 65 | 249.3 | 22.7 | 5 | 0 | 0 | A-3 (0) | SP | 23 | 32 | | | | | | | | | | | | | | |
| | PT-2 | 68 | 70 | 244.3 | 14.0 | 4 | 0 | 0 | A-1-b (0) | SW | - | - | | | | | | | | | 5199 | 125.4 | | | | |
| | SS-8 | 73.5 | 75 | 239.3 | 16.4 | 5 | 0 | 0 | A-1-b (0) | SP-SM | 32 | 45 | | | | | | | | | | | | | | |
| | SS-9 | 78.5 | 80 | 234.3 | 20.8 | 8 | 0 | 0 | A-3 (0) | SP-SM | 40 | 56 | | | | | | | | | | | | | | |
| | SS-10 | 83.5 | 85 | 229.3 | 18.1 | 6 | 0 | 0 | A-1-b (0) | SP-SM | 59 | 82 | | | | | | | | | | | | | | |
| | PT-3 | 88 | 88.5 | 225.8 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-11 | 88.5 | 90 | 224.3 | 21.7 | 41 | 19 | 6 | A-4 (0) | SC-SM | 17 | 24 | | | | | | | | | | | | | | |
| | SS-12 | 95 | 96.5 | 217.8 | 21.1 | 24 | 14 | 0 | A-2-4 (0) | SM | 44 | 61 | | | | | | | | | | | | | | |
| | PT-4 | 100 | 102 | 212.3 | 20.9 | 37 | 18 | 5 | A-4 (0) | SC-SM | - | - | | | | | | | | | | | | | | |
| | SS-13 | 108.5 | 110 | 204.3 | 19.1 | 9 | 0 | 0 | A-3 (0) | SP-SM | 53 | 74 | | | | | | | | | | | | | | |
| | SS-14 | 118.5 | 120 | 194.3 | 19.9 | 6 | 0 | 0 | A-3 (0) | SP-SM | 74 | 103 | | | | | | | | | | | | | | |
| | SS-15 | 128.5 | 128.8 | 185.5 | 23.4 | 9 | 0 | 0 | A-3 (0) | SP-SM | 50/0.3 | 50/0.3 | | | | | | | | | | | | | | |
| | SS-16 | 138.5 | 138.8 | 175.5 | 22.2 | 8 | 0 | 0 | A-3 (0) | SP-SM | 50/0.3 | 50/0.3 | | | | | | | | | | | | | | |
| | PT-5 | 148 | 148.5 | 165.8 | - | - | | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-17 | 148.5 | 149 | 165.3 | 20.7 | 4 | 0 | 0 | A-1-b (0) | SW | 50/0.5 | 50/0.5 | | | | | | | | | | | | | | |

US-51 Cairo
Ballard County, KY
Roadway Laboratory

| Boring Number | Sample Number | Sample Depth (ft.) | | Elevation at Bottom of Sample | Natural Moisture Content (%) | (%) Passing No. 200 | Atterberg Limits | | AASHTO Classification | ASTM Classification | N-Count | N-60 | Standard Proctor | | CBR | Consolidation | | | | | Triaxal Compression (UU/UC) | | Consolidated Undrained Triaxial Test (CU) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Liquid Limit | Plasticity Index | | | | | MDD (pcf) | OMC (%) | | Overburden Pressure (tsf) | Pc (tsf) | OCR | Cc | Cr | c (psf) | γ (pcf) | c (psf) | Ø (deg) | c' (psf) | Ø' (deg) |
| B-6 | ST-1 | 3 | 5 | 308.8 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-1 | 5 | 6.5 | 307.3 | 29.3 | 95 | 42 | 16 | A-7-6 (17) | ML | 8 | 12 | | | | | | | | | | | | | | |
| | ST-2 | 8 | 10 | 303.8 | 31.2 | 97 | 44 | 23 | A-7-6 (24) | CL | - | - | | | | 0.49 | 2.18 | 4.46 | 0.36 | 0.02 | 1429 | 120.5 | | | | |
| | ST-3 | 13 | 15 | 298.8 | 32.0 | 99 | 43 | 23 | A-7-6 (25) | CL | - | - | | | | | | | | | 849 | 121.1 | | | | |
| | ST-4 | 18 | 20 | 293.8 | 64.7 | 90 | 48 | 18 | A-7-5 (19) | ML | - | - | | | | 1.1 | 1.71 | 1.56 | 0.34 | 0.01 | 1445 | 109.3 | | | | |
| | ST-5 | 23 | 25 | 288.8 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-2 | 25 | 26.5 | 287.3 | 32.4 | 5 | 21 | 21 | A-3 (0) | SP-SM | 1 | 1 | | | | | | | | | | | | | | |
| | SS-3 | 28.5 | 30 | 283.8 | 31.7 | 4 | 20 | 20 | A-3 (0) | SP | 8 | 12 | | | | | | | | | | | | | | |
| | SS-4 | 33.5 | 35 | 278.8 | 29.4 | 4 | 22 | 22 | A-3 (0) | SP | 9 | 13 | | | | | | | | | | | | | | |
| | PT-6 | 38 | 40 | 273.8 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-5 | 40 | 41.5 | 272.3 | 30.0 | 5 | 17 | 17 | A-3 (0) | SP | 13 | 19 | | | | | | | | | | | | | | |
| | SS-6 | 43.5 | 45 | 268.8 | 29.9 | 4 | 19 | 19 | A-3 (0) | SP | 12 | 18 | | | | | | | | | | | | | | |
| | SS-7 | 48.5 | 50 | 263.8 | 28.8 | 6 | 22 | 22 | A-3 (0) | SP-SM | 23 | 34 | | | | | | | | | | | | | | |
| | SS-8 | 53.5 | 55 | 258.8 | 29.4 | 7 | 19 | 19 | A-3 (0) | SP-SM | 25 | 37 | | | | | | | | | | | | | | |
| | PT-7 | 58 | 60 | 253.8 | 22.0 | 15 | 21 | 21 | A-2-4 (0) | SM | - | - | | | | | | | | | | | 302.4 | 30.9 | 374.4 | 36.8 |
| | SS-9 | 63.5 | 65 | 248.8 | 40.6 | 35 | 21 | 21 | A-2-4 (0) | SM | 9 | 13 | | | | | | | | | | | | | | |
| | SS-10 | 68.5 | 70 | 243.8 | 7.8 | 2 | 0 | 0 | A-1-a (0) | GP | 23 | 34 | | | | | | | | | | | | | | |
| | SS-11 | 73.5 | 75 | 238.8 | 18.7 | 3 | 19 | 19 | A-3 (0) | SP | 15 | 22 | | | | | | | | | | | | | | |
| | PT-8 | 78 | 78 | 235.8 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-12 | 78 | 79.5 | 234.3 | 15.4 | 8 | 13 | 13 | A-3 (0) | SP-SM | 45 | 67 | | | | | | | | | | | | | | |
| | SS-13 | 83.5 | 85 | 228.8 | 9.2 | 10 | 0 | 0 | A-1-a (0) | GP-GM | 72 | 107 | | | | | | | | | | | | | | |
| | SS-14 | 88.5 | 90 | 223.8 | 26.2 | 10 | 14 | 14 | A-3 (0) | SP-SM | 18 | 27 | | | | | | | | | | | | | | |
| | SS-15 | 93.5 | 95 | 218.8 | 23.7 | 20 | 17 | 17 | A-2-4 (0) | SM | 21 | 31 | | | | | | | | | | | | | | |
| | PT-9 | 98 | 98 | 215.8 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-16 | 98 | 99.5 | 214.3 | 18.0 | 52 | 19 | 7 | A-4 (1) | CL-ML | 60 | 89 | | | | | | | | | | | | | | |
| | SS-17 | 103.5 | 103.7 | 210.1 | 26.3 | 12 | 18 | 18 | A-2-4 (0) | SP-SM | 50/0.2 | 50/0.2 | | | | | | | | | | | | | | |
| | SS-18 | 108.5 | 108.7 | 205.1 | 25.0 | 11 | 0 | 0 | A-2-4 (0) | SP-SM | 50/0.2 | 50/0.2 | | | | | | | | | | | | | | |
| | SS-19 | 113.5 | 114.2 | 199.6 | 22.2 | 18 | 16 | 16 | A-2-4 (0) | SM | 50/0.7 | 50/0.7 | | | | | | | | | | | | | | |
| | PT-10 | 118 | 119 | 194.8 | 27.6 | 54 | 17 | 5 | A-4 (0) | CL-ML | - | - | | | | | | | | | | | | | | |
| | SS-20 | 119 | 119.8 | 194.0 | 20.7 | 5 | 17 | 17 | A-3 (0) | SP | 50/0.8 | 50/0.8 | | | | | | | | | | | | | | |
| | SS-21 | 123.5 | 123.9 | 189.9 | 32.0 | 7 | 17 | 17 | A-3 (0) | SP-SM | 50/0.4 | 50/0.4 | | | | | | | | | | | | | | |
| | SS-22 | 128.5 | 128.9 | 184.9 | 23.4 | 5 | 16 | 16 | A-3 (0) | SP-SM | 50/0.4 | 50/0.4 | | | | | | | | | | | | | | |
| | SS-23 | 133.5 | 133.9 | 179.9 | 24.2 | 6 | 36 | 2 | A-2-4 (0) | SP-SM | 50/0.4 | 50/0.4 | | | | | | | | | | | | | | |
| | PT-11 | 138 | 138 | 175.8 | - | - | - | - | - | | - | - | | | | | | | | | | | | | | |
| | SS-24 | 138.00 | 138.3 | 175.5 | 23.8 | 10 | 17 | 17 | A-3 (0) | SP-SM | 50/0.3 | 50/0.3 | | | | | | | | | | | | | | |
| | SS-25 | 143.5 | 144.1 | 169.7 | 20.6 | 6 | 16 | 16 | A-1-b (0) | SP-SM | 50/0.6 | 50/0.6 | | | | | | | | | | | | | | |
| | PT-12 | 148 | 148 | 165.8 | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| | SS-26 | 148.00 | 148.3 | 165.5 | 22.3 | 5 | 18 | 18 | A-3 (0) | SP-SM | 50/0.3 | 50/0.3 | | | | | | | | | | | | | | |

# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-117 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Silt | | | | |
| Wet Density | : 111.9 | pcf | Initial Height | : 5.57 | in |
| Dry Density | : 86.7 | pcf | Initial Diameter | : 2.80 | in |
| Moisture | : 29.1 | % | Proving Ring | : #22734 | |

RESULTS:

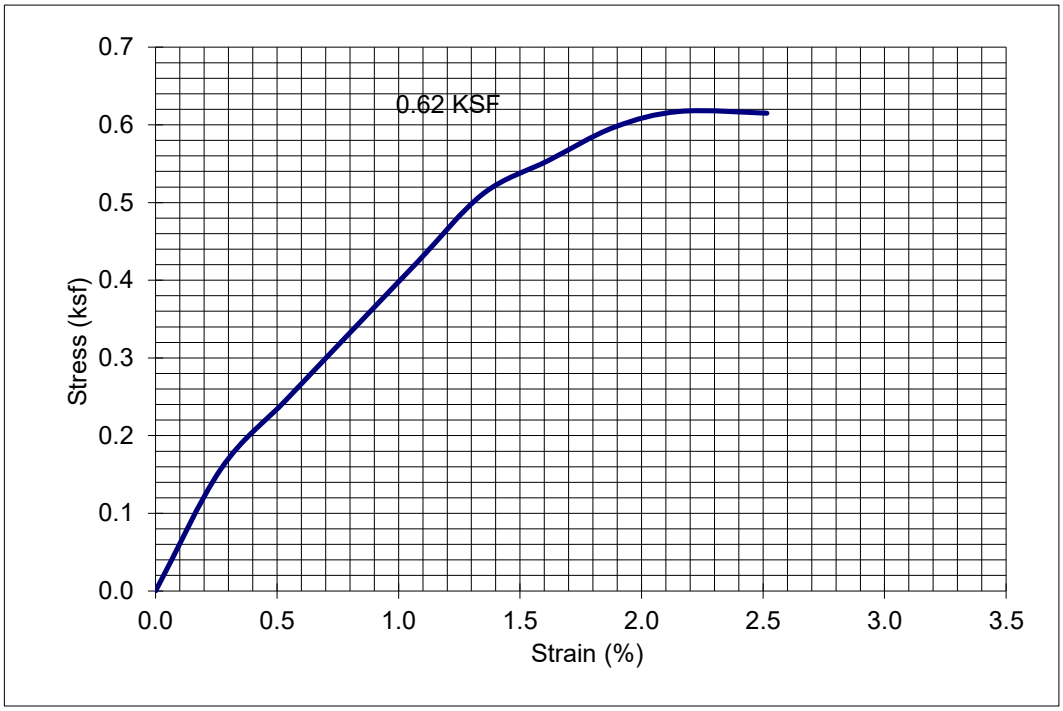
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 6.7 | 0.04 | 0.3 | 0.16 |
| 3 | 10.6 | 0.04 | 0.5 | 0.25 |
| 4 | 14.4 | 0.04 | 0.8 | 0.34 |
| 5 | 18.2 | 0.04 | 1.1 | 0.42 |
| 6 | 22.1 | 0.04 | 1.3 | 0.51 |
| 7 | 24.0 | 0.04 | 1.6 | 0.55 |
| 8 | 25.9 | 0.04 | 1.9 | 0.60 |
| 9 | 26.9 | 0.04 | 2.2 | 0.62 |
| 10 | 26.9 | 0.04 | 2.5 | 0.61 |
| 11 | 26.9 | 0.04 | 2.9 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-117 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |
| Soil Type | : Silt | | |
| Wet Density | : 111.9 pcf | Initial Height | : 5.57 in |
| Dry Density | : 86.7 pcf | Initial Diameter | : 2.80 in |
| Moisture | : 29.1 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 82.7 % | SPECIFIC GRAVITY | : 2.715 |
| Comments | : AASHTO: T-208 ; L / D Ratio < 2 | | |






APPROVED BY: _____

hdrinc.com

4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-119 |
| Project State | : Kentucky | Sample Depth | : 4.5' to 5.0' |
| Laboratory # | : 10174706 | Date Tested | : 1/20/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Elastic Silt | | | | |
| Wet Density | : 112.3 | pcf | Initial Height | : 5.56 | in |
| Dry Density | : 86.7 | pcf | Initial Diameter | : 2.86 | in |
| Moisture | : 29.5 | % | Proving Ring | : #22734 | |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 6.7 | 0.04 | 0.3 | 0.15 |
| 3 | 12.5 | 0.04 | 0.5 | 0.28 |
| 4 | 19.2 | 0.04 | 0.8 | 0.43 |
| 5 | 26.9 | 0.04 | 1.1 | 0.60 |
| 6 | 33.6 | 0.05 | 1.3 | 0.75 |
| 7 | 40.3 | 0.05 | 1.6 | 0.89 |
| 8 | 46.1 | 0.05 | 1.9 | 1.02 |
| 9 | 49.9 | 0.05 | 2.2 | 1.10 |
| 10 | 56.7 | 0.05 | 2.5 | 1.24 |
| 11 | 62.4 | 0.05 | 2.9 | 1.36 |
| 12 | 68.2 | 0.05 | 3.2 | 1.48 |
| 13 | 73.0 | 0.05 | 3.6 | 1.58 |
| 14 | 76.9 | 0.05 | 4.0 | 1.66 |
| 15 | 79.7 | 0.05 | 4.3 | 1.72 |
| 16 | 83.6 | 0.05 | 4.7 | 1.79 |
| 17 | 86.5 | 0.05 | 5.0 | 1.85 |
| 18 | 88.4 | 0.05 | 5.4 | 1.88 |
| 19 | 92.3 | 0.05 | 5.8 | 1.95 |
| 20 | 94.2 | 0.05 | 6.3 | 1.98 |
| 21 | 96.1 | 0.05 | 6.7 | 2.01 |
| 22 | 96.1 | 0.05 | 7.2 | 2.01 |
| 23 | 96.1 | 0.05 | 7.6 | 0.00 |

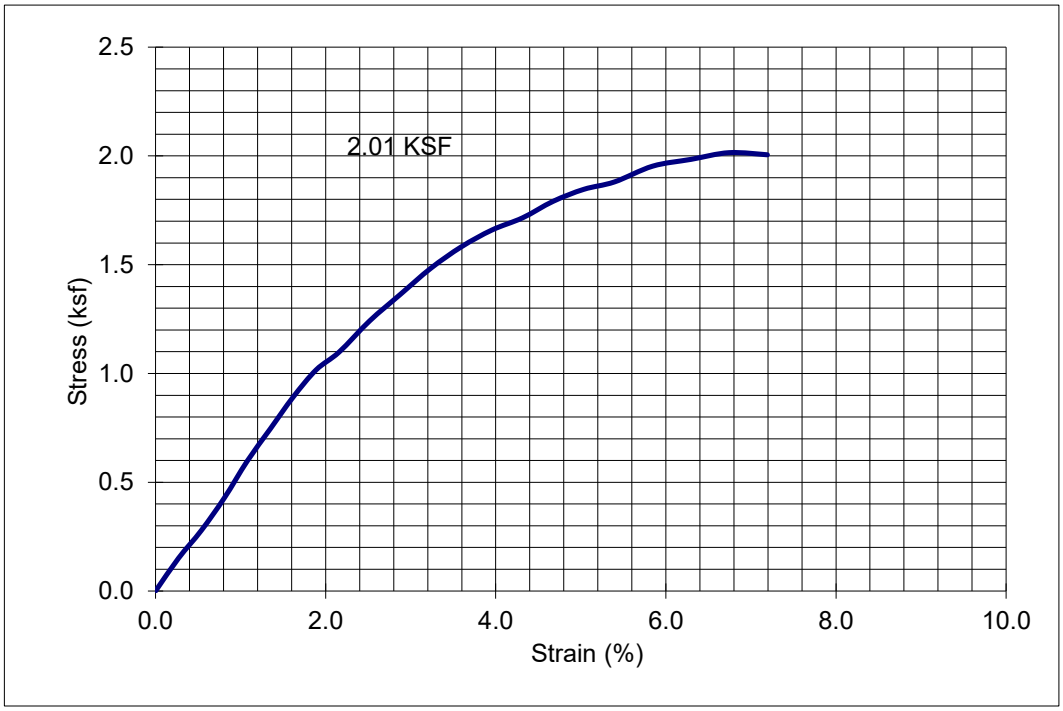
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-119 |
| Project State | : Kentucky | Sample Depth | : 4.5' to 5.0' |
| Laboratory # | : 10174706 | Date Tested | : 1/20/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |
| Soil Type | : Elastic Silt | | |
| Wet Density | : 112.3 pcf | Initial Height | : 5.56 in |
| Dry Density | : 86.7 pcf | Initial Diameter | : 2.86 in |
| Moisture | : 29.5 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 83.4 % | SPECIFIC GRAVITY | : 2.728 |

Comments : AASHTO: T-208 ; L / D Ratio < 2



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-119 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/20/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Silty Sand | | | | |
| Wet Density | : 115.6 | pcf | Initial Height | : 5.58 | in |
| Dry Density | : 88.0 | pcf | Initial Diameter | : 2.83 | in |
| Moisture | : 31.5 | % | Proving Ring | : #22734 | |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 7.7 | 0.04 | 0.3 | 0.18 |
| 3 | 11.5 | 0.04 | 0.5 | 0.26 |
| 4 | 15.4 | 0.04 | 0.8 | 0.35 |
| 5 | 20.2 | 0.04 | 1.1 | 0.46 |
| 6 | 24.0 | 0.04 | 1.3 | 0.54 |
| 7 | 27.8 | 0.04 | 1.6 | 0.63 |
| 8 | 30.7 | 0.04 | 1.9 | 0.69 |
| 9 | 35.5 | 0.04 | 2.2 | 0.79 |
| 10 | 41.3 | 0.04 | 2.5 | 0.92 |
| 11 | 46.1 | 0.05 | 2.9 | 1.02 |
| 12 | 49.9 | 0.05 | 3.2 | 1.10 |
| 13 | 54.7 | 0.05 | 3.6 | 1.21 |
| 14 | 58.6 | 0.05 | 3.9 | 1.29 |
| 15 | 63.4 | 0.05 | 4.3 | 1.39 |
| 16 | 67.2 | 0.05 | 4.7 | 1.47 |
| 17 | 70.1 | 0.05 | 5.0 | 1.52 |
| 18 | 73.0 | 0.05 | 5.4 | 1.58 |
| 19 | 76.9 | 0.05 | 5.8 | 1.66 |
| 20 | 80.7 | 0.05 | 6.3 | 1.73 |
| 21 | 84.6 | 0.05 | 6.7 | 1.80 |
| 22 | 87.4 | 0.05 | 7.2 | 1.86 |
| 23 | 90.3 | 0.05 | 7.6 | 1.91 |
| 24 | 92.3 | 0.05 | 8.1 | 1.94 |
| 25 | 96.1 | 0.05 | 8.5 | 2.01 |
| 26 | 98.0 | 0.05 | 9.0 | 2.04 |
| 27 | 101.8 | 0.05 | 9.9 | 2.10 |
| 28 | 103.8 | 0.05 | 10.8 | 2.12 |
| 29 | 105.7 | 0.05 | 11.6 | 2.13 |
| 30 | 106.6 | 0.05 | 12.5 | 2.13 |
| 31 | 104.7 | 0.05 | 13.4 | 2.07 |
| 32 | 99.0 | 0.05 | 14.3 | 1.94 |
| 33 | 89.4 | 0.05 | 15.2 | 0.00 |

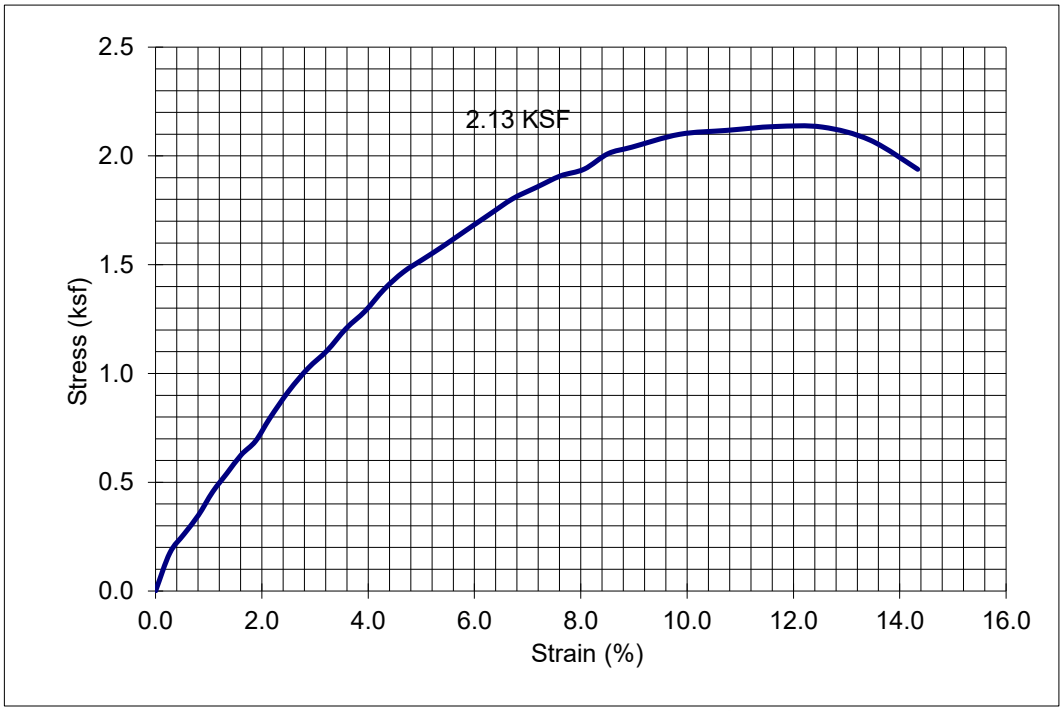
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-119 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/20/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |
| Soil Type | : Silty Sand | | |
| Wet Density | : 115.6 pcf | Initial Height | : 5.58 in |
| Dry Density | : 88.0 pcf | Initial Diameter | : 2.83 in |
| Moisture | : 31.5 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 94.7 % | SPECIFIC GRAVITY | : 2.650 |

Comments : AASHTO: T-208 ; L / D Ratio < 2



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-121 |
| Project State | : Kentucky | Sample Depth | : 4.0' to 4.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/29/2026 |
| Submitted By | : HDR | Date Reported | : 2/6/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Silt | | | | |
| Wet Density | : 113.8 | pcf | Initial Height | : 5.52 | in |
| Dry Density | : 83.2 | pcf | Initial Diameter | : 2.84 | in |
| Moisture | : 36.8 | % | Proving Ring | : #22734 | |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 6.7 | 0.04 | 0.3 | 0.15 |
| 3 | 12.5 | 0.04 | 0.5 | 0.28 |
| 4 | 17.3 | 0.04 | 0.8 | 0.39 |
| 5 | 22.1 | 0.04 | 1.1 | 0.50 |
| 6 | 24.0 | 0.04 | 1.4 | 0.54 |
| 7 | 26.9 | 0.04 | 1.6 | 0.60 |
| 8 | 27.8 | 0.04 | 1.9 | 0.62 |
| 9 | 30.7 | 0.04 | 2.2 | 0.68 |
| 10 | 31.7 | 0.05 | 2.5 | 0.70 |
| 11 | 32.6 | 0.05 | 2.9 | 0.72 |
| 12 | 34.6 | 0.05 | 3.3 | 0.76 |
| 13 | 35.5 | 0.05 | 3.6 | 0.78 |
| 14 | 37.4 | 0.05 | 4.0 | 0.82 |
| 15 | 38.4 | 0.05 | 4.4 | 0.84 |
| 16 | 39.4 | 0.05 | 4.7 | 0.85 |
| 17 | 40.3 | 0.05 | 5.1 | 0.87 |
| 18 | 41.3 | 0.05 | 5.4 | 0.89 |
| 19 | 42.2 | 0.05 | 5.9 | 0.90 |
| 20 | 42.2 | 0.05 | 6.3 | 0.90 |
| 21 | 42.2 | 0.05 | 6.8 | 0.90 |
| 22 | 42.2 | 0.05 | 7.3 | 0.00 |

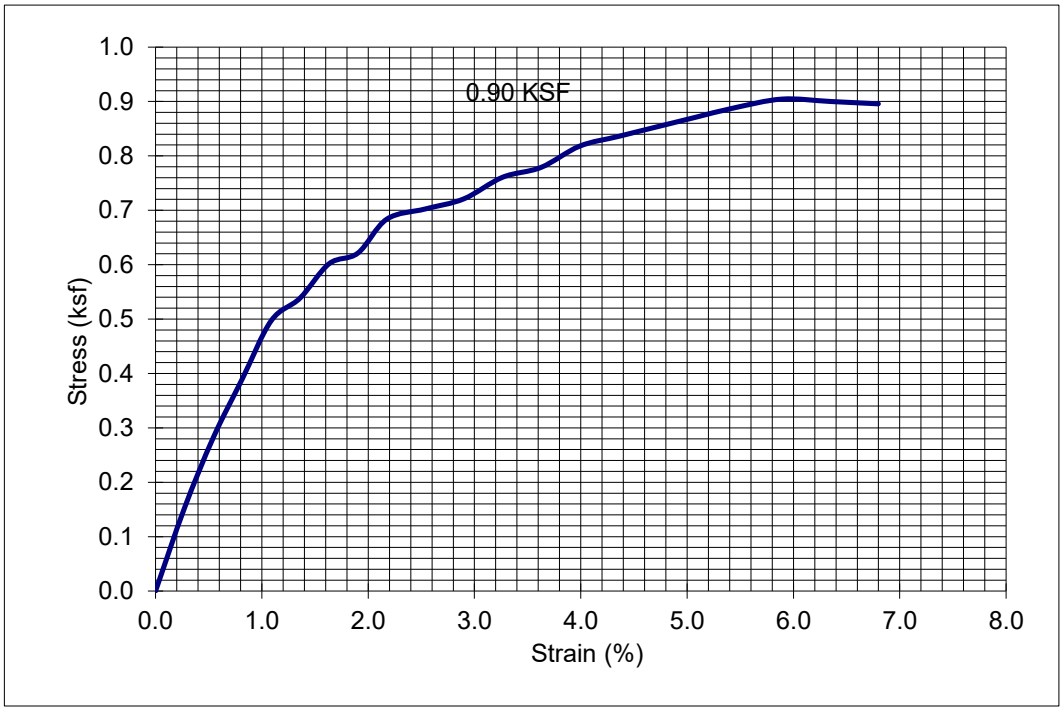
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-121 |
| Project State | : Kentucky | Sample Depth | : 4.0' to 4.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/29/2026 |
| Submitted By | : HDR | Date Reported | : 2/6/2026 |
| Soil Type | : Silt | | |
| Wet Density | : 113.8 pcf | Initial Height | : 5.52 in |
| Dry Density | : 83.2 pcf | Initial Diameter | : 2.84 in |
| Moisture | : 36.8 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 93.4 % | SPECIFIC GRAVITY | : 2.802 |

Comments : AASHTO: T-208 ; L / D Ratio < 2



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-121 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/29/2026 |
| Submitted By | : HDR | Date Reported | : 2/6/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Lean Clay | | | | |
| Wet Density | : 119.9 | pcf | Initial Height | : 5.61 | in |
| Dry Density | : 89.6 | pcf | Initial Diameter | : 2.80 | in |
| Moisture | : 33.8 | % | Proving Ring | : #22734 | |

RESULTS:

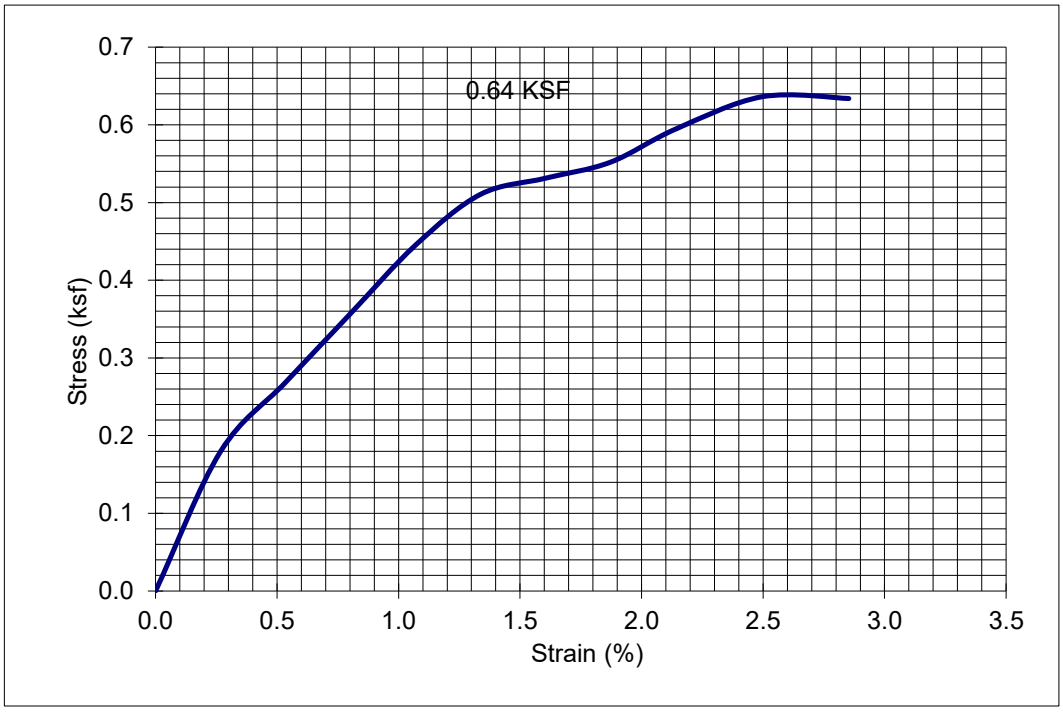
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 7.7 | 0.04 | 0.3 | 0.18 |
| 3 | 11.5 | 0.04 | 0.5 | 0.27 |
| 4 | 15.4 | 0.04 | 0.8 | 0.36 |
| 5 | 19.2 | 0.04 | 1.1 | 0.45 |
| 6 | 22.1 | 0.04 | 1.3 | 0.51 |
| 7 | 23.0 | 0.04 | 1.6 | 0.53 |
| 8 | 24.0 | 0.04 | 1.9 | 0.55 |
| 9 | 25.9 | 0.04 | 2.1 | 0.59 |
| 10 | 27.8 | 0.04 | 2.5 | 0.64 |
| 11 | 27.8 | 0.04 | 2.9 | 0.63 |
| 12 | 27.8 | 0.04 | 3.2 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-121 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/29/2026 |
| Submitted By | : HDR | Date Reported | : 2/6/2026 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 119.9 pcf | Initial Height | : 5.61 in |
| Dry Density | : 89.6 pcf | Initial Diameter | : 2.80 in |
| Moisture | : 33.8 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 100.0 % | SPECIFIC GRAVITY | : 2.780 |
| Comments | : AASHTO: T-208 | | |



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-121 |
| Project State | : Kentucky | Sample Depth | : 14.0' to 14.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/29/2026 |
| Submitted By | : HDR | Date Reported | : 2/6/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Lean Clay | | | | |
| Wet Density | : 111.4 | pcf | Initial Height | : 5.59 | in |
| Dry Density | : 77.9 | pcf | Initial Diameter | : 2.83 | in |
| Moisture | : 43.1 | % | Proving Ring | : #22734 | |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 5.8 | 0.04 | 0.3 | 0.13 |
| 3 | 10.6 | 0.04 | 0.5 | 0.24 |
| 4 | 15.4 | 0.04 | 0.8 | 0.35 |
| 5 | 20.2 | 0.04 | 1.1 | 0.46 |
| 6 | 24.0 | 0.04 | 1.3 | 0.54 |
| 7 | 27.8 | 0.04 | 1.6 | 0.63 |
| 8 | 32.6 | 0.04 | 1.9 | 0.73 |
| 9 | 35.5 | 0.04 | 2.1 | 0.80 |
| 10 | 40.3 | 0.04 | 2.5 | 0.90 |
| 11 | 45.1 | 0.04 | 2.9 | 1.00 |
| 12 | 49.0 | 0.05 | 3.2 | 1.08 |
| 13 | 51.8 | 0.05 | 3.6 | 1.14 |
| 14 | 54.7 | 0.05 | 3.9 | 1.20 |
| 15 | 56.7 | 0.05 | 4.3 | 1.24 |
| 16 | 59.5 | 0.05 | 4.7 | 1.30 |
| 17 | 62.4 | 0.05 | 5.0 | 1.36 |
| 18 | 65.3 | 0.05 | 5.4 | 1.41 |
| 19 | 66.3 | 0.05 | 5.8 | 1.43 |
| 20 | 67.2 | 0.05 | 6.3 | 1.44 |
| 21 | 68.2 | 0.05 | 6.7 | 1.46 |
| 22 | 68.2 | 0.05 | 7.2 | 1.45 |
| 23 | 68.2 | 0.05 | 7.6 | 0.00 |

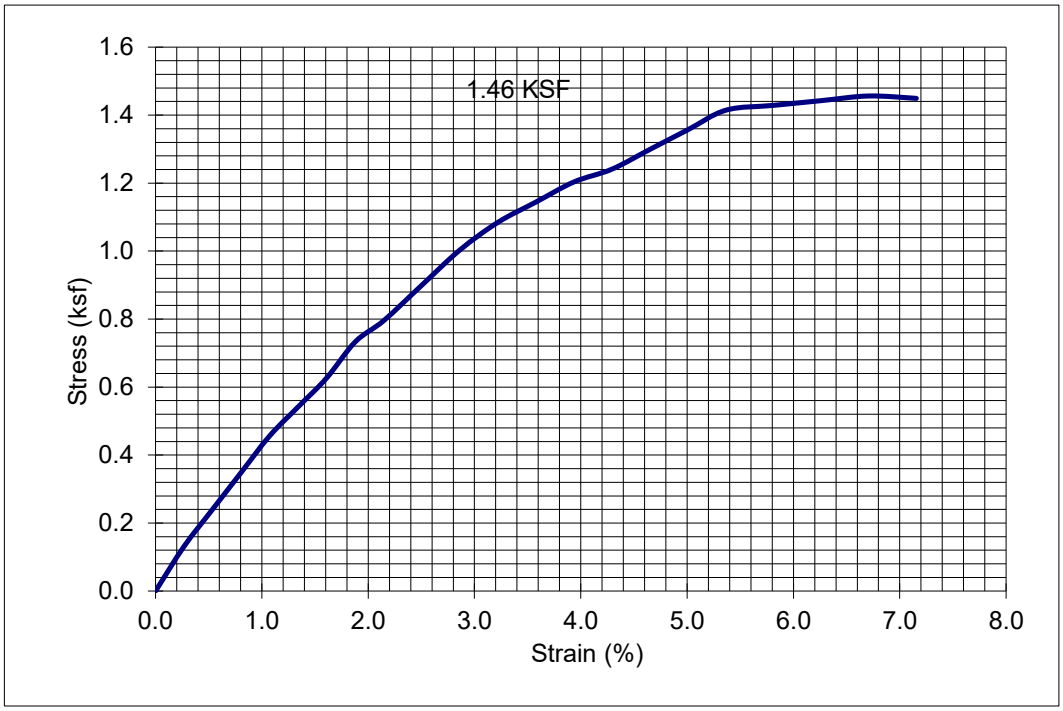
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-121 |
| Project State | : Kentucky | Sample Depth | : 14.0' to 14.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/29/2026 |
| Submitted By | : HDR | Date Reported | : 2/6/2026 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 111.4 pcf | Initial Height | : 5.59 in |
| Dry Density | : 77.9 pcf | Initial Diameter | : 2.83 in |
| Moisture | : 43.1 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 99.3 % | SPECIFIC GRAVITY | : 2.721 |

Comments : AASHTO: T-208 ; L / D Ratio < 2



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 4.0' to 4.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/20/2026 |
| Submitted By | : HDR | Date Reported | : 2/2/2026 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 113.9 pcf | Initial Height | : 5.61 in |
| Dry Density | : 86.1 pcf | Initial Diameter | : 2.84 in |
| Moisture | : 32.4 % | Proving Ring | : #22734 |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 17.3 | 0.04 | 0.3 | 0.39 |
| 3 | 27.8 | 0.04 | 0.5 | 0.63 |
| 4 | 36.5 | 0.04 | 0.8 | 0.82 |
| 5 | 46.1 | 0.04 | 1.1 | 1.03 |
| 6 | 53.8 | 0.04 | 1.3 | 1.20 |
| 7 | 60.5 | 0.04 | 1.6 | 1.35 |
| 8 | 66.3 | 0.04 | 1.9 | 1.48 |
| 9 | 70.1 | 0.05 | 2.1 | 1.56 |
| 10 | 74.9 | 0.05 | 2.5 | 1.66 |
| 11 | 78.8 | 0.05 | 2.9 | 1.74 |
| 12 | 81.7 | 0.05 | 3.2 | 1.79 |
| 13 | 83.6 | 0.05 | 3.6 | 1.83 |
| 14 | 85.5 | 0.05 | 3.9 | 1.87 |
| 15 | 86.5 | 0.05 | 4.3 | 1.88 |
| 16 | 87.4 | 0.05 | 4.6 | 1.89 |
| 17 | 88.4 | 0.05 | 5.0 | 1.91 |
| 18 | 89.4 | 0.05 | 5.3 | 1.92 |
| 19 | 89.4 | 0.05 | 5.8 | 1.91 |
| 20 | 89.4 | 0.05 | 6.2 | 0.00 |

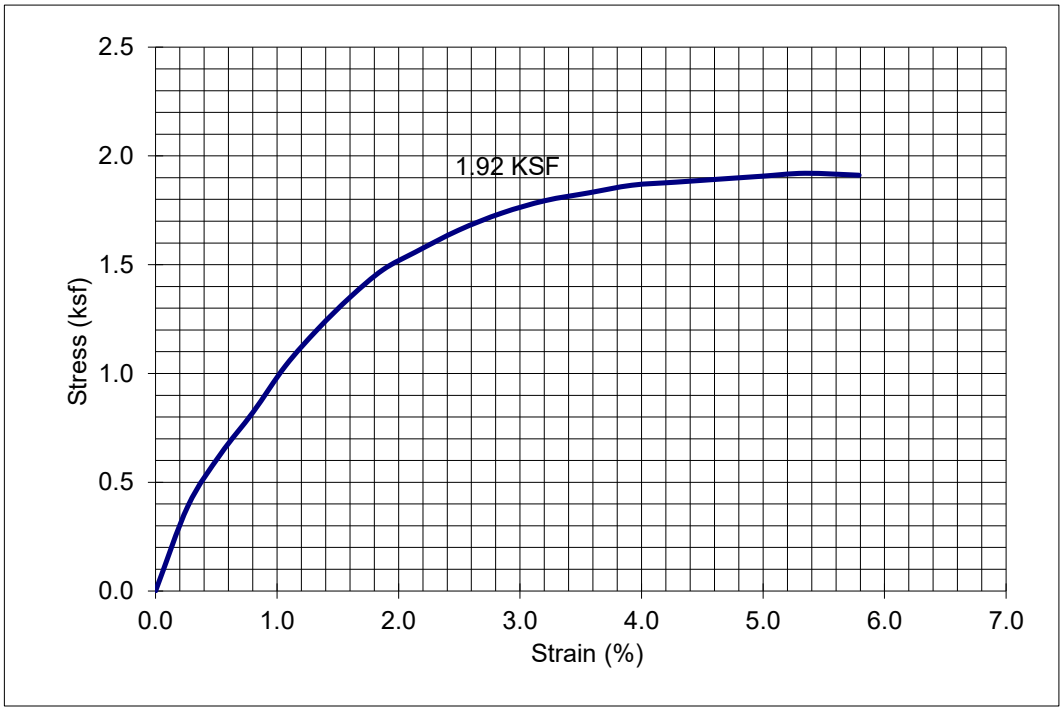
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 4.0' to 4.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/20/2026 |
| Submitted By | : HDR | Date Reported | : 2/2/2026 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 113.9 pcf | Initial Height | : 5.61 in |
| Dry Density | : 86.1 pcf | Initial Diameter | : 2.84 in |
| Moisture | : 32.4 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 90.9 % | SPECIFIC GRAVITY | : 2.708 |

Comments : AASHTO: T-208 ; L / D Ratio < 2



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 2/2/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Lean Clay | | | | |
| Wet Density | : 115.4 | pcf | Initial Height | : 5.56 | in |
| Dry Density | : 87.6 | pcf | Initial Diameter | : 2.84 | in |
| Moisture | : 31.7 | % | Proving Ring | : #22734 | |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 16.3 | 0.04 | 0.3 | 0.37 |
| 3 | 26.9 | 0.04 | 0.5 | 0.61 |
| 4 | 34.6 | 0.04 | 0.8 | 0.78 |
| 5 | 39.4 | 0.04 | 1.1 | 0.89 |
| 6 | 46.1 | 0.04 | 1.3 | 1.03 |
| 7 | 50.9 | 0.04 | 1.6 | 1.14 |
| 8 | 54.7 | 0.04 | 1.9 | 1.22 |
| 9 | 58.6 | 0.04 | 2.2 | 1.30 |
| 10 | 62.4 | 0.05 | 2.5 | 1.38 |
| 11 | 66.3 | 0.05 | 2.9 | 1.46 |
| 12 | 70.1 | 0.05 | 3.2 | 1.54 |
| 13 | 73.0 | 0.05 | 3.6 | 1.60 |
| 14 | 74.9 | 0.05 | 4.0 | 1.64 |
| 15 | 77.8 | 0.05 | 4.3 | 1.69 |
| 16 | 80.7 | 0.05 | 4.7 | 1.75 |
| 17 | 82.6 | 0.05 | 5.0 | 1.79 |
| 18 | 84.6 | 0.05 | 5.4 | 1.82 |
| 19 | 87.4 | 0.05 | 5.8 | 1.87 |
| 20 | 89.4 | 0.05 | 6.3 | 1.90 |
| 21 | 92.3 | 0.05 | 6.7 | 1.96 |
| 22 | 93.2 | 0.05 | 7.2 | 1.97 |
| 23 | 96.1 | 0.05 | 7.6 | 2.02 |
| 24 | 97.1 | 0.05 | 8.1 | 2.03 |
| 25 | 98.0 | 0.05 | 8.5 | 2.04 |
| 26 | 99.9 | 0.05 | 9.0 | 2.07 |
| 27 | 100.9 | 0.05 | 9.9 | 2.07 |
| 28 | 103.8 | 0.05 | 10.8 | 2.11 |
| 29 | 104.7 | 0.05 | 11.7 | 2.10 |
| 30 | 105.7 | 0.05 | 12.6 | 2.10 |
| 31 | 104.7 | 0.05 | 13.5 | 2.06 |
| 32 | 100.9 | 0.05 | 14.4 | 1.96 |
| 33 | 96.1 | 0.05 | 15.3 | 0.00 |

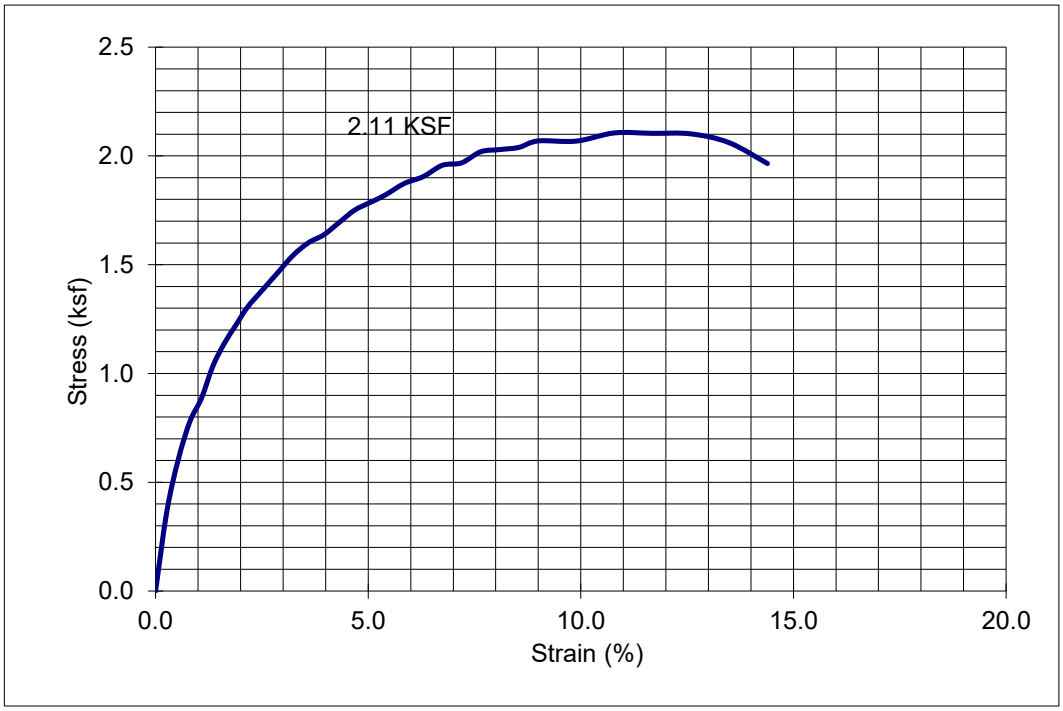
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 2/2/2026 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 115.4 pcf | Initial Height | : 5.56 in |
| Dry Density | : 87.6 pcf | Initial Diameter | : 2.84 in |
| Moisture | : 31.7 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 95.8 % | SPECIFIC GRAVITY | : 2.622 |

Comments : AASHTO: T-208 ; L / D Ratio < 2



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 14.5' to 15.0' |
| Laboratory # | : 10174706 | Date Tested | : 1/19/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Silt | | | | |
| Wet Density | : 112.0 | pcf | Initial Height | : 5.66 | in |
| Dry Density | : 91.2 | pcf | Initial Diameter | : 2.84 | in |
| Moisture | : 22.9 | % | Proving Ring | : #22734 | |

RESULTS:

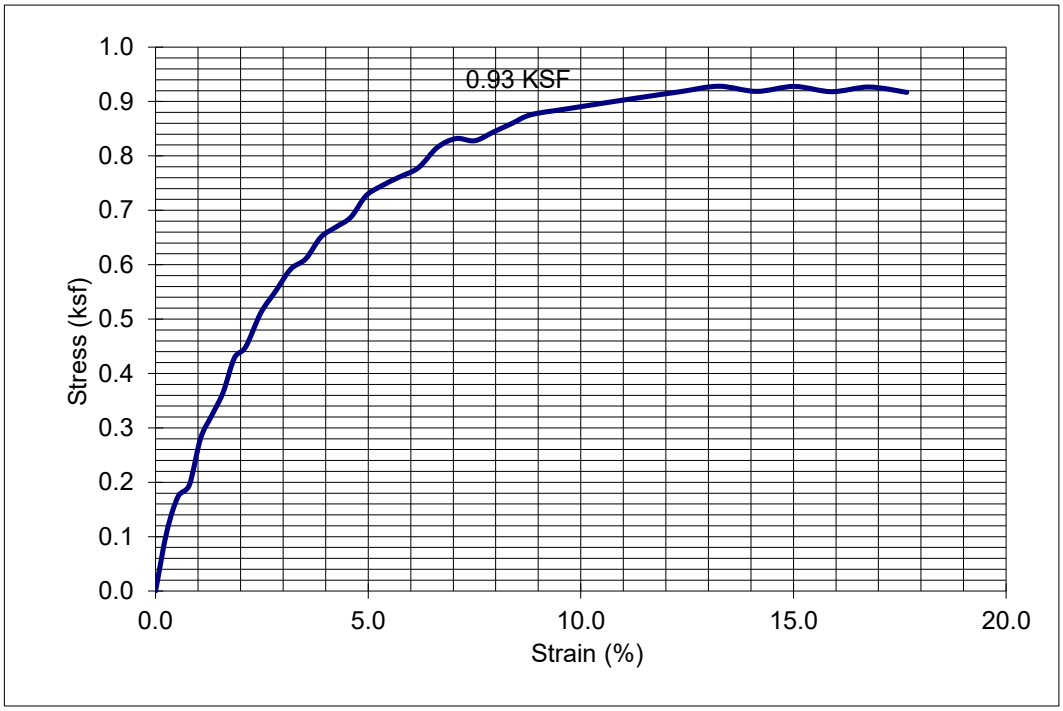
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 4.8 | 0.04 | 0.3 | 0.11 |
| 3 | 7.7 | 0.04 | 0.5 | 0.17 |
| 4 | 8.6 | 0.04 | 0.8 | 0.19 |
| 5 | 12.5 | 0.04 | 1.1 | 0.28 |
| 6 | 14.4 | 0.04 | 1.3 | 0.32 |
| 7 | 16.3 | 0.04 | 1.6 | 0.37 |
| 8 | 19.2 | 0.04 | 1.9 | 0.43 |
| 9 | 20.2 | 0.04 | 2.1 | 0.45 |
| 10 | 23.0 | 0.05 | 2.5 | 0.51 |
| 11 | 25.0 | 0.05 | 2.8 | 0.55 |
| 12 | 26.9 | 0.05 | 3.2 | 0.59 |
| 13 | 27.8 | 0.05 | 3.5 | 0.61 |
| 14 | 29.8 | 0.05 | 3.9 | 0.65 |
| 15 | 30.7 | 0.05 | 4.2 | 0.67 |
| 16 | 31.7 | 0.05 | 4.6 | 0.69 |
| 17 | 33.6 | 0.05 | 4.9 | 0.73 |
| 18 | 34.6 | 0.05 | 5.3 | 0.74 |
| 19 | 35.5 | 0.05 | 5.7 | 0.76 |
| 20 | 36.5 | 0.05 | 6.2 | 0.78 |
| 21 | 38.4 | 0.05 | 6.6 | 0.82 |
| 22 | 39.4 | 0.05 | 7.1 | 0.83 |
| 23 | 39.4 | 0.05 | 7.5 | 0.83 |
| 24 | 40.3 | 0.05 | 7.9 | 0.84 |
| 25 | 41.3 | 0.05 | 8.4 | 0.86 |
| 26 | 42.2 | 0.05 | 8.8 | 0.88 |
| 27 | 43.2 | 0.05 | 9.7 | 0.89 |
| 28 | 44.2 | 0.05 | 10.6 | 0.90 |
| 29 | 45.1 | 0.05 | 11.5 | 0.91 |
| 30 | 46.1 | 0.05 | 12.4 | 0.92 |
| 31 | 47.0 | 0.05 | 13.2 | 0.93 |
| 32 | 47.0 | 0.05 | 14.1 | 0.92 |
| 33 | 48.0 | 0.05 | 15.0 | 0.93 |
| 34 | 48.0 | 0.05 | 15.9 | 0.92 |
| 35 | 49.0 | 0.05 | 16.8 | 0.93 |
| 36 | 49.0 | 0.05 | 17.7 | 0.92 |
| 37 | 49.0 | 0.05 | 18.5 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 14.5' to 15.0' |
| Laboratory # | : 10174706 | Date Tested | : 1/19/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |
| Soil Type | : Silt | | |
| Wet Density | : 112.0 pcf | Initial Height | : 5.66 in |
| Dry Density | : 91.2 pcf | Initial Diameter | : 2.84 in |
| Moisture | : 22.9 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 77.5 % | SPECIFIC GRAVITY | : 2.564 |
| Comments | : AASHTO: T-208 ; L / D Ratio < 2 | | |



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-4 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 19.5' to 20.0' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Silt | | | | |
| Wet Density | : 94.5 | pcf | Initial Height | : 5.70 | in |
| Dry Density | : 55.2 | pcf | Initial Diameter | : 2.81 | in |
| Moisture | : 71.0 | % | Proving Ring | : #22734 | |

RESULTS:

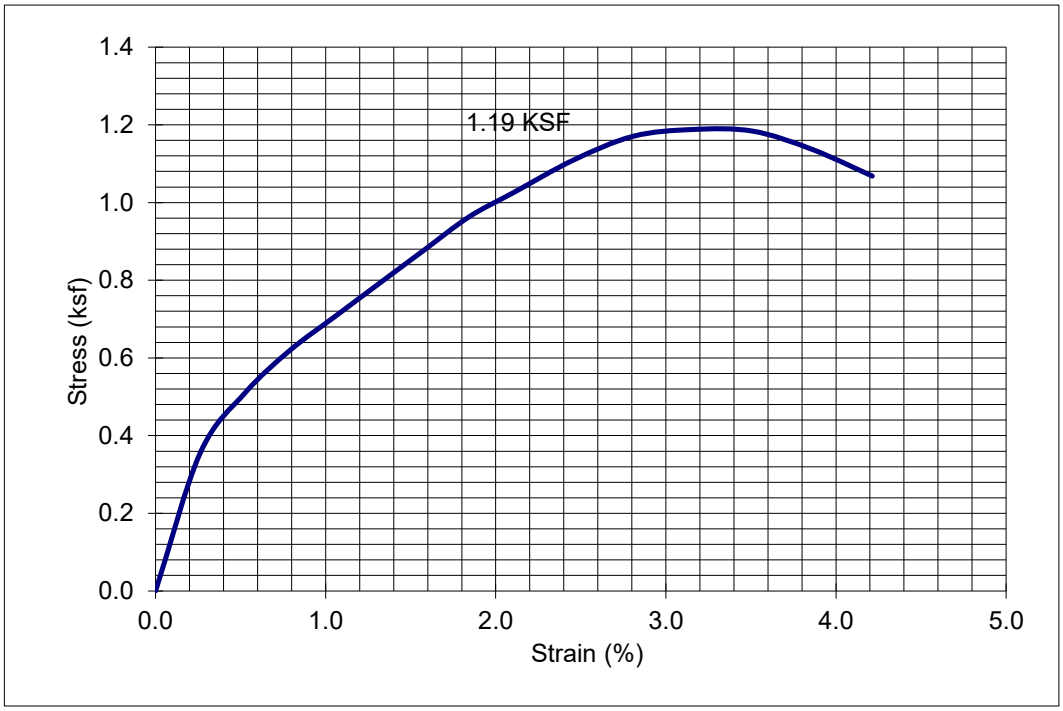
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 15.4 | 0.04 | 0.3 | 0.36 |
| 3 | 22.1 | 0.04 | 0.5 | 0.51 |
| 4 | 26.9 | 0.04 | 0.8 | 0.62 |
| 5 | 30.7 | 0.04 | 1.1 | 0.71 |
| 6 | 34.6 | 0.04 | 1.3 | 0.79 |
| 7 | 38.4 | 0.04 | 1.6 | 0.88 |
| 8 | 42.2 | 0.04 | 1.8 | 0.96 |
| 9 | 45.1 | 0.04 | 2.1 | 1.03 |
| 10 | 49.0 | 0.04 | 2.5 | 1.11 |
| 11 | 51.8 | 0.04 | 2.8 | 1.17 |
| 12 | 52.8 | 0.04 | 3.2 | 1.19 |
| 13 | 52.8 | 0.04 | 3.5 | 1.18 |
| 14 | 50.9 | 0.04 | 3.9 | 1.14 |
| 15 | 48.0 | 0.04 | 4.2 | 1.07 |
| 16 | 45.1 | 0.05 | 4.6 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-4 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 19.5' to 20.0' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |
| Soil Type | : Silt | | |
| Wet Density | : 94.5 pcf | Initial Height | : 5.70 in |
| Dry Density | : 55.2 pcf | Initial Diameter | : 2.81 in |
| Moisture | : 71.0 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 93.2 % | SPECIFIC GRAVITY | : 2.715 |
| Comments | : AASHTO: T-208 | | |



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-123 |
| Project State | : Kentucky | Sample Depth | : 4.0' to 4.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Elastic Silt | | | | |
| Wet Density | : 117.1 | pcf | Initial Height | : 5.72 | in |
| Dry Density | : 94.2 | pcf | Initial Diameter | : 2.85 | in |
| Moisture | : 24.3 | % | Proving Ring | : #22734 | |

RESULTS:

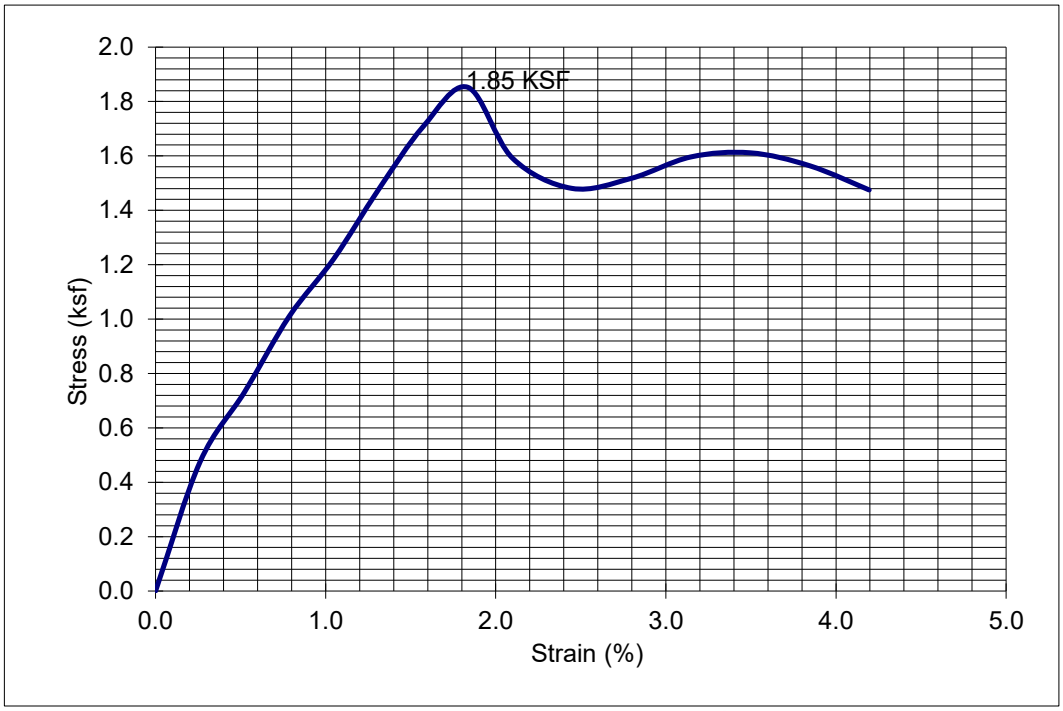
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 21.1 | 0.04 | 0.3 | 0.48 |
| 3 | 32.6 | 0.04 | 0.5 | 0.73 |
| 4 | 45.1 | 0.04 | 0.8 | 1.01 |
| 5 | 54.7 | 0.04 | 1.0 | 1.22 |
| 6 | 66.3 | 0.04 | 1.3 | 1.48 |
| 7 | 76.9 | 0.05 | 1.6 | 1.71 |
| 8 | 83.6 | 0.05 | 1.8 | 1.85 |
| 9 | 72.1 | 0.05 | 2.1 | 1.59 |
| 10 | 67.2 | 0.05 | 2.4 | 1.48 |
| 11 | 69.2 | 0.05 | 2.8 | 1.52 |
| 12 | 73.0 | 0.05 | 3.1 | 1.60 |
| 13 | 74.0 | 0.05 | 3.5 | 1.61 |
| 14 | 72.1 | 0.05 | 3.8 | 1.56 |
| 15 | 68.2 | 0.05 | 4.2 | 1.47 |
| 16 | 56.7 | 0.05 | 4.5 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-123 |
| Project State | : Kentucky | Sample Depth | : 4.0' to 4.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |
| Soil Type | : Elastic Silt | | |
| Wet Density | : 117.1 pcf | Initial Height | : 5.72 in |
| Dry Density | : 94.2 pcf | Initial Diameter | : 2.85 in |
| Moisture | : 24.3 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 85.3 % | SPECIFIC GRAVITY | : 2.649 |
| Comments | : AASHTO: T-208 | | |



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-123 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Silt | | | | |
| Wet Density | : 123.4 | pcf | Initial Height | : 5.56 | in |
| Dry Density | : 95.5 | pcf | Initial Diameter | : 2.81 | in |
| Moisture | : 29.2 | % | Proving Ring | : #22734 | |

RESULTS:

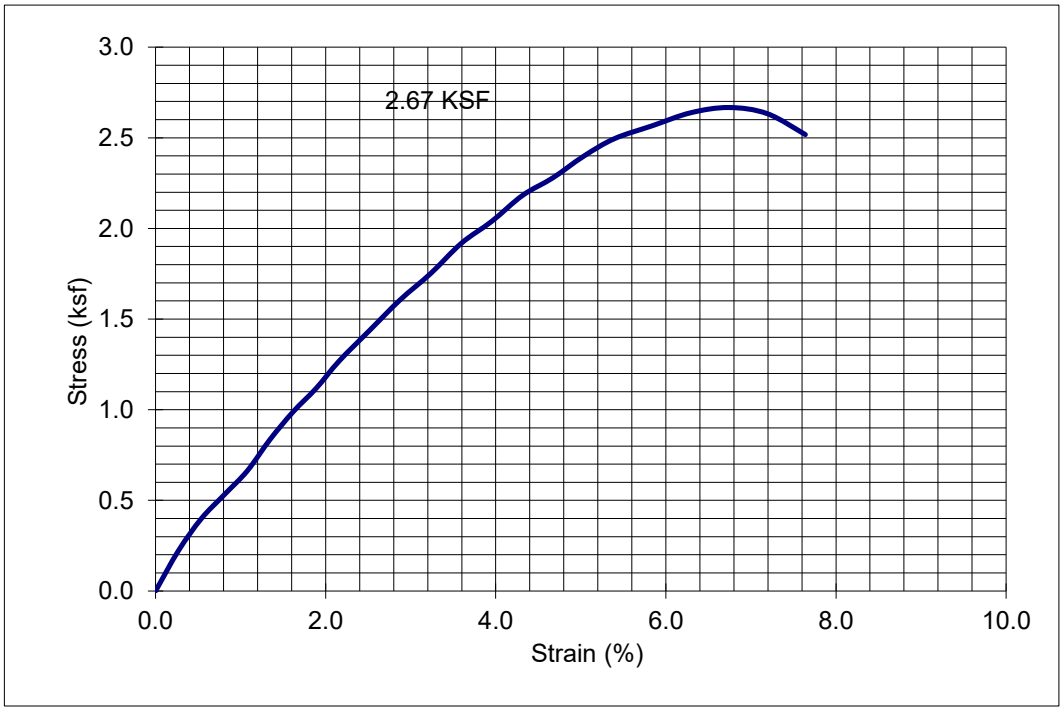
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 9.6 | 0.04 | 0.3 | 0.22 |
| 3 | 17.3 | 0.04 | 0.5 | 0.40 |
| 4 | 23.0 | 0.04 | 0.8 | 0.53 |
| 5 | 28.8 | 0.04 | 1.1 | 0.66 |
| 6 | 36.5 | 0.04 | 1.3 | 0.84 |
| 7 | 43.2 | 0.04 | 1.6 | 0.99 |
| 8 | 49.0 | 0.04 | 1.9 | 1.12 |
| 9 | 55.7 | 0.04 | 2.2 | 1.27 |
| 10 | 63.4 | 0.04 | 2.5 | 1.44 |
| 11 | 71.1 | 0.04 | 2.9 | 1.61 |
| 12 | 77.8 | 0.04 | 3.2 | 1.75 |
| 13 | 85.5 | 0.04 | 3.6 | 1.92 |
| 14 | 91.3 | 0.04 | 4.0 | 2.04 |
| 15 | 98.0 | 0.04 | 4.3 | 2.18 |
| 16 | 102.8 | 0.05 | 4.7 | 2.28 |
| 17 | 108.6 | 0.05 | 5.0 | 2.40 |
| 18 | 113.3 | 0.05 | 5.4 | 2.49 |
| 19 | 117.2 | 0.05 | 5.8 | 2.57 |
| 20 | 121.0 | 0.05 | 6.3 | 2.64 |
| 21 | 122.9 | 0.05 | 6.7 | 2.67 |
| 22 | 122.0 | 0.05 | 7.2 | 2.63 |
| 23 | 117.2 | 0.05 | 7.6 | 2.52 |
| 24 | 110.5 | 0.05 | 8.1 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-123 |
| Project State | : Kentucky | Sample Depth | : 9.0' to 9.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/21/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |
| Soil Type | : Silt | | |
| Wet Density | : 123.4 pcf | Initial Height | : 5.56 in |
| Dry Density | : 95.5 pcf | Initial Diameter | : 2.81 in |
| Moisture | : 29.2 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 100.0 % | SPECIFIC GRAVITY | : 2.555 |
| Comments | : AASHTO: T-208 ; L / D Ratio < 2 | | |



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-123 |
| Project State | : Kentucky | Sample Depth | : 14.0' to 14.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/20/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Silt | | | | |
| Wet Density | : 117.5 | pcf | Initial Height | : 5.54 | in |
| Dry Density | : 87.8 | pcf | Initial Diameter | : 2.85 | in |
| Moisture | : 33.8 | % | Proving Ring | : #22734 | |

RESULTS:

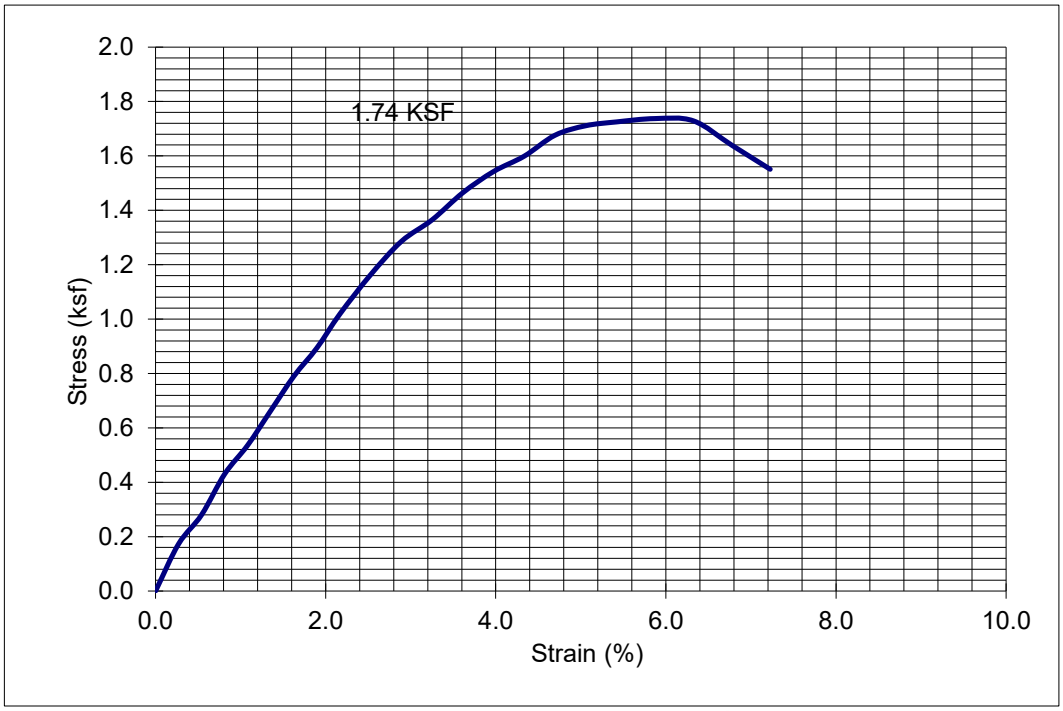
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 7.7 | 0.04 | 0.3 | 0.17 |
| 3 | 12.5 | 0.04 | 0.5 | 0.28 |
| 4 | 19.2 | 0.04 | 0.8 | 0.43 |
| 5 | 24.0 | 0.04 | 1.1 | 0.54 |
| 6 | 29.8 | 0.04 | 1.4 | 0.66 |
| 7 | 35.5 | 0.04 | 1.6 | 0.79 |
| 8 | 40.3 | 0.05 | 1.9 | 0.89 |
| 9 | 46.1 | 0.05 | 2.2 | 1.02 |
| 10 | 52.8 | 0.05 | 2.5 | 1.16 |
| 11 | 58.6 | 0.05 | 2.9 | 1.29 |
| 12 | 62.4 | 0.05 | 3.3 | 1.36 |
| 13 | 67.2 | 0.05 | 3.6 | 1.46 |
| 14 | 71.1 | 0.05 | 4.0 | 1.54 |
| 15 | 74.0 | 0.05 | 4.3 | 1.60 |
| 16 | 77.8 | 0.05 | 4.7 | 1.68 |
| 17 | 79.7 | 0.05 | 5.1 | 1.71 |
| 18 | 80.7 | 0.05 | 5.4 | 1.73 |
| 19 | 81.7 | 0.05 | 5.9 | 1.74 |
| 20 | 81.7 | 0.05 | 6.3 | 1.73 |
| 21 | 77.8 | 0.05 | 6.8 | 1.64 |
| 22 | 74.0 | 0.05 | 7.2 | 1.55 |
| 23 | 71.1 | 0.05 | 7.7 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-123 |
| Project State | : Kentucky | Sample Depth | : 14.0' to 14.5' |
| Laboratory # | : 10174706 | Date Tested | : 1/20/2026 |
| Submitted By | : HDR | Date Reported | : 1/29/2026 |
| Soil Type | : Silt | | |
| Wet Density | : 117.5 pcf | Initial Height | : 5.54 in |
| Dry Density | : 87.8 pcf | Initial Diameter | : 2.85 in |
| Moisture | : 33.8 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 95.8 % | SPECIFIC GRAVITY | : 2.790 |
| Comments | : AASHTO: T-208 ; L / D Ratio < 2 | | |



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-4 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-124P |
| Project State | : Kentucky | Sample Depth | : 13.0' to 15.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 121.8 pcf | Initial Height | : 5.86 in |
| Dry Density | : 94.7 pcf | Initial Diameter | : 2.83 in |
| Moisture | : 28.6 % | Proving Ring | : #22734 |

RESULTS:

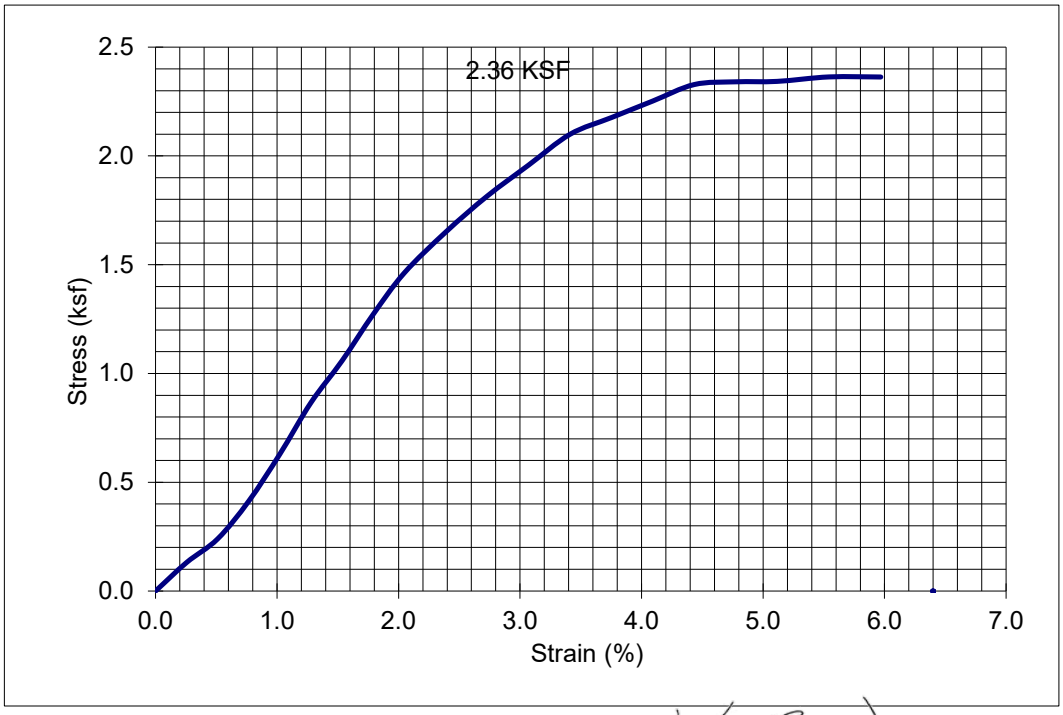
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 5.8 | 0.04 | 0.3 | 0.13 |
| 3 | 10.6 | 0.04 | 0.5 | 0.24 |
| 4 | 18.2 | 0.04 | 0.8 | 0.41 |
| 5 | 27.8 | 0.04 | 1.0 | 0.63 |
| 6 | 38.4 | 0.04 | 1.3 | 0.87 |
| 7 | 47.0 | 0.04 | 1.5 | 1.06 |
| 8 | 56.7 | 0.04 | 1.8 | 1.27 |
| 9 | 65.3 | 0.04 | 2.0 | 1.46 |
| 10 | 74.0 | 0.04 | 2.4 | 1.65 |
| 11 | 81.7 | 0.05 | 2.7 | 1.81 |
| 12 | 88.4 | 0.05 | 3.1 | 1.96 |
| 13 | 95.1 | 0.05 | 3.4 | 2.10 |
| 14 | 99.0 | 0.05 | 3.8 | 2.18 |
| 15 | 102.8 | 0.05 | 4.1 | 2.25 |
| 16 | 106.6 | 0.05 | 4.4 | 2.33 |
| 17 | 107.6 | 0.05 | 4.8 | 2.34 |
| 18 | 108.1 | 0.05 | 5.1 | 2.34 |
| 19 | 109.5 | 0.05 | 5.5 | 2.36 |
| 20 | 110.0 | 0.05 | 6.0 | 2.36 |
| 21 | 109.5 | 0.05 | 6.4 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-4 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-124P |
| Project State | : Kentucky | Sample Depth | : 13.0' to 15.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 121.8 pcf | Initial Height | : 5.86 in |
| Dry Density | : 94.7 pcf | Initial Diameter | : 2.83 in |
| Moisture | : 28.6 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 100.0 % | SPECIFIC GRAVITY | : 2.667 |
| Comments | : AASHTO: T-208 | | |






APPROVED BY: Kevin E. Walker

# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-5 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-124p |
| Project State | : Kentucky | Sample Depth | : 18.0' to 20.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Lean Clay | | | | |
| Wet Density | : 118.7 | pcf | Initial Height | : 5.84 | in |
| Dry Density | : 90.6 | pcf | Initial Diameter | : 2.83 | in |
| Moisture | : 31.1 | % | Proving Ring | : #22734 | |

RESULTS:

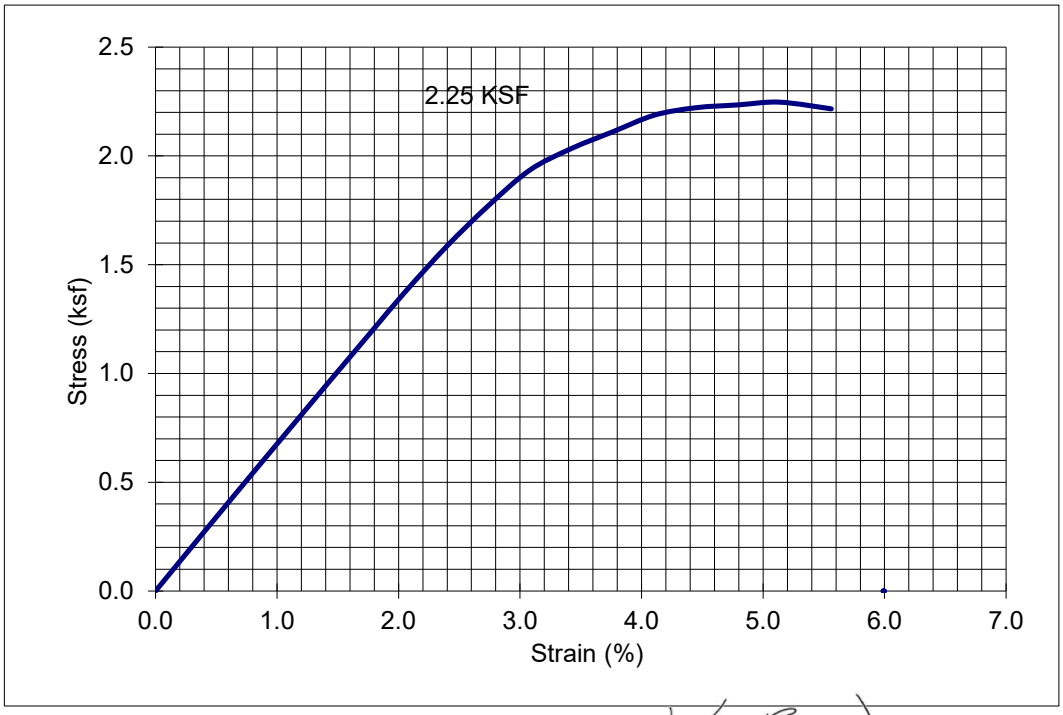
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 7.7 | 0.04 | 0.3 | 0.17 |
| 3 | 15.4 | 0.04 | 0.5 | 0.35 |
| 4 | 23.0 | 0.04 | 0.8 | 0.52 |
| 5 | 30.7 | 0.04 | 1.0 | 0.69 |
| 6 | 38.4 | 0.04 | 1.3 | 0.87 |
| 7 | 46.1 | 0.04 | 1.5 | 1.04 |
| 8 | 53.8 | 0.04 | 1.8 | 1.21 |
| 9 | 61.5 | 0.04 | 2.1 | 1.37 |
| 10 | 71.1 | 0.04 | 2.4 | 1.58 |
| 11 | 79.7 | 0.05 | 2.7 | 1.77 |
| 12 | 87.4 | 0.05 | 3.1 | 1.93 |
| 13 | 92.3 | 0.05 | 3.4 | 2.03 |
| 14 | 96.1 | 0.05 | 3.8 | 2.11 |
| 15 | 99.9 | 0.05 | 4.1 | 2.19 |
| 16 | 101.8 | 0.05 | 4.4 | 2.22 |
| 17 | 102.8 | 0.05 | 4.8 | 2.23 |
| 18 | 103.8 | 0.05 | 5.1 | 2.25 |
| 19 | 102.8 | 0.05 | 5.6 | 2.22 |
| 20 | 99.9 | 0.05 | 6.0 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-5 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-124p |
| Project State | : Kentucky | Sample Depth | : 18.0' to 20.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 118.7 pcf | Initial Height | : 5.84 in |
| Dry Density | : 90.6 pcf | Initial Diameter | : 2.83 in |
| Moisture | : 31.1 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 94.7 % | SPECIFIC GRAVITY | : 2.771 |
| Comments | : AASHTO: T-208 | | |






APPROVED BY: Kevin E. Walker

# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-125 |
| Project State | : Kentucky | Sample Depth | : 8.0' to 10.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 119.1 pcf | Initial Height | : 5.86 in |
| Dry Density | : 93.6 pcf | Initial Diameter | : 2.84 in |
| Moisture | : 27.2 % | Proving Ring | : #22734 |

RESULTS:

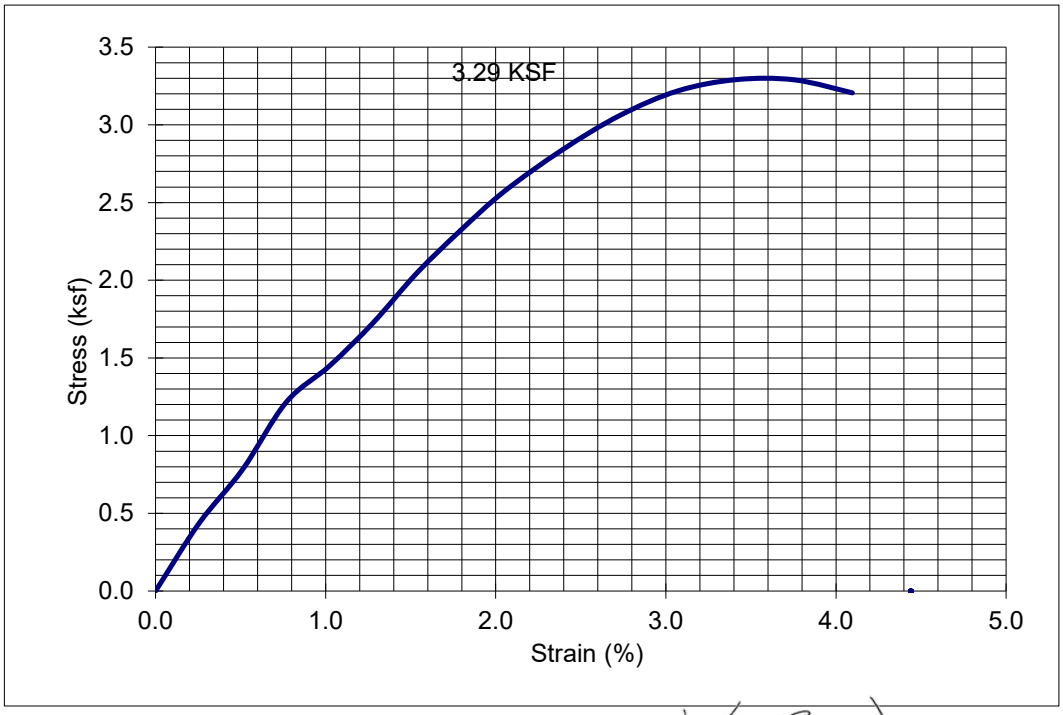
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 19.2 | 0.04 | 0.3 | 0.44 |
| 3 | 34.6 | 0.04 | 0.5 | 0.78 |
| 4 | 53.8 | 0.04 | 0.8 | 1.21 |
| 5 | 64.4 | 0.04 | 1.0 | 1.45 |
| 6 | 76.9 | 0.04 | 1.3 | 1.73 |
| 7 | 91.3 | 0.04 | 1.5 | 2.05 |
| 8 | 103.8 | 0.04 | 1.8 | 2.32 |
| 9 | 115.3 | 0.04 | 2.0 | 2.57 |
| 10 | 127.7 | 0.05 | 2.4 | 2.84 |
| 11 | 138.3 | 0.05 | 2.7 | 3.06 |
| 12 | 145.9 | 0.05 | 3.1 | 3.22 |
| 13 | 149.7 | 0.05 | 3.4 | 3.29 |
| 14 | 150.1 | 0.05 | 3.8 | 3.29 |
| 15 | 146.8 | 0.05 | 4.1 | 3.21 |
| 16 | 139.2 | 0.05 | 4.4 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-125 |
| Project State | : Kentucky | Sample Depth | : 8.0' to 10.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 119.1 pcf | Initial Height | : 5.86 in |
| Dry Density | : 93.6 pcf | Initial Diameter | : 2.84 in |
| Moisture | : 27.2 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 92.7 % | SPECIFIC GRAVITY | : 2.678 |
| Comments | : AASHTO: T-208 | | |






APPROVED BY: Kevin E. Walker

hdrinc.com

4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-5 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-125 |
| Project State | : Kentucky | Sample Depth | : 18.0' to 20.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Lean Clay | | | | |
| Wet Density | : 120.5 | pcf | Initial Height | : 5.83 | in |
| Dry Density | : 90.5 | pcf | Initial Diameter | : 2.82 | in |
| Moisture | : 33.2 | % | Proving Ring | : #22734 | |

RESULTS:

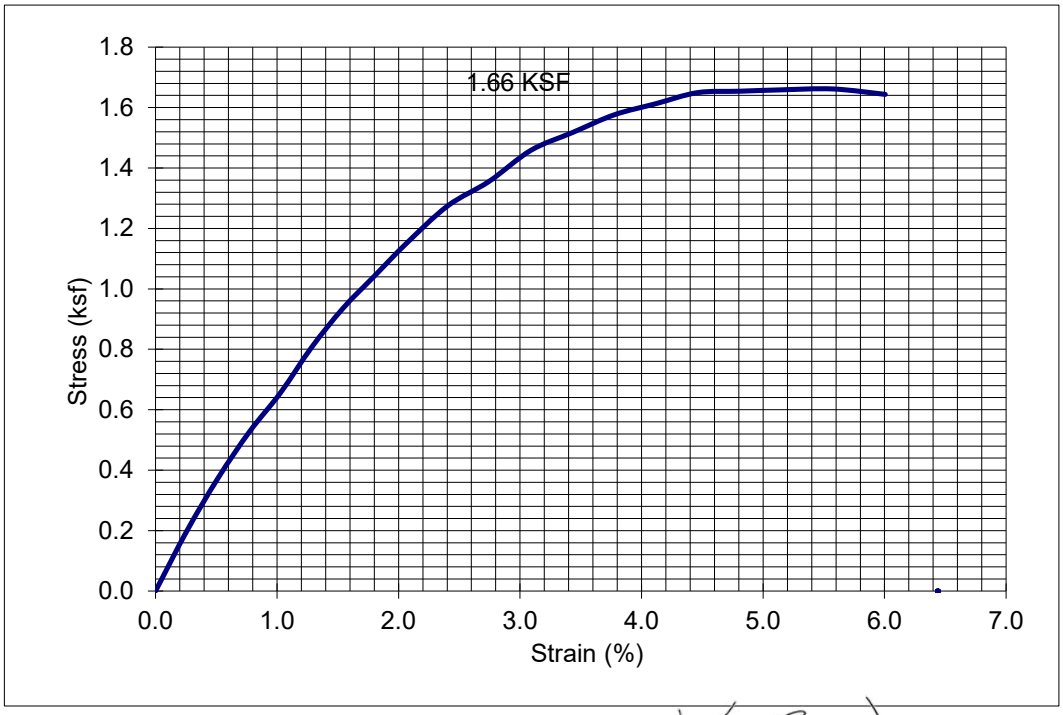
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.04 | 0.0 | 0.00 |
| 2 | 8.6 | 0.04 | 0.3 | 0.20 |
| 3 | 16.3 | 0.04 | 0.5 | 0.37 |
| 4 | 23.0 | 0.04 | 0.8 | 0.53 |
| 5 | 28.8 | 0.04 | 1.0 | 0.66 |
| 6 | 35.5 | 0.04 | 1.3 | 0.81 |
| 7 | 41.3 | 0.04 | 1.5 | 0.94 |
| 8 | 46.1 | 0.04 | 1.8 | 1.04 |
| 9 | 50.9 | 0.04 | 2.1 | 1.15 |
| 10 | 56.7 | 0.04 | 2.4 | 1.27 |
| 11 | 60.5 | 0.04 | 2.7 | 1.36 |
| 12 | 65.3 | 0.04 | 3.1 | 1.46 |
| 13 | 68.2 | 0.04 | 3.4 | 1.52 |
| 14 | 71.1 | 0.05 | 3.8 | 1.58 |
| 15 | 73.0 | 0.05 | 4.1 | 1.61 |
| 16 | 74.9 | 0.05 | 4.5 | 1.65 |
| 17 | 75.4 | 0.05 | 4.8 | 1.65 |
| 18 | 75.9 | 0.05 | 5.1 | 1.66 |
| 19 | 76.4 | 0.05 | 5.6 | 1.66 |
| 20 | 75.9 | 0.05 | 6.0 | 1.64 |
| 21 | 74.9 | 0.05 | 6.4 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-5 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-125 |
| Project State | : Kentucky | Sample Depth | : 18.0' to 20.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 120.5 pcf | Initial Height | : 5.83 in |
| Dry Density | : 90.5 pcf | Initial Diameter | : 2.82 in |
| Moisture | : 33.2 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 100.0 % | SPECIFIC GRAVITY | : 2.669 |
| Comments | : AASHTO: T-208 | | |



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# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-126A |
| Project State | : Kentucky | Sample Depth | : 13.0' to 15.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 118.7 pcf | Initial Height | : 5.85 in |
| Dry Density | : 91.0 pcf | Initial Diameter | : 2.88 in |
| Moisture | : 30.4 % | Proving Ring | : #22734 |

RESULTS:

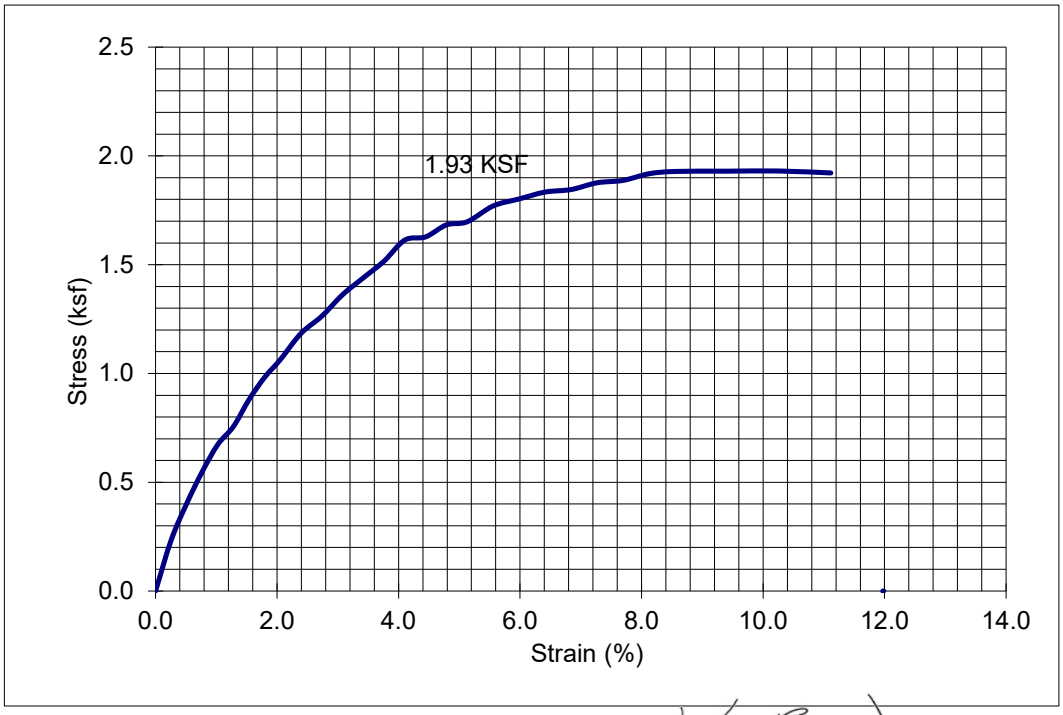
| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.05 | 0.0 | 0.00 |
| 2 | 10.6 | 0.05 | 0.3 | 0.23 |
| 3 | 18.2 | 0.05 | 0.5 | 0.40 |
| 4 | 25.0 | 0.05 | 0.8 | 0.55 |
| 5 | 30.7 | 0.05 | 1.0 | 0.67 |
| 6 | 34.6 | 0.05 | 1.3 | 0.76 |
| 7 | 40.3 | 0.05 | 1.5 | 0.88 |
| 8 | 45.1 | 0.05 | 1.8 | 0.98 |
| 9 | 49.0 | 0.05 | 2.1 | 1.06 |
| 10 | 54.7 | 0.05 | 2.4 | 1.18 |
| 11 | 58.6 | 0.05 | 2.7 | 1.26 |
| 12 | 63.4 | 0.05 | 3.1 | 1.36 |
| 13 | 67.2 | 0.05 | 3.4 | 1.44 |
| 14 | 71.1 | 0.05 | 3.8 | 1.52 |
| 15 | 75.9 | 0.05 | 4.1 | 1.61 |
| 16 | 76.9 | 0.05 | 4.4 | 1.63 |
| 17 | 79.7 | 0.05 | 4.8 | 1.68 |
| 18 | 80.7 | 0.05 | 5.1 | 1.70 |
| 19 | 84.6 | 0.05 | 5.6 | 1.77 |
| 20 | 86.5 | 0.05 | 6.0 | 1.80 |
| 21 | 88.4 | 0.05 | 6.4 | 1.83 |
| 22 | 89.4 | 0.05 | 6.8 | 1.85 |
| 23 | 91.3 | 0.05 | 7.3 | 1.88 |
| 24 | 92.3 | 0.05 | 7.7 | 1.89 |
| 25 | 94.2 | 0.05 | 8.1 | 1.92 |
| 26 | 95.1 | 0.05 | 8.5 | 1.93 |
| 27 | 96.1 | 0.05 | 9.4 | 1.93 |
| 28 | 97.1 | 0.05 | 10.3 | 1.93 |
| 29 | 97.5 | 0.05 | 11.1 | 1.92 |
| 30 | 97.1 | 0.05 | 12.0 | 0.00 |

# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 251877 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-126A |
| Project State | : Kentucky | Sample Depth | : 13.0' to 15.0' |
| Laboratory # | : 251877 | Date Tested | : 8/8/2025 |
| Submitted By | : HDR | Date Reported | : 8/8/2025 |
| Soil Type | : Lean Clay | | |
| Wet Density | : 118.7 pcf | Initial Height | : 5.85 in |
| Dry Density | : 91.0 pcf | Initial Diameter | : 2.88 in |
| Moisture | : 30.4 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 97.3 % | SPECIFIC GRAVITY | : 2.679 |
| Comments | : AASHTO: T-208 | | |






APPROVED BY: Kevin E. Walker

hdrinc.com

4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-2046 |
| Project State | : Kentucky | Sample Depth | : 4.0' to 4.5' |
| Laboratory # | : 10174706 | Date Tested | : 12/9/2025 |
| Submitted By | : HDR | Date Reported | : 12/11/2025 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Dark Brown Silt | | | | |
| Wet Density | : 114.8 | pcf | Initial Height | : 5.66 | in |
| Dry Density | : 91.4 | pcf | Initial Diameter | : 2.89 | in |
| Moisture | : 25.6 | % | Proving Ring | : #22734 | |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.05 | 0.0 | 0.00 |
| 2 | 15.4 | 0.05 | 0.3 | 0.34 |
| 3 | 20.2 | 0.05 | 0.5 | 0.44 |
| 4 | 24.0 | 0.05 | 0.8 | 0.52 |
| 5 | 26.9 | 0.05 | 1.1 | 0.59 |
| 6 | 29.8 | 0.05 | 1.3 | 0.65 |
| 7 | 32.6 | 0.05 | 1.6 | 0.71 |
| 8 | 34.6 | 0.05 | 1.9 | 0.75 |
| 9 | 36.5 | 0.05 | 2.1 | 0.79 |
| 10 | 38.4 | 0.05 | 2.5 | 0.82 |
| 11 | 40.3 | 0.05 | 2.8 | 0.86 |
| 12 | 42.2 | 0.05 | 3.2 | 0.90 |
| 13 | 43.2 | 0.05 | 3.5 | 0.92 |
| 14 | 45.1 | 0.05 | 3.9 | 0.95 |
| 15 | 46.1 | 0.05 | 4.2 | 0.97 |
| 16 | 46.1 | 0.05 | 4.6 | 0.97 |
| 17 | 46.1 | 0.05 | 4.9 | 0.96 |
| 18 | 46.1 | 0.05 | 5.3 | 0.00 |

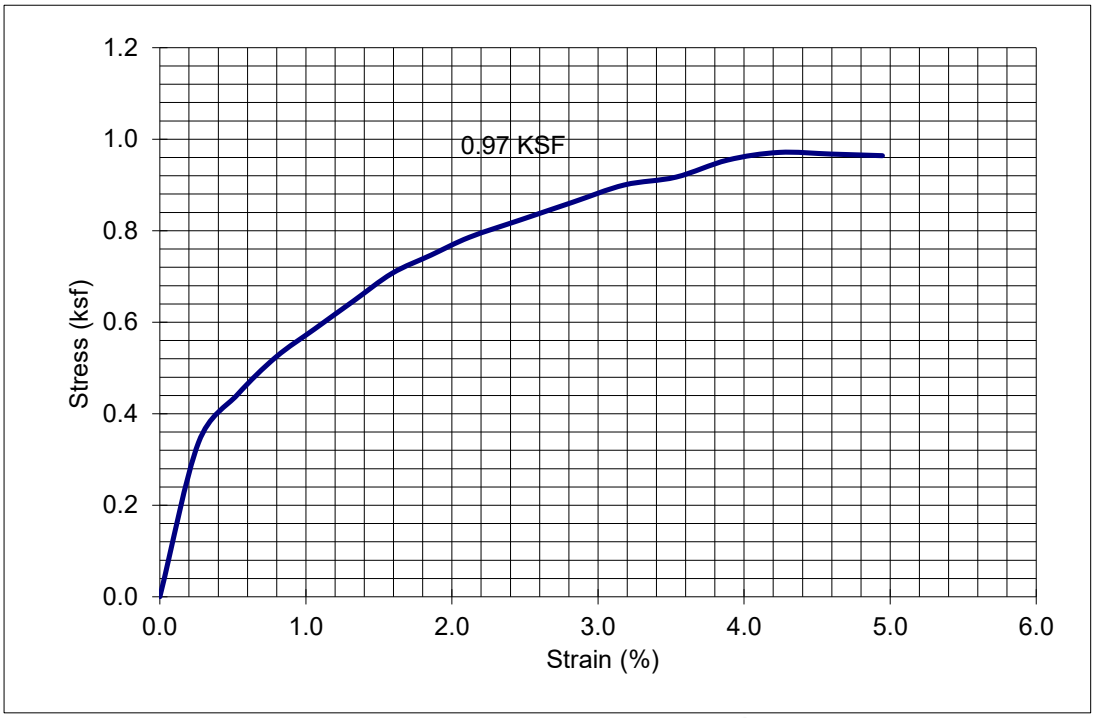
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-2046 |
| Project State | : Kentucky | Sample Depth | : 4.0' to 4.5' |
| Laboratory # | : 10174706 | Date Tested | : 12/9/2025 |
| Submitted By | : HDR | Date Reported | : 12/11/2025 |
| Soil Type | : Dark Brown Silt | | |
| Wet Density | : 114.8 pcf | Initial Height | : 5.66 in |
| Dry Density | : 91.4 pcf | Initial Diameter | : 2.89 in |
| Moisture | : 25.6 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 82.0 % | SPECIFIC GRAVITY | : 2.693 |

Comments : AASHTO: T-208 ; L / D Ratio < 2






APPROVED BY: W. Stewart

# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-2046 |
| Project State | : Kentucky | Sample Depth | : 8.5' to 9.0' |
| Laboratory # | : 10174706 | Date Tested | : 12/9/2025 |
| Submitted By | : HDR | Date Reported | : 12/11/2025 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Dark Brown Silt | | | | |
| Wet Density | : 119.6 | pcf | Initial Height | : 5.42 | in |
| Dry Density | : 93.4 | pcf | Initial Diameter | : 2.91 | in |
| Moisture | : 28.1 | % | Proving Ring | : #22734 | |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.05 | 0.0 | 0.00 |
| 2 | 4.8 | 0.05 | 0.3 | 0.10 |
| 3 | 7.7 | 0.05 | 0.6 | 0.17 |
| 4 | 8.6 | 0.05 | 0.8 | 0.19 |
| 5 | 11.5 | 0.05 | 1.1 | 0.25 |
| 6 | 11.5 | 0.05 | 1.4 | 0.25 |
| 7 | 11.5 | 0.05 | 1.7 | 0.25 |
| 8 | 11.5 | 0.05 | 1.9 | 0.00 |

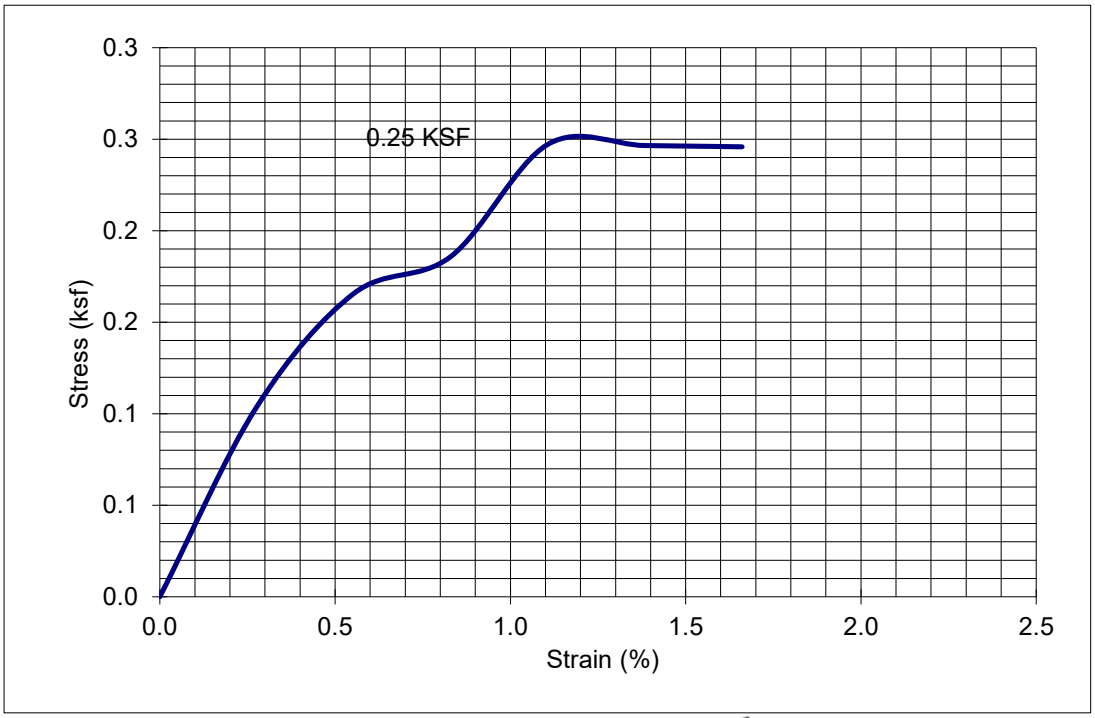
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-2 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-2046 |
| Project State | : Kentucky | Sample Depth | : 8.5' to 9.0' |
| Laboratory # | : 10174706 | Date Tested | : 12/9/2025 |
| Submitted By | : HDR | Date Reported | : 12/11/2025 |
| Soil Type | : Dark Brown Silt | | |
| Wet Density | : 119.6 pcf | Initial Height | : 5.42 in |
| Dry Density | : 93.4 pcf | Initial Diameter | : 2.91 in |
| Moisture | : 28.1 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 93.2 % | SPECIFIC GRAVITY | : 2.724 |

Comments : AASHTO: T-208 ; L / D Ratio < 2






APPROVED BY: W. Stucough

# UNCONFINED COMPRESSION TEST

AASHTO: T-208 

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-2046 |
| Project State | : Kentucky | Sample Depth | : 15.0' to 15.5' |
| Laboratory # | : 10174706 | Date Tested | : 12/9/2025 |
| Submitted By | : HDR | Date Reported | : 12/11/2025 |

| | | | | | |
|---|---|---|---|---|---|
| Soil Type | : Dark Gray Silt | | | | |
| Wet Density | : 114.4 | pcf | Initial Height | : 5.73 | in |
| Dry Density | : 85.4 | pcf | Initial Diameter | : 2.91 | in |
| Moisture | : 33.9 | % | Proving Ring | : #22734 | |

RESULTS:

| # | Axial Load lbs | Corrected Area sf | Unit Strain % | Stress Ksf |
|---|---|---|---|---|
| 1 | 0.0 | 0.05 | 0.0 | 0.00 |
| 2 | 6.7 | 0.05 | 0.3 | 0.15 |
| 3 | 9.6 | 0.05 | 0.5 | 0.21 |
| 4 | 12.5 | 0.05 | 0.8 | 0.27 |
| 5 | 15.4 | 0.05 | 1.0 | 0.33 |
| 6 | 17.3 | 0.05 | 1.3 | 0.37 |
| 7 | 19.2 | 0.05 | 1.6 | 0.41 |
| 8 | 21.1 | 0.05 | 1.8 | 0.45 |
| 9 | 23.0 | 0.05 | 2.1 | 0.49 |
| 10 | 25.0 | 0.05 | 2.4 | 0.53 |
| 11 | 26.9 | 0.05 | 2.8 | 0.57 |
| 12 | 28.8 | 0.05 | 3.1 | 0.60 |
| 13 | 30.7 | 0.05 | 3.5 | 0.64 |
| 14 | 31.7 | 0.05 | 3.8 | 0.66 |
| 15 | 33.6 | 0.05 | 4.2 | 0.70 |
| 16 | 35.5 | 0.05 | 4.5 | 0.73 |
| 17 | 36.5 | 0.05 | 4.9 | 0.75 |
| 18 | 38.4 | 0.05 | 5.2 | 0.79 |
| 19 | 39.4 | 0.05 | 5.7 | 0.80 |
| 20 | 41.3 | 0.05 | 6.1 | 0.84 |
| 21 | 43.2 | 0.05 | 6.5 | 0.87 |
| 22 | 44.2 | 0.05 | 7.0 | 0.89 |
| 23 | 46.1 | 0.05 | 7.4 | 0.92 |
| 24 | 47.0 | 0.05 | 7.9 | 0.94 |
| 25 | 49.0 | 0.05 | 8.3 | 0.97 |
| 26 | 50.9 | 0.05 | 8.7 | 1.01 |
| 27 | 53.8 | 0.05 | 9.6 | 1.05 |
| 28 | 55.7 | 0.05 | 10.5 | 1.08 |
| 29 | 58.6 | 0.05 | 11.3 | 1.13 |
| 30 | 61.5 | 0.05 | 12.2 | 1.17 |
| 31 | 63.4 | 0.05 | 13.1 | 1.19 |
| 32 | 65.3 | 0.05 | 14.0 | 1.22 |
| 33 | 70.1 | 0.05 | 14.8 | 1.29 |
| 34 | 73.0 | 0.05 | 15.7 | 0.00 |

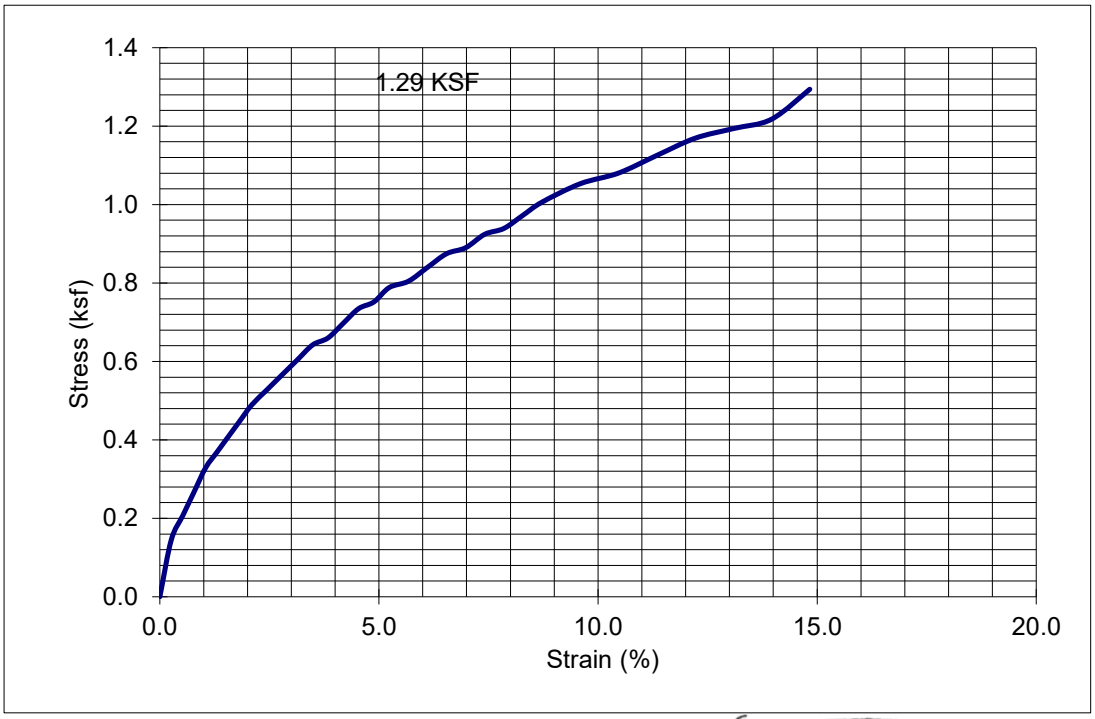
# UNCONFINED COMPRESSION TEST



| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project # | : 10174706 | Sample # | : ST-3 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-2046 |
| Project State | : Kentucky | Sample Depth | : 15.0' to 15.5' |
| Laboratory # | : 10174706 | Date Tested | : 12/9/2025 |
| Submitted By | : HDR | Date Reported | : 12/11/2025 |
| Soil Type | : Dark Gray Silt | | |
| Wet Density | : 114.4 pcf | Initial Height | : 5.73 in |
| Dry Density | : 85.4 pcf | Initial Diameter | : 2.91 in |
| Moisture | : 33.9 % | Proving Ring | : #22734 |
| Deg. of Sat. | : 92.6 % | SPECIFIC GRAVITY | : 2.742 |

Comments : AASHTO: T-208 ; L / D Ratio < 2






APPROVED BY: W. Stucough

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-117 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 19.5' to 20.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/12/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/20/2026 |

| | | | | | |
|---|---|---|---|---|---|
| SOIL TYPE | : Silty Sand | | | | |
| WET DENSITY | : 130.19 pcf | DELTA HEIGHT | : 0.45 cm | INITIAL HEIGHT | : 15.04 cm |
| DRY DENSITY | : 98.97 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 6.63 cm |
| MOISTURE | : 31.54 % | CHAMBER PRES. | : 16.01 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 16.01 | 16.01 | 1.00 |
| 2 | 0.09 | 16.01 | 16.52 | 1.03 |
| 3 | 0.17 | 16.01 | 16.77 | 1.05 |
| 4 | 0.26 | 16.01 | 17.02 | 1.06 |
| 5 | 0.35 | 16.01 | 17.02 | 1.06 |
| 6 | 0.44 | 16.01 | 17.02 | 1.06 |
| 7 | 0.52 | 16.01 | 17.27 | 1.08 |
| 8 | 1.04 | 16.01 | 17.76 | 1.11 |
| 9 | 1.57 | 16.01 | 18.75 | 1.17 |
| 10 | 2.09 | 16.01 | 19.23 | 1.2 |
| 11 | 2.61 | 16.01 | 19.71 | 1.23 |
| 12 | 3.13 | 16.01 | 20.43 | 1.28 |
| 13 | 3.48 | 16.01 | 20.87 | 1.3 |
| 14 | 4.35 | 16.01 | 21.58 | 1.35 |
| 15 | 5.22 | 16.01 | 22.01 | 1.37 |
| 16 | 6.09 | 16.01 | 22.67 | 1.42 |
| 17 | 6.97 | 16.01 | 23.04 | 1.44 |
| 18 | 7.84 | 16.01 | 23.48 | 1.47 |
| 19 | 8.71 | 16.01 | 23.87 | 1.49 |
| 20 | 9.58 | 16.01 | 24.25 | 1.51 |
| 21 | 10.45 | 16.01 | 24.4 | 1.52 |
| 22 | 11.32 | 16.01 | 24.54 | 1.53 |
| 23 | 12.19 | 16.01 | 24.46 | 1.53 |
| 24 | 13.06 | 16.01 | 24.6 | 1.54 |
| 25 | 13.93 | 16.01 | 24.68 | 1.54 |
| 26 | 14.80 | 16.01 | 24.86 | 1.55 |
| 27 | 15.67 | 16.01 | 24.98 | 1.56 |
| 28 | 16.54 | 16.01 | 25.1 | 1.57 |
| 29 | 17.41 | 16.01 | 25.21 | 1.57 |
| 30 | 18.28 | 16.01 | 25.32 | 1.58 |
| 31 | 19.15 | 16.01 | 25.43 | 1.59 |
| 32 | 20.03 | 16.01 | 25.33 | 1.58 |

Unconsolidated Undrained

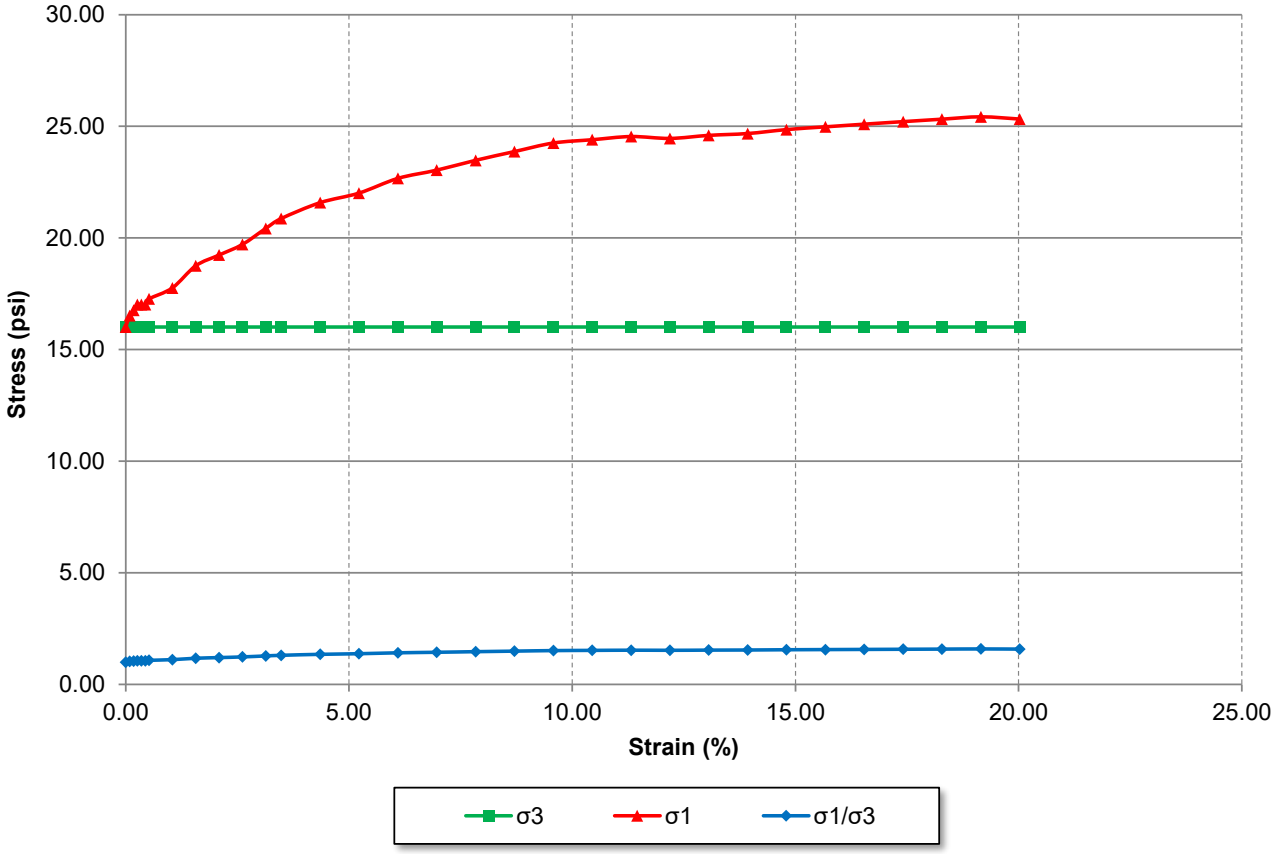
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-117 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 19.5' to 20.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 1/12/2026 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 1/20/2026 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 31.54 % | EFF. CONS. STRESS | : 16.01 psi |
| FINAL HEIGHT | : 11.67 cm | SPECIFIC GRAVITY | : 2.65 |
| FINAL DIAMETER | : 7.39 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-117 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 19.5' to 20.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/12/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/20/2026 |

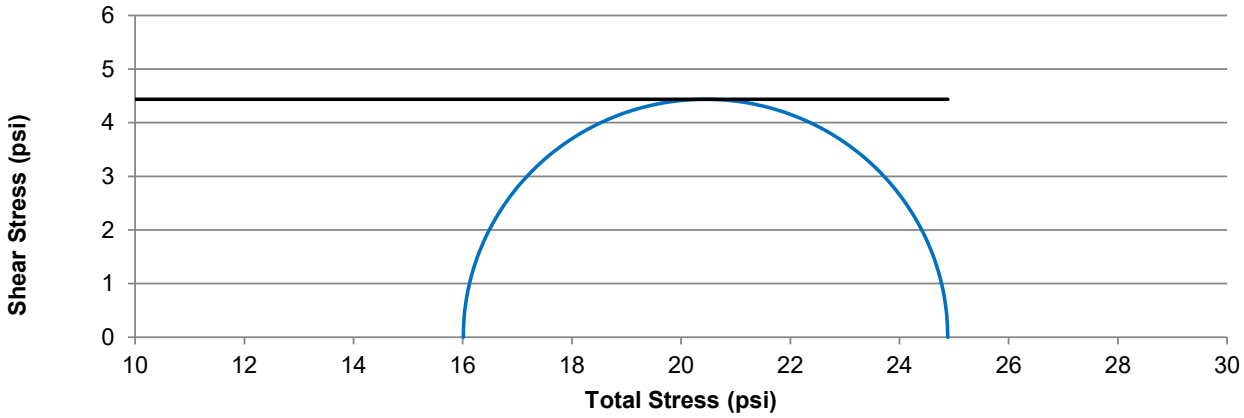
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 16.01 psi | 24.88 psi |

| | | |
|---|---|---|
| Compressive Strength = | 1278 | psf |
| Cohesion = | 639 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## At Maximum Deviator Stress 15%

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: W. Shuwarp

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-118 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 24.0' to 24.5' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/12/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/23/2026 |
| SOIL TYPE | : Lean Clay | | |

| | | | | | |
|---|---|---|---|---|---|
| WET DENSITY | : 118.33 pcf | DELTA HEIGHT | : 0.45 cm | INITIAL HEIGHT | : 14.83 cm |
| DRY DENSITY | : 90.75 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.19 cm |
| MOISTURE | : 30.39 % | CHAMBER PRES. | : 20.99 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 20.99 | 20.99 | 1.00 |
| 2 | 0.09 | 20.99 | 22.93 | 1.09 |
| 3 | 0.18 | 20.99 | 23.35 | 1.11 |
| 4 | 0.26 | 20.99 | 23.12 | 1.1 |
| 5 | 0.35 | 20.99 | 23.35 | 1.11 |
| 6 | 0.44 | 20.99 | 23.56 | 1.12 |
| 7 | 0.53 | 20.99 | 23.77 | 1.13 |
| 8 | 1.06 | 20.99 | 24.4 | 1.16 |
| 9 | 1.59 | 20.99 | 25.01 | 1.19 |
| 10 | 2.12 | 20.99 | 26.68 | 1.27 |
| 11 | 2.65 | 20.99 | 28.11 | 1.34 |
| 12 | 3.18 | 20.99 | 29.11 | 1.39 |
| 13 | 3.53 | 20.99 | 29.5 | 1.41 |
| 14 | 4.42 | 20.99 | 30.86 | 1.47 |
| 15 | 5.30 | 20.99 | 31.57 | 1.5 |
| 16 | 6.18 | 20.99 | 32.46 | 1.55 |
| 17 | 7.06 | 20.99 | 32.54 | 1.55 |
| 18 | 7.95 | 20.99 | 33.2 | 1.58 |
| 19 | 8.83 | 20.99 | 33.28 | 1.59 |
| 20 | 9.71 | 20.99 | 33.72 | 1.61 |
| 21 | 10.60 | 20.99 | 33.79 | 1.61 |
| 22 | 11.48 | 20.99 | 34.03 | 1.62 |
| 23 | 12.36 | 20.99 | 34.27 | 1.63 |
| 24 | 13.25 | 20.99 | 34.5 | 1.64 |
| 25 | 14.13 | 20.99 | 34.54 | 1.65 |
| 26 | 15.01 | 20.99 | 34.58 | 1.65 |
| 27 | 15.90 | 20.99 | 34.97 | 1.67 |
| 28 | 16.78 | 20.99 | 35.15 | 1.67 |
| 29 | 17.66 | 20.99 | 35.19 | 1.68 |
| 30 | 18.54 | 20.99 | 35.21 | 1.68 |
| 31 | 19.43 | 20.99 | 35.05 | 1.67 |
| 32 | 20.31 | 20.99 | 35.23 | 1.68 |

Unconsolidated Undrained

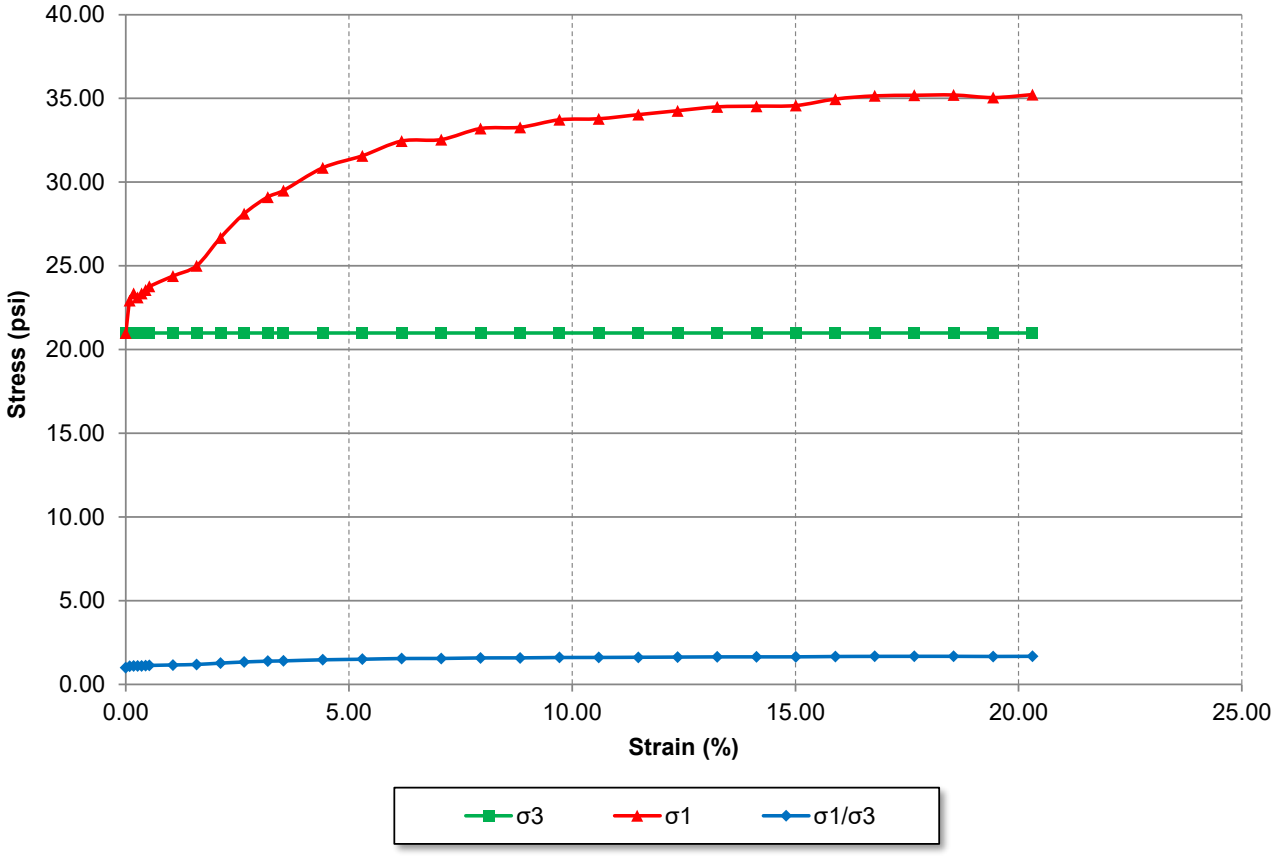
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-118 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 24.0' to 24.5' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 1/12/2026 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 1/23/2026 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 30.39 % | EFF. CONS. STRESS | : 20.99 psi |
| FINAL HEIGHT | : 11.46 cm | SPECIFIC GRAVITY | : 2.58 |
| FINAL DIAMETER | : 8.03 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-118 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 24.0' to 24.5' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/12/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/23/2026 |

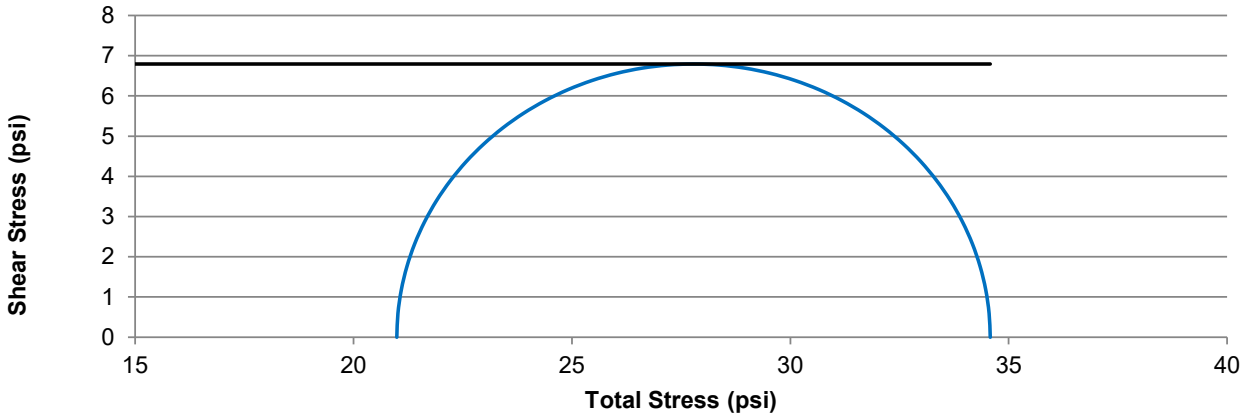
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 20.99 psi | 34.58 psi |

| | | |
|---|---|---|
| Compressive Strength = | 1956 | psf |
| Cohesion = | 978 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## At Maximum Deviator Stress 15%

### Triaxial Mohr's Circles
### Unconsolidated Undrained Triaxial Test




Approved By: _____

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-123 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 24.0' to 24.5' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/22/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/29/2026 |

| | | | | | |
|---|---|---|---|---|---|
| SOIL TYPE | : Sandy Silt | | | | |
| WET DENSITY | : 106.79 pcf | DELTA HEIGHT | : 0.2 cm | INITIAL HEIGHT | : 14.46 cm |
| DRY DENSITY | : 70.37 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.21 cm |
| MOISTURE | : 51.76 % | CHAMBER PRES. | : 20.99 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 20.99 | 20.99 | 1.00 |
| 2 | 0.09 | 20.99 | 22.08 | 1.05 |
| 3 | 0.18 | 20.99 | 22.3 | 1.06 |
| 4 | 0.27 | 20.99 | 22.51 | 1.07 |
| 5 | 0.36 | 20.99 | 23.15 | 1.1 |
| 6 | 0.45 | 20.99 | 23.38 | 1.11 |
| 7 | 0.53 | 20.99 | 23.81 | 1.13 |
| 8 | 1.07 | 20.99 | 25.28 | 1.2 |
| 9 | 1.60 | 20.99 | 26.14 | 1.25 |
| 10 | 2.14 | 20.99 | 27.61 | 1.32 |
| 11 | 2.67 | 20.99 | 28.85 | 1.37 |
| 12 | 3.21 | 20.99 | 29.65 | 1.41 |
| 13 | 3.56 | 20.99 | 30.04 | 1.43 |
| 14 | 4.45 | 20.99 | 30.79 | 1.47 |
| 15 | 5.34 | 20.99 | 31.72 | 1.51 |
| 16 | 6.23 | 20.99 | 31.82 | 1.52 |
| 17 | 7.12 | 20.99 | 31.91 | 1.52 |
| 18 | 8.01 | 20.99 | 31.8 | 1.52 |
| 19 | 8.91 | 20.99 | 31.7 | 1.51 |

Unconsolidated Undrained

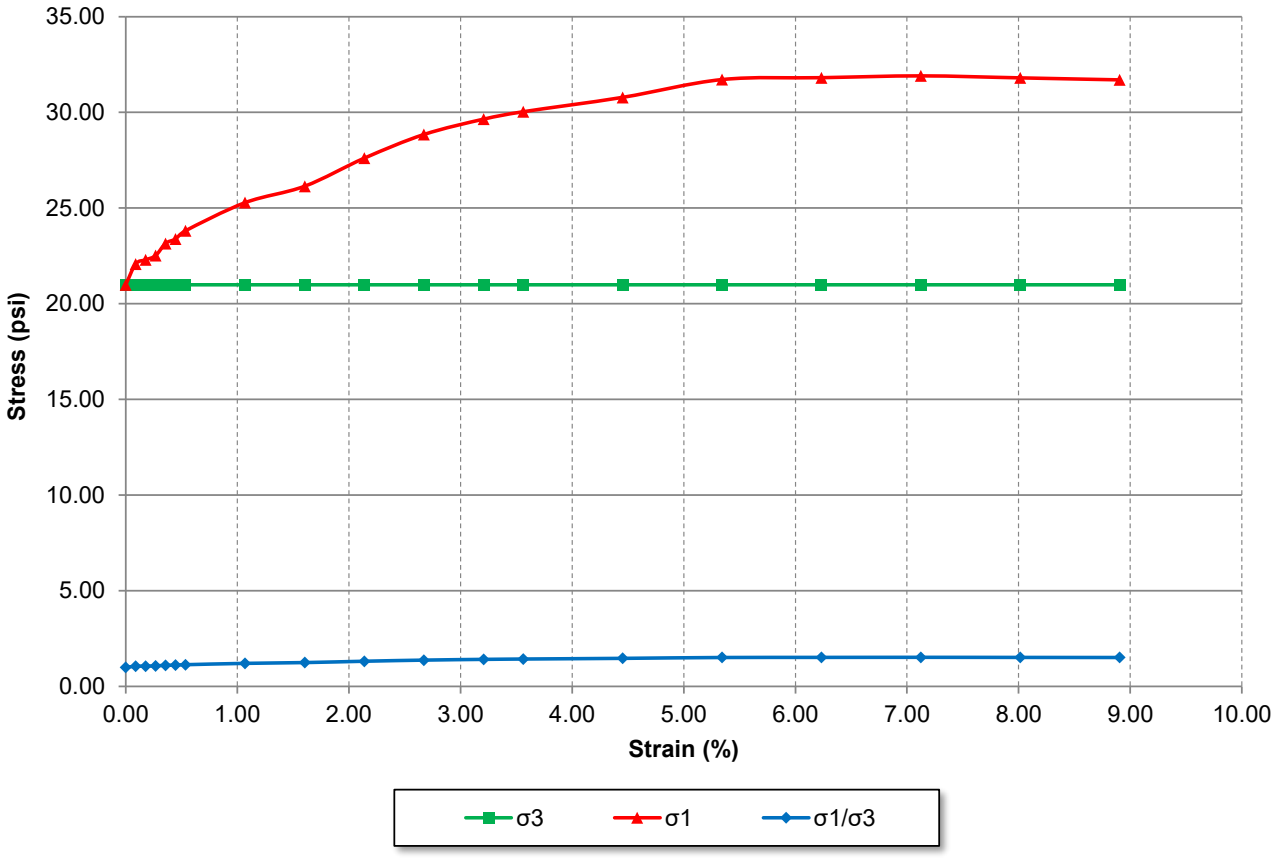
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-123 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 24.0' to 24.5' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 1/22/2026 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 1/29/2026 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 51.76 % | EFF. CONS. STRESS | : 20.99 psi |
| FINAL HEIGHT | : 12.99 cm | SPECIFIC GRAVITY | : 2.68 |
| FINAL DIAMETER | : 7.54 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-123 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 24.0' to 24.5' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/22/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/29/2026 |

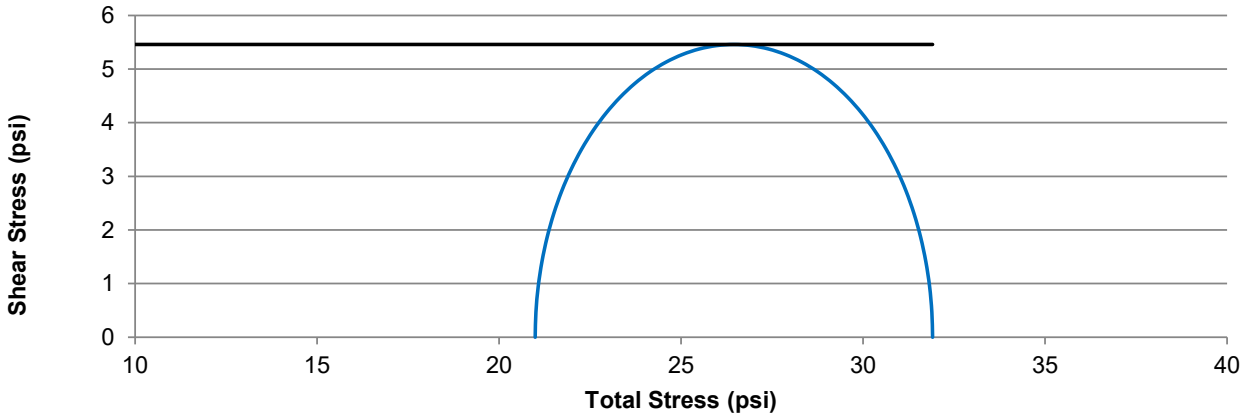
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 20.99 psi | 31.91 psi |

| | | |
|---|---|---|
| Compressive Strength = | 1572 | psf |
| Cohesion = | 786 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

### Triaxial Mohr's Circles
### Unconsolidated Undrained Triaxial Test




Approved By: W. Shumaker

hdrinc.com

4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-123 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 29.5' to 30.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/23/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/29/2026 |
| SOIL TYPE | : Lean Clay with Sand | | |

| | | | | | |
|---|---|---|---|---|---|
| WET DENSITY | : 108.5 pcf | DELTA HEIGHT | : 0.28 cm | INITIAL HEIGHT | : 14.09 cm |
| DRY DENSITY | : 73.07 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.21 cm |
| MOISTURE | : 48.5 % | CHAMBER PRES. | : 24.98 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 24.98 | 24.98 | 1.00 |
| 2 | 0.09 | 24.98 | 26.71 | 1.07 |
| 3 | 0.18 | 24.98 | 27.79 | 1.11 |
| 4 | 0.28 | 24.98 | 28.43 | 1.14 |
| 5 | 0.37 | 24.98 | 28.64 | 1.15 |
| 6 | 0.46 | 24.98 | 29.26 | 1.17 |
| 7 | 0.55 | 24.98 | 29.5 | 1.18 |
| 8 | 1.10 | 24.98 | 31.36 | 1.26 |
| 9 | 1.65 | 24.98 | 32.86 | 1.32 |
| 10 | 2.21 | 24.98 | 33.66 | 1.35 |
| 11 | 2.76 | 24.98 | 35.08 | 1.4 |
| 12 | 3.31 | 24.98 | 36.46 | 1.46 |
| 13 | 3.68 | 24.98 | 37.03 | 1.48 |
| 14 | 4.60 | 24.98 | 38.12 | 1.53 |
| 15 | 5.52 | 24.98 | 38.99 | 1.56 |
| 16 | 6.43 | 24.98 | 39.44 | 1.58 |
| 17 | 7.35 | 24.98 | 40.08 | 1.6 |
| 18 | 8.27 | 24.98 | 40.13 | 1.61 |
| 19 | 9.19 | 24.98 | 39.97 | 1.6 |
| 20 | 10.11 | 24.98 | 40.01 | 1.6 |
| 21 | 11.03 | 24.98 | 40.05 | 1.6 |
| 22 | 11.95 | 24.98 | 39.89 | 1.6 |
| 23 | 12.87 | 24.98 | 39.73 | 1.59 |

Unconsolidated Undrained

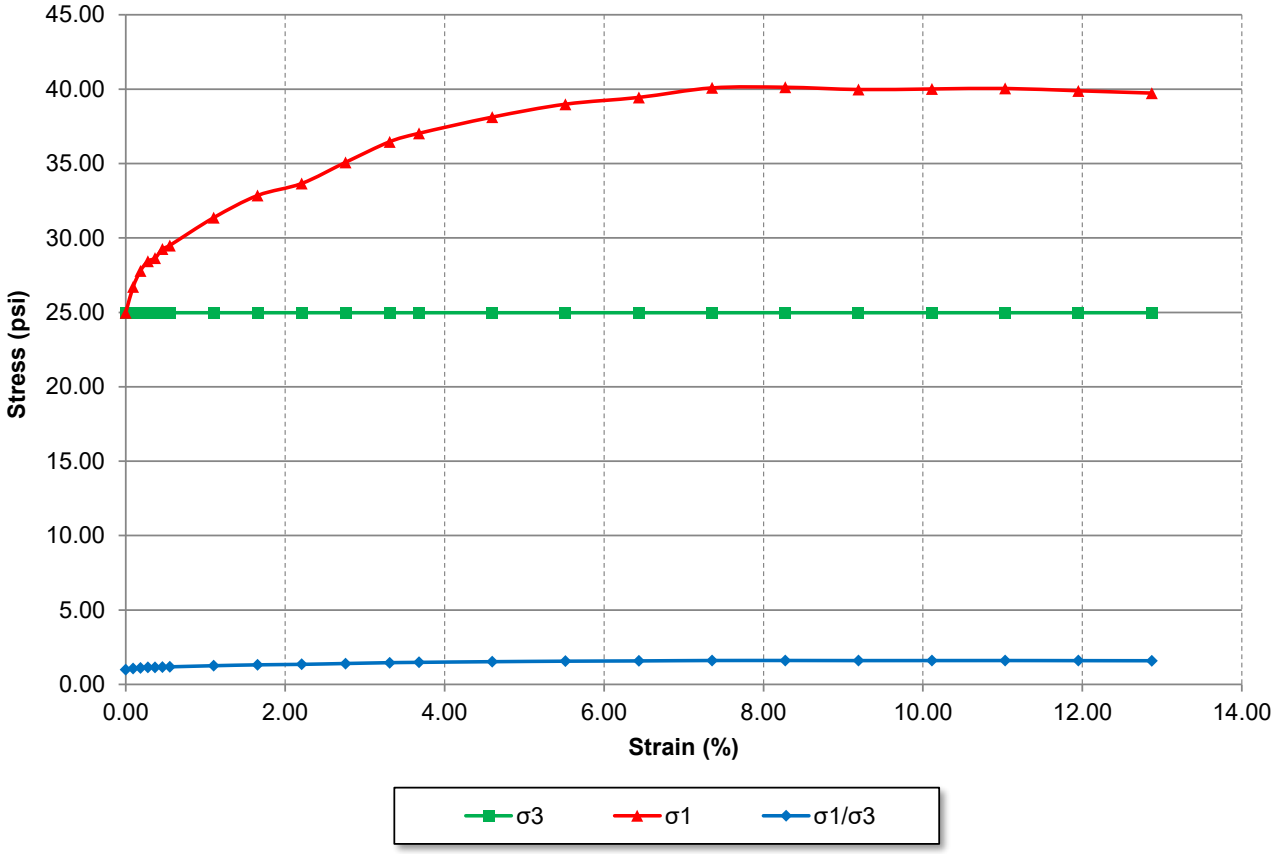
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-123 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 29.5' to 30.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 1/23/2026 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 1/29/2026 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 48.5 % | EFF. CONS. STRESS | : 24.98 psi |
| FINAL HEIGHT | : 12.04 cm | SPECIFIC GRAVITY | : 2.56 |
| FINAL DIAMETER | : 7.71 cm | COMMENTS | : AASHTO T-296 |

RESULTS:

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T 270.444.9691 F 270.538.1599

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-123 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 29.5' to 30.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/23/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/29/2026 |

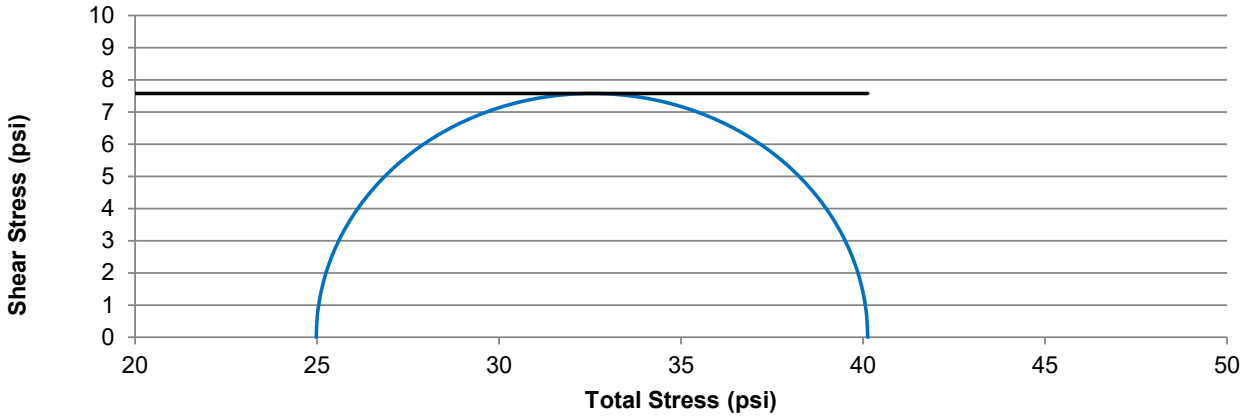
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 24.98 psi | 40.13 psi |

| | | |
|---|---|---|
| Compressive Strength = | 2182 | psf |
| Cohesion = | 1091 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

### Triaxial Mohr's Circles
### Unconsolidated Undrained Triaxial Test




Approved By: W. Shuwarp

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-123 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 34.3' to 34.8' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/22/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/29/2026 |

SOIL TYPE : Lean Clay with Sand

| | | | | | |
|---|---|---|---|---|---|
| WET DENSITY | : 120.74 pcf | DELTA HEIGHT | : 0.35 cm | INITIAL HEIGHT | : 13.75 cm |
| DRY DENSITY | : 87.8 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 6.97 cm |
| MOISTURE | : 37.51 % | CHAMBER PRES. | : 29.96 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 29.96 | 29.96 | 1.00 |
| 2 | 0.09 | 29.96 | 30.42 | 1.02 |
| 3 | 0.19 | 29.96 | 30.65 | 1.02 |
| 4 | 0.28 | 29.96 | 30.65 | 1.02 |
| 5 | 0.38 | 29.96 | 30.87 | 1.03 |
| 6 | 0.47 | 29.96 | 30.64 | 1.02 |
| 7 | 0.57 | 29.96 | 30.87 | 1.03 |
| 8 | 1.14 | 29.96 | 31.32 | 1.05 |
| 9 | 1.71 | 29.96 | 31.77 | 1.06 |
| 10 | 2.27 | 29.96 | 32.43 | 1.08 |
| 11 | 2.84 | 29.96 | 33.09 | 1.1 |
| 12 | 3.41 | 29.96 | 33.96 | 1.13 |
| 13 | 3.79 | 29.96 | 34.61 | 1.16 |
| 14 | 4.74 | 29.96 | 35.88 | 1.2 |
| 15 | 5.69 | 29.96 | 36.43 | 1.22 |
| 16 | 6.64 | 29.96 | 37.69 | 1.26 |
| 17 | 7.58 | 29.96 | 38.89 | 1.3 |
| 18 | 8.53 | 29.96 | 39.64 | 1.32 |
| 19 | 9.48 | 29.96 | 40.16 | 1.34 |
| 20 | 10.43 | 29.96 | 40.67 | 1.36 |
| 21 | 11.37 | 29.96 | 40.95 | 1.37 |
| 22 | 12.32 | 29.96 | 41.22 | 1.38 |
| 23 | 13.27 | 29.96 | 41.3 | 1.38 |
| 24 | 14.22 | 29.96 | 40.98 | 1.37 |
| 25 | 15.17 | 29.96 | 41.24 | 1.38 |
| 26 | 16.11 | 29.96 | 41.11 | 1.37 |
| 27 | 17.06 | 29.96 | 40.99 | 1.37 |

Unconsolidated Undrained

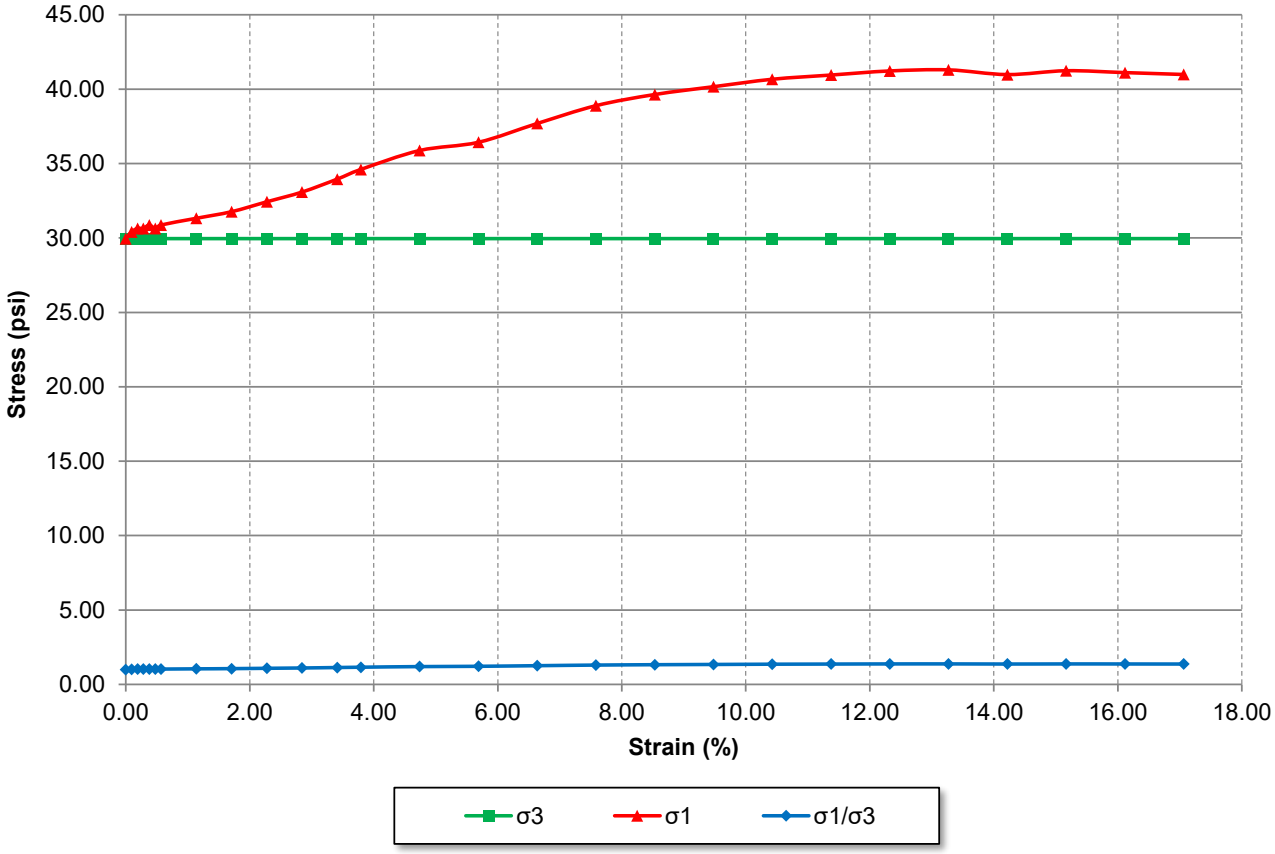
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-123 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 34.3' to 34.8' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 1/22/2026 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 1/29/2026 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 37.51 % | EFF. CONS. STRESS | : 29.96 psi |
| FINAL HEIGHT | : 11.11 cm | SPECIFIC GRAVITY | : 2.67 |
| FINAL DIAMETER | : 7.64 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-123 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 34.3' to 34.8' |
| LABORATORY # | : 10174706 | DATE TESTED | : 1/22/2026 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 1/29/2026 |

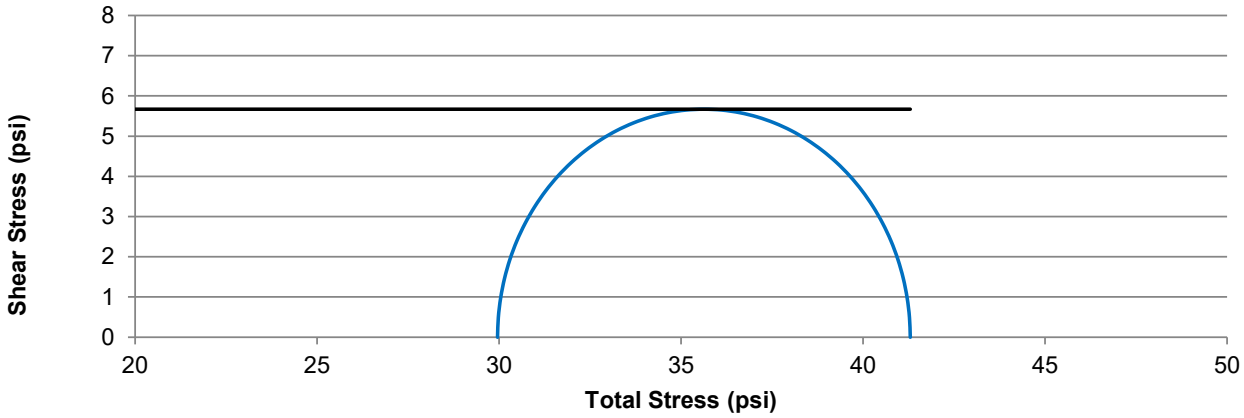
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 29.96 psi | 41.3 psi |

| | | |
|---|---|---|
| Compressive Strength = | 1633 | psf |
| Cohesion = | 816 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

### Triaxial Mohr's Circles
### Unconsolidated Undrained Triaxial Test




Approved By: W. Shumaker

hdrinc.com

4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-124P |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 23.0' to 25.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |

SOIL TYPE : Light Gray Lean Clay

| | | | | | |
|---|---|---|---|---|---|
| WET DENSITY | : 121.68 pcf | DELTA HEIGHT | : 0.12 cm | INITIAL HEIGHT | : 14.96 cm |
| DRY DENSITY | : 91.56 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.11 cm |
| MOISTURE | : 32.89 % | CHAMBER PRES. | : 20 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 20.00 | 20.00 | 1.00 |
| 2 | 0.09 | 20 | 22.24 | 1.11 |
| 3 | 0.17 | 20 | 24.48 | 1.22 |
| 4 | 0.26 | 20 | 26.07 | 1.3 |
| 5 | 0.34 | 20 | 27.41 | 1.37 |
| 6 | 0.43 | 20 | 28.3 | 1.41 |
| 7 | 0.51 | 20 | 29.64 | 1.48 |
| 8 | 1.03 | 20 | 34.4 | 1.72 |
| 9 | 1.54 | 20 | 37.13 | 1.86 |
| 10 | 2.05 | 20 | 38.33 | 1.92 |
| 11 | 2.57 | 20 | 39.09 | 1.95 |
| 12 | 3.08 | 20 | 39.2 | 1.96 |
| 13 | 3.42 | 20 | 39.13 | 1.96 |
| 14 | 4.28 | 20 | 38.97 | 1.95 |
| 15 | 5.13 | 20 | 38.59 | 1.93 |

Unconsolidated Undrained

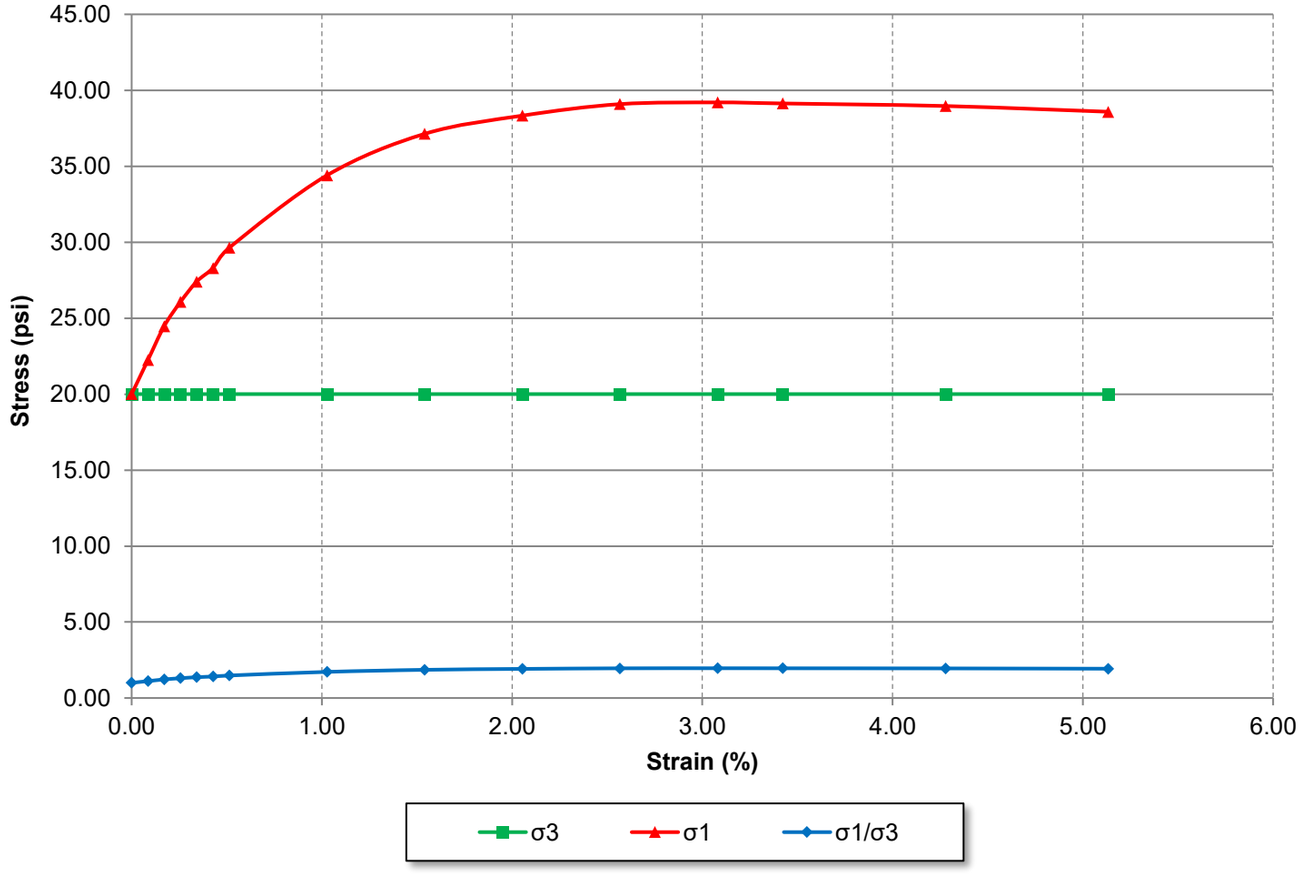
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-124P |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 23.0' to 25.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 32.89 % | EFF. CONS. STRESS | : 20 psi |
| FINAL HEIGHT | : 14.08 cm | SPECIFIC GRAVITY | : 2.65 |
| FINAL DIAMETER | : 7.3 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-124P |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 23.0' to 25.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |

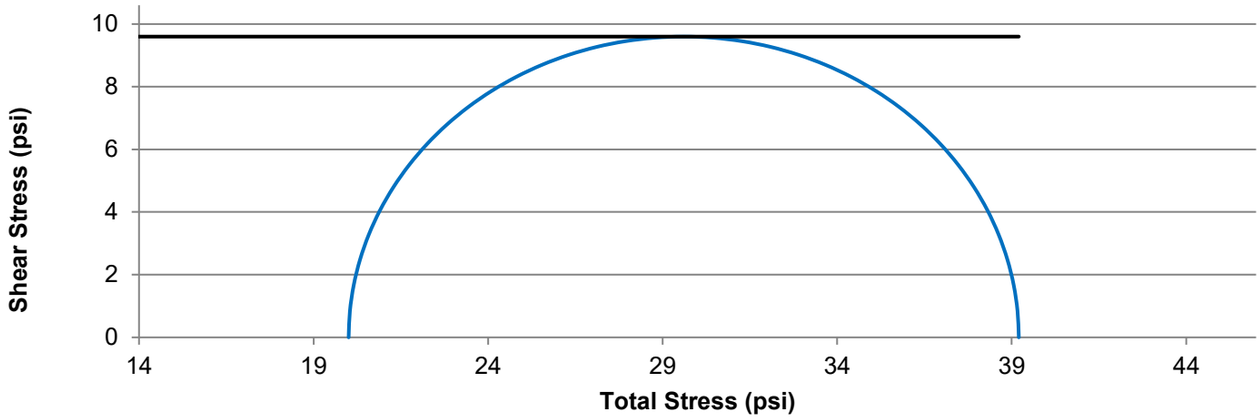
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 20 psi | 39.2 psi |

| | | |
|---|---|---|
| Compressive Strength = | 2765 | psf |
| Cohesion = | 1382 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: W. Shuecraft

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-125 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 33.0' to 35.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |
| SOIL TYPE | : Dark Gray Lean Clay | | |
| WET DENSITY | : 125.44 pcf | DELTA HEIGHT | : 0.35 cm |
| DRY DENSITY | : 91.4 pcf | DELTA VOLUME | : NA |
| MOISTURE | : 37.24 % | CHAMBER PRES. | : 29 psi |
| | | INITIAL HEIGHT | : 14.78 cm |
| | | INITIAL DIAMETER | : 7.11 cm |
| | | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 29.00 | 29.00 | 1.00 |
| 2 | 0.09 | 29 | 31.44 | 1.08 |
| 3 | 0.18 | 29 | 32.32 | 1.11 |
| 4 | 0.26 | 29 | 32.76 | 1.13 |
| 5 | 0.35 | 29 | 33.39 | 1.15 |
| 6 | 0.44 | 29 | 34.07 | 1.17 |
| 7 | 0.53 | 29 | 34.51 | 1.19 |
| 8 | 1.06 | 29 | 37.55 | 1.29 |
| 9 | 1.58 | 29 | 40.54 | 1.4 |
| 10 | 2.11 | 29 | 42.59 | 1.47 |
| 11 | 2.64 | 29 | 43.95 | 1.52 |
| 12 | 3.17 | 29 | 45.16 | 1.56 |
| 13 | 3.52 | 29 | 45.51 | 1.57 |
| 14 | 4.40 | 29 | 46.81 | 1.61 |
| 15 | 5.28 | 29 | 47.25 | 1.63 |
| 16 | 6.16 | 29 | 48.3 | 1.67 |
| 17 | 7.04 | 29 | 49.32 | 1.7 |
| 18 | 7.92 | 29 | 50.26 | 1.73 |
| 19 | 8.80 | 29 | 52.19 | 1.8 |
| 20 | 9.68 | 29 | 54.2 | 1.87 |
| 21 | 10.56 | 29 | 56.37 | 1.94 |
| 22 | 11.44 | 29 | 58.07 | 2 |
| 23 | 12.32 | 29 | 59.65 | 2.06 |
| 24 | 13.20 | 29 | 61.27 | 2.11 |
| 25 | 14.08 | 29 | 62.52 | 2.16 |
| 26 | 14.96 | 29 | 63.66 | 2.2 |
| 27 | 15.84 | 29 | 62.27 | 2.15 |

Unconsolidated Undrained

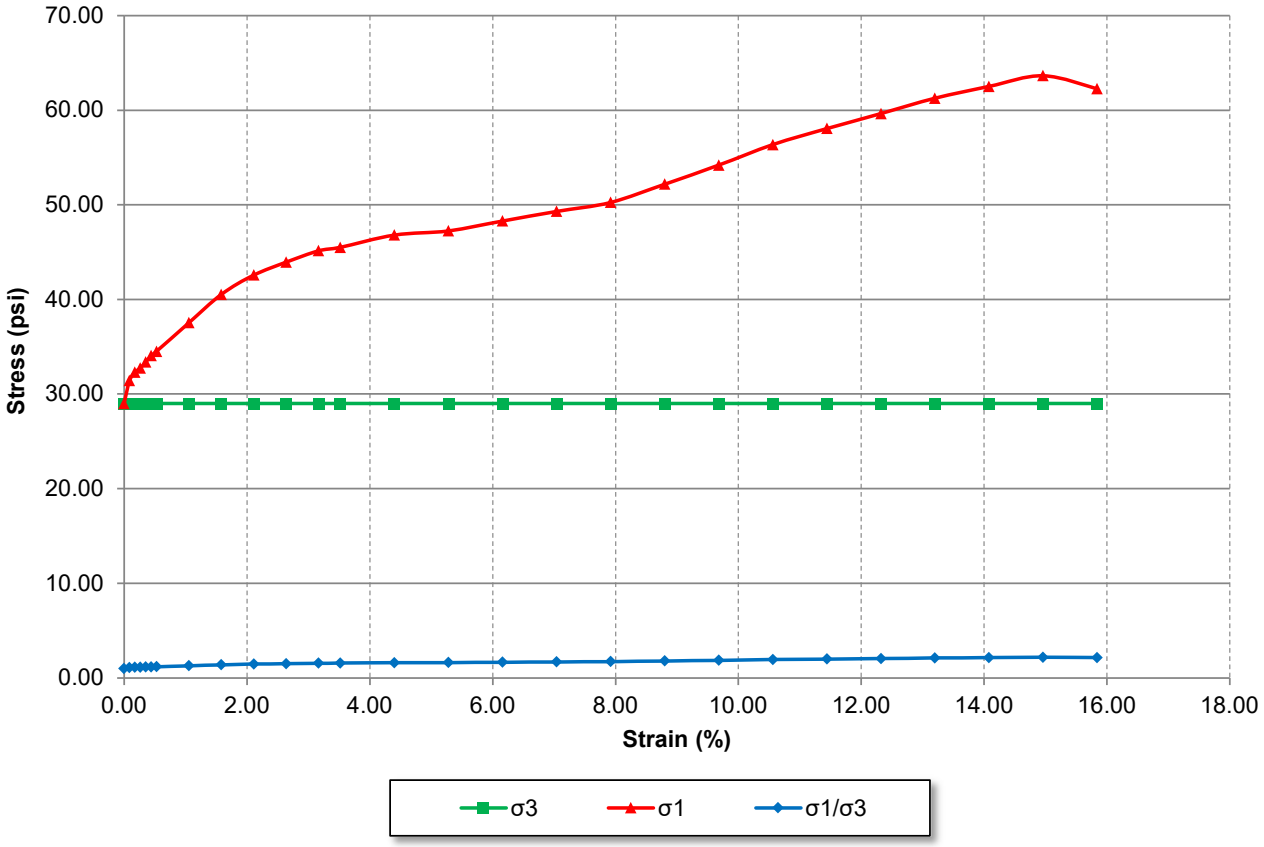
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-125 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 33.0' to 35.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 8/18/2025 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 8/19/2025 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 37.24 % | EFF. CONS. STRESS | : 29 psi |
| FINAL HEIGHT | : 12.14 cm | SPECIFIC GRAVITY | : 2.67 |
| FINAL DIAMETER | : 7.74 cm | COMMENTS | : AASHTO T-296 |

RESULTS:




hdrinc.com

4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-125 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 33.0' to 35.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |

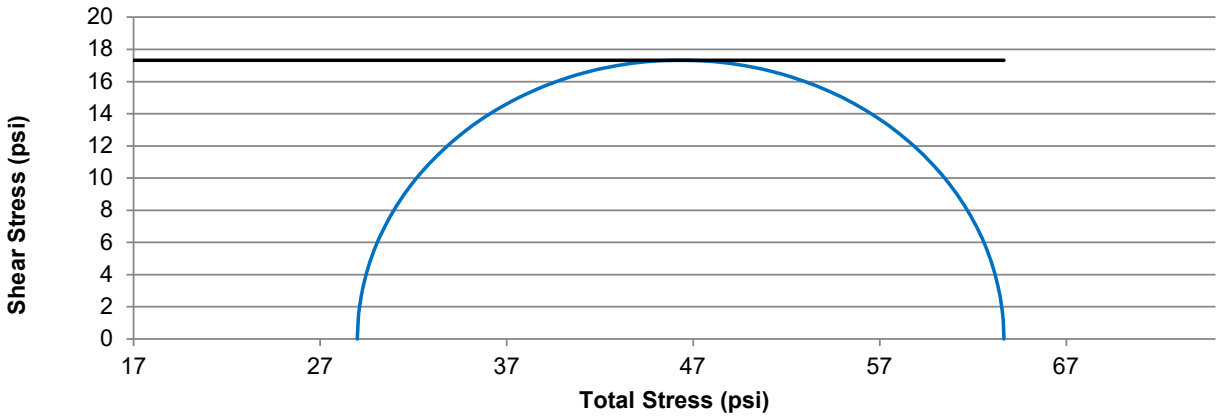
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 29 psi | 63.66 psi |

| | | |
|---|---|---|
| Compressive Strength = | 4991 | psf |
| Cohesion = | 2495 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: _____

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-126A |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 23.0' to 25.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |
| SOIL TYPE | : Dark Gray Clayey Sand | | |

| | | | | | |
|---|---|---|---|---|---|
| WET DENSITY | : 123.96 pcf | DELTA HEIGHT | : 0.33 cm | INITIAL HEIGHT | : 14.76 cm |
| DRY DENSITY | : 96 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.11 cm |
| MOISTURE | : 29.13 % | CHAMBER PRES. | : 20 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 20.00 | 20.00 | 1.00 |
| 2 | 0.09 | 20 | 20.89 | 1.04 |
| 3 | 0.18 | 20 | 21.11 | 1.06 |
| 4 | 0.26 | 20 | 21.55 | 1.08 |
| 5 | 0.35 | 20 | 21.77 | 1.09 |
| 6 | 0.44 | 20 | 21.99 | 1.1 |
| 7 | 0.53 | 20 | 22.2 | 1.11 |
| 8 | 1.06 | 20 | 22.42 | 1.12 |
| 9 | 1.58 | 20 | 22.63 | 1.13 |
| 10 | 2.11 | 20 | 22.83 | 1.14 |
| 11 | 2.64 | 20 | 23.25 | 1.16 |
| 12 | 3.17 | 20 | 23.66 | 1.18 |
| 13 | 3.52 | 20 | 23.64 | 1.18 |
| 14 | 4.40 | 20 | 24.03 | 1.2 |
| 15 | 5.28 | 20 | 24.18 | 1.21 |
| 16 | 6.16 | 20 | 24.38 | 1.22 |
| 17 | 7.04 | 20 | 24.54 | 1.23 |
| 18 | 7.92 | 20 | 24.7 | 1.23 |
| 19 | 8.81 | 20 | 25.06 | 1.25 |
| 20 | 9.69 | 20 | 25.22 | 1.26 |
| 21 | 10.57 | 20 | 25.16 | 1.26 |
| 22 | 11.45 | 20 | 25.31 | 1.27 |
| 23 | 12.33 | 20 | 25.45 | 1.27 |
| 24 | 13.21 | 20 | 25.59 | 1.28 |
| 25 | 14.09 | 20 | 25.53 | 1.28 |
| 26 | 14.97 | 20 | 25.48 | 1.27 |

Unconsolidated Undrained

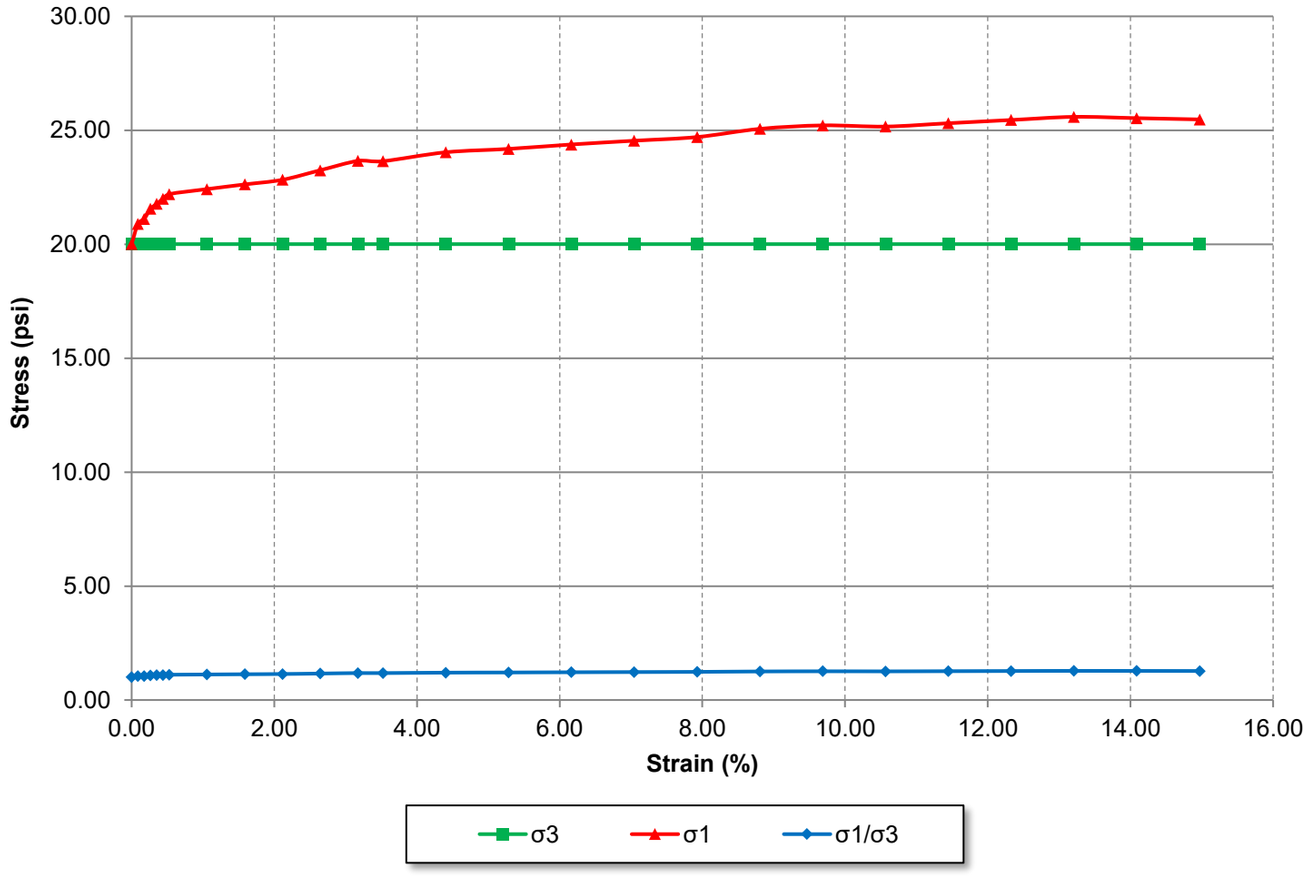
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-126A |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 23.0' to 25.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 8/18/2025 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 8/19/2025 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 29.13 % | EFF. CONS. STRESS | : 20 psi |
| FINAL HEIGHT | : 12.26 cm | SPECIFIC GRAVITY | : 2.65 |
| FINAL DIAMETER | : 7.7 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-126A |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 23.0' to 25.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |

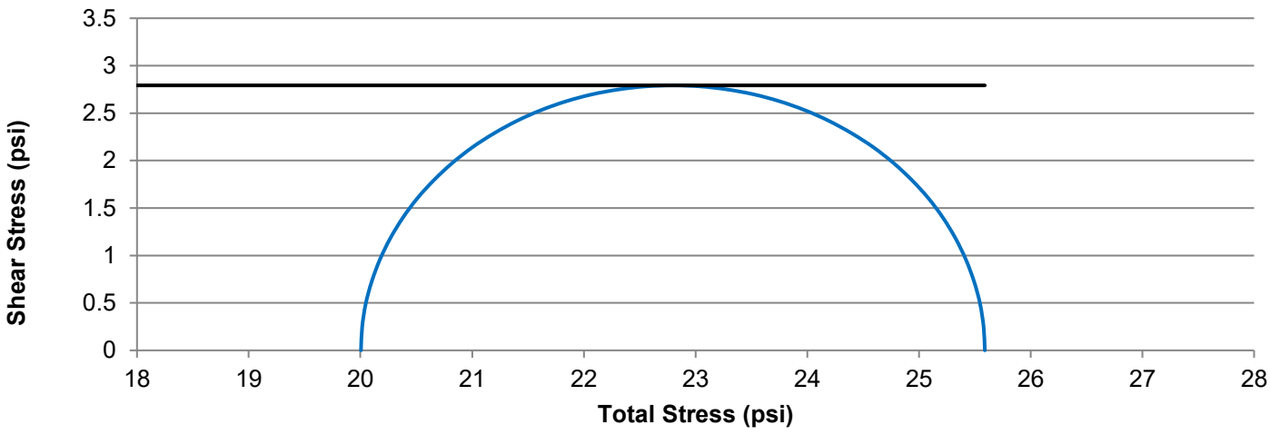
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 20 psi | 25.59 psi |

| | | |
|---|---|---|
| Compressive Strength = | 804 | psf |
| Cohesion = | 402 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: _____

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-126A |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 68.0' to 70.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |

| | | | | | |
|---|---|---|---|---|---|
| SOIL TYPE | : Silt | | | | |
| WET DENSITY | : 120.27 pcf | DELTA HEIGHT | : 0.45 cm | INITIAL HEIGHT | : 14.96 cm |
| DRY DENSITY | : 90.25 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.11 cm |
| MOISTURE | : 33.26 % | CHAMBER PRES. | : 59 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 59.00 | 59.00 | 1.00 |
| 2 | 0.09 | 59 | 60.76 | 1.03 |
| 3 | 0.18 | 59 | 61.41 | 1.04 |
| 4 | 0.26 | 59 | 62.07 | 1.05 |
| 5 | 0.35 | 59 | 62.51 | 1.06 |
| 6 | 0.44 | 59 | 62.72 | 1.06 |
| 7 | 0.53 | 59 | 63.35 | 1.07 |
| 8 | 1.05 | 59 | 65.31 | 1.11 |
| 9 | 1.58 | 59 | 67.01 | 1.14 |
| 10 | 2.10 | 59 | 68.48 | 1.16 |
| 11 | 2.63 | 59 | 69.72 | 1.18 |
| 12 | 3.15 | 59 | 70.9 | 1.2 |
| 13 | 3.50 | 59 | 71.89 | 1.22 |
| 14 | 4.38 | 59 | 73.59 | 1.25 |
| 15 | 5.25 | 59 | 74.7 | 1.27 |
| 16 | 6.13 | 59 | 75.56 | 1.28 |
| 17 | 7.00 | 59 | 76.6 | 1.3 |
| 18 | 7.88 | 59 | 77.42 | 1.31 |
| 19 | 8.75 | 59 | 77.84 | 1.32 |
| 20 | 9.63 | 59 | 78.24 | 1.33 |
| 21 | 10.50 | 59 | 78.68 | 1.33 |
| 22 | 11.38 | 59 | 78.97 | 1.34 |
| 23 | 12.26 | 59 | 79.37 | 1.35 |
| 24 | 13.13 | 59 | 79.76 | 1.35 |
| 25 | 14.01 | 59 | 80.02 | 1.36 |
| 26 | 14.88 | 59 | 80.15 | 1.36 |
| 27 | 15.76 | 59 | 80.39 | 1.36 |
| 28 | 16.63 | 59 | 80.4 | 1.36 |
| 29 | 17.51 | 59 | 80.51 | 1.36 |
| 30 | 18.38 | 59 | 80.51 | 1.36 |
| 31 | 19.26 | 59 | 80.39 | 1.36 |
| 32 | 20.13 | 59 | 80.26 | 1.36 |

Unconsolidated Undrained

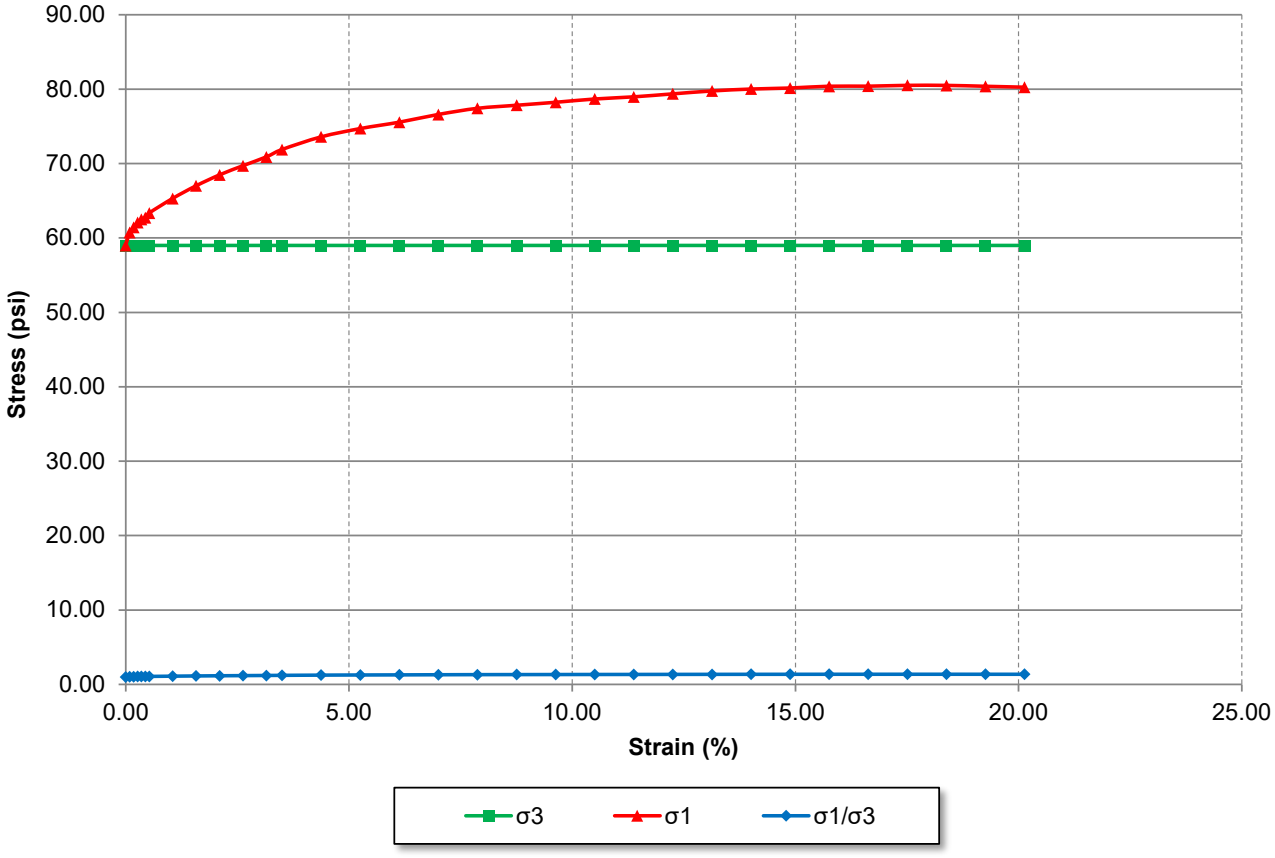
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-126A |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 68.0' to 70.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 8/18/2025 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 8/19/2025 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 33.26 % | EFF. CONS. STRESS | : 59 psi |
| FINAL HEIGHT | : 11.59 cm | SPECIFIC GRAVITY | : 2.55 |
| FINAL DIAMETER | : 7.93 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-126A |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 68.0' to 70.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 8/18/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 8/19/2025 |

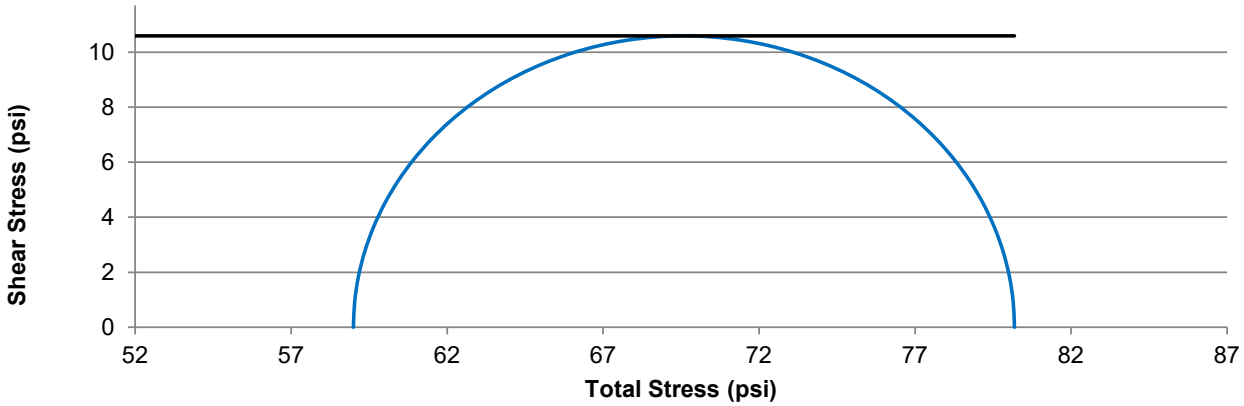
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 59 psi | 80.18 psi |

| | | |
|---|---|---|
| Compressive Strength = | 3051 | psf |
| Cohesion = | 1526 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## At Maximum Deviator Stress 15%

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: Kevin E. Walker

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-2046 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 19.5' to 20.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 10/10/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 12/23/2025 |
| SOIL TYPE | : Light Brown, Silt | | |

| | | | | | |
|---|---|---|---|---|---|
| WET DENSITY | : 115.91 pcf | DELTA HEIGHT | : 0.45 cm | INITIAL HEIGHT | : 14.57 cm |
| DRY DENSITY | : 86.97 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.15 cm |
| MOISTURE | : 33.28 % | CHAMBER PRES. | : 16.01 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 16.01 | 16.01 | 1.00 |
| 2 | 0.09 | 16.01 | 16.45 | 1.03 |
| 3 | 0.18 | 16.01 | 16.66 | 1.04 |
| 4 | 0.27 | 16.01 | 16.88 | 1.05 |
| 5 | 0.36 | 16.01 | 16.88 | 1.05 |
| 6 | 0.45 | 16.01 | 16.88 | 1.05 |
| 7 | 0.54 | 16.01 | 17.09 | 1.07 |
| 8 | 1.08 | 16.01 | 17.52 | 1.09 |
| 9 | 1.62 | 16.01 | 18.37 | 1.15 |
| 10 | 2.16 | 16.01 | 18.78 | 1.17 |
| 11 | 2.70 | 16.01 | 19.19 | 1.2 |
| 12 | 3.24 | 16.01 | 19.81 | 1.24 |
| 13 | 3.60 | 16.01 | 20.19 | 1.26 |
| 14 | 4.50 | 16.01 | 20.8 | 1.3 |
| 15 | 5.40 | 16.01 | 21.16 | 1.32 |
| 16 | 6.30 | 16.01 | 21.73 | 1.36 |
| 17 | 7.20 | 16.01 | 22.04 | 1.38 |
| 18 | 8.10 | 16.01 | 22.42 | 1.4 |
| 19 | 9.00 | 16.01 | 22.75 | 1.42 |
| 20 | 9.90 | 16.01 | 23.08 | 1.44 |
| 21 | 10.80 | 16.01 | 23.2 | 1.45 |
| 22 | 11.70 | 16.01 | 23.32 | 1.46 |
| 23 | 12.60 | 16.01 | 23.25 | 1.45 |
| 24 | 13.49 | 16.01 | 23.36 | 1.46 |
| 25 | 14.39 | 16.01 | 23.43 | 1.46 |
| 26 | 15.29 | 16.01 | 23.58 | 1.47 |
| 27 | 16.19 | 16.01 | 23.68 | 1.48 |
| 28 | 17.09 | 16.01 | 23.78 | 1.49 |
| 29 | 17.99 | 16.01 | 23.87 | 1.49 |
| 30 | 18.89 | 16.01 | 23.96 | 1.5 |
| 31 | 19.79 | 16.01 | 24.05 | 1.5 |
| 32 | 20.69 | 16.01 | 23.96 | 1.5 |

Unconsolidated Undrained

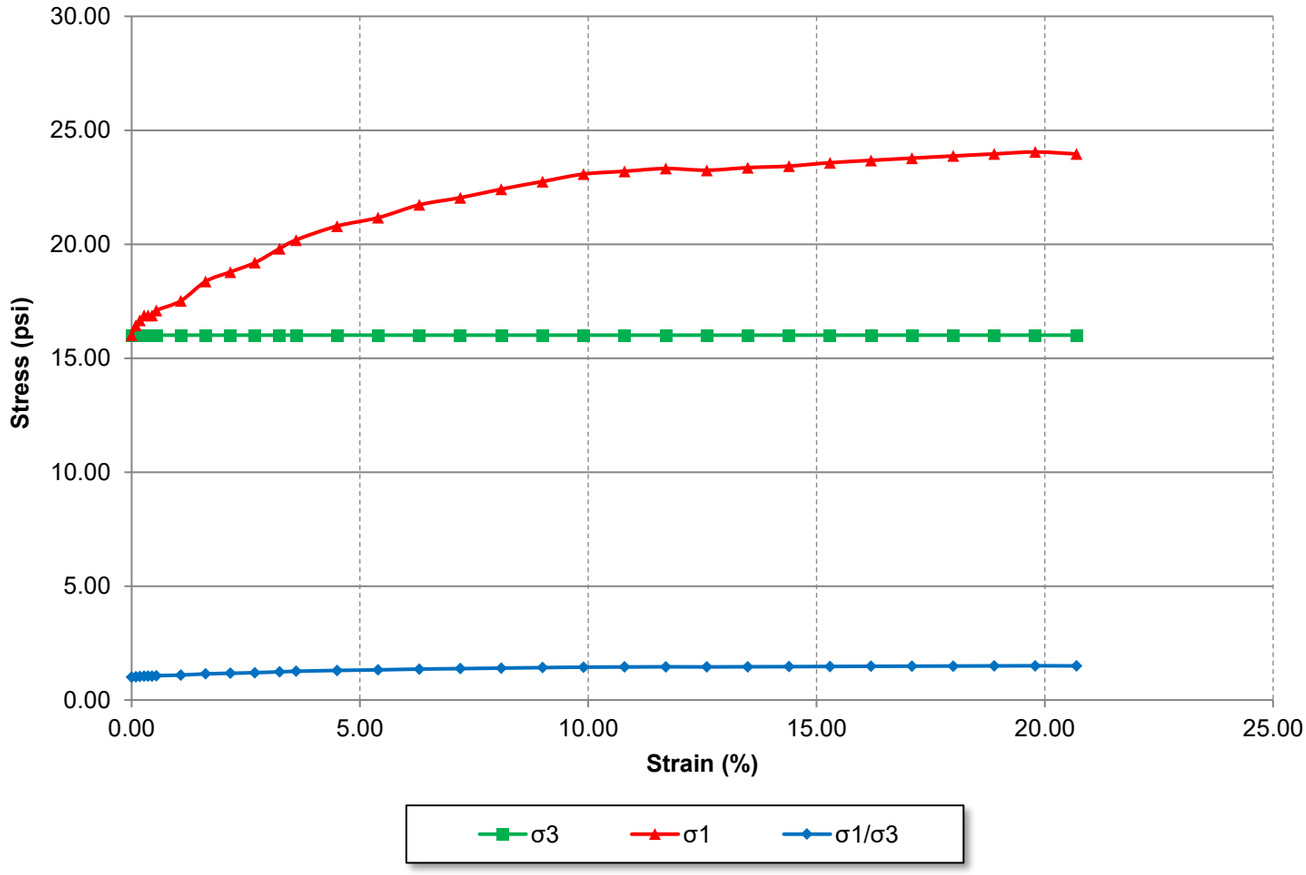
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-2046 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 19.5' to 20.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 10/10/2025 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 12/23/2025 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 33.28 % | EFF. CONS. STRESS | : 16.01 psi |
| FINAL HEIGHT | : 11.2 cm | SPECIFIC GRAVITY | : 2.7 |
| FINAL DIAMETER | : 7.99 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-2046 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 19.5' to 20.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 10/10/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 12/23/2025 |

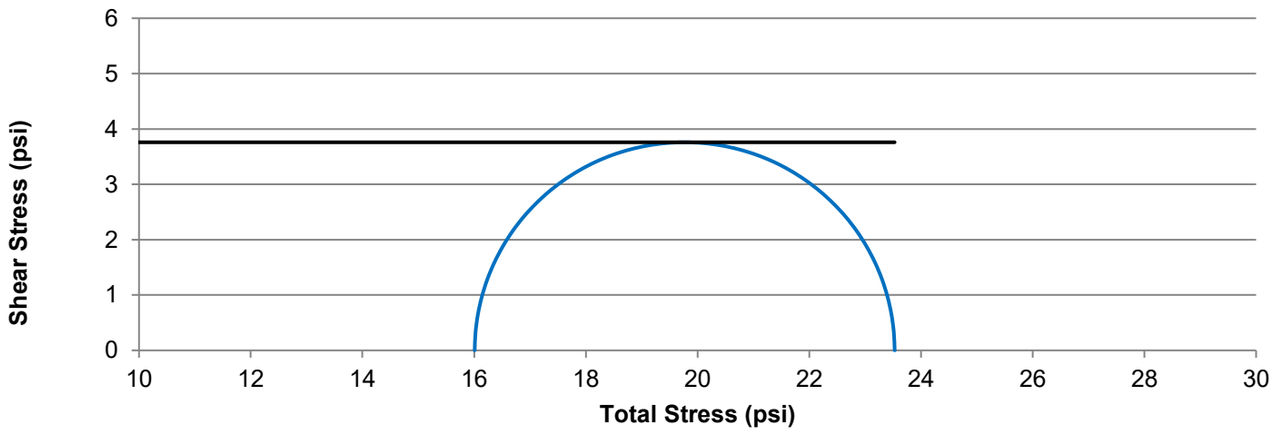
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 16.01 psi | 23.53 psi |

| | | |
|---|---|---|
| Compressive Strength = | 1083 | psf |
| Cohesion = | 541 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## At Maximum Deviator Stress 15%

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: W. Stwoogh

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-2046 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 49.5' to 50.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 12/4/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 12/23/2025 |
| SOIL TYPE | : Light Brown, Poorly Graded Sand | | |

| | | | | | |
|---|---|---|---|---|---|
| WET DENSITY | : 136.79 pcf | DELTA HEIGHT | : 0.16 cm | INITIAL HEIGHT | : 14.56 cm |
| DRY DENSITY | : 106.17 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 6.39 cm |
| MOISTURE | : 28.85 % | CHAMBER PRES. | : 41.91 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 41.91 | 41.91 | 1.00 |
| 2 | 0.09 | 41.91 | 42.75 | 1.02 |
| 3 | 0.18 | 41.91 | 43.58 | 1.04 |
| 4 | 0.26 | 41.91 | 44.41 | 1.06 |
| 5 | 0.35 | 41.91 | 44.96 | 1.07 |
| 6 | 0.44 | 41.91 | 45.79 | 1.09 |
| 7 | 0.53 | 41.91 | 46.62 | 1.11 |
| 8 | 1.06 | 41.91 | 51.83 | 1.24 |
| 9 | 1.59 | 41.91 | 56.15 | 1.34 |
| 10 | 2.12 | 41.91 | 60.32 | 1.44 |
| 11 | 2.65 | 41.91 | 63.92 | 1.53 |
| 12 | 3.18 | 41.91 | 67.73 | 1.62 |
| 13 | 3.53 | 41.91 | 70.25 | 1.68 |
| 14 | 4.41 | 41.91 | 73.46 | 1.75 |
| 15 | 5.29 | 41.91 | 66.91 | 1.6 |
| 16 | 6.17 | 41.91 | 59.56 | 1.42 |
| 17 | 7.06 | 41.91 | 55.61 | 1.33 |

Unconsolidated Undrained

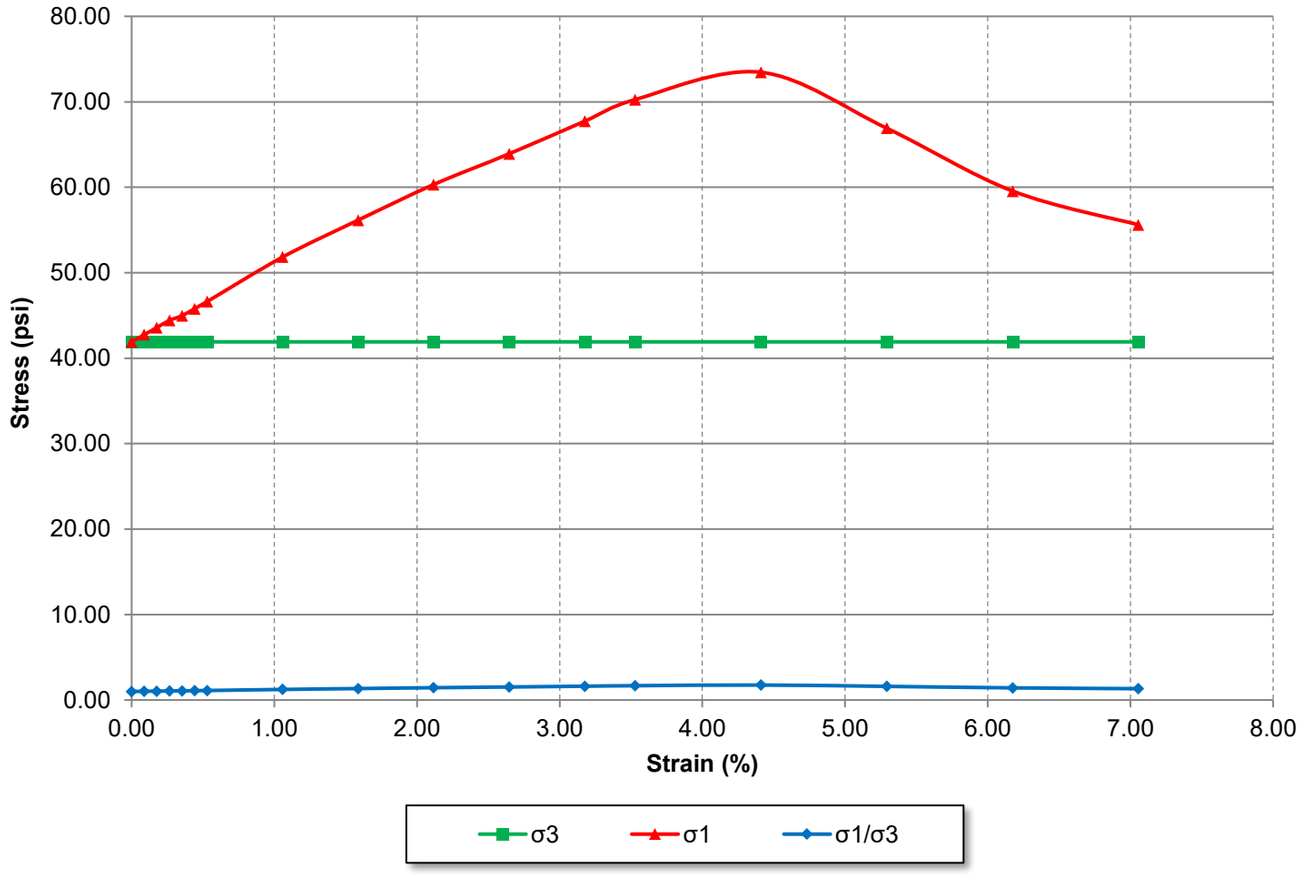
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-2046 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 49.5' to 50.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 12/4/2025 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 12/23/2025 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 28.85 % | EFF. CONS. STRESS | : 41.91 psi |
| FINAL HEIGHT | : 13.38 cm | SPECIFIC GRAVITY | : 2.65 |
| FINAL DIAMETER | : 6.62 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-2046 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 49.5' to 50.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 12/4/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 12/23/2025 |

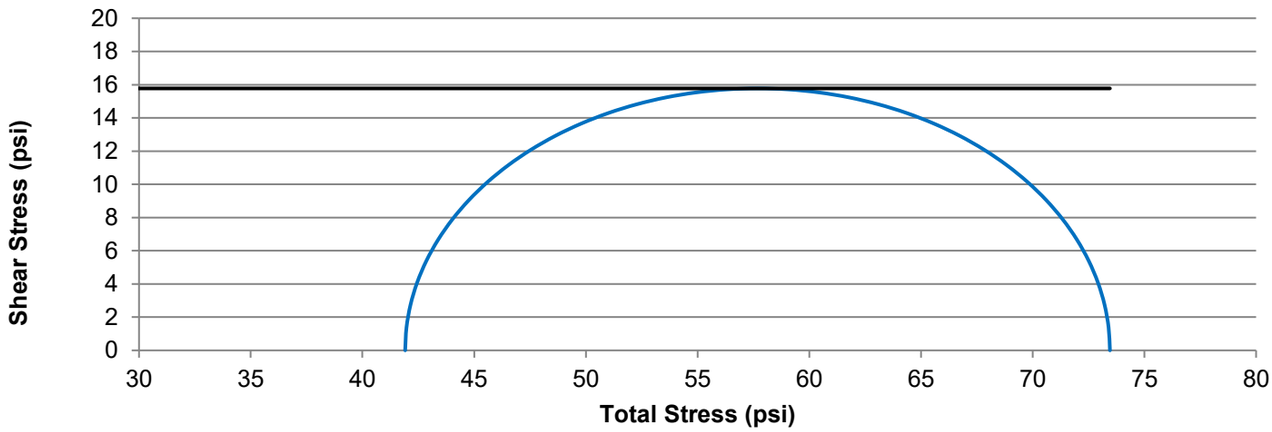
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 41.91 psi | 73.46 psi |

| | | |
|---|---|---|
| Compressive Strength = | 4543 | psf |
| Cohesion = | 2271 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: W. Shuwarp

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-2046 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 69.5' to 70.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 12/4/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 12/23/2025 |
| SOIL TYPE | : Light Brown, Well Graded Sand | | |

| | | | | | |
|---|---|---|---|---|---|
| WET DENSITY | : 125.35 pcf | DELTA HEIGHT | : 0.45 cm | INITIAL HEIGHT | : 14.54 cm |
| DRY DENSITY | : 107.93 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 6.86 cm |
| MOISTURE | : 16.14 % | CHAMBER PRES. | : 58.85 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 58.85 | 58.85 | 1.00 |
| 2 | 0.09 | 58.85 | 61.91 | 1.05 |
| 3 | 0.18 | 58.85 | 62.38 | 1.06 |
| 4 | 0.27 | 58.85 | 63.79 | 1.08 |
| 5 | 0.36 | 58.85 | 65.2 | 1.11 |
| 6 | 0.45 | 58.85 | 66.14 | 1.12 |
| 7 | 0.54 | 58.85 | 67.54 | 1.15 |
| 8 | 1.08 | 58.85 | 75.04 | 1.28 |
| 9 | 1.62 | 58.85 | 90.49 | 1.54 |
| 10 | 2.16 | 58.85 | 100.5 | 1.71 |
| 11 | 2.70 | 58.85 | 119.96 | 2.04 |
| 12 | 3.24 | 58.85 | 131.06 | 2.23 |
| 13 | 3.61 | 58.85 | 130.79 | 2.22 |
| 14 | 4.51 | 58.85 | 130.12 | 2.21 |
| 15 | 5.41 | 58.85 | 129.44 | 2.2 |
| 16 | 6.31 | 58.85 | 128.77 | 2.19 |
| 17 | 7.21 | 58.85 | 128.1 | 2.18 |
| 18 | 8.11 | 58.85 | 127.43 | 2.17 |
| 19 | 9.01 | 58.85 | 126.75 | 2.15 |
| 20 | 9.91 | 58.85 | 126.08 | 2.14 |
| 21 | 10.82 | 58.85 | 125.41 | 2.13 |
| 22 | 11.72 | 58.85 | 124.74 | 2.12 |
| 23 | 12.62 | 58.85 | 124.06 | 2.11 |
| 24 | 13.52 | 58.85 | 123.39 | 2.1 |
| 25 | 14.42 | 58.85 | 122.72 | 2.09 |
| 26 | 15.32 | 58.85 | 122.05 | 2.07 |
| 27 | 16.22 | 58.85 | 121.37 | 2.06 |
| 28 | 17.12 | 58.85 | 120.7 | 2.05 |
| 29 | 18.03 | 58.85 | 120.03 | 2.04 |
| 30 | 18.93 | 58.85 | 119.35 | 2.03 |
| 31 | 19.83 | 58.85 | 118.68 | 2.02 |
| 32 | 20.73 | 58.85 | 118.01 | 2.01 |

Unconsolidated Undrained

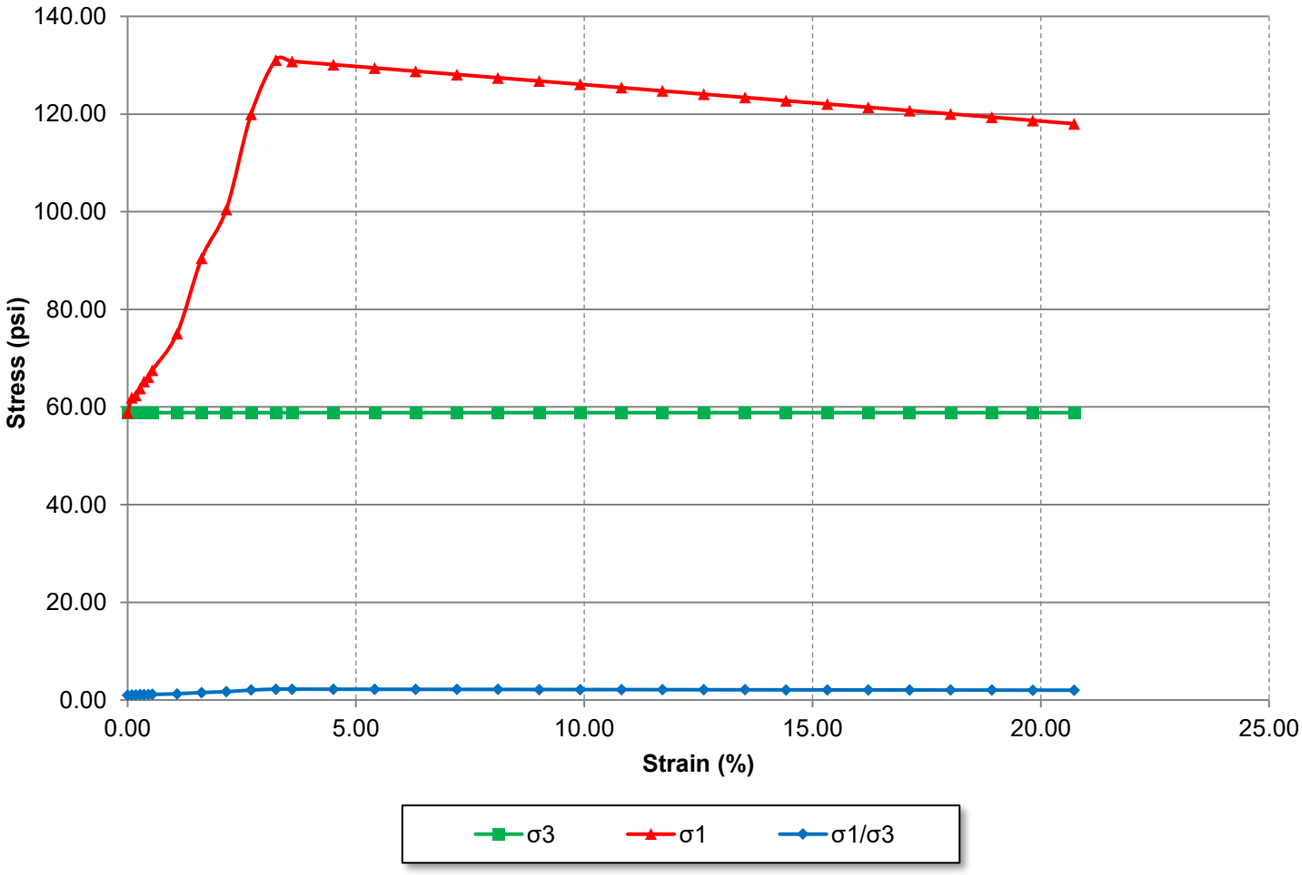
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-2046 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 69.5' to 70.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 12/4/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 12/23/2025 |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 16.14 % | EFF. CONS. STRESS | : 58.85 psi |
| FINAL HEIGHT | : 11.17 cm | SPECIFIC GRAVITY | : 2.65 |
| FINAL DIAMETER | : 7.68 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cario Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-2046 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 69.5' to 70.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 12/4/2025 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 12/23/2025 |

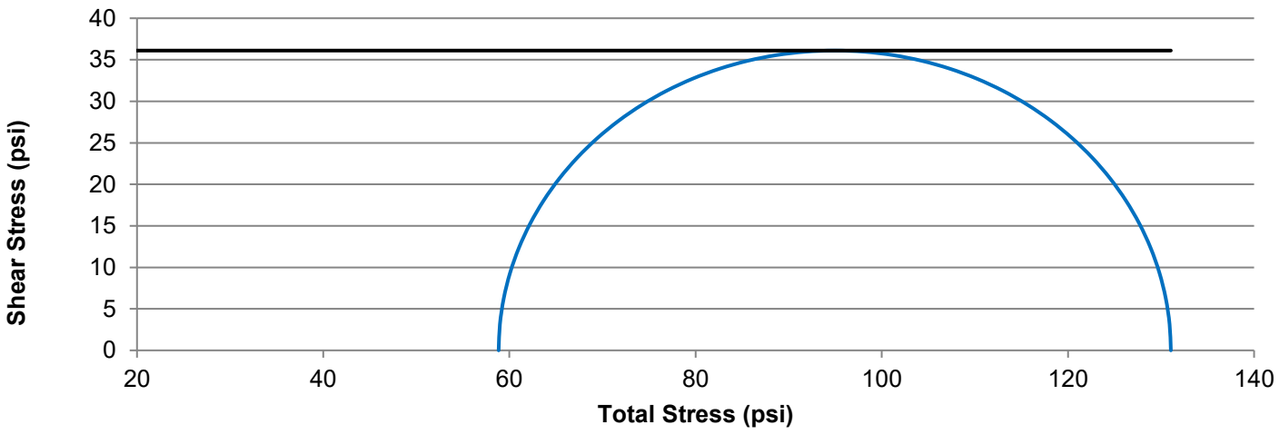
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 58.85 psi | 131.06 psi |

| | | |
|---|---|---|
| Compressive Strength = | 10398 | psf |
| Cohesion = | 5199 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: W. Shuwarp

hdrinc.com

4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-6 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 9.5'-10.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 6/30/2021 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 7/6/2021 |

| | | | | | |
|---|---|---|---|---|---|
| SOIL TYPE | : Lean Clay | | | | |
| WET DENSITY | : 120.47 pcf | DELTA HEIGHT | : 0.45 cm | INITIAL HEIGHT | : 14.43 cm |
| DRY DENSITY | : 94.62 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.31 cm |
| MOISTURE | : 27.32 % | CHAMBER PRES. | : 8.04 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 8.04 | 8.04 | 1.00 |
| 2 | 0.09 | 8.04 | 8.46 | 1.05 |
| 3 | 0.18 | 8.04 | 9.5 | 1.18 |
| 4 | 0.27 | 8.04 | 10.95 | 1.36 |
| 5 | 0.36 | 8.04 | 11.78 | 1.46 |
| 6 | 0.45 | 8.04 | 12.4 | 1.54 |
| 7 | 0.55 | 8.04 | 13.02 | 1.62 |
| 8 | 1.09 | 8.04 | 16.08 | 2 |
| 9 | 1.64 | 8.04 | 18.29 | 2.28 |
| 10 | 2.18 | 8.04 | 20.08 | 2.5 |
| 11 | 2.73 | 8.04 | 21.64 | 2.69 |
| 12 | 3.27 | 8.04 | 22.98 | 2.86 |
| 13 | 3.63 | 8.04 | 23.72 | 2.95 |
| 14 | 4.54 | 8.04 | 25.17 | 3.13 |
| 15 | 5.45 | 8.04 | 26.2 | 3.26 |
| 16 | 6.36 | 8.04 | 26.8 | 3.33 |
| 17 | 7.27 | 8.04 | 27.4 | 3.41 |
| 18 | 8.18 | 8.04 | 27.59 | 3.43 |
| 19 | 9.09 | 8.04 | 27.96 | 3.48 |
| 20 | 10.00 | 8.04 | 28.13 | 3.5 |
| 21 | 10.90 | 8.04 | 28.11 | 3.5 |
| 22 | 11.81 | 8.04 | 28.09 | 3.49 |
| 23 | 12.72 | 8.04 | 28.07 | 3.49 |
| 24 | 13.63 | 8.04 | 27.86 | 3.46 |
| 25 | 14.54 | 8.04 | 27.82 | 3.46 |
| 26 | 15.45 | 8.04 | 27.96 | 3.48 |
| 27 | 16.36 | 8.04 | 28.09 | 3.49 |
| 28 | 17.26 | 8.04 | 28.21 | 3.51 |
| 29 | 18.17 | 8.04 | 28.16 | 3.5 |
| 30 | 19.08 | 8.04 | 28.1 | 3.49 |
| 31 | 19.99 | 8.04 | 28.2 | 3.51 |
| 32 | 20.90 | 8.04 | 28.3 | 3.52 |

Unconsolidated Undrained

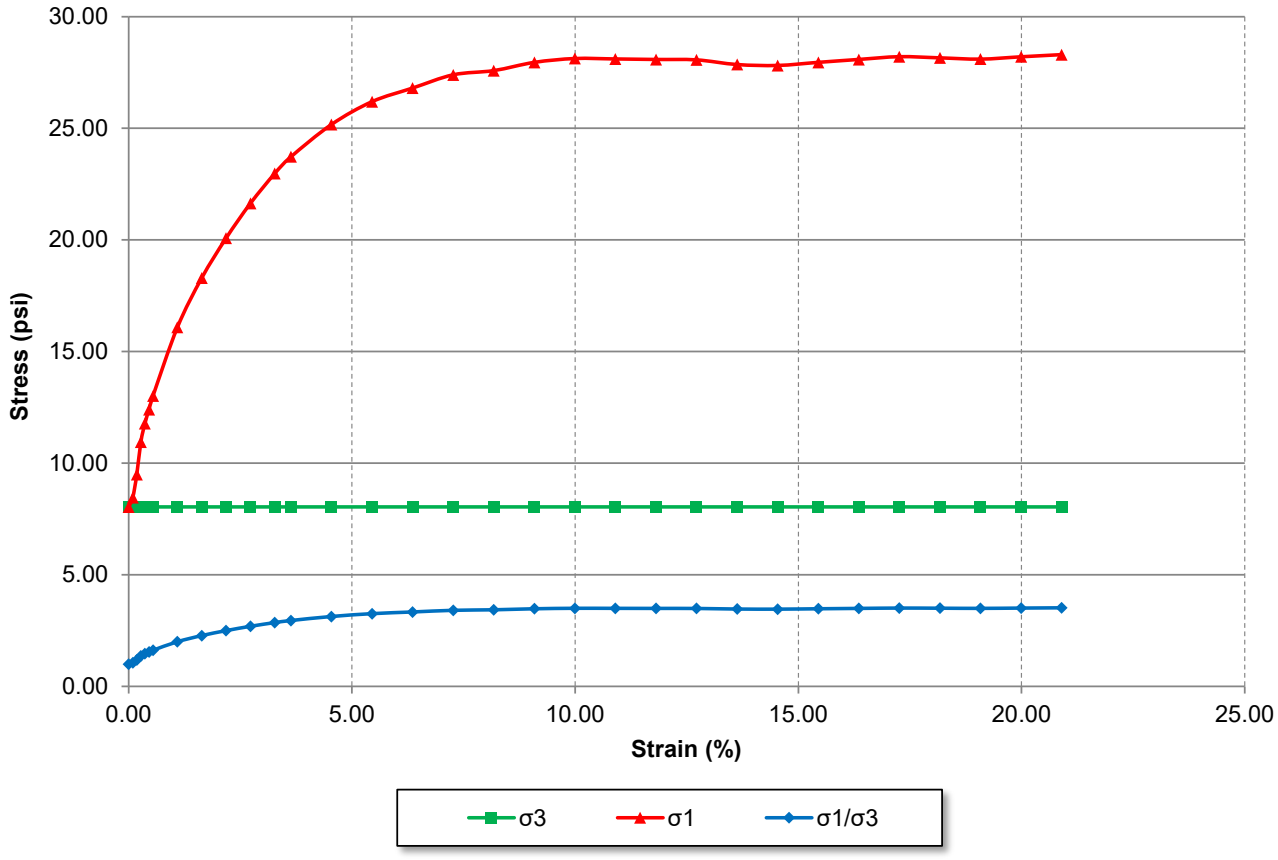
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-6 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 9.5'-10.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 6/30/2021 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 7/6/2021 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 27.32 % | EFF. CONS. STRESS | : 8.04 psi |
| FINAL HEIGHT | : 11.06 cm | SPECIFIC GRAVITY | : 2.69 |
| FINAL DIAMETER | : 8.19 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-6 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 9.5'-10.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 6/30/2021 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 7/6/2021 |

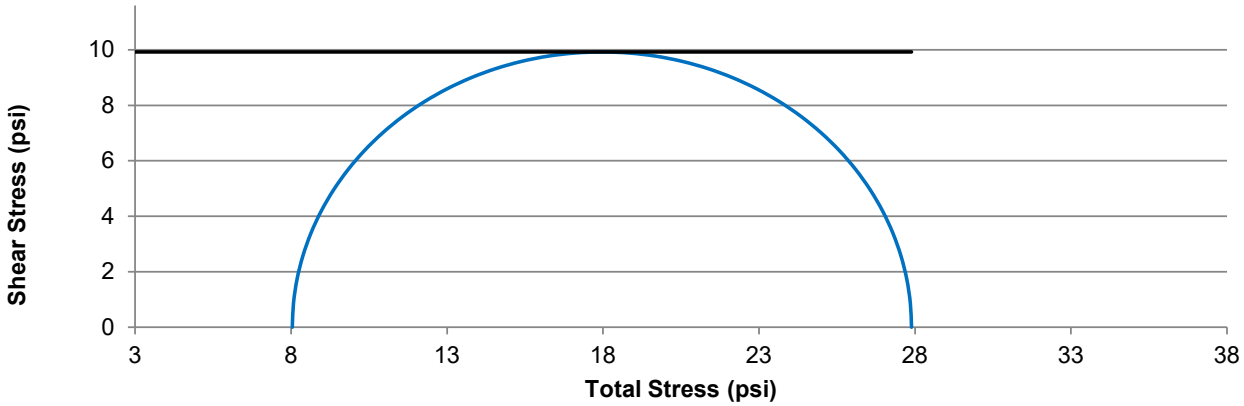
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 8.04 psi | 27.89 psi |

| | | |
|---|---|---|
| Compressive Strength = | 2858 | psf |
| Cohesion = | 1429 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## At Maximum Deviator Stress 15%

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: Kevin E. Walker

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-6 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 14'-14.5' |
| LABORATORY # | : 10174706 | DATE TESTED | : 6/30/2021 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 7/6/2021 |

| | | | | | |
|---|---|---|---|---|---|
| SOIL TYPE | : Lean Clay | | | | |
| WET DENSITY | : 121.08 pcf | DELTA HEIGHT | : 0.35 cm | INITIAL HEIGHT | : 14.92 cm |
| DRY DENSITY | : 91.3 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.18 cm |
| MOISTURE | : 32.61 % | CHAMBER PRES. | : 12.03 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 12.03 | 12.03 | 1.00 |
| 2 | 0.09 | 12.03 | 13.11 | 1.09 |
| 3 | 0.17 | 12.03 | 13.76 | 1.14 |
| 4 | 0.26 | 12.03 | 14.19 | 1.18 |
| 5 | 0.35 | 12.03 | 14.41 | 1.2 |
| 6 | 0.44 | 12.03 | 15.06 | 1.25 |
| 7 | 0.52 | 12.03 | 15.49 | 1.29 |
| 8 | 1.05 | 12.03 | 17.41 | 1.45 |
| 9 | 1.57 | 12.03 | 19.09 | 1.59 |
| 10 | 2.09 | 12.03 | 20.33 | 1.69 |
| 11 | 2.62 | 12.03 | 20.92 | 1.74 |
| 12 | 3.14 | 12.03 | 21.93 | 1.82 |
| 13 | 3.49 | 12.03 | 22.1 | 1.84 |
| 14 | 4.36 | 12.03 | 22.63 | 1.88 |
| 15 | 5.23 | 12.03 | 23.16 | 1.93 |
| 16 | 6.10 | 12.03 | 23.26 | 1.93 |
| 17 | 6.97 | 12.03 | 23.36 | 1.94 |
| 18 | 7.85 | 12.03 | 23.45 | 1.95 |
| 19 | 8.72 | 12.03 | 23.54 | 1.96 |
| 20 | 9.59 | 12.03 | 23.43 | 1.95 |
| 21 | 10.46 | 12.03 | 23.52 | 1.96 |
| 22 | 11.33 | 12.03 | 23.41 | 1.95 |
| 23 | 12.20 | 12.03 | 23.68 | 1.97 |
| 24 | 13.08 | 12.03 | 23.75 | 1.98 |
| 25 | 13.95 | 12.03 | 23.82 | 1.98 |
| 26 | 14.82 | 12.03 | 23.7 | 1.97 |
| 27 | 15.69 | 12.03 | 23.58 | 1.96 |

Unconsolidated Undrained

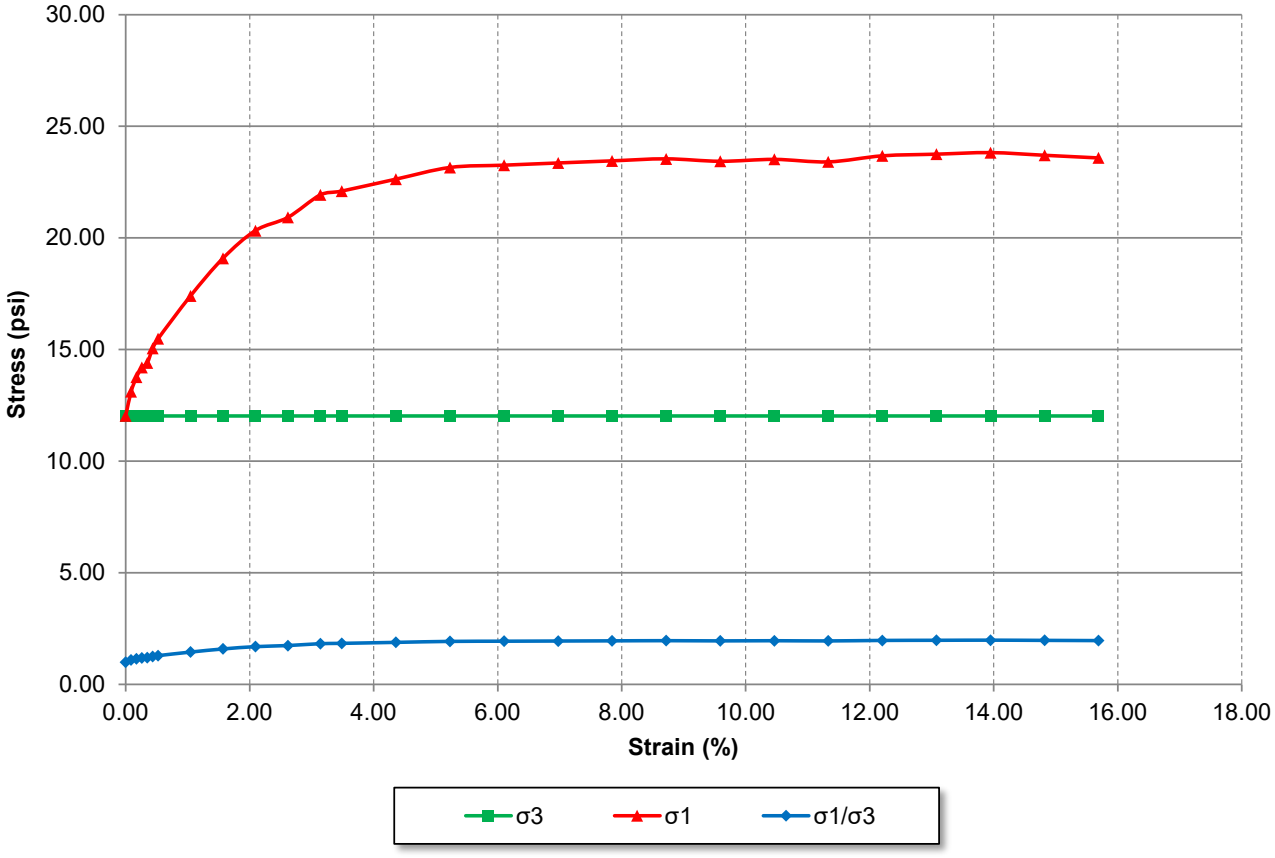
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-6 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 14'-14.5' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 6/30/2021 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 7/6/2021 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 32.61 % | EFF. CONS. STRESS | : 12.03 psi |
| FINAL HEIGHT | : 12.28 cm | SPECIFIC GRAVITY | : 2.67 |
| FINAL DIAMETER | : 7.81 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-6 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 14'-14.5' |
| LABORATORY # | : 10174706 | DATE TESTED | : 6/30/2021 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 7/6/2021 |

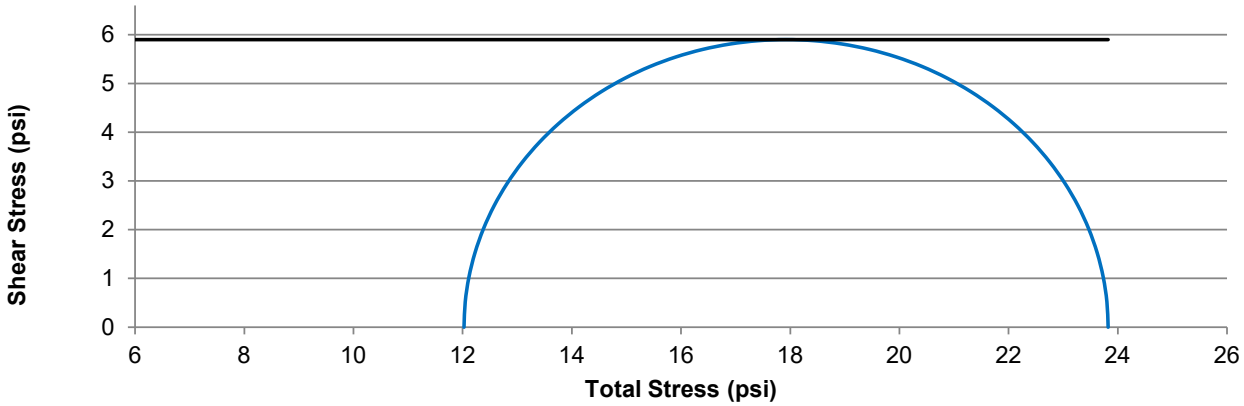
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 12.03 psi | 23.82 psi |

| | | |
|---|---|---|
| Compressive Strength = | 1699 | psf |
| Cohesion = | 849 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

## Maximum Deviator Stress

### Triaxial Mohr's Circles
### Unconsolidated Undrained Triaxial Test




Approved By: Kevin E. Walker

Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | POINT # | : 1 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-6 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 19.5'-20.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 7/2/2021 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 7/6/2021 |

| | | | | | |
|---|---|---|---|---|---|
| SOIL TYPE | : Silt | | | | |
| WET DENSITY | : 109.28 pcf | DELTA HEIGHT | : 0.33 cm | INITIAL HEIGHT | : 13.33 cm |
| DRY DENSITY | : 75.58 pcf | DELTA VOLUME | : NA | INITIAL DIAMETER | : 7.16 cm |
| MOISTURE | : 44.59 % | CHAMBER PRES. | : 16.01 psi | COMMENTS | : AASHTO T-296 |

RESULTS:

| | ε a | σ 3 (psi) | σ 1 (psi) | σ1/σ3 |
|---|---|---|---|---|
| 1 | 0.00 | 16.01 | 16.01 | 1.00 |
| 2 | 0.10 | 16.01 | 17.76 | 1.11 |
| 3 | 0.20 | 16.01 | 18.85 | 1.18 |
| 4 | 0.29 | 16.01 | 19.72 | 1.23 |
| 5 | 0.39 | 16.01 | 20.59 | 1.29 |
| 6 | 0.49 | 16.01 | 21.24 | 1.33 |
| 7 | 0.59 | 16.01 | 21.67 | 1.35 |
| 8 | 1.17 | 16.01 | 24.66 | 1.54 |
| 9 | 1.76 | 16.01 | 26.76 | 1.67 |
| 10 | 2.35 | 16.01 | 28.41 | 1.77 |
| 11 | 2.93 | 16.01 | 30.04 | 1.88 |
| 12 | 3.52 | 16.01 | 31.65 | 1.98 |
| 13 | 3.91 | 16.01 | 32.22 | 2.01 |
| 14 | 4.89 | 16.01 | 33.51 | 2.09 |
| 15 | 5.86 | 16.01 | 34.37 | 2.15 |
| 16 | 6.84 | 16.01 | 34.79 | 2.17 |
| 17 | 7.82 | 16.01 | 35.4 | 2.21 |
| 18 | 8.79 | 16.01 | 35.6 | 2.22 |
| 19 | 9.77 | 16.01 | 35.59 | 2.22 |
| 20 | 10.75 | 16.01 | 35.76 | 2.23 |
| 21 | 11.73 | 16.01 | 35.93 | 2.24 |
| 22 | 12.70 | 16.01 | 36.09 | 2.25 |
| 23 | 13.68 | 16.01 | 35.86 | 2.24 |
| 24 | 14.66 | 16.01 | 35.82 | 2.24 |
| 25 | 15.63 | 16.01 | 35.59 | 2.22 |
| 26 | 16.61 | 16.01 | 35.37 | 2.21 |

Unconsolidated Undrained

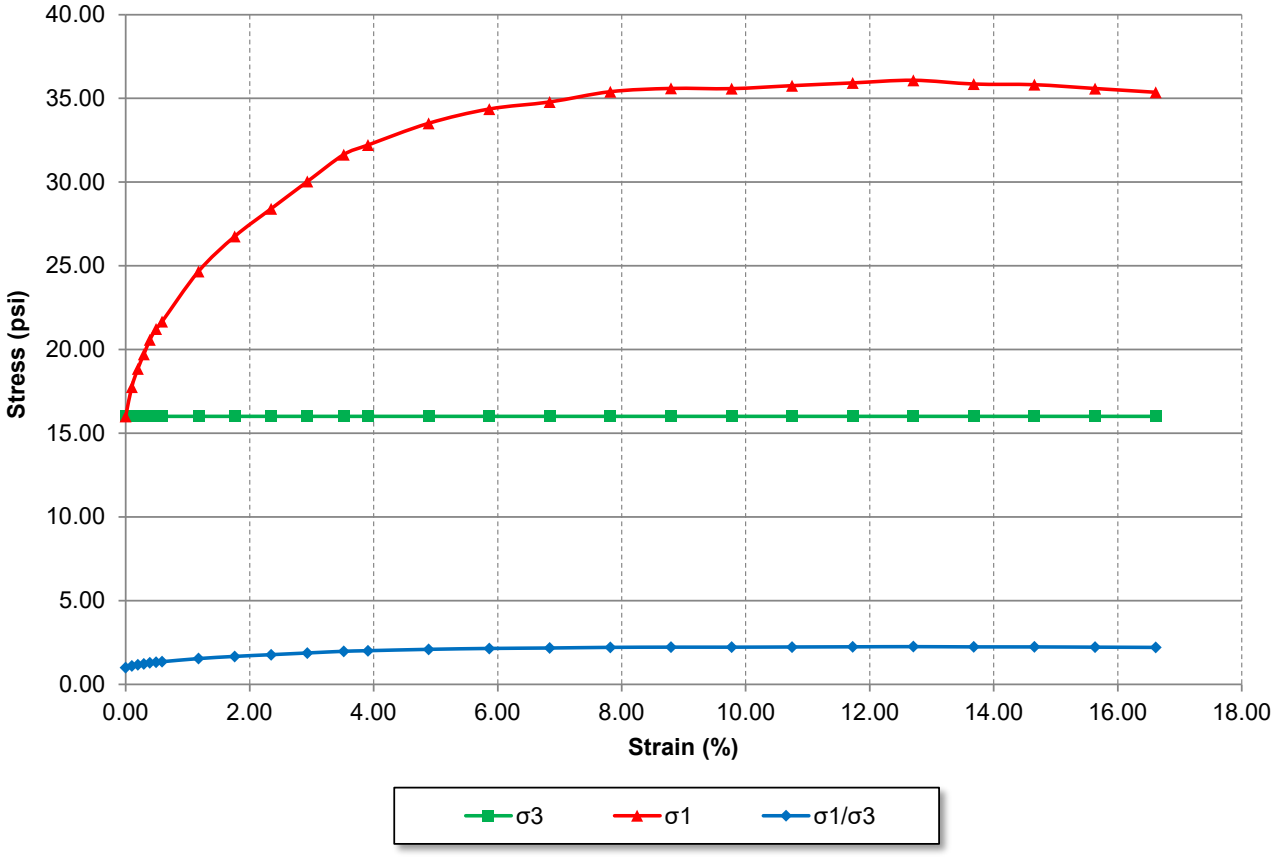
# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | POINT # | : 1 |
| PROJECT # | : 10174706 | SAMPLE LOC. | : B-6 |
| PROJECT COUNTY | : Ballard | SAMPLE DEPTH | : 19.5'-20.0' |
| PROJECT STATE | : Kentucky | DATE TESTED | : 7/2/2021 |
| LABORATORY # | : 10174706 | DATE REPORTED | : 7/6/2021 |
| SUBMITTED BY | : HDR | | |

| | | | |
|---|---|---|---|
| FINAL MOISTURE | : 44.59 % | EFF. CONS. STRESS | : 16.01 psi |
| FINAL HEIGHT | : 10.84 cm | SPECIFIC GRAVITY | : 2.52 |
| FINAL DIAMETER | : 7.82 cm | COMMENTS | : AASHTO T-296 |

RESULTS:



Unconsolidated Undrained

# TRIAXIAL COMPRESSION TEST



| | | | |
|---|---|---|---|
| PROJECT NAME | : KY Cairo Bridge | | |
| PROJECT # | : 10174706 | COMMENTS | : AASHTO T-296 |
| PROJECT COUNTY | : Ballard | SAMPLE LOC. | : B-6 |
| PROJECT STATE | : Kentucky | SAMPLE DEPTH | : 19.5'-20.0' |
| LABORATORY # | : 10174706 | DATE TESTED | : 7/2/2021 |
| SUBMITTED BY | : HDR | DATE REPORTED | : 7/6/2021 |

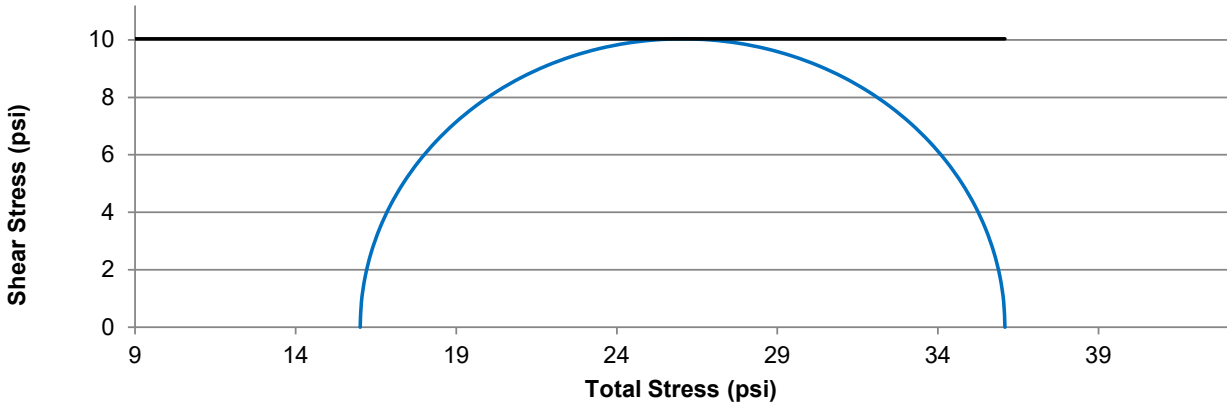
COEFFICIENT OF INTERNAL FRICTION AND COHESION BY THE METHOD OF LEAST SQUARES

| Test | Lateral | Total |
|---|---|---|
| 1 | 16.01 psi | 36.09 psi |

| | | |
|---|---|---|
| Compressive Strength = | 2891 | psf |
| Cohesion = | 1445 | psf |
| Phi = | 0 | deg |
| Tan (Phi) = | 0 | |

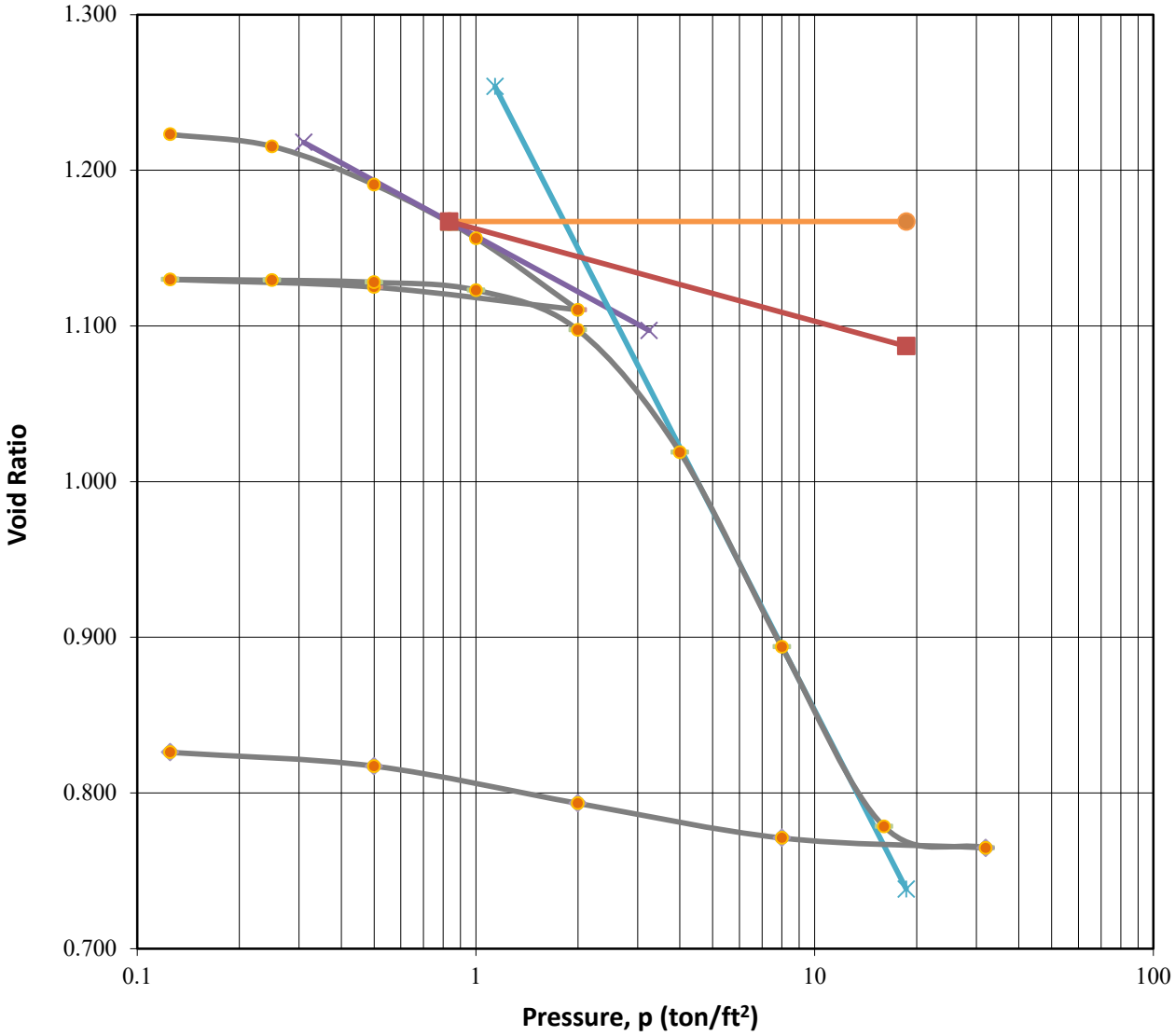
## Maximum Deviator Stress

## Triaxial Mohr's Circles
## Unconsolidated Undrained Triaxial Test




Approved By: Kevin E. Walker

# CONSOLIDATION TEST




**Test Date:** 1/21/2026

## Summary of Consolidation Test Results

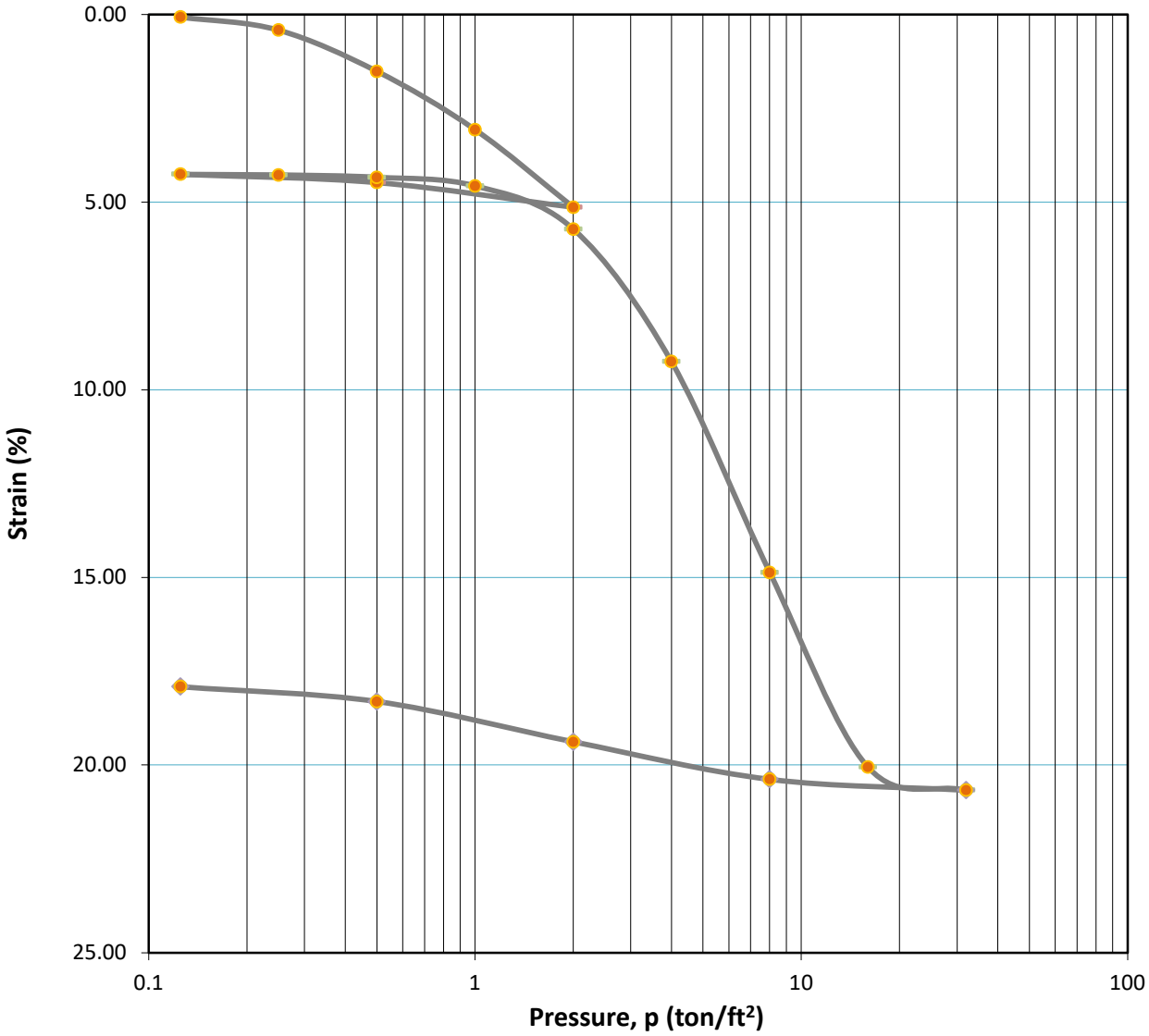
| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **0.26** | **Compression Index, $C_c$** | **0.42** |
| **Preconsol. Press., $P_c$ (tsf)** | **2.07** | **Rebound Index, $C_r$** | **0.01** |
| **Over Consolidation Ratio** | **7.96** | | |

| | | | | |
|---|---|---|---|---|
| **Soil Description:** | Elastic Silt with Sand | | | |
| **Project Number:** | 10174706 | **Depth:** | 4.0-4.5 | **Remarks:** |
| **Sample Number:** | ST-1 | **Boring Number:** | B-117 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |



4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| **Moisture (%):** | 36.1 | 30.6 | **Liquid Limits:** | 53 | **Test Date:** | 1/21/2026 |
| **Dry Density (pcf):** | 76.2 | 93.8 | **Plastic Limits:** | 31 | | |
| **Saturation (%):** | 79.9 | 100.0 | **Plasticity Index (%):** | 22 | | |
| **Void Ratio:** | 1.23 | 0.81 | **Specific Gravity:** | 2.721 | MEASURED | |

| | | | |
|---|---|---|---|
| **Sample Description:** | Elastic Silt with Sand | | |
| **Project Number:** | 10174706 | **Depth:** 4.0-4.5 | **Remarks:** |
| **Sample Number:** | ST-1 | **Boring Number:** B-117 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | |
| **Client:** | KYTC | | |
| **Location:** | Kentucky | | |



4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

# CONSOLIDATION TEST

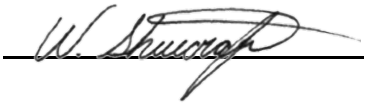
## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 10174706
**Project Number:** 10174706
**Test Date:** 1/21/2026

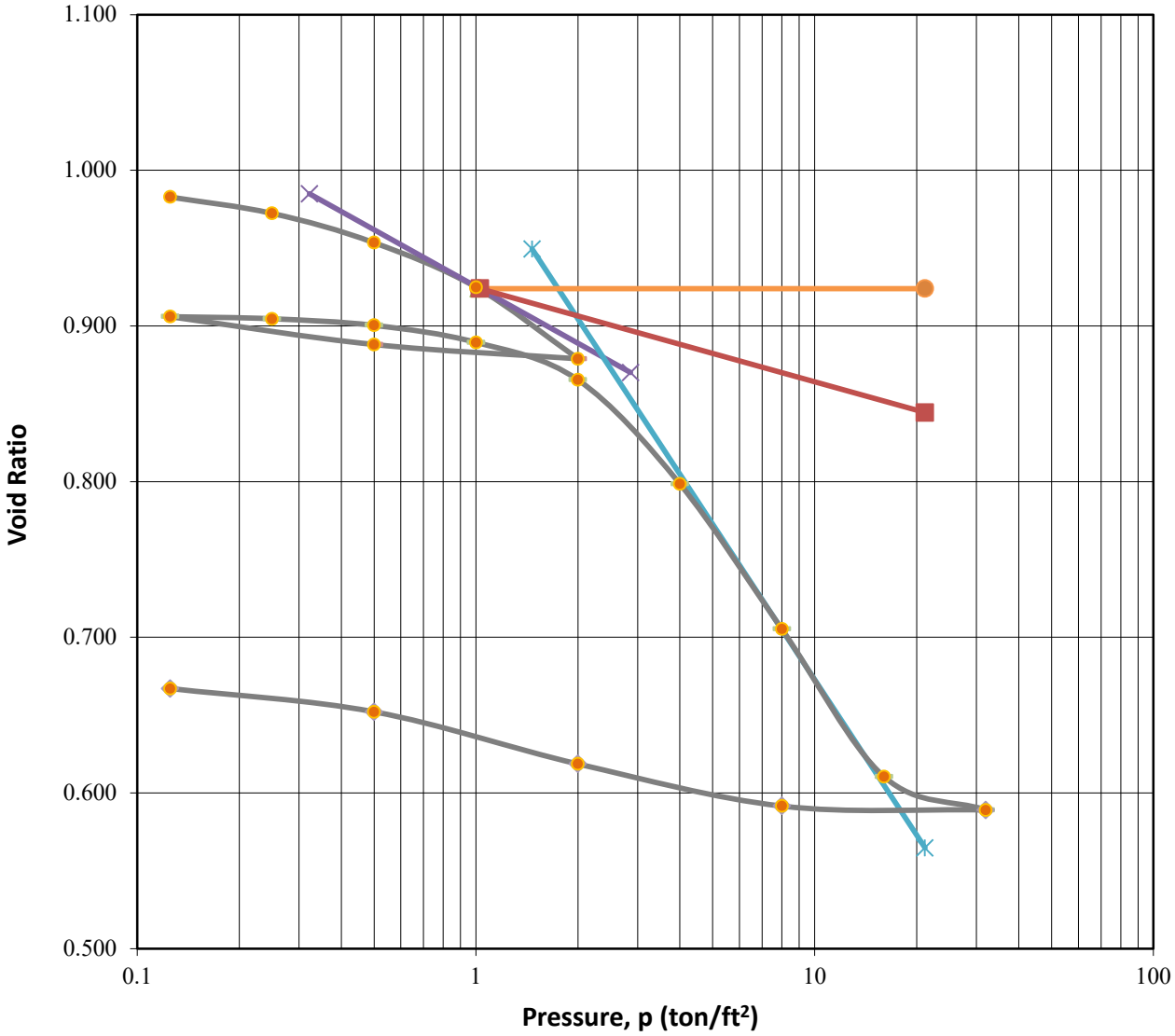
**Sample Number:** ST-1
**Boring Number:** B-117
**Depth:** 4.0-4.5
**Sample Type:** Undisturbed

**Sample Description:** Elastic Silt with Sand
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv ft²/Day | t50 Cv ft²/Day |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 1.2286 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | 0.0007 | 0.9993 | 0.5498 | 0.0700 | 1.2231 | 0.0096 | 0.0000 | 0.0000 | 0.0000 |
| 1 | 0.250 | 0.0042 | 0.9958 | 0.5463 | 0.4200 | 1.2153 | 0.1599 | 0.0225 | 0.2192 | 0.3596 |
| 2 | 0.500 | 0.0152 | 0.9848 | 0.5353 | 1.5200 | 1.1908 | 0.0219 | 0.0039 | 1.5640 | 2.0049 |
| 3 | 1.000 | 0.0307 | 0.9693 | 0.5198 | 3.0700 | 1.1564 | 0.0301 | 0.0052 | 1.1030 | 1.4038 |
| 4 | 2.000 | 0.0514 | 0.9486 | 0.4991 | 5.1400 | 1.1103 | 0.0089 | 0.0023 | 3.5579 | 2.9590 |
| 5 | 0.500 | 0.0448 | 0.9552 | 0.5057 | 4.4800 | 1.1250 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.125 | 0.0426 | 0.9574 | 0.5079 | 4.2600 | 1.1299 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.250 | 0.0428 | 0.9572 | 0.5077 | 4.2800 | 1.1294 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.500 | 0.0434 | 0.9566 | 0.5071 | 4.3400 | 1.1281 | 0.0971 | 0.0242 | 0.3329 | 0.2835 |
| 9 | 1.000 | 0.0457 | 0.9543 | 0.5048 | 4.5700 | 1.1230 | 0.0423 | 0.2947 | 0.7602 | 0.0230 |
| 10 | 2.000 | 0.0572 | 0.9428 | 0.4933 | 5.7200 | 1.0974 | 0.0732 | 0.0042 | 0.4290 | 1.5639 |
| 11 | 4.000 | 0.0925 | 0.9075 | 0.4580 | 9.2500 | 1.0189 | 0.0258 | 0.0036 | 1.1268 | 1.5908 |
| 12 | 8.000 | 0.1487 | 0.8513 | 0.4018 | 14.8700 | 0.8938 | 0.1501 | 0.0324 | 0.1706 | 0.1342 |
| 13 | 16.000 | 0.2005 | 0.7995 | 0.3500 | 20.0500 | 0.7786 | 0.3307 | 0.6203 | 0.0683 | 0.0048 |
| 14 | 32.000 | 0.2067 | 0.7933 | 0.3438 | 20.6700 | 0.7648 | 0.1442 | 0.0301 | 0.1542 | 0.0946 |
| 15 | 8.000 | 0.2038 | 0.7962 | 0.3467 | 20.3800 | 0.7713 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 2.000 | 0.1938 | 0.8062 | 0.3567 | 19.3800 | 0.7935 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | 0.1831 | 0.8169 | 0.3674 | 18.3100 | 0.8173 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | 0.1791 | 0.8209 | 0.3714 | 17.9100 | 0.8262 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: 

# CONSOLIDATION TEST



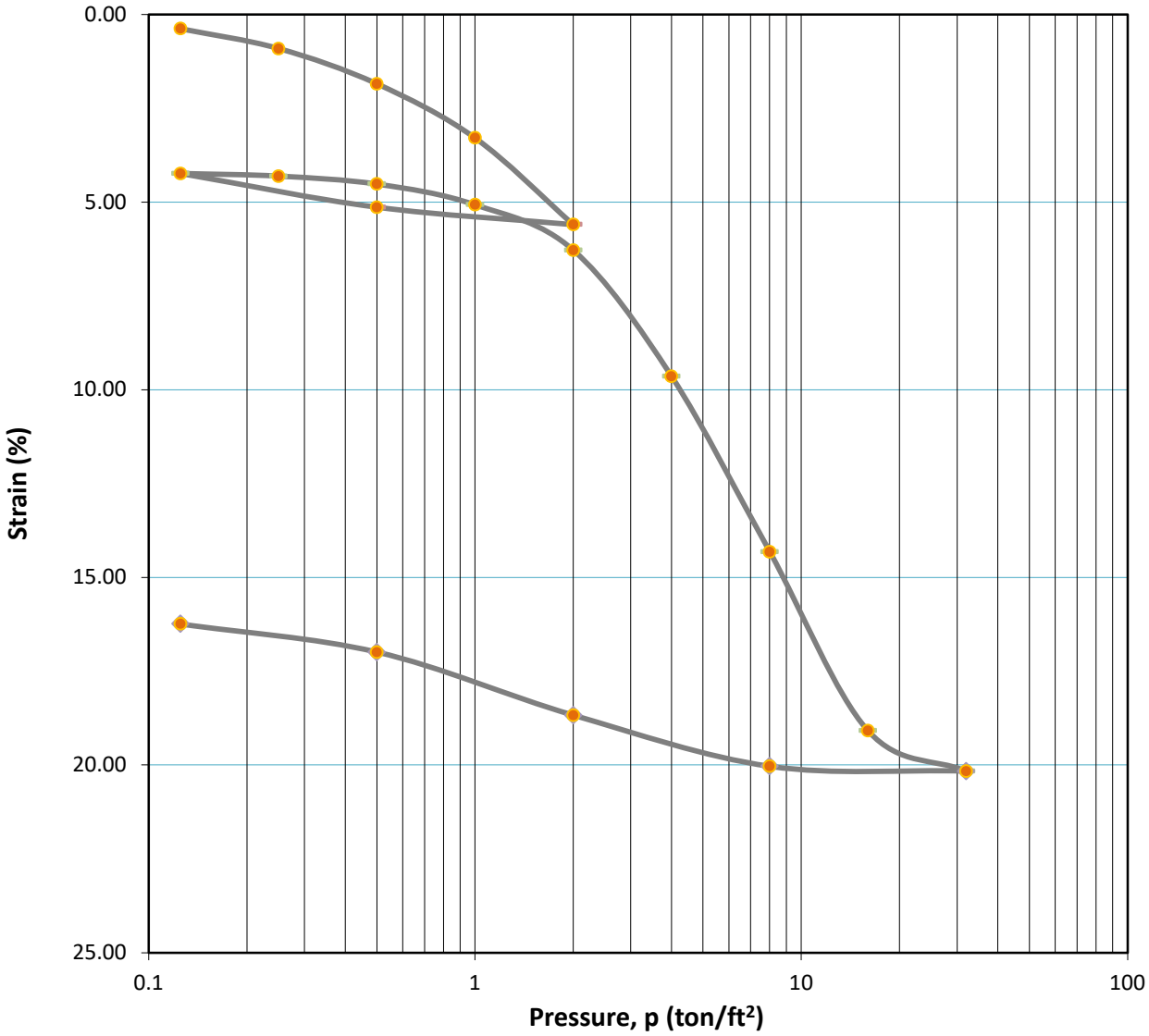

**Test Date:** 1/21/2026

## Summary of Consolidation Test Results

| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **1.73** | **Compression Index, $C_c$** | **0.33** |
| **Preconsol. Press., $P_c$ (tsf)** | **1.97** | **Rebound Index, $C_r$** | **0.03** |
| **Over Consolidation Ratio** | **1.14** | | |

| | | | | |
|---|---|---|---|---|
| **Soil Description:** | Silt | | | |
| **Project Number:** | 10174706 | **Depth:** | 28.7-29.0 | **Remarks:** |
| **Sample Number:** | ST-6 | **Boring Number:** | B-118 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |

## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| **Moisture (%):** | 32.6 | 26.1 | **Liquid Limits:** | 42 | **Test Date:** | 1/21/2026 |
| **Dry Density (pcf):** | 85.0 | 100.7 | **Plastic Limits:** | 31 | | |
| **Saturation (%):** | 89.0 | 100.0 | **Plasticity Index (%):** | 11 | | |
| **Void Ratio:** | 0.99 | 0.68 | **Specific Gravity:** | 2.716 | MEASURED | |

| | | | | |
|---|---|---|---|---|
| **Sample Description:** | Silt | | | |
| **Project Number:** | 10174706 | **Depth:** | 28.7-29.0 | **Remarks:** |
| **Sample Number:** | ST-6 | **Boring Number:** | B-118 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |

# CONSOLIDATION TEST

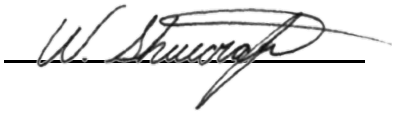
## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 10174706
**Project Number:** 10174706
**Test Date:** 1/21/2026

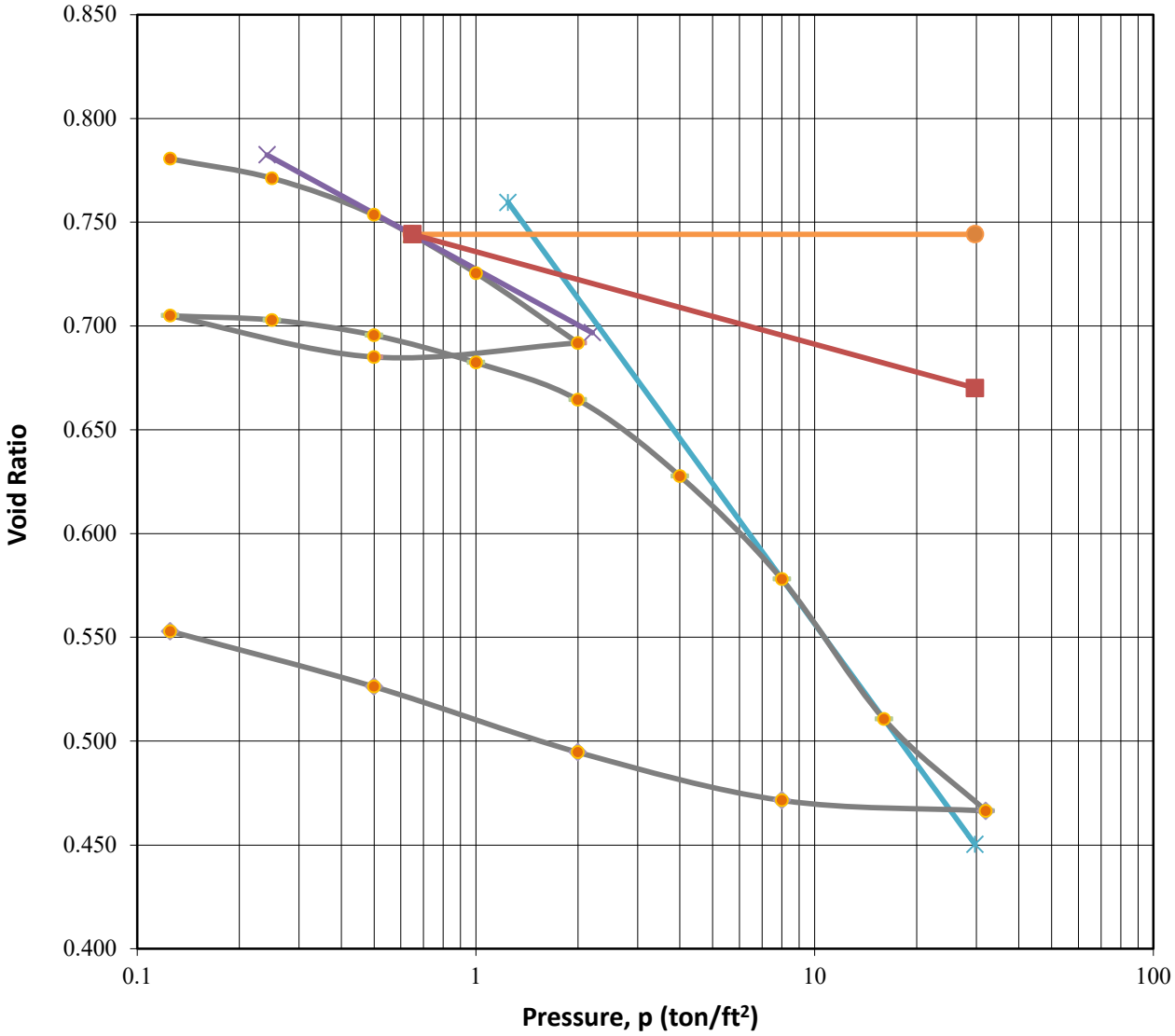
**Sample Number:** ST-6
**Boring Number:** B-118
**Depth:** 28.7-29.0
**Sample Type:** Undisturbed

**Sample Description:** Silt
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv ft²/Day | t50 Cv ft²/Day |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 0.9940 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | 0.0038 | 0.9962 | 0.4938 | 0.3800 | 0.9828 | 0.0118 | 0.0000 | 0.0000 | 0.0000 |
| 1 | 0.250 | 0.0091 | 0.9909 | 0.4885 | 0.9100 | 0.9723 | 0.0299 | 0.0061 | 1.1600 | 1.3039 |
| 2 | 0.500 | 0.0185 | 0.9815 | 0.4791 | 1.8500 | 0.9536 | 0.0355 | 0.0068 | 0.9595 | 1.1228 |
| 3 | 1.000 | 0.0329 | 0.9671 | 0.4647 | 3.2900 | 0.9249 | 0.2566 | 0.0360 | 0.1288 | 0.2021 |
| 4 | 2.000 | 0.0560 | 0.9440 | 0.4416 | 5.6000 | 0.8789 | 0.0545 | 0.0108 | 0.5782 | 0.6244 |
| 5 | 0.500 | 0.0514 | 0.9486 | 0.4462 | 5.1400 | 0.8881 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.125 | 0.0424 | 0.9576 | 0.4552 | 4.2400 | 0.9060 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.250 | 0.0431 | 0.9569 | 0.4545 | 4.3100 | 0.9046 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.500 | 0.0452 | 0.9548 | 0.4524 | 4.5200 | 0.9004 | 0.1124 | 0.0271 | 0.2865 | 0.2512 |
| 9 | 1.000 | 0.0507 | 0.9493 | 0.4469 | 5.0700 | 0.8895 | 0.1054 | 0.0203 | 0.3021 | 0.3290 |
| 10 | 2.000 | 0.0628 | 0.9372 | 0.4348 | 6.2800 | 0.8654 | 0.0937 | 0.0119 | 0.3313 | 0.5381 |
| 11 | 4.000 | 0.0964 | 0.9036 | 0.4012 | 9.6400 | 0.7985 | 0.1199 | 0.3818 | 0.2406 | 0.0143 |
| 12 | 8.000 | 0.1432 | 0.8568 | 0.3544 | 14.3200 | 0.7054 | 0.5162 | 0.1191 | 0.0503 | 0.0376 |
| 13 | 16.000 | 0.1908 | 0.8092 | 0.3068 | 19.0800 | 0.6106 | 0.5244 | 0.1229 | 0.0441 | 0.0277 |
| 14 | 32.000 | 0.2016 | 0.7984 | 0.2960 | 20.1600 | 0.5891 | 0.1342 | 0.0280 | 0.1678 | 0.1068 |
| 15 | 8.000 | 0.2003 | 0.7997 | 0.2973 | 20.0300 | 0.5917 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 2.000 | 0.1867 | 0.8133 | 0.3109 | 18.6700 | 0.6188 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | 0.1699 | 0.8301 | 0.3277 | 16.9900 | 0.6522 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | 0.1624 | 0.8376 | 0.3352 | 16.2400 | 0.6672 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: 

## CONSOLIDATION TEST



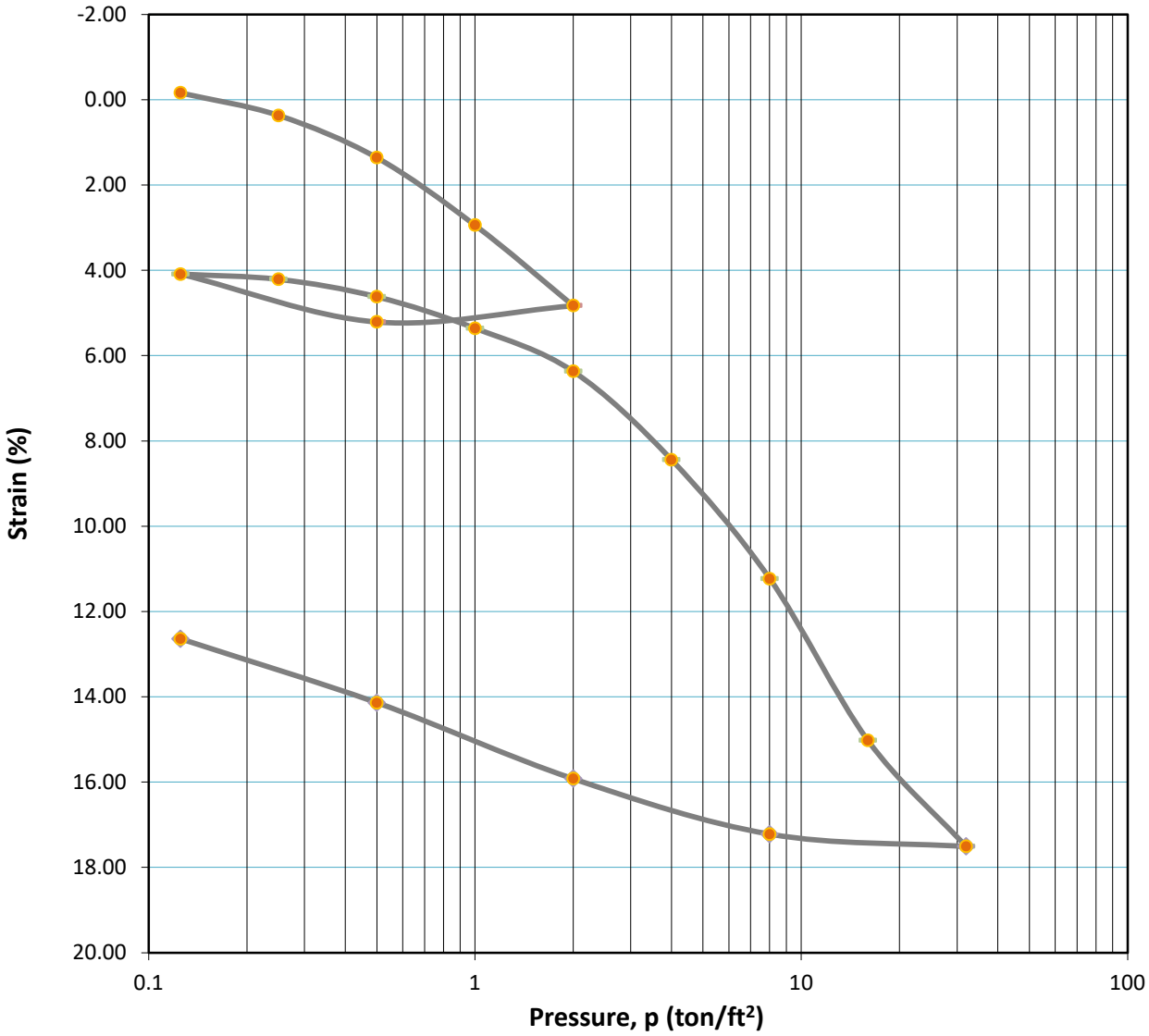

**Test Date:** 1/21/2026

### Summary of Consolidation Test Results

| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **0.59** | **Compression Index, $C_c$** | **0.22** |
| **Preconsol. Press., $P_c$ (tsf)** | **1.78** | **Rebound Index, $C_r$** | **0.03** |
| **Over Consolidation Ratio** | **3.02** | | |

| | | | | |
|---|---|---|---|---|
| **Soil Description:** | Silt | | | |
| **Project Number:** | 10174706 | **Depth:** | 9.5-10.0 | **Remarks:** |
| **Sample Number:** | ST-2 | **Boring Number:** | B-123 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |

## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| **Moisture (%):** | 29.6 | 24.1 | **Liquid Limits:** | 40 | **Test Date:** | 1/21/2026 |
| **Dry Density (pcf):** | 89.6 | 103.0 | **Plastic Limits:** | 27 | | |
| **Saturation (%):** | 96.9 | 100.0 | **Plasticity Index (%):** | 13 | | |
| **Void Ratio:** | 0.78 | 0.55 | **Specific Gravity:** | 2.555 | MEASURED | |

| | | | | |
|---|---|---|---|---|
| **Sample Description:** | Silt | | | |
| **Project Number:** | 10174706 | **Depth:** | 9.5-10.0 | **Remarks:** |
| **Sample Number:** | ST-2 | **Boring Number:** | B-123 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |

# CONSOLIDATION TEST

## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 10174706
**Project Number:** 10174706
**Test Date:** 1/21/2026

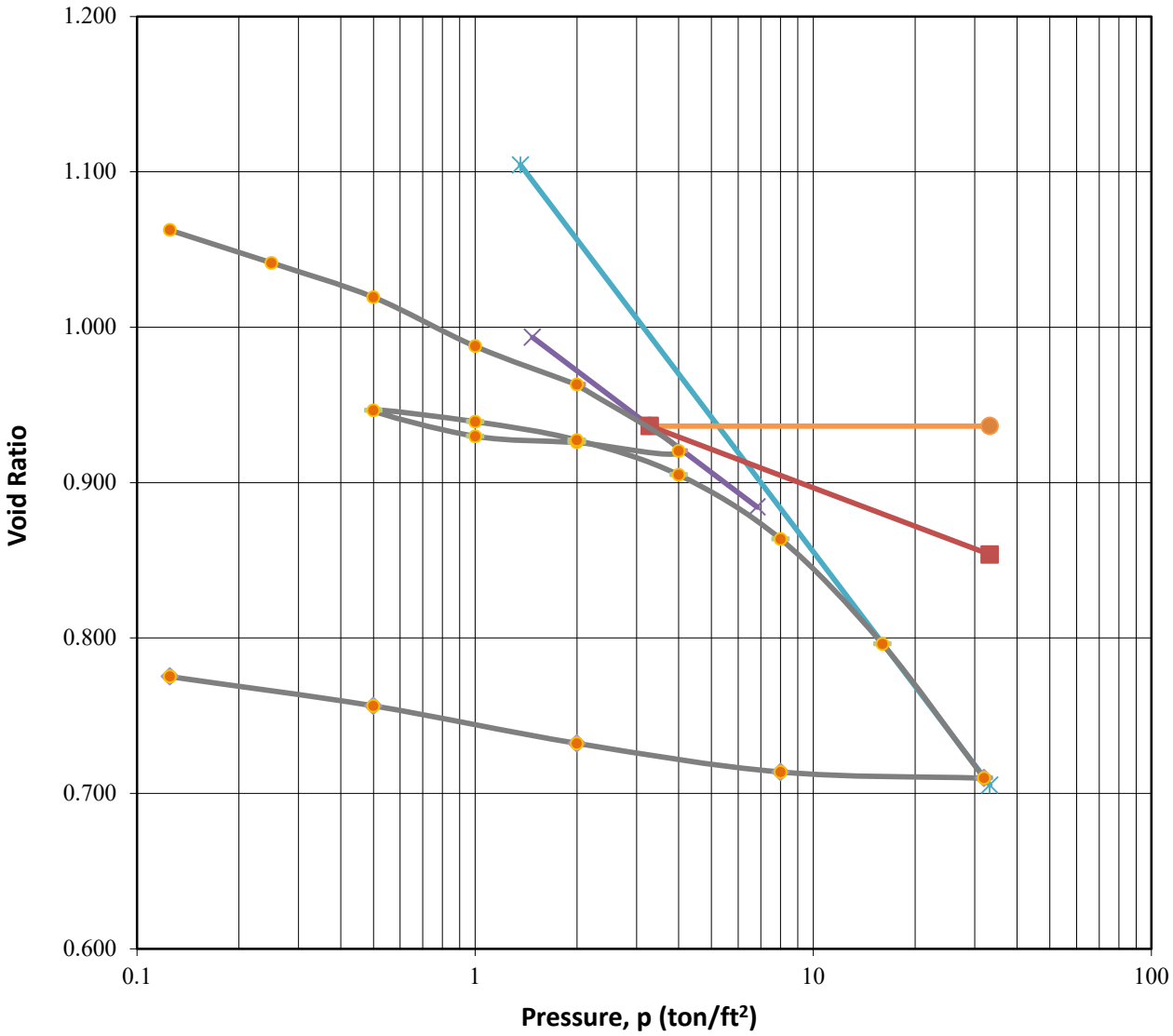
**Sample Number:** ST-2
**Boring Number:** B-123
**Depth:** 9.5-10.0
**Sample Type:** Undisturbed

**Sample Description:** Silt
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv ft²/Day | t50 Cv ft²/Day |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 0.7809 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | -0.0016 | 1.0016 | 0.4391 | -0.1600 | 0.7805 | 0.0226 | 0.0035 | 1.5667 | 2.3890 |
| 1 | 0.250 | 0.0037 | 0.9963 | 0.4338 | 0.3700 | 0.7711 | 0.0622 | 0.0080 | 0.5642 | 1.0102 |
| 2 | 0.500 | 0.0136 | 0.9864 | 0.4239 | 1.3600 | 0.7535 | 0.0817 | 0.0122 | 0.4209 | 0.6419 |
| 3 | 1.000 | 0.0294 | 0.9706 | 0.4081 | 2.9400 | 0.7254 | 0.1892 | 0.0301 | 0.1759 | 0.2450 |
| 4 | 2.000 | 0.0483 | 0.9517 | 0.3892 | 4.8300 | 0.6918 | 0.0419 | 0.1381 | 0.7632 | 0.0490 |
| 5 | 0.500 | 0.0521 | 0.9479 | 0.3854 | 5.2100 | 0.6851 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.125 | 0.0409 | 0.9591 | 0.3966 | 4.0900 | 0.7050 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.250 | 0.0421 | 0.9579 | 0.3954 | 4.2100 | 0.7028 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.500 | 0.0462 | 0.9538 | 0.3913 | 4.6200 | 0.6955 | 0.1784 | 0.0355 | 0.1802 | 0.1912 |
| 9 | 1.000 | 0.0536 | 0.9464 | 0.3839 | 5.3600 | 0.6824 | 0.1518 | 0.0330 | 0.2085 | 0.1999 |
| 10 | 2.000 | 0.0637 | 0.9363 | 0.3738 | 6.3700 | 0.6644 | 0.1006 | 0.0122 | 0.3080 | 0.5196 |
| 11 | 4.000 | 0.0844 | 0.9156 | 0.3531 | 8.4400 | 0.6276 | 0.2844 | 0.0536 | 0.1041 | 0.1086 |
| 12 | 8.000 | 0.1123 | 0.8877 | 0.3252 | 11.2300 | 0.5780 | 0.2110 | 0.0445 | 0.1320 | 0.1155 |
| 13 | 16.000 | 0.1502 | 0.8498 | 0.2873 | 15.0200 | 0.5107 | 0.2495 | 0.0558 | 0.1023 | 0.0761 |
| 14 | 32.000 | 0.1751 | 0.8249 | 0.2624 | 17.5100 | 0.4664 | 0.4284 | 0.0936 | 0.0561 | 0.0389 |
| 15 | 8.000 | 0.1722 | 0.8278 | 0.2653 | 17.2200 | 0.4716 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 2.000 | 0.1592 | 0.8408 | 0.2783 | 15.9200 | 0.4947 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | 0.1414 | 0.8586 | 0.2961 | 14.1400 | 0.5263 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | 0.1264 | 0.8736 | 0.3111 | 12.6400 | 0.5530 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: _____

## CONSOLIDATION TEST




**Test Date:** 1/21/2026

### Summary of Consolidation Test Results

| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **1.76** | **Compression Index, $C_c$** | **0.29** |
| **Preconsol. Press., $P_c$ (tsf)** | **6.30** | **Rebound Index, $C_r$** | **0.03** |
| **Over Consolidation Ratio** | **3.58** | | |

| | | | | |
|---|---|---|---|---|
| **Soil Description:** | Lean Clay with Sand | | | |
| **Project Number:** | 10174706 | **Depth:** | 29.0-29.5 | **Remarks:** |
| **Sample Number:** | ST-6 | **Boring Number:** | B-123 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |



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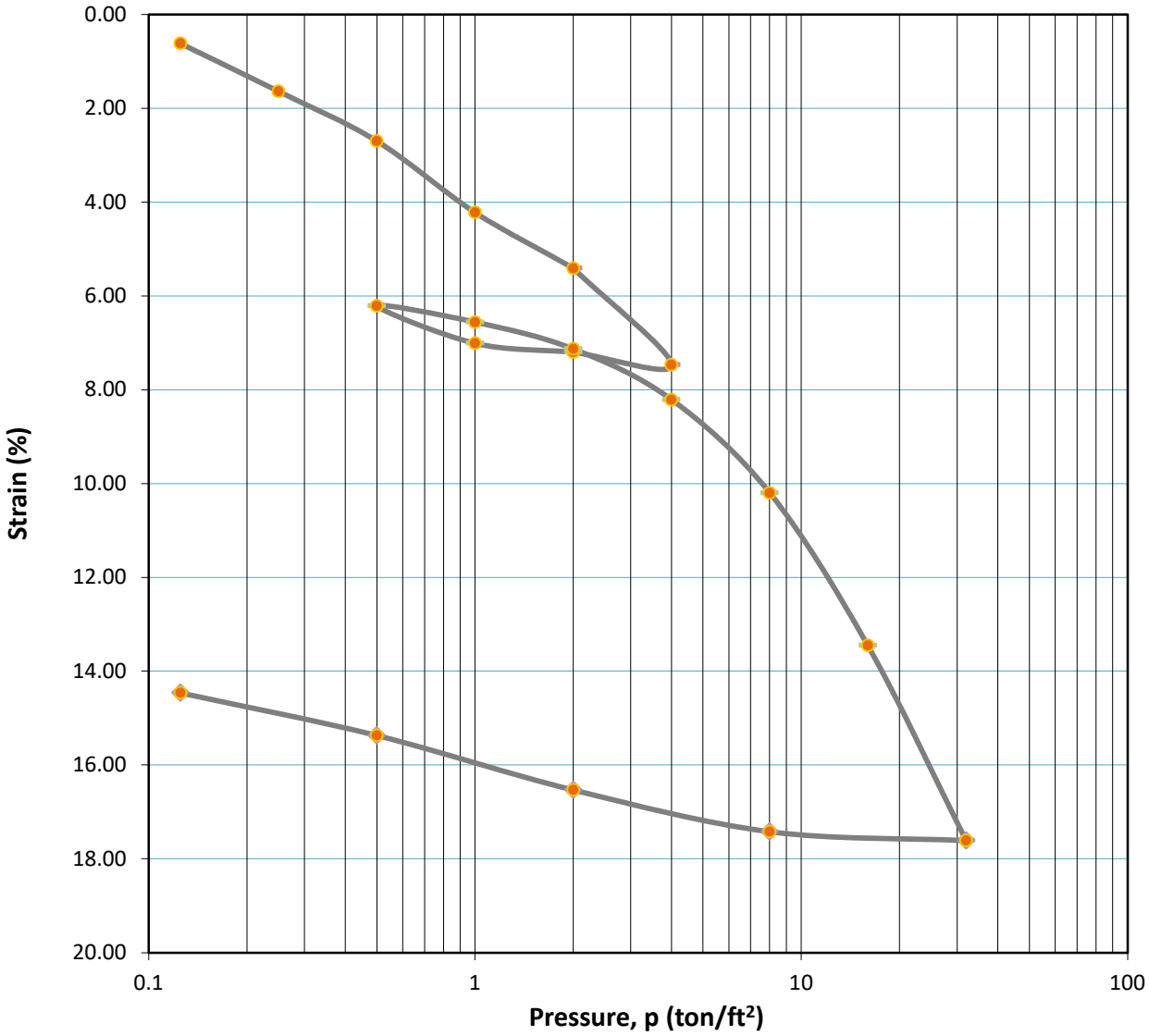
## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| **Moisture (%):** | 42.4 | 31.5 | **Liquid Limits:** | 36 | **Test Date:** | 1/21/2026 |
| **Dry Density (pcf):** | 77.0 | 92.3 | **Plastic Limits:** | 23 | | |
| **Saturation (%):** | 100.0 | 100.0 | **Plasticity Index (%):** | 13 | | |
| **Void Ratio:** | 1.08 | 0.73 | **Specific Gravity:** | 2.563 | MEASURED | |

| | | | | |
|---|---|---|---|---|
| **Sample Description:** | Lean Clay with Sand | | | |
| **Project Number:** | 10174706 | **Depth:** | 29.0-29.5 | **Remarks:** |
| **Sample Number:** | ST-6 | **Boring Number:** | B-123 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |

# CONSOLIDATION TEST

## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 10174706
**Project Number:** 10174706
**Test Date:** 1/21/2026

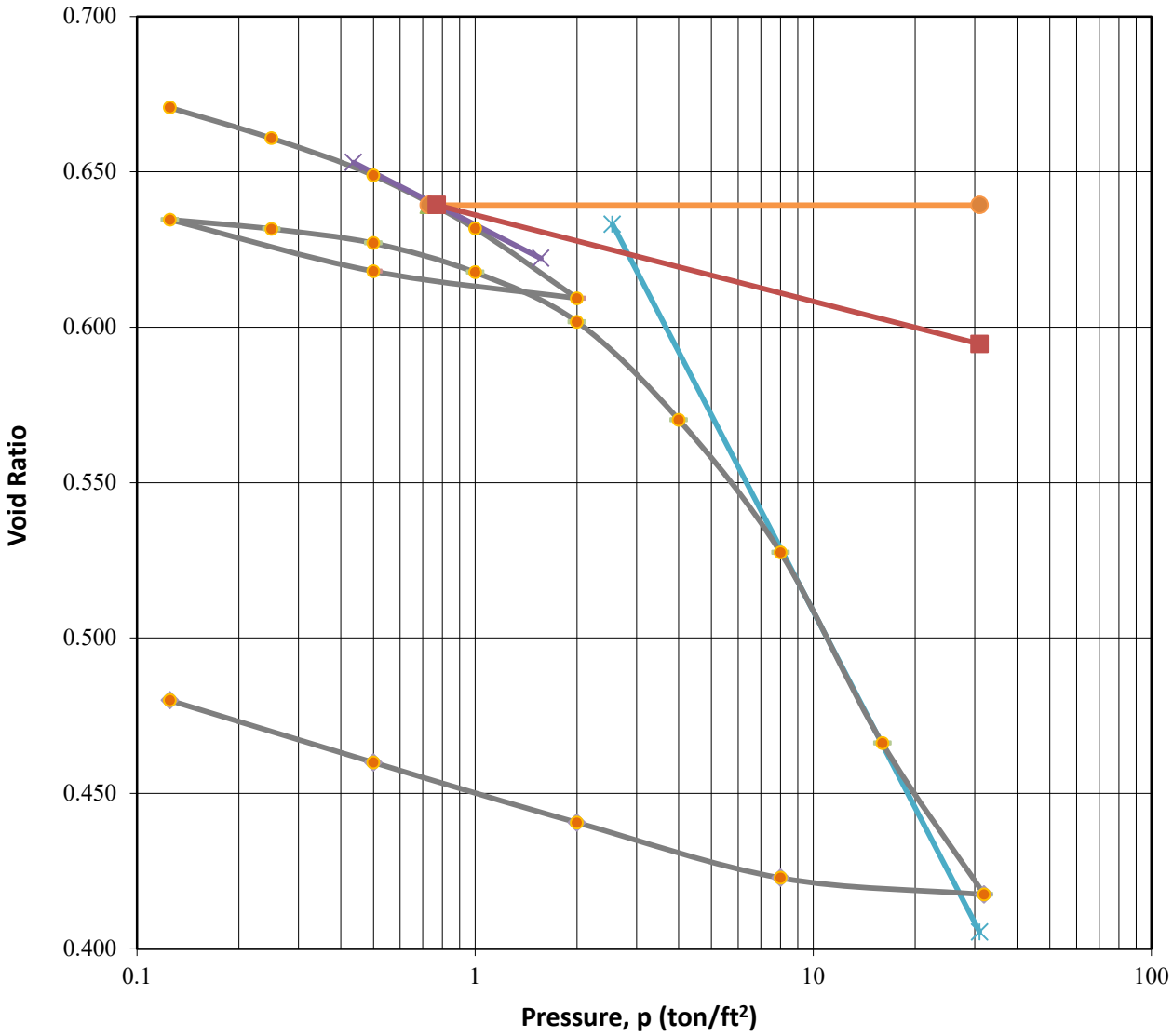
**Sample Number:** ST-6
**Boring Number:** B-123
**Depth:** 29.0-29.5
**Sample Type:** Undisturbed

**Sample Description:** Lean Clay with Sand
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv ft²/Day | t50 Cv ft²/Day |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 1.0791 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | 0.0062 | 0.9938 | 0.5120 | 0.6200 | 1.0625 | 0.0329 | 0.0078 | 1.0593 | 1.0351 |
| 1 | 0.250 | 0.0164 | 0.9836 | 0.5018 | 1.6400 | 1.0413 | 0.0333 | 0.0056 | 1.0255 | 1.3692 |
| 2 | 0.500 | 0.0270 | 0.9730 | 0.4912 | 2.7000 | 1.0193 | 0.0501 | 0.0096 | 0.6678 | 0.7677 |
| 3 | 1.000 | 0.0422 | 0.9578 | 0.4760 | 4.2200 | 0.9878 | 0.0864 | 0.0130 | 0.3751 | 0.5373 |
| 4 | 2.000 | 0.0541 | 0.9459 | 0.4641 | 5.4100 | 0.9631 | 0.0384 | 0.0062 | 0.8235 | 1.0762 |
| 5 | 4.000 | 0.0747 | 0.9253 | 0.4435 | 7.4700 | 0.9203 | 0.0450 | 0.0072 | 0.6717 | 0.8433 |
| 6 | 2.000 | 0.0720 | 0.9280 | 0.4462 | 7.2000 | 0.9260 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 1.000 | 0.0701 | 0.9299 | 0.4481 | 7.0100 | 0.9299 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.500 | 0.0621 | 0.9379 | 0.4561 | 6.2100 | 0.9465 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 9 | 1.000 | 0.0656 | 0.9344 | 0.4526 | 6.5600 | 0.9392 | 0.0436 | 0.0099 | 0.7069 | 0.6311 |
| 10 | 2.000 | 0.0713 | 0.9287 | 0.4469 | 7.1300 | 0.9274 | 0.0432 | 0.0048 | 0.7060 | 1.2555 |
| 11 | 4.000 | 0.0821 | 0.9179 | 0.4361 | 8.2100 | 0.9050 | 0.0492 | 0.0089 | 0.6055 | 0.6547 |
| 12 | 8.000 | 0.1020 | 0.8980 | 0.4162 | 10.2000 | 0.8637 | 0.0343 | 0.0063 | 0.8314 | 0.8512 |
| 13 | 16.000 | 0.1345 | 0.8655 | 0.3837 | 13.4500 | 0.7962 | 0.0343 | 0.0066 | 0.7723 | 0.6977 |
| 14 | 32.000 | 0.1761 | 0.8239 | 0.3421 | 17.6100 | 0.7099 | 0.0594 | 0.0120 | 0.4039 | 0.3049 |
| 15 | 8.000 | 0.1742 | 0.8258 | 0.3440 | 17.4200 | 0.7138 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 2.000 | 0.1653 | 0.8347 | 0.3529 | 16.5300 | 0.7323 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | 0.1537 | 0.8463 | 0.3645 | 15.3700 | 0.7564 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | 0.1446 | 0.8554 | 0.3736 | 14.4600 | 0.7753 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: _____

## CONSOLIDATION TEST




**Test Date:** 9/2/2025

### Summary of Consolidation Test Results

| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **0.89** | **Compression Index, $C_c$** | **0.21** |
| **Preconsol. Press., $P_c$ (tsf)** | **2.83** | **Rebound Index, $C_r$** | **0.01** |
| **Over Consolidation Ratio** | **3.19** | | |

| | | | | |
|---|---|---|---|---|
| **Soil Description:** | Lean Clay | | | |
| **Project Number:** | 10174706 | **Depth:** | 14.5-15.0 | **Remarks:** |
| **Sample Number:** | ST-4 | **Boring Number:** | B-124P | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |



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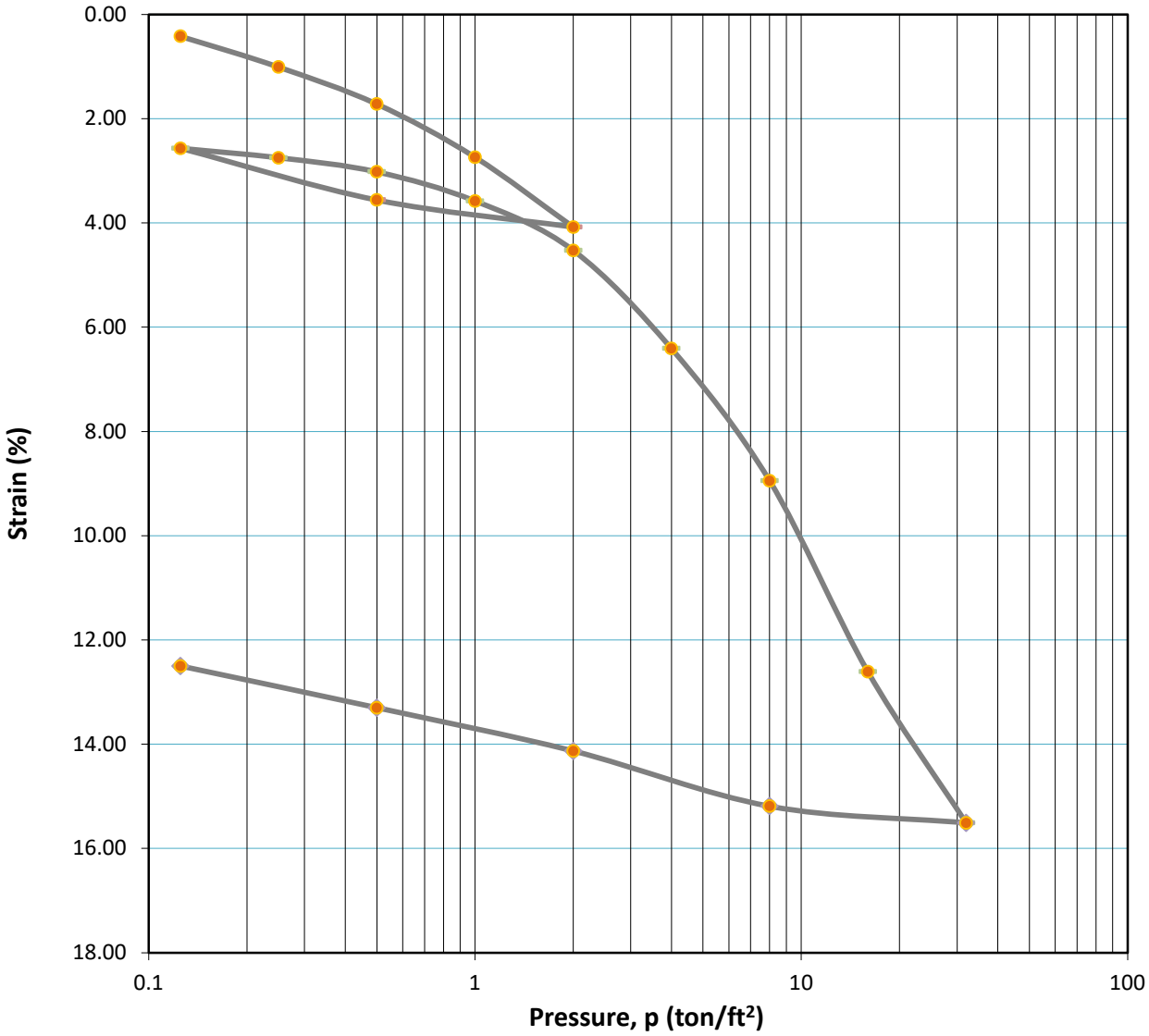
## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| **Moisture (%):** | 25.6 | 21.2 | **Liquid Limits:** | 40 | **Test Date:** | 9/2/2025 |
| **Dry Density (pcf):** | 99.1 | 98.6 | **Plastic Limits:** | 23 | | |
| **Saturation (%):** | 100.0 | 82.2 | **Plasticity Index (%):** | 17 | | |
| **Void Ratio:** | 0.68 | 0.69 | **Specific Gravity:** | 2.667 | ASSUMED | |

| | | | | |
|---|---|---|---|---|
| **Sample Description:** | Lean Clay | | | |
| **Project Number:** | 10174706 | **Depth:** | 14.5-15.0 | **Remarks:** |
| **Sample Number:** | ST-4 | **Boring Number:** | B-124P | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |

# CONSOLIDATION TEST

## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 10174706
**Project Number:** 10174706
**Test Date:** 9/2/2025

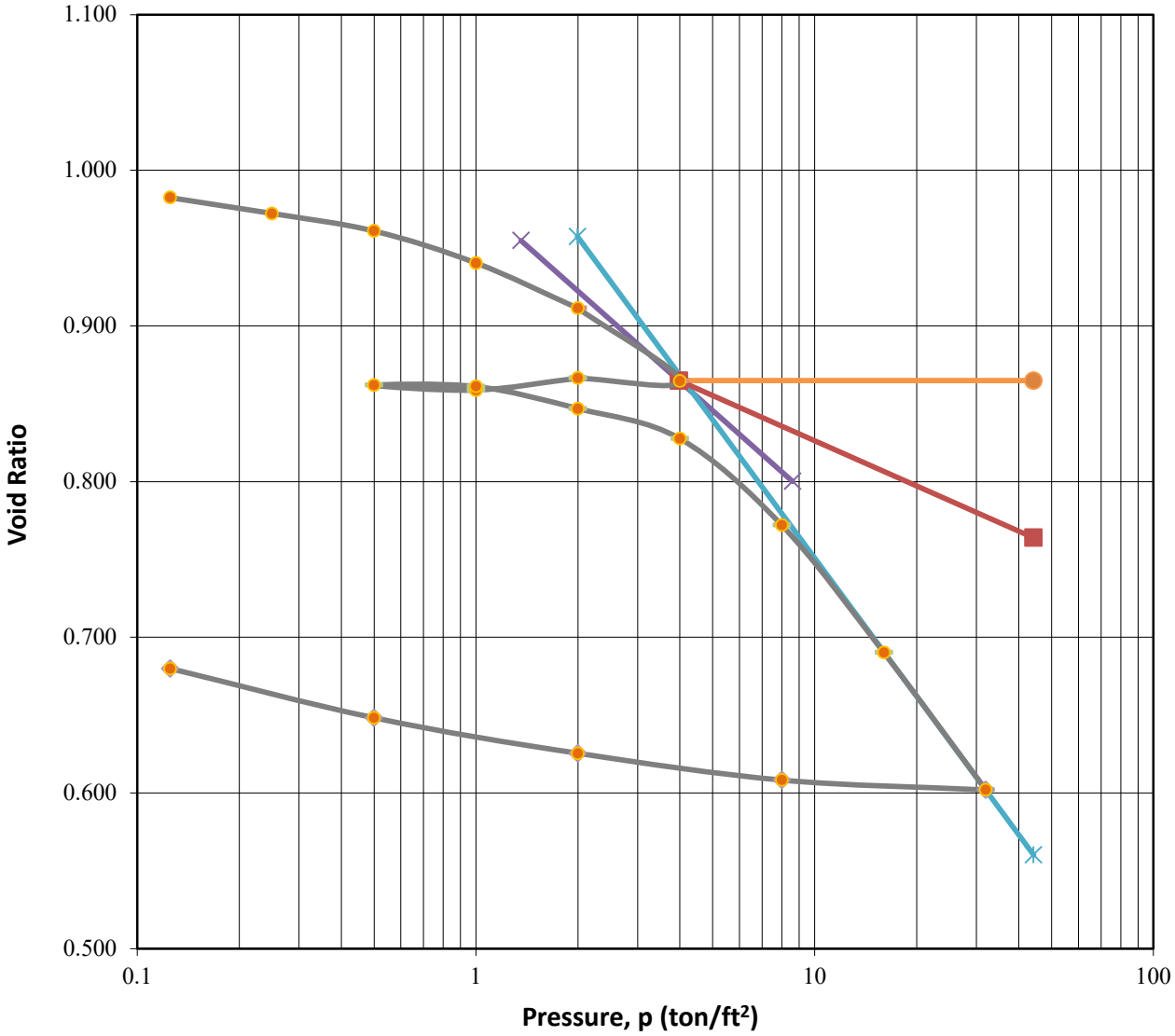
**Sample Number:** ST-4
**Boring Number:** B-124P
**Depth:** 14.5-15.0
**Sample Type:** Undisturbed

**Sample Description:** Lean Clay
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv $in^2$/Min | t50 Cv $in^2$/Min |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 0.6807 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | 0.0042 | 0.9958 | 0.3998 | 0.4200 | 0.6707 | 0.0227 | 0.0051 | 0.1545 | 0.1586 |
| 1 | 0.250 | 0.0101 | 0.9899 | 0.3939 | 1.0100 | 0.6608 | 0.1911 | 0.0515 | 0.0181 | 0.0154 |
| 2 | 0.500 | 0.0172 | 0.9828 | 0.3868 | 1.7200 | 0.6489 | 0.1769 | 0.0334 | 0.0193 | 0.0230 |
| 3 | 1.000 | 0.0274 | 0.9726 | 0.3766 | 2.7400 | 0.6318 | 0.0830 | 0.0172 | 0.0403 | 0.0430 |
| 4 | 2.000 | 0.0408 | 0.9592 | 0.3632 | 4.0800 | 0.6093 | 0.0218 | 0.0045 | 0.1489 | 0.1564 |
| 5 | 0.500 | 0.0356 | 0.9644 | 0.3684 | 3.5600 | 0.6180 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.125 | 0.0257 | 0.9743 | 0.3783 | 2.5700 | 0.6346 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.250 | 0.0275 | 0.9725 | 0.3765 | 2.7500 | 0.6316 | 0.0813 | 0.0166 | 0.0411 | 0.0442 |
| 8 | 0.500 | 0.0302 | 0.9698 | 0.3738 | 3.0200 | 0.6271 | 0.2248 | 0.3681 | 0.0148 | 0.0020 |
| 9 | 1.000 | 0.0358 | 0.9642 | 0.3682 | 3.5800 | 0.6177 | 0.1441 | 0.0321 | 0.0228 | 0.0221 |
| 10 | 2.000 | 0.0453 | 0.9547 | 0.3587 | 4.5300 | 0.6017 | 0.1260 | 0.0139 | 0.0255 | 0.0498 |
| 11 | 4.000 | 0.0641 | 0.9359 | 0.3399 | 6.4100 | 0.5702 | 0.0998 | 0.2615 | 0.0310 | 0.0024 |
| 12 | 8.000 | 0.0895 | 0.9105 | 0.3145 | 8.9500 | 0.5276 | 0.3218 | 0.5669 | 0.0091 | 0.0010 |
| 13 | 16.000 | 0.1261 | 0.8739 | 0.2779 | 12.6100 | 0.4662 | 0.2806 | 0.0657 | 0.0096 | 0.0074 |
| 14 | 32.000 | 0.1551 | 0.8449 | 0.2489 | 15.5100 | 0.4175 | 0.2672 | 0.0620 | 0.0094 | 0.0066 |
| 15 | 8.000 | 0.1519 | 0.8481 | 0.2521 | 15.1900 | 0.4229 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 2.000 | 0.1413 | 0.8587 | 0.2627 | 14.1300 | 0.4407 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | -0.0054 | 1.0054 | 0.4094 | 13.3000 | 0.4600 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | -0.0223 | 1.0223 | 0.4263 | 12.5000 | 0.4800 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: W. Shuwarp

# CONSOLIDATION TEST




**Test Date:** 9/2/2025

## Summary of Consolidation Test Results

| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **1.49** | **Compression Index, $C_c$** | **0.29** |
| **Preconsol. Press., $P_c$ (tsf)** | **4.17** | **Rebound Index, $C_r$** | **0.05** |
| **Over Consolidation Ratio** | **2.80** | | |

| | | | | |
|---|---|---|---|---|
| **Soil Description:** | Silt | | | |
| **Project Number:** | 10174706 | **Depth:** | 23.5-26.0 | **Remarks:** |
| **Sample Number:** | ST-6 | **Boring Number:** | B-125 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |



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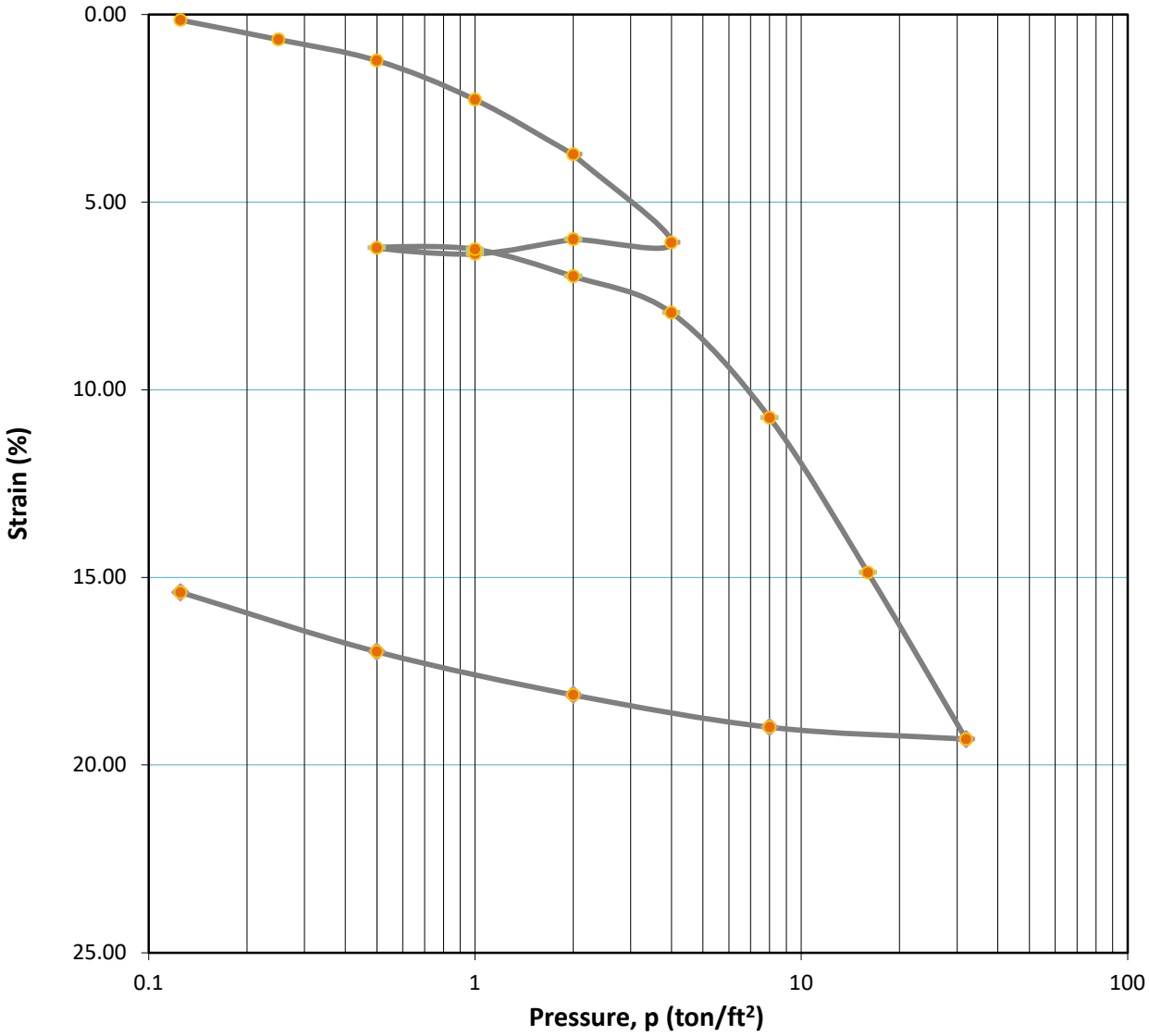
## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| | | | **Liquid Limits:** | 44 | **Test Date:** | 9/2/2025 |
| **Moisture (%):** | 31.2 | 23.5 | **Plastic Limits:** | 30 | | |
| **Dry Density (pcf):** | 84.1 | 83.5 | **Plasticity Index (%):** | 14 | | |
| **Saturation (%):** | 84.5 | 62.8 | | | | |
| **Void Ratio:** | 0.99 | 1.00 | **Specific Gravity:** | 2.681 | MEASURED | |

**Sample Description:** Silt

**Project Number:** 10174706 **Depth:** 23.5-26.0

**Sample Number:** ST-6 **Boring Number:** B-125

**Project:** KY Cairo Bridge

**Client:** KYTC

**Location:** Kentucky

**Remarks:**
ASTM D2435/D2435M-11

# CONSOLIDATION TEST

## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 10174706
**Project Number:** 10174706
**Test Date:** 9/2/2025

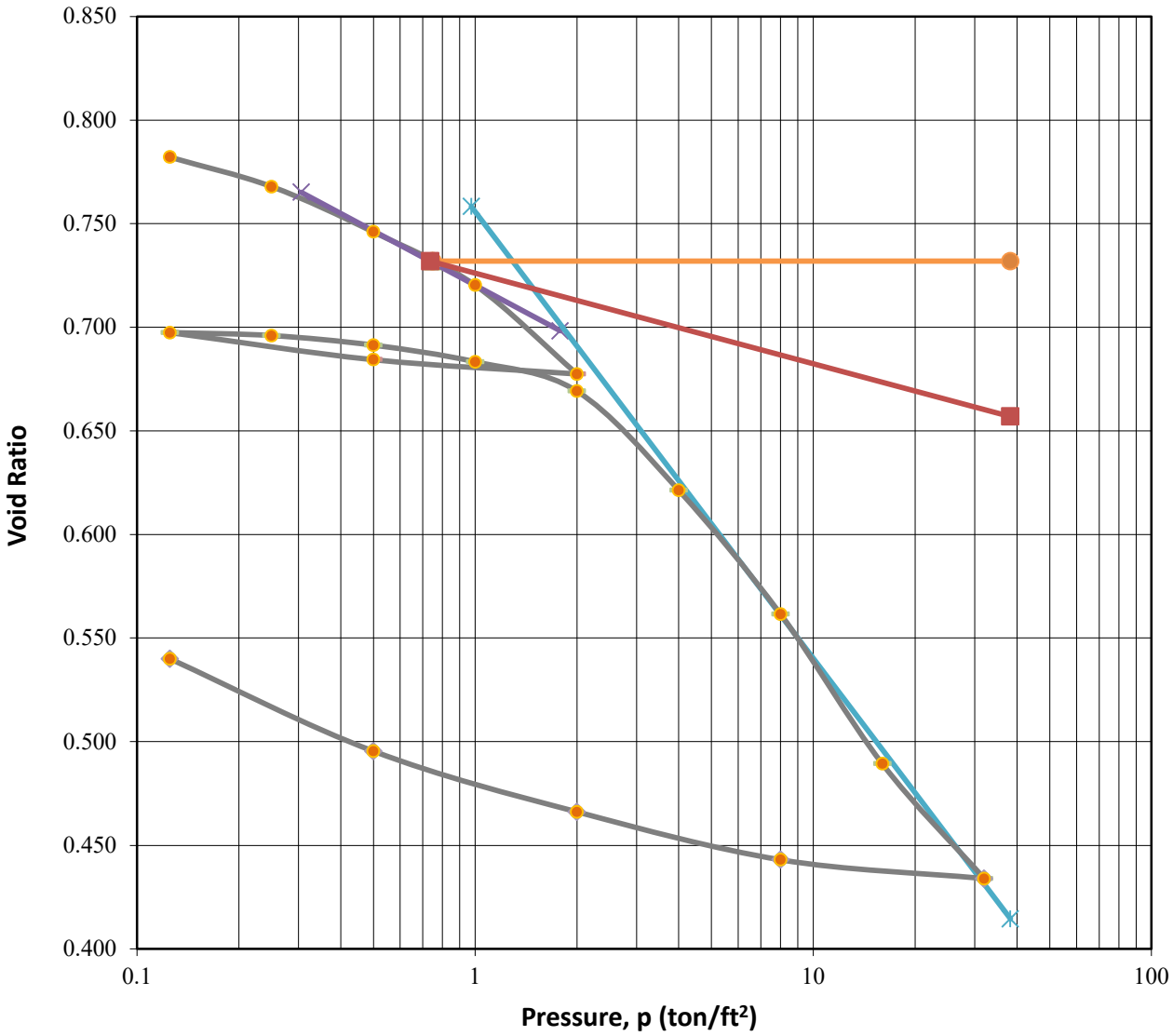
**Sample Number:** ST-6
**Boring Number:** B-125
**Depth:** 23.5-26.0
**Sample Type:** Undisturbed

**Sample Description:** Silt
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv ft²/Day | t50 Cv ft²/Day |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 0.9890 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | 0.0015 | 0.9985 | 0.4948 | 0.1500 | 0.9825 | 0.1502 | 0.0334 | 0.2346 | 0.2443 |
| 1 | 0.250 | 0.0067 | 0.9933 | 0.4896 | 0.6700 | 0.9722 | 0.0255 | 0.0039 | 1.3655 | 2.0387 |
| 2 | 0.500 | 0.0123 | 0.9877 | 0.4840 | 1.2300 | 0.9611 | 0.0409 | 0.1052 | 0.8420 | 0.0743 |
| 3 | 1.000 | 0.0227 | 0.9773 | 0.4736 | 2.2700 | 0.9404 | 0.0423 | 0.0081 | 0.7970 | 0.9273 |
| 4 | 2.000 | 0.0373 | 0.9627 | 0.4590 | 3.7300 | 0.9114 | 0.0415 | 0.0048 | 0.7897 | 1.4860 |
| 5 | 4.000 | 0.0608 | 0.9392 | 0.4355 | 6.0800 | 0.8648 | 0.0500 | 0.0068 | 0.6231 | 0.9572 |
| 6 | 2.000 | 0.0599 | 0.9401 | 0.4364 | 5.9900 | 0.8666 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 1.000 | 0.0638 | 0.9362 | 0.4325 | 6.3800 | 0.8588 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.500 | 0.0622 | 0.9378 | 0.4341 | 6.2200 | 0.8620 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 9 | 1.000 | 0.0626 | 0.9374 | 0.4337 | 6.2600 | 0.8612 | 0.0734 | 0.0150 | 0.4230 | 0.4227 |
| 10 | 2.000 | 0.0698 | 0.9302 | 0.4265 | 6.9800 | 0.8469 | 0.0604 | 0.0112 | 0.5063 | 0.5468 |
| 11 | 4.000 | 0.0795 | 0.9205 | 0.4168 | 7.9500 | 0.8276 | 0.0376 | 0.0051 | 0.7969 | 1.1443 |
| 12 | 8.000 | 0.1075 | 0.8925 | 0.3888 | 10.7500 | 0.7720 | 0.0661 | 0.0142 | 0.4259 | 0.3689 |
| 13 | 16.000 | 0.1487 | 0.8513 | 0.3476 | 14.8700 | 0.6902 | 0.0534 | 0.0117 | 0.4793 | 0.3685 |
| 14 | 32.000 | 0.1931 | 0.8069 | 0.3032 | 19.3100 | 0.6021 | 0.0694 | 0.0138 | 0.3316 | 0.2425 |
| 15 | 8.000 | 0.1899 | 0.8101 | 0.3064 | 18.9900 | 0.6084 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 2.000 | 0.1813 | 0.8187 | 0.3150 | 18.1300 | 0.6255 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | 0.1698 | 0.8302 | 0.3265 | 16.9800 | 0.6484 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | -0.0005 | 1.0005 | 0.4968 | 15.4000 | 0.6800 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: W. Struecker

# CONSOLIDATION TEST




**Test Date:** 9/4/2025

## Summary of Consolidation Test Results

| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **0.50** | **Compression Index, $C_c$** | **0.22** |
| **Preconsol. Press., $P_c$ (tsf)** | **1.49** | **Rebound Index, $C_r$** | **0.01** |
| **Over Consolidation Ratio** | **3.01** | | |

| | | | |
|---|---|---|---|
| **Soil Description:** | Lean Clay with Sand | | |
| **Project Number:** | 1017406 | **Depth:** 8.0-8.5 | **Remarks:** |
| **Sample Number:** | ST-2 | **Boring Number:** B-126A | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | |
| **Client:** | KYTC | | |
| **Location:** | Kentucky | | |



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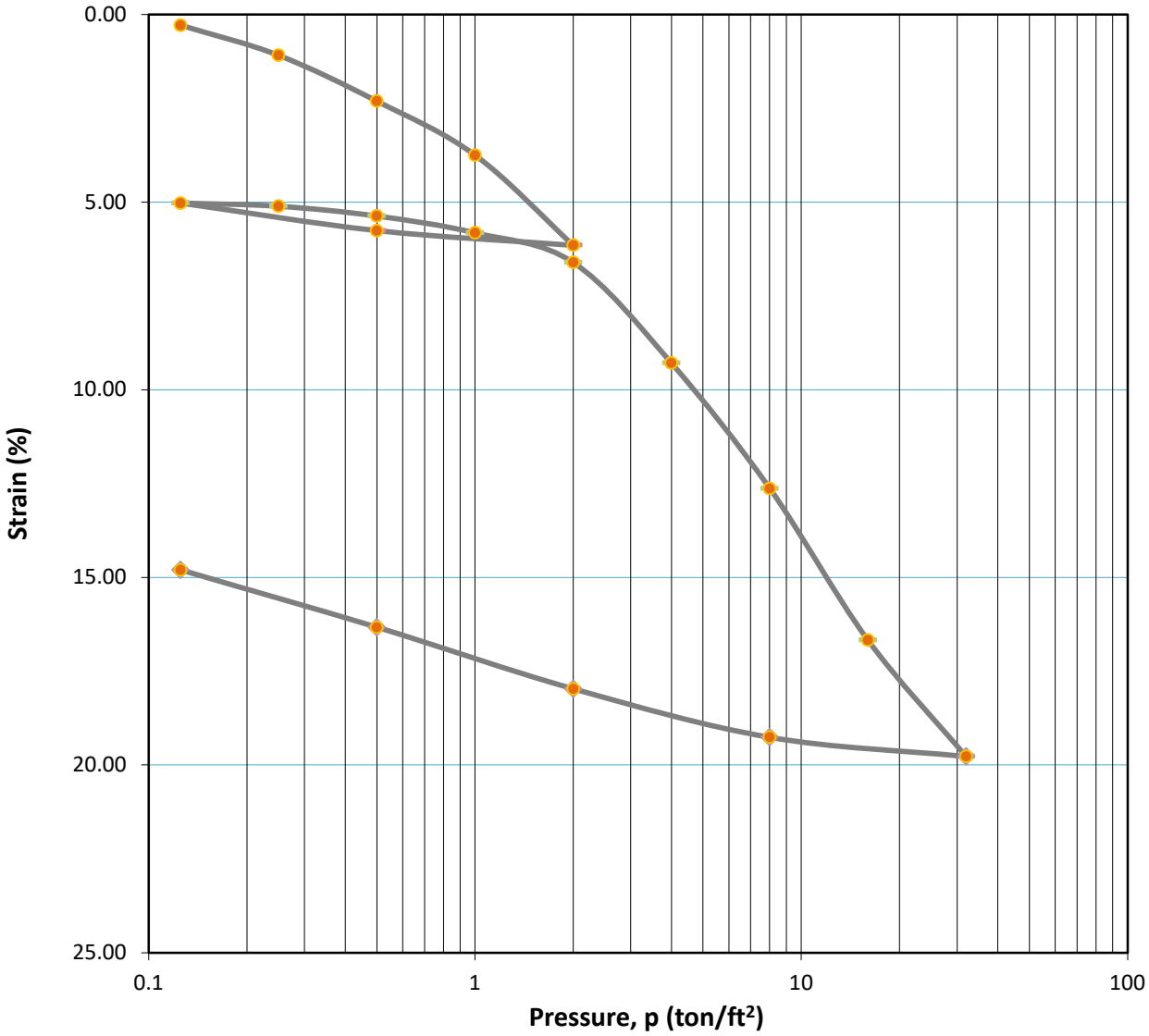
## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| **Moisture (%):** | 27.8 | 21.1 | **Liquid Limits:** | 25 | **Test Date:** | 9/4/2025 |
| **Dry Density (pcf):** | 94.2 | 86.0 | **Plastic Limits:** | 15 | | |
| **Saturation (%):** | 95.0 | 59.3 | **Plasticity Index (%):** | 10 | | |
| **Void Ratio:** | 0.79 | 0.96 | **Specific Gravity:** | 2.703 | MEASURED | |

| | | | | |
|---|---|---|---|---|
| **Sample Description:** | Lean Clay with Sand | | | |
| **Project Number:** | 1017406 | **Depth:** | 8.0-8.5 | **Remarks:** |
| **Sample Number:** | ST-2 | **Boring Number:** | B-126A | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |

# CONSOLIDATION TEST

## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 1017406
**Project Number:** 1017406
**Test Date:** 9/4/2025

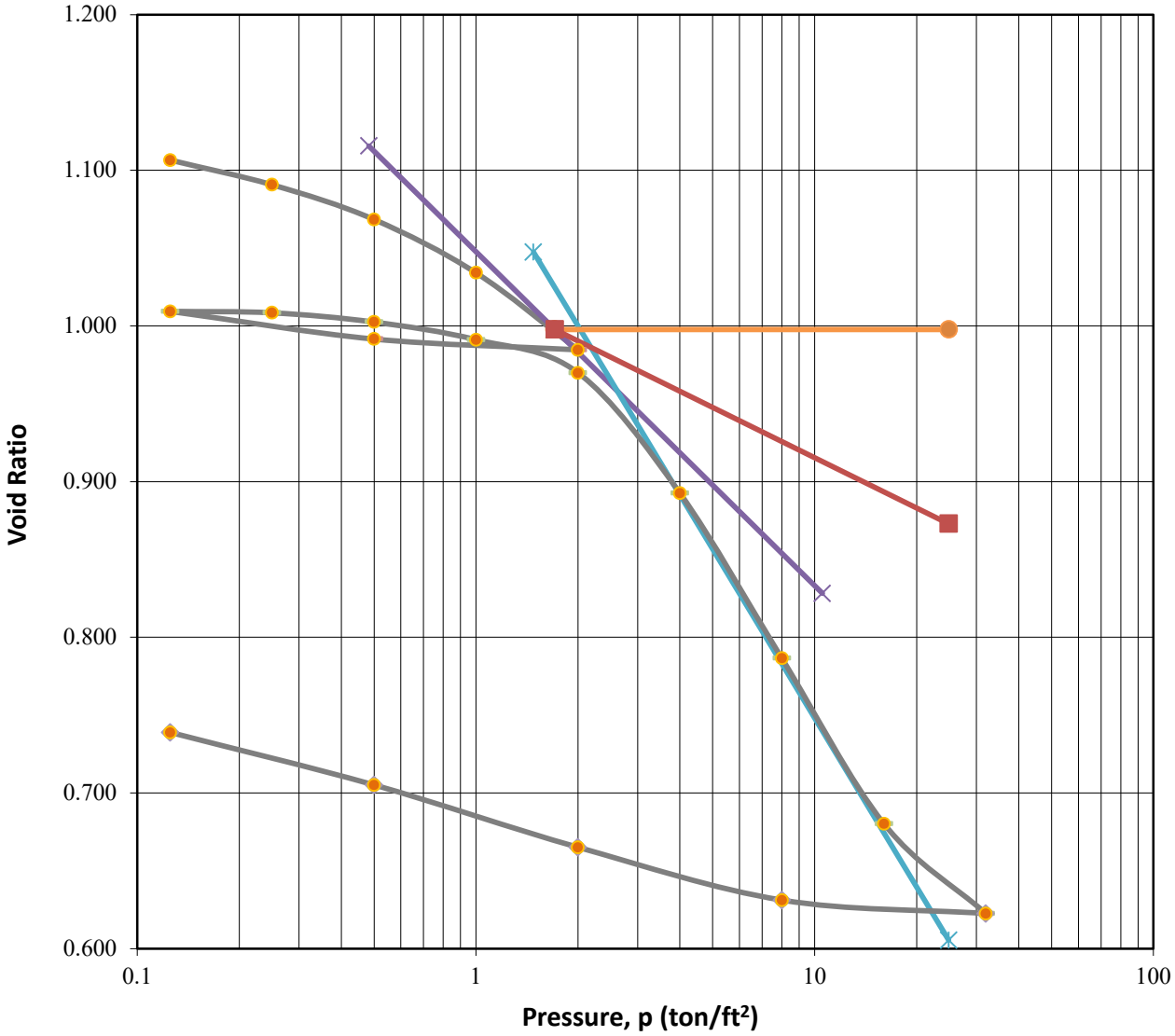
**Sample Number:** ST-2
**Boring Number:** B-126A
**Depth:** 8.0-8.5
**Sample Type:** Undisturbed

**Sample Description:** Lean Clay with Sand
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv $in^2$/Min | t50 Cv $in^2$/Min |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 0.7905 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | 0.0029 | 0.9971 | 0.4376 | 0.2900 | 0.7821 | 0.0102 | 0.0000 | 0.0000 | 0.0000 |
| 1 | 0.250 | 0.0109 | 0.9891 | 0.4296 | 1.0900 | 0.7678 | 0.0418 | 0.0076 | 0.0827 | 0.1037 |
| 2 | 0.500 | 0.0231 | 0.9769 | 0.4174 | 2.3100 | 0.7460 | 0.0769 | 0.2051 | 0.0439 | 0.0037 |
| 3 | 1.000 | 0.0375 | 0.9625 | 0.4030 | 3.7500 | 0.7203 | 0.0507 | 0.0115 | 0.0646 | 0.0620 |
| 4 | 2.000 | 0.0615 | 0.9385 | 0.3790 | 6.1500 | 0.6774 | 0.0644 | 0.0123 | 0.0483 | 0.0533 |
| 5 | 0.500 | 0.0576 | 0.9424 | 0.3829 | 5.7600 | 0.6844 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.125 | 0.0503 | 0.9497 | 0.3902 | 5.0300 | 0.6974 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.250 | 0.0511 | 0.9489 | 0.3894 | 5.1100 | 0.6960 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.500 | 0.0537 | 0.9463 | 0.3868 | 5.3700 | 0.6913 | 0.0497 | 0.0105 | 0.0636 | 0.0626 |
| 9 | 1.000 | 0.0582 | 0.9418 | 0.3823 | 5.8200 | 0.6833 | 0.0311 | 0.0068 | 0.1007 | 0.0941 |
| 10 | 2.000 | 0.0661 | 0.9339 | 0.3744 | 6.6100 | 0.6692 | 0.0345 | 0.0064 | 0.0894 | 0.0977 |
| 11 | 4.000 | 0.0929 | 0.9071 | 0.3476 | 9.2900 | 0.6213 | 0.0710 | 0.1540 | 0.0410 | 0.0036 |
| 12 | 8.000 | 0.1263 | 0.8737 | 0.3142 | 12.6300 | 0.5616 | 0.0518 | 0.0124 | 0.0521 | 0.0391 |
| 13 | 16.000 | 0.1667 | 0.8333 | 0.2738 | 16.6700 | 0.4894 | 0.0382 | 0.0093 | 0.0642 | 0.0424 |
| 14 | 32.000 | 0.1977 | 0.8023 | 0.2428 | 19.7700 | 0.4340 | 0.0455 | 0.0107 | 0.0500 | 0.0299 |
| 15 | 8.000 | 0.1926 | 0.8074 | 0.2479 | 19.2600 | 0.4431 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 2.000 | 0.1797 | 0.8203 | 0.2608 | 17.9700 | 0.4661 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | 0.1633 | 0.8367 | 0.2772 | 16.3300 | 0.4955 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | -0.0076 | 1.0076 | 0.4481 | 14.8000 | 0.5400 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: W. Stumph

## CONSOLIDATION TEST




**Test Date:** 7/8/2021

### Summary of Consolidation Test Results

| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **0.49** | **Compression Index, $C_c$** | **0.36** |
| **Preconsol. Press., $P_c$ (tsf)** | **2.18** | **Rebound Index, $C_r$** | **0.02** |
| **Over Consolidation Ratio** | **4.46** | | |

| | | | | |
|---|---|---|---|---|
| **Soil Description:** | Lean Clay | | | |
| **Project Number:** | 10174706 | **Depth:** | 8.0-10.0 | **Remarks:** |
| **Sample Number:** | ST-2 | **Boring Number:** | B-6 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |



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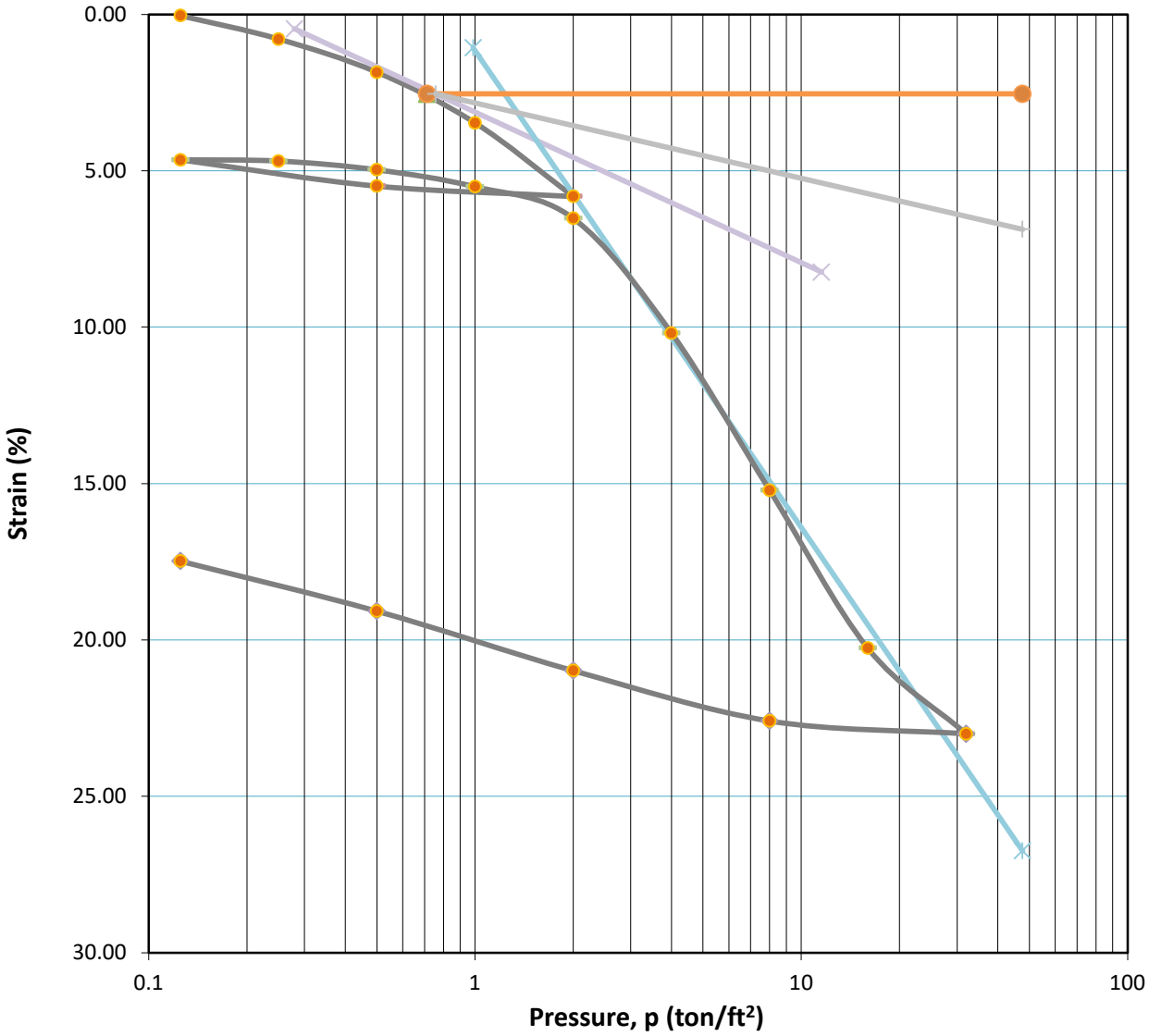
## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| **Moisture (%):** | 36.2 | 27.0 | **Liquid Limits:** | 44 | **Test Date:** | 7/8/2021 |
| **Dry Density (pcf):** | 79.7 | 97.3 | **Plastic Limits:** | 21 | | |
| **Saturation (%):** | 87.7 | 100.0 | **Plasticity Index (%):** | 23 | | |
| **Void Ratio:** | 1.11 | 0.73 | **Specific Gravity:** | 2.694 | MEASURED | |

| | | | | |
|---|---|---|---|---|
| **Sample Description:** | Lean Clay | | | |
| **Project Number:** | 10174706 | **Depth:** | 8.0-10.0 | **Remarks:** |
| **Sample Number:** | ST-2 | **Boring Number:** | B-6 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |

# CONSOLIDATION TEST

## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 10174706
**Project Number:** 10174706
**Test Date:** 7/8/2021

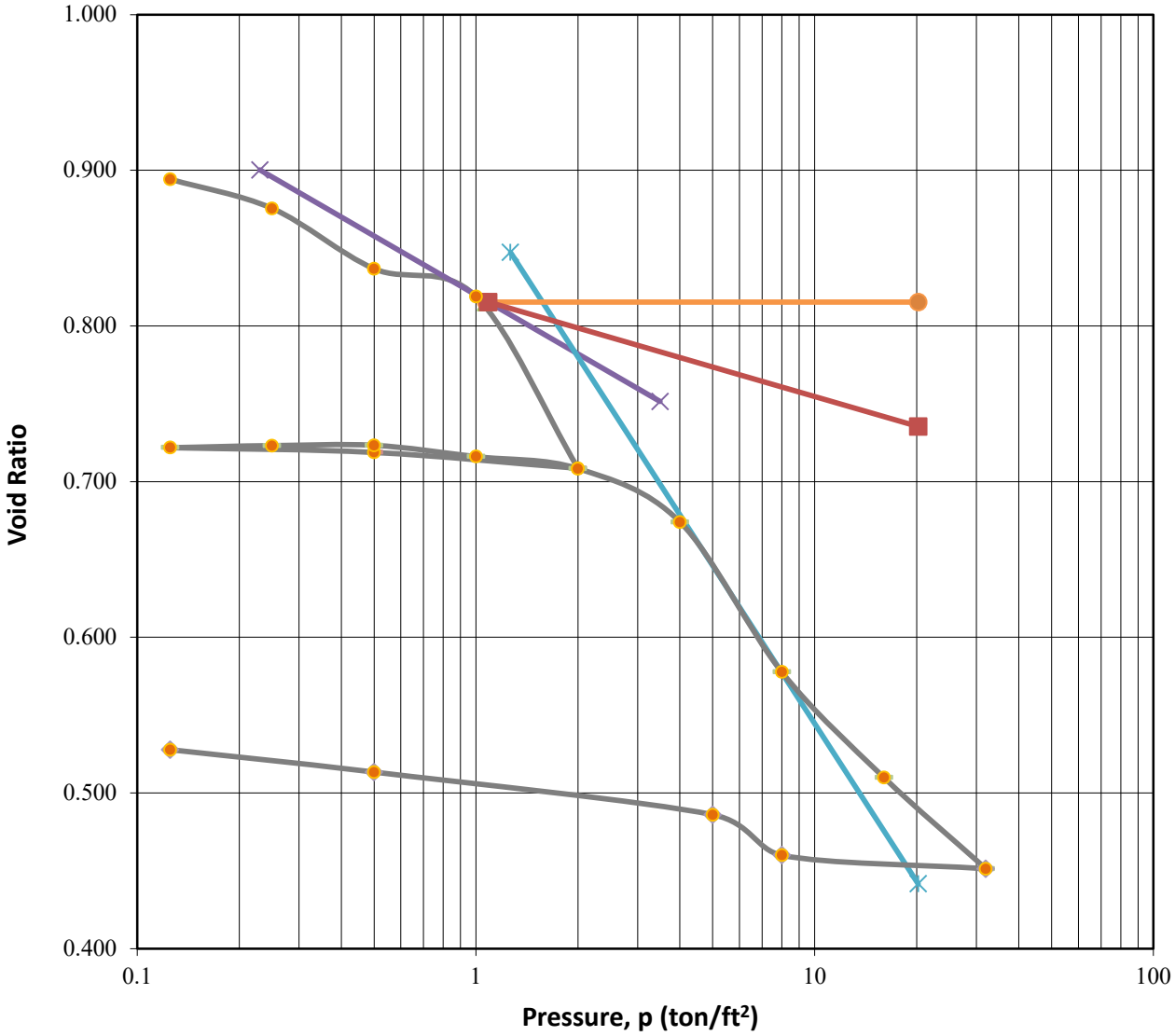
**Sample Number:** ST-2
**Boring Number:** B-6
**Depth:** 8.0-10.0
**Sample Type:** Undisturbed

**Sample Description:** Lean Clay
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv ft²/Day | t50 Cv ft²/Day |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 1.1111 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | 0.0004 | 0.9996 | 0.5251 | 0.0400 | 1.1065 | 0.0596 | 0.0127 | 0.5927 | 0.6460 |
| 1 | 0.250 | 0.0079 | 0.9921 | 0.5176 | 0.7900 | 1.0907 | 0.0233 | 0.0044 | 1.4902 | 1.8217 |
| 2 | 0.500 | 0.0185 | 0.9815 | 0.5070 | 1.8500 | 1.0683 | 0.0350 | 0.0080 | 0.9722 | 0.9516 |
| 3 | 1.000 | 0.0347 | 0.9653 | 0.4908 | 3.4700 | 1.0342 | 0.0180 | 0.0037 | 1.8259 | 1.9199 |
| 4 | 2.000 | 0.0582 | 0.9418 | 0.4673 | 5.8200 | 0.9847 | 0.0214 | 0.0050 | 1.4639 | 1.3051 |
| 5 | 0.500 | 0.0549 | 0.9451 | 0.4706 | 5.4900 | 0.9916 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.125 | 0.0465 | 0.9535 | 0.4790 | 4.6500 | 1.0093 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.250 | 0.0469 | 0.9531 | 0.4786 | 4.6900 | 1.0085 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.500 | 0.0497 | 0.9503 | 0.4758 | 4.9700 | 1.0026 | 0.0516 | 0.0090 | 0.6188 | 0.7443 |
| 9 | 1.000 | 0.0551 | 0.9449 | 0.4704 | 5.5100 | 0.9912 | 0.0485 | 0.0111 | 0.6510 | 0.5862 |
| 10 | 2.000 | 0.0652 | 0.9348 | 0.4603 | 6.5200 | 0.9699 | 0.0245 | 0.0049 | 1.2625 | 1.2833 |
| 11 | 4.000 | 0.1019 | 0.8981 | 0.4236 | 10.1900 | 0.8926 | 0.0197 | 0.0044 | 1.4453 | 1.2458 |
| 12 | 8.000 | 0.1522 | 0.8478 | 0.3733 | 15.2200 | 0.7866 | 0.0948 | 0.0213 | 0.2679 | 0.1987 |
| 13 | 16.000 | 0.2026 | 0.7974 | 0.3229 | 20.2600 | 0.6804 | 0.1960 | 0.0396 | 0.1146 | 0.0782 |
| 14 | 32.000 | 0.2300 | 0.7700 | 0.2955 | 23.0000 | 0.6226 | 0.1045 | 0.0244 | 0.2004 | 0.1021 |
| 15 | 8.000 | 0.2259 | 0.7741 | 0.2996 | 22.5900 | 0.6313 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 2.000 | 0.2098 | 0.7902 | 0.3157 | 20.9800 | 0.6652 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | 0.1908 | 0.8092 | 0.3347 | 19.0800 | 0.7053 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | 0.1748 | 0.8252 | 0.3507 | 17.4800 | 0.7390 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: James R. Hilt

# CONSOLIDATION TEST




**Test Date:** 7/8/2021

## Summary of Consolidation Test Results

| | | | |
|---|---|---|---|
| **Overburden Press. (tsf)** | **1.10** | **Compression Index, $C_c$** | **0.34** |
| **Preconsol. Press., $P_c$ (tsf)** | **1.71** | **Rebound Index, $C_r$** | **0.01** |
| **Over Consolidation Ratio** | **1.56** | | |

| | | | | |
|---|---|---|---|---|
| **Soil Description:** | Silt | | | |
| **Project Number:** | 10174706 | **Depth:** | 18.0-20.0 | **Remarks:** |
| **Sample Number:** | ST-4 | **Boring Number:** | B-6 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |



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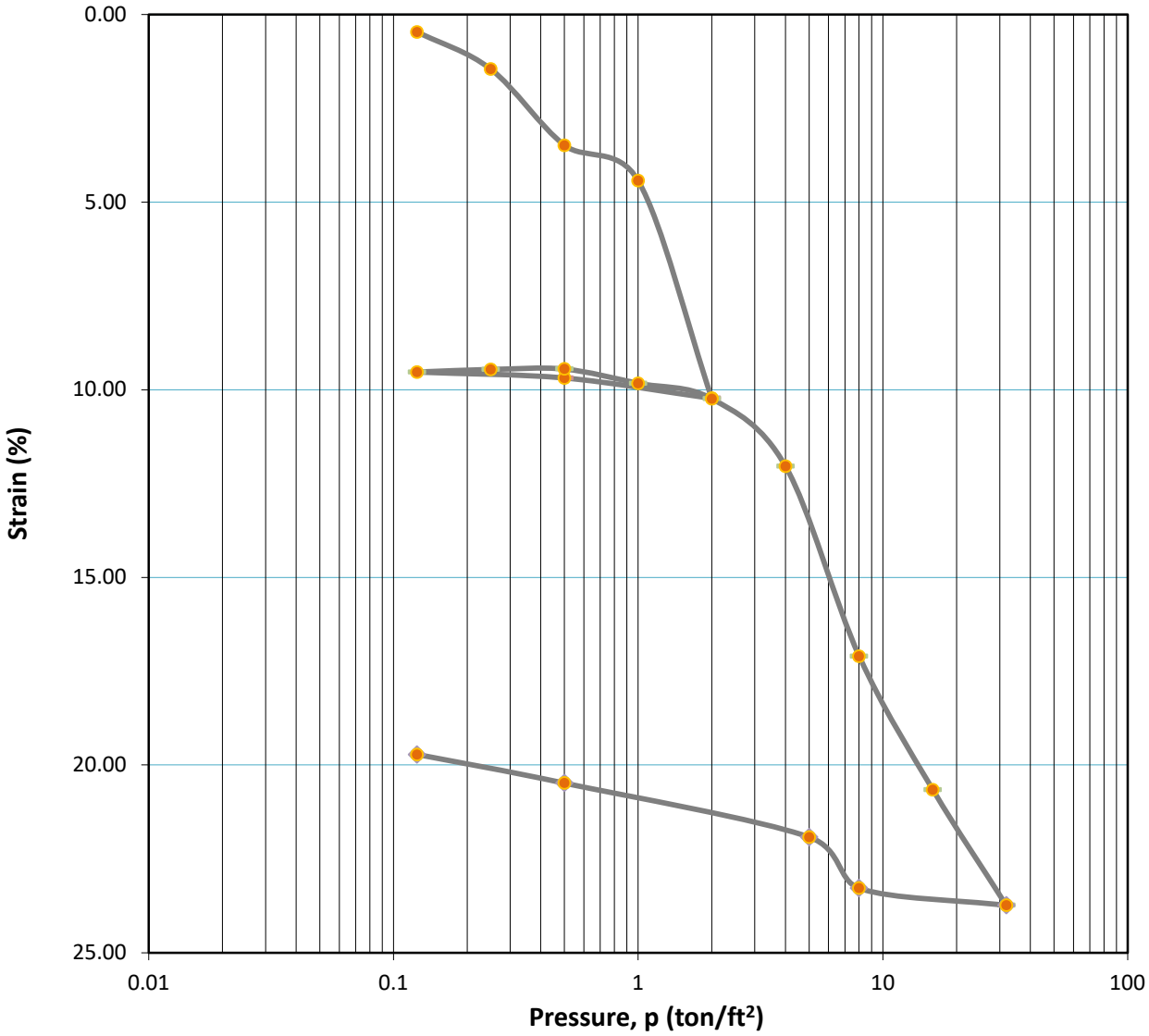
## CONSOLIDATION TEST




| | Before | After | | | | |
|---|---|---|---|---|---|---|
| **Moisture (%):** | 33.7 | 21.7 | **Liquid Limits:** | 30 | **Test Date:** | 7/8/2021 |
| **Dry Density (pcf):** | 86.8 | 103.4 | **Plastic Limits:** | 18 | | |
| **Saturation (%):** | 98.5 | 95.9 | **Plasticity Index (%):** | 12 | | |
| **Void Ratio:** | 0.91 | 0.60 | **Specific Gravity:** | 2.650 | ASSUMED | |

| | | | | |
|---|---|---|---|---|
| **Sample Description:** | Silt | | | |
| **Project Number:** | 10174706 | **Depth:** | 18.0-20.0 | **Remarks:** |
| **Sample Number:** | ST-4 | **Boring Number:** | B-6 | ASTM D2435/D2435M-11 |
| **Project:** | KY Cairo Bridge | | | |
| **Client:** | KYTC | | | |
| **Location:** | Kentucky | | | |



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# CONSOLIDATION TEST

## Test Summary

**Project:** KY Cairo Bridge
**Location:** Kentucky
**Job Number:** 10174706
**Project Number:** 10174706
**Test Date:** 7/8/2021

**Sample Number:** ST-4
**Boring Number:** B-6
**Depth:** 18.0-20.0
**Sample Type:** Undisturbed

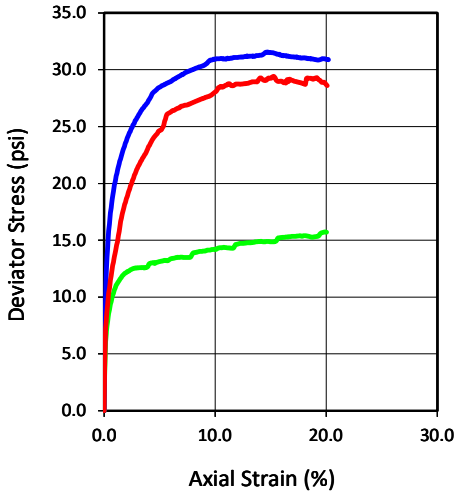
**Sample Description:** Silt
**Remarks:**

| Index | Load Sequence tsf | Change in Height in | Specimen Height in | Height of Void in | Vertical Strain | Void Ratio | t90 Fitting Time Hr | t50 Fitting Time Hr | t90 Cv ft²/Day | t50 Cv ft²/Day |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 | 0.9066 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0 | 0.125 | 0.0047 | 0.9953 | 0.4699 | 0.4700 | 0.8943 | 0.0236 | 0.0051 | 1.4841 | 1.5941 |
| 1 | 0.250 | 0.0146 | 0.9854 | 0.4600 | 1.4600 | 0.8754 | 0.1081 | 0.0250 | 0.3174 | 0.3105 |
| 2 | 0.500 | 0.0349 | 0.9651 | 0.4397 | 3.4900 | 0.8368 | 1.1802 | 0.0656 | 0.0279 | 0.1166 |
| 3 | 1.000 | 0.0443 | 0.9557 | 0.4303 | 4.4300 | 0.8189 | 0.0179 | 0.0042 | 1.7997 | 1.6517 |
| 4 | 2.000 | 0.1023 | 0.8977 | 0.3723 | 10.2300 | 0.7085 | 1.6015 | 0.3100 | 0.0178 | 0.0179 |
| 5 | 0.500 | 0.0969 | 0.9031 | 0.3777 | 9.6900 | 0.7188 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.125 | 0.0953 | 0.9047 | 0.3793 | 9.5300 | 0.7218 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.250 | 0.0946 | 0.9054 | 0.3800 | 9.4600 | 0.7232 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.500 | 0.0945 | 0.9055 | 0.3801 | 9.4500 | 0.7234 | 0.0328 | 0.0072 | 0.8827 | 0.7547 |
| 9 | 1.000 | 0.0983 | 0.9017 | 0.3763 | 9.8300 | 0.7161 | 0.2043 | 0.0357 | 0.1406 | 0.1490 |
| 10 | 2.000 | 0.1024 | 0.8976 | 0.3722 | 10.2400 | 0.7083 | 0.0282 | 0.0059 | 1.0079 | 0.8920 |
| 11 | 4.000 | 0.1204 | 0.8796 | 0.3542 | 12.0400 | 0.6741 | 0.0943 | 0.0237 | 0.2898 | 0.2053 |
| 12 | 8.000 | 0.1710 | 0.8290 | 0.3036 | 17.1000 | 0.5778 | 0.6028 | 0.1353 | 0.0403 | 0.0282 |
| 13 | 16.000 | 0.2066 | 0.7934 | 0.2680 | 20.6600 | 0.5100 | 0.2151 | 0.0582 | 0.1034 | 0.0518 |
| 14 | 32.000 | 0.2374 | 0.7626 | 0.2372 | 23.7400 | 0.4514 | 0.7430 | 0.0187 | 0.0277 | 0.2550 |
| 15 | 8.000 | 0.2328 | 0.7672 | 0.2418 | 23.2800 | 0.4602 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 5.000 | 0.2192 | 0.7808 | 0.2554 | 21.9200 | 0.4860 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.500 | 0.2048 | 0.7952 | 0.2698 | 20.4800 | 0.5134 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.125 | 0.1972 | 0.8028 | 0.2774 | 19.7200 | 0.5279 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Approved By: James R. Hiett

## Consolidated Undrained Triaxial Test (ASTM D4767)

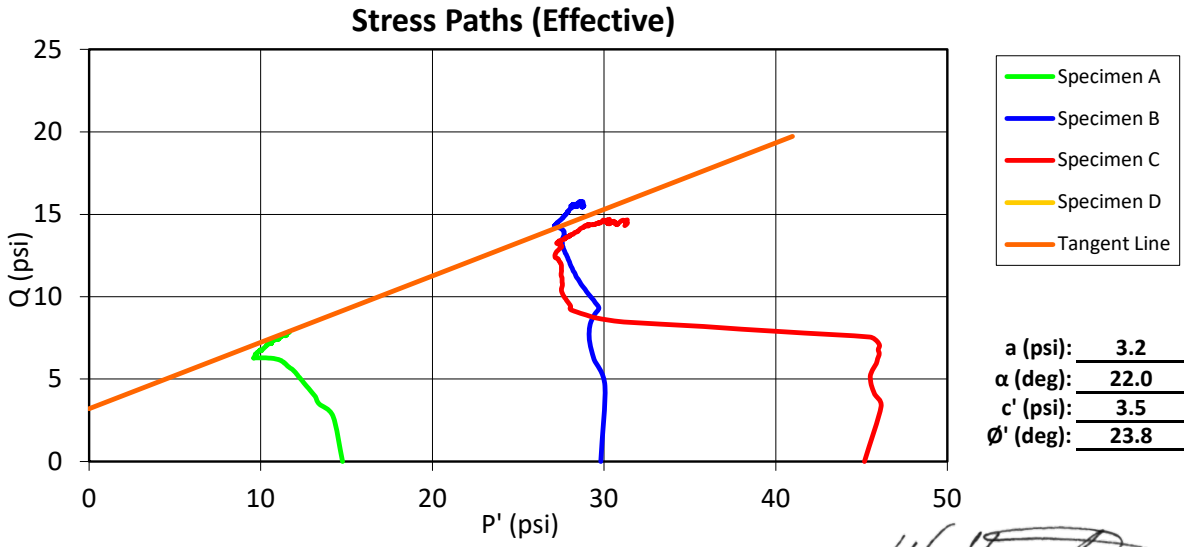
| | | | |
|---|---|---|---|
| PROJECT NAME : | KY Cairo Bridge | SAMPLE NO. : | ST-1, ST-5, ST-6 |
| PROJECT NO. : | 10174706 | SAMPLE DEPTH : | 4.5-5.0, 24.5-25.0, 29.5-30.0 |
| PROJECT LOCATION : | Kentucky | SAMPLE TYPE : | Undisturbed |
| BORING NUMBER : | B-118 | DESCRIPTION : | Lean Clay with Sand, Lean Clay, Silt |
| REMARKS : | 0 | TEST TYPE : | Consolidated Undrained |




| Initial | Specimen A | B | C | D |
|---|---|---|---|---|
| Water Content (%) | 24.9 | 31.5 | 32.9 | |
| Dry Density (pcf) | 93.8 | 91.5 | 90.3 | |
| Saturation (%) | 87.5 | 100..0 | 100.0 | |
| Void Ratio | 0.748 | 0.757 | 0.878 | |
| Diameter (in) | 2.802 | 2.828 | 2.844 | |
| Height (in) | 5.829 | 5.824 | 5.841 | |
| Specific Gravity | 2.63 | 2.58 | 2.72 | |
| Liquid Limit | 31 | 43 | 42 | |
| Plastic Limit | 19 | 26 | 31 | |
| **After Consolidation** | **A** | **B** | **C** | **D** |
| B-Value | 0.95 | 1.00 | 0.97 | |
| Water Content (%) | 28.3 | 28.5 | 30.2 | |
| Dry Density (pcf) | 93.9 | 91.8 | 90.6 | |
| Saturation (%) | 99.4 | 97.7 | 94.2 | |
| Void Ratio | 0.747 | 0.751 | 0.871 | |
| Effective Stress (psi) | 15.0 | 30.0 | 45.0 | |
| Back Press. (psi) | 59.4 | 45.0 | 78.8 | |
| Rate of Strain | 0.020 | 0.020 | 0.020 | |

| Maximum Deviator Stress Criterion | |
|---|---|
| c (psi) | 2.4 |
| Ø (deg) | 14.2 |
| c' (psi) | 3.3 |
| Ø' (deg) | 24.6 |

| After Shear | A | B | C | D |
|---|---|---|---|---|
| σ'1 at Failure (psi) | 19.53 | 44.46 | 45.01 | |
| σ'3 at Failure (psi) | 3.80 | 12.90 | 15.60 | |

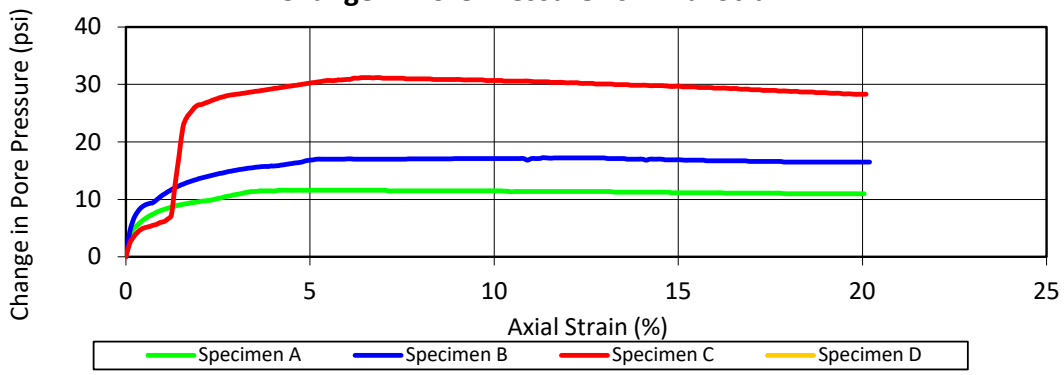



| | |
|---|---|
| a (psi): | 3.2 |
| α (deg): | 22.0 |
| c' (psi): | 3.5 |
| Ø' (deg): | 23.8 |

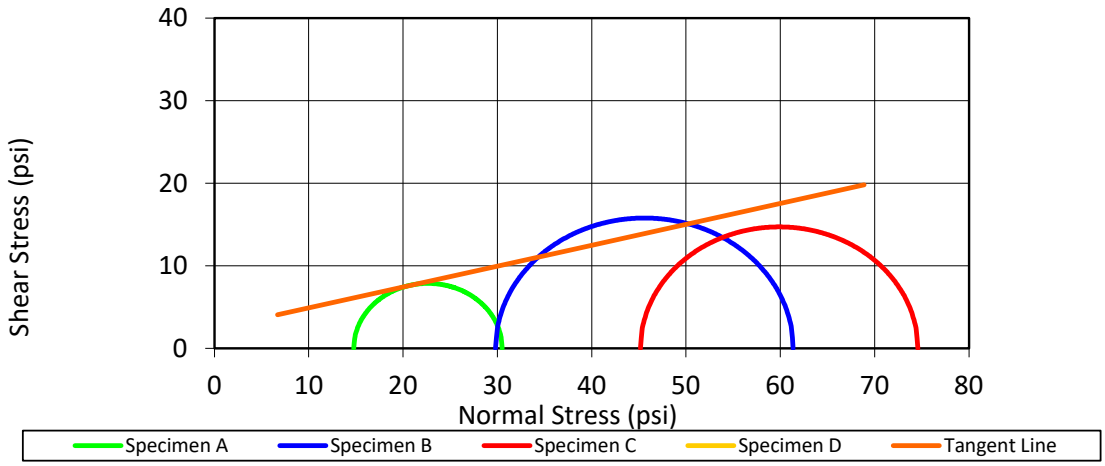
Approved By: W. Shuwalt

Date: 2/13/2026

## Change in Pore Pressure vs. Axial Strain

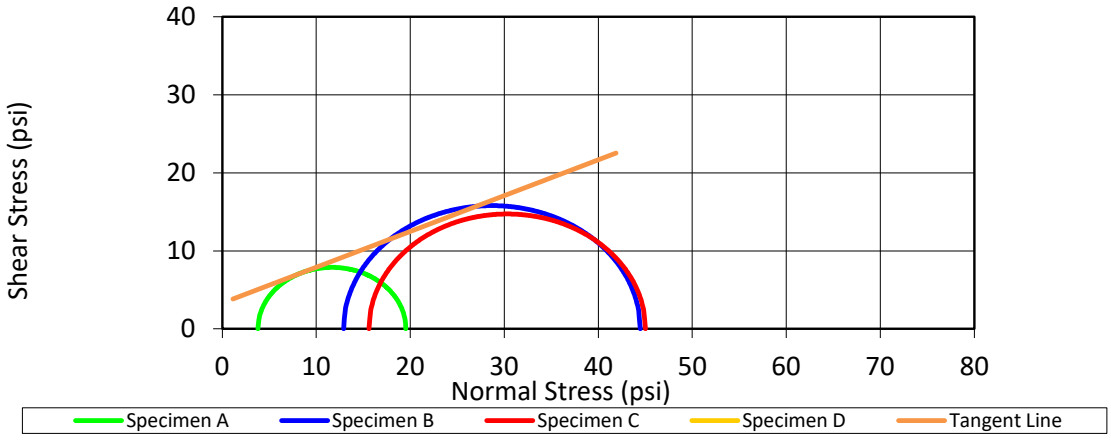



## Total Stress




**Maximium Deviator Stress Criterion:** **c (psi): 2.4** **Ø (deg): 14.2**

## Effective Stress

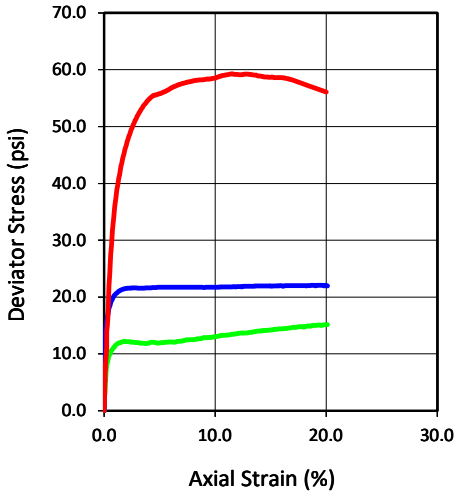



**Maximium Deviator Stress Criterion:** **c' (psi): 3.3** **Ø' (deg): 24.6**

## Consolidated Undrained Triaxial Test (ASTM D4767)

| | | | |
|---|---|---|---|
| PROJECT NAME : | KY Cairo Bridge | SAMPLE NO. : | ST-1, ST-2, ST-4 |
| PROJECT NO. : | 10174706 | SAMPLE DEPTH : | 3.5-4.0, 9.0-9.5, 19.1,19.6 |
| PROJECT LOCATION : | Kentucky | SAMPLE TYPE : | Undisturbed |
| BORING NUMBER : | B-120 | DESCRIPTION : | Lean Clay, Lean Clay, Lean Clay with Sand |
| REMARKS : | N/A | TEST TYPE : | Consolidated Undrained |

**Deviator Stress Vs. Axial Strain**

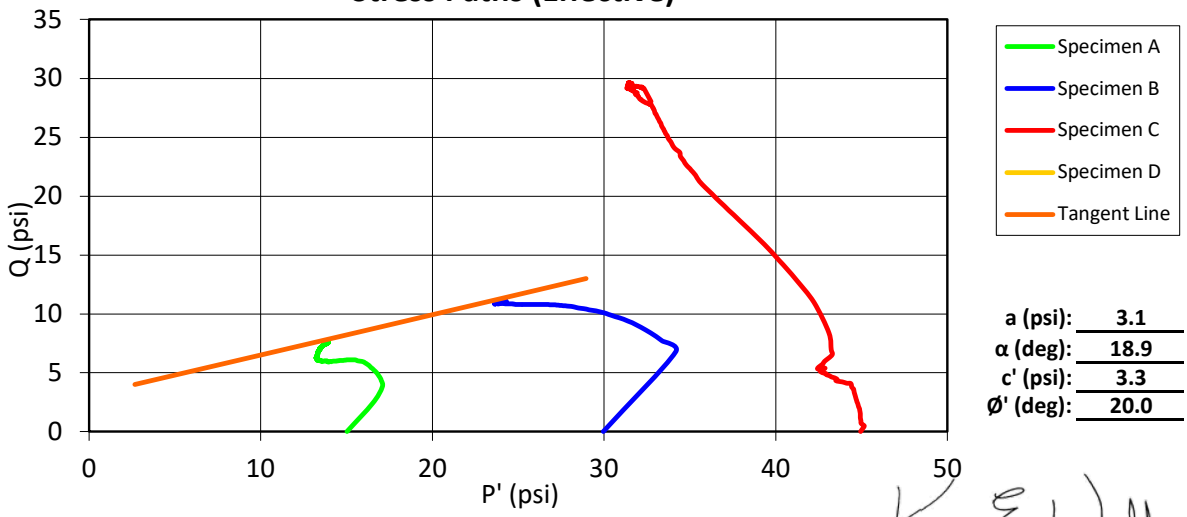



| Initial | A | B | C | D |
|---|---|---|---|---|
| Water Content (%) | 22.5 | 25.1 | 21.7 | |
| Dry Density (pcf) | 77.3 | 84.7 | 72.9 | |
| Saturation (%) | 54.5 | 68.4 | 45.2 | |
| Void Ratio | 1.047 | 0.995 | 1.272 | |
| Diameter (in) | 2.799 | 2.795 | 2.821 | |
| Height (in) | 5.991 | 5.998 | 5.937 | |
| Specific Gravity | 2.54 | 2.71 | 2.65 | |
| Liquid Limit | 44 | 42 | 35 | |
| Plastic Limit | 26 | 24 | 23 | |
| **After Consolidation** | **A** | **B** | **C** | **D** |
| B-Value | 1.00 | 0.95 | 1.00 | |
| Water Content (%) | 31.0 | 32.2 | 14.3 | |
| Dry Density (pcf) | 78.0 | 85.7 | 76.4 | |
| Saturation (%) | 76.5 | 89.8 | 32.5 | |
| Void Ratio | 1.029 | 0.972 | 1.167 | |
| Effective Stress (psi) | 15.0 | 30.0 | 45.0 | |
| Back Press. (psi) | 18.0 | 72.2 | 42.7 | |
| Rate of Strain | 0.020 | 0.020 | 0.020 | |

| Maximum Deviator Stress Criterion | |
|---|---|
| c (psi) | 3.2 |
| Ø (deg) | 11.5 |
| c' (psi) | 3.0 |
| Ø' (deg) | 19.9 |

| After Shear | A | B | C | D |
|---|---|---|---|---|
| σ'1 at Failure (psi) | 21.53 | 35.32 | 61.12 | |
| σ'3 at Failure (psi) | 6.37 | 13.25 | 1.83 | |

**Stress Paths (Effective)**

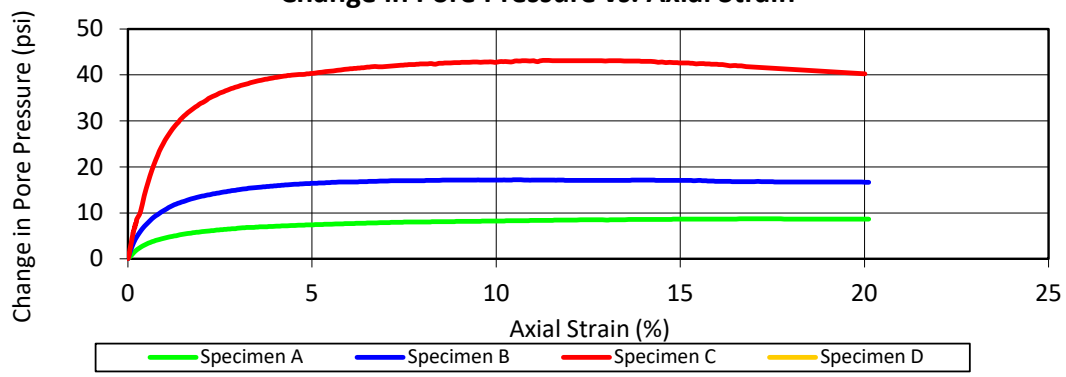



| | |
|---|---|
| a (psi): | 3.1 |
| α (deg): | 18.9 |
| c' (psi): | 3.3 |
| Ø' (deg): | 20.0 |

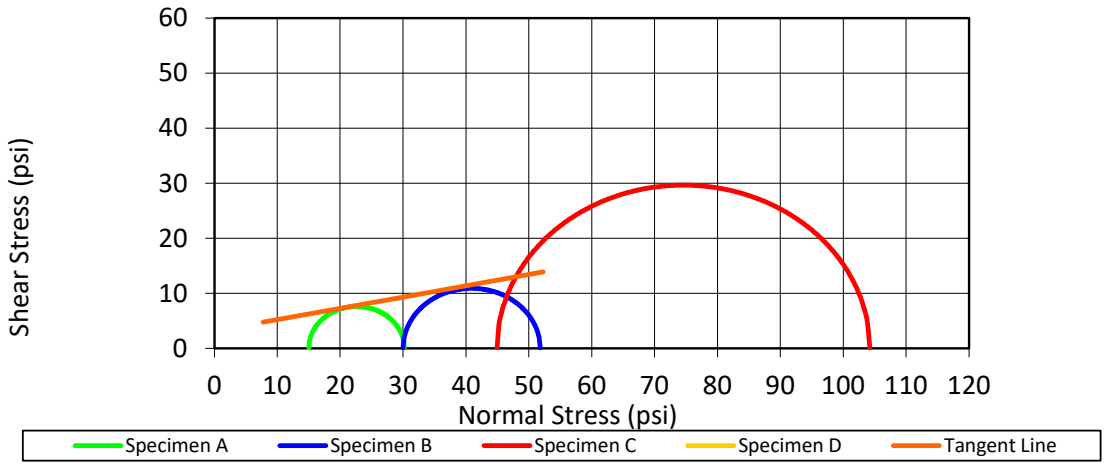
Approved By: Kevin E. Walker

Date: 2-25-26

## Change in Pore Pressure vs. Axial Strain

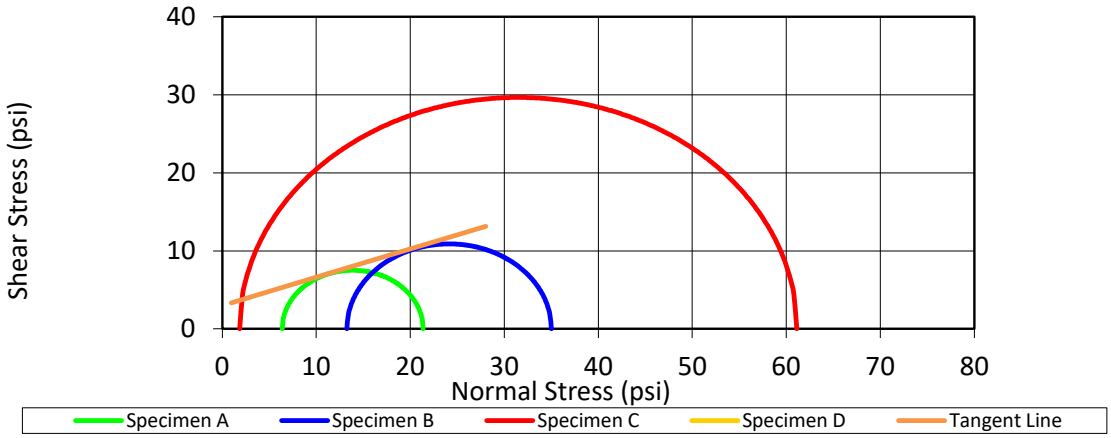



## Total Stress




**Maximium Deviator Stress Criterion:** **c (psi):** **3.2** **Ø (deg):** **11.5**

## Effective Stress

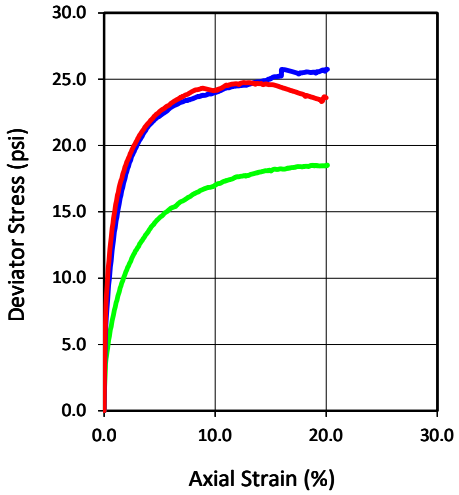



**Maximium Deviator Stress Criterion:** **c' (psi):** **3.0** **Ø' (deg):** **19.9**

## Consolidated Undrained Triaxial Test (ASTM D4767)

| | | | |
|---|---|---|---|
| PROJECT NAME : | Cairo Bridge | SAMPLE NO. : | ST-1; ST-2; ST-3 |
| PROJECT NO. : | 10174706 | SAMPLE DEPTH : | 4.5-5.0; 8.5-9.0; 14.0-14.5 |
| PROJECT LOCATION : | Kentucky | SAMPLE TYPE : | Undisturbed |
| BORING NUMBER : | B-121 | DESCRIPTION : | Silt; Lean Clay; Lean Clay |
| REMARKS : | N/A | TEST TYPE : | Consolidated Undrained |

**Deviator Stress Vs. Axial Strain**

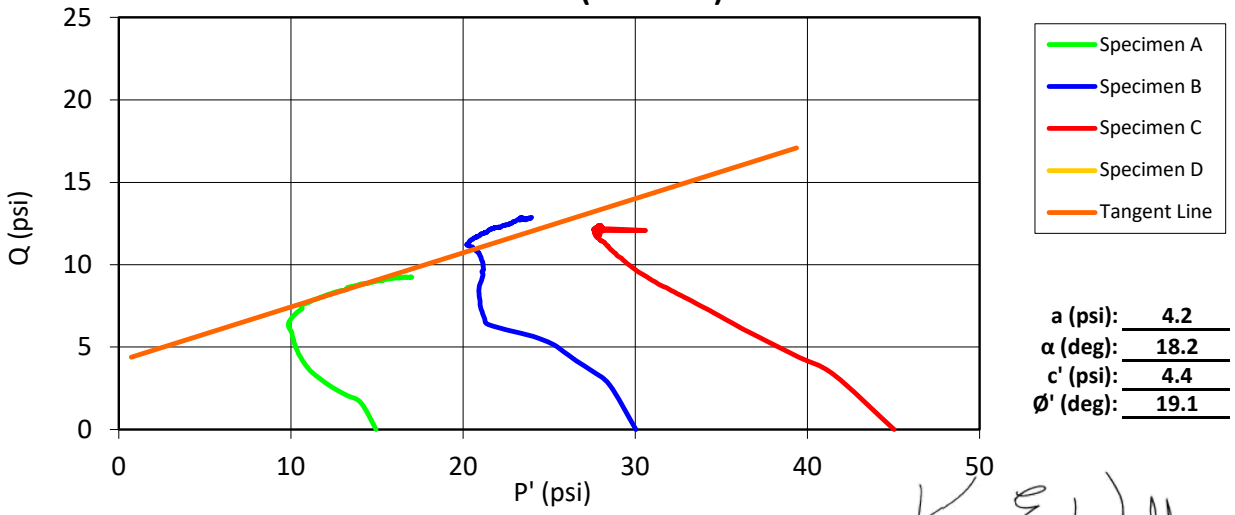



| Initial | Specimen A | B | C | D |
|---|---|---|---|---|
| Water Content (%) | 30.4 | 32.9 | 41.5 | |
| Dry Density (pcf) | 93.6 | 90.2 | 79.8 | |
| Saturation (%) | 98.1 | 99.2 | 100.0 | |
| Void Ratio | 0.869 | 0.923 | 1.128 | |
| Diameter (in) | 2.826 | 2.819 | 2.834 | |
| Height (in) | 5.825 | 5.828 | 5.866 | |
| Specific Gravity | 2.80 | 2.78 | 2.72 | |
| Liquid Limit | 43 | 43 | 44 | |
| Plastic Limit | 28 | 24 | 25 | |
| **After Consolidation** | **A** | **B** | **C** | **D** |
| B-Value | 0.98 | 0.96 | 1.00 | |
| Water Content (%) | 29.5 | 30.3 | 35.6 | |
| Dry Density (pcf) | 93.7 | 91.1 | 79.8 | |
| Saturation (%) | 95.4 | 93.0 | 85.9 | |
| Void Ratio | 0.867 | 0.905 | 1.128 | |
| Effective Stress (psi) | 15.0 | 30.0 | 45.0 | |
| Back Press. (psi) | 50.6 | 50.4 | 57.3 | |
| Rate of Strain | 0.020 | 0.020 | 0.020 | |

| Maximium Principal Stress Ratio | |
|---|---|
| c (psi) | 3.5 |
| Ø (deg) | 10.0 |
| c' (psi) | 4.1 |
| Ø' (deg) | 19.7 |

| After Shear | A | B | C | D |
|---|---|---|---|---|
| σ'1 at Failure (psi) | 18.24 | 33.00 | 40.24 | |
| σ'3 at Failure (psi) | 3.11 | 9.20 | 15.49 | |

**Stress Paths (Effective)**

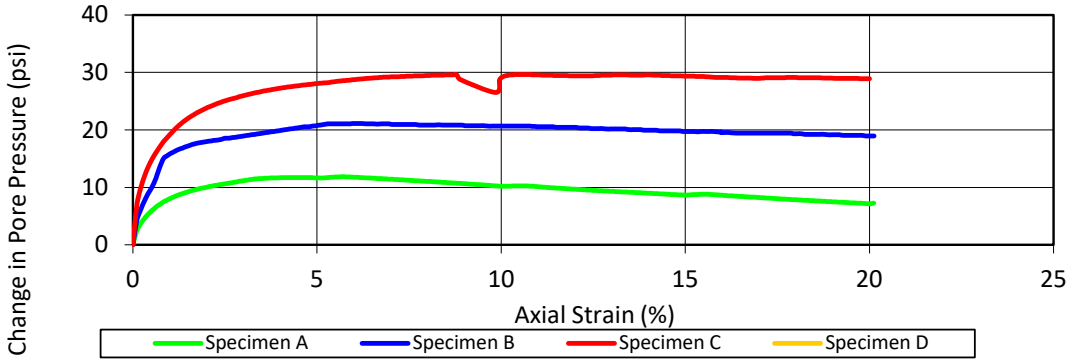



| | |
|---|---|
| a (psi): | 4.2 |
| α (deg): | 18.2 |
| c' (psi): | 4.4 |
| Ø' (deg): | 19.1 |

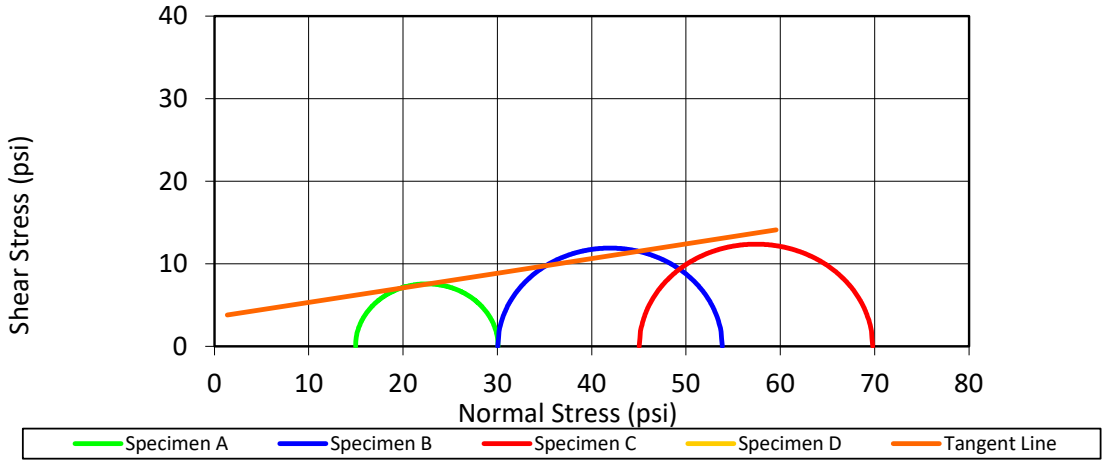
Approved By: Kevin E. Walker

Date: 2-23-26

## Change in Pore Pressure vs. Axial Strain

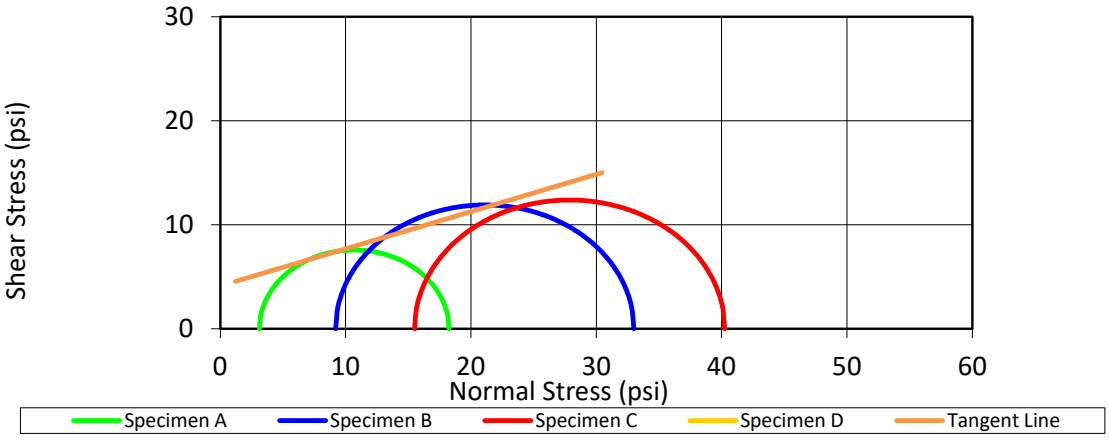



## Total Stress




**Maximum Principal Stress Ratio Criterion:** **c (psi):** **3.5** **Ø (deg):** **10.0**

## Effective Stress

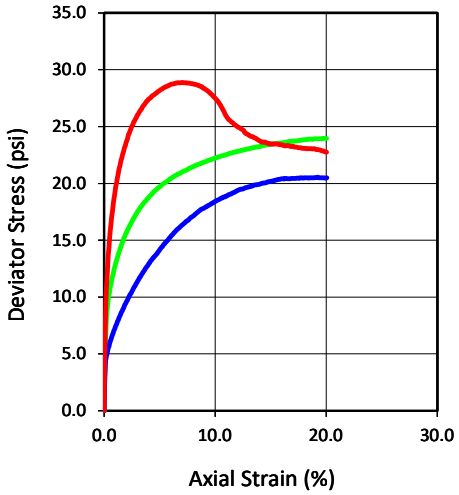



**Maximum Principal Stress Ratio Criterion:** **c' (psi):** **4.1** **Ø' (deg):** **19.7**

## Consolidated Undrained Triaxial Test (ASTM D4767)

| | | | |
|---|---|---|---|
| PROJECT NAME : | Cairo | SAMPLE NO. : | ST-2 |
| PROJECT NO. : | 10174706 | SAMPLE DEPTH : | 9.5-10.0 |
| PROJECT LOCATION : | Kentucky | SAMPLE TYPE : | Undisturbed |
| BORING NUMBER : | B-122 | DESCRIPTION : | Lean Clay, Silt |
| REMARKS : | ST-1 & ST-2 Lean Clay, ST-4 Silt | TEST TYPE : | Consolidated Undrained |

**Deviator Stress Vs. Axial Strain**

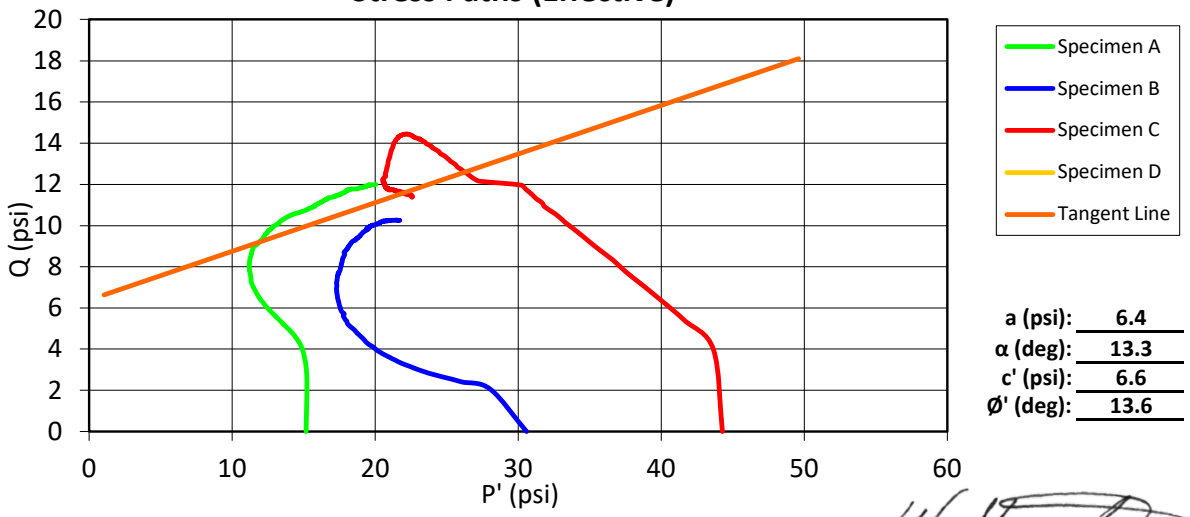



| Initial | Specimen A | B | C | D |
|---|---|---|---|---|
| Water Content (%) | 29.4 | 32.4 | 52.2 | |
| Dry Density (pcf) | 93.5 | 93.1 | 70.6 | |
| Saturation (%) | 98.4 | 112.1 | 101.0 | |
| Void Ratio | 0.809 | 0.757 | 1.402 | |
| Diameter (in) | 2.862 | 2.805 | 2.834 | |
| Height (in) | 5.814 | 5.840 | 5.861 | |
| Specific Gravity | 2.71 | 2.62 | 2.71 | |
| Liquid Limit | 43 | 43 | 45 | |
| Plastic Limit | 25 | 25 | 31 | |
| **After Consolidation** | **A** | **B** | **C** | **D** |
| B-Value | 0.95 | 1.00 | 0.99 | |
| Water Content (%) | 29.8 | 27.7 | 44.0 | |
| Dry Density (pcf) | 93.8 | 94.0 | 70.7 | |
| Saturation (%) | 100.0 | 98.2 | 85.7 | |
| Void Ratio | 0.802 | 0.741 | 1.396 | |
| Effective Stress (psi) | 15.0 | 30.0 | 45.0 | |
| Back Press. (psi) | 68.3 | 49.6 | 58.6 | |
| Rate of Strain | 0.020 | 0.020 | 0.020 | |

| Maximum Deviator Stress Criterion | |
|---|---|
| c (psi) | 4.4 |
| Ø (deg) | 9.0 |
| c' (psi) | 7.6 |
| Ø' (deg) | 6.9 |

| After Shear | A | B | C | D |
|---|---|---|---|---|
| σ'1 at Failure (psi) | 20.50 | 29.51 | 35.95 | |
| σ'3 at Failure (psi) | 2.55 | 9.63 | 7.32 | |

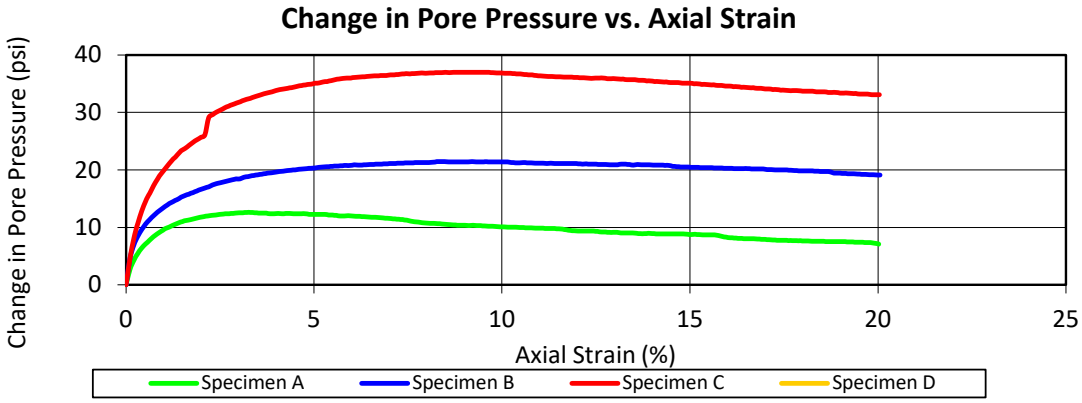
**Stress Paths (Effective)**

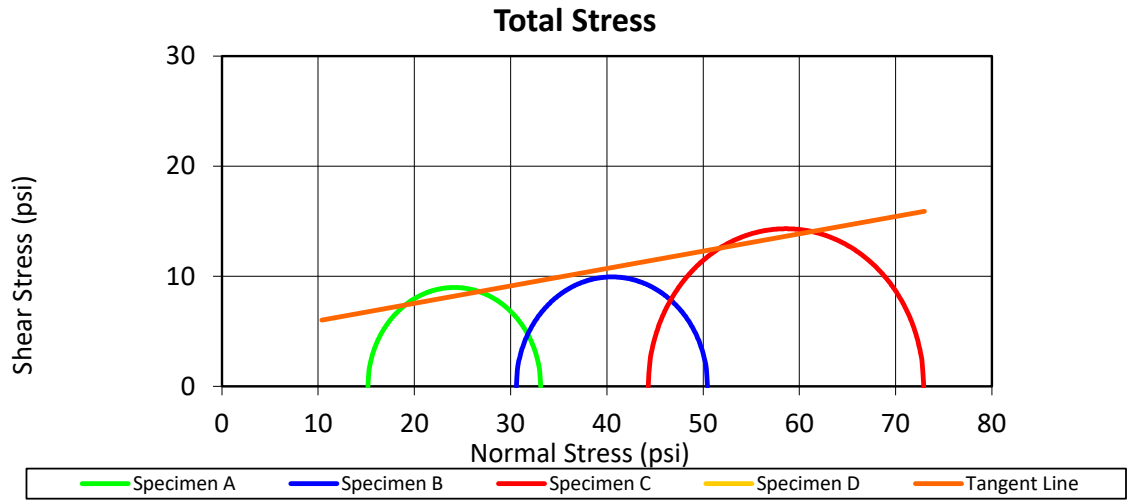



| | |
|---|---|
| a (psi): | 6.4 |
| α (deg): | 13.3 |
| c' (psi): | 6.6 |
| Ø' (deg): | 13.6 |

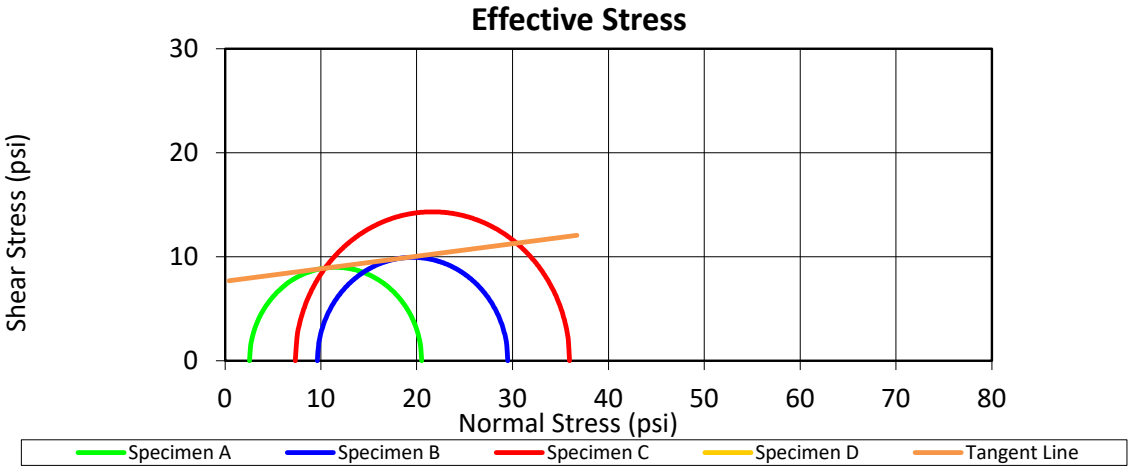
Approved By: W. Shumaker

Date: 2/12/2026




**Maximum Principle Stress Ratio Criterion:** **c (psi):** **4.4** **Ø (deg):** **9.0**

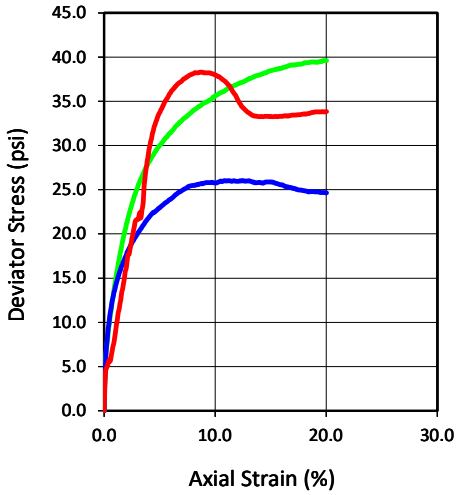



**Maximum Principle Stress Ratio Criterion:** **c' (psi):** **7.6** **Ø' (deg):** **6.9**

## Consolidated Undrained Triaxial Test (ASTM D4767)

| | | | |
|---|---|---|---|
| PROJECT NAME : | KY Cairo Bridge | SAMPLE NO. : | ST-5 |
| PROJECT NO. : | 10174706 | SAMPLE DEPTH : | 24.5-25.0 |
| PROJECT LOCATION : | Kentucky | SAMPLE TYPE : | Undisturbed |
| BORING NUMBER : | B-123 | DESCRIPTION : | Elastic Silt, Silt, & Sandy Silt |
| REMARKS : | 0 | TEST TYPE : | Consolidated Undrained |

**Deviator Stress Vs. Axial Strain**

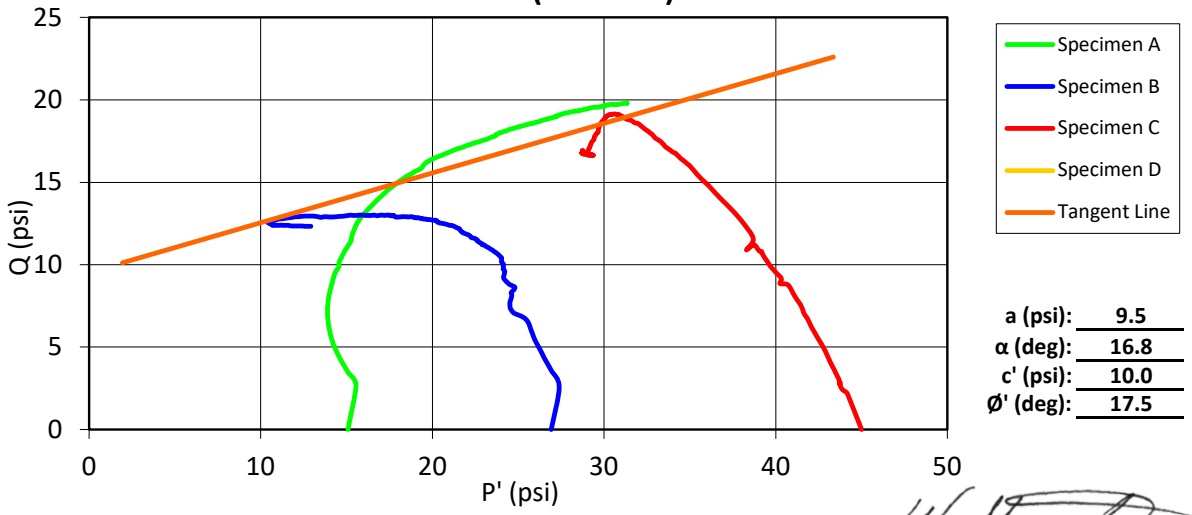



| Initial | Specimen A | B | C | D |
|---|---|---|---|---|
| Water Content (%) | 26.0 | 38.0 | 68.2 | |
| Dry Density (pcf) | 96.7 | 82.7 | 54.3 | |
| Saturation (%) | 97.1 | 95.9 | 87.7 | |
| Void Ratio | 0.709 | 1.107 | 2.083 | |
| Diameter (in) | 2.860 | 2.856 | 2.835 | |
| Height (in) | 5.917 | 5.812 | 5.992 | |
| Specific Gravity | 2.65 | 2.79 | 2.68 | |
| Liquid Limit | 50 | 41 | 44 | |
| Plastic Limit | 29 | 27 | 33 | |
| **After Consolidation** | **A** | **B** | **C** | **D** |
| B-Value | 0.95 | 0.98 | 1.00 | |
| Water Content (%) | 29.2 | 34.2 | 58.3 | |
| Dry Density (pcf) | 96.7 | 81.9 | 59.2 | |
| Saturation (%) | 100.0 | 84.7 | 85.5 | |
| Void Ratio | 0.709 | 1.127 | 1.826 | |
| Effective Stress (psi) | 15.0 | 30.0 | 45.0 | |
| Back Press. (psi) | 99.2 | 60.8 | 53.9 | |
| Rate of Strain | 0.020 | 0.020 | 0.020 | |

| Maximum Deviator Stress Criterion | |
|---|---|
| c (psi) | 1.9 |
| Ø (deg) | 15.6 |
| c' (psi) | 8.3 |
| Ø' (deg) | 22.2 |

| After Shear | A | B | C | D |
|---|---|---|---|---|
| σ'1 at Failure (psi) | 32.51 | 24.70 | 49.26 | |
| σ'3 at Failure (psi) | 2.93 | 0.01 | 11.15 | |

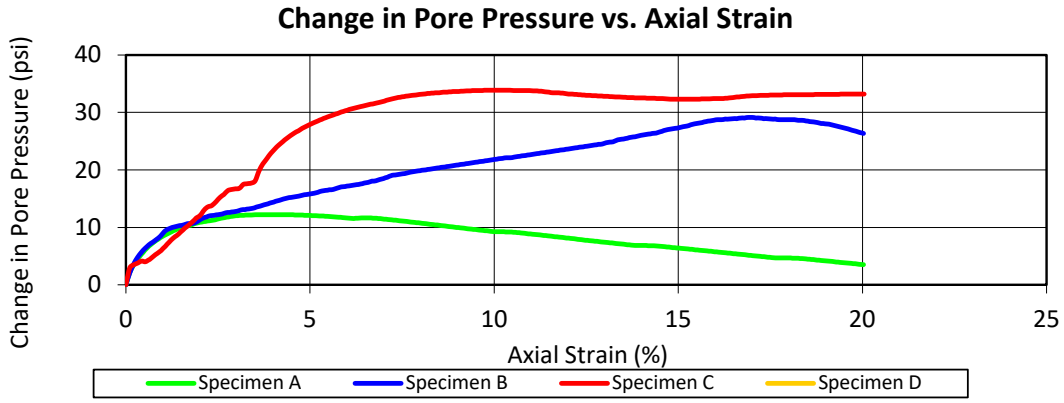
**Stress Paths (Effective)**

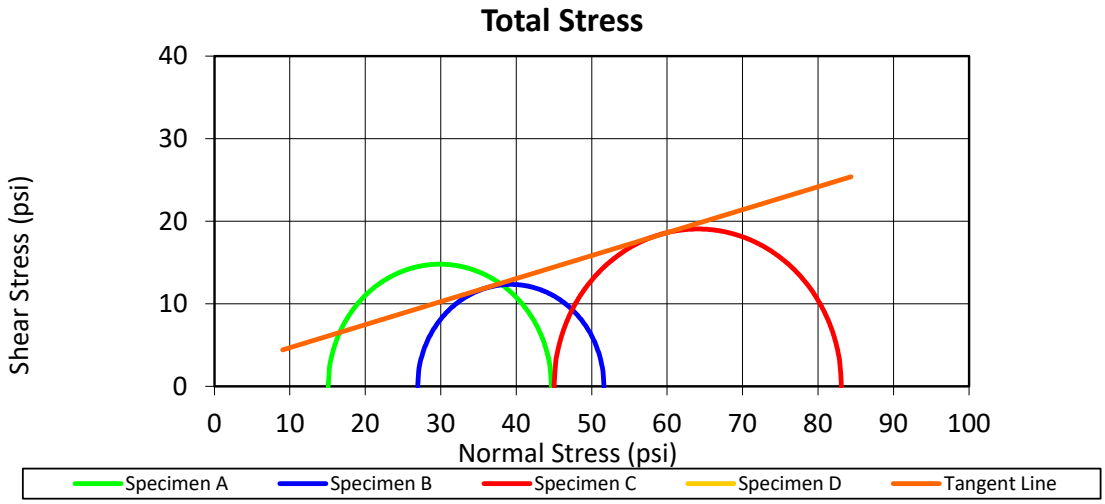



| | |
|---|---|
| **a (psi):** | **9.5** |
| **α (deg):** | **16.8** |
| **c' (psi):** | **10.0** |
| **Ø' (deg):** | **17.5** |

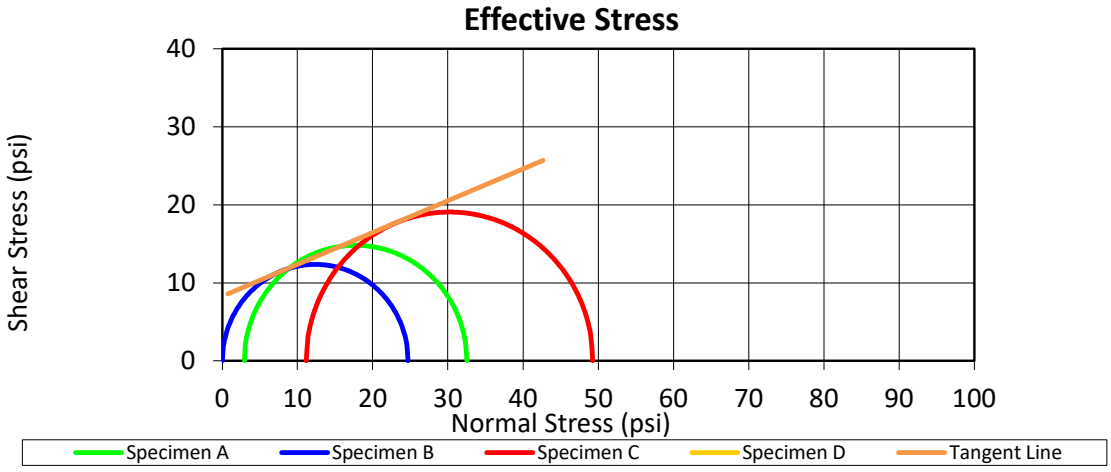
Approved By: W. Shumaker

Date: 2/12/2026




**Principle Stress Ratio Criterion:** **c (psi):** **1.9** **Ø (deg):** **15.6**

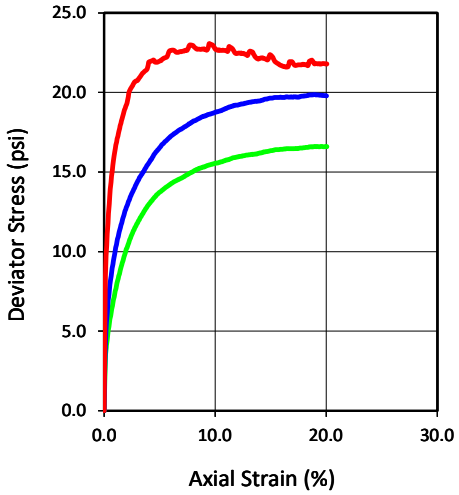



**Principle Stress Ratio Criterion:** **c' (psi):** **8.3** **Ø' (deg):** **22.2**

## Consolidated Undrained Triaxial Test (ASTM D4767)

| | | | |
|---|---|---|---|
| PROJECT NAME : | Cairo | SAMPLE NO. : | ST-2; ST-4; ST-7 |
| PROJECT NO. : | 10174706 | SAMPLE DEPTH : | 9.0-9.5; 19.0-19.5; 33.0-33.5 |
| PROJECT LOCATION : | Kentucky | SAMPLE TYPE : | ST |
| BORING NUMBER : | B-126 | DESCRIPTION : | Lean Clay w/Sand; Lean Clay; Sandy Silt |
| REMARKS : | N/A | TEST TYPE : | Consolidated Undrained |

**Deviator Stress Vs. Axial Strain**

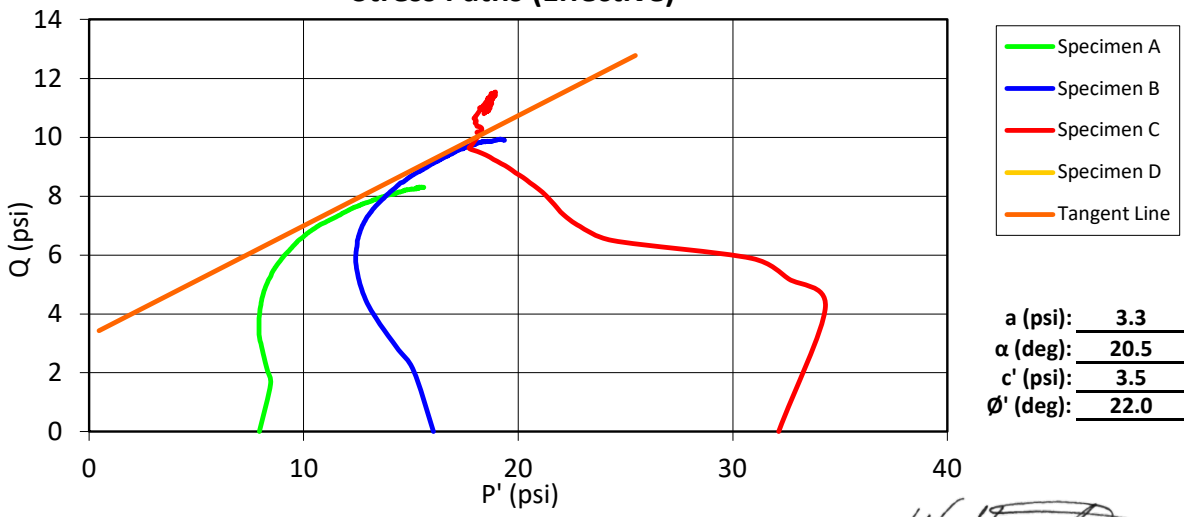



| Initial | Specimen A | B | C | D |
|---|---|---|---|---|
| Water Content (%) | 20.9 | 31.3 | 36.3 | |
| Dry Density (pcf) | 94.5 | 91.5 | 85.0 | |
| Saturation (%) | 71.9 | 99.8 | 101.9 | |
| Void Ratio | 0.787 | 0.852 | 0.940 | |
| Diameter (in) | 2.837 | 2.845 | 2.859 | |
| Height (in) | 5.772 | 5.826 | 5.509 | |
| Specific Gravity | 2.70 | 2.71 | 2.64 | |
| Liquid Limit | 25 | 38 | NP | |
| Plastic Limit | 15 | 22 | NP | |
| **After Consolidation** | **A** | **B** | **C** | **D** |
| B-Value | 0.99 | 0.99 | 0.96 | |
| Water Content (%) | 29.4 | 29.5 | 30.9 | |
| Dry Density (pcf) | 95.0 | 91.9 | 86.9 | |
| Saturation (%) | 100.0 | 94.7 | 90.9 | |
| Void Ratio | 0.775 | 0.844 | 0.897 | |
| Effective Stress (psi) | 8.0 | 16.0 | 32.0 | |
| Back Press. (psi) | 75.7 | 55.2 | 65.1 | |
| Rate of Strain | 0.005 | 0.005 | 0.005 | |

| Maximum Deviator Stress Criterion | |
|---|---|
| c (psi) | 6.2 |
| Ø (deg) | 8.3 |
| c' (psi) | 2.2 |
| Ø' (deg) | 24.6 |

| After Shear | A | B | C | D |
|---|---|---|---|---|
| σ'1 at Failure (psi) | 23.80 | 29.10 | 30.47 | |
| σ'3 at Failure (psi) | 7.19 | 9.23 | 7.40 | |

**Stress Paths (Effective)**




| | |
|---|---|
| **a (psi):** | **3.3** |
| **α (deg):** | **20.5** |
| **c' (psi):** | **3.5** |
| **Ø' (deg):** | **22.0** |

Approved By: W. Shuman

Date: 12/9/2025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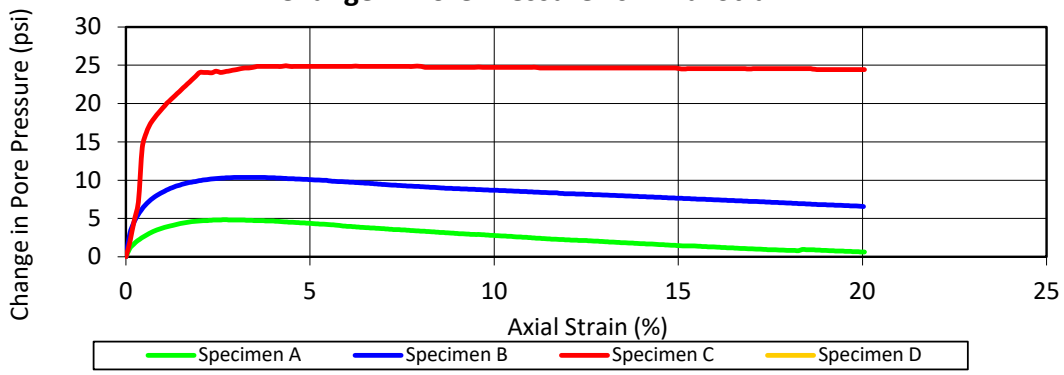
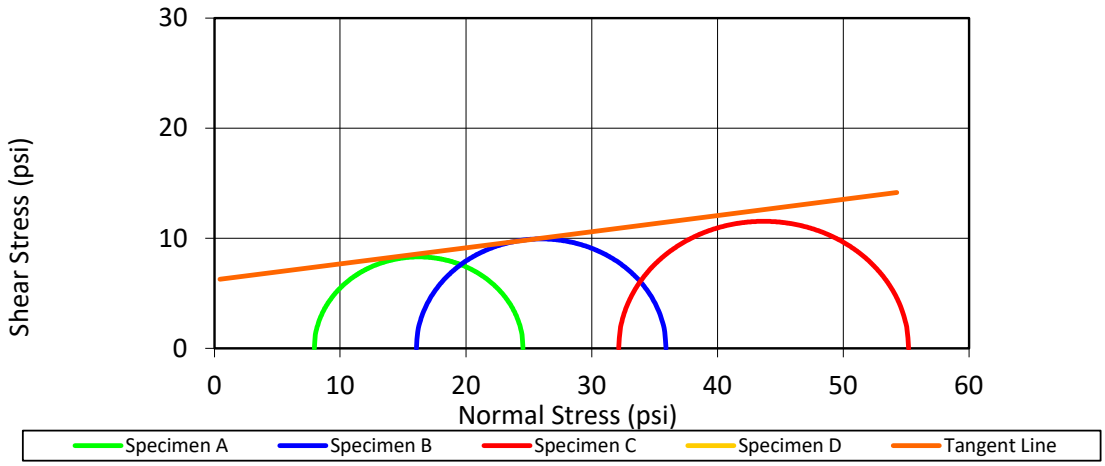
## Change in Pore Pressure vs. Axial Strain

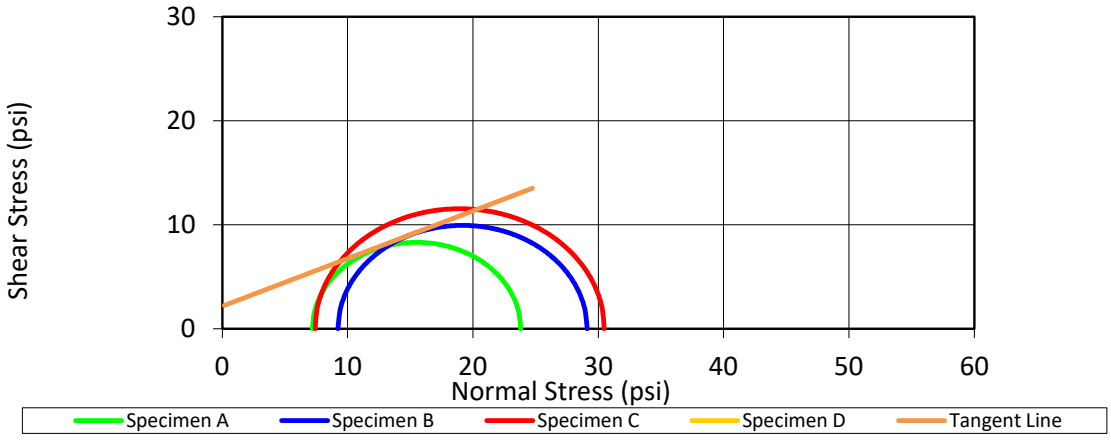



## Total Stress




**Maximium Deviator Stress Criterion:** **c (psi):** **6.2** **Ø (deg):** **8.3**

## Effective Stress

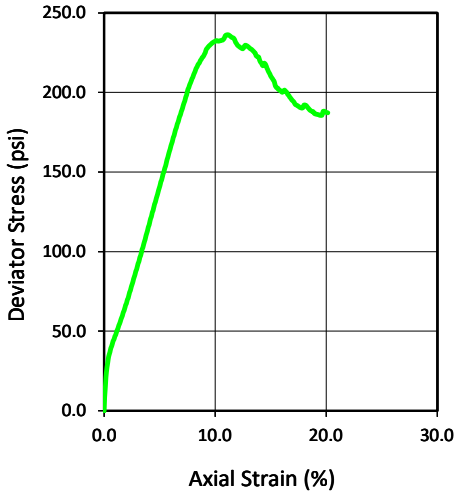



**Maximium Deviator Stress Criterion:** **c' (psi):** **2.2** **Ø' (deg):** **24.6**

## Consolidated Undrained Triaxial Test (ASTM D4767)

| | | | |
|---|---|---|---|
| PROJECT NAME : | Ky Cairo Bridge | SAMPLE NO. : | PT-7 |
| PROJECT NO. : | 10174706 | SAMPLE DEPTH : | 58.0-60.0 |
| PROJECT LOCATION : | Kentucky | SAMPLE TYPE : | Undisturbed |
| BORING NUMBER : | B-6 | DESCRIPTION : | Silty Sand |
| REMARKS : | NA | TEST TYPE : | Consolidated Undrained |

**Deviator Stress Vs. Axial Strain**

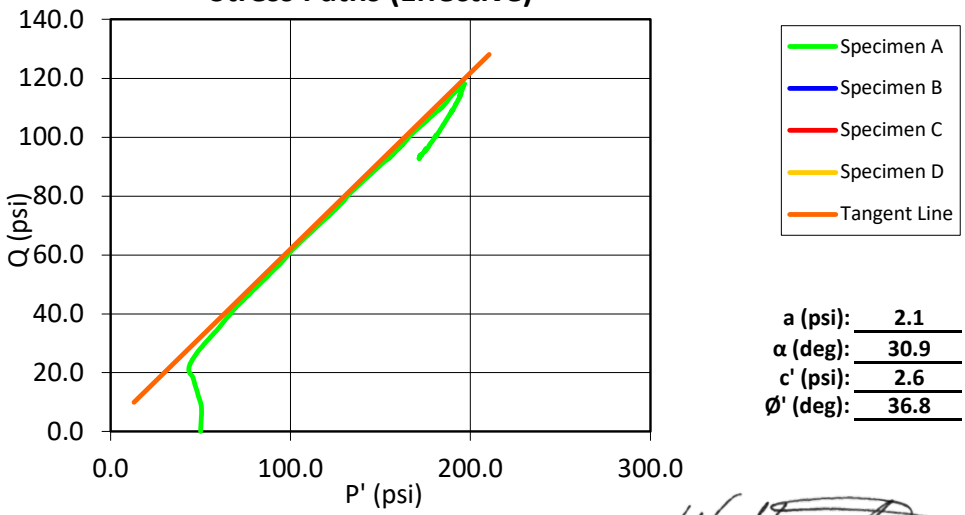



| Initial | A | B | C | D |
|---|---|---|---|---|
| Water Content (%) | 25.5 | | | |
| Dry Density (pcf) | 93.2 | | | |
| Saturation (%) | 87.35 | | | |
| Void Ratio | 0.775 | | | |
| Diameter (in) | 2.843 | | | |
| Height (in) | 5.921 | | | |
| Specific Gravity | 2.65 | | | |
| Liquid Limit | NP | | | |
| Plastic Limit | NP | | | |
| **After Consolidation** | **A** | **B** | **C** | **D** |
| B-Value | 1.00 | | | |
| Water Content (%) | 25.9 | | | |
| Dry Density (pcf) | 93.70 | | | |
| Saturation (%) | 100.00 | | | |
| Void Ratio | 0.765 | | | |
| Effective Stress (psi) | 50.0 | | | |
| Back Press. (psi) | 32.6 | | | |
| Rate of Strain | 0.0050 | | | |

| Effective Stress | |
|---|---|
| a (psi) | 2.1 |
| alpha (deg) | 30.9 |
| c' (psi) | 2.6 |
| Ø' (deg) | 36.8 |

| After Shear | A | B | C | D |
|---|---|---|---|---|
| σ'1 at Failure (psi) | 314.75 | | | |
| σ'3 at Failure (psi) | 78.40 | | | |
| | | | | |
| | | | | |

**Stress Paths (Effective)**

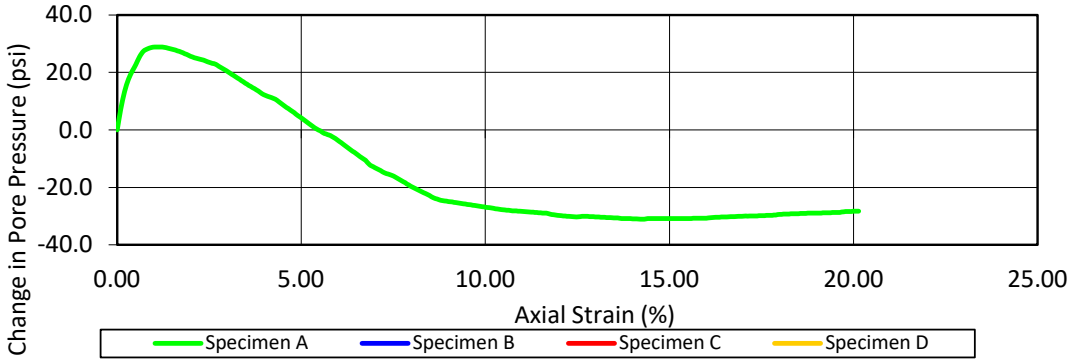



| | |
|---|---|
| **a (psi):** | **2.1** |
| **α (deg):** | **30.9** |
| **c' (psi):** | **2.6** |
| **Ø' (deg):** | **36.8** |

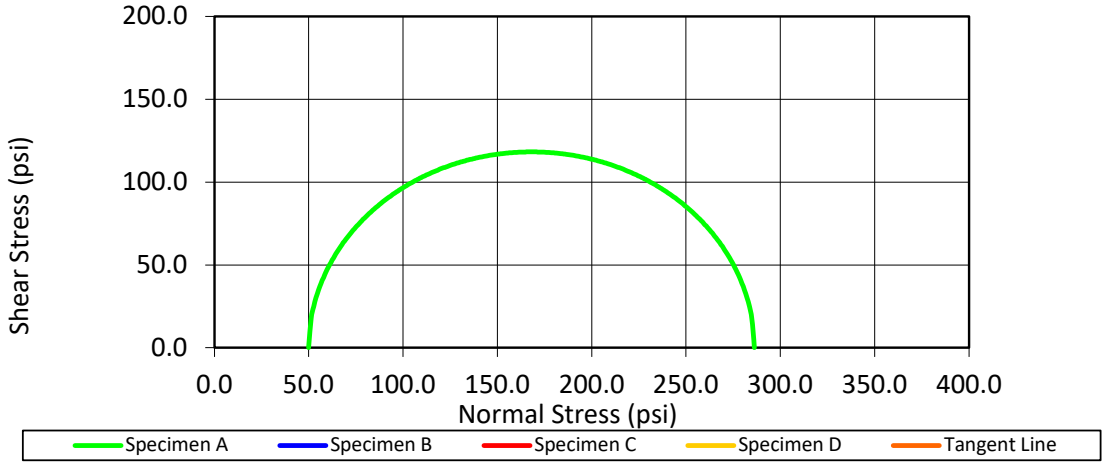
Approved By: W. Stevenson

Date: 3/26/2026

## Change in Pore Pressure vs. Axial Strain

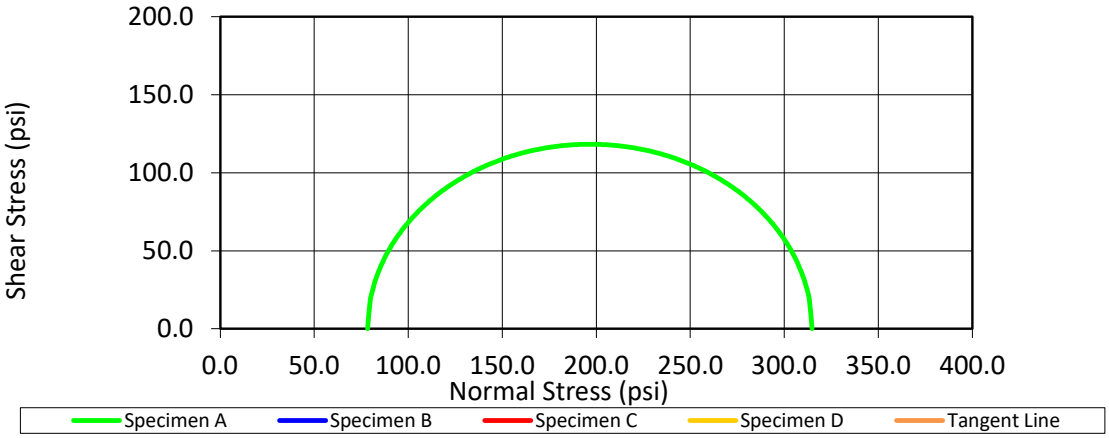



## Total Stress




**Maximium Deviator Stress Criterion:** **c (psi):** _____ **Ø (deg):** _____

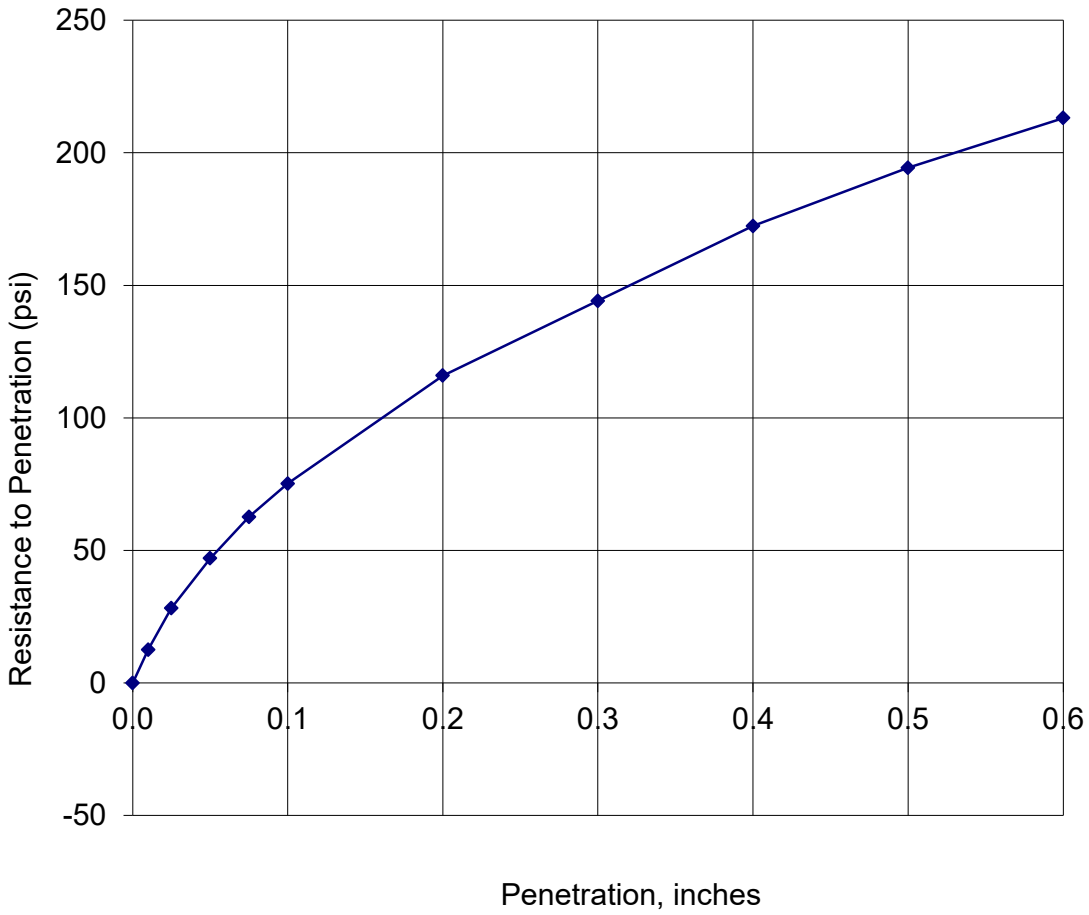
## Effective Stress




**Maximium Deviator Stress Criterion:** **c' (psi):** _____ **Ø' (deg):** _____

# CALIFORNIA BEARING RATIO

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project No. | : 10174706 | Sample No. | : Bag 1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-120 |
| Project State | : Kentucky | Sample Depth | : 0.0' to 8.0' |
| Laboratory No. | : 10174706 | Date Tested | : 3/26/26 |
| Submitted By | : HDR | Date Reported | : 4/9/26 |
| Soil Type | : Lean Clay | | |




Compaction Effort = 2000 psi
Percent Compacted = 104.3 %
Percent Swell = 5.82 %

C.B.R. @ 0.1 In. = 6.3*
C.B.R. @ 0.2 In. = 7.7
C.B.R. @ 0.3 In. = 7.6
C.B.R. @ 0.4 In. = 7.5
C.B.R. @ 0.5 In. = 7.5

COMMENTS: KM 64-501-02

APPROVED BY: KW

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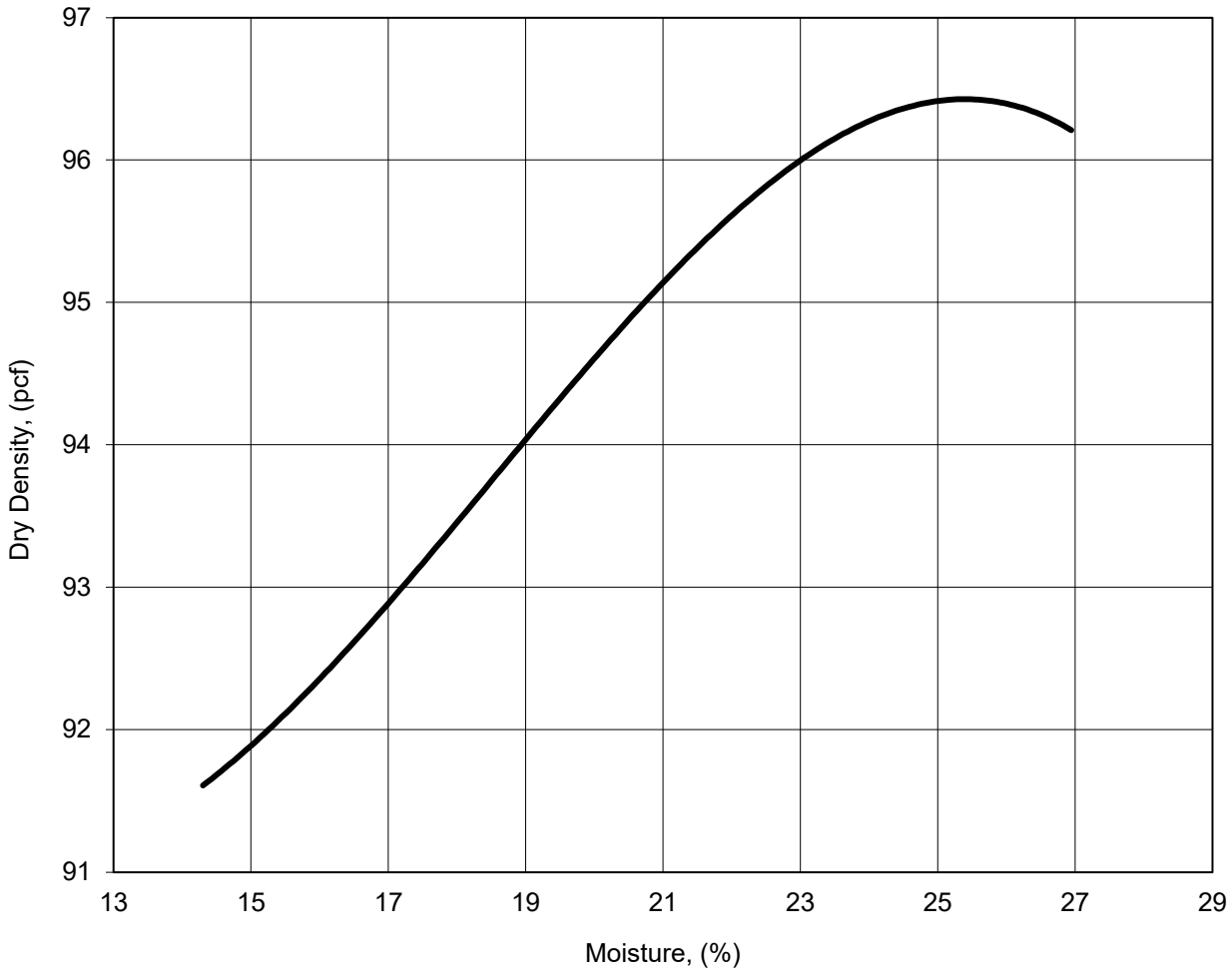
# MOISTURE-DENSITY RELATIONSHIP

| | | | | | |
|---|---|---|---|---|---|
| Project Name | : | KY Cairo Bridge | | | |
| Project No. | : | 10174706 | Sample No. | : | Bag 1 |
| Project County | : | Ballard | Sample Loc. | : | Boring No. B-120 |
| Project State | : | Kentucky | Sample Depth | : | 0.0' to 8.0' |
| Laboratory No. | : | 10174706 | Date Tested | : | 03/26/26 |
| Submitted By | : | HDR | Date Reported | : | 04/09/26 |
| Soil Type | : | Lean Clay | | | |




MAXIMUM DENSITY: 96.4 pcf

OPTIMUM MOISTURE: 25.4 %

COMMENTS: KM 64-511-03; Method (A)

APPROVED BY: KW

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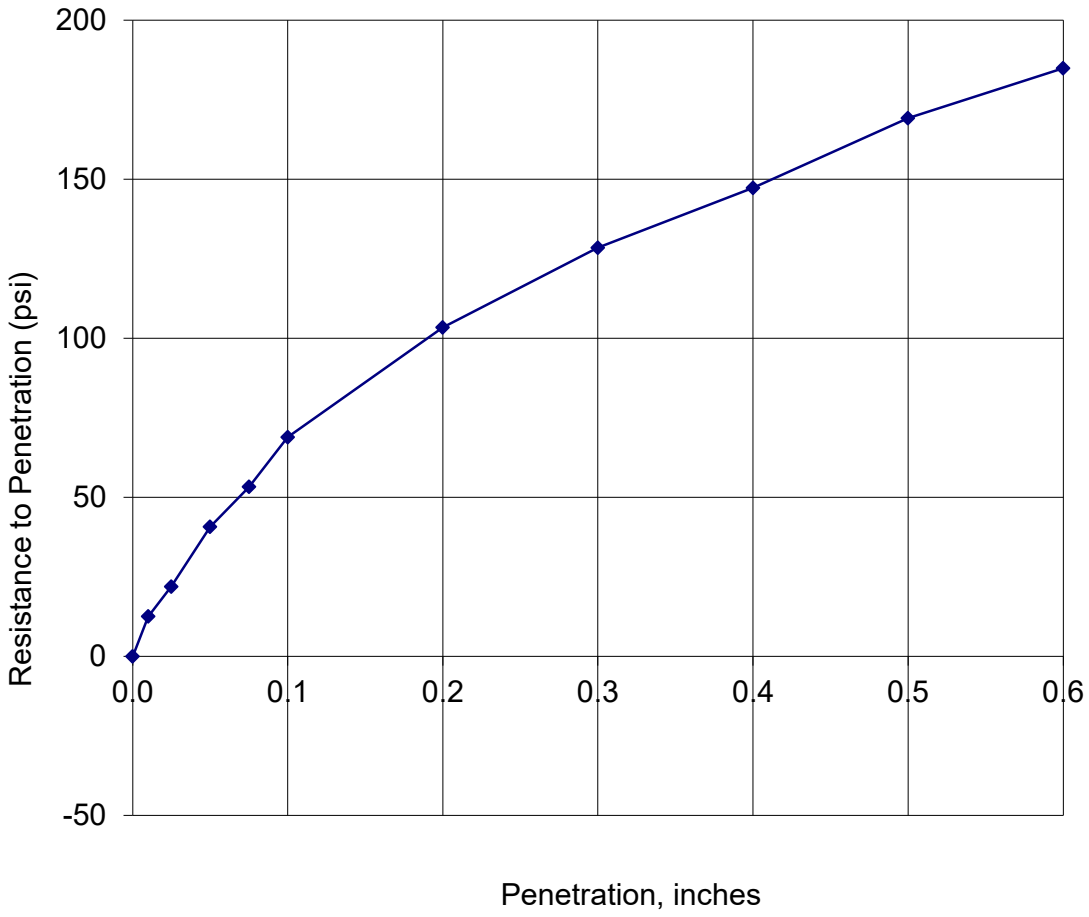
# CALIFORNIA BEARING RATIO

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project No. | : 10174706 | Sample No. | : Bag 1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-121 |
| Project State | : Kentucky | Sample Depth | : 0.0' to 8.0' |
| Laboratory No. | : 10174706 | Date Tested | : 3/26/26 |
| Submitted By | : HDR | Date Reported | : 4/9/26 |
| Soil Type | : Silt | | |




Compaction Effort = 2000 psi
Percent Compacted = 106.4 %
Percent Swell = 5.81 %

C.B.R. @ 0.1 In. = 5.3*
C.B.R. @ 0.2 In. = 6.9
C.B.R. @ 0.3 In. = 6.8
C.B.R. @ 0.4 In. = 6.4
C.B.R. @ 0.5 In. = 6.5

COMMENTS: KM 64-501-02

APPROVED BY: KW

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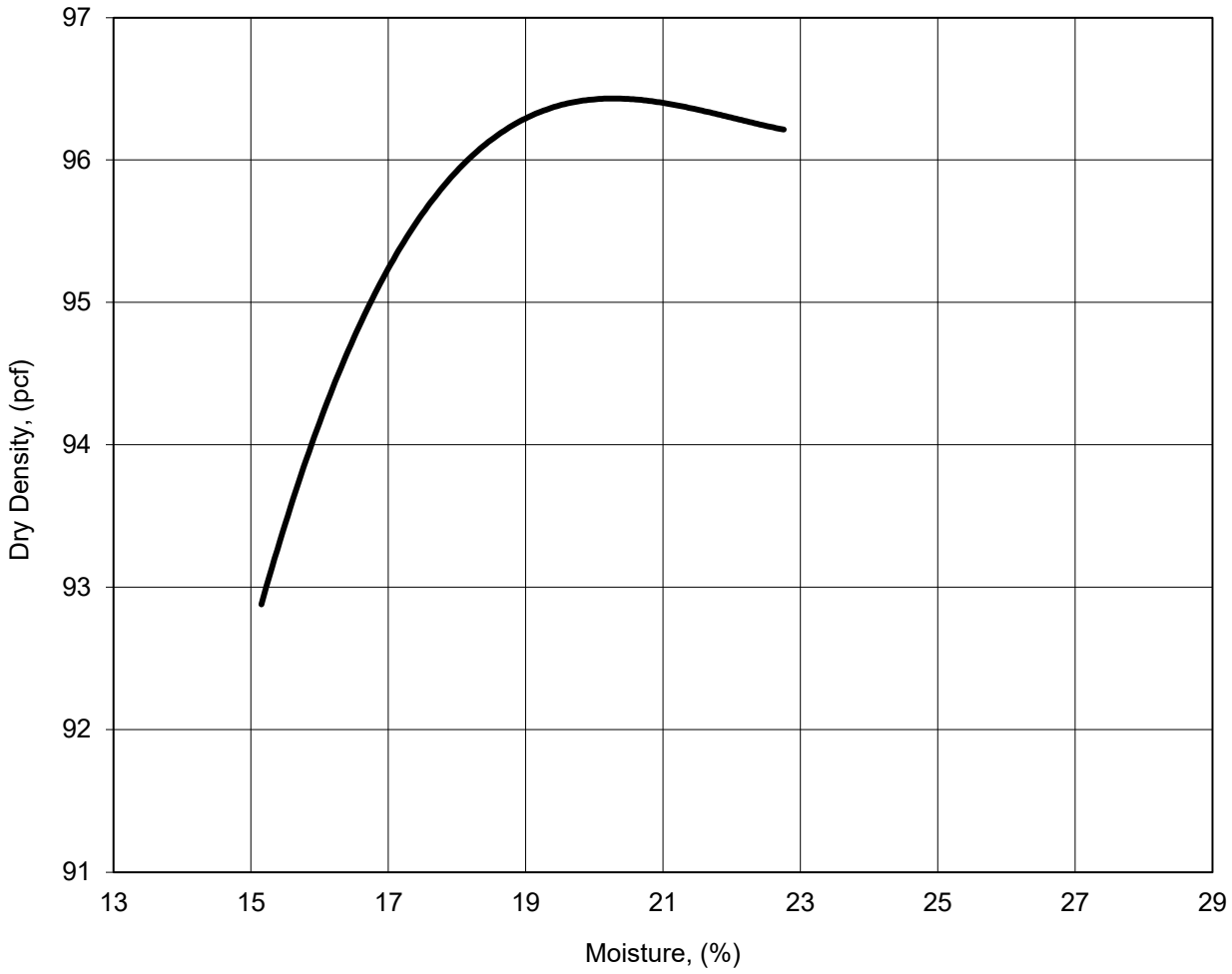
4645 Village Square Drive, Suite F, Paducah, KY 42001
T 270.444.9691 F 270.538.1599

# MOISTURE-DENSITY RELATIONSHIP

| | | | | | |
|---|---|---|---|---|---|
| Project Name | : | KY Cairo Bridge | | | |
| Project No. | : | 10174706 | Sample No. | : | Bag 1 |
| Project County | : | Ballard | Sample Loc. | : | Boring No. B-121 |
| Project State | : | Kentucky | Sample Depth | : | 0.0' to 8.0' |
| Laboratory No. | : | 10174706 | Date Tested | : | 03/26/26 |
| Submitted By | : | HDR | Date Reported | : | 04/09/26 |
| Soil Type | : | Silt | | | |




MAXIMUM DENSITY: 96.4 pcf

OPTIMUM MOISTURE: 20.3 %

COMMENTS: KM 64-511-03; Method (A)

APPROVED BY: KW

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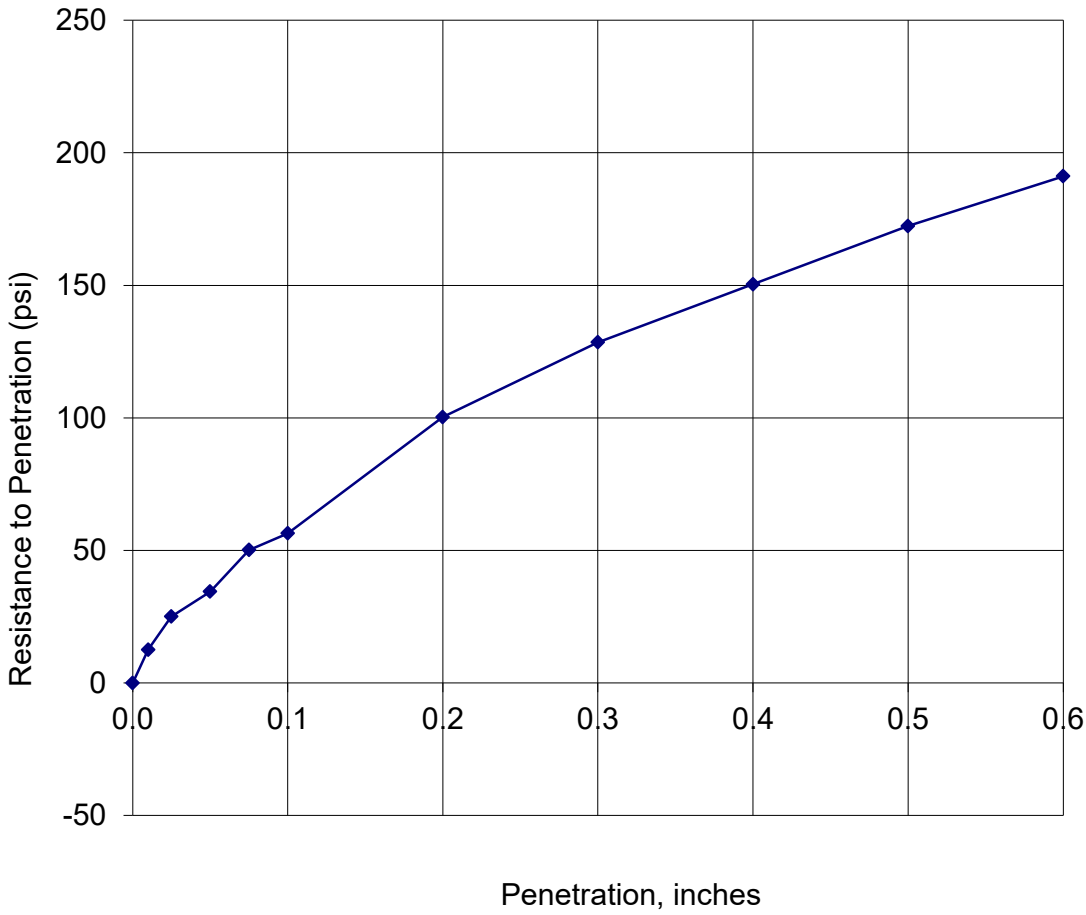
T 270.444.9691 F 270.538.1599

# CALIFORNIA BEARING RATIO

| | | | |
|---|---|---|---|
| Project Name | : KY Cairo Bridge | | |
| Project No. | : 10174706 | Sample No. | : Bag 1 |
| Project County | : Ballard | Sample Loc. | : Boring No. B-122 |
| Project State | : Kentucky | Sample Depth | : 0.0' to 8.0' |
| Laboratory No. | : 10174706 | Date Tested | : 3/26/26 |
| Submitted By | : HDR | Date Reported | : 4/9/26 |
| Soil Type | : Lean Clay | | |




Compaction Effort = 2000 psi
Percent Compacted = 105.9 %
Percent Swell = 5.81 %

C.B.R. @ 0.1 In. = 5*
C.B.R. @ 0.2 In. = 6.7
C.B.R. @ 0.3 In. = 6.8
C.B.R. @ 0.4 In. = 6.5
C.B.R. @ 0.5 In. = 6.6

COMMENTS: KM 64-501-02

APPROVED BY: KW

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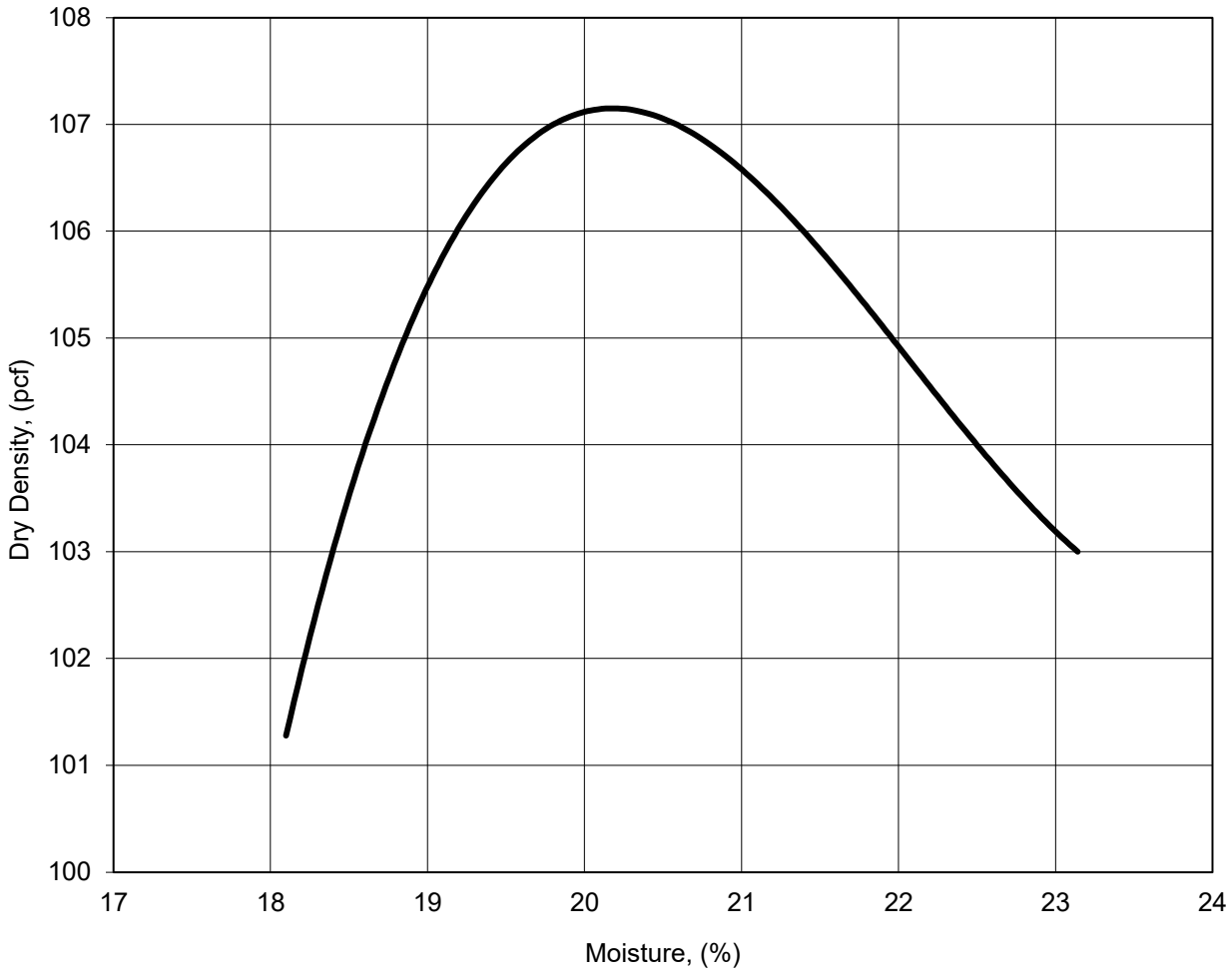
T 270.444.9691 F 270.538.1599

# MOISTURE-DENSITY RELATIONSHIP

| | | | | | |
|---|---|---|---|---|---|
| Project Name | : | KY Cairo Bridge | | | |
| Project No. | : | 10174706 | Sample No. | : | Bag 1 |
| Project County | : | Ballard | Sample Loc. | : | Boring No. B-122 |
| Project State | : | Kentucky | Sample Depth | : | 0.0' to 8.0' |
| Laboratory No. | : | 10174706 | Date Tested | : | 03/26/26 |
| Submitted By | : | HDR | Date Reported | : | 04/09/26 |
| Soil Type | : | Lean Clay | | | |




MAXIMUM DENSITY: 107.2 pcf

OPTIMUM MOISTURE: 20.2 %

COMMENTS: KM 64-511-03; Method (A)

APPROVED BY: KW

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T 270.444.9691 F 270.538.1599

# Attachment E: Soil Parameters

hdrinc.com

333 West Vine Street, Suite 1400, Lexington, KY 40507-1681
(859) 629-4800

# KY Abutment

| | | | | | |
|---|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | | |
| Sheet No. | 1 | of 4 | Scale | NTS | |
| Calculated By | GCD | | Date | 4/29/2026 | |
| Checked By | SGL | | Date | 4/29/2026 | |

## Summary Soil Profile and Derivation of Strength Parameters

A subsurface investigation was conducted at this site by Terracon from April 13 to April 17, 2021 and by HDR from July 18 to July 19, 2025. Two geotechnical sample borings (B-2046 and B-6) were drilled for a subsurface soil investigation at the KY abutment. The subsurface profile and associated strength parameters are based on the results of the drilling operations and laboratory testing program performed by HDR, Inc.

### KY Abutment Generalized Soil Profile

Elevation: 314.3 ft — Top of Existing Groundline

▽ GWT = 300.0 FT

Layer I: Silt, Lean Clay (ML, CL)

Elevation: 292.3 ft

Layer II: Silty Sand, Poorly Graded Sand with Silt, Poorly Graded Sand, Well Graded Sand, Poorly Graded Gravel, Poorly Graded Gravel with Silt and Sand, Silty Clayey Sand (SM, SP-SM, SP, SW, GP, GP-GM, SC-SM)

Elevation: 219.8 ft

Layer III: Silty Sand, Silty Clayey Sand, Poorly Graded Sand with Silt, Well Graded Sand, Sandy Silty Clay, Poorly Graded Sand (SM, SC-SM, SP-SM, SW, CL-ML, SP)

Elevation: 163.3 ft

Boring B-2046 Terminated at El. 164.3 (No Refusal)
Boring B-6 Terminated at El. 161.8 (No Refusal)

**Note:** USCS classification and soil index were taken from updated gINT boring log information. Blue text represents data from strength testing.

| | | | |
|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | |
| Sheet No. | 2 of 4 | Scale | NTS |
| Calculated By | GCD | Date | 4/29/2026 |
| Checked By | SGL | Date | 4/29/2026 |

**Layer I: Silt, Lean Clay (ML, CL)**

| Boring ID | Sample | Depth (ft) | | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B-2046 | ST-1 | 3.0 | 5.0 | 25.6 | 114.8 | 91.4 | 42 | 27 | 15 | ML | 91 |
| B-2046 | ST-2 | 8.0 | 10.0 | 28.1 | 119.6 | 93.4 | 44 | 28 | 16 | ML | 100 |
| B-2046 | ST-3 | 14.0 | 16.0 | 33.9 | 114.4 | 85.4 | 47 | 30 | 17 | ML | 89 |
| B-2046 | ST-4 | 18.0 | 20.0 | 33.3 | 115.9 | 87.0 | 48 | 29 | 19 | ML | 96 |
| B-6 | SS-1 | 5.0 | 6.5 | 29.3 | 120.7 | 93.3 | 42 | 26 | 16 | ML | 95 |
| B-6 | ST-2 | 8.0 | 10.0 | 27.3 | 120.5 | 94.6 | 44 | 21 | 23 | CL | 97 |
| B-6 | ST-3 | 13.0 | 15.0 | 32.6 | 121.1 | 91.3 | 43 | 20 | 23 | CL | 99 |
| B-6 | ST-4 | 18.0 | 20.0 | 44.6 | 109.3 | 75.6 | 48 | 30 | 18 | ML | 90 |
| | | Averages = | | 31.8 | 117.0 | 89.0 | 44.8 | 26.4 | 18.4 | | 94.6 |

| | | | | | |
|---|---|---|---|---|---|
| $Q_u$ = | 970 | psf | | (From Unconfined Compression Test) | [B-2046] |
| | 250 | psf | | (From Unconfined Compression Test) | [B-2046] |
| | 1290 | psf | | (From Unconfined Compression Test) | [B-2046] |
| | 1083 | psf | | (From Unconsolidated Undrained Triaxial Compression Test) | [B-2046] |
| | 2133 | psf | from N= 8 | (From Terzaghi & Peck, See Figure 1) | [B-6] |
| | 2858 | psf | | (From Unconsolidated Undrained Triaxial Compression Test) | [B-6] |
| | 1699 | psf | | (From Unconsolidated Undrained Triaxial Compression Test) | [B-6] |
| | 2891 | psf | | (From Unconsolidated Undrained Triaxial Compression Test) | [B-6] |

$N_{(avg)}$= 8

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 800 | psf | $c'$ = | 80 | psf |
| $\phi$ = | 0° | | $\phi'$ = | 28° | |
| $\gamma$ = | 115 | pcf | $\gamma'$ = | 115 | pcf |

**Settlement Parameters**

Results from Consolidaton Testing

| Boring ID | Depth | MC | $\gamma_{dry}$ (pcf) | LL | PL | PI | Sp. Gr. | OCR | $C_c$ | $C_r$ | $e_0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B-6 | 8.0'-10.0' | 36.2 | 79.7 | 44 | 21 | 23 | 2.70 | 4.21 | 0.36 | 0.02 | 1.11 |
| B-6 | 18.0'-20.0' | 33.7 | 86.8 | 30 | 18 | 12 | 2.70 | 1.84 | 0.34 | 0.01 | 0.91 |
| | | 34.95 | 83.25 | 37 | 19.5 | 18 | 2.70 | | 0.35 | 0.02 | 1.01 |

| | | |
|---|---|---|
| $NMC_{avg}$ | = | 35 |
| $PL_{avg}$ | = | 19.5 |
| $PI_{avg}$ | = | 18 |
| $LL_{avg}$ | = | 37 |
| SG | = | 2.7 |

For Analysis Use:
(Consolidation)

| | | | |
|---|---|---|---|
| $e_0$ | = | 1.01 | |
| $C_v$ | = | 0.71 | $ft^2$ / day |
| $C_c$ | = | 0.35 | |
| $C_r$ | = | 0.02 | |
| $\gamma$ | = | 115 | pcf |
| $OCR_1$ | = | 3.0 | |
| $OCR_2$ | = | 1.8 | |
| $C_a$ | = | 0.004 | |

An OCR of 3.0 will be used from the top of Layer II, at El. 314.3 feet, until El. 299.8 feet. Thereafter, the OCR will drop to 1.8.

$OCR_1$ was reduced from 4.2 to 3.0 due to engineering judgment.

Consolidation testing, empirical correlations, and engineering judgement were utilized in the determination of the consolidation parameters.

| | | | | | |
|---|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | | |
| Sheet No. | 3 | of | 4 | Scale | NTS |
| Calculated By | GCD | | | Date | 4/29/2026 |
| Checked By | SGL | | | Date | 4/29/2026 |

**Layer II: Silty Sand, Poorly Graded Sand with Silt, Poorly Graded Sand, Well Graded Sand, Poorly Graded Gravel, Poorly Graded Gravel with Silt and Sand, Silty Clayey Sand (SM, SP-SM, SP, SW, GP, GP-GM, SC-SM)**

| Boring ID | Sample | Depth (ft) | | MC (%) | γ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B-2046 | ST-5 | 23.0 | 25.0 | 37.8 | 113.9 | 82.6 | 21 | 18 | 3 | SM | 35 |
| B-2046 | SS-1 | 28.5 | 30.0 | 27.3 | 122.1 | 95.9 | NP | NP | NP | SP-SM | 7 |
| B-2046 | SS-2 | 33.5 | 35.0 | 32.6 | 117.6 | 88.7 | NP | NP | NP | SP-SM | 6 |
| B-2046 | SS-3 | 38.5 | 40.0 | 27.7 | 121.8 | 95.4 | NP | NP | NP | SP-SM | 8 |
| B-2046 | SS-4 | 43.5 | 45.0 | 27.0 | 122.4 | 96.4 | NP | NP | NP | SP-SM | 8 |
| B-2046 | PT-1 | 48.0 | 50.0 | 28.9 | 136.8 | 106.2 | NP | NP | NP | SP | 4 |
| B-2046 | SS-5 | 53.5 | 55.0 | 43.7 | 109.6 | 76.3 | NP | NP | NP | SM | 45 |
| B-2046 | SS-6 | 58.5 | 60.0 | 30.5 | 118.9 | 91.1 | NP | NP | NP | SM | 20 |
| B-2046 | SS-7 | 63.5 | 65.0 | 22.7 | 126.7 | 103.2 | NP | NP | NP | SP | 5 |
| B-2046 | PT-2 | 68.0 | 70.0 | 16.1 | 125.4 | 107.9 | NP | NP | NP | SW | 4 |
| B-2046 | SS-8 | 73.5 | 75.0 | 16.4 | 134.2 | 115.3 | NP | NP | NP | SP-SM | 5 |
| B-2046 | SS-9 | 78.5 | 80.0 | 20.8 | 128.8 | 106.6 | NP | NP | NP | SP-SM | 8 |
| B-2046 | SS-10 | 83.5 | 85.0 | 18.1 | 132.0 | 111.8 | NP | NP | NP | SP-SM | 6 |
| B-2046 | SS-11 | 88.5 | 90.0 | 21.7 | 128.1 | 105.2 | 19 | 13 | 6 | SC-SM | 41 |
| B-6 | SS-2 | 25.0 | 26.5 | 32.4 | 117.0 | 88.4 | NP | NP | NP | SP-SM | 5 |
| B-6 | SS-3 | 28.5 | 30.0 | 31.7 | 117.3 | 89.1 | NP | NP | NP | SP | 4 |
| B-6 | SS-4 | 33.5 | 35.0 | 29.4 | 119.3 | 92.2 | NP | NP | NP | SP | 4 |
| B-6 | SS-5 | 40.0 | 41.5 | 30.0 | 118.3 | 91.0 | NP | NP | NP | SP | 5 |
| B-6 | SS-6 | 43.5 | 45.0 | 29.9 | 118.5 | 91.2 | NP | NP | NP | SP | 4 |
| B-6 | SS-7 | 48.5 | 50.0 | 28.8 | 120.5 | 93.5 | NP | NP | NP | SP-SM | 6 |
| B-6 | SS-8 | 53.5 | 55.0 | 29.4 | 117.9 | 91.1 | NP | NP | NP | SP-SM | 7 |
| B-6 | PT-7 | 58.0 | 60.0 | 22.0 | 127.4 | 104.5 | NP | NP | NP | SM | 17.8 |
| B-6 | SS-9 | 63.5 | 65.0 | 40.6 | 109.4 | 77.8 | NP | NP | NP | SM | 35 |
| B-6 | SS-10 | 68.5 | 70.0 | 7.8 | 147.7 | 137.0 | NP | NP | NP | GP | 2 |
| B-6 | SS-11 | 73.5 | 75.0 | 18.7 | 130.0 | 109.5 | NP | NP | NP | SP | 3 |
| B-6 | SS-12 | 78.0 | 79.5 | 15.4 | 134.0 | 116.1 | NP | NP | NP | SP-SM | 8 |
| B-6 | SS-13 | 83.5 | 85.0 | 9.2 | 145.2 | 132.9 | NP | NP | NP | GP-GM | 10 |
| B-6 | SS-14 | 88.5 | 90.0 | 26.2 | 127.7 | 101.2 | NP | NP | NP | SP-SM | 10 |
| B-6 | SS-15 | 93.5 | 95.0 | 23.7 | 125.3 | 101.3 | NP | NP | NP | SM | 20 |
| | | Averages = | | 25.7 | 124.6 | 100.0 | NP | NP | NP | | 11.8 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 0 | psf | $c'$ = | 0 | psf |
| $\phi$ = | 32° | | $\phi'$ = | 32° | |
| $\gamma$ = | 130 | pcf | $\gamma'$ = | 130 | pcf |

**Settlement Parameters**

For Analysis Use:
(Elastic)

| | | | |
|---|---|---|---|
| $E_s$ | = | 331.7 | ksf |
| $\gamma$ | = | 130.0 | pcf |

| | | | | | |
|---|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | | |
| Sheet No. | 4 of 4 | | Scale | NTS | |
| Calculated By | GCD | | Date | 4/29/2026 | |
| Checked By | SGL | | Date | 4/29/2026 | |

**Layer III: Silty Sand, Silty Clayey Sand, Poorly Graded Sand with Silt, Well Graded Sand, Sandy Silty Clay, Poorly Graded Sand (SM, SC-SM, SP-SM, SW, CL-ML, SP)**

| Boring ID | Sample | Depth (ft) | | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B-2046 | SS-12 | 95.0 | 96.5 | 21.1 | 115.7 | 95.5 | NP | NP | NP | SM | 24 |
| B-2046 | PT-4 | 100.0 | 102.0 | 20.9 | 128.7 | 106.5 | 18 | 13 | 5 | SC-SM | 37 |
| B-2046 | SS-13 | 108.5 | 110.0 | 19.1 | 130.8 | 109.8 | NP | NP | NP | SP-SM | 9 |
| B-2046 | SS-14 | 118.5 | 120.0 | 19.9 | 129.8 | 108.3 | NP | NP | NP | SP-SM | 6 |
| B-2046 | SS-15 | 128.5 | 128.8 | 23.4 | 126.0 | 102.1 | NP | NP | NP | SP-SM | 9 |
| B-2046 | SS-16 | 138.5 | 138.8 | 22.2 | 127.2 | 104.1 | NP | NP | NP | SP-SM | 8 |
| B-2046 | SS-17 | 148.5 | 149.0 | 20.7 | 128.9 | 106.8 | NP | NP | NP | SW | 4 |
| B-6 | SS-16 | 98.0 | 99.5 | 18.0 | 131.1 | 111.1 | 19 | 12 | 7 | CL-ML | 52 |
| B-6 | SS-17 | 103.5 | 103.7 | 26.3 | 121.5 | 96.2 | NP | NP | NP | SP-SM | 12 |
| B-6 | SS-18 | 108.5 | 108.7 | 25.0 | 124.3 | 99.5 | NP | NP | NP | SP-SM | 11 |
| B-6 | SS-19 | 113.5 | 114.2 | 22.2 | 127.0 | 104.0 | NP | NP | NP | SM | 18 |
| B-6 | PT-10 | 118.0 | 119.0 | 27.6 | 121.8 | 95.4 | 17 | 12 | 5 | CL-ML | 54 |
| B-6 | SS-20 | 119.0 | 119.8 | 20.7 | 126.3 | 104.6 | NP | NP | NP | SP | 5 |
| B-6 | SS-21 | 123.5 | 123.9 | 32.0 | 116.7 | 88.4 | NP | NP | NP | SP-SM | 7 |
| B-6 | SS-22 | 128.5 | 128.9 | 23.4 | 125.2 | 101.5 | NP | NP | NP | SP-SM | 5 |
| B-6 | SS-23 | 133.5 | 133.9 | 24.2 | 124.1 | 99.9 | 36 | 34 | 2 | SP-SM | 6 |
| B-6 | SS-24 | 138.0 | 138.3 | 23.8 | 125.6 | 101.5 | NP | NP | NP | SP-SM | 10 |
| B-6 | SS-25 | 143.5 | 144.1 | 20.6 | 128.8 | 106.8 | NP | NP | NP | SP-SM | 6 |
| B-6 | SS-26 | 148.0 | 148.3 | 22.3 | 126.7 | 103.6 | NP | NP | NP | SP-SM | 5 |
| | | Averages = | | 22.8 | 125.6 | 102.4 | NP | NP | NP | | 15.2 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 0 | psf | $c'$ = | 0 | psf |
| $\phi$ = | 36° | | $\phi'$ = | 36° | |
| $\gamma$ = | 130 | pcf | $\gamma'$ = | 130 | pcf |

**Settlement Parameters**

For Analysis Use:
(Elastic)

| | | | |
|---|---|---|---|
| $E_s$ = | 505.8 | ksf | |
| $\gamma$ = | 130.0 | pcf | |

# STA 2096+50

| | | | | | |
|---|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | | |
| Sheet No. | 1 | of | 4 | Scale | NTS |
| Calculated By | ER | | | Date | 4/29/2026 |
| Checked By | SL | | | Date | 4/29/2026 |

## Summary Soil Profile and Derivation of Strength Parameters

A subsurface investigation was conducted at this site by HDR on November 14, November 15, and December 03, 2025. Three geotechnical sample borings (117, 118, and 119) were drilled for conducting soil investigations near the intersection of East Cairo Road and US-51 at Station 2096+50. The subsurface profile and associated strength parameters are based on the results of the drilling operations and laboratory testing program performed by HDR, Inc.

### STA 2096+50 Generalized Soil Profile

Elevation: 327.6 — Top of Existing Groundline

GWT = 300.0 FT

Layer I: Silt, Lean Clay, Elastic Silt with Sand, Silty Sand (ML, CL, MH, SM)

Elevation: Varies

Layer II: Silt, Silty Clay, Lean Clay (MH, ML, CL) [Found in 117 only]

Elevation: Varies

Layer III: Silty Sand, Poorly Graded Sand with Silt, Poorly Graded Sand (SM, SP-SM, SP)

Elevation: Varies

Layer IV: Poorly Graded Sand with Silt, Poorly Graded Sand (SP-SM, SP) [Found in 119 only]

Elevation: 253.4 ft

Boring 117 Terminated at El. 261.4 (No Refusal)
Boring 118 Terminated at El. 262.6 (No Refusal)
Boring 119 Terminated at El. 253.4 (No Refusal)

**Note:** USCS classification and soil index were taken from updated gINT boring log information. Blue text represents data from strength testing.

| | | | |
|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | |
| Sheet No. | 2 of 4 | Scale | NTS |
| Calculated By | EJR | Date | 4/29/2026 |
| Checked By | SL | Date | 4/29/2026 |

**Layer I: Silt, Lean Clay, Elastic Silt with Sand, Silty Sand (ML, CL, MH, SM)**

| Boring ID | Sample | Depth (ft) | | MC (%) | γ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 118 | ST-1 | 3.0 | 5.0 | 18.7 | 130.4 | 109.9 | 31 | 19 | 12 | CL | 80 |
| 118 | ST-2 | 8.0 | 10.0 | 25.9 | 124.5 | 98.9 | 32 | 21 | 11 | CL | 87 |
| 118 | SS-1 | 10.0 | 11.5 | 28.6 | 121.3 | 94.3 | 33 | 21 | 12 | CL | 57 |
| 118 | SS-2 | 15.0 | 16.5 | 31.2 | 122.0 | 93.0 | 40 | 25 | 15 | CL | 95 |
| 118 | SS-3 | 20.0 | 21.5 | 24.6 | 128.3 | 103.0 | 34 | 25 | 9 | ML | 57 |
| 118 | ST-5 | 23.0 | 25.0 | 30.4 | 118.3 | 90.8 | 43 | 26 | 17 | CL | 98 |
| 118 | ST-6 | 28.0 | 30.0 | 30.9 | 113.8 | 87.0 | 42 | 31 | 11 | ML | 100 |
| 119 | ST-1 | 3.0 | 5.0 | 29.5 | 112.3 | 86.7 | 54 | 31 | 23 | MH | 96 |
| 119 | ST-2 | 8.0 | 10.0 | 31.5 | 115.6 | 88.0 | NP | NP | NP | SM | 18 |
| | | Averages = | | 29.5 | 118.8 | 94.6 | 38.6 | 24.9 | 13.8 | | 76.4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| $Q_u$ = | 1333 | psf | from N= | 5 | (From Terzaghi & Peck, See Figure 1) | [118] |
| | 1867 | psf | from N= | 7 | (From Terzaghi & Peck, See Figure 1) | [118] |
| | 1600 | psf | from N= | 6 | (From Terzaghi & Peck, See Figure 1) | [118] |
| | 1956 | psf | | | (Unconsolidated Undrained Triaxial Compression Test) | [118] |
| | 2010 | psf | | | (Unconfined Compression Test) | [119] |
| | 2130 | psf | | | (Unconfined Compression Test) | [119] |

$N_{(avg)}$= 6

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 900 | psf | $c'$ = | 90 | psf |
| $\phi$ = | 0° | | $\phi'$ = | 26° | |
| $\gamma$ = | 120 | pcf | $\gamma'$ = | 120 | pcf |

**Settlement Parameters**

Results from Consolidation Testing

| Boring ID | Depth | MC | $\gamma_{dry}$ (pcf) | LL | PL | PI | Sp. Gr. | Pc (ksf) | $C_c$ | $C_r$ | $e_0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 118 | 28.7-29.0 | 32.6 | 85.0 | 42 | 31 | 11 | 2.716 | 3.94 | 0.33 | 0.03 | 0.99 |
| | | 32.6 | 85.0 | 42 | 31 | 11 | 2.72 | 3.94 | 0.33 | 0.03 | 0.99 |

| | | |
|---|---|---|
| $NMC_{avg}$ | = | 32.6 |
| $PL_{avg}$ | = | 31.0 |
| $PI_{avg}$ | = | 11.0 |
| $LL_{avg}$ | = | 42.0 |
| SG | = | 2.72 |

For Analysis Use:
(Consolidation)

| | | | |
|---|---|---|---|
| $e_0$ | = | 0.85 | |
| $C_v$ | = | 0.39 | $ft^2$ / day |
| $C_c$ | = | 0.25 | |
| $C_r$ | = | 0.06 | |
| γ | = | 120.0 | pcf |
| OCR | = | 1.2 | |
| Ca | = | 0.003 | |

Consolidation testing, empirical correlations, and engineering judgement were utilized in the determination of the consolidation parameters.

| | | | |
|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | |
| Sheet No. | 3 of 4 | Scale | NTS |
| Calculated By | EJR | Date | 4/29/2026 |
| Checked By | SL | Date | 4/29/2026 |

**Layer II: Silt, Silty Clay, Lean Clay (MH, ML, CL)** **[Found in 117 only]**

| Boring ID | Sample | Depth (ft) | | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 117 | ST-1 | 3.0 | 5.0 | 40.5 | 113.5 | 80.8 | 53.0 | 31.0 | 22.0 | MH | 80.0 |
| 117 | ST-2 | 8.0 | 10.0 | 29.1 | 111.9 | 86.7 | 38.0 | 25.0 | 13.0 | ML | 86.0 |
| 117 | ST-3 | 13.0 | 15.0 | 6.1 | 160.0 | 150.8 | 32.0 | 18.0 | 14.0 | CL | 69.0 |
| | | Averages = | | 25.2 | 128.5 | 106.1 | 41.0 | 24.7 | 16.3 | | 78.3 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 800 | psf | $c'$ = | 80 | psf |
| $\phi$ = | 0° | | $\phi'$ = | 26° | |
| $\gamma$ = | 120 | pcf | $\gamma'$ = | 120 | pcf |

**Settlement Parameters**

Results from Consolidation Testing

| Boring ID | Depth | MC | $\gamma_{dry}$ (pcf) | LL | PL | PI | Sp. Gr. | $P_c$ (ksf) | $C_c$ | $C_r$ | $e_0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 117 | 4.0-4.5 | 36.1 | 76.2 | 53 | 31 | 22 | 2.72 | 4.14 | 0.42 | 0.01 | 1.23 |
| | Averages = | 36.1 | 76.2 | 53 | 31 | 22 | 2.72 | 4.14 | 0.42 | 0.01 | 1.23 |

$NMC_{avg}$ = 36.1
$PL_{avg}$ = 31.0
$PI_{avg}$ = 22.0
$LL_{avg}$ = 53.0
SG = 2.72

For Analysis Use:
(Consolidation)

| | | | |
|---|---|---|---|
| $e_0$ | = | 1.11 | |
| $C_v$ | = | 0.86 | $ft^2$ / day |
| $C_c$ | = | 0.33 | |
| $C_r$ | = | 0.06 | |
| $\gamma$ | = | 120.0 | pcf |
| OCR | = | 3.0 | |
| Ca | = | 0.003 | |

The OCR was reduced from 9.7 to 3.0 due to engineering judgement.

Consolidation testing, empirical correlations, and engineering judgement were utilized in the determination of the consolidation parameters.

| | | | |
|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | |
| Sheet No. | 4 of 4 | Scale | NTS |
| Calculated By | EJR | Date | 4/29/2026 |
| Checked By | SGL | Date | 4/29/2026 |

**Layer III: Silty Sand, Poorly Graded Sand with Silt, Poorly Graded Sand (SM, SP-SM, SP)**

| Boring ID | Sample | Depth (ft) | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 117 | ST-4 | 18.0 20.0 | 31.5 | 130.2 | 99.0 | NP | NP | NP | SM | 13 |
| 117 | SS-1 | 25.0 26.5 | 26.5 | 122.9 | 97.1 | NP | NP | NP | SM | 12 |
| 117 | SS-2 | 30.0 31.5 | 25.9 | 123.5 | 98.1 | NP | NP | NP | SP-SM | 9 |
| 117 | SS-3 | 35.0 36.5 | 37.7 | 113.9 | 82.7 | NP | NP | NP | SP-SM | 8 |
| 117 | SS-4 | 40.0 41.5 | 35.3 | 115.6 | 85.4 | NP | NP | NP | SP-SM | 9 |
| 118 | SS-4 | 35.0 36.5 | 21.6 | 127.9 | 105.2 | NP | NP | NP | SP-SM | 7 |
| 118 | SS-5 | 38.5 40.0 | 29.8 | 119.9 | 92.4 | NP | NP | NP | SP-SM | 9 |
| 118 | SS-6 | 43.5 45.0 | 48.3 | 107.6 | 72.5 | NP | NP | NP | SP-SM | 7 |
| 118 | SS-7 | 48.5 50.0 | 29.3 | 120.4 | 93.1 | NP | NP | NP | SP-SM | 7 |
| 118 | SS-8 | 53.5 55.0 | 31.8 | 118.3 | 89.7 | NP | NP | NP | SP | 4 |
| 118 | SS-9 | 58.5 60.0 | 27.2 | 122.2 | 96.1 | NP | NP | NP | SP-SM | 6 |
| 118 | SS-10 | 63.5 65.0 | 27.5 | 122.0 | 95.7 | NP | NP | NP | SP | 5 |
| 119 | ST-3 | 13.0 15.0 | 4.1 | 155.3 | 149.2 | NP | NP | NP | SP-SM | 12 |
| 119 | SS-3 | 30.0 31.5 | 22.6 | 126.8 | 103.4 | NP | NP | NP | SP-SM | 8 |
| 119 | SS-4 | 35.0 36.5 | 23.9 | 125.4 | 101.2 | NP | NP | NP | SP-SM | 11 |
| 119 | SS-5 | 40.0 41.5 | 23.8 | 125.5 | 101.4 | NP | NP | NP | SP-SM | 6 |
| 119 | SS-6 | 45.0 46.5 | 26.3 | 123.1 | 97.4 | NP | NP | NP | SP-SM | 7 |
| 119 | SS-7 | 50.0 51.5 | 28.3 | 121.2 | 94.5 | NP | NP | NP | SP-SM | 7 |
| | | Averages = | 27.9 | 123.4 | 97.5 | NP | NP | NP | | 8.2 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 0 | psf | $c'$ = | 0 | psf |
| $\phi$ = | 32° | | $\phi'$ = | 32° | |
| $\gamma$ = | 130 | pcf | $\gamma'$ = | 130 | pcf |

For Analysis Use (Elastic):

| | | | |
|---|---|---|---|
| $E_s$ = | 300 | ksf | |
| $\gamma$ = | 130.0 | pcf | |

**Layer IV: Poorly Graded Sand with Silt, Poorly Graded Sand (SP-SM, SP)** **[Found in 119 only]**

| Boring ID | Sample | Depth (ft) | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 119 | SS-1 | 20.0 21.5 | 24.8 | 124.5 | 99.8 | NP | NP | NP | SP | 3 |
| 119 | SS-2 | 25.0 26.5 | 25.3 | 124.0 | 99.0 | NP | NP | NP | SP-SM | 6 |
| | | Averages = | 25.1 | 124.3 | 99.4 | NP | NP | NP | | 4.5 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 0 | psf | $c'$ = | 0 | psf |
| $\phi$ = | 28° | | $\phi'$ = | 28° | |
| $\gamma$ = | 125 | pcf | $\gamma'$ = | 125 | pcf |

For Analysis Use (Elastic):

| | | | |
|---|---|---|---|
| $E_s$ = | 65 | ksf | |
| $\gamma$ = | 125.0 | pcf | |

# STA 2107+50

| | | | | | |
|---|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | | |
| Sheet No. | 1 | of 2 | Scale | NTS | |
| Calculated By | GCD | | Date | 4/29/2026 | |
| Checked By | SGL | | Date | 4/29/2026 | |

**Summary Soil Profile and Derivation of Strength Parameters**

A subsurface investigation was conducted at this site by HDR on November 13, 2025. One geotechnical sample boring (123) was drilled for a subsurface soil investigation at STA. 2107+50. The subsurface profile and associated strength parameters are based on the results of the drilling operations and laboratory testing program performed by HDR, Inc.

**STA 2107+50 Generalized Soil Profile**

Elevation: 308.8 ft — Top of Existing Groundline

▽ GWT = 300.0 FT

Layer I: Elastic Silt, Silt, Lean Clay with Sand (MH, ML, CL)

Elevation: 272.1 ft

Layer II: Silty Sand, Sandy Silt (SM, ML)

Elevation: 248.8 ft

Boring 123 Terminated at El. 248.8 (No Refusal)

**Note:** USCS classification and soil index were taken from updated gINT boring log information. Blue text represents data from strength testing.

| | | | |
|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | |
| Sheet No. | 2 of 2 | Scale | NTS |
| Calculated By | GCD | Date | 4/29/2026 |
| Checked By | SGL | Date | 4/29/2026 |

**Layer I: Elastic Silt, Silt, Lean Clay with Sand (MH, ML, CL)**

| Boring ID | Sample | Depth (ft) | | MC (%) | γ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 123 | ST-1 | 3.0 | 5.0 | 24.3 | 117.1 | 94.2 | 50 | 29 | 21 | MH | 86 |
| 123 | ST-2 | 8.0 | 10.0 | 29.2 | 123.4 | 95.5 | 40 | 27 | 13 | ML | 91 |
| 123 | ST-3 | 13.0 | 15.0 | 33.8 | 117.5 | 87.8 | 41 | 27 | 14 | ML | 97 |
| 123 | SS-1 | 20.0 | 21.5 | 39.1 | 111.8 | 80.4 | 42 | 33 | 9 | ML | 98 |
| 123 | ST-5 | 23.0 | 25.0 | 51.8 | 106.8 | 70.4 | 44 | 33 | 11 | ML | 62 |
| 123 | ST-6 | 28.0 | 30.0 | 48.5 | 108.5 | 73.1 | 36 | 23 | 13 | CL | 81 |
| 123 | ST-7 | 33.0 | 35.0 | 37.5 | 120.7 | 87.8 | 31 | 21 | 10 | CL | 74 |
| | | Averages = | | 37.7 | 115.1 | 84.2 | 40.6 | 27.6 | 13.0 | | 84.1 |

| | | | | | |
|---|---|---|---|---|---|
| $Q_u$ = | 1850 | psf | | (From Unconfined Compression Test) | [123] |
| | 2670 | psf | | (From Unconfined Compression Test) | [123] |
| | 1740 | psf | | (From Unconfined Compression Test) | [123] |
| | 1067 | psf | from N= 4 | (From Terzaghi & Peck, See Figure 1) | [123] |
| | 1572 | psf | | (From Unconsolidated Undrained Triaxial Compression Test) | [123] |
| | 2182 | psf | | (From Unconsolidated Undrained Triaxial Compression Test) | [123] |
| | 1633 | psf | | (From Unconsolidated Undrained Triaxial Compression Test) | [123] |
| | | | $N_{(avg)}$= 4 | | |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 900 | psf | $c'$ = | 90 | psf |
| $\phi$ = | 0° | | $\phi'$ = | 28° | |
| $\gamma$ = | 115 | pcf | $\gamma'$ = | 115 | pcf |

**Settlement Parameters**

Results from Consolidaton Testing

| Boring ID | Depth | MC | $\gamma_{dry}$ (pcf) | LL | PL | PI | Sp. Gr. | OCR | $C_c$ | $C_r$ | $e_0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 123 | 9.5 - 10 | 29.6 | 89.6 | 40.0 | 27.0 | 13.0 | 2.60 | 3.4 | 0.22 | 0.03 | 0.78 |
| 123 | 29 - 29.5 | 42.4 | 77.0 | 36.0 | 23.0 | 13.0 | 2.60 | 6.0 | 0.29 | 0.03 | 1.08 |
| | | 36.0 | 83.3 | 38.0 | 25.0 | 13.0 | 2.60 | | 0.26 | 0.03 | 0.93 |

| | | |
|---|---|---|
| $NMC_{avg}$ | = | 36 |
| $PL_{avg}$ | = | 25 |
| $PI_{avg}$ | = | 13 |
| $LL_{avg}$ | = | 38 |
| SG | = | 2.60 |

For Analysis Use:
(Consolidation)

| | | | |
|---|---|---|---|
| $e_0$ | = | 0.98 | |
| $C_v$ | = | 0.55 | $ft^2$ / day |
| $C_c$ | = | 0.25 | |
| $C_r$ | = | 0.07 | |
| γ | = | 115 | pcf |
| OCR | = | 3.0 | |
| $C_a$ | = | 0.004 | |

The OCR was reduced from 4.69 to 3.0 due to engineering judgment.

Consolidation testing, empirical correlations, and engineering judgement were utilized in the determination of the consolidation parameters.

**Layer II: Silty Sand, Sandy Silt (SM, ML)**

| Boring ID | Sample | Depth (ft) | | MC (%) | γ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 123 | SS-2 | 38.5 | 40.0 | 28.4 | 119.0 | 92.7 | 15 | 14 | 1 | SM | 41 |
| 123 | SS-3 | 43.5 | 45.0 | 28.0 | 121.5 | 94.9 | NP | NP | NP | SM | 15 |
| 123 | SS-4 | 48.5 | 50.0 | 26.6 | 123.0 | 97.2 | 16 | 15 | 1 | ML | 53 |
| 123 | SS-5 | 53.5 | 55.0 | 26.7 | 122.7 | 96.8 | NP | NP | NP | SM | 15 |
| 123 | SS-6 | 58.5 | 60.0 | 18.9 | 131.0 | 110.2 | NP | NP | NP | SM | 13 |
| | | Averages = | | 25.7 | 123.4 | 98.4 | 15.5 | 14.5 | 1.0 | | 27.4 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 0 | psf | $c'$ = | 0 | psf |
| $\phi$ = | 32° | | $\phi'$ = | 32° | |
| $\gamma$ = | 120 | pcf | $\gamma'$ = | 120 | pcf |

**Settlement Parameters**

For Analysis Use:
(Elastic)

| | | | |
|---|---|---|---|
| $E_s$ | = | 288.7 | ksf |
| γ | = | 120.0 | pcf |

# STA 2118+50

| | | | | | |
|---|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | | |
| Sheet No. | 1 | of | 2 | Scale | NTS |
| Calculated By | ER | | | Date | 4/22/2026 |
| Checked By | SL | | | Date | 4/22/2026 |

## Summary Soil Profile and Derivation of Strength Parameters

A subsurface investigation was conducted at this site by HDR from May 14 to May 16, 2025. Two geotechnical sample borings (124P and 125) were drilled for conducting soil investigations on the Kentucky roadway Station 2118+50. The subsurface profile and associated strength parameters are based on the results of the drilling operations and laboratory testing program performed by HDR, Inc.

### STA 2118+50 Generalized Soil Profile

Elevation: 326.4 ft — Top of Existing Groundline

Layer I: Lean Clay, Silt, Clayey Sand, and Silty Sand (CL, ML, SC, SM) — GWT = 300.0 FT

Elevation: 287.8 ft

Layer II: Poorly-graded Sand with Silt (SP-SM)

Elevation: 274.5 ft

Boring 125 Terminated at El. 274.5 ft (No Refusal)
Boring 124P Terminated at El. 301.4 ft (No Refusal)

**Note:** USCS classification and soil index were taken from updated gINT boring log information. Index soil value in blue were taken from UU-Lab testing. USCS in red text was assumed from boring logs. NP - Non-Plastic

| | | | | | |
|---|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | | |
| Sheet No. | 2 of 2 | Scale | NTS |
| Calculated By | EJR | Date | 4/22/2026 |
| Checked By | SGL | Date | 4/22/2026 |

Layer I: Lean Clay, Silt, Clayey Sand, and Silty Sand (CL, ML, SC, SM)

| Boring ID | Sample | Depth (ft) | | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 | ST-1 | 3.0 | 5.0 | 21.0 | 128.5 | 106.2 | NP | NP | NP | SM | 33 |
| 125 | ST-2 | 8.0 | 10.0 | 19.8 | 119.1 | 93.6 | 43 | 23 | 20 | CL | 94 |
| 125 | ST-3 | 13.0 | 15.0 | 32.6 | 117.6 | 88.7 | 33 | 21 | 12 | CL | 89 |
| 125 | SS-4 | 15.0 | 16.5 | 30.2 | 119.6 | 91.9 | 36 | 19 | 17 | CL | 89 |
| 125 | ST-5 | 18.0 | 20.0 | 32.0 | 120.5 | 90.5 | 36 | 20 | 16 | CL | 96 |
| 125 | ST-6 | 23.0 | 25.0 | 33.0 | 117.3 | 88.2 | 44 | 30 | 14 | ML | 97 |
| 125 | ST-7 | 28.0 | 30.0 | 32.7 | 117.6 | 88.6 | 23 | 15 | 8 | CL | 39 |
| 125 | ST-8 | 33.0 | 35.0 | 32.3 | 125.4 | 91.4 | 35 | 24 | 11 | CL | 87 |
| 124P | ST-1 | 3.0 | 5.0 | 16.6 | 133.9 | 114.8 | NP | NP | NP | ML | 56 |
| 124P | SS-3 | 10.0 | 11.5 | 30.1 | 121.8 | 93.6 | 17 | 16 | 1 | SM | 32 |
| 124P | ST-4 | 13.0 | 15.0 | 31.0 | 121.8 | 94.7 | 40 | 23 | 17 | CL | 95 |
| 124P | ST-5 | 18.0 | 20.0 | 30.4 | 118.7 | 90.6 | 43 | 25 | 18 | CL | 98 |
| 124P | ST-6 | 23.0 | 25.0 | 34.5 | 121.7 | 91.6 | 42 | 24 | 18 | CL | 99 |
| | | Averages = | | 28.9 | 121.8 | 94.2 | 35.6 | 21.8 | 13.8 | | 77.2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| $Q_u$ = | 1600 | psf | from N= | 6 | (From Terzaghi & Peck, See Figure 1) | [124P] |
| | 2360 | psf | | | (Unconfined Compression Test) | [124P] |
| | 2250 | psf | | | (Unconfined Compression Test) | [124P] |
| | 2765 | psf | | | (Unconsolidated Undrained Triaxial Compression Test) | [124P] |
| | 3290 | psf | | | (Unconfined Compression Test) | [125] |
| | 1600 | psf | from N= | 6 | (From Terzaghi & Peck, See Figure 1) | [125] |
| | 1660 | psf | | | (Unconfined Compression Test) | [125] |
| | 4991 | psf | | | (Unconsolidated Undrained Triaxial Compression Test) | [125] |
| | | | $N_{(avg)}$= | 6 | | |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 1200 | psf | $c'$ = | 120 | psf |
| $\phi$ = | 0° | | $\phi'$ = | 28° | |
| $\gamma$ = | 120 | pcf | $\gamma'$ = | 120 | psf |

Layer II: Poorly-graded Sand with Silt (SP-SM)

| Boring ID | Sample | Depth (ft) | | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 | SS-9 | 38.5 | 40.0 | 27.9 | 127.3 | 99.5 | NP | NP | NP | SP-SM | 7 |
| 125 | SS-10 | 43.5 | 45.0 | 29.0 | 130.6 | 101.2 | NP | NP | NP | SP-SM | 7 |
| 125 | SS-11 | 48.5 | 50.0 | 27.6 | 127.3 | 99.7 | NP | NP | NP | SP-SM | 8 |
| | | Averages = | | 28.2 | 128.4 | 100.1 | NP | NP | NP | | 7.3 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 0 | psf | $c'$ = | 0 | psf |
| $\phi$ = | 32° | | $\phi'$ = | 32° | |
| $\gamma$ = | 125 | pcf | $\gamma'$ = | 125 | pcf |

# STA 2126+50

| | | | | | |
|---|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | | |
| Sheet No. | 1 | of | 2 | Scale | NTS |
| Calculated By | GCD | | | Date | 5/26/2026 |
| Checked By | SGL | | | Date | 5/26/2026 |

**Summary Soil Profile and Derivation of Strength Parameters**

A subsurface investigation was conducted at this site by HDR on May 15, 2025. One geotechnical sample boring was drilled for a subsurface soil investigation at STA. 2126+64. The subsurface profile and associated strength parameters are based on the results of the drilling operations and laboratory testing program performed by HDR, Inc.

**STA 2126+50 Generalized Soil Profile**

Elevation: 324.4 ft — Top of Existing Groundline

Layer I: Clayey Sand with Gravel, Lean Clay with Sand, Lean Clay, Clayey Sand, Sandy Silty Clay, Sandy Silt (SC, CL, CL-ML, ML)

▽ GWT = 300.0 FT

Elevation: 282.7 ft

Layer II: Poorly Graded Sand with Silt, Silty Sand (SP-SM, SM)

Elevation: 267.7 ft

Layer III: Sandy Silt, Lean Clay with Sand, Silt (ML, CL)

Elevation: 254.4 ft

Boring 126A Terminated at El. 254.4 (No Refusal)

**Note:** USCS classification and soil index were taken from updated gINT boring log information. Blue text represents data from strength testing.

| | | | | |
|---|---|---|---|---|
| Project | US-51 Cairo Bridge Over Ohio River<br>Ballard County, Kentucky | | | |
| Sheet No. | 2 of 2 | Scale | NTS | |
| Calculated By | GCD | Date | 5/26/2026 | |
| Checked By | SGL | Date | 5/26/2026 | |

**Layer I: Clayey Sand with Gravel, Lean Clay with Sand, Lean Clay, Clayey Sand, Sandy Silty Clay, Sandy Silt (SC, CL, CL-ML, ML)**

| Boring ID | Sample | Depth (ft) | | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 126A | SS-1 | 3.5 | 5.0 | 19.7 | 130.2 | 108.8 | 23 | 15 | 8 | SC | 26.4 |
| 126A | ST-2 | 8.0 | 10.0 | 29.5 | 121.5 | 93.8 | 25 | 15 | 10 | CL | 75.0 |
| 126A | ST-3 | 13.0 | 15.0 | 30.4 | 118.7 | 91.0 | 40 | 20 | 20 | CL | 95.0 |
| 126A | ST-4 | 18.0 | 20.0 | 27.9 | 123.3 | 96.4 | 38 | 22 | 16 | CL | 89.3 |
| 126A | ST-5 | 23.0 | 25.0 | 29.1 | 124.0 | 96.0 | 20 | 12 | 8 | SC | 39.8 |
| 126A | SS-6 | 30.0 | 31.5 | 30.9 | 120.5 | 92.0 | 23 | 16 | 7 | CL-ML | 59.8 |
| 126A | ST-7 | 33.0 | 35.0 | 29.4 | 120.0 | 92.8 | 22 | 22 | NP | ML | 55.9 |
| 126A | SS-8 | 38.5 | 40.0 | 45.1 | 109.1 | 75.2 | 22 | 19 | 3 | ML | 55.8 |
| | | Averages = | | 30.3 | 120.9 | 93.2 | 26.6 | 17.6 | 10.3 | | 62.1 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 800 | psf | $c'$ = | 80 | psf |
| $\phi$ = | 0° | | $\phi'$ = | 28° | |
| $\gamma$ = | 120 | pcf | $\gamma'$ = | 120 | pcf |

**Layer II: Poorly Graded Sand with Silt, Silty Sand (SP-SM, SM)**

| Boring ID | Sample | Depth (ft) | | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 126A | SS-9 | 43.5 | 45.0 | 24.9 | 124.4 | 99.6 | NP | NP | NP | SP-SM | 7.0 |
| 126A | SS-10 | 48.5 | 50.0 | 38.8 | 114.6 | 82.6 | 17 | 17 | NP | SM | 31.4 |
| 126A | SS-11 | 53.5 | 55.0 | 28.3 | 120.3 | 93.8 | 16 | 16 | NP | SM | 20.7 |
| | | Averages = | | 30.7 | 119.8 | 92.0 | 16.5 | 16.5 | NP | | 19.7 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 0 | psf | $c'$ = | 0 | psf |
| $\phi$ = | 30° | | $\phi'$ = | 30° | |
| $\gamma$ = | 125 | pcf | $\gamma'$ = | 125 | pcf |

**Layer III: Sandy Silt, Lean Clay with Sand, Silt (ML, CL)**

| Boring ID | Sample | Depth (ft) | | MC (%) | $\gamma$ (pcf) | $\gamma_{dry}$ (pcf) | LL | PL | PI | USCS | < #200 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 126A | SS-12 | 58.5 | 60.0 | 37.3 | 112.6 | 82.0 | 31 | 23 | 8 | ML | 67.6 |
| 126A | ST-13 | 63.0 | 65.0 | 53.2 | 103.0 | 67.2 | 32 | 19 | 13 | CL | 74.9 |
| 126A | ST-14 | 68.0 | 70.0 | 33.3 | 120.3 | 90.3 | NP | NP | NP | ML | 92.8 |
| | | Averages = | | 41.3 | 112.0 | 79.8 | 31.5 | 21.0 | 10.5 | | 78.4 |

For Analysis Use:

| Short-Term Total Stress | | | Long-Term Effective Stress | | |
|---|---|---|---|---|---|
| $c$ = | 1450 | psf | $c'$ = | 145 | psf |
| $\phi$ = | 0° | | $\phi'$ = | 30° | |
| $\gamma$ = | 120 | pcf | $\gamma'$ = | 120 | pcf |

# Attachment F: Liquefaction

hdrinc.com

333 West Vine Street, Suite 1400, Lexington, KY 40507-1681
(859) 629-4800

# SPT-Based Liquefaction Analysis & Seismic Settlement: 100-YR Return Period

Project: US-51 Bridge Replacement
Subject: Liquefaction
Task: SPT-Based Liquefaction
Job #: 10174706

Computed by: Pineda, Ray Date: 6/2/2026
Checked by: Edwards, Brian Date: 6/2/2026


**Boring Information**

| | |
|---|---|
| Liner Required: | N |
| Liner Used: | N |

**Earthquake Information**

| | | |
|---|---|---|
| Design Earthquake: | FEE | *100-Year Return Period Event* |
| PGA: | 0.078 | |
| Site Class: | DE | |
| $M_w$: | 5.98 | |
| R(km): | 127 | |

| | | |
|---|---|---|
| Min. GW Depth, ft: | -- | |
| Max Depth to Compute Liquefaction, ft: | No Liquefaction | *Including embankment hight.* |

| Boring Number | Latitude (Deg) | Longitude (Deg) | [1] Surface Elev. (ft) | Water Elev. (ft) | Alignment | Structure | Hammer Efficiency (%) | Borehole Diameter (in.) |
|---|---|---|---|---|---|---|---|---|
| B-2046 | 37.00066 | -89.137868 | 314.3 | 302.8 | US-51 | KY Abutment | 83.8 | 4.0 |
| B-6 | 37.00609 | -89.137896 | 313.8 | 302.3 | US-51 | KY Abutment | 89.4 | 4.0 |
| CPT-6 | 36.990514 | -89.153693 | 338.48 | 303.1 | US-51 | KY Abutment | -- | -- |

*1.The surface elevation of CPT-6 includes the embankment height.*

# Boring B-2046

Project: US-51 Bridge Replacement
Subject: Liquefaction
Task: SPT-Based Liquefaction
Job #: 10174706

Computed by: Pineda,Ray
Date: 6/2/2026
Checked by: Edwards, Brian Date: 6/2/2026


## Raw Data Input

| | |
|---|---|
| Boring Number: | B-2046 |
| Latitude: | 37.00066 |
| Longitude: | -89.13787 |
| Ground Elevation, ft msl: | 314.3 |
| Groundwater Depth, ft: | 11.5 |
| Groundwater Elevation, ft msl: | 302.8 |

| | |
|---|---|
| Hammer Energy Ratio (ER), %: | 83.8 |
| $C_E$: | 1.40 |
| Bore Hole Diameter, in.: | 4 |
| $C_B$: | 1.00 |
| Liner Required: | N |
| Liner Used: | N |
| $C_S$: | 1.00 |

| | |
|---|---|
| | Strength Loss |
| | Limited Liquefcation |
| | Full Liquefaction |

127

| | | | | | | | | | | | | | | | Calculated Strengths | | Strength Override | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPT Sample | Depth, ft | Elev., ft | $N_{meas}$, bpf | FC, % | LL | PL | PI | w, % | USCS Soil Type | Soil Layer | Flag: "NL" Non-Liq or Unreliable | General Geology | $K_{DR}$ | SSL Soil Type | φ', deg | c, psf | φ', deg | c, psf |
| SS-1 | 28.5 | 285.8 | 19 | 7.0 | NP | NP | NP | 27.3 | SP-SM | II | | Holocene | 1 | Sand-Like | 40 | - | | |
| SS-2 | 33.5 | 280.8 | 14 | 6.0 | NP | NP | NP | 32.6 | SP-SM | II | | Holocene | 1 | Sand-Like | 36 | - | | |
| SS-3 | 38.5 | 275.8 | 18 | 8.0 | NP | NP | NP | 27.7 | SP-SM | II | | Holocene | 1 | Sand-Like | 38 | - | | |
| SS-4 | 43.5 | 270.8 | 21 | 8.0 | NP | NP | NP | 27.0 | SP-SM | II | | Holocene | 1 | Sand-Like | 39 | - | | |
| SS-5 | 53.5 | 260.8 | 7 | 45.0 | NP | NP | NP | 43.7 | SM | II | | Holocene | 1 | Sand-Like | 31 | - | | |
| SS-6 | 58.5 | 255.8 | 14 | 20.0 | NP | NP | NP | 30.5 | SM | II | | Holocene | 1 | Sand-Like | 35 | - | | |
| SS-7 | 63.5 | 250.8 | 23 | 5.0 | NP | NP | NP | 22.7 | SP | II | | Holocene | 1 | Sand-Like | 39 | - | | |
| SS-8 | 73.5 | 240.8 | 32 | 5.0 | NP | NP | NP | 16.4 | SP-SM | II | | Holocene | 1 | Sand-Like | 41 | - | | |
| SS-9 | 78.5 | 235.8 | 40 | 8.0 | NP | NP | NP | 20.8 | SP-SM | II | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-10 | 83.5 | 230.8 | 50 | 6.0 | NP | NP | NP | 18.1 | SP-SM | II | | Eocene | 1 | Sand-Like | 46 | - | | |
| SS-11 | 88.5 | 225.8 | 17 | 41.0 | 19 | 13 | 6 | 21.7 | SC-SM | II | | Eocene | 1 | Sand-Like | 35 | - | | |
| SS-12 | 95.0 | 219.3 | 44 | 24.0 | NP | NP | NP | 21.1 | SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-13 | 108.5 | 205.8 | 50 | 9.0 | NP | NP | NP | 19.1 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-14 | 118.5 | 195.8 | 50 | 6.0 | NP | NP | NP | 19.9 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-15 | 128.5 | 185.8 | 50 | 9.0 | NP | NP | NP | 23.4 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-16 | 138.5 | 175.8 | 50 | 8.0 | NP | NP | NP | 22.2 | SP-SM | III | | Eocene | 1 | Sand-Like | 43 | - | | |
| SS-17 | 148.5 | 165.8 | 50 | 4.0 | NP | NP | NP | 20.7 | SW | III | | Eocene | 1 | Sand-Like | 43 | - | | |

## Standard Penetration Test Correction

| | | | |
|---|---|---|---|
| Boring Number: | B-2046 | Hammer Energy Ratio (ER), %: | 83.8 |
| Latitude: | 37.00066 | CE: | 1.40 |
| Longitude: | -89.13787 | Bore Hole Diameter, in.: | 4 |
| Ground Elevation, ft msl: | 314.3 | CB: | 1.00 |
| Groundwater Above Surface, ft: | 11.5 | Liner Required: | N |
| Groundwater Elevation, ft msl: | 302.8 | Liner Used: | N |
| | | CS: | 1.00 |

| SPT Sample | Depth, ft | Elev, ft msl | $N_{meas,}$ bpf | $C_E$ | $C_N$ | $C_R$ | $C_S$ | $C_B$ | $C_F$ | σ, psf | $\bar{\sigma}$, psf | FC, % | $N_{60}$ | $N_{1,60}$ | $N^*_{60}$ | $N^*_{1,60}$ | $N^*_{1,60,cs}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SS-1 | 28.5 | 285.8 | 19 | 1.40 | 0.95 | 0.98 | 1.0 | 1.00 | 1.0 | 3278 | 2217 | 7.0 | 26.5 | 25.2 | 26.0 | 24.7 | 25.7 |
| SS-2 | 33.5 | 280.8 | 14 | 1.40 | 0.90 | 0.99 | 1.0 | 1.00 | 1.0 | 3853 | 2480 | 6.0 | 19.6 | 17.6 | 19.3 | 17.4 | 18.1 |
| SS-3 | 38.5 | 275.8 | 18 | 1.40 | 0.85 | 0.99 | 1.0 | 1.00 | 1.1 | 4428 | 2743 | 8.0 | 25.1 | 21.5 | 25.0 | 21.3 | 22.4 |
| SS-4 | 43.5 | 270.8 | 21 | 1.40 | 0.82 | 1.00 | 1.0 | 1.00 | 1.0 | 5003 | 3006 | 8.0 | 29.3 | 23.9 | 29.2 | 23.8 | 25.0 |
| SS-5 | 53.5 | 260.8 | 7 | 1.40 | 0.75 | 1.00 | 1.0 | 1.00 | 1.4 | 6153 | 3532 | 45.0 | 9.8 | 7.4 | 9.8 | 7.3 | 10.1 |
| SS-6 | 58.5 | 255.8 | 14 | 1.40 | 0.73 | 1.00 | 1.0 | 1.00 | 1.2 | 6728 | 3795 | 20.0 | 19.6 | 14.2 | 19.5 | 14.2 | 16.3 |
| SS-7 | 63.5 | 250.8 | 23 | 1.40 | 0.70 | 1.00 | 1.0 | 1.00 | 1.0 | 7303 | 4058 | 5.0 | 32.1 | 22.6 | 32.1 | 22.5 | 23.2 |
| SS-8 | 73.5 | 240.8 | 32 | 1.40 | 0.66 | 1.00 | 1.0 | 1.00 | 1.0 | 8453 | 4584 | 5.0 | 44.7 | 29.5 | 44.7 | 29.5 | 30.4 |
| SS-9 | 78.5 | 235.8 | 40 | 1.40 | 0.64 | 1.00 | 1.0 | 1.00 | 1.0 | 9028 | 4847 | 8.0 | 50.0 | 32.1 | 55.9 | 35.9 | 37.4 |
| SS-10 | 83.5 | 230.8 | 50 | 1.40 | 0.63 | 1.00 | 1.0 | 1.00 | 1.0 | 9603 | 5110 | 6.0 | 50.0 | 31.3 | 69.8 | 43.7 | 45.0 |
| SS-11 | 88.5 | 225.8 | 17 | 1.40 | 0.61 | 1.00 | 1.0 | 1.00 | 1.3 | 10178 | 5373 | 41.0 | 23.7 | 14.5 | 23.7 | 14.5 | 18.3 |
| SS-12 | 95 | 219.3 | 44 | 1.40 | 0.59 | 1.00 | 1.0 | 1.00 | 1.1 | 10925 | 5715 | 24.0 | 50.0 | 29.6 | 61.5 | 36.4 | 41.0 |
| SS-13 | 108.5 | 205.8 | 50 | 1.40 | 0.56 | 1.00 | 1.0 | 1.00 | 1.0 | 12478 | 6425 | 9.0 | 50.0 | 27.9 | 69.8 | 39.0 | 40.8 |
| SS-14 | 118.5 | 195.8 | 50 | 1.40 | 0.54 | 1.00 | 1.0 | 1.00 | 1.0 | 13628 | 6951 | 6.0 | 50.0 | 26.8 | 69.8 | 37.5 | 38.7 |
| SS-15 | 128.5 | 185.8 | 50 | 1.40 | 0.52 | 1.00 | 1.0 | 1.00 | 1.0 | 14778 | 7477 | 9.0 | 50.0 | 25.9 | 69.8 | 36.1 | 37.9 |
| SS-16 | 138.5 | 175.8 | 50 | 1.40 | 0.50 | 1.00 | 1.0 | 1.00 | 1.0 | 15928 | 8003 | 8.0 | 50.0 | 25.0 | 69.8 | 34.9 | 36.4 |
| SS-17 | 148.5 | 165.8 | 50 | 1.40 | 0.48 | 1.00 | 1.0 | 1.00 | 1.0 | 17078 | 8529 | 4.0 | 50.0 | 24.2 | 69.8 | 33.8 | 33.8 |

## SPT-Based Soil Shear Strength Loss Evaluation

| | | | | | |
|---|---|---|---|---|---|
| Boring Number: | B-2046 | Design EQ: | FEE | $M_w$: | 5.98 |
| Latitude: | 37.00066 | Site Class: | DE | R(km): | 127 |
| Longitude: | -89.13787 | PGA: | 0.078 | $MSF_{sand}$: | 1.49 |
| Ground Elevation, ft msl: | 314.3 | $\phi_{SL\text{-}Sand}$ | 0.90 | $MSF_{clay}$: | 1.08 |
| Groundwater Depth, ft: | 11.5 | $\phi_{NSL\text{-}Sand}$ | 0.70 | | |
| Groundwater Elevation, ft msl: | 302.8 | $\phi_{SL\text{-}Clay}$ | 0.90 | | |

| | | | | | | | | Soil Strength Loss Triggering Summary | | | Geotechnical Seismic Hazards Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Idriss & Boulanger (2007) | | Olsen & Johnson (2008) | | Kramer & Wang (2015) | Idriss & Boulanger (2008) | | | |
| SPT Sample | Depth, ft | Elev, ft msl | $N^*_{1,60}$ | $\Delta N^*_{1,60}$ | $N^*_{1,60,cs}$ | SSL Potential | SSL Susceptibility Screening | $(D/C)_{SL}$ | $\phi_{SL}$ | $(D/C)_{SL} \le \phi_{SL}$ | $S_r/\sigma'_{vo}$ | $S_r$ (psf) | $S_r/\sigma'_{vo}$ | $S_r$ (psf) | $S_r$ (psf) | LDI, ft | ∑LDI, ft | $S_{v\text{-}1D}$, in | $\sum S_{v\text{-}1D}$, in |
| SS-1 | 28.5 | 285.8 | 24.7 | 0.1 | 24.8 | SSL | Sand-Like | 0.15 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-2 | 33.5 | 280.8 | 17.4 | 0.0 | 17.4 | SSL | Sand-Like | 0.24 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-3 | 38.5 | 275.8 | 21.3 | 0.4 | 21.7 | SSL | Sand-Like | 0.19 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-4 | 43.5 | 270.8 | 23.8 | 0.4 | 24.2 | SSL | Sand-Like | 0.16 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-5 | 53.5 | 260.8 | 7.3 | 5.5 | 12.8 | SSL | Sand-Like | 0.29 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-6 | 58.5 | 255.8 | 14.2 | 4.5 | 18.7 | SSL | Sand-Like | 0.21 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-7 | 63.5 | 250.8 | 22.5 | 0.0 | 22.5 | SSL | Sand-Like | 0.17 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-8 | 73.5 | 240.8 | 29.5 | 0.0 | 29.5 | SSL | Sand-Like | 0.09 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-9 | 78.5 | 235.8 | 35.9 | 0.4 | 36.3 | NSL-S | Sand-Like | 0.03 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-10 | 83.5 | 230.8 | 43.7 | 0.0 | 43.7 | NSL-S | Sand-Like | 0.00 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-11 | 88.5 | 225.8 | 14.5 | 5.5 | 20.0 | NSL-S | Sand-Like | 0.17 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-12 | 95 | 219.3 | 36.4 | 5.0 | 41.3 | NSL-S | Sand-Like | 0.01 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-13 | 108.5 | 205.8 | 39.0 | 0.7 | 39.7 | NSL-S | Sand-Like | 0.01 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-14 | 118.5 | 195.8 | 37.5 | 0.0 | 37.5 | NSL-S | Sand-Like | 0.02 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-15 | 128.5 | 185.8 | 36.1 | 0.7 | 36.8 | NSL-S | Sand-Like | 0.03 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-16 | 138.5 | 175.8 | 34.9 | 0.4 | 35.3 | NSL-S | Sand-Like | 0.04 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-17 | 148.5 | 165.8 | 33.8 | 0.0 | 33.8 | NSL-S | Sand-Like | 0.06 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |

# Boring B-6

## Raw Data Input

| | |
|---|---|
| Boring Number: | B-6 |
| Latitude: | 37.00609 |
| Longitude: | -89.13790 |
| Ground Elevation, ft msl: | 313.8 |
| Groundwater Depth, ft: | 11.5 |
| Groundwater Elevation, ft msl: | 302.3 |

| | |
|---|---|
| Hammer Energy Ratio (ER), %: | 89.4 |
| $C_E$: | 1.49 |
| Bore Hole Diameter, in.: | 4 |
| $C_B$: | 1.00 |
| Liner Required: | N |
| Liner Used: | N |
| $C_S$: | 1.00 |

Strength Loss
Limited Liquefcation
Full Liquefaction

127

| | | | | | | | | | | | | | | | Calculated Strengths | | Strength Override | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPT Sample | Depth, ft | Elev., ft | $N_{meas}$, bpf | FC, % | LL | PL | PI | w, % | USCS Soil Type | Soil Layer | Flag: "NL" Non-Liq or Unreliable | General Geology | $K_{DR}$ | SSL Soil Type | φ', deg | c, psf | φ', deg | c, psf |
| SS-1 | 5.0 | 308.8 | 8 | 95.0 | 42 | 26 | 16 | 29.3 | ML | I | | Holocene | 1 | Clay-Like | - | 1790 | | |
| SS-2 | 25.0 | 288.8 | 1 | 5.0 | NP | NP | NP | 32.4 | SP-SM | II | | Holocene | 1 | Sand-Like | 25 | - | | |
| SS-3 | 28.5 | 285.3 | 8 | 4.0 | NP | NP | NP | 31.7 | SP | II | | Holocene | 1 | Sand-Like | 33 | - | | |
| SS-4 | 33.5 | 280.3 | 9 | 4.0 | NP | NP | NP | 29.4 | SP | II | | Holocene | 1 | Sand-Like | 34 | - | | |
| SS-5 | 40.0 | 273.8 | 13 | 5.0 | NP | NP | NP | 30.0 | SP | II | | Holocene | 1 | Sand-Like | 36 | - | | |
| SS-6 | 43.5 | 270.3 | 12 | 4.0 | NP | NP | NP | 29.9 | SP | II | | Holocene | 1 | Sand-Like | 35 | - | | |
| SS-7 | 48.5 | 265.3 | 23 | 6.0 | NP | NP | NP | 28.8 | SP-SM | II | | Holocene | 1 | Sand-Like | 40 | - | | |
| SS-8 | 53.5 | 260.3 | 25 | 7.0 | NP | NP | NP | 29.4 | SP-SM | II | | Holocene | 1 | Sand-Like | 41 | - | | |
| SS-9 | 63.5 | 250.3 | 9 | 35.0 | NP | NP | NP | 40.6 | SM | II | | Holocene | 1 | Sand-Like | 32 | - | | |
| SS-10 | 68.5 | 245.3 | 23 | 2.0 | NP | NP | NP | 7.8 | GP | II | | Holocene | 1 | Sand-Like | 39 | - | | |
| SS-11 | 73.5 | 240.3 | 15 | 3.0 | NP | NP | NP | 18.7 | SP | II | | Holocene | 1 | Sand-Like | 35 | - | | |
| SS-12 | 78.0 | 235.8 | 45 | 8.0 | NP | NP | NP | 15.4 | SP-SM | II | | Holocene | 1 | Sand-Like | 46 | - | | |
| SS-13 | 83.5 | 230.3 | 50 | 10.0 | NP | NP | NP | 9.2 | GP-GM | II | | Eocene | 1 | Sand-Like | 47 | - | | |
| SS-14 | 88.5 | 225.3 | 18 | 10.0 | NP | NP | NP | 26.2 | SP-SM | II | | Eocene | 1 | Sand-Like | 36 | - | | |
| SS-15 | 93.5 | 220.3 | 21 | 20.0 | NP | NP | NP | 23.7 | SM | II | | Eocene | 1 | Sand-Like | 37 | - | | |
| SS-16 | 98.0 | 215.8 | 50 | 52.0 | 19 | 12 | 7 | 18.0 | CL-ML | III | | Eocene | 1 | Clay-Like | - | 3750 | | |
| SS-17 | 103.5 | 210.3 | 50 | 12.0 | NP | NP | NP | 26.3 | SP-SM | III | | Eocene | 1 | Sand-Like | 46 | - | | |
| SS-18 | 108.5 | 205.3 | 50 | 11.0 | NP | NP | NP | 25.0 | SP-SM | III | | Eocene | 1 | Sand-Like | 45 | - | | |
| SS-19 | 113.5 | 200.3 | 50 | 18.0 | NP | NP | NP | 22.2 | SM | III | | Eocene | 1 | Sand-Like | 45 | - | | |
| SS-20 | 119.0 | 194.8 | 50 | 5.0 | NP | NP | NP | 20.7 | SP | III | | Eocene | 1 | Sand-Like | 45 | - | | |
| SS-21 | 123.5 | 190.3 | 50 | 7.0 | NP | NP | NP | 32.0 | SP-SM | III | | Eocene | 1 | Sand-Like | 45 | - | | |
| SS-22 | 128.5 | 185.3 | 50 | 5.0 | NP | NP | NP | 23.4 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-23 | 133.5 | 180.3 | 50 | 6.0 | 36 | 34 | 2 | 24.2 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-24 | 138.0 | 175.8 | 50 | 10.0 | NP | NP | NP | 23.8 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-25 | 143.5 | 170.3 | 50 | 6.0 | NP | NP | NP | 20.6 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-26 | 148.0 | 165.8 | 50 | 5 | NP | NP | NP | 22.3 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |

## Standard Penetration Test Correction

| | | | |
|---|---|---|---|
| Boring Number: | B-6 | Hammer Energy Ratio (ER), %: | 89.4 |
| Latitude: | 37.00609 | CE: | 1.49 |
| Longitude: | -89.13790 | Bore Hole Diameter, in.: | 4 |
| Ground Elevation, ft msl: | 313.8 | CB: | 1.00 |
| Groundwater Above Surface, ft: | 11.5 | Liner Required: | N |
| Groundwater Elevation, ft msl: | 302.3 | Liner Used: | N |
| | | CS: | 1.00 |

| SPT Sample | Depth, ft | Elev, ft msl | $N_{meas}$, bpf | $C_E$ | $C_N$ | $C_R$ | $C_S$ | $C_B$ | $C_F$ | σ, psf | σ̄, psf | FC, % | $N_{60}$ | $N_{1,60}$ | $N^*_{60}$ | $N^*_{1,60}$ | $N^*_{1,60,cs}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SS-1 | 5 | 308.8 | 8 | 1.49 | 1.70 | 0.77 | 1.0 | 1.00 | 1.3 | 575 | 575 | 95.0 | 11.9 | 20.3 | 9.1 | 15.5 | 19.4 |
| SS-2 | 25 | 288.8 | 1 | 1.49 | 0.99 | 0.97 | 1.0 | 1.00 | 1.2 | 2875 | 2033 | 5.0 | 1.5 | 1.5 | 1.4 | 1.4 | 1.7 |
| SS-3 | 28.5 | 285.3 | 8 | 1.49 | 0.95 | 0.98 | 1.0 | 1.00 | 1.0 | 3278 | 2217 | 4.0 | 11.9 | 11.3 | 11.7 | 11.1 | 11.1 |
| SS-4 | 33.5 | 280.3 | 9 | 1.49 | 0.90 | 0.99 | 1.0 | 1.00 | 1.0 | 3853 | 2480 | 4.0 | 13.4 | 12.0 | 13.3 | 11.9 | 11.9 |
| SS-5 | 40 | 273.8 | 13 | 1.49 | 0.84 | 0.99 | 1.0 | 1.00 | 1.0 | 4600 | 2822 | 5.0 | 19.4 | 16.3 | 19.3 | 16.2 | 16.8 |
| SS-6 | 43.5 | 270.3 | 12 | 1.49 | 0.82 | 1.00 | 1.0 | 1.00 | 1.0 | 5003 | 3006 | 4.0 | 17.9 | 14.6 | 17.8 | 14.5 | 14.5 |
| SS-7 | 48.5 | 265.3 | 23 | 1.49 | 0.78 | 1.00 | 1.0 | 1.00 | 1.0 | 5578 | 3269 | 6.0 | 34.3 | 26.8 | 34.2 | 26.7 | 27.7 |
| SS-8 | 53.5 | 260.3 | 25 | 1.49 | 0.75 | 1.00 | 1.0 | 1.00 | 1.0 | 6153 | 3532 | 7.0 | 37.3 | 28.0 | 37.2 | 28.0 | 29.1 |
| SS-9 | 63.5 | 250.3 | 9 | 1.49 | 0.70 | 1.00 | 1.0 | 1.00 | 1.3 | 7303 | 4058 | 35.0 | 13.4 | 9.4 | 13.4 | 9.4 | 12.5 |
| SS-10 | 68.5 | 245.3 | 23 | 1.49 | 0.68 | 1.00 | 1.0 | 1.00 | 1.0 | 7878 | 4321 | 2.0 | 34.3 | 23.3 | 34.3 | 23.3 | 23.3 |
| SS-11 | 73.5 | 240.3 | 15 | 1.49 | 0.66 | 1.00 | 1.0 | 1.00 | 1.0 | 8453 | 4584 | 3.0 | 22.4 | 14.8 | 22.3 | 14.8 | 14.8 |
| SS-12 | 78 | 235.8 | 45 | 1.49 | 0.64 | 1.00 | 1.0 | 1.00 | 1.0 | 8970 | 4820 | 8.0 | 50.0 | 32.2 | 67.0 | 43.2 | 45.0 |
| SS-13 | 83.5 | 230.3 | 50 | 1.49 | 0.63 | 1.00 | 1.0 | 1.00 | 1.1 | 9603 | 5110 | 10.0 | 50.0 | 31.3 | 74.5 | 46.6 | 49.0 |
| SS-14 | 88.5 | 225.3 | 18 | 1.49 | 0.61 | 1.00 | 1.0 | 1.00 | 1.1 | 10178 | 5373 | 10.0 | 26.8 | 16.4 | 26.8 | 16.4 | 17.5 |
| SS-15 | 93.5 | 220.3 | 21 | 1.49 | 0.60 | 1.00 | 1.0 | 1.00 | 1.1 | 10753 | 5636 | 20.0 | 31.3 | 18.6 | 31.3 | 18.6 | 21.1 |
| SS-16 | 98 | 215.8 | 50 | 1.49 | 0.58 | 1.00 | 1.0 | 1.00 | 1.2 | 11270 | 5872 | 52.0 | 50.0 | 29.2 | 74.5 | 43.5 | 51.3 |
| SS-17 | 103.5 | 210.3 | 50 | 1.49 | 0.57 | 1.00 | 1.0 | 1.00 | 1.1 | 11903 | 6162 | 12.0 | 50.0 | 28.5 | 74.5 | 42.4 | 45.1 |
| SS-18 | 108.5 | 205.3 | 50 | 1.49 | 0.56 | 1.00 | 1.0 | 1.00 | 1.1 | 12478 | 6425 | 11.0 | 50.0 | 27.9 | 74.5 | 41.6 | 43.9 |
| SS-19 | 113.5 | 200.3 | 50 | 1.49 | 0.55 | 1.00 | 1.0 | 1.00 | 1.1 | 13053 | 6688 | 18.0 | 50.0 | 27.3 | 74.5 | 40.7 | 44.6 |
| SS-20 | 119 | 194.8 | 50 | 1.49 | 0.54 | 1.00 | 1.0 | 1.00 | 1.0 | 13685 | 6977 | 5.0 | 50.0 | 26.8 | 74.5 | 39.9 | 40.9 |
| SS-21 | 123.5 | 190.3 | 50 | 1.49 | 0.53 | 1.00 | 1.0 | 1.00 | 1.0 | 14203 | 7214 | 7.0 | 50.0 | 26.3 | 74.5 | 39.2 | 40.7 |
| SS-22 | 128.5 | 185.3 | 50 | 1.49 | 0.52 | 1.00 | 1.0 | 1.00 | 1.0 | 14778 | 7477 | 5.0 | 50.0 | 25.9 | 74.5 | 38.5 | 39.6 |
| SS-23 | 133.5 | 180.3 | 50 | 1.49 | 0.51 | 1.00 | 1.0 | 1.00 | 1.0 | 15353 | 7740 | 6.0 | 50.0 | 25.4 | 74.5 | 37.9 | 39.1 |
| SS-24 | 138 | 175.8 | 50 | 1.49 | 0.50 | 1.00 | 1.0 | 1.00 | 1.1 | 15870 | 7976 | 10.0 | 50.0 | 25.0 | 74.5 | 37.3 | 39.3 |
| SS-25 | 143.5 | 170.3 | 50 | 1.49 | 0.49 | 1.00 | 1.0 | 1.00 | 1.0 | 16503 | 8266 | 6.0 | 50.0 | 24.6 | 74.5 | 36.6 | 37.8 |
| SS-26 | 148 | 165.8 | 50 | 1.49 | 0.49 | 1.00 | 1.0 | 1.00 | 1.0 | 17020 | 8502 | 5.0 | 50.0 | 24.3 | 74.5 | 36.1 | 37.1 |

## SPT-Based Soil Shear Strength Loss Evaluation

| | | | | | |
|---|---|---|---|---|---|
| Boring Number: | B-6 | Design EQ: | FEE | $M_w$: | 5.98 |
| Latitude: | 37.00609 | Site Class: | DE | R(km): | 127 |
| Longitude: | -89.13790 | PGA: | 0.078 | $MSF_{sand}$: | 1.49 |
| Ground Elevation, ft msl: | 313.8 | $\phi_{SL\text{-}Sand}$ | 0.90 | $MSF_{clay}$: | 1.08 |
| Groundwater Depth, ft: | 11.5 | $\phi_{NSL\text{-}Sand}$ | 0.70 | | |
| Groundwater Elevation, ft msl: | 302.3 | $\phi_{SL\text{-}Clay}$ | 0.90 | | |

| | | | | | | | | Soil Strength Loss Triggering Summary | | | Geotechnical Seismic Hazards Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Idriss & Boulanger (2007) | | Olsen & Johnson (2008) | | Kramer & Wang (2015) | Idriss & Boulanger (2008) | | | |
| SPT Sample | Depth, ft | Elev, ft msl | $N^*_{1,60}$ | $\Delta N^*_{1,60}$ | $N^*_{1,60,cs}$ | SSL Potential | SSL Susceptibility Screening | $(D/C)_{SL}$ | $\phi_{SL}$ | $(D/C)_{SL} \le \phi_{SL}$ | $S_r/\sigma'_{vo}$ | $S_r$ (psf) | $S_r/\sigma'_{vo}$ | $S_r$ (psf) | $S_r$ (psf) | LDI, ft | ∑LDI, ft | $S_{v\text{-}1D}$, in | $\sum S_{v\text{-}1D}$, in |
| SS-1 | 5 | 308.8 | 15.5 | 5.5 | 21.0 | PSL | NS Clay-Like | 0.02 | 0.9 | No Strength Loss | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-2 | 25 | 288.8 | 1.4 | 0.0 | 1.4 | SSL | Sand-Like | 0.61 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-3 | 28.5 | 285.3 | 11.1 | 0.0 | 11.1 | SSL | Sand-Like | 0.34 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-4 | 33.5 | 280.3 | 11.9 | 0.0 | 11.9 | SSL | Sand-Like | 0.33 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-5 | 40 | 273.8 | 16.2 | 0.0 | 16.2 | SSL | Sand-Like | 0.26 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-6 | 43.5 | 270.3 | 14.5 | 0.0 | 14.5 | SSL | Sand-Like | 0.28 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-7 | 48.5 | 265.3 | 26.7 | 0.0 | 26.8 | SSL | Sand-Like | 0.13 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-8 | 53.5 | 260.3 | 28.0 | 0.1 | 28.1 | SSL | Sand-Like | 0.11 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-9 | 63.5 | 250.3 | 9.4 | 5.5 | 14.9 | SSL | Sand-Like | 0.25 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-10 | 68.5 | 245.3 | 23.3 | 0.0 | 23.3 | SSL | Sand-Like | 0.15 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-11 | 73.5 | 240.3 | 14.8 | 0.0 | 14.8 | SSL | Sand-Like | 0.24 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-12 | 78 | 235.8 | 43.2 | 0.4 | 43.6 | NSL-S | Sand-Like | 0.00 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-13 | 83.5 | 230.3 | 46.6 | 1.1 | 47.8 | NSL-S | Sand-Like | 0.00 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-14 | 88.5 | 225.3 | 16.4 | 1.1 | 17.5 | SSL | Sand-Like | 0.20 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-15 | 93.5 | 220.3 | 18.6 | 4.5 | 23.1 | SSL | Sand-Like | 0.14 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-16 | 98 | 215.8 | 43.5 | 5.5 | 49.0 | PSL | HS Clay-Like | 0.04 | 0.9 | No Strength Loss | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-17 | 103.5 | 210.3 | 42.4 | 2.1 | 44.5 | NSL-S | Sand-Like | 0.00 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-18 | 108.5 | 205.3 | 41.6 | 1.6 | 43.2 | NSL-S | Sand-Like | 0.00 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-19 | 113.5 | 200.3 | 40.7 | 4.1 | 44.8 | NSL-S | Sand-Like | 0.00 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-20 | 119 | 194.8 | 39.9 | 0.0 | 39.9 | NSL-S | Sand-Like | 0.01 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-21 | 123.5 | 190.3 | 39.2 | 0.1 | 39.4 | NSL-S | Sand-Like | 0.01 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-22 | 128.5 | 185.3 | 38.5 | 0.0 | 38.5 | NSL-S | Sand-Like | 0.02 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-23 | 133.5 | 180.3 | 37.9 | 0.0 | 37.9 | NSL-S | Sand-Like | 0.02 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-24 | 138 | 175.8 | 37.3 | 1.1 | 38.5 | NSL-S | Sand-Like | 0.02 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-25 | 143.5 | 170.3 | 36.6 | 0.0 | 36.7 | NSL-S | Sand-Like | 0.04 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-26 | 148 | 165.8 | 36.1 | 0.0 | 36.1 | NSL-S | Sand-Like | 0.04 | 0.7 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |

# SPT-Based Liquefaction Analysis & Seismic Settlement: 1,000-YR Return Period

Project: US-51 Bridge Replacement
Subject: Liquefaction
Task: SPT-Based Liquefaction
Job #: 10174706

Computed by: Pineda, Ray Date: 6/2/2026
Checked by: Edwards, Brian Date: 6/2/2026


**Boring Information**

| | |
|---|---|
| Liner Required: | N |
| Liner Used: | N |

**Earthquake Information**

| | | |
|---|---|---|
| Design Earthquake: | SEE | *1000-Year Return Period Event* |
| PGA: | 0.48 | |
| Site Class: | DE | |
| $M_w$: | 6.99 | |
| R(km): | 15 | |
| Min. GW Depth, ft: | -- | |
| Max Depth to Compute Liquefaction, ft: | 100.0 | *Including embankment hight.* |

| Boring Number | Latitude (Deg) | Longitude (Deg) | [1] Surface Elev. (ft) | Water Elev. (ft) | Alignment | Structure | Hammer Efficiency (%) | Borehole Diameter (in.) |
|---|---|---|---|---|---|---|---|---|
| B-2046 | 37.000660 | -89.137868 | 314.3 | 302.8 | US-51 | KY Abutment | 83.8 | 4.0 |
| B-6 | 37.000609 | -89.137896 | 313.8 | 302.3 | US-51 | KY Abutment | 89.4 | 4.0 |
| CPT-6 | 36.990514 | -89.153693 | 338.48 | 303.1 | US-51 | KY Abutment | -- | -- |

*1.The surface elevation of CPT-6 includes the embankment height.*

# Boring 2046

Project: US-51 Bridge Replacement
Subject: Liquefaction
Task: SPT-Based Liquefaction
Job #: 10174706

Computed by: Pineda,Ray
Date: 6/2/2026
Checked by: Edwards, Brian Date: 6/2/2026


## Raw Data Input

| | |
|---|---|
| Boring Number: | B-2046 |
| Latitude: | 37.00066 |
| Longitude: | -89.13787 |
| Ground Elevation, ft msl: | 314.3 |
| Groundwater Depth, ft: | 11.5 |
| Groundwater Elevation, ft msl: | 302.8 |

| | |
|---|---|
| Hammer Energy Ratio (ER), %: | 83.8 |
| $C_E$: | 1.40 |
| Bore Hole Diameter, in.: | 4 |
| $C_B$: | 1.00 |
| Liner Required: | N |
| Liner Used: | N |
| $C_S$: | 1.00 |

| | |
|---|---|
| | Strength Loss |
| | Limited Liquefcation |
| | Full Liquefaction |

| | | | | | | | | | | | | | | | Calculated Strengths | | Strength Override | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPT Sample | Depth, ft | Elev., ft | $N_{meas}$, bpf | FC, % | LL | PL | PI | w, % | USCS Soil Type | Soil Layer | Flag: "NL" Non-Liq or Unreliable | General Geology | $K_{DR}$ | SSL Soil Type | φ', deg | c, psf | φ', deg | c, psf |
| SS-1 | 28.5 | 285.8 | 19 | 7.0 | NP | NP | NP | 27.3 | SP-SM | II | | Holocene | 1 | Sand-Like | 40 | - | | |
| SS-2 | 33.5 | 280.8 | 14 | 6.0 | NP | NP | NP | 32.6 | SP-SM | II | | Holocene | 1 | Sand-Like | 36 | - | | |
| SS-3 | 38.5 | 275.8 | 18 | 8.0 | NP | NP | NP | 27.7 | SP-SM | II | | Holocene | 1 | Sand-Like | 38 | - | | |
| SS-4 | 43.5 | 270.8 | 21 | 8.0 | NP | NP | NP | 27.0 | SP-SM | II | | Holocene | 1 | Sand-Like | 39 | - | | |
| SS-5 | 53.5 | 260.8 | 7 | 45.0 | NP | NP | NP | 43.7 | SM | II | | Holocene | 1 | Sand-Like | 31 | - | | |
| SS-6 | 58.5 | 255.8 | 14 | 20.0 | NP | NP | NP | 30.5 | SM | II | | Holocene | 1 | Sand-Like | 35 | - | | |
| SS-7 | 63.5 | 250.8 | 23 | 5.0 | NP | NP | NP | 22.7 | SP | II | | Holocene | 1 | Sand-Like | 39 | - | | |
| SS-8 | 73.5 | 240.8 | 32 | 5.0 | NP | NP | NP | 16.4 | SP-SM | II | | Holocene | 1 | Sand-Like | 41 | - | | |
| SS-9 | 78.5 | 235.8 | 40 | 8.0 | NP | NP | NP | 20.8 | SP-SM | II | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-10 | 83.5 | 230.8 | 50 | 6.0 | NP | NP | NP | 18.1 | SP-SM | II | | Eocene | 1 | Sand-Like | 46 | - | | |
| SS-11 | 88.5 | 225.8 | 17 | 41.0 | 19 | 13 | 6 | 21.7 | SC-SM | II | NL | Eocene | 1 | Sand-Like | 35 | - | | |
| SS-12 | 95.0 | 219.3 | 44 | 24.0 | NP | NP | NP | 21.1 | SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-13 | 108.5 | 205.8 | 50 | 9.0 | NP | NP | NP | 19.1 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-14 | 118.5 | 195.8 | 50 | 6.0 | NP | NP | NP | 19.9 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-15 | 128.5 | 185.8 | 50 | 9.0 | NP | NP | NP | 23.4 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-16 | 138.5 | 175.8 | 50 | 8.0 | NP | NP | NP | 22.2 | SP-SM | III | | Eocene | 1 | Sand-Like | 43 | - | | |
| SS-17 | 148.5 | 165.8 | 50 | 4.0 | NP | NP | NP | 20.7 | SW | III | | Eocene | 1 | Sand-Like | 43 | - | | |

## Standard Penetration Test Correction

| | | | |
|---|---|---|---|
| Boring Number: | B-2046 | Hammer Energy Ratio (ER), %: | 83.8 |
| Latitude: | 37.00066 | CE: | 1.40 |
| Longitude: | -89.13787 | Bore Hole Diameter, in.: | 4 |
| Ground Elevation, ft msl: | 314.3 | CB: | 1.00 |
| Groundwater Above Surface, ft: | 11.5 | Liner Required: | N |
| Groundwater Elevation, ft msl: | 302.8 | Liner Used: | N |
| | | CS: | 1.00 |

| SPT Sample | Depth, ft | Elev, ft msl | $N_{meas,}$ bpf | $C_E$ | $C_N$ | $C_R$ | $C_S$ | $C_B$ | $C_F$ | σ, psf | $\bar{\sigma}$, psf | FC, % | $N_{60}$ | $N_{1,60}$ | $N^*_{60}$ | $N^*_{1,60}$ | $N^*_{1,60,cs}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SS-1 | 28.5 | 285.8 | 19 | 1.40 | 0.95 | 0.98 | 1.0 | 1.00 | 1.0 | 3278 | 2217 | 7.0 | 26.5 | 25.2 | 26.0 | 24.7 | 25.7 |
| SS-2 | 33.5 | 280.8 | 14 | 1.40 | 0.90 | 0.99 | 1.0 | 1.00 | 1.0 | 3853 | 2480 | 6.0 | 19.6 | 17.6 | 19.3 | 17.4 | 18.1 |
| SS-3 | 38.5 | 275.8 | 18 | 1.40 | 0.85 | 0.99 | 1.0 | 1.00 | 1.1 | 4428 | 2743 | 8.0 | 25.1 | 21.5 | 25.0 | 21.3 | 22.4 |
| SS-4 | 43.5 | 270.8 | 21 | 1.40 | 0.82 | 1.00 | 1.0 | 1.00 | 1.0 | 5003 | 3006 | 8.0 | 29.3 | 23.9 | 29.2 | 23.8 | 25.0 |
| SS-5 | 53.5 | 260.8 | 7 | 1.40 | 0.75 | 1.00 | 1.0 | 1.00 | 1.4 | 6153 | 3532 | 45.0 | 9.8 | 7.4 | 9.8 | 7.3 | 10.1 |
| SS-6 | 58.5 | 255.8 | 14 | 1.40 | 0.73 | 1.00 | 1.0 | 1.00 | 1.2 | 6728 | 3795 | 20.0 | 19.6 | 14.2 | 19.5 | 14.2 | 16.3 |
| SS-7 | 63.5 | 250.8 | 23 | 1.40 | 0.70 | 1.00 | 1.0 | 1.00 | 1.0 | 7303 | 4058 | 5.0 | 32.1 | 22.6 | 32.1 | 22.5 | 23.2 |
| SS-8 | 73.5 | 240.8 | 32 | 1.40 | 0.66 | 1.00 | 1.0 | 1.00 | 1.0 | 8453 | 4584 | 5.0 | 44.7 | 29.5 | 44.7 | 29.5 | 30.4 |
| SS-9 | 78.5 | 235.8 | 40 | 1.40 | 0.64 | 1.00 | 1.0 | 1.00 | 1.0 | 9028 | 4847 | 8.0 | 50.0 | 32.1 | 55.9 | 35.9 | 37.4 |
| SS-10 | 83.5 | 230.8 | 50 | 1.40 | 0.63 | 1.00 | 1.0 | 1.00 | 1.0 | 9603 | 5110 | 6.0 | 50.0 | 31.3 | 69.8 | 43.7 | 45.0 |
| SS-11 | 88.5 | 225.8 | 17 | 1.40 | 0.61 | 1.00 | 1.0 | 1.00 | 1.3 | 10178 | 5373 | 41.0 | 23.7 | 14.5 | 23.7 | 14.5 | 18.3 |
| SS-12 | 95 | 219.3 | 44 | 1.40 | 0.59 | 1.00 | 1.0 | 1.00 | 1.1 | 10925 | 5715 | 24.0 | 50.0 | 29.6 | 61.5 | 36.4 | 41.0 |
| SS-13 | 108.5 | 205.8 | 50 | 1.40 | 0.56 | 1.00 | 1.0 | 1.00 | 1.0 | 12478 | 6425 | 9.0 | 50.0 | 27.9 | 69.8 | 39.0 | 40.8 |
| SS-14 | 118.5 | 195.8 | 50 | 1.40 | 0.54 | 1.00 | 1.0 | 1.00 | 1.0 | 13628 | 6951 | 6.0 | 50.0 | 26.8 | 69.8 | 37.5 | 38.7 |
| SS-15 | 128.5 | 185.8 | 50 | 1.40 | 0.52 | 1.00 | 1.0 | 1.00 | 1.0 | 14778 | 7477 | 9.0 | 50.0 | 25.9 | 69.8 | 36.1 | 37.9 |
| SS-16 | 138.5 | 175.8 | 50 | 1.40 | 0.50 | 1.00 | 1.0 | 1.00 | 1.0 | 15928 | 8003 | 8.0 | 50.0 | 25.0 | 69.8 | 34.9 | 36.4 |
| SS-17 | 148.5 | 165.8 | 50 | 1.40 | 0.48 | 1.00 | 1.0 | 1.00 | 1.0 | 17078 | 8529 | 4.0 | 50.0 | 24.2 | 69.8 | 33.8 | 33.8 |

## SPT-Based Soil Shear Strength Loss Evaluation

| | | | | | |
|---|---|---|---|---|---|
| Boring Number: | B-2046 | Design EQ: | SEE | $M_w$: | 6.99 |
| Latitude: | 37.00066 | Site Class: | DE | R(km): | 15 |
| Longitude: | -89.13787 | PGA: | 0.48 | $MSF_{sand}$: | 1.14 |
| Ground Elevation, ft msl: | 314.3 | $\phi_{SL\text{-}Sand}$ | 0.90 | $MSF_{clay}$: | 1.02 |
| Groundwater Depth, ft: | 11.5 | $\phi_{NSL\text{-}Sand}$ | 0.75 | | |
| Groundwater Elevation, ft msl: | 302.8 | $\phi_{SL\text{-}Clay}$ | 0.90 | | |

| | | | | | | | | Soil Strength Loss Triggering Summary | | | Geotechnical Seismic Hazards Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Idriss & Boulanger (2007) | | Olsen & Johnson (2008) | | Kramer & Wang (2015) | Idriss & Boulanger (2008) | | | |
| SPT Sample | Depth, ft | Elev, ft msl | $N^*_{1,60}$ | $\Delta N^*_{1,60}$ | $N^*_{1,60,cs}$ | SSL Potential | SSL Susceptibility Screening | $(D/C)_{SL}$ | $\phi_{SL}$ | $(D/C)_{SL} \le \phi_{SL}$ | $S_r/\sigma'_{vo}$ | $S_r$ (psf) | $S_r/\sigma'_{vo}$ | $S_r$ (psf) | $S_r$ (psf) | LDI, ft | ∑LDI, ft | $S_{v\text{-}1D}$, in | $\sum S_{v\text{-}1D}$, in |
| SS-1 | 28.5 | 285.8 | 24.7 | 0.1 | 24.8 | SSL | Sand-Like | 1.27 | 0.9 | Full Liquefaction | 0.25 | 560.40 | 0.22 | 477.21 | 1579.44 | 1.68 | 9.0 | - | 11.1 |
| SS-2 | 33.5 | 280.8 | 17.4 | 0.0 | 17.4 | SSL | Sand-Like | 2.10 | 0.9 | Full Liquefaction | 0.15 | 366.05 | 0.16 | 397.20 | 729.51 | 1.06 | 7.3 | 1.55 | 11.1 |
| SS-3 | 38.5 | 275.8 | 21.3 | 0.4 | 21.7 | SSL | Sand-Like | 1.67 | 0.9 | Full Liquefaction | 0.20 | 540.13 | 0.19 | 520.93 | 1180.46 | 0.66 | 6.3 | 1.29 | 9.6 |
| SS-4 | 43.5 | 270.8 | 23.8 | 0.4 | 24.2 | SSL | Sand-Like | 1.43 | 0.9 | Full Liquefaction | 0.24 | 719.58 | 0.21 | 627.43 | 1623.38 | 0.39 | 5.6 | 1.14 | 8.3 |
| SS-5 | 53.5 | 260.8 | 7.3 | 5.5 | 12.8 | SSL | Sand-Like | 2.68 | 0.9 | Full Liquefaction | 0.14 | 503.65 | 0.09 | 300.58 | 292.05 | 3.47 | 5.2 | 3.84 | 7.2 |
| SS-6 | 58.5 | 255.8 | 14.2 | 4.5 | 18.7 | SSL | Sand-Like | 1.96 | 0.9 | Full Liquefaction | 0.16 | 607.75 | 0.14 | 517.55 | 641.05 | 0.92 | 1.8 | 1.46 | 3.3 |
| SS-7 | 63.5 | 250.8 | 22.5 | 0.0 | 22.5 | SSL | Sand-Like | 1.58 | 0.9 | Full Liquefaction | 0.21 | 851.37 | 0.20 | 807.77 | 1656.37 | 0.58 | 0.8 | 1.25 | 1.9 |
| SS-8 | 73.5 | 240.8 | 29.5 | 0.0 | 29.5 | SSL | Sand-Like | 0.86 | 0.9 | Lim. Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.25 | 0.3 | 0.61 | 0.6 |
| SS-9 | 78.5 | 235.8 | 35.9 | 0.4 | 36.3 | NSL-S | Sand-Like | 0.29 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-10 | 83.5 | 230.8 | 43.7 | 0.0 | 43.7 | NSL-S | Sand-Like | 0.03 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-11 | 88.5 | 225.8 | 14.5 | 5.5 | 20.0 | NSL-S | Sand-Like | 0.00 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-12 | 95 | 219.3 | 36.4 | 5.0 | 41.3 | NSL-S | Sand-Like | 0.07 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-13 | 108.5 | 205.8 | 39.0 | 0.7 | 39.7 | NSL-S | Sand-Like | 0.12 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-14 | 118.5 | 195.8 | 37.5 | 0.0 | 37.5 | NSL-S | Sand-Like | 0.23 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-15 | 128.5 | 185.8 | 36.1 | 0.7 | 36.8 | NSL-S | Sand-Like | 0.28 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-16 | 138.5 | 175.8 | 34.9 | 0.4 | 35.3 | NSL-S | Sand-Like | 0.41 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-17 | 148.5 | 165.8 | 33.8 | 0.0 | 33.8 | NSL-S | Sand-Like | 0.57 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |

# Boring B-6

## Raw Data Input

| | |
|---|---|
| Boring Number: | B-6 |
| Latitude: | 37.00061 |
| Longitude: | -89.13790 |
| Ground Elevation, ft msl: | 313.8 |
| Groundwater Depth, ft: | 11.5 |
| Groundwater Elevation, ft msl: | 302.3 |

| | |
|---|---|
| Hammer Energy Ratio (ER), %: | 89.4 |
| $C_E$: | 1.49 |
| Bore Hole Diameter, in.: | 4 |
| $C_B$: | 1.00 |
| Liner Required: | N |
| Liner Used: | N |
| $C_S$: | 1.00 |

| | |
|---|---|
| | Strength Loss |
| | Limited Liquefcation |
| | Full Liquefaction |

| | | | | | | | | | | | | | | | Calculated Strengths | | Strength Override | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPT Sample | Depth, ft | Elev., ft | $N_{meas}$, bpf | FC, % | LL | PL | PI | w, % | USCS Soil Type | Soil Layer | Flag: "NL" Non-Liq or Unreliable | General Geology | $K_{DR}$ | SSL Soil Type | φ', deg | c, psf | φ', deg | c, psf |
| SS-1 | 5.0 | 308.8 | 8 | 95.0 | 42 | 26 | 16 | 29.3 | ML | I | | Holocene | 1 | Clay-Like | - | 1790 | | |
| SS-2 | 25.0 | 288.8 | 1 | 5.0 | NP | NP | NP | 32.4 | SP-SM | II | | Holocene | 1 | Sand-Like | 25 | - | | |
| SS-3 | 28.5 | 285.3 | 8 | 4.0 | NP | NP | NP | 31.7 | SP | II | | Holocene | 1 | Sand-Like | 33 | - | | |
| SS-4 | 33.5 | 280.3 | 9 | 4.0 | NP | NP | NP | 29.4 | SP | II | | Holocene | 1 | Sand-Like | 34 | - | | |
| SS-5 | 40.0 | 273.8 | 13 | 5.0 | NP | NP | NP | 30.0 | SP | II | | Holocene | 1 | Sand-Like | 36 | - | | |
| SS-6 | 43.5 | 270.3 | 12 | 4.0 | NP | NP | NP | 29.9 | SP | II | | Holocene | 1 | Sand-Like | 35 | - | | |
| SS-7 | 48.5 | 265.3 | 23 | 6.0 | NP | NP | NP | 28.8 | SP-SM | II | | Holocene | 1 | Sand-Like | 40 | - | | |
| SS-8 | 53.5 | 260.3 | 25 | 7.0 | NP | NP | NP | 29.4 | SP-SM | II | | Holocene | 1 | Sand-Like | 41 | - | | |
| SS-9 | 63.5 | 250.3 | 9 | 35.0 | NP | NP | NP | 40.6 | SM | II | | Holocene | 1 | Sand-Like | 32 | - | | |
| SS-10 | 68.5 | 245.3 | 23 | 2.0 | NP | NP | NP | 7.8 | GP | II | | Holocene | 1 | Sand-Like | 39 | - | | |
| SS-11 | 73.5 | 240.3 | 15 | 3.0 | NP | NP | NP | 18.7 | SP | II | | Holocene | 1 | Sand-Like | 35 | - | | |
| SS-12 | 78.0 | 235.8 | 45 | 8.0 | NP | NP | NP | 15.4 | SP-SM | II | | Holocene | 1 | Sand-Like | 46 | - | | |
| SS-13 | 83.5 | 230.3 | 50 | 10.0 | NP | NP | NP | 9.2 | GP-GM | II | | Eocene | 1 | Sand-Like | 47 | - | | |
| SS-14 | 88.5 | 225.3 | 18 | 10.0 | NP | NP | NP | 26.2 | SP-SM | II | NL | Eocene | 1 | Sand-Like | 36 | - | | |
| SS-15 | 93.5 | 220.3 | 21 | 20.0 | NP | NP | NP | 23.7 | SM | II | NL | Eocene | 1 | Sand-Like | 37 | - | | |
| SS-16 | 98.0 | 215.8 | 50 | 52.0 | 19 | 12 | 7 | 18.0 | CL-ML | III | | Eocene | 1 | Clay-Like | - | 3750 | | |
| SS-17 | 103.5 | 210.3 | 50 | 12.0 | NP | NP | NP | 26.3 | SP-SM | III | | Eocene | 1 | Sand-Like | 46 | - | | |
| SS-18 | 108.5 | 205.3 | 50 | 11.0 | NP | NP | NP | 25.0 | SP-SM | III | | Eocene | 1 | Sand-Like | 45 | - | | |
| SS-19 | 113.5 | 200.3 | 50 | 18.0 | NP | NP | NP | 22.2 | SM | III | | Eocene | 1 | Sand-Like | 45 | - | | |
| SS-20 | 119.0 | 194.8 | 50 | 5.0 | NP | NP | NP | 20.7 | SP | III | | Eocene | 1 | Sand-Like | 45 | - | | |
| SS-21 | 123.5 | 190.3 | 50 | 7.0 | NP | NP | NP | 32.0 | SP-SM | III | | Eocene | 1 | Sand-Like | 45 | - | | |
| SS-22 | 128.5 | 185.3 | 50 | 5.0 | NP | NP | NP | 23.4 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-23 | 133.5 | 180.3 | 50 | 6.0 | 36 | 34 | 2 | 24.2 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-24 | 138.0 | 175.8 | 50 | 10.0 | NP | NP | NP | 23.8 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-25 | 143.5 | 170.3 | 50 | 6.0 | NP | NP | NP | 20.6 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |
| SS-26 | 148.0 | 165.8 | 50 | 5 | NP | NP | NP | 22.3 | SP-SM | III | | Eocene | 1 | Sand-Like | 44 | - | | |

## Standard Penetration Test Correction

| | | | |
|---|---|---|---|
| Boring Number: | B-6 | Hammer Energy Ratio (ER), %: | 89.4 |
| Latitude: | 37.00061 | CE: | 1.49 |
| Longitude: | -89.13790 | Bore Hole Diameter, in.: | 4 |
| Ground Elevation, ft msl: | 313.8 | CB: | 1.00 |
| Groundwater Above Surface, ft: | 11.5 | Liner Required: | N |
| Groundwater Elevation, ft msl: | 302.3 | Liner Used: | N |
| | | CS: | 1.00 |

| SPT Sample | Depth, ft | Elev, ft msl | $N_{meas}$, bpf | $C_E$ | $C_N$ | $C_R$ | $C_S$ | $C_B$ | $C_F$ | σ, psf | σ̄, psf | FC, % | $N_{60}$ | $N_{1,60}$ | $N^*_{60}$ | $N^*_{1,60}$ | $N^*_{1,60,cs}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SS-1 | 5 | 308.8 | 8 | 1.49 | 1.70 | 0.77 | 1.0 | 1.00 | 1.3 | 575 | 575 | 95.0 | 11.9 | 20.3 | 9.1 | 15.5 | 19.4 |
| SS-2 | 25 | 288.8 | 1 | 1.49 | 0.99 | 0.97 | 1.0 | 1.00 | 1.2 | 2875 | 2033 | 5.0 | 1.5 | 1.5 | 1.4 | 1.4 | 1.7 |
| SS-3 | 28.5 | 285.3 | 8 | 1.49 | 0.95 | 0.98 | 1.0 | 1.00 | 1.0 | 3278 | 2217 | 4.0 | 11.9 | 11.3 | 11.7 | 11.1 | 11.1 |
| SS-4 | 33.5 | 280.3 | 9 | 1.49 | 0.90 | 0.99 | 1.0 | 1.00 | 1.0 | 3853 | 2480 | 4.0 | 13.4 | 12.0 | 13.3 | 11.9 | 11.9 |
| SS-5 | 40 | 273.8 | 13 | 1.49 | 0.84 | 0.99 | 1.0 | 1.00 | 1.0 | 4600 | 2822 | 5.0 | 19.4 | 16.3 | 19.3 | 16.2 | 16.8 |
| SS-6 | 43.5 | 270.3 | 12 | 1.49 | 0.82 | 1.00 | 1.0 | 1.00 | 1.0 | 5003 | 3006 | 4.0 | 17.9 | 14.6 | 17.8 | 14.5 | 14.5 |
| SS-7 | 48.5 | 265.3 | 23 | 1.49 | 0.78 | 1.00 | 1.0 | 1.00 | 1.0 | 5578 | 3269 | 6.0 | 34.3 | 26.8 | 34.2 | 26.7 | 27.7 |
| SS-8 | 53.5 | 260.3 | 25 | 1.49 | 0.75 | 1.00 | 1.0 | 1.00 | 1.0 | 6153 | 3532 | 7.0 | 37.3 | 28.0 | 37.2 | 28.0 | 29.1 |
| SS-9 | 63.5 | 250.3 | 9 | 1.49 | 0.70 | 1.00 | 1.0 | 1.00 | 1.3 | 7303 | 4058 | 35.0 | 13.4 | 9.4 | 13.4 | 9.4 | 12.5 |
| SS-10 | 68.5 | 245.3 | 23 | 1.49 | 0.68 | 1.00 | 1.0 | 1.00 | 1.0 | 7878 | 4321 | 2.0 | 34.3 | 23.3 | 34.3 | 23.3 | 23.3 |
| SS-11 | 73.5 | 240.3 | 15 | 1.49 | 0.66 | 1.00 | 1.0 | 1.00 | 1.0 | 8453 | 4584 | 3.0 | 22.4 | 14.8 | 22.3 | 14.8 | 14.8 |
| SS-12 | 78 | 235.8 | 45 | 1.49 | 0.64 | 1.00 | 1.0 | 1.00 | 1.0 | 8970 | 4820 | 8.0 | 50.0 | 32.2 | 67.0 | 43.2 | 45.0 |
| SS-13 | 83.5 | 230.3 | 50 | 1.49 | 0.63 | 1.00 | 1.0 | 1.00 | 1.1 | 9603 | 5110 | 10.0 | 50.0 | 31.3 | 74.5 | 46.6 | 49.0 |
| SS-14 | 88.5 | 225.3 | 18 | 1.49 | 0.61 | 1.00 | 1.0 | 1.00 | 1.1 | 10178 | 5373 | 10.0 | 26.8 | 16.4 | 26.8 | 16.4 | 17.5 |
| SS-15 | 93.5 | 220.3 | 21 | 1.49 | 0.60 | 1.00 | 1.0 | 1.00 | 1.1 | 10753 | 5636 | 20.0 | 31.3 | 18.6 | 31.3 | 18.6 | 21.1 |
| SS-16 | 98 | 215.8 | 50 | 1.49 | 0.58 | 1.00 | 1.0 | 1.00 | 1.2 | 11270 | 5872 | 52.0 | 50.0 | 29.2 | 74.5 | 43.5 | 51.3 |
| SS-17 | 103.5 | 210.3 | 50 | 1.49 | 0.57 | 1.00 | 1.0 | 1.00 | 1.1 | 11903 | 6162 | 12.0 | 50.0 | 28.5 | 74.5 | 42.4 | 45.1 |
| SS-18 | 108.5 | 205.3 | 50 | 1.49 | 0.56 | 1.00 | 1.0 | 1.00 | 1.1 | 12478 | 6425 | 11.0 | 50.0 | 27.9 | 74.5 | 41.6 | 43.9 |
| SS-19 | 113.5 | 200.3 | 50 | 1.49 | 0.55 | 1.00 | 1.0 | 1.00 | 1.1 | 13053 | 6688 | 18.0 | 50.0 | 27.3 | 74.5 | 40.7 | 44.6 |
| SS-20 | 119 | 194.8 | 50 | 1.49 | 0.54 | 1.00 | 1.0 | 1.00 | 1.0 | 13685 | 6977 | 5.0 | 50.0 | 26.8 | 74.5 | 39.9 | 40.9 |
| SS-21 | 123.5 | 190.3 | 50 | 1.49 | 0.53 | 1.00 | 1.0 | 1.00 | 1.0 | 14203 | 7214 | 7.0 | 50.0 | 26.3 | 74.5 | 39.2 | 40.7 |
| SS-22 | 128.5 | 185.3 | 50 | 1.49 | 0.52 | 1.00 | 1.0 | 1.00 | 1.0 | 14778 | 7477 | 5.0 | 50.0 | 25.9 | 74.5 | 38.5 | 39.6 |
| SS-23 | 133.5 | 180.3 | 50 | 1.49 | 0.51 | 1.00 | 1.0 | 1.00 | 1.0 | 15353 | 7740 | 6.0 | 50.0 | 25.4 | 74.5 | 37.9 | 39.1 |
| SS-24 | 138 | 175.8 | 50 | 1.49 | 0.50 | 1.00 | 1.0 | 1.00 | 1.1 | 15870 | 7976 | 10.0 | 50.0 | 25.0 | 74.5 | 37.3 | 39.3 |
| SS-25 | 143.5 | 170.3 | 50 | 1.49 | 0.49 | 1.00 | 1.0 | 1.00 | 1.0 | 16503 | 8266 | 6.0 | 50.0 | 24.6 | 74.5 | 36.6 | 37.8 |
| SS-26 | 148 | 165.8 | 50 | 1.49 | 0.49 | 1.00 | 1.0 | 1.00 | 1.0 | 17020 | 8502 | 5.0 | 50.0 | 24.3 | 74.5 | 36.1 | 37.1 |

## SPT-Based Soil Shear Strength Loss Evaluation

| | | | | | |
|---|---|---|---|---|---|
| Boring Number: | B-6 | Design EQ: | SEE | $M_w$: | 6.99 |
| Latitude: | 37.00061 | Site Class: | DE | R(km): | 15 |
| Longitude: | -89.13790 | PGA: | 0.48 | $MSF_{sand}$: | 1.14 |
| Ground Elevation, ft msl: | 313.8 | $\phi_{SL\text{-}Sand}$ | 0.90 | $MSF_{clay}$: | 1.02 |
| Groundwater Depth, ft: | 11.5 | $\phi_{NSL\text{-}Sand}$ | 0.75 | | |
| Groundwater Elevation, ft msl: | 302.3 | $\phi_{SL\text{-}Clay}$ | 0.90 | | |

| | | | | | | | | Soil Strength Loss Triggering Summary | | | Geotechnical Seismic Hazards Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Idriss & Boulanger (2007) | | Olsen & Johnson (2008) | | Kramer & Wang (2015) | Idriss & Boulanger (2008) | | | |
| SPT Sample | Depth, ft | Elev, ft msl | $N^*_{1,60}$ | $\Delta N^*_{1,60}$ | $N^*_{1,60,cs}$ | SSL Potential | SSL Susceptibility Screening | $(D/C)_{SL}$ | $\phi_{SL}$ | $(D/C)_{SL} \le \phi_{SL}$ | $S_r/\sigma'_{vo}$ | $S_r$ (psf) | $S_r/\sigma'_{vo}$ | $S_r$ (psf) | $S_r$ (psf) | LDI, ft | ∑LDI, ft | $S_{v\text{-}1D}$, in | $\sum S_{v\text{-}1D}$, in |
| SS-1 | 5 | 308.8 | 15.5 | 5.5 | 21.0 | PSL | NS Clay-Like | 0.12 | 0.9 | No Strength Loss | NA | #N/A | NA | #N/A | #N/A | 0.00 | 21.0 | - | 32.9 |
| SS-2 | 25 | 288.8 | 1.4 | 0.0 | 1.4 | SSL | Sand-Like | 5.18 | 0.9 | Full Liquefaction | 0.04 | 80.25 | 0.04 | 82.85 | 113.50 | 10.00 | 21.0 | 18.51 | 32.9 |
| SS-3 | 28.5 | 285.3 | 11.1 | 0.0 | 11.1 | SSL | Sand-Like | 2.87 | 0.9 | Full Liquefaction | 0.11 | 248.32 | 0.11 | 250.99 | 347.75 | 1.47 | 11.0 | 1.47 | 14.4 |
| SS-4 | 33.5 | 280.3 | 11.9 | 0.0 | 11.9 | SSL | Sand-Like | 2.82 | 0.9 | Full Liquefaction | 0.12 | 307.97 | 0.12 | 295.78 | 399.81 | 1.92 | 9.6 | 2.02 | 12.9 |
| SS-5 | 40 | 273.8 | 16.2 | 0.0 | 16.2 | SSL | Sand-Like | 2.28 | 0.9 | Full Liquefaction | 0.30 | 840.07 | 0.15 | 427.80 | 683.27 | 1.57 | 7.6 | 2.12 | 10.9 |
| SS-6 | 43.5 | 270.3 | 14.5 | 0.0 | 14.5 | SSL | Sand-Like | 2.50 | 0.9 | Full Liquefaction | 0.19 | 585.71 | 0.14 | 417.69 | 586.52 | 1.01 | 6.1 | 1.23 | 8.8 |
| SS-7 | 48.5 | 265.3 | 26.7 | 0.0 | 26.8 | SSL | Sand-Like | 1.16 | 0.9 | Full Liquefaction | 0.30 | 989.15 | 0.23 | 753.77 | 2329.19 | 0.24 | 5.1 | 0.63 | 7.5 |
| SS-8 | 53.5 | 260.3 | 28.0 | 0.1 | 28.1 | SSL | Sand-Like | 1.02 | 0.9 | Full Liquefaction | 0.35 | 1230.34 | 0.24 | 847.49 | 2780.70 | 0.18 | 4.8 | 0.46 | 6.9 |
| SS-9 | 63.5 | 250.3 | 9.4 | 5.5 | 14.9 | SSL | Sand-Like | 2.35 | 0.9 | Full Liquefaction | 0.21 | 861.18 | 0.10 | 408.12 | 395.58 | 2.78 | 4.6 | 3.46 | 6.4 |
| SS-10 | 68.5 | 245.3 | 23.3 | 0.0 | 23.3 | SSL | Sand-Like | 1.49 | 0.9 | Full Liquefaction | 0.22 | 962.04 | 0.20 | 884.99 | 1866.38 | 0.46 | 1.9 | 1.21 | 3.0 |
| SS-11 | 73.5 | 240.3 | 14.8 | 0.0 | 14.8 | SSL | Sand-Like | 2.34 | 0.9 | Full Liquefaction | 0.21 | 940.19 | 0.14 | 644.97 | 760.34 | 1.41 | 1.4 | 1.74 | 1.7 |
| SS-12 | 78 | 235.8 | 43.2 | 0.4 | 43.6 | NSL-S | Sand-Like | 0.03 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-13 | 83.5 | 230.3 | 46.6 | 1.1 | 47.8 | NSL-S | Sand-Like | 0.00 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-14 | 88.5 | 225.3 | 16.4 | 1.1 | 17.5 | SSL | Sand-Like | 0.00 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-15 | 93.5 | 220.3 | 18.6 | 4.5 | 23.1 | SSL | Sand-Like | 0.00 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-16 | 98 | 215.8 | 43.5 | 5.5 | 49.0 | PSL | HS Clay-Like | 0.33 | 0.9 | No Strength Loss | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-17 | 103.5 | 210.3 | 42.4 | 2.1 | 44.5 | NSL-S | Sand-Like | 0.02 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-18 | 108.5 | 205.3 | 41.6 | 1.6 | 43.2 | NSL-S | Sand-Like | 0.03 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-19 | 113.5 | 200.3 | 40.7 | 4.1 | 44.8 | NSL-S | Sand-Like | 0.02 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-20 | 119 | 194.8 | 39.9 | 0.0 | 39.9 | NSL-S | Sand-Like | 0.12 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-21 | 123.5 | 190.3 | 39.2 | 0.1 | 39.4 | NSL-S | Sand-Like | 0.14 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-22 | 128.5 | 185.3 | 38.5 | 0.0 | 38.5 | NSL-S | Sand-Like | 0.19 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-23 | 133.5 | 180.3 | 37.9 | 0.0 | 37.9 | NSL-S | Sand-Like | 0.23 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-24 | 138 | 175.8 | 37.3 | 1.1 | 38.5 | NSL-S | Sand-Like | 0.20 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-25 | 143.5 | 170.3 | 36.6 | 0.0 | 36.7 | NSL-S | Sand-Like | 0.33 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |
| SS-26 | 148 | 165.8 | 36.1 | 0.0 | 36.1 | NSL-S | Sand-Like | 0.38 | 0.75 | No Liquefaction | NA | #N/A | NA | #N/A | #N/A | 0.00 | 0.0 | - | 0.0 |

# CPT-Based Liquefaction Analysis, Lateral Displacement & Seismic Settlement (CLiq): 100-YR Return Period

CPT-6

**GeoLogismiki**
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

# LIQUEFACTION ANALYSIS REPORT

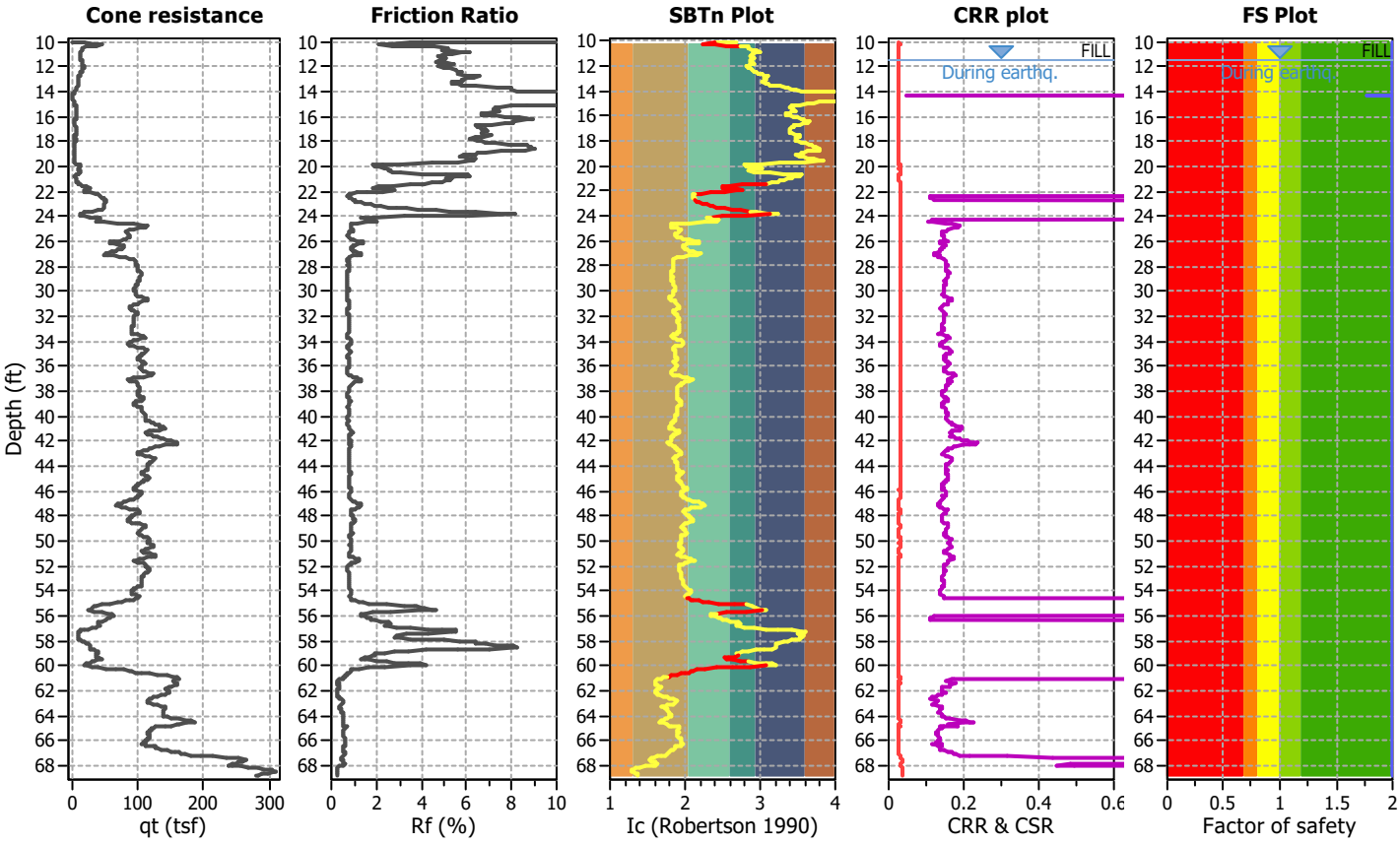
**Project title : US-51 Bridge Replacement**

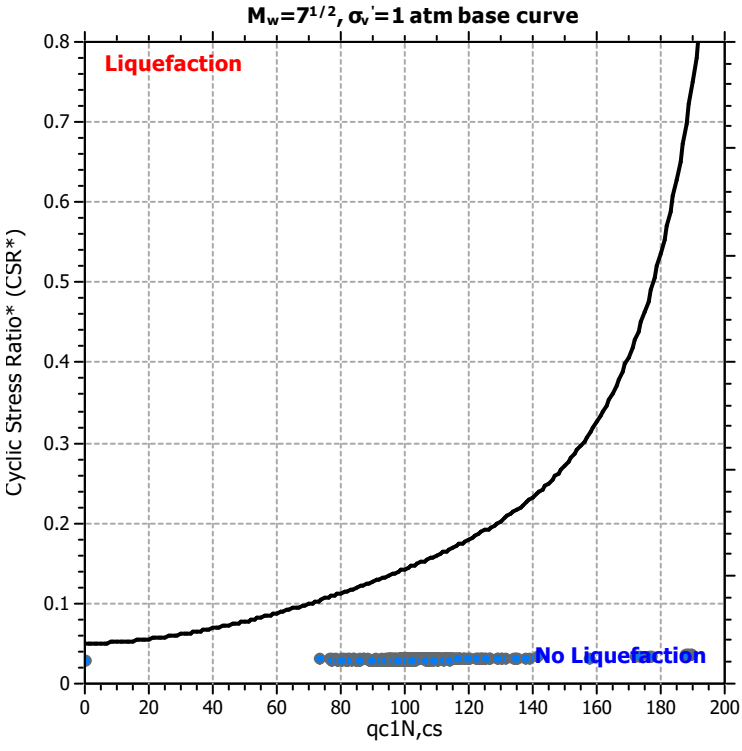
**Location : Ballard Co., KY & Alexander Co., IL**

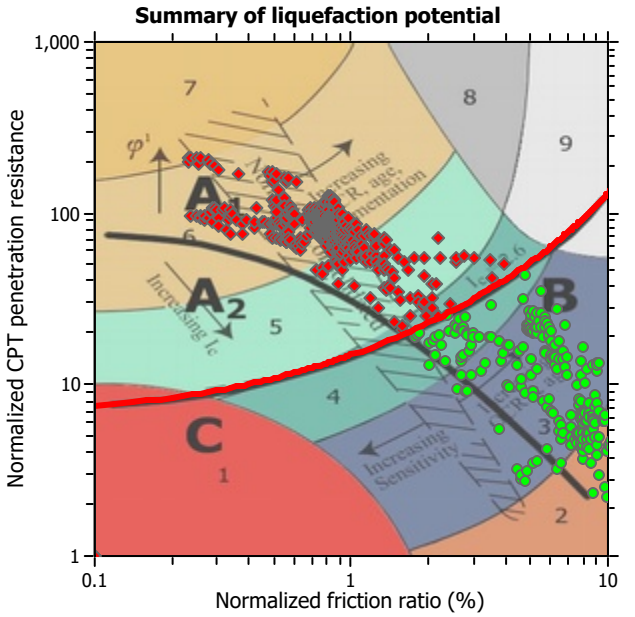
**CPT file : CPT-6- 100 YR**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | G.W.T. (in-situ): | 11.50 ft | Use fill: | Yes | Clay like behavior applied: | Sands only |
| Fines correction method: | R&W (1998) | G.W.T. (earthq.): | 35.38 ft | Fill height: | 23.88 ft | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | 120.00 lb/ft³ | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 5.98 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.08 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

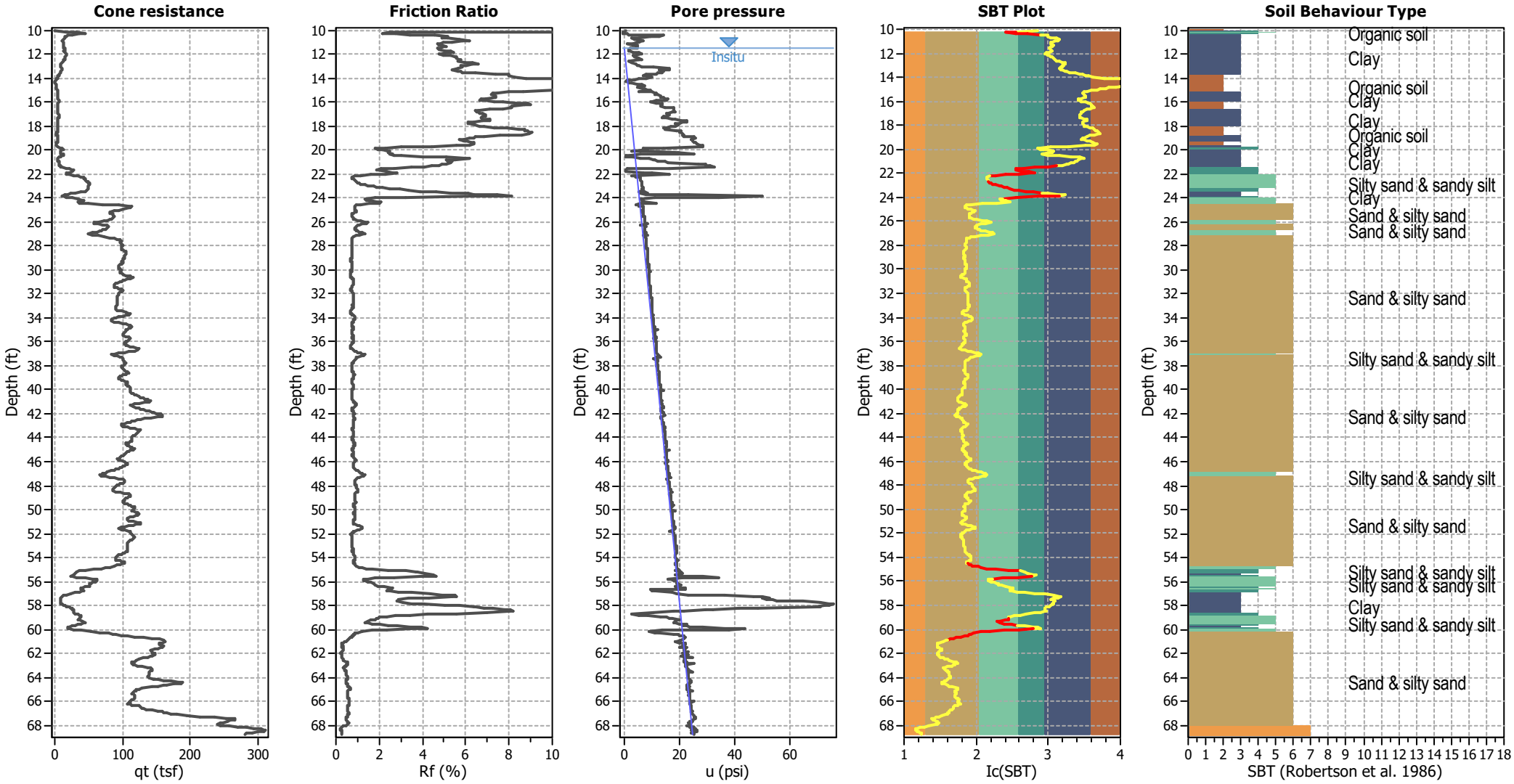



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots



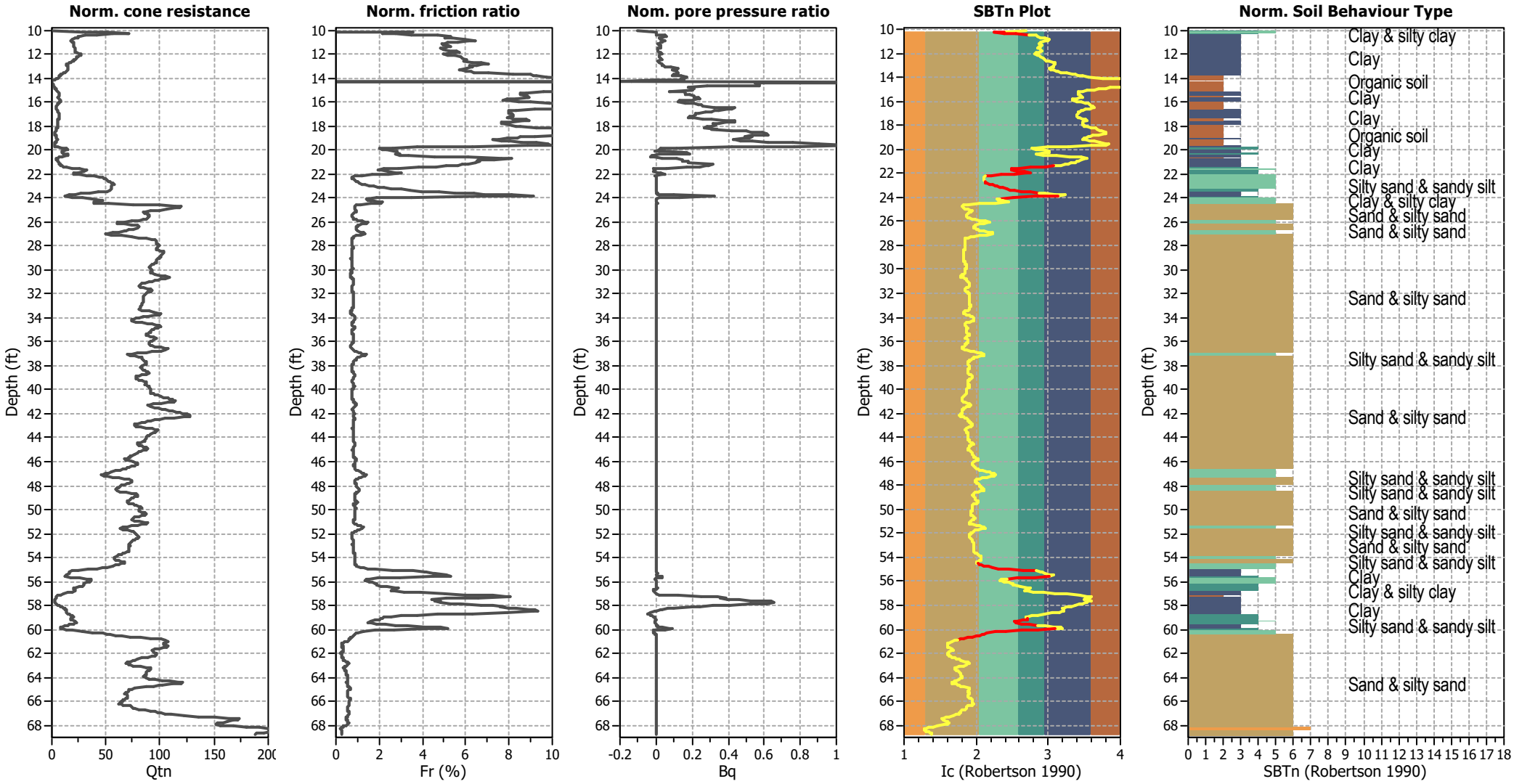

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 5.98 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.08 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

**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)



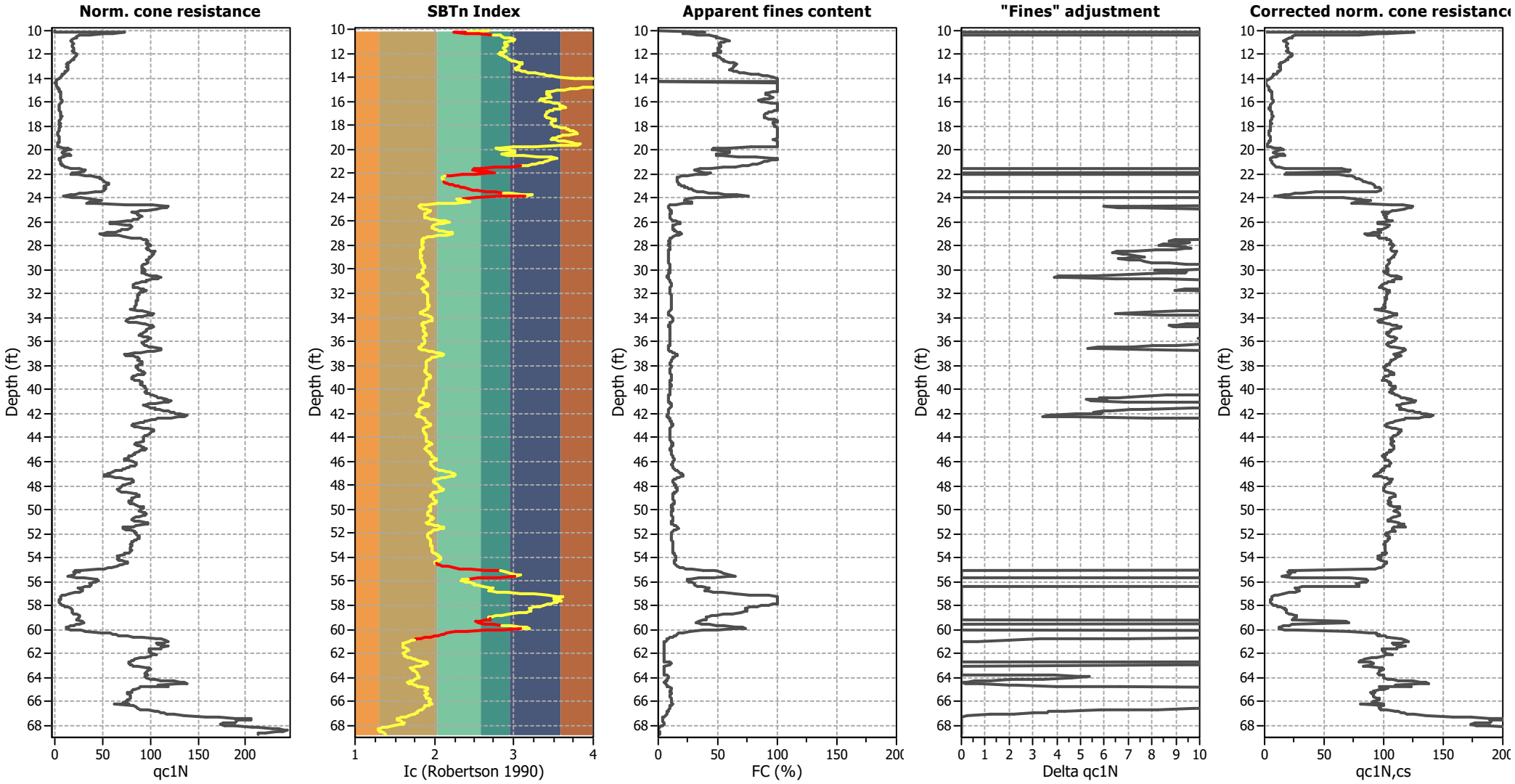

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 5.98 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.08 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

**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

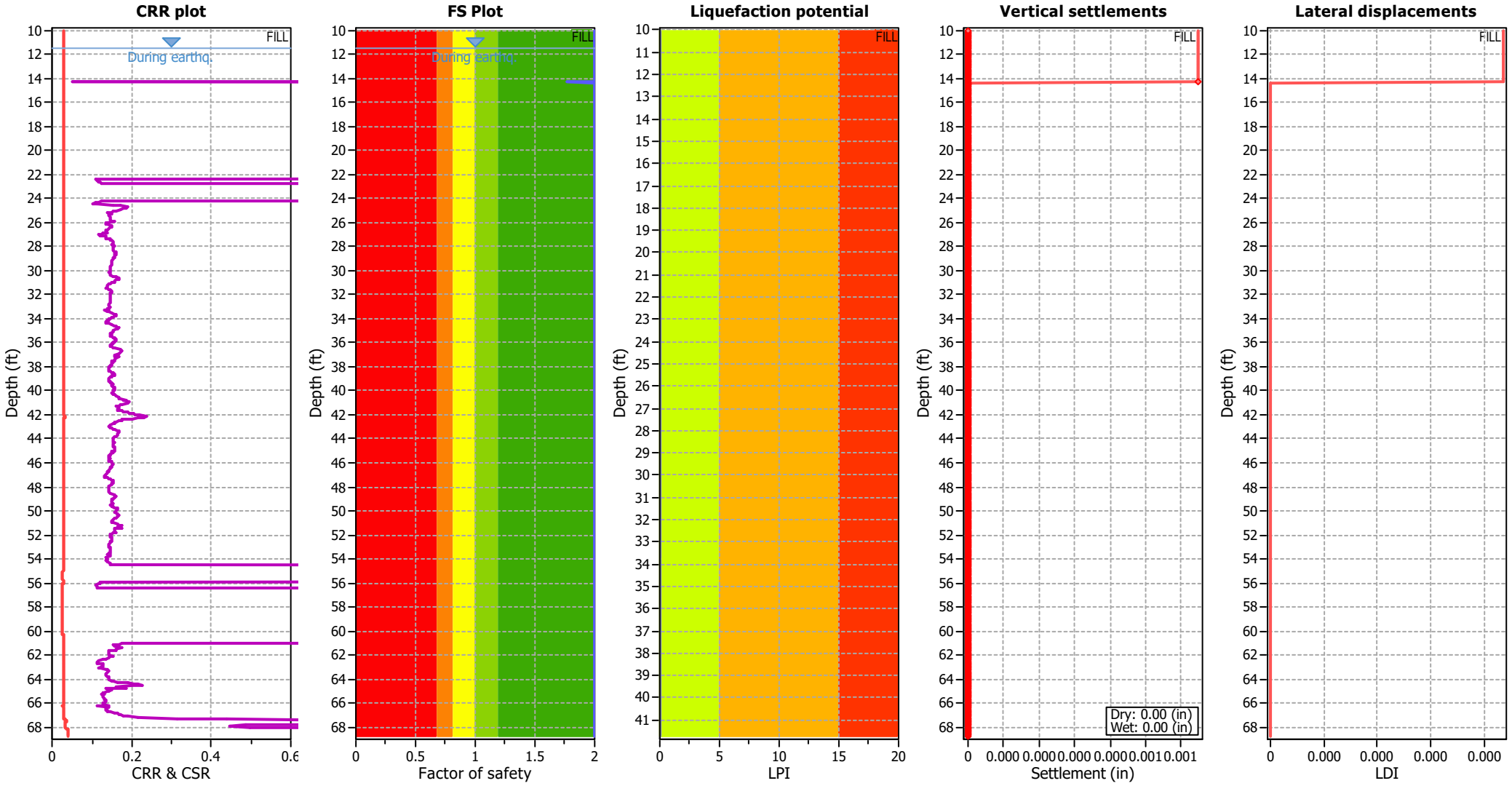
# Liquefaction analysis overall plots (intermediate results)




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 5.98 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.08 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 5.98 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.08 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

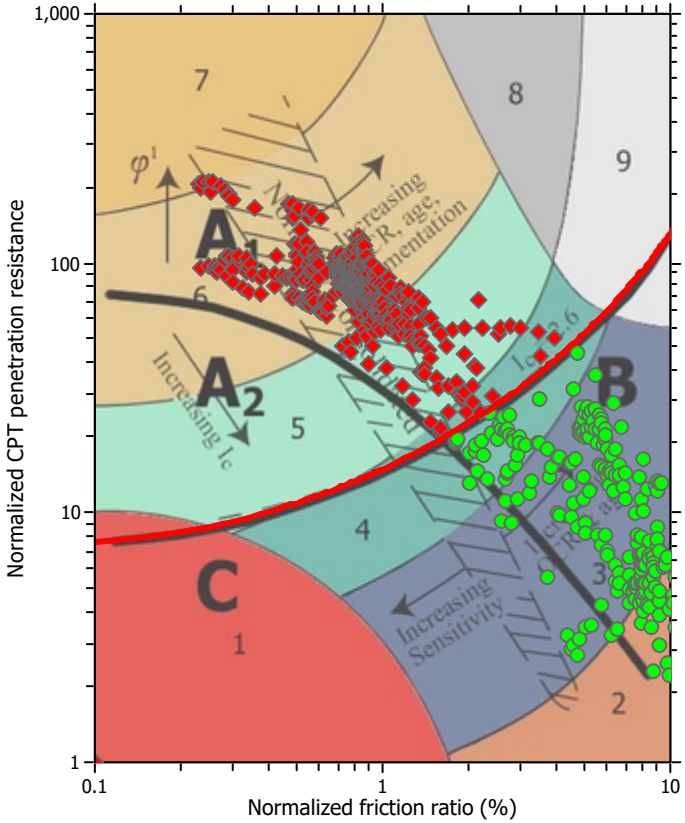
**F.S. color scheme**

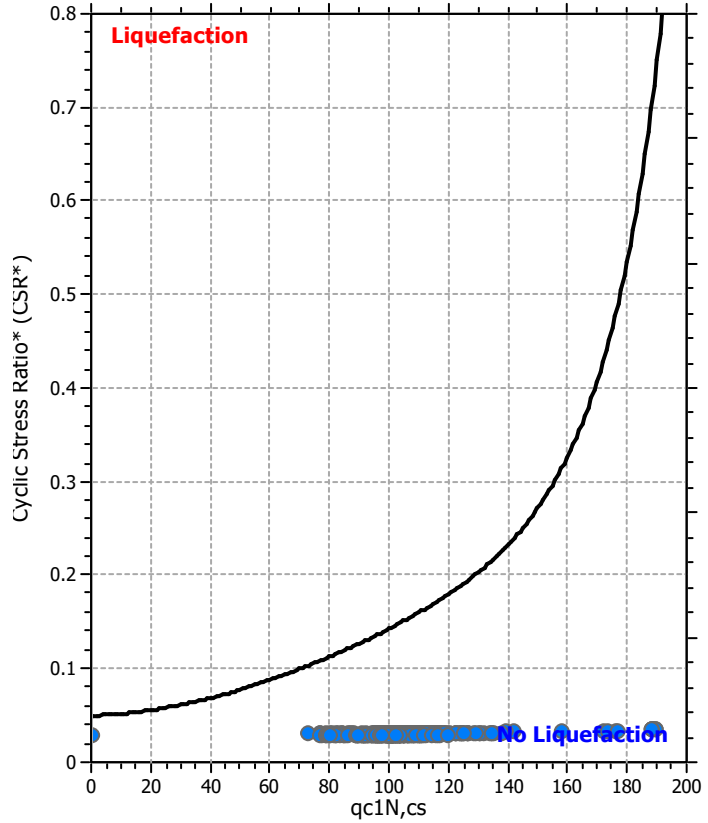
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

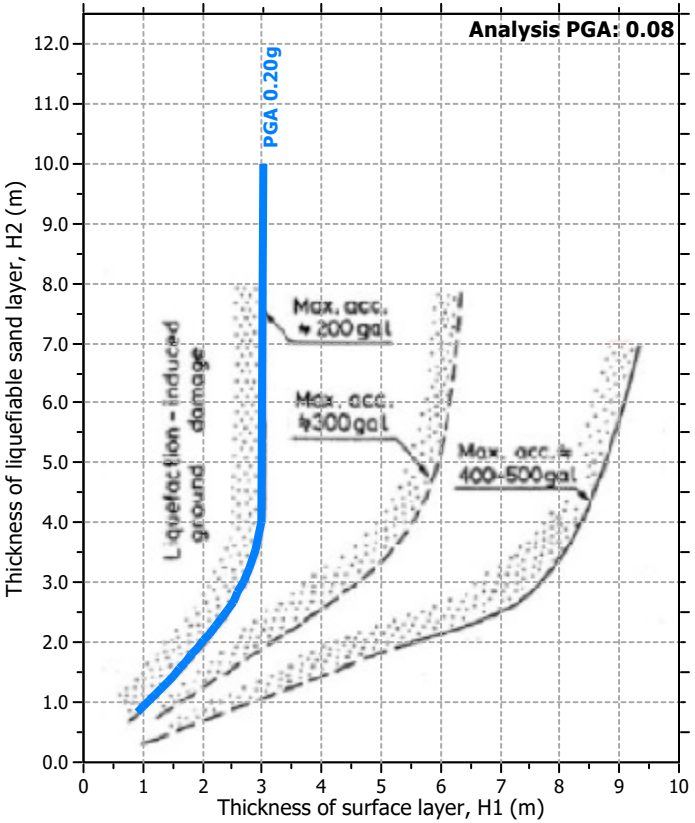
**LPI color scheme**

- Very high risk
- High risk
- Low risk

# Liquefaction analysis summary plots



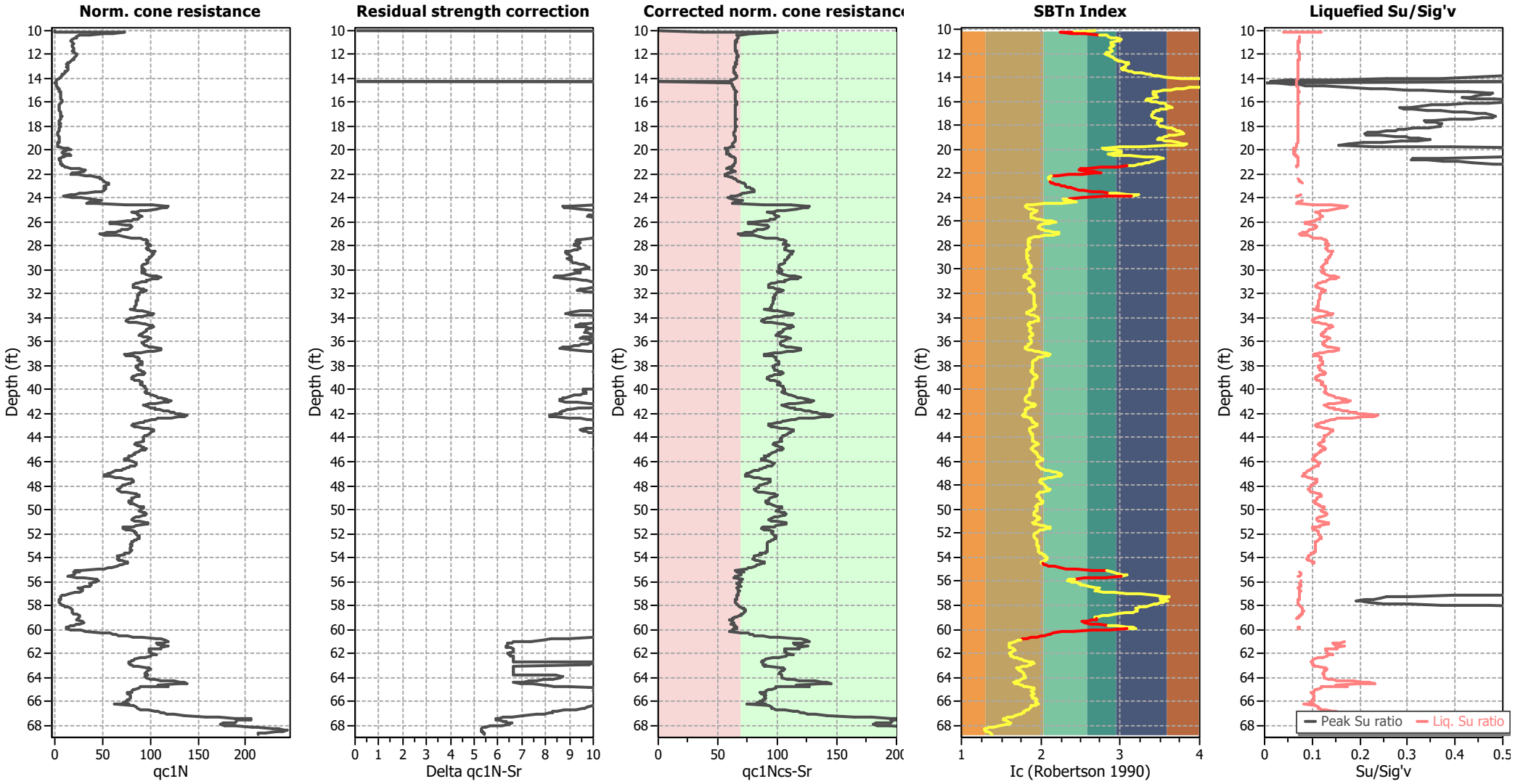




**Input parameters and analysis data**

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 5.98 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.08 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

# Check for strength loss plots (Idriss & Boulanger (2008))




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 5.98 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.08 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

# CPT-Based Liquefaction Analysis Lateral Displacement & Seismic Settlement (CLiq): 1,000-YR Return Period

CPT-6

**GeoLogismiki**
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

# LIQUEFACTION ANALYSIS REPORT

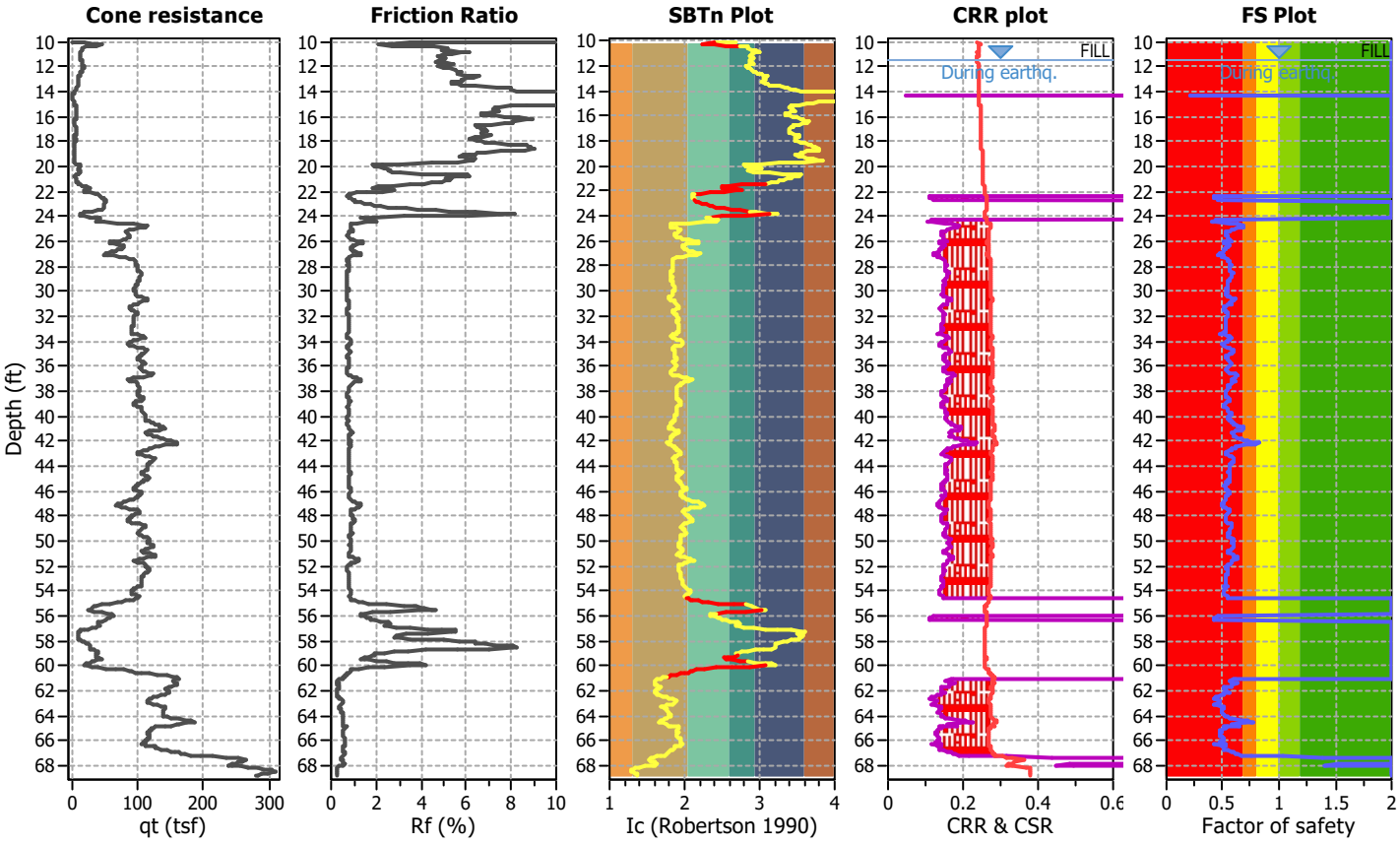
**Project title : US-51 Bridge Replacement**

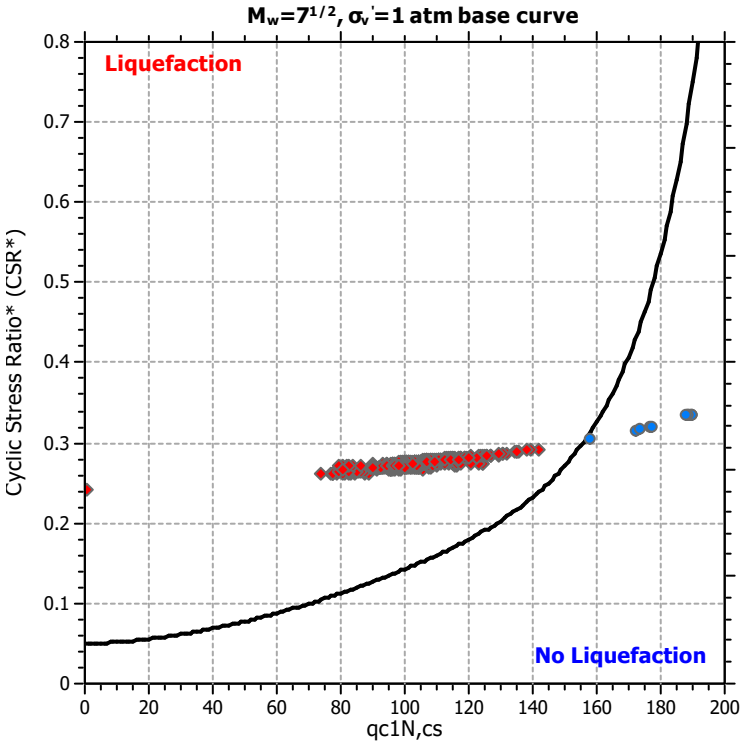
**Location : Ballard Co., KY & Alexander Co., IL**

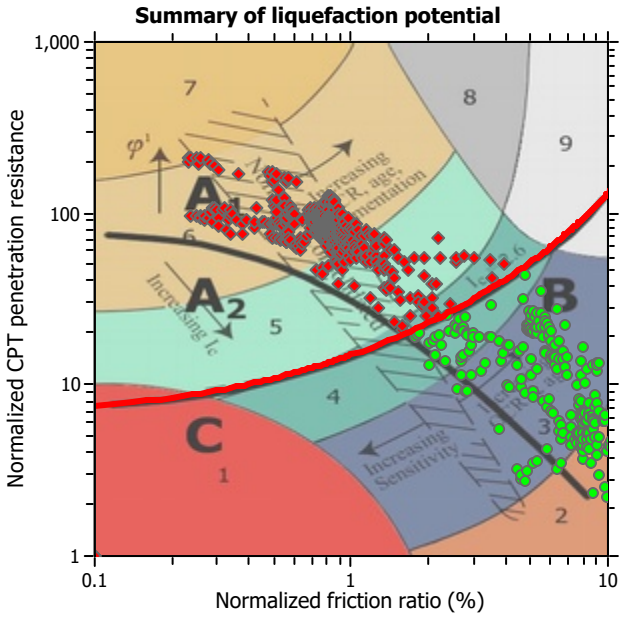
**CPT file : CPT-6- 1000 YR**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | G.W.T. (in-situ): | 11.50 ft | Use fill: | Yes | Clay like behavior applied: | Sands only |
| Fines correction method: | R&W (1998) | G.W.T. (earthq.): | 35.38 ft | Fill height: | 23.88 ft | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | 120.00 lb/ft³ | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.99 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.48 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

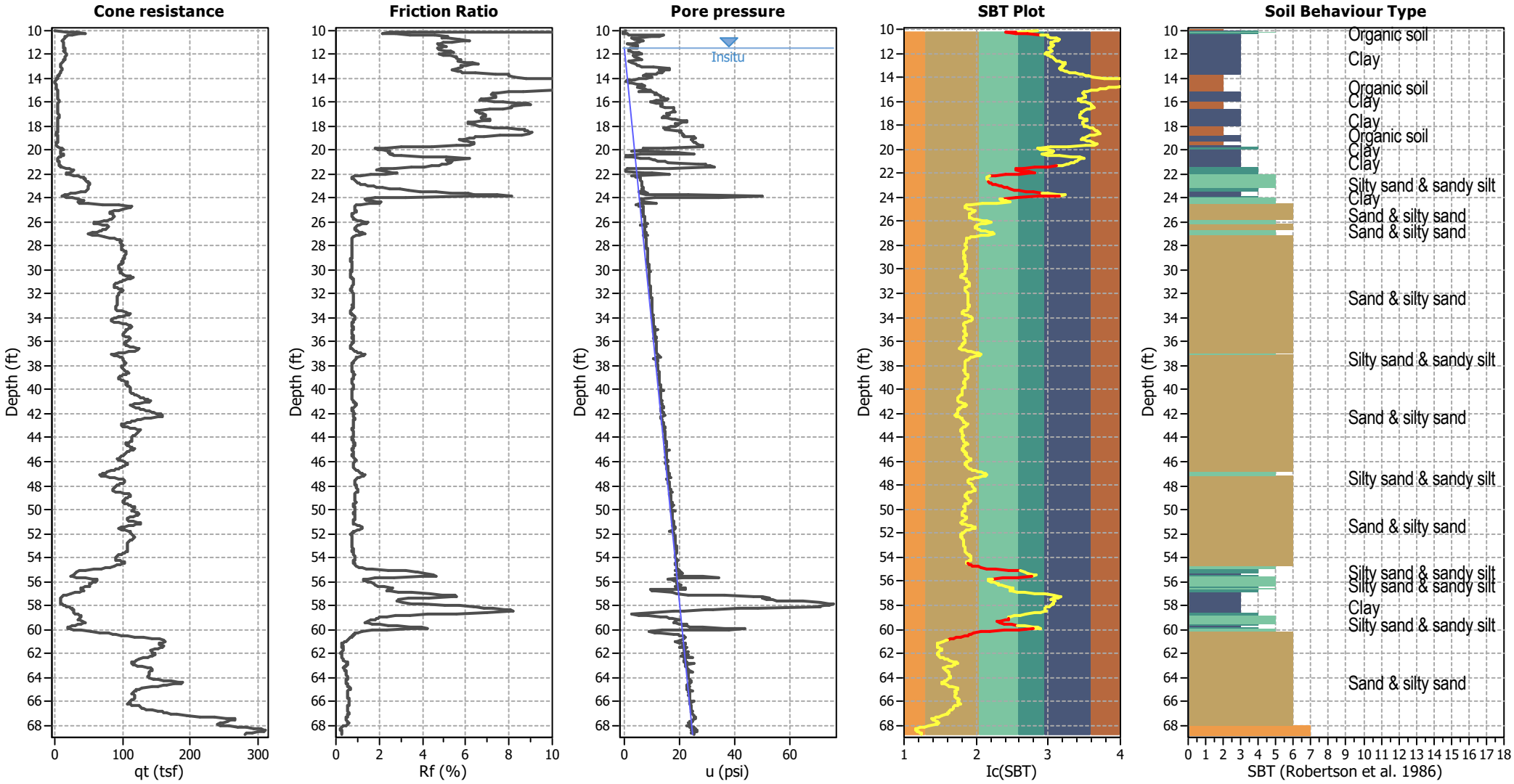



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots



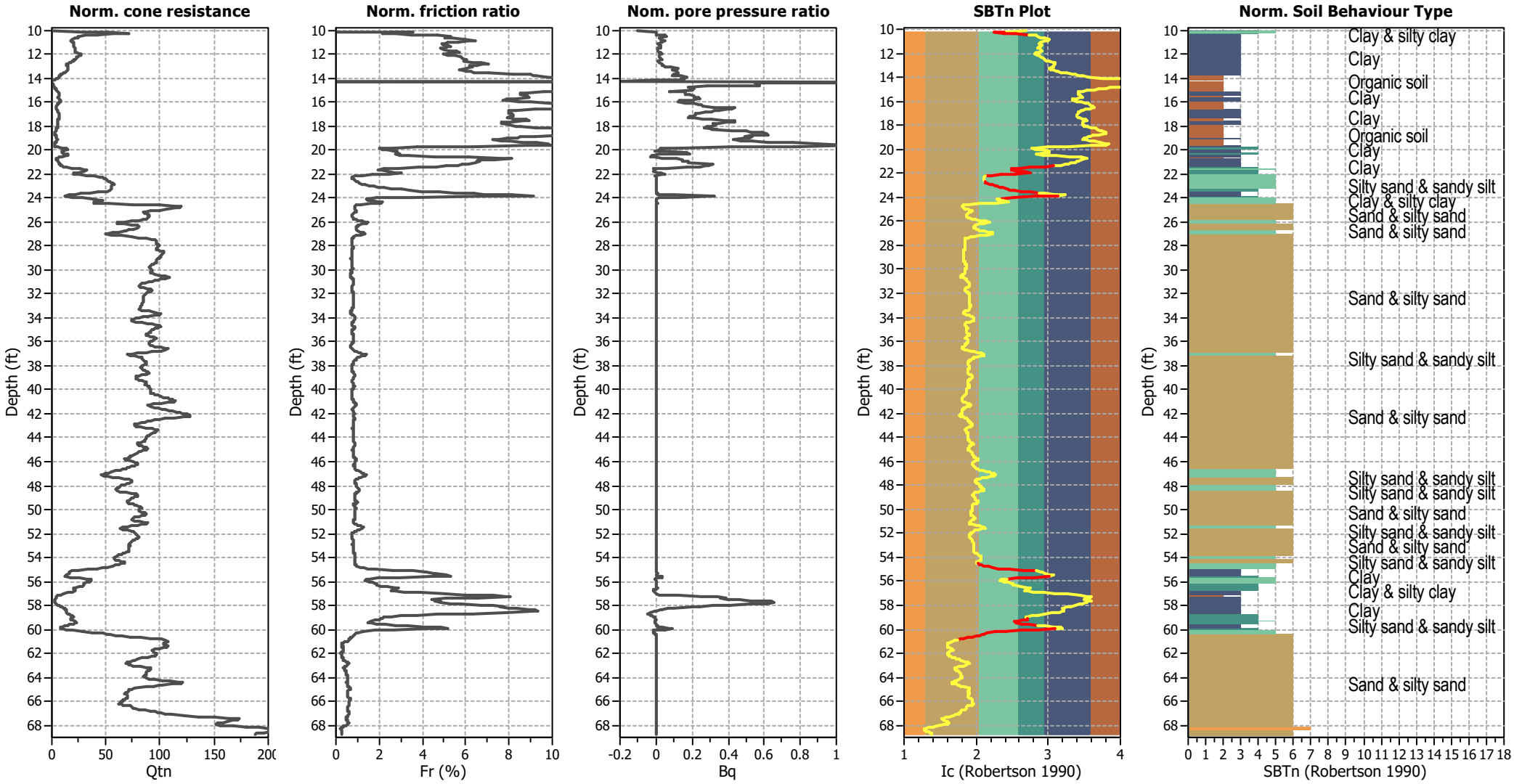

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 6.99 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.48 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

**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)



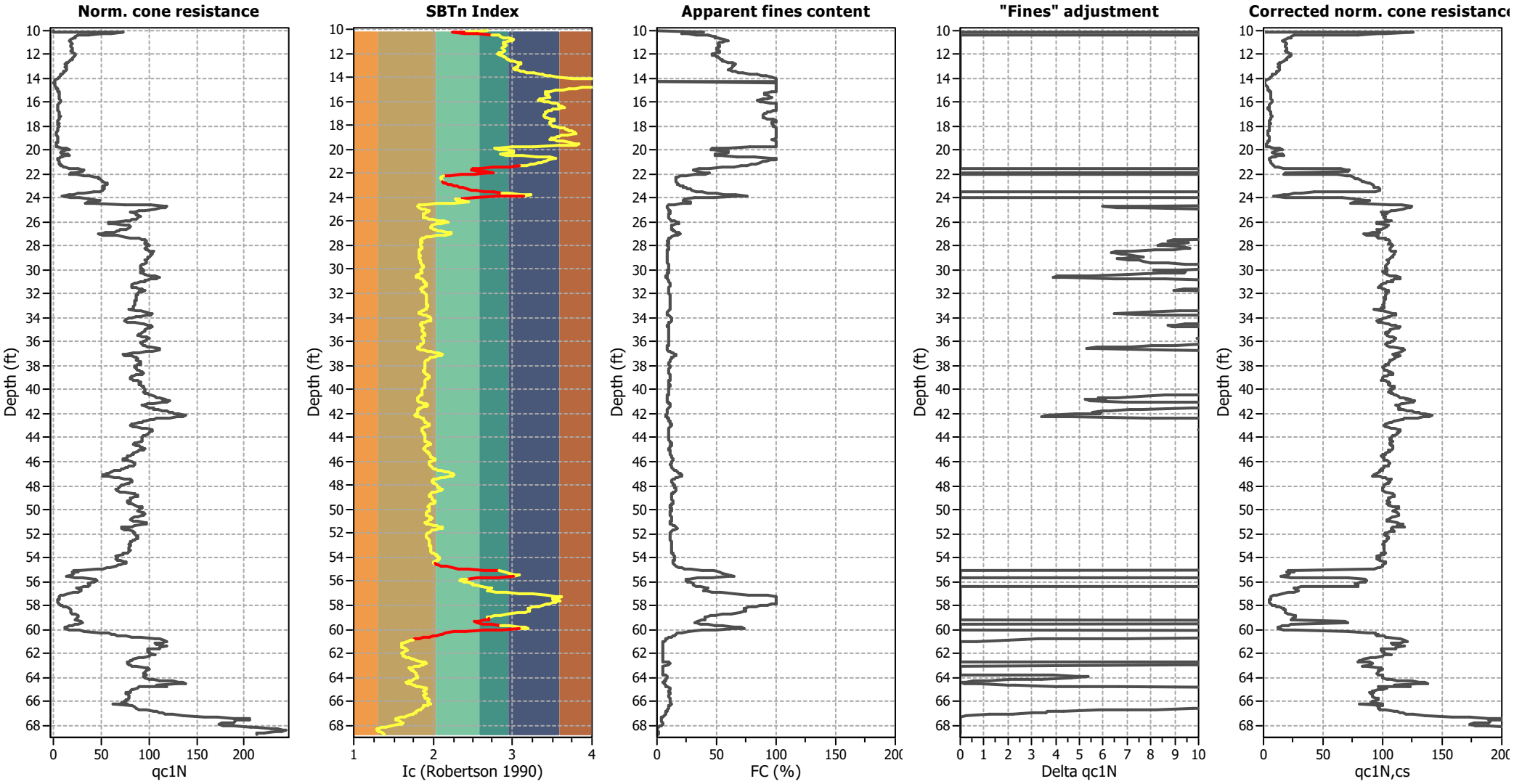

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 6.99 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.48 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

**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

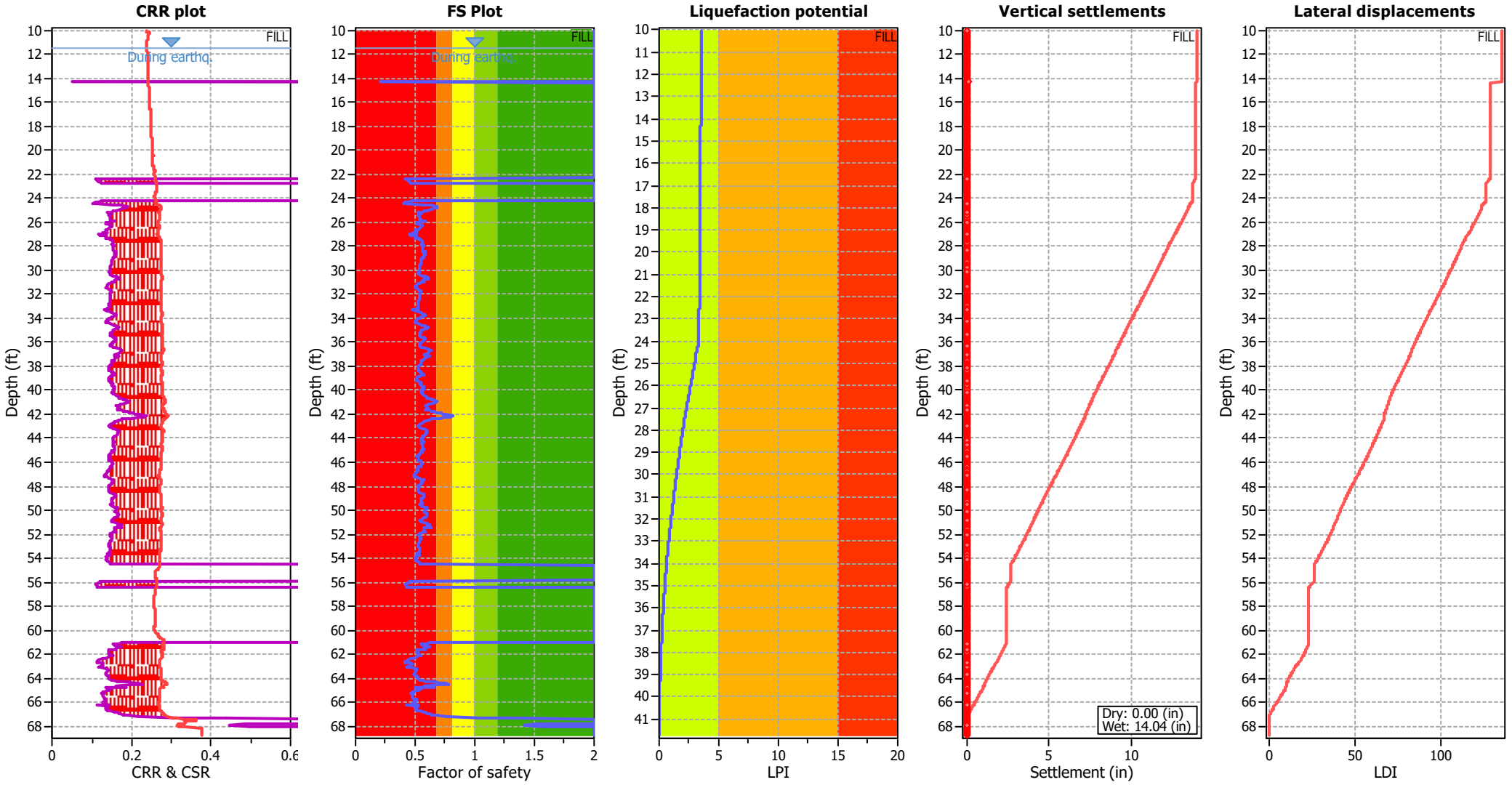
# Liquefaction analysis overall plots (intermediate results)




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 6.99 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.48 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 6.99 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.48 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

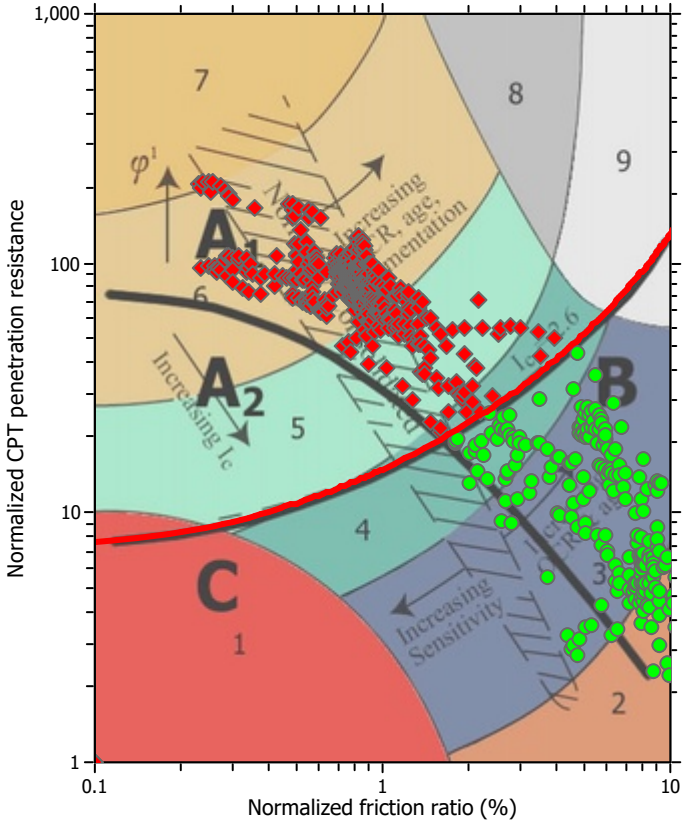
**F.S. color scheme**

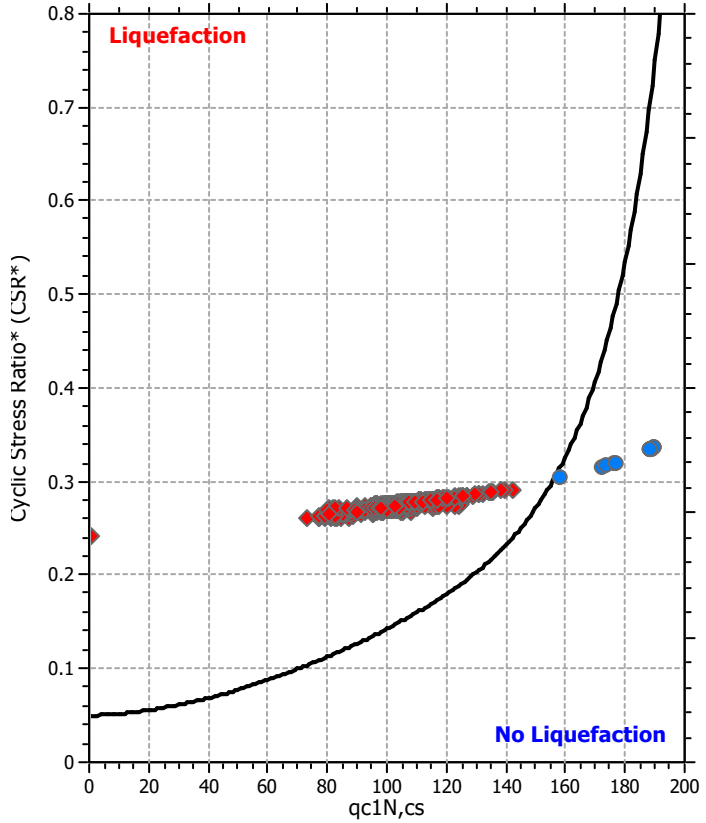
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

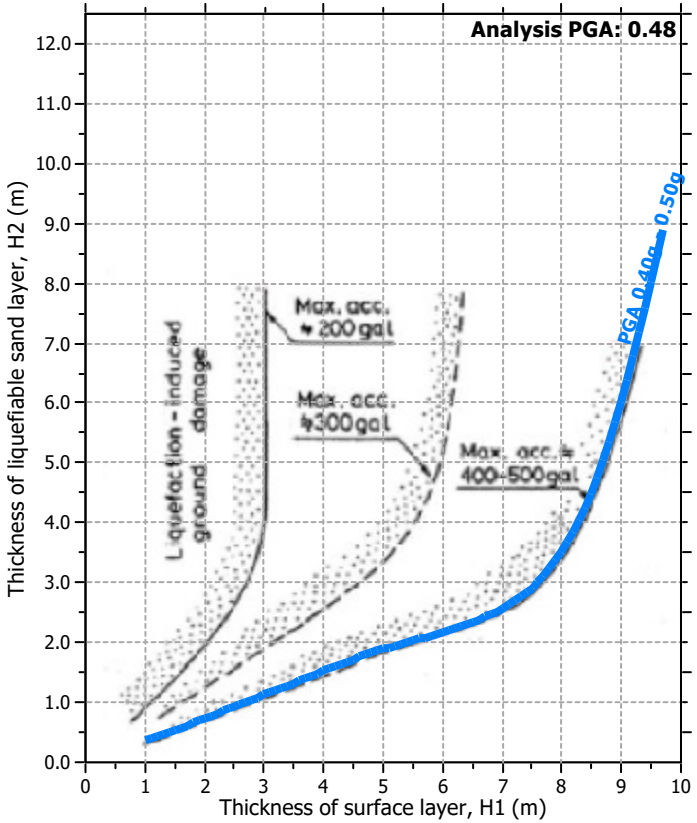
**LPI color scheme**

- Very high risk
- High risk
- Low risk

# Liquefaction analysis summary plots



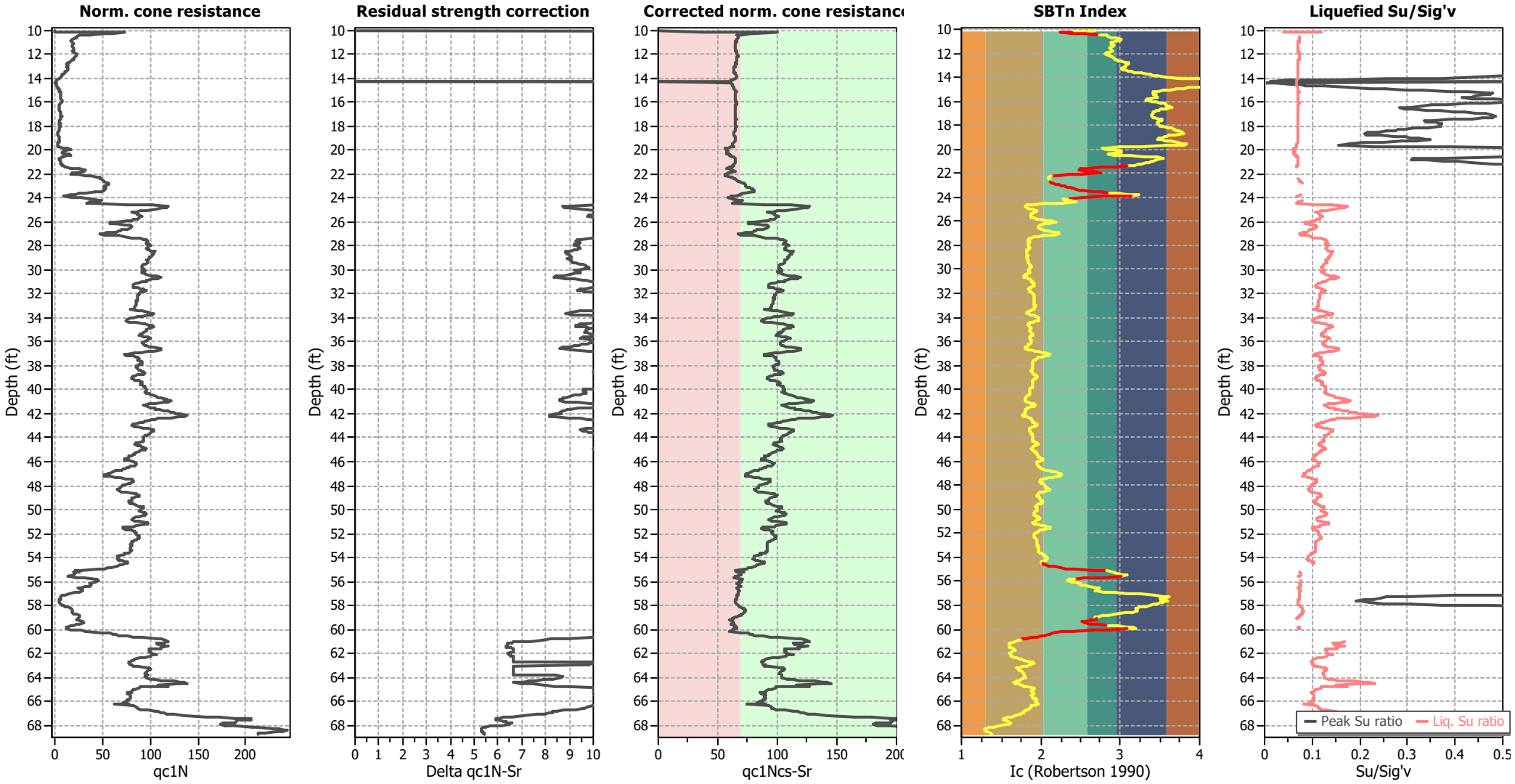




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (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 $M_w$: | 6.99 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.48 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

# Check for strength loss plots (Idriss & Boulanger (2008))




## Input parameters and analysis data

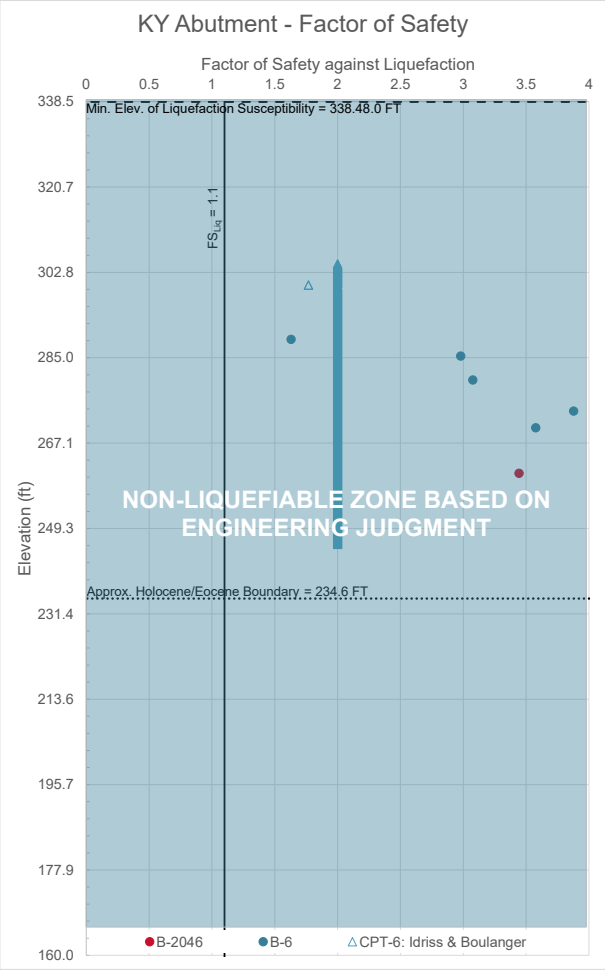
| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | I&B (2008) | Depth to GWT (erthq.): | 35.38 ft | Fill weight: | 120.00 lb/ft³ |
| Fines correction method: | R&W (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.99 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.48 | Use fill: | Yes | Limit depth applied: | No |
| Depth to water table (insitu): | 11.50 ft | Fill height: | 23.88 ft | Limit depth: | N/A |

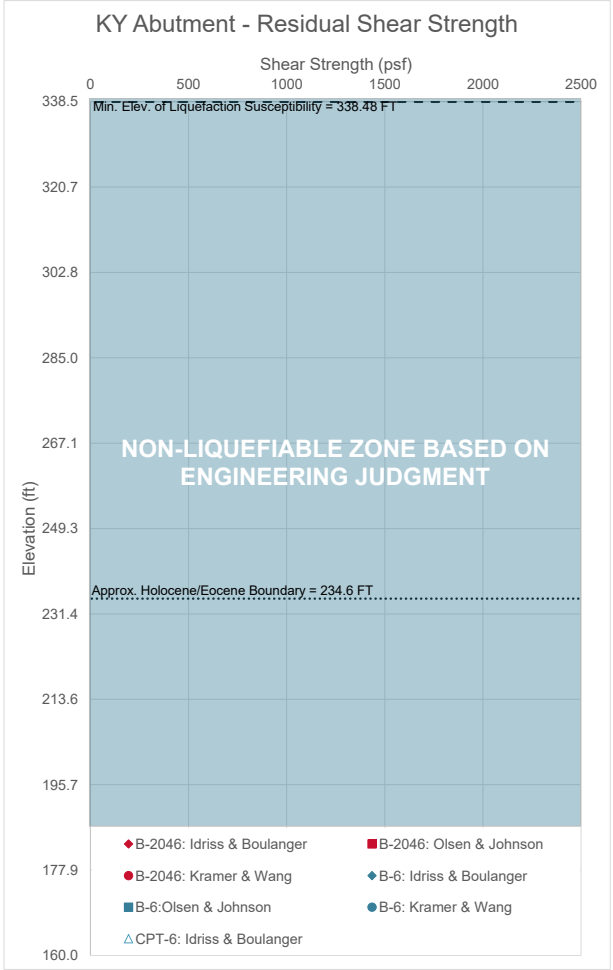
# Illustration of Liquefaction Results & Layers

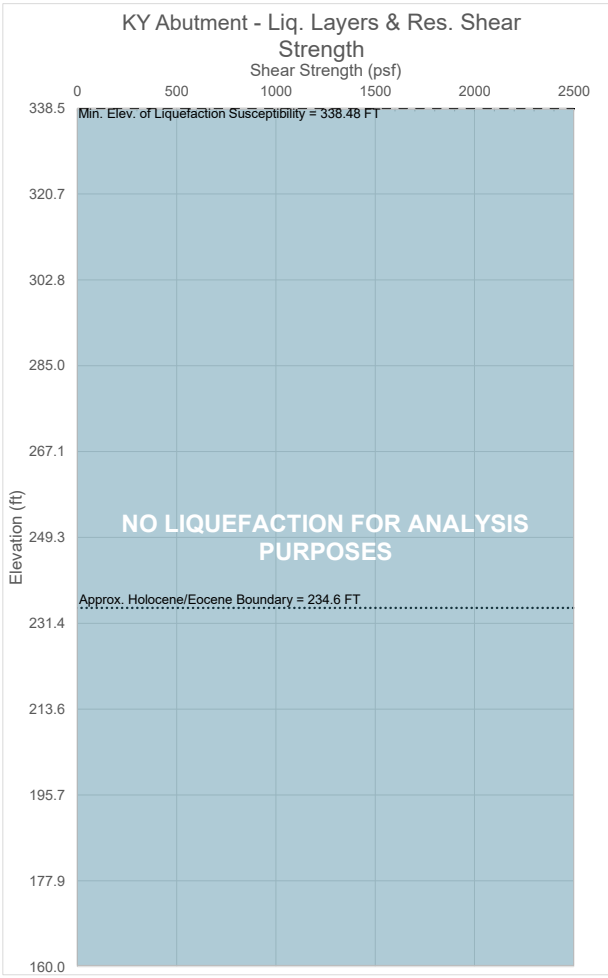
## 100-YR Return Period

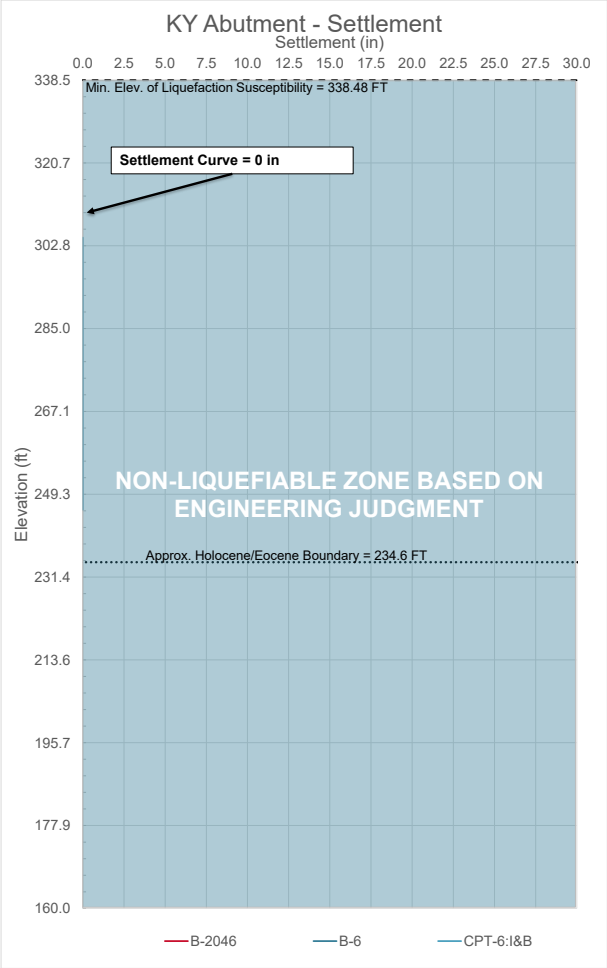
Project: US-51 Bridge Replacement
Subject: Seismic
Task: Liquefaction
Job #: 10174706

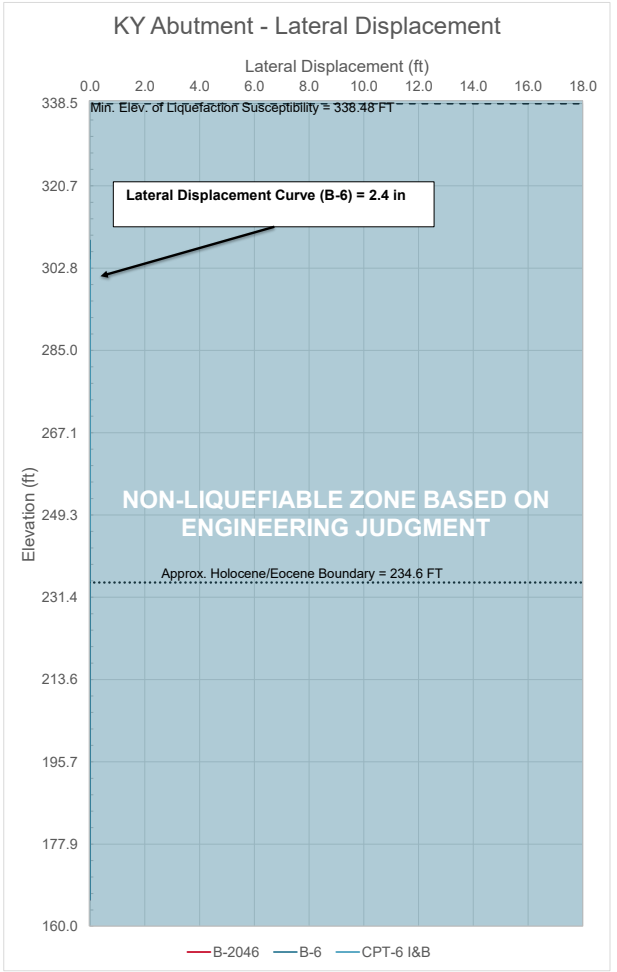
Computed by: Pineda, Ray Date: 6/2/2026
Checked by: Edwards, Brian Date: 6/2/2026
Page: 1 of 2



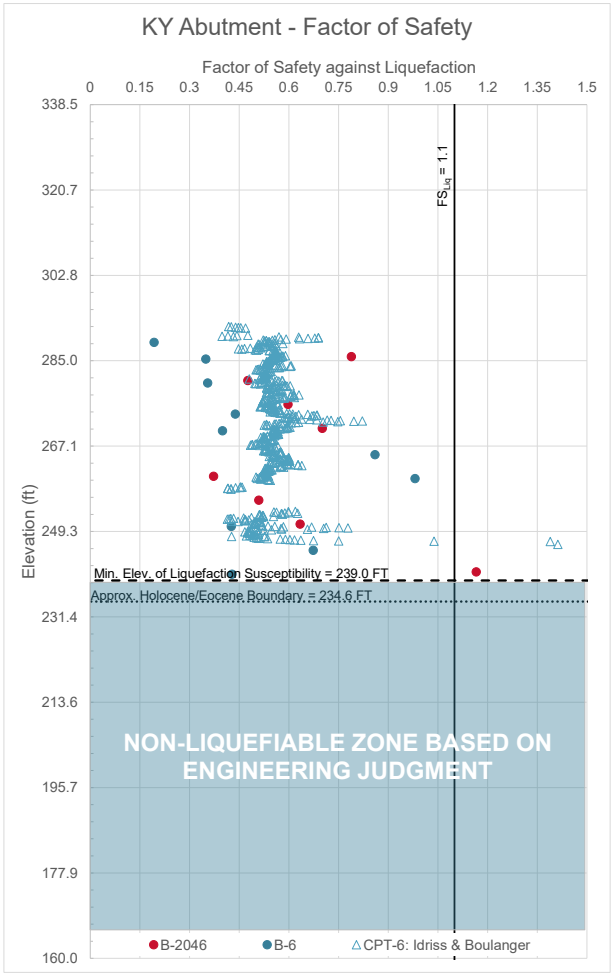

KY Abutment - Settlement
Settlement (in)
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0
Elevation (ft)
338.5
320.7
302.8
285.0
267.1
249.3
231.4
213.6
195.7
177.9
160.0
Min. Elev. of Liquefaction Susceptibility = 338.48 FT
Settlement Curve = 0 in
NON-LIQUEFIABLE ZONE BASED ON ENGINEERING JUDGMENT
Approx. Holocene/Eocene Boundary = 234.6 FT
B-2046
B-6
CPT-6:I&B

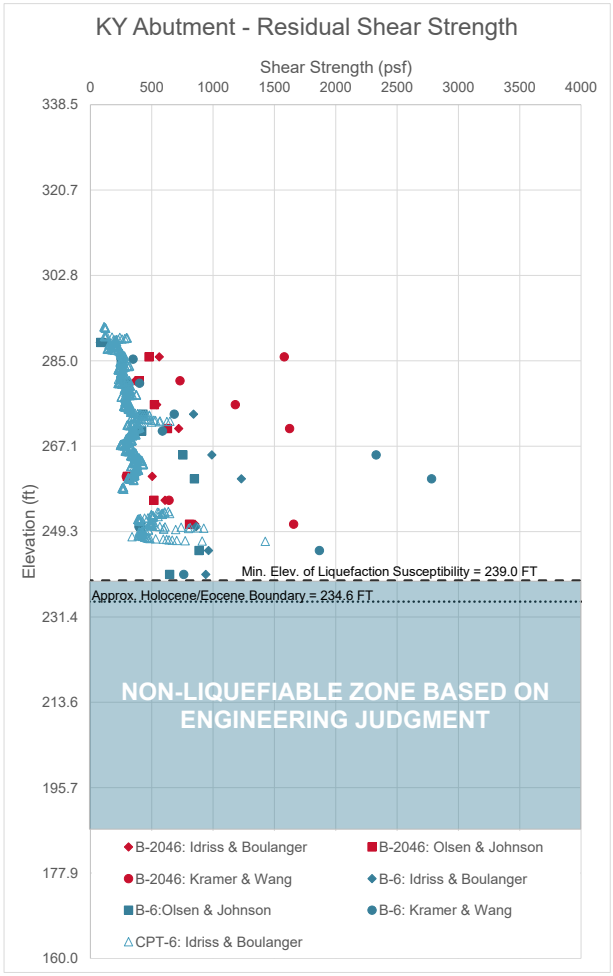

KY Abutment - Lateral Displacement
Lateral Displacement (ft)
0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0
Elevation (ft)
338.5
320.7
302.8
285.0
267.1
249.3
231.4
213.6
195.7
177.9
160.0
Min. Elev. of Liquefaction Susceptibility = 338.48 FT
Lateral Displacement Curve (B-6) = 2.4 in
NON-LIQUEFIABLE ZONE BASED ON ENGINEERING JUDGMENT
Approx. Holocene/Eocene Boundary = 234.6 FT
B-2046
B-6
CPT-6 I&B

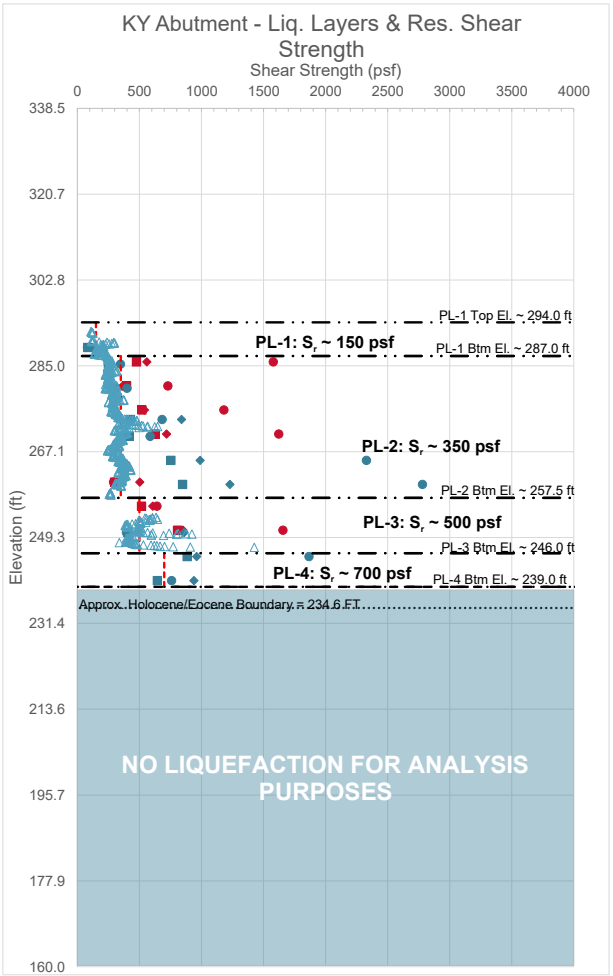
## 1,000-YR Return Period

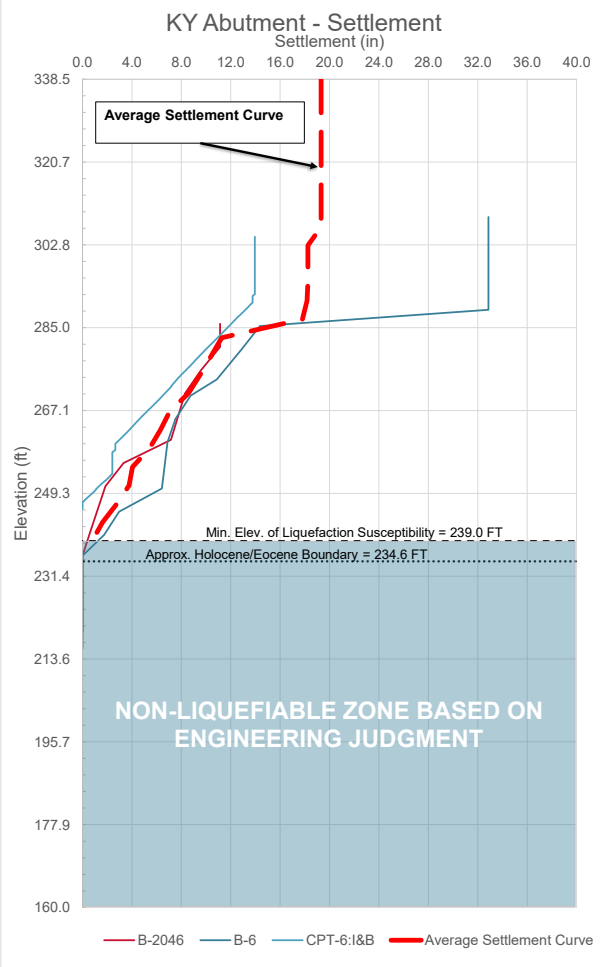
Project: US-51 Bridge Replacement
Subject: Seismic
Task: Liquefaction
Job #: 10174706

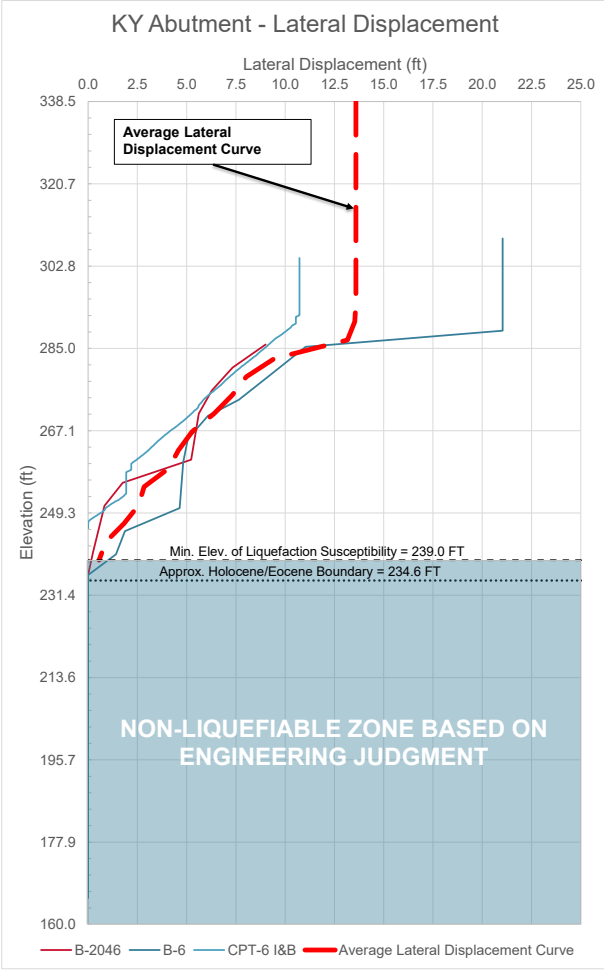
Computed by: Pineda,Ray Date: 6/2/2026
Checked by: Edwards, Brian Date: 6/2/2026
Page: 1 of 2




KY Abutment - Settlement
Settlement (in)
0.0 4.0 8.0 12.0 16.0 20.0 24.0 28.0 32.0 36.0 40.0
Elevation (ft)
338.5 320.7 302.8 285.0 267.1 249.3 231.4 213.6 195.7 177.9 160.0
Average Settlement Curve
Min. Elev. of Liquefaction Susceptibility = 239.0 FT
Approx. Holocene/Eocene Boundary = 234.6 FT
NON-LIQUEFIABLE ZONE BASED ON ENGINEERING JUDGMENT
B-2046
B-6
CPT-6:I&B
Average Settlement Curve


KY Abutment - Lateral Displacement
Lateral Displacement (ft)
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Elevation (ft)
338.5 320.7 302.8 285.0 267.1 249.3 231.4 213.6 195.7 177.9 160.0
Average Lateral Displacement Curve
Min. Elev. of Liquefaction Susceptibility = 239.0 FT
Approx. Holocene/Eocene Boundary = 234.6 FT
NON-LIQUEFIABLE ZONE BASED ON ENGINEERING JUDGMENT
B-2046
B-6
CPT-6 I&B
Average Lateral Displacement Curve

# Attachment G: Slope Stability Results

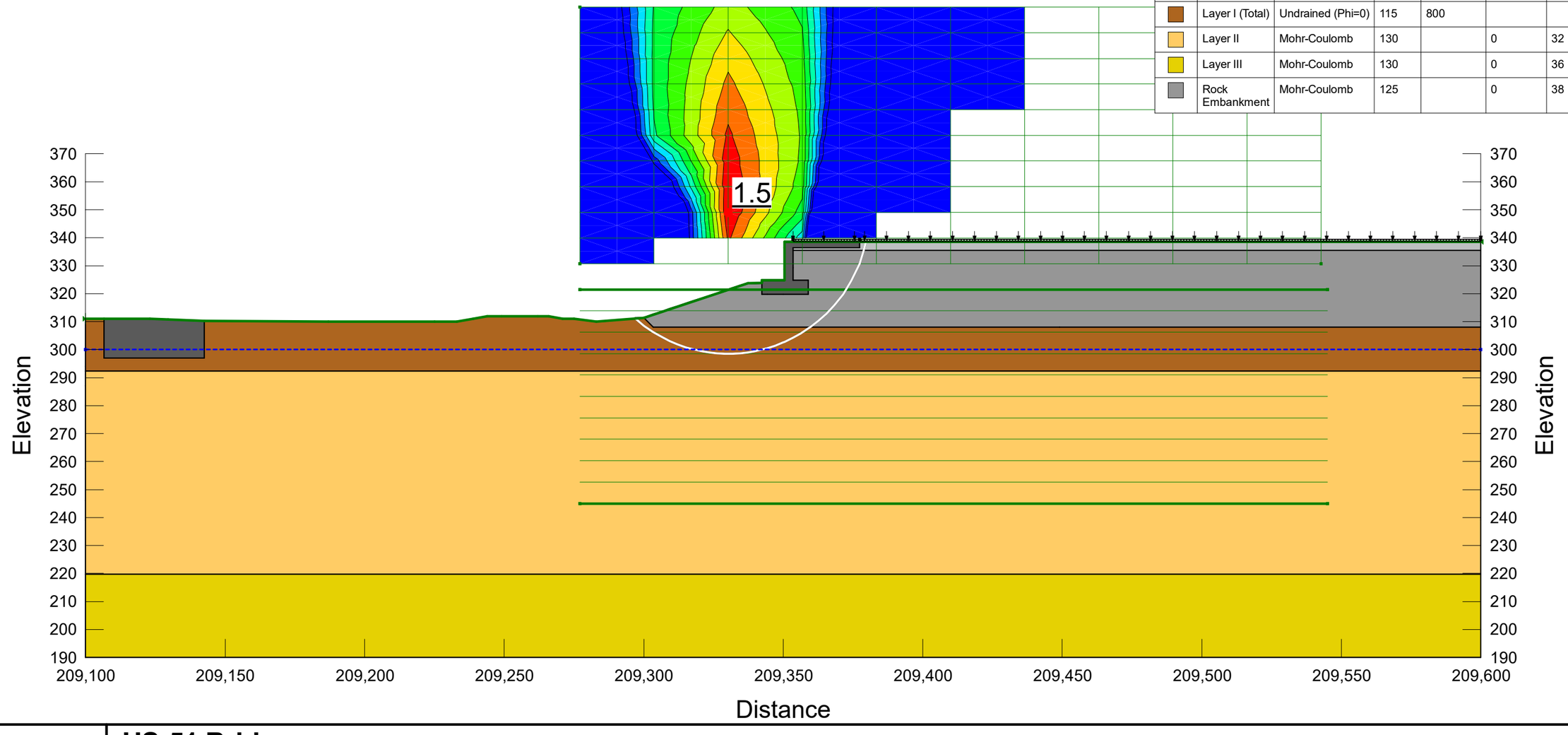
hdrinc.com

333 West Vine Street, Suite 1400, Lexington, KY 40507-1681
(859) 629-4800

# Spill-Through Abutment

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : Short Term**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 250 pcf**
**Horizontal Seismic Coefficient:**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

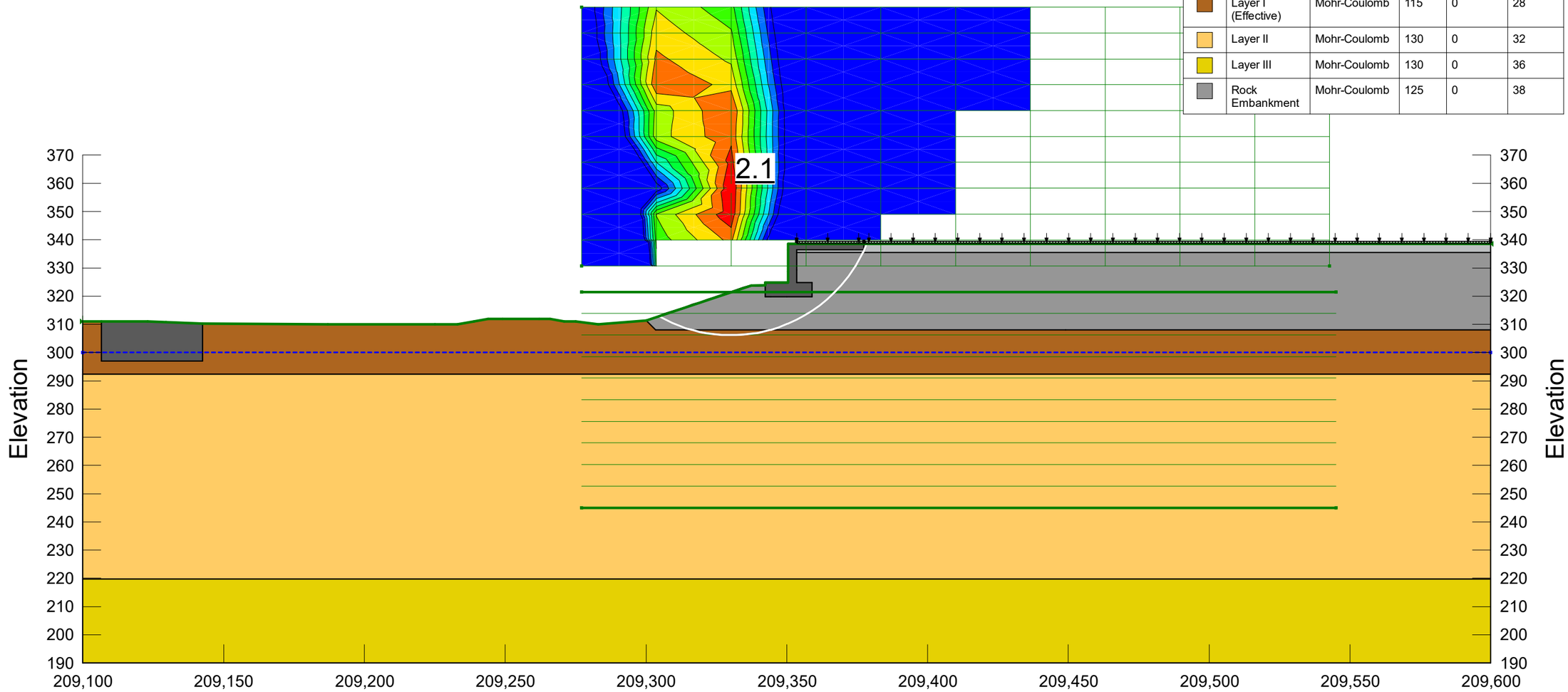
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : Long Term**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 250 pcf**
**Horizontal Seismic Coefficient:**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

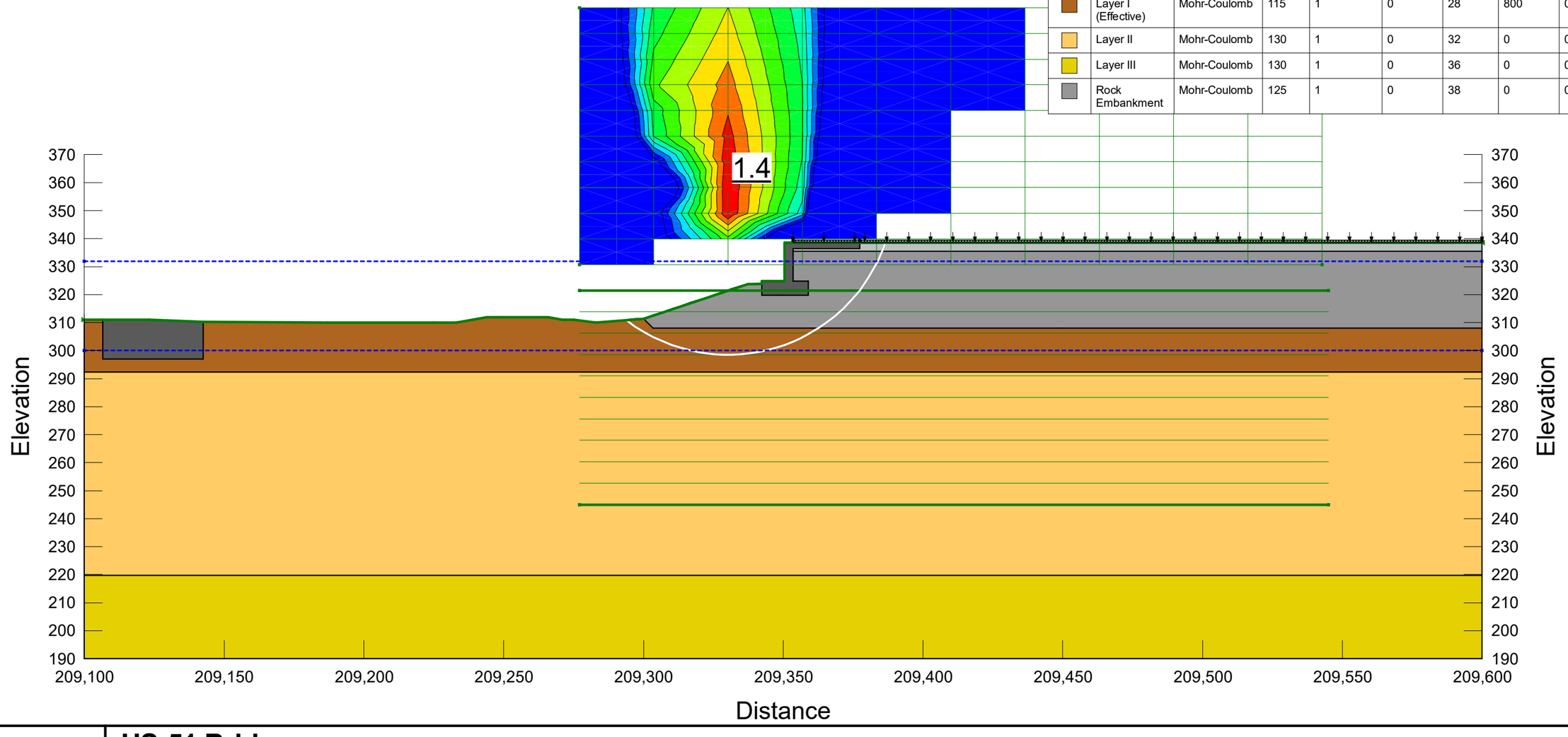
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | 0 | 35 |
| | Layer I (Effective) | Mohr-Coulomb | 115 | 0 | 28 |
| | Layer II | Mohr-Coulomb | 130 | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | 0 | 38 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : Rapid Drawdown**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 250 pcf**
**Horizontal Seismic Coefficient:**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

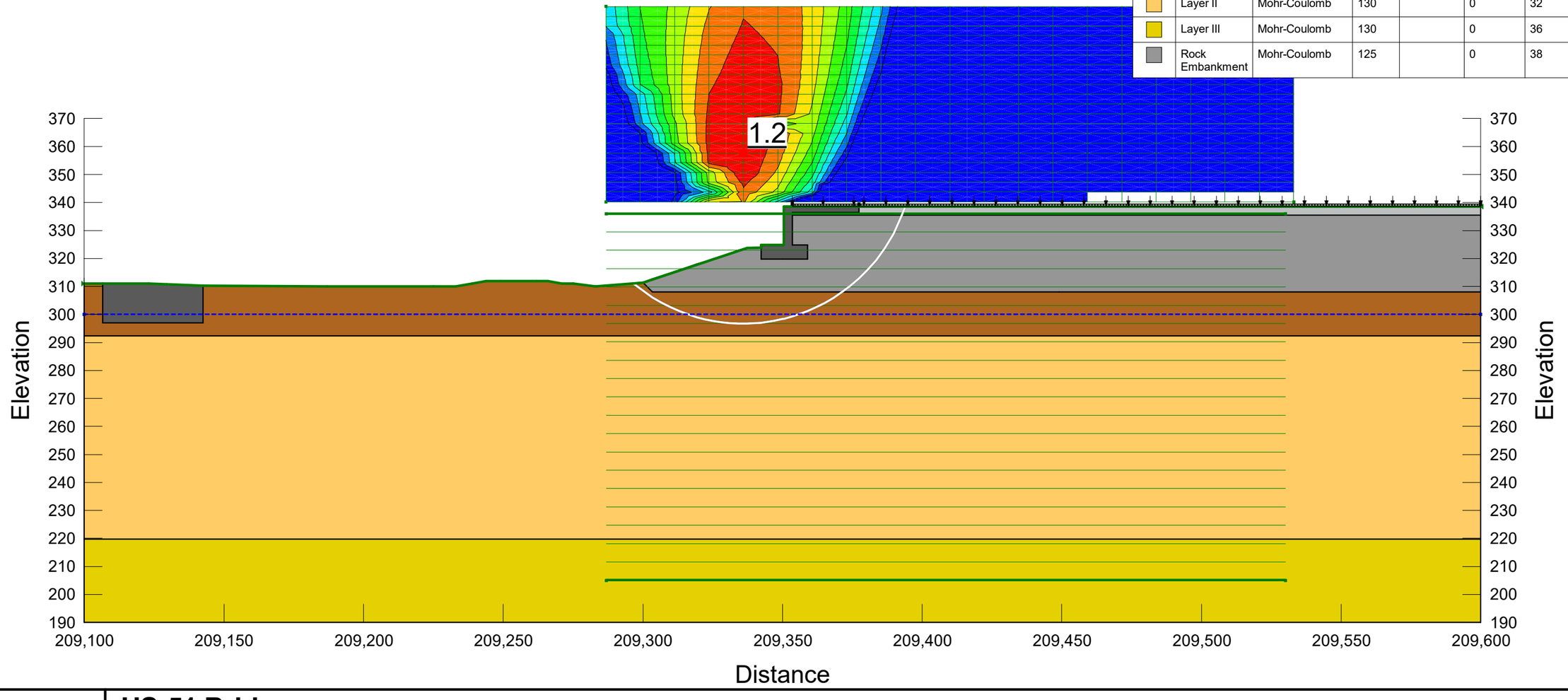
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Piezometric Surface After Drawdown | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) |
|---|---|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | 1 | | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | 1 | 0 | 35 | 0 | 0 |
| | Layer I (Effective) | Mohr-Coulomb | 115 | 1 | 0 | 28 | 800 | 0 |
| | Layer II | Mohr-Coulomb | 130 | 1 | 0 | 32 | 0 | 0 |
| | Layer III | Mohr-Coulomb | 130 | 1 | 0 | 36 | 0 | 0 |
| | Rock Embankment | Mohr-Coulomb | 125 | 1 | 0 | 38 | 0 | 0 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : Pseudo-Static (100-YR)**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.078**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

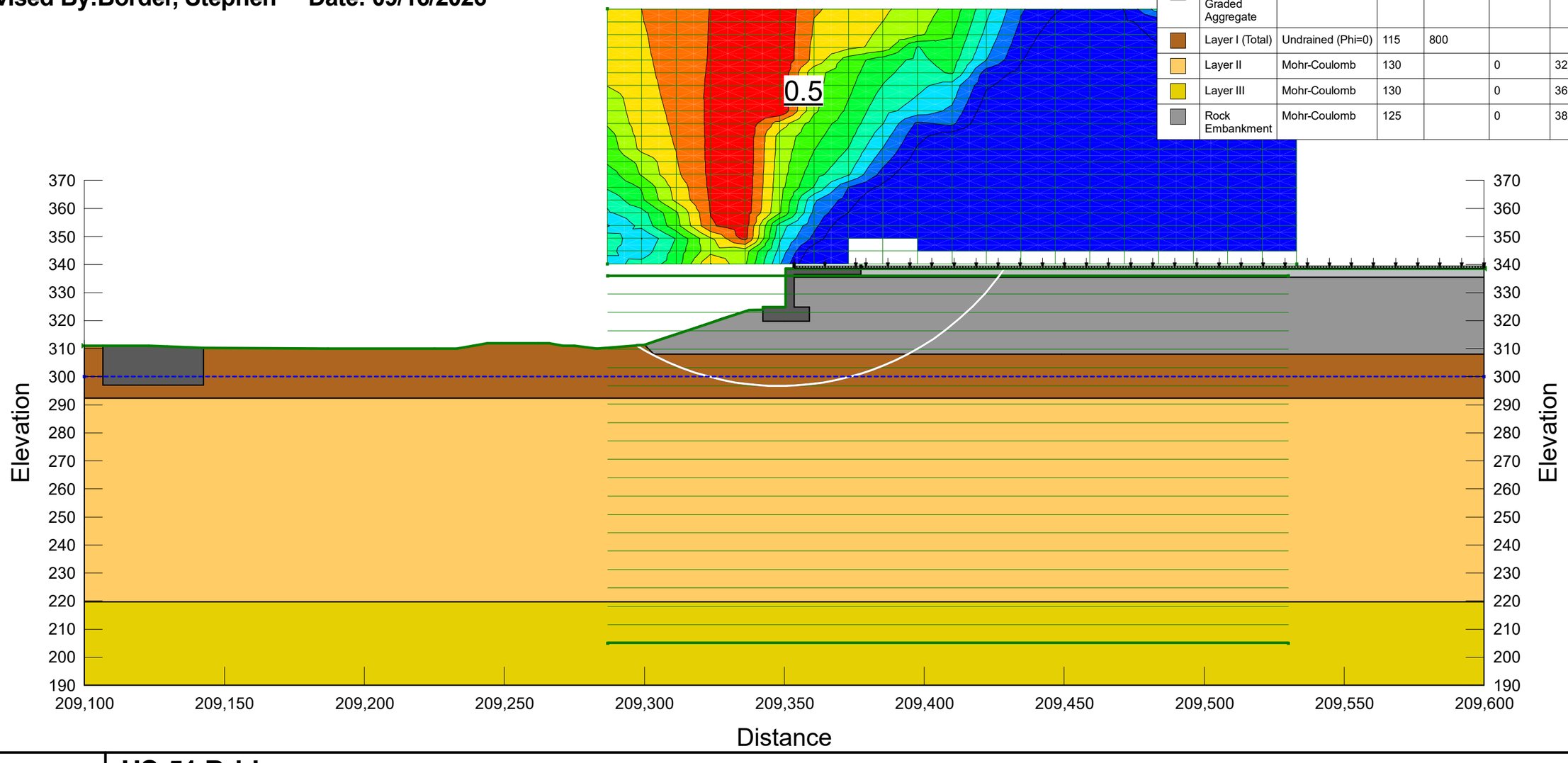
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : Pseudo-Static (1000-YR)**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.48**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

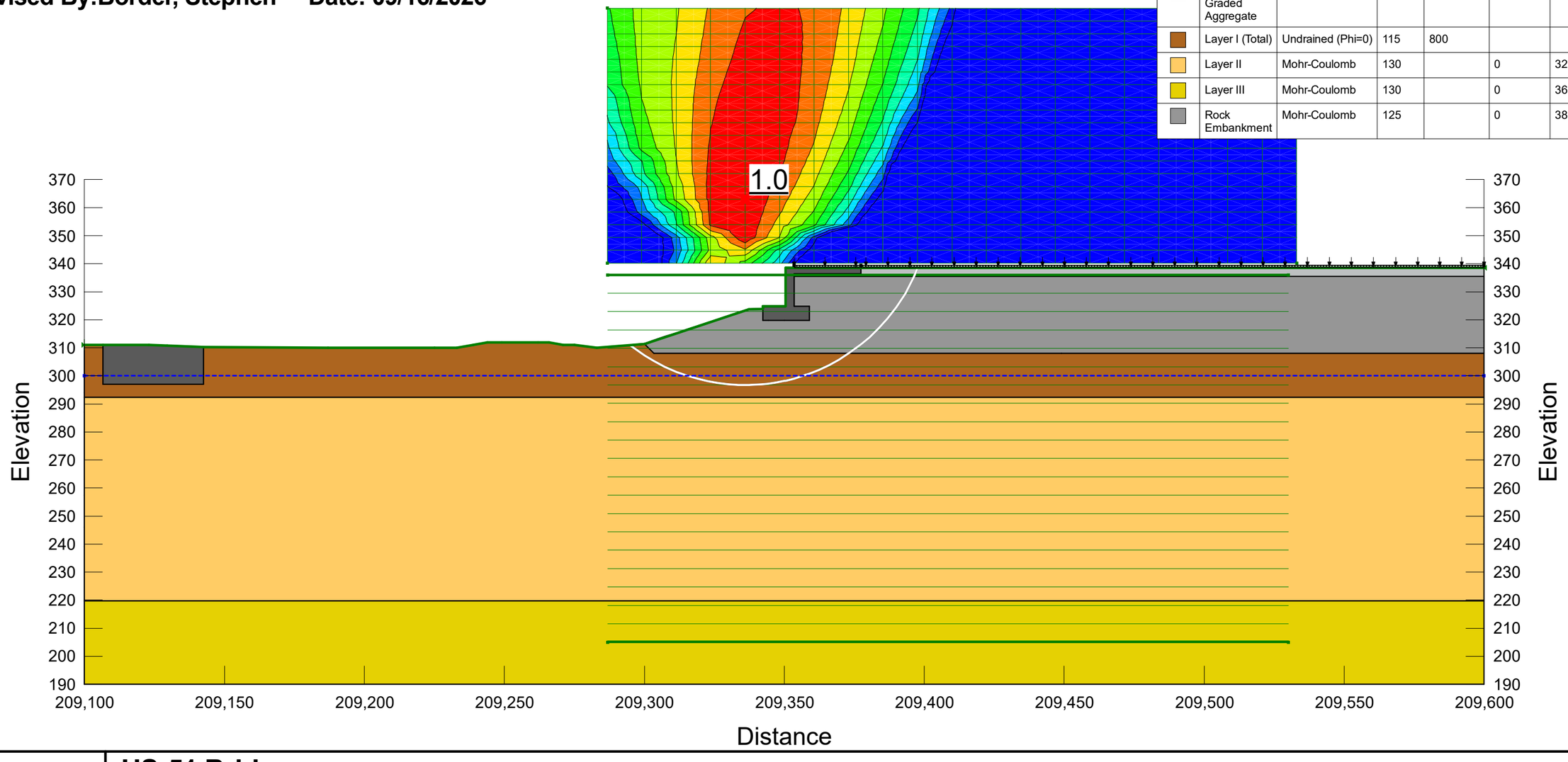
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : Pseudo-Static (Yield)**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.15**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

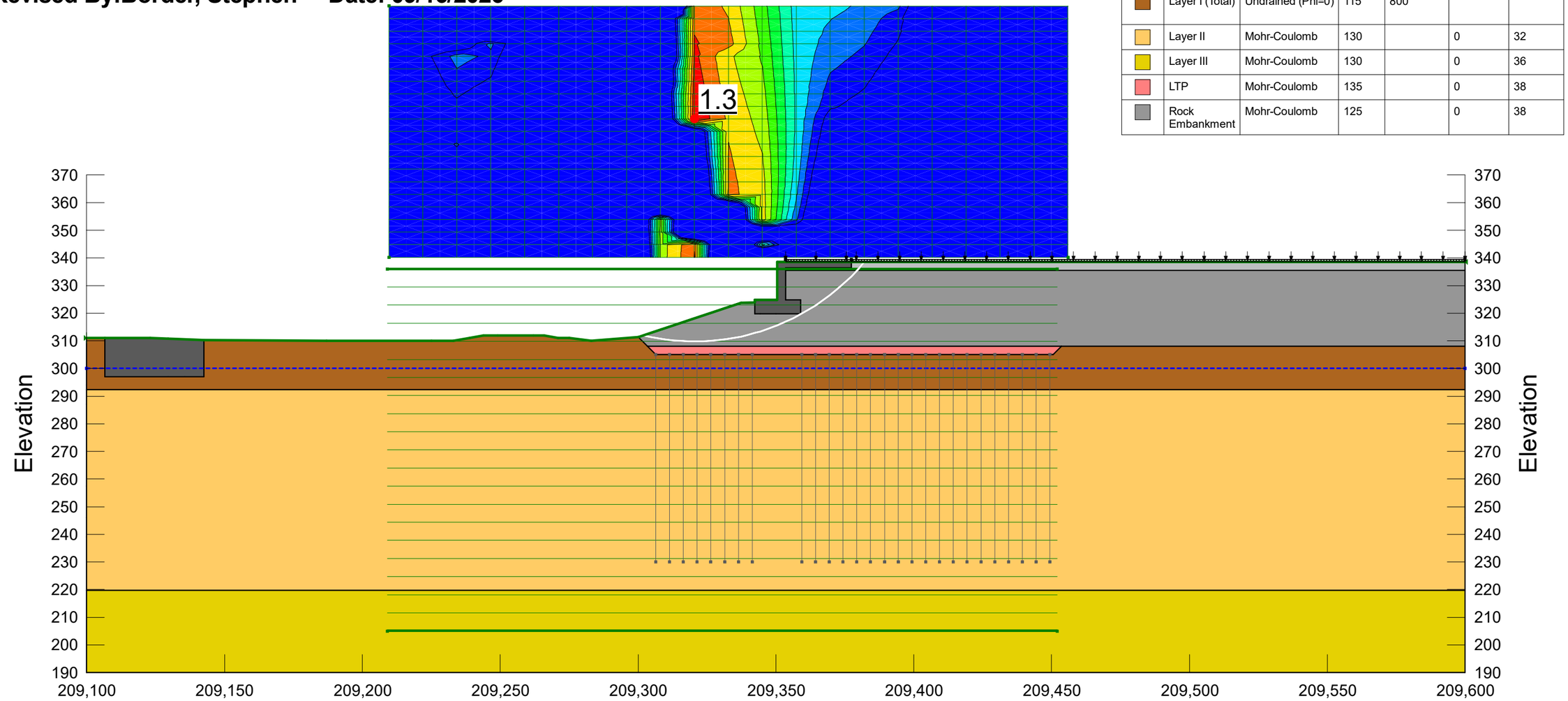



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : Modified Pseudo-Static (1/2 PGA 1000-YR)**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

**Rigid Inclusions Reinforcment**
**Shear Force: 94,000 lbf**
**Distance Between Reinforcements: 5 ft**
**Out-of-Plane Spacing: 5 ft**
**Length: 75 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 38 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

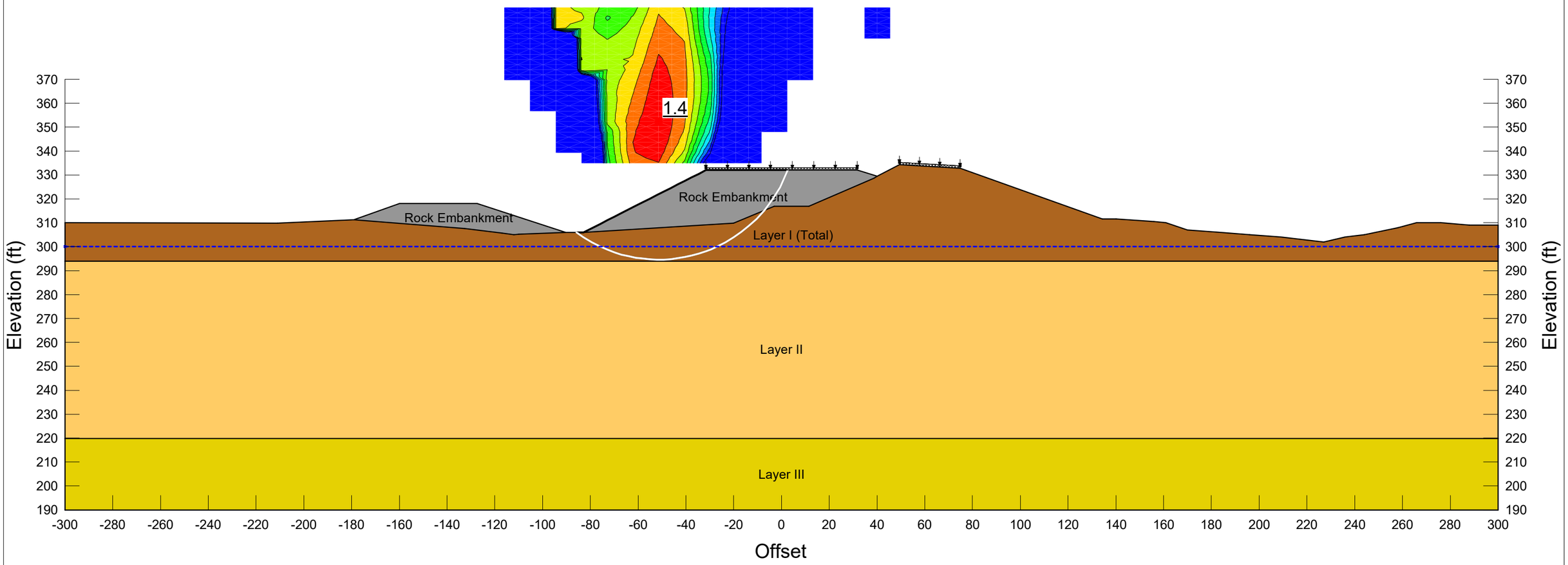



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

# 2094+50 (Cross Section) – Temporary Geometry

# KY Abutment (STA 2094+50)
# Pseudo-Static Analysis : Short Term_Temp
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 250 pcf
# Horizontal Seismic Coefficient:

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Undrained Shear Strength (psf) |
|---|---|---|---|---|---|---|
| | Layer I (Total) | Undrained (Phi=0) | 115 | | | 800 |
| | Layer II | Mohr-Coulomb | 130 | 0 | 32 | |
| | Layer III | Mohr-Coulomb | 130 | 0 | 36 | |
| | Rock Embankment | Mohr-Coulomb | 125 | 0 | 38 | |

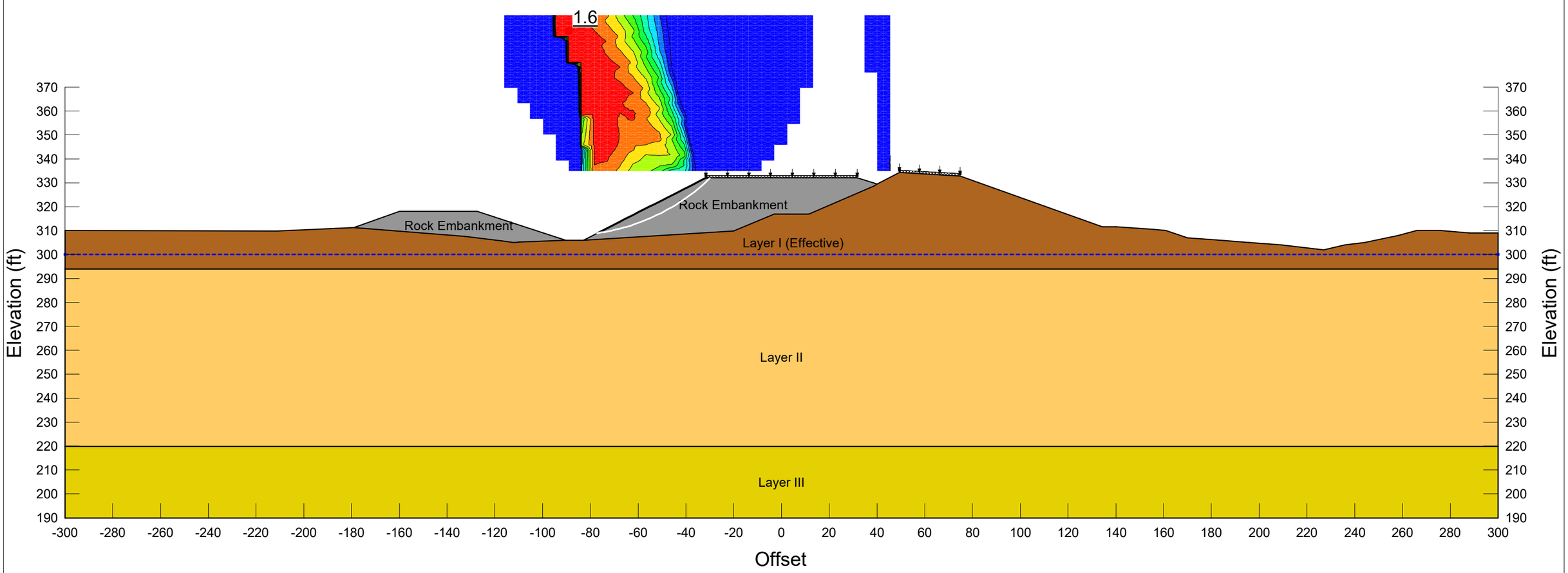



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/29/2026**

# KY Abutment (STA 2094+50)
# Pseudo-Static Analysis : Long Term_Temp
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 250 pcf
# Horizontal Seismic Coefficient:

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Layer I (Effective) | Mohr-Coulomb | 115 | 50 | 28 |
| | Layer II | Mohr-Coulomb | 130 | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | 0 | 38 |

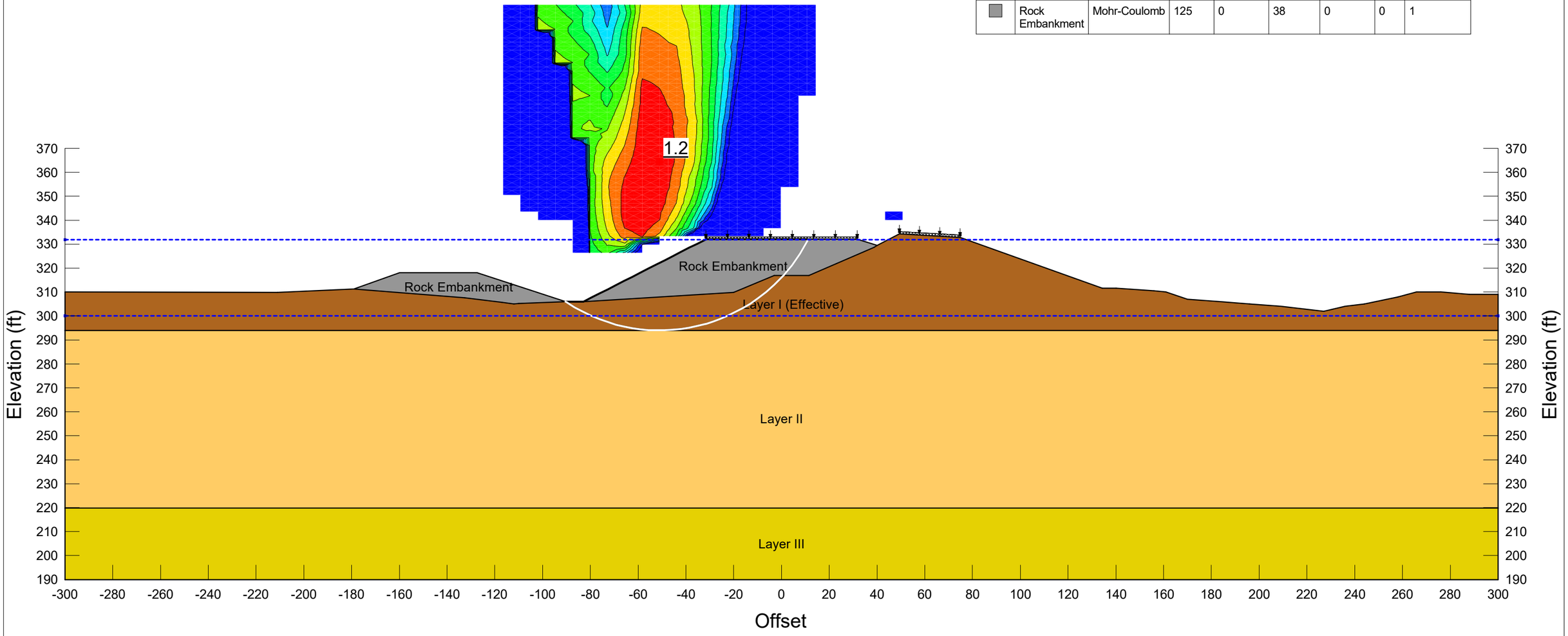



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/29/2026**

# KY Abutment (STA 2094+50)
# Pseudo-Static Analysis : Rapid Drawdown_Temp
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 250 pcf
# Horizontal Seismic Coefficient:

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) | Piezometric Surface After Drawdown |
|---|---|---|---|---|---|---|---|---|
| | Layer I (Effective) | Mohr-Coulomb | 115 | 50 | 28 | 800 | 0 | 1 |
| | Layer II | Mohr-Coulomb | 130 | 0 | 32 | 0 | 0 | 1 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 36 | 0 | 0 | 1 |
| | Rock Embankment | Mohr-Coulomb | 125 | 0 | 38 | 0 | 0 | 1 |

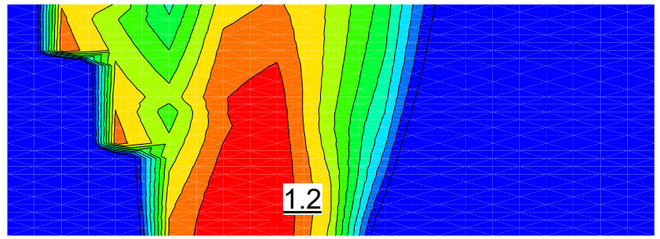


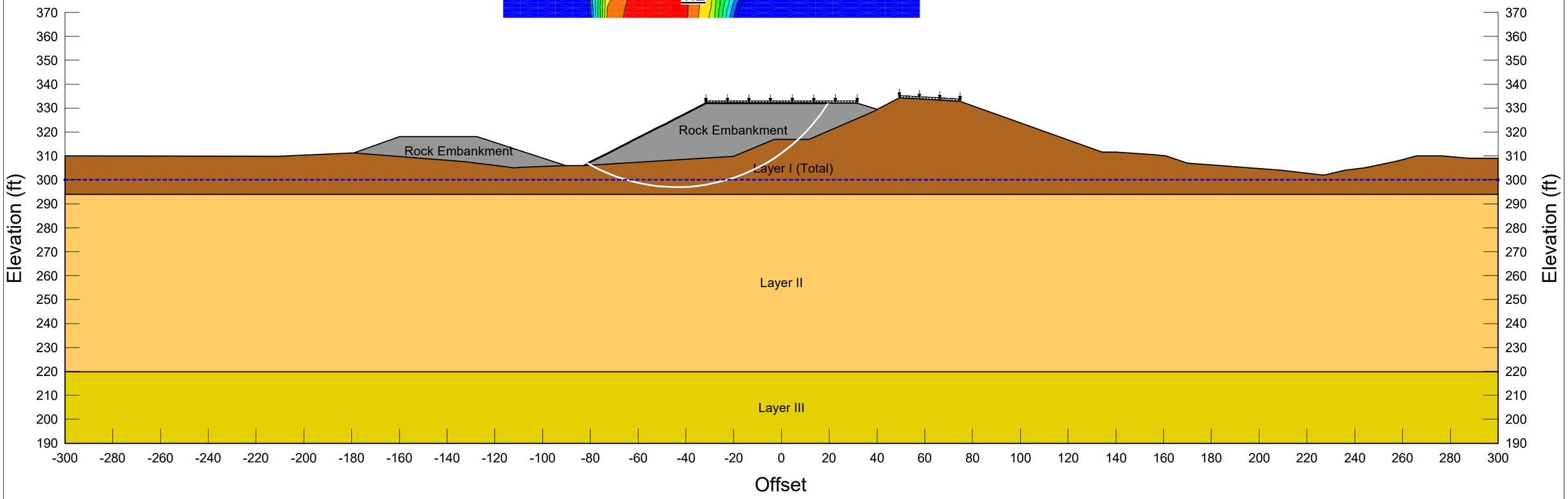

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen** **Date: 10/29/2026**

# KY Abutment (STA 2094+50)
# Pseudo-Static Analysis : Pseudo-Static_Temp (100YR PGA)
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.078

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Undrained Shear Strength (psf) |
|---|---|---|---|---|---|---|
| | Layer I (Total) | Undrained (Phi=0) | 115 | | | 800 |
| | Layer II | Mohr-Coulomb | 130 | 0 | 32 | |
| | Layer III | Mohr-Coulomb | 130 | 0 | 36 | |
| | Rock Embankment | Mohr-Coulomb | 125 | 0 | 38 | |

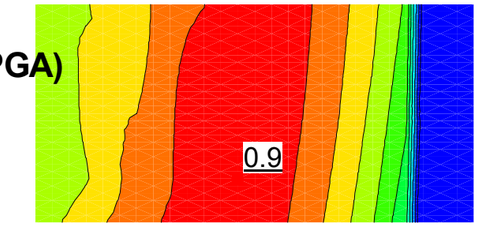


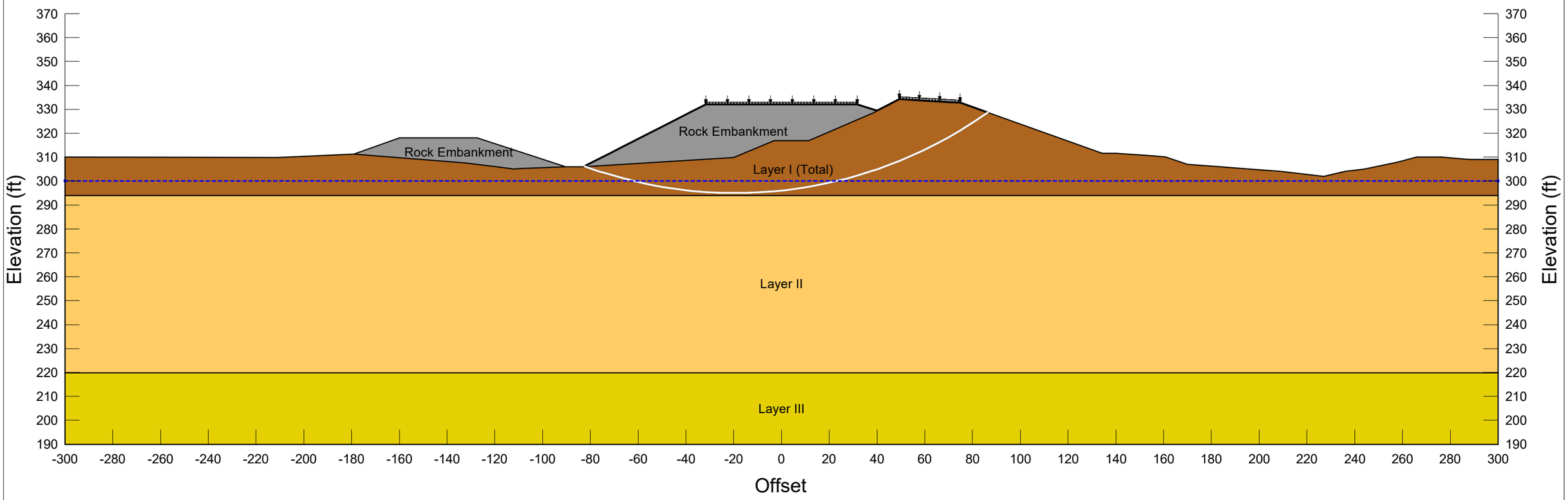

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/29/2026**

# KY Abutment (STA 2094+50)
# Pseudo-Static Analysis : Pseudo-Static_Temp (1000YR PGA)
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.24




| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Undrained Shear Strength (psf) |
|---|---|---|---|---|---|---|
| | Layer I (Total) | Undrained (Phi=0) | 115 | | | 800 |
| | Layer II | Mohr-Coulomb | 130 | 0 | 32 | |
| | Layer III | Mohr-Coulomb | 130 | 0 | 36 | |
| | Rock Embankment | Mohr-Coulomb | 125 | 0 | 38 | |



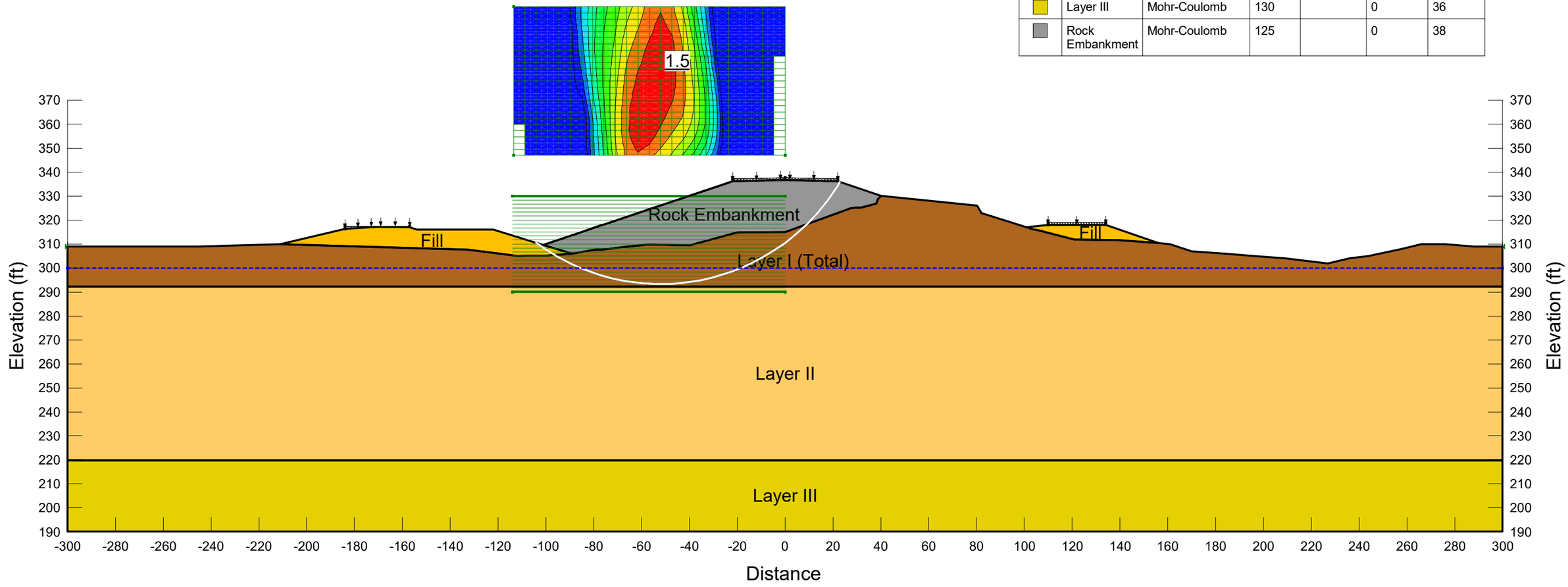

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/29/2026**

# 2094+00 (Cross Section) – Final Geometry

# KY Abutment (STA 2094+00)
# Static Analysis : Short Term (Final)
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 250 pcf
# Horizontal Seismic Coefficient: 0

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

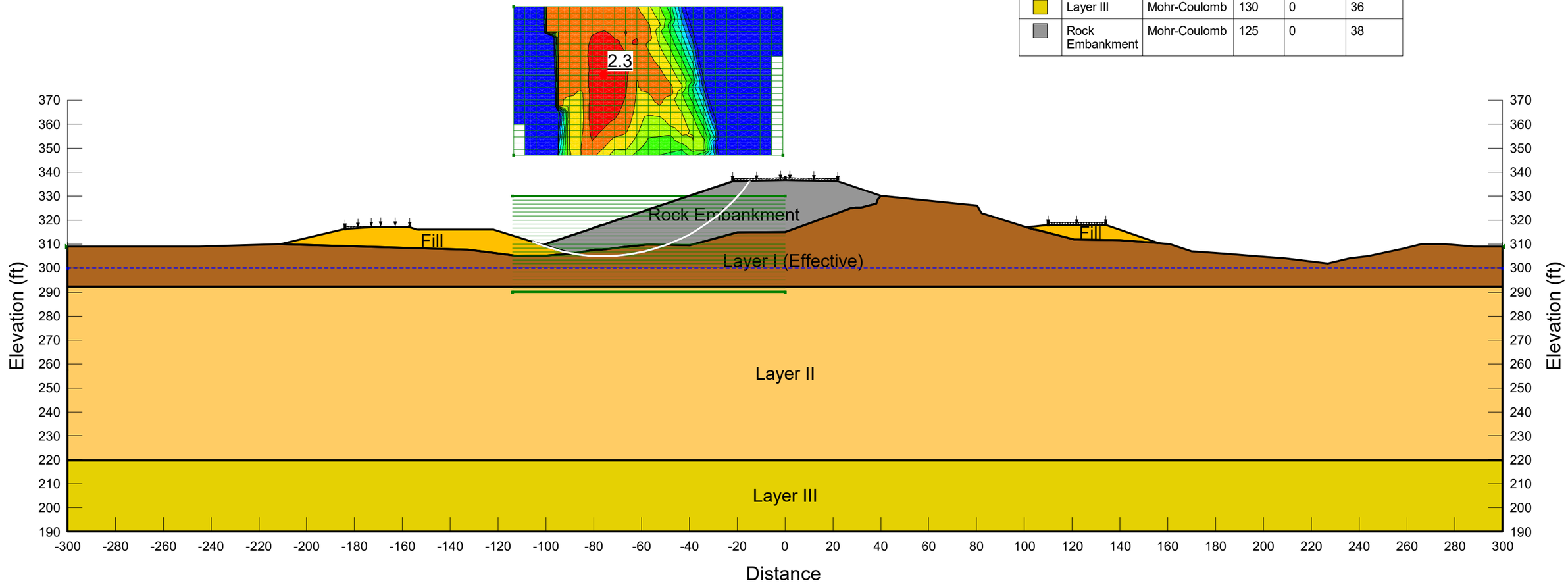



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 07/23/2026**

# KY Abutment (STA 2094+00)
# Static Analysis : Long Term (Final)
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 250 pcf
# Horizontal Seismic Coefficient: 0

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill | Mohr-Coulomb | 120 | 0 | 32 |
| | Layer I (Effective) | Mohr-Coulomb | 115 | 50 | 28 |
| | Layer II | Mohr-Coulomb | 130 | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | 0 | 38 |

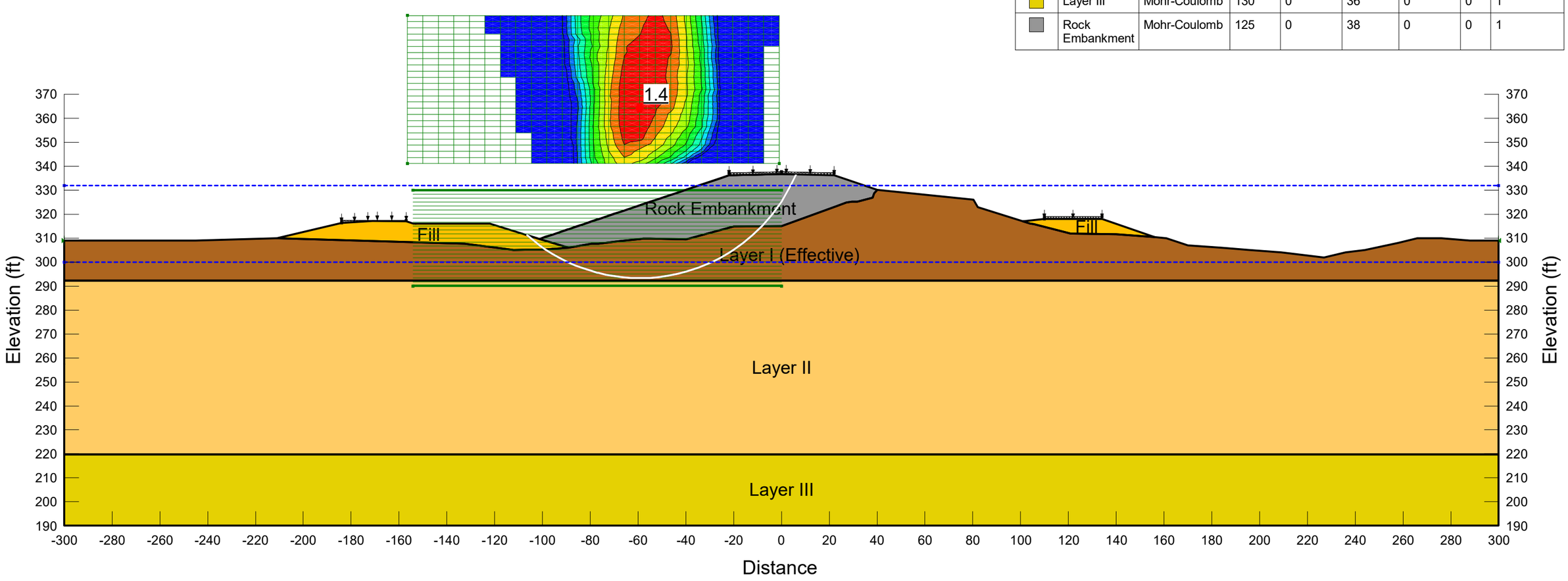



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen Date: 07/23/2026**

# KY Abutment (STA 2094+00)
# Static Analysis : Rapid Drawdown (Final)
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 250 pcf
# Horizontal Seismic Coefficient: 0

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) | Piezometric Surface After Drawdown |
|---|---|---|---|---|---|---|---|---|
| | Fill | Mohr-Coulomb | 120 | 0 | 32 | 0 | 0 | 1 |
| | Layer I (Effective) | Mohr-Coulomb | 115 | 50 | 28 | 800 | 0 | 1 |
| | Layer II | Mohr-Coulomb | 130 | 0 | 32 | 0 | 0 | 1 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 36 | 0 | 0 | 1 |
| | Rock Embankment | Mohr-Coulomb | 125 | 0 | 38 | 0 | 0 | 1 |

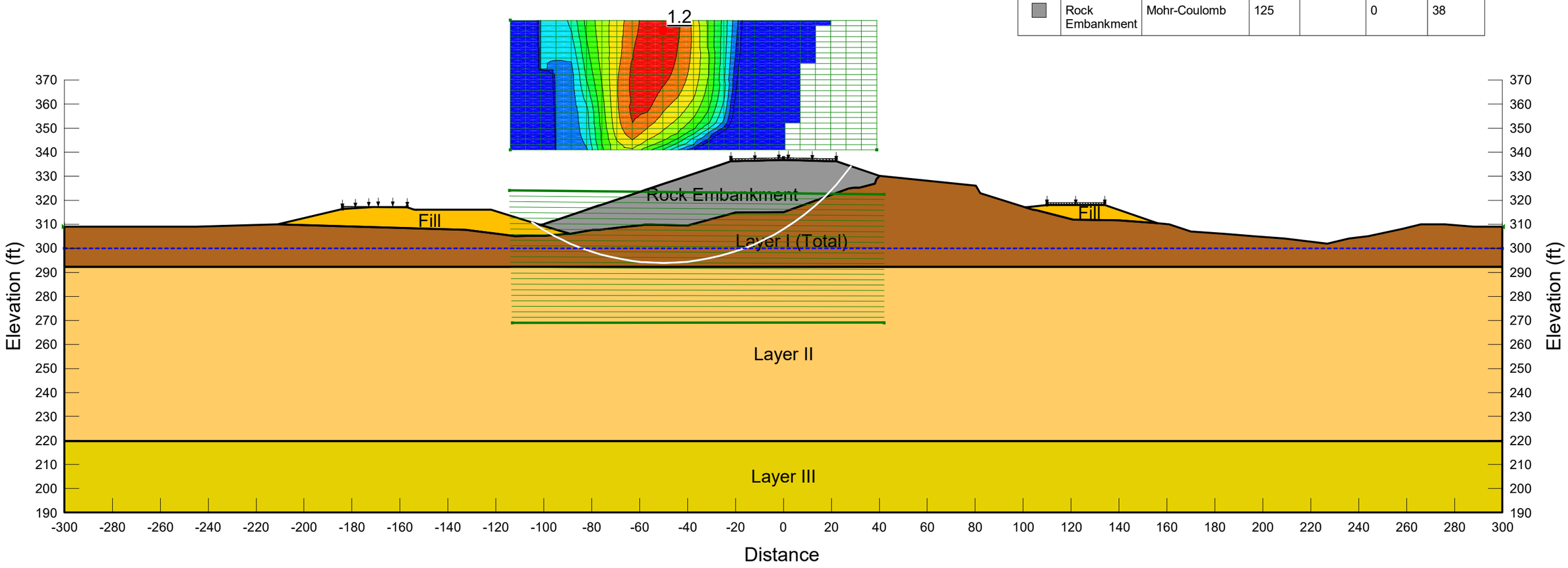



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 07/23/2026**

# KY Abutment (STA 2094+00)
# Static Analysis : FULL PGA- 100YR (Final)
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.078

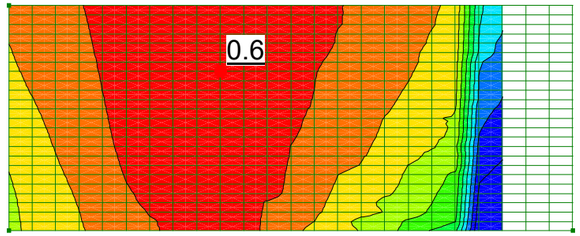
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |



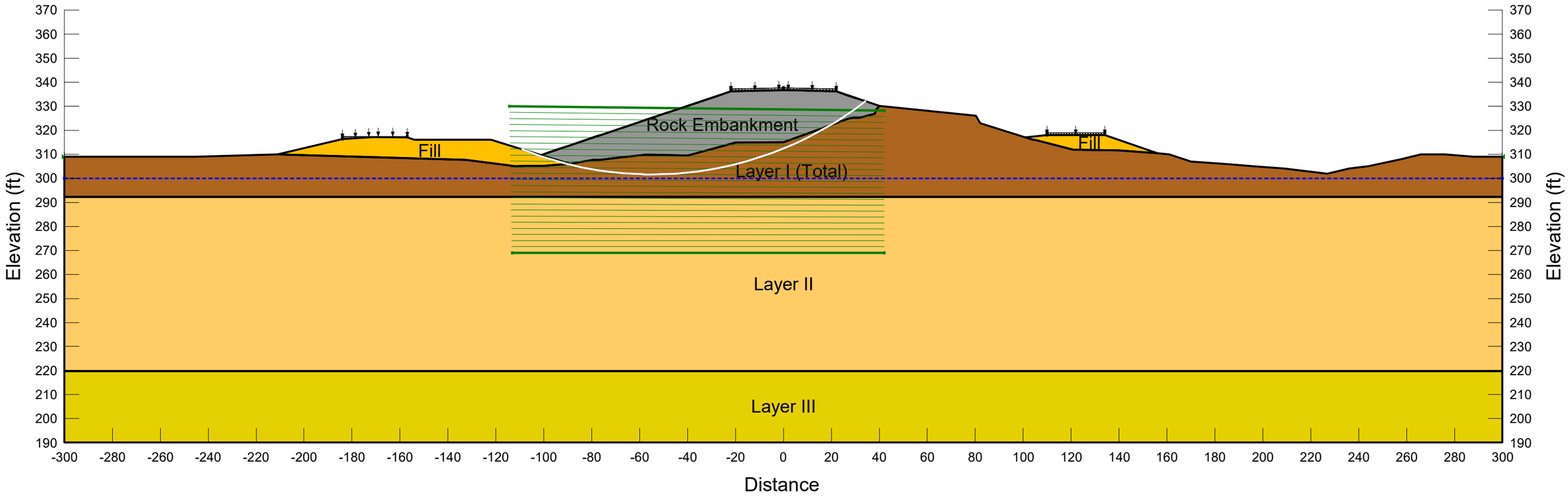

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 07/23/2026**

# KY Abutment (STA 2094+00)
# Static Analysis : FULL PGA- 1000YR (Final)
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.48




| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

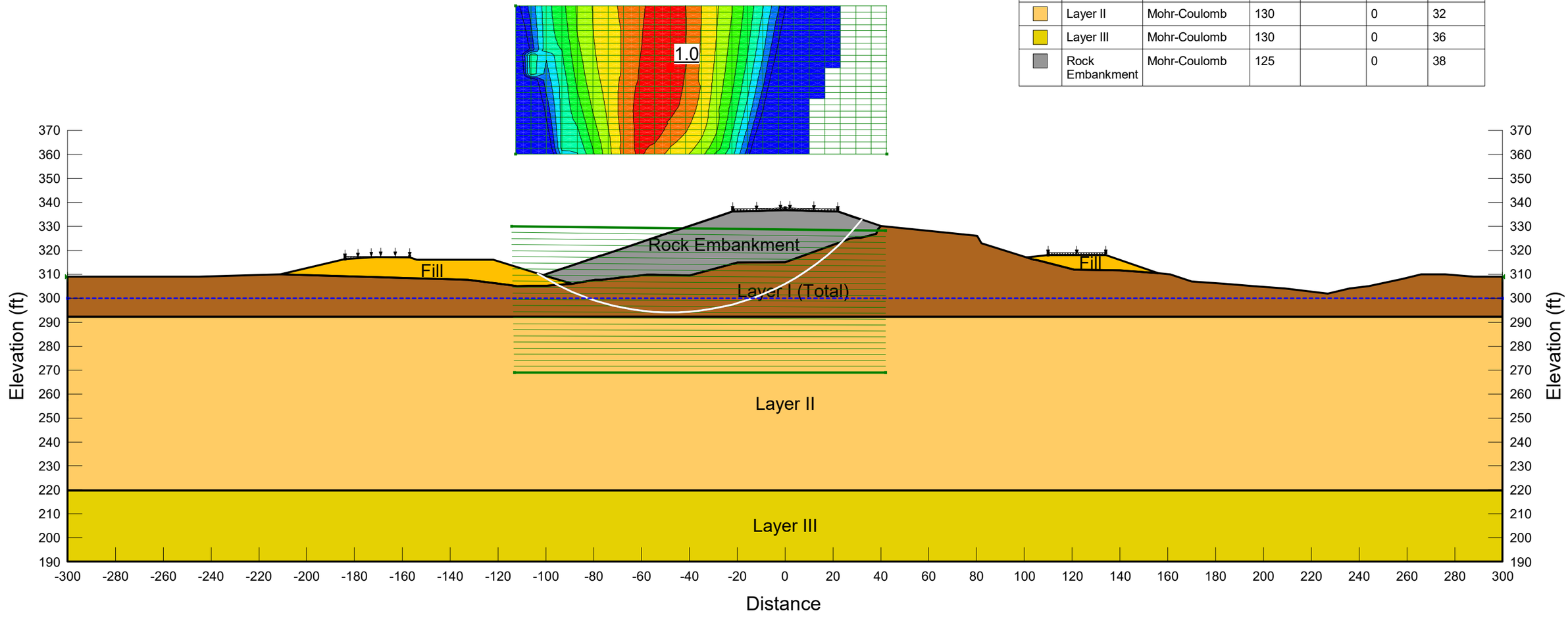



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 07/23/2026**

# KY Abutment (STA 2094+00)
# Static Analysis : YIELD PGA- 1000YR (Final)
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.15

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

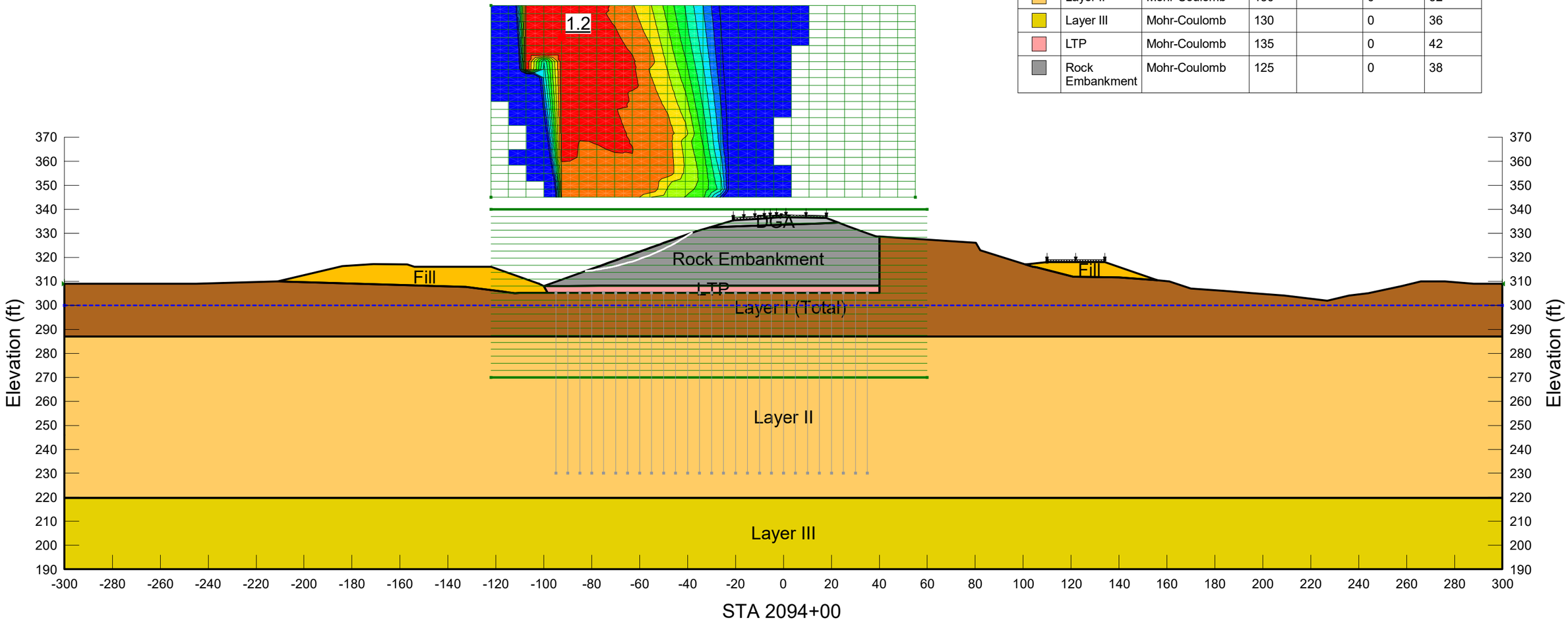



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 07/23/2026**

# KY Abutment (STA 2094+00)
# Static Analysis : HALF PGA- 1000YR_W/REINF.
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.24

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 09/16/2026**

# 2094+00 – Newmark Displacement Analysis

## Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** Spill-Through

| | |
|---|---|
| **Embankment Height (ft):** | 27 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.15 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.93 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.31 |
| **log(d)[5]:** | 1.35 |
| **Displacement, d (in):** | 22.3 |

1 $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}$ $where, 0.5 \leq \beta \leq 1.5$

2 $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$

3 $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$

4 $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$

5 $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$

## Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** STA 2094+00

| | |
|---|---|
| **Embankment Height (ft):** | 29 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.15 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.93 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.31 |
| **log(d)[5]:** | 1.35 |
| **Displacement, d (in):** | 22.4 |

[1] $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}$ $where, 0.5 \leq \beta \leq 1.5$

[2] $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$

[3] $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$

[4] $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$

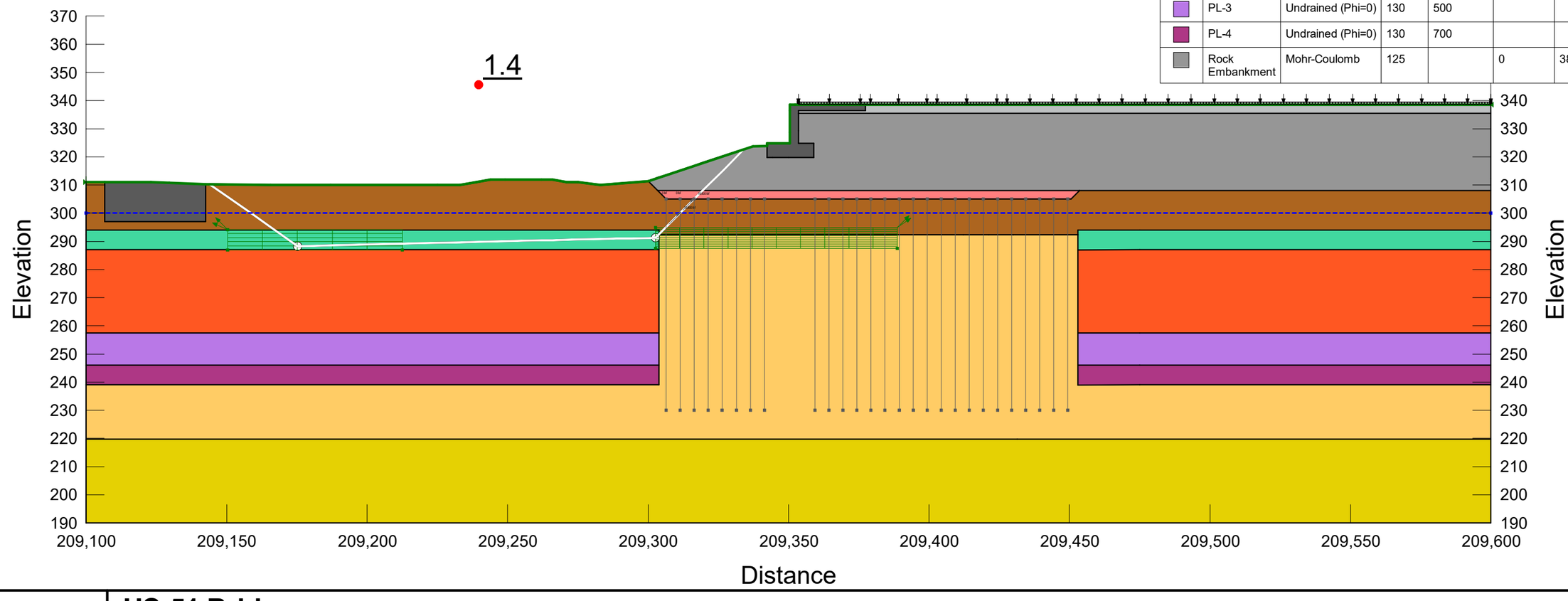
[5] $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$

# Spill-Through Abutment – Lateral Displacement Analysis

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : PL-1**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

**Rigid Inclusions Reinforcment**
**Shear Force: 94,000 lbf**
**Distance Between Reinforcements: 5 ft**
**Out-of-Plane Spacing: 5 ft**
**Length: 75 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 38 |
| | PL-1 | Undrained (Phi=0) | 120 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

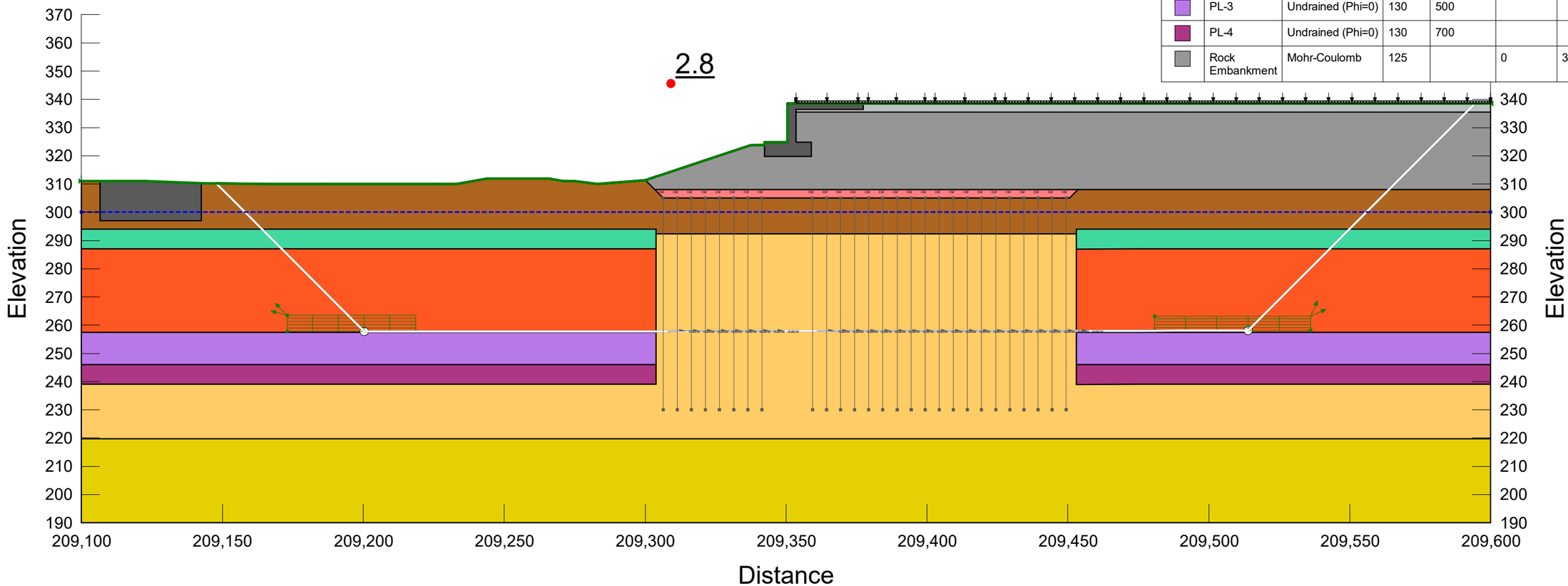



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : PL-2**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

**Rigid Inclusions Reinforcment**
**Shear Force: 94,000 lbf**
**Distance Between Reinforcements: 5 ft**
**Out-of-Plane Spacing: 5 ft**
**Length: 75 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 38 |
| | PL-1 | Undrained (Phi=0) | 120 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

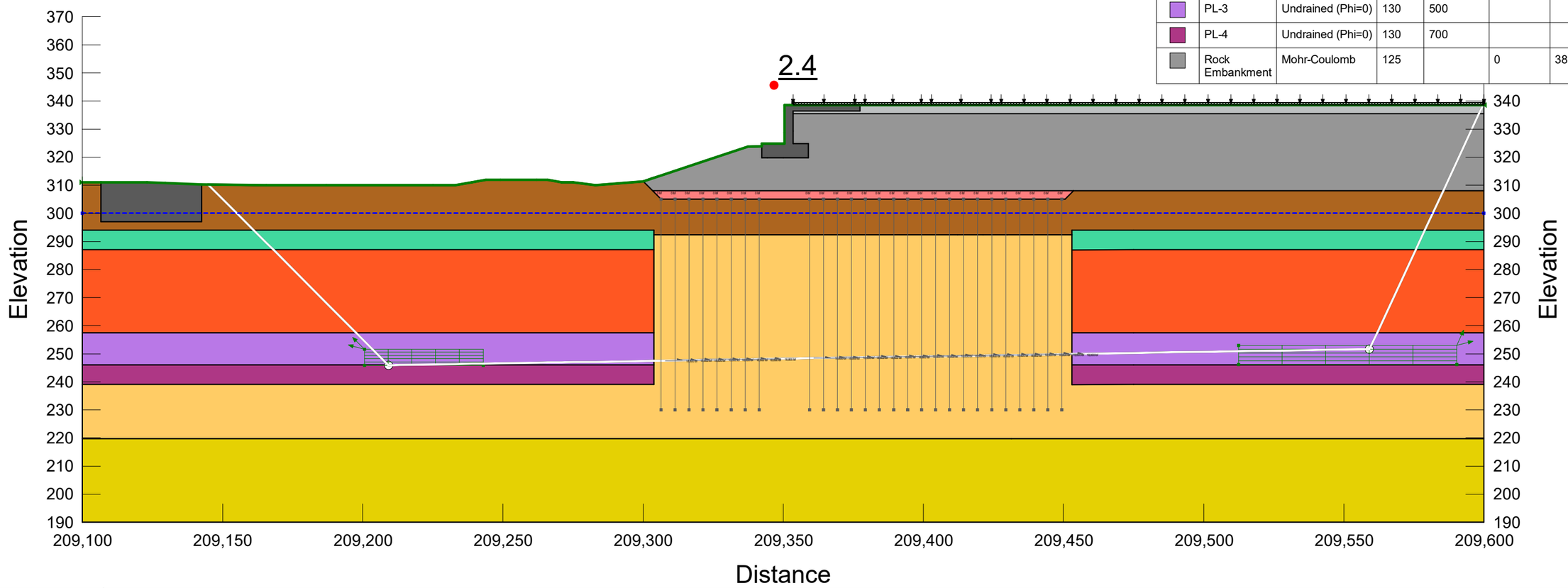



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : PL-3**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

**Rigid Inclusions Reinforcment**
**Shear Force: 94,000 lbf**
**Distance Between Reinforcements: 5 ft**
**Out-of-Plane Spacing: 5 ft**
**Length: 75 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 38 |
| | PL-1 | Undrained (Phi=0) | 120 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

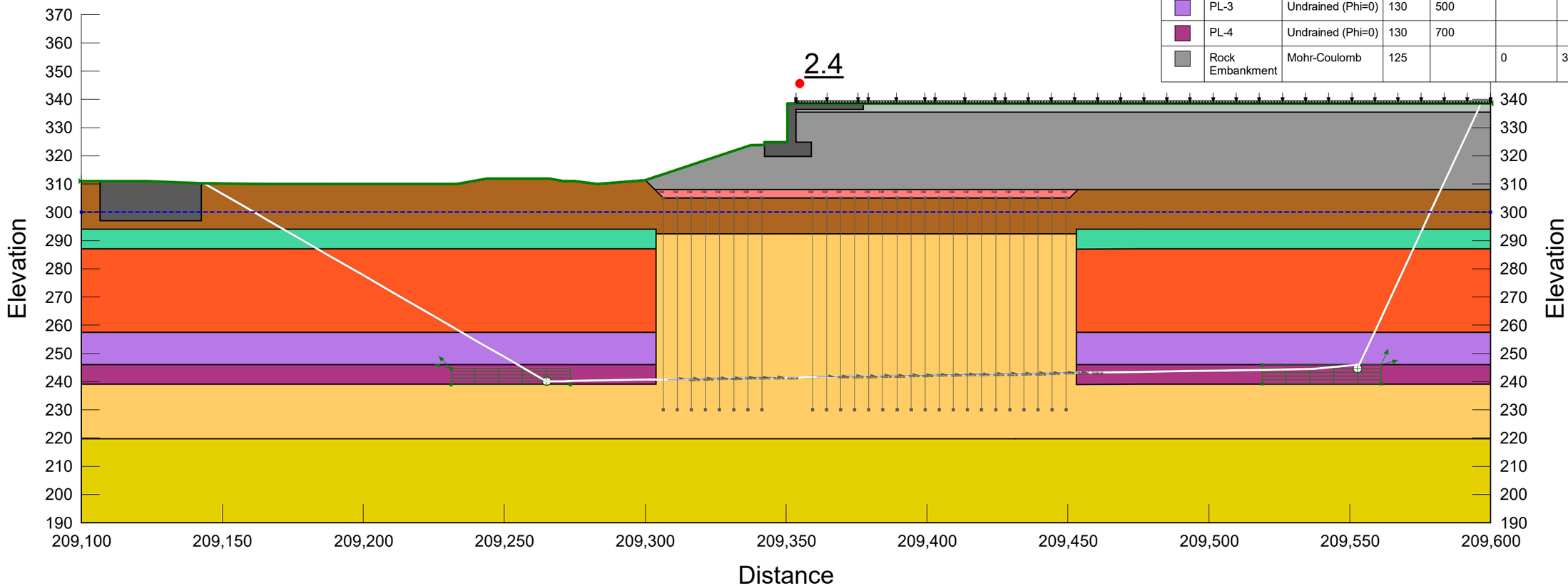



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Cairo Bridge - Kentucky Abutment (Spill Through)**
**Static Analysis : PL-4**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Created By: Pineda, Raydel Date: 09/16/2026**
**Revised By:Border, Stephen Date: 09/16/2026**

**Rigid Inclusions Reinforcment**
**Shear Force: 94,000 lbf**
**Distance Between Reinforcements: 5 ft**
**Out-of-Plane Spacing: 5 ft**
**Length: 75 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | C-Str | High Strength | 150 | | | |
| | Dense Graded Aggregate | Mohr-Coulomb | 125 | | 0 | 35 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 38 |
| | PL-1 | Undrained (Phi=0) | 120 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

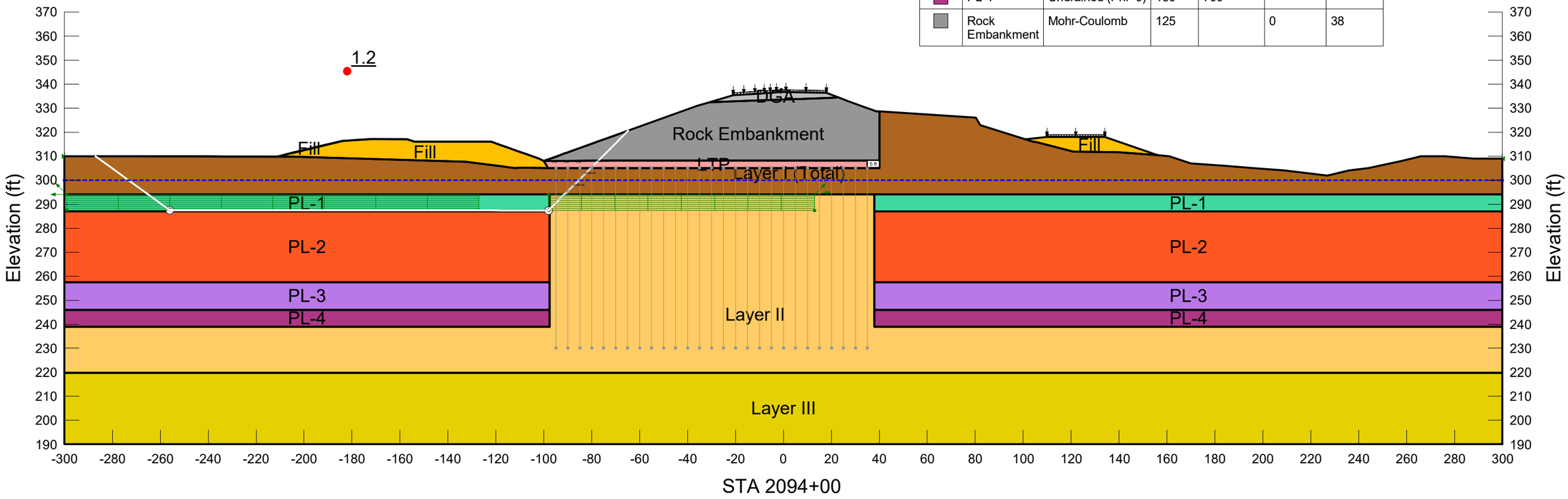



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

# STA 2094+00 – Lateral Displacement Analysis

**KY Abutment (STA 2094+00)**
**Static Analysis : PL-1**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Reinf Length:75 ft**
**Reinf Spacing:5 ft**
**Reinf Shear Force: 94,000 lbf**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

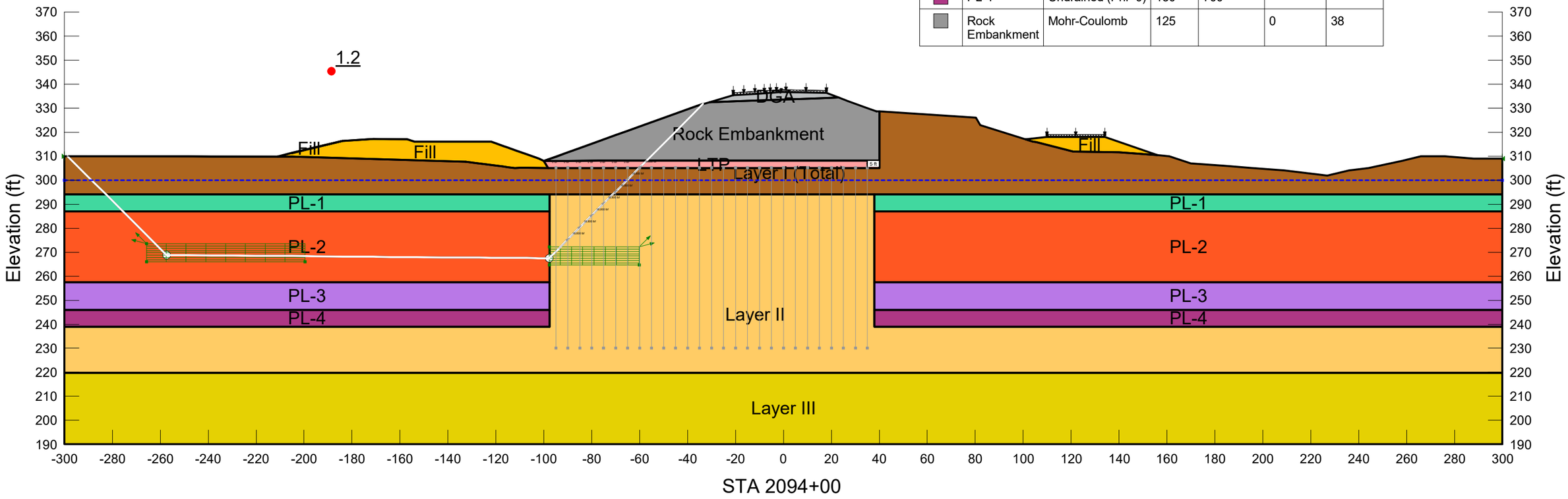



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen Date: 09/16/2026**

**KY Abutment (STA 2094+00)**
**Static Analysis : PL-2**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Reinf Length:75 ft**
**Reinf Spacing:5 ft**
**Reinf Shear Force: 94,000 lbf**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

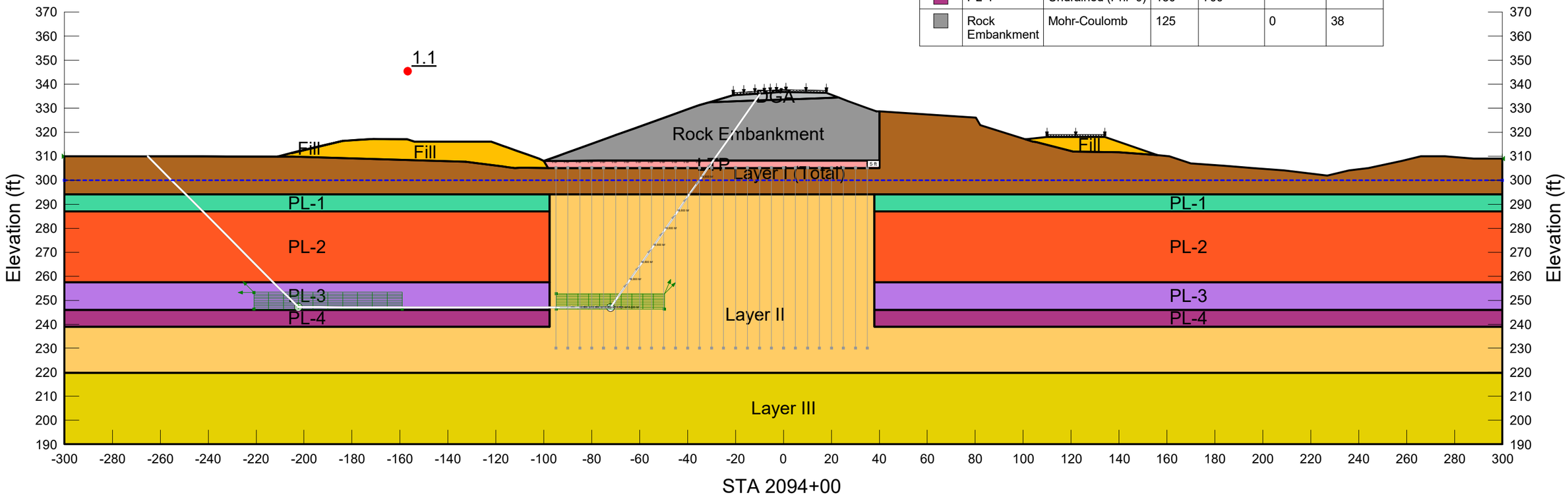



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen Date: 09/16/2026**

**KY Abutment (STA 2094+00)**
**Static Analysis : PL-3**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Reinf Length:75 ft**
**Reinf Spacing:5 ft**
**Reinf Shear Force: 94,000 lbf**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |

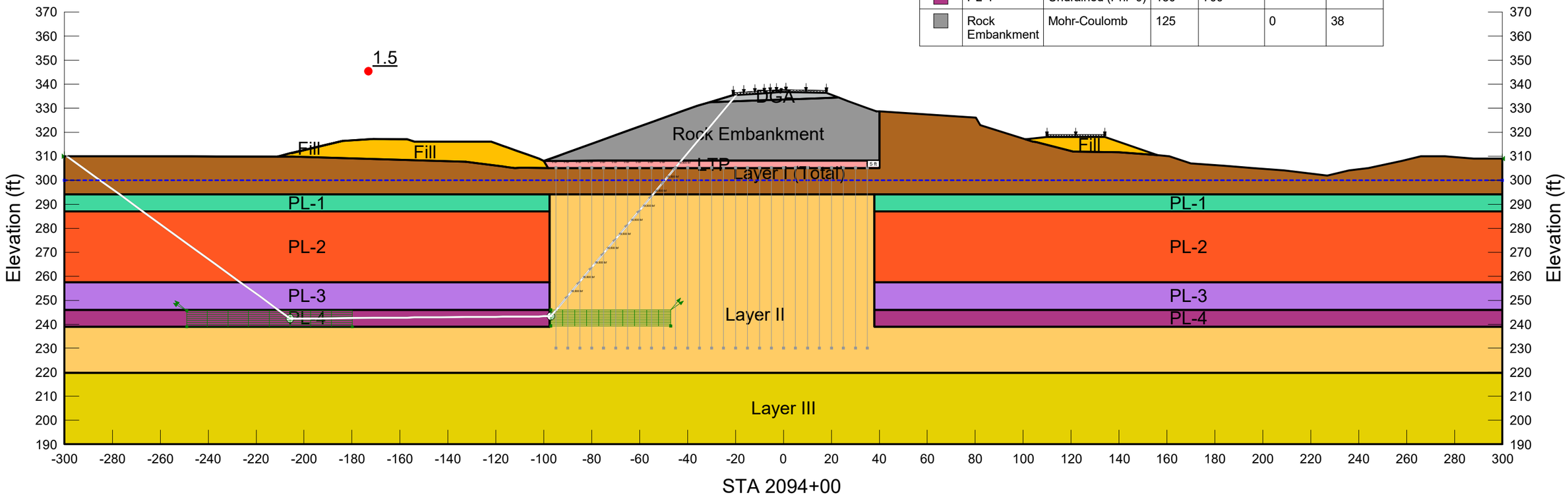



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen Date: 09/16/2026**

**KY Abutment (STA 2094+00)**
**Static Analysis : PL-4**
**GWT Elevation:300 ft**
**Surcharge (Unit Weight): 125 pcf**
**Horizontal Seismic Coefficient: 0.24**
**Reinf Length:75 ft**
**Reinf Spacing:5 ft**
**Reinf Shear Force: 94,000 lbf**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |



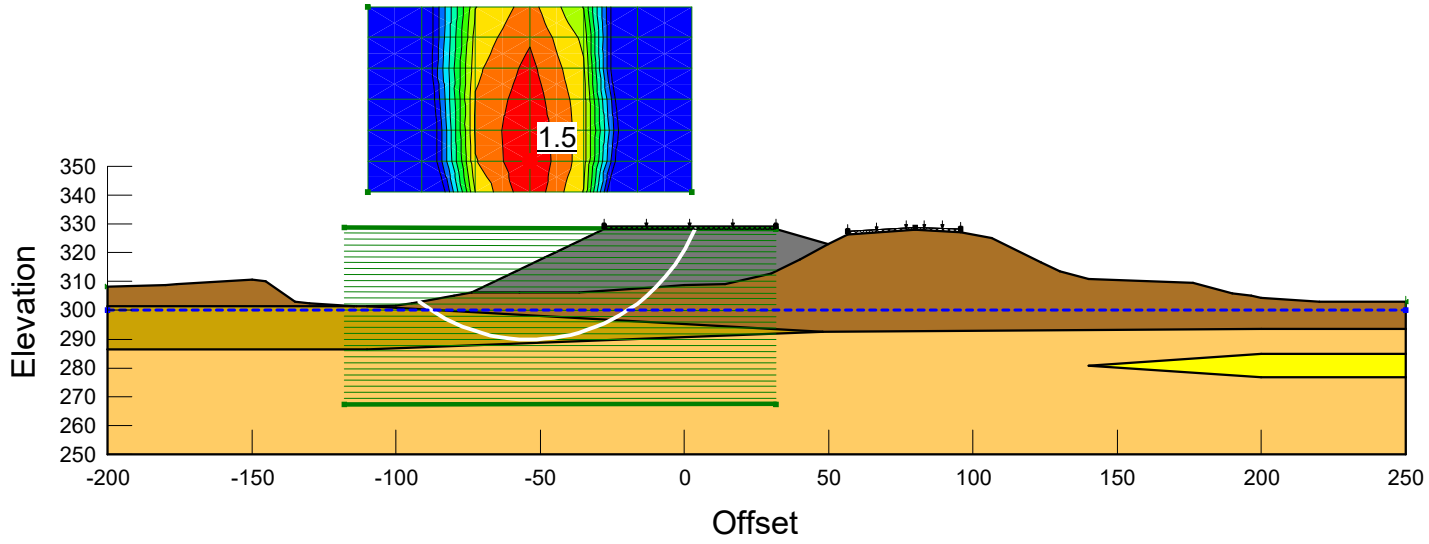

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen Date: 09/16/2026**

# 2096+50 – Temporary Geometry

**US-51 Cairo - STA 2096+50 Temporary Grade**
**Static Analysis: Short Term Temp**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-53.71844, 351.76926) ft**
**Radius: 61.936247 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |

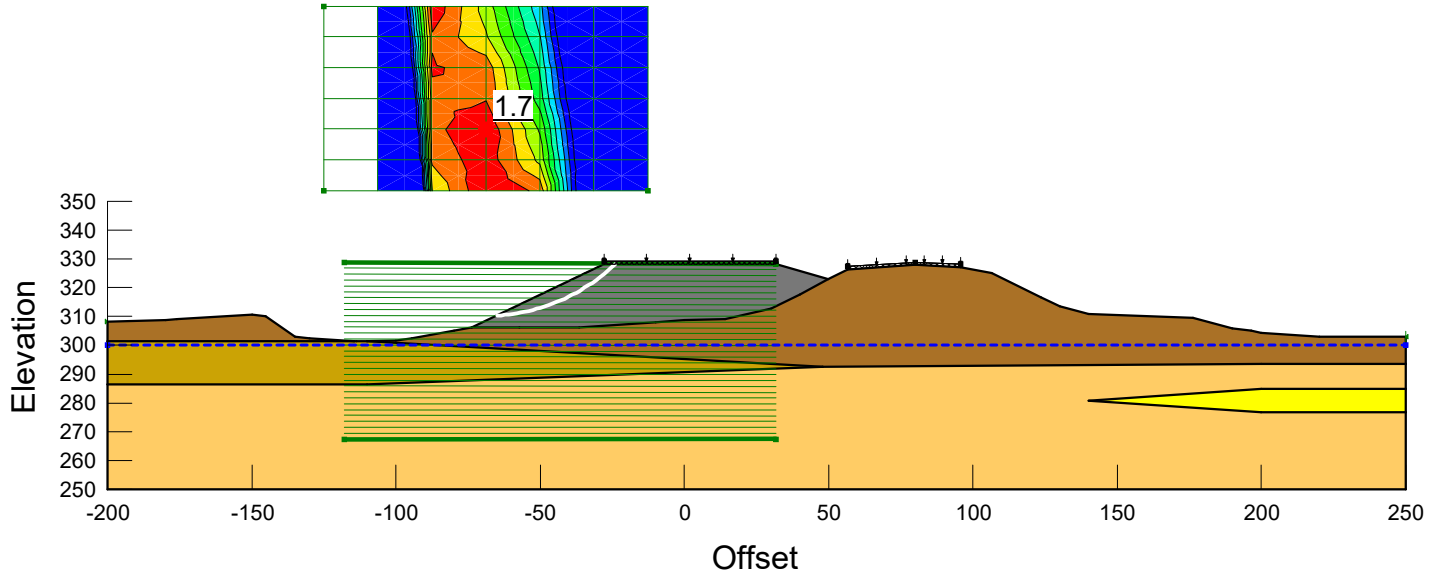



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Temporary Grade**
**Static Analysis: Long Term Temp**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-68.84444, 375.03783) ft**
**Radius: 64.797861 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I (Effective) | Mohr-Coulomb | 120 | 90 | 26 |
| | Layer II (Effective) | Mohr-Coulomb | 120 | 80 | 26 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | 0 | 28 |

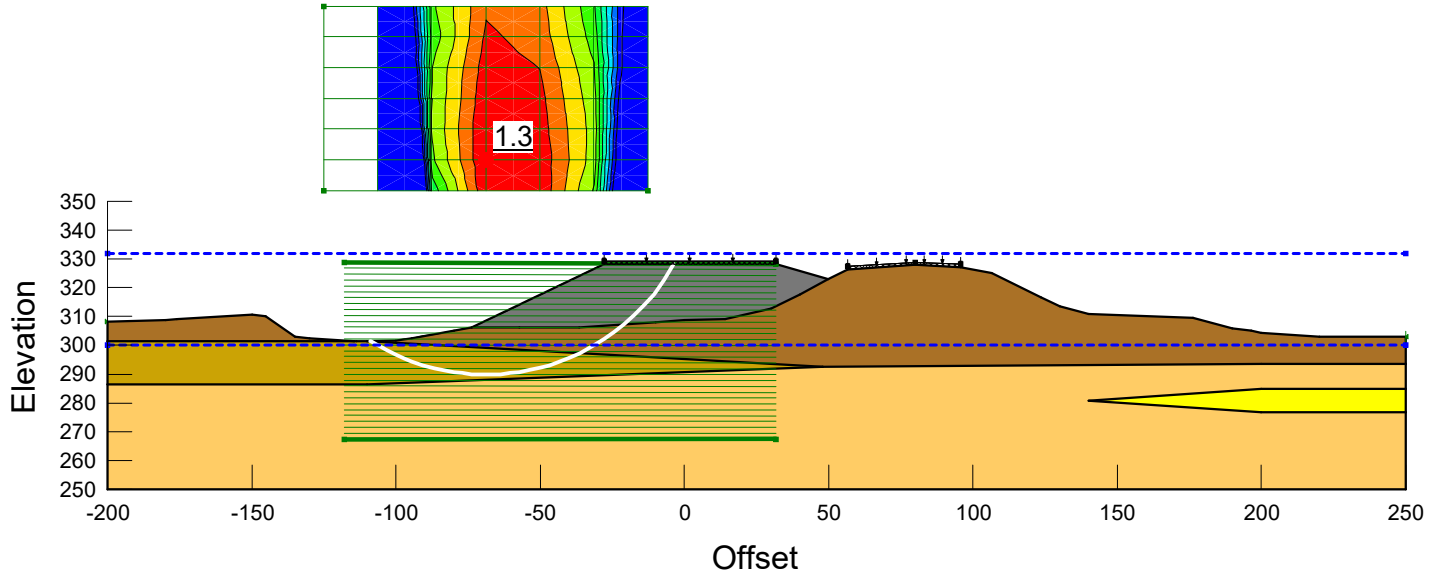



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Temporary Grade**
**Static Analysis: Rapid Drawdown Temp**
**GWT Elevation: 300 ft**
**Historic Max GWT Elevation: Coordinate: (250, 331.9) ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-68.84444, 364.34017) ft**
**Radius: 74.484522 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) | Piezometric Surface After Drawdown |
|---|---|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 | 0 | 38 | 1 |
| | Layer I (Effective) | Mohr-Coulomb | 120 | 90 | 26 | 900 | 0 | 1 |
| | Layer II (Effective) | Mohr-Coulomb | 120 | 80 | 26 | 800 | 0 | 1 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 32 | 0 | 32 | 1 |
| | Layer IV | Mohr-Coulomb | 125 | 0 | 28 | 0 | 28 | 1 |

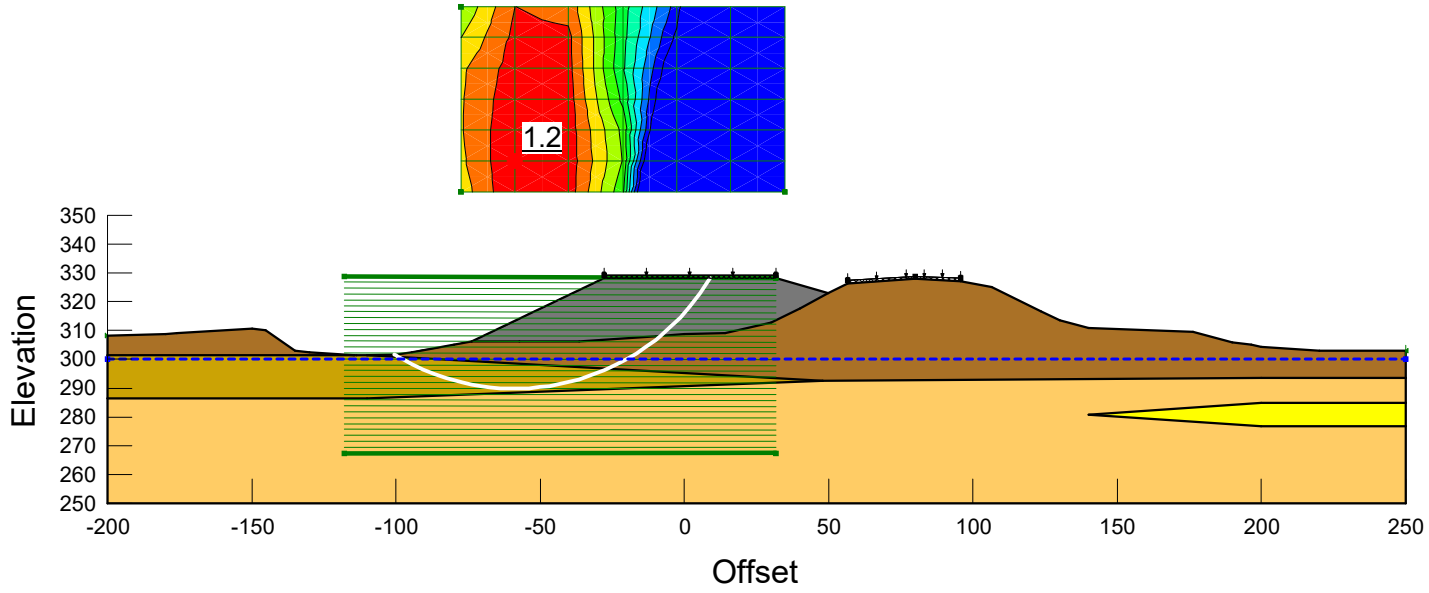



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Temporary Grade**
**Pseudo-Static Analysis: 100 YR PGA Temp**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.078**
**Surcharge Load: 250 pcf**
**Center: (-58.90994, 368.86417) ft**
**Radius: 79.023374 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |

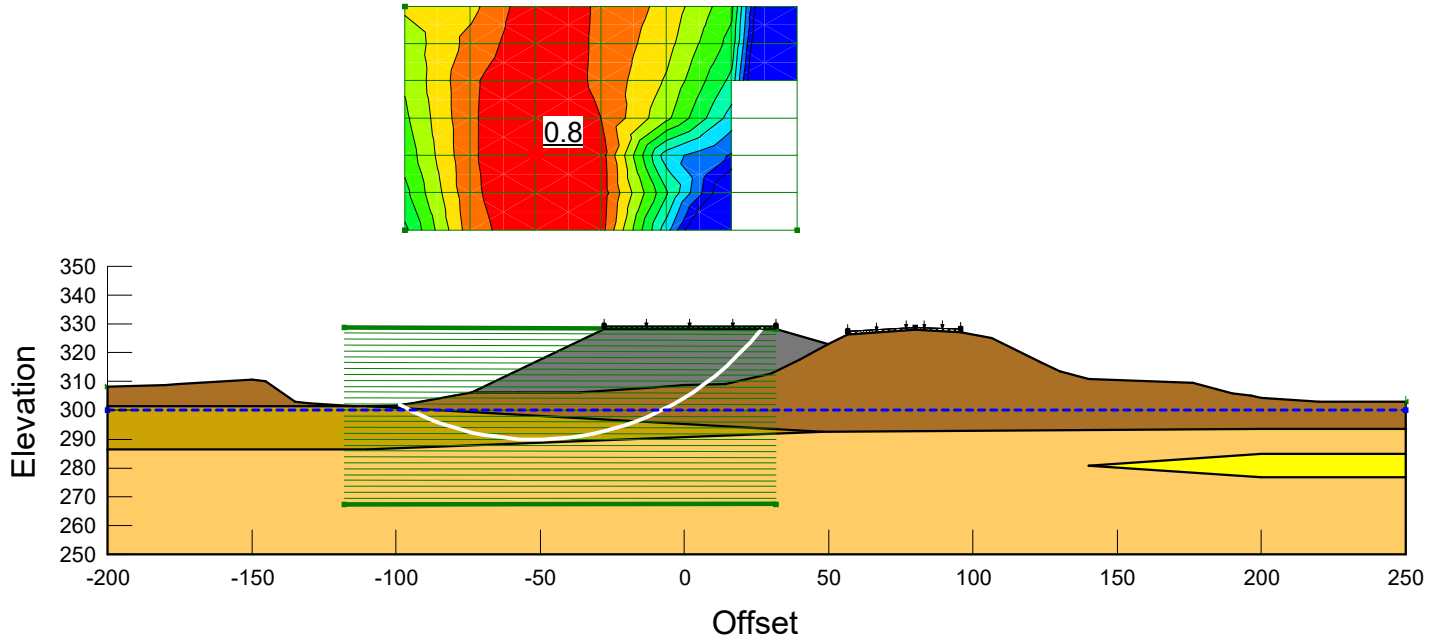



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Temporary Grade**
**Pseudo-Static Analysis: 1000 YR 1/2 PGA Temp**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.24**
**Surcharge Load: 250 pcf**
**Center: (-51.56666, 388.49102) ft**
**Radius: 98.661187 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |



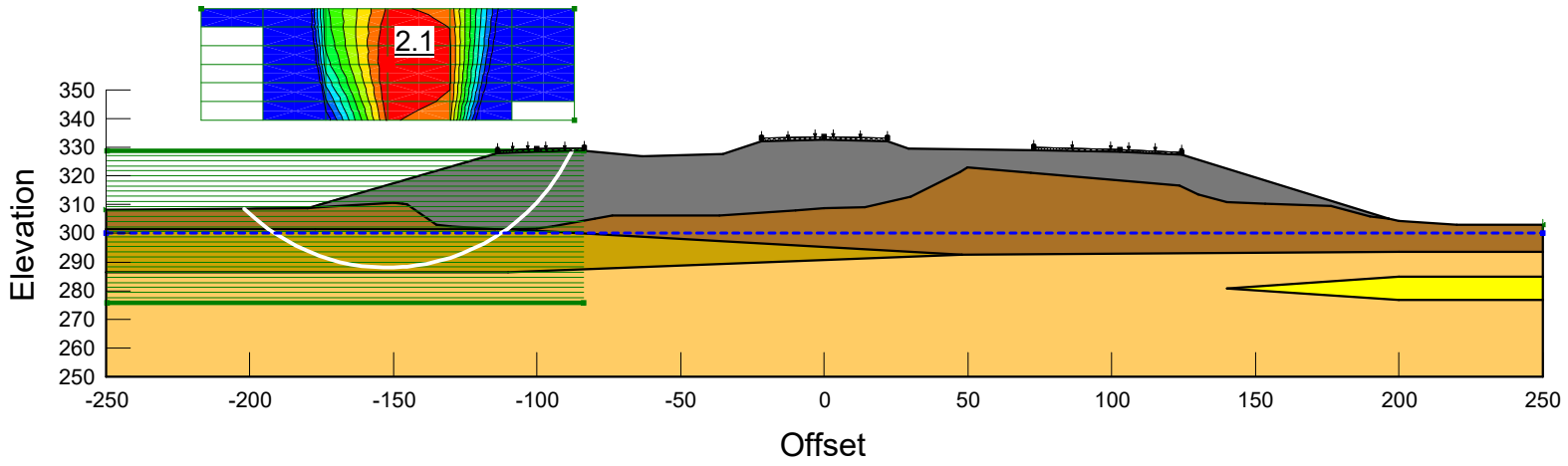

**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

# 2096+50 – Final Geometry (Left Slope)

**US-51 Cairo - STA 2096+50 Final Grade**
**Static Analysis: Short Term LT**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-151.97362, 358.961) ft**
**Radius: 70.896923 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |

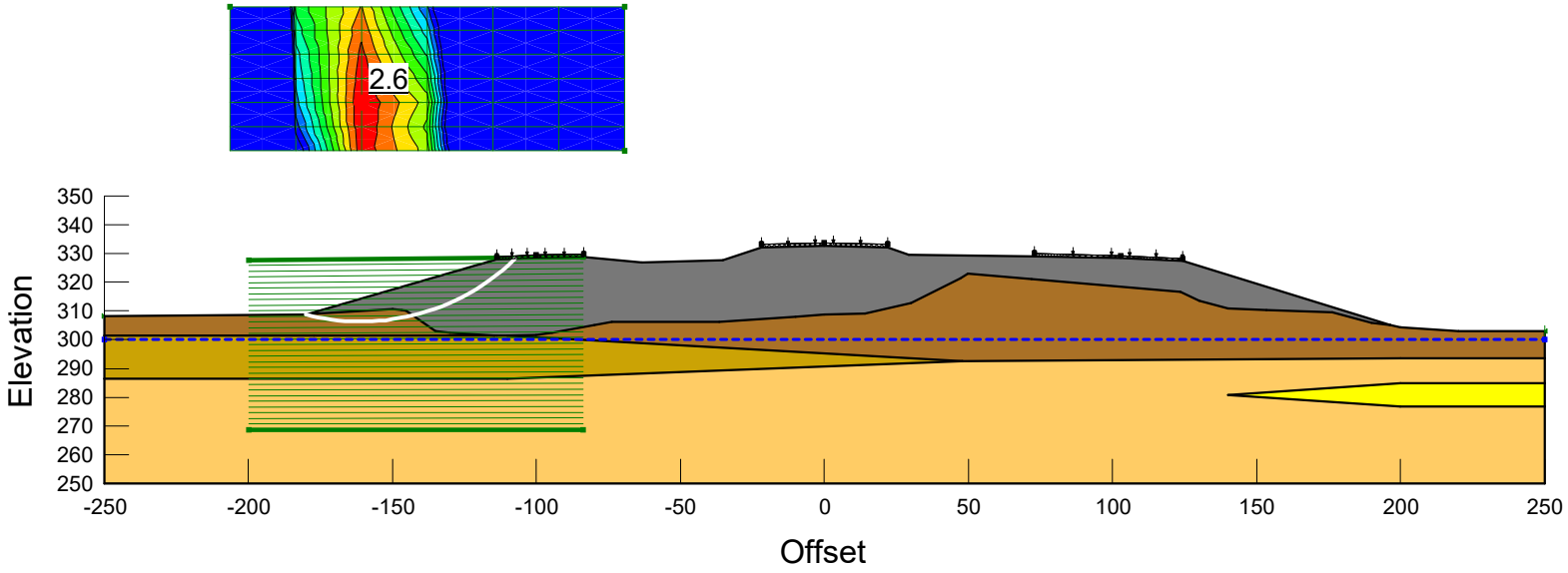



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Final Grade**
**Static Analysis: Long Term LT**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-160.8192, 382.43105) ft**
**Radius: 76.099897 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I (Effective) | Mohr-Coulomb | 120 | 90 | 26 |
| | Layer II (Effective) | Mohr-Coulomb | 120 | 80 | 26 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | 0 | 28 |

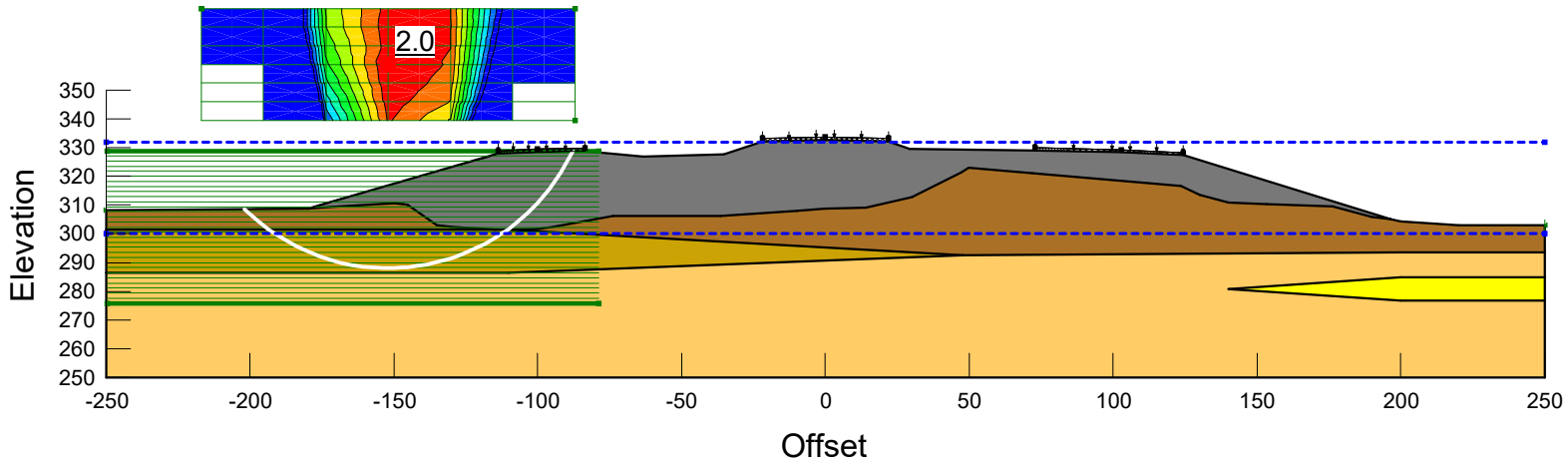



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Final Grade**
**Static Analysis: Rapid Drawdown LT**
**GWT Elevation: 300 ft**
**Historic Max GWT Elevation: 331.9 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-151.97362, 358.961) ft**
**Radius: 70.896923 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) | Piezometric Surface After Drawdown |
|---|---|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 | 0 | 38 | 1 |
| | Layer I (Effective) | Mohr-Coulomb | 120 | 90 | 26 | 900 | 0 | 1 |
| | Layer II (Effective) | Mohr-Coulomb | 120 | 80 | 26 | 800 | 0 | 1 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 32 | 0 | 32 | 1 |
| | Layer IV | Mohr-Coulomb | 125 | 0 | 28 | 0 | 28 | 1 |

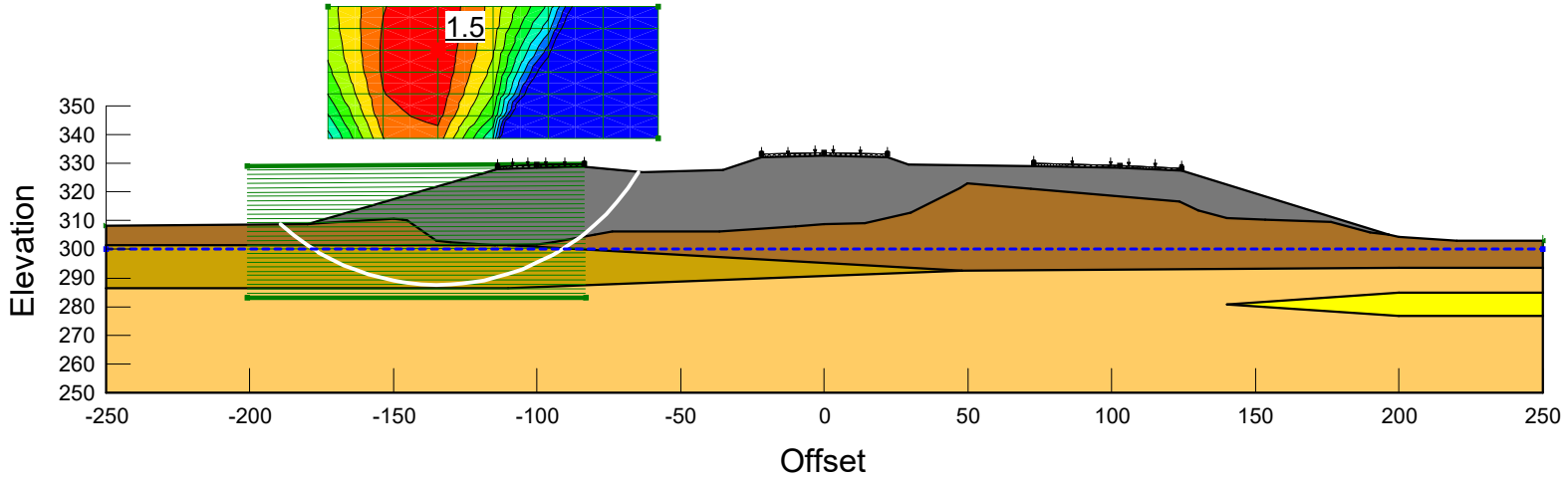



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Final Grade**
**Pseudo-Static Analysis: 100 YR PGA LT**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.078**
**Surcharge Load: 250 pcf**
**Center: (-134.53309, 369.39767) ft**
**Radius: 81.757072 ft**

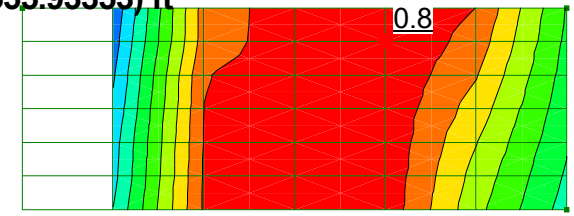
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |



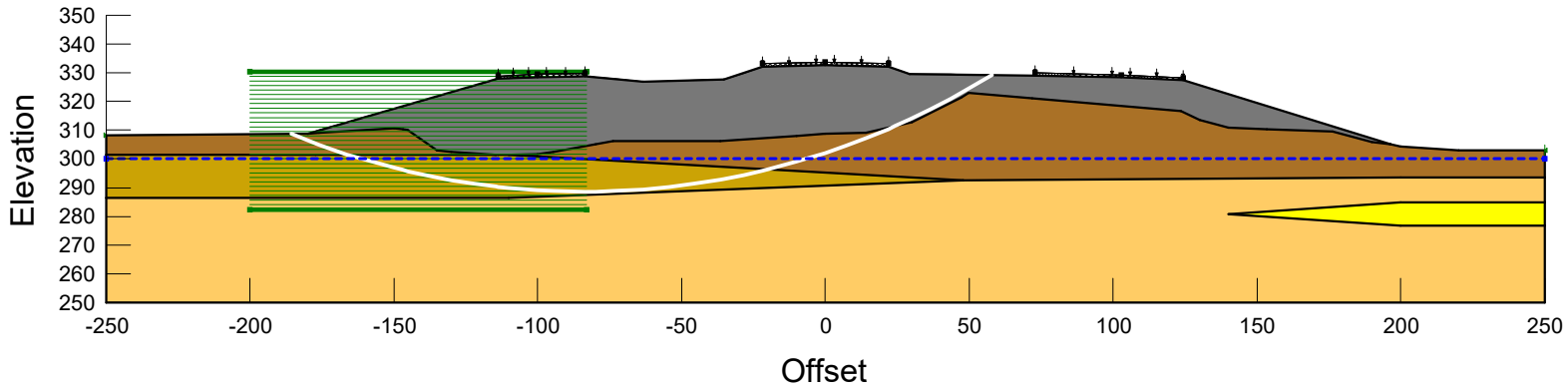

**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Final Grade**
**Pseudo-Static Analysis: 1000 YR 1/2 PGA LT**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.24**
**Surcharge Load: 250 pcf**
**Center: (-83.885447, 555.93353) ft**
**Radius: 267.34364 ft**




| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |



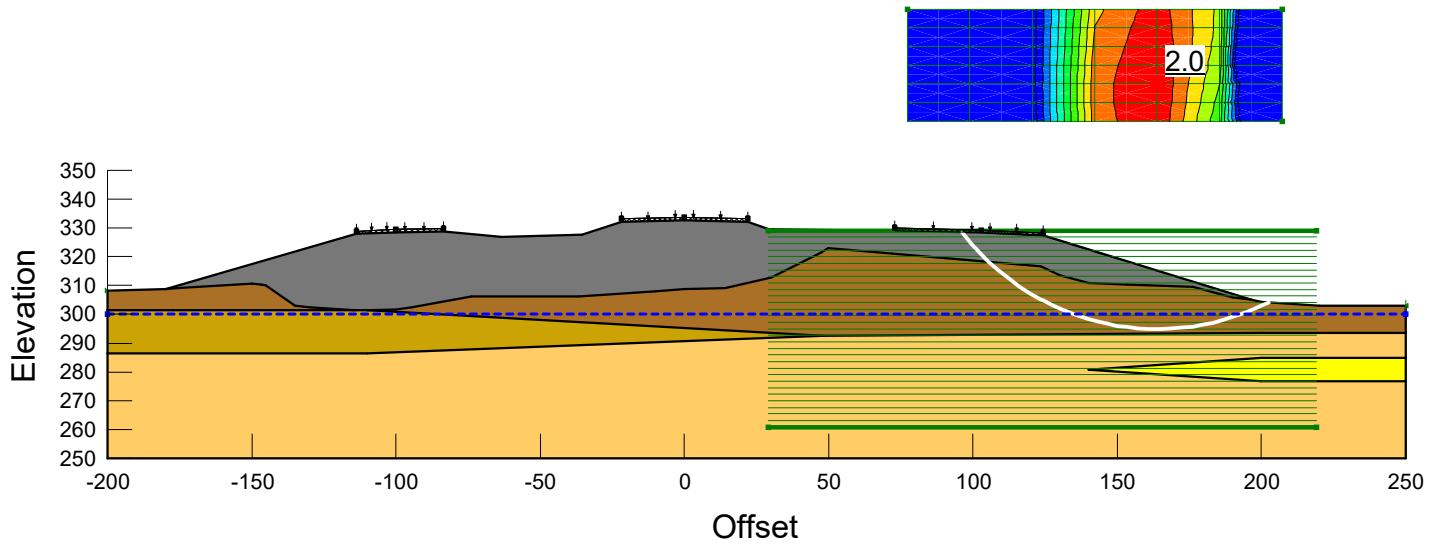

**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

# 2096+50 – Final Geometry (Right Slope)

**US-51 Cairo - STA 2096+50 Final Grade**
**Static Analysis: Short Term RT**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (163.94301, 380) ft**
**Radius: 85.111155 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |

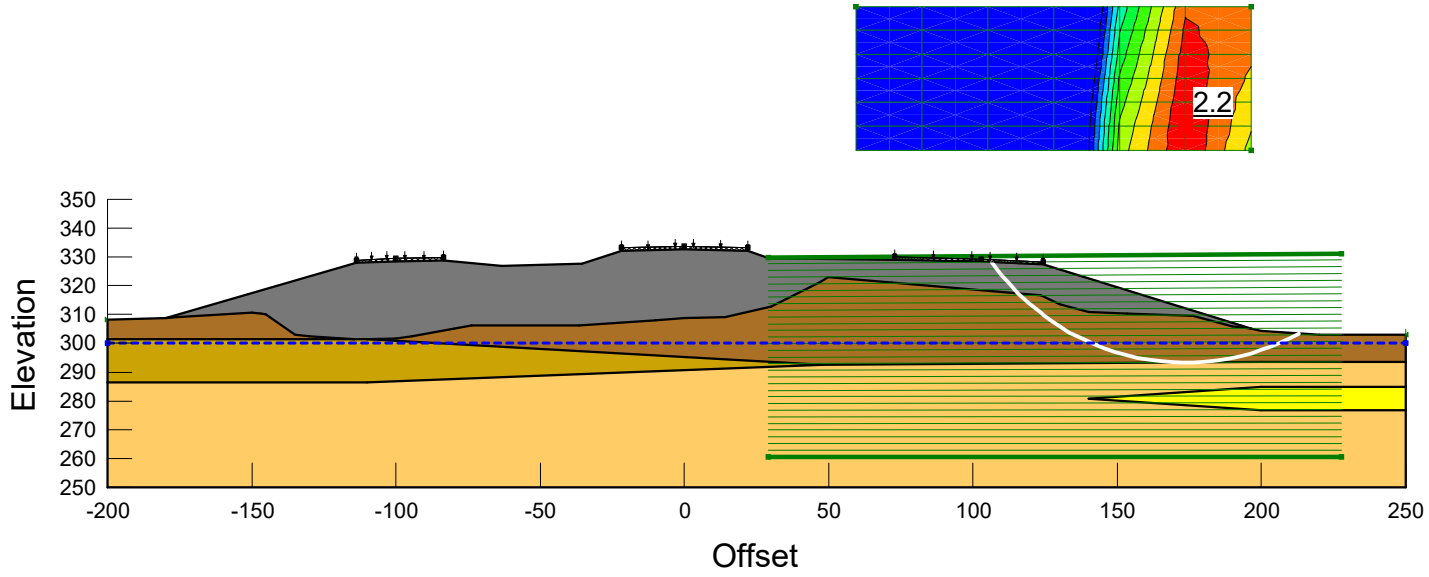



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Final Grade**
**Static Analysis: Long Term RT**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (173.6808, 375.33333) ft**
**Radius: 82.026541 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I (Effective) | Mohr-Coulomb | 120 | 90 | 26 |
| | Layer II (Effective) | Mohr-Coulomb | 120 | 80 | 26 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | 0 | 28 |

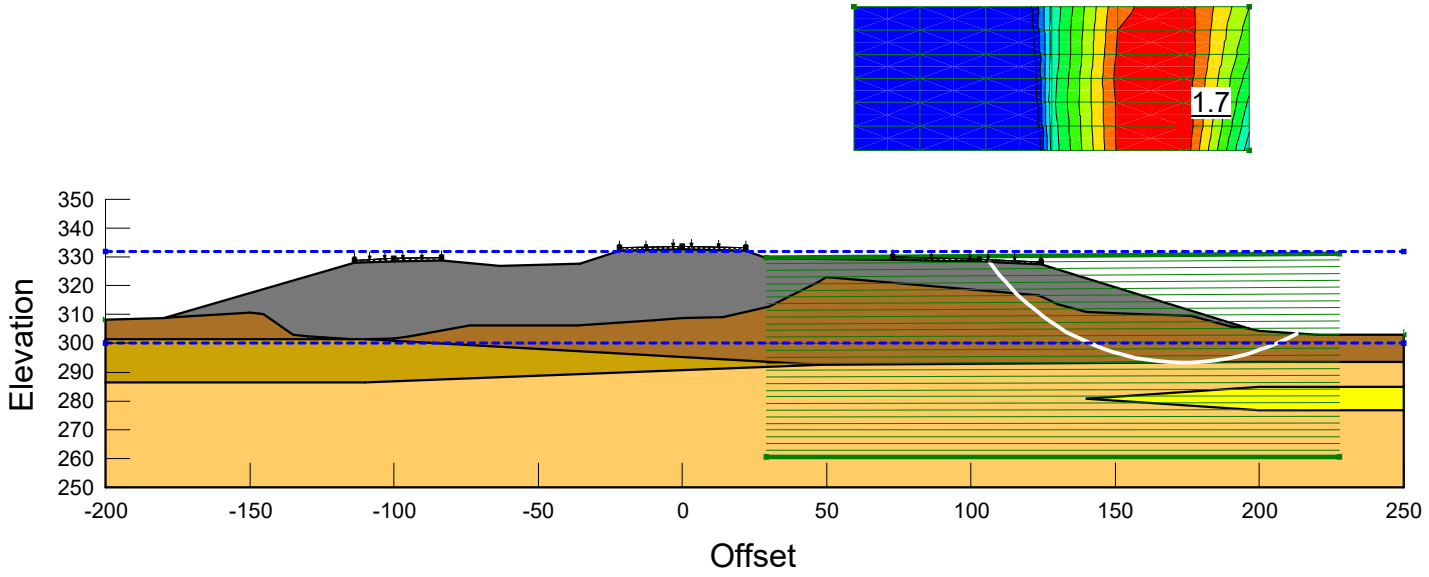



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Final Grade**
**Static Analysis: Rapid Drawdown RT**
**GWT Elevation: 300 ft**
**Historic Max GWT Elevation: Coordinate: (250, 331.9) ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (173.6808, 375.33333) ft**
**Radius: 82.026541 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) | Piezometric Surface After Drawdown |
|---|---|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 | 0 | 38 | 1 |
| | Layer I (Effective) | Mohr-Coulomb | 120 | 90 | 26 | 900 | 0 | 1 |
| | Layer II (Effective) | Mohr-Coulomb | 120 | 80 | 26 | 800 | 0 | 1 |
| | Layer III | Mohr-Coulomb | 130 | 0 | 32 | 0 | 32 | 1 |
| | Layer IV | Mohr-Coulomb | 125 | 0 | 28 | 0 | 28 | 1 |

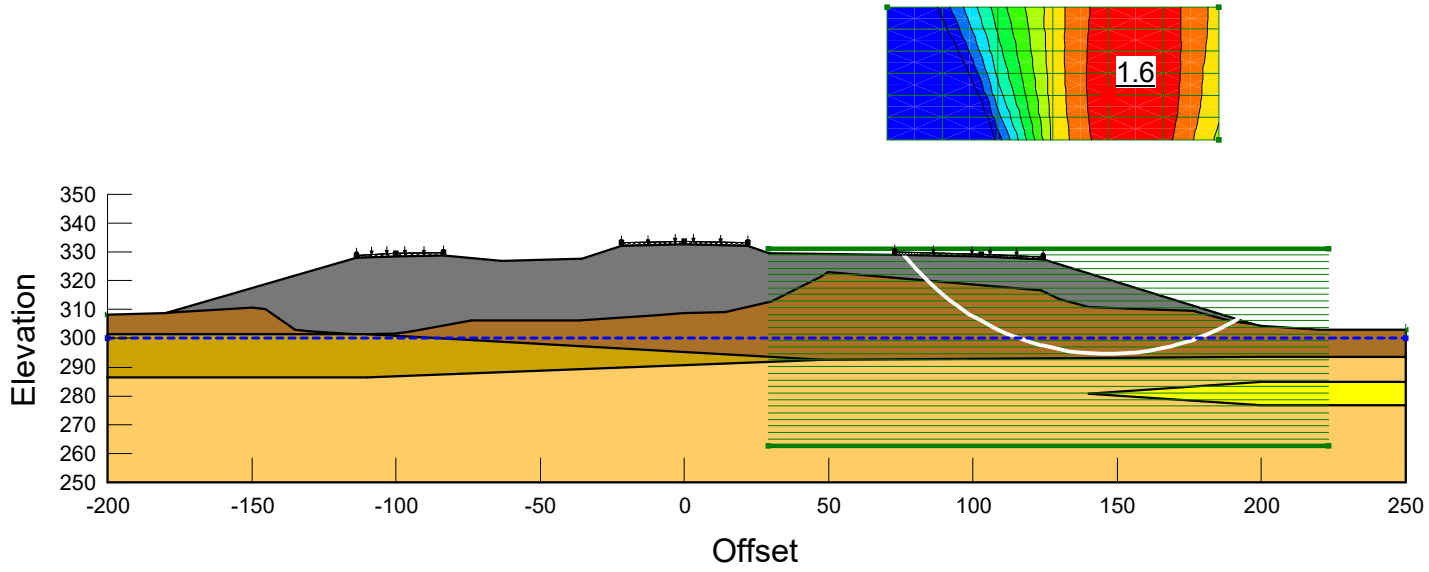



**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Final Grade**
**Pseudo-Static Analysis: 100 YR PGA RT**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.078**
**Surcharge Load: 250 pcf**
**Center: (146.80033, 384.33333) ft**
**Radius: 89.817579 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |

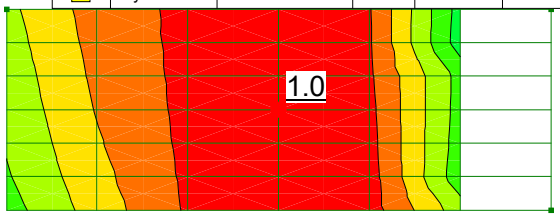


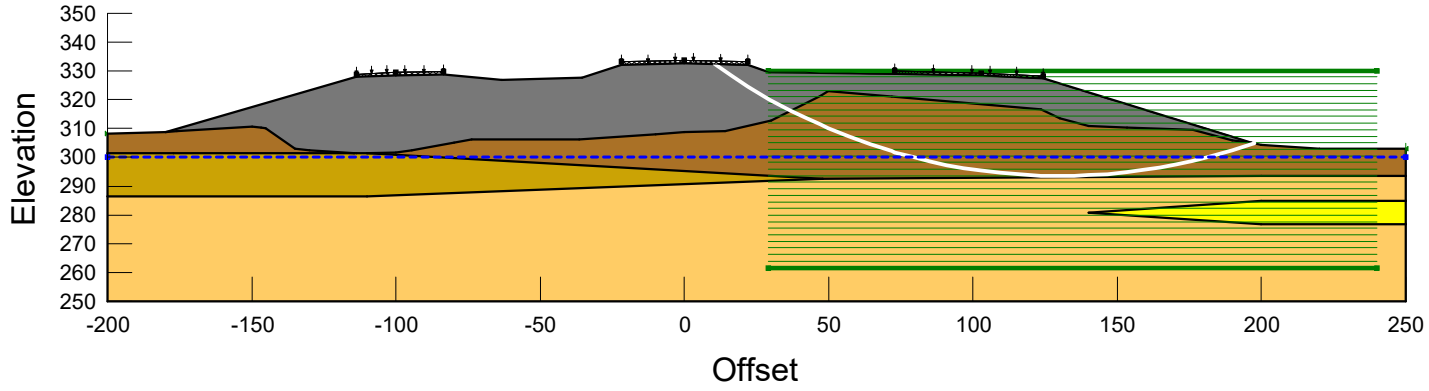

**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

**US-51 Cairo - STA 2096+50 Final Grade**
**Pseudo-Static Analysis: 1000 YR 1/2 PGA RT**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.24**
**Surcharge Load: 250 pcf**
**Center: (130.4252, 498.55991) ft**
**Radius: 205.00964 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I (Total) | Undrained (Phi=0) | 120 | 900 | | |
| | Layer II (Total) | Undrained (Phi=0) | 120 | 800 | | |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer IV | Mohr-Coulomb | 125 | | 0 | 28 |




**US-51 Bridge Replacement Project**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: 117, 118, and 119**

**Created By: ER Date: 06/01/2026**
**Checked by: BE Date: 06/01/2026**

# STA 2096+50 Newmark Displacement

# Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** STA 2096+50

| | |
|---|---|
| **Embankment Height (ft):** | 24 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.21 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.94 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.44 |
| **log(d)[5]:** | 0.92 |
| **Displacement, d (in):** | 8.3 |

[1] $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}$ $where, 0.5 \leq \beta \leq 1.5$

[2] $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$

[3] $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$

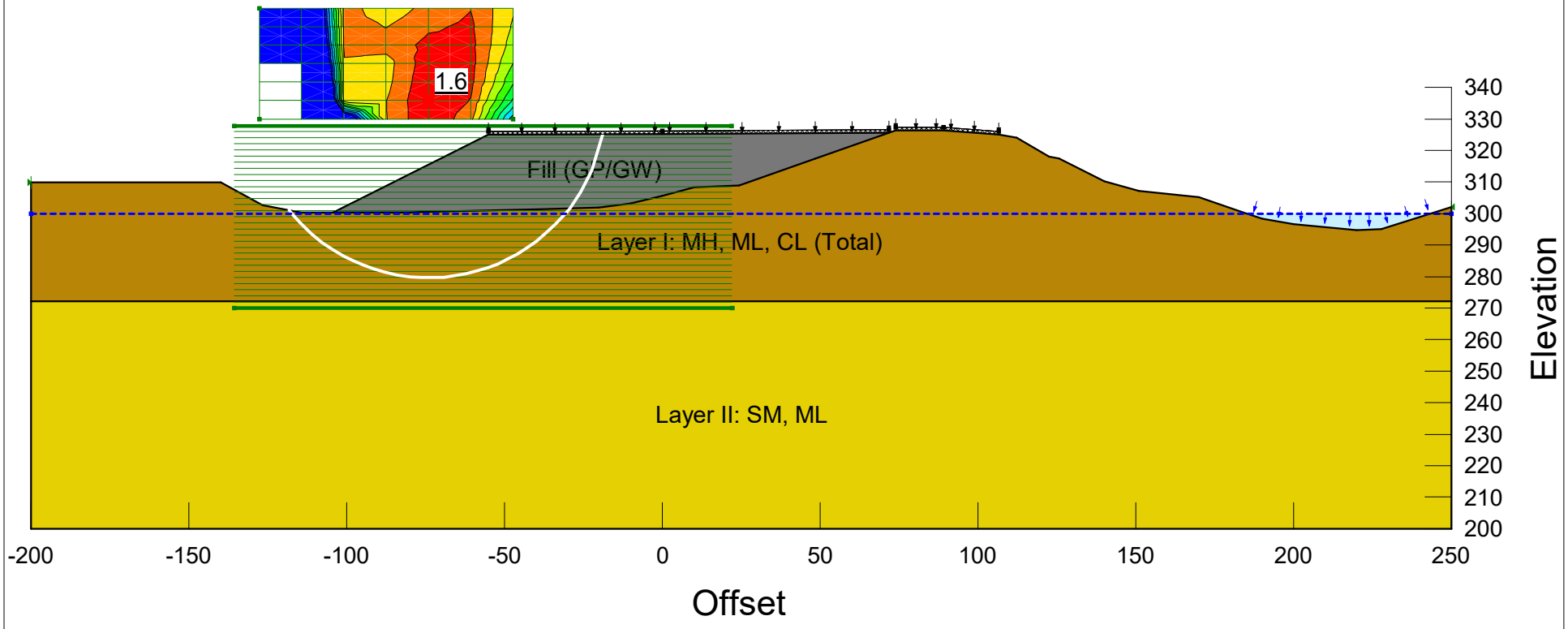
[4] $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$

[5] $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$

# 2107+50 – Temporary Geometry

**US-51 Cairo - STA 2107+50 Temporary Grade**
**Static Analysis: Short Term**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-74.06936, 335.81652) ft**
**Radius: 56.199358 ft**

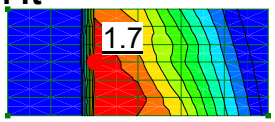
| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I: MH, ML, CL (Total) | Undrained (Phi=0) | 115 | 900 | | |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | | 0 | 32 |



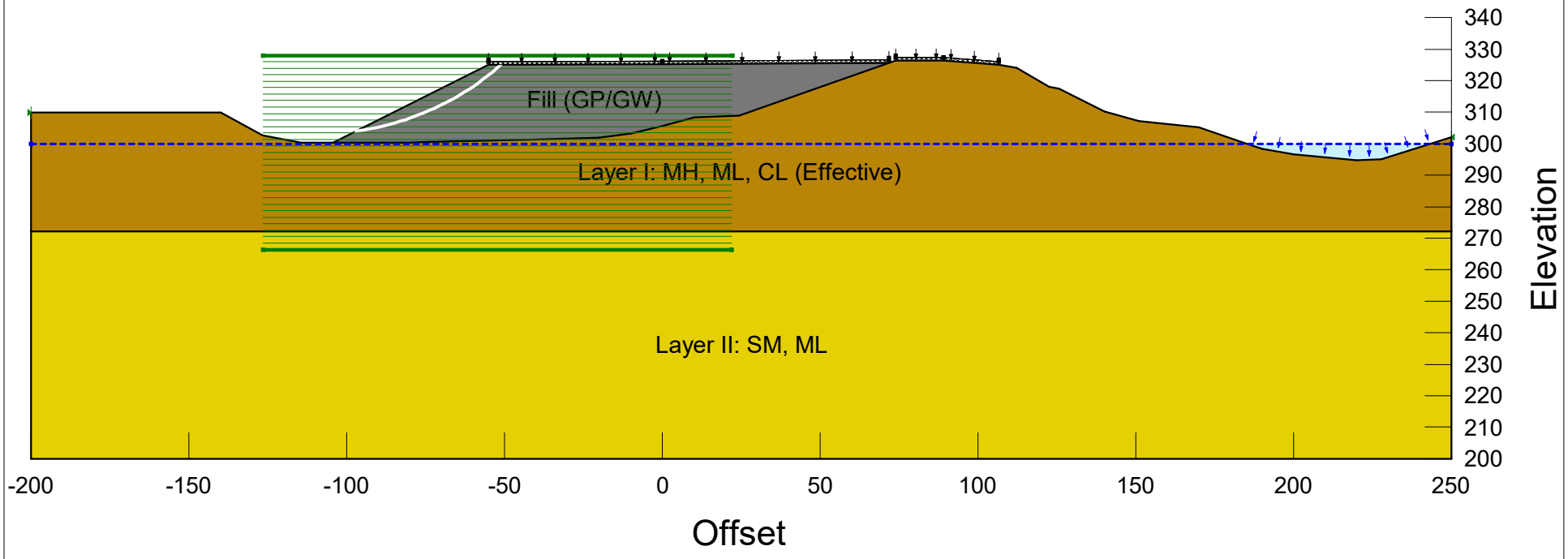

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2107+50 Temporary Grade**
**Static Analysis: Long Term**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-108.44227, 389.58176) ft**
**Radius: 86.305554 ft**




| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I: MH, ML, CL (Effective) | Mohr-Coulomb | 115 | 90 | 28 |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | 0 | 32 |

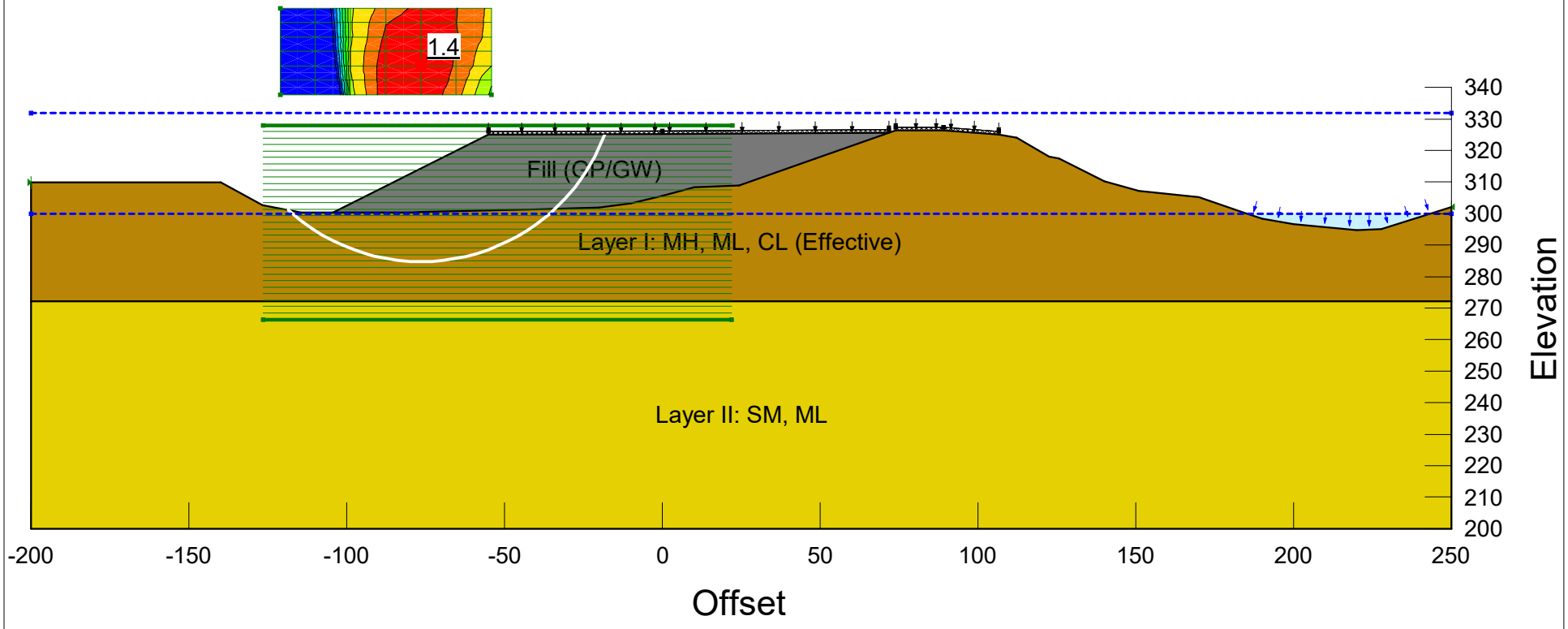



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2107+50 Temporary Grade**
**Static Analysis: Rapid Drawdown (Temp)**
**GWT Elevation: 300 ft**
**Historic Max GWT Elevation: 331.9 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-76.47432, 346.92759) ft**
**Radius: 62.149795 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) |
|---|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 | 0 | 38 |
| | Layer I: MH, ML, CL (Effective) | Mohr-Coulomb | 115 | 90 | 28 | 900 | 0 |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | 0 | 32 | 0 | 32 |

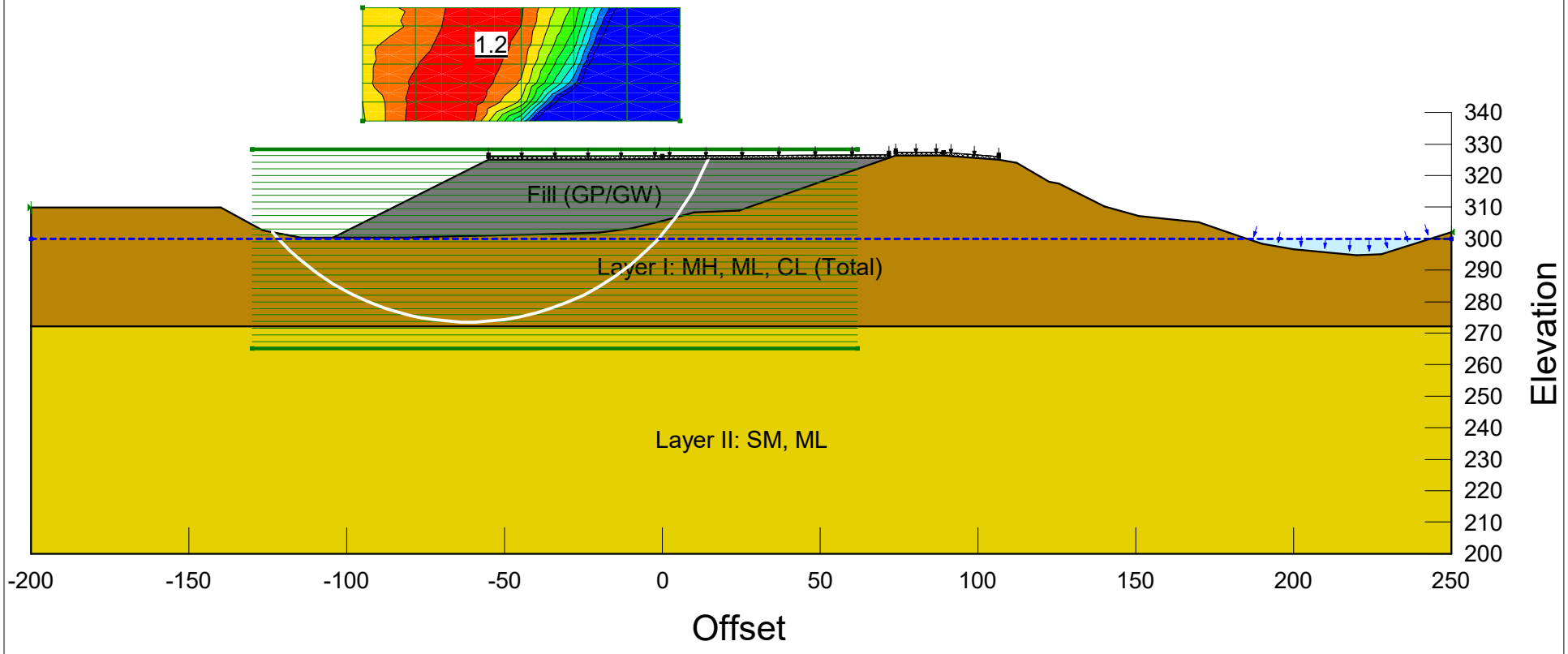



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2107+50 Temporary Grade**
**Pseudo-Static Analysis: 100 YR PGA**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.078**
**Surcharge Load: 250 pcf**
**Center: (-61.503983, 355.34121) ft**
**Radius: 81.788257 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I: MH, ML, CL (Total) | Undrained (Phi=0) | 115 | 900 | | |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | | 0 | 32 |

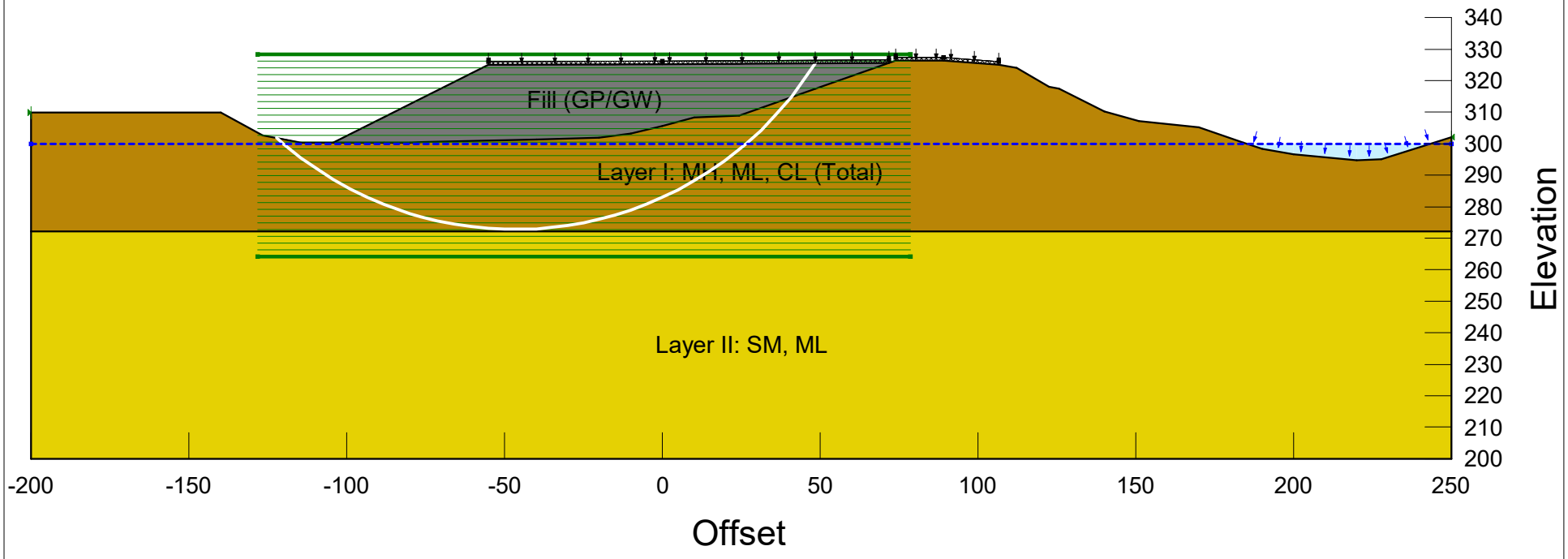



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2107+50 Temporary Grade**
**Pseudo-Static Analysis: 1000 YR 1/2 PGA**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.24**
**Surcharge Load: 250 pcf**
**Center: (-46.79501, 385.18915) ft**
**Radius: 112.38605 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I: MH, ML, CL (Total) | Undrained (Phi=0) | 115 | 900 | | |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | | 0 | 32 |



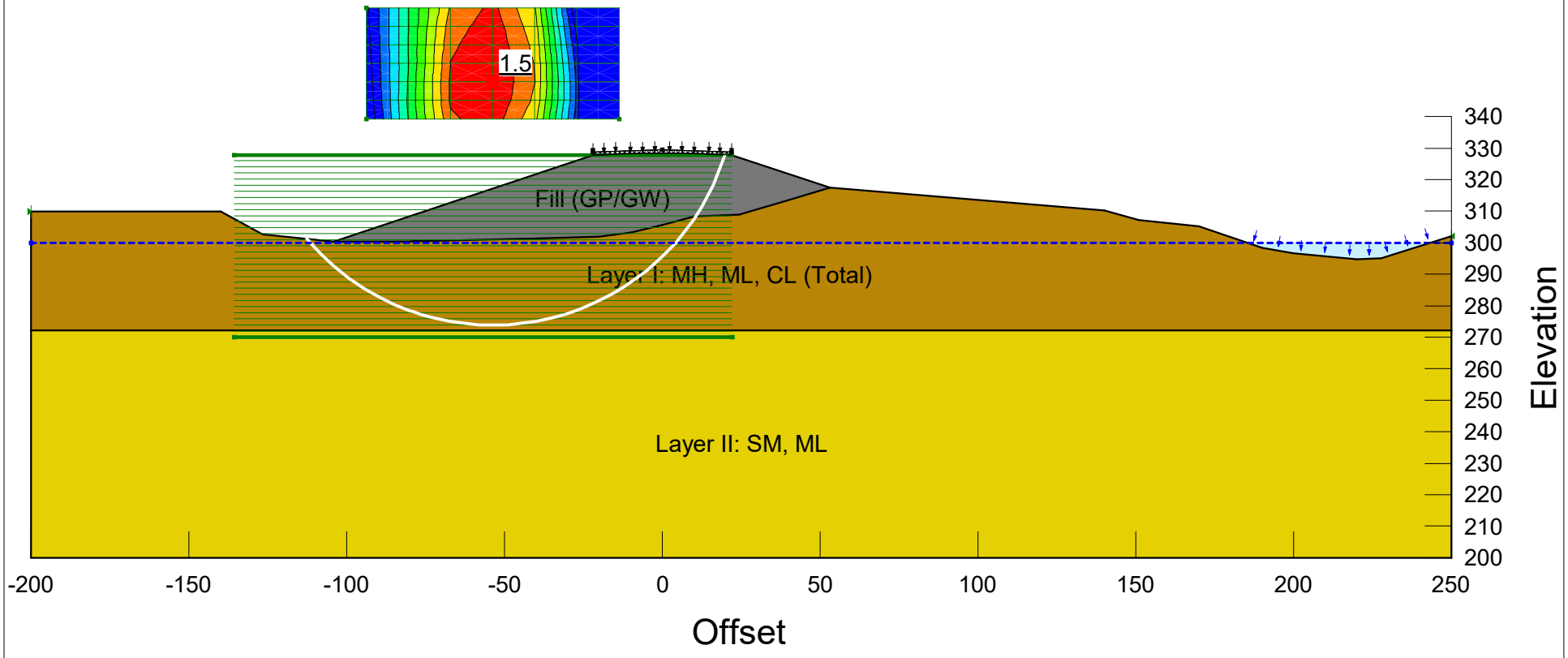

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

# 2107+50 – Final Geometry

**US-51 Cairo - STA 2107+50 Final Grade**
**Static Analysis: Short Term**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-53.714535, 350.94357) ft**
**Radius: 77.110487 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I: MH, ML, CL (Total) | Undrained (Phi=0) | 115 | 900 | | |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | | 0 | 32 |

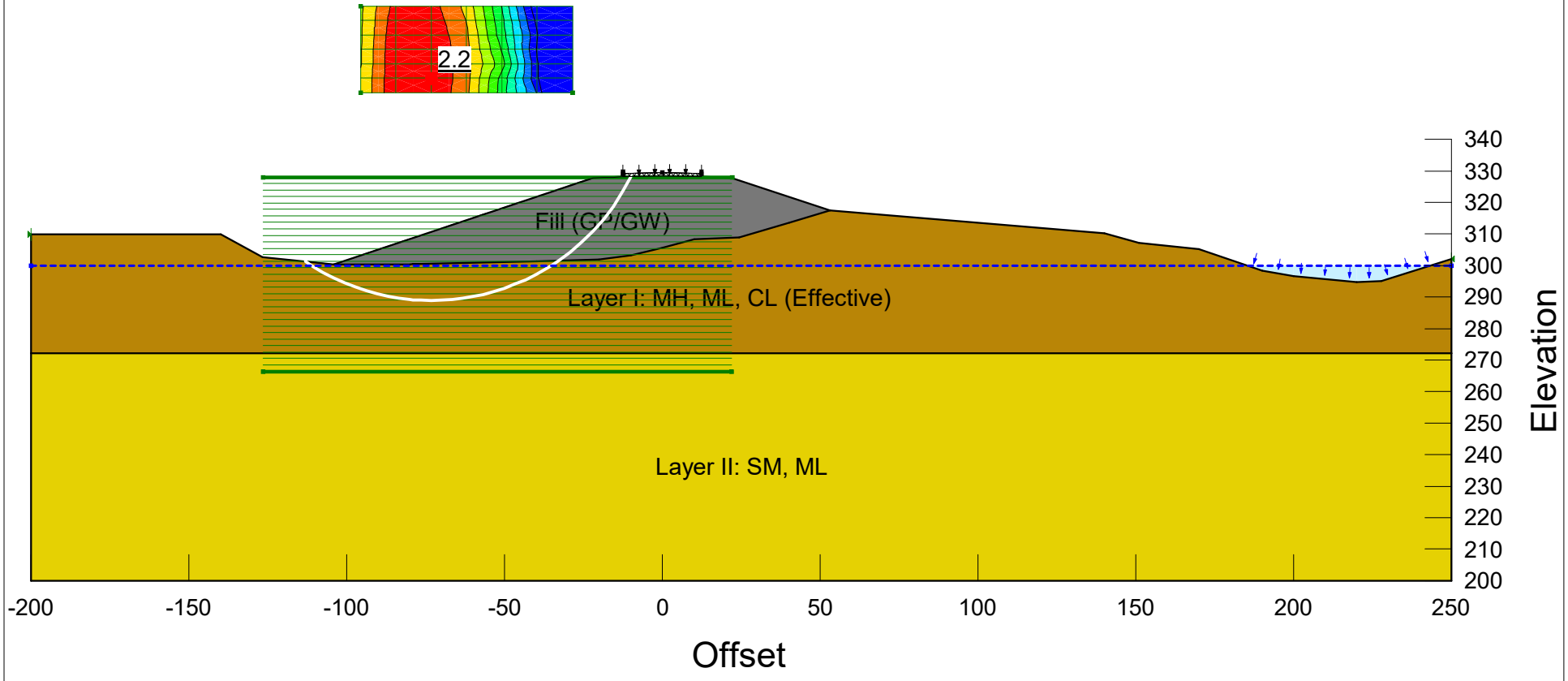



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2107+50 Final Grade**
**Static Analysis: Long Term**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-73.17927, 359.36004) ft**
**Radius: 70.471481 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I: MH, ML, CL (Effective) | Mohr-Coulomb | 115 | 90 | 28 |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | 0 | 32 |

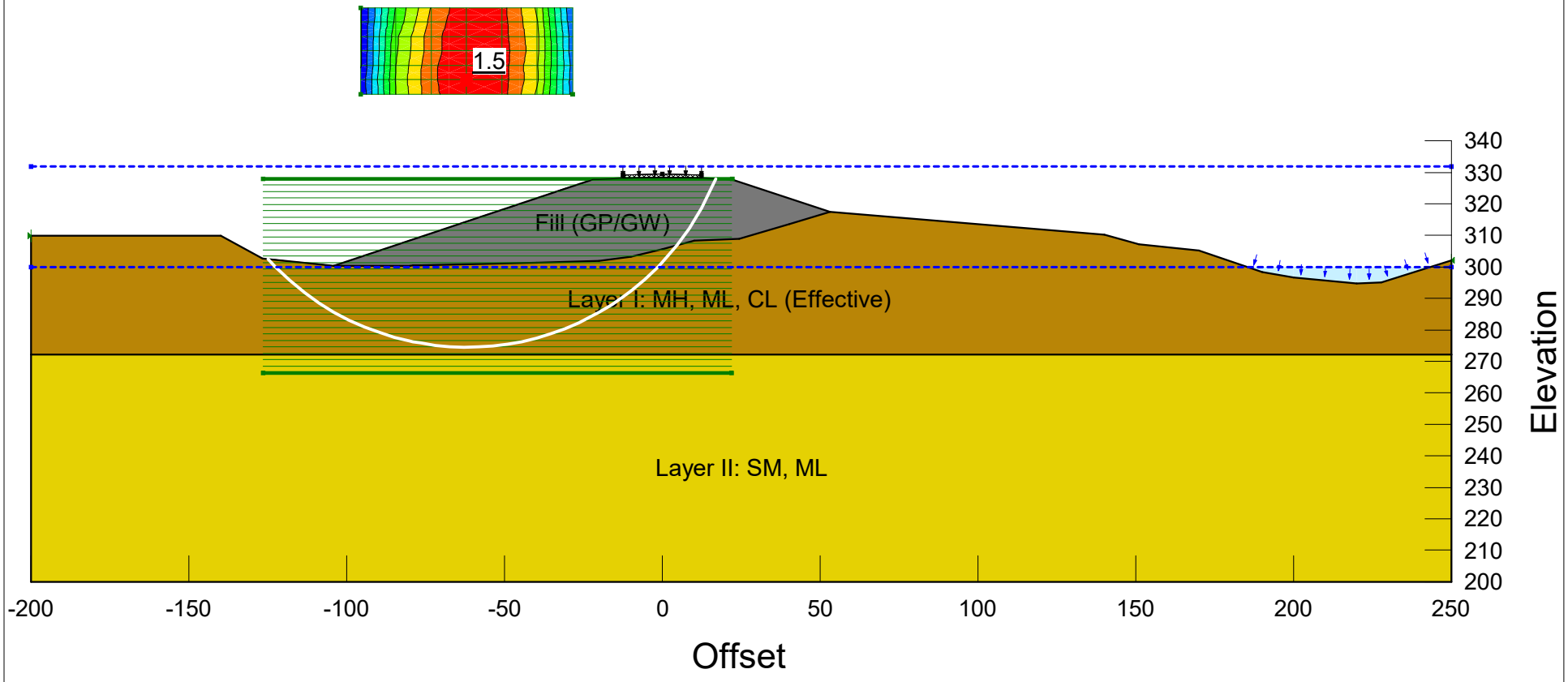



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2107+50 Final Grade**
**Static Analysis: Rapid Drawdown**
**GWT Elevation: 300 ft**
**Historic Max GWT Elevation: 331.9 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center: (-62.014195, 359.36004) ft**
**Radius: 84.859132 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) |
|---|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 | 0 | 38 |
| | Layer I: MH, ML, CL (Effective) | Mohr-Coulomb | 115 | 90 | 28 | 900 | 0 |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | 0 | 32 | 0 | 32 |

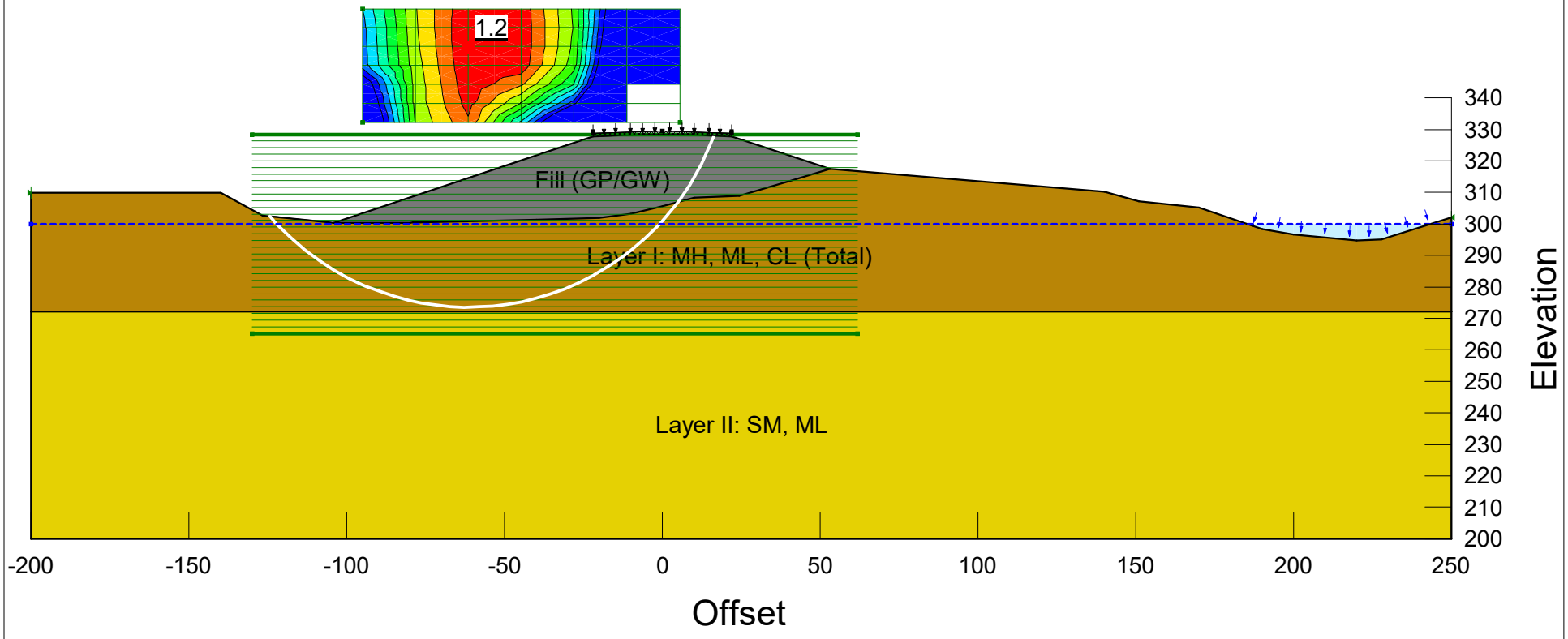



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2107+50 Final Grade**
**Pseudo-Static Analysis: 100 YR PGA**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.078**
**Surcharge Load: 250 pcf**
**Center: (-61.503983, 356.28005) ft**
**Radius: 82.727099 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I: MH, ML, CL (Total) | Undrained (Phi=0) | 115 | 900 | | |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | | 0 | 32 |

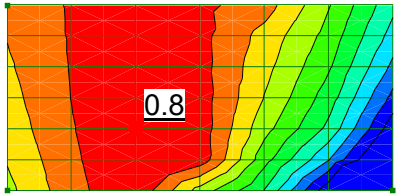


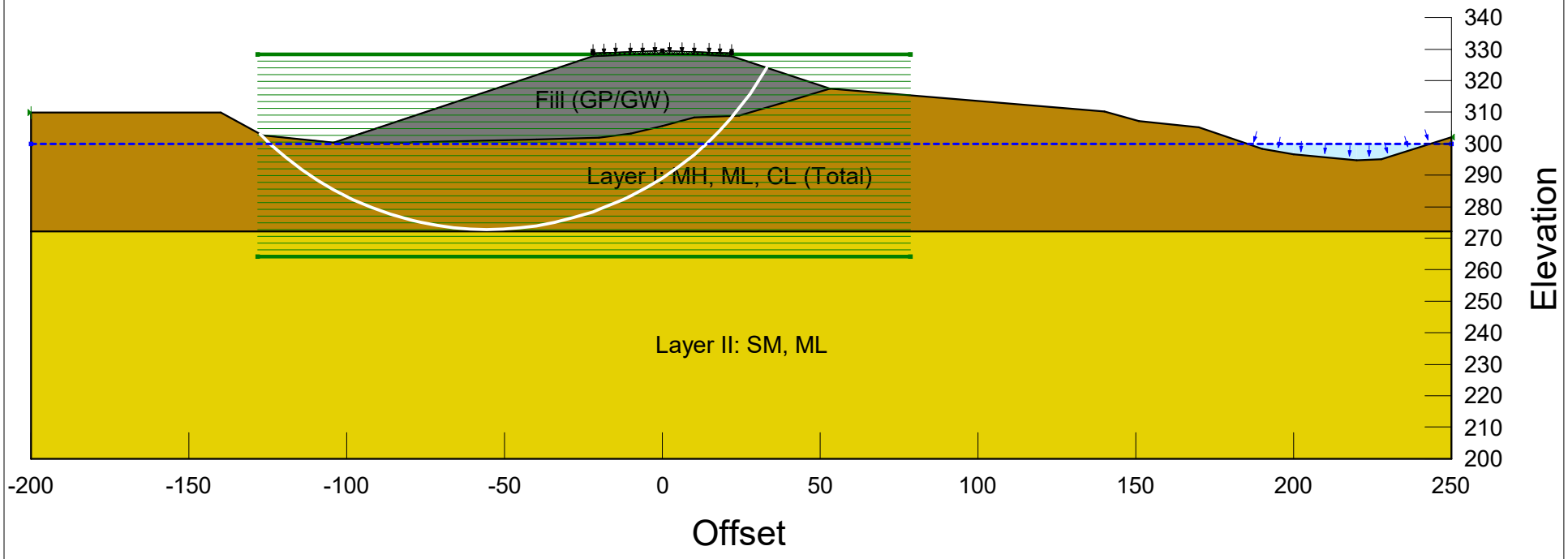

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2107+50 Final Grade**
**Pseudo-Static Analysis: 1000 YR 1/2 PGA**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.24**
**Surcharge Load: 250 pcf**
**Center: (-55.185583, 374.25843) ft**
**Radius: 101.45533 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Layer I: MH, ML, CL (Total) | Undrained (Phi=0) | 115 | 900 | | |
| | Layer II: SM, ML | Mohr-Coulomb | 120 | | 0 | 32 |



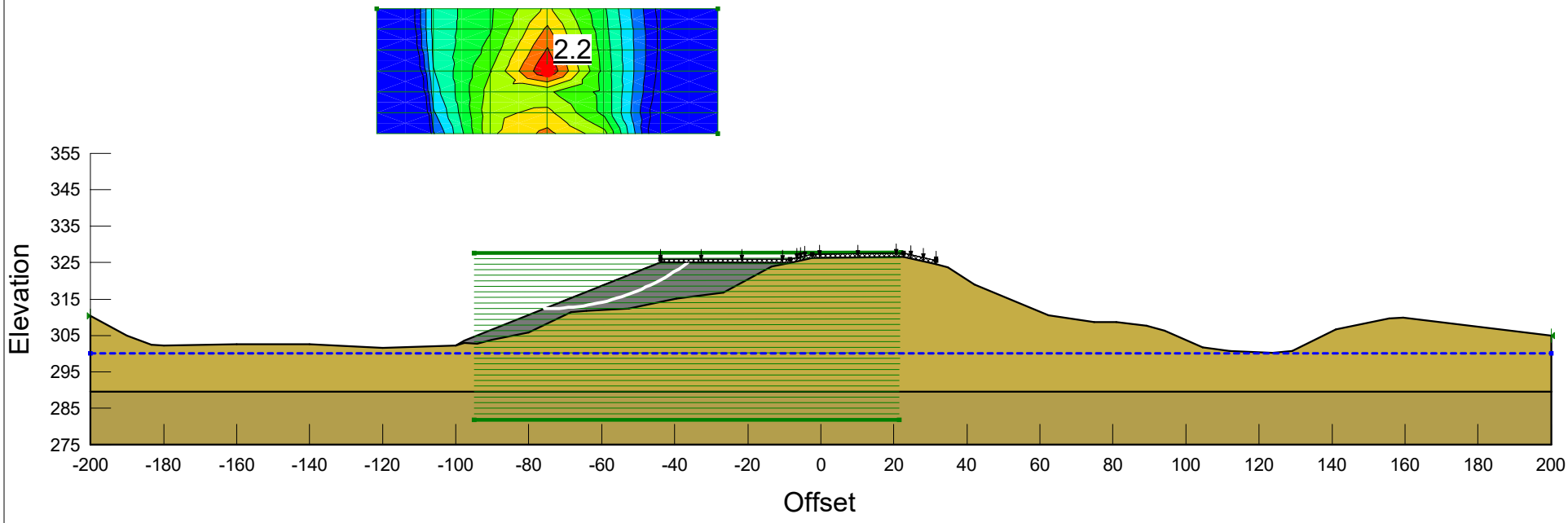

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

# 2118+50 – Temporary Geometry

**US-51 Cairo - STA 2118+50 Temporary Grade**
**Static Analysis: Short Term (Temp)**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center:(-74.91212, 377.54658) ft**
**Radius: 65.163085 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Soil Layer I: CL, SM (Total) | Undrained (Phi=0) | 120 | 1,200 | | |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | | 0 | 32 |

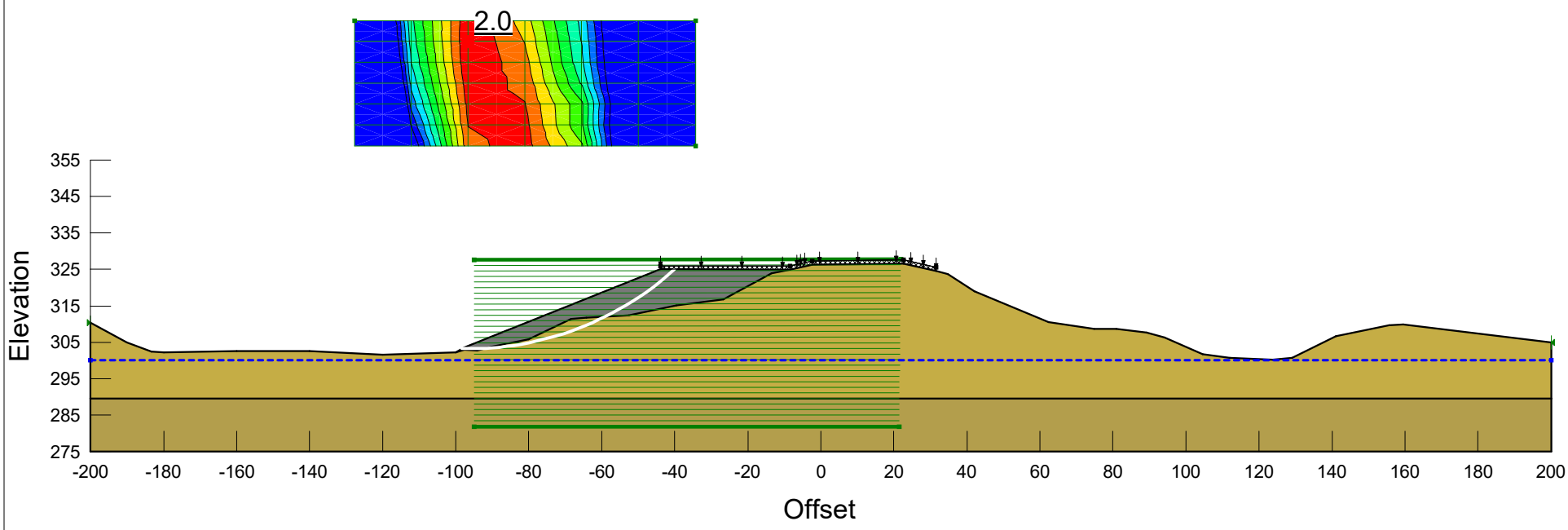



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2118+50 Temporary Grade**
**Static Analysis: Long Term (Temp)**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center:(-96.62551, 387.47309) ft**
**Radius: 84.275553 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 |
| | Soil Layer I: CL, SM (Effective) | Mohr-Coulomb | 120 | 120 | 28 |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | 0 | 32 |

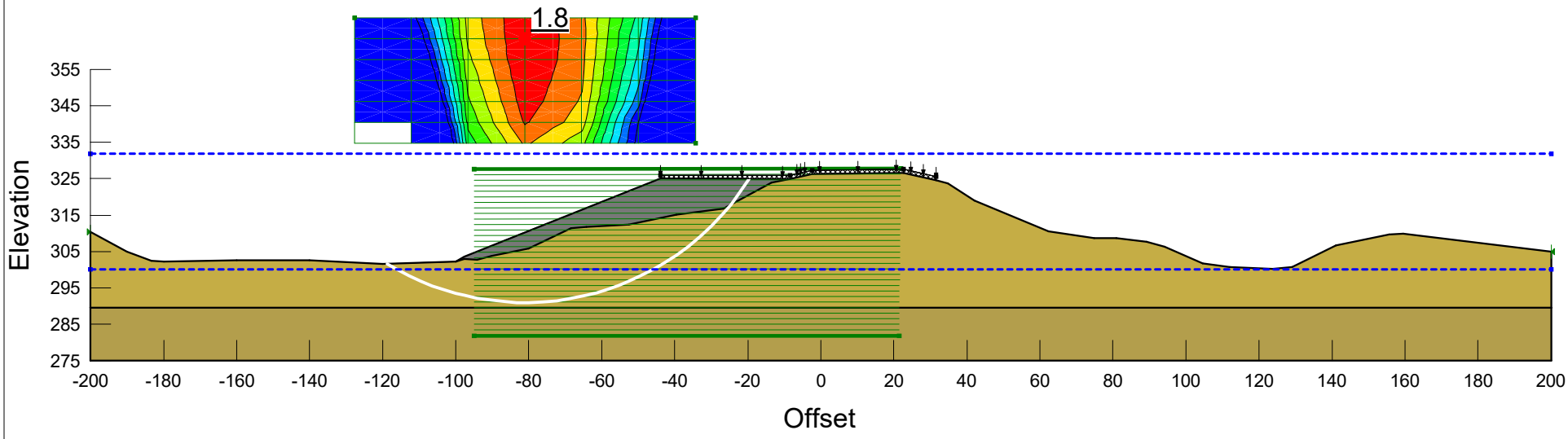



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2118+50 Temporary Grade**
**Static Analysis: Rapid Drawdown (Temp)**
**GWT Elevation: 300 ft**
**Historic Max GWT Elevation: 331.9 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center:(-81.03496, 363.43528) ft**
**Radius: 72.469479 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) |
|---|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 | 0 | 38 |
| | Soil Layer I: CL, SM (Effective) | Mohr-Coulomb | 120 | 120 | 28 | 1,200 | 0 |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | 0 | 32 | 0 | 32 |

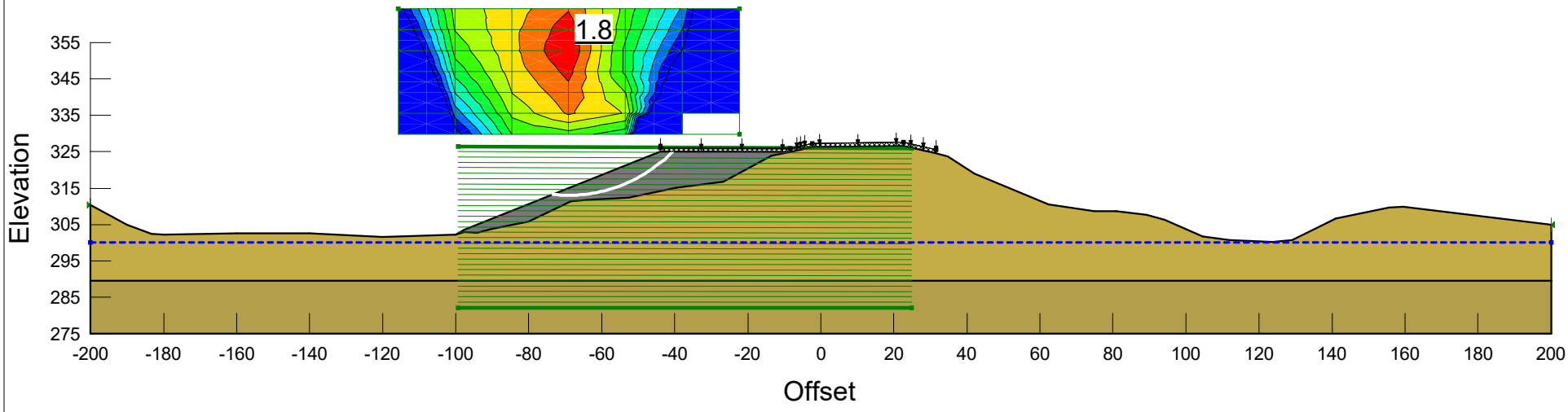



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2118+50 Temporary Grade**
**Pseudo-Static Analysis: 100 YR PGA (Temp)**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.078**
**Surcharge Load: 250 pcf**
**Center:(-69.01291, 352.75626) ft**
**Radius: 39.70315 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Soil Layer I: CL, SM (Total) | Undrained (Phi=0) | 120 | 1,200 | | |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | | 0 | 32 |

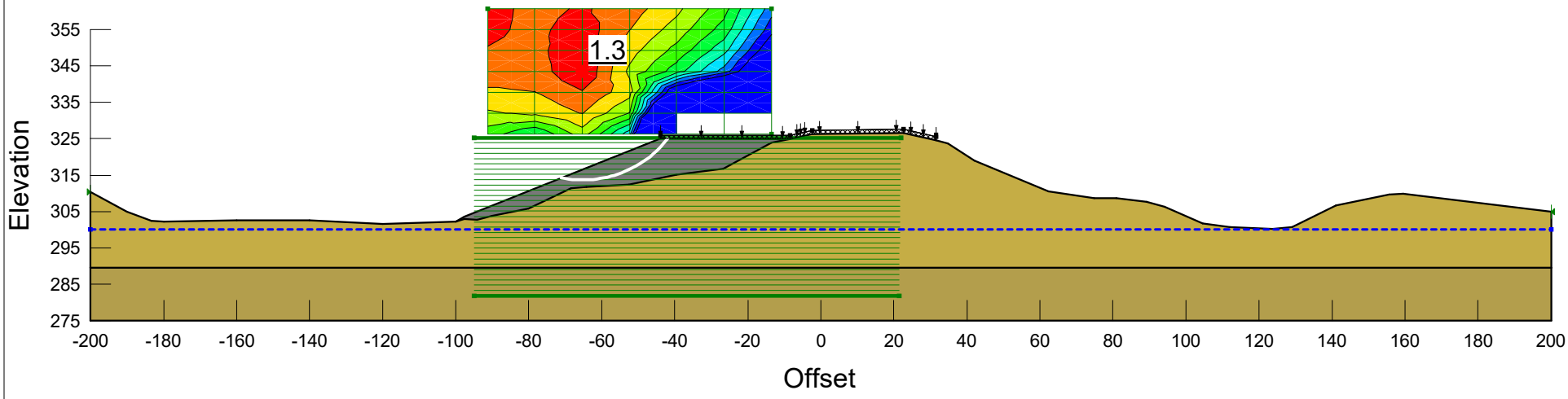



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2118+50 Temporary Grade**
**Pseudo-Static Analysis: 1000 YR, 1/2 PGA (Temp)**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.24**
**Surcharge Load: 250 pcf**
**Center:(-65.31127, 343.48597) ft**
**Radius: 29.824238 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Soil Layer I: CL, SM (Total) | Undrained (Phi=0) | 120 | 1,200 | | |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | | 0 | 32 |



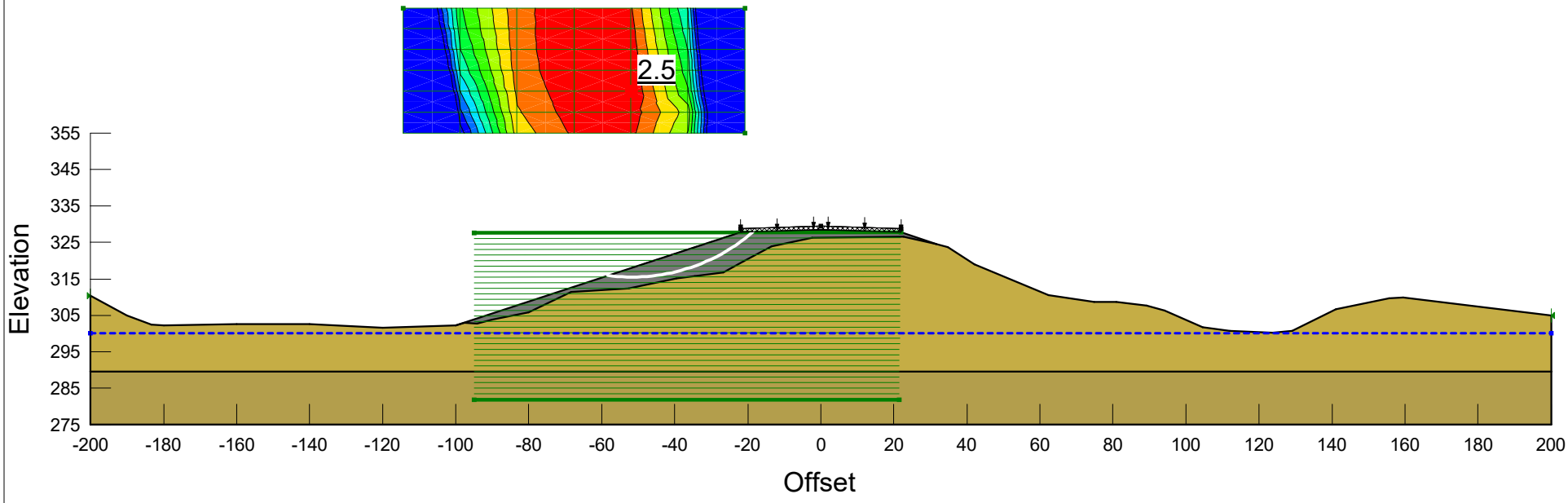

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

# 2118+50 – Final Geometry

**US-51 Cairo - STA 2118+50 Final Grade**
**Static Analysis: Short Term**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center:(-51.94243, 366.40871) ft**
**Radius: 50.953492 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Soil Layer I: CL, SM (Total) | Undrained (Phi=0) | 120 | 1,200 | | |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | | 0 | 32 |

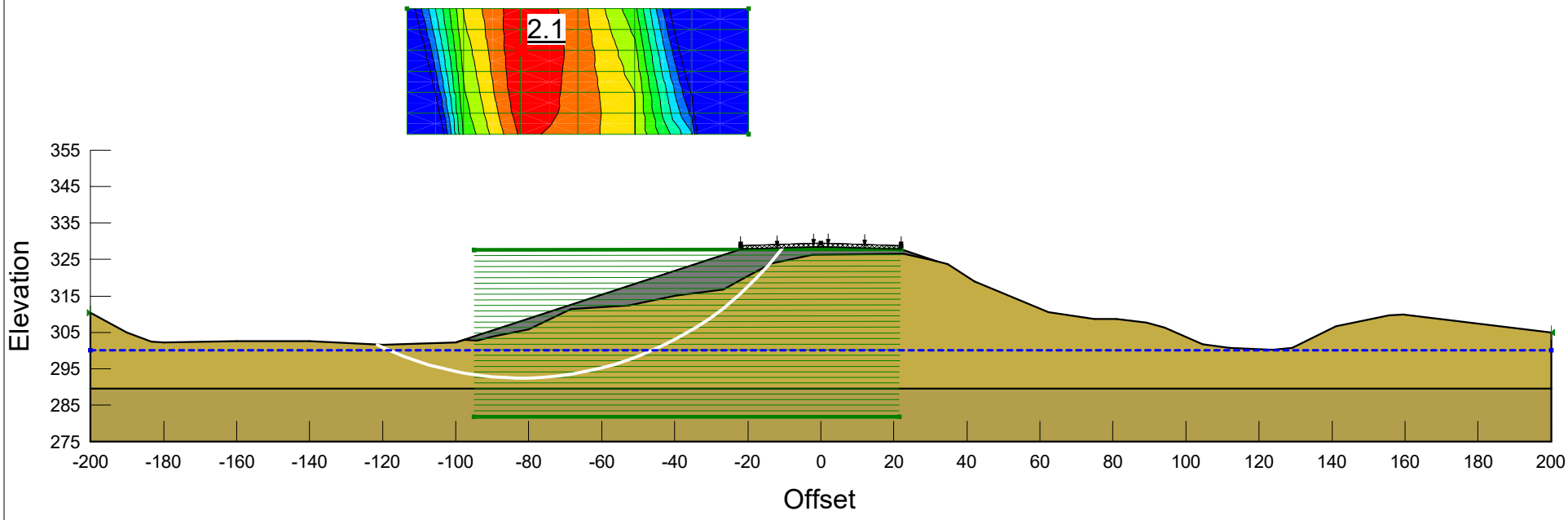



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2118+50 Final Grade**
**Static Analysis: Long Term**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center:(-82.14388, 382.28697) ft**
**Radius: 89.791733 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 |
| | Soil Layer I: CL, SM (Effective) | Mohr-Coulomb | 120 | 120 | 28 |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | 0 | 32 |

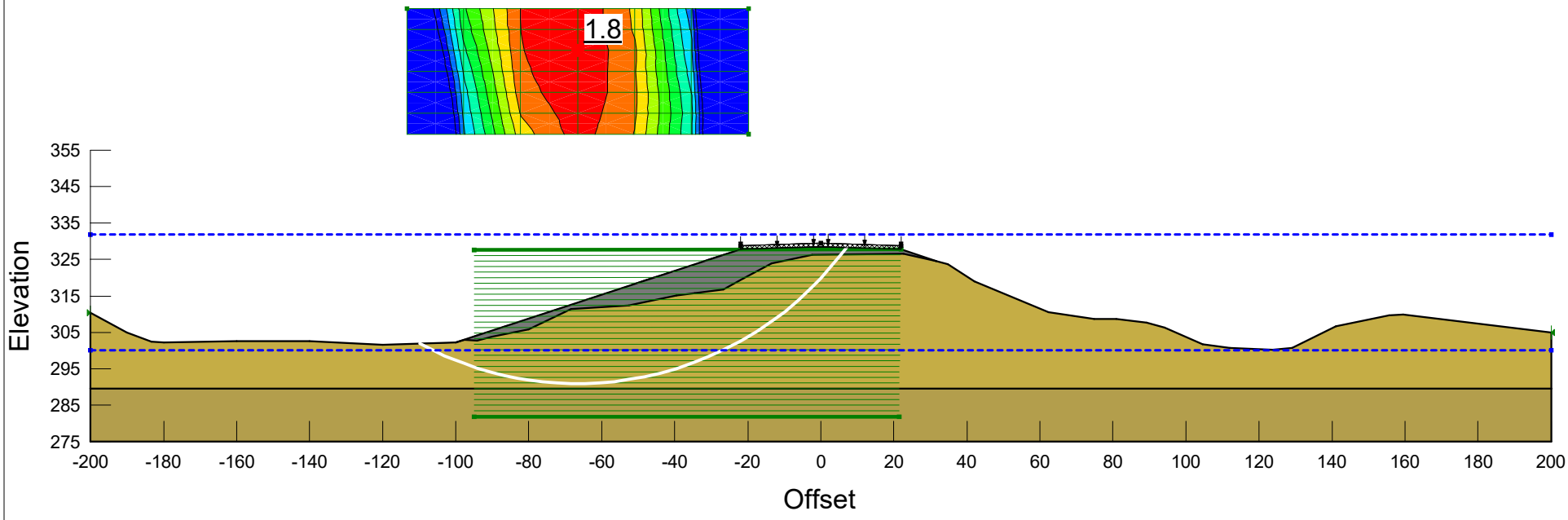



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2118+50 Final Grade**
**Static Analysis: Rapid Drawdown**
**GWT Elevation: 300 ft**
**Historic Max GWT Elevation: 331.9 ft**
**Horizontal Seismic Coefficient: 0**
**Surcharge Load: 250 pcf**
**Center:(-66.55333, 382.28697) ft**
**Radius: 91.319072 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) |
|---|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | 0 | 38 | 0 | 38 |
| | Soil Layer I: CL, SM (Effective) | Mohr-Coulomb | 120 | 120 | 28 | 1,200 | 0 |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | 0 | 32 | 0 | 32 |

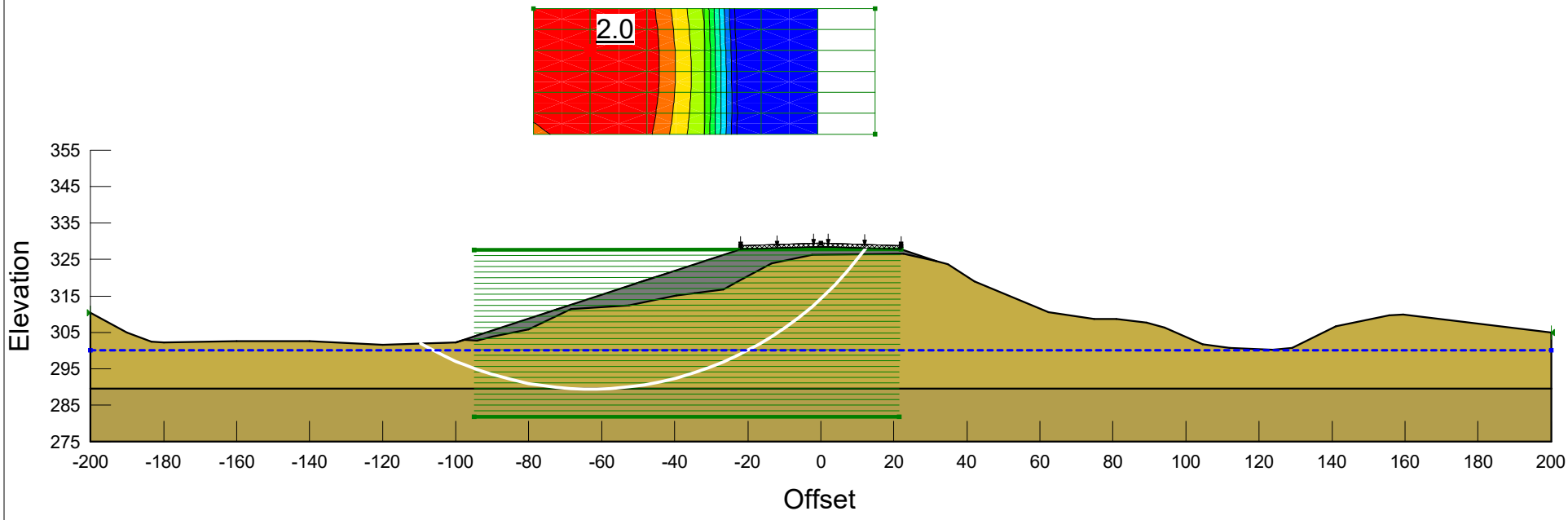



**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2118+50 Final Grade**
**Pseudo-Static Analysis: 100 YR PGA**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.078**
**Surcharge Load: 250 pcf**
**Center:(-63.12, 382.28696) ft**
**Radius: 92.848622 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Soil Layer I: CL, SM (Total) | Undrained (Phi=0) | 120 | 1,200 | | |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | | 0 | 32 |

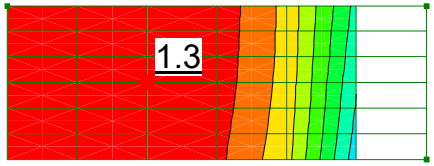


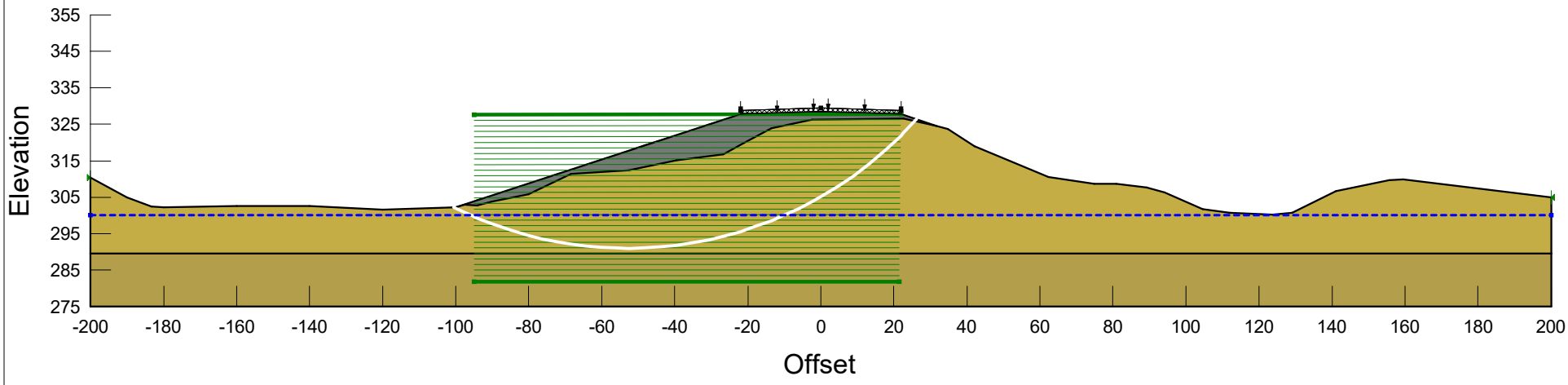

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**US-51 Cairo - STA 2118+50 Final Grade**
**Pseudo-Static Analysis: 1000 YR, 1/2 PGA**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.24**
**Surcharge Load: 250 pcf**
**Center:(-52.93512, 397.14378) ft**
**Radius: 106.17391 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Fill (GP/GW) | Mohr-Coulomb | 125 | | 0 | 38 |
| | Soil Layer I: CL, SM (Total) | Undrained (Phi=0) | 120 | 1,200 | | |
| | Soil Layer II: ML, SC, CL | Mohr-Coulomb | 125 | | 0 | 32 |



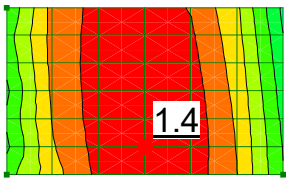

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 123**

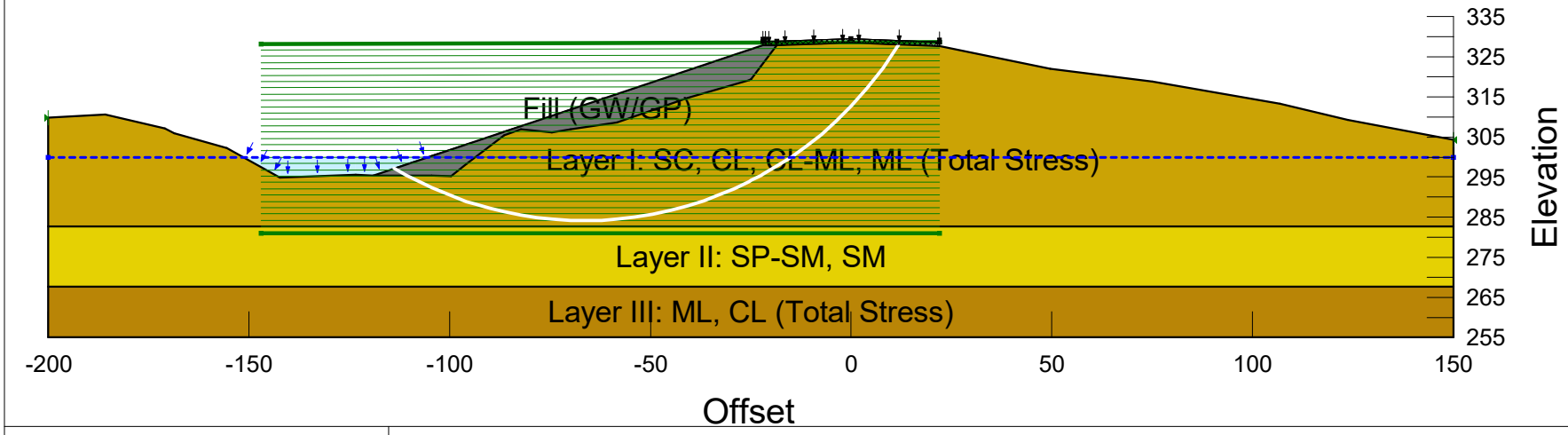
**Created By: ER Date: 06/05/2026**
**Checked By: BE Date: 06/05/2026**

**2126+50**

**US-51 Cairo - STA 2126+50**
**Static Analysis: Short Term**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Center: (-66.538335, 376.15861) ft**
**Radius: 91.987962 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GW/GP) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I: SC, CL, CL-ML, ML (Total Stress) | Mohr-Coulomb | 120 | 800 | 0 |
| | Layer II: SP-SM, SM | Mohr-Coulomb | 125 | 0 | 30 |
| | Layer III: ML, CL (Total Stress) | Mohr-Coulomb | 120 | 1,450 | 0 |



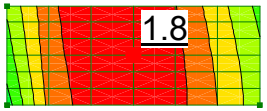



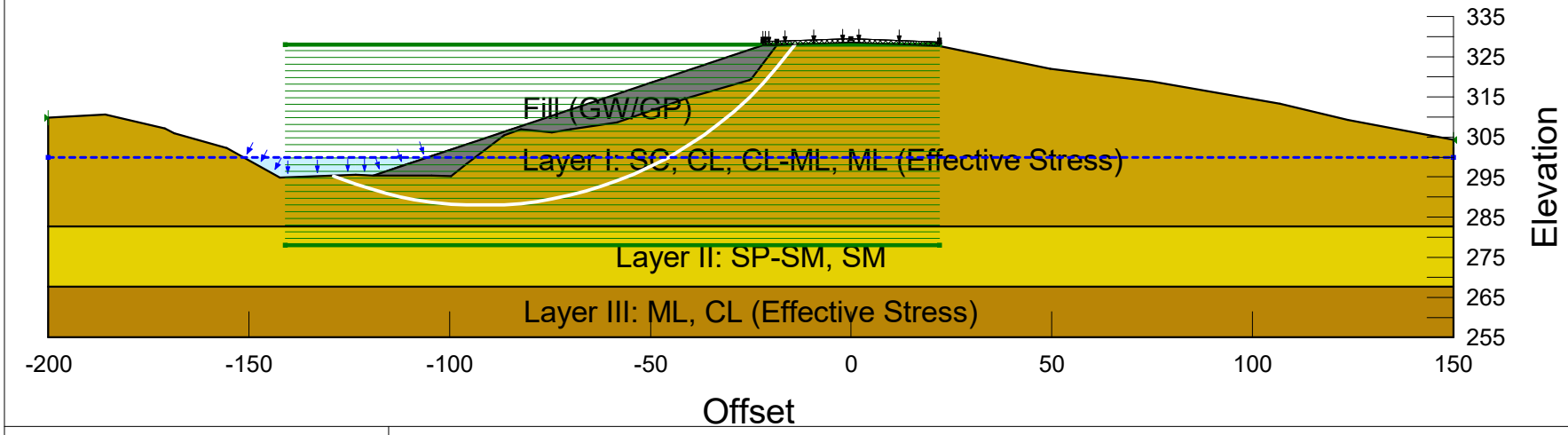

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 126A**

**Created By: GD Date: 06/05/2026**
**Created By: CT Date: 06/05/2026**

**US-51 Cairo - STA 2126+50**
**Static Analysis: Long Term**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0**
**Center: (-92.038345, 384.05986) ft**
**Radius: 96.103103 ft**

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GW/GP) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I: SC, CL, CL-ML, ML (Effective Stress) | Mohr-Coulomb | 120 | 80 | 28 |
| | Layer II: SP-SM, SM | Mohr-Coulomb | 125 | 0 | 30 |
| | Layer III: ML, CL (Effective Stress) | Mohr-Coulomb | 120 | 145 | 30 |

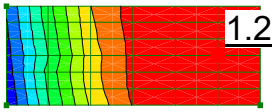


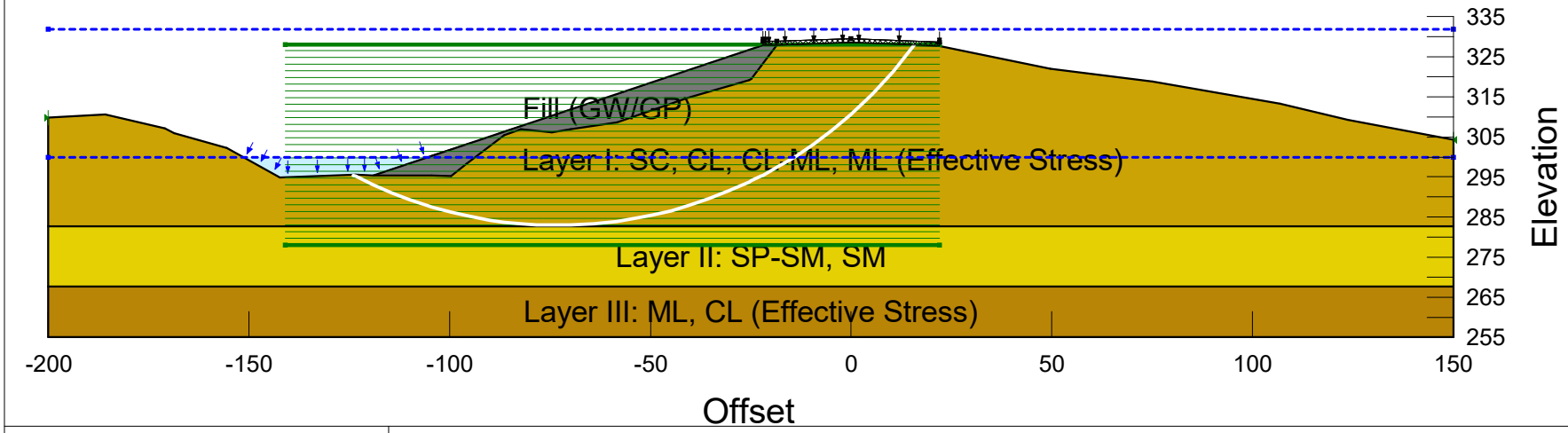

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 126A**

**Created By: GD Date: 06/05/2026**
**Created By: CT Date: 06/05/2026**

**US-51 Cairo - STA 2126+50**
**Static Analysis: Rapid Drawdown**
**GWT Elevation: 300 ft**
**Historic Max GWT Elevation: 331.9 ft**
**Horizontal Seismic Coefficient: 0**
**Center: (-73.011862, 393.05986) ft**
**Radius: 110.10776 ft**



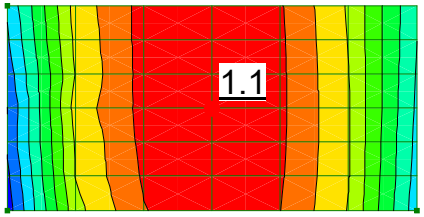

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) | Cohesion R (psf) | Phi R (°) |
|---|---|---|---|---|---|---|---|
| | Fill (GW/GP) | Mohr-Coulomb | 125 | 0 | 38 | 0 | 38 |
| | Layer I: SC, CL, CL-ML, ML (Effective Stress) | Mohr-Coulomb | 120 | 80 | 28 | 800 | 0 |
| | Layer II: SP-SM, SM | Mohr-Coulomb | 125 | 0 | 30 | 0 | 30 |
| | Layer III: ML, CL (Effective Stress) | Mohr-Coulomb | 120 | 145 | 30 | 1,450 | 0 |



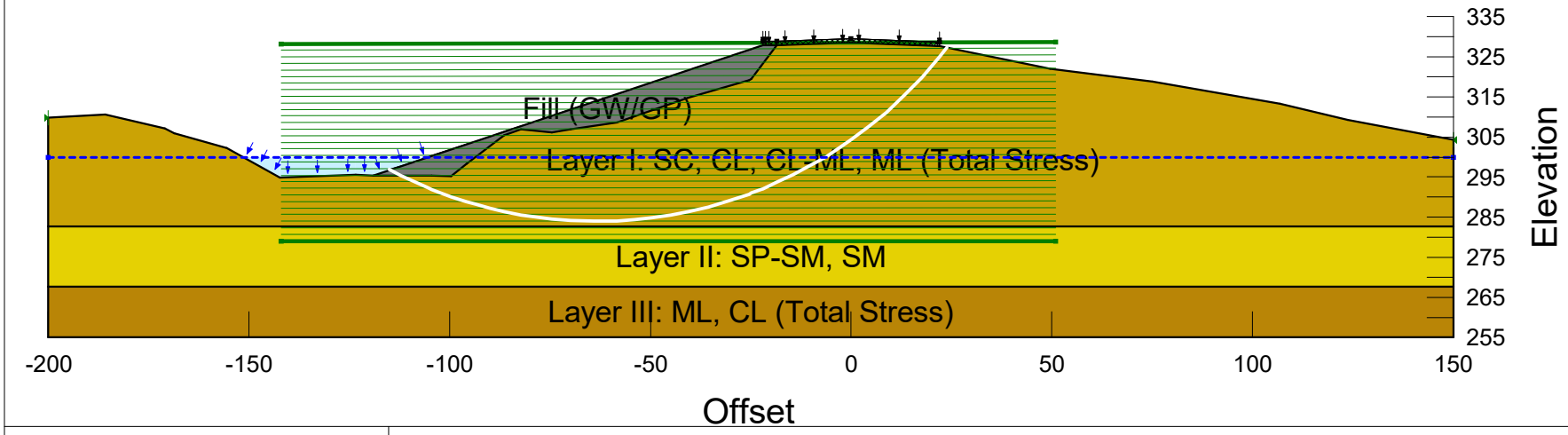

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 126A**

**Created By: GD Date: 06/05/2026**
**Created By: CT Date: 06/05/2026**

**US-51 Cairo - STA 2126+50**
**Pseudo-Static Analysis: 100 YR PGA**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.078**
**Center: (-63.439825, 393.32475) ft**
**Radius: 109.37129 ft**



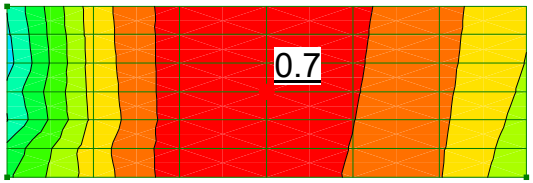

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GW/GP) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I: SC, CL, CL-ML, ML (Total Stress) | Mohr-Coulomb | 120 | 800 | 0 |
| | Layer II: SP-SM, SM | Mohr-Coulomb | 125 | 0 | 30 |
| | Layer III: ML, CL (Total Stress) | Mohr-Coulomb | 120 | 1,450 | 0 |



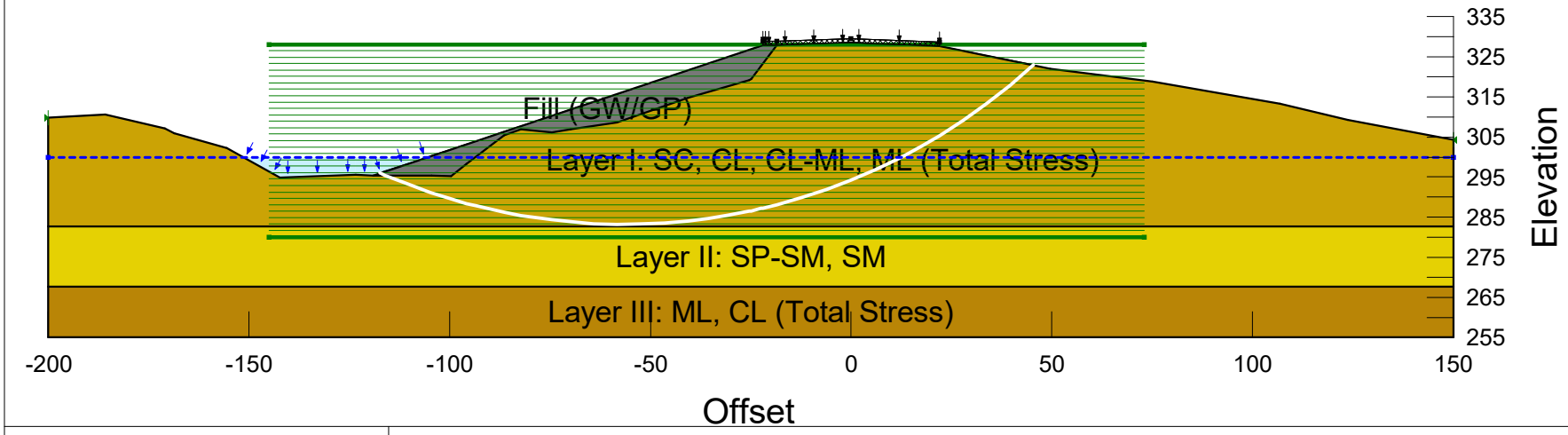

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 126A**

**Created By: GD Date: 06/05/2026**
**Created By: CT Date: 06/05/2026**

**US-51 Cairo - STA 2126+50**
**Pseudo-Static Analysis: 1000 YR 1/2 PGA**
**GWT Elevation: 300 ft**
**Horizontal Seismic Coefficient: 0.24**
**Center: (-56.518095, 433.79828) ft**
**Radius: 150.57939 ft**




| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|
| | Fill (GW/GP) | Mohr-Coulomb | 125 | 0 | 38 |
| | Layer I: SC, CL, CL-ML, ML (Total Stress) | Mohr-Coulomb | 120 | 800 | 0 |
| | Layer II: SP-SM, SM | Mohr-Coulomb | 125 | 0 | 30 |
| | Layer III: ML, CL (Total Stress) | Mohr-Coulomb | 120 | 1,450 | 0 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Boring: 126A**

**Created By: GD Date: 06/05/2026**
**Created By: CT Date: 06/05/2026**

# Attachment H: Newmark's Displacement Analysis Method Results

hdrinc.com

333 West Vine Street, Suite 1400, Lexington, KY 40507-1681
(859) 629-4800

# Lateral Spread Analysis at Kentucky Abutment

US-51 Bridge Replacement over Ohio River

*Ballard Co., KY*

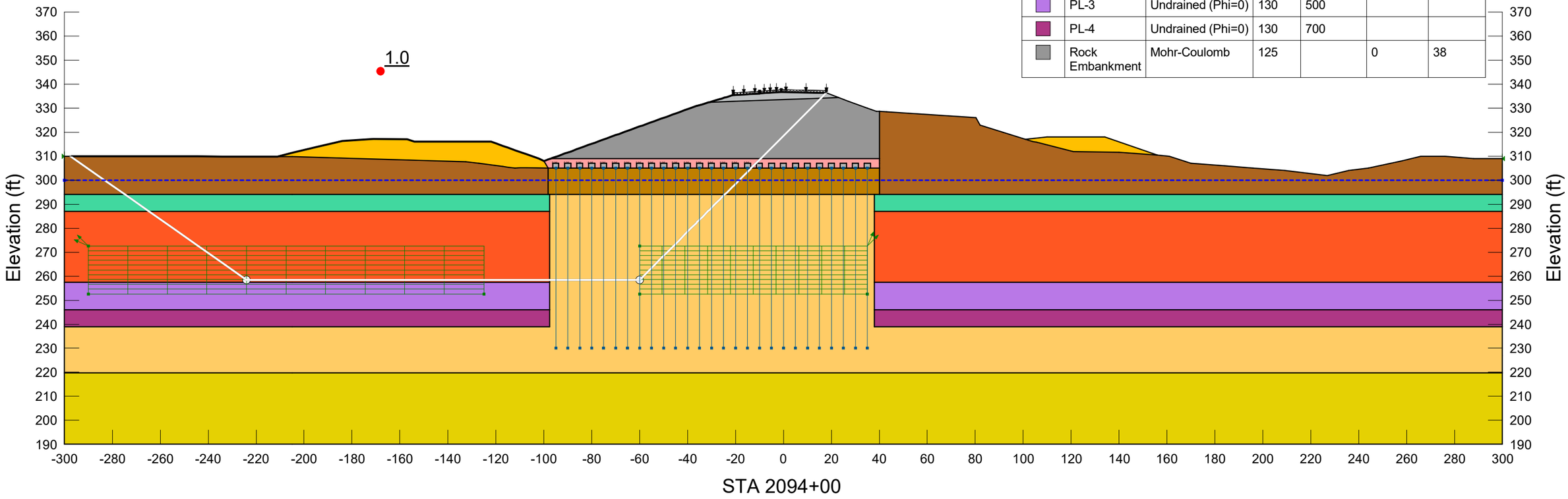
October 19, 2026

# Pseudo-Static Slope Stability Analysis

Find $(k_h)_y$ and $R_{Tot} = 0.0$

# KY Abutment (STA 2094+00)
# Pseudo-Static Analysis : Yield Wedge
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.18
# RI_UNR
# Shear Force: 0 lbf

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Cap | High Strength | 150 | | | |
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I - Imp. | Undrained (Phi=0) | 115 | 1,300 | | |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/13/2026**

# Obtain/Select an Input Range and the Discrete $R_{Total}$ Values

# Rigid Inclusions Section Properties

Section Type, Dimensions, and Cross-section Properties

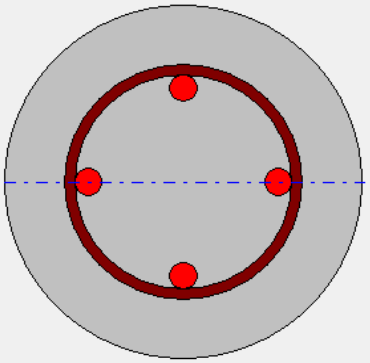
Section 1, Top [0.00 - 75.00 ] ft Number of Defined Sections = 1 Total Length = 75.00 ft

Section Type | Shaft Dimensions | Concrete | Rebars | Trans. Reinf.

Section Type and Shape

- Elastic Section (Non-yielding)
- Elastic Section with Specified Moment Capacity
- Rectangular Concrete Section
- Round Concrete Shaft (Bored Pile)
- Round Concrete Shaft with Permanent Casing
- Round Shaft with Casing and Core/Insert
- Steel Pipe Section
- Steel H Section Strong Axis
- Steel H Section Weak Axis
- Steel AISC Section Strong Axis
- Steel AISC Section Weak Axis
- Round Prestressed Concrete
- Round Prestressed Concrete with Void
- Square Prestressed Concrete
- Square Prestressed Concrete with Void
- Octagonal Prestressed Concrete
- Octagonal Prestressed Concrete with Void
- User Defined Non-linear Bending Section

Show: Section / Profile



- [x] Adjust Softening of Moment Curvature
- [ ] Compute Equivalent Elastoplastic Moment Curvature (CALTRANS)
  Note: Program will use the Equivalent Elastoplastic curve for analysis if this option is checked
- [ ] Estimate Resistance Factors and Shear Capacity (if Trans. Reinf. is defined
  Note: While using this option program will override resistance factors define

This shape is used to model uncased drilled shafts or bored piles. The reinforcing ba
bars or as two- or three-bar bundles. It is strongly advised that the bar pattern be sy
than 8 bars or bundles may result in deficient moment capacity if the rebar cage is i
casing. It is recommended that the minimum cover thickness be specified as 3 inch
inches or 100 mm for drilled shafts constructed using temporary casing. In cases wh
be specified as 6 inches (150 mm) to allow alignment with column steel and to perm
shaft position. If the rebar is permitted to be offset, the user should perform an analy

Add Section | Insert Section | Delete Section

- [x] Copy Current Section Properties for New Sections (Add/Insert)

Section Type, Dimensions, and Cross-section Properties

Section 1, Top [0.00 - 75.00 ] ft Number of Defined Sections = 1 Total Length = 75.00 ft

Section Type | Shaft Dimensions | Concrete | Rebars | Trans. Reinf.

**Elevation Dimensions**

Length of Section (ft): 75

**Elastic Section Properties:**

Structural Shape: Select Shape

| | At Top | At Bottom |
|---|---|---|
| Elas. Eq. Diam., p-y (in) | 0 | 0 |
| Elastic Sect. Width (in) | 0 | 0 |
| No data required (in) | 0 | 0 |
| Area (in^2) | 0 | 0 |
| Mom. of Inertia (in^4) | 0 | 0 |
| Plas. Mom. Cap. (in-lbs) | 0 | 0 |
| Shear Capacity (lbs) | 0 | 0 |

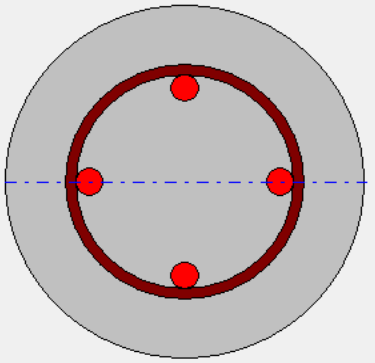
Compute Mom. of Inertia and Areas and Draw Section

**Drilled Shaft Section Dimensions:** [ ] Use Eq. D.

| | |
|---|---|
| Equiv. Diameter, p-y (in) | 0 |
| Section Diameter (in) | 18 |
| Casing Wall Thickness (in) | 0 |
| Section Width (in) | 0 |
| Section Depth (in) | 0 |
| Corner Chamfer (in) | 0 |
| Core Void Diameter (in) | 0 |
| Core Wall Thickness (in) | 0 |
| Flange Thickness (in) | 0 |
| Web Thickness (in) | 0 |
| Elastic Mod. (lbs/in^2) | 0 |

Copy Top Properties to Bottom

Show: Section / Profile



This shape is used to model uncased drilled shafts or bored piles. The reinforcing bars for drilled shafts are typically arranged in a circular pattern, either as single bars or as two- or three-bar bundles. It is strongly advised that the bar pattern be symmetrical and that no fewer than 8 bars or bundles be specified. Use of fewer than 8 bars or bundles may result in deficient moment capacity if the rebar cage is inadvertently rotated either during concrete placement or removal of temporary casing. It is recommended that the minimum cover thickness be specified as 3 inches or 75 mm for drilled shafts constructed without temporary casing and 4 inches or 100 mm for drilled shafts constructed using temporary casing. In cases where alignment of the shaft rebar with column steel is critical, a rebar cover may be specified as 6 inches (150 mm) to allow alignment with column steel and to permit use of the typical horizontal construction tolerance of 3 inches (75 mm) for shaft position. If the rebar is permitted to be offset, the user should perform an analysis in which the effect of offset rebar is included.

Add Section | Insert Section | Delete Section

OK

- [x] Copy Current Section Properties for New Sections (Add/Insert)

Section Type, Dimensions, and Cross-section Properties

Section 1, Top [0.00 - 75.00 ] ft Number of Defined Sections = 1 Total Length = 75.00 ft

Section Type | Shaft Dimensions | Concrete | Rebars | Trans. Reinf.

**Concrete Properties:**

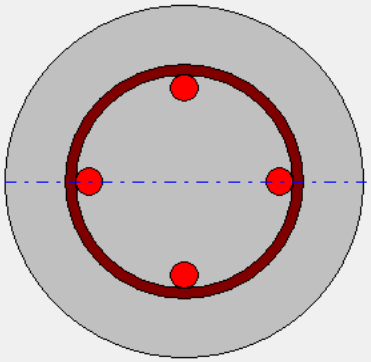
Compressive Strength (lbs/in^2) 4000

Max. Coarse Aggregate Size (in) 0.75

View Stress-Strain Curve

View Advice for Concrete Slump

Show: Section / Profile



This shape is used to model uncased drilled shafts or bored piles. The reinforcing bars f
bars or as two- or three-bar bundles. It is strongly advised that the bar pattern be symm
than 8 bars or bundles may result in deficient moment capacity if the rebar cage is inad
casing. It is recommended that the minimum cover thickness be specified as 3 inches o
inches or 100 mm for drilled shafts constructed using temporary casing. In cases where
be specified as 6 inches (150 mm) to allow alignment with column steel and to permit us
shaft position. If the rebar is permitted to be offset, the user should perform an analysis

Add Section | Insert Section | Delete Section

Copy Current Section Properties for New Sections (Add/Insert)

Section Type, Dimensions, and Cross-section Properties

Section 1, Top [0.00 - 75.00 ] ft Number of Defined Sections = 1 Total Length = 75.00 ft

Section Type | Shaft Dimensions | Concrete | Rebars | Trans. Reinf.

**Reinforcing Bar Properties:** Plain Concrete - No Rebars

Yield Stress (lbs/in^2) 60000 Elastic Modulus (lbs/in^2) 29000000

Continue Rebar Pattern and Size from Section Above

Rebar Size/Number Options

Bar Size US Std. #11

Bar Area (in^2) 1.56 Number of Bars 4

Bar/Bundle Options: Single Bars / 2-Bar Bundles / 3-Bar Bundles

Concrete Cover to Edge of Bar (in) 3

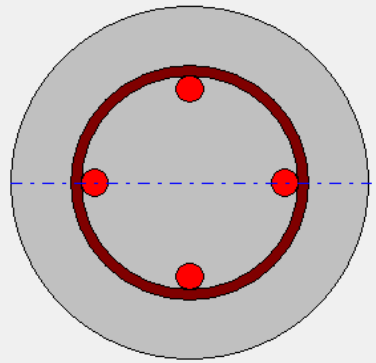
Note: To Edge of Transverse Reinf. if defined

Automatically positon bars in circle Edit Bar Positions

Offset Reinforcement Pattern from Centroid of Section Offset (in) 0

Bar Spacing = 5.37 in, Area of Steel = 6.24 sq. in, Percentage of Steel = 2.45%

Show: Section / Profile

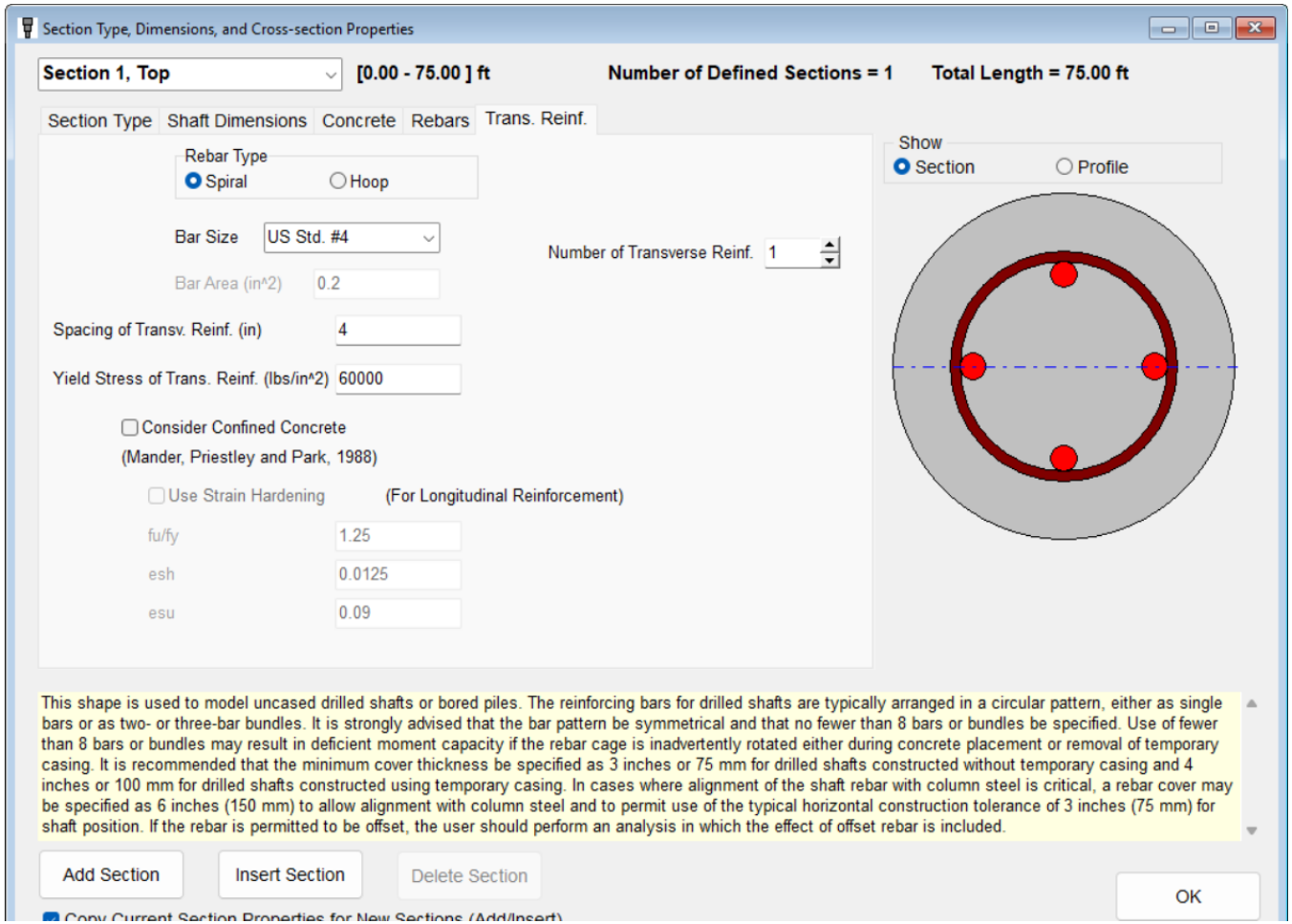


This shape is used to model uncased drilled shafts or bored piles. The reinforcing bars for drilled shafts are typically arranged in a circular pattern, either as single bars or as two- or three-bar bundles. It is strongly advised that the bar pattern be symmetrical and that no fewer than 8 bars or bundles be specified. Use of fewer than 8 bars or bundles may result in deficient moment capacity if the rebar cage is inadvertently rotated either during concrete placement or removal of temporary casing. It is recommended that the minimum cover thickness be specified as 3 inches or 75 mm for drilled shafts constructed without temporary casing and 4 inches or 100 mm for drilled shafts constructed using temporary casing. In cases where alignment of the shaft rebar with column steel is critical, a rebar cover may be specified as 6 inches (150 mm) to allow alignment with column steel and to permit use of the typical horizontal construction tolerance of 3 inches (75 mm) for shaft position. If the rebar is permitted to be offset, the user should perform an analysis in which the effect of offset rebar is included.

Add Section | Insert Section | Delete Section

Copy Current Section Properties for New Sections (Add/Insert)

OK


Section Type, Dimensions, and Cross-section Properties
Section 1, Top
[0.00 - 75.00 ] ft
Number of Defined Sections = 1
Total Length = 75.00 ft
Section Type
Shaft Dimensions
Concrete
Rebars
Trans. Reinf.
Rebar Type
Spiral
Hoop
Bar Size
US Std. #4
Bar Area (in^2)
0.2
Number of Transverse Reinf.
1
Spacing of Transv. Reinf. (in)
4
Yield Stress of Trans. Reinf. (lbs/in^2)
60000
Consider Confined Concrete
(Mander, Priestley and Park, 1988)
Use Strain Hardening
(For Longitudinal Reinforcement)
fu/fy
1.25
esh
0.0125
esu
0.09
Show
Section
Profile
This shape is used to model uncased drilled shafts or bored piles. The reinforcing bars for drilled shafts are typically arranged in a circular pattern, either as single bars or as two- or three-bar bundles. It is strongly advised that the bar pattern be symmetrical and that no fewer than 8 bars or bundles be specified. Use of fewer than 8 bars or bundles may result in deficient moment capacity if the rebar cage is inadvertently rotated either during concrete placement or removal of temporary casing. It is recommended that the minimum cover thickness be specified as 3 inches or 75 mm for drilled shafts constructed without temporary casing and 4 inches or 100 mm for drilled shafts constructed using temporary casing. In cases where alignment of the shaft rebar with column steel is critical, a rebar cover may be specified as 6 inches (150 mm) to allow alignment with column steel and to permit use of the typical horizontal construction tolerance of 3 inches (75 mm) for shaft position. If the rebar is permitted to be offset, the user should perform an analysis in which the effect of offset rebar is included.
Add Section
Insert Section
Delete Section
OK
Copy Current Section Properties for New Sections (Add/Insert)

## Soil Properties - Row 1

Soil Layers

| | Select p-y Curve Type from Drop-down List | Vertical Depth Below Pile Head of Top of Soil Layer (ft) | Vertical Depth Below Pile Head of Bottom of Soil Layer (ft) | Press Button to Enter Soil Properties |
|---|---|---|---|---|
| 1 | Stiff Clay w/o Free Water (Reese) | 0 | 5 | 1: Stiff Clay without Free Water |
| 2 | Stiff Clay w/o Free Water (Reese) | 5 | 11 | 2: Stiff Clay without Free Water |
| 3 | Soft Clay (Matlock) | 11 | 18 | 3: Soft Clay |
| 4 | Soft Clay (Matlock) | 18 | 47.5 | 4: Soft Clay |
| 5 | Soft Clay (Matlock) | 47.5 | 59 | 5: Soft Clay |
| 6 | Soft Clay (Matlock) | 59 | 66 | 6: Soft Clay |
| 7 | Sand (Reese) | 66 | 85.2 | 7: Sand (Reese, et al.) |
| 8 | Sand (Reese) | 85.2 | 141.7 | 8: Sand (Reese, et al.) |

Add Row | Insert Row | Delete Row

All positive depth coordinates are defined as vertical distances below the pile-head.
If the pile-head is embedded below the ground surface, the top layer must extend from the ground surface (defined by a negative vertical depth) to some point below the pile head.
Select the p-y soil type using the drop-down list in the left table column.

### Stiff Clay without Free Water 1

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Undrained Cohesion, c. (lbs/ft^2) | Non-default Strain Factor E50 |
|---|---|---|---|
| 1 | 115 | 800 | 0.009 |
| 2 | 115 | 800 | 0.009 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute default values for E50 if input values equal zero.

### Stiff Clay without Free Water 2

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Undrained Cohesion, c. (lbs/ft^2) | Non-default Strain Factor E50 |
|---|---|---|---|
| 1 | 52.6 | 800 | 0.009 |
| 2 | 52.6 | 800 | 0.009 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute default values for E50 if input values equal zero.

### Soft Clay 3

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Undrained Cohesion, c. (lbs/ft^2) | Non-default Strain Factor E50 |
|---|---|---|---|
| 1 | 52.6 | 150 | 0.05 |
| 2 | 52.6 | 150 | 0.05 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute a default value for E50 if the input value equals zero.

### Soft Clay 4

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Undrained Cohesion, c. (lbs/ft^2) | Non-default Strain Factor E50 |
|---|---|---|---|
| 1 | 67.6 | 350 | 0.05 |
| 2 | 67.6 | 350 | 0.05 |

LPile linearly interpolates over vertical depth to compute values between the

### Soft Clay 5

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Undrained Cohesion, c. (lbs/ft^2) | Non-default Strain Factor E50 |
|---|---|---|---|
| 1 | 67.6 | 500 | 0.05 |
| 2 | 67.6 | 500 | 0.05 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute a default value for E50 if the input value equals zero.

### Soft Clay 6

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Undrained Cohesion, c. (lbs/ft^2) | Non-default Strain Factor E50 |
|---|---|---|---|
| 1 | 67.6 | 700 | 0.05 |
| 2 | 67.6 | 700 | 0.05 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute a default value for E50 if the input value equals zero.

### Sand (Reese, et al.) 7

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Friction Angle, (DEG) | Non-default k, (lbs/in^3) |
|---|---|---|---|
| 1 | 67.6 | 32 | 60 |
| 2 | 67.6 | 32 | 60 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute a default value for k if the input value equals zero.

### Sand (Reese, et al.) 8

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Friction Angle, (DEG) | Non-default k, (lbs/in^3) |
|---|---|---|---|
| 1 | 67.6 | 36 | 125 |
| 2 | 67.6 | 36 | 125 |

LPile linearly interpolates over vertical depth to compute values

## Soil Properties – Row 2 & Row 3

## Soil Layers

| | Select p-y Curve Type from Drop-down List | Vertical Depth Below Pile Head of Top of Soil Layer (ft) | Vertical Depth Below Pile Head of Bottom of Soil Layer (ft) | Press Button to Enter Soil Properties |
|---|---|---|---|---|
| 1 | Stiff Clay w/o Free Water (Reese) | 0 | 5 | 1: Stiff Clay without Free Water |
| 2 | Stiff Clay w/o Free Water (Reese) | 5 | 12.7 | 2: Stiff Clay without Free Water |
| 3 | Sand (Reese) | 12.7 | 85.2 | 3: Sand (Reese, et al.) |
| 4 | Sand (Reese) | 85.2 | 141.7 | 4: Sand (Reese, et al.) |

Add Row | Insert Row | Delete Row

All positive depth coordinates are defined as vertical distances below the pile-head.
If the pile-head is embedded below the ground surface, the top layer must extend from the ground surface (defined by a negative vertical depth) to some point below the pile head.
Select the p-y soil type using the drop-down list in the left table column.

## Stiff Clay without Free Water 1

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Undrained Cohesion, c. (lbs/ft^2) | Non-default Strain Factor E50 |
|---|---|---|---|
| 1 | 115 | 800 | 0.009 |
| 2 | 115 | 800 | 0.009 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute default values for E50 if input values equal zero.

## Stiff Clay without Free Water 2

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Undrained Cohesion, c. (lbs/ft^2) | Non-default Strain Factor E50 |
|---|---|---|---|
| 1 | 52.6 | 800 | 0.009 |
| 2 | 52.6 | 800 | 0.009 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute default values for E50 if input values equal zero.

## Sand (Reese, et al.) 3

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Friction Angle, (DEG) | Non-default k, (lbs/in^3) |
|---|---|---|---|
| 1 | 67.6 | 32 | 60 |
| 2 | 67.6 | 32 | 60 |

LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute a default value for k if the input value equals zero.

## Sand (Reese, et al.) 4

| 1=Top, 2=Bottom | Effective Unit Weight, (lbs/ft^3) | Friction Angle, (DEG) | Non-default k, (lbs/in^3) |
|---|---|---|---|
| 1 | 67.6 | 36 | 125 |
| 2 | 67.6 | 36 | 125 |

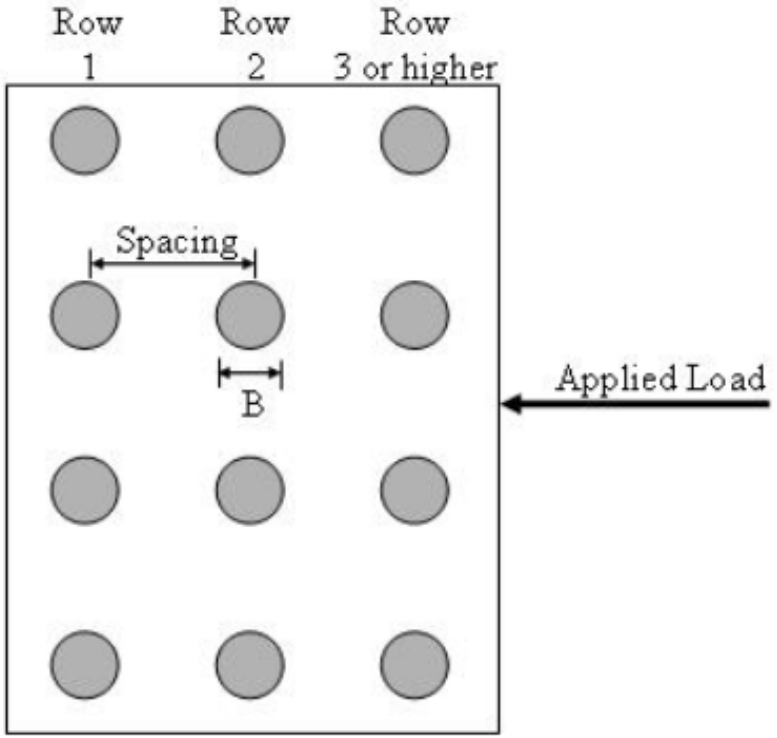
LPile linearly interpolates over vertical depth to compute values between the top and bottom of the layer.

LPile will substitute a default value for k if the input value equals zero.

## P-Multipliers due to Group Effects

**Table 10.7.2.4-1—Pile P-Multipliers, $P_m$, for Multiple Row Shading (averaged from Hannigan et al., 2006)**

| Pile *CTC* spacing (in the direction of loading) | *P*-Multipliers, $P_m$ | | |
|---|---|---|---|
| | Row 1 | Row 2 | Row 3 and higher |
| 3*B* | 0.8 | 0.4 | 0.3 |
| 5*B* | 1.0 | 0.85 | 0.7 |



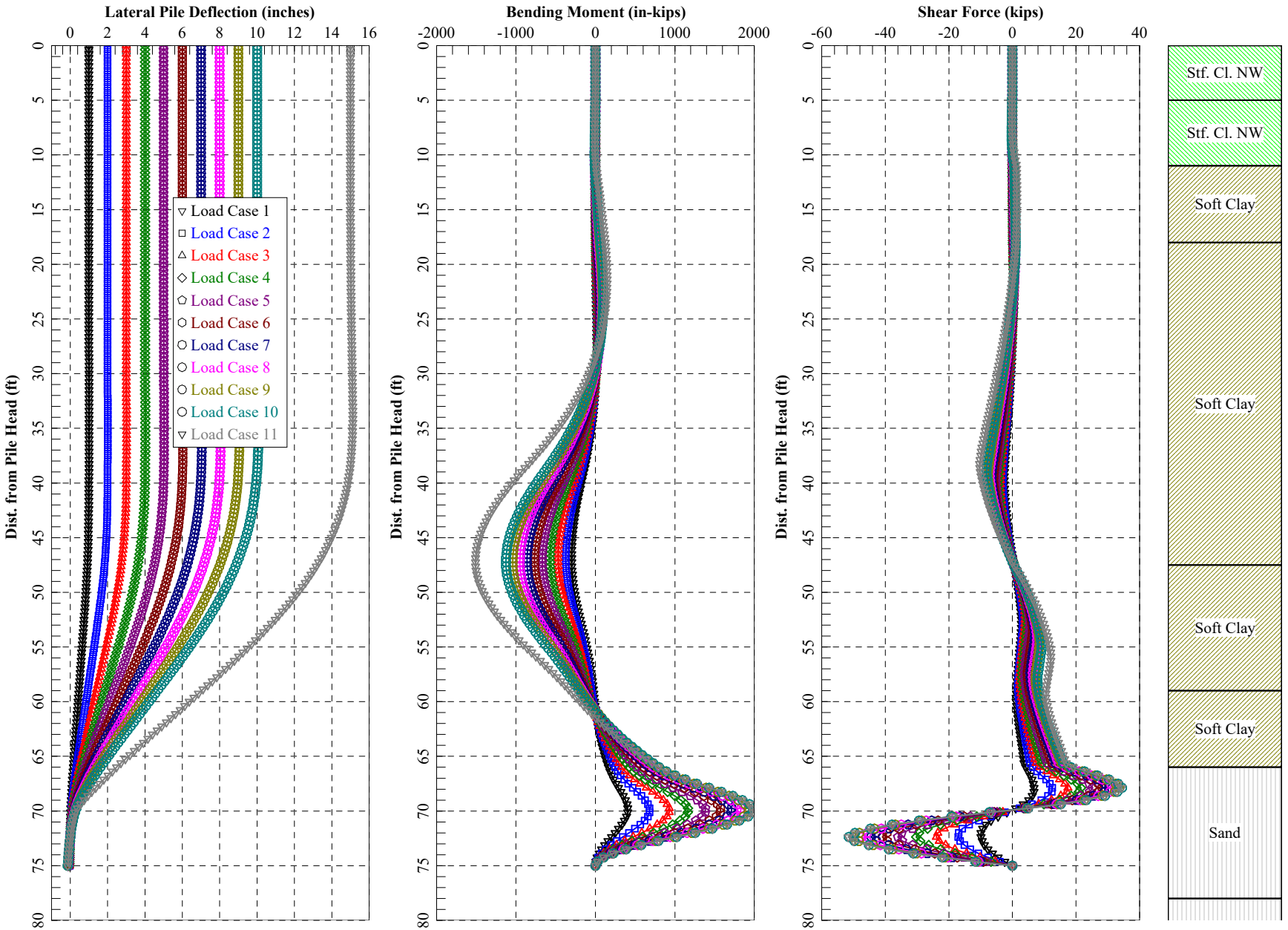

For this pushover analysis, the following will apply:

Row 1 $P_m$ = 0.83

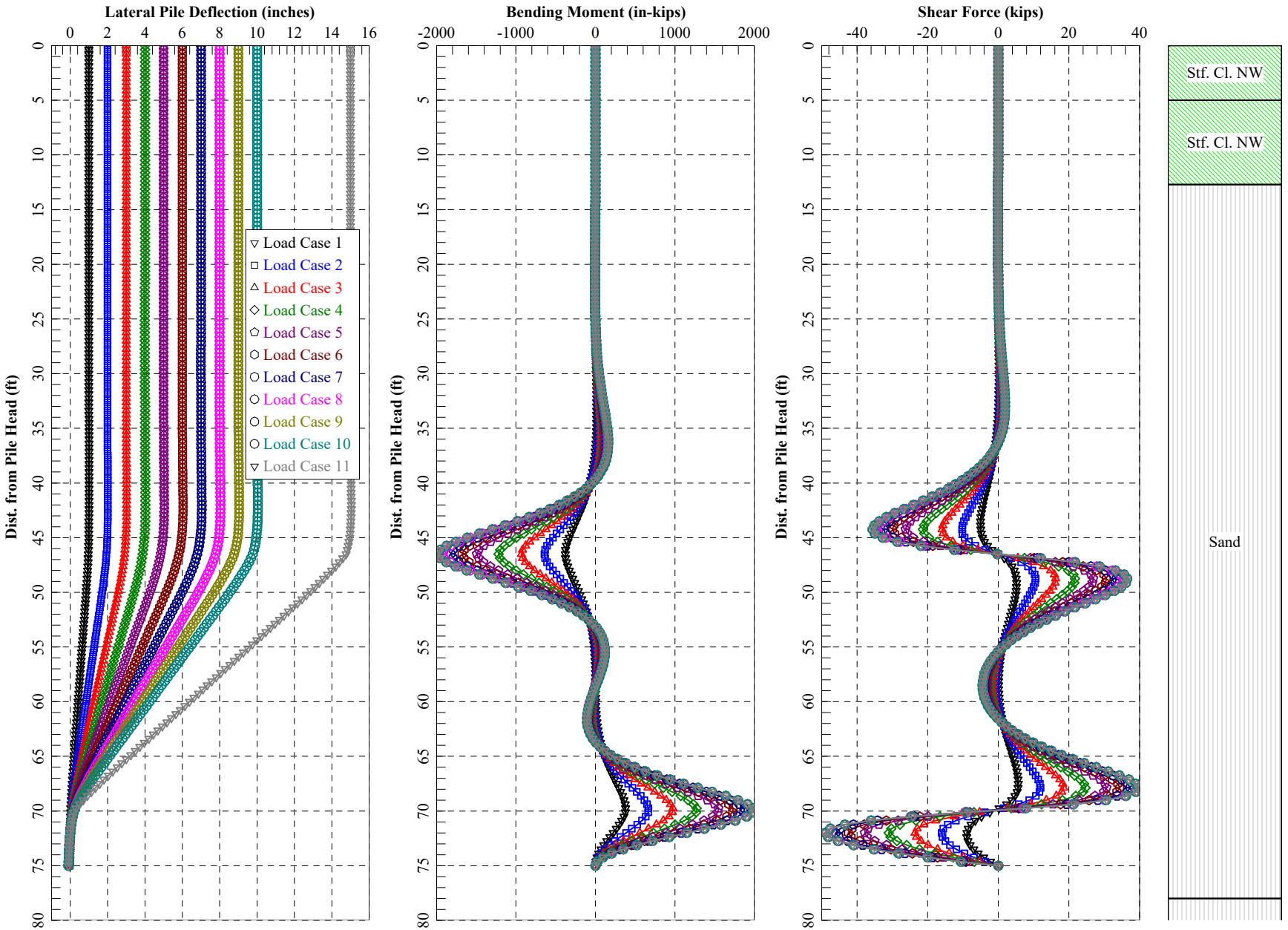
Row 2 $P_m$ = 0.47

Row 3+ $P_m$ = 0.37

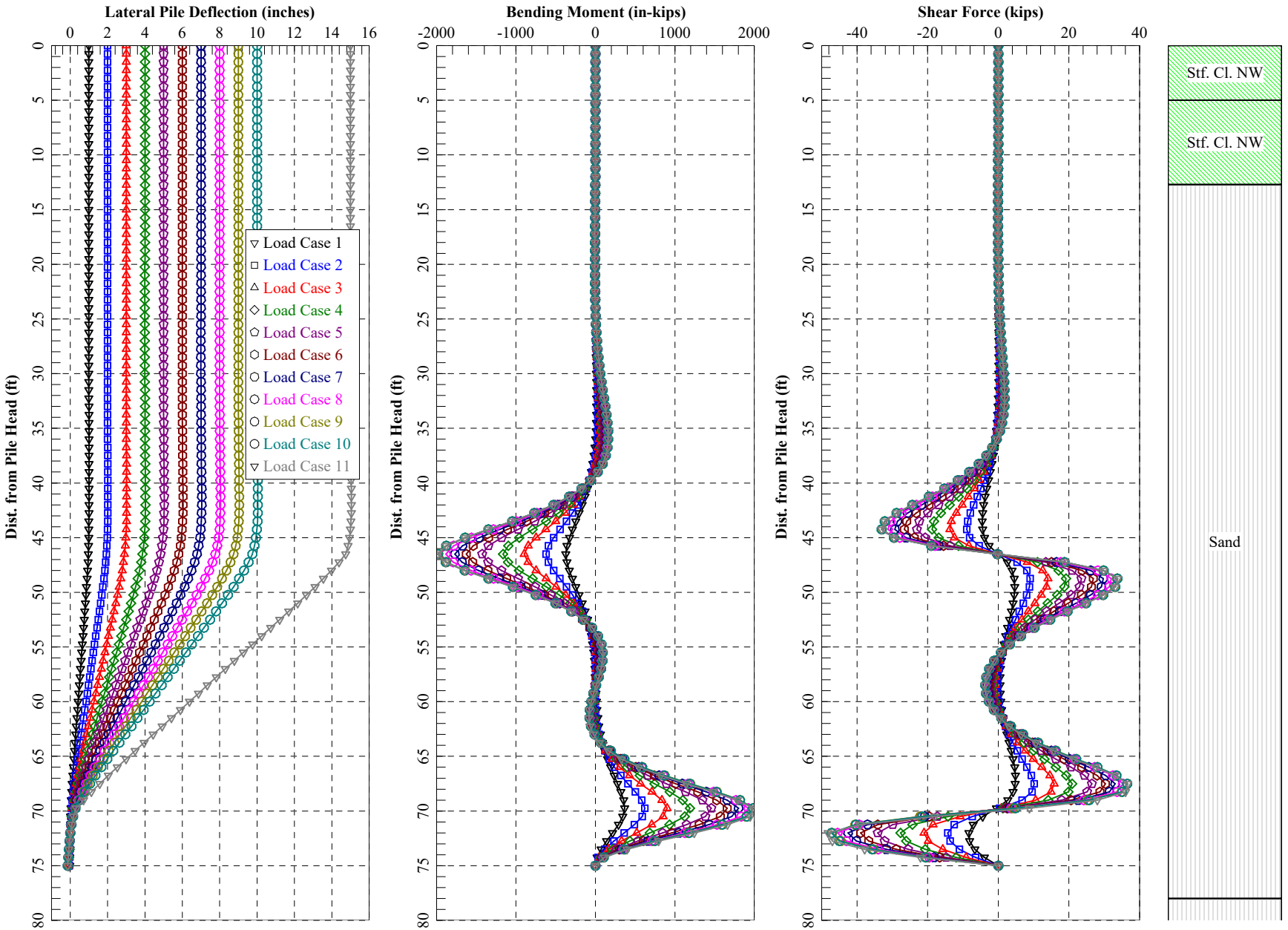
## Row 1


Lateral Pile Deflection (inches)
Bending Moment (in-kips)
Shear Force (kips)
Dist. from Pile Head (ft)
Load Case 1
Load Case 2
Load Case 3
Load Case 4
Load Case 5
Load Case 6
Load Case 7
Load Case 8
Load Case 9
Load Case 10
Load Case 11
Stf. Cl. NW
Stf. Cl. NW
Soft Clay
Soft Clay
Soft Clay
Sand

## Row 2


Lateral Pile Deflection (inches)
Bending Moment (in-kips)
Shear Force (kips)
Dist. from Pile Head (ft)
Load Case 1
Load Case 2
Load Case 3
Load Case 4
Load Case 5
Load Case 6
Load Case 7
Load Case 8
Load Case 9
Load Case 10
Load Case 11
Stf. Cl. NW
Stf. Cl. NW
Sand

## Row 3


Lateral Pile Deflection (inches)
Bending Moment (in-kips)
Shear Force (kips)
Dist. from Pile Head (ft)
Load Case 1
Load Case 2
Load Case 3
Load Case 4
Load Case 5
Load Case 6
Load Case 7
Load Case 8
Load Case 9
Load Case 10
Load Case 11
Stf. Cl. NW
Stf. Cl. NW
Sand

# LPILE Summary

| No. of Rows | Pile Spacing |
|---|---|
| N | S (ft) |
| 8 | 5 |

| ROW 1 - $P_m$ = 0.83 | |
|---|---|
| Δ (in) | Vc (Kips/Pile) |
| 0 | 0 |
| 1 | 2.8 |
| 2 | 3.3 |
| 3 | 4 |
| 4 | 4.8 |
| 5 | 5.5 |
| 6 | 6.3 |
| 7 | 7.1 |
| 8 | 7.8 |
| 9 | 8.5 |
| 10 | 9.1 |
| 15 | 12.1 |

| ROW 2 - $P_m$ = 0.47 | |
|---|---|
| Δ (in) | Vc (Kips/Pile) |
| 0 | 0 |
| 1 | 5.1 |
| 2 | 10.3 |
| 3 | 16.1 |
| 4 | 21.6 |
| 5 | 26.8 |
| 6 | 30.1 |
| 7 | 32.7 |
| 8 | 35.5 |
| 9 | 36.5 |
| 10 | 36.5 |
| 15 | 36.5 |

| ROW 3 - $P_m$ = 0.37 | |
|---|---|
| Δ (in) | Vc (Kips/Pile) |
| 0 | 0 |
| 1 | 4.6 |
| 2 | 9 |
| 3 | 14 |
| 4 | 19.1 |
| 5 | 23.5 |
| 6 | 26.9 |
| 7 | 29.7 |
| 8 | 32 |
| 9 | 33.6 |
| 10 | 33.8 |
| 15 | 33.8 |

| $R_{Tot}$ - 5-ft Spacing (Curve 1) | |
|---|---|
| Δ (in) | $R_{Tot}$ (Kips/ft) |
| 0 | 0 |
| 1 | 7.1 |
| 2 | 13.52 |
| 3 | 20.82 |
| 4 | 28.2 |
| 5 | 34.66 |
| 6 | 39.56 |
| 7 | 43.6 |
| 8 | 47.06 |
| 9 | 49.32 |
| 10 | 49.68 |
| 15 | 50.28 |

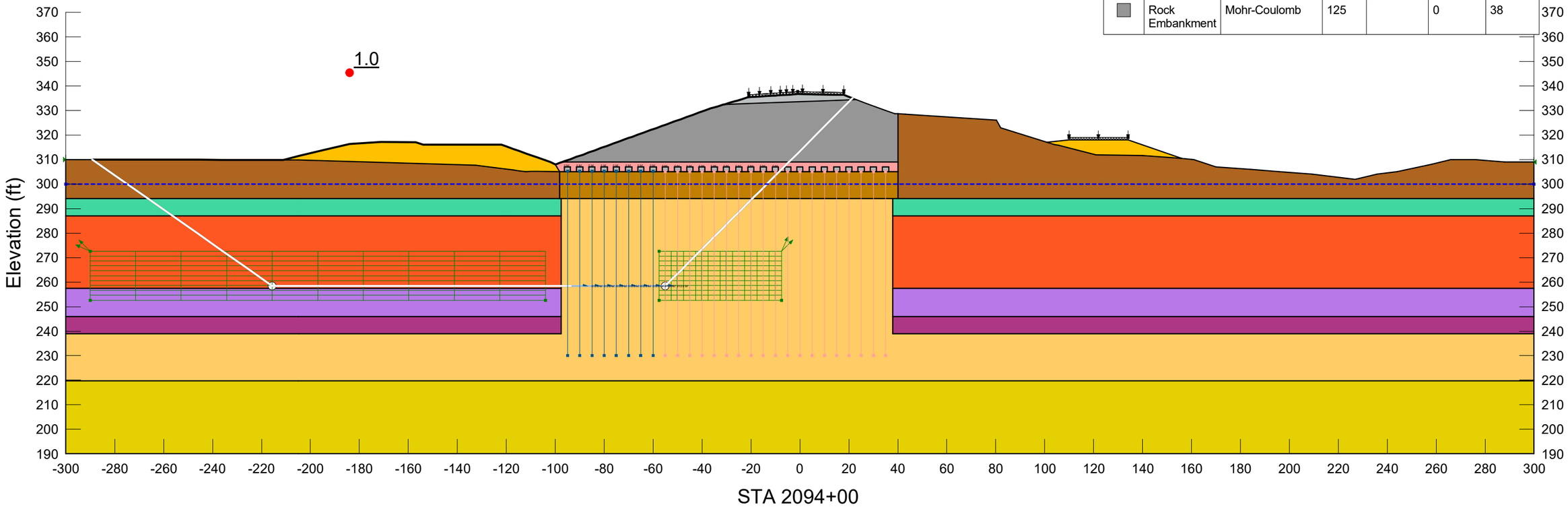
| $R_{Tot}$ - 5-ft Spacing (Curve 2) | | |
|---|---|---|
| Δ (in) | $R_{Tot}$ (Kips/ft) | $V_c$ (lbf) |
| 0 | 0.0 | 0 |
| 1 | 4.9 | 3063 |
| 2 | 7.6 | 4750 |
| 3 | 10.9 | 6813 |
| 4 | 14.3 | 8938 |
| 5 | 14.9 | 9313 |
| 10 | 26.5 | 16563 |

# Evaluate Coefficient of Horizontal Yield Accelerations $(k_h)_y$ Each $R_{Tot}$ Value

# KY Abutment (STA 2094+00)
# Pseudo-Static Analysis : Critical Wedge_Step 1
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.2

## RI_Step 1
## Shear Force: 3,063 lbf

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Cap | High Strength | 150 | | | |
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I - Imp. | Undrained (Phi=0) | 115 | 1,300 | | |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |



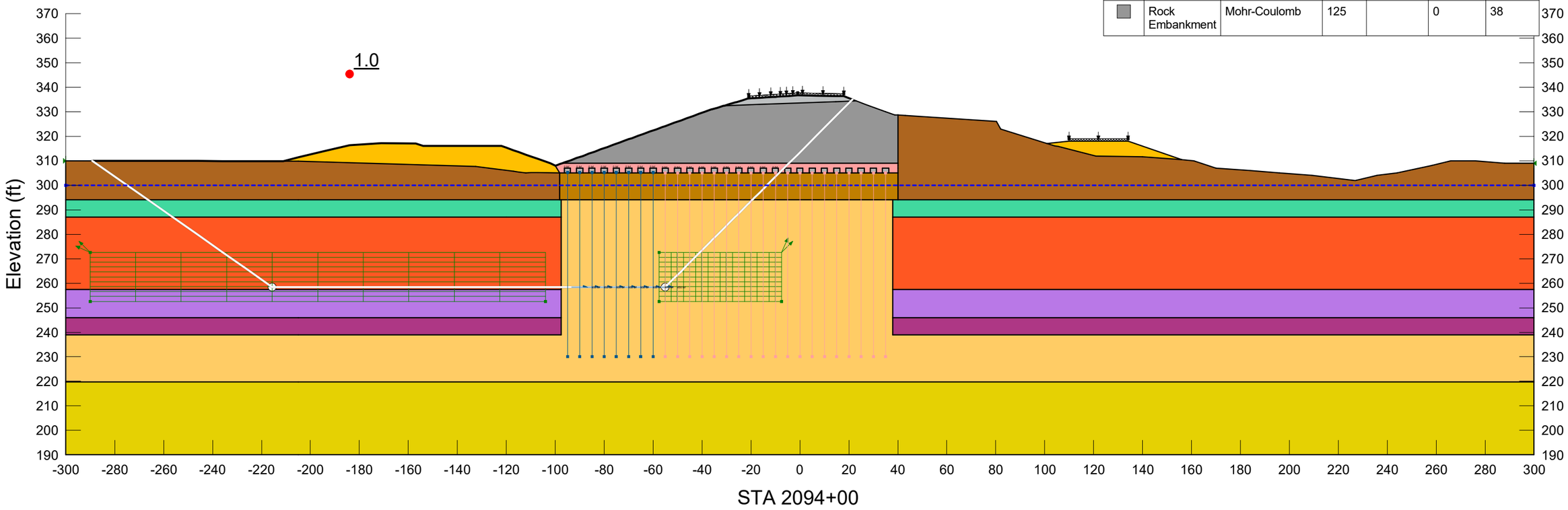

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/19/2026**

# KY Abutment (STA 2094+00)
# Pseudo-Static Analysis : Critical Wedge_Step 2
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.203

## RI_Step 2
## Shear Force: 4,750 lbf

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Cap | High Strength | 150 | | | |
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I - Imp. | Undrained (Phi=0) | 115 | 1,300 | | |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |



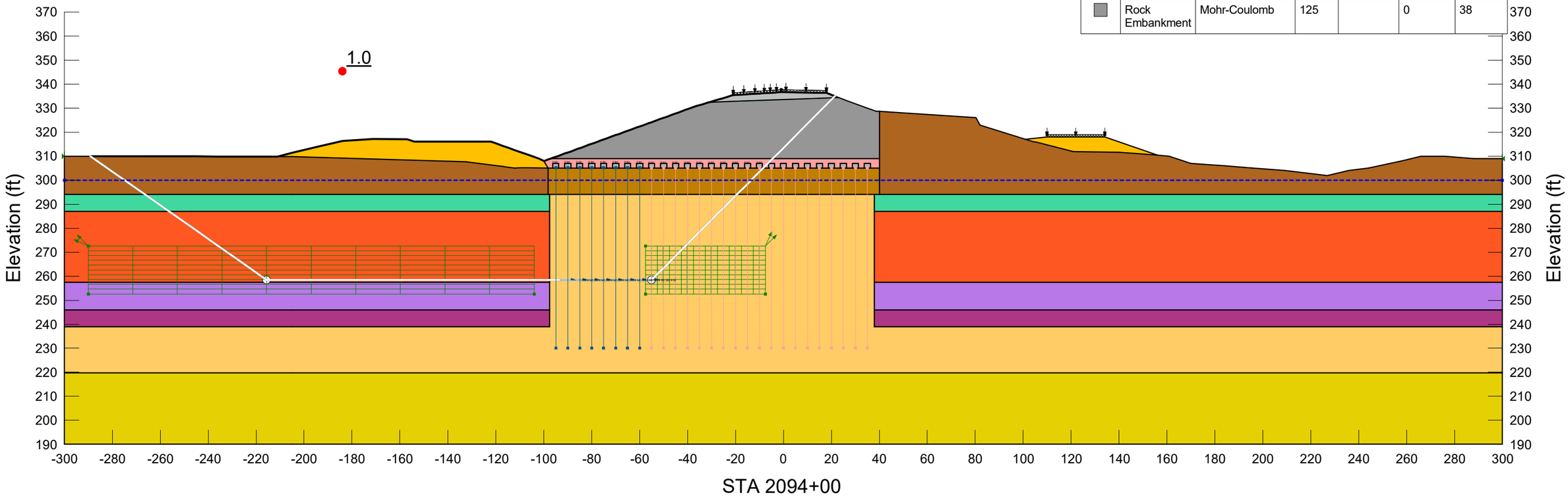

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/19/2026**

# KY Abutment (STA 2094+00)
# Pseudo-Static Analysis : Critical Wedge_Step 3
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.206

## RI_Step 3
## Shear Force: 6,813 lbf

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Cap | High Strength | 150 | | | |
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I - Imp. | Undrained (Phi=0) | 115 | 1,300 | | |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |



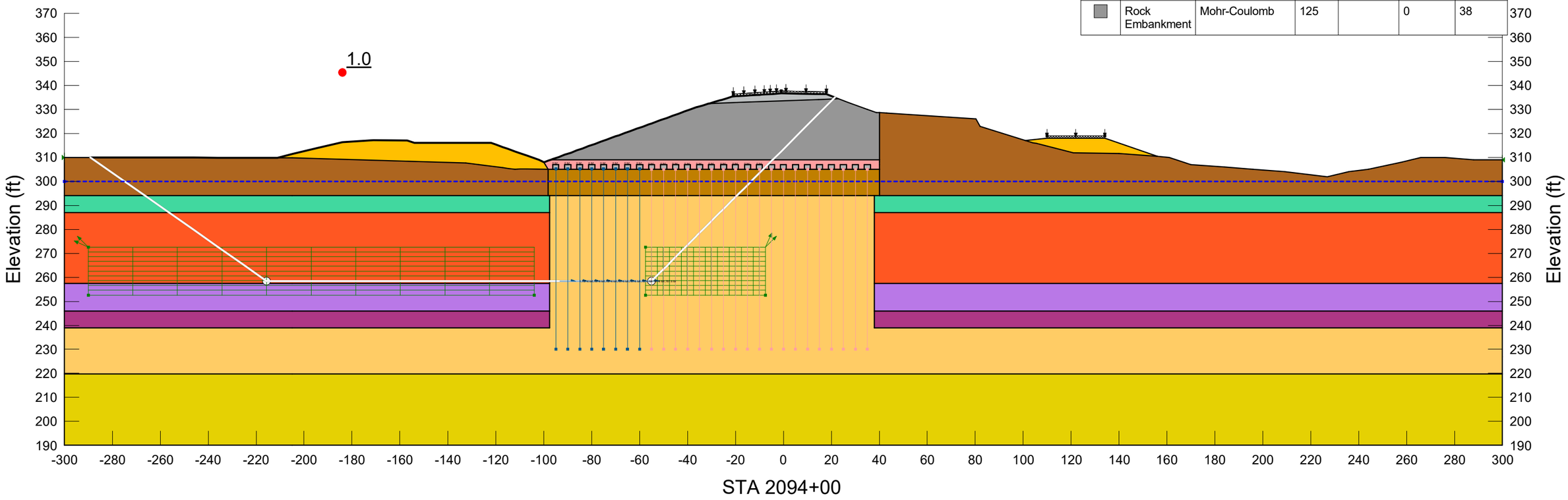

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/19/2026**

# KY Abutment (STA 2094+00)
# Pseudo-Static Analysis : Critical Wedge_Step 4
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.209

## RI_Step 4
## Shear Force: 8,938 lbf

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Cap | High Strength | 150 | | | |
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I - Imp. | Undrained (Phi=0) | 115 | 1,300 | | |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |



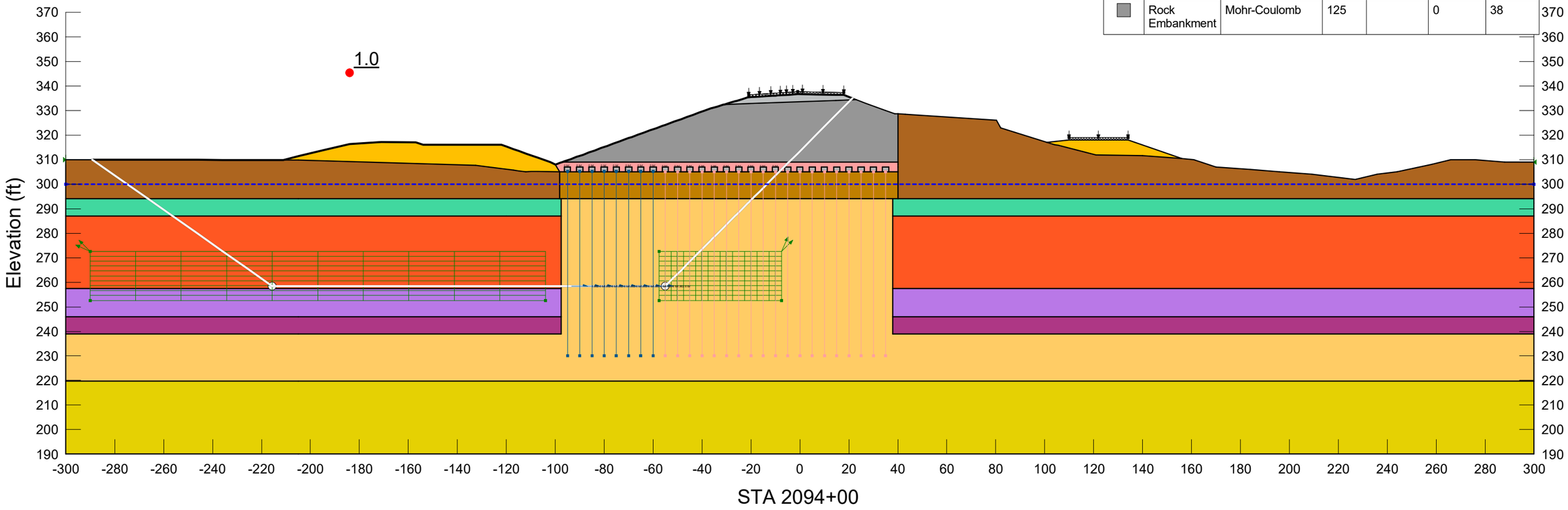

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/19/2026**

# KY Abutment (STA 2094+00)
# Pseudo-Static Analysis : Critical Wedge_Step 5
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.21

## RI_Step 5
## Shear Force: 9,313 lbf

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Cap | High Strength | 150 | | | |
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I - Imp. | Undrained (Phi=0) | 115 | 1,300 | | |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |



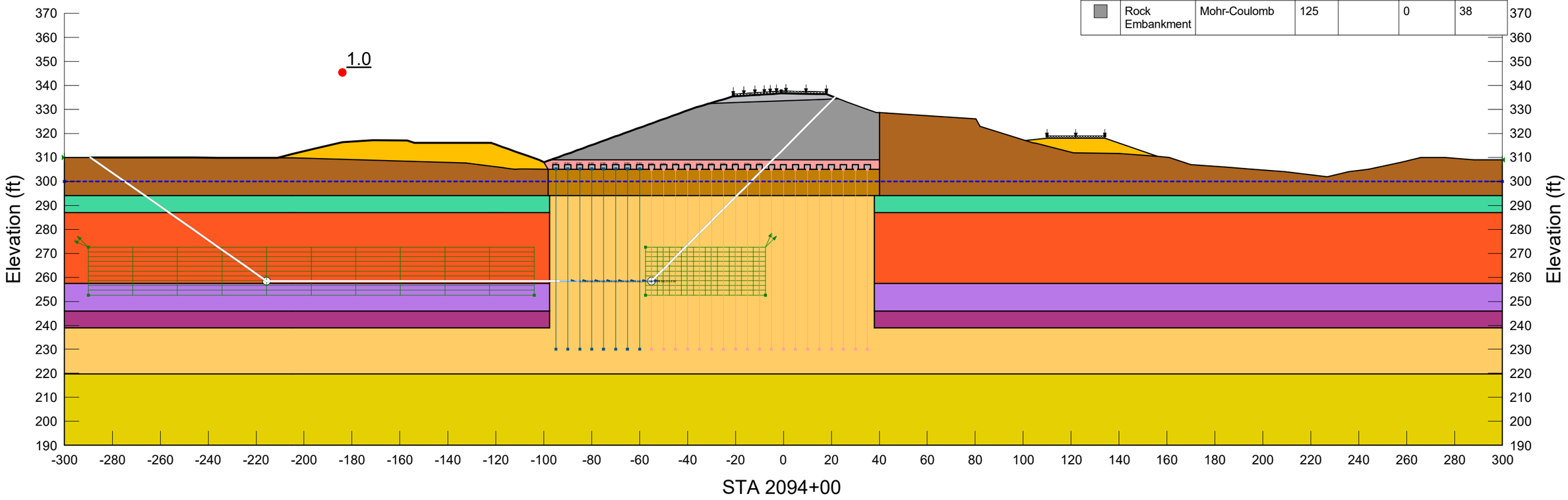

**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/19/2026**

# KY Abutment (STA 2094+00)
# Pseudo-Static Analysis : Critical Wedge_Step 6
# GWT Elevation:300 ft
# Surcharge (Unit Weight): 125 pcf
# Horizontal Seismic Coefficient: 0.222

## RI_Step 6
## Shear Force: 16,563 lbf

| Color | Name | Slope Stability Material Model | Unit Weight (pcf) | Undrained Shear Strength (psf) | Effective Cohesion (psf) | Effective Friction Angle (°) |
|---|---|---|---|---|---|---|
| | Cap | High Strength | 150 | | | |
| | DGA | Mohr-Coulomb | 125 | | 0 | 42 |
| | Fill | Mohr-Coulomb | 120 | | 0 | 32 |
| | Layer I - Imp. | Undrained (Phi=0) | 115 | 1,300 | | |
| | Layer I (Total) | Undrained (Phi=0) | 115 | 800 | | |
| | Layer II | Mohr-Coulomb | 130 | | 0 | 32 |
| | Layer III | Mohr-Coulomb | 130 | | 0 | 36 |
| | LTP | Mohr-Coulomb | 135 | | 0 | 42 |
| | PL-1 | Undrained (Phi=0) | 115 | 150 | | |
| | PL-2 | Undrained (Phi=0) | 130 | 350 | | |
| | PL-3 | Undrained (Phi=0) | 130 | 500 | | |
| | PL-4 | Undrained (Phi=0) | 130 | 700 | | |
| | Rock Embankment | Mohr-Coulomb | 125 | | 0 | 38 |




**US-51 Bridge**
**Alexander County, IL and Ballard County, KY**
**Analysis Type: Spencer**
**Critical Borings: B-2046 and B-6**

**Created By: Borders, Stephen  Date: 10/19/2026**

# Determine Newmark Displacements as a Function of $(k_h)_y$

# Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** STA 2094+00

| | |
|---|---|
| **Embankment Height (ft):** | 27.5 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.20 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.93 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.42 |
| **log(d)[5]:** | 1.00 |
| **Displacement, d (in):** | 9.9 |

Equation

[1] $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}\ where, 0.5 \leq \beta \leq 1.5$ (7-2)

[2] $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$ (7-2)

[3] $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$ (7-1)

[4] $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$ (5-11)

[5] $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$ (5-7)

## Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** STA 2094+00

| | |
|---|---|
| **Embankment Height (ft):** | 27.5 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.20 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.93 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.42 |
| **log(d)[5]:** | 0.97 |
| **Displacement, d (in):** | 9.4 |

Equation

[1] $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}\ where, 0.5 \leq \beta \leq 1.5$ (7-2)

[2] $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$ (7-2)

[3] $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$ (7-1)

[4] $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$ (5-11)

[5] $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$ (5-7)

## Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** STA 2094+00

| | |
|---|---|
| **Embankment Height (ft):** | 27.5 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.21 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.93 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.43 |
| **log(d)[5]:** | 0.95 |
| **Displacement, d (in):** | 9.0 |

Equation

1 $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}\ where, 0.5 \leq \beta \leq 1.5$ (7-2)

2 $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$ (7-2)

3 $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$ (7-1)

4 $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$ (5-11)

5 $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$ (5-7)

## Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** STA 2094+00

| | |
|---|---|
| **Embankment Height (ft):** | 27.5 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.21 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.93 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.44 |
| **log(d)[5]:** | 0.93 |
| **Displacement, d (in):** | 8.5 |

Equation

[1] $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}\ where, 0.5 \leq \beta \leq 1.5$ (7-2)

[2] $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$ (7-2)

[3] $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$ (7-1)

[4] $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$ (5-11)

[5] $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$ (5-7)

## Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** STA 2094+00

| | |
|---|---|
| **Embankment Height (ft):** | 27.5 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.21 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.93 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.44 |
| **log(d)[5]:** | 0.92 |
| **Displacement, d (in):** | 8.4 |

Equation

[1] $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}\ where, 0.5 \leq \beta \leq 1.5$ (7-2)

[2] $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$ (7-2)

[3] $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$ (7-1)

[4] $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$ (5-11)

[5] $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$ (5-7)

## Seismic Induced Newmark Sliding Block Displacements

*Based on National Cooperative Highway Research Program Report 611*
(http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_611.pdf)

LEGEND

| |
|---|
| Input Rqd |
| Calculation |
| Output |

**Analysis Location:** STA 2094+00

| | |
|---|---|
| **Embankment Height (ft):** | 27.5 |
| **Peak ADRS spectral acceleration at 1 second, $S_{D1}$:** | 0.93 |
| **Peak Horizontal Acceleration at Ground Surface, PGA ($k_{max}$):** | 0.48 |
| **Yield Acceleration, $k_y$:** | 0.22 |
| **Ground Motion Index[1], β:** | 1.50 |
| **Wave Scattering Scaling Factor[2], $\alpha_W$:** | 0.93 |
| **Average Seismic Horizontal Coeff. due to Wave Scattering[3], $k_h$:** | 0.45 |
| **Peak Ground Velocity[4], $V_{peak}$ (ft/s):** | 51.2 |
| **$k_y/k_{max}$:** | 0.46 |
| **log(d)[5]:** | 0.83 |
| **Displacement, d (in):** | 6.8 |

Equation

[1] $\beta = \frac{S_{D1}}{PGA} = \frac{F_v S_1}{k_{max}}\ where, 0.5 \leq \beta \leq 1.5$ (7-2)

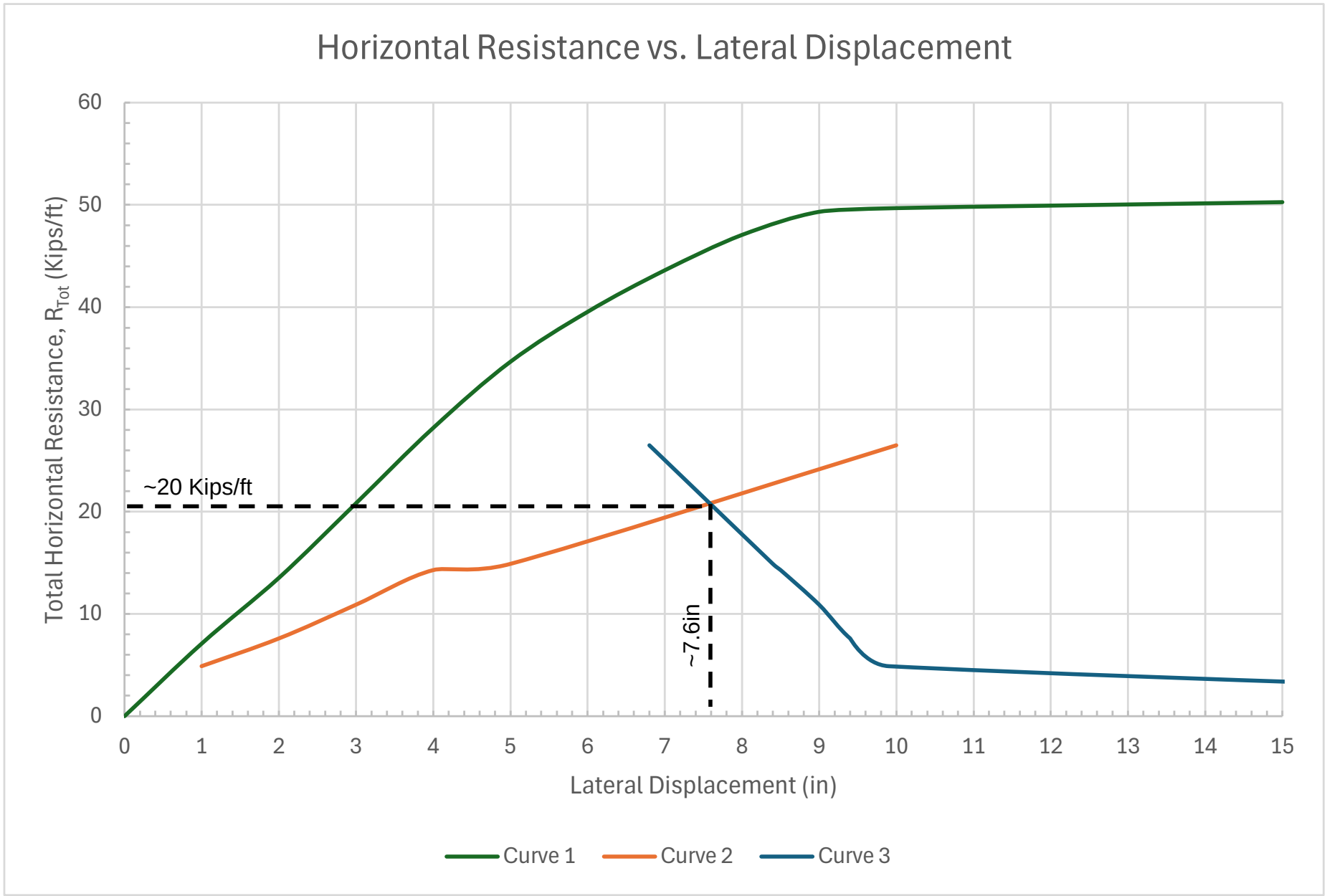
[2] $\alpha_W = 1 + 0.01H[(0.5\beta) - 1] \leq 1.0$ (7-2)

[3] $k_h = k_{avg} = \alpha_W k_{max} = \alpha_W PGA$ (7-1)

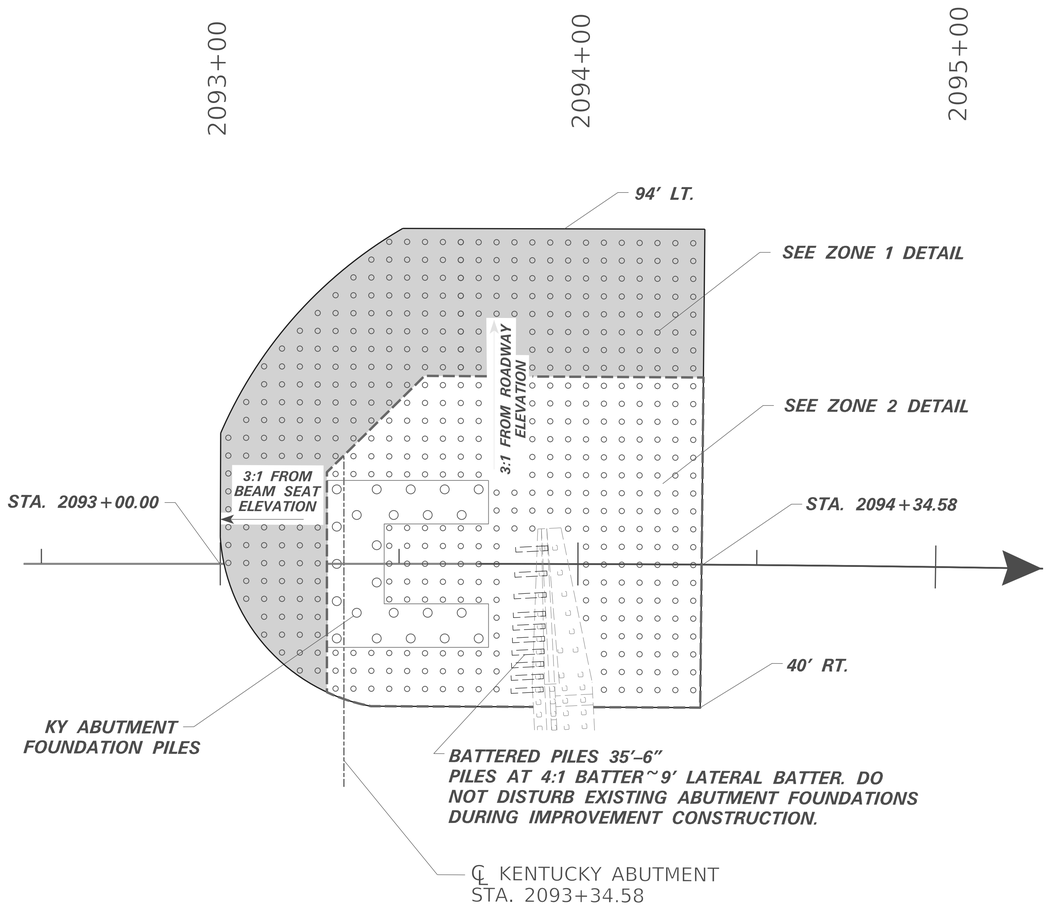
[4] $V_{peak} = PGV = 55F_v S_1 = 55S_{D1}$ (5-11)

[5] $\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{max}}\right)\right] - 0.85log(k_{max}) + 1.61log(V_{peak})$ (5-7)

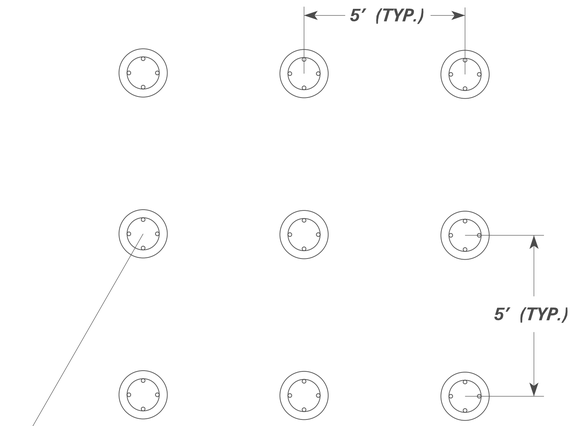
Plot $R_{Tot}$ versus Displacement ($\Delta$)


Horizontal Resistance vs. Lateral Displacement
Total Horizontal Resistance, $R_{Tot}$ (Kips/ft)
60
50
40
30
20
10
0
~20 Kips/ft
~7.6in
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Lateral Displacement (in)
Curve 1
Curve 2
Curve 3

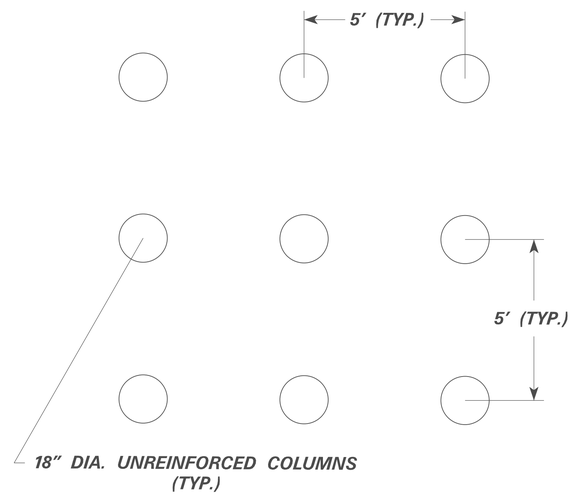
# Rigid Inclusion Layout




# US 51 BRIDGE
# KENTUCKY END BENT




## ZONE 1 DETAIL




## ZONE 2 DETAIL

US 51 BRIDGE REPLACEMENT

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
TEAM KENTUCKY TRANSPORTATION CABINET

| REVISION | DATE |
|---|---|
| | |
| | |
| | |

PREPARED BY: HDR

DATE: 02/27/2026 | CHECKED BY:
DESIGNED BY: S BORDERS
DETAILED BY: W SHUECRAFT

RIGID INCLUSION LAYOUT
CROSSING: OHIO RIVER

ROUTE: US 51
ITEM NO.: 01-1140.00
SHEET NO.:
COUNTY OF: BALLARD
DRAWING NUMBER:

# Attachment I: Settlement Results

hdrinc.com

333 West Vine Street, Suite 1400, Lexington, KY 40507-1681
(859) 629-4800

ROCSCIENCE



US-51 Cairo Bridge

HDR

Report Creation Date: 2026/05/28, 16:56:50

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# Settle3 Analysis Information

# US-51 Cairo Bridge

## Project Settings

| | |
|---|---|
| Document Name | KY Abutment STA 2093+72.58 Temp.s3z |
| Project Title | US-51 Cairo Bridge |
| Analysis | KY Abutment STA 2094+00 |
| Author | GCD |
| Company | HDR |
| Date Created | 03/27/2026, 12:11:27 PM |
| Last saved with Settle3 version | 5.026 |
| Stress Computation Method | Boussinesq |
| Stress Units | Imperial, stress as ksf |
| Settlement Units | inches |
| Time-dependent Consolidation Analysis | |
| Time Units | days |
| Permeability Units | feet/day |

### Advanced Settings

| | |
|---|---|
| Start of secondary consolidation (% of primary) | 95 |
| Min. stress for secondary consolidation (% of initial) | 1 |
| Reset time when load changes for secondary consolidation | No |
| Minimum settlement ratio for subgrade modulus | 0.9 |
| Use average poisson's ratio to calculate layered stresses | |
| Update Cv in each time step (improves consolidation accuracy) | |
| Ignore negative effective stresses in settlement calculations | |
| Add field points to load edges | |

### Soil Profile

| | |
|---|---|
| Layer Option | Horizontal Soil Layers |
| Vertical Axis | Elevation |
| Ground Elevation (ft) | 307.4 |

# Stage Settings

| Stage # | Name | Time [days] |
|---|---|---|
| 1 | Stage 1 | 0 |
| 2 | Stage 2 | 10000 |
| 3 | Stage 3 | 10000 |
| 4 | 50% Consolidation | 10013 |
| 5 | 90% Consolidation | 10041 |
| 6 | 6 Months after Placement | 10182.6 |
| 7 | 1 Year after Placement | 10365.3 |
| 8 | 1.5 Years after Placement | 10547.9 |
| 9 | 2 years after Placement | 10730.5 |
| 10 | Final | 10730.5 |
| 11 | After 75 Years | 37393.8 |

# Results (relative to Stage: Stage 2 = 10000 d)

Time taken to compute: 5.87977 seconds

## Stage: Stage 1 = 0 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | -15.1396 | 0 |
| Total Consolidation Settlement [in] | -15.1396 | 0 |
| Virgin Consolidation Settlement [in] | -14.4785 | 0 |
| Recompression Consolidation Settlement [in] | -0.661558 | 0 |
| Immediate Settlement [in] | 0 | 0 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | 0 | 0 |
| Loading Stress XX [ksf] | 0 | 0 |
| Loading Stress YY [ksf] | 0 | 0 |
| Effective Stress ZZ [ksf] | -3.37559 | 1.73548e-05 |
| Effective Stress XX [ksf] | -3.37559 | 1.82715e-05 |
| Effective Stress YY [ksf] | -3.37559 | 1.82715e-05 |
| Total Stress ZZ [ksf] | -1.82715e-05 | 1.77636e-15 |
| Total Stress XX [ksf] | -3.55271e-15 | 3.55271e-15 |
| Total Stress YY [ksf] | -3.55271e-15 | 1.77636e-15 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -0.374318 | 4.40858e-06 |
| Pore Water Pressure [ksf] | -1.82715e-05 | 3.37559 |
| Excess Pore Water Pressure [ksf] | -1.82715e-05 | 3.37559 |
| Degree of Consolidation [%] | -100 | 0 |
| Pre-consolidation Stress [ksf] | -3.35856 | 0 |
| Over-consolidation Ratio | -0.00306213 | 2 |
| Void Ratio | -8.86125e-06 | 0.752379 |
| Permeability [ft/d] | -0.371624 | 0 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -100 | 0 |
| Undrained Shear Strength | -0.151609 | 0 |

## Stage: Stage 2 = 10000 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 0 |
| Total Consolidation Settlement [in] | 0 | 0 |
| Virgin Consolidation Settlement [in] | 0 | 0 |
| Recompression Consolidation Settlement [in] | 0 | 0 |
| Immediate Settlement [in] | 0 | 0 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | 0 | 0 |
| Loading Stress XX [ksf] | 0 | 0 |
| Loading Stress YY [ksf] | 0 | 0 |
| Effective Stress ZZ [ksf] | 0 | 0 |
| Effective Stress XX [ksf] | 0 | 0 |
| Effective Stress YY [ksf] | 0 | 0 |
| Total Stress ZZ [ksf] | 0 | 0 |
| Total Stress XX [ksf] | 0 | 0 |
| Total Stress YY [ksf] | 0 | 0 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0 |
| Pore Water Pressure [ksf] | 0 | 0 |
| Excess Pore Water Pressure [ksf] | 0 | 0 |
| Degree of Consolidation [%] | 0 | 0 |
| Pre-consolidation Stress [ksf] | 0 | 0 |
| Over-consolidation Ratio | 0 | 0 |
| Void Ratio | 0 | 0 |
| Permeability [ft/d] | 0 | 0 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 0 |
| Undrained Shear Strength | 0 | 0 |

## Stage: Stage 3 = 10000 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 2.81731 |
| Total Consolidation Settlement [in] | -2.77556e-17 | 2.66454e-15 |
| Virgin Consolidation Settlement [in] | 0 | 1.77636e-15 |
| Recompression Consolidation Settlement [in] | -2.22045e-16 | 1.11022e-16 |
| Immediate Settlement [in] | 0 | 2.81731 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Loading Stress XX [ksf] | -0.95607 | 3.18157 |
| Loading Stress YY [ksf] | -0.4716 | 1.69357 |
| Effective Stress ZZ [ksf] | -8.88178e-16 | 8.88178e-16 |
| Effective Stress XX [ksf] | -0.95607 | 3.18157 |
| Effective Stress YY [ksf] | -0.4716 | 1.69357 |
| Total Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Total Stress XX [ksf] | -0.79277 | 5.08183 |
| Total Stress YY [ksf] | -0.431212 | 3.97347 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -3.46945e-18 | 0.0067403 |
| Pore Water Pressure [ksf] | -5.34523e-05 | 2.30137 |
| Excess Pore Water Pressure [ksf] | -5.34523e-05 | 2.30137 |
| Degree of Consolidation [%] | -96.9961 | 0 |
| Pre-consolidation Stress [ksf] | 0 | 8.88178e-16 |
| Over-consolidation Ratio | -8.88178e-16 | 8.88178e-16 |
| Void Ratio | -1.11022e-16 | 0 |
| Permeability [ft/d] | 0 | 0 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -100 | 0 |
| Undrained Shear Strength | -1.11022e-16 | 1.11022e-16 |

## Stage: 50% Consolidation = 10013 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 10.2966 |
| Total Consolidation Settlement [in] | 0 | 7.47924 |
| Virgin Consolidation Settlement [in] | 0 | 7.41366 |
| Recompression Consolidation Settlement [in] | -6.72347e-05 | 0.358156 |
| Immediate Settlement [in] | 0 | 2.81731 |
| Secondary Settlement [in] | 0 | 0.000222981 |
| Loading Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Loading Stress XX [ksf] | -0.95607 | 3.18157 |
| Loading Stress YY [ksf] | -0.4716 | 1.69357 |
| Effective Stress ZZ [ksf] | -0.059993 | 2.29696 |
| Effective Stress XX [ksf] | -0.823456 | 5.08183 |
| Effective Stress YY [ksf] | -0.431212 | 3.97347 |
| Total Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Total Stress XX [ksf] | -0.79277 | 5.08183 |
| Total Stress YY [ksf] | -0.431212 | 3.97347 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -5.96678e-05 | 0.148577 |
| Pore Water Pressure [ksf] | -0.0509178 | 1.81917 |
| Excess Pore Water Pressure [ksf] | -0.0509178 | 1.81917 |
| Degree of Consolidation [%] | -75.832 | 99.9608 |
| Pre-consolidation Stress [ksf] | 0 | 2.29632 |
| Over-consolidation Ratio | -1.10093 | 0.0411615 |
| Void Ratio | -0.298639 | 0.000119932 |
| Permeability [ft/d] | -0.00183698 | 0.0126303 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -95.8064 | 0 |
| Undrained Shear Strength | -0.000812821 | 0.111843 |

## Stage: 90% Consolidation = 10041 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 13.5251 |
| Total Consolidation Settlement [in] | 0 | 10.7077 |
| Virgin Consolidation Settlement [in] | 0 | 10.6417 |
| Recompression Consolidation Settlement [in] | 0 | 0.379805 |
| Immediate Settlement [in] | 0 | 2.81731 |
| Secondary Settlement [in] | 0 | 0.000696953 |
| Loading Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Loading Stress XX [ksf] | -0.95607 | 3.18157 |
| Loading Stress YY [ksf] | -0.4716 | 1.69357 |
| Effective Stress ZZ [ksf] | -0.0593888 | 2.29696 |
| Effective Stress XX [ksf] | -0.799388 | 5.08183 |
| Effective Stress YY [ksf] | -0.431212 | 3.97347 |
| Total Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Total Stress XX [ksf] | -0.79277 | 5.08183 |
| Total Stress YY [ksf] | -0.431212 | 3.97347 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -4.074e-05 | 0.148589 |
| Pore Water Pressure [ksf] | -0.0714983 | 0.438253 |
| Excess Pore Water Pressure [ksf] | -0.0714983 | 0.438253 |
| Degree of Consolidation [%] | -33.6418 | 99.9919 |
| Pre-consolidation Stress [ksf] | 0 | 2.29685 |
| Over-consolidation Ratio | -1.28038 | 0.0103227 |
| Void Ratio | -0.298664 | 8.18874e-05 |
| Permeability [ft/d] | -0.00183698 | 0.0126303 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -39.3507 | 0 |
| Undrained Shear Strength | -0.000424914 | 0.141071 |

## Stage: 6 Months after Placement = 10182.6 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 14.2989 |
| Total Consolidation Settlement [in] | 0 | 11.4794 |
| Virgin Consolidation Settlement [in] | 0 | 11.4134 |
| Recompression Consolidation Settlement [in] | 0 | 0.383451 |
| Immediate Settlement [in] | 0 | 2.81731 |
| Secondary Settlement [in] | 0 | 0.00310167 |
| Loading Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Loading Stress XX [ksf] | -0.95607 | 3.18157 |
| Loading Stress YY [ksf] | -0.4716 | 1.69357 |
| Effective Stress ZZ [ksf] | -0.0591214 | 2.31938 |
| Effective Stress XX [ksf] | -0.792789 | 5.08183 |
| Effective Stress YY [ksf] | -0.431212 | 3.97347 |
| Total Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Total Stress XX [ksf] | -0.79277 | 5.08183 |
| Total Stress YY [ksf] | -0.431212 | 3.97347 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80415e-05 | 0.148609 |
| Pore Water Pressure [ksf] | -0.0803051 | 0.0600307 |
| Excess Pore Water Pressure [ksf] | -0.0803051 | 0.0600307 |
| Degree of Consolidation [%] | -0.12121 | 100 |
| Pre-consolidation Stress [ksf] | 0 | 2.30123 |
| Over-consolidation Ratio | -1.34169 | 0.0102345 |
| Void Ratio | -0.298703 | 5.63635e-05 |
| Permeability [ft/d] | -0.00183698 | 0.0126303 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -0.0675051 | 0.0149187 |
| Undrained Shear Strength | -0.000407822 | 0.149408 |

## Stage: 1 Year after Placement = 10365.3 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 14.3028 |
| Total Consolidation Settlement [in] | 0 | 11.4803 |
| Virgin Consolidation Settlement [in] | 0 | 11.4143 |
| Recompression Consolidation Settlement [in] | 0 | 0.38346 |
| Immediate Settlement [in] | 0 | 2.81731 |
| Secondary Settlement [in] | 0 | 0.00615549 |
| Loading Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Loading Stress XX [ksf] | -0.95607 | 3.18157 |
| Loading Stress YY [ksf] | -0.4716 | 1.69357 |
| Effective Stress ZZ [ksf] | -0.0591209 | 2.31724 |
| Effective Stress XX [ksf] | -0.792778 | 5.08183 |
| Effective Stress YY [ksf] | -0.431212 | 3.97347 |
| Total Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Total Stress XX [ksf] | -0.79277 | 5.08183 |
| Total Stress YY [ksf] | -0.431212 | 3.97347 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -1.2394e-05 | 0.148631 |
| Pore Water Pressure [ksf] | -0.0803199 | 0.0600302 |
| Excess Pore Water Pressure [ksf] | -0.0803199 | 0.0600302 |
| Degree of Consolidation [%] | -0.0163414 | 100 |
| Pre-consolidation Stress [ksf] | 0 | 2.30164 |
| Over-consolidation Ratio | -1.34171 | 0.0102343 |
| Void Ratio | -0.298749 | 2.49119e-05 |
| Permeability [ft/d] | -0.00183698 | 0.0126303 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -0.0118308 | 0.015151 |
| Undrained Shear Strength | -0.000407822 | 0.149408 |

## Stage: 1.5 Years after Placement = 10547.9 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 14.3058 |
| Total Consolidation Settlement [in] | 0 | 11.4803 |
| Virgin Consolidation Settlement [in] | 0 | 11.4143 |
| Recompression Consolidation Settlement [in] | 0 | 0.38346 |
| Immediate Settlement [in] | 0 | 2.81731 |
| Secondary Settlement [in] | 0 | 0.00915434 |
| Loading Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Loading Stress XX [ksf] | -0.95607 | 3.18157 |
| Loading Stress YY [ksf] | -0.4716 | 1.69357 |
| Effective Stress ZZ [ksf] | -0.0591209 | 2.31641 |
| Effective Stress XX [ksf] | -0.792778 | 5.08183 |
| Effective Stress YY [ksf] | -0.431212 | 3.97347 |
| Total Stress ZZ [ksf] | -5.34523e-05 | 2.30137 |
| Total Stress XX [ksf] | -0.79277 | 5.08183 |
| Total Stress YY [ksf] | -0.431212 | 3.97347 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.148654 |
| Pore Water Pressure [ksf] | -0.0803199 | 0.0600302 |
| Excess Pore Water Pressure [ksf] | -0.0803199 | 0.0600302 |
| Degree of Consolidation [%] | -0.00587747 | 100 |
| Pre-consolidation Stress [ksf] | 0 | 2.30169 |
| Over-consolidation Ratio | -1.34164 | 0.0102343 |
| Void Ratio | -0.298794 | 0 |
| Permeability [ft/d] | -0.00183698 | 0.0126303 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -0.0118308 | 0.0151511 |
| Undrained Shear Strength | -0.000407822 | 0.149408 |

## Stage: 2 years after Placement = 10730.5 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 14.8892 |
| Total Consolidation Settlement [in] | 0 | 11.4811 |
| Virgin Consolidation Settlement [in] | 0 | 11.4152 |
| Recompression Consolidation Settlement [in] | -1.09788e-06 | 0.383459 |
| Immediate Settlement [in] | 0 | 3.39684 |
| Secondary Settlement [in] | 0 | 0.0121017 |
| Loading Stress ZZ [ksf] | -5.34088e-05 | 2.68942 |
| Loading Stress XX [ksf] | -1.21997 | 3.44314 |
| Loading Stress YY [ksf] | -0.555287 | 2.02615 |
| Effective Stress ZZ [ksf] | -0.0591209 | 2.33327 |
| Effective Stress XX [ksf] | -1.03193 | 5.2496 |
| Effective Stress YY [ksf] | -0.481112 | 4.30605 |
| Total Stress ZZ [ksf] | -5.34088e-05 | 2.68942 |
| Total Stress XX [ksf] | -1.01393 | 5.62086 |
| Total Stress YY [ksf] | -0.481112 | 4.69767 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.148676 |
| Pore Water Pressure [ksf] | -0.0768301 | 1.03849 |
| Excess Pore Water Pressure [ksf] | -0.0768301 | 1.03849 |
| Degree of Consolidation [%] | -99.3095 | 97.7782 |
| Pre-consolidation Stress [ksf] | 0 | 2.3035 |
| Over-consolidation Ratio | -1.34093 | 0.0102343 |
| Void Ratio | -0.298838 | 0 |
| Permeability [ft/d] | -0.00183698 | 0.0126303 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -100 | 0 |
| Undrained Shear Strength | -0.000407822 | 0.15028 |

## Stage: Final = 10730.5 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 14.9029 |
| Total Consolidation Settlement [in] | 0 | 11.4948 |
| Virgin Consolidation Settlement [in] | 0 | 11.4289 |
| Recompression Consolidation Settlement [in] | -1.09788e-06 | 0.383459 |
| Immediate Settlement [in] | 0 | 3.39684 |
| Secondary Settlement [in] | 0 | 0.0121017 |
| Loading Stress ZZ [ksf] | -5.34088e-05 | 2.68942 |
| Loading Stress XX [ksf] | -1.21997 | 3.44314 |
| Loading Stress YY [ksf] | -0.555287 | 2.02615 |
| Effective Stress ZZ [ksf] | -0.0591209 | 2.68942 |
| Effective Stress XX [ksf] | -1.0317 | 5.62086 |
| Effective Stress YY [ksf] | -0.481112 | 4.69767 |
| Total Stress ZZ [ksf] | -5.34088e-05 | 2.68942 |
| Total Stress XX [ksf] | -1.01393 | 5.62086 |
| Total Stress YY [ksf] | -0.481112 | 4.69767 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -7.0264e-06 | 0.233794 |
| Pore Water Pressure [ksf] | -0.0768301 | 1.03849 |
| Excess Pore Water Pressure [ksf] | -0.0768301 | 1.03849 |
| Degree of Consolidation [%] | -99.1584 | 98.9056 |
| Pre-consolidation Stress [ksf] | 0 | 2.6005 |
| Over-consolidation Ratio | -1.99998 | 0.0102343 |
| Void Ratio | -0.469926 | 1.41237e-05 |
| Permeability [ft/d] | -0.00183698 | 0.371624 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -100 | 0 |
| Undrained Shear Strength | -0.000407822 | 0.15028 |

## Stage: After 75 Years = 37393.8 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 16.3805 |
| Total Consolidation Settlement [in] | 0 | 12.7575 |
| Virgin Consolidation Settlement [in] | 0 | 12.6915 |
| Recompression Consolidation Settlement [in] | 0 | 0.625842 |
| Immediate Settlement [in] | 0 | 3.39684 |
| Secondary Settlement [in] | 0 | 0.310475 |
| Loading Stress ZZ [ksf] | -5.34088e-05 | 2.68942 |
| Loading Stress XX [ksf] | -1.21997 | 3.44314 |
| Loading Stress YY [ksf] | -0.555287 | 2.02615 |
| Effective Stress ZZ [ksf] | -0.0589578 | 2.68942 |
| Effective Stress XX [ksf] | -1.01393 | 5.62086 |
| Effective Stress YY [ksf] | -0.481112 | 4.69767 |
| Total Stress ZZ [ksf] | -5.34088e-05 | 2.68942 |
| Total Stress XX [ksf] | -1.01393 | 5.62086 |
| Total Stress YY [ksf] | -0.481112 | 4.69767 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -6.6727e-06 | 0.28711 |
| Pore Water Pressure [ksf] | -0.0803199 | 0.0600302 |
| Excess Pore Water Pressure [ksf] | -0.0803199 | 0.0600302 |
| Degree of Consolidation [%] | -0.000160284 | 100 |
| Pre-consolidation Stress [ksf] | 0 | 2.68942 |
| Over-consolidation Ratio | -1.99998 | 0.01018 |
| Void Ratio | -0.577092 | 1.34128e-05 |
| Permeability [ft/d] | -0.00183698 | 0.371624 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | -0.0118308 | 0.0151511 |
| Undrained Shear Strength | -0.000407822 | 0.159198 |

# Embankments

## 1. Embankment: "Embankment Load 2"

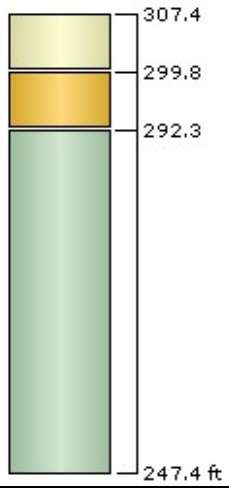
| | |
|---|---|
| Label | Embankment Load 2 |
| Center Line | (0, 0) to (0, 100) |
| Near End Angle | 14.04 degrees |
| Far End Angle | 90 degrees |
| Number of Layers | 3 |

| Layer | Stage | Unit Weight (kips/ft3) |
|---|---|---|
| 1 | 2 years after Placement | 0.125 |
| 2 | Stage 3 | 0.125 |
| 3 | Stage 1 | 0.115 |

# Soil Layers

Ground Surface Drained: Yes

| Layer # | Type | Thickness [ft] | Elevation [ft] | Drained at Bottom |
|---|---|---|---|---|
| 1 | Soil Property 1 | 7.6 | 307.4 | No |
| 2 | Soil Property 2 | 7.5 | 299.8 | Yes |
| 3 | Soil Property 3 | 44.9 | 292.3 | Yes |



# Soil Properties

| Property | Soil Property 1 | Soil Property 3 | Soil Property 2 |
|---|---|---|---|
| Color | | | |
| Unit Weight [kips/ft3] | 0.115 | 0.13 | 0.115 |
| Saturated Unit Weight [kips/ft3] | 0.12 | 0.13 | 0.12 |
| K0 | 1 | 1 | 1 |
| Immediate Settlement | Disabled | Enabled | Disabled |
| Es [ksf] | - | 331.7 | - |
| Esur [ksf] | - | 331.7 | - |
| Primary Consolidation | Enabled | Disabled | Enabled |
| Material Type | Non-Linear | | Non-Linear |
| Cc | 0.35 | - | 0.35 |
| Cr | 0.02 | - | 0.02 |
| e0 | 1.01 | - | 1.01 |
| OCR | 3 | - | 1.8 |
| Cv [ft2/d] | 0.71 | - | 0.71 |
| Cvr [ft2/d] | 0.71 | - | 0.71 |
| B-bar | 1 | - | 1 |
| Secondary Consolidation | Standard | Disabled | Standard |
| Ca | 0.004 | - | 0.004 |
| Car | 0.004 | - | 0.004 |
| Undrained Su A [kips/ft2] | 0 | 0 | 0 |
| Undrained Su S | 0.2 | 0.2 | 0.2 |
| Undrained Su m | 0.8 | 0.8 | 0.8 |
| Piezo Line ID | 1 | 1 | 1 |

# Groundwater

| | |
|---|---|
| Groundwater method | Piezometric Lines |
| Water Unit Weight | 0.0624 kips/ft3 |
| Generating excess pore pressure above water table | |

## Piezometric Line Entities

| ID | Elevation (ft) |
|---|---|
| 1 | 300 ft |

# Query

## Query Points

| Point # | Query Point Name | (X,Y) Location | Number of Divisions |
|---|---|---|---|
| 1 | Query Point 1 | -18.793, 44.379 | Auto: 57 |

## Field Point Grid

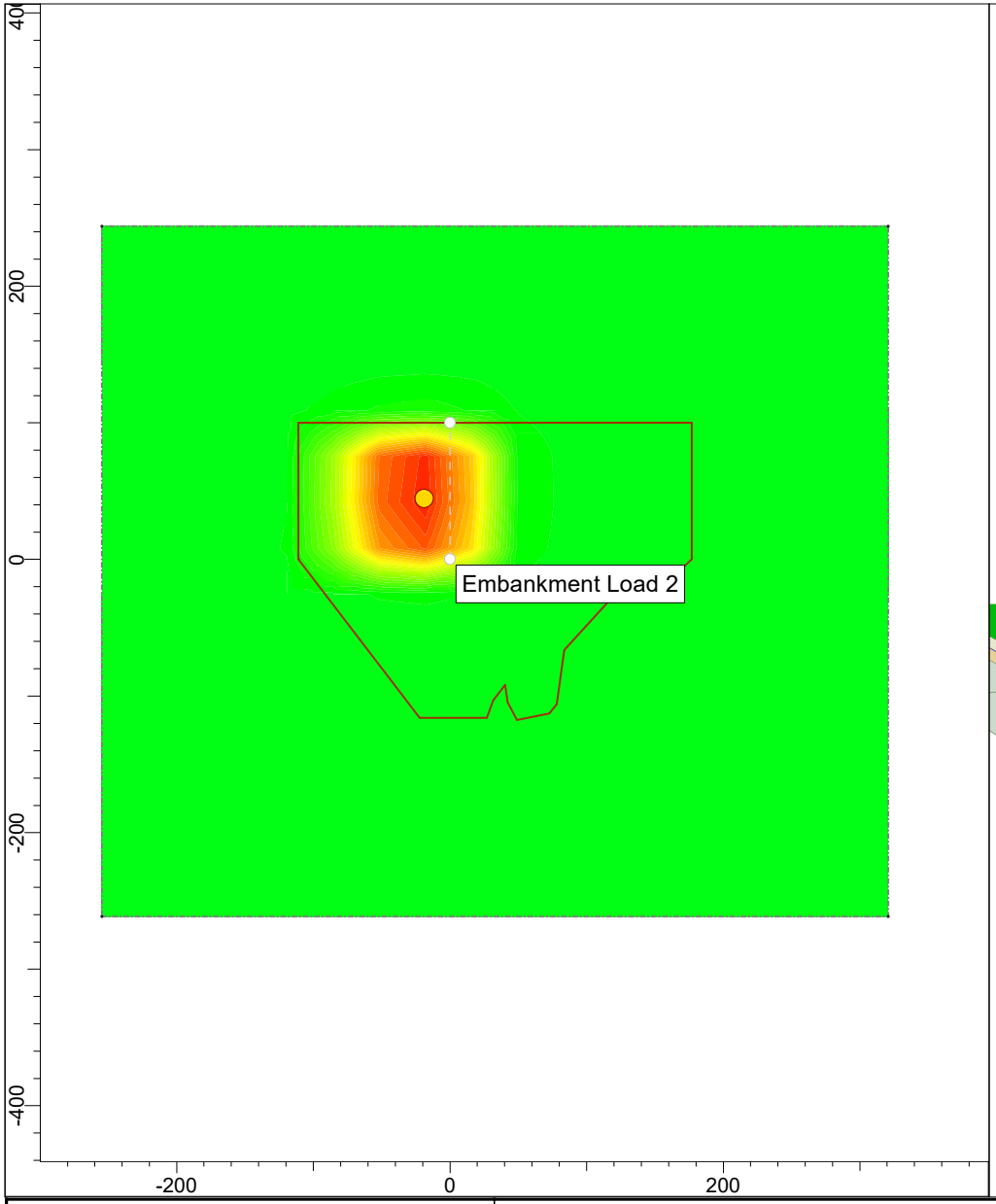
| | |
|---|---|
| Number of points | 288 |
| Expansion Factor | 2 |

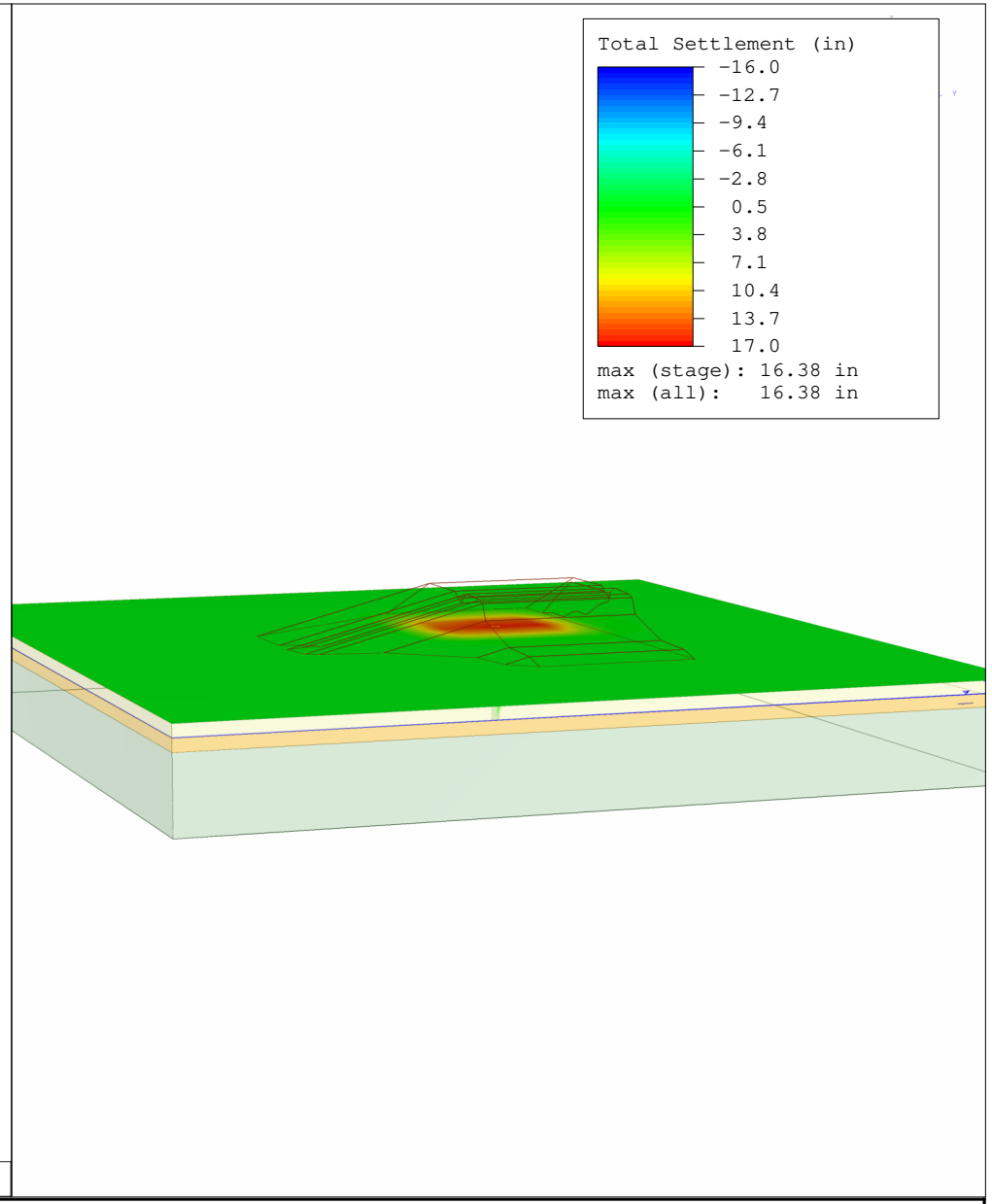
### Grid Coordinates

| X [ft] | Y [ft] |
|---|---|
| 320.696 | 243.896 |
| 320.696 | -261.463 |
| -254.887 | -261.463 |
| -254.887 | 243.896 |

# Time Points

| Point # | (X,Y) Location | Elevation | Goal Type | Goal | Time Until Goal |
|---|---|---|---|---|---|
| 1 | -18.793, 44.379 | 301.5 ft | Degree of Consolidation | 90% | 39.374 d |
| 2 | -18.793, 44.379 | 300.7 ft | Degree of Consolidation | 90% | 38.9672 d |
| 3 | -18.793, 44.379 | 300.7 ft | Degree of Consolidation | 50% | 12.4561 d |



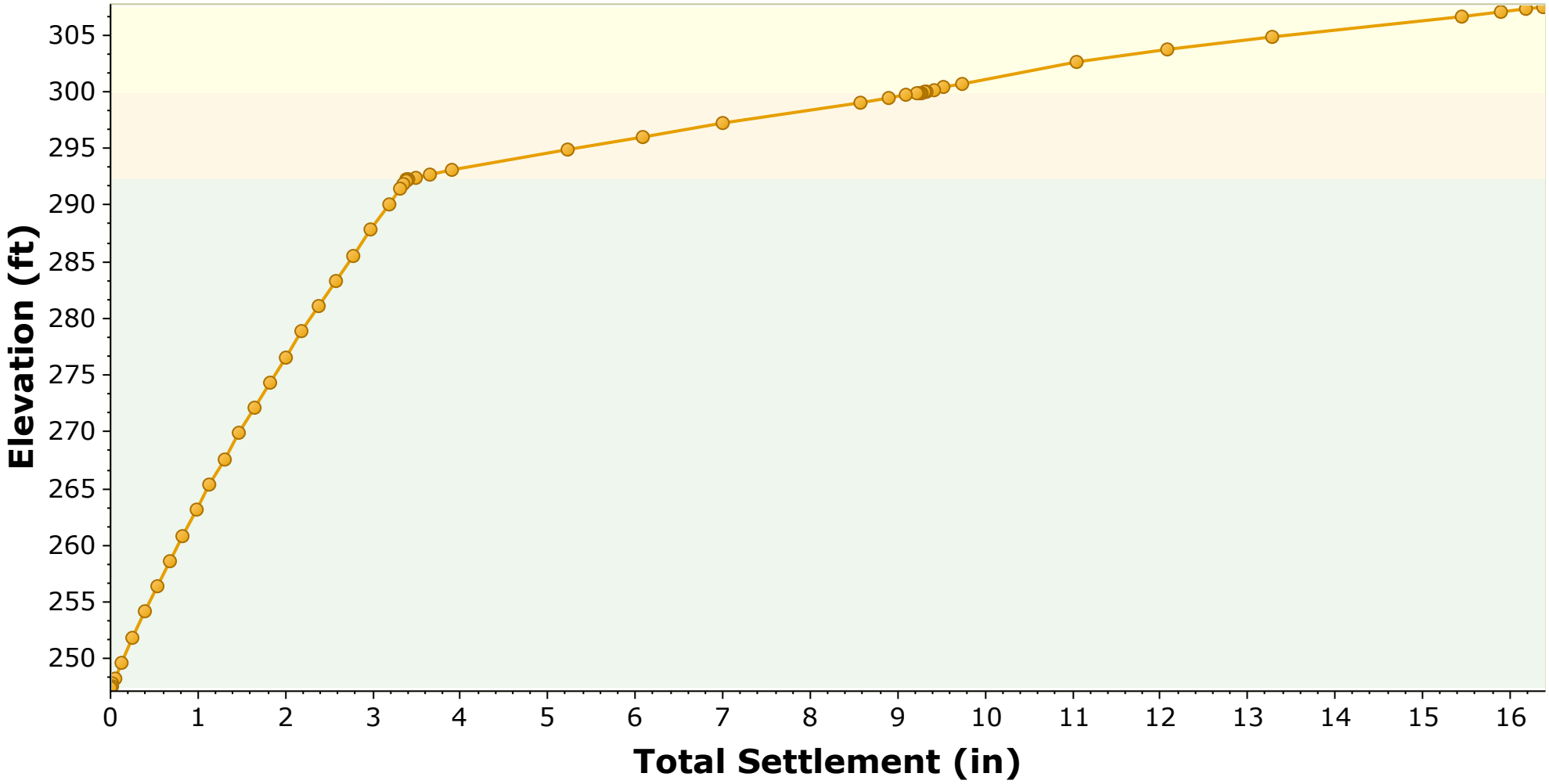




ROCSCIENCE

SETTLE3 5.026

| | | | |
|---|---|---|---|
| *Project* | US-51 Cairo Bridge | | |
| *Analysis Description* | KY Abutment STA 2094+00 | | |
| *Drawn By* | GCD | *Company* | HDR |
| *Date* | 03/27/2026, 12:11:27 PM | *File Name* | KY Abutment STA 2093+72.58 Temp.s3z |

# Total Settlement vs. Elevation



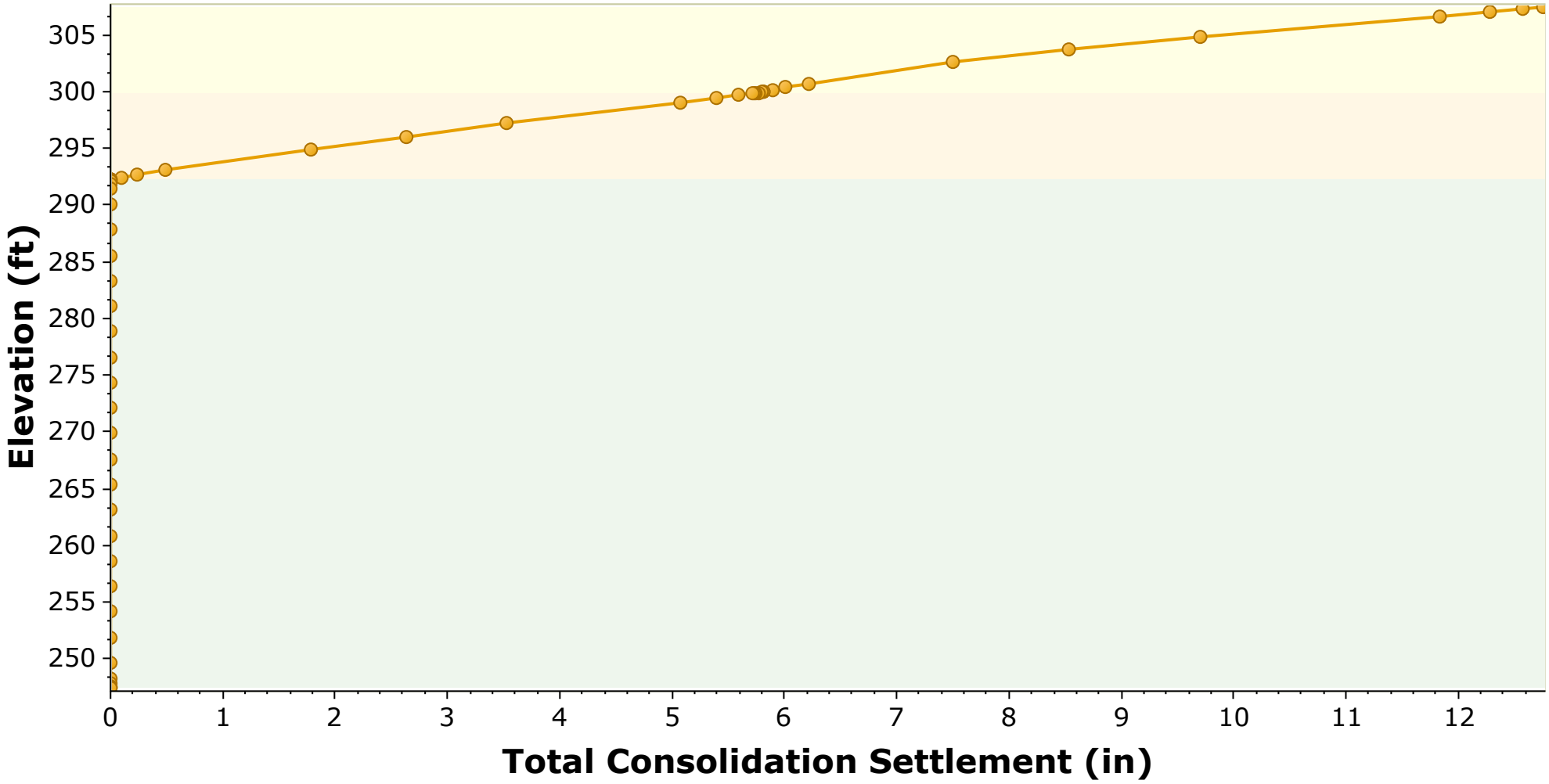

Query Point 1 (After 75 Years = 37393.8 d)

Reference Stage: Stage 2 = 10000 d

| | | | |
|---|---|---|---|
| ROCSCIENCE | *Project* | US-51 Cairo Bridge | |
| | *Analysis Description* | KY Abutment STA 2094+00 | |
| | *Drawn By* | GCD | *Company* HDR |
| | *Date* | 03/27/2026, 12:11:27 PM | *File Name* KY Abutment STA 2093+72.58 Temp.s3z |

SETTLE3 5.026

# Total Consolidation Settlement vs. Elevation




Query Point 1 (After 75 Years = 37393.8 d)

Reference Stage: Stage 2 = 10000 d

| | | |
|---|---|---|
| ROCSCIENCE | Project: US-51 Cairo Bridge | |
| | Analysis Description: KY Abutment STA 2094+00 | |
| | Drawn By: GCD | Company: HDR |
| | Date: 03/27/2026, 12:11:27 PM | File Name: KY Abutment STA 2093+72.58 Temp.s3z |

SETTLE3 5.026

ROCSCIENCE



US-51 over the Ohio River

HDR

Report Creation Date: 2026/04/27, 13:24:56

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# Settle3 Analysis Information

# US-51 over the Ohio River

## Project Settings

| | |
|---|---|
| Document Name | STA 2096+50 KY Temp Borehole.s3z |
| Project Title | US-51 over the Ohio River |
| Analysis | STA 2096+50 |
| Author | ER |
| Company | HDR |
| Date Created | 12/17/2025, 12:11:27 PM |
| Last saved with Settle3 version | 5.026 |
| Stress Computation Method | Boussinesq |
| Stress Units | Imperial, stress as ksf |
| Settlement Units | inches |
| Time-dependent Consolidation Analysis | |
| Time Units | days |
| Permeability Units | feet/day |

### Advanced Settings

| | |
|---|---|
| Start of secondary consolidation (% of primary) | 95 |
| Min. stress for secondary consolidation (% of initial) | 1 |
| Reset time when load changes for secondary consolidation | No |
| Minimum settlement ratio for subgrade modulus | 0.9 |
| Use average poisson's ratio to calculate layered stresses | |
| Update Cv in each time step (improves consolidation accuracy) | |
| Ignore negative effective stresses in settlement calculations | |
| Add field points to load edges | |

### Soil Profile

| | |
|---|---|
| Layer Option | Non-Horizontal Layers |
| Interpolation Method | TIN Triangulation |
| Use Non-Horizontal Ground Surface | No |
| Vertical Axis | Elevation |
| Ground Elevation (ft) | 300.5 |

# Stage Settings

| Stage # | Name | Time [days] |
|---|---|---|
| 1 | Existing Embankment | 0 |
| 2 | Existing Embankment Settled | 10000 |
| 3 | Temp Grade is Placed | 10000 |
| 4 | 50% Consolidation | 10007.2 |
| 5 | 90% Consolidation | 10054.7 |
| 6 | 0.5 Year after Placement | 10180 |
| 7 | 1 Year after Placement | 10360 |
| 8 | 1.5 Year after Placement | 10540 |
| 9 | 2 years after Placement | 10720 |
| 10 | Final Grade | 10720 |
| 11 | After 75 Years | 37393.8 |

# Results

Time taken to compute: 7.4063 seconds

## Stage: Existing Embankment = 0 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 6.10233 |
| Total Consolidation Settlement [in] | 0 | 0 |
| Virgin Consolidation Settlement [in] | 0 | 0 |
| Recompression Consolidation Settlement [in] | 0 | 0 |
| Immediate Settlement [in] | 0 | 6.10233 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.31217 |
| Loading Stress XX [ksf] | -0.491075 | 2.66197 |
| Loading Stress YY [ksf] | -0.774226 | 3.56255 |
| Effective Stress ZZ [ksf] | 0 | 3.187 |
| Effective Stress XX [ksf] | -0.491075 | 4.17667 |
| Effective Stress YY [ksf] | -0.35372 | 6.58411 |
| Total Stress ZZ [ksf] | -1.19147e-05 | 8.106 |
| Total Stress XX [ksf] | -0.491075 | 9.24153 |
| Total Stress YY [ksf] | -0.35372 | 11.6673 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.0453075 |
| Pore Water Pressure [ksf] | -1.19256e-05 | 5.08317 |
| Excess Pore Water Pressure [ksf] | -1.19256e-05 | 3.31217 |
| Degree of Consolidation [%] | 0 | 0 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.04907 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | -1.11022e-16 | 5.55112e-17 |

## Stage: Existing Embankment Settled = 10000 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 17.7164 |
| Total Consolidation Settlement [in] | 0 | 11.6623 |
| Virgin Consolidation Settlement [in] | 0 | 10.6763 |
| Recompression Consolidation Settlement [in] | 0 | 1.44547 |
| Immediate Settlement [in] | 0 | 6.10233 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.31217 |
| Loading Stress XX [ksf] | -0.491075 | 2.66197 |
| Loading Stress YY [ksf] | -0.774226 | 3.56255 |
| Effective Stress ZZ [ksf] | 0 | 5.4177 |
| Effective Stress XX [ksf] | -0.491075 | 6.54131 |
| Effective Stress YY [ksf] | -0.35372 | 8.97898 |
| Total Stress ZZ [ksf] | 0 | 8.106 |
| Total Stress XX [ksf] | -0.491075 | 9.24153 |
| Total Stress YY [ksf] | -0.35372 | 11.6673 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80237e-05 | 0.403136 |
| Pore Water Pressure [ksf] | -0.00650337 | 2.808 |
| Excess Pore Water Pressure [ksf] | -0.00650337 | 0.00841768 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.41713 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.174182 |

## Stage: Temp Grade is Placed = 10000 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 17.7942 |
| Total Consolidation Settlement [in] | 0 | 11.6623 |
| Virgin Consolidation Settlement [in] | 0 | 10.6763 |
| Recompression Consolidation Settlement [in] | 0 | 1.44547 |
| Immediate Settlement [in] | 0 | 6.18009 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.49686 |
| Loading Stress XX [ksf] | -0.480372 | 2.92584 |
| Loading Stress YY [ksf] | -1.60133 | 3.24957 |
| Effective Stress ZZ [ksf] | 0 | 5.4177 |
| Effective Stress XX [ksf] | -0.480372 | 6.61496 |
| Effective Stress YY [ksf] | -0.408276 | 8.0564 |
| Total Stress ZZ [ksf] | -1.13911e-10 | 8.39789 |
| Total Stress XX [ksf] | -0.480372 | 9.29754 |
| Total Stress YY [ksf] | -0.408276 | 11.4621 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80237e-05 | 0.403136 |
| Pore Water Pressure [ksf] | -0.00523141 | 4.4416 |
| Excess Pore Water Pressure [ksf] | -0.00523141 | 2.61055 |
| Degree of Consolidation [%] | 0 | 99.9998 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.41713 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.174182 |

## Stage: 50% Consolidation = 10007.2 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 17.7945 |
| Total Consolidation Settlement [in] | 0 | 11.6627 |
| Virgin Consolidation Settlement [in] | 0 | 10.6766 |
| Recompression Consolidation Settlement [in] | 0 | 1.47856 |
| Immediate Settlement [in] | 0 | 6.18009 |
| Secondary Settlement [in] | 0 | 6.95148e-05 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.49686 |
| Loading Stress XX [ksf] | -0.480372 | 2.92584 |
| Loading Stress YY [ksf] | -1.60133 | 3.24957 |
| Effective Stress ZZ [ksf] | 0 | 5.65163 |
| Effective Stress XX [ksf] | -0.480372 | 6.6165 |
| Effective Stress YY [ksf] | -0.408276 | 8.17137 |
| Total Stress ZZ [ksf] | 0 | 8.39789 |
| Total Stress XX [ksf] | -0.480372 | 9.29754 |
| Total Stress YY [ksf] | -0.408276 | 11.4621 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -0.000114591 | 0.406312 |
| Pore Water Pressure [ksf] | 0 | 5.13408 |
| Excess Pore Water Pressure [ksf] | 0 | 2.55146 |
| Degree of Consolidation [%] | 0 | 99.9999 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.65102 |
| Over-consolidation Ratio | 1 | 3.01954 |
| Void Ratio | 0 | 1.11017 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.174371 |

## Stage: 90% Consolidation = 10054.7 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 17.7954 |
| Total Consolidation Settlement [in] | 0 | 11.6635 |
| Virgin Consolidation Settlement [in] | 0 | 10.677 |
| Recompression Consolidation Settlement [in] | 0 | 1.95317 |
| Immediate Settlement [in] | 0 | 6.18009 |
| Secondary Settlement [in] | 0 | 0.000554367 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.49686 |
| Loading Stress XX [ksf] | -0.480372 | 2.92584 |
| Loading Stress YY [ksf] | -1.60133 | 3.24957 |
| Effective Stress ZZ [ksf] | 0 | 5.65616 |
| Effective Stress XX [ksf] | -0.480372 | 6.61757 |
| Effective Stress YY [ksf] | -0.408276 | 8.28444 |
| Total Stress ZZ [ksf] | 0 | 8.39789 |
| Total Stress XX [ksf] | -0.480372 | 9.29754 |
| Total Stress YY [ksf] | -0.408276 | 11.4621 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80238e-05 | 0.406322 |
| Pore Water Pressure [ksf] | 0 | 3.21298 |
| Excess Pore Water Pressure [ksf] | 0 | 0.597343 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.65555 |
| Over-consolidation Ratio | 1 | 3.00005 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.174504 |

## Stage: 0.5 Year after Placement = 10180 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 17.7966 |
| Total Consolidation Settlement [in] | 0 | 11.8951 |
| Virgin Consolidation Settlement [in] | 0 | 10.6772 |
| Recompression Consolidation Settlement [in] | 0 | 1.98214 |
| Immediate Settlement [in] | 0 | 6.18009 |
| Secondary Settlement [in] | 0 | 0.00184054 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.49686 |
| Loading Stress XX [ksf] | -0.480372 | 2.92584 |
| Loading Stress YY [ksf] | -1.60133 | 3.24957 |
| Effective Stress ZZ [ksf] | 0 | 5.76084 |
| Effective Stress XX [ksf] | -0.480372 | 7.0354 |
| Effective Stress YY [ksf] | -0.408276 | 8.85064 |
| Total Stress ZZ [ksf] | 0 | 8.39789 |
| Total Stress XX [ksf] | -0.480372 | 9.29754 |
| Total Stress YY [ksf] | -0.408276 | 11.4621 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80237e-05 | 0.406338 |
| Pore Water Pressure [ksf] | -2.26649e-05 | 2.808 |
| Excess Pore Water Pressure [ksf] | -2.26649e-05 | 0.0180561 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.75707 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.191445 |

## Stage: 1 Year after Placement = 10360 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 17.7981 |
| Total Consolidation Settlement [in] | 0 | 11.9158 |
| Virgin Consolidation Settlement [in] | 0 | 10.6772 |
| Recompression Consolidation Settlement [in] | 0 | 1.98229 |
| Immediate Settlement [in] | 0 | 6.18009 |
| Secondary Settlement [in] | 0 | 0.0036683 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.49686 |
| Loading Stress XX [ksf] | -0.480372 | 2.92584 |
| Loading Stress YY [ksf] | -1.60133 | 3.24957 |
| Effective Stress ZZ [ksf] | 0 | 5.77801 |
| Effective Stress XX [ksf] | -0.480372 | 7.05165 |
| Effective Stress YY [ksf] | -0.408276 | 8.86728 |
| Total Stress ZZ [ksf] | 0 | 8.39789 |
| Total Stress XX [ksf] | -0.480372 | 9.29754 |
| Total Stress YY [ksf] | -0.408276 | 11.4621 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80237e-05 | 0.406358 |
| Pore Water Pressure [ksf] | -8.86423e-05 | 2.808 |
| Excess Pore Water Pressure [ksf] | -8.86423e-05 | 0.000229293 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.77424 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.192047 |

## Stage: 1.5 Year after Placement = 10540 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 17.7996 |
| Total Consolidation Settlement [in] | 0 | 11.9159 |
| Virgin Consolidation Settlement [in] | 0 | 10.6772 |
| Recompression Consolidation Settlement [in] | 0 | 1.98229 |
| Immediate Settlement [in] | 0 | 6.18009 |
| Secondary Settlement [in] | 0 | 0.00546457 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.49686 |
| Loading Stress XX [ksf] | -0.480372 | 2.92584 |
| Loading Stress YY [ksf] | -1.60133 | 3.24957 |
| Effective Stress ZZ [ksf] | 0 | 5.77812 |
| Effective Stress XX [ksf] | -0.480372 | 7.05185 |
| Effective Stress YY [ksf] | -0.408276 | 8.86725 |
| Total Stress ZZ [ksf] | 0 | 8.39789 |
| Total Stress XX [ksf] | -0.480372 | 9.29754 |
| Total Stress YY [ksf] | -0.408276 | 11.4621 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80237e-05 | 0.406379 |
| Pore Water Pressure [ksf] | -0.000124441 | 2.808 |
| Excess Pore Water Pressure [ksf] | -0.000124441 | 0.000115886 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.77435 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.19205 |

## Stage: 2 years after Placement = 10720 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 17.801 |
| Total Consolidation Settlement [in] | 0 | 11.9159 |
| Virgin Consolidation Settlement [in] | 0 | 10.6772 |
| Recompression Consolidation Settlement [in] | 0 | 1.98229 |
| Immediate Settlement [in] | 0 | 6.18009 |
| Secondary Settlement [in] | 0 | 0.00723042 |
| Loading Stress ZZ [ksf] | -1.19256e-05 | 3.49686 |
| Loading Stress XX [ksf] | -0.480372 | 2.92584 |
| Loading Stress YY [ksf] | -1.60133 | 3.24957 |
| Effective Stress ZZ [ksf] | 0 | 5.77812 |
| Effective Stress XX [ksf] | -0.480372 | 7.05176 |
| Effective Stress YY [ksf] | -0.408276 | 8.86738 |
| Total Stress ZZ [ksf] | 0 | 8.39789 |
| Total Stress XX [ksf] | -0.480372 | 9.29754 |
| Total Stress YY [ksf] | -0.408276 | 11.4621 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80237e-05 | 0.406399 |
| Pore Water Pressure [ksf] | -9.64613e-05 | 2.808 |
| Excess Pore Water Pressure [ksf] | -9.64613e-05 | 0.000123421 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.77436 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.19205 |

## Stage: Final Grade = 10720 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 19.1579 |
| Total Consolidation Settlement [in] | 0 | 11.9159 |
| Virgin Consolidation Settlement [in] | 0 | 10.6772 |
| Recompression Consolidation Settlement [in] | 0 | 1.98229 |
| Immediate Settlement [in] | 0 | 7.77973 |
| Secondary Settlement [in] | 0 | 0.00723042 |
| Loading Stress ZZ [ksf] | -4.72039e-07 | 3.99478 |
| Loading Stress XX [ksf] | -0.426728 | 3.51917 |
| Loading Stress YY [ksf] | -1.92886 | 2.89776 |
| Effective Stress ZZ [ksf] | 0 | 5.77812 |
| Effective Stress XX [ksf] | -0.426728 | 7.43765 |
| Effective Stress YY [ksf] | -0.683901 | 8.03778 |
| Total Stress ZZ [ksf] | -4.72021e-07 | 8.90295 |
| Total Stress XX [ksf] | -0.426728 | 9.87433 |
| Total Stress YY [ksf] | -0.561195 | 11.5399 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -2.80237e-05 | 0.406399 |
| Pore Water Pressure [ksf] | -4.72021e-07 | 4.93142 |
| Excess Pore Water Pressure [ksf] | -4.72021e-07 | 3.40708 |
| Degree of Consolidation [%] | 0 | 95.3474 |
| Pre-consolidation Stress [ksf] | 6.70463e-05 | 5.77436 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 1.11 |
| Permeability [ft/d] | 0 | 6.14197 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.19205 |

## Stage: After 75 Years = 37393.8 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 20.4235 |
| Total Consolidation Settlement [in] | 0 | 12.9453 |
| Virgin Consolidation Settlement [in] | 0 | 11.7375 |
| Recompression Consolidation Settlement [in] | 0 | 2.2933 |
| Immediate Settlement [in] | 0 | 7.77973 |
| Secondary Settlement [in] | 0 | 0.391142 |
| Loading Stress ZZ [ksf] | -4.72039e-07 | 3.99478 |
| Loading Stress XX [ksf] | -0.426728 | 3.51917 |
| Loading Stress YY [ksf] | -1.92886 | 2.89776 |
| Effective Stress ZZ [ksf] | 0 | 6.27587 |
| Effective Stress XX [ksf] | -0.426728 | 7.92871 |
| Effective Stress YY [ksf] | -0.598527 | 8.81892 |
| Total Stress ZZ [ksf] | 0 | 8.90295 |
| Total Stress XX [ksf] | -0.426728 | 9.87433 |
| Total Stress YY [ksf] | -0.561195 | 11.5399 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -1.04049e-06 | 0.616014 |
| Pore Water Pressure [ksf] | -0.033782 | 2.808 |
| Excess Pore Water Pressure [ksf] | -0.033782 | 0.0278069 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 0.000776801 | 6.2721 |
| Over-consolidation Ratio | 1 | 3.00019 |
| Void Ratio | -0.289625 | 1.11 |
| Permeability [ft/d] | 0 | 25.5915 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.86 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.209285 |

# Embankments

## 1. Embankment: "Embankment Load 1"

| | |
|---|---|
| Label | Embankment Load 1 |
| Center Line | (209600, 0) to (209700, 0) |
| Near End Angle | 90 degrees |
| Far End Angle | 90 degrees |
| Number of Layers | 5 |

| Layer | Stage | Unit Weight (kips/ft3) |
|---|---|---|
| 1 | Final Grade | 0.125 |
| 2 | Final Grade | 0.125 |
| 3 | Existing Embankment | 0.12 |
| 4 | Temp Grade is Placed | 0.125 |
| 5 | Final Grade | 0.125 |

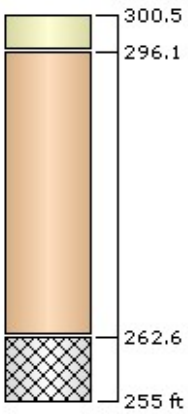
# Soil Layers

Ground Surface Drained: Yes

## 118

XY Location: 118: (209586, -48)

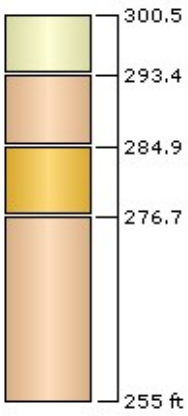
| Layer # | Type | Thickness [ft] | Elevation [ft] | Drained at Bottom |
|---|---|---|---|---|
| 1 | Layer I: ML,CL, MH, SM | 4.4 | 300.5 | No |
| 2 | Layer II: MH, ML, CL | 0 | 296.1 | No |
| 3 | Layer III: SM, SP-SM, SP | 33.5 | 296.1 | No |
| 4 | Layer IV: SP-SM, SP | 0 | 262.6 | No |
| 5 | Layer III: SM, SP-SM, SP | 0 | 262.6 | No |




## 119

XY Location: 119: (209650, -200)

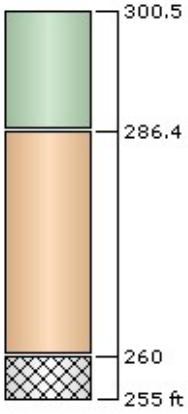
| Layer # | Type | Thickness [ft] | Elevation [ft] | Drained at Bottom |
|---|---|---|---|---|
| 1 | Layer I: ML,CL, MH, SM | 7.1 | 300.5 | No |
| 2 | Layer II: MH, ML, CL | 0 | 293.4 | No |
| 3 | Layer III: SM, SP-SM, SP | 8.5 | 293.4 | No |
| 4 | Layer IV: SP-SM, SP | 8.2 | 284.9 | No |
| 5 | Layer III: SM, SP-SM, SP | 21.7 | 276.7 | No |




## 117

XY Location: 117: (209650, 110)

| Layer # | Type | Thickness [ft] | Elevation [ft] | Drained at Bottom |
|---|---|---|---|---|
| 1 | Layer I: ML,CL, MH, SM | 0 | 300.5 | No |
| 2 | Layer II: MH, ML, CL | 14.1 | 300.5 | No |
| 3 | Layer III: SM, SP-SM, SP | 26.4 | 286.4 | No |
| 4 | Layer IV: SP-SM, SP | 0 | 260 | No |
| 5 | Layer III: SM, SP-SM, SP | 0 | 260 | No |



# Soil Properties

| Property | Layer I: ML,CL, MH, SM | Layer II: MH, ML, CL | Layer III: SM, SP-SM, SP | Layer IV: SP-SM, SP |
|---|---|---|---|---|
| Color | | | | |
| Unit Weight [kips/ft3] | 0.12 | 0.12 | 0.13 | 0.125 |
| Saturated Unit Weight [kips/ft3] | 0.125 | 0.125 | 0.135 | 0.13 |
| K0 | 1 | 1 | 1 | 1 |
| Immediate Settlement | Disabled | Disabled | Enabled | Enabled |
| Es [ksf] | - | - | 300 | 65 |
| Esur [ksf] | - | - | 300 | 65 |
| Primary Consolidation | Enabled | Enabled | Disabled | Disabled |
| Material Type | Non-Linear | Non-Linear | | |
| Cc | 0.25 | 0.33 | - | - |
| Cr | 0.06 | 0.06 | - | - |
| e0 | 0.85 | 1.11 | - | - |
| OCR | 1.2 | 3 | - | - |
| Cv [ft2/d] | 0.39 | 0.86 | - | - |
| Cvr [ft2/d] | 0.39 | 0.86 | - | - |
| B-bar | 1 | 1 | - | - |
| Secondary Consolidation | Standard | Standard | Disabled | Disabled |
| Ca | 0.003 | 0.003 | - | - |
| Car | 0.003 | 0.003 | - | - |
| Undrained Su A [kips/ft2] | 0 | 0 | 0 | 0 |
| Undrained Su S | 0.2 | 0.2 | 0.2 | 0.2 |
| Undrained Su m | 0.8 | 0.8 | 0.8 | 0.8 |
| Piezo Line ID | 0 | 0 | 1 | 1 |

# Groundwater

| | |
|---|---|
| Groundwater method | Piezometric Lines |
| Water Unit Weight | 0.0624 kips/ft3 |
| Generating excess pore pressure above water table | |

## Piezometric Line Entities

| ID | Elevation (ft) |
|---|---|
| 1 | 300 ft |

# Query

## Query Points

| Point # | Query Point Name | (X,Y) Location | Number of Divisions |
|---|---|---|---|
| 1 | Query Point 1 | 209653, 5.349 | Auto: 65 |

## Query Lines

| Line # | Query Line Name | Start Location | End Location | Horizontal Divisions | Vertical Divisions |
|---|---|---|---|---|---|
| 1 | Query Line 1 | 209650, -218.104 | 209650, 200 | 20 | Auto: 55 |

## Field Point Grid

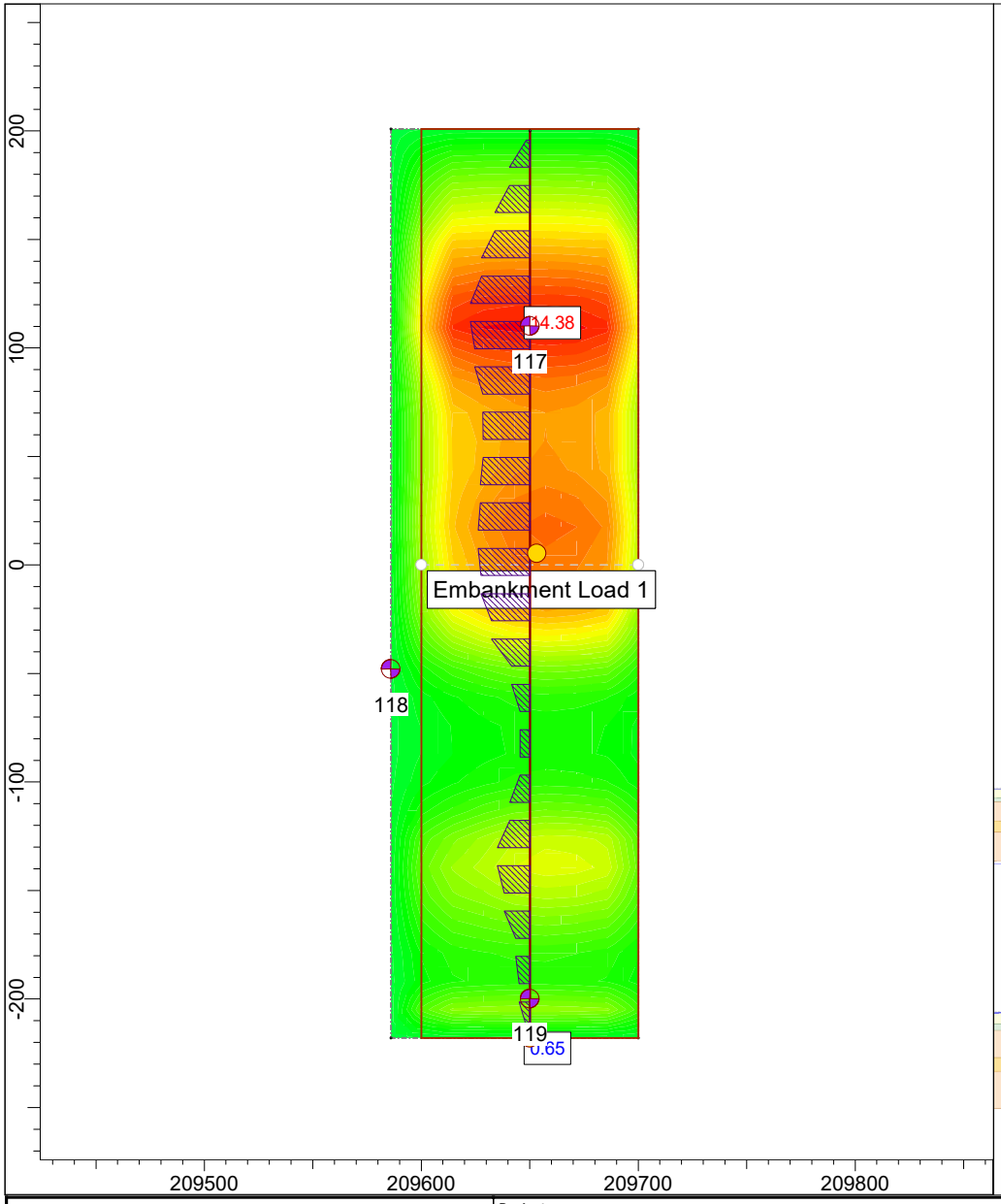
| | |
|---|---|
| Number of points | 297 |
| Expansion Factor | 1 |

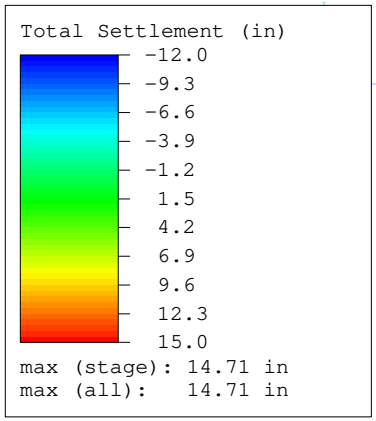
### Grid Coordinates

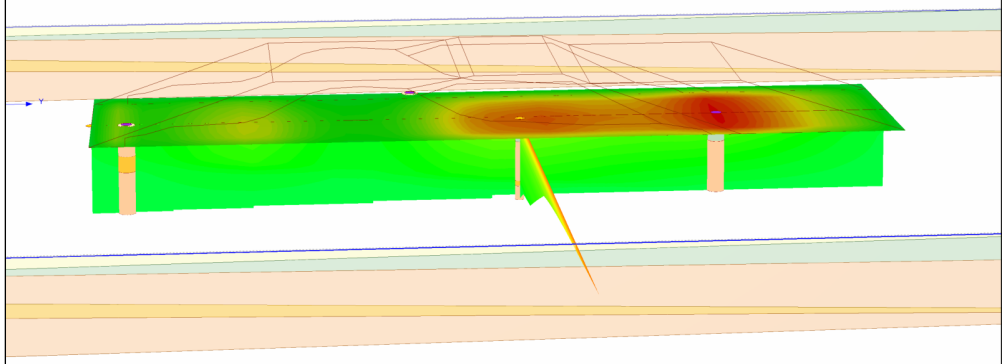
| X [ft] | Y [ft] |
|---|---|
| 209909 | 410.37 |
| 209909 | -427.595 |
| 209377 | -427.595 |
| 209377 | 410.37 |

# Time Points

| Point # | (X,Y) Location | Elevation | Goal Type | Goal | Time Until Goal |
|---|---|---|---|---|---|
| 1 | 209653, 7.854 | 297 ft | Degree of Consolidation | 50% | 15.2006 d |
| 2 | 209653, -1.809 | 297 ft | Degree of Consolidation | 90% | 67.292 d |



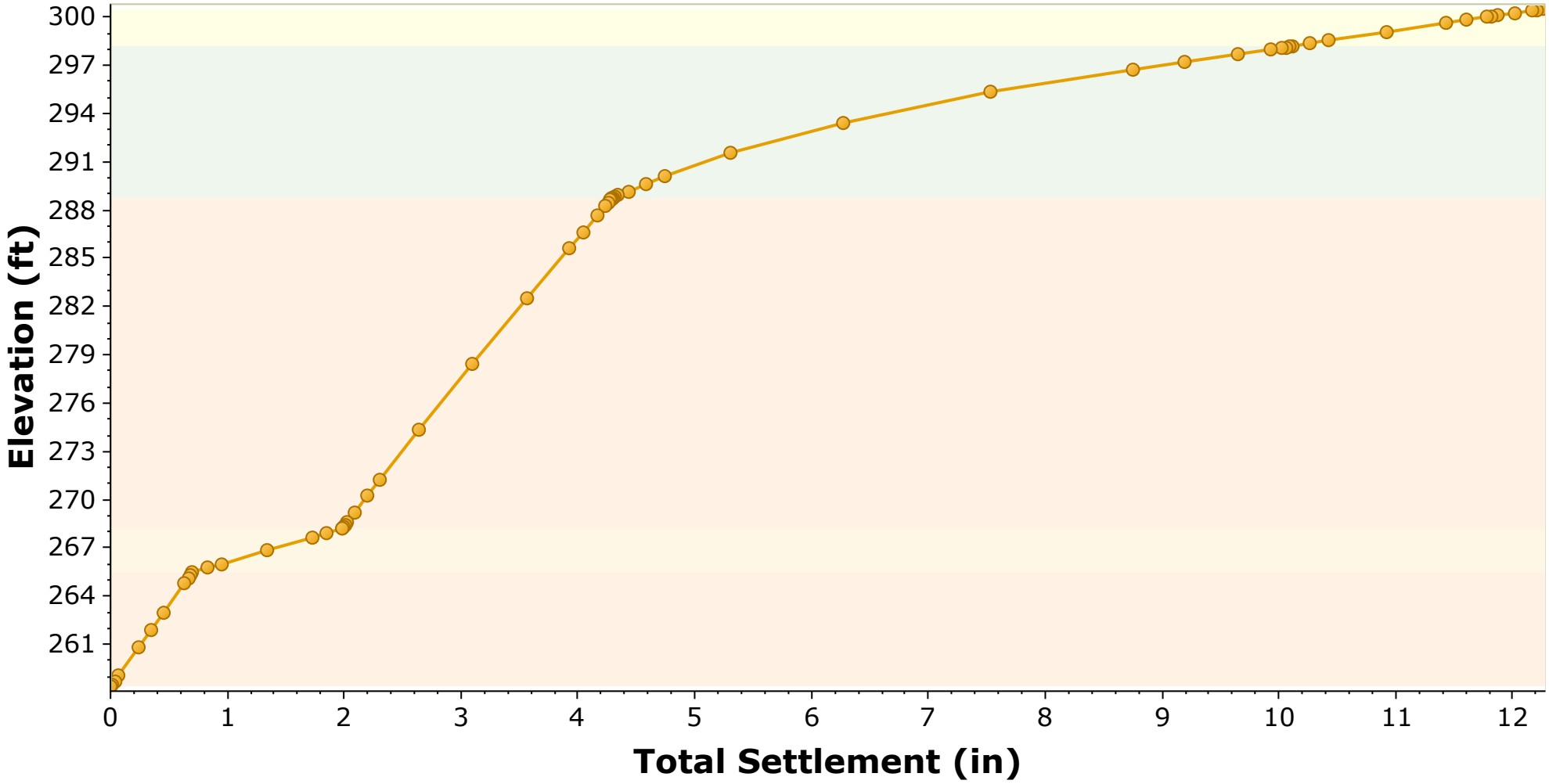



| | | | |
|---|---|---|---|
| ROCSCIENCE | *Project* | US-51 over the Ohio River | |
| | *Analysis Description* | STA 2096+50 | |
| | *Drawn By* | ER | *Company* HDR |
| | *Date* | 12/17/2025, 12:11:27 PM | *File Name* STA 2096+50 KY Temp Borehole.s3z |

SETTLE3 5.026

# Total Settlement vs. Elevation



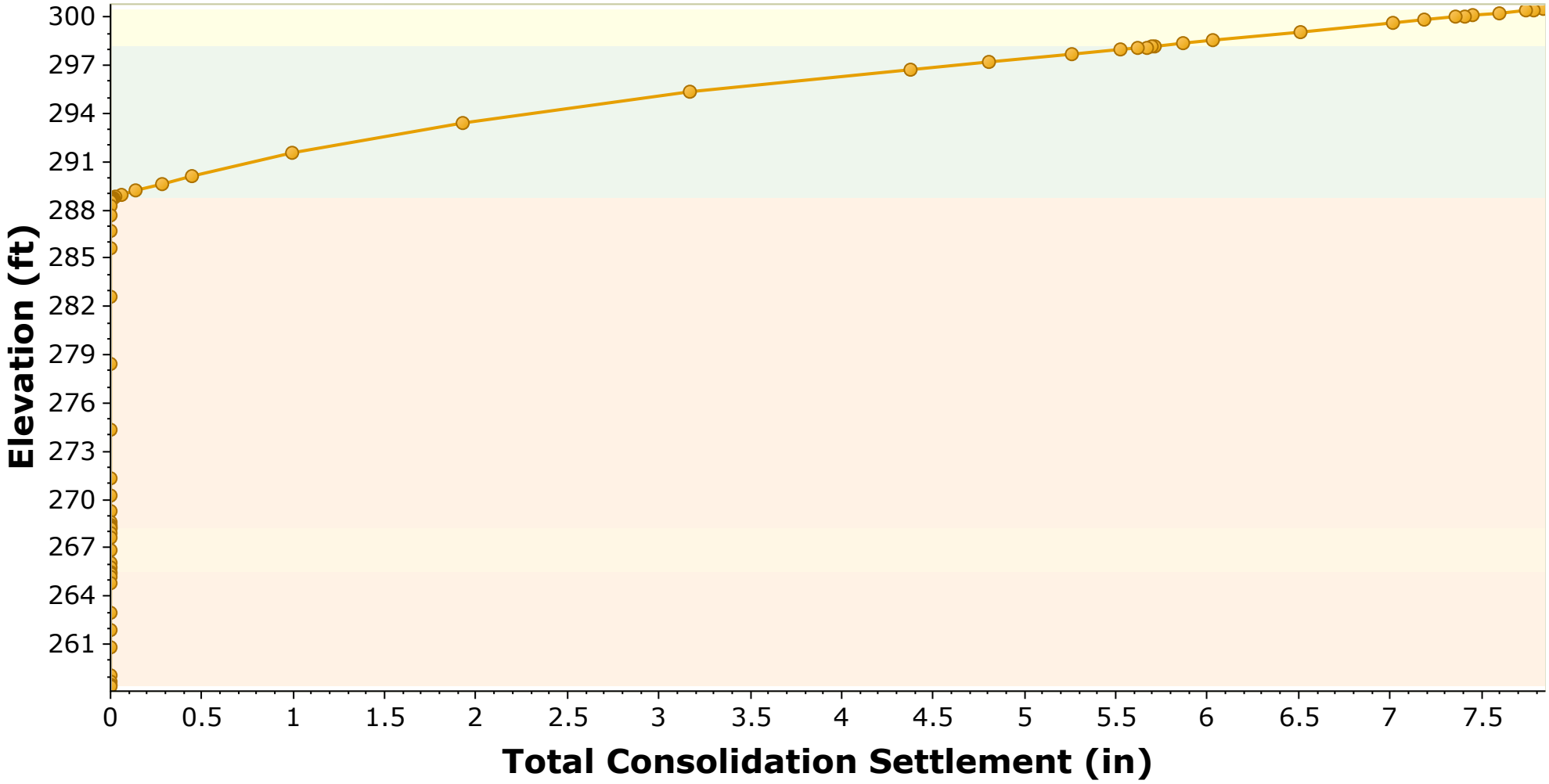

Query Point 1 (After 75 Years = 37393.8 d)

Reference Stage: Existing Embankment Settled = 10000 d

| | | | |
|---|---|---|---|
| ROCSCIENCE | Project | US-51 over the Ohio River | |
| | Analysis Description | STA 2096+50 | |
| | Drawn By | ER | Company: HDR |
| | Date | 12/17/2025, 12:11:27 PM | File Name: STA 2096+50 KY Temp Borehole.s3z |

SETTLE3 5.026

# Total Consolidation Settlement vs. Elevation




Query Point 1 (After 75 Years = 37393.8 d)

Reference Stage: Existing Embankment Settled = 10000 d

| | | | |
|---|---|---|---|
| ROCSCIENCE | *Project* | US-51 over the Ohio River | |
| | *Analysis Description* | STA 2096+50 | |
| | *Drawn By* | ER | *Company* HDR |
| | *Date* | 12/17/2025, 12:11:27 PM | *File Name* STA 2096+50 KY Temp Borehole.s3z |

SETTLE3 5.026

ROCSCIENCE



US-51 over the Ohio River

HDR

Report Creation Date: 2026/04/27, 13:44:13

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# Settle3 Analysis Information

# US-51 over the Ohio River

## Project Settings

| | |
|---|---|
| Document Name | STA 2107+50 KY Temp.s3z |
| Project Title | US-51 over the Ohio River |
| Analysis | STA 2107+50 |
| Author | KR |
| Company | HDR |
| Date Created | 03/27/2026, 8:52:53 AM |
| Last saved with Settle3 version | 5.026 |
| Stress Computation Method | Boussinesq |
| Stress Units | Imperial, stress as ksf |
| Settlement Units | inches |
| Time-dependent Consolidation Analysis | |
| Time Units | days |
| Permeability Units | feet/day |

### Advanced Settings

| | |
|---|---|
| Start of secondary consolidation (% of primary) | 95 |
| Min. stress for secondary consolidation (% of initial) | 1 |
| Reset time when load changes for secondary consolidation | No |
| Minimum settlement ratio for subgrade modulus | 0.9 |
| Use average poisson's ratio to calculate layered stresses | |
| Update Cv in each time step (improves consolidation accuracy) | |
| Ignore negative effective stresses in settlement calculations | |
| Add field points to load edges | |

### Soil Profile

| | |
|---|---|
| Layer Option | Horizontal Soil Layers |
| Vertical Axis | Elevation |
| Ground Elevation (ft) | 300.4 |

# Stage Settings

| Stage # | Name | Time [days] |
|---|---|---|
| 1 | Existing Embankment | 0 |
| 2 | Existing Embankment Settled | 10000 |
| 3 | Temp Grade is Placed | 10000 |
| 4 | 50% Consolidation | 10034.6 |
| 5 | 90% Consolidation | 10139 |
| 6 | 0.5 Year after Placement | 10180 |
| 7 | 1 Year after Placement | 10360 |
| 8 | 1.5 Year after Placement | 10540 |
| 9 | 2 Years after Placement | 10720 |
| 10 | Final Grade | 10720 |
| 11 | After 75 Year | 37393.8 |

# Results

Time taken to compute: 5.85198 seconds

## Stage: Existing Embankment = 0 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 2.27663 |
| Total Consolidation Settlement [in] | 0 | 0 |
| Virgin Consolidation Settlement [in] | 0 | 0 |
| Recompression Consolidation Settlement [in] | 0 | 0 |
| Immediate Settlement [in] | 0 | 2.27663 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | -1.61667e-09 | 3.151 |
| Loading Stress XX [ksf] | -1.12251 | 3.75496 |
| Loading Stress YY [ksf] | -0.574082 | 2.23673 |
| Effective Stress ZZ [ksf] | 0 | 3.11162 |
| Effective Stress XX [ksf] | -0.29501 | 6.86658 |
| Effective Stress YY [ksf] | -0.574082 | 4.22204 |
| Total Stress ZZ [ksf] | -1.61667e-09 | 8.32436 |
| Total Stress XX [ksf] | -0.29501 | 12.0793 |
| Total Stress YY [ksf] | -0.574082 | 9.30603 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.00929716 |
| Pore Water Pressure [ksf] | -1.61667e-09 | 5.21274 |
| Excess Pore Water Pressure [ksf] | -1.61667e-09 | 3.151 |
| Degree of Consolidation [%] | 0 | 0 |
| Pre-consolidation Stress [ksf] | 0.0069 | 4.95243 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 0.98 |
| Permeability [ft/d] | 0 | 0.229364 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 10.7369 |
| Undrained Shear Strength | -1.11022e-16 | 5.55112e-17 |

## Stage: Existing Embankment Settled = 10000 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 20.8607 |
| Total Consolidation Settlement [in] | 0 | 18.5841 |
| Virgin Consolidation Settlement [in] | 0 | 12.9096 |
| Recompression Consolidation Settlement [in] | 0 | 5.67444 |
| Immediate Settlement [in] | 0 | 2.27663 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | -1.61667e-09 | 3.151 |
| Loading Stress XX [ksf] | -1.12251 | 3.75496 |
| Loading Stress YY [ksf] | -0.574082 | 2.23673 |
| Effective Stress ZZ [ksf] | 0 | 5.12948 |
| Effective Stress XX [ksf] | -0.29501 | 8.88444 |
| Effective Stress YY [ksf] | -0.574082 | 6.11115 |
| Total Stress ZZ [ksf] | 0 | 8.32436 |
| Total Stress XX [ksf] | -0.29501 | 12.0793 |
| Total Stress YY [ksf] | -0.574082 | 9.30603 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.352716 |
| Pore Water Pressure [ksf] | -7.38735e-08 | 3.19488 |
| Excess Pore Water Pressure [ksf] | -0.0121975 | 0.013923 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.12866 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 0.98 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.164832 |

## Stage: Temp Grade is Placed = 10000 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 21.1082 |
| Total Consolidation Settlement [in] | 0 | 18.5841 |
| Virgin Consolidation Settlement [in] | 0 | 12.9096 |
| Recompression Consolidation Settlement [in] | 0 | 5.67444 |
| Immediate Settlement [in] | 0 | 2.68758 |
| Secondary Settlement [in] | 0 | 0 |
| Loading Stress ZZ [ksf] | -9.43101e-10 | 3.24173 |
| Loading Stress XX [ksf] | -1.66771 | 2.90715 |
| Loading Stress YY [ksf] | -0.630547 | 2.66319 |
| Effective Stress ZZ [ksf] | 0 | 5.12948 |
| Effective Stress XX [ksf] | -0.67448 | 7.72091 |
| Effective Stress YY [ksf] | -0.476025 | 5.93744 |
| Total Stress ZZ [ksf] | -2.48126e-11 | 8.82197 |
| Total Stress XX [ksf] | -0.46902 | 11.4553 |
| Total Stress YY [ksf] | -0.476025 | 9.45838 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.352716 |
| Pore Water Pressure [ksf] | -2.77095e-10 | 5.17514 |
| Excess Pore Water Pressure [ksf] | -0.00571306 | 2.9812 |
| Degree of Consolidation [%] | 0 | 99.9696 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.12866 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 0.98 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 99.993 |
| Undrained Shear Strength | 0 | 0.164832 |

## Stage: 50% Consolidation = 10034.6 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 21.1707 |
| Total Consolidation Settlement [in] | 0 | 18.6455 |
| Virgin Consolidation Settlement [in] | 0 | 12.9491 |
| Recompression Consolidation Settlement [in] | 0 | 5.69638 |
| Immediate Settlement [in] | 0 | 2.68758 |
| Secondary Settlement [in] | 0 | 0.00109102 |
| Loading Stress ZZ [ksf] | -9.43101e-10 | 3.24173 |
| Loading Stress XX [ksf] | -1.66771 | 2.90715 |
| Loading Stress YY [ksf] | -0.630547 | 2.66319 |
| Effective Stress ZZ [ksf] | 0 | 5.62709 |
| Effective Stress XX [ksf] | -0.623218 | 8.26039 |
| Effective Stress YY [ksf] | -0.476025 | 6.2635 |
| Total Stress ZZ [ksf] | 0 | 8.82197 |
| Total Stress XX [ksf] | -0.46902 | 11.4553 |
| Total Stress YY [ksf] | -0.476025 | 9.45838 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -0.000753888 | 0.354275 |
| Pore Water Pressure [ksf] | 0 | 3.62473 |
| Excess Pore Water Pressure [ksf] | 0 | 2.59386 |
| Degree of Consolidation [%] | 0 | 99.9996 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.62617 |
| Over-consolidation Ratio | 1 | 3.15098 |
| Void Ratio | 0 | 0.981493 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 99.992 |
| Undrained Shear Strength | 0 | 0.166874 |

## Stage: 90% Consolidation = 10139 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 21.2832 |
| Total Consolidation Settlement [in] | 0 | 18.7547 |
| Virgin Consolidation Settlement [in] | 0 | 13.055 |
| Recompression Consolidation Settlement [in] | 0 | 5.69975 |
| Immediate Settlement [in] | 0 | 2.68758 |
| Secondary Settlement [in] | 0 | 0.0155486 |
| Loading Stress ZZ [ksf] | -9.43101e-10 | 3.24173 |
| Loading Stress XX [ksf] | -1.66771 | 2.90715 |
| Loading Stress YY [ksf] | -0.630547 | 2.66319 |
| Effective Stress ZZ [ksf] | 0 | 5.62709 |
| Effective Stress XX [ksf] | -0.584874 | 8.26039 |
| Effective Stress YY [ksf] | -0.476025 | 6.2635 |
| Total Stress ZZ [ksf] | 0 | 8.82197 |
| Total Stress XX [ksf] | -0.46902 | 11.4553 |
| Total Stress YY [ksf] | -0.476025 | 9.45838 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -0.000121371 | 0.35429 |
| Pore Water Pressure [ksf] | 0 | 3.19488 |
| Excess Pore Water Pressure [ksf] | 0 | 0.878866 |
| Degree of Consolidation [%] | 0 | 99.9999 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.62617 |
| Over-consolidation Ratio | 1 | 3.02381 |
| Void Ratio | 0 | 0.98024 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 99.9966 |
| Undrained Shear Strength | 0 | 0.173259 |

## Stage: 0.5 Year after Placement = 10180 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 21.309 |
| Total Consolidation Settlement [in] | 0 | 18.7793 |
| Virgin Consolidation Settlement [in] | 0 | 13.079 |
| Recompression Consolidation Settlement [in] | 0 | 5.70026 |
| Immediate Settlement [in] | 0 | 2.68758 |
| Secondary Settlement [in] | 0 | 0.0225721 |
| Loading Stress ZZ [ksf] | -9.43101e-10 | 3.24173 |
| Loading Stress XX [ksf] | -1.66771 | 2.90715 |
| Loading Stress YY [ksf] | -0.630547 | 2.66319 |
| Effective Stress ZZ [ksf] | 0 | 5.62709 |
| Effective Stress XX [ksf] | -0.581644 | 8.26039 |
| Effective Stress YY [ksf] | -0.476025 | 6.2635 |
| Total Stress ZZ [ksf] | 0 | 8.82197 |
| Total Stress XX [ksf] | -0.46902 | 11.4553 |
| Total Stress YY [ksf] | -0.476025 | 9.45838 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -5.2139e-05 | 0.354296 |
| Pore Water Pressure [ksf] | 0 | 3.19488 |
| Excess Pore Water Pressure [ksf] | 0 | 0.628707 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.62617 |
| Over-consolidation Ratio | 1 | 3.0102 |
| Void Ratio | 0 | 0.980103 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 99.9979 |
| Undrained Shear Strength | 0 | 0.173595 |

## Stage: 1 Year after Placement = 10360 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 21.5835 |
| Total Consolidation Settlement [in] | 0 | 18.9186 |
| Virgin Consolidation Settlement [in] | 0 | 13.2105 |
| Recompression Consolidation Settlement [in] | 0 | 5.70956 |
| Immediate Settlement [in] | 0 | 2.68758 |
| Secondary Settlement [in] | 0 | 0.0679515 |
| Loading Stress ZZ [ksf] | -9.43101e-10 | 3.24173 |
| Loading Stress XX [ksf] | -1.66771 | 2.90715 |
| Loading Stress YY [ksf] | -0.630547 | 2.66319 |
| Effective Stress ZZ [ksf] | 0 | 5.62709 |
| Effective Stress XX [ksf] | -0.576111 | 8.26039 |
| Effective Stress YY [ksf] | -0.476025 | 6.2635 |
| Total Stress ZZ [ksf] | 0 | 8.82197 |
| Total Stress XX [ksf] | -0.46902 | 11.4553 |
| Total Stress YY [ksf] | -0.476025 | 9.45838 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -1.39096e-06 | 0.354319 |
| Pore Water Pressure [ksf] | 0 | 3.19488 |
| Excess Pore Water Pressure [ksf] | 0 | 0.169534 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.62617 |
| Over-consolidation Ratio | 1 | 3.00027 |
| Void Ratio | 0 | 0.980003 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 99.9998 |
| Undrained Shear Strength | 0 | 0.174947 |

## Stage: 1.5 Year after Placement = 10540 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 21.8913 |
| Total Consolidation Settlement [in] | 0 | 19.2318 |
| Virgin Consolidation Settlement [in] | 0 | 13.5184 |
| Recompression Consolidation Settlement [in] | 0 | 5.71436 |
| Immediate Settlement [in] | 0 | 2.68758 |
| Secondary Settlement [in] | 0 | 0.138997 |
| Loading Stress ZZ [ksf] | -9.43101e-10 | 3.24173 |
| Loading Stress XX [ksf] | -1.66771 | 2.90715 |
| Loading Stress YY [ksf] | -0.630547 | 2.66319 |
| Effective Stress ZZ [ksf] | 0 | 5.62709 |
| Effective Stress XX [ksf] | -0.575161 | 8.26039 |
| Effective Stress YY [ksf] | -0.476025 | 6.2635 |
| Total Stress ZZ [ksf] | 0 | 8.82197 |
| Total Stress XX [ksf] | -0.46902 | 11.4553 |
| Total Stress YY [ksf] | -0.476025 | 9.45838 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | -1.37829e-08 | 0.354343 |
| Pore Water Pressure [ksf] | 0 | 3.19488 |
| Excess Pore Water Pressure [ksf] | 0 | 0.0441223 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.62617 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 0.98 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.178865 |

## Stage: 2 Years after Placement = 10720 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 21.9759 |
| Total Consolidation Settlement [in] | 0 | 19.3136 |
| Virgin Consolidation Settlement [in] | 0 | 13.5989 |
| Recompression Consolidation Settlement [in] | 0 | 5.71588 |
| Immediate Settlement [in] | 0 | 2.68758 |
| Secondary Settlement [in] | 0 | 0.19007 |
| Loading Stress ZZ [ksf] | -9.43101e-10 | 3.24173 |
| Loading Stress XX [ksf] | -1.66771 | 2.90715 |
| Loading Stress YY [ksf] | -0.630547 | 2.66319 |
| Effective Stress ZZ [ksf] | 0 | 5.62709 |
| Effective Stress XX [ksf] | -0.574999 | 8.26039 |
| Effective Stress YY [ksf] | -0.476025 | 6.2635 |
| Total Stress ZZ [ksf] | 0 | 8.82197 |
| Total Stress XX [ksf] | -0.46902 | 11.4553 |
| Total Stress YY [ksf] | -0.476025 | 9.45838 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.354366 |
| Pore Water Pressure [ksf] | 0 | 3.19488 |
| Excess Pore Water Pressure [ksf] | -0.00992827 | 0.0197267 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.62617 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 0.98 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.179772 |

## Stage: Final Grade = 10720 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 22.5342 |
| Total Consolidation Settlement [in] | 0 | 19.3136 |
| Virgin Consolidation Settlement [in] | 0 | 13.5989 |
| Recompression Consolidation Settlement [in] | 0 | 5.71588 |
| Immediate Settlement [in] | 0 | 3.24993 |
| Secondary Settlement [in] | 0 | 0.19007 |
| Loading Stress ZZ [ksf] | -9.4516e-10 | 3.97119 |
| Loading Stress XX [ksf] | -1.95011 | 3.64379 |
| Loading Stress YY [ksf] | -0.650069 | 3.18405 |
| Effective Stress ZZ [ksf] | 0 | 5.62709 |
| Effective Stress XX [ksf] | -0.67116 | 9.12365 |
| Effective Stress YY [ksf] | -0.609476 | 6.53047 |
| Total Stress ZZ [ksf] | -1.47761e-10 | 9.32792 |
| Total Stress XX [ksf] | -0.538832 | 12.7728 |
| Total Stress YY [ksf] | -0.609476 | 10.1273 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.354366 |
| Pore Water Pressure [ksf] | -2.90742e-09 | 3.70083 |
| Excess Pore Water Pressure [ksf] | -2.90742e-09 | 0.733511 |
| Degree of Consolidation [%] | 0 | 99.9852 |
| Pre-consolidation Stress [ksf] | 0.0069 | 5.62617 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 0.98 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 99.9965 |
| Undrained Shear Strength | 0 | 0.179772 |

## Stage: After 75 Year = 37393.8 d

| Data Type | Minimum | Maximum |
|---|---|---|
| Total Settlement [in] | 0 | 25.9501 |
| Total Consolidation Settlement [in] | 0 | 22.3222 |
| Virgin Consolidation Settlement [in] | 0 | 16.5938 |
| Recompression Consolidation Settlement [in] | 0 | 5.72835 |
| Immediate Settlement [in] | 0 | 3.24993 |
| Secondary Settlement [in] | 0 | 0.842683 |
| Loading Stress ZZ [ksf] | -9.4516e-10 | 3.97119 |
| Loading Stress XX [ksf] | -1.95011 | 3.64379 |
| Loading Stress YY [ksf] | -0.650069 | 3.18405 |
| Effective Stress ZZ [ksf] | 0 | 6.13304 |
| Effective Stress XX [ksf] | -0.670953 | 9.57788 |
| Effective Stress YY [ksf] | -0.609476 | 7.11139 |
| Total Stress ZZ [ksf] | 0 | 9.32792 |
| Total Stress XX [ksf] | -0.538832 | 12.7728 |
| Total Stress YY [ksf] | -0.609476 | 10.1273 |
| Modulus of Subgrade Reaction (Total) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Immediate) [ksf/ft] | 0 | 0 |
| Modulus of Subgrade Reaction (Consolidation) [ksf/ft] | 0 | 0 |
| Total Strain | 0 | 0.367215 |
| Pore Water Pressure [ksf] | -4.44835e-18 | 3.19488 |
| Excess Pore Water Pressure [ksf] | -1.91532e-05 | 0.000218565 |
| Degree of Consolidation [%] | 0 | 100 |
| Pre-consolidation Stress [ksf] | 0.0069 | 6.13228 |
| Over-consolidation Ratio | 1 | 3 |
| Void Ratio | 0 | 0.98 |
| Permeability [ft/d] | 0 | 0.819156 |
| Coefficient of Consolidation [ft^2/d] | 0 | 0.55 |
| Hydroconsolidation Settlement [in] | 0 | 0 |
| Average Degree of Consolidation [%] | 0 | 100 |
| Undrained Shear Strength | 0 | 0.209636 |

# Embankments

## 1. Embankment: "Embankment Load 2"

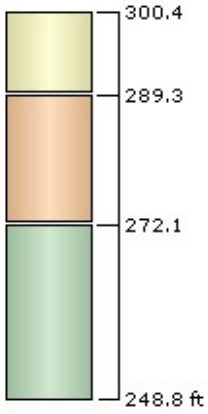
| | |
|---|---|
| Label | Embankment Load 2 |
| Center Line | (0, 0) to (0, 100) |
| Near End Angle | 90 degrees |
| Far End Angle | 90 degrees |
| Number of Layers | 3 |

| Layer | Stage | Unit Weight (kips/ft3) |
|---|---|---|
| 1 | Existing Embankment | 0.115 |
| 2 | Temp Grade is Placed | 0.125 |
| 3 | Final Grade | 0.125 |

# Soil Layers

Ground Surface Drained: Yes

| Layer # | Type | Thickness [ft] | Elevation [ft] | Drained at Bottom |
|---|---|---|---|---|
| 1 | Clay I | 11.1 | 300.4 | No |
| 2 | Clay II | 17.2 | 289.3 | Yes |
| 3 | Sand | 23.3 | 272.1 | Yes |



# Soil Properties

| Property | Clay I | Sand | Clay II |
|---|---|---|---|
| Color | | | |
| Unit Weight [kips/ft3] | 0.115 | 0.12 | 0.115 |
| Saturated Unit Weight [kips/ft3] | 0.12 | 0.125 | 0.12 |
| K0 | 1 | 1 | 1 |
| Immediate Settlement | Disabled | Enabled | Disabled |
| Es [ksf] | - | 288.7 | - |
| Esur [ksf] | - | 288.7 | - |
| Primary Consolidation | Enabled | Disabled | Enabled |
| Material Type | Non-Linear | | Non-Linear |
| Cc | 0.25 | - | 0.25 |
| Cr | 0.07 | - | 0.07 |
| e0 | 0.98 | - | 0.98 |
| OCR | 3 | - | 3 |
| Cv [ft2/d] | 0.55 | - | 0.55 |
| Cvr [ft2/d] | 0.55 | - | 0.55 |
| B-bar | 1 | - | 1 |
| Secondary Consolidation | Standard | Disabled | Standard |
| Ca | 0.004 | - | 0.004 |
| Car | 0.004 | - | 0.004 |
| Undrained Su A [kips/ft2] | 0 | 0 | 0 |
| Undrained Su S | 0.2 | 0.2 | 0.2 |
| Undrained Su m | 0.8 | 0.8 | 0.8 |
| Piezo Line ID | 1 | 1 | 1 |

# Groundwater

| | |
|---|---|
| Groundwater method | Piezometric Lines |
| Water Unit Weight | 0.0624 kips/ft3 |
| Generating excess pore pressure above water table | |

## Piezometric Line Entities

| ID | Elevation (ft) |
|---|---|
| 1 | 300 ft |

# Query

## Query Points

| Point # | Query Point Name | (X,Y) Location | Number of Divisions |
|---|---|---|---|
| 1 | Query Point 1 | -26.7465, 50 | Auto: 61 |

## Query Lines

| Line # | Query Line Name | Start Location | End Location | Horizontal Divisions | Vertical Divisions |
|---|---|---|---|---|---|
| 1 | Query Line 1 | -104.3, 50 | 179.888, 50 | 20 | Auto: 61 |

## Field Point Grid

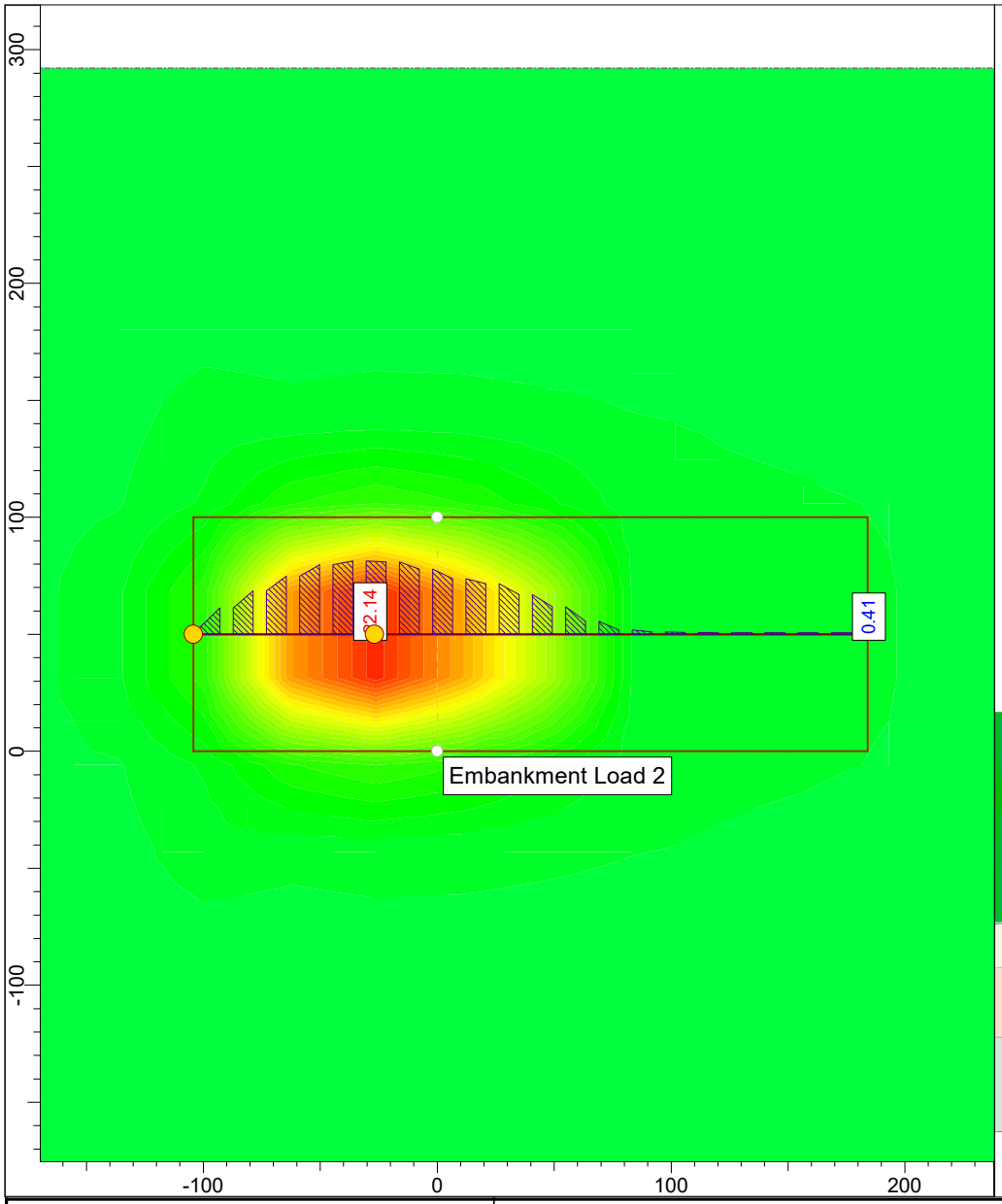
| | |
|---|---|
| Number of points | 308 |
| Expansion Factor | 2 |

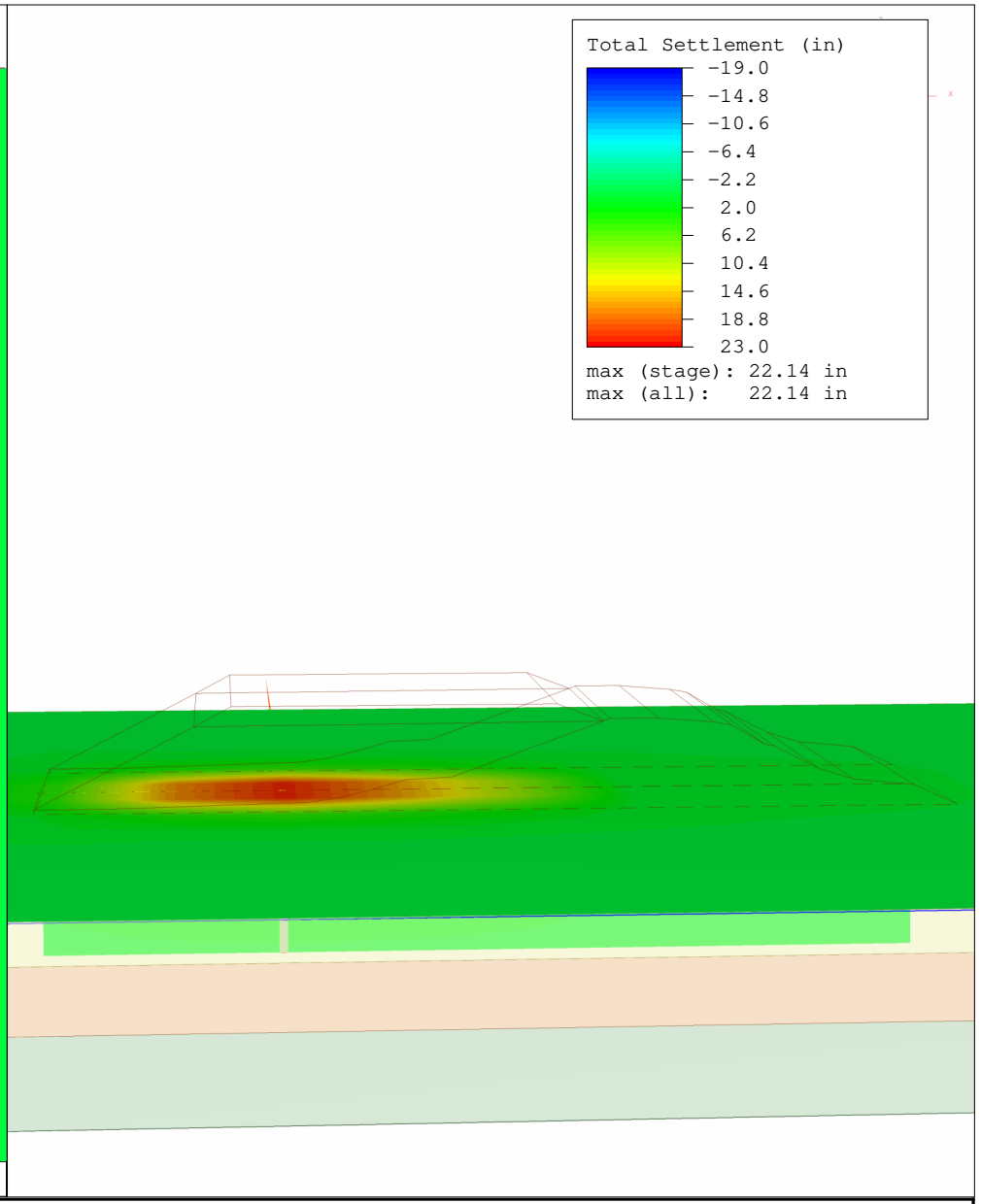
### Grid Coordinates

| X [ft] | Y [ft] |
|---|---|
| 376 | 292 |
| 376 | -192 |
| -392 | -192 |
| -392 | 292 |

# Time Points

| Point # | (X,Y) Location | Elevation | Goal Type | Goal | Time Until Goal |
|---|---|---|---|---|---|
| 1 | -26.917, 52.878 | 290 ft | Degree of Consolidation | 90% | 259.407 d |
| 2 | -26.475, 48.582 | 290 ft | Degree of Consolidation | 50% | 61.389 d |



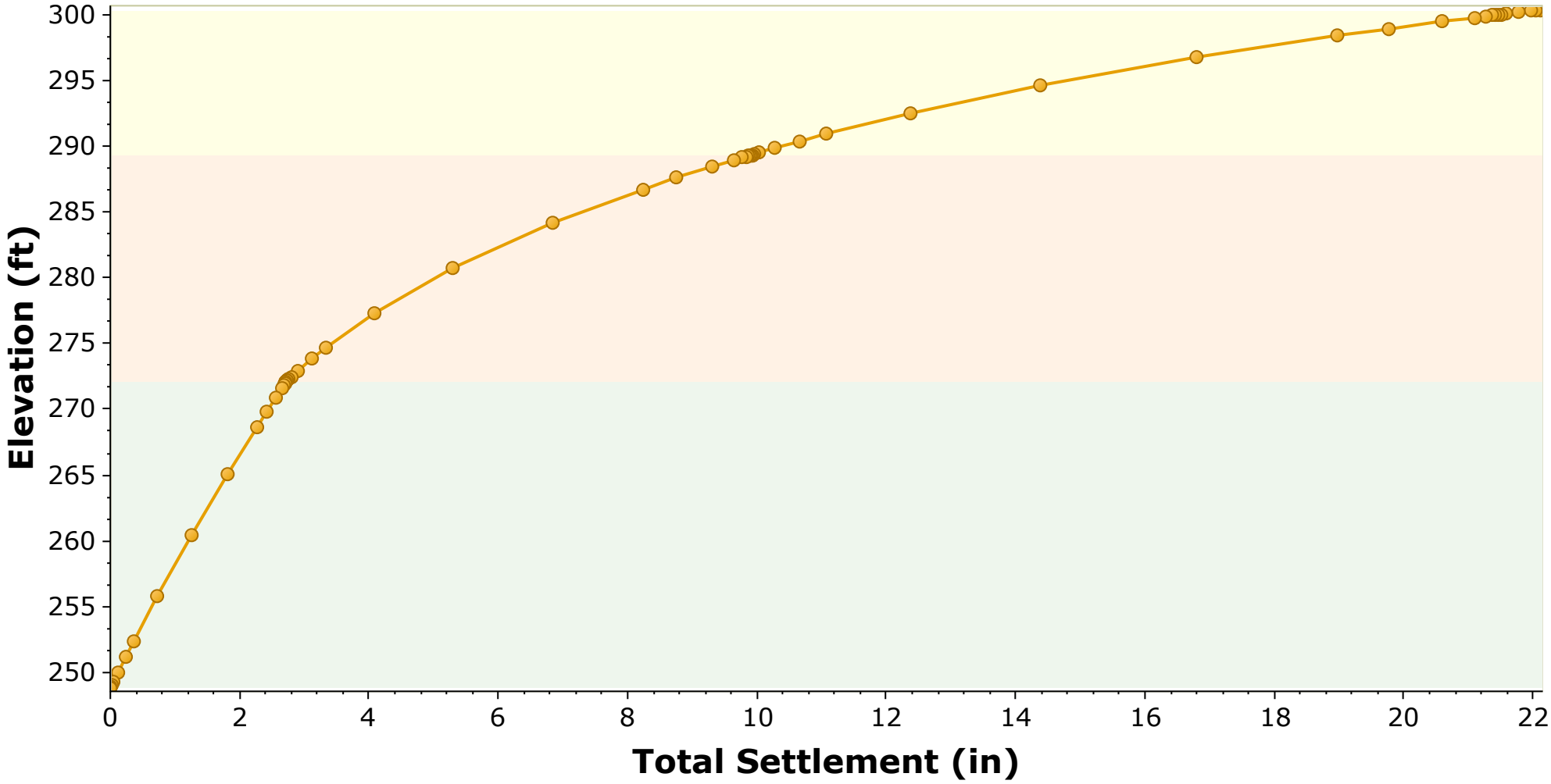




ROCSCIENCE

SETTLE3 5.026

| | | | |
|---|---|---|---|
| *Project* | US-51 over the Ohio River | | |
| *Analysis Description* | STA 2107+50 | | |
| *Drawn By* | KR | *Company* | HDR |
| *Date* | 03/27/2026, 8:52:53 AM | *File Name* | STA 2107+50 KY Temp.s3z |

# Total Settlement vs. Elevation



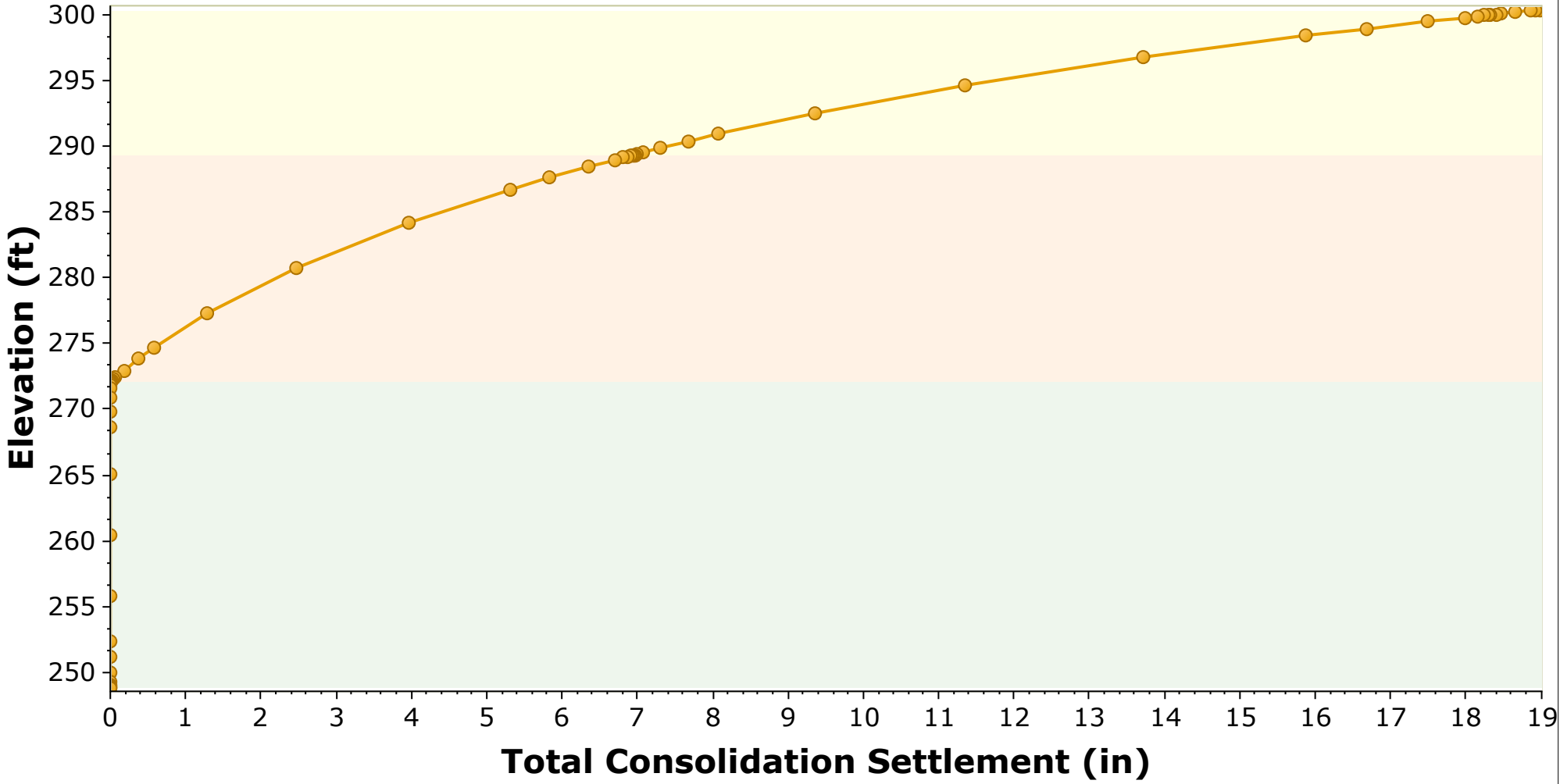

Query Point 1 (After 75 Year = 37393.8 d)

Reference Stage: Existing Embankment Settled = 10000 d

| | | | |
|---|---|---|---|
| ROCSCIENCE | Project | US-51 over the Ohio River | |
| | Analysis Description | STA 2107+50 | |
| | Drawn By | KR | Company: HDR |
| | Date | 03/27/2026, 8:52:53 AM | File Name: STA 2107+50 KY Temp.s3z |

SETTLE3 5.026

# Total Consolidation Settlement vs. Elevation




Query Point 1 (After 75 Year = 37393.8 d)

Reference Stage: Existing Embankment Settled = 10000 d

| | | | |
|---|---|---|---|
| ROCSCIENCE | Project | US-51 over the Ohio River | |
| | Analysis Description | STA 2107+50 | |
| | Drawn By | KR | Company: HDR |
| | Date | 03/27/2026, 8:52:53 AM | File Name: STA 2107+50 KY Temp.s3z |

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