Appendix H

Geotechnical Reports

Appendix H.1

Geotechnical Exploration Report
Off-Season Two Improvements

GEOTECHNICAL EXPLORATION REPORT
OFF-SEASON TWO IMPROVEMENTS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD DISTRICT OF LOS ANGELES, CALIFORNIA

Prepared For:

FORD THEATRE FOUNDATION
2580 Cahuenga Boulevard East
Hollywood, California 90068

Project No. 10296.001

September 10, 2013

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

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Ford Theatre Foundation
2580 Cahuenga Boulevard East
Hollywood, California 90068

c/o Bottega Management Group
3500 W. Olive Avenue, Suite 300
Burbank, California 91505

Attention: Mr. A. Leonard Madson, Principal

Subject: Geotechnical Investigation
Off-Season Two Improvements
2580 Cahuenga Boulevard East
Hollywood District of Los Angeles, California

Reference: Leighton Consulting, Inc., 2013, Preliminary Geotechnical Evaluation John Anson Ford Theaters Master Plan 2580 Cahuenga Boulevard East Hollywood District of Los Angeles, California, Project No. 603057-001, dated February 7, 2013.

In accordance with our April 30, 2013 proposal, authorized on May 2, 2013, Leighton Consulting, Inc. (Leighton) is pleased to present this geotechnical exploration report in support of the proposed Off-Season Two Improvements planned for the John Anson Ford Amphitheater. Our scope of work for this study included research, geologic mapping, subsurface exploration, laboratory testing, engineering analysis, design team meetings, and preparation of this report.

The Off Season Two Improvements are expected to include restoration of historic features and improvements to the amphitheater stage. Planned improvements include replacement of the existing stage, below stage spaces, and upstage retaining walls.

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The new basement floor levels below the stage are to be lowered and sub-surface and surface drainage elements improved, including new and replacement sanitary sewers and storm drains.

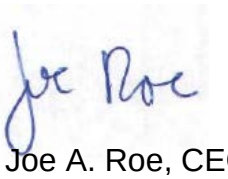
This report presents the results of our geotechnical exploration program and provides recommendations for design and construction of the proposed project.

We appreciate the opportunity to be of service to the Ford Theatre Foundation. If you have any questions or if we can be of further service, please call us at your convenience at (866) LEIGHTON, at the direct extensions listed below, or e-mail us as listed below.



Respectfully submitted,

LEIGHTON CONSULTING, INC.



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1.0 INTRODUCTION

1.1 Authorization

In accordance with your authorization on May 2, 2013, and based on our April 30, 2013 Off-Season Two Improvements proposal, Leighton Consulting, Inc. (Leighton) has performed document review, geologic mapping, subsurface exploration, laboratory testing, and engineering analysis for the John Anson Ford Theaters Master Plan Off-Season Two Improvements. The project is located at 2580 Cahuenga Boulevard in the Hollywood District of Los Angeles, California (Figure 1).

1.2 Objective

The objective of our investigation was to identify subsurface stratigraphy (soil type and thickness, depth to bedrock) within the area of planned improvements. Access constraints prevented exploration at some locations, such as below the existing basements and at the towers adjacent to the stage. Accordingly, assumptions have been made to model the stratigraphy at unexplored locations for our analysis and will require field verification during construction.

1.3 Scope of Work

Our scope included document review, geologic mapping, subsurface exploration, laboratory testing, engineering analysis, on-site meeting with the design team, and preparation of this report. To accomplish our scope of work we provided the following services:

- *Review of Available Data*: We reviewed the schematic design draft plans, Off Season Two Improvements, sheets S-200 Lower Level Plan, S-201 Mezzanine Level Plan, S-202 Amphitheater Plan, L-500 Sections and C3.00 Utility and Drainage Plan, prepared by Levin and Associates Architects, dated April 5, 2013 and accompanying memorandum dated April 9, 2013.

- *Geologic Mapping*: We performed field mapping of the observable rock mass, rockfall debris, and surficial soil conditions around the amphitheater to document current geologic conditions and identify potential geotechnical and geologic constraints impacting the overall project site (Plate 1, Geologic Map). Location of cross sections A-A' and B-B' developed during our preliminary

evaluation in 2012 are also shown on Plate 1. Geologic data, test pit, and cross section locations (C-C', D-D' and E-E') specific to the Off-Season Two project are shown on Plate 2, Test Pit and Cross Section Location Map). Geologic cross sections are shown on Plates 3, Generalized Geologic Cross Sections A-A' and B-B', and Plate 4, generalized Geologic Cross Sections C-C', D-D' and E-E'.

- *Geophysical Survey*: We performed a geophysical refraction and surface wave velocity survey as part of our preliminary investigation conducted in 2012. For ease of reference a copy of the seismic survey report (Leighton, 2013) is included in Appendix A of this report. Locations of the refraction surveys are shown on Plate 1.

- *Geotechnical Exploration*: We excavated four test pits (TP-1 through TP-4) behind the existing terraced retaining walls to the east of the amphitheater and in the landscape area adjacent to the north tower. Due to the extremely difficult site access and heavy vegetation, we hand excavated test pits in the selected areas to obtain geologic data. Test pit logs are incorporated in the geologic sections on Plate 4. Each test pit was photographed prior to backfilling. Bulks samples were collected from the test pits and transferred to our lab for geotechnical laboratory testing. The test pits were backfilled and compacted with the excavated material. Key photos of the proposed improvements area are included in Appendix B, Test Pit Logs and Photos.

- *Laboratory Testing*: We performed geotechnical laboratory testing on bulk samples recovered during the investigation to determine compaction characteristics (ASTM D1557-12), expansion potential (ASTM D 4829), and corrosion (California Test methods CT 417 Part II, 422, and 532/647). Laboratory test results are included in Appendix C, Laboratory Data.

- *Engineering Analysis*: We performed an evaluation of the proposed project based on the field data gathered during our current and prior studies at the site.

- *Report:* Leighton prepared this report documenting the results of the geological mapping, subsurface exploration, laboratory testing, and engineering analysis and provides recommendations for design and construction of the Off-Season Two Improvements.

1.4 Project Description

The Off-Season Two Improvements include demolition and construction of new footings within the amphitheater footprint, below the concrete tower structures north and south of the stage and north tunnel, removal and replacement of basement retaining walls, drainage improvements, and slab on grade construction. New terraced retaining walls are also planned to replace the existing stone walls behind the stage in conjunction with hillside landscaping. New and replacement sanitary sewer and storm drain lines are also planned.

1.5 Study Area

As presented on Figure 1, generally, the project site is located on steep hillside terrain within a County of Los Angeles Park. The study area is bordered to the west by Cahuenga Boulevard East and U.S. Route 101 and to the east by the steep flanks of the Santa Monica Mountains. The site of the existing Ford Theatre spans for approximately 1,320 feet along the base of the hills and contains three asphalt-paved parking lots (northern lot, motel lot and southern lot) facing Cahuenga Boulevard East, a former motel building, and the existing Amphitheatre with loading area, pedestrian walkways and box office. Elevations of the sites existing improvements range from approximate elevation El. 552 feet mean sea level (msl) near the entrance to the site at Cahuenga Boulevard East to a high of El. 654 feet msl in the northern region of the Off Season Two Improvements area (Plate 1). The ridgeline east of and above the amphitheater rises to a high of elevation 944 feet msl (USGS, 1966) before descending easterly to Weid Canyon, the site of Mulholland Dam (Hollywood Reservoir).

The Off-Season Two Improvements are proposed for construction within the amphitheater footprint (Plate 2, Test Pit and Cross Section Location Map), which consists of subterranean tunnels and corridors below the stage and amphitheater seating area, two concrete towers and mezzanines north and south of the stage, terraced stone walls and planter areas behind the stage. Erosion and debris flow impacted concrete drainage swales capture hillside runoff directed toward an 18-inch-diameter reinforced concrete storm drain pipe (RCP) upslope of the terraced stone walls. Existing upslope hillside improvements above the main masonry block wall include a wooden platform and a concrete cribwall that has been damaged by rockfalls in the north area of the site including a masonry block wall upslope in a heavily vegetated area. Photos of the Off-Season Two Improvements area are located in Appendix B, Test Pit Logs and Photos.

2.0 GEOLOGIC RECONNAISSANCE AND MAPPING

We performed geologic reconnaissance and field mapping of the Off-Season Two Improvements project area supplement the data procured during literature review. The following sections provide general descriptions of the conditions expected at the areas of the Off-Season Two Improvements. The interpreted subsurface conditions are shown on Plate 4, Generalized Geologic Cross Sections C-C', D-D', and E-E'.

2.1 Lower Level

The lower levels of the basement walls and north tunnel foundation footprints underlie the amphitheater stage and seating area (Figure B-1). The approximate footprint of the lower level basement retaining wall, interior walls, and corridors leading to and from the north tunnel are indicated on Plate 2.

The eastern basement retaining wall is of masonry block construction and exhibits mineral efflorescence along the mortar joints and block faces due to seepage through the wall indicating either non-functioning or non-existent wall drains. Based on regional mapping and extrapolated field conditions exposed within test pits TP-2 and TP-3 (Figure B-2), it appears bedrock underlying the foundations consists predominately of basalt and appears to have been cut to fit the "footprint" of the foundations and retaining walls during original construction of the Theater in the 1920's. Approximately 12 to 48-inches of overexcavation behind the retaining walls appears to have been performed to allow adequate space for construction.

Backfill material behind the walls consist of a mixture of the bedrock material, predominately basalt and a silty sand mixture of basalt and sandstone rock fragments. This backfill prism also contains an abundant overgrowth of roots from the many large trees that line the hillside. Abundant oversize material, i.e. cobbles and boulders are also present within the fill prisms.

2.2 Mezzanine Level

The mezzanine levels located north and south of the stage provide access to the upper tower levels and for stage lighting (Plate 2). The mezzanine decks adjacent to the two towers are bordered by steep bedrock slopes consisting of thick accumulations of colluvium and rock talus.

Upper Level Mezzanine Deck North: The slopes bordering the northern mezzanine level are inclined at 60-65 degrees, contain large diameter trees and consist of near vertical headscarp exposures of severely weathered basalt bedrock with thick accumulations of colluvium forming on the slope (Figure B-5). The colluvial material is subject to slow creep and debris flows during heavy precipitation as evidenced by bent trees, overtopping mezzanine walls, and sandbag barriers with plastic sheeting covering the slopes in an effort to prevent further mass erosion affecting the daily operations of the Theater.

Upper Level Mezzanine Deck South: The slopes bordering the southern mezzanine level are steeply inclined to near vertical and contain exposures of basalt, sandstone and thick accumulations of colluvium and rockfall debris. The basalt in this area degrades to angular, silty-clayey sand forming the majority of the colluvial material. The sandstone in this area is very hard, well cemented and heavily jointed due to faulting and tectonic uplift. This sandstone outcrop contains near vertical, fresh exposures of sandstone rock faces with thick accumulations of rock talus (rockfall debris). These accumulations form along the base of the slope impacting the southern concrete walls (Figure B-6). A steel H-beam reportedly installed to provide structural support to the concrete wall has been damaged by the boulder sized talus rockfalls occurring along structural planes of weakness. This area is shown on Plates 1 and 2 as having high potential for continued rockfalls.

2.3 Amphitheatre Plan

The existing improvements consist of a series of stacked stone walls and concrete stairs (Figure B-2) ascending to a concrete drainage swale and masonry block wall ranging in height from 32- to 84-inches tall (Figures B-3 and B-4). The stone retaining wall foundations were constructed on basalt bedrock (Figure B-2), drainage is accomplished by a series of 1- to 4-inch-diameter weep holes located above the wall footings. Some weep holes are partially obstructed by soil and weed overgrowth and were dry at the time of our observations.

The slopes above these stone walls are inclined from 50-65 degrees and consist of exposures of severely weathered basalt bedrock with thick accumulations of colluvium forming on the slope. Surficial slumping of undocumented artificial fill and colluvium was observed at several locations. Dense vegetation consists of large trees, small shrubs and grasses. The hillside above the amphitheater area

was constructed with a concrete lined drainage swale outletting to an 18-inch-diameter downdrain and retaining wall structure (Figure B-3).

The southern limit of the concrete drainage swale is obscured from view by thick accumulations of soil and vegetation (Figure B-4). Above the drainage swale to the northeast, concrete cribbing emplaced to prevent rockfall damage from upslope outcrops has sustained damage due to rockfalls evidenced from one of the many sandstone boulders perched on the slope face (Figure B-3). An additional masonry block wall was constructed easterly of the upper drainage swale in a small canyon drainage. The slopes below this area are heavily vegetated. The condition of the masonry block wall in this area is unknown but is suspected to be impacted by sediment build up and potential rockfall (Plates 1 and 2).

3.0 GEOLOGIC CONDITIONS

3.1 Regional Geology and Tectonics

The study area for the proposed project is located on the south flank of the eastern Santa Monica Mountains, west of the Cahuenga Fault within the Transverse Ranges Geomorphic Province of California. The distinctive uplifted east-west trending features of the Transverse Ranges were formed as a result of the compressive forces between the converging Pacific and North American Plates (Yerkes, 1965). The Santa Monica Mountains in this area expose north-trending, fault bound blocks containing an assemblage of older Tertiary-age marine and non-marine sedimentary and intrusive and extrusive volcanic rocks (Figure 2, Regional Geologic Map). An east-west trending ridge, in line with the main crest of the Santa Monica Mountains, is the principal topographic feature of the area. Cahuenga Pass, a low gap in the ridge, separates this ridge from the main crest of the Santa Monica Mountains (CDMG, 1953) formed largely as a result of erosion of soft shale outcrops west of the Cahuenga fault and formation of resistant sandstone to the east.

The present physiographic setting of the project site is predominantly northwest to west-facing steep sided to near-vertical (ridge forming sandstones) terrain along the eastern side of the study area. The topographic relief across the site varies between approximately 551 feet above msl in the northwestern portion of the site to approximately 944 feet above msl along the ridgeline to the east of the existing former motel building. The topographic features are closely related to tectonic uplift, ridgeline erosion, erosion of soft shales, and intrusive-extrusive basaltic flows. Internal drainage has eroded major gullies and rills into the underlying bedrock material.

3.2 Site Specific Geology

The local geologic units encountered at the Off-Season Two Improvements project area are discussed below, in order of relative age, youngest to oldest. The surficial units observed include recent and Quaternary-age sediments that form a thin mantle over the bedrock. These surficial units include undocumented artificial fill associated with the amphitheater construction, debris flows, surficial rock failures, and colluvium. The colluvium is generally not depicted on the map due to its relatively thin nature, except where it has been recently mapped during our geologic reconnaissance (Plates 1 and 2). Bedrock belonging to the Tertiary-

age Topanga Formation and intrusive-extrusive volcanic rocks (pillow basalt) correlative to the Topanga Formation exposed throughout the project study area and mapped during our geologic investigation is depicted on Plate 1.

Artificial Fill, Undocumented (Map Unit – Afu): Artificial fill materials have been mapped in the areas behind the terraced stone walls as shown on Plate 4. The thickness of the artificial fill underlying the majority of the improvements area is unknown; however, based on our current investigation we anticipate the existing foundations to be founded on bedrock with nominal amounts of fill underlying the slab on grade construction. As encountered at the test pit locations (shown on Plate 2), fill material consists predominately of silty sand to clayey sand (SM-SC) with varying amounts of basalt and sandstone rock fragments ranging in size from small cobbles to boulders greater than 14-inches in long dimension. The fill material depths at the test pit locations ranged from less than 12-inches up to 5 feet (Plate 4).

Debris Flows and Surficial Failures: Several small (volume) debris flows and surficial failures were mapped at various locations along the slopes at the site, as indicated on Plates 1 and 2. The debris flows (gravitational slides) affecting the proposed construction area consist of thick accumulations of colluvium characterized as silty-clayey sand (SM-SC) comprised of fine to coarse grained, angular sandstone and basalt rock fragments. The material is loose, occurs predominately within the basalt formation and is prone to sliding during significant, prolonged rainfall events.

Rockfalls: Rockfalls and wedge failure events originating in the initiation zone of the sandstone outcrop have resulted in thick accumulations of talus at the toe of the slope and concrete retaining wall constructed as part of the southern mezzanine deck area (Plate 2). These events can be expected to continue and consist of individual rocks to several cubic yard volume events. The run out zone below this outcrop is very narrow and constrained by the existing concrete retaining wall. A steel H-beam installed to provide structural support to the concrete wall is bent suggesting rockmass dislodged and either bounced, slid and/or rolled down slope before coming to rest against the steel structure. The principal causal mechanism of rockfalls and wedge failures in this area is a result of the steep near vertical topography, discontinuities within the rockmass, *weathering* susceptibility and root-wedging. Seismic shaking within the region can produce rockfall events.

Colluvium (Map Unit – Qcol): Slopewash or colluvial deposits are composed of materials that have been eroded, deposited, and transported by either running water (sheetflow), and/or gravitational sliding. The colluvial material at the site consists of brown, dry, loose silty clayey sands and rock fragments mechanically derived from severely weathered Topanga Formation basalt and sandstone material.

Topanga Formation Bedrock: The sedimentary bedrock unit exposed in the hillside and test pits belongs to the Tertiary-age Topanga Formation and is further described below:

Sandstone (Map Unit – Tts): This very hard, well cemented and heavily jointed sandstone outcrop was observed primarily in the southern portion of the site occurring in fault and depositional intrusive contact with the basalt formations, as indicated on Plate 1. The sandstone unit was observed to be orange brown, hard, thin to thickly bedded, well cemented with fine to coarse grained quartz sand and fine pebble sized subangular quartz inclusions. The rockmass is well oxidized with trace amounts of pyrite that contain reddish black oxide rimming along the cubic grains. The sandstone is in fault contact with very fine grained, siliceous quartz sandstone containing dark red cherty laminations. These rock masses are severely fractured, heavily jointed with very narrow zones of rock gouge along the faults.

Sandstone (Map Symbol - Ttbs): Although not observed in the Off Season Two Improvements area, this friable sandstone was observed during our earlier investigation east of the northern parking lot, north of the former motel building, and east of the southernmost parking lot, as indicated on Plate 1. This sandstone unit was observed to be dark gray with basalt fragments and rounded manganese nodules throughout, friable or crumbly, and severely weathered and fractured. Heavy secondary mineralization and chemical alteration of the mafic minerals within the unit was also observed.

Tertiary Volcanic Rocks (Map Unit – Tvb): The Tertiary-age pillow basalt formed from flows issuing from deep linear fissures (mid-oceanic fractures) in the ocean crust, observed within the test pits, forms the majority of the bedrock material exposed in the slopes immediately above the proposed improvement area (Plate 1). This highly weathered, intrusive-extrusive igneous rock is massive, orange brown on oxidized surfaces to grayish black on less weathered surfaces. Chemical weathering and decomposition of the basalt mineralogy is severe

causing degradation of the rock mass into angular sand and gravel sized fragments thereby influencing the rock strength and elastic properties. Fresh or discolored (dark grayish black) rock is present as a discontinuous framework and as corestones. This degradation to soil causes thick accumulations of secondary clayey colluvium which are susceptible to debris flows.

3.3 Geologic Structure

Regional uplift of the Santa Monica Mountains is primarily the result of movement along the Santa Monica and Hollywood faults combined with extrusive igneous intrusions that once occurred along linear fissures in oceanic crust. The major faults in the project area most important to the structural and stratigraphic evolution of the fault bound blocks are the Cahuenga Fault Zone, the Brush Canyon fault, the Ferndell fault, the Griffith fault and the Los Angeles River fault.

Minor faults mapped in the sandstone outcrop in the southern area of the site generally strike N66°W to N76°W and dip steeply out of slope between 84° to 88° to the north correlating well to the regional trend of the local fault structure. Bedrock strikes predominately in a north-south direction dipping steeply into slope to the east between 60° to 65° (Plate 1). Contact between the sandstone bedrock and the pillow basalt exposed in the southern portion of the site were partially obscured due to dense vegetation and colluvial buildup and is therefore queried (Plate 1).

3.4 Rippability

As indicated in Section 1.3, a seismic refraction survey was completed in the southern and motel parking lots (Leighton, 2013). The seismic refraction survey was performed to predict the rippability of the material that underlies the site, which is primarily volcanic basalt and sandstone bedrock. Based on the seismic velocity profiles, jointed and fractured nature of the bedrock structure, the onsite materials within the planned excavation depths are considered rippable with conventional grading equipment.

However, due to access constraints conventional earthmoving equipment will likely not be able to access the areas of proposed improvements without significant access provided. As part of the current study, hand held electric chisels were used to excavate the basalt formation in the test pits. A depth of approximately 4 feet was obtained in Test Pit TP-1 with little difficulty.

Excavation of the material below a depth of 4 feet proved slightly difficult due to decreasing bedrock weathering with depth and equipment access constraints. The sandstone outcrop mapped in the southern portion of the site should be expected to be encountered during the planned renovations along the southern boundary. This material is hard and well cemented, pervasively fractured and jointed, and will prove moderately difficult to excavate with hand held equipment.

3.5 Groundwater

Due to the relatively high topographical relief and the exposed or shallow bedrock throughout the majority of the proposed project site, shallow groundwater is not expected to exist at the site. However, if prolonged seasonal precipitation occurs during the construction period, nuisance water should be expected to build up behind the eastern basement retaining wall thereby posing minor constraints on construction. Additionally, surface runoff during rainfall events should be anticipated. Should nuisance water be encountered during construction, dewatering the excavation(s) may be necessary and could be accomplished using sump pumps.

4.0 GEOLOGIC HAZARDS

Geologic hazards for the overall Theater complex include surface faulting, ground lurching, seismic shaking, landslides, liquefaction, seismically-induced settlement, lateral spreading, seismically-induced landslides, and flooding. Additional geologic hazards specifically affecting the proposed Off-Season Two Improvements Area include the potential for mass movements in the form of debris flows and rockfalls. The following sections discuss these hazards and their potential impacts at the site in more detail.

4.1 Faulting and Seismicity

In general, the primary seismic hazards for sites in the region include strong ground shaking and surface fault rupture. Our discussion of faults potentially impacting the site is prefaced with a discussion of California legislation and state policies concerning the classification and land-use criteria associated with faults. By definition of the California Geological Survey (CGS), an active fault is a fault which has had surface displacement within Holocene time (about the last 11,000 years). The state geologist has defined a potentially active fault as any fault considered to have been active during Quaternary time (last 1,800,000 years). This definition is used in delineating Earthquake Fault Zones (EFZ) as mandated by the Alquist-Priolo Earthquake Faulting Zones Act of 1972 and as most recently revised in 2007 (Hart and Bryant, 2007). The intent of this act is to ensure that urban development and habitable structures are not sited across the traces of active faults. Based on our review, the site is not located within an EFZ, (CGS, 2000).

Numerous active and potentially active faults have been mapped within the southern California region, several of which are within close proximity to the site (Figure 3 – Regional Fault Map). Per the latest California Geological Survey fault database, the major active and potentially active fault systems that could produce significant ground shaking at the site include the Hollywood and Santa Monica fault zones, and the Upper Elysian Park Thrust fault. The distance of these faults and the estimated slip rates if known are provided below:

Hollywood Fault: The active Hollywood fault is located approximately 0.7 kilometers (0.4 miles) to the south of the site. The fault is capable of producing an estimated maximum magnitude (Mw) 6.4 earthquake. The fault is truncated on the west by the north-northwest trending erosional escarpment known locally

as the West Beverly Hills Lineament (WBHL) marking the left step between the Santa Monica fault and the Hollywood fault (Dolan et al., 2000a). The WBHL creates a topographic erosional escarpment separating older alluvium on the west from younger alluvium on the east. Subsurface evidence for late Quaternary faulting is evident from several studies based upon geomorphic evidence, stratigraphic correlation between borings and fault trenching studies conducted in Hollywood (Dolan et al., 1997, 2000b). Recent faulting at Camino Palmero occurred after deposition of 9ka sediments and prior to deposition of sediments dated at 6ka making this fault active by definition by classification criteria adopted by the California Geological Survey that defines activity of faults based on dates of known rupture events. Based on sediment accumulation rates determined by radiocarbon dating, the dip separation is low but at least 0.75 mm/yr (D. Ponti in Hummon et al., 1994). Dolan et al., (1997) estimate that strike separation on the fault is greater than 0.25 mm/yr.

Santa Monica Fault Zone: The Santa Monica fault zone is located approximately 2.3 km (1.4 mi) from the site and is part of the west trending Transverse Ranges Southern Boundary fault system. The Santa Monica faults extends from Pacific Palisades through Santa Monica and into west Los Angeles were it merges with the Hollywood fault at the WBHL in Beverley Hills. The Santa Monica fault is thought to be capable of producing an estimated maximum magnitude (Mw) 6.6 earthquake. Several investigations (Dolan et al., 2000a; Hummon et al., 1992; Dolan and Sieh, 1992; and Crook and Proctor, 1992) have indicated the fault is active based on geomorphic evidence and fault trenching studies indicating the active portion of the Santa Monica fault does not extend east of the WBHL of Dolan and Sieh (1992). The fault has not been zoned, however, the fault is considered active by the State Geologist.

Upper Elysian Park Anticlinorium: The Elysian Park Anticlinorium is a southward verging anticline approximately 20 kilometers long (12.4 mi) with a curved, southward-convex axis, lying between the Hollywood fault on the northwest through the Silver Lake District to the right lateral East Montebello fault on the east in the City of San Gabriel. Uplift along the structure has produced the Elysian, Repetto and Monterey Park Hills. Deformed Quaternary deposits across the Coyote Pass Escarpment and related structures allowed Oskin et al., (2000) to estimate a late Quaternary slip rate on the blind Elysian Park reverse fault of 0.8-2.2 mm/yr. The California Geological Survey (2003) has estimated an average slip rate of 1.3mm/yr and an estimated maximum magnitude (Mw) of 6.4 for the Elysian Park Thrust fault system.

4.2 Surface Fault Rupture

Our review of available in-house literature indicates that no known active faults have been mapped across the site, and the site is not located within an Alquist-Priolo Earthquake Fault Zone (Hart and Bryant, 2007; CGS, 1986). Based on the United States Geological Survey (USGS) fault parameters database and latitude and longitude coordinates N34.1136° and W118.3355°, the closest active fault to the site is the Hollywood fault, located approximately 0.4 miles south of the site (http://geohazards.usgs.gov/cfusion/hazfaults_search). Based on the current geologic framework, the potential for surface fault rupture onsite is expected to be low.

4.3 Ground Shaking

Strong ground shaking can be expected at the site during moderate to severe earthquakes in this general region. This is common to virtually all of Southern California. Intensity of ground shaking at a given location depends primarily upon earthquake magnitude, site distance from the source, and site response (soil type) characteristics. According to the United States Geological Survey (USGS) at the time of this writing, the most recent local (within 25 kilometers of the site) earthquake was the MW 3.4 earthquake on September 7, 2012, approximately 3.4 miles to the southwest (http://earthquake.usgs.gov/earthquakes/eqarchives/epic/) believed to be attributed to movement along the San Vicente Blind thrust fault. The 2010 California Building Code (CBC) seismic coefficients are presented in the following subsections:

- *CBC Coefficients*: Based on our site reconnaissance, the project site is underlain predominantly by bedrock. The shear wave velocity in the upper 30 meters at the project site based on the recent geophysical survey performed at the site as a part of this evaluation (GeoVision, 2012) ranges between 1,880 and 2,139 feet-per-second.

  In accordance with the 2010 Edition of the CBC, this site should be classified as a Class C site. The following values may be used for the seismic design method based on the 2010 CBC:

2010 CBC Based Seismic Design Parameters (Mapped Values)

CBC Categorization/Coefficient	Design Value
Site Longitude (decimal degrees)	-118.3355 W
Site Latitude (decimal degrees)	34.1136 N
Site Class Definition	C
Seismic Design Category	D
Mapped spectral response acceleration parameter at short period, S_S	1.79
Mapped spectral response acceleration parameter at a period of 1 sec, S_1	0.60
Short Period (0.2 sec) Site Coefficient, F_a	1.0
Long Period (1.0 sec) Site Coefficient, F_v	1.3
Adjusted spectral response acceleration parameter at short period, S_{MS}	1.79
Adjusted spectral response acceleration parameter at a period of 1 sec, S_{M1}	0.78
Design spectral response acceleration parameter at short period, S_{DS}	1.19
Design spectral response acceleration parameter at a period of 1 sec, S_{D1}	0.52

4.4 Secondary Seismic Hazards

Liquefaction Potential: Liquefaction is the loss of soil strength or stiffness due to a buildup of pore-water pressure during severe ground shaking. Liquefaction is associated primarily with loose (low density), saturated, fine- to medium-grained, cohesionless soils. As shown on the State of California Seismic Hazard Zones Map for the Hollywood Quadrangle (CDMG, 1999), portions of the overall study area are located within an area that has been identified by the State of California as being potentially susceptible to liquefaction (see Figure 4). The Off Season Two Improvements are underlain by bedrock and are not located within a liquefiable area.

Lateral Spreading Potential: Lateral spreading is a phenomenon in which large blocks of intact, non-liquefied soil move downslope on a liquefied soil layer. Lateral spreading is often a regional event. For lateral spreading to occur, a liquefiable soil zone must be laterally continuous, unconstrained laterally in at

least one direction and free to move along sloping ground. Due to the topographic relief and the potential for liquefaction to occur, there is a potential for lateral spreading at the overall project site.

Seismically-Induced Settlement: Since the project site is underlain predominantly by bedrock, the potential for seismically-induced settlement is low.

Seismically-Induced Landslides: As shown on the State of California Seismic Hazard Zones Map for the Hollywood Quadrangle (CDMG, 1999), a portion of the project site is located within an area that has been identified by the State of California as being potentially susceptible to seismically induced landslides (see Figure 4).

Seiches, Tsunamis, Inundation Due to Large Water Storage Facilities: Seiches are large waves generated in very large enclosed bodies of water or partially enclosed arms of the sea in response to ground shaking. The only large enclosed body of water within close proximity to the site is the Hollywood Reservoir located to the northeast of the site. Based on the location and elevation of the large ridgeline between the site and the Hollywood Reservoir, the seiche risk at the site is considered negligible.

Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. The project area is predominantly at elevations higher than 500 feet above mean sea level, therefore the tsunami risk at the site is considered nil.

Earthquake-induced flooding can be caused by failure of dams or other water-retaining structures as a result of earthquake. According to the County of Los Angeles Seismic Safety Element (1990) and the City of Los Angeles Safety Element (1996), the site is not located within a potential inundation area for an earthquake induced dam failure from Hollywood Reservoir. Even though the site is not located within a potential inundation area for the Hollywood Reservoir, the dam is continually monitored by the Army Corp of Engineers (ACOE) to guard against the threat of dam failure. The possibility of dam failures during an earthquake has been addressed by the California Division of Mines and Geology in an earthquake planning scenario for a magnitude 8.3 earthquake on the San Andreas fault (Davis et al., 1982) and a magnitude 7.0 earthquake on the Newport Inglewood Fault Zone (Toppozada et al., 1988). Both reports state catastrophic failure of a dam as a result of an earthquake is highly unlikely.

Current design practices, dam review, modification or total reconstruction of existing dams are intended to ensure that all dams are capable of withstanding the maximum earthquake for the site. Therefore the potential for the site to be inundated as a result of dam failure is considered negligible.

4.5 Slope Stability

The results of the stability analyses provided in this report (Appendix D) indicate the project site will generally attain sufficient stability with minor surficial grading and slope reinforcement measures. The global factor of safety is estimated to be about 1.5 and 1.1 for static and pseudostatic conditions, respectively. Slope stability issues specific to the Off-Season Two Improvements are discussed below.

4.5.1 Debris flows

Mass movements include landslides and debris flows. Debris flow areas were encountered during our subsurface investigation at the project area, subsequent verbal conversations with Theater personnel indicate debris flows have occurred at the site (Figure B-5). The project site lies within a previously existing canyon cut down into the formational material surrounded by moderately steep natural slopes composed of massive pillow basalt and steeply dipping sandstone formations.

During our geotechnical investigation we mapped several areas that were possibly debris flow scars and/or accumulations of colluvium (Figure B-5). Areas of thick accumulation of surficial materials, predominately basalt, have the potential to develop into debris flows.

Debris flows and debris slides should be expected to occur in the heads of steep gullies, on steep slopes and along ridgelines underlain by basalt. When rainfall intensity is great enough to cause water to percolate into the colluvium at a rate which exceeds the rate at which the water can percolate into the bedrock, slope failure of colluvium will occur. The surficial stability of the natural slopes is dependent upon the thickness of weaker soils and the slope gradient. Thick accumulations of colluvial soils on steep slopes are susceptible to surficial failures, debris flows and downhill creep during periods of heavy rain. The most likely source of

debris flow potential is from the steep slopes and drainages in the northeastern and southern portion of the proposed improvements area.

Our recommendations regarding mitigation of debris flow are discussed in Section 6.0 of this report.

4.5.2 Rockfalls

Field mapping and geologic analysis of the sandstone rock outcrops exposed in the southern portion of the site indicated the presence of intersecting pairs of joint sets and conjugate fault planes. Due to local orientations of the joint sets, the presence of fractured, freshly exposed rock faces and damage to the previously referenced H-beam (Figure B-6), the potential exists for detachment and down slope translation of rock, which could impact the proposed development.

The proposed development is expected to require provisions to protect improvements and occupants from rock fall hazards. On a preliminary basis, provisions should be included in the site layout to include such devices as a rock fence located near the toe of the slopes. Other more elaborate techniques such as rock netting situated along the faces of slopes vulnerable to rock falls may also be necessary after landscaping is implemented.

4.6 Expansive Soils

Based on our geotechnical exploration at the site, the near surface soils are generally granular with localized silt and clay layers. The laboratory test result of two representative samples from Leighton test pit TP-1 and TP-4, showed low expansion index (EI) potential wetted EI =11 and EI=24, respectfully. Results of expansion index tests indicate that the onsite soils have low expansion potential.

4.7 Corrosive Soils

Corrosive soils are characterized by their ability to degrade concrete and corrode ferrous materials in contact with water or soil. In particular, concrete is susceptible to corrosion when it is in contact with soil or water that contains high concentrations of soluble sulfates which can result in chemical deterioration of the concrete. Results of laboratory testing indicate soluble sulfate contents of 73

and 175 ppm, which range from negligible to moderate sulfate exposure. Since irrigation water in Southern California is considered to have moderate sulfate attack potential (typical sulfate concentrations of 150 to 250 ppm), concrete should be designed to resist moderate sulfate exposure.

The site soils are deemed highly corrosive to ferrous metals based on minimum soil resistivity 1,200 to 2,050 ohm-cm recorded from two samples.

5.0 FINDINGS AND CONCLUSIONS

Based on our investigation, we conclude that the proposed project is feasible from a geotechnical standpoint. We did not encounter significant geotechnical constraints that cannot be mitigated by proper planning, design, and sound construction practices. The key findings of our investigation for the site are summarized below:

- The near surface materials encountered consist of undocumented fill soils and colluvium. The upper 3 to 5 feet of colluvial material are considered compressible. Undocumented fills locally contain large oversize sandstone rock fragments and concrete debris. The fill as encountered at the site is associated with past construction activities.

- The colluvium as encountered consisted predominately of angular sands and gravel sized basalt rock fragments intermixed with organic debris from hillside vegetation. The colluvium forms thick accumulations near the toe of slopes and behind the existing concrete, stone and masonry block retaining walls and within the drainage swales impeding flow. Our observations suggest the colluvium has overtopped the various retaining walls at some point if the past and will continue to do so unless mitigated and maintained. Colluvium is subject to continuous downhill creep due to gravity and rapid releases in the form of debris flows following periods of intense precipitation.

- The basalt bedrock on site has massive pillow structure, is very blocky, interlocked, and partially disturbed with multi-faceted angular blocks formed by joint sets and as a result of rapid crystallization during formation. Basalt at the site should also be expected to occur in dikes and sills in the sedimentary formations. Zeolite veining and other minerals are common.

- The sandstone outcrop in the southern portion of the Off-Season Two Improvements area contain weak planar structural features in unfavorable orientation with respect to the north facing rock slope. This area is prone to rock falls and is expected to require some provisions such as debris walls, rock fences, or rock netting to protect improvements and occupants from the hazards associated with localized rock falls and/or pop-outs. A detached boulder greater than five feet long remains perched near the top of the talus pile while smaller sized rock material up to 2 feet long provide the majority of the talus debris now resting against the southern mezzanine level concrete retaining wall.

- Based on the rock quality determined during the test pit excavations, field mapping and refraction survey (Appendix A), it is our opinion that the basalt and sandstone materials will vary from easily rippable near surface to moderately difficult using electric hand chisels below 4 feet in depth.

- Groundwater was not encountered. Nuisance water could be encountered during and after seasonal precipitation behind the eastern basement retaining wall.

- Results of laboratory testing indicate soluble sulfate contents of 73 and 175 ppm, which range from negligible to moderate sulfate exposure. Since irrigation water in Southern California is considered to have moderate sulfate attack potential (typical sulfate concentrations of 150 to 250 ppm), concrete should be designed to resist moderate sulfate exposure.

- Results of the expansion testing indicate the two representative samples from Leighton test pits TP-1 and TP-4 showed low expansion index (EI) potential when wetted EI =11 and EI=24, respectfully. Non-cohesive granular fill derived from a mixture of these materials is expected to have low expansion potential. Expansive soils not specifically encountered during this investigation may be present locally onsite.

- The existing onsite soils expected to be generated from the basalt formation appear to be suitable for re-use as fill during proposed construction provided they are free of organic material and oversize debris. However, the potential for significant erosion exists if granular fill soils are used on slope faces.

- Oversize material (cobble sized to 14 inches in long dimension) was encountered in Test Pit TP-4. Oversize material could also be generated while excavating the sandstone rocks in the southern portion of the site. Oversize material should be removed from the site or placed at a designated, pre-approved disposal area within the Theater complex.

- Several sandstone boulders lie on the slope face in the northeastern portion of the site above the existing concrete swale and below the crib wall. Damage to the crib wall was observed suggesting sandstone boulders become dislodged in the form of rockfall.

6.0 GEOTECHNICAL RECOMMENDATIONS

Extensive removals of loose slope materials will be required for the project. Many areas around the Theater currently have substantial debris flow and rock fall accumulations. These materials should be removed to unload retaining walls, re-establish proper freeboard behind walls, and reduce the potential for remobilization.

Due to the slopes surrounding the Theater complex, continued regular maintenance will be necessary, especially after periods of heavy or prolonged precipitation. Considering that significant landscaping on the slopes is already planned as part of the project, we recommend that trails and paths be established to facilitate access for maintenance crews to slope areas that currently have debris flow and rock fall accumulations because these areas will likely require regular cleanouts.

The damaged crib wall should be repaired and filled in with crushed rock to provide protection against rock falls and debris flows. The repair should include removal of the debris and rock fall/soil accumulation behind the crib wall.

For protection against future debris flows all new retaining walls should have a minimum freeboard height of 9 inches (height of wall above retained soil). Backfill behind existing walls should be lowered where possible to establish a nominal 9-inch freeboard.

For protection against future rockfalls, we recommend installation of flexible barriers at the bottom of the slope, several feet upslope of any existing retaining walls. Considering that the project site is a performance venue, we anticipate that aesthetics will be an important factor in selecting the rockfall mitigation system. The visual impact of flexible barriers, such as stainless steel cables with steel bollards or wrought iron fencing, will be easier to mitigate. The barrier should establish an effective freeboard of 4 feet. Alternatively, an anchored mesh net may be used. However, its visual impact will be more difficult to mitigate since all upslope areas with potentially loose rock fragments will require coverage.

New structural elements may be supported on spread-type shallow foundation systems established in engineered fill or undisturbed natural soils. Alternatively, deep foundations may be used. Capacities developed for new foundations may be used to evaluate existing footings and cast-in-drilled-hole (CIDH) piles.

The following geotechnical recommendations have been developed based on the exhibited engineering properties of the onsite materials and their anticipated behavior during and after construction, seismic design considerations, floor slabs, and grading.

There are existing basement walls below the stage. Shallow foundations (spread footings) for new structures should be deepened to extend below the active zone of existing basement walls, roughly a plane extending from the base of the basement wall at a 60 degree angle from horizontal, to avoid surcharging the walls. Footings may be deepened by excavating below the active zone and backfilling with concrete or with controlled low strength material (CLSM).

New basement walls planned below existing foundations within their active zones should be designed to accommodate surcharge loads. Surcharge may be modeled as half the footing bearing pressure within the wall's active zone applied horizontally.

New pile segments within the active zone of existing basement walls should be isolated from surrounding soils using Sonotubes or equivalent.

Leighton should review the grading plans, shoring plans, foundation plans, and specifications when they are available to verify that the recommendations presented in this report have been properly interpreted and incorporated.

6.1 Earthwork and Grading

All earthwork and grading should be performed in accordance with the following recommendations and Earthwork and Grading Guide Specifications presented in Appendix E.

6.1.1 Site Preparation

Prior to construction, the area of proposed new structures/foundations should be cleared of any vegetation and demolition trash and debris. These materials should be removed from the site. Any underground obstructions onsite should be removed. Efforts should be made to locate any existing utility lines to be removed or rerouted where interfering with the proposed construction. Any resulting cavities should be properly backfilled and compacted. After the site is cleared, the soils should be carefully observed for the removal of all unsuitable deposits. All undocumented fill should be excavated from proposed structure footprints.

6.1.2 General Grading Recommendations

New structures may be supported on conventional shallow footing foundation systems established on engineered fill or undisturbed bedrock.

The existing undocumented artificial fill should be removed and replaced as engineered fill. Overexcavation and recompaction should extend a minimum horizontal distance equal to the vertical distance between the proposed footing bottom and depth of overexcavation.

After completion of the overexcavation and prior to fill placement, the exposed soils/weathered bedrock should be scarified to a minimum depth of 12 inches, moisture conditioned and compacted to at least 90 percent relative compaction based on ASTM Test Method D 1557.

The onsite soils, less any deleterious material or organic matter, can be used in required fills. Cobbles larger than 6 inches in largest diameter should not be used in the fill. Any required import material should consist of relatively non-expansive soils with an Expansion Index (EI) less than 20. The imported materials should contain sufficient fines (binder material) so as to be relatively impermeable and result in a stable subgrade when compacted. All proposed import materials should be approved by the geotechnical engineer of record prior to being placed at the site.

6.1.3 Pipe Bedding

Any proposed pipe should be placed on properly placed bedding materials. Pipe bedding should extend to a depth in accordance to the pipe manufacturer's specification. The pipe bedding should extend to at least 12 inches over the top of the pipeline. The bedding material may consist of compacted free-draining sand, gravel, or crushed rock. Pipe bedding material should have a Sand Equivalent (SE) of at least 30.

6.1.4 Trench Backfill

Trench excavations above pipe bedding may be backfilled with onsite soils under the observation of the geotechnical consultant. All fill soils should be placed in loose lifts, moisture conditioned as required and compacted to a minimum of 90 percent relative compaction based on ASTM Test Method D 1557-12. Lift thickness will be dependent on the equipment used as suggested in the latest edition of the *Standard Specifications for Public Works Construction* (Greenbook). The fill soils should extend to the bottom of the aggregate base for new pavement, or to finished grade.

6.2 Shallow Foundations

New shallow spread footings may be established in engineered fill or undisturbed natural soils or bedrock.

6.2.1 Minimum Embedment and Width

Footings should have a minimum embedment of 12 inches and have a minimum width of 12 inches.

6.2.2 Bearing Value

Footings established on engineered fill or undisturbed natural soils may be designed to impose an allowable bearing pressure of 3,000 pounds per square foot (psf). A one-third increase in the bearing value for short duration loading, such as wind or seismic forces, may be used.

The ultimate bearing capacity can be taken as 9,000 psf, which does not incorporate a factor of safety. A resistance factor of 0.5 should be used for bearing capacity evaluation with factored loads. The recommended bearing value is a net value, and the weight of concrete in the footings can be taken as 150 pounds per cubic foot (pcf); the weight of soil backfill can be neglected when determining the downward loads.

6.2.3 Settlement

The estimated total settlement of the structures supported on spread footings as recommended above is less than 1 inch. The differential settlement between adjacent columns is estimated to be less than ½ inch over a horizontal distance of 30 feet.

6.2.4 Lateral Resistance

Lateral loads can be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.35 can be used between the footings and the floor slab and the supporting soils. The ultimate passive resistance of undisturbed natural soils or engineered fill soils can be assumed to be equal to the pressure developed by a fluid with a density of 300 pounds per cubic foot (pcf). The friction resistance and the passive resistance of the soils can be combined without reduction in determining

the total lateral resistance. A resistance factor of 1 should be used for lateral capacity evaluation with factored loads.

6.3 Deep Foundations

Cast-In-Drilled Hole (CIDH) concrete piles or micropiles may also be used to support new structural elements.

6.3.1 Cast-In-Drilled Hole (CIDH) Piles

Details of pile capacity analyses are presented in Appendix F. Design recommendations are summarized in the following subsections.

6.3.1.1 Axial Capacity of CIDH Pile

We understand that theatrical lighting towers are proposed on the hillsides surrounding the amphitheater. The capacities below may be used for design of drilled, cast-in-place concrete piles (CIDH).

Downward Capacity of CIDH Piles (kips)			
Depth of Pile Tip (feet)	**18-inch-diameter**	**24-inch-diameter**	**30-inch-diameter**
15	20	25	30
20	30	45	50
25	45	65	80

Dead-plus-live load capacities are shown. A one-third increase may be used for wind or seismic loads. A factor of safety of 3 was used for shaft friction and end bearing was neglected in determining the pile capacities.

Uplift capacities may be taken as equal to 50 percent of the downward capacities. The capacities presented are based on the strength of the soils; the strength of the pile section should be checked to verify the structural capacity of the piles.

A resistance factor of 0.5 should be used for downward and uplift capacity evaluation with factored loads.

Piles in groups may be spaced at 3 pile widths on-centers. If the piles are so spaced, no reduction in axial capacity due to group action need be considered in the design.

6.3.1.2 Lateral Capacity of CIDH Pile

Lateral loads may be resisted by the caissons and by the passive resistance of the soils. The lateral capacity of the caissons will depend on the caisson type and size, the permissible deflection, and on the degree of fixity at the top of the caisson. We have assumed piles will be installed on an effective 45 to 60 degree slope.

We have calculated lateral load, maximum moments, and depths to maximum moment for CIDH concrete piles (caissons) using the computer program LPILE by ENSOFT, Inc. We have assumed a concrete compressive strength value (f'_c) of 5,000 pounds per square inch (psi).

Lateral Capacities of 18-Inch-Diameter CIDH Pile

Pile Head Deflection (inches)	Fixity	Shear Force at Pile Top (kips)	Maximum Bending Moment (kips-in)	Depth to Maximum Moment (feet)
¼	Free Head	14	640	6
½	Free Head	20	1,030	7
¼	Fixed Head	30	1,620	0
½	Fixed Head	44	2,610	0

Lateral Capacities of 24-Inch Diameter-CIDH Pile

Pile Head Deflection (inches)	Fixity	Shear Force at Pile Top (kips)	Maximum Bending Moment (kips-in)	Depth to Maximum Moment (feet)
¼	Free Head	23	1,320	6
½	Free Head	33	2,110	7
¼	Fixed Head	50	3,325	0
½	Fixed Head	72	5,330	0

Lateral Capacities of 36-Inch Diameter-CIDH Pile

Pile Head Deflection (inches)	Fixity	Shear Force at Pile Top (kips)	Maximum Bending Moment (kips-in)	Depth to Maximum Moment (feet)
¼	Free Head	35	2,290	10
½	Free Head	50	3,660	11
¼	Fixed Head	74	5,780	0
½	Fixed Head	100	8,800	0

The analyses performed uses the flexural stiffness of the caissons computed from the modulus of elasticity (*E*) and moment of inertia (*I*). The modulus of elasticity (*E*) is derived based on the concrete compressive strength and the moment of inertia (*I*) is derived based on the caisson cross-section geometry. The values of *E* and *I* are assumed constant along the entire length of the caissons.

Lateral pile capacities considering a reduced moment of inertia due to cracked concrete pile sections should be evaluated after reinforcing details become available.

A resistance factor of 1 should be used for lateral capacity evaluation with factored loads.

The capacities presented in the table above are for pile lengths equal to or greater than 20 feet. This length is measured below the pile cap. The lateral capacity and reduction in the bending moment are based in part on the assumption that any required backfill adjacent to the caisson caps and grade beams are properly compacted.

For caissons in groups spaced at least 3 pile widths on-center, no reduction in the lateral capacity need be considered for the first row of caissons. For subsequent rows in the direction parallel to loading, caissons in groups spaced closer than 8 caisson widths on-center will have a reduction in lateral capacity due to group effects. The lateral capacity of caissons in groups spaced at 3 caisson widths on-center may be assumed to be reduced by half. The reduction for other caisson spacings may be interpolated between no reduction for caissons spaced at 8 caisson widths on-center and the reduction for caissons spaced at 3 caisson widths on-center.

The passive resistance of engineered fill against caisson caps and grade beams will depend on the method of installation. The passive resistance of engineered fill may be assumed to be equal to the pressure developed by a fluid with a density of 300 pounds per cubic foot (pcf), up to a maximum pressure of 3,000 pounds per square foot. A one-third increase in the passive value may be used for wind or seismic loads. The lateral resistance of the caissons and the passive resistance of the soils may be combined without reduction in determining the total lateral resistance.

6.3.1.3 Settlement

Piles in groups may be spaced at 3 pile widths on-centers. If the piles are so spaced, no reduction in axial capacity due to group action need be considered in the design.

The settlement of the proposed improvements founded on caissons in the manner recommended, will be approximately ½ inch or less. Differential settlement will be approximately ¼ inch or less. The

differential settlement is anticipated to occur over a minimum span of 40 feet.

Settlement of piles, generally resulting from settlement of the supporting soils and elastic compression of piles, is expected to be on the order of ¼ inch. The settlement analysis should be evaluated when the actual structural load and pile cap configuration become available.

6.3.1.4 Construction

The drilling of the pile shafts and placement of the steel reinforcement and concrete should be done under the continuous observation of the project geotechnical engineer. Localized caving within unsupported excavations should be anticipated. Casing may be required where/if sands layers occur. Excavations for piles that are spaced at less than five diameters (center to center) should be not open simultaneously. Concrete for closely spaced piles should be placed and allowed to set for at least 24 hours before initiating the excavation for any adjacent piles. Steel reinforcement and concrete should be placed as soon as possible after approval of the drill hole. Pile excavations should not be left open overnight. Tremie pipes should be utilized when placing the concrete to prevent the concrete from falling and/or striking the walls of the borehole. Although groundwater was not encountered in our explorations, perched groundwater table may be present following periods of rainfall.

6.4 Slabs-on-Grade

Concrete slabs may be designed using a modulus of subgrade reaction of 150 pci provided the subgrade is prepared as described in Section 6.1, *Earthwork and Grading*. From a geotechnical standpoint, we recommend slab-on-grade be a minimum 5 inches thick with No. 3 rebars placed at the center of the slab at 24 inches on center in each direction. The structural engineer should design the actual thickness and reinforcement based on anticipated loading conditions. Where moisture-sensitive floor coverings or equipment is planned, the slabs should be protected by a minimum 10-mil-thick vapor barrier between the slab and subgrade.

Minor cracking of concrete after curing due to drying and shrinkage is normal and should be expected; however, concrete is often aggravated by a high water/cement ration, high concrete temperature at the time of placement, small nominal aggregate size, and rapid moisture loss due to hot, dry, and/or windy weather conditions during placement and curing. Cracking due to temperature and moisture fluctuations can also be expected. The use of low-slump concrete or low water/cement ratios can reduce the potential for shrinkage cracking. Additionally, our experience indicates that the use of reinforcement in slabs and foundations can generally reduce the potential for concrete cracking.

To reduce the potential for excessive cracking, concrete slabs-on-grade should be provided with construction or weakened plane joints at frequent intervals. Joints should be laid out to form approximately square panels.

6.5 Lateral Earth Pressures

Recommended lateral earth pressures are provided as equivalent fluid unit weights, in psf/ft. or pcf., for design of basement and retaining walls in drained conditions using onsite sandy soils as backfill. These values do not contain an appreciable factor of safety, so the structural engineer should apply the applicable factors of safety and/or load factors during design.

Lateral Earth Pressures

Condition	Equivalent Fluid Unit Weight (psf/ft)
	Level Backfill
Active	35
Seismic Increment	20
At-Rest	55
Passive	300
Coefficient of Friction	0.35

Walls that are free to rotate or deflect may be designed using active earth pressure. For the basement walls or walls that are fixed against rotation, the at-rest pressure should be used. For seismic condition, the pressure should be distributed as an inverted triangular distribution and the dynamic thrust should be applied at a height of 0.6H above the base of the wall.

Care should be taken to provide appropriate drainage so as no water is allowed to remain behind the retaining wall for any significant length of time. Retaining structures should be provided with a drainage system, as illustrated on Figure 5, *Retaining Wall Backfill and Subdrain Detail*, to prevent buildup of hydrostatic pressure behind the wall.

In addition to the recommended earth pressures, walls below grade adjacent to existing structures or streets and areas of traffic should be designed to accommodate surcharge loads. For traffic surcharge, a uniform lateral pressure of 100 pounds per square foot acting as a result of an assumed 300 pounds per square foot surcharge behind the wall due to normal traffic; the traffic surcharge load may be neglected provided a minimum of 10 foot clearance between the wall and the traffic is maintained. We will provide surcharge loading from adjacent foundations after reviewing details of the planned basement walls in relation to existing foundations.

Backfills for retaining walls should be compacted to a minimum of 90 percent relative compaction (based on ASTM Test Method D1557). During construction of retaining walls, the backcut should be made in accordance with the requirements of Cal/OSHA Construction Safety Orders. Relatively light construction equipment should be used to backfill retaining walls. We also recommend using at-rest pressures for design of walls supporting settlement-sensitive structures.

Earth pressures used in the design of the walls should be indicated on the retaining wall plans. All retaining wall designs and plans should be reviewed by the project geotechnical consultant to confirm that the appropriate soil parameters are used.

6.6 Flexible Pavement

To provide support for paving of the new transit plaza, and surface parking and driveways, the subgrade soils should be prepared as recommended in Section 6.1, *Earthwork and Grading*. The preparation of the paving area subgrade should be performed immediately prior to placement of the base course. Proper drainage of the paved areas should be provided since this will reduce moisture infiltration into the subgrade and increase the life of the paving.

6.6.1 Aggregate Base Course

The base course for hot mix asphalt (HMA) concrete paving should meet the specifications for Class 2 Aggregate Base as defined in Section 26 of the latest edition of the State of California Department of Transportation Standard and Specifications. Alternatively, the base course could meet the specifications for untreated base as defined in Section 200-2 of the latest edition of *Standard Specifications for Public Works Construction* (Greenbook). Crushed Miscellaneous Base (CMB) may be used for the base course provided the geotechnical consultant evaluates and tests it before delivery to the site.

6.6.2 Hot Mix Asphalt (HMA) Concrete

The required HMA concrete paving and base thicknesses will depend on the expected wheel loads and volume of traffic (Traffic Index or TI). Assuming that the paving subgrade will consist of engineered fill or bedrock materials with an R-value of at least 30 compacted to at least 90 percent relative compaction based on ASTM Test Method D 1557, the minimum recommended paving thicknesses are presented in the following table:

Asphalt Concrete Pavement Section for Reconstruction

Traffic Index	Hot Mix Asphalt Thickness (inches)	Aggregate Base Thickness (inches)	Total (inches)
5.0 or less	3.0	4.0	7.0
6.0	3.5	5.5	9.0
7.0	4.0	7.0	11.0
8.0	5.0	8.0	12.0
9.0	5.5	9.5	15.0

Representative samples of the actual subgrade materials should be obtained and tested for R-Value following rough grading of the pavement subgrade to confirm the pavement design sections.

6.7 Temporary Excavations

All temporary excavations, including footings, utility trenches, dry wells should be performed in accordance with project plans, specifications, and all OSHA requirements. Excavations 5 feet or deeper should be laid back or shored in accordance with OSHA requirements before personnel are allowed to enter.

No surcharge loads should be permitted within a horizontal distance equal to the height of cut or 5 feet, whichever is greater from the top of the cut, unless the cut is shored appropriately.

During construction, the soil conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor shall be responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Soil types will vary, but Type C soils can be expected at shallow depths and Type A soils within bedrock. Close coordination between the competent person and the geotechnical engineer should be maintained to facilitate construction while providing safe excavations.

6.8 Shoring

Shoring may be required to accommodate removal of existing basement walls and construction of new basement walls. Shoring and underpinning may also be required to prevent undermining of adjacent existing foundations. The anticipated shoring/underpinning system for the site will consist of soldier piles and lagging. Soldier piles may consist of steel H-beams set in predrilled holes and backfilled with lean-mix concrete to the ground surface.

6.8.1 Lateral Earth Pressures

For design of cantilevered shoring, where the surface of the backfill is level, it can be assumed that drained soils will exert a lateral pressure equal to that developed by a fluid with a density of 35 pounds per cubic foot (pcf).

In addition to the recommended earth pressure, the upper 10 feet of shoring adjacent to streets and driveways should be designed to resist a uniform lateral pressure 100 psf, acting as a result of an assumed 100 psf surcharge behind the shoring due to normal street traffic. If the traffic is kept back at least 10 feet from the shoring, the traffic surcharge may be

neglected. We can determine lateral surcharge pressures for specific cases, such as construction crane, concrete trucks, and other heavy construction equipment adjacent to shoring, if requested.

6.8.2 Surcharge Pressure from Adjacent Foundations

Where existing foundations are within a 1:1 plan projected upward from the bottom of the planned shoring and basement walls, a lateral surcharge load should be applied to the active earth pressure to account for the pressure imposed by the foundation. Once details of existing adjacent foundations are established, we can provide design surcharge pressures to be applied to shoring and basement walls.

6.8.3 Design of Soldier Piles

For the design of soldier piles spaced at least two diameters on centers (OC), the allowable lateral bearing value (passive value) of the soils below the level of excavation may be assumed to be 600 psf at the excavated surface, up to a maximum of 6,000 psf. To develop the full lateral value, provisions should be taken to assure firm contact between the soldier piles and the undisturbed soils. The concrete placed in the soldier pile excavations may be a lean-mix concrete. However, the concrete used in that portion of the soldier pile which is below the planned excavated level should be of sufficient strength to adequately transfer the imposed loads from the soldier pile to the surrounding soils.

The frictional resistance between the soldier piles and the retained earth may be used in resisting the downward component of the design load. The coefficient of friction between the soldier piles and the retained earth may be taken as 0.4. This value is based on the assumption that uniform full bearing will be developed between the steel soldier beam and the lean-mix concrete and between the lean-mix concrete and the retained earth. In addition, provided that the portion of the soldier piles below the excavated level is backfilled with structural concrete, the soldier piles below the excavated level may be used to resist downward loads. The frictional resistance between the concrete soldier piles and the soils below the excavated level may be taken as equal to 500 psf.

6.8.4 Lagging

Continuous lagging will be required between the soldier piles above the bedrock contact. Careful installation of the lagging will be necessary to achieve bearing against the retained earth.

The soldier piles should be designed for the full anticipated lateral pressure. However, the pressure on the lagging will be less due to arching in the soils. For clear spans up to 8 feet, we recommend that the lagging be designed for a semi-circular distribution of earth pressure where the maximum pressure is 400 psf at the midline between soldier piles, and 0 psf at the soldier piles.

Deflection: It is difficult to accurately predict the amount of deflection of a shored embankment. It should be realized, however, that some deflection will occur. To help protect adjacent existing buildings and infrastructure, the maximum allowable horizontal shoring deflection as measured at the top of the excavation is ½ inch.

If greater deflection occurs during construction, additional bracing may be necessary to minimize settlement of adjacent structures and of any utilities in the adjacent streets. To reduce the deflection of the shoring, if desired, a greater active pressure could be used in the shoring design.

Monitoring: Some means of monitoring the performance of the shoring system is recommended. The monitoring should consist of periodic surveying of the lateral and vertical locations of the tops of all the soldier piles. We will be pleased to discuss this further with the design consultants and the contractor when the design of the shoring system is finalized. Other methods of monitoring could include the installation of inclinometers.

6.9 Maintenance Guidelines and Erosion Control

We understand it will be the responsibility of the County of Los Angeles to maintain the slopes surrounding the theater site, including adequate planting, proper irrigation and maintenance, and repair of faulty irrigation systems. To reduce the potential for erosion and slumping of soil prisms on steep slopes, all slopes should be planted with plants that require minimal irrigation. Slope

planting should be carried out as soon as practical upon completion of the Off Season Two Improvements. Surface water runoff and standing water at the top of slopes should be avoided. Oversteepening of slopes should be avoided during landscaping activity. Maintenance of proper drainage and proper maintenance of vegetation, including regular slope irrigation, should be performed. Slope irrigation should avoid directly spraying onto the slope face. Drip system irrigation should be considered. Overwatering and consequent runoff and ground saturation should be avoided. If automatic sprinklers systems are installed, their use must be adjusted to account for rainfall conditions.

Any soil, debris or vegetation overgrowth should be removed from all terrace drains to enable runoff water to flow freely and properly. Regular maintenance and cleanup of terrace drains should be performed especially during the rainy season and immediately following prolonged seasonal events. Damage to terrace drains such as minor cracking should be promptly repaired and/or sealed prior to the start of the rainy season. Water should not be allowed to enter cracks or expansion gaps within the terrace drains where applicable.

6.10 Additional Geotechnical Services

The geotechnical recommendations presented in this report are based on subsurface conditions as interpreted from limited geologic mapping and seismic refraction surveys. Our conclusions and recommendations presented in this report should be reviewed and verified by Leighton during site construction and revised accordingly if exposed geotechnical conditions vary from our preliminary findings and interpretations. The recommendations presented in this report are only valid if Leighton verifies the site conditions during construction. Geotechnical observation and testing should be provided during the following activities:

- Grading and excavation of the site;
- Landscape excavation and grading;
- Overexcavation and compaction;
- Compaction of all fill materials;
- Shoring and underpinning system installation;

- Excavation and installation of foundations;
- After excavation of all slabs and footings and prior to placement of steel or concrete to confirm the slabs and footings are founded in firm, compacted fill;
- Utility trench backfilling and compaction; and
- When any conditions are encountered that varies significantly from the conditions described in this report.

Leighton should review the grading and foundation plans and specifications, when available, to comment on the geotechnical aspects. Our recommendations should be revised, as necessary, based on future plans and incorporated into the final design plans and specifications.

7.0 COUNTY OF LOS ANGELES BUILDING CODE SECTION 111 STATEMENT

Provided that the recommendations in this report are implemented, it is Leighton's opinion that the proposed improvements will be safe from the hazards of landslide, settlement, or slippage, and that the completed grading and proposed improvements will not adversely affect the stability of adjacent properties.

8.0 LIMITATIONS

This research report was based wholly on available published data and very limited non-invasive subsurface exploration. Such information is, therefore, incomplete. The nature of many projects is such that differing earth materials and/or geologic conditions can be present within small distances and under varying climatic conditions. Changes in subsurface conditions can and do occur over time. Therefore, findings, conclusions and recommendations presented in this feasibility report are based on the assumption that Leighton will provide design-specific geotechnical exploration and testing, and geotechnical observation and testing during construction.

This report was prepared for the sole use of the Ford Theatre Foundation and their design team, for their use in assessing the proposed Off-Season Two Improvements, in accordance with generally accepted geotechnical engineering practices at this time in the County of Los Angeles.

9.0 REFERENCES

Bozorgnia, Y., Campbell, K.W., and Niazi, M., 1999, Vertical Ground Motion: Characteristics, Relationships with Horizontal Component, and Building Code Implication, *in* Proceedings to the SMIP99 Seminar on Utilization of Strong-Motion Data, September 15, 1999, Oakland, pp. 23-49.

California Building Standards Commission (CBSC), 2010 California Building Code, Based on 2006 International Building Code.

California Division of Mines and Geology, 1953, Geology of the Griffith Park Area, Los Angeles County, California, Special Report 33, by G. J. Neuerburg, September 1953.

California Geological Survey (CGS) formerly California Division of Mines and Geology (CDMG), 1986, State of California Special Studies Zones Map for the Hollywood Quadrangle, Revised Official Map, Effective: July 1, 1986, Scale 1:24,000.

_____, 1998, State of California Seismic Hazard Zones Report, Hollywood 7.5-Minute Quadrangle, scale 1:24,000.

_____, 1999, State of California Seismic Hazard Zones Map, Hollywood 7.5-Minute Quadrangle, scale 1:24,000.

———, 2000, CD-ROM containing digital images of Official Maps of Alquist-Priolo Earthquake Fault Zones that affect the Southern Region, CDMG CD 2000-003 2000.

Cao, T., Bryant, W.A., Rowshandel, B., Branum, D., and Wills, C.J., 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps, June 2003.

City of Los Angeles Department of City Planning, 1996, Safety Element of the Los Angeles City General Plan, City Plan Case No. 95-0371, Council File No. 86-0662, Approved by the City Planning Commission August 8, 1996, Adopted by the City Council November 26, 1996.

County of Los Angeles Department of Regional Planning, 1990, Safety Element, Los Angeles County General Plan, Prepared by Leighton and Associates, Inc., Prepared in Cooperation with Sedway Cooke Associates and William Spangle and Associates, Adopted by The Board of Supervisors December 6, 1990.

Crook, R., Jr., and Proctor, R.J., 1992, The Santa Monica and Hollywood Faults and the Southern Boundary of the Transverse Ranges Province, in Engineering Geology Practice in Southern California.

Davis, J.F., Bennett, J.H., Borchardt, G.Al, Kahle, J.E., Rice, S.J., Silva, M.A., 1982, Earthquake Planning Scenario for a Magnitude 8.3 Earthquake on the San Andrea Fault in Southern California, California Division of Mines and Geology Special Publication 60.

Dibblee Jr., T.W., 1991, Geologic map of the Hollywood and Burbank (South ½) Quadrangles, Dibblee Geological Foundation Map DF-30, Santa Barbara, California, scale 1:24 000.

Dolan J.F., Sieh, K.E., Rockwell, T.K., Guptill, P., and Miller, G., 1997, Active Tectonics, Paleoseismology, and Seismic Hazards of the Hollywood Fault, Northern Los Angeles Basin, California, Geological Society of America Bulletin, Vol. 109, No. 12.

Dolan, J.F., Sieh, K., and Rockwell, T.K., 2000a, Late Quaternary Activity and Seismic Potential of the Santa Monica Fault System, Los Angeles, California, Geological Society of America Bulletin, Volume 112, No. 10, October 2000.

Dolan, J.F., Stevens, D., and Rockwell, T.K., 2000b, Paleoseismologic Evidence for an Early to Mid-Holocene Age of the Most Recent Surface Fault Rupture on the Hollywood Fault, Los Angeles, California, Bulletin of the Seismological Society of America, April 2000.

Dolan, J.F., and Sieh, K., 1992, Paleoseismology and Geomorphology of the Northern Los Angeles Basin: Evidence for Holocene Activity on the Santa Monica Fault and Identification of New Strike Slip Faults through Downtown Los Angeles, EOS Transactions of the American Geophysical Union, Vol. 73, p. 589.

Hart, E.W. and Bryant, W.A., Interim Revision 2007, Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps: California Geological Survey, Special Publications 42, 42p.

Hoots, H.W., 1931, Geology of the Eastern Part of the Santa Monica Mountains, Los Angeles, County, California: USGS Professional paper 165-C, Plate 16, scale 1:24 000.

Hummon, C., Schneider, C.L., Yeats, R.S., and Huftile, G.J., 1992, Active Tectonics of the Northern Los Angeles Basin: An Analysis of Subsurface Data, in Proceedings of the 35th Annual Meeting of the Association of Engineering Geologists.

Hummon, C., Schneider, C.L., Yeats, R.S., Dolan, J.F., Sieh, K.E. and Huftile, G.J., 1994, Wilshire Fault: Earthquakes in Hollywood?, Geology, Vol. 22, pp. 291-294.

Kohler, M., H. Magistrale, and R. Clayton, 2003, Mantle heterogeneities and the SCEC three-dimensional seismic velocity model version 3, Bull. Seismol. Soc. Am., Vol 93, pp. 757-774.

Leighton Consulting, Inc., 2013, Preliminary Geotechnical Evaluation John Anson Ford Theater Master Plan, 2580 Caheunga Boulevard East, Hollywood District of Los Angeles, California, Project No. 603507-001, dated February 7, 2013

Magistrale, H., 2005, Using the SCEC Version 4 southern California reference seismic velocity model, Readme File dated September 27, 2005.

Magistrale, H., S. Day, R.W. Clayton, and R. Graves, 2000. The SCEC Southern California reference 3D seismic velocity model Version 2, Bull. Seismol. Soc. Am., Vol. 90, No. 6B, pp. S65-S76.

Mattison, E., and Loyd, R.C., 1998, Liquefaction Zones in the Hollywood 7.5-Minute Quadrangle, Los Angeles, County, California, in Seismic Hazard Zone Report for the Hollywood 7.5-Minute Quadrangle, Los Angeles County, California: California Division of Mines and Geology, Seismic Hazard Zone Report 026, pp. 3-15.

Oskin, M., Sieh, K., Rockwell, T., Miller, G., Guptill, P., Curtis, M., McArdle, S., and Elliot, P., 2000, Active Parasitic Folds on the Elysian Park Anticline: Implications for Seismic Hazard in Los Angeles, California, Geological Society of America Bulletin 112:693-707.

Petersen, M.D., Cramer, C.H., Faneros, G.A., Real, C.R., and Reichle, M.S., 1998, Potential Ground Shaking in the Hollywood 7.5-Minute Quadrangle, Los Angeles, County, California, in Seismic Hazard Zone Report for the Hollywood 7.5-Minute Quadrangle, Los Angeles County, California: California Division of Mines and Geology, Seismic Hazard Zone Report 026, pp. 37-47.

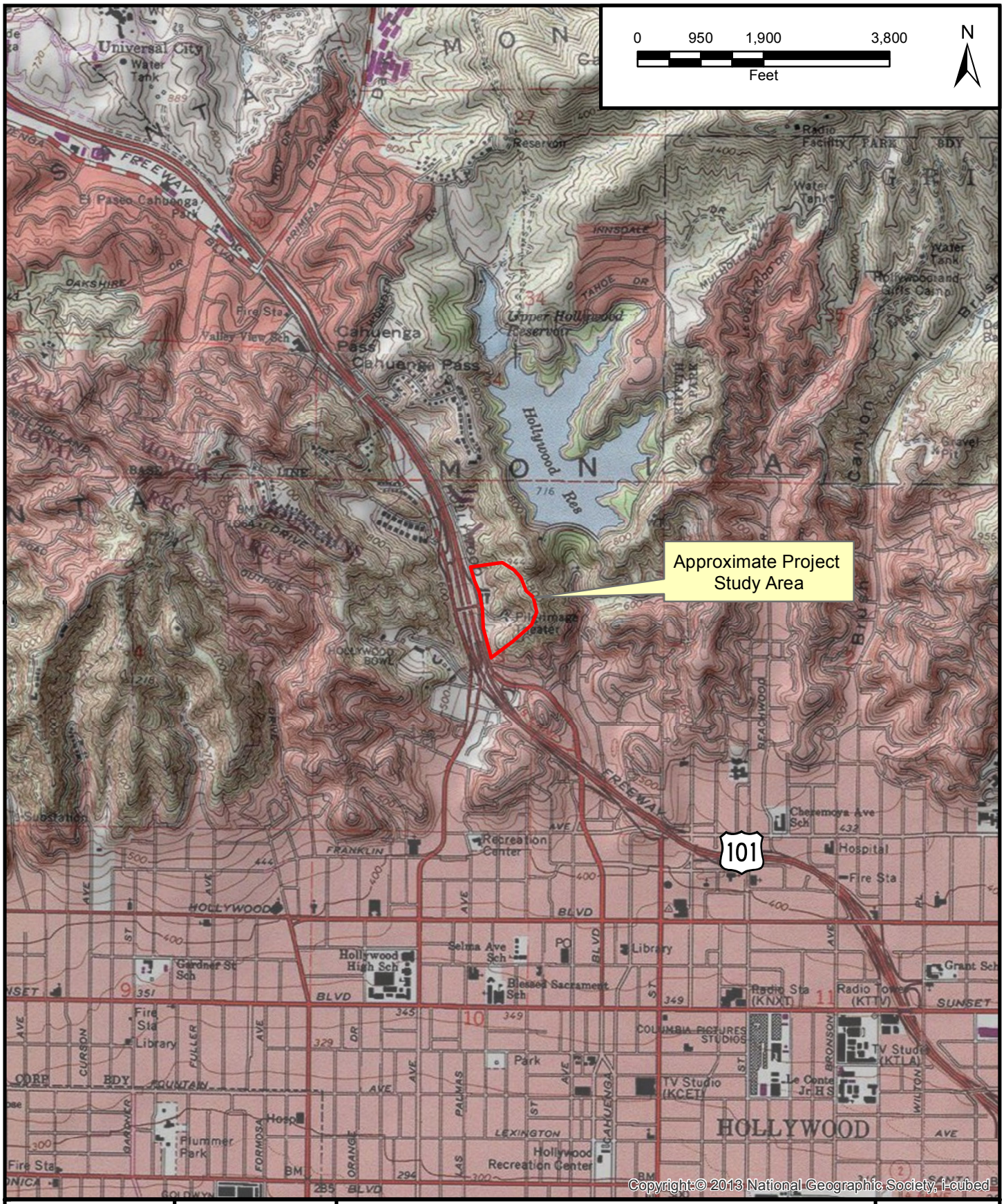
Petersen, M.D., Frankel, A.D., Harmsen, S.C., Mueller, C.S., Haller, K.M., Wheeler, R.L., Wesson, R.L., Zeng, Y., Boyd, O.S., Perkins, D.M., Luco, N., Field, E.H., Wills, C.J., and Rukstales, K.S., 2008, Documentation for the 2008 Update of the United States National Seismic Hazard Maps, United States Geological Survey (USGS) Open File Report 2008-1128, 61p.

Silva, M.A., and Irvine, P.J., 1998, Earthquake-Induced Landslide Zones in the Hollywood 7.5-Minute Quadrangle, Los Angeles, County, California, in Seismic Hazard Zone Report for the Hollywood 7.5-Minute Quadrangle, Los Angeles County, California: California Division of Mines and Geology, Seismic Hazard Zone Report 026, pp. 17-35.

Toppozada, T.R., et al., 1988, Planning Scenario for a Major Earthquake on the Newport Inglewood Fault Zone, California Division of Mines and Geology Special Publication 99.

United States Geological Survey, 1966, Hollywood Quadrangle, California-Los Angeles 7.5 Minute Series (Topographic), Scale 1:24,000

Yerkes, R.F., and Campbell, R.H., 2005, Preliminary Geologic Map of the Los Angeles 30’ x 60’ Quadrangle, Southern California, United States Geological Survey, Open File Report 2005-1019, Version 1.0, Scale 1:100,000.



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Scale: 1 " = 2,000 '	Date: Sept 2013

Base Map: ESRI Resource Center, 2012
Thematic Info: Leighton
Author: mmurphy (mmurphy)

SITE LOCATION MAP

John Ansen Ford Theatre
2580 Cahuenga Boulevard East
Los Angeles, California

Figure 1

Leighton

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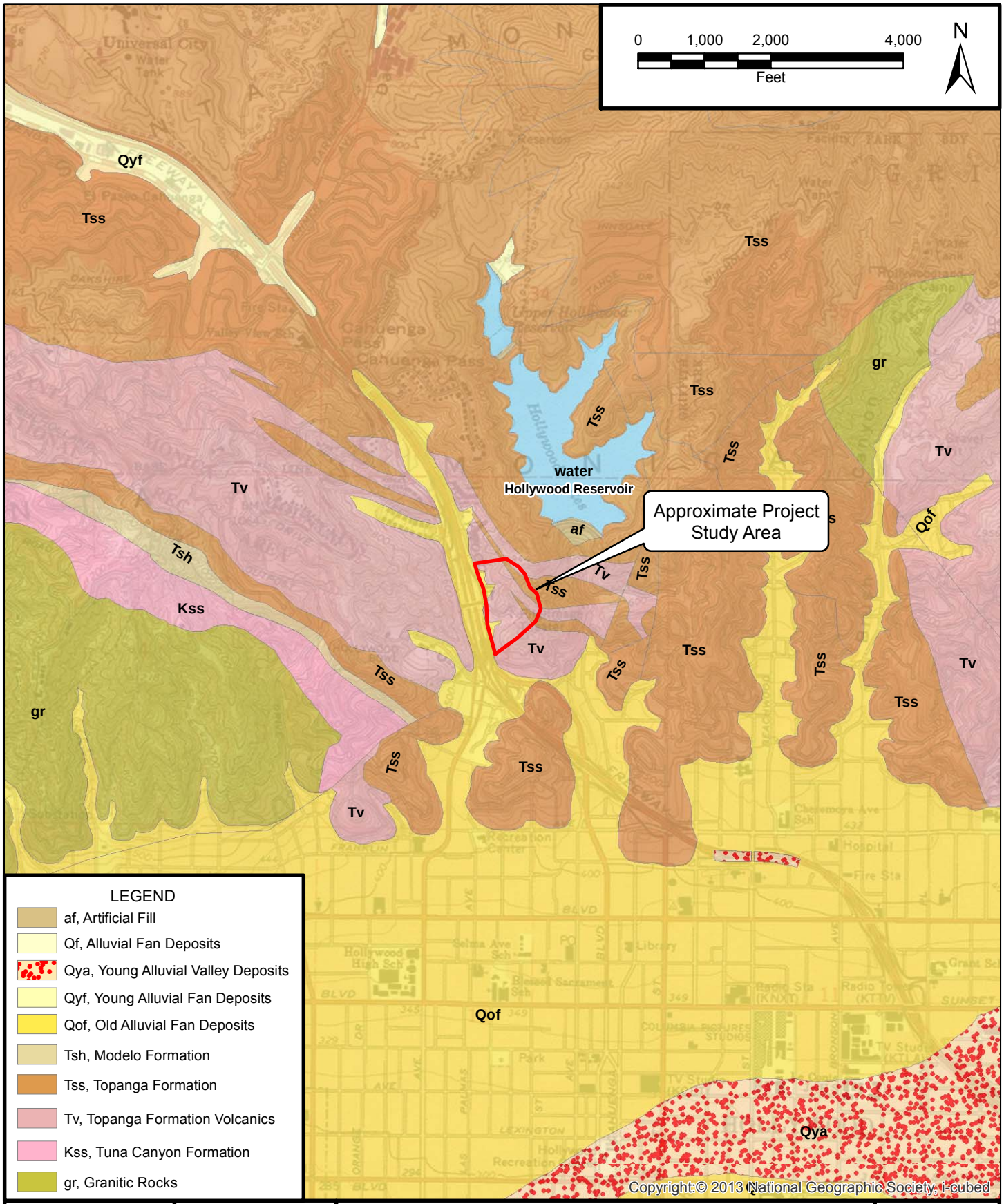


Project: 10296.001	Eng/Geol: CCK/JAR
Scale: 1 in = 2,000 ft	Date: September, 2013

Reference: USGS, 2006, Geologic map of the San Bernardino and Santa Ana 30' x 60' quadrangles, California, Version 1.0, Open File Report 2006-1217

Author: (mmurphy)

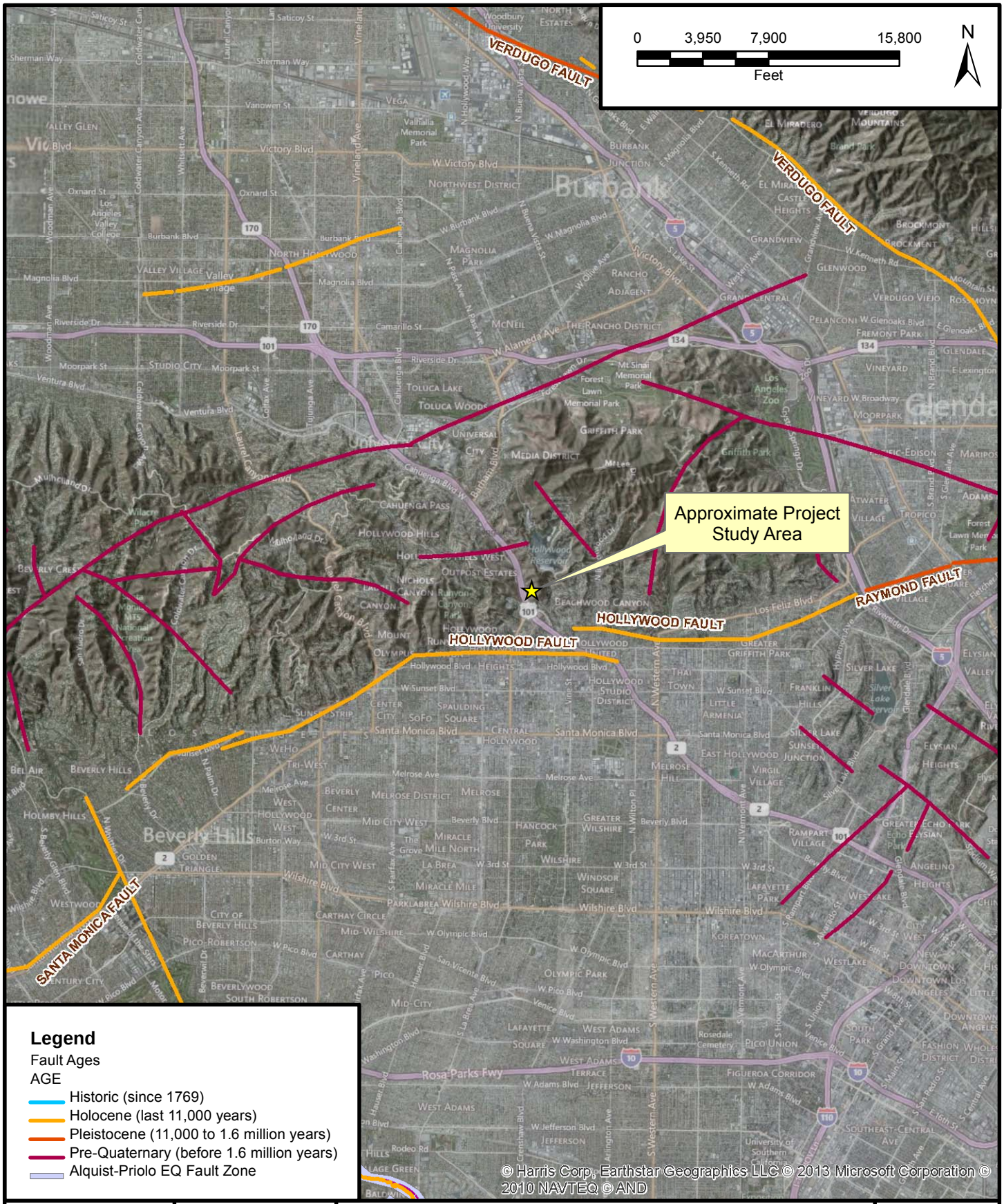
REGIONAL GEOLOGIC MAP

John Ansen Ford Theatre
2580 Cahuenga Boulevard East
Los Angeles, California

Figure 2

Leighton

Map Saved as P:\drafting\10296\001\GIS\of_2013-07-11\Fig2-Regional Geology Map.mxd on 9/10/2013 2:44:34 PM



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Scale: 1 in = 8,000 ft	Date: Sept 2013

Base Map: ESRI Resource Center, 2012
Thematic Info: Leighton
Author: (mmurphy)

REGIONAL FAULT MAP

John Ansen Ford Theatre
2580 Cahuenga Boulevard East
Los Angeles, California

Figure 3

Leighton

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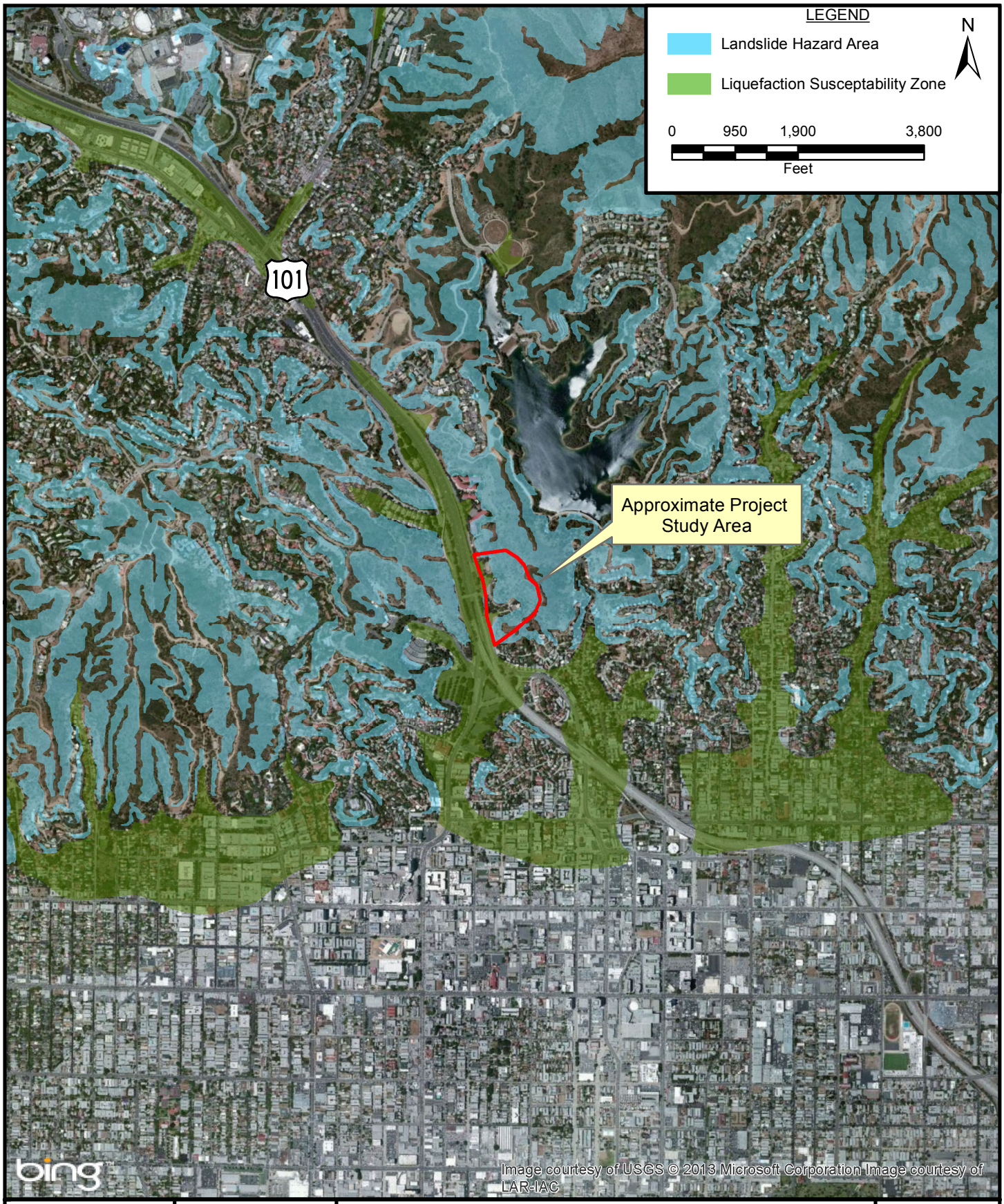

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Scale: 1 in = 2,000 ft	Date: Sept 2013

Base Map: ESRI Resource Center, 2012
Thematic Info: Leighton
Author: mmurphy (mmurphy)

SEISMIC HAZARDS MAP

John Ansen Ford Theatre
2580 Cahuenga Boulevard East
Los Angeles, California

Figure 4

Leighton

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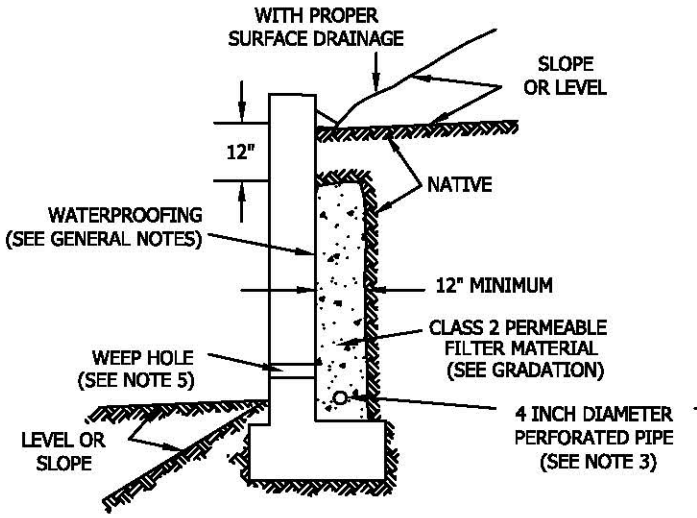
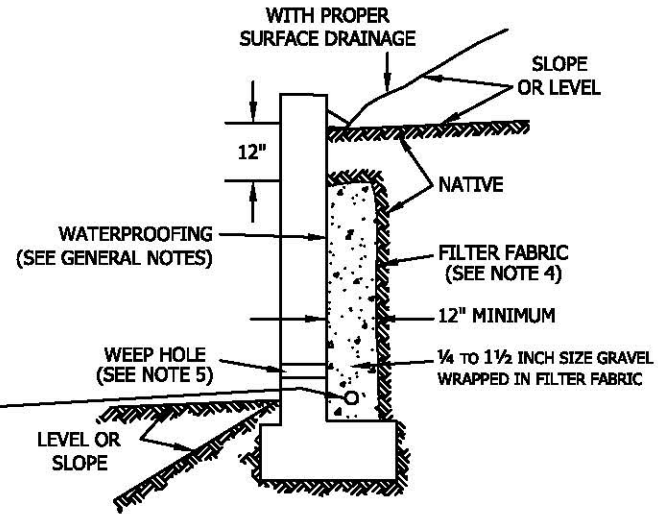
SUBDRAIN OPTIONS AND BACKFILL WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤50

OPTION 1: PIPE SURROUNDED WITH CLASS 2 PERMEABLE MATERIAL



OPTION 2: GRAVEL WRAPPED IN FILTER FABRIC



Class 2 Filter Permeable Material Gradation
Per Caltrans Specifications

Sieve Size	Percent Passing
1"	100
3/4"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

GENERAL NOTES:

* Waterproofing should be provided where moisture nuisance problem through the wall is undesirable.
* Water proofing of the walls is not under purview of the geotechnical engineer
* All drains should have a gradient of 1 percent minimum
*Outlet portion of the subdrain should have a 4-inch diameter solid pipe discharged into a suitable disposal area designed by the project engineer. The subdrain pipe should be accessible for maintenance (rodding)
*Other subdrain backfill options are subject to the review by the geotechnical engineer and modification of design parameters.

Notes:
1) Sand should have a sand equivalent of 30 or greater and may be densified by water jetting.
2) 1 Cu. ft. per ft. of 1/4- to 1 1/2-inch size gravel wrapped in filter fabric
3) Pipe type should be ASTM D1527 Acrylonitrile Butadiene Styrene (ABS) SDR35 or ASTM D1785 Polyvinyl Chloride plastic (PVC), Schedule 40, Armco A2000 PVC, or approved equivalent. Pipe should be installed with perforations down. Perforations should be 3/8 inch in diameter placed at the ends of a 120-degree arc in two rows at 3-inch on center (staggered)
4) Filter fabric should be Mirafi 140NC or approved equivalent.
5) Weephole should be 3-inch minimum diameter and provided at 10-foot maximum intervals. If exposure is permitted, weepholes should be located 12 inches above finished grade. If exposure is not permitted such as for a wall adjacent to a sidewalk/curb, a pipe under the sidewalk to be discharged through the curb face or equivalent should be provided. For a basement-type wall, a proper subdrain outlet system should be provided.
6) Retaining wall plans should be reviewed and approved by the geotechnical engineer.
7) Walls over six feet in height are subject to a special review by the geotechnical engineer and modifications to the above requirements.

RETAINING WALL BACKFILL AND SUBDRAIN DETAIL FOR WALLS 6 FEET OR LESS IN HEIGHT

WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤50

Leighton

Figure 5

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APPENDIX A

REPORT
SEISMIC SURVEY

Ford Amphitheatre
Los Angeles, California

GEO*Vision* Project No. 12281

Prepared for

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September 17, 2012

Report 12281-01 Rev 0

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Appendix A	Technical Note - Seismic Refraction Method
	Technical Note - Active and Passive Surface Wave Techniques

1 INTRODUCTION

A seismic refraction and surface wave survey was conducted at the Ford Amphitheatre in Los Angeles, California on August 30th through the 31st, 2012. The survey was conducted along two (2) arrays designated as S-1 and S-2 (Figure 1). The purpose of this investigation was to provide a shear (S) wave velocity profile to a depth of 30 meters (98.4 ft), or more, for UBC/IBC site classification and to determine depth to bedrock beneath the two (2) profiles.

Each array (S-1 and S-2) was collected using total lengths in the space available, as located by Leighton personnel. The endpoints and center of each array were recorded by **GEO*V**ision* using a submeter GPS (Table 1) and plotted on a site map (Figure 1). Array S-1 was located in the southern parking lot and had a total line length of 47 m. Array S-2 was located in the central parking lot and had a total line length of 70.5 m.

The average shear wave velocity of the upper 30 m (V_S30) is used in the NEHRP provisions and the Uniform Building Code (UBC) to separate sites into classes for earthquake engineering design (BSSC, 1994). The average shear wave velocity of the upper 100 feet (V_S100) is used in the International Building Code (IBC) for site classification. These site classes are as follows:

Class A – hard rock – $V_S30 > 1500$ m/s (UBC) or $V_S100 > 5{,}000$ ft/s (IBC)
Class B – rock – $760 < V_S30 \leq 1500$ m/s (UBC) or $2{,}500 < V_S100 \leq 5{,}000$ ft/s (IBC)
Class C – very dense soil and soft rock – $360 < V_S30 \leq 760$ m/s (UBC)
or $1{,}200 < V_S100 \leq 2{,}500$ ft/s (IBC)
Class D – stiff soil – $180 < V_S30 \leq 360$ m/s (UBC) or $600 < V_S100 \leq 1{,}200$ ft/s (IBC)
Class E – soft soil – $V_S30 < 180$ m/s (UBC) or $V_S100 < 600$ ft/s (IBC)
Class F – soils requiring site-specific evaluation

At many sites, active surface wave techniques (SASW and MASW) with the utilization of portable energy sources, such as hammers and weight drops, are sufficient to obtain a 30 m/100 ft S-wave velocity sounding. At sites with high ambient noise levels and/or very soft soils, these energy sources may not be sufficient to image to 30 m and a larger energy source, such as a bulldozer, is necessary. Alternatively, passive surface wave techniques, such as the refraction microtremor method of Louie (2001) or the array microtremor technique can be used to extend the depth of investigation at sites that have adequate noise levels.

The following sections include a discussion of equipment and field procedures, data processing, results of the geophysical survey and conclusions.

2 EQUIPMENT AND FIELD PROCEDURES

Seismic refraction and surface wave equipment used during this investigation consisted of two Geometrics Geode 24-channel signal enhancement seismographs, 4.5 Hz vertical geophones, seismic cables with 10-foot takeouts, a 3 lb hammer, a 10 lb hammer, a 20 lb sledgehammer, a vehicle mounted accelerated weight drop and an aluminum plate. The GPS system consisted of a Trimble ProXRS with OmniSTAR submeter differential corrections.

Each seismic line consisted of one spread of 48 geophones aligned in a linear array. Each spread was placed with geophones spaced 1 to 1.5 m apart for a total length of 47 to 70.5 m as outlined in Table 1. All geophone locations were measured using a 100-meter tape measure. Relative elevations along each seismic line were surveyed using a Nikon AP-7 automatic level.

Up to 31 shot point locations were occupied on each line: off-end shots, end shots and multiple interior shot points located between every fourth geophone. Site access and topography limited the placement of some of the off-end shot points and the energy source used.

A typical seismic survey field layout is shown in Appendix A. The 20 lb sledgehammer or a vehicle mounted accelerated weight drop (AWD) were used as the energy source for each shot point. The 3 lb hammer and 10 lb hammer were used for the 1 m to 1.5 m offset source locations and the shot point located at the center of the array. A Geometrics hammer switch attached to the sledgehammer, or mounted on the aluminum plate, and coupled to the Geode via a trigger extension was used to trigger the seismograph upon impact. The final seismic record at each shot point was the result of stacking 5 to 10 shots to increase the signal to noise ratio. All seismic records were stored on a laptop computer. Data files were named with the sequential line, spread and shot number and a ".dat" extension (i.e. data file 1105.dat is the seismic record from line 1, spread 1, shot 5). Data acquisition parameters, file names and leveling data were recorded on a field form, which is retained in project files.

3 METHODOLOGY

3.1 Seismic Refraction Technique

Detailed discussions of the seismic refraction method can be found in Telford et al. (1990), Dobrin and Savit (1988) and Redpath (1973).

When conducting a seismic survey, acoustic energy is input to the subsurface by an energy source such as a sledgehammer impacting a metallic plate, weight drop, vibratory source or explosive charge. The acoustic waves propagate into the subsurface at a velocity dependent upon the elastic properties of the material through which they travel. When the waves reach an interface where the density or velocity changes significantly, a portion of the energy is reflected back to the surface and the remainder is transmitted into the lower layer. Where the velocity of the lower layer is higher than that of the upper layer, a portion of the energy is also critically refracted along the interface. Critically refracted waves travel along the interface at the velocity of the lower layer and continually refract energy back to the surface. Receivers (geophones) laid out in linear array on the surface, record the incoming refracted and reflected waves. The seismic refraction method involves analysis of the travel times of the first energy to arrive at the geophones. These first arrivals are from either the direct wave (at geophones close to the source) or critically refracted waves (at geophones further from the source).

Analysis of seismic refraction data depends upon the complexity of the subsurface velocity structure. If the subsurface target is planar in nature then the slope intercept method (Telford et al., 1990) can be used to model multiple horizontal or dipping planar layers. A minimum of one end shot is required to model horizontal layers and reverse end shots are required to model dipping planar layers. If the subsurface target is undulating (i.e. bedrock valley) then layer based analysis routines such as the generalized reciprocal method (Palmer, 1980 and 1981; Lankston and Lankston, 1986 and Lankston, 1990), reciprocal method (Hawkins, 1961) also referred to as the ABC method, Hales' method (Hales, 1958), delay time method (Wyrobek, 1956 and Gardner, 1967), time-term inversion (Scheidegger and Willmore, 1959), plus-minus method (Hagedoorn, 1959) and wavefront method (Rockwell, 1967) are required to model subsurface velocity structure. These methods generally require a minimum of 5 shot points per spread (end shots, off-end shots and a center shot). If subsurface velocity structure is complex and cannot be adequately modeled using layer-based modeling techniques (i.e. complex weathering profile in bedrock, numerous lateral velocity variations), then Monte Carlo or tomographic inversion techniques (Zhang and Toksoz, 1998; Schuster and Quintus-Bosz, 1993) are required to model the seismic refraction data. These techniques require a high shot density; typically every 2 to 6 stations/geophones. Generally, these techniques cannot effectively take advantage of off-end shots to extend depth of investigation, so longer profiles are required.

Errors in seismic refraction models can be caused by velocity inversions, hidden layers or lateral velocity variations. At sites with steeply dipping or highly irregular bedrock surfaces, out of plane refractions (refractions from structures to the side of the line rather than from beneath the line) may severely complicate modeling. A velocity inversion is a geologic layer with a lower seismic velocity than an overlying layer. Critical refraction does not occur along such a layer because velocity has to increase with depth for critical refraction to occur. This type of layer, therefore, cannot be recognized or modeled and depths to underlying layers would be

overestimated. A hidden layer is a layer with a velocity increase, but of sufficiently small thickness relative to the velocities of overlying and underlying layers, that refracted arrivals do not arrive at the geophones before those from the deeper, higher velocity layer. Because the seismic refraction method generally only involves the interpretation of first arrivals, a hidden layer cannot be recognized or modeled and depths to underlying layers would be underestimated. Saturated sediments, overlying high velocity bedrock can be a hidden layer under many field conditions. However, saturated sediments generally have a much higher velocity than unsaturated sediments, typically in the 5,000 to 7,000 ft/s range, and can occasionally be interpreted as a second arrival when the layer does not give rise to a first arrival. A subsurface velocity structure that increases as a function of depth rather than as discrete layers will also cause depths to subsurface refractors to be underestimated, in a manner very similar to that of the hidden layer problem. Lateral velocity variations that are not adequately addressed in the seismic models will also lead to depth errors. Tomographic imaging techniques can often resolve the complex velocity structures associated with hidden layers, velocity gradients and lateral velocity variations. However, in the event of an abrupt increase in velocity at a geologic horizon, the velocity model generated using tomographic inversion routines will smooth the horizon with velocity being underestimated at the interface and possibly overestimated at depth.

3.2 Surface Wave Technique

A discussion of active and passive surface wave methods is provided in the technical note included as Appendix A. Active surface wave techniques include the spectral analysis of surface waves (SASW) and multi-channel array surface wave (MASW) methods. The passive surface wave technique consisted of the array microtremor method.

The basis of surface wave methods is the dispersive characteristic of Rayleigh waves when propagating in a layered medium. The phase velocity, V_R, depends primarily on the material properties (V_S, mass density, and Poisson's ratio or compression wave velocity) over a depth of approximately one wavelength. Waves of different wavelengths, λ, (or frequencies, f) sample different depths. As a result of the variance in the shear stiffness of the layers, waves with different wavelengths travel at different phase velocities; hence, dispersion. A surface wave dispersion curve, or dispersion curve for short, is the variation of V_R with λ or f.

The SASW and MASW methods are in-situ seismic methods for determining shear wave velocity (V_S) profiles (Stokoe et al., 1994; Stokoe et al., 1989; Park et al., 1999a and 1999b, Foti, 2000). Surface wave techniques are non-invasive and non-destructive, with all testing performed on the ground surface at strain levels in the soil in the elastic range (< 0.001%). SASW testing consists of collecting surface wave phase data in the field, generating the dispersion curve, and then using iterative forward or inverse modeling to calculate the shear stiffness profile. MASW testing consists of collecting multi-channel seismic data in the field and applying a wavefield transform to obtain the dispersion curve and data modeling.

A detailed description of the SASW field procedure is given in Joh, 1996. A vertical dynamic load is used to generate horizontally-propagating Rayleigh waves. The ground motions are monitored by two, or more, vertical receivers and recorded by the data acquisition system

capable of performing both time- and frequency-domain calculations. Theoretical, as well as practical considerations, such as attenuation, necessitate the use of several receiver spacings to generate the dispersion curve over the wavelength range required to evaluate the stiffness profile. To minimize phase shifts due to differences in receiver coupling and subsurface variability, the source location is reversed.

After the time-domain motions from the two receivers are converted to frequency-domain records using the Fast Fourier Transform, the cross power spectrum and coherence are calculated. The phase of the cross power spectrum, ϕ_w (f), represents the phase differences between the two receivers as the wave train propagates past them. It ranges from $-\pi$ to π in a wrapped form and must be unwrapped through an interactive process called masking. Phase jumps are specified, near-field data (wavelengths longer than three times the distance from the source to first receiver), and low-coherence data are removed. The experimental dispersion curve is calculated from the unwrapped phase angle and the distance between receivers by:

$$V_R = f * d_2/(\Delta\phi/360°),$$

Where V_R is Rayleigh wave phase velocity, f is frequency, d_2 is the distance between receivers, and $\Delta\phi$ is the phase difference in degrees.

WinSASW V1, a program developed at the University of Texas at Austin, or WinSASW V2 (Joh, 2002) is used to reduce SASW data and interpret the dispersion curve.

A detailed description of the MASW method is given by Park, 1999a and 1999b. Ground motions are recorded by 24 or more geophones spaced 1 to 2 m apart and aligned in a linear array and connected to a seismograph. A wavefield transform, such as the f-k or τ-p transform, is applied to the time history data to isolate the surface wave dispersion curve. PICKWIN95, software developed by Oyo Corporation is typically used to process the MASW data and obtain the dispersion curve.

A detailed discussion of the array microtremor method can be found in Okada, 2003. This technique uses 4 to 24 receivers aligned in a 2-dimensional array. Triangle, circle, semi-circle and "L" shaped arrays are commonly used, although any 2-dimensional arrangement of receivers can be used. Receivers typically consist of 1 to 4.5 Hz geophones. The triangle array, which consists of several embedded equilateral triangles, is often used as it provides good results with a relatively small number of geophones. With this array the outer side of the triangle should be at least equal to the desired depth of investigation. The "L" array is useful at sites located at the corner of perpendicular intersecting streets. Typically 10 to 20, 30-second noise records are acquired for analysis. The surface wave dispersion curve is estimated by calculating the spatial autocorrelation (SPAC) function for the time-history data. A first-order Bessel function is fit to the SPAC function to obtain the dispersion curve (phase velocity at each frequency). PICKWIN95, software developed by Oyo Corporation is typically used to process the array microtremor data and obtain the dispersion curve.

The active and passive surface wave techniques compliment one another as outlined below:

- SASW/MASW techniques image the shallow velocity structure which cannot be imaged by the microtremor technique and is needed for an accurate V_S30/V_S100' estimate.
- Microtremor techniques work best in noisy environments where SASW/MASW depth investigation may be limited.
- In a noisy environment the microtremor technique will usually extend the depth of an SASW/MASW sounding.
- The degree of fit in the overlapping portion of the dispersion curves from the two techniques provides a level of confidence in the results.

The dispersion curves generated from the active and passive surface wave soundings are generally combined and modeled. Typically, WinSASW V1 or V2 is used to model the data, whereby through iterative forward and/or inverse modeling, a V_S profile is found whose theoretical dispersion curve is a close fit to the field data.

The final model profile is assumed to represent actual site conditions. Several options exist for forward modeling: a formulation that takes into account only fundamental-mode Rayleigh wave motion (called the 2-D solution) and one that includes all stress waves and incorporates receiver geometry (3-D solution) (Roesset et al., 1991).

The theoretical model used to interpret the dispersion assumes horizontally layered, laterally invariant, homogeneous-isotropic material. Although these conditions are seldom strictly met at a site, the results of active and/or passive surface wave testing provide a good "global" estimate of the material properties along the array. The results may be more representative of the site than a borehole "point" estimate.

Based on our experience at other sites, the shear wave velocity models determined by surface wave testing are within 20% of the velocities that would be determined by other seismic methods (Brown, 1998). The average velocity of the upper 30 meters or 100 feet, however, is much more accurate than this, often to better than 5%, because it is less sensitive to the layering in the model.

4 DATA REDUCTION AND MODELING

4.1 Seismic Refraction Survey

Seismic refraction data were first modeled using the generalized reciprocal method (GRM), as outlined in Palmer, 1980 and 1981, Lankston and Lankston, 1986, and Lankston, 1990. GRM is a seismic-refraction interpretation method designed to accurately map undulating refractor surfaces from in-line refraction data using both forward and reverse shots. This method can accurately model refractor surfaces with dips of less than 20 degrees. The seismic refraction models developed using the GRM technique were used as starting models for the tomographic inversion discussed later in this section.

The first step in data processing consisted of picking the arrival time of the first energy received at each geophone (first arrival) for each shot point. The first arrivals on each seismic record are either a direct arrival from a compressional (P) wave traveling in the uppermost layer or a refracted arrival from a subsurface interface where there is a velocity increase. First-arrival times were selected using the automatic and manual picking routines in the software package SeisImager™ (Oyo Corporation). These first arrival times were saved in an ASCII file containing shot location, geophone locations and associated first arrival time. Errors in the first arrival times were variable with error generally increasing with distance from the shot point. First arrival picking errors probably averaged about 1 ms with error probably less than 0.5 ms at geophone locations near the shot point and up to 2 ms at distal geophone locations.

Relative elevations for each geophone location were calculated from the leveling data using a spreadsheet and converted to approximate elevations using GPS data collected at the end of each line.

Data qualities were affected by factors such as: on site activity (e.g. traffic), weak coupling of geophones and source to the asphalt surface and geologic conditions. For certain lines, data acquisition was delayed due to traffic noise and continued when traffic ceased or lessened to acceptable limits.

The seismic refraction data were processed using the GRM computer program VIEWSEIS (Viewlog Systems, Inc.). The first arrival and elevation data files were entered into the program and time-distance plots for the forward and reverse shots were generated. Forward shots are shot points where energy travels from geophone 1 to 48. Energy travels in the opposite direction for reverse shots and shots inside each spread (interior and center shots) have both forward and reverse components. The first arrival data for all the shot points were then assigned to the layer from which they were refracted. Two layers were assigned to the travel time data. These layers corresponded to sediments and bedrock/saturated sediments. The travel time data refracted from the deepest imaged layer were then phantomed (shifted in time) to line up with the travel-time data associated with the zero-offset end shot, therefore, forming a single travel-time curve for each refractor along the line. This method was employed for both forward and reverse shots. After phantoming was completed, GRM processing was conducted to generate depth and velocity models.

Seismic refraction data were then modeled using the tomographic analysis technique available in the SeisImager™ Plotrefa software package, developed by Oyo Corporation. Refraction tomography techniques are often able to resolve complex velocity structure (e.g. velocity gradients) that can be observed in bedrock weathering profiles. Layer based modeling techniques such as the GRM are not able to accurately model the velocity gradients that can be observed in weathered bedrock.

Tomographic analysis was conducted as outlined in the following steps. An initial model was generated using parameters outlined by the processor. The initial model had 20 layers with the top of the bottom layer at a depth related to the imaged depth of the model. Velocity ranges were also set to values outside of the starting model minimum and maximum. The velocity models were extended to permit the use of off-end shot points during the inversion. A minimum of 20 iterations of non-linear raypath inversion were then implemented to improve the fits of the travel time curves to near-surface sediments/rock. After each set of inversions were completed, the initial parameters were adjusted and the model run again in an iterative process. These steps were repeated until acceptable fits and RMS error were achieved. The final tomographic velocity models for the seismic line were exported as ASCII files and imported into the Geosoft Oasis montaj® v7 mapping system where the velocity model was gridded, contoured and annotated for presentation.

4.2 Surface Wave Survey

The MASW data were reduced using the software Seismic Pro Surface V6.0 developed by Geogiga using the following steps:

- Input seismic record into software.
- Enter receiver spacing, geometry and wavelength restrictions, as necessary.
- Apply wavefield transform to seismic record to convert the data to phase velocity – frequency space.
- Identify and pick dispersion curve.
- Repeat for all shot records and merge dispersion curves.
- Convert dispersion curves to WinSASW format for modeling.

The surface wave dispersion curves from the active surface wave data were used for modeling. An iterative forward modeling process was used to generate an S-wave velocity model for the sounding. During this process an initial velocity model was generated based on general characteristics of the dispersion curve. The theoretical dispersion curve was then generated using the 2-D modeling algorithm (fundamental mode Rayleigh wave dispersion module) and compared to the field dispersion curve. Adjustments were then made to the thickness and velocities of each layer and the process repeated until an acceptable fit to the field data was obtained.

Data inputs into the modeling software included layer thickness, S-wave velocity, P-wave velocity and mass density. P-wave velocity and mass density only have a very small influence (i.e. less than 10%) on the S-wave velocity model generated from a surface wave dispersion

curve. However, realistic assumptions for P-wave velocity, which is impacted by the location of the bedrock, and mass density will slightly improve the accuracy of the S-wave velocity model.

Constant mass density values of 1.7 to 2.2 g/cc were used in the profile for subsurface soils. Variation in mass density has a negligible effect on surface wave dispersion within the normal range encountered in geotechnical engineering. During data modeling, the compression wave velocity, V_P, of unsaturated soils was estimated using a Poisson's ratio, ν, of 0.30 and the relationship:

$$V_P = V_S \left[(2(1-\nu))/(1-2\nu)\right]^{0.5}$$

Depth to groundwater at this site is unknown. For modeling purposes, the water table was assumed to be greater than 30 m. The presence of water at a depth of less than 30 m would have a negligible effect on the model and V_{S30}.

5 DISCUSSION OF RESULTS

The seismic tomography models for S-1 and S-2 are presented as Figures 2 and 3, respectively. The color scheme used on the tomography images consist of blue-green, yellow-orange and red-pink representing low, intermediate and high velocities, respectively. The transition from blue to green occurs at a velocity of 800 m/s and the transition from green to yellow occurs at a velocity of 1,400 m/s. The transition from orange to red occurs at 2,200 m/s. The GRM model is not presented as it was considered redundant.

Tomographic inversion techniques will typically model a gradual increase in velocity with depth even if an abrupt velocity contact is present. Therefore, if velocity gradients are not present, tomographic inversion routines will overestimate and underestimate velocity above and below a layer contact, respectively. Velocity gradients can, however, be very common in geologic environments with alluvial deposits and weathered rock, such as the project site. In tomographic images, layer contacts are not clearly defined and thus, ranges of velocities are used to interpret possible rock conditions and competency. For the purpose of discussion, velocities of less than 500 m/s are considered to be unconsolidated sediments, velocities in the 1,000 m/s to 2,000 m/s range are interpreted as weathered rock and velocities greater than 2,500 m/s are the interpreted rock layer.

The fit of the theoretical dispersion curves to the experimental data collected and the modeled V_S profiles for S-1 and S-2 are presented in Figures 3 and 4, respectively. The resolution decreases gradually with depth because of the loss of sensitivity of the dispersion curve to changes in V_S at greater depth. The V_S profiles used to match the field data of S-1 and S-2 is provided in tabular form as Table 2 and 3.

Analysis of Rayleigh wave (MASW) data was very difficult due to higher modes (probable first higher mode) that were dominant at high frequencies. The data were modeled using an effective mode modeling approach which allowed the jump from fundamental mode to first higher mode to be modeled. The half space velocity is not well constrained; however, this has no effect on V_{S30} because the upper portion of the subsurface controls the average shear wave velocity for the profile. It is our recommendation that Love wave (MALW) techniques should be performed at this site; it has been our experience that dominant higher modes are not an issue in MALW data.

5.1 Seismic Array S-1

The seismic refraction tomography model for seismic array S-1 is presented as Figure 2. The seismic tomography model for this line shows a thicker layer of sediments on the western side of the line with a gradual decrease in thickness toward the eastern portion of the line. The interpreted unconsolidated sediments at the 500 m/s contour are approximately 1 m thick beneath the western and central portion and less than 1 m beneath the eastern portion of the line. The interpreted weathered rock unit at the 1,000 m/s contour is approximately 4 m deep beneath the western and central portion and 3 m beneath the eastern portion of the line. The interpreted rock unit at the 2,500 m/s contour is approximately 8 m deep beneath the western and central portion and 9 m beneath the eastern portion of the line. The large change in depth between the 1,000 m/s

and 2,500 m/s contours likely reflects a weathered rock zone and not an abrupt contact between the two interpreted layers.

The shear wave velocity profile for seismic array S-1 consists of about 2.75 m of soft sediments or fill material with an S-wave velocity of 190 m/s to 218 m/s. At a depth of approximately 4.75 m, S-wave velocity increases from about 285 m/s to 820 m/s. S-wave velocity increases to about 1,008 m/s at a depth of about 10 m. S-wave velocity is relatively uniform between a depth of 10 m and 30 m, ranging from about 1,008 to 1,194 m/s. Average shear wave velocity to a depth of 30 m, V_{S30}, is 652 m/s at the location of the surface wave array.

5.2 Seismic Array S-2

The seismic refraction tomography model for seismic array S-2 is presented as Figure 3. The seismic tomography model for this line shows a thicker layer of sediments on the northern side of the line with a gradual decrease in thickness toward the southern portion of the line. The interpreted unconsolidated sediments at the 500 m/s contour are less than 1 m thick beneath the southern portion and approximately 2 m beneath the central and northern portion of the line. The interpreted weathered rock unit at the 1,000 m/s contour is approximately 2 m deep beneath the southern portion and 6 m to 7 m beneath the central and northern section of the line. The interpreted rock unit at the 2,500 m/s contour is approximately 15 m deep beneath the southern portion, about 14 m deep beneath the central portion and 16 m beneath the northern portion of the line. The large change in depth between the 1,000 m/s and 2,500 m/s contours likely reflects a weathered rock zone and not an abrupt contact between the two interpreted layers.

The shear wave velocity profile for seismic array S-2 consists of about 2.5 m of soft sediments or fill material with an S-wave velocity of 147 m/s to 234 m/s. Below a depth of 5 m, S-wave velocity increases from about 385 m/s to 715 m/s at a depth of approximately 8.75 m. S-wave velocity increases to about 1,014 m/s at a depth of about 14 m. Below a depth of 20 m, S-wave velocity increases from about 1,230 m/s to 1,508 m/s at a depth of approximately 27 m. Average shear wave velocity to a depth of 30 m, V_{S30}, is 573 m/s at the location of the surface wave array.

6 CONCLUSION

A seismic refraction and surface wave survey was conducted along two (2) lines (S-1 and S-2) at Ford Amphitheatre in Los Angeles, California. The locations of the seismic lines are presented in Figure 1 and Table 1.

The seismic refraction survey was conducted to determine the depth to rock. The seismic refraction tomography models for seismic arrays S-1 and S-2 are presented as Figure 3 and 4, respectively. The interpreted weathered rock unit is approximately 4 m deep beneath the western and central portion and 3 m beneath the eastern portion of array S-1 and approximately 2 m deep beneath the southern portion and 6 to 7 m beneath the central and northern portion of the array S-2. The interpreted rock unit is approximately 8 m deep beneath the western and central portion and 9 m beneath the eastern portion of the array S-1. The interpreted rock unit beneath seismic array S-2 is approximately 15 m deep beneath the southern portion, about 14 m deep beneath the central portion and 16 m beneath the northern portion of the line.

Active surface wave measurements using MASW were made at two locations to characterize shear wave velocity of the upper 30 m, or more. The locations of the active surface wave arrays are presented in Figure 1 and Table 1. The shear wave velocity depth profiles (S-1 and S-2) determined by this method are presented as Figures 3 and 4 and in Tables 2 and 3.

V_{S30} is approximately 652 m/s beneath the surface wave array S-1. V_S30 is approximately 573 m/s beneath the surface wave array S-2. Therefore, according to the Uniform and International Building Codes, the area in the vicinity of the arrays is classified as Class C, very dense soil and soft rock.

7 REFERENCES

Brown, L.T., 1998, "Comparison of V_S profiles from SASW and borehole measurements at strong motion sites in Southern California", Master's thesis, University of Texas, Austin.

BSSC, 1994, *NEHRP Recommended provisions for the development of seismic regulations for new buildings, part I: Provisions*, Building Seismic Safety Council, Federal Emergency Management Agency, Washington D.C.

Dobrin, M.S., and Savit, J., 1988, Introduction to Geophysical Prospecting, McGraw-Hill Co., New York.

Foti, S., 2000, "Multistation Methods for Geotechnical Characterization using Surface Waves", Ph.D. Dissertation, Politecnico di Torino, Italy.

Gardner, L.W., 1967, Refraction seismograph profile interpretation, in Musgrave, A.W., ed., Seismic Refraction Prospecting: Society of Exploration Geophysicists, p. 338-347.

Hales, F. W., 1958, An accurate graphical method for interpreting seismic refraction lines: Geophysical Prospecting, v. 6, p 285-294.

Hagedoorn, J.G., 1959, The plus-minus method of interpreting seismic refraction sections, Geophysical Prospecting, v. 7, p 158-182.

Hawkins, L. V., 1961, The reciprocal method of routine shallow seismic refraction investigation: Geophysics, v. 26, p. 806-819.

International Committee of Building Officials, 2000 International Building Code, ICC, Hauppauge, NY, Section 1615.1.1

Joh, S.H., 1996, "Advances in interpretation and analysis techniques for spectral-analysis-of-surface-waves (SASW) measurements", Ph.D. Dissertation, University of Texas, Austin.

Joh, S.H., 2002, "WinSASW V2.0, Data Interpretation and Analysis for SASW Measurements", Department of Civil Engineering, Chung-Ang University, Anseong, Korea.

Kassenaar, J. D. C., 1989-1992, VIEWSEIS seismic refraction analysis system, installation manual, program tutorial, reference manual, 50 p.

Lankston, R. W., 1990, High-resolution refraction seismic data acquisition and interpretation, in Ward, S. H., ed., Geotechnical and Environmental Geophysics, Volume I: Review and Tutorial: Society of Exploration Geophysicists, Tulsa, Oklahoma, p. 45-74.

Lankston, R. W., and Lankston, M. M., 1986, Obtaining multilayer reciprocal times through phantoming, Geophysics, v. 51, p. 45-49.

Louie, J.N., 2001, "Faster, Better: Shear-Wave Velocity to 100 Meters Depth from Refraction Microtremor Arrays", Bulletin of the Seismological Society of America, vol. 91, no. 2, p. 347-364.

Okada, H, 2003, "The Microtremor Survey Method," Society of Exploration Geophysics Geophysical Monograph Series, Number 12, 135p.

Palmer, D., 1980, The generalized reciprocal method of seismic refraction interpretation: Society of Exploration Geophysics, Tulsa, Oklahoma, 104 p.

Palmer, D., 1981, An introduction to the field of seismic refraction interpretation: Geophysics, v. 46, p. 1508-1518.

Park, C.B., Miller, R.D. and Xia, J., 1999a, "Multimodal analysis of high frequency surface waves", *Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems '99*, 115-121.

Park, C.B., Miller, R.D. and Xia, J., 1999b, "Multichannel analysis of surface waves", Geophysics, Vol 64, No. 3, 800-808.

Redpath, B. B., 1973, Seismic refraction exploration for engineering site investigations: U. S. Army Engineer Waterway Experiment Station Explosive Excavation Research Laboratory, Livermore, California, Technical Report E-73-4, 51 p.

Roesset, J.M., Chang, D.W. and Stokoe, K.H., II, 1991, "Comparison of 2-D and 3-D Models for Analysis of Surface Wave Tests," *Proceedings*, 5th *International Conference on Soil Dynamics and Earthquake Engineering*, Karlsruhe, Germany.

Rockwell, D.W., 1967, General Wavefront Method, in Musgrave, A.W., ed., Seismic Refraction Prospecting: Society of Exploration Geophysicists, p. 363-415.

Scheidegger, A., and Willmore, P.L., 1957, The use of a least square method for the interpretation of data from seismic surveys, Geophysics, v. 22, p. 9-22.

Schuster, G. T. and Quintus-Bosz, A., 1993, Wavepath eikonal traveltime inversion: Theory: Geophysics, v. 58, no. 9, p. 1314-1323.

Stokoe, K.H., II, Wright, S.G., Bay, J.A. and Roesset, J.M., 1994, "Characterization of Geotechnical Sites by SASW Method," *ISSMFE Technical Committee 10 for XIII ICSMFE*, Geophysical Characteristics of Sites, A.A. Balkema Publishers/Rotterdam & Brookfield, Netherlands, pp. 146.

Stokoe, K.H.,II, Rix, G.L. and S. Nazarian, 1989, "In situ seismic testing with surface waves" *Proceedings, Twelfth International Conference on Soil Mechanics and Foundation Engineering, Vol. 1,* Rio de Janeiro, Brazil, pp. 330-334.

Telford, W. M., Geldart, L.P., Sheriff, R.E., 1990, Applied Geophysics, Second Edition, Cambridge University Press.

Wyrobek, S.M., 1956, Application of delay and intercept times in the interpretation of multilayer time distance curves, Geophysical Prospecting, v. 4, p 112-130.

Zhang, J. and Toksoz, M. N., 1998, Nonlinear refraction traveltime tomography, Geophysics, V. 63, p. 1726-1737.

8 CERTIFICATION

All geophysical data, analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by a **GEO*Vision*** California Professional Engineer.

Prepared by



09/17/12

David Carpenter — Date
Staff Geophysicist
GEO*Vision* Geophysical Services

Reviewed and approved by





09/17/12

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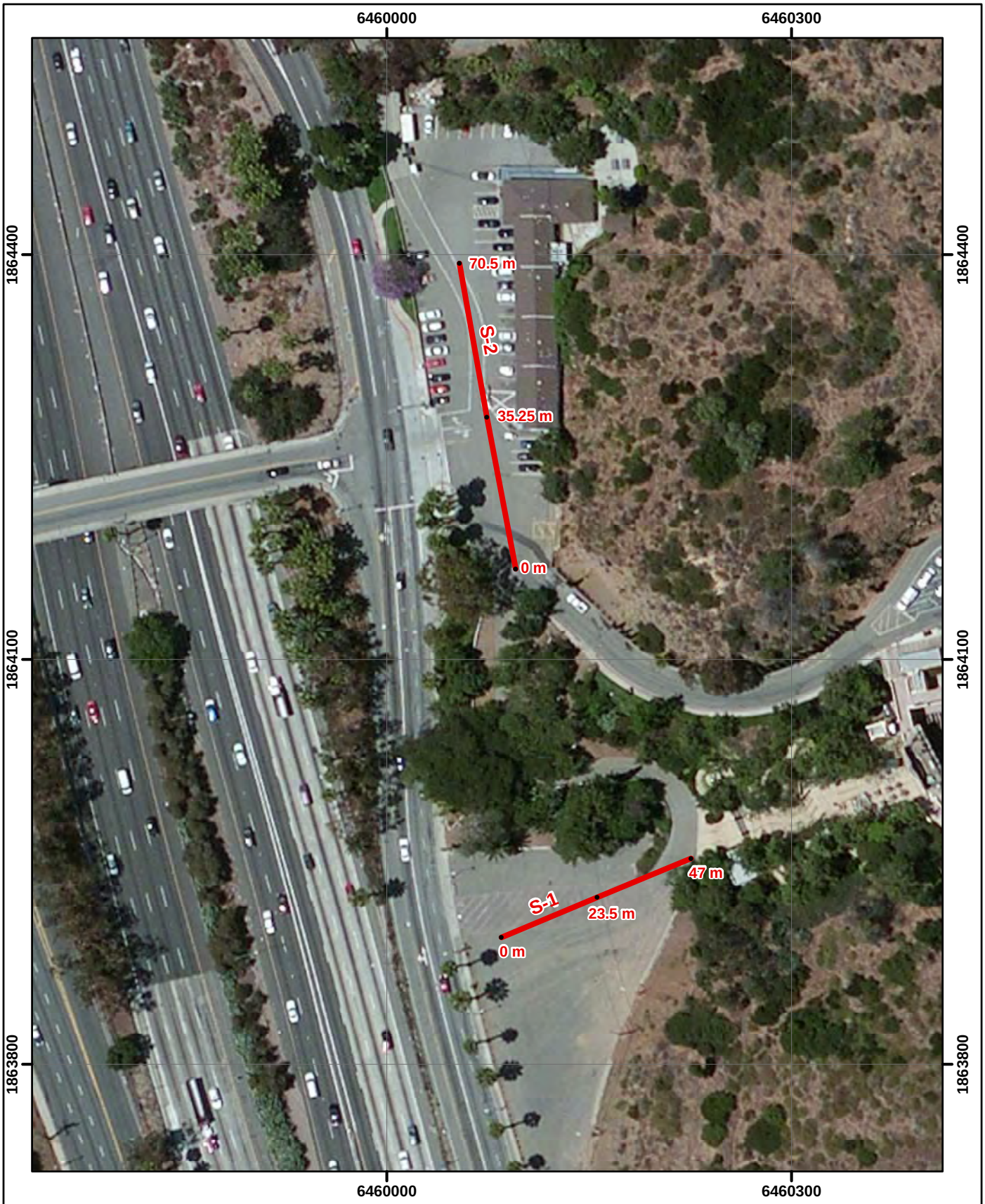
California Professional Geophysicist, P.GP 989
GEO*Vision* Geophysical Services

* This geophysical investigation was conducted under the supervision of a California Professional Engineer using industry standard methods and equipment. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing interpretation and reporting. All original field data files, field notes and observations, and other pertinent information are maintained in the project files and are available for the client to review for a period of at least one year.

  A professional engineer's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations or ordinances.

FIGURES



Legend
Seismic Array

0 30 60 90
Feet

N

NOTES:
1. California State Plane Coordinate System, NAD 83 Zone V (0405), US Feet
2. Image Source: (c) Microsoft Corporation and its data suppliers

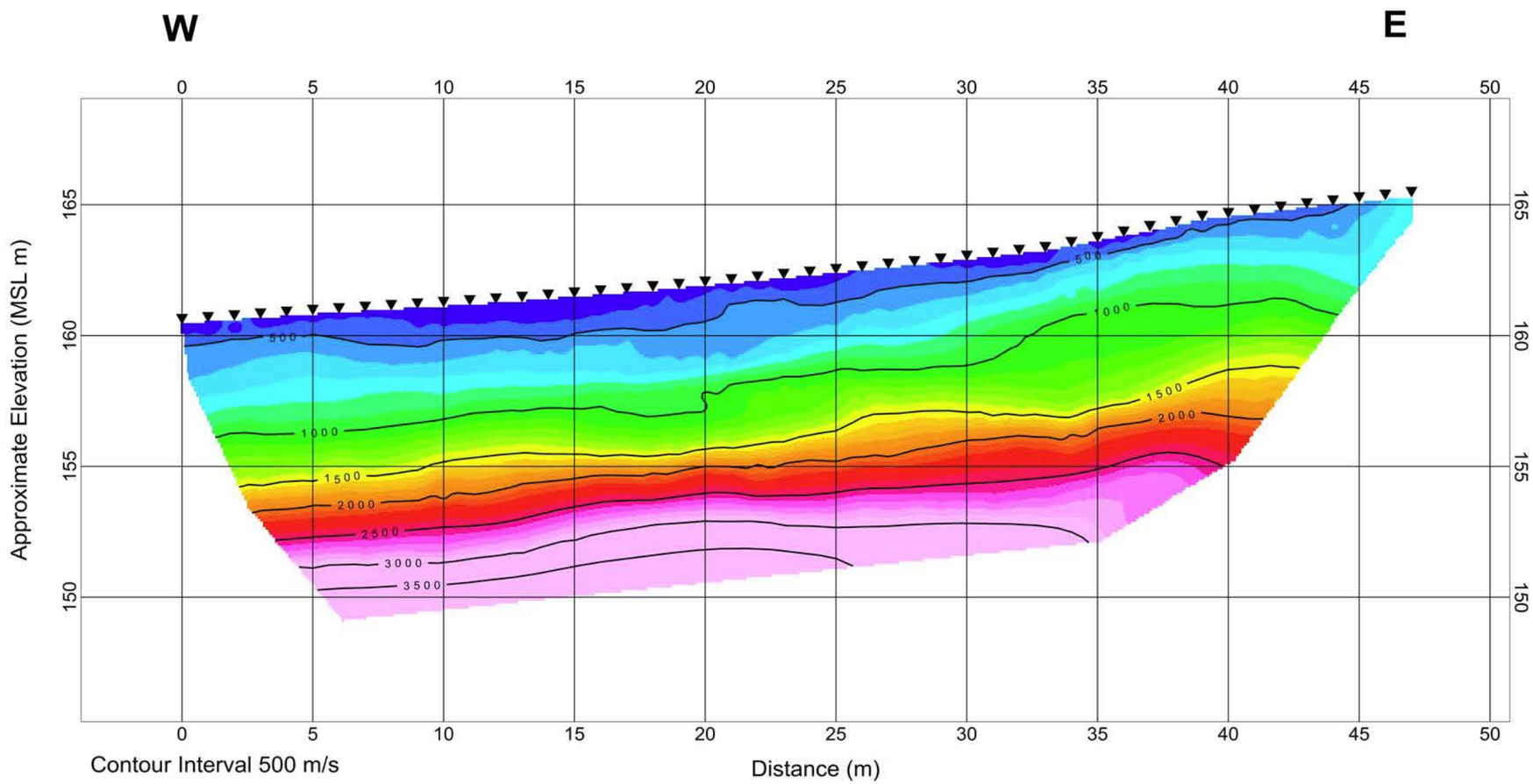
GEOVision geophysical services

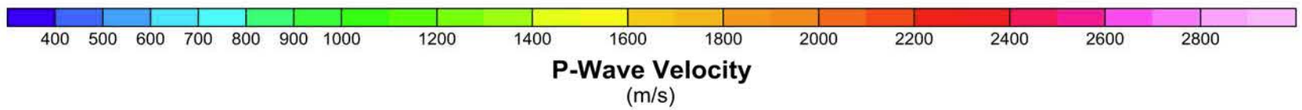
Date:	9/6/2012
GV Project:	12281
Developed by:	D Carpenter
Drawn by:	T Rodriguez
Approved by:	W Dalrymple
File Name:	12281-1.MXD

FIGURE 1
SITE MAP

FORD AMPHITHEATER
LOS ANGELES, CA

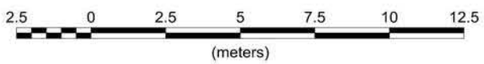
PREPARED FOR
LEIGHTON CONSULTING





LEGEND

▼ Geophone Location



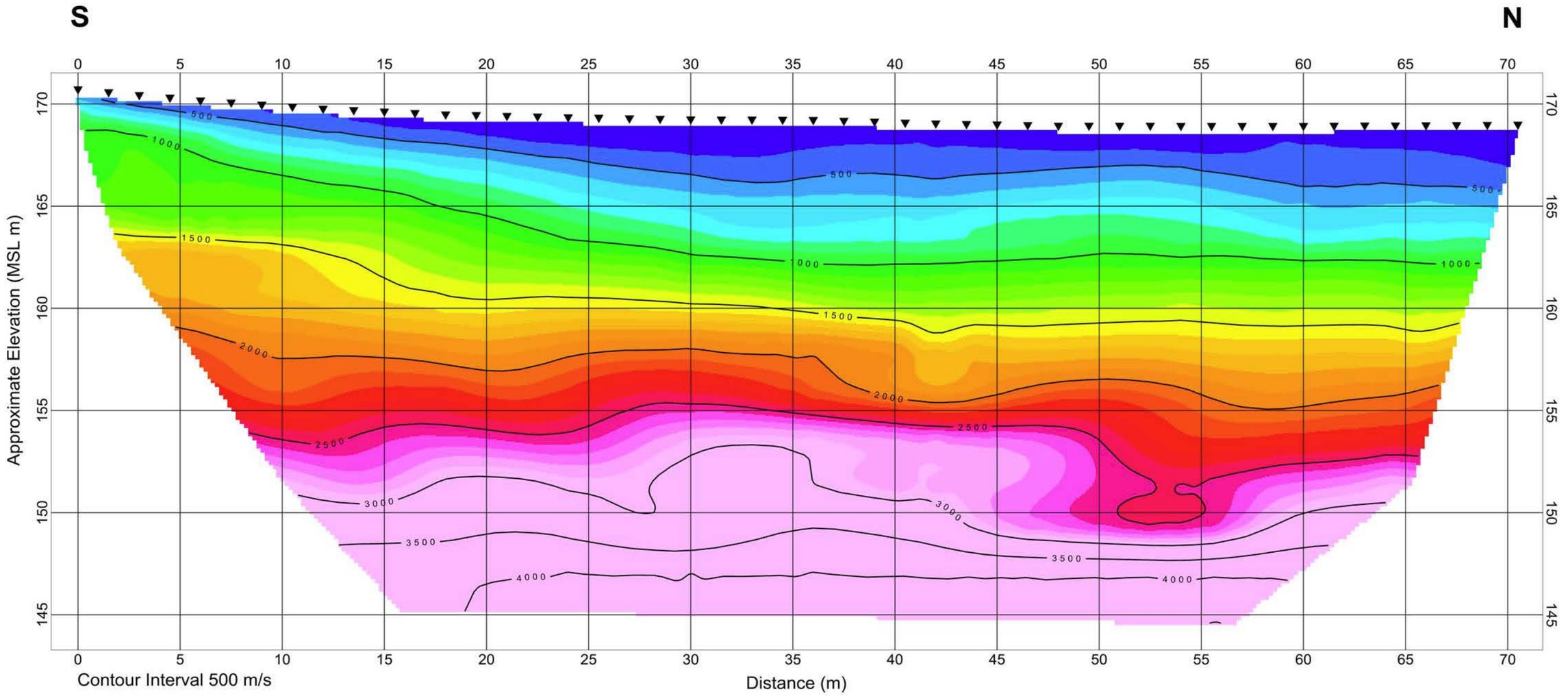
GEOVision geophysical services

Figure 2

S-1 Seismic Tomography Model
GV Project No. 12281

Ford Amphitheatre
Los Angeles, California

Prepared for Leighton Consulting



LEGEND

▼ Geophone Location

2.5 0 2.5 5 7.5 10 12.5
(meters)

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Figure 3

S-2 Seismic Tomography Model
GV Project No. 12281

Ford Amphitheatre
Los Angeles, California

Prepared for Leighton Consulting

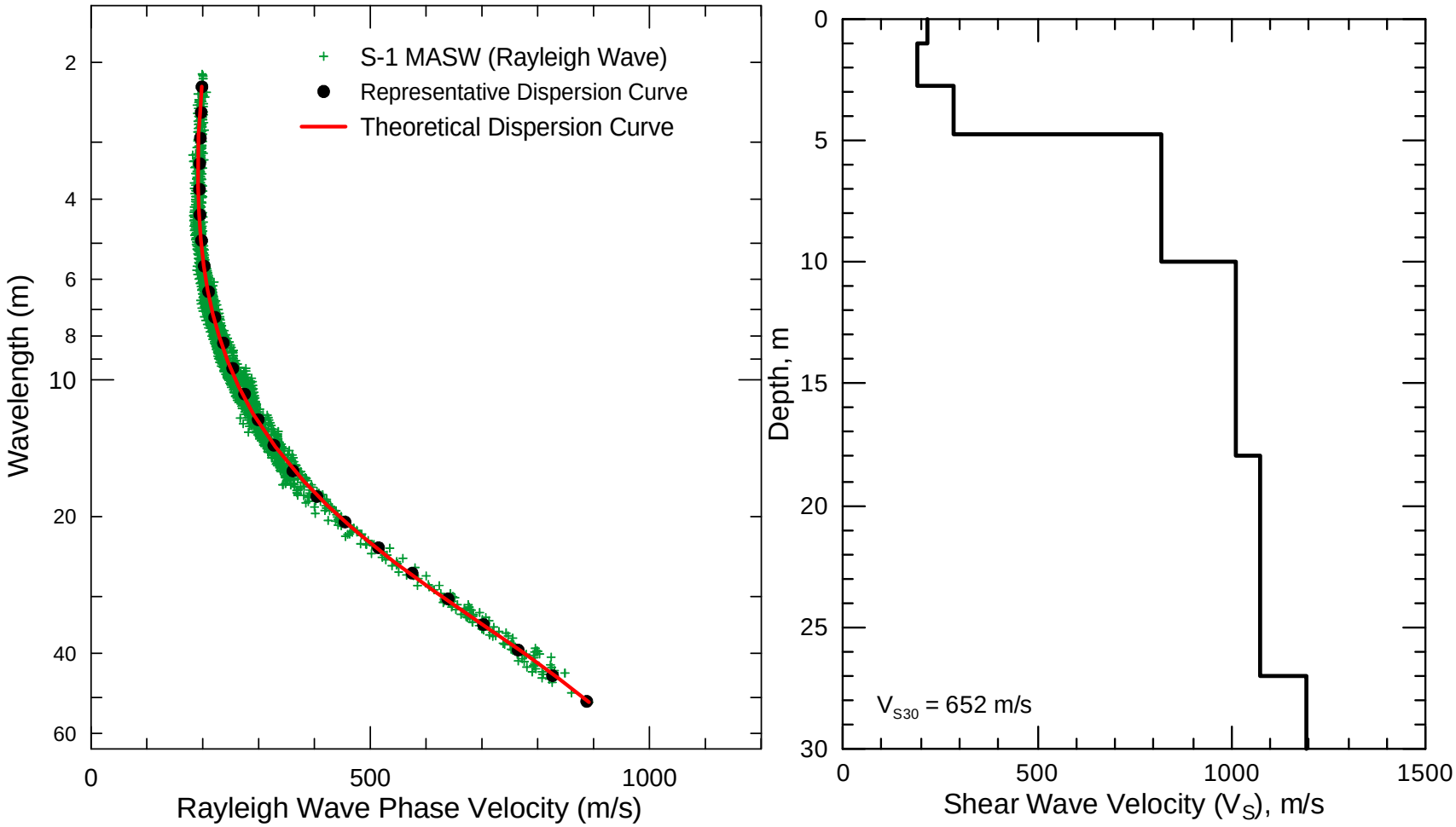


Figure 4: S-1 Field, representative and inverted theoretical Rayleigh wave dispersion data (left) and associated V_S model (right)

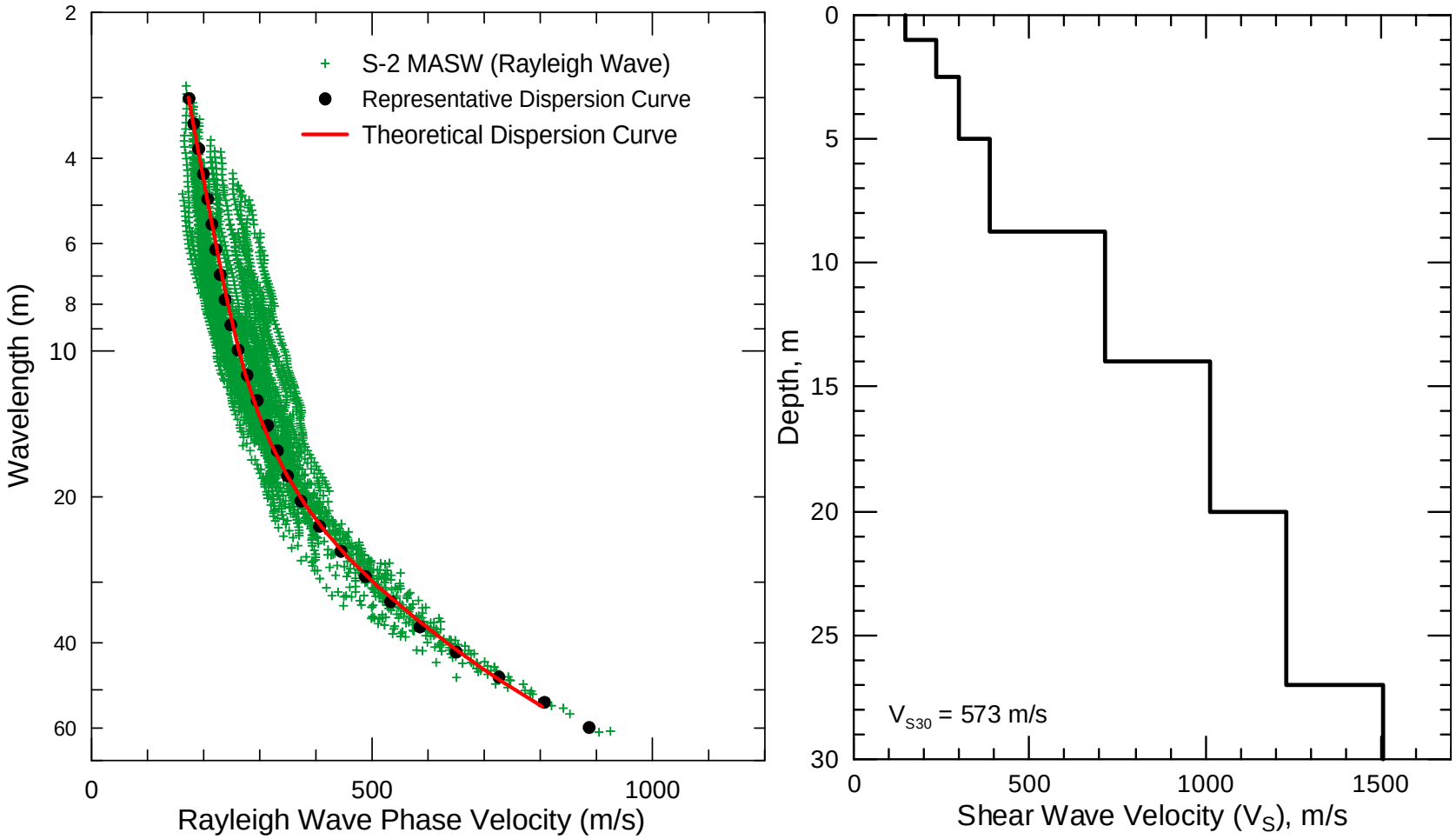


Figure 5: S-2 Field, representative and inverted theoretical Rayleigh wave dispersion data (left) and associated V_S model (right)

TABLES

Table 1: Seismic Line Geometry

Line	Location (m)	Spacing (m)	Northing (US Ft)	Easting (US Ft)
S-1	0	1	1,863,894	6,460,085
S-1	47		1,863,952	6,460,226
S-2	0	1.5	1,864,167	6,460,096
S-2	70.5		1,864,393	6,460,054

Notes:

1. Coordinates collected using a Trimble ProXRS GPS system with OmniSTAR differential corrections.
2. Coordinates in California State Plane, NAD83, Zone V (0405), US Survey Feet.

Table 2 Velocity Model for S-1 Surface Wave Array

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Assumed Poisson's Ratio	Assumed Density (g/cm^3)
0	1	218	406	0.3	1.70
1	1.75	190	356	0.3	1.70
2.75	2	285	533	0.3	1.75
4.75	5.25	820	1535	0.3	2.10
10	8	1,008	1,888	0.3	2.15
18	9	1,072	2,006	0.3	2.15
27	>3	1,194	2,236	0.3	2.2

Table 3 Velocity Model for S-2 Surface Wave Array

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Assumed Poisson's Ratio	Assumed Density (g/cm^3)
0	1	147	274	0.3	1.60
1	1.5	234	441	0.3	1.70
2.5	2.5	296	554	0.3	1.75
5	3.75	385	723	0.3	1.90
8.75	5.25	715	1,334	0.3	2.10
14	6	1,014	1,892	0.3	2.15
20	7	1,230	2,295	0.3	2.15
27	>3	1,508	2,828	0.3	2.2

APPENDICES

SEISMIC REFRACTION METHOD

GEO*Vision* geophysical services

GEO*Vision* conducts high-resolution seismic refraction and seismic reflection surveys in support of a variety of engineering, environmental, and hydrogeologic investigations.

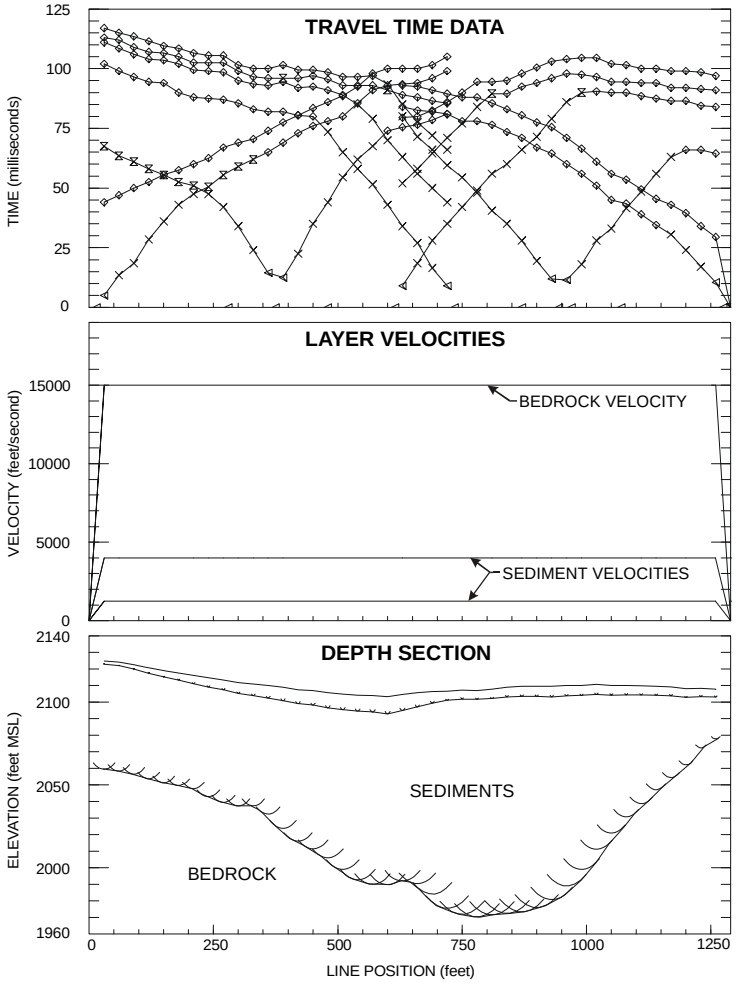
When conducting seismic surveys, acoustic energy is input to the subsurface by an energy source such as a sledgehammer impacting a metallic plate, weight drop, vibratory source, or explosive charge. The acoustic waves propagate into the subsurface at a velocity dependent upon the elastic properties of the material through which they travel. When the waves reach an interface where the density or velocity changes significantly, a portion of the energy is reflected back to the surface, and the remainder is transmitted into the lower layer. Where the velocity of the lower layer is higher than that of the upper layer, a portion of the energy is also critically refracted along the interface. Critically refracted waves travel along the interface at the velocity of the lower layer and continually refract energy back to surface. Receivers (geophones), laid out in linear array on the surface, record the incoming refracted and reflected waves. The seismic refraction method involves analysis of the travel times of the first energy to arrive at the geophones. These first arrivals are from either the direct wave (at geophones close to the source), or critically refracted waves (at geophones further from the source). The seismic reflection method involves the analysis of reflected waves, which occur later in the seismic record.

GEO*Vision* uses the seismic refraction method to:

- **Map bedrock topography**
- **Map depth to groundwater**
- **Map faults in bedrock**
- **Map faults forming groundwater barriers**
- **Characterize landslides**
- **Estimate bedrock rippability**
- **Evaluate soil and rock properties**



Seismic Refraction Survey in Mojave Desert, California using XLR8 2700 lb Accelerated Weight Drop Energy Source



Seismic Refraction Survey to Map Bedrock Topography

1124 Olympic Drive, Corona, California 92881 ph 951-549-1234 fx 951-549-1236 www.geovision.com

GEO*Vision* seismic refraction equipment includes:

- Multiple Geometrics Geode 24-channel seismographs
- Oyo DAS-1 seismograph with 144-channel capability
- Seismic refraction cables with 10 to 55 ft takeouts
- 4.5, 8 and 10 Hz geophones
- 40 and 100 kg accelerated weight drop energy sources
- Betsy downhole percussion firing rod
- Seismic Source and Gisco radio trigger modules
- High-voltage blaster

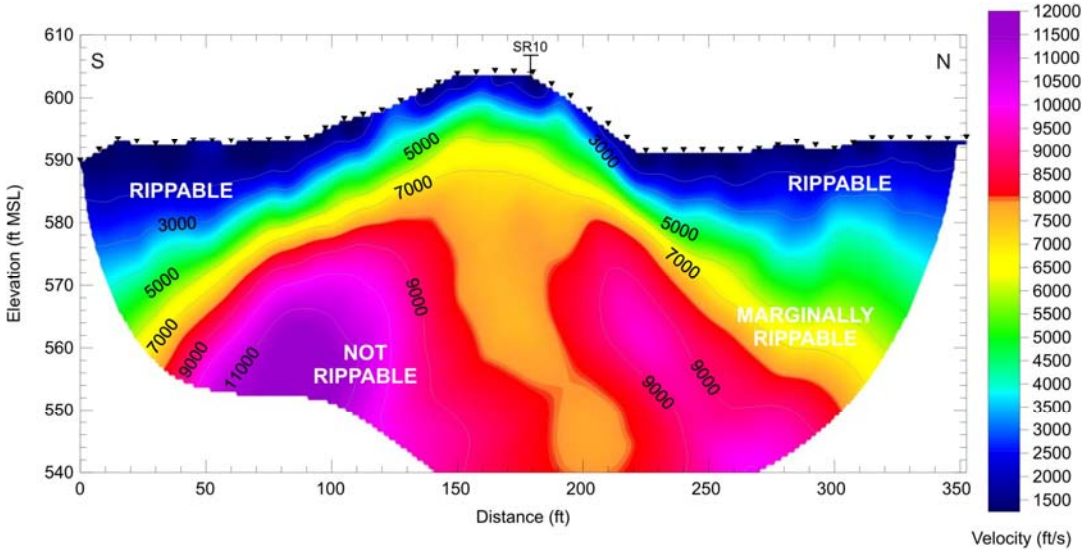


100 kg Accelerated Weight Drop



Geometrics Geode Seismographs

Analysis of seismic refraction data depends upon the complexity of the subsurface seismic velocity structure. If the subsurface target is planar in nature then the slope intercept method can be used to model multiple horizontal or dipping planar layers. A minimum of one end shot is required to model horizontal layers and reverse end shots are required to model dipping planar layers. If the subsurface target is undulating and exhibits an abrupt velocity increase (e.g. basement surface) then layer based analysis routines such as the generalized reciprocal method, delay time method, time-term method, plus-minus method and wavefront method are required to model subsurface velocity structure. These methods generally require a minimum of 5 to 7 shot points per spread (end shots, off end shots and a center shot). If subsurface velocity structure is complex and cannot be adequately modeled using layer-based modeling techniques (e.g., complex weathering profile in bedrock, numerous lateral velocity variations), then tomographic inversion techniques are best suited to model the seismic refraction data. These techniques require a high shot density (typically every 2 to 6 stations/ geophones).



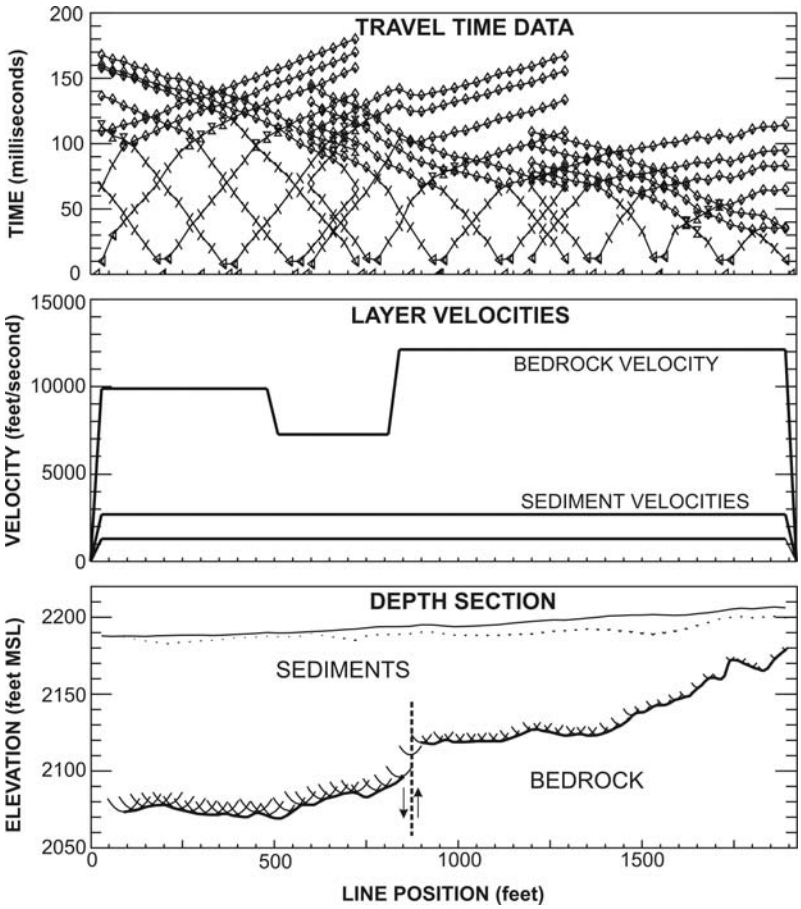
Seismic Refraction Survey to Map Bedrock Rippability

GEO*Vision* maintains several software packages to model seismic refraction data including:

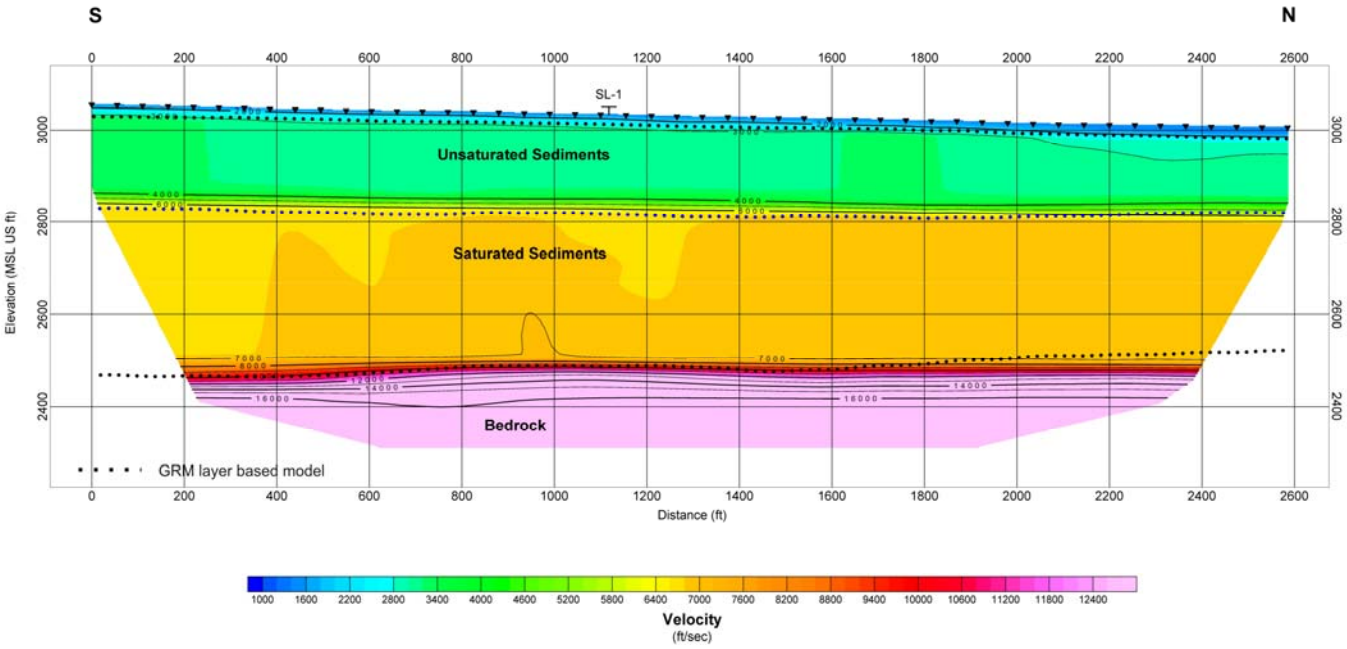
- Firstpix™ by Interpex, Ltd.
- IXrefraX by Interpex ,Ltd.
- Viewseis™ by Viewlog Systems, Ltd.
- Refract by Geogiga
- Seisimager™ by Geometrics, Inc./Oyo Corporation
- Rayfract™ by Intelligent Resources, Inc.
- SeisOpt™ Pro by Optim LLC

These software packages allow processing of seismic refraction data using the following layer based and smooth velocity model techniques:

- Generalized reciprocal method (GRM)
- Reciprocal method/delay time method
- Time-Term method
- Plus-Minus method
- Wavefront method
- Monte Carlo based inversion
- Delta t-V tomographic inversion
- Wavepath Eikonal traveltime tomographic inversion
- Nonlinear traveltime tomographic analysis



Seismic Refraction Survey to Map Bedrock Fault



Seismic Refraction Survey to Map Depth to Groundwater (200 ft deep) and Bedrock (500 to 600 ft deep) as part of a Groundwater Resources Investigation. Energy Source Consisted of XLR8 2700 lb Accelerated Weight Drop. Data modeled using Nonlinear Traveltime Tomographic Analysis with a Layer-Based Starting Model.

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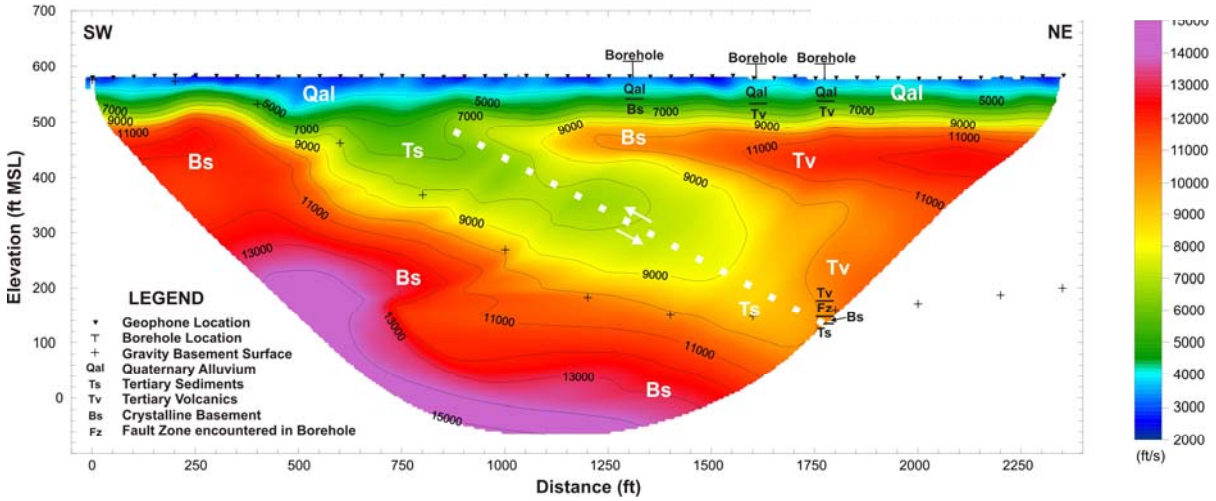
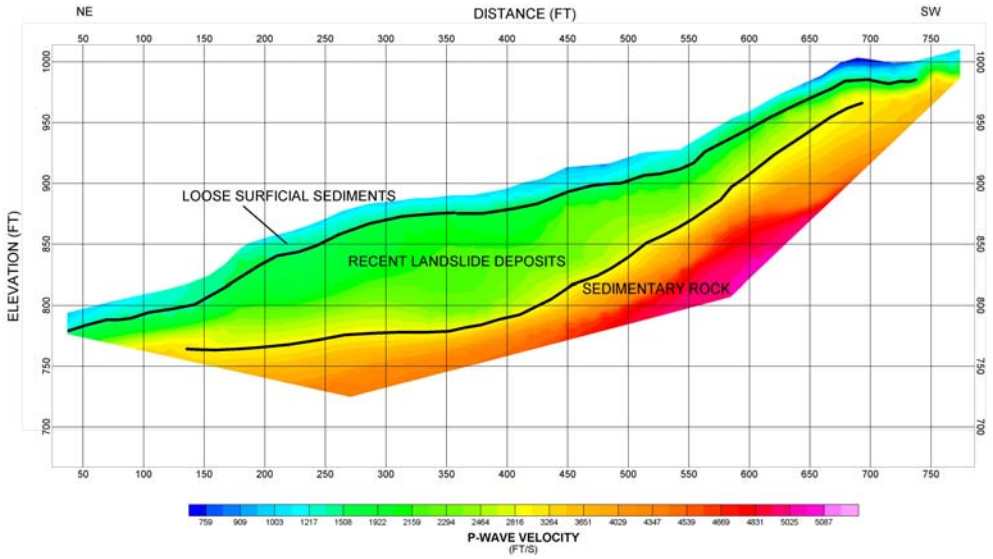
Drilling Shot Holes for Explosive Seismic Refraction Survey



Loading Explosive Charge



Seismic Refraction Imaging of Complex Geologic Structure consisting of Tertiary Volcanic Rocks and Basement Rocks Thrust over Tertiary Sediments and Basement Complex. Small Explosive Charges used as the Energy Source and Data Modeled using Wavepath Eikonal Traveltime Tomographic Inversion.



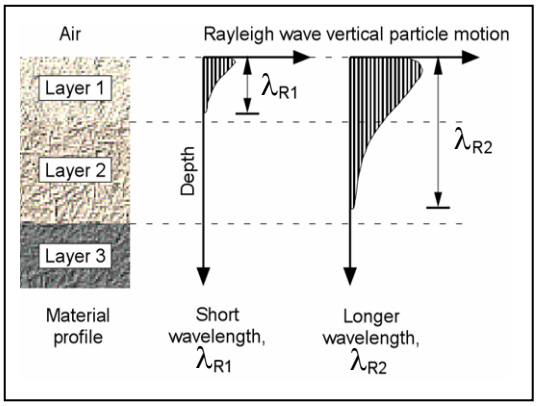
Seismic Refraction Survey to Characterize a Landslide

ACTIVE AND PASSIVE SURFACE WAVE TECHNIQUES

GEOVision geophysical services

Overview

Active and passive surface wave techniques are relatively new in-situ seismic methods for determining shear wave velocity (V_S) profiles. Testing is performed on the ground surface, allowing for less costly measurements than with traditional borehole methods. The basis of surface wave techniques is the dispersive characteristic of Rayleigh waves when traveling through a layered medium. Rayleigh wave velocity is determined by the material properties (primarily shear wave velocity, but also to a lesser degree compression wave velocity and material density) of the subsurface to a depth of approximately 1 to 2 wavelengths. As shown in the adjacent diagram, longer wavelengths penetrate deeper and their velocity is affected by the material properties at greater depth. Surface wave testing consists of measuring the surface wave dispersion curve at a site and modeling it to obtain the corresponding shear wave velocity profile.



Active Surface Wave Techniques

Active surface wave techniques measure surface waves generated by dynamic sources such as hammers, weight drops, electromechanical shakers, vibroseis and bulldozers. These techniques include the spectral analysis of surface waves (SASW) and multi-channel array surface wave (MASW) methods.



Hammer Energy Sources



Accelerated Weight Drop



Electromechanical Shaker



Bulldozer Energy Source

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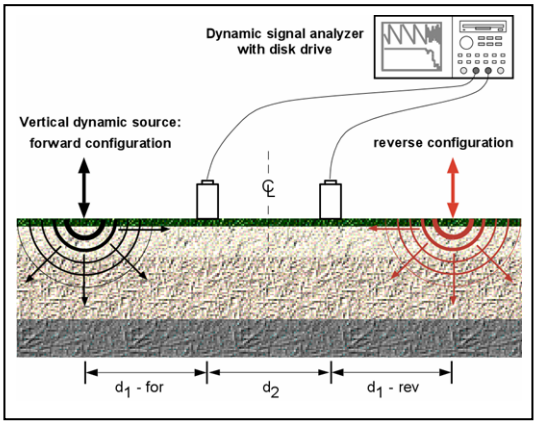
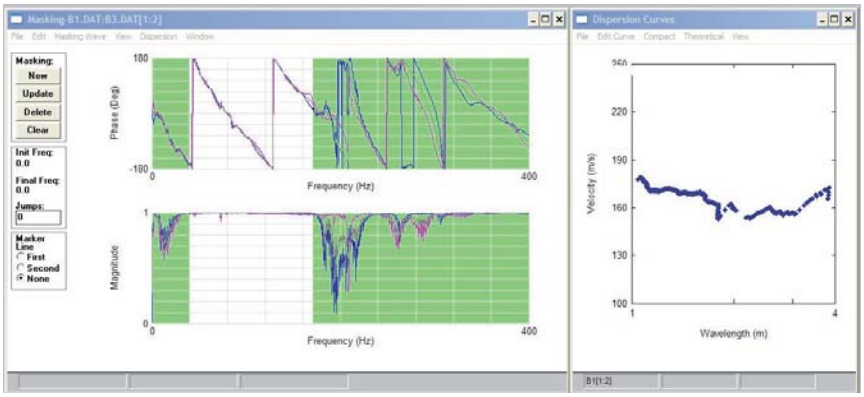
The SASW method is optimized for conducting V_S depth soundings. A dynamic source is used to generate surface waves of different wavelengths (or frequencies) which are monitored by two or more receivers at known offsets. An expanding receiver spread and optimized source-receiver geometry are used to minimize near field effects, body wave signal and attenuation. A dynamic signal analyzer is typically used to calculate the phase and coherence of the cross spectrum of the time history data collected at a pair of receivers. During data analysis, an interactive masking process is used to discard low quality data and to unwrap the phase spectrum, as shown in the figure below. The dispersion curve (Rayleigh wave phase velocity versus frequency or alternatively wavelength) is calculated from the unwrapped phase spectrum.



SASW Setup



HP Dynamic Signal Analyzer

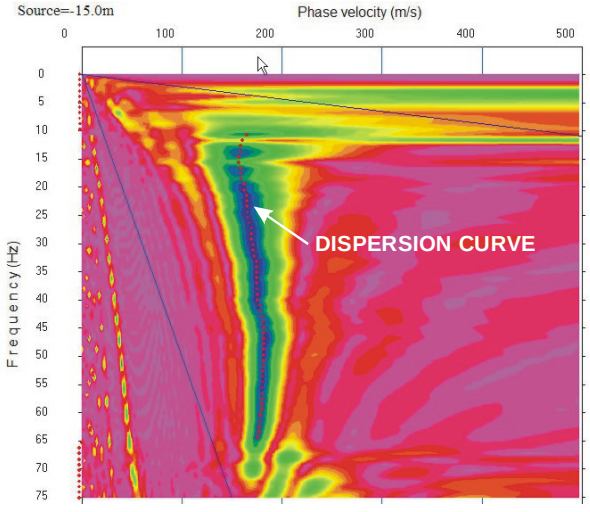


Masking of Wrapped Phase Spectrum and Resulting Dispersion Curve

The MASW field layout is similar to that of the seismic refraction technique. Twenty four, or more, geophones are laid out in a linear array with 1 to 2m spacing and connected to a multi-channel seismograph as shown below. This technique is ideally suited to 2D V_S imaging, with data collected in a roll-along manner similar to that of the seismic reflection technique. The source is offset at a predetermined distance from the near geophone usually determined by field testing. The Rayleigh wave dispersion curve is obtained by a wavefield transformation of the seismic record such as the f-k or τ-p transforms. These transforms are very effective at isolating surface wave energy from that of body waves. The dispersion curve is picked as the peak of the surface wave energy in slowness (or velocity) – frequency space as shown. One advantage of the MASW technique is that the wavefield transformation may not only identify the fundamental mode but also higher modes of surface waves. At some sites, particularly those with large velocity inversions, higher surface wave modes may contain more energy than the fundamental mode.



MASW Field Setup

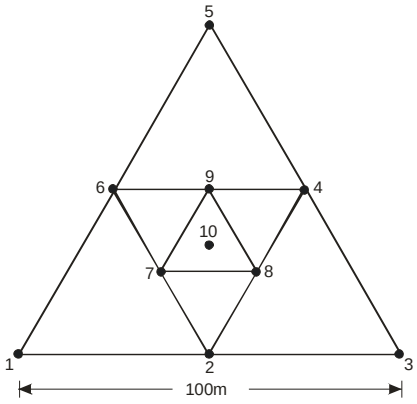


Wavefield Transform of MASW data

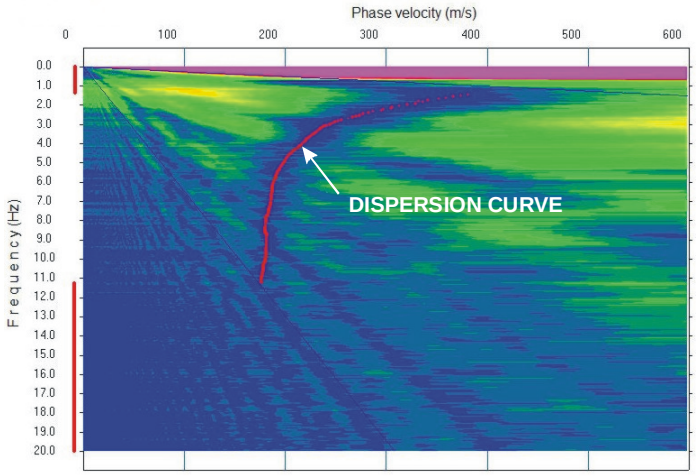
Passive Surface Wave Techniques

Passive surface wave techniques measure noise; surface waves from ocean wave activity, traffic, factories, etc. These techniques include the array microtremor and refraction microtremor (REMI) techniques.

The array microtremor technique typically uses 7 or more 4.5- or 1-Hz geophones arranged in a two-dimensional array. The most common arrays are the triangle, circle, semi-circle and "L" arrays. The triangle array, which consists of several embedded equilateral triangles, is often used as it provides good results with a relatively small number of geophones. With this array the outer side of the triangle should be at least as long as the desired depth of investigation. Typically, fifteen to twenty 30-second noise records are acquired for analysis. The spatial autocorrelation (SPAC) technique is one of several methods that can be used to estimate the Rayleigh wave dispersion curve. A first order Bessel function is fit to the SPAC function to determine the phase velocity for particular frequency. The image shown below shows the degree of fitness of the Bessel function to the SPAC function for a wide range of phase velocity and frequency. The dispersion curve, is the peak (best fit), as shown in the figure below.



Triangle Array Geometry

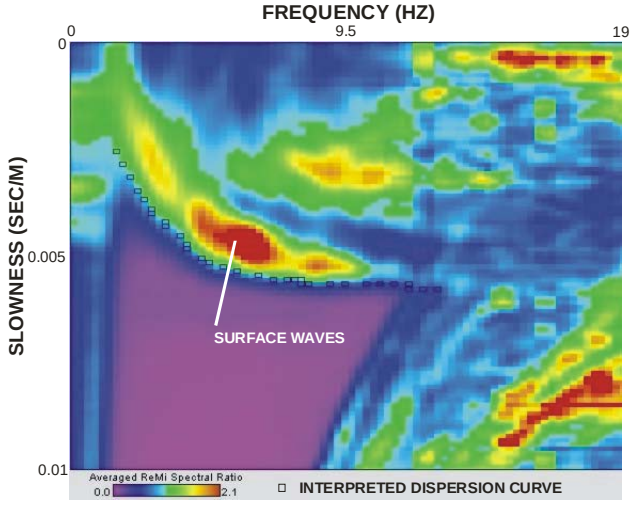


Dispersion Curve from Array Microtremor Measurements

The refraction microtremor (REMI) technique uses a field layout similar to the seismic refraction method (hence its name). Twenty-four, 4.5 Hz geophones are laid out in a linear array with a spacing of 6 to 8m and fifteen to twenty 30-second noise records are acquired. A slowness-frequency (p-f) wavefield transform is used to separate Rayleigh wave energy from that of other waves. Because the noise field can originate from any direction, the wavefield transform is conducted for multiple vectors through the geophone array, all of which are summed. The dispersion curve is defined as the lower envelope of the Rayleigh wave energy in p-f space. Because the lower envelope is picked rather than the energy peak (energy traveling along the profile is slower than that approaching from an angle), this technique may be somewhat more subjective than the others, particularly at low frequencies. The SPAC technique can also be used to extract the surface wave dispersion curve from linear array microtremor data providing there are omni-directional noise sources.



Refraction Microtremor Array Layout



Wavefield Transform of REMI Data

Depth of Investigation

Active surface wave investigations typically use various sized sledge hammers to image the shear wave velocity structure to depths of up to 15m. Weight drops and electromechanical shakers can often be used to image to depths of 30m. Bulldozers and vibroseis trucks can be used to image to depths as great as 100m. Passive surface wave techniques can often image shear wave velocity structure to depths of over 100m, given sufficient noise sources and space for the receiver array. Large passive arrays, utilizing long-period seismometers with GPS clocks have been used to image shear wave velocity structure to depths of several kilometers.

Combined Active and Passive Surface Wave Testing

The combined use of active and passive techniques may offer significant advantages on many investigations. It can be very costly to mobilize large energy sources for 30m/100ft active surface wave soundings. In urban environments, the combined use of active and passive surface wave techniques can image to these depths without the need for large energy sources. We have found that dispersion curves from active and passive surface wave techniques are generally in good agreement, making the combined use of the two techniques viable. It is not recommended that passive surface wave techniques be applied alone for UBC/IBC site classification investigations. Microtremor techniques do not generally characterize near surface velocity, which may have a significant impact of the average shear wave velocity of the upper 30m or 100ft and so should always be used in conjunction with SASW or MASW. An SASW sounding to a depth of 30m requires at least a 60m linear array. If sufficient space is not available for this, it may be possible to use a 45m triangle array on the site or place a 100-200m long REMI array along an adjacent sidewalk or an "L" array at an adjacent street intersection.



Microtremor Measurements along Sidewalk

Modeling

There are several options for interpreting surface wave dispersion curves, depending on the accuracy required in the shear wave velocity profile. A simple empirical analysis can be done to estimate the average shear wave velocity profile. For greater accuracy, forward modeling of fundamental-mode Rayleigh wave dispersion as well as full stress wave propagation can be performed using several software packages. A formal inversion scheme may also be used. With many of the analytical approaches, background information on the site can be incorporated into the model and the resolution of the final profile may be quantified.

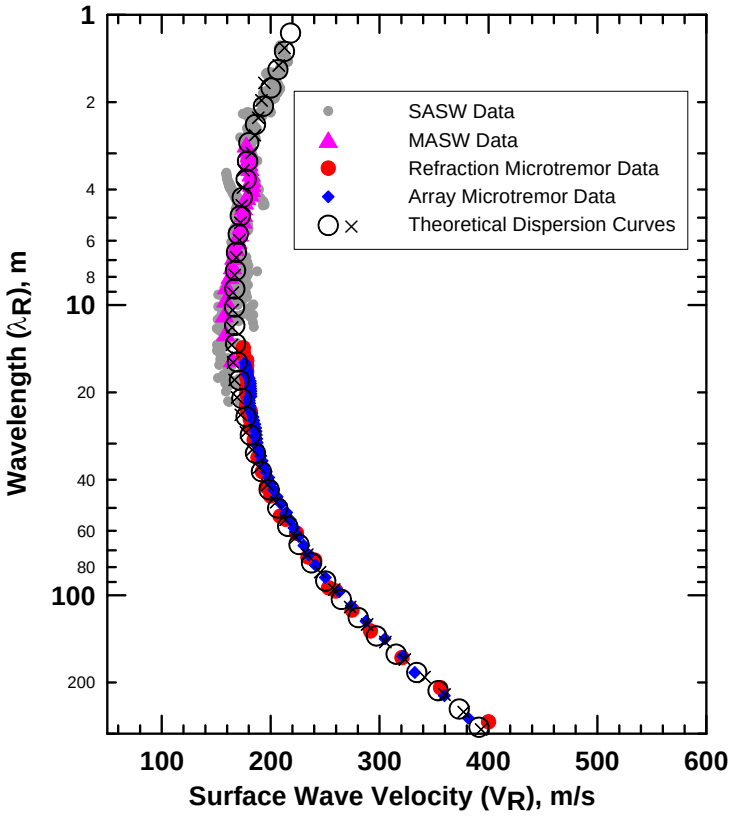
Applications

Active and passive surface wave testing can be used to obtain V_S profiles for:

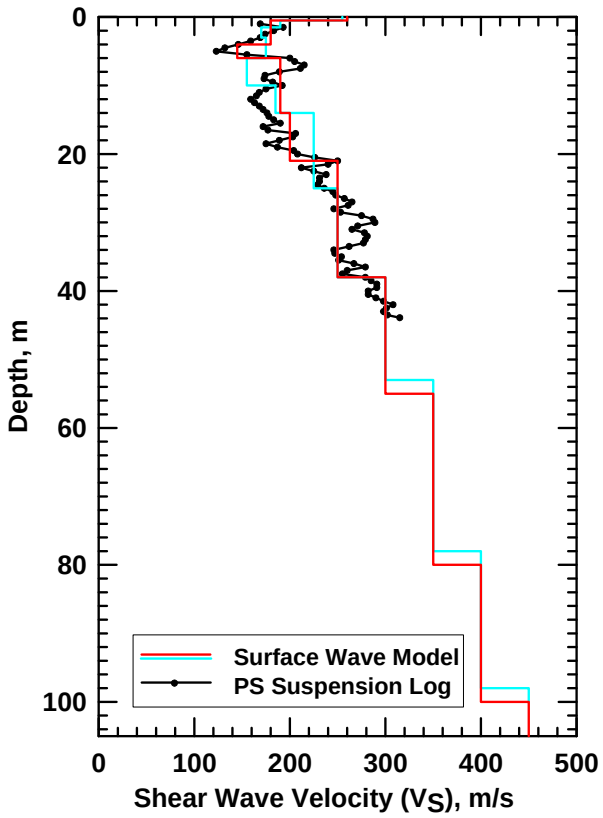
- UBC/IBC site classification for seismic design
- Earthquake site response
- Seismic microzonation
- Liquefaction analysis
- Soil compaction control
- Mapping subsurface stratigraphy
- Locating potentially weak zones in earthen embankments and levees

Case History

The figures below show the surface wave dispersion curves and alternative shear wave velocity models for a site in Los Angeles, California. All of the previous figures illustrating SASW, MASW, array and refraction microtremor techniques were from this site. The dispersion curves from all four methods are shown on the left along with the theoretical dispersion curves for alternative S-wave velocity versus depth models on the right. Conditions at this site were very poor for active surface wave techniques because of the presence of very low velocity hydraulic fill. In fact, with active surface wave techniques it was only possible to image to a depth of about 12.5m with energy sources typically capable of imaging to 30m. There is excellent agreement in the dispersion curves generated from all of the methods over the overlapping wavelength ranges. The minor differences probably result from variable velocity of the hydraulic fill within the sampling volume of the specific methods. Two Vs versus depth models were generated to illustrate the difficulty modeling the highly variable, near surface velocity structure evident in the PS log. The two surface wave models yielded similar values for the average shear-wave velocity of the upper 30m (V_S30), 201 and 202 m/s, illustrating that Vs30 is much more tightly constrained than the actual layer thicknesses and velocities in the models. V_S30 estimated from the PS log (194 m/s) is within 4% of that estimated from the two surface wave models (201 and 202 m/s). The small differences in V_S30 between the two methods may easily result from the different sampling regimes (borehole versus large area) rather than errors in either of the methods.



Field Data and Theoretical Dispersion Curve



VS Model

In contrast to borehole measurements which are point estimates, surface wave testing is a global measurement, that is, a much larger volume of the subsurface is sampled. The resulting profile is representative of the subsurface properties averaged over distances of up to several hundred feet. Although surface wave techniques do not have the layer sensitivity or accuracy (velocity and layer thickness) of borehole techniques; the average velocity over a large depth interval (i.e. the average shear wave velocity of the upper 30m or 100ft) is very well constrained. Because surface wave methods are non-invasive and non-destructive, it is relatively easy to obtain the necessary permits for testing. At sites that are favorable for surface wave propagation, active and passive surface wave techniques allow appreciable cost and time savings.

APPENDIX B









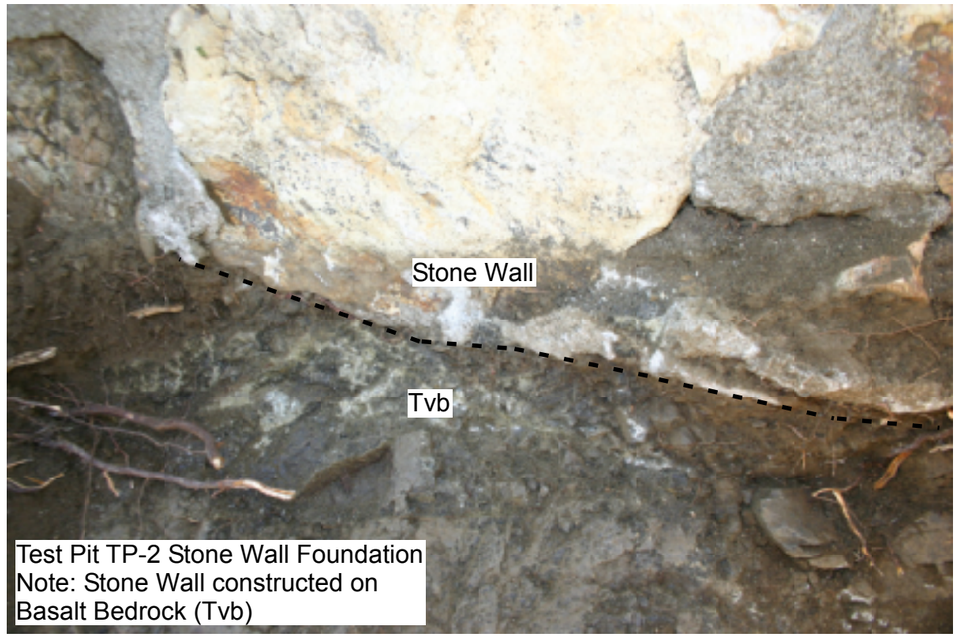
PHOTOS

Ford Theatre
East Cahuenga Blvd.
Hollywood, California

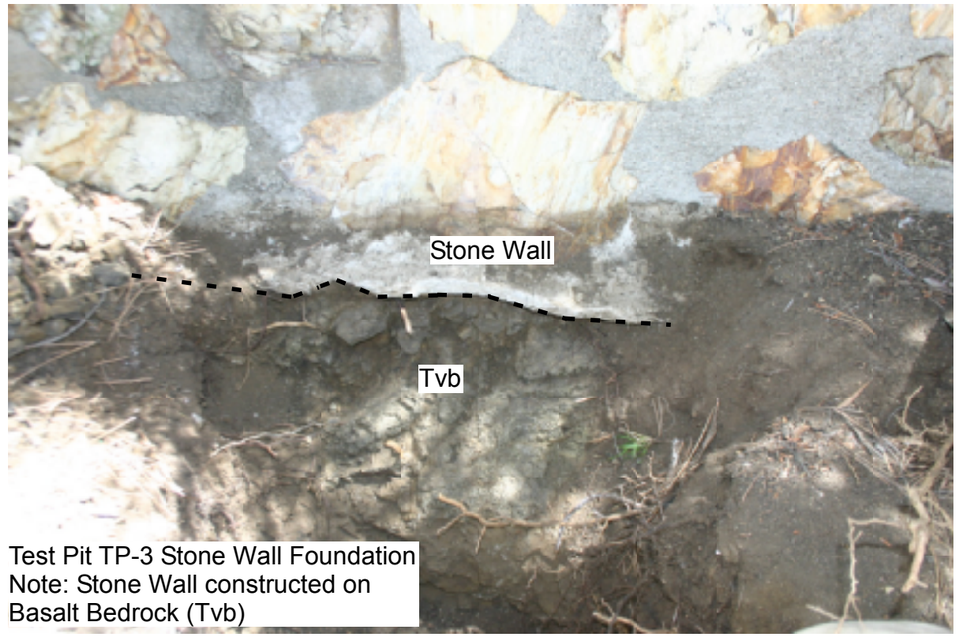
Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

Leighton

Figure No. B-1

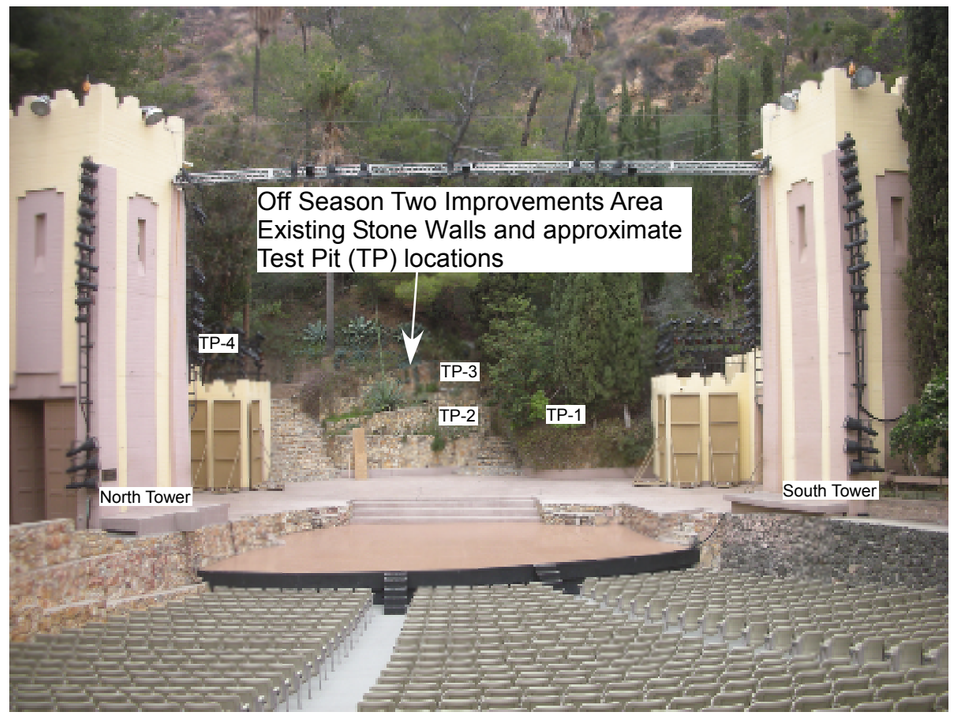


Test Pit TP-2 Stone Wall Foundation
Note: Stone Wall constructed on
Basalt Bedrock (Tvb)



Test Pit TP-3 Stone Wall Foundation
Note: Stone Wall constructed on
Basalt Bedrock (Tvb)





Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt

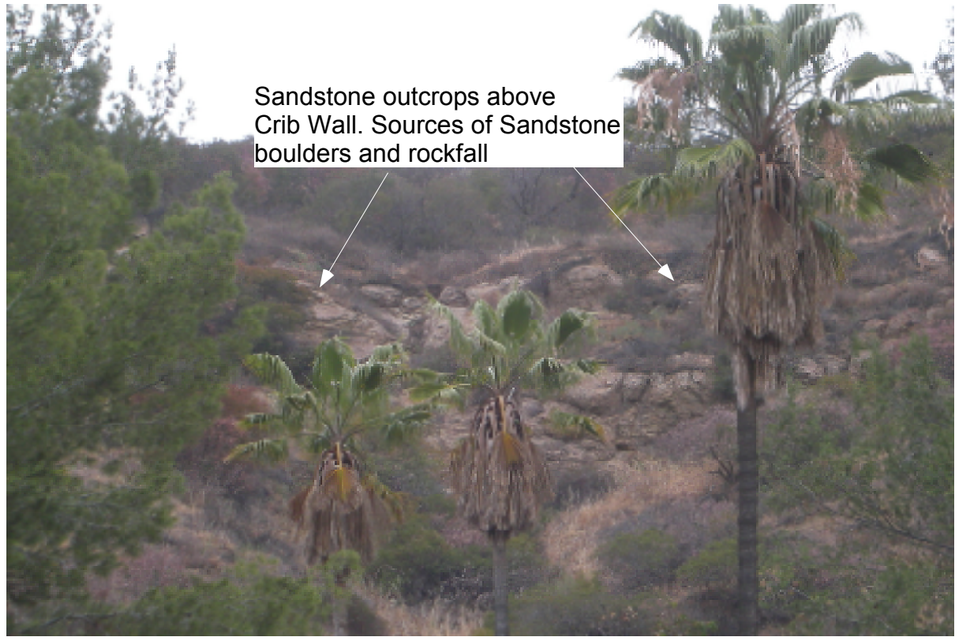
PHOTOS

Ford Theatre
East Cahuenga Blvd.
Hollywood, California

Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

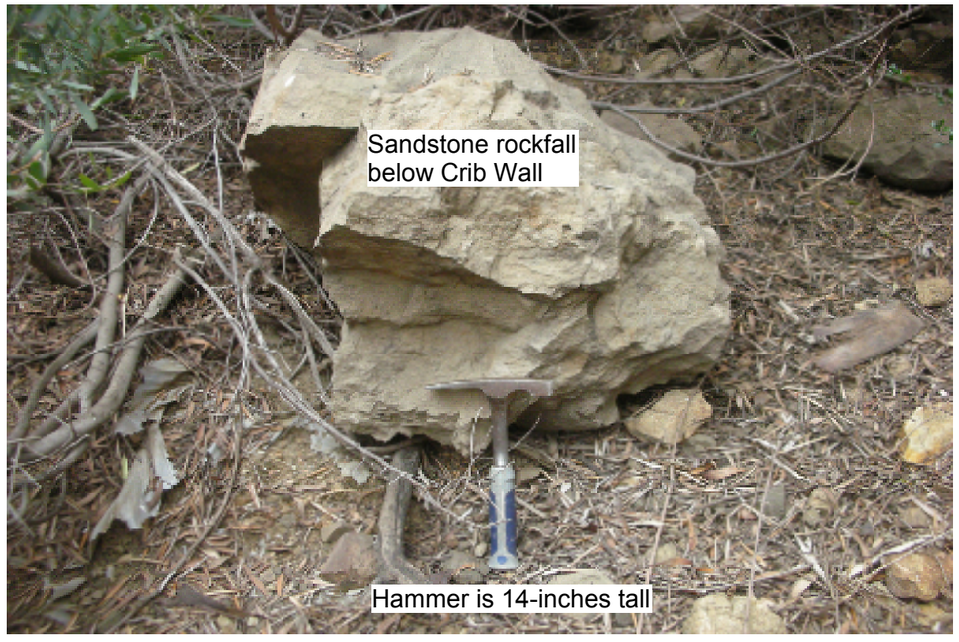
Leighton

Figure No. B-2









Area of Existing Upslope Drainage Improvements and Rockfall Protection Devices. Northeast Portion of Site.

Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt

PHOTOS

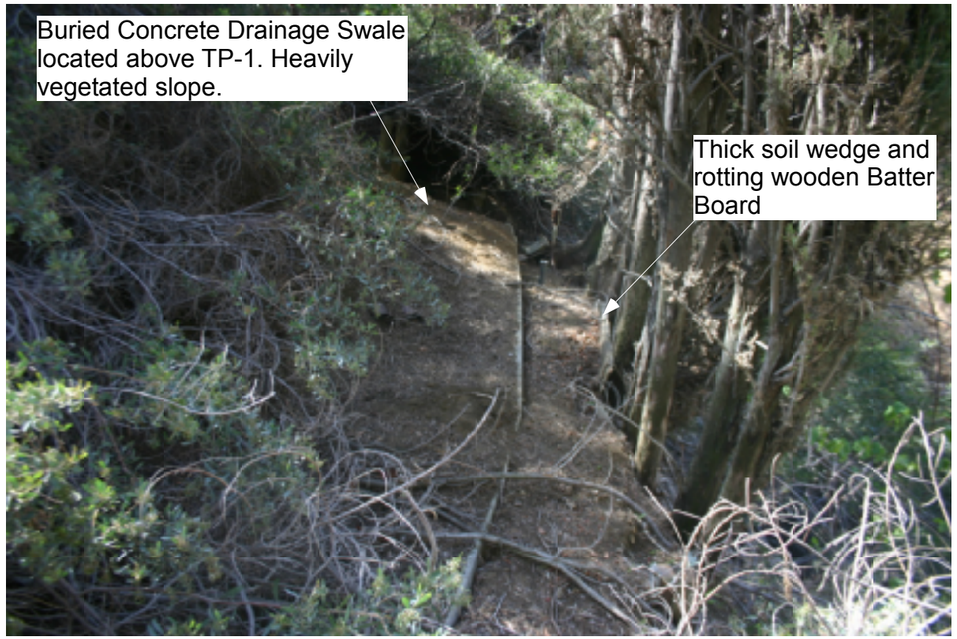
John Anson Ford Theatre
East Cahuenga Blvd.
Hollywood, California

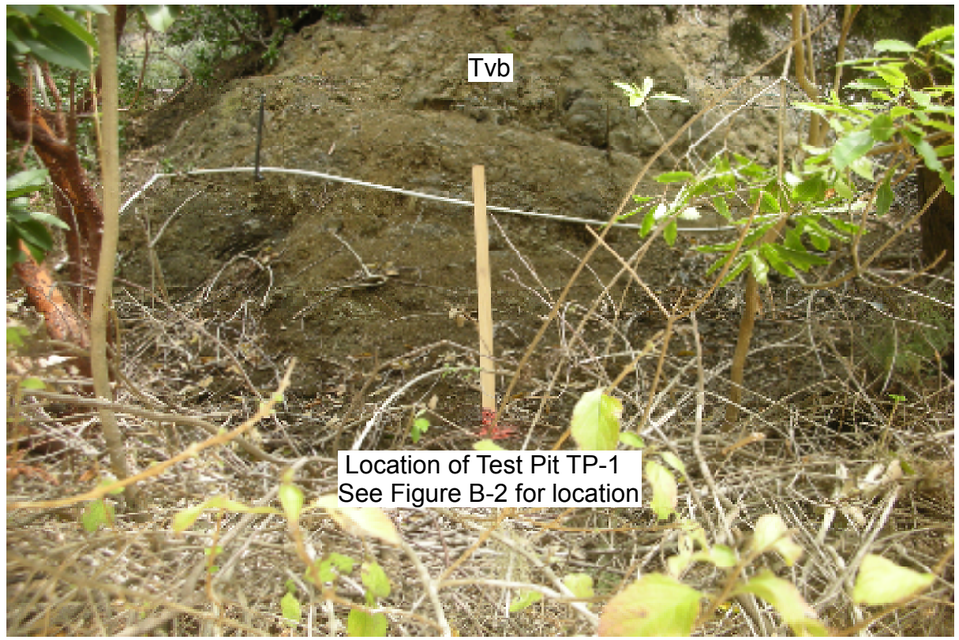
Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

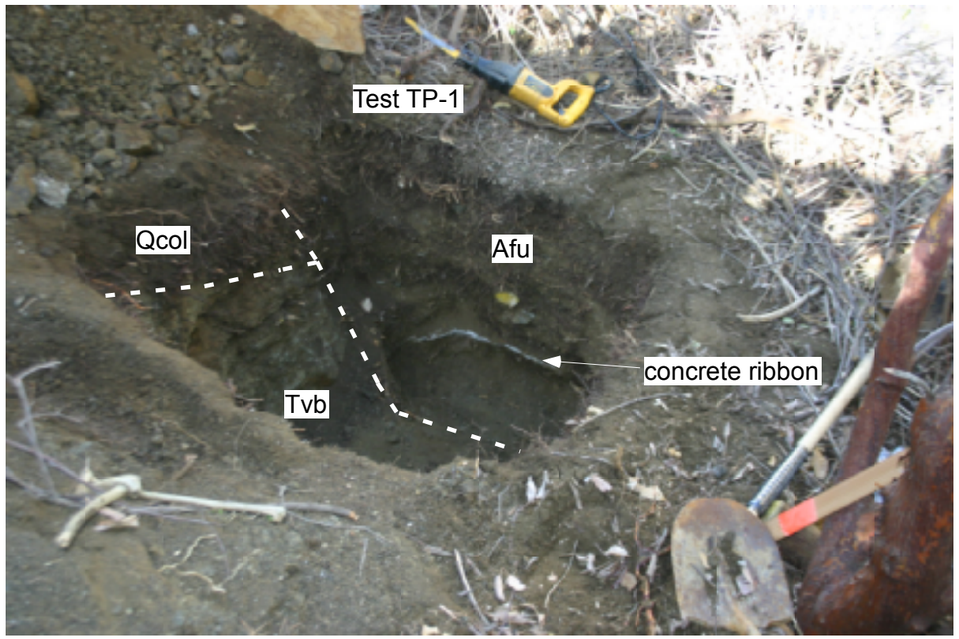
Leighton

Figure No. B-3









Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt

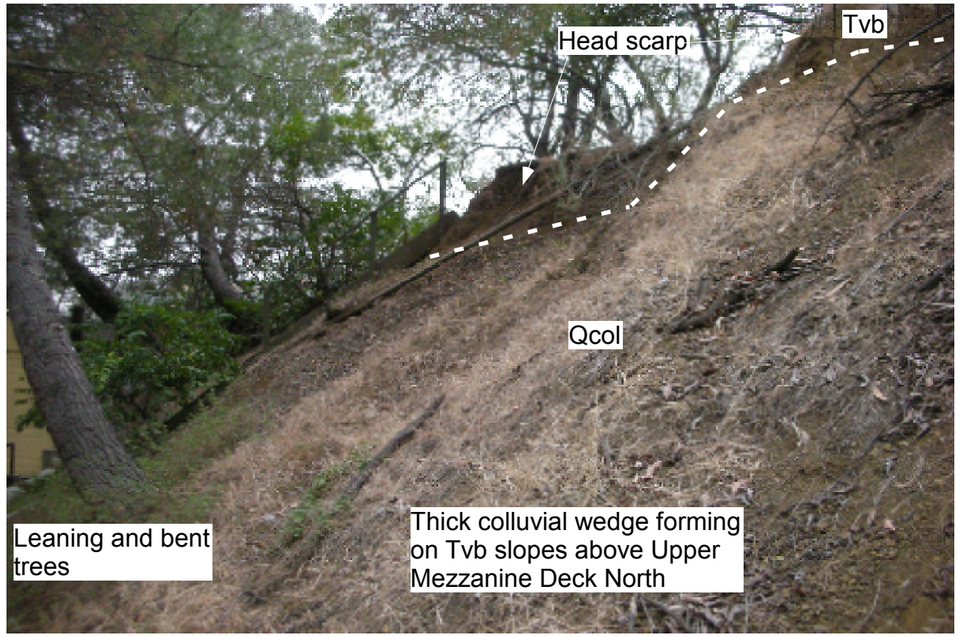
PHOTOS

John Anson Ford Theatre
East Cahuenga Blvd.
Hollywood, California

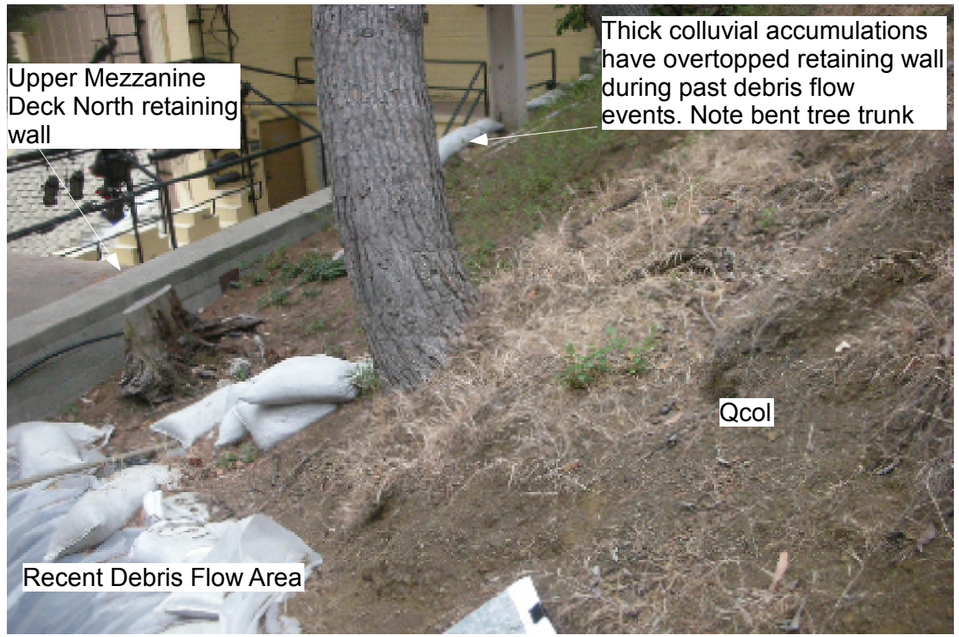
Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

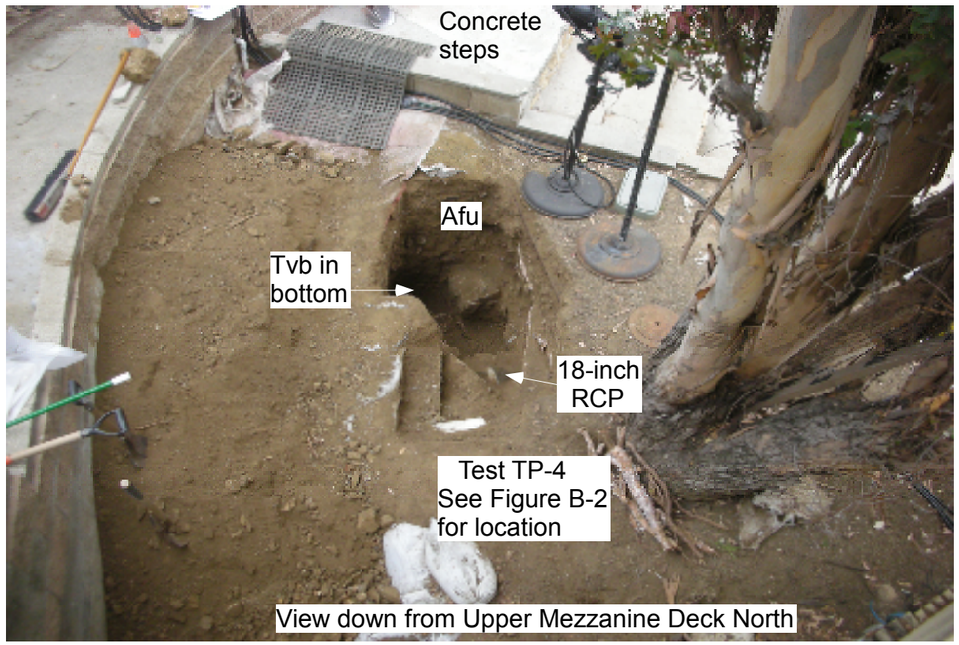
Leighton

Figure No. B-4









Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt

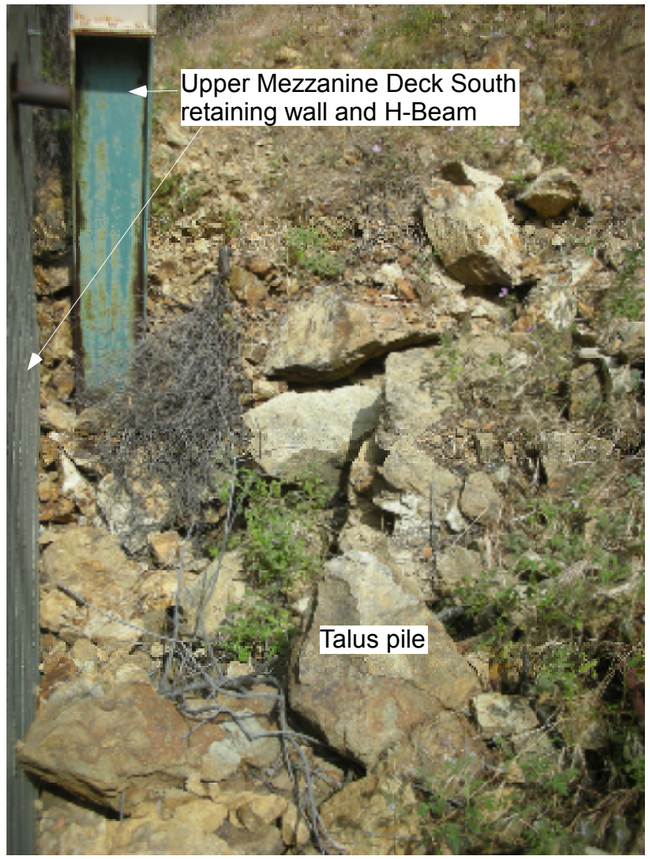
PHOTOS

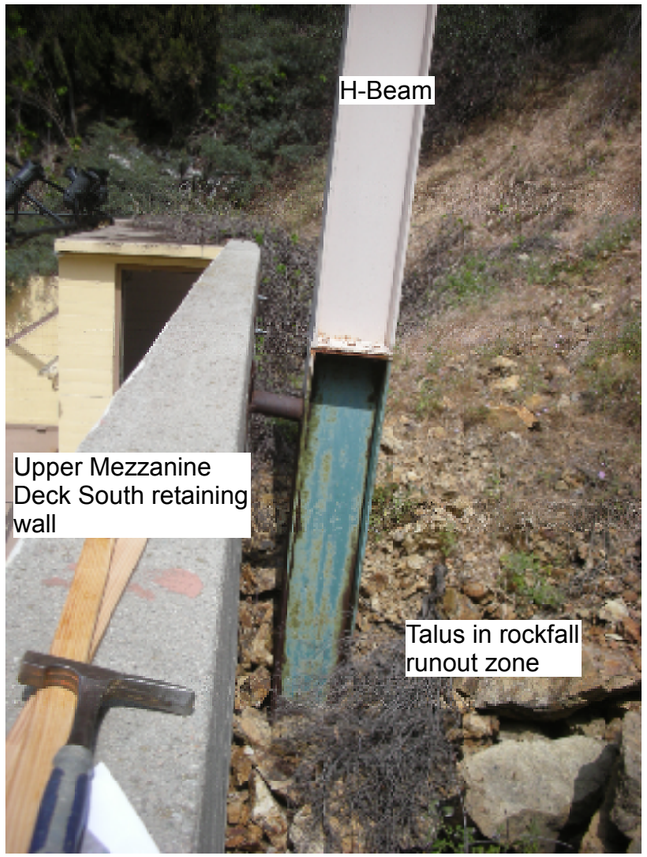
John Anson Ford Theatre
East Cahuenga Blvd.
Hollywood, California

Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

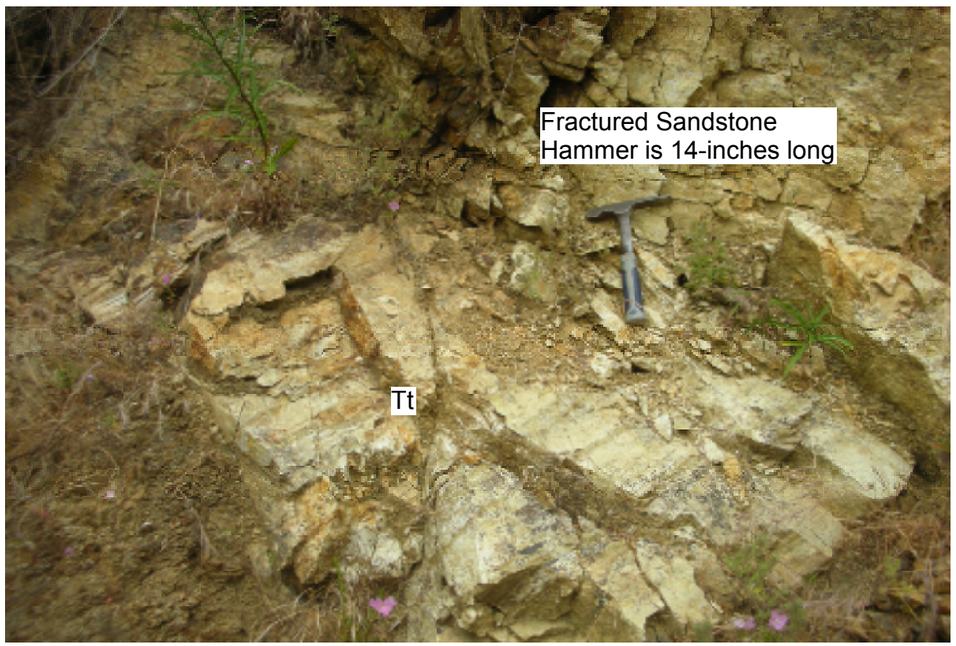
Leighton

Figure No. B-5

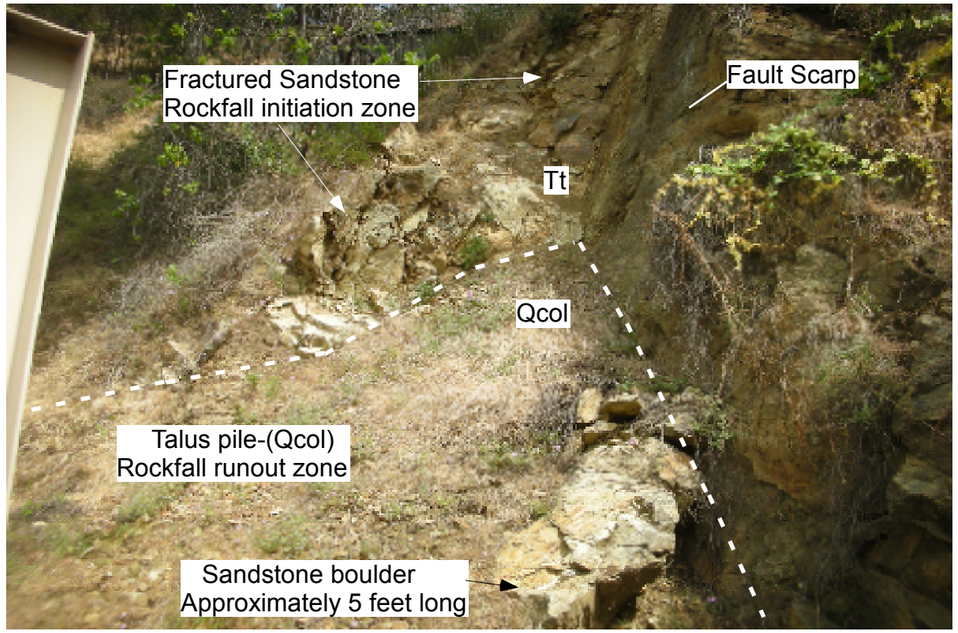








Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt



PHOTOS

John Anson Ford Theatre
East Cahuenga Blvd.
Hollywood, California

Project No.	10296-002
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

Leighton

Figure No. B-6

LOG OF TRENCH: TP-1

Project Name:	Ford Theatre	Logged by:	Joe Roe
Project Number:	603507-002	Elevation:	602 ft (approximate)
Equipment:	Shovels, Electric Chisel Hammer	Location/Grid:	Ford Theatre - SE Corner near stage

GEOLOGIC ATTITUDES	DATE: 14 May, 2013 DESCRIPTION:	GEOLOGIC UNIT	ENGINEERING PROPERTIES: USCS	Sample No.	Moisture (%)	Density (pcf)
Massive pillow basalt structure - No preferred orientation	Afu - Silty SAND to Clayey SAND (SM-SC), with basalt rock fragments, dark brown, slightly moist, fine to coarse angular sand, fine to coarse gravel sized basalt rock fragments	Afu	SM-SC			
	Qcol - 21-inch thick soil and root zone, thin upslope (55°) to 21-inch thick at toe, abundant roots	Qcol	SM-SC with roots			
	Tvb - Pillow Basalt, severely weathered near surface, oxidized orange brown on weathered to black with moderate luster on fresh surfaces, pervasive blocky fracturing, fracture frequency from <1/4-inch to several inches, no preferred orientation, massive	Tvb		BB-1		

GRAPHICAL REPRESENTATION: SCALE: 1" = 5' SURFACE SLOPE: 55° TREND: 3'x3'

Total Depth = Feet
No Ground Water Encountered
Backfilled: 14 May, 2013

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LOG OF TRENCH: TP-2

Project Name:	Ford Theatre	Logged by:	Joe Roe
Project Number:	603507-002	Elevation:	602 ft (approximate)
Equipment:	Hand tools, Electric Chisel	Location/Grid:	Ford Theatre - SE Corner near stage

GEOLOGIC ATTITUDES	DATE: 14 May, 2013 DESCRIPTION:	GEOLOGIC UNIT	ENGINEERING PROPERTIES: USCS	Sample No.	Moisture (%)	Density (pcf)
Massive pillow basalt structure - No preferred orientation	Afu - Silty SAND to Clayey SAND (SM-SC), with basalt rock fragments, dark brown, slightly moist, fine to coarse angular sand, fine to coarse gravel sized basalt rock fragments	Afu	SM-SC			
	Qcol - 21-inch thick soil and root zone, thin upslope (55°) to 21-inch thick at toe, abundant roots	Qcol	SM-SC with roots			
	Tvb - Pillow Basalt, severely weathered near surface, oxidized orange brown on weathered to black with moderate luster on fresh surfaces, pervasive blocky fracturing, fracture frequency from <1/4-inch to several inches, no preferred orientation, massive	Tvb				

GRAPHICAL REPRESENTATION: SCALE: 1" = 5' SURFACE SLOPE: 55° TREND: 3'x3'

Total Depth = Feet
No Ground Water Encountered
Backfilled: 14 May, 2013

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

LOG OF TRENCH: TP-3

Project Name:	Ford Theatre	Logged by:	Joe Roe
Project Number:	603507-002	Elevation:	602 ft (approximate)
Equipment:	Hand tools, Electric Chisel	Location/Grid:	Ford Theatre - SE Corner near stage

GEOLOGIC ATTITUDES	DATE: 14 May, 2013 DESCRIPTION:	GEOLOGIC UNIT	ENGINEERING PROPERTIES: USCS	Sample No.	Moisture (%)	Density (pcf)
Massive pillow basalt structure - No preferred orientation	Afu - Silty SAND to Clayey SAND (SM-SC), with basalt rock fragments, dark brown, slightly moist, fine to coarse angular sand, fine to coarse gravel sized basalt rock fragments	Afu	SM-SC			
	Qcol - 21-inch thick soil and root zone, thin upslope (55°) to 21-inch thick at toe, abundant roots	Qcol	SM-SC with roots			
	Tvb - Pillow Basalt, severely weathered near surface, oxidized orange brown on weathered to black with moderate luster on fresh surfaces, pervasive blocky fracturing, fracture frequency from <1/4-inch to several inches, no preferred orientation, massive	Tvb				

GRAPHICAL REPRESENTATION: SCALE: 1" = 5' SURFACE SLOPE: 55° TREND: 3'x3'

Total Depth = Feet
No Ground Water Encountered
Backfilled: 14 May, 2013

Leighton Consulting, Inc.
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LOG OF TRENCH: TP-4

Project Name:	Ford Theatre	Logged by:	Joe Roe
Project Number:	603507-002	Elevation:	602 ft (approximate)
Equipment:	Electric Chisel	Location/Grid:	Ford Theatre - NE Corner near stage

GEOLOGIC ATTITUDES	DATE: 16 May, 2013 DESCRIPTION:	GEOLOGIC UNIT	ENGINEERING PROPERTIES: USCS	Sample No.	Moisture (%)	Density (pcf)
Massive pillow basalt structure - No preferred orientation	Afu - Silty SAND with gravel to Sandy Silty GRAVEL (SM-GM), brown, dry, fine to coarse sands, fine to coarse angular basalt and sandstone gravel with cobble to boulder sized material and fragments, 6 to 12-inches long dimension, encountered 18-inch diameter SD Pipe, ~3' bgs - concrete slab 3-inches thick with 8-inch thick short concrete slab, many large roots from eucalyptus tree, sandstone is well cemented, very hard, abundant oversize fragments, >3-inches in long dimension Tvb - @5' bgs, Pillow Basalt, severely weathered near surface, oxidized orange brown on weathered to black with moderate luster on fresh surfaces, pervasive blocky fracturing, fracture frequency from <1/4-inch to several inches, no preferred orientation, massive	Afu Qcol Tvb	SMg-GM SM-SC with roots	BB-1		

GRAPHICAL REPRESENTATION: SCALE: 1" = 5' SURFACE SLOPE: 55° TREND: 3'x3'

Total Depth = 5.2 Feet
No Ground Water Encountered
Backfilled: 16 May, 2013

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APPENDIX C

Leighton

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Project Name: Ford Theatre Tested By : G. Berdy Date: 06/14/13

Project No. : 603507-002 Data Input By: J. Ward Date: 06/20/13

Boring No.	TP-1	TP-4		
Sample No.	BB-1 (Basalt)	BB-1 (AF)		
Sample Depth (ft)	0-4	0-5		
Soil Identification:	Olive (SC-SM)g	Dark yellowish brown (SC-SM)g		
Wet Weight of Soil + Container (g)	283.49	257.25		
Dry Weight of Soil + Container (g)	262.36	240.36		
Weight of Container (g)	65.71	57.85		
Moisture Content (%)	10.74	9.25		
Weight of Soaked Soil (g)	100.07	100.12		

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	26	30		
Crucible No.	14	18		
Furnace Temperature (°C)	830	830		
Time In / Time Out	9:00/9:45	9:00/9:45		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	19.3168	19.7411		
Wt. of Crucible (g)	19.3130	19.7395		
Wt. of Residue (g) (A)	0.0038	0.0016		
PPM of Sulfate (A) x 41150	156.37	65.84		
PPM of Sulfate, Dry Weight Basis	**175**	**73**		

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	30	5		
ml of AgNO3 Soln. Used in Titration (C)	1.4	0.8		
PPM of Chloride (C -0.2) * 100 * 30 / B	120	360		
PPM of Chloride, Dry Wt. Basis	**134**	**397**		

pH TEST, DOT California Test 532/643

pH Value	**7.28**	**7.48**		
Temperature °C	21.1	21.0		

Leighton

SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

Project Name:	Ford Theatre		Tested By :	A. Santos	Date: 06/19/13
Project No. :	603507-002		Data Input By:	J. Ward	Date: 06/20/13
Boring No.:	TP-1		Depth (ft.) :	0-4	
Sample No. :	BB-1 (Basalt)				

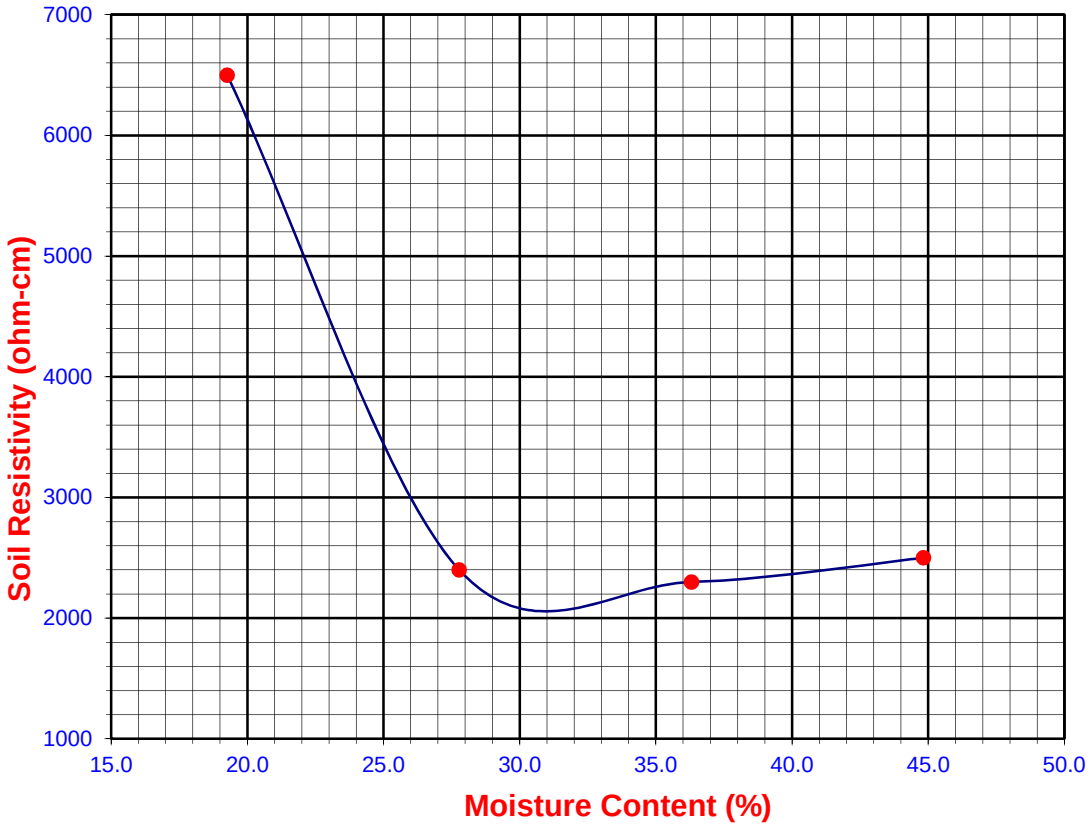
Soil Identification:* Olive (SC-SM)g

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	10	19.26	6500	6500
2	20	27.78	2400	2400
3	30	36.30	2300	2300
4	40	44.82	2500	2500
5				

Moisture Content (%) (MCi)	10.74
Wet Wt. of Soil + Cont. (g)	283.49
Dry Wt. of Soil + Cont. (g)	262.36
Wt. of Container (g)	65.71
Container No.	
Initial Soil Wt. (g) (Wt)	130.00
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
2050	**31.0**	**175**	**134**	**7.28**	**21.1**



Leighton

SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

Project Name:	Ford Theatre		Tested By :	G. Berdy	Date: 06/19/13
Project No. :	603507-002		Data Input By:	J. Ward	Date: 06/20/13
Boring No.:	TP-4		Depth (ft.) :	0-5	
Sample No. :	BB-1 (AF)				

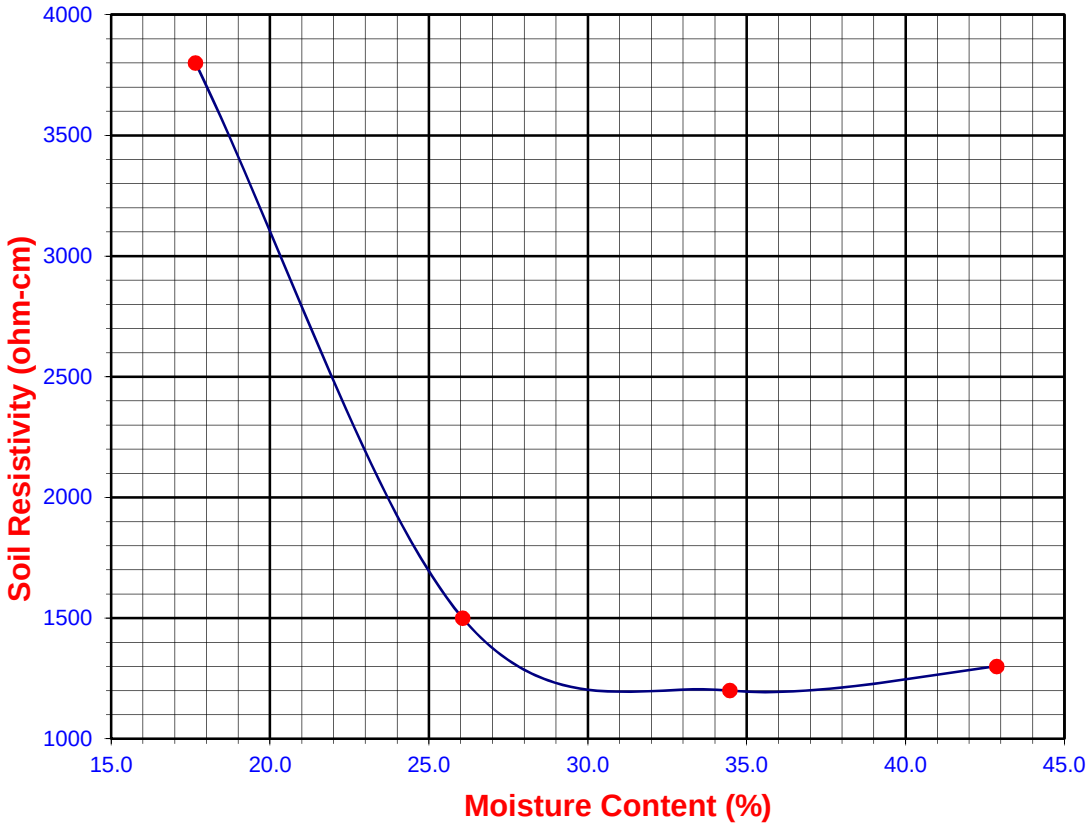
Soil Identification:* Dark yellowish brown (SC-SM)g

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	10	17.66	3800	3800
2	20	26.06	1500	1500
3	30	34.47	1200	1200
4	40	42.87	1300	1300
5				

Moisture Content (%) (MCi)	9.25
Wet Wt. of Soil + Cont. (g)	257.25
Dry Wt. of Soil + Cont. (g)	240.36
Wt. of Container (g)	57.85
Container No.	
Initial Soil Wt. (g) (Wt)	130.00
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
1200	**34.5**	**73**	**397**	**7.48**	**21.0**



Leighton

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name:	Ford Theatre		Tested By:	S. Felter	Date: 07/12/13
Project No. :	10296.001		Checked By:	J. Ward	Date: 07/15/13
Boring No.:	TP-1		Depth (ft.)	0-4	
Sample No. :	BB-1 (Basalt)				
Soil Identification:	Olive silty, clayey sand with gravel (SC-SM)g				

Dry Wt. of Soil + Cont. (g)	1000.00
Wt. of Container No. (g)	0.00
Dry Wt. of Soil (g)	1000.00
Weight Soil Retained on #4 Sieve	0.00
Percent Passing # 4	100.00

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0110
Wt. Comp. Soil + Mold (g)	584.90	435.18
Wt. of Mold (g)	188.30	0.00
Specific Gravity (Assumed)	2.70	2.70
Container No.	O	O
Wet Wt. of Soil + Cont. (g)	798.10	623.48
Dry Wt. of Soil + Cont. (g)	725.50	548.86
Wt. of Container (g)	0.00	188.30
Moisture Content (%)	10.01	20.70
Wet Density (pcf)	119.6	129.8
Dry Density (pcf)	108.7	107.6
Void Ratio	0.550	0.567
Total Porosity	0.355	0.362
Pore Volume (cc)	73.5	75.7
Degree of Saturation (%) [S_{meas}]	**49.1**	98.5

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
07/12/13	10:02	1.0	0	0.2250
07/12/13	10:12	1.0	10	0.2250
Add Distilled Water to the Specimen				
07/12/13	13:23	1.0	191	0.2340
07/15/13	6:30	1.0	4098	0.2360
07/15/13	7:40	1.0	4168	0.2360

Expansion Index (EI_{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	**11**

Leighton

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name:	Ford Theatre	Tested By:	S. Felter	Date:	07/12/13
Project No. :	10296.001	Checked By:	J. Ward	Date:	07/15/13
Boring No.:	TP-4	Depth (ft.)	0-5		
Sample No. :	BB-1 (AF)				
Soil Identification:	Dark yellowish brown silty, clayey sand with gravel (SC-SM)g				

Dry Wt. of Soil + Cont. (g)	1000.00
Wt. of Container No. (g)	0.00
Dry Wt. of Soil (g)	1000.00
Weight Soil Retained on #4 Sieve	0.00
Percent Passing # 4	100.00

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0230
Wt. Comp. Soil + Mold (g)	554.30	431.67
Wt. of Mold (g)	163.70	0.00
Specific Gravity (Assumed)	2.70	2.70
Container No.	O	O
Wet Wt. of Soil + Cont. (g)	787.90	595.37
Dry Wt. of Soil + Cont. (g)	713.10	517.14
Wt. of Container (g)	0.00	163.70
Moisture Content (%)	10.49	22.13
Wet Density (pcf)	117.8	127.3
Dry Density (pcf)	106.6	104.2
Void Ratio	0.581	0.618
Total Porosity	0.367	0.382
Pore Volume (cc)	76.1	80.9
Degree of Saturation (%) [S_{meas}]	**48.8**	96.8

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
07/12/13	10:26	1.0	0	0.1040
07/12/13	10:36	1.0	10	0.1030
Add Distilled Water to the Specimen				
07/12/13	13:24	1.0	168	0.1260
07/15/13	6:27	1.0	4071	0.1270
07/15/13	7:42	1.0	4146	0.1270

Expansion Index (EI_{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	**24**

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Project Name:	Ford Theatre	Tested By :	G. Berdy	Date:	06/14/13
Project No.:	603507-002	Input By :	J. Ward	Date:	06/18/13
Boring No.:	TP-1	Depth (ft.)	0-4		
Sample No. :	BB-1 (Basalt)				
Soil Identification:	Olive silty, clayey sand with gravel (SC-SM)g				

Preparation Method:	X	Moist	
		Dry	
Compaction Method	X	Mechanical Ram	
		Manual Ram	

Scalp Fraction (%)	
#3/4	7.1
#3/8	
#4	

Rammer Weight (lb.) = 10.0

Height of Drop (in.) = 18.0

Mold Volume (ft³) 0.07510

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	7020.0	7458.0	7547.0	7501.0		
Weight of Mold (g)	2741.0	2741.0	2741.0	2741.0		
Net Weight of Soil (g)	4279.0	4717.0	4806.0	4760.0		
Wet Weight of Soil + Cont. (g)	1064.50	950.10	737.80	865.00		
Dry Weight of Soil + Cont. (g)	982.50	858.20	655.40	751.90		
Weight of Container (g)	75.70	77.30	76.90	76.50		
Moisture Content (%)	9.04	11.77	14.24	16.75		
Wet Density (pcf)	125.6	138.5	141.1	139.7		
Dry Density (pcf)	115.2	123.9	123.5	119.7		

Maximum Dry Density (pcf) 124.5

Corrected Dry Density (pcf) 127.0

Optimum Moisture Content (%) 13.0

Corrected Moisture Content (%) 12.0

☐ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☐ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

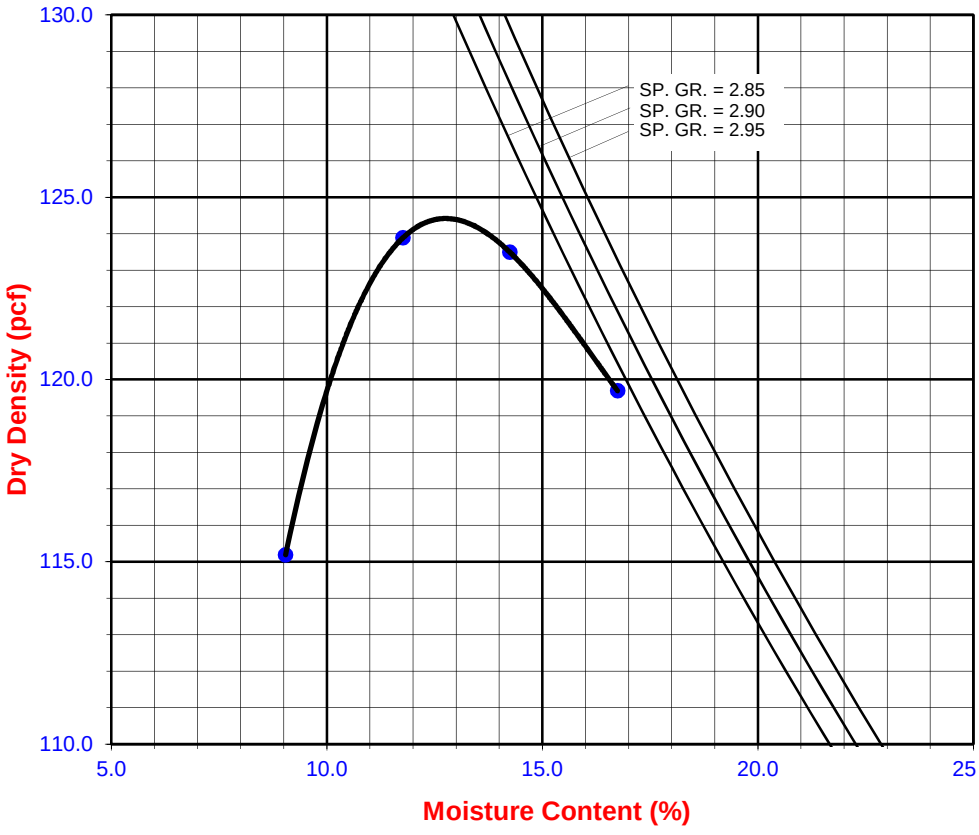
☒ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



MX TP-1, BB-1 (Basalt) @ 0-4

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	Ford Theatre	Tested By :	G. Berdy	Date:	06/14/13
Project No.:	603507-002	Input By :	J. Ward	Date:	06/18/13
Boring No.:	TP-4	Depth (ft.)	0-5		
Sample No. :	BB-1 (AF)				
Soil Identification:	Dark yellowish brown silty, clayey sand with gravel (SC-SM)g				

Note: Correction for oversize material includes only material passing the 3-in sieve

Preparation Method:	X	Moist	Scalp Fraction (%)		Rammer Weight (lb.) = 10.0
		Dry	#3/4	12.0	Height of Drop (in.) = 18.0
Compaction Method	X	Mechanical Ram	#3/8		
		Manual Ram	#4		Mold Volume (ft³) 0.07510

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	7050.0	7378.0	7512.0	7327.0		
Weight of Mold (g)	2741.0	2741.0	2741.0	2741.0		
Net Weight of Soil (g)	4309.0	4637.0	4771.0	4586.0		
Wet Weight of Soil + Cont. (g)	914.40	909.00	847.30	912.50		
Dry Weight of Soil + Cont. (g)	847.80	824.60	752.80	792.00		
Weight of Container (g)	75.30	74.30	75.20	75.50		
Moisture Content (%)	8.62	11.25	13.95	16.82		
Wet Density (pcf)	126.5	136.1	140.1	134.6		
Dry Density (pcf)	116.5	122.4	122.9	115.2		

Maximum Dry Density (pcf)	**123.5**	**Optimum Moisture Content (%)**	**13.0**
Corrected Dry Density (pcf)	**127.5**	**Corrected Moisture Content (%)**	**11.5**

☐ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☐ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

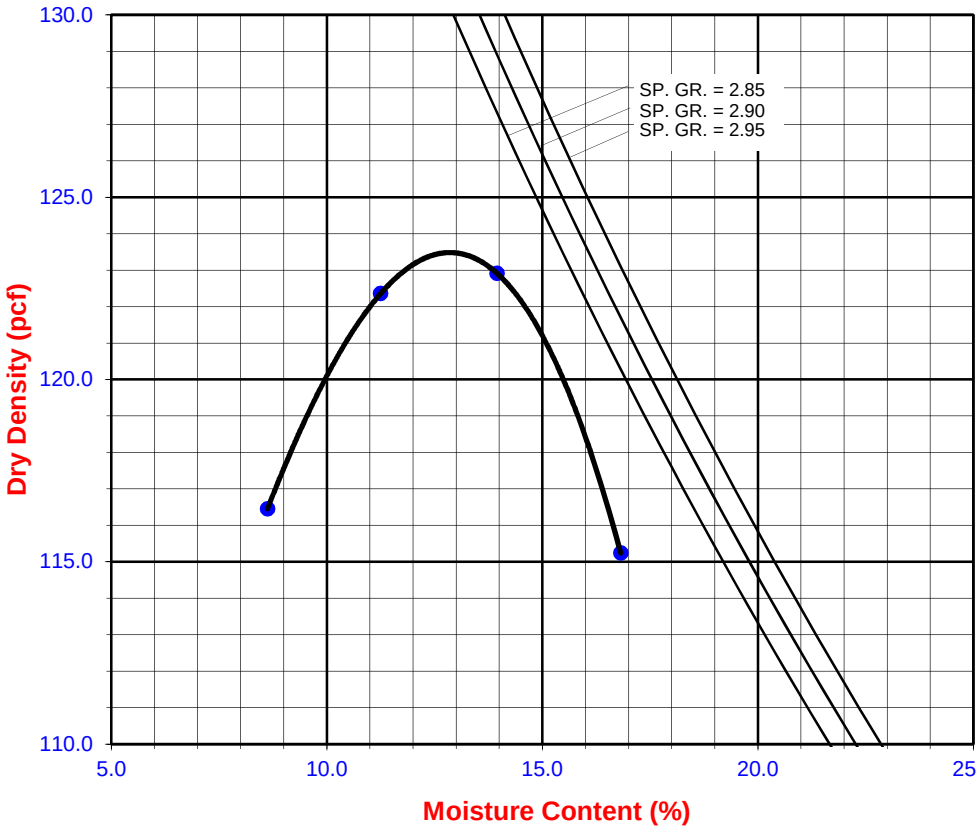
☒ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



APPENDIX D

Section B-B': Global Stability Analysis - Circular

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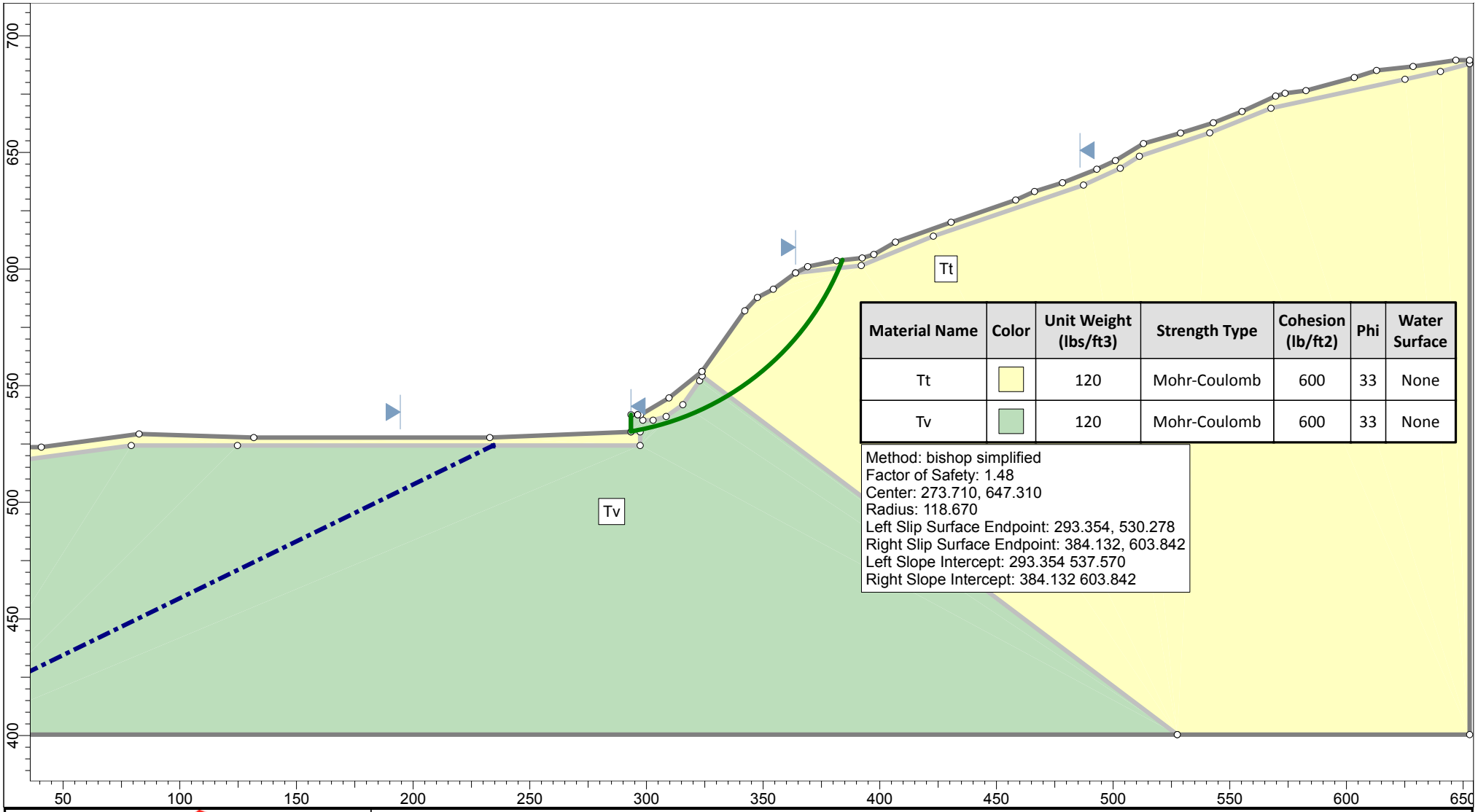

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None

Method: bishop simplified
Factor of Safety: 1.48
Center: 273.710, 647.310
Radius: 118.670
Left Slip Surface Endpoint: 293.354, 530.278
Right Slip Surface Endpoint: 384.132, 603.842
Left Slope Intercept: 293.354 537.570
Right Slope Intercept: 384.132 603.842

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: FORD THEATRE			
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Static		

Section B-B': Global Stability Analysis - Non Circular

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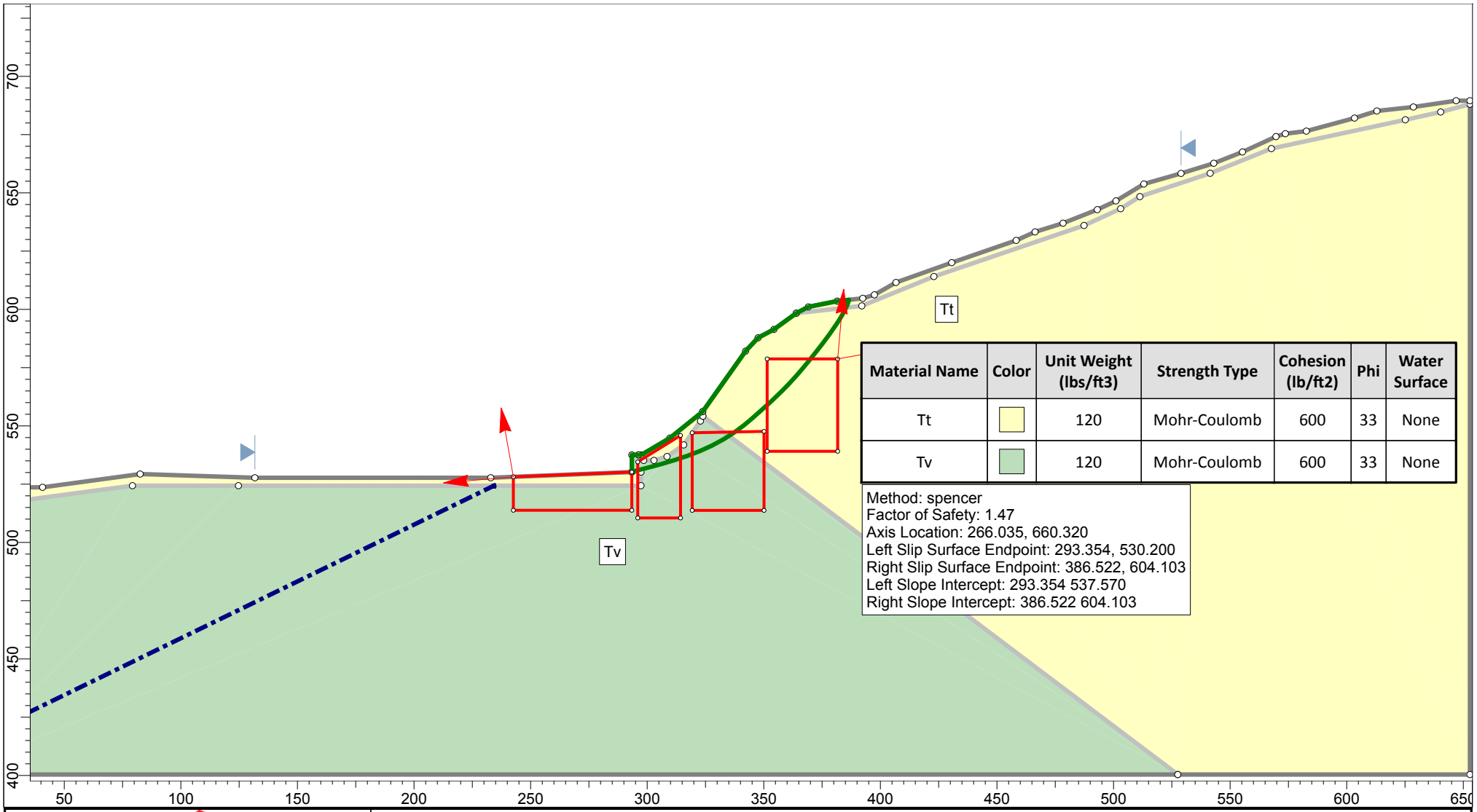

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None

Method: spencer
Factor of Safety: 1.47
Axis Location: 266.035, 660.320
Left Slip Surface Endpoint: 293.354, 530.200
Right Slip Surface Endpoint: 386.522, 604.103
Left Slope Intercept: 293.354 537.570
Right Slope Intercept: 386.522 604.103

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: FORD THEATRE			
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Static		

Section B-B': Global Stability Analysis - Non Circular

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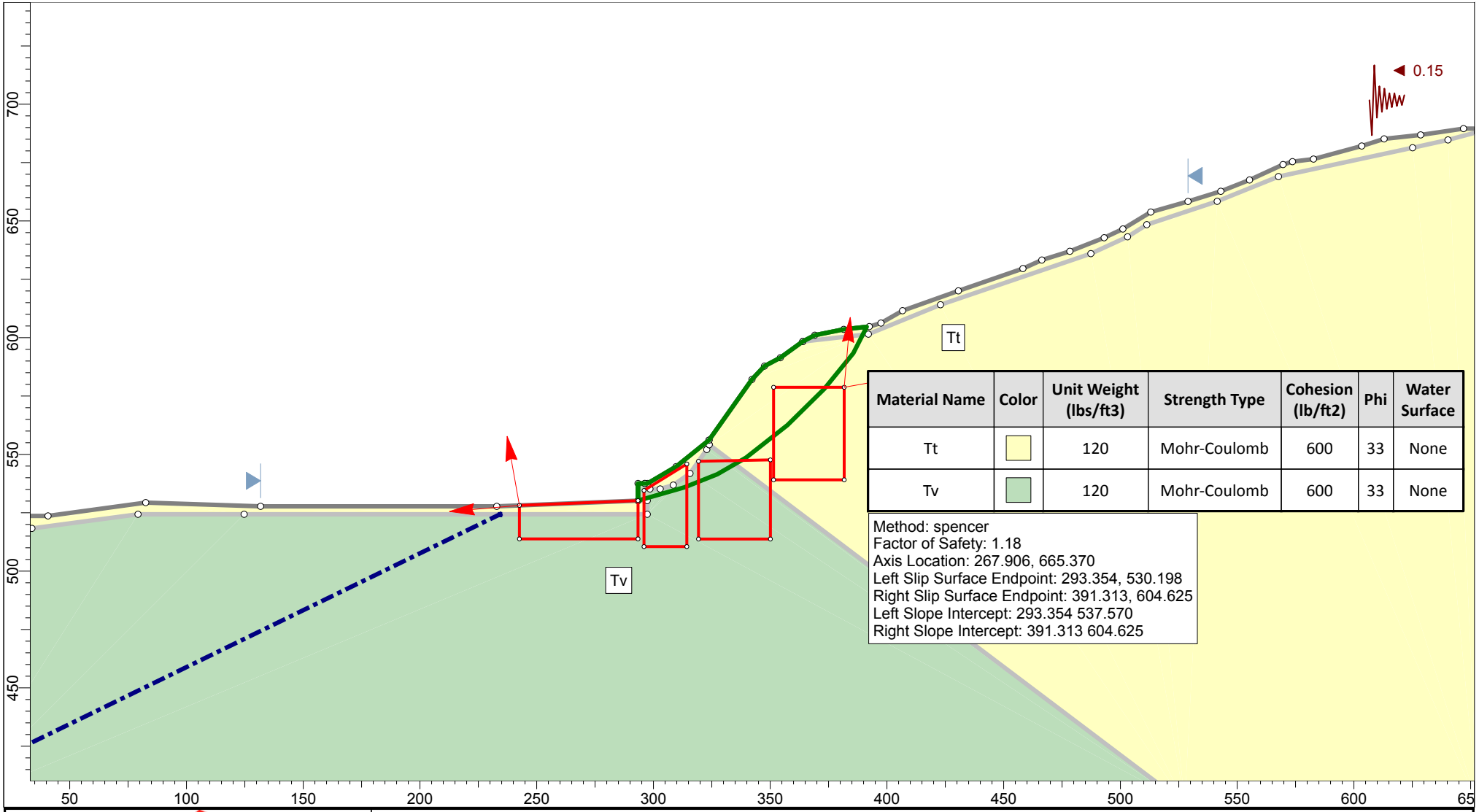

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None

Method: spencer
Factor of Safety: 1.18
Axis Location: 267.906, 665.370
Left Slip Surface Endpoint: 293.354, 530.198
Right Slip Surface Endpoint: 391.313, 604.625
Left Slope Intercept: 293.354 537.570
Right Slope Intercept: 391.313 604.625

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: FORD THEATRE			
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Pseudostatic		

Section B-B': Global Stability Analysis

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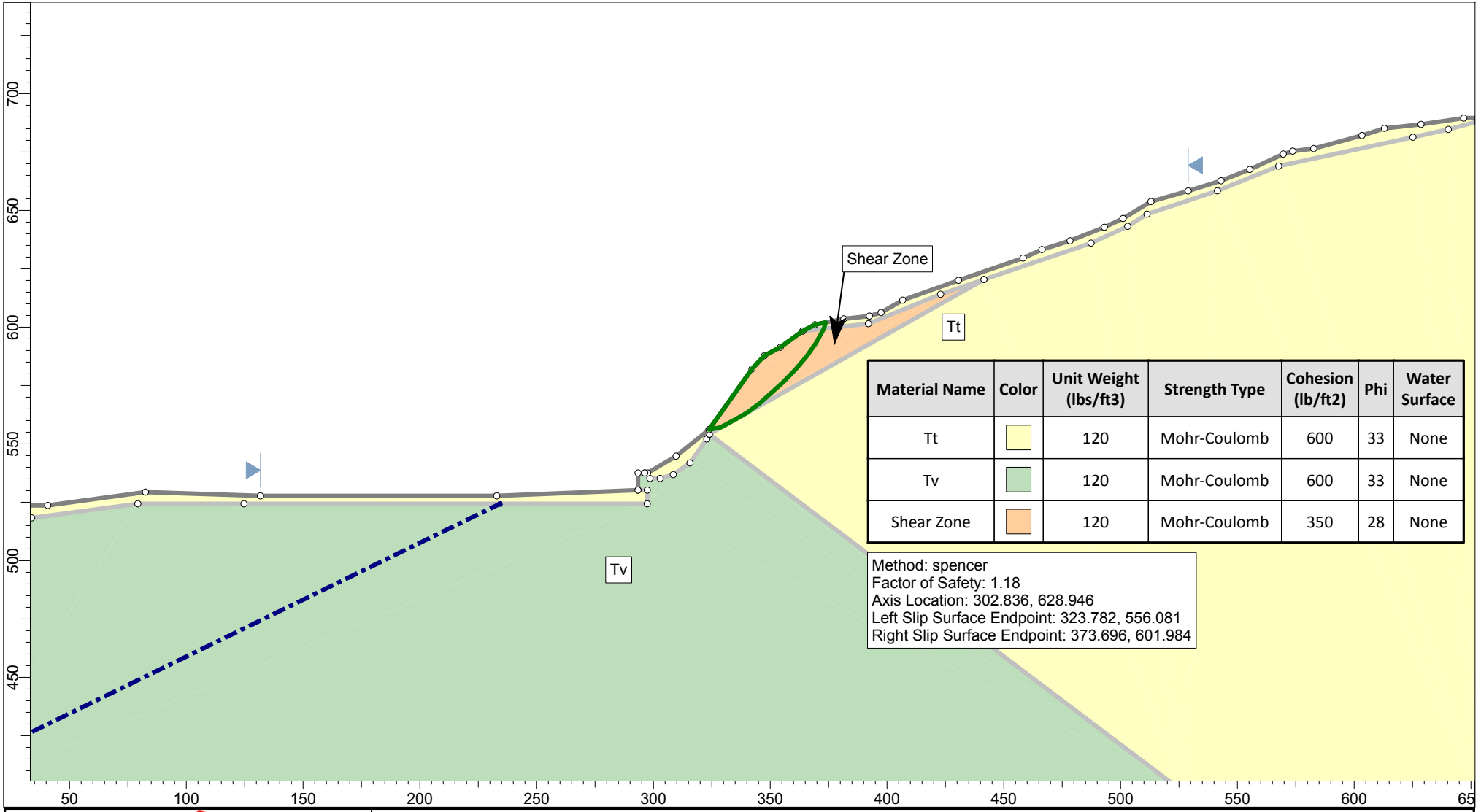

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None
Shear Zone		120	Mohr-Coulomb	350	28	None

Method: spencer
Factor of Safety: 1.18
Axis Location: 302.836, 628.946
Left Slip Surface Endpoint: 323.782, 556.081
Right Slip Surface Endpoint: 373.696, 601.984

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	FORD THEATRE		
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Static		

Section B-B': Global Stability Analysis

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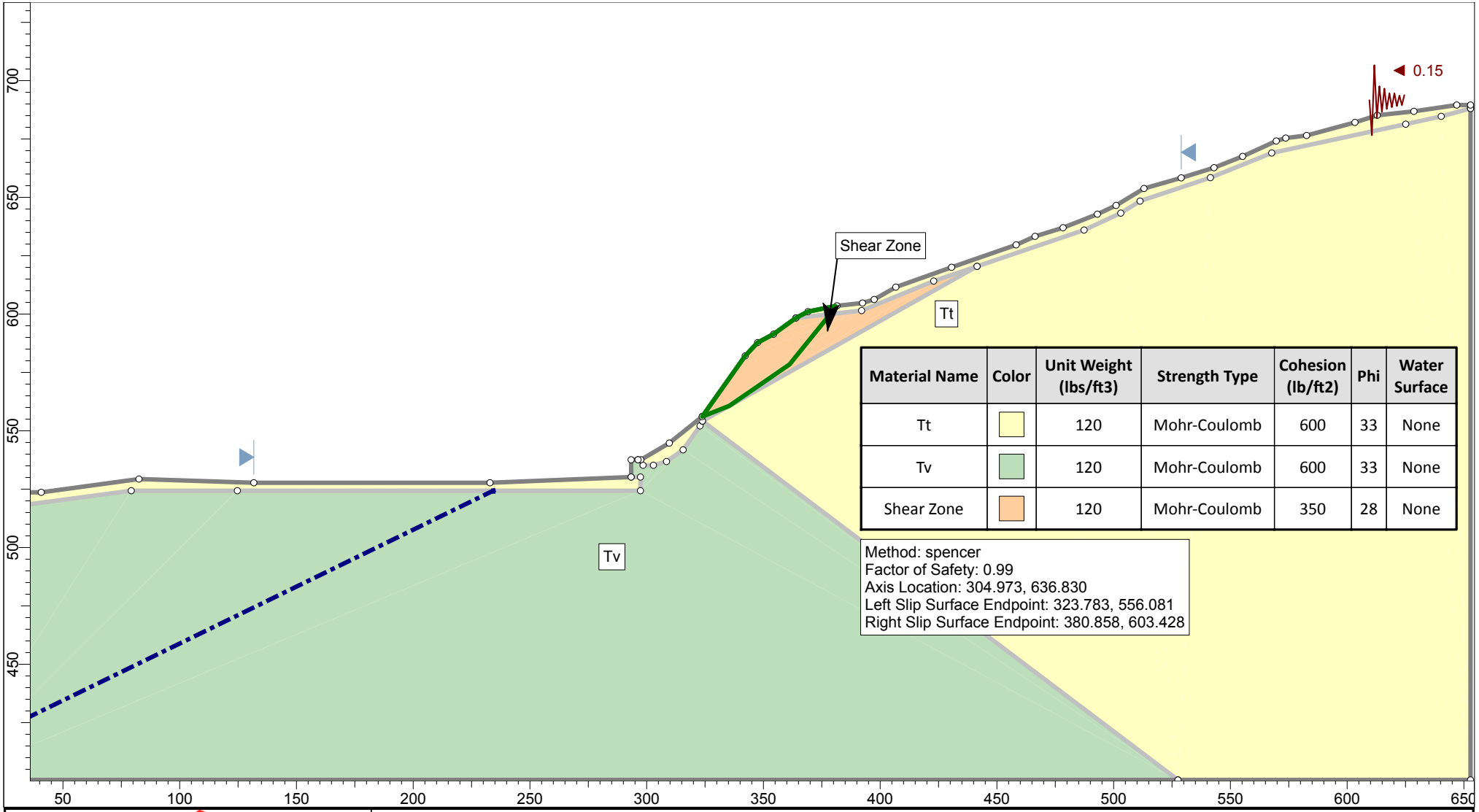

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None
Shear Zone		120	Mohr-Coulomb	350	28	None

Method: spencer
Factor of Safety: 0.99
Axis Location: 304.973, 636.830
Left Slip Surface Endpoint: 323.783, 556.081
Right Slip Surface Endpoint: 380.858, 603.428

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: FORD THEATRE			
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Pseudostatic		

APPENDIX E

APPENDIX E

LEIGHTON CONSULTING, INC.
EARTHWORK AND GRADING GUIDE SPECIFICATIONS

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E-1.0 GENERAL

E-1.1 Intent

These Earthwork and Grading Guide Specifications are for grading and earthwork shown on the current, approved grading plan(s) and/or indicated in the Leighton Consulting, Inc. geotechnical report(s). These Guide Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the project-specific recommendations in the geotechnical report shall supersede these Guide Specifications. Leighton Consulting, Inc. shall provide geotechnical observation and testing during earthwork and grading. Based on these observations and tests, Leighton Consulting, Inc. may provide new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

E-1.2 Role of Leighton Consulting, Inc.

Prior to commencement of earthwork and grading, Leighton Consulting, Inc. shall review the "work plan" prepared by the earthwork contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing. During earthwork and grading, Leighton Consulting, Inc. shall observe, map, and document subsurface exposures to verify geotechnical design assumptions. If observed conditions are found to be significantly different than the interpreted assumptions during the design phase, Leighton Consulting, Inc. shall inform the owner, recommend appropriate changes in design to accommodate these observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include (1) natural ground after clearing to receiving fill but before fill is placed, (2) bottoms of all "remedial removal" areas, (3) all key bottoms, and (4) benches made on sloping ground to receive fill.

Leighton Consulting, Inc. shall observe moisture-conditioning and processing of the subgrade and fill materials, and perform relative compaction testing of fill to determine the attained relative compaction. Leighton Consulting, Inc. shall provide test results to the owner and the Contractor on a routine and frequent basis.

E-1.3 The Earthwork Contractor

The earthwork contractor (Contractor) shall be qualified, experienced and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Guide

Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing grading and backfilling in accordance with the current, approved plans and specifications.

For projects in excess of 10,000 cubic-yards of earthwork, the Contractor shall prepare and submit to the owner and Leighton Consulting, Inc. a work plan that indicates the sequence of earthwork grading, the number of "spreads" of work and the estimated quantities of daily earthwork contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and Leighton Consulting, Inc. of changes in work schedules and updates to the work plan at least one working day in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that Leighton Consulting, Inc. is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish earthwork and grading in accordance with the applicable grading codes and agency ordinances, these Guide Specifications, and recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of Leighton Consulting, Inc., unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, Leighton Consulting, Inc. shall reject the work and may recommend to the owner that earthwork and grading be stopped until these unsatisfactory condition(s) are rectified.

E-2.0 PREPARATION OF AREAS TO BE FILLED

E-2.1 Clearing and Grubbing

Vegetation, such as brush, grass, roots and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies and Leighton Consulting, Inc.. Care should be taken not to encroach upon or otherwise damage native and/or historic trees designated by the Owner or appropriate agencies to remain. Pavements, flatwork or other construction should not extend under the “drip line” of designated trees to remain.

Leighton Consulting, Inc. shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 2 percent of organic materials (by dry weight: ASTM D 2974-00). No fill lift shall contain more than 5 percent of organic matter. Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area. As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed.

E-2.2 Processing

Existing ground that has been declared satisfactory for support of fill, by Leighton Consulting, Inc., shall be scarified to a minimum depth of 6 inches (15 cm). Existing ground that is not satisfactory shall be overexcavated as specified in the following Section E-2.3. Scarification shall continue until soils are broken down and free of large clay lumps or clods and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

E-2.3 Overexcavation

In addition to removals and overexcavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be overexcavated to competent ground as evaluated by Leighton Consulting, Inc. during grading. All undocumented fill soils under proposed structure footprints should be excavated

E-2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), (>20 percent grade) the ground shall be stepped or benched. The lowest bench or key shall be a minimum of 15 feet (4.5 m) wide and at least 2 feet (0.6 m) deep, into competent material as evaluated by Leighton Consulting, Inc.. Other benches shall be excavated a minimum height of 4 feet (1.2 m) into competent material or as otherwise recommended by Leighton Consulting, Inc.. Fill placed on ground sloping flatter than 5:1 (horizontal to vertical units), (<20 percent grade) shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.

E-2.5 Evaluation/Acceptance of Fill Areas

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by Leighton Consulting, Inc. as suitable to receive fill. The Contractor shall obtain a written acceptance (*Daily Field Report*) from Leighton Consulting, Inc. prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

E-3.0 FILL MATERIAL

E-3.1 Fill Quality

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by Leighton Consulting, Inc. prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to Leighton Consulting, Inc. or mixed with other soils to achieve satisfactory fill material.

E-3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 6 inches (15 cm), shall not be buried or placed in fill unless location, materials and placement methods are specifically accepted by Leighton Consulting, Inc.. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 feet (3 m) measured vertically from finish grade, or within 2 feet (0.61 m) of future utilities or underground construction.

E-3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of Section E-3.1, and be free of hazardous materials ("contaminants") and rock larger than 3-inches (8 cm) in largest dimension. All import soils shall have an Expansion Index (EI) of 20 or less and a sulfate content no greater than ($\leq$) 500 parts-per-million (ppm). A representative sample of a potential import source shall be given to Leighton Consulting, Inc. at least two full working days before importing begins, so that suitability of this import material can be determined and appropriate tests performed.

E-4.0 FILL PLACEMENT AND COMPACTION

E-4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill, as described in Section E-2.0, above, in near-horizontal layers not exceeding 8 inches (20 cm) in loose thickness. Leighton Consulting, Inc. may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers, and only if the building officials with the appropriate jurisdiction approve. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

E-4.2 Fill Moisture Conditioning

Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture-content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM) Test Method D 1557-02^{e1}.

E-4.3 Compaction of Fill

After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density as determined by ASTM Test Method D 1557-02$^{\varepsilon 1}$. For fills thicker than 15 feet (4.5 m), the portion of the fill deeper than 15 feet below proposed finish grade shall be compacted to 95 percent of the ASTM D 1557-02$^{\varepsilon 1}$ laboratory maximum density. Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

E-4.4 Compaction of Fill Slopes

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet (1 to 1.2 m) in fill elevation, or by other methods producing satisfactory results acceptable to Leighton Consulting, Inc.. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of the ASTM D 1557-02$^{\varepsilon 1}$ laboratory maximum density.

E-4.5 Compaction Testing

Field-tests for moisture content and relative compaction of the fill soils shall be performed by Leighton Consulting, Inc.. Location and frequency of tests shall be at our field representative(s) discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

E-4.6 Compaction Test Locations

Leighton Consulting, Inc. shall document the approximate elevation and horizontal coordinates of each density test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that Leighton Consulting, Inc. can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than 5 feet apart from potential test locations shall be provided.

E-5.0 EXCAVATION

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by Leighton Consulting, Inc. during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by Leighton Consulting, Inc. based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by Leighton Consulting, Inc. prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by Leighton Consulting, Inc.

E-6.0 TRENCH BACKFILLS

E-6.1 Safety

The Contractor shall follow all OSHA and Cal/OSHA requirements for safety of trench excavations. Work should be performed in accordance with Article 6 of the *California Construction Safety Orders*, 2003 Edition or more current.

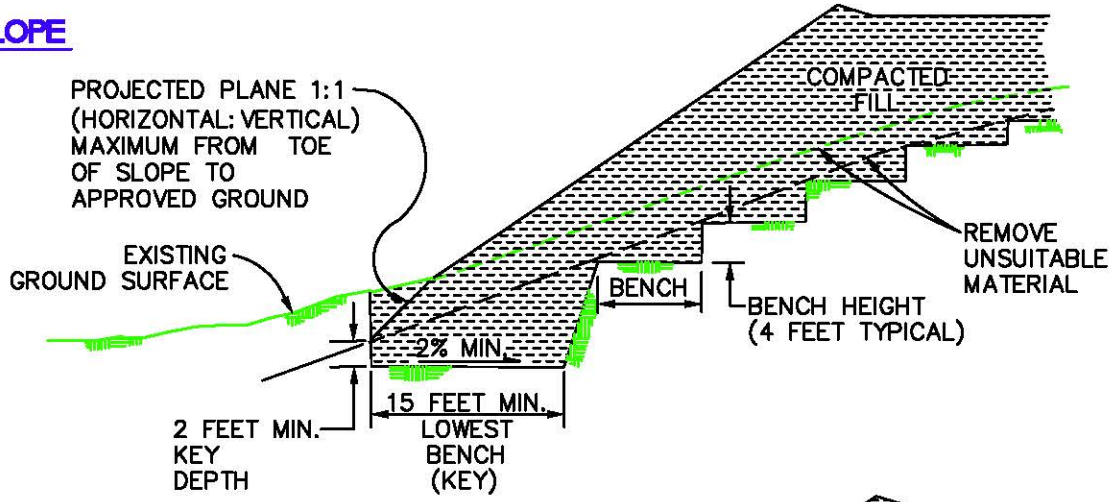
E-6.2 Bedding and Backfill

All bedding and backfill of utility trenches shall be performed in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). Bedding shall be placed to 1-foot (0.3 m) over the top of the conduit, and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of relative compaction (ASTM D 1557-02$^{\varepsilon 1}$) from 1 foot (0.3 m) above the top of the conduit to the surface. Jetting of the bedding around the conduits shall be observed by Leighton Consulting, Inc. and backfill above the pipe zone (bedding) shall be observed and tested by Leighton Consulting, Inc..

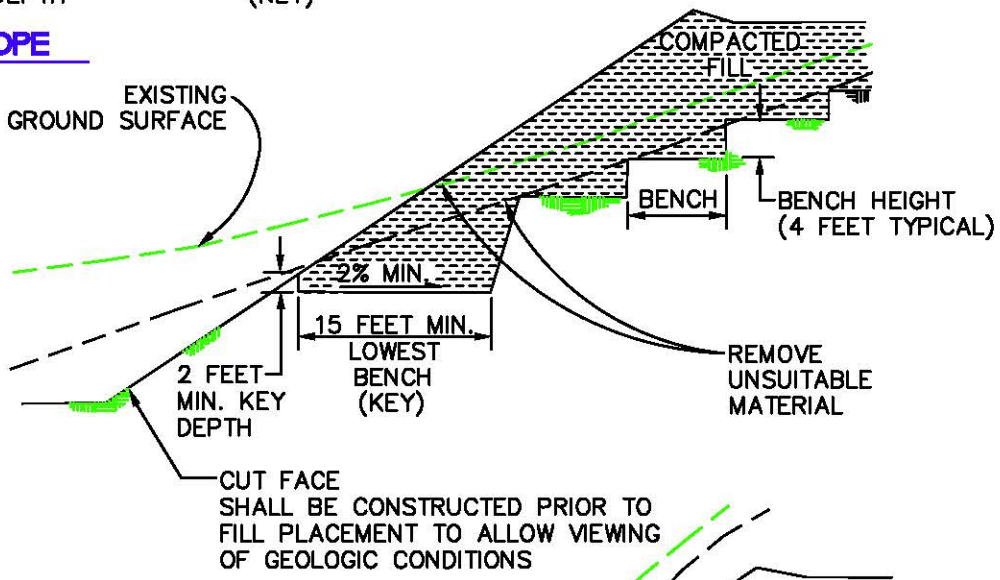
E-6.3 Lift Thickness

Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to Leighton Consulting, Inc. that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method, and only if the building officials with the appropriate jurisdiction approve.

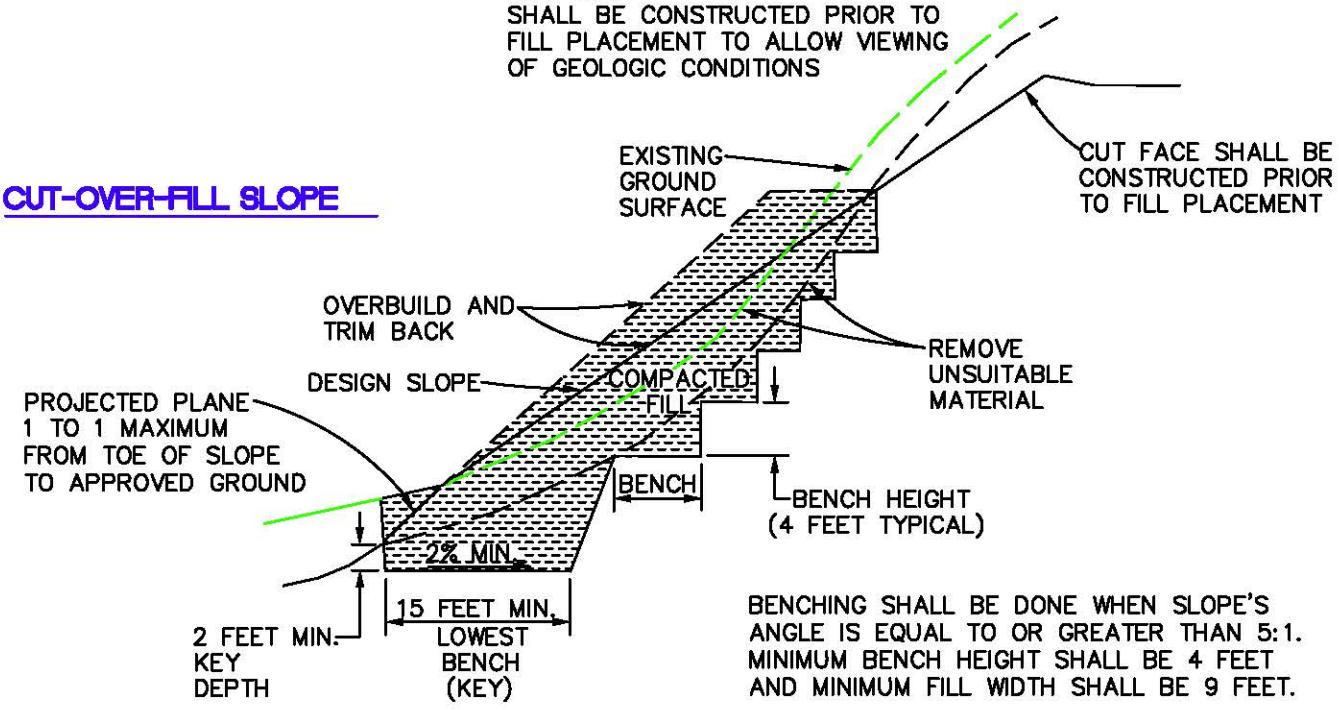
FILL SLOPE



FILL-OVER-CUT SLOPE

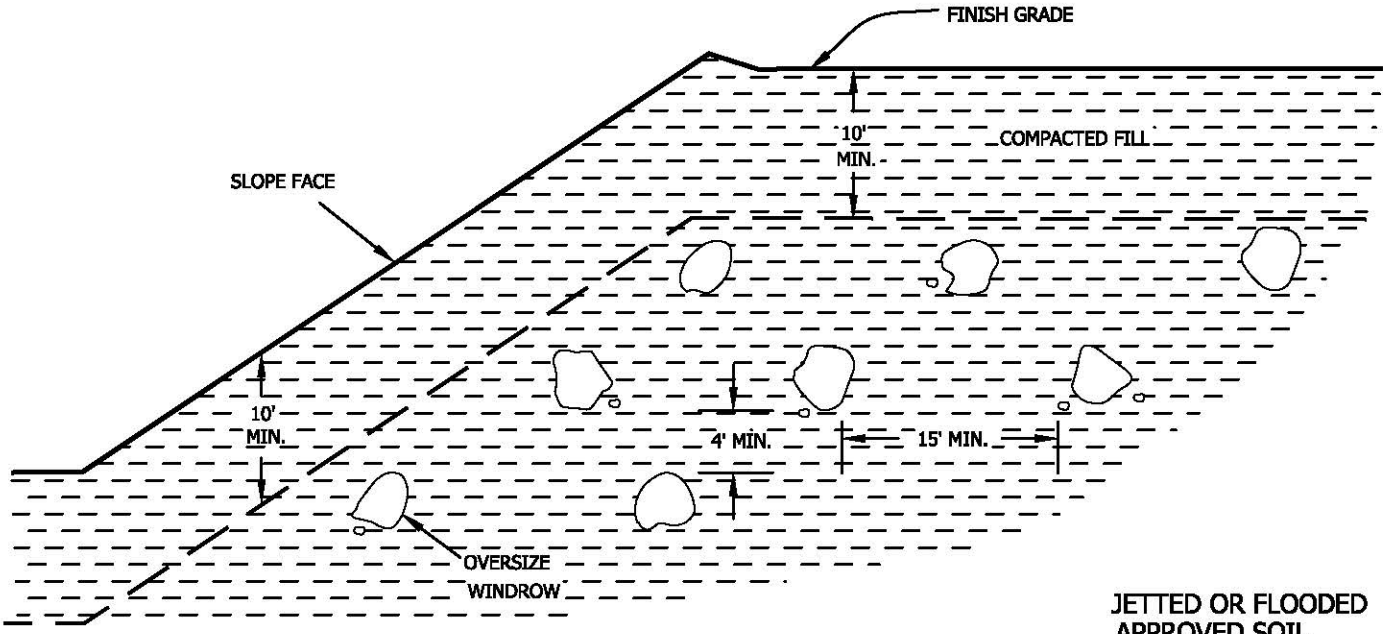


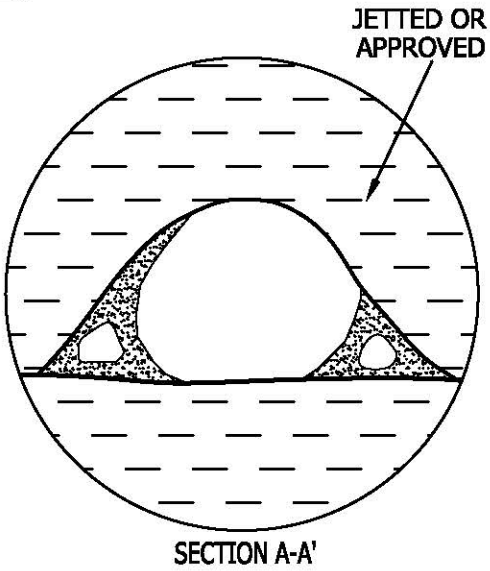
CUT-OVER-FILL SLOPE



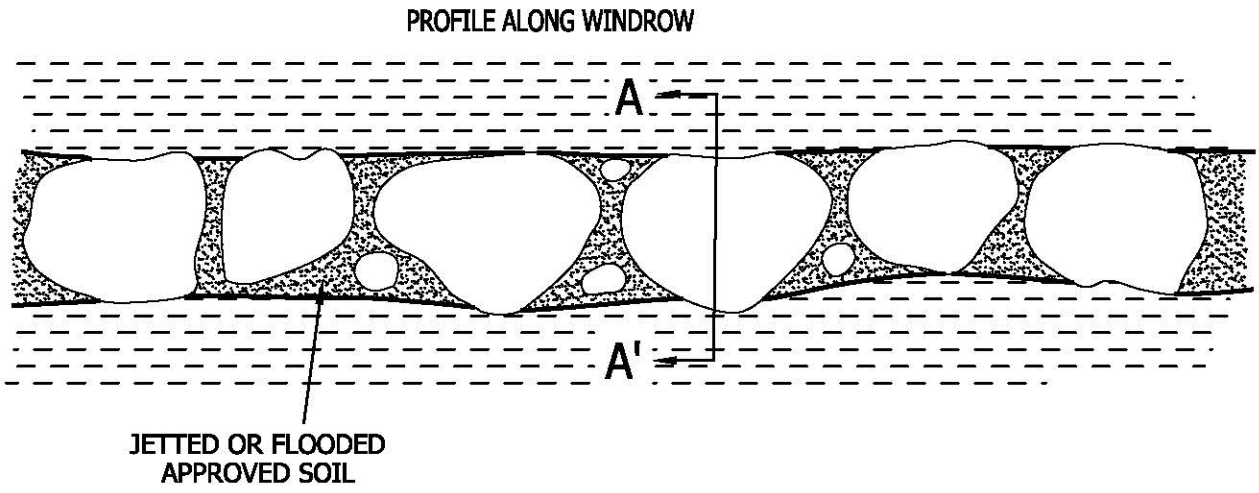
BENCHING SHALL BE DONE WHEN SLOPE'S ANGLE IS EQUAL TO OR GREATER THAN 5:1. MINIMUM BENCH HEIGHT SHALL BE 4 FEET AND MINIMUM FILL WIDTH SHALL BE 9 FEET.

KEYING AND BENCHING	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS A	Leighton





- Oversize rock is larger than 8 inches in largest dimension.
- Backfill with approved soil jetted or flooded in place to fill all the voids.
- Do not bury rock within 10 feet of finish grade.
- Windrow of buried rock shall be parallel to the finished slope face.



OVERSIZE ROCK DISPOSAL

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
STANDARD DETAILS B

Leighton

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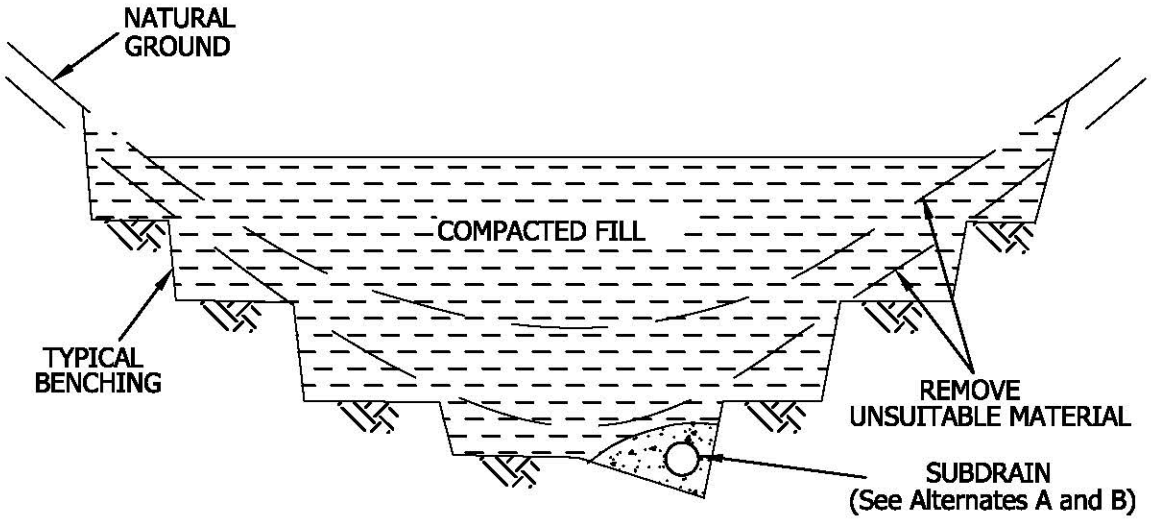
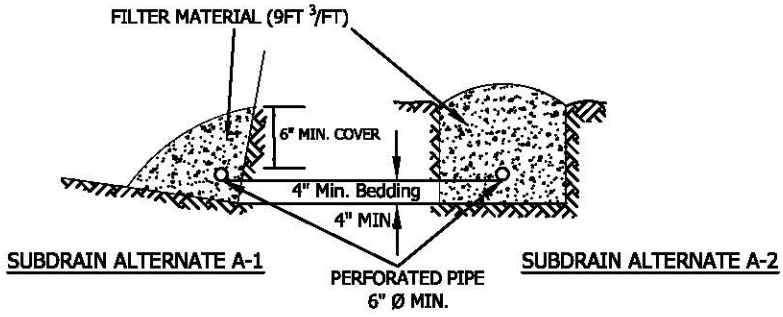


SUBDRAIN ALTERNATE A

PERFORATED PIPE SURROUNDED WITH FILTER MATERIAL

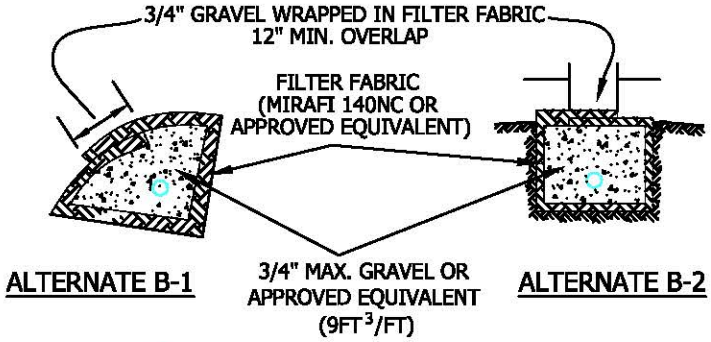


FILTER MATERIAL

FILTER MATERIAL SHALL BE CLASS 2 PERMEABLE MATERIAL PER STATE OF CALIFORNIA STANDARD SPECIFICATION, OR APPROVED ALTERNATE. CLASS 2 GRADING AS FOLLOWS:

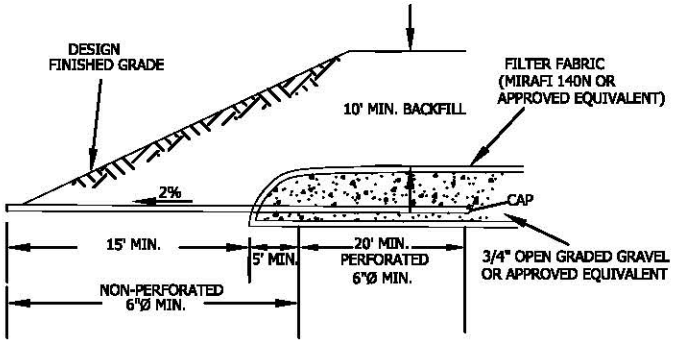
Sieve Size	Percent Passing
1"	100
3/4"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

SUBDRAIN ALTERNATE B



○ PERFORATED PIPE IS OPTIONAL PER GOVERNING AGENCY'S REQUIREMENTS

DETAIL OF CANYON SUBDRAIN TERMINAL



CANYON SUBDRAIN	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS C	Leighton

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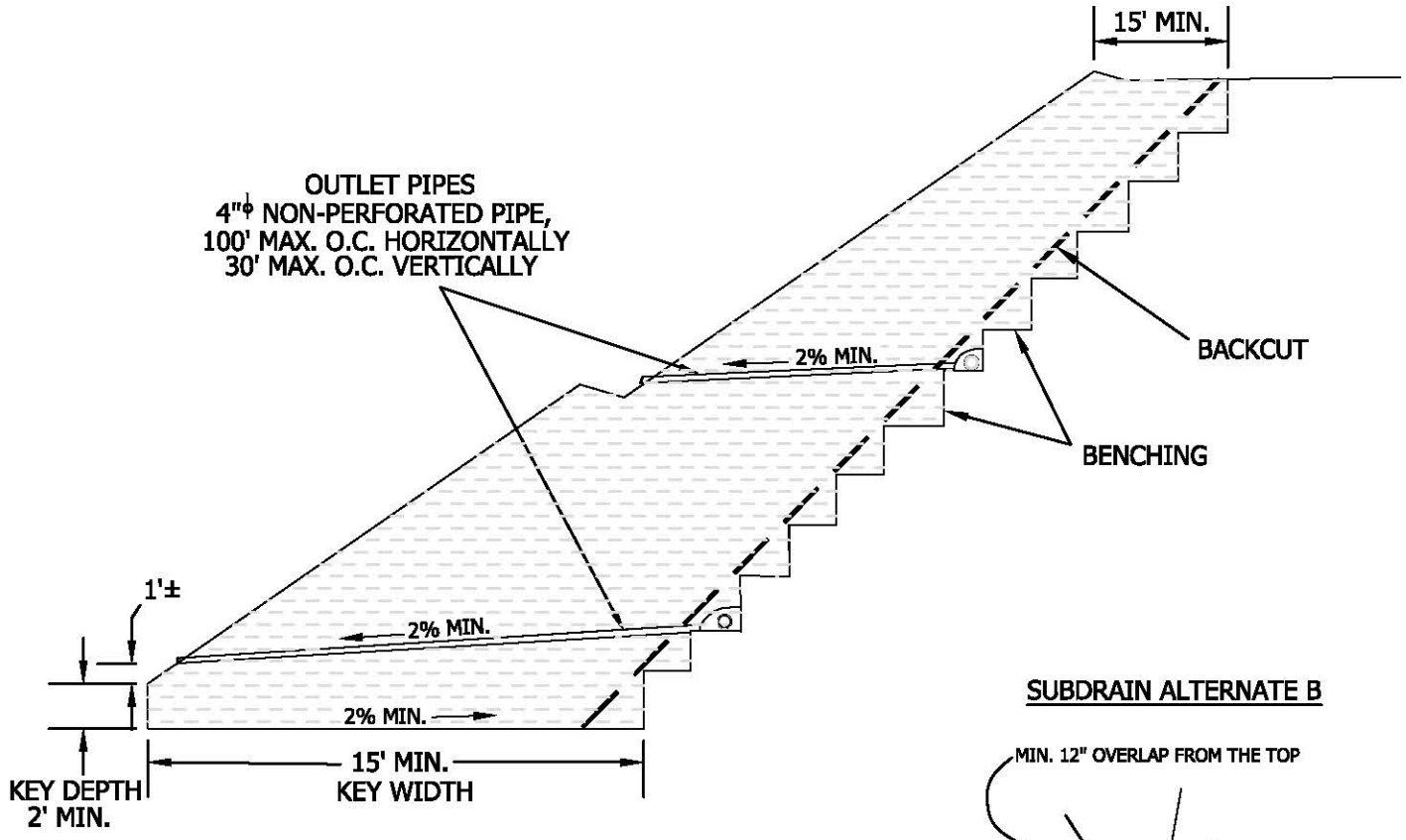
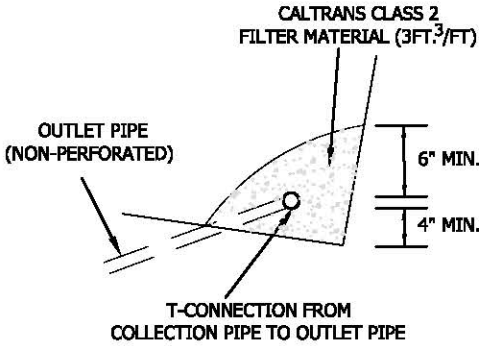
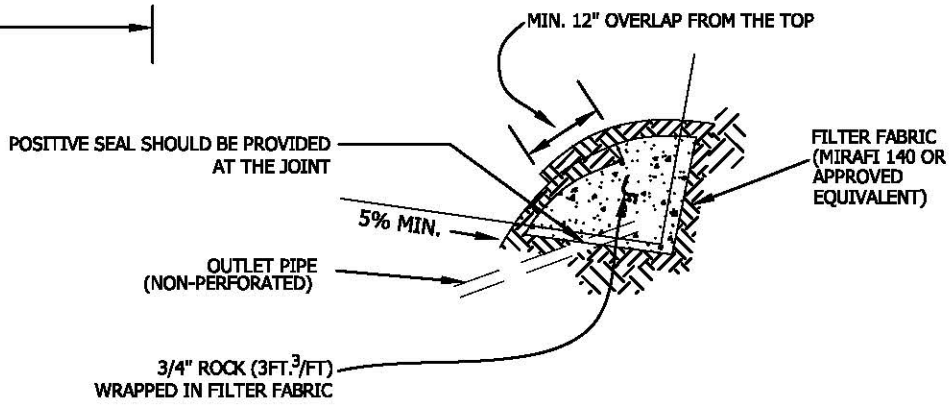


SUBDRAIN ALTERNATE A



SUBDRAIN ALTERNATE B



- SUBDRAIN INSTALLATION - Subdrain collector pipe shall be installed with perforations down or, unless otherwise designated by the geotechnical consultant. Outlet pipes shall be non-perforated pipe. The subdrain pipe shall have at least 8 perforations uniformly spaced per foot. Perforation shall be 1/4" to 1/2" if drilled holes are used. All subdrain pipes shall have a gradient at least 2% towards the outlet.
- SUBDRAIN PIPE - Subdrain pipe shall be ASTM D2751, ASTM D1527 (Schedule 40) or SDR 23.5 ABS pipe or ASTM D3034 (Schedule 40) or SDR 23.5 PVC pipe.
- All outlet pipe shall be placed in a trench and, after fill is placed above it, rodded to verify integrity.

BUTTRESS OR REPLACEMENT FILL SUBDRAINS	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS D	Leighton

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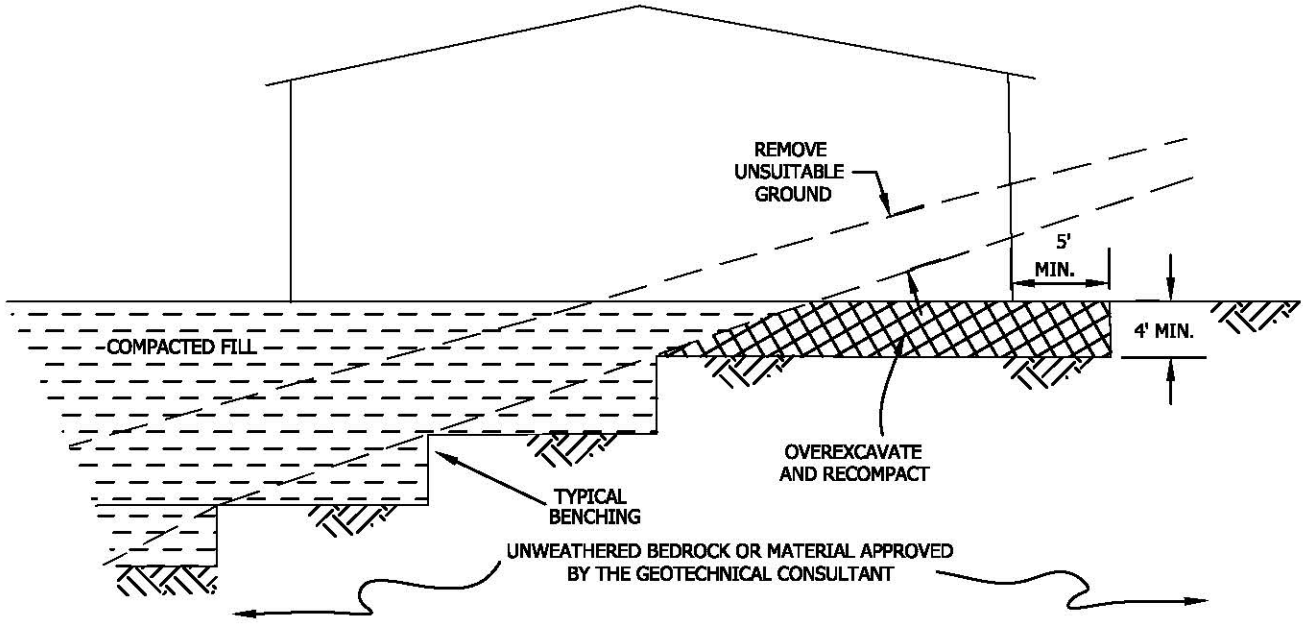
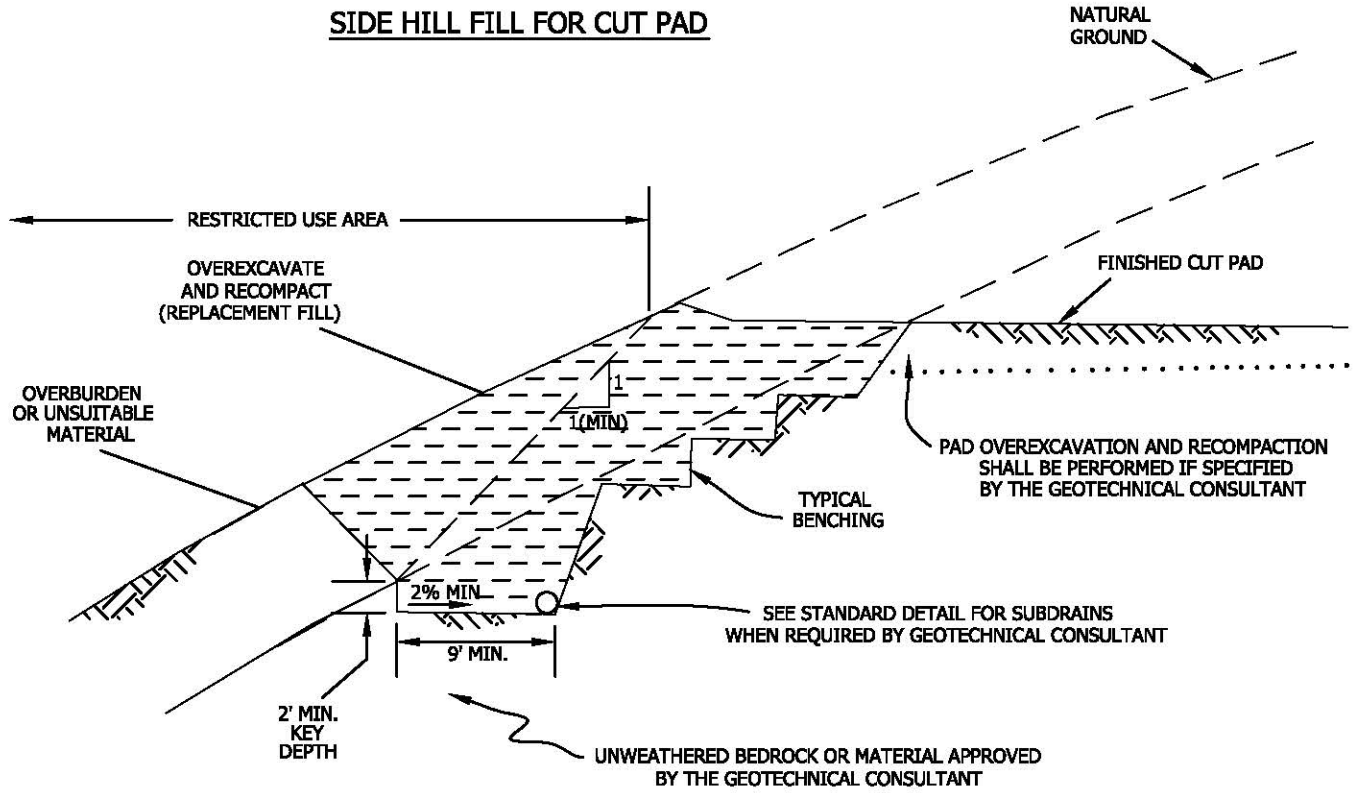
CUT-FILL TRANSITION LOT OVEREXCAVATION



SIDE HILL FILL FOR CUT PAD



TRANSITION LOT FILLS AND SIDE HILL FILLS

GENERAL EARTHWORK AND GRADING
SPECIFICATIONS
STANDARD DETAILS E

Leighton

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APPENDIX F

LPile Plus for Windows, Version 6.0 (6.0.08)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Sreekar Pulijala
Leighton and Associates, INc.

Files Used for Analysis

Path to file locations: P:\Leighton Consulting\603000\603507.002 Ford Theatre\Analyses\LPile\
Name of input data file: 18 inch Dia CIDH.lp6d
Name of output file: 18 inch Dia CIDH.lp6o
Name of plot output file: 18 inch Dia CIDH.lp6p
Name of runtime file: 18 inch Dia CIDH.lp6r

Date and Time of Analysis

Date: July 10, 2013 Time: 15:26:54

Problem Title

Ford Theater Foundation

603507-002

Ford Theater Foundation

SP

Drilled, Cast-in-Place Concrete Caissons - 18-inch Diameter

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip

- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100
- Maximum number of iterations allowed	=	1000
- Deflection tolerance for convergence	=	1.0000E-05 in
- Maximum allowable deflection	=	100.0000 in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections	=	1
Total Pile Length	=	25.00 ft
Depth of ground surface below top of pile	=	0.00 ft
Slope angle of ground surface	=	45.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	25.000000	18.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	25.000 in
Top Width	=	18.000 in
Bottom Width	=	18.000 in
Top Area	=	254.469005 sq. in
Bottom Area	=	254.469005 sq. in
Moment of Inertia at Top	=	5.153E+03 in^4
Moment of Inertia at Bottom	=	5.153E+03 in^4
Elastic Modulus	=	3800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	45.000 degrees
	=	0.785 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer = 0.000 ft
Distance from top of pile to bottom of layer = 5.000 ft

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer = 5.000 ft
Distance from top of pile to bottom of layer = 50.000 ft

(Depth of lowest layer extends 25.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	0.00	120.00000
2	5.00	120.00000
3	5.00	130.00000
4	50.00	130.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	kpy pci	Rock Emass psi	Depth krm ft	Eff. Unit Wt., pcf	Cohesion Test Prop. psf	Friction Ang., deg.	qu Elas. Subgr. psi	RQD percent	Epsilon 50
1	Stiff Clay w/o Free Water	--	--	0.00	120.000	1500.000	--	--	--	0.00
				5.000	120.000	1500.000	--	--	--	0.00
2	Stiff Clay w/o Free Water	--	--	5.000	130.000	3000.000	--	--	--	0.00
				50.000	130.000	3000.000	--	--	--	0.00

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 6

Load Load Condition 1 Condition 2 Axial Thrust

18 inch Dia CIDH

No.	Type				Force, lbs
1	5	y =	0.250 in	S = 0.000 in/in	0.000
2	5	y =	0.500 in	S = 0.000 in/in	0.000
3	5	y =	1.000 in	S = 0.000 in/in	0.000
4	4	y =	0.250 in	M = 0.000 in-lbs	0.000
5	4	y =	0.500 in	M = 0.000 in-lbs	0.000
6	4	y =	1.000 in	M = 0.000 in-lbs	0.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

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Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 0.250000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2500	-1618042.	30784.	0.000	2826.0022	1.958E+10	-132.7302	796.3815	0.000
3.000	0.2496	-1526309.	30372.	-0.000241	2665.7840	1.958E+10	-137.2510	1649.4652	0.000
6.000	0.2486	-1435810.	29954.	-0.000468	2507.7233	1.958E+10	-141.6684	1709.9059	0.000
9.000	0.2468	-1346587.	29522.	-0.000681	2351.8895	1.958E+10	-145.9781	1774.2952	0.000
12.000	0.2445	-1258677.	29078.	-0.000880	2198.3503	1.958E+10	-150.1754	1842.8745	0.000
15.000	0.2415	-1172119.	28621.	-0.001067	2047.1717	1.958E+10	-154.2560	1915.9177	0.000
18.000	0.2381	-1086949.	28153.	-0.001240	1898.4178	1.958E+10	-158.2154	1993.7332	0.000
21.000	0.2341	-1003203.	27672.	-0.001400	1752.1510	1.958E+10	-162.0493	2076.6668	0.000
24.000	0.2297	-920916.	27181.	-0.001547	1608.4314	1.958E+10	-165.7532	2165.1049	0.000
27.000	0.2248	-840120.	26678.	-0.001682	1467.3172	1.958E+10	-169.3227	2259.4784	0.000
30.000	0.2196	-760848.	26165.	-0.001805	1328.8647	1.958E+10	-172.7535	2360.2678	0.000
33.000	0.2140	-683132.	25642.	-0.001915	1193.1277	1.958E+10	-176.0412	2468.0084	0.000
36.000	0.2081	-606999.	25109.	-0.002014	1060.1578	1.958E+10	-179.1814	2583.2973	0.000
39.000	0.2019	-532479.	24567.	-0.002102	930.0046	1.958E+10	-182.1698	2706.8001	0.000
42.000	0.1955	-459599.	24016.	-0.002178	802.7148	1.958E+10	-185.0019	2839.2606	0.000
45.000	0.1888	-388383.	23457.	-0.002242	678.3331	1.958E+10	-187.6733	2981.5098	0.000
48.000	0.1820	-318857.	22890.	-0.002297	556.9014	1.958E+10	-190.1798	3134.4785	0.000
51.000	0.1751	-251042.	22316.	-0.002340	438.4592	1.958E+10	-192.5169	3299.2098	0.000
54.000	0.1680	-184960.	21735.	-0.002374	323.0431	1.958E+10	-194.6803	3476.8751	0.000
57.000	0.1608	-120630.	21148.	-0.002397	210.6873	1.958E+10	-196.6656	3668.7915	0.000
60.000	0.1536	-58070.	20492.	-0.002411	101.4228	1.958E+10	-240.8038	4703.3236	0.000
63.000	0.1464	2322.5748	19647.	-0.002415	4.0565	1.958E+10	-322.8766	6618.5775	0.000
66.000	0.1391	59809.	18672.	-0.002410	104.4605	1.958E+10	-326.5977	7043.5288	0.000
69.000	0.1319	114357.	17688.	-0.002397	199.7307	1.958E+10	-329.9699	7505.6734	0.000
72.000	0.1247	165935.	16693.	-0.002376	289.8141	1.958E+10	-332.9840	8009.3293	0.000
75.000	0.1176	214515.	15690.	-0.002346	374.6633	1.958E+10	-335.6305	8559.4445	0.000
78.000	0.1106	260076.	14680.	-0.002310	454.2368	1.958E+10	-337.9002	9161.7086	0.000
81.000	0.1038	302595.	13663.	-0.002267	528.4988	1.958E+10	-339.7835	9822.6880	0.000
84.000	0.0970	342056.	12642.	-0.002218	597.4197	1.958E+10	-341.2708	10550.	0.000
87.000	0.0905	378445.	11616.	-0.002162	660.9762	1.958E+10	-342.3524	11352.	0.000
90.000	0.0841	411754.	10588.	-0.002102	719.1512	1.958E+10	-343.0184	12240.	0.000
93.000	0.0779	441975.	9558.8683	-0.002036	771.9344	1.958E+10	-343.2584	13226.	0.000

18 inch Dia CIDH

96.000	0.0719	469107.	8529.3876	-0.001967	819.3219	1.958E+10	-343.0620	14324.	0.000
99.000	0.0661	493151.	7501.1670	-0.001893	861.3167	1.958E+10	-342.4184	15550.	0.000
102.000	0.0605	514114.	6475.5653	-0.001816	897.9291	1.958E+10	-341.3161	16926.	0.000
105.000	0.0552	532005.	5453.9760	-0.001736	929.1764	1.958E+10	-339.7434	18476.	0.000
108.000	0.0501	546838.	4437.8290	-0.001653	955.0832	1.958E+10	-337.6879	20229.	0.000
111.000	0.0452	558632.	3428.5925	-0.001568	975.6819	1.958E+10	-335.1365	22220.	0.000
114.000	0.0407	567409.	2427.7751	-0.001482	991.0126	1.958E+10	-332.0751	24495.	0.000
117.000	0.0364	573198.	1436.9290	-0.001395	1001.1233	1.958E+10	-328.4889	27107.	0.000
120.000	0.0323	576031.	457.6532	-0.001307	1006.0706	1.958E+10	-324.3616	30124.	0.000
123.000	0.0285	575944.	-508.4025	-0.001218	1005.9193	1.958E+10	-319.6755	33632.	0.000
126.000	0.0250	572981.	-1459.5323	-0.001130	1000.7429	1.958E+10	-314.4110	37740.	0.000
129.000	0.0217	567187.	-2393.9676	-0.001043	990.6243	1.958E+10	-308.5459	42590.	0.000
132.000	0.0187	558617.	-3309.8696	-0.000957	975.6557	1.958E+10	-302.0554	48368.	0.000
135.000	0.0160	547328.	-4205.3184	-0.000872	955.9391	1.958E+10	-294.9104	55320.	0.000
138.000	0.0135	533385.	-5078.2990	-0.000789	931.5868	1.958E+10	-287.0766	63783.	0.000
141.000	0.0113	516858.	-5926.6826	-0.000709	902.7219	1.958E+10	-278.5125	74222.	0.000
144.000	0.009250	497825.	-6748.2008	-0.000631	869.4790	1.958E+10	-269.1663	87301.	0.000
147.000	0.007471	476369.	-7540.4074	-0.000556	832.0052	1.958E+10	-258.9715	103994.	0.000
150.000	0.005911	452582.	-8300.6231	-0.000485	790.4606	1.958E+10	-247.8390	125789.	0.000
153.000	0.004559	426565.	-9025.8479	-0.000418	745.0202	1.958E+10	-235.6441	155065.	0.000
156.000	0.003403	398427.	-9712.6161	-0.000355	695.8757	1.958E+10	-222.2014	195880.	0.000
159.000	0.002430	368290.	-10357.	-0.000296	643.2384	1.958E+10	-207.2147	255776.	0.000
162.000	0.001627	336287.	-10953.	-0.000242	587.3439	1.958E+10	-190.1619	350638.	0.000
165.000	0.000978	302573.	-11493.	-0.000193	528.4602	1.958E+10	-169.9780	521336.	0.000
168.000	0.000468	267329.	-11964.	-0.000149	466.9047	1.958E+10	-143.8680	921575.	0.000
171.000	8.141E-05	230790.	-12225.	-0.000111	403.0877	1.958E+10	-30.6076	1127941.	0.000
174.000	-0.000199	193976.	-11991.	-7.876E-05	338.7896	1.958E+10	186.9776	2812500.	0.000
177.000	-0.000391	158844.	-11198.	-5.173E-05	277.4306	1.958E+10	341.9392	2622650.	0.000
180.000	-0.000510	126790.	-10135.	-2.985E-05	221.4465	1.958E+10	366.2025	2154873.	0.000
183.000	-0.000570	98032.	-9020.5680	-1.263E-05	171.2188	1.958E+10	376.9882	1983326.	0.000
186.000	-0.000586	72667.	-7885.5114	4.485E-07	126.9169	1.958E+10	379.7162	1945299.	0.000
189.000	-0.000568	50719.	-6750.6038	9.900E-06	88.5838	1.958E+10	376.8889	1992206.	0.000
192.000	-0.000526	32163.	-5630.3969	1.625E-05	56.1751	1.958E+10	369.9157	2109030.	0.000
195.000	-0.000470	16937.	-4535.9836	2.001E-05	29.5810	1.958E+10	359.6932	2295676.	0.000
198.000	-0.000406	4947.4242	-3476.1832	2.169E-05	8.6410	1.958E+10	346.8404	2562073.	0.000
201.000	-0.000340	-3920.3439	-2477.9009	2.177E-05	6.8471	1.958E+10	318.6812	2812500.	0.000
204.000	-0.000276	-9919.9810	-1612.4144	2.071E-05	17.3258	1.958E+10	258.3098	2812500.	0.000
207.000	-0.000216	-13595.	-921.6304	1.890E-05	23.7441	1.958E+10	202.2128	2812500.	0.000
210.000	-0.000162	-15450.	-390.3504	1.668E-05	26.9839	1.958E+10	151.9738	2812500.	0.000
213.000	-0.000116	-15937.	0.1983	1.427E-05	27.8348	1.958E+10	108.3920	2812500.	0.000
216.000	-7.646E-05	-15449.	270.3022	1.187E-05	26.9818	1.958E+10	71.6773	2812500.	0.000
219.000	-4.439E-05	-14315.	440.2471	9.591E-06	25.0022	1.958E+10	41.6193	2812500.	0.000
222.000	-1.891E-05	-12807.	529.2704	7.513E-06	22.3683	1.958E+10	17.7296	2812500.	0.000
225.000	6.844E-07	-11139.	555.3882	5.679E-06	19.4558	1.958E+10	-0.3177	1392653.	0.000
228.000	1.516E-05	-9474.7619	544.2436	4.100E-06	16.5482	1.958E+10	-7.1121	1407361.	0.000
231.000	2.528E-05	-7874.0353	515.5994	2.771E-06	13.7524	1.958E+10	-11.9841	1422069.	0.000
234.000	3.178E-05	-6381.1655	474.7902	1.679E-06	11.1451	1.958E+10	-15.2221	1436777.	0.000
237.000	3.535E-05	-5025.2943	426.2998	8.048E-07	8.7770	1.958E+10	-17.1048	1451486.	0.000
240.000	3.661E-05	-3823.3664	373.8020	1.270E-07	6.6777	1.958E+10	-17.8937	1466194.	0.000
243.000	3.611E-05	-2782.4820	320.2202	-3.791E-07	4.8598	1.958E+10	-17.8275	1480903.	0.000
246.000	3.434E-05	-1902.0451	267.8007	-7.379E-07	3.3220	1.958E+10	-17.1188	1495612.	0.000
249.000	3.169E-05	-1175.6778	218.1935	-9.737E-07	2.0534	1.958E+10	-15.9526	1510321.	0.000
252.000	2.850E-05	-592.8842	172.5359	-1.109E-06	1.0355	1.958E+10	-14.4858	1525030.	0.000
255.000	2.503E-05	-140.4626	131.5356	-1.165E-06	0.2453	1.958E+10	-12.8477	1539739.	0.000
258.000	2.150E-05	196.3295	95.5506	-1.161E-06	0.3429	1.958E+10	-11.1423	1554448.	0.000
261.000	1.807E-05	432.8411	64.6631	-1.113E-06	0.7560	1.958E+10	-9.4494	1569157.	0.000
264.000	1.483E-05	584.3079	38.7471	-1.035E-06	1.0205	1.958E+10	-7.8279	1583867.	0.000
267.000	1.186E-05	665.3236	17.5287	-9.392E-07	1.1620	1.958E+10	-6.3177	1598576.	0.000
270.000	9.191E-06	689.4800	0.6379	-8.354E-07	1.2042	1.958E+10	-4.9428	1613286.	0.000
273.000	6.844E-06	669.1510	-12.3470	-7.314E-07	1.1687	1.958E+10	-3.7138	1627996.	0.000
276.000	4.803E-06	615.3979	-21.8629	-6.330E-07	1.0748	1.958E+10	-2.6301	1642706.	0.000
279.000	3.046E-06	537.9736	-28.3322	-5.446E-07	0.9396	1.958E+10	-1.6827	1657415.	0.000
282.000	1.536E-06	445.4046	-32.1402	-4.693E-07	0.7779	1.958E+10	-0.8559	1672125.	0.000
285.000	2.302E-07	345.1324	-33.6182	-4.087E-07	0.6028	1.958E+10	-0.1294	1686835.	0.000
288.000	-9.167E-07	243.6954	-32.5232	-3.636E-07	0.4256	1.958E+10	0.8594	2812500.	0.000
291.000	-1.952E-06	149.9930	-28.4898	-3.335E-07	0.2620	1.958E+10	1.8296	2812500.	0.000
294.000	-2.917E-06	72.7568	-21.6427	-3.164E-07	0.1271	1.958E+10	2.7351	2812500.	0.000
297.000	-3.850E-06	20.1366	-12.1261	-3.093E-07	0.0352	1.958E+10	3.6093	2812500.	0.000
300.000	-4.773E-06	0.000	0.000	-3.077E-07	0.000	1.958E+10	4.4748	1406250.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships. The above values of total stress are computed for combined axial stress and do not equal the actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      0.2500000 inches
Computed slope at pile head      =   -0.000007027 radians
Maximum bending moment           =      -1618042. inch-lbs
Maximum shear force              =         30784. lbs
Depth of maximum bending moment  =       0.000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             16
Number of zero deflection points =              3
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 0.500000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.5000	-2604361.	44181.	0.000	4548.6631	1.958E+10	-157.8438	473.5313	0.000
3.000	0.4994	-2472554.	43691.	-0.000389	4318.4540	1.958E+10	-163.2317	980.5640	0.000
6.000	0.4977	-2342215.	43193.	-0.000758	4090.8108	1.958E+10	-168.5203	1015.8625	0.000
9.000	0.4949	-2213394.	42680.	-0.001107	3865.8166	1.958E+10	-173.7046	1053.0632	0.000
12.000	0.4910	-2086135.	42151.	-0.001436	3643.5528	1.958E+10	-178.7799	1092.2830	0.000
15.000	0.4862	-1960486.	41607.	-0.001746	3424.0993	1.958E+10	-183.7416	1133.6506	0.000
18.000	0.4805	-1836490.	41049.	-0.002037	3207.5340	1.958E+10	-188.5850	1177.3074	0.000
21.000	0.4740	-1714192.	40476.	-0.002309	2993.9331	1.958E+10	-193.3056	1223.4091	0.000
24.000	0.4667	-1593634.	39889.	-0.002562	2783.3708	1.958E+10	-197.8989	1272.1262	0.000
27.000	0.4586	-1474856.	39289.	-0.002797	2575.9192	1.958E+10	-202.3605	1323.6459	0.000
30.000	0.4499	-1357900.	38675.	-0.003014	2371.6485	1.958E+10	-206.6858	1378.1737	0.000
33.000	0.4406	-1242804.	38049.	-0.003214	2170.6268	1.958E+10	-210.8705	1435.9349	0.000
36.000	0.4306	-1129606.	37410.	-0.003395	1972.9197	1.958E+10	-214.9102	1497.1770	0.000
39.000	0.4202	-1018342.	36760.	-0.003560	1778.5908	1.958E+10	-218.8006	1562.1721	0.000
42.000	0.4093	-909047.	36098.	-0.003707	1587.7012	1.958E+10	-222.5374	1631.2195	0.000
45.000	0.3979	-801755.	35425.	-0.003839	1400.3097	1.958E+10	-226.1162	1704.6485	0.000
48.000	0.3862	-696498.	34741.	-0.003953	1216.4725	1.958E+10	-229.5327	1782.8224	0.000
51.000	0.3742	-593307.	34048.	-0.004052	1036.2433	1.958E+10	-232.7828	1866.1419	0.000
54.000	0.3619	-492210.	33345.	-0.004135	859.6732	1.958E+10	-235.8623	1955.0498	0.000
57.000	0.3494	-393237.	32633.	-0.004203	686.8107	1.958E+10	-238.7668	2050.0357	0.000
60.000	0.3367	-296413.	31835.	-0.004256	517.7013	1.958E+10	-293.0051	2610.6070	0.000
63.000	0.3239	-202225.	30805.	-0.004294	353.1977	1.958E+10	-393.7986	3647.7110	0.000
66.000	0.3109	-111582.	29615.	-0.004318	194.8842	1.958E+10	-399.3364	3852.8098	0.000
69.000	0.2980	-24533.	28410.	-0.004329	42.8479	1.958E+10	-404.5330	4072.9701	0.000
72.000	0.2850	58876.	27189.	-0.004326	102.8296	1.958E+10	-409.3794	4309.6692	0.000
75.000	0.2720	138600.	25954.	-0.004311	242.0720	1.958E+10	-413.8665	4564.5645	0.000
78.000	0.2591	214599.	24706.	-0.004284	374.8088	1.958E+10	-417.9856	4839.5202	0.000
81.000	0.2463	286836.	23447.	-0.004245	500.9754	1.958E+10	-421.7277	5136.6383	0.000
84.000	0.2336	355278.	22176.	-0.004196	620.5128	1.958E+10	-425.0837	5458.2954	0.000
87.000	0.2211	419894.	20897.	-0.004137	733.3683	1.958E+10	-428.0449	5807.1866	0.000
90.000	0.2088	480657.	19609.	-0.004068	839.4953	1.958E+10	-430.6020	6186.3771	0.000
93.000	0.1967	537546.	18314.	-0.003990	938.8538	1.958E+10	-432.7459	6599.3641	0.000
96.000	0.1849	590539.	17013.	-0.003903	1031.4098	1.958E+10	-434.4672	7050.1516	0.000
99.000	0.1733	639622.	15707.	-0.003809	1117.1365	1.958E+10	-435.7565	7543.3390	0.000
102.000	0.1620	684784.	14399.	-0.003708	1196.0136	1.958E+10	-436.6041	8084.2306	0.000
105.000	0.1511	726016.	13089.	-0.003600	1268.0276	1.958E+10	-437.0001	8678.9667	0.000
108.000	0.1404	763315.	11778.	-0.003486	1333.1725	1.958E+10	-436.9342	9334.6858	0.000
111.000	0.1301	796682.	10468.	-0.003366	1391.4492	1.958E+10	-436.3959	10060.	0.000
114.000	0.1202	826121.	9159.9566	-0.003242	1442.8661	1.958E+10	-435.3744	10864.	0.000
117.000	0.1107	851641.	7856.1077	-0.003113	1487.4394	1.958E+10	-433.8582	11759.	0.000
120.000	0.1015	873257.	6557.5669	-0.002981	1525.1929	1.958E+10	-431.8356	12758.	0.000

123.000	0.0928	890987.	5265.8723	-0.002846	1556.1584	1.958E+10	-429.2941	13877.	0.000
126.000	0.0845	904852.	3982.6005	-0.002708	1580.3758	1.958E+10	-426.2205	15137.	0.000
129.000	0.0766	914882.	2709.3685	-0.002569	1597.8934	1.958E+10	-422.6008	16561.	0.000
132.000	0.0691	921109.	1447.8371	-0.002428	1608.7682	1.958E+10	-418.4201	18177.	0.000
135.000	0.0620	923569.	199.7136	-0.002287	1613.0658	1.958E+10	-413.6622	20021.	0.000
138.000	0.0553	922307.	-1033.2442	-0.002146	1610.8610	1.958E+10	-408.3096	22136.	0.000
141.000	0.0491	917370.	-2249.2230	-0.002005	1602.2381	1.958E+10	-402.3429	24578.	0.000
144.000	0.0433	908812.	-3446.3483	-0.001865	1587.2907	1.958E+10	-395.7406	27414.	0.000
147.000	0.0379	896692.	-4622.6772	-0.001727	1566.1226	1.958E+10	-388.4786	30733.	0.000
150.000	0.0329	881076.	-5776.1890	-0.001590	1538.8481	1.958E+10	-380.5292	34648.	0.000
153.000	0.0284	862035.	-6904.7735	-0.001457	1505.5920	1.958E+10	-371.8604	39309.	0.000
156.000	0.0242	839647.	-8006.2154	-0.001326	1466.4906	1.958E+10	-362.4342	44916.	0.000
159.000	0.0204	813997.	-9078.1735	-0.001200	1421.6922	1.958E+10	-352.2046	51741.	0.000
162.000	0.0170	785178.	-10118.	-0.001077	1371.3574	1.958E+10	-341.1146	60165.	0.000
165.000	0.0140	753288.	-11123.	-0.000959	1315.6606	1.958E+10	-329.0915	70734.	0.000
168.000	0.0113	718437.	-12091.	-0.000847	1254.7909	1.958E+10	-316.0391	84259.	0.000
171.000	0.008878	680741.	-13018.	-0.000739	1188.9533	1.958E+10	-301.8249	101996.	0.000
174.000	0.006816	640329.	-13900.	-0.000638	1118.3713	1.958E+10	-286.2576	126002.	0.000
177.000	0.005048	597341.	-14733.	-0.000543	1043.2897	1.958E+10	-269.0430	159896.	0.000
180.000	0.003555	551931.	-15511.	-0.000455	963.9790	1.958E+10	-249.6909	210729.	0.000
183.000	0.002315	504274.	-16227.	-0.000375	880.7433	1.958E+10	-227.2856	294514.	0.000
186.000	0.001307	454572.	-16867.	-0.000301	793.9350	1.958E+10	-199.7787	458387.	0.000
189.000	0.000509	403071.	-17408.	-0.000235	703.9864	1.958E+10	-160.5900	947037.	0.000
192.000	-0.000105	350125.	-17501.	-0.000178	611.5134	1.958E+10	98.2531	2812500.	0.000
195.000	-0.000557	298064.	-16793.	-0.000128	520.5849	1.958E+10	373.6339	2010964.	0.000
198.000	-0.000873	249365.	-15604.	-8.610E-05	435.5295	1.958E+10	419.2193	1440631.	0.000
201.000	-0.001074	204439.	-14312.	-5.133E-05	357.0638	1.958E+10	441.9704	1234584.	0.000
204.000	-0.001181	163491.	-12970.	-2.315E-05	285.5455	1.958E+10	452.8184	1150266.	0.000
207.000	-0.001213	126618.	-11607.	-9.257E-07	221.1450	1.958E+10	455.9637	1127816.	0.000
210.000	-0.001187	93849.	-10243.	1.596E-05	163.9119	1.958E+10	453.5318	1146685.	0.000
213.000	-0.001117	65161.	-8892.3010	2.814E-05	113.8077	1.958E+10	446.7702	1199822.	0.000
216.000	-0.001018	40495.	-7567.4208	3.624E-05	70.7264	1.958E+10	436.4833	1286693.	0.000
219.000	-0.000900	19757.	-6277.8612	4.085E-05	34.5062	1.958E+10	423.2231	1411263.	0.000
222.000	-0.000773	2827.6197	-5031.9508	4.258E-05	4.9386	1.958E+10	407.3838	1581928.	0.000
225.000	-0.000644	-10435.	-3837.0004	4.200E-05	18.2253	1.958E+10	389.2498	1812787.	0.000
228.000	-0.000521	-20194.	-2699.6011	3.965E-05	35.2706	1.958E+10	369.0164	2126601.	0.000
231.000	-0.000406	-26633.	-1625.8981	3.607E-05	46.5154	1.958E+10	346.7856	2560862.	0.000
234.000	-0.000304	-29950.	-677.9751	3.173E-05	52.3090	1.958E+10	285.1630	2812500.	0.000
237.000	-0.000216	-30700.	53.3235	2.709E-05	53.6201	1.958E+10	202.3694	2812500.	0.000
240.000	-0.000142	-29630.	556.0842	2.246E-05	51.7502	1.958E+10	132.8044	2812500.	0.000
243.000	-8.107E-05	-27364.	869.3010	1.810E-05	47.7927	1.958E+10	76.0068	2812500.	0.000
246.000	-3.307E-05	-24414.	1029.8113	1.413E-05	42.6405	1.958E+10	31.0001	2812500.	0.000
249.000	3.719E-06	-21185.	1073.5028	1.064E-05	37.0010	1.958E+10	-1.8724	1510321.	0.000
252.000	3.077E-05	-17973.	1047.2330	7.640E-06	31.3909	1.958E+10	-15.6408	1525030.	0.000
255.000	4.956E-05	-14902.	985.6200	5.121E-06	26.0266	1.958E+10	-25.4346	1539739.	0.000
258.000	6.150E-05	-12059.	899.6726	3.056E-06	21.0622	1.958E+10	-31.8637	1554448.	0.000
261.000	6.789E-05	-9503.6558	798.6108	1.404E-06	16.5987	1.958E+10	-35.5109	1569157.	0.000
264.000	6.992E-05	-7267.6223	689.9727	1.194E-07	12.6933	1.958E+10	-36.9146	1583867.	0.000
267.000	6.861E-05	-5363.8199	579.7635	-8.483E-07	9.3682	1.958E+10	-36.5582	1598576.	0.000
270.000	6.483E-05	-3789.0414	472.6312	-1.549E-06	6.6178	1.958E+10	-34.8633	1613286.	0.000
273.000	5.931E-05	-2528.0324	372.0570	-2.033E-06	4.4154	1.958E+10	-32.1862	1627996.	0.000
276.000	5.263E-05	-1556.6993	280.5495	-2.346E-06	2.7189	1.958E+10	-28.8188	1642706.	0.000
279.000	4.523E-05	-844.7354	199.8354	-2.530E-06	1.4754	1.958E+10	-24.9906	1657415.	0.000
282.000	3.745E-05	-357.6867	131.0394	-2.622E-06	0.6247	1.958E+10	-20.8734	1672125.	0.000
285.000	2.950E-05	-58.4988	74.8481	-2.654E-06	0.1022	1.958E+10	-16.5875	1686835.	0.000
288.000	2.152E-05	91.4017	31.6543	-2.652E-06	0.1596	1.958E+10	-12.2084	1701545.	0.000
291.000	1.359E-05	131.4271	1.6792	-2.635E-06	0.2295	1.958E+10	-7.7750	1716256.	0.000
294.000	5.717E-06	101.4772	-14.9314	-2.617E-06	0.1772	1.958E+10	-3.2988	1730966.	0.000
297.000	-2.110E-06	41.8385	-16.9129	-2.606E-06	0.0731	1.958E+10	1.9778	2812500.	0.000
300.000	-9.917E-06	0.000	0.000	-2.603E-06	0.000	1.958E+10	9.2974	1406250.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.5000000 inches
Computed slope at pile head = -0.0000101 radians

18 inch Dia CIDH

Maximum bending moment = -2604361. inch-lbs
Maximum shear force = 44181. lbs
Depth of maximum bending moment = 0.000000 inches below pile head
Depth of maximum shear force = 0.000000 inches below pile head
Number of iterations = 18
Number of zero deflection points = 3

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 3

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 1.000000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.0000	-4189377.	63438.	0.000	7316.9821	1.958E+10	-187.7089	281.5634	0.000
3.000	0.9990	-3999937.	62855.	-0.000627	6986.1155	1.958E+10	-194.1277	582.9443	0.000
6.000	0.9962	-3812245.	62263.	-0.001226	6658.3003	1.958E+10	-200.4509	603.6247	0.000
9.000	0.9917	-3626357.	61653.	-0.001796	6333.6360	1.958E+10	-206.6735	625.2207	0.000
12.000	0.9855	-3442328.	61024.	-0.002337	6012.2204	1.958E+10	-212.7906	647.7890	0.000
15.000	0.9777	-3260215.	60376.	-0.002851	5694.1497	1.958E+10	-218.7973	671.3905	0.000
18.000	0.9684	-3080071.	59711.	-0.003336	5379.5183	1.958E+10	-224.6888	696.0911	0.000
21.000	0.9576	-2901950.	59028.	-0.003794	5068.4187	1.958E+10	-230.4605	721.9618	0.000
24.000	0.9456	-2725902.	58328.	-0.004226	4760.9418	1.958E+10	-236.1079	749.0789	0.000
27.000	0.9323	-2551980.	57612.	-0.004630	4457.1762	1.958E+10	-241.6262	777.5252	0.000
30.000	0.9178	-2380232.	56879.	-0.005008	4157.2087	1.958E+10	-247.0112	807.3900	0.000
33.000	0.9022	-2210707.	56130.	-0.005359	3861.1241	1.958E+10	-252.2583	838.7699	0.000
36.000	0.8857	-2043452.	55365.	-0.005685	3569.0046	1.958E+10	-257.3631	871.7696	0.000
39.000	0.8681	-1878514.	54586.	-0.005986	3280.9307	1.958E+10	-262.3213	906.5026	0.000
42.000	0.8497	-1715937.	53792.	-0.006261	2996.9802	1.958E+10	-267.1287	943.0920	0.000
45.000	0.8306	-1555764.	52983.	-0.006512	2717.2287	1.958E+10	-271.7810	981.6716	0.000
48.000	0.8107	-1398036.	52161.	-0.006738	2441.7493	1.958E+10	-276.2739	1022.3867	0.000
51.000	0.7901	-1242796.	51326.	-0.006940	2170.6127	1.958E+10	-280.6033	1065.3956	0.000
54.000	0.7690	-1090080.	50478.	-0.007119	1903.8869	1.958E+10	-284.7651	1110.8708	0.000
57.000	0.7474	-939928.	49618.	-0.007274	1641.6373	1.958E+10	-288.7552	1159.0003	0.000
60.000	0.7254	-792374.	48652.	-0.007407	1383.9266	1.958E+10	-354.9774	1468.0912	0.000
63.000	0.7030	-648016.	47403.	-0.007517	1131.7959	1.958E+10	-477.9838	2039.8122	0.000
66.000	0.6803	-507959.	45957.	-0.007606	887.1786	1.958E+10	-485.6648	2141.7546	0.000
69.000	0.6573	-372273.	44489.	-0.007673	650.1954	1.958E+10	-493.0118	2250.0109	0.000
72.000	0.6342	-241024.	43000.	-0.007720	420.9619	1.958E+10	-500.0161	2365.1113	0.000
75.000	0.6110	-114275.	41490.	-0.007748	199.5882	1.958E+10	-506.6687	2487.6402	0.000
78.000	0.5878	7913.4346	39960.	-0.007756	13.8213	1.958E+10	-512.9612	2618.2438	0.000
81.000	0.5645	125485.	38412.	-0.007746	219.1674	1.958E+10	-518.8849	2757.6371	0.000
84.000	0.5413	238388.	36847.	-0.007718	416.3573	1.958E+10	-524.4312	2906.6132	0.000
87.000	0.5182	346570.	35266.	-0.007673	605.3035	1.958E+10	-529.5916	3066.0535	0.000
90.000	0.4952	449986.	33670.	-0.007612	785.9252	1.958E+10	-534.3576	3236.9397	0.000
93.000	0.4725	548592.	32061.	-0.007535	958.1472	1.958E+10	-538.7206	3420.3676	0.000
96.000	0.4500	642350.	30439.	-0.007444	1121.9011	1.958E+10	-542.6719	3617.5632	0.000
99.000	0.4278	731225.	28805.	-0.007339	1277.1248	1.958E+10	-546.2029	3829.9015	0.000
102.000	0.4060	815183.	27162.	-0.007220	1423.7627	1.958E+10	-549.3049	4058.9286	0.000
105.000	0.3845	894197.	25510.	-0.007090	1561.7660	1.958E+10	-551.9689	4306.3875	0.000
108.000	0.3635	968244.	23851.	-0.006947	1691.0930	1.958E+10	-554.1860	4574.2488	0.000
111.000	0.3428	1037303.	22186.	-0.006793	1811.7087	1.958E+10	-555.9469	4864.7467	0.000
114.000	0.3227	1101359.	20516.	-0.006629	1923.5854	1.958E+10	-557.2424	5180.4221	0.000
117.000	0.3031	1160399.	18843.	-0.006456	2026.7029	1.958E+10	-558.0629	5524.1743	0.000
120.000	0.2840	1214417.	17168.	-0.006274	2121.0481	1.958E+10	-558.3987	5899.3222	0.000
123.000	0.2654	1263410.	15493.	-0.006084	2206.6159	1.958E+10	-558.2396	6309.6793	0.000
126.000	0.2475	1307378.	13820.	-0.005887	2283.4088	1.958E+10	-557.5753	6759.6436	0.000
129.000	0.2301	1346328.	12149.	-0.005684	2351.4371	1.958E+10	-556.3950	7254.3077	0.000
132.000	0.2134	1380270.	10482.	-0.005475	2410.7194	1.958E+10	-554.6877	7799.5937	0.000
135.000	0.1972	1409220.	8821.4092	-0.005262	2461.2826	1.958E+10	-552.4416	8402.4198	0.000
138.000	0.1818	1433199.	7168.2801	-0.005044	2503.1619	1.958E+10	-549.6445	9070.9068	0.000
141.000	0.1670	1452230.	5524.3877	-0.004823	2536.4014	1.958E+10	-546.2837	9814.6367	0.000
144.000	0.1528	1466345.	3891.4440	-0.004599	2561.0538	1.958E+10	-542.3455	10645.	0.000
147.000	0.1394	1475579.	2271.2027	-0.004374	2577.1811	1.958E+10	-537.8154	11576.	0.000

150.000	0.1266	1479972.	665.4627	-0.004148	2584.8545	1.958E+10	-532.6779	12623.	0.000
153.000	0.1145	1479571.	-923.9287	-0.003921	2584.1548	1.958E+10	-526.9163	13806.	0.000
156.000	0.1031	1474428.	-2495.0718	-0.003695	2575.1724	1.958E+10	-520.5124	15149.	0.000
159.000	0.0923	1464601.	-4046.0094	-0.003469	2558.0081	1.958E+10	-513.4460	16683.	0.000
162.000	0.0823	1450152.	-5574.7208	-0.003246	2532.7729	1.958E+10	-505.6950	18442.	0.000
165.000	0.0729	1431153.	-7079.1147	-0.003025	2499.5887	1.958E+10	-497.2343	20475.	0.000
168.000	0.0641	1407678.	-8557.0197	-0.002808	2458.5884	1.958E+10	-488.0357	22838.	0.000
171.000	0.0560	1379811.	-10006.	-0.002594	2409.9168	1.958E+10	-478.0664	25607.	0.000
174.000	0.0485	1347641.	-11424.	-0.002385	2353.7304	1.958E+10	-467.2880	28880.	0.000
177.000	0.0417	1311265.	-12809.	-0.002182	2290.1987	1.958E+10	-455.6548	32785.	0.000
180.000	0.0355	1270789.	-14157.	-0.001984	2219.5045	1.958E+10	-443.1109	37498.	0.000
183.000	0.0298	1226325.	-15466.	-0.001793	2141.8451	1.958E+10	-429.5866	43260.	0.000
186.000	0.0247	1177994.	-16733.	-0.001609	2057.4331	1.958E+10	-414.9926	50415.	0.000
189.000	0.0201	1125929.	-17954.	-0.001432	1966.4977	1.958E+10	-399.2104	59466.	0.000
192.000	0.0161	1070270.	-19126.	-0.001264	1869.2872	1.958E+10	-382.0774	71184.	0.000
195.000	0.0126	1011173.	-20244.	-0.001104	1766.0707	1.958E+10	-363.3593	86811.	0.000
198.000	0.009476	948806.	-21303.	-0.000954	1657.1427	1.958E+10	-342.6997	108492.	0.000
201.000	0.006832	883354.	-22296.	-0.000814	1542.8277	1.958E+10	-319.5140	140309.	0.000
204.000	0.004593	815027.	-23215.	-0.000684	1423.4903	1.958E+10	-292.7377	191205.	0.000
207.000	0.002729	744065.	-24044.	-0.000564	1299.5513	1.958E+10	-260.0865	285911.	0.000
210.000	0.001207	670762.	-24757.	-0.000456	1171.5241	1.958E+10	-214.8584	534023.	0.000
213.000	-6.705E-06	595526.	-25069.	-0.000359	1040.1195	1.958E+10	6.2856	2812500.	0.000
216.000	-0.000947	520346.	-24418.	-0.000273	908.8137	1.958E+10	428.1303	1356688.	0.000
219.000	-0.001648	449019.	-23037.	-0.000199	784.2376	1.958E+10	492.5446	896865.	0.000
222.000	-0.002142	382126.	-21509.	-0.000136	667.4039	1.958E+10	526.2174	736992.	0.000
225.000	-0.002461	319968.	-19902.	-8.177E-05	558.8418	1.958E+10	544.9159	664301.	0.000
228.000	-0.002633	262714.	-18253.	-3.713E-05	458.8452	1.958E+10	554.2452	631589.	0.000
231.000	-0.002684	210449.	-16586.	-8.859E-07	367.5609	1.958E+10	556.9357	622589.	0.000
234.000	-0.002638	163196.	-14919.	2.774E-05	285.0310	1.958E+10	554.5509	630664.	0.000
237.000	-0.002517	120934.	-13265.	4.950E-05	211.2180	1.958E+10	548.0801	653196.	0.000
240.000	-0.002341	83605.	-11636.	6.517E-05	146.0204	1.958E+10	538.1929	689718.	0.000
243.000	-0.002126	51119.	-10040.	7.549E-05	89.2826	1.958E+10	525.3631	741269.	0.000
246.000	-0.001888	23362.	-8487.5132	8.120E-05	40.8030	1.958E+10	509.9354	810286.	0.000
249.000	-0.001639	194.1492	-6984.3665	8.300E-05	0.3391	1.958E+10	492.1624	900831.	0.000
252.000	-0.001390	-18544.	-5537.7873	8.159E-05	32.3885	1.958E+10	472.2237	1019202.	0.000
255.000	-0.001149	-33033.	-4154.1022	7.764E-05	57.6933	1.958E+10	450.2330	1175075.	0.000
258.000	-0.000924	-43469.	-2839.4062	7.178E-05	75.9208	1.958E+10	426.2310	1383690.	0.000
261.000	-0.000719	-50069.	-1599.8231	6.462E-05	87.4483	1.958E+10	400.1577	1670209.	0.000
264.000	-0.000536	-53068.	-441.9085	5.672E-05	92.6859	1.958E+10	371.7854	2079306.	0.000
267.000	-0.000378	-52720.	626.5994	4.861E-05	92.0793	1.958E+10	340.5532	2699588.	0.000
270.000	-0.000245	-49308.	1481.5725	4.080E-05	86.1195	1.958E+10	229.4288	2812500.	0.000
273.000	-0.000134	-43831.	2013.6765	3.366E-05	76.5534	1.958E+10	125.3071	2812500.	0.000
276.000	-4.274E-05	-37226.	2261.7450	2.745E-05	65.0175	1.958E+10	40.0719	2812500.	0.000
279.000	3.106E-05	-30261.	2296.1097	2.228E-05	52.8518	1.958E+10	-17.1621	1657415.	0.000
282.000	9.096E-05	-23449.	2194.3152	1.817E-05	40.9558	1.958E+10	-50.7008	1672125.	0.000
285.000	0.000140	-17095.	2000.1138	1.506E-05	29.8568	1.958E+10	-78.7668	1686835.	0.000
288.000	0.000181	-11449.	1727.6763	1.288E-05	19.9959	1.958E+10	-102.8581	1701545.	0.000
291.000	0.000217	-6728.6076	1386.8735	1.149E-05	11.7519	1.958E+10	-124.3438	1716256.	0.000
294.000	0.000250	-3127.5340	983.7608	1.073E-05	5.4624	1.958E+10	-144.3981	1730966.	0.000
297.000	0.000282	-826.0430	521.2557	1.043E-05	1.4427	1.958E+10	-163.9387	1745676.	0.000
300.000	0.000313	0.000	0.000	1.036E-05	0.000	1.958E+10	-183.5651	880193.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

```
Pile-head deflection             =      1.0000000 inches
Computed slope at pile head      =     -0.0000145 radians
Maximum bending moment           =      -4189377. inch-lbs
Maximum shear force              =         63438. lbs
Depth of maximum bending moment  =       0.000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             20
Number of zero deflection points =              2
```

18 inch Dia CIDH

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 4

Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.250000 in
Moment at pile head = 0.000 in-lbs
Axial load at pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2500	0.000	14356.	-0.003230	0.000	1.958E+10	-132.7302	796.3815	0.000
3.000	0.2403	42470.	13953.	-0.003227	74.1767	1.958E+10	-135.9520	1697.2085	0.000
6.000	0.2306	83717.	13540.	-0.003217	146.2163	1.958E+10	-139.0440	1808.5894	0.000
9.000	0.2210	123712.	13119.	-0.003201	216.0703	1.958E+10	-142.0024	1927.5695	0.000
12.000	0.2114	162429.	12689.	-0.003179	283.6921	1.958E+10	-144.8233	2054.8891	0.000
15.000	0.2019	199843.	12250.	-0.003152	349.0375	1.958E+10	-147.5028	2191.3757	0.000
18.000	0.1925	235930.	11804.	-0.003118	412.0643	1.958E+10	-150.0369	2337.9575	0.000
21.000	0.1832	270666.	11350.	-0.003079	472.7327	1.958E+10	-152.4217	2495.6776	0.000
24.000	0.1740	304030.	10889.	-0.003035	531.0051	1.958E+10	-154.6531	2665.7118	0.000
27.000	0.1650	336002.	10422.	-0.002986	586.8465	1.958E+10	-156.7268	2849.3897	0.000
30.000	0.1561	366564.	9949.2984	-0.002932	640.2244	1.958E+10	-158.6388	3048.2188	0.000
33.000	0.1474	395698.	9470.7635	-0.002874	691.1086	1.958E+10	-160.3845	3263.9139	0.000
36.000	0.1389	423388.	8987.2471	-0.002811	739.4717	1.958E+10	-161.9597	3498.4317	0.000
39.000	0.1305	449621.	8499.2679	-0.002744	785.2890	1.958E+10	-163.3598	3754.0125	0.000
42.000	0.1224	474384.	8007.3580	-0.002674	828.5384	1.958E+10	-164.5801	4033.2301	0.000
45.000	0.1145	497665.	7512.0640	-0.002599	869.2008	1.958E+10	-165.6159	4339.0521	0.000
48.000	0.1068	519456.	7013.9464	-0.002521	907.2599	1.958E+10	-166.4624	4674.9129	0.000
51.000	0.0994	539749.	6513.5808	-0.002440	942.7023	1.958E+10	-167.1146	5044.8023	0.000
54.000	0.0922	558538.	6011.5579	-0.002356	975.5179	1.958E+10	-167.5674	5453.3738	0.000
57.000	0.0852	575819.	5508.4836	-0.002269	1005.6995	1.958E+10	-167.8155	5906.0770	0.000
60.000	0.0786	591589.	4951.2724	-0.002180	1033.2431	1.958E+10	-203.6586	7776.4879	0.000
63.000	0.0722	605526.	4239.9150	-0.002088	1057.5855	1.958E+10	-270.5797	11249.	0.000
66.000	0.0660	617028.	3427.3696	-0.001994	1077.6747	1.958E+10	-271.1173	12316.	0.000
69.000	0.0602	626090.	2613.8360	-0.001899	1093.5021	1.958E+10	-271.2385	13517.	0.000
72.000	0.0546	632711.	1800.5809	-0.001803	1105.0659	1.958E+10	-270.9315	14874.	0.000
75.000	0.0494	636894.	988.9074	-0.001705	1112.3710	1.958E+10	-270.1842	16414.	0.000
78.000	0.0444	638645.	180.1559	-0.001608	1115.4290	1.958E+10	-268.9835	18170.	0.000
81.000	0.0397	637975.	-624.2933	-0.001510	1114.2589	1.958E+10	-267.3159	20182.	0.000
84.000	0.0354	634899.	-1423.0174	-0.001412	1108.8868	1.958E+10	-265.1668	22502.	0.000
87.000	0.0313	629437.	-2214.5480	-0.001316	1099.3466	1.958E+10	-262.5203	25193.	0.000
90.000	0.0275	621612.	-2997.3670	-0.001220	1085.6798	1.958E+10	-259.3591	28336.	0.000
93.000	0.0239	611452.	-3769.9020	-0.001125	1067.9362	1.958E+10	-255.6642	32035.	0.000
96.000	0.0207	598992.	-4530.5195	-0.001033	1046.1738	1.958E+10	-251.4141	36425.	0.000
99.000	0.0177	584269.	-5277.5174	-0.000942	1020.4593	1.958E+10	-246.5845	41684.	0.000
102.000	0.0151	567327.	-6009.1143	-0.000854	990.8689	1.958E+10	-241.1467	48052.	0.000
105.000	0.0126	548215.	-6723.4352	-0.000768	957.4878	1.958E+10	-235.0672	55859.	0.000
108.000	0.0104	526987.	-7418.4929	-0.000686	920.4117	1.958E+10	-228.3046	65568.	0.000
111.000	0.008509	503704.	-8092.1605	-0.000607	879.7469	1.958E+10	-220.8072	77846.	0.000
114.000	0.006804	478434.	-8742.1322	-0.000532	835.6112	1.958E+10	-212.5074	93694.	0.000
117.000	0.005319	451251.	-9365.8633	-0.000460	788.1352	1.958E+10	-203.3134	114668.	0.000
120.000	0.004041	422238.	-9960.4739	-0.000394	737.4632	1.958E+10	-193.0937	143335.	0.000
123.000	0.002958	391488.	-10523.	-0.000331	683.7560	1.958E+10	-181.6471	184239.	0.000
126.000	0.002054	359103.	-11048.	-0.000274	627.1935	1.958E+10	-168.6390	246301.	0.000
129.000	0.001315	325200.	-11531.	-0.000221	567.9801	1.958E+10	-153.4428	349957.	0.000
132.000	0.000726	289916.	-11963.	-0.000174	506.3548	1.958E+10	-134.6445	556245.	0.000
135.000	0.000270	253420.	-12294.	-0.000133	442.6130	1.958E+10	-85.7079	951526.	0.000
138.000	-6.926E-05	216153.	-12325.	-9.660E-05	377.5240	1.958E+10	64.9280	2812500.	0.000
141.000	-0.000309	179471.	-11792.	-6.630E-05	313.4555	1.958E+10	290.0507	2812500.	0.000
144.000	-0.000467	145398.	-10820.	-4.141E-05	253.9464	1.958E+10	358.1070	2300326.	0.000
147.000	-0.000558	114549.	-9720.8413	-2.150E-05	200.0663	1.958E+10	374.8398	2015829.	0.000
150.000	-0.000596	87073.	-8586.6097	-6.052E-06	152.0784	1.958E+10	381.3146	1919337.	0.000
153.000	-0.000594	63029.	-7442.9404	5.447E-06	110.0844	1.958E+10	381.1315	1924405.	0.000
156.000	-0.000563	42416.	-6307.0219	1.352E-05	74.0813	1.958E+10	376.1475	2003163.	0.000
159.000	-0.000513	25187.	-5191.5823	1.870E-05	43.9909	1.958E+10	367.4789	2148955.	0.000
162.000	-0.000451	11266.	-4106.5627	2.150E-05	19.6770	1.958E+10	355.8675	2366590.	0.000
165.000	-0.000384	547.8688	-3060.0052	2.240E-05	0.9569	1.958E+10	341.8375	2670329.	0.000
168.000	-0.000317	-7093.8780	-2101.8705	2.190E-05	12.3899	1.958E+10	296.9189	2812500.	0.000
171.000	-0.000253	-12063.	-1301.2062	2.043E-05	21.0693	1.958E+10	236.8573	2812500.	0.000
174.000	-0.000194	-14901.	-672.9299	1.837E-05	26.0256	1.958E+10	181.9936	2812500.	0.000

177.000	-0.000142	-16101.	-199.6134	1.599E-05	28.1212	1.958E+10	133.5508	2812500.	0.000
180.000	-9.818E-05	-16099.	138.7814	1.352E-05	28.1175	1.958E+10	92.0457	2812500.	0.000
183.000	-6.131E-05	-15268.	363.0662	1.112E-05	26.6669	1.958E+10	57.4775	2812500.	0.000
186.000	-3.145E-05	-13920.	493.5150	8.885E-06	24.3128	1.958E+10	29.4883	2812500.	0.000
189.000	-7.997E-06	-12307.	548.9936	6.876E-06	21.4951	1.958E+10	7.4974	2812500.	0.000
192.000	9.803E-06	-10626.	554.2063	5.119E-06	18.5597	1.958E+10	-4.0222	1230876.	0.000
195.000	2.272E-05	-8981.9177	534.0235	3.617E-06	15.6874	1.958E+10	-9.4330	1245582.	0.000
198.000	3.151E-05	-7422.2957	500.0197	2.361E-06	12.9635	1.958E+10	-13.2362	1260288.	0.000
201.000	3.688E-05	-5981.7996	456.6518	1.334E-06	10.4475	1.958E+10	-15.6757	1274994.	0.000
204.000	3.951E-05	-4682.3848	407.6593	5.171E-07	8.1780	1.958E+10	-16.9860	1289701.	0.000
207.000	3.999E-05	-3535.8438	356.1010	-1.125E-07	6.1756	1.958E+10	-17.3863	1304408.	0.000
210.000	3.884E-05	-2545.7790	304.4067	-5.784E-07	4.4463	1.958E+10	-17.0766	1319115.	0.000
213.000	3.652E-05	-1709.4036	254.4386	-9.043E-07	2.9856	1.958E+10	-16.2355	1333822.	0.000
216.000	3.341E-05	-1019.1474	207.5578	-1.113E-06	1.7800	1.958E+10	-15.0184	1348529.	0.000
219.000	2.984E-05	-464.0569	164.6932	-1.227E-06	0.8105	1.958E+10	-13.5580	1363237.	0.000
222.000	2.605E-05	-30.9885	126.4091	-1.265E-06	0.0541	1.958E+10	-11.9647	1377945.	0.000
225.000	2.225E-05	294.3979	92.9709	-1.245E-06	0.5142	1.958E+10	-10.3275	1392653.	0.000
228.000	1.858E-05	526.8367	64.4047	-1.182E-06	0.9201	1.958E+10	-8.7166	1407361.	0.000
231.000	1.516E-05	680.8261	40.5530	-1.089E-06	1.1891	1.958E+10	-7.1845	1422069.	0.000
234.000	1.205E-05	770.1550	21.1232	-9.781E-07	1.3451	1.958E+10	-5.7687	1436777.	0.000
237.000	9.288E-06	807.5656	5.7297	-8.573E-07	1.4105	1.958E+10	-4.4937	1451486.	0.000
240.000	6.901E-06	804.5333	-6.0702	-7.338E-07	1.4052	1.958E+10	-3.3730	1466194.	0.000
243.000	4.885E-06	771.1444	-14.7468	-6.131E-07	1.3468	1.958E+10	-2.4114	1480903.	0.000
246.000	3.223E-06	716.0526	-20.7741	-4.991E-07	1.2506	1.958E+10	-1.6068	1495612.	0.000
249.000	1.890E-06	646.4995	-24.6117	-3.948E-07	1.1291	1.958E+10	-0.9516	1510321.	0.000
252.000	8.544E-07	568.3822	-26.6906	-3.017E-07	0.9927	1.958E+10	-0.4343	1525030.	0.000
255.000	7.991E-08	486.3559	-27.4036	-2.209E-07	0.8494	1.958E+10	-0.0410	1539739.	0.000
258.000	-4.711E-07	403.9605	-26.8027	-1.527E-07	0.7055	1.958E+10	0.4416	2812500.	0.000
261.000	-8.364E-07	325.5396	-24.9642	-9.683E-08	0.5686	1.958E+10	0.7841	2812500.	0.000
264.000	-1.052E-06	254.1755	-22.3086	-5.242E-08	0.4439	1.958E+10	0.9863	2812500.	0.000
267.000	-1.151E-06	191.6878	-19.2108	-1.827E-08	0.3348	1.958E+10	1.0789	2812500.	0.000
270.000	-1.162E-06	138.9106	-15.9589	7.060E-09	0.2426	1.958E+10	1.0890	2812500.	0.000
273.000	-1.109E-06	95.9346	-12.7665	2.505E-08	0.1676	1.958E+10	1.0392	2812500.	0.000
276.000	-1.011E-06	62.3117	-9.7855	3.717E-08	0.1088	1.958E+10	0.9481	2812500.	0.000
279.000	-8.855E-07	37.2218	-7.1181	4.480E-08	0.0650	1.958E+10	0.8301	2812500.	0.000
282.000	-7.425E-07	19.6032	-4.8287	4.915E-08	0.0342	1.958E+10	0.6961	2812500.	0.000
285.000	-5.906E-07	8.2498	-2.9539	5.128E-08	0.0144	1.958E+10	0.5537	2812500.	0.000
288.000	-4.348E-07	1.8795	-1.5119	5.206E-08	0.003283	1.958E+10	0.4077	2812500.	0.000
291.000	-2.782E-07	-0.8217	-0.5091	5.214E-08	0.001435	1.958E+10	0.2608	2812500.	0.000
294.000	-1.220E-07	-1.1753	0.0537	5.199E-08	0.002053	1.958E+10	0.1144	2812500.	0.000
297.000	3.368E-08	-0.4994	0.1959	5.186E-08	0.000872	1.958E+10	-0.0196	1745676.	0.000
300.000	1.891E-07	0.000	0.000	5.182E-08	0.000	1.958E+10	-0.1110	880193.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 4:

```
Pile-head deflection             =      0.2500000 inches
Computed slope at pile head      =     -0.0032300 radians
Maximum bending moment           =        638645. inch-lbs
Maximum shear force              =         14356. lbs
Depth of maximum bending moment  =     78.0000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             15
Number of zero deflection points =              4
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 5

```
Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head   =        0.500000 in
Moment at pile head       =           0.000 in-lbs
Axial load at pile head   =           0.000 lbs
```

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.5000	0.000	20468.	-0.005798	0.000	1.958E+10	-157.8438	473.5313	0.000
3.000	0.4826	60695.	19989.	-0.005793	106.0073	1.958E+10	-161.8418	1006.0482	0.000
6.000	0.4652	119933.	19498.	-0.005779	209.4705	1.958E+10	-165.7057	1068.5159	0.000
9.000	0.4479	177681.	18995.	-0.005757	310.3290	1.958E+10	-169.4318	1134.7653	0.000
12.000	0.4307	233903.	18481.	-0.005725	408.5243	1.958E+10	-173.0165	1205.1268	0.000
15.000	0.4136	288568.	17957.	-0.005685	503.9999	1.958E+10	-176.4559	1279.9653	0.000
18.000	0.3966	341645.	17423.	-0.005637	596.7017	1.958E+10	-179.7462	1359.6849	0.000
21.000	0.3798	393104.	16879.	-0.005580	686.5782	1.958E+10	-182.8837	1444.7340	0.000
24.000	0.3631	442917.	16326.	-0.005516	773.5799	1.958E+10	-185.8643	1535.6113	0.000
27.000	0.3467	491058.	15764.	-0.005445	857.6599	1.958E+10	-188.6842	1632.8726	0.000
30.000	0.3304	537500.	15194.	-0.005366	938.7741	1.958E+10	-191.3393	1737.1386	0.000
33.000	0.3145	582220.	14616.	-0.005280	1016.8806	1.958E+10	-193.8256	1849.1045	0.000
36.000	0.2988	625196.	14031.	-0.005188	1091.9404	1.958E+10	-196.1389	1969.5508	0.000
39.000	0.2833	666407.	13439.	-0.005089	1163.9170	1.958E+10	-198.2751	2099.3557	0.000
42.000	0.2682	705833.	12842.	-0.004984	1232.7770	1.958E+10	-200.2297	2239.5100	0.000
45.000	0.2534	743457.	12238.	-0.004873	1298.4895	1.958E+10	-201.9986	2391.1347	0.000
48.000	0.2390	779263.	11630.	-0.004756	1361.0268	1.958E+10	-203.5772	2555.5012	0.000
51.000	0.2249	813237.	11017.	-0.004634	1420.3641	1.958E+10	-204.9610	2734.0559	0.000
54.000	0.2112	845366.	10401.	-0.004507	1476.4796	1.958E+10	-206.1455	2928.4487	0.000
57.000	0.1979	875640.	9780.6180	-0.004375	1529.3547	1.958E+10	-207.1261	3140.5672	0.000
60.000	0.1849	904050.	9091.5621	-0.004239	1578.9740	1.958E+10	-252.2445	4091.9791	0.000
63.000	0.1724	930189.	8208.6169	-0.004098	1624.6283	1.958E+10	-336.3856	5852.8296	0.000
66.000	0.1603	953302.	7196.4285	-0.003954	1664.9949	1.958E+10	-338.4067	6331.6445	0.000
69.000	0.1487	973368.	6178.7942	-0.003807	1700.0421	1.958E+10	-340.0162	6859.8942	0.000
72.000	0.1375	990374.	5156.9642	-0.003656	1729.7446	1.958E+10	-341.2039	7444.3635	0.000
75.000	0.1268	1004310.	4132.2196	-0.003503	1754.0837	1.958E+10	-341.9592	8093.0126	0.000
78.000	0.1165	1015168.	3105.8739	-0.003349	1773.0475	1.958E+10	-342.2713	8815.2265	0.000
81.000	0.1067	1022945.	2079.2736	-0.003192	1786.6312	1.958E+10	-342.1289	9622.1298	0.000
84.000	0.0973	1027643.	1053.8000	-0.003035	1794.8369	1.958E+10	-341.5202	10527.	0.000
87.000	0.0885	1029268.	30.8702	-0.002878	1797.6743	1.958E+10	-340.4330	11546.	0.000
90.000	0.0801	1027829.	-988.0604	-0.002720	1795.1604	1.958E+10	-338.8541	12697.	0.000
93.000	0.0721	1023340.	-2001.4963	-0.002563	1787.3201	1.958E+10	-336.7698	14006.	0.000
96.000	0.0647	1015820.	-3007.8987	-0.002407	1774.1860	1.958E+10	-334.1651	15499.	0.000
99.000	0.0577	1005292.	-4005.6826	-0.002252	1755.7993	1.958E+10	-331.0241	17213.	0.000
102.000	0.0512	991785.	-4993.2124	-0.002099	1732.2091	1.958E+10	-327.3291	19191.	0.000
105.000	0.0451	975333.	-5968.7972	-0.001948	1703.4737	1.958E+10	-323.0608	21490.	0.000
108.000	0.0395	955973.	-6930.6844	-0.001800	1669.6601	1.958E+10	-318.1974	24180.	0.000
111.000	0.0343	933749.	-7877.0521	-0.001656	1630.8447	1.958E+10	-312.7144	27354.	0.000
114.000	0.0295	908710.	-8805.9988	-0.001515	1587.1138	1.958E+10	-306.5834	31131.	0.000
117.000	0.0252	880913.	-9715.5307	-0.001377	1538.5637	1.958E+10	-299.7711	35673.	0.000
120.000	0.0213	850417.	-10604.	-0.001245	1485.3015	1.958E+10	-292.2375	41200.	0.000
123.000	0.0177	817291.	-11468.	-0.001117	1427.4456	1.958E+10	-283.9334	48014.	0.000
126.000	0.0146	781610.	-12306.	-0.000995	1365.1265	1.958E+10	-274.7964	56554.	0.000
129.000	0.0118	743456.	-13115.	-0.000878	1298.4880	1.958E+10	-264.7448	67463.	0.000
132.000	0.009310	702919.	-13893.	-0.000767	1227.6879	1.958E+10	-253.6673	81737.	0.000
135.000	0.007171	660099.	-14635.	-0.000663	1152.9004	1.958E+10	-241.4045	100993.	0.000
138.000	0.005335	615107.	-15339.	-0.000565	1074.3182	1.958E+10	-227.7139	128051.	0.000
141.000	0.003782	568065.	-15999.	-0.000474	992.1566	1.958E+10	-212.1970	168340.	0.000
144.000	0.002489	519113.	-16608.	-0.000391	906.6595	1.958E+10	-194.1220	233943.	0.000
147.000	0.001436	468414.	-17157.	-0.000315	818.1110	1.958E+10	-171.8944	359183.	0.000
150.000	0.000597	416168.	-17626.	-0.000248	726.8605	1.958E+10	-140.6766	706478.	0.000
153.000	-4.969E-05	362656.	-17767.	-0.000188	633.3987	1.958E+10	46.5856	2812500.	0.000
156.000	-0.000530	309563.	-17144.	-0.000136	540.6692	1.958E+10	368.8378	2087485.	0.000
159.000	-0.000868	259790.	-15963.	-9.280E-05	453.7374	1.958E+10	418.6179	1446557.	0.000
162.000	-0.001087	213784.	-14670.	-5.652E-05	373.3859	1.958E+10	443.2855	1223576.	0.000
165.000	-0.001207	171768.	-13322.	-2.699E-05	300.0024	1.958E+10	455.3158	1131413.	0.000
168.000	-0.001249	133850.	-11950.	-3.575E-06	233.7760	1.958E+10	459.2972	1103391.	0.000
171.000	-0.001229	100065.	-10575.	1.434E-05	174.7693	1.958E+10	457.5039	1117003.	0.000
174.000	-0.001163	70398.	-9212.1392	2.740E-05	122.9541	1.958E+10	451.2535	1164307.	0.000
177.000	-0.001064	44792.	-7873.1765	3.623E-05	78.2322	1.958E+10	441.3883	1244124.	0.000
180.000	-0.000945	23159.	-6568.3704	4.143E-05	40.4485	1.958E+10	428.4824	1359736.	0.000
183.000	-0.000816	5382.0386	-5306.2320	4.362E-05	9.4000	1.958E+10	412.9433	1518639.	0.000
186.000	-0.000684	-8678.4127	-4094.2204	4.336E-05	15.1573	1.958E+10	395.0644	1733596.	0.000
189.000	-0.000556	-19183.	-2939.0516	4.123E-05	33.5047	1.958E+10	375.0481	2025235.	0.000
192.000	-0.000436	-26313.	-1846.9717	3.775E-05	45.9567	1.958E+10	353.0051	2427377.	0.000
195.000	-0.000329	-30265.	-854.6797	3.341E-05	52.8597	1.958E+10	308.5229	2812500.	0.000
198.000	-0.000236	-31441.	-60.2835	2.868E-05	54.9131	1.958E+10	221.0745	2812500.	0.000
201.000	-0.000157	-30627.	492.0891	2.393E-05	53.4915	1.958E+10	147.1739	2812500.	0.000

204.000	-9.223E-05	-28488.	842.5549	1.940E-05	49.7564	1.958E+10	86.4701	2812500.	0.000
207.000	-4.058E-05	-25571.	1029.3226	1.526E-05	44.6620	1.958E+10	38.0417	2812500.	0.000
210.000	-6.741E-07	-22312.	1087.3330	1.159E-05	38.9697	1.958E+10	0.6319	2812500.	0.000
213.000	2.897E-05	-19047.	1068.9575	8.424E-06	33.2675	1.958E+10	-12.8823	1333822.	0.000
216.000	4.987E-05	-15899.	1016.0095	5.747E-06	27.7678	1.958E+10	-22.4164	1348529.	0.000
219.000	6.346E-05	-12951.	939.1328	3.537E-06	22.6204	1.958E+10	-28.8348	1363237.	0.000
222.000	7.109E-05	-10264.	846.9022	1.758E-06	17.9263	1.958E+10	-32.6522	1377945.	0.000
225.000	7.401E-05	-7870.0174	746.3919	3.693E-07	13.7454	1.958E+10	-34.3546	1392653.	0.000
228.000	7.330E-05	-5785.4377	643.2768	-6.768E-07	10.1046	1.958E+10	-34.3887	1407361.	0.000
231.000	6.994E-05	-4010.3567	541.9605	-1.427E-06	7.0043	1.958E+10	-33.1555	1422069.	0.000
234.000	6.474E-05	-2533.6749	445.7175	-1.928E-06	4.4252	1.958E+10	-31.0065	1436777.	0.000
237.000	5.837E-05	-1336.0517	356.8431	-2.225E-06	2.3335	1.958E+10	-28.2431	1451486.	0.000
240.000	5.139E-05	-392.6163	276.8028	-2.357E-06	0.6857	1.958E+10	-25.1171	1466194.	0.000
243.000	4.423E-05	324.7652	206.3768	-2.363E-06	0.5672	1.958E+10	-21.8336	1480903.	0.000
246.000	3.722E-05	845.6444	145.7950	-2.273E-06	1.4770	1.958E+10	-18.5543	1495612.	0.000
249.000	3.059E-05	1199.5351	94.8608	-2.116E-06	2.0951	1.958E+10	-15.4018	1510321.	0.000
252.000	2.452E-05	1414.8092	53.0609	-1.916E-06	2.4710	1.958E+10	-12.4647	1525030.	0.000
255.000	1.910E-05	1517.9006	19.6611	-1.691E-06	2.6511	1.958E+10	-9.8018	1539739.	0.000
258.000	1.437E-05	1532.7755	-6.2125	-1.458E-06	2.6771	1.958E+10	-7.4472	1554448.	0.000
261.000	1.035E-05	1480.6253	-25.5056	-1.227E-06	2.5860	1.958E+10	-5.4148	1569157.	0.000
264.000	7.012E-06	1379.7418	-39.1812	-1.008E-06	2.4098	1.958E+10	-3.7022	1583867.	0.000
267.000	4.307E-06	1245.5383	-48.1767	-8.065E-07	2.1754	1.958E+10	-2.2948	1598576.	0.000
270.000	2.173E-06	1090.6815	-53.3720	-6.275E-07	1.9049	1.958E+10	-1.1687	1613286.	0.000
273.000	5.413E-07	925.3061	-55.5658	-4.731E-07	1.6161	1.958E+10	-0.2938	1627996.	0.000
276.000	-6.654E-07	757.2869	-55.0707	-3.442E-07	1.3226	1.958E+10	0.6238	2812500.	0.000
279.000	-1.524E-06	594.8820	-51.9918	-2.406E-07	1.0390	1.958E+10	1.4288	2812500.	0.000
282.000	-2.109E-06	445.3361	-46.8825	-1.610E-07	0.7778	1.958E+10	1.9774	2812500.	0.000
285.000	-2.490E-06	313.5871	-40.4150	-1.028E-07	0.5477	1.958E+10	2.3342	2812500.	0.000
288.000	-2.726E-06	202.8459	-33.0800	-6.326E-08	0.3543	1.958E+10	2.5558	2812500.	0.000
291.000	-2.869E-06	115.1071	-25.2112	-3.891E-08	0.2010	1.958E+10	2.6901	2812500.	0.000
294.000	-2.960E-06	51.5787	-17.0141	-2.614E-08	0.0901	1.958E+10	2.7747	2812500.	0.000
297.000	-3.026E-06	13.0225	-8.5964	-2.119E-08	0.0227	1.958E+10	2.8371	2812500.	0.000
300.000	-3.087E-06	0.000	0.000	-2.019E-08	0.000	1.958E+10	2.8939	1406250.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 5:

```
Pile-head deflection             =      0.5000000 inches
Computed slope at pile head      =     -0.0057979 radians
Maximum bending moment           =       1029268. inch-lbs
Maximum shear force              =         20468. lbs
Depth of maximum bending moment  =     87.0000000 inches below pile head
Depth of maximum shear force     =      0.000000 inches below pile head
Number of iterations             =             17
Number of zero deflection points =              3
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 6

```
Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head   =        1.000000 in
Moment at pile head       =           0.000 in-lbs
Axial load at pile head   =           0.000 lbs
```

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.0000	0.000	29237.	-0.0104	0.000	1.958E+10	-187.7089	281.5634	0.000
3.000	0.9688	86867.	28667.	-0.0104	151.7186	1.958E+10	-192.6414	596.5419	0.000
6.000	0.9376	172001.	28082.	-0.0104	300.4092	1.958E+10	-197.4352	631.7108	0.000
9.000	0.9065	255357.	27482.	-0.0103	445.9962	1.958E+10	-202.0867	668.7691	0.000

18 inch Dia CIDH

12.000	0.8756	336895.	26869.	-0.0103	588.4066	1.958E+10	-206.5923	707.8648	0.000
15.000	0.8447	416574.	26243.	-0.0102	727.5696	1.958E+10	-210.9484	749.1596	0.000
18.000	0.8141	494354.	25604.	-0.0102	863.4167	1.958E+10	-215.1514	792.8307	0.000
21.000	0.7837	570197.	24952.	-0.0101	995.8818	1.958E+10	-219.1976	839.0724	0.000
24.000	0.7536	644068.	24289.	-0.009996	1124.9014	1.958E+10	-223.0834	888.0981	0.000
27.000	0.7237	715931.	23614.	-0.009892	1250.4143	1.958E+10	-226.8049	940.1427	0.000
30.000	0.6942	785753.	22928.	-0.009777	1372.3621	1.958E+10	-230.3584	995.4651	0.000
33.000	0.6651	853502.	22232.	-0.009652	1490.6888	1.958E+10	-233.7400	1054.3516	0.000
36.000	0.6363	919147.	21526.	-0.009516	1605.3414	1.958E+10	-236.9459	1117.1186	0.000
39.000	0.6080	982659.	20811.	-0.009370	1716.2695	1.958E+10	-239.9721	1184.1173	0.000
42.000	0.5801	1044012.	20087.	-0.009215	1823.4254	1.958E+10	-242.8146	1255.7377	0.000
45.000	0.5527	1103179.	19354.	-0.009050	1926.7645	1.958E+10	-245.4695	1332.4138	0.000
48.000	0.5258	1160137.	18614.	-0.008877	2026.2451	1.958E+10	-247.9327	1414.6300	0.000
51.000	0.4994	1214864.	17867.	-0.008695	2121.8285	1.958E+10	-250.2000	1502.9274	0.000
54.000	0.4736	1267339.	17113.	-0.008505	2213.4789	1.958E+10	-252.2672	1597.9121	0.000
57.000	0.4484	1317544.	16354.	-0.008307	2301.1639	1.958E+10	-254.1302	1700.2645	0.000
60.000	0.4238	1365461.	15507.	-0.008101	2384.8543	1.958E+10	-310.3461	2196.9994	0.000
63.000	0.3998	1410585.	14419.	-0.007889	2463.6663	1.958E+10	-415.0858	3114.8051	0.000
66.000	0.3764	1451974.	13168.	-0.007670	2535.9536	1.958E+10	-418.8841	3338.2146	0.000
69.000	0.3538	1489592.	11906.	-0.007444	2601.6565	1.958E+10	-422.2732	3580.9166	0.000
72.000	0.3318	1523410.	10635.	-0.007213	2660.7216	1.958E+10	-425.2436	3845.1178	0.000
75.000	0.3105	1553401.	9355.2757	-0.006978	2713.1024	1.958E+10	-427.7862	4133.3409	0.000
78.000	0.2899	1579542.	8068.7596	-0.006738	2758.7587	1.958E+10	-429.8912	4448.4795	0.000
81.000	0.2701	1601814.	6776.5994	-0.006494	2797.6576	1.958E+10	-431.5490	4793.8646	0.000
84.000	0.2509	1620201.	5480.1517	-0.006247	2829.7730	1.958E+10	-432.7495	5173.3458	0.000
87.000	0.2326	1634694.	4180.8038	-0.005998	2855.0860	1.958E+10	-433.4824	5591.3895	0.000
90.000	0.2150	1645286.	2879.9745	-0.005747	2873.5851	1.958E+10	-433.7371	6053.2009	0.000
93.000	0.1981	1651974.	1579.1151	-0.005494	2885.2662	1.958E+10	-433.5025	6564.8735	0.000
96.000	0.1820	1654761.	279.7108	-0.005241	2890.1331	1.958E+10	-432.7670	7133.5769	0.000
99.000	0.1667	1653653.	-1016.7175	-0.004987	2888.1974	1.958E+10	-431.5185	7767.7907	0.000
102.000	0.1521	1648661.	-2308.6114	-0.004734	2879.4786	1.958E+10	-429.7441	8477.6013	0.000
105.000	0.1383	1639801.	-3594.3730	-0.004482	2864.0047	1.958E+10	-427.4303	9275.0805	0.000
108.000	0.1252	1627094.	-4872.3621	-0.004232	2841.8120	1.958E+10	-424.5624	10175.	0.000
111.000	0.1129	1610567.	-6140.8931	-0.003984	2812.9455	1.958E+10	-421.1249	11194.	0.000
114.000	0.1013	1590249.	-7398.2313	-0.003739	2777.4595	1.958E+10	-417.1006	12355.	0.000
117.000	0.0904	1566177.	-8642.5884	-0.003497	2735.4170	1.958E+10	-412.4709	13684.	0.000
120.000	0.0803	1538393.	-9872.1173	-0.003259	2686.8909	1.958E+10	-407.2150	15215.	0.000
123.000	0.0709	1506945.	-11085.	-0.003026	2631.9637	1.958E+10	-401.3099	16988.	0.000
126.000	0.0621	1471884.	-12279.	-0.002798	2570.7284	1.958E+10	-394.7292	19058.	0.000
129.000	0.0541	1433271.	-13452.	-0.002575	2503.2883	1.958E+10	-387.4424	21492.	0.000
132.000	0.0467	1391171.	-14603.	-0.002359	2429.7580	1.958E+10	-379.4141	24381.	0.000
135.000	0.0399	1345656.	-15728.	-0.002149	2350.2637	1.958E+10	-370.6016	27845.	0.000
138.000	0.0338	1296806.	-16825.	-0.001947	2264.9439	1.958E+10	-360.9529	32046.	0.000
141.000	0.0282	1244707.	-17892.	-0.001752	2173.9503	1.958E+10	-350.4030	37214.	0.000
144.000	0.0233	1189454.	-18926.	-0.001566	2077.4487	1.958E+10	-338.8679	43673.	0.000
147.000	0.0189	1131152.	-19923.	-0.001388	1975.6205	1.958E+10	-326.2355	51911.	0.000
150.000	0.0149	1069913.	-20881.	-0.001219	1868.6641	1.958E+10	-312.3503	62679.	0.000
153.000	0.0115	1005864.	-21795.	-0.001060	1756.7979	1.958E+10	-296.9856	77221.	0.000
156.000	0.008588	939141.	-22661.	-0.000911	1640.2634	1.958E+10	-279.7896	97737.	0.000
159.000	0.006070	869901.	-23470.	-0.000773	1519.3309	1.958E+10	-260.1693	128585.	0.000
162.000	0.003952	798319.	-24216.	-0.000645	1394.3087	1.958E+10	-236.9984	179922.	0.000
165.000	0.002200	724604.	-24883.	-0.000528	1265.5612	1.958E+10	-207.6736	283148.	0.000
168.000	0.000782	649020.	-25439.	-0.000423	1133.5493	1.958E+10	-163.0396	625451.	0.000
171.000	-0.000338	571968.	-25209.	-0.000330	998.9745	1.958E+10	316.8611	2812500.	0.000
174.000	-0.001195	497768.	-24052.	-0.000248	869.3805	1.958E+10	454.0908	1139874.	0.000
177.000	-0.001823	427655.	-22613.	-0.000177	746.9244	1.958E+10	505.2706	831290.	0.000
180.000	-0.002255	362090.	-21056.	-0.000116	632.4106	1.958E+10	533.0787	709125.	0.000
183.000	-0.002521	301322.	-19434.	-6.537E-05	526.2762	1.958E+10	548.2312	652506.	0.000
186.000	-0.002647	245489.	-17779.	-2.348E-05	428.7595	1.958E+10	555.0679	628986.	0.000
189.000	-0.002661	194650.	-16112.	1.023E-05	339.9680	1.958E+10	555.8362	626536.	0.000
192.000	-0.002586	148815.	-14451.	3.654E-05	259.9136	1.958E+10	551.8700	640211.	0.000
195.000	-0.002442	107946.	-12807.	5.621E-05	188.5341	1.958E+10	544.0322	668288.	0.000
198.000	-0.002249	71974.	-11191.	7.000E-05	125.7062	1.958E+10	532.9143	710945.	0.000
201.000	-0.002022	40798.	-9613.6628	7.863E-05	71.2552	1.958E+10	518.9373	769849.	0.000
204.000	-0.001777	14292.	-8081.6475	8.285E-05	24.9614	1.958E+10	502.4062	848205.	0.000
207.000	-0.001525	-7692.3517	-6602.7269	8.336E-05	13.4351	1.958E+10	483.5408	951164.	0.000
210.000	-0.001277	-25325.	-5183.6793	8.083E-05	44.2308	1.958E+10	462.4909	1086689.	0.000
213.000	-0.001040	-38794.	-3830.9332	7.592E-05	67.7567	1.958E+10	439.3398	1267184.	0.000
216.000	-0.000821	-48310.	-2550.7837	6.925E-05	84.3765	1.958E+10	414.0932	1512625.	0.000
219.000	-0.000625	-54099.	-1349.6738	6.140E-05	94.4872	1.958E+10	386.6467	1856985.	0.000
222.000	-0.000453	-56408.	-234.6485	5.294E-05	98.5202	1.958E+10	356.7035	2362988.	0.000
225.000	-0.000307	-55507.	732.1494	4.436E-05	96.9461	1.958E+10	287.8283	2812500.	0.000
228.000	-0.000187	-52015.	1426.4142	3.613E-05	90.8477	1.958E+10	175.0149	2812500.	0.000

231.000	-9.026E-05	-46949.	1815.8582	2.855E-05	81.9983	1.958E+10	84.6145	2812500.	0.000
234.000	-1.541E-05	-41120.	1964.4459	2.180E-05	71.8187	1.958E+10	14.4440	2812500.	0.000
237.000	4.054E-05	-35162.	1956.6888	1.596E-05	61.4122	1.958E+10	-19.6154	1451486.	0.000
240.000	8.033E-05	-29380.	1868.3761	1.101E-05	51.3139	1.958E+10	-39.2597	1466194.	0.000
243.000	0.000107	-23952.	1730.5441	6.927E-06	41.8328	1.958E+10	-52.6283	1480903.	0.000
246.000	0.000122	-18997.	1560.4520	3.637E-06	33.1790	1.958E+10	-60.7664	1495612.	0.000
249.000	0.000128	-14589.	1372.3143	1.064E-06	25.4803	1.958E+10	-64.6587	1510321.	0.000
252.000	0.000128	-10763.	1177.5165	-8.782E-07	18.7980	1.958E+10	-65.2065	1525030.	0.000
255.000	0.000123	-7523.7917	984.8862	-2.279E-06	13.1407	1.958E+10	-63.2137	1539739.	0.000
258.000	0.000115	-4853.5949	800.9969	-3.227E-06	8.4771	1.958E+10	-59.3791	1554448.	0.000
261.000	0.000104	-2717.8100	630.4878	-3.807E-06	4.7468	1.958E+10	-54.2937	1569157.	0.000
264.000	9.176E-05	-1070.6682	476.3830	-4.097E-06	1.8700	1.958E+10	-48.4428	1583867.	0.000
267.000	7.922E-05	140.4883	340.4013	-4.169E-06	0.2454	1.958E+10	-42.2117	1598576.	0.000
270.000	6.674E-05	971.7397	223.2454	-4.083E-06	1.6972	1.958E+10	-35.8923	1613286.	0.000
273.000	5.472E-05	1479.9609	124.8677	-3.896E-06	2.5848	1.958E+10	-29.6929	1627996.	0.000
276.000	4.337E-05	1720.9459	44.7062	-3.650E-06	3.0057	1.958E+10	-23.7481	1642706.	0.000
279.000	3.281E-05	1748.1981	-18.1094	-3.385E-06	3.0533	1.958E+10	-18.1290	1657415.	0.000
282.000	2.306E-05	1612.2895	-64.5842	-3.127E-06	2.8160	1.958E+10	-12.8542	1672125.	0.000
285.000	1.405E-05	1360.6928	-95.7163	-2.900E-06	2.3765	1.958E+10	-7.9005	1686835.	0.000
288.000	5.665E-06	1037.9916	-112.3867	-2.716E-06	1.8129	1.958E+10	-3.2131	1701545.	0.000
291.000	-2.244E-06	686.3723	-114.0513	-2.584E-06	1.1988	1.958E+10	2.1034	2812500.	0.000
294.000	-9.837E-06	353.6838	-97.0630	-2.504E-06	0.6177	1.958E+10	9.2221	2812500.	0.000
297.000	-1.727E-05	103.9942	-58.9473	-2.469E-06	0.1816	1.958E+10	16.1884	2812500.	0.000
300.000	-2.465E-05	0.000	0.000	-2.461E-06	0.000	1.958E+10	23.1098	1406250.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 6:

```
Pile-head deflection             =      1.0000000 inches
Computed slope at pile head      =     -0.0104031 radians
Maximum bending moment           =       1654761. inch-lbs
Maximum shear force              =         29237. lbs
Depth of maximum bending moment  =     96.0000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             21
Number of zero deflection points =              3
```

Summary of Pile Response(s)

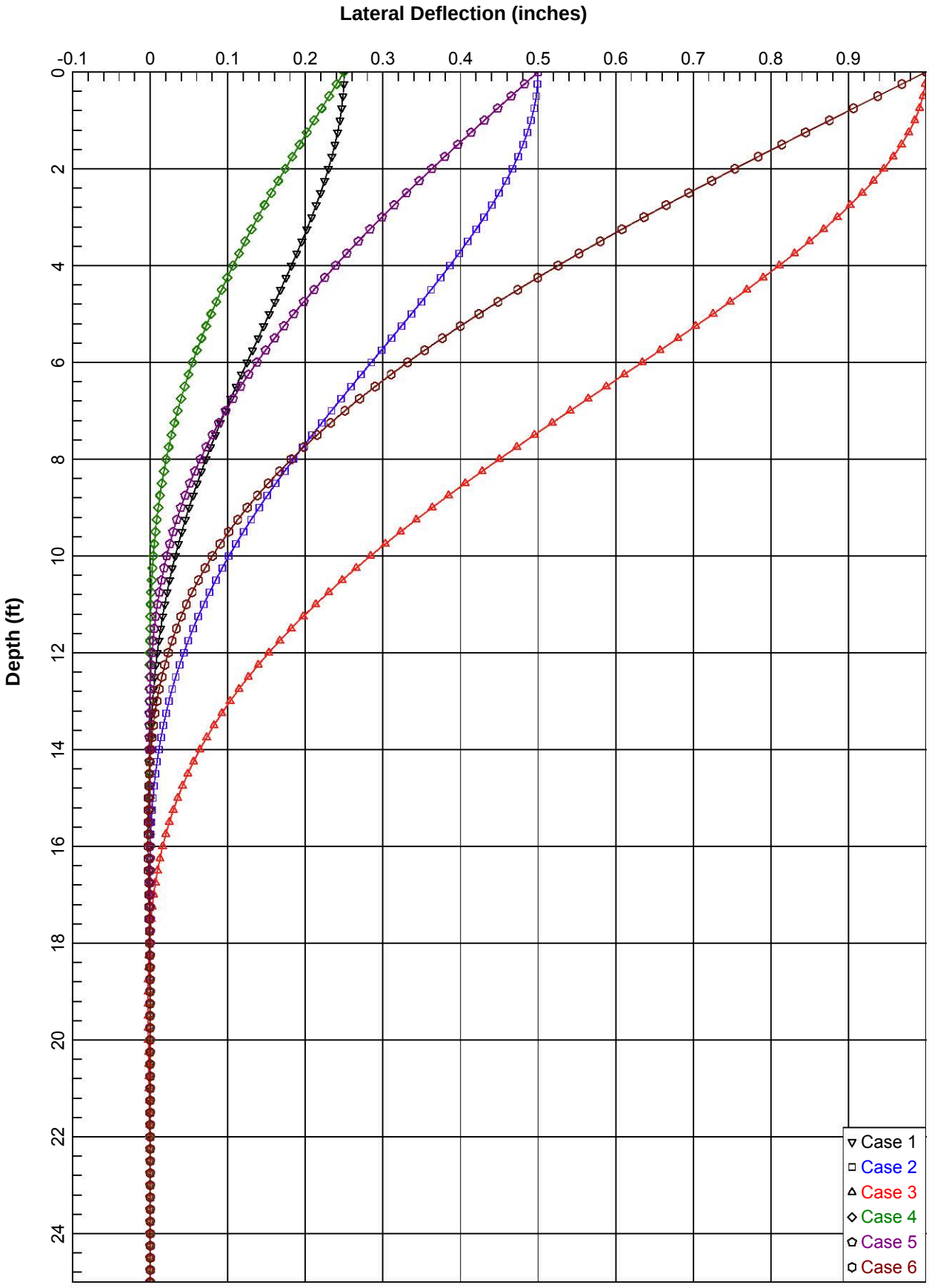
Definitions of Pile-Head Loading Conditions:

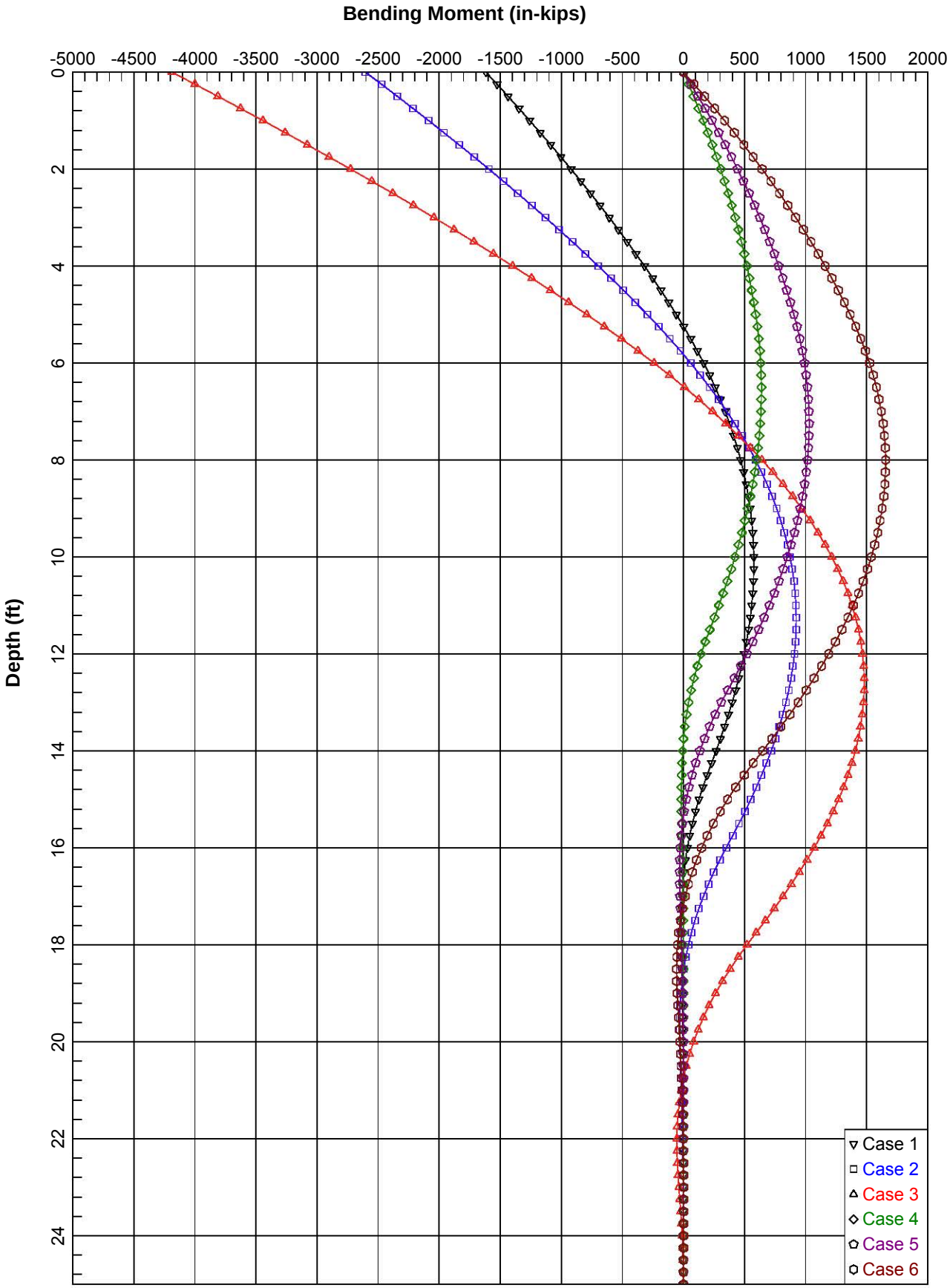
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

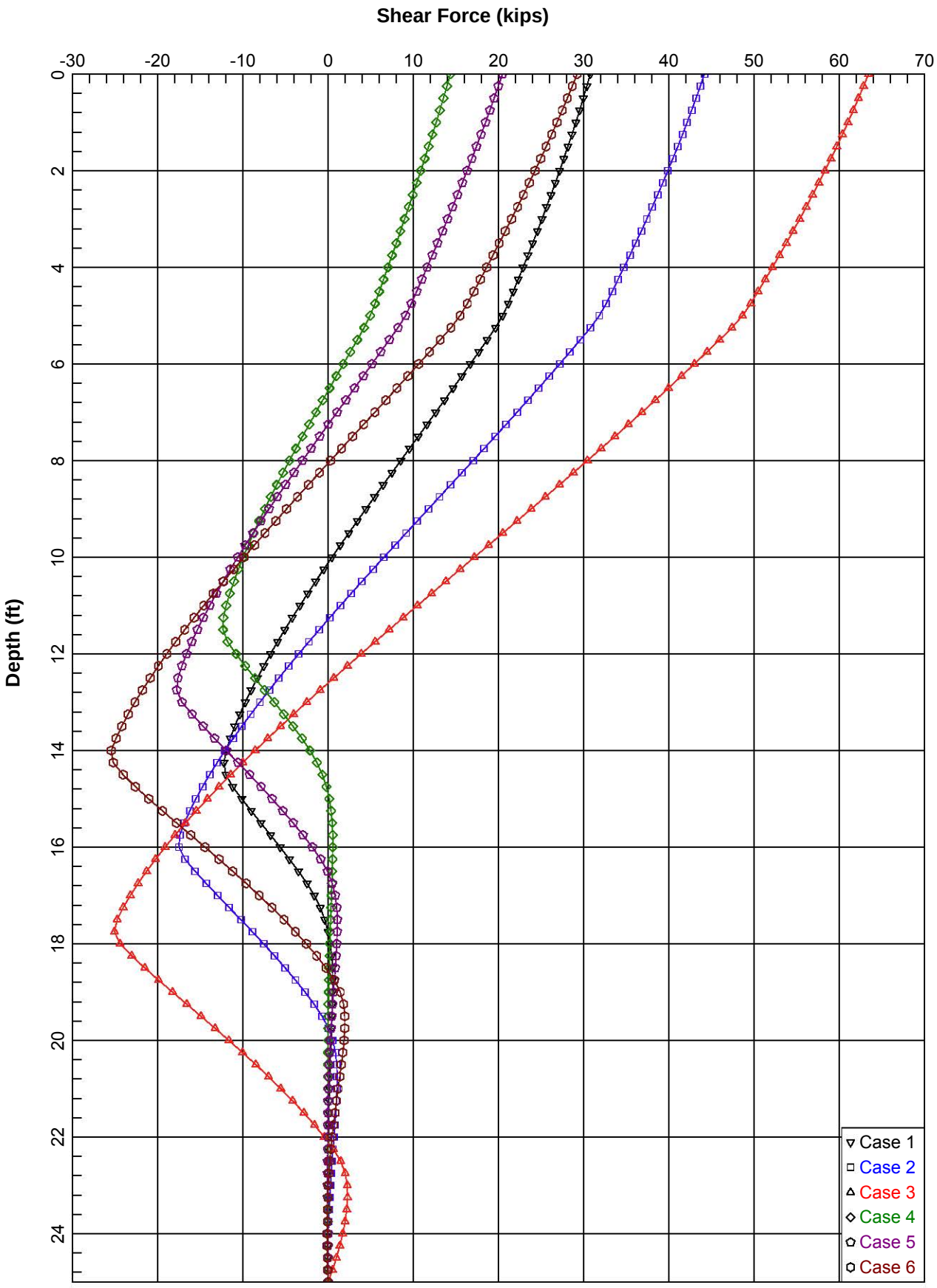
Load Case	Load Type	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	5	y = 0.2500	S = 0.000	0.0000000	0.25000000	-1618042.	30784.	0.00000000
2	5	y = 0.5000	S = 0.000	0.0000000	0.50000000	-2604361.	44181.	0.00000000

```
  3    5   y =     1.0000  S =      0.000      0.0000000     1.00000000      -4189377.         63438.
0.00000000
  4     4   y =     0.2500  M =      0.000      0.0000000     0.25000000        638645.         14356.
0.00000000
  5     4   y =     0.5000  M =      0.000      0.0000000     0.50000000       1029268.         20468.
0.00000000
  6     4   y =     1.0000  M =      0.000      0.0000000     1.00000000       1654761.         29237.
0.00000000
```

The analysis ended normally.


Lateral Deflection (inches)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6


Bending Moment (in-kips)
-5000
-4500
-4000
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6


Shear Force (kips)
-30
-20
-10
0
10
20
30
40
50
60
70
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

LPile Plus for Windows, Version 6.0 (6.0.08)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Leighton and Associates, INc.

Files Used for Analysis

Path to file locations: P:\Leighton Consulting\603000\603507.002 Ford Theatre\Analyses\LPile\
Name of input data file: 24 inch Dia CIDH.lp6d
Name of output file: 24 inch Dia CIDH.lp6o
Name of plot output file: 24 inch Dia CIDH.lp6p
Name of runtime file: 24 inch Dia CIDH.lp6r

Date and Time of Analysis

Date: July 10, 2013 Time: 15:24:54

Problem Title

Ford Theater Foundation

603507-002

Ford Theater Foundation

SP

Drilled, Cast-in-Place Concrete Caissons - 24-inch Diameter

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip

- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100
- Maximum number of iterations allowed	=	1000
- Deflection tolerance for convergence	=	1.0000E-05 in
- Maximum allowable deflection	=	100.0000 in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections	=	1
Total Pile Length	=	25.00 ft
Depth of ground surface below top of pile	=	0.00 ft
Slope angle of ground surface	=	45.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	25.000000	24.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	25.000 in
Top Width	=	24.000 in
Bottom Width	=	24.000 in
Top Area	=	452.389342 sq. in
Bottom Area	=	452.389342 sq. in
Moment of Inertia at Top	=	1.629E+04 in^4
Moment of Inertia at Bottom	=	1.629E+04 in^4
Elastic Modulus	=	3800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	45.000 degrees
	=	0.785 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer = 0.000 ft
Distance from top of pile to bottom of layer = 5.000 ft

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer = 5.000 ft
Distance from top of pile to bottom of layer = 50.000 ft

(Depth of lowest layer extends 25.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	0.00	120.00000
2	5.00	120.00000
3	5.00	130.00000
4	50.00	130.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion Test Prop. psf	Friction Ang., deg.	qu Subgr. psi
		kpy pci	Rock Emass psi	krm	Test Type	RQD percent	Epsilon 50	
1	Stiff Clay w/o Free Water	0.00	120.000	1500.000	--	--
--	0.00	--	--	--	--	--	--	
				5.000	120.000	1500.000	--	--
--	0.00	--	--	--	--	--	--	
2	Stiff Clay w/o Free Water	5.000	130.000	3000.000	--	--
--	0.00	--	--	--	--	--	--	
				50.000	130.000	3000.000	--	--
--	0.00	--	--	--	--	--	--	

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 6

Load	Load	Condition 1	Condition 2	Axial Thrust

24 inch Dia CIDH

No.	Type				Force, lbs
1	5	y =	0.250 in	S = 0.000 in/in	0.000
2	5	y =	0.500 in	S = 0.000 in/in	0.000
3	5	y =	1.000 in	S = 0.000 in/in	0.000
4	4	y =	0.250 in	M = 0.000 in-lbs	0.000
5	4	y =	0.500 in	M = 0.000 in-lbs	0.000
6	4	y =	1.000 in	M = 0.000 in-lbs	0.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

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Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 0.250000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2500	-3325652.	50912.	0.000	2450.4352	6.189E+10	-164.6925	988.1553	0.000
3.000	0.2498	-3173677.	50405.	-0.000158	2338.4558	6.189E+10	-169.1807	2032.1336	0.000
6.000	0.2491	-3023225.	49890.	-0.000308	2227.5983	6.189E+10	-173.5862	2090.9395	0.000
9.000	0.2479	-2874335.	49363.	-0.000451	2117.8919	6.189E+10	-177.9063	2152.8574	0.000
12.000	0.2464	-2727046.	48823.	-0.000586	2009.3654	6.189E+10	-182.1380	2218.0322	0.000
15.000	0.2444	-2581397.	48270.	-0.000715	1902.0467	6.189E+10	-186.2785	2286.6252	0.000
18.000	0.2421	-2437424.	47706.	-0.000837	1795.9632	6.189E+10	-190.3251	2358.8152	0.000
21.000	0.2394	-2295164.	47129.	-0.000951	1691.1419	6.189E+10	-194.2748	2434.7985	0.000
24.000	0.2364	-2154652.	46540.	-0.001059	1587.6089	6.189E+10	-198.1248	2514.7907	0.000
27.000	0.2330	-2015924.	45940.	-0.001160	1485.3898	6.189E+10	-201.8724	2599.0277	0.000
30.000	0.2294	-1879012.	45329.	-0.001255	1384.5094	6.189E+10	-205.5148	2687.7671	0.000
33.000	0.2255	-1743950.	44707.	-0.001343	1284.9919	6.189E+10	-209.0492	2781.2898	0.000
36.000	0.2213	-1610769.	44075.	-0.001424	1186.8606	6.189E+10	-212.4729	2879.9023	0.000
39.000	0.2169	-1479501.	43432.	-0.001499	1090.1384	6.189E+10	-215.7831	2983.9386	0.000
42.000	0.2123	-1350175.	42780.	-0.001567	994.8471	6.189E+10	-218.9770	3093.7625	0.000
45.000	0.2075	-1222819.	42119.	-0.001630	901.0079	6.189E+10	-222.0520	3209.7707	0.000
48.000	0.2026	-1097462.	41448.	-0.001686	808.6413	6.189E+10	-225.0054	3332.3956	0.000
51.000	0.1974	-974130.	40769.	-0.001736	717.7668	6.189E+10	-227.8345	3462.1087	0.000
54.000	0.1921	-852849.	40081.	-0.001781	628.4032	6.189E+10	-230.5366	3599.4245	0.000
57.000	0.1867	-733642.	39386.	-0.001819	540.5683	6.189E+10	-233.1091	3744.9046	0.000
60.000	0.1812	-616533.	38592.	-0.001852	454.2793	6.189E+10	-296.4587	4907.4231	0.000
63.000	0.1756	-502093.	37551.	-0.001879	369.9563	6.189E+10	-397.3339	6786.9689	0.000
66.000	0.1700	-391228.	36352.	-0.001900	288.2682	6.189E+10	-401.9910	7095.7105	0.000
69.000	0.1642	-283982.	35139.	-0.001917	209.2458	6.189E+10	-406.4011	7423.8351	0.000
72.000	0.1585	-180393.	33914.	-0.001928	132.9185	6.189E+10	-410.5585	7772.9247	0.000
75.000	0.1527	-80499.	32676.	-0.001934	59.3138	6.189E+10	-414.4575	8144.7252	0.000
78.000	0.1469	15665.	31427.	-0.001936	11.5425	6.189E+10	-418.0924	8541.1659	0.000
81.000	0.1410	108066.	30168.	-0.001933	79.6262	6.189E+10	-421.4576	8964.3826	0.000
84.000	0.1353	196674.	28899.	-0.001926	144.9150	6.189E+10	-424.5477	9416.7436	0.000
87.000	0.1295	281461.	27621.	-0.001914	207.3884	6.189E+10	-427.3570	9900.8807	0.000
90.000	0.1238	362402.	26335.	-0.001898	267.0279	6.189E+10	-429.8799	10420.	0.000
93.000	0.1181	439474.	25042.	-0.001879	323.8166	6.189E+10	-432.1109	10977.	0.000

96.000	0.1125	512656.	23743.	-0.001856	377.7398	6.189E+10	-434.0443	11575.	0.000
99.000	0.1070	581933.	22439.	-0.001829	428.7847	6.189E+10	-435.6744	12219.	0.000
102.000	0.1015	647288.	21130.	-0.001800	476.9404	6.189E+10	-436.9954	12914.	0.000
105.000	0.0962	708711.	19817.	-0.001767	522.1981	6.189E+10	-438.0014	13664.	0.000
108.000	0.0909	766191.	18502.	-0.001731	564.5513	6.189E+10	-438.6866	14475.	0.000
111.000	0.0858	819723.	17186.	-0.001692	603.9954	6.189E+10	-439.0448	15354.	0.000
114.000	0.0808	869304.	15868.	-0.001652	640.5279	6.189E+10	-439.0699	16309.	0.000
117.000	0.0759	914933.	14552.	-0.001608	674.1488	6.189E+10	-438.7554	17348.	0.000
120.000	0.0711	956614.	13236.	-0.001563	704.8601	6.189E+10	-438.0949	18481.	0.000
123.000	0.0665	994351.	11924.	-0.001516	732.6662	6.189E+10	-437.0816	19719.	0.000
126.000	0.0620	1028155.	10614.	-0.001467	757.5738	6.189E+10	-435.7085	21076.	0.000
129.000	0.0577	1058037.	9309.8559	-0.001416	779.5920	6.189E+10	-433.9685	22565.	0.000
132.000	0.0535	1084014.	8011.1223	-0.001364	798.7324	6.189E+10	-431.8539	24205.	0.000
135.000	0.0495	1106104.	6719.3058	-0.001311	815.0090	6.189E+10	-429.3570	26016.	0.000
138.000	0.0457	1124330.	5435.5661	-0.001257	828.4383	6.189E+10	-426.4695	28022.	0.000
141.000	0.0420	1138718.	4161.0879	-0.001202	839.0395	6.189E+10	-423.1826	30250.	0.000
144.000	0.0384	1149296.	2897.0831	-0.001147	846.8343	6.189E+10	-419.4872	32734.	0.000
147.000	0.0351	1156100.	1644.7924	-0.001091	851.8474	6.189E+10	-415.3733	35514.	0.000
150.000	0.0319	1159165.	405.4868	-0.001035	854.1059	6.189E+10	-410.8304	38636.	0.000
153.000	0.0289	1158533.	-819.5295	-0.000979	853.6400	6.189E+10	-405.8471	42159.	0.000
156.000	0.0260	1154248.	-2028.9165	-0.000922	850.4828	6.189E+10	-400.4109	46150.	0.000
159.000	0.0233	1146359.	-3221.2949	-0.000867	844.6702	6.189E+10	-394.5081	50697.	0.000
162.000	0.0208	1134920.	-4395.2422	-0.000811	836.2415	6.189E+10	-388.1235	55903.	0.000
165.000	0.0185	1119988.	-5549.2874	-0.000757	825.2390	6.189E+10	-381.2400	61901.	0.000
168.000	0.0163	1101625.	-6681.9051	-0.000703	811.7083	6.189E+10	-373.8384	68856.	0.000
171.000	0.0143	1079897.	-7791.5074	-0.000650	795.6985	6.189E+10	-365.8964	76982.	0.000
174.000	0.0124	1054876.	-8876.4338	-0.000598	777.2623	6.189E+10	-357.3879	86552.	0.000
177.000	0.0107	1026638.	-9934.9384	-0.000548	756.4560	6.189E+10	-348.2819	97930.	0.000
180.000	0.009100	995266.	-10965.	-0.000499	733.3402	6.189E+10	-338.5408	111602.	0.000
183.000	0.007676	960847.	-11965.	-0.000451	707.9793	6.189E+10	-328.1179	128234.	0.000
186.000	0.006392	923475.	-12933.	-0.000406	680.4426	6.189E+10	-316.9538	148762.	0.000
189.000	0.005242	883250.	-13866.	-0.000362	650.8040	6.189E+10	-304.9706	174545.	0.000
192.000	0.004220	840281.	-14761.	-0.000320	619.1429	6.189E+10	-292.0623	207627.	0.000
195.000	0.003321	794683.	-15616.	-0.000281	585.5451	6.189E+10	-278.0786	251236.	0.000
198.000	0.002537	746582.	-16428.	-0.000243	550.1032	6.189E+10	-262.7956	310804.	0.000
201.000	0.001861	696117.	-17191.	-0.000208	512.9186	6.189E+10	-245.8558	396273.	0.000
204.000	0.001287	643438.	-17899.	-0.000176	474.1036	6.189E+10	-226.6344	528223.	0.000
207.000	0.000807	588720.	-18545.	-0.000146	433.7857	6.189E+10	-203.8796	758277.	0.000
210.000	0.000412	532167.	-19083.	-0.000119	392.1158	6.189E+10	-154.8237	1128189.	0.000
213.000	9.417E-05	474221.	-19369.	-9.435E-05	349.4192	6.189E+10	-35.7721	1139641.	0.000
216.000	-0.000154	415952.	-19206.	-7.277E-05	306.4853	6.189E+10	144.7483	2812500.	0.000
219.000	-0.000342	358986.	-18507.	-5.399E-05	264.5114	6.189E+10	321.0681	2812500.	0.000
222.000	-0.000478	304910.	-17353.	-3.790E-05	224.6665	6.189E+10	448.4446	2812500.	0.000
225.000	-0.000570	254870.	-15977.	-2.433E-05	187.7956	6.189E+10	468.7863	2467872.	0.000
228.000	-0.000624	209049.	-14554.	-1.309E-05	154.0333	6.189E+10	479.7553	2305303.	0.000
231.000	-0.000648	167546.	-13108.	-3.959E-06	123.4526	6.189E+10	484.4056	2241276.	0.000
234.000	-0.000648	130402.	-11655.	3.263E-06	96.0841	6.189E+10	484.4115	2242360.	0.000
237.000	-0.000629	97618.	-10207.	8.789E-06	71.9281	6.189E+10	480.8148	2293917.	0.000
240.000	-0.000595	69162.	-8774.0332	1.283E-05	50.9605	6.189E+10	474.3198	2390135.	0.000
243.000	-0.000552	44974.	-7364.4085	1.560E-05	33.1383	6.189E+10	465.4301	2530324.	0.000
246.000	-0.000502	24975.	-5984.4862	1.729E-05	18.4026	6.189E+10	454.5181	2717552.	0.000
249.000	-0.000448	9067.3367	-4672.6223	1.812E-05	6.6811	6.189E+10	420.0579	2812500.	0.000
252.000	-0.000393	-3060.2697	-3489.8138	1.826E-05	2.2549	6.189E+10	368.4811	2812500.	0.000
255.000	-0.000338	-11872.	-2461.1096	1.790E-05	8.7473	6.189E+10	317.3216	2812500.	0.000
258.000	-0.000286	-17827.	-1583.4563	1.718E-05	13.1354	6.189E+10	267.7806	2812500.	0.000
261.000	-0.000235	-21372.	-850.7801	1.623E-05	15.7477	6.189E+10	220.6701	2812500.	0.000
264.000	-0.000188	-22932.	-255.0647	1.516E-05	16.8967	6.189E+10	176.4735	2812500.	0.000
267.000	-0.000144	-22903.	212.7504	1.405E-05	16.8753	6.189E+10	135.4033	2812500.	0.000
270.000	-0.000104	-21655.	562.0386	1.297E-05	15.9561	6.189E+10	97.4555	2812500.	0.000
273.000	-6.662E-05	-19530.	801.9122	1.197E-05	14.3906	6.189E+10	62.4602	2812500.	0.000
276.000	-3.214E-05	-16844.	940.7940	1.109E-05	12.4109	6.189E+10	30.1276	2812500.	0.000
279.000	-9.754E-08	-13886.	986.1226	1.034E-05	10.2314	6.189E+10	0.0914	2812500.	0.000
282.000	2.992E-05	-10927.	965.2686	9.742E-06	8.0512	6.189E+10	-13.9941	1403073.	0.000
285.000	5.835E-05	-8094.0641	903.0073	9.281E-06	5.9639	6.189E+10	-27.5134	1414528.	0.000
288.000	8.560E-05	-5508.8528	800.7015	8.951E-06	4.0591	6.189E+10	-40.6904	1425983.	0.000
291.000	0.000112	-3289.8550	659.1285	8.738E-06	2.4241	6.189E+10	-53.6916	1437437.	0.000
294.000	0.000138	-1554.0815	478.5955	8.620E-06	1.1451	6.189E+10	-66.6637	1448892.	0.000
297.000	0.000164	-418.2817	259.0136	8.572E-06	0.3082	6.189E+10	-79.7242	1460347.	0.000
300.000	0.000189	0.000	0.000	8.562E-06	0.000	6.189E+10	-92.9515	735901.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships. The above values of total stress are computed for combined axial stress and do not equal the actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      0.2500000 inches
Computed slope at pile head      =   -0.000003684 radians
Maximum bending moment           =      -3325652. inch-lbs
Maximum shear force              =         50912. lbs
Depth of maximum bending moment  =       0.000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             16
Number of zero deflection points =              2
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 0.500000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.5000	-5331546.	72832.	0.000	3928.4351	6.189E+10	-195.8535	587.5606	0.000
3.000	0.4996	-5113956.	72228.	-0.000253	3768.1082	6.189E+10	-201.2005	1208.1398	0.000
6.000	0.4985	-4898176.	71617.	-0.000496	3609.1155	6.189E+10	-206.4684	1242.5854	0.000
9.000	0.4966	-4684255.	70990.	-0.000728	3451.4921	6.189E+10	-211.6541	1278.5234	0.000
12.000	0.4941	-4472238.	70347.	-0.000950	3295.2722	6.189E+10	-216.7547	1316.0246	0.000
15.000	0.4909	-4262172.	69689.	-0.001162	3140.4897	6.189E+10	-221.7670	1355.1657	0.000
18.000	0.4871	-4054102.	69017.	-0.001363	2987.1778	6.189E+10	-226.6882	1396.0299	0.000
21.000	0.4828	-3848073.	68329.	-0.001555	2835.3693	6.189E+10	-231.5153	1438.7068	0.000
24.000	0.4778	-3644126.	67628.	-0.001736	2685.0960	6.189E+10	-236.2455	1483.2932	0.000
27.000	0.4723	-3442307.	66912.	-0.001908	2536.3893	6.189E+10	-240.8759	1529.8932	0.000
30.000	0.4664	-3242654.	66183.	-0.002070	2389.2801	6.189E+10	-245.4035	1578.6191	0.000
33.000	0.4599	-3045211.	65440.	-0.002223	2243.7982	6.189E+10	-249.8258	1629.5917	0.000
36.000	0.4530	-2850016.	64684.	-0.002366	2099.9730	6.189E+10	-254.1397	1682.9409	0.000
39.000	0.4457	-2657108.	63915.	-0.002499	1957.8331	6.189E+10	-258.3427	1738.8067	0.000
42.000	0.4380	-2466526.	63134.	-0.002623	1817.4064	6.189E+10	-262.4319	1797.3397	0.000
45.000	0.4300	-2278305.	62341.	-0.002738	1678.7200	6.189E+10	-266.4047	1858.7021	0.000
48.000	0.4216	-2092482.	61536.	-0.002844	1541.8003	6.189E+10	-270.2584	1923.0689	0.000
51.000	0.4129	-1909091.	60719.	-0.002941	1406.6728	6.189E+10	-273.9903	1990.6281	0.000
54.000	0.4040	-1728166.	59892.	-0.003029	1273.3622	6.189E+10	-277.5978	2061.5829	0.000
57.000	0.3947	-1549740.	59054.	-0.003109	1141.8925	6.189E+10	-281.0783	2136.1522	0.000
60.000	0.3853	-1373843.	58095.	-0.003180	1012.2868	6.189E+10	-357.9781	2787.2251	0.000
63.000	0.3757	-1201168.	56838.	-0.003242	885.0550	6.189E+10	-480.5127	3837.2733	0.000
66.000	0.3659	-1032818.	55386.	-0.003296	761.0097	6.189E+10	-486.9186	3992.7291	0.000
69.000	0.3559	-868850.	53916.	-0.003342	640.1933	6.189E+10	-493.0834	4156.4763	0.000
72.000	0.3458	-709320.	52428.	-0.003380	522.6468	6.189E+10	-499.0013	4329.0964	0.000
75.000	0.3356	-554280.	50923.	-0.003411	408.4095	6.189E+10	-504.6667	4511.2224	0.000
78.000	0.3253	-403783.	49401.	-0.003434	297.5188	6.189E+10	-510.0741	4703.5439	0.000
81.000	0.3150	-257876.	47863.	-0.003450	190.0106	6.189E+10	-515.2179	4906.8133	0.000
84.000	0.3046	-116607.	46310.	-0.003459	85.9191	6.189E+10	-520.0928	5121.8518	0.000
87.000	0.2942	19982.	44743.	-0.003462	14.7235	6.189E+10	-524.6934	5349.5578	0.000
90.000	0.2839	151849.	43162.	-0.003458	111.8865	6.189E+10	-529.0142	5590.9150	0.000
93.000	0.2735	278954.	41569.	-0.003447	205.5414	6.189E+10	-533.0500	5847.0019	0.000
96.000	0.2632	401262.	39964.	-0.003431	295.6615	6.189E+10	-536.7955	6119.0034	0.000
99.000	0.2529	518739.	38349.	-0.003408	382.2218	6.189E+10	-540.2452	6408.2231	0.000
102.000	0.2427	631354.	36723.	-0.003381	465.1995	6.189E+10	-543.3939	6716.0973	0.000
105.000	0.2326	739078.	35089.	-0.003347	544.5736	6.189E+10	-546.2361	7044.2119	0.000
108.000	0.2226	841886.	33446.	-0.003309	620.3255	6.189E+10	-548.7664	7394.3209	0.000
111.000	0.2128	939755.	31797.	-0.003266	692.4382	6.189E+10	-550.9793	7768.3681	0.000
114.000	0.2030	1032665.	30141.	-0.003218	760.8972	6.189E+10	-552.8692	8168.5118	0.000
117.000	0.1935	1120600.	28480.	-0.003166	825.6898	6.189E+10	-554.4305	8597.1535	0.000
120.000	0.1841	1203544.	26815.	-0.003109	886.8057	6.189E+10	-555.6576	9056.9714	0.000

123.000	0.1748	1281488.	25146.	-0.003049	944.2368	6.189E+10	-556.5446	9550.9588	0.000
126.000	0.1658	1354423.	23476.	-0.002985	997.9772	6.189E+10	-557.0856	10082.	0.000
129.000	0.1569	1422344.	21804.	-0.002918	1048.0233	6.189E+10	-557.2746	10655.	0.000
132.000	0.1483	1485249.	20133.	-0.002848	1094.3739	6.189E+10	-557.1054	11274.	0.000
135.000	0.1398	1543141.	18462.	-0.002774	1137.0301	6.189E+10	-556.5716	11942.	0.000
138.000	0.1316	1596023.	16794.	-0.002698	1175.9953	6.189E+10	-555.6668	12667.	0.000
141.000	0.1236	1643905.	15129.	-0.002620	1211.2757	6.189E+10	-554.3843	13453.	0.000
144.000	0.1159	1686797.	13468.	-0.002539	1242.8797	6.189E+10	-552.7170	14308.	0.000
147.000	0.1084	1724714.	11813.	-0.002456	1270.8184	6.189E+10	-550.6579	15240.	0.000
150.000	0.1012	1757676.	10165.	-0.002372	1295.1055	6.189E+10	-548.1994	16259.	0.000
153.000	0.0942	1785704.	8524.5988	-0.002286	1315.7572	6.189E+10	-545.3336	17374.	0.000
156.000	0.0874	1808823.	6893.5198	-0.002199	1332.7925	6.189E+10	-542.0524	18598.	0.000
159.000	0.0810	1827065.	5272.9204	-0.002111	1346.2332	6.189E+10	-538.3472	19946.	0.000
162.000	0.0748	1840461.	3664.0865	-0.002022	1356.1039	6.189E+10	-534.2088	21433.	0.000
165.000	0.0688	1849049.	2068.3320	-0.001932	1362.4320	6.189E+10	-529.6275	23080.	0.000
168.000	0.0632	1852871.	487.0013	-0.001843	1365.2479	6.189E+10	-524.5930	24910.	0.000
171.000	0.0578	1851971.	-1078.5294	-0.001753	1364.5850	6.189E+10	-519.0941	26949.	0.000
174.000	0.0527	1846400.	-2626.8489	-0.001663	1360.4798	6.189E+10	-513.1188	29231.	0.000
177.000	0.0478	1836210.	-4156.5082	-0.001574	1352.9718	6.189E+10	-506.6540	31794.	0.000
180.000	0.0432	1821461.	-5666.0171	-0.001485	1342.1040	6.189E+10	-499.6852	34685.	0.000
183.000	0.0389	1802214.	-7153.8396	-0.001397	1327.9225	6.189E+10	-492.1965	37963.	0.000
186.000	0.0348	1778538.	-8618.3891	-0.001311	1310.4771	6.189E+10	-484.1699	41697.	0.000
189.000	0.0310	1750504.	-10058.	-0.001225	1289.8209	6.189E+10	-475.5852	45977.	0.000
192.000	0.0275	1718189.	-11471.	-0.001141	1266.0109	6.189E+10	-466.4193	50911.	0.000
195.000	0.0242	1681677.	-12856.	-0.001059	1239.1078	6.189E+10	-456.6452	56641.	0.000
198.000	0.0211	1641056.	-14210.	-0.000978	1209.1765	6.189E+10	-446.2313	63346.	0.000
201.000	0.0183	1596418.	-15532.	-0.000900	1176.2861	6.189E+10	-435.1397	71264.	0.000
204.000	0.0157	1547864.	-16820.	-0.000823	1140.5100	6.189E+10	-423.3242	80708.	0.000
207.000	0.0134	1495500.	-18071.	-0.000750	1101.9267	6.189E+10	-410.7269	92105.	0.000
210.000	0.0112	1439439.	-19283.	-0.000678	1060.6197	6.189E+10	-397.2746	106054.	0.000
213.000	0.009307	1379803.	-20453.	-0.000610	1016.6781	6.189E+10	-382.8705	123411.	0.000
216.000	0.007577	1316721.	-21578.	-0.000545	970.1976	6.189E+10	-367.3839	145457.	0.000
219.000	0.006039	1250333.	-22655.	-0.000483	921.2808	6.189E+10	-350.6305	174195.	0.000
222.000	0.004682	1180789.	-23680.	-0.000424	870.0388	6.189E+10	-332.3378	212953.	0.000
225.000	0.003497	1108254.	-24646.	-0.000368	816.5929	6.189E+10	-312.0767	267736.	0.000
228.000	0.002473	1032910.	-25548.	-0.000316	761.0775	6.189E+10	-289.1127	350723.	0.000
231.000	0.001599	954964.	-26375.	-0.000268	703.6448	6.189E+10	-262.0186	491480.	0.000
234.000	0.000865	874660.	-27109.	-0.000224	644.4746	6.189E+10	-227.3607	788890.	0.000
237.000	0.000257	792310.	-27608.	-0.000183	583.7967	6.189E+10	-105.5003	1231262.	0.000
240.000	-0.000235	709011.	-27436.	-0.000147	522.4191	6.189E+10	220.5742	2812500.	0.000
243.000	-0.000625	627696.	-26389.	-0.000115	462.5043	6.189E+10	477.2808	2292770.	0.000
246.000	-0.000922	550677.	-24882.	-8.597E-05	405.7545	6.189E+10	527.4240	1715305.	0.000
249.000	-0.001140	478405.	-23256.	-6.102E-05	352.5023	6.189E+10	556.6870	1464579.	0.000
252.000	-0.001289	411143.	-21559.	-3.946E-05	302.9418	6.189E+10	574.2660	1336969.	0.000
255.000	-0.001377	349049.	-19822.	-2.104E-05	257.1894	6.189E+10	584.0638	1272398.	0.000
258.000	-0.001415	292212.	-18063.	-5.495E-06	215.3103	6.189E+10	588.1397	1247106.	0.000
261.000	-0.001410	240669.	-16300.	7.421E-06	177.3314	6.189E+10	587.7181	1250422.	0.000
264.000	-0.001370	194414.	-14543.	1.797E-05	143.2499	6.189E+10	583.5768	1277640.	0.000
267.000	-0.001302	153412.	-12803.	2.640E-05	113.0384	6.189E+10	576.2217	1327446.	0.000
270.000	-0.001212	117596.	-11090.	3.297E-05	86.6481	6.189E+10	565.9706	1401030.	0.000
273.000	-0.001104	86874.	-9411.3052	3.792E-05	64.0110	6.189E+10	552.9901	1502072.	0.000
276.000	-0.000984	61128.	-7775.8679	4.151E-05	45.0410	6.189E+10	537.3015	1637493.	0.000
279.000	-0.000855	40218.	-6191.7809	4.397E-05	29.6341	6.189E+10	518.7565	1819343.	0.000
282.000	-0.000721	23978.	-4668.1907	4.552E-05	17.6673	6.189E+10	496.9703	2069036.	0.000
285.000	-0.000582	12209.	-3215.9852	4.640E-05	8.9962	6.189E+10	471.1668	2427546.	0.000
288.000	-0.000442	4681.5980	-1887.4014	4.681E-05	3.4495	6.189E+10	414.5558	2812500.	0.000
291.000	-0.000301	884.8948	-841.6825	4.694E-05	0.6520	6.189E+10	282.5901	2812500.	0.000
294.000	-0.000161	-368.4971	-192.0415	4.696E-05	0.2715	6.189E+10	150.5039	2812500.	0.000
297.000	-1.970E-05	-267.3540	61.4162	4.694E-05	0.1970	6.189E+10	18.4679	2812500.	0.000
300.000	0.000121	0.000	0.000	4.693E-05	0.000	6.189E+10	-59.4120	735901.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.5000000 inches
Computed slope at pile head = -0.000005274 radians

24 inch Dia CIDH

Maximum bending moment = -5331546. inch-lbs
Maximum shear force = 72832. lbs
Depth of maximum bending moment = 0.000000 inches below pile head
Depth of maximum shear force = 0.000000 inches below pile head
Number of iterations = 18
Number of zero deflection points = 2

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 3

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 1.000000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.0000	-8354772.	102050.	0.000	6156.0339	6.189E+10	-232.9104	349.3657	0.000
3.000	0.9994	-8049698.	101333.	-0.000398	5931.2465	6.189E+10	-239.2791	718.2737	0.000
6.000	0.9976	-7746777.	100605.	-0.000780	5708.0458	6.189E+10	-245.5738	738.4833	0.000
9.000	0.9947	-7446067.	99859.	-0.001149	5486.4737	6.189E+10	-251.7914	759.3918	0.000
12.000	0.9907	-7147622.	99095.	-0.001502	5266.5713	6.189E+10	-257.9288	781.0329	0.000
15.000	0.9857	-6851499.	98312.	-0.001842	5048.3793	6.189E+10	-263.9830	803.4424	0.000
18.000	0.9797	-6557752.	97511.	-0.002167	4831.9379	6.189E+10	-269.9511	826.6579	0.000
21.000	0.9727	-6266434.	96692.	-0.002478	4617.2867	6.189E+10	-275.8300	850.7194	0.000
24.000	0.9648	-5977599.	95856.	-0.002774	4404.4647	6.189E+10	-281.6170	875.6693	0.000
27.000	0.9560	-5691298.	95003.	-0.003057	4193.5102	6.189E+10	-287.3092	901.5525	0.000
30.000	0.9465	-5407583.	94132.	-0.003326	3984.4610	6.189E+10	-292.9039	928.4165	0.000
33.000	0.9361	-5126504.	93245.	-0.003582	3777.3541	6.189E+10	-298.3984	956.3119	0.000
36.000	0.9250	-4848111.	92342.	-0.003823	3572.2261	6.189E+10	-303.7898	985.2921	0.000
39.000	0.9132	-4572452.	91423.	-0.004052	3369.1126	6.189E+10	-309.0756	1015.4142	0.000
42.000	0.9007	-4299574.	90488.	-0.004267	3168.0488	6.189E+10	-314.2533	1046.7384	0.000
45.000	0.8876	-4029525.	89537.	-0.004469	2969.0689	6.189E+10	-319.3201	1079.3291	0.000
48.000	0.8739	-3762350.	88572.	-0.004657	2772.2065	6.189E+10	-324.2735	1113.2543	0.000
51.000	0.8596	-3498093.	87592.	-0.004833	2577.4946	6.189E+10	-329.1111	1148.5867	0.000
54.000	0.8449	-3236798.	86598.	-0.004997	2384.9652	6.189E+10	-333.8305	1185.4035	0.000
57.000	0.8296	-2978508.	85589.	-0.005147	2194.6495	6.189E+10	-338.4291	1223.7868	0.000
60.000	0.8140	-2723264.	84434.	-0.005285	2006.5781	6.189E+10	-431.5743	1590.6288	0.000
63.000	0.7979	-2471903.	82917.	-0.005411	1821.3687	6.189E+10	-580.0848	2181.0027	0.000
66.000	0.7815	-2225764.	81164.	-0.005525	1640.0061	6.189E+10	-588.6539	2259.7047	0.000
69.000	0.7648	-1984922.	79385.	-0.005627	1462.5471	6.189E+10	-596.9956	2341.8829	0.000
72.000	0.7477	-1749454.	77582.	-0.005718	1289.0471	6.189E+10	-605.1045	2427.7420	0.000
75.000	0.7305	-1519431.	75755.	-0.005797	1119.5598	6.189E+10	-612.9753	2517.5014	0.000
78.000	0.7130	-1294925.	73904.	-0.005865	954.1374	6.189E+10	-620.6030	2611.3969	0.000
81.000	0.6953	-1076004.	72032.	-0.005923	792.8305	6.189E+10	-627.9825	2709.6814	0.000
84.000	0.6774	-862736.	70137.	-0.005970	635.6881	6.189E+10	-635.1089	2812.6271	0.000
87.000	0.6594	-655183.	68221.	-0.006006	482.7573	6.189E+10	-641.9775	2920.5264	0.000
90.000	0.6414	-453408.	66285.	-0.006033	334.0838	6.189E+10	-648.5836	3033.6943	0.000
93.000	0.6232	-257470.	64330.	-0.006051	189.7114	6.189E+10	-654.9224	3152.4702	0.000
96.000	0.6051	-67427.	62356.	-0.006058	49.6820	6.189E+10	-660.9895	3277.2199	0.000
99.000	0.5869	116668.	60365.	-0.006057	85.9640	6.189E+10	-666.7802	3408.3386	0.000
102.000	0.5687	294761.	58356.	-0.006047	217.1883	6.189E+10	-672.2902	3546.2531	0.000
105.000	0.5506	466804.	56331.	-0.006029	343.9544	6.189E+10	-677.5148	3691.4255	0.000
108.000	0.5326	632749.	54291.	-0.006002	466.2275	6.189E+10	-682.4498	3844.3561	0.000
111.000	0.5146	792552.	52237.	-0.005968	583.9750	6.189E+10	-687.0906	4005.5872	0.000
114.000	0.4968	946172.	50169.	-0.005926	697.1661	6.189E+10	-691.4330	4175.7079	0.000
117.000	0.4790	1093568.	48089.	-0.005876	805.7720	6.189E+10	-695.4726	4355.3585	0.000
120.000	0.4615	1234705.	45997.	-0.005820	909.7659	6.189E+10	-699.2050	4545.2357	0.000
123.000	0.4441	1369549.	43894.	-0.005757	1009.1230	6.189E+10	-702.6258	4746.0993	0.000
126.000	0.4270	1498070.	41782.	-0.005687	1103.8207	6.189E+10	-705.7307	4958.7781	0.000
129.000	0.4100	1620239.	39660.	-0.005611	1193.8384	6.189E+10	-708.5154	5184.1783	0.000
132.000	0.3933	1736032.	37531.	-0.005530	1279.1576	6.189E+10	-710.9753	5423.2920	0.000
135.000	0.3768	1845426.	35395.	-0.005443	1359.7620	6.189E+10	-713.1062	5677.2067	0.000
138.000	0.3606	1948401.	33253.	-0.005351	1435.6375	6.189E+10	-714.9035	5947.1169	0.000
141.000	0.3447	2044943.	31106.	-0.005255	1506.7721	6.189E+10	-716.3628	6234.3368	0.000
144.000	0.3291	2135037.	28955.	-0.005153	1573.1562	6.189E+10	-717.4794	6540.3147	0.000
147.000	0.3138	2218674.	26802.	-0.005048	1634.7823	6.189E+10	-718.2487	6866.6500	0.000

24 inch Dia CIDH

150.000	0.2988	2295847.	24646.	-0.004938	1691.6455	6.189E+10	-718.6661	7215.1122	0.000
153.000	0.2842	2366552.	22490.	-0.004825	1743.7428	6.189E+10	-718.7266	7587.6634	0.000
156.000	0.2699	2430788.	20334.	-0.004709	1791.0739	6.189E+10	-718.4254	7986.4837	0.000
159.000	0.2559	2488559.	18180.	-0.004590	1833.6408	6.189E+10	-717.7572	8414.0017	0.000
162.000	0.2423	2539869.	16028.	-0.004468	1871.4479	6.189E+10	-716.7167	8872.9292	0.000
165.000	0.2291	2584729.	13880.	-0.004344	1904.5022	6.189E+10	-715.2984	9366.3024	0.000
168.000	0.2163	2623152.	11737.	-0.004217	1932.8130	6.189E+10	-713.4965	9897.5304	0.000
171.000	0.2038	2655153.	9600.0509	-0.004089	1956.3922	6.189E+10	-711.3048	10470.	0.000
174.000	0.1917	2680752.	7470.0188	-0.003960	1975.2545	6.189E+10	-708.7167	11089.	0.000
177.000	0.1800	2699973.	5348.3559	-0.003830	1989.4170	6.189E+10	-705.7252	11759.	0.000
180.000	0.1687	2712842.	3236.2841	-0.003699	1998.8994	6.189E+10	-702.3227	12486.	0.000
183.000	0.1579	2719391.	1135.0487	-0.003567	2003.7245	6.189E+10	-698.5009	13275.	0.000
186.000	0.1473	2719653.	-954.0785	-0.003435	2003.9174	6.189E+10	-694.2506	14135.	0.000
189.000	0.1372	2713666.	-3029.7968	-0.003303	1999.5065	6.189E+10	-689.5616	15073.	0.000
192.000	0.1275	2701474.	-5090.7729	-0.003172	1990.5228	6.189E+10	-684.4225	16101.	0.000
195.000	0.1182	2683122.	-7135.6371	-0.003042	1977.0004	6.189E+10	-678.8203	17228.	0.000
198.000	0.1093	2658660.	-9162.9777	-0.002912	1958.9764	6.189E+10	-672.7401	18469.	0.000
201.000	0.1007	2628144.	-11171.	-0.002784	1936.4911	6.189E+10	-666.1646	19839.	0.000
204.000	0.0926	2591632.	-13159.	-0.002657	1909.5882	6.189E+10	-659.0736	21358.	0.000
207.000	0.0848	2549189.	-15125.	-0.002533	1878.3147	6.189E+10	-651.4433	23049.	0.000
210.000	0.0774	2500882.	-17067.	-0.002410	1842.7212	6.189E+10	-643.2452	24939.	0.000
213.000	0.0703	2446787.	-18984.	-0.002291	1802.8620	6.189E+10	-634.4449	27064.	0.000
216.000	0.0636	2386981.	-20873.	-0.002173	1758.7955	6.189E+10	-625.0003	29466.	0.000
219.000	0.0573	2321550.	-22732.	-0.002059	1710.5844	6.189E+10	-614.8594	32199.	0.000
222.000	0.0513	2250586.	-24561.	-0.001948	1658.2958	6.189E+10	-603.9575	35334.	0.000
225.000	0.0456	2174186.	-26355.	-0.001841	1602.0022	6.189E+10	-592.2120	38964.	0.000
228.000	0.0402	2092456.	-28113.	-0.001738	1541.7813	6.189E+10	-579.5169	43214.	0.000
231.000	0.0352	2005511.	-29830.	-0.001638	1477.7173	6.189E+10	-565.7329	48258.	0.000
234.000	0.0304	1913474.	-31505.	-0.001543	1409.9018	6.189E+10	-550.6731	54343.	0.000
237.000	0.0259	1816480.	-33132.	-0.001453	1338.4345	6.189E+10	-534.0806	61842.	0.000
240.000	0.0217	1714681.	-34707.	-0.001367	1263.4254	6.189E+10	-515.5891	71340.	0.000
243.000	0.0177	1608240.	-36222.	-0.001287	1184.9972	6.189E+10	-494.6541	83822.	0.000
246.000	0.0140	1497348.	-37670.	-0.001212	1103.2888	6.189E+10	-470.4161	101093.	0.000
249.000	0.0104	1382222.	-39037.	-0.001142	1018.4608	6.189E+10	-441.3968	126914.	0.000
252.000	0.007109	1263124.	-40307.	-0.001078	930.7057	6.189E+10	-404.6928	170788.	0.000
255.000	0.003967	1140383.	-41443.	-0.001020	840.2669	6.189E+10	-353.0584	266981.	0.000
258.000	0.000992	1014465.	-42352.	-0.000967	747.4868	6.189E+10	-252.6371	764299.	0.000
261.000	-0.001836	886273.	-41789.	-0.000921	653.0314	6.189E+10	627.9628	1025848.	0.000
264.000	-0.004536	763733.	-39664.	-0.000881	562.7402	6.189E+10	788.2887	521401.	0.000
267.000	-0.007124	648287.	-37158.	-0.000847	477.6766	6.189E+10	882.7725	371761.	0.000
270.000	-0.009618	540787.	-34406.	-0.000818	398.4670	6.189E+10	951.7104	296867.	0.000
273.000	-0.0120	441851.	-31468.	-0.000794	325.5687	6.189E+10	1006.6264	250972.	0.000
276.000	-0.0144	351976.	-28380.	-0.000775	259.3458	6.189E+10	1052.6157	219544.	0.000
279.000	-0.0167	271574.	-25162.	-0.000760	200.1032	6.189E+10	1092.4249	196439.	0.000
282.000	-0.0189	201003.	-21832.	-0.000749	148.1050	6.189E+10	1127.7163	178590.	0.000
285.000	-0.0212	140583.	-18401.	-0.000740	103.5852	6.189E+10	1159.5745	164287.	0.000
288.000	-0.0234	90598.	-14878.	-0.000735	66.7551	6.189E+10	1188.7444	152499.	0.000
291.000	-0.0256	51312.	-11272.	-0.000731	37.8081	6.189E+10	1215.7559	142568.	0.000
294.000	-0.0278	22968.	-7586.5645	-0.000729	16.9233	6.189E+10	1240.9949	134053.	0.000
297.000	-0.0300	5792.4991	-3827.9526	-0.000729	4.2681	6.189E+10	1264.7464	126647.	0.000
300.000	-0.0321	0.000	0.000	-0.000729	0.000	6.189E+10	1287.2220	60067.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

```
Pile-head deflection             =      1.0000000 inches
Computed slope at pile head      =   -0.000007394 radians
Maximum bending moment           =      -8354772. inch-lbs
Maximum shear force              =        102050. lbs
Depth of maximum bending moment  =       0.000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             21
Number of zero deflection points =              1
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 4

Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.250000 in
Moment at pile head = 0.000 in-lbs
Axial load at pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2500	0.000	23723.	-0.002614	0.000	6.189E+10	-164.6925	988.1553	0.000
3.000	0.2422	70427.	23224.	-0.002612	51.8928	6.189E+10	-167.8790	2079.7784	0.000
6.000	0.2343	139344.	22716.	-0.002607	102.6723	6.189E+10	-170.9615	2188.7453	0.000
9.000	0.2265	206721.	22198.	-0.002599	152.3180	6.189E+10	-173.9376	2303.6316	0.000
12.000	0.2187	272533.	21672.	-0.002587	200.8104	6.189E+10	-176.8048	2424.8967	0.000
15.000	0.2110	336754.	21138.	-0.002572	248.1302	6.189E+10	-179.5606	2553.0422	0.000
18.000	0.2033	399359.	20595.	-0.002554	294.2593	6.189E+10	-182.2023	2688.6182	0.000
21.000	0.1957	460324.	20045.	-0.002533	339.1801	6.189E+10	-184.7275	2832.2274	0.000
24.000	0.1881	519627.	19487.	-0.002510	382.8759	6.189E+10	-187.1335	2984.5328	0.000
27.000	0.1806	577245.	18922.	-0.002483	425.3308	6.189E+10	-189.4176	3146.2636	0.000
30.000	0.1732	633159.	18351.	-0.002454	466.5295	6.189E+10	-191.5772	3318.2244	0.000
33.000	0.1659	687348.	17773.	-0.002422	506.4578	6.189E+10	-193.6096	3501.3039	0.000
36.000	0.1587	739795.	17189.	-0.002387	545.1022	6.189E+10	-195.5120	3696.4857	0.000
39.000	0.1516	790483.	16600.	-0.002350	582.4500	6.189E+10	-197.2816	3904.8604	0.000
42.000	0.1446	839394.	16006.	-0.002311	618.4896	6.189E+10	-198.9156	4127.6399	0.000
45.000	0.1377	886516.	15407.	-0.002269	653.2101	6.189E+10	-200.4111	4366.1732	0.000
48.000	0.1310	931834.	14803.	-0.002225	686.6016	6.189E+10	-201.7654	4621.9648	0.000
51.000	0.1244	975336.	14196.	-0.002178	718.6550	6.189E+10	-202.9754	4896.6964	0.000
54.000	0.1179	1017011.	13586.	-0.002130	749.3625	6.189E+10	-204.0382	5192.2513	0.000
57.000	0.1116	1056850.	12972.	-0.002080	778.7169	6.189E+10	-204.9509	5510.7429	0.000
60.000	0.1054	1094844.	12276.	-0.002028	806.7121	6.189E+10	-258.9039	7368.4403	0.000
63.000	0.0994	1130508.	11371.	-0.001974	832.9905	6.189E+10	-344.6448	10401.	0.000
66.000	0.0936	1163070.	10335.	-0.001918	856.9833	6.189E+10	-346.2787	11103.	0.000
69.000	0.0879	1192516.	9293.8468	-0.001861	878.6798	6.189E+10	-347.6176	11864.	0.000
72.000	0.0824	1218833.	8249.4376	-0.001803	898.0711	6.189E+10	-348.6551	12694.	0.000
75.000	0.0771	1242013.	7202.3781	-0.001743	915.1504	6.189E+10	-349.3845	13598.	0.000
78.000	0.0719	1262048.	6153.6026	-0.001682	929.9126	6.189E+10	-349.7992	14587.	0.000
81.000	0.0670	1278934.	5104.0656	-0.001621	942.3553	6.189E+10	-349.8922	15670.	0.000
84.000	0.0622	1292672.	4054.7426	-0.001558	952.4776	6.189E+10	-349.6565	16860.	0.000
87.000	0.0576	1303263.	3006.6306	-0.001496	960.2812	6.189E+10	-349.0848	18170.	0.000
90.000	0.0532	1310712.	1960.7488	-0.001432	965.7698	6.189E+10	-348.1697	19617.	0.000
93.000	0.0490	1315027.	918.1395	-0.001369	968.9496	6.189E+10	-346.9032	21220.	0.000
96.000	0.0450	1316221.	-120.1312	-0.001305	969.8289	6.189E+10	-345.2772	23001.	0.000
99.000	0.0412	1314307.	-1152.9714	-0.001241	968.4185	6.189E+10	-343.2830	24987.	0.000
102.000	0.0376	1309303.	-2179.2628	-0.001177	964.7316	6.189E+10	-340.9113	27209.	0.000
105.000	0.0342	1301231.	-3197.8586	-0.001114	958.7840	6.189E+10	-338.1525	29705.	0.000
108.000	0.0309	1290116.	-4207.5816	-0.001051	950.5940	6.189E+10	-334.9961	32520.	0.000
111.000	0.0278	1275986.	-5207.2216	-0.000989	940.1824	6.189E+10	-331.4306	35710.	0.000
114.000	0.0250	1258872.	-6195.5331	-0.000928	927.5730	6.189E+10	-327.4437	39342.	0.000
117.000	0.0223	1238812.	-7171.2314	-0.000867	912.7921	6.189E+10	-323.0218	43500.	0.000
120.000	0.0198	1215845.	-8132.9882	-0.000808	895.8692	6.189E+10	-318.1495	48287.	0.000
123.000	0.0174	1190014.	-9079.4272	-0.000749	876.8364	6.189E+10	-312.8098	53835.	0.000
126.000	0.0153	1161368.	-10009.	-0.000692	855.7293	6.189E+10	-306.9831	60310.	0.000
129.000	0.0133	1129960.	-10921.	-0.000637	832.5864	6.189E+10	-300.6468	67929.	0.000
132.000	0.0114	1095845.	-11812.	-0.000583	807.4498	6.189E+10	-293.7739	76975.	0.000
135.000	0.009781	1059087.	-12682.	-0.000531	780.3651	6.189E+10	-286.3325	87827.	0.000
138.000	0.008266	1019751.	-13529.	-0.000480	751.3815	6.189E+10	-278.2828	101001.	0.000
141.000	0.006899	977911.	-14351.	-0.000432	720.5526	6.189E+10	-269.5751	117221.	0.000
144.000	0.005675	933645.	-15146.	-0.000385	687.9359	6.189E+10	-260.1447	137525.	0.000
147.000	0.004586	887037.	-15911.	-0.000341	653.5941	6.189E+10	-249.9047	163468.	0.000
150.000	0.003627	838180.	-16644.	-0.000300	617.5951	6.189E+10	-238.7339	197476.	0.000
153.000	0.002789	787175.	-17341.	-0.000260	580.0129	6.189E+10	-226.4539	243575.	0.000
156.000	0.002066	734132.	-18000.	-0.000223	540.9290	6.189E+10	-212.7857	308988.	0.000
159.000	0.001450	679173.	-18615.	-0.000189	500.4341	6.189E+10	-197.2537	408237.	0.000
162.000	0.000932	622439.	-19180.	-0.000157	458.6310	6.189E+10	-178.9404	576040.	0.000
165.000	0.000505	564095.	-19682.	-0.000129	415.6413	6.189E+10	-155.6656	925116.	0.000
168.000	0.000160	504350.	-19992.	-0.000103	371.6193	6.189E+10	-51.5283	967887.	0.000
171.000	-0.000112	444141.	-19912.	-7.981E-05	327.2557	6.189E+10	105.0229	2812500.	0.000
174.000	-0.000319	384877.	-19306.	-5.972E-05	283.5884	6.189E+10	299.2245	2812500.	0.000

177.000	-0.000470	328306.	-18195.	-4.243E-05	241.9055	6.189E+10	440.9528	2812500.	0.000
180.000	-0.000574	275704.	-16830.	-2.780E-05	203.1467	6.189E+10	469.2357	2453383.	0.000
183.000	-0.000637	227325.	-15404.	-1.560E-05	167.4997	6.189E+10	481.8967	2269103.	0.000
186.000	-0.000667	183283.	-13949.	-5.650E-06	135.0483	6.189E+10	487.6540	2192038.	0.000
189.000	-0.000671	143630.	-12485.	2.273E-06	105.8308	6.189E+10	488.4007	2183537.	0.000
192.000	-0.000654	108373.	-11025.	8.381E-06	79.8520	6.189E+10	485.2885	2226914.	0.000
195.000	-0.000621	77483.	-9578.0031	1.289E-05	57.0915	6.189E+10	479.0847	2315405.	0.000
198.000	-0.000576	50905.	-8153.8737	1.600E-05	37.5080	6.189E+10	470.3350	2447776.	0.000
201.000	-0.000525	28559.	-6759.2021	1.792E-05	21.0435	6.189E+10	459.4461	2626662.	0.000
204.000	-0.000469	10349.	-5410.6408	1.887E-05	7.6257	6.189E+10	439.5948	2812500.	0.000
207.000	-0.000412	-3904.3455	-4172.5090	1.902E-05	2.8768	6.189E+10	385.8264	2812500.	0.000
210.000	-0.000355	-14686.	-3094.8842	1.857E-05	10.8208	6.189E+10	332.5902	2812500.	0.000
213.000	-0.000300	-22474.	-2173.9644	1.767E-05	16.5592	6.189E+10	281.3563	2812500.	0.000
216.000	-0.000249	-27729.	-1402.1505	1.645E-05	20.4318	6.189E+10	233.1863	2812500.	0.000
219.000	-0.000201	-30887.	-769.1755	1.503E-05	22.7581	6.189E+10	188.7970	2812500.	0.000
222.000	-0.000159	-32344.	-263.0522	1.350E-05	23.8323	6.189E+10	148.6186	2812500.	0.000
225.000	-0.000120	-32465.	129.1507	1.193E-05	23.9210	6.189E+10	112.8500	2812500.	0.000
228.000	-8.694E-05	-31570.	420.6871	1.038E-05	23.2614	6.189E+10	81.5076	2812500.	0.000
231.000	-5.810E-05	-29941.	624.6523	8.888E-06	22.0612	6.189E+10	54.4693	2812500.	0.000
234.000	-3.361E-05	-27822.	753.6257	7.488E-06	20.4998	6.189E+10	31.5130	2812500.	0.000
237.000	-1.317E-05	-25419.	819.4200	6.197E-06	18.7294	6.189E+10	12.3499	2812500.	0.000
240.000	3.571E-06	-22905.	835.7260	5.026E-06	16.8772	6.189E+10	-1.4792	1242716.	0.000
243.000	1.698E-05	-20405.	822.8569	3.976E-06	15.0347	6.189E+10	-7.1002	1254169.	0.000
246.000	2.743E-05	-17968.	794.8488	3.046E-06	13.2393	6.189E+10	-11.5718	1265623.	0.000
249.000	3.526E-05	-15636.	754.9747	2.232E-06	11.5207	6.189E+10	-15.0109	1277076.	0.000
252.000	4.082E-05	-13438.	706.1589	1.527E-06	9.9016	6.189E+10	-17.5330	1288530.	0.000
255.000	4.443E-05	-11399.	650.9830	9.252E-07	8.3988	6.189E+10	-19.2509	1299984.	0.000
258.000	4.637E-05	-9532.2673	591.6994	4.179E-07	7.0236	6.189E+10	-20.2715	1311438.	0.000
261.000	4.693E-05	-7848.3910	530.2484	-3.346E-09	5.7829	6.189E+10	-20.6958	1322892.	0.000
264.000	4.635E-05	-6350.7770	468.2796	-3.475E-07	4.6794	6.189E+10	-20.6167	1334346.	0.000
267.000	4.485E-05	-5038.7135	407.1762	-6.236E-07	3.7127	6.189E+10	-20.1189	1345800.	0.000
270.000	4.261E-05	-3907.7198	348.0809	-8.404E-07	2.8793	6.189E+10	-19.2780	1357255.	0.000
273.000	3.981E-05	-2950.2284	291.9226	-1.007E-06	2.1738	6.189E+10	-18.1608	1368709.	0.000
276.000	3.657E-05	-2156.1843	239.4442	-1.130E-06	1.5887	6.189E+10	-16.8248	1380164.	0.000
279.000	3.302E-05	-1513.5634	191.2290	-1.219E-06	1.1152	6.189E+10	-15.3186	1391618.	0.000
282.000	2.926E-05	-1008.8104	147.7273	-1.280E-06	0.7433	6.189E+10	-13.6824	1403073.	0.000
285.000	2.534E-05	-627.1995	109.2812	-1.320E-06	0.4621	6.189E+10	-11.9483	1414528.	0.000
288.000	2.133E-05	-353.1232	76.1474	-1.344E-06	0.2602	6.189E+10	-10.1409	1425983.	0.000
291.000	1.728E-05	-170.3151	48.5186	-1.357E-06	0.1255	6.189E+10	-8.2783	1437437.	0.000
294.000	1.320E-05	-62.0118	26.5420	-1.362E-06	0.0457	6.189E+10	-6.3728	1448892.	0.000
297.000	9.104E-06	-11.0634	10.3353	-1.364E-06	0.008152	6.189E+10	-4.4317	1460347.	0.000
300.000	5.011E-06	0.000	0.000	-1.364E-06	0.000	6.189E+10	-2.4585	735901.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 4:

```
Pile-head deflection             =      0.2500000 inches
Computed slope at pile head      =     -0.0026137 radians
Maximum bending moment           =      1316221. inch-lbs
Maximum shear force              =        23723. lbs
Depth of maximum bending moment  =     96.0000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             15
Number of zero deflection points =              2
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 5

```
Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head   =        0.500000 in
Moment at pile head       =           0.000 in-lbs
Axial load at pile head   =           0.000 lbs
```

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.5000	0.000	33825.	-0.004683	0.000	6.189E+10	-195.8535	587.5606	0.000
3.000	0.4860	100593.	33231.	-0.004681	74.1196	6.189E+10	-199.8109	1233.5246	0.000
6.000	0.4719	199387.	32626.	-0.004673	146.9142	6.189E+10	-203.6612	1294.6845	0.000
9.000	0.4579	296349.	32009.	-0.004661	218.3581	6.189E+10	-207.4021	1358.7906	0.000
12.000	0.4439	391444.	31382.	-0.004645	288.4268	6.189E+10	-211.0311	1426.0474	0.000
15.000	0.4300	484639.	30743.	-0.004623	357.0959	6.189E+10	-214.5458	1496.6765	0.000
18.000	0.4162	575904.	30095.	-0.004598	424.3423	6.189E+10	-217.9439	1570.9183	0.000
21.000	0.4025	665207.	29436.	-0.004568	490.1435	6.189E+10	-221.2227	1649.0337	0.000
24.000	0.3888	752519.	28767.	-0.004533	554.4776	6.189E+10	-224.3799	1731.3062	0.000
27.000	0.3753	837812.	28090.	-0.004495	617.3237	6.189E+10	-227.4130	1818.0444	0.000
30.000	0.3618	921058.	27403.	-0.004452	678.6618	6.189E+10	-230.3194	1909.5848	0.000
33.000	0.3485	1002231.	26708.	-0.004405	738.4725	6.189E+10	-233.0966	2006.2946	0.000
36.000	0.3354	1081307.	26005.	-0.004355	796.7374	6.189E+10	-235.7420	2108.5753	0.000
39.000	0.3224	1158260.	25294.	-0.004301	853.4391	6.189E+10	-238.2530	2216.8662	0.000
42.000	0.3096	1233070.	24576.	-0.004243	908.5607	6.189E+10	-240.6271	2331.6490	0.000
45.000	0.2970	1305713.	23850.	-0.004181	962.0867	6.189E+10	-242.8615	2453.4526	0.000
48.000	0.2845	1376171.	23119.	-0.004116	1014.0021	6.189E+10	-244.9536	2582.8583	0.000
51.000	0.2723	1444425.	22381.	-0.004048	1064.2931	6.189E+10	-246.9008	2720.5063	0.000
54.000	0.2602	1510456.	21637.	-0.003976	1112.9468	6.189E+10	-248.7003	2867.1024	0.000
57.000	0.2484	1574249.	20889.	-0.003901	1159.9513	6.189E+10	-250.3495	3023.4263	0.000
60.000	0.2368	1635789.	20038.	-0.003824	1205.2956	6.189E+10	-316.9689	4015.3112	0.000
63.000	0.2255	1694476.	18928.	-0.003743	1248.5379	6.189E+10	-422.9441	5627.5371	0.000
66.000	0.2144	1749356.	17655.	-0.003659	1288.9755	6.189E+10	-426.0153	5962.0562	0.000
69.000	0.2035	1800403.	16372.	-0.003573	1326.5880	6.189E+10	-428.7932	6320.8899	0.000
72.000	0.1929	1847590.	15082.	-0.003485	1361.3570	6.189E+10	-431.2719	6706.3691	0.000
75.000	0.1826	1890896.	13785.	-0.003394	1393.2660	6.189E+10	-433.4452	7121.1046	0.000
78.000	0.1726	1930301.	12482.	-0.003302	1422.3006	6.189E+10	-435.3072	7568.0268	0.000
81.000	0.1628	1965788.	11174.	-0.003207	1448.4485	6.189E+10	-436.8518	8050.4334	0.000
84.000	0.1533	1997343.	9861.3717	-0.003111	1471.6995	6.189E+10	-438.0726	8572.0451	0.000
87.000	0.1441	2024956.	8545.8175	-0.003014	1492.0453	6.189E+10	-438.9635	9137.0713	0.000
90.000	0.1352	2048618.	7228.0951	-0.002915	1509.4803	6.189E+10	-439.5181	9750.2884	0.000
93.000	0.1266	2068325.	5909.2236	-0.002815	1524.0005	6.189E+10	-439.7296	10417.	0.000
96.000	0.1183	2084074.	4590.2421	-0.002715	1535.6048	6.189E+10	-439.5914	11144.	0.000
99.000	0.1103	2095866.	3272.2103	-0.002613	1544.2939	6.189E+10	-439.0965	11937.	0.000
102.000	0.1027	2103707.	1956.2091	-0.002511	1550.0711	6.189E+10	-438.2376	12806.	0.000
105.000	0.0953	2107604.	643.3419	-0.002409	1552.9422	6.189E+10	-437.0072	13760.	0.000
108.000	0.0882	2107567.	-665.2650	-0.002307	1552.9153	6.189E+10	-435.3974	14808.	0.000
111.000	0.0814	2103612.	-1968.4611	-0.002205	1550.0011	6.189E+10	-433.4000	15966.	0.000
114.000	0.0750	2095756.	-3265.0706	-0.002103	1544.2128	6.189E+10	-431.0063	17246.	0.000
117.000	0.0688	2084021.	-4553.8907	-0.002002	1535.5663	6.189E+10	-428.2071	18667.	0.000
120.000	0.0630	2068433.	-5833.6899	-0.001901	1524.0802	6.189E+10	-424.9924	20249.	0.000
123.000	0.0574	2049019.	-7103.2065	-0.001802	1509.7757	6.189E+10	-421.3520	22018.	0.000
126.000	0.0522	2025814.	-8361.1459	-0.001703	1492.6771	6.189E+10	-417.2743	24002.	0.000
129.000	0.0472	1998852.	-9606.1777	-0.001605	1472.8114	6.189E+10	-412.7470	26238.	0.000
132.000	0.0425	1968177.	-10837.	-0.001509	1450.2085	6.189E+10	-407.7566	28768.	0.000
135.000	0.0381	1933831.	-12052.	-0.001415	1424.9016	6.189E+10	-402.2881	31644.	0.000
138.000	0.0340	1895865.	-13250.	-0.001322	1396.9269	6.189E+10	-396.3249	34933.	0.000
141.000	0.0302	1854331.	-14429.	-0.001231	1366.3241	6.189E+10	-389.8480	38716.	0.000
144.000	0.0267	1809290.	-15588.	-0.001142	1333.1360	6.189E+10	-382.8358	43095.	0.000
147.000	0.0234	1760802.	-16725.	-0.001055	1297.4091	6.189E+10	-375.2634	48201.	0.000
150.000	0.0203	1708937.	-17839.	-0.000971	1259.1937	6.189E+10	-367.1012	54204.	0.000
153.000	0.0175	1653769.	-18927.	-0.000890	1218.5438	6.189E+10	-358.3138	61328.	0.000
156.000	0.0150	1595375.	-19988.	-0.000811	1175.5179	6.189E+10	-348.8582	69872.	0.000
159.000	0.0127	1533842.	-21019.	-0.000735	1130.1784	6.189E+10	-338.6803	80249.	0.000
162.000	0.0106	1469261.	-22019.	-0.000662	1082.5931	6.189E+10	-327.7108	93040.	0.000
165.000	0.008686	1401730.	-22984.	-0.000593	1032.8345	6.189E+10	-315.8586	109090.	0.000
168.000	0.007009	1331357.	-23912.	-0.000527	980.9814	6.189E+10	-302.9985	129683.	0.000
171.000	0.005526	1258256.	-24800.	-0.000464	927.1189	6.189E+10	-288.9524	156863.	0.000
174.000	0.004226	1182555.	-25644.	-0.000405	871.3402	6.189E+10	-273.4523	194120.	0.000
177.000	0.003098	1104393.	-26438.	-0.000349	813.7482	6.189E+10	-256.0663	247979.	0.000
180.000	0.002130	1023926.	-27176.	-0.000298	754.4580	6.189E+10	-236.0277	332396.	0.000
183.000	0.001312	941335.	-27848.	-0.000250	693.6027	6.189E+10	-211.7587	484371.	0.000
186.000	0.000630	856839.	-28434.	-0.000206	631.3431	6.189E+10	-179.0039	852734.	0.000
189.000	7.256E-05	770731.	-28741.	-0.000167	567.8964	6.189E+10	-25.3501	1048032.	0.000
192.000	-0.000373	684395.	-28255.	-0.000132	504.2816	6.189E+10	349.2546	2812500.	0.000
195.000	-0.000718	601202.	-26989.	-0.000101	442.9829	6.189E+10	494.3817	2065340.	0.000
198.000	-0.000976	522459.	-25445.	-7.338E-05	384.9627	6.189E+10	534.8528	1643585.	0.000
201.000	-0.001158	448530.	-23805.	-4.985E-05	330.4893	6.189E+10	558.7166	1446930.	0.000

204.000	-0.001275	379628.	-22108.	-2.978E-05	279.7210	6.189E+10	572.5882	1346893.	0.000
207.000	-0.001337	315881.	-20380.	-1.292E-05	232.7498	6.189E+10	579.5599	1300355.	0.000
210.000	-0.001353	257349.	-18639.	9.743E-07	189.6220	6.189E+10	581.3641	1289179.	0.000
213.000	-0.001331	204049.	-16898.	1.216E-05	150.3494	6.189E+10	579.0841	1304993.	0.000
216.000	-0.001280	155962.	-15169.	2.088E-05	114.9170	6.189E+10	573.4510	1344105.	0.000
219.000	-0.001206	113035.	-13461.	2.740E-05	83.2874	6.189E+10	564.9855	1405513.	0.000
222.000	-0.001116	75193.	-11783.	3.197E-05	55.4045	6.189E+10	554.0743	1490108.	0.000
225.000	-0.001014	42338.	-10140.	3.481E-05	31.1959	6.189E+10	541.0138	1600411.	0.000
228.000	-0.000907	14352.	-8539.6138	3.619E-05	10.5750	6.189E+10	526.0358	1740650.	0.000
231.000	-0.000797	-8899.6038	-6986.5762	3.632E-05	6.5575	6.189E+10	509.3226	1917123.	0.000
234.000	-0.000689	-27567.	-5486.0689	3.544E-05	20.3124	6.189E+10	491.0156	2138891.	0.000
237.000	-0.000584	-41816.	-4042.7224	3.375E-05	30.8112	6.189E+10	471.2154	2419007.	0.000
240.000	-0.000486	-51824.	-2660.9362	3.149E-05	38.1852	6.189E+10	449.9754	2776671.	0.000
243.000	-0.000395	-57782.	-1429.8301	2.883E-05	42.5752	6.189E+10	370.7621	2812500.	0.000
246.000	-0.000313	-60403.	-433.2565	2.596E-05	44.5064	6.189E+10	293.6203	2812500.	0.000
249.000	-0.000240	-60381.	344.2445	2.304E-05	44.4906	6.189E+10	224.7137	2812500.	0.000
252.000	-0.000175	-58337.	927.3739	2.016E-05	42.9845	6.189E+10	164.0393	2812500.	0.000
255.000	-0.000119	-54817.	1340.4104	1.742E-05	40.3907	6.189E+10	111.3184	2812500.	0.000
258.000	-7.048E-05	-50295.	1606.4948	1.487E-05	37.0586	6.189E+10	66.0712	2812500.	0.000
261.000	-2.953E-05	-45178.	1747.1230	1.255E-05	33.2884	6.189E+10	27.6810	2812500.	0.000
264.000	4.853E-06	-39812.	1785.4066	1.049E-05	29.3346	6.189E+10	-2.1586	1334346.	0.000
267.000	3.344E-05	-34466.	1759.6651	8.695E-06	25.3952	6.189E+10	-15.0024	1345800.	0.000
270.000	5.702E-05	-29254.	1698.4659	7.150E-06	21.5552	6.189E+10	-25.7970	1357255.	0.000
273.000	7.634E-05	-24275.	1607.5243	5.853E-06	17.8863	6.189E+10	-34.8307	1368709.	0.000
276.000	9.214E-05	-19609.	1491.6965	4.789E-06	14.4484	6.189E+10	-42.3878	1380164.	0.000
279.000	0.000105	-15325.	1355.0006	3.942E-06	11.2916	6.189E+10	-48.7428	1391618.	0.000
282.000	0.000116	-11479.	1200.6551	3.293E-06	8.4580	6.189E+10	-54.1542	1403073.	0.000
285.000	0.000125	-8120.6160	1031.1332	2.818E-06	5.9835	6.189E+10	-58.8604	1414528.	0.000
288.000	0.000133	-5292.0884	848.2311	2.493E-06	3.8994	6.189E+10	-63.0743	1425983.	0.000
291.000	0.000140	-3031.2295	653.1504	2.291E-06	2.2335	6.189E+10	-66.9795	1437437.	0.000
294.000	0.000146	-1373.1860	446.5922	2.184E-06	1.0118	6.189E+10	-70.7259	1448892.	0.000
297.000	0.000153	-351.6760	228.8643	2.142E-06	0.2591	6.189E+10	-74.4260	1460347.	0.000
300.000	0.000159	0.000	0.000	2.134E-06	0.000	6.189E+10	-78.1502	735901.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
The above values of total stress are computed for combined axial stress and do not equal the
actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 5:

```
Pile-head deflection             =      0.5000000 inches
Computed slope at pile head      =     -0.0046829 radians
Maximum bending moment           =       2107604. inch-lbs
Maximum shear force              =         33825. lbs
Depth of maximum bending moment  =    105.0000000 inches below pile head
Depth of maximum shear force     =      0.000000 inches below pile head
Number of iterations             =             17
Number of zero deflection points =              2
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 6

```
Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head   =        1.000000 in
Moment at pile head       =           0.000 in-lbs
Axial load at pile head   =           0.000 lbs
```

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.0000	0.000	48252.	-0.008386	0.000	6.189E+10	-232.9104	349.3657	0.000
3.000	0.9748	143709.	47546.	-0.008383	105.8886	6.189E+10	-237.7959	731.7990	0.000
6.000	0.9497	285277.	46826.	-0.008372	210.2003	6.189E+10	-242.5708	766.2528	0.000
9.000	0.9246	424663.	46091.	-0.008355	312.9034	6.189E+10	-247.2329	802.1781	0.000

24 inch Dia CIDH

12.000	0.8996	561823.	45342.	-0.008331	413.9670	6.189E+10	-251.7799	839.6667	0.000
15.000	0.8746	696717.	44580.	-0.008301	513.3610	6.189E+10	-256.2096	878.8167	0.000
18.000	0.8498	829305.	43805.	-0.008264	611.0558	6.189E+10	-260.5195	919.7339	0.000
21.000	0.8250	959549.	43018.	-0.008221	707.0231	6.189E+10	-264.7073	962.5319	0.000
24.000	0.8004	1087410.	42217.	-0.008171	801.2350	6.189E+10	-268.7708	1007.3331	0.000
27.000	0.7760	1212853.	41405.	-0.008115	893.6645	6.189E+10	-272.7074	1054.2692	0.000
30.000	0.7518	1335841.	40581.	-0.008053	984.2856	6.189E+10	-276.5150	1103.4827	0.000
33.000	0.7277	1456340.	39746.	-0.007986	1073.0729	6.189E+10	-280.1910	1155.1272	0.000
36.000	0.7038	1574318.	38900.	-0.007912	1160.0022	6.189E+10	-283.7330	1209.3688	0.000
39.000	0.6802	1689742.	38044.	-0.007833	1245.0500	6.189E+10	-287.1387	1266.3876	0.000
42.000	0.6568	1802582.	37178.	-0.007748	1328.1936	6.189E+10	-290.4055	1326.3784	0.000
45.000	0.6337	1912808.	36302.	-0.007658	1409.4114	6.189E+10	-293.5311	1389.5529	0.000
48.000	0.6109	2020392.	35417.	-0.007563	1488.6826	6.189E+10	-296.5129	1456.1406	0.000
51.000	0.5883	2125308.	34523.	-0.007463	1565.9875	6.189E+10	-299.3485	1526.3914	0.000
54.000	0.5661	2227530.	33621.	-0.007357	1641.3073	6.189E+10	-302.0355	1600.5773	0.000
57.000	0.5442	2327033.	32711.	-0.007247	1714.6242	6.189E+10	-304.5712	1678.9944	0.000
60.000	0.5226	2423795.	31675.	-0.007132	1785.9214	6.189E+10	-386.3264	2217.5824	0.000
63.000	0.5014	2517081.	30320.	-0.007012	1854.6566	6.189E+10	-516.4798	3090.1438	0.000
66.000	0.4806	2605718.	28764.	-0.006888	1919.9668	6.189E+10	-521.2750	3254.1657	0.000
69.000	0.4601	2689663.	27193.	-0.006759	1981.8202	6.189E+10	-525.7772	3428.3298	0.000
72.000	0.4400	2768876.	25610.	-0.006627	2040.1869	6.189E+10	-529.9806	3613.4626	0.000
75.000	0.4203	2843320.	24014.	-0.006491	2095.0391	6.189E+10	-533.8798	3810.4746	0.000
78.000	0.4011	2912959.	22407.	-0.006351	2146.3509	6.189E+10	-537.4689	4020.3705	0.000
81.000	0.3822	2977760.	20789.	-0.006209	2194.0985	6.189E+10	-540.7424	4244.2610	0.000
84.000	0.3638	3037695.	19163.	-0.006063	2238.2601	6.189E+10	-543.6947	4483.3756	0.000
87.000	0.3458	3092737.	17528.	-0.005914	2278.8163	6.189E+10	-546.3200	4739.0788	0.000
90.000	0.3283	3142861.	15885.	-0.005763	2315.7496	6.189E+10	-548.6127	5012.8873	0.000
93.000	0.3113	3188049.	14237.	-0.005610	2349.0448	6.189E+10	-550.5669	5306.4907	0.000
96.000	0.2947	3228281.	12582.	-0.005454	2378.6889	6.189E+10	-552.1767	5621.7757	0.000
99.000	0.2785	3263543.	10924.	-0.005297	2404.6713	6.189E+10	-553.4361	5960.8536	0.000
102.000	0.2629	3293825.	9262.3414	-0.005138	2426.9836	6.189E+10	-554.3389	6326.0934	0.000
105.000	0.2477	3319117.	7598.5149	-0.004978	2445.6199	6.189E+10	-554.8788	6720.1593	0.000
108.000	0.2330	3339416.	5933.6227	-0.004816	2460.5764	6.189E+10	-555.0493	7146.0562	0.000
111.000	0.2188	3354719.	4268.7832	-0.004654	2471.8522	6.189E+10	-554.8437	7607.1830	0.000
114.000	0.2051	3365028.	2605.1348	-0.004491	2479.4486	6.189E+10	-554.2552	8107.3953	0.000
117.000	0.1919	3370350.	943.8375	-0.004328	2483.3695	6.189E+10	-553.2764	8651.0810	0.000
120.000	0.1791	3370691.	-713.9269	-0.004164	2483.6213	6.189E+10	-551.8999	9243.2507	0.000
123.000	0.1669	3366066.	-2366.9537	-0.004001	2480.2132	6.189E+10	-550.1180	9889.6461	0.000
126.000	0.1551	3356490.	-4014.0141	-0.003838	2473.1571	6.189E+10	-547.9223	10597.	0.000
129.000	0.1438	3341982.	-5653.8539	-0.003676	2462.4674	6.189E+10	-545.3043	11373.	0.000
132.000	0.1331	3322567.	-7285.1925	-0.003514	2448.1615	6.189E+10	-542.2547	12226.	0.000
135.000	0.1228	3298271.	-8906.7206	-0.003354	2430.2598	6.189E+10	-538.7640	13166.	0.000
138.000	0.1129	3269126.	-10517.	-0.003195	2408.7852	6.189E+10	-534.8216	14206.	0.000
141.000	0.1036	3235168.	-12115.	-0.003037	2383.7640	6.189E+10	-530.4165	15361.	0.000
144.000	0.0947	3196436.	-13699.	-0.002881	2355.2253	6.189E+10	-525.5364	16645.	0.000
147.000	0.0863	3152975.	-15267.	-0.002727	2323.2016	6.189E+10	-520.1682	18081.	0.000
150.000	0.0784	3104832.	-16819.	-0.002576	2287.7284	6.189E+10	-514.2974	19691.	0.000
153.000	0.0709	3052060.	-18352.	-0.002426	2248.8447	6.189E+10	-507.9080	21506.	0.000
156.000	0.0638	2994717.	-19866.	-0.002280	2206.5928	6.189E+10	-500.9820	23559.	0.000
159.000	0.0572	2932865.	-21358.	-0.002136	2161.0186	6.189E+10	-493.4992	25895.	0.000
162.000	0.0510	2866572.	-22826.	-0.001996	2112.1719	6.189E+10	-485.4364	28567.	0.000
165.000	0.0452	2795910.	-24269.	-0.001858	2060.1059	6.189E+10	-476.7670	31644.	0.000
168.000	0.0398	2720957.	-25686.	-0.001725	2004.8784	6.189E+10	-467.4597	35210.	0.000
171.000	0.0349	2641797.	-27073.	-0.001595	1946.5509	6.189E+10	-457.4773	39378.	0.000
174.000	0.0303	2558519.	-28429.	-0.001469	1885.1896	6.189E+10	-446.7748	44293.	0.000
177.000	0.0260	2471221.	-29752.	-0.001347	1820.8656	6.189E+10	-435.2969	50148.	0.000
180.000	0.0222	2380004.	-31040.	-0.001229	1753.6549	6.189E+10	-422.9737	57208.	0.000
183.000	0.0187	2284981.	-32289.	-0.001116	1683.6393	6.189E+10	-409.7156	65848.	0.000
186.000	0.0155	2186271.	-33497.	-0.001008	1610.9067	6.189E+10	-395.4033	76606.	0.000
189.000	0.0126	2084002.	-34659.	-0.000904	1535.5520	6.189E+10	-379.8737	90299.	0.000
192.000	0.0101	1978314.	-35774.	-0.000806	1457.6782	6.189E+10	-362.8936	108223.	0.000
195.000	0.007786	1869360.	-36834.	-0.000712	1377.3978	6.189E+10	-344.1126	132582.	0.000
198.000	0.005785	1757309.	-37835.	-0.000625	1294.8355	6.189E+10	-322.9677	167484.	0.000
201.000	0.004039	1642352.	-38767.	-0.000542	1210.1315	6.189E+10	-298.4625	221670.	0.000
204.000	0.002532	1524708.	-39617.	-0.000465	1123.4482	6.189E+10	-268.5547	318152.	0.000
207.000	0.001247	1404647.	-40362.	-0.000394	1034.9840	6.189E+10	-227.7583	547890.	0.000
210.000	0.000166	1282537.	-40797.	-0.000329	945.0094	6.189E+10	-62.4856	1128189.	0.000
213.000	-0.000728	1159864.	-40147.	-0.000270	854.6205	6.189E+10	496.1610	2043854.	0.000
216.000	-0.001454	1041656.	-38515.	-0.000217	767.5218	6.189E+10	591.7534	1220926.	0.000
219.000	-0.002028	928774.	-36662.	-0.000169	684.3473	6.189E+10	643.7226	952112.	0.000
222.000	-0.002468	821686.	-34682.	-0.000126	605.4416	6.189E+10	676.3541	822315.	0.000
225.000	-0.002787	720685.	-32621.	-8.910E-05	531.0212	6.189E+10	697.4464	750694.	0.000
228.000	-0.003002	625961.	-30509.	-5.646E-05	461.2258	6.189E+10	710.6273	710129.	0.000

231.000	-0.003126	537633.	-28366.	-2.826E-05	396.1429	6.189E+10	717.9178	688986.	0.000
234.000	-0.003172	455765.	-26208.	-4.181E-06	335.8209	6.189E+10	720.5728	681574.	0.000
237.000	-0.003151	380383.	-24048.	1.609E-05	280.2773	6.189E+10	719.4293	684940.	0.000
240.000	-0.003075	311476.	-21896.	3.285E-05	229.5046	6.189E+10	715.0733	697600.	0.000
243.000	-0.002954	249005.	-19762.	4.644E-05	183.4738	6.189E+10	707.9276	718968.	0.000
246.000	-0.002797	192905.	-17653.	5.715E-05	142.1377	6.189E+10	698.3010	749114.	0.000
249.000	-0.002611	143089.	-15576.	6.529E-05	105.4323	6.189E+10	686.4166	788674.	0.000
252.000	-0.002405	99452.	-13537.	7.117E-05	73.2788	6.189E+10	672.4265	838876.	0.000
255.000	-0.002184	61866.	-11544.	7.508E-05	45.5845	6.189E+10	656.4177	901676.	0.000
258.000	-0.001954	30188.	-9601.7381	7.731E-05	22.2432	6.189E+10	638.4095	980035.	0.000
261.000	-0.001720	4255.3963	-7716.6131	7.815E-05	3.1355	6.189E+10	618.3405	1078434.	0.000
264.000	-0.001485	-16112.	-5895.0383	7.786E-05	11.8717	6.189E+10	596.0426	1203842.	0.000
267.000	-0.001253	-31115.	-4144.1906	7.672E-05	22.9263	6.189E+10	571.1892	1367640.	0.000
270.000	-0.001025	-40977.	-2472.6133	7.497E-05	30.1931	6.189E+10	543.1957	1589763.	0.000
273.000	-0.000803	-45951.	-891.3047	7.286E-05	33.8576	6.189E+10	511.0100	1908840.	0.000
276.000	-0.000588	-46325.	584.1251	7.063E-05	34.1335	6.189E+10	472.6098	2411788.	0.000
279.000	-0.000379	-42446.	1826.5222	6.847E-05	31.2752	6.189E+10	355.6549	2812500.	0.000
282.000	-0.000177	-35366.	2608.9507	6.659E-05	26.0585	6.189E+10	165.9641	2812500.	0.000
285.000	2.017E-05	-26792.	2843.6348	6.508E-05	19.7412	6.189E+10	-9.5081	1414528.	0.000
288.000	0.000213	-18304.	2677.1757	6.399E-05	13.4869	6.189E+10	-101.4647	1425983.	0.000
291.000	0.000404	-10729.	2234.5458	6.329E-05	7.9054	6.189E+10	-193.6219	1437437.	0.000
294.000	0.000593	-4896.6656	1577.8482	6.291E-05	3.6080	6.189E+10	-244.1764	1234933.	0.000
297.000	0.000782	-1261.9148	816.1109	6.276E-05	0.9298	6.189E+10	-263.6484	1012039.	0.000
300.000	0.000970	0.000	0.000	6.273E-05	0.000	6.189E+10	-280.4255	433775.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 6:

```
Pile-head deflection             =      1.0000000 inches
Computed slope at pile head      =     -0.0083864 radians
Maximum bending moment           =       3370691. inch-lbs
Maximum shear force              =         48252. lbs
Depth of maximum bending moment  =    120.0000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             21
Number of zero deflection points =              2
```

Summary of Pile Response(s)

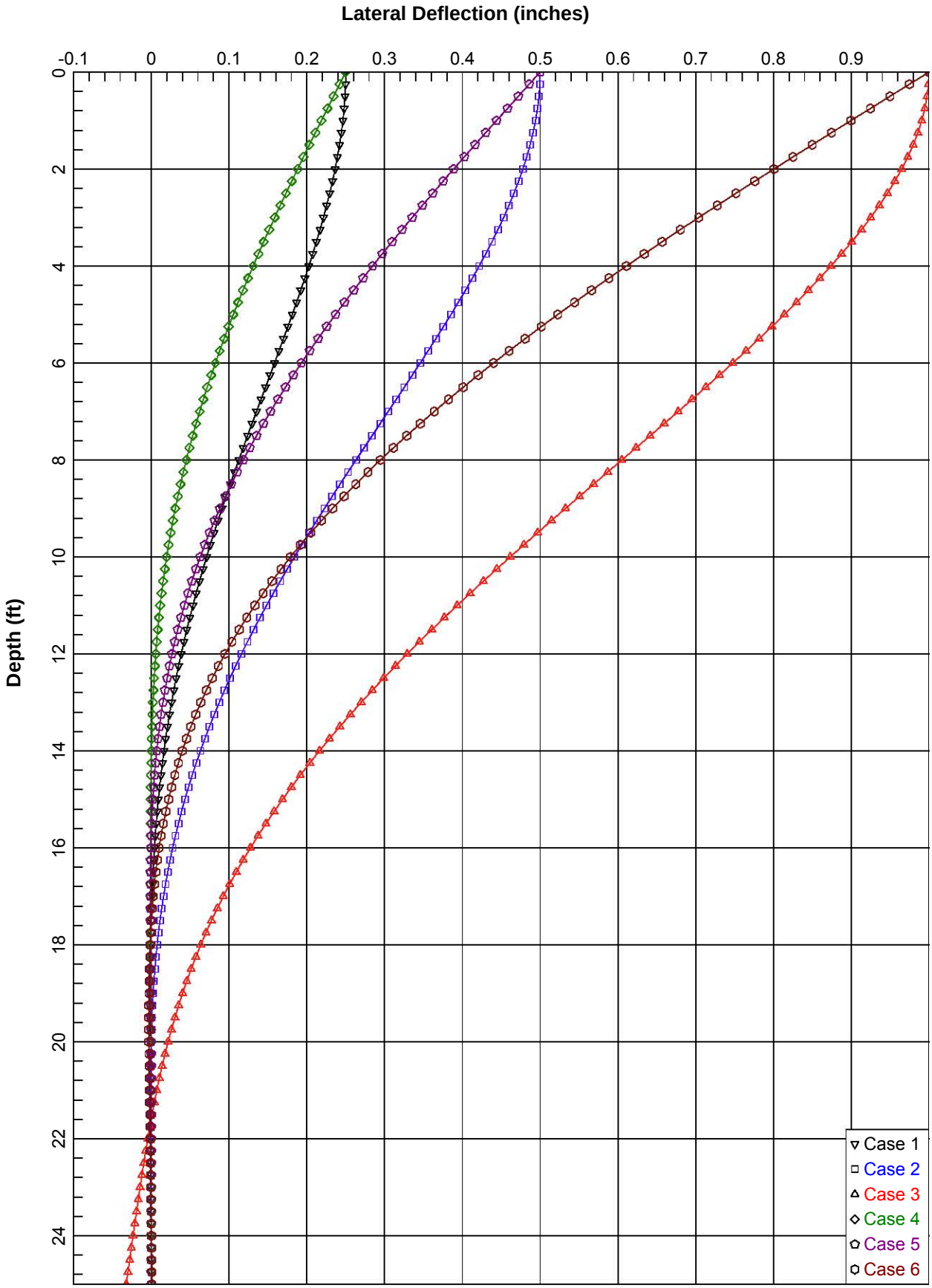
Definitions of Pile-Head Loading Conditions:

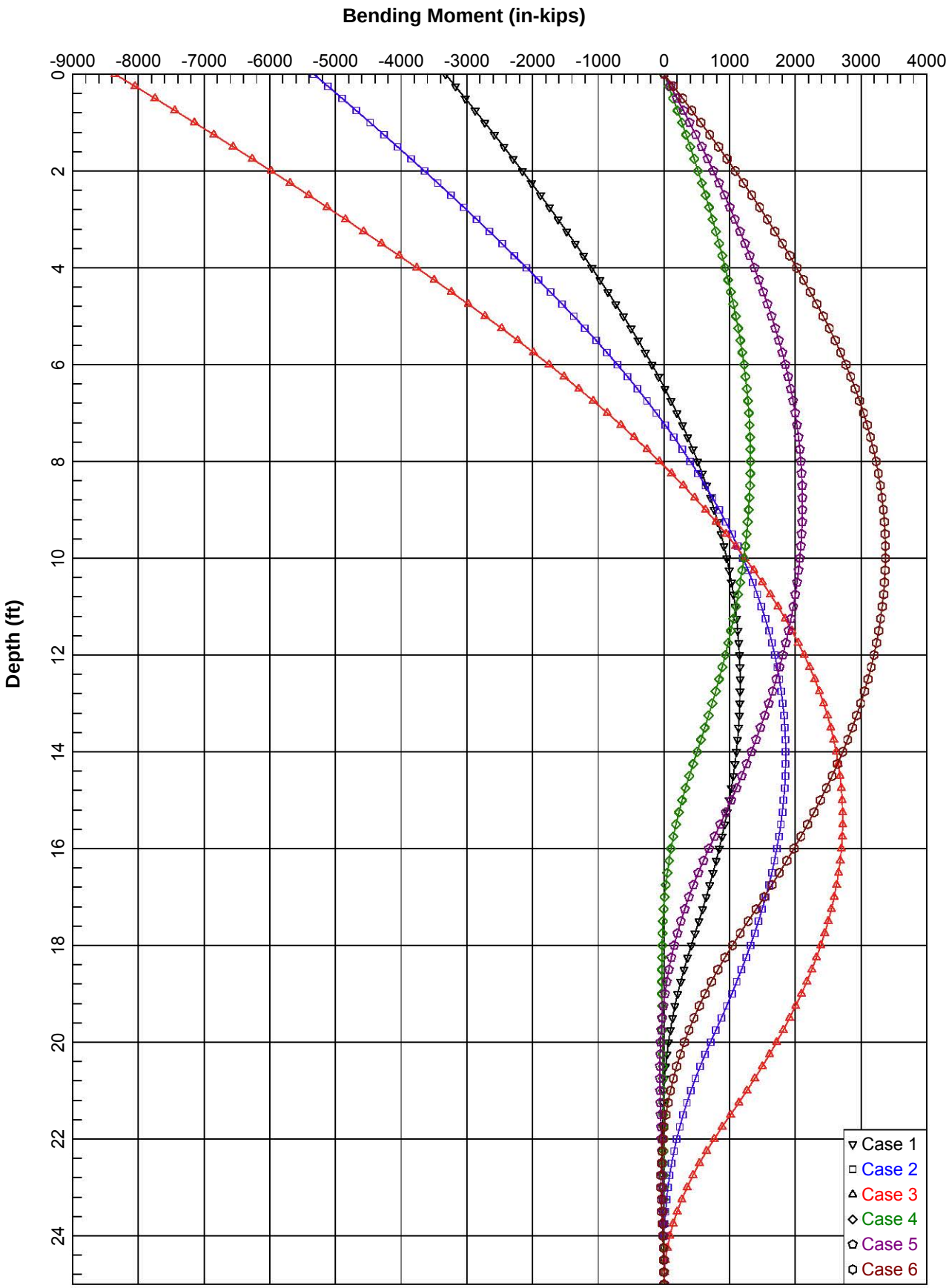
```
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians
```

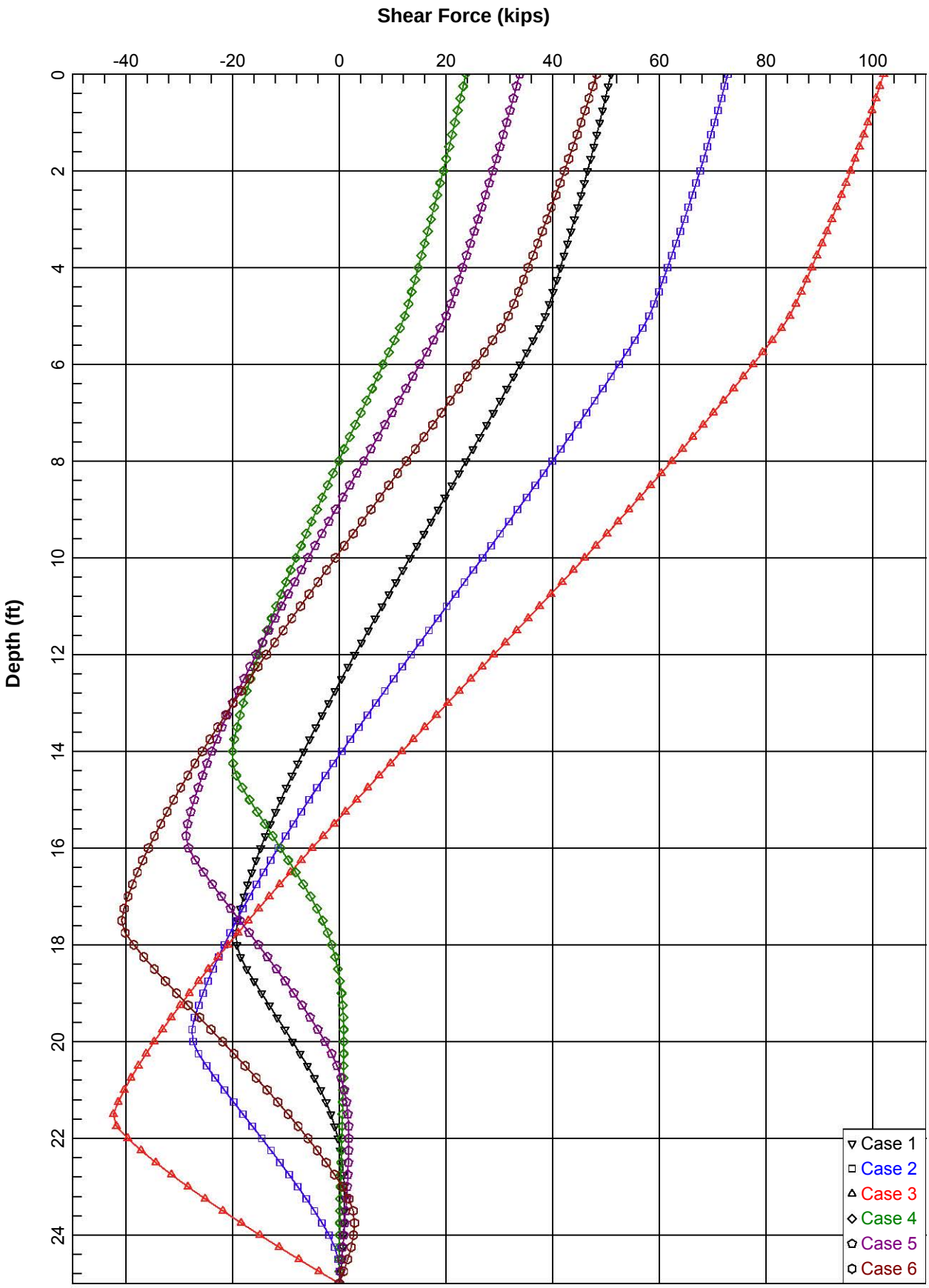
Load Case	Load Type	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	5	y = 0.2500	S = 0.000	0.0000000	0.25000000	-3325652.	50912.	0.00000000
2	5	y = 0.5000	S = 0.000	0.0000000	0.50000000	-5331546.	72832.	0.00000000

```
  3    5   y =     1.0000  S =      0.000      0.0000000     1.00000000      -8354772.        102050.
0.00000000
  4     4   y =     0.2500  M =      0.000      0.0000000     0.25000000       1316221.         23723.
0.00000000
  5     4   y =     0.5000  M =      0.000      0.0000000     0.50000000       2107604.         33825.
0.00000000
  6     4   y =     1.0000  M =      0.000      0.0000000     1.00000000       3370691.         48252.
0.00000000

The analysis ended normally.
```


Lateral Deflection (inches)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6


Bending Moment (in-kips)
-9000
-8000
-7000
-6000
-5000
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6


Shear Force (kips)
-40
-20
0
20
40
60
80
100
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

LPile Plus for Windows, Version 6.0 (6.0.08)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Sreekar Pulijala
Leighton and Associates, INc.

Files Used for Analysis

Path to file locations: P:\Leighton Consulting\603000\603507.002 Ford Theatre\Analyses\LPile\
Name of input data file: 30 inch Dia CIDH.lp6d
Name of output file: 30 inch Dia CIDH.lp6o
Name of plot output file: 30 inch Dia CIDH.lp6p
Name of runtime file: 30 inch Dia CIDH.lp6r

Date and Time of Analysis

Date: July 10, 2013 Time: 15:20:49

Problem Title

Ford Theater Foundation

603507-002

Ford Theater Foundation

SP

Drilled, Cast-in-Place Concrete Caissons - 30-inch Diameter

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip

- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100
- Maximum number of iterations allowed	=	1000
- Deflection tolerance for convergence	=	1.0000E-05 in
- Maximum allowable deflection	=	100.0000 in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections	=	1
Total Pile Length	=	25.00 ft
Depth of ground surface below top of pile	=	0.00 ft
Slope angle of ground surface	=	45.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	30.0000000
2	25.000000	30.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	25.000 in
Top Width	=	30.000 in
Bottom Width	=	30.000 in
Top Area	=	706.858347 sq. in
Bottom Area	=	706.858347 sq. in
Moment of Inertia at Top	=	3.976E+04 in^4
Moment of Inertia at Bottom	=	3.976E+04 in^4
Elastic Modulus	=	3800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	45.000 degrees
	=	0.785 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer = 0.000 ft
Distance from top of pile to bottom of layer = 5.000 ft

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer = 5.000 ft
Distance from top of pile to bottom of layer = 50.000 ft

(Depth of lowest layer extends 25.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	0.00	120.00000
2	5.00	120.00000
3	5.00	130.00000
4	50.00	130.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion Test Prop. psf	Friction Ang., deg.	qu Elas. Subgr. psi
		Epsilon 50	kpy pci	Rock Emass psi	krm Test Type	RQD percent
1	Stiff Clay w/o Free Water	0.00	120.000	1500.000	--	--
--	0.00	--	--	--	--	--
			5.000	120.000	1500.000	--
--	0.00	--	--	--	--	--
2	Stiff Clay w/o Free Water	5.000	130.000	3000.000	--	--
--	0.00	--	--	--	--	--
		50.000	130.000	3000.000	--	--
--	0.00	--	--	--	--	--

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 6

Load	Load	Condition 1	Condition 2	Axial Thrust

30 inch Dia CIDH

No.	Type					Force, lbs
1	5	y =	0.250 in	S =	0.000 in/in	0.000
2	5	y =	0.500 in	S =	0.000 in/in	0.000
3	5	y =	1.000 in	S =	0.000 in/in	0.000
4	4	y =	0.250 in	M =	0.000 in-lbs	0.000
5	4	y =	0.500 in	M =	0.000 in-lbs	0.000
6	4	y =	1.000 in	M =	0.000 in-lbs	0.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 0.250000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2500	-5771914.	74800.	0.000	2177.4902	1.511E+11	-194.6957	1168.1745	0.000
3.000	0.2498	-5548410.	74203.	-0.000112	2093.1717	1.511E+11	-199.2044	2392.0975	0.000
6.000	0.2493	-5326698.	73598.	-0.000220	2009.5296	1.511E+11	-203.6440	2450.3373	0.000
9.000	0.2485	-5106819.	72981.	-0.000324	1926.5789	1.511E+11	-208.0125	2511.1574	0.000
12.000	0.2474	-4888812.	72350.	-0.000423	1844.3345	1.511E+11	-212.3079	2574.6562	0.000
15.000	0.2460	-4672716.	71707.	-0.000518	1762.8109	1.511E+11	-216.5282	2640.9420	0.000
18.000	0.2443	-4458569.	71051.	-0.000609	1682.0225	1.511E+11	-220.6712	2710.1327	0.000
21.000	0.2423	-4246407.	70383.	-0.000695	1601.9834	1.511E+11	-224.7351	2782.3562	0.000
24.000	0.2401	-4036269.	69703.	-0.000777	1522.7073	1.511E+11	-228.7178	2857.7513	0.000
27.000	0.2377	-3828189.	69011.	-0.000855	1444.2077	1.511E+11	-232.6173	2936.4676	0.000
30.000	0.2350	-3622202.	68308.	-0.000929	1366.4980	1.511E+11	-236.4317	3018.6663	0.000
33.000	0.2321	-3418343.	67593.	-0.000999	1289.5910	1.511E+11	-240.1590	3104.5212	0.000
36.000	0.2290	-3216646.	66867.	-0.001065	1213.4995	1.511E+11	-243.7973	3194.2189	0.000
39.000	0.2257	-3017143.	66130.	-0.001127	1138.2357	1.511E+11	-247.3447	3287.9600	0.000
42.000	0.2222	-2819866.	65383.	-0.001185	1063.8117	1.511E+11	-250.7993	3385.9597	0.000
45.000	0.2186	-2624846.	64625.	-0.001239	990.2392	1.511E+11	-254.1591	3488.4493	0.000
48.000	0.2148	-2432113.	63858.	-0.001289	917.5297	1.511E+11	-257.4223	3595.6767	0.000
51.000	0.2108	-2241698.	63081.	-0.001336	845.6943	1.511E+11	-260.5871	3707.9081	0.000
54.000	0.2068	-2053627.	62295.	-0.001378	774.7436	1.511E+11	-263.6515	3825.4291	0.000
57.000	0.2026	-1867930.	61499.	-0.001417	704.6881	1.511E+11	-266.6139	3948.5460	0.000
60.000	0.1983	-1684632.	60577.	-0.001453	635.5378	1.511E+11	-347.9279	5264.7574	0.000
63.000	0.1939	-1504465.	59357.	-0.001484	567.5688	1.511E+11	-465.9389	7210.7860	0.000
66.000	0.1894	-1328492.	57951.	-0.001512	501.1819	1.511E+11	-471.1668	7464.8797	0.000
69.000	0.1848	-1156760.	56530.	-0.001537	436.3947	1.511E+11	-476.2044	7731.5608	0.000
72.000	0.1801	-989313.	55094.	-0.001558	373.2243	1.511E+11	-481.0478	8011.6166	0.000
75.000	0.1754	-826195.	53644.	-0.001576	311.6873	1.511E+11	-485.6928	8305.8988	0.000
78.000	0.1707	-667449.	52180.	-0.001591	251.7993	1.511E+11	-490.1357	8615.3293	0.000
81.000	0.1659	-513114.	50703.	-0.001603	193.5755	1.511E+11	-494.3725	8940.9068	0.000
84.000	0.1611	-363229.	49214.	-0.001612	137.0303	1.511E+11	-498.3994	9283.7137	0.000
87.000	0.1562	-217829.	47713.	-0.001617	82.1772	1.511E+11	-502.2127	9644.9247	0.000
90.000	0.1514	-76949.	46201.	-0.001620	29.0294	1.511E+11	-505.8088	10026.	0.000
93.000	0.1465	59379.	44679.	-0.001620	22.4011	1.511E+11	-509.1839	10428.	0.000

96.000	0.1416	191124.	43147.	-0.001618	72.1028	1.511E+11	-512.3343	10852.	0.000
99.000	0.1368	318258.	41605.	-0.001613	120.0649	1.511E+11	-515.2565	11301.	0.000
102.000	0.1320	440755.	40055.	-0.001605	166.2776	1.511E+11	-517.9468	11776.	0.000
105.000	0.1271	558590.	38498.	-0.001595	210.7317	1.511E+11	-520.4015	12279.	0.000
108.000	0.1224	671742.	36933.	-0.001583	253.4189	1.511E+11	-522.6170	12811.	0.000
111.000	0.1176	780190.	35362.	-0.001569	294.3316	1.511E+11	-524.5896	13377.	0.000
114.000	0.1130	883917.	33786.	-0.001552	333.4632	1.511E+11	-526.3156	13977.	0.000
117.000	0.1083	982907.	32205.	-0.001534	370.8077	1.511E+11	-527.7913	14615.	0.000
120.000	0.1038	1077147.	30620.	-0.001513	406.3603	1.511E+11	-529.0129	15295.	0.000
123.000	0.0993	1166626.	29031.	-0.001491	440.1167	1.511E+11	-529.9767	16019.	0.000
126.000	0.0948	1251335.	27440.	-0.001467	472.0737	1.511E+11	-530.6788	16791.	0.000
129.000	0.0905	1331267.	25848.	-0.001441	502.2288	1.511E+11	-531.1152	17615.	0.000
132.000	0.0862	1406420.	24254.	-0.001414	530.5807	1.511E+11	-531.2822	18497.	0.000
135.000	0.0820	1476792.	22660.	-0.001386	557.1287	1.511E+11	-531.1757	19441.	0.000
138.000	0.0779	1542382.	21067.	-0.001356	581.8732	1.511E+11	-530.7915	20453.	0.000
141.000	0.0738	1603196.	19476.	-0.001324	604.8155	1.511E+11	-530.1255	21540.	0.000
144.000	0.0699	1659238.	17887.	-0.001292	625.9578	1.511E+11	-529.1735	22708.	0.000
147.000	0.0661	1710518.	16301.	-0.001259	645.3035	1.511E+11	-527.9311	23967.	0.000
150.000	0.0624	1757047.	14720.	-0.001224	662.8566	1.511E+11	-526.3938	25325.	0.000
153.000	0.0587	1798837.	13143.	-0.001189	678.6225	1.511E+11	-524.5569	26792.	0.000
156.000	0.0552	1835907.	11573.	-0.001153	692.6074	1.511E+11	-522.4158	28379.	0.000
159.000	0.0518	1868276.	10009.	-0.001116	704.8185	1.511E+11	-519.9655	30102.	0.000
162.000	0.0485	1895964.	8453.6985	-0.001079	715.2641	1.511E+11	-517.2008	31973.	0.000
165.000	0.0453	1918998.	6906.7225	-0.001041	723.9537	1.511E+11	-514.1165	34010.	0.000
168.000	0.0423	1937404.	5369.4874	-0.001002	730.8978	1.511E+11	-510.7069	36234.	0.000
171.000	0.0393	1951215.	3842.9779	-0.000964	736.1078	1.511E+11	-506.9661	38665.	0.000
174.000	0.0365	1960462.	2328.1966	-0.000925	739.5965	1.511E+11	-502.8881	41331.	0.000
177.000	0.0338	1965184.	826.1654	-0.000886	741.3777	1.511E+11	-498.4661	44262.	0.000
180.000	0.0312	1965419.	-662.0733	-0.000847	741.4665	1.511E+11	-493.6931	47493.	0.000
183.000	0.0287	1961211.	-2135.4554	-0.000808	739.8791	1.511E+11	-488.5616	51064.	0.000
186.000	0.0263	1952607.	-3592.8932	-0.000769	736.6329	1.511E+11	-483.0635	55024.	0.000
189.000	0.0241	1939654.	-5033.2733	-0.000731	731.7465	1.511E+11	-477.1899	59431.	0.000
192.000	0.0220	1922407.	-6455.4544	-0.000692	725.2399	1.511E+11	-470.9309	64352.	0.000
195.000	0.0199	1900921.	-7858.2643	-0.000654	717.1343	1.511E+11	-464.2757	69868.	0.000
198.000	0.0180	1875257.	-9240.4961	-0.000617	707.4524	1.511E+11	-457.2122	76080.	0.000
201.000	0.0162	1845478.	-10601.	-0.000580	696.2181	1.511E+11	-449.7265	83105.	0.000
204.000	0.0146	1811652.	-11938.	-0.000543	683.4568	1.511E+11	-441.8028	91092.	0.000
207.000	0.0130	1773849.	-13251.	-0.000508	669.1955	1.511E+11	-433.4228	100223.	0.000
210.000	0.0115	1732146.	-14538.	-0.000473	653.4626	1.511E+11	-424.5647	110728.	0.000
213.000	0.0101	1686621.	-15798.	-0.000439	636.2882	1.511E+11	-415.2024	122899.	0.000
216.000	0.008868	1637360.	-17028.	-0.000406	617.7040	1.511E+11	-405.3044	137112.	0.000
219.000	0.007698	1584451.	-18229.	-0.000374	597.7437	1.511E+11	-394.8311	153862.	0.000
222.000	0.006623	1527988.	-19396.	-0.000343	576.4428	1.511E+11	-383.7329	173815.	0.000
225.000	0.005639	1468072.	-20530.	-0.000314	553.8391	1.511E+11	-371.9452	197883.	0.000
228.000	0.004742	1404808.	-21627.	-0.000285	529.9724	1.511E+11	-359.3820	227358.	0.000
231.000	0.003929	1338310.	-22685.	-0.000258	504.8856	1.511E+11	-345.9261	264137.	0.000
234.000	0.003196	1268698.	-23701.	-0.000232	478.6242	1.511E+11	-331.4108	311132.	0.000
237.000	0.002538	1196104.	-24671.	-0.000207	451.2376	1.511E+11	-315.5899	373083.	0.000
240.000	0.001951	1120670.	-25592.	-0.000184	422.7795	1.511E+11	-298.0782	458323.	0.000
243.000	0.001431	1042552.	-26456.	-0.000163	393.3093	1.511E+11	-278.2257	583174.	0.000
246.000	0.000974	961931.	-27256.	-0.000143	362.8944	1.511E+11	-254.8063	785200.	0.000
249.000	0.000573	879017.	-27964.	-0.000125	331.6144	1.511E+11	-217.3333	1137673.	0.000
252.000	0.000225	794146.	-28419.	-0.000108	299.5965	1.511E+11	-86.0479	1147174.	0.000
255.000	-7.574E-05	708501.	-28442.	-9.322E-05	267.2864	1.511E+11	71.0093	2812500.	0.000
258.000	-0.000334	623495.	-27865.	-8.000E-05	235.2174	1.511E+11	313.4149	2812500.	0.000
261.000	-0.000556	541310.	-26614.	-6.843E-05	204.2126	1.511E+11	521.0022	2812500.	0.000
264.000	-0.000745	463814.	-24939.	-5.846E-05	174.9767	1.511E+11	595.0831	2396572.	0.000
267.000	-0.000906	391674.	-23109.	-4.996E-05	147.7613	1.511E+11	625.0500	2068624.	0.000
270.000	-0.001045	325159.	-21200.	-4.285E-05	122.6681	1.511E+11	647.6908	1859940.	0.000
273.000	-0.001164	264473.	-19230.	-3.699E-05	99.7741	1.511E+11	665.4586	1715761.	0.000
276.000	-0.001267	209776.	-17212.	-3.228E-05	79.1395	1.511E+11	679.8291	1610140.	0.000
279.000	-0.001357	161198.	-15155.	-2.860E-05	60.8131	1.511E+11	691.7755	1529059.	0.000
282.000	-0.001438	118846.	-13064.	-2.582E-05	44.8355	1.511E+11	701.9804	1464227.	0.000
285.000	-0.001512	82812.	-10945.	-2.382E-05	31.2413	1.511E+11	710.9399	1410422.	0.000
288.000	-0.001581	53176.	-8800.0801	-2.247E-05	20.0610	1.511E+11	719.0210	1364214.	0.000
291.000	-0.001647	30012.	-6631.8061	-2.164E-05	11.3220	1.511E+11	726.4950	1323306.	0.000
294.000	-0.001711	13385.	-4441.7286	-2.121E-05	5.0497	1.511E+11	733.5567	1286162.	0.000
297.000	-0.001774	3361.1348	-2230.8860	-2.105E-05	1.2680	1.511E+11	740.3384	1251787.	0.000
300.000	-0.001837	0.000	0.000	-2.101E-05	0.000	1.511E+11	746.9189	609791.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships. The above values of total stress are computed for combined axial stress and do not equal the actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      0.2500000 inches
Computed slope at pile head      =   -0.000002219 radians
Maximum bending moment           =      -5771914. inch-lbs
Maximum shear force              =         74800. lbs
Depth of maximum bending moment  =       0.000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             18
Number of zero deflection points =              1
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 0.500000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.5000	-8800018.	101732.	0.000	3319.8610	1.511E+11	-231.5336	694.6007	0.000
3.000	0.4997	-8495888.	101021.	-0.000172	3205.1262	1.511E+11	-236.9050	1422.1752	0.000
6.000	0.4990	-8193891.	100303.	-0.000337	3091.1957	1.511E+11	-242.2135	1456.2819	0.000
9.000	0.4977	-7894073.	99568.	-0.000497	2978.0876	1.511E+11	-247.4572	1491.5642	0.000
12.000	0.4960	-7596482.	98818.	-0.000651	2865.8198	1.511E+11	-252.6339	1528.0677	0.000
15.000	0.4938	-7301165.	98052.	-0.000799	2754.4096	1.511E+11	-257.7416	1565.8410	0.000
18.000	0.4912	-7008168.	97272.	-0.000941	2643.8746	1.511E+11	-262.7784	1604.9359	0.000
21.000	0.4882	-6717536.	96476.	-0.001077	2534.2319	1.511E+11	-267.7422	1645.4072	0.000
24.000	0.4847	-6429313.	95665.	-0.001208	2425.4981	1.511E+11	-272.6312	1687.3131	0.000
27.000	0.4809	-6143545.	94840.	-0.001332	2317.6901	1.511E+11	-277.4434	1730.7152	0.000
30.000	0.4767	-5860273.	94001.	-0.001452	2210.8240	1.511E+11	-282.1770	1775.6790	0.000
33.000	0.4722	-5579541.	93147.	-0.001565	2104.9160	1.511E+11	-286.8301	1822.2735	0.000
36.000	0.4673	-5301390.	92280.	-0.001673	1999.9819	1.511E+11	-291.4010	1870.5721	0.000
39.000	0.4622	-5025862.	91399.	-0.001776	1896.0372	1.511E+11	-295.8877	1920.6522	0.000
42.000	0.4567	-4752996.	90505.	-0.001873	1793.0972	1.511E+11	-300.2887	1972.5959	0.000
45.000	0.4509	-4482834.	89597.	-0.001965	1691.1767	1.511E+11	-304.6020	2026.4900	0.000
48.000	0.4449	-4215413.	88677.	-0.002051	1590.2904	1.511E+11	-308.8261	2082.4263	0.000
51.000	0.4386	-3950771.	87744.	-0.002132	1490.4527	1.511E+11	-312.9593	2140.5018	0.000
54.000	0.4321	-3688946.	86800.	-0.002208	1391.6775	1.511E+11	-316.9998	2200.8195	0.000
57.000	0.4254	-3429974.	85843.	-0.002278	1293.9787	1.511E+11	-320.9462	2263.4881	0.000
60.000	0.4184	-3173890.	84732.	-0.002344	1197.3696	1.511E+11	-419.3597	3006.5897	0.000
63.000	0.4113	-2921581.	83260.	-0.002405	1102.1843	1.511E+11	-562.3441	4101.5693	0.000
66.000	0.4040	-2674332.	81562.	-0.002460	1008.9084	1.511E+11	-569.4448	4228.4128	0.000
69.000	0.3966	-2432209.	79843.	-0.002511	917.5659	1.511E+11	-576.3721	4360.3644	0.000
72.000	0.3889	-2195273.	78104.	-0.002557	828.1804	1.511E+11	-583.1221	4497.6839	0.000
75.000	0.3812	-1963586.	76345.	-0.002598	740.7747	1.511E+11	-589.6913	4640.6487	0.000
78.000	0.3734	-1737205.	74566.	-0.002635	655.3713	1.511E+11	-596.0760	4789.5548	0.000
81.000	0.3654	-1516189.	72769.	-0.002667	571.9917	1.511E+11	-602.2731	4944.7180	0.000
84.000	0.3574	-1300594.	70953.	-0.002695	490.6569	1.511E+11	-608.2790	5106.4753	0.000
87.000	0.3492	-1090473.	69119.	-0.002719	411.3875	1.511E+11	-614.0907	5275.1863	0.000
90.000	0.3410	-885879.	67268.	-0.002738	334.2031	1.511E+11	-619.7051	5451.2355	0.000
93.000	0.3328	-686862.	65401.	-0.002754	259.1228	1.511E+11	-625.1189	5635.0334	0.000
96.000	0.3245	-493471.	63518.	-0.002766	186.1650	1.511E+11	-630.3293	5827.0194	0.000
99.000	0.3162	-305753.	61620.	-0.002774	115.3473	1.511E+11	-635.3331	6027.6633	0.000
102.000	0.3079	-123754.	59706.	-0.002778	46.6868	1.511E+11	-640.1276	6237.4688	0.000
105.000	0.2995	52485.	57779.	-0.002779	19.8003	1.511E+11	-644.7097	6456.9755	0.000
108.000	0.2912	222921.	55838.	-0.002776	84.0984	1.511E+11	-649.0766	6686.7625	0.000
111.000	0.2829	387516.	53885.	-0.002770	146.1927	1.511E+11	-653.2253	6927.4517	0.000
114.000	0.2746	546231.	51919.	-0.002761	206.0691	1.511E+11	-657.1531	7179.7116	0.000
117.000	0.2663	699032.	49942.	-0.002748	263.7142	1.511E+11	-660.8570	7444.2617	0.000
120.000	0.2581	845886.	47955.	-0.002733	319.1156	1.511E+11	-664.3342	7721.8772	0.000

123.000	0.2499	986760.	45957.	-0.002715	372.2613	1.511E+11	-667.5818	8013.3939	0.000
126.000	0.2418	1121626.	43949.	-0.002694	423.1404	1.511E+11	-670.5969	8319.7147	0.000
129.000	0.2338	1250457.	41934.	-0.002670	471.7426	1.511E+11	-673.3766	8641.8156	0.000
132.000	0.2258	1373227.	39910.	-0.002644	518.0585	1.511E+11	-675.9179	8980.7537	0.000
135.000	0.2179	1489914.	37878.	-0.002616	562.0794	1.511E+11	-678.2178	9337.6748	0.000
138.000	0.2101	1600498.	35841.	-0.002585	603.7976	1.511E+11	-680.2733	9713.8233	0.000
141.000	0.2024	1704958.	33797.	-0.002552	643.2060	1.511E+11	-682.0812	10111.	0.000
144.000	0.1948	1803280.	31749.	-0.002517	680.2986	1.511E+11	-683.6382	10529.	0.000
147.000	0.1873	1895450.	29696.	-0.002481	715.0700	1.511E+11	-684.9410	10972.	0.000
150.000	0.1799	1981454.	27639.	-0.002442	747.5159	1.511E+11	-685.9862	11440.	0.000
153.000	0.1726	2061285.	25580.	-0.002402	777.6325	1.511E+11	-686.7701	11935.	0.000
156.000	0.1655	2134935.	23519.	-0.002360	805.4174	1.511E+11	-687.2890	12460.	0.000
159.000	0.1585	2202400.	21457.	-0.002317	830.8688	1.511E+11	-687.5387	13016.	0.000
162.000	0.1516	2263676.	19394.	-0.002273	853.9857	1.511E+11	-687.5151	13607.	0.000
165.000	0.1448	2318765.	17332.	-0.002228	874.7683	1.511E+11	-687.2136	14235.	0.000
168.000	0.1382	2367669.	15271.	-0.002181	893.2177	1.511E+11	-686.6292	14903.	0.000
171.000	0.1317	2410393.	13213.	-0.002134	909.3357	1.511E+11	-685.7566	15616.	0.000
174.000	0.1254	2446946.	11157.	-0.002085	923.1253	1.511E+11	-684.5901	16376.	0.000
177.000	0.1192	2477337.	9105.7034	-0.002036	934.5906	1.511E+11	-683.1233	17188.	0.000
180.000	0.1132	2501580.	7058.9948	-0.001987	943.7364	1.511E+11	-681.3491	18058.	0.000
183.000	0.1073	2519691.	5018.0814	-0.001937	950.5689	1.511E+11	-679.2598	18990.	0.000
186.000	0.1016	2531688.	2983.9215	-0.001887	955.0950	1.511E+11	-676.8467	19991.	0.000
189.000	0.0960	2537594.	957.5017	-0.001837	957.3231	1.511E+11	-674.0999	21069.	0.000
192.000	0.0906	2537433.	-1060.1607	-0.001786	957.2624	1.511E+11	-671.0083	22231.	0.000
195.000	0.0853	2531233.	-3068.0122	-0.001736	954.9234	1.511E+11	-667.5594	23487.	0.000
198.000	0.0801	2519025.	-5064.9591	-0.001686	950.3178	1.511E+11	-663.7386	24848.	0.000
201.000	0.0752	2500844.	-7049.8608	-0.001636	943.4586	1.511E+11	-659.5292	26327.	0.000
204.000	0.0703	2476726.	-9021.5225	-0.001587	934.3602	1.511E+11	-654.9120	27940.	0.000
207.000	0.0656	2446714.	-10979.	-0.001538	923.0381	1.511E+11	-649.8643	29704.	0.000
210.000	0.0611	2410854.	-12920.	-0.001489	909.5095	1.511E+11	-644.3598	31641.	0.000
213.000	0.0567	2369194.	-14844.	-0.001442	893.7931	1.511E+11	-638.3670	33778.	0.000
216.000	0.0524	2321789.	-16749.	-0.001395	875.9093	1.511E+11	-631.8489	36146.	0.000
219.000	0.0483	2268698.	-18634.	-0.001350	855.8802	1.511E+11	-624.7606	38785.	0.000
222.000	0.0443	2209983.	-20497.	-0.001305	833.7298	1.511E+11	-617.0479	41747.	0.000
225.000	0.0405	2145715.	-22336.	-0.001262	809.4843	1.511E+11	-608.6447	45094.	0.000
228.000	0.0368	2075970.	-24148.	-0.001220	783.1723	1.511E+11	-599.4689	48910.	0.000
231.000	0.0332	2000829.	-25931.	-0.001180	754.8249	1.511E+11	-589.4177	53308.	0.000
234.000	0.0297	1920383.	-27683.	-0.001141	724.4763	1.511E+11	-578.3603	58439.	0.000
237.000	0.0263	1834732.	-29400.	-0.001104	692.1640	1.511E+11	-566.1265	64515.	0.000
240.000	0.0231	1743986.	-31077.	-0.001068	657.9294	1.511E+11	-552.4906	71848.	0.000
243.000	0.0199	1648267.	-32712.	-0.001034	621.8191	1.511E+11	-537.1438	80908.	0.000
246.000	0.0169	1547715.	-34297.	-0.001003	583.8849	1.511E+11	-519.6481	92449.	0.000
249.000	0.0139	1442485.	-35826.	-0.000973	544.1864	1.511E+11	-499.3514	107766.	0.000
252.000	0.0110	1332761.	-37287.	-0.000945	502.7924	1.511E+11	-475.2160	129311.	0.000
255.000	0.008228	1218761.	-38668.	-0.000920	459.7849	1.511E+11	-445.4233	162396.	0.000
258.000	0.005504	1100751.	-39946.	-0.000897	415.2651	1.511E+11	-406.2589	221415.	0.000
261.000	0.002846	979085.	-41077.	-0.000876	369.3659	1.511E+11	-347.5928	366387.	0.000
264.000	0.000246	854291.	-41744.	-0.000858	322.2865	1.511E+11	-97.2047	1185177.	0.000
267.000	-0.002303	728622.	-40711.	-0.000842	274.8771	1.511E+11	785.6402	1023359.	0.000
270.000	-0.004809	610024.	-38115.	-0.000829	230.1352	1.511E+11	945.4415	589808.	0.000
273.000	-0.007278	499934.	-35123.	-0.000818	188.6033	1.511E+11	1049.0122	432384.	0.000
276.000	-0.009718	399286.	-31858.	-0.000809	150.6332	1.511E+11	1127.8194	348165.	0.000
279.000	-0.0121	308788.	-28377.	-0.000802	116.4923	1.511E+11	1192.3079	294789.	0.000
282.000	-0.0145	229021.	-24718.	-0.000797	86.3997	1.511E+11	1247.3654	257519.	0.000
285.000	-0.0169	160481.	-20903.	-0.000793	60.5423	1.511E+11	1295.7070	229801.	0.000
288.000	-0.0193	103601.	-16951.	-0.000790	39.0842	1.511E+11	1339.0072	208250.	0.000
291.000	-0.0217	58773.	-12875.	-0.000789	22.1724	1.511E+11	1378.3744	190932.	0.000
294.000	-0.0240	26350.	-8685.7842	-0.000788	9.9407	1.511E+11	1414.5796	176659.	0.000
297.000	-0.0264	6658.1334	-4391.6463	-0.000788	2.5118	1.511E+11	1448.1790	164658.	0.000
300.000	-0.0287	0.000	0.000	-0.000788	0.000	1.511E+11	1479.5852	77202.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.5000000 inches
Computed slope at pile head = -0.000003019 radians

30 inch Dia CIDH

Maximum bending moment = -8800018. inch-lbs
Maximum shear force = 101732. lbs
Depth of maximum bending moment = 0.000000 inches below pile head
Depth of maximum shear force = 0.000000 inches below pile head
Number of iterations = 19
Number of zero deflection points = 1

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 3

Pile-head conditions are Displacement and Slope (BC Type 5)
Displacement of pile head = 1.000000 in
Slope of pile head = 0.000E+00 in/in
Axial load on pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.0000	-13404342.	135661.	0.000	5056.8705	1.511E+11	-275.3414	413.0120	0.000
3.000	0.9996	-12998627.	134816.	-0.000262	4903.8120	1.511E+11	-281.7379	845.5512	0.000
6.000	0.9984	-12595447.	133961.	-0.000516	4751.7101	1.511E+11	-288.0772	865.5931	0.000
9.000	0.9965	-12194861.	133087.	-0.000762	4600.5863	1.511E+11	-294.3574	886.1707	0.000
12.000	0.9939	-11796923.	132195.	-0.001001	4450.4620	1.511E+11	-300.5762	907.3056	0.000
15.000	0.9905	-11401691.	131284.	-0.001231	4301.3582	1.511E+11	-306.7317	929.0205	0.000
18.000	0.9865	-11009219.	130355.	-0.001453	4153.2958	1.511E+11	-312.8219	951.3388	0.000
21.000	0.9818	-10619563.	129407.	-0.001668	4006.2956	1.511E+11	-318.8447	974.2852	0.000
24.000	0.9765	-10232776.	128442.	-0.001875	3860.3779	1.511E+11	-324.7984	997.8853	0.000
27.000	0.9705	-9848913.	127458.	-0.002074	3715.5631	1.511E+11	-330.6809	1022.1658	0.000
30.000	0.9640	-9468026.	126458.	-0.002266	3571.8710	1.511E+11	-336.4905	1047.1548	0.000
33.000	0.9569	-9090167.	125440.	-0.002450	3429.3213	1.511E+11	-342.2252	1072.8814	0.000
36.000	0.9493	-8715388.	124404.	-0.002627	3287.9337	1.511E+11	-347.8833	1099.3764	0.000
39.000	0.9412	-8343740.	123352.	-0.002797	3147.7272	1.511E+11	-353.4630	1126.6716	0.000
42.000	0.9325	-7975273.	122284.	-0.002959	3008.7208	1.511E+11	-358.9626	1154.8006	0.000
45.000	0.9234	-7610037.	121199.	-0.003113	2870.9332	1.511E+11	-364.3803	1183.7985	0.000
48.000	0.9139	-7248080.	120098.	-0.003261	2734.3828	1.511E+11	-369.7145	1213.7019	0.000
51.000	0.9039	-6889451.	118981.	-0.003401	2599.0877	1.511E+11	-374.9634	1244.5495	0.000
54.000	0.8934	-6534196.	117848.	-0.003534	2465.0657	1.511E+11	-380.1254	1276.3815	0.000
57.000	0.8826	-6182363.	116700.	-0.003661	2332.3344	1.511E+11	-385.1988	1309.2404	0.000
60.000	0.8715	-5833996.	115367.	-0.003780	2200.9109	1.511E+11	-503.7818	1734.2279	0.000
63.000	0.8600	-5490163.	113597.	-0.003892	2071.1979	1.511E+11	-676.2061	2358.9499	0.000
66.000	0.8481	-5152416.	111554.	-0.003998	1943.7808	1.511E+11	-685.4372	2424.5358	0.000
69.000	0.8360	-4820838.	109484.	-0.004097	1818.6910	1.511E+11	-694.5062	2492.3120	0.000
72.000	0.8235	-4495511.	107387.	-0.004190	1695.9593	1.511E+11	-703.4090	2562.3751	0.000
75.000	0.8108	-4176515.	105264.	-0.004276	1575.6158	1.511E+11	-712.1419	2634.8274	0.000
78.000	0.7979	-3863927.	103115.	-0.004355	1457.6903	1.511E+11	-720.7010	2709.7777	0.000
81.000	0.7847	-3557826.	100940.	-0.004429	1342.2118	1.511E+11	-729.0828	2787.3408	0.000
84.000	0.7713	-3258287.	98741.	-0.004497	1229.2088	1.511E+11	-737.2837	2867.6388	0.000
87.000	0.7577	-2965383.	96517.	-0.004559	1118.7090	1.511E+11	-745.3004	2950.8009	0.000
90.000	0.7440	-2679187.	94269.	-0.004615	1010.7398	1.511E+11	-753.1293	3036.9643	0.000
93.000	0.7300	-2399769.	91998.	-0.004665	905.3277	1.511E+11	-760.7673	3126.2744	0.000
96.000	0.7160	-2127198.	89705.	-0.004710	802.4986	1.511E+11	-768.2108	3218.8858	0.000
99.000	0.7018	-1861541.	87389.	-0.004750	702.2778	1.511E+11	-775.4567	3314.9626	0.000
102.000	0.6875	-1602863.	85052.	-0.004784	604.6899	1.511E+11	-782.5016	3414.6796	0.000
105.000	0.6731	-1351228.	82694.	-0.004813	509.7589	1.511E+11	-789.3421	3518.2228	0.000
108.000	0.6586	-1106696.	80316.	-0.004838	417.5079	1.511E+11	-795.9749	3625.7904	0.000
111.000	0.6440	-869329.	77919.	-0.004857	327.9596	1.511E+11	-802.3966	3737.5937	0.000
114.000	0.6295	-639183.	75502.	-0.004872	241.1355	1.511E+11	-808.6039	3853.8589	0.000
117.000	0.6148	-416314.	73068.	-0.004883	157.0570	1.511E+11	-814.5931	3974.8272	0.000
120.000	0.6002	-200777.	70615.	-0.004889	75.7442	1.511E+11	-820.3607	4100.7574	0.000
123.000	0.5855	7377.3871	68146.	-0.004891	2.7832	1.511E+11	-825.9032	4231.9268	0.000
126.000	0.5708	208098.	65660.	-0.004889	78.5064	1.511E+11	-831.2167	4368.6330	0.000
129.000	0.5561	401338.	63159.	-0.004883	151.4073	1.511E+11	-836.2974	4511.1961	0.000
132.000	0.5415	587051.	60643.	-0.004873	221.4688	1.511E+11	-841.1412	4659.9609	0.000
135.000	0.5269	765194.	58112.	-0.004859	288.6743	1.511E+11	-845.7441	4815.2991	0.000
138.000	0.5124	935726.	55569.	-0.004843	353.0083	1.511E+11	-850.1017	4977.6126	0.000
141.000	0.4979	1098606.	53012.	-0.004822	414.4559	1.511E+11	-854.2095	5147.3363	0.000
144.000	0.4834	1253799.	50444.	-0.004799	473.0033	1.511E+11	-858.0628	5324.9419	0.000
147.000	0.4691	1401269.	47864.	-0.004773	528.6372	1.511E+11	-861.6565	5510.9422	0.000

30 inch Dia CIDH

150.000	0.4548	1540984.	45274.	-0.004743	581.3456	1.511E+11	-864.9853	5705.8954	0.000
153.000	0.4406	1672914.	42675.	-0.004712	631.1170	1.511E+11	-868.0436	5910.4112	0.000
156.000	0.4265	1797032.	40066.	-0.004677	677.9412	1.511E+11	-870.8255	6125.1566	0.000
159.000	0.4125	1913312.	37450.	-0.004640	721.8087	1.511E+11	-873.3244	6350.8633	0.000
162.000	0.3987	2021732.	34827.	-0.004601	762.7110	1.511E+11	-875.5336	6588.3361	0.000
165.000	0.3849	2122273.	32197.	-0.004560	800.6405	1.511E+11	-877.4455	6838.4628	0.000
168.000	0.3713	2214917.	29563.	-0.004517	835.5909	1.511E+11	-879.0523	7102.2258	0.000
171.000	0.3578	2299649.	26924.	-0.004472	867.5566	1.511E+11	-880.3450	7380.7153	0.000
174.000	0.3445	2376458.	24281.	-0.004426	896.5333	1.511E+11	-881.3144	7675.1458	0.000
177.000	0.3313	2445335.	21636.	-0.004378	922.5176	1.511E+11	-881.9499	7986.8744	0.000
180.000	0.3182	2506275.	18990.	-0.004329	945.5075	1.511E+11	-882.2401	8317.4243	0.000
183.000	0.3053	2559274.	16343.	-0.004278	965.5019	1.511E+11	-882.1726	8668.5115	0.000
186.000	0.2925	2604334.	13697.	-0.004227	982.5010	1.511E+11	-881.7335	9042.0778	0.000
189.000	0.2799	2641458.	11053.	-0.004175	996.5064	1.511E+11	-880.9073	9440.3310	0.000
192.000	0.2675	2670654.	8412.5407	-0.004122	1007.5208	1.511E+11	-879.6768	9865.7937	0.000
195.000	0.2552	2691934.	5775.9912	-0.004069	1015.5485	1.511E+11	-878.0229	10321.	0.000
198.000	0.2431	2705310.	3145.0708	-0.004016	1020.5950	1.511E+11	-875.9240	10810.	0.000
201.000	0.2311	2710804.	521.1512	-0.003962	1022.6675	1.511E+11	-873.3558	11337.	0.000
204.000	0.2193	2708437.	-2094.3184	-0.003908	1021.7747	1.511E+11	-870.2906	11905.	0.000
207.000	0.2077	2698238.	-4699.8000	-0.003854	1017.9269	1.511E+11	-866.6971	12521.	0.000
210.000	0.1962	2680239.	-7293.6545	-0.003801	1011.1365	1.511E+11	-862.5392	13190.	0.000
213.000	0.1849	2654476.	-9874.1266	-0.003748	1001.4175	1.511E+11	-857.7755	13920.	0.000
216.000	0.1737	2620994.	-12439.	-0.003696	988.7860	1.511E+11	-852.3579	14722.	0.000
219.000	0.1627	2579840.	-14987.	-0.003644	973.2606	1.511E+11	-846.2302	15605.	0.000
222.000	0.1518	2531070.	-17516.	-0.003593	954.8619	1.511E+11	-839.3263	16584.	0.000
225.000	0.1411	2474747.	-20022.	-0.003543	933.6135	1.511E+11	-831.5677	17677.	0.000
228.000	0.1306	2410939.	-22504.	-0.003495	909.5417	1.511E+11	-822.8603	18906.	0.000
231.000	0.1202	2339726.	-24957.	-0.003448	882.6759	1.511E+11	-813.0898	20301.	0.000
234.000	0.1099	2261194.	-27380.	-0.003402	853.0495	1.511E+11	-802.1156	21899.	0.000
237.000	0.0997	2175444.	-29768.	-0.003358	820.6997	1.511E+11	-789.7620	23754.	0.000
240.000	0.0897	2082586.	-32116.	-0.003316	785.6684	1.511E+11	-775.8053	25936.	0.000
243.000	0.0798	1982746.	-34420.	-0.003275	748.0030	1.511E+11	-759.9544	28552.	0.000
246.000	0.0701	1876066.	-36673.	-0.003237	707.7573	1.511E+11	-741.8192	31755.	0.000
249.000	0.0604	1762709.	-38867.	-0.003201	664.9929	1.511E+11	-720.8590	35788.	0.000
252.000	0.0509	1642865.	-40992.	-0.003167	619.7810	1.511E+11	-696.2904	41058.	0.000
255.000	0.0414	1516754.	-43037.	-0.003136	572.2050	1.511E+11	-666.9074	48299.	0.000
258.000	0.0321	1384642.	-44984.	-0.003107	522.3646	1.511E+11	-630.6920	59014.	0.000
261.000	0.0228	1246852.	-46805.	-0.003081	470.3828	1.511E+11	-583.8077	76879.	0.000
264.000	0.0136	1103809.	-48457.	-0.003058	416.4188	1.511E+11	-517.1647	114282.	0.000
267.000	0.004436	956111.	-49824.	-0.003037	360.6988	1.511E+11	-394.4528	266749.	0.000
270.000	-0.004647	804863.	-49010.	-0.003020	303.6396	1.511E+11	937.3169	605156.	0.000
273.000	-0.0137	662051.	-45761.	-0.003005	249.7629	1.511E+11	1228.7169	269424.	0.000
276.000	-0.0227	530298.	-41826.	-0.002993	200.0580	1.511E+11	1394.3734	184465.	0.000
279.000	-0.0316	411093.	-37461.	-0.002984	155.0875	1.511E+11	1515.5583	143696.	0.000
282.000	-0.0406	305529.	-32769.	-0.002977	115.2627	1.511E+11	1612.8900	119237.	0.000
285.000	-0.0495	214481.	-27807.	-0.002972	80.9142	1.511E+11	1695.0808	102729.	0.000
288.000	-0.0584	138688.	-22614.	-0.002968	52.3210	1.511E+11	1766.7062	90740.	0.000
291.000	-0.0673	78796.	-17218.	-0.002966	29.7263	1.511E+11	1830.4916	81585.	0.000
294.000	-0.0762	35378.	-11640.	-0.002965	13.3467	1.511E+11	1888.2010	74333.	0.000
297.000	-0.0851	8954.5141	-5896.4056	-0.002964	3.3781	1.511E+11	1941.0451	68428.	0.000
300.000	-0.0940	0.000	0.000	-0.002964	0.000	1.511E+11	1989.8920	31756.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

```
Pile-head deflection             =      1.0000000 inches
Computed slope at pile head      =   -0.000004028 radians
Maximum bending moment           =     -13404342. inch-lbs
Maximum shear force              =        135661. lbs
Depth of maximum bending moment  =       0.000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             29
Number of zero deflection points =              1
```

30 inch Dia CIDH

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 4

Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.250000 in
Moment at pile head = 0.000 in-lbs
Axial load at pile head = 0.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2500	0.000	35069.	-0.002214	0.000	1.511E+11	-194.6957	1168.1745	0.000
3.000	0.2434	104330.	34480.	-0.002213	39.3592	1.511E+11	-197.9022	2439.6354	0.000
6.000	0.2367	206879.	33882.	-0.002210	78.0465	1.511E+11	-201.0207	2547.5365	0.000
9.000	0.2301	307619.	33274.	-0.002205	116.0513	1.511E+11	-204.0495	2660.3489	0.000
12.000	0.2235	406523.	32657.	-0.002197	153.3632	1.511E+11	-206.9868	2778.3916	0.000
15.000	0.2169	503563.	32032.	-0.002188	189.9724	1.511E+11	-209.8309	2902.0084	0.000
18.000	0.2104	598716.	31399.	-0.002177	225.8691	1.511E+11	-212.5797	3031.5704	0.000
21.000	0.2039	691954.	30757.	-0.002165	261.0441	1.511E+11	-215.2316	3167.4783	0.000
24.000	0.1974	783256.	30107.	-0.002150	295.4883	1.511E+11	-217.7846	3310.1655	0.000
27.000	0.1910	872598.	29450.	-0.002134	329.1930	1.511E+11	-220.2370	3460.1011	0.000
30.000	0.1846	959958.	28786.	-0.002115	362.1500	1.511E+11	-222.5867	3617.7936	0.000
33.000	0.1783	1045314.	28115.	-0.002095	394.3512	1.511E+11	-224.8319	3783.7949	0.000
36.000	0.1720	1128647.	27437.	-0.002074	425.7890	1.511E+11	-226.9708	3958.7046	0.000
39.000	0.1658	1209937.	26753.	-0.002051	456.4562	1.511E+11	-229.0013	4143.1749	0.000
42.000	0.1597	1289166.	26063.	-0.002026	486.3459	1.511E+11	-230.9215	4337.9162	0.000
45.000	0.1537	1366317.	25368.	-0.001999	515.4515	1.511E+11	-232.7294	4543.7032	0.000
48.000	0.1477	1441373.	24667.	-0.001972	543.7669	1.511E+11	-234.4232	4761.3819	0.000
51.000	0.1418	1514320.	23961.	-0.001942	571.2864	1.511E+11	-236.0008	4991.8770	0.000
54.000	0.1360	1585142.	23251.	-0.001912	598.0046	1.511E+11	-237.4603	5236.2007	0.000
57.000	0.1304	1653827.	22537.	-0.001879	623.9166	1.511E+11	-238.7996	5495.4622	0.000
60.000	0.1248	1720364.	21714.	-0.001846	649.0177	1.511E+11	-309.8965	7451.0422	0.000
63.000	0.1193	1784111.	20630.	-0.001811	673.0667	1.511E+11	-412.6823	10379.	0.000
66.000	0.1139	1844143.	19389.	-0.001775	695.7145	1.511E+11	-414.9539	10929.	0.000
69.000	0.1086	1900442.	18141.	-0.001738	716.9534	1.511E+11	-416.9962	11515.	0.000
72.000	0.1035	1952987.	16887.	-0.001700	736.7764	1.511E+11	-418.8047	12142.	0.000
75.000	0.0984	2001763.	15628.	-0.001660	755.1775	1.511E+11	-420.3749	12811.	0.000
78.000	0.0935	2046756.	14365.	-0.001620	772.1513	1.511E+11	-421.7024	13528.	0.000
81.000	0.0887	2087953.	13098.	-0.001579	787.6933	1.511E+11	-422.7827	14296.	0.000
84.000	0.0840	2125346.	11829.	-0.001537	801.7998	1.511E+11	-423.6114	15121.	0.000
87.000	0.0795	2158926.	10557.	-0.001495	814.4680	1.511E+11	-424.1838	16008.	0.000
90.000	0.0751	2188688.	9283.9925	-0.001452	825.6960	1.511E+11	-424.4953	16963.	0.000
93.000	0.0708	2214630.	8010.4377	-0.001408	835.4826	1.511E+11	-424.5412	17993.	0.000
96.000	0.0666	2236750.	6737.1506	-0.001364	843.8279	1.511E+11	-424.3169	19106.	0.000
99.000	0.0626	2255052.	5464.9496	-0.001319	850.7324	1.511E+11	-423.8172	20310.	0.000
102.000	0.0587	2269540.	4194.6682	-0.001274	856.1980	1.511E+11	-423.0371	21616.	0.000
105.000	0.0550	2280220.	2927.1555	-0.001229	860.2272	1.511E+11	-421.9714	23034.	0.000
108.000	0.0513	2287103.	1663.2764	-0.001184	862.8237	1.511E+11	-420.6147	24579.	0.000
111.000	0.0479	2290200.	403.9125	-0.001138	863.9921	1.511E+11	-418.9612	26264.	0.000
114.000	0.0445	2289527.	-850.0370	-0.001093	863.7380	1.511E+11	-417.0052	28107.	0.000
117.000	0.0413	2285100.	-2097.6552	-0.001047	862.0680	1.511E+11	-414.7403	30127.	0.000
120.000	0.0382	2276941.	-3338.0058	-0.001002	858.9899	1.511E+11	-412.1601	32347.	0.000
123.000	0.0353	2265072.	-4570.1323	-0.000957	854.5123	1.511E+11	-409.2576	34794.	0.000
126.000	0.0325	2249520.	-5793.0569	-0.000912	848.6452	1.511E+11	-406.0255	37498.	0.000
129.000	0.0298	2230314.	-7005.7791	-0.000868	841.3995	1.511E+11	-402.4560	40496.	0.000
132.000	0.0273	2207485.	-8207.2737	-0.000824	832.7874	1.511E+11	-398.5404	43831.	0.000
135.000	0.0249	2181070.	-9396.4890	-0.000780	822.8221	1.511E+11	-394.2698	47554.	0.000
138.000	0.0226	2151106.	-10572.	-0.000737	811.5181	1.511E+11	-389.6339	51726.	0.000
141.000	0.0205	2117636.	-11734.	-0.000695	798.8912	1.511E+11	-384.6219	56421.	0.000
144.000	0.0184	2080704.	-12879.	-0.000653	784.9583	1.511E+11	-379.2215	61728.	0.000
147.000	0.0165	2040359.	-14008.	-0.000612	769.7379	1.511E+11	-373.4190	67757.	0.000
150.000	0.0148	1996653.	-15119.	-0.000572	753.2497	1.511E+11	-367.1987	74644.	0.000
153.000	0.0131	1949643.	-16211.	-0.000533	735.5147	1.511E+11	-360.5431	82557.	0.000
156.000	0.0116	1899387.	-17282.	-0.000495	716.5555	1.511E+11	-353.4313	91710.	0.000
159.000	0.0101	1845951.	-18331.	-0.000457	696.3963	1.511E+11	-345.8392	102377.	0.000
162.000	0.008817	1789402.	-19356.	-0.000421	675.0629	1.511E+11	-337.7377	114915.	0.000
165.000	0.007607	1729813.	-20356.	-0.000386	652.5828	1.511E+11	-329.0913	129793.	0.000
168.000	0.006499	1667263.	-21330.	-0.000353	628.9853	1.511E+11	-319.8562	147649.	0.000
171.000	0.005491	1601834.	-22275.	-0.000320	604.3018	1.511E+11	-309.9764	169363.	0.000
174.000	0.004578	1533615.	-23189.	-0.000289	578.5658	1.511E+11	-299.3793	196189.	0.000

177.000	0.003756	1462702.	-24070.	-0.000259	551.8134	1.511E+11	-287.9667	229977.	0.000
180.000	0.003022	1389197.	-24915.	-0.000231	524.0832	1.511E+11	-275.6020	273584.	0.000
183.000	0.002371	1313212.	-25722.	-0.000204	495.4172	1.511E+11	-262.0857	331678.	0.000
186.000	0.001797	1234868.	-26485.	-0.000179	465.8614	1.511E+11	-247.1090	412495.	0.000
189.000	0.001297	1154300.	-27201.	-0.000155	435.4666	1.511E+11	-230.1556	532203.	0.000
192.000	0.000866	1071660.	-27862.	-0.000133	404.2904	1.511E+11	-210.2574	728097.	0.000
195.000	0.000499	987128.	-28419.	-0.000113	372.4002	1.511E+11	-160.8308	966687.	0.000
198.000	0.000191	901149.	-28753.	-9.386E-05	339.9640	1.511E+11	-62.0557	976185.	0.000
201.000	-6.402E-05	814611.	-28756.	-7.682E-05	307.3171	1.511E+11	60.0215	2812500.	0.000
204.000	-0.000270	728614.	-28286.	-6.150E-05	274.8740	1.511E+11	253.3417	2812500.	0.000
207.000	-0.000433	644896.	-27297.	-4.787E-05	243.2910	1.511E+11	405.9732	2812500.	0.000
210.000	-0.000557	564832.	-25904.	-3.586E-05	213.0865	1.511E+11	522.5913	2812500.	0.000
213.000	-0.000648	489472.	-24261.	-2.539E-05	184.6563	1.511E+11	572.5101	2649781.	0.000
216.000	-0.000710	419264.	-22524.	-1.637E-05	158.1699	1.511E+11	585.7898	2475972.	0.000
219.000	-0.000746	354328.	-20755.	-8.688E-06	133.6725	1.511E+11	593.2957	2384673.	0.000
222.000	-0.000762	294732.	-18971.	-2.244E-06	111.1895	1.511E+11	596.4196	2348426.	0.000
225.000	-0.000760	240504.	-17182.	3.069E-06	90.7316	1.511E+11	596.0672	2353356.	0.000
228.000	-0.000743	191640.	-15399.	7.360E-06	72.2974	1.511E+11	592.8675	2392266.	0.000
231.000	-0.000716	148112.	-13628.	1.073E-05	55.8763	1.511E+11	587.2787	2461720.	0.000
234.000	-0.000679	109870.	-11878.	1.329E-05	41.4491	1.511E+11	579.6455	2560710.	0.000
237.000	-0.000636	76844.	-10153.	1.515E-05	28.9900	1.511E+11	570.2315	2690068.	0.000
240.000	-0.000588	48951.	-8470.6773	1.640E-05	18.4670	1.511E+11	551.4359	2812500.	0.000
243.000	-0.000538	26020.	-6887.5922	1.714E-05	9.8163	1.511E+11	503.9541	2812500.	0.000
246.000	-0.000485	7625.2695	-5449.1322	1.747E-05	2.8767	1.511E+11	455.0193	2812500.	0.000
249.000	-0.000433	-6674.5404	-4158.1155	1.748E-05	2.5180	1.511E+11	405.6586	2812500.	0.000
252.000	-0.000380	-17323.	-3014.6218	1.725E-05	6.5354	1.511E+11	356.6706	2812500.	0.000
255.000	-0.000329	-24762.	-2016.6409	1.683E-05	9.3417	1.511E+11	308.6500	2812500.	0.000
258.000	-0.000279	-29423.	-1160.6474	1.629E-05	11.1001	1.511E+11	262.0123	2812500.	0.000
261.000	-0.000231	-31726.	-442.1025	1.568E-05	11.9689	1.511E+11	217.0176	2812500.	0.000
264.000	-0.000185	-32076.	144.1160	1.505E-05	12.1008	1.511E+11	173.7947	2812500.	0.000
267.000	-0.000141	-30861.	603.3527	1.442E-05	11.6427	1.511E+11	132.3630	2812500.	0.000
270.000	-9.883E-05	-28456.	940.8794	1.384E-05	10.7351	1.511E+11	92.6548	2812500.	0.000
273.000	-5.817E-05	-25216.	1161.6650	1.330E-05	9.5130	1.511E+11	54.5356	2812500.	0.000
276.000	-1.901E-05	-21486.	1270.2053	1.284E-05	8.1056	1.511E+11	17.8246	2812500.	0.000
279.000	1.887E-05	-17595.	1285.3145	1.245E-05	6.6378	1.511E+11	-7.7518	1232683.	0.000
282.000	5.570E-05	-13774.	1239.0943	1.214E-05	5.1963	1.511E+11	-23.0617	1242185.	0.000
285.000	9.171E-05	-10160.	1147.1081	1.190E-05	3.8331	1.511E+11	-38.2625	1251687.	0.000
288.000	0.000127	-6891.2419	1009.5589	1.173E-05	2.5998	1.511E+11	-53.4370	1261188.	0.000
291.000	0.000162	-4103.0315	826.4106	1.162E-05	1.5479	1.511E+11	-68.6619	1270690.	0.000
294.000	0.000197	-1932.7781	597.4116	1.156E-05	0.7292	1.511E+11	-84.0042	1280192.	0.000
297.000	0.000231	-518.5622	322.1297	1.154E-05	0.1956	1.511E+11	-99.5171	1289694.	0.000
300.000	0.000266	0.000	0.000	1.153E-05	0.000	1.511E+11	-115.2360	649598.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 4:

```
Pile-head deflection             =      0.2500000 inches
Computed slope at pile head      =     -0.0022138 radians
Maximum bending moment           =      2290200. inch-lbs
Maximum shear force              =        35069. lbs
Depth of maximum bending moment  =    111.0000000 inches below pile head
Depth of maximum shear force     =       0.000000 inches below pile head
Number of iterations             =             15
Number of zero deflection points =              2
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 5

```
Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head   =        0.500000 in
Moment at pile head       =           0.000 in-lbs
Axial load at pile head   =           0.000 lbs
```

30 inch Dia CIDH

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.5000	0.000	49933.	-0.003960	0.000	1.511E+11	-231.5336	694.6007	0.000
3.000	0.4881	148757.	49232.	-0.003959	56.1195	1.511E+11	-235.5158	1447.4912	0.000
6.000	0.4762	295395.	48520.	-0.003955	111.4394	1.511E+11	-239.4077	1508.0919	0.000
9.000	0.4644	439877.	47796.	-0.003947	165.9464	1.511E+11	-243.2074	1571.1366	0.000
12.000	0.4526	582171.	47061.	-0.003937	219.6277	1.511E+11	-246.9132	1636.7675	0.000
15.000	0.4408	722243.	46315.	-0.003924	272.4706	1.511E+11	-250.5235	1705.1366	0.000
18.000	0.4290	860060.	45558.	-0.003908	324.4629	1.511E+11	-254.0365	1776.4064	0.000
21.000	0.4173	995591.	44791.	-0.003890	375.5927	1.511E+11	-257.4504	1850.7510	0.000
24.000	0.4057	1128804.	44013.	-0.003869	425.8483	1.511E+11	-260.7635	1928.3568	0.000
27.000	0.3941	1259671.	43226.	-0.003845	475.2186	1.511E+11	-263.9741	2009.4240	0.000
30.000	0.3826	1388162.	42430.	-0.003819	523.6926	1.511E+11	-267.0803	2094.1673	0.000
33.000	0.3712	1514249.	41624.	-0.003790	571.2598	1.511E+11	-270.0803	2182.8177	0.000
36.000	0.3599	1637906.	40809.	-0.003759	617.9099	1.511E+11	-272.9725	2275.6232	0.000
39.000	0.3486	1759105.	39986.	-0.003725	663.6333	1.511E+11	-275.7549	2372.8513	0.000
42.000	0.3375	1877823.	39155.	-0.003689	708.4204	1.511E+11	-278.4258	2474.7900	0.000
45.000	0.3265	1994035.	38316.	-0.003651	752.2621	1.511E+11	-280.9833	2581.7498	0.000
48.000	0.3156	2107719.	37469.	-0.003610	795.1498	1.511E+11	-283.4257	2694.0663	0.000
51.000	0.3048	2218851.	36616.	-0.003567	837.0752	1.511E+11	-285.7510	2812.1019	0.000
54.000	0.2942	2327412.	35755.	-0.003522	878.0304	1.511E+11	-287.9576	2936.2486	0.000
57.000	0.2837	2433381.	34888.	-0.003474	918.0079	1.511E+11	-290.0434	3066.9308	0.000
60.000	0.2734	2536740.	33887.	-0.003425	957.0006	1.511E+11	-377.0232	4137.6146	0.000
63.000	0.2632	2636705.	32567.	-0.003374	994.7132	1.511E+11	-502.9448	5733.4640	0.000
66.000	0.2531	2732144.	31053.	-0.003320	1030.7181	1.511E+11	-506.6292	6004.6135	0.000
69.000	0.2432	2823023.	29528.	-0.003265	1065.0029	1.511E+11	-510.0850	6291.1360	0.000
72.000	0.2335	2909312.	27993.	-0.003208	1097.5558	1.511E+11	-513.3080	6594.1751	0.000
75.000	0.2240	2990981.	26448.	-0.003150	1128.3659	1.511E+11	-516.2939	6914.9814	0.000
78.000	0.2146	3068003.	24895.	-0.003090	1157.4229	1.511E+11	-519.0385	7254.9235	0.000
81.000	0.2055	3140353.	23335.	-0.003028	1184.7177	1.511E+11	-521.5376	7615.5021	0.000
84.000	0.1965	3208010.	21767.	-0.002965	1210.2417	1.511E+11	-523.7872	7998.3643	0.000
87.000	0.1877	3270953.	20192.	-0.002901	1233.9873	1.511E+11	-525.7831	8405.3215	0.000
90.000	0.1791	3329164.	18612.	-0.002835	1255.9477	1.511E+11	-527.5211	8838.3684	0.000
93.000	0.1706	3382627.	17028.	-0.002769	1276.1170	1.511E+11	-528.9971	9299.7057	0.000
96.000	0.1624	3431329.	15439.	-0.002701	1294.4901	1.511E+11	-530.2068	9791.7655	0.000
99.000	0.1544	3475260.	13847.	-0.002632	1311.0631	1.511E+11	-531.1459	10317.	0.000
102.000	0.1467	3514410.	12252.	-0.002563	1325.8327	1.511E+11	-531.8100	10879.	0.000
105.000	0.1391	3548773.	10656.	-0.002493	1338.7966	1.511E+11	-532.1947	11481.	0.000
108.000	0.1317	3578347.	9059.5327	-0.002422	1349.9535	1.511E+11	-532.2954	12126.	0.000
111.000	0.1245	3603130.	7462.9284	-0.002351	1359.3032	1.511E+11	-532.1075	12818.	0.000
114.000	0.1176	3623125.	5867.3280	-0.002279	1366.8461	1.511E+11	-531.6261	13563.	0.000
117.000	0.1109	3638334.	4273.6192	-0.002207	1372.5841	1.511E+11	-530.8464	14365.	0.000
120.000	0.1043	3648766.	2682.7047	-0.002135	1376.5196	1.511E+11	-529.7632	15231.	0.000
123.000	0.0981	3654431.	1095.5029	-0.002062	1378.6565	1.511E+11	-528.3713	16166.	0.000
126.000	0.0920	3655340.	-487.0518	-0.001990	1378.9994	1.511E+11	-526.6651	17179.	0.000
129.000	0.0861	3651508.	-2064.0081	-0.001917	1377.5540	1.511E+11	-524.6390	18277.	0.000
132.000	0.0805	3642955.	-3634.3969	-0.001845	1374.3274	1.511E+11	-522.2869	19471.	0.000
135.000	0.0750	3629702.	-5197.2310	-0.001772	1369.3274	1.511E+11	-519.6025	20771.	0.000
138.000	0.0698	3611772.	-6751.5037	-0.001700	1362.5633	1.511E+11	-516.5793	22190.	0.000
141.000	0.0648	3589193.	-8296.1877	-0.001629	1354.0452	1.511E+11	-513.2101	23743.	0.000
144.000	0.0601	3561995.	-9830.2342	-0.001558	1343.7845	1.511E+11	-509.4875	25447.	0.000
147.000	0.0555	3530212.	-11353.	-0.001488	1331.7941	1.511E+11	-505.4037	27321.	0.000
150.000	0.0511	3493880.	-12862.	-0.001418	1318.0876	1.511E+11	-500.9498	29388.	0.000
153.000	0.0470	3453039.	-14358.	-0.001349	1302.6802	1.511E+11	-496.1168	31674.	0.000
156.000	0.0430	3407733.	-15838.	-0.001281	1285.5884	1.511E+11	-490.8946	34212.	0.000
159.000	0.0393	3358010.	-17302.	-0.001214	1266.8298	1.511E+11	-485.2720	37039.	0.000
162.000	0.0358	3303919.	-18749.	-0.001147	1246.4236	1.511E+11	-479.2371	40200.	0.000
165.000	0.0324	3245514.	-20177.	-0.001082	1224.3902	1.511E+11	-472.7762	43748.	0.000
168.000	0.0293	3182855.	-21585.	-0.001019	1200.7517	1.511E+11	-465.8742	47750.	0.000
171.000	0.0263	3116003.	-22972.	-0.000956	1175.5313	1.511E+11	-458.5139	52285.	0.000
174.000	0.0235	3045024.	-24336.	-0.000895	1148.7541	1.511E+11	-450.6758	57452.	0.000
177.000	0.0209	2969989.	-25675.	-0.000835	1120.4468	1.511E+11	-442.3370	63375.	0.000
180.000	0.0185	2890973.	-26989.	-0.000777	1090.6376	1.511E+11	-433.4710	70210.	0.000
183.000	0.0163	2808056.	-28275.	-0.000720	1059.3566	1.511E+11	-424.0460	78156.	0.000
186.000	0.0142	2721323.	-29532.	-0.000666	1026.6358	1.511E+11	-414.0237	87475.	0.000
189.000	0.0123	2630863.	-30758.	-0.000612	992.5093	1.511E+11	-403.3572	98512.	0.000
192.000	0.0105	2536773.	-31951.	-0.000561	957.0133	1.511E+11	-391.9875	111734.	0.000
195.000	0.008917	2439155.	-33109.	-0.000512	920.1864	1.511E+11	-379.8390	127793.	0.000
198.000	0.007454	2338119.	-34229.	-0.000464	882.0698	1.511E+11	-366.8123	147622.	0.000
201.000	0.006131	2233781.	-35308.	-0.000419	842.7078	1.511E+11	-352.7725	172611.	0.000

204.000	0.004941	2126269.	-36344.	-0.000376	802.1480	1.511E+11	-337.5298	204933.	0.000
207.000	0.003878	2015718.	-37331.	-0.000334	760.4421	1.511E+11	-320.8038	248198.	0.000
210.000	0.002934	1902281.	-38266.	-0.000296	717.6471	1.511E+11	-302.1550	308934.	0.000
213.000	0.002104	1786124.	-39140.	-0.000259	673.8261	1.511E+11	-280.8336	400416.	0.000
216.000	0.001380	1667439.	-39945.	-0.000225	629.0517	1.511E+11	-255.3893	555052.	0.000
219.000	0.000756	1546456.	-40661.	-0.000193	583.4101	1.511E+11	-222.3427	882353.	0.000
222.000	0.000224	1423472.	-41112.	-0.000163	537.0135	1.511E+11	-78.4551	1052174.	0.000
225.000	-0.000224	1299782.	-40915.	-0.000136	490.3506	1.511E+11	209.7980	2812500.	0.000
228.000	-0.000594	1177980.	-39766.	-0.000112	444.4001	1.511E+11	556.7247	2812500.	0.000
231.000	-0.000894	1061188.	-38003.	-8.943E-05	400.3397	1.511E+11	618.4104	2075838.	0.000
234.000	-0.001130	949962.	-36090.	-6.946E-05	358.3791	1.511E+11	656.5502	1742435.	0.000
237.000	-0.001310	844645.	-34083.	-5.164E-05	318.6477	1.511E+11	681.6807	1560517.	0.000
240.000	-0.001440	745464.	-32013.	-3.586E-05	281.2308	1.511E+11	698.2235	1454363.	0.000
243.000	-0.001526	652566.	-29903.	-2.198E-05	246.1845	1.511E+11	708.5211	1393229.	0.000
246.000	-0.001572	566045.	-27769.	-9.880E-06	213.5439	1.511E+11	713.9791	1362436.	0.000
249.000	-0.001585	485950.	-25625.	5.635E-07	183.3275	1.511E+11	715.5105	1354346.	0.000
252.000	-0.001569	412294.	-23481.	9.481E-06	155.5405	1.511E+11	713.7390	1364913.	0.000
255.000	-0.001528	345062.	-21347.	1.700E-05	130.1768	1.511E+11	709.1034	1392188.	0.000
258.000	-0.001467	284212.	-19230.	2.325E-05	107.2207	1.511E+11	701.9138	1435645.	0.000
261.000	-0.001389	229679.	-17139.	2.835E-05	86.6479	1.511E+11	692.3836	1495913.	0.000
264.000	-0.001297	181378.	-15079.	3.243E-05	68.4259	1.511E+11	680.6453	1574763.	0.000
267.000	-0.001194	139202.	-13058.	3.561E-05	52.5149	1.511E+11	666.7562	1675308.	0.000
270.000	-0.001083	103027.	-11082.	3.802E-05	38.8677	1.511E+11	650.6936	1802498.	0.000
273.000	-0.000966	72709.	-9157.6651	3.976E-05	27.4299	1.511E+11	632.3397	1964061.	0.000
276.000	-0.000844	48081.	-7291.9834	4.096E-05	18.1390	1.511E+11	611.4481	2172329.	0.000
279.000	-0.000720	28957.	-5493.4402	4.173E-05	10.9242	1.511E+11	587.5807	2447920.	0.000
282.000	-0.000594	15121.	-3776.6763	4.216E-05	5.7044	1.511E+11	556.9285	2812500.	0.000
285.000	-0.000467	6296.9256	-2284.4022	4.238E-05	2.3756	1.511E+11	437.9209	2812500.	0.000
288.000	-0.000340	1414.3629	-1149.6785	4.245E-05	0.5336	1.511E+11	318.5616	2812500.	0.000
291.000	-0.000212	-601.1453	-373.1511	4.246E-05	0.2268	1.511E+11	199.1233	2812500.	0.000
294.000	-8.503E-05	-824.5436	45.1118	4.245E-05	0.3111	1.511E+11	79.7186	2812500.	0.000
297.000	4.228E-05	-330.4742	137.4239	4.244E-05	0.1247	1.511E+11	-18.1772	1289694.	0.000
300.000	0.000170	0.000	0.000	4.243E-05	0.000	1.511E+11	-73.4387	649598.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 5:

```
Pile-head deflection             =      0.5000000 inches
Computed slope at pile head      =     -0.0039605 radians
Maximum bending moment           =       3655340. inch-lbs
Maximum shear force              =         49933. lbs
Depth of maximum bending moment  =    126.0000000 inches below pile head
Depth of maximum shear force     =      0.000000 inches below pile head
Number of iterations             =             18
Number of zero deflection points =              2
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 6

```
Pile-head conditions are Displacement and Moment (BC Type 4)
Deflection at pile head   =        1.000000 in
Moment at pile head       =           0.000 in-lbs
Axial load at pile head   =           0.000 lbs
```

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb/rad.	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.0000	0.000	69448.	-0.006968	0.000	1.511E+11	-275.3414	413.0120	0.000
3.000	0.9791	207106.	68615.	-0.006966	78.1320	1.511E+11	-280.2818	858.7980	0.000
6.000	0.9582	411689.	67767.	-0.006960	155.3123	1.511E+11	-285.1310	892.7047	0.000
9.000	0.9373	613707.	66904.	-0.006950	231.5246	1.511E+11	-289.8873	927.8015	0.000

30 inch Dia CIDH

12.000	0.9165	813115.	66028.	-0.006936	306.7525	1.511E+11	-294.5493	964.1492	0.000
15.000	0.8957	1009872.	65137.	-0.006917	380.9804	1.511E+11	-299.1153	1001.8121	0.000
18.000	0.8750	1203937.	64233.	-0.006895	454.1928	1.511E+11	-303.5838	1040.8583	0.000
21.000	0.8543	1395270.	63316.	-0.006870	526.3743	1.511E+11	-307.9533	1081.3602	0.000
24.000	0.8338	1583832.	62385.	-0.006840	597.5103	1.511E+11	-312.2222	1123.3945	0.000
27.000	0.8133	1769583.	61443.	-0.006807	667.5861	1.511E+11	-316.3888	1167.0427	0.000
30.000	0.7929	1952487.	60487.	-0.006770	736.5877	1.511E+11	-320.4517	1212.3914	0.000
33.000	0.7727	2132507.	59520.	-0.006729	804.5013	1.511E+11	-324.4094	1259.5326	0.000
36.000	0.7526	2309607.	58541.	-0.006685	871.3135	1.511E+11	-328.2601	1308.5642	0.000
39.000	0.7326	2483753.	57551.	-0.006638	937.0110	1.511E+11	-332.0023	1359.5907	0.000
42.000	0.7127	2654911.	56549.	-0.006587	1001.5814	1.511E+11	-335.6346	1412.7230	0.000
45.000	0.6931	2823048.	55537.	-0.006532	1065.0121	1.511E+11	-339.1552	1468.0796	0.000
48.000	0.6735	2988132.	54514.	-0.006475	1127.2914	1.511E+11	-342.5627	1525.7869	0.000
51.000	0.6542	3150134.	53482.	-0.006414	1188.4075	1.511E+11	-345.8555	1585.9798	0.000
54.000	0.6351	3309023.	52439.	-0.006349	1248.3493	1.511E+11	-349.0320	1648.8021	0.000
57.000	0.6161	3464771.	51388.	-0.006282	1307.1060	1.511E+11	-352.0907	1714.4078	0.000
60.000	0.5974	3617349.	50172.	-0.006212	1364.6673	1.511E+11	-458.3953	2302.0618	0.000
63.000	0.5788	3765803.	48566.	-0.006139	1420.6723	1.511E+11	-612.4914	3174.3887	0.000
66.000	0.5605	3908743.	46720.	-0.006062	1474.5976	1.511E+11	-618.0239	3307.6544	0.000
69.000	0.5425	4046122.	44858.	-0.005983	1526.4245	1.511E+11	-623.3361	3447.2173	0.000
72.000	0.5246	4177891.	42980.	-0.005902	1576.1350	1.511E+11	-628.4239	3593.4643	0.000
75.000	0.5071	4304004.	41088.	-0.005818	1623.7118	1.511E+11	-633.2838	3746.8120	0.000
78.000	0.4897	4424417.	39181.	-0.005731	1669.1385	1.511E+11	-637.9120	3907.7090	0.000
81.000	0.4727	4539089.	37261.	-0.005642	1712.3992	1.511E+11	-642.3051	4076.6397	0.000
84.000	0.4559	4647980.	35327.	-0.005551	1753.4791	1.511E+11	-646.4596	4254.1266	0.000
87.000	0.4394	4751053.	33382.	-0.005457	1792.3641	1.511E+11	-650.3721	4440.7340	0.000
90.000	0.4231	4848273.	31426.	-0.005362	1829.0408	1.511E+11	-654.0392	4637.0724	0.000
93.000	0.4072	4939606.	29458.	-0.005265	1863.4969	1.511E+11	-657.4577	4843.8025	0.000
96.000	0.3915	5025023.	27481.	-0.005166	1895.7208	1.511E+11	-660.6241	5061.6405	0.000
99.000	0.3762	5104493.	25495.	-0.005065	1925.7016	1.511E+11	-663.5351	5291.3633	0.000
102.000	0.3612	5177992.	23500.	-0.004963	1953.4295	1.511E+11	-666.1875	5533.8146	0.000
105.000	0.3464	5245496.	21498.	-0.004860	1978.8955	1.511E+11	-668.5779	5789.9125	0.000
108.000	0.3320	5306982.	19489.	-0.004755	2002.0915	1.511E+11	-670.7029	6060.6566	0.000
111.000	0.3179	5362431.	17474.	-0.004649	2023.0102	1.511E+11	-672.5591	6347.1369	0.000
114.000	0.3041	5411828.	15454.	-0.004542	2041.6454	1.511E+11	-674.1431	6650.5442	0.000
117.000	0.2906	5455157.	13430.	-0.004434	2057.9917	1.511E+11	-675.4515	6972.1808	0.000
120.000	0.2775	5492407.	11402.	-0.004326	2072.0446	1.511E+11	-676.4807	7313.4734	0.000
123.000	0.2647	5523569.	9371.4802	-0.004216	2083.8006	1.511E+11	-677.2271	7675.9876	0.000
126.000	0.2522	5548636.	7339.1087	-0.004106	2093.2572	1.511E+11	-677.6871	8061.4443	0.000
129.000	0.2400	5567604.	5305.7926	-0.003996	2100.4129	1.511E+11	-677.8570	8471.7385	0.000
132.000	0.2282	5580471.	3272.4080	-0.003885	2105.2671	1.511E+11	-677.7327	8908.9610	0.000
135.000	0.2167	5587239.	1239.8433	-0.003774	2107.8202	1.511E+11	-677.3105	9375.4231	0.000
138.000	0.2056	5587910.	-791.0015	-0.003664	2108.0735	1.511E+11	-676.5861	9873.6853	0.000
141.000	0.1947	5582493.	-2819.2134	-0.003553	2106.0297	1.511E+11	-675.5552	10407.	0.000
144.000	0.1843	5570995.	-4843.8664	-0.003442	2101.6921	1.511E+11	-674.2135	10977.	0.000
147.000	0.1741	5553429.	-6864.0209	-0.003331	2095.0654	1.511E+11	-672.5562	11589.	0.000
150.000	0.1643	5529811.	-8878.7226	-0.003221	2086.1552	1.511E+11	-670.5783	12247.	0.000
153.000	0.1548	5500157.	-10887.	-0.003112	2074.9681	1.511E+11	-668.2748	12954.	0.000
156.000	0.1456	5464489.	-12888.	-0.003003	2061.5120	1.511E+11	-665.6399	13715.	0.000
159.000	0.1367	5422830.	-14880.	-0.002895	2045.7959	1.511E+11	-662.6677	14538.	0.000
162.000	0.1282	5375207.	-16863.	-0.002788	2027.8299	1.511E+11	-659.3518	15426.	0.000
165.000	0.1200	5321650.	-18836.	-0.002682	2007.6251	1.511E+11	-655.6852	16389.	0.000
168.000	0.1121	5262191.	-20797.	-0.002577	1985.1941	1.511E+11	-651.6603	17434.	0.000
171.000	0.1046	5196868.	-22745.	-0.002473	1960.5504	1.511E+11	-647.2685	18571.	0.000
174.000	0.0973	5125719.	-24680.	-0.002370	1933.7092	1.511E+11	-642.5005	19810.	0.000
177.000	0.0903	5048788.	-26600.	-0.002269	1904.6864	1.511E+11	-637.3459	21164.	0.000
180.000	0.0837	4966121.	-28503.	-0.002170	1873.4996	1.511E+11	-631.7929	22649.	0.000
183.000	0.0773	4877767.	-30390.	-0.002072	1840.1677	1.511E+11	-625.8278	24281.	0.000
186.000	0.0713	4783781.	-32258.	-0.001976	1804.7110	1.511E+11	-619.4354	26080.	0.000
189.000	0.0655	4684220.	-34106.	-0.001882	1767.1510	1.511E+11	-612.5976	28072.	0.000
192.000	0.0600	4579146.	-35933.	-0.001790	1727.5111	1.511E+11	-605.2937	30285.	0.000
195.000	0.0547	4468624.	-37737.	-0.001700	1685.8161	1.511E+11	-597.4988	32754.	0.000
198.000	0.0498	4352725.	-39517.	-0.001613	1642.0924	1.511E+11	-589.1837	35523.	0.000
201.000	0.0450	4231523.	-41271.	-0.001528	1596.3682	1.511E+11	-580.3130	38645.	0.000
204.000	0.0406	4105098.	-42998.	-0.001445	1548.6736	1.511E+11	-570.8435	42188.	0.000
207.000	0.0364	3973536.	-44695.	-0.001365	1499.0409	1.511E+11	-560.7224	46238.	0.000
210.000	0.0324	3836927.	-46361.	-0.001287	1447.5043	1.511E+11	-549.8832	50907.	0.000
213.000	0.0287	3695369.	-47993.	-0.001212	1394.1008	1.511E+11	-538.2421	56344.	0.000
216.000	0.0251	3548967.	-49589.	-0.001140	1338.8697	1.511E+11	-525.6909	62753.	0.000
219.000	0.0218	3397834.	-51146.	-0.001071	1281.8538	1.511E+11	-512.0873	70419.	0.000
222.000	0.0187	3242092.	-52660.	-0.001005	1223.0991	1.511E+11	-497.2393	79757.	0.000
225.000	0.0158	3081875.	-54127.	-0.000943	1162.6562	1.511E+11	-480.8804	91402.	0.000
228.000	0.0130	2917330.	-55542.	-0.000883	1100.5805	1.511E+11	-462.6265	106374.	0.000

30 inch Dia CIDH

231.000	0.0105	2748621.	-56899.	-0.000827	1036.9341	1.511E+11	-441.8945	126439.	0.000
234.000	0.008086	2575935.	-58189.	-0.000774	971.7873	1.511E+11	-417.7371	154985.	0.000
237.000	0.005841	2399490.	-59398.	-0.000725	905.2222	1.511E+11	-388.4499	199521.	0.000
240.000	0.003738	2219548.	-60506.	-0.000679	837.3382	1.511E+11	-350.4158	281205.	0.000
243.000	0.001768	2036453.	-61471.	-0.000636	768.2644	1.511E+11	-293.0022	497111.	0.000
246.000	-8.061E-05	1850721.	-61797.	-0.000598	698.1957	1.511E+11	75.5700	2812500.	0.000
249.000	-0.001819	1665668.	-60570.	-0.000563	628.3837	1.511E+11	742.7577	1224861.	0.000
252.000	-0.003459	1487301.	-58148.	-0.000532	561.0935	1.511E+11	871.9410	756328.	0.000
255.000	-0.005009	1316781.	-55405.	-0.000504	496.7639	1.511E+11	956.4678	572808.	0.000
258.000	-0.006482	1154870.	-52440.	-0.000479	435.6817	1.511E+11	1020.0672	472128.	0.000
261.000	-0.007885	1002139.	-49303.	-0.000458	378.0630	1.511E+11	1071.2728	407572.	0.000
264.000	-0.009229	859049.	-46025.	-0.000439	324.0816	1.511E+11	1114.2424	362193.	0.000
267.000	-0.0105	725988.	-42627.	-0.000424	273.8834	1.511E+11	1151.3516	328275.	0.000
270.000	-0.0118	603289.	-39124.	-0.000410	227.5943	1.511E+11	1184.0994	301777.	0.000
273.000	-0.0130	491246.	-35527.	-0.000400	185.3257	1.511E+11	1213.4978	280366.	0.000
276.000	-0.0142	390125.	-31847.	-0.000391	147.1772	1.511E+11	1240.2634	262600.	0.000
279.000	-0.0153	300167.	-28089.	-0.000384	113.2398	1.511E+11	1264.9218	247538.	0.000
282.000	-0.0165	221593.	-24260.	-0.000379	83.5972	1.511E+11	1287.8681	234539.	0.000
285.000	-0.0176	154609.	-20364.	-0.000375	58.3274	1.511E+11	1309.4044	223155.	0.000
288.000	-0.0187	99411.	-16405.	-0.000373	37.5033	1.511E+11	1329.7643	213060.	0.000
291.000	-0.0198	56180.	-12387.	-0.000371	21.1942	1.511E+11	1349.1292	204016.	0.000
294.000	-0.0210	25091.	-8311.4317	-0.000370	9.4658	1.511E+11	1367.6399	195843.	0.000
297.000	-0.0221	6311.2743	-4181.8650	-0.000370	2.3810	1.511E+11	1385.4046	188405.	0.000
300.000	-0.0232	0.000	0.000	-0.000370	0.000	1.511E+11	1402.5054	90798.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 6:

```
Pile-head deflection             =      1.0000000 inches
Computed slope at pile head      =     -0.0069681 radians
Maximum bending moment           =      5587910. inch-lbs
Maximum shear force              =        69448. lbs
Depth of maximum bending moment  =    138.0000000 inches below pile head
Depth of maximum shear force     =      0.000000 inches below pile head
Number of iterations             =             22
Number of zero deflection points =              1
```

Summary of Pile Response(s)

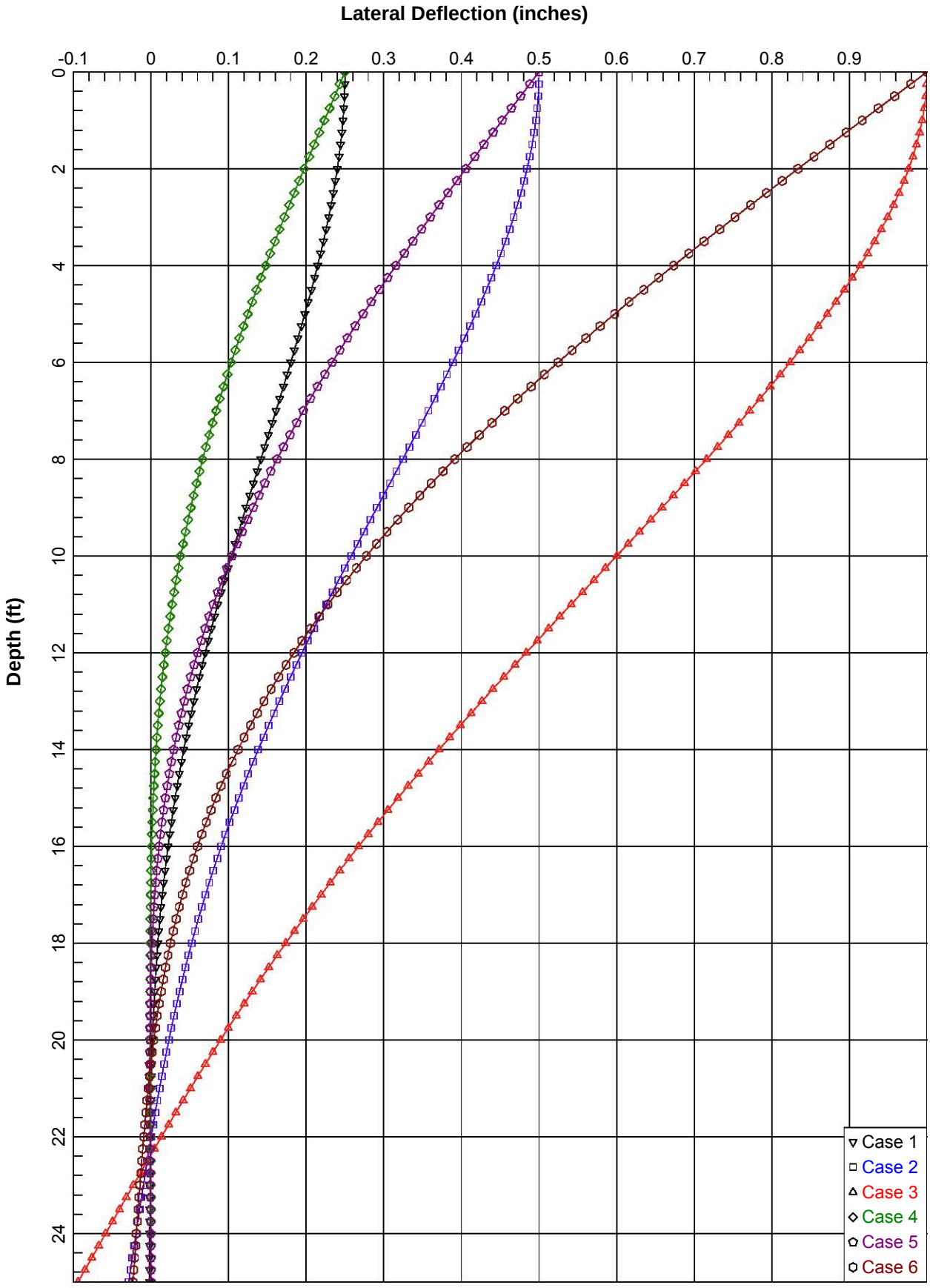
Definitions of Pile-Head Loading Conditions:

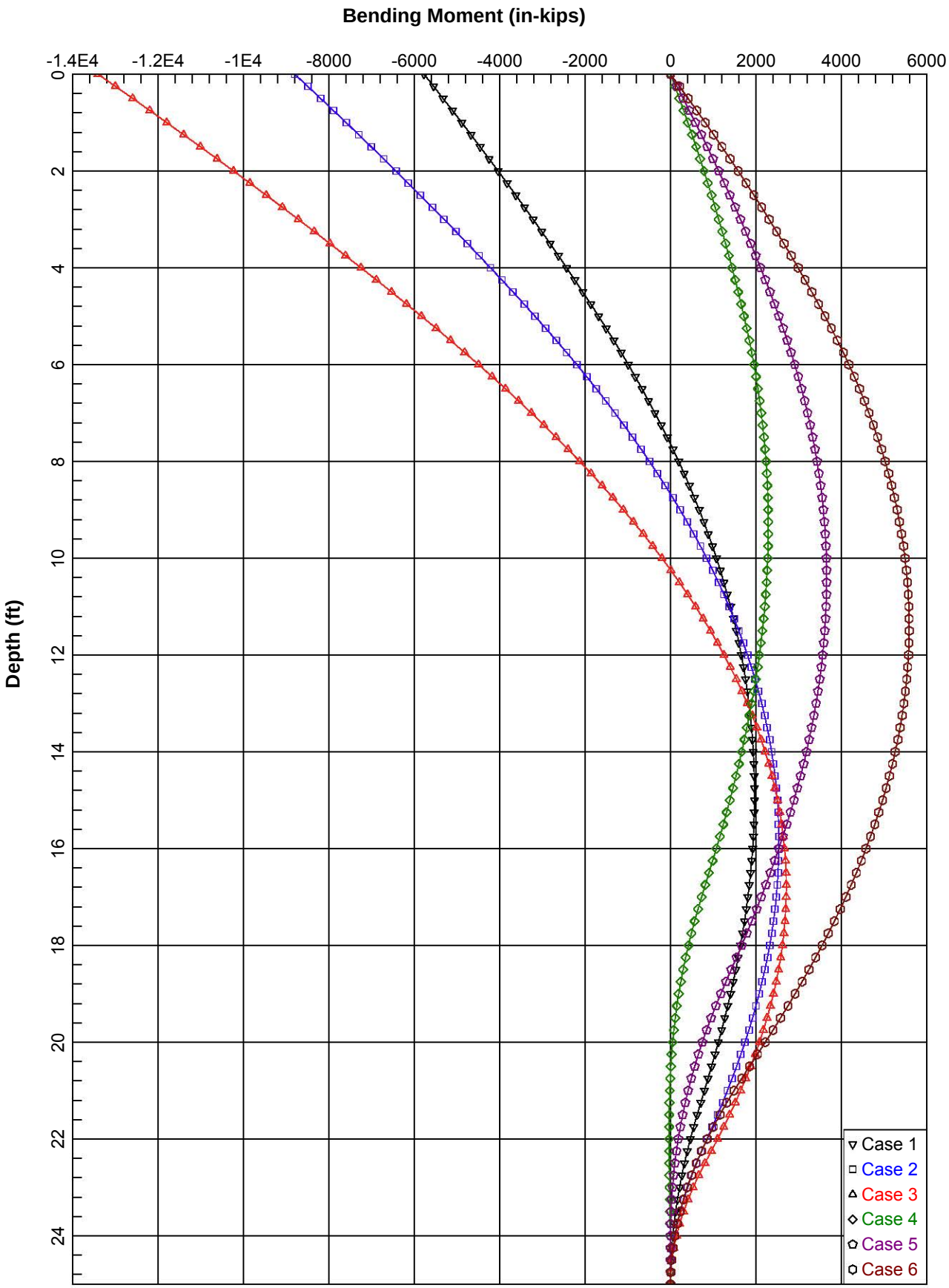
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

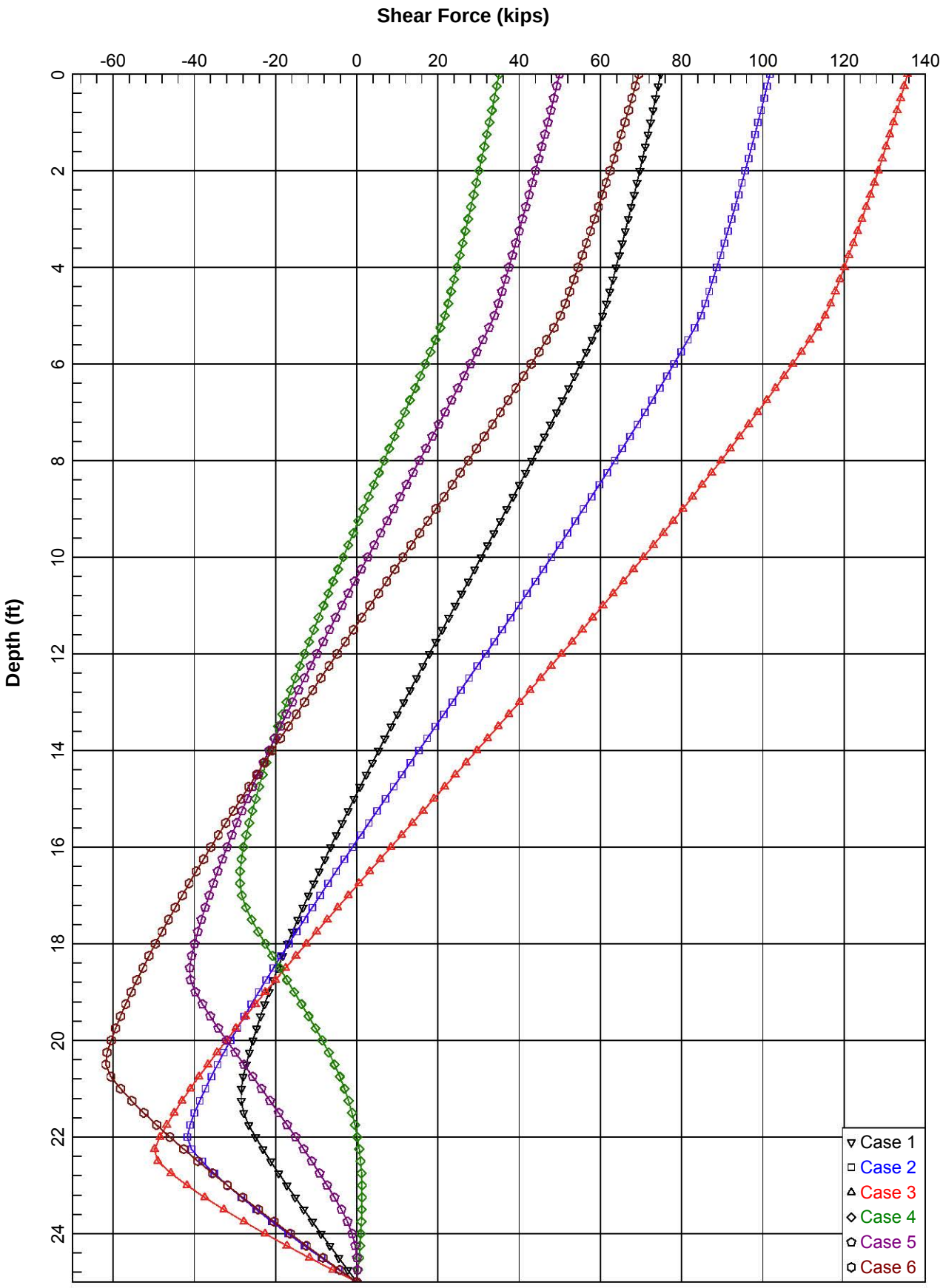
Load Case	Load Type	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	5	y = 0.2500	S = 0.000	0.0000000	0.25000000	-5771914.	74800.	0.00000000
2	5	y = 0.5000	S = 0.000	0.0000000	0.50000000	-8800018.	101732.	0.00000000

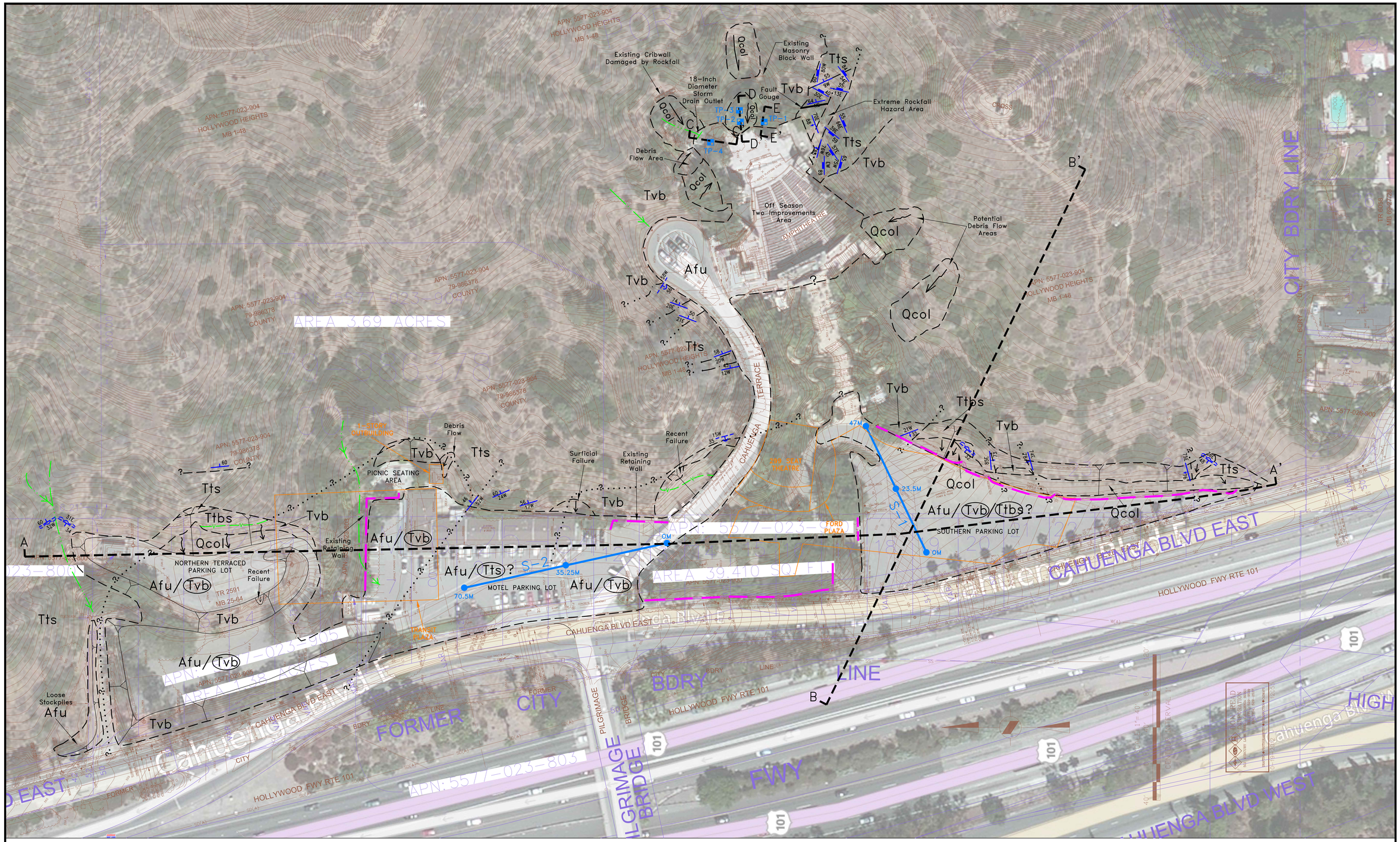
```
  3    5   y =     1.0000  S =      0.000      0.0000000     1.00000000     -13404342.        135661.
0.00000000
  4     4   y =     0.2500  M =      0.000      0.0000000     0.25000000       2290200.         35069.
0.00000000
  5     4   y =     0.5000  M =      0.000      0.0000000     0.50000000       3655340.         49933.
0.00000000
  6     4   y =     1.0000  M =      0.000      0.0000000     1.00000000       5587910.         69448.
0.00000000
```

The analysis ended normally.


Lateral Deflection (inches)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6


Bending Moment (in-kips)
-1.4E4
-1.2E4
-1E4
-8000
-6000
-4000
-2000
0
2000
4000
6000
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6


Shear Force (kips)
-60
-40
-20
0
20
40
60
80
100
120
140
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6



LEGEND

Afu — ARTIFICIAL FILL-UNDOCUMENTED, CONTAINS STOCKPILED ONSITE DEBRIS SILTY SANDY GRAVEL TO GRAVELLY SAND WITH COBBLE AND BOULDER SIZED DEBRIS.

Qcol — QUATERNARY COLLUVIUM, LOOSE, CONSISTS OF LOCALLY DERIVED BEDROCK MATERIAL, UNCONSOLIDATED, SUSCEPTIBLE TO SLOPE CREEP AND RAPID EROSION, MANTLES SLOPES, WITH THICK WEDGE AT TOES OF CUT SLOPES. DEBRIS FLOW HAZARD

MIDDLE TOPANGA FORMATION AND VOLCANIC BEDROCK

Tts — LIGHT GREY TO ORANGE BROWN, HARD, THICKLY BEDDED, RESISTANT TO EROSION, MODERATELY TO WELL CEMENTED SANDSTONE WITH LOCALIZED PEBBLY LAYERS. FINE TO COARSE ANGULAR TO TRACE ROUNDED GRAINS. INCLUDES QUARTZ PEBBLE SIZED INCLUSIONS. UNIT INCLUDES VERY FINE GRAINED SANDY SILTSTONE IS THINLY BEDDED AND CONTAINS DARK REDDISH BROWN, SILICEOUS CHERTY BEDS. SEVERELY FRACTURED, BLOCKY. ROCKFALL HAZARD ALONG CUT SLOPES. CIRCLED WHERE BURIED.

Ttbs — DARK GREY, CRUMBLY SANDSTONE WITH BASALT FRAGMENTS AND ROUNDED MANGANESE NODULES. SEVERELY WEATHERED AND FRACTURED. HEAVY SECONDARY MINERALIZATION AND CHEMICAL ALTERATION OF MAFIC MINERALS, CIRCLED WHERE BURIED.

Tvb — EXTRUSIVE BASALTIC VOLCANIC ROCKS, DARK GREY TO BLACK. VESSICULAR TO PILLOW STRUCTURE, SEVERELY WEATHERED AND FRACTURED. PERVASSIVE BLOCKY FRACTURE. MODERATE LUSTER ON WEATHERED BLOCKY FACER. DEGRADES TO SAND SIZED FRAGMENTS. HEAVY SECONDARY MINERALIZATION TO EPIDOTE. CHEMICALLY WEATHERED. FRIABLE- NEAR SURFACE, HARD WITH DEPTH, CIRCLED WHERE BURIED.

GEOLOGIC CONTACT, DASHED WHERE APPROXIMATE, DOTTED WHERE CONCEALED, QUERRIED WHERE UNCERTAIN

APPROXIMATE BOUNDARIES OF CUT SLOPES

APPROXIMATE BOUNDARY OF COLLUVIUM. DEBRIS FLOWS PRIMARILY WITHIN BASALT FORMATION DENOTES DIRECTION OF MOVEMENT. AREAS ARE SUBJECT TO ONGOING CREEP AND SEDIMENT BUILDUP BEHIND EXISTING WALL IMPROVEMENTS.

STRIKE AND DIP OF BEDDING

STRIKE AND DIP OF FAULT

STRIKE AND DIP OF BEDROCK CONTACT

STRIKE AND DIP OF LOCALIZED SHEAR SURFACES

EXISTING RETAINING WALLS

BASALT DIKE

SURFACE CONTACT OF SANDSTONE BEDDING AND INTRUSIVE BASALT OUTCROPS

APPROXIMATE CENTERLINE OF EXISTING DRAINAGES. ARROW DENOTES DIRECTION OF SURFACE FLOW

APPROXIMATE LOCATION OF SEISMIC LINES S-1 AND S-2, SHOWN WITH LENGTH IN METERS (M). (LEIGHOTN, 2013)

LOCATION OF GEOLOGIC CROSS SECTIONS (LEIGHTON 2013 AND CURRENT STUDY)

SCALE 0 40 80 FEET

GEOLOGIC MAP

FORD THEATRE
EAST CAHUENGA BOULEVARD
LOS ANGELES, CALIFORNIA

PLATE 1

Proj: 10296.001	Eng/Geol: CCK/JAR
Scale: 1"=40'	Date: 09/2013
Drafted By: BGT	Checked By: BGT

Leighton

TEST PIT AND CROSS SECTION LOCATION MAP FORD THEATRE EAST CAHUENGA BOULEVARD LOS ANGELES, CALIFORNIA	PLATE 2
Proj: 10296.001 / Eng/Geol: CCK/JAR	Leighton
Scale: As Shown / Date: 09/2013	

LEGEND

TP–4 T.D.5.2' — APPROXIMATE LOCATION OF TEST PITS SHOWN WITH TOTAL DEPTH (T.D.)

E — E' — LOCATION OF GEOLOGIC CROSS SECTIONS C-C', D-D' AND E-E' SEE PLATE 1 GEOLOGIC MAP FOR LOCATION OF SECTIONS AA' AND BB'

APPROXIMATE LIMITS OF SURFICIAL DEBRIS FLOW FAILURE AND ROCKFALL HAZARD. ARROW DENOTES DIRECTION OF FAILURE.

APPROXIMATE AREA OF MASONRY BLOCK WALL NOT SHOWN ON PLAN. POTENTIAL DEBRIS FLOW AREA ORIGINATING UPSLOPE OF BLOCK WALL

EXISTING MASONRY BLOCK WALL, VARYING HEIGHT FROM 32–84–INCHES TALL

18-INCH RCP AND CONCRETE DRAINAGE SWALE

CONCRETE SWALE

Concrete Slab

Debris Flow

Head Scarp

Qcol

UPPER LEVEL MEZZANINE DECK NORTH

UPPER LEVEL MEZZANINE DECK SOUTH

APPROXIMATE FOOTPRINT OF LOWER LEVEL

APPROXIMATE FOOTPRINT NORTH TOWER

APPROXIMATE FOOTPRINT SOUTH TOWER

EXISTING AND PROPOSED, STACKED, TERRACED STONE AND RETAINING WALLS WITH DRAINAGE IMPROVEMENTS

BASEMENT RETAINING WALL

NORTH TUNNEL

AREA OF EXTREME ROCKFALL HAZARD, AND COBBLE TO BOULDER SIZED TALUS PILE IMPACTING EXISTING CONCRETE WALL

TP–1 T.D.3.5'
TP–2 T.D.2.75'
TP–3 T.D.2.5'
TP–4 T.D.5.2'

S=2.0% MIN.

588.90 TG
587.40 INV IN
(585.25) INV OUT

590.80 TG
589.05 IE
LP

590.80 TG
589.30 IE

590.80 TG
589.06 IE
LP

590.80 TG
589.30 IE

GRAPHIC SCALE
SCALE : 1"= 5'

LEGEND

- SSD — SUBSURFACE DRAIN
- SD — (E) STORM DRAIN
- SD — NEW STORM DRAIN
- SS — NEW SANITARY SEWER
- FM — (E) STORM DRAIN FORCE MAIN
- FM — STORM DRAIN FORCE MAIN

SEWER CONSTRUCTION NOTES

1. EXISTING SANITARY SEWER TO BE REMOVED AND REPLACED. SEE PLUMBING PLANS FOR DETAILS.
2. POINT OF CONNECTION TO EXISTING SANITARY SEWER.

SD CONSTRUCTION NOTES

1. EXISTING STORM DRAIN PIPE TO REMAIN, SEE PLAN FOR SIZE.
2. EXISTING STORM DRAIN CATCH BASIN, TO REMAIN.
3. EXISTING STORM DRAIN CATCH BASIN, TO BE REMOVED AND REPLACED. SIZE 3'x3' GRATE.
4. EXISTING 4" SUMP PUMP DISCHARGE OUTLET, TO REMAIN.
5. INSTALL PVC SDR35 STORM DRAIN LINE. SEE PLAN FOR SIZE AND SLOPE.
6. INSTALL PERFORATED PVC SDR35 SUB–SURFACE STORM DRAIN LINE IN GRAVEL POCKET WITH NON–DIRECTIONAL GEOTEXTILE FABRIC. SEE DETAIL 1 ON SHEET C4.00.
7. INSTALL 6" NDS BRASS ATRIUM GRATE AREA DRAIN.
8. CONSTRUCT 5'ø CONCRETE WET WELL AND INSTALL DUAL SUBMERSIBLE VORTEX SUMP PUMPS. SEE DETAIL 3 ON SHEET C4.00 FOR PUMP AND DETAILS.
9. INSTALL 4" C.I. STORM DRAIN FORCE MAIN.
10. POINT OF CONNECTION TO EXISTING STORM DRAIN.
11. INSTALL VECTOR DRAIN SLOT DRAIN SYSTEM AT BASE OF STAGE. SEE DETAIL 2 ON SHEET C4.00.
12. STAGE DRAINS AND OVERFLOW DRAINS PER PLUMBING PLAN.
13. INSTALL 6" CAST IRON STORM DRAIN OVERFLOW PIPE.
14. INSTALL PERFORATED PVC SDR35 SUB–SURFACE STORM DRAIN LINE IN GRAVEL POCKET WITH NON–DIRECTIONAL GEOTEXTILE FABRIC UNDER STAGE FOOTINGS.
15. INSTALL STORM DRAIN CLEAN–OUT WITH RISER AND COVER TO NEW FINISH GRADE.

OFF-SEASON TWO IMPROVEMENTS

John Anson Ford Theatres
2580 Cahuenga Boulevard East
Hollywood, California 90068

Levin & Associates Architects
811 West Seventh Street, Suite 900
Los Angeles, California 90017
213.623.8141 Fax 213.623.9207

CIVIL ENGINEERING
SURVEYING+MAPPING
LAND DEVELOPMENT

MOLLENHAUER GROUP
213 624 2661 TEL
213 614 1863 FAX
316 WEST 2nd STREET – FIFTH FLOOR
LOS ANGELES CALIFORNIA 90012

NOT FOR CONSTRUCTION

Issued For:
SCHEMATIC DESIGN 4/1/13

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Sheet Title

UTILITY AND DRAINAGE PLAN

Scale: 1" = 5'

Date / Project Number: 12210

CAD File: LA30158_C2.00_GRADING.DWG

Sheet Number: C3.00

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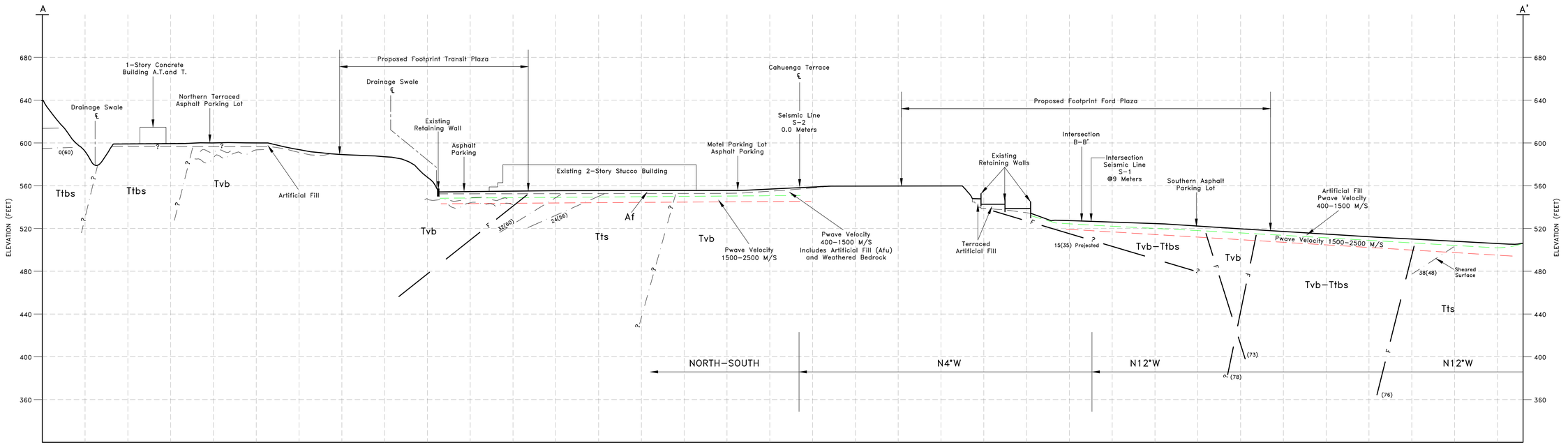
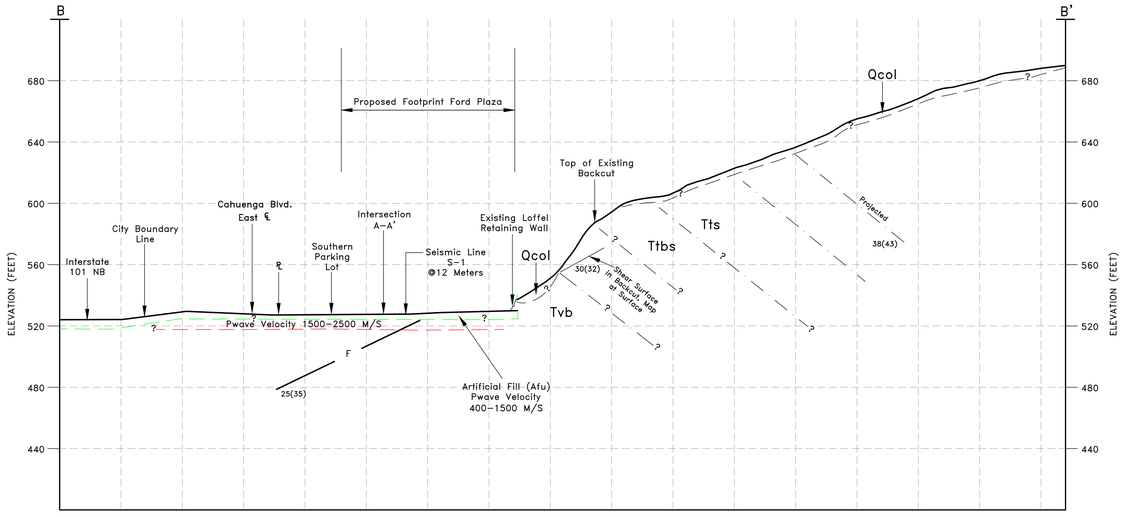


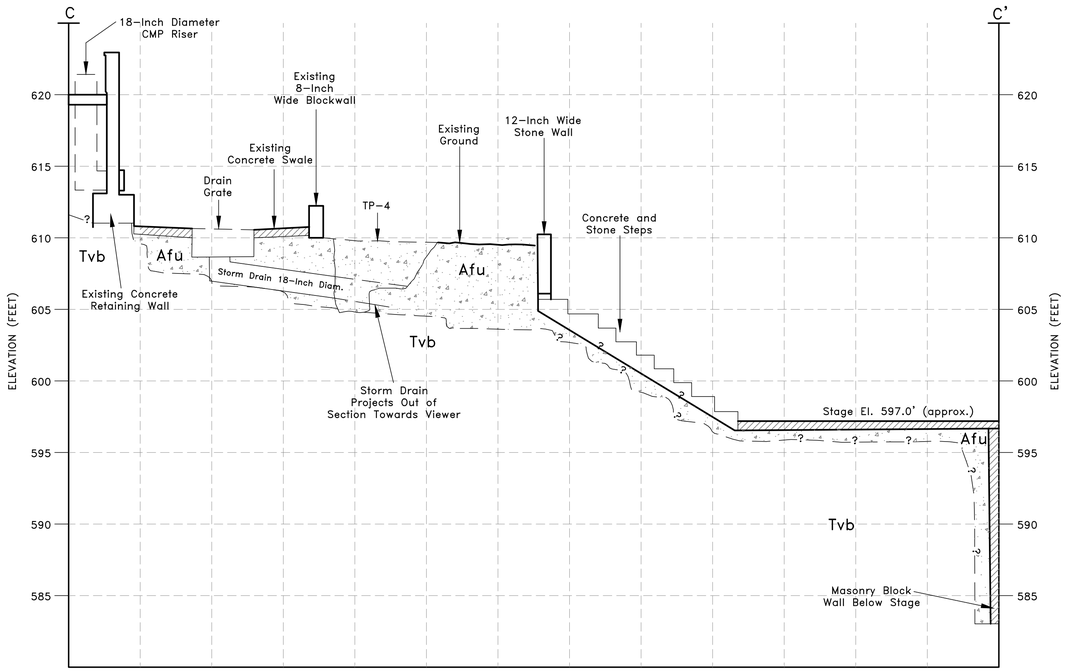
SEE PLATE 1 FOR DISCRIPTION OF EARTH UNITS

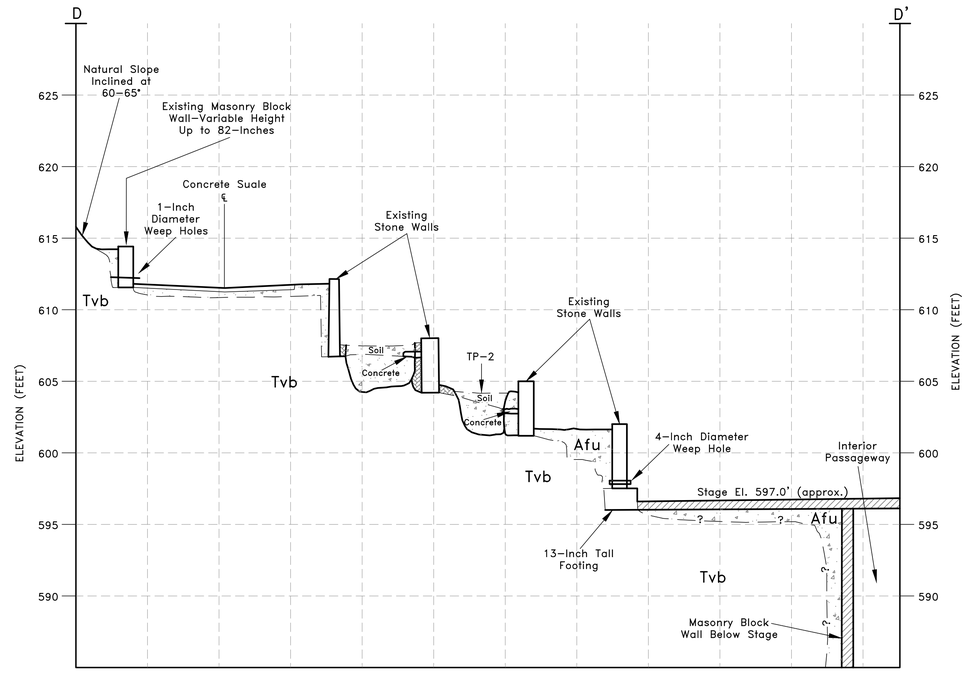


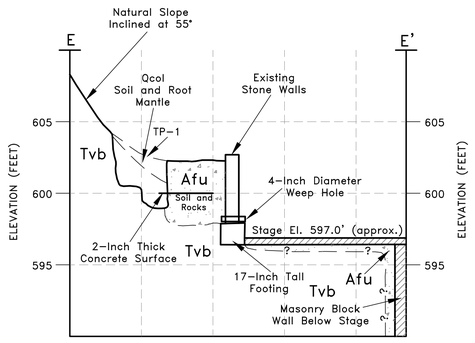
LEGEND

- GEOLOGIC CONTACT BETWEEN DIFFERENT ROCK TYPES, PROJECTED TO SECTION, DASHED AND QUERRIED DUE TO UNCERTAINTY.
- FAULT CONTACT SHOWN GEOMETRICALLY WITH APPARENT DIP; ACTUAL DIP SHOWN IN PARENTHESES.
- BASALTIC PILLOW STRUCTURE, NO PREFERRED ORIENTATION
- APPROXIMATE LAYERING BASED ON SEISMIC PWAVE VELOCITIES REPORTED IN METERS PER SECOND (M/S)
- APPARENT DIP OF BEDDING, ACTUAL DIP IN PARENTHESES

GENERALIZED GEOLOGIC CROSS SECTIONS A-A' AND B-B' FORD THEATRE EAST CAHUENGA BLVD. LOS ANGELES, CALIFORNIA		PLATE 3
Proj: 10296.001	Eng/Geol: CK/JR	Leighton
Scale: 1"=40'	Date: 09/2013	
Drafted By: BQT	Checked By: BQT	P:\DRAFTING\10296\002\DF_2013-07-12\PLATE 3-A- CROSS SECTIONS.DWG (09-09-13 3:20:40PM) Plotted by: bkan







GENERALIZED GEOLOGIC
CROSS SECTIONS C-C', D-D' AND E-E'
FORD THEATRE
EAST CAHUENGA BLVD.
LOS ANGELES, CALIFORNIA

PLATE 4

Proj: 10296.001	Eng/Geol: CK/JR
Scale: 1"=40'	Date: 09/2013

Drafted By: BQT | Checked By: BQT | P:\DRAFTING\10296\GEOL\F_2013-07-12\PLATE 3-4 CROSS SECTIONS.DWG 09-09-13 3:22:15PM by: btran

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Appendix H.2

Addendum 1 to Geotechnical Exploration Report

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

October 15, 2013

Project No. 10296.001

Ford Theatre Foundation
2580 Cahuenga Boulevard East
Hollywood, California 90068

c/o Bottega Management Group
3500 W. Olive Avenue, Suite 300
Burbank, California 91505

Attention: Mr. A. Leonard Madson

Subject: Addendum to Geotechnical Investigation Report
Off-Season Two Improvements
John Anson Ford Theater
2580 Cahuenga Boulevard East
Hollywood District of Los Angeles, California

References: Leighton Consulting, Inc., 2013, Geotechnical Investigation, Off-Season Two Improvements, 2580 Cahuenga Boulevard East, Hollywood District of Los Angeles, California, Project No. 10296.001, dated September 10.

Ensoft, Inc., 2011, LPile Version 6.0.14, Computer Program for Analyzing Stress and Deformation of a Pile or Drilled Shaft Under Lateral Load.

We were requested to provide supplementary geotechnical recommendations to support the design of the project. We received memoranda dated August 16, 2013 and September 12, 2013 from Structural Focus, the project structural engineer requesting supplementary information. The subject memoranda are included herewith as Appendices A and B.

Surcharge Loading on Retaining walls and Basement Walls

Retaining wall surcharge information was requested in the August 16, 2013 memorandum. As generally stated in Leighton Consulting, Inc. (2013), shallow foundations (spread footings) for new structures should be deepened to extend below the active zone of existing basement walls, roughly a plane extending from the base of the basement wall at a 60 degree angle from horizontal, to avoid surcharging the walls. Footings may be deepened by excavating below the active zone and backfilling with concrete or with controlled low strength material (CLSM).

New basement walls planned below existing foundations within their active zones should be designed to accommodate surcharge loads. Surcharge may be modeled as half the footing bearing pressure within the wall's active zone applied horizontally.

The stacked walls shown on page A-3 of Appendix A need not be designed to accommodate surcharge loading because upslope footings are not planned within the active zones of the walls. However, the basement wall should be designed to accommodate a surcharge from the upslope stacked walls. The surcharge pressure may be modeled as an additional equivalent fluid weight of 50 pounds per square foot per square foot depth (psf/ft) of wall.

There is insufficient detail in the exhibit on page A-2 to provide more detailed surcharge information. The relative elevations and horizontal distances between walls and adjacent footings are required.

LIGHT POLE FOUNDATIONS

Drilled, cast-in-place concrete pile foundation information to support lighting fixtures was requested in the September 12, 2013 memorandum. Maximum combined design reaction loads provided in the memorandum are as follows:

Axial = 25 kips
Lateral Shear = 15 kips
Moment = 510 kip-feet

We used the computer program LPILE (Ensoft, Inc., 2011) to build and analyze our pile foundation models. Results are presented in Appendix C. We used a concrete compressive strength value (f_c') of 4 kips per square inch (ksi) and a yield stress (f_y) of 60 ksi for the steel reinforcing.

To account for the reduction in bending stiffness due to concrete cracking, a subroutine in the program LPILE that computes the bending stiffness as a function of applied bending moment and axial loading was incorporated into the analyses. We have assumed that the minimum steel reinforcing consists of 12 US Std. #9 bars with clear concrete cover thickness of 3-inches for the 36-inch-diameter piles. For 42-inch-diameter piles, we have assumed that the minimum steel reinforcing consists of 12 US Std. #10 bars with clear concrete cover thickness of 3-inches.

Results are summarized in the table below:

Pile Head Deflection (inches)	Pile Diameter (Free Head)	Shear Force at Pile Top (kips)	Maximum Bending Moment (kips-in)	Depth to Maximum Moment (feet)
1	36 inches	15	6,500	4
½	42 inches	15	6,500	4

Adjacent walls should be designed to accommodate a lateral point load of 15 kips imposed by the pile foundation.

We appreciate the opportunity to work with you on this project. If you have any questions regarding this addendum or if we can be of further service, please call us at your convenience.



Respectfully submitted,

LEIGHTON CONSULTING, INC.

Carl C. Kim, PE, GE
Senior Principal Engineer

CCK/lr

Attachments: Appendix A and B – Memorandum from Structural Focus
Appendix C – Pile Foundation Analysis

Distribution: (3) Addressee

Leighton

APPENDIX A

Memo

Date:	August 16, 2013	**Project No.:**	13023
Project Name:	Ford Theater – Off-season Two Improvements		
To:	Kaitlin Drisko, Levin & Associates Architects	**Via:**	Email
Cc:	Robert Stone, Levin & Associates Architects	**Via:**	Email
From:	Melineh Zomorrodian, Structural Focus		
Subject:	Surcharge Loading	**Pages:**	1

Memo:

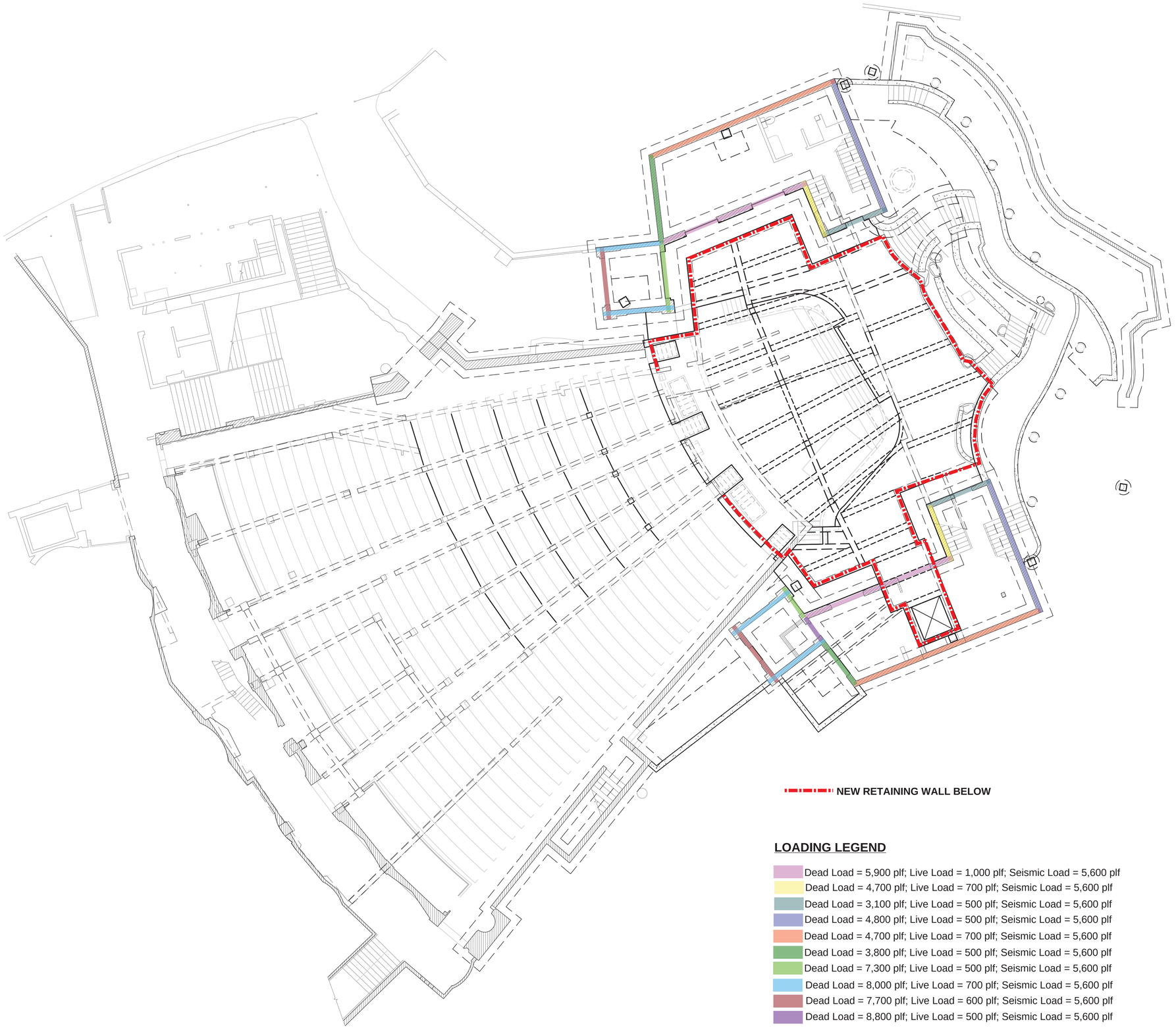
In our previous memos dated April 9, 2013 and August 7, 2013, we have requested surcharge loading recommendations from the geotechnical engineer. During the geotechnical coordination meeting on August 9, 2013, we were asked to provide foundation loading to the geotechnical engineer so that they can include the surcharge loading recommendation in the final report.

1. For surcharge loading on new basement walls:
   Attached foundation plan includes dead, live, and seismic loading demands on existing building foundations.

2. Surcharge loading for new stacked site retaining walls:
   Attached section shows the stacked site retaining walls with the weight of the walls and the weight of the finishes. Please note the height of the walls vary and the elevation of the foundations vary along the length of the retaining wall.

3. Surcharge loading from new light pole piles adjacent to existing or new retaining walls:
   Loading on the light pole piles to be provided in a future memo after coordination with design team.

19210 S. VERMONT AVE, BUILDING B, SUITE 210, GARDENA, CALIFORNIA 90248
PHONE 310-323-9924 FAX 310-323-9925



NEW RETAINING WALL BELOW

LOADING LEGEND

- Dead Load = 5,900 plf; Live Load = 1,000 plf; Seismic Load = 5,600 plf
- Dead Load = 4,700 plf; Live Load = 700 plf; Seismic Load = 5,600 plf
- Dead Load = 3,100 plf; Live Load = 500 plf; Seismic Load = 5,600 plf
- Dead Load = 4,800 plf; Live Load = 500 plf; Seismic Load = 5,600 plf
- Dead Load = 4,700 plf; Live Load = 700 plf; Seismic Load = 5,600 plf
- Dead Load = 3,800 plf; Live Load = 500 plf; Seismic Load = 5,600 plf
- Dead Load = 7,300 plf; Live Load = 500 plf; Seismic Load = 5,600 plf
- Dead Load = 8,000 plf; Live Load = 700 plf; Seismic Load = 5,600 plf
- Dead Load = 7,700 plf; Live Load = 600 plf; Seismic Load = 5,600 plf
- Dead Load = 8,800 plf; Live Load = 500 plf; Seismic Load = 5,600 plf

OFF-SEASON TWO IMPROVEMENTS

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REGISTERED PROFESSIONAL ENGINEER
DAVID W. COOKE
No. S3005
Exp. 6/30/14
STRUCTURAL
STATE OF CALIFORNIA

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Issued For:

SCHEMATIC DESIGN	04/26/13
DESIGN DEVELOPMENT	08/08/13

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Sheet Title

Scale:

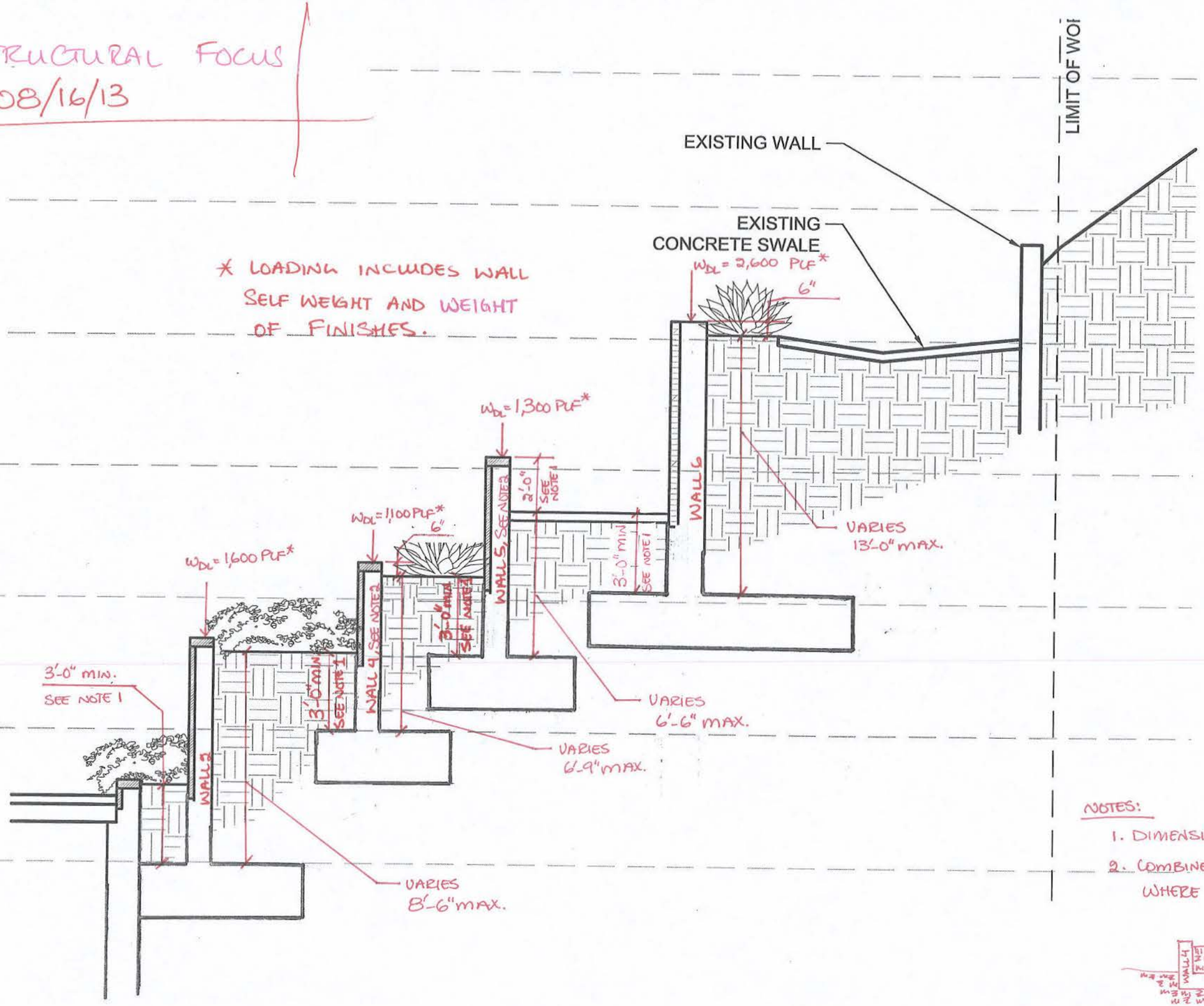
Date	Project Number
	13023

CAD File

Sheet Number

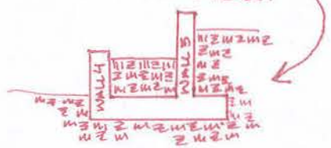
STRUCTURAL FOCUS
08/16/13

* LOADING INCLUDES WALL SELF WEIGHT AND WEIGHT OF FINISHES.



NOTES:

1. DIMENSION PER LANDSCAPE REQUIREMENTS.
2. COMBINE FOOTINGS FOR WALL 4 & 5 WHERE POSSIBLE.



STACKED SITE RETAINING WALL SECTION

APPENDIX B

Memo

Date:	September 12, 2013	**Project No.:**	13023
Project Name:	Ford Theater – Off-season Two Improvements		
To:	Kaitlin Drisko, Levin & Associates Architects	**Via:**	Email
Cc:	Robert Stone, Levin & Associates Architects	**Via:**	Email
From:	Melineh Zomorrodian, Structural Focus		
Subject:	Reaction Loads on New Pile Foundations	**Pages:**	1

Memo:

During the geotechnical coordination meeting on August 9, 2013, we were asked to provide loading on the new pile foundations to the geotechnical engineer so that they can provide recommendations on the pile depth and size as well as the recommended surcharge loading to be used in the design and/or analysis of the existing or new retaining walls adjacent to the new pile foundations. Loading on the light pole pile foundations is provided on the attached plan.

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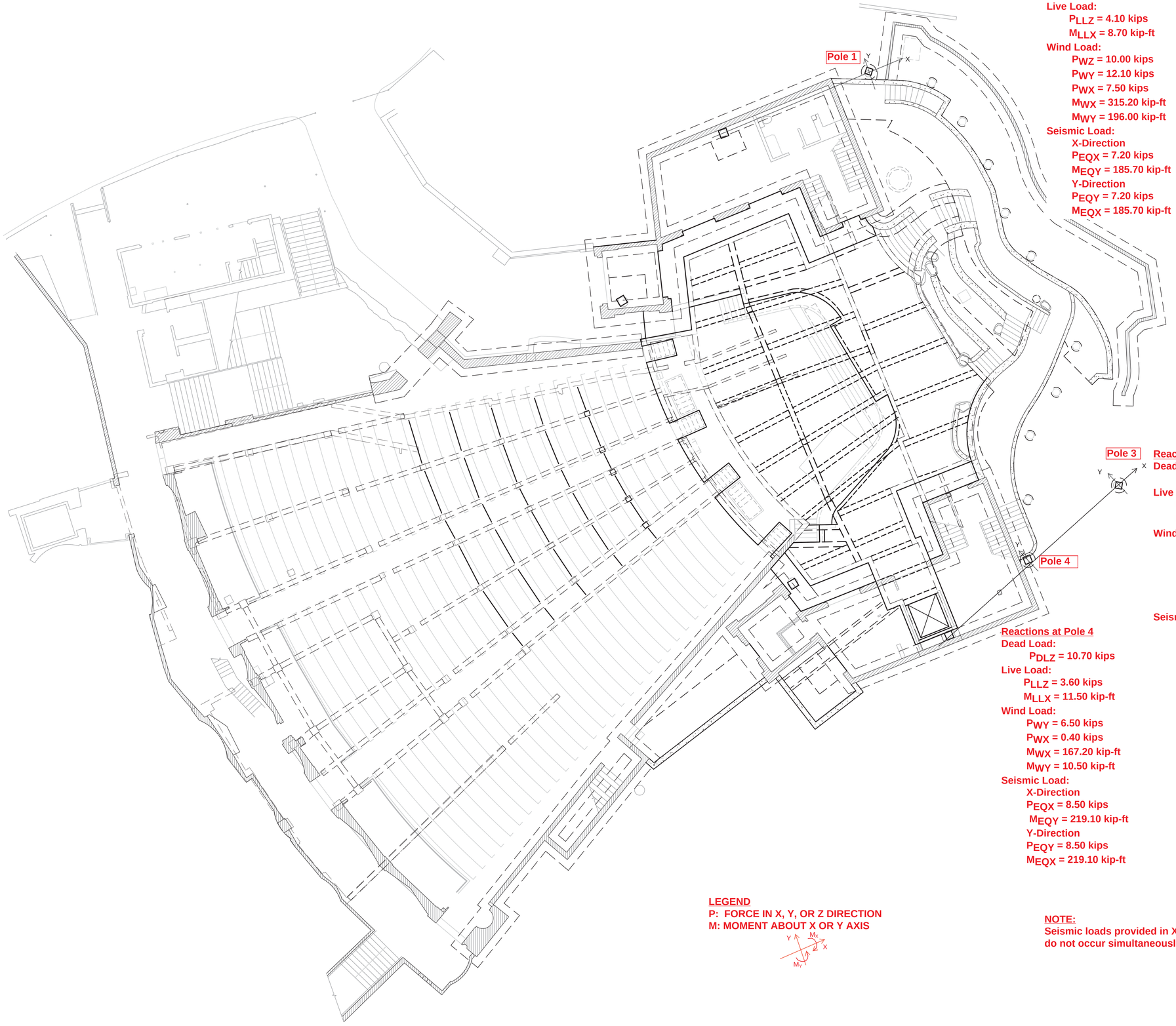
STRUCTURAL FOCUS
09/12/2013



Reactions at Pole 1
Dead Load:
P_{DLZ} = 11.20 kips
Live Load:
P_{LLZ} = 4.10 kips
M_{LLX} = 8.70 kip-ft
Wind Load:
P_{WZ} = 10.00 kips
P_{WY} = 12.10 kips
P_{WX} = 7.50 kips
M_{WX} = 315.20 kip-ft
M_{WY} = 196.00 kip-ft
Seismic Load:
X-Direction
P_{EQX} = 7.20 kips
M_{EQY} = 185.70 kip-ft
Y-Direction
P_{EQY} = 7.20 kips
M_{EQX} = 185.70 kip-ft

Reactions at Pole 3
Dead Load:
P_{DLZ} = 7.00 kips
Live Load:
P_{LLZ} = 3.60 kips
M_{LLX} = 7.61 kip-ft
Wind Load:
P_{WZ} = 10.00 kips
P_{WY} = 11.60 kips
P_{WX} = 7.50 kips
M_{WX} = 161.80 kip-ft
M_{WY} = 105.20 kip-ft
Seismic Load:
X-Direction
P_{EQX} = 5.70 kips
M_{EQY} = 78.70 kip-ft
Y-Direction
P_{EQY} = 5.70 kips
M_{EQX} = 78.70 kip-ft

Reactions at Pole 4
Dead Load:
P_{DLZ} = 10.70 kips
Live Load:
P_{LLZ} = 3.60 kips
M_{LLX} = 11.50 kip-ft
Wind Load:
P_{WY} = 6.50 kips
P_{WX} = 0.40 kips
M_{WX} = 167.20 kip-ft
M_{WY} = 10.50 kip-ft
Seismic Load:
X-Direction
P_{EQX} = 8.50 kips
M_{EQY} = 219.10 kip-ft
Y-Direction
P_{EQY} = 8.50 kips
M_{EQX} = 219.10 kip-ft

LEGEND
P: FORCE IN X, Y, OR Z DIRECTION
M: MOMENT ABOUT X OR Y AXIS

NOTE:
Seismic loads provided in X and Y directions do not occur simultaneously.

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Project Number 13023
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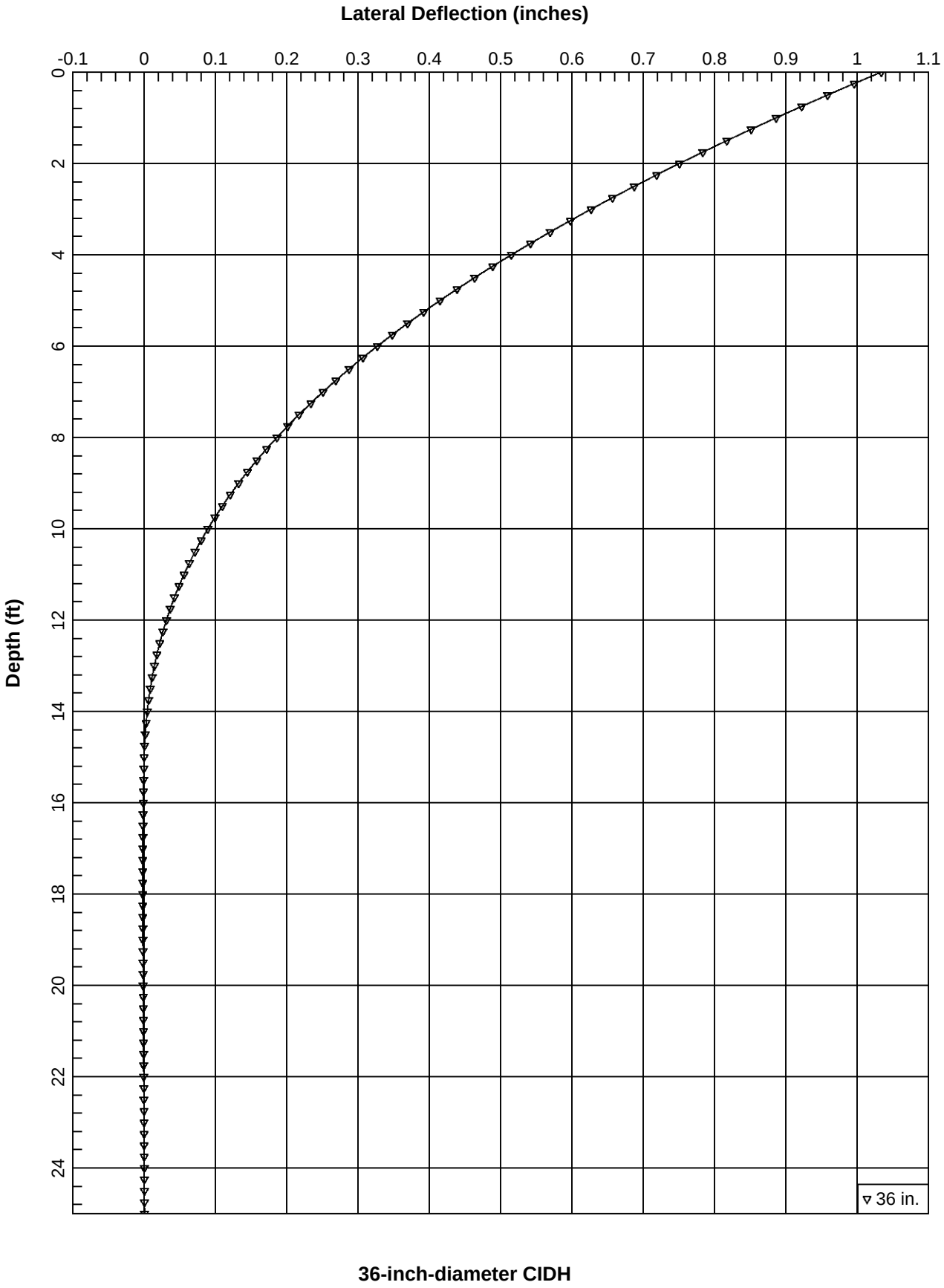
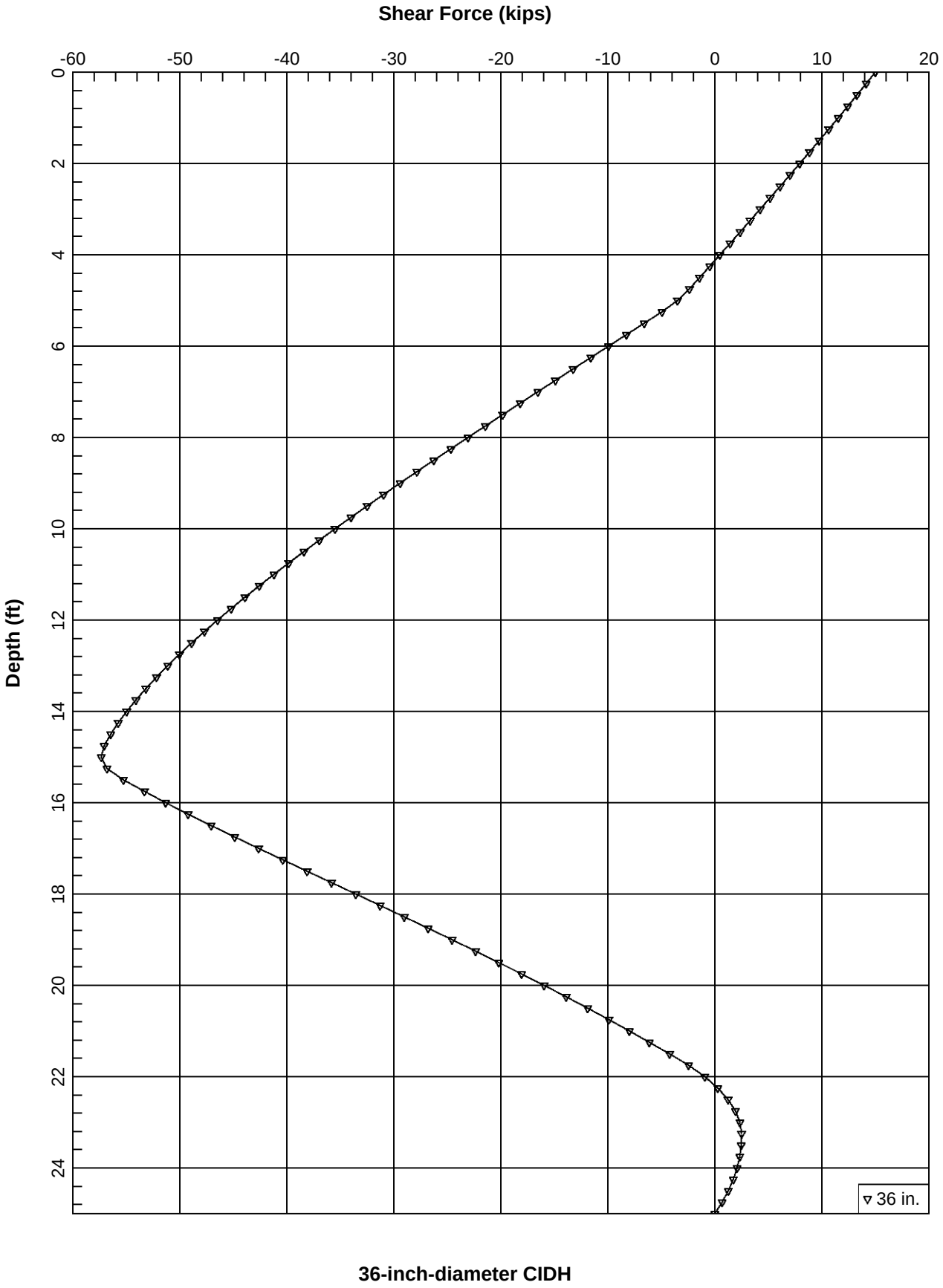
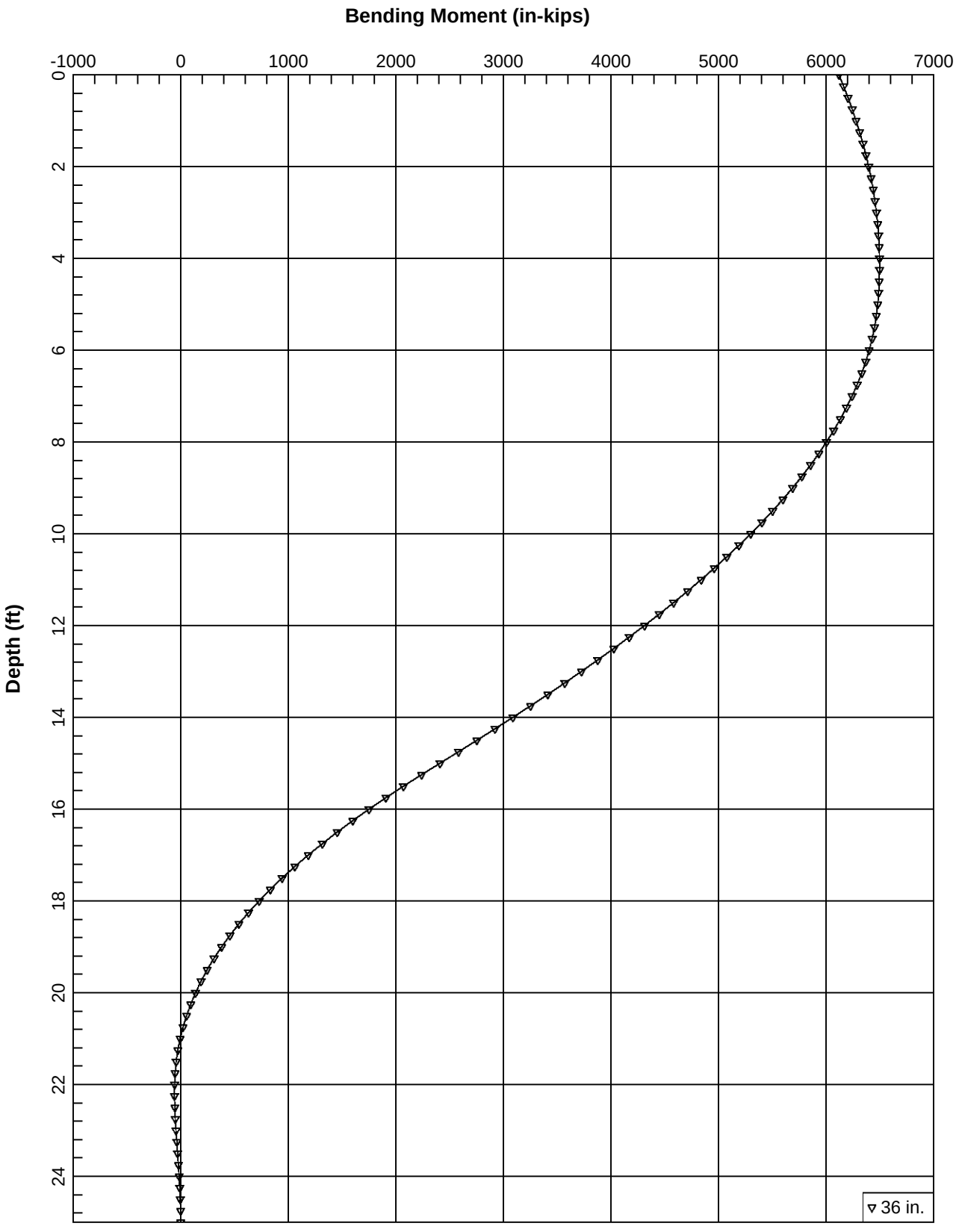
APPENDIX C



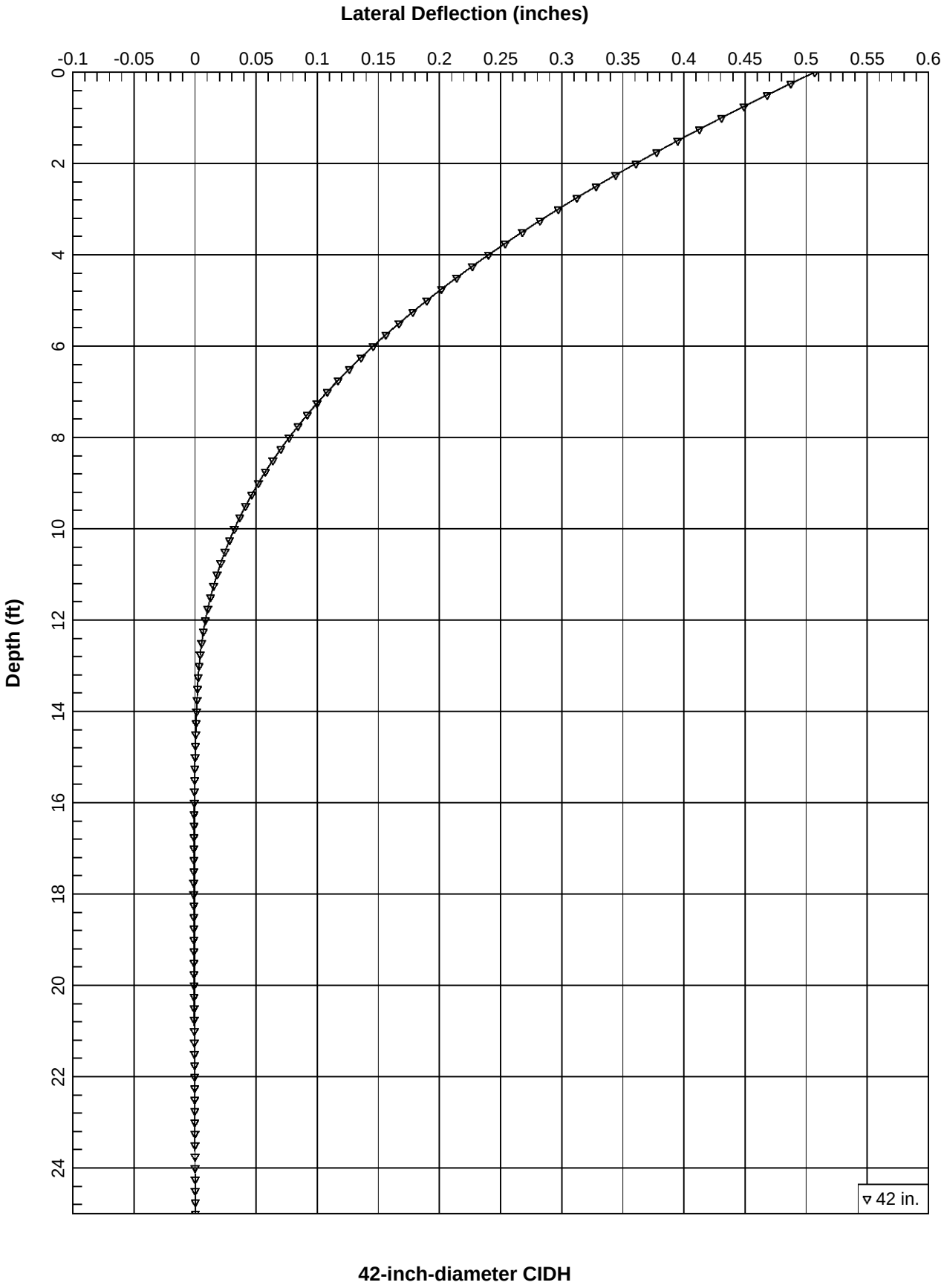
36-inch-diameter CIDH



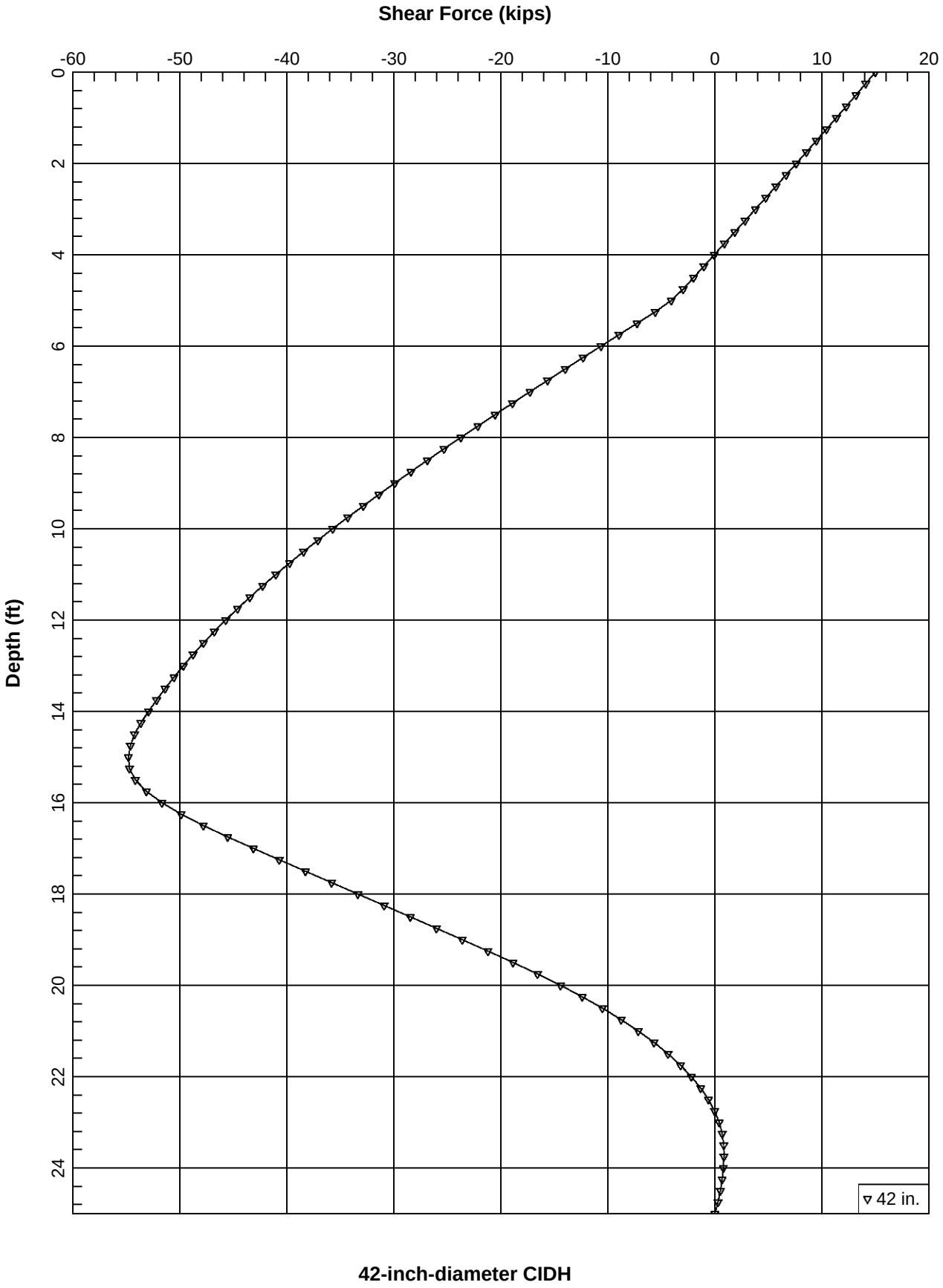
36-inch-diameter CIDH



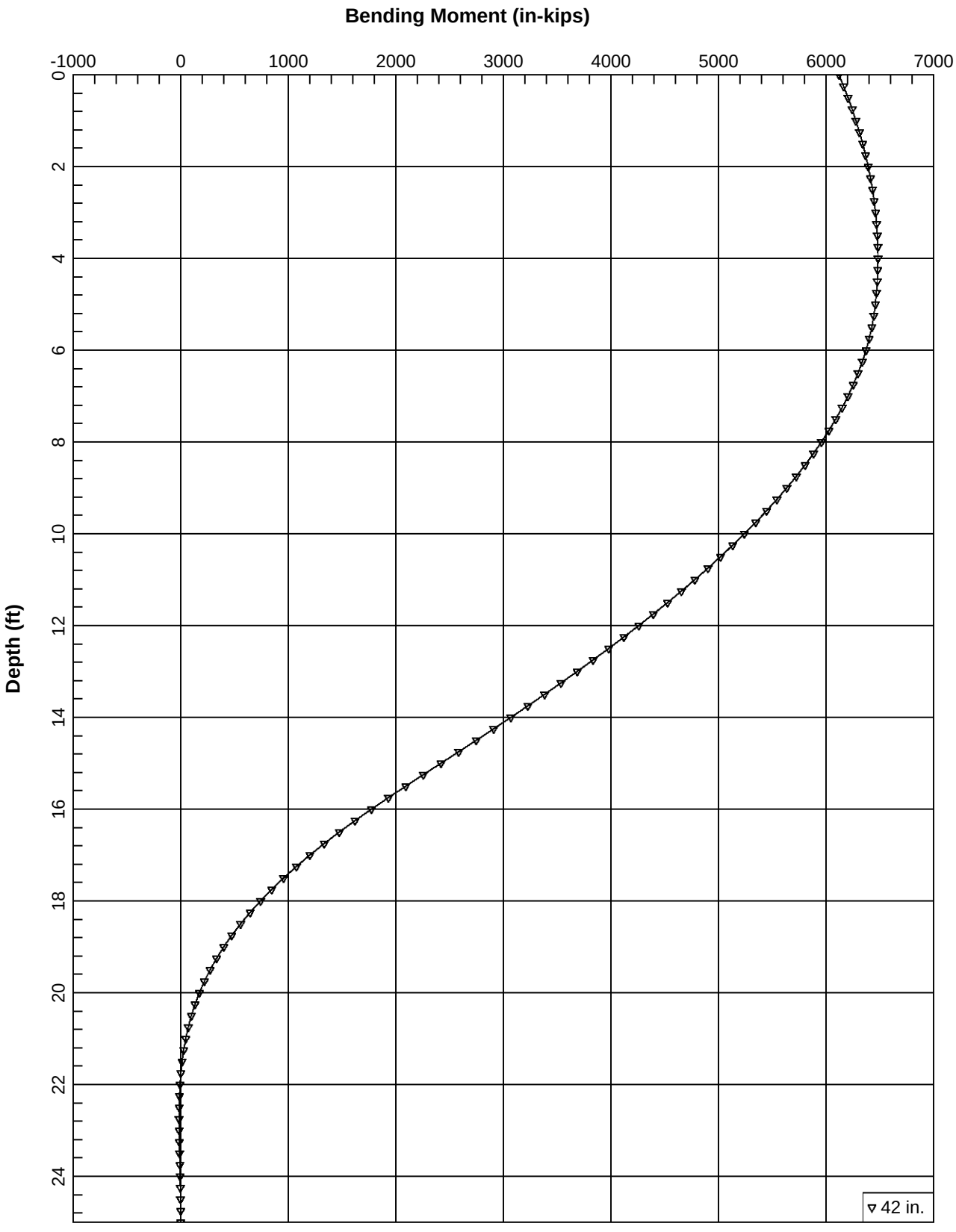
36-inch-diameter CIDH



42-inch-diameter CIDH



42-inch-diameter CIDH



42-inch-diameter CIDH

LPile Plus for Windows, Version 6.0 (6.0.14)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

(c) 1985-2011 by Ensoft, Inc.
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This program is licensed to:

Carl Kim
Leighton Group

Files Used for Analysis

Path to file locations: P:\Infocus Projects\10296 Ford Theatre\Analyses\lpile\
Name of input data file: 36 inch Dia CIDH demand.lp6d
Name of output file: 36 inch Dia CIDH demand.lp6o
Name of plot output file: 36 inch Dia CIDH demand.lp6p
Name of runtime file: 36 inch Dia CIDH demand.lp6r

Date and Time of Analysis

Date: October 8, 2013 Time: 11:50:48

Problem Title

Ford Theater Foundation

603507-002

Ford Theater Foundation

SP

Drilled, Cast-in-Place Concrete Caissons - 30-inch Diameter

Program Options

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal moment capacity with pile response computed using nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- p-y curves computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 1000
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 25.00 ft

Depth of ground surface below top of pile = 0.00 ft

Slope angle of ground surface = 45.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	36.0000000
2	25.000000	36.0000000

Input Structural Properties:

Section No. 1:

Section Type = Drilled Shaft (Bored Pile)

Section Length = 25.000 ft
Section Diameter = 36.000 in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 45.000 degrees
= 0.785 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer = 0.000 ft
Distance from top of pile to bottom of layer = 5.000 ft

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer = 5.000 ft
Distance from top of pile to bottom of layer = 50.000 ft

(Depth of lowest layer extends 25.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	0.00	120.00000
2	5.00	120.00000
3	5.00	130.00000
4	50.00	130.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction	Test Type	qu	RQD	Epsilon 50	kpy	Test Prop.	Rock Emass	krm	Elas. Subgr.

Ang., deg.	psi	percent	pci	pci	psi
1	Stiff Clay w/o Free Water		0.00	120.000	1500.000
			0.00	120.000	1500.000
2	Stiff Clay w/o Free Water		0.00	130.000	3000.000
			0.00	130.000	3000.000

Loading Type

Cyclic loading criteria were used for computation of p-y curves for all analyses.

Number of cycles of loading = 10

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 15000.000 lbs	M = 6120000.000 in-lbs	25.000

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially

Output of p-y Curves at Specified Depths

Lateral load-transfer (p-y) curves are computed and output at 6 depths.
(Note the depths of these curves may differ from nodal point depths.),/

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	5.000	5.000
3	10.000	10.000

4	15.000	15.000
5	20.000	20.000
6	25.000	25.000

Depth of ground surface below top of pile = 0.00 ft

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Sections Analyzed = 1

Section No. 1:

Dimensions and Properties of Drilled Shaft:

Length of Section	=	25.00000000 ft
Shaft Diameter	=	36.00000000 in
Concrete Cover Thickness	=	3.00000000 in
Number of Reinforcing Bars	=	12 bars
Yield Stress of Reinforcing Bars	=	60.00000000 ksi
Modulus of Elasticity of Reinforcing Bars	=	29000. ksi
Gross Area of Shaft	=	1017.87601976 sq. in.
Total Area of Reinforcing Steel	=	12.00000000 sq. in.
Area Ratio of Steel Reinforcement	=	1.18 percent

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As	=	4139.979 kips
Tensile Load for Cracking of Concrete	=	-458.502 kips
Nominal Axial Tensile Capacity	=	-720.000 kips

Reinforcing Bar Dimensions and Positions Used in Computations:

Bar Number	Bar Diam. inches	Bar Area sq. in.	X inches	Y inches
1	1.12800	1.00000	14.43600	0.00000
2	1.12800	1.00000	12.50194	7.21800
3	1.12800	1.00000	7.21800	12.50194
4	1.12800	1.00000	0.00000	14.43600
5	1.12800	1.00000	-7.21800	12.50194
6	1.12800	1.00000	-12.50194	7.21800
7	1.12800	1.00000	-14.43600	0.00000
8	1.12800	1.00000	-12.50194	-7.21800
9	1.12800	1.00000	-7.21800	-12.50194
10	1.12800	1.00000	0.00000	-14.43600
11	1.12800	1.00000	7.21800	-12.50194
12	1.12800	1.00000	12.50194	-7.21800

Concrete Properties:

Compressive Strength of Concrete	=	4.0000000 ksi
Modulus of Elasticity of Concrete	=	3604.9965326 ksi
Modulus of Rupture of Concrete	=	-0.4743416 ksi
Compression Strain at Peak Stress	=	0.0018863
Tensile Strain at Fracture of Concrete	=	-0.0001154
Maximum Coarse Aggregate Size	=	0.7500000 in

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	0.025

Definitions of Run Messages and Notes:

C = concrete in section has cracked in tension
Y = stress in reinforcing steel has reached yield stress
T = tensile strain in reinforcement exceeds 0.005 when compressive strain in concrete is less than 0.003.
Z = depth of tensile zone in concrete section is less than 10 percent of section depth
Bending Stiffness (EI) = Bending Moment / Curvature
Position of neutral axis is computed from compression side of pile
Compressive stresses are positive in sign. Tensile stresses are negative in sign.

Axial Thrust Force = 0.025 kips

Bending Max Concrete Curvature rad/in.	Bending Max Steel Stress ksi	Bending Run Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Msg
0.000000625	237.5023960	380003834.	18.0087019	0.0000113	-0.0000112	
0.0471195	0.3231452					
0.000001250	474.1329721	379306378.	18.0043674	0.0000225	-0.0000225	
0.0939372	0.6461333					
0.000001875	709.8917279	378608922.	18.0029226	0.0000338	-0.0000337	
0.1404759	0.9691214					
0.000002500	944.7786634	377911465.	18.0022003	0.0000450	-0.0000450	
0.1867358	1.2921095					
0.000003125	1178.7937786	377214009.	18.0017669	0.0000563	-0.0000562	
0.2327167	1.6150976					
0.000003750	1411.9370733	376516553.	18.0014780	0.0000675	-0.0000675	
0.2784187	1.9380857					
0.000004375	1644.2085478	375819097.	18.0012717	0.0000788	-0.0000787	
0.3238418	2.2610739					
0.000005000	1875.6082019	375121640.	18.0011170	0.0000900	-0.0000900	
0.3689860	2.5840620					
0.000005625	2106.1360356	374424184.	18.0009967	0.0001013	-0.0001012	
0.4138513	2.9070501					
0.000006250	2335.7920490	373726728.	18.0009004	0.0001125	-0.0001125	
0.4584377	3.2300382					
0.000006875	2335.7920490	339751571.	9.0870639	0.0000625	-0.0001850	
0.2554970	-5.3298791					C

0.000007500	2335.7920490	311438940.	9.0891541	0.0000682	-0.0002018
0.2783701	-5.8139590 C				
0.000008125	2335.7920490	287482098.	9.0912880	0.0000739	-0.0002186
0.3011852	-6.2979527 C				
0.000008750	2335.7920490	266947663.	9.0934572	0.0000796	-0.0002354
0.3239422	-6.7818602 C				
0.000009375	2335.7920490	249151152.	9.0956554	0.0000853	-0.0002522
0.3466411	-7.2656812 C				
0.0000100	2335.7920490	233579205.	9.0978781	0.0000910	-0.0002690
0.3692818	-7.7494153 C				
0.0000106	2335.7920490	219839252.	9.1001217	0.0000967	-0.0002858
0.3918642	-8.2330625 C				
0.0000113	2335.7920490	207625960.	9.1023834	0.0001024	-0.0003026
0.4143883	-8.7166224 C				
0.0000119	2335.7920490	196698278.	9.1046611	0.0001081	-0.0003194
0.4368539	-9.2000948 C				
0.0000125	2335.7920490	186863364.	9.1069530	0.0001138	-0.0003362
0.4592609	-9.6834795 C				
0.0000131	2335.7920490	177965108.	9.1092577	0.0001196	-0.0003529
0.4816094	-10.1667763 C				
0.0000138	2335.7920490	169875785.	9.1115741	0.0001253	-0.0003697
0.5038991	-10.6499848 C				
0.0000144	2335.7920490	162489882.	9.1139012	0.0001310	-0.0003865
0.5261301	-11.1331049 C				
0.0000150	2335.7920490	155719470.	9.1162383	0.0001367	-0.0004033
0.5483022	-11.6161363 C				
0.0000156	2335.7920490	149490691.	9.1185847	0.0001425	-0.0004200
0.5704154	-12.0990788 C				
0.0000163	2335.7920490	143741049.	9.1209398	0.0001482	-0.0004368
0.5924696	-12.5819321 C				
0.0000169	2335.7920490	138417307.	9.1233033	0.0001540	-0.0004535
0.6144647	-13.0646959 C				
0.0000175	2335.7920490	133473831.	9.1256746	0.0001597	-0.0004703
0.6364005	-13.5473701 C				
0.0000181	2335.7920490	128871285.	9.1280535	0.0001654	-0.0004871
0.6582771	-14.0299544 C				
0.0000188	2335.7920490	124575576.	9.1304396	0.0001712	-0.0005038
0.6800943	-14.5124484 C				
0.0000194	2335.7920490	120557009.	9.1328327	0.0001769	-0.0005206
0.7018521	-14.9948521 C				
0.0000200	2335.7920490	116789602.	9.1352326	0.0001827	-0.0005373
0.7235504	-15.4771650 C				
0.0000206	2335.7920490	113250524.	9.1376391	0.0001885	-0.0005540
0.7451890	-15.9593871 C				
0.0000213	2335.7920490	109919626.	9.1400521	0.0001942	-0.0005708
0.7667680	-16.4415179 C				
0.0000219	2335.7920490	106779065.	9.1424713	0.0002000	-0.0005875
0.7882871	-16.9235572 C				
0.0000225	2335.7920490	103812980.	9.1448966	0.0002058	-0.0006042
0.8097464	-17.4055049 C				
0.0000231	2335.7920490	101007224.	9.1473280	0.0002115	-0.0006210
0.8311457	-17.8873606 C				
0.0000238	2335.7920490	98349139.	9.1497654	0.0002173	-0.0006377
0.8524850	-18.3691240 C				
0.0000244	2335.7920490	95827366.	9.1522086	0.0002231	-0.0006544
0.8737642	-18.8507950 C				
0.0000256	2335.7920490	91152860.	9.1571123	0.0002347	-0.0006878
0.9161417	-19.8138584 C				
0.0000269	2335.7920490	86913193.	9.1620387	0.0002462	-0.0007213
0.9582776	-20.7765486 C				
0.0000281	2335.7920490	83050384.	9.1669873	0.0002578	-0.0007547
1.0001713	-21.7388635 C				
0.0000294	2340.7575926	79685365.	9.1719580	0.0002694	-0.0007881

1.0418219	-22.7008008 C				
0.0000306	2439.2596952	79649296.	9.1769504	0.0002810	-0.0008215
1.0832287	-23.6623585 C				
0.0000319	2537.6690616	79613147.	9.1818841	0.0002927	-0.0008548
1.1243819	-24.6236083 C				
0.0000331	2635.9854485	79576919.	9.1867134	0.0003043	-0.0008882
1.1652744	-25.5846010 C				
0.0000344	2734.2080334	79540597.	9.1915624	0.0003160	-0.0009215
1.2059192	-26.5452238 C				
0.0000356	2832.3363096	79504177.	9.1964312	0.0003276	-0.0009549
1.2463157	-27.5054746 C				
0.0000369	2930.3698135	79467656.	9.2013196	0.0003393	-0.0009882
1.2864631	-28.4653514 C				
0.0000381	3028.3080773	79431032.	9.2062279	0.0003510	-0.0010215
1.3263606	-29.4248519 C				
0.0000394	3126.1506285	79394302.	9.2111558	0.0003627	-0.0010548
1.3660076	-30.3839741 C				
0.0000406	3223.8969902	79357464.	9.2161035	0.0003744	-0.0010881
1.4054032	-31.3427157 C				
0.0000419	3321.5466807	79320518.	9.2210711	0.0003861	-0.0011214
1.4445468	-32.3010744 C				
0.0000431	3419.0992137	79283460.	9.2260585	0.0003979	-0.0011546
1.4834374	-33.2590482 C				
0.0000444	3516.5540983	79246290.	9.2310659	0.0004096	-0.0011879
1.5220745	-34.2166347 C				
0.0000456	3613.9108384	79209005.	9.2360934	0.0004214	-0.0012211
1.5604572	-35.1738316 C				
0.0000469	3711.1689334	79171604.	9.2411411	0.0004332	-0.0012543
1.5985846	-36.1306366 C				
0.0000481	3808.3278775	79134086.	9.2462090	0.0004450	-0.0012875
1.6364561	-37.0870473 C				
0.0000494	3905.3871599	79096449.	9.2512972	0.0004568	-0.0013207
1.6740708	-38.0430615 C				
0.0000506	4002.3462646	79058692.	9.2564060	0.0004686	-0.0013539
1.7114280	-38.9986767 C				
0.0000519	4099.2046705	79020813.	9.2615353	0.0004804	-0.0013871
1.7485267	-39.9538905 C				
0.0000531	4195.9618513	78982811.	9.2666854	0.0004923	-0.0014202
1.7853662	-40.9087006 C				
0.0000544	4292.6172752	78944686.	9.2718564	0.0005042	-0.0014533
1.8219457	-41.8631043 C				
0.0000556	4389.1704050	78906434.	9.2770484	0.0005160	-0.0014865
1.8582643	-42.8170992 C				
0.0000569	4485.6206981	78868056.	9.2822615	0.0005279	-0.0015196
1.8943213	-43.7706828 C				
0.0000581	4581.9676060	78829550.	9.2874959	0.0005398	-0.0015527
1.9301156	-44.7238526 C				
0.0000594	4678.2105749	78790915.	9.2927518	0.0005518	-0.0015857
1.9656465	-45.6766060 C				
0.0000606	4774.3490449	78752149.	9.2980292	0.0005637	-0.0016188
2.0009132	-46.6289403 C				
0.0000619	4870.3824505	78713252.	9.3033285	0.0005756	-0.0016519
2.0359147	-47.5808530 C				
0.0000631	4966.3102200	78674221.	9.3086496	0.0005876	-0.0016849
2.0706502	-48.5323413 C				
0.0000644	5062.1317758	78635057.	9.3139929	0.0005996	-0.0017179
2.1051187	-49.4834026 C				
0.0000656	5157.8465342	78595757.	9.3193584	0.0006116	-0.0017509
2.1393195	-50.4340342 C				
0.0000669	5253.4539052	78556320.	9.3247463	0.0006236	-0.0017839
2.1732515	-51.3842332 C				
0.0000681	5348.9532923	78516746.	9.3301569	0.0006356	-0.0018169
2.2069139	-52.3339970 C				

0.0000694	5444.3440927	78477032.	9.3355902	0.0006477	-0.0018498
2.2403058	-53.2833226 C				
0.0000706	5539.6256973	78437178.	9.3410466	0.0006597	-0.0018828
2.2734262	-54.2322072 C				
0.0000719	5634.7974899	78397182.	9.3465260	0.0006718	-0.0019157
2.3062741	-55.1806480 C				
0.0000731	5729.8588478	78357044.	9.3520289	0.0006839	-0.0019486
2.3388487	-56.1286420 C				
0.0000744	5824.8091414	78316762.	9.3575553	0.0006960	-0.0019815
2.3711490	-57.0761863 C				
0.0000794	6203.4872178	78154170.	9.3799003	0.0007445	-0.0021130
2.4975875	-60.0000000 CY				
0.0000844	6580.3357131	77989164.	9.4026383	0.0007933	-0.0022442
2.6195578	-60.0000000 CY				
0.0000894	6951.7426698	77781736.	9.4241587	0.0008423	-0.0023752
2.7366479	-60.0000000 CY				
0.0000944	7260.5371153	76932844.	9.4192512	0.0008889	-0.0025086
2.8433580	-60.0000000 CY				
0.0000994	7516.7878425	75640632.	9.3940074	0.0009335	-0.0026440
2.9408479	-60.0000000 CY				
0.0001044	7677.4214937	73556134.	9.3307992	0.0009739	-0.0027836
3.0252416	-60.0000000 CY				
0.0001094	7833.0668072	71616611.	9.2729509	0.0010142	-0.0029233
3.1060401	-60.0000000 CY				
0.0001144	7987.9150347	69839694.	9.2215203	0.0010547	-0.0030628
3.1836415	-60.0000000 CY				
0.0001194	8141.9254830	68204611.	9.1754958	0.0010953	-0.0032022
3.2579595	-60.0000000 CY				
0.0001244	8294.8791068	66692495.	9.1324633	0.0011359	-0.0033416
3.3285782	-60.0000000 CY				
0.0001294	8419.5664701	65078775.	9.0801511	0.0011747	-0.0034828
3.3929750	-60.0000000 CY				
0.0001344	8489.2099892	63175516.	9.0055216	0.0012101	-0.0036274
3.4485940	-60.0000000 CY				
0.0001394	8549.9119508	61344660.	8.9328692	0.0012450	-0.0037725
3.5008359	-60.0000000 CY				
0.0001444	8610.2016367	59637760.	8.8660471	0.0012800	-0.0039175
3.5506422	-60.0000000 CY				
0.0001494	8669.8648694	58040936.	8.8035109	0.0013150	-0.0040625
3.5977938	-60.0000000 CY				
0.0001544	8728.5282858	56541074.	8.7431164	0.0013497	-0.0042078
3.6419586	-60.0000000 CY				
0.0001594	8786.7867445	55132780.	8.6872598	0.0013845	-0.0043530
3.6836979	-60.0000000 CY				
0.0001644	8844.6337623	53807658.	8.6355383	0.0014195	-0.0044980
3.7229864	-60.0000000 CY				
0.0001694	8902.0626523	52558303.	8.5875971	0.0014545	-0.0046430
3.7597984	-60.0000000 CY				
0.0001744	8959.0665484	51378159.	8.5431222	0.0014897	-0.0047878
3.7941073	-60.0000000 CY				
0.0001794	9015.6383974	50261399.	8.5018353	0.0015250	-0.0049325
3.8258861	-60.0000000 CY				
0.0001844	9071.7709502	49202825.	8.4634885	0.0015605	-0.0050770
3.8551070	-60.0000000 CY				
0.0001894	9127.0515753	48195652.	8.4256498	0.0015956	-0.0052219
3.8814360	-60.0000000 CY				
0.0001944	9181.8595251	47237863.	8.3902288	0.0016309	-0.0053666
3.9051870	-60.0000000 CY				
0.0001994	9236.2296628	46325917.	8.3572766	0.0016662	-0.0055113
3.9263654	-60.0000000 CY				
0.0002044	9288.6333091	45448970.	8.3256465	0.0017016	-0.0056559
3.9448410	-60.0000000 CY				
0.0002094	9337.1813943	44595493.	8.2940349	0.0017366	-0.0058009

3.9605209	-60.0000000 CY				
0.0002144	9371.5028365	43715465.	8.2556616	0.0017698	-0.0059477
3.9729728	-60.0000000 CY				
0.0002194	9396.1339619	42831380.	8.2134836	0.0018018	-0.0060957
3.9827347	-60.0000000 CY				
0.0002244	9414.5761781	41959114.	8.1698684	0.0018331	-0.0062444
3.9901625	-60.0000000 CY				
0.0002294	9429.5126972	41109592.	8.1265043	0.0018640	-0.0063935
3.9954609	-60.0000000 CY				
0.0002344	9443.8922846	40293940.	8.0842187	0.0018947	-0.0065428
3.9987217	-60.0000000 CY				
0.0002394	9457.4802956	39509056.	8.0420123	0.0019251	-0.0066924
3.9999792	-60.0000000 CY				
0.0002444	9470.7754939	38755092.	8.0020673	0.0019555	-0.0068420
3.9955764	-60.0000000 CY				
0.0002494	9483.8529100	38030488.	7.9641550	0.0019861	-0.0069914
3.9986329	-60.0000000 CY				
0.0002544	9496.7229908	37333555.	7.9281441	0.0020167	-0.0071408
3.9999463	-60.0000000 CY				
0.0002594	9509.2739362	36662261.	7.8940703	0.0020475	-0.0072900
3.9941422	-60.0000000 CY				
0.0002644	9521.6012395	36015513.	7.8617043	0.0020784	-0.0074391
3.9976448	-60.0000000 CY				
0.0002694	9533.7409191	35392078.	7.8309075	0.0021095	-0.0075880
3.9995831	-60.0000000 CY				
0.0002744	9545.6413557	34790492.	7.8016626	0.0021406	-0.0077369
3.9976885	60.0000000 CY				
0.0003044	9610.5784835	31574796.	7.6457059	0.0023272	-0.0086303
3.9969371	60.0000000 CY				
0.0003344	9668.3149753	28914587.	7.5238012	0.0025158	-0.0095217
3.9988080	60.0000000 CY				
0.0003644	9721.0839946	26678790.	7.4309932	0.0027077	-0.0104098
3.9989028	60.0000000 CY				
0.0003944	9769.4136160	24771889.	7.3574056	0.0029016	-0.0112959
3.9972446	60.0000000 CY				
0.0004244	9813.8328494	23125379.	7.2956188	0.0030961	-0.0121814
3.9911390	60.0000000 CY				
0.0004544	9855.8048293	21690905.	7.2471793	0.0032929	-0.0130646
3.9948962	60.0000000 CY				
0.0004844	9895.4651063	20429347.	7.2095727	0.0034921	-0.0139454
3.9971106	60.0000000 CY				
0.0005144	9930.4435095	19305844.	7.1789610	0.0036927	-0.0148248
3.9851877	60.0000000 CY				
0.0005444	9930.4435095	18241917.	7.1884896	0.0039132	-0.0156843
3.9989353	60.0000000 CY				

Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain
1	0.025	9791.891	0.00300000

Note note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318-08, the value of the strength reduction factor depends on whether

the transverse reinforcing steel bars are spirals or tied hoops.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to ACI 318-08, Section 9.3.2.2 or the value required by the design standard being followed.

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p-y Curves Reported for Specified Depths

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p-y Curve Computed Using Cyclic Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 in
Depth below ground surface	=	0.000 in
Ground Slope Angle	=	45.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	45.000 degrees
Equivalent Depth	=	0.000 in
Diameter	=	36.000 in
Undrained cohesion, c	=	10.41667 lbs/in**2
Average Eff. Unit Weight	=	0.06944 lbs/in**3
Epsilon-50	=	0.00700
Pct	=	562.500 lbs/in
Pcd	=	3375.000 lbs/in
Pu	=	562.500 lbs/in
y50	=	0.630 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000
Number of cycles of loading	=	10.

y, in	p, lbs/in
0.0000	0.0000
0.0001008	28.12500
0.0005040	42.05668
0.00101	50.01411
0.00504	74.78854
0.01008	88.93906
0.05040	132.99491
0.10080	158.15850
0.25200	198.87378
0.50400	236.50212
0.75600	261.73262
1.00800	281.25000
2.52000	353.65315
5.04000	420.56684
10.08000	500.14108
15.12000	553.49709
20.16000	562.50000

p-y Curve Computed Using Cyclic Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	60.000 in
Depth below ground surface	=	60.000 in

Ground Slope Angle	=	45.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	45.000 degrees
Equivalent Depth	=	22.547 in
Diameter	=	36.000 in
Undrained cohesion, c	=	15.62500 lbs/in**2
Average Eff. Unit Weight	=	0.06944 lbs/in**3
Epsilon-50	=	0.00500
Pct	=	960.010 lbs/in
Pcd	=	5062.500 lbs/in
Pu	=	960.010 lbs/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000
Number of cycles of loading	=	10.

y, in	p, lbs/in
0.0000	0.0000
0.0000720	48.00051
0.0003600	71.77750
0.0007200	85.35832
0.00360	127.64046
0.00720	151.79094
0.03600	226.98039
0.07200	269.92670
0.18000	339.41486
0.36000	403.63456
0.54000	446.69507
0.72000	480.00509
1.80000	603.57445
3.60000	717.77503
7.20000	853.58317
10.80000	944.64506
14.40000	960.01019

p-y Curve Computed Using Cyclic Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	120.000 in
Depth below ground surface	=	120.000 in
Ground Slope Angle	=	45.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	45.000 degrees
Equivalent Depth	=	82.547 in
Diameter	=	36.000 in
Undrained cohesion, c	=	20.83333 lbs/in**2
Average Eff. Unit Weight	=	0.07234 lbs/in**3
Epsilon-50	=	0.00500
Pct	=	1662.418 lbs/in
Pcd	=	6750.000 lbs/in
Pu	=	1662.418 lbs/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000
Number of cycles of loading	=	10.

y, in	p, lbs/in
0.0000	0.0000

0.0000720	83.12091
0.0003600	124.29475
0.0007200	147.81220
0.00360	221.03079
0.00720	262.85139
0.03600	393.05450
0.07200	467.42321
0.18000	587.75358
0.36000	698.96074
0.54000	773.52722
0.72000	831.20908
1.80000	1045.19008
3.60000	1242.94748
7.20000	1478.12199
10.80000	1635.81089
14.40000	1662.41816

p-y Curve Computed Using Cyclic Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2	
Depth below pile head	=	180.000	in
Depth below ground surface	=	180.000	in
Ground Slope Angle	=	45.000	degrees
Pile Batter Angle	=	0.000	degrees
Effective Slope	=	45.000	degrees
Equivalent Depth	=	142.547	in
Diameter	=	36.000	in
Undrained cohesion, c	=	20.83333	lbs/in**2
Average Eff. Unit Weight	=	0.07330	lbs/in**3
Epsilon-50	=	0.00500	
Pct	=	2055.518	lbs/in
Pcd	=	6750.000	lbs/in
Pu	=	2055.518	lbs/in
y50	=	0.450	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	
Number of cycles of loading	=	10.	

y, in	p, lbs/in
0.0000	0.0000
0.0000720	102.77590
0.0003600	153.68581
0.0007200	182.76426
0.00360	273.29632
0.00720	325.00593
0.03600	485.99721
0.07200	577.95134
0.18000	726.73534
0.36000	864.23884
0.54000	956.43750
0.72000	1027.75897
1.80000	1292.33848
3.60000	1536.85812
7.20000	1827.64261
10.80000	2022.61904
14.40000	2055.51794

p-y Curve Computed Using Cyclic Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2	
Depth below pile head	=	240.000	in
Depth below ground surface	=	240.000	in
Ground Slope Angle	=	45.000	degrees
Pile Batter Angle	=	0.000	degrees
Effective Slope	=	45.000	degrees
Equivalent Depth	=	202.547	in
Diameter	=	36.000	in
Undrained cohesion, c	=	20.83333	lbs/in**2
Average Eff. Unit Weight	=	0.07378	lbs/in**3
Epsilon-50	=	0.00500	
Pct	=	2448.943	lbs/in
Pcd	=	6750.000	lbs/in
Pu	=	2448.943	lbs/in
y50	=	0.450	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	
Number of cycles of loading	=	10.	

y, in	p, lbs/in
0.0000	0.0000
0.0000720	122.44714
0.0003600	183.10118
0.0007200	217.74523
0.00360	325.60507
0.00720	387.21186
0.03600	579.01678
0.07200	688.57087
0.18000	865.83204
0.36000	1029.65363
0.54000	1139.49906
0.72000	1224.47142
1.80000	1539.69129
3.60000	1831.01184
7.20000	2177.45230
10.80000	2409.74710
14.40000	2448.94284

p-y Curve Computed Using Cyclic Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2	
Depth below pile head	=	300.000	in
Depth below ground surface	=	300.000	in
Ground Slope Angle	=	45.000	degrees
Pile Batter Angle	=	0.000	degrees
Effective Slope	=	45.000	degrees
Equivalent Depth	=	262.547	in
Diameter	=	36.000	in
Undrained cohesion, c	=	20.83333	lbs/in**2
Average Eff. Unit Weight	=	0.07407	lbs/in**3
Epsilon-50	=	0.00500	
Pct	=	2842.498	lbs/in
Pcd	=	6750.000	lbs/in
Pu	=	2842.498	lbs/in
y50	=	0.450	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	
Number of cycles of loading	=	10.	

y, in	p, lbs/in
0.0000	0.0000
0.0000720	142.12489
0.0003600	212.52628
0.0007200	252.73776
0.00360	377.93111
0.00720	449.43836
0.03600	672.06710
0.07200	799.22697
0.18000	1004.97472
0.36000	1195.12309
0.54000	1322.62113
0.72000	1421.24889
1.80000	1787.12585
3.60000	2125.26278
7.20000	2527.37762
10.80000	2797.00312
14.40000	2842.49777

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Horizontal shear force at pile head = 15000.000 lbs
Applied moment at pile head = 6120000.000 in-lbs
Axial thrust load on pile head = 25.000 lbs

Depth X	Deflect. y	Bending Moment	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil Res. Es*h	Soil Spr. Lat. Load	Distrib. p
inches	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/inch	lb/inch	lb/in
0.00	1.0338	6120000.	15000.	-0.0127	0.000	7.817E+10	-283.0321	410.6804	0.000
3.000	0.9959	6163727.	14146.	-0.0125	0.000	7.817E+10	-286.1673	862.0404	0.000
6.000	0.9587	6204879.	13283.	-0.0123	0.000	7.817E+10	-289.1688	904.8473	0.000
9.000	0.9223	6243428.	12411.	-0.0120	0.000	7.814E+10	-292.0347	949.9287	0.000
12.000	0.8866	6279349.	11531.	-0.0118	0.000	7.812E+10	-294.7630	997.4444	0.000
15.000	0.8515	6312617.	10643.	-0.0115	0.000	7.810E+10	-297.3518	1047.5682	0.000
18.000	0.8173	6343209.	9747.2962	-0.0113	0.000	7.809E+10	-299.7991	1100.4894	0.000
21.000	0.7837	6371103.	8844.4433	-0.0111	0.000	7.808E+10	-302.1028	1156.4145	0.000
24.000	0.7509	6396277.	7934.8978	-0.0108	0.000	7.807E+10	-304.2609	1215.5689	0.000
27.000	0.7188	6418714.	7019.0999	-0.0106	0.000	7.806E+10	-306.2711	1278.1992	0.000

30.000	0.6875	6438394.	6097.4966	-0.0103	0.000	7.805E+10	-308.1312	1344.5754	0.000
33.000	0.6569	6455300.	5170.5413	-0.0101	0.000	7.804E+10	-309.8390	1414.9938	0.000
36.000	0.6271	6469418.	4238.6945	-0.009825	0.000	7.804E+10	-311.3922	1489.7800	0.000
39.000	0.5980	6480734.	3302.4239	-0.009576	0.000	7.803E+10	-312.7883	1569.2924	0.000
42.000	0.5696	6489234.	2362.2043	-0.009327	0.000	7.803E+10	-314.0248	1653.9260	0.000
45.000	0.5420	6494909.	1418.5179	-0.009077	0.000	7.802E+10	-315.0994	1744.1171	0.000
48.000	0.5151	6497747.	471.8549	-0.008828	0.000	7.802E+10	-316.0093	1840.3487	0.000
51.000	0.4890	6497741.	-477.2870	-0.008578	0.000	7.802E+10	-316.7519	1943.1559	0.000
54.000	0.4637	6494884.	-1428.4016	-0.008328	0.000	7.802E+10	-317.3245	2053.1334	0.000
57.000	0.4391	6489172.	-2380.9747	-0.008078	0.000	7.803E+10	-317.7243	2170.9427	0.000
60.000	0.4152	6480600.	-3485.0007	-0.007829	0.000	7.803E+10	-418.2930	3022.3583	0.000
63.000	0.3921	6468263.	-4943.6442	-0.007580	0.000	7.804E+10	-554.1360	4239.9133	0.000
66.000	0.3697	6450939.	-6606.3278	-0.007332	0.000	7.804E+10	-554.3197	4497.9115	0.000
69.000	0.3481	6428626.	-8269.0696	-0.007084	0.000	7.805E+10	-554.1749	4776.0696	0.000
72.000	0.3272	6401326.	-9930.8735	-0.006838	0.000	7.807E+10	-553.6944	5076.4642	0.000
75.000	0.3071	6369042.	-11591.	-0.006592	0.000	7.808E+10	-552.8711	5401.4443	0.000
78.000	0.2877	6331782.	-13248.	-0.006348	0.000	7.810E+10	-551.6979	5753.6747	0.000
81.000	0.2690	6289557.	-14900.	-0.006106	0.000	7.811E+10	-550.1671	6136.1883	0.000
84.000	0.2510	6242381.	-16548.	-0.005865	0.000	7.814E+10	-548.2710	6552.4481	0.000
87.000	0.2338	6190270.	-18189.	-0.005627	0.000	7.816E+10	-546.0014	7006.4232	0.000
90.000	0.2173	6133245.	-19823.	-0.005390	0.000	7.818E+10	-543.3497	7502.6792	0.000
93.000	0.2014	6071330.	-21449.	-0.005156	0.000	7.821E+10	-540.3071	8046.4892	0.000
96.000	0.1863	6004552.	-23065.	-0.004925	0.000	7.824E+10	-536.8638	8643.9697	0.000
99.000	0.1719	5932943.	-24670.	-0.004696	0.000	7.827E+10	-533.0098	9302.2490	0.000
102.000	0.1582	5856536.	-26262.	-0.004470	0.000	7.830E+10	-528.7342	10030.	0.000
105.000	0.1451	5775371.	-27841.	-0.004247	0.000	7.834E+10	-524.0253	10836.	0.000
108.000	0.1327	5689489.	-29406.	-0.004028	0.000	7.837E+10	-518.8704	11733.	0.000
111.000	0.1209	5598937.	-30954.	-0.003812	0.000	7.841E+10	-513.2560	12735.	0.000
114.000	0.1098	5503767.	-32484.	-0.003599	0.000	7.845E+10	-507.1669	13857.	0.000
117.000	0.0993	5404031.	-33996.	-0.003391	0.000	7.849E+10	-500.5869	15121.	0.000
120.000	0.0895	5299791.	-35487.	-0.003186	0.000	7.854E+10	-493.4977	16550.	0.000
123.000	0.0802	5191109.	-36956.	-0.002986	0.000	7.858E+10			

-485.8793	18175.	0.000				
126.000	0.0715	5078054.	-38402.	-0.002790	0.000	7.863E+10
-477.7091	20033.	0.000				
129.000	0.0635	4960699.	-39822.	-0.002599	0.000	7.868E+10
-468.9616	22170.	0.000				
132.000	0.0559	4839124.	-41215.	-0.002412	0.000	7.873E+10
-459.6080	24645.	0.000				
135.000	0.0490	4713412.	-42578.	-0.002230	0.000	7.878E+10
-449.6153	27534.	0.000				
138.000	0.0426	4583654.	-43911.	-0.002053	0.000	7.883E+10
-438.9449	30935.	0.000				
141.000	0.0367	4449946.	-45211.	-0.001881	0.000	7.888E+10
-427.5519	34977.	0.000				
144.000	0.0313	4312389.	-46475.	-0.001714	0.000	7.894E+10
-415.3829	39835.	0.000				
147.000	0.0264	4171094.	-47702.	-0.001553	0.000	7.899E+10
-402.3737	45750.	0.000				
150.000	0.0220	4026178.	-48888.	-0.001398	0.000	7.905E+10
-388.4453	53060.	0.000				
153.000	0.0180	3877765.	-50031.	-0.001248	0.000	7.911E+10
-373.4992	62254.	0.000				
156.000	0.0145	3725991.	-51127.	-0.001104	0.000	7.917E+10
-357.4087	74068.	0.000				
159.000	0.0114	3571000.	-52174.	-0.000965	0.000	7.923E+10
-340.0063	89655.	0.000				
162.000	0.008684	3412950.	-53165.	-0.000833	0.000	7.929E+10
-321.0615	110918.	0.000				
165.000	0.006378	3252009.	-54097.	-0.000707	0.000	7.935E+10
-300.2399	141228.	0.000				
168.000	0.004441	3088367.	-54963.	-0.000587	0.000	7.941E+10
-277.0204	187149.	0.000				
171.000	0.002854	2922231.	-55754.	-0.000474	0.000	7.947E+10
-250.5006	263358.	0.000				
174.000	0.001597	2753841.	-56458.	-0.000367	0.000	7.953E+10
-218.8272	410975.	0.000				
177.000	0.000653	2583481.	-57063.	-0.000266	0.000	7.960E+10
-184.5960	848272.	0.000				
180.000	4.264E-07	2411460.	-57341.	-0.000172	0.000	7.966E+10
-0.1217	856466.	0.000				
183.000	-0.000380	2239438.	-56807.	-0.000118	0.000	3.740E+11
355.8187	2812500.	0.000				
186.000	-0.000706	2070619.	-55281.	-0.000100	0.000	3.745E+11
661.5152	2812500.	0.000				
189.000	-0.000982	1907752.	-53316.	-8.448E-05	0.000	3.750E+11
648.4626	1981179.	0.000				
192.000	-0.001212	1750723.	-51318.	-6.985E-05	0.000	3.755E+11
683.6020	1691431.	0.000				
195.000	-0.001401	1599845.	-49229.	-5.647E-05	0.000	3.759E+11
708.7795	1517689.	0.000				
198.000	-0.001551	1455346.	-47076.	-4.429E-05	0.000	3.764E+11
727.0796	1406066.	0.000				
201.000	-0.001667	1317392.	-44875.	-3.324E-05	0.000	3.768E+11
740.2581	1332379.	0.000				
204.000	-0.001751	1186099.	-42640.	-2.328E-05	0.000	3.772E+11
749.4219	1284156.	0.000				
207.000	-0.001806	1061552.	-40383.	-1.435E-05	0.000	3.775E+11
755.3194	1254357.	0.000				
210.000	-0.001837	943802.	-38112.	-6.384E-06	0.000	3.779E+11
758.4821	1238769.	0.000				
213.000	-0.001845	832878.	-35836.	6.654E-07	0.000	3.782E+11
759.3027	1234789.	0.000				
216.000	-0.001833	728789.	-33559.	6.857E-06	0.000	3.785E+11
758.0789	1240807.	0.000				

219.000	-0.001804	631522.	-31290.	1.225E-05	0.000	3.788E+11
755.0418	1255867.	0.000				
222.000	-0.001759	541050.	-29032.	1.689E-05	0.000	3.790E+11
750.3723	1279483.	0.000				
225.000	-0.001702	457332.	-26790.	2.084E-05	0.000	3.793E+11
744.2135	1311535.	0.000				
228.000	-0.001634	380311.	-24568.	2.415E-05	0.000	3.795E+11
736.6777	1352219.	0.000				
231.000	-0.001557	309921.	-22372.	2.688E-05	0.000	3.797E+11
727.8515	1402034.	0.000				
234.000	-0.001473	246081.	-20203.	2.907E-05	0.000	3.800E+11
717.7983	1461795.	0.000				
237.000	-0.001383	188702.	-18067.	3.079E-05	0.000	3.800E+11
706.5603	1532685.	0.000				
240.000	-0.001288	137681.	-15966.	3.208E-05	0.000	3.800E+11
694.1575	1616343.	0.000				
243.000	-0.001191	92909.	-13903.	3.299E-05	0.000	3.800E+11
680.5858	1715008.	0.000				
246.000	-0.001090	54261.	-11884.	3.357E-05	0.000	3.800E+11
665.8140	1831739.	0.000				
249.000	-0.000989	21605.	-9910.4589	3.387E-05	0.000	3.800E+11
649.7766	1970781.	0.000				
252.000	-0.000887	-5201.9370	-7987.2486	3.393E-05	0.000	3.800E+11
632.3636	2138153.	0.000				
255.000	-0.000786	-26318.	-6118.5971	3.381E-05	0.000	3.800E+11
613.4041	2342663.	0.000				
258.000	-0.000684	-41914.	-4236.0399	3.354E-05	0.000	3.800E+11
641.6340	2812500.	0.000				
261.000	-0.000584	-51734.	-2451.9306	3.317E-05	0.000	3.800E+11
547.7722	2812500.	0.000				
264.000	-0.000485	-56625.	-947.6837	3.274E-05	0.000	3.800E+11
455.0590	2812500.	0.000				
267.000	-0.000388	-57420.	280.3096	3.229E-05	0.000	3.800E+11
363.6032	2812500.	0.000				
270.000	-0.000292	-54943.	1235.8478	3.185E-05	0.000	3.800E+11
273.4223	2812500.	0.000				
273.000	-0.000197	-50005.	1922.6732	3.143E-05	0.000	3.800E+11
184.4613	2812500.	0.000				
276.000	-0.000103	-43407.	2344.2811	3.106E-05	0.000	3.800E+11
96.6106	2812500.	0.000				
279.000	-1.037E-05	-35940.	2503.7827	3.075E-05	0.000	3.800E+11
9.7238	2812500.	0.000				
282.000	8.146E-05	-28385.	2472.1348	3.050E-05	0.000	3.800E+11
-30.8223	1135176.	0.000				
285.000	0.000173	-21107.	2327.2212	3.030E-05	0.000	3.800E+11
-65.7868	1143376.	0.000				
288.000	0.000263	-14421.	2076.9546	3.016E-05	0.000	3.800E+11
-101.0576	1151575.	0.000				
291.000	0.000354	-8645.1093	1720.3303	3.007E-05	0.000	3.800E+11
-136.6920	1159775.	0.000				
294.000	0.000444	-4099.2346	1256.1818	3.002E-05	0.000	3.800E+11
-172.7403	1167974.	0.000				
297.000	0.000534	-1108.0229	683.2065	3.000E-05	0.000	3.800E+11
-209.2432	1176174.	0.000				
300.000	0.000624	0.000	0.000	3.000E-05	0.000	3.800E+11
-246.2278	592187.	0.000				

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      1.0337679 inches
Computed slope at pile head      =     -0.0127416 radians
Maximum bending moment           =      6497747. inch-lbs
Maximum shear force              =       -57341. lbs
Depth of maximum bending moment  =     48.0000000 inches below pile head
Depth of maximum shear force     =    180.0000000 inches below pile head
Number of iterations             =             55
Number of zero deflection points =              2
```

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

```
Shear      =          15000. lbs
Moment     =        6120000. in-lbs
Axial Load =             25. lbs
```

Pile Length in	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
300.000	1.0337679	6497747.	-57341.
285.000	1.0489069	6496493.	-56888.
270.000	1.0443903	6496955.	-56767.
255.000	1.0481950	6496534.	-57813.
240.000	1.0776772	6493622.	-62521.
225.000	1.2667619	6477807.	-68989.
210.000	1.7207090	6450576.	-75157.
195.000	2.7281931	6415102.	-81183.
180.000	5.0619441	6374078.	-87220.
165.000	10.4347758	6333747.	-94573.
150.000	25.7988810	6309280.	-104327.

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

```
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians
```

Load No.	Load Type	Condition 1 V(lbs) or Shear lbs	Condition 2 in-lb, rad., y(inches) or Rotation in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Pile-Head Shear lbs
1	1	V = 15000.	M = 6120000.	25.00000000	1.03376790	6497747.	-57341.

The analysis ended normally.

LPile Plus for Windows, Version 6.0 (6.0.14)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Carl Kim
Leighton Group

Files Used for Analysis

Path to file locations: P:\Infocus Projects\10296 Ford Theatre\Analyses\lpile\
Name of input data file: 42 inch Dia CIDH demand.lp6d
Name of output file: 42 inch Dia CIDH demand.lp6o
Name of plot output file: 42 inch Dia CIDH demand.lp6p
Name of runtime file: 42 inch Dia CIDH demand.lp6r

Date and Time of Analysis

Date: October 8, 2013 Time: 12:01:35

Problem Title

Ford Theater Foundation

603507-002

Ford Theater Foundation

SP

Drilled, Cast-in-Place Concrete Caissons - 30-inch Diameter

Program Options

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal moment capacity with pile response computed using nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 1000
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 25.00 ft

Depth of ground surface below top of pile = 0.00 ft

Slope angle of ground surface = 45.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	42.0000000
2	25.000000	42.0000000

Input Structural Properties:

Section No. 1:

Section Type = Drilled Shaft (Bored Pile)

Section Length = 25.000 ft
Section Diameter = 42.000 in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 45.000 degrees
= 0.785 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer = 0.000 ft
Distance from top of pile to bottom of layer = 5.000 ft

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer = 5.000 ft
Distance from top of pile to bottom of layer = 50.000 ft

(Depth of lowest layer extends 25.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	0.00	120.00000
2	5.00	120.00000
3	5.00	130.00000
4	50.00	130.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction	Test Type	qu	RQD	Epsilon 50	kpy	Test Prop.	Rock Emass	Elas. Subgr. krm
1	Stiff Clay w/o Free Water	0.00	120.000	1500.000	--	--	--	--	0.00	--	--	--	--
		5.000	120.000	1500.000	--	--	--	--	0.00	--	--	--	--
2	Stiff Clay w/o Free Water	5.000	130.000	3000.000	--	--	--	--	0.00	--	--	--	--
		50.000	130.000	3000.000	--	--	--	--	0.00	--	--	--	--

Ang., deg.	psi	percent	pci	pci	psi
1	Stiff Clay w/o Free Water	0.00	120.000	1500.000	
		0.00	5.000	120.000	1500.000
2	Stiff Clay w/o Free Water	0.00	5.000	130.000	3000.000
		0.00	50.000	130.000	3000.000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 15000.000 lbs	M = 6120000.000 in-lbs	25.000

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust force values were determined from pile-head loading conditions

Number of Sections Analyzed = 1

Section No. 1:

Dimensions and Properties of Drilled Shaft:

Length of Section = 25.00000000 ft

Shaft Diameter	=	42.00000000 in
Concrete Cover Thickness	=	3.00000000 in
Number of Reinforcing Bars	=	12 bars
Yield Stress of Reinforcing Bars	=	60.00000000 ksi
Modulus of Elasticity of Reinforcing Bars	=	29000. ksi
Gross Area of Shaft	=	1385.44236023 sq. in.
Total Area of Reinforcing Steel	=	15.24000000 sq. in.
Area Ratio of Steel Reinforcement	=	1.10 percent

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As	=	5573.088 kips
Tensile Load for Cracking of Concrete	=	-620.869 kips
Nominal Axial Tensile Capacity	=	-914.400 kips

Reinforcing Bar Dimensions and Positions Used in Computations:

Bar Number	Bar Diam. inches	Bar Area sq. in.	X inches	Y inches
1	1.27000	1.27000	17.36500	0.00000
2	1.27000	1.27000	15.03853	8.68250
3	1.27000	1.27000	8.68250	15.03853
4	1.27000	1.27000	0.00000	17.36500
5	1.27000	1.27000	-8.68250	15.03853
6	1.27000	1.27000	-15.03853	8.68250
7	1.27000	1.27000	-17.36500	0.00000
8	1.27000	1.27000	-15.03853	-8.68250
9	1.27000	1.27000	-8.68250	-15.03853
10	1.27000	1.27000	0.00000	-17.36500
11	1.27000	1.27000	8.68250	-15.03853
12	1.27000	1.27000	15.03853	-8.68250

Concrete Properties:

Compressive Strength of Concrete	=	4.0000000 ksi
Modulus of Elasticity of Concrete	=	3604.9965326 ksi
Modulus of Rupture of Concrete	=	-0.4743416 ksi
Compression Strain at Peak Stress	=	0.0018863
Tensile Strain at Fracture of Concrete	=	-0.0001154
Maximum Coarse Aggregate Size	=	0.7500000 in

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	0.025

Definitions of Run Messages and Notes:

C = concrete in section has cracked in tension
Y = stress in reinforcing steel has reached yield stress
T = tensile strain in reinforcement exceeds 0.005 when compressive strain in concrete is less than 0.003.

Z = depth of tensile zone in concrete section is less than 10 percent of section depth
Bending Stiffness (EI) = Bending Moment / Curvature
Position of neutral axis is computed from compression side of pile
Compressive stresses are positive in sign. Tensile stresses are negative in sign.

Axial Thrust Force = 0.025 kips

Bending Max Concrete Curvature Stress rad/in. ksi	Bending Max Steel Stress ksi	Bending Run Moment in-kip	Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Msg
0.000000625	439.5675038	703308006.		21.0064639	0.0000131	-0.0000131	
0.0549359	0.3769359						
0.000001250	877.2513129	701801050.		21.0032657	0.0000263	-0.0000262	
0.1094753	0.7537559						
0.000001875	1313.0514258	700294094.		21.0021998	0.0000394	-0.0000394	
0.1636350	1.1305759						
0.000002500	1746.9678424	698787137.		21.0016670	0.0000525	-0.0000525	
0.2174151	1.5073959						
0.000003125	2179.0005628	697280180.		21.0013474	0.0000656	-0.0000656	
0.2708156	1.8842159						
0.000003750	2609.1495870	695773223.		21.0011344	0.0000788	-0.0000787	
0.3238365	2.2610359						
0.000004375	3037.4149149	694266266.		21.0009823	0.0000919	-0.0000919	
0.3764777	2.6378559						
0.000005000	3463.7965467	692759309.		21.0008683	0.0001050	-0.0001050	
0.4287394	3.0146759						
0.000005625	3463.7965467	615786053.		10.3893633	0.0000584	-0.0001778	
0.2391591	-5.1222289		C				
0.000006250	3463.7965467	554207447.		10.3921122	0.0000650	-0.0001975	
0.2653477	-5.6908672		C				
0.000006875	3463.7965467	503824952.		10.3949185	0.0000715	-0.0002173	
0.2914604	-6.2593944		C				
0.000007500	3463.7965467	461839540.		10.3977695	0.0000780	-0.0002370	
0.3174972	-6.8278101		C				
0.000008125	3463.7965467	426313421.		10.4006563	0.0000845	-0.0002567	
0.3434579	-7.3961141		C				
0.000008750	3463.7965467	395862462.		10.4035726	0.0000910	-0.0002765	
0.3693423	-7.9643059		C				
0.000009375	3463.7965467	369471632.		10.4065137	0.0000976	-0.0002962	
0.3951505	-8.5323853		C				
0.0000100	3463.7965467	346379655.		10.4094762	0.0001041	-0.0003159	
0.4208822	-9.1003519		C				
0.0000106	3463.7965467	326004381.		10.4124575	0.0001106	-0.0003356	
0.4465373	-9.6682053		C				
0.0000113	3463.7965467	307893026.		10.4154554	0.0001172	-0.0003553	
0.4721157	-10.2359452		C				
0.0000119	3463.7965467	291688130.		10.4184684	0.0001237	-0.0003750	
0.4976173	-10.8035712		C				
0.0000125	3463.7965467	277103724.		10.4214952	0.0001303	-0.0003947	
0.5230420	-11.3710830		C				
0.0000131	3463.7965467	263908308.		10.4245348	0.0001368	-0.0004144	
0.5483897	-11.9384802		C				
0.0000138	3463.7965467	251912476.		10.4275863	0.0001434	-0.0004341	
0.5736602	-12.5057624		C				
0.0000144	3463.7965467	240959760.		10.4306490	0.0001499	-0.0004538	
0.5988533	-13.0729294		C				

0.0000150	3463.7965467	230919770.	10.4337223	0.0001565	-0.0004735
0.6239691	-13.6399807	C			
0.0000156	3463.7965467	221682979.	10.4368059	0.0001631	-0.0004932
0.6490073	-14.2069160	C			
0.0000163	3463.7965467	213156711.	10.4398993	0.0001696	-0.0005129
0.6739678	-14.7737349	C			
0.0000169	3463.7965467	205262018.	10.4430021	0.0001762	-0.0005325
0.6988505	-15.3404371	C			
0.0000175	3463.7965467	197931231.	10.4461140	0.0001828	-0.0005522
0.7236553	-15.9070221	C			
0.0000181	3463.7965467	191106016.	10.4492349	0.0001894	-0.0005719
0.7483821	-16.4734896	C			
0.0000188	3463.7965467	184735816.	10.4523646	0.0001960	-0.0005915
0.7730307	-17.0398392	C			
0.0000194	3463.7965467	178776596.	10.4555027	0.0002026	-0.0006112
0.7976010	-17.6060706	C			
0.0000200	3463.7965467	173189827.	10.4586493	0.0002092	-0.0006308
0.8220928	-18.1721833	C			
0.0000206	3463.7965467	167941651.	10.4618042	0.0002158	-0.0006505
0.8465061	-18.7381771	C			
0.0000213	3463.7965467	163002190.	10.4649673	0.0002224	-0.0006701
0.8708407	-19.3040514	C			
0.0000219	3463.7965467	158344985.	10.4681384	0.0002290	-0.0006898
0.8950964	-19.8698059	C			
0.0000225	3463.7965467	153946513.	10.4713175	0.0002356	-0.0007094
0.9192733	-20.4354403	C			
0.0000231	3463.7965467	149785797.	10.4745046	0.0002422	-0.0007290
0.9433710	-21.0009541	C			
0.0000238	3463.7965467	145844065.	10.4776996	0.0002488	-0.0007487
0.9673895	-21.5663469	C			
0.0000244	3502.0242141	143672788.	10.4809024	0.0002555	-0.0007683
0.9913287	-22.1316184	C			
0.0000256	3679.8014106	143602006.	10.4873313	0.0002687	-0.0008075
1.0389685	-23.2617958	C			
0.0000269	3857.3960218	143531015.	10.4937912	0.0002820	-0.0008467
1.0862892	-24.3914828	C			
0.0000281	4034.8069503	143459803.	10.5002819	0.0002953	-0.0008859
1.1332900	-25.5206764	C			
0.0000294	4212.0331442	143388362.	10.5068033	0.0003086	-0.0009251
1.1799695	-26.6493733	C			
0.0000306	4389.0735400	143316687.	10.5133555	0.0003220	-0.0009643
1.2263267	-27.7775701	C			
0.0000319	4565.9270619	143244771.	10.5199384	0.0003353	-0.0010034
1.2723606	-28.9052634	C			
0.0000331	4742.5926222	143172607.	10.5265520	0.0003487	-0.0010426
1.3180700	-30.0324499	C			
0.0000344	4919.0691210	143100193.	10.5331967	0.0003621	-0.0010817
1.3634537	-31.1591260	C			
0.0000356	5095.3554456	143027521.	10.5398723	0.0003755	-0.0011208
1.4085106	-32.2852884	C			
0.0000369	5271.4504706	142954589.	10.5465791	0.0003889	-0.0011598
1.4532396	-33.4109335	C			
0.0000381	5447.3530579	142881392.	10.5533173	0.0004023	-0.0011989
1.4976394	-34.5360576	C			
0.0000394	5623.0620558	142807925.	10.5600870	0.0004158	-0.0012379
1.5417090	-35.6606572	C			
0.0000406	5798.5762995	142734186.	10.5668884	0.0004293	-0.0012770
1.5854470	-36.7847287	C			
0.0000419	5973.8946105	142660170.	10.5737218	0.0004428	-0.0013160
1.6288524	-37.9082682	C			
0.0000431	6149.0157962	142585874.	10.5805874	0.0004563	-0.0013550
1.6719238	-39.0312720	C			
0.0000444	6323.9386502	142511294.	10.5874854	0.0004698	-0.0013939

1.7146601	-40.1537364	C			
0.0000456	6498.6619515	142436426.	10.5944161	0.0004834	-0.0014329
1.7570599	-41.2756574	C			
0.0000469	6673.1844646	142361269.	10.6013797	0.0004969	-0.0014718
1.7991222	-42.3970312	C			
0.0000481	6847.5049389	142285817.	10.6083766	0.0005105	-0.0015107
1.8408455	-43.5178538	C			
0.0000494	7021.6221090	142210068.	10.6154069	0.0005241	-0.0015496
1.8822286	-44.6381211	C			
0.0000506	7195.5346938	142134019.	10.6224709	0.0005378	-0.0015885
1.9232702	-45.7578292	C			
0.0000519	7369.2413966	142057665.	10.6295691	0.0005514	-0.0016273
1.9639691	-46.8769739	C			
0.0000531	7542.7409046	141981005.	10.6367016	0.0005651	-0.0016662
2.0043238	-47.9955511	C			
0.0000544	7716.0318890	141904035.	10.6438687	0.0005788	-0.0017050
2.0443330	-49.1135565	C			
0.0000556	7889.1130041	141826751.	10.6510709	0.0005925	-0.0017438
2.0839954	-50.2309858	C			
0.0000569	8061.9828875	141749150.	10.6583084	0.0006062	-0.0017826
2.1233096	-51.3478347	C			
0.0000581	8234.6401596	141671229.	10.6655815	0.0006199	-0.0018213
2.1622743	-52.4640989	C			
0.0000594	8407.0834233	141592984.	10.6728906	0.0006337	-0.0018600
2.2008880	-53.5797738	C			
0.0000606	8579.3112636	141514413.	10.6802360	0.0006475	-0.0018988
2.2391494	-54.6948549	C			
0.0000619	8751.3222473	141435511.	10.6876181	0.0006613	-0.0019375
2.2770569	-55.8093377	C			
0.0000631	8923.1149227	141356276.	10.6950372	0.0006751	-0.0019761
2.3146092	-56.9232175	C			
0.0000644	9094.6878194	141276704.	10.7024937	0.0006890	-0.0020148
2.3518048	-58.0364896	C			
0.0000656	9266.0394474	141196792.	10.7099880	0.0007028	-0.0020534
2.3886422	-59.1491492	C			
0.0000669	9437.1819445	141116739.	10.7171842	0.0007167	-0.0020920
2.4250602	-60.0000000	CY			
0.0000681	9608.1003200	141036335.	10.7244150	0.0007306	-0.0021306
2.4611153	-60.0000000	CY			
0.0000694	9778.7952961	140955608.	10.7316814	0.0007445	-0.0021692
2.4968063	-60.0000000	CY			
0.0000706	9949.2646640	140874544.	10.7389837	0.0007584	-0.0022078
2.5321318	-60.0000000	CY			
0.0000719	10120.	140793140.	10.7463221	0.0007724	-0.0022464
2.5670903	-60.0000000	CY			
0.0000731	10290.	140711392.	10.7536972	0.0007864	-0.0022849
2.6016801	-60.0000000	CY			
0.0000744	10454.	140564312.	10.7594726	0.0008002	-0.0023235
2.6355984	-60.0000000	CY			
0.0000794	11013.	138742702.	10.7509013	0.0008534	-0.0024804
2.7615210	-60.0000000	CY			
0.0000844	11417.	135317745.	10.6959126	0.0009025	-0.0026413
2.8723537	-60.0000000	CY			
0.0000894	11698.	130884218.	10.6063532	0.0009479	-0.0028058
2.9701745	-60.0000000	CY			
0.0000944	11977.	126904797.	10.5283780	0.0009936	-0.0029701
3.0639634	-60.0000000	CY			
0.0000994	12254.	123310642.	10.4602817	0.0010395	-0.0031343
3.1536692	-60.0000000	CY			
0.0001044	12529.	120036916.	10.4003275	0.0010855	-0.0032982
3.2391696	-60.0000000	CY			
0.0001094	12729.	116377437.	10.3205222	0.0011288	-0.0034649
3.3152649	-60.0000000	CY			

0.0001144	12839.	112253844.	10.2130205	0.0011681	-0.0036356	
3.3807513	-60.0000000	CY				
0.0001194	12946.	108449771.	10.1133382	0.0012073	-0.0038065	
3.4427230	-60.0000000	CY				
0.0001244	13053.	104945528.	10.0228329	0.0012466	-0.0039772	
3.5016446	-60.0000000	CY				
0.0001294	13158.	101706256.	9.9404580	0.0012860	-0.0041477	
3.5574819	-60.0000000	CY				
0.0001344	13263.	98701665.	9.8650159	0.0013256	-0.0043181	
3.6101453	-60.0000000	CY				
0.0001394	13366.	95898695.	9.7918062	0.0013647	-0.0044890	
3.6589247	-60.0000000	CY				
0.0001444	13468.	93284662.	9.7247295	0.0014040	-0.0046597	
3.7046219	-60.0000000	CY				
0.0001494	13569.	90840501.	9.6631887	0.0014434	-0.0048303	
3.7472003	-60.0000000	CY				
0.0001544	13670.	88549614.	9.6066644	0.0014830	-0.0050007	
3.7866224	-60.0000000	CY				
0.0001594	13770.	86397485.	9.5547032	0.0015228	-0.0051710	
3.8228493	-60.0000000	CY				
0.0001644	13869.	84371358.	9.5069077	0.0015627	-0.0053411	
3.8558415	-60.0000000	CY				
0.0001694	13967.	82459983.	9.4629280	0.0016028	-0.0055110	
3.8855578	-60.0000000	CY				
0.0001744	14057.	80611252.	9.4170559	0.0016421	-0.0056817	
3.9113626	-60.0000000	CY				
0.0001794	14123.	78735611.	9.3627416	0.0016794	-0.0058543	
3.9327949	-60.0000000	CY				
0.0001844	14165.	76829348.	9.3003543	0.0017148	-0.0060290	
3.9503099	-60.0000000	CY				
0.0001894	14195.	74958289.	9.2360549	0.0017491	-0.0062047	
3.9647945	-60.0000000	CY				
0.0001944	14222.	73165370.	9.1741807	0.0017832	-0.0063805	
3.9767340	-60.0000000	CY				
0.0001994	14247.	71460382.	9.1160540	0.0018175	-0.0065562	
3.9862416	-60.0000000	CY				
0.0002044	14273.	69836835.	9.0614083	0.0018519	-0.0067318	
3.9932886	-60.0000000	CY				
0.0002094	14297.	68286031.	9.0082308	0.0018861	-0.0069077	
3.9978095	-60.0000000	CY				
0.0002144	14321.	66801551.	8.9555097	0.0019198	-0.0070839	
3.9998526	-60.0000000	CY				
0.0002194	14343.	65382556.	8.9058918	0.0019537	-0.0072600	
3.9943731	-60.0000000	CY				
0.0002244	14366.	64024966.	8.8591064	0.0019878	-0.0074360	
3.9982134	-60.0000000	CY				
0.0002294	14388.	62724986.	8.8149214	0.0020219	-0.0076118	
3.9999119	-60.0000000	CY				
0.0002344	14409.	61478170.	8.7733526	0.0020563	-0.0077875	
3.9934877	-60.0000000	CY				
0.0002394	14430.	60281787.	8.7340959	0.0020907	-0.0079630	
3.9975282	-60.0000000	CY				
0.0002444	14451.	59133029.	8.6969429	0.0021253	-0.0081384	
3.9996538	60.0000000	CY				
0.0002494	14471.	58028542.	8.6618939	0.0021601	-0.0083137	
3.9962549	60.0000000	CY				
0.0002544	14491.	56965639.	8.6288458	0.0021950	-0.0084888	
3.9952151	60.0000000	CY				
0.0002594	14510.	55941300.	8.5962344	0.0022296	-0.0086641	
3.9983848	60.0000000	CY				
0.0002644	14528.	54952791.	8.5634547	0.0022640	-0.0088398	
3.9998655	60.0000000	CY				
0.0002694	14546.	53999385.	8.5325109	0.0022984	-0.0090153	

3.9949231	60.0000000	CY				
0.0002744	14564.	53079505.	8.5031984	0.0023331	-0.0091907	
3.9942085	60.0000000	CY				
0.0003044	14664.	48177469.	8.3554440	0.0025432	-0.0102406	
3.9976016	60.0000000	CY				
0.0003344	14756.	44130029.	8.2460881	0.0027573	-0.0112865	
3.9980330	60.0000000	CY				
0.0003644	14841.	40728932.	8.1611888	0.0029737	-0.0123300	
3.9959096	60.0000000	CY				
0.0003944	14919.	37829694.	8.0915489	0.0031911	-0.0133726	
3.9880534	60.0000000	CY				
0.0004244	14993.	35330760.	8.0385240	0.0034113	-0.0144124	
3.9968463	60.0000000	CY				
0.0004544	15049.	33120196.	7.9936910	0.0036321	-0.0154516	
3.9949392	60.0000000	CY				
0.0004844	15083.	31138165.	7.9458239	0.0038488	-0.0164950	
3.9906472	60.0000000	CY				

Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain
1	0.025	14850.088	0.00300000

Note note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318-08, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are spirals or tied hoops.

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318-08, Section
9.3.2.2 or the value required by the design standard being followed.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Horizontal shear force at pile head = 15000.000 lbs
Applied moment at pile head = 6120000.000 in-lbs
Axial thrust load on pile head = 25.000 lbs

Depth X	Deflect. y	Bending Moment	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil Res. Spr. Distrib. p
Es*h	Lat. Load						
inches	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/in
lb/inch	lb/inch						
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0.00	0.5070	6120000.	15000.	-0.006621	0.000	1.426E+11
-299.0422	884.6696	0.000				
3.000	0.4874	6163655.	14099.	-0.006491	0.000	1.426E+11
-301.5980	1856.4760	0.000				
6.000	0.4681	6204595.	13191.	-0.006361	0.000	1.426E+11
-304.0139	1948.4230	0.000				
9.000	0.4492	6242799.	12275.	-0.006230	0.000	1.425E+11
-306.2876	2045.5345	0.000				
12.000	0.4307	6278247.	11353.	-0.006099	0.000	1.425E+11
-308.4170	2148.1971	0.000				
15.000	0.4126	6310919.	10425.	-0.005966	0.000	1.425E+11
-310.3998	2256.8340	0.000				
18.000	0.3949	6340797.	9490.9372	-0.005833	0.000	1.425E+11
-312.2336	2371.9088	0.000				
21.000	0.3776	6367866.	8551.7127	-0.005699	0.000	1.425E+11
-313.9161	2493.9307	0.000				
24.000	0.3607	6392109.	7607.6716	-0.005565	0.000	1.425E+11
-315.4446	2623.4592	0.000				
27.000	0.3442	6413512.	6659.2796	-0.005430	0.000	1.425E+11
-316.8167	2761.1107	0.000				
30.000	0.3281	6432065.	5707.0098	-0.005295	0.000	1.425E+11
-318.0298	2907.5655	0.000				
33.000	0.3125	6447755.	4751.3437	-0.005159	0.000	1.425E+11
-319.0810	3063.5755	0.000				
36.000	0.2972	6460574.	3792.7710	-0.005023	0.000	1.425E+11
-319.9675	3229.9740	0.000				
39.000	0.2823	6470513.	2831.7901	-0.004887	0.000	1.424E+11
-320.6864	3407.6854	0.000				
42.000	0.2679	6477565.	1868.9083	-0.004751	0.000	1.424E+11
-321.2347	3597.7384	0.000				
45.000	0.2538	6481727.	904.6423	-0.004614	0.000	1.424E+11
-321.6093	3801.2795	0.000				
48.000	0.2402	6482994.	-60.4818	-0.004478	0.000	1.424E+11
-321.8068	4019.5899	0.000				
51.000	0.2270	6481365.	-1025.9279	-0.004341	0.000	1.424E+11
-321.8240	4254.1042	0.000				
54.000	0.2141	6476839.	-1991.1498	-0.004205	0.000	1.424E+11
-321.6573	4506.4330	0.000				
57.000	0.2017	6469418.	-2955.5903	-0.004068	0.000	1.424E+11
-321.3031	4778.3890	0.000				
60.000	0.1897	6459106.	-4079.6749	-0.003932	0.000	1.425E+11
-428.0867	6769.1685	0.000				
63.000	0.1781	6444941.	-5569.9038	-0.003796	0.000	1.425E+11
-565.3993	9522.2807	0.000				
66.000	0.1669	6425687.	-7263.8207	-0.003661	0.000	1.425E+11
-563.8787	10133.	0.000				
69.000	0.1562	6401359.	-8952.6396	-0.003526	0.000	1.425E+11
-562.0006	10796.	0.000				
72.000	0.1458	6371972.	-10635.	-0.003391	0.000	1.425E+11
-559.7560	11518.	0.000				
75.000	0.1358	6337547.	-12311.	-0.003258	0.000	1.425E+11
-557.1356	12306.	0.000				
78.000	0.1262	6298109.	-13978.	-0.003125	0.000	1.425E+11
-554.1296	13168.	0.000				
81.000	0.1171	6253683.	-15635.	-0.002992	0.000	1.425E+11
-550.7281	14113.	0.000				
84.000	0.1083	6204300.	-17281.	-0.002861	0.000	1.426E+11
-546.9204	15152.	0.000				
87.000	0.0999	6149996.	-18916.	-0.002731	0.000	1.426E+11
-542.6953	16297.	0.000				
90.000	0.0919	6090807.	-20537.	-0.002603	0.000	1.426E+11
-538.0412	17564.	0.000				
93.000	0.0843	6026775.	-22143.	-0.002475	0.000	1.426E+11

-532.9454	18969.	0.000				
96.000	0.0771	5957947.	-23734.	-0.002349	0.000	1.427E+11
-527.3947	20534.	0.000				
99.000	0.0702	5884373.	-25307.	-0.002225	0.000	1.427E+11
-521.3749	22284.	0.000				
102.000	0.0637	5806106.	-26861.	-0.002102	0.000	1.427E+11
-514.8708	24247.	0.000				
105.000	0.0576	5723205.	-28395.	-0.001981	0.000	1.428E+11
-507.8660	26460.	0.000				
108.000	0.0518	5635734.	-29908.	-0.001861	0.000	1.428E+11
-500.3432	28967.	0.000				
111.000	0.0464	5543759.	-31397.	-0.001744	0.000	1.428E+11
-492.2834	31820.	0.000				
114.000	0.0414	5447354.	-32861.	-0.001628	0.000	1.429E+11
-483.6668	35086.	0.000				
117.000	0.0366	5346596.	-34298.	-0.001515	0.000	1.429E+11
-474.4718	38847.	0.000				
120.000	0.0323	5241567.	-35707.	-0.001404	0.000	1.430E+11
-464.6755	43206.	0.000				
123.000	0.0282	5132357.	-37085.	-0.001295	0.000	1.430E+11
-454.2541	48295.	0.000				
126.000	0.0245	5019058.	-38431.	-0.001189	0.000	1.431E+11
-443.1827	54282.	0.000				
129.000	0.0211	4901771.	-39743.	-0.001085	0.000	1.431E+11
-431.4366	61385.	0.000				
132.000	0.0180	4780600.	-41019.	-0.000983	0.000	1.432E+11
-418.9922	69891.	0.000				
135.000	0.0152	4655659.	-42256.	-0.000884	0.000	1.432E+11
-405.8299	80176.	0.000				
138.000	0.0127	4527065.	-43453.	-0.000788	0.000	1.433E+11
-391.9377	92743.	0.000				
141.000	0.0105	4394944.	-44606.	-0.000695	0.000	1.433E+11
-377.3195	108264.	0.000				
144.000	0.008509	4259427.	-45715.	-0.000604	0.000	1.434E+11
-362.0076	127633.	0.000				
147.000	0.006830	4120652.	-46778.	-0.000517	0.000	1.434E+11
-346.0855	152021.	0.000				
150.000	0.005409	3978762.	-47791.	-0.000432	0.000	1.435E+11
-329.7283	182876.	0.000				
153.000	0.004238	3833904.	-48756.	-0.000350	0.000	1.435E+11
-313.2695	221761.	0.000				
156.000	0.003307	3686227.	-49672.	-0.000272	0.000	1.436E+11
-297.3102	269691.	0.000				
159.000	0.002608	3535874.	-50542.	-0.000196	0.000	1.437E+11
-282.8637	325437.	0.000				
162.000	0.002129	3382976.	-51373.	-0.000152	0.000	6.930E+11
-271.4676	382460.	0.000				
165.000	0.001695	3227634.	-52169.	-0.000138	0.000	6.935E+11
-258.8554	458110.	0.000				
168.000	0.001303	3069962.	-52924.	-0.000124	0.000	6.941E+11
-244.6491	563358.	0.000				
171.000	0.000950	2910089.	-53633.	-0.000111	0.000	6.947E+11
-228.2062	720449.	0.000				
174.000	0.000635	2748162.	-54229.	-9.902E-05	0.000	6.952E+11
-168.8664	797257.	0.000				
177.000	0.000356	2584715.	-54626.	-8.752E-05	0.000	6.958E+11
-95.5141	804520.	0.000				
180.000	0.000110	2420408.	-54814.	-7.673E-05	0.000	6.964E+11
-29.8556	811784.	0.000				
183.000	-0.000104	2255833.	-54712.	-6.666E-05	0.000	6.970E+11
97.7034	2812500.	0.000				
186.000	-0.000290	2092137.	-54158.	-5.731E-05	0.000	6.975E+11
271.5350	2812500.	0.000				

```
   189.000  -0.000448   1930885.    -53121. -4.866E-05      0.000  6.981E+11
420.0598   2812500.      0.000
   192.000  -0.000582   1773413.    -51673. -4.070E-05      0.000  6.987E+11
545.2459   2812500.      0.000
   195.000  -0.000692   1620849.    -49881. -3.342E-05      0.000  6.991E+11
649.0155   2812500.      0.000
   198.000  -0.000782   1474126.    -47808. -2.678E-05      0.000  6.996E+11
733.2241   2812500.      0.000
   201.000  -0.000853   1334002.    -45522. -2.076E-05      0.000  7.002E+11
790.4251   2780038.      0.000
   204.000  -0.000907   1200991.    -43133. -1.533E-05      0.000  7.006E+11
802.6048   2655644.      0.000
   207.000  -0.000945   1075204.    -40713. -1.046E-05      0.000  7.010E+11
810.9617   2574584.      0.000
   210.000  -0.000969    956716.    -38272. -6.114E-06      0.000  7.014E+11
816.1761   2525710.      0.000
   213.000  -0.000982    845573.    -35819. -2.261E-06      0.000  7.019E+11
818.7432   2502156.      0.000
   216.000  -0.000983    741799.    -33363.  1.131E-06      0.000  7.021E+11
819.0359   2499586.      0.000
   219.000  -0.000975    645396.    -30908.  4.095E-06      0.000  7.023E+11
817.3413   2515264.      0.000
   222.000  -0.000958    556350.    -28461.  6.661E-06      0.000  7.027E+11
813.8850   2547534.      0.000
   225.000  -0.000935    474628.    -26027.  8.861E-06      0.000  7.031E+11
808.8463   2595523.      0.000
   228.000  -0.000905    400186.    -23610.  1.073E-05      0.000  7.033E+11
802.3680   2658979.      0.000
   231.000  -0.000871    332965.    -21215.  1.229E-05      0.000  7.033E+11
794.5623   2738193.      0.000
   234.000  -0.000832    272895.    -18854.  1.358E-05      0.000  7.033E+11
779.5601   2812500.      0.000
   237.000  -0.000789    219842.    -16575.  1.463E-05      0.000  7.033E+11
739.7218   2812500.      0.000
   240.000  -0.000744    173446.    -14420.  1.547E-05      0.000  7.033E+11
697.2460   2812500.      0.000
   243.000  -0.000696    133325.    -12395.  1.613E-05      0.000  7.033E+11
652.6895   2812500.      0.000
   246.000  -0.000647     99078.    -10506.  1.662E-05      0.000  7.033E+11
606.5334   2812500.      0.000
   249.000  -0.000596     70290. -8757.1966  1.698E-05      0.000  7.033E+11
559.1888   2812500.      0.000
   252.000  -0.000545     46535. -7151.9121  1.723E-05      0.000  7.033E+11
511.0009   2812500.      0.000
   255.000  -0.000493     27379. -5692.0287  1.739E-05      0.000  7.033E+11
462.2547   2812500.      0.000
   258.000  -0.000441     12383. -4378.8766  1.748E-05      0.000  7.033E+11
413.1801   2812500.      0.000
   261.000  -0.000388  1105.2909 -3213.1712  1.750E-05      0.000  7.033E+11
363.9569   2812500.      0.000
   264.000  -0.000336 -6896.4179 -2195.1552  1.749E-05      0.000  7.033E+11
314.7204   2812500.      0.000
   267.000  -0.000283    -12066. -1324.7245  1.745E-05      0.000  7.033E+11
265.5667   2812500.      0.000
   270.000  -0.000231    -14845.  -601.5379  1.739E-05      0.000  7.033E+11
216.5577   2812500.      0.000
   273.000  -0.000179    -15675.   -25.1110  1.733E-05      0.000  7.033E+11
167.7269   2812500.      0.000
   276.000  -0.000127    -14995.   405.1054  1.726E-05      0.000  7.033E+11
119.0840   2812500.      0.000
   279.000 -7.533E-05    -13244.   689.6631  1.720E-05      0.000  7.033E+11
70.6211   2812500.      0.000
   282.000 -2.380E-05    -10857.   829.0703  1.715E-05      0.000  7.033E+11
```



```
22.3171   2812500.      0.000
   285.000  2.758E-05 -8269.8239   847.8436  1.711E-05      0.000  7.033E+11
-9.8016   1066141.      0.000
   288.000  7.886E-05 -5770.4015   790.8166  1.708E-05      0.000  7.033E+11
-28.2164   1073410.      0.000
   291.000   0.000130 -3524.9266   678.2123  1.706E-05      0.000  7.033E+11
-46.8531   1080680.      0.000
   294.000   0.000181 -1701.1301   509.3501  1.705E-05      0.000  7.033E+11
-65.7217   1087950.      0.000
   297.000   0.000232  -468.8288   283.5221  1.705E-05      0.000  7.033E+11
-84.8303   1095219.      0.000
   300.000   0.000283      0.000      0.000  1.704E-05      0.000  7.033E+11
-104.1845    551245.      0.000

* This analysis makes computations of pile response using nonlinear moment-curvature
relationships.
  The above values of total stress are computed for combined axial stress and do not
equal the
  actual stresses in concrete and steel in the range of nonlinear bending.


Output Verification: Computed forces and moments are within specified convergence
limits.


Output Summary for Load Case No. 1:

Pile-head deflection             =      0.5070405 inches
Computed slope at pile head      =     -0.0066206 radians
Maximum bending moment           =      6482994. inch-lbs
Maximum shear force              =       -54814. lbs
Depth of maximum bending moment  =     48.0000000 inches below pile head
Depth of maximum shear force     =    180.0000000 inches below pile head
Number of iterations             =             70
Number of zero deflection points =              2



---------------------------------------------------------------------------------
                          Summary of Pile Response(s)
---------------------------------------------------------------------------------


Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians


Load  Load    Condition 1    Condition 2        Axial        Pile-Head       Maximum
       Maximum       Pile-Head
Case  Type    V(lbs) or     in-lb, rad.,        Load        Deflection       Moment
        Shear         Rotation
 No.   No.    y(inches)     or in-lb/rad.        lbs          inches         in-lbs
         lbs          radians
----  ----  --------------  --------------  -------------  -------------
-------------  -------------  -------------
  1     1   V =     15000.  M =   6120000.    25.00000000     0.50704045
6482994.        -54814.    -0.00662060
```

42 inch Dia CIDH demand

The analysis ended normally.

Appendix H.3

Addendum 2 to Geotechnical Exploration Report

ADDENDUM NO. 2 TO GEOTECHNICAL EXPLORATION REPORT RESPONSE TO REVIEW COMMENTS OFF-SEASON TWO IMPROVEMENTS JOHN ANSON FORD THEATERS 2580 CAHUENGA BOULEVARD EAST HOLLYWOOD DISTRICT OF LOS ANGELES, CALIFORNIA

Prepared for

Ford Theatre Foundation

2580 Cahuenga Boulevard East
Hollywood, California 90068

Project No. 10296.002

February 27, 2014

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

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February 27, 2014

Project No. 10296.002

Ford Theatre Foundation
2580 Cahuenga Boulevard East
Hollywood, California 90068

Attention: Mr. Mohammad Saeid, CCM Senior Project Manager

Subject: Addendum No. 2 to Geotechnical Exploration Report
Response to Review Comments
Off-Season Two Improvements
John Anson Ford Theaters
2580 Cahuenga Boulevard East
Hollywood District of Los Angeles, California

Leighton Consulting, Inc. (Leighton) is pleased to present this second addendum to the referenced geotechnical exploration report (Leighton, 2013b) responding to review comments from the County of Los Angeles Department of Public Works (County).

This addendum responds to comments in the Geologic Review Sheet from the Geotechnical and Materials Engineering Division (GMED), dated December 24, 2013; comments in the Soils Engineering Review Sheet from GMED, dated December 11, 2013; and Comment Nos. 46, 47, and 55 from the Building and Safety Division (Plan Check No. BL1311250035), dated December 18, 2013. Copies of the referenced review sheets are included in Appendix A. For the ease of reference, the comments are presented below in italics before our responses.

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RESPONSES TO GEOLOGIC REVIEW SHEET

Comment

The geotechnical consultants provide recommendations for rockfall and debris flow protection/mitigation, none of which appear to have been incorporated into the plans submitted to this office.

The project manager and developer/owner should determine if protecting the facility from these hazards is within the scope of the proposed work, and if so, should have the consultant's recommendations incorporated into the plans. If it is determined that protecting the facility from these hazards is not within the scope of work for this project, then it must be understood by all parties that these hazards will continue to affect the facility.

Response to Comment

We understand that our recommendations for rockfall and debris hazard mitigation will be incorporated into future plans. Leighton will review the plans and document their general conformance with our recommendations.

RESPONSES TO SOILS ENGINEERING REVIEW SHEET

Comment No. 1

Provide original copies of the Leighton report dated 2/7/13 and 7/12/13 to the Soils Engineering Section for review. These reports are referenced on the submitted plans however were not provided for our review. Additional comments may arise once the requested information is provided.

Response to Comment No. 1

The requested reports along with Leighton (2013b) and Leighton (2013c) are included in the enclosed CD-ROM. The July 12, 2013 report was a draft version of Leighton (2013b).

Comment No. 2

Provide calculations and recommendations for seismic earth pressure for all retaining walls with retained heights greater than 6 feet. Per County policy, the seismic loading for retaining walls with retained heights greater than 6 feet must be derived from the peak ground acceleration at the subject site. Verify and provide calculations and recommendations as necessary.

Response to Comment No. 2

The requested recommendations are presented in Leighton (2013b). It was our understanding that the project falls under the 2010 California Building Code and 2011 County of Los Angeles Building Code. Accordingly, the recommended seismic increment of 20 pounds per cubic foot (page 31 of Leighton, 2013b) was based on 50 percent of the site ground acceleration per Section 3.5.14 of the County's 2010 Manual for Preparation of Geotechnical Reports.

Calculations are included in Appendix B. We used a friction angle of 33 degrees with a cohesion intercept of zero. See our response to Comment No. 7 below for further discussion on shear strength parameters.

Comment No. 3

Provide calculations for the surcharge loads recommended in the soils report.

Response to Comment No. 3

Surcharge loads were based on an at-rest horizontal earth pressure coefficient of 0.5. Actual surcharge pressures are anticipated to range between induced active and at-rest pressures. Accordingly, the recommended coefficient of 0.5 (half of bearing pressure) is deemed appropriately conservative.

Comment No. 4

Clarify which of the proposed retaining walls will be designed with additional surcharge load due to stacked (upslope) retaining walls. Show and identify these retaining walls on the plans and geotechnical map.

Response to Comment No. 4

The subject terraced (stacked) landscape planter and retaining walls are located behind the stage in the main amphitheater and were shown on plan view on Plate 2 of Leighton (2013b) and in cross-section on Plate 4 of Leighton (2013b), and reproduced herein as Figures 1a and 1b for ease of reference. The stacked walls are clouded and identified on Figures 1a and 1b.

As stated in Leighton (2013b), only the new basement wall immediately adjacent to the lowermost stacked wall will be designed to accommodate surcharge. The surcharge loading of 50 pounds per cubic foot was calculated based on an equivalent sloped backfill (Appendix C).

Comment No. 5

Provide a table with all the retaining walls, basement walls, and the design lateral earth pressures. Include the expected surcharge loading and seismic loading for each wall. Add the table to the plans.

Response to Comment No. 5

All walls are to be designed to accommodate the earth pressures recommended in Leighton (2013b) and surcharge pressures recommended in Leighton (2013c). Final dimensioning and tallying of retaining walls will be performed by others and reviewed by Leighton for conformance with Leighton recommendations.

Comment No. 6

Discuss and address the Soils Nail shoring system shown on the shoring plans. Provide calculations and analyses that show the proposed soil nail wall shoring system will meet the County minimum factors of safety. Specify the soil nails which will be tested. Per the submitted shoring plans, the geotechnical engineer must observe all proof and performance tests and clarify soil types. The soils engineer must discuss and verify existing soil conditions and provide recommendations and conclusions and/or provide appropriate modifications.

Response to Comment No. 6

Soil nail design calculations are included herein as Appendix D.

Five percent of the soil nails will be proof tested. In general, every 20th anchor will be proof tested in sequence. Proof testing will be performed out of sequence if necessary to obtain a relatively uniform area distribution of test anchors.

In addition, two anchors will be performance tested. We currently anticipate testing one of the top row anchors shown on Sheets ES-2 and ES-6 of shoring drawings in Appendix D.

Comment No. 7

Provide direct shear test data results which substantiate the shear strengths utilized in the Soil Nail system. Provide boring logs and the locations of soil samples of the shear tests.

Response to Comment No. 7

The shear strengths utilized in the soil nail wall design were based on parameters used for slope stability analysis in Leighton (2013a). These shear strength parameters were generally based on the group mean values listed in CDMG (1998)[1]. Pertinent pages from the reference are included in Appendix E.

Comment Nos. 8 to 10

These comments pertain to required additions to design drawings, which are being addressed by others.

Comment No. 11

The Soils Engineer of record must review the building plans and sign and stamp the plans in verification of his recommendations. Original manual signature and wet stamp are required.

[1] California Division of Mines and Geology (CDMG), 1998, State of California Seismic Hazard Zones Report, Hollywood 7.5-Minute Quadrangle, scale 1:24,000.

Response to Comment No. 11

Acknowledged. Leighton will review, sign, and stamp the final plans.

Comment No. 12

This comment pertains to submittal of revised drawings, which is being addressed by others.

Comment No. 13

Requirements of the Geology Section are attached.

Response to Comment No. 13

Acknowledged.

Comment No. 14

Include a copy of this review sheet with your response.

Response to Comment No. 14

Acknowledged. The review sheet is included in Appendix A.

RESPONSES TO BUILDING AND SAFETY REVIEW SHEET

Comment No. 46

Update the soils report references, include all reports.

Response to Comment No. 46

Acknowledged.

Comment No. 47

Have the consulting soils/geotechnical engineer review and approve the foundation plans, shoring plans and details (106.4.3).

Response to Comment No. 46

Acknowledged. Leighton will review, and upon acceptance will sign and stamp the final plans. Additional recommendations, if any, will be provided at that time.

Comment No. 55

The soils report does not contain recommendation for the soil nail and the shoring design is based on the soil nail and shotcrete. Provide recommendations for the soil nail from the soil engineer or revise the shoring design per the soils report. The shoring design is not checked at this time. Resubmit the revised shoring design or revised soils report for shoring plan check. Additional corrections may follow.

Response to Comment No. 55

Acknowledged. Shoring design had not been started at the time Leighton (2013a) and Leighton (2013b) were published. We have reviewed the shoring design in Appendix D and it is in general conformance with our recommendations. Leighton will review, sign, and stamp the final plans.

CLOSURE

Leighton appreciates the opportunity to be of continued service to the Ford Theater Foundation on this project. Should you have any questions regarding this report, or if we may be of further assistance, please contact us at your convenience. The undersigned may be reached at (213) 892-1530.



Respectfully submitted,

LEIGHTON CONSULTING, INC.

Joe A. Roe, CEG 2456
Senior Project Geologist



Carl C. Kim, GE 2620
Senior Principal Engineer

JAR/CCK/lr

Attachments: References
Figures 1a and 1b
Appendix A – County of Los Angeles Review Sheets
Appendix B – Seismic Increment of Earth Pressure
Appendix C – Surcharge from Stacked Walls
Appendix D – Shoring Design
Appendix E – Reference for Shear Strength Parameters

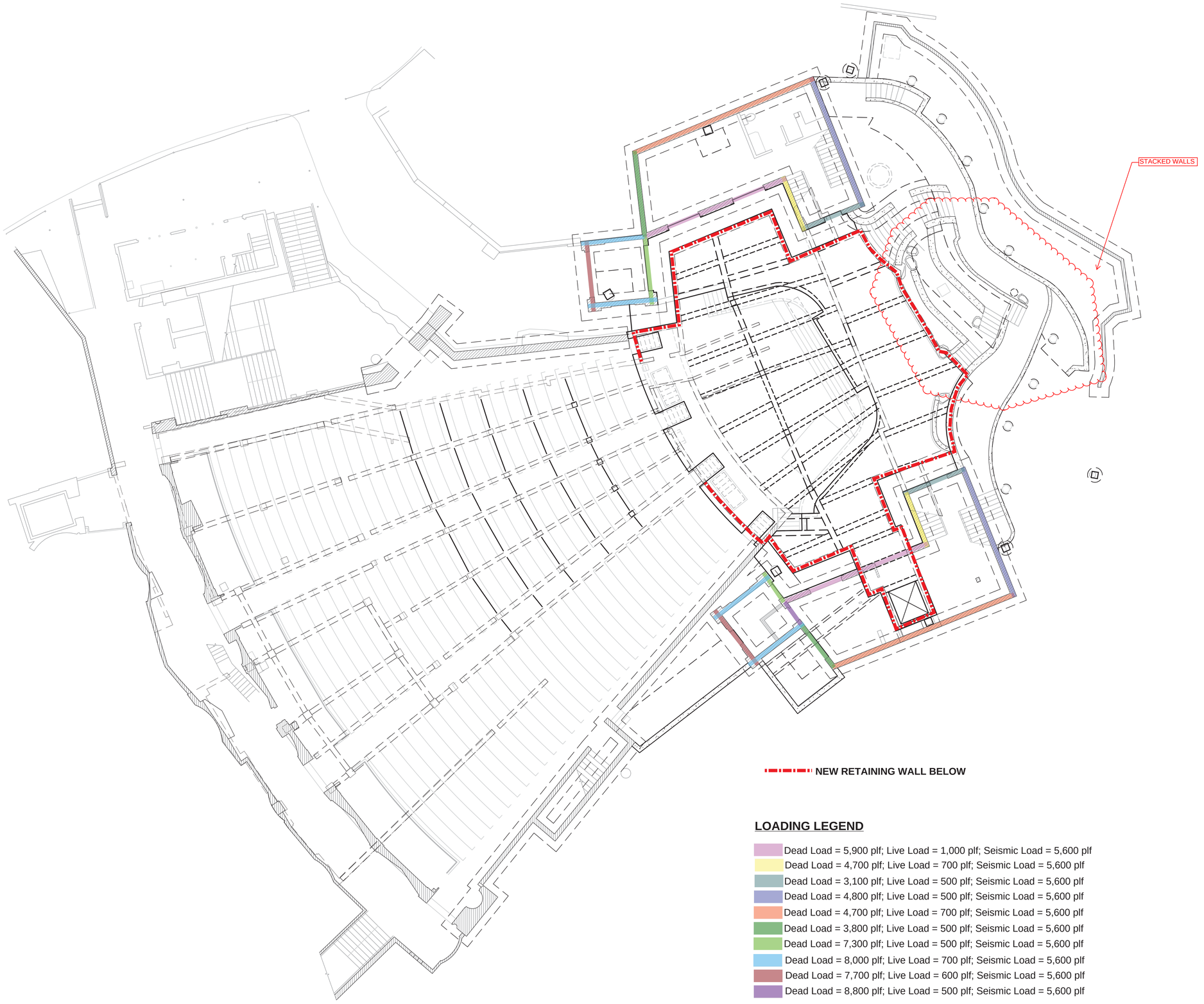
Distribution: (1) Addressee
(1) County of Los Angeles Department of Public Works

References

Leighton Consulting, Inc., 2013a, Preliminary Geotechnical Evaluation, John Anson Ford Theaters Master Plan, 2580 Cahuenga Boulevard East, Hollywood District of Los Angeles, California, dated February 7.

Leighton Consulting, Inc., 2013b, Geotechnical Exploration Report Off-Season Two Improvements, 2580 Cahuenga Boulevard East, Hollywood District of Los Angeles, California, dated September 10.

Leighton Consulting, Inc., 2013c, Addendum to Geotechnical Exploration Report Off-Season Two Improvements, John Anson Ford Theater 2580 Cahuenga Boulevard East, Hollywood District of Los Angeles, California, dated October 15.



NEW RETAINING WALL BELOW

LOADING LEGEND

- Dead Load = 5,900 plf; Live Load = 1,000 plf; Seismic Load = 5,600 plf
- Dead Load = 4,700 plf; Live Load = 700 plf; Seismic Load = 5,600 plf
- Dead Load = 3,100 plf; Live Load = 500 plf; Seismic Load = 5,600 plf
- Dead Load = 4,800 plf; Live Load = 500 plf; Seismic Load = 5,600 plf
- Dead Load = 4,700 plf; Live Load = 700 plf; Seismic Load = 5,600 plf
- Dead Load = 3,800 plf; Live Load = 500 plf; Seismic Load = 5,600 plf
- Dead Load = 7,300 plf; Live Load = 500 plf; Seismic Load = 5,600 plf
- Dead Load = 8,000 plf; Live Load = 700 plf; Seismic Load = 5,600 plf
- Dead Load = 7,700 plf; Live Load = 600 plf; Seismic Load = 5,600 plf
- Dead Load = 8,800 plf; Live Load = 500 plf; Seismic Load = 5,600 plf

FIGURE 1a

OFF-SEASON TWO IMPROVEMENTS

John Anson Ford Theatres
2580 Cahuenga Boulevard East
Hollywood, California 90068

Levin & Associates Architects
811 West Seventh Street, Suite 900
Los Angeles, California 90017
213.623.8141 Fax 213.623.9207

STRUCTURAL FOCUS
19210 S. VERMONT AVENUE
BUILDING B, SUITE 210
GARDENA, CALIFORNIA 90248
TEL: 310.323.9924
FAX: 310.323.9925

REGISTERED PROFESSIONAL ENGINEER
DAVID W. COOKE
No. S3005
Exp. 6/30/14
STRUCTURAL
STATE OF CALIFORNIA

NOT FOR CONSTRUCTION

Issued For:

SCHEMATIC DESIGN	04/26/13
DESIGN DEVELOPMENT	08/08/13

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Sheet Title

Scale:

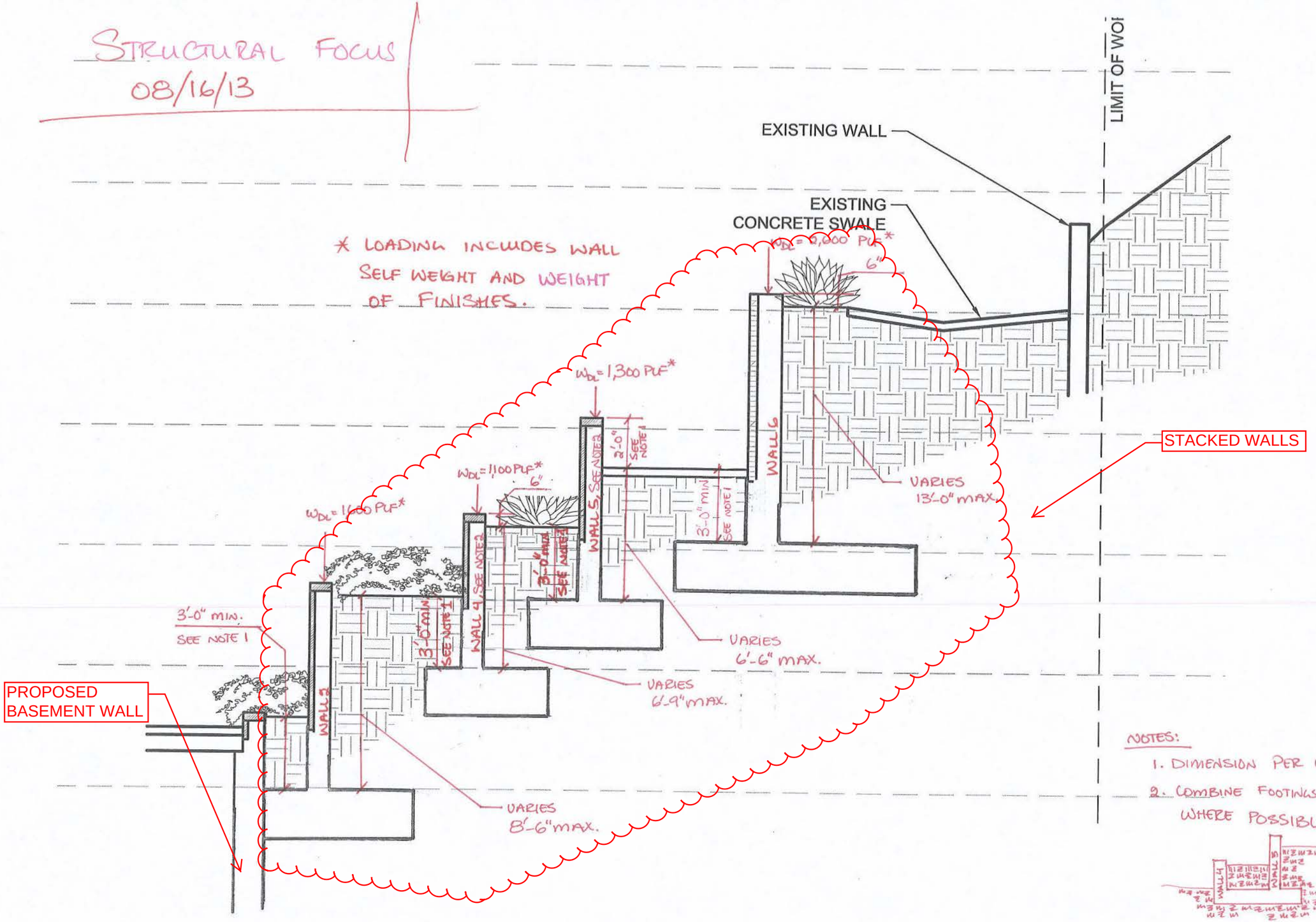
Date	Project Number
	13023

CAD File

Sheet Number

STRUCTURAL FOCUS
08/16/13

* LOADING INCLUDES WALL SELF WEIGHT AND WEIGHT OF FINISHES.



NOTES:
1. DIMENSION PER LANDSCAPE REQUIREMENTS.
2. COMBINE FOOTINGS FOR WALL 4 & 5 WHERE POSSIBLE.

STACKED SITE RETAINING WALL SECTION

FIGURE 1b

APPENDIX A

Dist. Office 99.01

Sheet 1 of 1

County of Los Angeles Department of Public Works
GEOTECHNICAL AND MATERIALS ENGINEERING DIVISION
GEOLOGIC REVIEW SHEET
900 So. Fremont Ave., Alhambra, CA 91803
TEL. (626) 458-7984

DISTRIBUTION
1 Dist. Office
__ Geologist
1 Soils Engineer
1 GMED File
__ LDD - Grading

Tract / Parcel Map		**Lot(s)**	
Parent Tract		**Location**	Los Angeles
Site Address	2580 Cahuenga Blvd	**APN**	5577-025-904
Geologist	Leighton Consulting	**Developer/Owner**	County of Los Angeles
Soils Engineer	Leighton Consulting	**Engineer/Arch.**	Structural Focus / Levin & Assoc.

Building P.C. No. 1310240093 & 1311250035 For: Rehab portions of amphitheater & retaining walls
Geologic Report(s) Dated
Soils Engineering Report(s) Dated 10/15/13
Geology and Soils Engineering Report(s) Dated 9/10/13
Additional Reports Reviewed

Action: Plan is not recommended for approval for reasons below.

Remarks/Conditions:

The geotechnical consultants provide recommendations for rockfall and debrisflow protection/mitigation, none of which appear to have been incorporated into the plans submitted to this office.

The project manager and developer/owner should determine if protecting the facility from these hazards is within the scope of the proposed work, and if so, should have the consultant's recommendations incorporated into the plans. If it is determined that protecting the facility from these hazards is not within the scope of work for this project, then it must be understood by all parties that these hazards will continue to affect the facility.

Requirements of the Soils Engineering Section dated 12/11/13 are attached

Prepared by  Reviewed by _____ Date 12/24/13
Charles Nestle

Please complete a Customer Service Survey at http://dpw.lacounty.gov/go/gmedsurvey

COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
GEOTECHNICAL AND MATERIALS ENGINEERING DIVISION

SOILS ENGINEERING REVIEW SHEET

Address: 900 S. Fremont Ave., Alhambra, CA 91803
Telephone: (626) 458-4925
Fax: (626) 458-4913

District Office 99.01
Job Number GMBPRR

Review No. 1

John Anson Ford Theater
Restoration and Rehabilitation of Amphitheater
Replace Stage and New Below Stage - Basement Walls, Retaining Walls, Piles, Shoring

Location	2580 Cahuenga Boulevard, East Los Angeles
Developer/Owner	County of Los Angeles
Engineer/Architect	Structural Focus / Levin and Associates Architects
Soils Engineer	Leighton Consulting, Inc. (10296.001)
Geologist	-----

DISTRIBUTION:

___	Drainage
___	Grading
1	Geo/Soils Central File
___	District Engineer
___	Geologist
1	Soils Engineer
1	Engineer/Architect

Building Plan Check No. 1310240093, 1311250035

Review of:
Building Plan Dated By Processing Center **11/25/13, 9/10/13**
Soils Engineering Report Dated **10/15/13**

ACTION:

Building plan is not recommended for approval.

REMARKS:

1. Provide original copies of the Leighton report dated 2/7/13 and 7/12/13 to the Soils Engineering Section for review. These reports are referenced on the submitted plans however were not provided for review. Additional comments may arise once the requested information is provided.

2. Provide calculations and recommendations for seismic earth pressure for all retaining walls and basement walls with retained height greater than 6 feet. Per County policy, the seismic loading for retaining walls with a retained height greater than 6 feet must be derived from the peak ground acceleration at the subject site. Verify and provide calculations and recommendations, as necessary.

3. Provide calculations for the surcharge loads recommended in the soils report.

4. Clarify which of the proposed retaining walls will be designed with additional surcharge load due to stacked (upslope) retaining walls. Show and identify these retaining walls on the plans and on the geotechnical map.

5. Provide a table with all of the retaining walls, basement walls, and the design lateral earth pressures. Include the expected surcharge loading and seismic loading for each wall. Add the table to the plans.

6. Discuss and address the Soils Nail shoring system shown on the Shoring Plans. Provide calculations and analyses that show the proposed soil nail wall shoring system will meet County minimum factors of safety. Specify the soil nails which will be tested. Per the submitted shoring plans, the geotechnical engineer must observe all proof and performance tests and clarify soil types. The soils engineer must discuss and verify existing soils conditions and provide recommendations and conclusions and/or provide appropriate modifications.

7. Provide direct shear test data results which substantiate the shear strengths utilized in the Soil Nail system. Provide boring logs and the locations of soil samples of the shear tests.

8. Show the following on the Building plans:
   a. Indicate all relevant soils reports by the Soils Engineer of record. The latest soils reports submitted are not shown on the plans.
   b. Existing and proposed grades.
   c. Show table of retaining walls with design earth pressures recommended by the Soils Engineer. See Remark 5 above.
   d. Provide reference to the submitted Shoring Plans.
   e. All standard notes regarding fill compaction and density testing requirements, as necessary.
   f. All recommended mitigation measures, as necessary.

9. Show the following on the Shoring Plans:
   a. Indicate the Soils Engineer of record and all relevant soils reports by the Soils Engineer of record.
   b. Provide foundation details for the Soil Nail shoring system.
   c. Specify the soil nails which will be proof and performance tested.
   d. All recommended mitigation measures, as necessary.

COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
GEOTECHNICAL AND MATERIALS ENGINEERING DIVISION

SOILS ENGINEERING REVIEW SHEET

Building Plan Check No. 1310240093, 1311250035

10. Add the following notes on the building plans:
    The Soils Engineer of record shall inspect and approve the foundation excavations before steel or concrete is placed.
11. The Soils Engineer of record must review the building plans and sign and stamp the plans in verification of his recommendations. Original manual signature and wet stamp are required.
12. Submit two sets of revised plans to the Soils Section for verification of compliance with County codes and policies.
13. Requirements of the Geology Section are attached.
14. Include a copy of this review sheet with your response.

NOTE TO THE PLAN CHECKER/BUILDING AND SAFETY DISTRICT ENGINEER:
THE ON-SITE SOILS ARE MODERATELY CORROSIVE TO FERROUS METALS.

REGISTERED PROFESSIONAL ENGINEER
YOSHIYA MORISAKU
No. 67587
Exp. 6/30/15
CIVIL
STATE OF CALIFORNIA

Reviewed by Yoshiya Morisaku Date 12/11/13

Yoshiya Morisaku

NOTICE: Public safety, relative to geotechnical subsurface exploration, shall be provided in accordance with current codes for excavations, inclusive of the Los Angeles County Code, Chapter 11.48, and the State of California, Title 8, Construction Safety Orders.

COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
BUILDING AND SAFETY DIVISION

NON-RESIDENTIAL
PLAN REVIEW LIST

GENERAL PROJECT INFORMATION

PLAN CHECK NO. BL1311250035 DISTRICT NO _____ INITIAL VALUATION $12.9 mil

JOB ADDRESS 2580 E Cahuenga Bl CITY Hollywood ZIP _____

OWNER County of LA TELEPHONE ( ) _____

ARCHITECT Brenda Levin TELEPHONE ( ) _____

ENGINEER _____ TELEPHONE ( ) _____

APPLICANT Robert Stone TELEPHONE (213) 623-8141

ADDRESS _____ CITY _____ ZIP _____

PROJECT INFORMATION

USE ZONE _____ CLIMATE ZONE _____ VHFHSZ: ☐YES ☐NO FLOOD ZONE: ☐YES ☐NO

BUILDING ELEMENT	SQ. FT.	NO. OF STORIES	CONSTR. TYPE	OCC. GROUP	$ / SQ. FT.	$ VALUE
Ford Theater		2	II-B			
				New Valuation:		

PROJECT DESCRIPTION

Repair and addition to Ford Theater.

FIRE SPRINKLER AND CONSTRUCTION INFORMATION

FIRE SPRINKLER ☑YES ☐NO

PLAN CHECK ENGINEER AND CORRECTION INFROMATION

REVIEWED BY Jae Lee DATE 12-18-2013 TELEPHONE 626-458-6389

RECHECKED BY _____ DATE _____ TELEPHONE _____

RECHECKED BY _____ DATE _____ TELEPHONE _____

APPROVED BY _____ DATE _____ TELEPHONE _____

Your application for a permit, together with plans and specifications, has been examined and you are advised that the issuance of a permit is withheld for the reasons hereinafter set forth. The approval of plans and specifications does not permit the violation of any section of the Building Code, or other local ordinance or state law.

NOTE: Numbers in the parenthesis ( ) refer to sections of the 2011 edition of the County of Los Angeles Building Code (LACBC), Table (T), Plumbing Code (PC), Mechanical Code (MC), Electrical Code (EC), Fire Code (FC), or Building Code Manual (B.C.M.), 2005 National Design Specifications (NDS), 2008 AF&PA Special Design Provisions for Wind and Seismic (SDPWS), 2005 Minimum Design Loads for Buildings and Other Structures including Supplement No. 1 (ASCE7). For County of Los Angeles Building Code Amendments and B.C.M.s, visit www.dpw.lacounty.gov/bsd.

INSTRUCTIONS

- All corrections apply to this plan check.
- In the left-hand margin of the circled corrections, please indicate the sheet number and detail or note number on the plans where the corrections are made. Resubmit marked original plans and two corrected sets of plans, calculations and this plan review list.
- Incomplete, unclear, or faded drawings or calculations will not be accepted.
- The plan check engineer will be available for conference and telephone calls between the hours of 9 AM and 3 PM on the following days: Tue and Thurs. **Appointments are recommended**. Incorporate all comments as marked on checked set of plans and calculations and these correction sheets.

GENERAL REQUIREMENTS

APPLICATION AND PERMIT

1. A separate application and permit(s) is/are required for: (106.1)
   a. Electrical work
   b. Mechanical work
   c. Plumbing work
2. The permit application must be signed by the property owner, or licensed contractor, or authorized agent at the time the permit is to be issued:
   a. For owner-builder permits: Owners' signature must be verified by notarization or personal identification.
   b. For contractor building permits: Prior to the issuance of a building permit, the contractor shall have the following:
      i. A certificate of workers Compensation Insurance made out to the Contractors State License Board.
      ii. Notarized letter of authorization for agents.
      iii. Copy of Contractors State License or pocket ID.

REFERRALS

(issued by Ben Ling during prior meeting) ← NOT RECEIVED BY LBA

ALL AGENCY APPROVALS are required prior to permit issuance. Please see the attached agency referral sheet for details.

3. (Soil)(Foundation)(Geology) report(s) must be approved by the Geotechnical & Materials Engineering Division. Provide a copy of approved report and Department approval letter.
4. A Grading Permit may be / is required and a separate grading permit application may need to be processed. Contact Drainage & Grading Section of Building and Safety Division to determine if a grading permit is required. (Appendix J103)

   A grading permit is required for the following:
   a. All excavations exceeding 2-ft. in depth (except for footings, basements and retaining walls). Note: the placement of excess material from such excavations may require a grading permit.
   b. All fills:
      i. Intended to support structures.
      ii. That obstructs or diverts a drainage course.
      iii. One foot or more in depth placed on natural slopes steeper than 5 units horizontal to 1 unit vertical.
      iv. 3-ft. or more in depth at its deepest point and greater than 50 cubic yards.
      v. 5-ft. or more in depth at its deepest point and greater than 20 cubic yards.
   c. The grading of access roads or pads for exploratory excavations.
5. Rough grading approval is required before a building permit can be issued. (Appendix J105.7)

SUPPLEMENTAL PLAN REVIEW COMMENTS/SHEETS

6. Refer to the attached sheets for supplemental plan review comments:
   a. Solid Waste Disposal
   b. Non-residential Green Building Standards Code Review
7. Photocopy/blueprint the following on the plans: (Do NOT staple to the plans)
   a. Best Management Practice for Construction Activity (Attachment A) requirements

AREA, OCCUPANCY, AND CONSTRUCTION

8. Specify the type of construction on the Title Sheet.
9. The basic allowable building area is 8500 SF per Table 503. Justify and provide allowable building area analysis on the plan.

MEANS OF EGRESS

10. Provide required head room: 6'8" at the stairs and 7'6" at exit path.
11. Provide details for all stairway showing the following: (1009, 1012)

a. Maximum 7-in., minimum 4-in. rise and minimum 11-in. run (tread).
b. The tolerance between the largest and smallest riser height and/or tread depth shall not exceed 0.375-in. in any flight of stairs.
c. Minimum headroom over the stairs 6-ft. 8-in.
d. Minimum 44-in. clear width.
e. Provide handrails at both sides. The handrail height shall be 34-in. to 38-in. above the nosing, with 1-1/2-in. clearance to the wall, and ends returned to the wall. Open handrails shall have intermediate rails or an ornamental pattern such that a 4-in. sphere in diameter cannot pass through.
f. Handgrip portion of handrails shall not be less than 1-1/4-in. nor more than 2-in. in cross-sectional dimension having a smooth surface with no sharp corners.
g. Stairway framing, connections, bracings, and footings.
h. One-hour construction for the enclosed usable space under the stairs.

12. Provide Exit signs.
13. Exit signs shall be internally or externally illuminated. Internally illuminated exit signs shall be listed and labeled in accordance with UL 924 and shall be installed in accordance with the manufacturer's instructions and Chapter 27. Externally illuminated exits signs shall comply with the graphics and power source requirements in Sections 1011.5.1 and 1011.5.3, respectively. When the face of an exit sign is illuminated from an external source, it shall have an intensity of not less than 5-foot-candles (54 lux).(1011.2)
14. Note on the plans: "Any time a building or a portion of a building is occupied, the means of egress serving the occupied portion shall be illuminated at an intensity of not less than 1-foot-candle (11 lux) at the walking surface level." (1006)
15. The power supply for means of egress illumination shall be provided by the premise's electrical supply. In the event of power supply failure, illumination shall be automatically provided from an emergency system for the following areas: (1006.3)
    a. Aisles and unenclosed egress stairways in rooms and spaces that require two or more means of egress.
    b. Corridors, exit enclosures, and exit passageways in buildings required to have two or more exits.
    c. Exterior egress components at other than the level of exit discharge until exit discharge is accomplished for buildings required to have two or more exits.
    d. Interior exit discharge elements, as permitted in Section 1027.1, in buildings required to have two or more exits.
    e. Exterior landings, as required by Section 1008.1.6, for exit discharge doorways in buildings required to have two or more exits.
16. The exit signs shall also be connected to an emergency electrical system which is to provide continued illumination for a duration of not less than 1-1/2 hr. in case of primary power loss. Continued illumination is to be provided from storage batteries, unit equipment, or an on-site generator and the installation of the emergency power system shall be installed in accordance with Chapter 27. (1006.3)
17. Emergency lighting facilities shall be arranged to provide initial illumination that is at least an average of 1-foot-candle (11 lux) and a minimum at any point of 0.1-foot-candle (1 lux) measured along the path of egress at floor level. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded. (1006.4)
18. Egress doors or gates shall be openable from the egress side without the use of a key, special knowledge, or effort. Door handles, pulls, latches, locks, and other operating devices shall be installed 34 to 48 in. above the finished floor. Manually operated flush bolts or surface bolts are not permitted. The unlatching of any door or leaf shall not require more than one operation. (1008.1.9)
19. Plans must indicate / detail the floor or landing on each side of doors is not more than 1/2-in. lower than the threshold of the doorway. Raised thresholds and floor level changes greater than 1/4-in. at doorways shall be beveled with a slope not greater than one unit vertical in two units horizontal (50% slope). (1008.1.7)

FIRE DAMPERS, DUCTS AND RETURN AIR PLENUMS

20. Fire and smoke dampers to be installed at penetrations in the following locations: (716.5)
    a. fire barrier,

GENERAL REQUIREMENTS

21. Obtain architect's and engineer's stamp and signature on the plan include soils engineer.
22. Update code reference to LACBC.
23. Identify historical stairs and guardrails on the plan.
24. Submit a modification for use of non-complying ramp to Research Section, Jonathan Lam at 626-458-6352, for approval.

25. Provide 45 min door at 1 hour fire barrier.
26. Provide panic hardware at the door from an electrical room with more than 1200 A.
27. Provide 1 hour separation from each other: dressing rooms, store room and etc per 410.5.2.
28. Coordinate door number at the lower level between the door schedule and floor plan.
29. Detail guards when located along open-sided walking surfaces, mezzanines, industrial equipment platforms, stairways, ramps and landings that are located more than 30-in above the floor or grade below. (1013.1)
    a. Have a minimum height of 42-in.
    b. Have intermediate rails or an ornamental pattern such that a 4-in. diameter sphere cannot pass through. (1013.3)
    c. Shall be designed for 50-plf applied in any direction at the top and to transfer the load through the supports of the structure. (1607.7)
    d. Shall be designed for a 200 lb concentrated load applied in any direction at any point along the top.(1607.7.1)
30. Provide 42" guard at the roof hatch that located within 10 feet from the roof boundary.

Disabled Access

31. Provide a detailed program to explain how path of travel will be provided to the Public Street and accessible parking space to the theater. The program shall be approved by Research Section, Jonathan Lam at 626-458-6352 and provide the approved program on the plan.
32. Provide an accessible route from wheel chair seats to stage, dressing rooms, locker rooms and other spaces use by performers. 1104B.3.11
33. Provide applicable and enlarged accessible parking plan and passenger loading space plan with details, dimensions and notes to verify disabled access requirements.
34. Provide loading and unloading space on the passenger side for van access parking.
35. Provide applicable and enlarged plans and sections for each stairs (include scenic stairs): rise/run, stripping, handrail, handrail extension, guard, nosing, width, and dimensions.
36. Handrail extension shall be in the direction of the stair flight.
37. Handrails shall extend a minimum of 12 inches beyond the top nosing and 12 inches plus the tread width beyond the bottom nosing
38. Provide a removal base under sinks for knee clearance and reference knee clearance details.
39. Provide 28: to 34: high counter with knee clearance under the sink.
40. Provide applicable enlarged restroom plan with dimensions, details and all clear spaces marked.
41. A door is not allowed to encroach into the required clear space at the front of plumbing fixtures.
42. Provide applicable enlarged stair plan and sections
43. Comply with Emergency Standard effective August 1, 2012:
    a. Provide 16" to 18" between the centerline of the accessible water closet and the side of wall or partition.
    b. Provide 60" clear space around the water closet. A fixture is not allowed within the clear space.
    c. Provide toilet tissue dispensers at 7" to 9" in the front of the water closet measured to the center of the dispenser.
    d. Provide the spout of the drinking fountain at minimum 15" from the vertical support and Maximum 5" from the front edge of the unit, including bumpers.
    e. Provide visual characters and raised characters on the signs with fonts comply with the width of the upper case letter "O" is 60% minimum of and 110% maximum of the height of the uppercase letter "I" and stroke thickness of the uppercase letter "I" shall be maximum 15% of the height of the character.
    f. Signs with raised characters and Braille shall be located 48" minimum above the finish floor or ground surface, measured from the baseline of the lowest line of Braille and 60 inches maximum above the finish floor or ground surface, measured from the baseline of the highest line of raised characters.
    g. Provide the sign within 3" from the approach side of a door

STRUCTURAL REQUIREMENTS

44. NOTE ON THE PLANS: "The use of rolled steel sections and/or bolts manufactured outside the United States will require verification that the products comply with applicable ASTM Standards. Mill certificates will be required for all steel. Steel grades other than ASTM-A36 will require testing by an approved laboratory. All foreign bolts must be approved by County of Los Angeles Building and Safety prior to their use."
45. Note on the plans: "Compaction report shall be submitted to the Building Inspector prior to footing inspection."

46. Update the soils report references, include all the reports.
47. Have the consulting soils/geotechnical engineer review and approve the foundation plans, shoring plans and details. (106.4.3)
48. All shop welding shall be performed within a licensed fabricator by LA City of ICC.
49. The occupancy category for this building is III. Design the building with I factor of 1.25.
50. Update occupancy category and I factor on seismic design information.
51. Provide structural calculations for foundation, stairs, handrail, guard
52. Provide framing plan over the pit as shown on the calc.
53. Use 0.35 for friction per the soils report.
54. Obtain seismic load requirement for retaining wall and basement wall over 6 feet from the soils engineer.
55. The soils reports do not contain recommendation for the soil nail and the shoring design is based on the soil nail and shotcrete. Provide recommendations for soil nail from the soil engineer or revise the shoring design per the soils report. The shoring design is not checked at this time. Resubmit the revised shoring design or revised soils report for shoring plan check. Additional corrections may follow.

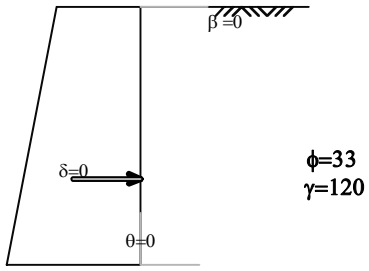
APPENDIX B

INPUT DATA

Condition:…… Horizontal Soil Layer (DE)

ϕ, Soil friction (deg)	33.0
δ, Friction angle between soil and concrete wall (deg)	0.0
β, Backfill slope angle (deg)	0.0
θ, Angle of wall slope with vertical wall	0.0
γ, Wet unit weight of the soil (pcf)	120
PeakHorizontal Acceleration	0.48
k_h, Horizontal acceleration coefficient	0.24
k_v, Vertical acceleration coefficient	0.00
$\psi = \tan^{-1}(k_h/(1-k_v))$	13.5 deg

CONFIGURATION



OUTPUT

a) At Rest condition

1. Coeff of **Earth Pressure at Rest, Ko** :…….....…… **0.46**
   Equivalent Fluid Pressure…….. 54.6 psf/ft

USE 55 psf/ft

Rankine Solution (For vertical wall only, θ = 0, assuming no wall friction, δ = 0, and upward backfill only, β>0)

1. Coeff of **Active Earth Pressure, K_A** :…….. **0.29**
   Equivalent Fluid Pressure…….. 35.4 psf/ft

USE 35 psf/ft

$$K_A^{RANKINE} = \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}$$

2. Coeff of **Passive Earth Pressure, K_P**:…….. **3.39**
   Equivalent Fluid Pressure…….. 407.1 psf/ft

USE 400 psf/ft

$$K_P^{RANKINE} = \frac{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}$$

3. Coeff of **Seismic & Static Active Earth Pressure, K_{AE}** :…… **0.46**
   Equivalent Fluid Pressure…….. 55 psf/ft

$$K_{AE} = \frac{\cos^2(\phi-\theta-\psi)}{\cos\psi\cos^2\theta\cos(\delta+\theta+\psi)\left[1+\sqrt{\frac{\sin(\delta+\phi)\sin(\phi-\beta-\psi)}{\cos(\delta+\theta+\psi)\cos(\beta-\theta)}}\right]^2}$$

4. **Seismic Active Earth Pressure**
   Equivalent Fluid Pressure: 55 psf/ft- 35 psf/ft= 20.0 psf/ft

USE 20 psf/ft

Ref:
1. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prince Hall, 1996.
2. Donald P. Couto, "Foundation Design, Principles and Design", Prince Hall, 1994.

C:\Users\ckim\SkyDrive\Documents\2013 projects\ford theater os3\[appendix b.xls]Output

PASSIVE AND ACTIVE PRESSURES **Ford Theater** **Hollywood, CALIFORNIA**	PROJECT NAME : JAFT PROJECT NUMBER : 10296.002 DESIGNED/CHECKED BY: sp/ck	**Figure B-1**

APPENDIX C

Ind. Surcharge on Basement Wall
(See attached Figure)

equivalent backslope $\beta \sim 40°$

$\phi = 33°$, $c = 600$ psf (CDMG, 1998)

Basement wall ~ 12' High

Calculate equivalent ϕ^*

ϕ^* incorporates cohesion

$\tau = c + \sigma \tan\phi = \sigma \tan\phi^*$

$= 600 \text{ psf} + 12 \times 120 \tan 33 = 12 \times 120 \tan\phi^*$

$\Rightarrow \phi^* = 46.8°$

considering that a portion of the active soil wedge may be in wall backfill, reduce c by FS = 2 $\Rightarrow c^* = 300$ psf

$\tan\phi^{**} = [300 \text{ psf} + 12 \times 120 \tan 33°] / 12 \times 120$

$\phi^{**} = 40.6° \sim 40°$

Project No.	10296.001
Project Name	JAFT
Engineer	CK
Date	Oct '13
Figure No.	X1

Leighton and Associates
A LEIGHTON GROUP COMPANY

Using NAVFAC 7.2-64 (Anchored)

with $\beta = 45°$, $\phi^{**} = 40°$

$K_A = 0.6 \Rightarrow 72$ pcf

Rec'd surcharge for active case

$= 72 - 35$ (rec'd active pressure for level backfill) $= 37$ pcf

Ratio of $\frac{\text{At-Rest}}{\text{Active}} = \frac{55 \text{ pcf}}{35 \text{ pcf}} = 1.57$

Rec'd surcharge for at-rest case

$= 37 \times 1.57 = 58$ pcf

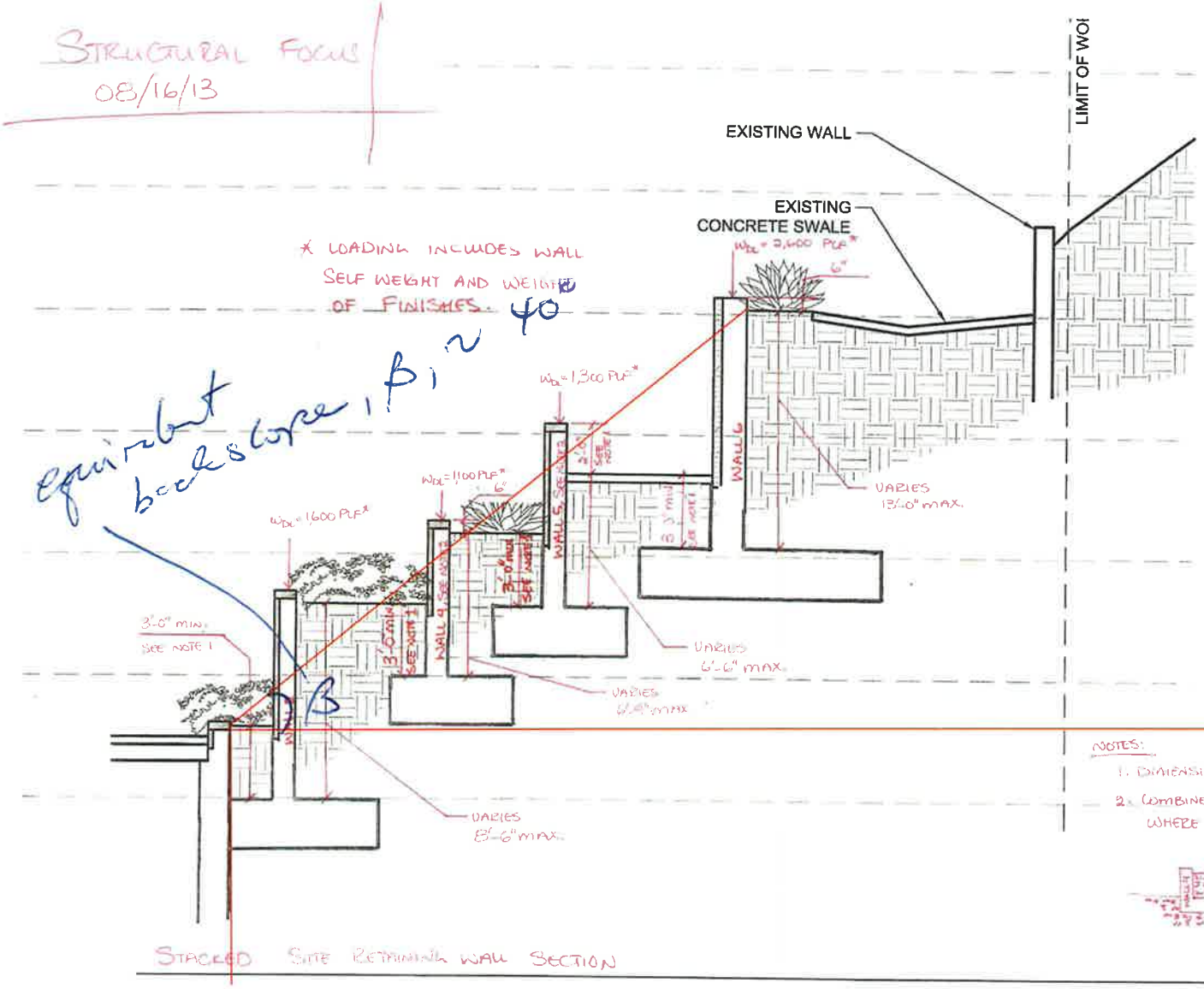
Considering that actual case will be between Active & At-rest condition, use Arith. of values: $\frac{37 + 58}{2} = 47.6$

$\Rightarrow$ Rec'd surcharge = $\boxed{50 \text{ pcf}}$

	Project No. _____
	Project Name _____
	Engineer _____
	Date _____ Figure No. X2

Leighton and Associates
A LEIGHTON GROUP COMPANY

STRUCTURAL FOCUS
08/16/13



NOTES:
1. DIMENSION PER LANDSCAPE REQUIREMENTS.
2. COMBINE FOOTINGS FOR WALL 4 & 5 WHERE POSSIBLE.



STACKED SITE RETAINING WALL SECTION

FIGURE 1b

2/26/2014 4:23:47 PM

figure c-2.pdf 1

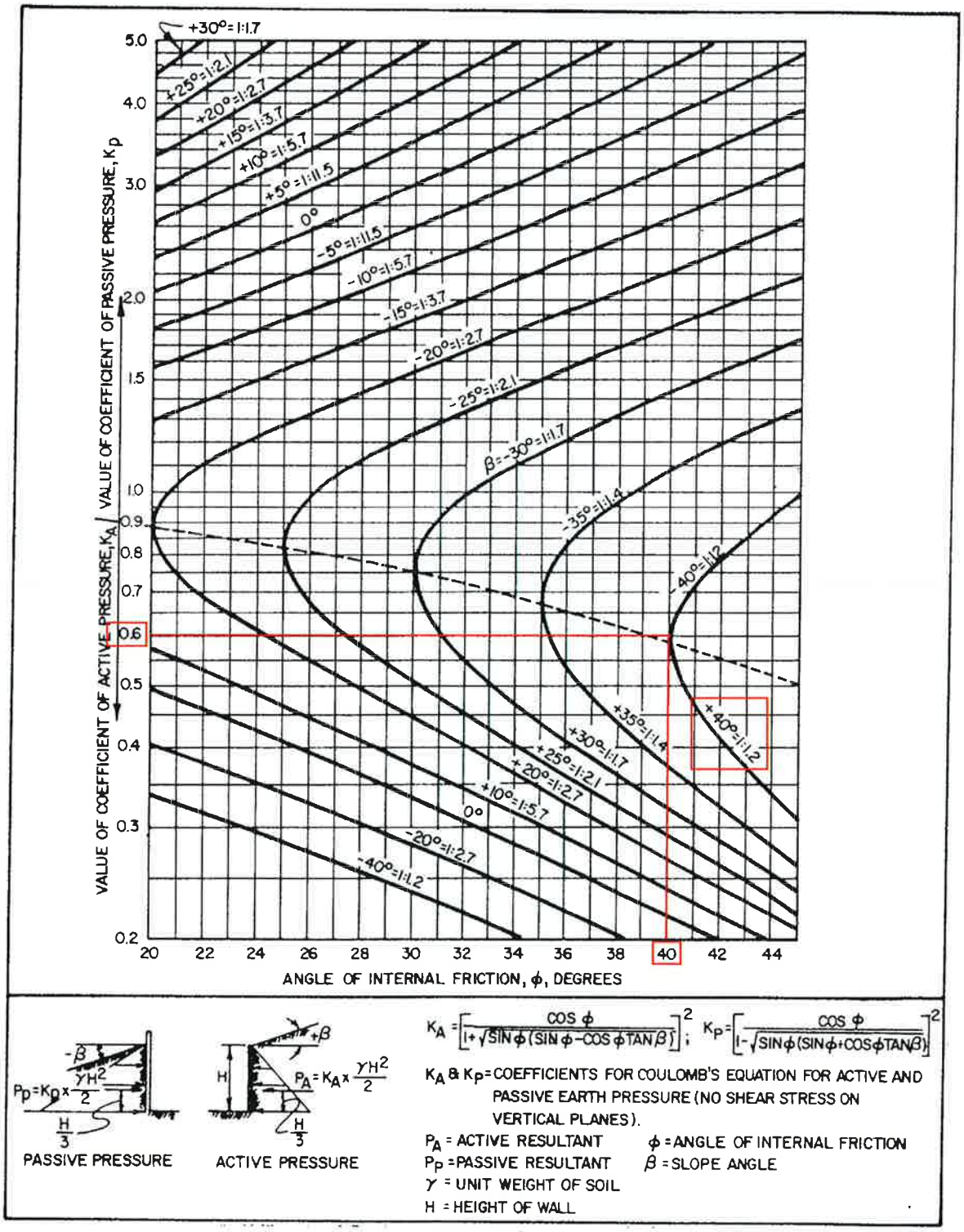


FIGURE 3
Active and Passive Coefficients, Sloping Backfill
(Granular Soils)

APPENDIX D

EARTH SUPPORT SYSTEMS

November 15, 2013

Mr. Rudy Delgadillo
Bernards
555 First Street
San Fernando, CA 91340

(818) 898-1521 tel.
(818) 838-7956 fax

Re: **JAF Amphitheatre** **JOB #13-146**
Hollywood, California

Subject: **Temporary Shoring Design Submittal**

Dear Mr. Delgadillo:

Enclosed please find the temporary shoring design submittal for the above referenced project.

Should you have any additional questions or comments regarding this matter, please advise.

Sincerely,

EARTH SUPPORT SYSTEMS, INC.



Roy P. Reed, P.E.
Project Engineer

Encl: Design Calculations

EARTH SUPPORT SYSTEMS

Temporary Shoring Design Calculations

John Ansen Ford Theaters (JAF Amphitheatre)

Hollywood, California

November 15, 2013

ESSI Project # 13-146

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Shoring Plans: 1

Temporary Shotcrete Facing: 2

Soil Nail Design (H=15' max., **Detail 1/ES10**): 3

Soil Nail Design (H=11' max., **Detail 2/ES10**): 4

Soil Nail Design (H=19' max., **Detail 3/ES10**): 5

Soil Nail Design (H=22' max., **Detail 4/ES10**): 6

Soil Nail Design (H=20' max., with Building Surcharge, **Detail 5/ES10**): 7

Soil Nail Design (H=16' max., **6/ES10**): 8

Soil Nail Design (H=25' max., **7/ES10**): 9

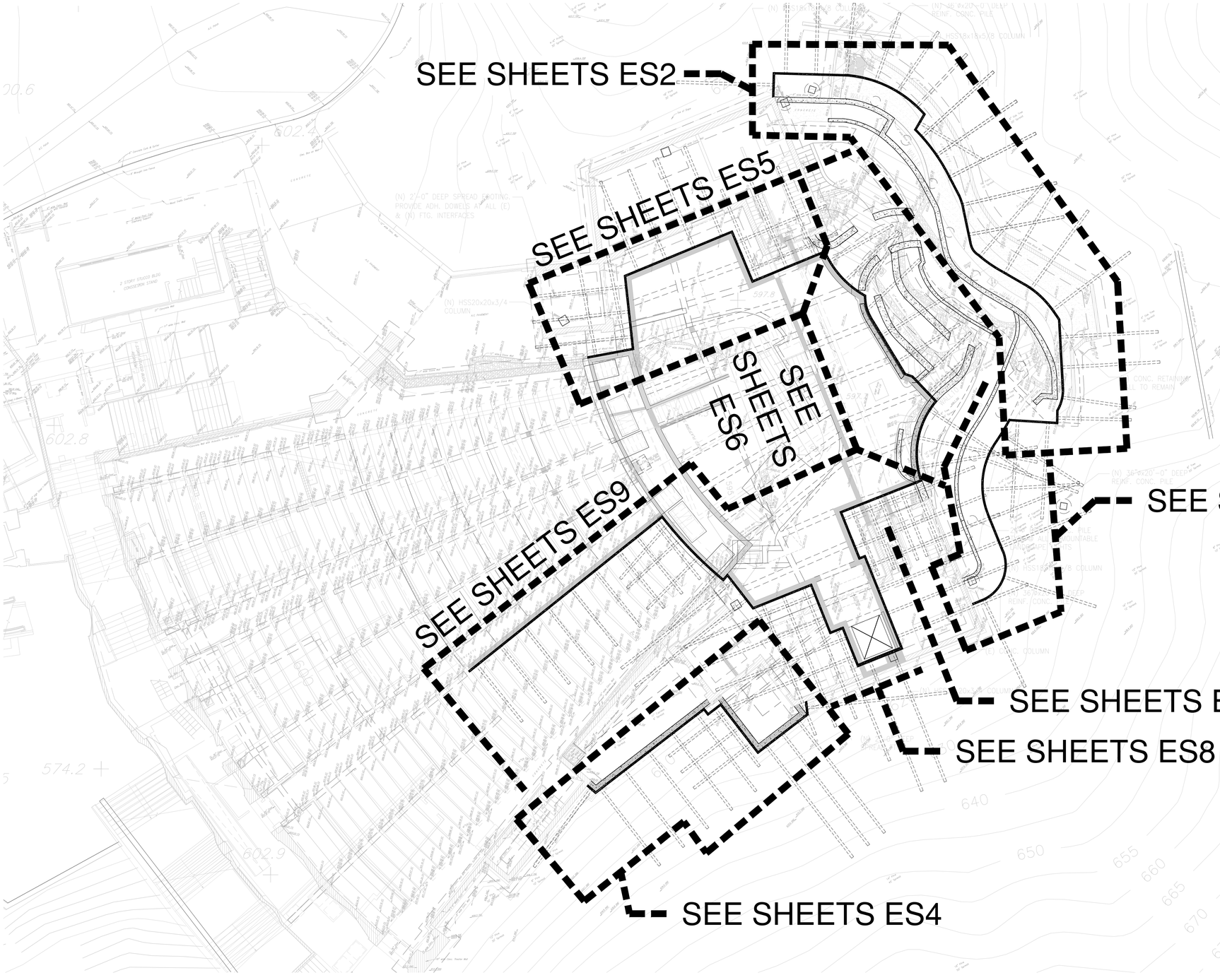
Vertical Element Design: 10

Rock Bolt Capacity Design: 11

Geotechnical Report (Partial Copy): 12

9685 Via Excelencia, Suite 104 | San Diego, CA 92126 | phone (760) 929-2851
www.earthsupportsys.com

SECTION 1



Underground Service Alert of Southern California

Call: TOLL FREE
800-422-4133

TWO WORKING DAYS BEFORE YOU DIG
RE-NOTIFY EVERY TWO WEEKS

TICKET # _____

DATE CALLED: _____

CAUTION!!!

ALL EXISTING UTILITIES MAY NOT BE SHOWN ON THESE PLANS. DIG ALERT & GENERAL CONTRACTOR SHALL LOCATE & POTHOLE (AS NEEDED), ALL EXISTING UTILITIES BEFORE SHORING WALL CONSTRUCTION BEGINS.

THINK SAFETY:

1. SAFETY MEETING AT LEAST ONCE A WEEK.
2. IN CASE OF ACCIDENT, CALL GENERAL CONTRACTOR'S OFFICE IMMEDIATELY.

STATE OF CALIFORNIA

DEPARTMENT OF INDUSTRIAL RELATIONS
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
TRENCH/EXCAVATION PERMIT NO._____

SITE PLAN VIEW
SCALE: 1" = 10'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

REGISTERED PROFESSIONAL ENGINEER ROY P. REED C 80503 Exp. 3/31/15 CIVIL STATE OF CALIFORNIA

EARTH SUPPORT SYSTEMS
5937 DARWIN CT. SUITE 105 CARLSBAD, CA 92008
TEL (760) 929-2851 FAX (760) 929-2852

DELTA	REVISION	DATE

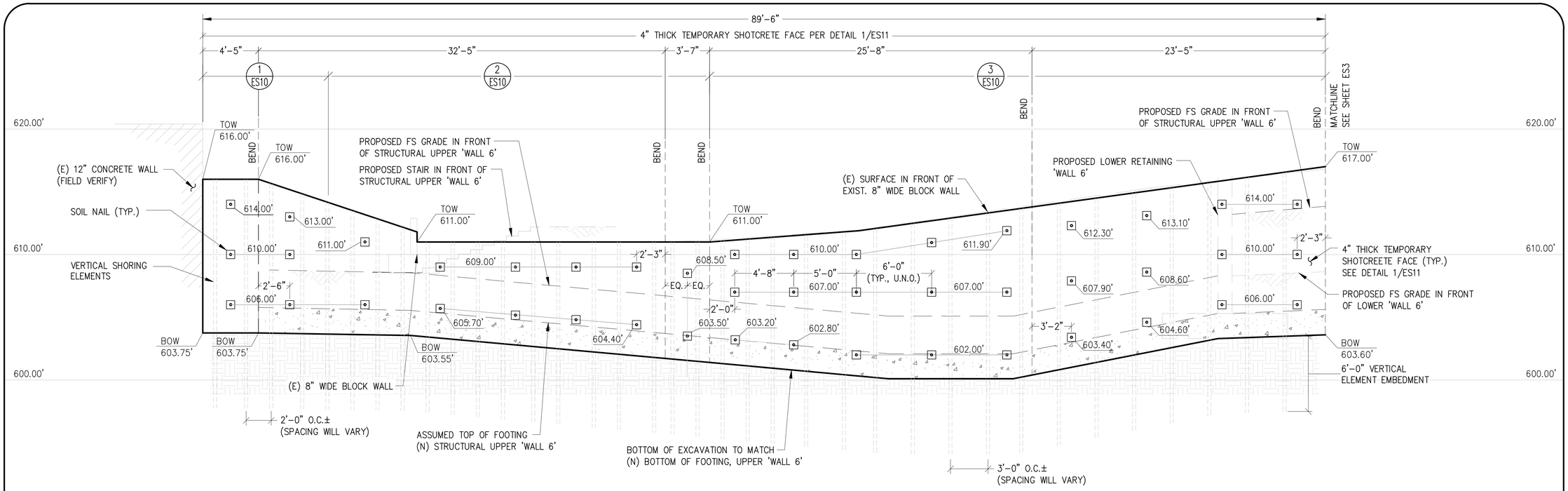
PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

DRAWING NAME: PROPOSED TEMPORARY SHORING
SITE PLAN VIEW

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 10'

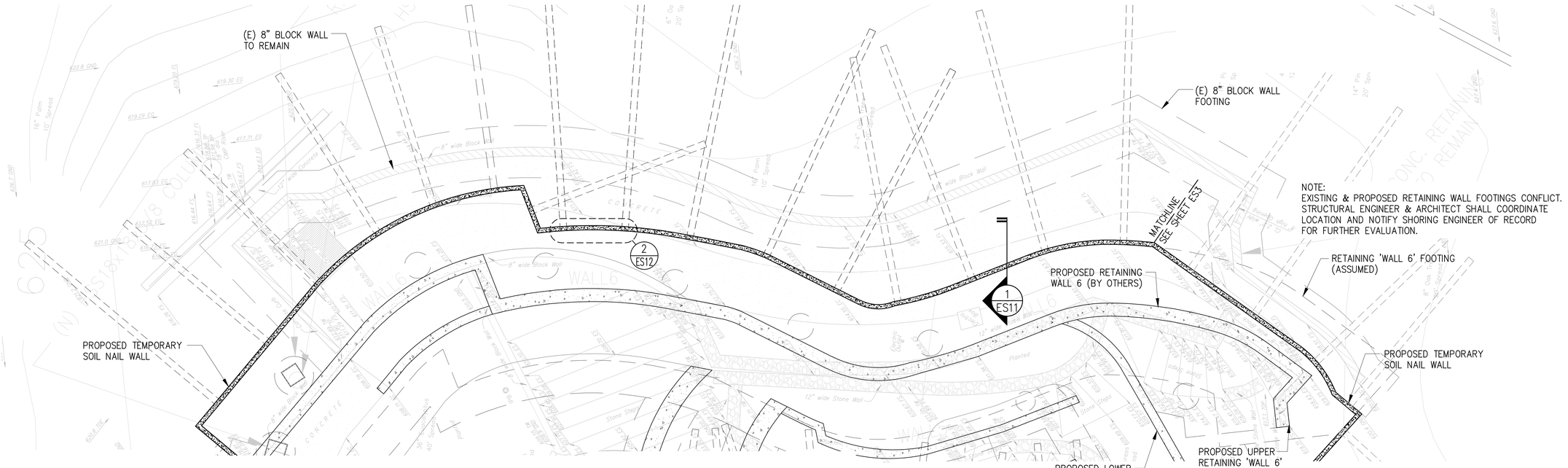
SHEET
ES1
OF 13 SHEETS

REFERENCE ONLY - NOT FOR CONSTRUCTION



NOTES:
1. FIELD LOCATE EXISTING & PROPOSED IMPROVEMENTS PRIOR TO ANY SHORING INSTALLATION.
2. CONTRACTOR SHALL FIELD ASSESS THE EXTENT OF VERTICAL ELEMENTS REQUIRED TO STABILIZE THE PROPOSED SOIL NAIL EXCAVATION. WHERE REQUIRED, THE MAXIMUM CENTER TO CENTER SPACING SHALL NOT EXCEED 3'-0".
3. TEMPORARY SHOTCRETE FACING MAY BE OMITTED IN EXCAVATIONS EXPLORING COMPETENT ROCK.

ELEVATION VIEW - LOOKING NORTH - WALL '6'
SCALE: 1" = 4'



PLAN VIEW - WALL '6'
SCALE: 1" = 4'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

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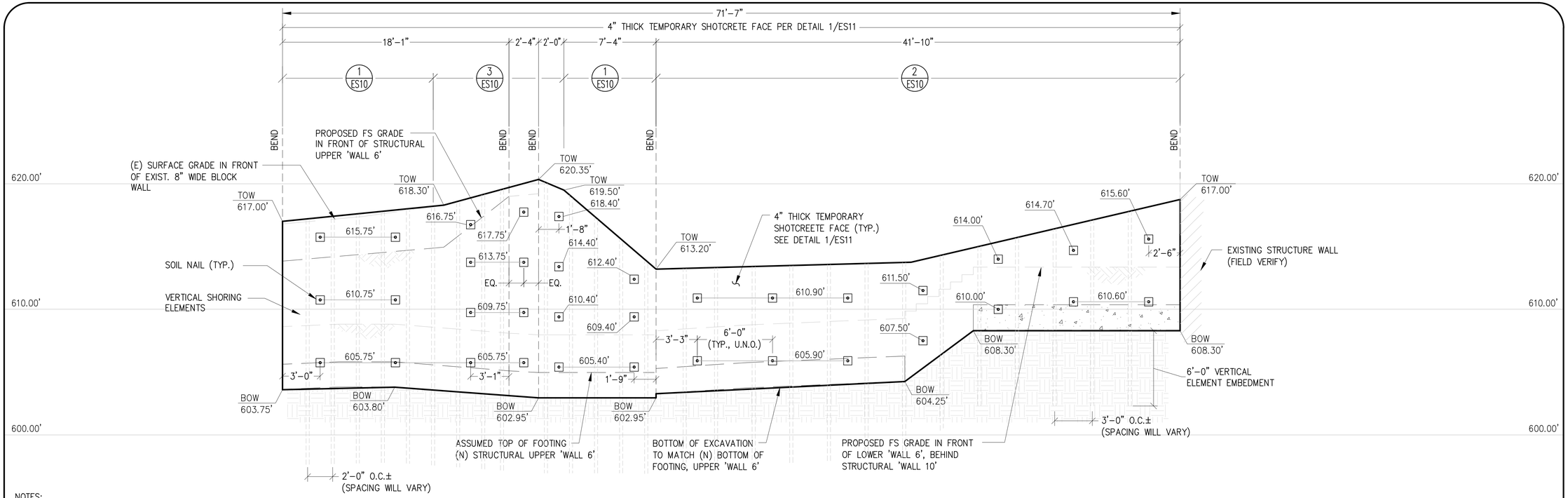
PLAN AND ELEVATION

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 4'

SHEET ES2 OF 13 SHEETS

REFERENCE ONLY - NOT FOR CONSTRUCTION



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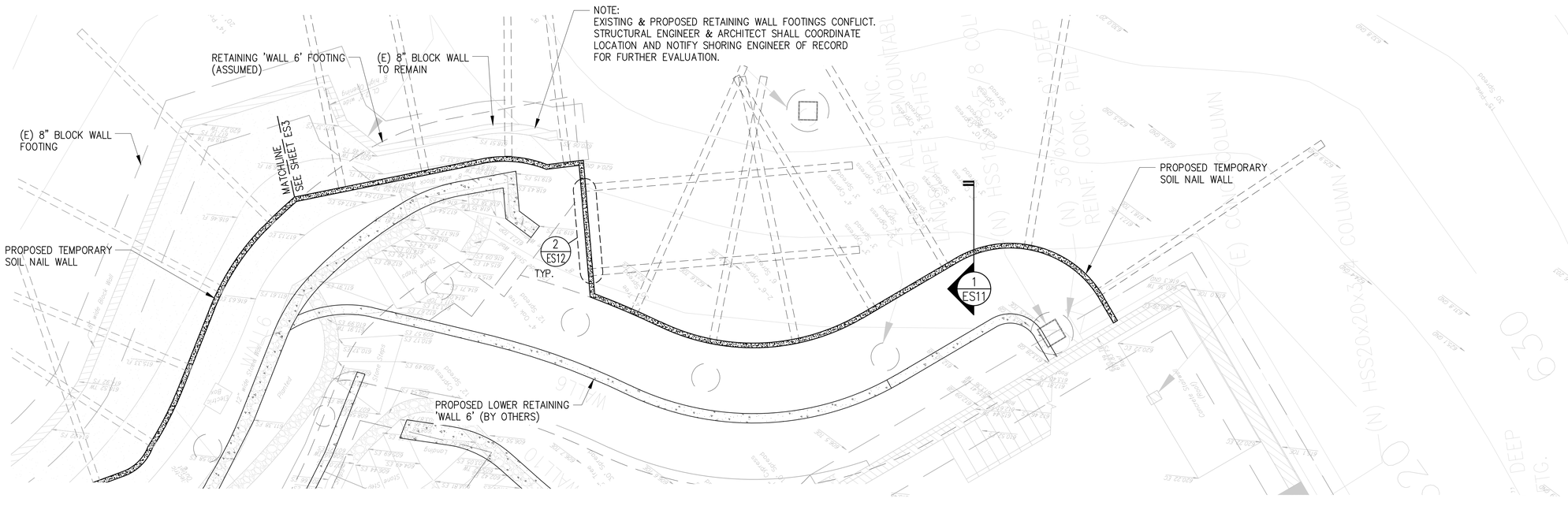
SCALE: 1" = 4'



PLAN VIEW @ WALL '6'
SCALE: 1" = 4'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

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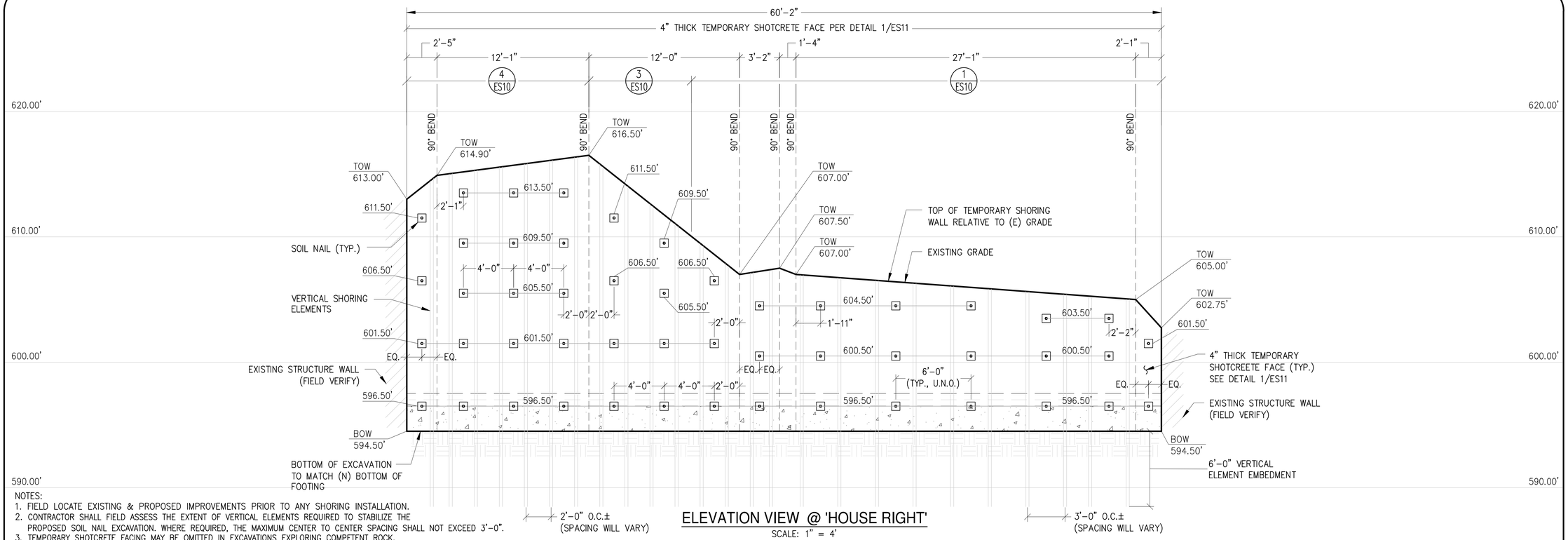
DELTA | REVISION | DATE

PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

DRAWING NAME: PROPOSED TEMPORARY SHORING PLAN AND ELEVATION

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 4'

SHEET ES3 OF 13 SHEETS



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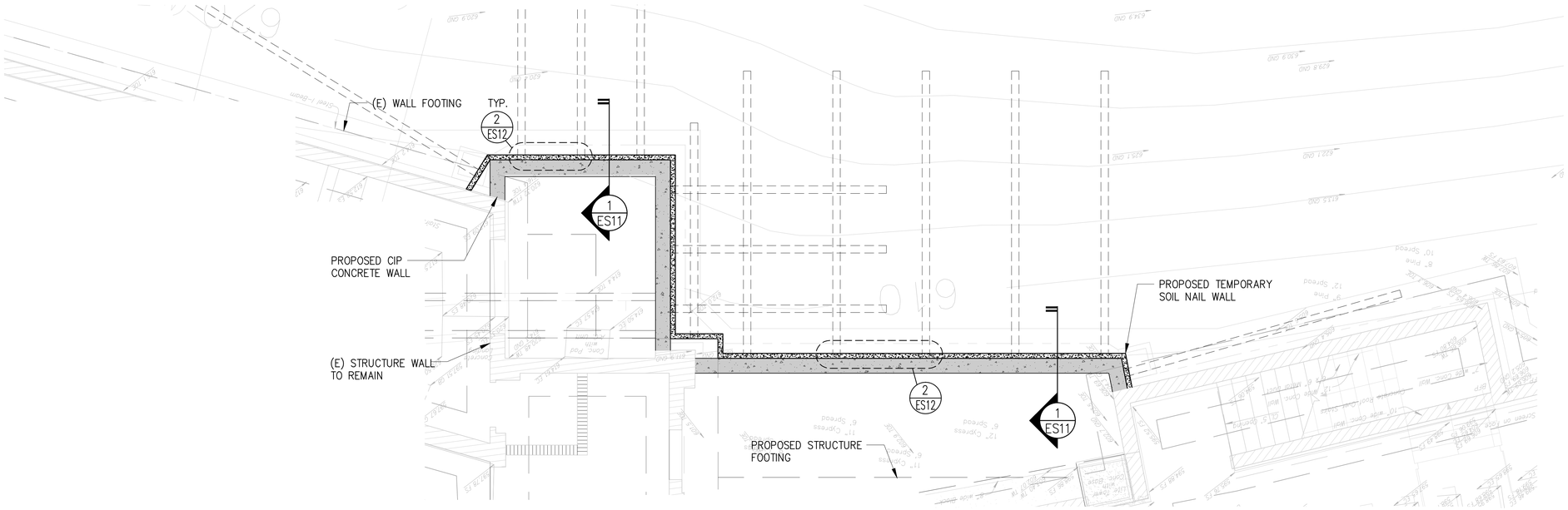
ELEVATION VIEW @ 'HOUSE RIGHT'
SCALE: 1" = 4'



PLAN VIEW @ 'HOUSE RIGHT'
SCALE: 1" = 4'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

REGISTERED PROFESSIONAL ENGINEER ROY P. REED C 80503 Exp. 3/31/15 CIVIL STATE OF CALIFORNIA

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5937 DARWIN CT. SUITE 105 CARLSBAD, CA 92008
TEL (760) 929-2851 FAX (760) 929-2852

DATE | REVISION | DELTA

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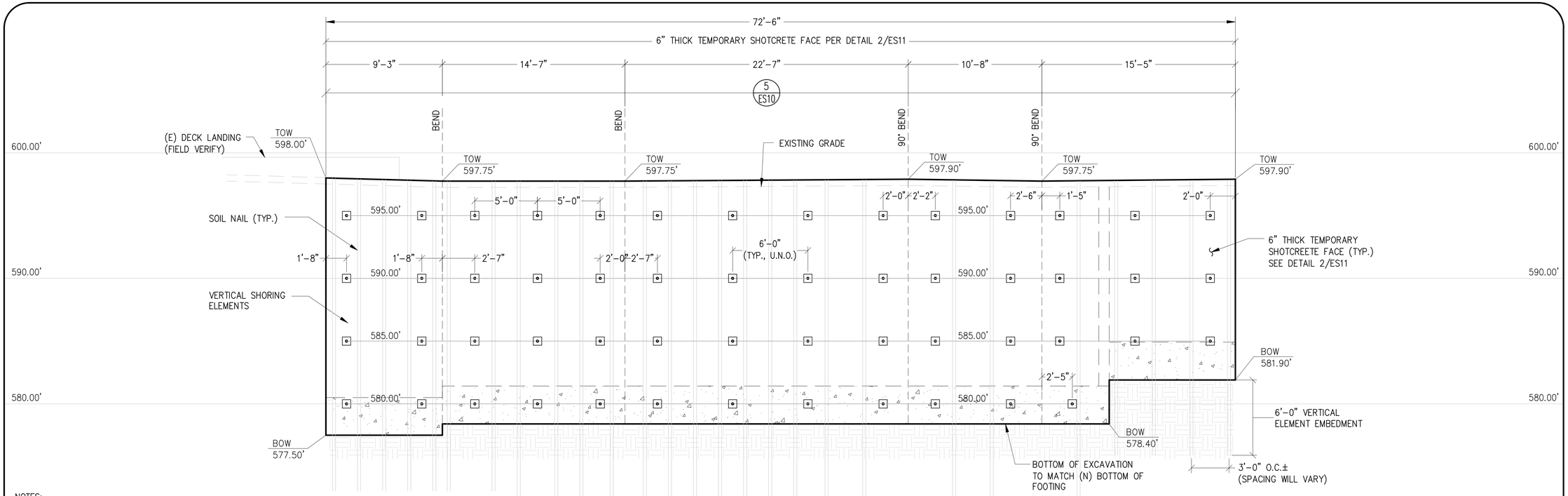
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

DRAWING NAME: PROPOSED TEMPORARY SHORING PLAN AND ELEVATION

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 4'

SHEET ES4 OF 13 SHEETS



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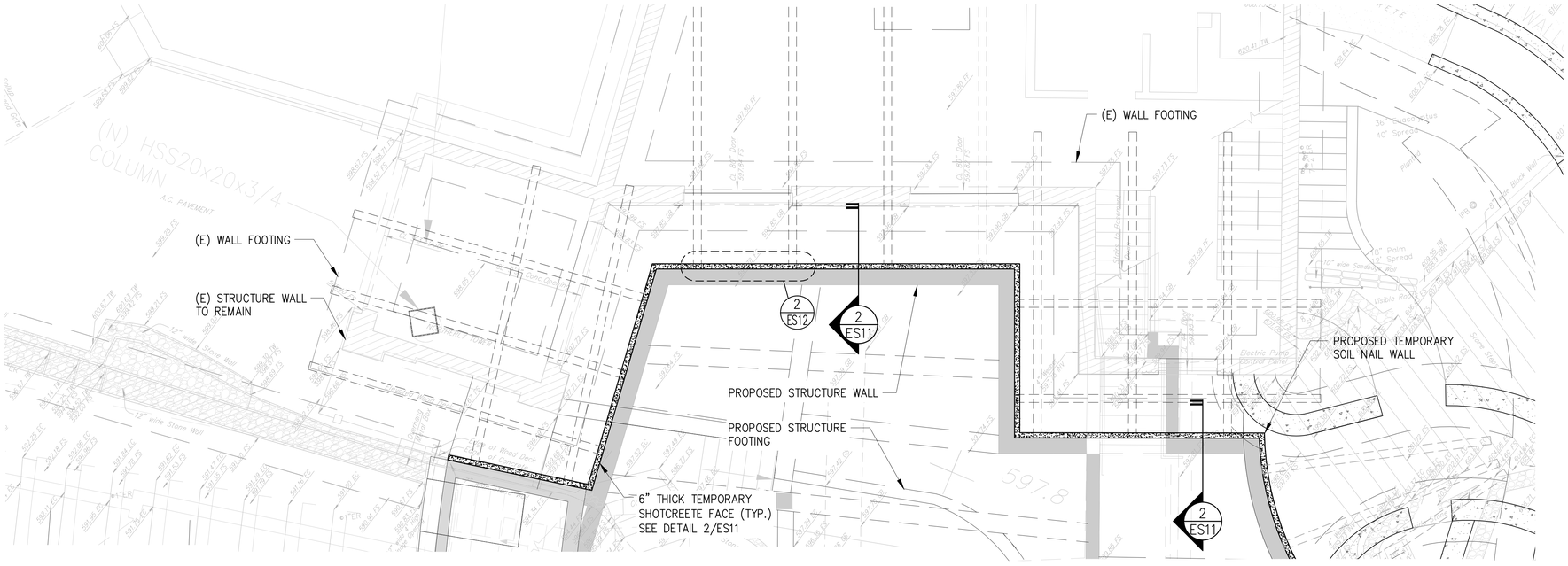
ELEVATION VIEW - LOOKING WEST
SCALE: 1" = 4'



PLAN VIEW - WEST
SCALE: 1" = 4'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

REGISTERED PROFESSIONAL ENGINEER ROY P. REED C 80503 Exp. 3/31/15 CIVIL STATE OF CALIFORNIA

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5937 DARWIN CT. SUITE 105 CARLSBAD, CA 92008
TEL (760) 929-2851 FAX (760) 929-2852

DATE | REVISION | DELTA

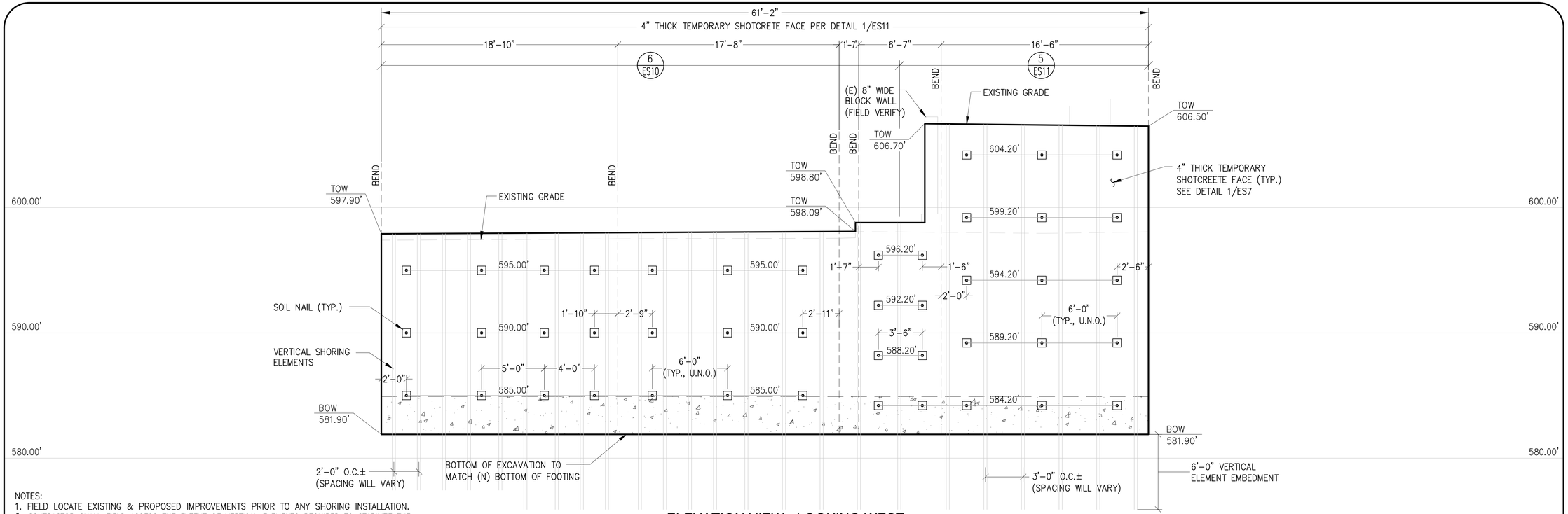
PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

DRAWING NAME: PROPOSED TEMPORARY SHORING
PLAN AND ELEVATION

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 4'

SHEET ES5 OF 13 SHEETS

REFERENCE ONLY - NOT FOR CONSTRUCTION



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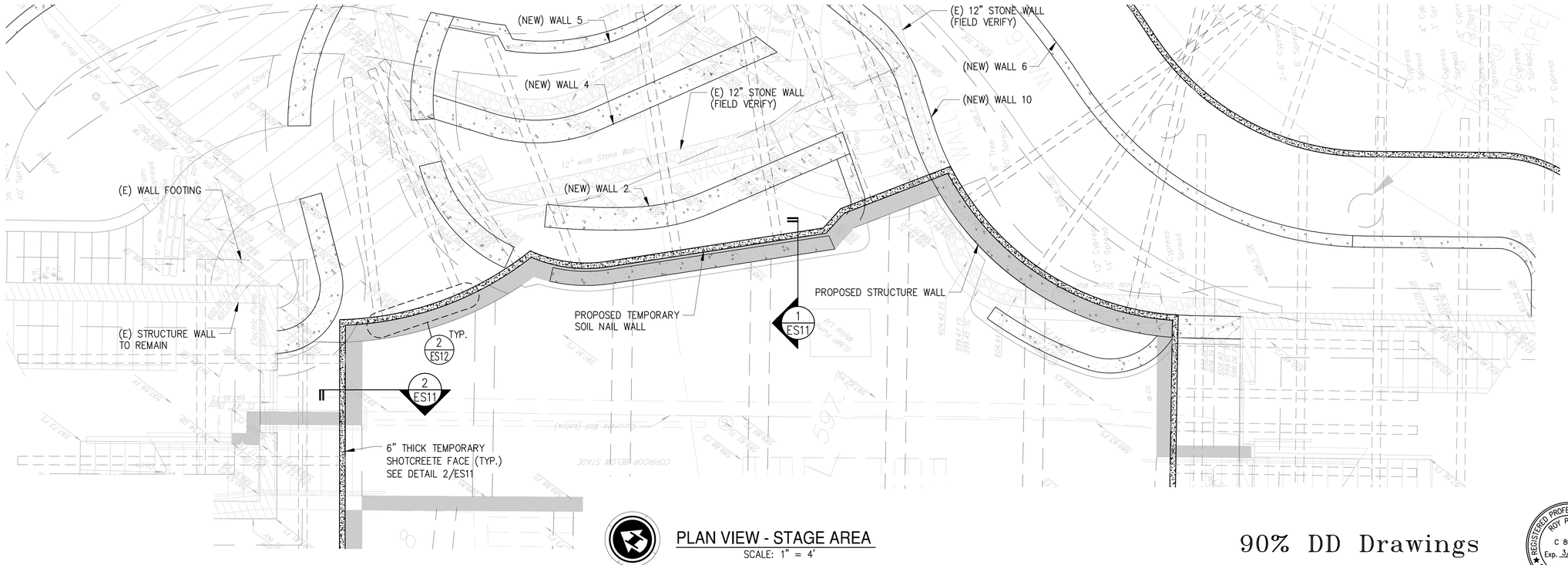
SCALE: 1" = 4'



PLAN VIEW - STAGE AREA
SCALE: 1" = 4'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

REGISTERED PROFESSIONAL ENGINEER ROY P. REED C 80503 Exp. 3/31/15 CIVIL STATE OF CALIFORNIA

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5937 DARWIN CT. SUITE 105 CARLSBAD, CA 92008
TEL (760) 929-2851 FAX (760) 929-2852

DELTA | REVISION | DATE

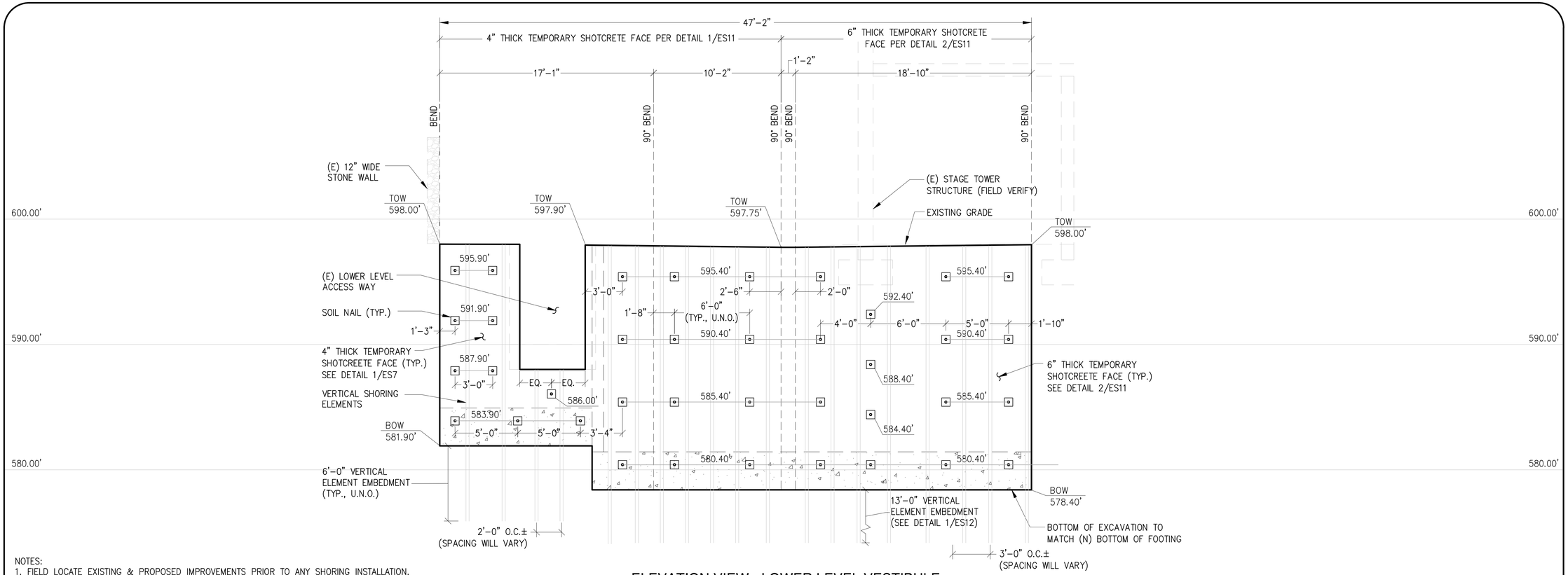
PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

DRAWING NAME: PROPOSED TEMPORARY SHORING
PLAN AND ELEVATION

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 4'

SHEET ES6 OF 13 SHEETS

REFERENCE ONLY - NOT FOR CONSTRUCTION



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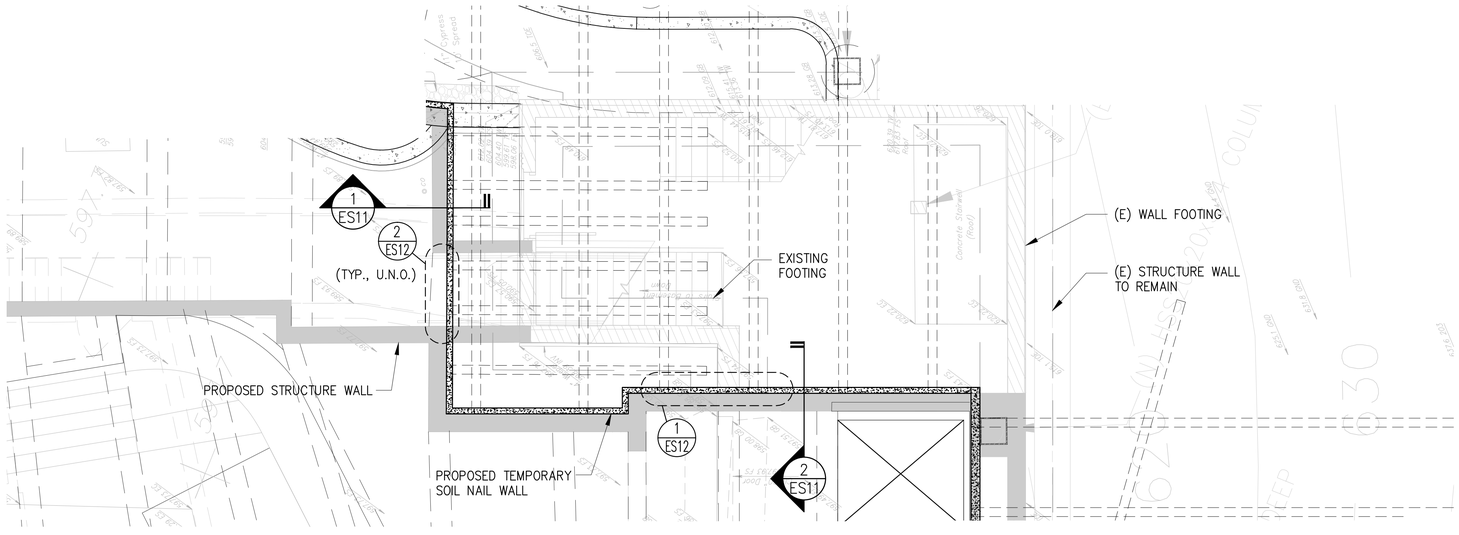
ELEVATION VIEW - LOWER LEVEL VESTIBULE
SCALE: 1" = 4'



PLAN VIEW - LOWER LEVEL VESTIBULE
SCALE: 1" = 4'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

REGISTERED PROFESSIONAL ENGINEER ROY P. REED C 80503 Exp. 3/31/15 CIVIL STATE OF CALIFORNIA

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5937 DARWIN CT. SUITE 105 CARLSBAD, CA 92008
TEL (760) 929-2851 FAX (760) 929-2852

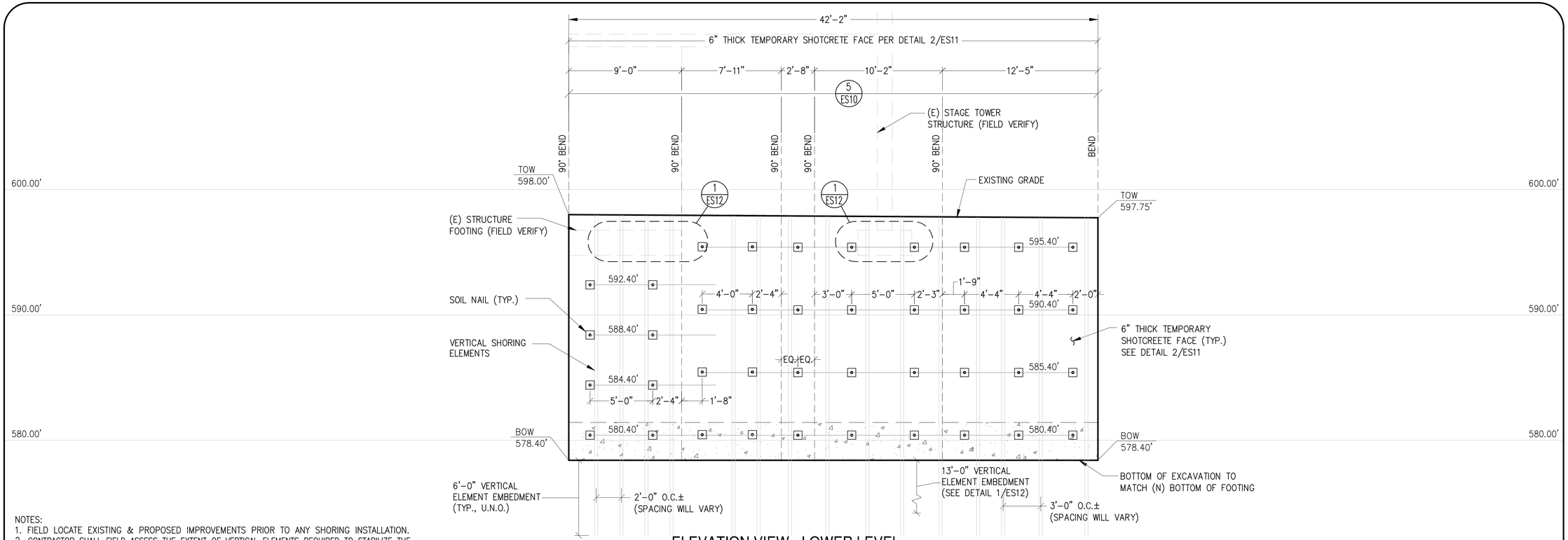
DELTA | REVISION | DATE

PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

DRAWING NAME: PROPOSED TEMPORARY SHORING
PLAN AND ELEVATION

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 4'

SHEET ES7 OF 13 SHEETS



ELEVATION VIEW - LOWER LEVEL

SCALE: 1" = 4'

NOTES:
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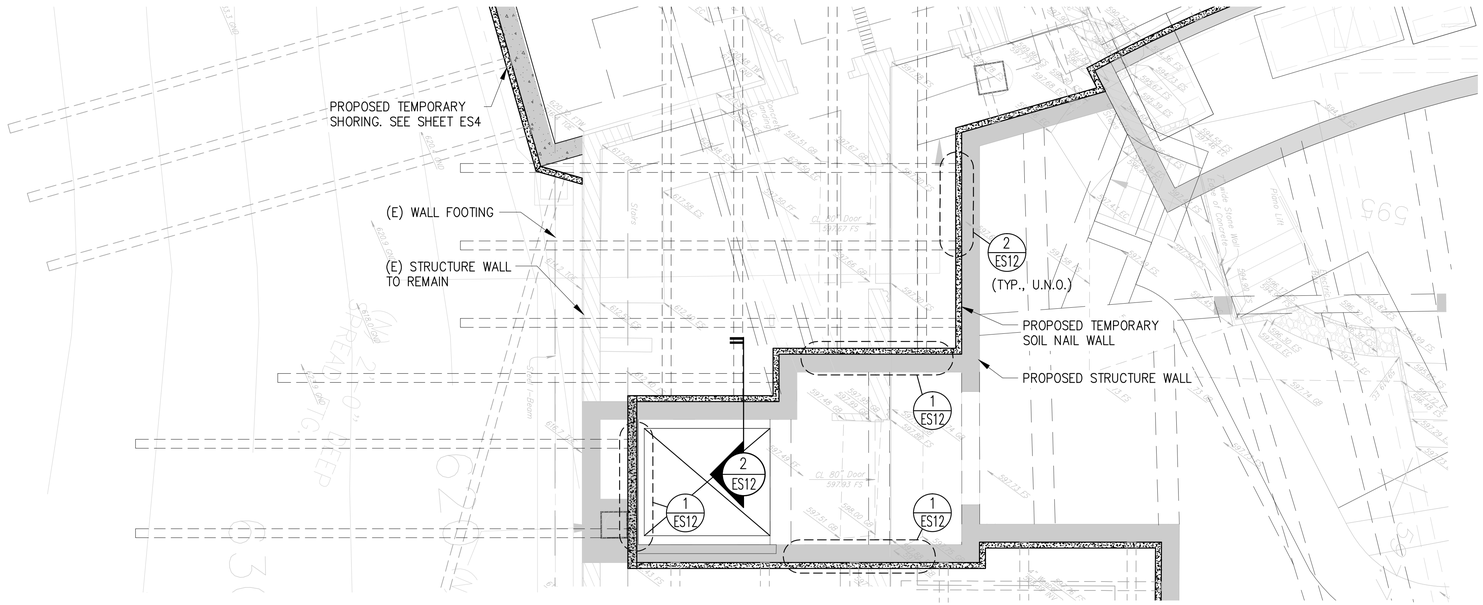

PLAN VIEW - LOWER LEVEL

SCALE: 1" = 4'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

REGISTERED PROFESSIONAL ENGINEER ROY P. REED C 80503 Exp. 3/31/15 CIVIL STATE OF CALIFORNIA

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5937 DARWIN CT. SUITE 105 CARLSBAD, CA 92008
TEL (760) 929-2851 FAX (760) 929-2852

DELTA	REVISION	DATE

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2580 CAHUENGA BOULEVARD EAST
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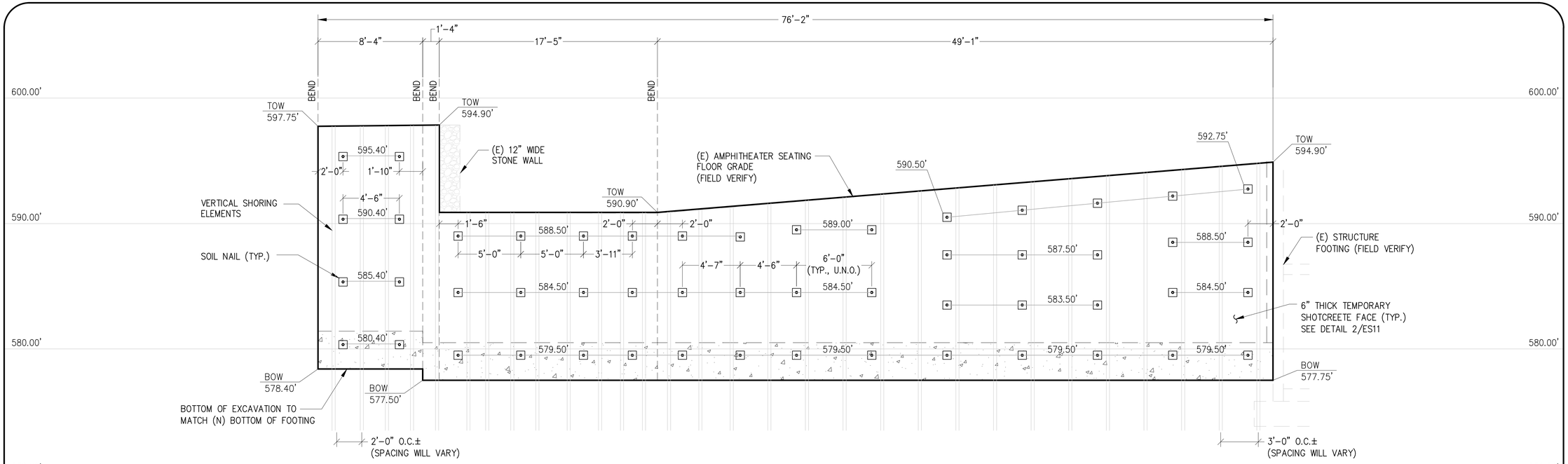
PLAN AND ELEVATION

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 4'

SHEET ES8 OF 13 SHEETS



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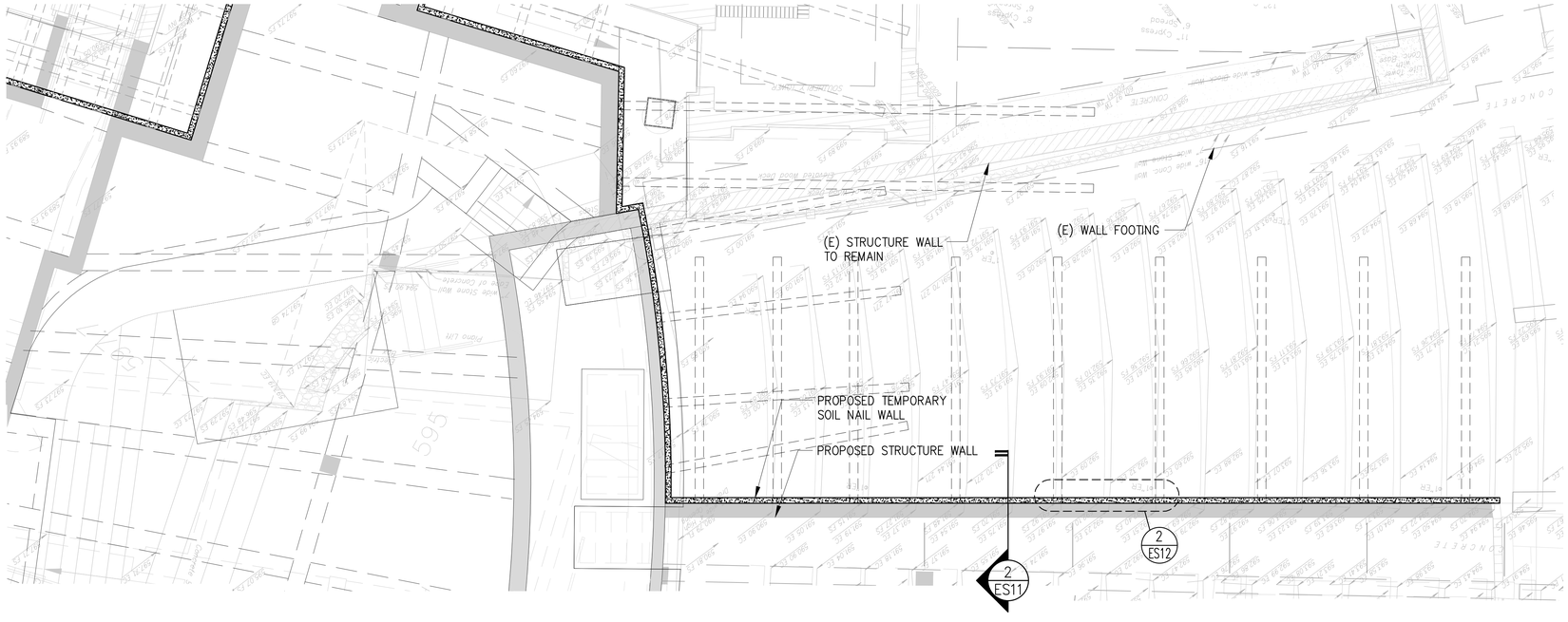
ELEVATION VIEW - AMPHITHEATER SEATING

SCALE: 1" = 4'



PLAN VIEW - AMPHITHEATER SEATING

SCALE: 1" = 4'

90% DD Drawings

ROY P. REED R.C.E. 80503 EXP. 3-31-15 DATE

REGISTERED PROFESSIONAL ENGINEER
ROY P. REED
C 80503
Exp. 3/31/15
CIVIL
STATE OF CALIFORNIA

REFERENCE ONLY - NOT FOR CONSTRUCTION

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2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

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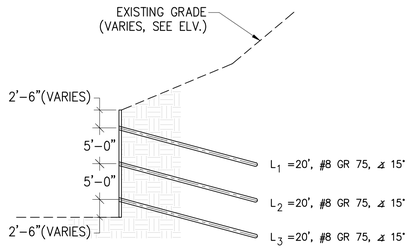
DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: 1" = 4'

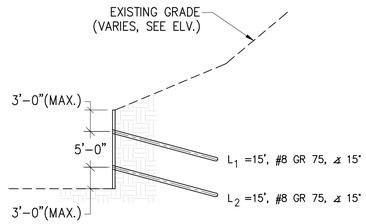
SHEET
ES9
OF 13 SHEETS



NOTES

1. UNDERGROUND UTILITIES MUST BE FIELD VERIFIED. POTHOLE AND AS-BUILT BEFORE SHORING CONSTRUCTION BEGINS.
2. VERTICAL & HORIZONTAL NAIL SPACING VARIES, SEE ELEVATIONS.
3. THE GENERAL CONTRACTOR SHALL GRADE SAFE WORKING AND DRILLING BENCHES NOT MORE THAN TWO (2) FEET LOWER THAN THE ANCHOR LEVEL.

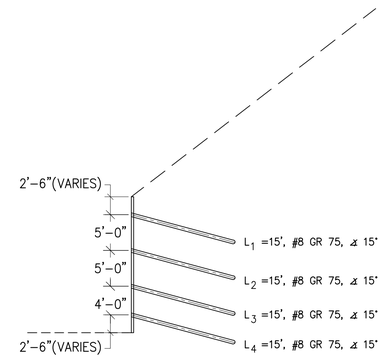
1 / ES10 SOIL NAIL SECTION
N.T.S.



NOTES

1. UNDERGROUND UTILITIES MUST BE FIELD VERIFIED. POTHOLE AND AS-BUILT BEFORE SHORING CONSTRUCTION BEGINS.
2. VERTICAL & HORIZONTAL NAIL SPACING VARIES, SEE ELEVATIONS.
3. THE GENERAL CONTRACTOR SHALL GRADE SAFE WORKING AND DRILLING BENCHES NOT MORE THAN TWO (2) FEET LOWER THAN THE ANCHOR LEVEL.

2 / ES10 SOIL NAIL SECTION
N.T.S.



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3 / ES10 SOIL NAIL SECTION
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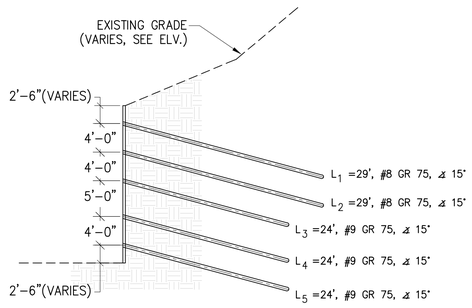

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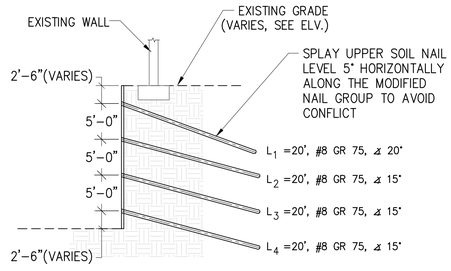
4 / ES10 SOIL NAIL SECTION
N.T.S.



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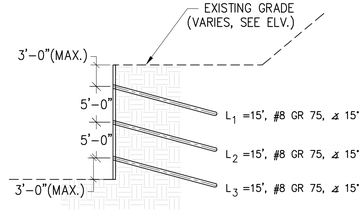
5 / ES10 SOIL NAIL SECTION
N.T.S.



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6 / ES10 SOIL NAIL SECTION
N.T.S.

90% DD Drawings

RICARDO JORDAN R.C.E. 68436 EXP. 9-30-15 DATE

REGISTERED PROFESSIONAL ENGINEER
RICARDO JORDAN
No. 68436
Exp. 9/30/15
CIVIL
STATE OF CALIFORNIA

EARTH SUPPORT SYSTEMS
9685 VIA EXCELENCIA - SUITE 104, SAN DIEGO, CA 92126
TEL (760) 929-2851 FAX (760) 929-2852

DATE | REVISION | DELTA

PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

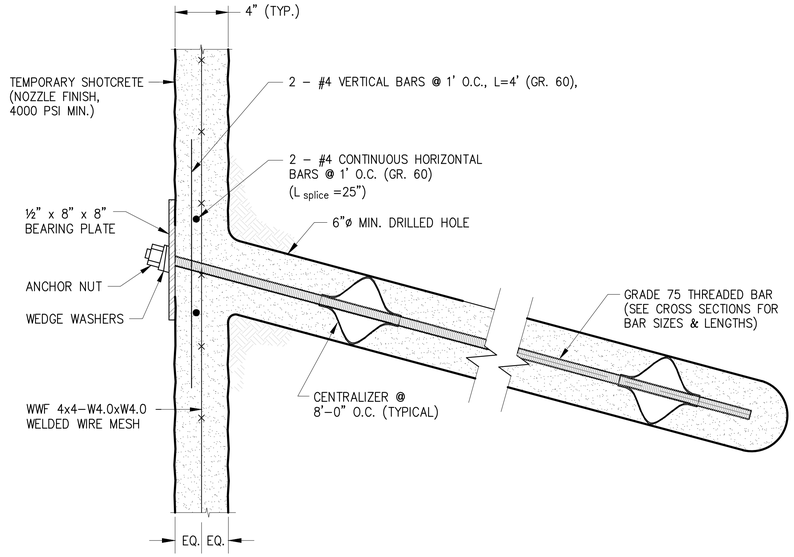
PROPOSED TEMPORARY SHORING

DRAWING: SOIL NAIL SECTIONS

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: N.T.S.

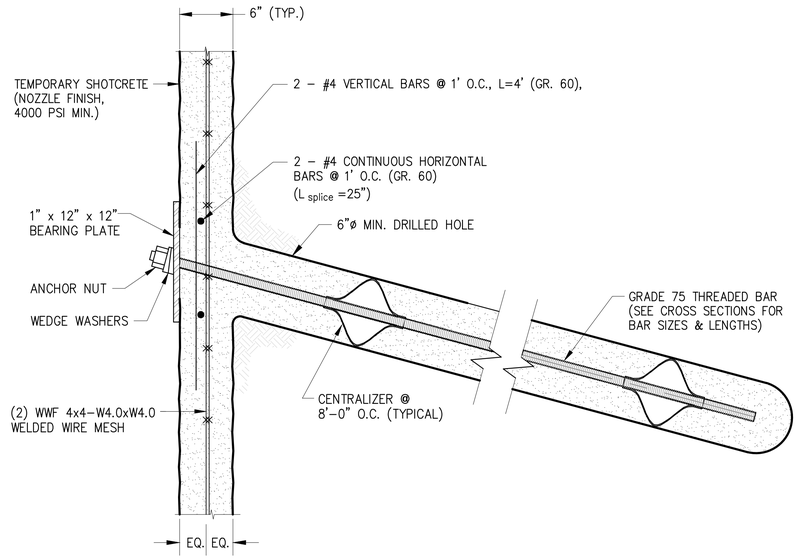
SHEET
ES10
OF 13 SHEETS

REFERENCE ONLY - NOT FOR CONSTRUCTION



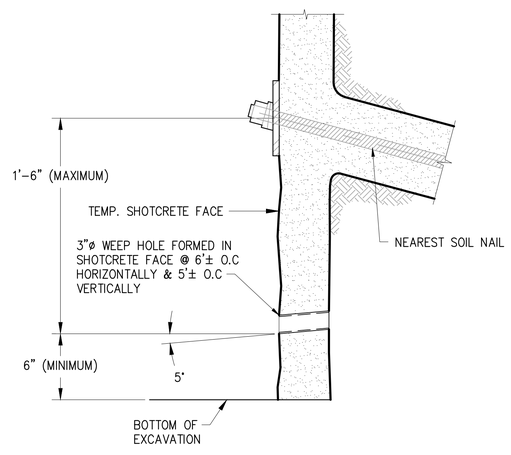
NOTES:
1. FOR WEEP HOLE DETAIL SEE 3/ES11.
2. FOR SAFETY RAIL DETAIL SEE 4/ES11.
3. PERMANENT STRUCTURE NOT SHOWN FOR CLARITY.

1/ES11 TEMPORARY SOIL NAIL DETAIL
N.T.S.



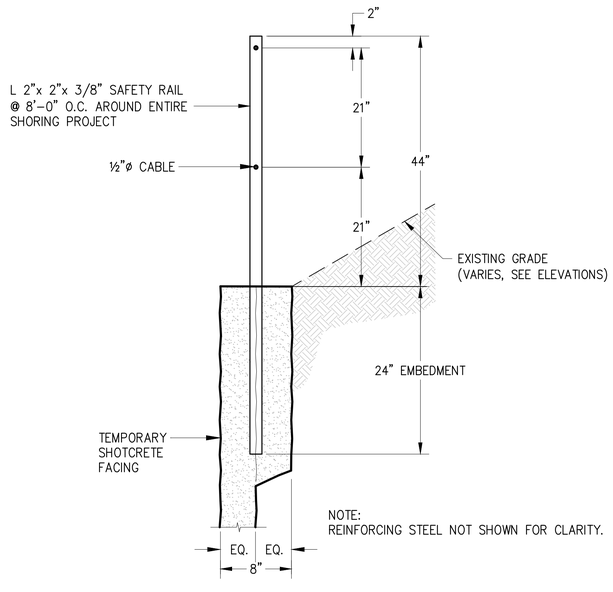
NOTES:
1. FOR WEEP HOLE DETAIL SEE 3/ES11.
2. FOR SAFETY RAIL DETAIL SEE 4/ES11.
3. PERMANENT STRUCTURE NOT SHOWN FOR CLARITY.

2/ES11 TEMPORARY SOIL NAIL DETAIL
N.T.S.



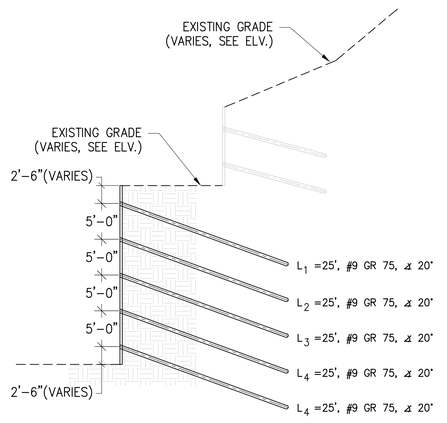
NOTE:
REINFORCING STEEL NOT SHOWN FOR CLARITY.

3/ES11 WEEP HOLE DETAIL
TEMPORARY SHOTCRETE (TYPICAL)
N.T.S.



NOTE:
REINFORCING STEEL NOT SHOWN FOR CLARITY.

4/ES11 TEMPORARY SAFETY RAILING DETAIL
@ TOP OF SOIL NAIL WALL DETAIL
N.T.S.



NOTES
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5/ES11 SOIL NAIL SECTION
N.T.S.

90% DD Drawings

RICARDO JORDAN R.C.E. 68436 EXP. 9–30–15 DATE

REGISTERED PROFESSIONAL ENGINEER RICARDO JORDAN No. 68436 Exp. 9/30/15 CIVIL STATE OF CALIFORNIA

EARTH SUPPORT SYSTEMS
9685 VIA EXCELENCIA - SUITE 104, SAN DIEGO, CA 92126
TEL (760) 929-2851 FAX (760) 929-2852

DELTA	REVISION	DATE

PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

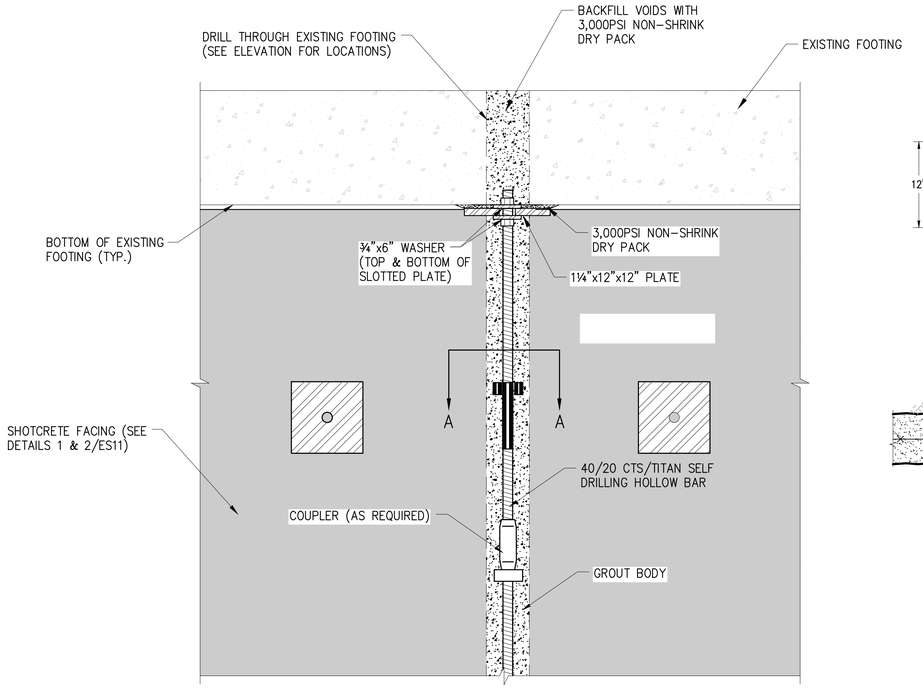
PROPOSED TEMPORARY SHORING

DRAWING: SOIL NAIL SECTIONS & DETAILS

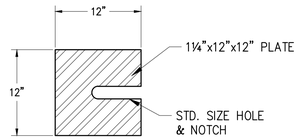
DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13–146
REVISION: –
SCALE: N.T.S.

SHEET
ES11
OF 13 SHEETS

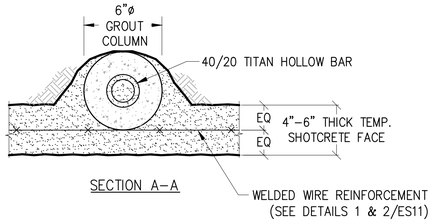
REFERENCE ONLY - NOT FOR CONSTRUCTION



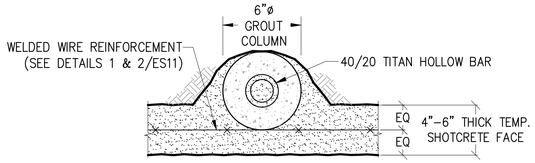
ELEVATION



BEARING PLATE PLAN



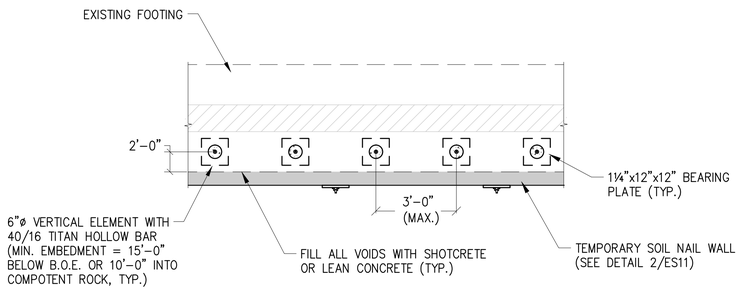
SECTION A-A



NOTES: 1. POSITION VERTICAL ELEMENTS ACCORDING TO FIELD CONDITIONS.
2. EMBED VERTICAL ELEMENT 5'-0" BELOW BOTTOM OF EXCAVATION.

2 / ES12 VERTICAL ELEMENT DETAIL (TYP.)
N.T.S.

1 / ES12 VERTICAL ELEMENT AT EXISTING FOOTING DETAIL (TYP.)
N.T.S.



3 / ES12 VERTICAL ELEMENTS AT EXISTING FOOTING (PLAN)
N.T.S.

90% DD Drawings

RICARDO JORDAN R.C.E. 68436 EXP. 9-30-15 DATE

REGISTERED PROFESSIONAL ENGINEER
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9685 VIA EXCELENCIA - SUITE 104, SAN DIEGO, CA 92126
TEL (760) 929-2851 FAX (760) 929-2852

DELTA	REVISION	DATE

PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA
PROPOSED TEMPORARY SHORING
DRAWING NAME: DETAILS

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: N.T.S.

SHEET
ES12
OF 13 SHEETS

REFERENCE ONLY - NOT FOR CONSTRUCTION

GENERAL NOTES AND DEFINITIONS

1. THE SHORING ENGINEER IS DEFINED AS THE REGISTERED CIVIL ENGINEER WHOSE STAMP RESIDES ON THESE DRAWINGS.
2. THE GENERAL CONTRACTOR (GC) IS AS DEFINED WITHIN THE CONTRACT DOCUMENTS.
3. CONSTRUCTION SHALL CONFORM TO ALL APPLICABLE SAFETY AND CONSTRUCTION CODES.
4. THE SHORING CONTRACTOR IS DEFINED AS THE ENTITY WHICH INSTALLS THE SUPPORT SYSTEM(S) SHOWN ON AND DESCRIBED WITHIN THE CONTRACT DOCUMENTS.
5. THE DESIGN OF THE SOIL NAIL WALL IS BASED ON THE GUIDELINES SET FORTH BY THE FHWA CIRCULAR NO. 7 DESIGN & CONSTRUCTION MONITORING OF SOIL NAIL WALLS."
6. GENERAL SITE EXCAVATION SHALL BE COORDINATED WITH THE INSTALLATION OF THE SHORING SYSTEM TO ENSURE SAFE WORKING CONDITIONS AND TO PREVENT THE LOSS OF GROUND AND THE CAVING OF BANKS.
7. PILE DRIVING EQUIPMENT, DRILL EQUIPMENT & CRANES SHALL NOT BE LOCATED WITHIN TEN (10) FEET OF THE SHORING BULKHEAD UNLESS SPECIFICALLY PROVIDED FOR IN THE DESIGN AND SPECIFICALLY SHOWN IN THESE DRAWINGS.
8. ALL SHORING DATA ON THESE SHEETS ARE THE EXCLUSIVE PROPERTY EARTH SUPPORT SYSTEMS INC. AND NO PART OF THESE DRAWINGS SHALL BE COPIED AND/OR USED WITHOUT OUR WRITTEN CONSENT.
9. THE GENERAL CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONDITIONS AT THE SITE AND REPORT ANY VARIATIONS TO THE SHORING ENGINEER.
10. THE GENERAL CONTRACTOR SHALL COORDINATE SHORING WITH DRAWINGS OF RECORD TO ENSURE PROVISIONS OF POCKETS, BLOCKOUTS, OFFSETS AND ANY OTHER ITEMS THAT MAY BE IN CONFLICT WITH OR AFFECTED BY THE SHORING SYSTEM.
11. ALL INSPECTION SERVICES, MATERIAL TESTING OR NOTIFICATIONS SHALL BE THE RESPONSIBILITY OF THE GENERAL CONTRACTOR.
12. ALL PERMITS (EXCEPT OSHA PERMIT) SHALL BE PROCURED AND PAID FOR BY THE GENERAL CONTRACTOR.
13. ALL ENCROACHMENT EASEMENTS AND PERMISSIONS SHALL BE PROCURED AND PAID FOR BY THE GENERAL CONTRACTOR.
14. ALL STRUCTURAL DETAILS OR SHAPES SHOWN ARE THOSE UTILIZED FOR DESIGN. ALTERNATE DETAILS, CONNECTIONS, SHAPES AND/OR MATERIALS MAY BE USED SUBJECT TO THE APPROVAL OF THE SHORING ENGINEER AND THE BUILDING OFFICIAL.
15. THE GENERAL CONTRACTOR SHALL PERIODICALLY MONITOR THE FACE OF SHOTCRETE AS THE INSTALLATION PROGRESSESS. THE SURVEY DATA SHALL BE REDUCED, INTERPRETED AND TRANSMITTED TO THE SHORING ENGINEER.
16. IF IN THE OPINION OF THE SHORING ENGINEER, MONITORING DATA INDICATES EXCESSIVE MOVEMENT, ALL SHORING WORK SHALL CEASE UNTIL THE SHORING ENGINEER INVESTIGATES THE SITUATION AND MAKES RECOMMENDATIONS FOR REMEDIATION OR CONTINUING. IN ADDITION, THE SURVEY DATA WILL BE USED BY THE SHORING CONTRACTOR TO MAINTAIN ALIGNMENT OF THE SHORING FACE.

PROCEDURE FOR SOIL NAILING

1. LINES AND GRADES ARE TO BE ESTABLISHED BY THE GENERAL CONTRACTOR TO ENSURE PROPER LOCATION OF SOIL NAIL ANCHORS.
2. EXCAVATED FACE SHALL BE TRIMMED UNIFORMLY TO A VERTICAL PLANE OR BATTER (SEE PLANS & SECTIONS) AT BACK FACE OF SHOTCRETE BY CONTRACTOR. START EXCAVATION AND SHOTCRETE IN LIFTS NOT TO EXCEED FIVE (5) FEET OR AS OTHERWISE AUTHORIZED BY THE SHORING ENGINEER. CONTINUE THIS EXCAVATION PROCEDURE UNTIL ANCHOR LEVELS ARE REACHED.
3. THE GENERAL CONTRACTOR SHALL GRADE SAFE WORKING AND DRILLING BENCHES NOT MORE THAN TWO (2) FEET LOWER THAN THE ANCHOR LEVEL. BENCHES SHALL HAVE LENGTHS AND WIDTHS WHICH WILL ALLOW FOR SAFE AND PRODUCTIVE MOVEMENT OF THE ANCHOR DRILLING EQUIPMENT.
4. DRILL ANCHOR HOLES TO THE DEPTHS AND DIAMETERS INDICATED OR AS OTHERWISE AUTHORIZED BY THE SHORING ENGINEER. IF CAVING OCCURS, CASING OR OTHER ALTERNATE DRILLING METHODS MAY BE USED AS AUTHORIZED BY THE SHORING ENGINEER.
5. INSERT THE ANCHOR TENDONS INTO THE DRILLED SHAFTS WHILE TAKING MEASURES TO ENSURE THAT THE TENDONS ARE CENTERED (I.E. BY THE USE OF CENTRALIZING DEVICES OR OTHER MEANS ACCEPTABLE TO THE SHORING ENGINEER) IN THE DRILLED SHAFT.
6. BACKFILL THE ANCHOR LENGTH WITH A CONCRETE GROUT MIX IDENTIFIED IN MATERIALS.
7. AFTER ANCHORS HAVE BEEN PLACED, REINFORCEMENT & SHOTCRETE SHALL BE APPLIED TO THE EXCAVATED FACE. A BEARING PLATE WILL THEN BE PLACED ON THE ANCHOR AND BOLTED DOWN WITH A BEARING NUT.
8. EXCAVATE TO NEXT DRILL BENCH LOCATION AFTER SHOTCRETE HAS CURED FOR TWO (2) DAYS MIN.
9. REPEAT STEPS 5 THROUGH 10 AS APPLICABLE FOR EACH ADDITIONAL LEVEL OF ANCHORS OR UNTIL BOTTOM OF EXCAVATION IS REACHED.

PROCEDURE FOR SOIL NAIL TESTING

1. PROOF TEST 5% OF TOTAL ANCHORS @ 150% OF ALLOWABLE PULL-OUT RESISTANCE IN ACCORDANCE WITH FHWA "GEOTECHNICAL ENGINEERING CIRCULAR No.7."
2. PERFORMANCE TEST 2 ANCHORS MINIMUM @ 150% OF ALLOWABLE PULL-OUT RESISTANCE IN ACCORDANCE WITH FHWA "GEOTECHNICAL ENGINEERING CIRCULAR No.7."
3. ALLOWABLE PULL OUT RESISTANCE FOR THIS PROJECT EQUALS: 2,827 POUNDS PER LINEAL FOOT. (12.5-PSI)
4. ALL TESTING TO BE PERFORMED UNDER THE SUPERVISION OF THE GEOTECHNICAL ENGINEER'S REPRESENTATIVE.

MATERIALS (SOIL NAIL WALL)

1. WELDING: ELECTRIC ARC USING ELECTRODES E70-XX PLACED BY QUALIFIED WELDERS.
2. MISCELLANEOUS STEEL: STEEL SHALL CONFORM TO REQUIREMENTS OF ASTM A-36 (36 KSI) OR BETTER.
3. ANCHOR TENDON: ANCHOR TENDON SHALL BE GRADE 75 ASTM A-615 THREADED BAR OR BETTER. SEE CROSS SECTIONS FOR BAR SIZES & LENGTHS.
4. ANCHOR CONCRETE/GROUT: ANCHOR PLUG FOR SOIL NAILS SHALL BE NEAT PORTLAND CEMENT WITH A MAXIMUM WATER-CEMENT RATIO OF 0.45 BY WEIGHT. IT MAY CONTAIN AN ADDITIVE TO CONTROL SHRINKAGE, SUCH AS INTRAPLAST-N BY SIKA CORP., AND SHALL HAVE SUFFICIENT STRENGTH TO INSURE LOAD TRANSFER BETWEEN THE THREADED BAR AND SOIL. AT THE SHORING CONTRACTORS OPTION, A 3000 PSI CONCRETE @ 28 DAYS COMPRESSIVE STRENGTH MAY BE UTILIZED.
5. SHOTCRETE: SHOTCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS OF 4000 PSI.
6. REINFORCING STEEL: REINFORCING STEEL SHALL BE GRADE 60 AND CONFORM TO REQUIREMENTS OF ASTM A615.
7. WELDED WIRE FABRIC: STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A-185.
8. HOLLOW BARS: CTS TITAN HOLLOW BARS CONFORMING TO MANUFACTURER'S SPECIFICATIONS.

MONITORING (TEMPORARY)

1. MONITORING OF THE SURROUNDING GRADE ADJACENT TO THE SHORED EXCAVATION AND EXISTING STRUCTURES SHALL BE PERFORMED AT REGULAR INTERVALS, NOT TO EXCEED FIVE DAYS OR WITH EACH LIFT OF THE EXCAVATION (WHICHEVER IS MORE FREQUENT), TO CONFIRM THAT HORIZONTAL MONUMENTS AND SETTLEMENTS AGREE WITH THOSE ESTIMATED. (MAXIMUM ESTIMATED LATERAL MOVEMENT OR SETTLEMENT = 1.0 INCH) MONITORING MAY BE PERFORMED WEEKLY IF THE RESULTS OF PERFORMANCE MONITORING INDICATE STABLE CONDITIONS AND THE CONSTRUCTION MANAGER CONCURS THAT MONITORING FREQUENCY CAN BE REDUCED. A BASELINE SURVEY SHALL BE PERFORMED PRIOR TO THE BEGINNING OF CONSTRUCTION. SURVEY MONITORING POINTS SHALL BE PLACED AT SOIL NAIL LEVEL ONE AT APPROXIMATELY 36 FEET ON CENTER HORIZONTALLY. A SECOND SERIES OF MONITORING POINTS SHALL BE PLACED 15 FEET FROM THE FACE OF THE SHORING WALL ON THE ADJACENT GROUND.
2. THE EFFECTS OF THE PROPOSED EXCAVATION AND SHORING SYSTEM ON EXISTING IMPROVEMENTS & UTILITIES SHALL BE MONITORED IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE GEOTECHNICAL CONSULTANT CONTAINED IN THE GEOTECHNICAL DOCUMENTS LISTED UNDER THE "GRADING & GEOTECHNICAL SPECIFICATIONS".

SUMMARY OF SPECIAL INSPECTION

1	Concrete	13.1	Verify soils conditions are substantially in conformance with the soil investigation report
2	Bolts installed in concrete	13.2	Verify that foundation excavations extend to proper depth and bearing strata
3	Concrete moment-resisting space frame	13.3	Provide soil compaction test results, depth of fill, relative density, bearing values
4	Reinforcing steel and prestressing steel	13.4	Provide soil expansion test results, expansion index, recommendations for foundations, on-grade floor slab design for each building site
5.1	All structural welding	14	Smoke control system
5.2	Weld testing ductile moment-resisting steel frame	15	Special cases (describe)
5.3	Welding reinforcing steel	16	off-site fabrication of building components
6	High-strength bolting	17	Other special inspections as required by designer (Structural Observation)
7	Structural masonry		
8	Reinforced gypsum concrete		
9	Insulating concrete fill		
10	Spray-applied fireproofing		
11	Deep foundations (piling & drilled caissons)		
12	Shotcrete		

Number	Description of Type of Inspection Required, Location, Remarks, etc.	Design Strength
1	Shotcrete. Verify design mix & strength.	4000 psi
2	Anchor Grout. Verify design mix & strength.	3000 psi
3	Verify drilled shaft length, diameter & angle for soil nails.	
4	Proof testing 5% of total anchors to 150%.	
5	Performance testing @150% (min. 2 anchors per soil type).	
6	Placement of reinf. steel & soil nails.	
7	Field Welds	E70-XX
8	Soil item 13.1	

a. The Special Inspections listed are in addition to the called inspections required by the CBC, as amended. Special Inspection is not a substitute for inspection by a City Inspector.
   1. Structural Observation does not include or waive the responsibility for the inspections required by the CBC.

b. Continuous inspection is always required during the performance of the work unless otherwise specified. When work in more than one category of work requiring special inspection is to be performed simultaneously, or the geographic location of the work is such that it cannot be continuously observed in accordance with the provisions of the CBC, it is the agent's responsibility to employ a sufficient number of inspectors to assure that all the work is inspected in accordance with those provisions.

c. The Special Inspectors must be certified by the City of San Diego to perform the type of inspection specified.

Exceptions:
1. Soils inspections by the Soils Engineer of record.
2. Smoke Control System, by the Mechanical Engineer of record.
3. When waived by the Building Official.

d. It is the responsibility of the contractor to notify the Special Inspector or inspection agency at least one working day prior to performing any work that requires special inspection.

e. Specially inspected work that is installed or covered without the approval of the City Inspector is subject to removal or exposure.

TEMPORARY SOIL NAIL DESIGN PARAMETERS

FORMATION (BORING NO.4):
Ø = 33° γ = 125 pcf.
C = 600 psf. Fa = 25 psi. (ultimate)

SOIL DESIGN PARAMETERS USED FOR SOIL NAIL WALL DESIGN ARE BASED IN THE RECOMMENDATIONS CONTAINED IN:

- GEOTECHNICAL EXPLORATION REPORT: OFF SEASON TWO IMPROVEMENTS
  2580 CAHUENGA BOULEVARD EAST
  HOLLYWOOD DISTRICT OF LOS ANGELES, CALIFORNIA
  LEIGHTON PROJECT NO. 10296.001
  PREPARED BY: LEIGHTON CONSULTING, INC.
  DATED: SEPTEMBER 10, 2013

90% DD Drawings

REGISTERED PROFESSIONAL ENGINEER
RICARDO JORDAN
No. 68436
Exp. 9/30/15
CIVIL
STATE OF CALIFORNIA

RICARDO JORDAN R.C.E. 68436 EXP. 9-30-15 DATE

EARTH SUPPORT SYSTEMS
9685 VIA EXCELENCIA - SUITE 104, SAN DIEGO, CA 92126
TEL (760) 929-2851 FAX (760) 929-2852

DATE | REVISION | DELTA

PROJECT: JOHN ANSEN FORD THEATERS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD, CA

DRAWING: PROPOSED TEMPORARY SHORING NOTES

DATE: 11/15/2013
DRAWN BY: R.M.
PROJECT No: 13-146
REVISION: -
SCALE: N.T.S.

SHEET
ES13
OF 13 SHEETS

REFERENCE ONLY - NOT FOR CONSTRUCTION

SECTION 2

Earth Support Systems, Inc.
5937 Darwin Court # 105
Carlsbad, CA 92008

Temporary Shotcrete Facing Design

Facing Properties

$H := 25 \cdot ft$ = Maximum retained height

$Hs := 110 \cdot ft$ = Retained slope height

$t_f := 4 \cdot in$ = Shotcrete facing thickness

$f'_c := 4000 \cdot psi$ = Shotcrete compressive strength

$shaft := 6 \cdot in$ = Soil nail drill shaft diameter

$Sh := 6 \cdot ft$ = Horizontal nail spacing

$Sv := 5 \cdot ft$ = Vertical nail spacing

Welded Wire Reinforcement

Wire ≡ "W4.0 x W4.0"

grid ≡ 4·in = Welded wire center-to-center grid spacing

$N := 1$ = Number of welded wire reinforcement per layer

$Ast = 0.12 \cdot \frac{in^2}{ft}$ = Weld wire reinforcement area per foot width

$Ah := N \cdot Ast$ = Welded wire horizontal cross sectional area

$Av := Ah$ = Welded wire vertical cross sectional area

$Fy_{wire} := 60 \cdot ksi$ = Welded wire yield strength (ASTM A 1064)

Welded Wire

$Ah = 0.12 \cdot \frac{in^2}{ft}$
$Av = 0.12 \cdot \frac{in^2}{ft}$

Waler Bars at Nail Head (As Applicable)

bar ≡ 4 = Waler rebar size ("N/A" = Not applicable)

$Nb := 2$ = Number of waler / bearing bars

$db := diabar$ = Waler / bearing bar nominal diameter

$Ab := areabar$ = Waler / bearing bar cross sectional area

$Fy_b := 60 \cdot ksi$ = Waler / bearing bar yield strength (Grade 60)

Waler / Bearing Bars

$db = 0.5 \cdot in$
$Ab = 0.2 \cdot in^2$

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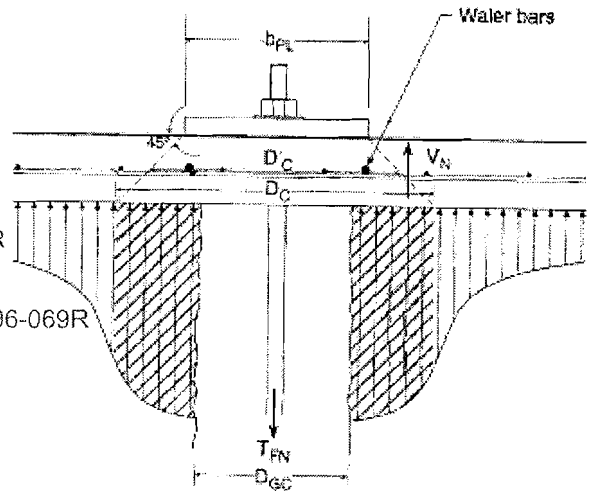
Facing Properties (Continued)



Nail Head Assembly

Plate := "8-in x 8-in x 3/4in"

$b_p := 8 \cdot in$ = Bearing plate width - 8" min, FHWA-SA-96-069R

$t_p := 0.75 \cdot in$ = Bearing plate thickness - 0.75" min, FHWA-SA-96-069R

$Fy_p := 36 \cdot ksi$ = Bearing plate yield strength (Grade 36)

Soil Stremgth Properties

$\phi := \frac{33 \cdot deg}{1.5}$ = Internal soil friction angle (Conservative)

$\gamma := 125 \cdot pcf$ = Soil unit weight

$C := \frac{600 \cdot psf}{1.5}$ = Soil cohesion

$x := 1.4$ = Horizontal Slope Projection

$y := 1$ = Vertical Slope Projection

Internal Failure Loading

Initial Guess fail := 35·deg

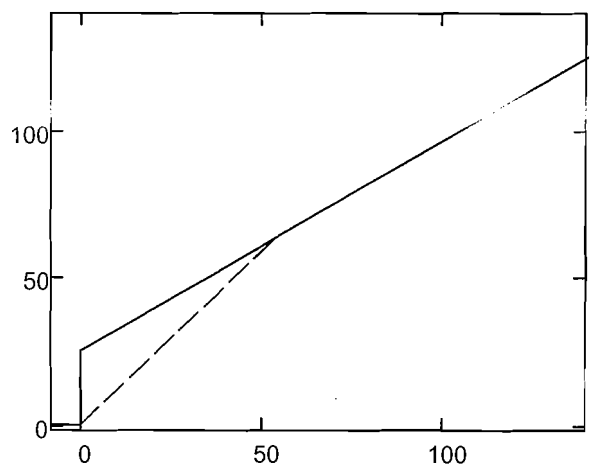
Given

$$\frac{d}{dfail} Q(fail) = 0$$

$\beta := Find(fail)$

$\beta = 40.3 \cdot deg$
$Q(\beta) = 9288 \cdot plf$

Critical Failure Plane Geometry



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I. Facing Flexure

SLD Strength Factors - Group IV, Temporary

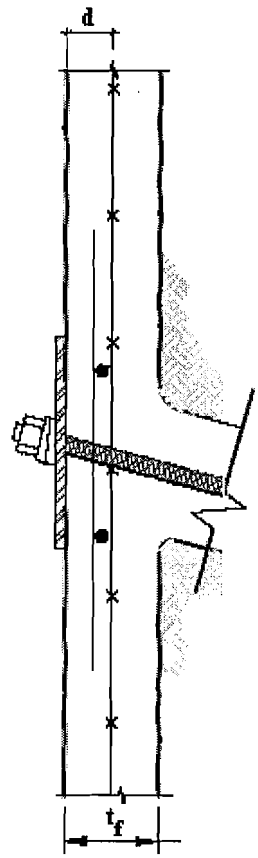
$d := \frac{t_f - dia}{2}$ = Distance to tensile negative moment reinforcement

$A_{v_j} := Av \cdot Sh + Nb \cdot Ab \cdot (j - 1)$ = Negative reinforcement area

$A_{h_j} := Ah \cdot Sv + Nb \cdot Ab$ = Positive reinforcement area

$C_F := \begin{cases} 2.0 & \text{if } t_f \le 4 \cdot in \\ 1.5 & \text{if } 4 \cdot in < t_f \le 6 \cdot in \\ 1.0 & \text{otherwise} \end{cases}$ = Flexure pressure factor
Table 4.2, p. 104 FHWA-SA-96-069R

$\alpha_F := 0.67$ = Nail head facing flexure factor
Table 4.4, p. 119 FHWA-SA-96-069R



Reinforcing depth, $d = 1.9 \cdot in$

Reinforcement Area

$A_{v_1} = 0.72 \cdot in^2$	$A_{h_1} = 1 \cdot in^2$	***Positive***
$A_{v_2} = 1.12 \cdot in^2$	$A_{h_2} = 1 \cdot in^2$	***Negative***

Horizontal Moment Capacity

$$mv_j := \frac{A_{v_j} \cdot \min(Fy_{wire}, Fy_b)}{Sh} \cdot \left(d - \frac{A_{v_j} \cdot \min(Fy_{wire}, Fy_b)}{1.7 \cdot f'_c \cdot Sh} \right)$$

= Negative moment capacity
p. 106 eqn 4.1A FHWA-SA-96-069R

$$mh_j := \frac{A_{h_j} \cdot \min(Fy_{wire}, Fy_b)}{Sv} \cdot \left(d - \frac{A_{h_j} \cdot \min(Fy_{wire}, Fy_b)}{1.7 \cdot f'_c \cdot Sv} \right)$$

= Positive moment capacity
p. 106 eqn 4.1A FHWA-SA-96-069R

$$T_F := \min\left[\begin{bmatrix} 8C_F \cdot (mv_1 + mv_2) \cdot \left(\frac{Sh}{Sv}\right) \\ 8C_F \cdot (mh_1 + mh_2) \cdot \left(\frac{Sv}{Sh}\right) \end{bmatrix}\right]$$

= Nominal nail head flexural capacity
p. 105 eqn 4.1A FHWA-SA-96-069R

Ultimate Strength	$T_F = 46.4 \cdot kip$
Allowable Strength	$\alpha_F \cdot T_F = 31.1 \cdot kip$

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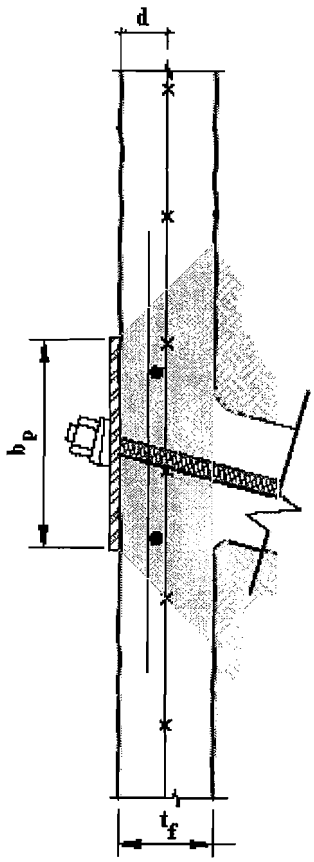
II. Punching Shear



SLD Strength Factors - Group I, Permanent

Figure 4.9, p. 108 FHWA-SA-96-069R

$hc := t_f$ = Effective punching cone height

$Dc := b_p + 2hc$ = Effective punching cone diameter (Bottom)

$Dc' := b_p + hc$ = Critical punching cone diameter (Mid-height)

$Dgc := shaft$ = Diameter of grouted soil nail column

$Ac := \frac{\pi \cdot Dc^2}{4}$ = Area of effective punching cone

$Agc := \frac{\pi \cdot Dgc^2}{4}$ = Area of effective punching cone

$Ac = 201 \cdot in^2$	Critical cone diameter, $Dc' = 12 \cdot in$
$Agc = 28 \cdot in^2$	Grouted col. diameter, $Dgc = 6 \cdot in$

Nominal Nail Head Shear Strength

$\alpha_s := 0.67$ = Punching shear strength factor - Table 4.5, p. 121 FHWA-SA-96-069R

$C_s := 1.0$ = Punching shear pressure factor - Table 4.5, p. 121 FHWA-SA-96-069R

$V_N := 4 \cdot \sqrt{f'_c \cdot psi} \cdot \pi \cdot Dc' \cdot hc$ = Internal punching shear strength - Table 4.2, p. 107 FHWA-SA-96-069R
ACI 318-99, Eqn. 11-37

$$T_{PS} := \frac{V_N}{1 - C_s \cdot \frac{(Ac - Agc)}{Sv \cdot Sh - Agc}}$$

= Nominal nail head srength (Punching shear)
Eqn. 4.3, p. 109 FHWA-SA-96-069R

Ultimate Strength	$T_{PS} = 39.7 \cdot kip$
Allowable Strength	$\alpha_s \cdot T_{PS} = 26.6 \cdot kip$

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GOVERNING ALLOWABLE NAIL HEAD STRENGTH

$$Tgov := \min\left(\begin{pmatrix} \alpha_F \cdot T_F \\ \alpha_s \cdot T_{PS} \end{pmatrix}\right)$$

$Tgov = 26.6 \cdot kip$	*Allowable flexural capacity governs facing strength*

Minimum Allowable Nail Head Service Load Check

$F_F := 0.50$ = Nail head survice factor p. 50 & 119 FHWA-SA-96-069R

$kc := 1.5$ = Complexity coefficient p. 50 & 119 FHWA-SA-96-069R
kc = 1 for normal configurations
kc = 2 for complex multi-layered soil configurations

$$t_F := \frac{2kc \cdot F_F \cdot Q(\beta) \cdot Sh \cdot Sv}{H}$$ = Nail head survice load eqn. 4.6 FHWA-SA-96-069R

$SLoad := if(t_F \le Tgov, "Ok", "No Good")$

$SLoad = "Ok"$

Nail Head Allowable Load	$Tgov = 26.6 \cdot kip$
Nail Head Service Load	$t_F = 16.7 \cdot kip$

Check Upper Cantilever

One-Way Service Flexure Check

$Hcant := 3.5 \cdot ft$ = Maximum height of cantilevered shotcrete

$Ps := 100 \cdot psf$ = Uniform surcharge load

$$ms := \frac{2 \cdot Q(\beta)}{H^2} \cdot \frac{Hcant^3}{6} + Ps \cdot \frac{Hcant^2}{2}$$ = Cantilevered one-way service moment

$Mall := \alpha_F \cdot mv_2$ = Allowable one-way service moment

$Flexure := if(ms \le Mall, "Ok", "No Good")$

$ms = 0.82 \cdot kip \cdot \frac{ft}{ft}$
$Mall = 1.09 \cdot kip \cdot \frac{ft}{ft}$

$Flexure = "Ok"$

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One-Way Service Shear

$vs := \frac{2 \cdot Q(\beta)}{H^2} \cdot \frac{Hcant^2}{2} + Ps \cdot Hcant$ = Cantilevered service shear

$V_{NS} := 2 \cdot \sqrt{f'_c \cdot psi} \cdot d$ = Cantilevered one-way nominal shear
ACI 318, Eqn. 11-28

$Vall := \alpha_s \cdot V_{NS}$ = Cantilevered one-way allowable shear

$Shear := if(vs \le Vall, "Ok", "No Good")$

$vs = 0.5 \cdot klf$
$Vall = 1.9 \cdot klf$

Shear = "Ok"

Welded Wire Mesh Minimum Development & Splice Length

$\lambda := 1$ = Aggregate concrete factor - ACI 12.2.4

$Awire := Ah \cdot grid$ = Cross sectional area of welded wire grid

$l_d := 0.27 \cdot \frac{Awire \cdot in}{grid} \cdot \left(\frac{Fy_{wire}}{\sqrt{f'_c \cdot lb}} \right) \cdot \lambda$ = Welded wire fabric development length - ACI 12.8

$splice := \max\left(\begin{pmatrix} grid + 2 \cdot in \\ 1.5 \cdot l_d \\ 6 \cdot in \end{pmatrix} \right)$ = Minimum welded wire splice length
ACI 12.19.1 & 12.19.2

$l_d = 2.6 \cdot in$
$splice = 6 \cdot in$

Minimum splice, Lap 2 Sqaures

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Facing Reinforcement Details (Continued)

Waler & Bearing Bars Minimum Development Length (As Applicable)

bar = 4 = Waler / Bearing rebar size (As applicable)

db = 0.5·in = Waler bar nominal diameter

$\alpha := 1$ = Rebar location factor - ACI 12.2.4

$\beta := 1$ = Coating factor - ACI 12.2.4

$\lambda := 1$ = Aggregate concrete factor - ACI 12.2.4

$cmin := t_f - d$ = Waler / Bearing rebar minimum cover (As applicable)

spacing := 12·in = Waler / Bearing spacing (As applicable)

ACI 7.7.1 & ACI 12.2.2

Cover := if(cmin ≥ 2·in, "Ok" , "No Good")

Space := if(spacing ≥ 2·db, "Ok" , "No Good")

Cover = "Ok"
Space = "Ok"

Minimum Waler Bar Length

$$l_d := \begin{cases} 0\cdot in & \text{if bar = "N/A"} \\ \text{otherwise} & \\ \quad \dfrac{\dfrac{Fy_b}{psi}\cdot\alpha\cdot\beta\cdot\lambda}{25\cdot\sqrt{\dfrac{f'_c}{psi}}}\cdot db & \text{if bar} \le 6 \\ \quad \dfrac{\dfrac{Fy_b}{psi}\cdot\alpha\cdot\beta\cdot\lambda}{20\cdot\sqrt{\dfrac{f'_c}{psi}}}\cdot db & \text{if bar} > 6 \end{cases}$$

= Basic development length - ACI 12.2.2

$l_d = 19\cdot in$

Use, 24" Long Waler Bars 12" o.c.

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Theoretical Displacement

$H = 25\,ft$ = Maximum soil nail retained height

$Lnail := 25 \cdot ft$ = Average nail length of wall under consideration

$Soil\_type := "A"$ = Soil type - Use: "A" for dense granular soils / rock
"B" for medium dense granular soils
"C" for loose granular soils / clays

$C := 0.70$ = Typical nail length to wall height ratio

$$\delta := \begin{cases} 0.1\% & \text{if } Soil\_type = "A" \\ 0.2\% & \text{if } Soil\_type = "B" \\ (0.4\%) & \text{if } Soil\_type = "C" \end{cases}$$ = Peak wall displacement coefficients p. 53, 2.4.6 FHWA-SA-96-069R

$$\Delta := \frac{\delta \cdot C \cdot H^2}{Lnail}$$ = Maximum theoretical deflection

$\Delta = 0.2 \cdot in$

Facing Reinforcement Details

Minimum Reinforcement

$b := 12 \cdot in$ = Width of concrete section for analysis

Vertical Direction

$Asvmin := 0.0012 \cdot t_f \cdot b$ = Minimum vertical reinforcement area - ACI 14.3.2

$Avsteel := Av \cdot b$ = Total vertical reinforcement per foot width

$Vertical := if(Asvmin \le Avsteel, "Ok", "No Good")$

$Asvmin = 0.06 \cdot in^2$

$Avsteel = 0.12 \cdot in^2$

Vertical = "Ok"

Horizontal Direction

$Ashmin := 0.0020 \cdot t_f \cdot b$ = Minimum horizontal reinforcement area - ACI 14.3.3

$Ahsteel := Ah \cdot b + Nb \cdot Ab$ = Total horizontal reinforcement per foot width

$Horizontal := if(Ashmin \le Ahsteel, "Ok", "No Good")$

$Ashmin = 0.1 \cdot in^2$

$Ahsteel = 0.52 \cdot in^2$

Horizontal = "Ok"

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Temporary Shotcrete Facing Design

Facing Properties

$H := 20 \cdot ft$ = Maximum retained height

$Hs := 0 \cdot ft$ = Retained slope height

$t_f := 6 \cdot in$ = Shotcrete facing thickness

$f'_c := 4000 \cdot psi$ = Shotcrete compressive strength

$shaft := 6 \cdot in$ = Soil nail drill shaft diameter

$Sh := 6 \cdot ft$ = Horizontal nail spacing

$Sv := 5 \cdot ft$ = Vertical nail spacing

Welded Wire Reinforcement

Wire ≡ "W4.0 x W4.0"

grid ≡ 4·in = Welded wire center-to-center grid spacing

$N := 2$ = Number of welded wire reinforcement per layer

$Ast = 0.12 \cdot \frac{in^2}{ft}$ = Weld wire reinforcement area per foot width

$Ah := N \cdot Ast$ = Welded wire horizontal cross sectional area

$Av := Ah$ = Welded wire vertical cross sectional area

$Fy_{wire} := 60 \cdot ksi$ = Welded wire yield strength (ASTM A 1064)

Welded Wire

$Ah = 0.24 \cdot \frac{in^2}{ft}$
$Av = 0.24 \cdot \frac{in^2}{ft}$

Waler Bars at Nail Head (As Applicable)

bar ≡ 4 = Waler rebar size ("N/A" = Not applicable)

$Nb := 2$ = Number of waler / bearing bars

$db := diabar$ = Waler / bearing bar nominal diameter

$Ab := areabar$ = Waler / bearing bar cross sectional area

$Fy_b := 60 \cdot ksi$ = Waler / bearing bar yield strength (Grade 60)

Waler / Bearing Bars

$db = 0.5 \cdot in$
$Ab = 0.2 \cdot in^2$

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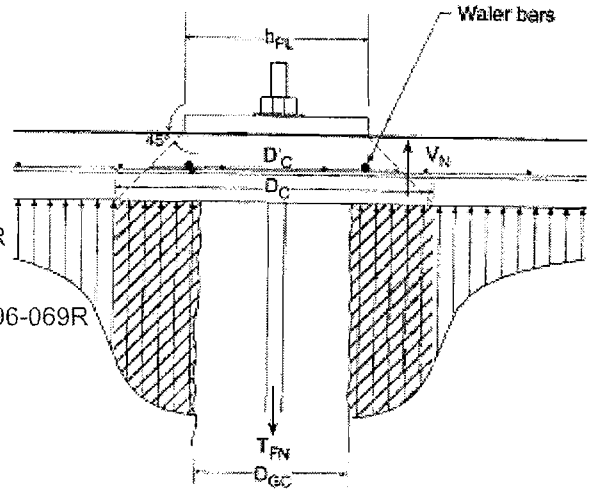
Facing Properties (Continued)



Nail Head Assembly

Plate := "12-in x 12-in x 1in"

$b_p := 12 \cdot in$ = Bearing plate width - 8" min, FHWA-SA-96-069R

$t_p := 1 \cdot in$ = Bearing plate thickness - 0.75" min, FHWA-SA-96-069R

$Fy_p := 36 \cdot ksi$ = Bearing plate yield strength (Grade 36)

Soil Stremgth Properties

$\phi := \frac{33 \cdot deg}{1.5}$ = Internal soil friction angle (Conservative)

$\gamma := 125 \cdot pcf$ = Soil unit weight

$C := \frac{600 \cdot psf}{1.5}$ = Soil cohesion

$x := 0$ = Horizontal Slope Projection

$y := 0$ = Vertical Slope Projection

Internal Failure Loading

Initial Guess fail := 35·deg

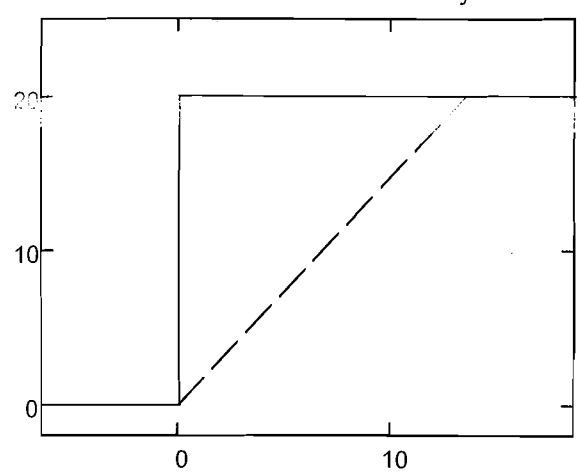
Given

$\frac{d}{dfail} C(fail) = 0$

$\beta := Find(fail)$

$\beta = 34 \cdot deg$
$Q(\beta) = 582 \cdot plf$

Critical Failure Plane Geometry



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I. Facing Flexure

SLD Strength Factors - Group IV, Temporary

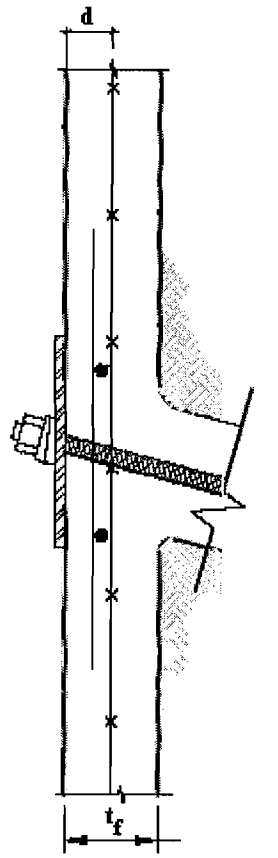
$d := \frac{t_f - dia}{2}$ = Distance to tensile negative moment reinforcement

$A_{v_j} := Av \cdot Sh + Nb \cdot Ab \cdot (j - 1)$ = Negative reinforcement area

$A_{h_j} := Ah \cdot Sv + Nb \cdot Ab$ = Positive reinforcement area

$C_F := \begin{cases} 2.0 & \text{if } t_f \le 4 \cdot in \\ 1.5 & \text{if } 4 \cdot in < t_f \le 6 \cdot in \\ 1.0 & \text{otherwise} \end{cases}$ = Flexure pressure factor
Table 4.2, p. 104 FHWA-SA-96-069R

$\alpha_F := 0.67$ = Nail head facing flexure factor
Table 4.4, p. 119 FHWA-SA-96-069R



Reinforcing depth, $d = 2.9 \cdot in$

Reinforcement Area

$A_{v_1} = 1.44 \cdot in^2$	$A_{h_1} = 1.6 \cdot in^2$	***Positive***
$A_{v_2} = 1.84 \cdot in^2$	$A_{h_2} = 1.6 \cdot in^2$	***Negative***

Horizontal Moment Capacity

$$mv_j := \frac{A_{v_j} \cdot \min(Fy_{wire}, Fy_b)}{Sh} \cdot \left(d - \frac{A_{v_j} \cdot \min(Fy_{wire}, Fy_b)}{1.7 \cdot f'_c \cdot Sh} \right)$$

= Negative moment capacity
p. 106 eqn 4.1A FHWA-SA-96-069R

$$mh_j := \frac{A_{h_j} \cdot \min(Fy_{wire}, Fy_b)}{Sv} \cdot \left(d - \frac{A_{h_j} \cdot \min(Fy_{wire}, Fy_b)}{1.7 \cdot f'_c \cdot Sv} \right)$$

= Positive moment capacity
p. 106 eqn 4.1A FHWA-SA-96-069R

$$T_F := \min\left[\begin{bmatrix} 8C_F \cdot (mv_1 + mv_2) \cdot \left(\frac{Sh}{Sv}\right) \\ 8C_F \cdot (mh_1 + mh_2) \cdot \left(\frac{Sv}{Sh}\right) \end{bmatrix}\right]$$

= Nominal nail head flexural capacity
p. 105 eqn 4.1A FHWA-SA-96-069R

Ultimate Strength	$T_F = 84.9 \cdot kip$
Allowable Strength	$\alpha_F \cdot T_F = 56.9 \cdot kip$

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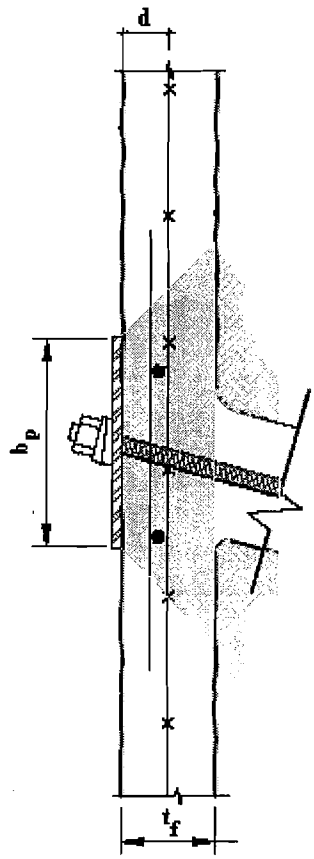
II. Punching Shear

SLD Strength Factors - Group I, Permanent

Figure 4.9, p. 108 FHWA-SA-96-069R



$hc := t_f$ = Effective punching cone height

$Dc := b_p + 2hc$ = Effective punching cone diameter (Bottom)

$Dc' := b_p + hc$ = Critical punching cone diameter (Mid-height)

$Dgc := shaft$ = Diameter of grouted soil nail column

$Ac := \frac{\pi \cdot Dc^2}{4}$ = Area of effective punching cone

$Agc := \frac{\pi \cdot Dgc^2}{4}$ = Area of effective punching cone

$Ac = 452 \cdot in^2$	Critical cone diameter, $Dc' = 18 \cdot in$
$Agc = 28 \cdot in^2$	Grouted col. diameter, $Dgc = 6 \cdot in$

Nominal Nail Head Shear Strength

$\alpha_s := 0.67$ = Punching shear strength factor - Table 4.5, p. 121 FHWA-SA-96-069R

$C_s := 1.0$ = Punching shear pressure factor - Table 4.5, p. 121 FHWA-SA-96-069R

$V_N := 4 \cdot \sqrt{f'_c \cdot psi} \cdot \pi \cdot Dc' \cdot hc$ = Internal punching shear strength - [illegible]
ACI 318-99, Eqn. 11-37

$$T_{PS} := \frac{V_N}{1 - C_s \cdot \frac{(Ac - Agc)}{Sv \cdot Sh - Agc}}$$

= Nominal nail head srength (Punching shear)
Eqn. 4.3, p. 109 FHWA-SA-96-069R

Ultimate Strength	$T_{PS} = 95.2 \cdot kip$
Allowable Strength	$\alpha_s \cdot T_{PS} = 63.8 \cdot kip$

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GOVERNING ALLOWABLE NAIL HEAD STRENGTH

$$Tgov := \min\left(\begin{pmatrix} \alpha_F \cdot T_F \\ \alpha_s \cdot T_{PS} \end{pmatrix}\right)$$

Tgov = 56.9·kip

Allowable flexural capacity governs facing strength

Minimum Allowable Nail Head Service Load Check ---> $Ps := 1500 \cdot psf$ = Uniform surcharge load

$F_F := 0.50$ = Nail head survice factor p. 50 & 119 FHWA-SA-96-069R

$kc := 1.5$ = Complexity coefficient p. 50 & 119 FHWA-SA-96-069R
kc = 1 for normal configurations
kc = 2 for complex multi-layered soil configurations

$$t_F := \frac{2kc \cdot F_F \cdot Q(\beta) \cdot Sh \cdot Sv}{H} + Ps \cdot Sh \cdot Sv$$ = Nail head survice load eqn. 4.6 FHWA-SA-96-069R

$SLoad := if(t_F \le Tgov, "Ok", "No Good")$

SLoad = "Ok"

Nail Head Allowable Load	Tgov = 56.9·kip
Nail Head Service Load	t_F = 46.3·kip

Check Upper Cantilever

One-Way Service Flexure Check

$Hcant := 3 \cdot ft$ = Maximum height of cantilevered shotcrete

$Ps := 100 \cdot psf$ = Uniform surcharge load (Footing outside 1-1 projection)

$$ms := \frac{2 \cdot Q(\beta)}{H^2} \cdot \frac{Hcant^3}{6} + Ps \cdot \frac{Hcant^2}{2}$$ = Cantilevered one-way service moment

$Mall := \alpha_F \cdot mv_2$ = Allowable one-way service moment

$Flexure := if(ms \le Mall, "Ok", "No Good")$

ms = 0.46·kip·ft/ft
Mall = 2.73·kip·ft/ft

Flexure = "Ok"

One-Way Service Shear

$vs := \frac{2 \cdot Q(\beta)}{H^2} \cdot \frac{Hcant^2}{2} + Ps \cdot Hcant$ = Cantilevered service shear

$V_{NS} := 2 \cdot \sqrt{f'_c \cdot psi} \cdot d$ = Cantilevered one-way nominal shear
ACI 318, Eqn. 11-28

$Vall := \alpha_s \cdot V_{NS}$ = Cantilevered one-way allowable shear

Shear := if(vs ≤ Vall, "Ok", "No Good")

vs = 0.3·klf
Vall = 2.9·klf

Shear = "Ok"

Welded Wire Mesh Minimum Development & Splice Length

$\lambda := 1$ = Aggregate concrete factor - ACI 12.2.4

$Awire := Ah \cdot grid$ = Cross sectional area of welded wire grid

$l_d := 0.27 \cdot \frac{Awire \cdot in}{grid} \cdot \left(\frac{Fy_{wire}}{\sqrt{f'_c \cdot lb}} \right) \cdot \lambda$ = Welded wire fabric development length - ACI 12.8

$splice := \max\left(\begin{pmatrix} grid + 2 \cdot in \\ 1.5 \cdot l_d \\ 6 \cdot in \end{pmatrix} \right)$ = Minimum welded wire splice length
ACI 12.19.1 & 12.19.2

$l_d = 5.1 \cdot in$
splice = 8·in

Minimum splice, Lap 2 Sqaures

Facing Reinforcement Details (Continued)

Waler & Bearing Bars Minimum Development Length (As Applicable)

bar = 4 = Waler / Bearing rebar size (As applicable)

db = 0.5·in = Waler bar nominal diameter

$\alpha := 1$ = Rebar location factor - ACI 12.2.4

$\beta := 1$ = Coating factor - ACI 12.2.4

$\lambda := 1$ = Aggregate concrete factor - ACI 12.2.4

$cmin := t_f - d$ = Waler / Bearing rebar minimum cover (As applicable)

spacing := 12·in = Waler / Bearing spacing (As applicable)

ACI 7.7.1 & ACI 12.2.2

Cover := if(cmin ≥ 2·in, "Ok" , "No Good")

Cover = "Ok"

Space := if(spacing ≥ 2·db, "Ok" , "No Good")

Space = "Ok"

Minimum Waler Bar Length

$$l_d := \begin{cases} 0\cdot in & \text{if bar = "N/A"} \\ \text{otherwise} & \\ \quad \begin{cases} \dfrac{\dfrac{Fy_b}{psi}\cdot\alpha\cdot\beta\cdot\lambda}{25\cdot\sqrt{\dfrac{f'_c}{psi}}}\cdot db & \text{if bar} \le 6 \\ \dfrac{\dfrac{Fy_b}{psi}\cdot\alpha\cdot\beta\cdot\lambda}{20\cdot\sqrt{\dfrac{f'_c}{psi}}}\cdot db & \text{if bar} > 6 \end{cases} & \end{cases}$$

= Basic development length - ACI 12.2.2

$l_d = 19\cdot in$

Use, 24" Long Waler Bars 12" o.c.

Theoretical Displacement

$H = 20\,ft$ = Maximum soil nail retained height

$Lnail := 20 \cdot ft$ = Average nail length of wall under consideration

$Soil\_type := "A"$ = Soil type - Use: "A" for dense granular soils / rock
"B" for medium dense granular soils
"C" for loose granular soils / clays

$C := 0.70$ = Typical nail length to wall height ratio

$$\delta := \begin{cases} 0.1\% & \text{if } Soil\_type = "A" \\ 0.2\% & \text{if } Soil\_type = "B" \\ (0.4\%) & \text{if } Soil\_type = "C" \end{cases}$$ = Peak wall displacement coefficients p. 53, 2.4.6 FHWA-SA-96-069R

$$\Delta := \frac{\delta \cdot C \cdot H^2}{Lnail}$$ = Maximum theoretical deflection

$\Delta = 0.2 \cdot in$

Facing Reinforcement Details

Minimum Reinforcement

$b := 12 \cdot in$ = Width of concrete section for analysis

Vertical Direction

$Asvmin := 0.0012 \cdot t_f \cdot b$ = Minimum vertical reinforcement area - ACI 14.3.2

$Avsteel := Av \cdot b$ = Total vertical reinforcement per foot width

$Vertical := if(Asvmin \le Avsteel, "Ok", "No Good")$

$Asvmin = 0.09 \cdot in^2$

$Avsteel = 0.24 \cdot in^2$

$Vertical = "Ok"$

Horizontal Direction

$Ashmin := 0.0020 \cdot t_f \cdot b$ = Minimum horizontal reinforcement area - ACI 14.3.3

$Ahsteel := Ah \cdot b + Nb \cdot Ab$ = Total horizontal reinforcement per foot width

$Horizontal := if(Ashmin \le Ahsteel, "Ok", "No Good")$

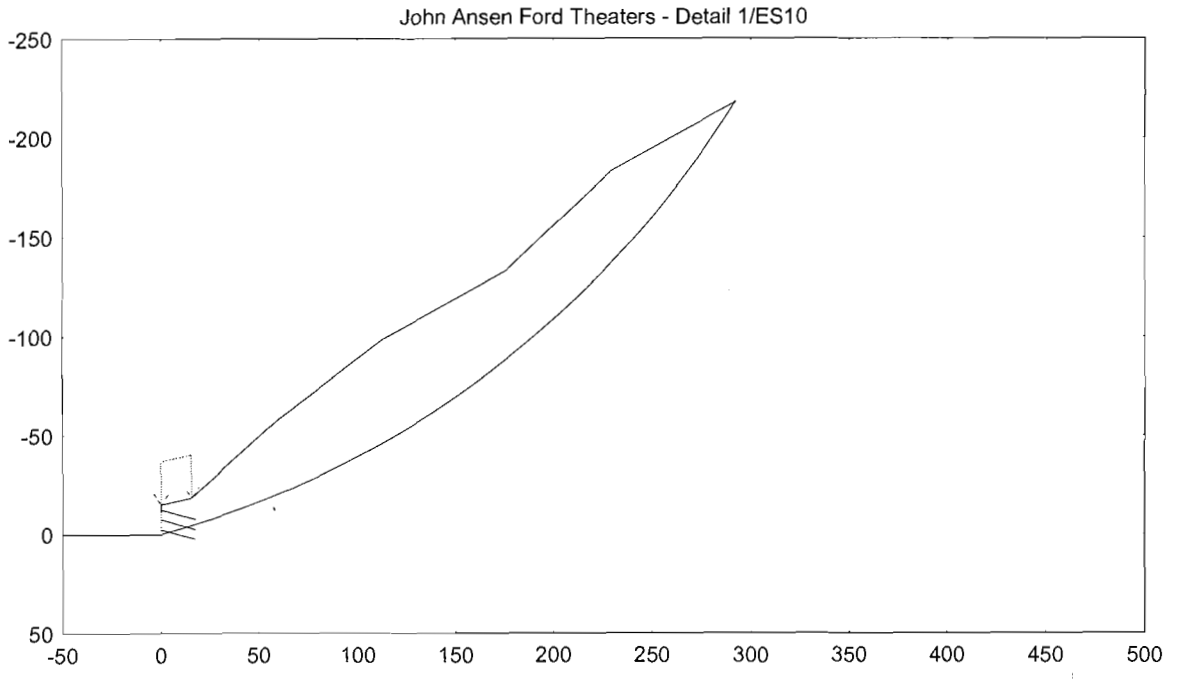
$Ashmin = 0.14 \cdot in^2$

$Ahsteel = 0.64 \cdot in^2$

$Horizontal = "Ok"$

SECTION 3

Input File: G:\PROJECTS\LOSANG~1\JAFTHE~1\DESIGN\R0\GOLDNAIL\WALL15.gni



John Ansen Ford Theaters - Detail 1/ES10

General Data	
File Indentifier	WALL15.GNI
Unit weight of water	62.4
Base depth for analysis	15.0
Seismic Coefficient	0.0
Minimum Base Exit Angle	-15.0
X Search limit (left)	0.002
X Search limit (right)	292.25
Number of slip circles	250
No. of slip circle exits	30

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
SLD Safety and Strength Factors (mode S only)	
FS for Soil Cohesion	1.3
FS for Soil Friction	1.3
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
LRFD Load Factors (mode L only)	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.35
LF for Surcharge Loads	1.75
LF for Seismic Loads	1
LRFD Resistance Factors (mode L only)	
RF for Soil Cohesion	1
RF for Soil Friction Angle	0.75
RF for Head Strength	0.9
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	0	0	16			31		
2	0.001	-15	17			32		
3	15.5	-18.5	18			33		
4	59.75	-58.5	19			34		
5	112.58	-98.5	20			35		
6	176.08	-133.17	21			36		
7	229.25	-183.17	22			37		
8	292.25	-218.17	23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2	3	4	1	12			
3	4	5	1	13			
4	5	6	1	14			
5	6	7	1	15			
6	7	8	1	16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	600	33	120	5655
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1	15.5	500	0
2			
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	2.5	20	59300	39700	
Nail Row 2	7.5	20	59300	39700	
Nail Row 3	12.5	20	59300	39700	
Nail Row 4					
Nail Row 5					
Nail Row 6					
Nail Row 7					
Nail Row 8					
Nail Row 9					
Nail Row 10					
Nail Row 11					
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					

Horiz. Spacing	6
Nail Declination	15

Design Data

Nail Head Factor = 1.00 for circle no 4
Nail Length Factor = 0.90 for circle no 2

Nail No.	Circle No	Required Nail Tendon Strength
1	4	0.00
2	2	20564.35
3	2	58906.50

Nail No.	Circle No	Required Nail Length
1		18.03
2		18.03
3		18.03

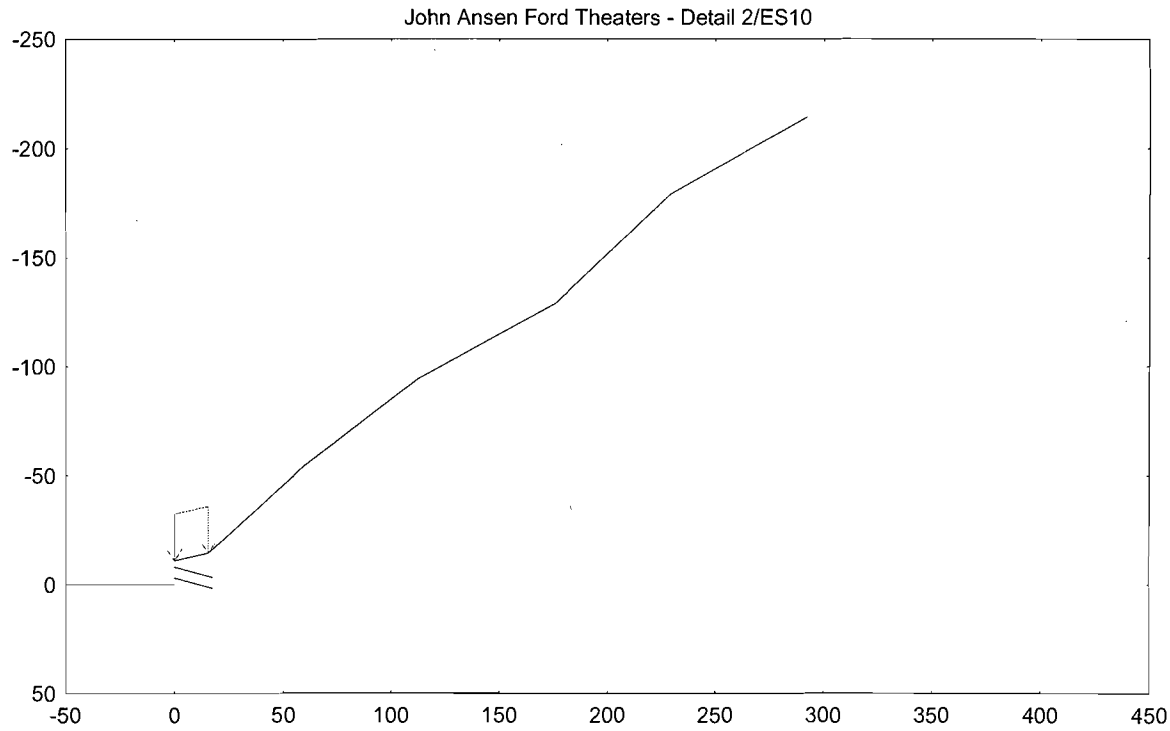
Output Data

Wall Height = 15.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
1	292.25	17.86	-172.82	-536.33	1.001	4536.13
2	292.25	15.17	-129.80	-478.71	1.000	7284.83
3	292.25	12.48	-95.92	-433.32	1.000	6501.97
4	292.25	9.79	-68.44	-396.50	0.999	1951.76

SECTION 4

Input File: G:\PROJECTS\LOSANG~1\JAFTHE~1\DESIGN\R0\GOLDNAIL\WALL11.gni



John Ansen Ford Theaters - Detail 2/ES10

General Data	
File Indentifier	WALL11.GNI
Unit weight of water	62.4
Base depth for analysis	11.0
Seismic Coefficient	0.0
Minimum Base Exit Angle	-15.0
X Search limit (left)	0.002
X Search limit (right)	292.25
Number of slip circles	250
No. of slip circle exits	30

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
SLD Safety and Strength Factors (mode S only)	
FS for Soil Cohesion	1.3
FS for Soil Friction	1.3
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
LRFD Load Factors (mode L only)	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.35
LF for Surcharge Loads	1.75
LF for Seismic Loads	1
LRFD Resistance Factors (mode L only)	
RF for Soil Cohesion	1
RF for Soil Friction Angle	0.75
RF for Head Strength	0.9
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	0	0	16			31		
2	0.001	-11	17			32		
3	15.5	-14.5	18			33		
4	59.75	-54.5	19			34		
5	112.58	-94.5	20			35		
6	176.08	-129.17	21			36		
7	229.25	-179.17	22			37		
8	292.25	-214.17	23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2	3	4	1	12			
3	4	5	1	13			
4	5	6	1	14			
5	6	7	1	15			
6	7	8	1	16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	600	33	120	5655
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1	15.5	500	0
2			
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	3	15	59300	39700	
Nail Row 2	8	15	59300	39700	
Nail Row 3					
Nail Row 4					
Nail Row 5					
Nail Row 6					
Nail Row 7					
Nail Row 8					
Nail Row 9					
Nail Row 10					
Nail Row 11					
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					

Horiz. Spacing	6
Nail Declination	15

Design Data

Nail Head Factor = 1.00 for circle no 4
Nail Length Factor = 0.90 for circle no 2

Nail No.	Circle No	Required Nail Tendon Strength
1	4	0.00
2	2	20564.35

Nail No.	Circle No	Required Nail Length
1		18.03
2		18.03

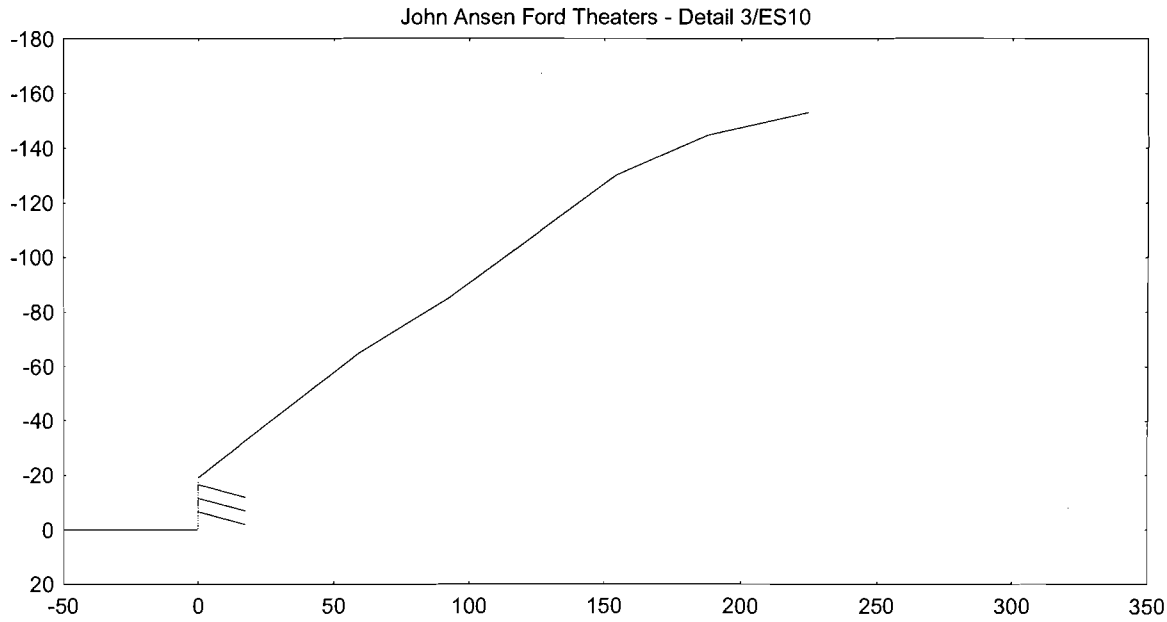
Output Data

Wall Height = 11.00
Wall Slope = 89.99

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length

SECTION 5

Input File: G:\PROJECTS\LOSANG~1\JAFTHE~1\DESIGN\R0\GOLDNAIL\WALL19.gni



John Ansen Ford Theaters - Detail 3/ES10

General Data	
File Indentifier	WALL19.GNI
Unit weight of water	62.4
Base depth for analysis	19.0
Seismic Coefficient	0.0
Minimum Base Exit Angle	-15.0
X Search limit (left)	0.002
X Search limit (right)	224.66
Number of slip circles	250
No. of slip circle exits	30

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
SLD Safety and Strength Factors (mode S only)	
FS for Soil Cohesion	1.3
FS for Soil Friction	1.3
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
LRFD Load Factors (mode L only)	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.35
LF for Surcharge Loads	1.75
LF for Seismic Loads	1
LRFD Resistance Factors (mode L only)	
RF for Soil Cohesion	1
RF for Soil Friction Angle	0.75
RF for Head Strength	0.9
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	0	0	16			31		
2	0.001	-19	17			32		
3	59.33	-64.67	18			33		
4	92.33	-85	19			34		
5	154.33	-130	20			35		
6	187.83	-144.67	21			36		
7	224.66	-153	22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2	3	4	1	12			
3	4	5	1	13			
4	5	6	1	14			
5	6	7	1	15			
6				16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	600	33	120	5655
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	2.5	15	59300	39700	
Nail Row 2	7.5	15	59300	39700	
Nail Row 3	12.5	15	59300	39700	
Nail Row 4	17.5	15	59300	39700	
Nail Row 5					
Nail Row 6					
Nail Row 7					
Nail Row 8					
Nail Row 9					
Nail Row 10					
Nail Row 11					
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					

Horiz. Spacing	6
Nail Declination	15

Design Data

Nail Head Factor = for circle no
Nail Length Factor = for circle no

Nail No.	Circle No	Required Nail Tendon Strength
1		
2		
3		
4		

Nail No.	Circle No	Required Nail Length
1		
2		
3		
4		

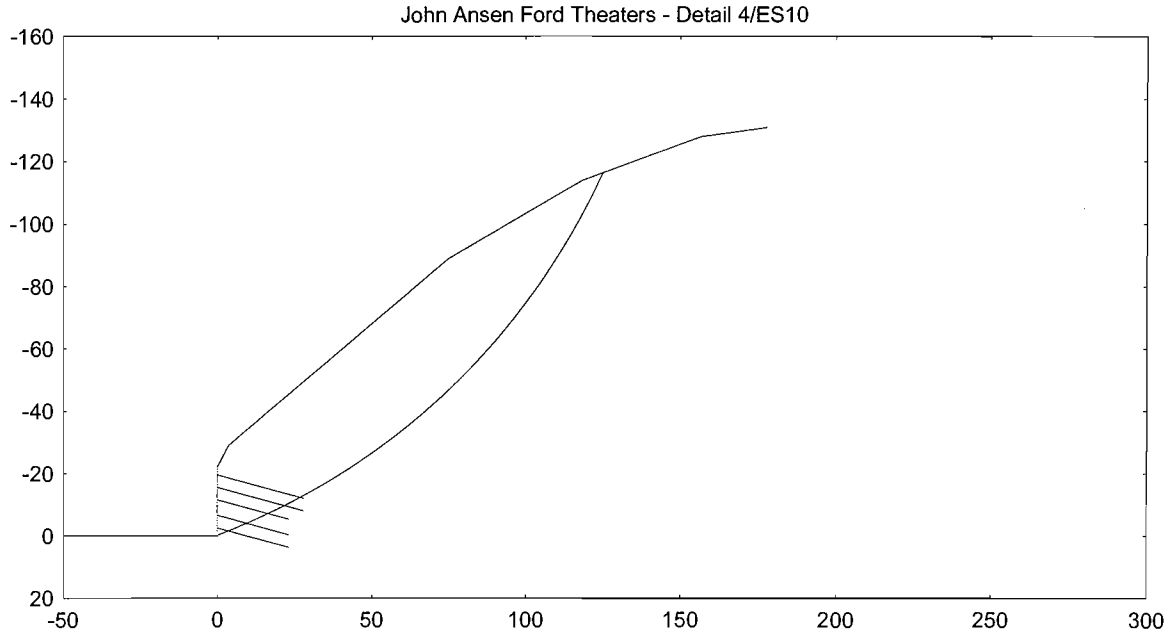
Output Data

Wall Height = 19.00
Wall Slope = 89.94

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length

SECTION 6

Input File: G:\PROJECTS\LOSANG~1\JAFTHE~1\DESIGN\R0\GOLDNAIL\WALL23.gni



John Ansen Ford Theaters - Detail 4/ES10

General Data	
File Indentifier	WALL23.GNI
Unit weight of water	62.4
Base depth for analysis	22.0
Seismic Coefficient	0.0
Minimum Base Exit Angle	-15.0
X Search limit (left)	0.002
X Search limit (right)	177.91
Number of slip circles	250
No. of slip circle exits	30

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
= SLD Safety and Strength Factors (mode S only) =	
FS for Soil Cohesion	1.3
FS for Soil Friction	1.3
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
= LRFD Load Factors (mode L only) =	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.35
LF for Surcharge Loads	1.75
LF for Seismic Loads	1
= LRFD Resistance Factors (mode L only) =	
RF for Soil Cohesion	1
RF for Soil Friction Angle	0.75
RF for Head Strength	0.9
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	0	0	16			31		
2	0.001	-22	17			32		
3	3.5	-28.83	18			33		
4	74.75	-88.83	19			34		
5	118.25	-113.83	20			35		
6	156.58	-127.83	21			36		
7	177.91	-130.83	22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2	3	4	1	12			
3	4	5	1	13			
4	5	6	1	14			
5	6	7	1	15			
6				16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	600	33	120	5655
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	2.5	29	59300	39700	
Nail Row 2	6.5	29	59300	39700	
Nail Row 3	10.5	24	75000	39700	
Nail Row 4	15.5	24	75000	39700	
Nail Row 5	19.5	24	75000	39700	
Nail Row 6					
Nail Row 7					
Nail Row 8					
Nail Row 9					
Nail Row 10					
Nail Row 11					
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					

Horiz. Spacing	6
Nail Declination	15

Design Data

Nail Head Factor = 1.00 for circle no 149
Nail Length Factor = 1.00 for circle no 130

Nail No.	Circle No	Required Nail Tendon Strength
1	113	29176.81
2	127	46310.16
3	127	44769.94
4	129	73266.14
5	130	67185.89

Nail No.	Circle No	Required Nail Length
1		28.88
2		28.88
3		23.90
4		23.90
5		23.90

Output Data

Wall Height = 22.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
1	10.56	56.46	-52.99	-35.11	1.008	401.64
2	12.15	60.28	-85.99	-49.08	1.005	128.57
3	12.15	57.52	-67.13	-42.72	1.008	1103.26
4	12.15	54.76	-54.44	-38.44	1.010	1762.68
5	14.00	61.25	-121.53	-66.66	1.002	323.98
6	14.00	58.49	-89.03	-54.57	1.004	1406.22
7	14.00	55.73	-69.36	-47.25	1.007	2298.07
8	14.00	52.97	-56.12	-42.32	1.008	2887.36
9	14.00	50.21	-46.56	-38.76	1.009	3193.57
10	16.17	62.13	-194.17	-102.65	1.001	333.17
11	16.17	59.37	-126.69	-74.99	1.002	1592.39
12	16.17	56.61	-92.61	-61.02	1.004	2619.57
13	16.17	53.85	-71.98	-52.57	1.006	3413.72
14	16.17	51.09	-58.10	-46.88	1.009	4031.17
15	16.17	48.33	-48.08	-42.77	1.009	4291.22
16	16.17	45.57	-40.47	-39.65	1.009	4251.34
17	18.77	62.92	-414.17	-211.73	1.000	83.56
18	18.77	60.16	-204.07	-117.04	1.001	1545.95
19	18.77	57.40	-132.85	-84.94	1.002	2749.27
20	18.77	[illegible]	[illegible]	[illegible]	1.003	[illegible]
21	18.77	51.88	-75.12	-58.92	1.005	4475.11
22	18.77	49.12	-60.47	-52.32	1.008	5012.04
23	18.77	46.36	-49.89	-47.55	1.007	5154.03
24	18.77	43.60	-41.86	-43.93	1.007	5044.95
25	21.93	60.85	-439.62	-245.17	1.000	1159.62
26	21.93	58.09	-216.11	-134.55	1.001	2619.73
27	21.93	55.33	-140.35	-97.05	1.002	3812.87
28	21.93	52.57	-102.09	-78.12	1.003	4749.45
29	21.93	49.81	-78.93	-66.66	1.005	5439.08
30	21.93	47.05	-63.34	-58.94	1.007	5913.29
31	21.93	44.29	-52.09	-53.37	1.009	6170.86
32	21.93	41.53	-43.55	-49.15	1.008	5946.07
33	21.93	38.77	-36.82	-45.82	1.006	5459.34

Output Data

Wall Height = 22.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
34	25.86	61.44	-23817.99	-12965.74	1.000	240.78
35	25.86	58.68	-471.33	-286.81	1.000	2051.04
36	25.86	55.92	-231.11	-156.36	1.001	3534.03
37	25.86	53.16	-149.69	-112.14	1.002	4730.03
38	25.86	50.40	-108.57	-89.81	1.003	5659.19
39	25.86	47.64	-83.68	-76.29	1.004	6322.95
40	25.86	44.88	-66.93	-67.19	1.006	6734.89
41	25.86	42.12	-54.83	-60.63	1.008	6933.67
42	25.86	39.36	-45.66	-55.64	1.010	6900.08
43	25.86	36.60	-38.42	-51.71	1.007	6292.47
44	25.86	33.84	-32.55	-48.53	1.010	5718.84
45	30.91	59.16	-25940.34	-15491.14	1.000	784.35
46	30.91	56.39	-511.98	-340.21	1.000	2726.47
47	30.91	53.63	-250.35	-184.32	1.001	4315.56
48	30.91	50.87	-161.66	-131.48	1.001	5577.10
49	30.91	48.11	-116.88	-104.80	1.002	6520.95
50	30.91	45.35	-89.77	-88.65	1.004	7205.94
51	30.91	42.59	-71.52	-77.77	1.005	7611.22
52	30.91	39.83	-58.35	-69.93	1.006	7750.66
53	30.91	37.07	-48.36	-63.97	1.008	7627.77
54	30.91	34.31	-40.48	-59.28	1.005	6824.22
55	30.91	31.55	-34.08	-55.47	1.006	6108.74
56	30.91	28.79	-28.76	-52.30	1.008	5127.84
57	37.63	56.76	-28766.66	-18854.21	1.000	933.08
58	37.63	54.00	-566.12	-411.32	1.000	3126.03
59	37.63	51.24	-275.97	-221.56	1.001	4907.83
60	37.63	48.48	-177.61	-157.24	1.001	6319.95
61	37.63	45.72	-127.95	-124.76	1.002	7379.15
62	37.63	42.96	-97.88	-105.10	1.003	8109.99
63	37.63	40.20	-77.65	-91.86	1.004	8526.52
64	37.63	37.44	-63.04	-82.31	1.005	8624.69
65	37.63	34.68	-51.95	-75.06	1.006	8427.79
66	37.63	31.92	-43.21	-69.35	1.008	7917.42
67	37.63	29.16	-36.12	-64.71	1.009	7098.51
68	37.63	26.40	-30.22	-60.85	1.004	5288.09
69	37.63	23.64	-25.22	-57.58	1.005	3765.27
70	47.05	54.24	-32727.84	-23567.68	1.000	490.57
71	47.05	51.48	-642.00	-510.99	1.000	3138.58
72	47.05	48.72	-311.87	-273.76	1.001	5299.14
73	47.05	45.96	-199.96	-193.34	1.001	7016.69
74	47.05	43.20	-143.46	-152.74	1.002	8292.15
75	47.05	40.44	-109.25	-128.15	1.003	9169.35
76	47.05	37.68	-86.22	-111.61	1.003	9660.48
77	47.05	34.92	-69.60	-99.67	1.004	9766.51
78	47.05	32.16	-56.[illegible]	-90.[illegible]	1.00[illegible]	[illegible]
79	47.05	29.40	-47.05	-83.46	1.006	8828.01
80	47.05	26.64	-38.98	-77.66	1.007	7787.29
81	47.05	23.88	-32.27	-72.84	1.008	6374.31
82	47.05	21.12	-26.58	-68.75	1.009	4581.45
83	61.25	48.84	-756.38	-661.22	1.000	2586.73
84	61.25	46.08	-365.99	-352.43	1.001	5484.61
85	61.25	43.32	-233.66	-247.76	1.001	7803.59
86	61.25	40.56	-166.84	-194.91	1.002	9564.87
87	61.25	37.80	-126.38	-162.91	1.002	10800.38
88	61.25	35.04	-99.16	-141.37	1.003	11495.06
89	61.25	32.28	-79.50	-125.83	1.003	11678.92
90	61.25	29.52	-64.59	-114.03	1.004	11358.53
91	61.25	26.76	-52.83	-104.73	1.004	10524.51

Output Data

Wall Height = 22.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
92	61.25	24.00	-43.29	-97.18	1.004	9193.87
93	61.25	21.24	-35.35	-90.91	1.005	7380.56
94	61.25	18.48	-28.62	-85.58	1.005	5058.55
95	61.25	15.72	-22.81	-80.99	1.006	2245.92
96	80.30	46.07	-894.82	-862.13	1.000	3734.26
97	80.30	43.31	-431.03	-457.29	1.000	7602.08
98	80.30	40.54	-273.81	-320.06	1.001	10691.83
99	80.30	37.78	-194.43	-250.77	1.001	13038.45
100	80.30	35.02	-146.37	-208.82	1.002	14666.29
101	80.30	32.26	-114.03	-180.58	1.002	15561.58
102	80.30	29.50	-90.68	-160.20	1.002	15788.95
103	80.30	26.74	-72.96	-144.73	1.002	15365.19
104	80.30	23.98	-58.99	-132.54	1.002	14217.61
105	80.30	21.22	-47.65	-122.65	1.002	12404.71
106	80.30	18.46	-38.23	-114.42	1.002	9923.60
107	80.30	15.70	-30.23	-107.44	1.001	6800.55
108	80.30	12.94	-23.33	-101.42	1.001	3062.53
109	99.73	45.91	-51544.34	-49928.91	1.000	2434.77
110	99.73	43.15	-998.55	-1065.11	1.000	7656.67
111	99.73	40.39	-478.48	-562.35	1.000	11905.87
112	99.73	37.63	-302.20	-391.93	1.001	15193.38
113	99.73	34.87	-213.18	-305.88	1.001	17604.41
114	99.73	32.11	-159.29	-253.78	1.001	19120.02
115	99.73	29.35	-123.02	-218.72	1.001	19741.81
116	99.73	26.59	-96.83	-193.40	1.001	19528.15
117	99.73	23.83	-76.96	-174.19	1.001	18418.98
118	99.73	21.07	-61.30	-159.06	1.001	16457.64
119	99.73	18.31	-48.59	-146.77	1.001	13590.13
120	99.73	15.55	-38.02	-136.55	1.000	9854.40
121	99.73	12.79	-29.05	-127.88	0.999	5230.35
122	125.13	42.85	-58109.69	-62635.86	1.000	4639.69
123	125.13	40.09	-1119.52	-1329.77	1.000	10372.03
124	125.13	37.33	-533.14	-698.99	1.000	14933.17
125	125.13	34.57	-334.38	-485.17	1.001	18362.67
126	125.13	31.81	-234.02	-377.20	1.001	20711.21
127	125.13	29.05	-173.25	-311.84	1.001	21916.32
128	125.13	26.29	-132.36	-267.85	1.001	22065.73
129	125.13	23.53	-102.84	-236.09	1.001	21135.48
130	125.13	20.77	-80.43	-211.99	1.001	19042.86
131	125.13	18.01	-62.78	-193.00	1.001	15833.05
132	125.13	15.25	-48.44	-177.58	1.000	11537.83
133	125.13	12.49	-36.52	-164.76	0.999	6194.81
134	151.90	39.64	-62983.86	-76022.16	1.000	5096.25
135	151.90	36.88	-1205.45	-1606.57	1.000	10562.15
136	151.90	34.12	-961.61	-1340.90	1.000	[illegible]
137	151.90	31.36	-354.35	-581.36	1.000	17443.56
138	151.90	28.60	-245.55	-450.31	1.001	18910.51
139	151.90	25.84	-179.68	-370.97	1.001	19129.16
140	151.90	23.08	-135.35	-317.57	1.001	17972.88
141	151.90	20.32	-103.35	-279.02	1.001	15456.00
142	151.90	17.56	-79.07	-249.77	1.001	11564.83
143	151.90	14.80	-59.93	-226.71	1.000	6230.04
144	177.91	33.51	-1240.30	-1873.21	1.000	3690.52
145	177.91	30.75	-580.92	-976.45	1.000	6519.90
146	177.91	27.99	-357.41	-672.47	1.000	7857.82
147	177.91	25.23	-244.55	-518.98	1.000	7692.65
148	177.91	22.47	-176.23	-426.05	1.001	5987.79
149	177.91	19.71	-130.24	-363.51	1.000	2774.87

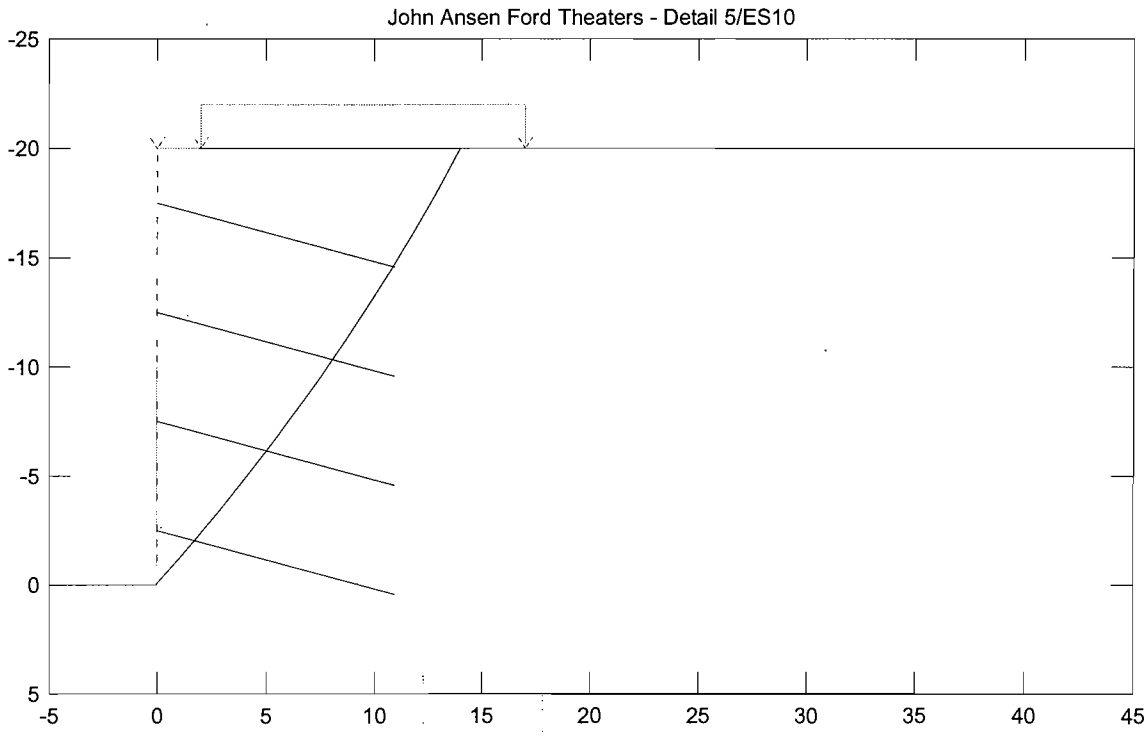
Output Data

Wall Height = 22.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length

SECTION 7

Input File: G:\PROJECTS\LOSANG~1\JAFTHE~1\DESIGN\R0\GOLDNAIL\WALL20B.gni



John Ansen Ford Theaters - Detail 5/ES10

General Data	
File Indentifier	WALL20B.GNI
Unit weight of water	62.4
Base depth for analysis	20.0
Seismic Coefficient	0.0
Minimum Base Exit Angle	-15.0
X Search limit (left)	0.002
X Search limit (right)	60.0
Number of slip circles	250
No. of slip circle exits	30

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
= SLD Safety and Strength Factors (mode S only) =	
FS for Soil Cohesion	1.3
FS for Soil Friction	1.3
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
= LRFD Load Factors (mode L only) =	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.35
LF for Surcharge Loads	1.75
LF for Seismic Loads	1
= LRFD Resistance Factors (mode L only) =	
RF for Soil Cohesion	1
RF for Soil Friction Angle	0.75
RF for Head Strength	0.9
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	0	0	16			31		
2	0.001	-20	17			32		
3	60	-20	18			33		
4			19			34		
5			20			35		
6			21			36		
7			22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2				12			
3				13			
4				14			
5				15			
6				16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	600	33	120	5655
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1	2	0	0
2	17	1500	0
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	2.5	20	59300	84900	
Nail Row 2	7.5	20	59300	84900	
Nail Row 3	12.5	20	59300	84900	
Nail Row 4	17.5	20	59300	84900	
Nail Row 5					
Nail Row 6					
Nail Row 7					
Nail Row 8					
Nail Row 9					
Nail Row 10					
Nail Row 11					
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					

Horiz. Spacing	6
Nail Declination	15

Design Data

Nail Head Factor = 1.00 for circle no 111
Nail Length Factor = 0.57 for circle no 72

Nail No.	Circle No	Required Nail Tendon Strength
1	33	11648.39
2	49	19408.56
3	70	31469.79
4	72	48104.93

Nail No.	Circle No	Required Nail Length
1		11.31
2		11.31
3		11.31
4		11.31

Output Data

Wall Height = 20.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
1	5.15	72.27	-174.33	-55.72	0.999	37.50
2	5.15	69.09	-86.39	-32.99	0.999	633.50
3	5.15	65.92	-56.61	-25.29	0.999	1137.02
4	5.15	62.74	-41.56	-21.40	1.000	1525.96
5	5.85	73.58	-9997.08	-2945.82	1.000	1657.83
6	5.85	70.40	-173.98	-61.93	0.999	2276.11
7	5.85	67.22	-86.04	-36.12	0.998	2767.89
8	5.85	64.05	-56.26	-27.37	0.998	3150.78
9	5.85	60.87	-41.20	-22.95	0.999	3455.99
10	5.85	57.69	-32.08	-20.27	1.000	3637.61
11	6.60	71.62	-9996.70	-3321.79	1.000	3650.06
12	6.60	68.44	-173.60	-68.58	0.999	4167.67
13	6.60	65.26	-85.67	-39.46	0.998	4565.58
14	6.60	62.08	-55.88	-29.60	0.997	4845.97
15	6.60	58.91	-40.83	-24.61	0.998	5039.33
16	6.60	55.73	-31.70	-21.59	0.999	5161.26
17	7.41	69.56	-9996.30	-3725.86	1.000	5320.30
18	7.41	66.38	-173.20	-75.73	0.998	5736.61
19	7.41	63.20	-85.26	-43.06	0.997	6034.43
20	7.41	60.02	-55.48	-31.99	0.997	6222.08
21	7.41	56.85	-40.42	-26.39	0.997	6300.37
22	7.41	53.67	-31.80	-23.40	0.997	6311.42
23	7.41	50.49	-25.14	-20.71	0.999	6226.81
24	8.28	67.39	-9995.86	-4161.96	1.000	6682.81
25	8.28	64.22	-172.76	-83.45	0.998	7009.25
26	8.28	61.04	-84.83	-46.94	0.997	7195.37
27	8.28	57.86	-55.04	-34.57	0.996	7282.70
28	8.28	54.68	-39.99	-28.32	0.996	7270.55
29	8.28	51.50	-30.86	-24.53	0.996	7149.99
30	8.28	48.33	-24.70	-21.97	0.997	6969.95
31	8.28	45.15	-20.24	-20.12	1.000	6696.28
32	9.23	65.12	-9995.39	-4634.85	1.000	7745.38
33	9.23	61.94	-172.29	-91.81	0.998	7975.48
34	9.23	58.77	-84.35	-51.14	0.996	8080.85
35	9.23	55.59	-54.57	-37.37	0.995	8042.13

Output Data

Wall Height = 20.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
36	9.23	52.41	-39.52	-30.41	0.995	7923.10
37	9.23	49.23	-30.39	-26.18	0.994	7685.22
38	9.23	46.05	-24.23	-23.34	0.996	7397.75
39	9.23	42.88	-19.77	-21.27	0.998	7008.02
40	10.26	62.74	-9994.88	-5150.46	1.000	8510.08
41	10.26	59.56	-171.77	-100.93	0.997	8645.24
42	10.26	56.38	-83.84	-55.73	0.995	8632.74
43	10.26	53.20	-54.05	-40.42	0.994	8540.37
44	10.26	50.02	-39.00	-32.68	0.993	8281.51
45	10.26	46.85	-29.87	-27.99	0.993	7961.02
46	10.26	43.67	-23.71	-24.82	0.992	7493.79
47	10.26	40.49	-19.25	-22.53	0.994	6970.76
48	10.26	37.31	-15.86	-20.79	0.997	6388.31
49	11.39	60.23	-9994.31	-5716.19	1.000	8971.41
50	11.39	57.05	-171.21	-110.94	0.997	9030.25
51	11.39	53.88	-83.27	-60.76	0.995	8936.59
52	11.39	50.70	-53.49	-43.77	0.992	8689.34
53	11.39	47.52	-38.43	-35.18	0.992	8399.07
54	11.39	44.34	-29.31	-29.97	0.991	7919.82
55	11.39	41.16	-23.15	-26.45	0.991	7379.85
56	11.39	37.98	-18.69	-23.91	0.991	6695.48
57	11.39	34.81	-15.29	-21.97	0.992	5895.23
58	11.39	31.63	-12.61	-20.44	0.994	4982.09
59	12.64	57.60	-9993.68	-6341.47	1.000	9114.71
60	12.64	54.42	-170.58	-122.00	0.998	9111.25
61	12.64	51.25	-82.65	-66.32	0.995	8933.95
62	12.64	48.07	-52.86	-47.47	0.992	8601.79
63	12.64	44.89	-37.81	-37.94	0.990	8140.48
64	12.64	41.71	-28.68	-32.16	0.992	7724.47
65	12.64	38.53	-22.52	-28.26	0.993	7113.27
66	12.64	35.36	-18.06	-25.43	0.995	6398.70
67	12.64	32.18	-14.67	-23.28	0.990	5269.86
68	12.64	29.00	-11.98	-21.58	0.992	4247.42
69	12.64	25.82	-9.79	-20.20	0.994	3032.17
70	14.04	54.84	-9992.99	-7038.44	1.000	8915.29
71	14.04	51.66	-169.88	-134.33	0.998	8858.48
72	14.04	48.48	-81.95	-72.52	0.996	8626.79
73	14.04	45.31	-52.16	-51.59	0.993	8211.71
74	14.04	42.13	-37.11	-41.01	0.991	7678.41
75	14.04	38.95	-27.98	-34.59	0.994	7210.69
76	14.04	35.77	-21.83	-30.27	0.992	6389.89
77	14.04	32.59	-17.37	-27.13	0.991	5492.96
78	14.04	29.42	-13.97	-24.75	0.993	4567.62
79	14.04	26.24	-11.29	-22.86	0.996	3507.44
80	14.04	23.06	-9.09	-21.32	0.991	2304.10
81	14.04	19.88	-7.26	-20.03	0.991	308.49
82	15.61	51.94	-9992.20	-7823.05	1.000	8335.01
83	15.61	48.76	-169.10	-148.21	0.998	8223.04
84	15.61	45.59	-81.16	-79.50	0.996	7930.60
85	15.61	42.41	-51.38	-56.23	0.993	7449.95
86	15.61	39.23	-36.33	-44.47	0.992	6877.70
87	15.61	36.05	-27.20	-37.34	0.994	6306.63
88	15.61	32.87	-21.04	-32.53	0.992	5371.98
89	15.61	29.69	-16.58	-29.05	0.992	4413.48
90	15.61	26.52	-13.19	-26.39	0.991	3284.13
91	15.61	23.34	-10.50	-24.29	0.990	1999.88
92	15.61	20.16	-8.31	-22.58	0.996	796.92
93	17.39	48.90	-9991.31	-8716.71	1.000	7030.77

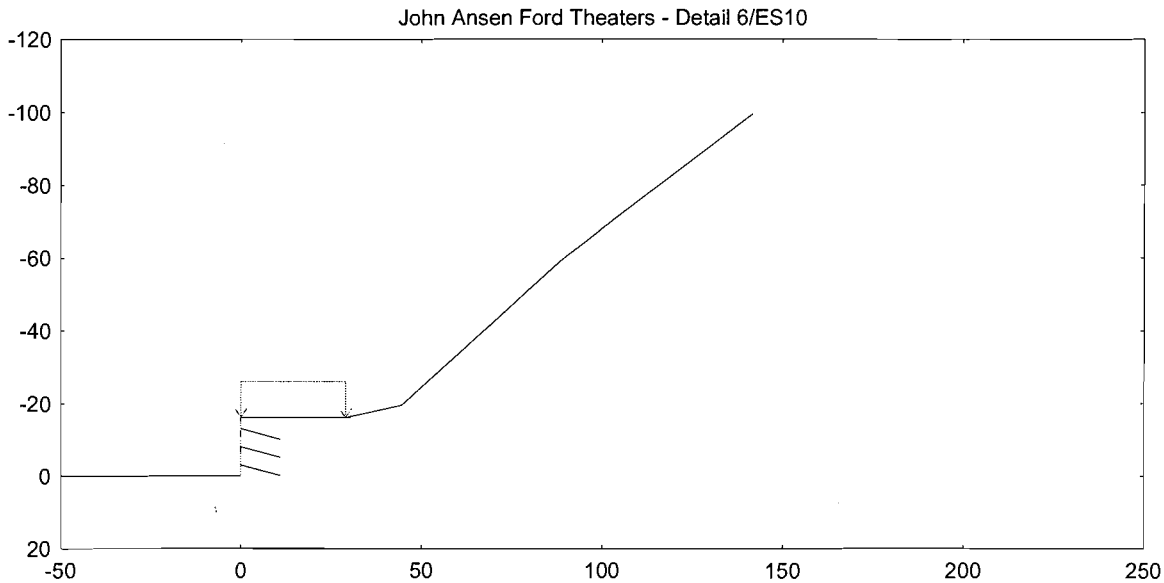
Output Data

Wall Height = 20.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
94	17.39	45.72	-168.21	-164.02	0.998	6848.80
95	17.39	42.54	-80.27	-87.45	0.997	6512.31
96	17.39	39.36	-50.49	-61.52	0.995	5991.74
97	17.39	36.18	-35.43	-48.41	0.992	5287.06
98	17.39	33.01	-26.30	-40.47	0.995	4645.43
99	17.39	29.83	-20.15	-35.11	0.996	3781.46
100	17.39	26.65	-15.69	-31.22	0.994	2666.04
101	17.39	23.47	-12.29	-28.27	0.992	1363.87
102	19.46	45.70	-9990.28	-9748.78	1.000	4302.87
103	19.46	42.52	-167.17	-182.27	0.998	3960.70
104	19.46	39.34	-79.24	-96.63	0.996	3452.80
105	19.46	36.17	-49.45	-67.63	0.997	2931.42
106	19.46	32.99	-34.40	-52.97	0.995	2126.51
107	19.46	29.81	-25.27	-44.08	0.993	1175.56
108	19.46	26.63	-19.11	-38.08	0.992	108.69
109	21.88	42.34	-9989.06	-10960.75	1.000	1246.85
110	21.88	39.17	-165.96	-203.71	0.998	766.19
111	21.88	35.99	-78.03	-107.42	0.997	150.55

SECTION 8

Input File: G:\PROJECTS\LOSANG~1\JAFTHE~1\DESIGN\R0\GOLDNAIL\WALL16.gni



John Ansen Ford Theaters - Detail 6/ES10

General Data	
File Indentifier	WALL16.GNI
Unit weight of water	62.4
Base depth for analysis	16.0
Seismic Coefficient	0.0
Minimum Base Exit Angle	-15.0
X Search limit (left)	0.002
X Search limit (right)	141.58
Number of slip circles	250
No. of slip circle exits	30

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
SLD Safety and Strength Factors (mode S only)	
FS for Soil Cohesion	1.3
FS for Soil Friction	1.3
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
LRFD Load Factors (mode L only)	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.35
LF for Surcharge Loads	1.75
LF for Seismic Loads	1
LRFD Resistance Factors (mode L only)	
RF for Soil Cohesion	1
RF for Soil Friction Angle	0.75
RF for Head Strength	0.9
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	0	0	16			31		
2	0.001	-16	17			32		
3	29	-16	18			33		
4	44.5	-19.5	19			34		
5	88.75	-59.5	20			35		
6	141.58	-99.5	21			36		
7			22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2	3	4	1	12			
3	4	5	1	13			
4	5	6	1	14			
5				15			
6				16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	600	33	120	5655
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1	29	500	0
2			
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	3	15	59300	39700	
Nail Row 2	8	15	59300	39700	
Nail Row 3	13	15	59300	39700	
Nail Row 4					
Nail Row 5					
Nail Row 6					
Nail Row 7					
Nail Row 8					
Nail Row 9					
Nail Row 10					
Nail Row 11					
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					

Horiz. Spacing	6
Nail Declination	15

Design Data

Nail Head Factor = 1.00 for circle no 111
Nail Length Factor = 0.57 for circle no 72

Nail No.	Circle No	Required Nail Tendon Strength
1	33	11648.39
2	49	19408.56
3	70	31469.79

Nail No.	Circle No	Required Nail Length
1		11.31
2		11.31
3		11.31

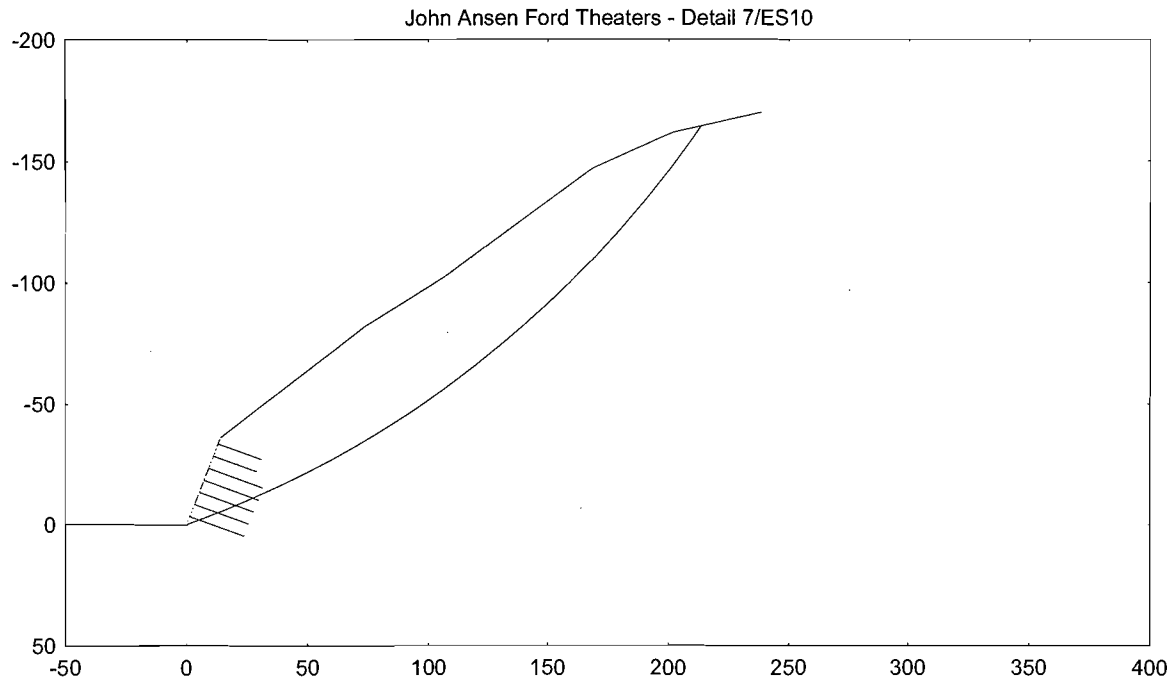
Output Data

Wall Height = 16.00
Wall Slope = 90.00

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length

SECTION 9

Input File: G:\PROJECTS\LOSANG~1\JAFTHE~1\DESIGN\R0\GOLDNAIL\WALL25.gni



John Ansen Ford Theaters - Detail 7/ES10

General Data	
File Indentifier	WALL25.GNI
Unit weight of water	62.4
Base depth for analysis	36.0
Seismic Coefficient	0.0
Minimum Base Exit Angle	-15.0
X Search limit (left)	0.002
X Search limit (right)	238.66
Number of slip circles	250
No. of slip circle exits	30

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
= SLD Safety and Strength Factors (mode S only) =	
FS for Soil Cohesion	1.3
FS for Soil Friction	1.3
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
= LRFD Load Factors (mode L only) =	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.35
LF for Surcharge Loads	1.75
LF for Seismic Loads	1
= LRFD Resistance Factors (mode L only) =	
RF for Soil Cohesion	1
RF for Soil Friction Angle	0.75
RF for Head Strength	0.9
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	0	0	16			31		
2	14	-36	17			32		
3	73.34	-81.67	18			33		
4	106.34	-102	19			34		
5	168.34	-147	20			35		
6	201.83	-161.67	21			36		
7	238.66	-170	22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2	3	4	1	12			
3	4	5	1	13			
4	5	6	1	14			
5	6	7	1	15			
6				16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	600	33	120	5655
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	2.5	20	59300	39700	
Nail Row 2	7.5	20	59300	39700	
Nail Row 3	12.5	25	75000	39700	
Nail Row 4	17.5	25	75000	39700	
Nail Row 5	22.5	25	75000	39700	
Nail Row 6	27.5	25	75000	39700	
Nail Row 7	32.5	25	75000	39700	
Nail Row 8					
Nail Row 9					
Nail Row 10					
Nail Row 11					
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					

Horiz. Spacing	6
Nail Declination	20

Design Data

Nail Head Factor = 1.00 for circle no 61
Nail Length Factor = 0.96 for circle no 56

Nail No.	Circle No	Required Nail Tendon Strength
1	9	667.57
2	9	1095.86
3	31	6909.40
4	55	20339.45
5	55	40680.58
6	56	69273.44
7	56	70337.23

Nail No.	Circle No	Required Nail Length
1		19.14
2		19.14
3		23.92
4		23.92
5		23.92
6		23.92
7		23.92

Output Data

Wall Height = 36.00
Wall Slope = 68.75

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
1	32.20	30.74	-34.08	-57.31	1.008	132.27
2	35.07	34.03	-46.82	-69.33	1.009	313.38
3	35.07	29.63	-34.86	-61.30	1.007	860.38
4	35.07	25.22	-26.10	-55.42	1.010	873.39
5	38.47	32.87	-48.34	-74.83	1.008	1116.49
6	38.47	28.46	-35.79	-66.01	1.005	1472.67
7	38.47	24.06	-26.59	-59.56	1.008	1270.68
8	42.55	36.05	-69.68	-95.74	1.005	490.86
9	42.55	31.64	-50.17	-81.42	1.007	1942.06
10	42.55	27.24	-36.90	-71.68	1.009	2467.18
11	42.55	22.83	-27.17	-64.54	1.005	1404.59
12	47.53	34.76	-73.20	-105.48	1.004	1391.91
13	47.53	30.36	-52.41	-89.49	1.006	2708.25
14	47.53	25.95	-38.25	-78.60	1.008	3036.39
15	47.53	21.55	-27.89	-70.63	1.003	1697.63
16	53.76	33.41	-77.61	-117.85	1.004	[illegible]
17	53.76	29.01	-55.21	-99.56	1.005	3479.01
18	53.76	24.60	-39.95	-87.25	1.007	3581.76
19	53.76	20.20	-28.78	-78.23	1.008	2637.75
20	61.77	36.40	-123.37	-167.33	1.002	665.44
21	61.77	31.99	-83.28	-133.30	1.004	3081.56
22	61.77	27.59	-58.80	-112.52	1.005	4240.62
23	61.77	23.19	-42.13	-98.37	1.006	4121.33
24	61.77	18.78	-29.93	-88.01	1.007	2751.89
25	72.45	34.91	-135.45	-194.08	1.002	1582.90
26	72.45	30.51	-90.83	-154.16	1.003	4242.59
27	72.45	26.10	-63.59	-129.79	1.004	5364.06
28	72.45	21.70	-45.04	-113.19	1.005	4949.48
29	72.45	17.29	-31.46	-101.04	1.005	3054.54

Output Data

Wall Height = 36.00
Wall Slope = 68.75

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
30	82.52	33.35	-143.85	-218.58	1.002	3450.35
31	82.52	28.94	-95.74	-173.12	1.002	5975.54
32	82.52	24.54	-66.37	-145.36	1.003	6751.04
33	82.52	20.13	-46.37	-126.46	1.003	5749.04
34	82.52	15.73	-31.72	-112.62	1.003	3057.43
35	95.20	36.11	-257.32	-352.69	1.001	299.96
36	95.20	31.71	-154.07	-249.38	1.001	4729.41
37	95.20	27.30	-101.66	-196.93	1.002	7074.08
38	95.20	22.90	-69.66	-164.91	1.002	7407.01
39	95.20	18.49	-47.86	-143.10	1.002	5714.82
40	95.20	14.09	-31.91	-127.13	1.002	2054.22
41	115.34	29.99	-172.40	-298.76	1.001	5056.19
42	115.34	25.58	-112.61	-235.22	1.002	7627.61
43	115.34	21.18	-76.09	-196.42	1.002	7679.37
44	115.34	16.77	-51.24	-170.00	1.002	5213.72
45	157.72	28.18	-216.41	-403.99	1.001	5411.63
46	157.72	23.77	-139.68	-317.10	1.002	9555.01
47	157.72	19.37	-92.82	-264.04	1.001	9771.94
48	157.72	14.96	-60.91	-227.91	1.000	6032.56
49	188.92	30.68	-405.57	-683.51	1.000	4183.63
50	188.92	26.28	-236.26	-478.49	1.001	12638.26
51	188.92	21.87	-150.31	-374.41	1.001	16157.17
52	188.92	17.47	-97.83	-310.85	1.000	14664.75
53	188.92	13.06	-62.09	-267.58	0.999	7972.99
54	213.78	28.69	-419.93	-767.35	1.000	9156.17
55	213.78	24.28	-241.55	-535.35	1.001	16087.44
56	213.78	19.88	-151.00	-417.58	1.001	17443.28
57	213.78	15.47	-95.70	-345.67	1.000	13011.31
58	213.78	11.07	-58.05	-296.70	0.999	2490.08
59	238.66	26.60	-425.52	-849.91	1.000	5421.13
60	238.66	22.19	-241.04	-590.91	1.001	9615.84
61	238.66	17.79	-147.38	-459.44	1.000	7505.09

SECTION 10

Earth Support Systems, Inc.
9685 Via Excelencia #104
Carlsbad, CA 92126

SOIL NAIL WALL SUPPORT DESIGN
(Vertical Elements)

PARAMETERS:

$F_y := 75 \cdot ksi$ = STEEL YIELD STRENGTH

$F_b := 0.66 \cdot F_y$ = ALLOWABLE STEEL BENDING STRENGTH

$f'_c := 4000 \cdot psi$ = GROUT COMPRESSIVE STRENGTH

$E := 29000 \cdot ksi$ = STEEL MODULUS OF ELASTICITY

$x_{pile} := 3 \cdot ft$ = HORIZONTAL SPACING OF PILES

$t_{conc} := 6 \cdot in$ = MAXIMUM SOIL NAIL WALL THICKNESS

$t_{soil} := 3.0 \cdot ft$ = ASSUMED THICKNESS OF MOBILIZED SOIL MASS

$\gamma_c := 150 \cdot pcf$ = UNIT WEIGHT OF CONCRETE

$c := 0.0 \cdot psf$ = SOIL COHESION

$\gamma_s := 125 \cdot pcf$ = UNIT WEIGHT OF SOIL

$h := 25 \cdot ft - 5 \cdot ft$ = MAX. HEIGHT OF SOIL MASS ABOVE CUT

$h = 20 ft$

$R_b := x_{pile} \cdot (t_{conc} \cdot \gamma_c + t_{soil} \cdot \gamma_s) h \ldots$
$+ -c \cdot h \cdot x_{pile}$

$R_b = 27 \cdot kip$ = MAXIMUM VERTICAL SOIL LOAD

$P_s := 0 \cdot psf$ = SURCHARGE PRESSURE

$l := 5.0 \cdot ft$ = MAXIMUM UNBRACED LENGTH

$l = 5 \cdot ft$

$d_{shaft} := 6 \cdot in$ = DRILLED SHAFT DIAMETER

PILE DIMENSIONS & MATERIAL PROPERTIES

$d := \frac{11}{8}in$ = BAR DIAMETER

$A := \frac{\pi \cdot d^2}{4}$ = AREA OF BAR

$K := 0.65$ = EFFECTIVE LENGTH FACTOR

$E := 29000 \cdot ksi$ = MODULAS OF ELASTICITY OF STEEL

$\gamma_{stl} := 490 \cdot pcf$ = UNIT WEIGHT OF STEEL

STRUCTURAL PROPERTY CALCULATIONS

$r := \frac{d}{4}$ = RADIUS OF GYRATION

$r = 0.34 \cdot in$

$S_x := \frac{\pi \cdot d^3}{32}$ = SECTION MODULUS

$S_x = 0.26 \cdot in^3$

$I_x := \frac{\pi \cdot d^4}{64}$

$I_x = 0.18 \cdot in^4$ = MOMENT OF INERTIA

$A_{grout} := \frac{\pi \cdot d_{shaft}^2}{4} - A$

$A_{grout} = 26.79 \cdot in^2$ = AREA OF GROUT

CALCULATE ALLOWABLE AXIAL COMPRESSIVE STRESS:

$$C_c := \sqrt{\frac{2\cdot\pi^2\cdot E}{F_y}} \qquad C_c = 87.36$$

$$\frac{K\cdot l}{r} = 113.45$$

$$F_a := \text{if}\left[\frac{K\cdot l}{r} < C_c, \left[1 - \frac{\left[\left(\frac{K\cdot l}{r}\right)^2\right]}{2\cdot C_c^2}\right]\cdot F_y, \frac{\pi^2\cdot E}{\left(\frac{K\cdot l}{r}\right)^2}\right]$$

$F_a = 22.24\cdot ksi$ = ALLOWABLE COMPRESSIVE STRESS

$$P_c := \left(0.40\cdot f'_c\cdot A_{grout} + F_y\cdot A\right)\cdot\frac{F_a}{F_y}$$

$P_c = 45.73\cdot kip$ = ALLOWABLE PILE LOAD

$$\text{Check} := \text{if}\left(R_b \le P_c, \text{"OK!"}, \text{"NO GOOD!"}\right)$$

Check = "OK!"

$S := x_{pile}$ = MAXIMUM PILE SPACING

$L_1 := S - d$ = CLEAR DISTANCE BETWEEN PILES

$L_1 = 2.89\cdot ft$

$$L_2 := \frac{L_1}{2}$$

$L_2 = 1.44\cdot ft$

$$\phi := \frac{33\cdot deg}{1.3}$$ = INTERNAL FRICTION ANGLE FOR SOIL

$$P_{hmax} := \left(\gamma_s\cdot L_2 - 2\cdot c\right)\cdot\tan\left(45\cdot deg - \frac{\phi}{2}\right)$$ = MAXIMUM SOIL PRESSURE

$P_{hmax} = 114.04\cdot psf$

$R := \frac{P_{hmax} \cdot L_1}{3} + P_s \cdot d_{shaft}$ $\quad R = 0.11 \cdot \frac{kip}{ft}$ = MAXIMUM SOIL FORCE ON PILE

$M := \frac{R \cdot l^2}{10}$ $\quad M = 0.27 \cdot kip \cdot ft$ = MOMENT ON UNSUPPORTED LENGTH

$S_{xreq} := \frac{M}{F_b}$ $\quad S_{xreq} = 0.07 \cdot in^3$ = REQUIRED SECTION MODULUS

$Check := if(S_{xreq} \leq S_x, "OK!", "NO GOOD!")$

Check = "OK!"

CALCULATE REQUIRED EMBEDMENT DEPTH:

$f_{fric} := 25 \cdot psi$ $\quad f_{fric} = 25 \cdot psi$

$D_{shaft} := \frac{R_b}{\pi \cdot d_{shaft} \cdot f_{fric}}$ $\quad D_{shaft} = 4.8\,ft$ = REQUIRED EMBEDMENT DEPTH (NEGLECTING END BEARING)

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SOIL NAIL WALL SUPPORT DESIGN
(Vertical Elements at Existing Footings)

PARAMETERS:

$f'_c := 4000 \cdot psi$ = GROUT COMPRESSIVE STRENGTH

$E := 29000 \cdot ksi$ = STEEL MODULUS OF ELASTICITY

$qb := 3000 \cdot psf$ = ALLOWABLE BEARING PRESSURE

$B := 4 \cdot ft$ = TRIBUTARY WIDTH OF EXISTING FOUNDATION

$x_{pile} := 3 \cdot ft$ = HORIZONTAL SPACING OF PILES (MAXIMUM)

$Pv := qb \cdot (B \cdot x_{pile})$ = TRIBUTARY WIDTH OF EXISTING FOUNDATION

$Pv = 36 \cdot kip$

$t_{conc} := 6 \cdot in$ = MAXIMUM SOIL NAIL WALL THICKNESS

$t_{soil} := 3.0 \cdot ft$ = ASSUMED THICKNESS OF MOBILIZED SOIL MASS

$\gamma_c := 150 \cdot pcf$ = UNIT WEIGHT OF CONCRETE

$c := 0 \cdot psf$ = SOIL COHESION

$\gamma_s := 125 \cdot pcf$ = UNIT WEIGHT OF SOIL

$h := 20 \cdot ft - 5 \cdot ft$ = MAX. HEIGHT OF SOIL MASS ABOVE CUT

$h = 15 ft$

$R_b := x_{pile} \cdot (t_{conc} \cdot \gamma_c + t_{soil} \cdot \gamma_s) h \ldots + -c \cdot h \cdot x_{pile} + Pv$ = MAXIMUM VERTICAL DEAD LOAD

$P_s := 500 \cdot psf$ = SURCHARGE PRESSURE

$l := 5 \cdot ft$ = MAXIMUM UNBRACED LENGTH

$d_{shaft} := 6 \cdot in$ = DRILLED SHAFT DIAMETER

$\gamma_{stl} := 490 \cdot pcf$ = UNIT WEIGHT OF STEEL

Net Vertical Dead Load

$R_b = 56.25 \cdot kip$

PILE DIMENSIONS & MATERIAL PROPERTIES

Pile := "Titan 52/26 Hollow Bar"

$A := 2.07 \cdot in^2$ = HOLLOW BAR CROSS SECTIONAL AREA

$d_o := 2.05 \cdot in$ = HOLLOW BAR NOMINAL OUTSIDE DIAMETER

$d_i := 1.02 \cdot in$ = HOLLOW BAR NOMINAL OUTSIDE DIAMETER

$Yield := 164.1 \cdot kip$ = HOLLOW BAR YIELD LOAD

$K := 0.65$ = EFFECTIVE LENGTH FACTOR

$E := 29000 \cdot ksi$ = MODULAS OF ELASTICITY OF STEEL

STRUCTURAL PROPERTY CALCULATIONS ---> $F_y := \frac{Yield}{A}$ = STEEL YIELD STRESS

$$r := \frac{\sqrt{d_o^2 + d_i^2}}{4}$$ = RADIUS OF GYRATION

$r = 0.57 \cdot in$

$$I := \frac{\pi \cdot \left(d_o^4 - d_i^4\right)}{64}$$ = MOMENT OF INERTIA

$I = 0.81 \cdot in^4$

$$S := \frac{2 \cdot I}{d_o}$$ = MOMENT OF INERTIA

$S = 0.79 \cdot in^3$

$$A_{grout} := \frac{\pi \cdot d_{shaft}^2}{4} - A$$

$A_{grout} = 26.2 \cdot in^2$ = AREA OF GROUT

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CALCULATE ALLOWABLE AXIAL COMPRESSIVE STRESS:

$$C_c := \sqrt{\frac{2\cdot\pi^2\cdot E}{F_y}} \qquad C_c = 84.98$$

$$\frac{K\cdot l}{r} = 68.13$$

$$F_a := \text{if}\left[\frac{K\cdot l}{r} < C_c, \left[1 - \frac{\left[\frac{\left(\frac{K\cdot l}{r}\right)^2}{2\cdot C_c^{\,2}}\right]\cdot F_y}{4\cdot\pi^2\cdot E}\right]\cdot F_y, \frac{\pi^2\cdot E}{\left(\frac{K\cdot l}{r}\right)^2}\right] \qquad F_a = 79.27\cdot ksi$$

= ALLOWABLE COMPRESSIVE STRESS

$$P_c := \left(0.40\cdot f'_c\cdot A_{grout} + F_y\cdot A\right)\cdot\frac{F_a}{F_y} \qquad P_c = 206.02\cdot kip$$

= ALLOWABLE PILE LOAD

$$Check := \text{if}\left(R_b \le P_c, \text{"OK!"}, \text{"NO GOOD!"}\right) \qquad Check = \text{"OK!"}$$

$$F_b := 0.66\cdot F_y$$

= ALLOWABLE STEEL BENDING STRENGTH

$$span := x_{pile}$$

= MAXIMUM PILE SPACING

$$L_1 := span - d_o \qquad L_1 = 2.83\cdot ft$$

= CLEAR DISTANCE BETWEEN PILES

$$L_2 := \frac{L_1}{2} \qquad L_2 = 1.41\cdot ft$$

$$\phi := \frac{33\cdot deg}{1.3}$$

= INTERNAL FRICTION ANGLE FOR SOIL

$$P_{hmax} := \left(\gamma_s\cdot L_2 - 2\cdot c\right)\cdot\tan\left(45\cdot deg - \frac{\phi}{2}\right)$$

= MAXIMUM SOIL PRESSURE

$$P_{hmax} = 111.82\cdot psf$$

FLEXURAL STRESS

$R := \frac{P_{hmax} \cdot L_1}{3} + P_s \cdot d_{shaft}$ $R = 0.36 \cdot \frac{kip}{ft}$ **= MAXIMUM SOIL FORCE ON PILE**

$M := \frac{R \cdot l^2}{8}$ $M = 1.11 \cdot kip \cdot ft$ = MOMENT ON UNSUPPORTED LENGTH

$S_{xreq} := \frac{M}{F_b}$ $S_{xreq} = 0.25 \cdot in^3$ = REQUIRED SECTION MODULUS

$Check := if(S_{xreq} \le S, "OK!", "NO GOOD!")$

$Check = "OK!"$ $S = 0.79 \cdot in^3$

COMBINED STRESS

$\frac{R_b}{P_c} + \frac{M}{F_b \cdot S} = 0.59$

CALCULATE REQUIRED EMBEDMENT DEPTH:

$f_{fric} := 25 \cdot psi$

$D_{shaft} := \frac{R_b}{\pi \cdot d_{shaft} \cdot f_{fric}} \cdot 1.3$ = REQUIRED EMBEDMENT DEPTH (NEGLECTING END BEARING)

$D_{shaft} = 12.9 ft$

Use: 15'-0" embedment depth

V. MICROPILE CONNECTION (CONTINUED) --->

I. Compressive Punching Shear

$\delta := 1.4$ = Dead Load Factor - ACI 9.2.1

$\delta \cdot R_b = 78.75 \cdot kip$ = Ultimate Compressive Load

$\phi_v := 0.75$ = Shear Strength Reduction - ACI 9.3.22

$t_f := 24 \cdot in$ = Footing Thickness

$c_1 := 3 \cdot in$ = Flexural Reinforcement cover

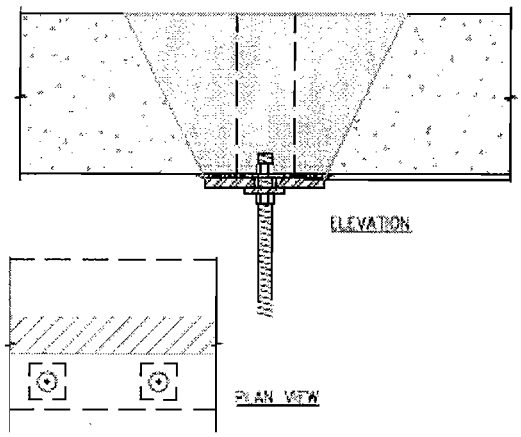
$d := t_f - c_1$ = Depth to Flexural Reinforcement

$edge_1 := \frac{d}{2}$ = Critical Shear Edge No. 1

$edge_2 := edge_1$ = Critical Shear Edge No. 2

$edge_3 := edge_1$ = Critical Shear Edge No. 3

$edge_4 := 0$ = Critical Shear Edge No. 4



Bearing Plate Dimensions

$b_p = 12 \cdot in$
$L_p = 12 \cdot in$

Plate Dimensions: $b_p := 12 \cdot in$ $L_p := 12 \cdot in$

PUNCHING SHEAR CARRIED BY CONCRETE - ACI 318 CHAPTER 11

$\beta_c := 1$ = Perimeter Ratio

$b_o := 2(edge_1) + 1(L_p + edge_1 + edge_3)$ = Critical Shear Perimeter

$b_o = 54 \cdot in$

$\alpha_s := 30$ = Column Type Coefficient - ACI 11.12.2.1 Eqn. 11-36
Interior Columns = 40
Edge Columns = 30
Corner Columns = 20

$$V_c := \min\left[\begin{array}{c} \left(2 + \frac{4}{\beta_c}\right) \cdot \sqrt{f'_c \cdot psi} \cdot b_o \cdot d \\ \left(\frac{\alpha_s \cdot d}{b_o} + 2\right) \cdot \left(\sqrt{f'_c \cdot psi} \cdot b_o \cdot d\right) \\ 4 \cdot \left(\sqrt{f'_c \cdot psi} \cdot b_o \cdot d\right) \end{array}\right]$$

= Critical Punching Shear - ACI 11.12.2.1

Compressive Punching Shear Capacity (Bottom Plate)

$\phi_v \cdot V_c = 215.2 \cdot kip$

$Check := if(\delta \cdot R_b \le \phi_v \cdot V_c, "Ok", "No Good")$

Check = "Ok"

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BEARING PLATE THICKNESS

Minimum Plate Thickness

$F_{yplate} := 36 \cdot ksi$ = Bearing Plate Yield Stress

$f_a := \frac{R_b}{b_p \cdot L_p}$ = Maximum Bearing Load

$f_a = 56250 \cdot psf$

$b_{analysis} := 1 \cdot in$ = Plate Width for Bending Analysis

$M_{max} := \frac{1}{2} \cdot \left(\frac{\min(b_p, L_p) - d_o}{2} \right)^2 \cdot f_a \cdot b_{analysis}$ = Maximum Bearing Moment - Conservative Analysis FHWA 5-83

$M_{max} = 402.84\,lb \cdot ft$

Minimum Plate Thickness (Continued)

$F_b := 0.55 \cdot F_{yplate}$ = Bearing Plate Allowable Bending Stress

$F_b = 19.8 \cdot ksi$

$S_{req} := \frac{M_{max}}{F_b}$ = Bearing Plate Minimum Section Modulus

$S_{req} = 0.24 \cdot in^3$

$t_{req} := \sqrt{\frac{6 \cdot S_{req}}{b_{analysis}}}$ = Bearing Plate Minimum Thickness

$t_{req} = 1.21 \cdot in$

USE: $t_p := 1.25 \cdot in$ *Conservative, 12" x 12" x 1.25" Bearing Plate*

SECTION 11

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ROCK ANCHOR DESIGN

PARAMETERS:

xpile := 6·ft = Soil nail center to center spacing

fu := 25·psi = Ultimate grout-rock bond stress

FS := 2 = Allowable pull out grout-rock factor of safety

$fa := \frac{fu}{FS}$ = Allowable grout-rock bond stress

fa = 12.5·psi

$\alpha := 50 \cdot deg$ = Interior pull out cone angle

$\gamma := 125 \cdot pcf$ = Unit weight of rock mass

A. Solid thread bar

Bar := "No. 9 Grade 75 Bar"

$T_{bar} := 75 \cdot kip$ = Thread (solid) bar yield load

dshaft := 6·in = Thread bar drill shaft diameter

B. Hollow bar alternate

Hollow := "Titan 40/20 Hollow Bar"

$T_{hollow} := 97 \cdot kip$ = Alternate hollow bar yield load

dbit := 70·mm = Carbide cross cut drill bit diameter

gbody := 1.2 = Grout body factor

Depth of embedment. Assume vertical rock surface defines failure plane (or critical geometry for stability analysis). Therefore the un-bonded length is zero ---> Check cone failure.

- Assume 10'-0" long rock anchor.

- Neglect 2'-0" at rock surface to account for fractured/weathered rock interfrace ---> L = 10'-2' = 8'-0"

Cone frictional capacity

$L := 10 \cdot ft - 2 \cdot ft$ = Minimum soil nail / rock bolt length

$hcone := 5.1962 \cdot ft$ = Height of cone below intersection

A. Cone

$r := hcone \cdot \tan\left(\frac{\alpha}{2}\right)$ = Radius of cone

$r = 2.42\,ft$

$S := \sqrt{L^2 + r^2}$ = Hypotenuse of cone

$S = 8.36\,ft$

$SA_1 := \pi \cdot r \cdot S$ = Surface area of cone

$SA_1 = 63.63\,ft^2$

B. Cylinder above intersection

$hc := 2.8038 \cdot ft$ = Height of cylinder above cone intersection

$SA_2 := \pi \cdot 2 \cdot r \cdot hc$ = Surface area of cone

$SA_2 = 42.69\,ft^2$

Net surface area

$SA := SA_1 + SA_2$ = Surface area of cone

$SA = 106.32\,ft^2$

$Capacity := SA \cdot fa$ = Allowable pull out capacity

$Capacity = 191.37 \cdot kip$ **Ok, greater than yield capacity of hollow & solid bars**

SECTION 12

GEOTECHNICAL EXPLORATION REPORT
OFF-SEASON TWO IMPROVEMENTS
2580 CAHUENGA BOULEVARD EAST
HOLLYWOOD DISTRICT OF LOS ANGELES, CALIFORNIA

Prepared For:

FORD THEATRE FOUNDATION
2580 Cahuenga Boulevard East
Hollywood, California 90068

Project No. 10296.001

September 10, 2013

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

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A LEIGHTON GROUP COMPANY

September 10, 2013

Project No. 10296.001

Ford Theatre Foundation
2580 Cahuenga Boulevard East
Hollywood, California 90068

c/o Bottega Management Group
3500 W. Olive Avenue, Suite 300
Burbank, California 91505

Attention: Mr. A. Leonard Madson, Principal

Subject: Geotechnical Investigation
Off-Season Two Improvements
2580 Cahuenga Boulevard East
Hollywood District of Los Angeles, California

Reference: Leighton Consulting, Inc., 2013, Preliminary Geotechnical Evaluation John Anson Ford Theaters Master Plan 2580 Cahuenga Boulevard East Hollywood District of Los Angeles, California, Project No. 603057-001, dated February 7, 2013.

In accordance with our April 30, 2013 proposal, authorized on May 2, 2013, Leighton Consulting, Inc. (Leighton) is pleased to present this geotechnical exploration report in support of the proposed Off-Season Two Improvements planned for the John Anson Ford Amphitheater. Our scope of work for this study included research, geologic mapping, subsurface exploration, laboratory testing, engineering analysis, design team meetings, and preparation of this report.

The Off Season Two Improvements are expected to include restoration of historic features and improvements to the amphitheater stage. Planned improvements include replacement of the existing stage, below stage spaces, and upstage retaining walls.

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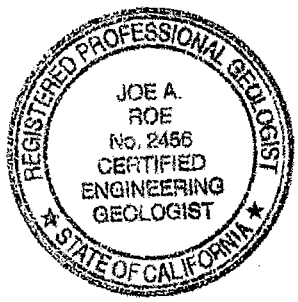
The new basement floor levels below the stage are to be lowered and sub-surface and surface drainage elements improved, including new and replacement sanitary sewers and storm drains.

This report presents the results of our geotechnical exploration program and provides recommendations for design and construction of the proposed project.

We appreciate the opportunity to be of service to the Ford Theatre Foundation. If you have any questions or if we can be of further service, please call us at your convenience at (866) LEIGHTON, at the direct extensions listed below, or e-mail us as listed below.



Respectfully submitted,

LEIGHTON CONSULTING, INC.



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1.0 INTRODUCTION

1.1 Authorization

In accordance with your authorization on May 2, 2013, and based on our April 30, 2013 Off-Season Two Improvements proposal, Leighton Consulting, Inc. (Leighton) has performed document review, geologic mapping, subsurface exploration, laboratory testing, and engineering analysis for the John Anson Ford Theaters Master Plan Off-Season Two Improvements. The project is located at 2580 Cahuenga Boulevard in the Hollywood District of Los Angeles, California (Figure 1).

1.2 Objective

The objective of our investigation was to identify subsurface stratigraphy (soil type and thickness, depth to bedrock) within the area of planned improvements. Access constraints prevented exploration at some locations, such as below the existing basements and at the towers adjacent to the stage. Accordingly, assumptions have been made to model the stratigraphy at unexplored locations for our analysis and will require field verification during construction.

1.3 Scope of Work

Our scope included document review, geologic mapping, subsurface exploration, laboratory testing, engineering analysis, on-site meeting with the design team, and preparation of this report. To accomplish our scope of work we provided the following services:

- *Review of Available Data*: We reviewed the schematic design draft plans, Off Season Two Improvements, sheets S-200 Lower Level Plan, S-201 Mezzanine Level Plan, S-202 Amphitheater Plan, L-500 Sections and C3.00 Utility and Drainage Plan, prepared by Levin and Associates Architects, dated April 5, 2013 and accompanying memorandum dated April 9, 2013.

- *Geologic Mapping*: We performed field mapping of the observable rock mass, rockfall debris, and surficial soil conditions around the amphitheater to document current geologic conditions and identify potential geotechnical and geologic constraints impacting the overall project site (Plate 1, Geologic Map). Location of cross sections A-A' and B-B' developed during our preliminary

evaluation in 2012 are also shown on Plate 1. Geologic data, test pit, and cross section locations (C-C', D-D' and E-E') specific to the Off-Season Two project are shown on Plate 2, Test Pit and Cross Section Location Map). Geologic cross sections are shown on Plates 3, Generalized Geologic Cross Sections A-A' and B-B', and Plate 4, generalized Geologic Cross Sections C-C', D-D' and E-E'.

- *Geophysical Survey*: We performed a geophysical refraction and surface wave velocity survey as part of our preliminary investigation conducted in 2012. For ease of reference a copy of the seismic survey report (Leighton, 2013) is included in Appendix A of this report. Locations of the refraction surveys are shown on Plate 1.

- *Geotechnical Exploration*: We excavated four test pits (TP-1 through TP-4) behind the existing terraced retaining walls to the east of the amphitheater and in the landscape area adjacent to the north tower. Due to the extremely difficult site access and heavy vegetation, we hand excavated test pits in the selected areas to obtain geologic data. Test pit logs are incorporated in the geologic sections on Plate 4. Each test pit was photographed prior to backfilling. Bulks samples were collected from the test pits and transferred to our lab for geotechnical laboratory testing. The test pits were backfilled and compacted with the excavated material. Key photos of the proposed improvements area are included in Appendix B, Test Pit Logs and Photos.

- *Laboratory Testing*: We performed geotechnical laboratory testing on bulk samples recovered during the investigation to determine compaction characteristics (ASTM D1557-12), expansion potential (ASTM D 4829), and corrosion (California Test methods CT 417 Part II, 422, and 532/647). Laboratory test results are included in Appendix C, Laboratory Data.

- *Engineering Analysis*: We performed an evaluation of the proposed project based on the field data gathered during our current and prior studies at the site.

- *Report:* Leighton prepared this report documenting the results of the geological mapping, subsurface exploration, laboratory testing, and engineering analysis and provides recommendations for design and construction of the Off-Season Two Improvements.

1.4 Project Description

The Off-Season Two Improvements include demolition and construction of new footings within the amphitheater footprint, below the concrete tower structures north and south of the stage and north tunnel, removal and replacement of basement retaining walls, drainage improvements, and slab on grade construction. New terraced retaining walls are also planned to replace the existing stone walls behind the stage in conjunction with hillside landscaping. New and replacement sanitary sewer and storm drain lines are also planned.

1.5 Study Area

As presented on Figure 1, generally, the project site is located on steep hillside terrain within a County of Los Angeles Park. The study area is bordered to the west by Cahuenga Boulevard East and U.S. Route 101 and to the east by the steep flanks of the Santa Monica Mountains. The site of the existing Ford Theatre spans for approximately 1,320 feet along the base of the hills and contains three asphalt-paved parking lots (northern lot, motel lot and southern lot) facing Cahuenga Boulevard East, a former motel building, and the existing Amphitheatre with loading area, pedestrian walkways and box office. Elevations of the sites existing improvements range from approximate elevation El. 552 feet mean sea level (msl) near the entrance to the site at Cahuenga Boulevard East to a high of El. 654 feet msl in the northern region of the Off Season Two Improvements area (Plate 1). The ridgeline east of and above the amphitheater rises to a high of elevation 944 feet msl (USGS, 1966) before descending easterly to Weid Canyon, the site of Mulholland Dam (Hollywood Reservoir).

The Off-Season Two Improvements are proposed for construction within the amphitheater footprint (Plate 2, Test Pit and Cross Section Location Map), which consists of subterranean tunnels and corridors below the stage and amphitheater seating area, two concrete towers and mezzanines north and south of the stage, terraced stone walls and planter areas behind the stage. Erosion and debris flow impacted concrete drainage swales capture hillside runoff directed toward an 18-inch-diameter reinforced concrete storm drain pipe (RCP) upslope of the terraced stone walls. Existing upslope hillside improvements above the main masonry block wall include a wooden platform and a concrete cribwall that has been damaged by rockfalls in the north area of the site including a masonry block wall upslope in a heavily vegetated area. Photos of the Off-Season Two Improvements area are located in Appendix B, Test Pit Logs and Photos.

2.0 GEOLOGIC RECONNAISSANCE AND MAPPING

We performed geologic reconnaissance and field mapping of the Off-Season Two Improvements project area supplement the data procured during literature review. The following sections provide general descriptions of the conditions expected at the areas of the Off-Season Two Improvements. The interpreted subsurface conditions are shown on Plate 4, Generalized Geologic Cross Sections C-C', D-D', and E-E'.

2.1 Lower Level

The lower levels of the basement walls and north tunnel foundation footprints underlie the amphitheater stage and seating area (Figure B-1). The approximate footprint of the lower level basement retaining wall, interior walls, and corridors leading to and from the north tunnel are indicated on Plate 2.

The eastern basement retaining wall is of masonry block construction and exhibits mineral efflorescence along the mortar joints and block faces due to seepage through the wall indicating either non-functioning or non-existent wall drains. Based on regional mapping and extrapolated field conditions exposed within test pits TP-2 and TP-3 (Figure B-2), it appears bedrock underlying the foundations consists predominately of basalt and appears to have been cut to fit the "footprint" of the foundations and retaining walls during original construction of the Theater in the 1920's. Approximately 12 to 48-inches of overexcavation behind the retaining walls appears to have been performed to allow adequate space for construction.

Backfill material behind the walls consist of a mixture of the bedrock material, predominately basalt and a silty sand mixture of basalt and sandstone rock fragments. This backfill prism also contains an abundant overgrowth of roots from the many large trees that line the hillside. Abundant oversize material, i.e. cobbles and boulders are also present within the fill prisms.

2.2 Mezzanine Level

The mezzanine levels located north and south of the stage provide access to the upper tower levels and for stage lighting (Plate 2). The mezzanine decks adjacent to the two towers are bordered by steep bedrock slopes consisting of thick accumulations of colluvium and rock talus.

Upper Level Mezzanine Deck North: The slopes bordering the northern mezzanine level are inclined at 60-65 degrees, contain large diameter trees and consist of near vertical headscarp exposures of severely weathered basalt bedrock with thick accumulations of colluvium forming on the slope (Figure B-5). The colluvial material is subject to slow creep and debris flows during heavy precipitation as evidenced by bent trees, overtopping mezzanine walls, and sandbag barriers with plastic sheeting covering the slopes in an effort to prevent further mass erosion affecting the daily operations of the Theater.

Upper Level Mezzanine Deck South: The slopes bordering the southern mezzanine level are steeply inclined to near vertical and contain exposures of basalt, sandstone and thick accumulations of colluvium and rockfall debris. The basalt in this area degrades to angular, silty-clayey sand forming the majority of the colluvial material. The sandstone in this area is very hard, well cemented and heavily jointed due to faulting and tectonic uplift. This sandstone outcrop contains near vertical, fresh exposures of sandstone rock faces with thick accumulations of rock talus (rockfall debris). These accumulations form along the base of the slope impacting the southern concrete walls (Figure B-6). A steel H-beam reportedly installed to provide structural support to the concrete wall has been damaged by the boulder sized talus rockfalls occurring along structural planes of weakness. This area is shown on Plates 1 and 2 as having high potential for continued rockfalls.

2.3 Amphitheatre Plan

The existing improvements consist of a series of stacked stone walls and concrete stairs (Figure B-2) ascending to a concrete drainage swale and masonry block wall ranging in height from 32- to 84-inches tall (Figures B-3 and B-4). The stone retaining wall foundations were constructed on basalt bedrock (Figure B-2), drainage is accomplished by a series of 1- to 4-inch-diameter weep holes located above the wall footings. Some weep holes are partially obstructed by soil and weed overgrowth and were dry at the time of our observations.

The slopes above these stone walls are inclined from 50-65 degrees and consist of exposures of severely weathered basalt bedrock with thick accumulations of colluvium forming on the slope. Surficial slumping of undocumented artificial fill and colluvium was observed at several locations. Dense vegetation consists of large trees, small shrubs and grasses. The hillside above the amphitheater area

was constructed with a concrete lined drainage swale outletting to an 18-inch-diameter downdrain and retaining wall structure (Figure B-3).

The southern limit of the concrete drainage swale is obscured from view by thick accumulations of soil and vegetation (Figure B-4). Above the drainage swale to the northeast, concrete cribbing emplaced to prevent rockfall damage from upslope outcrops has sustained damage due to rockfalls evidenced from one of the many sandstone boulders perched on the slope face (Figure B-3). An additional masonry block wall was constructed easterly of the upper drainage swale in a small canyon drainage. The slopes below this area are heavily vegetated. The condition of the masonry block wall in this area is unknown but is suspected to be impacted by sediment build up and potential rockfall (Plates 1 and 2).

3.0 GEOLOGIC CONDITIONS

3.1 Regional Geology and Tectonics

The study area for the proposed project is located on the south flank of the eastern Santa Monica Mountains, west of the Cahuenga Fault within the Transverse Ranges Geomorphic Province of California. The distinctive uplifted east-west trending features of the Transverse Ranges were formed as a result of the compressive forces between the converging Pacific and North American Plates (Yerkes, 1965). The Santa Monica Mountains in this area expose north-trending, fault bound blocks containing an assemblage of older Tertiary-age marine and non-marine sedimentary and intrusive and extrusive volcanic rocks (Figure 2, Regional Geologic Map). An east-west trending ridge, in line with the main crest of the Santa Monica Mountains, is the principal topographic feature of the area. Cahuenga Pass, a low gap in the ridge, separates this ridge from the main crest of the Santa Monica Mountains (CDMG, 1953) formed largely as a result of erosion of soft shale outcrops west of the Cahuenga fault and formation of resistant sandstone to the east.

The present physiographic setting of the project site is predominantly northwest to west-facing steep sided to near-vertical (ridge forming sandstones) terrain along the eastern side of the study area. The topographic relief across the site varies between approximately 551 feet above msl in the northwestern portion of the site to approximately 944 feet above msl along the ridgeline to the east of the existing former motel building. The topographic features are closely related to tectonic uplift, ridgeline erosion, erosion of soft shales, and intrusive-extrusive basaltic flows. Internal drainage has eroded major gullies and rills into the underlying bedrock material.

3.2 Site Specific Geology

The local geologic units encountered at the Off-Season Two Improvements project area are discussed below, in order of relative age, youngest to oldest. The surficial units observed include recent and Quaternary-age sediments that form a thin mantle over the bedrock. These surficial units include undocumented artificial fill associated with the amphitheater construction, debris flows, surficial rock failures, and colluvium. The colluvium is generally not depicted on the map due to its relatively thin nature, except where it has been recently mapped during our geologic reconnaissance (Plates 1 and 2). Bedrock belonging to the Tertiary-

age Topanga Formation and intrusive-extrusive volcanic rocks (pillow basalt) correlative to the Topanga Formation exposed throughout the project study area and mapped during our geologic investigation is depicted on Plate 1.

Artificial Fill, Undocumented (Map Unit – Afu): Artificial fill materials have been mapped in the areas behind the terraced stone walls as shown on Plate 4. The thickness of the artificial fill underlying the majority of the improvements area is unknown; however, based on our current investigation we anticipate the existing foundations to be founded on bedrock with nominal amounts of fill underlying the slab on grade construction. As encountered at the test pit locations (shown on Plate 2), fill material consists predominately of silty sand to clayey sand (SM-SC) with varying amounts of basalt and sandstone rock fragments ranging in size from small cobbles to boulders greater than 14-inches in long dimension. The fill material depths at the test pit locations ranged from less than 12-inches up to 5 feet (Plate 4).

Debris Flows and Surficial Failures: Several small (volume) debris flows and surficial failures were mapped at various locations along the slopes at the site, as indicated on Plates 1 and 2. The debris flows (gravitational slides) affecting the proposed construction area consist of thick accumulations of colluvium characterized as silty-clayey sand (SM-SC) comprised of fine to coarse grained, angular sandstone and basalt rock fragments. The material is loose, occurs predominately within the basalt formation and is prone to sliding during significant, prolonged rainfall events.

Rockfalls: Rockfalls and wedge failure events originating in the initiation zone of the sandstone outcrop have resulted in thick accumulations of talus at the toe of the slope and concrete retaining wall constructed as part of the southern mezzanine deck area (Plate 2). These events can be expected to continue and consist of individual rocks to several cubic yard volume events. The run out zone below this outcrop is very narrow and constrained by the existing concrete retaining wall. A steel H-beam installed to provide structural support to the concrete wall is bent suggesting rockmass dislodged and either bounced, slid and/or rolled down slope before coming to rest against the steel structure. The principal causal mechanism of rockfalls and wedge failures in this area is a result of the steep near vertical topography, discontinuities within the rockmass, *weathering* susceptibility and root-wedging. Seismic shaking within the region can produce rockfall events.

Colluvium (Map Unit – Qcol): Slopewash or colluvial deposits are composed of materials that have been eroded, deposited, and transported by either running water (sheetflow), and/or gravitational sliding. The colluvial material at the site consists of brown, dry, loose silty clayey sands and rock fragments mechanically derived from severely weathered Topanga Formation basalt and sandstone material.

Topanga Formation Bedrock: The sedimentary bedrock unit exposed in the hillside and test pits belongs to the Tertiary-age Topanga Formation and is further described below:

Sandstone (Map Unit – Tts): This very hard, well cemented and heavily jointed sandstone outcrop was observed primarily in the southern portion of the site occurring in fault and depositional intrusive contact with the basalt formations, as indicated on Plate 1. The sandstone unit was observed to be orange brown, hard, thin to thickly bedded, well cemented with fine to coarse grained quartz sand and fine pebble sized subangular quartz inclusions. The rockmass is well oxidized with trace amounts of pyrite that contain reddish black oxide rimming along the cubic grains. The sandstone is in fault contact with very fine grained, siliceous quartz sandstone containing dark red cherty laminations. These rock masses are severely fractured, heavily jointed with very narrow zones of rock gouge along the faults.

Sandstone (Map Symbol - Ttbs): Although not observed in the Off Season Two Improvements area, this friable sandstone was observed during our earlier investigation east of the northern parking lot, north of the former motel building, and east of the southernmost parking lot, as indicated on Plate 1. This sandstone unit was observed to be dark gray with basalt fragments and rounded manganese nodules throughout, friable or crumbly, and severely weathered and fractured. Heavy secondary mineralization and chemical alteration of the mafic minerals within the unit was also observed.

Tertiary Volcanic Rocks (Map Unit – Tvb): The Tertiary-age pillow basalt formed from flows issuing from deep linear fissures (mid-oceanic fractures) in the ocean crust, observed within the test pits, forms the majority of the bedrock material exposed in the slopes immediately above the proposed improvement area (Plate 1). This highly weathered, intrusive-extrusive igneous rock is massive, orange brown on oxidized surfaces to grayish black on less weathered surfaces. Chemical weathering and decomposition of the basalt mineralogy is severe

causing degradation of the rock mass into angular sand and gravel sized fragments thereby influencing the rock strength and elastic properties. Fresh or discolored (dark grayish black) rock is present as a discontinuous framework and as corestones. This degradation to soil causes thick accumulations of secondary clayey colluvium which are susceptible to debris flows.

3.3 Geologic Structure

Regional uplift of the Santa Monica Mountains is primarily the result of movement along the Santa Monica and Hollywood faults combined with extrusive igneous intrusions that once occurred along linear fissures in oceanic crust. The major faults in the project area most important to the structural and stratigraphic evolution of the fault bound blocks are the Cahuenga Fault Zone, the Brush Canyon fault, the Ferndell fault, the Griffith fault and the Los Angeles River fault.

Minor faults mapped in the sandstone outcrop in the southern area of the site generally strike N66°W to N76°W and dip steeply out of slope between 84° to 88° to the north correlating well to the regional trend of the local fault structure. Bedrock strikes predominately in a north-south direction dipping steeply into slope to the east between 60° to 65° (Plate 1). Contact between the sandstone bedrock and the pillow basalt exposed in the southern portion of the site were partially obscured due to dense vegetation and colluvial buildup and is therefore queried (Plate 1).

3.4 Rippability

As indicated in Section 1.3, a seismic refraction survey was completed in the southern and motel parking lots (Leighton, 2013). The seismic refraction survey was performed to predict the rippability of the material that underlies the site, which is primarily volcanic basalt and sandstone bedrock. Based on the seismic velocity profiles, jointed and fractured nature of the bedrock structure, the onsite materials within the planned excavation depths are considered rippable with conventional grading equipment.

However, due to access constraints conventional earthmoving equipment will likely not be able to access the areas of proposed improvements without significant access provided. As part of the current study, hand held electric chisels were used to excavate the basalt formation in the test pits. A depth of approximately 4 feet was obtained in Test Pit TP-1 with little difficulty.

Excavation of the material below a depth of 4 feet proved slightly difficult due to decreasing bedrock weathering with depth and equipment access constraints. The sandstone outcrop mapped in the southern portion of the site should be expected to be encountered during the planned renovations along the southern boundary. This material is hard and well cemented, pervasively fractured and jointed, and will prove moderately difficult to excavate with hand held equipment.

3.5 Groundwater

Due to the relatively high topographical relief and the exposed or shallow bedrock throughout the majority of the proposed project site, shallow groundwater is not expected to exist at the site. However, if prolonged seasonal precipitation occurs during the construction period, nuisance water should be expected to build up behind the eastern basement retaining wall thereby posing minor constraints on construction. Additionally, surface runoff during rainfall events should be anticipated. Should nuisance water be encountered during construction, dewatering the excavation(s) may be necessary and could be accomplished using sump pumps.

4.0 GEOLOGIC HAZARDS

Geologic hazards for the overall Theater complex include surface faulting, ground lurching, seismic shaking, landslides, liquefaction, seismically-induced settlement, lateral spreading, seismically-induced landslides, and flooding. Additional geologic hazards specifically affecting the proposed Off-Season Two Improvements Area include the potential for mass movements in the form of debris flows and rockfalls. The following sections discuss these hazards and their potential impacts at the site in more detail.

4.1 Faulting and Seismicity

In general, the primary seismic hazards for sites in the region include strong ground shaking and surface fault rupture. Our discussion of faults potentially impacting the site is prefaced with a discussion of California legislation and state policies concerning the classification and land-use criteria associated with faults. By definition of the California Geological Survey (CGS), an active fault is a fault which has had surface displacement within Holocene time (about the last 11,000 years). The state geologist has defined a potentially active fault as any fault considered to have been active during Quaternary time (last 1,800,000 years). This definition is used in delineating Earthquake Fault Zones (EFZ) as mandated by the Alquist-Priolo Earthquake Faulting Zones Act of 1972 and as most recently revised in 2007 (Hart and Bryant, 2007). The intent of this act is to ensure that urban development and habitable structures are not sited across the traces of active faults. Based on our review, the site is not located within an EFZ, (CGS, 2000).

Numerous active and potentially active faults have been mapped within the southern California region, several of which are within close proximity to the site (Figure 3 – Regional Fault Map). Per the latest California Geological Survey fault database, the major active and potentially active fault systems that could produce significant ground shaking at the site include the Hollywood and Santa Monica fault zones, and the Upper Elysian Park Thrust fault. The distance of these faults and the estimated slip rates if known are provided below:

Hollywood Fault: The active Hollywood fault is located approximately 0.7 kilometers (0.4 miles) to the south of the site. The fault is capable of producing an estimated maximum magnitude (Mw) 6.4 earthquake. The fault is truncated on the west by the north-northwest trending erosional escarpment known locally

as the West Beverly Hills Lineament (WBHL) marking the left step between the Santa Monica fault and the Hollywood fault (Dolan et al., 2000a). The WBHL creates a topographic erosional escarpment separating older alluvium on the west from younger alluvium on the east. Subsurface evidence for late Quaternary faulting is evident from several studies based upon geomorphic evidence, stratigraphic correlation between borings and fault trenching studies conducted in Hollywood (Dolan et al., 1997, 2000b). Recent faulting at Camino Palmero occurred after deposition of 9ka sediments and prior to deposition of sediments dated at 6ka making this fault active by definition by classification criteria adopted by the California Geological Survey that defines activity of faults based on dates of known rupture events. Based on sediment accumulation rates determined by radiocarbon dating, the dip separation is low but at least 0.75 mm/yr (D. Ponti in Hummon et al., 1994). Dolan et al., (1997) estimate that strike separation on the fault is greater than 0.25 mm/yr.

Santa Monica Fault Zone: The Santa Monica fault zone is located approximately 2.3 km (1.4 mi) from the site and is part of the west trending Transverse Ranges Southern Boundary fault system. The Santa Monica faults extends from Pacific Palisades through Santa Monica and into west Los Angeles were it merges with the Hollywood fault at the WBHL in Beverley Hills. The Santa Monica fault is thought to be capable of producing an estimated maximum magnitude (Mw) 6.6 earthquake. Several investigations (Dolan et al., 2000a; Hummon et al., 1992; Dolan and Sieh, 1992; and Crook and Proctor, 1992) have indicated the fault is active based on geomorphic evidence and fault trenching studies indicating the active portion of the Santa Monica fault does not extend east of the WBHL of Dolan and Sieh (1992). The fault has not been zoned, however, the fault is considered active by the State Geologist.

Upper Elysian Park Anticlinorium: The Elysian Park Anticlinorium is a southward verging anticline approximately 20 kilometers long (12.4 mi) with a curved, southward-convex axis, lying between the Hollywood fault on the northwest through the Silver Lake District to the right lateral East Montebello fault on the east in the City of San Gabriel. Uplift along the structure has produced the Elysian, Repetto and Monterey Park Hills. Deformed Quaternary deposits across the Coyote Pass Escarpment and related structures allowed Oskin et al., (2000) to estimate a late Quaternary slip rate on the blind Elysian Park reverse fault of 0.8-2.2 mm/yr. The California Geological Survey (2003) has estimated an average slip rate of 1.3mm/yr and an estimated maximum magnitude (Mw) of 6.4 for the Elysian Park Thrust fault system.

4.2 Surface Fault Rupture

Our review of available in-house literature indicates that no known active faults have been mapped across the site, and the site is not located within an Alquist-Priolo Earthquake Fault Zone (Hart and Bryant, 2007; CGS, 1986). Based on the United States Geological Survey (USGS) fault parameters database and latitude and longitude coordinates N34.1136° and W118.3355°, the closest active fault to the site is the Hollywood fault, located approximately 0.4 miles south of the site (http://geohazards.usgs.gov/cfusion/hazfaults_search). Based on the current geologic framework, the potential for surface fault rupture onsite is expected to be low.

4.3 Ground Shaking

Strong ground shaking can be expected at the site during moderate to severe earthquakes in this general region. This is common to virtually all of Southern California. Intensity of ground shaking at a given location depends primarily upon earthquake magnitude, site distance from the source, and site response (soil type) characteristics. According to the United States Geological Survey (USGS) at the time of this writing, the most recent local (within 25 kilometers of the site) earthquake was the MW 3.4 earthquake on September 7, 2012, approximately 3.4 miles to the southwest (http://earthquake.usgs.gov/earthquakes/eqarchives/epic/) believed to be attributed to movement along the San Vicente Blind thrust fault. The 2010 California Building Code (CBC) seismic coefficients are presented in the following subsections:

- *CBC Coefficients*: Based on our site reconnaissance, the project site is underlain predominantly by bedrock. The shear wave velocity in the upper 30 meters at the project site based on the recent geophysical survey performed at the site as a part of this evaluation (GeoVision, 2012) ranges between 1,880 and 2,139 feet-per-second.

  In accordance with the 2010 Edition of the CBC, this site should be classified as a Class C site. The following values may be used for the seismic design method based on the 2010 CBC:

2010 CBC Based Seismic Design Parameters (Mapped Values)

CBC Categorization/Coefficient	Design Value
Site Longitude (decimal degrees)	-118.3355 W
Site Latitude (decimal degrees)	34.1136 N
Site Class Definition	C
Seismic Design Category	D
Mapped spectral response acceleration parameter at short period, S_S	1.79
Mapped spectral response acceleration parameter at a period of 1 sec, S_1	0.60
Short Period (0.2 sec) Site Coefficient, F_a	1.0
Long Period (1.0 sec) Site Coefficient, F_v	1.3
Adjusted spectral response acceleration parameter at short period, S_{MS}	1.79
Adjusted spectral response acceleration parameter at a period of 1 sec, S_{M1}	0.78
Design spectral response acceleration parameter at short period, S_{DS}	1.19
Design spectral response acceleration parameter at a period of 1 sec, S_{D1}	0.52

4.4 Secondary Seismic Hazards

Liquefaction Potential: Liquefaction is the loss of soil strength or stiffness due to a buildup of pore-water pressure during severe ground shaking. Liquefaction is associated primarily with loose (low density), saturated, fine- to medium-grained, cohesionless soils. As shown on the State of California Seismic Hazard Zones Map for the Hollywood Quadrangle (CDMG, 1999), portions of the overall study area are located within an area that has been identified by the State of California as being potentially susceptible to liquefaction (see Figure 4). The Off Season Two Improvements are underlain by bedrock and are not located within a liquefiable area.

Lateral Spreading Potential: Lateral spreading is a phenomenon in which large blocks of intact, non-liquefied soil move downslope on a liquefied soil layer. Lateral spreading is often a regional event. For lateral spreading to occur, a liquefiable soil zone must be laterally continuous, unconstrained laterally in at

least one direction and free to move along sloping ground. Due to the topographic relief and the potential for liquefaction to occur, there is a potential for lateral spreading at the overall project site.

Seismically-Induced Settlement: Since the project site is underlain predominantly by bedrock, the potential for seismically-induced settlement is low.

Seismically-Induced Landslides: As shown on the State of California Seismic Hazard Zones Map for the Hollywood Quadrangle (CDMG, 1999), a portion of the project site is located within an area that has been identified by the State of California as being potentially susceptible to seismically induced landslides (see Figure 4).

Seiches, Tsunamis, Inundation Due to Large Water Storage Facilities: Seiches are large waves generated in very large enclosed bodies of water or partially enclosed arms of the sea in response to ground shaking. The only large enclosed body of water within close proximity to the site is the Hollywood Reservoir located to the northeast of the site. Based on the location and elevation of the large ridgeline between the site and the Hollywood Reservoir, the seiche risk at the site is considered negligible.

Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. The project area is predominantly at elevations higher than 500 feet above mean sea level, therefore the tsunami risk at the site is considered nil.

Earthquake-induced flooding can be caused by failure of dams or other water-retaining structures as a result of earthquake. According to the County of Los Angeles Seismic Safety Element (1990) and the City of Los Angeles Safety Element (1996), the site is not located within a potential inundation area for an earthquake induced dam failure from Hollywood Reservoir. Even though the site is not located within a potential inundation area for the Hollywood Reservoir, the dam is continually monitored by the Army Corp of Engineers (ACOE) to guard against the threat of dam failure. The possibility of dam failures during an earthquake has been addressed by the California Division of Mines and Geology in an earthquake planning scenario for a magnitude 8.3 earthquake on the San Andreas fault (Davis et al., 1982) and a magnitude 7.0 earthquake on the Newport Inglewood Fault Zone (Toppozada et al., 1988). Both reports state catastrophic failure of a dam as a result of an earthquake is highly unlikely.

Current design practices, dam review, modification or total reconstruction of existing dams are intended to ensure that all dams are capable of withstanding the maximum earthquake for the site. Therefore the potential for the site to be inundated as a result of dam failure is considered negligible.

4.5 Slope Stability

The results of the stability analyses provided in this report (Appendix D) indicate the project site will generally attain sufficient stability with minor surficial grading and slope reinforcement measures. The global factor of safety is estimated to be about 1.5 and 1.1 for static and pseudostatic conditions, respectively. Slope stability issues specific to the Off-Season Two Improvements are discussed below.

4.5.1 Debris flows

Mass movements include landslides and debris flows. Debris flow areas were encountered during our subsurface investigation at the project area, subsequent verbal conversations with Theater personnel indicate debris flows have occurred at the site (Figure B-5). The project site lies within a previously existing canyon cut down into the formational material surrounded by moderately steep natural slopes composed of massive pillow basalt and steeply dipping sandstone formations.

During our geotechnical investigation we mapped several areas that were possibly debris flow scars and/or accumulations of colluvium (Figure B-5). Areas of thick accumulation of surficial materials, predominately basalt, have the potential to develop into debris flows.

Debris flows and debris slides should be expected to occur in the heads of steep gullies, on steep slopes and along ridgelines underlain by basalt. When rainfall intensity is great enough to cause water to percolate into the colluvium at a rate which exceeds the rate at which the water can percolate into the bedrock, slope failure of colluvium will occur. The surficial stability of the natural slopes is dependent upon the thickness of weaker soils and the slope gradient. Thick accumulations of colluvial soils on steep slopes are susceptible to surficial failures, debris flows and downhill creep during periods of heavy rain. The most likely source of

debris flow potential is from the steep slopes and drainages in the northeastern and southern portion of the proposed improvements area.

Our recommendations regarding mitigation of debris flow are discussed in Section 6.0 of this report.

4.5.2 Rockfalls

Field mapping and geologic analysis of the sandstone rock outcrops exposed in the southern portion of the site indicated the presence of intersecting pairs of joint sets and conjugate fault planes. Due to local orientations of the joint sets, the presence of fractured, freshly exposed rock faces and damage to the previously referenced H-beam (Figure B-6), the potential exists for detachment and down slope translation of rock, which could impact the proposed development.

The proposed development is expected to require provisions to protect improvements and occupants from rock fall hazards. On a preliminary basis, provisions should be included in the site layout to include such devices as a rock fence located near the toe of the slopes. Other more elaborate techniques such as rock netting situated along the faces of slopes vulnerable to rock falls may also be necessary after landscaping is implemented.

4.6 Expansive Soils

Based on our geotechnical exploration at the site, the near surface soils are generally granular with localized silt and clay layers. The laboratory test result of two representative samples from Leighton test pit TP-1 and TP-4, showed low expansion index (EI) potential wetted EI =11 and EI=24, respectfully. Results of expansion index tests indicate that the onsite soils have low expansion potential.

4.7 Corrosive Soils

Corrosive soils are characterized by their ability to degrade concrete and corrode ferrous materials in contact with water or soil. In particular, concrete is susceptible to corrosion when it is in contact with soil or water that contains high concentrations of soluble sulfates which can result in chemical deterioration of the concrete. Results of laboratory testing indicate soluble sulfate contents of 73

and 175 ppm, which range from negligible to moderate sulfate exposure. Since irrigation water in Southern California is considered to have moderate sulfate attack potential (typical sulfate concentrations of 150 to 250 ppm), concrete should be designed to resist moderate sulfate exposure.

The site soils are deemed highly corrosive to ferrous metals based on minimum soil resistivity 1,200 to 2,050 ohm-cm recorded from two samples.

5.0 FINDINGS AND CONCLUSIONS

Based on our investigation, we conclude that the proposed project is feasible from a geotechnical standpoint. We did not encounter significant geotechnical constraints that cannot be mitigated by proper planning, design, and sound construction practices. The key findings of our investigation for the site are summarized below:

- The near surface materials encountered consist of undocumented fill soils and colluvium. The upper 3 to 5 feet of colluvial material are considered compressible. Undocumented fills locally contain large oversize sandstone rock fragments and concrete debris. The fill as encountered at the site is associated with past construction activities.

- The colluvium as encountered consisted predominately of angular sands and gravel sized basalt rock fragments intermixed with organic debris from hillside vegetation. The colluvium forms thick accumulations near the toe of slopes and behind the existing concrete, stone and masonry block retaining walls and within the drainage swales impeding flow. Our observations suggest the colluvium has overtopped the various retaining walls at some point if the past and will continue to do so unless mitigated and maintained. Colluvium is subject to continuous downhill creep due to gravity and rapid releases in the form of debris flows following periods of intense precipitation.

- The basalt bedrock on site has massive pillow structure, is very blocky, interlocked, and partially disturbed with multi-faceted angular blocks formed by joint sets and as a result of rapid crystallization during formation. Basalt at the site should also be expected to occur in dikes and sills in the sedimentary formations. Zeolite veining and other minerals are common.

- The sandstone outcrop in the southern portion of the Off-Season Two Improvements area contain weak planar structural features in unfavorable orientation with respect to the north facing rock slope. This area is prone to rock falls and is expected to require some provisions such as debris walls, rock fences, or rock netting to protect improvements and occupants from the hazards associated with localized rock falls and/or pop-outs. A detached boulder greater than five feet long remains perched near the top of the talus pile while smaller sized rock material up to 2 feet long provide the majority of the talus debris now resting against the southern mezzanine level concrete retaining wall.

- Based on the rock quality determined during the test pit excavations, field mapping and refraction survey (Appendix A), it is our opinion that the basalt and sandstone materials will vary from easily rippable near surface to moderately difficult using electric hand chisels below 4 feet in depth.

- Groundwater was not encountered. Nuisance water could be encountered during and after seasonal precipitation behind the eastern basement retaining wall.

- Results of laboratory testing indicate soluble sulfate contents of 73 and 175 ppm, which range from negligible to moderate sulfate exposure. Since irrigation water in Southern California is considered to have moderate sulfate attack potential (typical sulfate concentrations of 150 to 250 ppm), concrete should be designed to resist moderate sulfate exposure.

- Results of the expansion testing indicate the two representative samples from Leighton test pits TP-1 and TP-4 showed low expansion index (EI) potential when wetted EI =11 and EI=24, respectfully. Non-cohesive granular fill derived from a mixture of these materials is expected to have low expansion potential. Expansive soils not specifically encountered during this investigation may be present locally onsite.

- The existing onsite soils expected to be generated from the basalt formation appear to be suitable for re-use as fill during proposed construction provided they are free of organic material and oversize debris. However, the potential for significant erosion exists if granular fill soils are used on slope faces.

- Oversize material (cobble sized to 14 inches in long dimension) was encountered in Test Pit TP-4. Oversize material could also be generated while excavating the sandstone rocks in the southern portion of the site. Oversize material should be removed from the site or placed at a designated, pre-approved disposal area within the Theater complex.

- Several sandstone boulders lie on the slope face in the northeastern portion of the site above the existing concrete swale and below the crib wall. Damage to the crib wall was observed suggesting sandstone boulders become dislodged in the form of rockfall.

6.0 GEOTECHNICAL RECOMMENDATIONS

Extensive removals of loose slope materials will be required for the project. Many areas around the Theater currently have substantial debris flow and rock fall accumulations. These materials should be removed to unload retaining walls, re-establish proper freeboard behind walls, and reduce the potential for remobilization.

Due to the slopes surrounding the Theater complex, continued regular maintenance will be necessary, especially after periods of heavy or prolonged precipitation. Considering that significant landscaping on the slopes is already planned as part of the project, we recommend that trails and paths be established to facilitate access for maintenance crews to slope areas that currently have debris flow and rock fall accumulations because these areas will likely require regular cleanouts.

The damaged crib wall should be repaired and filled in with crushed rock to provide protection against rock falls and debris flows. The repair should include removal of the debris and rock fall/soil accumulation behind the crib wall.

For protection against future debris flows all new retaining walls should have a minimum freeboard height of 9 inches (height of wall above retained soil). Backfill behind existing walls should be lowered where possible to establish a nominal 9-inch freeboard.

For protection against future rockfalls, we recommend installation of flexible barriers at the bottom of the slope, several feet upslope of any existing retaining walls. Considering that the project site is a performance venue, we anticipate that aesthetics will be an important factor in selecting the rockfall mitigation system. The visual impact of flexible barriers, such as stainless steel cables with steel bollards or wrought iron fencing, will be easier to mitigate. The barrier should establish an effective freeboard of 4 feet. Alternatively, an anchored mesh net may be used. However, its visual impact will be more difficult to mitigate since all upslope areas with potentially loose rock fragments will require coverage.

New structural elements may be supported on spread-type shallow foundation systems established in engineered fill or undisturbed natural soils. Alternatively, deep foundations may be used. Capacities developed for new foundations may be used to evaluate existing footings and cast-in-drilled-hole (CIDH) piles.

The following geotechnical recommendations have been developed based on the exhibited engineering properties of the onsite materials and their anticipated behavior during and after construction, seismic design considerations, floor slabs, and grading.

There are existing basement walls below the stage. Shallow foundations (spread footings) for new structures should be deepened to extend below the active zone of existing basement walls, roughly a plane extending from the base of the basement wall at a 60 degree angle from horizontal, to avoid surcharging the walls. Footings may be deepened by excavating below the active zone and backfilling with concrete or with controlled low strength material (CLSM).

New basement walls planned below existing foundations within their active zones should be designed to accommodate surcharge loads. Surcharge may be modeled as half the footing bearing pressure within the wall's active zone applied horizontally.

New pile segments within the active zone of existing basement walls should be isolated from surrounding soils using Sonotubes or equivalent.

Leighton should review the grading plans, shoring plans, foundation plans, and specifications when they are available to verify that the recommendations presented in this report have been properly interpreted and incorporated.

6.1 Earthwork and Grading

All earthwork and grading should be performed in accordance with the following recommendations and Earthwork and Grading Guide Specifications presented in Appendix E.

6.1.1 Site Preparation

Prior to construction, the area of proposed new structures/foundations should be cleared of any vegetation and demolition trash and debris. These materials should be removed from the site. Any underground obstructions onsite should be removed. Efforts should be made to locate any existing utility lines to be removed or rerouted where interfering with the proposed construction. Any resulting cavities should be properly backfilled and compacted. After the site is cleared, the soils should be carefully observed for the removal of all unsuitable deposits. All undocumented fill should be excavated from proposed structure footprints.

6.1.2 General Grading Recommendations

New structures may be supported on conventional shallow footing foundation systems established on engineered fill or undisturbed bedrock.

The existing undocumented artificial fill should be removed and replaced as engineered fill. Overexcavation and recompaction should extend a minimum horizontal distance equal to the vertical distance between the proposed footing bottom and depth of overexcavation.

After completion of the overexcavation and prior to fill placement, the exposed soils/weathered bedrock should be scarified to a minimum depth of 12 inches, moisture conditioned and compacted to at least 90 percent relative compaction based on ASTM Test Method D 1557.

The onsite soils, less any deleterious material or organic matter, can be used in required fills. Cobbles larger than 6 inches in largest diameter should not be used in the fill. Any required import material should consist of relatively non-expansive soils with an Expansion Index (EI) less than 20. The imported materials should contain sufficient fines (binder material) so as to be relatively impermeable and result in a stable subgrade when compacted. All proposed import materials should be approved by the geotechnical engineer of record prior to being placed at the site.

6.1.3 Pipe Bedding

Any proposed pipe should be placed on properly placed bedding materials. Pipe bedding should extend to a depth in accordance to the pipe manufacturer's specification. The pipe bedding should extend to at least 12 inches over the top of the pipeline. The bedding material may consist of compacted free-draining sand, gravel, or crushed rock. Pipe bedding material should have a Sand Equivalent (SE) of at least 30.

6.1.4 Trench Backfill

Trench excavations above pipe bedding may be backfilled with onsite soils under the observation of the geotechnical consultant. All fill soils should be placed in loose lifts, moisture conditioned as required and compacted to a minimum of 90 percent relative compaction based on ASTM Test Method D 1557-12. Lift thickness will be dependent on the equipment used as suggested in the latest edition of the *Standard Specifications for Public Works Construction* (Greenbook). The fill soils should extend to the bottom of the aggregate base for new pavement, or to finished grade.

6.2 Shallow Foundations

New shallow spread footings may be established in engineered fill or undisturbed natural soils or bedrock.

6.2.1 Minimum Embedment and Width

Footings should have a minimum embedment of 12 inches and have a minimum width of 12 inches.

6.2.2 Bearing Value

Footings established on engineered fill or undisturbed natural soils may be designed to impose an allowable bearing pressure of 3,000 pounds per square foot (psf). A one-third increase in the bearing value for short duration loading, such as wind or seismic forces, may be used.

The ultimate bearing capacity can be taken as 9,000 psf, which does not incorporate a factor of safety. A resistance factor of 0.5 should be used for bearing capacity evaluation with factored loads. The recommended bearing value is a net value, and the weight of concrete in the footings can be taken as 150 pounds per cubic foot (pcf); the weight of soil backfill can be neglected when determining the downward loads.

6.2.3 Settlement

The estimated total settlement of the structures supported on spread footings as recommended above is less than 1 inch. The differential settlement between adjacent columns is estimated to be less than ½ inch over a horizontal distance of 30 feet.

6.2.4 Lateral Resistance

Lateral loads can be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.35 can be used between the footings and the floor slab and the supporting soils. The ultimate passive resistance of undisturbed natural soils or engineered fill soils can be assumed to be equal to the pressure developed by a fluid with a density of 300 pounds per cubic foot (pcf). The friction resistance and the passive resistance of the soils can be combined without reduction in determining

the total lateral resistance. A resistance factor of 1 should be used for lateral capacity evaluation with factored loads.

6.3 Deep Foundations

Cast-In-Drilled Hole (CIDH) concrete piles or micropiles may also be used to support new structural elements.

6.3.1 Cast-In-Drilled Hole (CIDH) Piles

Details of pile capacity analyses are presented in Appendix F. Design recommendations are summarized in the following subsections.

6.3.1.1 Axial Capacity of CIDH Pile

We understand that theatrical lighting towers are proposed on the hillsides surrounding the amphitheater. The capacities below may be used for design of drilled, cast-in-place concrete piles (CIDH).

Downward Capacity of CIDH Piles (kips)			
Depth of Pile Tip (feet)	**18-inch-diameter**	**24-inch-diameter**	**30-inch-diameter**
15	20	25	30
20	30	45	50
25	45	65	80

Dead-plus-live load capacities are shown. A one-third increase may be used for wind or seismic loads. A factor of safety of 3 was used for shaft friction and end bearing was neglected in determining the pile capacities.

Uplift capacities may be taken as equal to 50 percent of the downward capacities. The capacities presented are based on the strength of the soils; the strength of the pile section should be checked to verify the structural capacity of the piles.

A resistance factor of 0.5 should be used for downward and uplift capacity evaluation with factored loads.

Piles in groups may be spaced at 3 pile widths on-centers. If the piles are so spaced, no reduction in axial capacity due to group action need be considered in the design.

6.3.1.2 Lateral Capacity of CIDH Pile

Lateral loads may be resisted by the caissons and by the passive resistance of the soils. The lateral capacity of the caissons will depend on the caisson type and size, the permissible deflection, and on the degree of fixity at the top of the caisson. We have assumed piles will be installed on an effective 45 to 60 degree slope.

We have calculated lateral load, maximum moments, and depths to maximum moment for CIDH concrete piles (caissons) using the computer program LPILE by ENSOFT, Inc. We have assumed a concrete compressive strength value (f'_c) of 5,000 pounds per square inch (psi).

Lateral Capacities of 18-Inch-Diameter CIDH Pile

Pile Head Deflection (inches)	Fixity	Shear Force at Pile Top (kips)	Maximum Bending Moment (kips-in)	Depth to Maximum Moment (feet)
¼	Free Head	14	640	6
½	Free Head	20	1,030	7
¼	Fixed Head	30	1,620	0
½	Fixed Head	44	2,610	0

Lateral Capacities of 24-Inch Diameter-CIDH Pile

Pile Head Deflection (inches)	Fixity	Shear Force at Pile Top (kips)	Maximum Bending Moment (kips-in)	Depth to Maximum Moment (feet)
¼	Free Head	23	1,320	6
½	Free Head	33	2,110	7
¼	Fixed Head	50	3,325	0
½	Fixed Head	72	5,330	0

Lateral Capacities of 36-Inch Diameter-CIDH Pile

Pile Head Deflection (inches)	Fixity	Shear Force at Pile Top (kips)	Maximum Bending Moment (kips-in)	Depth to Maximum Moment (feet)
¼	Free Head	35	2,290	10
½	Free Head	50	3,660	11
¼	Fixed Head	74	5,780	0
½	Fixed Head	100	8,800	0

The analyses performed uses the flexural stiffness of the caissons computed from the modulus of elasticity (E) and moment of inertia (I). The modulus of elasticity (E) is derived based on the concrete compressive strength and the moment of inertia (I) is derived based on the caisson cross-section geometry. The values of E and I are assumed constant along the entire length of the caissons.

Lateral pile capacities considering a reduced moment of inertia due to cracked concrete pile sections should be evaluated after reinforcing details become available.

A resistance factor of 1 should be used for lateral capacity evaluation with factored loads.

The capacities presented in the table above are for pile lengths equal to or greater than 20 feet. This length is measured below the pile cap. The lateral capacity and reduction in the bending moment are based in part on the assumption that any required backfill adjacent to the caisson caps and grade beams are properly compacted.

For caissons in groups spaced at least 3 pile widths on-center, no reduction in the lateral capacity need be considered for the first row of caissons. For subsequent rows in the direction parallel to loading, caissons in groups spaced closer than 8 caisson widths on-center will have a reduction in lateral capacity due to group effects. The lateral capacity of caissons in groups spaced at 3 caisson widths on-center may be assumed to be reduced by half. The reduction for other caisson spacings may be interpolated between no reduction for caissons spaced at 8 caisson widths on-center and the reduction for caissons spaced at 3 caisson widths on-center.

The passive resistance of engineered fill against caisson caps and grade beams will depend on the method of installation. The passive resistance of engineered fill may be assumed to be equal to the pressure developed by a fluid with a density of 300 pounds per cubic foot (pcf), up to a maximum pressure of 3,000 pounds per square foot. A one-third increase in the passive value may be used for wind or seismic loads. The lateral resistance of the caissons and the passive resistance of the soils may be combined without reduction in determining the total lateral resistance.

6.3.1.3 Settlement

Piles in groups may be spaced at 3 pile widths on-centers. If the piles are so spaced, no reduction in axial capacity due to group action need be considered in the design.

The settlement of the proposed improvements founded on caissons in the manner recommended, will be approximately ½ inch or less. Differential settlement will be approximately ¼ inch or less. The

differential settlement is anticipated to occur over a minimum span of 40 feet.

Settlement of piles, generally resulting from settlement of the supporting soils and elastic compression of piles, is expected to be on the order of ¼ inch. The settlement analysis should be evaluated when the actual structural load and pile cap configuration become available.

6.3.1.4 Construction

The drilling of the pile shafts and placement of the steel reinforcement and concrete should be done under the continuous observation of the project geotechnical engineer. Localized caving within unsupported excavations should be anticipated. Casing may be required where/if sands layers occur. Excavations for piles that are spaced at less than five diameters (center to center) should be not open simultaneously. Concrete for closely spaced piles should be placed and allowed to set for at least 24 hours before initiating the excavation for any adjacent piles. Steel reinforcement and concrete should be placed as soon as possible after approval of the drill hole. Pile excavations should not be left open overnight. Tremie pipes should be utilized when placing the concrete to prevent the concrete from falling and/or striking the walls of the borehole. Although groundwater was not encountered in our explorations, perched groundwater table may be present following periods of rainfall.

6.4 Slabs-on-Grade

Concrete slabs may be designed using a modulus of subgrade reaction of 150 pci provided the subgrade is prepared as described in Section 6.1, *Earthwork and Grading*. From a geotechnical standpoint, we recommend slab-on-grade be a minimum 5 inches thick with No. 3 rebars placed at the center of the slab at 24 inches on center in each direction. The structural engineer should design the actual thickness and reinforcement based on anticipated loading conditions. Where moisture-sensitive floor coverings or equipment is planned, the slabs should be protected by a minimum 10-mil-thick vapor barrier between the slab and subgrade.

Minor cracking of concrete after curing due to drying and shrinkage is normal and should be expected; however, concrete is often aggravated by a high water/cement ration, high concrete temperature at the time of placement, small nominal aggregate size, and rapid moisture loss due to hot, dry, and/or windy weather conditions during placement and curing. Cracking due to temperature and moisture fluctuations can also be expected. The use of low-slump concrete or low water/cement ratios can reduce the potential for shrinkage cracking. Additionally, our experience indicates that the use of reinforcement in slabs and foundations can generally reduce the potential for concrete cracking.

To reduce the potential for excessive cracking, concrete slabs-on-grade should be provided with construction or weakened plane joints at frequent intervals. Joints should be laid out to form approximately square panels.

6.5 Lateral Earth Pressures

Recommended lateral earth pressures are provided as equivalent fluid unit weights, in psf/ft. or pcf., for design of basement and retaining walls in drained conditions using onsite sandy soils as backfill. These values do not contain an appreciable factor of safety, so the structural engineer should apply the applicable factors of safety and/or load factors during design.

Lateral Earth Pressures

Condition	Equivalent Fluid Unit Weight (psf/ft)
	Level Backfill
Active	35
Seismic Increment	20
At-Rest	55
Passive	300
Coefficient of Friction	0.35

Walls that are free to rotate or deflect may be designed using active earth pressure. For the basement walls or walls that are fixed against rotation, the at-rest pressure should be used. For seismic condition, the pressure should be distributed as an inverted triangular distribution and the dynamic thrust should be applied at a height of 0.6H above the base of the wall.

Care should be taken to provide appropriate drainage so as no water is allowed to remain behind the retaining wall for any significant length of time. Retaining structures should be provided with a drainage system, as illustrated on Figure 5, *Retaining Wall Backfill and Subdrain Detail*, to prevent buildup of hydrostatic pressure behind the wall.

In addition to the recommended earth pressures, walls below grade adjacent to existing structures or streets and areas of traffic should be designed to accommodate surcharge loads. For traffic surcharge, a uniform lateral pressure of 100 pounds per square foot acting as a result of an assumed 300 pounds per square foot surcharge behind the wall due to normal traffic; the traffic surcharge load may be neglected provided a minimum of 10 foot clearance between the wall and the traffic is maintained. We will provide surcharge loading from adjacent foundations after reviewing details of the planned basement walls in relation to existing foundations.

Backfills for retaining walls should be compacted to a minimum of 90 percent relative compaction (based on ASTM Test Method D1557). During construction of retaining walls, the backcut should be made in accordance with the requirements of Cal/OSHA Construction Safety Orders. Relatively light construction equipment should be used to backfill retaining walls. We also recommend using at-rest pressures for design of walls supporting settlement-sensitive structures.

Earth pressures used in the design of the walls should be indicated on the retaining wall plans. All retaining wall designs and plans should be reviewed by the project geotechnical consultant to confirm that the appropriate soil parameters are used.

6.6 Flexible Pavement

To provide support for paving of the new transit plaza, and surface parking and driveways, the subgrade soils should be prepared as recommended in Section 6.1, *Earthwork and Grading*. The preparation of the paving area subgrade should be performed immediately prior to placement of the base course. Proper drainage of the paved areas should be provided since this will reduce moisture infiltration into the subgrade and increase the life of the paving.

6.6.1 Aggregate Base Course

The base course for hot mix asphalt (HMA) concrete paving should meet the specifications for Class 2 Aggregate Base as defined in Section 26 of the latest edition of the State of California Department of Transportation Standard and Specifications. Alternatively, the base course could meet the specifications for untreated base as defined in Section 200-2 of the latest edition of *Standard Specifications for Public Works Construction* (Greenbook). Crushed Miscellaneous Base (CMB) may be used for the base course provided the geotechnical consultant evaluates and tests it before delivery to the site.

6.6.2 Hot Mix Asphalt (HMA) Concrete

The required HMA concrete paving and base thicknesses will depend on the expected wheel loads and volume of traffic (Traffic Index or TI). Assuming that the paving subgrade will consist of engineered fill or bedrock materials with an R-value of at least 30 compacted to at least 90 percent relative compaction based on ASTM Test Method D 1557, the minimum recommended paving thicknesses are presented in the following table:

Asphalt Concrete Pavement Section for Reconstruction

Traffic Index	Hot Mix Asphalt Thickness (inches)	Aggregate Base Thickness (inches)	Total (inches)
5.0 or less	3.0	4.0	7.0
6.0	3.5	5.5	9.0
7.0	4.0	7.0	11.0
8.0	5.0	8.0	12.0
9.0	5.5	9.5	15.0

Representative samples of the actual subgrade materials should be obtained and tested for R-Value following rough grading of the pavement subgrade to confirm the pavement design sections.

6.7 Temporary Excavations

All temporary excavations, including footings, utility trenches, dry wells should be performed in accordance with project plans, specifications, and all OSHA requirements. Excavations 5 feet or deeper should be laid back or shored in accordance with OSHA requirements before personnel are allowed to enter.

No surcharge loads should be permitted within a horizontal distance equal to the height of cut or 5 feet, whichever is greater from the top of the cut, unless the cut is shored appropriately.

During construction, the soil conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor shall be responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Soil types will vary, but Type C soils can be expected at shallow depths and Type A soils within bedrock. Close coordination between the competent person and the geotechnical engineer should be maintained to facilitate construction while providing safe excavations.

6.8 Shoring

Shoring may be required to accommodate removal of existing basement walls and construction of new basement walls. Shoring and underpinning may also be required to prevent undermining of adjacent existing foundations. The anticipated shoring/underpinning system for the site will consist of soldier piles and lagging. Soldier piles may consist of steel H-beams set in predrilled holes and backfilled with lean-mix concrete to the ground surface.

6.8.1 Lateral Earth Pressures

For design of cantilevered shoring, where the surface of the backfill is level, it can be assumed that drained soils will exert a lateral pressure equal to that developed by a fluid with a density of 35 pounds per cubic foot (pcf).

In addition to the recommended earth pressure, the upper 10 feet of shoring adjacent to streets and driveways should be designed to resist a uniform lateral pressure 100 psf, acting as a result of an assumed 100 psf surcharge behind the shoring due to normal street traffic. If the traffic is kept back at least 10 feet from the shoring, the traffic surcharge may be

neglected. We can determine lateral surcharge pressures for specific cases, such as construction crane, concrete trucks, and other heavy construction equipment adjacent to shoring, if requested.

6.8.2 Surcharge Pressure from Adjacent Foundations

Where existing foundations are within a 1:1 plan projected upward from the bottom of the planned shoring and basement walls, a lateral surcharge load should be applied to the active earth pressure to account for the pressure imposed by the foundation. Once details of existing adjacent foundations are established, we can provide design surcharge pressures to be applied to shoring and basement walls.

6.8.3 Design of Soldier Piles

For the design of soldier piles spaced at least two diameters on centers (OC), the allowable lateral bearing value (passive value) of the soils below the level of excavation may be assumed to be 600 psf at the excavated surface, up to a maximum of 6,000 psf. To develop the full lateral value, provisions should be taken to assure firm contact between the soldier piles and the undisturbed soils. The concrete placed in the soldier pile excavations may be a lean-mix concrete. However, the concrete used in that portion of the soldier pile which is below the planned excavated level should be of sufficient strength to adequately transfer the imposed loads from the soldier pile to the surrounding soils.

The frictional resistance between the soldier piles and the retained earth may be used in resisting the downward component of the design load. The coefficient of friction between the soldier piles and the retained earth may be taken as 0.4. This value is based on the assumption that uniform full bearing will be developed between the steel soldier beam and the lean-mix concrete and between the lean-mix concrete and the retained earth. In addition, provided that the portion of the soldier piles below the excavated level is backfilled with structural concrete, the soldier piles below the excavated level may be used to resist downward loads. The frictional resistance between the concrete soldier piles and the soils below the excavated level may be taken as equal to 500 psf.

6.8.4 Lagging

Continuous lagging will be required between the soldier piles above the bedrock contact. Careful installation of the lagging will be necessary to achieve bearing against the retained earth.

The soldier piles should be designed for the full anticipated lateral pressure. However, the pressure on the lagging will be less due to arching in the soils. For clear spans up to 8 feet, we recommend that the lagging be designed for a semi-circular distribution of earth pressure where the maximum pressure is 400 psf at the midline between soldier piles, and 0 psf at the soldier piles.

Deflection: It is difficult to accurately predict the amount of deflection of a shored embankment. It should be realized, however, that some deflection will occur. To help protect adjacent existing buildings and infrastructure, the maximum allowable horizontal shoring deflection as measured at the top of the excavation is ½ inch.

If greater deflection occurs during construction, additional bracing may be necessary to minimize settlement of adjacent structures and of any utilities in the adjacent streets. To reduce the deflection of the shoring, if desired, a greater active pressure could be used in the shoring design.

Monitoring: Some means of monitoring the performance of the shoring system is recommended. The monitoring should consist of periodic surveying of the lateral and vertical locations of the tops of all the soldier piles. We will be pleased to discuss this further with the design consultants and the contractor when the design of the shoring system is finalized. Other methods of monitoring could include the installation of inclinometers.

6.9 Maintenance Guidelines and Erosion Control

We understand it will be the responsibility of the County of Los Angeles to maintain the slopes surrounding the theater site, including adequate planting, proper irrigation and maintenance, and repair of faulty irrigation systems. To reduce the potential for erosion and slumping of soil prisms on steep slopes, all slopes should be planted with plants that require minimal irrigation. Slope

planting should be carried out as soon as practical upon completion of the Off Season Two Improvements. Surface water runoff and standing water at the top of slopes should be avoided. Oversteepening of slopes should be avoided during landscaping activity. Maintenance of proper drainage and proper maintenance of vegetation, including regular slope irrigation, should be performed. Slope irrigation should avoid directly spraying onto the slope face. Drip system irrigation should be considered. Overwatering and consequent runoff and ground saturation should be avoided. If automatic sprinklers systems are installed, their use must be adjusted to account for rainfall conditions.

Any soil, debris or vegetation overgrowth should be removed from all terrace drains to enable runoff water to flow freely and properly. Regular maintenance and cleanup of terrace drains should be performed especially during the rainy season and immediately following prolonged seasonal events. Damage to terrace drains such as minor cracking should be promptly repaired and/or sealed prior to the start of the rainy season. Water should not be allowed to enter cracks or expansion gaps within the terrace drains where applicable.

6.10 Additional Geotechnical Services

The geotechnical recommendations presented in this report are based on subsurface conditions as interpreted from limited geologic mapping and seismic refraction surveys. Our conclusions and recommendations presented in this report should be reviewed and verified by Leighton during site construction and revised accordingly if exposed geotechnical conditions vary from our preliminary findings and interpretations. The recommendations presented in this report are only valid if Leighton verifies the site conditions during construction. Geotechnical observation and testing should be provided during the following activities:

- Grading and excavation of the site;
- Landscape excavation and grading;
- Overexcavation and compaction;
- Compaction of all fill materials;
- Shoring and underpinning system installation;

- Excavation and installation of foundations;
- After excavation of all slabs and footings and prior to placement of steel or concrete to confirm the slabs and footings are founded in firm, compacted fill;
- Utility trench backfilling and compaction; and
- When any conditions are encountered that varies significantly from the conditions described in this report.

Leighton should review the grading and foundation plans and specifications, when available, to comment on the geotechnical aspects. Our recommendations should be revised, as necessary, based on future plans and incorporated into the final design plans and specifications.

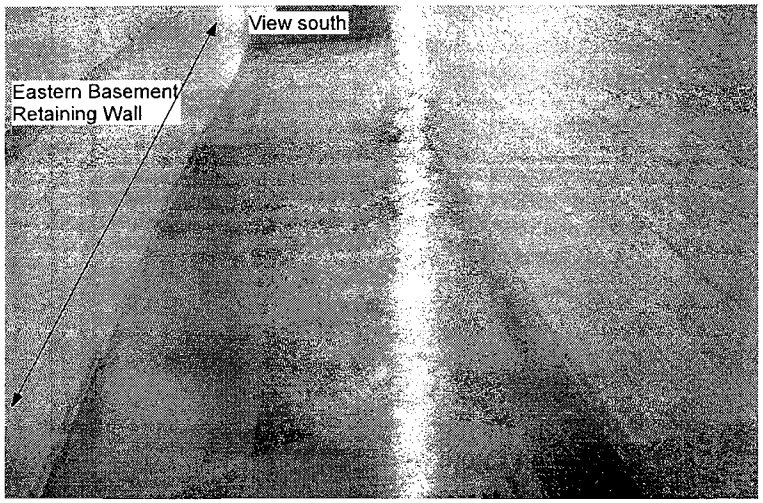
7.0 COUNTY OF LOS ANGELES BUILDING CODE SECTION 111 STATEMENT

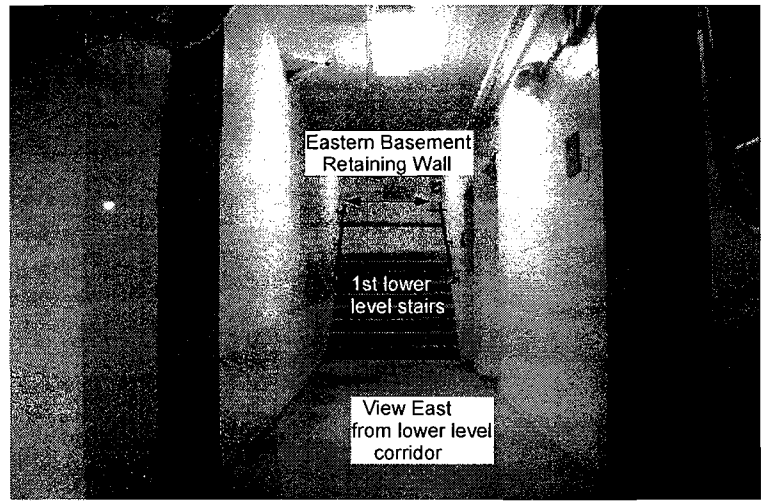
Provided that the recommendations in this report are implemented, it is Leighton's opinion that the proposed improvements will be safe from the hazards of landslide, settlement, or slippage, and that the completed grading and proposed improvements will not adversely affect the stability of adjacent properties.

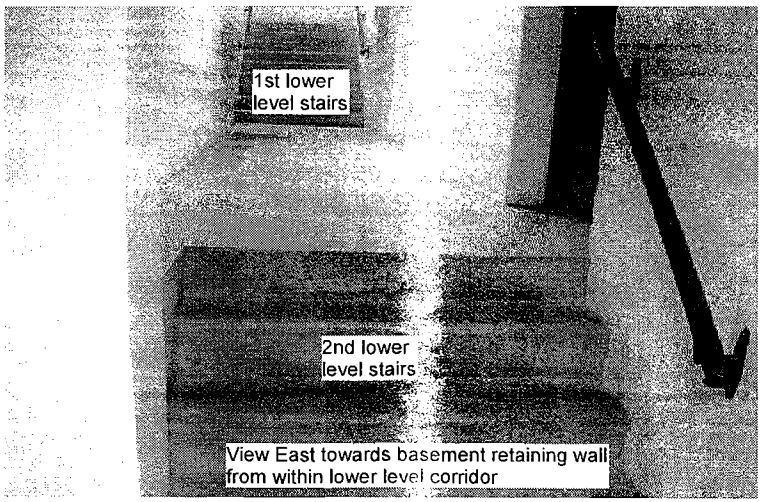
8.0 LIMITATIONS

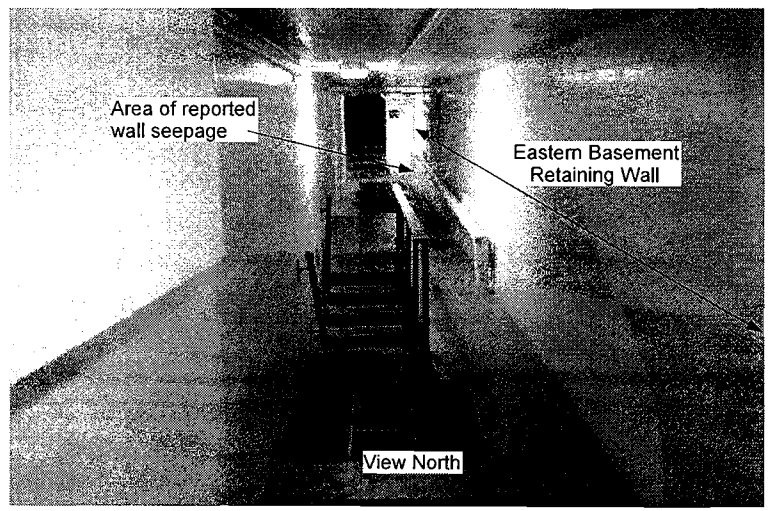
This research report was based wholly on available published data and very limited non-invasive subsurface exploration. Such information is, therefore, incomplete. The nature of many projects is such that differing earth materials and/or geologic conditions can be present within small distances and under varying climatic conditions. Changes in subsurface conditions can and do occur over time. Therefore, findings, conclusions and recommendations presented in this feasibility report are based on the assumption that Leighton will provide design-specific geotechnical exploration and testing, and geotechnical observation and testing during construction.

This report was prepared for the sole use of the Ford Theatre Foundation and their design team, for their use in assessing the proposed Off-Season Two Improvements, in accordance with generally accepted geotechnical engineering practices at this time in the County of Los Angeles.









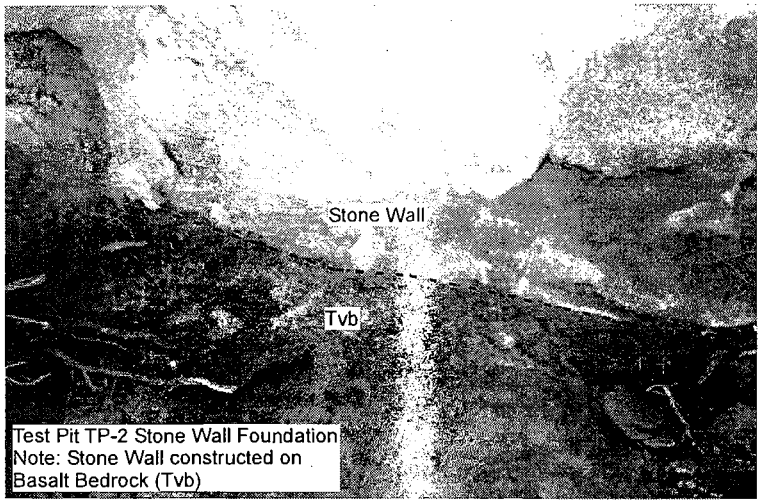
PHOTOS

Ford Theatre
East Cahuenga Blvd.
Hollywood, California

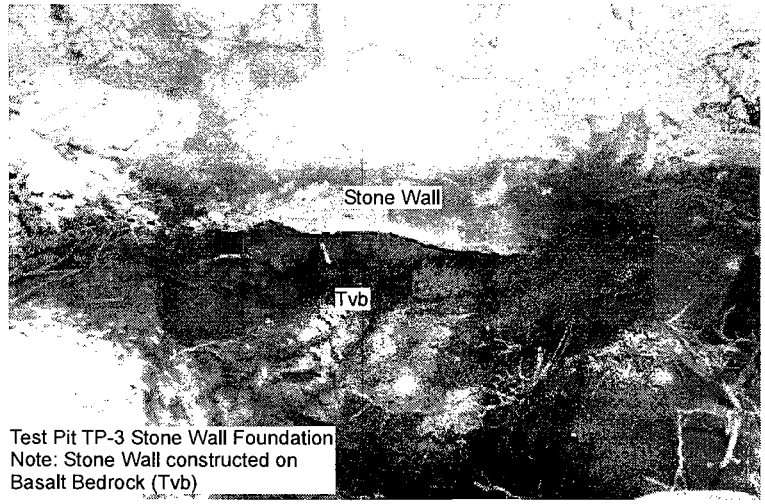
Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

Leighton

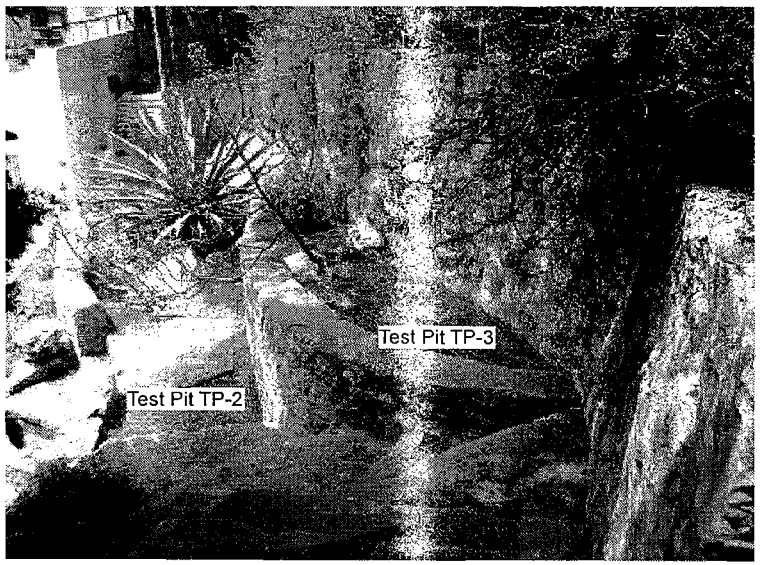
Figure No. B-1

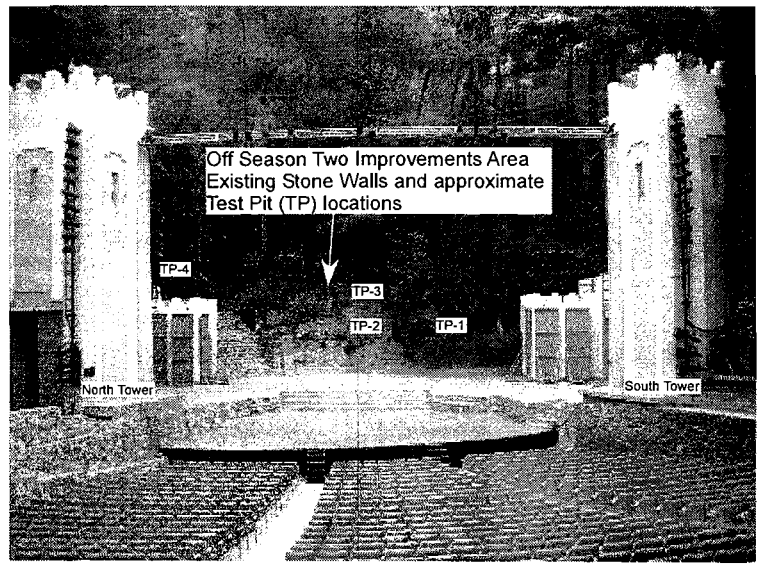


Test Pit TP-2 Stone Wall Foundation
Note: Stone Wall constructed on
Basalt Bedrock (Tvb)



Test Pit TP-3 Stone Wall Foundation
Note: Stone Wall constructed on
Basalt Bedrock (Tvb)





Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt

PHOTOS

Ford Theatre
East Cahuenga Blvd.
Hollywood, California

Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
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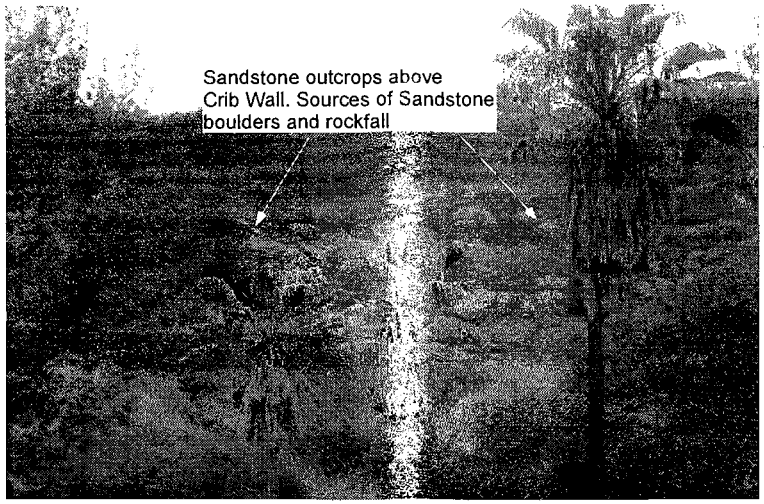
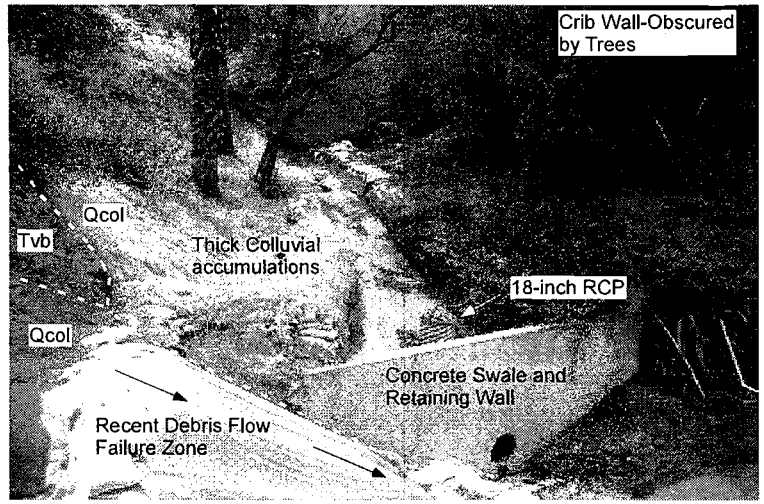
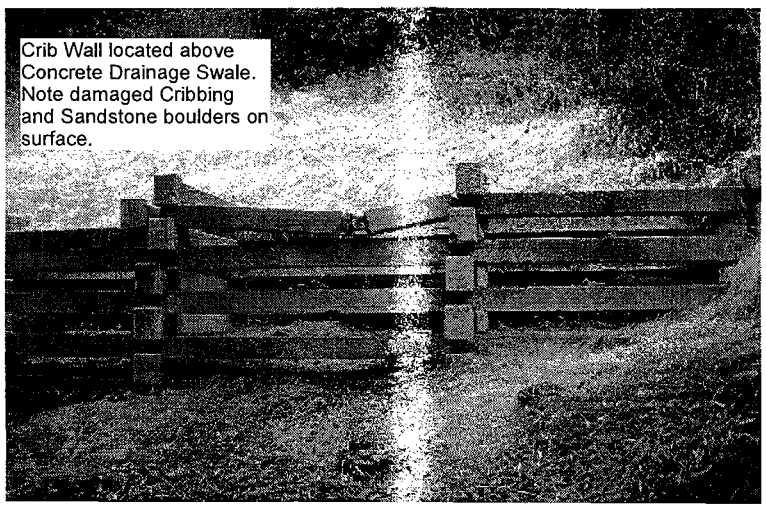
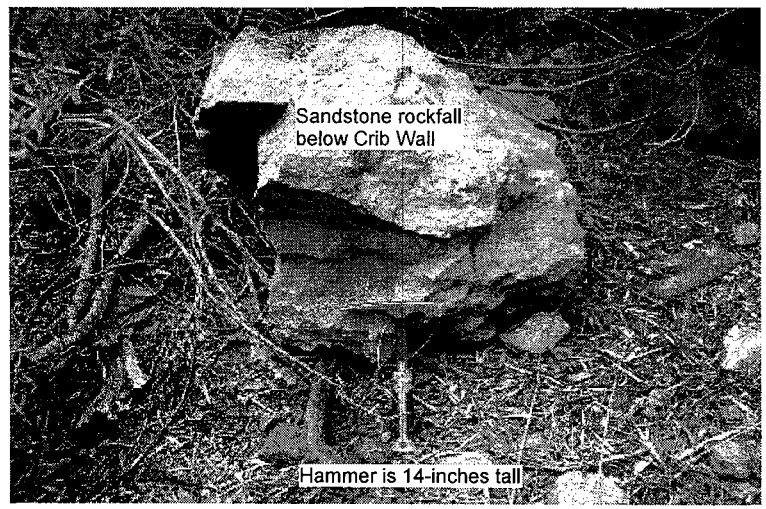
Leighton

Figure No. B-2









Area of Existing Upslope Drainage Improvements and Rockfall Protection Devices. Northeast Portion of Site.

Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt

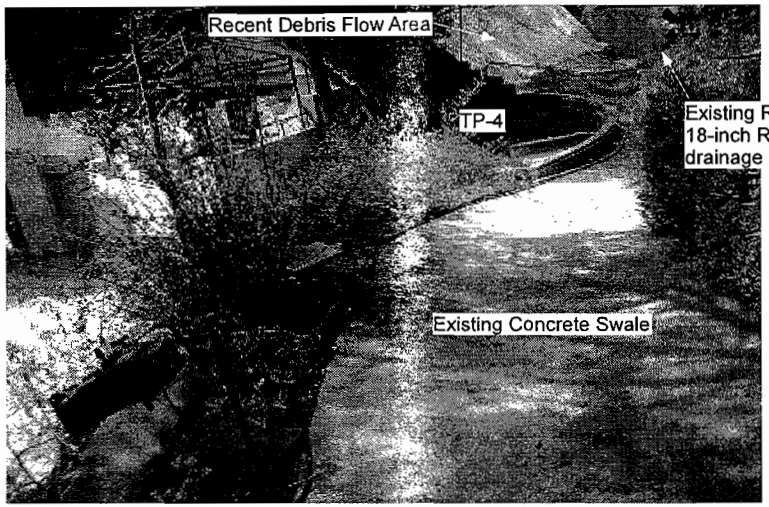
PHOTOS

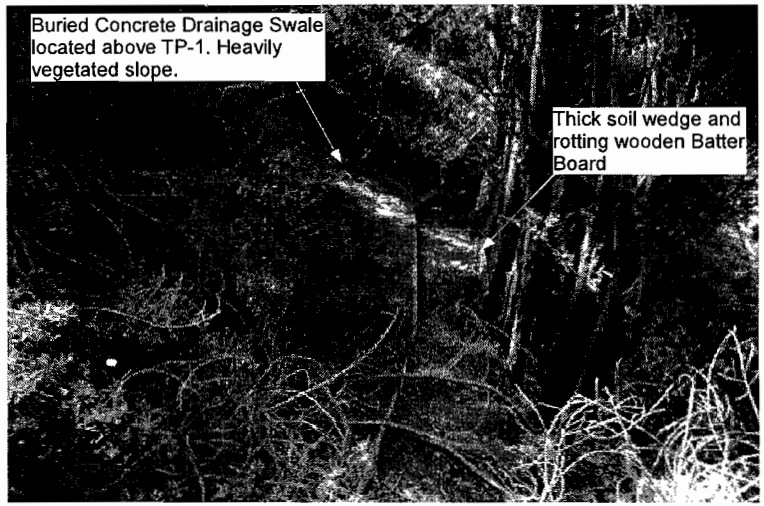
John Anson Ford Theatre
East Cahuenga Blvd.
Hollywood, California

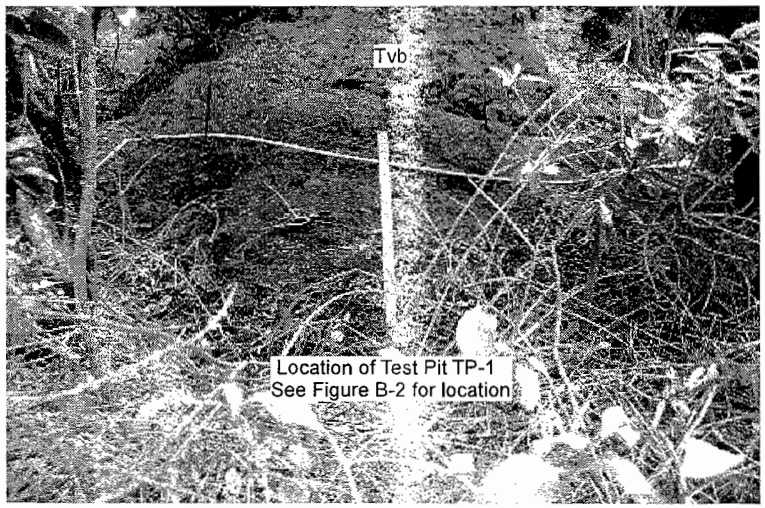
Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

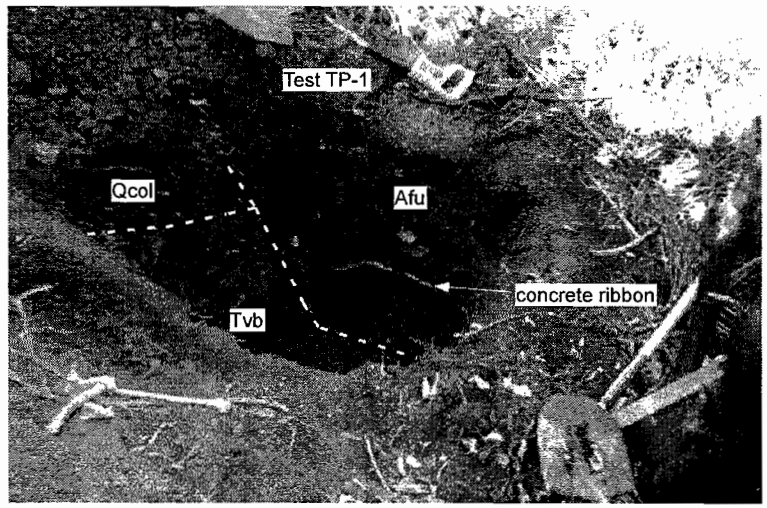
Leighton

Figure No. B-3









Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt

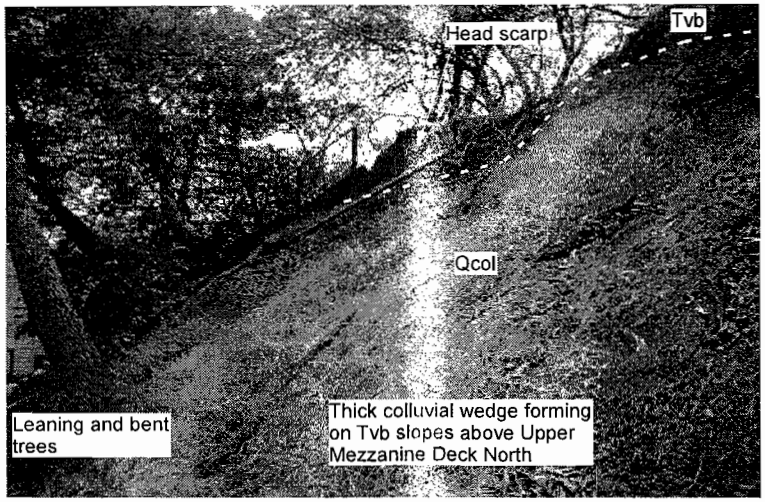
PHOTOS

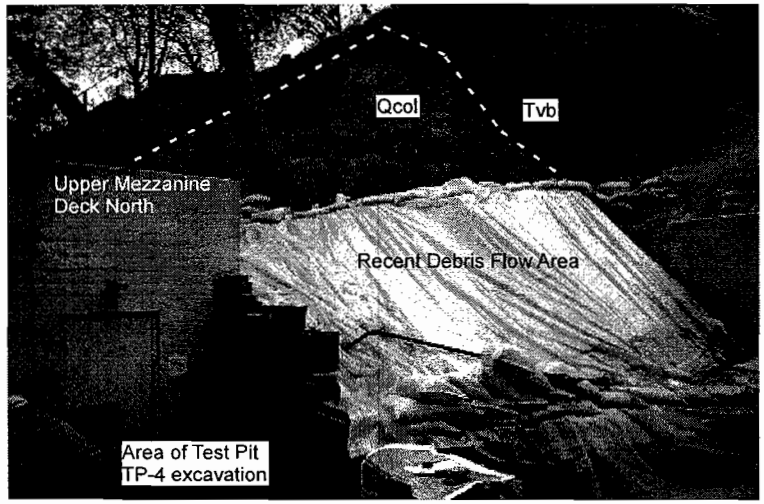
John Anson Ford Theatre
East Cahuenga Blvd.
Hollywood, California

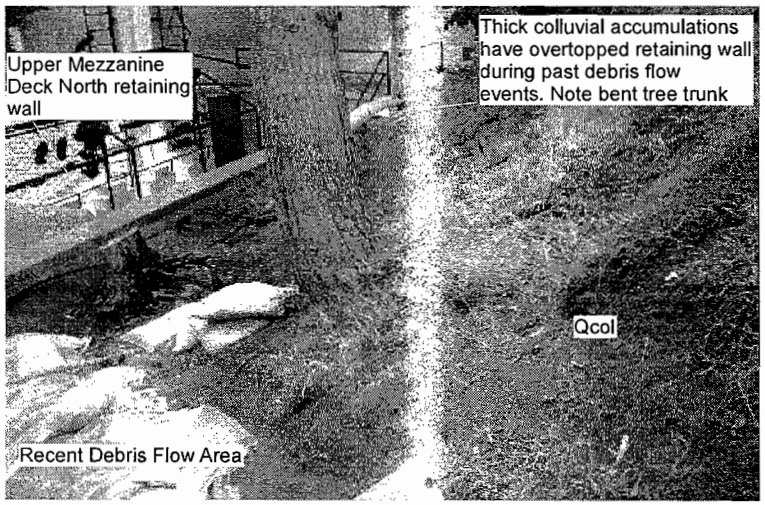
Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

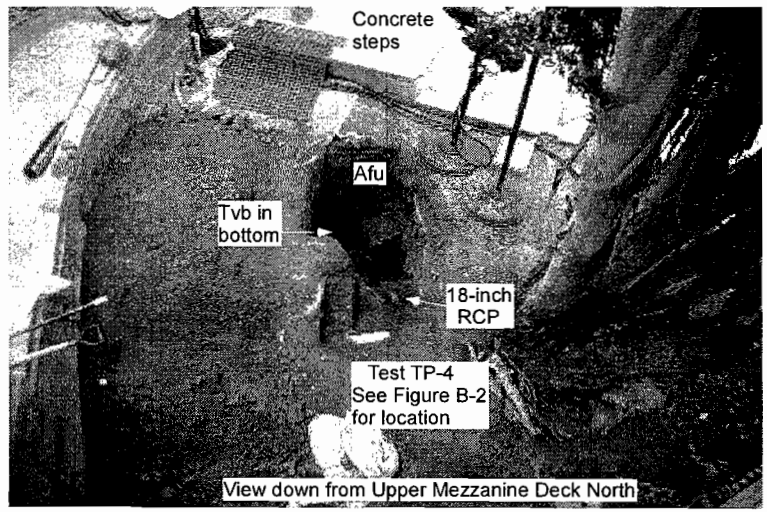
Leighton

Figure No. B-4









Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt

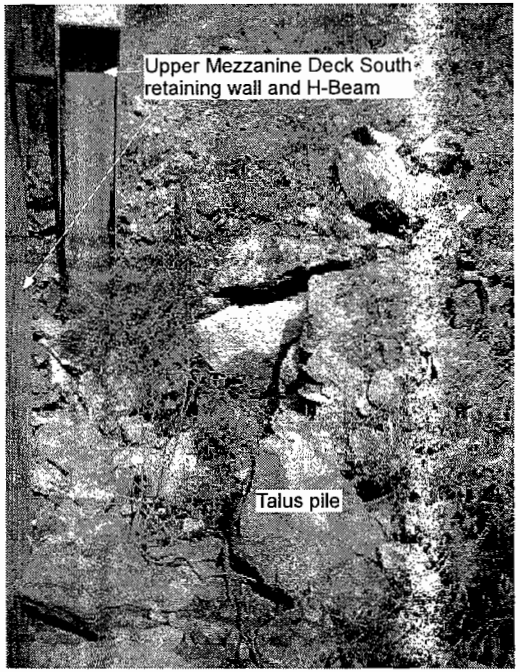
PHOTOS

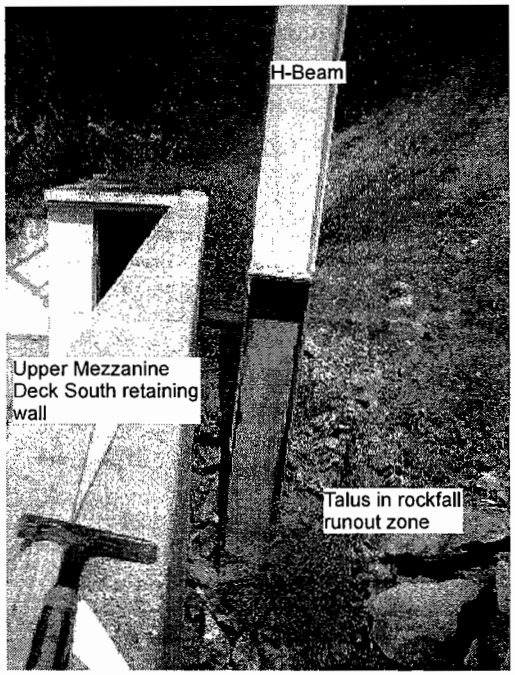
John Anson Ford Theatre
East Cahuenga Blvd.
Hollywood, California

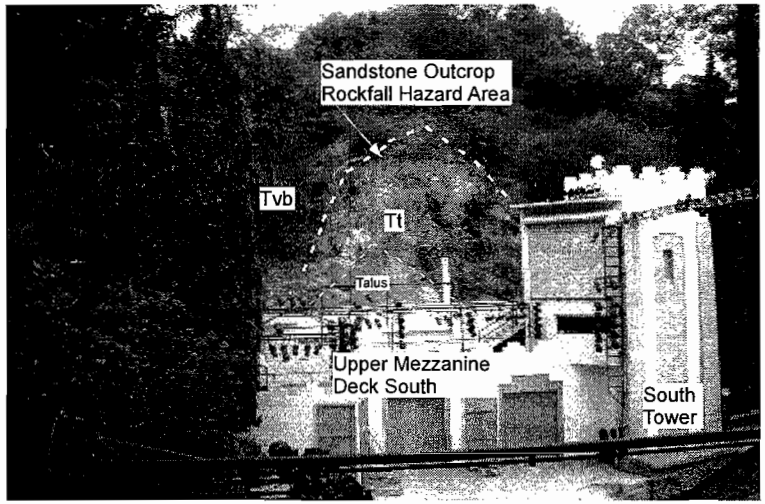
Project No.	10296-001
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

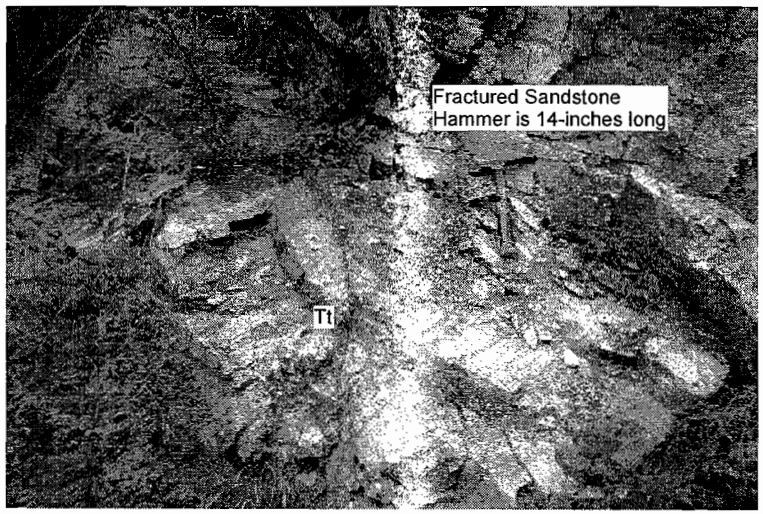
Leighton

Figure No. B-5

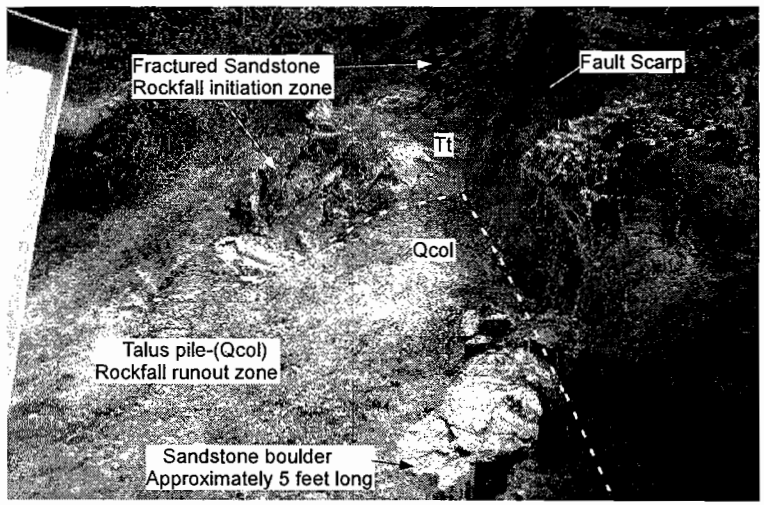








Afu: Undocumented artificial fill
Qcol: Quaternary age colluvium
Tt: Topanga Formation Sandstone
Tvb: Topanga Formation Basalt



PHOTOS

John Anson Ford Theatre
East Cahuenga Blvd.
Hollywood, California

Project No.	10296-002
Scale (Approx)	No Scale
Engr./Geol.	CK / JAR
Drafted By	JAR
Date	July 2013

Leighton

Figure No. B-6

LOG OF TRENCH: TP-1

Project Name:	Ford Theatre	Logged by:	Joe Roe
Project Number:	603507-002	Elevation:	602 ft (approximate)
Equipment:	Shovels, Electric Chisel Hammer	Location/Grid:	Ford Theatre - SE Corner near stage

GEOLOGIC ATTITUDES	DATE: 14 May, 2013 DESCRIPTION:	GEOLOGIC UNIT	ENGINEERING PROPERTIES: USCS	Sample No.	Moisture (%)	Density (pcf)
Massive pillow basalt structure - No preferred orientation	Afu - Silty SAND to Clayey SAND (SM-SC), with basalt rock fragments, dark brown, slightly moist, fine to coarse angular sand, fine to coarse gravel sized basalt rock fragments	Afu	SM-SC			
	Qcol - 21-inch thick soil and root zone, thin upslope (55°) to 21-inch thick at toe, abundant roots	Qcol	SM-SC with roots			
	Tvb - Pillow Basalt, severely weathered near surface, oxidized orange brown on weathered to black with moderate luster on fresh surfaces, pervasive blocky fracturing, fracture frequency from <1/4-inch to several inches, no preferred orientation, massive	Tvb		BB-1		

GRAPHICAL REPRESENTATION: SCALE: 1" = 5' SURFACE SLOPE: 55° TREND: 3'x3'

Total Depth = Feet
No Ground Water Encountered
Backfilled: 14 May, 2013

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

LOG OF TRENCH: TP-2

Project Name:	Ford Theatre	Logged by:	Joe Roe
Project Number:	603507-002	Elevation:	602 ft (approximate)
Equipment:	Hand tools, Electric Chisel	Location/Grid:	Ford Theatre - SE Corner near stage

GEOLOGIC ATTITUDES	DATE: 14 May, 2013 DESCRIPTION:	GEOLOGIC UNIT	ENGINEERING PROPERTIES: USCS	Sample No.	Moisture (%)	Density (pcf)
Massive pillow basalt structure - No preferred orientation	Afu - Silty SAND to Clayey SAND (SM-SC), with basalt rock fragments, dark brown, slightly moist, fine to coarse angular sand, fine to coarse gravel sized basalt rock fragments	Afu	SM-SC			
	Qcol - 21-inch thick soil and root zone, thin upslope (55°) to 21-inch thick at toe, abundant roots	Qcol	SM-SC with roots			
	Tvb - Pillow Basalt, severely weathered near surface, oxidized orange brown on weathered to black with moderate luster on fresh surfaces, pervasive blocky fracturing, fracture frequency from <1/4-inch to several inches, no preferred orientation, massive	Tvb				

GRAPHICAL REPRESENTATION: SCALE: 1" = 5' SURFACE SLOPE: 55° TREND: 3'x3'

Total Depth = Feet
No Ground Water Encountered
Backfilled: 14 May, 2013

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

LOG OF TRENCH: TP-3

Project Name:	Ford Theatre	Logged by:	Joe Roe
Project Number:	603507-002	Elevation:	602 ft (approximate)
Equipment:	Hand tools, Electric Chisel	Location/Grid:	Ford Theatre - SE Corner near stage

GEOLOGIC ATTITUDES	DATE: 14 May, 2013 DESCRIPTION:	GEOLOGIC UNIT	ENGINEERING PROPERTIES: USCS	Sample No.	Moisture (%)	Density (pcf)
Massive pillow basalt structure - No preferred orientation	Afu - Silty SAND to Clayey SAND (SM-SC), with basalt rock fragments, dark brown, slightly moist, fine to coarse angular sand, fine to coarse gravel sized basalt rock fragments	Afu	SM-SC			
	Qcol - 21-inch thick soil and root zone, thin upslope (55°) to 21-inch thick at toe, abundant roots	Qcol	SM-SC with roots			
	Tvb - Pillow Basalt, severely weathered near surface, oxidized orange brown on weathered to black with moderate luster on fresh surfaces, pervasive blocky fracturing, fracture frequency from <1/4-inch to several inches, no preferred orientation, massive	Tvb				

GRAPHICAL REPRESENTATION: SCALE: 1" = 5' SURFACE SLOPE: 55° TREND: 3'x3'

Total Depth = Feet
No Ground Water Encountered
Backfilled: 14 May, 2013

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Section B-B': Global Stability Analysis - Circular

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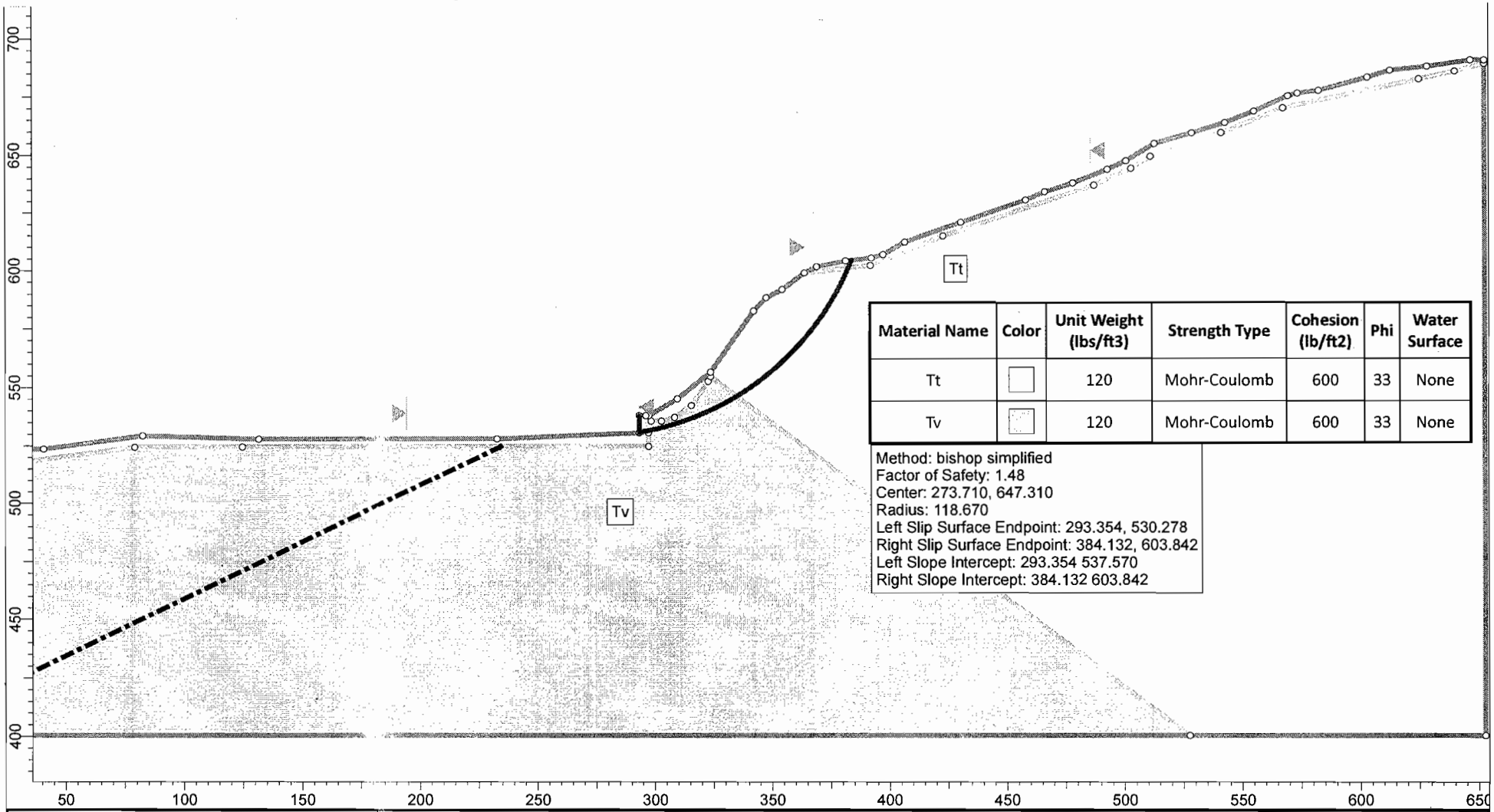

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None

Method: bishop simplified
Factor of Safety: 1.48
Center: 273.710, 647.310
Radius: 118.670
Left Slip Surface Endpoint: 293.354, 530.278
Right Slip Surface Endpoint: 384.132, 603.842
Left Slope Intercept: 293.354 537.570
Right Slope Intercept: 384.132 603.842

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **FORD THEATRE**

Analyzed By	Units	Scale	Project No.:
SP	feet	1:720	**PN: 603507-001**

Date	Condition
2/5/2013, 2:54:41 PM	Static

Section B-B': Global Stability Analysis - Non Circular

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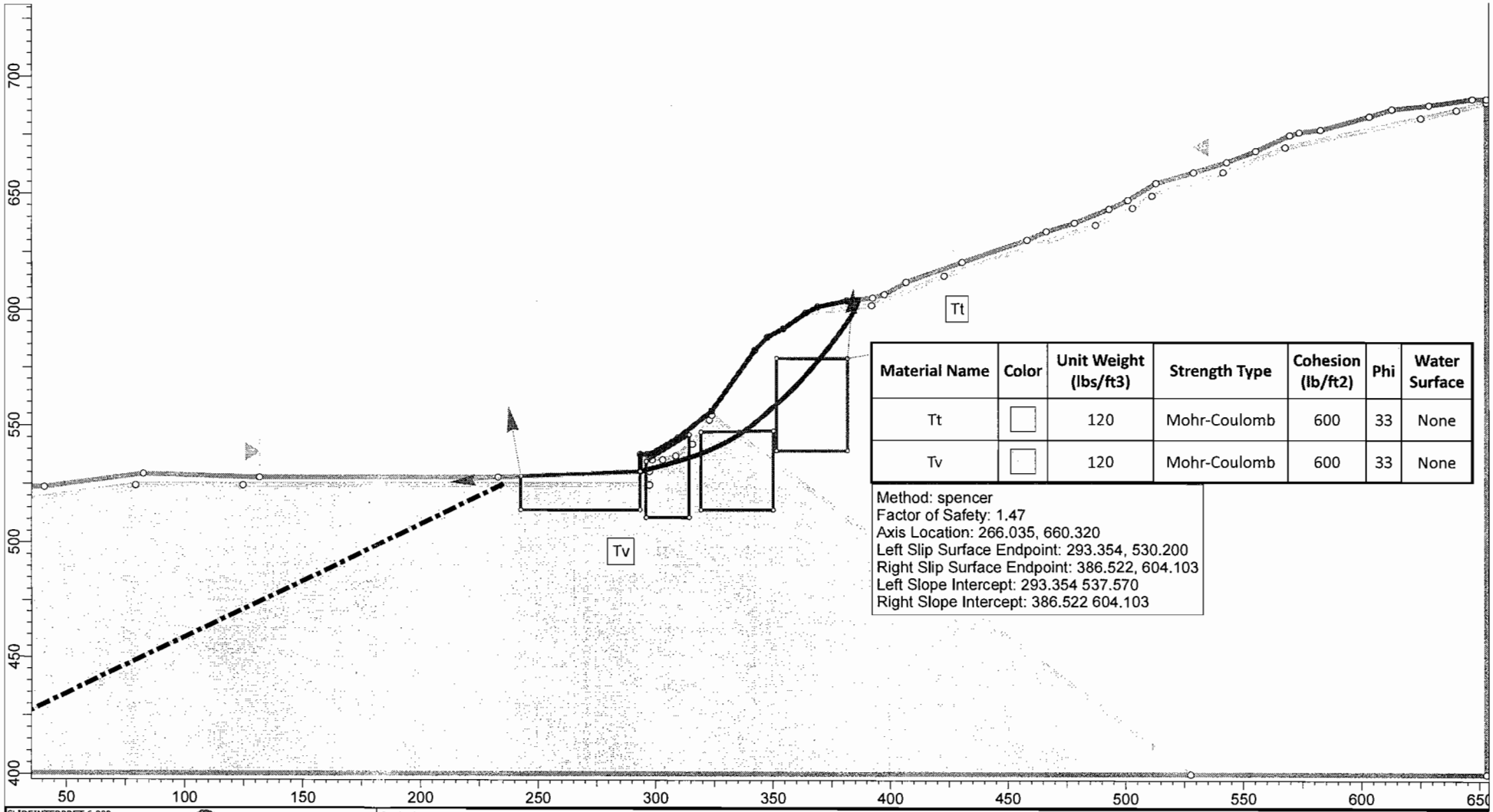

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None

Method: spencer
Factor of Safety: 1.47
Axis Location: 266.035, 660.320
Left Slip Surface Endpoint: 293.354, 530.200
Right Slip Surface Endpoint: 386.522, 604.103
Left Slope Intercept: 293.354 537.570
Right Slope Intercept: 386.522 604.103

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project			
FORD THEATRE			
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Static		

Section B-B': Global Stability Analysis

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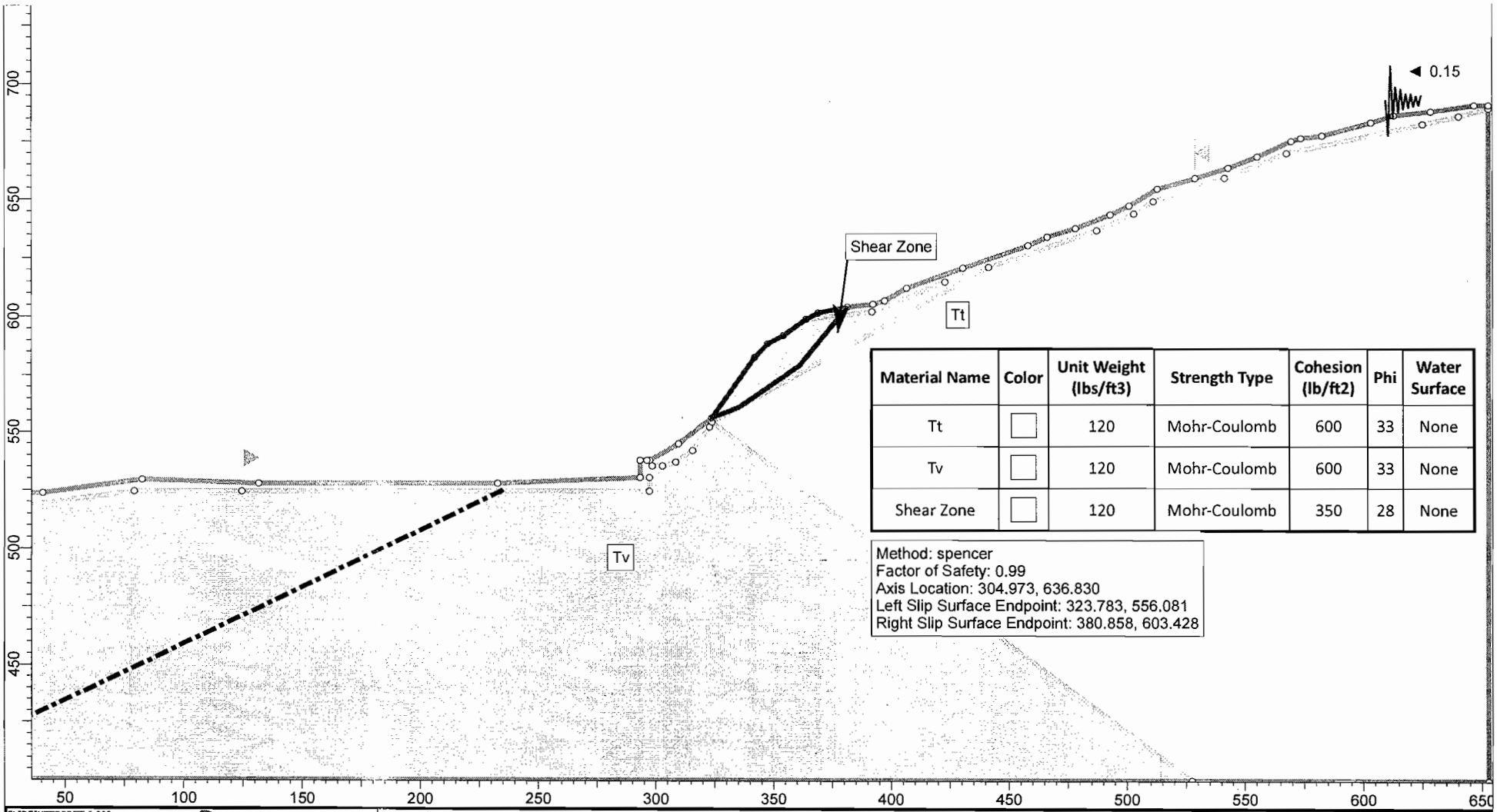

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None
Shear Zone		120	Mohr-Coulomb	350	28	None

Method: spencer
Factor of Safety: 0.99
Axis Location: 304.973, 636.830
Left Slip Surface Endpoint: 323.783, 556.081
Right Slip Surface Endpoint: 380.858, 603.428

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	FORD THEATRE		
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Pseudostatic		

Section B-B': Global Stability Analysis - Non Circular

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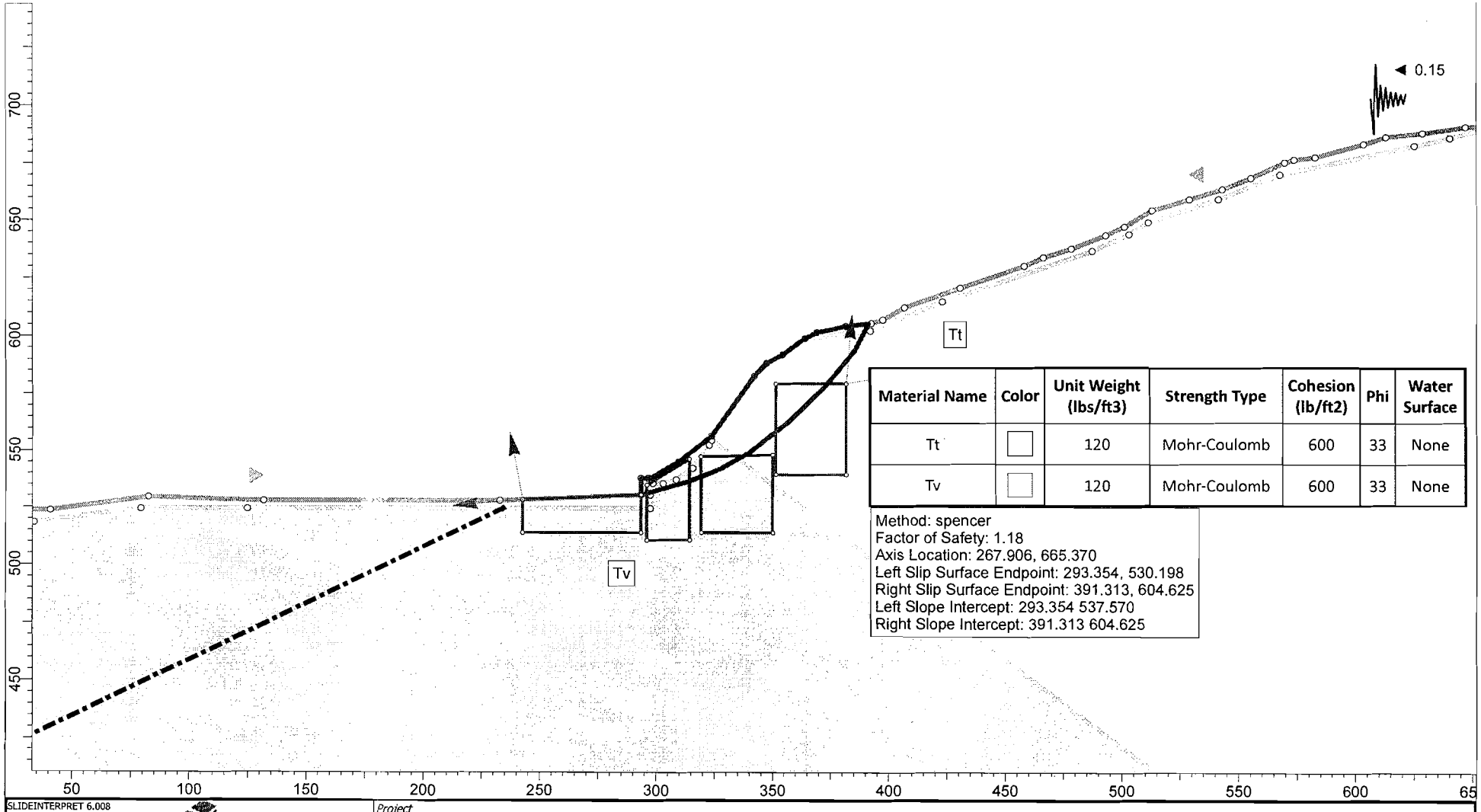

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None

Method: spencer
Factor of Safety: 1.18
Axis Location: 267.906, 665.370
Left Slip Surface Endpoint: 293.354, 530.198
Right Slip Surface Endpoint: 391.313, 604.625
Left Slope Intercept: 293.354 537.570
Right Slope Intercept: 391.313 604.625

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: FORD THEATRE			
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Pseudostatic		

SE1

Section B-B': Global Stability Analysis

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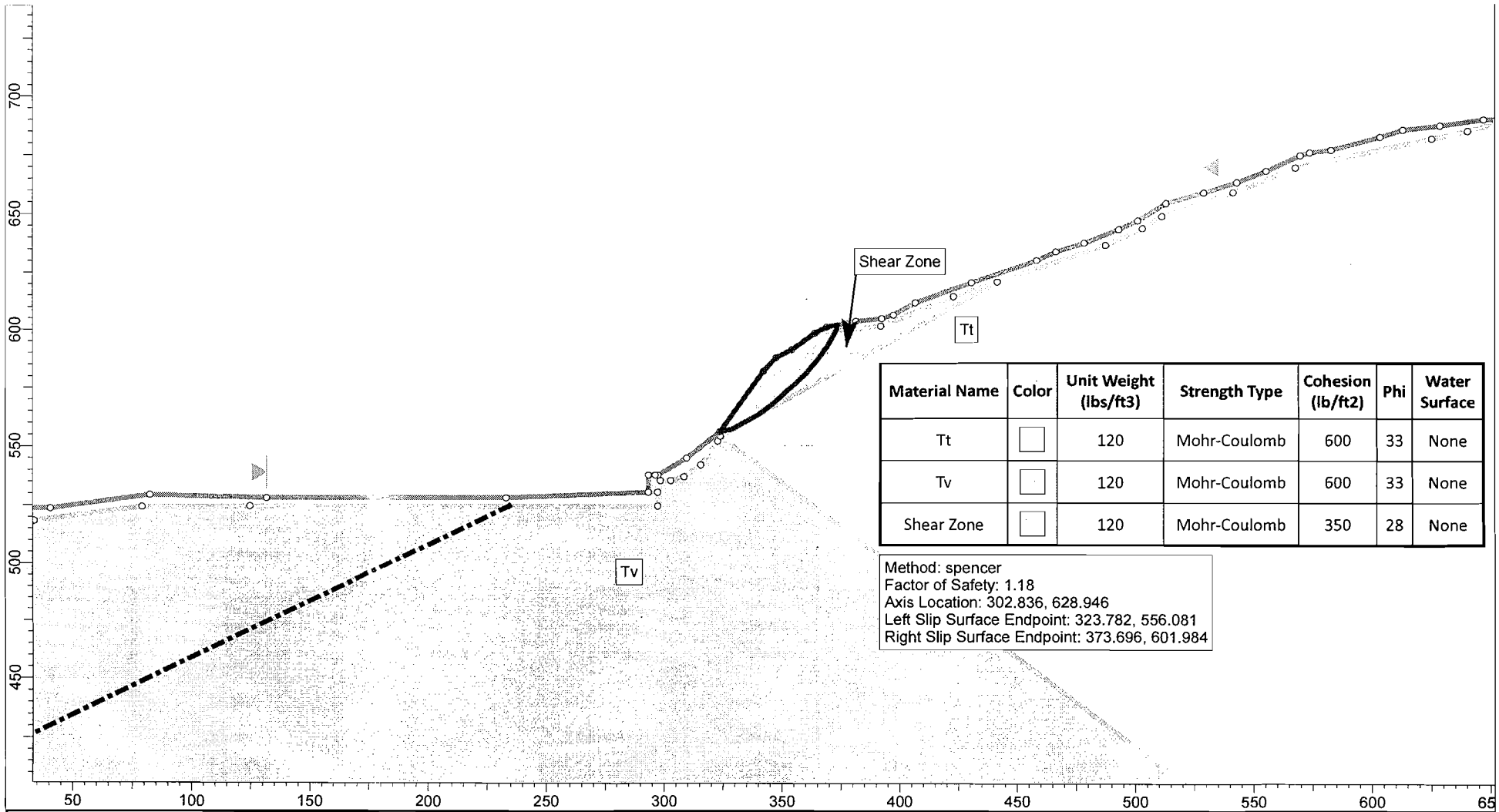


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None
Shear Zone		120	Mohr-Coulomb	350	28	None

Method: spencer
Factor of Safety: 1.18
Axis Location: 302.836, 628.946
Left Slip Surface Endpoint: 323.782, 556.081
Right Slip Surface Endpoint: 373.696, 601.984

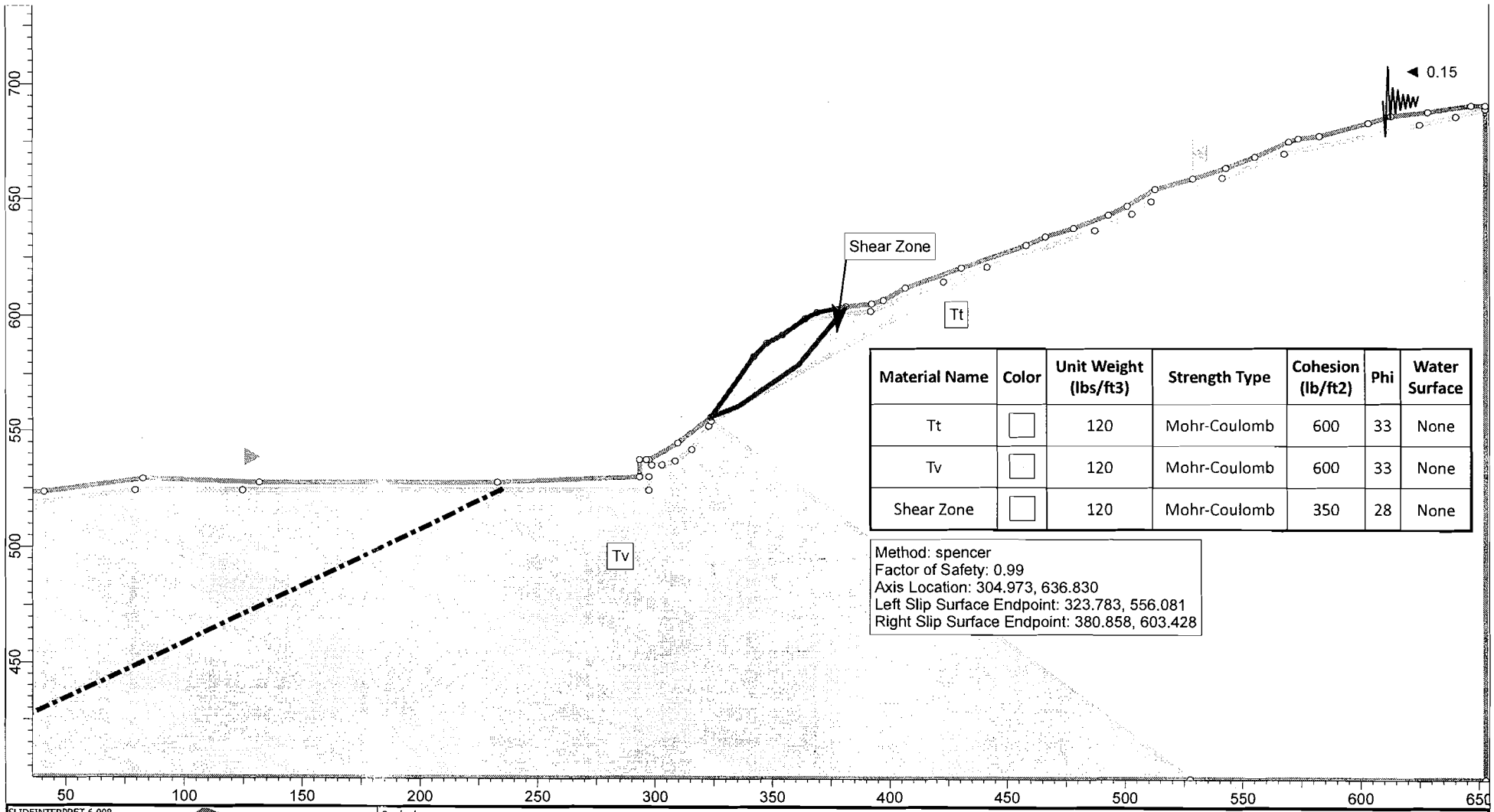
SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project			
FORD THEATRE			
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Static		

Section B-B': Global Stability Analysis

P:\Leighton Consulting\603000\603507.001 Ford Theatre\Analyses\Slope Stability\Section B_Non Circular_Path Search_SZ PS.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface
Tt		120	Mohr-Coulomb	600	33	None
Tv		120	Mohr-Coulomb	600	33	None
Shear Zone		120	Mohr-Coulomb	350	28	None

Method: spencer
Factor of Safety: 0.99
Axis Location: 304.973, 636.830
Left Slip Surface Endpoint: 323.783, 556.081
Right Slip Surface Endpoint: 380.858, 603.428

SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	FORD THEATRE		
Analyzed By: SP	Units: feet	Scale: 1:720	Project No.: PN: 603507-001
Date: 2/5/2013, 2:54:41 PM	Condition: Pseudostatic		

LEGEND

Afu	ARTIFICIAL FILL-UNDOCUMENTED, CONTAINS STOCKPILED ONSITE DEBRIS SILTY SANDY GRAVEL TO GRAVELLY SAND WITH COBBLE AND BOULDER SIZED DEBRIS.
Qcol	QUATERNARY COLLUVIUM, LOOSE, CONSISTS OF LOCALLY DERIVED BEDROCK MATERIAL, UNCONSOLIDATED, SUSCEPTIBLE TO SLOPE CREEP AND RAPID EROSION, MANTLES SLOPES, WITH THICK WEDGE AT TOES OF CUT SLOPES. DEBRIS FLOW HAZARD

MIDDLE TOPANGA FORMATION AND VOLCANIC BEDROCK

Tts	LIGHT GREY TO ORANGE BROWN, HARD, THICKLY BEDDED, RESISTANT TO EROSION. MODERATELY TO WELL CEMENTED SANDSTONE WITH LOCALIZED PEBBLY LAYERS. FINE TO COARSE ANGULAR TO TRACE ROUNDED GRAINS, INCLUDES QUARTZ PEBBLE SIZED INCLUSIONS. UNIT INCLUDES VERY FINE GRAINED SANDY SILTSTONE IS THINLY BEDDED AND CONTAINS DARK REDDISH BROWN, SILICEOUS CHERTY BEDS. SEVERELY FRACTURED, BLOCKY, ROCKFALL HAZARD ALONG CUT SLOPES, CIRCLED WHERE BURIED.
Ttbs	DARK GREY, CRUMBLY SANDSTONE WITH BASALT FRAGMENTS AND ROUNDED MANGANESE NODULES. SEVERELY WEATHERED AND FRACTURED. HEAVY SECONDARY MINERALIZATION AND CHEMICAL ALTERATION OF MAFIC MINERALS. CIRCLED WHERE BURIED.
Tvb	EXTRUSIVE BASALTIC VOLCANIC ROCKS, DARK GREY TO BLACK, VESSICULAR TO PILLOW STRUCTURE. SEVERELY WEATHERED AND FRACTURED. PERVASSIVE BLOCKY FRACTURE. MODERATE LUSTER ON WEATHERED BLOCKY FACES. DEGRADES TO SAND SIZED FRAGMENTS. HEAVY SECONDARY MINERALIZATION TO EPIDOTE, CHEMICALLY WEATHERED, FRIABLE NEAR SURFACE, HARD WITH DEPTH. CIRCLED WHERE BURIED.
— — — — . . . .?	GEOLOGIC CONTACT, DASHED WHERE APPROXIMATE, DOTTED WHERE CONCEALED. QUERRIED WHERE UNCERTAIN

	APPROXIMATE BOUNDARIES OF CUT SLOPES
	APPROXIMATE BOUNDARY OF COLLUVIUM. DEBRIS FLOWS PRIMARILY WITHIN BASALT FORMATION DENOTES DIRECTION OF MOVEMENT. AREAS ARE SUBJECT TO ONGOING CREEP AND SEDIMENT BUILDUP BEHIND EXISTING WALL IMPROVEMENTS.
30/15	STRIKE AND DIP OF BEDDING
310/75	STRIKE AND DIP OF FAULT
130/30	STRIKE AND DIP OF BEDROCK CONTACT
290/30	STRIKE AND DIP OF LOCALIZED SHEAR SURFACES
	EXISTING RETAINING WALLS
	BASALT DIKE
	SURFACE CONTACT OF SANDSTONE BEDDING AND INTRUSIVE BASALT OUTCROPS
	APPROXIMATE CENTERLINE OF EXISTING DRAINAGES. ARROW DENOTES DIRECTION OF SURFACE FLOW
33.2SM 70.5M	APPROXIMATE LOCATION OF SEISMIC LINES S-1 AND S-2. SHOWN WITH LENGTH IN METERS (M). (LEIGHTON, 2013)
E E'	LOCATION OF GEOLOGIC CROSS SECTIONS (LEIGHTON 2013 AND CURRENT STUDY)

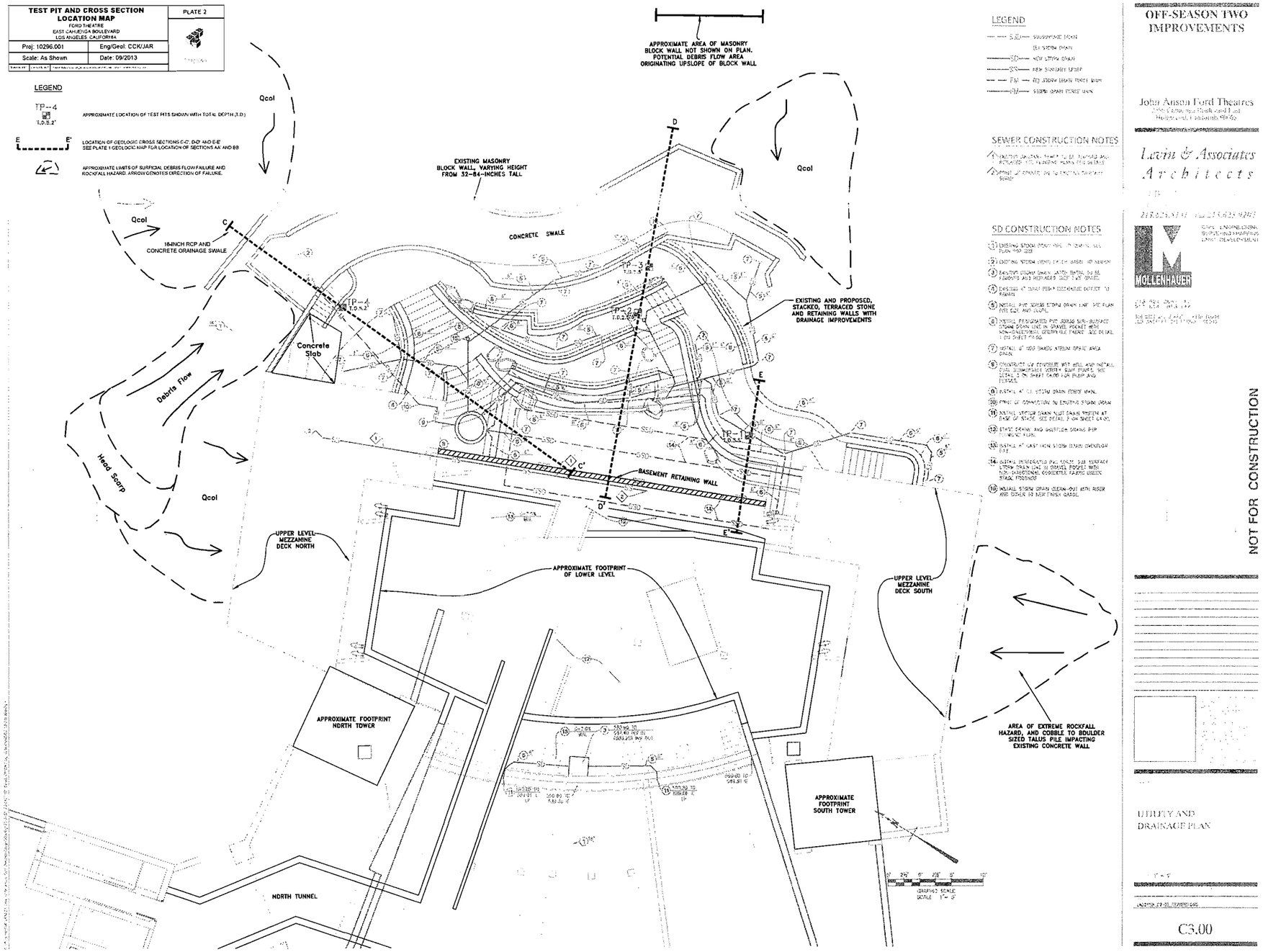
SCALE 0 40 80 FEET

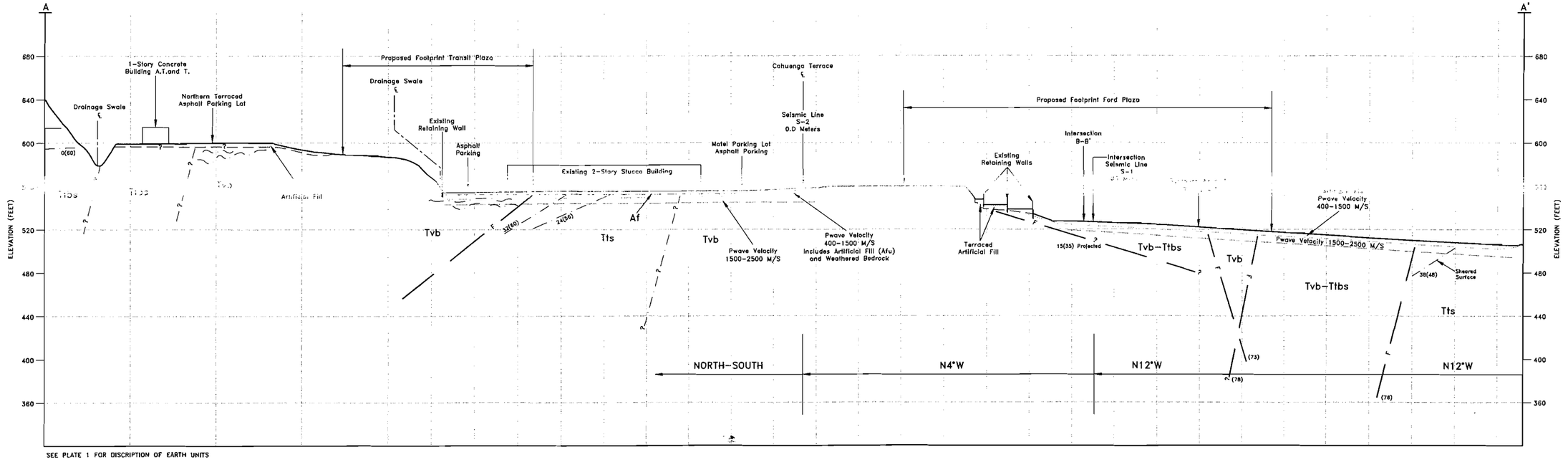
GEOLOGIC MAP
FORD THEATRE
EAST CAHUENGA BOULEVARD
LOS ANGELES, CALIFORNIA

PLATE 1

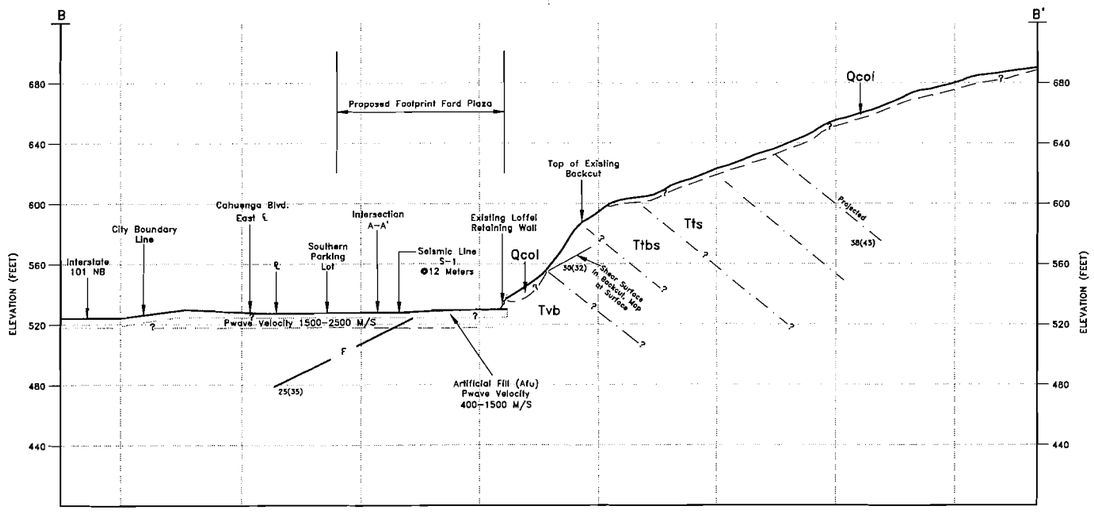
Proj: 10296.001	Eng/Geol: CCK/JAR
Scale: 1"=40'	Date: 09/2013

Drawn By: BDT | Checked By: MPP | A geotechnical data file of Plate 1 of Geologic Map (1 of 2)


TEST PIT AND CROSS SECTION LOCATION MAP
FORD THEATRE
EAST CAHUENGA BOULEVARD
LOS ANGELES, CALIFORNIA
PLATE 2
Proj: 10296.001
Eng/Geol: CCK/JAR
Scale: As Shown
Date: 09/2013
LEGEND
TP-4
T.D.5.2'
APPROXIMATE LOCATION OF TEST PITS SHOWN WITH TOTAL DEPTH (T.D.)
E E'
LOCATION OF GEOLOGIC CROSS SECTIONS C-C', D-D' AND E-E'
SEE PLATE 1 GEOLOGIC MAP FOR LOCATION OF SECTIONS AA' AND BB
APPROXIMATE LIMITS OF SURFICIAL DEBRIS FLOW FAILURE AND ROCKFALL HAZARD. ARROW DENOTES DIRECTION OF FAILURE.
APPROXIMATE AREA OF MASONRY BLOCK WALL NOT SHOWN ON PLAN. POTENTIAL DEBRIS FLOW AREA ORIGINATING UPSLOPE OF BLOCK WALL
EXISTING MASONRY BLOCK WALL, VARYING HEIGHT FROM 32-84-INCHES TALL
CONCRETE SWALE
18-INCH RCP AND CONCRETE DRAINAGE SWALE
Qcol
Concrete Slab
Debris Flow
Head Scarp
EXISTING AND PROPOSED, STACKED, TERRACED STONE AND RETAINING WALLS WITH DRAINAGE IMPROVEMENTS
BASEMENT RETAINING WALL
UPPER LEVEL MEZZANINE DECK NORTH
APPROXIMATE FOOTPRINT OF LOWER LEVEL
UPPER LEVEL MEZZANINE DECK SOUTH
APPROXIMATE FOOTPRINT NORTH TOWER
APPROXIMATE FOOTPRINT SOUTH TOWER
NORTH TUNNEL
AREA OF EXTREME ROCKFALL HAZARD, AND COBBLE TO BOULDER SIZED TALUS PILE IMPACTING EXISTING CONCRETE WALL
LEGEND
SEWER CONSTRUCTION NOTES
SD CONSTRUCTION NOTES
OFF-SEASON TWO IMPROVEMENTS
John Anson Ford Theatres
Levin & Associates Architects
MOLLENHAUER
NOT FOR CONSTRUCTION
UTILITY AND DRAINAGE PLAN
C3.00



SEE PLATE 1 FOR DISCRIPTION OF EARTH UNITS



LEGEND

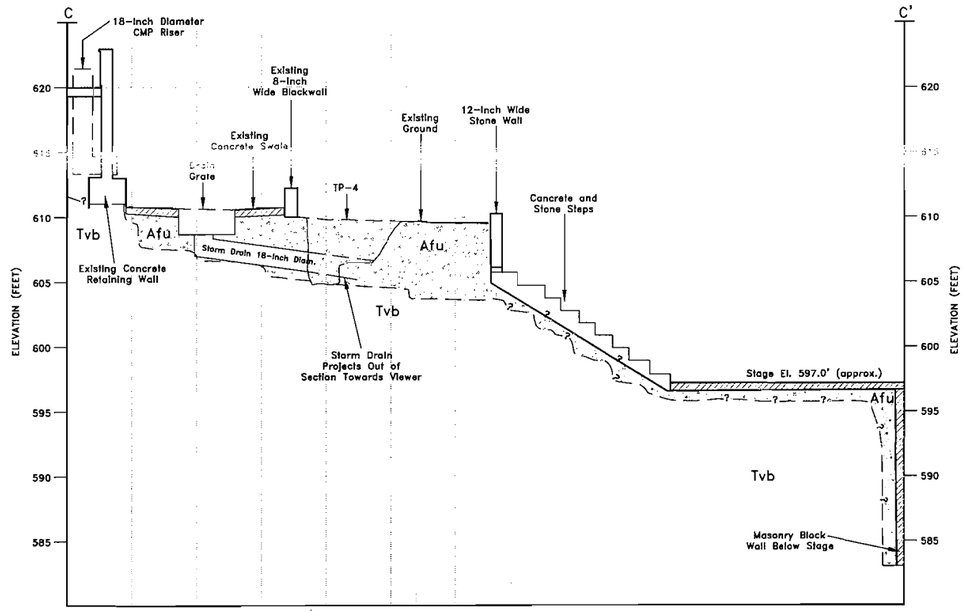
- GEOLOGIC CONTACT BETWEEN DIFFERENT ROCK TYPES, PROJECTED TO SECTION, DASHED AND QUERRIED DUE TO UNCERTAINTY.
- FAULT CONTACT SHOWN GEOMETRICALLY WITH APPARENT DIP; ACTUAL DIP SHOWN IN PARENTHESES.
- BASALTIC PILLOW STRUCTURE, NO PREFERRED ORIENTATION
- APPROXIMATE LAYERING BASED ON SEISMIC PWAVE VELOCITIES REPORTED IN METERS PER SECOND (M/S)
- APPARENT DIP OF BEDDING, ACTUAL DIP IN PARENTHESES

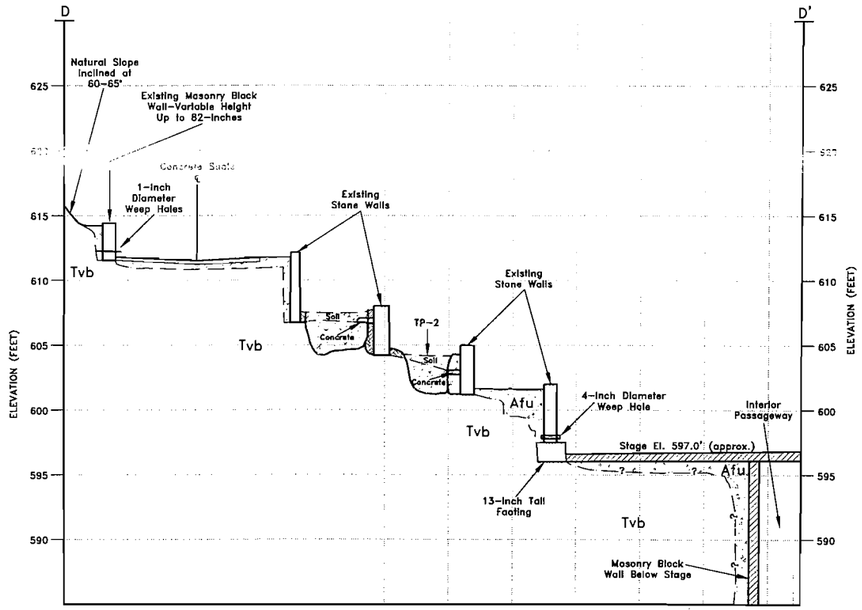
GENERALIZED GEOLOGIC CROSS SECTIONS A-A' AND B-B'
FORD THEATRE
EAST CAHUENGA BLVD.
LOS ANGELES, CALIFORNIA

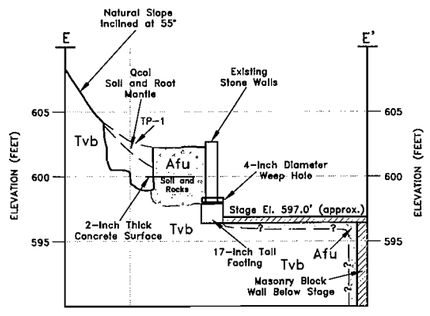
PLATE 3

Proj: 10296.001	Eng/Geol: CK/JR
Scale: 1"=40'	Date: 09/2013

Leighton







GENERALIZED GEOLOGIC CROSS SECTIONS C-C', D-D' AND E-E'
FORD THEATRE
EAST CAHUENGA BLVD.
LOS ANGELES, CALIFORNIA

PLATE 4

Proj: 10296.001	Eng/Geol: CK/JR
Scale: 1"=40'	Date: 09/2013

Leighton

APPENDIX E

SEISMIC HAZARD ZONE REPORT FOR THE HOLLYWOOD 7.5-MINUTE QUADRANGLE, LOS ANGELES COUNTY, CALIFORNIA

1998



DEPARTMENT OF CONSERVATION
Division of Mines and Geology

STATE OF CALIFORNIA
GRAY DAVIS
GOVERNOR

THE RESOURCES AGENCY
MARY D. NICHOLS
SECRETARY FOR RESOURCES

DEPARTMENT OF CONSERVATION
DARRYL YOUNG
DIRECTOR

The results of the grouping of geologic materials in the Hollywood Quadrangle are in Tables 2.1 and 2.2.

HOLLYWOOD QUADRANGLE SHEAR STRENGTH GROUPS							
	Formation Name	**Number Tests**	**Mean/ Median Phi**	**Mean/ Median Group phi (deg)**	**Group Mean/ Median C (psf)**	**No Data: Similar Lithology**	**Phi Values Used in Stability Analysis**
GROUP 1	Kgr	28	40.5/40	40.5/40	483/440		40.5
GROUP 2	Tpn4(fbc) Tb Tm(fbc) Tt(fbc) Tpn1(fbc)	27 22 22 36 16	34.2/34 33.8/33.5 33.5/34.5 33.0/34.7 31.4/31	33.2/34	597/500	Kt Ttc(fbc) Tts(fbc) TK	33.2
GROUP 3	Qi Tt(abc) Tf3 Qa Qsp Tpn Tpn4(abc) Tpn1(abc)	35 17 3 6 30 5 5 30	29.9/29 29.8/31 29/28 28.8/29 28.2/30 27.8/29 27.4/26 26.8/26	28.5/29	366/300	af, Qao Qay1, Qay2 Qc?,Qoa Qof?,Qp, Qt Qw, Qya1 Qya2, Qyf1 Tss	28.5
GROUP 4	Tpn3 Tm(abc)	16 20	23/19 22/22	22.4/20.1	392/364		22.4
GROUP 5	Qls	-	-	-	-		14

abc = adverse bedding condition, fine-grained material strength
fbc = favorable bedding condition, coarse-grained material strength

Table 2.1. Summary of the Shear Strength Statistics for the Hollywood Quadrangle.

Appendix H.4

Addendum 3 to Geotechnical Exploration Report

ADDENDUM NO. 3 TO GEOTECHNICAL EXPLORATION REPORT OFF-SEASON THREE AND FOUR IMPROVEMENTS JOHN ANSON FORD THEATERS 2580 CAHUENGA BOULEVARD EAST HOLLYWOOD DISTRICT OF LOS ANGELES, CALIFORNIA

Prepared for

Ford Theatre Foundation

2580 Cahuenga Boulevard East
Hollywood, California 90068

Project No. 10296.002

February 28, 2014

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

February 28, 2014

Project No. 10296.002

To: Ford Theatre Foundation
2580 Cahuenga Boulevard East
Hollywood, CA 90068

Attention: Mr. Mohammad Saeid, CCM Senior Project Manager

Subject: Addendum No. 3 to Geotechnical Exploration Report
Off-Season Three and Four Improvements
John Anson Ford Theaters
2580 Cahuenga Boulevard East
Hollywood District of Los Angeles, California

In accordance with our January 6, 2014 proposal, authorized on January 13, 2014, Leighton Consulting, Inc. (Leighton) is pleased to present this third addendum to our geotechnical exploration report in support of the proposed Off-Season Three and Four Improvements. Our scope of work for this study included geologic mapping, subsurface exploration, laboratory testing, engineering analysis, and preparation of this report.

This addendum presents the results of our geotechnical exploration and field mapping program and provides recommendations for design and construction of the proposed improvements.

We appreciate the opportunity to be of service to the Ford Theatre Foundation. If you have any questions or if we can be of further service, please call us at your convenience at (866) LEIGHTON, at the direct extensions listed below, or e-mail us as listed below.

Respectfully submitted,

LEIGHTON CONSULTING, INC.

Joe A. Roe, CEG 2456
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ATTACHMENTS:

Figure 1 – Site Location Map

Appendix A – References
Appendix B – Subsurface Exploration
Appendix C – Laboratory Testing
Appendix D – Slope Stability Analysis

Plate 1 – Revised Geologic Map
Plate 2 – Generalized Geologic Cross Sections A-A' through E-E'
Plate 3 – Generalized Geologic Cross Sections F-F" through J-J'

1.0 INTRODUCTION

1.1 Authorization

In accordance with your authorization on January 13, 2014, and based on our January 6, 2014 proposal, Leighton Consulting, Inc. (Leighton) has performed geologic mapping, subsurface exploration, laboratory testing, and engineering analysis for the proposed Off-Season Three and Four Improvements at John Anson Ford Theaters. The project is located at 2580 East Cahuenga Boulevard in the Hollywood District of Los Angeles, California (Figure 1, *Site Location Map*).

1.2 Objective

The objective of our investigation was to obtain rock quality designation (RQD) estimates of bedrock to evaluate proposed grading, which includes lowering the grade of the cul-de-sac road immediately north of the existing amphitheater by approximately 10 feet and significant hillside cuts ranging from 35 to 50 feet in height for proposed transformer and generator pads and a central plant, see Plate 1, *Revised Geologic Map*.

The transformer and generator pads, proposed on the north and east sides of the cul-de-sac, are located below a potential debris flow area emanating from the drainage swale that outlets to the cul-de-sac. The Central Plant, proposed north of the cul-de-sac entrance, is partially within a surfically mapped failure originating from within the basalt formation.

Therefore, we focused on the area surrounding the cul-de-sac entrance and hillside terrain within the planned 0.75-mile-long pedestrian trail. The main geologic considerations are the potential for debris flows emanating from the hillside swale above the area of planned transformer and generator pads and slope stability.

1.3 Scope of Work

Our scope included document review, geologic mapping, subsurface exploration, laboratory testing, engineering analysis, on-site meeting with the design team, and preparation of this report. To accomplish our scope of work we provided the following services:

- *Review of Available Data*: We reviewed the Draft Interim Site Plan Off-Season 3 and 4, Scale 1"=40', prepared by Levin and Associates Architects, dated December 9, 2013.

- *Geologic Mapping*: We performed field mapping of the observable rock mass, and surficial soil conditions in the project area. Newly collected geologic and structural data is shown on Plate 1, *Revised Geologic Map*.

- *Geotechnical Cross Sections:* We updated existing cross sections A-A' and B-B' developed during our preliminary evaluation (Leighton, 2013a) and constructed five (5) additional cross sections F-F', G-G' H-H', I-I' and J-J' to evaluate the proposed improvements with respect to interpreted subsurface conditions. Geologic cross sections are shown on Plates 2 and 3.

- *Geotechnical Exploration*: We excavated one rock core (RC-1) to a depth of 37 feet below the existing ground surface (bgs) within the cul-de-sac in the area of the planned transformer and generator pads to obtain recoverable rock cores in determination of Rock Quality Designation (RQD) for use in slope stability analysis. The RQD is a modified core recovery percentage in which unrecovered core, fragments and pieces of rock and altered rock are not counted so as to downgrade the quality designation of recovered rock. Rock coring at this location identified the soft crumbly weathered basalt bedrock to a depth of approximately 10 feet below grade. Below 10 feet the formational material becomes extremely hard, very well cemented and resistant characterized as andesitic brecciated basalt bedrock to the total depth of the core. RQD are included on the boring log in Appendix B, *Subsurface Exploration*. Rock cores were collected from the boring at approximate 2.5- and 5-foot intervals and transferred to our lab for analysis. The boring was backfilled with bentonite grout and capped with concrete to the ground surface after completion. Drill cuttings and drilling mud were disposed of on-site.

- *Laboratory Testing*: Unconfined compression testing of samples from RC-1 was performed to develop shear strength parameters for slope stability analysis. Results are shown in Appendix C, *Laboratory Testing*.

- *Engineering Analysis*: We performed an evaluation of the proposed Off-Season Three and Four improvements project based on the field data gathered during our current and prior studies at the site.

- *Report:* Leighton prepared this report documenting the results of the geological mapping, subsurface exploration and engineering analysis and provides updated recommendations where applicable for design and construction of the Off-Season Three and Four Improvements.

1.4 Project Description

The overall John Anson Ford Theaters Master Plan Project includes the following primary components: (1) preservation and rehabilitation of certain portions of the existing Amphitheatre; (2) the Ford Terrace, which would include a four-story structure with three levels of office space and lower-level concessions area and a raised plaza deck above a service level; (3) the Ford Plaza, which would be set atop a new three-level parking structure and would feature a restaurant, a 299-seat theatre, a new box office, a meeting hall, and offices and visitor amenities; (4) the Transit Plaza, which would include a designated area for bus and valet drop-off, a new three-level parking structure, and a 99-seat rehearsal and event space; and (5) a 0.75-mile hiking trail.

Leighton understands the Off-Season 3 and 4 improvements are to consist primarily of a new concessions building, loading dock and service court, pads for new transformers and generator, new Central Plant and electrical services, and a 0.75-mile-long pedestrian trail and associated appurtenances. Geotechnical information was collected to supplement previous information provided in our referenced reports (Leighton 2013a and 2013b) in order to complete the current scope of work.

1.5 Study Area

The project site (Site) is situated within a west-facing hillside slope immediately east of US 101 (Hollywood Freeway). The summit and upper ridgeline ranges from Elevation +840 to +940 feet mean sea level (msl) and are approximately 350 feet higher than the lowest elevation along the western portion of the Site adjacent to Cahuenga Boulevard East (Elevation +510 to +570 feet msl). As such, the topography of the Site is widely varied from moderately sloping surface parking areas along the western portion of the Site to steep hillsides that are vegetated primarily with chaparral and scattered trees along the northern, southern, and eastern portions.

Rock outcroppings are visible primarily along the ridgelines and as steep near-vertical cliffs. Thick surficial deposits of colluvium and weathered bedrock obscure the structural rock exposures over most of the hillside terrain except as indicated on Plate 1.

The remaining areas are comprised of surface parking and undeveloped open space. Landscaping is provided along driveways, surface parking areas, and pedestrian pathways. Additionally, while there are no designated hiking trails within the Site, there are existing user-created trails and badly distressed concrete stairs in the hills behind the Amphitheater.

2.0 GEOLOGIC RECONNAISSANCE AND MAPPING

We advanced a continuous rock core boring (RC-1) to a depth of 37 feet bgs and performed field mapping of the Off-Season Three and Four Improvements project area to supplement the data provided in our referenced reports. The interpreted subsurface conditions are shown on revised cross sections, Plate 2, sections A-A' and B-B' developed during our preliminary evaluation and new cross sections F-F', G-G' H-H', I-I' and J-J' on Plate 3. Cross Sections C-C', D-D' and E-E', developed in support of the Off-Season Two improvements, remain unaffected by acquisition the new geologic information and are included for reference on Plate 2.

2.1 Cul-de-Sac Parking Area

The circular parking area (cul-de-sac) will be lowered by approximately 10 feet below current grade to accommodate construction of a four-story Office and Concessions Building, Ford Terrace Plaza, new loading dock and staging area, Artist Workshop Building, and generator and transformer pads (See Plate 3, Cross Sections F-F' and G-G'). The approximate footprint of the proposed improvements is shown on Plate 1.

From our geologic field mapping and core boring (RC-1), it appears bedrock within the hillside above the cul-de-sac consists predominately of weathered pillow basalt in contact with steeply dipping (N9˚E,54˚SE to N20˚E,67˚SE) and severely weathered sandstone and lesser shale. Based on data recovered from the core boring, basaltic bedrock underlying the footprint of these proposed areas is expected to become extremely hard and resistant (RQD>90%) at approximately 10 feet below current grade corresponding to Elevation +592 feet msl. Basalt bedrock encountered at this depth interval consists of extremely hard, resistant and well cemented andesitic brecciated basalt and will prove difficult to excavate below weathered depths.

The swale above the proposed transformer and generator pads has been reported verbally to have been subject to enormous debris flows that cascaded down the cul-de-sac to the access drive to East Cahuenga Boulevard. Retaining walls for the transformer and generator pads will require significant freeboard (extension of wall above retained backslope) and to consider temporary surcharge imposed by wet soil debris. A storm drain catch basin will need to be constructed to allow regular rainfall runoff to be transported away for the retaining structures to prevent buildup of hydrostatic pressure behind the walls. Periodic

maintenance to prevent excessive buildup of soil debris will need to be regularly performed.

Based on the results of slope stability analysis, the required cuts for the transformer and generator pads may be accomplished without shoring. The weathered zone (upper 10 feet of excavation) will likely slough and require a 2:1 (horizontal to vertical) backslope. Retaining walls will be required to augment the stability of the cut slopes and establish the recommended freeboard. Results of slope stability analyses are shown in Appendix D, *Slope Stability Analysis*.

2.2 Central Plant and Electrical Services

A new Central Plant and Electrical Services Building (Central Plant) is proposed in an area of surficial instability, within heavily weathered pillow basalt formation (Plate 3, Cross Section H-H'). There is an existing cast-in-place concrete wall with timber lagging immediately west of the proposed Central Plant. The timber lagging is heavily distressed and rotting in place. The concrete wall is slightly terraced, and intermittently overtopped with surficial soil debris during heavy precipitation. The concrete wall has several cracks within the face and will need to be removed and replaced in order to construct the Central Plant.

Based on the results of slope stability analysis, the required cut for the Central Plant may be accomplished without shoring. The weathered zone (upper 10 feet of excavation) will likely slough and require a 2:1 (horizontal to vertical) backslope. Retaining walls will be required to augment the stability of the cut slope and establish the recommended freeboard. Results of slope stability analyses are shown in Appendix D.

2.3 Pedestrian Trail

A 0.75-mile-long pedestrian trail is proposed for construction to access the hillside areas of the theatre. Based on our geologic mapping (Plate 1), the main geotechnical considerations for this pathway are thick, loose soil accumulations; hard, resistant ridge top; and cliff-forming sandstone and shale. The existing heavily damaged and cracked concrete stairs constructed on the hillside to provide access to the cross above the amphitheater will require repair or replacement. It is anticipated that the trail will consist of lightweight pipe and batter board to account for stepped elevation differences with aluminum or wood stairs constructed in areas of cliff-forming sandstone and shale. A majority of the

pathway is expected to require relatively minor earthwork improvements such as stabilization and compaction of loose soil.

3.0 FINDINGS AND CONCLUSIONS

Based on the results of our supplemental exploration, we conclude that the proposed Off-Season Three and Four improvements project is feasible from a geotechnical standpoint. We did not encounter significant geotechnical constraints that cannot be mitigated by proper planning, design, and sound construction practices. The key findings of our supplemental investigation for the site are summarized below:

- The near surface materials encountered consist of a thin layer (less than 1-foot thick) of undocumented fill in the cul-de-sac area. Undocumented fills locally contain large oversize rock fragments and basalt debris. The fill encountered at the site is associated with past construction activities.

- The colluvium consists predominately of angular sands and gravel sized basalt rock fragments intermixed with organic debris from hillside vegetation. The colluvium forms thick accumulations in the swale above the proposed generator and transformer pads at the cul-de-sac. Verbal discussions with onsite personnel indicate the colluvium has slid down the swale as a debris flow during the winter of 2005-2006. Colluvium is subject to continuous downhill creep and subject rapid releases in the form of debris flows following periods of intense precipitation.

- The basalt bedrock in the cul-de-sac area has massive pillow structure, is very blocky, interlocked, and partially disturbed with multi-faceted angular blocks formed by joint sets and as a result of tectonic uplift during the mountain building process. Basalt in this location was observed to be weathered to a depth of approximately 10 feet below grade becoming very hard, very well cemented brecciated basalt and will prove difficult to excavate below its weathered depth. Heavy ripping should be anticipated.

- Steeply dipping sandstone and very hard shale with weak planar structural features in unfavorable orientation (N9˚E,54˚SE to N20˚E,67˚SE) to the proposed pads is expected to be encountered in the western portion of the cut for transformer and generator pads. The sandstone is of limited thickness (approximately 6-inches) at this location and embedded with the heavily fractured and weathered shale. The shale is well cemented and can be prove moderately difficult to excavate in the weathered zone. Sandstone on other areas of the site was observed to be thickly bedded and outcrops along ridge tops and in cliff forming exposures. Heavy ripping should be anticipated.

- Based on the rock quality (RQD) determined during the core boring (RC-1) excavation (Appendix B), it is our opinion that the basalt and sandstone materials will vary from easily rippable near surface to difficult below 10 feet in depth.

- Groundwater was not encountered. Nuisance water could be encountered during and after seasonal precipitation emanating from the natural drainage swale above the area of proposed transformer and generator pads.

- The required cuts for the transformer and generator pads and Central Plant may be accomplished without shoring. The weathered zone (upper 10 feet of excavation) will likely slough and require a 2:1 (horizontal to vertical) backslope. Retaining walls will be required to augment the stability of the cut slope and establish the recommended freeboard to protect against debris flows.

- The existing onsite soils are expected to be generated from the basalt formation and are not suitable for re-use as fill behind the retaining structures. Select free draining backfill material is required to prevent hydrostatic pressure from building up behind the retaining walls.

- Oversize material could be generated while excavating the sandstone rocks and brecciated basalt during excavation in the cul-de-sac area. Oversize material should be removed from the site or placed at a designated, pre-approved disposal area within the theater complex.

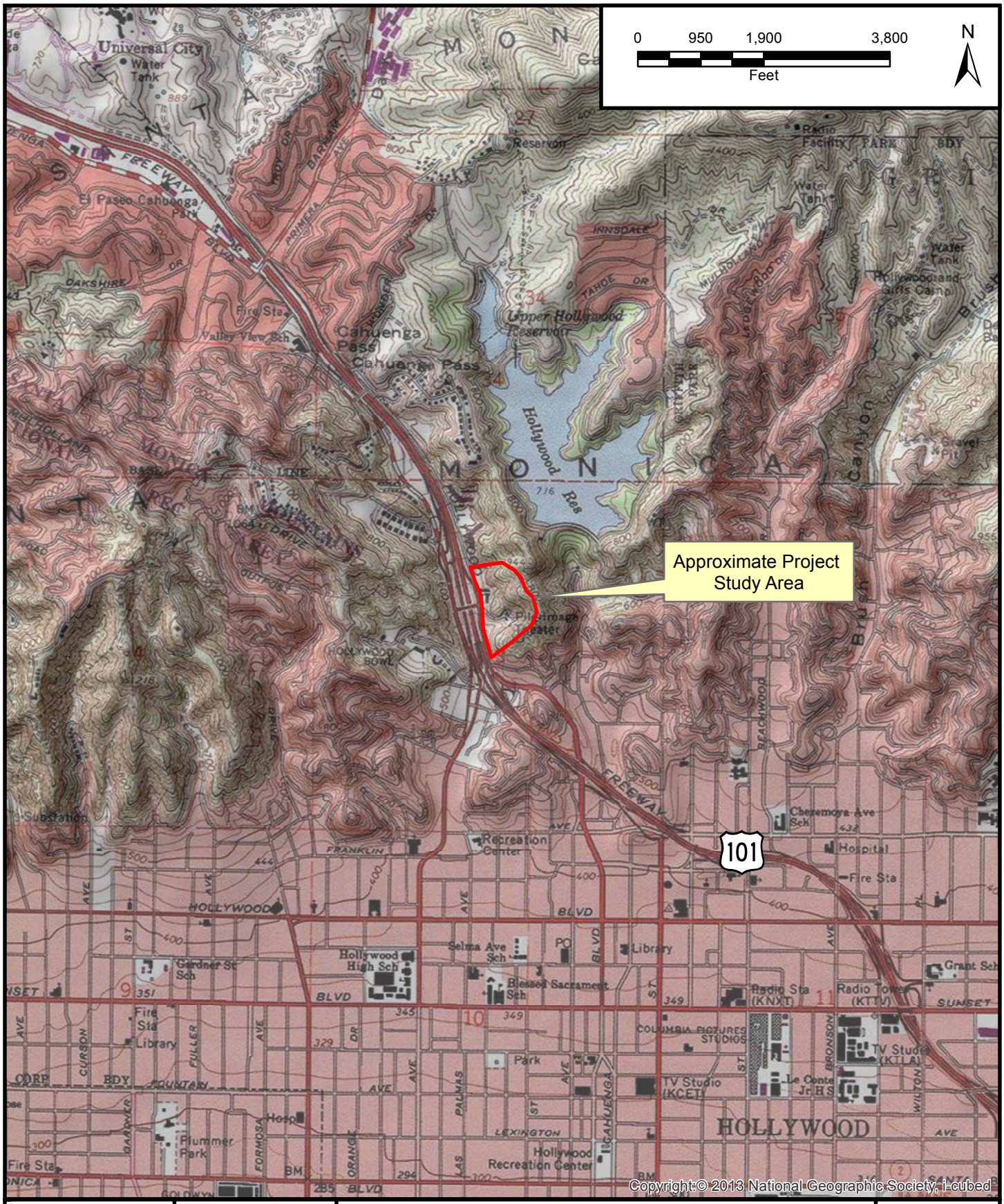
4.0 GEOTECHNICAL RECOMMENDATIONS

Recommendations contained in the referenced reports and addendum (Leighton 2013a, 2013b, 2013c) remain applicable to the site except were superseded by more stringent recommendations contained herein. Extensive removals and recompaction of loose slope materials will be required for the project as they have substantial debris flow potential. These materials should be removed and recompacted where applicable or removed in their entirety to reduce the potential for remobilization.

For protection against future debris flows the new retaining walls for the generator and transformer pads and the Central Plant should have a minimum freeboard height of 24 inches (height of wall above retained soil). A storm drain and catch basin should be constructed in the swale above the planned walls to provide an outlet for rainfall runoff and to catch eroded materials. Eroded materials will build up in the catch basin and regular maintenance should be performed to preserve the basin and drain functionality.

Retaining wall recommendations are presented in Leighton (2013b). The concrete pads for transformer and generator pads and the Central Plant may be established on 18-inches of engineered fill or directly on bedrock overlain by a sand leveling course of nominal thickness. From a geotechnical standpoint, we recommend that the slab-on-grade be a minimum of 5 inches thick with No. 3 rebars placed at the center of the slab at 24 inches on center in each direction. The structural engineer should design the actual thickness and reinforcement based on anticipated loading conditions.

Leighton should review the grading plans, shoring plans, foundation plans, and specifications when they are available to verify that the recommendations presented in this report have been properly interpreted and incorporated.



Project: 10296.001	Eng/Geol: CK/JAR
Scale: 1 " = 2,000 '	Date: February 2014

Base Map: ESRI Resource Center, 2012
Thematic Info: Leighton
Author: mmurphy (btran)

SITE LOCATION MAP

John Ansen Ford Theatre
2580 Cahuenga Boulevard East
Los Angeles, California

Figure 1

Leighton

Map Saved as V:\Drafting\10296\001\GIS\of_2013-07-11\Fig1-SiteLocMap603507.mxd on 7/15/2013 4:24:51 PM

APPENDIX A

APPENDIX A

References

Draft Baseline Site Plan Off Season 2, Scale 1"=40', prepared by Levin and Associates Architects, dated December 9, 2013

Draft Interim Site Plan Off Season 3 and 4, Scale 1"=40', prepared by Levin and Associates, dated December 9, 2013

Ford Theaters Master Plan Update Diagram, dated October 30, 2013

Leighton Consulting, Inc., 2013a, Preliminary Geotechnical Evaluation, John Anson Ford Theaters Master Plan, 2580 Cahuenga Boulevard East, Hollywood District of Los Angeles, California, dated February 7, 2013.

_____, 2013b, Geotechnical Exploration Report Off-Season Two Improvements, 2580 Cahuenga Boulevard East, Hollywood District of Los Angeles, California, dated September 10, 2013.

_____, 2013c, Addendum to Geotechnical Exploration Report Off-Season Two Improvements, John Anson Ford Theater 2580 Cahuenga Boulevard East, Hollywood District of Los Angeles, California, dated October 15, 2013.

_____, 2014, Addendum No. 2 to Geotechnical Exploration Report Response to Review Comments Off-Season Two Improvements John Anson Ford Theaters 2580 Cahuenga Boulevard East Hollywood District of Los Angeles, California, dated February 27, 2014

APPENDIX B

LEIGHTON

CORE BORING LOG

BORING NO. **RC-1**
PAGE 1 OF 2

PROJECT: **Ford Theatre**
CLIENT: **Ford Theatre Foundation**
CONTRACTOR: **Gregg Drilling**
EQUIPMENT USED: **CME-85**

GROUNDWATER:		DEPTH TO (Feet):			ORIENTATION		CORE BARREL	
DATE	HRS AFT COMP	WATER	BOT. OF CASING	BOT. OF HOLE	X	VERTICAL	TYPE	HQ3
						HORIZONTAL	SIZE	3+3/8
						INCLINED	Bit (Feet)	
						BEARING	Barrel (Feet)	5.0
					0	ANG. FROM VERT.	Total (Feet)	

JOB NO.: **10296.002**
PAGE NO.: **1 of 2**
ELEVATION: **602 Feet**
DATE START: **1/29/2014**
DATE FINISH: **1/29/2014**
DRILLER: **Gregg Drilling**
PREPARED BY: **EBP**
LOCATION: **See Plate 1: Revised Geologic Map**

ELEVATION & CORE DEPTH (Feet)	CORE DEPTH RANGE (Feet)	SAMPLE NUMBER	RECOVERY %	RQD	GRAPHIC LOG	FIELD CLASSIFICATION, REMARKS, AND LIMITATIONS
						The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.
602 0						@0': 3-inches Asphalt Concrete over 9-inches Aggregate Base
	1-3.5	Run 1	84	0		**Pillow Basalt: (Tvb)** @1': Dark gray, severely weathered, very hard, highly to intensely fractured. @1.7': Intensely fractured, appears mechanical. @1.9': Fracture: 60°, 0.2-inches wide, sandy clay infill. @2.0': Fracture: 70°, no infill. @3.0': Mechcanical break, pulverized.
597 5	3.5-7.5	Run 2	88	44		@3.5': Bluish gray, moderately weathered, very hard, highly fractured, many healed fractures to 2-inches, slight oxidation along joint and fracture surfaces, few fractures infilled with sandy clay, zeolite veining. @4.1': Joint: 10°, 0.1-inches wide, no fill, planar, rough. @4.6': Mechcanical break. @5.8': Joint: 10°, 0.1-inches wide, partial clay infill, wavy, rough.
592 10	7.5-12.5	Run 3	100	73		**Andesite Breccia: (Tvb)** @7.5': Dark olive green, fresh to slightly weathered along fractures, very hard, many tight fractures with calcite infill, fractures typically at 60°, 0-10°, highly fractured, aphanitic, dark pinkish gray basalt clasts, up to 3-inches, subrounded to angular, larger clasts tend to be elongated and rectangular, calcite infilling up to 1/2-inch and irregular. @10.6': Joint: 60°, 0.05-inches wide, partial clay infill, wavy, rough.
587 15	12.5-17.5	Run 4	100	82		@12.4': Mechcanical break. @12.5': Fresh. @17.2': Joint: 50°, 0.05-inches wide, biotite infill, planar, slightly rough.
582 20	17.5-22.5	Run 5	100	95		@20': Moderately fractured. @20.5': Joint: 30°, 0.05-inches wide, calcite infill, planar, slightly rough. @21.5': Mechcanical break.
	22.5-25	Run 6	100	97		@23.7': Mechcanical break. @24.8': Joint: 50°, 0.05-inches wide, partial calcite infill, planar, slightly rough.
577 25						

FIELD HARDNESS		BEDDING		ATTITUDE AND ANGLE	JOINTS / SHEAR / FRACTURE		WEATHERING
V. HARD	- KNIFE CAN'T SCRATCH	V. THIN	<2"	HORIZONTAL (0-5°)	V. CLOSE	<2"	FRESH
HARD	- SCRATCHES DIFFICULT	THIN	2"-12"	SHALLOW OR LOW ANGLE (5-35°)	CLOSE	2"-12"	V. SLIGHT
MOD. HARD	- SCRATCHES EASILY	MEDIUM	12"-36"	MODERATELY DIPPING (35-55°)	MOD. CLOSE	12"-36"	SLIGHT
SOFT	- GROVES	THICK	36"-120"	STEEP OR HIGH ANGLE (55-85°)	WIDE	36"-120"	MODERATE
V. SOFT	- CARVES	V. THICK	>120"	VERTICAL (85-90°)	V. WIDE	>120"	MOD. SEVERE
							V. SEVERE
					Fe = Iron Oxide	Mn = Manganese Oxide	COMPLETE

ROCKLOG2014 RC-1.GPJ ROCKLOG2012.GDT 2/25/14

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

LEIGHTON

CORE BORING LOG

BORING NO. **RC-1**
PAGE 2 OF 2

PROJECT: **Ford Theatre**
CLIENT: **Ford Theatre Foundation**
CONTRACTOR: **Gregg Drilling**
EQUIPMENT USED: **CME-85**

GROUNDWATER:		DEPTH TO (Feet):			ORIENTATION		CORE BARREL	
DATE	HRS AFT COMP	WATER	BOT. OF CASING	BOT. OF HOLE	X	VERTICAL	TYPE	HQ3
						HORIZONTAL	SIZE	3+3/8
						INCLINED	Bit (Feet)	
						BEARING	Barrel (Feet)	5.0
					0	ANG. FROM VERT.	Total (Feet)	

JOB NO.: **10296.002**
PAGE NO.: **2 of 2**
ELEVATION: **602 Feet**
DATE START: **1/29/2014**
DATE FINISH: **1/29/2014**
DRILLER: **Gregg Drilling**
PREPARED BY: **EBP**
LOCATION: **See Plate 1: Revised Geologic Map**

ELEVATION & CORE DEPTH (Feet)	CORE DEPTH RANGE (Feet)	SAMPLE NUMBER	RECOVERY %	RQD	GRAPHIC LOG	FIELD CLASSIFICATION, REMARKS, AND LIMITATIONS
						The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.
577 25	25-27.5	Run 6	100	97		**Andesite Breccia: (Tvb)** continued Dark olive green, fresh, very hard, many tight fractures with calcite infill, fractures typically at 60°, 0-10°, moderately fractured, aphanitic, dark pinkish gray basalt clasts, up to 3-inches, subrounded to angular, larger clasts tend to be elongated and rectangular, calcite infilling up to 1/2-inch and irregular. @25.3': Mechcanical break. @26.6': Mechcanical break. @27.5': Healed fractures with calcite up to 0.1-inches. @28.3': Joint: 50°, 0.05-inches wide, partial calcite infill, planar, slightly rough. @29.0': Mechcanical break. @29.6': Joint: 40°, 0.05-inches wide, calcite infill, planar, slightly rough.
572 30	27.5-32.5	Run 7	100	100		@30.8': Mechcanical break. @31.8': Joint: 50°, 0.05-inches wide, partial calcite infill, wavy, rough.
567 35	32.5-37.5	Run 8	100	100		@33.1': Mechcanical break. @34.0: Joint: 50°, 0.05-inches wide, partial calcite infill, planar, slightly rough. @34.9': Mechcanical break. @35.5': Joint: 50°, 0.05-inches wide, no infill, planar, rough. @36.2': Joint: 45°, 0.05-inches wide, partial calcite infill, planar, rough. @37.0': Mechcanical break.
562 40						Total Depth = 37.5 feet No groundwater was encountered during drilling Backfilled with bentonite chips to 1 foot below surface and capped with concrete on 1/28/14
557 45						
552 50						

FIELD HARDNESS		BEDDING		ATTITUDE AND ANGLE	JOINTS / SHEAR / FRACTURE		WEATHERING
V. HARD	- KNIFE CAN'T SCRATCH	V. THIN	<2"	HORIZONTAL (0-5°)	V. CLOSE	<2"	FRESH
HARD	- SCRATCHES DIFFICULT	THIN	2"-12"	SHALLOW OR LOW ANGLE (5-35°)	CLOSE	2"-12"	V. SLIGHT
MOD. HARD	- SCRATCHES EASILY	MEDIUM	12"-36"	MODERATELY DIPPING (35-55°)	MOD. CLOSE	12"-36"	SLIGHT
SOFT	- GROVES	THICK	36"-120"	STEEP OR HIGH ANGLE (55-85°)	WIDE	36"-120"	MODERATE
V. SOFT	- CARVES	V. THICK	>120"	VERTICAL (85-90°)	V. WIDE	>120"	MOD. SEVERE
							V. SEVERE
					Fe = Iron Oxide	Mn = Manganese Oxide	COMPLETE

ROCKLOG2014 RC-1.GPJ ROCKLOG2012.GDT 2/25/14

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

APPENDIX C

Leighton

17781 Cowan
Irvine, CA 92614
Tel. (949) 222-5321
Fax (949) 263-8843

Unconfined Compressive Strength ASTM 2938-95

Project Name:	Ford Theatre	Project No.:	10296.002
Sampled By:	E. Price	Sample Date:	2/3/2014

MATERIAL SAMPLE TYPE

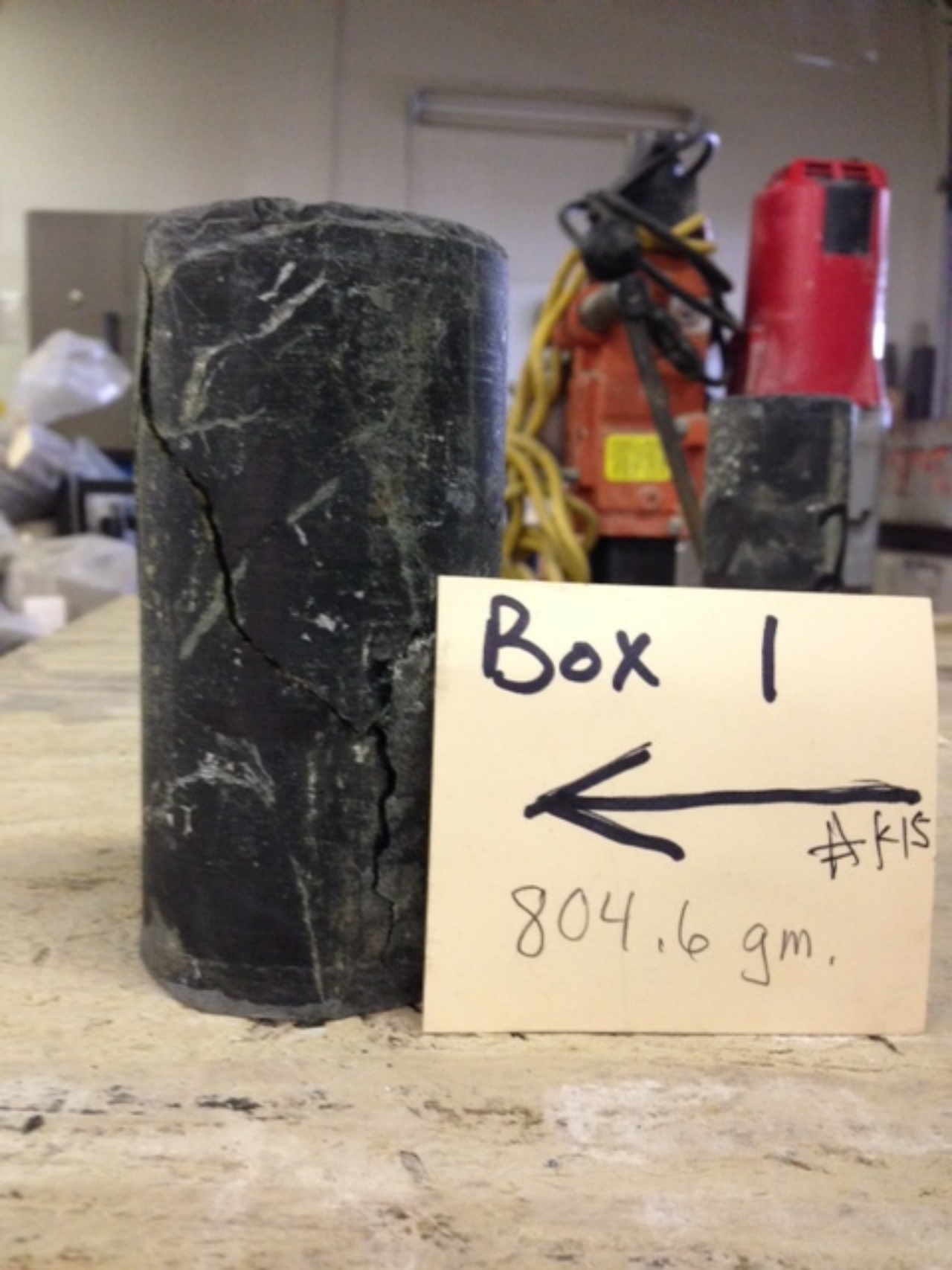
Rock **X** **Boring No. RC-1**

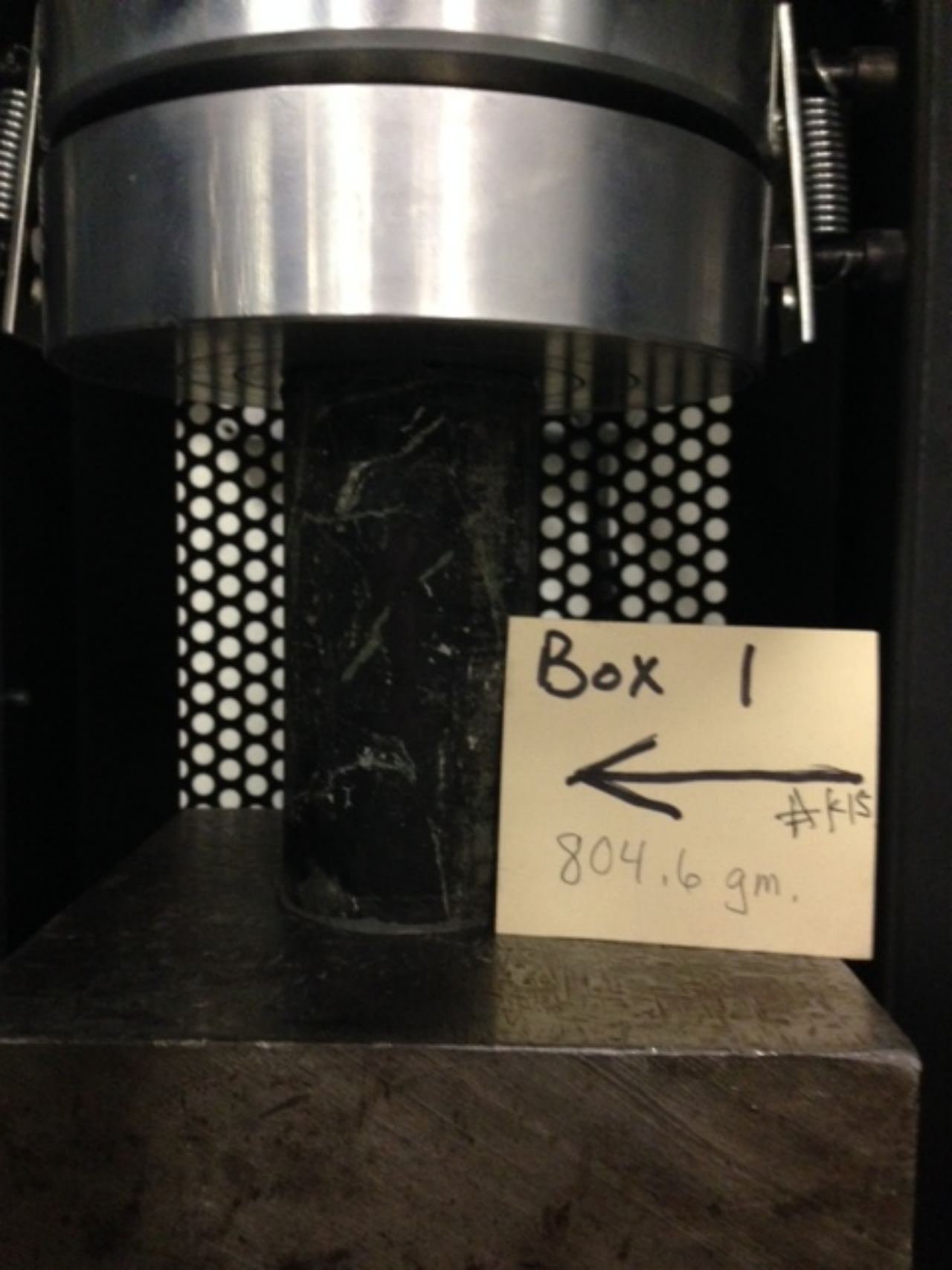
FOR LAB USE ONLY	**DATE RECEIVED:** 2/12/2014	**By:** A. Santos

Laboratory Test Data

Laboratory No.	Sample Wt. (g)	Test Date	Height (in)	Diam. (in)	Area (sq. in.)	Load (lbs.)	Compr. (psi)	H/D Ratio	Corr. Factor	Compr. (psi)	Failure Type
Box 1	804.6	02/20/14	4.74	2.40	4.52	11830	2620	1.98	1.00	2620	N/A
Box 2	832.7	02/20/14	4.73	2.40	4.52	25340	5610	1.97	1.00	5610	N/A
Box 3	842.8	02/20/14	4.71	2.40	4.52	39330	8700	1.96	1.00	8700	N/A
Box 4	880.3	02/20/14	4.80	2.40	4.52	38790	8580	2.00	1.00	8580	N/A
Box 5	796.9	02/20/14	4.70	2.40	4.52	4110	910	1.96	1.00	910	N/A

Notes: Samples were not machined at the ends; samples were capped with sulfur mortar


Box 1
#K15
804.6 gm.


Box 1
#K15
804.6 gm.

DRILL# RC-1

BOX# 1 1/28/14

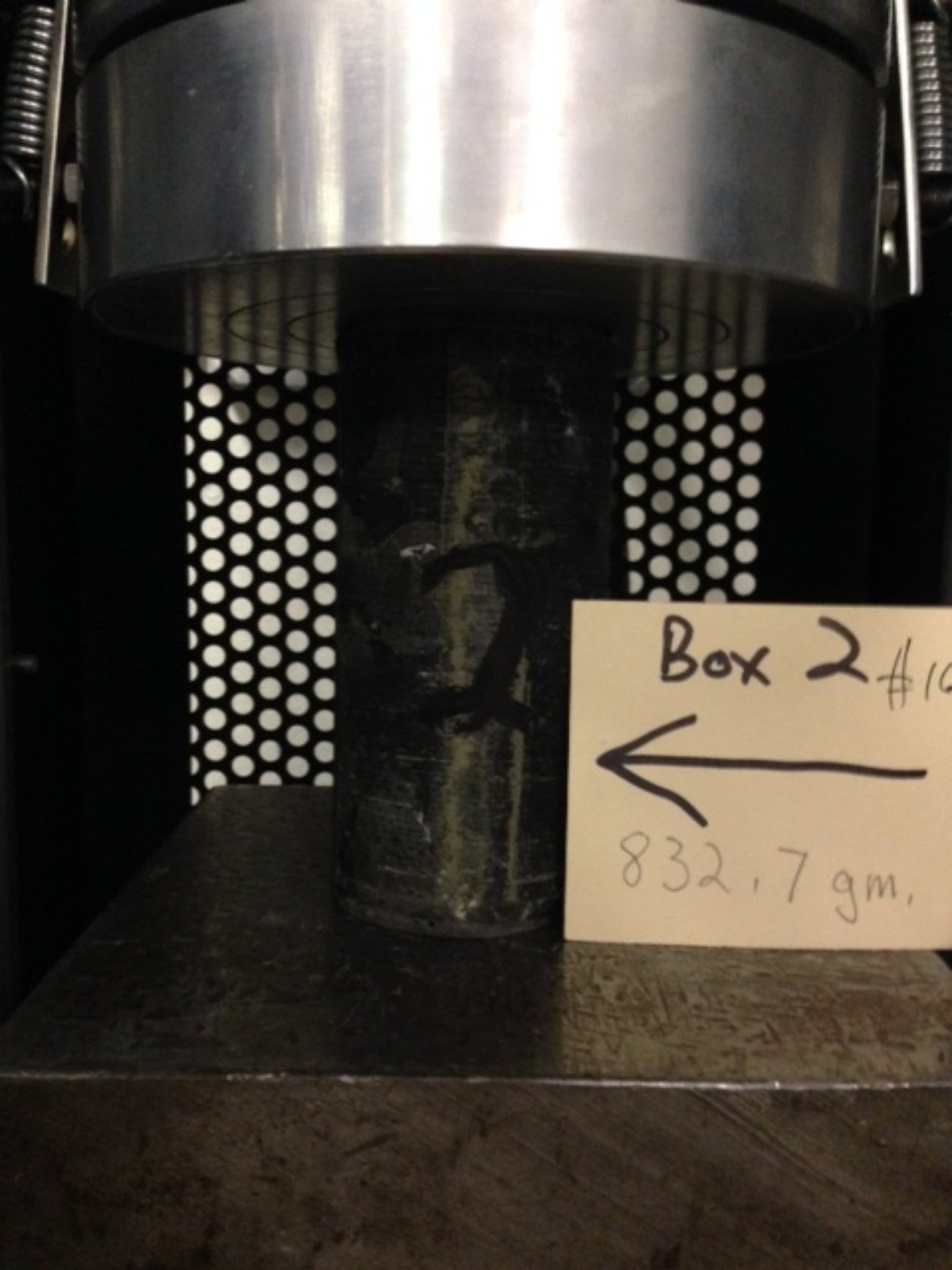
FROM: 1'

TO: 10.5

10296-002


R1
1'
R2
3.5
R2
7'
7'-R2→7.5
R3
7.5
Box 1
CONT→
R3 CONT. NEXT ROW
→
10.5


Box 2 #10
832.7 gm.


Box 2 #10
832.7 gm.

DRILL# RC-1

BOX# 2 1/28/14

FROM: 10.5

TO: 19.5

10296.002


Box 2


Box 3
#22
842.8 gm.


Box 3
842.8 gm.

DRILL# RC-1

BOX# 3 1/28/14

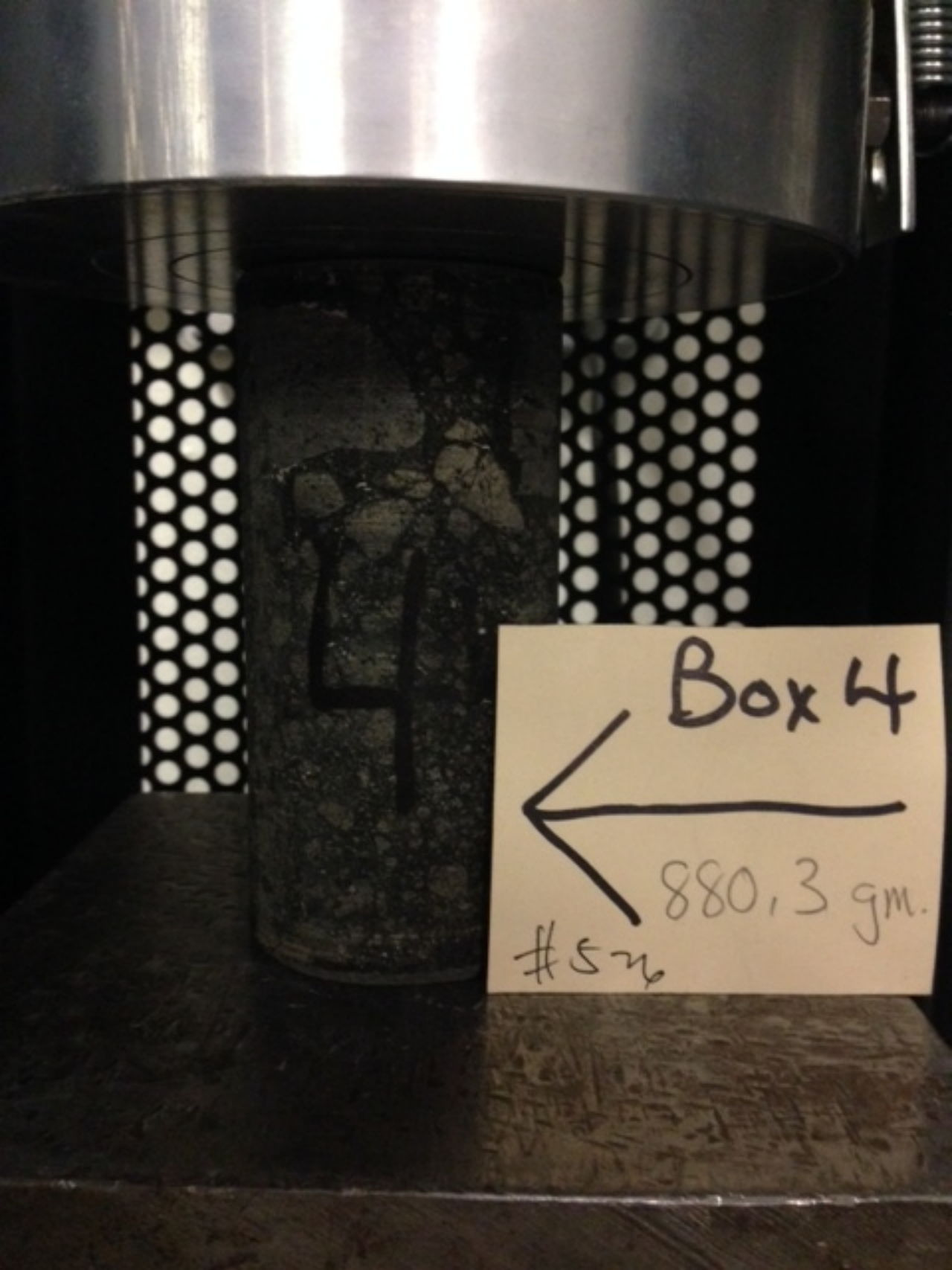
FROM: 19.5

TO: 26.5

10296-002


Box 3
R6
CONT→
R5


Box 4
880.3 gm.
#5


Box 4
880.3 gm.
#54

DRILL# RC-1

BOX# 4 1/28/14

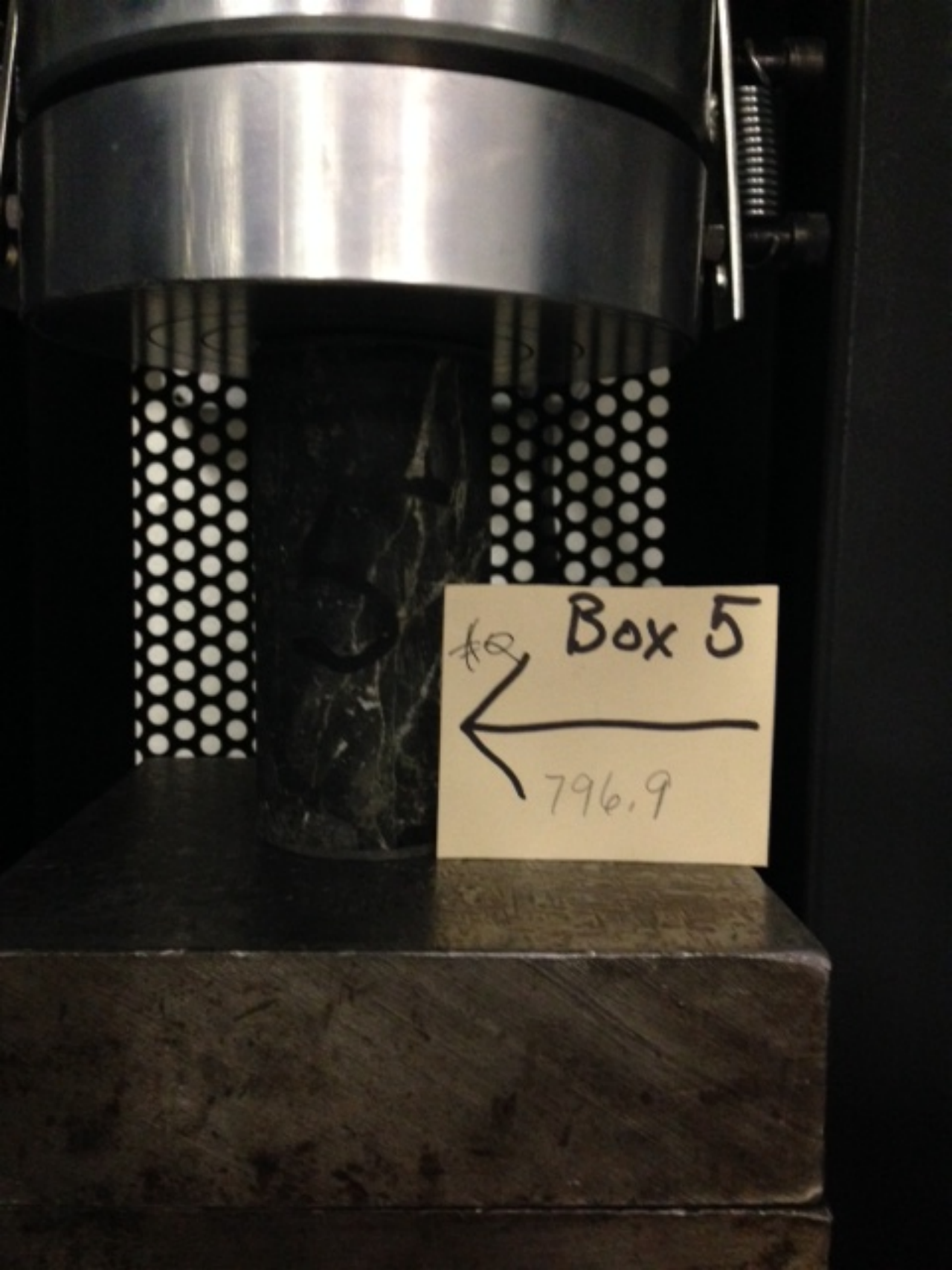
FROM: 19.5'

TO: 33.5'

10296.002


Box 4
PLUG NO. 8


Box 5
#9
796.9


Box 5
796.9

DRILL# RC-1

BOX# 5 1/28/14

FROM: 33.5

TO: 37.5

10296-002


Box 5
END

APPENDIX D

APPENDIX D

SLOPE STABILITY ANALYSIS

Global Stability

Slope stability analyses were performed for the cross sections shown on Plate 3. The locations of these cross sections are shown on Plate 1. The results of the analyses are presented at the rear of this appendix. The slope stability analyses were conducted using the computer program *SLIDE v6.008* (Rocscience, 2011). *SLIDE* performs stability calculations using two-dimensional (2D) limit equilibrium techniques based on vertical slice equilibrium.

Geologic Model

The geologic model used in the slope stability analyses is based on our geologic reconnaissance, results of our subsurface exploration, and review of pertinent information in the literature. In general, the slope stability models were constructed with stratigraphy identical to that shown on Plate 3.

Material Strength Parameters

The strength parameters used in our preliminary evaluation (Leighton, 2013a) were generally based on the parameters listed in the *Seismic Hazard Zone Report for the Hollywood 7.5-Minute Quadrangle, Los Angeles County, California* (CDMG, 1998). Our slope stability models for cross sections A-A' and B-B' were updated with the results of field exploration performed as part of the current study.

The Hoek-Brown failure criterion was selected as the appropriate approach to represent shear strength of the basalt (T_{vb}) rock mass at the project site. The basalt exhibited non-persistent (apparently random) jointing. Its structure varied widely form generally massive to blocky. Shearing would involve both intact rock and joints. Postulated failure planes would most likely follow step paths.

Considering that the individual blocks within the basalt rock mass are much smaller than the slope, the Hoek-Brown rock mass model provides a reasonable methodology to analyze step-path failure as an equivalent failure through a heavily-jointed isotropic rock mass. The incorporation of an appropriate Geological Strength Index (GSI) of the rock mass model provides a rational methodology to account for the impact of sheared

zones at faults. For this study, a GSI of 33 (seamy structure with fair to poor surface conditions) was conservatively assigned to the basalt. The computer program RocLab v1.031 (Rocscience, Inc., 2007) was used to develop Mohr-Coulomb parameters for slope stability analysis based on the Hoek-Brown criterion. An intact uniaxial compressive strength of 130 kips per square foot (ksf) was used based on the weakest sample tested in the laboratory. The resulting shear strength parameters are shown in Table D1 below.

Similarly, the cross-bedding strength of the Topanga formation sandstone/shale was estimated used the Hoek-Brown failure criterion. An intact uniaxial compressive strength of 130 ksf was used with a GSI of 40 (seamy structure with good to fair surface conditions). The along-bedding strengths were adopted from CDMG (1998). The resulting shear strength parameters are shown in Table C1 below.

The strength parameters for the other subsurface materials modeled in our slope stability analyses were generally consistent CDMG (1998).

Table C1: Shear Strength Parameters for Slope Stability Analysis

Material Description	Cross Bedding		Along Bedding	
	c′ (psf*)	ø′ (degrees)	c′ psf	ø′ (degrees)
Artificial Fill - A_f (Static)	255	30	Isotropic	
(Pseudostatic)				
Colluvium/Slope Wash (Static)	400	14	Isotropic	
(Pseudostatic)				
Tertiary Volcanic Rocks - T_{vb} (Static)	4,000	38	Isotropic	
(Pseudostatic)				
Topanga Formation Bedrock - T_t (Static)	5,000	40	350	28
(Pseudostatic)				

*pounds per square foot

Stability Analysis Methodology

The search techniques for circular and block slip surfaces programmed into the software was used for the analyses. The Factor of Safety (FOS) of each surface was computed using Spencer's method of slices for limit equilibrium. The above analyses were conducting for both static and pseudostatic scenarios; the pseudostatic analyses were computed using a coefficient of horizontal acceleration (k_h) of 0.15.

Results of Analyses

The results of the analyses (program output files) are included in the rear of this appendix. The results are organized by cross section and present the results of the static analyses followed by the pseudostatic analyses.

Conclusions

The results of the stability analyses provided in this report indicate the proposed grading for the project will provide sufficient stability of the proposed improvements and the surrounding hillside. With the anticipated support provided by recommended retaining structures, the factor of safety for each scenario was calculated to be over 1.5 and 1.1 for static and pseudostatic conditions, respectively.

Section A

Global Stability

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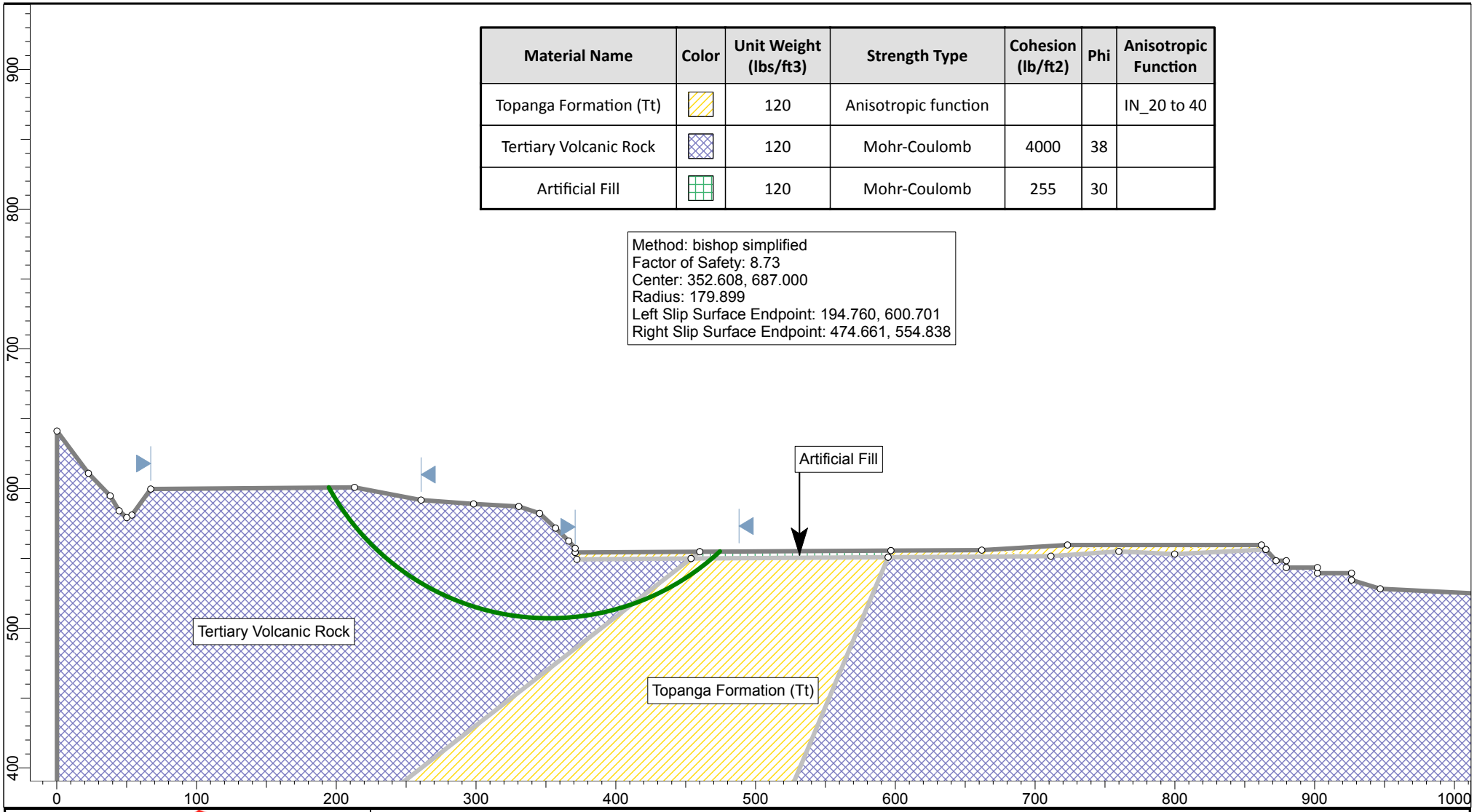
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			IN_20 to 40
Tertiary Volcanic Rock		120	Mohr-Coulomb	4000	38	
Artificial Fill		120	Mohr-Coulomb	255	30	

Method: bishop simplified
Factor of Safety: 8.73
Center: 352.608, 687.000
Radius: 179.899
Left Slip Surface Endpoint: 194.760, 600.701
Right Slip Surface Endpoint: 474.661, 554.838



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	Ford Theatre		
Analyzed By SP	*Units* feet	*Scale* 1:1200	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section A

Global Stability

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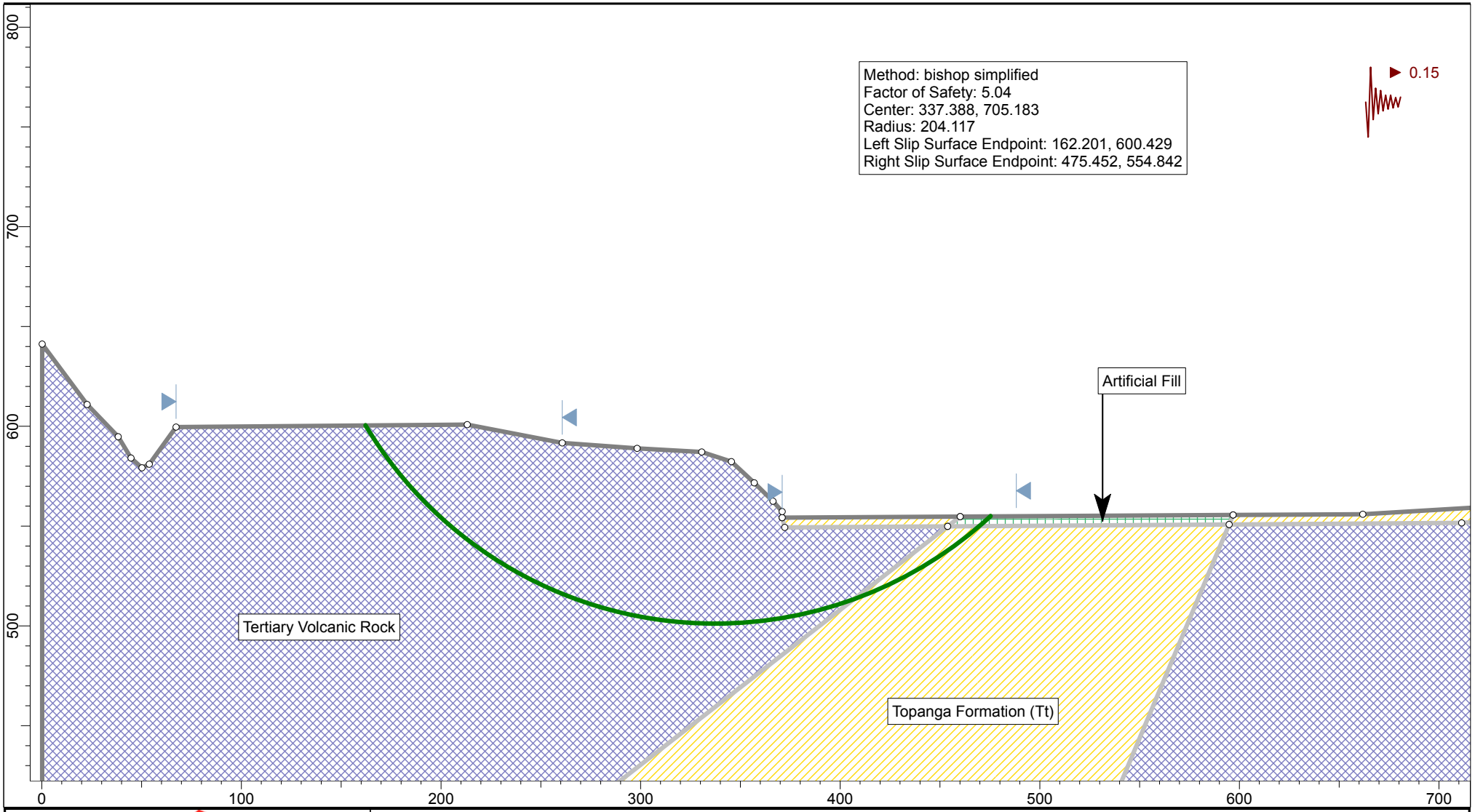


SLIDEINTERPRET 6.008	*Project*	Ford Theatre		
Leighton Consulting, Inc. A LEIGHTON GROUP COMPANY	*Analyzed By* SP	*Units* feet	*Scale* 1:840	*Project No.:* **10296.002**
	Date 2/28/2014	*Condition* Pseudostatic		

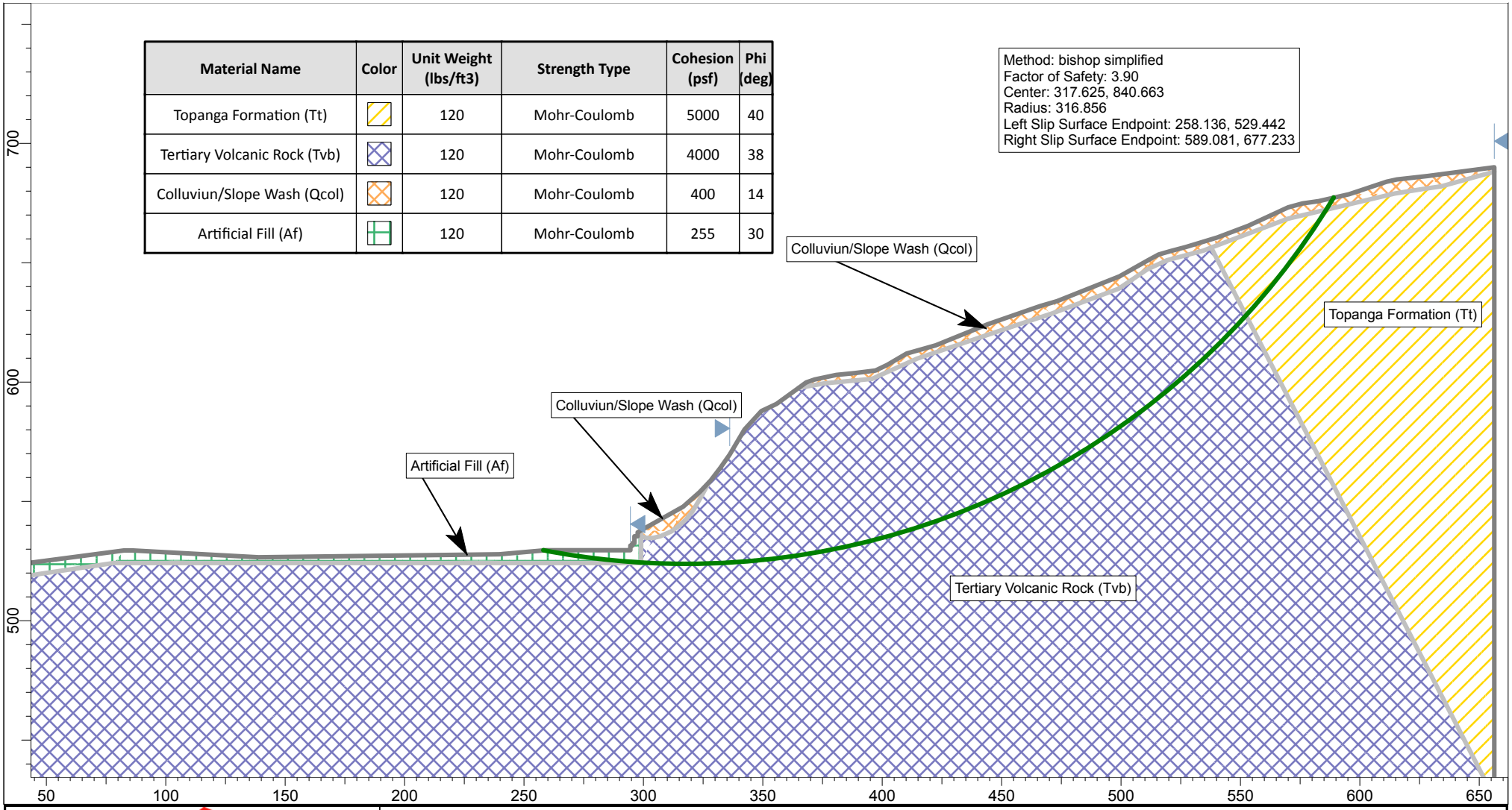
Section B

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section B\Section B_Static.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Topanga Formation (Tt)		120	Mohr-Coulomb	5000	40
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Colluviun/Slope Wash (Qcol)		120	Mohr-Coulomb	400	14
Artificial Fill (Af)		120	Mohr-Coulomb	255	30

Method: bishop simplified
Factor of Safety: 3.90
Center: 317.625, 840.663
Radius: 316.856
Left Slip Surface Endpoint: 258.136, 529.442
Right Slip Surface Endpoint: 589.081, 677.233



SLIDEINTERPRET 6.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	**Ford Theatre**		
Analyzed By SP / CD	*Units* feet	*Scale* 1:720	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section B

Global Stability

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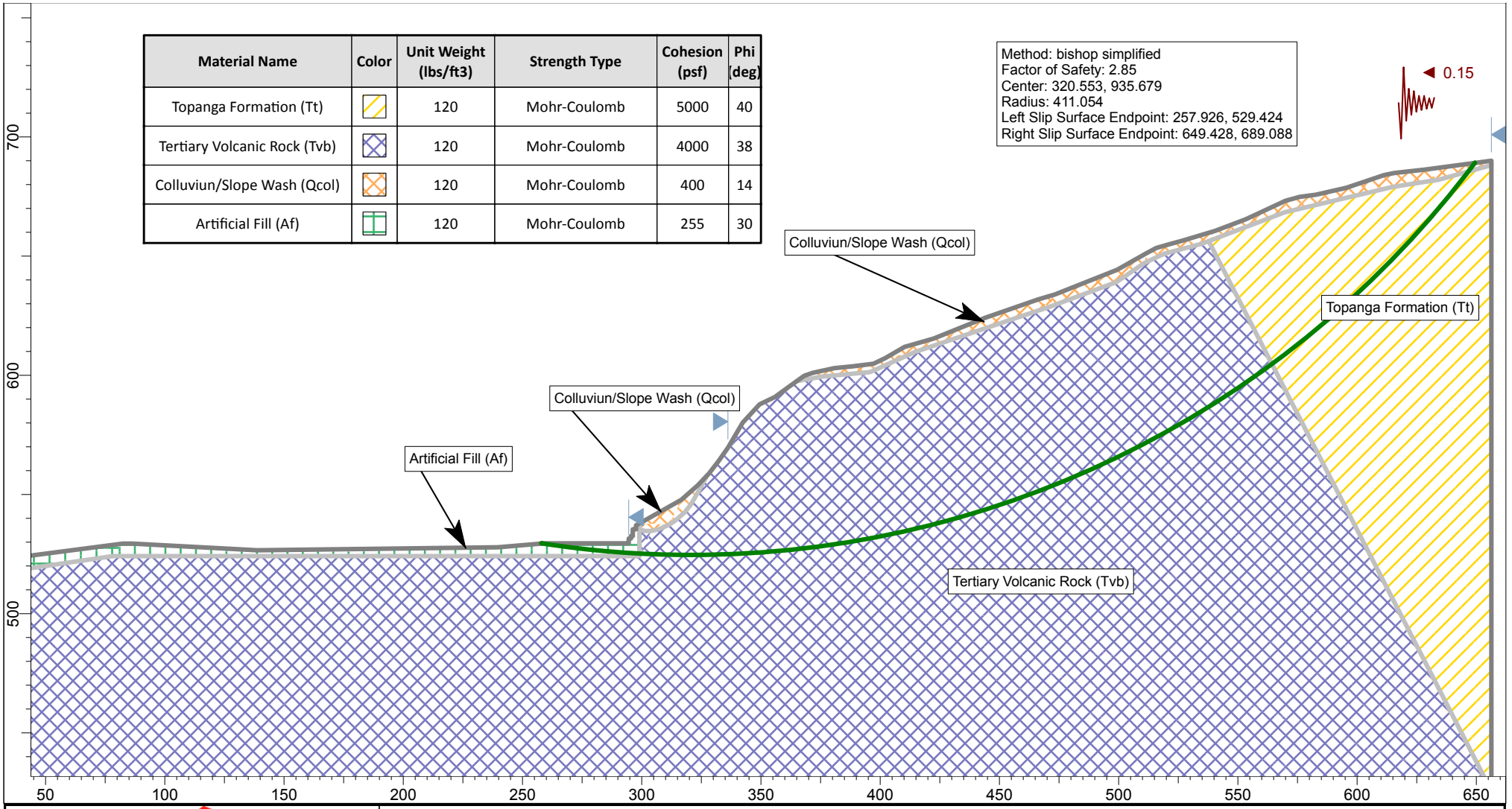
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Topanga Formation (Tt)		120	Mohr-Coulomb	5000	40
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Colluviun/Slope Wash (Qcol)		120	Mohr-Coulomb	400	14
Artificial Fill (Af)		120	Mohr-Coulomb	255	30



SLIDEINTERPRET 6.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	**Ford Theatre**		
Analyzed By SP / CD	*Units* feet	*Scale* 1:720	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Pseudostatic		

Section C

Global Stability

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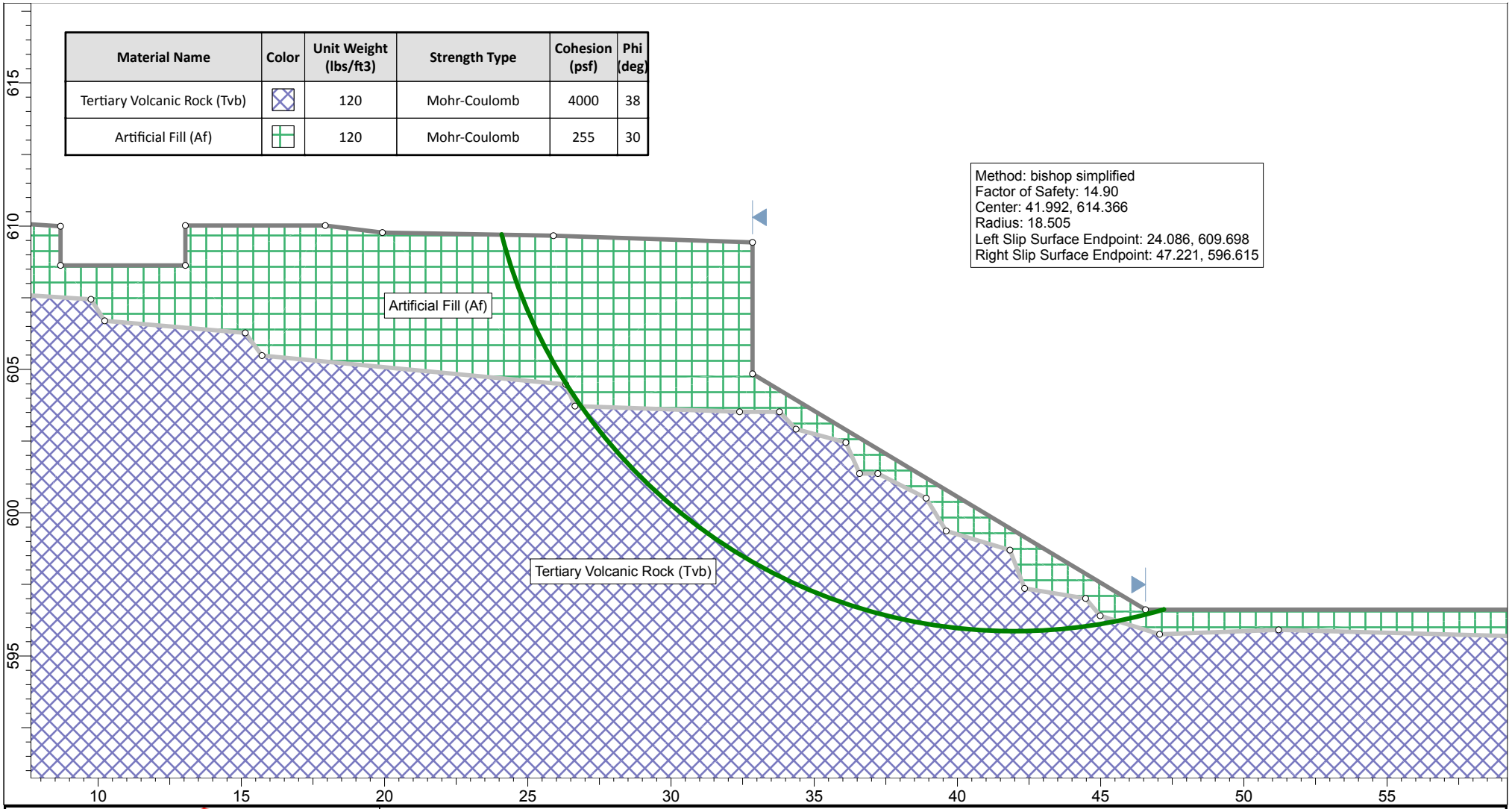
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Artificial Fill (Af)		120	Mohr-Coulomb	255	30



SLIDEINTERPRET 6.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	**Ford Theatre**		
Analyzed By SP/CD	*Units* feet	*Scale* 1:60	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section C

Global Stability

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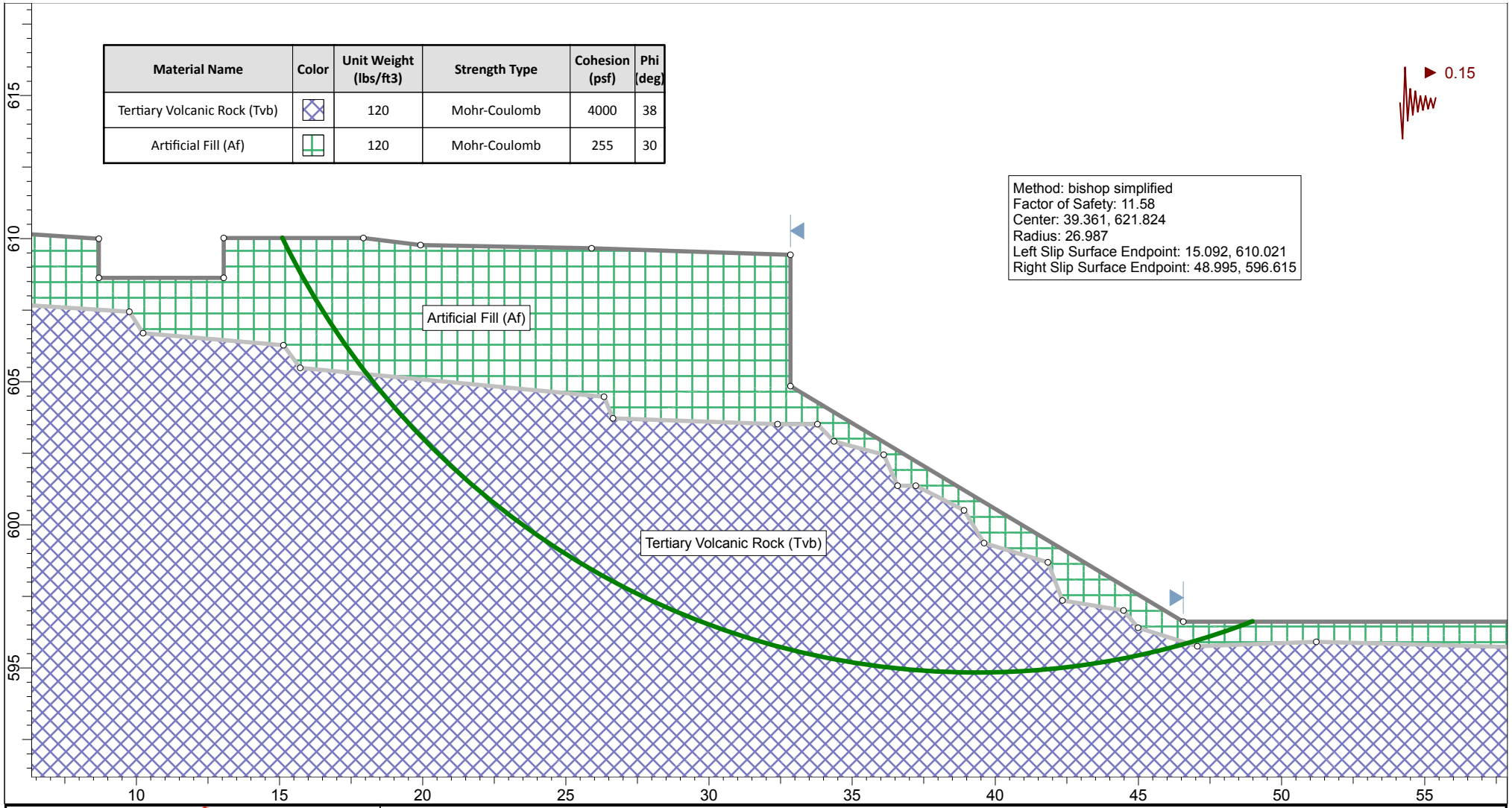
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Artificial Fill (Af)		120	Mohr-Coulomb	255	30



SLIDEINTERPRET 6.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	**Ford Theatre**		
Analyzed By SP/CD	*Units* feet	*Scale* 1:60	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Pseudostatic		

Section D

Global Stability

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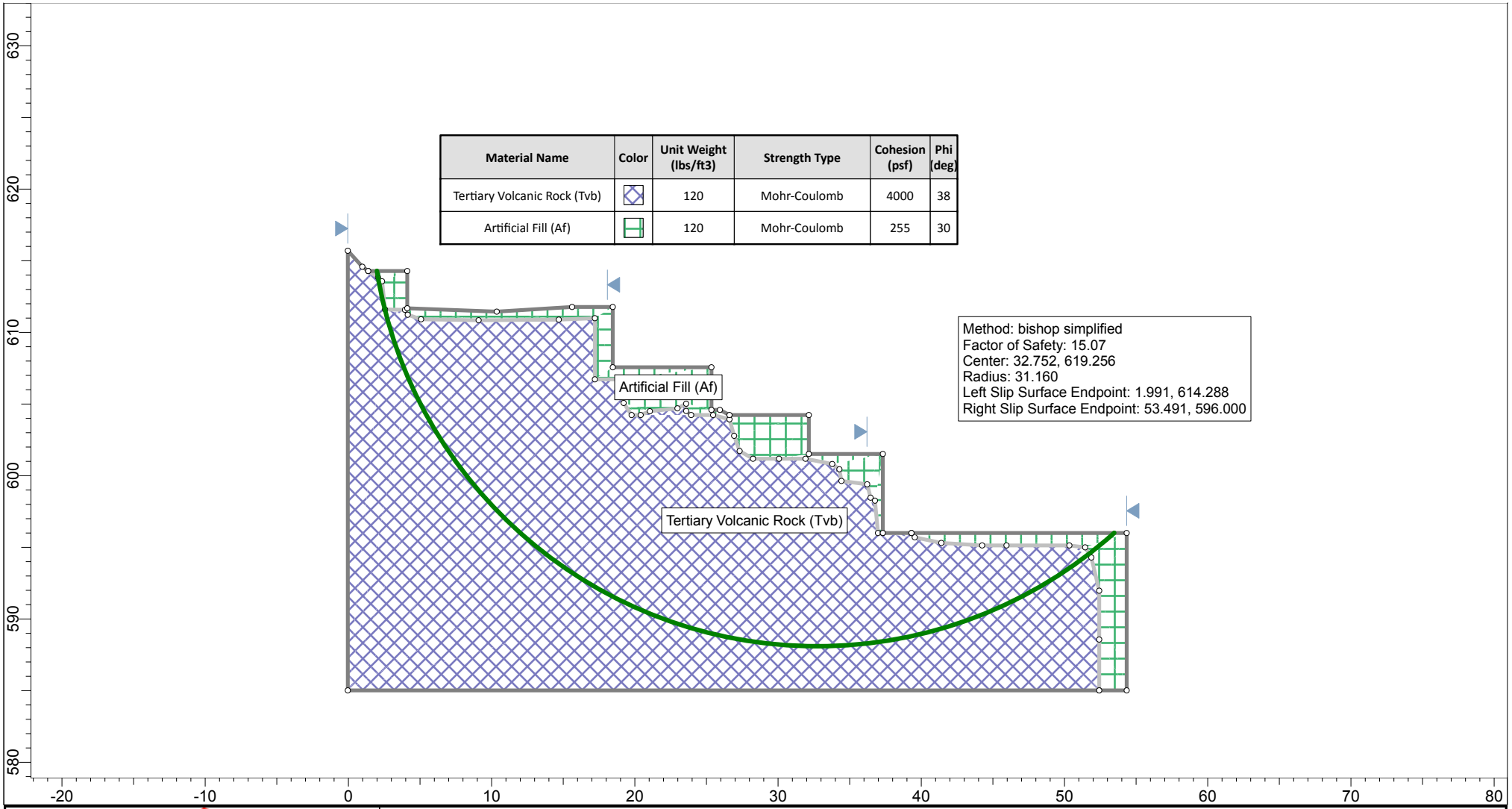
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Artificial Fill (Af)		120	Mohr-Coulomb	255	30



SLIDEINTERPRET 6.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	**Ford Theatre**		
Analyzed By SP/CD	*Units* feet	*Scale* 1:120	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section D

Global Stability

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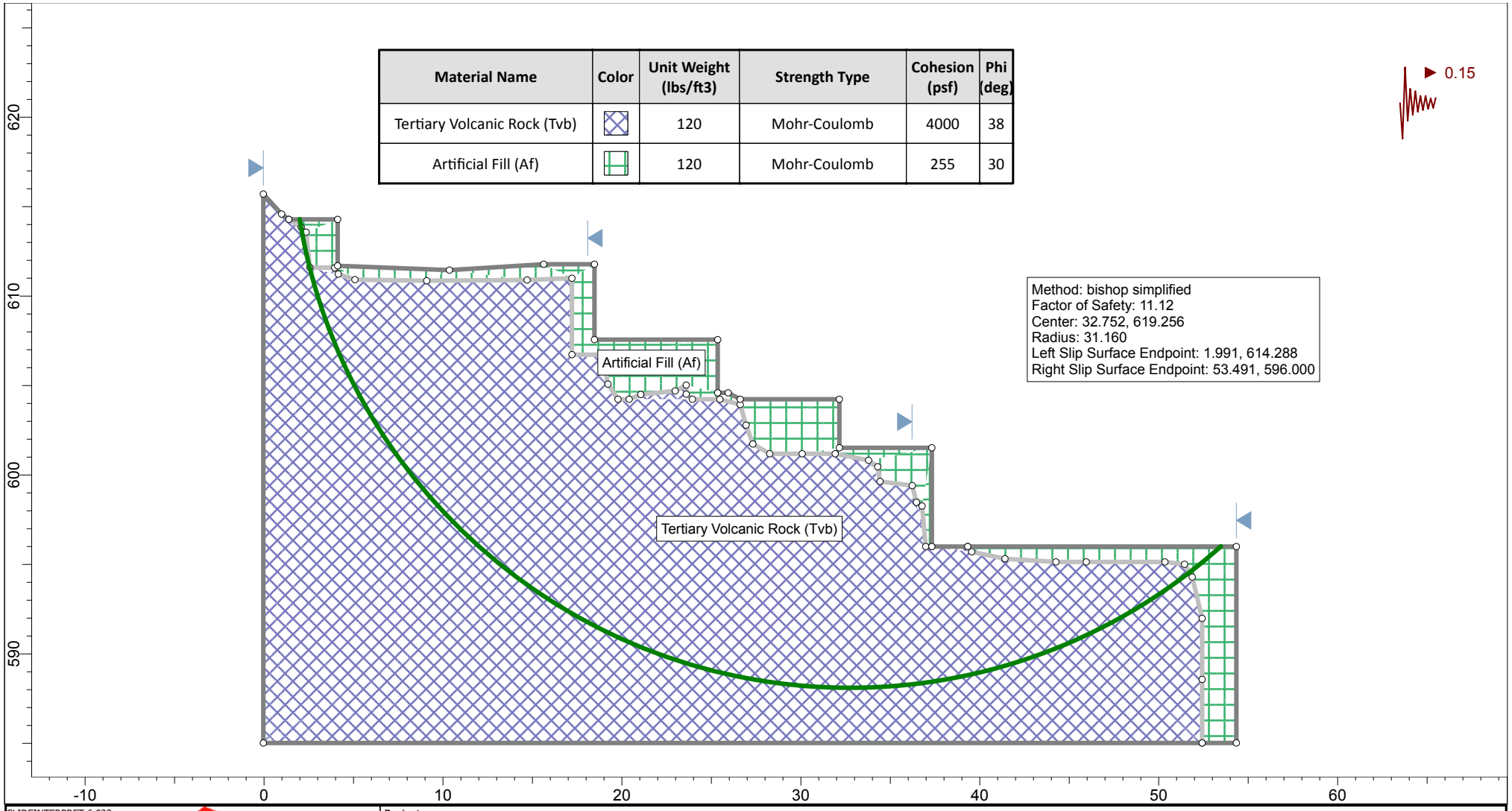
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Artificial Fill (Af)		120	Mohr-Coulomb	255	30



SLIDEINTERPRET 6.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	**Ford Theatre**		
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Date 2/28/2014	*Condition* Pseudostatic		

Section E

Global Stability

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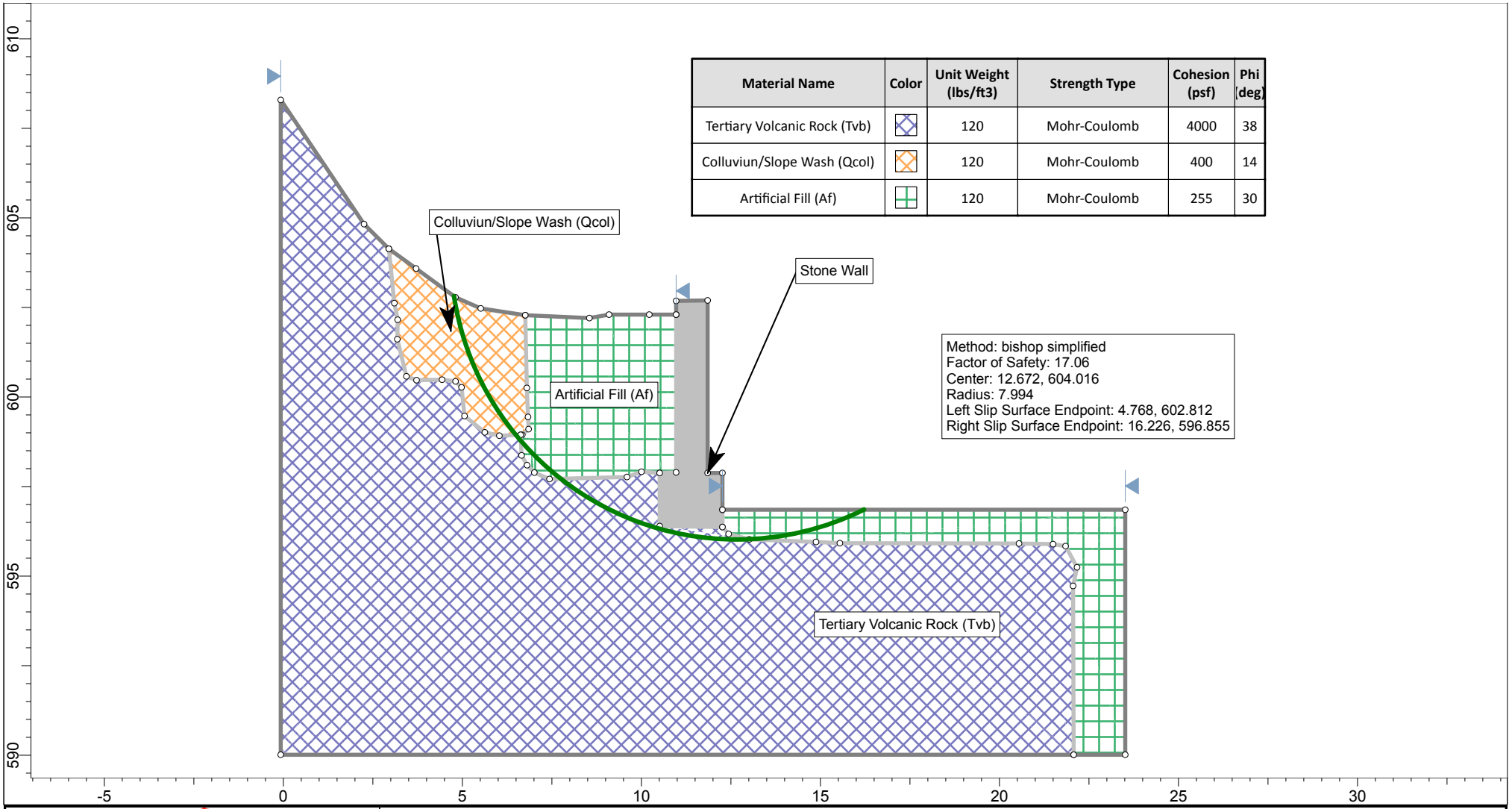


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Colluviun/Slope Wash (Qcol)		120	Mohr-Coulomb	400	14
Artificial Fill (Af)		120	Mohr-Coulomb	255	30

SLIDEINTERPRET 6.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

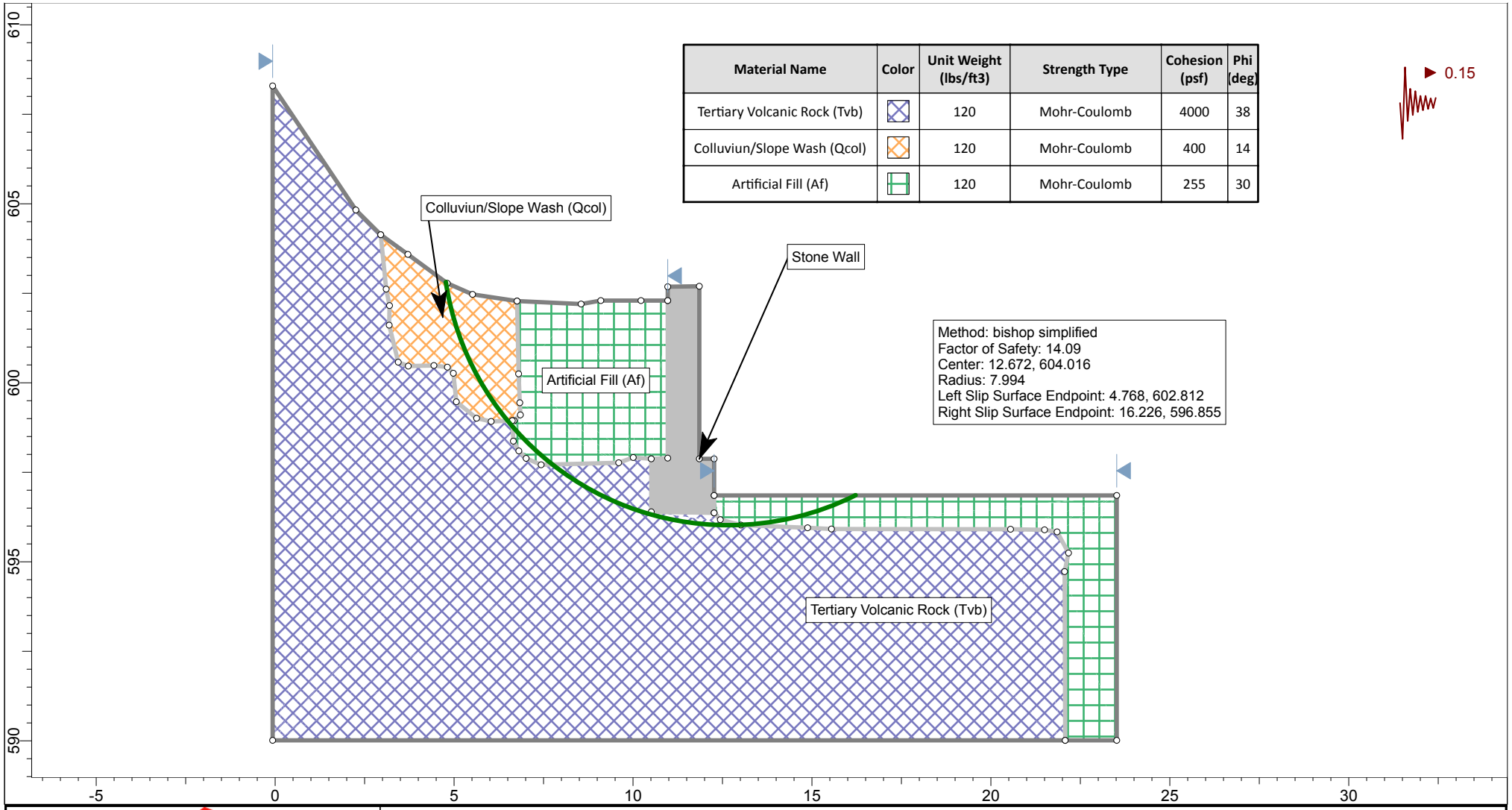
Project	**Ford Theatre**		
Analyzed By SP/CD	*Units* feet	*Scale* 1:48	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section E

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section E\Section E_P-Static.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Colluviun/Slope Wash (Qcol)		120	Mohr-Coulomb	400	14
Artificial Fill (Af)		120	Mohr-Coulomb	255	30



SLIDEINTERPRET 6.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	**Ford Theatre**		
Analyzed By SP/CD	*Units* feet	*Scale* 1:48	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Pseudostatic		

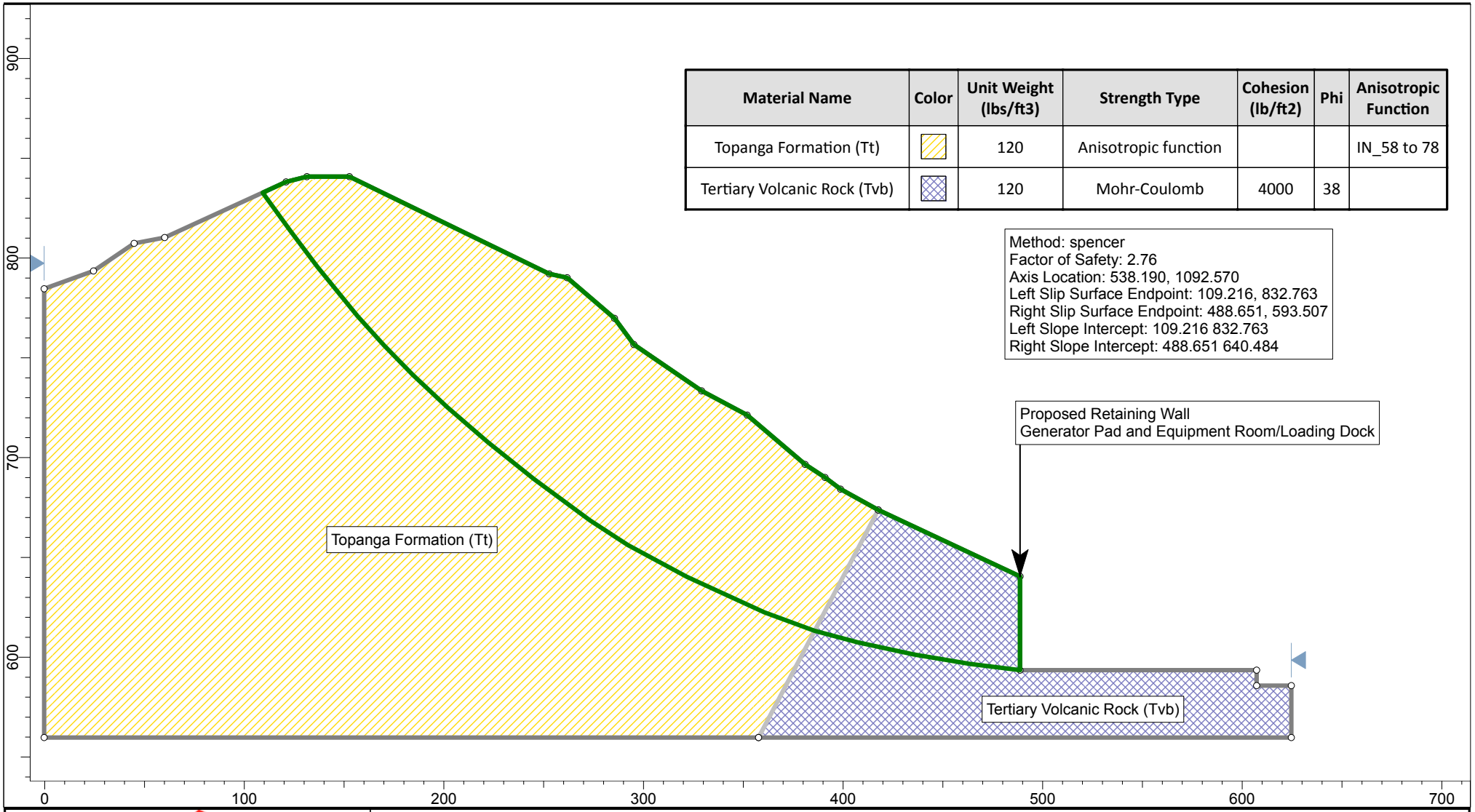
Section F

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section F\Section F_Static_path.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			IN_58 to 78
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38	

Method: spencer
Factor of Safety: 2.76
Axis Location: 538.190, 1092.570
Left Slip Surface Endpoint: 109.216, 832.763
Right Slip Surface Endpoint: 488.651, 593.507
Left Slope Intercept: 109.216 832.763
Right Slope Intercept: 488.651 640.484



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

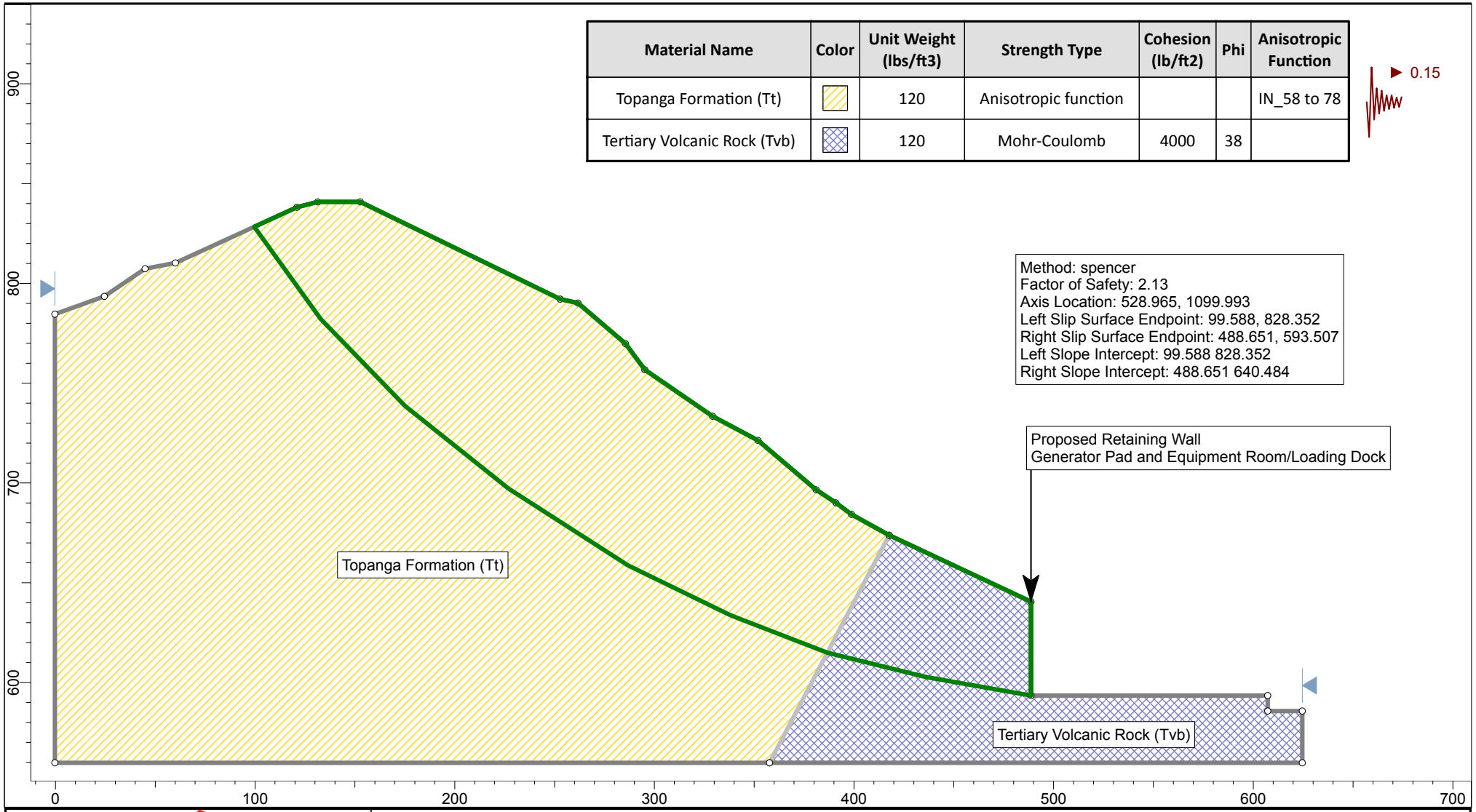
Project: Ford Theatre			
Analyzed By: Sreekar Pulijala	Units: feet	Scale: 1:840	Project No.: 10296.002
Date: 2/28/2014	Condition: Static		

Section F

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section F\Section F_Static_path_PS.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			IN_58 to 78
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38	



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

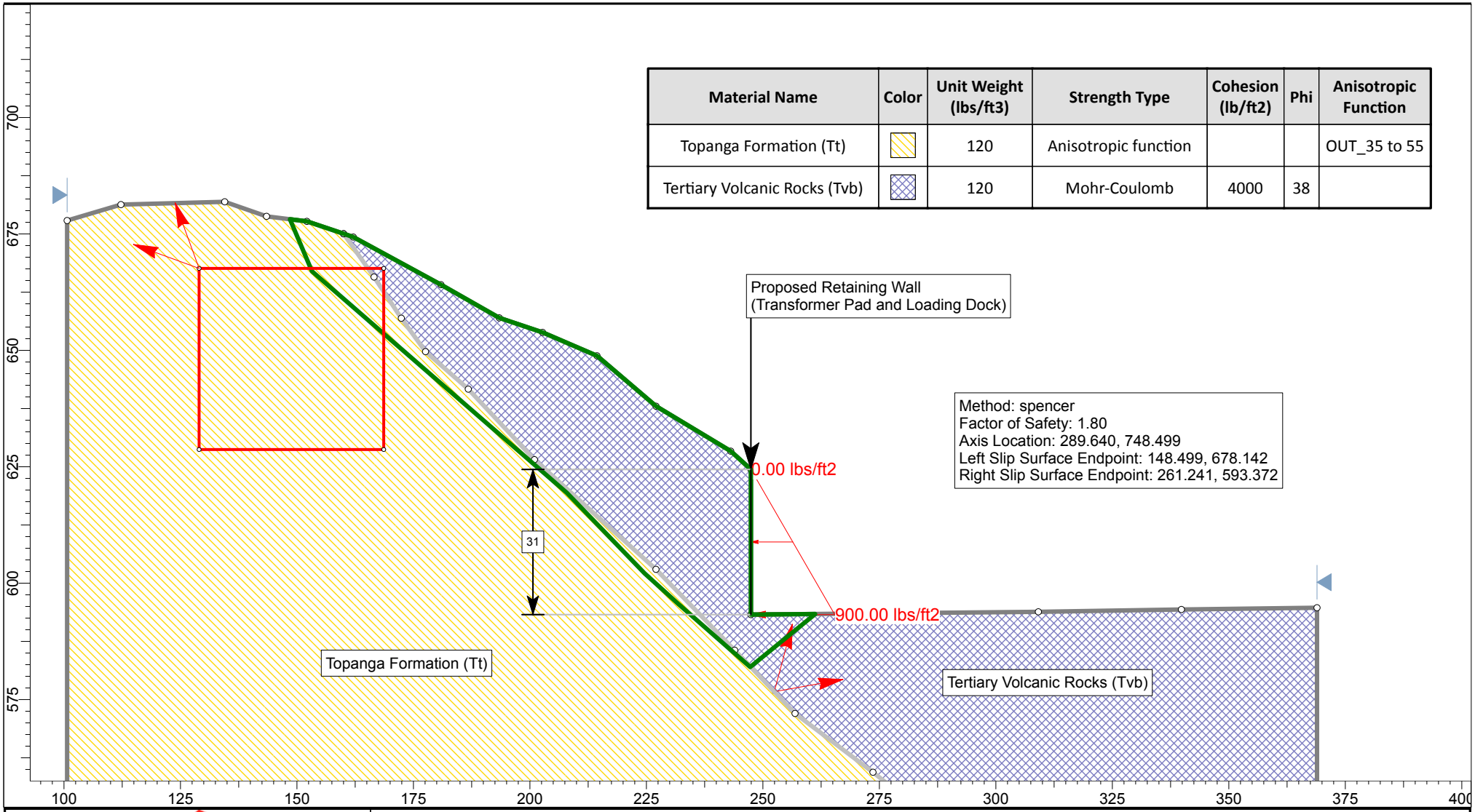
Project: Ford Theatre			
Analyzed By: Sreekar Pulijala	Units: feet	Scale: 1:840	Project No.: 10296.002
Date: 2/28/2014	Condition: Pseudostatic		

Section G

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section G\Section G Static_block.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			OUT_35 to 55
Tertiary Volcanic Rocks (Tvb)		120	Mohr-Coulomb	4000	38	



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

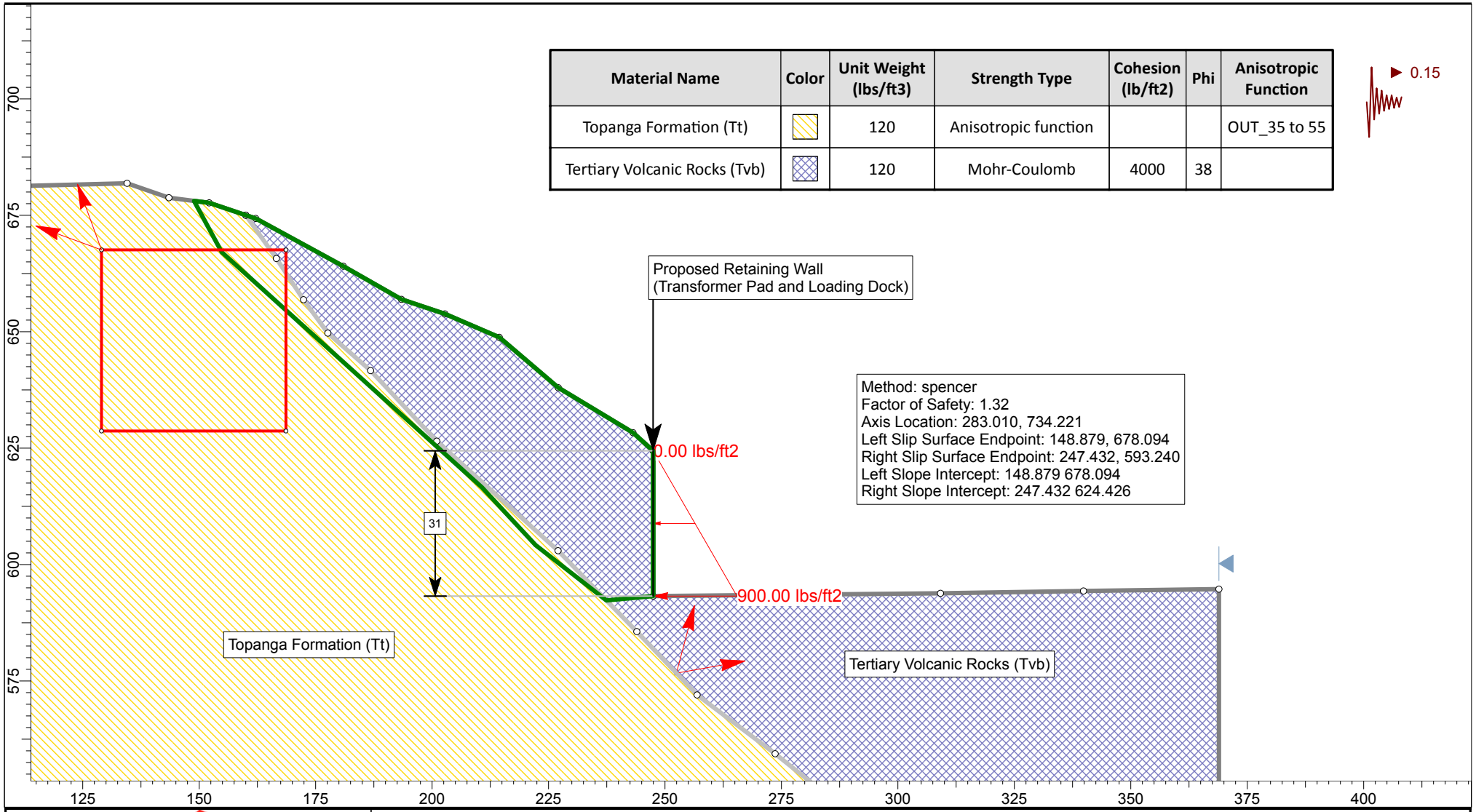
Project	Ford Theatre		
Analyzed By Sreekar Pulijala	*Units* feet	*Scale* 1:360	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section G

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section G\Section G Static_block_PS.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			OUT_35 to 55
Tertiary Volcanic Rocks (Tvb)		120	Mohr-Coulomb	4000	38	



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

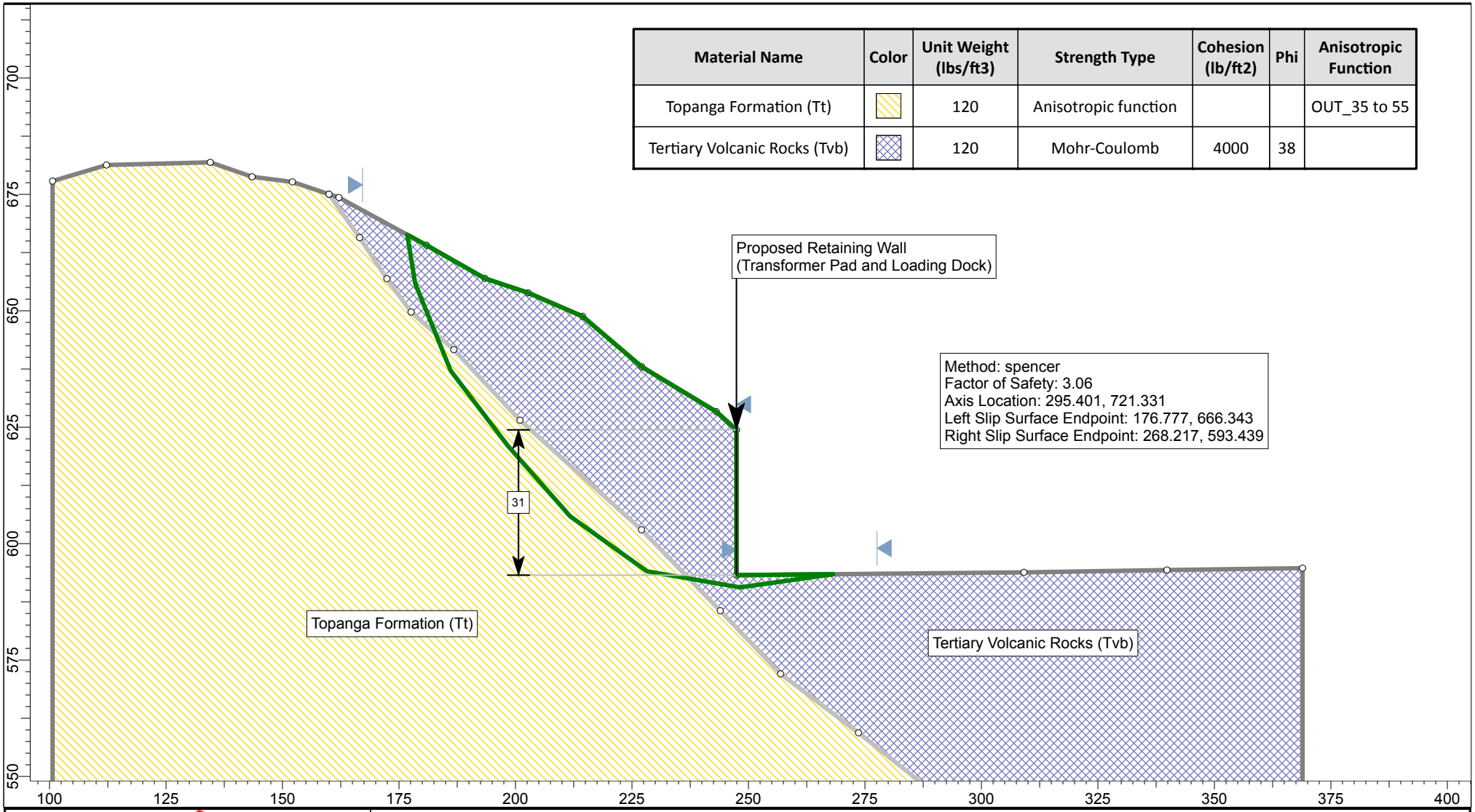
Project: Ford Theatre			
Analyzed By: Sreekar Pulijala	Units: feet	Scale: 1:360	Project No.: 10296.002
Date: 2/28/2014	Condition: Pseudostatic		

Section G

Local Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section G\Section G Static_block_local.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			OUT_35 to 55
Tertiary Volcanic Rocks (Tvb)		120	Mohr-Coulomb	4000	38	



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

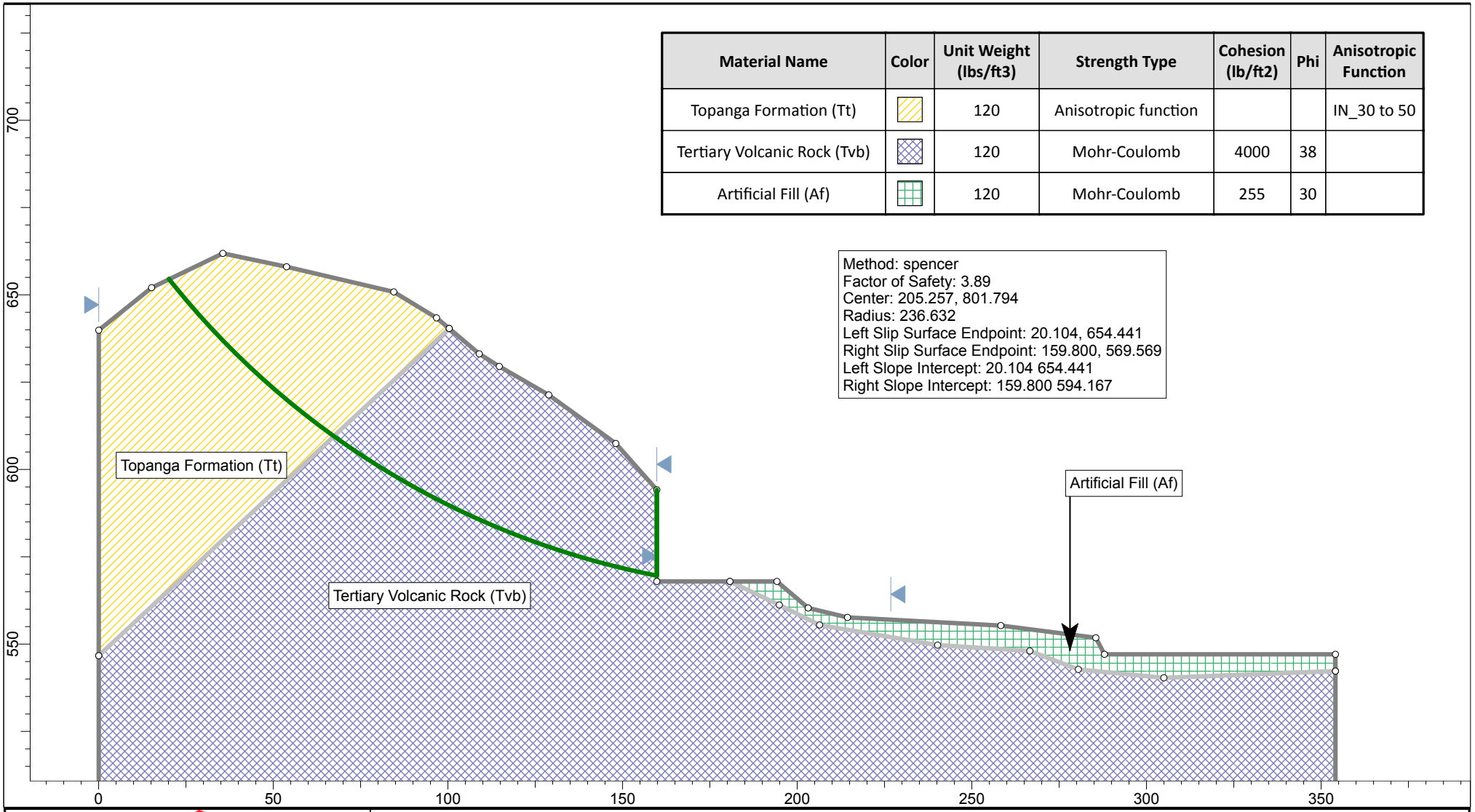
Project	Ford Theatre		
Analyzed By Sreekar Pulijala	*Units* feet	*Scale* 1:360	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section H

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section H\Section H_Static_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			IN_30 to 50
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38	
Artificial Fill (Af)		120	Mohr-Coulomb	255	30	



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	Ford Theatre		
Analyzed By SP	*Units* feet	*Scale* 1:480	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section H

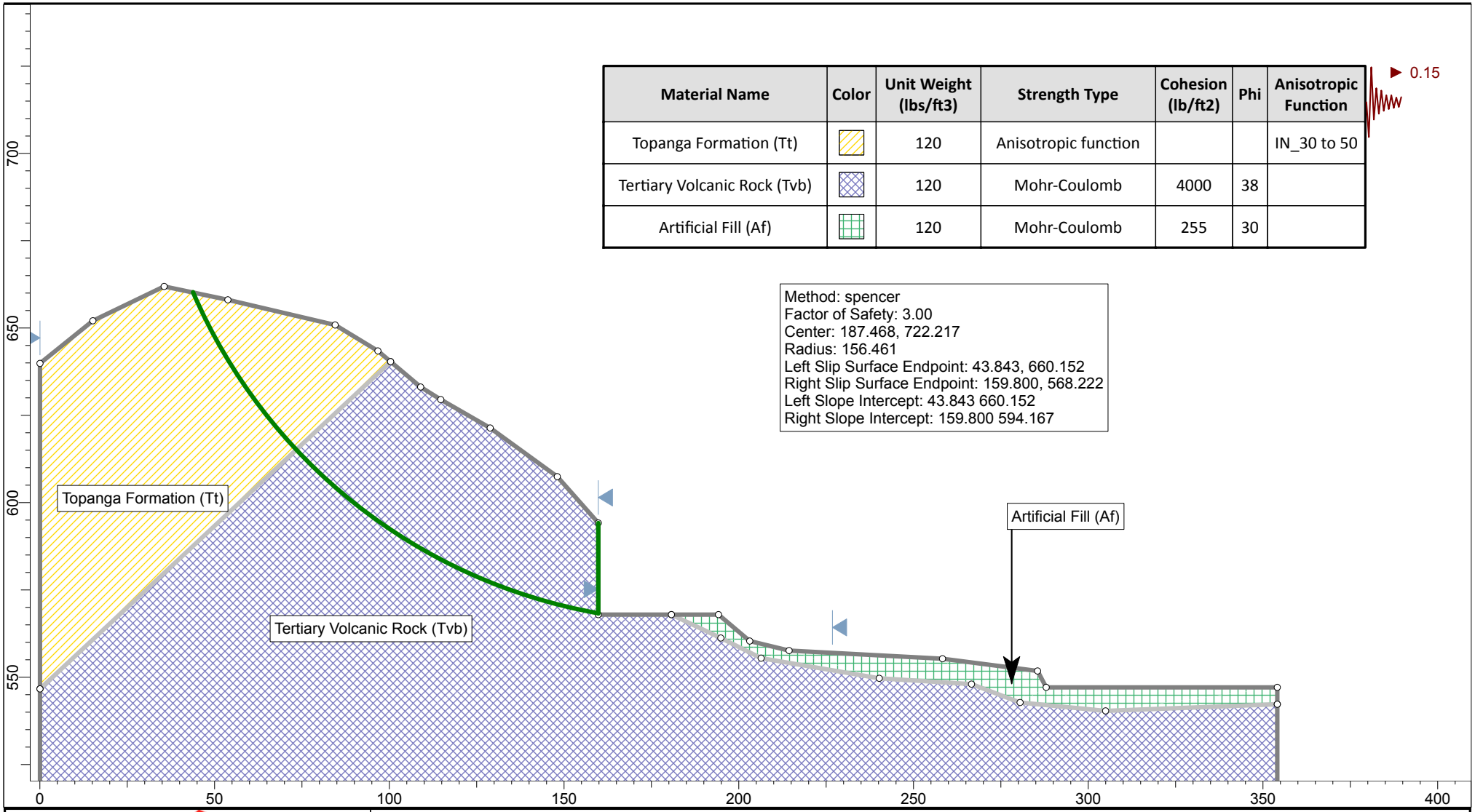
Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section H\Section H_Static_Circular_PS.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			IN_30 to 50
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38	
Artificial Fill (Af)		120	Mohr-Coulomb	255	30	

0.15

Method: spencer
Factor of Safety: 3.00
Center: 187.468, 722.217
Radius: 156.461
Left Slip Surface Endpoint: 43.843, 660.152
Right Slip Surface Endpoint: 159.800, 568.222
Left Slope Intercept: 43.843 660.152
Right Slope Intercept: 159.800 594.167



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

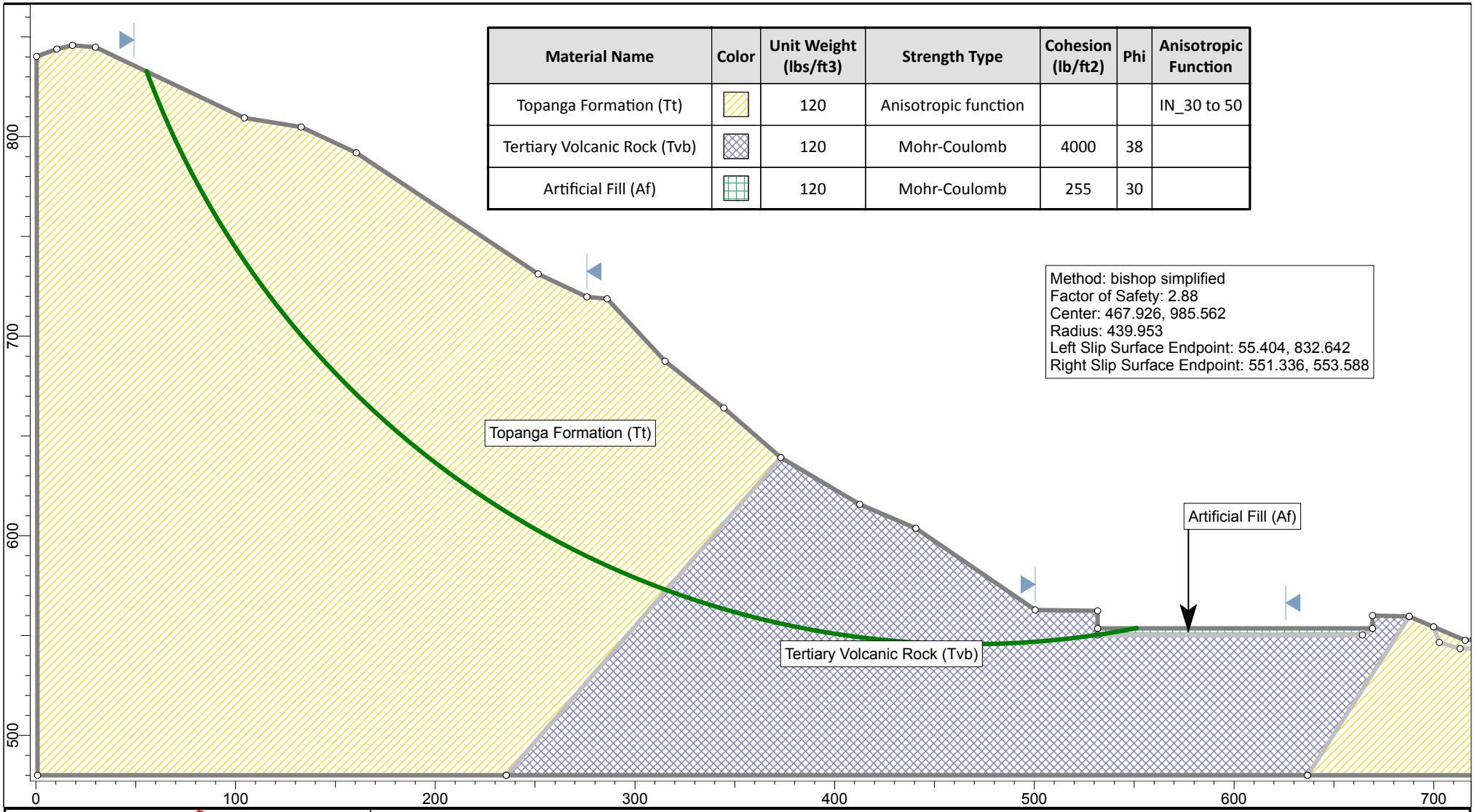
Project: Ford Theatre			
Analyzed By: SP	Units: feet	Scale: 1:480	Project No.: 10296.002
Date: 2/28/2014	Condition: Pseudostatic		

Section I

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section I\Section I_Static.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			IN_30 to 50
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38	
Artificial Fill (Af)		120	Mohr-Coulomb	255	30	



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

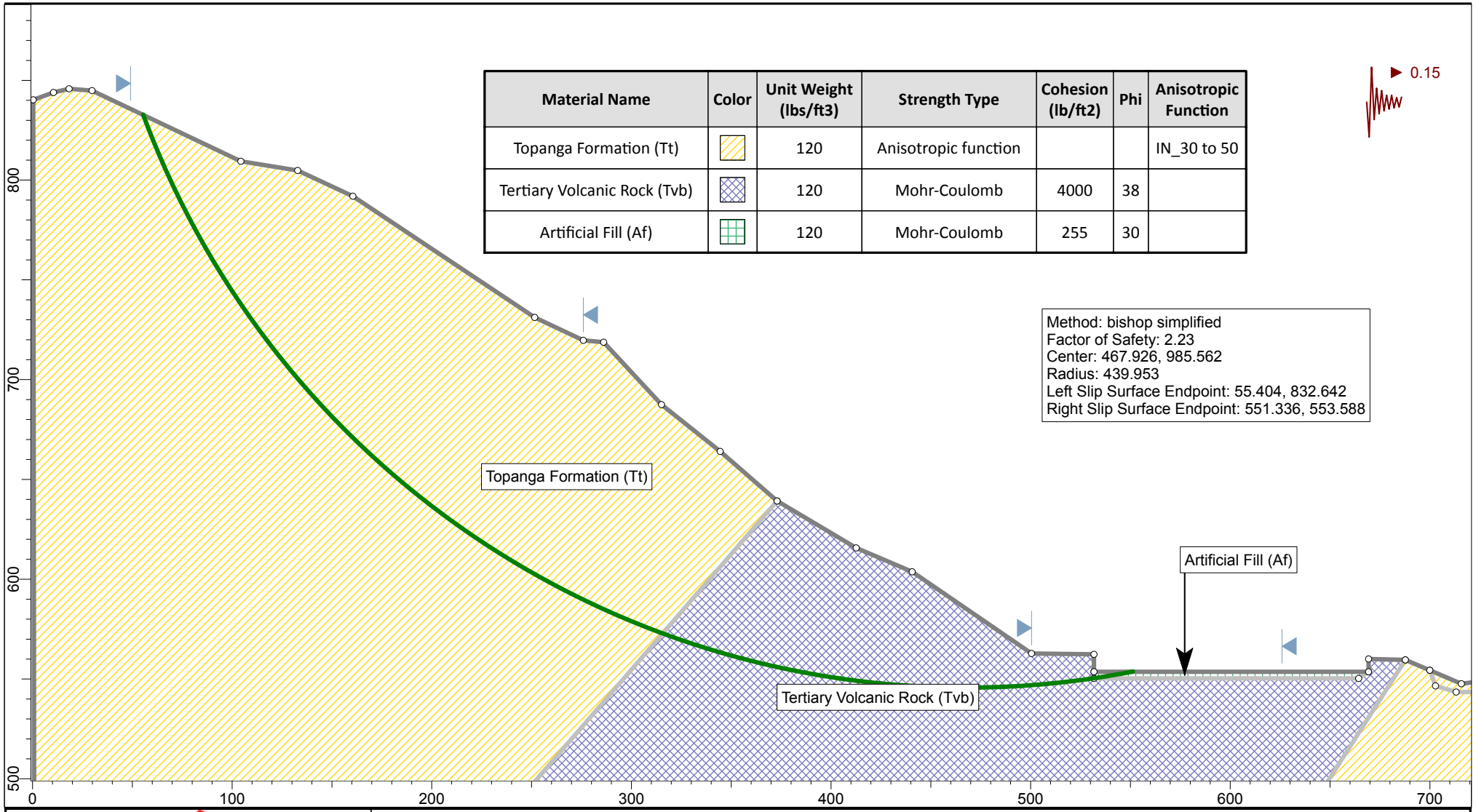
Project	Ford Theatre		
Analyzed By SP	*Units* feet	*Scale* 1:840	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section I

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section I\Section I_Static_PS.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Anisotropic Function
Topanga Formation (Tt)		120	Anisotropic function			IN_30 to 50
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38	
Artificial Fill (Af)		120	Mohr-Coulomb	255	30	



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

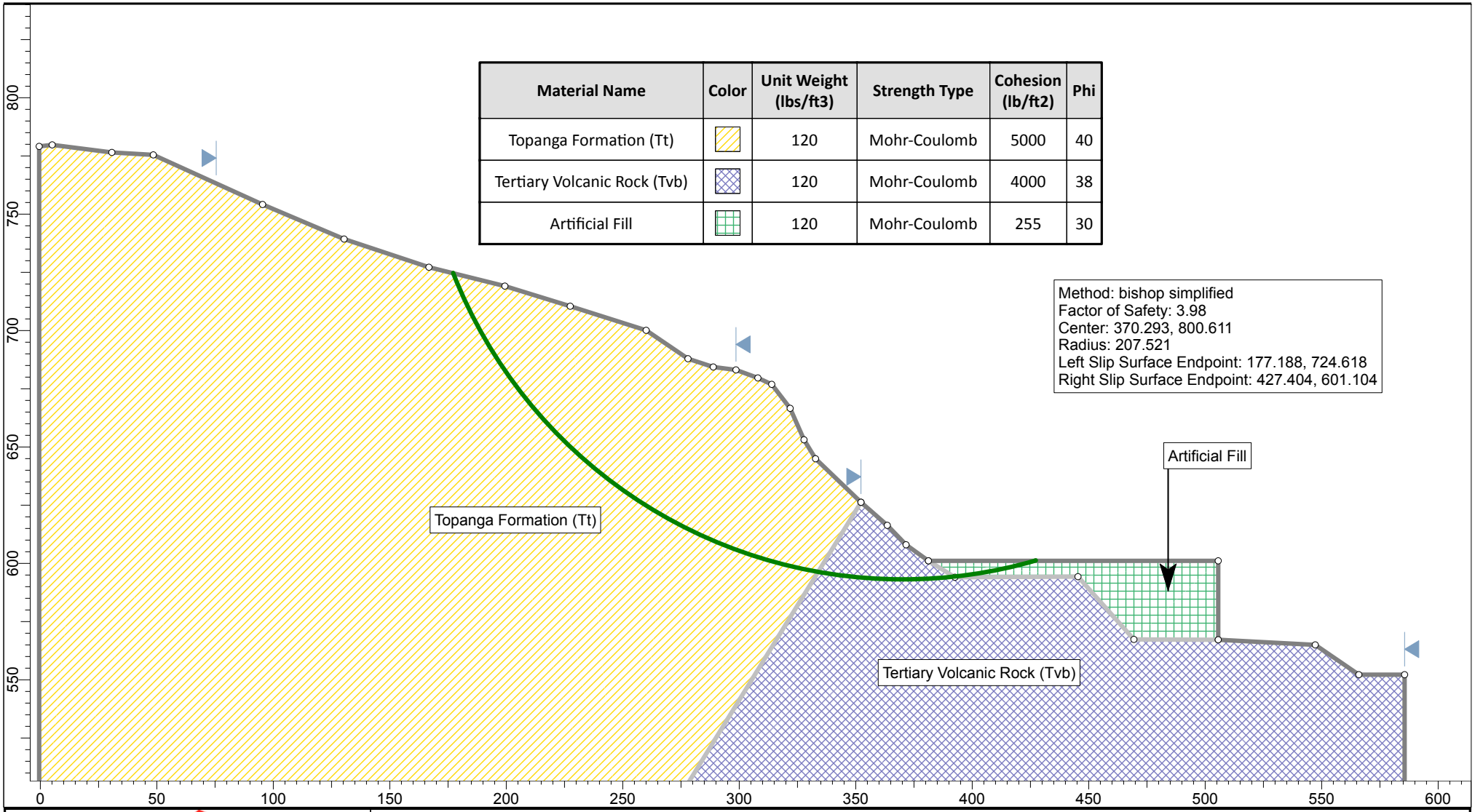
Project	Ford Theatre		
Analyzed By SP	*Units* feet	*Scale* 1:840	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Pseudostatic		

Section J

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section J\Section J Static_Circular.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Topanga Formation (Tt)		120	Mohr-Coulomb	5000	40
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Artificial Fill		120	Mohr-Coulomb	255	30



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

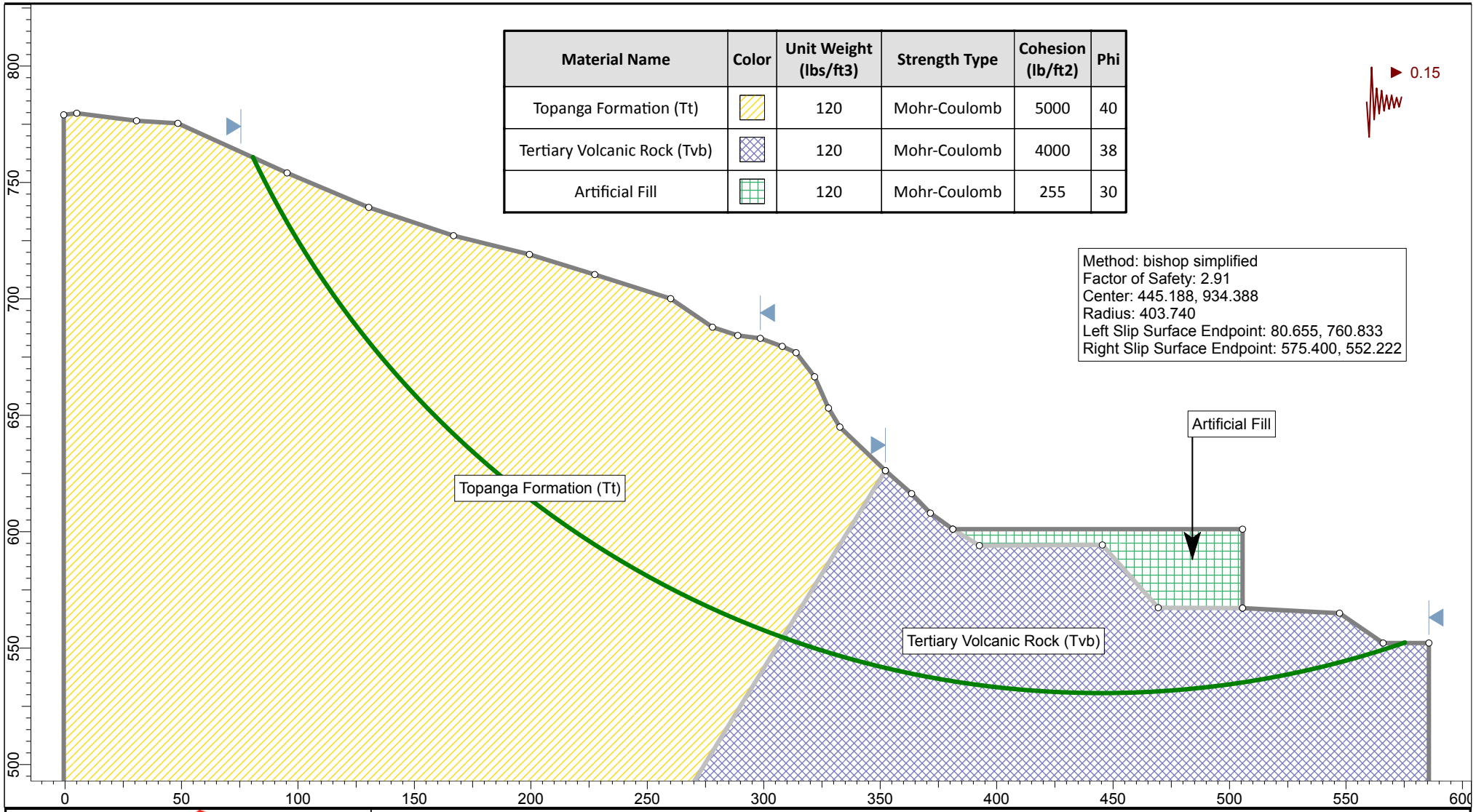
Project	Ford Theatre		
Analyzed By SP	*Units* feet	*Scale* 1:720	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Static		

Section J

Global Stability

P:\Infocus Projects\10296 Ford Theatre\002\Analyses\Slope Stability\Section J\Section J Static_Circular_PS.slim

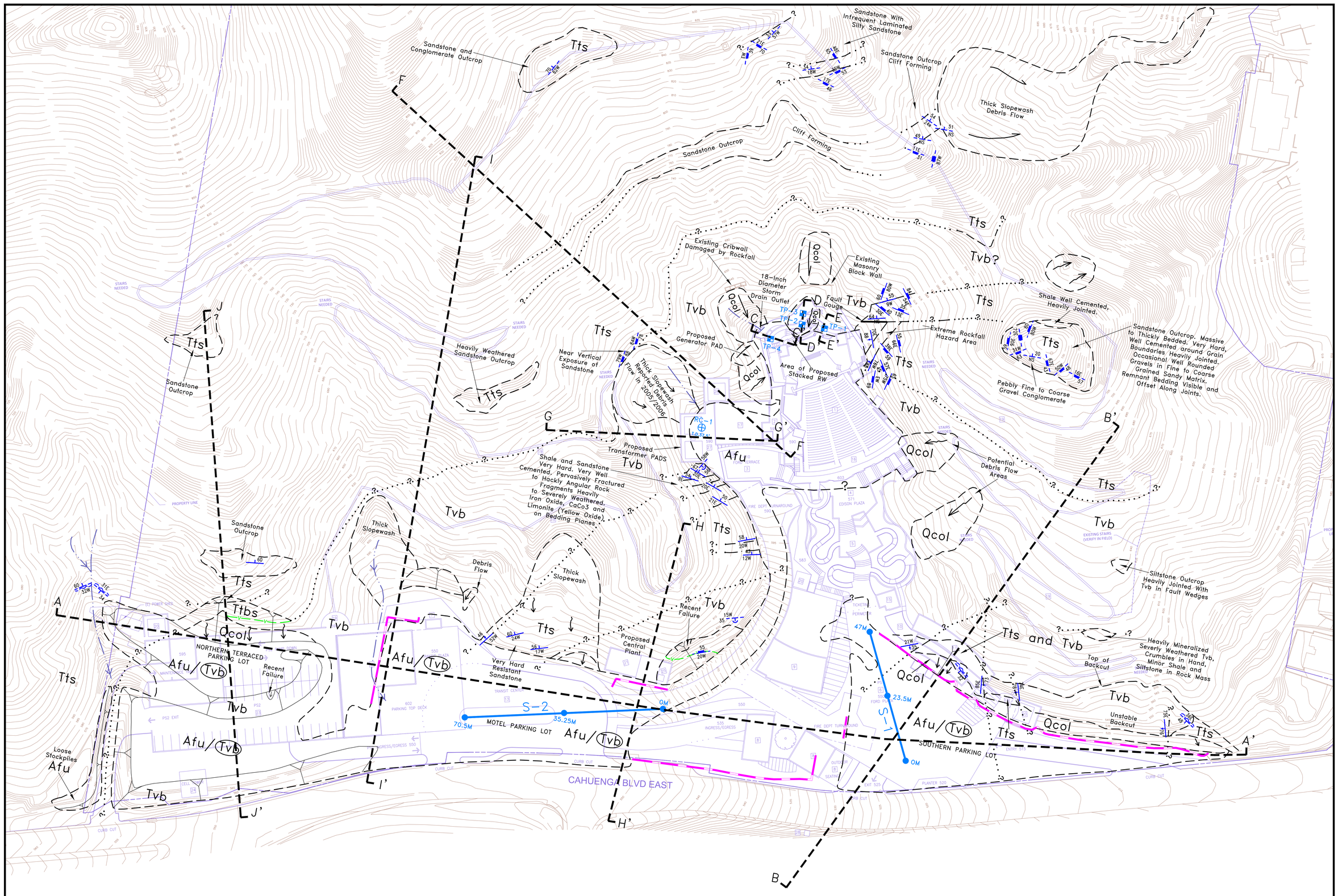
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Topanga Formation (Tt)		120	Mohr-Coulomb	5000	40
Tertiary Volcanic Rock (Tvb)		120	Mohr-Coulomb	4000	38
Artificial Fill		120	Mohr-Coulomb	255	30



SLIDEINTERPRET 6.008

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project	Ford Theatre		
Analyzed By SP	*Units* feet	*Scale* 1:720	*Project No.:* **10296.002**
Date 2/28/2014	*Condition* Pseudostatic		



LEGEND

Afu — ARTIFICIAL FILL-UNDOCUMENTED, CONTAINS STOCKPILED ONSITE DEBRIS SILTY SANDY GRAVEL TO GRAVELLY SAND WITH COBBLE AND BOULDER SIZED DEBRIS.

Qcol — QUATERNARY COLLUVIUM, LOOSE, CONSISTS OF LOCALLY DERIVED BEDROCK MATERIAL, UNCONSOLIDATED, SUSCEPTIBLE TO SLOPE CREEP AND RAPID EROSION. MANTLES SLOPES, WITH THICK WEDGE AT TOES OF CUT SLOPES. DEBRIS FLOW HAZARD

MIDDLE TOPANGA FORMATION AND VOLCANIC BEDROCK

Tts — LIGHT GREY TO ORANGE BROWN, HARD, THICKLY BEDDED, RESISTANT TO EROSION, MODERATELY TO WELL CEMENTED SANDSTONE WITH LOCALIZED PEBBLY LAYERS. FINE TO COARSE ANGULAR TO TRACE ROUNDED GRAINS. INCLUDES QUARTZ PEBBLE SIZED INCLUSIONS. UNIT INCLUDES VERY FINE GRAINED SANDY SILTSTONE, THINLY BEDDED AND CONTAINS DARK REDDISH BROWN, SILICEOUS CHERTY BEDS. CLIFF FORMING. SEVERELY FRACTURED, BLOCKY. ROCKFALL HAZARD ALONG CUT SLOPES. CIRCLED WHERE BURIED.

Ttbs — DARK GREY, CRUMBLY SANDSTONE WITH BASALT FRAGMENTS AND ROUNDED MANGANESE NODULES. SEVERELY WEATHERED AND FRACTURED. HEAVY SECONDARY MINERALIZATION AND CHEMICAL ALTERATION OF MAFIC MINERALS. CIRCLED WHERE BURIED.

Tvb — EXTRUSIVE BASALTIC VOLCANIC ROCKS, DARK GREY TO BLACK. VESSICULAR TO PILLOW STRUCTURE, SEVERELY WEATHERED AND FRACTURED. PERVASSIVE BLOCKY FRACTURE, MODERATE LUSTER ON WEATHERED BLOCKY FACES. DEGRADES TO SAND SIZED FRAGMENTS. HEAVY SECONDARY MINERALIZATION TO EPIDOTE. CHEMICALLY WEATHERED. FRIABLE- NEAR SURFACE, HARD AND VERY RESISTANT WITH DEPTH, CIRCLED WHERE BURIED.

GEOLOGIC CONTACT, DASHED WHERE APPROXIMATE, DOTTED WHERE CONCEALED, QUERRIED WHERE UNCERTAIN

F. . ?. — FAULT CONTACT, DASHED WHERE APPROXIMATE AND OBSERVED DOTTED WHERE CONCEALED, QUERIED WHERE UNCERTAIN.

APPROXIMATE BOUNDARIES OF CUT SLOPES

APPROXIMATE BOUNDARY OF COLLUVIUM. DEBRIS FLOWS PRIMARILY WITHIN BASALT FORMATION. ARROW DENOTES DIRECTION OF MOVEMENT. AREAS ARE SUBJECT TO ONGOING CREEP AND SEDIMENT BUILDUP BEHIND EXISTING RETAINING WALL IMPROVEMENTS.

50↓ 24W — STRIKE AND DIP OF BEDDING

21W 35 — STRIKE AND DIP OF FAULT

15W 35 — STRIKE AND DIP OF BEDROCK CONTACT

60 38W 34E — STRIKE AND DIP OF LOCALIZED SHEAR SURFACES

20W 55 — STRIKE AND DIP OF JOINTS

EXISTING RETAINING WALLS

BASALT DIKE

SURFACE CONTACT OF SANDSTONE BEDDING AND INTRUSIVE BASALT OUTCROPS

APPROXIMATE CENTERLINE OF EXISTING DRAINAGES. ARROW DENOTES DIRECTION OF SURFACE FLOW

OM 70.5M — APPROXIMATE LOCATION OF SEISMIC LINES S-1 AND S-2, SHOWN WITH LENGTH IN METERS (M) AND VELOCITY IN METERS PER SECOND (M/S). (LEIGHTON, 2013a)

J J' — LOCATION OF GEOLOGIC CROSS SECTIONS (LEIGHTON 2013a AND CURRENT STUDY)

RC-1 T.D.37.5' — LOCATION OF ROCK CORE BORING SHOWING TOTAL DEPTH (T.D.)

SCALE 0 40 80 FEET

REVISED GEOLOGIC MAP

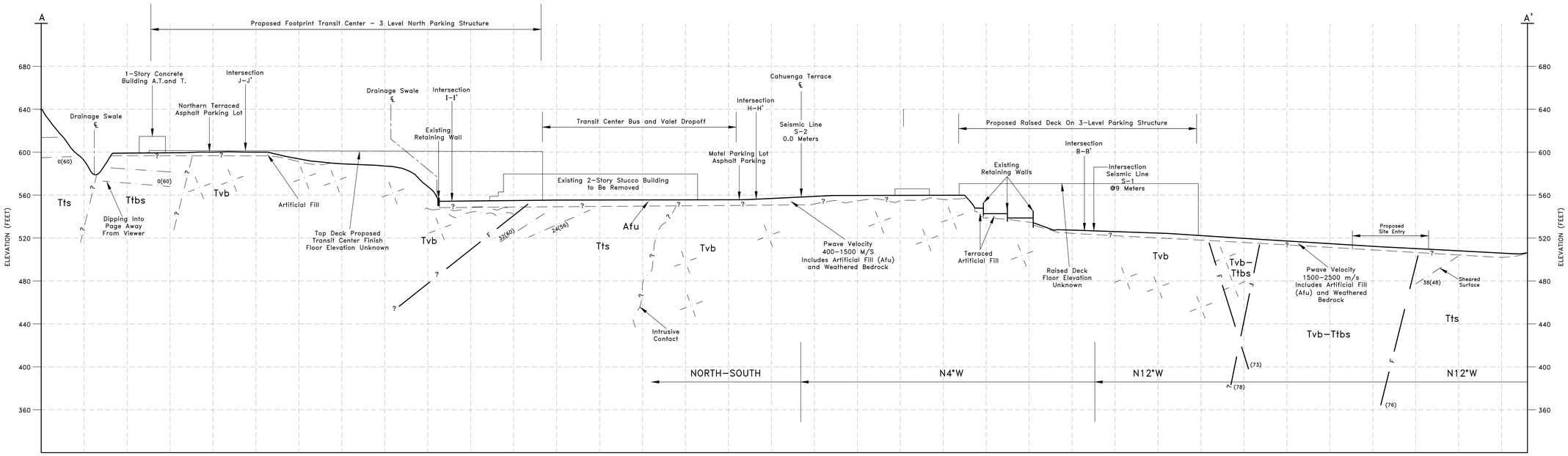
FORD THEATRE
EAST CAHUENGA BOULEVARD
LOS ANGELES, CALIFORNIA

PLATE 1

Proj: 10296.002	Eng/Geol: CCK/JAR
Scale: 1"=40'	Date: 02/2014

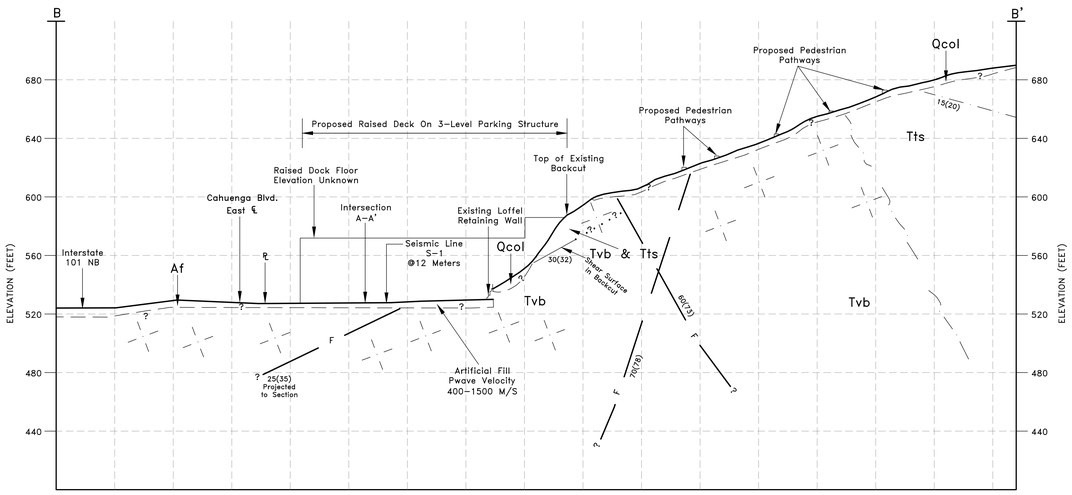
Drafted By: BQT | Checked By: BQT | P:\SHAT\WO10296\00\CP_2014-02-03\10296-002-PLATE-1-SM.DWG 02-28-14 2:57:48PM, Plotted by: tetas

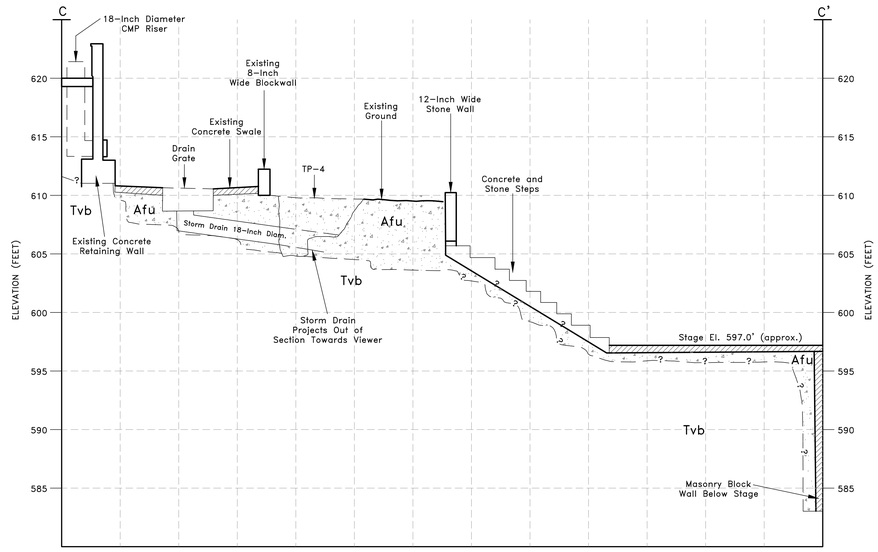
Leighton

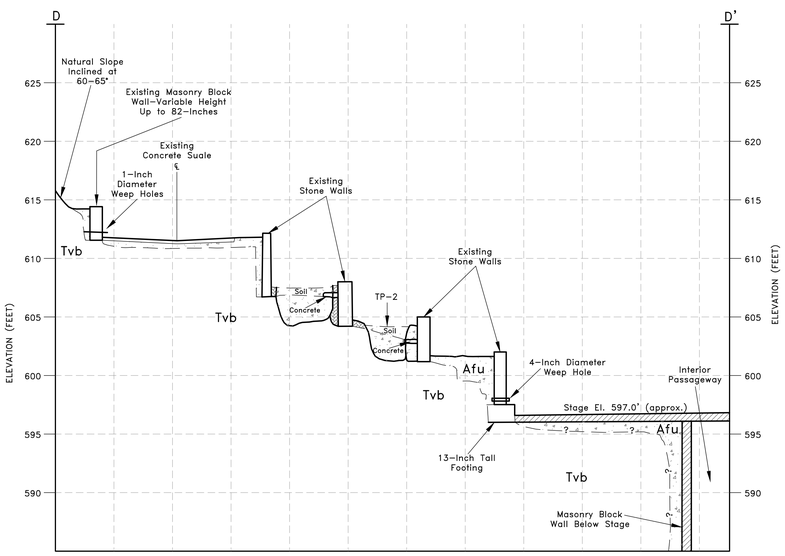


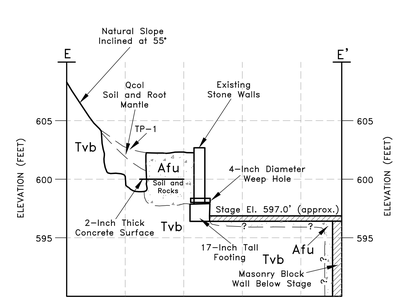
SEE PLATE 1, REVISED GEOLOGIC MAPFOR EXPLANATION OF EARTH UNITS

68(70) INCLINATION OF BEDDING. APPARENT DIP SHOWN WITH ACTUAL DIP IN PARANTHESES







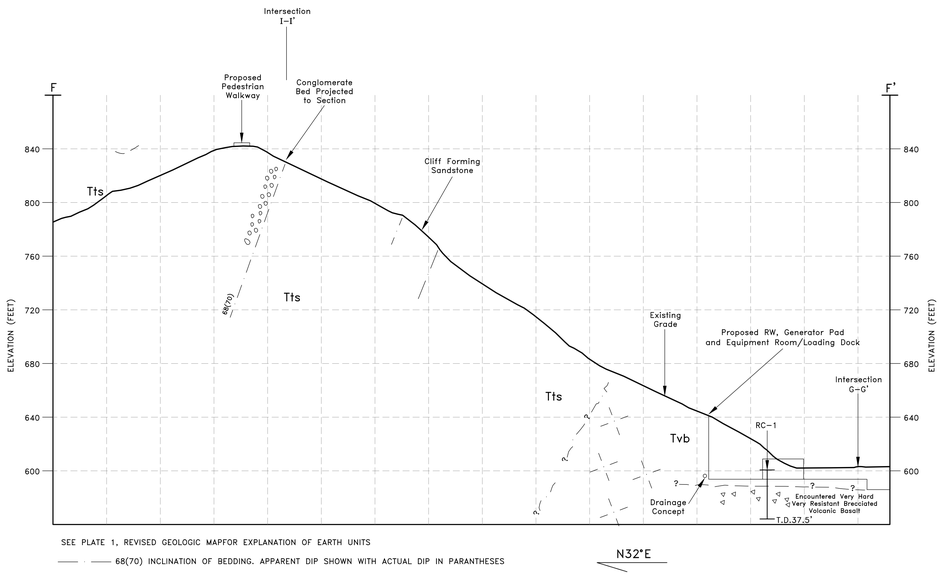


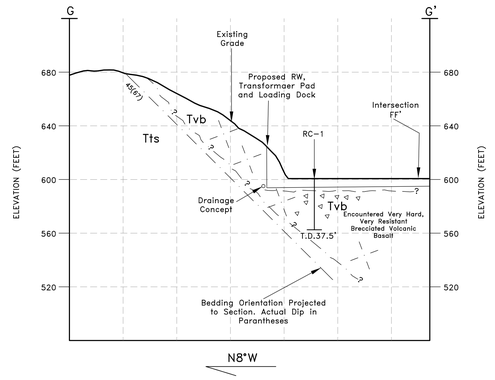
GENERALIZED GEOLOGIC
CROSS SECTIONS A-A' THROUGH E-E'
FORD THEATRE
EAST CAHUENGA BLVD.
LOS ANGELES, CALIFORNIA

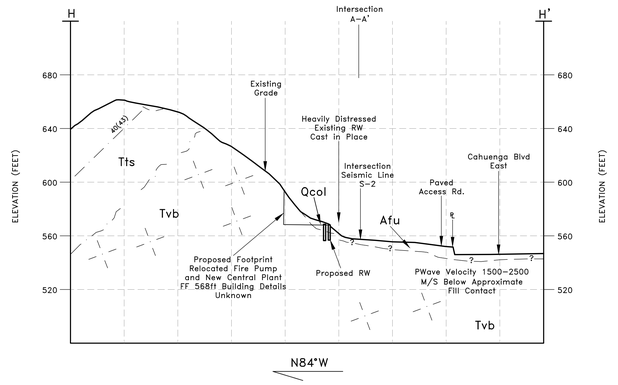
PLATE 2

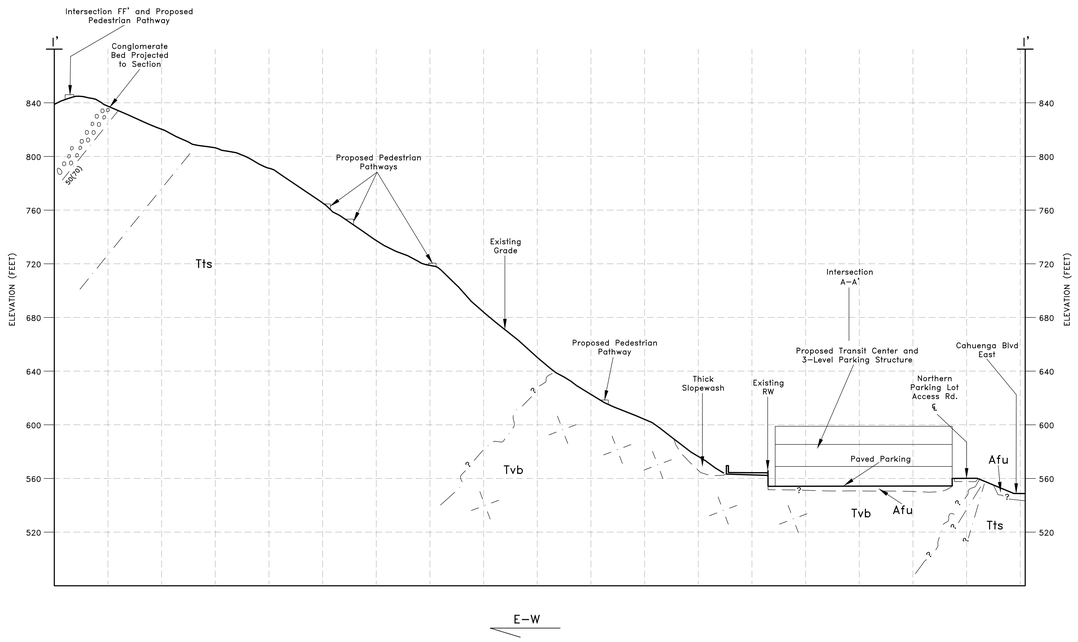
Proj: 10296.002	Eng/Geol: CK/JR
Scale: 1"=40'	Date: 02/2014

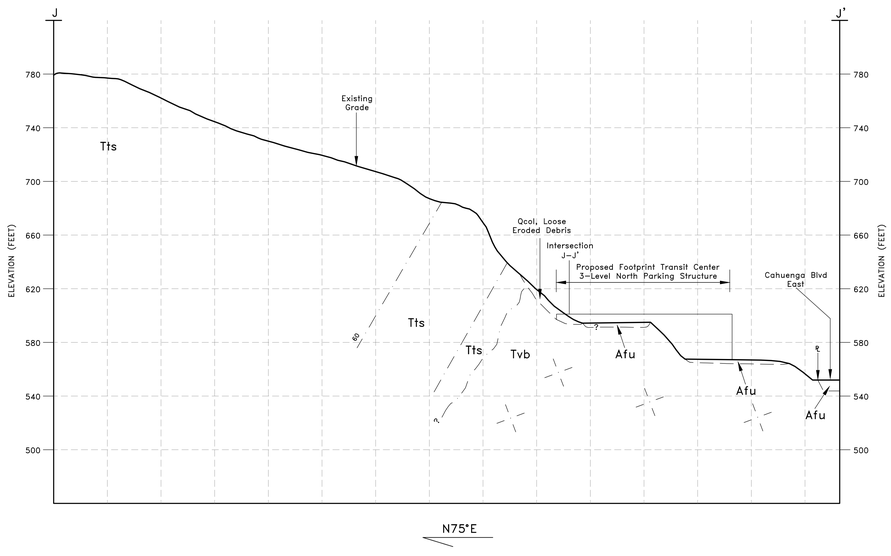
Leighton











GENERALIZED GEOLOGIC CROSS SECTIONS F-F' THROUGH J-J'
FORD THEATRE
EAST CAHUENGA BLVD.
LOS ANGELES, CALIFORNIA

PLATE 3

Proj: 10296.002 | Eng/Geol: CK/JR

Scale: 1"=40' | Date: 02/2014

Drafted By: BQT | Checked By: BQT | P:\Shelf Files\2010\10296.002\PLATE 3 CROSS SECTIONS.DWG 02-24-14 10:12 Users: Pinned by: Brett

Leighton

Appendix H.5

Résumés

CARL C. KIM | Senior Principal Engineer

Years of Experience | Years with Leighton: **20 | 7**

- ME, Civil and Environmental Engineering, Massachusetts Institute of Technology Cambridge, MA, 1997
- BS, Civil Engineering, University of California Berkeley, 1993
- 2002 / California Geotechnical Engineer - 2620
- 1998 / California Civil Engineer - 58046

Mr. Kim specializes in soil mechanics, forensic investigations, and geotechnical earthquake engineering. He has extensive experience in evaluation of geotechnical engineering design and failure analysis. He is an expert in seismic hazard analyses, non-linear analysis of structures using earthquake time histories, liquefaction evaluations, slope stability analyses, and foundation investigations. He has managed geotechnical investigations to provide recommendations for design as well as forensic investigations for litigation support. He has developed geotechnical recommendations for deep and shallow foundation systems, pavement design, remedial grading, shoring for deep excavations, and mitigation of expansive soils and landslides.

Mr. Kim has worked extensively with commercial, industrial, and government clients on a wide variety of geotechnical assignments. He has successfully managed numerous complex technical projects with budgets ranging up to several million dollars; he has a proven record of delivering his projects on time and within budget.

CHOC TOWER II EXPANSION PROJECT, ORANGE, CA. Principal Engineer for PSHA under the 2007 California Building Code. Optimized the foundation design by recommending a combined mat foundation and pile system to support the 7-story tower. Some portions were supported on piles to prevent surcharging of adjacent existing basement areas and to control differential settlement. The Tower II Expansion Project (South Tower) consists of a 416,000-square-foot, seven-story building with a basement, including appurtenant utilities and site work.

CITRUS VALLEY HEALTH PARTNERS, COVINA, CA. Project Manager for the geotechnical exploration to characterize engineering properties of onsite soils and identify geologic and seismic hazards that may impact the sites. Mr. Kim and the team provided document review, subsurface exploration, laboratory testing, geologic-seismic hazards evaluation, site-specific ground motion study, and engineering analyses.

SOUTH BUILDING AT HOAG MEMORIAL HOSPITAL PRESBYTERIAN, NEWPORT BEACH, CA. Developed and managed the geotechnical investigation and engineering support program for this base-isolated structure, which included the selection and scaling of 14 time histories per building code requirements. Probabilistic and deterministic response spectra were developed to establish the targets for scaling.

KAISER HOSPITAL ADDITIONS, ONTARIO, CA. Provided technical direction for analysis of ground motion and seismic hazards to help obtain review agency approval for this project, which included a new nursing tower and a central plant. The task included the selection and matching of 14 time histories per building code requirements, probabilistic and deterministic response spectra, and evaluation of seismic hazards.

DOWNEY REGIONAL MEDICAL CENTER, DOWNEY, CA. Mr. Kim assumed responsibility as principal-in-charge to procure and obtain review agency approval for the project. The task included the

development of a ground improvement program using vibro-replacement techniques (stone columns) to mitigate liquefaction hazard.

HENRY MAYO MEMORIAL HOSPITAL, NEWHALL, CA. Developed and managed the geotechnical investigation and geotechnical engineering support program for design and construction of various additions and improvements to the medical center.

SAN JUAN VA MEDICAL CENTER ADDITION, SAN JUAN, PUERTO RICO. Developed and managed the geotechnical earthquake engineering program for this project, which included development of probabilistic and deterministic response spectra and evaluation of seismic hazards (liquefaction, seismically-induced slope stability, lateral spreading, etc.).

SEISMIC UPGRADE OF ORIGINAL HOAG MEMORIAL HOSPITAL PRESBYTERIAN BUILDING, NEWPORT BEACH, CA. Developed and managed the geotechnical investigation and engineering support program for the retrofit of this structure, which required extensive analysis of soil-structure interaction to develop feasible alternatives for foundation underpinning and strengthening within confined spaces with severely limited access.

WOMEN'S PAVILION AT HOAG MEMORIAL HOSPITAL PRESBYTERIAN, NEWPORT BEACH, CA. Developed and managed the geotechnical investigation and engineering support program for this base-isolated structure, which included the selection and scaling of 14 time histories per building code requirements. Probabilistic and deterministic response spectra were developed to establish the targets for scaling.

TORRANCE MEMORIAL MEDICAL CENTER, TORRANCE, CA. Performed numerous geotechnical investigations for the design and construction of new facilities and for the seismic evaluation of existing facilities at the site.

WESTMINSTER POLICE DEPARTMENT HEADQUARTERS AND PARKING STRUCTURE, WESTMINSTER, CA. Project Principal and Geotechnical Engineer. Performed supplementary geotechnical investigations and indicator pile program to reduce pile foundation lengths from 75 to 55 feet for the proposed 3-story new police station building and 4-level parking structure at the site of the existing police department headquarters campus.

LOS ANGELES COUNTY DATA CENTER, RANCHO LOS AMIGOS NATIONAL REHABILITATION CENTER, DOWNEY, CA. Project Principal and Project Manager. Performed a comprehensive geotechnical investigation and geologic hazard evaluation for the proposed 46,000 square foot data center facility for the County of Los Angeles, which will consolidate data processing for nine County departments into a single location. The project was designed to be partially underground and to withstand increased seismic loading commensurate with a critical facility.

SAN DIEGO CONVENTION CENTER EXPANSION, SAN DIEGO, CA. Developed and managed the investigation and test pile program to develop the final design lengths and the installation program of foundation piles. The project included profiling the depth and thickness of a discrete bearing layer within stratified subsurface materials, conducting Pile Driver Analyzer measurements during the test pile program, and developing target depth contours to maximize axial capacity and to minimize pile lengths and pile driving effort.

DISNEY'S CALIFORNIA ADVENTURE, ANAHEIM, CA. Managed the geotechnical engineering services for the expansion of the amusement park. The expansion created an amusement park and resort including hotels, movie theaters, and retail establishments. Mr. Kim provided on-going consultation to Walt

Disney Imagineering for all aspects of geotechnical engineering, including shallow and deep foundations, tunnels, retaining structures, seismic design criteria, drainage, and earthwork.

JOE ROE, PG, CEG
Project Geologist

Education

- B.S. Geology, Cal State University Fullerton, 2000, Veteran United States Navy, Desert Storm

Professional Registrations

- California Certified Engineering Geologist – 2456
- California Professional Geologist - 7921
- Certified Nuclear Density Gauge Operator
- Radiation Safety Officer (RSO)
- Caltrans Certified CTM 125 Sampling Highway Materials & Products
- Caltrans Certified CTM 231 Relative Compaction of Soils & Aggregates by Nuclear Method
- Caltrans Certified CTM 375 In-Place Density & Relative Compaction of AC Pavement by Nuclear Method
- Certified Nuclear Density Gauge Operator for use with Troxler 3440 and CPN MC3, CME 75, 85 and 95 rigs used for soil sampling, drive tube and sand cone techniques.
- Member of SCGS, regular attendance at monthly meetings to discuss geologic issues pertaining to the construction and academic geologic environment.

Professional Summary

Mr. Roe has extensive experience managing and conducting field geotechnical investigations for various projects including slope stabilization, Alquist-Priolo fault investigations, mass grading, piles, caissons, asphalt paving, footings, utility backfills, drill logging, rock coring, test trenching, micro-tunneling, monitoring and pump well installations including forensic geotechnical and geologic investigations for litigation support. He has participated in many aspects of project development from project planning, investigation, construction services, and project management and business development.

He has worked extensively with local and State agencies to develop geotechnical recommendations for deep and shallow fill sites, remedial grading and mitigation of active faults, shear zones, landslides and debris flows.

Project Experience

- **Heritage Fields, Irvine, CA.** Project Geologist involved in planning and instituting geotechnical investigations for residential and commercial development over several thousand acre parcel formerly the El Toro Marine Air Base. Geologic mapping based on interpolation of subsurface conditions from several hundred borings in order to determine available sand deposits for mining. Analyzed lab data with respect to planned development in order to provide recommendations for earthwork construction. The project involved multiple field explorations, laboratory testing and geotechnical report preparation and avoidance of known and unknown US Navy landfill sites.

- **Great Wolf Lodge and Resort, Garden Grove, CA.** Senior Project geologist/Project Manager investigating a proposed 250 million dollar development that includes a 9-story hotel, conference center, restaurant, indoor and outdoor water park, and a multi-level at-grade parking structure. Our multiple geotechnical studies identified the significant design considerations for the project was the potential impact to on site utilities and building structures due to settlement of the compressible soils underlying the site. Evaluated the impact of settlement on the proposed development, identified ground improvement alternatives for settlement mitigations, and provided preliminary recommendations for site grading and other planned incidental improvements for the project that were not subject to the adverse effects of settlement.

Master-Planned Community

- **Whispering Hills, San Juan Capistrano, CA.** Senior Staff Geologist during massive hillside grading in a well-documented landslide complex adjacent to the Forester fault. Drilled 40 bucket augers, downhole logged and sampled bucket augers to depths of 120-200 feet for purposes of classifying numerous landslides, geological field mapping of excavations to determine suitable and unsuitable material left in place or to be removed during the grading operations. Communicated daily with engineers and superintendent to convey in field recommendations regarding removal and stabilization of constructed hillsides. Preliminary investigation data used in support of Environmental Impact Report (EIR).

- **Greater Tehachapi Area Specific Plan (GTASP), CA.** Project Geologist involved in research and collection of geologic and fault data over a 400 square mile area for the generation of the Specific Plan for the Tehachapi Area, Kern County, California. The County of Kern was tasked with updating planning and environmental information in this unincorporated Greater Tehachapi area. Involved in preparing a new program-level Greater Tehachapi Area Specific Plan (GTASP) that will rescind and consolidate the existing specific and other community plans in the area. This new Specific Plan will allow the County to identify and coordinate implementation strategies and policies for future land uses by balancing the competing social, economic, resource and environmental factors for future growth in the Greater Tehachapi area.

Forensics

- **Edgeridge Drive Embankment Stabilization, Hacienda Heights, (Unincorporated Los Angeles County), CA.** Project Manager/Geologist responsible for developing a field investigation to support recommendations for the stabilization of the existing Edgeridge Road embankment where a concrete retaining wall failed along the southerly and downslope edge of the roadway. Based on field observations the observed distress within the area of these existing concrete retaining walls was mostly surficial in nature, associated with erosion of colluvial materials on the slope face along the south edge of the active roadway, exposing roadway subgrade and a retaining wall foundation. It was determined that primarily grading and drainage improvements are required to reduce if not eliminate erosion. Recommendations to stabilize the embankment consisted of soldier piles with a spanning concrete wall face to support the road embankment between the soldier piles tied-back by “deadman” piles drilled on the north side of the road embankment, anchored by corrosion-resistant steel anchor cables.

- **Forensic Investigation California Water Service Company Easement, Diamondhead Lane, Rancho Palos Verdes, CA**-Senior Project Geologist planned and executed geotechnical investigation, summarized the findings from assessment and evaluation of a slope failure within the California Water Service Company (Cal-Water) easement. Used limited access rilling and hand dug test pits to identify failure plane and failure mechanisms. Made recommendations for removal and recompaction of landslide and debris flow material to stabilize utility lines and to repair slope to original conditions.

Industrial

- **Barstow Industrial Facility, Barstow, CA.** Project Manager/Geologist. The purpose of this study was to evaluate the potential of faulting onsite. Performed review of stereoscopic paired aerial photos of the site from the San Bernardino County Flood Control District, geological and State of California fault maps, verbal communication with the City of San Bernardino Geologist, performed a site visit to document the current site conditions and preparation of site reports presenting findings and conclusions as to the presence or absence of active faults postulated to cross the site.

- **J.H. Baxter Facility, Long Beach, CA.** Project Geologist responsible for planning and implementing an investigation for the 13-acre area intended for development of 142 cross-dock positions, 50 semi-tractor stalls, 402 trailer stalls, 412 auto stalls and an office building, maintenance shed and a guard booth totaling 10,400 square feet. Challenges were working with contaminated site soils that could not be removed. Recommendations consisted of use of geotextile fabrics to support the planned improvements thereby keeping disturbance of contaminated site soils to a minimum.

Institutional

- **Parking Structure III, California State University Los Angeles, CA.** Project Geologist for the geotechnical investigation performed in support of the design of the three-level concrete parking structure. Investigation included drilling borings in existing fill across a buried canyon in order to determine depths to bedrock. Recommendations included a two type foundation consisting of spread footings at grade in bedrock and deep caissons to support the structure across the pre-existing canyon. Field mapping during the project construction helped develop recommendations to mitigate seepage from the rock structure exposed in the cut walls by means of recommending additional drains and dewatering wells to accommodate nuisance water removal during wet years.

- **Athletic Facility, West Los Angeles Community College, Culver City, CA.** Project Geologist for geotechnical exploration. The site's split level, proposed design and undocumented fill, all presented challenges for the geotechnical recommendations. While the Athletic building, with a two-level basement, would require up to 20 feet of excavation, which would essentially remove the undocumented fill, the Fitness center an at-grade structure would require removal and compaction. Leighton recommendations for the foundations and site grading were based on the laboratory results from the field exploration which included hollow-stem auger borings and Cone Penetration Test (CPT) soundings.

Municipal Infrastructure

- **Mulholland Dam Monitoring Well Installation, Los Angeles, CA.** :Senior Project Geologist involved in the destruction of an existing monitoring well 82-D (MW 82-D) and installing a replacement monitoring well 2010-A (MW 2010-A) to 123 feet using a Myersburg Mobile B 53 mud rotary rig and recirculation of bentonite drilling fluid. Drilling mud and cuttings were stored in 55 gallon drums, analytically characterized and disposed of properly. Completed and filed a well completion report In accordance with Sections 13750 through 13755 (Division 7, Chapter 10, Article 3) of the California Water Code with the Department of Water Resources.

- **Numerous Alquist-Priolo Fault Investigations over active traces of Newport Inglewood, San Andreas, San Jacinto, Chicken Hill and Casa Loma Faults in Los Angeles, San Bernardino and Riverside Counties, CA.** Duties involved extensive field mapping at appropriate scales and interaction with appropriate agencies required for report submittal.

- **Ocean Trails Landslide, Palos Verdes, CA.** Senior Staff Field Geologist for slope stabilization and buildup of geosynthetic mechanically stabilized earth wall, geologic mapping, installation and monitoring of instrumentation array, including survey monuments and extensometers, slope inclinometers along perimeter and within Landslide "C" to monitor landslide movements. Installed hydraugers and monitoring wells to monitor subsurface water and drain the landslide. The project involved daily to weekly monitoring of an array of inclinometers, extensometers and monitoring wells during landslide removals and replacement of mechanically stabilized earth walls to repair the golf course. Project involved daily analysis and weekly reporting of current and changing conditions to city and county officials.

Schools- DSA

- **Beverly Hills High School, Beverly Hills, CA.** -Senior Project Geologist/ Project Manager involved in assessment of postulated faults across the Beverly Hills High School campus in response to the Century City Metrolink Tunnel study. Conducted several continuous east west core boring and cone penetrometer (CPT) transects to depths of 160 feet below ground surface to evaluate type and nature of subsurface stratigraphy along the West Beverly Hills Lineament (WBHL). Excavated overlapping fault trenches to depths of 15-20 feet in the dense urban environment along a Methane Buffer Zone. Coordinated field activities, logged core borings, provided detailed fault trench logging to investigate fault traces should they exist in order to evaluate their activity. Integrated pedochronolgic soil age dating techniques and optically stimulated luminescence (OSL) along with carbon analysis to provide ages of soils below the High School site. Additionally integrated the use of optical mineralogy to determine the origin of clays lining subsurface fractures in order to provide their origin, i.e. tectonic or illuviation in response to California Geological Survey (CGS) concerns as to the origin of clay lined fractures observed in the fault trenches. Submitted data to supplement two detailed responses to California Geological Survey resulting in all geologic issues being “adequately addressed”. This was a major hurtle for the District to overcome as the Leighton report refuted completely the geologic data presented by other consultants resulting a the project design to move forward as originally planned.

- **Malibu High School, Malibu, CA.** Senior Project Geologist implemented and conducted a geotechnical investigation to support design and construction of proposed renovations and additions to the existing campus. Investigation included use of hollow stem auger borings, shallow test pits, infiltration testing to support percolation devices for draining the Olympic sized pool on a weekly basis. Project involved multiple agency reviews ultimately gaining acceptance from CGS and DSA for the projects to move forward.

Transportation

- **Loma Ridge State Route 241-Landslide Repair, Orange, CA.**. Project Geologist involved in detailed slope mapping during excavation of several million yards of La Vida Formation bedrock over a 9 month period in order to provide hillside buttress stabilization in response to activation of a paleo landslide threatening a major state route out of Orange County. Managed contractor activities and continuously mapped field exposures daily during excavation. Field activities consisted of mapping bedrock, confirming elimination of disturbed bedrock and approving subgrade for placement of structurally controlled fill to overseeing installation of multiple tiered sub drainage and back drainage systems to provide adequate passive dewatering of the mechanically buttressed 300 foot high hillside adjacent to the northbound State Highway 241. Communicated daily with contractors and engineers from multiple municipalities and state agencies in order to provide updated geologic cross sections for slope stability analyses.

- **California High Speed Rail, Los Angeles – Orange County Segment.** Project Geologist involved in the collection and presentation of geologic data for the proposed 30-mile rail alignment from Los Angeles Union Station to the Anaheim Station. Collected data for the study area was defined by the following key issues: topography; geology; soils; landslide hazards; surface fault ruptures; ground shaking; liquefaction, other ground failure, seismically induced landslides; tsunami, seiches, dam failure inundation; subsurface gas hazards; mineral resources; oil and natural gas resources; paleontological resources; width of study area; at-grade sections; tunnel and cut-and-cover sections; cut and fill sections; and aerial sections. The alignment travels through 14 cities in Los Angeles and Orange counties, and unincorporated areas of Los Angeles County.

Water Infrastructure

- **Santa Ana Regional Interceptor (SARI Line), Yorba Linda, CA.** Project Geologist involved in Hydrogeologic and Geotechnical Investigation to support design and construction of a 3-mile Sanitary Trunk Sewer line along the Santa Ana River that conveys raw sewage and brine (wastewater from agriculture, commercial and other sources) from the Inland Empire to the OCSD treatment plant in Fountain Valley. Investigation consisted of interaction and acquisition of permits from multiple governing agencies such as Orange County Flood Control District, Orange County Harbors Beaches and Parks, Caltrans, State of California State Parks, Regional Water Quality Control Board for the Santa Ana Region. Investigation included drilling and logging of multiple borings along the 3 mile segment and installation and development of multiple monitoring and pumping wells in performance of aquifer testing for construction dewatering purposes. Determined aquifer and soil characteristics for shoring and constructability purposes. Conducted additional investigations in support of tunnel design and to delineate areas along the tunnel crown that had experienced piping and settlement within a major roadway due to issues tunneling through loose alluvial soils. Identified areas for a compaction grouting program to be instituted by the tunneling contractor.

- **Nohl Canyon Reservoir, City of Anaheim, CA.** Project Geologist involved in planning and instituting investigations in a documented landslide complex to evaluate subsurface conditions for planned addition of a 10-million-gallon tank. Project involved installation of an array of inclinometers as well as monitoring well installation and design to establish baseline conditions prior to construction. Project involved monthly monitoring of existing piezometers as well as newly installed instrumentation, data analysis and report preparation. Responsibilities during construction included extensive field mapping of bedrock exposures during grading in order to collect geotechnical data used in slope stability analysis. Daily communication with engineers, client, and multiple superintendents on the job. Evaluated and approved stability excavations, oversaw installation of extensive sub and backdrain systems during grading operations.

- **Rawlings Reservoir, City of Tustin, CA.** Project Manager/Project Geologist. Project consists of replacing existing 4.2 million-gallon (MG) water reservoir with two 3-MG concrete circular water tanks. Made recommendation to provide temporary shoring wall to protect the north and east sides of the site prior to demolition of the existing tank. Project consisted of multiple styles of drilling using hollow stem augers, limited access rigs due to restricted access and bucket auger and downhole logging to better define the subsurface conditions prior to construction. Main geotechnical issues consisted of failure of existing reservoir and attempted lining repairs (by others); expansive soils and retaining wall failures in the past; slope stability and proposed cut excavations; "Shear zone" and localized shallow groundwater in the ravine draining to the site footprint.