# INFORMATION HANDOUT

**For Contract No. 10-0W8004**
**At 10-Tuo-Toulumne-27.4**

**Identified by**
**Project ID 101200063**

## MATERIALS INFORMATION

Summary of Foundation Recommendation Reports dated May 29, 2013.

Amendment to Foundation Report for Slope Stabilization (Issue date January 7, 2014)

Alternative in line terminal system

State of California
DEPARTMENT OF' TRANSPORTATION

Business, Transportation and Housing Agency

# Memorandum

*Flex your power!*
*Be energy efficient!*

**To:** MR. GARY JOE
Branch Chief
Structure Design
Bridge Design North
Branch 17

Attention: AE Tern

**Date:** May 29, 2013

**File:** 10-Tuo-120
PM 27.4
EA: 10-0W8001
EFIS: 1012000063
Slope Stabilization

**From:** **DEPARTMENT OF TRANSPORTATION**
**DIVISION OF ENGINEERING SERVICES**
**GEOTECHNICAL SERVICES – MS 5**

**Subject:** Foundation Report

## Introduction

As requested, the Office of Geotechnical Design North (OGDN) is providing a Foundation Report (FR) for the slope stabilization project situated on the New Priest Grade at PM 27.4, State Route (SR) 120, in Tuolumne County. The slope stabilization project proposes to install soil nails stabilizing an existing Hilfiker wall that is slowly creeping down the embankment slope during the winter months.

## Project Description

The site is located on SR 120 in Tuolumne County, on the New Priest Grade between the towns of Moccasin to the west and Big Oak Flat to the east. This portion of SR 120 is a two-lane highway with many curves. At this location (PM 27.4), the roadway is about 24-foot in width with a two-foot paved shoulder on the WB side and a four-foot paved shoulder on the EB side. A Metal Beam Guardrail is situated adjacent to the EB side of the roadway, between the highway and the existing Hilfiker wall. A Vicinity Map and Aerial Photograph are provided on Plate 1.

According to as-built documents, the subject Hilfiker wall and other similar walls situated between PM R24.2 and PM 29.0 were constructed to widen SR 120 to accommodate longer vehicles reaching Yosemite National Park after the Ferguson Slide closed Highway 140 in 2006. In general, the Hilfiker wall was constructed with vertical panels composed of 4-guage welded wire on 4-inch spacing and ¼-inch mesh backing. The vertical panels are visible from the outside face of the wall and vary between 18-inch and four-foot in height. Each vertical panel is connected to a horizontal panel of similar design. No information for the length of the

horizontal panels and wall thickness is available. It is presumably our anticipation that the horizontal panels span the entire wall thickness and that the maximum wall thickness is 10 feet.

Through verbal communications with Mr. Cliff Rice, Caltrans Construction Supervisor, the wall was constructed using surplus materials from the Ferguson Slide temporary bridge abutment construction. The wall is maximum 82-feet in length, extending from Station 10+73.76 to Station 11+48.88. The wall was constructed in four lifts/rows with the face of each row set about 1- to 2-foot behind its adjacent lower row, resulting a battered wall face of approximately 1/2:1 (h:v) through four rows. The bottom row is four-foot in height and each successive upper row is 18-inch to two-foot in height. With four total rows and one-foot of additional gravel at the top the total wall height is about eleven-foot.

The project proposes to stabilize the wall utilizing soil nails. Our office recommends the use of 20-foot long nails to extend through the existing Hilfiker wall into the native bedrock. It is recommended that the nails be spaced five-foot horizontally in each row. Vertical spacing is set as 2 to 2.5-ft to accommodate the existing wall construction. Plates 2 and 3 (attached) depict the Plan View and Profile View of the wall.

**Field Investigation and Testing Program**

An investigation including field reconnaissance, review of historic and recent aerial photography and subsurface sampling was performed for this project. One mud-rotary boring was drilled at the site to determine the subsurface conditions for the soil nail wall design.

**Laboratory Testing Program**

Unconfined Compressive Strength (UCS) testing was performed on rock cores collected during the subsurface investigation. Test results are summarized in Table 1. UCS values in the table may not be representative of the subsurface conditions of the site as only limited samples were suitable to be submitted for testing.

**Table 1 Rock Unconfined Compressive Strength**

| *Boring* | *Depth (ft)* | *Elevation (ft)* | *UCS(pounds per square inch)* |
|---|---|---|---|
| R-12-001 | 17 | 1908 | 2435 |
| R-12-001 | 22.5 | 1902.5 | 3055** |
| R-12-001 | 30 | 1895 | * |
| R-12-001 | 35 | 1890 | 2640** |
| R-12-001 | 41 | 1884 | 5534 |

*Sample fell apart while preparing for testing – Not suitable for testing
**Test specimen length/diameter ratio was no in compliance with test method

**Climate**

Information regarding the climate in the project area is provided by the Western Regional Climate Center period of record from 1948 to 2012. The closest station in proximity to the project location is at Groveland 2 (Station #043669). The average annual total precipitation is 36.18 inches. The majority of this precipitation falls between October and May. The average daily minimum temperature ranges from 30.1° F in January to 56° F in July, and the average daily maximum temperature ranges from 51.4° F in December to 91.2° F in July. Yearly updates are available at the Western Regional Climate Center web site.

**Topography and Drainage**

Based on the USGS Topographic Map of the Moccasin Quadrangle, 1987 (Plate 3) and our field investigation, the project is situated in an area of steep topography ranging in elevations from about 1750-foot above mean sea level in Grizzly Gulch below the site to about 2250-foot on the ridge above the project location. The town of Moccasin and the Moccasin Reservoir are situated to the southwest of the project location. The general drainage of the area is through Grizzly Gulch toward the southwest into Moccasin reservoir. Surface drainage is handled through a series of drainage swales adjacent to the cut slopes into drop inlets and culverts, letting out through oversized drains at the base of the embankment slopes.

**Site Geology**

According to the Geologic Map of the Chinese Camp and Moccasin quadrangles, Tuolumne County, California (USGS, 1976), the bedrock that outcrops in the cut slope adjacent to the eastbound lane consists of the Calaveras Formation (Pzcv) which is an albite-epidot-actinolite greenschist which is a fine-grained metavolcanic rock with an andesite composition. This unit was originally deposited as volcanic flows that have been sub-sequentially metamorphosed.

The geology of the boring coincided with the geologic map and consisted of 6-inches of asphalt concrete overlying about 8-inches of aggregate base rock (A.B.). The roadway section overlies about four-feet of artificial fill that consisted of silty CLAY that was orange-brown, moist to wet and contained mostly fines with some fine to coarse SAND and some fine to coarse rounded gravel. Trace cobbles were encountered. Under the fill was weathered METAVOLCANIC BEDROCK that was orange, and brown, to a depth of about 30-feet bgs where fresh, unweathered bedrock was encountered.

**Seismic Recommendations**

Based on the *Caltrans Seismic Design Procedure*, the following active faults could seismically impact the project site. The Caltrans ARS Online Tool was used to estimate the Peak Ground

Acceleration (pga) at the site with an estimated average shear wave velocity ($V_{S30}$) of 2500 ft/sec (760 m/s) for the rock mass at the site. The estimated pga is 0.2g.

**Table 2 Active Faults**

| *Fault Name* | *Fault ID* | *Fault Type* | *Moment magnitude of maximum credible earthquake* | *Distance from fault to project site (miles)* |
|---|---|---|---|---|
| Foothills Fault System (Bowie Flat Fault) | 419 | N | 6.3 | 13 |
| San Andreas (Santa Cruz Mts) | 158 | SS | 8 | 96 |
| San Andreas (Peninsula) | 134 | SS | 8 | 107 |

**Design Criteria of Soil Nails**

The design for the soil nail stabilized Hilfiker wall was analyzed using Slope/W, which is part of the Geostudio 2007 suite (Version 7.2) from Geo-Slope, LLC. A two dimensional model was developed based on the existing wall/slope geometry. Engineering parameters for rock and other materials were based on field observation of the adjacent cut-slope in conjunction with laboratory analysis and the program Roclab. Plate 4 is a conceptual cross section showing the anticipated wall location and subsurface conditions.

The existing slope/wall was modeled such that when dry (during the summer months), the wall would have a Factor of Safety (FOS) of just above one. When wet (during the winter months) the FOS falls to just below one. With three rows of soil nails installed in the top three lifts of the existing wall, the minimum FOS is increased to 1.56 with a static loading and high water table. The minimum FOS is 1.16 with seismic loading and high water table. Plate 5 shows the satisfying FOS of the Hilfiker wall that is stabilized with soil nails.

The following criteria were used in the analysis:

1. Minimum factor of safety for static loading, $FOS_{static}$ = 1.5, and for seismic loading, $FOS_{seismic}$ = 1.1
2. Maximum design wall height = 11-ft
3. Maximum horizontal and vertical spacing of nails = 5.0-foot horizontal and 2 to 2.5-foot vertical
4. Inclination angle of the nails to the horizontal = 15 degrees
5. Minimum diameter of drilled hole = 6.0-inch
6. Maximum vertical distance from bottom of wall to the bottom row of soil nails = 5-foot.

7. Three zones are recommended for design and construction control using the following parameters:

   Fill of Existing Wall:
   Total unit weight, $\gamma = 130$ pcf
   Friction angle, $\phi = 35°$
   Cohesion, c = 0 psf

   Weathered Rock:
   Total unit weight, $\gamma = 120$ pcf
   Friction angle, $\phi = 28°$
   Cohesion, c = 200 psf
   Design Pullout Resistance, $Q_d = 3280$ lb/lf

   Fresh Rock:
   Total unit weight, $\gamma = 150$ pcf
   Friction angle, $\phi = 35$
   Cohesion, c = 500 psf
   Design Pullout Resistance, $Q_d = 4863$ lb/lf

8. Minimum Punching shear capacity = 35 kips
9. Nail Bar Size Diameter = 1.13-inch (#9)
10. Maximum vertical distance between top of wall and the top most row of soil nails = 2-foot
11. Minimum embedment length of soil nails from face of wall = 20-foot

**Stability Testing**

For the purpose of stability and load testing, it is recommended that the entire wall be treated as a single zone.

**Nail Verification Testing**

In the event of failing verification tests, Geotechnical Design North should be contacted as soon as possible to determine the cause of failure and provide guidance.

**Nail Proof Testing**

Approximately five nail proof tests are anticipated (10% of production nails). When we are provided with a copy of the General Plan we will provide a wall elevation view showing the recommended locations of the proof tests.

**Construction Considerations**

The typical sequence of excavation, nail installation and facing installation shall follow the Caltrans 2010 Standard Plans and Specifications and the Special Provisions for this project.

A. Construction Staging
Construction should commence during the dry season so as the FOS of the existing wall is at its highest.

The construction should be staged such that the top row of anchors is installed first, prior to drilling equipment accessing the top of the wall. The following two lifts can then be installed in successive order from top down. Trench plate may be used to minimize damage to the top of the wall, the roadway and to bridge the interface between the wall and roadway paving, while placing the top row of nails.

B. Excavation and Drilling Difficulties
Drilling in very hard rock is anticipated. It is anticipated that caving may occur in moderately to highly fractured rock. The drill holes may need casing where this condition is encountered. The Contractor should utilize an appropriate drilling method and/or equipment to mitigate such ground conditions.

Drilling through the existing Hilfiker Wall will necessitate the use of casing to prevent caving, limit grout migration and aid with progression of the hole until native earth materials are encountered.

C. Grout and Test Nail
Due to the existence of moderately to highly fractured rock material at the project site, some loss of grout material may occur during the grouting operation. If such situation occurs, a representative of Geotechnical Services should be contacted for further recommendations.

**Project Information**

Standard Special Provisions SSP-280, "Project Information", discloses to bidders and contractors a list of pertinent information available for their inspection prior to bid opening. The following is an excerpt for SSP-280 disclosing information originating from Geotechnical Services. Items listed to be included in the Information Handout will be provided in Acrobat (.pdf) format to addressee(s) of this report via electronic mail.

*Data and information attached with the project plans are:*

*A. None*

*Data and information included in the Information Handout provided to the bidders and contractors are:*

*A. Foundation Report for Soil Nail Retaining Wall dated May 29, 2013*

*Data and Information available for observation at the Transportation Laboratory:*

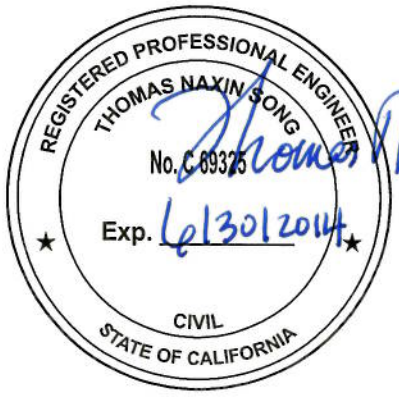
*A. Cores*

**Pertinent Reports and Investigations**

The following presents a list of references used in preparation of this report.


- Caltrans, Project Plans for Construction on State Highway in Tuolumne County on Priest Grade at Various Locations, Contract No. 10-0P7704, February 27, 2008.
- Caltrans, Email Recommendations for Repair at 10-Mpa-49 PM 27.4, May, 2011.
- Caltrans, District Preliminary Geotechnical Design Report, June, 14 2012.
- Western Regional Climate Center for 1989-2007.
- Topographic Map of the Moccasin Quadrangle, United States Geological Survey, 1987
- Morgan, B.A., 1976, Geologic map of the Chinese Camp and Moccasin quadrangles, Tuolumne County, California: U.S. Geological Survey, Miscellaneous Field Studies Map MF-840, scale 1:24000


If you have any questions or comments, please call Brandon Badeker at (916) 227-1046, or Thomas Song at (916) 227-1057.


BRANDON BADEKER, CEG
Engineering Geologist
Geotechnical Design - North

THOMAS SONG, P.E.
Transportation Engineer, Civil
Geotechnical Design - North

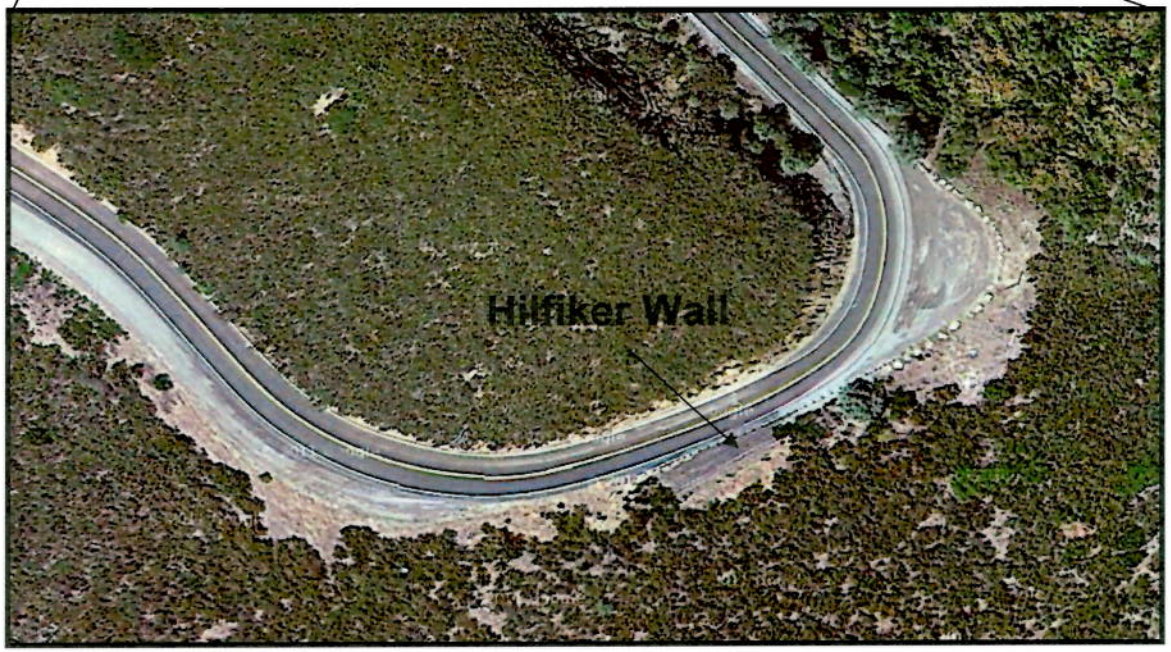
Attachments:

- Plate 1: Vicinity Map/Aerial Photograph
- Plate 2: Plan View
- Plate 3: Wall Profile
- Plate 4: Slope Analysis Cross Section
- Plate 5: Cross Sections – Final Configuration

C: District Project Manager, Jes Padda
GS Corporate, Shira Rajendra
Structure Construction RE Pending File (RE_pending_file@dot.ca.gov)
DES Office Engineer, Office of PS&E, John Stayton
District Material Engineer, Dave Dhillon
GS File Room (gs_file_room@dot.ca.gov)

# Appendix A

## Figures


Maps adapted from Google Maps, 2013

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Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

EA: 10-0W8001

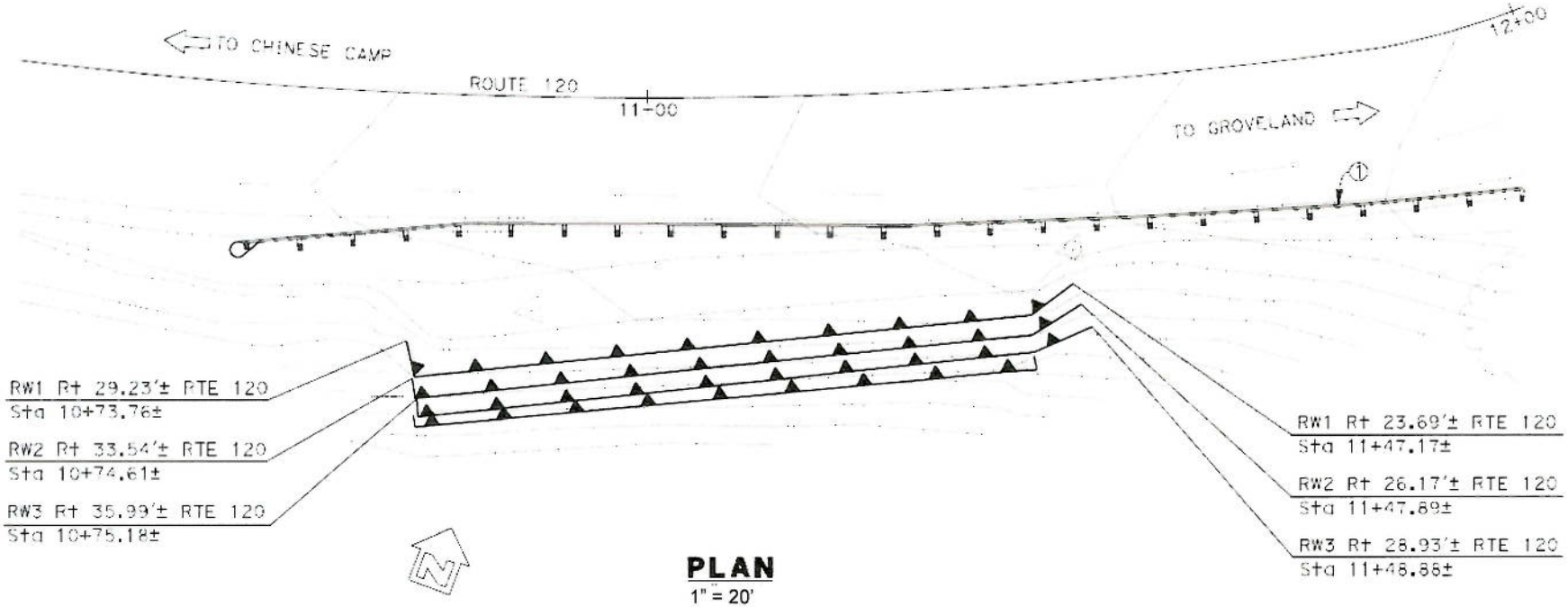
Date: May, 2013

# Vicinity Map/Aerial Photograph

Plate 1

**10-Tuo-120 PM 27.4**

**Slope Stabilization**




**PLAN**
1" = 20'

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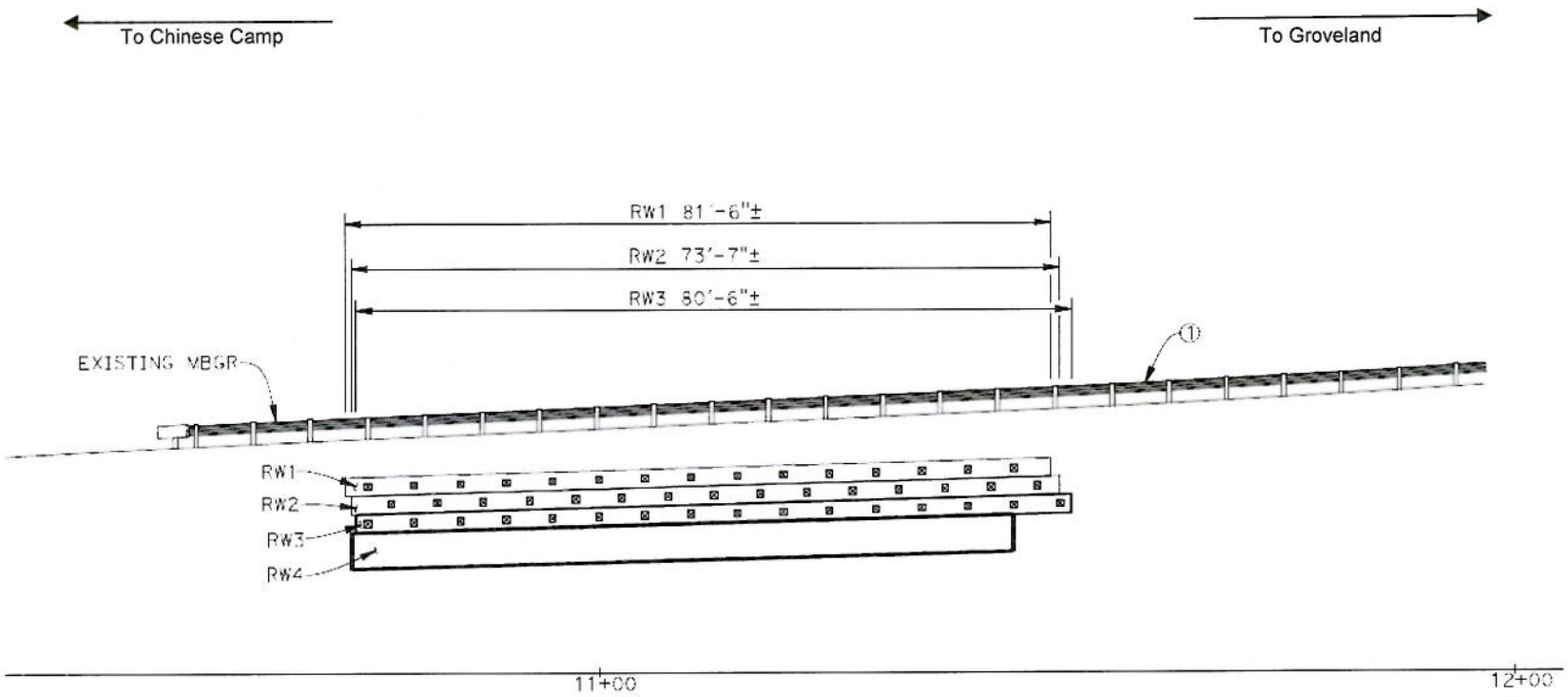
Office of Geotechnical Design - North

EA: 10-0W8001
Date: May, 2013

# Plan View

Plate 2

**10-Tuo-120 PM 27.4**
**Slope Stabilization**




Reinforcement not shown for clarity

**ELEVATION**
1" = 20'

LEGEND:
▣ Indicates Soil Nail

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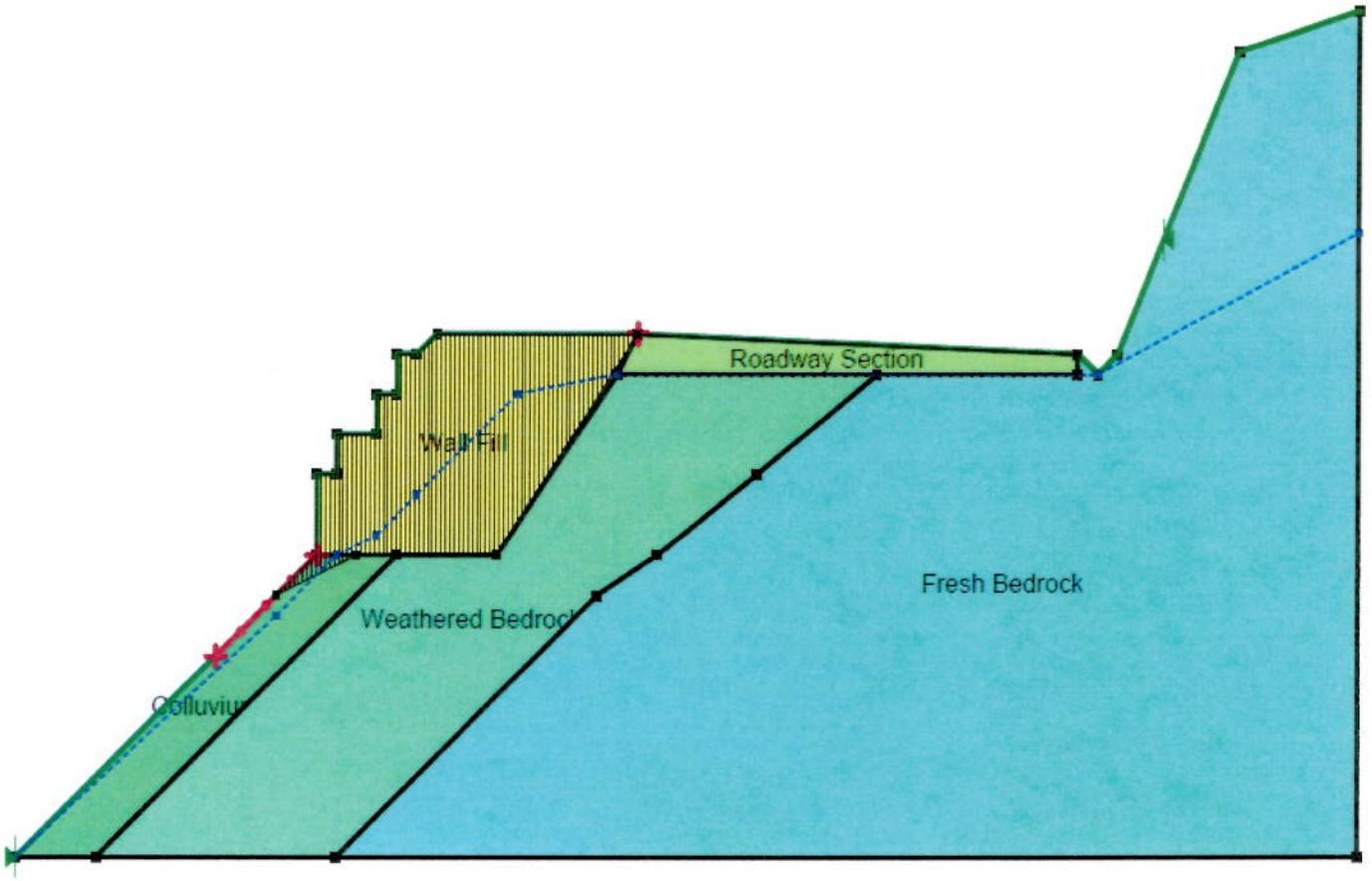
Geotechnical Services
Office of Geotechnical Design - North

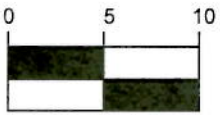
EA: 10-0W8001
Date: May, 2013

# Wall Profile

Plate 3

**10-Tuo-120 PM 27.4**
**Slope Stabilization**




Scale: 1" = 10'

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Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

EA: 10-0W8001

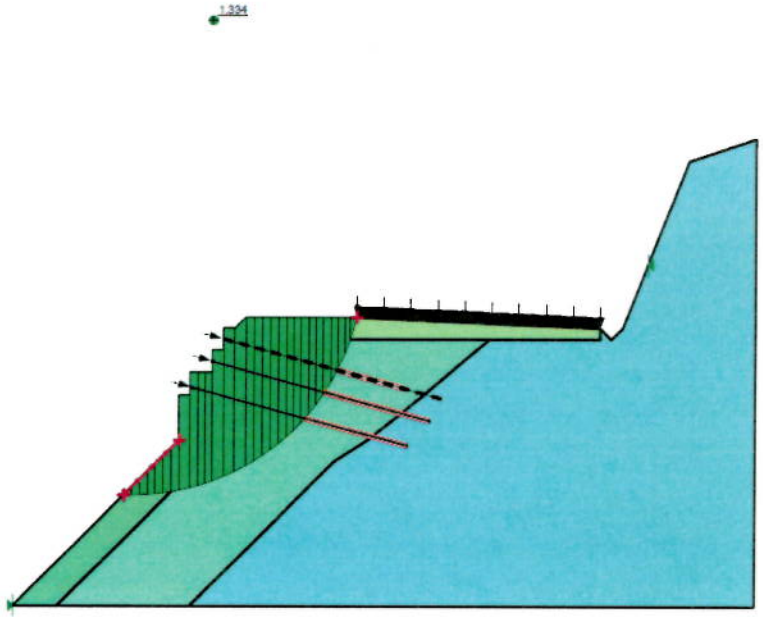
Date: May, 2013

# Slope Analysis Cross Section

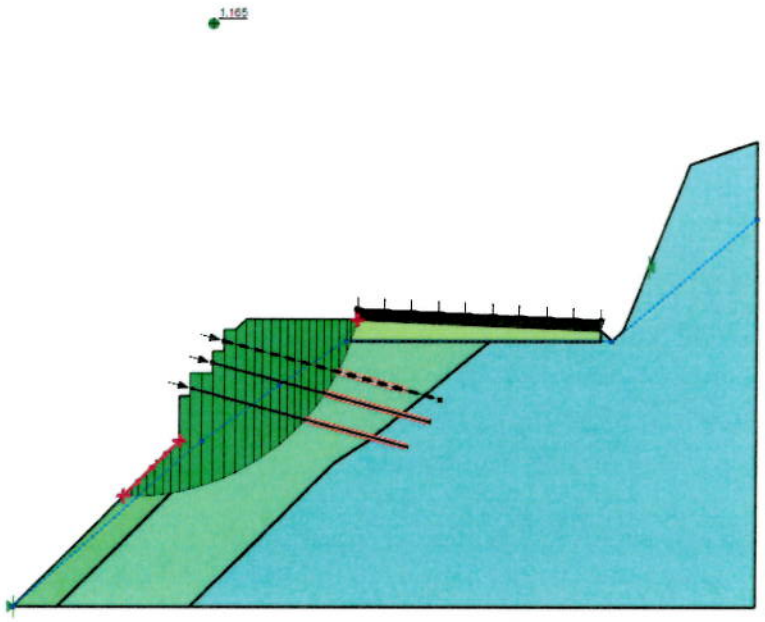
Plate 4

**10-Tuo-120 PM 27.4**

**Slope Stabilization**




**Dry Months Stability – $FOS_{seismic}$ = 1.334**




**Wet Months Stability – $FOS_{seismic}$ = 1.165**

Scale: 1" = 20'

| | | | |
|---|---|---|---|
| CALTRANS<br>Division of Engineering Services<br>Geotechnical Services<br>Office of Geotechnical Design - North | EA: 10-0W8001<br>Date: May, 2013 | **Cross Sections – Final Configuration** | Plate 5 |
| | | **10-Tuo-120 PM 27.4**<br>**Slope Stabilization** | |

# Appendix B

## Laboratory Testing Information

DIVISION OF
ENGINEERING SERVICES
OFFICE OF GEOTECHNICAL SUPPORT
**GEOTECHNICAL LABORATORY**
5900 Folsom Boulevard
Sacramento, CA 95819

**Date:** 5/2/2013

**To:** Brandon Badeker / GDN

**From:** Lilibeth C. Purta / (916) 227-5239

**RE:** Laboratory Test Report -- EA: 10-0W8001
Project: 1012000062
GL 13-015

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**Final test results.**

**Note: All remaining test specimens will be disposed of in 30 calendar days from the release date of the final test results.**

AAPA®
AASHTO R18

CALIFORNIA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL LABORATORY

GL TRACKING NO : 13-015
Dist - EA: 10-0W8001
Report Date: May 2, 2013
Page: 1/1

# CLASSIFICATION TEST SUMMARY

| SAMPLE ID | % FINER THAN | | | | | | | | | | | | | | | | | ATTERBERG LIMITS | | AS RECEIVED | | Gs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3" | 2 1/2" | 2" | 1 1/2" | 1" | 3/4" | 1/2" | 3/8" | No. 4 | No. 8 | No. 16 | No. 30 | No. 50 | No. 100 | No. 200 | 5μ | 1μ | LL | PI | γd (pcf) | %m | |
| R-12-001_1 | | | | | | | | | | | | | | | | | | | | 111.5 | 18.1 | |
| R-12-001_2 | | | | | | | | | | | | | | | | | | | | | | |
| R-12-001_3 | | | | | | | | | | | | | | | | | | | | | | |
| R-12-001_4 | | | | | | | | | | | | | | | | | | | | | | |
| R-12-001_5 | | | | | | | | | | | | | | | | | | | | | | |
| R-12-001_6 | | | | | | | | | | | | | | | | | | | | | | |

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
OFFICE OF GEOTECHNICAL SUPPORT
GEOTECHNICAL LABORATORY

## UNCONFINED COMPRESSION TEST RESULTS (ASTM D7012 Method C)

JOB LOCATION **10-Tuo-120 PM 27.4** GL No. **13-015** DATE **4/25/2013**

TEST BY **AZM**

JOB NUMBER **10-0W8001 Priest Grade Slope Stability** Bridge No. _____ CHECKED BY **LP 5/1/13**

| SAMPLE NO. | DEPTH FT. | DIA. IN. | LENGTH IN. | L/D RATIO | WEIGHT LBS. | LOAD LBS. | DENSITY PCF | STRENGTH PSI | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| R-12-001-2 | 17.0 | 2.37 | 5.54 | 2.34 | 2.3 | 10740 | 161 | 2435 | |
| R-12-001-3 | 22.5 | 2.37 | 4.56 | 1.92 | 1.9 | 13476 | 162 | 3055 | ** |
| R-12-001-4 | 30.0 | | | | | | | | * |
| R-12-001-5 | 35.0 | 2.35 | 4.45 | 1.89 | 1.8 | 11451 | 164 | 2640 | ** |
| R-12-001-6 | 41.0 | 2.34 | 5.51 | 2.35 | 2.3 | 23801 | 170 | 5534 | |
| | | | | | | | | | |
| | | | | | | | | | |
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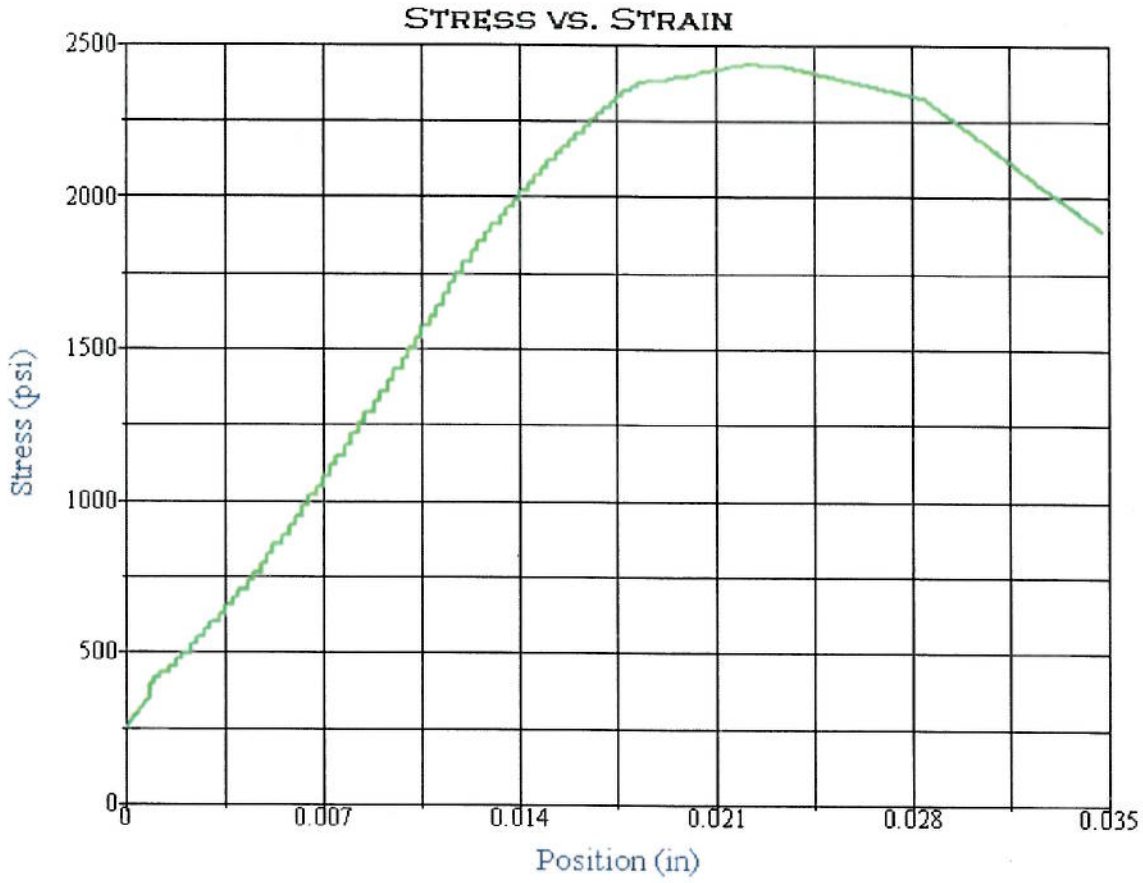
| | | | | | | | | | |

**Note: No moistures recorded**

* Sample fell apart while preparing for testing -- Not suitable for testing

** The test specimen length/diameter ratio was not in compliance with the test method

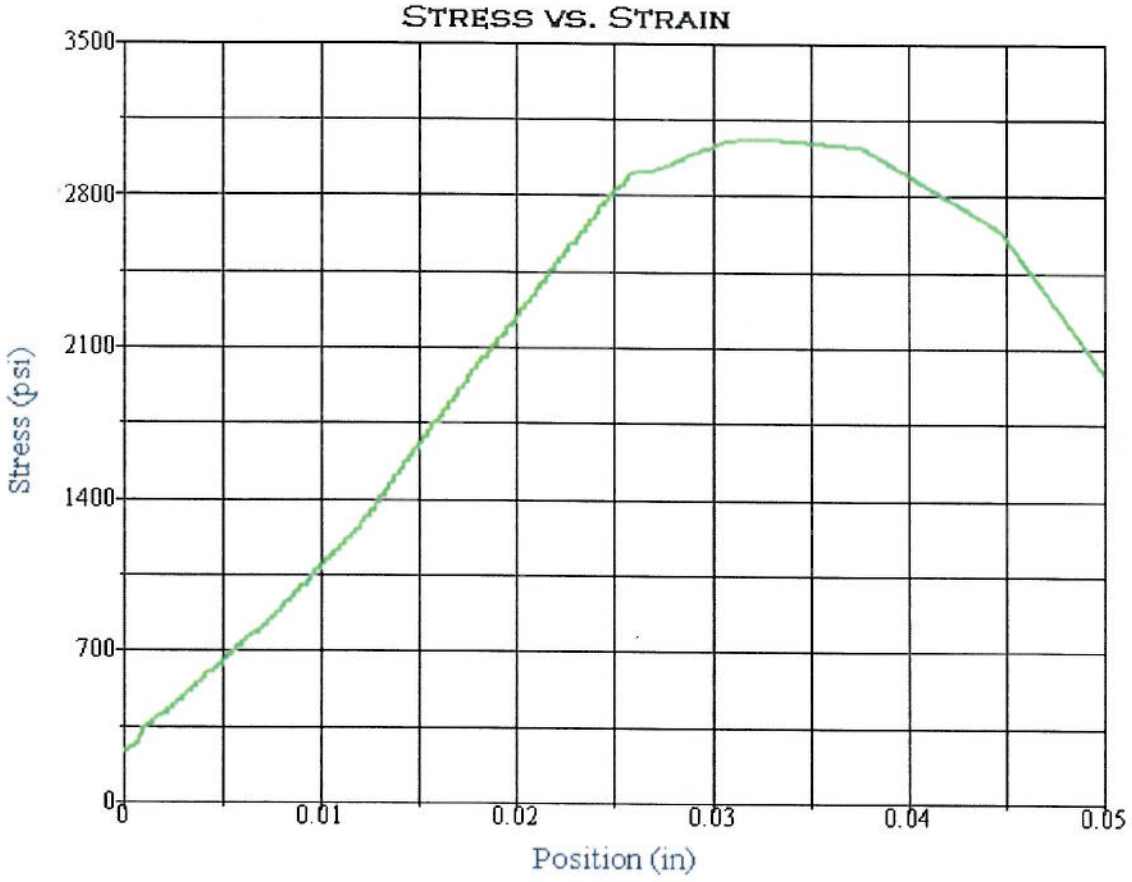



**Test Summary**

| | |
|---|---|
| Counter: | 2432 |
| Elapsed Time: | 00:00:59 |
| Operator: | AZM |
| Sample: | R-12-001-2 |
| Resident Engineer: | |
| Ticket: | GL# 13-015 |
| E.A.NUMBER: | 10-0W8001 |
| Procedure Name: | Cores test for Soil |
| Start Date: | 4/25/2013 |
| Start Time: | 5:29:38 PM |
| End Date: | 4/25/2013 |
| End Time: | 5:30:37 PM |
| Workstation: | D1K00YB1 |
| Tested By: | AZM |
| Lab: | Q13-017 |

**Test Results**

| | |
|---|---|
| Specimen Gage Length: | 5.5400 in |
| Diameter: | 2.3700 in |
| Area: | 4.4115 $in^2$ |
| Maximum Load: | 10740 lbf |
| Compressive Strength: | 2435 psi |

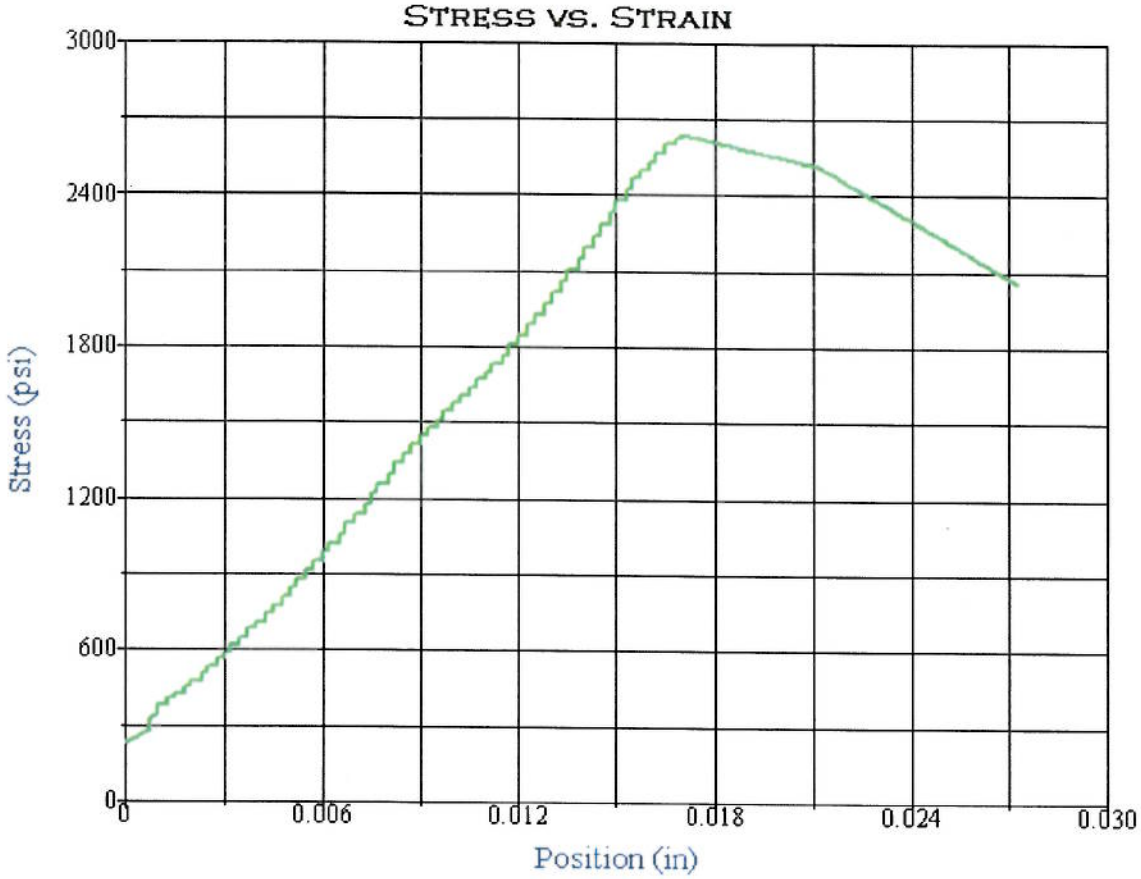



**Test Summary**

| | |
|---|---|
| Counter: | 2433 |
| Elapsed Time: | 00:01:19 |
| Operator: | AZM |
| Sample: | R-12-001-3 |
| Resident Engineer: | AZM |
| Ticket: | GL# 13-015 |
| E.A.NUMBER: | 10-0W8001 |
| Procedure Name: | Cores test for Soil |
| Start Date: | 4/25/2013 |
| Start Time: | 5:37:11 PM |
| End Date: | 4/25/2013 |
| End Time: | 5:38:30 PM |
| Workstation: | D1K00YB1 |
| Tested By: | AZM |
| Lab: | Q13-018 |

**Test Results**

| | |
|---|---|
| Specimen Gage Length: | 4.5600 in |
| Diameter: | 2.3700 in |
| Area: | 4.4115 in² |
| Maximum Load: | 13476 lbf |
| Compressive Strength: | 3055 psi |

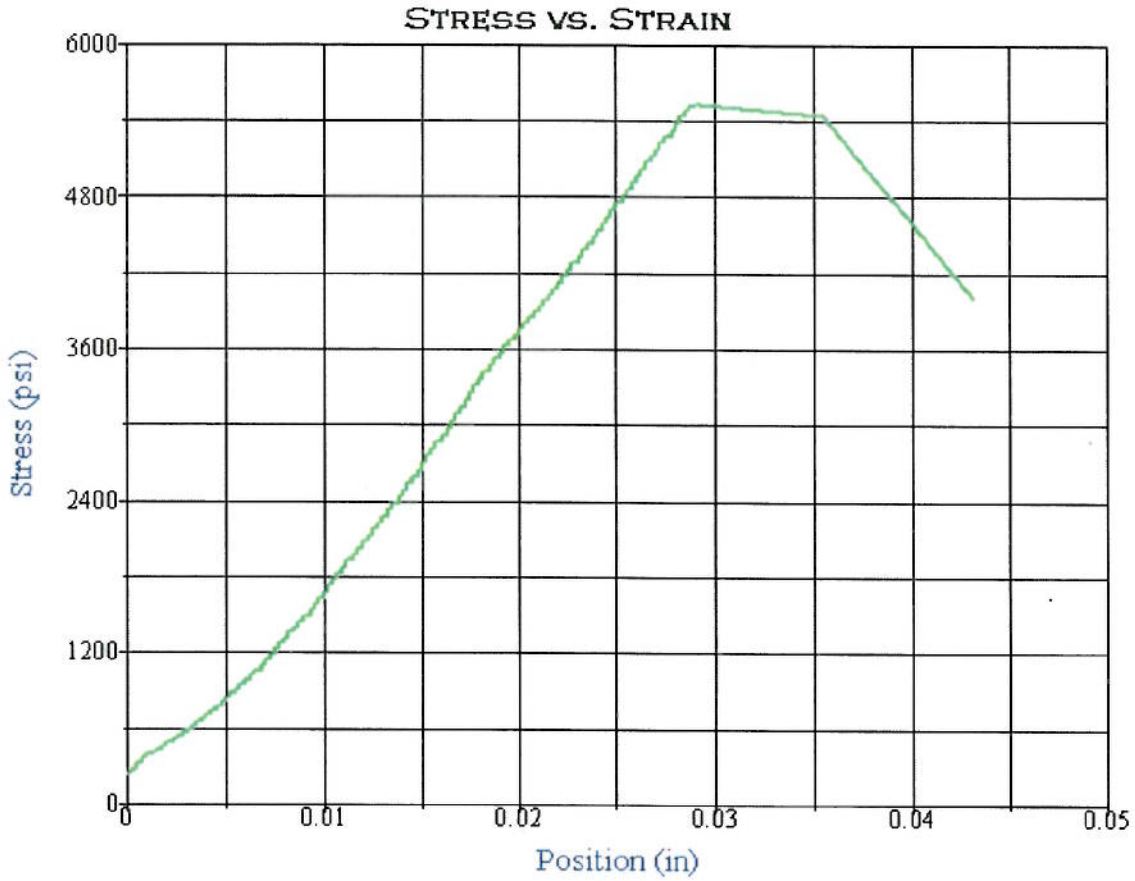



**Test Summary**

| | |
|---|---|
| Counter: | 2434 |
| Elapsed Time: | 00:01:05 |
| Operator: | AZM |
| Sample: | R-12-001-5 |
| Resident Engineer: | |
| Ticket: | GL# 13-015 |
| E.A.NUMBER: | 10-0W8001 |
| Procedure Name: | Cores test for Soil |
| Start Date: | 4/25/2013 |
| Start Time: | 5:45:25 PM |
| End Date: | 4/25/2013 |
| End Time: | 5:46:30 PM |
| Workstation: | D1K00YB1 |
| Tested By: | AZM |
| Lab: | Q13-020 |

**Test Results**

| | |
|---|---|
| Specimen Gage Length: | 4.4500 in |
| Diameter: | 2.3500 in |
| Area: | 4.3374 $in^2$ |
| Maximum Load: | 11451 lbf |
| Compressive Strength: | 2640 psi |




**Test Summary**

| | |
|---|---|
| Counter: | 2435 |
| Elapsed Time: | 00:02:29 |
| Operator: | AZM |
| Sample: | R-12-001-6 |
| Resident Engineer: | |
| Ticket: | GL# 13-015 |
| E.A. NUMBER: | 10-0W8001 |
| Procedure Name: | Cores test for Soil |
| Start Date: | 4/25/2013 |
| Start Time: | 6:00:08 PM |
| End Date: | 4/25/2013 |
| End Time: | 6:02:37 PM |
| Workstation: | D1K00YB1 |
| Tested By: | AZM |
| Lab: | Q13-021 |

**Test Results**

| | |
|---|---|
| Specimen Gage Length: | 5.5100 in |
| Diameter: | 2.3400 in |
| Area: | 4.3005 $in^2$ |
| Maximum Load: | 23801 lbf |
| Compressive Strength: | 5534 psi |

Division of Engineering Services
Geotechnical Laboratory

# Point Load Strength Index

Dist-EA: 10-0W8001
Dist-Co-Rte-PM: TUO-120-27.4/

GI Tracking No.: 13-015
Report Date: May 2, 2013

| Sample ID | Test Type | Length , L (mm) | Width, W (mm) | Initial Distance Between Contact Points, D(mm) | Final Distance Between Contact Points, D'(mm) | Equivalent Diameter, De (mm) | Failure Load, P (lbs) | Uncorrected Point Load Strength Index Is (psi) | Point Load Strength Index Is (50) (psi) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| R-12-001_4 | A-L | | 59.7 | 39.5 | 35 | 51.58 | 3046.56 | 738.8 | 749 | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |


R-12-001_4

**No Image Available**

**No Image Available**

**No Image Available**

Test Type Abbreviations: D- Diametral, A - Axial, B - Block, I - Irregular Lump

Orientation of Load Direction (if anisotropic): P - Perpendicular to plane of weakness, L - Parallel to plane of weakness

# Appendix C

## Slope/W Analysis

# SLOPE/W Analysis



## File Information

Revision Number: 54
Last Edited By: Badeker, Brandon H@DOT
Date: 5/23/2013
Time: 11:25:13 AM
File Name: Wall Analysis Final Dry.gsz
Directory: N:\RGE\Geotech North\BBadeker\10-TUO-120 PM 27.6\
Last Solved Date: 5/23/2013
Last Solved Time: 11:25:16 AM

## Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

## Analysis Settings

### SLOPE/W Analysis

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: No
    Tension Crack
        Tension Crack Option: Tension Crack Line
        Percentage Wet: 1
        Tension Crack Fluid Unit Weight: 62.4 pcf
FOS Distribution

FOS Calculation Option: Constant

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

# Materials

## Wall Fill

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion: 0 psf
Phi: 40 °
Phi-B: 0 °

## Roadway Section

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °

## Colluvium

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 50 psf
Phi: 25 °
Phi-B: 0 °

## Weathered Bedrock

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 28 °
Phi-B: 0 °

## Fresh Bedrock

Model: Mohr-Coulomb
Unit Weight: 150 pcf

Cohesion: 500 psf
Phi: 35 °
Phi-B: 0 °

## Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (3, 7) ft
Left-Zone Right Coordinate: (8, 12) ft
Left-Zone Increment: 4
Right Projection: Point
Right Coordinate: (24, 23) ft
Right-Zone Increment: 4
Radius Increments: 4

## Slip Surface Limits

Left Coordinate: (-7, -3) ft
Right Coordinate: (50.275862, 27.689655) ft

## Surcharge Loads

### Surcharge Load 1

Surcharge (Unit Weight): 240 pcf
Direction: Vertical

Coordinates

| | X (ft) | Y (ft) |
|---|---|---|
| | 24.011414 | 24.000013 |
| | 46 | 23 |

## Seismic Loads

Horz Seismic Load: 0.2
Ignore seismic load in strength: No

## Reinforcements

### Reinforcement 1

Type: Nail
Outside Point: (12.000218, 21.002016) ft
Inside Point: (31.548115, 15.764173) ft

Slip Surface Intersection: (22.25, 18.256) ft
Total Length: 20.237472 ft
Reinforcement Direction: 165 °
Applied Load Option: Variable
F of S Dependent: No
Bond Diameter: 0.5 ft
Bond Safety Factor: 1.5
Bond Skin Friction: 1500 psf
Bond Resistance: 314.15927 lbs/ft
Nail Spacing: 5 ft
Bar Capacity: 10000 lbs
Bar Safety Factor: 1
Bar Load: 2000 lbs
Load Distribution: Even along reinf.
Shear Capacity: 0 lbs
Shear Safety Factor: 1
Shear Option: Parallel to Slip
Shear Load: 0 lbs
Applied Load: 2000 lbs
Nail Load Used: 2000 lbs
Resisting Force Used: 314.16 lbs/ft
Available Bond Length: 9.6263 ft
Required Bond Length: 6.3662 ft
Governing Component: Bar

## Reinforcement 2

Type: Nail
Outside Point: (10.9999, 19.000092) ft
Inside Point: (30.525276, 13.768283) ft
Slip Surface Intersection: (21.102, 16.293) ft
Total Length: 20.214157 ft
Reinforcement Direction: 165 °
Applied Load Option: Variable
F of S Dependent: No
Bond Diameter: 0.31830989 ft
Bond Safety Factor: 1.5
Bond Skin Friction: 1500 psf
Bond Resistance: 200 lbs/ft
Nail Spacing: 5 ft
Bar Capacity: 10000 lbs
Bar Safety Factor: 1
Bar Load: 2000 lbs
Load Distribution: Even along reinf.
Shear Capacity: 0 lbs
Shear Safety Factor: 1
Shear Option: Parallel to Slip
Shear Load: 0 lbs
Applied Load: 2000 lbs

Nail Load Used: 1951.2 lbs
Resisting Force Used: 200 lbs/ft
Available Bond Length: 9.7558 ft
Required Bond Length: 9.7558 ft
Governing Component: Bond

### Reinforcement 3

Type: Nail
Outside Point: (9.183397, 16.702264) ft
Inside Point: (28.501913, 11.525883) ft
Slip Surface Intersection: (19.328, 13.984) ft
Total Length: 20 ft
Reinforcement Direction: 165 °
Applied Load Option: Variable
F of S Dependent: No
Bond Diameter: 0.31830989 ft
Bond Safety Factor: 1.5
Bond Skin Friction: 1500 psf
Bond Resistance: 200 lbs/ft
Nail Spacing: 5 ft
Bar Capacity: 10000 lbs
Bar Safety Factor: 1
Bar Load: 2000 lbs
Load Distribution: Even along reinf.
Shear Capacity: 0 lbs
Shear Safety Factor: 1
Shear Option: Parallel to Slip
Shear Load: 0 lbs
Applied Load: 2000 lbs
Nail Load Used: 1899.4 lbs
Resisting Force Used: 200 lbs/ft
Available Bond Length: 9.4971 ft
Required Bond Length: 9.4971 ft
Governing Component: Bond

## Tension Crack Line

| | X (ft) | Y (ft) |
|---|---|---|
| | 6 | 10 |
| | 10 | 12 |
| | 17 | 12 |
| | 24 | 23 |

## Regions

| | Material | Points | Area ($ft^2$) |
|---|---|---|---|
| Region 1 | Wall Fill | 1,2,3,4,5,6,7,8,9,10,11,21,12,15 | 117.5 |
| Region 2 | Colluvium | 1,13,14,15 | 60 |
| Region 3 | Weathered Bedrock | 15,14,16,17,18,19,20,21,12 | 276 |
| Region 4 | Roadway Section | 11,21,20,22,23 | 34 |
| Region 5 | Fresh Bedrock | 23,24,25,26,27,28,16,17,18,19,20,22 | 1070.5 |

## Points

| | X (ft) | Y (ft) |
|---|---|---|
| Point 1 | 8 | 12 |
| Point 2 | 8 | 16 |
| Point 3 | 9 | 16 |
| Point 4 | 9 | 18 |
| Point 5 | 11 | 18 |
| Point 6 | 11 | 20 |
| Point 7 | 12 | 20 |
| Point 8 | 12 | 22 |
| Point 9 | 13 | 22 |
| Point 10 | 14 | 23 |
| Point 11 | 24 | 23 |
| Point 12 | 17 | 12 |
| Point 13 | -7 | -3 |
| Point 14 | -3 | -3 |
| Point 15 | 12 | 12 |
| Point 16 | 9 | -3 |
| Point 17 | 22 | 10 |
| Point 18 | 25 | 12 |
| Point 19 | 30 | 16 |
| Point 20 | 36 | 21 |
| Point 21 | 23 | 21 |
| Point 22 | 46 | 21 |
| Point 23 | 46 | 22 |
| Point 24 | 47 | 21 |
| Point 25 | 48 | 22 |

| | | |
|---|---|---|
| Point 26 | 54 | 37 |
| Point 27 | 60 | 39 |
| Point 28 | 60 | -3 |

## Critical Slip Surfaces

| | Slip Surface | FOS | Center (ft) | Radius (ft) | Entry (ft) | Exit (ft) |
|---|---|---|---|---|---|---|
| 1 | 4 | 1.334 | (3.797, 27.736) | 20.751 | (24, 23) | (3, 7) |

### Slices of Slip Surface: 4

| | Slip Surface | X (ft) | Y (ft) | PWP (psf) | Base Normal Stress (psf) | Frictional Strength (psf) | Cohesive Strength (psf) |
|---|---|---|---|---|---|---|---|
| 1 | 4 | 3.3565845 | 6.9924375 | 0 | 39.311437 | 18.331224 | 50 |
| 2 | 4 | 4.0697535 | 6.989571 | 0 | 111.75907 | 52.11411 | 50 |
| 3 | 4 | 4.7829225 | 7.011239 | 0 | 179.79591 | 83.840209 | 50 |
| 4 | 4 | 5.4960915 | 7.057519 | 0 | 244.44722 | 113.98761 | 50 |
| 5 | 4 | 6.20926 | 7.1285765 | 0 | 306.51479 | 142.93019 | 50 |
| 6 | 4 | 6.9224285 | 7.2246695 | 0 | 366.60492 | 170.95068 | 50 |
| 7 | 4 | 7.6395065 | 7.3469605 | 0 | 374.67191 | 199.21659 | 200 |
| 8 | 4 | 8.5 | 7.531305 | 0 | 885.69734 | 470.93363 | 200 |
| 9 | 4 | 9.3333335 | 7.7400015 | 0 | 1109.1542 | 589.74777 | 200 |
| 10 | 4 | 9.9999985 | 7.9367415 | 0 | 1073.1091 | 570.58224 | 200 |
| 11 | 4 | 10.666665 | 8.1581545 | 0 | 1044.8068 | 555.5336 | 200 |
| 12 | 4 | 11.5 | 8.475106 | 0 | 1253.555 | 666.52699 | 200 |
| 13 | 4 | 12.5 | 8.9061965 | 0 | 1455.0795 | 773.67951 | 200 |
| 14 | 4 | 13.5 | 9.4019405 | 0 | 1443.1359 | 767.32895 | 200 |
| 15 | 4 | 14.375 | 9.8888465 | 0 | 1433.5018 | 762.20644 | 200 |
| 16 | 4 | 15.125 | 10.355545 | 0 | 1378.2721 | 732.84026 | 200 |
| 17 | 4 | 15.875 | 10.868505 | 0 | 1316.0405 | 699.75116 | 200 |
| 18 | 4 | 16.625 | 11.432105 | 0 | 1244.8447 | 661.89568 | 200 |
| 19 | 4 | 17.333335 | 12.01418 | 0 | 1158.6366 | 616.058 | 200 |
| 20 | 4 | 18 | 12.614285 | 0 | 1066.707 | 567.17817 | 200 |
| 21 | 4 | 18.666665 | 13.270035 | 0 | 966.2818 | 513.78115 | 200 |
| 22 | 4 | 19.333335 | 13.98944 | 0 | 857.24452 | 455.805 | 200 |
| 23 | 4 | 20 | 14.78318 | 0 | 729.42043 | 387.83972 | 200 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24 | 4 | 20.666665 | 15.66608 | 0 | 594.35719 | 316.02533 | 200 |
| 25 | 4 | 21.333335 | 16.65976 | 0 | 452.65219 | 240.67944 | 200 |
| 26 | 4 | 22 | 17.798115 | 0 | 283.60587 | 150.79592 | 200 |
| 27 | 4 | 22.666665 | 19.1405 | 0 | 98.95037 | 52.612845 | 200 |
| 28 | 4 | 23.21199 | 20.43615 | 0 | -34.483703 | -18.33531 | 200 |
| 29 | 4 | 23.71199 | 22 | 0 | 51.266134 | 32.034636 | 0 |

**Housing Agency**

# M e m o r a n d u m

***Flex your power!***
***Be energy efficient!***

**To:** Rene Coria
Bridge Design Branch 17

**Date:** January 7, 2014

**File**: 10-TUO-120 PM 27.4
EA 10-0W8001
1012000063

Attention:

**From: DEPARTMENT OF TRANSPORTATION**
**DIVISION OF ENGINEERING SERVICES**
**Geotechnical Services**
**Office of Geotechnical Design – South 1**
**Branch A**

**Subject:** Amendment to Foundation Report for Slope Stabilization (Issue Date: May 29, 2013)

In response to the request from the Office of Bridge Design, the Office of Geotechnical Design South 1 (OGDS1) prepared this amendment to change the slope stabilization method from a soil nail wall to a solider pile cantilever wall, and provide geotechnical recommendations for the proposed wall. This change was proposed by as a result of constructability review and field observation of existing Hilfiker wall performed in December 2014. The bulging and out of plumb of exiting wall and very wet and soft condition of the fill materials behind the wall rendered the originally recommended and planned soil nail wall difficult to construct.

The recommendations and construction consideration for the design of the soil nail wall presented in the report issued on May 29, 2013 are superseded by this amendment.

## Recommendations

Based on the foundation report and subsurface exploration performed on November 16 2012, following engineering properties should be used to estimate earth pressure coefficient and corresponding lateral earth pressure for the proposed wall design.

| Depth[1] (ft) | Soil Type | Unit Weight ($lb/ft^3$) | Friction Angle (degree) | Cohesion ($lb/ft^2$) |
|---|---|---|---|---|
| 0 to 10 | Fill[2] | 125 | 28 | 0 |
| 10 to 25 | Weathered[3] Rock | 120 | 28 | 200 |
| 25 to | Rock | 150 | 35 | 500 |

(1) Depth starts from existing ground at the proposed wall location.

(2) According to Caltrans Construction, the existing walls constructed from extra materials from the Ferguson Slide temporary bridge abutments.

(3) Weathered rock properties should be used for design purpose only and hard excavation through this material should be anticipated.

The above engineering parameters have been assumed to arrive at a conservative design and must be used for design purpose only. These conservatively assumed values cannot be used for the selection of equipment and construction method.

Design wall height is assumed to be 10 feet and the diameter of drilled hole should be at least 4 inches larger than the greatest dimension of H-beam.

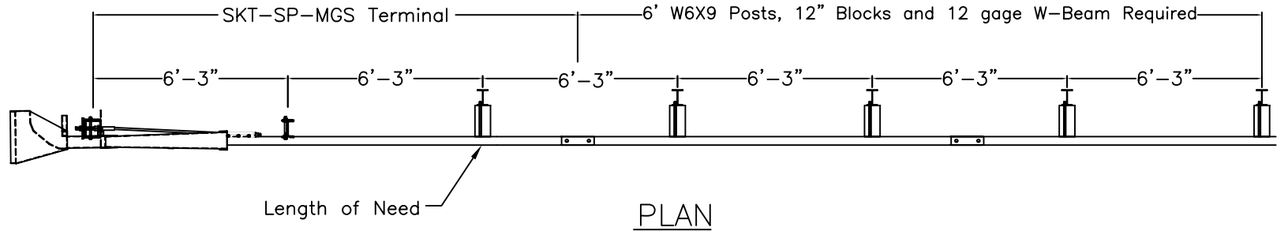
**Construction Consideration**

Section 49-4.03B Drilled Holes through Rock Material and Pile Substitutions:

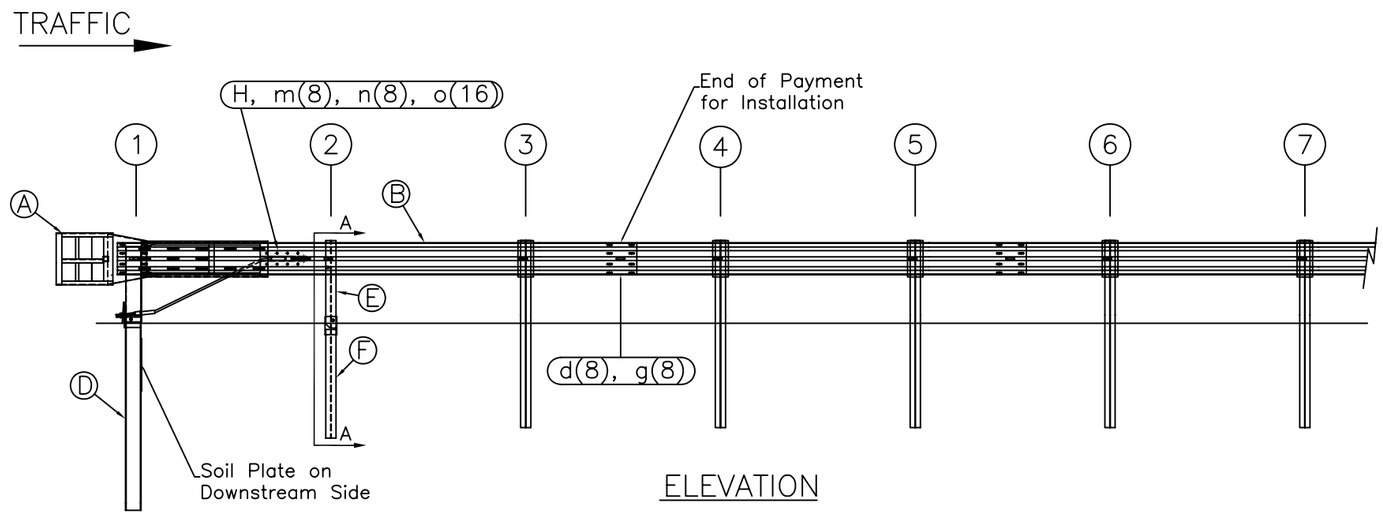
Based on LOTB, hard excavation through weathered and fresh rock materials during pile installation should be expected.

If you have any question regarding this report, please contact Seungwoon Han.

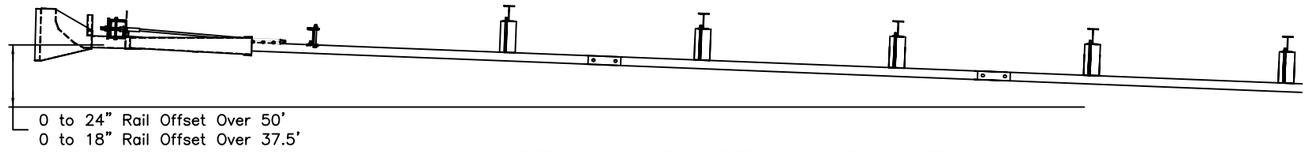

Seungwoon Han, Ph.D, P.E.
Transportation Engineer




PLAN



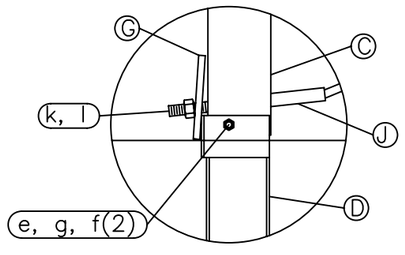

ELEVATION



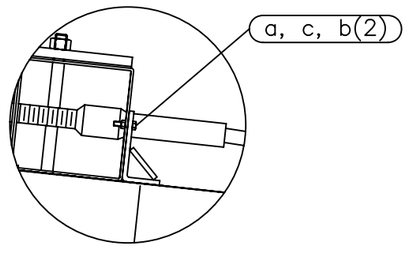

OPTIONAL FLARED INSTALLATION
25:1 maximum flare rate

| ITEM | QTY | BILL OF MATERIALS | ITEM NO. |
|---|---|---|---|
| A | 1 | IMPACT HEAD | S3000 |
| B | 1 | W–BEAM GUARDRAIL END SECTION, 12 Ga. | MGS–SF1303 |
| C | 1 | FIRST POST TOP (6X6X$\frac{1}{8}$" Tube) | TPHP1A |
| D | 1 | FIRST POST BOTTOM (6' W6X15) | TPHP1B |
| E | 1 | SECOND POST ASSEMBLY TOP | UHP2A |
| F | 1 | SECOND POST ASSEMBLY BOTTOM | HP3B |
| G | 1 | BEARING PLATE | E750 |
| H | 1 | CABLE ANCHOR BOX | S760 |
| J | 1 | BCT CABLE ANCHOR ASSEMBLY | E770 |
| | | | |
| | | HARDWARE (ALL DIMENSIONS IN INCHES) | |
| a | 2 | 5/16 x 1 HEX BOLT GRD 5 | B5160104A |
| b | 4 | 5/16 WASHER | W0516 |
| c | 2 | 5/16 HEX NUT | N0516 |
| d | 9 | 5/8 Dia. x 1 1/4 SPLICE BOLT (POST #2) | B580122 |
| e | 1 | 5/8 Dia. x 9 HEX BOLT GRD 5 | B580904A |
| f | 3 | 5/8 WASHER | W050 |
| g | 10 | 5/8 Dia. H.G.R NUT | N050 |
| h | 1 | 3/4 Dia. x 8 1/2 HEX BOLT GRD A449 | B340854A |
| j | 1 | 3/4 Dia. HEX NUT | N030 |
| k | 2 | 1 ANCHOR CABLE HEX NUT | N100 |
| l | 2 | 1 ANCHOR CABLE WASHER | W100 |
| m | 8 | CABLE ANCHOR BOX SHOULDER BOLT | SB58A |
| n | 8 | 1/2 A325 STRUCTURAL NUT | N055A |
| o | 16 | 1 1/16 OD x 9/16 ID A325 STR. WASHER | W050A |

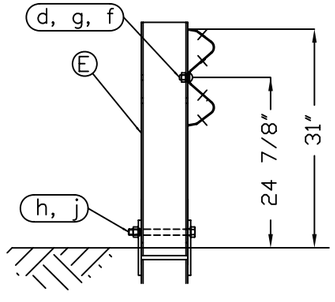
GENERAL NOTES:
1. All bolts, nuts, cable assemblies, cable anchors and bearing plates shall be galvanized.
2. The lower sections of the Posts 1&2 shall not protrude more than 4 in above the ground (measured along a 5' cord). Site grading may be necessary to meet this requirement.
3. The lower sections of the hinged posts should not be driven with the upper post attached. If the post is placed in a drilled hole, the backfill material must be satisfactorily compacted to prevent settlement.
4. When competent rock is encountered, a 12" Ø post hole, 20 in. deep cored into the rock surface may be used if approved by the engineer for post 1. Granular material will be placed in the bottom of the hole, approximately 2.5" deep to provide drainage. The first post can be field cut to length, placed in the hole and backfilled with suitable backfill. The soil plate may be trimmed if required.
5. A site evaluation should be considered if there is less than 25' between the outlet side of the terminal and any adjacent driving lane.
6. The breakaway cable assembly must be taut. A locking device (vice grips or channel lock pliers) should be used to prevent the cable from twisting when tightening nuts.




Post #1 Connection Detail




Impact Head Connection Detail



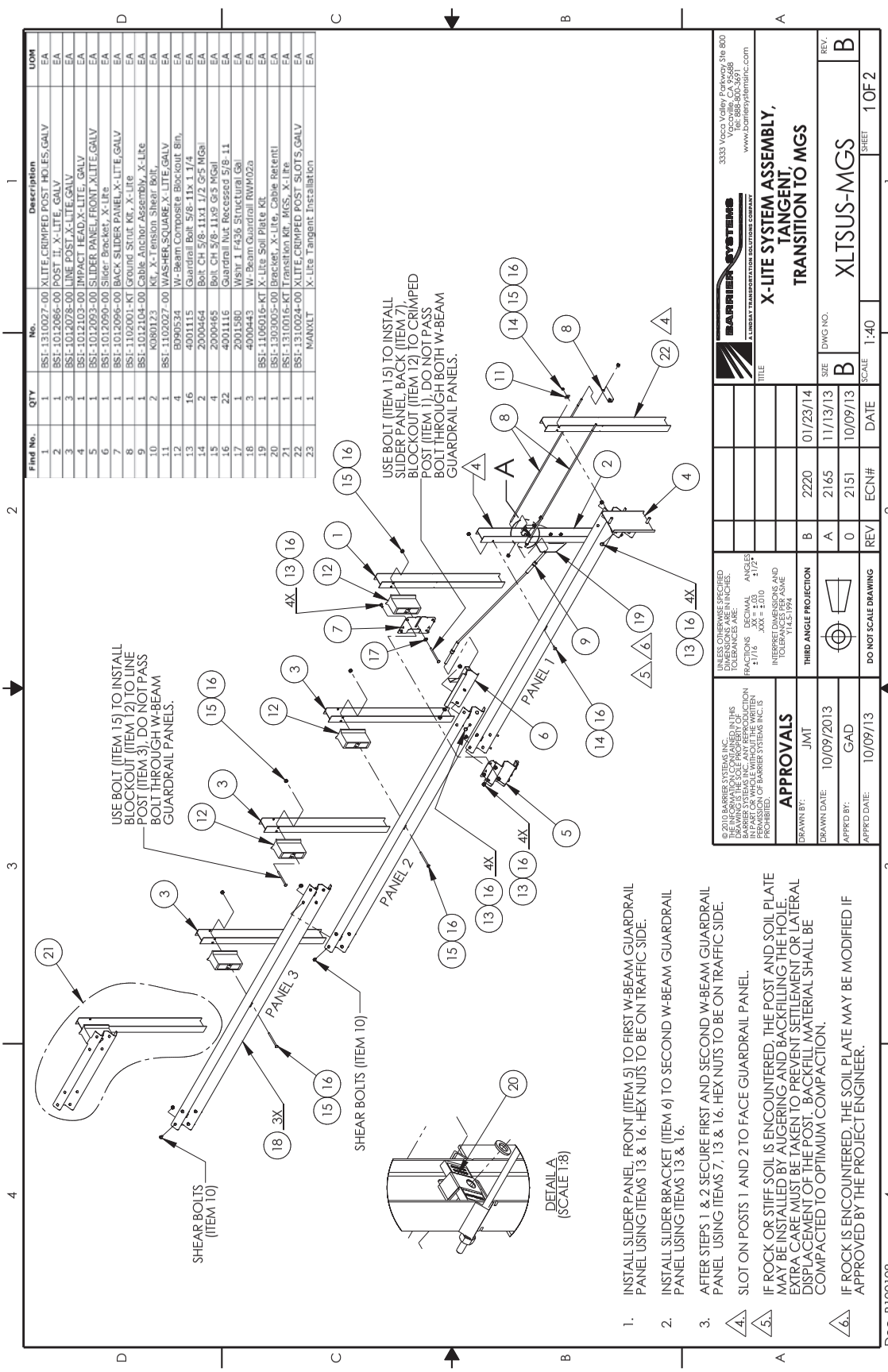

SECTION A–A
Post #2

**Road Systems, Inc.**
Big Spring, TX
Phone: 432-263-2435
or Phone: 330-346-0721

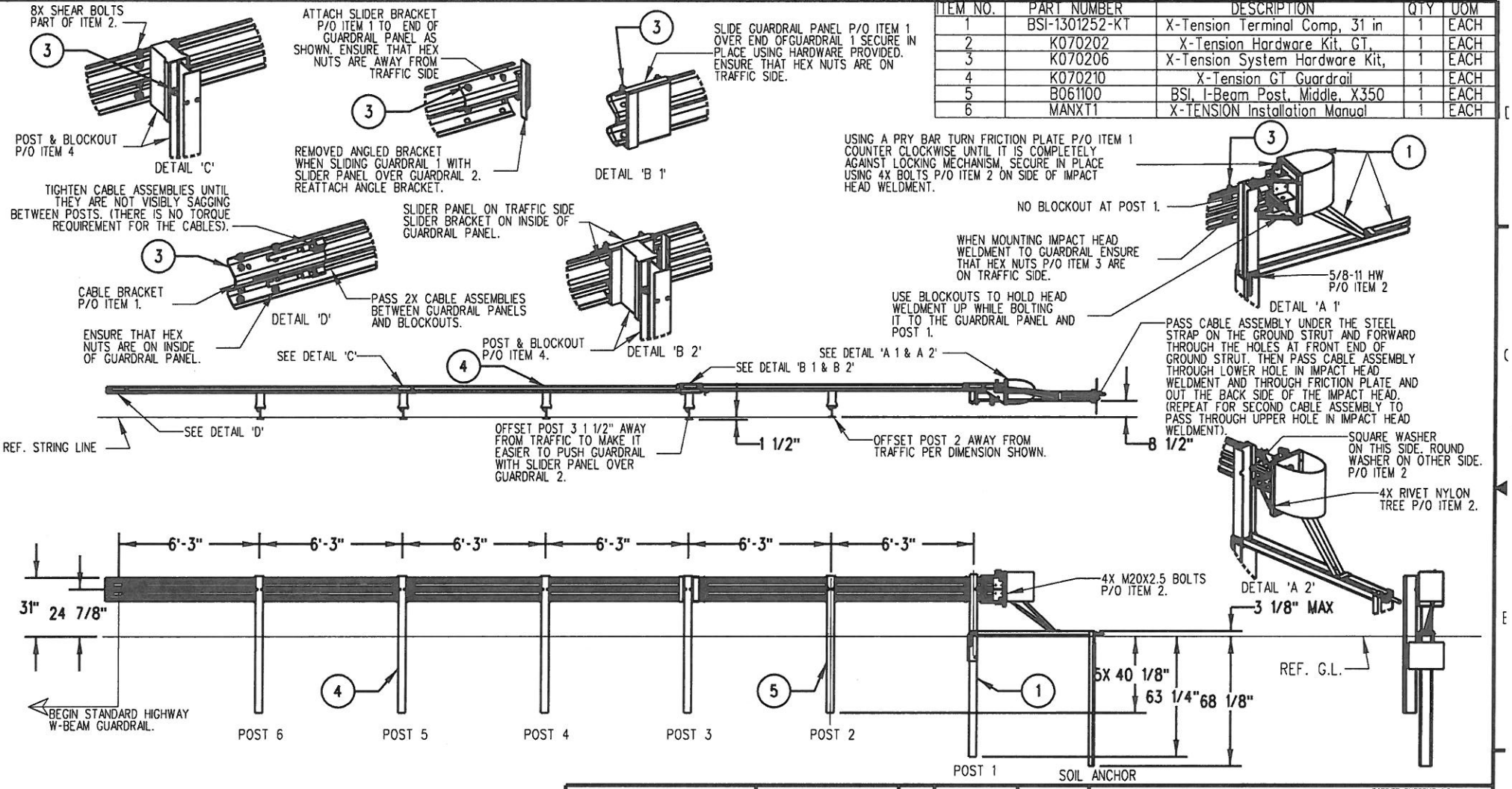
SKT-SP-MGS Terminal
Midwest Guardrail System
31" Top of Rail

Sheet: 1
Date: 02/24/10
By: JRR
Drawing Name: SKT-SP-S-MGS
Scale: None
Rev: 0

## Appendix A - System Configuration, 37’ 6” MGS



| ITEM NO. | PART NUMBER | DESCRIPTION | QTY | UOM |
|---|---|---|---|---|
| 1 | BSI-1301252-KT | X-Tension Terminal Comp, 31 in | 1 | EACH |
| 2 | K070202 | X-Tension Hardware Kit, GT, | 1 | EACH |
| 3 | K070206 | X-Tension System Hardware Kit, | 1 | EACH |
| 4 | K070210 | X-Tension GT Guardrail | 1 | EACH |
| 5 | B061100 | BSI, I-Beam Post, Middle, X350 | 1 | EACH |
| 6 | MANXT1 | X-TENSION Installation Manual | 1 | EACH |




NOTES: UNLESS OTHERWISE SPECIFIED.

1. SYSTEM TO BE INSTALLED PER MANUFACTURER SPECIFICATIONS.
2. ONLY TIGHTEN THE CABLE ASSEMBLIES USING THE NUTS AT THE CABLE BRACKET (SEE DETAIL 'D'). DO NOT TIGHTEN THE CABLES AT THE FRONT OF THE GROUND ANCHOR.
3. WHEN DRIVING STEEL POST, ENSURE THAT A DRIVING CAP WITH TIMBER OR PLASTIC INSERT IS USED TO PREVENT DAMAGE TO THE GALVANIZING TO THE TOP OF THE POST.



APPROVALS

| | |
|---|---|
| DRAWN BY: | NMV |
| DRAWN DATE: | 2/08/13 |
| APPR'D BY: | JMT |
| APPR'D DATE: | 2/08/13 |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
FRACTIONS ±1/16 DECIMAL .XX ± .03 .XXX ± .010 ANGLES ±1/2°
INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-1994
THIRD ANGLE PROJECTION
DO NOT SCALE DRAWING

| REV | ECN# | DATE |
|---|---|---|
| B | 2067 | 05/02/13 |
| A | 2022 | 2/08/13 |

LINDSAY TRANSPORTATION SOLUTIONS™


BARRIER SYSTEMS INC.
3333 Vaca Valley Parkway Ste 800
Vacaville, CA 95688
Tel: 888-800-3691
www.barriersystemsinc.com


TITLE
X-TENSION GUARDRAIL TERMINAL SYSTEM
STEEL POST WITH COMPOSITE BLOCKOUT
31" RAIL HEIGHT

| SIZE | DWG NO. | REV. |
|---|---|---|
| B | XTGTSS5 | B |

SCALE 1:50 SHEET 1 OF 1