

SHORING PLAN  
COASTLINE DR 12-INCH  
WATERLINE IMPROVEMENT

REV #2

DESIGN CALCULATIONS  
May 1, 2025

PREPARED BY:  
SCOTT F CANNON, PE



MZB ENGINEERING, INC

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D:\DROPOBOX\KORPL\_CANNON\_ENGINEERING\PROJECTS\KC-0119 - MZB ENGINEERING\DESIGN\EXCAV - SHORING\4.0 COASTLINE DR SHORING\COASTLINE DR - R0 EXCAV FILE.DWG

PLANS FOR CONSTRUCTION ON  
COASTLINE ROAD  
IN LOS ANGELES COUNTY  
12-INCH WATERLINE  
SHORING PLAN  
REVISION 2

INDEX TO PLANS

| SHEET NO. | TITLE         |
|-----------|---------------|
| 1         | COVER         |
| 2         | SHORING NOTES |
| 3         | PLAN VIEW     |
| 4         | PLAN VIEW     |
| 5         | PLAN VIEW     |
| 6         | SECTION VIEW  |

LOCATION MAP



May 1, 2025



| DESIGN BY: | REV. | DATE    | DESCRIPTION                  |
|------------|------|---------|------------------------------|
| S. CANNON  | 0    | 3-26-25 | RFC SUBMITTAL                |
| DRAWN BY:  | 1    | 4-17-25 | LACPW COMMENTS DATED 4/15/25 |
| S. CANNON  | 2    | 4-30-25 | LACPW COMMENTS DATED 4/29/25 |
| SCALE:     |      |         |                              |
| AS SHOWN   |      |         |                              |

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|                           |       |                          |
|---------------------------|-------|--------------------------|
| COASTLINE DR SHORING PLAN | COVER | CONTRACT NO.: WWD2900063 |
| PROJECT: COASTLINE DR.    |       |                          |
| JOB NUMBER:               |       |                          |

|               |
|---------------|
| SHEET NUMBER: |
| 1             |
| OF 6 SHEETS   |

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GENERAL NOTES:

1. ALL EXCAVATIONS SHALL BE CONSTRUCTED AND MAINTAINED IN ACCORDANCE WITH OSHA CFR 29, PART 1926, SUBPART P, AND CAL/OSHA SAFETY ORDERS TITLE 8, SECTION 1504, AND 1539-1547.
2. THE DESIGN OF THIS EXCAVATION IS IN ACCORDANCE WITH THE 2024 CALTRANS STANDARD SPECIFICATIONS AND THE 2011 CT TRENCHING AND SHORING MANUAL.
3. THE SURCHARGE SETBACK TABLE LIMIT FOR HORIZONTAL SHORING LOADS TO 72 PSF FOR 1 TO 10 FT AND 50 PSF FOR 10 TO 20 FT.

LOCATION AND PROTECTION OF EXISTING UTILITIES:

1. THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES, OTHER OBSTACLES, DIMENSIONS, OFFSETS, ELEVATIONS AND CONDITIONS IN THE FIELD PRIOR TO STARTING ANY WORK. ALL EXISTING UTILITIES SHOWN ON THE CONTRACT PLANS WITHIN THE WORK ZONE SHALL BE POSITIVELY IDENTIFIED PRIOR TO STARTING WORK. THE CONTRACTOR IS RESPONSIBLE TO POTHOLE ALL UTILITIES (AS NEEDED) BEFORE SHORING WALL CONSTRUCTION IS TO BEGIN. THE ENGINEER SHALL BE NOTIFIED OF ANY DISCREPANCIES OR INCONSISTENCIES BEFORE PROCEEDING FURTHER WITH THE WORK.

SURVEYING AND GROUND ELEVATION INFORMATION:

1. EXISTING GROUND ELEVATIONS AND CONSEQUENTIAL ELEVATION HEIGHTS HAVE BEEN DETERMINED BASED ON TOPOGRAPHICAL INFORMATION PROVIDED BY THE PLANS AND OR ACTUAL FIELD DATA.

COMPETENT PERSONS:

1. A COMPETENT PERSON IS CAPABLE OF IDENTIFYING EXISTING AND PREDICTABLE HAZARDS IN THE SURROUNDINGS, OR WORKING CONDITIONS WHICH ARE UNSANITARY, HAZARDOUS, OR DANGEROUS TO EMPLOYEES AND WHO HAS AUTHORIZATION TO TAKE PROMPT CORRECTIVE MEASURES TO ELIMINATE THEM.
2. BEFORE COMMENCING ANY EXCAVATION, THE CONTRACTOR SHALL OBTAIN UNDERGROUND SERVICE ALERT (USA) INQUIRY I.D. NUMBER. A MINIMUM OF 3 DAYS SHALL BE ALLOWED AFTER THE I.D. NUMBER IS OBTAINED AND BEFORE THE EXCAVATION WORK IS STARTED TO NOTIFY UTILITY OWNERS. IF THE UTILITY OWNER IS THE CITY, A CONFIRMATION NUMBER INDICATING THE CITY HAS BEEN NOTIFIED SHALL BE OBTAINED BY USA AND/OR THE CONTRACTOR FROM THE APPROPRIATE CITY DEPARTMENT. THE I.D. NUMBER TOGETHER WITH THE DATE ACQUIRED SHALL BE REPORTED TO THE INSPECTOR WHEN CALLING FOR INSPECTION. USA I.D. NUMBERS WILL NOT BE GIVEN MORE THAN TEN (10) WORK DAYS BEFORE STARTING EXCAVATION WORK.
3. THE CONTRACTORS COMPETENT PERSON SHALL BE ON-SITE OBSERVING THE EXCAVATION PROCESS AND SHALL BE THE RESPONSIBLE PARTY IN THE DETERMINATION OF THE SOIL TYPE EXPOSED IN THE EXCAVATION WALLS. IF THE SOIL TYPE ENCOUNTERED IS DIFFERENT THAN THAT SPECIFIED ON THE PLANS, THE DESIGN ENGINEER MUST BE NOTIFIED.
4. THE COMPETENT PERSON SHALL INSPECT THE TRENCH OR EXCAVATION AT THE BEGINNING OF EACH SHIFT PRIOR TO WORKERS ENTERING THE TRENCH OR EXCAVATION AND/OR IF WEATHER HAS CHANGED OR EFFECTED THE WORK AREA.

ENVIRONMENTAL/SWPPP COMPLIANCE:

1. DESIGN OF EXCAVATIONS IS BASED ON ASSUMPTIONS THAT SOIL PROPERTIES AND GROUND CONDITIONS REMAIN CONSTANT THROUGH THE LIFE OF THE EXCAVATION. WATER CAN EFFECT THE STRENGTH OF SOILS AND GREAT CARE SHOULD BE TAKEN TO PREVENT CHANGES FROM EXISTING SOIL CONDITIONS. SLOPES MUST BE PROTECTED FROM EXCESSIVE SOIL SATURATION AND EROSION DURING CONSTRUCTION. WATER PONDING IN THE BASE OF EXCAVATIONS IS UNACCEPTABLE AND SHOULD BE DIVERTED OR REMOVED. PROPER SWPPP AND BMP MEASURES SHALL BE USED TO PREVENT ENVIRONMENTAL INDUCED SLOPE INSTABILITY.

CAL/OSHA REQUIREMENTS:

1. A CAL/OSHA EXCAVATION PERMIT MUST BE OBTAINED PRIOR TO ANY EXCAVATION.
2. A COPY OF THIS SHORING PLAN MUST BE AT THE JOB SITE DURING CONSTRUCTION.
3. INGRESS AND EGRESS TO THE EXCAVATION SHALL CONFORM TO ALL OSHA REQUIREMENTS INCLUDING: HANDRAILS, LADDER ACCESS AND FALL PROTECTION AS REQUIRED. IN ADDITION TO OSHA REQUIREMENTS, OPEN TRENCHES SHALL BE PROTECTED BY PROTECTIVE & SECURITY FENCING OR PLATES WITH LACDPW STANDARD PLAN 6008.
4. CONTINGENCY PLANS FOR EMERGENCY SITUATIONS SHALL BE ADDRESSED IN JHA.
5. LADDERS TO BE PLACED EVERY 25 FEET OF WORKING AREA PER OSHA REQUIREMENTS.

CONSTRUCTION REQUIREMENTS:

1. CONTACT THE DESIGN ENGINEER IF EXCAVATION SHOWS SIGNS OF SLOUGHING, SWELLING OR PUMPING.
2. CAUTION SHALL BE TAKEN WHEN EXCAVATIONS ARE ADJACENT TO TRAFFIC AND THE TRAVELING PUBLIC.

CONTROLLING FIELD DIMENSIONS

1. THE FIELD SUPERINTENDENT WILL VERIFY ALL CONTROLLING FIELD DIMENSIONS BEFORE ORDERING, FABRICATING, OR INSTALLING SHORING. UPON APPROVAL BY THE DESIGN ENGINEER DIMENSIONS OF THE SHORING WILL BE ADJUSTED TO FIT THE ACTUAL DIMENSIONS.
2. IF AT ANY POINT THE EXCAVATION EXCEEDS THE DEPTH SHOWN ON THE PLANS BY MORE THAN 1 FT, NOTIFY THE DESIGN ENGINEER IMMEDIATELY.

SOIL LAYER DESCRIPTIONS:

1. THE FOLLOWING SOIL DESCRIPTIONS ARE ASSUMED TO BE PRESENT DURING EXCAVATION. IF SOILS DIFFER FROM THOSE DESCRIBED BELOW, STOP THE EXCAVATION AND CONSULT WITH THE DESIGN ENGINEER.

SOIL TYPES & DESCRIPTIONS:

0' TO 6' - SAND, SILTY  
6' TO 12' - SHALE CLAYEY  
12' TO BELOW - SANDSTONE

DESIGN PARAMETERS:

1. EXCAVATION SLOPE DESIGN BASED ON BORING B-1 TO B-7 OF THE CONTRACT PLANS (SHEET 9 OF 12).

SOIL PARAMETERS:

0' TO 6' 6' TO 12  
γ = 119 PCF γ = 112 PCF  
φ = 31° φ = 37°  
Su = 0 PSF Su = 0 PSF  
Ka = 0.31 Ka = 0.25  
Kw = 36.6 PCF Kw = 27.8 PCF

DESIGN SURCHARGE PARAMETERS:

1. IF K-RAIL IS LESS THAN 2 FT FROM TOP OF SLOPE IT MUST BE PINNED. SEE 2024 CALTRANS STANDARD PLAN T3B.
2. K-RAIL MAY NOT BE PLACED CLOSER THAN 3" FROM TOP OF SLOPE. (200PSF).
3. SLOPES WERE DESIGNED WITH A HS20-44 TRAFFIC SURCHARGE (300PSF) PLACED 2 FT FROM TOP OF SLOPE OR AS SHOWN IN THE SURCHARGE TABLE(S) IN THESE PLANS.
4. FOR SURCHARGE OFFSETS REFER TO "ASSUMED SURCHARGES & MIN. OFFSETS" TABLES ON SECTION VIEWS.
5. IF HIGHER GROUND PRESSURE IS ANTICIPATED, CONSULT WITH THE DESIGN ENGINEER.

ROAD PLATES:

1. PLATES ARE A MINIMUM ASTM A36 MIN Fy=36 KSI.
2. TRENCH PLATE INSTALLATION INCLUDING MIX RAMPING WITHIN THE CITY OF LOS ANGELES AND ALL PAVEMENT REPAIRS SHALL BE IN ACCORDANCE LAPW STANDARD S-601-3.
3. THERE SHALL BE NO PAINT ON THE SURFACE OF THE ROAD PLATES.
4. ALL TOPS OF THE ROAD PLATES MUST BE FLUSH.
5. DESIGN IS BASED ON ALLOWABLE BENDING STRENGTH.
6. REFER TO TRENCH SHORING PRODUCT DATA.



May 1, 2025



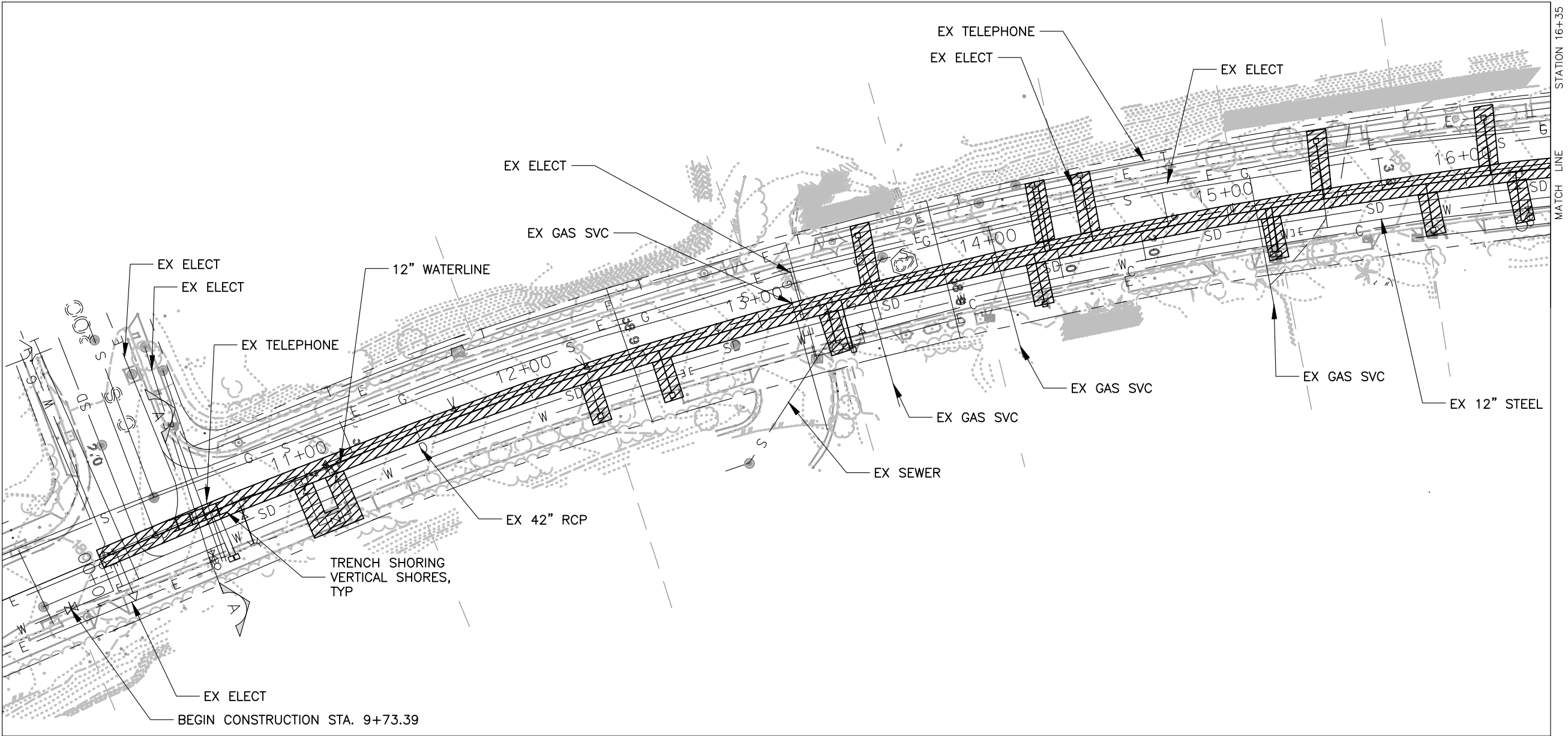
| DESCRIPTION                  | DATE    | REV. | DESIGN BY:      |
|------------------------------|---------|------|-----------------|
| RFC SUBMITTAL                | 3-26-25 | 0    | S. CANNON       |
| LACPW COMMENTS DATED 4/15/25 | 4-17-25 | 1    | S. CANNON       |
| LACPW COMMENTS DATED 4/29/25 | 4-30-25 | 2    | S. CANNON       |
|                              |         |      | SCALE: AS SHOWN |

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|                           |                         |                        |               |                          |
|---------------------------|-------------------------|------------------------|---------------|--------------------------|
| COASTLINE DR SHORING PLAN | GENERAL & SHORING NOTES | PROJECT: COASTLINE DR. | JOB NUMBER: - | CONTRACT NO.: WWD2900063 |
|---------------------------|-------------------------|------------------------|---------------|--------------------------|

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PLAN VIEW  
SCALE: 1/4" = 1'-0"

NOTES:

1. CONTRACTOR TO VERIFY ALL UTILITY LOCATIONS.
2. VERTICAL RAILS ARE FOR LAYOUT ONLY.
3. REFER TO THE COASTLINE DRIVE TRAFFIC CONTROL PLAN.
4. LIMITS OF SHORING DESIGN ARE FROM STATION 9+73.39 TO 30+08.61.

LEGEND:

LIMITS OF SHORING



1



Call: TOLL FREE  
1-800-422-4133



May 1, 2025



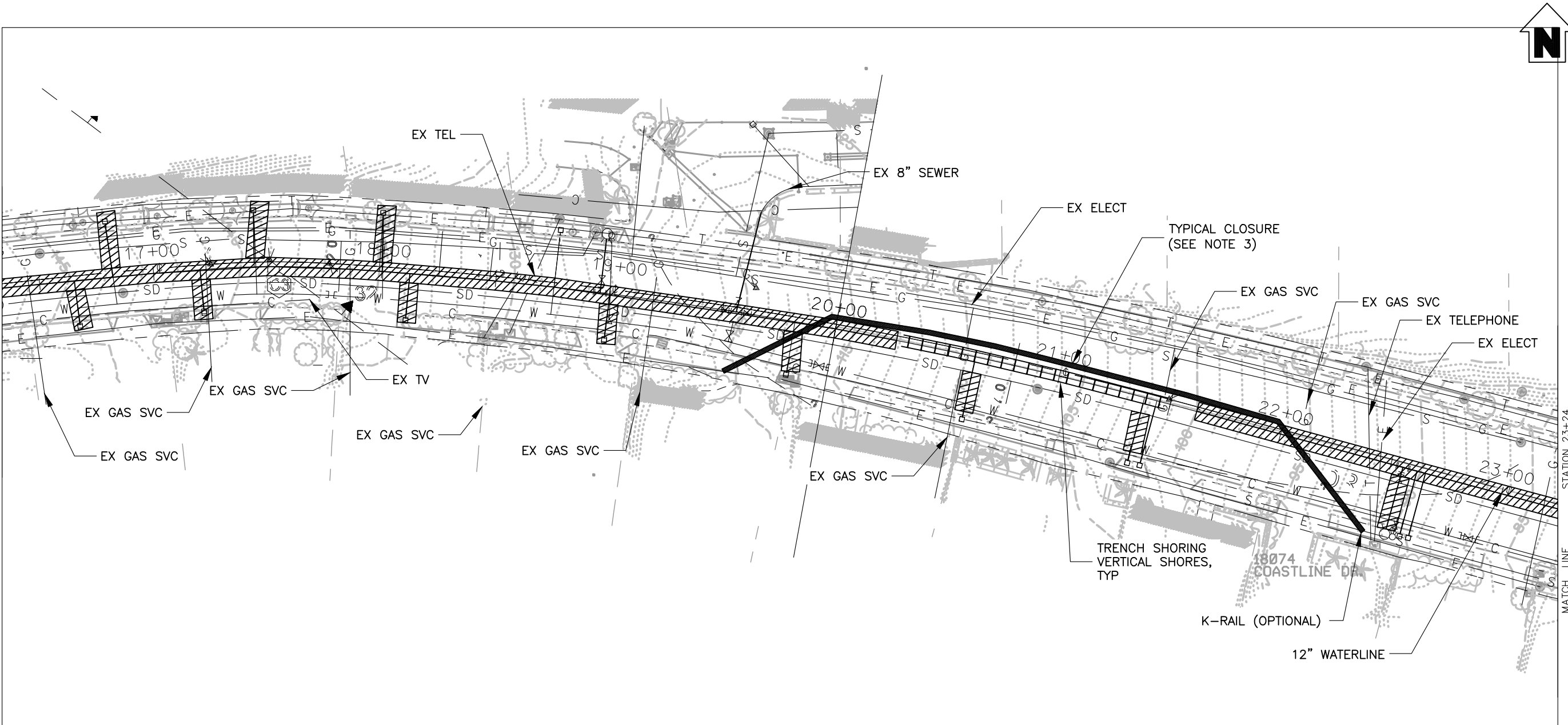
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|                           |               |                          |
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| COASTLINE DR SHORING PLAN | PLAN VIEW     | CONTRACT NO.: WWD2900063 |
| PROJECT: COASTLINE DR.    | JOB NUMBER: - | SHEET NUMBER: 3          |
| OF 6 SHEETS               |               |                          |

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PLAN VIEW  
SCALE: 1/4" = 1'-0"

- NOTES:
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  - 2. VERTICAL RAILS ARE FOR LAYOUT ONLY.
  - 3. REFER TO THE COASTLINE DRIVE TRAFFIC CONTROL PLAN.

LEGEND:

LIMITS OF SHORING



Underground Service Alert



Call: TOLL FREE  
1-800-422-4133

TWO WORKING DAYS BEFORE YOU DIG

May 1, 2025



| DESIGN BY: | DATE     | DESCRIPTION                  |
|------------|----------|------------------------------|
| S. CANNON  | 3-26-25  | RFC SUBMITTAL                |
| S. CANNON  | 4-17-25  | LACPW COMMENTS DATED 4/15/25 |
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| SCALE:     | AS SHOWN |                              |

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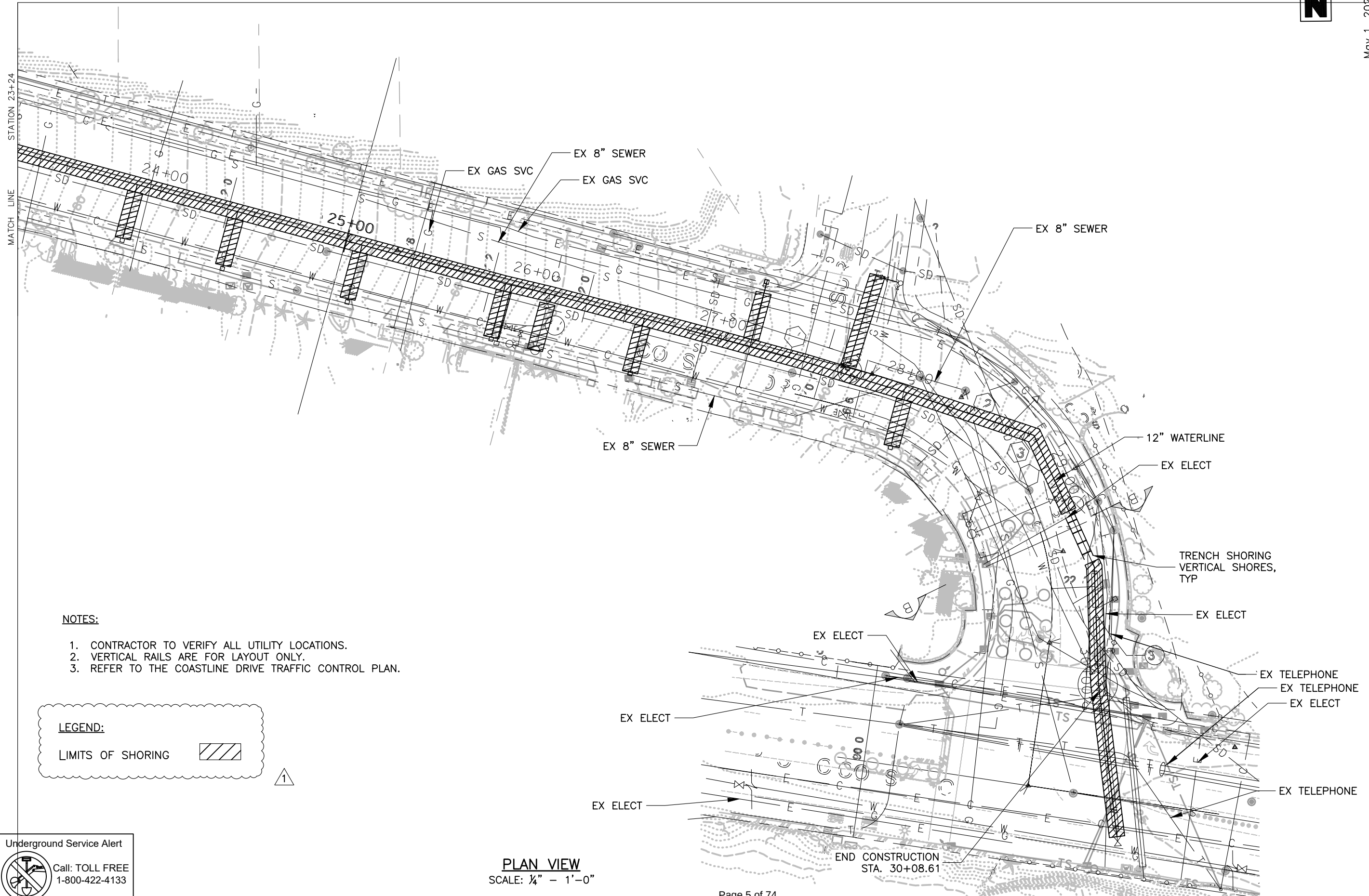


| COASTLINE DR SHORING PLAN |                          |
|---------------------------|--------------------------|
| PLAN VIEW                 |                          |
| PROJECT: COASTLINE DR.    | CONTRACT NO.: WWD2900063 |
| JOB NUMBER: -             |                          |

SHEET NUMBER:  
4

OF 6 SHEETS

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- NOTES:**
1. CONTRACTOR TO VERIFY ALL UTILITY LOCATIONS.
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**LEGEND:**

LIMITS OF SHORING

**Underground Service Alert**

Call: TOLL FREE  
1-800-422-4133

TWO WORKING DAYS BEFORE YOU DIG

**PLAN VIEW**  
SCALE: 1/4" = 1'-0"



May 1, 2025



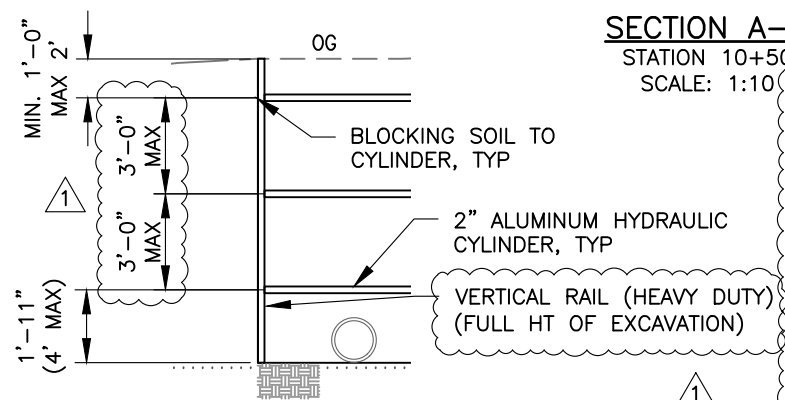
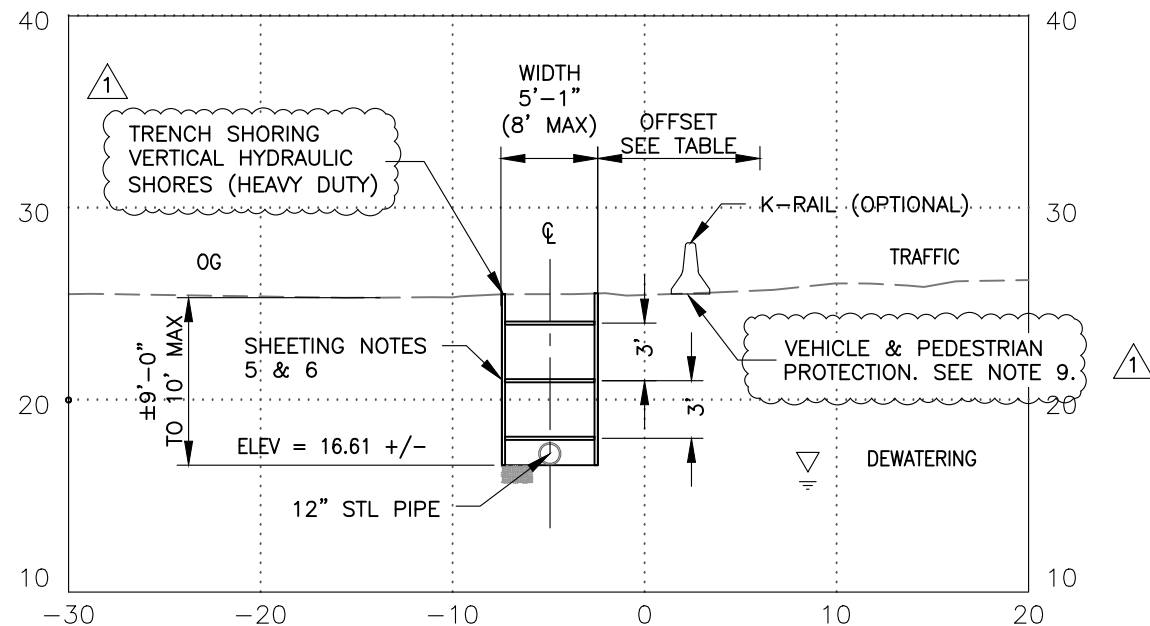
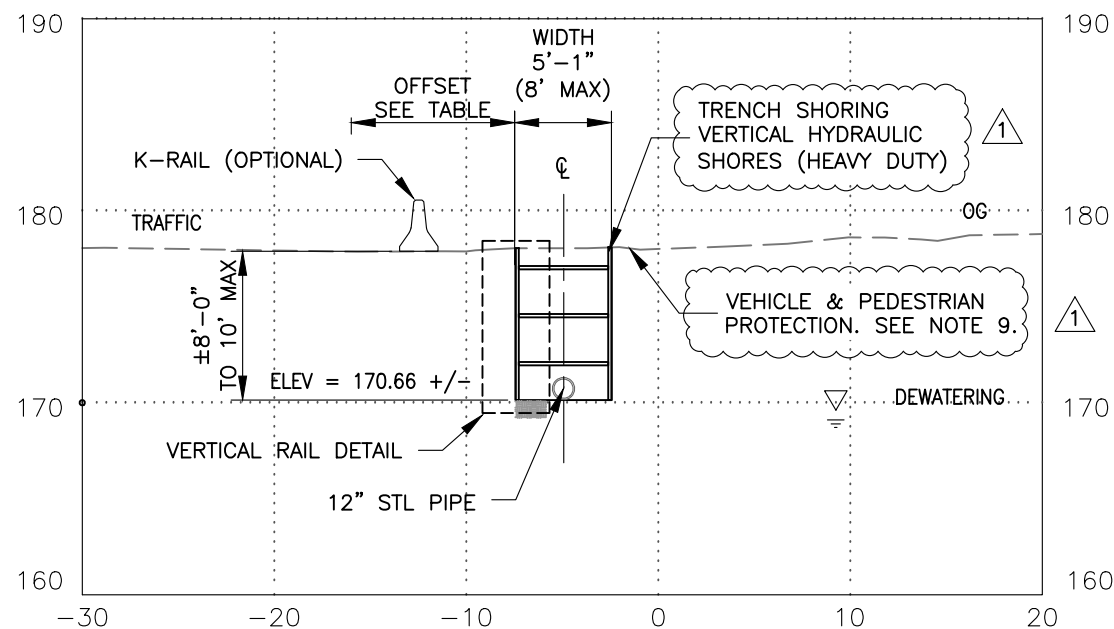
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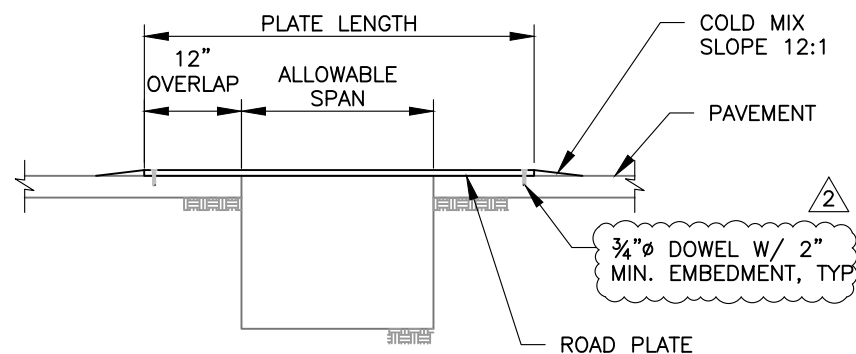


|                           |                          |
|---------------------------|--------------------------|
| COASTLINE DR SHORING PLAN | CONTRACT NO.: WWD2900063 |
| PLAN VIEW                 | JOB NUMBER: -            |
| PROJECT: COASTLINE DR.    | SHEET NUMBER: 5          |
| OF 6 SHEETS               |                          |

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SECTION A-A  
STATION 10+50  
SCALE: 1:10



SECTION C-C  
SCALE: 1:5

SECTION B-B  
STATION 29+70  
SCALE: 1:10

NOTES:

VERTICAL SHORES

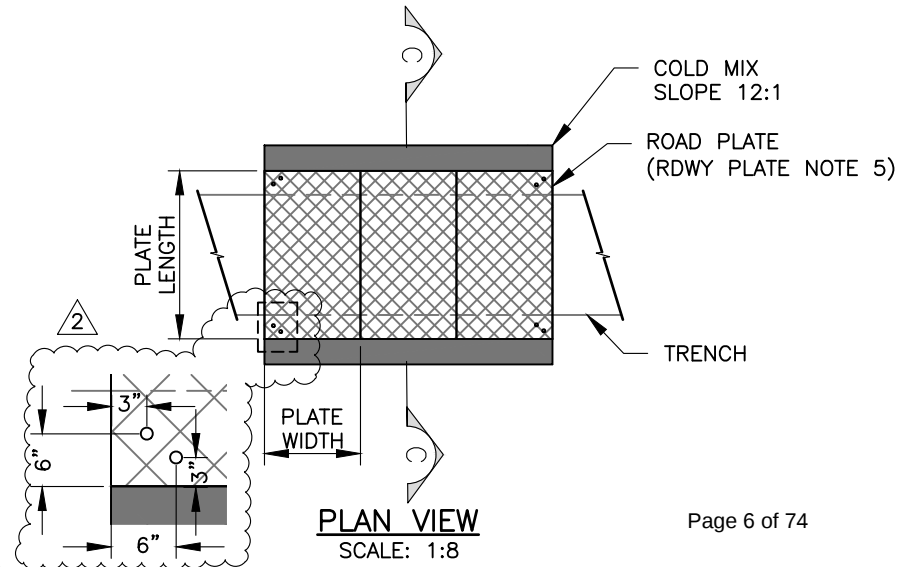
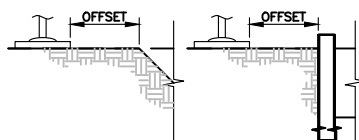
1. THERE MUST BE A MINIMUM OF THREE COLUMNS OF SHORES SPACED EQUALLY IN THE TRENCH AT ALL TIMES.
2. MAY USE SHEETING FOR THE PREVENTION OF LOCAL RAVELING OR SLOUGHING. TYPES OF SHEETING ARE 2 EA SHEETS OF  $\frac{1}{8}$ " HDO STRUCTURAL 1 OR EQUIVALENT. MAY ALSO USE  $\frac{1}{2}$ " A36 STEEL PLATE.
3. SHORING SYSTEM SHALL BE FULLY ASSEMBLED WITH ALL HYDRAULIC CYLINDERS IN PLACE PRIOR TO TO PLACING IT IN THE EXCAVATION.
4. DESIGNED FOR TYPE C-60 SOIL.
5. SHEETING IS REQUIRED WHEN SLOUGHING OR RAVELING OCCURS AND IN C-60 OVER 8 FT.
6. IN TYPE C-60 SOIL, SHEETING MUST EXTEND TO BOTTOM OF EXCAVATION. SHEETING IS 4 FT WIDE.
7. MINIMUM OF THREE SHORES IN TRENCHES GREATER THAN 12 FT.
8. REFER TO TAB DATA.
9. OPEN TRENCH WILL BE BACKFILLED AT THE END OF EACH SHIFT. IF NOT, USE EITHER STEEL PLATES OR FENCING TO PROTECT PEDESTRIANS AND TRAFFIC FROM THE TRENCH OPENING.

ROADWAY PLATES:

1. SPAN MEASUREMENT IS AC EDGE TO AC EDGE.
2. TRAFFIC MAY RUN IN ANY DIRECTION ON THE PLATES.
3. PLATE MAY BE PLACED IN EITHER DIRECTION OF THE TRENCH IN ACCORDANCE WITH THE CONDITIONS AND NOTES SPECIFIED HEREIN.
4. IT IS THE PLATE INSTALLERS RESPONSIBILITY TO INSTALL & MAINTAIN THE PLATES IN ACCORDANCE WITH THE TRENCH SHORING DATA SHEET AND LOCAL JURISDICTION REQUIREMENTS.
5. REFER TO ALLOWABLE SPANS AND PLATE SIZES ON SHEET 2.
6. REFER TO TRENCH SHORING PRODUCT DATA.

VERTICAL RAIL DETAIL  
SCALE: 1:5

| MINIMUM OFFSETS      |        |
|----------------------|--------|
| SURCHARGE            | OFFSET |
| K-RAIL               | 1 FT   |
| TRAFFIC              | 4 FT   |
| SPOIL PILE (HT=4FT)  | 2 FT   |
| CAT 325 EXCAVATOR    | 3 FT   |
| 3 CY LOADER          | 2 FT   |
| 5 CY LOADER          | 3 FT   |
| DUMP TRUCK           | 3 FT   |
| 12 CY CONCRETE TRUCK | 3 FT   |
| BOOM TRUCK           | 6 FT   |



PLAN VIEW  
SCALE: 1:8



May 1, 2025



| REV. | DATE    | DESCRIPTION                  |
|------|---------|------------------------------|
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COASTLINE DR SHORING PLAN

SECTION VIEW

SHEET NUMBER:

6

OF 6 SHEETS

PROJECT: COASTLINE DR.  
JOB NUMBER: -  
CONTRACT NO.: WWD2900063

## Calculations



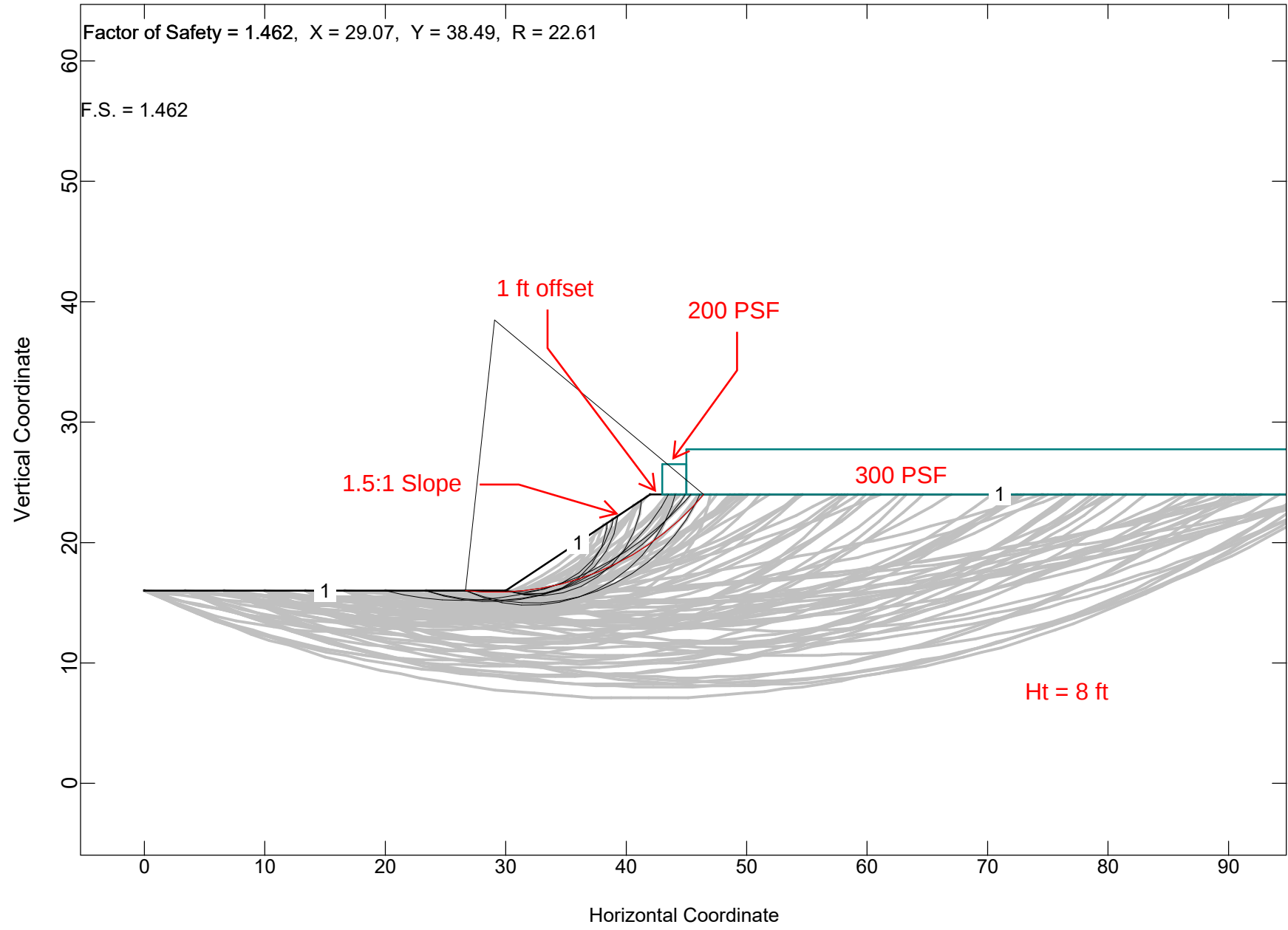
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Section A  
Type C Soil  
Traffic & K-Rail Surcharge



=====

STABLPro for Windows, Version 2015.4.5

Upgraded from:  
FHWA-PCSTABLE

Serial Number : 357267753

--Slope Stability Analysis--  
Simplified Janbu, Simplified Bishop  
or Spencer Method of Slices

=====

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Las Vegas, NV, USA

Path to file locations :

D:\Dropbox\Korpi\_Cannon\_Engineering\Projects\KC-0119 - MZB Engineering\Design\Excav  
- Shoring\4.0 Coastline Dr\Design\

Name of input data file : Sect A Excav.sl4d  
Name of output file : Sect A Excav.sl4o  
Name of plot output file : Sect A Excav.sl4p

-----  
Time and Date of Analysis  
-----

Date: March 26, 2025 Time: 13:23:25

1

PROBLEM DESCRIPTION New Slope

BOUNDARY COORDINATES

3 Top Boundaries  
3 Total Boundaries

| Boundary No. | X-Left ft. | Y-Left ft. | X-Right ft. | Y-Right ft. | Soil Type Below Bnd |
|--------------|------------|------------|-------------|-------------|---------------------|
| 1            | 0.00       | 16.00      | 30.00       | 16.00       | 1                   |
| 2            | 30.00      | 16.00      | 42.00       | 24.00       | 1                   |
| 3            | 42.00      | 24.00      | 100.00      | 24.00       | 1                   |

1

#### ISOTROPIC SOIL PARAMETERS

1 Type(s) of Soil

| Soil Type No. | Total Unit Wt. pcf | Saturated Unit Wt. pcf | Cohesion Intercept psf | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant psf | Piez. Surface No. |
|---------------|--------------------|------------------------|------------------------|----------------------|----------------------|-----------------------|-------------------|
| 1             | 118.0              | 118.0                  | 0.0                    | 37.0                 | 0.00                 | 0.0                   | 0                 |

1

#### BOUNDARY LOAD(S)

2 Load(s) Specified

| Load No. | X-Left ft. | X-Right ft. | Intensity psf | Deflection (deg) |
|----------|------------|-------------|---------------|------------------|
| 1        | 43.00      | 45.00       | 200.0         | 0.0              |
| 2        | 45.00      | 100.00      | 300.0         | 0.0              |

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 0.00 ft.

and  $X = 30.00$  ft.

Each Surface Terminates Between  $X = 37.00$  ft.  
and  $X = 100.00$  ft.

Unless Further Limitations Were Imposed, The Minimum Elevation  
At Which A Surface Extends Is  $Y = 0.00$  ft.

1.60 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation.  
The Angle Has Been Restricted Between The Angles Of  $-25.0$   
And  $0.0$  deg.

1

Following Are Displayed The Ten Most Critical Of The Trial  
Failure Surfaces Examined. They Are Ordered - Most Critical  
First.

\* \* Safety Factors Are Calculated By The Modified Bishop Method \* \*

Failure Surface Specified By 15 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 26.67         | 16.00         |
| 2            | 28.26         | 15.89         |
| 3            | 29.86         | 15.89         |
| 4            | 31.46         | 16.00         |
| 5            | 33.04         | 16.22         |
| 6            | 34.61         | 16.56         |
| 7            | 36.14         | 17.01         |
| 8            | 37.65         | 17.56         |
| 9            | 39.10         | 18.22         |
| 10           | 40.51         | 18.98         |
| 11           | 41.86         | 19.84         |
| 12           | 43.15         | 20.79         |
| 13           | 44.37         | 21.83         |
| 14           | 45.50         | 22.95         |
| 15           | 46.43         | 24.00         |

Circle Center At X = 29.1 ; Y = 38.5 and Radius, 22.6

\*\*\* 1.462 \*\*\*

Individual data on the 18 slices

| Slice<br>No. | Width<br>Ft | Weight<br>Lbs | Water               | Water               | Tie                  | Tie                 | Earthquake          |                     | Surcharge<br>Load<br>Lbs |
|--------------|-------------|---------------|---------------------|---------------------|----------------------|---------------------|---------------------|---------------------|--------------------------|
|              |             |               | Force<br>Top<br>Lbs | Force<br>Bot<br>Lbs | Force<br>Norm<br>Lbs | Force<br>Tan<br>Lbs | Force<br>Hor<br>Lbs | Force<br>Ver<br>Lbs |                          |
| 1            | 1.6         | 0.11E+02      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 2            | 1.6         | 0.21E+02      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 3            | 0.1         | 0.18E+01      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 4            | 1.5         | 0.93E+02      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 5            | 1.6         | 0.26E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 6            | 1.6         | 0.40E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 7            | 1.5         | 0.51E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 8            | 1.5         | 0.59E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 9            | 1.5         | 0.64E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 10           | 1.4         | 0.65E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 11           | 1.4         | 0.65E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 12           | 0.1         | 0.66E+02      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 13           | 1.0         | 0.44E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.00E+00                 |
| 14           | 0.1         | 0.57E+02      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.30E+02                 |
| 15           | 1.2         | 0.39E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.24E+03                 |
| 16           | 0.6         | 0.14E+03      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.13E+03                 |
| 17           | 0.5         | 0.77E+02      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.15E+03                 |
| 18           | 0.9         | 0.57E+02      | 0.00E+00            | 0.00E+00            | 0.00E+00             | 0.00E+00            | 0.00E+00            | 0.00E+00            | 0.28E+03                 |

Failure Surface Specified By 9 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 30.00         | 16.00         |
| 2            | 31.60         | 15.90         |
| 3            | 33.18         | 16.12         |
| 4            | 34.69         | 16.65         |
| 5            | 36.06         | 17.48         |
| 6            | 37.23         | 18.57         |
| 7            | 38.15         | 19.88         |

|   |       |       |
|---|-------|-------|
| 8 | 38.80 | 21.34 |
| 9 | 38.93 | 21.95 |

Circle Center At X = 31.3 ; Y = 23.8 and Radius, 7.9

\*\*\* 1.547 \*\*\*

1

Failure Surface Specified By 17 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 23.33         | 16.00         |
| 2            | 24.88         | 15.61         |
| 3            | 26.46         | 15.34         |
| 4            | 28.06         | 15.21         |
| 5            | 29.66         | 15.22         |
| 6            | 31.25         | 15.36         |
| 7            | 32.83         | 15.63         |
| 8            | 34.38         | 16.03         |
| 9            | 35.89         | 16.55         |
| 10           | 37.35         | 17.21         |
| 11           | 38.75         | 17.98         |
| 12           | 40.08         | 18.87         |
| 13           | 41.33         | 19.86         |
| 14           | 42.50         | 20.96         |
| 15           | 43.57         | 22.15         |
| 16           | 44.54         | 23.42         |
| 17           | 44.90         | 24.00         |

Circle Center At X = 28.8 ; Y = 34.3 and Radius, 19.1

\*\*\* 1.586 \*\*\*

Failure Surface Specified By 16 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 23.33         | 16.00         |
| 2            | 24.87         | 15.55         |

|    |       |       |
|----|-------|-------|
| 3  | 26.44 | 15.26 |
| 4  | 28.04 | 15.11 |
| 5  | 29.64 | 15.12 |
| 6  | 31.23 | 15.28 |
| 7  | 32.80 | 15.59 |
| 8  | 34.33 | 16.05 |
| 9  | 35.81 | 16.66 |
| 10 | 37.23 | 17.40 |
| 11 | 38.56 | 18.28 |
| 12 | 39.81 | 19.28 |
| 13 | 40.96 | 20.40 |
| 14 | 41.99 | 21.62 |
| 15 | 42.91 | 22.93 |
| 16 | 43.51 | 24.00 |

Circle Center At X = 28.8 ; Y = 31.8 and Radius, 16.7

\*\*\* 1.643 \*\*\*

1

Failure Surface Specified By 19 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 20.00         | 16.00         |
| 2            | 21.56         | 15.65         |
| 3            | 23.14         | 15.40         |
| 4            | 24.73         | 15.25         |
| 5            | 26.33         | 15.20         |
| 6            | 27.93         | 15.26         |
| 7            | 29.53         | 15.41         |
| 8            | 31.10         | 15.67         |
| 9            | 32.66         | 16.03         |
| 10           | 34.20         | 16.48         |
| 11           | 35.70         | 17.04         |
| 12           | 37.16         | 17.68         |
| 13           | 38.58         | 18.42         |
| 14           | 39.95         | 19.25         |
| 15           | 41.27         | 20.16         |
| 16           | 42.52         | 21.16         |
| 17           | 43.71         | 22.23         |
| 18           | 44.82         | 23.37         |
| 19           | 45.36         | 24.00         |

Circle Center At X = 26.3 ; Y = 40.3 and Radius, 25.1

\*\*\* 1.646 \*\*\*

Failure Surface Specified By 16 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 26.67         | 16.00         |
| 2            | 28.19         | 15.50         |
| 3            | 29.75         | 15.17         |
| 4            | 31.34         | 15.00         |
| 5            | 32.94         | 15.00         |
| 6            | 34.54         | 15.16         |
| 7            | 36.10         | 15.49         |
| 8            | 37.62         | 15.98         |
| 9            | 39.09         | 16.63         |
| 10           | 40.48         | 17.42         |
| 11           | 41.77         | 18.36         |
| 12           | 42.96         | 19.43         |
| 13           | 44.04         | 20.61         |
| 14           | 44.98         | 21.90         |
| 15           | 45.79         | 23.29         |
| 16           | 46.11         | 24.00         |

Circle Center At X = 32.2 ; Y = 30.3 and Radius, 15.3

\*\*\* 1.684 \*\*\*

1

Failure Surface Specified By 9 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 30.00         | 16.00         |
| 2            | 31.58         | 15.72         |
| 3            | 33.17         | 15.80         |
| 4            | 34.72         | 16.22         |
| 5            | 36.13         | 16.96         |
| 6            | 37.35         | 18.00         |
| 7            | 38.32         | 19.27         |

|   |       |       |
|---|-------|-------|
| 8 | 38.99 | 20.73 |
| 9 | 39.30 | 22.20 |

Circle Center At X = 32.0 ; Y = 23.0 and Radius, 7.3

\*\*\* 1.704 \*\*\*

Failure Surface Specified By 11 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 30.00         | 16.00         |
| 2            | 31.56         | 15.65         |
| 3            | 33.16         | 15.60         |
| 4            | 34.74         | 15.84         |
| 5            | 36.25         | 16.37         |
| 6            | 37.64         | 17.16         |
| 7            | 38.86         | 18.20         |
| 8            | 39.87         | 19.44         |
| 9            | 40.63         | 20.85         |
| 10           | 41.11         | 22.38         |
| 11           | 41.26         | 23.50         |

Circle Center At X = 32.7 ; Y = 24.2 and Radius, 8.7

\*\*\* 1.743 \*\*\*

1

Failure Surface Specified By 15 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 26.67         | 16.00         |
| 2            | 28.15         | 15.41         |
| 3            | 29.70         | 15.01         |
| 4            | 31.29         | 14.82         |
| 5            | 32.89         | 14.82         |
| 6            | 34.48         | 15.04         |
| 7            | 36.02         | 15.45         |
| 8            | 37.50         | 16.06         |

|    |       |       |
|----|-------|-------|
| 9  | 38.89 | 16.85 |
| 10 | 40.17 | 17.81 |
| 11 | 41.32 | 18.93 |
| 12 | 42.31 | 20.19 |
| 13 | 43.13 | 21.56 |
| 14 | 43.78 | 23.02 |
| 15 | 44.06 | 24.00 |

Circle Center At X = 32.0 ; Y = 27.3 and Radius, 12.5

\*\*\* 1.755 \*\*\*

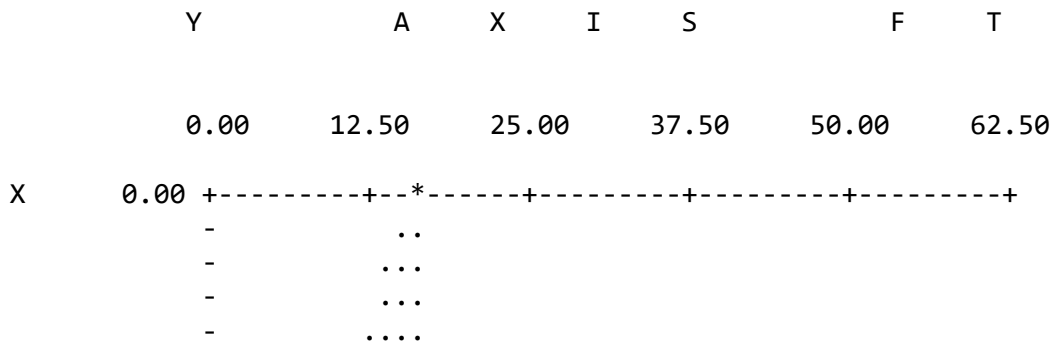
Failure Surface Specified By 9 Coordinate Points

| Point<br>No. | X-Surf<br>ft. | Y-Surf<br>ft. |
|--------------|---------------|---------------|
| 1            | 30.00         | 16.00         |
| 2            | 31.57         | 15.69         |
| 3            | 33.17         | 15.77         |
| 4            | 34.69         | 16.25         |
| 5            | 36.06         | 17.09         |
| 6            | 37.17         | 18.24         |
| 7            | 37.96         | 19.63         |
| 8            | 38.39         | 21.17         |
| 9            | 38.40         | 21.60         |

Circle Center At X = 32.0 ; Y = 22.1 and Radius, 6.4

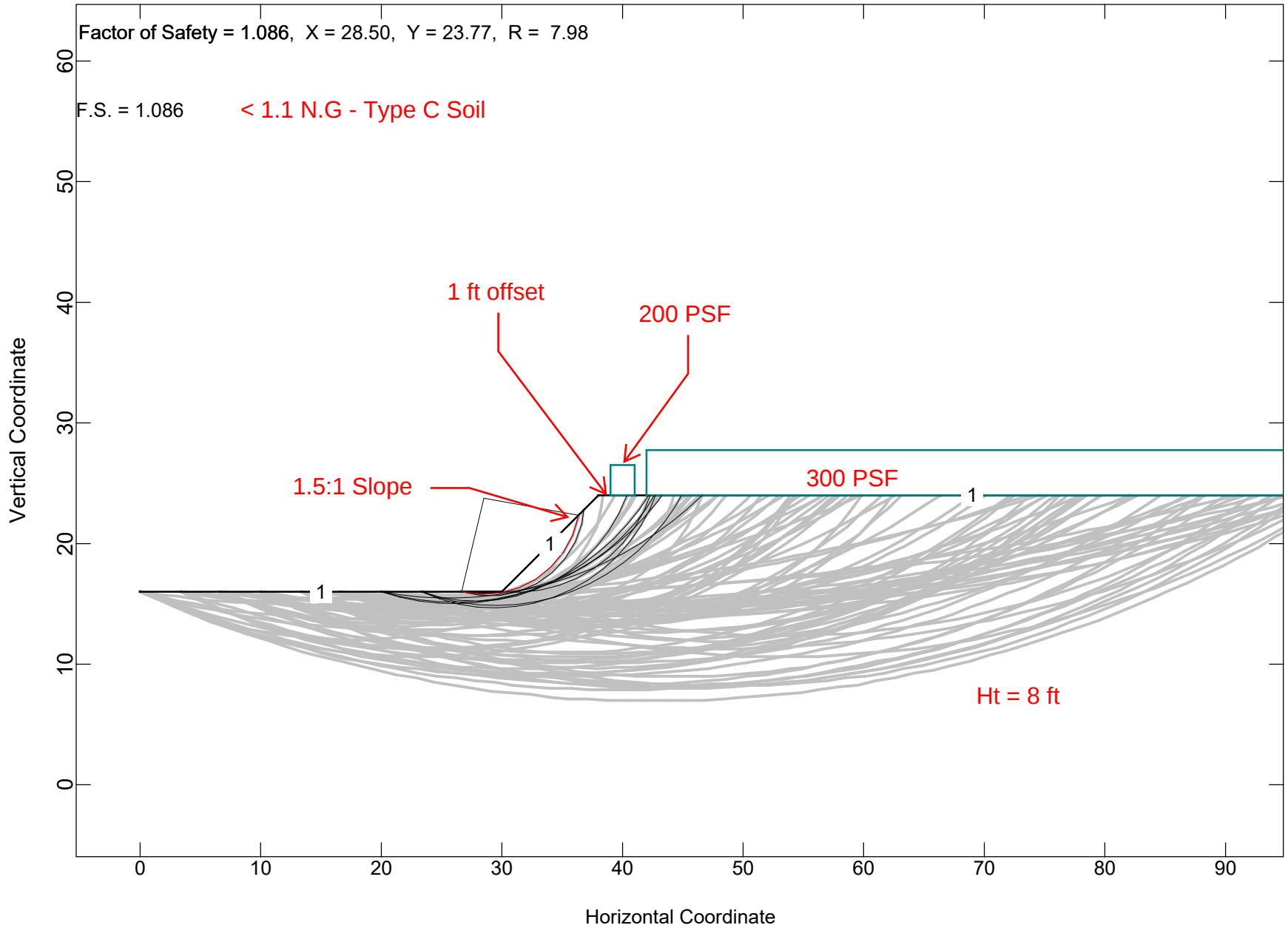
\*\*\* 1.766 \*\*\*

1



|   |        |   |             |
|---|--------|---|-------------|
|   |        | - | .....       |
|   | 12.50  | + | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....5      |
|   |        | - | .....53     |
| A | 25.00  | + | .....3.     |
|   |        | - | .....31     |
|   |        | - | .....3*     |
|   |        | - | .....31     |
|   |        | - | .....41.    |
|   |        | - | .....611.   |
| X | 37.50  | + | .....61220  |
|   |        | - | .....631822 |
|   |        | - | .....6138*  |
|   |        | - | .....6133/1 |
|   |        | - | .....111/2  |
|   |        | - | .....       |
| I | 50.00  | + | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
| S | 62.50  | + | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   | 75.00  | + | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
| F | 87.50  | + | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
|   |        | - | .....       |
| T | 100.00 | + | *2/         |

Section A  
Type B Soil  
Traffic & K-Rail Surcharge



Rev 1

Soil

| Bore Location | N field | EH  | CR   | CS | CB   | N60 | Unit Weight (y) | Friction Angle | Soil   | 45-φ/2 | ka   | Kw=ka*y (pcf) |
|---------------|---------|-----|------|----|------|-----|-----------------|----------------|--------|--------|------|---------------|
| B-1           | 22      | 0.7 | 0.75 | 1  | 1.05 | 20  | 119             | 32             | Type C | 29     | 0.31 | 36.56         |
| B-2           | 38      | 0.7 | 0.75 | 1  | 1.05 | 35  | 118             | 37             | Type C | 26.5   | 0.25 | 29.33         |
| B-3           | 53      | 0.7 | 0.75 | 1  | 1.05 | 49  | 117             | 38             | Type B | 26     | 0.24 | 27.83         |
| B-4           | 14      | 0.7 | 0.75 | 1  | 1.05 | 13  | 109             | 31             | Type C | 29.5   | 0.32 | 34.89         |
| B-5           | 36      | 0.7 | 0.75 | 1  | 1.05 | 33  | 112             | 37             | Type C | 26.5   | 0.25 | 27.84         |
| B-6           | 111     | 0.7 | 0.75 | 1  | 1.05 | 102 | 126             | 41             | Type B | 24.5   | 0.21 | 26.17         |
| B-7           | 18      | 0.7 | 0.75 | 1  | 1.05 | 17  | 99              | 31             | Type C | 29.5   | 0.32 | 31.69         |

$$N60=(N_{field} \times EH \times CR \times CS \times CB)/0.6$$



9608 Aqua Harbor Way  
Las Vegas, NV. 89178  
(702) 808-1295

# Boussinesq Lateral Earth Pressure

## Coastline Section A

Date: 3/26/2025

Design values per CALTRANS 2015 Standard Specs

& 2011 Trenching and Shoring Manual (Revision 1, August 2011)

Sheet 1 of 3

### Shoring & Surcharge Parameters

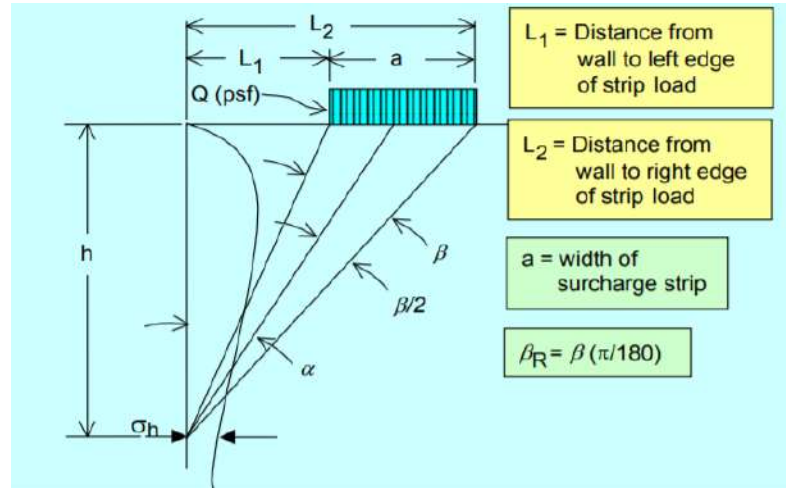
|                                    |         |
|------------------------------------|---------|
| Shoring Depth = h =                | 10.0 ft |
| Offset Distance = L <sub>1</sub> = | 4.0 ft  |
| Total Length = L <sub>2</sub> =    | 19.0 ft |
| Strip Width = a =                  | 15.0 ft |
| Surcharge Pressure = Q =           | 300 psf |

### TRAFFIC

### Soil Parameters

|                      |        |
|----------------------|--------|
| Unit Weight = λ =    | 99 pcf |
| Cohesion = C =       | 0 psf  |
| Friction Angle = φ = | 31.0°  |

Note to user: Spreadsheet only works for shoring < 49.9ft.



### Results Summary

The maximum total lateral pressure acting on the shoring is 438.84psf and occurs 10ft from the top of shoring.

The maximum lateral soil pressure acting on the shoring is 316.9psf and occurs 10ft from the top of shoring.

The maximum lateral surcharge pressure acting on the shoring is 168.83psf and occurs 4.6ft from the top of shoring.

### Sample Calculation at h = 10ft

$$\begin{aligned}\text{Rankine's Active Earth Pressure Coefficient} &= K_a = \tan^2(45^\circ - (\phi/2)) \\ &= \tan^2(45^\circ - (31^\circ/2)) \\ &= 0.32\end{aligned}$$

[Trenching and Shoring Manual, Eq. 4-9]

$$\begin{aligned}\text{Lateral Pressure Due to Soil} &= \sigma_{h(\text{Soil})} = (\lambda \times h \times K_a) - (2 \times C \times \text{Sqrt}(K_a)) \\ &= (99\text{pcf} \times 10\text{ft} \times 0.32) - (2 \times 0\text{psf} \times \text{Sqrt}(0.32)) \\ &= 316.90 \text{ psf}\end{aligned}$$

[Trenching and Shoring Manual, Eq. 4-33]

$$\begin{aligned}\text{Lateral Pressure Due to Surcharge} &= \sigma_{h(\text{Surcharge})} = (2Q/\pi) \times [\beta_R - (\sin(\beta) \times \cos(2\alpha))] \\ &= (2 \times 300 \text{ psf}/\pi) \times [0.71 \text{ Rad} - (\sin(40.4^\circ) \times \cos(2 \times 42^\circ))] \\ &= 121.94 \text{ psf}\end{aligned}$$

[Trenching and Shoring Manual, Eq. 4-67]

$$\begin{aligned}\text{Total Lateral Pressure} &= \sigma_{h(\text{Total})} = \sigma_{h(\text{Soil})} + \sigma_{h(\text{Surcharge})} \\ &= 316.9\text{psf} + 121.94\text{psf} \\ &= 438.84 \text{ psf}\end{aligned}$$



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# Boussinesq Lateral Earth Pressure

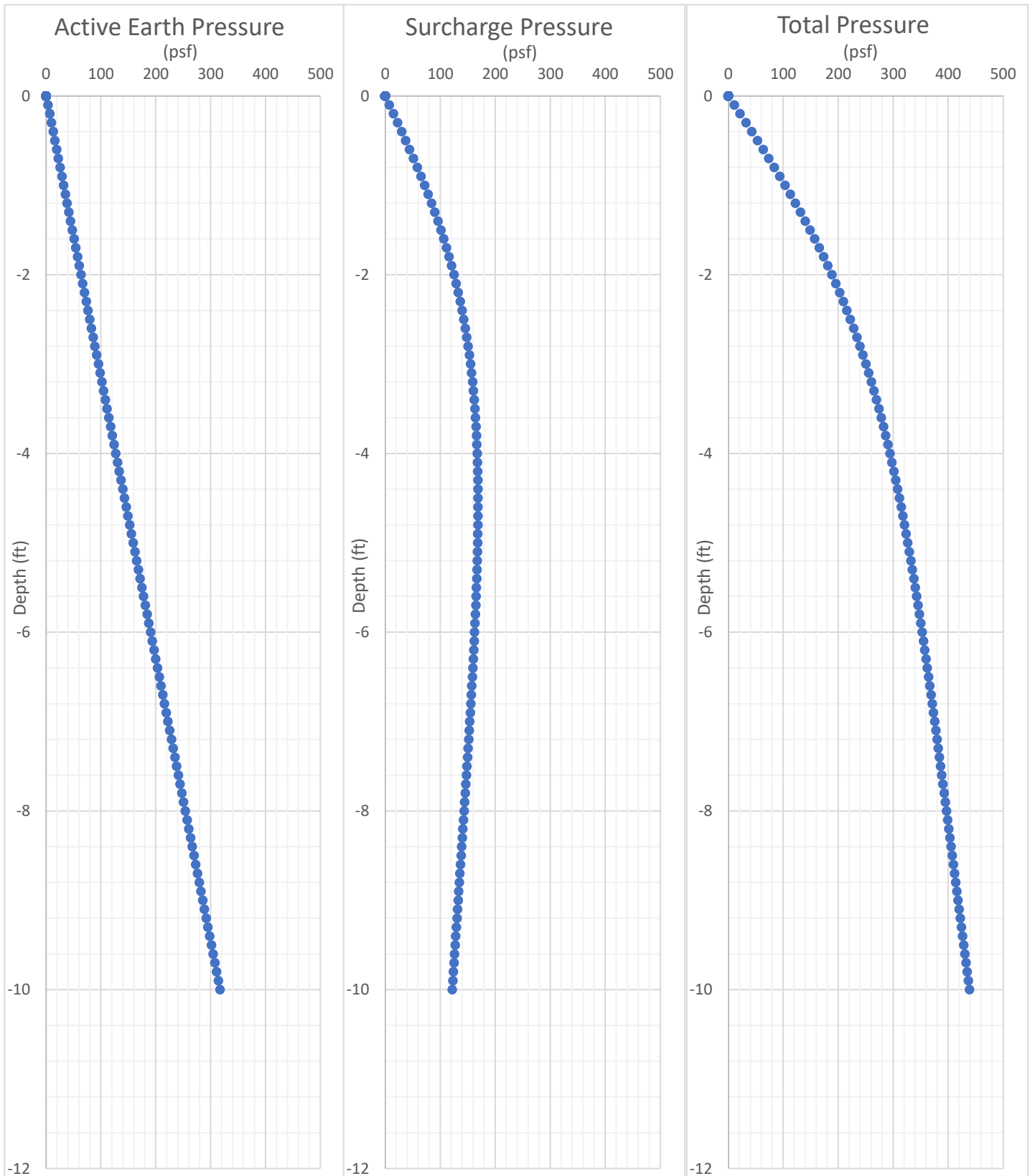
## Coastline Section A

Date: 3/26/2025

Design values per CALTRANS 2015 Standard Specs

& 2011 Trenching and Shoring Manual (Revision 1, August 2011)

Sheet 2 of 3





9608 Aqua Harbor Way  
Las Vegas, NV. 89178  
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# Boussinesq Lateral Earth Pressure

## Coastline Section A

Date: 3/26/2025

Design values per CALTRANS 2015 Standard Specs

& 2011 Trenching and Shoring Manual (Revision 1, August 2011)

Sheet 3 of 3

### Detailed Results Summary

| $h$    | $\theta_1$ | $\theta_2$ | $\beta$ | $\beta_R$ | $\alpha$ | $\sigma_{h(\text{Soil})}$ | $\sigma_{h(\text{Surcharge})}$ | $\sigma_{h(\text{Total})}$ |
|--------|------------|------------|---------|-----------|----------|---------------------------|--------------------------------|----------------------------|
| 0.0 ft | -          | -          | -       | -         | -        | 0.0 psf                   | 0.0 psf                        | 0.0 psf                    |
| 1.0 ft | 14.0°      | 3.0°       | 11.0°   | 0.19 Rad  | 81.5°    | 31.7 psf                  | 71.7 psf                       | 103.3 psf                  |
| 2.0 ft | 26.6°      | 6.0°       | 20.6°   | 0.36 Rad  | 73.7°    | 63.4 psf                  | 125.0 psf                      | 188.4 psf                  |
| 3.0 ft | 36.9°      | 9.0°       | 27.9°   | 0.49 Rad  | 67.1°    | 95.1 psf                  | 155.2 psf                      | 250.3 psf                  |
| 4.0 ft | 45.0°      | 11.9°      | 33.1°   | 0.58 Rad  | 61.6°    | 126.8 psf                 | 167.4 psf                      | 294.1 psf                  |
| 5.0 ft | 51.3°      | 14.7°      | 36.6°   | 0.64 Rad  | 57.0°    | 158.4 psf                 | 168.1 psf                      | 326.6 psf                  |
| 6.0 ft | 56.3°      | 17.5°      | 38.8°   | 0.68 Rad  | 53.1°    | 190.1 psf                 | 162.6 psf                      | 352.7 psf                  |
| 7.0 ft | 60.3°      | 20.2°      | 40.0°   | 0.70 Rad  | 49.8°    | 221.8 psf                 | 153.8 psf                      | 375.6 psf                  |
| 8.0 ft | 63.4°      | 22.8°      | 40.6°   | 0.71 Rad  | 46.9°    | 253.5 psf                 | 143.4 psf                      | 396.9 psf                  |
| 8.7 ft | 65.3°      | 24.6°      | 40.7°   | 0.71 Rad  | 45.0°    | 275.7 psf                 | 135.9 psf                      | 411.6 psf                  |



9608 Aqua Harbor Way  
Las Vegas, NV. 89178  
(702) 808-1295

# Boussinesq Lateral Earth Pressure

DS-11

Date: 3/26/2025

Design values per CALTRANS 2015 Standard Specs

& 2011 Trenching and Shoring Manual (Revision 1, August 2011)

Sheet 1 of 3

## Shoring & Surcharge Parameters

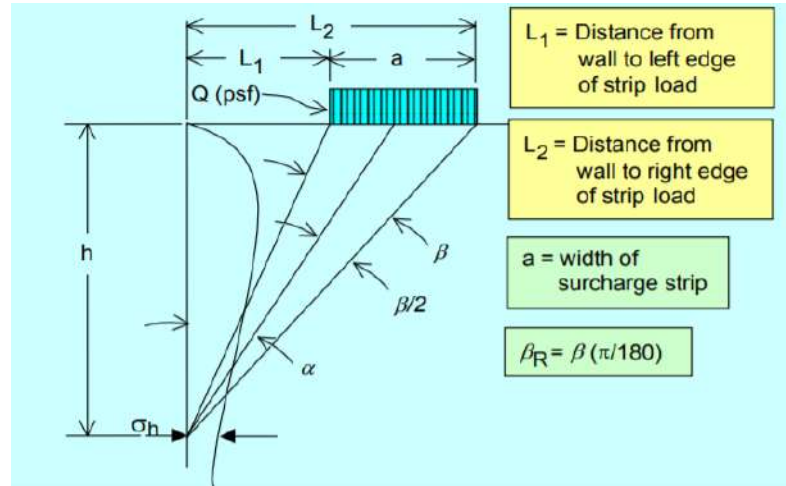
|                                    |         |
|------------------------------------|---------|
| Shoring Depth = h =                | 10.0 ft |
| Offset Distance = L <sub>1</sub> = | 3.0 ft  |
| Total Length = L <sub>2</sub> =    | 5.8 ft  |
| Strip Width = a =                  | 2.8 ft  |
| Surcharge Pressure = Q =           | 900 psf |

CAT 315 Excavator

## Soil Parameters

|                      |        |
|----------------------|--------|
| Unit Weight = λ =    | 99 pcf |
| Cohesion = C =       | 0 psf  |
| Friction Angle = φ = | 31.0°  |

Note to user: Spreadsheet only works for shoring < 49.9ft.



## Results Summary

The maximum total lateral pressure acting on the shoring is 359psf and occurs 10ft from the top of shoring.

The maximum lateral soil pressure acting on the shoring is 316.9psf and occurs 10ft from the top of shoring.

The maximum lateral surcharge pressure acting on the shoring is 235.87psf and occurs 2.4ft from the top of shoring.

## Sample Calculation at h = 10ft

$$\begin{aligned} \text{Rankine's Active Earth Pressure Coefficient} &= K_a = \tan^2(45^\circ - (\phi/2)) \\ &= \tan^2(45^\circ - (31^\circ/2)) \\ &= 0.32 \end{aligned}$$

[Trenching and Shoring Manual, Eq. 4-9]

$$\begin{aligned} \text{Lateral Pressure Due to Soil} &= \sigma_{h(\text{Soil})} = (\lambda \times h \times K_a) - (2 \times C \times \text{Sqrt}(K_a)) \\ &= (99\text{pcf} \times 10\text{ft} \times 0.32) - (2 \times 0\text{psf} \times \text{Sqrt}(0.32)) \\ &= 316.90 \text{ psf} \end{aligned}$$

[Trenching and Shoring Manual, Eq. 4-33]

$$\begin{aligned} \text{Lateral Pressure Due to Surcharge} &= \sigma_{h(\text{Surcharge})} = (2Q/\pi) \times [\beta_R - (\sin(\beta) \times \cos(2\alpha))] \\ &= (2 \times 900 \text{ psf}/\pi) \times [0.23 \text{ Rad} - (\sin(13.2^\circ) \times \cos(2 \times 23.3^\circ))] \\ &= 42.10 \text{ psf} \end{aligned}$$

[Trenching and Shoring Manual, Eq. 4-67]

$$\begin{aligned} \text{Total Lateral Pressure} &= \sigma_{h(\text{Total})} = \sigma_{h(\text{Soil})} + \sigma_{h(\text{Surcharge})} \\ &= 316.9\text{psf} + 42.1\text{psf} \\ &= 359.00 \text{ psf} \end{aligned}$$



9608 Aqua Harbor Way  
Las Vegas, NV. 89178  
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# Boussinesq Lateral Earth Pressure

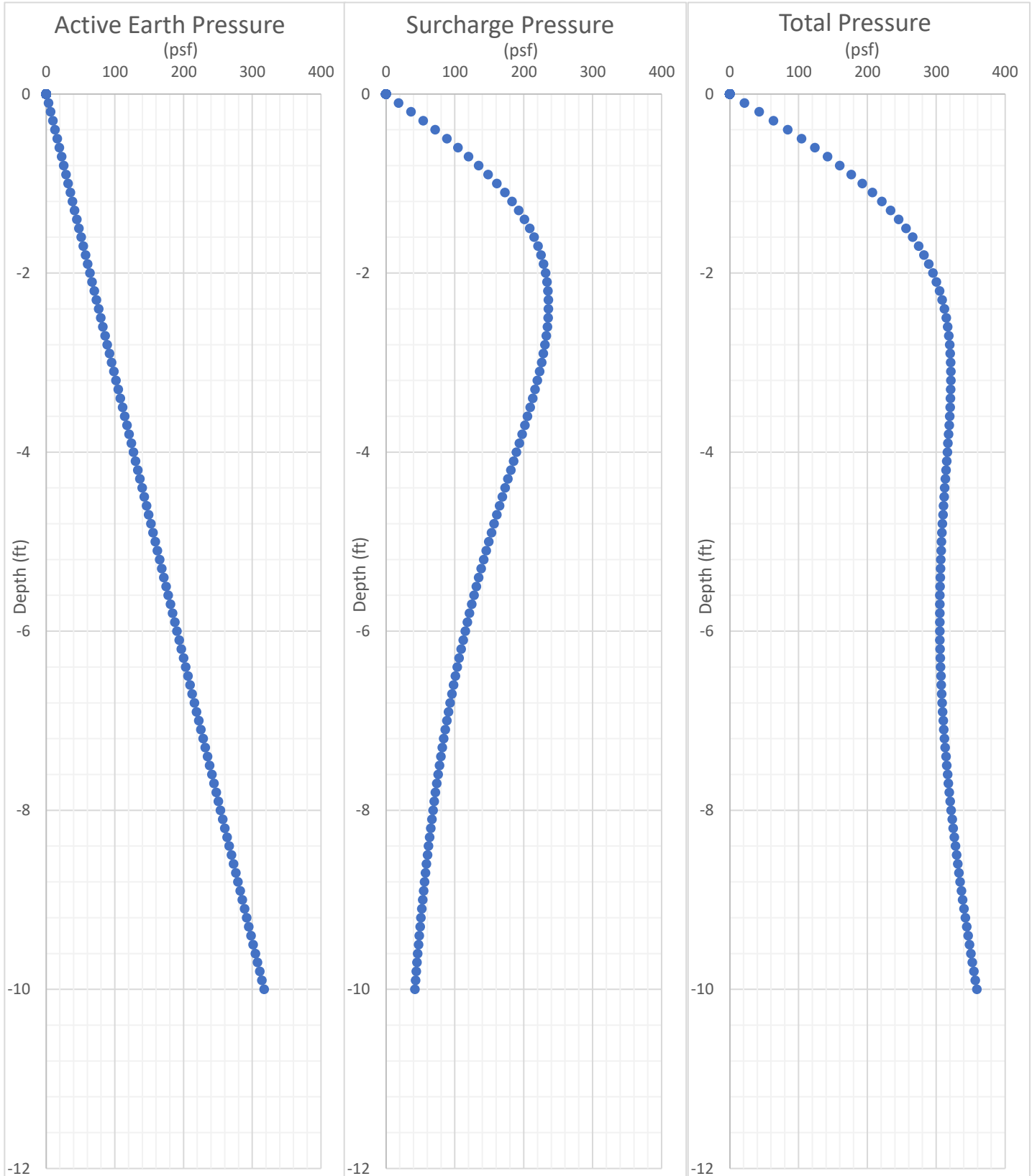
## DS-11

Date: 3/26/2025

Design values per CALTRANS 2015 Standard Specs

& 2011 Trenching and Shoring Manual (Revision 1, August 2011)

Sheet 2 of 3





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(702) 808-1295

# Boussinesq Lateral Earth Pressure

## DS-11

Date: 3/26/2025

Design values per CALTRANS 2015 Standard Specs

& 2011 Trenching and Shoring Manual (Revision 1, August 2011)

Sheet 3 of 3

### Detailed Results Summary

| h      | $\theta_1$ | $\theta_2$ | $\beta$ | $\beta_R$ | $\alpha$ | $\sigma_{h(\text{Soil})}$ | $\sigma_{h(\text{Surcharge})}$ | $\sigma_{h(\text{Total})}$ |
|--------|------------|------------|---------|-----------|----------|---------------------------|--------------------------------|----------------------------|
| 0.0 ft | -          | -          | -       | -         | -        | 0.0 psf                   | 0.0 psf                        | 0.0 psf                    |
| 1.0 ft | 18.4°      | 9.9°       | 8.6°    | 0.15 Rad  | 75.8°    | 31.7 psf                  | 160.9 psf                      | 192.5 psf                  |
| 2.0 ft | 33.7°      | 19.2°      | 14.5°   | 0.25 Rad  | 63.6°    | 63.4 psf                  | 231.8 psf                      | 295.2 psf                  |
| 3.0 ft | 45.0°      | 27.6°      | 17.4°   | 0.30 Rad  | 53.7°    | 95.1 psf                  | 226.0 psf                      | 321.0 psf                  |
| 4.0 ft | 53.1°      | 34.8°      | 18.3°   | 0.32 Rad  | 46.0°    | 126.8 psf                 | 189.5 psf                      | 316.2 psf                  |
| 5.0 ft | 59.0°      | 41.0°      | 18.0°   | 0.31 Rad  | 40.0°    | 158.4 psf                 | 149.3 psf                      | 307.8 psf                  |
| 6.0 ft | 63.4°      | 46.2°      | 17.2°   | 0.30 Rad  | 35.2°    | 190.1 psf                 | 115.1 psf                      | 305.3 psf                  |
| 7.0 ft | 66.8°      | 50.6°      | 16.2°   | 0.28 Rad  | 31.3°    | 221.8 psf                 | 88.4 psf                       | 310.3 psf                  |
| 8.0 ft | 69.4°      | 54.3°      | 15.2°   | 0.26 Rad  | 28.1°    | 253.5 psf                 | 68.3 psf                       | 321.9 psf                  |
| 8.7 ft | 71.0°      | 56.5°      | 14.4°   | 0.25 Rad  | 26.2°    | 275.7 psf                 | 57.4 psf                       | 333.1 psf                  |



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## SHORING PLAN

Project Name: Coastline Drive 12-Inch Waterline Improvements Project



**TABULATED DATA**

**VERTICAL  
ALUMINUM  
HYDRAULIC  
SHORING**

**2021**



CER, Inc.  
Construction Engineering Resource,  
Inc.  
1837 Wright St.  
Santa Rosa, CA 95404

Effective Date: April 15, 2012

Corporate Office  
Trench Shoring Company  
206 N. Central Ave.  
Compton, CA 90220

310-327-5554  
[TrenchShoring.com](http://TrenchShoring.com)



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### About Trench Shoring Safety Vertical Aluminum Hydraulic Shore Tabulated Data

Vertical Aluminum Hydraulic Shores were first developed in the late 1950's and early 1960's. To this day, the shores are built practically the same as they were then. There are several major manufacturers all with similar parts and their own version of manufacturer's tabulated data. Some parts are also interchangeable. Due to the interchangeability and variety of tabulated data available, Trench Shoring has developed this set of universal tabulated data under;

Federal OSHA 29CFR, Part 1926, Subpart P-Excavations and Trenches

1926.652(c)(3)-**Option (3)** - Designs Using other Tabulated Data.

1926.652(c)(3)(i) -Design of support systems, shield systems, or other protective systems shall be in accordance with tabulated data, such as tables and charts.

Note that **manufacturer's** tabulated data is developed under;

1926.652(c)(3)-**Option (2)** - Designs Using Manufacturers Tabulated Data.

Federal OSHA 29CFR also has tabulated data for vertical hydraulic shores under;

1926 Subpart P-**Appendix D**-Aluminum Hydraulic Shoring for Trenches



## **VERTICAL ALUMINUM HYDRAULIC SHORING TABULATED DATA**

**2**

Federal OSHA 29CFR only allows use of Appendix D when Option 2 is not available. Appendix D tabulated data is more restrictive than manufacturer's tabulated data in two major ways;

1. There is no category for OSHA Type C soil
2. The tables only allow trench depths to 20 ft deep

Use of this Trench Shoring Universal Vertical Aluminum Hydraulic Shore tabulated data will result in selection of a system that, at a minimum, conforms to manufacturers tabulated data developed by;

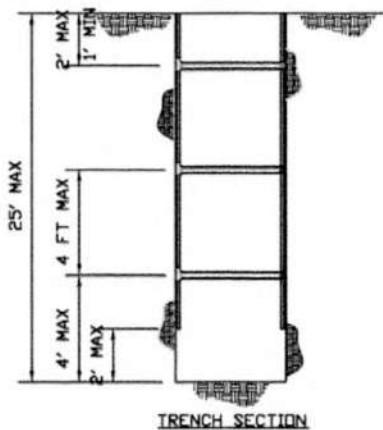
- Allied Tren-Shore
- Cerda
- Efficiency Corporation
- GME Corporation
- Kundle Tren-Shore
- Pacific Shoring, LLC
- Quick Shore
- Safety Shore
- Speed Shore Corporation

In some cases, this tabulated data will be more restrictive than the manufacturers version; however it is always less restrictive than the OSHA Appendix D version. The competent person utilizing this tabulated data should have a clear understanding that he is selecting a shoring system under Option 3, Designs Using other Tabulated Data.

## Vertical Aluminum Hydraulic Shoring Quick Use Guide

This quick use guide provides a step-by-step methodology for determining the proper configuration of a vertical aluminum hydraulic shoring system. Proper use of this process will result in a system constructed in accordance with the tabulated data presented here. To be in conformance with this tabulated data, all of the information presented in this document shall be read and understood by the person utilizing this data.

### 1) VERTICAL SPACING



### 2) HORIZONTAL SPACING

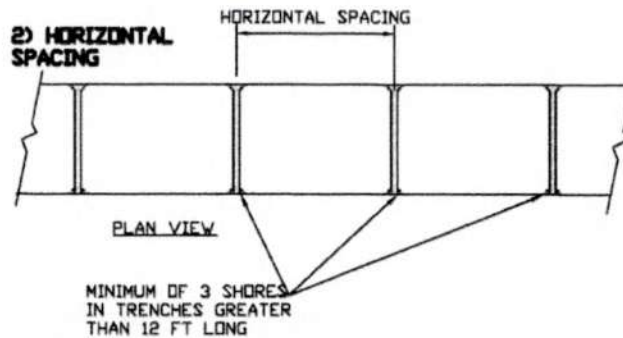


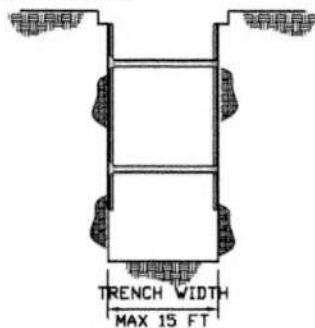
Table 5-HORIZONTAL SHORE SPACING

| Depth<br>ft   | OSHA Soil Type |   |      |
|---------------|----------------|---|------|
|               | A              | B | C-60 |
| over 5 to 10  | 8              | 8 | 6    |
| over 10 to 15 | 8              | 6 | 4    |
| over 15 to 20 | 8              | 6 | 4    |
| over 20 to 25 | 6              | 4 | 3    |

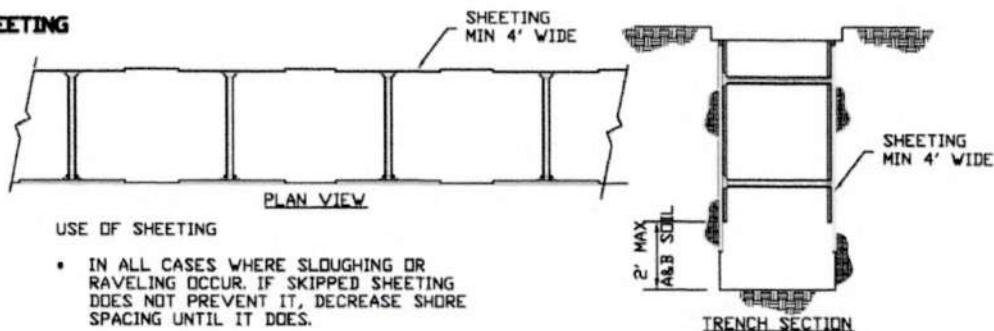
### TRENCH WIDTH OVERSLEEVE REQUIREMENTS:

- 0 TO 8 FT WIDE NO OVERSLEEVE REQUIRED TYPE A & B SOIL
- 8 TO 12 FT WIDE 3" ROUND ALUMINUM OVERSLEEVE
- 12 TO 15 FT WIDE 3.5' X 3.5' X 1/4" WALL SQUARE STEEL OVERSLEEVE

### 3) TRENCH WIDTH



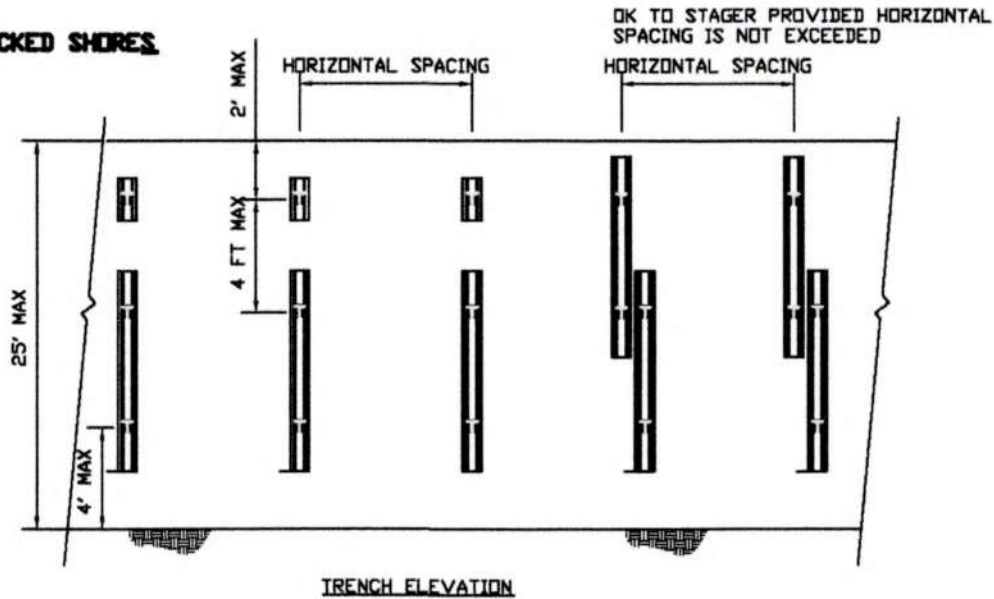
### 4) SHEETING



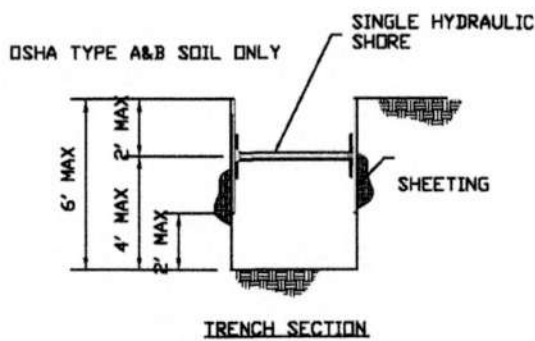
#### USE OF SHEETING

- IN ALL CASES WHERE SLOUGHING OR RAVELING OCCUR, IF SKIPPED SHEETING DOES NOT PREVENT IT, DECREASE SHORE SPACING UNTIL IT DOES.
- TYPE C-60 SOIL
- MAXIMUM 2 FT ABOVE BOTTOM IN TYPE A & B SOIL TO BOTTOM IN C-60 SOIL

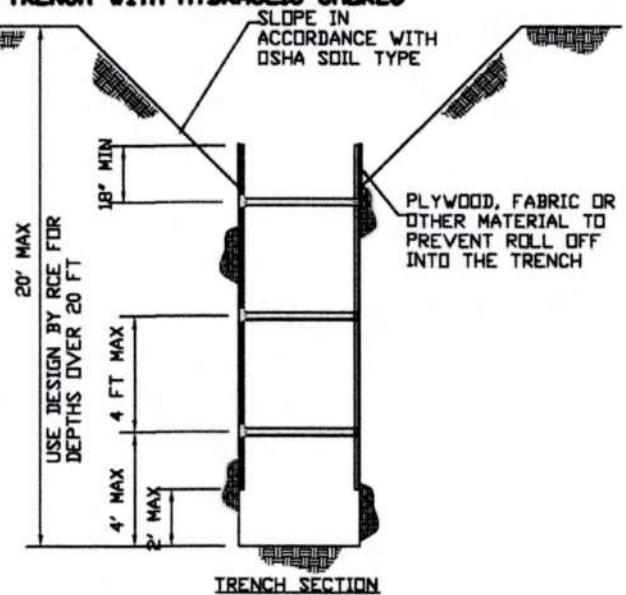
## 5) STACKED SHORES



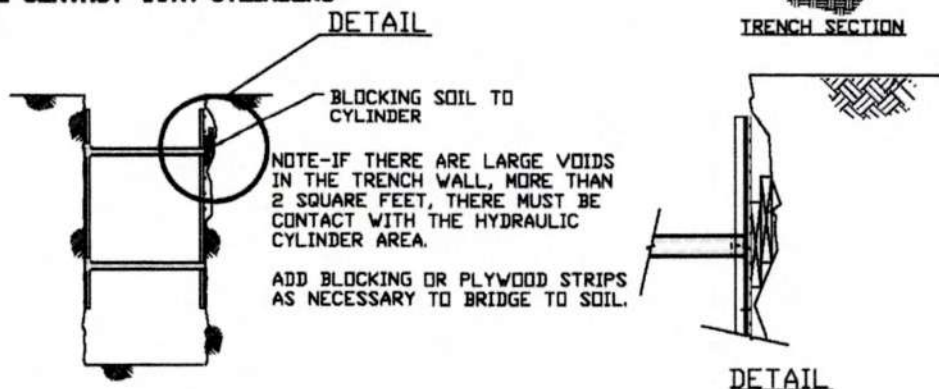
## 6) SINGLE SHORE IN 6 FT TRENCH



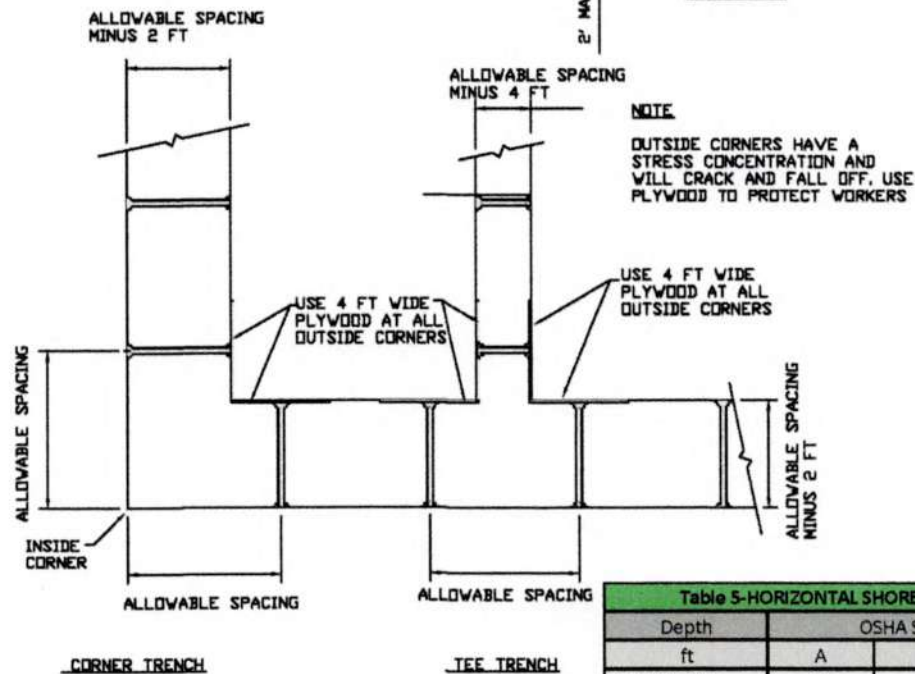
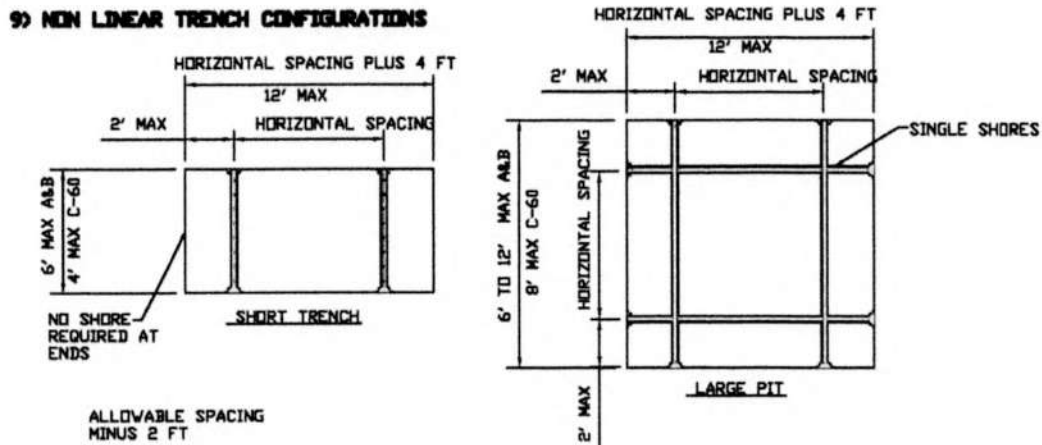
## 7) SLOPED TRENCH WITH HYDRAULIC SHORES



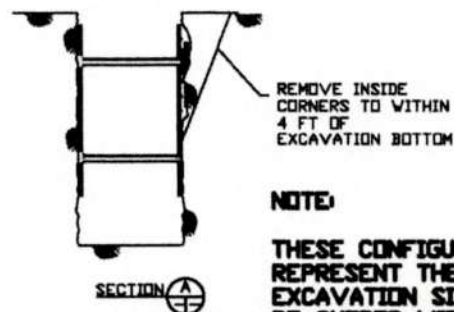
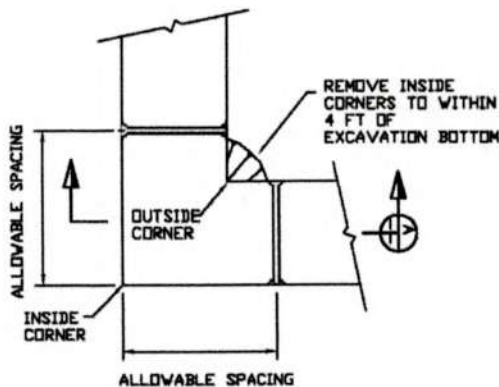
## 8) SOIL CONTACT WITH CYLINDERS



### 9) NON LINEAR TRENCH CONFIGURATIONS



| Table 5-HORIZONTAL SHORE SPACING |                |   |      |
|----------------------------------|----------------|---|------|
| Depth<br>ft                      | OSHA Soil Type |   |      |
|                                  | A              | B | C-60 |
| over 5 to 10                     | 8              | 8 | 6    |
| over 10 to 15                    | 8              | 6 | 4    |
| over 15 to 20                    | 8              | 6 | 4    |
| over 20 to 25                    | 6              | 4 | 3    |

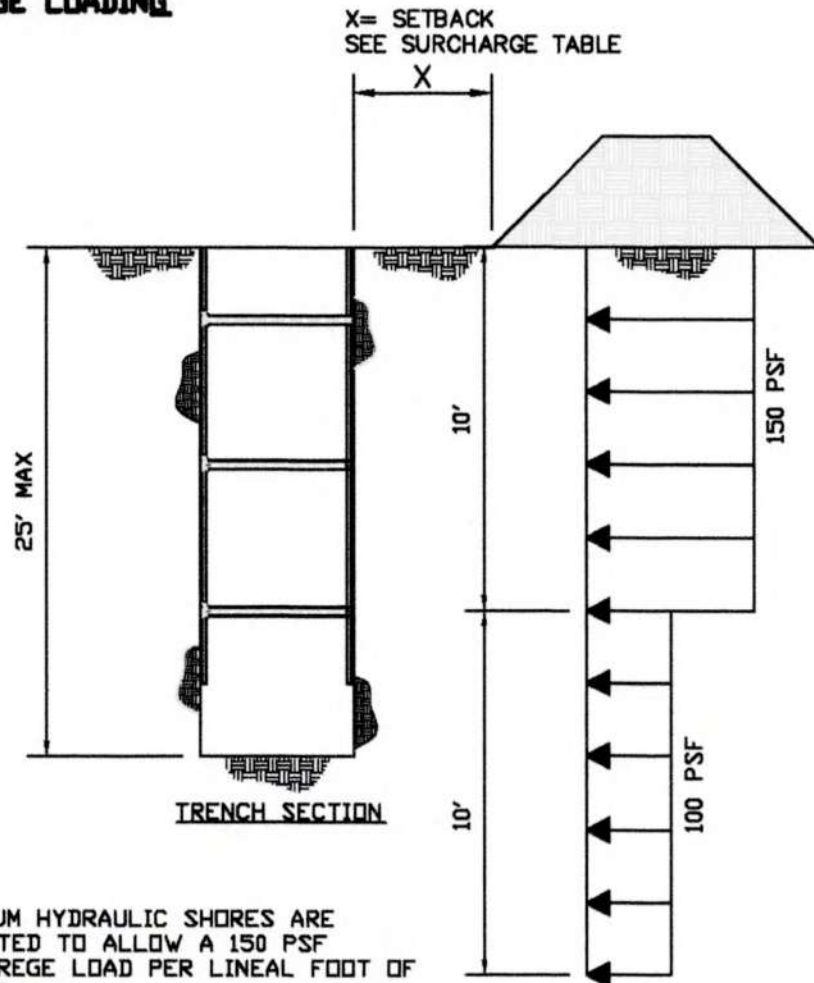


#### NOTE:

THESE CONFIGURATIONS REPRESENT THE LIMITS OF EXCAVATION SIZES THAT CAN BE SHORED WITH 2" VERTICAL HYDRAULIC SHORES

CORNER AND T TRENCH ALTERNATIVE TO USING PLYWOOD AT OUTSIDE CORNERS

## 10) SURCHARGE LOADING



### NOTE

ALUMINUM HYDRAULIC SHORES ARE  
TABULATED TO ALLOW A 150 PSF  
SURCHARGE LOAD PER LINEAL FOOT OF  
SPACING

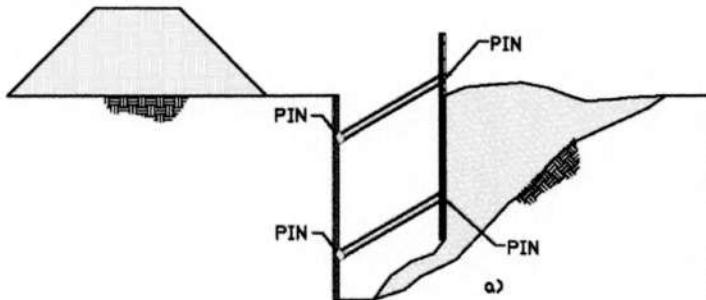
### SURCHARGE LOADING DIAGRAM

SURCHARGE AFTER 20 FT DEEP IS 50 PSF OR LESS

| SURCHARGE SETBACK TABLE                                                                                                       |                    |                            |                    |
|-------------------------------------------------------------------------------------------------------------------------------|--------------------|----------------------------|--------------------|
| Surcharge                                                                                                                     | Setback Distance x | Surcharge                  | Setback Distance x |
| K-Rail                                                                                                                        | 1 ft               | 3 Cy Loader                | 2 ft               |
| HS20-44 Traffic                                                                                                               | 4 ft               | 5 Cy Loader                | 3 ft               |
| Spoil Pile 4 ft high                                                                                                          | 2 ft               | 225 Excavator              | 2 ft               |
| Backhoe                                                                                                                       | 2 ft               | 325 Excavator              | 3 ft               |
| Equipment < 20,000 lb                                                                                                         | 2 ft               | Dump Truck and Haul Trucks | 3 ft               |
| Equipment >20,000 lb                                                                                                          | 3 ft               | 12 CY Concrete Truck       | 3 ft               |
|                                                                                                                               |                    | Boom Truck Pad             | 6 ft               |
| Table Notes:                                                                                                                  |                    |                            |                    |
| 1 These setbacks limit horizontal shoring loads to 72 psf for 0 to 10 ft and 50 psf 10 to 20 ft                               |                    |                            |                    |
| 2 Provide separate surcharge analysis for all cranes and structures within 15 ft of the excavation                            |                    |                            |                    |
| 3 Table setbacks are for open trenches. When traffic covers are in place HS20-44 traffic can pass over the covered excavation |                    |                            |                    |

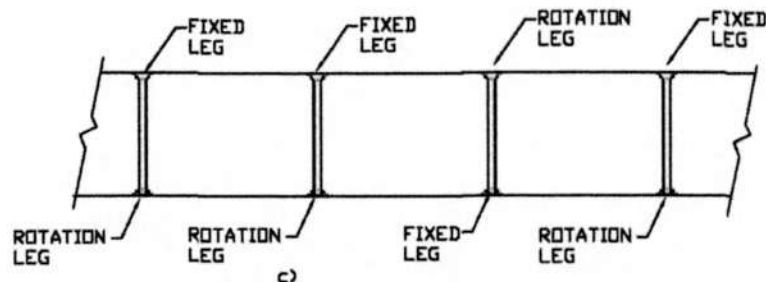
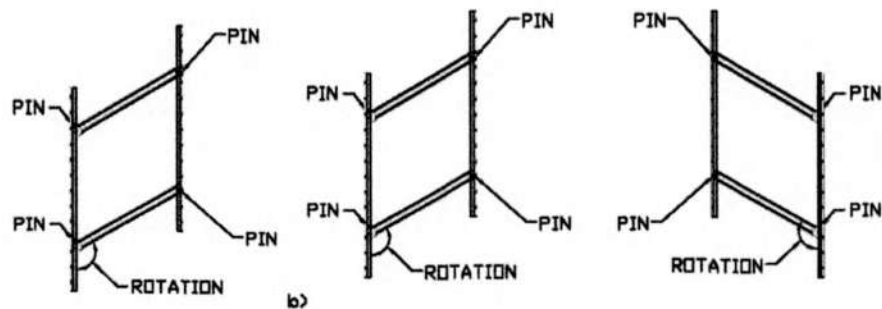
## Hydraulic Shore Safety Issues

### 1) SHORE FOLD UP



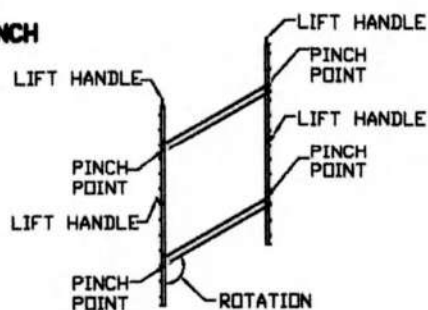
**PROBLEM**  
SHORES WITH 2 HYDRAULIC CYLINDERS OR  
2 SINGLE CYLINDER SHORES CAN ROTATE  
DUE TO UNBALANCED LOADING ON ONE  
SIDE

**SOLUTION**  
SET EVERY THIRD SHORE SO THAT THE  
SHORE ROTATION IS OPPOSITE



PLAN VIEW

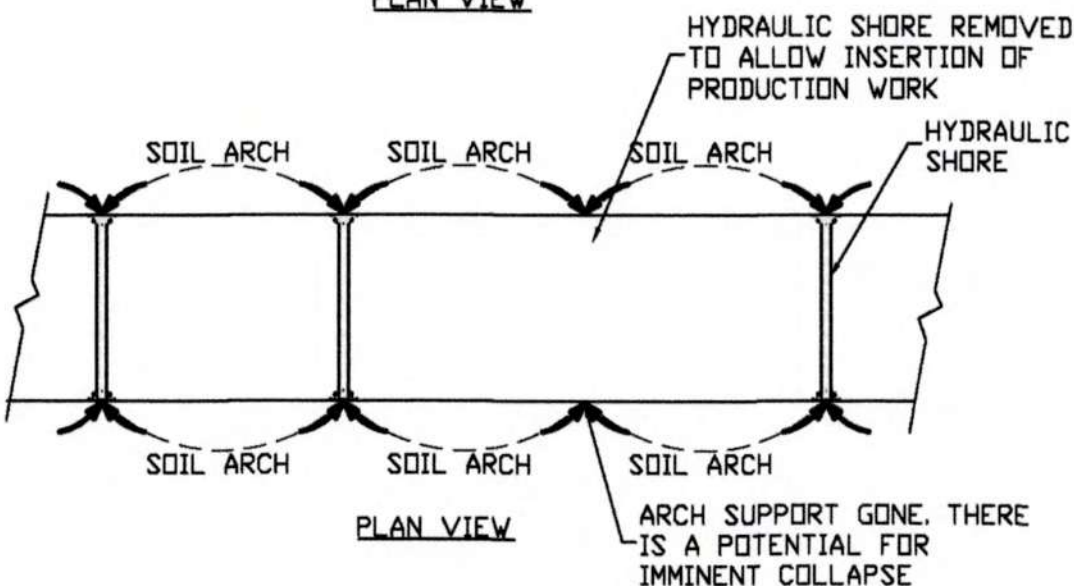
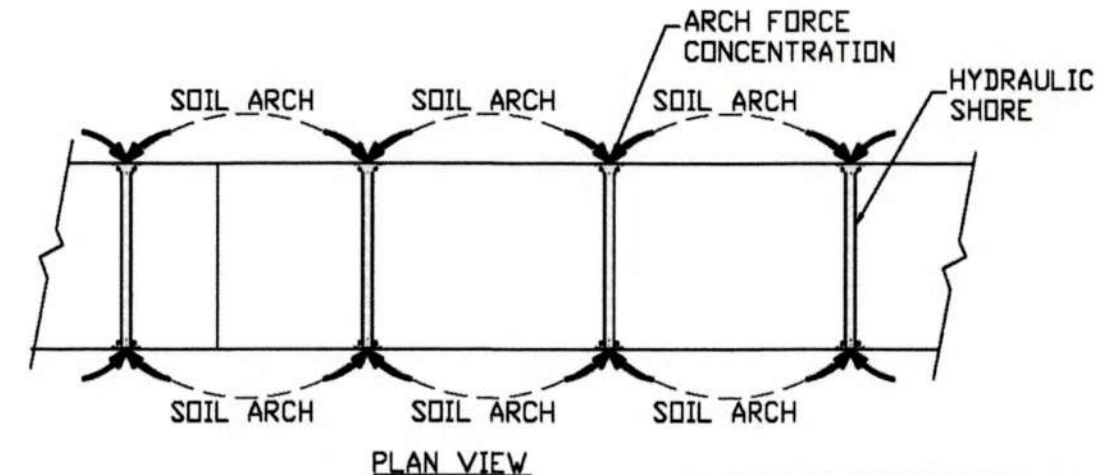
### 2) FINGER PINCH



**PROBLEM**  
FINGERS CAN BE PINCHED OR SEVERED  
BETWEEN THE RAIL AND THE CYLINDER  
BLOCK WHEN MOVING OR SETTING SHORES

**SOLUTION**  
USE LIFT HANDLES ONLY TO LIFT AND  
SET THE SHORE

### 3) REMOVAL OF SOIL ARCH



#### PROBLEM

SOIL ARCHING IS ESTABLISHED WHEN SHORES ARE INSTALLED. TEMPORARY OR PERMANENT REMOVAL OF THE SHORE IS A POTENTIAL FOR IMMINENT COLLAPSE

#### SOLUTION

1. WHEN REMOVING SHORES KEEP BACKFILL CLOSE TO SHORES BEING REMOVED
2. WHEN REMOVING AND RESETTING SHORES TO ALLOW PLACEMENT OF PRODUCTION WORK USE REMOTE EQUIPMENT SUCH AS BACKHOE OR BOOM TRUCK TO PICK AND RESET SHORES. OPERATE SHORE HYDRAULICS FROM SHORED AREA.



## **VERTICAL ALUMINUM HYDRAULIC SHORING TABULATED DATA**

**9**

### **Vertical Aluminum Hydraulic Shores Description**

Vertical Aluminum Hydraulic Shores are constructed from standard duty or heavy-duty vertical rails attached to 2" hydraulic cylinders. The rail lengths vary from 18" to 20 ft long. The cylinders can extend from 18" to 88". Cylinder extensions can be added to obtain lengths to 15'. The hydraulic cylinder consists of a 2" OD piston, a 2" ID x 3/16" barrel, and a 3" OD x 3/16" oversleeve. The cylinders provide a 23,000 lb safe working load for cylinder bulging at a 1.5 factor of safety. At lengths 8 ft to 12 ft an additional 3" round aluminum over sleeve is required and at 12 ft to 15 ft a 3.5" x 3.5" x 3/16" wall a square steel oversleeve is required to prevent buckling. Based on the principal of soil arching Vertical Aluminum Hydraulic Shores can be spaced horizontally as much as 8 ft apart without sheeting on the trench walls. Plywood sheeting is used either attached or separate behind the rails to prevent the trench walls from sloughing or raveling.

Vertical Aluminum Hydraulic Shores are installed from outside the excavation. The shores are hinged so that they can be folded when lowered into the trench and then opened up and pressurized with a hydraulic hand pump. The hydraulic fluid is water soluble, environmentally safe, and biodegradable. Rails 5 ft long and less can typically be moved, set, and removed by a two man crew. Larger shores are typically handled by backhoe, loader or boom truck.

Vertical Aluminum Hydraulic Shores are typically used in linear trench applications in OSHA Type A, Type B, and Type C-60 soils at depths to 23 ft and trench widths to 15 ft. Constraints such as the requirement that the bottom cylinder be set a maximum of 4 ft from the bottom of the excavation, bedding requirements, and pipe wall thicknesses limits the pipe diameter or duct height to approximately 36" maximum. The 8 ft maximum horizontal spacing limits large pipe lengths to approximately 8 ft, while smaller diameters with longer lengths to 20 ft such as PVC sewer and water lines can be maneuvered between the cylinders to fit into the trench.

### **General Information for Use of Vertical Aluminum Hydraulic Shores**

1. The vertical aluminum hydraulic shoring system tabulated here is based on requirements of Federal OSHA 29CFR, Part 1926, Subpart P-Excavations and Trenches

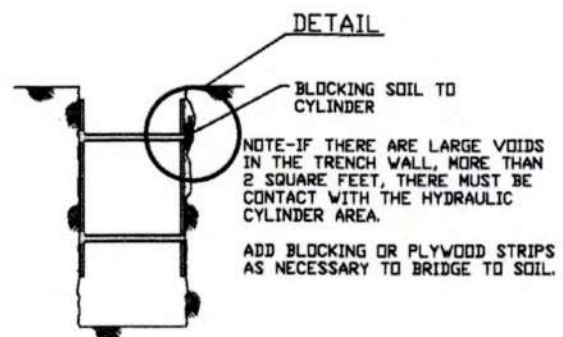
1926.652(c)(3)-Option (3) - Designs Using other Tabulated Data.

1926.652(c)(3)(i) -Design of support systems, shield systems, or other protective systems shall be in accordance with tabulated data, such as tables and charts.

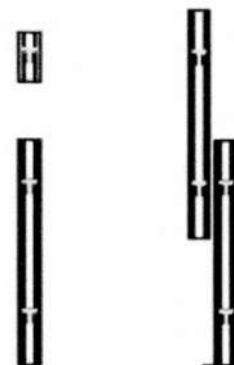
All provisions of Subpart P apply when utilizing this tabulated data. The contractor's competent person shall use this data to select:

- allowable trench depth
- vertical and horizontal shore spacing
- proper oversleeve requirement based on trench width
- plywood use requirements

2. The competent person utilizing this tabulated data shall be experienced and knowledgeable of all requirements of Subpart P, and trained in the use and safety procedures for aluminum vertical hydraulic shores.
3. For specific Subpart P requirements regarding aluminum hydraulic shoring that is in addition to the tabulated data requirements, see OSHA Subpart P additional requirements related to aluminum hydraulic shoring. Some of these requirements are listed at the end of this document, See **Header PG. 29**
4. Use of this tabulated data is dependent on first classifying the soil in accordance with OSHA Appendix A, Soil Classification. Classification shall be just prior to installing Vertical Hydraulic Shoring. Soil conditions may change at a later date and require Vertical Hydraulic Shoring to be reset at a different spacing.
5. Hydraulic vertical shores are tabulated based on the effect of a 20,000 lb surcharge load set back 2 ft from the edge of the trench and the equivalent weight effect of the OSHA soil type, See classification of soil types, 2.
6. The depth and spacing given in **Table 1** governs the use of Vertical Hydraulic Shores and not tabulations given in OSHA Appendix C
7. Faces of excavations shall be vertical and there shall be in contact with the soil at each cylinder, **Figure 1**.
8. Shores shall be set near vertical; however, they may be set as much as 30 degrees from vertical provided that vertical and horizontal spacing is maintained.
9. Vertical Hydraulic Shores may be stacked or longitudinally lapped, **Figure 2**, provided shore spacing is maintained.

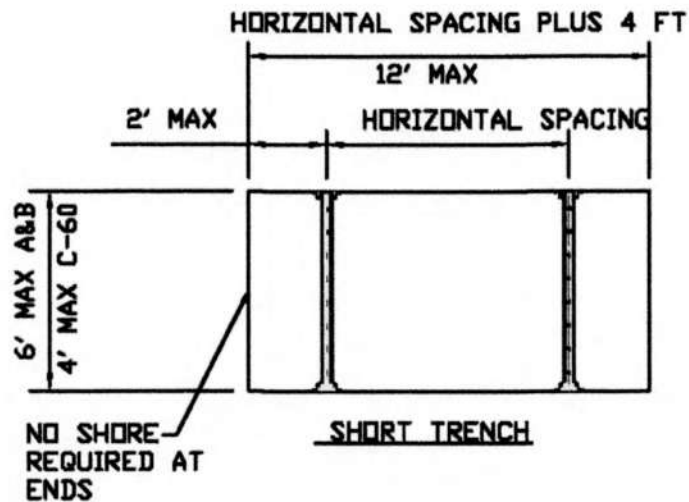


**Figure 1. – See note 7**



**Stacked                  Lapped**  
**Figure 2. – See note 9**

10. Trenches maximum 12 ft long or horizontal spacing 4 ft or less shall have a minimum of 2 shores set in accordance with spacing requirements. Longer trenches shall have a minimum of 3 shores set at required spacing. See **Figure 3**.
11. Shores shall be installed and removed from outside the trench, see installation and removal procedure.
12. Single cylinder shores may be used in place of multiple cylinder shores provided that horizontal and vertical spacing is maintained.
13. The competent person shall continually monitor the shored excavation for changed conditions such as water seepage, soil movement cracks at the surface, sloughing or raveling, proper surcharge load weight less than 20,000 lbs and setback a minimum of 2 ft and damaged shores.
14. Workers shall always enter, exit, and work inside the shored area of the trench.



**Figure 3. - Short trench, See Note 10**



## VERTICAL ALUMINUM HYDRAULIC SHORING TABULATED DATA

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### Classification of Soil Types

1. Soil classification shall be in accordance with OSHA Appendix A and classified just prior to installing hydraulic vertical shores. Soil conditions may change at a later date and require hydraulic vertical shores to be reset at a different spacing.

2. The equivalent weight of OSHA soil types\* is assumed to be as follows:

- |                      |                          |
|----------------------|--------------------------|
| • OSHA Type "A" Soil | 25 PSF per ft of depth   |
| • OSHA Type "B" Soil | 45 PSF per ft of depth   |
| • Type "C-60" Soil   | 60 PSF per ft of depth** |
| • OSHA Type "C" Soil | 80 PSF per ft of depth   |

\* These equivalent weights were adapted from OSHA 1926 Subpart P App C, Timber Shoring for Trenches, Tables C-1.1, C-1.2, and C-1.3

\*\* Type C-60 soil is not identified or classified in OSHA Appendix A

3. Type C-60 soil is;

- soil that does not qualify as OSHA Type A, or Type B, can be cut with vertical walls and will stand up long enough to safely insert and pressurize the hydraulic shore,
- the water table must be at or below the bottom of the excavation with no visible water seeping from the sides of the excavation

4. Hydraulic shores shall not be used in OSHA Type C-80 Soil



# VERTICAL ALUMINUM HYDRAULIC SHORING TABULATED DATA

13

## Vertical Aluminum Hydraulic Shore Selection Guide

| Table 1 Vertical Hydraulic Shore Selection Guide <sup>(1)</sup> |                                 |                                        |                                        |         |          |           |
|-----------------------------------------------------------------|---------------------------------|----------------------------------------|----------------------------------------|---------|----------|-----------|
| Depth of Trench (ft)                                            | Hydraulic Cylinder Requirements |                                        |                                        |         |          | Sheeting  |
|                                                                 | Maximum Horizontal Spacing (ft) | Maximum Vertical Cylinder Spacing (ft) | Cylinder Size Width of Excavation (ft) |         |          |           |
|                                                                 |                                 |                                        | to 8                                   | 8 to 12 | 12 to 15 |           |
| TYPE "A" Soil                                                   |                                 |                                        |                                        |         |          |           |
| to 10'                                                          | 8'                              | 4'                                     | 2"                                     | 2"      | 2"+OS2   | NOTE 2    |
| 10' to 15'                                                      | ↓                               | ↓                                      | ↓                                      | 2"      | 2"+OS2   |           |
| 15' to 20'                                                      |                                 |                                        |                                        | 2"+OS1  | 2"+OS2   |           |
| 20' to 25'                                                      | ↓                               | ↓                                      | ↓                                      | 2"+OS1  | 2"+OS2   |           |
| TYPE "B" Soil                                                   |                                 |                                        |                                        |         |          |           |
| to 10'                                                          | 8'                              | 4'                                     | 2"                                     | 2"      | 2"+OS2   | NOTE 2    |
| 10' to 15'                                                      | 7'                              | ↓                                      |                                        | 2"      | 2"+OS2   |           |
| 15' to 20'                                                      | 6'                              |                                        |                                        | 2"+OS1  | 2"+OS2   |           |
| 20' to 25'                                                      | 5'                              | ↓                                      |                                        | 2"+OS1  | 2"+OS2   | NOTE 3, 4 |
| TYPE "C-60" Soil                                                |                                 |                                        |                                        |         |          |           |
| to 10'                                                          | 6'                              | 4'                                     | 2"                                     | 2"      | 2"+OS2   | NOTE 3    |
| 10' to 15'                                                      | 5'                              | ↓                                      | ↓                                      | 2"      | 2"+OS2   |           |
| 15' to 20'                                                      | 4'                              |                                        |                                        | 2"+OS1  | 2"+OS2   |           |
| 20' to 25'                                                      | 3'                              | ↓                                      | ↓                                      | 2"+OS1  | 2"+OS2   |           |
| OS1 = 3"X3/16" Wall Aluminum Oversleeve                         |                                 |                                        |                                        |         |          |           |
| OS2 = 3.5"x3.5"x3/16" Wall Steel Oversleeve                     |                                 |                                        |                                        |         |          |           |

### Notes

- Soil shall first be classified in accordance with OSHA Appendix A Soil Classification for use with this selection guide.  
Type C-60 soil is OSHA Appendix A Type C soil that will stand up long enough to install the hydraulic shores.
- Sheeting is required at any depth whenever sloughing or raveling occur. If sloughing or raveling occurs between sheeting, decrease spacing until it is prevented. See **Table 2** for allowable sheeting. Sheeting may be attached to jack or set into trench separately.

| Table 2-ALLOWABLE SHEETING     |                |      |                                          |  |
|--------------------------------|----------------|------|------------------------------------------|--|
| Plywood                        |                |      | Other Materials                          |  |
| 3/4" Finn Form                 |                |      | 1/2" thick steel plate 4 ft wide x depth |  |
| 3/4" Omni Form                 |                |      | Steel sheet piling                       |  |
| 3/4" plyform, Class 1 Exterior |                |      | Aluminum sheet piling                    |  |
| 3/4" HDO, High Debsity Overlay |                |      | Buildable box panels                     |  |
| 3/4" HDO, High Density Overlay |                |      |                                          |  |
| 3/4" 14 Ply Artic White Birch  |                |      |                                          |  |
| 1-1/8" CDX                     |                |      |                                          |  |
| 2 sheets of 3/4" CDX           |                |      |                                          |  |
| Timber Lagging Set Horizontal  |                |      |                                          |  |
| Thickness                      | Soil Type/Span |      |                                          |  |
|                                | A              | B    | C-60                                     |  |
| 2"                             | 4 ft           |      |                                          |  |
| 3"                             | 5 ft           | 4 ft |                                          |  |
| 4"                             | 8 ft           | 6 ft | 4 ft                                     |  |
| DF#2 or Oak                    |                |      |                                          |  |



**VERTICAL ALUMINUM  
HYDRAULIC SHORING  
TABULATED DATA**

**14**

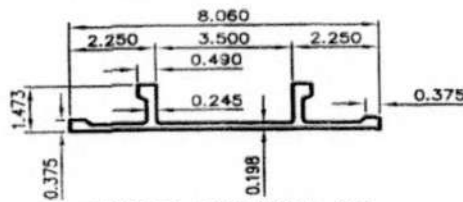
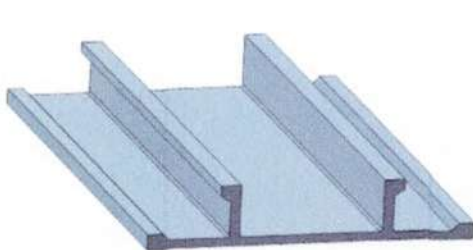
---

3. Sheeting is required at this depth.
4. Sheeting must extend to the bottom of the excavation.
5. This tabulation includes lateral loading from equipment weighing 20,000 lbs or less and a maximum 2 ft high spoil pile set back a minimum of 2 ft. The competent person shall determine the effect of all other surcharge loads and reduce hydraulic shore spacing as required to resist those loads.

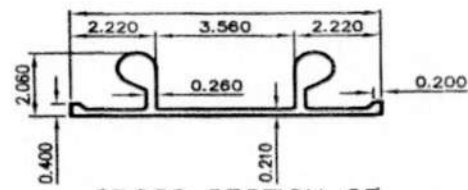
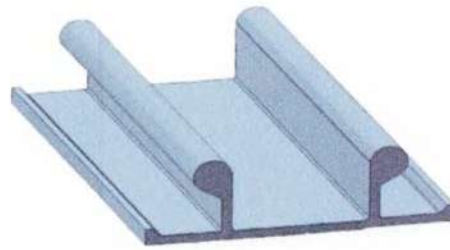
## Vertical Aluminum Rail Specification

### VERTICAL RAIL SPECIFICATION SHEET

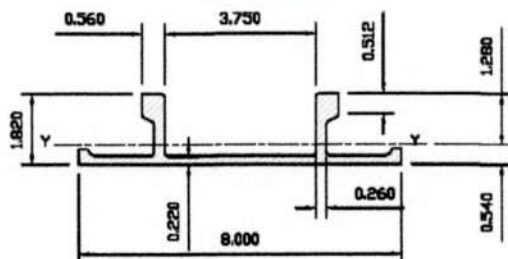
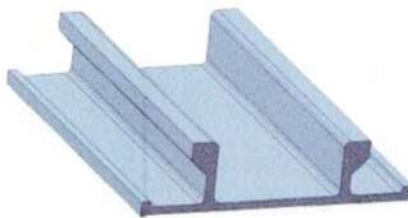
| SECTION PROPERTIES                        | STANDARD RAIL        | HEAVY DUTY RAIL      |
|-------------------------------------------|----------------------|----------------------|
| MATERIAL                                  | ALUMINUM             | ALUMINUM             |
| ALLOY                                     | 6061-T6              | 6061-T6              |
| AREA                                      | 2.45 in <sup>2</sup> | 3.47 in <sup>2</sup> |
| WEIGHT                                    | 2.94 plf             | 4.17 plf             |
| SECTION-MODULUS - TOP (LEG SIDE )         | 0.44 in <sup>3</sup> | 1.25 in <sup>3</sup> |
| SECTION-MODULUS - BOTTOM (BLADE SIDE )    | 1.29 in <sup>3</sup> | 2.38 in <sup>3</sup> |
| EQUIVALENT TIMBER SIZE * (#2 DOULAS FIR ) | 3x10 (FLAT )         | 4x10 (FLAT )         |



CROSS SECTION OF  
STANDARD VERTICAL RAIL

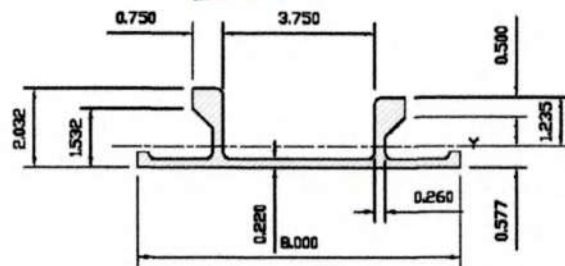
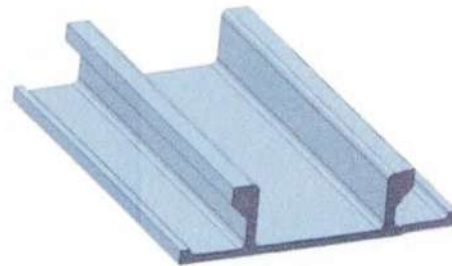


CROSS SECTION OF  
HEAVY DUTY VERTICAL RAIL



ALLIED HEAVY DUTY  
TRENCH JACK RAIL

|                              |                       |
|------------------------------|-----------------------|
| AREA                         | =3.08 IN <sup>2</sup> |
| WEIGHT                       | =3.52 PLF             |
| MOMENT OF INERTIA            | =0.52 IN <sup>4</sup> |
| SECTION MODULUS TENSION      | =0.99 IN <sup>3</sup> |
| SECTION MODULUS, COMPRESSION | =2.37 IN <sup>3</sup> |

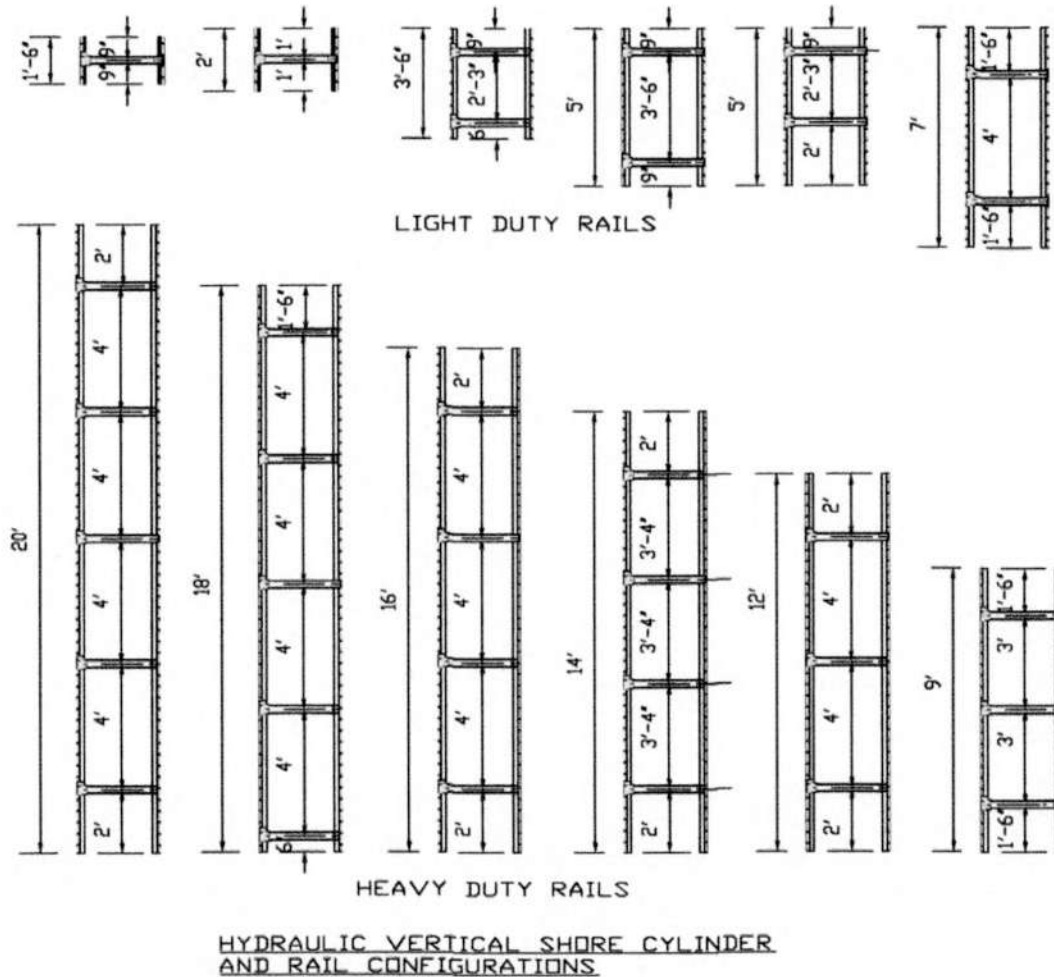


ALLIED EXTRA HEAVY  
DUTY TRENCH JACK RAIL

|                              |                        |
|------------------------------|------------------------|
| AREA                         | =3.48 IN <sup>2</sup>  |
| WEIGHT                       | =3.98 PLF              |
| MOMENT OF INERTIA            | =1.565 IN <sup>4</sup> |
| SECTION MODULUS TENSION      | =1.26 IN <sup>3</sup>  |
| SECTION MODULUS, COMPRESSION | =2.71 IN <sup>3</sup>  |

**Figure 4. Vertical Rail Specifications**

**Typical Vertical Aluminum Hydraulic Rail Dimensions**



**Figure 5 – Rail Dimensions**

**Note** - Custom rail and cylinder spacing available upon request, however when using them with this tabulated data all spacing requirements of the data shall be met.

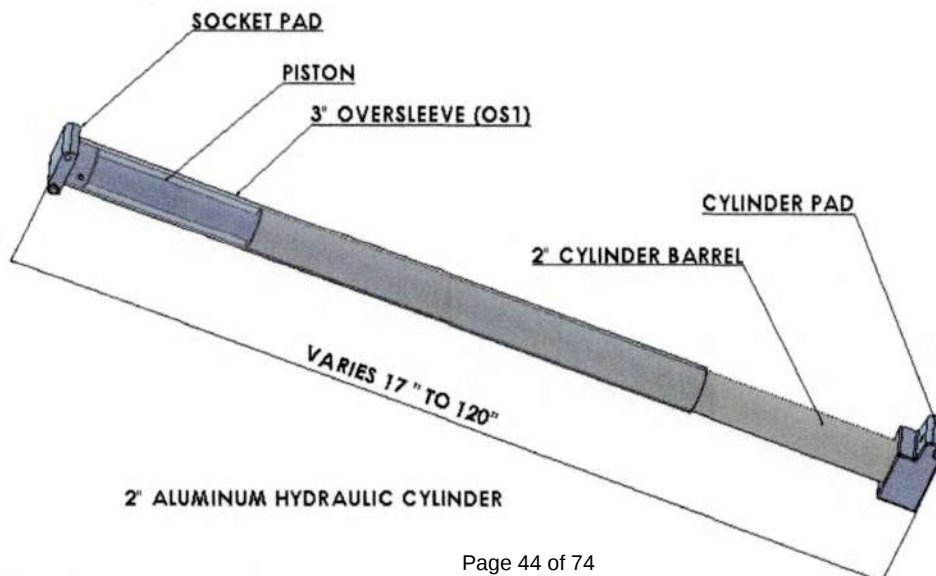
## Hydraulic Cylinder Specifications

To configure for trench width, the proper cylinder range, extension if necessary, and oversleeve must be determined. **Table 3** lists some of the available cylinder ranges and some of the ranges with extensions.

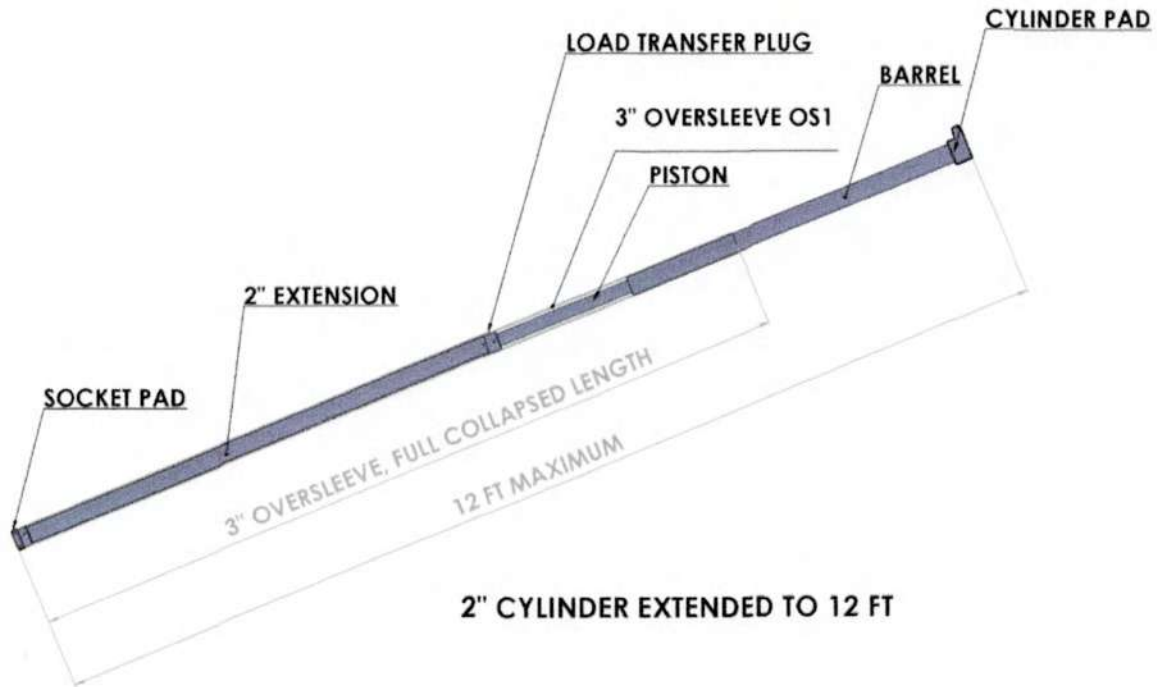
| Table 3- HYDRAULIC CYLINDER RANGE |          |              |           |          |              |
|-----------------------------------|----------|--------------|-----------|----------|--------------|
| Extension                         | Range    |              | Extension | Range    |              |
|                                   | Cylinder | w/ Extension |           | Cylinder | w/ Extension |
| (in)                              | (in)     | (in)         | (in)      | (in)     | (in)         |
| 11                                | 17-27    | 28-38        | 21        | 40-64    | 61-85        |
| 22                                |          | 39-49        | 42        |          | 82-106       |
| 33                                |          | 50-60        | 56        |          | 96-120       |
| 11                                | 22-36    | 33-47        | 24        | 52-88    | 76-112       |
| 22                                |          | 44-58        | 42        |          | 94-130       |
| 33                                |          | 55-69        | 56        |          | 108-144      |
| 15                                | 28-46    | 43-61        | 74        | 52-88    | 126-162      |
| 30                                |          | 58-76        | 82        |          | 132-168      |
| 45                                |          | 73-91        | 92        |          | 144-180      |
| 18                                | 34-55    | 52-73        | 128       |          | 180-216      |
| 36                                |          | 70-91        |           |          |              |
| 54                                |          | 88-109       |           |          |              |

Oversleeve requirements are given in **Table 4** and shown in **Figures 6, 7, 8**.

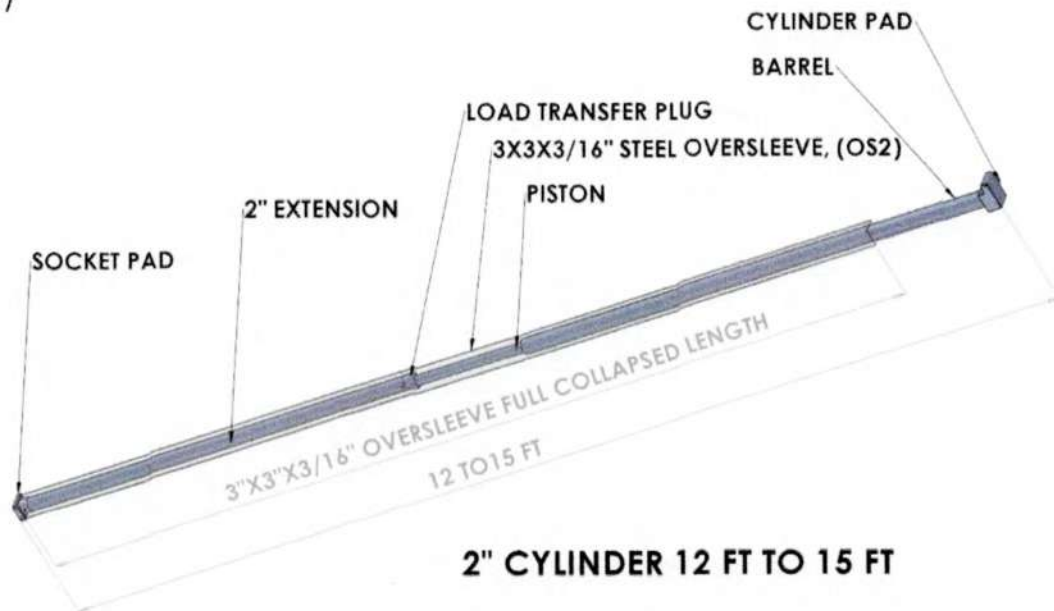
| Table 4-OVERSLEEVE REQUIREMENTS |                                          |
|---------------------------------|------------------------------------------|
| Trench Width                    | Oversleeve Required                      |
| to 8 ft                         | No oversleeve required                   |
| 8 ft to 12 ft                   | 3" x 3/16" round aluminum oversleeve     |
| 12 ft to 15 ft                  | 3-1/2" x 3-1/2" x 3/16" steel oversleeve |



**Figure 6**



**Figure 7**



**Figure 8**



## **VERTICAL ALUMINUM HYDRAULIC SHORING TABULATED DATA**

**19**

### **Vertical Aluminum Hydraulic Shore Installation and Removal Procedure**

#### **Required for installation**

- Vertical Hydraulic Jack
- Pump with fluid and operating pressure gauge
- Release tool

#### **Installation Procedure**

- Step 1 Attach hydraulic hose to hydraulic fitting on shore. Open the valve on the pump can so that the shore cannot be pressurized. Set plywood if required and not attached to the shore into trench.
- Step 2 Lower shore into trench with folded up blade toward opposite trench wall and hydraulic fitting toward adjacent wall. After the shore is set to elevation, hold adjacent blade in place with release tool and let go of opposite blade allowing it to completely unfold and lock into position. In order for the shore to lock into position, the cylinder must be 90 degrees from the blade. Heavy or wide shores that cannot be safely lifted by one person should be set in with lifting equipment such as backhoe, boom truck or crane.
- Step 3 Close the valve on the pump can and pressurize the hydraulic shore to between 750 and 1500 psi. Pressure gauge should hold at pressure and not indicate any loss of pressure.
- Step 4 Remove the hydraulic hose by prying off with release tool. Clip hose to top of pump to prevent contamination by dragging it in the dirt. Move to next shore location and repeat process.

#### **While trench shores are in place**

- Check at least at start of shift for loose shores. This can be done by tapping the top of the shore with a metal rod; it will sound loose, sort of like kicking a tire to see if it is flat. Remove and replace loose shores.
- Check for sloughing or raveling. If it is occurring, sheeting must be used.
- Confirm that soil classification has not changed.

#### **Required for Removal**

- Vertical Hydraulic shore
- Release tool
- Removal tool or lifting equipment



## **VERTICAL ALUMINUM HYDRAULIC SHORING TABULATED DATA**

**20**

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### **Removal Procedure**

Step 1 Place release tool over hydraulic fitting and removal hook in handle on opposite blade.

Step 2 Push release tool away to release fluid and pressure. Pull up on the removal hook to fold the shore up and then lift it out of trench.

**Note** - Depending on the length of the shore and width of the trench different installation procedures may be used. It is the responsibility of the contractor and his competent person to establish a safe installation and removal procedure for each application. All trench shore installers shall be instructed in the procedure prior to installing the shores.

## Installation steps for use of Vertical Aluminum Hydraulic Trench Shores

### Step 1 - Determine trench shoring requirements (Figure 9)

- Trench Depth
- Trench Width
- Trench Length

Note - Dewatering must be to the bottom of the excavation

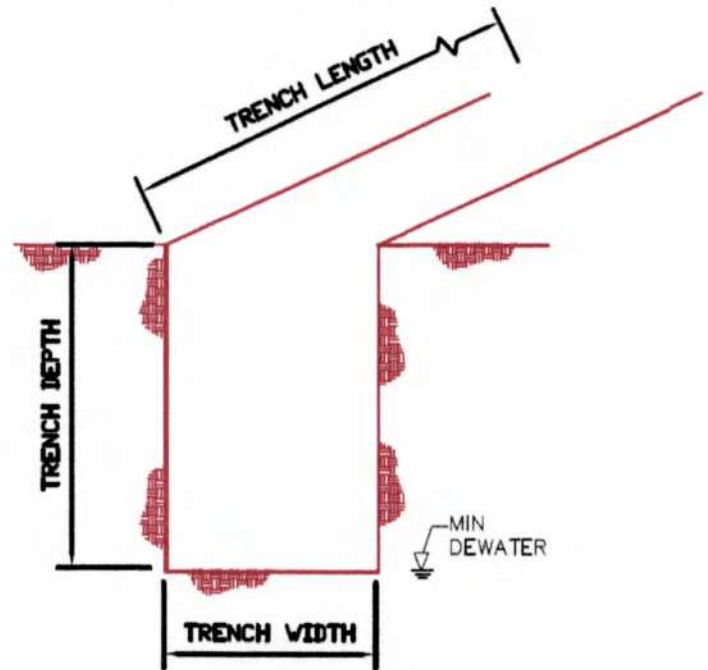


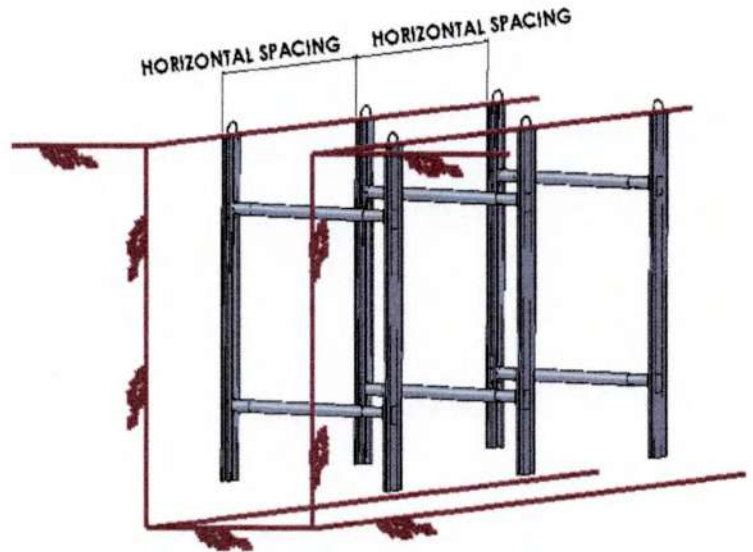
Figure 9 - Trench Parameters

### Step 2 - Determine soil type in conformance with OSHA Appendix A

- Type A-25 Sloping  $\frac{3}{4}$  :1
- Type B-45 Sloping 1:1
- Type C-60 Sloping 1-1  $\frac{1}{2}$  :1

Hydraulic Shores cannot be used in Type C-80 soil

**Step 3 - Determine horizontal shore spacing (Figure 10)**



**Figure 10 - Horizontal**

**Table 5 Notes**

1. A competent person must decide whether trenches under 5 ft deep are stable or will require shoring.
2. Aluminum hydraulic shores are not allowed at any spacing in C-80 soil

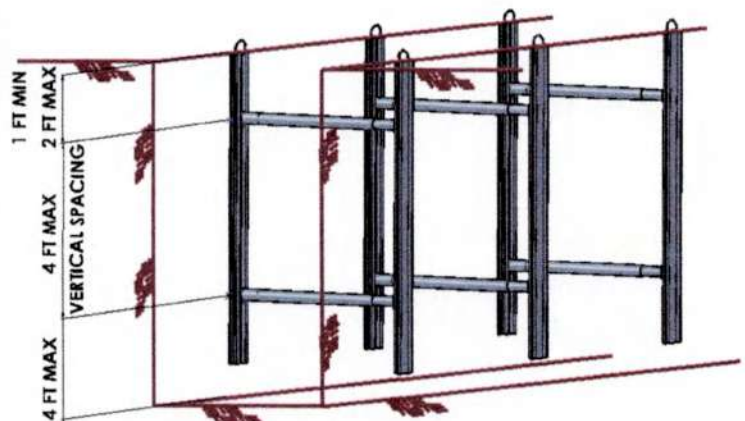
| Table 5-HORIZONTAL SHORE SPACING |                |   |      |
|----------------------------------|----------------|---|------|
| Depth                            | OSHA Soil Type |   |      |
| ft                               | A              | B | C-60 |
| over 5 to 10                     | 8              | 8 | 6    |
| over 10 to 15                    | 8              | 6 | 4    |
| over 15 to 20                    | 8              | 6 | 4    |
| over 20 to 25                    | 6              | 4 | 3    |

**Step 4 - Determine vertical cylinder spacing (Figure 11)**

| Table 6-VERTICAL CYLINDER SPACING                       |                 |                 |
|---------------------------------------------------------|-----------------|-----------------|
| Between                                                 | Maximum<br>(ft) | Minimum<br>(ft) |
| Top cylinder and surface                                | 2               | 1               |
| Between cylinders (note 3)                              | 4               | —               |
| Bottom to first cylinder                                | 4               | —               |
| Bottom of trench and lowest element of shoring (note 1) | —               | 2               |

**Table 6 Notes**

1. See OSHA 1926.652 (e) (2) Additional requirements for trench excavations (i)
2. — Indicates no limitation
3. When stacking hydraulic shores do not set hydraulic cylinders more than 4 ft apart

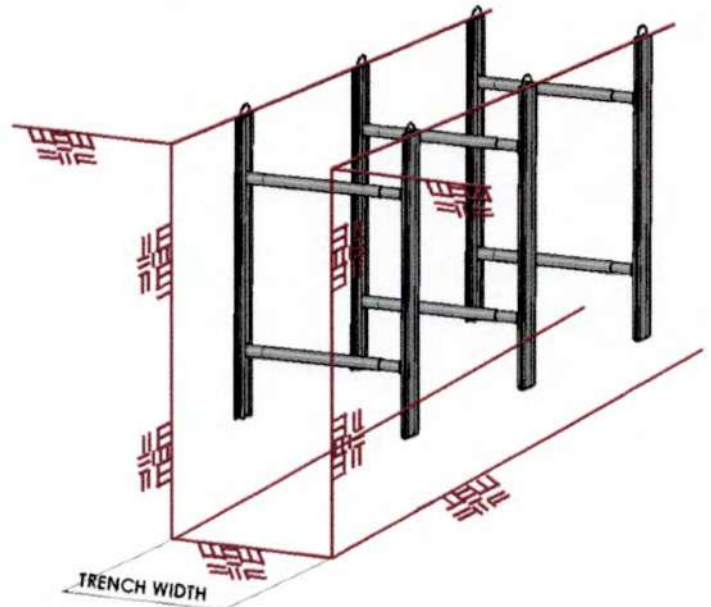


**Figure 11 - Vertical**

**Step 5 - Determine Cylinder size and Oversleeve Requirement for trench width**

| Table 7-ALLOWABLE TRENCH WIDTH |                          |          |          |  |
|--------------------------------|--------------------------|----------|----------|--|
| Depth                          | OSHA Type A, B, and C-60 |          |          |  |
|                                | Trench Width             |          |          |  |
|                                | To 8                     | 8 to 12  | 12 to 15 |  |
| (ft)                           | (ft)                     | (ft)     | (ft)     |  |
| to 5                           | 2"                       | 2" +OS 1 | 2" +OS2  |  |
| over 5 to 10                   | 2"                       | 2" +OS 1 | 2" +OS2  |  |
| over 10 to 15                  | 2"                       | 2" +OS 1 | 2" +OS2  |  |
| over 15 to 20                  | 2"                       | 2" +OS2  | 2" +OS2  |  |
| over 20 to 25                  | 2"                       | 2" +OS2  | 2" +OS2  |  |
| Depth                          | OSHA Type B-45 Soil      |          |          |  |
|                                | Trench Width             |          |          |  |
|                                | To 8                     | 8 to 12  | 12 to 15 |  |
| (ft)                           | (ft)                     | (ft)     | (ft)     |  |
| to 5                           | 2"                       | 2" +OS 1 | 2" +OS2  |  |
| over 5 to 10                   | 2"                       | 2" +OS 1 | 2" +OS2  |  |
| over 10 to 15                  | 2"                       | 2" +OS2  | 2" +OS2  |  |
| over 15 to 20                  | 2"                       | 2" +OS2  | 2" +OS2  |  |
| over 20 to 25                  | 2"                       | 2" +OS2  | 2" +OS2  |  |
| Depth                          | OSHA Type C-60 Soil      |          |          |  |
|                                | Trench Width             |          |          |  |
|                                | To 8                     | 8 to 12  | 12 to 15 |  |
| (ft)                           | (ft)                     | (ft)     | (ft)     |  |
| to 5                           | 2"                       | 2" +OS 1 | 2" +OS2  |  |
| over 5 to 10                   | 2"                       | 2" +OS 1 | 2" +OS2  |  |
| over 10 to 15                  | 2"                       | 2" +OS2  | 2" +OS2  |  |
| over 15 to 20                  | 2"                       | 2" +OS2  | 2" +OS2  |  |
| over 20 to 25                  | 2"                       | 2" +OS2  | 2" +OS2  |  |

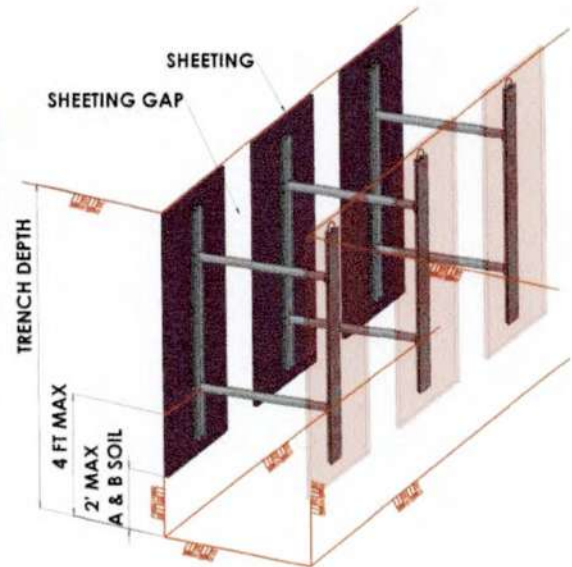
OS 1 = 3" round x 3/16" wall aluminum oversleeve  
OS2 = 3x3x3/16" wall square steel oversleeve



**Figure 12 - Trench Width**

**Step 6 - Determine sheeting requirements  
(Figure 13)**

| Table 8-SHEETING REQUIREMENTS |                |              |              |
|-------------------------------|----------------|--------------|--------------|
| Depth                         | OSHA Soil Type |              |              |
| ft                            | A              | B            | C-60         |
| to 8                          | Not Required   | Not Required | Not Required |
| over 8 to 10                  | ↓              | ↓            | Required     |
| over 10 to 15                 | ↓              | ↓            | ↓            |
| over 15 to 20                 | ↓              | ↓            | ↓            |
| over 20 to 25                 | ↓              | ↓            | ↓            |



**Table 8 Notes:**

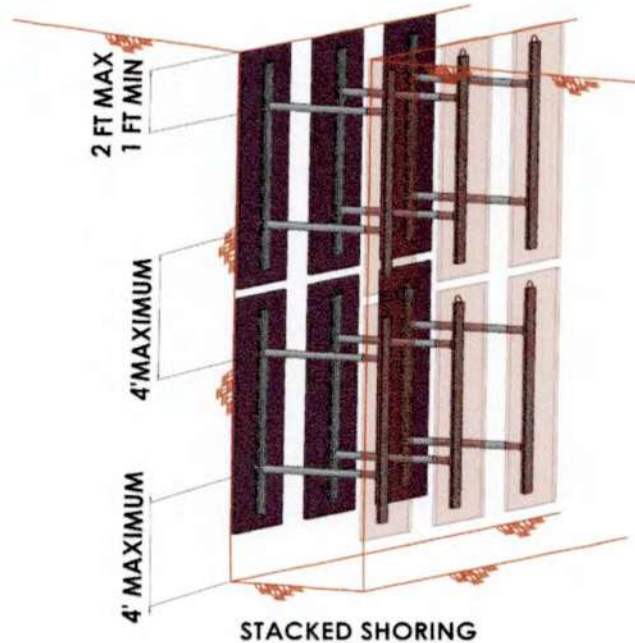
**Figure 13 Sheeting Requirements**

- Sheeting is always required when sloughing or raveling occurs and in C-60 soil over 8' deep.
- If there is a sheeting gap due to allowable shore spacing, the gap must be reduced until sloughing or raveling is prevented.
- Sloughing is associated with soft cohesive soil that squeezes around the rail or sheeting. Raveling is associated with non-cohesive soil, sands and gravels that fall off the face of the trench wall. Trench wall face exposure over time can create raveling as moisture cohesion weakens due to drying.
- Sheeting is not considered a structural part of the shore. Sheeting material requirements are strictly to meet minimum durability and handling requirements.
- Sheeting may be set separately or connected to the shore.
- In C-60 soil sheeting shall extend to the bottom of the excavation.
- See Table 2 for allowable sheeting material.

| Table 2-ALLOWABLE SHEETING     |                |      |                                          |  |
|--------------------------------|----------------|------|------------------------------------------|--|
| Plywood                        |                |      | Other Materials                          |  |
| 3/4" Finn Form                 |                |      | 1/2" thick steel plate 4 ft wide x depth |  |
| 3/4" Omni Form                 |                |      | Steel sheet piling                       |  |
| 3/4" plyform, Class 1 Exterior |                |      | Aluminum sheet piling                    |  |
| 3/4" HDO, High Debsity Overlay |                |      | Buildable box panels                     |  |
| 3/4" HDO, High Density Overlay |                |      |                                          |  |
| 3/4" 14 Ply Artic White Birch  |                |      |                                          |  |
| 1-1/8" CDX                     |                |      |                                          |  |
| 2 sheets of 3/4" CDX           |                |      |                                          |  |
| Timber Lagging Set Horizontal  |                |      |                                          |  |
| Thickness                      | Soil Type/Span |      |                                          |  |
|                                | A              | B    | C-60                                     |  |
| 2"                             | 4 ft           |      |                                          |  |
| 3"                             | 5 ft           | 4 ft |                                          |  |
| 4"                             | 8 ft           | 6 ft | 4 ft                                     |  |
| DF#2 or Oak                    |                |      |                                          |  |

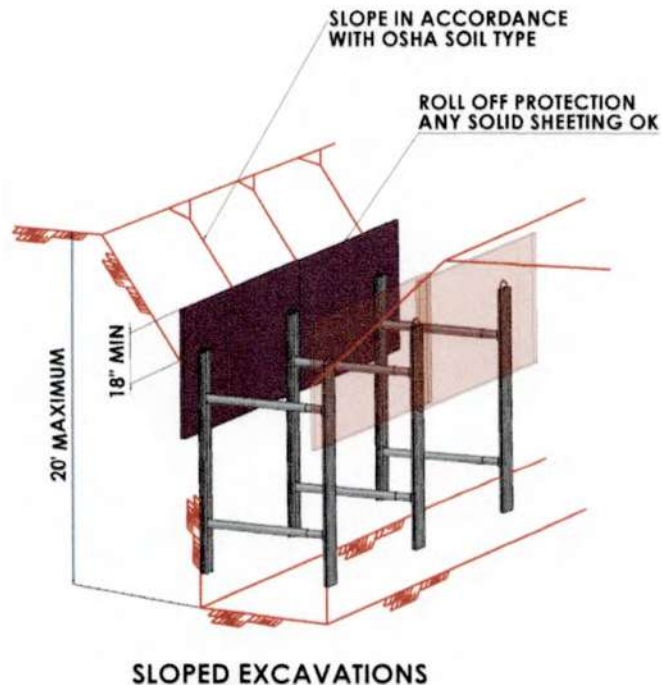
**Step 7 - Stacked Configurations (Figure 14)**

- Shores may be stacked vertically as long as the hydraulic cylinders are no more than 4 ft apart
- Shores may be staggered as long as allowable shore spacing is not exceeded

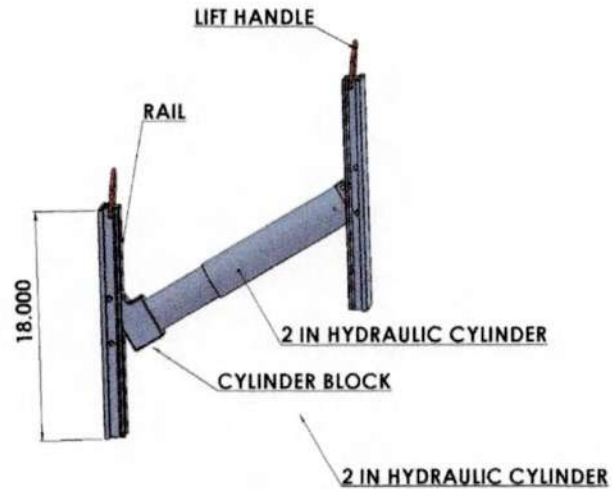


**Figure 14**

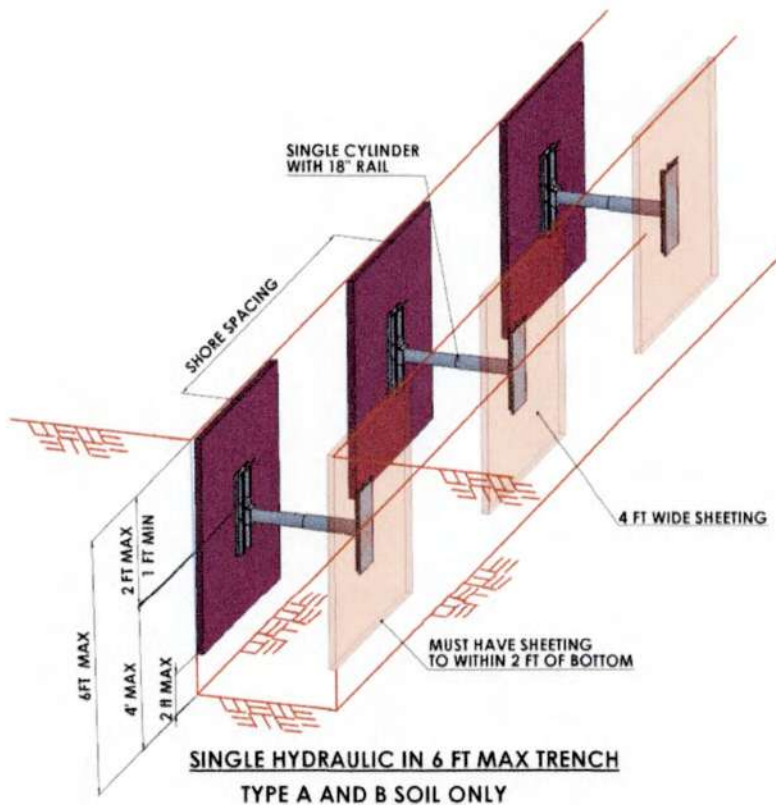
**Step 8 - Combined sloping and shoring configurations**

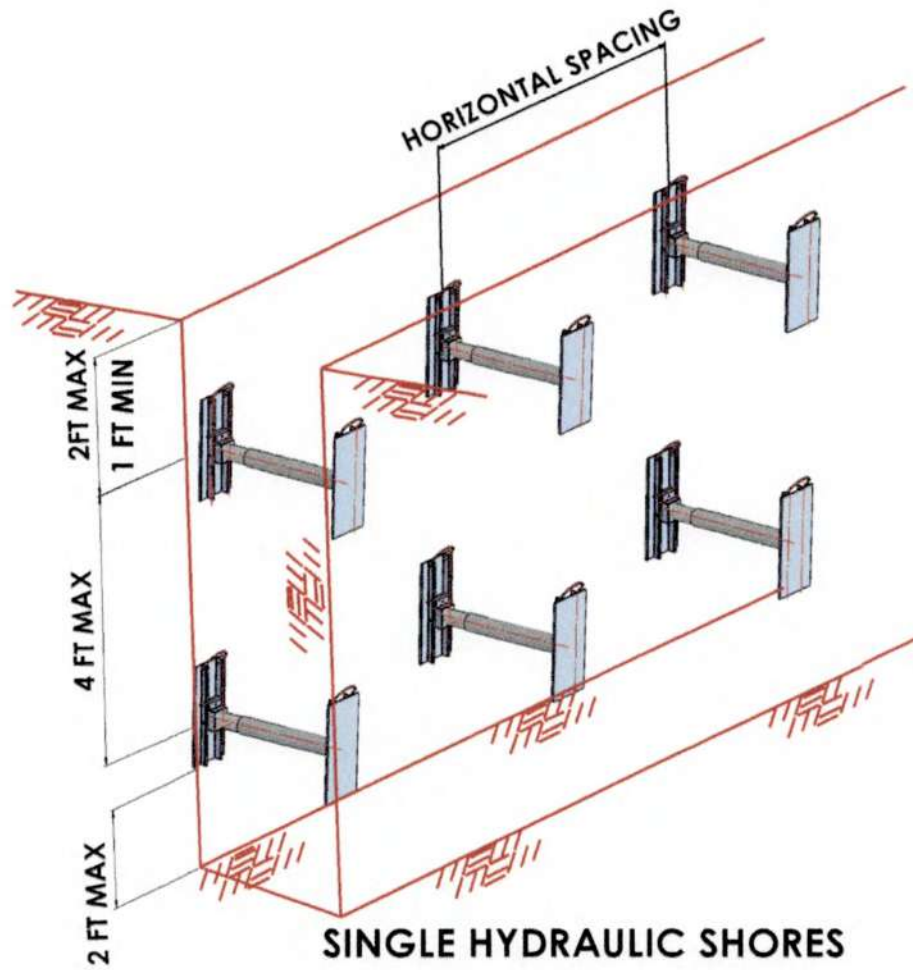


**Step 9 - Single Hydraulic Shore**

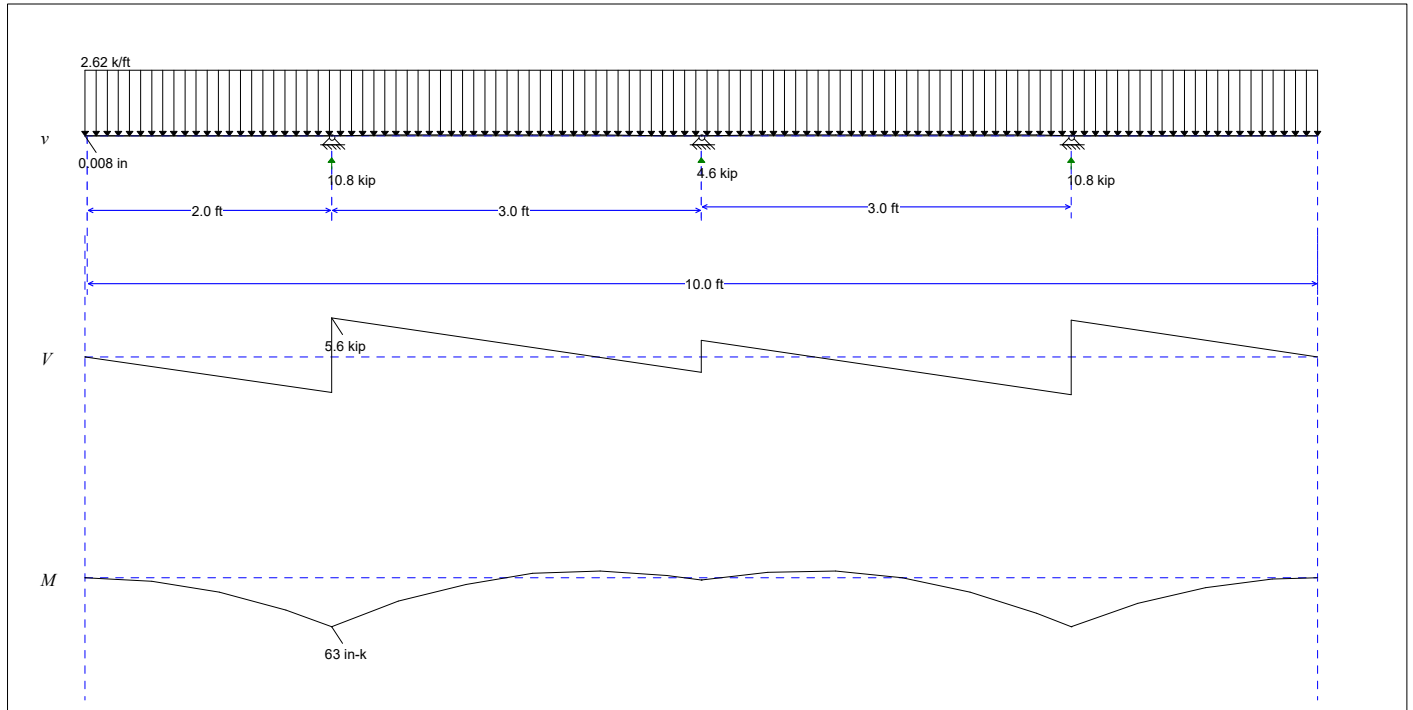


**SINGLE HYDRAULIC SHORE**





Rev 1



Beam Parameters: Length = 10.0 ft, E = 16000.0 ksi, I = 140.0 in<sup>4</sup>, A = 2.5 in<sup>2</sup>

Assume Max Ht = 10 ft

$M = wl^2/10$  - Per Caltrans Trench & Shoring Manual Section 5.2

$F_y = 40,000 \text{ psi} \times 0.60 = 24,000 \text{ psi}$

$w = 438 \text{ psf} \times 6 \text{ ft spacing} = 2628 \text{ lb/ft}$

$f_b = \text{Moment} / S_x = 52 \text{ in-k} / 2.38 \text{ in}^3 = 21,849 \text{ psi} < F_y \text{ OK}$

Cylinder Load = 10,800 lbs < 23,000 lbs ok

## **Revision 2 Calculations**



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## Hydraulic Vertical Shores

### Check Sheeting Placed Parallel to Vertical Rail

|                                                                                                |                                                                         |
|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| $D_1 := 2 \text{ ft}$                                                                          | Depth to Top Strut                                                      |
| $D_2 := 5 \text{ ft}$                                                                          | Depth to Mid Strut                                                      |
| $P_1 := 459 \frac{\text{lb}}{\text{ft}^2}$                                                     | Loading at D1                                                           |
| $P_2 := 459 \frac{\text{lb}}{\text{ft}^2}$                                                     | Loading at D2                                                           |
| $W := P_1 = 459 \frac{\text{lb}}{\text{ft}^2}$                                                 | Avg loading on panel, used for end plate loading                        |
| $a := 0.6$                                                                                     | Soil Arching factor for sheeting or lagging per Caltrans Shoring Manual |
| $W_d := P_1 \cdot a = 275.4 \frac{\text{lb}}{\text{ft}^2}$                                     | Design Soil Load on Shoring                                             |
| $w_s := 4 \text{ ft}$                                                                          | Sheeting Width                                                          |
| $w_R := 0.67 \text{ ft}$                                                                       | Rail Width                                                              |
| $Arch := 2$                                                                                    | Rail Width Arch Factor                                                  |
| $L := 1.33 \text{ ft}$                                                                         | Span of end panel sheeting                                              |
| $M_u := \frac{W \cdot L^2 \cdot a \cdot 1 \text{ ft}}{2} = 243.578 \text{ lb} \cdot \text{ft}$ | Sheeting max Moment                                                     |
| $V_u := \frac{W \cdot a \cdot L \cdot \text{ft}}{2} = 183.141 \text{ lb}$                      | Sheeting max Shear                                                      |

### Check Plywood Sheeting

|               |                      |
|---------------|----------------------|
| $Ldf := 1.25$ | Load Duration Factor |
|---------------|----------------------|

Per NDS Specification Table 1A

|                                             |                |
|---------------------------------------------|----------------|
| $F_b := 1545 \frac{\text{lb}}{\text{in}^2}$ | Bending Stress |
|---------------------------------------------|----------------|

$$F_v := 57 \frac{lb}{in^2}$$

Rolling Shear

$$E := 1500000 \frac{lb}{in^2}$$

Modulus of Elasticity

$$F'_b := F_b \cdot Ldf = 1931 \frac{lb}{in^2}$$

Allowable Bending Stress

$$F'_v := F_v \cdot Ldf = 71.25 \frac{lb}{in^2}$$

Allowable Bending Stress

$$t := 1.125 \text{ in}$$

Sheeting Thickness

$$n := 2$$

Number of Sheets

Section Properties

$$KS := 0.955 \text{ in}^3$$

$$I := 0.623 \text{ in}^3$$

$$lb.Q := 8.841 \text{ in}^2$$

$$f_b := \frac{M_u}{KS \cdot n} = 1530 \frac{lb}{in^2}$$

< F'b OK

$$f_v := \frac{V_u}{lb.Q \cdot n} = 10 \frac{lb}{in^2}$$

< F'v OK

$$\Delta := \frac{W \cdot L^4}{8 \cdot E \cdot I} = 0.028 \text{ in}$$

< 1 in OK

### Check Steel Plate Sheeting

$$Ov := 1.33$$

Temporary Loading Overstress Factor

$$\Omega := 1.67$$

ASD bending/shear reduction factor

$$F_y := 36000 \frac{lb}{in^2}$$

Bending Stress

$$S_{req} := \frac{\Omega \cdot M_u}{Ov \cdot F_y} = 0.102 \text{ in}^3$$

## Shear Stress

$$A_{req} := \frac{\Omega \cdot V_u}{0.6 \cdot O_v \cdot F_y} = 0.011 \text{ in}^2$$

## 1/2" Steel Plate

$$w_{plate} := 12 \text{ in}$$

$$ht_{plate} := 0.5 \text{ in}$$

$$S_{plate} := \frac{w_{plate} \cdot ht_{plate}^2}{6} = 0.5 \text{ in}^3 \quad > \quad S_{req} \quad \text{OK}$$

$$S_{plate} := w_{plate} \cdot ht_{plate} = 6 \text{ in}^2 \quad > \quad A_{req} \quad \text{OK}$$

**Table 4.13: Effective section properties for B-B Plyform plywood (12 in. widths)\***

| plyform grade | Sanded plywood, net thickness, in. | 12 in. width, used with face grain parallel to span |                                                   |                                                  | 12 in. width, used with face grain perpendicular to span |                                                   |                                                  | Approximate weight, lb |                     |
|---------------|------------------------------------|-----------------------------------------------------|---------------------------------------------------|--------------------------------------------------|----------------------------------------------------------|---------------------------------------------------|--------------------------------------------------|------------------------|---------------------|
|               |                                    | Moment of inertia $I$ , in. <sup>4</sup>            | Effective section modulus $KS$ , in. <sup>3</sup> | Rolling shear constant $lb/Q$ , in. <sup>2</sup> | Moment of inertia $I$ , in. <sup>4</sup>                 | Effective section modulus $KS$ , in. <sup>3</sup> | Rolling shear constant $lb/Q$ , in. <sup>2</sup> | 4x8 ft sheet           | per ft <sup>2</sup> |
| Class I       | 15/32                              | 0.066                                               | 0.244                                             | 4.743                                            | 0.018                                                    | 0.107                                             | 2.419                                            | 45                     | 1.4                 |
|               | 1/2                                | 0.077                                               | 0.268                                             | 5.153                                            | 0.024                                                    | 0.130                                             | 2.739                                            | 48                     | 1.5                 |
|               | 19/32                              | 0.115                                               | 0.335                                             | 5.438                                            | 0.029                                                    | 0.146                                             | 2.834                                            | 57                     | 1.8                 |
|               | 5/8                                | 0.130                                               | 0.358                                             | 5.717                                            | 0.038                                                    | 0.175                                             | 3.094                                            | 60                     | 1.9                 |
|               | 11/16                              | 0.164                                               | 0.409                                             | 6.175                                            | 0.044                                                    | 0.183                                             | 3.524                                            | 66                     | 2.1                 |
|               | 23/32                              | 0.180                                               | 0.430                                             | 7.009                                            | 0.072                                                    | 0.247                                             | 3.798                                            | 69                     | 2.2                 |
|               | 3/4                                | 0.199                                               | 0.455                                             | 7.187                                            | 0.092                                                    | 0.306                                             | 4.063                                            | 72                     | 2.3                 |
|               | 7/8                                | 0.296                                               | 0.584                                             | 8.555                                            | 0.151                                                    | 0.422                                             | 6.028                                            | 84                     | 2.6                 |
|               | 1                                  | 0.427                                               | 0.737                                             | 9.374                                            | 0.270                                                    | 0.634                                             | 7.014                                            | 96                     | 3.0                 |
|               | 1-1/8                              | 0.554                                               | 0.849                                             | 10.430                                           | 0.398                                                    | 0.799                                             | 8.419                                            | 108                    | 3.4                 |
|               | 15/32                              | 0.067                                               | 0.246                                             | 4.503                                            | 0.021                                                    | 0.147                                             | 2.405                                            | 45                     | 1.4                 |
| Structural I  | 1/2                                | 0.078                                               | 0.271                                             | 4.908                                            | 0.029                                                    | 0.178                                             | 2.725                                            | 48                     | 1.5                 |
|               | 19/32                              | 0.116                                               | 0.338                                             | 5.018                                            | 0.034                                                    | 0.199                                             | 2.811                                            | 57                     | 1.8                 |
|               | 5/8                                | 0.131                                               | 0.361                                             | 5.258                                            | 0.045                                                    | 0.238                                             | 3.073                                            | 60                     | 1.9                 |
|               | 11/16                              | 0.167                                               | 0.418                                             | 5.621                                            | 0.051                                                    | 0.249                                             | 3.493                                            | 66                     | 2.1                 |
|               | 23/32                              | 0.183                                               | 0.439                                             | 6.109                                            | 0.085                                                    | 0.338                                             | 3.780                                            | 69                     | 2.2                 |
|               | 3/4                                | 0.202                                               | 0.464                                             | 6.189                                            | 0.108                                                    | 0.418                                             | 4.047                                            | 72                     | 2.3                 |
|               | 7/8                                | 0.317                                               | 0.626                                             | 7.539                                            | 0.179                                                    | 0.579                                             | 5.991                                            | 84                     | 2.6                 |
|               | 1                                  | 0.479                                               | 0.827                                             | 7.978                                            | 0.321                                                    | 0.870                                             | 6.981                                            | 96                     | 3.0                 |
|               | 1-1/8                              | 0.623                                               | 0.955                                             | 8.841                                            | 0.474                                                    | 1.098                                             | 8.377                                            | 108                    | 3.4                 |

\*Use listed  $KS$  value in bending calculations and use  $I$  only in deflection calculations. Properties from APA Form No. V345V-12.

any reuse is desired. Plywood grades and types are defined in a commercial standard, NIST PS 1-09, "Structural Plywood." The product standard defines grades of veneer—N and A through D—depending on the freedom of the surface from knots and other defects. Grades B-B and B-C are commonly used for formwork. B-B has both faces of B-grade veneer, which is a smoothly sanded solid surface sheet with repair plugs and small tight knots permitted. B-C has one face of C-grade veneer, which allows small knots, knot holes, and patches. The product standard also establishes three classes of plywood depending on the kinds of woods used in manufacture—Class I, Class II, and Structural I. Class I and Structural I are stronger and stiffer than Class II, and also the most widely available.

The standard further provides that plywood labeled as concrete form-grade shall be mill oiled unless otherwise agreed between buyer and seller. Mill oiling does not eliminate the need for oiling on the job, but mill-oiled plywood does give better service than that which is job treated only. Some form release agents require an unoiled base. If the use of such agents is planned, it is important to specify unoiled plywood. Edge sealing of plywood adds protection against moisture and is recommended before the first use of any concrete form plywood. Moisture ingress through unprotected edges may cause swelling and deterioration of wood layers even though the glue itself is waterproof. Plywood designated OES indicates it has been oiled and edge-sealed during manufacture. Resealing the edges and tie holes after a number of uses, or sealing freshly cut edges, helps prolong the life of the forms.

It is a good practice to specify panels carrying the mark of an approved inspection and testing agency that indicates type and grade, species of veneer, and conformance with applicable standards. If there is any doubt as to quality of plywood purchased, a certification of type and grade may be requested. Structural properties of Class I and Structural I Plyform are listed in Table 4.13 based on APA V345V-2012, "Concrete Forming – Design/Construction Guide."

ACI SP-4 (14)  
Formwork for Concrete

**Table 4.14: Plyform (used wet) reference and adjusted design values for Class I and Structural I**

|                                                                                              |             | Concrete setting factor $C_s = C_e \times C_d$ |                      |                 |   | Adjusted design value for |                       |
|----------------------------------------------------------------------------------------------|-------------|------------------------------------------------|----------------------|-----------------|---|---------------------------|-----------------------|
|                                                                                              | Value       | Reference design value<br>used wet, psi        | Experience<br>factor | Duration factor |   | $C_d = 1.0$ ,<br>psi      | $C_d = 1.25$ ,<br>psi |
| Bending                                                                                      | $F'_b =$    | $(F_b = 1190)$                                 | $(C_e = 1.3)$        | $C_d$           | = | 1545                      | 1933                  |
| Rolling shear (Class I)                                                                      | $F'_r =$    | $(F_r = 44)$                                   | $(C_e = 1.3)$        | $C_d$           | = | 57                        | 72                    |
| Rolling shear (Structural I)                                                                 | $F'_r =$    | $(F_r = 63)$                                   | $(C_e = 1.3)$        | $C_d$           | = | 82                        | 102                   |
| Bearing on face                                                                              | $F'_{cl} =$ | $(F_{cl} = 210)$                               | —                    | $C_d$           | = | 210                       | 263                   |
| Modulus of elasticity (for<br>bending deflection when shear<br>deflection is not considered) | $E' =$      | $(E = 1,500,000)$                              | —                    | —               | = | 1,500,000                 | 1,500,000             |
| Modulus of elasticity (for shear<br>deflection)                                              | $E'_s =$    | $(E_s = 1,500,000)$                            | —                    | —               | = | 1,500,000                 | 1,500,000             |
| Modulus of elasticity (for<br>bending deflection when shear<br>deflection is considered)     | $E' =$      | $(E = 1,650,000)$                              | —                    | —               | = | 1,650,000                 | 1,650,000             |

Values from APA Form No. V345V 12

### 4.3.4 Textured Surfaces

Plywood textures range from the very smooth PSF and HDO to striations, wood grain, or patterned board-and-batten siding panels. The pattern or design of the plywood is transferred to the concrete, providing decorative surfaces that may have a marked reduction in light reflection and glare.

Exterior-type textured plywood may be used as a form liner or as the basic forming panel. Fewer reuses of textured panels can be expected because the repeated stripping damages plywood. Coating the plywood with a film-forming material such as epoxy or polyurethane, along with the use of a proper release agent, will make stripping easier and allow more reuses of the material.

### 4.3.5 Strength Properties

ASD values for plywood are based on the strength properties and reference design values for wood as determined by the U.S. Forest Products Laboratory. Recommended reference design values and ASD adjusted design values for Plyform sheathing are included in Table 4.14 for the most commonly used formwork grade of plywood from APA V345V. Design values for other grades should be based on tables in APA D510C-2012, "Panel Design Specification," or other manufacturers' recommendations.

Table 4.14 includes the reference design values, usual adjustment factors for formwork applications, and the adjusted design values for Class I and Structural I concrete form plywood. Design values shown in Table 4.14 have already been adjusted for wet use as recommended by the plywood manufacturers because form sheathing will generally become wet when loaded with fresh concrete. For high-density overlaid plywood or plywood coated on the job to make it impervious to moisture, higher design values are permissible because the reduction for moisture no longer applies.

Plywood sheathing acts as a beam, but plies with grain running perpendicular to the span contribute little to the bending strength and stiffness of the panel. Table 4.13 gives the effective section properties for various thicknesses of plywood for two cases—face plies parallel to the plywood span and face plies perpendicular to the span. For a given thickness of plywood panel,  $I$  and  $KS$  are larger when the face grain is parallel to the span. This is referred to as using plywood the strong way. Conversely, plywood with its face grain perpendicular to the span is said to be used the weak way. Due to involved considerations concerning properties of plywood, the effective moment of inertia  $I$  divided by distance to extreme fiber  $c$  does not equal effective section modulus  $KS$  (Table 4.13). Therefore, effective section modulus,  $KS$ , as tabulated should be used for all bending stress calculations and moment of inertia,  $I$ , should be used only for deflection calculation.

### 4.3.6 Bending Plywood to Curved Surfaces

Simple curves with radii not less than 24 in. can readily be made in plywood form sheathing. Table 4.15 shows minimum radii for bending panels that are manually nailed. Note that shorter radius curves can be obtained when plywood is bent across the grain. Shorter radii than those tabulated may be developed by wetting or steaming, but this

## **Reference Material**



MZB ENGINEERING, INC

[TEL:949.254.4792](tel:949.254.4792)

[engineering@mzbinc.com](mailto:engineering@mzbinc.com)

[www.mzbinc.com](http://www.mzbinc.com)

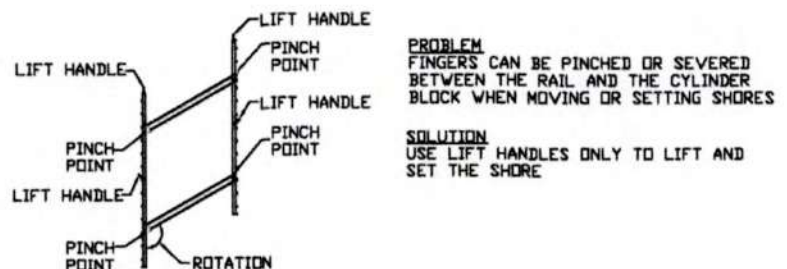
## Safe Handling and Use of Trench Shores

By removing the shoring installer from the unshored trench and making shoring equipment more available and easy to install, trench jacks have no doubt had a huge impact on excavation safety. Utilizing trench jacks for shoring still has safety hazards that users should understand and protect workers from these hazards. These things happen rarely however it is still important that workers be informed of the risks they are taking before placing them at risk. The following are hazards and safety procedures associated with the use of trench jacks

- Injury to back and muscles from lifting heavy objects - An 8 ft long 52x88 extension trench jack weighs approximately 120 lbs. A two-man crew can safely lift, set and remove it from the trench. Anything longer or heavier should be lifted and set with equipment such as a backhoe or boom truck.
- Overhead lifting hazard - When jacks are being hoisted by sling from a tractor bucket or boom truck, the swinging jack presents a hazard to workers guiding it. Loose plywood and rocks can also fall off onto workers. Workers should stand clear and guide with a lead rope.
- Finger and hand protection - Trench jacks have moving parts at the connection between the cylinder and the rail. When the jack swings open fingers can be crushed under the cylinder block and when it is swung closed fingers can easily be sheared off if they are between the block and the rail leg. When the hydraulic hose is being connected to the block, fitting and when the jack is being lifted by hand shearing and crushing is most likely to happen.

Awareness through safety instruction and hand placement a safe distance, 12", from the blocks is safe practice. Trench jacks may have optional finger guards however, it is still possible to get fingers under the block and wrists cut and banged when the jack folds or unfolds.

See **Figure 15**.



**Figure 15.** Trench Safety issues

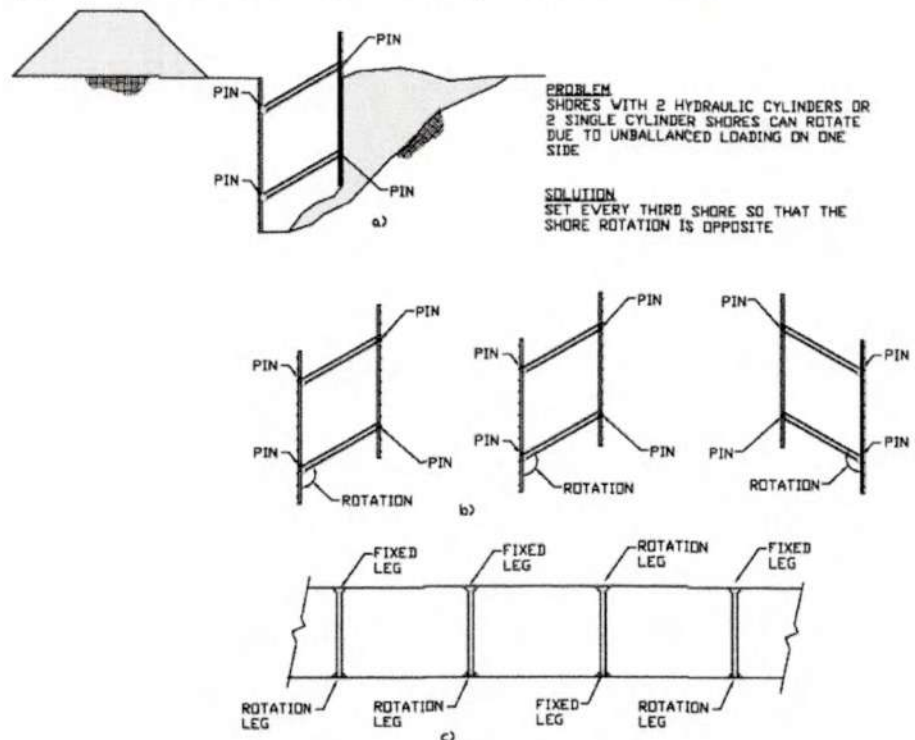
- Bank collapse with worker standing on it - When the jack is being set it is still possible for the trench wall to collapse from the additional weight and activity going on around it. Trench jack installation should closely follow the excavation activity.

During jack removal, the arch column is being literally removed with the load still on it. Pipe bedding and initial backfill cut the trench depth adding some stability prior to removing the jack. If backfill operations are closely following jack removal, the length of unshored collapsible trench wall becomes short. Soil arching back to the backfilled area is likely and trench wall failure becomes less likely. Remote backfill operation such as

excavator wheel or vibraplate, or remote operated compactors must always be used for compaction outside the shored area. When trench jacks are being removed to allow pipe installation and then reset there is a greater likelihood of trench wall collapse. Equipment and personnel in close proximity are at risk of loosing the ground under their feet. Keep equipment and personnel except those needed to remove the jack a safe distance away. This type of operation is not uncommon and most often works safely, however if there is any evidence of trench wall collapse the operation should be discontinued and a different method of getting production materials into the trench or a different shoring system should be used. Several bad accidents have occurred in conjunction with this type of operation.

- Get the surcharge loads right - Equipment over 20,000 lbs and large spoil piles over 2 ft high quickly add additional surcharges, especially in the top 10 ft, that can easily overload the trench jack. If one cylinder fails, a progressive failure to the bottom of the trench and then down the length of the trench is possible. A boom truck or backhoe outrigger placed next to a trench jack can trigger this. The way to adjust for additional surcharge load is to move the load away from the trench, spread the load with timber pad or steel plate, or decrease the trench jack spacing. Centering the load on the jack, places most of the load on that jack. The alternative, centering the load between the jacks distributes the load evenly between the jacks, however it increases the possibility of the arch void to fall out or arch shear failure at the jack. One alternative may not be any better than the other.

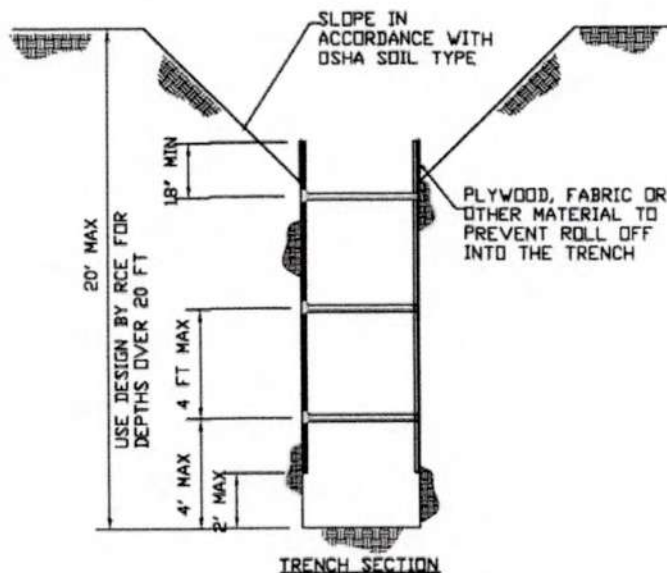
- Trench Jack fold-up failure - If all of the jacks were unfolded into the trench from one side of the trench, it is possible to get a bank failure that can lift the rotating jack leg. This type of failure is not common; however, the author has spoken with more than one worker that has, fortunately from outside the trench, witnessed this type of failure.



**Figure 16. a) Trench jack fold up failure, b) leg rotation, c) jack rotation to prevent fold up failure**

No workers were inside the trench. The story goes that 40 ft of trench folded up the jacks and collapsed. The solution is to rotate the jack so that the rotation leg is on the other side of the trench. The problem is that the installers have to move to the other side of the trench to set and pressurize the jack. Two soil conditions that this would be most likely to happen are in medium dense to loose non-cohesive soils and soft clays with high surcharge loads. See **Figure 16**

- Loose trench jacks in the trench - Jacks that are not pressurized in the trench are not setting up arching and preventing trench collapse. In this condition the jacks can also fall down on workers below them. Jacks should not leak at all. Pressure can change slightly up or down due to temperature changes or increase due to loading however it should never loosen up in the ditch. If jacks are left overnight they should be checked before entering the trench in the morning. Simply tap them with a hammer or bar of metal, they will sound loose if they are. Remove and replace jacks that bleed off.  
If the trench wall has voids where the cylinder hits the wall, use wood blocking to extend the connection to the soil.
- Non-vertical trench walls - Trench walls that are not vertical, an inverted A shape, the trench jack is not stable. Assuming a coefficient of friction of 0.1 between the soil and the aluminum rail and applying a factor of safety of 1.5 calculations indicate that the slope of the trench wall should not exceed 3 degrees or the jack will lift up and fail to provide an arching point.
- In trenches that are sloped above, extending the jack 18" above the hinge point does not provide roll off protection for workers below due to the fact that the jack is spaced. Place fabric or boards behind the jack rail to stop objects at the surface and bank ravel from falling on workers, See **Figure 17**.



**Figure 17.** Trench Safety issues



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## **Subpart P Additional Requirements Related to Hydraulic Shoring with Commentary**

The following are excerpts from Subpart P that are relative to hydraulic shoring use.

**1926.652(e)(1)(ii)** Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

**1926.652(e)(2)(ii)**

Installation of a support system shall be closely coordinated with the excavation of trenches.

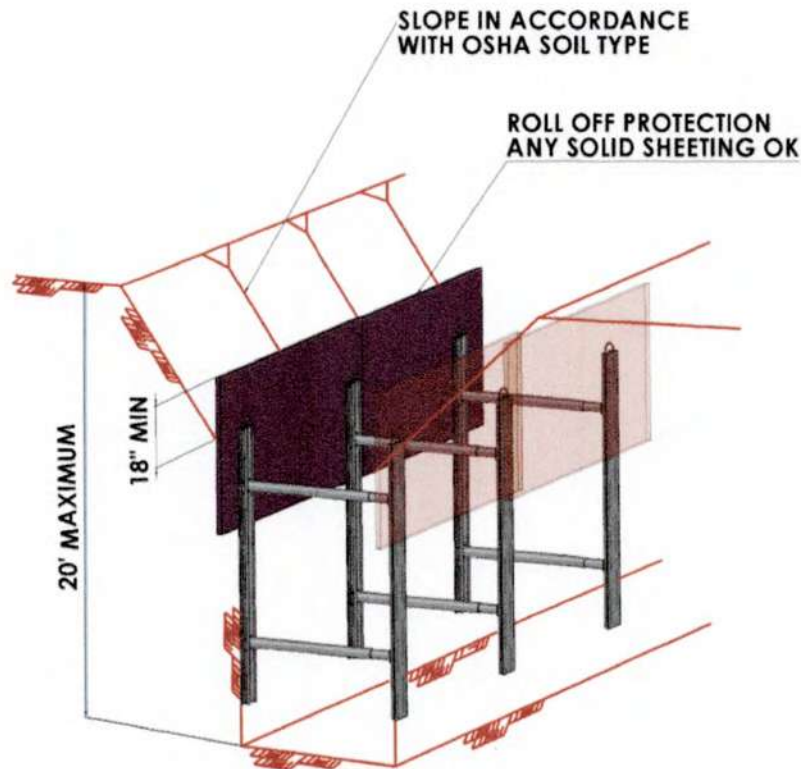
**Commentary** - Hydraulic shores were developed so that they could be installed and removed from outside the excavation. Cave-in from the surface is still a hazard while installing and removing the shore. Hydraulic shores should be installed as soon as possible after the trench is excavated. This means that if the shores are being installed horizontally at 6 ft on center there should be no more than 6 to 10 ft of trench unshored at any time. It is not acceptable to open a length of trench and then go back and install the shores later.

When hydraulic shores are being removed use caution, stand away from the trench edge and backfill as close to the shore removal location as possible.

It is not allowed to remove and replace a hydraulic shore in order to install production work that will not fit within the shore spacing. If a hydraulic shore is being removed and replaced in order to set pipe into the excavation the soil arching support that was originally set up is being removed similar to removing a column from under an arch. Collapse is imminent and can occur immediately or at the time of resetting the shore.

**1926.652(f)** Sloping and benching systems. Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.

**Commentary** - When hydraulic shores are used in sloped excavations without sheeting some form of roll off protection must be provided.



**SLOPED EXCAVATIONS**

**1926.652(e)(2)(i)** Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

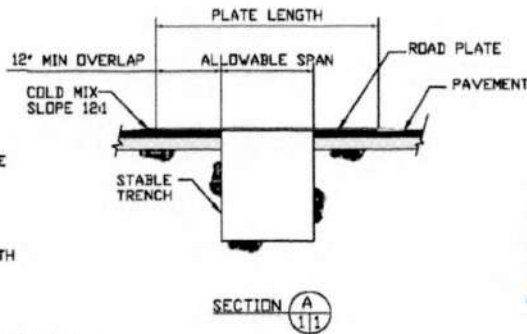
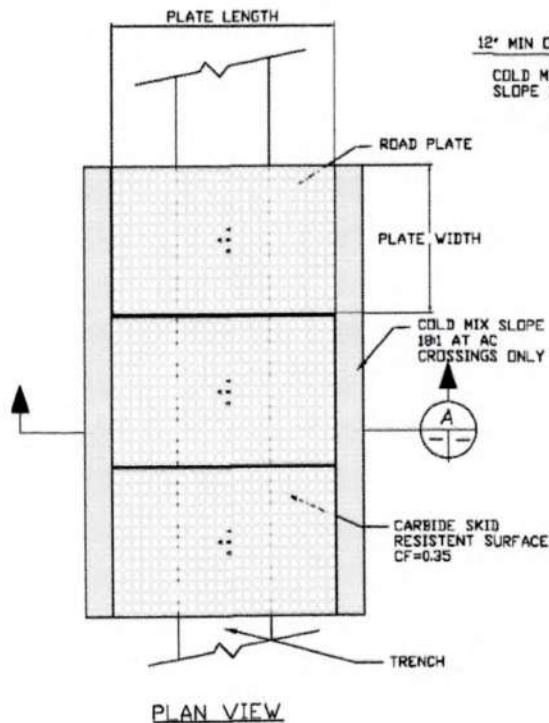
**Commentary** - Either the rail or the plywood must be within 2 ft of the bottom of the excavation.

**1926.652(d)(2)** Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

**Commentary** - Daily inspections are required to check for equipment malfunctions.



# ROAD PLATE WITH or WITHOUT CARBIDE SKID RESISTANT SURFACE TABULATED DATA Effective 11-15-16



## TABLE NOTES:

1. SPAN MEASUREMENT IS AC EDGE TO AC EDGE.
2. TRAFFIC MAY RUN IN ANY DIRECTION ON THE PLATES.
3. PLATE MAY BE PLACED IN EITHER DIRECTION OF THE TRENCH IN ACCORDANCE WITH THE CONDITIONS AND NOTES SPECIFIED HEREIN.
4. IT IS THE PLATE INSTALLERS RESPONSIBILITY TO INSTALL AND MAINTAIN THE PLATES IN ACCORDANCE WITH THIS DATA SHEET AND LOCAL JURISDICTION REQUIREMENTS.

**Table 1-ALLOWABLE SPANS AND WEIGHTS FOR STEEL ROAD PLATES**

| Plate Thickness | Allowable Span | Plate Size / Weight |        |        |        |        |  |
|-----------------|----------------|---------------------|--------|--------|--------|--------|--|
| 1"              | 2.5'           | Size                | 4'x5'  |        |        |        |  |
|                 |                | Weight (lbs)        | 816    |        |        |        |  |
|                 | 4.5'           | Size                | 4'x6'  | 4'x8'  |        |        |  |
|                 |                | Weight (lbs)        | 979    | 1306   |        |        |  |
|                 |                | Size                | 5'x8'  | 5'x10' |        |        |  |
|                 |                | Weight (lbs)        | 1632   | 2040   |        |        |  |
|                 |                | Size                | 6'x8'  | 6'x10' | 6'x12' |        |  |
|                 |                | Weight (lbs)        | 1958   | 2448   | 2938   |        |  |
| 1.25"           | 7'             | Size                | 8'x10' |        |        |        |  |
|                 |                | Weight (lbs)        | 4080   |        |        |        |  |
| 1.5"            | 10'            | Size                | 8'x12' | 8'x15' | 8'x16' | 8'x20' |  |
|                 |                | Weight (lbs)        | 5875   | 7344   | 7834   | 9792   |  |

Note-Plates must always be set in a direction that provides a 1' overlap on the each side of the excavation

**Table 2-ALLOWABLE SPANS AND WEIGHTS FOR DOUBLE STACKED STEEL ROAD PLATES**

| Plate Thickness | Allowable Span | Plate Size / Weight |        |        |        |        |        |
|-----------------|----------------|---------------------|--------|--------|--------|--------|--------|
| 2-1"            | 8'             | Size                | 5'x10' |        |        |        |        |
|                 |                | Weight (lbs)        | 4080   |        |        |        |        |
|                 |                | Size                | 6'x10' | 6'x12' |        |        |        |
|                 |                | Weight (lbs)        | 4896   | 5875   |        |        |        |
|                 |                | Size                | 8'x10' | 8'x12' | 8'x15' | 8'x16' | 8'x20' |
|                 |                | Weight (lbs)        | 6528   | 7834   | 9792   | 10445  | 13056  |
| 2-1.25"         | 11'            | Size                | 8'x15' | 8'x16' | 8'x20' |        |        |
|                 |                | Weight (lbs)        | 14688  | 15667  | 19584  |        |        |
| 2-1.5"          | 15'            | Size                | 8'x20' |        |        |        |        |
|                 |                | Weight (lbs)        | 19584  |        |        |        |        |

Note-Plates must always be set in a direction that provides a 1' overlap on each side of the excavation

## General Conditions

## TRENCH SHORING COMPANY

206 N. Central Ave., Compton, CA 90220 310-327-5554



# **ROAD PLATE WITH or WITHOUT CARBIDE SKID RESISTANT SURFACE TABULATED DATA Effective 11-15-16**

---

1. Plates are minimum ASTM A36 Min  $F_y = 36$  ksi
2. Trench plate installations including cold mix ramping within the City of Los Angeles and all pavement repairs shall be in accordance Los Angeles Public Works Standard S-601-3, WATCH Manual and all other jurisdiction requirements.
3. Plates are designed for HS20-44 and HL-93 axel loading with 1.33 impact factor
4. Design is based on allowable bending strength
5. Minimum overlap is 12"
6. There shall be no paint on the surface of the road plates.
7. When skid resistance is required, the non-skid surface shall have a dynamic coefficient of friction of 0.35 per California Test Method No. 342 or equivalent skid number of 0.35 as tested per ASTM E274. Any trench plate with non-skid surface less than specified frictional resistance shall be removed and replaced
8. This data sheet applies to general use in all locations, areas where skid resistance is required and where it is not required.
9. All road plates with carbide skid resistant surface are manufactured in Trench Shoring Company Plant at 206 N. Central Ave., Compton, CA 90220.
10. All tops of the road plates must be flush.

CER, Inc.  
Construction Engineering Resource, Inc.  
1837 Wright Street  
Santa Rosa, CA 95404  
(707) 484-4704      jmtengr2@aol.com



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## **TRENCH SHORING COMPANY**

206 N. Central Ave., Compton, CA 90220 310-327-5554

# SUBMITTAL TRANSMITTAL

|                                                                                                       |                                                                                                                                                                      |                              |            |
|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------|
| <b>TO:</b>                                                                                            | Los Angeles County Public Works<br>Project Management Division III, 8 <sup>th</sup> Floor<br>900 S Fremont Ave, Alhambra, CA 91803<br><br>Attention: Mr. Navid Ehsan | <b>SUBMITTAL<br/>NUMBER:</b> | 60         |
| <b>FROM:</b>                                                                                          | Dominguez General Engineering, Inc.<br>11096 Pipeline Avenue<br>Pomona, CA 91766                                                                                     | <b>DATE<br/>REQUESTED:</b>   | 09/25/2024 |
| <b>PROJECT:</b> COASTLINE DRIVE 12-INCH WATERLINE IMPROVEMENTS PROJECT<br>(PROJECT ID NO. WWD2900063) |                                                                                                                                                                      |                              |            |

|                                          |             |                    |                         |
|------------------------------------------|-------------|--------------------|-------------------------|
| <b>SUBMITTAL<br/>SUBJECT:</b>            |             | Shoring Plan       |                         |
| <b>SPECIFICATION<br/>SECTION NUMBER:</b> |             |                    |                         |
| <b>PARAGRAPH<br/>NUMBER:</b>             |             |                    |                         |
| <b>NUMBER<br/>OF PAGES</b>               |             | 35                 |                         |
| <b>NUMBER<br/>OF COPIES</b>              | <b>DATE</b> | <b>DESCRIPTION</b> |                         |
| 1                                        | 02/21/2025  | Shoring Plan       |                         |
| <b>TRANSMITTED<br/>BY:</b>               |             | Jesus Carvajal     | <b>DATE:</b> 02/21/2025 |

## REVIEW COMMENTS

Please provide project specific plans (plot plan and sections) with the responsible engineers stamp and signature on the plans. Please provide any reference information related to the shores such as manufacturer data sheets and diagrams etc or calculations for components that are not included as part of the data sheets. Note: addition shoring related information is provided in the project specifications, such as minimum active and surcharge pressures.

The plan shall include the types of shoring that is proposed at various portions of project, maximum heights that the shoring is to be constructed to, any utilities in the vicinity of the excavation and any other detail related to the shoring such as the number of shores, spacing of shores, type of sheathing, and limitation on live loading adjacent to the excavations.

Please see project specifications including Section 306-4.3 and Los Angeles County Department of Public Works Standard Plan 3090-1 for shoring plan submittal requirements.

|                   |                 |              |           |
|-------------------|-----------------|--------------|-----------|
| <b>REVIEW BY:</b> | Hakop Meymarian | <b>DATE:</b> | 3-20-2025 |
|-------------------|-----------------|--------------|-----------|

Cc: File - Submittal # \_\_\_\_\_

underground excavations shall be in accordance with the Tunnel Safety Orders of the State of California, Department of Industrial Relations.

Prior to the beginning of work, the Contractor shall designate in writing to the Engineer someone whose responsibility it is to supervise the installation and removal of sheeting, shoring and bracing.

### **306–4.3 Submittals.**

The Contractor shall prepare and submit in accordance with 3–8 Working Drawings and supporting information for its proposed shoring system showing the reaches, design criteria, calculations, sketches, sequence of placement and removal, and other data required in order to shore the excavation for the appropriate cases of shoring expected to be used on the Project. Where shields are to be used, the Working Drawings shall include a typical cross section of the proposed conduit showing adjacent utilities. If a previously approved shield is to be used, submittal of calculations for the shield are not required if the current calculated load does not exceed the load for which the shield was previously approved. If it is requested that the limitation on the use of shields in the vicinity of existing utilities be waived, the submittal shall also include the written statements from the affected utility owners and Working Drawings and calculations of the required utility support. The submitted Working Drawings shall be of the same format as that shown on LACDPW Standard Plan 3091. In particular, the Working Drawings shall indicate the methods of sheeting, shoring and bracing which will be used, applicable reaches, and the installation and removal sequence. The Working Drawings shall also show the positioning of said sheeting, shoring and bracing with respect to the planned location of the proposed structures. Existing improvements which may be affected by the proposed excavation shall also be shown. It is the Contractor's responsibility to submit to the Engineer all test data and calculations required to substantiate the load supporting ability of special components of shoring systems such as screw jacks, speed shores, etc.

Partial submittals will be rejected. Submittals shall include the following:

- a) Shoring plans which show on each sheet the Project title, sheet number, total number of sheets, and wet stamp and signature of the California Registered Civil or Structural Engineer responsible for the design.
- b) Limits of application for the shoring design, with beginning station and end station.

- c) Working Drawings (plans, sections, elevations, and details), material specifications, notes, construction and removal procedures, etc. necessary for the construction and inspection of the shoring system.
- d) Supporting calculations prepared by the responsible Registered Civil or Structural Engineer, who will wet stamp and sign the first sheet of these calculations. The calculations shall show and justify the design loads on the shoring. The calculations shall also show the capacity of the shoring system is adequate to withstand the imposed loads.
- e) Shoring design criteria. A sample of some of the information required is shown on LACDPW Standard Plan 3091.
- f) Notes as shown on LACDPW Standard Plan 3091.
- g) A statement confirming the Contractor has reviewed the proposed shoring Working Drawings and found them compatible with the site conditions and proposed construction methods.
- h) If shields are proposed, the shoring Working Drawings shall show the limits of Zone A and Zone B offset from the toe of excavation as delineated on LACDPW Standard Plan 3090 Case 4. The shoring designer shall verify the field condition and state on the Working Drawings that the design conforms to the requirements shown in Section D "SHIELDS" on Sheet 4 of LACDPW Standard Plan 3090.

The submittal package shall also include:

- i) Manufacturer's specifications and other data necessary for the review of the proposed shoring as applicable.
- j) Traffic Control Plan, *if not included with the Plans*, if it affects the live load surcharge or the aforementioned Zone A requirements on the shoring system.

#### **306–4.4 Agency Review.**

A review of the submitted Working Drawings and supporting information will be performed by the Agency. The review will be for the purpose of determining that the following items have been considered and are in accordance with the stated criteria.

- a) Soil Loads.

GENERAL MINIMUM REQUIREMENTS (CONT.)

C. SPECIAL SHORING SYSTEMS

SYSTEMS SUCH AS SPEED-SHORE, TREN-SHORE, ETC., WILL BE ALLOWED ONLY IF THE CONTRACTOR FILES OR HAS FILED WITH THE DEPARTMENT SUBSTANTIATING CERTIFIED TESTS CLEARLY DENOTING THE CAPACITY OF THE SYSTEM. UNTESTED MEMBERS OF SPECIAL SYSTEMS, COMPOSITE MEMBERS, BUILT-UP MEMBERS, ETC., MUST BE THEORETICALLY DESIGNED. VERTICAL SHORES MUST BE AT LEAST 200mm(8") WIDE. STRUTS TESTED UNDER IDEAL OR LABORATORY CONDITIONS SHALL BE USED WITH A MINIMUM SAFETY FACTOR OF 1.5.

D. SHIELDS

1. SHIELDS ARE ACCEPTABLE AS A MEANS OF SHORING EXCAVATIONS, AS SHOWN ON CASE 4, WITH THE FOLLOWING RESTRICTIONS.

- a. ZONE A SHALL NOT INTERCEPT PROPERTY LINES OR INTERCEPT AN AREA REQUIRED BY THE SPECIFICATIONS FOR TRAFFIC.
- b. ZONE A SHALL NOT CONTAIN ANY EXISTING UTILITY OTHER THAN METALLIC ELECTRIC CONDUITS OR PIPE 100mm(4") OR LESS IN DIAMETER USED FOR LOW PRESSURE GAS DISTRIBUTION.
- c. ZONES A AND B SHALL NOT SUPPORT SURCHARGE DEAD LOADS SUCH AS PILING OR BUILDINGS.

THE RESTRICTIONS STATED IN b ABOVE WILL BE WAIVED PROVIDED THE CONTRACTOR SUBMITS WRITTEN APPROVAL FROM THE OWNER OF THE UTILITY FOR THE PROPOSED CONSTRUCTION METHOD. THE CONTRACTOR COMPLIES WITH ANY SUPPORT OR PROTECTION METHODS REQUIRED BY THE UTILITY COMPANY, AND THE OWNER OF THE UTILITY STATES, IN WRITING, THAT THEY WILL ACCEPT RESPONSIBILITY FOR ALL CLAIMS FOR DAMAGES THAT MAY ARISE AS A RESULT OF DISTURBANCE TO THE UTILITY. AN ACCEPTABLE SHORING SYSTEM MUST BE INSTALLED WHEN THE SHIELD IS REMOVED.

2. THE LENGTH OF UNSUPPORTED TRENCH IN FRONT OF THE SHIELD SHALL BE 2.5m(9'-0") MAXIMUM FROM THE FORWARD EDGE OF THE SHIELD TO THE TOE OF SLOPE BEING EXCAVATED.
3. SHIELDS SHALL CONFORM TO THE DESIGN CRITERIA NOTED HEREON.

E. TEMPORARY BRIDGES

PLANS AND CALCULATIONS FOR SHORING SYSTEMS AT TEMPORARY BRIDGES SHALL MEET THE REQUIREMENTS OF SUBSECTION 7-10.3.6(7) AS AMENDED.

CALCULATIONS AND DRAWINGS

SHORING SYSTEMS SHALL BE DESIGNED BY A CIVIL OR STRUCTURAL ENGINEER REGISTERED IN THE STATE OF CALIFORNIA.

- A. COMPLETE CALCULATIONS MUST BE SUBMITTED TO THE DEPARTMENT NOTING ALL ASSUMPTIONS AND REFERENCES. CALCULATIONS SHALL BE BASED ON STANDARD METHODS AND PROCEDURES BY RECOGNIZED AUTHORITIES. COMPUTER PRINTOUTS AND OTHER SUBMITTALS THAT DO NOT CLEARLY INDICATE THE COMPUTATION METHOD WILL NOT BE ACCEPTED. CROSS-SECTIONS OR SKETCHES SHOWING THE LOCATION OF EXISTING IMPROVEMENTS AND UTILITIES SHALL BE INCLUDED WHEN THE TYPE OF SHORING IS AFFECTED.
- B. DEPARTMENT STANDARD PLAN 3091 SHOWS THE FORMAT THAT IS TO BE USED. HOWEVER, THE SUPPORTING CALCULATIONS MAY BE ATTACHED ON LETTER-SIZED PAPER.

ACCEPTANCE

IF FOUND IN CONFORMANCE WITH THIS DRAWING AND THE SPECIFICATIONS, THE DEPARTMENT WILL INDICATE ACCEPTANCE BY SIGNING THE SUBMITTED DRAWINGS. IF THE METHOD SELECTED AND ACCEPTED BY THE DEPARTMENT DOES NOT PROVIDE ADEQUATE SUPPORT UNDER ACTUAL FIELD CONDITIONS, IT SHALL BE REPLACED WITH AN ACCEPTED ALTERNATE. THE DETAILS ARE ALSO SUBJECT TO THE REVIEW OF THE DIVISION OF INDUSTRIAL SAFETY. ANY DEVIATION FROM THE ACCEPTED DESIGN MUST BE APPROVED BY THE DEPARTMENT.

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS

CRITERIA FOR THE DESIGN  
OF SHORING FOR EXCAVATIONS

STANDARD PLAN  
METRIC

3090-1

SHEET 4 OF 4

|                                                                                                   |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
|---------------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------|-----------------|------|----|---------------|
| Project: Coastline Dr. Watermain Replacement<br>Project Location: Coastline Dr.<br>PCA: Y5292286A |                                   |                                    |                                                                                                                                   | GEOTECHNICAL LOG OF BORING AND SAMPLING<br>Los Angeles County Department of Public Works<br>Geotechnical and Materials Engineering Division |                           |                          |                 |      |    |               |
| Boring No. B-2                                                                                    |                                   | Date(s) Drilled: 6/3/15            | Logged by RLM, JUJ and K. Burger                                                                                                  | Boring Diameter: 6 in.                                                                                                                      | Ground Elevation: 159'    | Page 1 of 1              |                 |      |    |               |
| Boring Location: STA 14-22                                                                        |                                   | Drilled by: FMD, Mendoza           | Hammer Weight: 140 lbs                                                                                                            | Total Depth: 16'                                                                                                                            | Depth to Invert: 29'      | ft.                      |                 |      |    |               |
| Latitude & Longitude: 34.042 & -118.572                                                           |                                   | Drilling Method: Hollow stem auger | Equipment: CME                                                                                                                    | Drop Height: 30 in.                                                                                                                         | Depth to Groundwater: N/A | Depth to Bedrock: 6'     |                 |      |    |               |
| FIELD DATA                                                                                        |                                   |                                    |                                                                                                                                   | LABORATORY TESTING                                                                                                                          |                           |                          |                 |      |    |               |
| DEPTH (FEET)                                                                                      | Soils as Drilled (Soils as Bored) | Original Log                       | DESCRIPTION                                                                                                                       | USCS                                                                                                                                        |                           | Semi Quantitative        |                 | LL   | PI | Type of Tests |
|                                                                                                   |                                   |                                    |                                                                                                                                   | $\gamma_d$ (pcf)                                                                                                                            | MC (%)                    | In-situ $\gamma_d$ (pcf) | Passing No. 200 |      |    |               |
| 0                                                                                                 |                                   |                                    | 0' - 8" Asphalt                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
|                                                                                                   |                                   |                                    | 8' - 1' Aggregate Base                                                                                                            |                                                                                                                                             |                           |                          |                 |      |    |               |
|                                                                                                   |                                   |                                    | 1' - 6' Sand, silty, (Terrace deposits), gravel present up to 20%, angular, yellowish-brown, moist                                |                                                                                                                                             |                           |                          |                 |      |    |               |
| 6                                                                                                 |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
| 1R                                                                                                |                                   | 13/1721                            |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
| 2B                                                                                                |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
|                                                                                                   |                                   |                                    | 6' - 11'6" Shale, clayey, (Tuna Canyon Formation), orange-brown, fractured, firm, moist, contact with sandstone in tip of sampler | GM/GC                                                                                                                                       | 118.0                     | 6.2                      | 56.4            | 21.4 | 29 | 7 SA          |
|                                                                                                   |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
| 10                                                                                                |                                   | 14/3450                            |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
| 3R                                                                                                |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
| 4B                                                                                                |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
|                                                                                                   |                                   |                                    | 11'6" - TD Sandstone, (Tuna Canyon Formation), silty, very fine-grained, dark gray, fractured                                     |                                                                                                                                             |                           |                          |                 |      |    |               |
|                                                                                                   |                                   |                                    | @ 16' similar material as above, except with 15% more sand                                                                        |                                                                                                                                             |                           |                          |                 |      |    |               |
| 15                                                                                                |                                   | 45/761                             |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
| 5R                                                                                                |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
|                                                                                                   |                                   |                                    | TD = 16' Groundwater or seepage not encountered Backfilled with cuttings                                                          |                                                                                                                                             | 120.0                     | 5.1                      | 83.9            | 35.0 | -- | SE            |
| 20                                                                                                |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
| 25                                                                                                |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |
| 30                                                                                                |                                   |                                    |                                                                                                                                   |                                                                                                                                             |                           |                          |                 |      |    |               |

SPT (2 in. OD) Sample

SPT (3 in. OD) Sample

Depth to invert

Seepage Encountered

Dry Density

Moisture Content Encountered

District Contact

Geotechnical or Unconform Contact

Dry Density

Moisture Content

Types of Tests  
CO - Consolidation  
CR - Compression  
CS - Direct Shear  
SI - Expansion Index  
SW - Swell Potential  
RD - Maximum Density  
PE - Permeability  
SA - Shear Analysis  
SE - Seepage Equivalence

Note: This log contains observations and interpretations that are valid only for the specific date and location of the boring. Subsurface conditions may vary between borings and with time. Material descriptions are derived using visual classification methods and may vary from descriptions/classifications based on laboratory testing.

| Project: Coastline Dr. Watermain Replacement      |            |                                                      |                                                                                                                                                                                                                                      | GEOTECHNICAL LOG OF BORING AND SAMPLING                                                          |                             |                            |                                |          |                |
|---------------------------------------------------|------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------|----------------------------|--------------------------------|----------|----------------|
| Project Location: Coastline Dr.<br>PCA: Y5292286A |            |                                                      |                                                                                                                                                                                                                                      | Los Angeles County Department of Public Works<br>Geotechnical and Materials Engineering Division |                             |                            |                                |          |                |
|                                                   |            | Monitoring Well Installed: Yes (No)                  |                                                                                                                                                                                                                                      |                                                                                                  |                             |                            |                                |          |                |
| Boring No.                                        | B-4        | Date(s) Drilled<br>6/3/15                            | Logged by<br>R.M. JUU<br>and<br>K. Burger                                                                                                                                                                                            | Boring Diameter<br>6 in.                                                                         | Ground Elevation<br>111'    | Page 1 of 1                |                                |          |                |
| Boring Location:                                  | STA 20+50  | Drilled by<br>FMC; Aldrete                           | Hammer Weight<br>140 lbs.                                                                                                                                                                                                            | Total Depth<br>16'6"                                                                             | Depth to Invert<br>ft.      |                            |                                |          |                |
| Latitude & Longitude: 34.042 E - 118.570          |            | Drilling Method: Hollow stem auger<br>Equipment: CME | Drop Height<br>30 in.                                                                                                                                                                                                                | Depth to Groundwater<br>N/A                                                                      | Depth to Bedrock<br>6'6"    |                            |                                |          |                |
| DEPTH<br>(FEET)                                   | FIELD DATA |                                                      |                                                                                                                                                                                                                                      | LABORATORY TESTING                                                                               |                             |                            |                                |          |                |
|                                                   | Sample No. | Date                                                 | Graphic Log                                                                                                                                                                                                                          | USCS                                                                                             | In-situ<br>$\gamma_d$ (pcf) | Save<br>%<br>Mo<br>No. 200 | % Passing<br>No. 40<br>No. 200 | LL<br>PI | Type of Tests  |
| 0                                                 |            |                                                      | 0 - 6" Asphalt<br>6" - 1' Aggregate Base<br>1' - 6'6" Sand, silty, (Fill), sporadic gravel, light brownish-gray, loose, moist<br>@ 6'6" poor recovery, fine to medium grained, dark gray color, few gravels (5%)<br>@ 5' No Recovery |                                                                                                  |                             |                            |                                |          |                |
| 5                                                 | NR         | 7/7/7                                                | 6'6" - TD Sandstone, (Seape Formation), clayey to silty with sporadic gravel, fine to medium grained, contains very few volcanic pebbles (3%), medium red-brown to 34", very moist                                                   |                                                                                                  |                             |                            |                                |          |                |
| 10                                                | 3R         | 6/9/7                                                |                                                                                                                                                                                                                                      |                                                                                                  | 108.9                       | 10.2                       | 83.5                           | 23.4     | --<br>SA<br>OS |
| 15                                                | 5R         | 6/9/11                                               |                                                                                                                                                                                                                                      |                                                                                                  | 94.2                        | 12.5                       | 99.6                           | 26.6     | --<br>SA       |
| 20                                                |            |                                                      | @ 16' increased moisture content, color changes to magenta brown<br>TD = 16'6"<br>Groundwater or seepage not encountered<br>Backfilled with cuttings                                                                                 |                                                                                                  |                             |                            |                                |          |                |
| 25                                                |            |                                                      |                                                                                                                                                                                                                                      |                                                                                                  |                             |                            |                                |          |                |
| 30                                                |            |                                                      |                                                                                                                                                                                                                                      |                                                                                                  |                             |                            |                                |          |                |

**LEGEND**

California Ring (2.5 in. O.D.)  
 Sample  
 SPT (2 in. O.D.)  
 Depth to Invert  
 Seepage Encountered  
 Boring Casing  
 Remediation Encountered  
 Bulk Sample

Distinct Contact  
 Gradational or Dispersed Contact  
 On Density  
 Moisture Content

**Types of Tests**

CO - Consolidation  
CR - Corrosion  
CS - Direct Shear  
EX - Expansion Index  
HY - Hydrometer  
MD - Maximum Density  
PC - Permeability  
SA - Seave Analysis  
SE - Sand Equivalence  
TS - Triaxial

Note: This log contains observations and interpretations that are valid only for the specific data and the boring. Subsurface conditions may vary between borings and with time. Material descriptions are derived using small classification methods and may vary from description classifications based on laboratory testing.

| Project: Coastline Dr. Watermain Replacement<br>Project Location: Coastline Dr.<br>PCA: Y5222286A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                |                                                   |                                                                                                                                                                                                        | GEOTECHNICAL LOG OF BORING AND SAMPLING<br>Los Angeles County Department of Public Works<br>Geotechnical and Materials Engineering Division |                           |                            |             |    |                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|----------------------------|-------------|----|----------------|
| Boring No.: B-6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                | Date(s) Drilled: 6/4/15                           | Logged by RLM, JUJ and K. Burger                                                                                                                                                                       |                                                                                                                                             | Boring Diameter: 6 in.    | Ground Elevation: 52'      | Page 1 of 1 |    |                |
| Boring Location: STA 26+48                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                | Drilled by: FMD; Puga                             |                                                                                                                                                                                                        | Hammer Weight: 140 lbs                                                                                                                      | Total Depth: 166'         | Depth to Invert: ft        |             |    |                |
| Latitude & Longitude: 34.042 & -118.568                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                | Drilling Method: Hollow stem auger Equipment: CME |                                                                                                                                                                                                        | Drop Height: 30 in.                                                                                                                         | Depth to Groundwater: N/A | Depth to Bedrock: 1'       |             |    |                |
| DEPTH (FEET)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | FIELD DATA                     |                                                   | DESCRIPTION                                                                                                                                                                                            | LABORATORY TESTING                                                                                                                          |                           |                            |             |    |                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Soils Test Results (Soils 600) | Geotech Log                                       |                                                                                                                                                                                                        | USCS                                                                                                                                        | In-situ $\gamma_d$ (pcf)  | Sieve % Passing MC No. 400 | LL          | PI | Type of Test   |
| 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                |                                                   | 0 - 8.5' Asphalt<br>8.5' - 1' Aggregate Base                                                                                                                                                           |                                                                                                                                             |                           |                            |             |    |                |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1R<br>2B                       | 164683                                            | 1' - TD Sandstone, (Sespe Formation), clayey to silty, fine to medium grained, light greenish gray, some magenta mottling, friable, weakly to moderately cemented, very dense, slightly moist to moist | 126.1                                                                                                                                       | 7.6                       | 90.7                       | 22.4        | 32 | 1A<br>SA<br>SE |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3R<br>4B                       | 25517<br>75 sec 7                                 | @ 11' becomes magenta-brown, slightly moist to moist                                                                                                                                                   | 117.7                                                                                                                                       | 8.6                       | 99.7                       | 29.4        | 32 | 1A<br>SD<br>SA |
| 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 5R                             | 163972                                            | TD = 166'<br>Groundwater or seepage not encountered<br>Backfilled with cuttings                                                                                                                        | 133.0                                                                                                                                       | 8.0                       | 89.2                       | 30.7        | 38 | 1A<br>SA       |
| 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |                                                   |                                                                                                                                                                                                        |                                                                                                                                             |                           |                            |             |    |                |
| 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |                                                   |                                                                                                                                                                                                        |                                                                                                                                             |                           |                            |             |    |                |
| <div><div><input type="checkbox"/> California Ring (2.5 in. OD)<br/><input type="checkbox"/> Sample<br/><input type="checkbox"/> California Ring (3 in. OD)<br/><input type="checkbox"/> Sample</div><div><input type="checkbox"/> SPT (2 in. OD)<br/><input type="checkbox"/> Sample<br/><input type="checkbox"/> Data<br/><input type="checkbox"/> Sample</div><div><input type="checkbox"/> Depth to Invert<br/><input type="checkbox"/> Seepage Encountered<br/><input type="checkbox"/> Data<br/><input type="checkbox"/> Seepage Encountered</div><div><input type="checkbox"/> District Contact<br/><input type="checkbox"/> Unsaturation Contact<br/><input type="checkbox"/> Dry Density<br/><input type="checkbox"/> MC - Moisture Content</div><div>LEGEND</div><div>Types of Tests<br/>CO - Consolidation<br/>CR - Compression<br/>CS - Direct Shear<br/>EP - Expansion Index<br/>FE - Permeability<br/>SA - Stress Analysis<br/>SE - Seepage Envelope<br/>SI - Swell Potential</div></div> |                                |                                                   |                                                                                                                                                                                                        |                                                                                                                                             |                           |                            |             |    |                |
| Note: This log contains observations and interpretations that are valid only for the specific date and location of the boring. Subsurface conditions may vary between borings and with time.<br>Material descriptions are derived using visual classification methods and may vary from descriptions/classifications based on laboratory testing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                |                                                   |                                                                                                                                                                                                        |                                                                                                                                             |                           |                            |             |    |                |

| Project: Coastline Dr: Watermain Replacement<br>Project Location: Coastline Dr.<br>PCA: Y5292286A |             |                            |                                               |                                                                                                                                                                                             | GEOTECHNICAL LOG OF BORING AND SAMPLING<br>Los Angeles County Department of Public Works<br>Geotechnical and Materials Engineering Division |                    |                              |                        |                         |      |              |    |    |
|---------------------------------------------------------------------------------------------------|-------------|----------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------------------|------------------------|-------------------------|------|--------------|----|----|
| Boring No.: B-7                                                                                   |             | Date(s) Drilled:<br>6/4/15 | Logged by RLM, JUJ<br>and K Burger            |                                                                                                                                                                                             | Boring Diameter:                                                                                                                            | 6 in.              | Ground Elevation:            | 29'                    | Page 1 of 1             |      |              |    |    |
| Boring Location:<br>STA 29+00                                                                     |             |                            | Drilled by:<br>FMD, Puga                      |                                                                                                                                                                                             | Hammer Weight:                                                                                                                              | 140 lbs            | Total Depth:                 | 16'6"                  | Depth to Invert:        |      |              |    |    |
| Latitude & Longitude: 34.042 & -116.567                                                           |             |                            | Drilling Method: Hollow stem auger Equipment: |                                                                                                                                                                                             | Drop Height:                                                                                                                                | 30 in.             | Depth to Groundwater:<br>N/A |                        | Depth to Bedrock:<br>6' |      |              |    |    |
|                                                                                                   |             |                            |                                               |                                                                                                                                                                                             | CME                                                                                                                                         |                    |                              |                        |                         |      |              |    |    |
| DEPTH (FEET)                                                                                      | FIELD DATA  |                            | Graphic Log                                   | DESCRIPTION                                                                                                                                                                                 | USCS                                                                                                                                        | LABORATORY TESTING |                              |                        |                         |      |              |    |    |
|                                                                                                   | Sensor Data | Tube                       |                                               |                                                                                                                                                                                             |                                                                                                                                             | In-situ $\gamma_d$ | % MC                         | Seve % Passing No. 200 | LL                      | PI   | Type of Test |    |    |
| 0                                                                                                 |             |                            |                                               | 0'-6" Asphalt                                                                                                                                                                               |                                                                                                                                             |                    |                              |                        |                         |      |              |    |    |
|                                                                                                   |             |                            |                                               | 6"-9" Aggregate Base                                                                                                                                                                        |                                                                                                                                             |                    |                              |                        |                         |      |              |    |    |
|                                                                                                   |             |                            |                                               | 9'-6" Sand, (alluvium), fine to medium grained, medium brownish-gray, loose, slightly moist @ 1' large volcanic cobble encountered (5" diameter)<br>@ 2' medium volcanic cobble encountered | SM                                                                                                                                          | 99.4               | 13.7                         | 91.5                   | 28.7                    | --   | --           | SA |    |
| 5                                                                                                 | 1R<br>2B    | 1812                       |                                               | 6'-TD Siltsstone-claystone, (Sespe Formation), reddish-brown, fractured, mottled, slightly moist to moist, dense                                                                            |                                                                                                                                             |                    |                              |                        |                         | 98.5 | 65.3         | 31 | 14 |
| 10                                                                                                | 3R<br>4B    | 133564                     |                                               | @ 115' oxidized, medium gray color                                                                                                                                                          |                                                                                                                                             | 120.7              | 4.7                          | 86.4                   | 55.3                    | 28   | 9            | SA |    |
| 15                                                                                                | 5R          | 382727                     |                                               | @ 165' some oxidation, reddish-brown mottling                                                                                                                                               |                                                                                                                                             |                    |                              |                        |                         | 98.2 | 66.2         | 35 | 19 |
|                                                                                                   |             |                            |                                               | TD = 16'6"<br>Groundwater or seepage not encountered<br>Backfilled with cuttings                                                                                                            |                                                                                                                                             | 97.9               | 8.1                          | 90.6                   | 58.0                    | 36   | 15           | SA |    |
| 20                                                                                                |             |                            |                                               |                                                                                                                                                                                             |                                                                                                                                             |                    |                              |                        |                         |      |              |    |    |
| 25                                                                                                |             |                            |                                               |                                                                                                                                                                                             |                                                                                                                                             |                    |                              |                        |                         |      |              |    |    |

California Ring (2.5 in. OD)

Sample

California Ring (3 in. OD)

Sample

Sample

SPT (2 in. OD)

Sample

Tube

Sample

Depth to invert

Seepage Encountered During Driving

Uplift Encountered During Driving

District Contact

Gravelly or Overlain Contact

T<sub>90</sub> (Dry Density)

MC - Moisture Content

Types of Tests  
CO - Consolidation  
CR - Corrosion  
CS - Direct Shear  
E - Expansion Index  
FE - Permeability  
FS - Seve Analysis  
SE - Sealed Equivalence Ratio  
SI - Maximum Density  
SP - Shrinkage  
TR - Thixal

Note: This log contains observations and interpretations that are valid only for the specific date and location of the boring. Subsurface conditions may vary between borings and over time.  
Material descriptions are derived solely using classification methods and may vary from descriptions/classifications based on laboratory testing.