

January 7, 2019

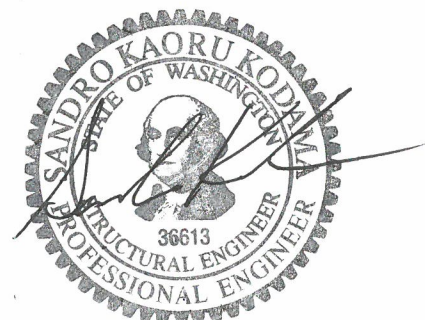
STRUCTURAL CALCULATIONS - SHORING
(Permit Submittal)

LUNDIN RESIDENCE
4041 West Mercer Way
Mercer Island, WA 98040

Quantum Job Number: 18689.01

Prepared for:
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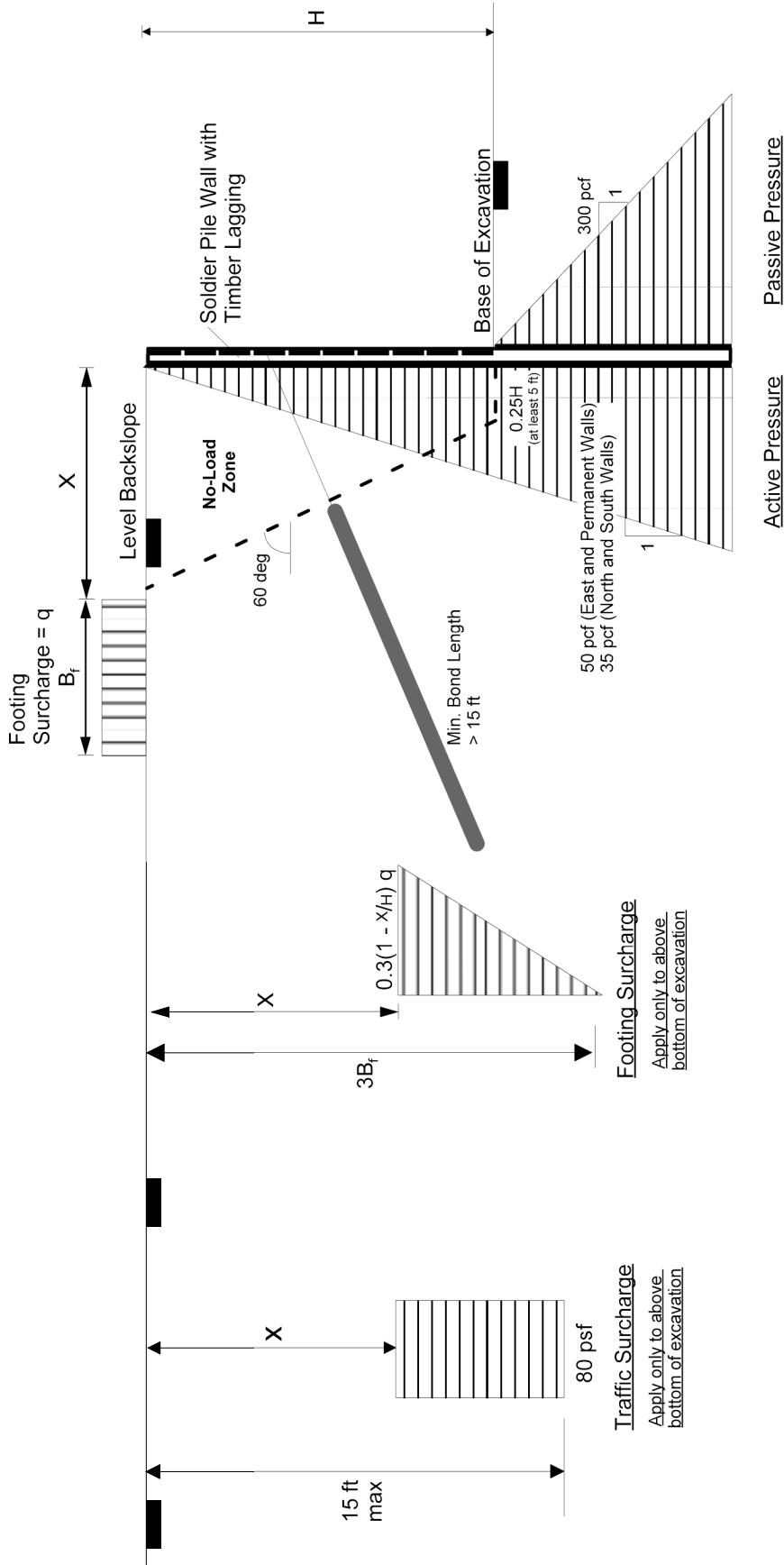
SHORING WALL DESIGN..... B - 1

LAGGING DESIGN C - 1

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DESIGN CRITERIA



Active Pressure Passive Pressure

Notes:

1. Minimum embedment should be at least 10 feet below bottom of excavation.
2. A factor of safety of 1.5 has been applied to the recommended passive pressure values.
No factor of safety has been applied to the recommended active earth pressure values.
3. Active pressures should be applied over the full width of the pile spacing above the base of the excavation, and over one pile diameter below the base of the excavation.
4. Surcharge pressures should be applied over the entire length of the soldier piles.
5. Passive pressure should be applied to two times the diameter of the soldier piles.
6. Use 50% of the active and surcharge pressures for lagging design with soldier piles spaced at 8' or less.
7. Refer to report text for additional discussions.



Proposed Development
4041 West Mercer Way
Seattle, WA 98040

DESIGN LATERAL PRESSURES
SOLDIER PILE WALL
CANTILEVERED OR WITH ONE TIEBACK

Project No. 18-282 Figure No. 4

GENERAL SHORING NOTES

(The following apply unless shown otherwise on the plans)

CRITERIA

1. ALL MATERIALS, WORKMANSHIP, DESIGN, AND CONSTRUCTION SHALL CONFORM TO THE DRAWINGS, SPECIFICATIONS, THE 2015 EDITION OF THE INTERNATIONAL BUILDING CODE (IBC).
2. REFERENCE DOCUMENTS:
 - A. TOPOGRAPHICAL AND BOUNDARY ALTA/ACSM LAND TITLE SURVEY BY HANSEN SURVEYING & CONSULTING, DATED AUGUST 29, 2018.
 - B. GEOTECHNICAL ENGINEERING INVESTIGATION REPORT #18-282 BY PanGEO, INC., DATED OCTOBER 12, 2018.
3. DESIGN LOADS: THE SOIL PRESSURE DIAGRAMS SHOWN ON THIS SHEET WERE USED FOR DESIGN.
4. SUBMITTALS: SHOP DRAWINGS SHALL BE SUBMITTED TO THE ENGINEER PRIOR TO ANY FABRICATION OR CONSTRUCTION FOR ALL STRUCTURAL ITEMS INCLUDING THE FOLLOWING: STRUCTURAL STEEL, MISCELLANEOUS METAL, TENDONS, AND ANCHORS. PROPOSED DEMOLITION AND SHORING SEQUENCE SHALL ALSO BE SUBMITTED TO THE STRUCTURAL ENGINEER FOR REVIEW.
5. INSPECTION: INSPECTION BY THE GEOTECHNICAL ENGINEER SHALL BE PERFORMED FOR PILE PLACEMENT AND TIEBACK PLACING AND STRESSING. ALL PREPARED SOIL BEARING SURFACES SHALL BE INSPECTED BY THE GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF PILE. SOIL COMPACTION SHALL BE SUPERVISED BY AN APPROVED TESTING LAB. INSPECTION BY A QUALIFIED TESTING LAB SHALL BE PERFORMED FOR STEEL FABRICATION, ERECTION AND WELDING.
6. UTILITY LOCATION: THE SHORING CONTRACTOR SHALL DETERMINE THE LOCATION OF ALL ADJACENT UNDERGROUND UTILITIES PRIOR TO DRILLING PILE HOLES, OR CUTTING OR DIGGING IN STREETS OR ALLEYS. THE UTILITIES INFORMATION SHOWN ON THE SURVEY MAY BE NOT COMPLETE.
7. VERIFICATION: CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND LOCATIONS OF EXISTING STRUCTURES PRIOR TO FABRICATION AND INSTALLATION OF ANY STRUCTURAL MEMBER. CONTRACTOR SHALL NOTIFY ENGINEER OF ALL DISCREPANCIES IN DIMENSIONS AND ALL FIELD CHANGES PRIOR TO FABRICATION AND INSTALLATION.
8. SOILS: SEE GEOTECHNICAL REPORT FOR MORE COMPLETE INFORMATION (NOTE 2 ABOVE). FOLLOW THE RECOMMENDATIONS OF THE REPORT INCLUDING THE FOLLOWING ITEMS:

- A. SHORING - SEE DETAILS **ON THIS SHEET** FOR THE SOIL PRESSURE DIAGRAM. ALL PILES SHALL BE EMBEDDED PER THESE DRAWINGS, A MINIMUM OF **10 FEET** BELOW THE EXCAVATION BASE AND **5 FEET** BELOW ANY EXCAVATIONS LOCATED WITHIN **10 FEET** HORIZONTALLY OF THE PILE.
 - B. TIEBACKS – PER THE **GEOTECHNICAL REPORT**, TIEBACK ANCHORS SHALL BE TESTED. SEE THE SEPARATE SECTION AT THE END OF THESE NOTES.
 - C. SHORING MONITORING - PER THE GEOTECHNICAL REPORT, THE GEOTECHNICAL ENGINEER SHALL CONTINUOUSLY MONITOR THE INSTALLATION OF THE PILES. PER **SECTION 7.0 OF THE REPORT**, THE GEOTECHNICAL ENGINEER SHALL ALSO REVIEW THE SHORING WALL DEFLECTION DATA COLLECTED BY THE PROJECT SURVEYOR. AT A MINIMUM THE SHORING SHALL BE SURVEYED **BEFORE EXCAVATION BEGINS, DURING EXCAVATION, ONCE THE EXCAVATION IS COMPLETE, AND** AFTER THE EXCAVATION IS COMPLETE. SURVEYING MUST CONTINUE UNTIL THE PERMANENT STRUCTURE (INCLUDING FLOOR SLABS AS BRACES) IS COMPLETE UP TO STREET GRADES. THE FREQUENCY AND DURATION OF MONITORING SHALL BE DETERMINED BY THE GEOTECHNICAL ENGINEER BASED ON SHORING PERFORMANCE.
 - D. EXCAVATION - PER THE GEOTECHNICAL REPORT, EXPECT BOTH **STRUCTURAL FILL AND GLACIAL TILL SOIL** TYPES TO BE ENCOUNTERED. SEE REPORT FOR RECOMMENDATIONS.
 - E. LAGGING - PER THE GEOTECHNICAL REPORT, LAGGING SHALL BE INSTALLED BETWEEN ALL SHORING PILES.
 - F. BACKFILL - PER THE GEOTECHNICAL REPORT, **PEA GRAVEL, SAND AND SUITABLE EXCAVATION SPOILS MAY BE USED AS SHORING WALL BACKFILL, WHEREAS CONCRETE, CDF OR OTHER IMPERMEABLE MATERIALS MAY NOT BE USED.**
 - G. DRAINAGE - PER THE GEOTECHNICAL REPORT, BACKFILL BEHIND THE WALL SHOULD CONNECT TO A CONTINUOUS HORIZONTAL DRAIN LOCATED IN FRONT OF THE WALL THROUGH THE USE OF PREFABRICATED VERTICAL DRAINAGE STRIPS.
9. PRE-CONSTRUCTION MEETING: A PRE-CONSTRUCTION MEETING WITH THE BUILDING DEPARTMENT, IS REQUIRED BEFORE THE START OF SHORING INSTALLATION. ATTENDEES SHALL INCLUDE REPRESENTATIVES OF THE OWNER, GENERAL CONTRACTOR, EXCAVATION AND SHORING SUBCONTRACTORS, THE GEOTECHNICAL ENGINEER, SURVEYOR, STRUCTURAL ENGINEER AND BUILDING DEPARTMENT PERSONNEL.

CONCRETE GROUT

10. CONCRETE SHALL CONFORM TO ALL REQUIREMENTS OF CHAPTER 19 OF THE IBC. CONCRETE GROUT STRENGTHS OVER 1,000

PSI SHALL BE VERIFIED BY STANDARD CYLINDER TESTS, UNLESS APPROVED OTHERWISE. REQUIRED ULTIMATE COMPRESSIVE STRENGTHS OF CONCRETE GROUT SHALL BE REACHED BY **7 DAYS FOR TIEBACKS AND** 28 DAYS FOR PILES.

f_c (PSI)	MINIMUM CEMENT PER CUBIC YARD	MAXIMUM WATER PER 94 LB OF CEMENT	USE
500	1-1/2 SACKS	--	PILE & TIEBACK (ZONE "B") LEAN CONCRETE GROUT
2,500	5 SACKS	--	PILE STRUCTURAL CONCRETE GROUT
3,000	6 SACKS	6 GALLONS	UNDERPINNING STRUCTURAL GROUT
3,000	6 SACKS	6 GALLONS	TIEBACK STRUCTURAL GROUT (ZONE "A")

THE CONTRACTOR SHALL SUBMIT A CONCRETE GROUT MIX DESIGN FOR APPROVAL TWO WEEKS PRIOR TO PLACING ANY CONCRETE. THE MIX DESIGNS WILL BE REVIEWED FOR CONFORMANCE TO IBC CH. 19.

STEEL

11. STRUCTURAL STEEL DESIGN, FABRICATION, AND ERECTION SHALL BE BASED ON THE A.I.S.C. "SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS," LATEST EDITION, PLUS ALL REFERENCED CODES.

12. STRUCTURAL STEEL SHALL CONFORM TO THE FOLLOWING REQUIREMENTS:

TYPE OF MEMBER	ASTM SPECIFICATION	FY
A. PLATES, SHAPES, ANGLES, AND RODS	A36	36 KSI
B. SOLDIER PILES	A992 OR A572, GRADE 50	50 KSI
C. HEADED SHEAR STUDS	A108	49 KSI
D. PIPE SECTIONS	A53 (TYPE E OR S, GRADE B)	35 KSI
E. PIPE SECTIONS	A500 (GRADE B)	42 KSI
F. STRUCTURAL TUBING	A500 (GRADE B)	46 KSI

13. ALL WELDING SHALL BE IN CONFORMANCE WITH A.I.S.C. AND A.W.S. STANDARDS AND SHALL BE PERFORMED BY **W.A.B.O.** CERTIFIED WELDERS USING E70XX ELECTRODES OR 70 KSI WELD METAL. ONLY PREQUALIFIED WELDS (AS DEFINED BY A.W.S.) SHALL BE USED.

14. PRE-STRESSING STEEL:

A. HIGH STRENGTH RODS (STRESSED AND NON-STRESSED) SHALL BE DYWIDAG THREAD BARS WITH APPROPRIATE ANCHORAGE PLATES, NUTS AND COUPLERS, IN CONFORMANCE WITH ASTM **A722** ($F_{pu} = 150,000$ PSI).

B. STRAND SHALL BE 1/2" DIAMETER, 7-WIRE STRESS-RELIEVED (OR LOW RELAXATION), CLEAN AND FREE FROM CORROSION, HAVING A GUARANTEED MINIMUM ULTIMATE STRENGTH OF 41,300 POUNDS AND MANUFACTURED IN ACCORDANCE WITH ASTM [A416](#), GRADE 270. ONE MILL TEST SHALL BE SUBMITTED FOR REVIEW FOR EACH REEL USED.

WOOD LAGGING

15. SAWN LUMBER: SAWN LUMBER SHALL CONFORM TO "GRADING AND DRESSING RULES," WEST COAST LUMBER INSPECTION BUREAU (WCLIB), LATEST EDITION. LUMBER SHALL BE THE SPECIES AND GRADE NOTED BELOW:

<u>USE</u>	<u>GRADE</u>	<u>MAX. SPAN</u>	<u>SIZE</u>	<u>DEPTH BELOW GRADE</u>
TIMBER LAGGING	HEM-FIR OR DF-L NO. 2	7'-8"	6X12	0'-0" TO 20'-0" (EAST/SOUTH WALL)
TIMBER LAGGING	HEM-FIR OR DF-L NO. 2	8'-0"	4X12	0'-0" TO 12'-0"

TIMBER LAGGING SHALL BE PRESSURE TREATED WITH WATERBORNE PRESERVATIVES IN ACCORDANCE WITH AWPA STANDARD [U1](#) TO A MINIMUM RETENTION OF 0.4 LBS/CU.FT.

SHORING INSTALLATION

16. DEMOLITION: SHORING AND SOIL EXCAVATION SHALL BE DONE SIMULTANEOUSLY.

17. HOLE DIGGING: PILE AND ANCHOR HOLES SHALL BE DRILLED WITHOUT LOSS OF GROUND AND WITHOUT ENDANGERING PREVIOUSLY INSTALLED PILES **AND ANCHORS**. THIS MAY INVOLVE CASING THE HOLES OR OTHER METHODS OF PROTECTION FROM CAVING. SEE GEOTECHNICAL REPORT FOR RECOMMENDED HOLE DIGGING PROCEDURE. **THE BOTTOM OF THE BORED HOLES SHALL BE CLEANED OUT USING A BUCKET AUGER.**

18. PILE PLACEMENT: FOR ALL PILES SPACED CLOSER **THAN 7' O.C.**, ALTERNATE PILES SHALL BE PLACED SO THAT A MINIMUM OF 24 HOURS IS ALLOWED FOR THE CONCRETE GROUT TO CURE BEFORE DRILLING THE DIRECTLY ADJACENT PILES.

19. STEEL PILE TOLERANCES:

- 1" INSIDE PERPENDICULAR TO SHORING WALL.
- 1" OUTSIDE PERPENDICULAR TO SHORING WALL.
- 3" Laterally.

20. EXCAVATION BELOW TIEBACKS: **TIEBACK INSTALLATION AND PRE-STRESSING SHALL BE COMPLETED BEFORE**

EXCAVATING MORE THAN 2 FEET BELOW THE TIEBACK LEVEL.

21. LAGGING: TIMBER LAGGING SHALL BE INSTALLED IN ALL AREAS. VOIDS BETWEEN LAGGING AND SOIL SHALL BE BACKFILLED. DRAINAGE BEHIND THE WALL MUST BE MAINTAINED (SEE ITEM 8F ABOVE). IT IS THE CONTRACTOR'S RESPONSIBILITY TO LIMIT THE AMOUNT OF EXPOSED SOIL WITHOUT LAGGING TO AVOID LOSS OF SOIL. IN NO CASE SHALL THE EXPOSED SOIL HEIGHT EXCEED 4'-0". SPECIAL CARE SHOULD BE TAKEN TO AVOID GROUND LOSS DURING EXCAVATION. NO EXCAVATION FOR THE IMMEDIATE LOWER LIFT IS ALLOWED UNTIL VOIDS BEHIND THE LAGGING OF THE PRECEDING LIFT ARE FILLED WITH APPROVED MATERIALS.
22. SHORING MONITORING: SYSTEMATIC PROGRAM OF OBSERVATION SHALL BE CONDUCTED DURING THE PROJECT EXECUTION TO DETERMINE THE EFFECT OF CONSTRUCTION ON ADJACENT FACILITIES AND STRUCTURES IN ORDER TO PROTECT THEM FROM SERIOUS DAMAGE. SEE GEOTECHNICAL REPORT FOR RECOMMENDATIONS. A LICENSED SURVEYOR (NOT THE CONTRACTOR) MUST DO THE SURVEYING AT LEAST ONCE A WEEK. FIELD DATA AND MEASUREMENTS ARE TO BE SUBMITTED TO STRUCTURAL AND GEOTECHNICAL ENGINEER FOR REVIEW (SEE ITEM 8B ABOVE).
23. SLOPES: ALL SLOPES SHALL BE PROTECTED PER THE RECOMMENDATIONS OF THE GEOTECHNICAL ENGINEER.
24. REMOVAL: ALL PILES, ANCHORS, GROUT AND LAGGING LOCATED WITHIN THE CITY R.O.W. SHALL BE REMOVED TO A DEPTH OF 4'-0" BELOW FINAL GRADE ONCE THEY ARE NO LONGER NEEDED FOR CONSTRUCTION.

TIEBACK TESTING AND STRESSING

25. VERIFICATION TESTS (200% TESTS):
 - * PRIOR TO INSTALLING PRODUCTION ANCHORS, PERFORM A MINIMUM OF TWO TESTS EACH ON EACH ANCHOR TYPE, INSTALLATION METHOD AND SOIL TYPE WITH THE TESTED ANCHORS CONSTRUCTED TO THE SAME DIMENSIONS AS PRODUCTION ANCHORS.
 - * TEST LOCATIONS TO BE DETERMINED IN CONJUNCTION WITH AND APPROVED BY THE GEOTECHNICAL ENGINEER.
 - * TEST ANCHORS, WHICH WILL BE LOADED TO 200% OF THE DESIGN LOAD, MAY REQUIRE ADDITIONAL PRESTRESSING STEEL (STEEL LOAD NOT TO EXCEED 80% OF THE ULTIMATE TENSILE STRENGTH) OR REINFORCING OF THE SOLDIER PILE.
 - * LOAD TEST ANCHORS TO 150% LOAD IN 25% LOAD INCREMENTS, HOLDING EACH INCREMENTAL LOAD FOR AT LEAST 5 MINUTES AND RECORDING DEFLECTION OF THE ANCHOR HEAD AT VARIOUS TIMES WITHIN EACH HOLD TO THE NEAREST 0.01 INCH.
 - * AT THE 150% LOAD, THE HOLDING PERIOD SHALL BE AT LEAST 60 MINUTES.
 - * AFTER COMPLETION OF THE 150% HOLD, LOAD THE ANCHOR IN 25% INCREMENTS TO THE 200% LOAD, WHICH WILL BE HELD FOR 10 MINUTES.

* A SUCCESSFUL TEST SHALL PROVIDE A MEASURED CREEP RATE OF 0.04 INCHES OR LESS AT THE 150% LOAD BETWEEN 1 AND 10 MINUTES, AND 0.08 INCHES OR LESS BETWEEN 6 AND 60 MINUTES, AND ALL TIME INCREMENTS SHALL HAVE A CREEP RATE THAT IS LINEAR OR DECREASING WITH TIME. THE APPLIED LOAD MUST REMAIN CONSTANT DURING ALL HOLDING PERIODS (I.E., NO MORE THAN 5% VARIATION FROM THE SPECIFIED LOAD).

26. PROOF TESTS (130% TESTS ON ALL LOAD ANCHORS):

* LOAD TEST ALL PRODUCTION ANCHORS TO 130% OF THE DESIGN LOAD IN 25% LOAD INCREMENTS, HOLDING EACH INCREMENTAL LOAD UNTIL A STABLE DEFLECTION IS ACHIEVED (RECORD DEFLECTION OF THE ANCHOR HEAD AT VARIOUS TIMES WITHIN EACH HOLD TO THE NEAREST 0.01 INCH).

* AT THE 130% LOAD, THE HOLDING PERIOD SHALL BE AT LEAST 10 MINUTES.

* A SUCCESSFUL TEST SHALL PROVIDE A MEASURED CREEP RATE OF 0.04 INCHES OR LESS AT THE 130% LOAD BETWEEN 1 AND 10 MINUTES WITH A CREEP RATE THAT IS LINEAR OR DECREASING WITH TIME. THE APPLIED LOAD MUST REMAIN CONSTANT DURING THE HOLDING PERIOD (I.E., NO MORE THAN 5% VARIATION FROM THE 130% LOAD). ANCHORS FAILING THIS PROOF TESTING CREEP ACCEPTANCE CRITERIA MAY BE HELD AN ADDITIONAL 50 MINUTES FOR CREEP MEASUREMENT. ACCEPTABLE PERFORMANCE WOULD EQUATE TO A CREEP OF 0.08 INCHES OR LESS BETWEEN 5 AND 50 MINUTES WITH A LINEAR OR DECREASING CREEP RATE.

FOLLOWING PROOF LOADING, EACH ANCHOR SHALL BE LOCKED OFF AT 100% OF DESIGN LOADING.

VERIFICATION TESTED ANCHORS OR EXTENDED CREEP PROOF TESTED ANCHORS NOT MEETING THE ACCEPTANCE CRITERIA WILL REQUIRE A REDESIGN BY THE CONTRACTOR TO ACHIEVE THE ACCEPTANCE CRITERIA.

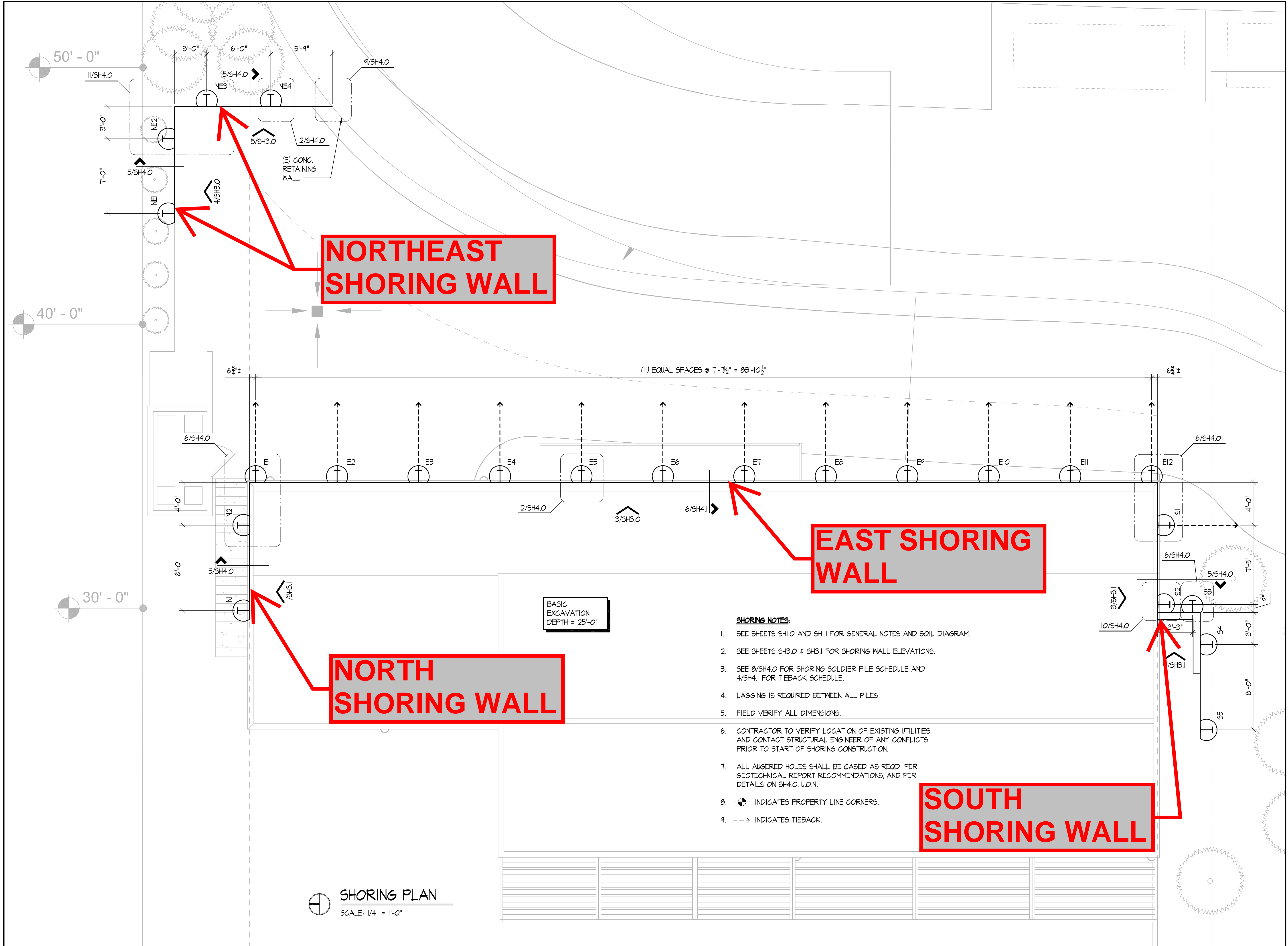
27. TIEBACK NOTES: ALL TIEBACKS ARE TO BE REMAIN STRESSED.

A BOND BREAKER (SUCH AS A SLIP SHEATH) SHALL BE CONSTRUCTED IN THE NO LOAD ZONE WHEN THE INSTALLATION PROCEDURES USE SINGLE STAGE GROUTING.

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SHORING WALL DESIGN



NORTHEAST SHORING WALL

EAST SHORING WALL

NORTH SHORING WALL

SOUTH SHORING WALL

- SHORING NOTES:**
1. SEE SHEETS SH1.0 AND SH1.1 FOR GENERAL NOTES AND SOIL DIAGRAM.
 2. SEE SHEETS SH3.0 & SH3.1 FOR SHORING WALL ELEVATIONS.
 3. SEE SH4.0 FOR SHORING SOLDIER PILE SCHEDULE AND SH4.1 FOR TIEBACK SCHEDULE.
 4. LAGGING IS REQUIRED BETWEEN ALL PILES.
 5. FIELD VERIFY ALL DIMENSIONS.
 6. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES AND CONTACT STRUCTURAL ENGINEER OF ANY CONFLICTS PRIOR TO START OF SHORING CONSTRUCTION.
 7. ALL AUGERED HOLES SHALL BE CASED AS REQD. PER GEOTECHNICAL REPORT RECOMMENDATIONS, AND PER DETAILS ON SH4.0, U.O.N.
 8. INDICATES PROPERTY LINE CORNERS.
 9. INDICATES TIEBACK.

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



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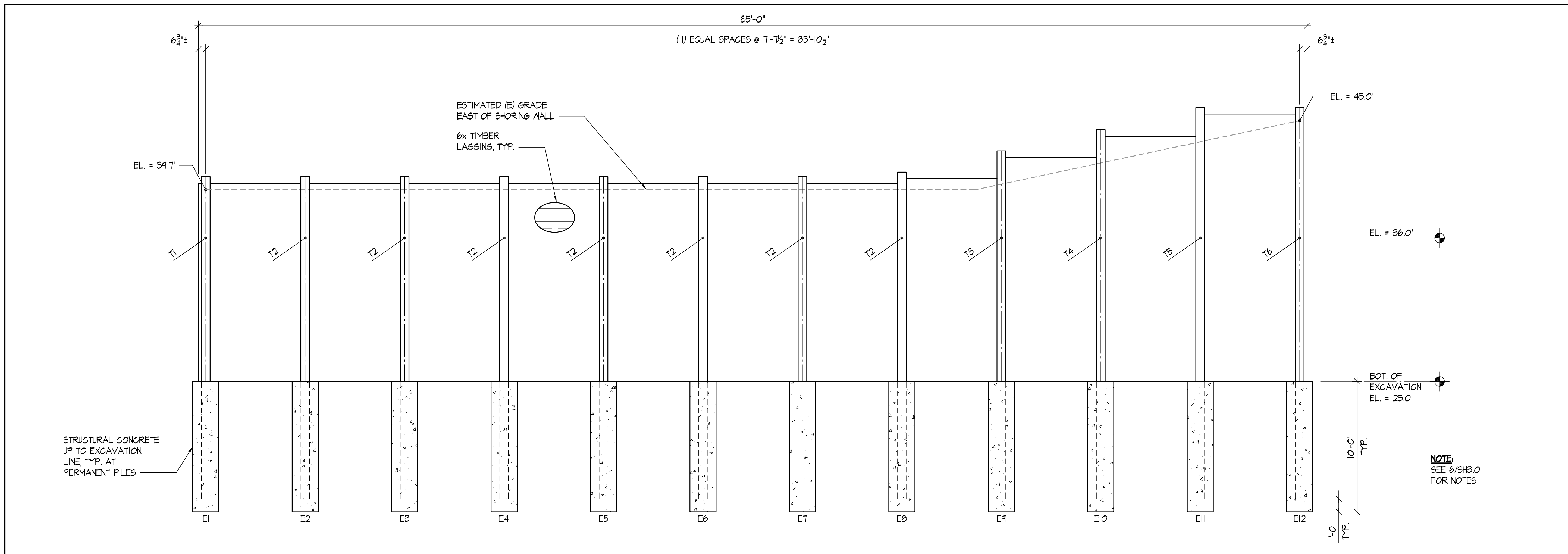
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DESIGN	SKK
DRAWN	SC
CHECKED	SKK
DATE	1/8/2019
REVISIONS	
PERMIT SET	1/8/2019

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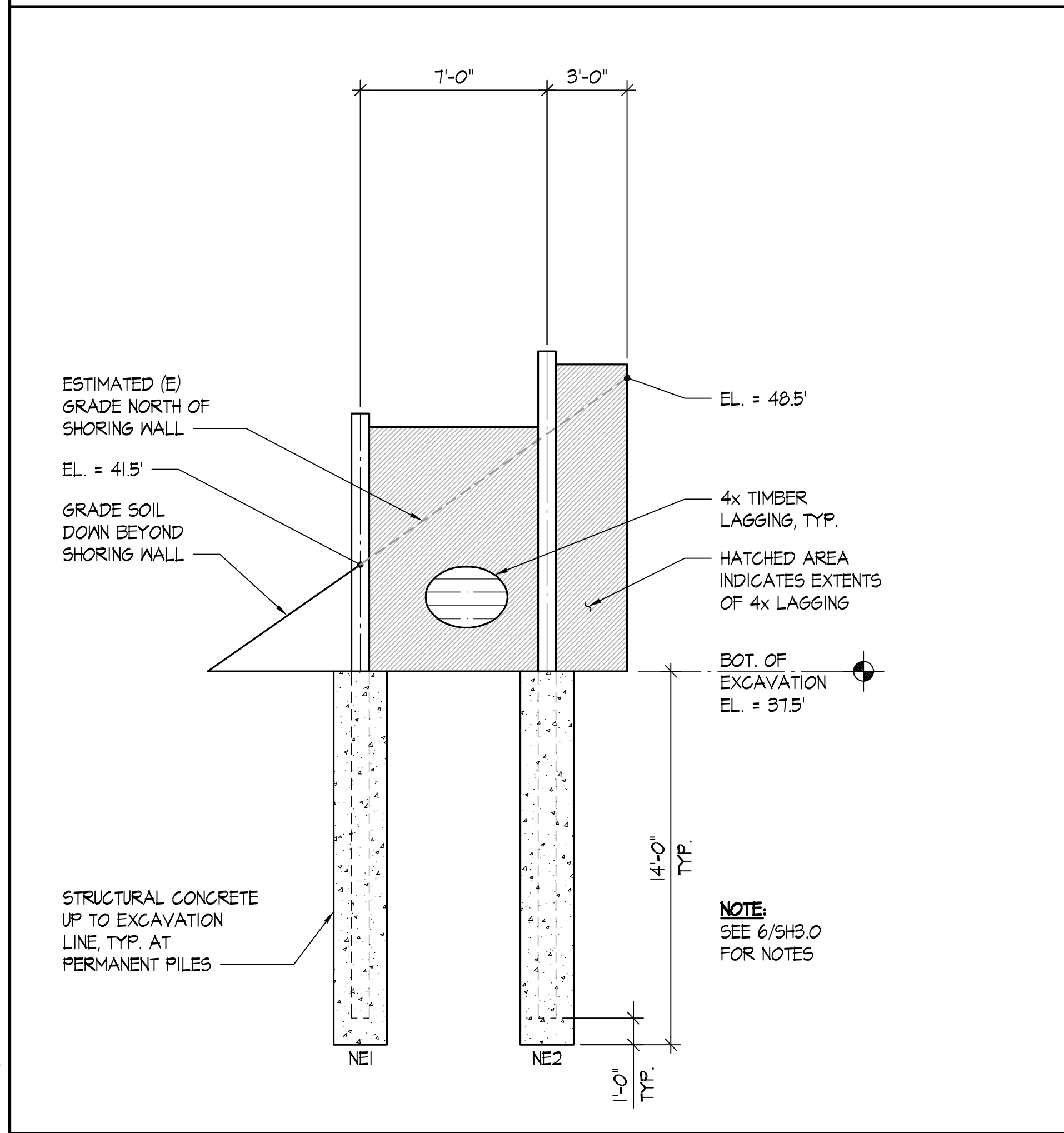
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SHORING PLAN



EAST SHORING WALL ELEVATION

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

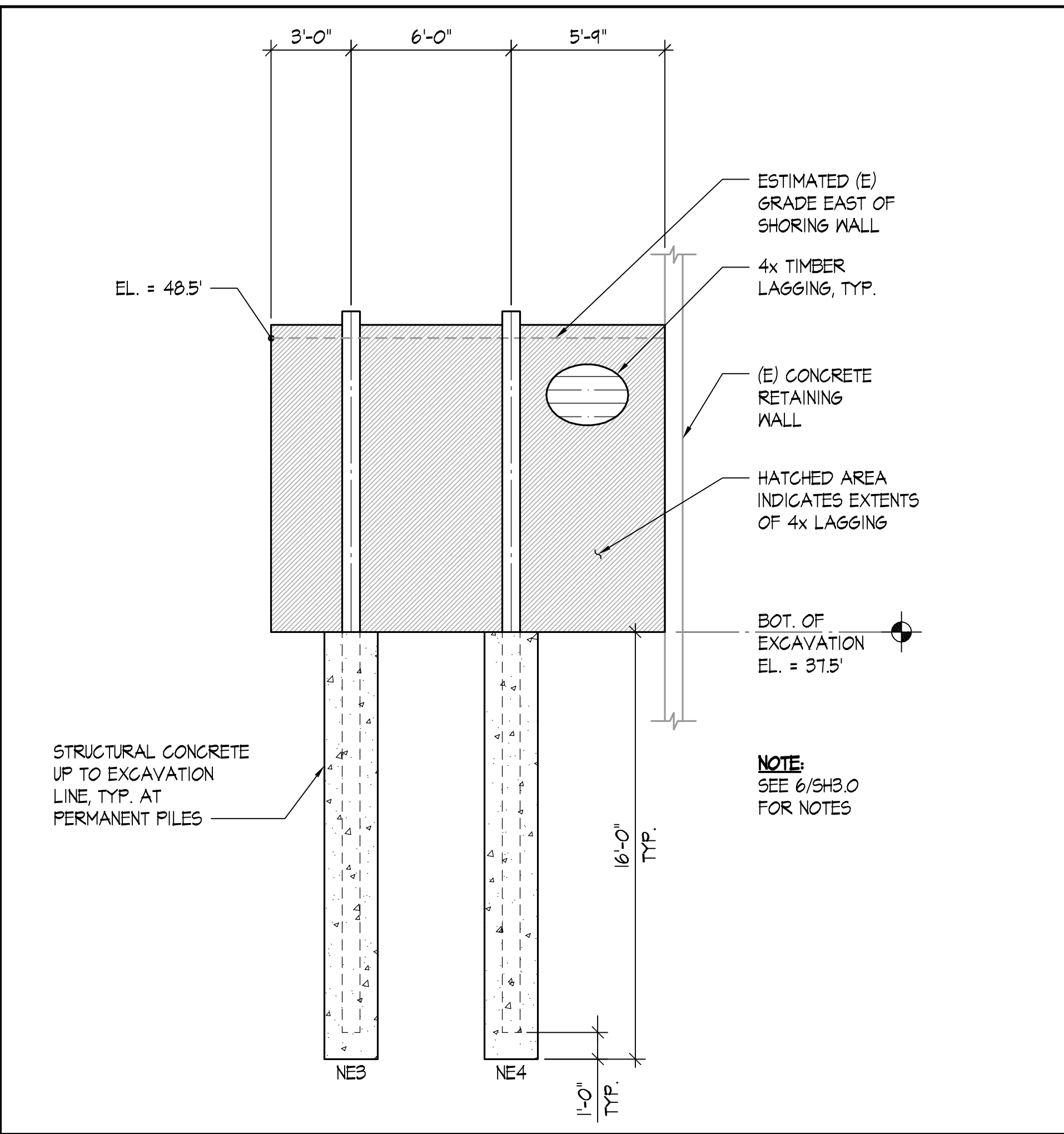
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NORTHEAST SHORING WALL ELEVATION

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

4



NORTHEAST SHORING WALL ELEVATION

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

5

- NOTES:**
1. W1 INDICATES SOLDIER PILE PER SCHEDULE ON 8/SH4.0.
 2. T1 = XX' INDICATES TIE BACK PER SCHEDULE ON 4/SH4.1.
 3. SPOT GRADE ELEVATIONS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.
 4. CONTRACTOR TO VERIFY AND COORDINATE ELEVATIONS & PILE HEIGHT/DEPTH WITH FIELD CONDITIONS.

SHORING NOTES

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

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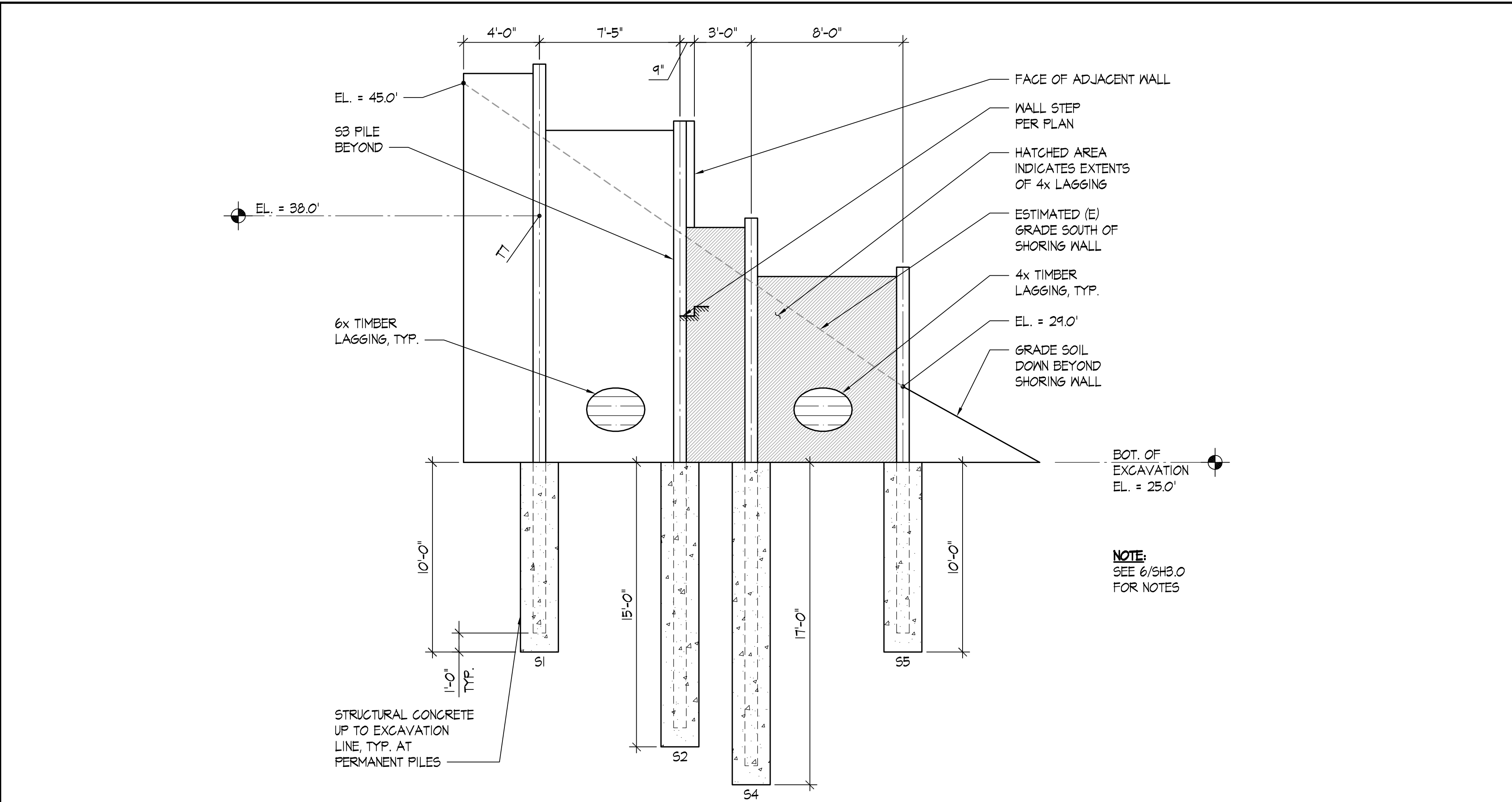
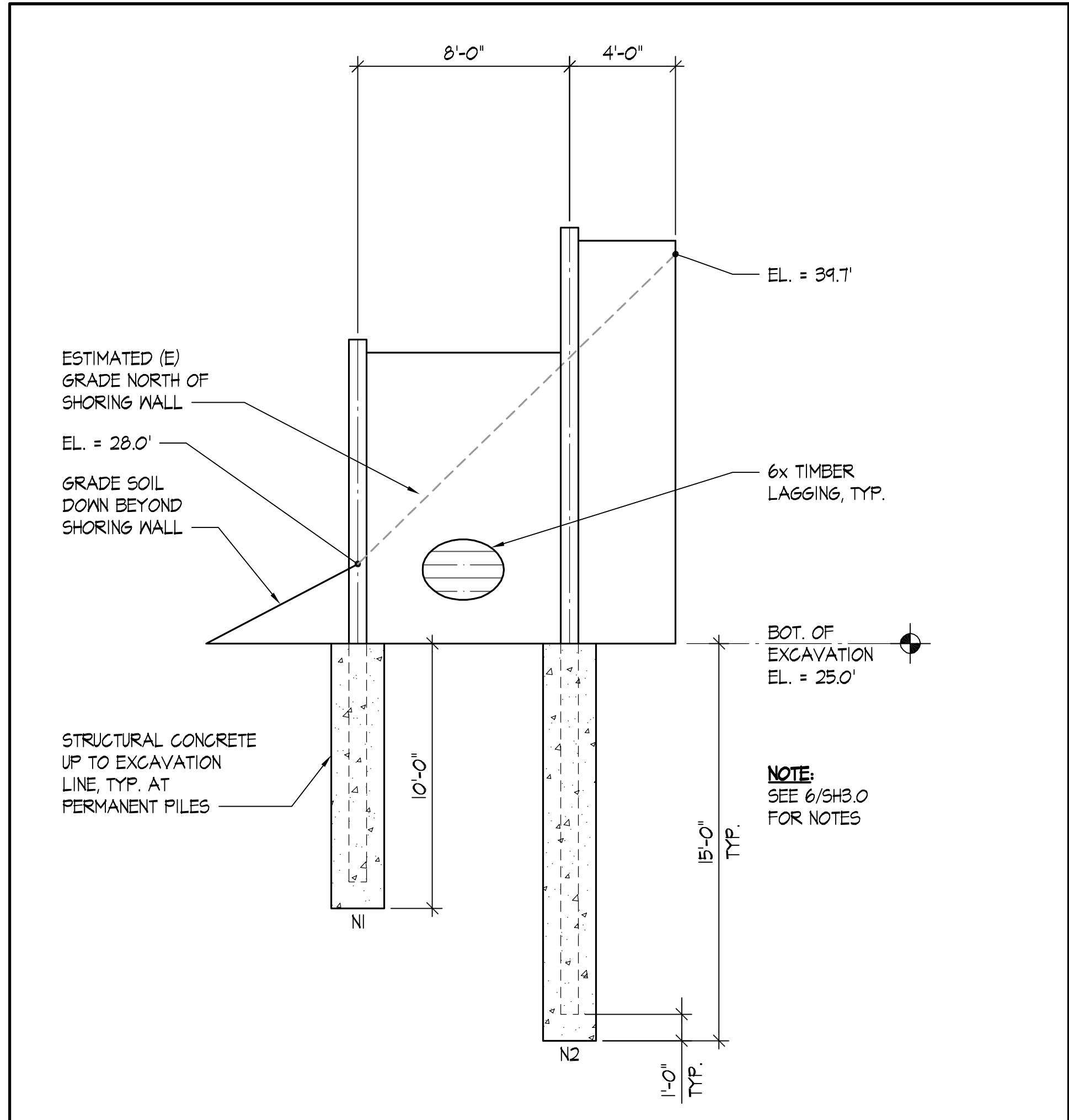
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SHORING ELEVATIONS



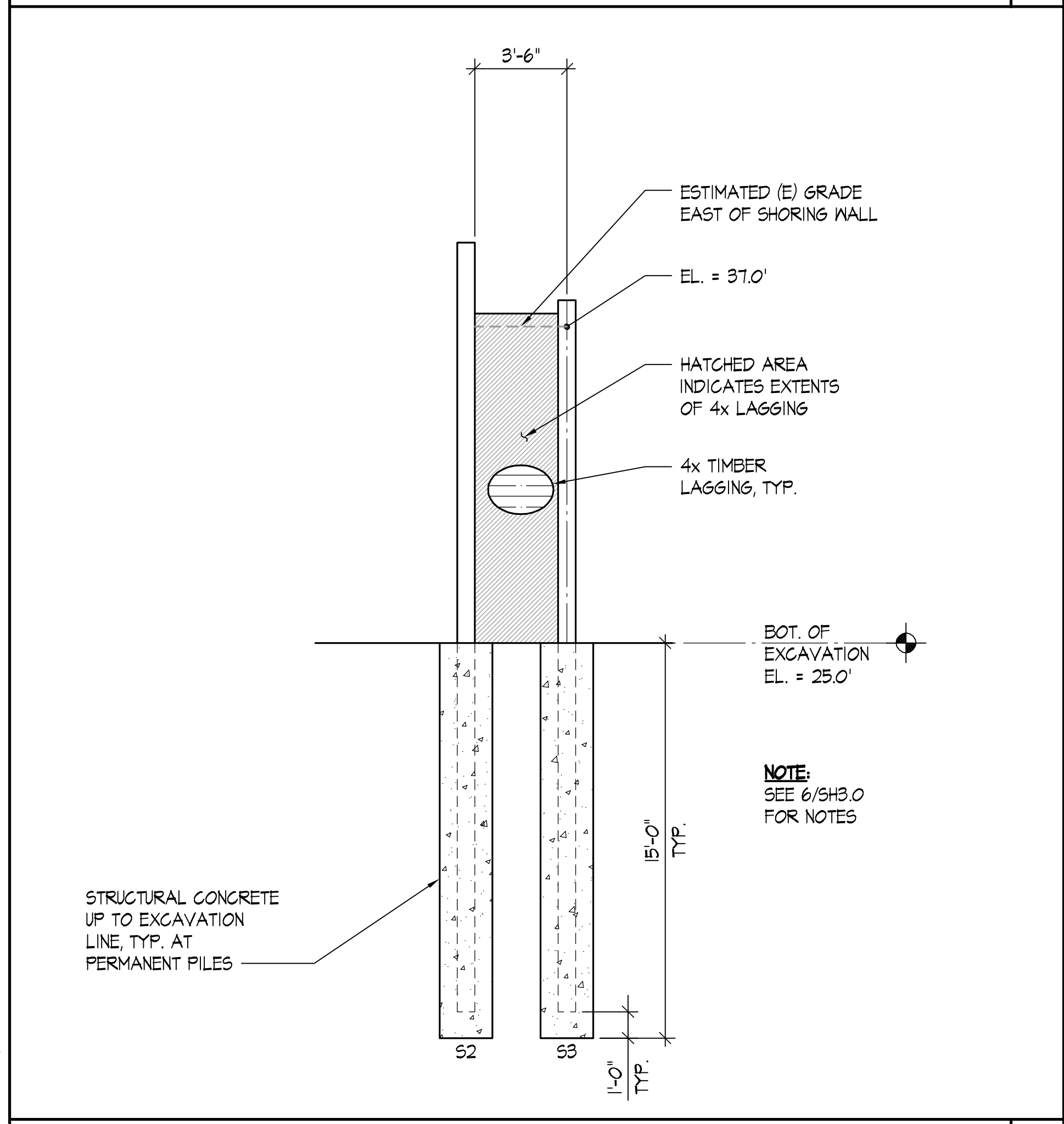
NORTH SHORING WALL ELEVATION

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

SOUTH SHORING WALL ELEVATION

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

3



SOUTH SHORING WALL ELEVATION

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

4

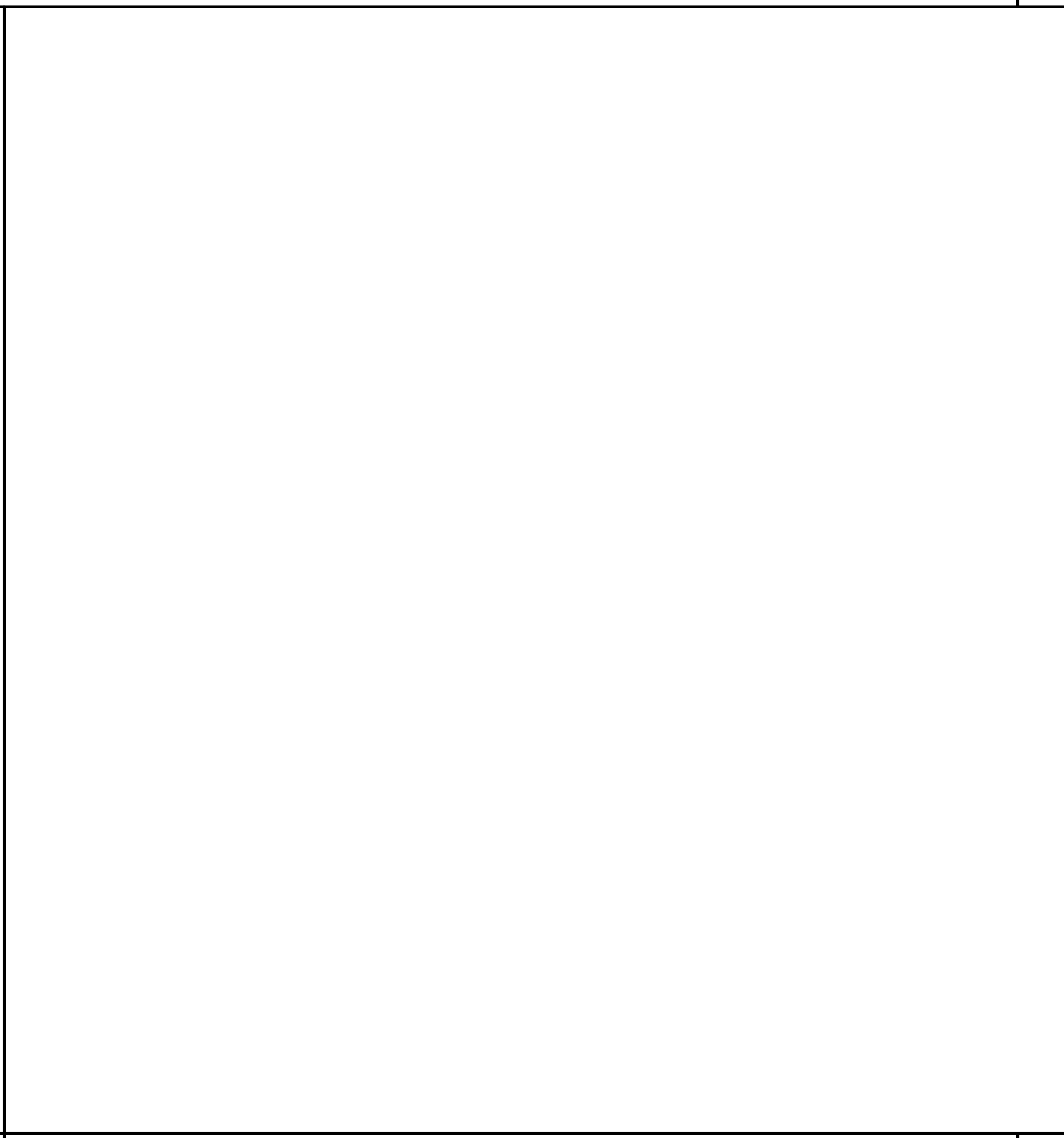
DETAIL



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

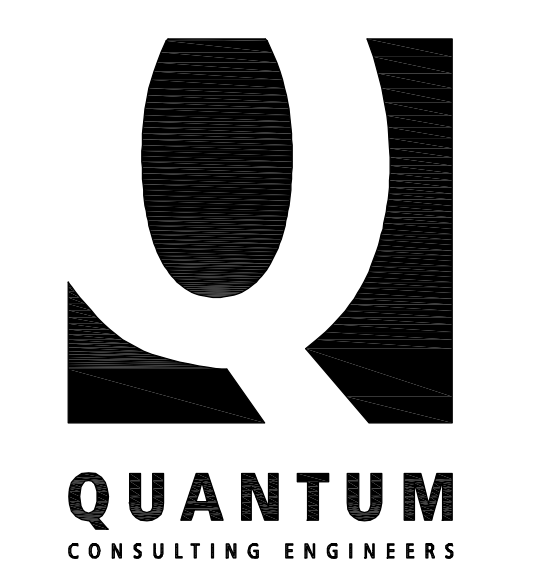
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DETAIL



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

6



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SHORING ELEVATIONS

SOLDIER PILE SCHEDULE

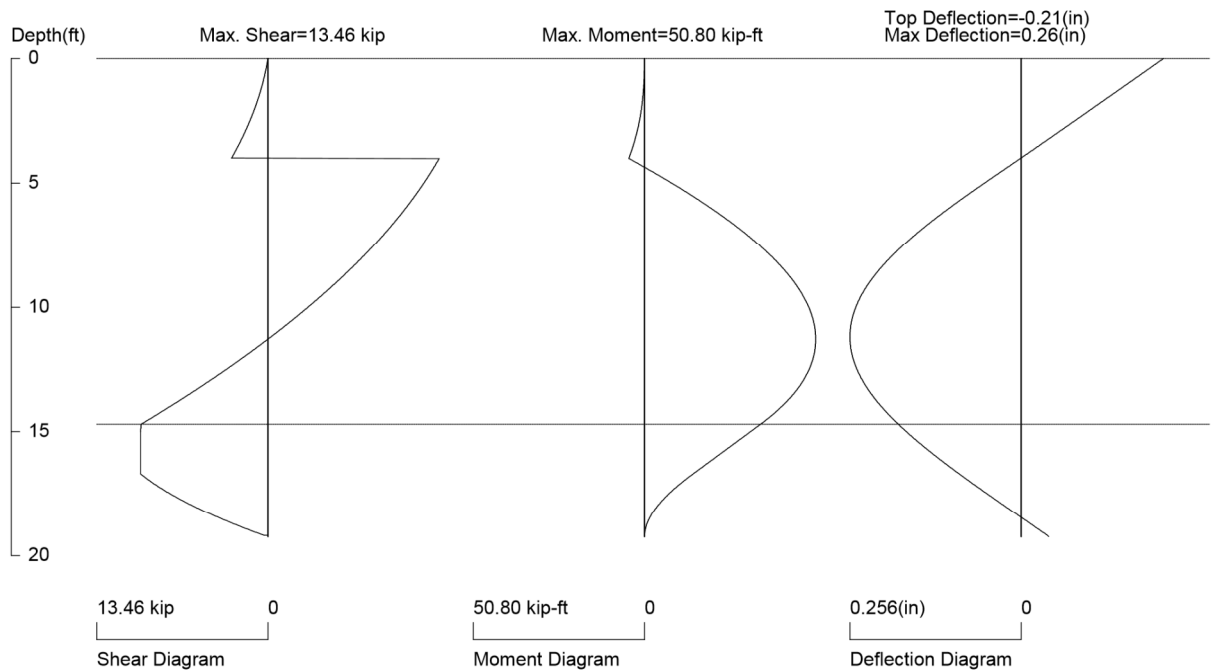
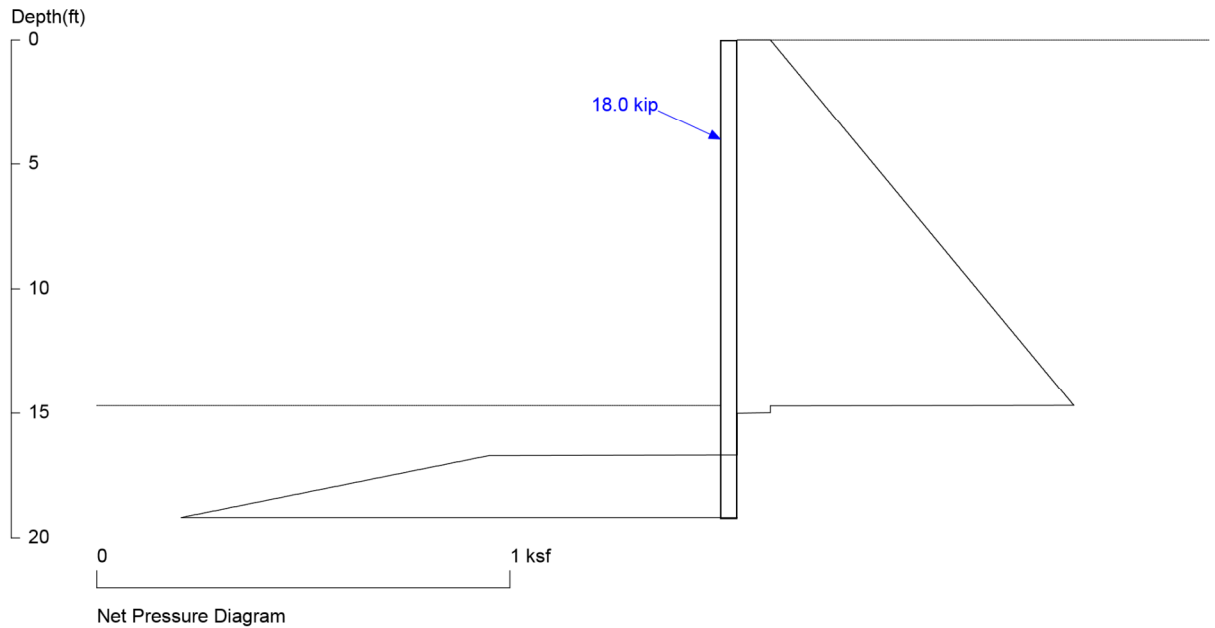
PILE MARK	PILE DIAMETER	SOLDIER PILE STEEL SECTION	BOTTOM EL. OF EXCAVATION	EMBEDMENT DEPTH 'D'	MAX. APPROX. HT. 'H'	STEEL SECTION LENGTH (ESTIMATED)	REMARKS
E1	24"	W14x26	25.0'	10'-0"	14'-8"	24'-8"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
E2 - E8	24"	W14x38	25.0'	10'-0"	14'-8"	24'-8"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
E9	24"	W14x43	25.0'	10'-0"	15'-6"	27'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
E10	24"	W14x43	25.0'	10'-0"	17'-0"	29'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
E11	24"	W14x48	25.0'	10'-0"	18'-6"	30'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
E12	24"	W14x26	25.0'	10'-0"	20'-0"	30'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
N1	24"	W12x14	25.0'	10'-0"	4'-0"	21'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
N2	24"	W14x74	25.0'	15'-0"	12'-0"	30'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
NE1	24"	W12x26	37.5'	14'-0"	6'-0"	23'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
NE2	24"	W12x26	37.5'	14'-0"	9'-0"	24'-8"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
NE3	24"	W14x68	37.5'	16'-0"	11'-0"	27'-3"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
NE4	24"	W14x74	37.5'	16'-0"	11'-0"	27'-3"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S1	24"	W14x43	25.0'	10'-0"	18'-0"	30'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S2	24"	W14x74	25.0'	15'-0"	12'-0"	31'-8"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S3	24"	W14x68	25.0'	15'-0"	12'-0"	27'-3"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S4	24"	W14x48	25.0'	17'-0"	10'-0"	28'-4"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S5	24"	W12x14	25.0'	10'-0"	6'-0"	19'-6"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE

TIEBACK SCHEDULE

TIEBACK MARK	ELEV.	F (k)	B (ft)	A (ft)	L (ft)	NOTES
T1	36.0'	23.0k	8.6'	9.2'	17.8'	PILE E1
T2	36.0'	45.8k	9.8'	18.3'	28.1'	PILE E2 - E8
T3	36.0'	51.3k	9.8'	20.5'	30.3'	PILE E9
T4	36.0'	63.8k	9.8'	25.5'	35.3'	PILE E10
T5	36.0'	79.4k	9.8'	31.8'	41.6'	PILE E11
T6	36.0'	48.2k	9.8'	19.3'	29.1'	PILE E12
T7	38.0'	39.5k	10.4'	15.8'	26.2'	PILE S1

SHORING DESIGN FOR LOAD CASE WITH SOIL LOAD AND TRAFFIC SURCHARGE

**Lundin Residence Shoring
Pile E1**



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 4.0 foot or meter

User Input Pile, W14X26: E (ksi)=29000.0, I (in⁴)/pile=245.0

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SHORING WALL CALCULATION SUMMARY
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The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile E1

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 14.70
 Pile Diameter: 2.00
 Pile Spacing: 4.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 3. Tieback
 Top Brace Increase (Multi-Bracing): Add 15%*
 Brace Position (One Brace Case): Normal Brace*
 No-Load Zone:
 Vertical Depth for No-Load Zone: 14.70
 H-Distance (Input H/V ratio) for No-Load Zone: 0.25
 Angle from H. Line for No-Load Zone: 60.00
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Check Vertical Bearing Capacity:
 Side Friction for Bearing: 1.00
 Tip Resistance for Bearing: 15.00
 Pile Properties:
 Steel Strength, Fy: 65 ksi = 448 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 245.00
 User Input Pile: W14X26

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	14.7	0.735	.05

2 0 .08 0.080

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	16.7	.6	34.7	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	4.00
2	14.70	2.00

* PASSIVE SPACE *

No.	Z depth	Spacing
1	14.70	4.00

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

No.	Z brace	Angle	Spacing	Input1*	Input2*
1	4.00	25.0	4.00	0.50	1.60

Type Tieback

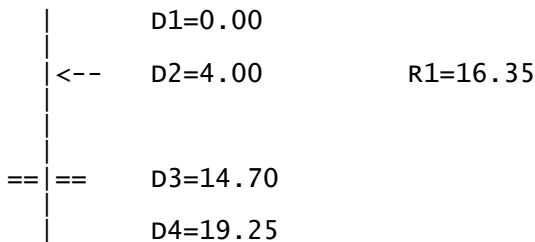
*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

NUMBER OF BRACE LEVEL = 1



D1 - TOP DEPTH
 D2 - BRACE DEPTH R1 - REACTION
 D3 - EXCAVATION BASE
 D4 - PILE TIP

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TOTAL REACTION: R1 = 16.35
TOTAL PRESSURES ACTING ON WALL = 16.35
Total Reactions = Total Pressures, OK!

BRACE NO.1 AT DEPTH = 4.00
R1 = Brace Load = 16.35

*****RESULTS*****

* EMBEDMENT *

MINIMUM EMBEDMENT = 4.55 (5~10ft recommended!!!), TOTAL MINIMUM PILE LENGTH = 19.25

* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

No.	Depth	M @ Brace	Mmax in Span	Depth of Mmax
1	4.00	4.65	50.80	11.29

Overall Maximum Moment = 50.80 at 11.29

Maximum Shear = 13.46

Moment and Shear are per pile spacing: 4.0 foot or meter

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

The calculated brace force are per brace spacing.

No.	DEPTH	Tangle	SPACING	HORIZONTAL	VERTICAL
1	4.00	25.0	4.00	16.35	7.62
18.04					

No.	DEPTH	Free length	Brace Type
1	4.00	8.57	Tieback, Bond length = 7.18

* VERTICAL LOADING *

Vertical Loading from Braces = 7.62

Vertical Loading from External Load = 0.00

Total Vertical Loading = 7.62

* VERTICAL BEARING CAPACITY CHECK (Option 1, Not including side area above base) *

Tip area + Total side area of embedment below base only.

Tip Depth	Tip Area*	Bearing	Tip Resistance
19.25	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
4.55	28.58	1.00	28.58

*Total side area is the surface area of embedment below base only.

Total Vertical Resistance = 75.70

Total Vertical Loading = 7.62

Vertical Factor of Safety = 9.93

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* VERTICAL BEARING CAPACITY CHECK (Option 2, including side area above base) *
Tip area + Total side area of embedment below base + Back side between pile and soil above base.

Tip Depth	Tip Area*	Bearing	Tip Resistance
19.25	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
4.55	74.76	1.00	74.76

*Total side area is the surface area of embedment below base and back side between pile and soil above base.

Total Vertical Resistance = 121.89

Total Vertical Loading = 7.62

Vertical Factor of Safety = 15.99

*****SPECIFIED PILE *****

Overall Maximum Moment = 50.80 at 11.29

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 14.21 in³/pile = 232.85 cm³/pile, Fy= 65 ksi = 448 MPa, Fb/Fy=0.66

W14X26 has been found in soldier pile list!

(English Units):

Area= 7.69 in. Depth= 13.9 in. width= 5.03 in. Height= 14 in.

Flange thickness= 0.42 in. Web thickness= 0.255 in.

Ix= 245 in⁴/pile Sx= 35.3 in³/pile Iy= 8.91 in⁴/pile Sy= 3.55 in³/pile

(Metric Units):

Ix= 101.97 x100cm⁴/pile Sx= 578.46 cm³/pile Iy= 3.71 x100cm⁴/pile Sy= 58.17 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X26 is capable to support the shoring!

Top deflection = -0.213(in)

Max. deflection = 0.256(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.81

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.41

Pile Spacing =4.0, Max. Moment in lagging = 0.81

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.42

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.17

If 30% loading is used for lagging design, Design Pressure = 0.24

Pile Spacing =4.0, Max. Moment in lagging = 0.49

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending

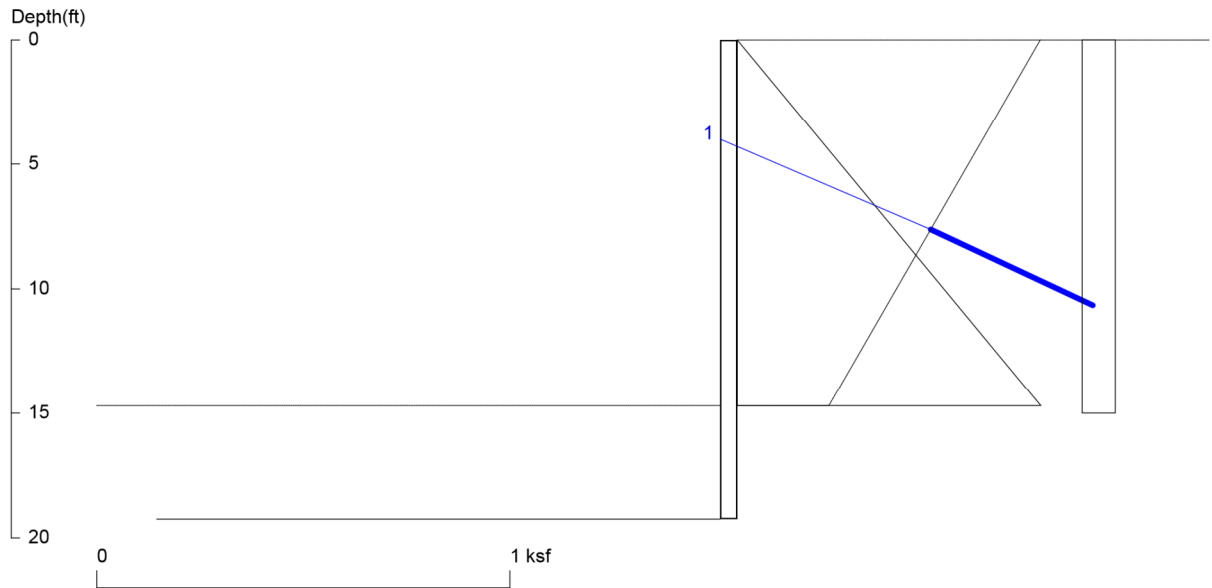
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strength, $fb=M/S=0.25$

For 6"x12" Timber, Section Modulus $S=57.98$ in³. The request allowable bending strength, $fb=M/S=0.10$

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile E1



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Wall Height=14.7 Pile Diameter=2.0 Pile Spacing=4.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=4.55 (5~10ft is recommended!!!) Min. Pile Length=19.25
MOMENT IN PILE: Max. Moment=50.80 per Pile Spacing=4.0 at Depth=11.29

VERTICAL BEARING CAPACITY: Vertical Loading=7.6, Resistance=121.9, Vertical Factor of Safety=15.99

PILE SELECTION:

Request Min. Section Modulus = 14.2 in³/pile=232.85 cm³/pile, F_y= 65 ksi = 448 MPa, F_b/F_y=0.66
W14X26 has Section Modulus = 35.3 in³/pile=578.46 cm³/pile. It is greater than Min. Requirements!
Top Deflection = -0.21(in) based on E (ksi)=29000.00 and I (in⁴)/pile=245.0

BRACE FORCE: Strut, Tieback, Plate Anchor, Deadman, Sheet Pile as Anchor

No. & Type	Depth	Angle	Space	Total F.	Horiz. F.	Vert. F.	L _{free}	Fixed Length
1. Tieback	4.0	25.0	4.0	18.0	16.3	7.6	8.6	7.2

UNITS: Width,Diameter,Spacing,Length,Depth,and Height - ft; Force - kip; Bond Strength and Pressure - ksf

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	14.7	0.735	.05
0	.08	15	0.080	

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
16.7	.6	34.7	6.000	.3

ACTIVE SPACING:

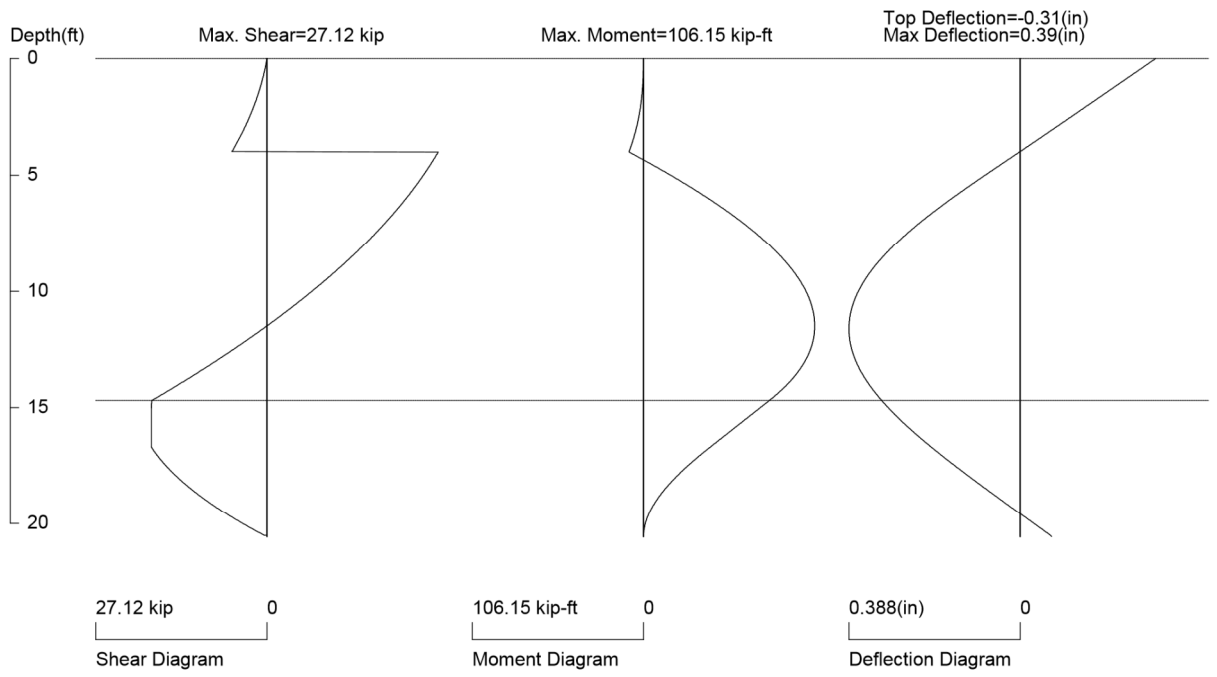
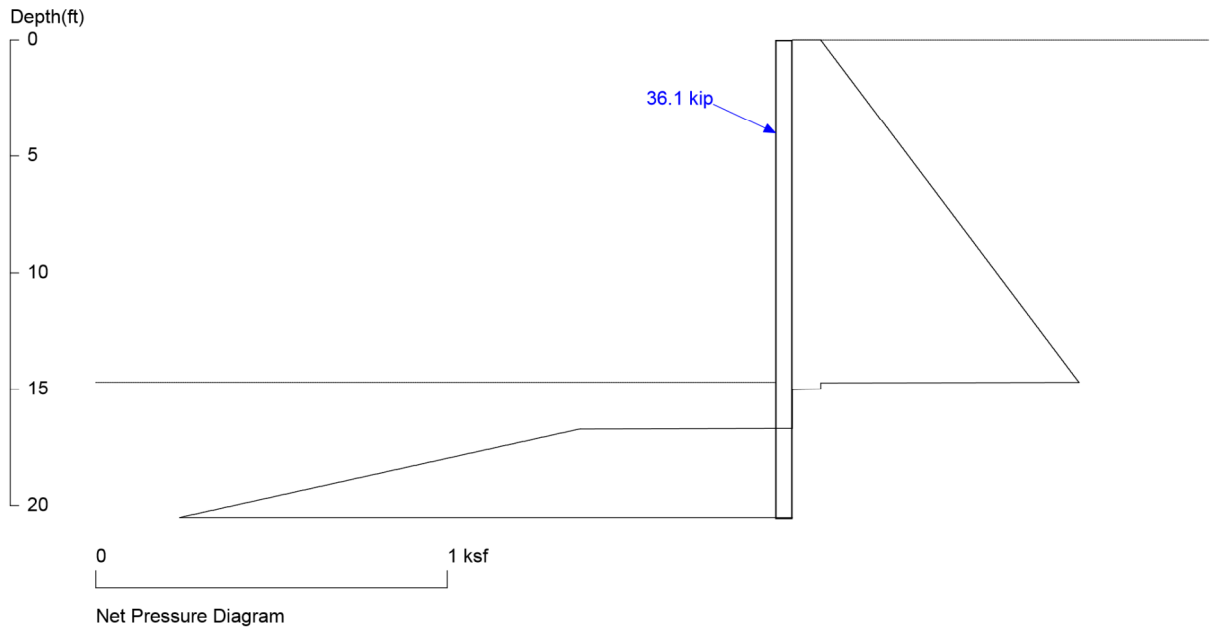
No.	Z depth	Spacing
1	0.00	4.00
2	14.70	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	14.70	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Piles E2 to E8



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.8 foot or meter

User Input Pile, W14X38: E (ksi)=29000.0, I (in⁴)/pile=385.0

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The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Residence\Calculations\Shoring\Pile E2 to E8.sh8

Title: Lundin Residence Shoring
Subtitle: Piles E2 to E8

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 14.70
 Pile Diameter: 2.00
 Pile Spacing: 7.75
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 3. Tieback
 Top Brace Increase (Multi-Bracing): Add 15%*
 Brace Position (One Brace Case): Normal Brace*
 No-Load Zone:
 Vertical Depth for No-Load Zone: 14.70
 H-Distance (Input H/V ratio) for No-Load Zone: 0.34
 Angle from H. Line for No-Load Zone: 60.00
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Check Vertical Bearing Capacity:
 Side Friction for Bearing: 1.00
 Tip Resistance for Bearing: 15.00
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 385.00
 User Input Pile: W14X38

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	14.7	0.735	.05

2 0 .08 0.080

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	16.7	.6	34.7	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.75
2	14.70	2.00

* PASSIVE SPACE *

No.	Z depth	Spacing
1	14.70	4.00

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

No.	Z brace	Angle	Spacing	Input1*	Input2*
1	4.00	25.0	7.75	0.50	1.60

Type
Tieback

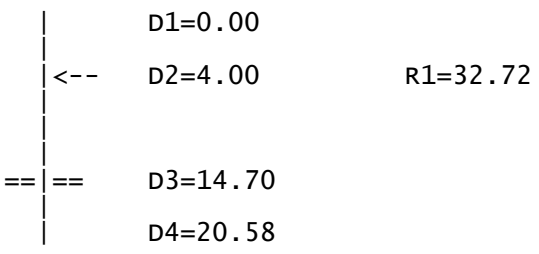
*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

NUMBER OF BRACE LEVEL = 1



D1 - TOP DEPTH
 D2 - BRACE DEPTH R1 - REACTION
 D3 - EXCAVATION BASE
 D4 - PILE TIP

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TOTAL REACTION: R1 = 32.72
TOTAL PRESSURES ACTING ON WALL = 32.72
Total Reactions = Total Pressures, OK!

BRACE NO.1 AT DEPTH = 4.00
R1 = Brace Load = 32.72

*****RESULTS*****

* EMBEDMENT *

MINIMUM EMBEDMENT = 5.88, TOTAL MINIMUM PILE LENGTH = 20.58

* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

No.	Depth	M @ Brace	Mmax in Span	Depth of Mmax
1	4.00	9.00	106.15	11.49

Overall Maximum Moment = 106.15 at 11.49

Maximum Shear = 27.12

Moment and Shear are per pile spacing: 7.8 foot or meter

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

The calculated brace force are per brace spacing.

No.	DEPTH	Tangle	SPACING	HORIZONTAL	VERTICAL
1	4.00	25.0	7.75	32.72	15.26
36.10					

No.	DEPTH	Free length	Brace Type
1	4.00	9.72	Tieback, Bond length = 14.36

* VERTICAL LOADING *

Vertical Loading from Braces = 15.26

Vertical Loading from External Load = 0.00

Total Vertical Loading = 15.26

* VERTICAL BEARING CAPACITY CHECK (Option 1, Not including side area above base) *

Tip area + Total side area of embedment below base only.

Tip Depth	Tip Area*	Bearing	Tip Resistance
20.58	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
5.88	36.92	1.00	36.92

*Total side area is the surface area of embedment below base only.

Total Vertical Resistance = 84.04

Total Vertical Loading = 15.26

Vertical Factor of Safety = 5.51

* VERTICAL BEARING CAPACITY CHECK (Option 2, including side area above base) *
 Tip area + Total side area of embedment below base + Back side between pile and soil above base.

Tip Depth	Tip Area*	Bearing	Tip Resistance
20.58	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
5.88	83.10	1.00	83.10

*Total side area is the surface area of embedment below base and back side between pile and soil above base.

Total Vertical Resistance = 130.22
 Total Vertical Loading = 15.26
 Vertical Factor of Safety = 8.54

*****SPECIFIED PILE *****

Overall Maximum Moment = 106.15 at 11.49
 The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 38.60 in³/pile = 632.55 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X38 has been found in soldier pile list!
 (English Units):
 Area= 11.2 in. Depth= 14.1 in. width= 6.77 in. Height= 14 in.
 Flange thickness= 0.515 in. web thickness= 0.31 in.
 Ix= 385 in⁴/pile Sx= 54.6 in³/pile Iy= 26.7 in⁴/pile Sy= 7.88 in³/pile
 (Metric Units):
 Ix= 160.24 x100cm⁴/pile Sx= 894.73 cm³/pile Iy= 11.11 x100cm⁴/pile Sy= 129.13 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X38 is capable to support the shoring!
 Top deflection = -0.307(in)
 Max. deflection = 0.388(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.81
 Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.
 If 50% loading is used for lagging design, Design Pressure = 0.41
 Pile Spacing =7.8, Max. Moment in lagging = 3.06
 For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=1.56
 For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.63

If 30% loading is used for lagging design, Design Pressure = 0.24
 Pile Spacing =7.8, Max. Moment in lagging = 1.84
 For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending

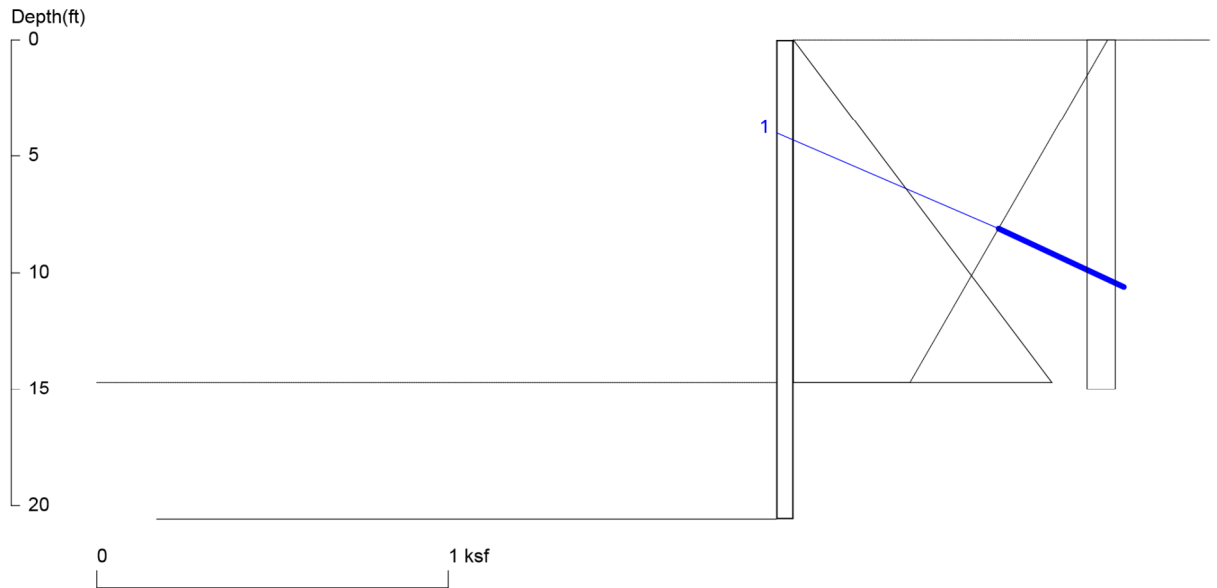
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strength, $fb=M/S=0.94$

For 6"x12" Timber, Section Modules $S=57.98$ in³. The request allowable bending strength, $fb=M/S=0.38$

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Piles E2 to E8



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Wall Height=14.7 Pile Diameter=2.0 Pile Spacing=7.8 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=5.88 Min. Pile Length=20.58
MOMENT IN PILE: Max. Moment=106.15 per Pile Spacing=7.8 at Depth=11.49

VERTICAL BEARING CAPACITY: Vertical Loading=15.3, Resistance=130.2, Vertical Factor of Safety=8.54

PILE SELECTION:

Request Min. Section Modulus = 38.6 in³/pile=632.55 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66
W14X38 has Section Modulus = 54.6 in³/pile=894.73 cm³/pile. It is greater than Min. Requirements!
Top Deflection = -0.31(in) based on E (ksi)=29000.00 and I (in⁴)/pile=385.0

BRACE FORCE: Strut, Tieback, Plate Anchor, Deadman, Sheet Pile as Anchor

No. & Type	Depth	Angle	Space	Total F.	Horiz. F.	Vert. F.	L_free	Fixed Length
1. Tieback	4.0	25.0	7.8	36.1	32.7	15.3	9.7	14.4

UNITS: Width,Diameter,Spacing,Length,Depth,and Height - ft; Force - kip; Bond Strength and Pressure - ksf

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	14.7	0.735	.05
0	.08	15	0.080	

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
16.7	.6	34.7	6.000	.3

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	7.75
2	14.70	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	14.70	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

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SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software
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ShoringSuite Software is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Date: 12/18/2018 File: M:\Stuart Silk\18689 - Lundin
Residence\Calculations\Shoring\Pile E9.sh8

Title: Lundin Residence Shoring
Subtitle: Pile E9

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 15.50
 Pile Diameter: 2.00
 Pile Spacing: 7.75
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 3. Tieback
 Top Brace Increase (Multi-Bracing): Add 15%*
 Brace Position (One Brace Case): Normal Brace*
 No-Load Zone:
 Vertical Depth for No-Load Zone: 15.50
 H-Distance (Input H/V ratio) for No-Load Zone: 0.32
 Angle from H. Line for No-Load Zone: 60.00
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Check Vertical Bearing Capacity:
 Side Friction for Bearing: 1.00
 Tip Resistance for Bearing: 15.00
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 428.00
 User Input Pile: W14X43

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	15.5	0.775	.05

2	0	.08	report.out 15.5	0.080
---	---	-----	--------------------	-------

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	17.5	.6	35.5	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.75
2	15.50	2.00

* PASSIVE SPACE *

No.	Z depth	Spacing
1	15.50	4.00

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

No.	Z brace	Angle	Spacing	Input1*	Input2*
1	4.50	25.0	7.75	0.50	1.60

Type Tieback

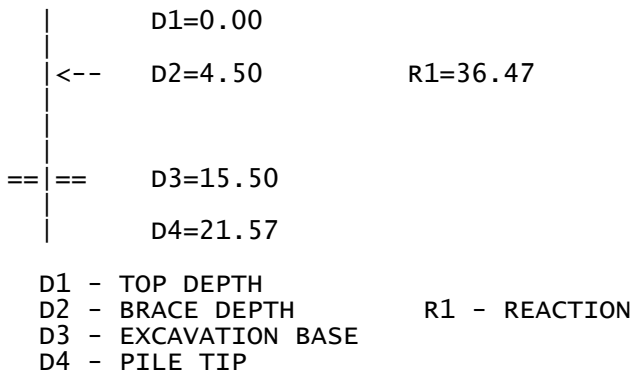
*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

NUMBER OF BRACE LEVEL = 1



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TOTAL REACTION: R1 = 36.47
TOTAL PRESSURES ACTING ON WALL = 36.47
Total Reactions = Total Pressures, OK!

BRACE NO.1 AT DEPTH = 4.50
R1 = Brace Load = 36.47

*****RESULTS*****

* EMBEDMENT *

MINIMUM EMBEDMENT = 6.07, TOTAL MINIMUM PILE LENGTH = 21.57

* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

No.	Depth	M @ Brace	Mmax in Span	Depth of Mmax
1	4.50	12.08	117.39	12.21

Overall Maximum Moment = 117.39 at 12.21

Maximum Shear = 29.73

Moment and Shear are per pile spacing: 7.8 foot or meter

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

The calculated brace force are per brace spacing.

No.	DEPTH	Tangle	SPACING	HORIZONTAL	VERTICAL
1	4.50	25.0	7.75	36.47	17.01
40.24					

No.	DEPTH	Free length	Brace Type
1	4.50	9.83	Tieback, Bond length = 16.01

* VERTICAL LOADING *

Vertical Loading from Braces = 17.01

Vertical Loading from External Load = 0.00

Total Vertical Loading = 17.01

* VERTICAL BEARING CAPACITY CHECK (Option 1, Not including side area above base) *

Tip area + Total side area of embedment below base only.

Tip Depth	Tip Area*	Bearing	Tip Resistance
21.57	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
6.07	38.12	1.00	38.12

*Total side area is the surface area of embedment below base only.

Total Vertical Resistance = 85.25

Total Vertical Loading = 17.01

Vertical Factor of Safety = 5.01

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* VERTICAL BEARING CAPACITY CHECK (Option 2, including side area above base) *
Tip area + Total side area of embedment below base + Back side between pile and soil above base.

Tip Depth	Tip Area*	Bearing	Tip Resistance
21.57	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
6.07	86.82	1.00	86.82

*Total side area is the surface area of embedment below base and back side between pile and soil above base.

Total Vertical Resistance = 133.94

Total Vertical Loading = 17.01

Vertical Factor of Safety = 7.88

*****SPECIFIED PILE *****

Overall Maximum Moment = 117.39 at 12.21

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 42.69 in³/pile = 699.49 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X43 has been found in soldier pile list!

(English Units):

Area= 12.6 in. Depth= 13.7 in. width= 8 in. Height= 14 in.

Flange thickness= 0.53 in. Web thickness= 0.305 in.

Ix= 428 in⁴/pile Sx= 62.6 in³/pile Iy= 45.2 in⁴/pile Sy= 11.3 in³/pile

(Metric Units):

Ix= 178.13 x100cm⁴/pile Sx= 1025.83 cm³/pile Iy= 18.81 x100cm⁴/pile Sy= 185.17 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X43 is capable to support the shoring!

Top deflection = -0.350(in)

Max. deflection = 0.408(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.85

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.43

Pile Spacing =7.8, Max. Moment in lagging = 3.21

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=1.64

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.66

If 30% loading is used for lagging design, Design Pressure = 0.26

Pile Spacing =7.8, Max. Moment in lagging = 1.92

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending

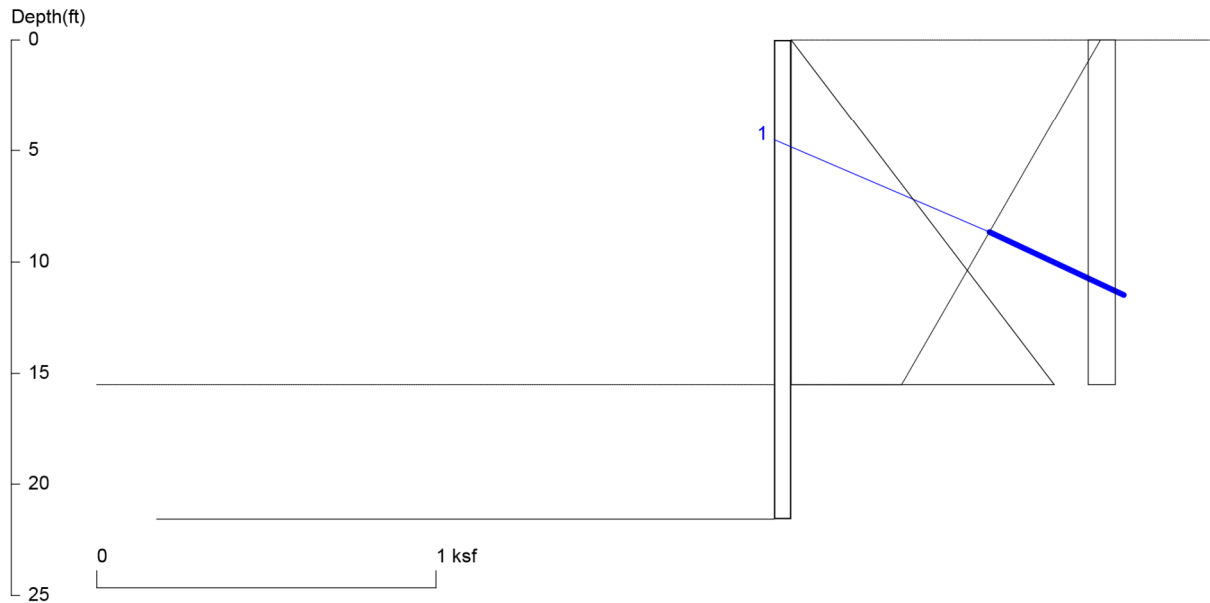
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strength, $fb=M/S=0.98$

For 6"x12" Timber, Section Modules $S=57.98$ in³. The request allowable bending strength, $fb=M/S=0.40$

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile E9



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Wall Height=15.5 Pile Diameter=2.0 Pile Spacing=7.8 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=6.07 Min. Pile Length=21.57
 MOMENT IN PILE: Max. Moment=117.39 per Pile Spacing=7.8 at Depth=12.21

VERTICAL BEARING CAPACITY: Vertical Loading=17.0, Resistance=133.9, Vertical Factor of Safety=7.88

PILE SELECTION:

Request Min. Section Modulus = 42.7 in³/pile=699.49 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X43 has Section Modulus = 62.6 in³/pile=1025.83 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = -0.35(in) based on E (ksi)=29000.00 and I (in⁴)/pile=428.0

BRACE FORCE: Strut, Tieback, Plate Anchor, Deadman, Sheet Pile as Anchor

No. & Type	Depth	Angle	Space	Total F.	Horiz. F.	Vert. F.	L _{free}	Fixed Length
1. Tieback	4.5	25.0	7.8	40.2	36.5	17.0	9.8	16.0

UNITS: Width,Diameter,Spacing,Length,Depth,and Height - ft; Force - kip; Bond Strength and Pressure - ksf

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	15.5	0.775	.05
0	.08	15.5	0.080	

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
17.5	.6	35.5	6.000	.3

ACTIVE SPACING:

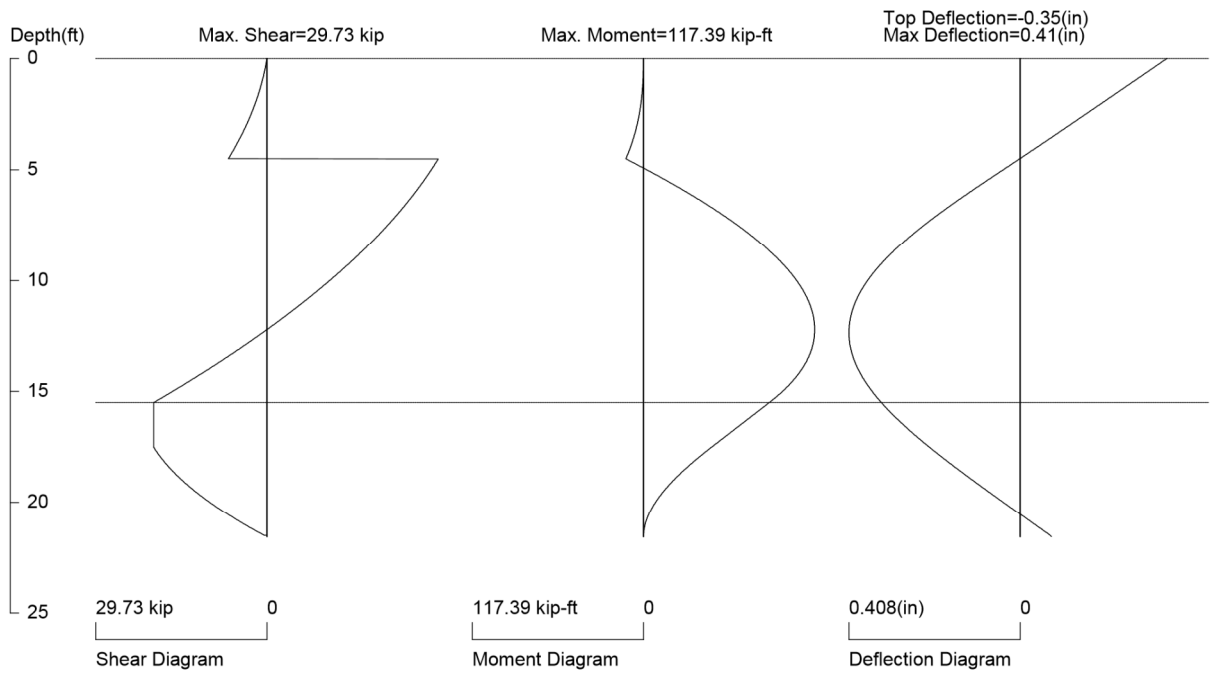
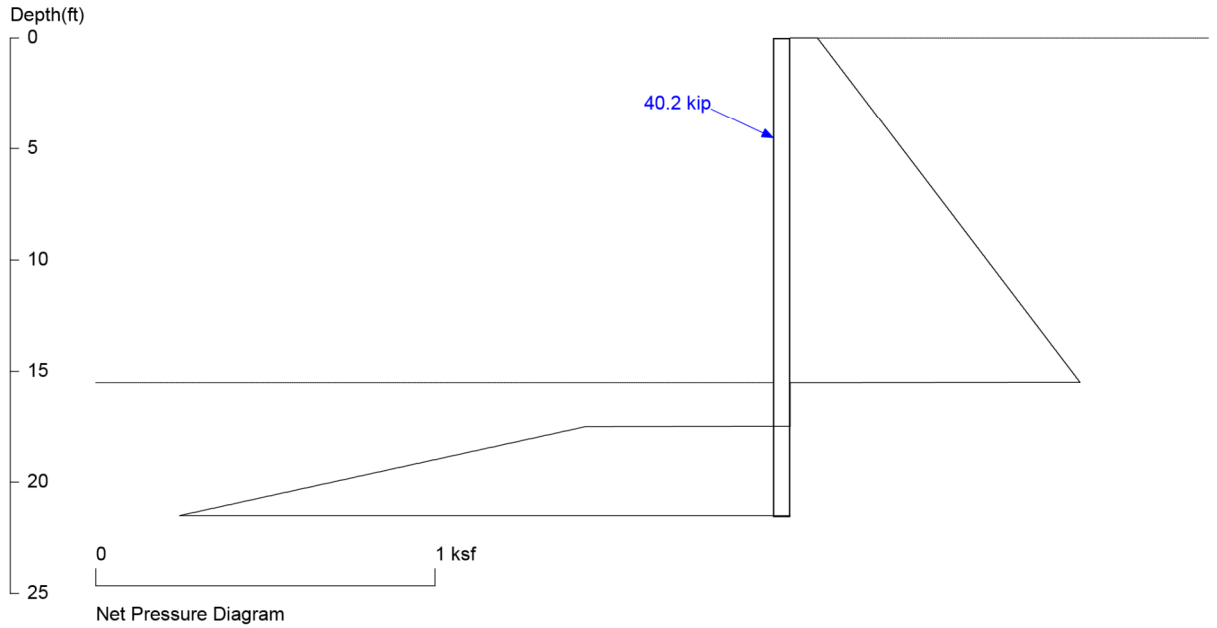
No.	Z depth	Spacing
1	0.00	7.75
2	15.50	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	15.50	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile E9



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.8 foot or meter

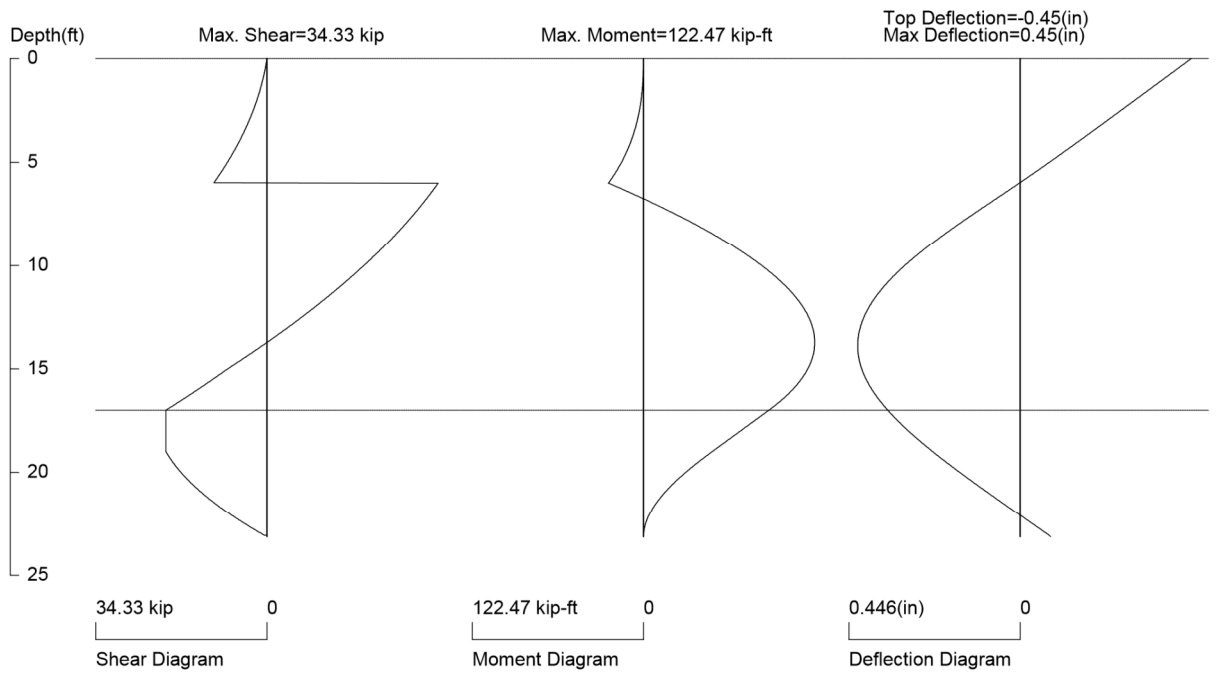
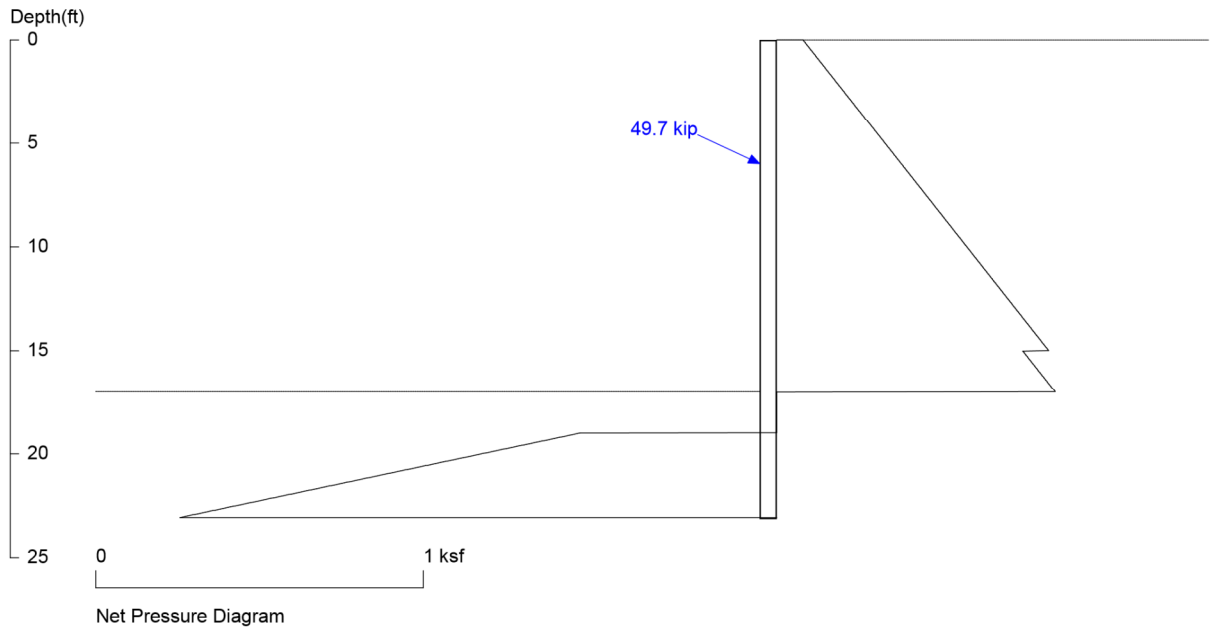
User Input Pile, W14X43: E (ksi)=29000.0, I (in⁴)/pile=428.0

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Lundin Residence Shoring Pile E10



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.8 foot or meter

User Input Pile, W14X43: E (ksi)=29000.0, I (in⁴)/pile=428.0

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5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Residence\Calculations\Shoring\Pile E10.sh8

Title: Lundin Residence Shoring
Subtitle: Pile E10

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 17.00
 Pile Diameter: 2.00
 Pile Spacing: 7.75
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 3. Tieback
 Top Brace Increase (Multi-Bracing): Add 15%*
 Brace Position (One Brace Case): Normal Brace*
 No-Load Zone:
 Vertical Depth for No-Load Zone: 17.00
 H-Distance (Input H/V ratio) for No-Load Zone: 0.29
 Angle from H. Line for No-Load Zone: 60.00
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Check Vertical Bearing Capacity:
 Side Friction for Bearing: 1.00
 Tip Resistance for Bearing: 15.00
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 428.00
 User Input Pile: W14X43

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	17	0.850	.05

2 0 .08 0.080

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	19	.6	37	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.75
2	17.00	2.00

* PASSIVE SPACE *

No.	Z depth	Spacing
1	17.00	4.00

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

No.	Z brace	Angle	Spacing	Input1*	Input2*
1 Tieback	6.00	25.0	7.75	0.50	1.60

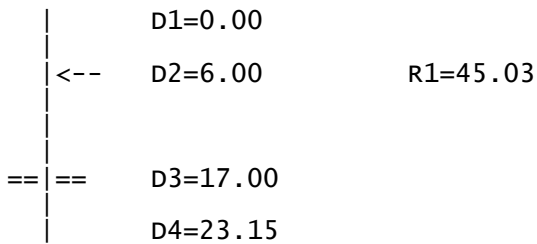
*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

NUMBER OF BRACE LEVEL = 1



D1 - TOP DEPTH
 D2 - BRACE DEPTH
 D3 - EXCAVATION BASE
 D4 - PILE TIP
 R1 - REACTION

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TOTAL REACTION: R1 = 45.03
TOTAL PRESSURES ACTING ON WALL = 45.03
Total Reactions = Total Pressures, OK!

BRACE NO.1 AT DEPTH = 6.00
R1 = Brace Load = 45.03

*****RESULTS*****

* EMBEDMENT *

MINIMUM EMBEDMENT = 6.15, TOTAL MINIMUM PILE LENGTH = 23.15

* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

No.	Depth	M @ Brace	Mmax in Span	Depth of Mmax
1	6.00	24.84	122.47	13.73

Overall Maximum Moment = 122.47 at 13.73

Maximum Shear = 34.33

Moment and Shear are per pile spacing: 7.8 foot or meter

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

The calculated brace force are per brace spacing.

No.	DEPTH	Tangle	SPACING	HORIZONTAL	VERTICAL
1	6.00	25.0	7.75	45.03	21.00

No.	DEPTH	Free length	Brace Type
1	6.00	9.81	Tieback, Bond length = 19.77

* VERTICAL LOADING *

Vertical Loading from Braces = 21.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 21.00

* VERTICAL BEARING CAPACITY CHECK (Option 1, Not including side area above base) *

Tip area + Total side area of embedment below base only.

Tip Depth	Tip Area*	Bearing	Tip Resistance
23.15	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
6.15	38.62	1.00	38.62

*Total side area is the surface area of embedment below base only.

Total Vertical Resistance = 85.74

Total Vertical Loading = 21.00

Vertical Factor of Safety = 4.08

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* VERTICAL BEARING CAPACITY CHECK (Option 2, including side area above base) *
Tip area + Total side area of embedment below base + Back side between pile and soil above base.

Tip Depth	Tip Area*	Bearing	Tip Resistance
23.15	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
6.15	92.02	1.00	92.02

*Total side area is the surface area of embedment below base and back side between pile and soil above base.

Total Vertical Resistance = 139.15

Total Vertical Loading = 21.00

Vertical Factor of Safety = 6.63

*****SPECIFIED PILE *****

Overall Maximum Moment = 122.47 at 13.73

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 44.54 in³/pile = 729.81 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X43 has been found in soldier pile list!

(English Units):

Area= 12.6 in. Depth= 13.7 in. width= 8 in. Height= 14 in.

Flange thickness= 0.53 in. Web thickness= 0.305 in.

Ix= 428 in⁴/pile Sx= 62.6 in³/pile Iy= 45.2 in⁴/pile Sy= 11.3 in³/pile

(Metric Units):

Ix= 178.13 x100cm⁴/pile Sx= 1025.83 cm³/pile Iy= 18.81 x100cm⁴/pile Sy= 185.17 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X43 is capable to support the shoring!

Top deflection = -0.446(in)

Max. deflection = 0.446(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.85

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.42

Pile Spacing =7.8, Max. Moment in lagging = 3.19

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=1.63

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.66

If 30% loading is used for lagging design, Design Pressure = 0.25

Pile Spacing =7.8, Max. Moment in lagging = 1.91

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending

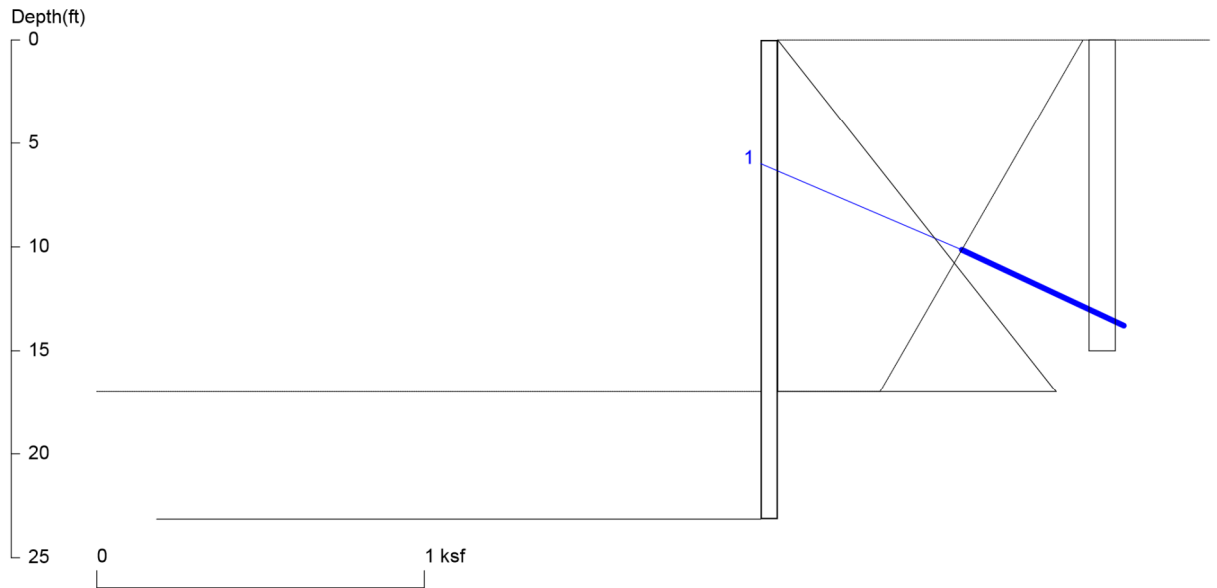
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strength, $fb=M/S=0.98$

For 6"x12" Timber, Section Modulus $S=57.98$ in³. The request allowable bending strength, $fb=M/S=0.40$

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile E10



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Wall Height=17.0 Pile Diameter=2.0 Pile Spacing=7.8 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=6.15 Min. Pile Length=23.15
 MOMENT IN PILE: Max. Moment=122.47 per Pile Spacing=7.8 at Depth=13.73

VERTICAL BEARING CAPACITY: Vertical Loading=21.0, Resistance=139.1, Vertical Factor of Safety=6.63

PILE SELECTION:

Request Min. Section Modulus = 44.5 in³/pile=729.81 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X43 has Section Modulus = 62.6 in³/pile=1025.83 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = -0.45(in) based on E (ksi)=29000.00 and I (in⁴)/pile=428.0

BRACE FORCE: Strut, Tieback, Plate Anchor, Deadman, Sheet Pile as Anchor

No. & Type	Depth	Angle	Space	Total F.	Horiz. F.	Vert. F.	L _{free}	Fixed Length
1. Tieback	6.0	25.0	7.8	49.7	45.0	21.0	9.8	19.8

UNITS: Width,Diameter,Spacing,Length,Depth,and Height - ft; Force - kip; Bond Strength and Pressure - ksf

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	17	0.850	.05
0	.08	15	0.080	

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
19	.6	37	6.000	.3

ACTIVE SPACING:

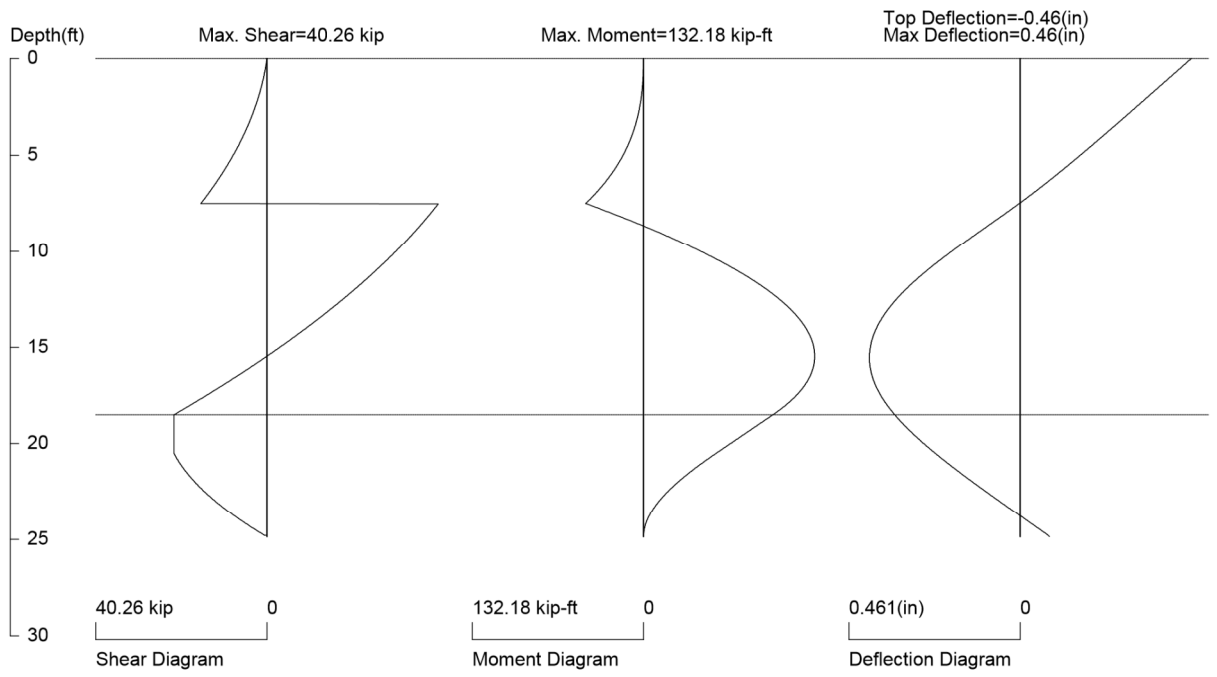
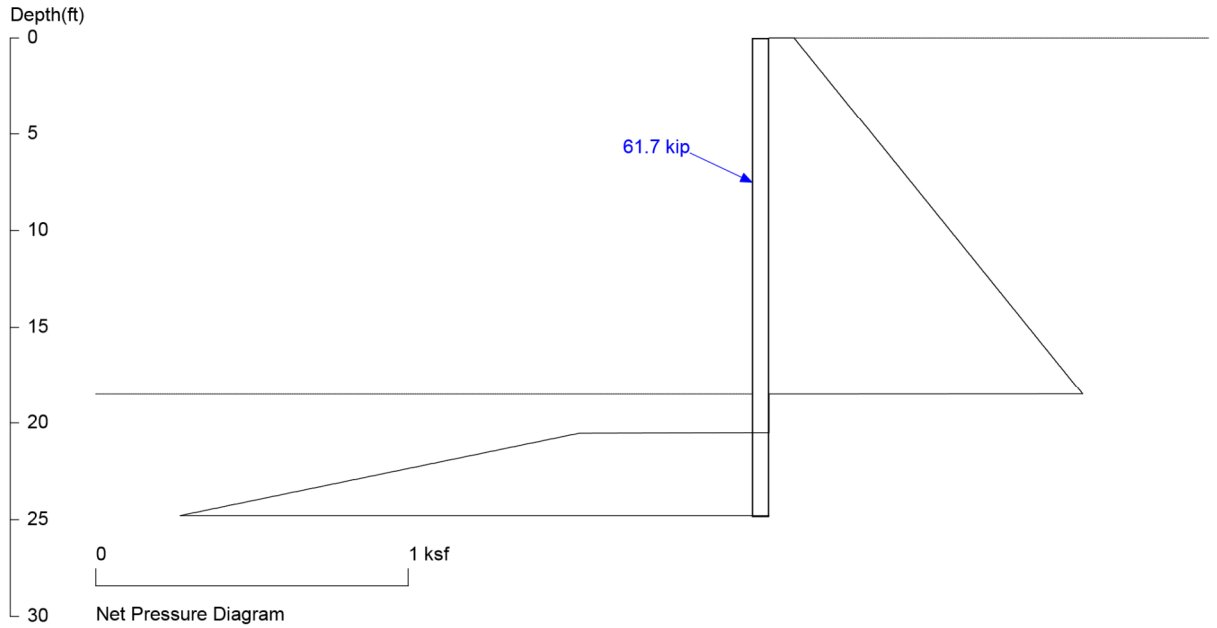
No.	Z depth	Spacing
1	0.00	7.75
2	17.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	17.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile E11



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.8 foot or meter

User Input Pile, W14X48: E (ksi)=29000.0, I (in⁴)/pile=484.0

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3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Residence\Calculations\Shoring\Pile E11.sh8

Title: Lundin Residence Shoring
Subtitle: Pile E11

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 18.50
 Pile Diameter: 2.00
 Pile Spacing: 7.75
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 3. Tieback
 Top Brace Increase (Multi-Bracing): Add 15%*
 Brace Position (One Brace Case): Normal Brace*
 No-Load Zone:
 Vertical Depth for No-Load Zone: 18.50
 H-Distance (Input H/V ratio) for No-Load Zone: 0.25
 Angle from H. Line for No-Load Zone: 60.00
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Check Vertical Bearing Capacity:
 Side Friction for Bearing: 1.00
 Tip Resistance for Bearing: 15.00
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 484.00
 User Input Pile: W14X48

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	18.5	0.925	.05

report.out
18.5

2 0 .08 0.080

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	20.5	.6	38.5	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.75
2	18.50	2.00

* PASSIVE SPACE *

No.	Z depth	Spacing
1	18.50	4.00

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

No.	Z brace	Angle	Spacing	Input1*	Input2*
1	7.50	25.0	7.75	0.50	1.60

Tieback

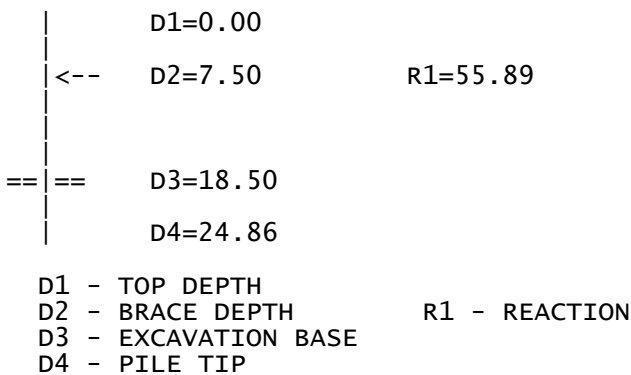
*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

NUMBER OF BRACE LEVEL = 1



report.out

TOTAL REACTION: R1 = 55.89
TOTAL PRESSURES ACTING ON WALL = 55.89
Total Reactions = Total Pressures, OK!

BRACE NO.1 AT DEPTH = 7.50
R1 = Brace Load = 55.89

*****RESULTS*****

* EMBEDMENT *

MINIMUM EMBEDMENT = 6.36, TOTAL MINIMUM PILE LENGTH = 24.86

* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

No.	Depth	M @ Brace	Mmax in Span	Depth of Mmax
1	7.50	44.19	132.18	15.46

Overall Maximum Moment = 132.18 at 15.46

Maximum Shear = 40.26

Moment and Shear are per pile spacing: 7.8 foot or meter

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

The calculated brace force are per brace spacing.

No.	DEPTH	Tangle	SPACING	HORIZONTAL	VERTICAL
1	7.50	25.0	7.75	55.89	26.06

No.	DEPTH	Free length	Brace Type
1	7.50	9.54	Tieback, Bond length = 24.54

* VERTICAL LOADING *

Vertical Loading from Braces = 26.06

Vertical Loading from External Load = 0.00

Total Vertical Loading = 26.06

* VERTICAL BEARING CAPACITY CHECK (Option 1, Not including side area above base) *

Tip area + Total side area of embedment below base only.

Tip Depth	Tip Area*	Bearing	Tip Resistance
24.86	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
6.36	39.98	1.00	39.98

*Total side area is the surface area of embedment below base only.

Total Vertical Resistance = 87.10

Total Vertical Loading = 26.06

Vertical Factor of Safety = 3.34

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* VERTICAL BEARING CAPACITY CHECK (Option 2, including side area above base) *
Tip area + Total side area of embedment below base + Back side between pile and soil above base.

Tip Depth	Tip Area*	Bearing	Tip Resistance
24.86	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
6.36	98.09	1.00	98.09

*Total side area is the surface area of embedment below base and back side between pile and soil above base.

Total Vertical Resistance = 145.22

Total Vertical Loading = 26.06

Vertical Factor of Safety = 5.57

*****SPECIFIED PILE *****

Overall Maximum Moment = 132.18 at 15.46

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 48.06 in³/pile = 787.64 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X48 has been found in soldier pile list!

(English Units):

Area= 14.1 in. Depth= 13.8 in. width= 8.03 in. Height= 14 in.

Flange thickness= 0.595 in. Web thickness= 0.34 in.

Ix= 484 in⁴/pile Sx= 70.2 in³/pile Iy= 51.4 in⁴/pile Sy= 12.8 in³/pile

(Metric Units):

Ix= 201.44 x100cm⁴/pile Sx= 1150.37 cm³/pile Iy= 21.39 x100cm⁴/pile Sy= 209.75 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X48 is capable to support the shoring!

Top deflection = -0.461(in)

Max. deflection = 0.461(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 1.00

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.50

Pile Spacing =7.8, Max. Moment in lagging = 3.77

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=1.93

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.78

If 30% loading is used for lagging design, Design Pressure = 0.30

Pile Spacing =7.8, Max. Moment in lagging = 2.26

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending

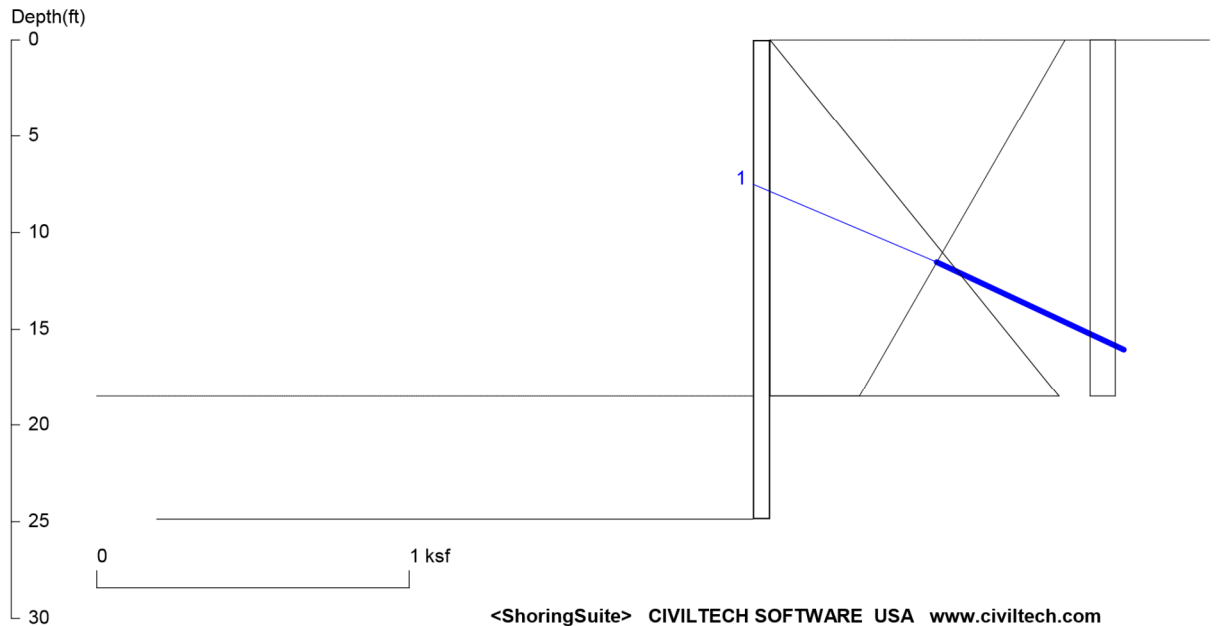
report.out

strength, $fb=M/S=1.16$

For 6"x12" Timber, Section Modulus $S=57.98$ in³. The request allowable bending strength, $fb=M/S=0.47$

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile E11



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Wall Height=18.5 Pile Diameter=2.0 Pile Spacing=7.8 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=6.36 Min. Pile Length=24.86
 MOMENT IN PILE: Max. Moment=132.18 per Pile Spacing=7.8 at Depth=15.46

VERTICAL BEARING CAPACITY: Vertical Loading=26.1, Resistance=145.2, Vertical Factor of Safety=5.57

PILE SELECTION:

Request Min. Section Modulus = 48.1 in³/pile=787.64 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X48 has Section Modulus = 70.2 in³/pile=1150.37 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = -0.46(in) based on E (ksi)=29000.00 and I (in⁴)/pile=484.0

BRACE FORCE: Strut, Tieback, Plate Anchor, Deadman, Sheet Pile as Anchor

No. & Type	Depth	Angle	Space	Total F.	Horiz. F.	Vert. F.	L _{free}	Fixed Length
1. Tieback	7.5	25.0	7.8	61.7	55.9	26.1	9.5	24.5

UNITS: Width,Diameter,Spacing,Length,Depth,and Height - ft; Force - kip; Bond Strength and Pressure - ksf

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	18.5	0.925	.05
0	.08	18.5	0.080	

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
20.5	.6	38.5	6.000	.3

ACTIVE SPACING:

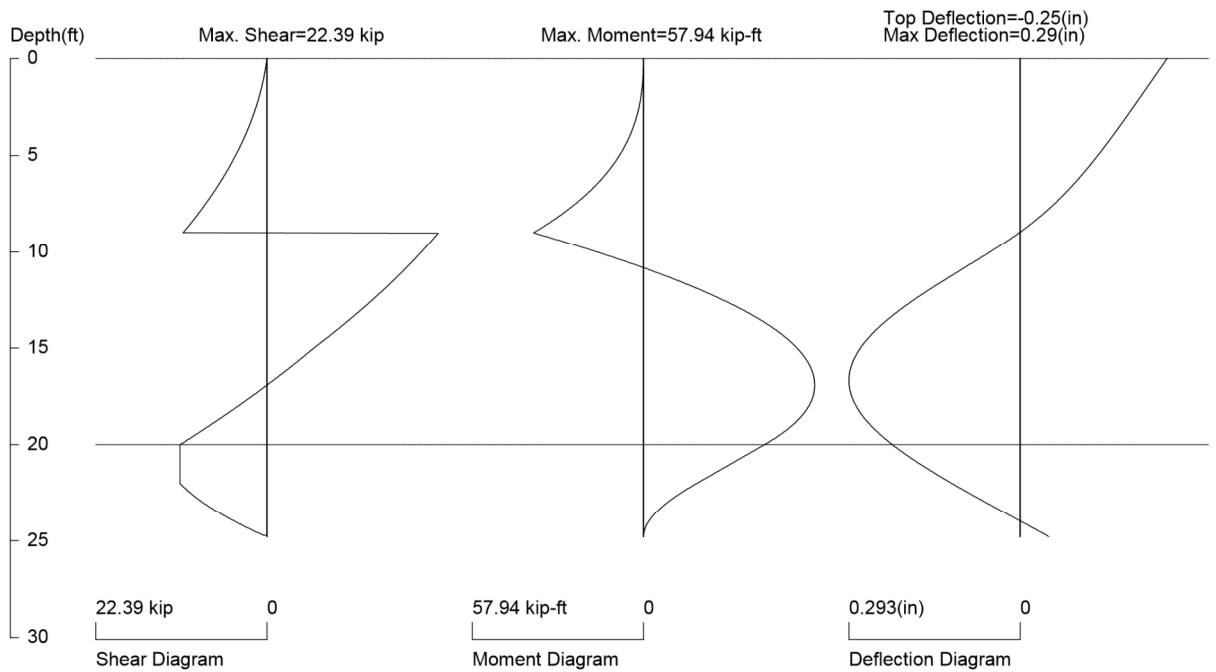
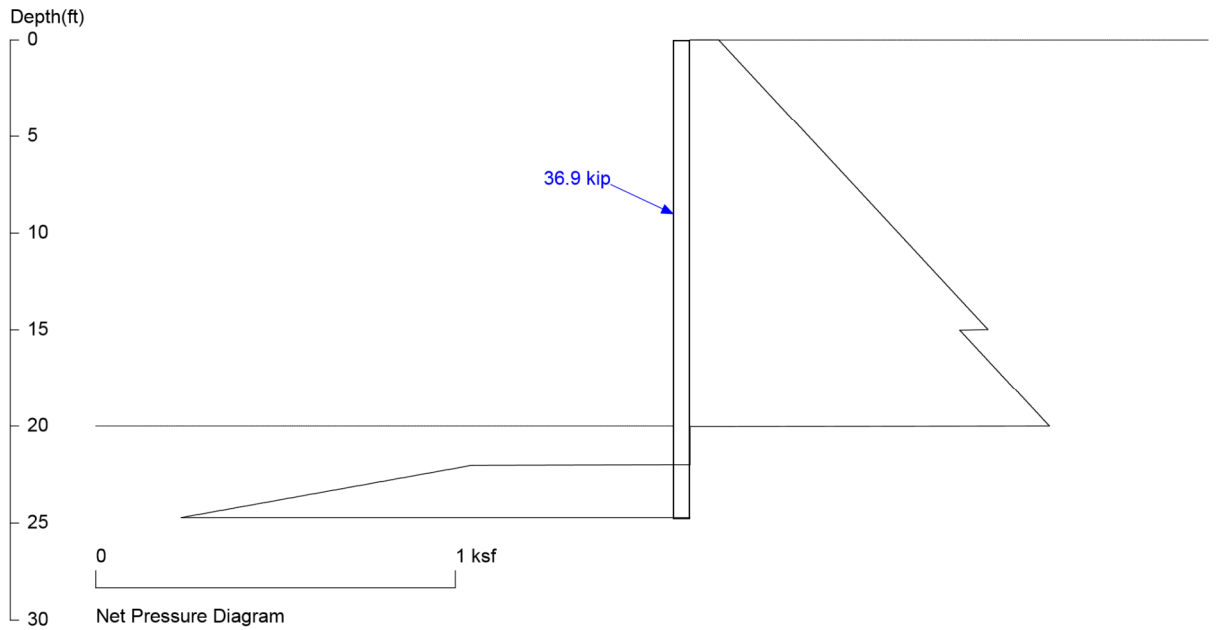
No.	Z depth	Spacing
1	0.00	7.75
2	18.50	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	18.50	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile E12



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 4.0 foot or meter

User Input Pile, W14X26: E (ksi)=29000.0, I (in⁴)/pile=245.0

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SHORING WALL CALCULATION SUMMARY
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ShoringSuite Software is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile E12

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 20.00
 Pile Diameter: 2.00
 Pile Spacing: 4.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 3. Tieback
 Top Brace Increase (Multi-Bracing): Add 15%*
 Brace Position (One Brace Case): Normal Brace*
 No-Load Zone:
 Vertical Depth for No-Load Zone: 20.00
 H-Distance (Input H/V ratio) for No-Load Zone: 0.25
 Angle from H. Line for No-Load Zone: 60.00
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Check Vertical Bearing Capacity:
 Side Friction for Bearing: 1.00
 Tip Resistance for Bearing: 15.00
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 245.00
 User Input Pile: W14X26

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	20	1.000	.05

2 0 .08 0.080

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	22	.6	40	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	4.00
2	20.00	2.00

* PASSIVE SPACE *

No.	Z depth	Spacing
1	20.00	4.00

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

No.	Z brace	Angle	Spacing	Input1*	Input2*
1	9.00	25.0	4.00	0.50	1.60

Type Tieback

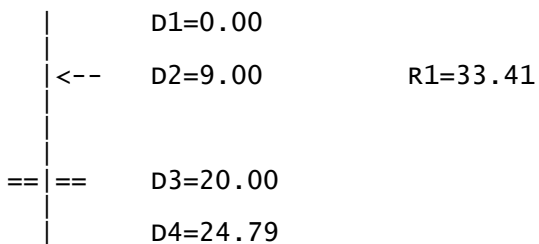
*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

NUMBER OF BRACE LEVEL = 1



D1 - TOP DEPTH
 D2 - BRACE DEPTH R1 - REACTION
 D3 - EXCAVATION BASE
 D4 - PILE TIP

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TOTAL REACTION: R1 = 33.41
TOTAL PRESSURES ACTING ON WALL = 33.41
Total Reactions = Total Pressures, OK!

BRACE NO.1 AT DEPTH = 9.00
R1 = Brace Load = 33.41

*****RESULTS*****

* EMBEDMENT *
MINIMUM EMBEDMENT = 4.79 (5~10ft recommended!!!), TOTAL MINIMUM PILE LENGTH = 24.79

* MOMENT IN PILE (per pile spacing)*
Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.
No. Depth M @ Brace Mmax in Span Depth of Mmax

No.	Depth	M @ Brace	Mmax in Span	Depth of Mmax
1	9.00	36.88	57.94	16.91

Overall Maximum Moment = 57.94 at 16.91
Maximum Shear = 22.39
Moment and Shear are per pile spacing: 4.0 foot or meter

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*
The calculated brace force are per brace spacing.

No.	DEPTH	Tangle	SPACING	HORIZONTAL	VERTICAL
1	9.00	25.0	4.00	33.41	15.58

No.	DEPTH	Free length	Brace Type
1	9.00	9.87	Tieback, Bond length = 14.67

* VERTICAL LOADING *
Vertical Loading from Braces = 15.58
Vertical Loading from External Load = 0.00
Total Vertical Loading = 15.58

* VERTICAL BEARING CAPACITY CHECK (Option 1, Not including side area above base) *
Tip area + Total side area of embedment below base only.

Tip Depth	Tip Area*	Bearing	Tip Resistance
24.79	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
4.79	30.12	1.00	30.12

*Total side area is the surface area of embedment below base only.

Total Vertical Resistance = 77.24
Total Vertical Loading = 15.58
Vertical Factor of Safety = 4.96

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* VERTICAL BEARING CAPACITY CHECK (Option 2, including side area above base) *
Tip area + Total side area of embedment below base + Back side between pile and soil above base.

Tip Depth	Tip Area*	Bearing	Tip Resistance
24.79	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
4.79	92.95	1.00	92.95

*Total side area is the surface area of embedment below base and back side between pile and soil above base.

Total Vertical Resistance = 140.08

Total Vertical Loading = 15.58

Vertical Factor of Safety = 8.99

*****SPECIFIED PILE *****

Overall Maximum Moment = 57.94 at 16.91

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 21.07 in³/pile = 345.27 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X26 has been found in soldier pile list!

(English Units):

Area= 7.69 in. Depth= 13.9 in. width= 5.03 in. Height= 14 in.

Flange thickness= 0.42 in. Web thickness= 0.255 in.

Ix= 245 in⁴/pile Sx= 35.3 in³/pile Iy= 8.91 in⁴/pile Sy= 3.55 in³/pile

(Metric Units):

Ix= 101.97 x100cm⁴/pile Sx= 578.46 cm³/pile Iy= 3.71 x100cm⁴/pile Sy= 58.17 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X26 is capable to support the shoring!

Top deflection = -0.251(in)

Max. deflection = 0.293(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 1.00

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.50

Pile Spacing =4.0, Max. Moment in lagging = 1.00

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.51

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.21

If 30% loading is used for lagging design, Design Pressure = 0.30

Pile Spacing =4.0, Max. Moment in lagging = 0.60

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending

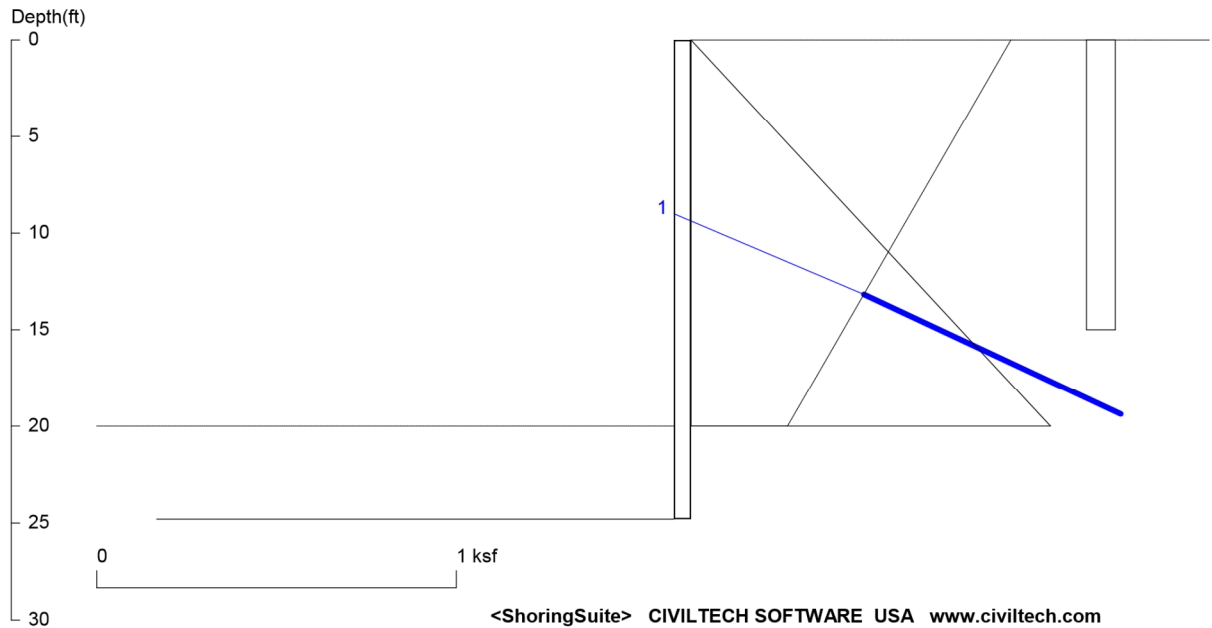
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strength, $fb=M/S=0.31$

For 6"x12" Timber, Section Modulus $S=57.98$ in³. The request allowable bending strength, $fb=M/S=0.12$

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile E12



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Wall Height=20.0 Pile Diameter=2.0 Pile Spacing=4.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=4.79 (5~10ft is recommended!!!) Min. Pile Length=24.79
 MOMENT IN PILE: Max. Moment=57.94 per Pile Spacing=4.0 at Depth=16.91

VERTICAL BEARING CAPACITY: Vertical Loading=15.6, Resistance=140.1, Vertical Factor of Safety=8.99

PILE SELECTION:

Request Min. Section Modulus = 21.1 in³/pile=345.27 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X26 has Section Modulus = 35.3 in³/pile=578.46 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = -0.25(in) based on E (ksi)=29000.00 and I (in⁴)/pile=245.0

BRACE FORCE: Strut, Tieback, Plate Anchor, Deadman, Sheet Pile as Anchor

No. & Type	Depth	Angle	Space	Total F.	Horiz. F.	Vert. F.	L _{free}	Fixed Length
1. Tieback	9.0	25.0	4.0	36.9	33.4	15.6	9.9	14.7

UNITS: Width,Diameter,Spacing,Length,Depth,and Height - ft; Force - kip; Bond Strength and Pressure - ksf

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	20	1.000	.05
0	.08	15	0.080	

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
22	.6	40	6.000	.3

ACTIVE SPACING:

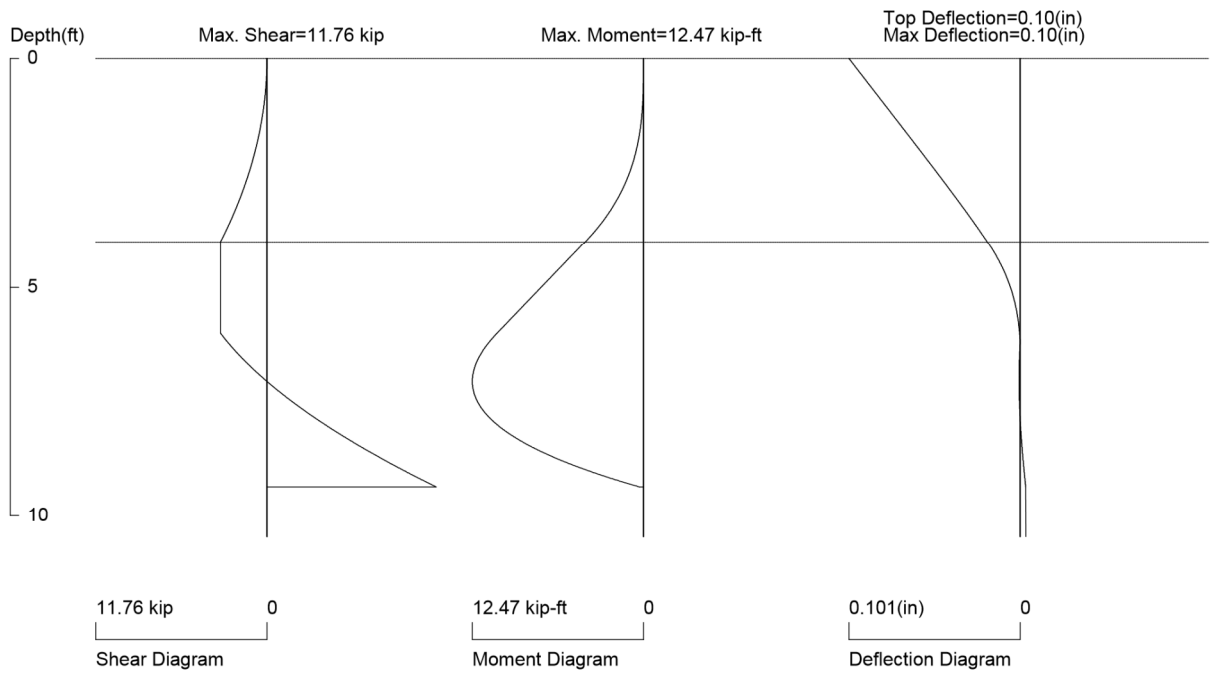
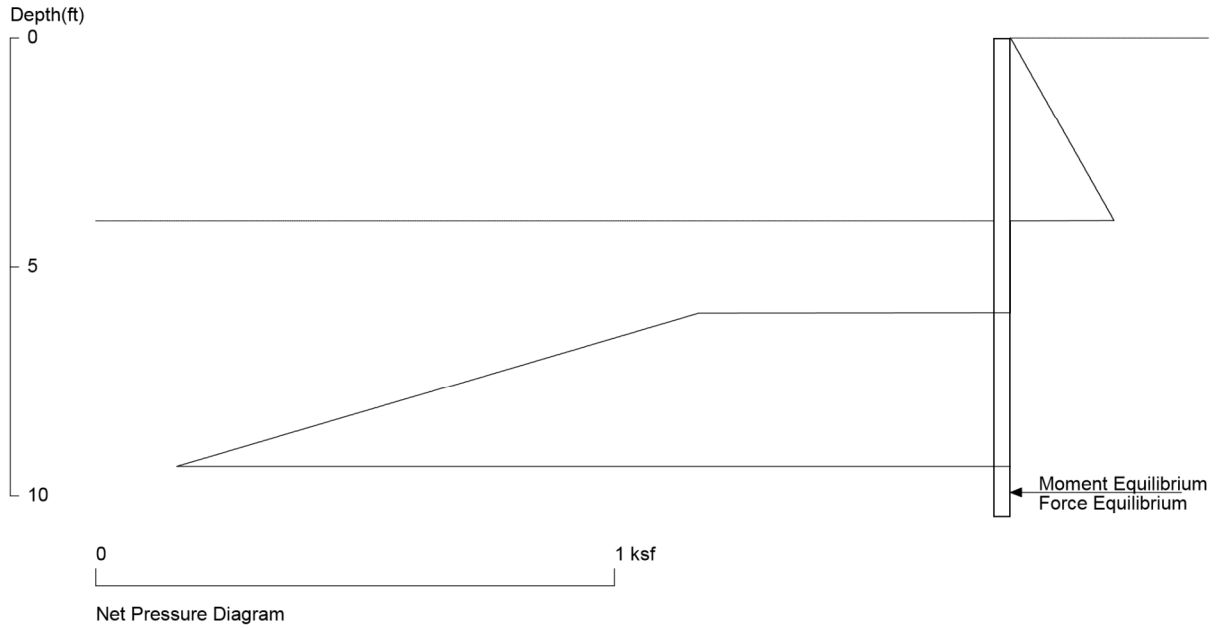
No.	Z depth	Spacing
1	0.00	4.00
2	20.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	20.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile N1



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 8.0 foot or meter

User Input Pile, W12X14: E (ksi)=29000.0, I (in⁴)/pile=88.6

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SHORING WALL CALCULATION SUMMARY
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ShoringSuite Software is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
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7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Residence\Calculations\Shoring\Pile N1.sh8

Title: Lundin Residence Shoring
Subtitle: Pile N1

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 4.00
 Pile Diameter: 2.00
 Pile Spacing: 8.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 88.60
 User Input Pile: W12X14

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	4	0.200	.05

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	6	.6	24	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	8.00
2	4.00	2.00

* PASSIVE SPACE *

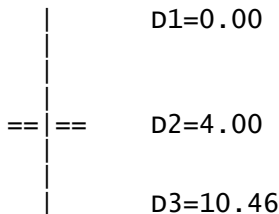
No.	Z depth	Spacing
1	4.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=9.38 WITH EMBEDMENT OF 5.38
 FORCE equilibrium AT DEPTH=10.46 WITH EMBEDMENT OF 6.46

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 5.38
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 6.46

Embedment Information:

If 20% increased, the total design embedment is 6.46
 If 30% increased, the total design embedment is 7.00
 If 40% increased, the total design embedment is 7.54
 If 50% increased, the total design embedment is 8.08

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* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 12.47 at 7.06

Maximum Shear = 11.76

Moment and Shear are per pile spacing: 8.0 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 12.47 at 7.06

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 4.54 in³/pile = 74.32 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W12X14 has been found in Soldier Pile list!

(English Units):

Area= 4.16 in. Depth= 11.9 in. Width= 3.97 in. Height= 12 in.

Flange thickness= 0.225 in. Web thickness= 0.2 in.

Ix= 88.6 in⁴/pile Sx= 14.9 in³/pile Iy= 2.36 in⁴/pile Sy= 1.19 in³/pile

(Metric Units):

Ix= 36.88 x100cm⁴/pile Sx= 244.17 cm³/pile Iy= 0.98 x100cm⁴/pile Sy= 19.50 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W12X14 is capable to support the shoring!

Top deflection = 0.101(in)

Max. deflection = 0.101(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.20

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.10

Pile Spacing =8.0, Max. Moment in lagging = 0.80

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.41

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.17

If 30% loading is used for lagging design, Design Pressure = 0.06

Pile Spacing =8.0, Max. Moment in lagging = 0.48

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.24

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.10

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile N1



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Wall Height=4.0 Pile Diameter=2.0 Pile Spacing=8.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=6.46 Min. Pile Length=10.46
 MOMENT IN PILE: Max. Moment=12.47 per Pile Spacing=8.0 at Depth=7.06

PILE SELECTION:
 Request Min. Section Modulus = 4.5 in³/pile=74.32 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W12X14 has Section Modulus = 14.9 in³/pile=244.17 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.10(in) based on E (ksi)=29000.00 and I (in⁴)/pile=88.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	4	0.200	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
6	.6	24	6.000	.3

ACTIVE SPACING:

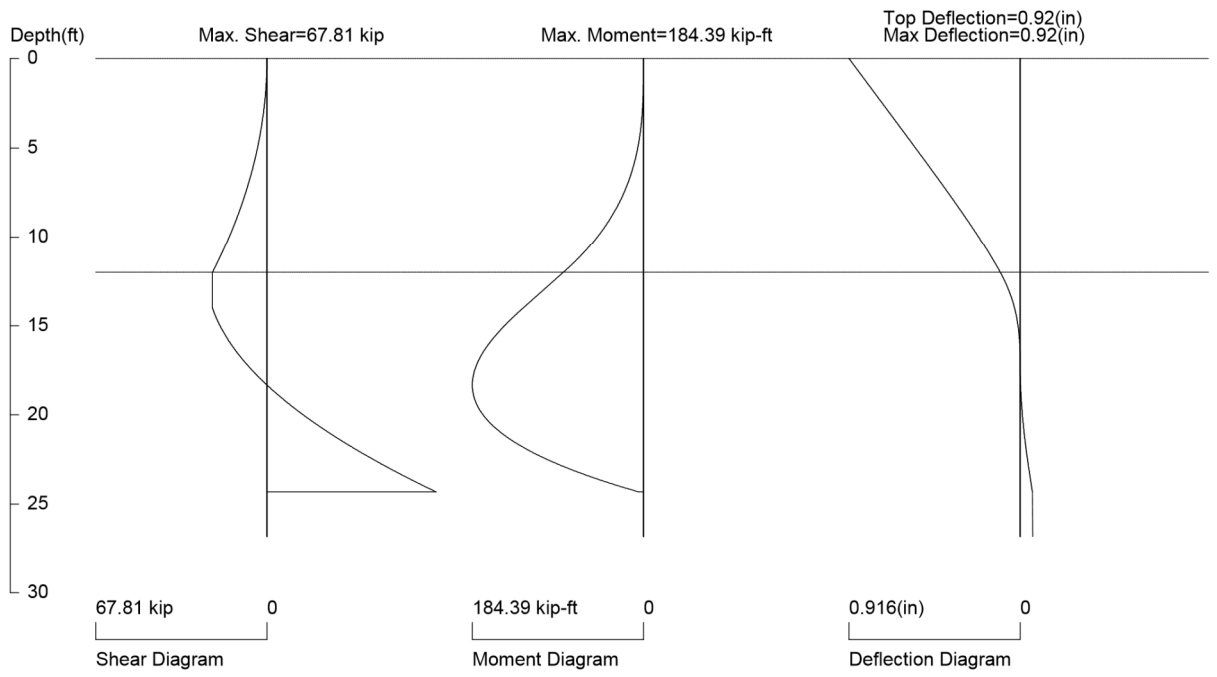
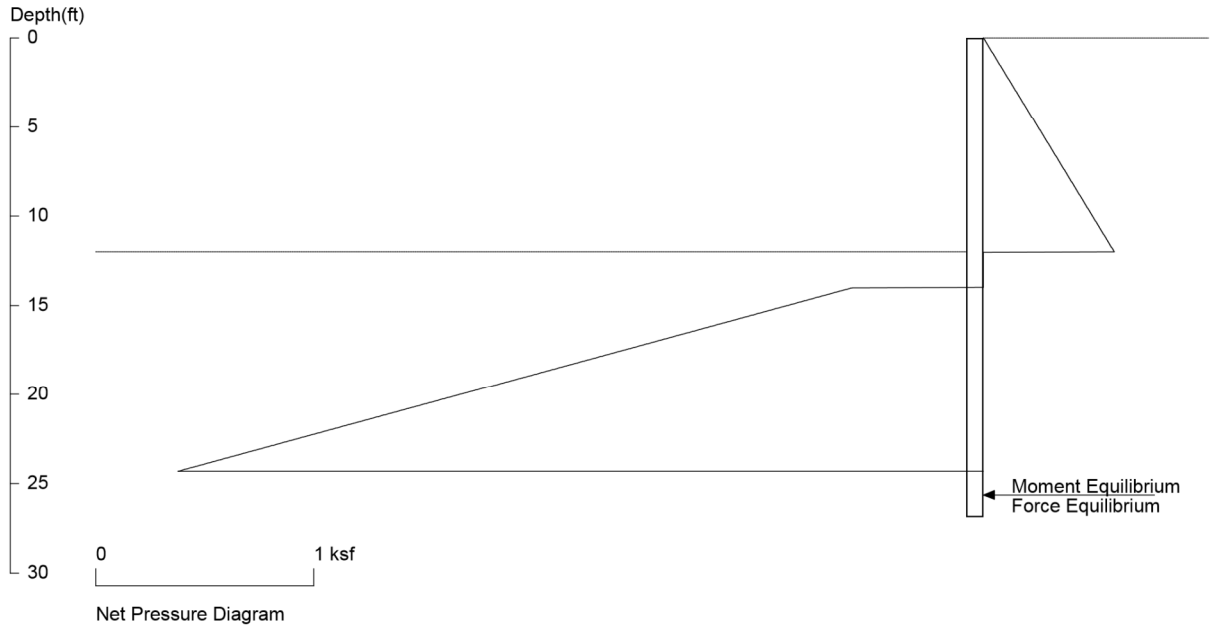
No.	Z depth	Spacing
1	0.00	8.00
2	4.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	4.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile N2



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 6.0 foot or meter

User Input Pile, W14X74: E (ksi)=29000.0, I (in⁴)/pile=795.0

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2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile N2

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 12.00
 Pile Diameter: 2.00
 Pile Spacing: 6.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 795.00
 User Input Pile: W14X74

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12	0.600	.05

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14	.6	32	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	6.00
2	12.00	2.00

* PASSIVE SPACE *

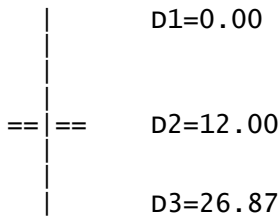
No.	Z depth	Spacing
1	12.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=24.39 WITH EMBEDMENT OF 12.39
 FORCE equilibrium AT DEPTH=26.87 WITH EMBEDMENT OF 14.87

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 12.39
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 14.87

Embedment Information:

If 20% increased, the total design embedment is 14.87
 If 30% increased, the total design embedment is 16.11
 If 40% increased, the total design embedment is 17.35
 If 50% increased, the total design embedment is 18.59

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* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 184.39 at 18.32

Maximum Shear = 67.81

Moment and Shear are per pile spacing: 6.0 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 184.39 at 18.32

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 67.05 in³/pile = 1098.78 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X74 has been found in Soldier Pile list!

(English Units):

Area= 21.8 in. Depth= 14.2 in. width= 10.1 in. Height= 14 in.

Flange thickness= 0.785 in. web thickness= 0.45 in.

Ix= 795 in⁴/pile Sx= 112 in³/pile Iy= 134 in⁴/pile Sy= 26.6 in³/pile

(Metric Units):

Ix= 330.88 x100cm⁴/pile Sx= 1835.34 cm³/pile Iy= 55.77 x100cm⁴/pile Sy= 435.89 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X74 is capable to support the shoring!

Top deflection = 0.916(in)

Max. deflection = 0.916(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.60

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.30

Pile Spacing =6.0, Max. Moment in lagging = 1.35

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.69

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.28

If 30% loading is used for lagging design, Design Pressure = 0.18

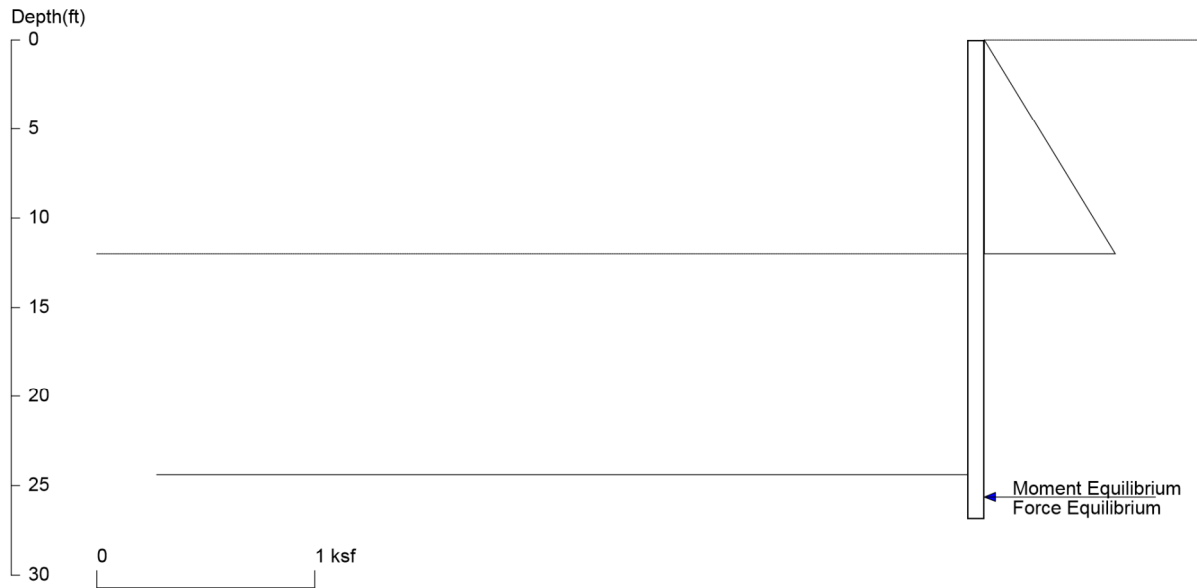
Pile Spacing =6.0, Max. Moment in lagging = 0.81

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.41

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.17

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile N2



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Wall Height=12.0 Pile Diameter=2.0 Pile Spacing=6.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=14.87 Min. Pile Length=26.87
 MOMENT IN PILE: Max. Moment=184.39 per Pile Spacing=6.0 at Depth=18.32

PILE SELECTION:
 Request Min. Section Modulus = 67.1 in³/pile=1098.78 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X74 has Section Modulus = 112.0 in³/pile=1835.34 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.92(in) based on E (ksi)=29000.00 and I (in⁴)/pile=795.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	12	0.600	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
14	.6	32	6.000	.3

ACTIVE SPACING:

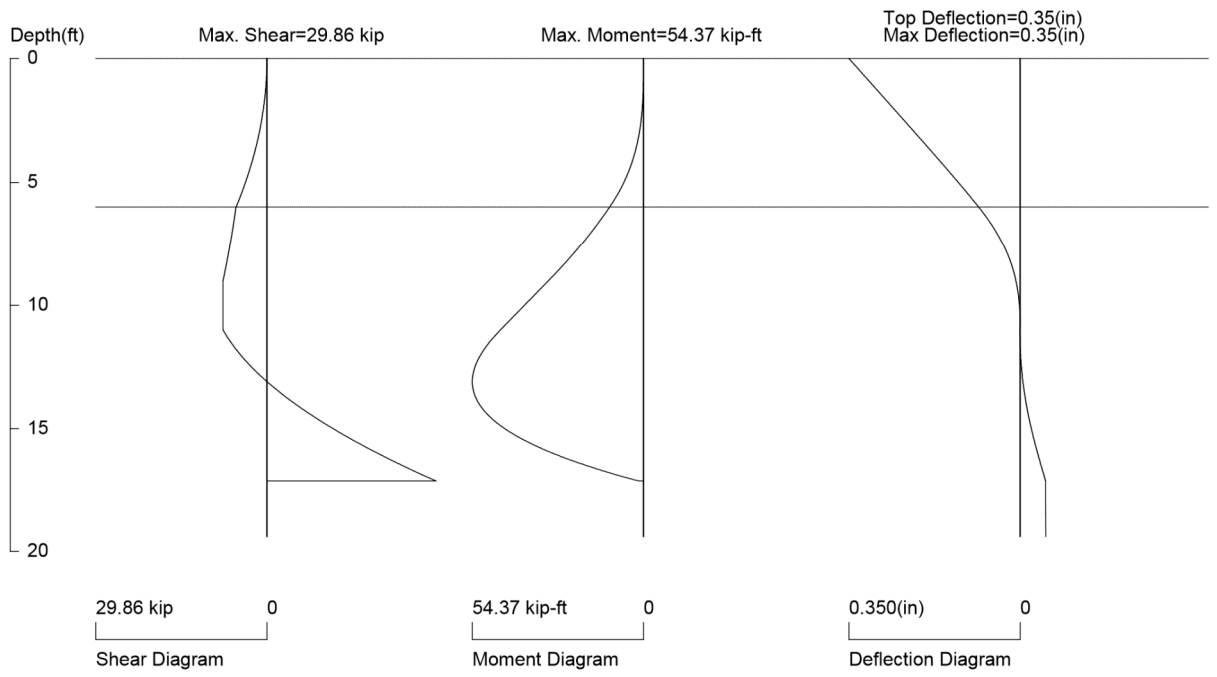
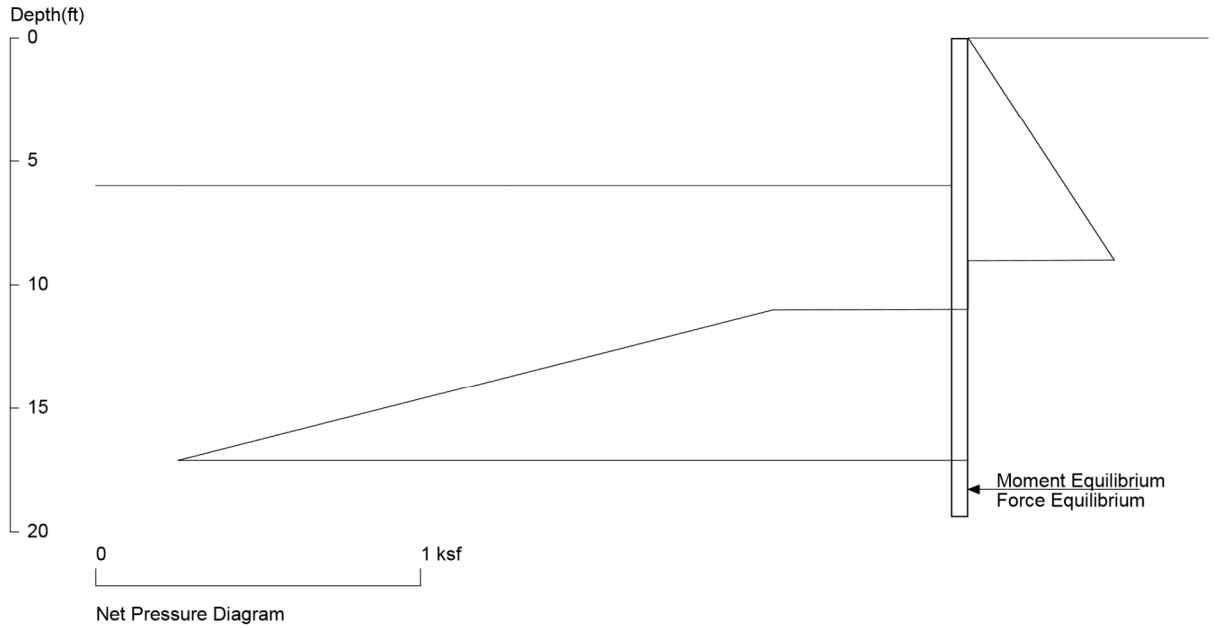
No.	Z depth	Spacing
1	0.00	6.00
2	12.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	12.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile NE1



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 6.0 foot or meter

User Input Pile, w12x26: E (ksi)=29000.0, I (in⁴)/pile=204.0

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6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile NE1

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 6.00
 Pile Diameter: 2.00
 Pile Spacing: 6.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 130.00
 User Input Pile: w12x26

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	9	0.450	.05

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	11	.6	29	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	6.00
2	6.00	2.00

* PASSIVE SPACE *

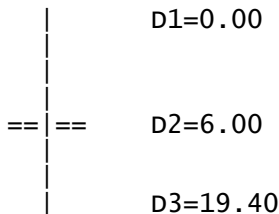
No.	Z depth	Spacing
1	6.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=17.17 WITH EMBEDMENT OF 11.17
 FORCE equilibrium AT DEPTH=19.40 WITH EMBEDMENT OF 13.40

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 11.17
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 13.40

Embedment Information:

If 20% increased, the total design embedment is 13.40
 If 30% increased, the total design embedment is 14.52
 If 40% increased, the total design embedment is 15.64
 If 50% increased, the total design embedment is 16.75

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* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 54.37 at 13.09

Maximum Shear = 29.86

Moment and Shear are per pile spacing: 6.0 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 54.37 at 13.09

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 19.77 in³/pile = 323.99 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66

W12X26 has been found in Soldier Pile list!

(English Units):

Area= 7.65 in. Depth= 12.2 in. Width= 6.49 in. Height= 12 in.

Flange thickness= 0.38 in. Web thickness= 0.23 in.

I_x= 204 in⁴/pile S_x= 33.4 in³/pile I_y= 17.3 in⁴/pile S_y= 5.34 in³/pile

(Metric Units):

I_x= 84.90 x100cm⁴/pile S_x= 547.33 cm³/pile I_y= 7.20 x100cm⁴/pile S_y= 87.51 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W12X26 is capable to support the shoring!

Top deflection = 0.350(in)

Max. deflection = 0.350(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.30

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.15

Pile Spacing =6.0, Max. Moment in lagging = 0.67

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.35

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.14

If 30% loading is used for lagging design, Design Pressure = 0.09

Pile Spacing =6.0, Max. Moment in lagging = 0.40

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.21

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.08

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile NE1



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Wall Height=6.0 Pile Diameter=2.0 Pile Spacing=6.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=13.40 Min. Pile Length=19.40
 MOMENT IN PILE: Max. Moment=54.37 per Pile Spacing=6.0 at Depth=13.09

PILE SELECTION:

Request Min. Section Modulus = 19.8 in³/pile=323.99 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66
 W12X26 has Section Modulus = 33.4 in³/pile=547.33 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.35(in) based on E (ksi)=29000.00 and I (in⁴)/pile=204.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	9	0.450	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
11	.6	29	6.000	.3

ACTIVE SPACING:

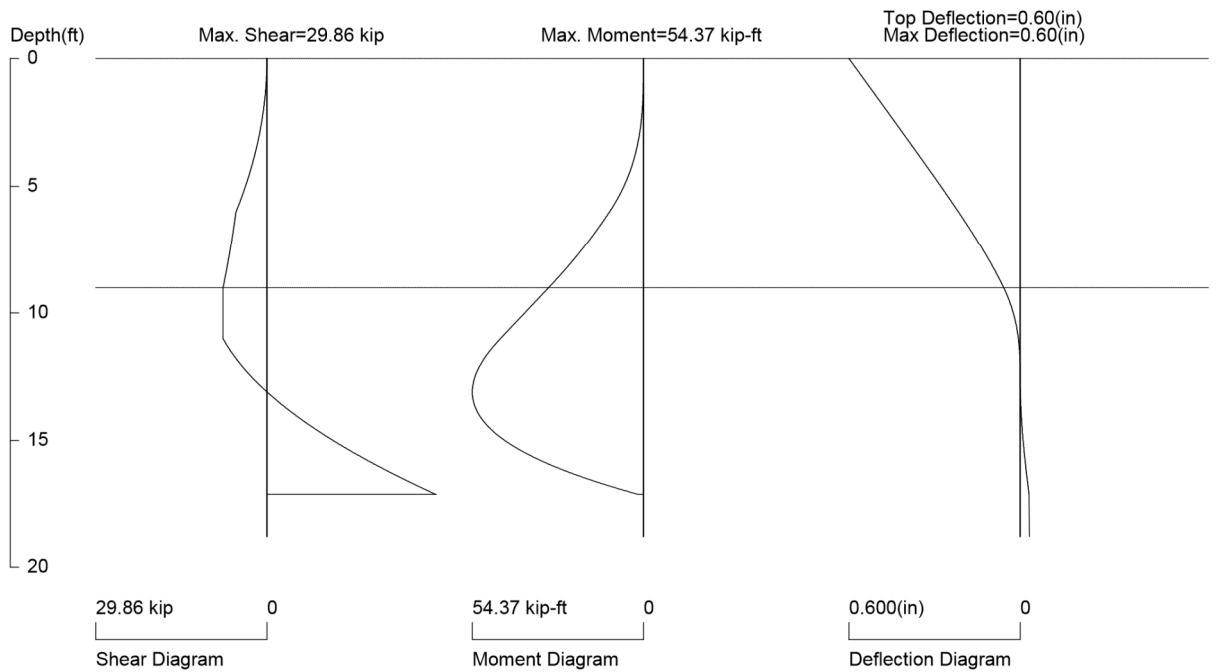
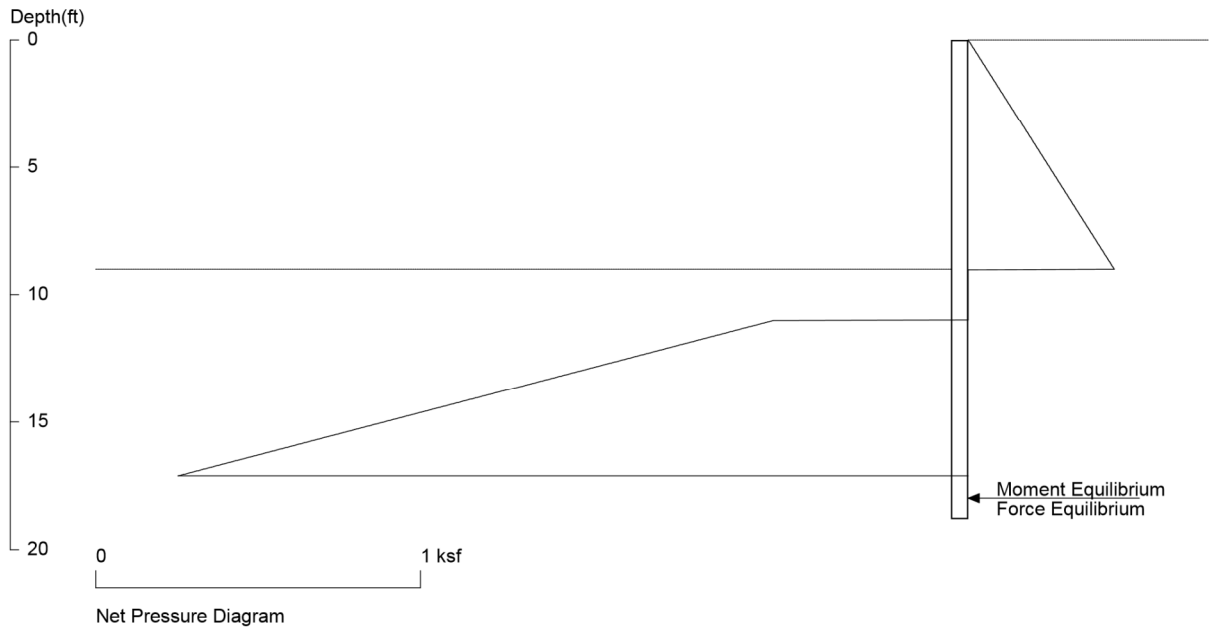
No.	Z depth	Spacing
1	0.00	6.00
2	6.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	6.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile NE2



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 5.0 foot or meter

User Input Pile, w12x26: E (ksi)=29000.0, I (in⁴)/pile=204.0

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2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Residence\Calculations\Shoring\Pile NE2.sh8

Title: Lundin Residence Shoring
Subtitle: Pile NE2

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 9.00
 Pile Diameter: 2.00
 Pile Spacing: 5.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 130.00
 User Input Pile: w12x26

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	9	0.450	.05

* PASSIVE PRESSURE *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	11	.6	29	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	6.00
2	6.00	2.00

* PASSIVE SPACE *

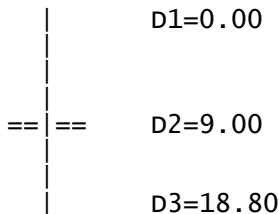
No.	Z depth	Spacing
1	6.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=17.17 WITH EMBEDMENT OF 8.17
 FORCE equilibrium AT DEPTH=18.80 WITH EMBEDMENT OF 9.80

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 8.17
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 9.80

Embedment Information:

If 20% increased, the total design embedment is 9.80
 If 30% increased, the total design embedment is 10.62
 If 40% increased, the total design embedment is 11.44
 If 50% increased, the total design embedment is 12.25

report.out

* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 54.37 at 13.09

Maximum Shear = 29.86

Moment and Shear are per pile spacing: 5.0 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 54.37 at 13.09

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 19.77 in³/pile = 323.99 cm³/pile, F_y = 50 ksi = 345 MPa, F_b/F_y=0.66

W12X26 has been found in Soldier Pile list!

(English Units):

Area= 7.65 in. Depth= 12.2 in. Width= 6.49 in. Height= 12 in.

Flange thickness= 0.38 in. Web thickness= 0.23 in.

I_x= 204 in⁴/pile S_x= 33.4 in³/pile I_y= 17.3 in⁴/pile S_y= 5.34 in³/pile

(Metric Units):

I_x= 84.90 x100cm⁴/pile S_x= 547.33 cm³/pile I_y= 7.20 x100cm⁴/pile S_y= 87.51 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W12X26 is capable to support the shoring!

Top deflection = 0.600(in)

Max. deflection = 0.600(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.45

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.22

Pile Spacing =6.0, Max. Moment in lagging = 1.01

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.52

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.21

If 30% loading is used for lagging design, Design Pressure = 0.13

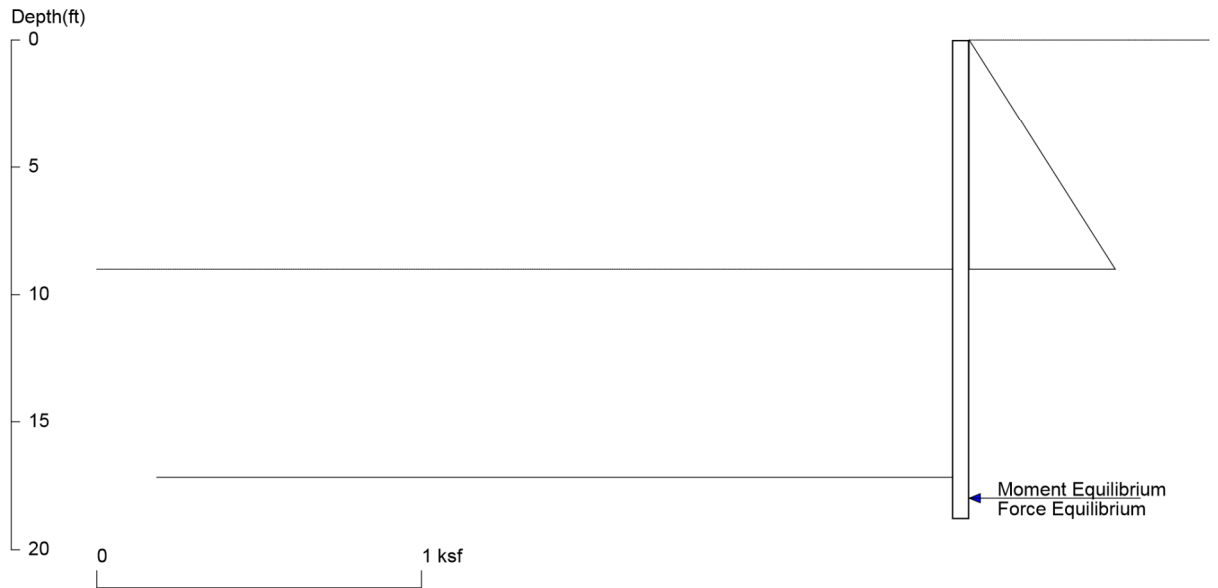
Pile Spacing =6.0, Max. Moment in lagging = 0.61

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.31

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.13

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile NE2



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Wall Height=9.0 Pile Diameter=2.0 Pile Spacing=5.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=9.80 Min. Pile Length=18.80
 MOMENT IN PILE: Max. Moment=54.37 per Pile Spacing=5.0 at Depth=13.09

PILE SELECTION:
 Request Min. Section Modulus = 19.8 in³/pile=323.99 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W12X26 has Section Modulus = 33.4 in³/pile=547.33 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.60(in) based on E (ksi)=29000.00 and I (in⁴)/pile=204.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	9	0.450	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
11	.6	29	6.000	.3

ACTIVE SPACING:

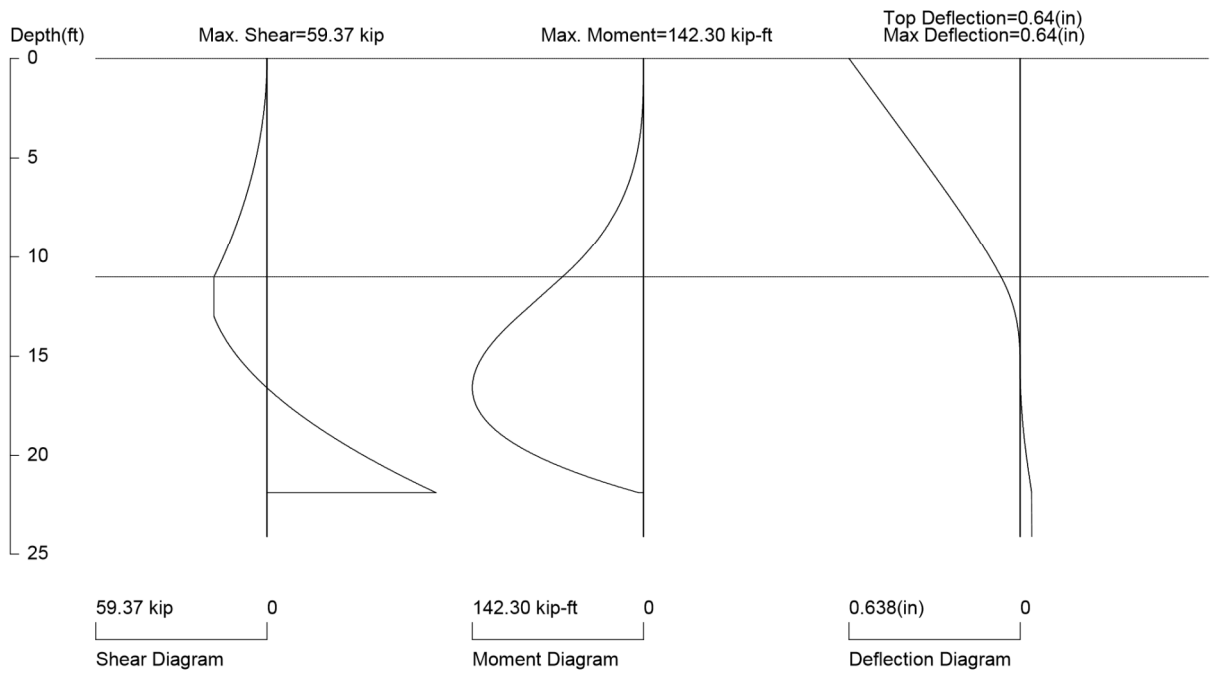
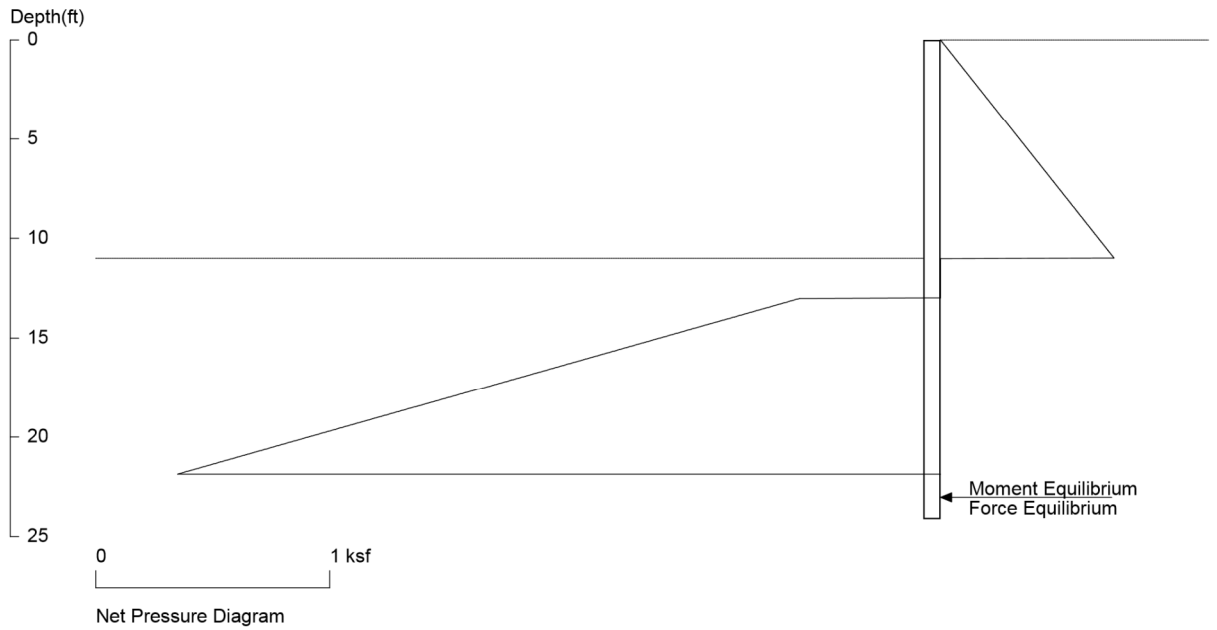
No.	Z depth	Spacing
1	0.00	6.00
2	6.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	6.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile NE3



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 4.5 foot or meter

User Input Pile, W14X68: E (ksi)=29000.0, I (in⁴)/pile=722.0

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SHORING WALL CALCULATION SUMMARY
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The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Residence\Calculations\Shoring\Pile NE3.sh8

Title: Lundin Residence Shoring
Subtitle: Pile NE3

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 11.00
 Pile Diameter: 2.00
 Pile Spacing: 4.50
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 722.00
 User Input Pile: W14X68

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11	0.743	.0675

* PASSIVE PRESSURE *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13	.6	31	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	4.50
2	11.00	3.00

* PASSIVE SPACE *

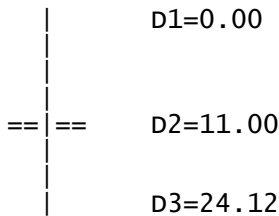
No.	Z depth	Spacing
1	11.00	4.50

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=21.94 WITH EMBEDMENT OF 10.94
 FORCE equilibrium AT DEPTH=24.12 WITH EMBEDMENT OF 13.12

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 10.94
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 13.12

Embedment Information:

If 20% increased, the total design embedment is 13.12
 If 30% increased, the total design embedment is 14.22
 If 40% increased, the total design embedment is 15.31
 If 50% increased, the total design embedment is 16.40

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* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 142.30 at 16.60

Maximum Shear = 59.37

Moment and Shear are per pile spacing: 4.5 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 142.30 at 16.60

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 51.75 in³/pile = 847.95 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66

W14X68 has been found in Soldier Pile list!

(English Units):

Area= 20 in. Depth= 14 in. Width= 10 in. Height= 14 in.

Flange thickness= 0.72 in. Web thickness= 0.415 in.

I_x= 722 in⁴/pile S_x= 103 in³/pile I_y= 121 in⁴/pile S_y= 24.2 in³/pile

(Metric Units):

I_x= 300.50 x100cm⁴/pile S_x= 1687.86 cm³/pile I_y= 50.36 x100cm⁴/pile S_y= 396.57 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X68 is capable to support the shoring!

Top deflection = 0.638(in)

Max. deflection = 0.638(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.74

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.37

Pile Spacing =4.5, Max. Moment in lagging = 0.94

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.48

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.19

If 30% loading is used for lagging design, Design Pressure = 0.22

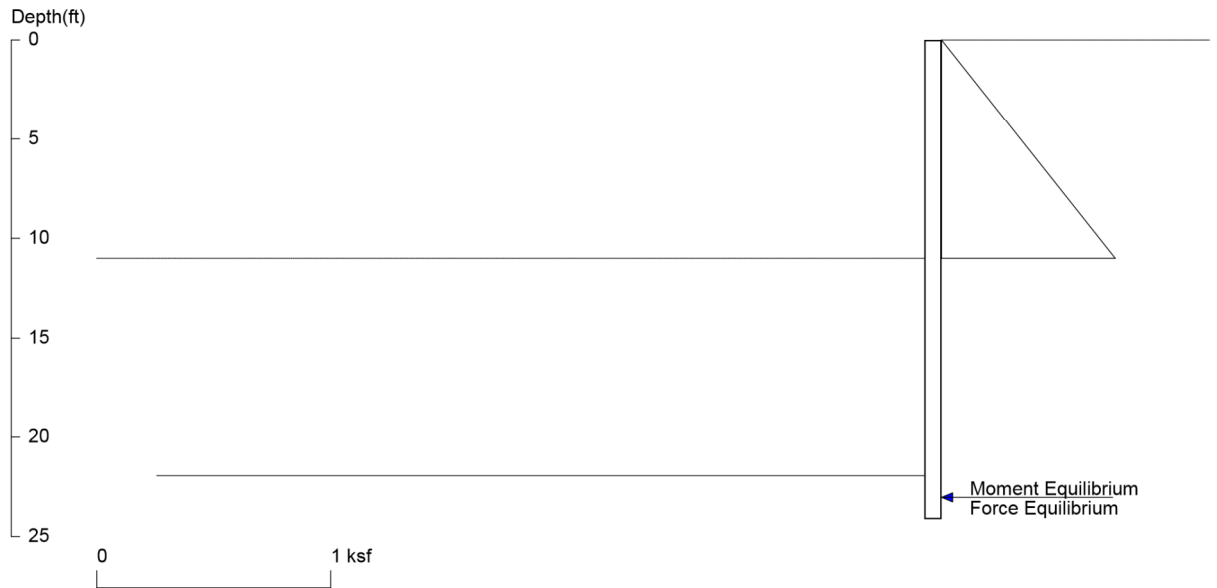
Pile Spacing =4.5, Max. Moment in lagging = 0.56

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.29

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.12

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile NE3



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Wall Height=11.0 Pile Diameter=2.0 Pile Spacing=4.5 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=13.12 Min. Pile Length=24.12
 MOMENT IN PILE: Max. Moment=142.30 per Pile Spacing=4.5 at Depth=16.60

PILE SELECTION:
 Request Min. Section Modulus = 51.7 in³/pile=847.95 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X68 has Section Modulus = 103.0 in³/pile=1687.86 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.64(in) based on E (ksi)=29000.00 and I (in⁴)/pile=722.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	11	0.743	.0675

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
13	.6	31	6.000	.3

ACTIVE SPACING:

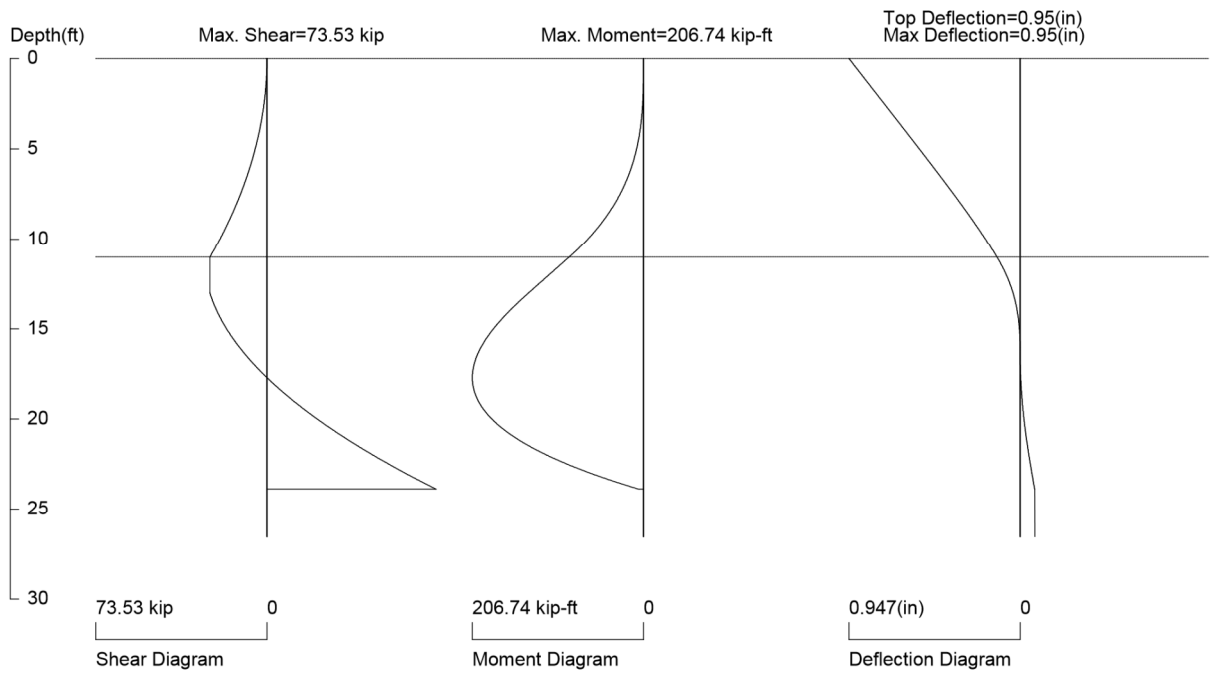
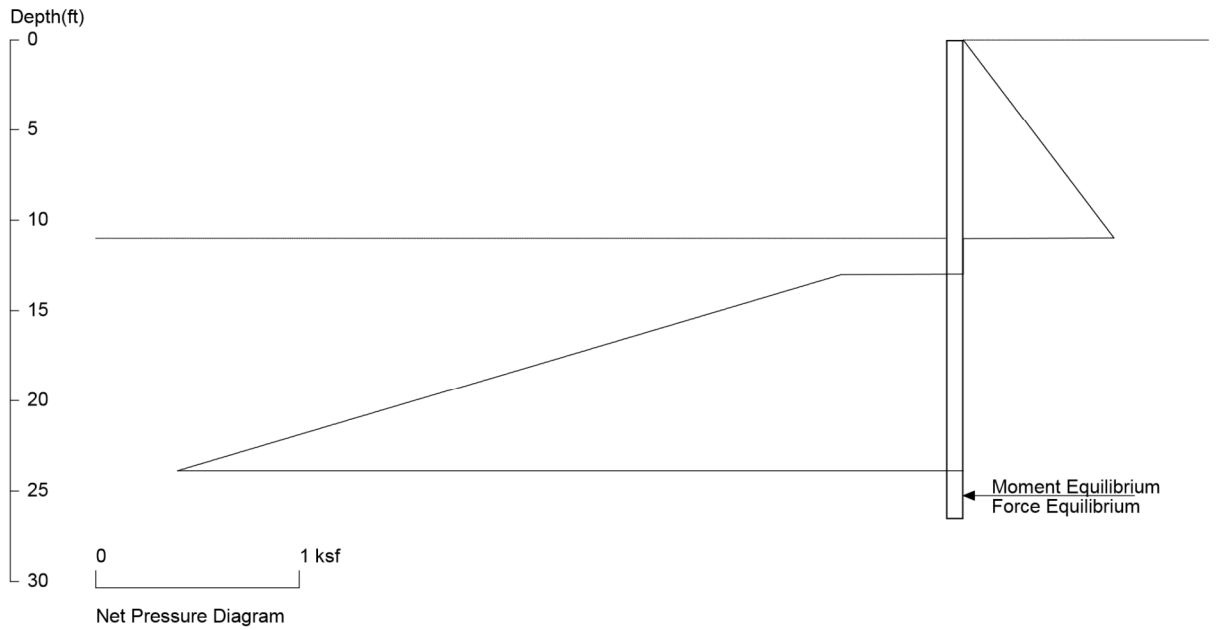
No.	Z depth	Spacing
1	0.00	4.50
2	11.00	3.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	11.00	4.50

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile NE4



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 6.0 foot or meter

User Input Pile, W14X74: E (ksi)=29000.0, I (in⁴)/pile=795.0

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The calculation method is based on the following references:

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2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile NE3

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 11.00
 Pile Diameter: 2.00
 Pile Spacing: 6.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 722.00
 User Input Pile: W14X74

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11	0.743	.0675

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13	.6	31	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	6.00
2	11.00	2.00

* PASSIVE SPACE *

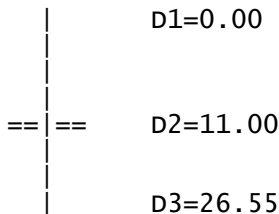
No.	Z depth	Spacing
1	11.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=23.96 WITH EMBEDMENT OF 12.96
 FORCE equilibrium AT DEPTH=26.55 WITH EMBEDMENT OF 15.55

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 12.96
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 15.55

Embedment Information:

If 20% increased, the total design embedment is 15.55
 If 30% increased, the total design embedment is 16.85
 If 40% increased, the total design embedment is 18.14
 If 50% increased, the total design embedment is 19.44

report.out

* MOMENT IN PILE (per pile spacing)*
Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 206.74 at 17.70
Maximum Shear = 73.53
Moment and Shear are per pile spacing: 6.0 foot or meter

* VERTICAL LOADING *
Vertical Loading from Braces = 0.00
Vertical Loading from External Load = 0.00
Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 206.74 at 17.70
The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 75.18 in³/pile = 1231.93 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X74 has been found in Soldier Pile list!
(English Units):
Area= 21.8 in. Depth= 14.2 in. width= 10.1 in. Height= 14 in.
Flange thickness= 0.785 in. web thickness= 0.45 in.
Ix= 795 in⁴/pile Sx= 112 in³/pile Iy= 134 in⁴/pile Sy= 26.6 in³/pile
(Metric Units):
Ix= 330.88 x100cm⁴/pile Sx= 1835.34 cm³/pile Iy= 55.77 x100cm⁴/pile Sy= 435.89 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X74 is capable to support the shoring!
Top deflection = 0.947(in)
Max. deflection = 0.947(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.74
Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.37

Pile Spacing =6.0, Max. Moment in lagging = 1.67

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.85

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.35

If 30% loading is used for lagging design, Design Pressure = 0.22

Pile Spacing =6.0, Max. Moment in lagging = 1.00

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.51

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.21

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile NE4



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Wall Height=11.0 Pile Diameter=2.0 Pile Spacing=6.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=15.55 Min. Pile Length=26.55
 MOMENT IN PILE: Max. Moment=206.74 per Pile Spacing=6.0 at Depth=17.70

PILE SELECTION:
 Request Min. Section Modulus = 75.2 in³/pile=1231.93 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X74 has Section Modulus = 112.0 in³/pile=1835.34 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.95(in) based on E (ksi)=29000.00 and I (in⁴)/pile=795.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	11	0.743	.0675

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
13	.6	31	6.000	.3

ACTIVE SPACING:

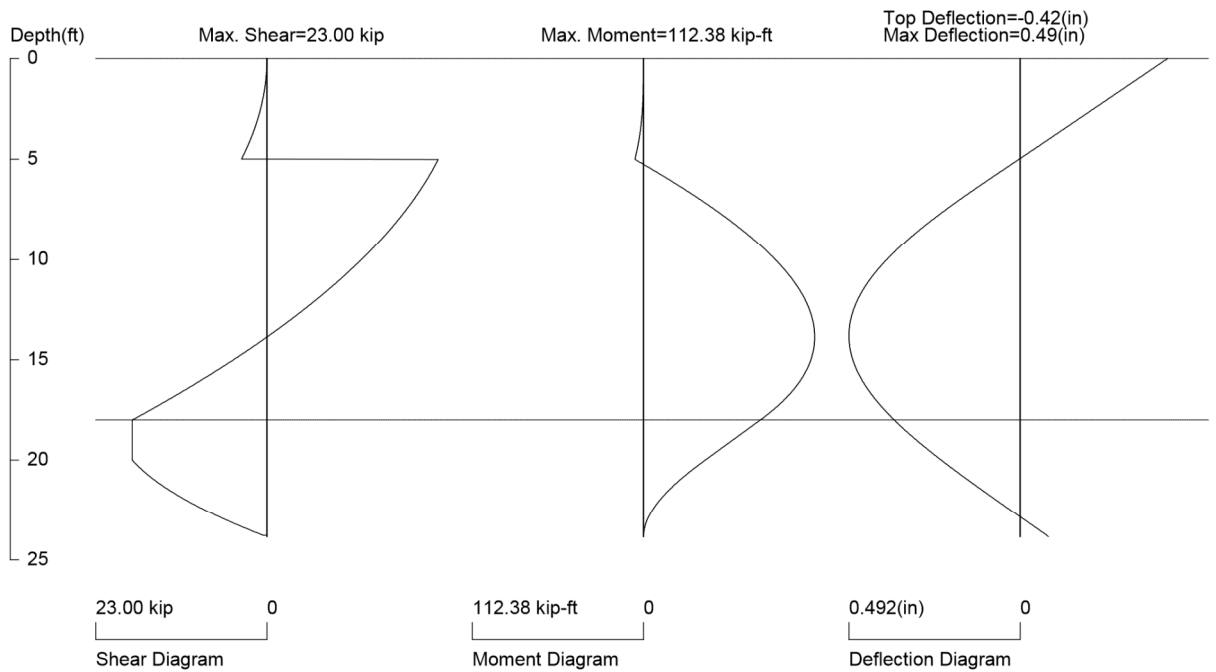
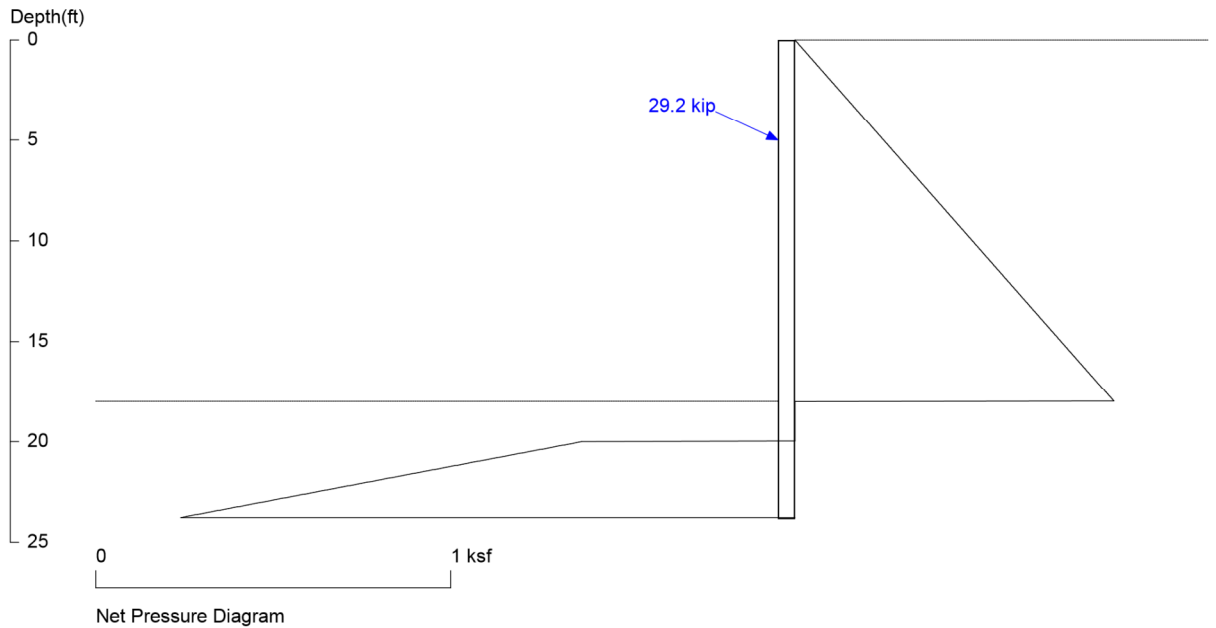
No.	Z depth	Spacing
1	0.00	6.00
2	11.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	11.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile S1 - Alternate Tieback Design



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 5.5 foot or meter

User Input Pile, W14X43: E (ksi)=29000.0, I (in⁴)/pile=428.0

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1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Residence\Calculations\Shoring\Pile S1 - Alternate.sh8

Title: Lundin Residence Shoring
Subtitle: Pile S1 - Alternate Tieback Design

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 18.00
 Pile Diameter: 2.00
 Pile Spacing: 5.50
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 3. Tieback
 Top Brace Increase (Multi-Bracing): Add 15%*
 Brace Position (One Brace Case): Normal Brace*
 No-Load Zone:
 Vertical Depth for No-Load Zone: 18.00
 H-Distance (Input H/V ratio) for No-Load Zone: 0.25
 Angle from H. Line for No-Load Zone: 60.00
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Check Vertical Bearing Capacity:
 Side Friction for Bearing: 1.00
 Tip Resistance for Bearing: 15.00
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 428.00
 User Input Pile: W14X43

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	18	0.900	.05

* PASSIVE PRESSURE *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	20	.6	38	6.000	.3

* ACTIVE SPACE *		
No.	Z depth	Spacing
1	0.00	5.50
2	18.00	2.00

* PASSIVE SPACE *		
No.	Z depth	Spacing
1	18.00	4.00

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*					
No.	Z brace	Angle	Spacing	Input1*	Input2*
Type					
1	5.00	25.0	5.50	0.50	1.60
Tieback					

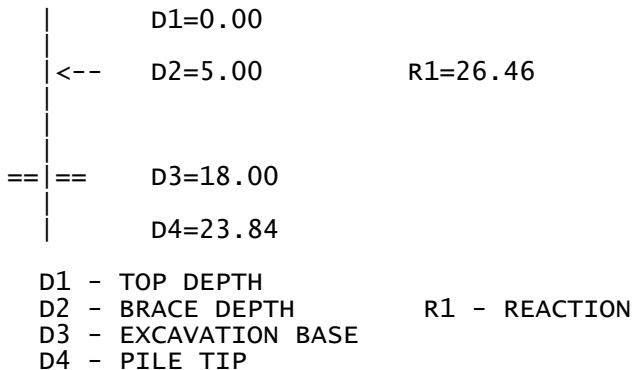
*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00

NUMBER OF BRACE LEVEL = 1



TOTAL REACTION: R1 = 26.46

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TOTAL PRESSURES ACTING ON WALL = 26.46
 Total Reactions = Total Pressures, OK!

BRACE NO.1 AT DEPTH = 5.00
 R1 = Brace Load = 26.46

*****RESULTS*****

* EMBEDMENT *

MINIMUM EMBEDMENT = 5.84, TOTAL MINIMUM PILE LENGTH = 23.84

* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

No.	Depth	M @ Brace	Mmax in Span	Depth of Mmax
1	5.00	5.60	112.38	13.87

Overall Maximum Moment = 112.38 at 13.87

Maximum Shear = 23.00

Moment and Shear are per pile spacing: 5.5 foot or meter

* BRACE: STRUT, TIEBACK, ANCHOR PLATE, DEADMAN, OR SHEET PILE AS ANCHOR*

The calculated brace force are per brace spacing.

No.	DEPTH	Tangle	SPACING	HORIZONTAL	VERTICAL
1	5.00	25.0	5.50	26.46	12.34

No.	DEPTH	Free length	Brace Type
1	5.00	10.44	Tieback, Bond length = 11.62

* VERTICAL LOADING *

Vertical Loading from Braces = 12.34

Vertical Loading from External Load = 0.00

Total Vertical Loading = 12.34

* VERTICAL BEARING CAPACITY CHECK (Option 1, Not including side area above base) *

Tip area + Total side area of embedment below base only.

Tip Depth	Tip Area*	Bearing	Tip Resistance
23.84	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
5.84	36.72	1.00	36.72

*Total side area is the surface area of embedment below base only.

Total Vertical Resistance = 83.84

Total Vertical Loading = 12.34

Vertical Factor of Safety = 6.80

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* VERTICAL BEARING CAPACITY CHECK (Option 2, including side area above base) *
Tip area + Total side area of embedment below base + Back side between pile and soil above base.

Tip Depth	Tip Area*	Bearing	Tip Resistance
23.84	3.14	15.00	47.12

*Tip Area is based on shaft diameter, D=2.0 (input in Page A, Item 3)

Embedment	Side Area*	Friction	Side Resistance
5.84	93.27	1.00	93.27

*Total side area is the surface area of embedment below base and back side between pile and soil above base.

Total Vertical Resistance = 140.39
Total Vertical Loading = 12.34
Vertical Factor of Safety = 11.38

*****SPECIFIED PILE *****

Overall Maximum Moment = 112.38 at 13.87
The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 40.87 in³/pile = 669.67 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X43 has been found in Soldier Pile list!
(English Units):
Area= 12.6 in. Depth= 13.7 in. width= 8 in. Height= 14 in.
Flange thickness= 0.53 in. web thickness= 0.305 in.
Ix= 428 in⁴/pile Sx= 62.6 in³/pile Iy= 45.2 in⁴/pile Sy= 11.3 in³/pile
(Metric Units):
Ix= 178.13 x100cm⁴/pile Sx= 1025.83 cm³/pile Iy= 18.81 x100cm⁴/pile Sy= 185.17 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X43 is capable to support the shoring!
Top deflection = -0.424(in)
Max. deflection = 0.492(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.90
Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.45

Pile Spacing =5.5, Max. Moment in lagging = 1.70

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.87

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.35

If 30% loading is used for lagging design, Design Pressure = 0.27

Pile Spacing =5.5, Max. Moment in lagging = 1.02

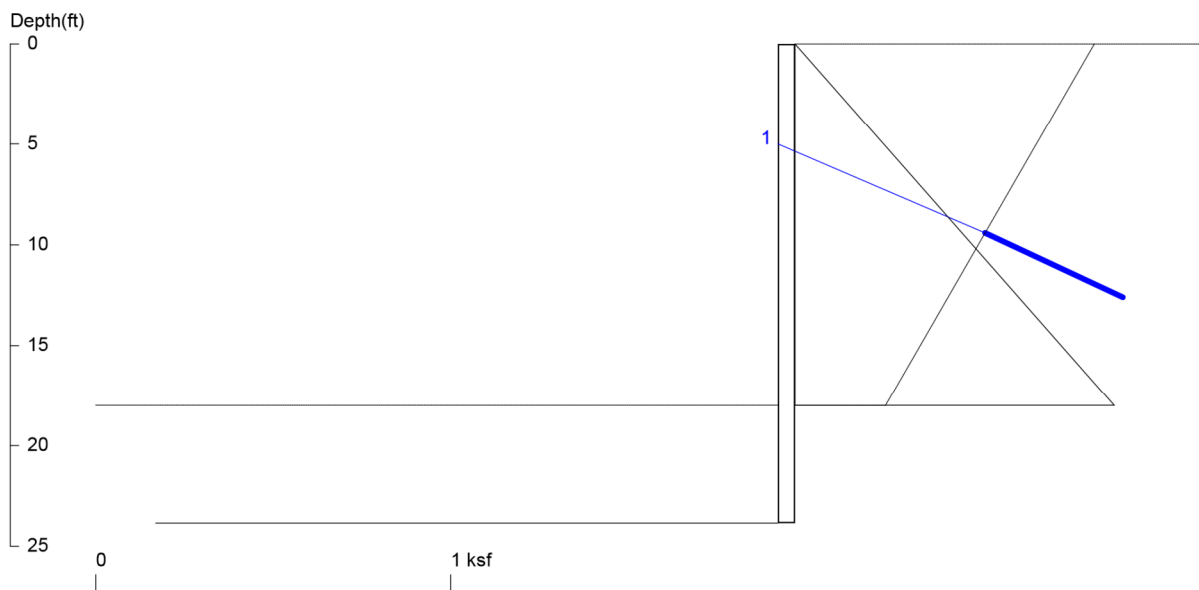
For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.52

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For 6"x12" Timber, Section Modulus $S=57.98$ in³. The request allowable bending strength, $fb=M/S=0.21$

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile S1 - Alternate Tieback Design



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Wall Height=18.0 Pile Diameter=2.0 Pile Spacing=5.5 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=5.84 Min. Pile Length=23.84
 MOMENT IN PILE: Max. Moment=112.38 per Pile Spacing=5.5 at Depth=13.87

VERTICAL BEARING CAPACITY: Vertical Loading=12.3, Resistance=140.4, Vertical Factor of Safety=11.38

PILE SELECTION:
 Request Min. Section Modulus = 40.9 in³/pile=669.67 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X43 has Section Modulus = 62.6 in³/pile=1025.83 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = -0.42(in) based on E (ksi)=29000.00 and I (in⁴)/pile=428.0

BRACE FORCE: Strut, Tieback, Plate Anchor, Deadman, Sheet Pile as Anchor

No. & Type	Depth	Angle	Space	Total F.	Horiz. F.	Vert. F.	L _{free}	Fixed Length
1. Tieback	5.0	25.0	5.5	29.2	26.5	12.3	10.4	11.6

UNITS: Width,Diameter,Spacing,Length,Depth,and Height - ft; Force - kip; Bond Strength and Pressure - ksf

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	18	0.900	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
20	.6	38	6.000	.3

ACTIVE SPACING:

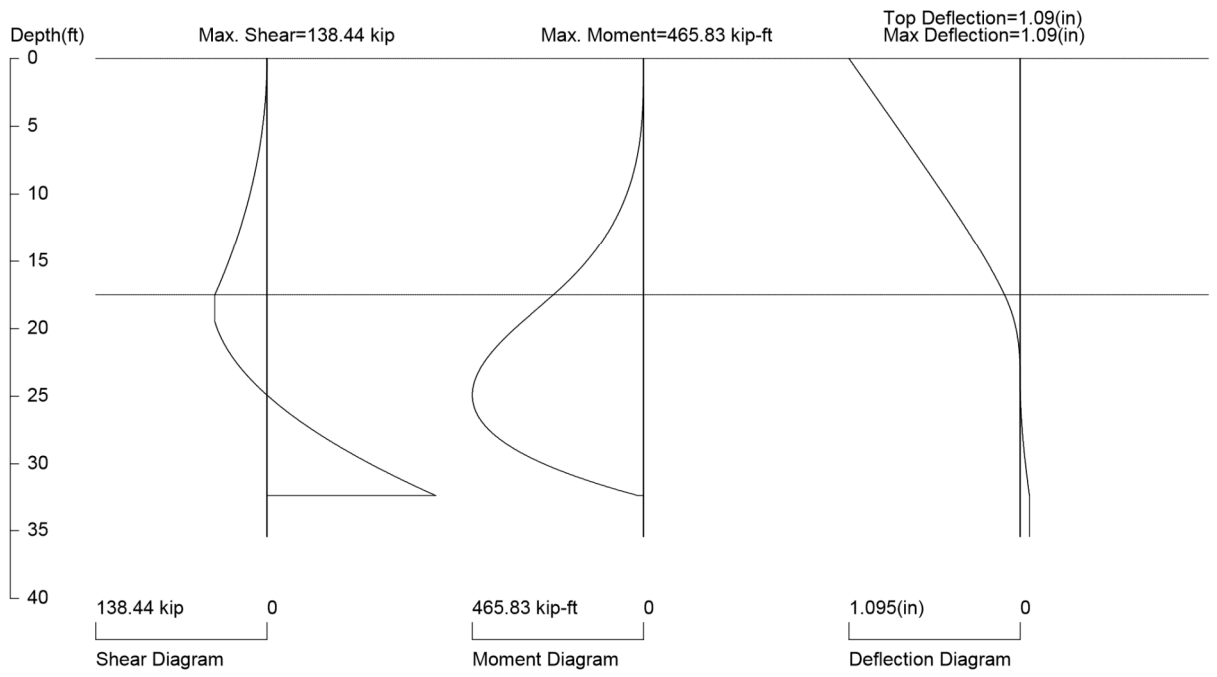
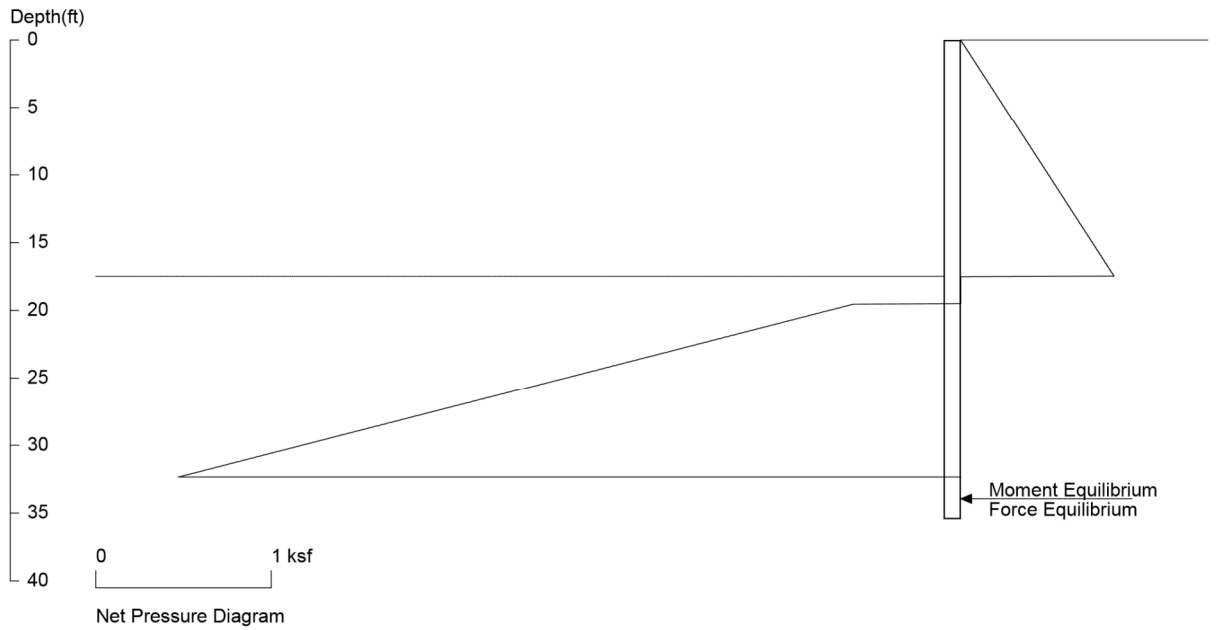
No.	Z depth	Spacing
1	0.00	5.50
2	18.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	18.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile S1



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 5.5 foot or meter

User Input Pile, W21x132: E (ksi)=29000.0, I (in⁴)/pile=3220.0

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5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile S1

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 17.50
 Pile Diameter: 3.00
 Pile Spacing: 5.50
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 3220.0
 User Input Pile: W21x132

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	17.5	0.875	.05

* PASSIVE PRESSURE *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	19.5	.6	37.5	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	5.50
2	17.50	3.00

* PASSIVE SPACE *

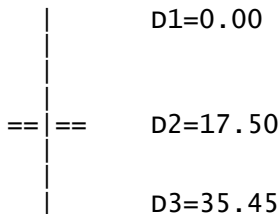
No.	Z depth	Spacing
1	17.50	5.50

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=32.46 WITH EMBEDMENT OF 14.96
 FORCE equilibrium AT DEPTH=35.45 WITH EMBEDMENT OF 17.95

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 14.96
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 17.95

Embedment Information:

If 20% increased, the total design embedment is 17.95
 If 30% increased, the total design embedment is 19.45
 If 40% increased, the total design embedment is 20.94
 If 50% increased, the total design embedment is 22.44

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* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 465.83 at 24.92

Maximum Shear = 138.44

Moment and Shear are per pile spacing: 5.5 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 465.83 at 24.92

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 169.39 in³/pile = 2775.86 cm³/pile, F_y = 50 ksi = 345 MPa, F_b/F_y=0.66

W21X132 has been found in Soldier Pile list!

(English Units):

Area= 38.8 in. Depth= 21.8 in. Width= 12.4 in. Height= 21 in.

Flange thickness= 1.04 in. Web thickness= 0.65 in.

I_x= 3220 in⁴/pile S_x= 295 in³/pile I_y= 333 in⁴/pile S_y= 53.5 in³/pile

(Metric Units):

I_x= 1340.16 x100cm⁴/pile S_x= 4834.17 cm³/pile I_y= 138.59 x100cm⁴/pile S_y= 876.70 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W21X132 is capable to support the shoring!

Top deflection = 1.095(in)

Max. deflection = 1.095(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.87

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.44

Pile Spacing =5.5, Max. Moment in lagging = 1.65

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.84

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.34

If 30% loading is used for lagging design, Design Pressure = 0.26

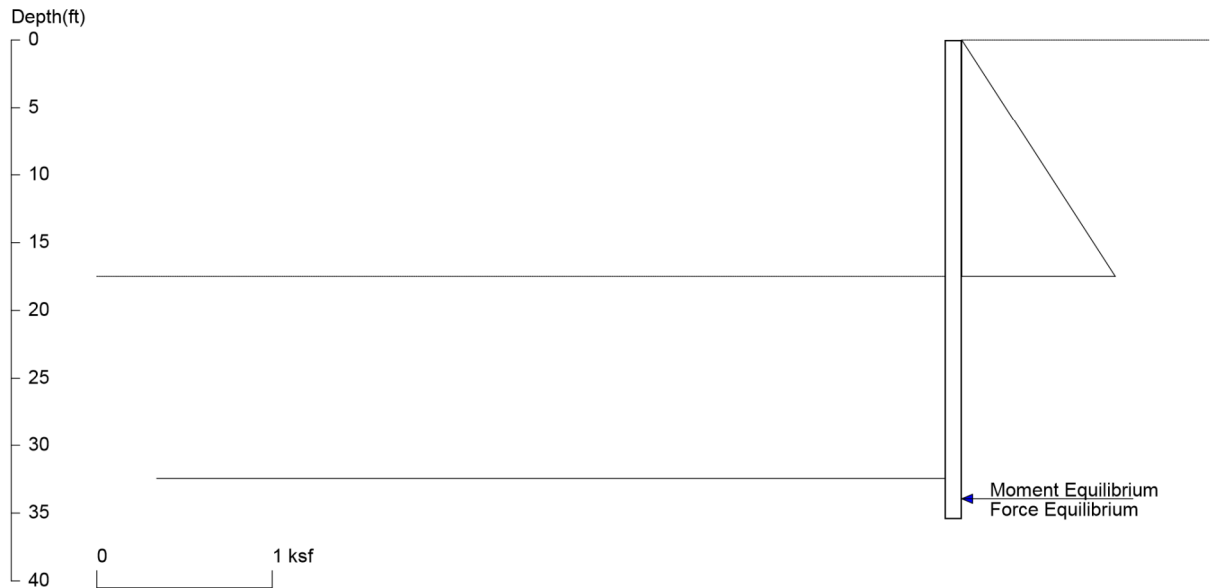
Pile Spacing =5.5, Max. Moment in lagging = 0.99

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.51

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.21

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile S1



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Wall Height=17.5 Pile Diameter=3.0 Pile Spacing=5.5 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=17.95 Min. Pile Length=35.45
 MOMENT IN PILE: Max. Moment=465.83 per Pile Spacing=5.5 at Depth=24.92

PILE SELECTION:
 Request Min. Section Modulus = 169.4 in³/pile=2775.86 cm³/pile, F_y = 50 ksi = 345 MPa, F_b/F_y=0.66
 W21X132 has Section Modulus = 295.0 in³/pile=4834.17 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 1.09(in) based on E (ksi)=29000.00 and I (in⁴)/pile=3220.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	17.5	0.875	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
19.5	.6	37.5	6.000	.3

ACTIVE SPACING:

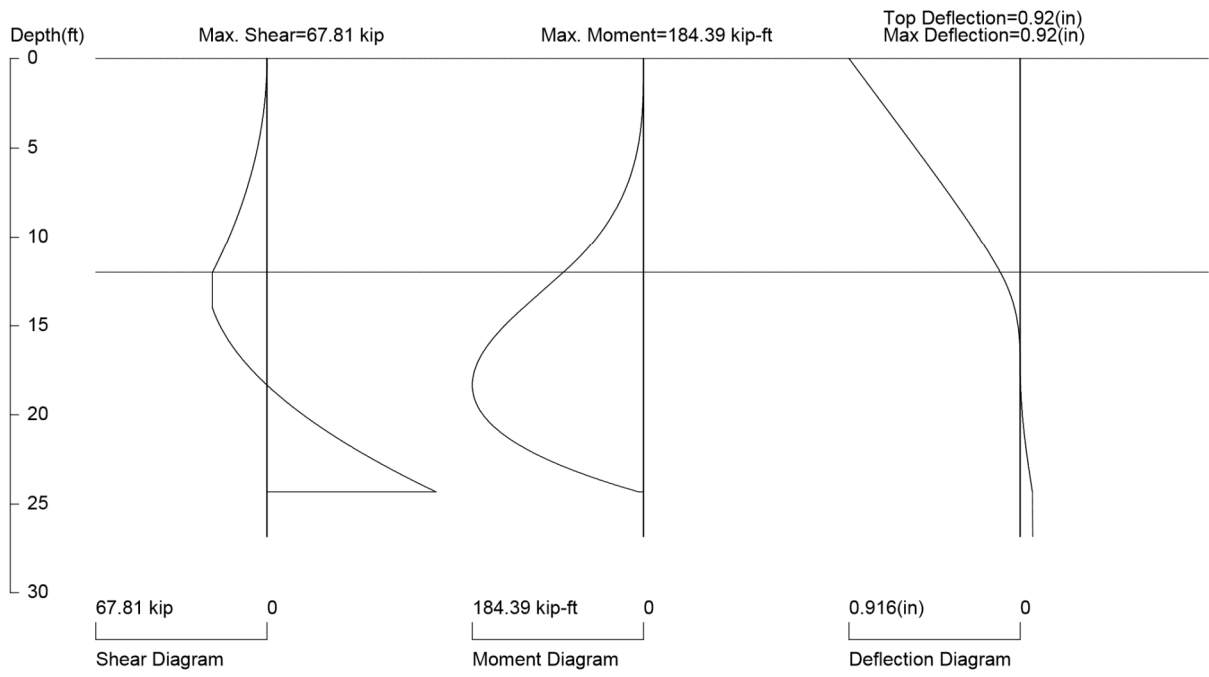
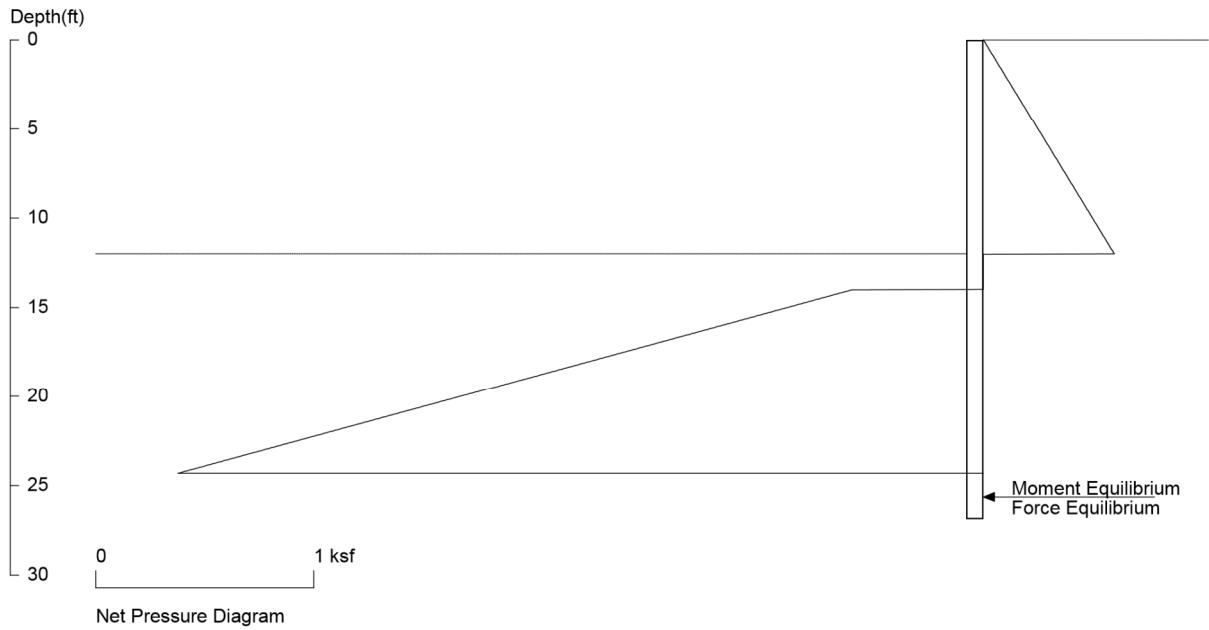
No.	Z depth	Spacing
1	0.00	5.50
2	17.50	3.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	17.50	5.50

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile S2



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 6.0 foot or meter

User Input Pile, W14X74: E (ksi)=29000.0, I (in⁴)/pile=795.0

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9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile S2

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 12.00
 Pile Diameter: 2.00
 Pile Spacing: 6.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 795.00
 User Input Pile: W14X74

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12	0.600	.05

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14	.6	32	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	6.00
2	12.00	2.00

* PASSIVE SPACE *

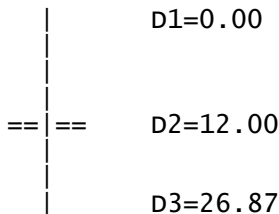
No.	Z depth	Spacing
1	12.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=24.39 WITH EMBEDMENT OF 12.39
 FORCE equilibrium AT DEPTH=26.87 WITH EMBEDMENT OF 14.87

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 12.39
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 14.87

Embedment Information:

If 20% increased, the total design embedment is 14.87
 If 30% increased, the total design embedment is 16.11
 If 40% increased, the total design embedment is 17.35
 If 50% increased, the total design embedment is 18.59

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* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 184.39 at 18.32

Maximum Shear = 67.81

Moment and Shear are per pile spacing: 6.0 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 184.39 at 18.32

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 67.05 in³/pile = 1098.78 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X74 has been found in Soldier Pile list!

(English Units):

Area= 21.8 in. Depth= 14.2 in. width= 10.1 in. Height= 14 in.

Flange thickness= 0.785 in. web thickness= 0.45 in.

Ix= 795 in⁴/pile Sx= 112 in³/pile Iy= 134 in⁴/pile Sy= 26.6 in³/pile

(Metric Units):

Ix= 330.88 x100cm⁴/pile Sx= 1835.34 cm³/pile Iy= 55.77 x100cm⁴/pile Sy= 435.89 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X74 is capable to support the shoring!

Top deflection = 0.916(in)

Max. deflection = 0.916(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.60

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.30

Pile Spacing =6.0, Max. Moment in lagging = 1.35

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.69

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.28

If 30% loading is used for lagging design, Design Pressure = 0.18

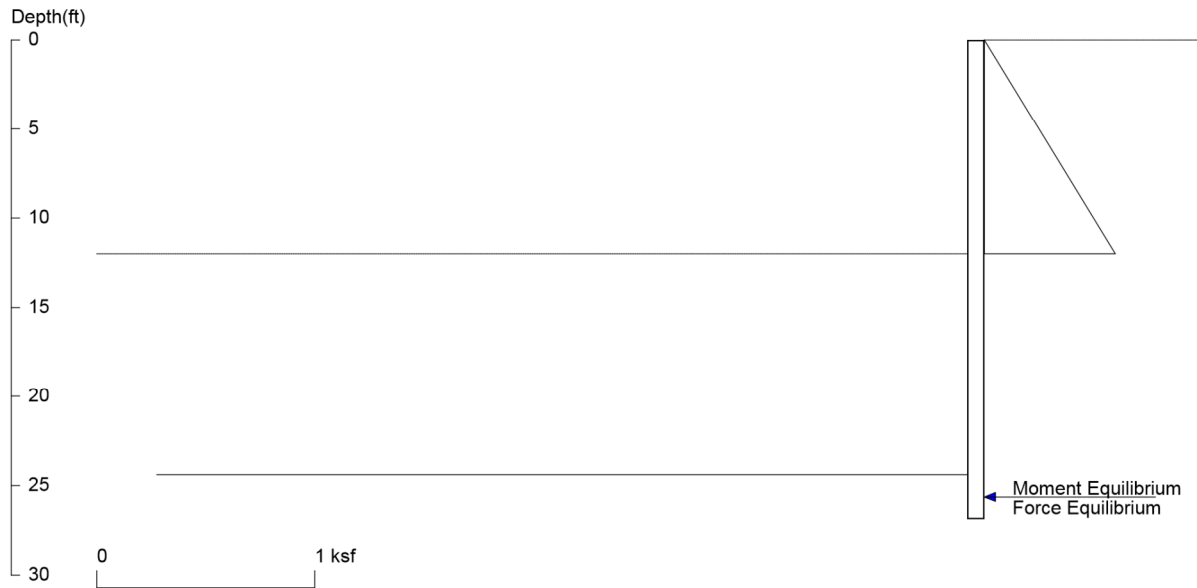
Pile Spacing =6.0, Max. Moment in lagging = 0.81

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.41

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.17

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile S2



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Wall Height=12.0 Pile Diameter=2.0 Pile Spacing=6.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=14.87 Min. Pile Length=26.87
 MOMENT IN PILE: Max. Moment=184.39 per Pile Spacing=6.0 at Depth=18.32

PILE SELECTION:
 Request Min. Section Modulus = 67.1 in³/pile=1098.78 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X74 has Section Modulus = 112.0 in³/pile=1835.34 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.92(in) based on E (ksi)=29000.00 and I (in⁴)/pile=795.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	12	0.600	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
14	.6	32	6.000	.3

ACTIVE SPACING:

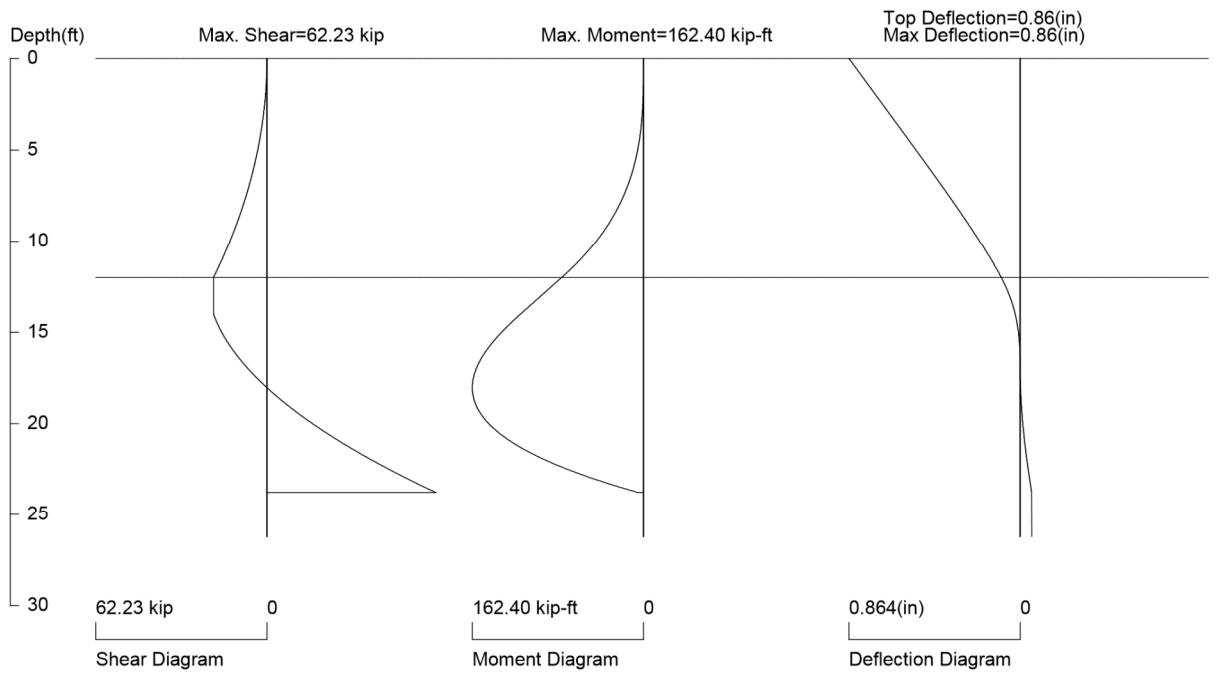
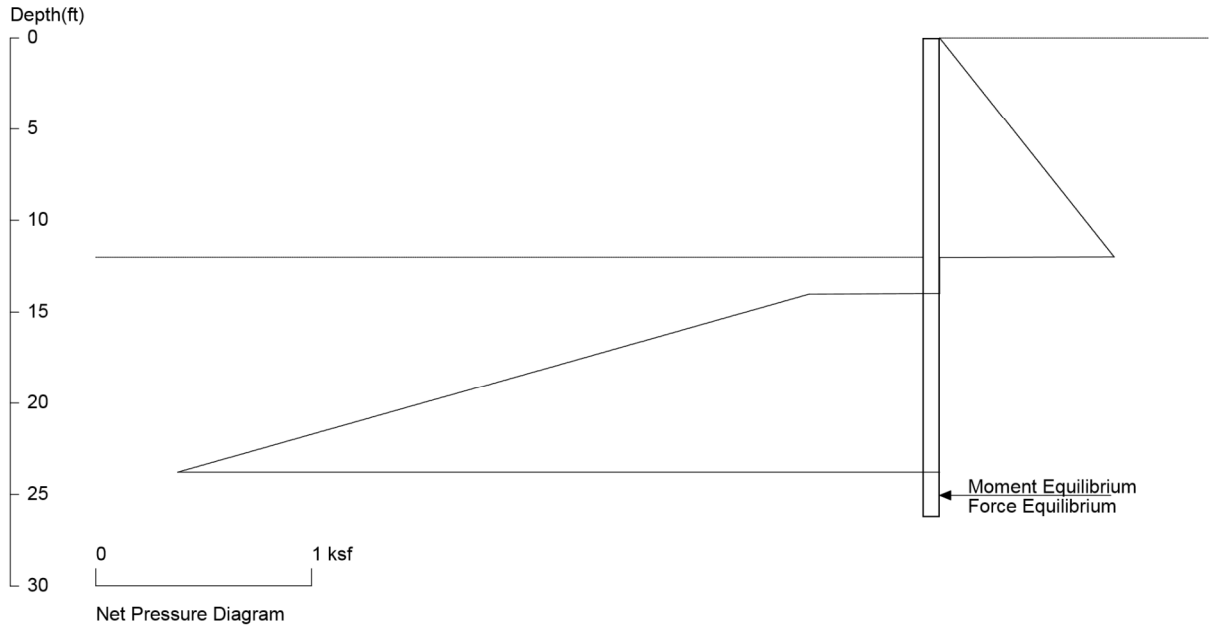
No.	Z depth	Spacing
1	0.00	6.00
2	12.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	12.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile S3



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 4.0 foot or meter

User Input Pile, W14X68: E (ksi)=29000.0, I (in⁴)/pile=722.0

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2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile S3

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 12.00
 Pile Diameter: 2.00
 Pile Spacing: 4.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 722.00
 User Input Pile: W14X68

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12	0.810	.0675

* PASSIVE PRESSURE *					
No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14	.6	32	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	4.00
2	12.00	2.00

* PASSIVE SPACE *

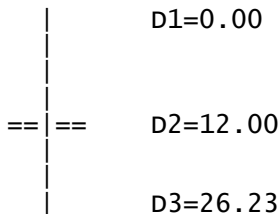
No.	Z depth	Spacing
1	12.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=23.86 WITH EMBEDMENT OF 11.86
 FORCE equilibrium AT DEPTH=26.23 WITH EMBEDMENT OF 14.23

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 11.86
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 14.23

Embedment Information:

If 20% increased, the total design embedment is 14.23
 If 30% increased, the total design embedment is 15.42
 If 40% increased, the total design embedment is 16.60
 If 50% increased, the total design embedment is 17.79

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* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 162.40 at 18.02

Maximum Shear = 62.23

Moment and Shear are per pile spacing: 4.0 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 162.40 at 18.02

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 59.06 in³/pile = 967.75 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X68 has been found in Soldier Pile list!

(English Units):

Area= 20 in. Depth= 14 in. width= 10 in. Height= 14 in.

Flange thickness= 0.72 in. web thickness= 0.415 in.

Ix= 722 in⁴/pile Sx= 103 in³/pile Iy= 121 in⁴/pile Sy= 24.2 in³/pile

(Metric Units):

Ix= 300.50 x100cm⁴/pile Sx= 1687.86 cm³/pile Iy= 50.36 x100cm⁴/pile Sy= 396.57 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X68 is capable to support the shoring!

Top deflection = 0.864(in)

Max. deflection = 0.864(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.81

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.40

Pile Spacing =4.0, Max. Moment in lagging = 0.81

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.41

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.17

If 30% loading is used for lagging design, Design Pressure = 0.24

Pile Spacing =4.0, Max. Moment in lagging = 0.49

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.25

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.10

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile S3



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Wall Height=12.0 Pile Diameter=2.0 Pile Spacing=4.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=14.23 Min. Pile Length=26.23
 MOMENT IN PILE: Max. Moment=162.40 per Pile Spacing=4.0 at Depth=18.02

PILE SELECTION:
 Request Min. Section Modulus = 59.1 in³/pile=967.75 cm³/pile, F_y= 50 ksi = 345 MPa, F_b/F_y=0.66
 W14X68 has Section Modulus = 103.0 in³/pile=1687.86 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.86(in) based on E (ksi)=29000.00 and I (in⁴)/pile=722.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	12	0.810	.0675

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
14	.6	32	6.000	.3

ACTIVE SPACING:

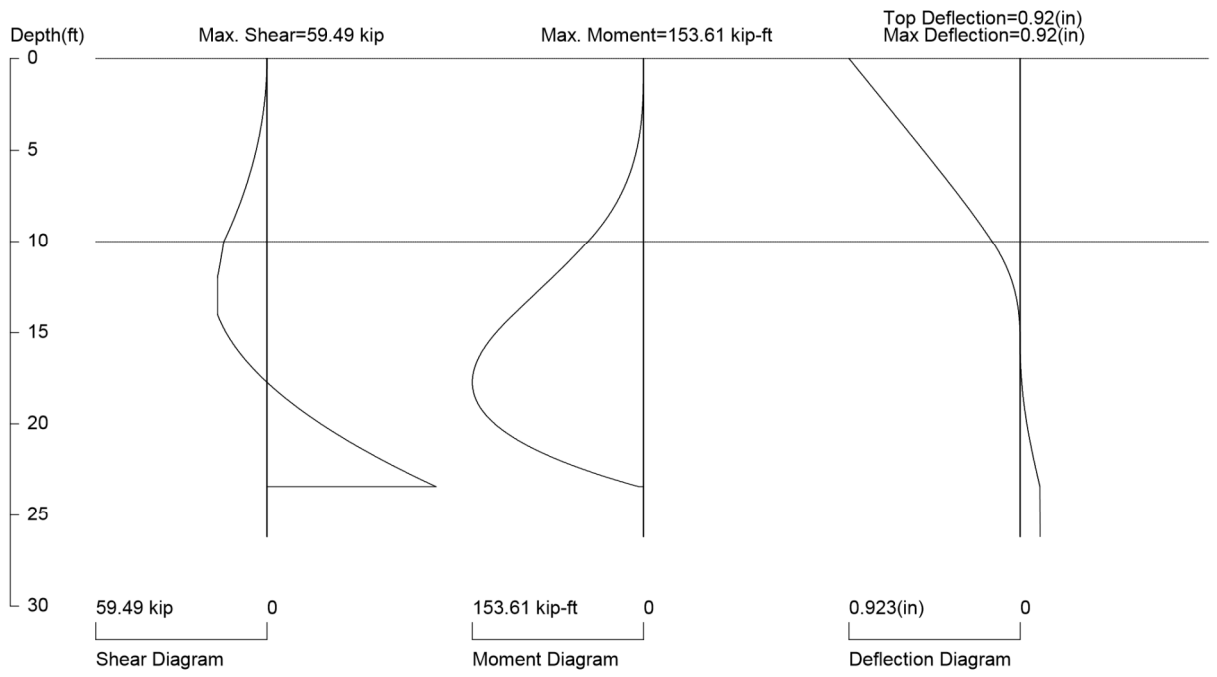
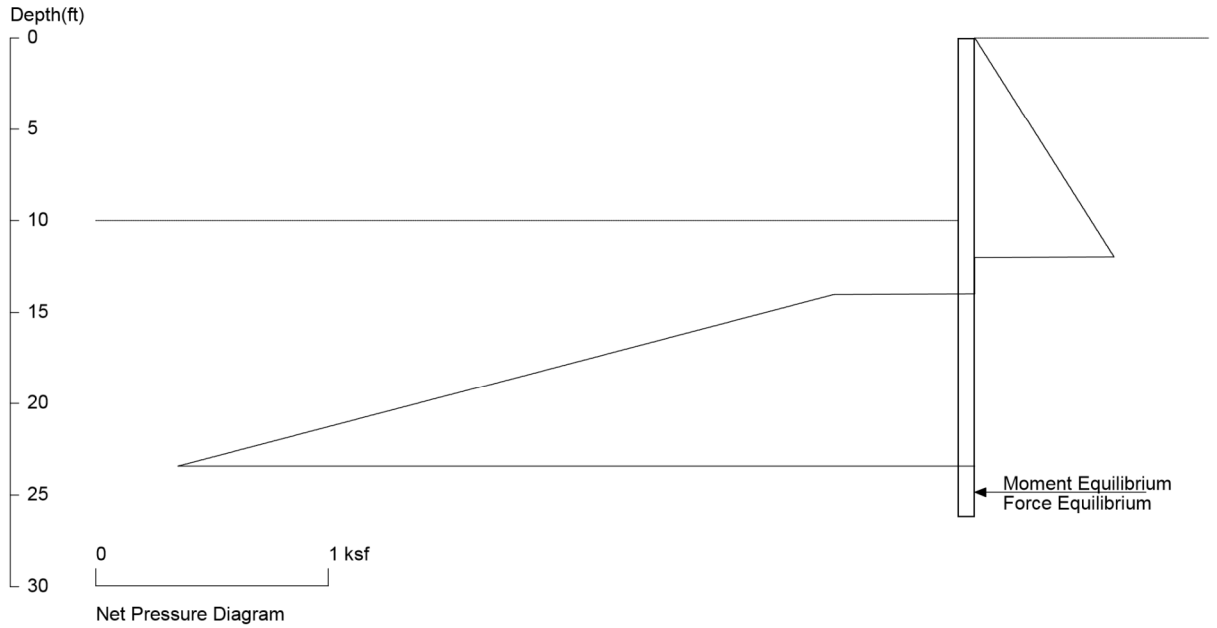
No.	Z depth	Spacing
1	0.00	4.00
2	12.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	12.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile S4



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 6.0 foot or meter

User Input Pile, W14X48: E (ksi)=29000.0, I (in⁴)/pile=484.0

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6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Title: Lundin Residence Shoring
Subtitle: Pile S4

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 10.00
 Pile Diameter: 2.00
 Pile Spacing: 6.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 484.00
 User Input Pile: W14X48

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12	0.600	.05

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14	.6	32	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	6.00
2	10.00	2.00

* PASSIVE SPACE *

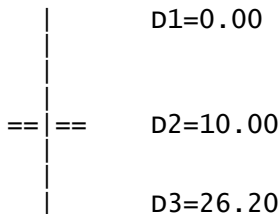
No.	Z depth	Spacing
1	10.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=23.50 WITH EMBEDMENT OF 13.50
 FORCE equilibrium AT DEPTH=26.20 WITH EMBEDMENT OF 16.20

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 13.50
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 16.20

Embedment Information:

If 20% increased, the total design embedment is 16.20
 If 30% increased, the total design embedment is 17.55
 If 40% increased, the total design embedment is 18.90
 If 50% increased, the total design embedment is 20.25

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* MOMENT IN PILE (per pile spacing)*

Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.

Overall Maximum Moment = 153.61 at 17.70

Maximum Shear = 59.49

Moment and Shear are per pile spacing: 6.0 foot or meter

* VERTICAL LOADING *

Vertical Loading from Braces = 0.00

Vertical Loading from External Load = 0.00

Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 153.61 at 17.70

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 55.86 in³/pile = 915.38 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X48 has been found in Soldier Pile list!

(English Units):

Area= 14.1 in. Depth= 13.8 in. Width= 8.03 in. Height= 14 in.

Flange thickness= 0.595 in. Web thickness= 0.34 in.

Ix= 484 in⁴/pile Sx= 70.2 in³/pile Iy= 51.4 in⁴/pile Sy= 12.8 in³/pile

(Metric Units):

Ix= 201.44 x100cm⁴/pile Sx= 1150.37 cm³/pile Iy= 21.39 x100cm⁴/pile Sy= 209.75 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W14X48 is capable to support the shoring!

Top deflection = 0.923(in)

Max. deflection = 0.923(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.50

Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.25

Pile Spacing =6.0, Max. Moment in lagging = 1.12

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.57

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.23

If 30% loading is used for lagging design, Design Pressure = 0.15

Pile Spacing =6.0, Max. Moment in lagging = 0.67

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.34

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.14

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile S4



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Wall Height=10.0 Pile Diameter=2.0 Pile Spacing=6.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=16.20 Min. Pile Length=26.20
 MOMENT IN PILE: Max. Moment=153.61 per Pile Spacing=6.0 at Depth=17.70

PILE SELECTION:
 Request Min. Section Modulus = 55.9 in³/pile=915.38 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66
 W14X48 has Section Modulus = 70.2 in³/pile=1150.37 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.92(in) based on E (ksi)=29000.00 and I (in⁴)/pile=484.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	12	0.600	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
14	.6	32	6.000	.3

ACTIVE SPACING:

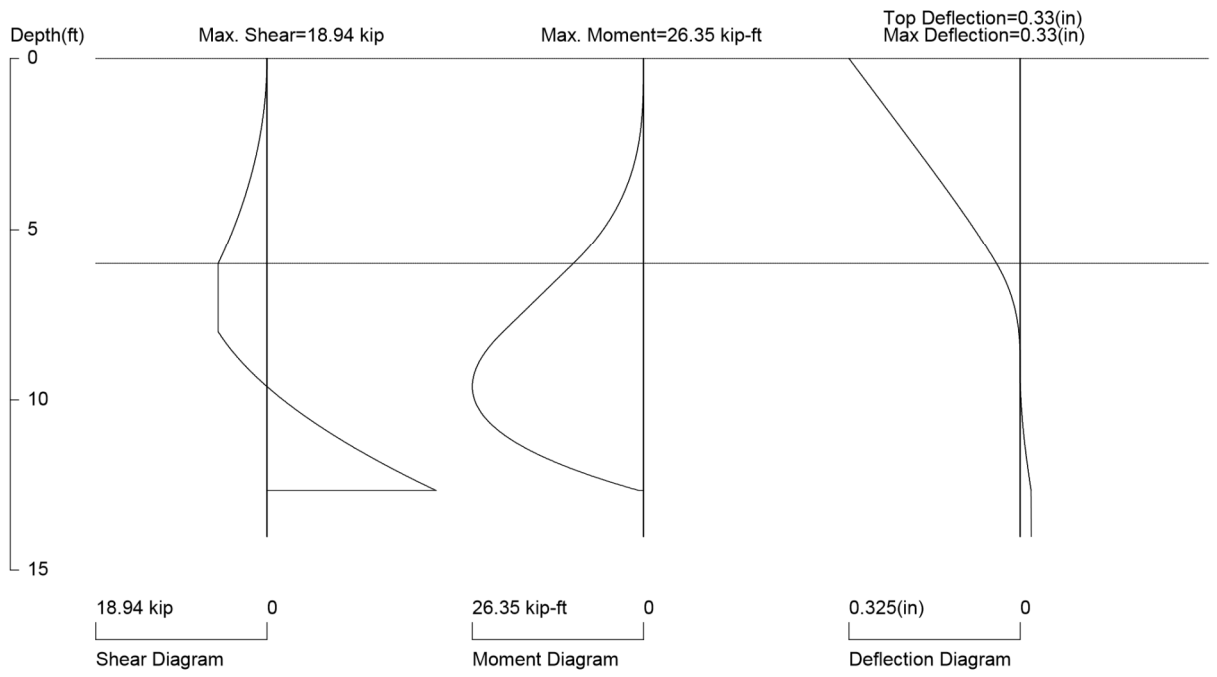
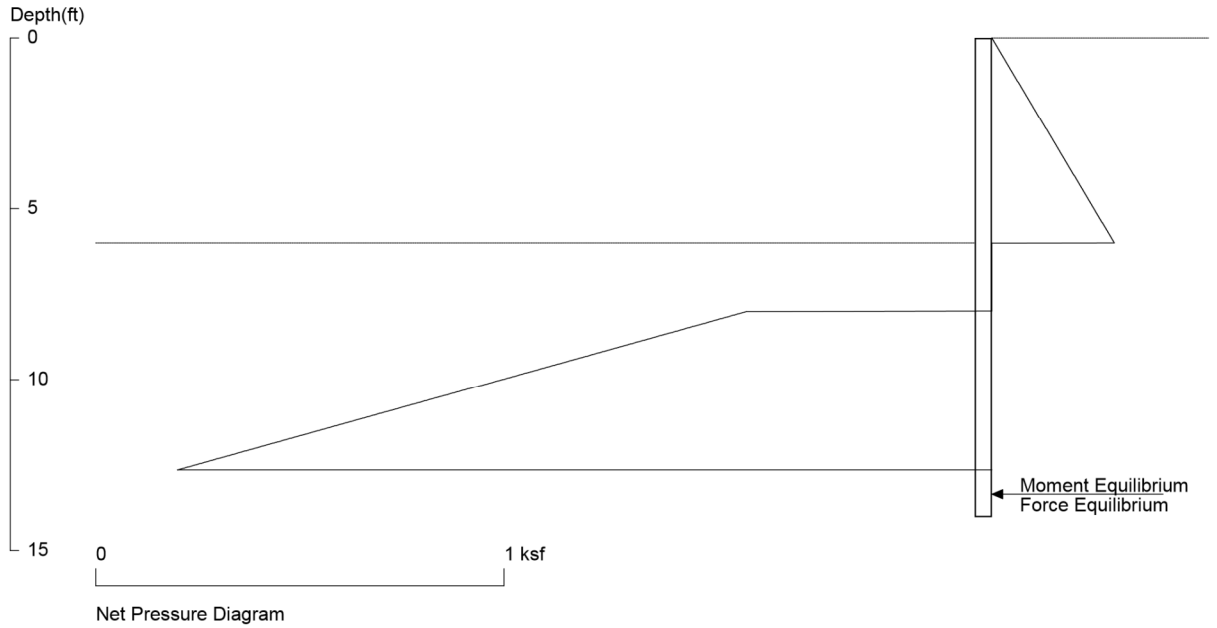
No.	Z depth	Spacing
1	0.00	6.00
2	10.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	10.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in

Lundin Residence Shoring Pile S5



PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 6.0 foot or meter

User Input Pile, W12X14: E (ksi)=29000.0, I (in⁴)/pile=88.6

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3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. Temporary Structures in Construction, Robert T. Ratay (Co-author of Chapter 7: John J. Peirce), McGraw-Hill. 2012
9. AASHTO HB-17, American Association of State and Highway Transportation officials, 2 September 2002

UNITS: width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft³, Deflection - in

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Residence\Calculations\Shoring\Pile S5.sh8

Title: Lundin Residence Shoring
Subtitle: Pile S5

*****INPUT DATA*****

Wall Type: 2. Soldier Pile, Drilled
 wall Height: 6.00
 Pile Diameter: 2.00
 Pile Spacing: 6.00
 Factor of Safety (F.S.): 1.00
 Lateral Support Type (Braces): 1. No
 Top Brace Increase (Multi-Bracing): Add 15%*
 Embedment Option: 1. Yes
 Friction at Pile Tip: No
 Pile Properties:
 Steel Strength, Fy: 50 ksi = 345 MPa
 Allowable Fb/Fy: 0.66
 Elastic Module, E: 29000.00
 Moment of Inertia, I: 88.60
 User Input Pile: W12X14

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	6	0.300	.05

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	8	.6	26	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	6.00
2	6.00	2.00

* PASSIVE SPACE *

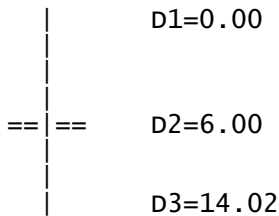
No.	Z depth	Spacing
1	6.00	4.00

*For Tieback: Input1 = Diameter; Input2 = Bond Strength
 *For Plate: Input1 = Diameter; Input2 = Allowable Pressure
 *For Deadman: Input1 = Horz. Width; Input2 = Passive Pressure;
 *For Sheet Pile Anchor: Input1 = Horz. Width; Input2 = Passive Slope;

*****CALCULATION*****

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
 D2 - EXCAVATION BASE
 D3 - PILE TIP

MOMENT equilibrium AT DEPTH=12.68 WITH EMBEDMENT OF 6.68
 FORCE equilibrium AT DEPTH=14.02 WITH EMBEDMENT OF 8.02

The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2

*****RESULTS*****

* EMBEDMENT Notes *

Based on USS Design Manual, first calculate embedment for moment equilibrium, then increased the embedment to get the design depth.
 The embedment for moment equilibrium is 6.68
 The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
 The total design embedment is 8.02

Embedment Information:

If 20% increased, the total design embedment is 8.02
 If 30% increased, the total design embedment is 8.69
 If 40% increased, the total design embedment is 9.36
 If 50% increased, the total design embedment is 10.03

report.out

* MOMENT IN PILE (per pile spacing)*
Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 26.35 at 9.61
Maximum Shear = 18.94
Moment and Shear are per pile spacing: 6.0 foot or meter

* VERTICAL LOADING *
Vertical Loading from Braces = 0.00
Vertical Loading from External Load = 0.00
Total Vertical Loading = 0.00

*****SPECIFIED PILE *****

Overall Maximum Moment = 26.35 at 9.61
The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 9.58 in³/pile = 157.01 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W12X14 has been found in Soldier Pile list!
(English Units):
Area= 4.16 in. Depth= 11.9 in. Width= 3.97 in. Height= 12 in.
Flange thickness= 0.225 in. Web thickness= 0.2 in.
Ix= 88.6 in⁴/pile Sx= 14.9 in³/pile Iy= 2.36 in⁴/pile Sy= 1.19 in³/pile
(Metric Units):
Ix= 36.88 x100cm⁴/pile Sx= 244.17 cm³/pile Iy= 0.98 x100cm⁴/pile Sy= 19.50 cm³/pile

The pile selection is based on the magnitude of the moment only. Axial force is neglected.

W12X14 is capable to support the shoring!
Top deflection = 0.325(in)
Max. deflection = 0.325(in)

***** LAGGING SIZE ESTIMATION *****

Max. Pressure above base = 0.30
Piles are more rigid than timber lagging, due to arching, only portion of pressures are acting to lagging, 30-50% loading is suggested.

If 50% loading is used for lagging design, Design Pressure = 0.15

Pile Spacing =6.0, Max. Moment in lagging = 0.67

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.35

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.14

If 30% loading is used for lagging design, Design Pressure = 0.09

Pile Spacing =6.0, Max. Moment in lagging = 0.40

For 4"x12" Timber, Section Modules S=23.47 in³. The request allowable bending strength, fb=M/S=0.21

For 6"x12" Timber, Section Modules S=57.98 in³. The request allowable bending strength, fb=M/S=0.08

Unit: Pressure: ksf, Spacing: ft, Moment: kip-ft, Bending Strength, fb: ksi

Lundin Residence Shoring Pile S5



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Wall Height=6.0 Pile Diameter=2.0 Pile Spacing=6.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=8.02 Min. Pile Length=14.02
 MOMENT IN PILE: Max. Moment=26.35 per Pile Spacing=6.0 at Depth=9.61

PILE SELECTION:
 Request Min. Section Modulus = 9.6 in³/pile=157.01 cm³/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66
 W12X14 has Section Modulus = 14.9 in³/pile=244.17 cm³/pile. It is greater than Min. Requirements!
 Top Deflection = 0.33(in) based on E (ksi)=29000.00 and I (in⁴)/pile=88.6

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	6	0.300	.05

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
8	.6	26	6.000	.3

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	6.00
2	6.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	6.00	4.00

UNITS: Width, Spacing, Diameter, Length, and Depth - ft; Force - kip; Moment - kip-ft
 Friction, Bearing, and Pressure - ksf; Pres. Slope - kip/ft³; Deflection - in