QUANTUM
CONSULTING ENGINEERS

March 11, 2019

STRUCTURAL CALCULATIONS - SHORING
(Permit Submittal)

LEE-BOYLE RESIDENCE
4150 Boulevard Place
Mercer Island, WA 98040

Quantum Job Number: 19052.01

Prepared for:
STUART SILK ARCHITECTS
2400 North 45TH Street
Seattle, WA 98103

Prepared by:
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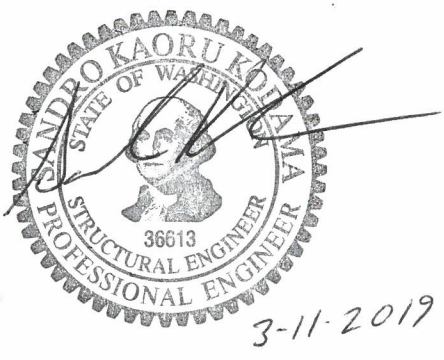

3-11-2019

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DESIGN CRITERIA

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 GEODIMENSIONS, INC. DATED SEPTEMBER 3, 2015.
   B. GEOTECHNICAL ENGINEERING INVESTIGATION REPORT ES-4134.01 BY EARTH SOLUTIONS NW, INC. DATED AUGUST 13, 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 FORPILE 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 LEAN CONCRETE GROUT
2,500	5 SACKS	-	PILE STRUCTURAL CONCRETE GROUT

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	44 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 (Fpu = 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:

USE	GRADE	MAX. SPAN	SIZE	DEPTH BELOW GRADE
TIMBER LAGGING	HEM-FIR OR DF-L NO. 2	8'-0"	4x12	0'-0" TO 13'-4"

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.

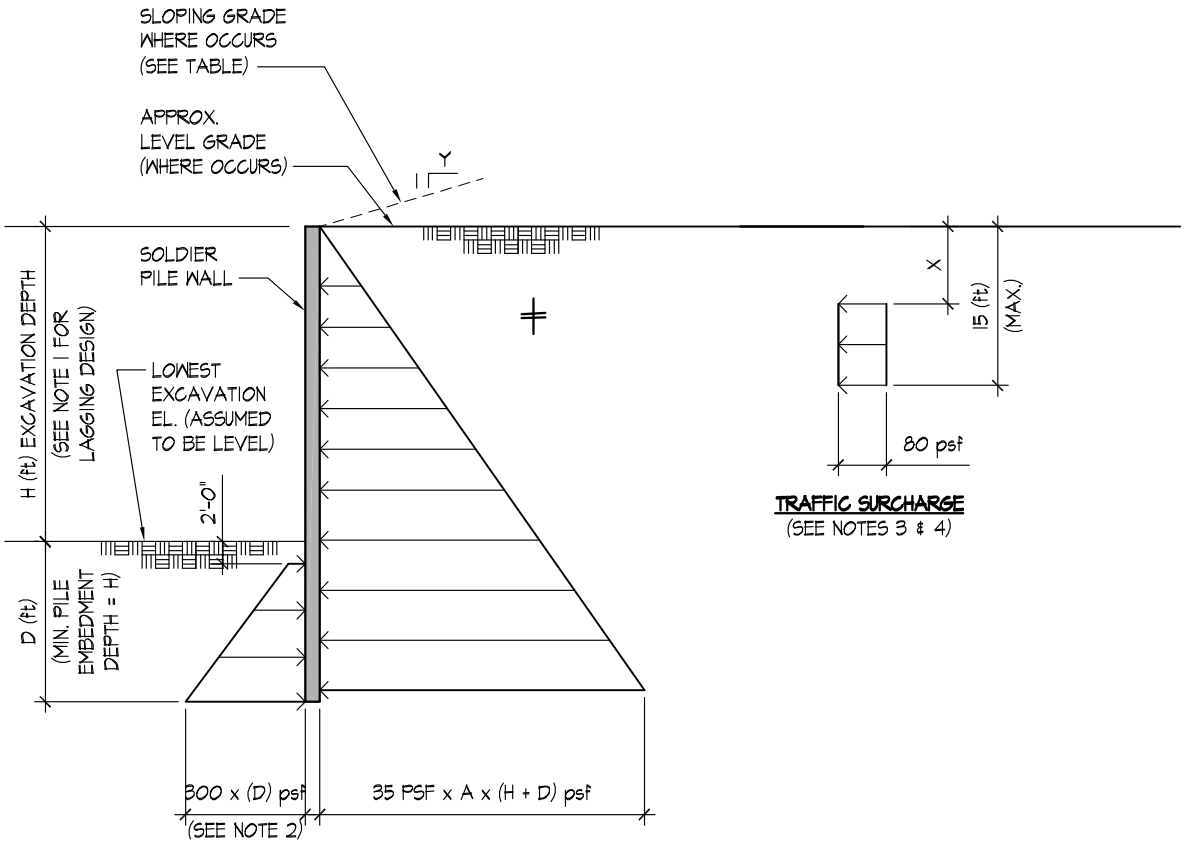
20. LAGGING: TIMBER LAGGING SHALL BE INSTALLED IN ALL AREAS. VOIDS BETWEEN LAGGING AND SOIL SHALL BE BACKFILLED.

21. 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.



PASSIVE PRESSURE **ACTIVE PRESSURE**

NOTES:

1. 50% OF THE LATERAL EARTH PRESSURE USED TO DESIGN TIMBER LAGGING.
2. PASSIVE PRESSURE ACTS OVER 2.0 TIMES THE GROUTED SOLDIER PILE DIAMETER.
3. ACTIVE AND AT-REST SOIL PRESSURES ACT OVER THE PILE SPACING ABOVE AND PILE DIAMETER BELOW BOTTOM OF EXCAVATION. IT IS ASSUMED THAT NO HYDROSTATIC PRESSURES ACT ON THE BACK OF SHORING.
4. 80 PSF UNIFORM SURCHARGE NOT APPLIED AT SLOPED BACKSLOPE CONDITION.

EARTH PRESSURE FACTOR FOR BACKSLOPE	
BACKSLOPE Y:1	EARTH PRESSURE FACTOR, A
FLAT	1.00
2 : 1	1.35
1.5 : 1	1.50

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SHORING WALL DESIGN

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SHORING INSTALLATION

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    3" LATERALLY.

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SANDRO K. KODAMA
STATE OF WASHINGTON
36633
STRUCTURAL ENGINEER
PROFESSIONAL ENGINEER

DESIGN	FRU, TVM, MDA
DRAWN	SSN
CHECKED	SKK
SHEET ISSUE DATE - 3/11/19	
DRAWING SETS	
DATE	DESCRIPTION
3/11/19	PERMIT SET
REVISIONS	

Stuart Silk Architects
2400 N. 45th St.
Seattle, WA 98103
WWW.STUARTSILK.COM

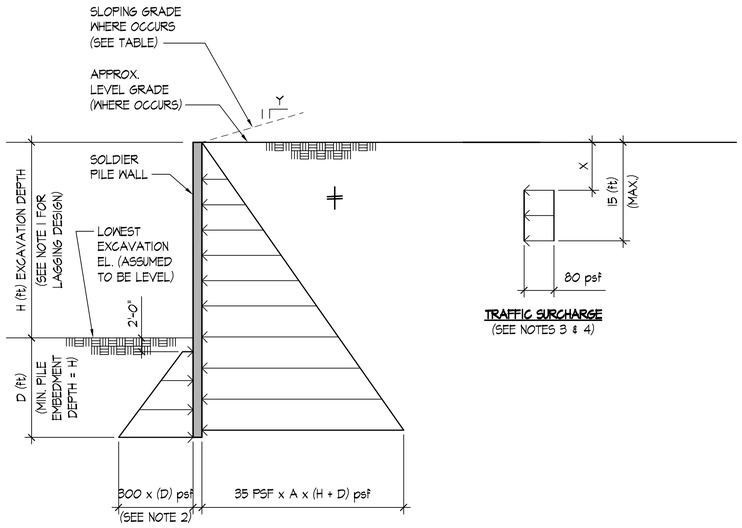
LEE-BOYLE

4150 BOULEVARD PLACE
MERCER ISLAND, WA 98040

PROJECT NO. 19052.01

TYPICAL SHORING NOTES

SH1.0



NOTES:

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3. ACTIVE AND AT-REST SOIL PRESSURES ACT OVER THE PILE SPACING ABOVE AND PILE DIAMETER BELOW BOTTOM OF EXCAVATION. IT IS ASSUMED THAT NO HYDROSTATIC PRESSURES ACT ON THE BACK OF SHORING.
4. 80 PSF UNIFORM SURCHARGE NOT APPLIED AT SLOPED BACKSLOPE CONDITION.

EARTH PRESSURE FACTOR FOR BACKSLOPE	
BACKSLOPE Y:1	EARTH PRESSURE FACTOR, A
FLAT	1.00
2 : 1	1.35
1.5 : 1	1.50

SOIL PRESSURE DIAGRAM FOR CANTILEVERED SOLDIER PILE SHORING WALLS — SCALE: NONE — 6

DETAIL — SCALE: 3/4"=1'-0" — 3

DETAIL — SCALE: NONE — 4

DETAIL — SCALE: 3/4"=1'-0" — 7

DETAIL — SCALE: NONE — 8

DETAIL — SCALE: 3/4"=1'-0" — 9

DETAIL — SCALE: 3/4"=1'-0" — 10

DETAIL — SCALE: 3/4"=1'-0" — 11

DETAIL — SCALE: 3/4"=1'-0" — 12

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SANDRO K. KODAMA — STATE OF WASHINGTON — 36633 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DESIGN	FRU, TVM, MDA
DRAWN	SSN
CHECKED	SKK
SHEET ISSUE DATE - 3/11/19	

DRAWING SETS

DATE	DESCRIPTION
3/11/19	PERMIT SET

REVISIONS

Stuart Silk Architects
2400 N. 45th St.
Seattle, WA 98103
WWW.STUARTSILK.COM

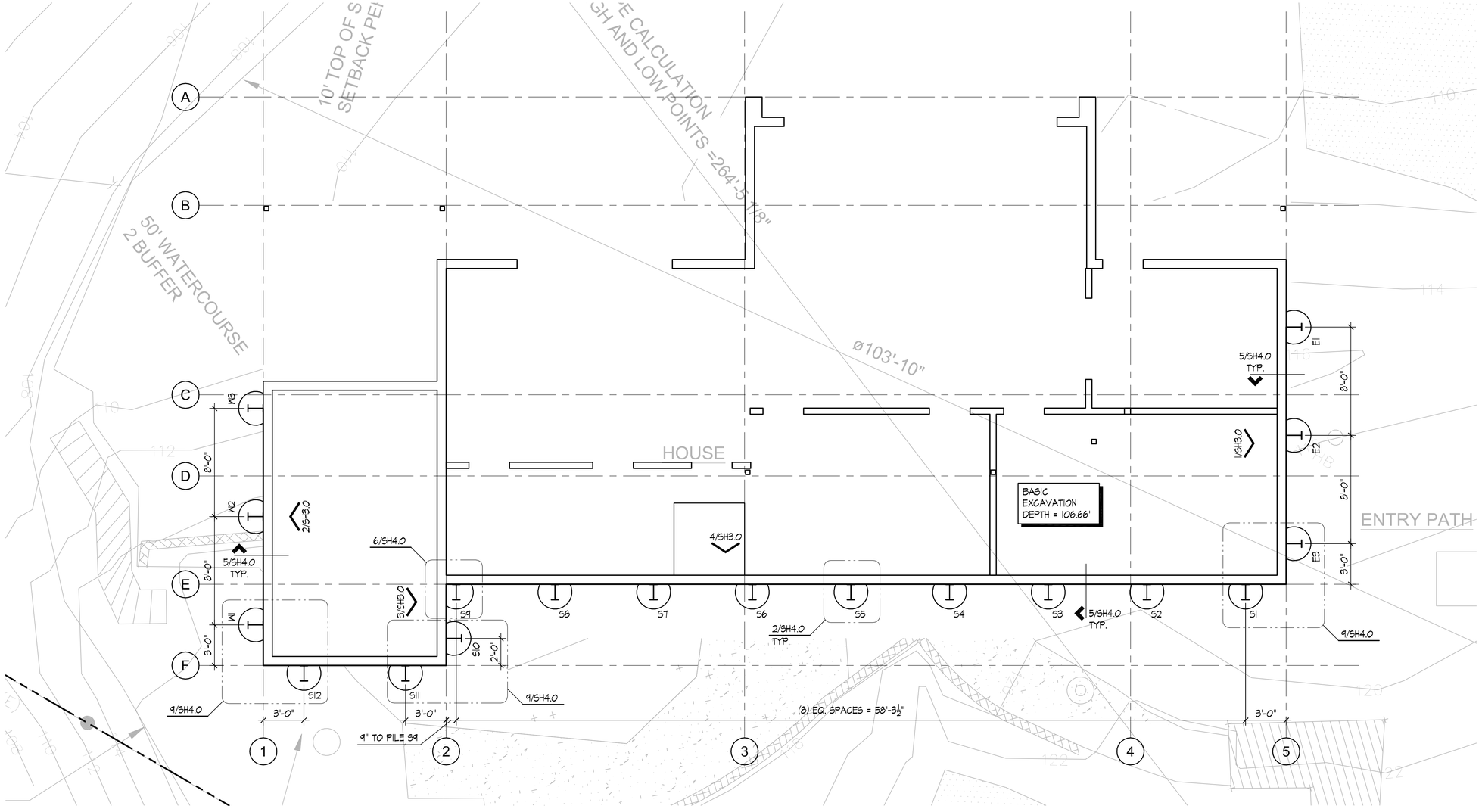
LEE-BOYLE

4150 BOULEVARD PLACE
MERCER ISLAND, WA 98040

PROJECT NO. 19052.01

TYPICAL SHORING DIAGRAM

SH1.1



SHORING NOTES:

1. SEE SHEETS SH1.0 AND SH1.1 FOR GENERAL NOTES AND SOIL DIAGRAM.
2. SEE SHEET SH3.0 FOR SHORING WALL ELEVATIONS.
3. SEE 8/SH4.0 FOR SHORING SOLDIER PILE 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.

SHORING PLAN

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

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STATE OF WASHINGTON
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PROFESSIONAL ENGINEER

DESIGN	FRU, TVM, MDA
DRAWN	SSN
CHECKED	SKK
SHEET ISSUE DATE - 3/11/19	
DRAWING SETS	
DATE	DESCRIPTION
3/11/19	PERMIT SET

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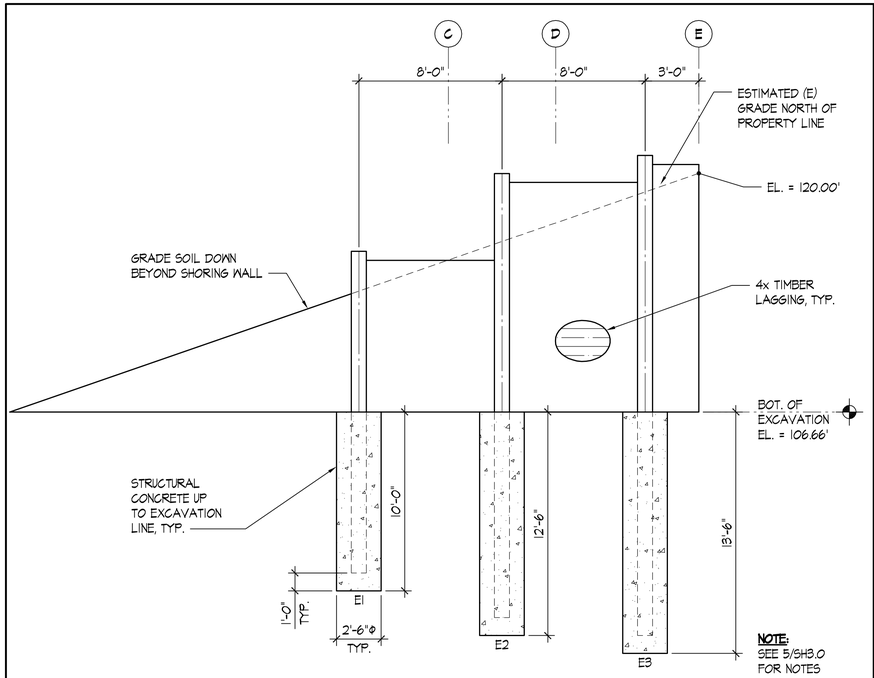
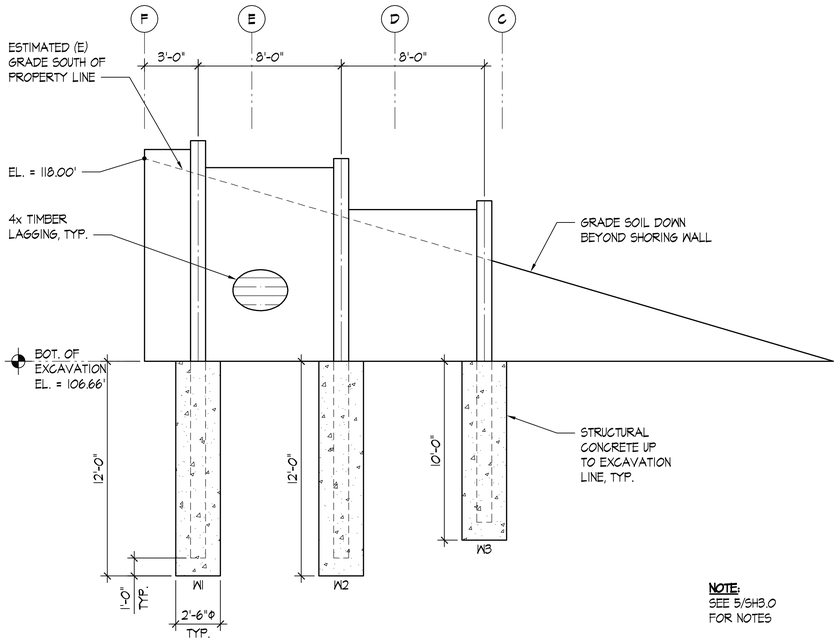
PROJECT NO. 19052.01

SHORING PLAN

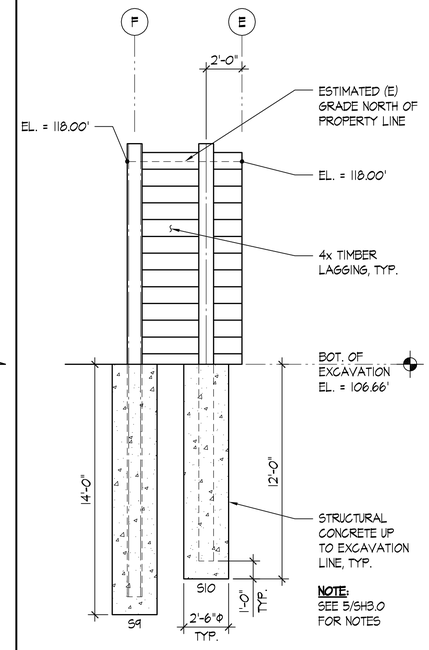
SH2.0



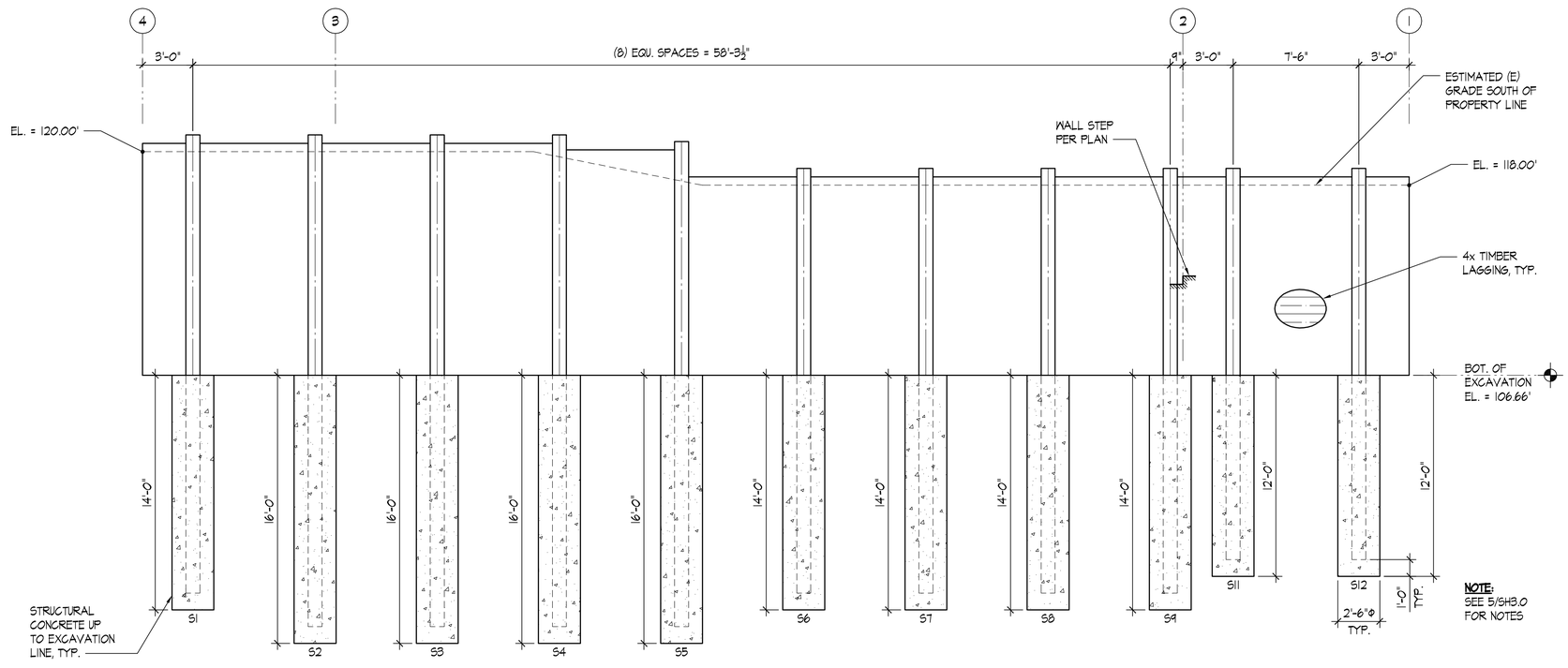
EAST SHORING WALL ELEVATION — SCALE: 1/4"=1'-0" | 1



WEST SHORING WALL ELEVATION — SCALE: 1/4"=1'-0" | 2



SOUTHWEST SHORING WALL ELEVATION — SCALE: 1/4"=1'-0" | 3



SOUTH SHORING WALL ELEVATION — SCALE: 1/4"=1'-0" | 4

SHORING NOTES:

1. W1 INDICATES SOLDIER PILE PER SCHEDULE ON 8/SH4.0.
2. SPOT GRADE ELEVATIONS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.
3. CONTRACTOR TO VERIFY AND COORDINATE ELEVATIONS & PILE HEIGHT/DEPTH WITH FIELD CONDITIONS.

SHORING NOTES — SCALE: 1/4"=1'-0" | 5

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DRAWING SETS

DATE	DESCRIPTION
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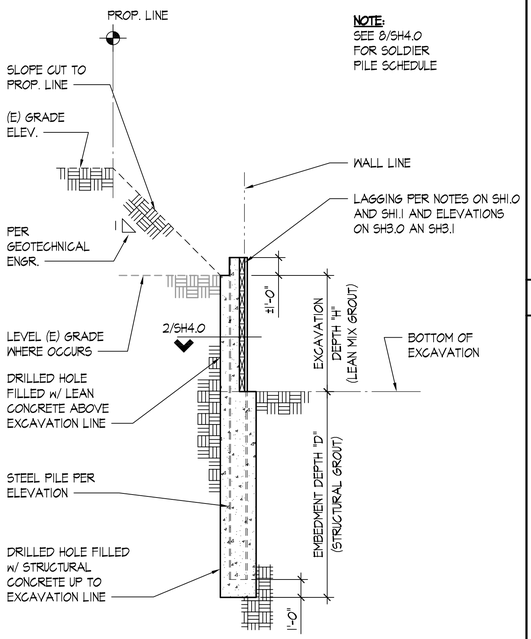
PROJECT NO. 19052.01

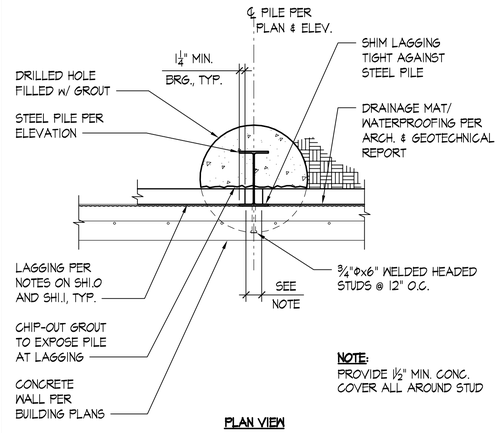
SHORING ELEVATIONS

SH3.0



NOTE:
SEE 8/SH4.0 FOR SOLDIER PILE SCHEDULE

TYPICAL SOLDIER PILE SHORING SECTION — SCALE: NONE — 5



NOTE:
PROVIDE 1½" MIN. CONC. COVER ALL AROUND STUD

PLAN VIEW

TYPICAL PERMANENT SOLDIER PILE — SCALE: NONE — 2

PLAN VIEW

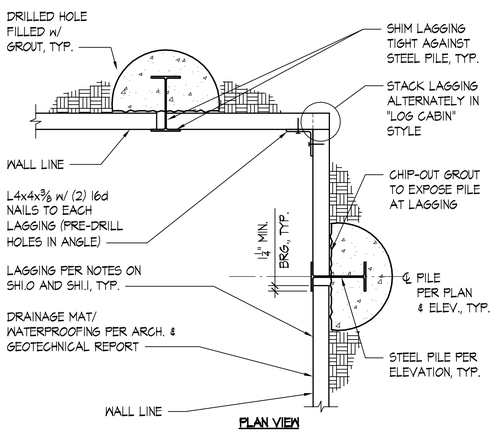
TYPICAL INSIDE CORNER — SCALE: NONE — 6

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
S1	30"	W18x55	106.66'	14'-0"	13'-4"	27'-4"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S2 - S4	30"	W18x65	106.66'	16'-0"	13'-4"	29'-4"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S5	30"	W18x65	106.66'	16'-0"	12'-4"	28'-4"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S6 - S9	30"	W18x50	106.66'	14'-0"	11'-4"	25'-4"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S10	30"	W18x35	106.66'	12'-0"	11'-4"	23'-4"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
S11 - S12	30"	W18x40	106.66'	12'-0"	11'-4"	23'-4"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
E1	30"	W16x26	106.66'	10'-0"	7'-0"	18'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
E2	30"	W16x40	106.66'	12'-6"	9'-6"	25'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
E3	30"	W18x50	106.66'	13'-6"	12'-4"	26'-10"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
W1	30"	W18x50	106.66'	12'-0"	11'-0"	23'-4"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
W2	30"	W16x36	106.66'	12'-0"	9'-0"	22'-6"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE
W3	30"	W14x22	106.66'	10'-0"	6'-0"	18'-0"	PILE AND LAGGING EXTEND ABOVE FINISHED GRADE

NOTE:
CONTRACTOR TO COORDINATE FINISH GRADE ELEVATION AND PILE HEIGHT w/ FIELD CONDITIONS

SOLDIER PILE SCHEDULE — SCALE: NONE — 8



PLAN VIEW

TYPICAL OUTSIDE CORNER — SCALE: NONE — 9

DETAIL — SCALE: NONE — 10

DETAIL — SCALE: NONE — 11

DETAIL — SCALE: NONE — 12

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DESIGN	FRU, TVM, MDA
DRAWN	SSN
CHECKED	SKK
SHEET ISSUE DATE - 3/11/19	
DRAWING SETS	
DATE	DESCRIPTION
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PROJECT NO. 19052.01

TYPICAL SHORING SCHEDULE AND DETAILS

SH4.0

****

SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

www.civiltech.com

****

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: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles E1 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles E1 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 7.00
Pile Diameter: 2.50
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: .88
Elastic Module, E: 29000.00

Moment of Inertia, I: 301.00
User Input Pile: W16X26

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	7	0.331	.04725
2	0	.049	7	0.049	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	9	.8	27	8.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	8.00
2	7.00	2.50

* PASSIVE SPACE *

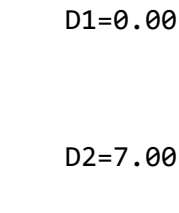
No.	Z depth	Spacing
1	7.00	5.00

*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



```
        |
        |      D3=16.15

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

   MOMENT equilibrium   AT DEPTH=14.63  WITH EMBEDMENT OF 7.63
   FORCE equilibrium   AT DEPTH=16.15  WITH EMBEDMENT OF 9.15

   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 7.63
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 9.15

Embedment Information:
If 20% increased, the total design embedment is 9.15
If 30% increased, the total design embedment is 9.92
If 40% increased, the total design embedment is 10.68
If 50% increased, the total design embedment is 11.44


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 68.57 at 11.00
Maximum Shear = 42.01
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 = 68.57 at 11.00
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 18.70 in3/pile = 306.44 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=.88

W16X26 has been found in Soldier Pile list!
(English Units):
Area= 7.68 in. Depth= 15.7 in. Width= 5.5 in. Height= 16 in.
Flange thickness= 0.345 in. Web thickness= 0.25 in.
Ix= 301 in4/pile Sx= 38.4 in3/pile Iy= 9.59 in4/pile Sy= 3.49 in3/pile
(Metric Units):
Ix= 125.28 x100cm4/pile Sx= 629.26 cm3/pile Iy= 3.99 x100cm4/pile Sy= 57.19 cm3/pile

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

W16X26 is capable to support the shoring!
Top deflection = 0.321(in)
Max. deflection = 0.321(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.38
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 = 0.19
Pile Spacing =8.0, Max. Moment in lagging = 1.52
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.78
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.31

If 30% loading is used for lagging design, Design Pressure = 0.11
Pile Spacing =8.0, Max. Moment in lagging = 0.91
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.47
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.19

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

****

SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

www.civiltech.com

****

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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
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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
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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: Lee-Boyle Residence Shoring
Subtitle: Piles E1 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 7.00
Pile Diameter: 2.50
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: 301.00
User Input Pile: W16X26

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	7	0.331	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	9	.6	27	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	8.00
2	7.00	2.50

* PASSIVE SPACE *

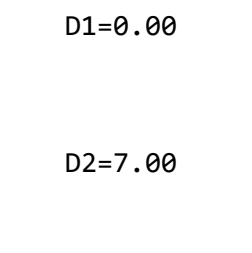
No.	Z depth	Spacing
1	7.00	5.00

*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



```
        |      D3=16.16

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

   MOMENT equilibrium   AT DEPTH=14.63  WITH EMBEDMENT OF 7.63
   FORCE equilibrium   AT DEPTH=16.16  WITH EMBEDMENT OF 9.16

   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 7.63
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 9.16

Embedment Information:
If 20% increased, the total design embedment is 9.16
If 30% increased, the total design embedment is 9.92
If 40% increased, the total design embedment is 10.69
If 50% increased, the total design embedment is 11.45


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 50.66 at 11.04
Maximum Shear = 31.31
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 = 50.66 at 11.04
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 18.42 in3/pile = 301.87 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W16X26 has been found in Soldier Pile list!
(English Units):
Area= 7.68 in. Depth= 15.7 in. Width= 5.5 in. Height= 16 in.
Flange thickness= 0.345 in. Web thickness= 0.25 in.
Ix= 301 in4/pile Sx= 38.4 in3/pile Iy= 9.59 in4/pile Sy= 3.49 in3/pile
(Metric Units):
Ix= 125.28 x100cm4/pile Sx= 629.26 cm3/pile Iy= 3.99 x100cm4/pile Sy= 57.19 cm3/pile

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

W16X26 is capable to support the shoring!
Top deflection = 0.232(in)
Max. deflection = 0.232(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.33
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 = 0.17
Pile Spacing =8.0, Max. Moment in lagging = 1.32
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.68
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.27

If 30% loading is used for lagging design, Design Pressure = 0.10
Pile Spacing =8.0, Max. Moment in lagging = 0.79
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=0.16

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

****

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****

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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: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles E2 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles E2 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 9.50
Pile Diameter: 2.50
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: .88
Elastic Module, E: 29000.00

Moment of Inertia, I: 518.00
User Input Pile: W16X40

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	9.5	0.449	.04725
2	0	.067	9.5	0.067	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	11.5	.8	29.5	8.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	8.00
2	9.50	2.50

* PASSIVE SPACE *

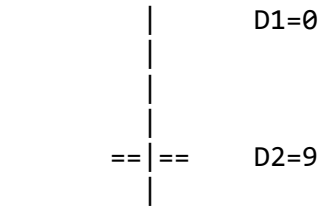
No.	Z depth	Spacing
1	9.50	5.00

*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



```
        |
        |      D3=21.52

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

   MOMENT equilibrium   AT DEPTH=19.51  WITH EMBEDMENT OF 10.01
   FORCE equilibrium   AT DEPTH=21.52  WITH EMBEDMENT OF 12.02
```

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 10.01
The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
The total desigh embedment is 12.02

Embedment Information:
If 20% increased, the total design embedment is 12.02
If 30% increased, the total design embedment is 13.02
If 40% increased, the total design embedment is 14.02
If 50% increased, the total design embedment is 15.02

* MOMENT IN PILE (per pile spacing)*
Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 162.01 at 14.61
Maximum Shear = 73.79
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 = 162.01 at 14.61
The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 44.19 in3/pile = 724.07 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=.88

W16X40 has been found in Soldier Pile list!
(English Units):
Area= 11.8 in. Depth= 16 in. Width= 7 in. Height= 16 in.
Flange thickness= 0.505 in. Web thickness= 0.305 in.
Ix= 518 in4/pile Sx= 64.7 in3/pile Iy= 28.9 in4/pile Sy= 8.25 in3/pile
(Metric Units):
Ix= 215.59 x100cm4/pile Sx= 1060.24 cm3/pile Iy= 12.03 x100cm4/pile Sy= 135.19 cm3/pile

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

W16X40 is capable to support the shoring!
Top deflection = 0.811(in)
Max. deflection = 0.811(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.52
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 = 0.26
Pile Spacing =8.0, Max. Moment in lagging = 2.06
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=1.05
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.43

If 30% loading is used for lagging design, Design Pressure = 0.15
Pile Spacing =8.0, Max. Moment in lagging = 1.24
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.63
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.26

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

****

SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

www.civiltech.com

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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: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles E2 Soil Only.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles E2 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 9.50
Pile Diameter: 2.50
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: 518.00
User Input Pile: W16X40

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	9.5	0.449	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	11.5	.6	29.5	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	8.00
2	9.50	2.50

* PASSIVE SPACE *

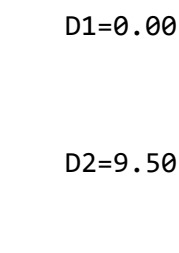
No.	Z depth	Spacing
1	9.50	5.00

*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



```
        |      D3=21.51

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

   MOMENT equilibrium   AT DEPTH=19.51  WITH EMBEDMENT OF 10.01
   FORCE equilibrium   AT DEPTH=21.51  WITH EMBEDMENT OF 12.01

   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 10.01
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 12.01

Embedment Information:
If 20% increased, the total design embedment is 12.01
If 30% increased, the total design embedment is 13.01
If 40% increased, the total design embedment is 14.01
If 50% increased, the total design embedment is 15.02


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 119.16 at 14.67
Maximum Shear = 54.85
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 = 119.16 at 14.67
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 43.33 in3/pile = 710.08 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W16X40 has been found in Soldier Pile list!
(English Units):
Area= 11.8 in. Depth= 16 in. Width= 7 in. Height= 16 in.
Flange thickness= 0.505 in. Web thickness= 0.305 in.
Ix= 518 in4/pile Sx= 64.7 in3/pile Iy= 28.9 in4/pile Sy= 8.25 in3/pile
(Metric Units):
Ix= 215.59 x100cm4/pile Sx= 1060.24 cm3/pile Iy= 12.03 x100cm4/pile Sy= 135.19 cm3/pile

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

W16X40 is capable to support the shoring!
Top deflection = 0.573(in)
Max. deflection = 0.573(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 =8.0, Max. Moment in lagging = 1.79
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.92
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.37

If 30% loading is used for lagging design, Design Pressure = 0.13
Pile Spacing =8.0, Max. Moment in lagging = 1.08
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.55
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.22

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

****

SHORING WALL CALCULATION SUMMARY
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****

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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
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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: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles E3 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles E3 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 12.33
Pile Diameter: 2.50
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: 800.00
User Input Pile: W18X50

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12.33	0.583	.04725
2	0	.0863	12.33	0.086	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14.33	.8	22.33	4.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	5.50
2	12.33	2.50

* PASSIVE SPACE *

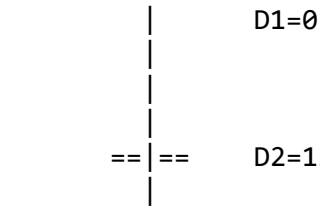
No.	Z depth	Spacing
1	12.33	5.00

*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



```
        |
        |      D3=25.60

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

MOMENT equilibrium AT DEPTH=23.39 WITH EMBEDMENT OF 11.06
FORCE equilibrium AT DEPTH=25.60 WITH EMBEDMENT OF 13.27

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 11.06
The program calculates an embedment for moment equilibrium, then increase the embedment by 1.2
The total desigh embedment is 13.27

Embedment Information:
If 20% increased, the total design embedment is 13.27
If 30% increased, the total design embedment is 14.38
If 40% increased, the total design embedment is 15.48
If 50% increased, the total design embedment is 16.59

* MOMENT IN PILE (per pile spacing)*
Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 219.24 at 17.77
Maximum Shear = 70.40
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 = 219.24 at 17.77
The pile selection is based on the magnitude of the moment only. Axial force is neglected.

Request Min. Section Modulus = 79.72 in3/pile = 1306.41 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W18X50 has been found in Soldier Pile list!
(English Units):
Area= 14.7 in. Depth= 18 in. Width= 7.5 in. Height= 18 in.
Flange thickness= 0.57 in. Web thickness= 0.355 in.
Ix= 800 in4/pile Sx= 88.9 in3/pile Iy= 40.1 in4/pile Sy= 10.7 in3/pile
(Metric Units):
Ix= 332.96 x100cm4/pile Sx= 1456.80 cm3/pile Iy= 16.69 x100cm4/pile Sy= 175.34 cm3/pile

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

W18X50 is capable to support the shoring!
Top deflection = 1.096(in)
Max. deflection = 1.096(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.67
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 = 0.33
Pile Spacing =5.5, Max. Moment in lagging = 1.26
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.65
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.26

If 30% loading is used for lagging design, Design Pressure = 0.20
Pile Spacing =5.5, Max. Moment in lagging = 0.76
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.39
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.16

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

****

SHORING WALL CALCULATION SUMMARY
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****

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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
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4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
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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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Title: Lee-Boyle Residence Shoring
Subtitle: Piles E3 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 12.33
Pile Diameter: 2.50
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: 800.00
User Input Pile: W18X50

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12.33	0.583	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14.33	.6	22.33	3.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	5.50
2	12.33	2.50

* PASSIVE SPACE *

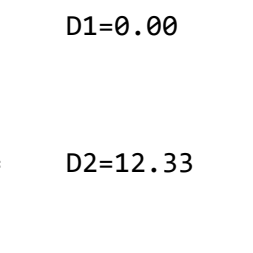
No.	Z depth	Spacing
1	12.33	5.00

*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



```
        |      D3=25.59

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

   MOMENT equilibrium   AT DEPTH=23.38  WITH EMBEDMENT OF 11.05
   FORCE equilibrium   AT DEPTH=25.59  WITH EMBEDMENT OF 13.26

   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 11.05
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 13.26

Embedment Information:
If 20% increased, the total design embedment is 13.26
If 30% increased, the total design embedment is 14.36
If 40% increased, the total design embedment is 15.47
If 50% increased, the total design embedment is 16.57


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 160.74 at 17.84
Maximum Shear = 52.25
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 = 160.74 at 17.84
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 58.45 in3/pile = 957.86 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W18X50 has been found in Soldier Pile list!
(English Units):
Area= 14.7 in. Depth= 18 in. Width= 7.5 in. Height= 18 in.
Flange thickness= 0.57 in. Web thickness= 0.355 in.
Ix= 800 in4/pile Sx= 88.9 in3/pile Iy= 40.1 in4/pile Sy= 10.7 in3/pile
(Metric Units):
Ix= 332.96 x100cm4/pile Sx= 1456.80 cm3/pile Iy= 16.69 x100cm4/pile Sy= 175.34 cm3/pile

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

W18X50 is capable to support the shoring!
Top deflection = 0.767(in)
Max. deflection = 0.767(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.58
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 = 0.29
Pile Spacing =5.5, Max. Moment in lagging = 1.10
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.56
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 = 0.17
Pile Spacing =5.5, Max. Moment in lagging = 0.66
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

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: Lee-Boyle Residence Shoring
Subtitle: Piles S1 Soil and Seismic

**********INPUT DATA**********
Wall Type: 2. Soldier Pile, Drilled
Wall Height: 13.33
Pile Diameter: 2.50
Pile Spacing: 5.13
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: .88
Elastic Module, E: 29000.00
Moment of Inertia, I: 890.00
User Input Pile: W18X55

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	13.33	0.633	.0475
2	0	.0933	13.33	0.093	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	15.33	.8	33.33	8.000	.4

```
* ACTIVE SPACE *
 No.    Z depth         Spacing
--------------------------------------------------------------------------------
 1      0.00            5.13
 2      13.33           2.50
--------------------------------------------------------------------------------

* PASSIVE SPACE *
 No.    Z depth         Spacing
--------------------------------------------------------------------------------
 1      13.33           5.00
--------------------------------------------------------------------------------
*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=0.00
         |
         |
         |
      ==|==    D2=13.33
        |
        |
        |      D3=27.06

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

   MOMENT equilibrium   AT DEPTH=24.78  WITH EMBEDMENT OF 11.45
   FORCE equilibrium   AT DEPTH=27.06  WITH EMBEDMENT OF 13.73

   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 11.45
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 13.73

Embedment Information:
If 20% increased, the total design embedment is 13.73
If 30% increased, the total design embedment is 14.88
If 40% increased, the total design embedment is 16.02
If 50% increased, the total design embedment is 17.17
```

```
* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 254.13 at 18.99
Maximum Shear = 98.47
Moment and Shear are per pile spacing: 5.1 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 = 254.13 at 18.99
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.

   Request Min. Section Modulus = 69.31 in3/pile = 1135.74 cm3/pile, Fy= 50 ksi =
345 MPa, Fb/Fy=.88

   W18X55 has been found in Soldier Pile list!
   (English Units):
   Area= 16.2 in.  Depth= 18.1 in.  Width= 7.53 in.  Height= 18 in.
   Flange thickness= 0.63 in.   Web thickness= 0.39 in.
   Ix= 890 in4/pile   Sx= 98.3 in3/pile   Iy= 44.9 in4/pile   Sy= 11.9 in3/pile
   (Metric Units):
   Ix= 370.42 x100cm4/pile   Sx= 1610.84 cm3/pile   Iy= 18.69 x100cm4/pile   Sy=
195.01 cm3/pile



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

   W18X55 is capable to support the shoring!
   Top deflection = 1.301(in)
   Max. deflection = 1.301(in)

********************** LAGGING SIZE ESTIMATION ***********************
Max. Pressure above base = 0.73
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 = 0.36
     Pile Spacing =5.1, Max. Moment in lagging = 1.19
     For 4"x12" Timber, Section Modules S=23.47 in3.  The request allowable bending
strength, fb=M/S=0.61
     For 6"x12" Timber, Section Modules S=57.98 in3.  The request allowable bending
strength, fb=M/S=0.25

     If 30% loading is used for lagging design, Design Pressure = 0.22
     Pile Spacing =5.1, Max. Moment in lagging = 0.72
     For 4"x12" Timber, Section Modules S=23.47 in3.  The request allowable bending
strength, fb=M/S=0.37
     For 6"x12" Timber, Section Modules S=57.98 in3.  The request allowable bending
strength, fb=M/S=0.15

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

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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: Lee-Boyle Residence Shoring
Subtitle: Piles S1 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 13.33
Pile Diameter: 2.50
Pile Spacing: 5.13
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: 800.00
User Input Pile: W18X55

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	13.33	0.630	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	15.33	.6	33.33	6.000	.3

```
* ACTIVE SPACE *
 No.    Z depth         Spacing
-------------------------------------------------------------------------------
 1      0.00            5.13
 2      13.33           2.50
-------------------------------------------------------------------------------

* PASSIVE SPACE *
 No.    Z depth         Spacing
-------------------------------------------------------------------------------
 1      13.33           5.00
-------------------------------------------------------------------------------
*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=0.00
         |
         |
         |
      ==|==    D2=13.33
        |
        |
        |      D3=27.03

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

   MOMENT equilibrium   AT DEPTH=24.74  WITH EMBEDMENT OF 11.41
   FORCE equilibrium   AT DEPTH=27.03  WITH EMBEDMENT OF 13.70

   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 11.41
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 13.70

Embedment Information:
If 20% increased, the total design embedment is 13.70
If 30% increased, the total design embedment is 14.84
If 40% increased, the total design embedment is 15.98
If 50% increased, the total design embedment is 17.12
```

```
* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 185.24 at 19.05
Maximum Shear = 72.78
Moment and Shear are per pile spacing: 5.1 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 = 185.24 at 19.05
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.

   Request Min. Section Modulus = 67.36 in3/pile = 1103.84 cm3/pile, Fy= 50 ksi =
345 MPa, Fb/Fy=0.66

   W18X55 has been found in Soldier Pile list!
   (English Units):
   Area= 16.2 in.  Depth= 18.1 in.  Width= 7.53 in.  Height= 18 in.
   Flange thickness= 0.63 in.   Web thickness= 0.39 in.
   Ix= 890 in4/pile   Sx= 98.3 in3/pile   Iy= 44.9 in4/pile   Sy= 11.9 in3/pile
   (Metric Units):
   Ix= 370.42 x100cm4/pile   Sx= 1610.84 cm3/pile   Iy= 18.69 x100cm4/pile   Sy=
195.01 cm3/pile



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

   W18X55 is capable to support the shoring!
   Top deflection = 0.901(in)
   Max. deflection = 0.901(in)

*********************** LAGGING SIZE ESTIMATION ***********************
Max. Pressure above base = 0.63
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 = 0.31
     Pile Spacing =5.1, Max. Moment in lagging = 1.04
     For 4"x12" Timber, Section Modules S=23.47 in3.  The request allowable bending
strength, fb=M/S=0.53
     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 = 0.19
     Pile Spacing =5.1, Max. Moment in lagging = 0.62
     For 4"x12" Timber, Section Modules S=23.47 in3.  The request allowable bending
strength, fb=M/S=0.32
     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
```

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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: Lee-Boyle Residencd Shoring
Subtitle: Piles S2-S4 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 13.33
Pile Diameter: 2.50
Pile Spacing: 7.33
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: 0.88
Elastic Module, E: 29000.00

Moment of Inertia, I: 1070.0
User Input Pile: W18x65

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	13.33	0.630	.04725
2	0	.093	13.33	0.093	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	15.33	.8	33.33	8.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.33
2	13.33	2.50

* PASSIVE SPACE *

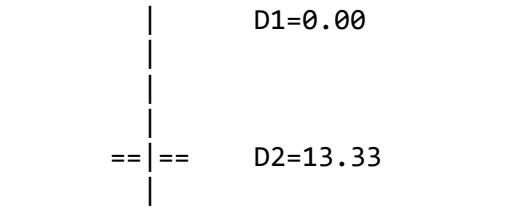
No.	Z depth	Spacing
1	13.33	5.00

*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



```
        |
        |      D3=29.21

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

   MOMENT equilibrium   AT DEPTH=26.56  WITH EMBEDMENT OF 13.23
   FORCE equilibrium   AT DEPTH=29.21  WITH EMBEDMENT OF 15.88

   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 13.23
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 15.88

Embedment Information:
If 20% increased, the total design embedment is 15.88
If 30% increased, the total design embedment is 17.20
If 40% increased, the total design embedment is 18.53
If 50% increased, the total design embedment is 19.85


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 385.59 at 19.95
Maximum Shear = 130.59
Moment and Shear are per pile spacing: 7.3 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 = 385.59 at 19.95
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 105.16 in3/pile = 1723.25 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.88

W18X65 has been found in Soldier Pile list!
(English Units):
Area= 19.1 in. Depth= 18.4 in. Width= 7.59 in. Height= 18 in.
Flange thickness= 0.75 in. Web thickness= 0.45 in.
Ix= 1070 in4/pile Sx= 117 in3/pile Iy= 54.8 in4/pile Sy= 14.4 in3/pile
(Metric Units):
Ix= 445.33 x100cm4/pile Sx= 1917.28 cm3/pile Iy= 22.81 x100cm4/pile Sy= 235.97 cm3/pile

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

W18X65 is capable to support the shoring!
Top deflection = 1.800(in)
Max. deflection = 1.800(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.72
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 = 0.36
Pile Spacing =7.3, Max. Moment in lagging = 2.43
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=1.24
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.50

If 30% loading is used for lagging design, Design Pressure = 0.22
Pile Spacing =7.3, Max. Moment in lagging = 1.46
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.74
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.30

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

****

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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: Lee-Boyle Residence Shoring
Subtitle: Piles S2-S4 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 12.33
Pile Diameter: 2.50
Pile Spacing: 7.33
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: 1070.0
User Input Pile: W18X65

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12.33	0.583	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14.33	.6	32.33	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.33
2	12.33	2.50

* PASSIVE SPACE *

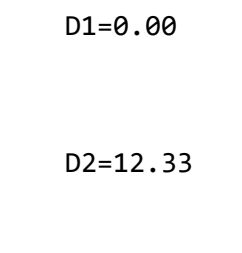
No.	Z depth	Spacing
1	12.33	5.00

*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



```
        |      D3=27.09

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

   MOMENT equilibrium   AT DEPTH=24.63  WITH EMBEDMENT OF 12.30
   FORCE equilibrium   AT DEPTH=27.09  WITH EMBEDMENT OF 14.76

   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 12.30
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 14.76

Embedment Information:
If 20% increased, the total design embedment is 14.76
If 30% increased, the total design embedment is 15.99
If 40% increased, the total design embedment is 17.22
If 50% increased, the total design embedment is 18.44


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 226.46 at 18.58
Maximum Shear = 83.67
Moment and Shear are per pile spacing: 7.3 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 = 226.46 at 18.58
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 82.35 in3/pile = 1349.47 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W18X65 has been found in Soldier Pile list!
(English Units):
Area= 19.1 in. Depth= 18.4 in. Width= 7.59 in. Height= 18 in.
Flange thickness= 0.75 in. Web thickness= 0.45 in.
Ix= 1070 in4/pile Sx= 117 in3/pile Iy= 54.8 in4/pile Sy= 14.4 in3/pile
(Metric Units):
Ix= 445.33 x100cm4/pile Sx= 1917.28 cm3/pile Iy= 22.81 x100cm4/pile Sy= 235.97 cm3/pile

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

W18X65 is capable to support the shoring!
Top deflection = 0.863(in)
Max. deflection = 0.863(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.58
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 = 0.29
Pile Spacing =7.3, Max. Moment in lagging = 1.96
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=1.00
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.40

If 30% loading is used for lagging design, Design Pressure = 0.17
Pile Spacing =7.3, Max. Moment in lagging = 1.17
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.60
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.24

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

****

SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

www.civiltech.com

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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Pile S5 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles S5 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 12.33
Pile Diameter: 2.50
Pile Spacing: 7.33
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: 0.88
Elastic Module, E: 29000.00

Moment of Inertia, I: 1070.0
User Input Pile: W18X65

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12.33	0.583	.04725
2	0	.0863	12.33	0.086	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14.33	.8	32.33	8.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.33
2	12.33	2.50

* PASSIVE SPACE *

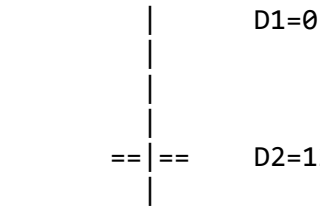
No.	Z depth	Spacing
1	12.33	5.00

*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



```
        |
        |      D3=27.08

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

   MOMENT equilibrium   AT DEPTH=24.62  WITH EMBEDMENT OF 12.29
   FORCE equilibrium   AT DEPTH=27.08  WITH EMBEDMENT OF 14.75

   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 12.29
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 14.75

Embedment Information:
If 20% increased, the total design embedment is 14.75
If 30% increased, the total design embedment is 15.98
If 40% increased, the total design embedment is 17.21
If 50% increased, the total design embedment is 18.44


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 307.76 at 18.49
Maximum Shear = 112.50
Moment and Shear are per pile spacing: 7.3 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 = 307.76 at 18.49
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 83.94 in3/pile = 1375.45 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.88

W18X65 has been found in Soldier Pile list!
(English Units):
Area= 19.1 in. Depth= 18.4 in. Width= 7.59 in. Height= 18 in.
Flange thickness= 0.75 in. Web thickness= 0.45 in.
Ix= 1070 in4/pile Sx= 117 in3/pile Iy= 54.8 in4/pile Sy= 14.4 in3/pile
(Metric Units):
Ix= 445.33 x100cm4/pile Sx= 1917.28 cm3/pile Iy= 22.81 x100cm4/pile Sy= 235.97 cm3/pile

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

W18X65 is capable to support the shoring!
Top deflection = 1.226(in)
Max. deflection = 1.226(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.67
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 = 0.33
Pile Spacing =7.3, Max. Moment in lagging = 2.24
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=1.15
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.46

If 30% loading is used for lagging design, Design Pressure = 0.20
Pile Spacing =7.3, 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

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

****

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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: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Pile S5 Soil Only.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles S5 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 12.33
Pile Diameter: 2.50
Pile Spacing: 7.33
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: 1070.0
User Input Pile: W18X65

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	12.33	0.583	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	14.33	.6	32.33	6.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.33
2	12.33	2.50

* PASSIVE SPACE *

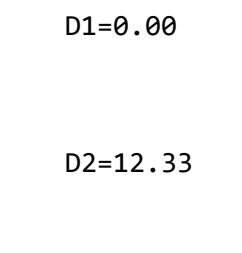
No.	Z depth	Spacing
1	12.33	5.00

*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



```
        |      D3=27.09

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

   MOMENT equilibrium   AT DEPTH=24.63  WITH EMBEDMENT OF 12.30
   FORCE equilibrium   AT DEPTH=27.09  WITH EMBEDMENT OF 14.76

   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 12.30
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 14.76

Embedment Information:
If 20% increased, the total design embedment is 14.76
If 30% increased, the total design embedment is 15.99
If 40% increased, the total design embedment is 17.22
If 50% increased, the total design embedment is 18.44


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 226.46 at 18.58
Maximum Shear = 83.67
Moment and Shear are per pile spacing: 7.3 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 = 226.46 at 18.58
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 82.35 in3/pile = 1349.47 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W18X65 has been found in Soldier Pile list!
(English Units):
Area= 19.1 in. Depth= 18.4 in. Width= 7.59 in. Height= 18 in.
Flange thickness= 0.75 in. Web thickness= 0.45 in.
Ix= 1070 in4/pile Sx= 117 in3/pile Iy= 54.8 in4/pile Sy= 14.4 in3/pile
(Metric Units):
Ix= 445.33 x100cm4/pile Sx= 1917.28 cm3/pile Iy= 22.81 x100cm4/pile Sy= 235.97 cm3/pile

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

W18X65 is capable to support the shoring!
Top deflection = 0.863(in)
Max. deflection = 0.863(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.58
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 = 0.29
Pile Spacing =7.3, Max. Moment in lagging = 1.96
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=1.00
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.40

If 30% loading is used for lagging design, Design Pressure = 0.17
Pile Spacing =7.3, Max. Moment in lagging = 1.17
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.60
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.24

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

****

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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles S6-S9 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles S6-S9 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 11.33
Pile Diameter: 2.50
Pile Spacing: 7.33
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: .88
Elastic Module, E: 29000.00

Moment of Inertia, I: 800.00
User Input Pile: W18X50

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11.33	0.535	.04725
2	0	.0793	11.33	0.079	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13.33	.8	21.33	4.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.33
2	11.33	2.50

* PASSIVE SPACE *

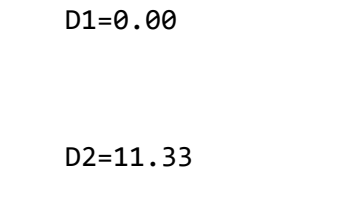
No.	Z depth	Spacing
1	11.33	5.00

*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



```
        |
        |      D3=25.30

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

   MOMENT equilibrium   AT DEPTH=22.98  WITH EMBEDMENT OF 11.65
   FORCE equilibrium   AT DEPTH=25.30  WITH EMBEDMENT OF 13.97

   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 11.65
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 13.97

Embedment Information:
If 20% increased, the total design embedment is 13.97
If 30% increased, the total design embedment is 15.14
If 40% increased, the total design embedment is 16.30
If 50% increased, the total design embedment is 17.47


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 241.13 at 17.05
Maximum Shear = 67.20
Moment and Shear are per pile spacing: 7.3 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 = 241.13 at 17.05
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 65.76 in3/pile = 1077.67 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=.88

W18X50 has been found in Soldier Pile list!
(English Units):
Area= 14.7 in. Depth= 18 in. Width= 7.5 in. Height= 18 in.
Flange thickness= 0.57 in. Web thickness= 0.355 in.
Ix= 800 in4/pile Sx= 88.9 in3/pile Iy= 40.1 in4/pile Sy= 10.7 in3/pile
(Metric Units):
Ix= 332.96 x100cm4/pile Sx= 1456.80 cm3/pile Iy= 16.69 x100cm4/pile Sy= 175.34 cm3/pile

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

W18X50 is capable to support the shoring!
Top deflection = 1.114(in)
Max. deflection = 1.114(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.61
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 = 0.31
Pile Spacing =7.3, Max. Moment in lagging = 2.06
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=1.05
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.43

If 30% loading is used for lagging design, Design Pressure = 0.18
Pile Spacing =7.3, Max. Moment in lagging = 1.24
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.63
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.26

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

****

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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles S6-S9 Soil Only.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles S6-S9 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 11.33
Pile Diameter: 2.50
Pile Spacing: 7.33
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: 800.00
User Input Pile: W18X50

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11.33	0.535	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13.33	.6	21.33	3.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	7.33
2	11.33	2.50

* PASSIVE SPACE *

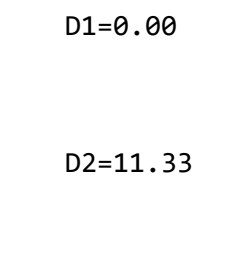
No.	Z depth	Spacing
1	11.33	5.00

*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



```
        |      D3=25.31

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

   MOMENT equilibrium   AT DEPTH=22.98  WITH EMBEDMENT OF 11.65
   FORCE equilibrium   AT DEPTH=25.31  WITH EMBEDMENT OF 13.98

   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 11.65
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 13.98

Embedment Information:
If 20% increased, the total design embedment is 13.98
If 30% increased, the total design embedment is 15.15
If 40% increased, the total design embedment is 16.31
If 50% increased, the total design embedment is 17.48


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 177.51 at 17.13
Maximum Shear = 49.77
Moment and Shear are per pile spacing: 7.3 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 = 177.51 at 17.13
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 64.55 in3/pile = 1057.76 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W18X50 has been found in Soldier Pile list!
(English Units):
Area= 14.7 in. Depth= 18 in. Width= 7.5 in. Height= 18 in.
Flange thickness= 0.57 in. Web thickness= 0.355 in.
Ix= 800 in4/pile Sx= 88.9 in3/pile Iy= 40.1 in4/pile Sy= 10.7 in3/pile
(Metric Units):
Ix= 332.96 x100cm4/pile Sx= 1456.80 cm3/pile Iy= 16.69 x100cm4/pile Sy= 175.34 cm3/pile

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

W18X50 is capable to support the shoring!
Top deflection = 0.787(in)
Max. deflection = 0.787(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.54
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 = 0.27
Pile Spacing =7.3, Max. Moment in lagging = 1.80
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.92
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.37

If 30% loading is used for lagging design, Design Pressure = 0.16
Pile Spacing =7.3, Max. Moment in lagging = 1.08
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.55
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.22

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

****

SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

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1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles S10 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles S10 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 11.33
Pile Diameter: 2.50
Pile Spacing: 3.00
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: .88
Elastic Module, E: 29000.00

Moment of Inertia, I: 510.00
User Input Pile: W18X35

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11.33	0.535	.04725
2	0	.0793	11.33	0.079	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13.33	.8	21.33	4.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	3.00
2	11.33	2.50

* PASSIVE SPACE *

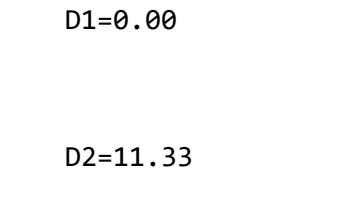
No.	Z depth	Spacing
1	11.33	3.00

*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



```
        |
        |      D3=23.01

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

   MOMENT equilibrium   AT DEPTH=21.07  WITH EMBEDMENT OF 9.74
   FORCE equilibrium   AT DEPTH=23.01  WITH EMBEDMENT OF 11.68

   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 9.74
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 11.68

Embedment Information:
If 20% increased, the total design embedment is 11.68
If 30% increased, the total design embedment is 12.66
If 40% increased, the total design embedment is 13.63
If 50% increased, the total design embedment is 14.60


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 92.41 at 16.20
Maximum Shear = 42.46
Moment and Shear are per pile spacing: 3.0 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 = 92.41 at 16.20
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 25.20 in3/pile = 412.99 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=.88

W18X35 has been found in Soldier Pile list!
(English Units):
Area= 10.3 in. Depth= 17.7 in. Width= 6 in. Height= 18 in.
Flange thickness= 0.425 in. Web thickness= 0.3 in.
Ix= 510 in4/pile Sx= 57.6 in3/pile Iy= 15.3 in4/pile Sy= 5.12 in3/pile
(Metric Units):
Ix= 212.26 x100cm4/pile Sx= 943.89 cm3/pile Iy= 6.37 x100cm4/pile Sy= 83.90 cm3/pile

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

W18X35 is capable to support the shoring!
Top deflection = 0.596(in)
Max. deflection = 0.596(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.61
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 = 0.31
Pile Spacing =3.0, Max. Moment in lagging = 0.35
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.18
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.07

If 30% loading is used for lagging design, Design Pressure = 0.18
Pile Spacing =3.0, Max. Moment in lagging = 0.21
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.11
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.04

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

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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: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles S10 Soil Only.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles S10 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 11.33
Pile Diameter: 2.50
Pile Spacing: 3.00
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: 510.00
User Input Pile: W18X35

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11.33	0.535	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13.33	.6	21.33	3.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	3.00
2	11.33	2.50

* PASSIVE SPACE *

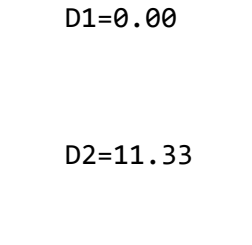
No.	Z depth	Spacing
1	11.33	3.00

*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



```
        |      D3=23.00

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

   MOMENT equilibrium   AT DEPTH=21.05  WITH EMBEDMENT OF 9.72
   FORCE equilibrium   AT DEPTH=23.00  WITH EMBEDMENT OF 11.67

   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 9.72
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 11.67

Embedment Information:
If 20% increased, the total design embedment is 11.67
If 30% increased, the total design embedment is 12.64
If 40% increased, the total design embedment is 13.61
If 50% increased, the total design embedment is 14.59


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 67.72 at 16.26
Maximum Shear = 31.50
Moment and Shear are per pile spacing: 3.0 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 = 67.72 at 16.26
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 24.62 in3/pile = 403.51 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W18X35 has been found in Soldier Pile list!
(English Units):
Area= 10.3 in. Depth= 17.7 in. Width= 6 in. Height= 18 in.
Flange thickness= 0.425 in. Web thickness= 0.3 in.
Ix= 510 in4/pile Sx= 57.6 in3/pile Iy= 15.3 in4/pile Sy= 5.12 in3/pile
(Metric Units):
Ix= 212.26 x100cm4/pile Sx= 943.89 cm3/pile Iy= 6.37 x100cm4/pile Sy= 83.90 cm3/pile

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

W18X35 is capable to support the shoring!
Top deflection = 0.421(in)
Max. deflection = 0.421(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.53
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 = 0.27
Pile Spacing =3.0, Max. Moment in lagging = 0.30
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.15
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.06

If 30% loading is used for lagging design, Design Pressure = 0.16
Pile Spacing =3.0, Max. Moment in lagging = 0.18
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.09
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.04

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

****

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4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles S11-S12 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles S11-S12 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 11.33
Pile Diameter: 2.50
Pile Spacing: 5.25
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: .88
Elastic Module, E: 29000.00

Moment of Inertia, I: 612.00
User Input Pile: W18X40

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11.33	0.535	.04725
2	0	.0793	11.33	0.079	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13.33	.8	21.33	4.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	5.25
2	11.33	2.50

* PASSIVE SPACE *

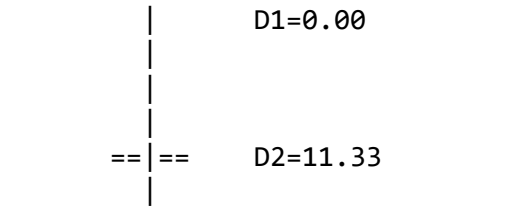
No.	Z depth	Spacing
1	11.33	5.00

*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



```
        |
        |      D3=23.24

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

   MOMENT equilibrium   AT DEPTH=21.26  WITH EMBEDMENT OF 9.93
   FORCE equilibrium   AT DEPTH=23.24  WITH EMBEDMENT OF 11.91

   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 9.93
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 11.91

Embedment Information:
If 20% increased, the total design embedment is 11.91
If 30% increased, the total design embedment is 12.90
If 40% increased, the total design embedment is 13.90
If 50% increased, the total design embedment is 14.89


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 162.97 at 16.29
Maximum Shear = 73.52
Moment and Shear are per pile spacing: 5.3 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 = 162.97 at 16.29
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 44.45 in3/pile = 728.36 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=.88

W18X40 has been found in Soldier Pile list!
(English Units):
Area= 11.8 in. Depth= 17.9 in. Width= 6.02 in. Height= 18 in.
Flange thickness= 0.525 in. Web thickness= 0.315 in.
Ix= 612 in4/pile Sx= 68.4 in3/pile Iy= 19.1 in4/pile Sy= 6.35 in3/pile
(Metric Units):
Ix= 254.71 x100cm4/pile Sx= 1120.87 cm3/pile Iy= 7.95 x100cm4/pile Sy= 104.06 cm3/pile

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

W18X40 is capable to support the shoring!
Top deflection = 0.877(in)
Max. deflection = 0.877(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.61
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 = 0.31
Pile Spacing =5.3, Max. Moment in lagging = 1.06
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.54
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.22

If 30% loading is used for lagging design, Design Pressure = 0.18
Pile Spacing =5.3, Max. Moment in lagging = 0.63
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.32
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

****

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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: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles S11-S12 Soil Only.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles S11-S12 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 11.33
Pile Diameter: 2.50
Pile Spacing: 5.25
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: 510.00
User Input Pile: W18X40

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11.33	0.535	.04725

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13.33	.6	21.33	3.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	5.25
2	11.33	2.50

* PASSIVE SPACE *

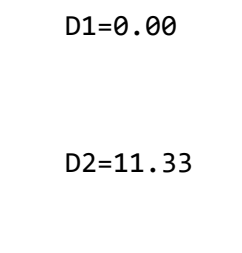
No.	Z depth	Spacing
1	11.33	5.00

*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



```
        |      D3=23.23

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

   MOMENT equilibrium   AT DEPTH=21.25  WITH EMBEDMENT OF 9.92
   FORCE equilibrium   AT DEPTH=23.23  WITH EMBEDMENT OF 11.90

   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 9.92
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 11.90

Embedment Information:
If 20% increased, the total design embedment is 11.90
If 30% increased, the total design embedment is 12.89
If 40% increased, the total design embedment is 13.88
If 50% increased, the total design embedment is 14.87


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 119.49 at 16.36
Maximum Shear = 54.55
Moment and Shear are per pile spacing: 5.3 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 = 119.49 at 16.36
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 43.45 in3/pile = 712.04 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W18X40 has been found in Soldier Pile list!
(English Units):
Area= 11.8 in. Depth= 17.9 in. Width= 6.02 in. Height= 18 in.
Flange thickness= 0.525 in. Web thickness= 0.315 in.
Ix= 612 in4/pile Sx= 68.4 in3/pile Iy= 19.1 in4/pile Sy= 6.35 in3/pile
(Metric Units):
Ix= 254.71 x100cm4/pile Sx= 1120.87 cm3/pile Iy= 7.95 x100cm4/pile Sy= 104.06 cm3/pile

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

W18X40 is capable to support the shoring!
Top deflection = 0.614(in)
Max. deflection = 0.614(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.54
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 = 0.27
Pile Spacing =5.3, Max. Moment in lagging = 0.92
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.47
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 = 0.16
Pile Spacing =5.3, Max. Moment in lagging = 0.55
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.28
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.11

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

****

SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

www.civiltech.com

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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: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles W1 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles W1 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 11.00
Pile Diameter: 2.50
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: .88
Elastic Module, E: 29000.00

Moment of Inertia, I: 800.00
User Input Pile: W18X50

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	11	0.520	.04725
2	0	.077	11	0.077	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	13	.8	21	4.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	5.50
2	11.00	2.50

* PASSIVE SPACE *

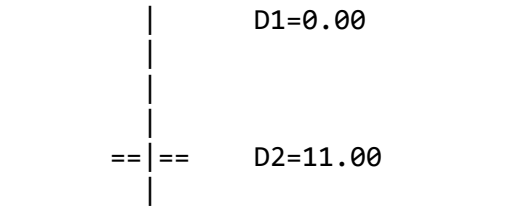
No.	Z depth	Spacing
1	11.00	5.00

*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



```
        |
        |      D3=22.81

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

   MOMENT equilibrium   AT DEPTH=20.84  WITH EMBEDMENT OF 9.84
   FORCE equilibrium   AT DEPTH=22.81  WITH EMBEDMENT OF 11.81

   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 9.84
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 11.81

Embedment Information:
If 20% increased, the total design embedment is 11.81
If 30% increased, the total design embedment is 12.80
If 40% increased, the total design embedment is 13.78
If 50% increased, the total design embedment is 14.77


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 158.19 at 15.93
Maximum Shear = 72.16
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 = 158.19 at 15.93
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 43.14 in3/pile = 707.00 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=.88

W18X50 has been found in Soldier Pile list!
(English Units):
Area= 14.7 in. Depth= 18 in. Width= 7.5 in. Height= 18 in.
Flange thickness= 0.57 in. Web thickness= 0.355 in.
Ix= 800 in4/pile Sx= 88.9 in3/pile Iy= 40.1 in4/pile Sy= 10.7 in3/pile
(Metric Units):
Ix= 332.96 x100cm4/pile Sx= 1456.80 cm3/pile Iy= 16.69 x100cm4/pile Sy= 175.34 cm3/pile

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

W18X50 is capable to support the shoring!
Top deflection = 0.624(in)
Max. deflection = 0.624(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 =5.5, Max. Moment in lagging = 1.13
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.58
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 = 0.18
Pile Spacing =5.5, Max. Moment in lagging = 0.68
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

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

****

SHORING WALL CALCULATION SUMMARY
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www.civiltech.com

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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles W1 Soil Only.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles W1 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 11.00
Pile Diameter: 2.50
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: 800.00
User Input Pile: W18X50

* 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	21	3.000	.3

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	5.50
2	11.00	2.50

* PASSIVE SPACE *

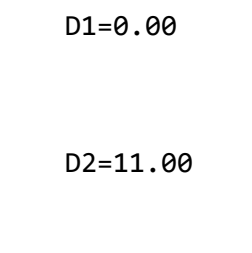
No.	Z depth	Spacing
1	11.00	5.00

*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



```
        |      D3=25.01

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

   MOMENT equilibrium   AT DEPTH=22.67  WITH EMBEDMENT OF 11.67
   FORCE equilibrium   AT DEPTH=25.01  WITH EMBEDMENT OF 14.01

   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 11.67
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 14.01

Embedment Information:
If 20% increased, the total design embedment is 14.01
If 30% increased, the total design embedment is 15.18
If 40% increased, the total design embedment is 16.34
If 50% increased, the total design embedment is 17.51


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 177.25 at 16.83
Maximum Shear = 49.54
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 = 177.25 at 16.83
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 64.46 in3/pile = 1056.23 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W18X50 has been found in Soldier Pile list!
(English Units):
Area= 14.7 in. Depth= 18 in. Width= 7.5 in. Height= 18 in.
Flange thickness= 0.57 in. Web thickness= 0.355 in.
Ix= 800 in4/pile Sx= 88.9 in3/pile Iy= 40.1 in4/pile Sy= 10.7 in3/pile
(Metric Units):
Ix= 332.96 x100cm4/pile Sx= 1456.80 cm3/pile Iy= 16.69 x100cm4/pile Sy= 175.34 cm3/pile

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

W18X50 is capable to support the shoring!
Top deflection = 0.757(in)
Max. deflection = 0.757(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 =5.5, Max. Moment in lagging = 1.40
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.72
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.29

If 30% loading is used for lagging design, Design Pressure = 0.22
Pile Spacing =5.5, Max. Moment in lagging = 0.84
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.43
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

****

SHORING WALL CALCULATION SUMMARY
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****

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4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles W2 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles W2 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 9.00
Pile Diameter: 2.50
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: .88
Elastic Module, E: 29000.00

Moment of Inertia, I: 448.00
User Input Pile: W16X36

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	9	0.425	.04725
2	0	.063	9	0.063	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	11	.8	29	8.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	8.00
2	9.00	2.50

* PASSIVE SPACE *

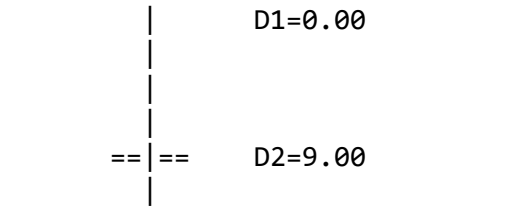
No.	Z depth	Spacing
1	9.00	5.00

*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



```
        |
        |      D3=20.43

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

   MOMENT equilibrium   AT DEPTH=18.53  WITH EMBEDMENT OF 9.53
   FORCE equilibrium   AT DEPTH=20.43  WITH EMBEDMENT OF 11.43

   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 9.53
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 11.43

Embedment Information:
If 20% increased, the total design embedment is 11.43
If 30% increased, the total design embedment is 12.38
If 40% increased, the total design embedment is 13.34
If 50% increased, the total design embedment is 14.29


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 138.63 at 13.89
Maximum Shear = 66.60
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 = 138.63 at 13.89
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 37.81 in3/pile = 619.57 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=.88

W16X36 has been found in Soldier Pile list!
(English Units):
Area= 10.6 in. Depth= 15.9 in. Width= 6.99 in. Height= 16 in.
Flange thickness= 0.43 in. Web thickness= 0.295 in.
Ix= 448 in4/pile Sx= 56.5 in3/pile Iy= 24.5 in4/pile Sy= 7 in3/pile
(Metric Units):
Ix= 186.46 x100cm4/pile Sx= 925.87 cm3/pile Iy= 10.20 x100cm4/pile Sy= 114.71 cm3/pile

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

W16X36 is capable to support the shoring!
Top deflection = 0.718(in)
Max. deflection = 0.718(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.49
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 = 0.24
Pile Spacing =8.0, Max. Moment in lagging = 1.95
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=1.00
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.40

If 30% loading is used for lagging design, Design Pressure = 0.15
Pile Spacing =8.0, Max. Moment in lagging = 1.17
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.60
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.24

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

****

SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

www.civiltech.com

****

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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles W2 Soil Only.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles W2 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 9.00
Pile Diameter: 2.50
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: 448.00
User Input Pile: W16X36

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	9	0.425	.04725

* 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	8.00
2	9.00	2.50

* PASSIVE SPACE *

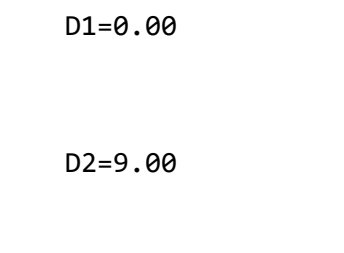
No.	Z depth	Spacing
1	9.00	5.00

*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



```
        |      D3=20.44

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

   MOMENT equilibrium   AT DEPTH=18.53  WITH EMBEDMENT OF 9.53
   FORCE equilibrium   AT DEPTH=20.44  WITH EMBEDMENT OF 11.44

   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 9.53
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 11.44

Embedment Information:
If 20% increased, the total design embedment is 11.44
If 30% increased, the total design embedment is 12.39
If 40% increased, the total design embedment is 13.34
If 50% increased, the total design embedment is 14.30


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 102.23 at 13.94
Maximum Shear = 49.59
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 = 102.23 at 13.94
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 37.18 in3/pile = 609.21 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W16X36 has been found in Soldier Pile list!
(English Units):
Area= 10.6 in. Depth= 15.9 in. Width= 6.99 in. Height= 16 in.
Flange thickness= 0.43 in. Web thickness= 0.295 in.
Ix= 448 in4/pile Sx= 56.5 in3/pile Iy= 24.5 in4/pile Sy= 7 in3/pile
(Metric Units):
Ix= 186.46 x100cm4/pile Sx= 925.87 cm3/pile Iy= 10.20 x100cm4/pile Sy= 114.71 cm3/pile

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

W16X36 is capable to support the shoring!
Top deflection = 0.510(in)
Max. deflection = 0.510(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.42
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 = 0.21
Pile Spacing =8.0, 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 = 0.13
Pile Spacing =8.0, 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
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

****

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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles W3 Soil and Seismic.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles W3 Soil and Seismic

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 6.00
Pile Diameter: 2.50
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: .88
Elastic Module, E: 29000.00

Moment of Inertia, I: 199.00
User Input Pile: W14X22

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	6	0.283	.04725
2	0	.042	6	0.042	

* PASSIVE PRESSURE *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	8	.8	26	8.000	.4

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	8.00
2	6.00	2.50

* PASSIVE SPACE *

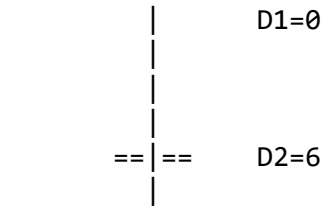
No.	Z depth	Spacing
1	6.00	5.00

*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



```
        |
        |      D3=14.04

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

   MOMENT equilibrium   AT DEPTH=12.70  WITH EMBEDMENT OF 6.70
   FORCE equilibrium   AT DEPTH=14.04  WITH EMBEDMENT OF 8.04

   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 6.70
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 8.04

Embedment Information:
If 20% increased, the total design embedment is 8.04
If 30% increased, the total design embedment is 8.71
If 40% increased, the total design embedment is 9.38
If 50% increased, the total design embedment is 10.05


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 44.92 at 9.58
Maximum Shear = 31.93
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 = 44.92 at 9.58
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 12.25 in3/pile = 200.77 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=.88

W14X22 has been found in Soldier Pile list!
(English Units):
Area= 6.49 in. Depth= 13.7 in. Width= 5 in. Height= 14 in.
Flange thickness= 0.335 in. Web thickness= 0.23 in.
Ix= 199 in4/pile Sx= 29 in3/pile Iy= 7 in4/pile Sy= 2.8 in3/pile
(Metric Units):
Ix= 82.82 x100cm4/pile Sx= 475.22 cm3/pile Iy= 2.91 x100cm4/pile Sy= 45.88 cm3/pile

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

W14X22 is capable to support the shoring!
Top deflection = 0.238(in)
Max. deflection = 0.238(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.33
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 = 0.16
Pile Spacing =8.0, Max. Moment in lagging = 1.30
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.66
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.27

If 30% loading is used for lagging design, Design Pressure = 0.10
Pile Spacing =8.0, Max. Moment in lagging = 0.78
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.40
For 6"x12" Timber, Section Modules S=57.98 in3. The request allowable bending strength, fb=M/S=0.16

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

****

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****

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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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Date: 3/11/2019 File: M:\Stuart Silk\19052.01_Lee-Boyle Residence\Calculations\Shoring Design\Piles W3 Soil Only.sh8

Title: Lee-Boyle Residence Shoring
Subtitle: Piles W3 Soil Only

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

Wall Type: 2. Soldier Pile, Drilled
Wall Height: 6.00
Pile Diameter: 2.50
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: 199.00
User Input Pile: W14X22

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

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	0	0	6	0.283	.04725

* 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	8.00
2	6.00	2.50

* PASSIVE SPACE *

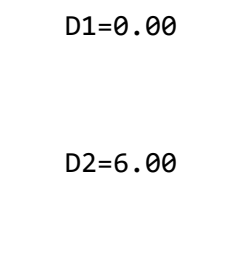
No.	Z depth	Spacing
1	6.00	5.00

*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



```
        |      D3=14.05

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

   MOMENT equilibrium   AT DEPTH=12.70  WITH EMBEDMENT OF 6.70
   FORCE equilibrium   AT DEPTH=14.05  WITH EMBEDMENT OF 8.05

   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 6.70
The program calculates an embedment for moment equilibrium, then increase the
embedment by 1.2
The total desigh embedment is 8.05

Embedment Information:
If 20% increased, the total design embedment is 8.05
If 30% increased, the total design embedment is 8.72
If 40% increased, the total design embedment is 9.39
If 50% increased, the total design embedment is 10.06


* MOMENT IN PILE (per pile spacing)*
Pile Spacing:  sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 33.24 at 9.61
Maximum Shear = 23.82
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 = 33.24 at 9.61
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected.
```

Request Min. Section Modulus = 12.09 in3/pile = 198.07 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66

W14X22 has been found in Soldier Pile list!
(English Units):
Area= 6.49 in. Depth= 13.7 in. Width= 5 in. Height= 14 in.
Flange thickness= 0.335 in. Web thickness= 0.23 in.
Ix= 199 in4/pile Sx= 29 in3/pile Iy= 7 in4/pile Sy= 2.8 in3/pile
(Metric Units):
Ix= 82.82 x100cm4/pile Sx= 475.22 cm3/pile Iy= 2.91 x100cm4/pile Sy= 45.88 cm3/pile

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

W14X22 is capable to support the shoring!
Top deflection = 0.175(in)
Max. deflection = 0.175(in)

********** LAGGING SIZE ESTIMATION **********
Max. Pressure above base = 0.28
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 = 0.14
Pile Spacing =8.0, Max. Moment in lagging = 1.13
For 4"x12" Timber, Section Modules S=23.47 in3. The request allowable bending strength, fb=M/S=0.58
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 = 0.08
Pile Spacing =8.0, Max. Moment in lagging = 0.68
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

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

LEE-BOYLE RESIDENCE - SHORING
4150 BOULEVARD PLACE
MERCER ISLAND, WA 98040

Quantum Job Number: 19052.01

LAGGING DESIGN

LAGGING DESIGN

LOAD ON LAGGING = 35 PCF (13.33' MAX. HT)(1.35 FACTOR FOR SLOPING BACKFILL)(0.50 LAGGING FACTOR)

= 315 PLF

$M_{MAX} = w l^2/8 = 315 \text{ PLF} (7.5')^2/8 = 2215 \text{ FT-LB} = 26580 \text{ IN-LB}$

↑ 8' SPACING, SO USE 7.5' FOR LAGGING LENGTH

FOR 4x MEMBERS: $S = 12"(4" \text{ ROUGH})^2/6 = 32 \text{ IN}^3$

$M_{MAX}/S = 26500 \text{ IN-LB}/32 \text{ IN}^3 = 831 \text{ PSI}$ (OK) ⇒ USE HF #2 OR DF #2 4x LAGGING.

QUANTUM | CONSULTING ENGINEERS

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project: 166 - BOYLE RESIDENCE SHORING	date: 3/11/19	project no.: 19052.01
	designer: FLM	sheet: C-1
client: STUART SOLIC ARCHITECTS	checked by	