NORTH SHORE LEVEE

Aberdeen & Hoquiam, WA

STRUCTURAL CALCULATIONS – CLOMR SUBMITTAL

KPFF Project No. 41600177

July 10, 2017

kpff Consulting Engineers

612 Woodland Square Loop SE, Suite 100
Lacey, WA 98503 360.292.7230

North Shore Levee

Aberdeen, WA

Structural Calculations

CALCULATIONS INCLUDED:

These Calculations cover this scope:

- **Structural Design of Steel Sheet Pile I-Walls**
- **Structural Design of Concrete T-Walls**

kpff

612 Woodland Square Loop
Suite 100
Lacey, WA 98503

KPFF Project No. 1600210

March 22, 2017

STRUCTURAL DESIGN CRITERIA

Datum:

NAVD88

Geotechnical:

Draft Preliminary Design and Construction Recommendations by GeoEngineers, January 25, 2017.

Codes and References:

- 1998 Uniform Building Code (as noted by FEMA Form 086-0-27B)
- 2015 International Building Code
- US Army Corps of Engineers EM 1110-2-2502, *Retaining and Flood Walls* (for concrete T-Walls)
- US Army Corps of Engineers EC 1110-2-6066, *Design of I-Walls* (for steel sheet pile I-Walls)

DESIGN FLOOD CONDITIONS

Flood Levels

- Design Water Level: Elevation 13.2' (2' below top of wall). Return period = 100 years.
- 500-year flood Elevation 14.2' (1' below top of wall).
- Overtopping condition: Water to top of wall at Elevation 15.2'. Return period at least 750 years.

Design Water Level:

- Elevation 13.2'
- Recurrence: 100 years
- I-Walls:
    - Load Condition Probability for I-Walls per CM 1110-2-6066, Table 6-2: "Unusual" for 100-year return period.
    - Rotational Stability Factor of Safety for I-Walls for DWL Load for "Unusual" probability and "ordinary" soil definition (per EC 1110-2-6066, Table 6-2): 1.5.
    - Construction and earthquake load conditions for I-walls are highly unlikely to occur during a design flood, so these load conditions aren't considered.
- T-Walls:
    - Design water level of 14.2' conservatively used for T-Walls in lieu of 13.2'.
    - Sliding factor of safety: 1.5 (per EM 1110-2-2502, Table 4-2)
    - Overturning factor of safety: 100% of base width in compression (per EM 1110-2-2502, Table 4-2)
    - Additional overturning factor of safety requirement: 1.5 (set equal to sliding FS by design team)
    - Bearing factor of safety: 3.0 (per EM 1110-2-2502, Table 4-2)

Water to Top of Wall:

- Elevation 15.2'
- Recurrence: at least 750 years
- I-Walls
    - Load Condition Probability for I-Walls per CM 1110-2-6066, Table 6-2: "Extreme" for greater than 750-year return period. Factor of safety of 1.5 for "Unusual" condition conservatively used in lieu of the 1.3 factor of safety allowed for "Extreme" condition.
- T-Walls
    - Sliding: 1.33 (per EM 1110-2-2502, Table 4-2)
    - Overturning: 75% of base width in compression (per EM 1110-2-2502, Table 4-2)
    - Additional overturning requirement: 1.33 (set equal to sliding FS by design team)
    - Overturning for planter empty of soil: 1.1 (established by design team)
    - Bearing: 2.0 (per EM 1110-2-2502, Table 4-2)

SHEETPILE I-WALLS

SHEETPILE SUMMARY

SHEETPILE FY: 50 KSI

REGION	SHEAR STRENGTH CONDITION	LOAD CONDITION	REQUIRED EMBEDMENT (FT)	MAXIMUM MOMENT (K-FT)	REQ'D MIN SECTION MODULUS (IN^3)	SELECTED NZ SHEETPILE SIZE	SECTION MODULUS (IN^3)	MOMENT CAPACITY/ DEMAND RATIO	MOMENT OF INERTIA (IN^4)	SCALED DEFLECTION AT GRADE (LB-IN^3)	DEFLECTION AT GRADE (IN)
HOQUIAM	SHORT TERM	OVT1	9.3	2.53	1.012	NZ14-770	25.65	25.3	171.7	1.10E+08	0.02
	LONG TERM	DWL	17	4.1	1.64	NZ14-770	25.65	15.6	171.7	6.05E+08	0.12
GRAYS HARBOR	SHORT TERM	OVT1	8.6	2.3	0.92	NZ14-770	25.65	27.9	171.7	8.52E+07	0.02
	LONG TERM	DWL	19.6	5.8	2.32	NZ14-770	25.65	11.1	171.7	1.16E+09	0.23
CHEHALIS WEST	SHORT TERM	OVT1	5.6	1.6	0.64	NZ14-770	25.65	40.1	171.7	2.27E+07	0.00
	LONG TERM	DWL	19.1	4.9	1.96	NZ14-770	25.65	13.1	171.7	9.22E+08	0.19
CHEHALIS EAST	SHORT TERM	OVT1	6	1.6	0.64	NZ14-770	25.65	40.1	171.7	2.60E+07	0.01
	LONG TERM	DWL	26.2	11.7	4.68	NZ14-770	25.65	5.5	171.7	4.00E+09	0.80
WISHKAH	SHORT TERM	OVT1	10.6	2.8	1.12	NZ14-770	25.65	22.9	171.7	1.61E+08	0.03
	LONG TERM	DWL	27.1	9.2	3.68	NZ14-770	25.65	7.0	171.7	3.46E+09	0.69

NOTE: FOR EACH REGION, SELECT THE LARGER OF THE EMBEDMENTS CALCULUATED FOR THE DWL AND OVT1 LOAD CONDITIONS.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:13:46

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

I.--HEADING
'HOQUIAM GROUP - OVT1 - ST

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
102.00	102.00	0.00	260.00	0.00	0.00	-2.00	0.00	DEF	DEF
109.00	109.00	0.00	284.00	0.00	0.00	-7.00	0.00	DEF	DEF
109.00	109.00	0.00	324.00	0.00	0.00	-12.00	0.00	DEF	DEF
109.00	109.00	0.00	364.00	0.00	0.00	-17.00	0.00	DEF	DEF
109.00	109.00	0.00	404.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
102.00	102.00	0.00	260.00	0.00	0.00	-2.00	0.00	DEF	DEF
109.00	109.00	0.00	284.00	0.00	0.00	-7.00	0.00	DEF	DEF
109.00	109.00	0.00	324.00	0.00	0.00	-12.00	0.00	DEF	DEF
109.00	109.00	0.00	364.00	0.00	0.00	-17.00	0.00	DEF	DEF
109.00	109.00	0.00	404.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 15.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 20:14:04

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'HOQUIAM GROUP - OVT1 - ST

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
13.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
12.2	187.2	0.0	0.0	187.2	187.2	0.0	0.0
11.2	249.6	0.0	0.0	249.6	249.6	0.0	0.0
10.7+	280.8	0.0	0.0	280.8	280.8	0.0	0.0
10.7-	280.8	346.7	0.0	-65.9	627.5	0.0	346.7
10.2	280.8	366.5	0.0	-85.7	647.3	0.0	366.5
9.7	280.8	386.3	0.0	-105.5	667.1	0.0	386.3
9.2	280.8	406.1	0.0	-125.3	686.9	0.0	406.1
8.2	280.8	445.7	0.0	-164.9	726.5	0.0	445.7
7.2	280.8	485.3	0.0	-204.5	766.1	0.0	485.3
6.2	280.8	524.9	0.0	-244.1	805.7	0.0	524.9
5.2	280.8	564.5	0.0	-283.7	845.3	0.0	564.5
4.2	280.8	604.1	0.0	-323.3	884.9	0.0	604.1
3.2	280.8	643.7	0.0	-362.9	924.5	0.0	643.7
2.2	280.8	683.3	0.0	-402.5	964.1	0.0	683.3
1.9	280.8	693.3	0.0	-412.5	974.1	0.0	693.3
1.2	280.8	722.9	29.5	-412.5	974.1	29.5	722.9
0.2	280.8	762.5	69.1	-412.5	974.1	69.1	762.5
-0.8	280.8	802.1	108.7	-412.5	974.1	108.7	802.1
-1.8	280.8	841.7	148.3	-412.5	974.1	148.3	841.7
-2.0+	280.8	849.6	156.3	-444.5	1006.1	156.3	849.6
-2.0-	280.8	881.6	124.3	-444.5	1006.1	124.3	881.6
-2.8	280.8	918.9	161.5	-476.5	1038.1	161.5	918.9
-3.8	280.8	965.5	208.1	-476.5	1038.1	208.1	965.5
-4.8	280.8	1012.1	254.7	-476.5	1038.1	254.7	1012.1
-5.8	280.8	1058.7	301.3	-476.5	1038.1	301.3	1058.7
-6.8	280.8	1105.3	347.9	-476.5	1038.1	347.9	1105.3
-7.0+	280.8	1114.6	357.3	-529.9	1091.5	357.3	1114.6
-7.0-	280.8	1167.9	303.9	-529.9	1091.5	303.9	1167.9
-7.8	280.8	1205.2	341.2	-583.2	1144.8	341.2	1205.2
-8.8	280.8	1251.8	387.8	-583.2	1144.8	387.8	1251.8
-9.8	280.8	1298.4	434.4	-583.2	1144.8	434.4	1298.4
-10.8	280.8	1345.0	481.0	-583.2	1144.8	481.0	1345.0
-11.8	280.8	1391.6	527.6	-583.2	1144.8	527.6	1391.6
-12.0+	280.8	1400.9	536.9	-636.5	1198.1	536.9	1400.9
-12.0-	280.8	1454.3	483.6	-636.5	1198.1	483.6	1454.3
-12.8	280.8	1491.5	520.9	-689.9	1251.5	520.9	1491.5
-13.8	280.8	1538.1	567.5	-689.9	1251.5	567.5	1538.1
-14.8	280.8	1584.7	614.1	-689.9	1251.5	614.1	1584.7
-15.8	280.8	1631.3	660.7	-689.9	1251.5	660.7	1631.3

-16.8	280.8	1677.9	707.3	-689.9	1251.5	707.3	1677.9
-17.0+	280.8	1687.3	716.6	-743.2	1304.8	716.6	1687.3
-17.0-	280.8	1740.6	663.3	-743.2	1304.8	663.3	1740.6
-17.8	280.8	1777.9	700.5	-796.5	1358.1	700.5	1777.9
-18.8	280.8	1824.5	747.1	-796.5	1358.1	747.1	1824.5
-19.8	280.8	1871.1	793.7	-796.5	1358.1	793.7	1871.1

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:14:05

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'HOQUIAM GROUP - OVT1 - ST

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : 1.38
PENETRATION (FT) : 9.32

MAX. BEND. MOMENT (LB-FT) : 2.5314E+03
AT ELEVATION (FT) : 6.47

MAX. SCALED DEFL. (LB-IN^3): 2.3979E+08
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:14:05

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'HOQUIAM GROUP - OVT1 - ST

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	2.3979E+08	0.00
14.20	1.0400E+01	31.	2.1071E+08	62.40
13.20	8.3200E+01	125.	1.8166E+08	124.80

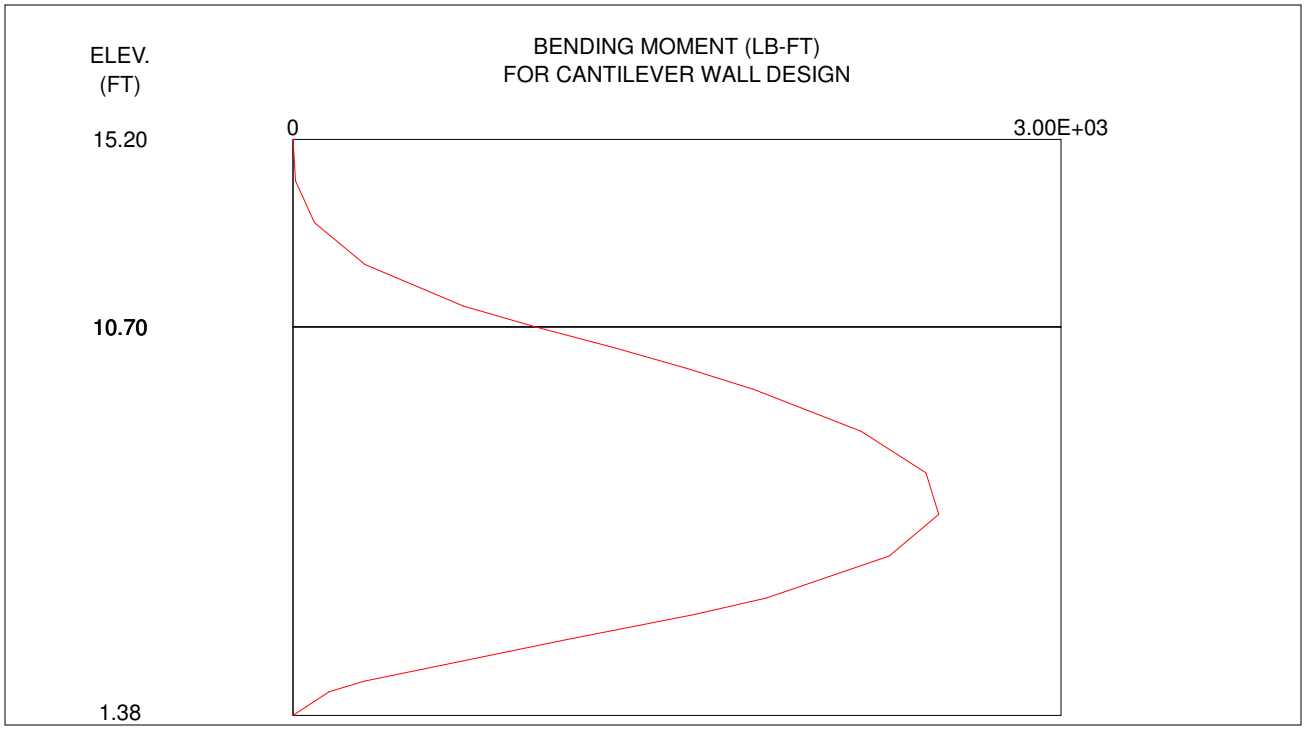
12.20	2.8080E+02	281.	1.5278E+08	187.20
11.20	6.6560E+02	499.	1.2440E+08	249.60
10.70+	9.4770E+02	632.	1.1060E+08	280.80
10.70-	9.4770E+02	632.	1.1060E+08	-65.87
10.20	1.2545E+03	594.	9.7207E+07	-85.67
9.70	1.5400E+03	546.	8.4358E+07	-105.47
9.20	1.7990E+03	488.	7.2173E+07	-125.27
8.20	2.2182E+03	343.	5.0229E+07	-164.87
7.20	2.4726E+03	159.	3.2094E+07	-204.47
6.20	2.5225E+03	-66.	1.8203E+07	-244.07
5.20	2.3283E+03	-329.	8.6352E+06	-283.67
4.20	1.8504E+03	-633.	3.0500E+06	-323.27
3.79	1.5667E+03	-767.	1.7481E+06	-339.33
3.20	1.0697E+03	-873.	6.1645E+05	-16.34
2.20	2.7917E+02	-618.	2.9110E+04	527.03
1.95	1.4068E+02	-466.	6.8244E+03	665.16
1.38	0.0000E+00	0.	0.0000E+00	974.13

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

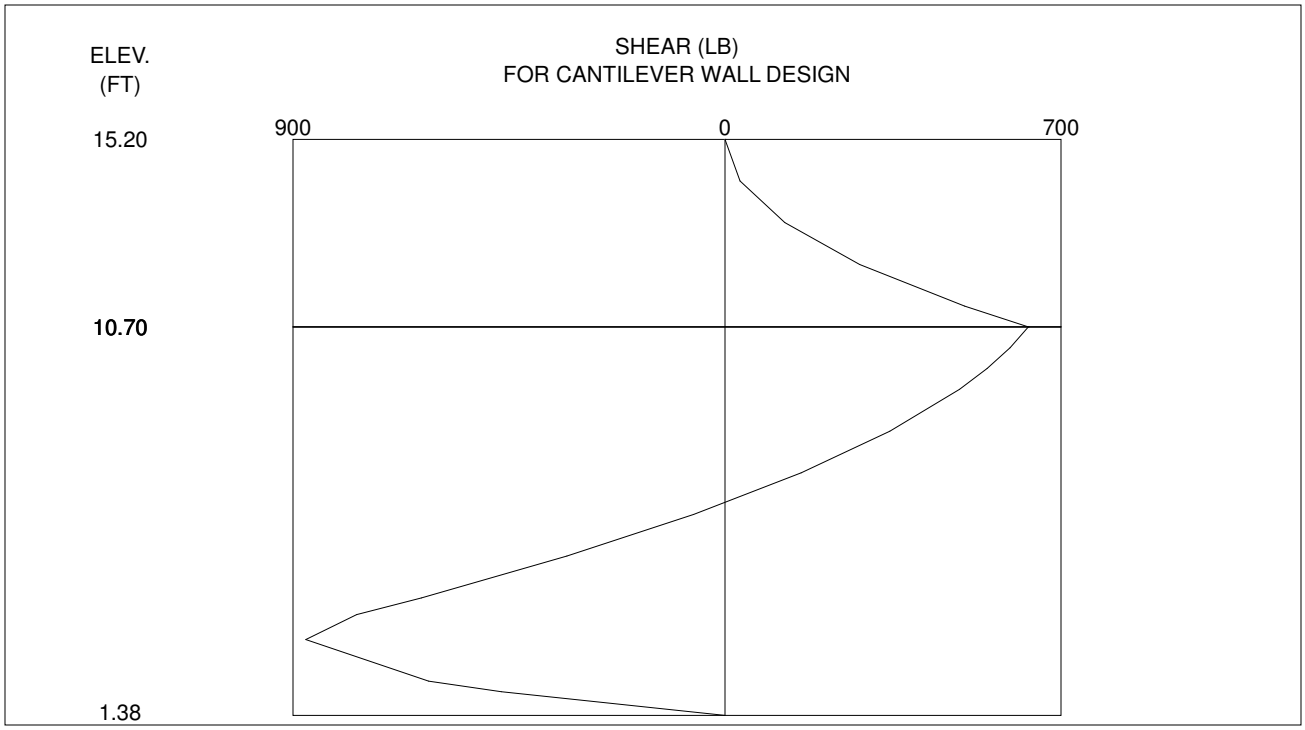
III.--WATER AND SOIL PRESSURES

		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION	PRESSURE	PASSIVE	ACTIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.20	0.	0.	0.	0.	0.
14.20	62.	0.	0.	0.	0.
13.20	125.	0.	0.	0.	0.
12.20	187.	0.	0.	0.	0.
11.20	250.	0.	0.	0.	0.
10.70+	281.	0.	0.	0.	0.
10.70-	281.	347.	0.	0.	347.
10.20	281.	366.	0.	0.	366.
9.70	281.	386.	0.	0.	386.
9.20	281.	406.	0.	0.	406.
8.20	281.	446.	0.	0.	446.
7.20	281.	485.	0.	0.	485.
6.20	281.	525.	0.	0.	525.
5.20	281.	564.	0.	0.	564.
4.20	281.	604.	0.	0.	604.
3.79	281.	620.	0.	0.	620.
3.20	281.	644.	0.	0.	644.
2.20	281.	683.	0.	0.	683.
1.95	281.	693.	0.	0.	693.
1.38	281.	723.	30.	30.	723.
0.20	281.	762.	69.	69.	762.

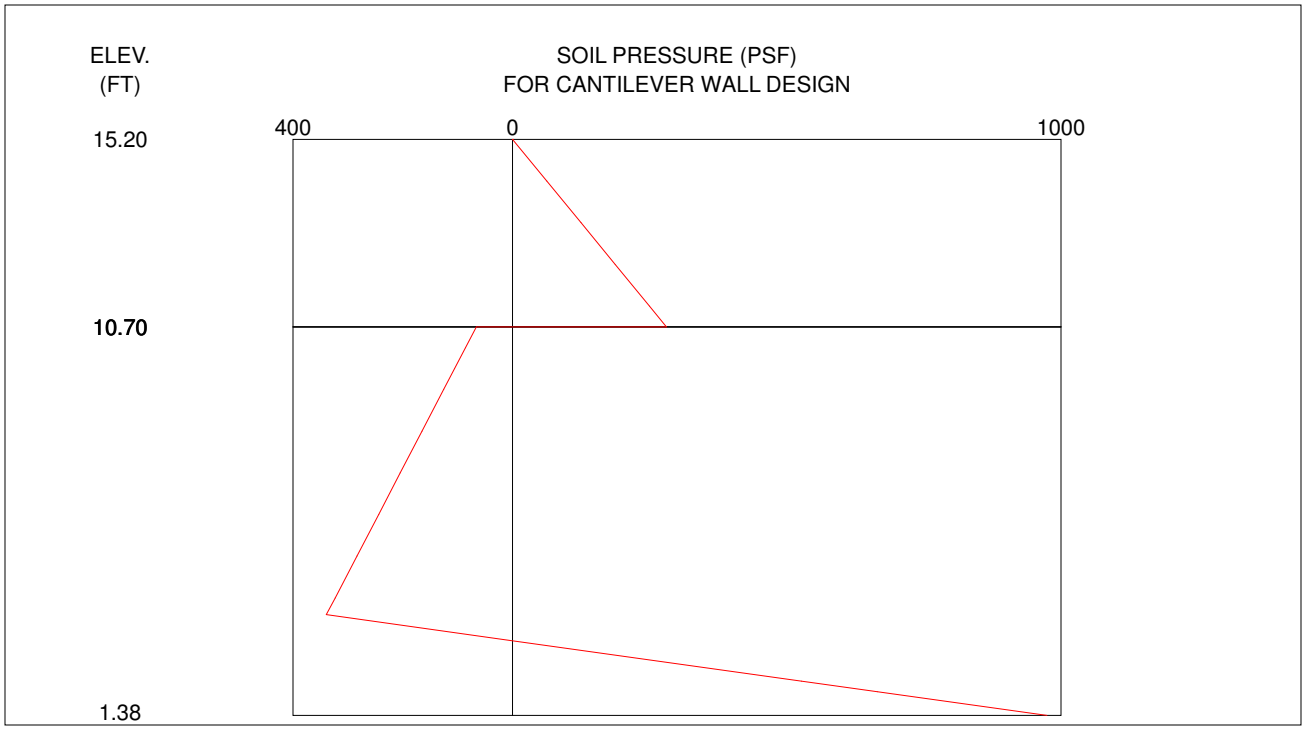
'HOQUIAM GROUP - OVT1 - ST



'HOQUIAM GROUP - OVT1 - ST



'HOQUIAM GROUP - OVT1 - ST



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 20:05:08

****
* INPUT DATA *
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I.--HEADING
'HOQUIAM GROUP - DWL LT

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
102.00	102.00	18.00	0.00	0.00	0.00	-2.00	0.00	DEF	DEF
109.00	109.00	18.20	0.00	0.00	0.00	-7.00	0.00	DEF	DEF
109.00	109.00	18.60	0.00	0.00	0.00	-12.00	0.00	DEF	DEF
109.00	109.00	19.00	0.00	0.00	0.00	-17.00	0.00	DEF	DEF
109.00	109.00	19.40	0.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
102.00	102.00	18.00	0.00	0.00	0.00	-2.00	0.00	DEF	DEF
109.00	109.00	18.20	0.00	0.00	0.00	-7.00	0.00	DEF	DEF
109.00	109.00	18.60	0.00	0.00	0.00	-12.00	0.00	DEF	DEF
109.00	109.00	19.00	0.00	0.00	0.00	-17.00	0.00	DEF	DEF
109.00	109.00	19.40	0.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 13.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 20:05:12

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'HOQUIAM GROUP - DWL LT

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
11.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
10.7	156.0	0.0	0.0	156.0	156.0	0.0	0.0
10.2	156.0	30.4	12.9	138.4	173.6	12.9	30.4
9.7	156.0	60.9	25.8	120.9	191.1	25.8	60.9
9.2	156.0	91.3	38.6	103.3	208.7	38.6	91.3
8.2	156.0	152.2	64.4	68.2	243.8	64.4	152.2
7.2	156.0	213.0	90.2	33.1	278.9	90.2	213.0
6.3	156.0	270.5	114.5	0.0	312.0	114.5	270.5
6.2	156.0	273.9	115.9	-2.0	314.0	115.9	273.9
5.2	156.0	334.8	141.7	-37.1	349.1	141.7	334.8
4.2	156.0	395.7	167.5	-72.2	384.2	167.5	395.7
3.2	156.0	456.5	193.2	-107.3	419.3	193.2	456.5
2.2	156.0	517.4	219.0	-142.4	454.4	219.0	517.4
1.2	156.0	578.3	244.7	-177.5	489.5	244.7	578.3
0.2	156.0	639.1	270.5	-212.6	524.6	270.5	639.1
-0.8	156.0	700.0	296.3	-247.7	559.7	296.3	700.0
-1.8	156.0	760.9	322.0	-282.8	594.8	322.0	760.9
-2.0+	156.0	773.0	327.2	-292.6	604.6	327.2	773.0
-2.0-	156.0	776.9	325.5	-292.6	604.6	325.5	776.9
-2.8	156.0	834.5	349.7	-328.9	640.9	349.7	834.5
-3.8	156.0	906.5	379.8	-370.7	682.7	379.8	906.5
-4.8	156.0	978.5	410.0	-412.5	724.5	410.0	978.5
-5.8	156.0	1050.5	440.2	-454.3	766.3	440.2	1050.5
-6.8	156.0	1122.5	470.3	-496.2	808.2	470.3	1122.5
-7.0+	156.0	1136.9	476.4	-512.7	824.7	476.4	1136.9
-7.0-	156.0	1148.4	471.6	-512.7	824.7	471.6	1148.4
-7.8	156.0	1206.6	495.5	-555.1	867.1	495.5	1206.6
-8.8	156.0	1279.3	525.3	-598.0	910.0	525.3	1279.3
-9.8	156.0	1352.1	555.2	-640.9	952.9	555.2	1352.1
-10.8	156.0	1424.8	585.1	-683.7	995.7	585.1	1424.8
-11.8	156.0	1497.5	614.9	-726.6	1038.6	614.9	1497.5
-12.0+	156.0	1512.0	620.9	-746.0	1058.0	620.9	1512.0
-12.0-	156.0	1527.4	614.6	-746.0	1058.0	614.6	1527.4
-12.8	156.0	1586.2	638.3	-791.9	1103.9	638.3	1586.2
-13.8	156.0	1659.7	667.8	-835.8	1147.8	667.8	1659.7
-14.8	156.0	1733.1	697.4	-879.7	1191.7	697.4	1733.1
-15.8	156.0	1806.6	727.0	-923.6	1235.6	727.0	1806.6
-16.8	156.0	1880.1	756.5	-967.5	1279.5	756.5	1880.1

-17.0+	156.0	1894.7	762.4	-989.9	1301.9	762.4	1894.7
-17.0-	156.0	1914.1	754.7	-989.9	1301.9	754.7	1914.1
-17.8	156.0	1973.5	778.1	-1039.3	1351.3	778.1	1973.5
-18.8	156.0	2047.7	807.4	-1084.3	1396.3	807.4	2047.7
-19.8	156.0	2121.9	836.7	-1129.3	1441.3	836.7	2121.9

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:05:13

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'HOQUIAM GROUP - DWL LT

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : -6.27
PENETRATION (FT) : 16.97

MAX. BEND. MOMENT (LB-FT) : 4.0613E+03
AT ELEVATION (FT) : 0.70

MAX. SCALED DEFL. (LB-IN^3): 9.0878E+08
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:05:13

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'HOQUIAM GROUP - DWL LT

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	9.0878E+08	0.00
14.20	-3.0559E-10	0.	8.4126E+08	0.00
13.20	4.3656E-11	0.	7.7374E+08	0.00
12.20	1.0400E+01	31.	7.0622E+08	62.40

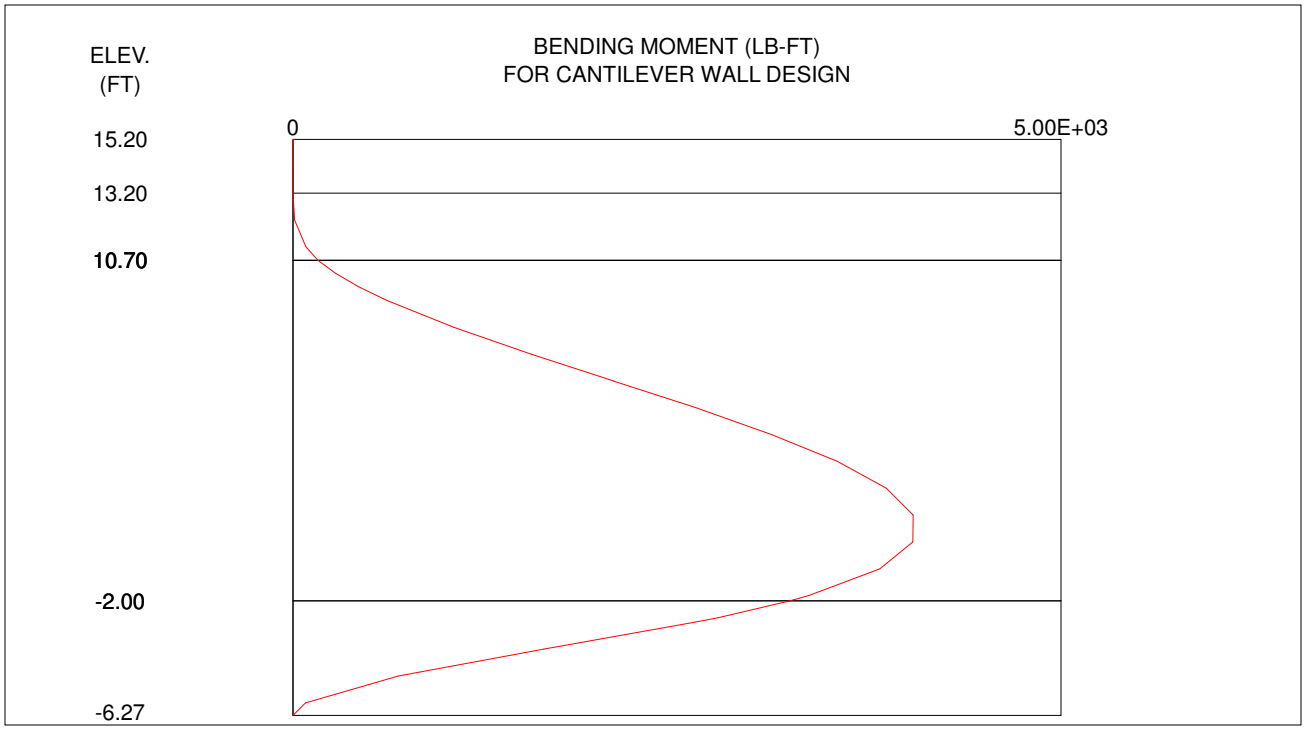
11.20	8.3200E+01	125.	6.3872E+08	124.80
10.70	1.6250E+02	195.	6.0502E+08	156.00
10.20	2.7877E+02	269.	5.7139E+08	138.45
9.70	4.2965E+02	333.	5.3788E+08	120.89
9.20	6.1075E+02	390.	5.0456E+08	103.34
8.20	1.0461E+03	475.	4.3880E+08	68.23
7.20	1.5496E+03	526.	3.7485E+08	33.12
6.26	2.0557E+03	542.	3.1696E+08	0.00
6.20	2.0863E+03	542.	3.1359E+08	-1.98
5.20	2.6210E+03	522.	2.5594E+08	-37.09
4.20	3.1186E+03	467.	2.0280E+08	-72.20
3.20	3.5440E+03	378.	1.5505E+08	-107.30
2.20	3.8621E+03	253.	1.1340E+08	-142.41
1.20	4.0378E+03	93.	7.8412E+07	-177.52
0.20	4.0360E+03	-102.	5.0372E+07	-212.63
-0.80	3.8215E+03	-332.	2.9275E+07	-247.73
-1.80	3.3594E+03	-598.	1.4746E+07	-282.84
-2.00	3.2341E+03	-655.	1.2566E+07	-292.63
-2.62	2.7660E+03	-847.	7.1536E+06	-320.91
-2.80	2.6126E+03	-899.	5.9817E+06	-267.57
-3.80	1.6310E+03	-1014.	1.6951E+06	36.28
-4.80	6.8560E+02	-826.	2.3196E+05	340.12
-5.80	8.0336E+01	-334.	2.5530E+03	643.97
-6.27	0.0000E+00	0.	0.0000E+00	785.88

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

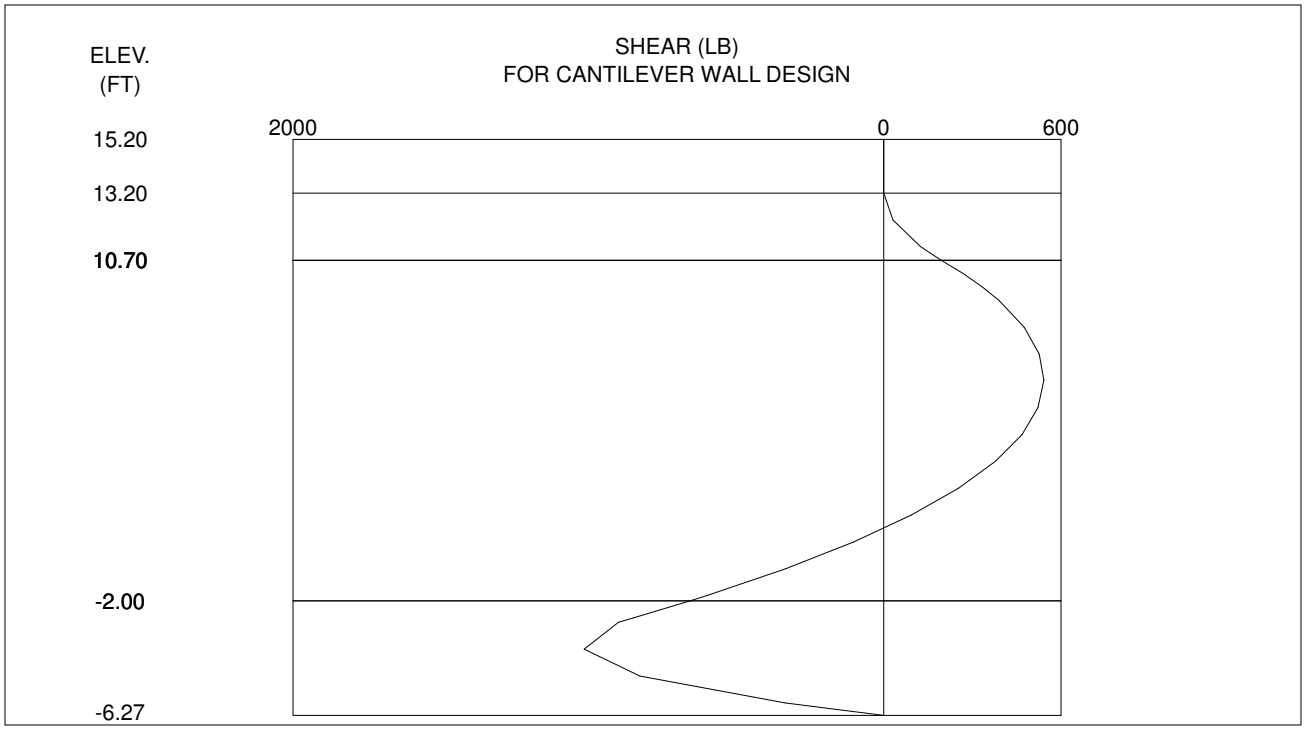
III.--WATER AND SOIL PRESSURES

		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION (FT)	PRESSURE (PSF)	PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
15.20	0.	0.	0.	0.	0.
14.20	0.	0.	0.	0.	0.
13.20	0.	0.	0.	0.	0.
12.20	62.	0.	0.	0.	0.
11.20	125.	0.	0.	0.	0.
10.70	156.	0.	0.	0.	0.
10.20	156.	30.	13.	13.	30.
9.70	156.	61.	26.	26.	61.
9.20	156.	91.	39.	39.	91.
8.20	156.	152.	64.	64.	152.
7.20	156.	213.	90.	90.	213.
6.26	156.	270.	114.	114.	270.
6.20	156.	274.	116.	116.	274.
5.20	156.	335.	142.	142.	335.
4.20	156.	396.	167.	167.	396.
3.20	156.	457.	193.	193.	457.
2.20	156.	517.	219.	219.	517.
1.20	156.	578.	245.	245.	578.
0.20	156.	639.	271.	271.	639.
-0.80	156.	700.	296.	296.	700.
-1.80	156.	761.	322.	322.	761.
-2.00+	156.	773.	327.	327.	773.
-2.00-	156.	777.	326.	326.	777.
-2.62	156.	822.	344.	344.	822.
-2.80	156.	835.	350.	350.	835.
-3.80	156.	907.	380.	380.	907.
-4.80	156.	979.	410.	410.	979.
-5.80	156.	1051.	440.	440.	1051.
-6.27	156.	1123.	470.	470.	1123.
-7.00+	156.	1137.	476.	476.	1137.
-7.00-	156.	1148.	472.	472.	1148.

'HOQUIAM GROUP - DWL LT



'HOQUIAM GROUP - DWL LT



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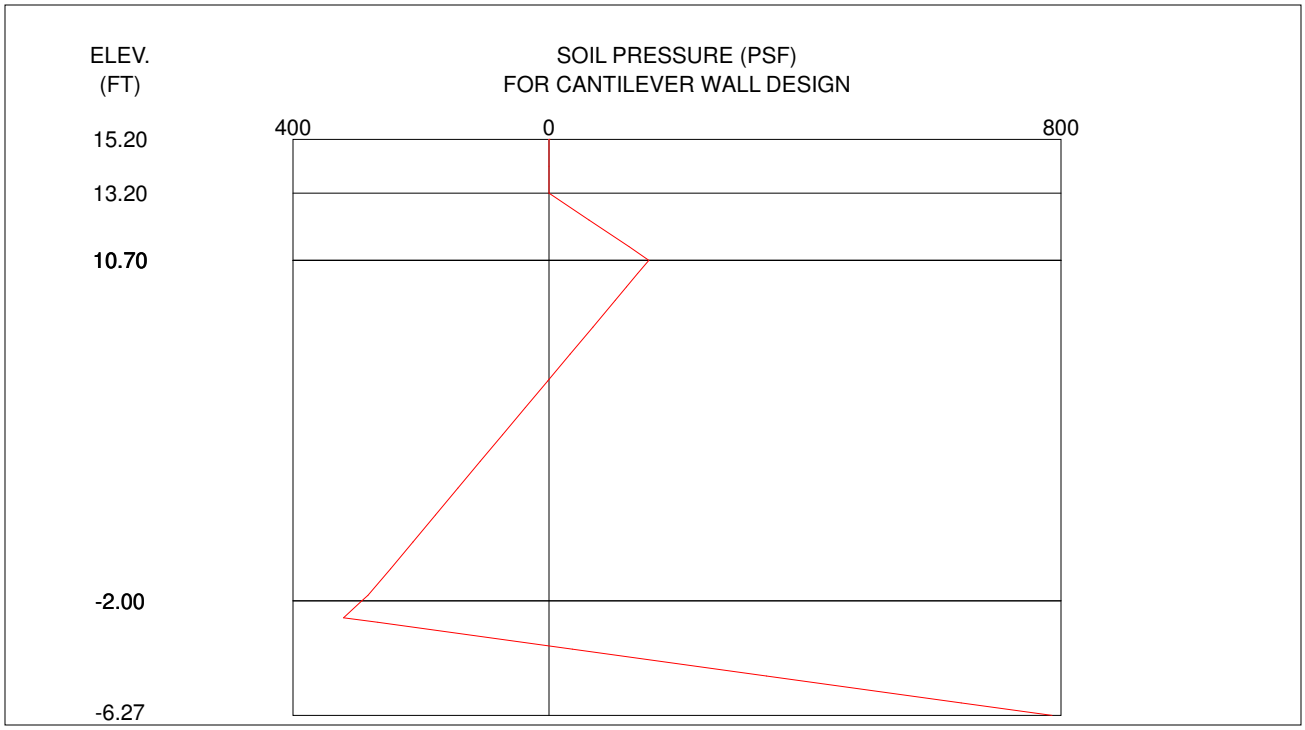


PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 5-FEBRUARY-2017 TIME: 15:24:41

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

I.--HEADING
'GRAYS HARBOR ANALYSIS GROUP - SHORT TERM

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
102.00	102.00	0.00	280.00	0.00	0.00	2.00	0.00	DEF	DEF
109.00	109.00	0.00	378.00	0.00	0.00	-4.00	0.00	DEF	DEF
109.00	109.00	0.00	546.00	0.00	0.00	-10.00	0.00	DEF	DEF
109.00	109.00	0.00	714.00	0.00	0.00	-16.00	0.00	DEF	DEF
109.00	109.00	29.00	0.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
102.00	102.00	0.00	280.00	0.00	0.00	2.00	0.00	DEF	DEF
109.00	109.00	0.00	378.00	0.00	0.00	-4.00	0.00	DEF	DEF
109.00	109.00	0.00	546.00	0.00	0.00	-10.00	0.00	DEF	DEF
109.00	109.00	0.00	714.00	0.00	0.00	-16.00	0.00	DEF	DEF
109.00	109.00	29.00	0.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 15.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 5-FEBRUARY-2017 TIME: 15:24:46

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'GRAYS HARBOR ANALYSIS GROUP - SHORT TERM

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
13.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
12.2	187.2	0.0	0.0	187.2	187.2	0.0	0.0
11.2	249.6	0.0	0.0	249.6	249.6	0.0	0.0
10.7+	280.8	0.0	0.0	280.8	280.8	0.0	0.0
10.7-	280.8	373.3	0.0	-92.5	654.1	0.0	373.3
10.2	280.8	393.1	0.0	-112.3	673.9	0.0	393.1
9.7	280.8	412.9	0.0	-132.1	693.7	0.0	412.9
9.2	280.8	432.7	0.0	-151.9	713.5	0.0	432.7
8.2	280.8	472.3	0.0	-191.5	753.1	0.0	472.3
7.2	280.8	511.9	0.0	-231.1	792.7	0.0	511.9
6.2	280.8	551.5	0.0	-270.7	832.3	0.0	551.5
5.2	280.8	591.1	0.0	-310.3	871.9	0.0	591.1
4.2	280.8	630.7	0.0	-349.9	911.5	0.0	630.7
3.2	280.8	670.3	0.0	-389.5	951.1	0.0	670.3
2.2	280.8	709.9	0.0	-429.1	990.7	0.0	709.9
2.0+	280.8	717.9	0.0	-502.4	1064.0	0.0	717.9
2.0-	280.8	848.5	0.0	-502.4	1064.0	0.0	848.5
1.2	280.8	885.8	0.0	-605.0	1166.6	0.0	885.8
0.2	280.8	932.4	0.0	-651.6	1213.2	0.0	932.4
-0.8	280.8	979.0	0.0	-698.2	1259.8	0.0	979.0
-1.4	280.8	1008.0	0.0	-727.2	1288.8	0.0	1008.0
-1.8	280.8	1025.6	17.6	-727.2	1288.8	17.6	1025.6
-2.8	280.8	1072.2	64.2	-727.2	1288.8	64.2	1072.2
-3.8	280.8	1118.8	110.8	-727.2	1288.8	110.8	1118.8
-4.0+	280.8	1128.1	120.1	-899.3	1460.9	120.1	1128.1
-4.0-	280.8	1352.1	0.0	-899.3	1460.9	0.0	1352.1
-4.8	280.8	1389.4	0.0	-1108.6	1670.2	0.0	1389.4
-5.8	280.8	1436.0	0.0	-1155.2	1716.8	0.0	1436.0
-6.2	280.8	1456.0	0.0	-1175.2	1736.8	0.0	1456.0
-6.8	280.8	1482.6	26.6	-1175.2	1736.8	26.6	1482.6
-7.8	280.8	1529.2	73.2	-1175.2	1736.8	73.2	1529.2
-8.8	280.8	1575.8	119.8	-1175.2	1736.8	119.8	1575.8
-9.8	280.8	1622.4	166.4	-1175.2	1736.8	166.4	1622.4
-10.0+	280.8	1631.7	175.7	-1375.1	1936.7	175.7	1631.7
-10.0-	280.8	1855.7	0.0	-1375.1	1936.7	0.0	1855.7
-10.8	280.8	1893.0	0.0	-1612.2	2173.8	0.0	1893.0
-11.0	280.8	1904.0	0.0	-1623.2	2184.8	0.0	1904.0
-11.8	280.8	1939.6	35.6	-1623.2	2184.8	35.6	1939.6
-12.8	280.8	1986.2	82.2	-1623.2	2184.8	82.2	1986.2
-13.8	280.8	2032.8	128.8	-1623.2	2184.8	128.8	2032.8

-14.8	280.8	2079.4	175.4	-1623.2	2184.8	175.4	2079.4
-15.8	280.8	2126.0	222.0	-1623.2	2184.8	222.0	2126.0
-16.0+	280.8	2135.3	231.3	-1603.6	2165.2	231.3	2135.3
-16.0-	280.8	2438.9	574.1	-1603.6	2165.2	574.1	2438.9
-16.8	280.8	2515.7	592.2	-1642.7	2204.3	592.2	2515.7
-17.8	280.8	2611.8	614.8	-1716.1	2277.7	614.8	2611.8
-18.8	280.8	2707.8	637.4	-1789.6	2351.2	637.4	2707.8
-19.8	280.8	2803.8	660.1	-1863.0	2424.6	660.1	2803.8

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 5-FEBRUARY-2017 TIME: 15:24:48

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'GRAYS HARBOR ANALYSIS GROUP - SHORT TERM

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : 2.12
PENETRATION (FT) : 8.58

MAX. BEND. MOMENT (LB-FT) : 2.3184E+03
AT ELEVATION (FT) : 6.92

MAX. SCALED DEFL. (LB-IN^3): 1.9587E+08
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 5-FEBRUARY-2017 TIME: 15:24:48

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'GRAYS HARBOR ANALYSIS GROUP - SHORT TERM

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	1.9587E+08	0.00

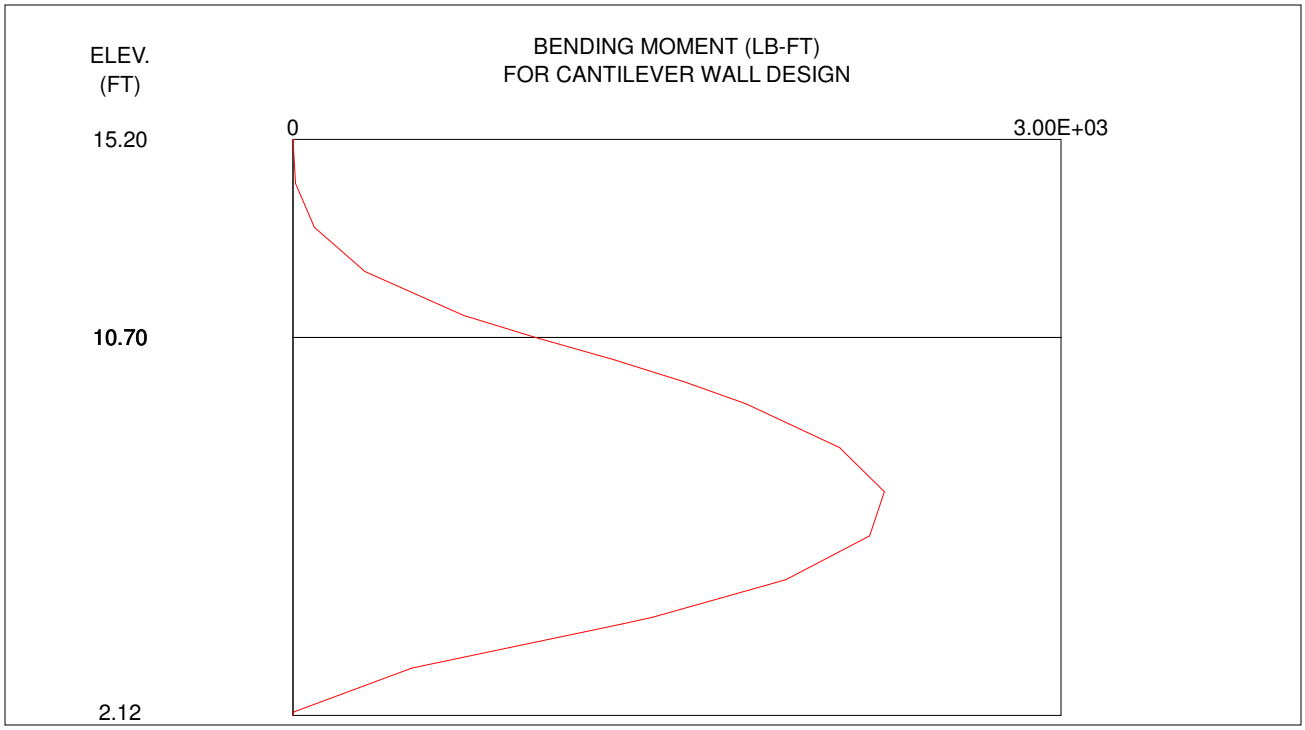
14.20	1.0400E+01	31.	1.7091E+08	62.40
13.20	8.3200E+01	125.	1.4598E+08	124.80
12.20	2.8080E+02	281.	1.2122E+08	187.20
11.20	6.6560E+02	499.	9.6960E+07	249.60
10.70+	9.4770E+02	632.	8.5219E+07	280.80
10.70-	9.4770E+02	632.	8.5219E+07	-92.53
10.20	1.2512E+03	581.	7.3889E+07	-112.33
9.70	1.5266E+03	519.	6.3098E+07	-132.13
9.20	1.7690E+03	448.	5.2965E+07	-151.93
8.20	2.1349E+03	277.	3.5077E+07	-191.53
7.20	2.3093E+03	65.	2.0850E+07	-231.13
6.20	2.2525E+03	-186.	1.0580E+07	-270.73
5.20	1.9250E+03	-476.	4.1635E+06	-310.33
4.35	1.4056E+03	-753.	1.3310E+06	-343.91
4.20	1.2875E+03	-799.	1.0286E+06	-251.01
3.20	4.6516E+02	-744.	8.6469E+04	360.24
2.20	3.0751E+00	-78.	2.6510E+00	971.48
2.12	0.0000E+00	0.	0.0000E+00	1019.51

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

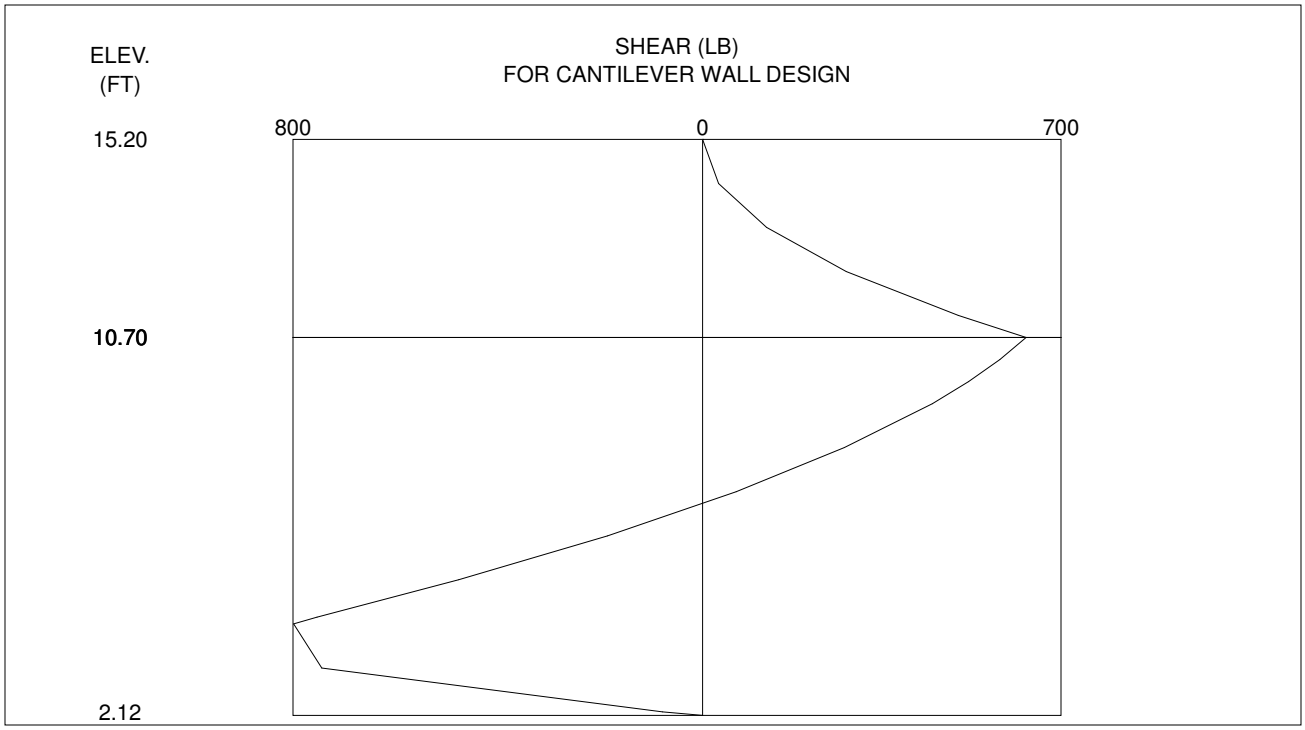
III.--WATER AND SOIL PRESSURES

		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION (FT)	PRESSURE (PSF)	PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
15.20	0.	0.	0.	0.	0.
14.20	62.	0.	0.	0.	0.
13.20	125.	0.	0.	0.	0.
12.20	187.	0.	0.	0.	0.
11.20	250.	0.	0.	0.	0.
10.70+	281.	0.	0.	0.	0.
10.70-	281.	373.	0.	0.	373.
10.20	281.	393.	0.	0.	393.
9.70	281.	413.	0.	0.	413.
9.20	281.	433.	0.	0.	433.
8.20	281.	472.	0.	0.	472.
7.20	281.	512.	0.	0.	512.
6.20	281.	552.	0.	0.	552.
5.20	281.	591.	0.	0.	591.
4.35	281.	625.	0.	0.	625.
4.20	281.	631.	0.	0.	631.
3.20	281.	670.	0.	0.	670.
2.20	281.	710.	0.	0.	710.
2.12+	281.	718.	0.	0.	718.
2.12-	281.	849.	0.	0.	849.
1.20	281.	886.	0.	0.	886.

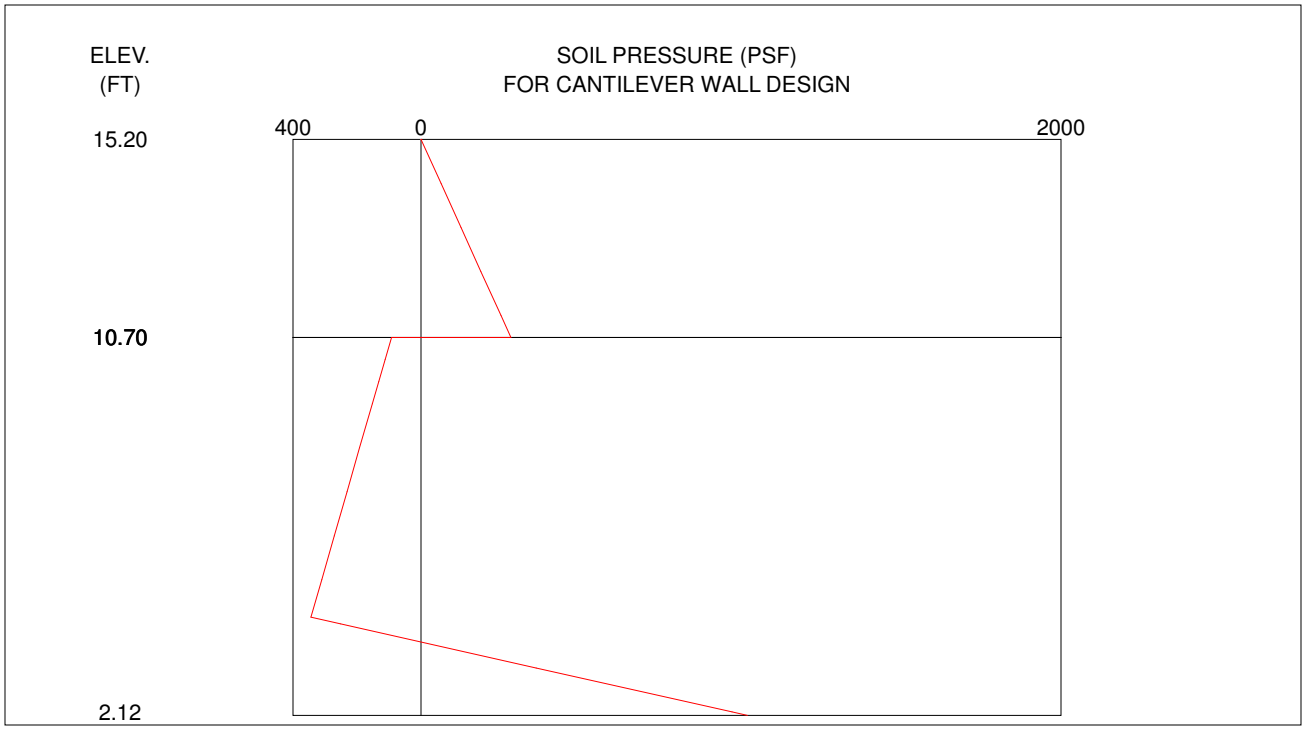
'Grays Harbor Analysis Group - Short Term



'GRAYS HARBOR ANALYSIS GROUP - SHORT TERM



'GRAYS HARBOR ANALYSIS GROUP - SHORT TERM



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 19:59:31

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

I.--HEADING
'GRAYS HARBOR LONG TERM DWL

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
102.00	102.00	14.00	0.00	0.00	0.00	2.00	0.00	DEF	DEF
109.00	109.00	15.80	0.00	0.00	0.00	-4.00	0.00	DEF	DEF
109.00	109.00	18.80	0.00	0.00	0.00	-10.00	0.00	DEF	DEF
109.00	109.00	21.80	0.00	0.00	0.00	-16.00	0.00	DEF	DEF
109.00	109.00	29.00	0.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
102.00	102.00	14.00	0.00	0.00	0.00	2.00	0.00	DEF	DEF
109.00	109.00	15.80	0.00	0.00	0.00	-4.00	0.00	DEF	DEF
109.00	109.00	18.80	0.00	0.00	0.00	-10.00	0.00	DEF	DEF
109.00	109.00	21.80	0.00	0.00	0.00	-16.00	0.00	DEF	DEF
109.00	109.00	29.00	0.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 13.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 20:00:26

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'GRAYS HARBOR LONG TERM DWL

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
11.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
10.7	156.0	0.0	0.0	156.0	156.0	0.0	0.0
10.2	156.0	27.6	14.2	142.7	169.3	14.2	27.6
9.7	156.0	55.1	28.4	129.3	182.7	28.4	55.1
9.2	156.0	82.7	42.7	116.0	196.0	42.7	82.7
8.2	156.0	137.8	71.1	89.3	222.7	71.1	137.8
7.2	156.0	193.0	99.6	62.6	249.4	99.6	193.0
6.2	156.0	248.1	128.0	35.9	276.1	128.0	248.1
5.2	156.0	303.2	156.4	9.2	302.8	156.4	303.2
4.9	156.0	322.2	166.2	0.0	312.0	166.2	322.2
4.2	156.0	358.4	184.9	-17.5	329.5	184.9	358.4
3.2	156.0	413.5	213.3	-44.2	356.2	213.3	413.5
2.2	156.0	468.6	241.8	-70.9	382.9	241.8	468.6
2.0+	156.0	479.7	247.5	-92.4	404.4	247.5	479.7
2.0-	156.0	501.3	236.8	-92.4	404.4	236.8	501.3
1.2	156.0	555.6	262.4	-137.2	449.2	262.4	555.6
0.2	156.0	623.4	294.4	-173.0	485.0	294.4	623.4
-0.8	156.0	691.2	326.4	-208.8	520.8	326.4	691.2
-1.8	156.0	759.0	358.5	-244.5	556.5	358.5	759.0
-2.8	156.0	826.8	390.5	-280.3	592.3	390.5	826.8
-3.8	156.0	894.6	422.5	-316.1	628.1	422.5	894.6
-4.0+	156.0	908.2	428.9	-374.1	686.1	428.9	908.2
-4.0-	156.0	978.9	397.9	-374.1	686.1	397.9	978.9
-4.8	156.0	1037.4	421.7	-459.7	771.7	421.7	1037.4
-5.8	156.0	1110.5	451.4	-503.1	815.1	451.4	1110.5
-6.8	156.0	1183.6	481.1	-546.5	858.5	481.1	1183.6
-7.8	156.0	1256.7	510.8	-589.8	901.8	510.8	1256.7
-8.8	156.0	1329.7	540.5	-633.2	945.2	540.5	1329.7
-9.8	156.0	1402.8	570.2	-676.6	988.6	570.2	1402.8
-10.0+	156.0	1417.4	576.2	-763.4	1075.4	576.2	1417.4
-10.0-	156.0	1531.0	533.4	-763.4	1075.4	533.4	1531.0
-10.8	156.0	1594.2	555.4	-882.7	1194.7	555.4	1594.2
-11.8	156.0	1673.1	583.0	-934.2	1246.2	583.0	1673.1
-12.8	156.0	1752.1	610.5	-985.6	1297.6	610.5	1752.1
-13.8	156.0	1831.0	638.0	-1037.0	1349.0	638.0	1831.0
-14.8	156.0	1910.0	665.5	-1088.5	1400.5	665.5	1910.0
-15.8	156.0	1988.9	693.0	-1139.9	1451.9	693.0	1988.9
-16.0+	156.0	2004.7	698.5	-1429.5	1741.5	698.5	2004.7

-16.0-	156.0	2438.9	574.1	-1429.5	1741.5	574.1	2438.9
-16.8	156.0	2515.7	592.2	-1767.5	2079.5	592.2	2515.7
-17.8	156.0	2611.8	614.8	-1840.9	2152.9	614.8	2611.8
-18.8	156.0	2707.8	637.4	-1914.4	2226.4	637.4	2707.8
-19.8	156.0	2803.8	660.1	-1987.8	2299.8	660.1	2803.8

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:00:27

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'GRAYS HARBOR LONG TERM DWL

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : -8.90
PENETRATION (FT) : 19.60

MAX. BEND. MOMENT (LB-FT) : 5.8313E+03
AT ELEVATION (FT) : -1.27

MAX. SCALED DEFL. (LB-IN^3): 1.6551E+09
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:00:27

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'GRAYS HARBOR LONG TERM DWL

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	1.6551E+09	0.00
14.20	0.0000E+00	0.	1.5459E+09	0.00
13.20	0.0000E+00	0.	1.4366E+09	0.00
12.20	1.0400E+01	31.	1.3274E+09	62.40

11.20	8.3200E+01	125.	1.2181E+09	124.80
10.70	1.6250E+02	195.	1.1636E+09	156.00
10.20	2.7894E+02	270.	1.1091E+09	142.65
9.70	4.3105E+02	338.	1.0547E+09	129.31
9.20	6.1549E+02	399.	1.0005E+09	115.96
8.20	1.0680E+03	502.	8.9305E+08	89.27
7.20	1.6098E+03	578.	7.8743E+08	62.58
6.20	2.2141E+03	627.	6.8460E+08	35.89
5.20	2.8544E+03	649.	5.8560E+08	9.20
4.86	3.0787E+03	651.	5.5255E+08	0.00
4.20	3.5039E+03	645.	4.9153E+08	-17.49
3.20	4.1358E+03	614.	4.0352E+08	-44.18
2.20	4.7236E+03	557.	3.2265E+08	-70.87
2.00	4.8334E+03	540.	3.0742E+08	-92.38
1.20	5.2315E+03	449.	2.4993E+08	-137.18
0.20	5.6056E+03	294.	1.8623E+08	-172.97
-0.80	5.8067E+03	103.	1.3219E+08	-208.75
-1.80	5.7991E+03	-124.	8.8154E+07	-244.54
-2.80	5.5470E+03	-386.	5.4105E+07	-280.32
-3.80	5.0145E+03	-685.	2.9600E+07	-316.11
-4.00	4.8709E+03	-754.	2.5773E+07	-374.13
-4.71	4.2358E+03	-1046.	1.4833E+07	-450.00
-4.80	4.1392E+03	-1085.	1.3713E+07	-419.72
-5.80	2.8997E+03	-1338.	4.9211E+06	-85.58
-6.80	1.5747E+03	-1256.	1.1278E+06	248.56
-7.80	4.9822E+02	-841.	9.1510E+04	582.70
-8.80	4.4372E+00	-91.	5.9007E+00	916.84
-8.90	0.0000E+00	0.	0.0000E+00	949.44

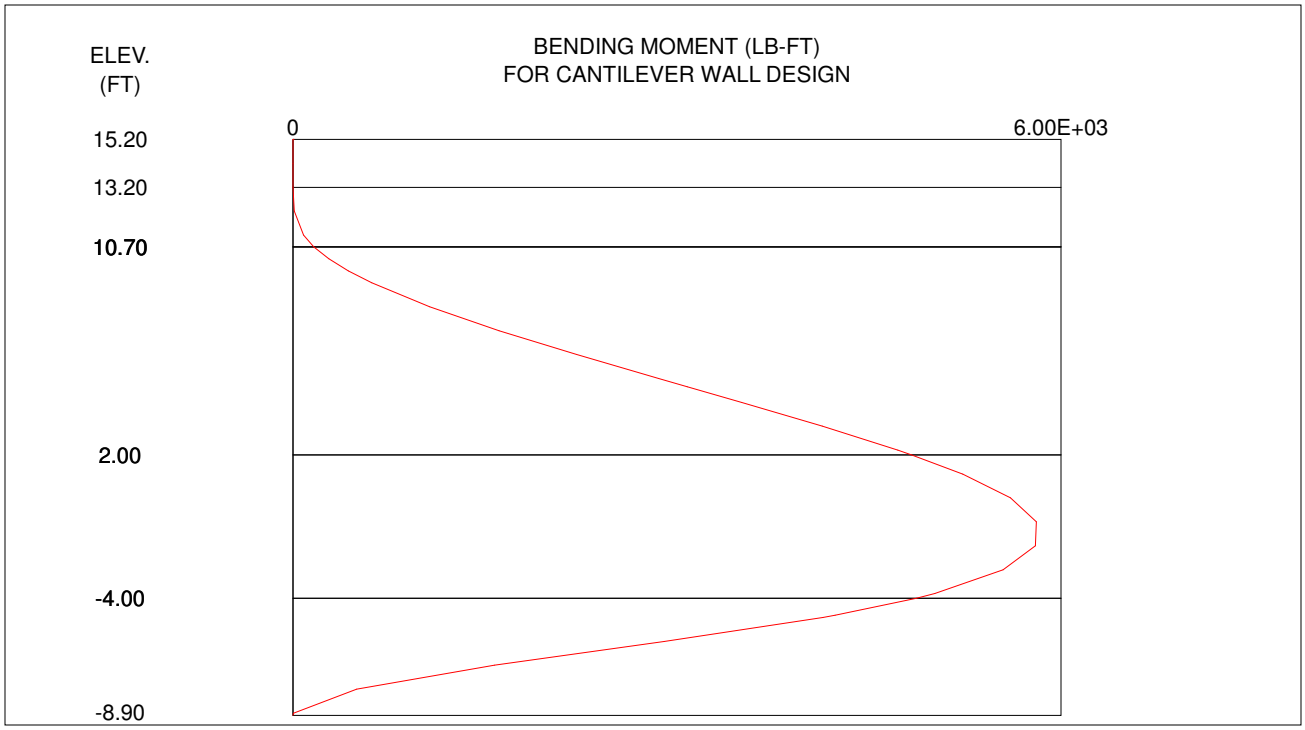
NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

III.--WATER AND SOIL PRESSURES

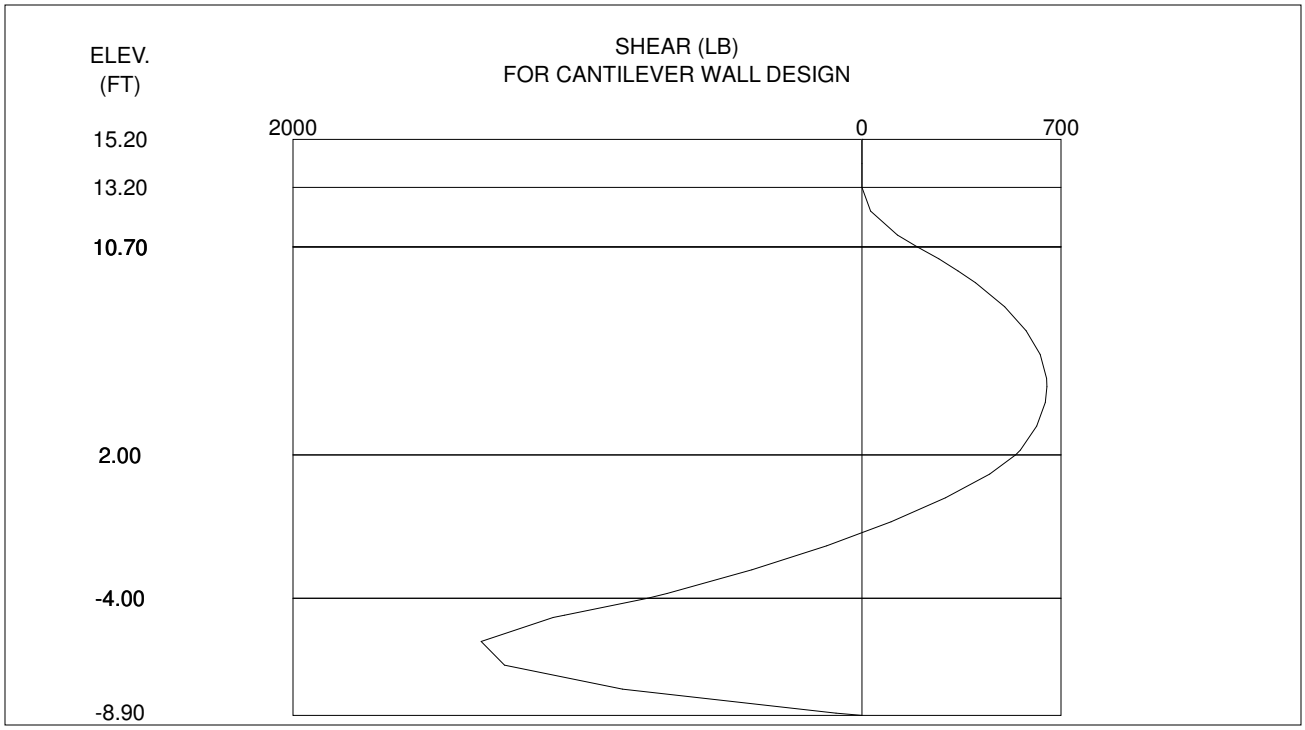
		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION (FT)	PRESSURE (PSF)	PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
15.20	0.	0.	0.	0.	0.
14.20	0.	0.	0.	0.	0.
13.20	0.	0.	0.	0.	0.
12.20	62.	0.	0.	0.	0.
11.20	125.	0.	0.	0.	0.
10.70	156.	0.	0.	0.	0.
10.20	156.	28.	14.	14.	28.
9.70	156.	55.	28.	28.	55.
9.20	156.	83.	43.	43.	83.
8.20	156.	138.	71.	71.	138.
7.20	156.	193.	100.	100.	193.
6.20	156.	248.	128.	128.	248.
5.20	156.	303.	156.	156.	303.
4.86	156.	322.	166.	166.	322.
4.20	156.	358.	185.	185.	358.
3.20	156.	413.	213.	213.	413.
2.20	156.	469.	242.	242.	469.
2.00+	156.	480.	247.	247.	480.
2.00-	156.	501.	237.	237.	501.
1.20	156.	556.	262.	262.	556.
0.20	156.	623.	294.	294.	623.
-0.80	156.	691.	326.	326.	691.
-1.80	156.	759.	358.	358.	759.
-2.80	156.	827.	390.	390.	827.
-3.80	156.	895.	423.	423.	895.
-4.00+	156.	908.	429.	429.	908.
-4.00-	156.	979.	398.	398.	979.
-4.71	156.	1031.	419.	419.	1031.
-4.80	156.	1037.	422.	422.	1037.
-5.80	156.	1110.	451.	451.	1110.
-6.80	156.	1184.	481.	481.	1184.
-7.80	156.	1257.	511.	511.	1257.
-8.80	156.	1330.	541.	541.	1330.
-8.90	156.	1403.	570.	570.	1403.

-10.00+	156.	1417.	576.	576.	1417.
-10.00-	156.	1531.	533.	533.	1531.

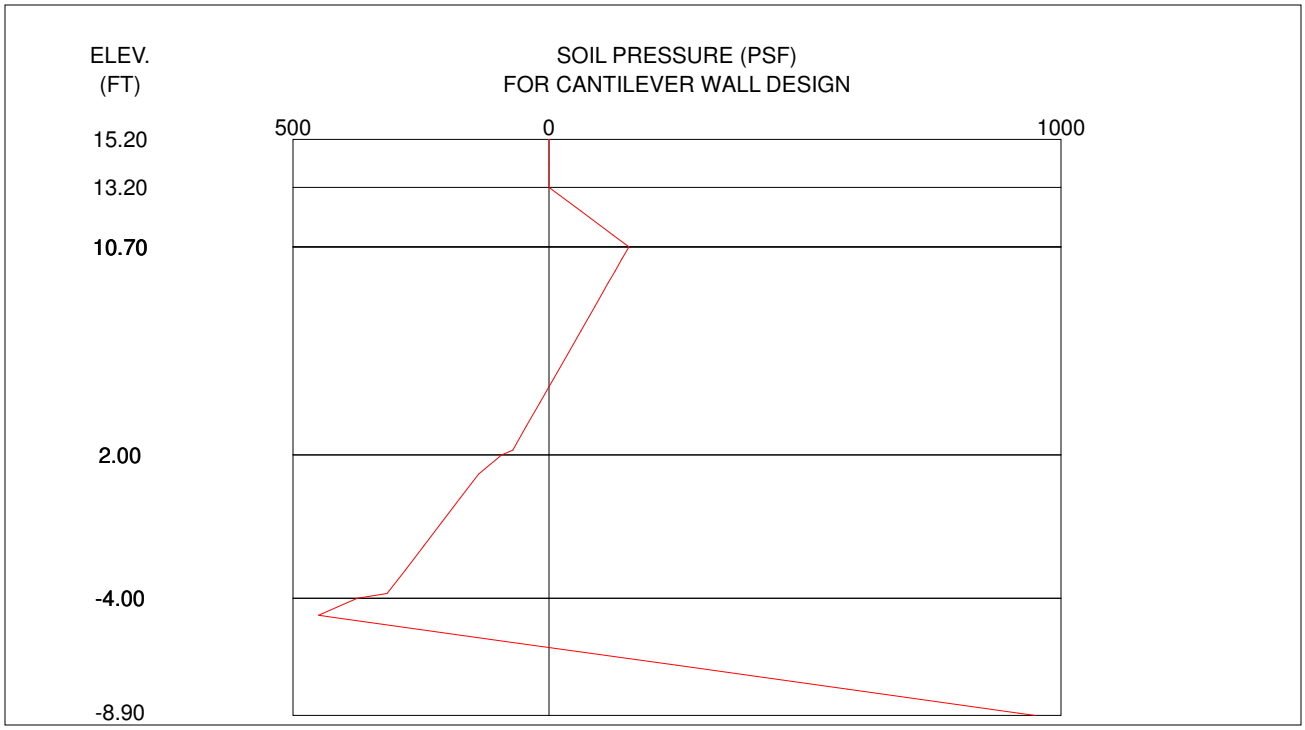
'GRAYS HARBOR LONG TERM DWL



'GRAYS HARBOR LONG TERM DWL



'GRAYS HARBOR LONG TERM DWL



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 20:52:47

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

I.--HEADING
'CHEHALIS WEST - SHORT TERM

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
90.00	90.00	0.00	430.00	0.00	0.00	-8.00	0.00	DEF	DEF
90.00	90.00	0.00	350.00	0.00	0.00	-18.00	0.00	DEF	DEF
107.00	107.00	0.00	700.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
90.00	90.00	0.00	430.00	0.00	0.00	-8.00	0.00	DEF	DEF
90.00	90.00	0.00	350.00	0.00	0.00	-18.00	0.00	DEF	DEF
107.00	107.00	0.00	700.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 15.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 20:52:52

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* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS WEST - SHORT TERM

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
13.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
12.2	187.2	0.0	0.0	187.2	187.2	0.0	0.0
11.2	249.6	0.0	0.0	249.6	249.6	0.0	0.0
10.7+	280.8	0.0	0.0	280.8	280.8	0.0	0.0
10.7-	280.8	573.3	0.0	-292.5	854.1	0.0	573.3
10.2	280.8	587.1	0.0	-306.3	867.9	0.0	587.1
9.7	280.8	600.9	0.0	-320.1	881.7	0.0	600.9
9.2	280.8	614.7	0.0	-333.9	895.5	0.0	614.7
8.2	280.8	642.3	0.0	-361.5	923.1	0.0	642.3
7.2	280.8	669.9	0.0	-389.1	950.7	0.0	669.9
6.2	280.8	697.5	0.0	-416.7	978.3	0.0	697.5
5.2	280.8	725.1	0.0	-444.3	1005.9	0.0	725.1
4.2	280.8	752.7	0.0	-471.9	1033.5	0.0	752.7
3.2	280.8	780.3	0.0	-499.5	1061.1	0.0	780.3
2.2	280.8	807.9	0.0	-527.1	1088.7	0.0	807.9
1.2	280.8	835.5	0.0	-554.7	1116.3	0.0	835.5
0.2	280.8	863.1	0.0	-582.3	1143.9	0.0	863.1
-0.8	280.8	890.7	0.0	-609.9	1171.5	0.0	890.7
-1.8	280.8	918.3	0.0	-637.5	1199.1	0.0	918.3
-2.8	280.8	945.9	0.0	-665.1	1226.7	0.0	945.9
-3.8	280.8	973.5	0.0	-692.7	1254.3	0.0	973.5
-4.8	280.8	1001.1	0.0	-720.3	1281.9	0.0	1001.1
-5.8	280.8	1028.7	0.0	-747.9	1309.5	0.0	1028.7
-6.8	280.8	1056.3	0.0	-775.5	1337.1	0.0	1056.3
-7.8	280.8	1083.9	0.0	-803.1	1364.7	0.0	1083.9
-8.0+	280.8	1089.5	0.0	-730.6	1292.2	0.0	1089.5
-8.0-	280.8	982.8	49.5	-730.6	1292.2	49.5	982.8
-8.8	280.8	1004.9	71.5	-652.5	1214.1	71.5	1004.9
-9.8	280.8	1032.5	99.1	-652.5	1214.1	99.1	1032.5
-10.8	280.8	1060.1	126.7	-652.5	1214.1	126.7	1060.1
-11.8	280.8	1087.7	154.3	-652.5	1214.1	154.3	1087.7
-12.8	280.8	1115.3	181.9	-652.5	1214.1	181.9	1115.3
-13.8	280.8	1142.9	209.5	-652.5	1214.1	209.5	1142.9
-14.8	280.8	1170.5	237.1	-652.5	1214.1	237.1	1170.5
-15.8	280.8	1198.1	264.7	-652.5	1214.1	264.7	1198.1
-16.8	280.8	1225.7	292.3	-652.5	1214.1	292.3	1225.7
-17.8	280.8	1253.3	319.9	-652.5	1214.1	319.9	1253.3
-18.0+	280.8	1258.8	325.5	-1048.6	1610.2	325.5	1258.8
-18.0-	280.8	1725.5	0.0	-1048.6	1610.2	0.0	1725.5
-18.8	280.8	1761.1	0.0	-1480.3	2041.9	0.0	1761.1
-19.8	280.8	1805.7	0.0	-1524.9	2086.5	0.0	1805.7

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:52:53

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS WEST - SHORT TERM

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : 5.06
PENETRATION (FT) : 5.64

MAX. BEND. MOMENT (LB-FT) : 1.5895E+03
AT ELEVATION (FT) : 8.72

MAX. SCALED DEFL. (LB-IN^3): 7.5713E+07
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:52:53

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS WEST - SHORT TERM

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	7.5713E+07	0.00
14.20	1.0400E+01	31.	6.3564E+07	62.40
13.20	8.3200E+01	125.	5.1441E+07	124.80
12.20	2.8080E+02	281.	3.9480E+07	187.20
11.20	6.6560E+02	499.	2.8032E+07	249.60
10.70+	9.4770E+02	632.	2.2694E+07	280.80
10.70-	9.4770E+02	632.	2.2694E+07	-292.53
10.20	1.2265E+03	482.	1.7767E+07	-306.33
9.70	1.4286E+03	325.	1.3366E+07	-320.13
9.20	1.5508E+03	162.	9.5791E+06	-333.93
8.20	1.5412E+03	-186.	4.0233E+06	-361.53
7.20	1.1700E+03	-561.	1.0786E+06	-389.13

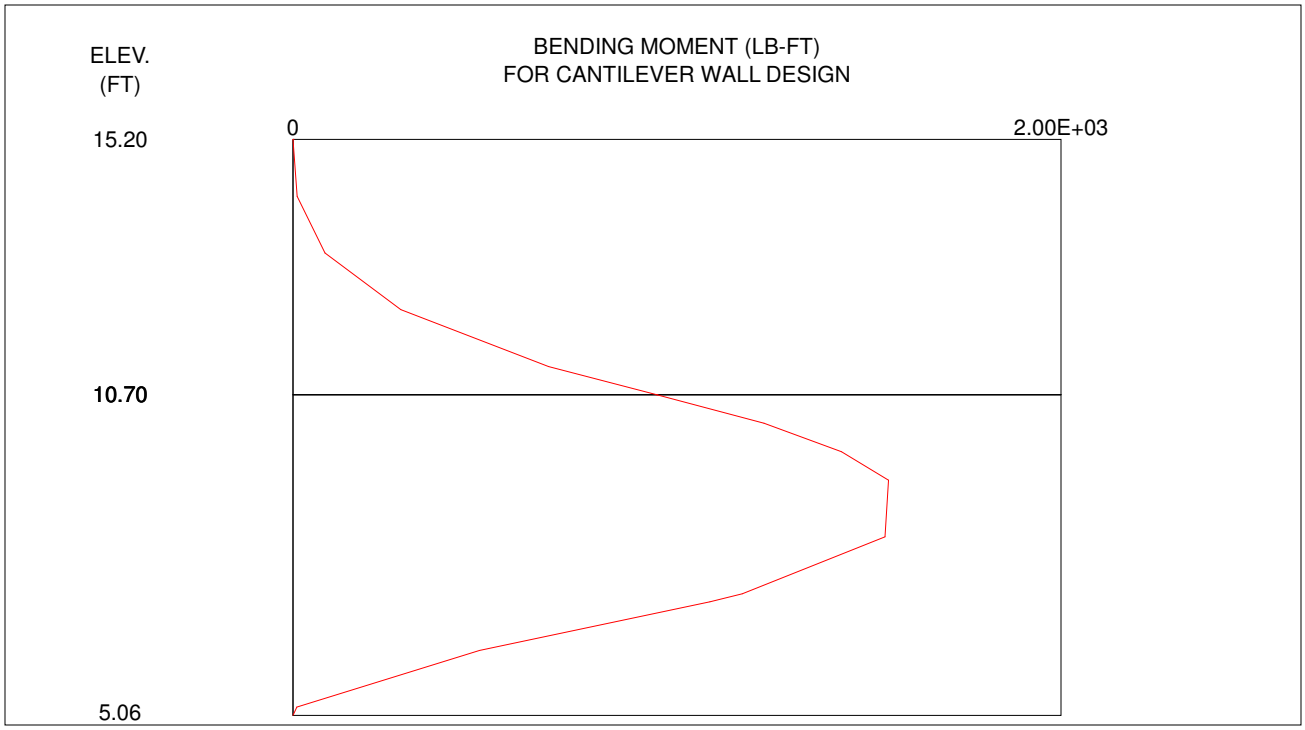
7.06	1.0854E+03	-617.	8.4062E+05	-393.09
6.20	4.8602E+02	-697.	1.0447E+05	207.32
5.20	9.7130E+00	-139.	2.1756E+01	908.36
5.06	0.0000E+00	0.	0.0000E+00	1009.93

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

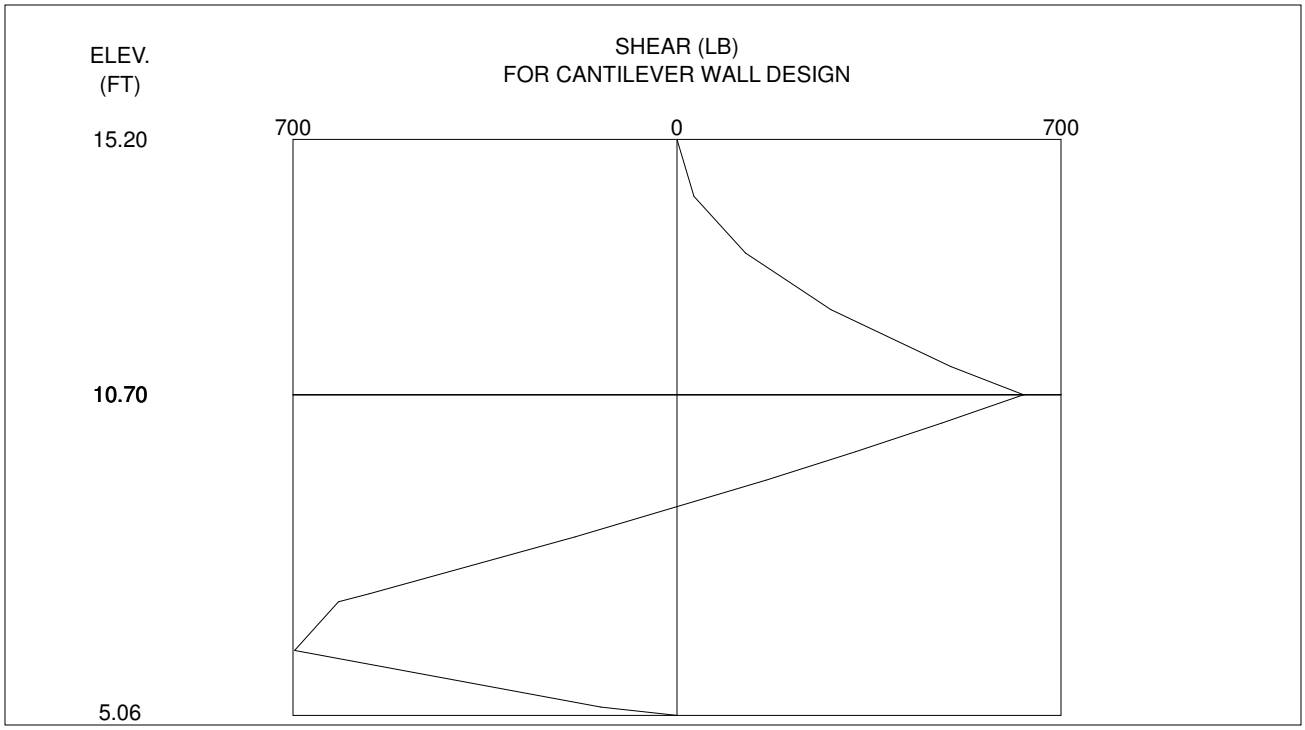
III.--WATER AND SOIL PRESSURES

		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION (FT)	PRESSURE (PSF)	PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
15.20	0.	0.	0.	0.	0.
14.20	62.	0.	0.	0.	0.
13.20	125.	0.	0.	0.	0.
12.20	187.	0.	0.	0.	0.
11.20	250.	0.	0.	0.	0.
10.70+	281.	0.	0.	0.	0.
10.70-	281.	573.	0.	0.	573.
10.20	281.	587.	0.	0.	587.
9.70	281.	601.	0.	0.	601.
9.20	281.	615.	0.	0.	615.
8.20	281.	642.	0.	0.	642.
7.20	281.	670.	0.	0.	670.
7.06	281.	674.	0.	0.	674.
6.20	281.	698.	0.	0.	698.
5.20	281.	725.	0.	0.	725.
5.06	281.	753.	0.	0.	753.
3.20	281.	780.	0.	0.	780.

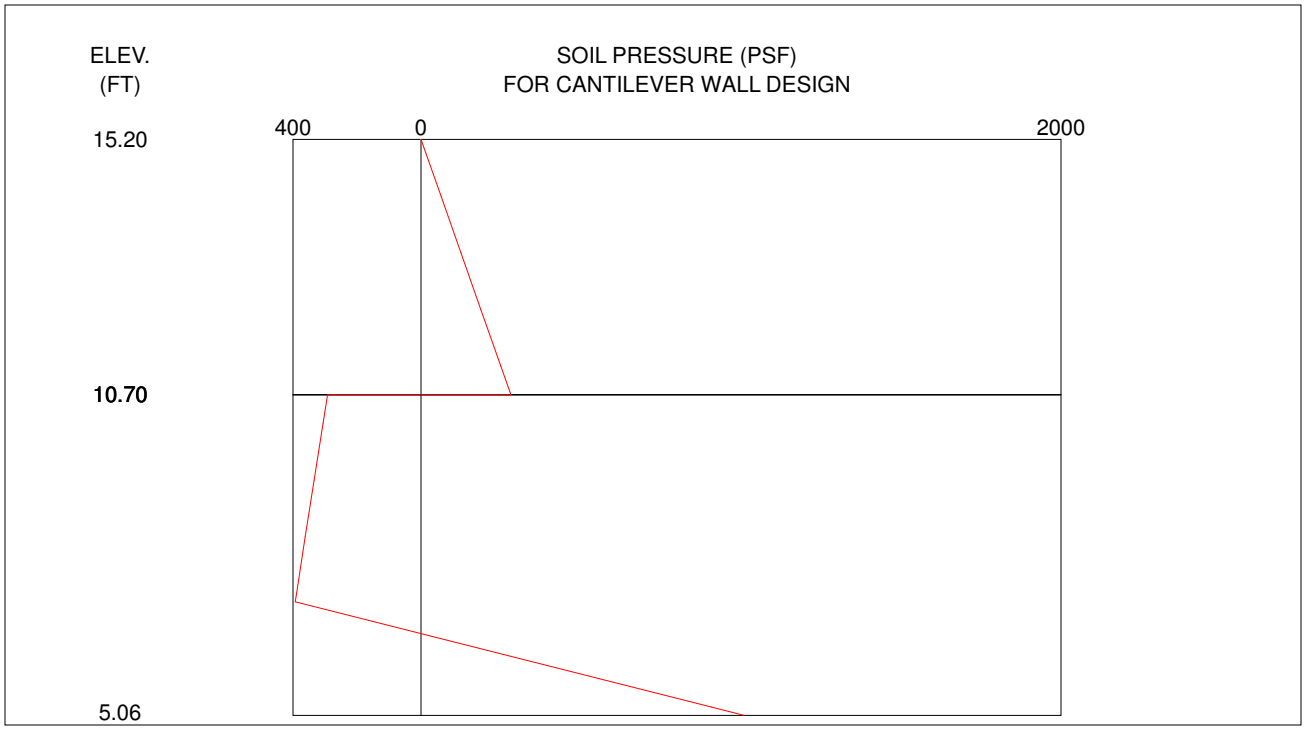
'CHEHALIS WEST - SHORT TERM



'CHEHALIS WEST - SHORT TERM



'CHEHALIS WEST - SHORT TERM



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 19:56:23

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

I.--HEADING
'CHEHALIS WEST - LONG TERM - DWL

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
90.00	90.00	22.00	0.00	0.00	0.00	-8.00	0.00	DEF	DEF
90.00	90.00	22.00	0.00	0.00	0.00	-18.00	0.00	DEF	DEF
107.00	107.00	25.00	0.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
90.00	90.00	22.00	0.00	0.00	0.00	-8.00	0.00	DEF	DEF
90.00	90.00	22.00	0.00	0.00	0.00	-18.00	0.00	DEF	DEF
107.00	107.00	25.00	0.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 13.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 19:56:25

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS WEST - LONG TERM - DWL

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
11.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
10.7	156.0	0.0	0.0	156.0	156.0	0.0	0.0
10.2	156.0	23.5	8.1	140.6	171.4	8.1	23.5
9.7	156.0	47.0	16.2	125.2	186.8	16.2	47.0
9.2	156.0	70.5	24.3	109.8	202.2	24.3	70.5
8.2	156.0	117.5	40.5	79.0	233.0	40.5	117.5
7.2	156.0	164.5	56.7	48.2	263.8	56.7	164.5
6.2	156.0	211.5	72.9	17.4	294.6	72.9	211.5
5.6	156.0	238.1	82.1	0.0	312.0	82.1	238.1
5.2	156.0	258.5	89.1	-13.4	325.4	89.1	258.5
4.2	156.0	305.5	105.3	-44.2	356.2	105.3	305.5
3.2	156.0	352.5	121.6	-75.0	387.0	121.6	352.5
2.2	156.0	399.5	137.8	-105.8	417.8	137.8	399.5
1.2	156.0	446.5	154.0	-136.6	448.6	154.0	446.5
0.2	156.0	493.5	170.2	-167.4	479.4	170.2	493.5
-0.8	156.0	540.5	186.4	-198.2	510.2	186.4	540.5
-1.8	156.0	587.5	202.6	-229.0	541.0	202.6	587.5
-2.8	156.0	634.5	218.8	-259.7	571.7	218.8	634.5
-3.8	156.0	681.5	235.0	-290.5	602.5	235.0	681.5
-4.8	156.0	728.5	251.2	-321.3	633.3	251.2	728.5
-5.8	156.0	775.5	267.4	-352.1	664.1	267.4	775.5
-6.8	156.0	822.5	283.6	-382.9	694.9	283.6	822.5
-7.8	156.0	869.6	299.8	-413.7	725.7	299.8	869.6
-8.0	156.0	879.0	303.1	-419.9	731.9	303.1	879.0
-8.8	156.0	916.6	316.0	-444.5	756.5	316.0	916.6
-9.8	156.0	963.6	332.2	-475.3	787.3	332.2	963.6
-10.8	156.0	1010.6	348.4	-506.1	818.1	348.4	1010.6
-11.8	156.0	1057.6	364.7	-536.9	848.9	364.7	1057.6
-12.8	156.0	1104.6	380.9	-567.7	879.7	380.9	1104.6
-13.8	156.0	1151.6	397.1	-598.5	910.5	397.1	1151.6
-14.8	156.0	1198.6	413.3	-629.3	941.3	413.3	1198.6
-15.8	156.0	1245.6	429.5	-660.1	972.1	429.5	1245.6
-16.8	156.0	1292.6	445.7	-690.9	1002.9	445.7	1292.6
-17.8	156.0	1339.6	461.9	-721.7	1033.7	461.9	1339.6
-18.0+	156.0	1349.0	465.1	-801.7	1113.7	465.1	1349.0
-18.0-	156.0	1461.0	429.5	-801.7	1113.7	429.5	1461.0
-18.8	156.0	1526.8	448.8	-922.0	1234.0	448.8	1526.8
-19.8	156.0	1609.0	473.0	-980.0	1292.0	473.0	1609.0

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 19:56:26

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS WEST - LONG TERM - DWL

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : -8.37
PENETRATION (FT) : 19.07

MAX. BEND. MOMENT (LB-FT) : 4.9201E+03
AT ELEVATION (FT) : -0.56

MAX. SCALED DEFL. (LB-IN^3): 1.3317E+09
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 19:56:26

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS WEST - LONG TERM - DWL

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	1.3317E+09	0.00
14.20	-4.3656E-11	0.	1.2406E+09	0.00
13.20	-4.3656E-11	0.	1.1495E+09	0.00
12.20	1.0400E+01	31.	1.0584E+09	62.40
11.20	8.3200E+01	125.	9.6726E+08	124.80
10.70	1.6250E+02	195.	9.2176E+08	156.00
10.20	2.7886E+02	269.	8.7634E+08	140.60
9.70	4.3037E+02	336.	8.3103E+08	125.20
9.20	6.1318E+02	394.	7.8591E+08	109.81
8.20	1.0573E+03	489.	6.9656E+08	79.01
7.20	1.5804E+03	552.	6.0905E+08	48.21
6.20	2.1518E+03	585.	5.2427E+08	17.42
5.63	2.4846E+03	590.	4.7791E+08	0.00

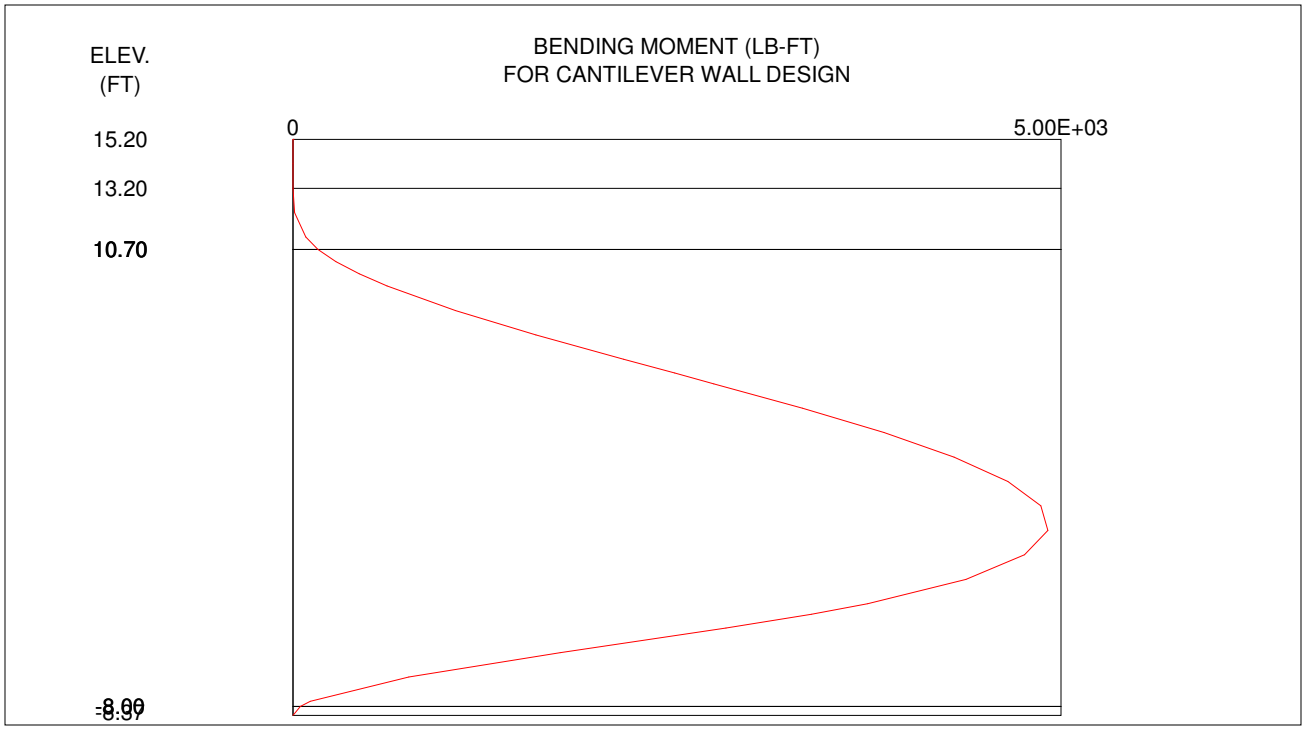
5.20	2.7405E+03	587.	4.4322E+08	-13.38
4.20	3.3159E+03	558.	3.6690E+08	-44.17
3.20	3.8471E+03	499.	2.9630E+08	-74.97
2.20	4.3034E+03	408.	2.3234E+08	-105.77
1.20	4.6539E+03	287.	1.7581E+08	-136.56
0.20	4.8678E+03	135.	1.2729E+08	-167.36
-0.80	4.9143E+03	-47.	8.7163E+07	-198.16
-1.80	4.7627E+03	-261.	5.5498E+07	-228.95
-2.80	4.3822E+03	-505.	3.2030E+07	-259.75
-3.80	3.7419E+03	-780.	1.6097E+07	-290.54
-4.23	3.3757E+03	-909.	1.1267E+07	-303.90
-4.80	2.8196E+03	-1041.	6.5883E+06	-160.58
-5.80	1.7406E+03	-1075.	1.9289E+06	92.47
-6.80	7.5414E+02	-856.	2.9068E+05	345.53
-7.80	1.1317E+02	-384.	5.3450E+03	598.58
-8.00	4.8705E+01	-259.	9.3018E+02	649.19
-8.37	0.0000E+00	0.	0.0000E+00	743.35

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

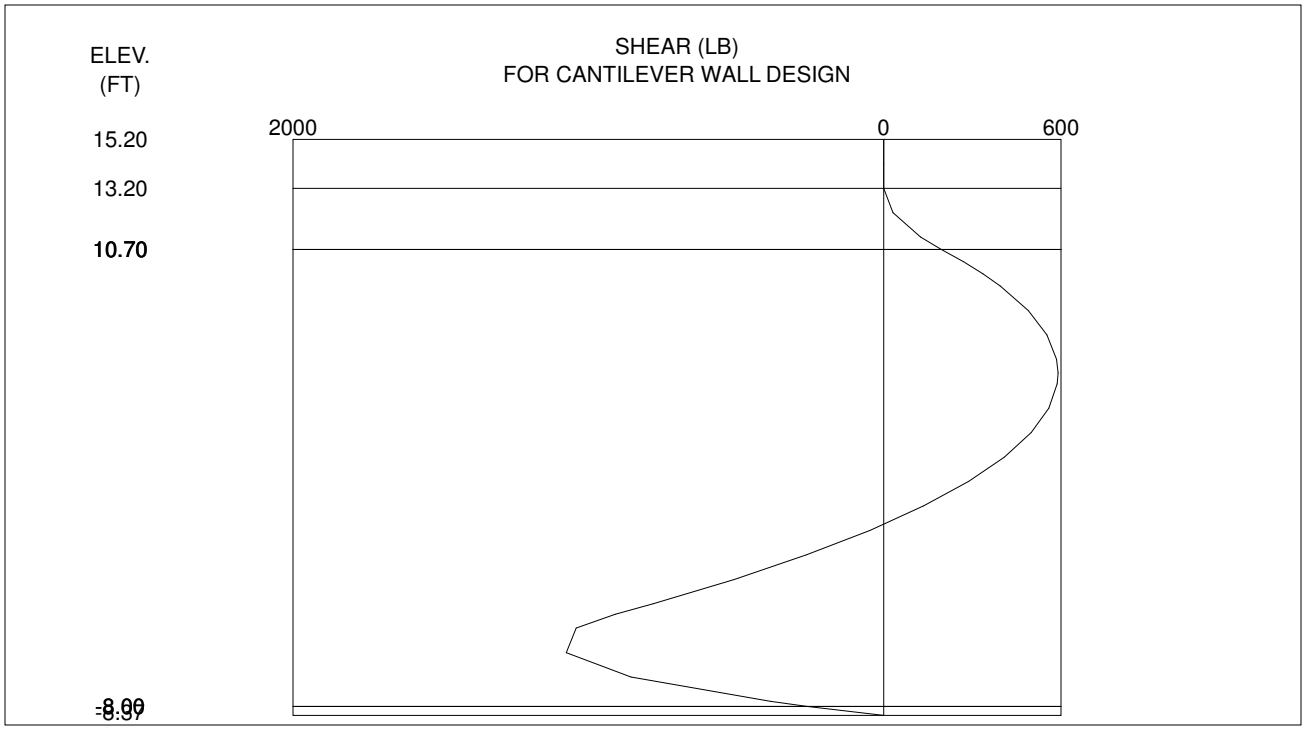
III.--WATER AND SOIL PRESSURES

		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION	PRESSURE	PASSIVE	ACTIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.20	0.	0.	0.	0.	0.
14.20	0.	0.	0.	0.	0.
13.20	0.	0.	0.	0.	0.
12.20	62.	0.	0.	0.	0.
11.20	125.	0.	0.	0.	0.
10.70	156.	0.	0.	0.	0.
10.20	156.	24.	8.	8.	24.
9.70	156.	47.	16.	16.	47.
9.20	156.	71.	24.	24.	71.
8.20	156.	118.	41.	41.	118.
7.20	156.	165.	57.	57.	165.
6.20	156.	212.	73.	73.	212.
5.63	156.	238.	82.	82.	238.
5.20	156.	259.	89.	89.	259.
4.20	156.	306.	105.	105.	306.
3.20	156.	353.	122.	122.	353.
2.20	156.	400.	138.	138.	400.
1.20	156.	447.	154.	154.	447.
0.20	156.	494.	170.	170.	494.
-0.80	156.	541.	186.	186.	541.
-1.80	156.	588.	203.	203.	588.
-2.80	156.	635.	219.	219.	635.
-3.80	156.	682.	235.	235.	682.
-4.23	156.	702.	242.	242.	702.
-4.80	156.	729.	251.	251.	729.
-5.80	156.	776.	267.	267.	776.
-6.80	156.	823.	284.	284.	823.
-7.80	156.	870.	300.	300.	870.
-8.00	156.	879.	303.	303.	879.
-8.37	156.	917.	316.	316.	917.
-9.80	156.	964.	332.	332.	964.

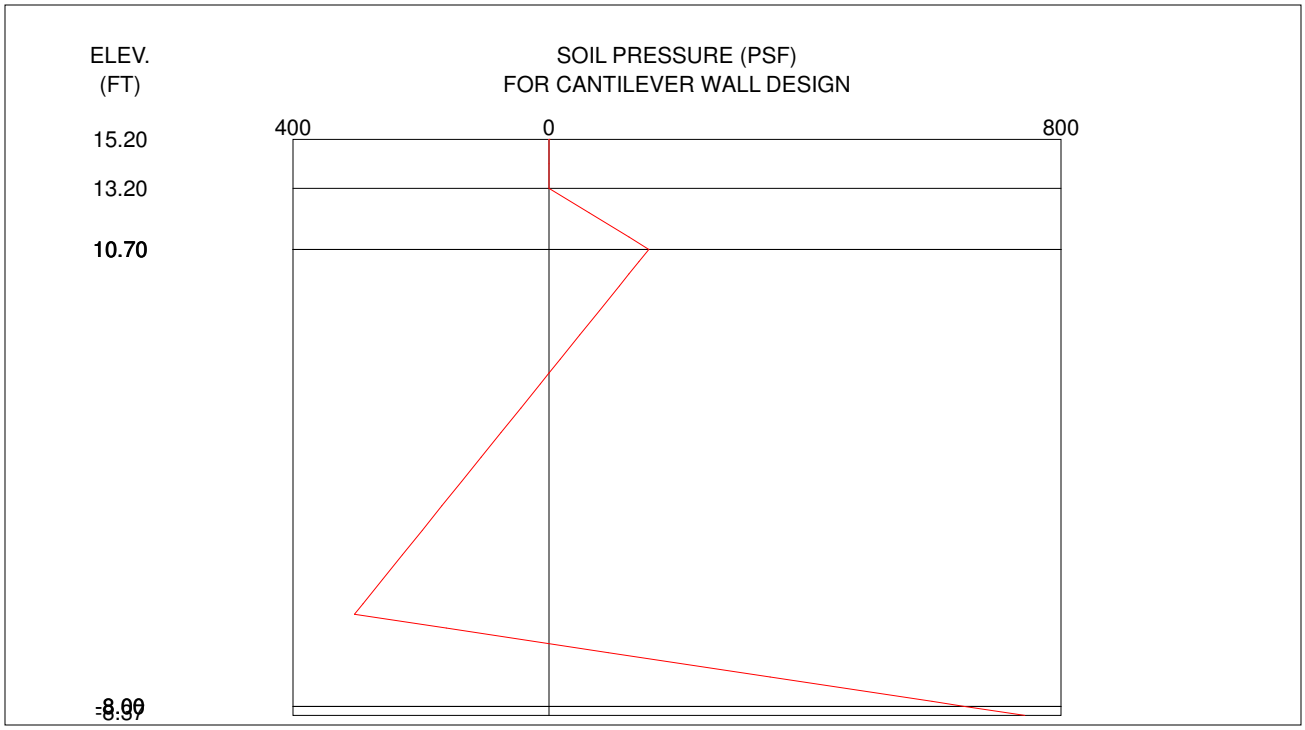
'CHEHALIS WEST - LONG TERM - DWL



'CHEHALIS WEST - LONG TERM - DWL



'CHEHALIS WEST - LONG TERM - DWL



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 5-FEBRUARY-2017 TIME: 15:21:44

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

I.--HEADING
'CHEHALIS EAST - SHORT TERM

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
83.00	83.00	0.00	420.00	0.00	0.00	-2.00	0.00	DEF	DEF
99.00	99.00	0.00	500.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
83.00	83.00	0.00	420.00	0.00	0.00	-2.00	0.00	DEF	DEF
99.00	99.00	0.00	500.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 15.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 5-FEBRUARY-2017 TIME: 15:21:46

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS EAST - SHORT TERM

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
13.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
12.2	187.2	0.0	0.0	187.2	187.2	0.0	0.0
11.2	249.6	0.0	0.0	249.6	249.6	0.0	0.0
10.7+	280.8	0.0	0.0	280.8	280.8	0.0	0.0
10.7-	280.8	560.0	0.0	-279.2	840.8	0.0	560.0
10.2	280.8	570.3	0.0	-289.5	851.1	0.0	570.3
9.7	280.8	580.6	0.0	-299.8	861.4	0.0	580.6
9.2	280.8	590.9	0.0	-310.1	871.7	0.0	590.9
8.2	280.8	611.5	0.0	-330.7	892.3	0.0	611.5
7.2	280.8	632.1	0.0	-351.3	912.9	0.0	632.1
6.2	280.8	652.7	0.0	-371.9	933.5	0.0	652.7
5.2	280.8	673.3	0.0	-392.5	954.1	0.0	673.3
4.2	280.8	693.9	0.0	-413.1	974.7	0.0	693.9
3.2	280.8	714.5	0.0	-433.7	995.3	0.0	714.5
2.2	280.8	735.1	0.0	-454.3	1015.9	0.0	735.1
1.2	280.8	755.7	0.0	-474.9	1036.5	0.0	755.7
0.2	280.8	776.3	0.0	-495.5	1057.1	0.0	776.3
-0.8	280.8	796.9	0.0	-516.1	1077.7	0.0	796.9
-1.8	280.8	817.5	0.0	-536.7	1098.3	0.0	817.5
-2.0+	280.8	821.6	0.0	-594.2	1155.8	0.0	821.6
-2.0-	280.8	928.3	0.0	-594.2	1155.8	0.0	928.3
-2.8	280.8	957.6	0.0	-676.8	1238.4	0.0	957.6
-3.8	280.8	994.2	0.0	-713.4	1275.0	0.0	994.2
-4.8	280.8	1030.8	0.0	-750.0	1311.6	0.0	1030.8
-5.8	280.8	1067.4	0.0	-786.6	1348.2	0.0	1067.4
-6.8	280.8	1104.0	0.0	-823.2	1384.8	0.0	1104.0
-7.8	280.8	1140.6	0.0	-859.8	1421.4	0.0	1140.6
-8.8	280.8	1177.2	0.0	-896.4	1458.0	0.0	1177.2
-9.8	280.8	1213.8	0.0	-933.0	1494.6	0.0	1213.8
-10.8	280.8	1250.4	0.0	-969.6	1531.2	0.0	1250.4
-11.8	280.8	1287.0	0.0	-1006.2	1567.8	0.0	1287.0
-12.8	280.8	1323.6	0.0	-1042.8	1604.4	0.0	1323.6
-13.1	280.8	1333.3	0.0	-1052.5	1614.1	0.0	1333.3
-13.8	280.8	1360.2	26.8	-1052.5	1614.1	26.8	1360.2
-14.8	280.8	1396.8	63.4	-1052.5	1614.1	63.4	1396.8
-15.8	280.8	1433.4	100.0	-1052.5	1614.1	100.0	1433.4
-16.8	280.8	1470.0	136.6	-1052.5	1614.1	136.6	1470.0
-17.8	280.8	1506.6	173.2	-1052.5	1614.1	173.2	1506.6
-18.8	280.8	1543.2	209.8	-1052.5	1614.1	209.8	1543.2
-19.8	280.8	1579.8	246.4	-1052.5	1614.1	246.4	1579.8

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 5-FEBRUARY-2017 TIME: 15:21:48

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS EAST - SHORT TERM

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : 4.76
PENETRATION (FT) : 5.94

MAX. BEND. MOMENT (LB-FT) : 1.6270E+03
AT ELEVATION (FT) : 8.60

MAX. SCALED DEFL. (LB-IN^3): 8.2575E+07
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 5-FEBRUARY-2017 TIME: 15:21:48

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS EAST - SHORT TERM

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	8.2575E+07	0.00
14.20	1.0400E+01	31.	6.9614E+07	62.40
13.20	8.3200E+01	125.	5.6680E+07	124.80
12.20	2.8080E+02	281.	4.3908E+07	187.20
11.20	6.6560E+02	499.	3.1648E+07	249.60
10.70+	9.4770E+02	632.	2.5905E+07	280.80
10.70-	9.4770E+02	632.	2.5905E+07	-279.20
10.20	1.2283E+03	490.	2.0571E+07	-289.50
9.70	1.4365E+03	342.	1.5766E+07	-299.80
9.20	1.5697E+03	190.	1.1578E+07	-310.10
8.20	1.6011E+03	-131.	5.2526E+06	-330.70
7.20	1.3017E+03	-472.	1.6461E+06	-351.30
6.80	1.0830E+03	-615.	8.6390E+05	-359.60
6.20	6.7481E+02	-714.	2.3911E+05	28.13
5.20	8.3358E+01	-361.	2.3346E+03	677.45

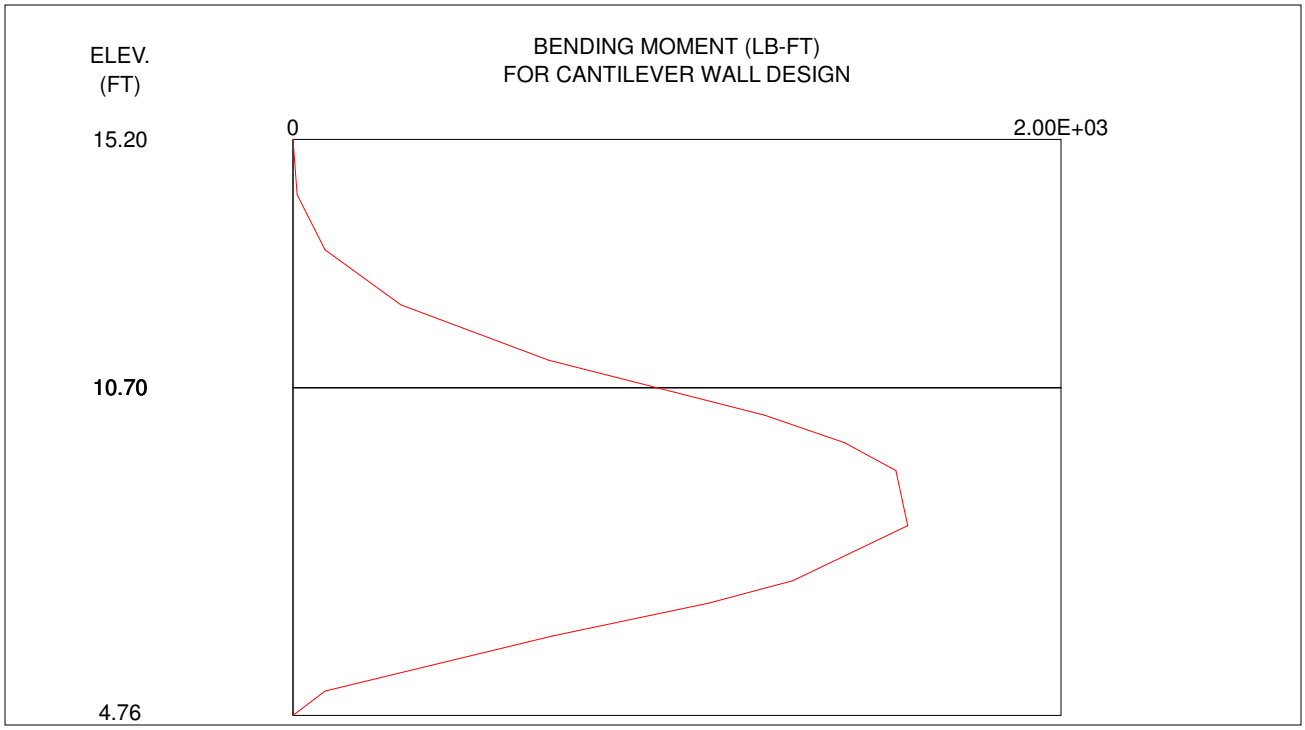
4.76	0.0000E+00	0.	0.0000E+00	963.16

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

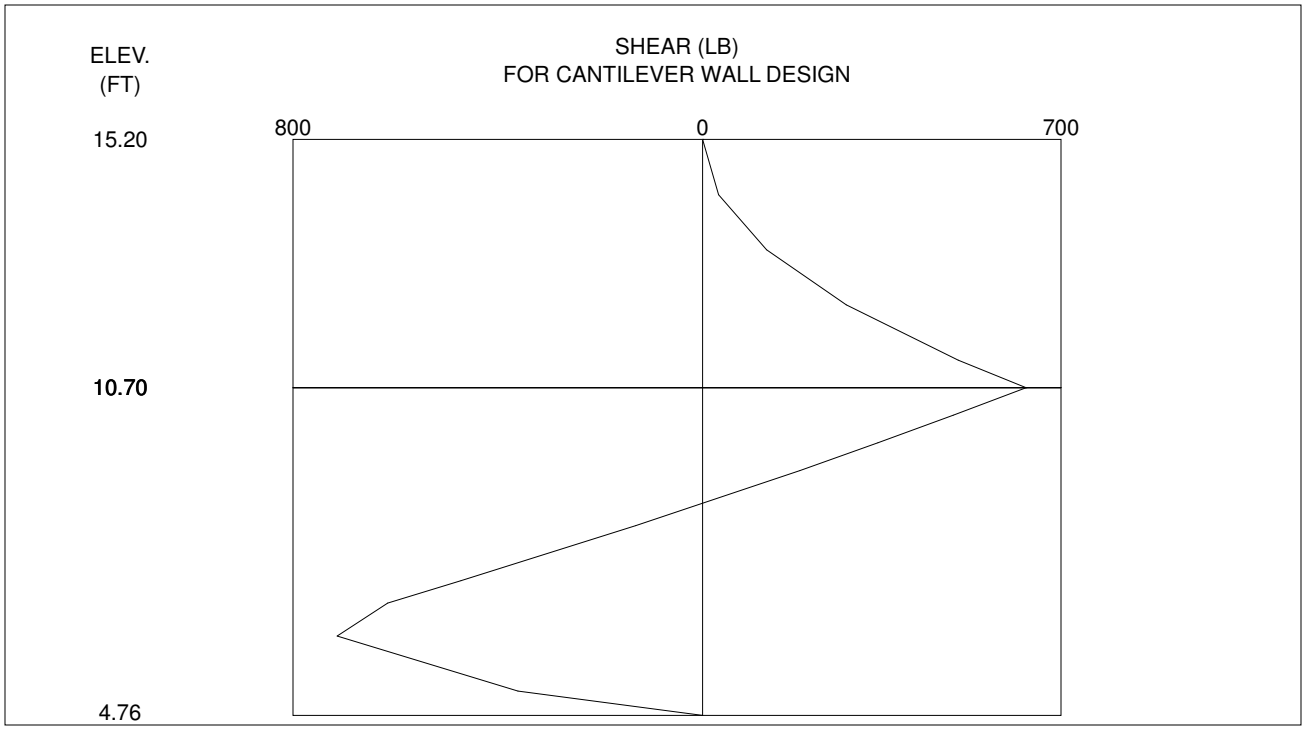
III.--WATER AND SOIL PRESSURES

		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION	PRESSURE	PASSIVE	ACTIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.20	0.	0.	0.	0.	0.
14.20	62.	0.	0.	0.	0.
13.20	125.	0.	0.	0.	0.
12.20	187.	0.	0.	0.	0.
11.20	250.	0.	0.	0.	0.
10.70+	281.	0.	0.	0.	0.
10.70-	281.	560.	0.	0.	560.
10.20	281.	570.	0.	0.	570.
9.70	281.	581.	0.	0.	581.
9.20	281.	591.	0.	0.	591.
8.20	281.	612.	0.	0.	612.
7.20	281.	632.	0.	0.	632.
6.80	281.	640.	0.	0.	640.
6.20	281.	653.	0.	0.	653.
5.20	281.	673.	0.	0.	673.
4.76	281.	694.	0.	0.	694.
3.20	281.	715.	0.	0.	715.

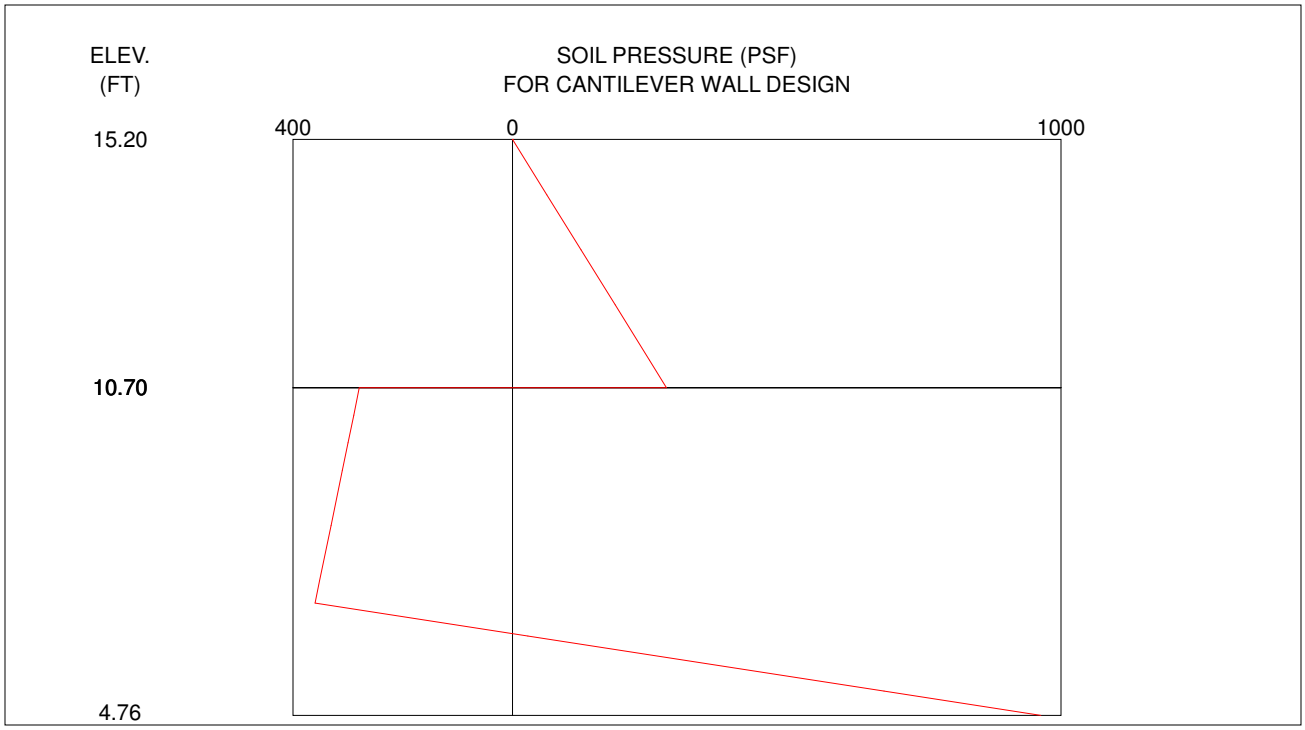
'CHEHALIS EAST - SHORT TERM



'CHEHALIS EAST - SHORT TERM



'CHEHALIS EAST - SHORT TERM



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 19:50:10

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

I.--HEADING
'CHEHALIS EAST - LONG TERM - DWL

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
83.00	83.00	16.00	0.00	0.00	0.00	-2.00	0.00	DEF	DEF
99.00	99.00	23.00	0.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
83.00	83.00	16.00	0.00	0.00	0.00	-2.00	0.00	DEF	DEF
99.00	99.00	23.00	0.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 13.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 19:50:15

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS EAST - LONG TERM - DWL

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
11.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
10.7	156.0	0.0	0.0	156.0	156.0	0.0	0.0
10.2	156.0	15.1	7.0	148.0	164.0	7.0	15.1
9.7	156.0	30.1	14.1	140.0	172.0	14.1	30.1
9.2	156.0	45.2	21.1	131.9	180.1	21.1	45.2
8.2	156.0	75.3	35.2	115.9	196.1	35.2	75.3
7.2	156.0	105.4	49.3	99.9	212.1	49.3	105.4
6.2	156.0	135.6	63.4	83.8	228.2	63.4	135.6
5.2	156.0	165.7	77.5	67.8	244.2	77.5	165.7
4.2	156.0	195.8	91.6	51.8	260.2	91.6	195.8
3.2	156.0	225.9	105.7	35.7	276.3	105.7	225.9
2.2	156.0	256.1	119.7	19.7	292.3	119.7	256.1
1.2	156.0	286.2	133.8	3.6	308.4	133.8	286.2
1.0	156.0	293.0	137.0	0.0	312.0	137.0	293.0
0.2	156.0	316.3	147.9	-12.4	324.4	147.9	316.3
-0.8	156.0	346.4	162.0	-28.4	340.4	162.0	346.4
-1.8	156.0	376.6	176.1	-44.5	356.5	176.1	376.6
-2.0+	156.0	382.6	178.9	-99.7	411.7	178.9	382.6
-2.0-	156.0	457.4	149.6	-99.7	411.7	149.6	457.4
-2.8	156.0	508.6	166.4	-186.2	498.2	166.4	508.6
-3.8	156.0	572.6	187.3	-229.3	541.3	187.3	572.6
-4.8	156.0	636.6	208.3	-272.3	584.3	208.3	636.6
-5.8	156.0	700.6	229.2	-315.4	627.4	229.2	700.6
-6.8	156.0	764.6	250.1	-358.4	670.4	250.1	764.6
-7.8	156.0	828.5	271.1	-401.5	713.5	271.1	828.5
-8.8	156.0	892.5	292.0	-444.5	756.5	292.0	892.5
-9.8	156.0	956.5	312.9	-487.6	799.6	312.9	956.5
-10.8	156.0	1020.5	333.9	-530.7	842.7	333.9	1020.5
-11.8	156.0	1084.5	354.8	-573.7	885.7	354.8	1084.5
-12.8	156.0	1148.5	375.7	-616.8	928.8	375.7	1148.5
-13.8	156.0	1212.5	396.7	-659.8	971.8	396.7	1212.5
-14.8	156.0	1276.5	417.6	-702.9	1014.9	417.6	1276.5
-15.8	156.0	1340.5	438.5	-745.9	1057.9	438.5	1340.5
-16.8	156.0	1404.4	459.5	-789.0	1101.0	459.5	1404.4
-17.8	156.0	1468.4	480.4	-832.0	1144.0	480.4	1468.4
-18.8	156.0	1532.4	501.3	-875.1	1187.1	501.3	1532.4
-19.8	156.0	1596.4	522.3	-918.2	1230.2	522.3	1596.4

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 19:50:16

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS EAST - LONG TERM - DWL

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : -15.51
PENETRATION (FT) : 26.21

MAX. BEND. MOMENT (LB-FT) : 1.1664E+04
AT ELEVATION (FT) : -5.83

MAX. SCALED DEFL. (LB-IN^3): 5.2685E+09
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 19:50:16

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'CHEHALIS EAST - LONG TERM - DWL

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	5.2685E+09	0.00
14.20	-5.2387E-10	0.	4.9938E+09	0.00
13.20	-5.2387E-10	0.	4.7190E+09	0.00
12.20	1.0400E+01	31.	4.4443E+09	62.40
11.20	8.3200E+01	125.	4.1695E+09	124.80
10.70	1.6250E+02	195.	4.0322E+09	156.00
10.20	2.7917E+02	271.	3.8950E+09	147.98
9.70	4.3283E+02	343.	3.7578E+09	139.96
9.20	6.2148E+02	411.	3.6209E+09	131.94
8.20	1.0957E+03	535.	3.3479E+09	115.91
7.20	1.6859E+03	643.	3.0769E+09	99.87
6.20	2.3759E+03	735.	2.8088E+09	83.83
5.20	3.1498E+03	810.	2.5447E+09	67.80
4.20	3.9915E+03	870.	2.2862E+09	51.76
3.20	4.8849E+03	914.	2.0345E+09	35.72
2.20	5.8140E+03	942.	1.7913E+09	19.68

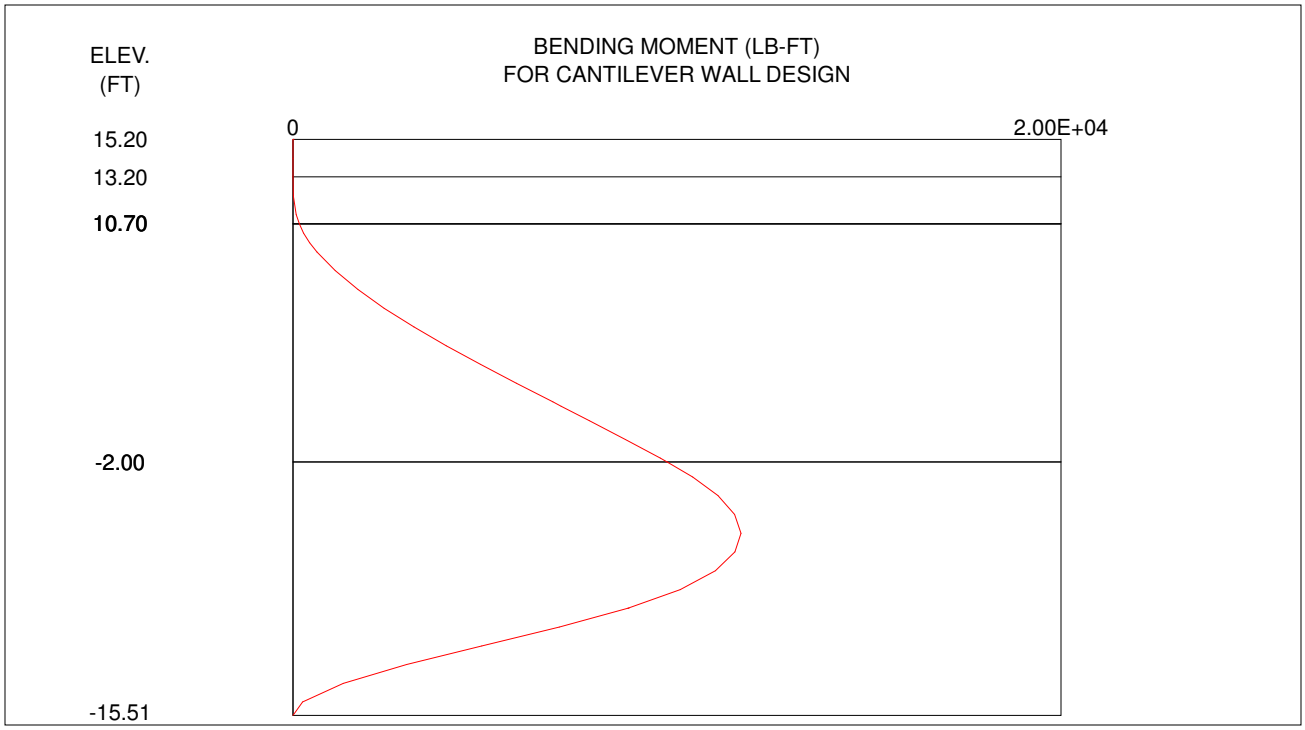
1.20	6.7629E+03	953.	1.5582E+09	3.65
0.97	6.9797E+03	954.	1.5067E+09	0.00
0.20	7.7153E+03	949.	1.3367E+09	-12.39
-0.80	8.6554E+03	929.	1.1286E+09	-28.43
-1.80	9.5671E+03	892.	9.3537E+08	-44.46
-2.00	9.7442E+03	878.	8.9867E+08	-99.72
-2.80	1.0405E+04	763.	7.5871E+08	-186.21
-3.80	1.1068E+04	556.	6.0000E+08	-229.27
-4.80	1.1502E+04	305.	4.6038E+08	-272.32
-5.80	1.1663E+04	11.	3.4060E+08	-315.38
-6.80	1.1510E+04	-326.	2.4092E+08	-358.43
-7.80	1.0997E+04	-706.	1.6109E+08	-401.49
-8.80	1.0083E+04	-1129.	1.0020E+08	-444.54
-9.80	8.7268E+03	-1594.	5.6709E+07	-487.55
-9.80	8.7250E+03	-1595.	5.6667E+07	-487.24
-10.80	6.9310E+03	-1948.	2.8148E+07	-218.94
-11.80	4.9182E+03	-2033.	1.1574E+07	49.35
-12.80	2.9547E+03	-1849.	3.5060E+06	317.64
-13.80	1.3088E+03	-1398.	5.8922E+05	585.93
-14.80	2.4881E+02	-678.	1.8356E+04	854.22
-15.51	0.0000E+00	0.	0.0000E+00	1045.59

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

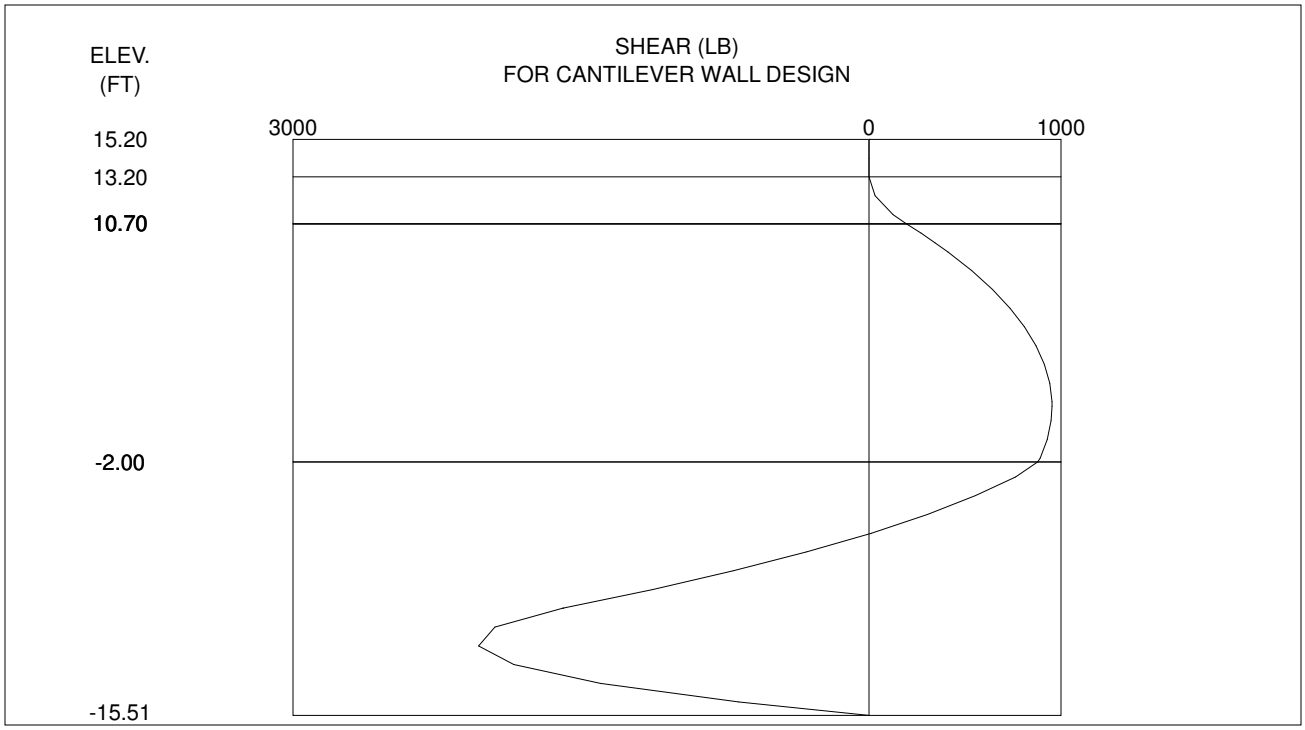
III.--WATER AND SOIL PRESSURES

		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION (FT)	PRESSURE (PSF)	PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
15.20	0.	0.	0.	0.	0.
14.20	0.	0.	0.	0.	0.
13.20	0.	0.	0.	0.	0.
12.20	62.	0.	0.	0.	0.
11.20	125.	0.	0.	0.	0.
10.70	156.	0.	0.	0.	0.
10.20	156.	15.	7.	7.	15.
9.70	156.	30.	14.	14.	30.
9.20	156.	45.	21.	21.	45.
8.20	156.	75.	35.	35.	75.
7.20	156.	105.	49.	49.	105.
6.20	156.	136.	63.	63.	136.
5.20	156.	166.	77.	77.	166.
4.20	156.	196.	92.	92.	196.
3.20	156.	226.	106.	106.	226.
2.20	156.	256.	120.	120.	256.
1.20	156.	286.	134.	134.	286.
0.97	156.	293.	137.	137.	293.
0.20	156.	316.	148.	148.	316.
-0.80	156.	346.	162.	162.	346.
-1.80	156.	377.	176.	176.	377.
-2.00+	156.	383.	179.	179.	383.
-2.00-	156.	457.	150.	150.	457.
-2.80	156.	509.	166.	166.	509.
-3.80	156.	573.	187.	187.	573.
-4.80	156.	637.	208.	208.	637.
-5.80	156.	701.	229.	229.	701.
-6.80	156.	765.	250.	250.	765.
-7.80	156.	829.	271.	271.	829.
-8.80	156.	893.	292.	292.	893.
-9.80	156.	956.	313.	313.	956.
-9.80	156.	957.	313.	313.	957.
-10.80	156.	1021.	334.	334.	1021.
-11.80	156.	1085.	355.	355.	1085.
-12.80	156.	1148.	376.	376.	1148.
-13.80	156.	1212.	397.	397.	1212.
-14.80	156.	1276.	418.	418.	1276.
-15.51	156.	1340.	439.	439.	1340.
-16.80	156.	1404.	459.	459.	1404.

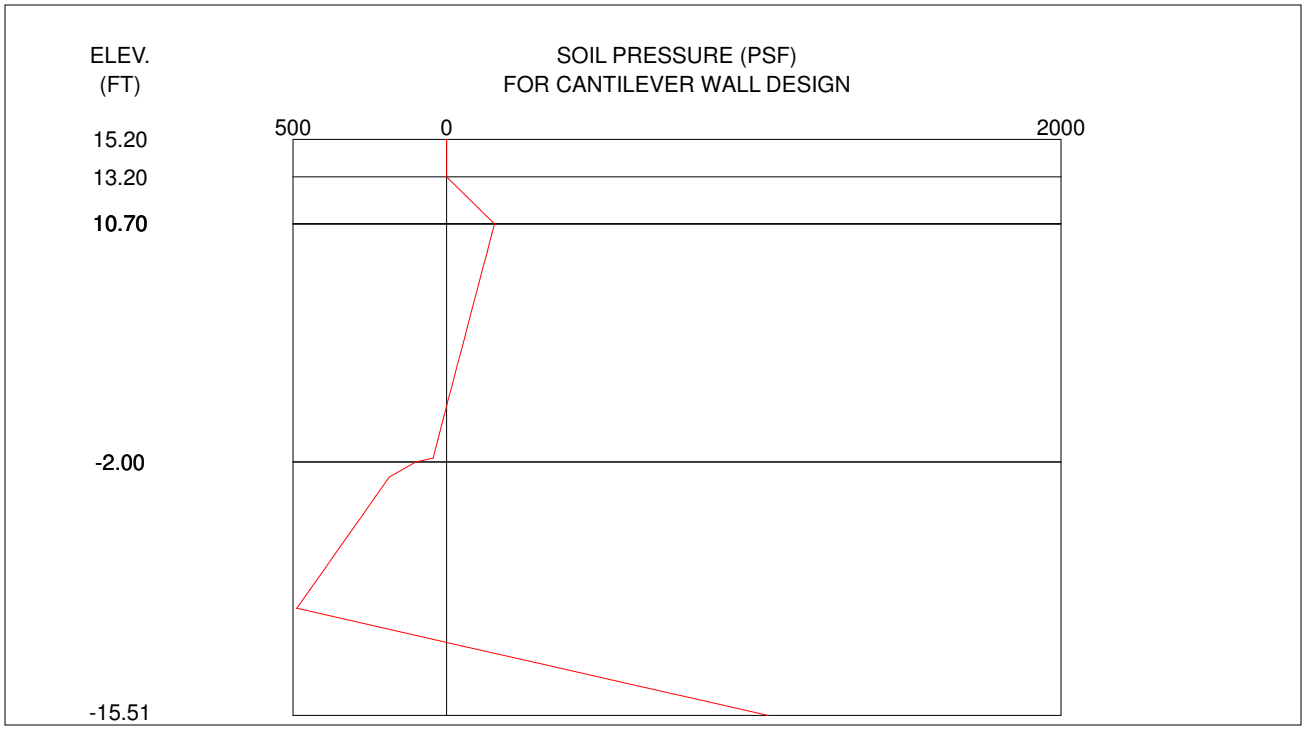
'CHEHALIS EAST - LONG TERM - DWL



'CHEHALIS EAST - LONG TERM - DWL



'CHEHALIS EAST - LONG TERM - DWL



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 5-FEBRUARY-2017 TIME: 15:27:51

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

I.--HEADING
'WISHKAH - SHORT TERM

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
93.00	93.00	0.00	250.00	0.00	0.00	-2.00	0.00	DEF	DEF
94.00	94.00	0.00	271.00	0.00	0.00	-7.00	0.00	DEF	DEF
94.00	94.00	0.00	306.00	0.00	0.00	-12.00	0.00	DEF	DEF
94.00	94.00	0.00	341.00	0.00	0.00	-17.00	0.00	DEF	DEF
94.00	94.00	0.00	376.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
93.00	93.00	0.00	250.00	0.00	0.00	-2.00	0.00	DEF	DEF
94.00	94.00	0.00	271.00	0.00	0.00	-7.00	0.00	DEF	DEF
94.00	94.00	0.00	306.00	0.00	0.00	-12.00	0.00	DEF	DEF
94.00	94.00	0.00	341.00	0.00	0.00	-17.00	0.00	DEF	DEF
94.00	94.00	0.00	376.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 15.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 5-FEBRUARY-2017 TIME: 15:27:52

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'WISHKAH - SHORT TERM

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
13.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
12.2	187.2	0.0	0.0	187.2	187.2	0.0	0.0
11.2	249.6	0.0	0.0	249.6	249.6	0.0	0.0
10.7+	280.8	0.0	0.0	280.8	280.8	0.0	0.0
10.7-	280.8	333.3	0.0	-52.5	614.1	0.0	333.3
10.2	280.8	348.6	0.0	-67.8	629.4	0.0	348.6
9.7	280.8	363.9	0.0	-83.1	644.7	0.0	363.9
9.2	280.8	379.2	0.0	-98.4	660.0	0.0	379.2
8.2	280.8	409.8	0.0	-129.0	690.6	0.0	409.8
7.2	280.8	440.4	0.0	-159.6	721.2	0.0	440.4
6.2	280.8	471.0	0.0	-190.2	751.8	0.0	471.0
5.2	280.8	501.6	0.0	-220.8	782.4	0.0	501.6
4.2	280.8	532.2	0.0	-251.4	813.0	0.0	532.2
3.2	280.8	562.8	0.0	-282.0	843.6	0.0	562.8
2.2	280.8	593.4	0.0	-312.6	874.2	0.0	593.4
1.2	280.8	624.0	0.0	-343.2	904.8	0.0	624.0
0.2	280.8	654.6	0.0	-373.8	935.4	0.0	654.6
-0.2	280.8	666.7	0.0	-385.9	947.5	0.0	666.7
-0.8	280.8	685.2	18.6	-385.9	947.5	18.6	685.2
-1.8	280.8	715.8	49.2	-385.9	947.5	49.2	715.8
-2.0+	280.8	722.0	55.3	-413.9	975.5	55.3	722.0
-2.0-	280.8	750.0	27.3	-413.9	975.5	27.3	750.0
-2.8	280.8	775.2	52.6	-441.9	1003.5	52.6	775.2
-3.8	280.8	806.8	84.2	-441.9	1003.5	84.2	806.8
-4.8	280.8	838.4	115.8	-441.9	1003.5	115.8	838.4
-5.8	280.8	870.0	147.4	-441.9	1003.5	147.4	870.0
-6.8	280.8	901.6	179.0	-441.9	1003.5	179.0	901.6
-7.0+	280.8	908.0	185.3	-488.5	1050.1	185.3	908.0
-7.0-	280.8	954.6	138.6	-488.5	1050.1	138.6	954.6
-7.8	280.8	979.9	163.9	-535.2	1096.8	163.9	979.9
-8.8	280.8	1011.5	195.5	-535.2	1096.8	195.5	1011.5
-9.8	280.8	1043.1	227.1	-535.2	1096.8	227.1	1043.1
-10.8	280.8	1074.7	258.7	-535.2	1096.8	258.7	1074.7
-11.8	280.8	1106.3	290.3	-535.2	1096.8	290.3	1106.3
-12.0+	280.8	1112.6	296.6	-581.9	1143.5	296.6	1112.6
-12.0-	280.8	1159.3	250.0	-581.9	1143.5	250.0	1159.3
-12.8	280.8	1184.6	275.2	-628.5	1190.1	275.2	1184.6
-13.8	280.8	1216.2	306.8	-628.5	1190.1	306.8	1216.2
-14.8	280.8	1247.8	338.4	-628.5	1190.1	338.4	1247.8
-15.8	280.8	1279.4	370.0	-628.5	1190.1	370.0	1279.4

-16.8	280.8	1311.0	401.6	-628.5	1190.1	401.6	1311.0
-17.0+	280.8	1317.3	408.0	-675.2	1236.8	408.0	1317.3
-17.0-	280.8	1364.0	361.3	-675.2	1236.8	361.3	1364.0
-17.8	280.8	1389.2	386.6	-721.9	1283.5	386.6	1389.2
-18.8	280.8	1420.8	418.2	-721.9	1283.5	418.2	1420.8
-19.8	280.8	1452.4	449.8	-721.9	1283.5	449.8	1452.4

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 5-FEBRUARY-2017 TIME: 15:27:54

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'WISHKAH - SHORT TERM

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : 0.11
PENETRATION (FT) : 10.59

MAX. BEND. MOMENT (LB-FT) : 2.8130E+03
AT ELEVATION (FT) : 5.77

MAX. SCALED DEFL. (LB-IN^3): 3.2262E+08
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 5-FEBRUARY-2017 TIME: 15:27:54

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'WISHKAH - SHORT TERM

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	3.2262E+08	0.00
14.20	1.0400E+01	31.	2.8643E+08	62.40
13.20	8.3200E+01	125.	2.5026E+08	124.80

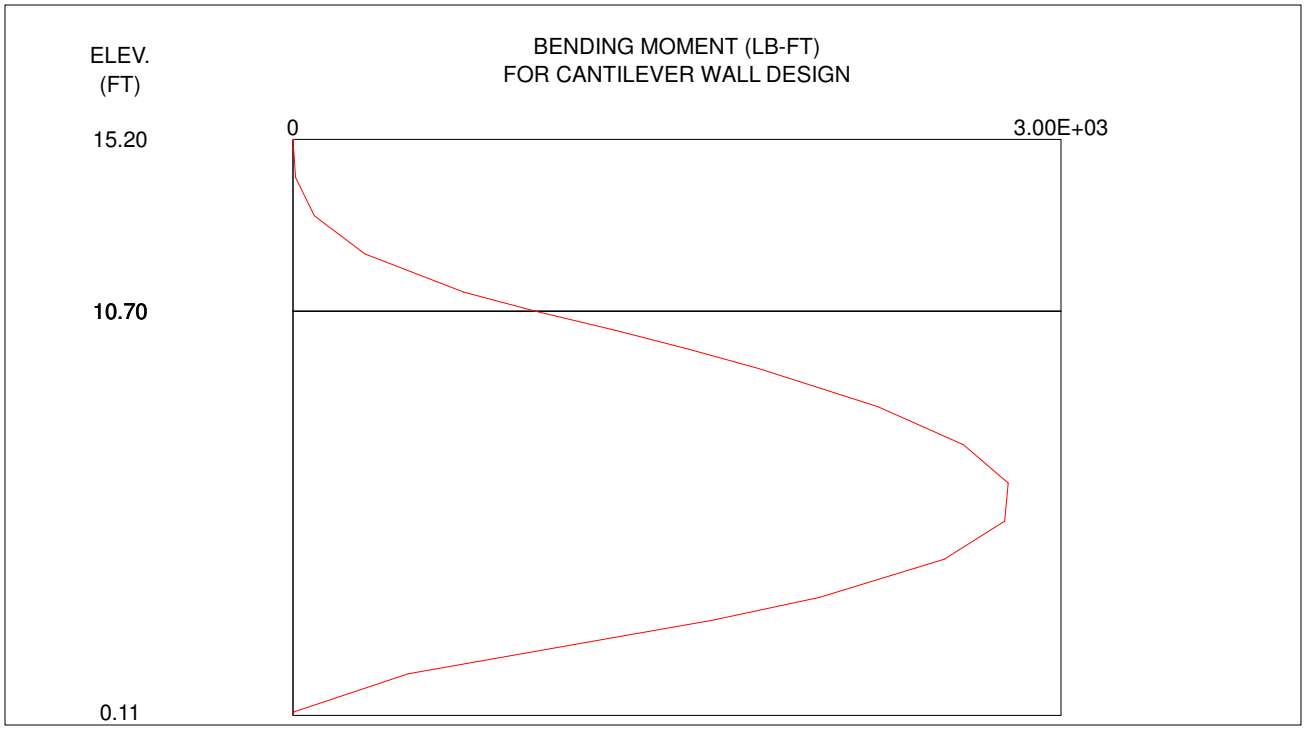
12.20	2.8080E+02	281.	2.1425E+08	187.20
11.20	6.6560E+02	499.	1.7876E+08	249.60
10.70+	9.4770E+02	632.	1.6140E+08	280.80
10.70-	9.4770E+02	632.	1.6140E+08	-52.53
10.20	1.2564E+03	602.	1.4445E+08	-67.83
9.70	1.5481E+03	564.	1.2804E+08	-83.13
9.20	1.8191E+03	519.	1.1230E+08	-98.43
8.20	2.2833E+03	405.	8.3285E+07	-129.03
7.20	2.6186E+03	261.	5.8194E+07	-159.63
6.20	2.7942E+03	86.	3.7606E+07	-190.23
5.20	2.7795E+03	-120.	2.1819E+07	-220.83
4.20	2.5440E+03	-356.	1.0803E+07	-251.43
3.20	2.0571E+03	-623.	4.1462E+06	-282.03
2.61	1.6358E+03	-796.	1.9277E+06	-300.23
2.20	1.2940E+03	-877.	1.0041E+06	-99.11
1.20	4.5031E+02	-728.	8.4392E+04	397.18
0.20	3.7475E+00	-83.	4.3971E+00	893.46
0.11	0.0000E+00	0.	0.0000E+00	938.19

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

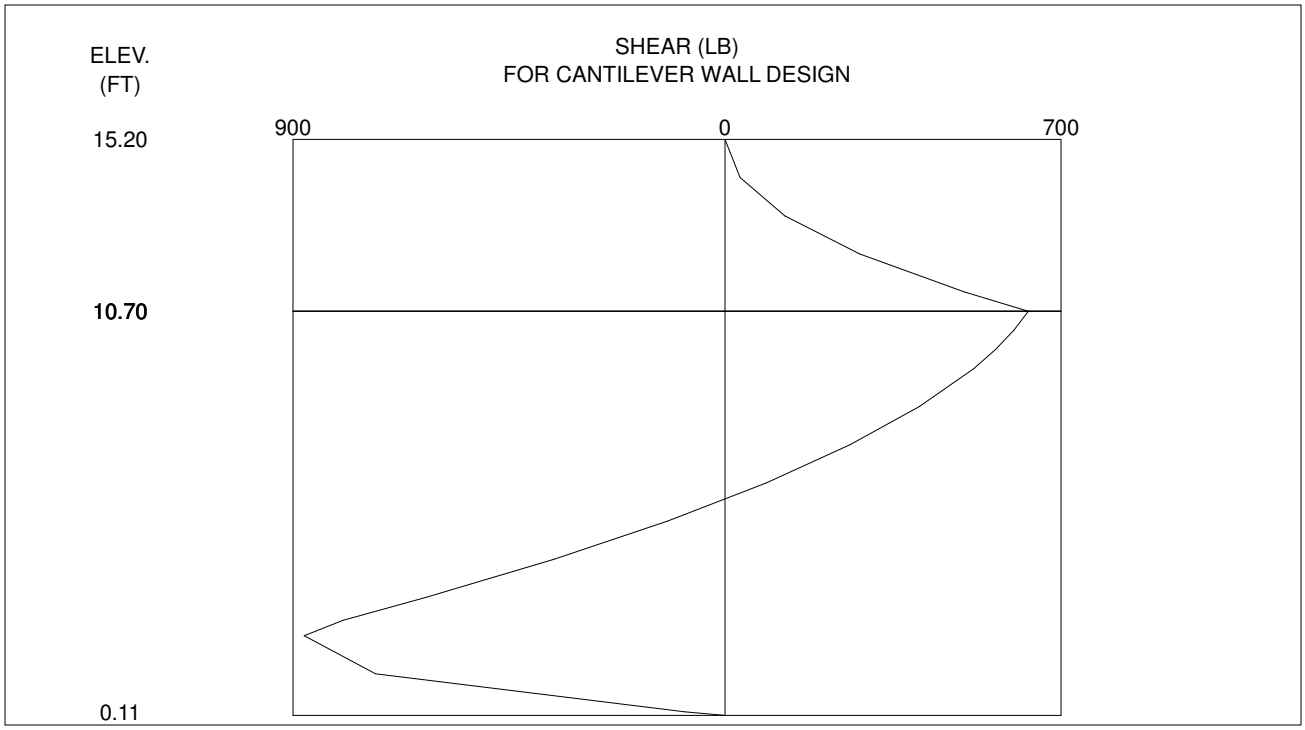
III.--WATER AND SOIL PRESSURES

		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION (FT)	PRESSURE (PSF)	PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
15.20	0.	0.	0.	0.	0.
14.20	62.	0.	0.	0.	0.
13.20	125.	0.	0.	0.	0.
12.20	187.	0.	0.	0.	0.
11.20	250.	0.	0.	0.	0.
10.70+	281.	0.	0.	0.	0.
10.70-	281.	333.	0.	0.	333.
10.20	281.	349.	0.	0.	349.
9.70	281.	364.	0.	0.	364.
9.20	281.	379.	0.	0.	379.
8.20	281.	410.	0.	0.	410.
7.20	281.	440.	0.	0.	440.
6.20	281.	471.	0.	0.	471.
5.20	281.	502.	0.	0.	502.
4.20	281.	532.	0.	0.	532.
3.20	281.	563.	0.	0.	563.
2.61	281.	581.	0.	0.	581.
2.20	281.	593.	0.	0.	593.
1.20	281.	624.	0.	0.	624.
0.20	281.	655.	0.	0.	655.
0.11	281.	667.	0.	0.	667.
-0.80	281.	685.	19.	19.	685.

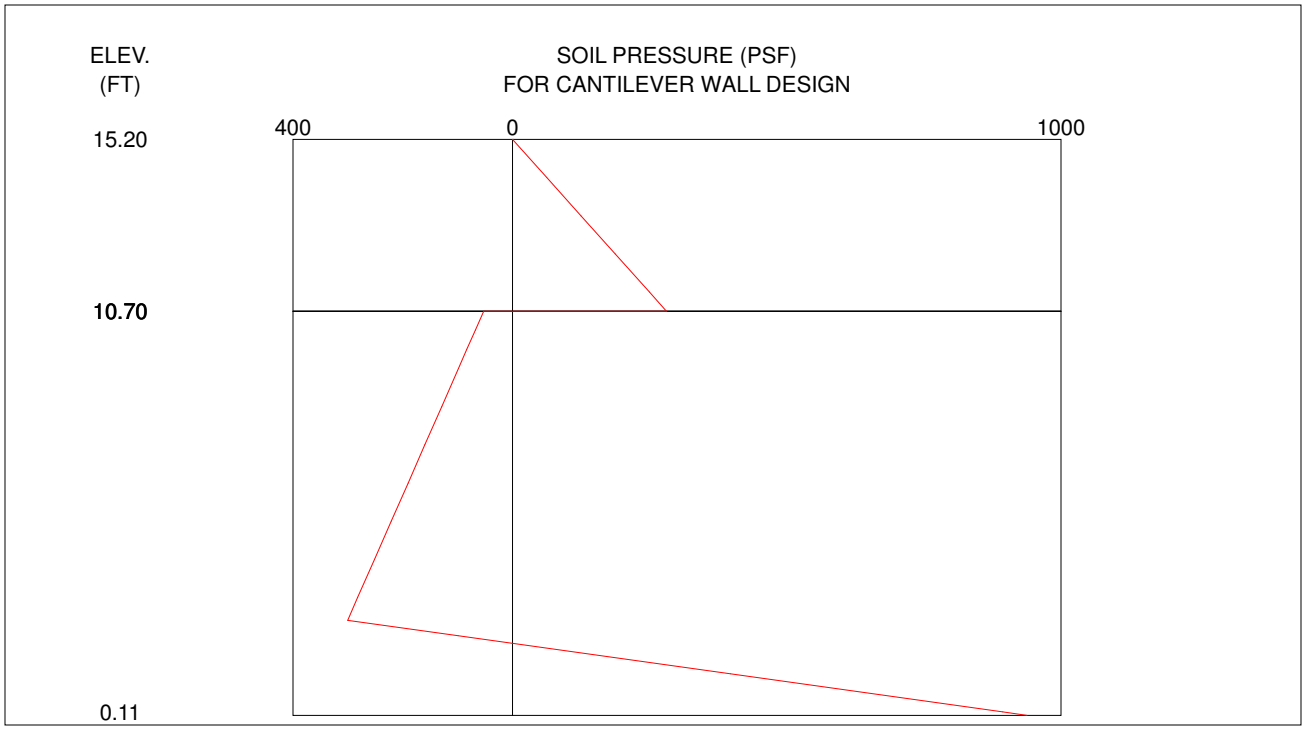
'WISHKAH - SHORT TERM



'WISHKAH - SHORT TERM



'WISHKAH - SHORT TERM



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:09:39

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

I.--HEADING
'WISHKAH - LONG TERM - DWL - LT

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.50
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 15.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	10.70

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
93.00	93.00	14.00	0.00	0.00	0.00	-2.00	0.00	DEF	DEF
94.00	94.00	14.00	0.00	0.00	0.00	-7.00	0.00	DEF	DEF
94.00	94.00	14.20	0.00	0.00	0.00	-12.00	0.00	DEF	DEF
94.00	94.00	14.30	0.00	0.00	0.00	-17.00	0.00	DEF	DEF
94.00	94.00	14.30	0.00	0.00	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
93.00	93.00	14.00	0.00	0.00	0.00	-2.00	0.00	DEF	DEF
94.00	94.00	14.00	0.00	0.00	0.00	-7.00	0.00	DEF	DEF
94.00	94.00	14.20	0.00	0.00	0.00	-12.00	0.00	DEF	DEF
94.00	94.00	14.30	0.00	0.00	0.00	-17.00	0.00	DEF	DEF
94.00	94.00	14.30	0.00	0.00	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = 13.20 (FT)
LEFTSIDE ELEVATION = 10.70 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 8-FEBRUARY-2017 TIME: 20:09:42

****
* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'WISHKAH - LONG TERM - DWL - LT

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

				<------NET------>			
	NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12.2	62.4	0.0	0.0	62.4	62.4	0.0	0.0
11.2	124.8	0.0	0.0	124.8	124.8	0.0	0.0
10.7	156.0	0.0	0.0	156.0	156.0	0.0	0.0
10.2	156.0	21.3	11.0	145.7	166.3	11.0	21.3
9.7	156.0	42.6	22.0	135.4	176.6	22.0	42.6
9.2	156.0	63.9	33.0	125.1	186.9	33.0	63.9
8.2	156.0	106.5	54.9	104.4	207.6	54.9	106.5
7.2	156.0	149.1	76.9	83.8	228.2	76.9	149.1
6.2	156.0	191.7	98.9	63.2	248.8	98.9	191.7
5.2	156.0	234.3	120.9	42.6	269.4	120.9	234.3
4.2	156.0	276.9	142.9	21.9	290.1	142.9	276.9
3.2	156.0	319.5	164.8	1.3	310.7	164.8	319.5
3.1	156.0	322.2	166.2	0.0	312.0	166.2	322.2
2.2	156.0	362.1	186.8	-19.3	331.3	186.8	362.1
1.2	156.0	404.7	208.8	-39.9	351.9	208.8	404.7
0.2	156.0	447.3	230.8	-60.6	372.6	230.8	447.3
-0.8	156.0	489.9	252.8	-81.2	393.2	252.8	489.9
-1.8	156.0	532.5	274.7	-101.8	413.8	274.7	532.5
-2.0	156.0	541.1	279.1	-105.9	417.9	279.1	541.1
-2.8	156.0	576.3	297.3	-123.0	435.0	297.3	576.3
-3.8	156.0	620.2	320.0	-144.3	456.3	320.0	620.2
-4.8	156.0	664.2	342.7	-165.6	477.6	342.7	664.2
-5.8	156.0	708.2	365.4	-186.9	498.9	365.4	708.2
-6.8	156.0	752.2	388.1	-208.2	520.2	388.1	752.2
-7.0+	156.0	761.0	392.6	-215.2	527.2	392.6	761.0
-7.0-	156.0	764.8	390.7	-215.2	527.2	390.7	764.8
-7.8	156.0	800.1	408.8	-235.4	547.4	408.8	800.1
-8.8	156.0	844.3	431.4	-257.0	569.0	431.4	844.3
-9.8	156.0	888.5	453.9	-278.6	590.6	453.9	888.5
-10.8	156.0	932.8	476.5	-300.2	612.2	476.5	932.8
-11.8	156.0	977.0	499.1	-321.8	633.8	499.1	977.0
-12.0+	156.0	985.8	503.6	-328.0	640.0	503.6	985.8
-12.0-	156.0	988.2	502.4	-328.0	640.0	502.4	988.2
-12.8	156.0	1023.7	520.4	-347.2	659.2	520.4	1023.7
-13.8	156.0	1068.0	543.0	-369.0	681.0	543.0	1068.0
-14.8	156.0	1112.3	565.5	-390.8	702.8	565.5	1112.3
-15.8	156.0	1156.6	588.0	-412.6	724.6	588.0	1156.6
-16.8	156.0	1201.0	610.6	-434.4	746.4	610.6	1201.0
-17.0	156.0	1209.8	615.1	-438.7	750.7	615.1	1209.8

-17.8	156.0	1245.3	633.1	-456.2	768.2	633.1	1245.3
-18.8	156.0	1289.6	655.6	-478.0	790.0	655.6	1289.6
-19.8	156.0	1333.9	678.2	-499.8	811.8	678.2	1333.9

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:09:44

****
* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'WISHKAH - LONG TERM - DWL - LT

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELLASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : -16.35
PENETRATION (FT) : 27.05

MAX. BEND. MOMENT (LB-FT) : 9.1733E+03
AT ELEVATION (FT) : -5.56

MAX. SCALED DEFL. (LB-IN^3): 4.5295E+09
AT ELEVATION (FT) : 15.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 8-FEBRUARY-2017 TIME: 20:09:44

****
* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'WISHKAH - LONG TERM - DWL - LT

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
15.20	0.0000E+00	0.	4.5295E+09	0.00
14.20	-1.3970E-09	0.	4.2928E+09	0.00
13.20	-1.3970E-09	0.	4.0561E+09	0.00
12.20	1.0400E+01	31.	3.8194E+09	62.40
11.20	8.3200E+01	125.	3.5827E+09	124.80
10.70	1.6250E+02	195.	3.4644E+09	156.00

10.20	2.7907E+02	270.	3.3461E+09	145.69
9.70	4.3206E+02	341.	3.2280E+09	135.38
9.20	6.1890E+02	406.	3.1101E+09	125.06
8.20	1.0838E+03	521.	2.8751E+09	104.44
7.20	1.6531E+03	615.	2.6421E+09	83.81
6.20	2.3063E+03	688.	2.4119E+09	63.19
5.20	3.0226E+03	741.	2.1857E+09	42.57
4.20	3.7815E+03	773.	1.9647E+09	21.94
3.20	4.5624E+03	785.	1.7503E+09	1.32
3.14	4.6125E+03	785.	1.7368E+09	0.00
2.20	5.3445E+03	776.	1.5437E+09	-19.31
1.20	6.1074E+03	746.	1.3464E+09	-39.93
0.20	6.8303E+03	696.	1.1597E+09	-60.56
-0.80	7.4927E+03	625.	9.8468E+08	-81.18
-1.80	8.0739E+03	534.	8.2265E+08	-101.80
-2.00	8.1785E+03	513.	7.9188E+08	-105.93
-2.80	8.5532E+03	421.	6.7455E+08	-122.97
-3.80	8.9095E+03	288.	5.4121E+08	-144.27
-4.80	9.1216E+03	133.	4.2325E+08	-165.56
-5.80	9.1682E+03	-43.	3.2102E+08	-186.86
-6.80	9.0278E+03	-241.	2.3461E+08	-208.16
-7.00	8.9755E+03	-283.	2.1921E+08	-215.24
-7.80	8.6779E+03	-463.	1.6377E+08	-235.35
-8.80	8.0932E+03	-710.	1.0790E+08	-256.98
-9.80	7.2515E+03	-977.	6.5967E+07	-278.60
-10.71	6.2496E+03	-1239.	3.8826E+07	-298.18
-10.80	6.1312E+03	-1266.	3.6528E+07	-280.86
-11.80	4.7554E+03	-1455.	1.7645E+07	-97.66
-12.00	4.4627E+03	-1471.	1.4933E+07	-61.02
-12.80	3.2820E+03	-1461.	6.9654E+06	85.54
-13.80	1.8941E+03	-1284.	1.9694E+06	268.74
-14.80	7.7490E+02	-924.	2.8502E+05	451.94
-15.80	1.0768E+02	-380.	4.7920E+03	635.14
-16.35	0.0000E+00	0.	0.0000E+00	736.68

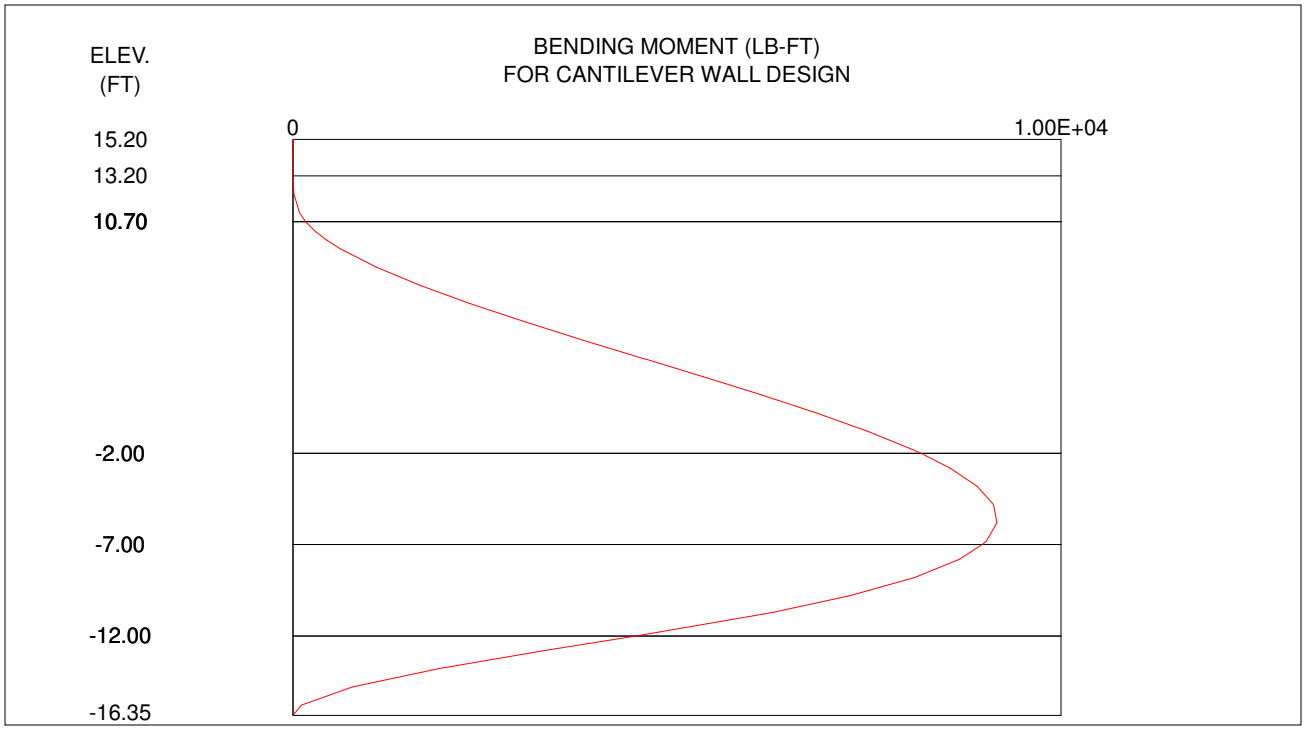
NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELLASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

III.--WATER AND SOIL PRESSURES

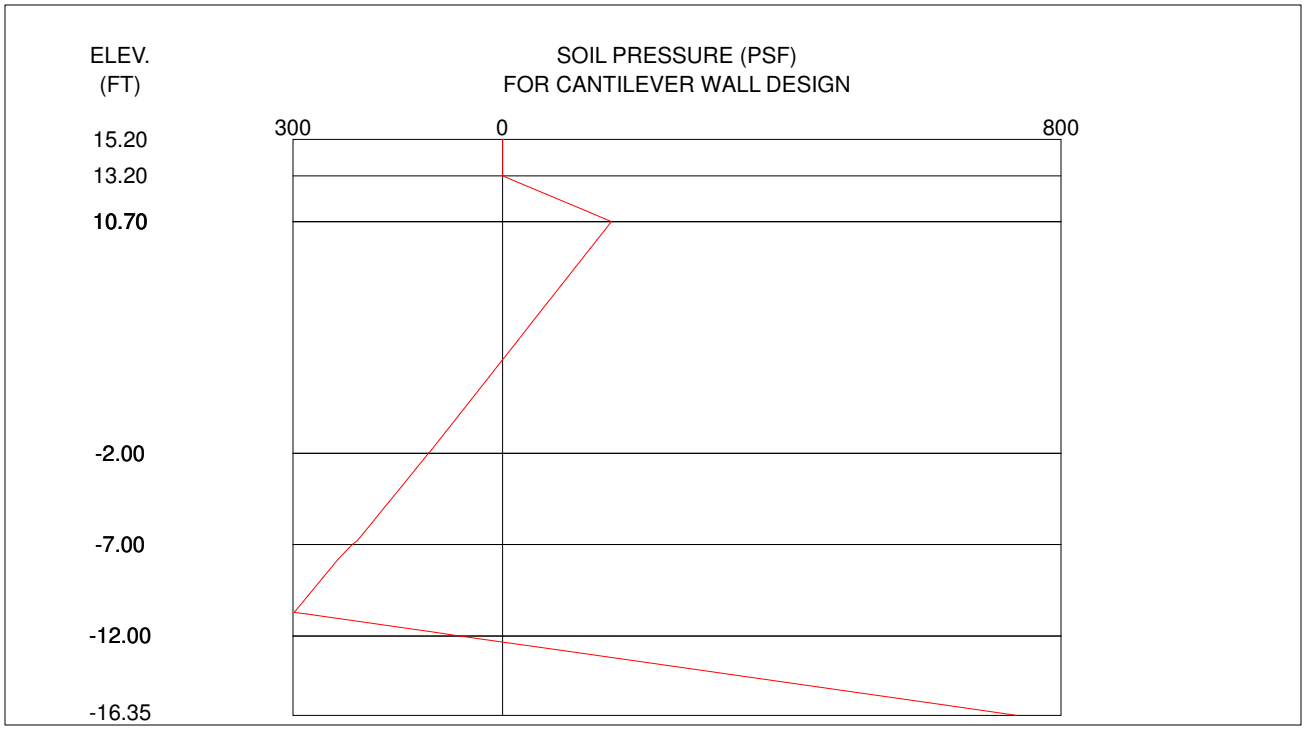
		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION (FT)	PRESSURE (PSF)	PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
15.20	0.	0.	0.	0.	0.
14.20	0.	0.	0.	0.	0.
13.20	0.	0.	0.	0.	0.
12.20	62.	0.	0.	0.	0.
11.20	125.	0.	0.	0.	0.
10.70	156.	0.	0.	0.	0.
10.20	156.	21.	11.	11.	21.
9.70	156.	43.	22.	22.	43.
9.20	156.	64.	33.	33.	64.
8.20	156.	107.	55.	55.	107.
7.20	156.	149.	77.	77.	149.
6.20	156.	192.	99.	99.	192.
5.20	156.	234.	121.	121.	234.
4.20	156.	277.	143.	143.	277.
3.20	156.	320.	165.	165.	320.
3.14	156.	322.	166.	166.	322.
2.20	156.	362.	187.	187.	362.
1.20	156.	405.	209.	209.	405.
0.20	156.	447.	231.	231.	447.
-0.80	156.	490.	253.	253.	490.
-1.80	156.	533.	275.	275.	533.
-2.00	156.	541.	279.	279.	541.
-2.80	156.	576.	297.	297.	576.
-3.80	156.	620.	320.	320.	620.
-4.80	156.	664.	343.	343.	664.
-5.80	156.	708.	365.	365.	708.
-6.80	156.	752.	388.	388.	752.
-7.00+	156.	761.	393.	393.	761.

-7.00-	156.	765.	391.	391.	765.
-7.80	156.	800.	409.	409.	800.
-8.80	156.	844.	431.	431.	844.
-9.80	156.	889.	454.	454.	889.
-10.71	156.	929.	474.	474.	929.
-10.80	156.	933.	477.	477.	933.
-11.80	156.	977.	499.	499.	977.
-12.00+	156.	986.	504.	504.	986.
-12.00-	156.	988.	502.	502.	988.
-12.80	156.	1024.	520.	520.	1024.
-13.80	156.	1068.	543.	543.	1068.
-14.80	156.	1112.	565.	565.	1112.
-15.80	156.	1157.	588.	588.	1157.
-16.35	156.	1201.	611.	611.	1201.
-17.00	156.	1210.	615.	615.	1210.

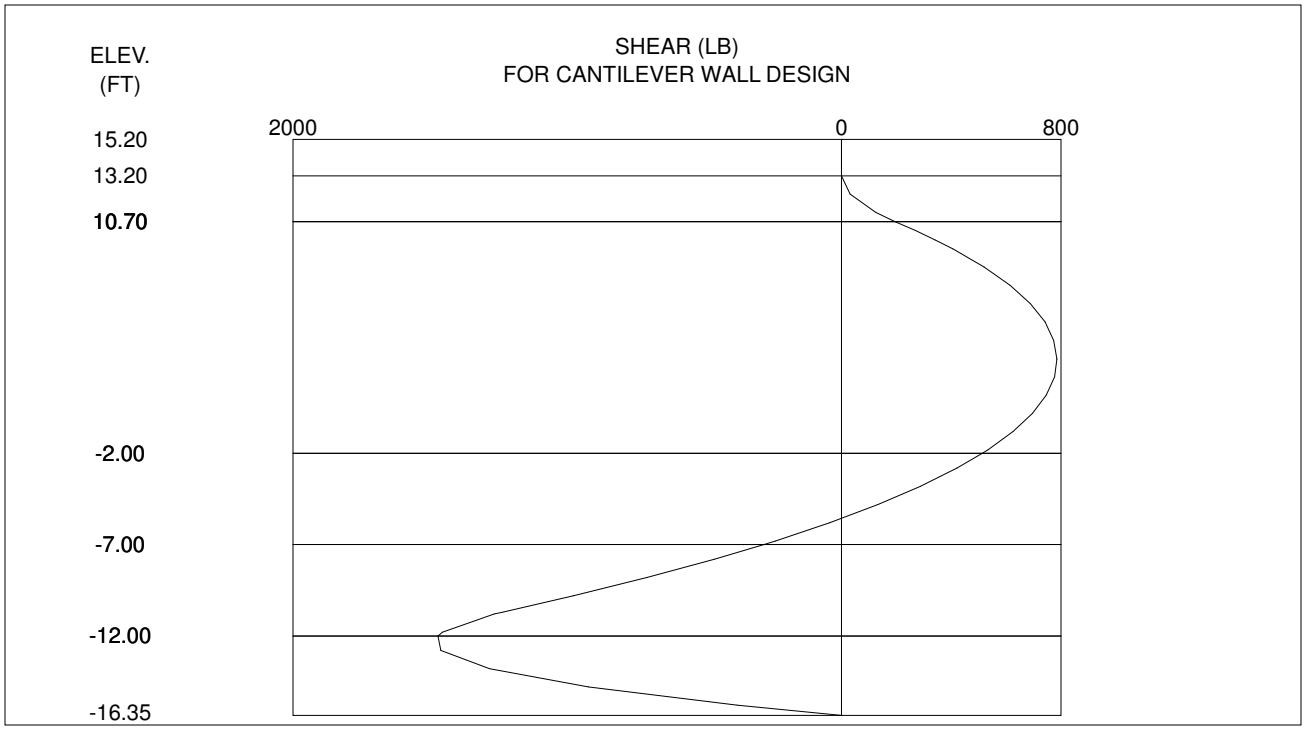
'WISHKAH - LONG TERM - DWL - LT



'WISHKAH - LONG TERM - DWL - LT

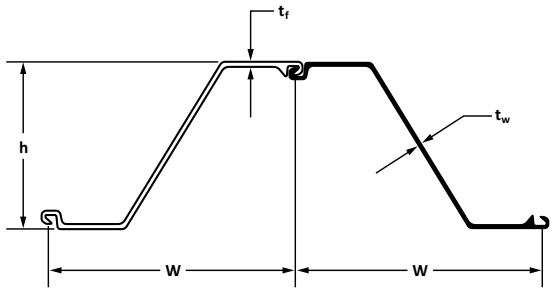


'WISHKAH - LONG TERM - DWL - LT



NZ

NZ Hot Rolled Steel Sheet Pile



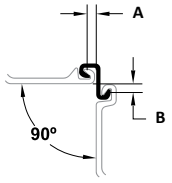
SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
NZ14-770	30.31 770	13.39 340	0.375 9.5	0.375 9.5	6.40 135.4	55 81.85	21.77 106.30	25.65 1379	30.50 1640	171.7 23447	6.10 1.86	1.20 1.20
NZ19	27.56 700	16.14 410	0.375 9.5	0.375 9.5	7.07 149.6	55 82.23	24.05 117.40	35.08 1886	41.33 2222	283.1 38659	6.18 1.88	1.35 1.35
NZ20	27.56 700	16.16 411	0.394 10.0	0.394 10.0	7.34 155.4	57 85.37	24.82 122.00	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ21	27.56 700	16.20 412	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.70	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ26	27.56 700	17.32 440	0.500 12.7	0.500 12.7	9.08 192.2	71 105.66	30.99 151.30	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41
NZ28	27.56 700	17.38 441	0.560 14.2	0.560 14.2	9.98 211.2	78 116.08	33.96 165.82	52.62 2829	62.16 3342	457.4 62461	6.49 1.98	1.41 1.41

NZ

NZ Hot Rolled Steel Sheet Pile

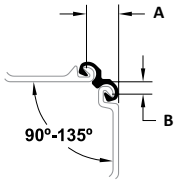
Available Steel Grades		
NZ		
ASTM	YIELD STRENGTH	
	(ksi)	(MPa)
A 328	39	270
A 572 Gr. 50	50	345
A 572 Gr. 60	60	415
A 588	50	345
A 690	50	345

Corner Piles



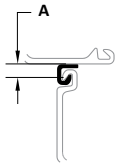
C 14

Gr: S 355 GP
Wt: 9.68 lb/ft (14.4 kg/m)
A: ~0.98" (25 mm)
B: ~0.98" (25 mm)



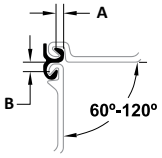
Omega 18

Gr: S 430 GP
Wt: 12.10 lb/ft (18.0 kg/m)
A: ~2.76" ~(70 mm)
B: ~1.18" ~(30 mm)



E 22

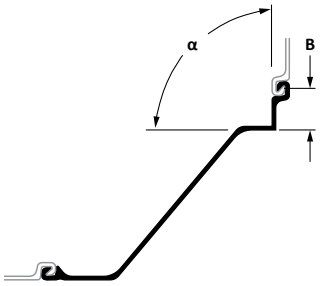
Gr: S 355 GP
Wt: 6.87 lb/ft (10.2 kg/m)
A: ~1.18" (~30 mm)



Delta 13

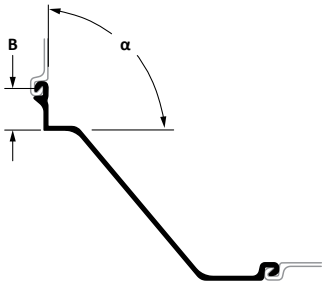
Gr: S 355 GP
Wt: 8.73 lb/ft (13.0 kg/m)
A: ~0.59" (~15 mm)
B: ~0.79" (~20 mm)

Fabricated Corner Piles



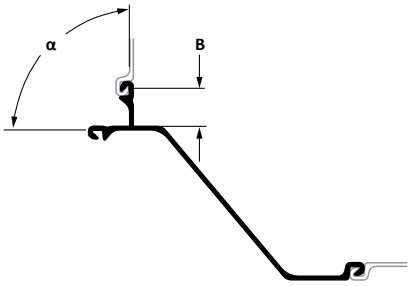
Type 1 - α

α: Angle varies
B: 3"–6" (76.2mm– 152.4mm)



Type 2 - α

α: Angle varies
B: 3"–6" (76.2mm– 152.4mm)



T Pile

α: Angle varies
B: 3"–6" (76.2mm– 152.4mm)

Delivery Conditions & Tolerances

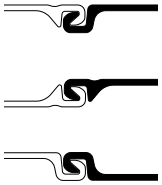
	ASTM A 6	
Mass	± 2.5%	
Length	+ 5 inches	– 0 inches

Maximum Rolled Lengths*

NZ	105.0 feet	(32.0 m)

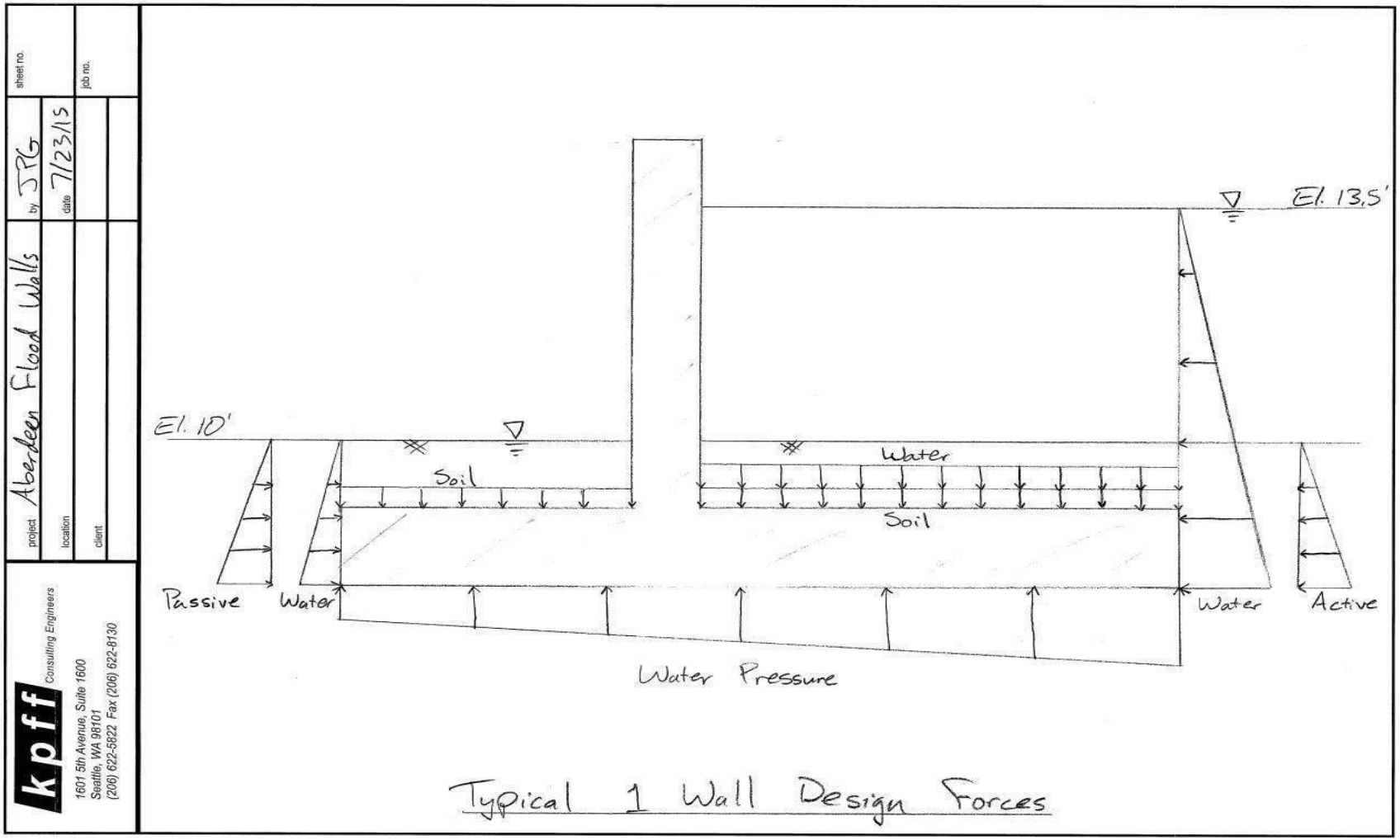
* Longer lengths may be possible upon request.

Interlock Combinations



CONCRETE T-WALLS

APPROACH:
GEOTECHNICAL MEMO TABLE 3 LISTS FOOTING BEARING VALUES FOR EACH OF THE 5 REGIONS. THE FOLLOWING PAGES USE THE BEARING VALUES FOR THE WISHKAH REGION, WHICH HAS THE LOWEST VALUES. IT IS FOUND BEARING DOESN'T CONTROL, SO BEARING VALUES FOR THE WISHKAH REGION ARE USED FOR ALL T-WALLS.


sheet no.
job no.
by JRG
date 7/23/15
project Aberdeen Flood Walls
location
client
kpff Consulting Engineers
1601 5th Avenue, Suite 1600
Seattle, WA 98101
(206) 622-5822 Fax (206) 622-8130
El. 13.5'
El. 10'
Soil
Water
Soil
Passive
Water
Water
Active
Water Pressure
Typical 1 Wall Design Forces

sheet no.

job no.

project Aberdeen Flood Walls

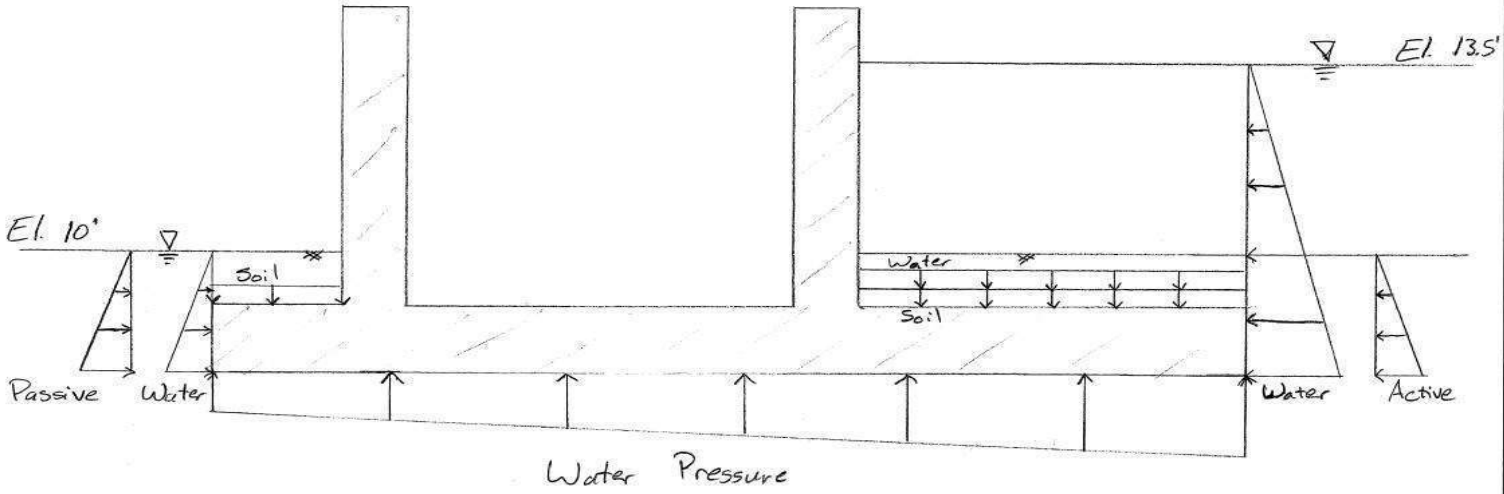
by JPG

date 7/23/15

location

client

kpff Consulting Engineers
1601 5th Avenue, Suite 1600
Seattle, WA 98101
(206) 622-5822 Fax (206) 622-8130



Planter 2 Wall Design Forces

Concrete Flood Wall - Design Water Level (DWL)

Single Stem T-Wall Design

Dimensions

Wall Height	5.50	*ft*
Depth to T/Ftg	12	*in*
Wall Thickness	12	*in*
Footing Width	13	*ft*
Toe Width	5	*ft*
Heel Width	7.00	*ft*
Footing Thickness	16	*in*

Rebar	**Size**	**Spacing**	
Footing Primary	6	10	*in*
Footing Secondary	5	12	*in*
Wall Front	5	10	*in*
Wall Back	5	10	*in*
Wall Secondary	4	8	*in*

Design Flood (3.5' for DWL, 4.5' for OVT1)

Flood depth	3.5	*ft*

Depths to Bottom of Footing

Depth to Ftg Bot	2.33	*ft*
Flood Level	5.83	*ft*
Top of Wall	6.83	*ft*

Soil

Active	18	*psf/ft*
Passive	190	*psf/ft*
Bearing Capacity	1.46	*ksf*
Saturated Density	100	*pcf*
Cohesion	250	*psf*
Friction Coefficient	0.6	

Design C/D's		**Required**	
Wall Flexure	**11.61**	1	
Wall Shear	**14.52**	1	
Wall Steel	**1.02**	1	
Footing Flexure	**1.62**	1	
Footing Shear	**2.79**	1	
Footing Steel	**1.06**	1	
Overturning	**1.51**	1.5	EM Tbl 4-2
Sliding	**2.22**	1.5	EM Tbl 4-2
Bearing	**6.15**	3	EM Tbl 4-2

2-Stem (Planter) T-Wall Design

Dimensions

Wall Height	5.50	*ft*
Depth to T/Ftg	12	*in*
Wall Thickness	12	*in*
Footing Width	16	*ft*
Toe Width	1.75	*ft*
Planter Width	6	*ft*
Heel Width	6.25	*ft*
Footing Thickness	16	*in*

Rebar	**Size**	**Spacing**	
Footing Primary	6	10	*in*
Footing Secondary	5	12	*in*
Wall Front	5	10	*in*
Wall Back	5	10	*in*
Wall Secondary	4	8	*in*

Design Flood (3.5' for DWL, 4.5' for OVT1)

Flood depth	3.5	*ft*

Depths to Bottom of Footing

Depth to Ftg Bot	2.33	*ft*	
Planter Level	1.33	*ft*	(empty)
Flood Level	5.83	*ft*	
Top of Wall	6.83	*ft*	

Soil Pressures

Active	18	*psf/ft*
Passive	190	*psf/ft*
Bearing Capacity	1.46	*ksf*
Saturated Density	100	*pcf*
Cohesion	250	*psf*
Friction Coefficient	0.6	

Design C/D's		**Required**	
Wall Flexure	**11.09**	1	
Wall Shear	**11.66**	1	
Wall Steel	**1.02**	1	
Footing Flexure	**2.03**	1	
Footing Shear	**3.13**	1	
Footing Steel	**1.06**	1	
Overturning	**1.55**	1.5	EM Tbl 4-2
Sliding	**3.27**	1.5	EM Tbl 4-2
Bearing	**4.08**	3	EM Tbl 4-2

Strength design (wall and footing flexure, shear, and steel) was done using ACI 318-11. Stability checks (overturning, sliding, and bearing) were done using the US Army Corps of Engineers Retaining and Flood Walls Engineer Manual 1110-2-2502. Overturning considers both overturning moments and reaction resultant location.

The planter two wall case assumes a minimum of 3'-0" of soil in planter. The available depth is 5'-6".

Wall Design (DWL)

Properties

Reinforcing

f_y	60	*ksi*
Bar_{front}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
Bar_{back}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
$Bar_{secondary}$	4	
d_{bar}	0.5	*in*
A_{bar}	0.20	in^2
Ties	4	
d_{bar}	0.50	*in*
A_{bar}	0.20	in^2

Concrete

f'_c	4	*ksi*
L_{unit}	12	*in*
t	12	*in*
h	5.50	*ft*
cover	2	*in*
d	9.2	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	1728	in^4
y_t	6.0	*in*

Soil

γ_{sat}	100	*pcf*	GeoEngineers Figure X1
S_u	250	*psf*	GeoEngineers Figure X1

Elevations

h_{flood}	14.2	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ wall}$	15.2	*ft*
$h_{bottom\ wall}$	9.70	*ft*
d_{water}	4.50	*ft*
d_{soil}	1.00	*ft*

Pressures

Flood Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	281	*psf*
P_{water}	0.63	*k/ft*
$h_{P\text{-}water}$	1.50	*ft*

Active Earth

γ_{soil}	18	*psf*
$\sigma_{wall\ bot}$	18	*psf*
P_{soil}	0.01	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Protected Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	62	*psf*
P_{water}	0.03	*k/ft*
$h_{P\text{-}water}$	0.33	*ft*

Passive Earth

γ_{soil}	190	*psf*
$\sigma_{wall\ bot}$	190	*psf*
P_{soil}	0.10	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Flexural Design - ACI Chapter 10

Moment Demand

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
M_u	**1.3**	***k-ft/ft***	
M_s	**0.9**	***k-ft/ft***	

Minimum Reinforcement

ρ_{min}	0.002		ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft	
$A_{s\ min\ vert}$	0.35	in^2/ft	ACI 10.5.1
f_s	3.5	*ksi*	conservative
$s_{max\ vert}$	138.6	*in*	ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.03	in^2/ft	ρ_{req}	0.00028
s_{req}	119.3	*in*		
s_{vert}	**10**	***in***		
N_{bars}	1.20	*/ft*		
$A_{s\ vert}$	0.37	in^2/ft	ρ	0.00334
a	0.54	*in*		

Crack Control

s_{trans}	**8**	***in***		
$A_{s\ trans}$	0.29	in^2/ft	ρ	0.00204

Checks

Strength

ΦM_n	**15**	***k-ft/ft***
C/D	**11.6**	**OK**

Serviceability

$A_{s\ vert} > A_{s\ min\ vert}$	1.06	**OK**
$s_{vert} < s_{max\ vert}$	13.86	**OK**
$A_{s\ trans} > A_{s\ min\ trans}$	1.02	**OK**

Shear Design - ACI Chapter 11

Demand Shear

Strength Factors — ACI 9.2.1

Pressure (F)	1.4
Dead (D)	1.4
V_u	**0.7** ***k/ft***

Concrete Shear Strength

ΦV_c	**10.5**	***k/ft***	ACI 11.2.1.1

Steel Shear Strength

Not required — ACI 11.4.6

ΦV_s	**0**	***k/ft***

Checks

Strength

ΦV_n	**10.5**	***k/ft***
C/D	**14.5**	**OK**

Rebar Layout Summary

Back Vertical	**# 5**	**@ 10.0 in.**
Front Vertical	**# 5**	**@ 10.0 in.**
Horizontal	**# 4**	**@ 10.0 in.**

Footing Design (DWL)

Properties

Reinforcing

f_y	60	*ksi*
$Bar_{primary}$	6	
d_{bar}	0.75	*in*
A_{bar}	0.44	in^2
$Bar_{secondary}$	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2

Concrete

f'_c	4	*ksi*
γ_c	155	*pcf*
L	12	*in*
h	16	*in*
b_{total}	13.0	*ft*
b_{heel}	7.00	*ft*
b_{toe}	5.00	*ft*
cover	3	*in*
d	12.6	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	4096	in^4
y_t	8.0	*in*

Soil

γ_{sat}	100	*pcf*	Assumed
C	250	*psf*	GeoEngineers Table 4
γ_{water}	62.4	*psf*	

Elevations

h_{flood}	14.2	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ foot}$	9.70	*ft*
$h_{bottom\ foot}$	8.37	*ft*
d_{water}	5.83	*ft*
d_{soil}	2.33	*ft*

Flexural Design - ACI Chapter 10

Demand Moment

conservatively neglect bearing resistance pressure

Strength Factors — ACI 9.2.1

Pressure (F)	1.4	
Dead (D)	1.4	
$M_{u\ heel}$	18.0	*k-ft/ft*
$M_{u\ toe}$	5.4	*k-ft/ft*
M_u	**18.0**	***k-ft/ft***
$M_{s\ heel}$	12.9	*k-ft/ft*
$M_{s\ toe}$	3.8	*k-ft/ft*
M_s	**3.8**	***k-ft/ft***

Minimum Reinforcement

ρ_{min}	0.002		ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft	
$A_{s\ min\ long}$	0.48	in^2/ft	ACI 10.5.1
f_s	7.4	*ksi*	conservative
$s_{max\ liong}$	64.9	*in*	ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.32	in^2/ft	ρ_{req}	0.00213
s_{req}	16.4	*in*		
s_{long}	**10**	***in***		
N_{bars}	1.2	*/ft*		
$A_{s\ long}$	0.53	in^2	ρ	0.00350
a	0.78	*in*		

Crack Control

s_{trans}	**12**	***in***		
$A_{s\ trans}$	0.31	in^2/ft	ρ	0.00160

Checks

Strength

ΦM_n	**29.2**	***k-ft/ft***
C/D	**1.6**	**OK**

Serviceability

$A_{s\ long} > A_{s\ min\ long}$	1.11	**OK**
$s_{long} < s_{max\ long}$	6.49	**OK**
$A_{s\ trans} > A_{s\ min\ trans}$	1.06	**OK**

Shear Design - ACI Chapter 11

Demand Shear *conservatively neglect bearing resistance pressure*

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$V_{u\ heel}$	5.1	*k/ft*	
$V_{u\ toe}$	2.1	*k/ft*	
V_u	**5.1**	***k/ft***	

Concrete Shear Strength

ΦV_c	**14.4**	***k/ft***	ACI 11.2.1.1

Steel Shear Strength

Not required			ACI 11.4.6
ΦV_s	**0**	***k/ft***	

Checks

Strength			
ΦV_n	**14.4**	***k/ft***	
C/D	**2.8**	**OK**	

Rebar Layout Summary

Primary	**# 6**	**@ 10.0 in.**
Secondary	**# 5**	**@ 10.0 in.**

Stability

Properties

Concrete

f'_c	4 *ksi*	
γ_c	155 *pcf*	
L_{unit}	1 *ft*	
h_{foot}	16 *in*	
b_{total}	13.0 *ft*	
b_{heel}	7.00 *ft*	
b_{toe}	5.00 *ft*	
t_{wall}	12 *in*	
h_{wall}	5.50 *ft*	

Soil

γ_{sat}	100 *pcf*	Assumed
C	250 *psf*	GeoEngineers Table 4
μ	0.6	GeoEngineers Table 4

Elevations

h_{flood}	14.2 *ft*
$h_{ground\ surface}$	10.7 *ft*
$h_{top\ foot}$	9.70 *ft*
$h_{bottom\ foot}$	8.37 *ft*
d_{water}	5.83 *ft*
d_{soil}	2.33 *ft*

Pressures

Flood Side Water

γ_{water}	62.4 *pcf*
$\sigma_{foot\ bot}$	364 *psf*
P_{water}	1.06 *k/ft*
$h_{P\text{-}water}$	1.94 *ft*

Active Earth

γ_{soil}	18 *psf*
$\sigma_{foot\ bot}$	42 *psf*
P_{soil}	0.05 *k/ft*
$h_{P\text{-}soil}$	0.78 *ft*

Protected Side Water

γ_{water}	62.4 *psf*
$\sigma_{foot\ bot}$	146 *psf*
P_{water}	0.17 *k/ft*
$h_{P\text{-}water}$	0.78 *ft*

Passive Earth

γ_{soil}	190 *psf*	
$\sigma_{foot\ bot}$	443 *psf*	
P_{soil}	0.52 *k/ft*	
$h_{P\text{-}soil}$	0.78 *ft*	

Water Under Footing

γ_{water}	62.4 *psf*	
$\sigma_{toe\ bot}$	146 *psf*	
$\sigma_{heel\ bot}$	364 *psf*	
P_{water}	3.31 *k/ft*	
$b_{P\text{-}water}$	7.43 *ft*	*From toe*

Overturning

Overturning Moments

Horizontal		
Flood Water	2.06 *k-ft/ft*	
Active Soil	0.04 *k-ft/ft*	
Vertical		
Footing Water	24.61 *k-ft/ft*	
	26.71 *k-ft/ft*	

Resisting Moments

Horizontal		
Protected Water	0.13 *k-ft/ft*	
Passive Soil	0.40 *k-ft/ft*	
Vertical		
Toe Soil	1.25 *k-ft/ft*	
Heel Soil	6.65 *k-ft/ft*	
Footing	17.46 *k-ft/ft*	
Wall	3.03 *k-ft/ft*	
Flood Water	11.47 *k-ft/ft*	
	40.39 *k-ft/ft*	
C/D	**1.51**	**OK**

Sliding

Driving

Active Soil	0.05 *k/ft*	
Flood Water	1.06 *k/ft*	
	1.11 *k/ft*	

Resisting

Passive Soil	0.52 *k/ft*	
Protected Water	0.17 *k/ft*	
Friction	1.77 *k/ft*	
	2.46 *k/ft*	
C/D	**2.22**	**OK**
Required	**1.50**	USACE EM 1110-2-2502 Table 4-2

Bearing

Vertical Forces

Concrete	3.54	*k/ft*
Soil	1.20	*k/ft*
Water Weight	1.53	*k/ft*
Footing Water	-3.31	*k/ft*
P_{total}	2.96	*k/ft*

Moments about Bottom Center of Footing

Vertical		
Wall	-0.85	*k-ft/ft*
Heel Soil	2.10	*k-ft/ft*
Toe Soil	-2.00	*k-ft/ft*
Flood Water	4.59	*k-ft/ft*
Footing Water	-3.08	*k-ft/ft*
Horizontal		
Passive Soil	0.40	*k-ft/ft*
Active Soil	-0.04	*k-ft/ft*
Protected Water	0.13	*k-ft/ft*
Flood Water	-2.06	*k-ft/ft*
M_{total}	0.81	*k-ft/ft*

Resultant Location and Maximum Pressure

e	**0.27**	***ft***	
σ_{max}	**0.24**	***ksf***	AASHTO 11.6.3.2
Max e (+-)	2.17	*ft*	USACE EM 1110-2-2502 Table 4-2 & Figure 4-4
e C/D	**7.91**	**OK**	
Max σ	1.46	*ksf*	GeoEngineers Table 3
σ C/D	**6.15**	**OK**	
Required	**3.00**		USACE EM 1110-2-2502 Table 4-2

Planter Wall Design (DWL)

Properties

Reinforcing

f_y	60	*ksi*
Bar_{front}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
Bar_{back}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
$Bar_{secondary}$	4	
d_{bar}	0.5	*in*
A_{bar}	0.20	in^2
Ties	4	
d_{bar}	0.50	*in*
A_{bar}	0.20	in^2

Concrete

f'_c	4	*ksi*
N_{walls}	2	
$s_{opening}$	6	*ft*
L_{unit}	12	*in*
t	12	*in*
h	5.50	*ft*
cover	2	*in*
d	9.2	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	1728	in^4
y_t	6.0	*in*

Soil

γ_{sat}	100	*pcf*	GeoEngineers Figure X1
S_u	250	*psf*	GeoEngineers Figure X1

Elevations

h_{flood}	14.2	*ft*
$h_{planter\ surface}$	9.70	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ wall}$	15.2	*ft*
$h_{bottom\ wall}$	9.70	*ft*
d_{water}	4.50	*ft*
$d_{planter\ soil}$	0.00	*ft*
d_{soil}	1.00	*ft*

Pressures

Flood Wall

Flood Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	281	*psf*
P_{water}	0.63	*k/ft*
$h_{P\text{-}water}$	1.50	*ft*

Active Earth

γ_{soil}	18	*psf*
$\sigma_{wall\ bot}$	18	*psf*
P_{soil}	0.01	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Planter Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{water}	0.00	*k/ft*
$h_{P\text{-}water}$	0.00	*ft*

Passive Planter Earth

γ_{soil}	190	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{soil}	0.00	*k/ft*
$h_{P\text{-}soil}$	0.00	*ft*

Protected Wall

Planter Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{water}	0.00	*k/ft*
$h_{P\text{-}water}$	0.00	*ft*

Active Planter Earth

γ_{soil}	33.5	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{soil}	0.00	*k/ft*
$h_{P\text{-}soil}$	0.00	*ft*

Protected Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	62	*psf*
P_{water}	0.03	*k/ft*
$h_{P\text{-}water}$	0.33	*ft*

Passive Exterior Earth

γ_{soil}	41	*psf*
$\sigma_{wall\ bot}$	41	*psf*
P_{soil}	0.02	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Flexural Design - ACI Chapter 10

Moment Demand

Strength Factors — ACI 9.2.1

Pressure (F)	1.4
Dead (D)	1.4

$M_{u\ front}$	1.3	*k-ft/ft*
$M_{u\ back}$	0.0	*k-ft/ft*
M_u	**1.3**	***k-ft/ft***
$M_{s\ front}$	1.0	*k-ft/ft*
$M_{s\ back}$	0.0	*k-ft/ft*
M_s	**1.0**	***k-ft/ft***

Minimum Reinforcement

ρ_{min}	0.002		ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft	
$A_{s\ min\ vert}$	0.35	in^2/ft	ACI 10.5.1
f_s	3.6	*ksi*	conservative
$s_{max\ vert}$	132.9	*in*	ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.03	in^2/ft	ρ_{req}	0.00029
s_{req}	114.0	*in*		
s_{vert}	**10**	***in***		
N_{bars}	1.20	*/ft*		
$A_{s\ vert}$	0.37	in^2	ρ	0.00334
a	0.54	*in*		

Crack Control

s_{trans}	**8**	***in***		
$A_{s\ trans}$	0.29	in^2/ft	ρ	0.00204

Checks

Strength

ΦM_n	**14.8**	***k-ft/ft***	
C/D	**11.1**	**OK**	0.090

Serviceability

$A_{s\ vert} > A_{s\ min\ vert}$	1.06	**OK**
$s_{vert} < s_{max\ vert}$	13.29	**OK**
$A_{s\ trans} > A_{s\ min\ trans}$	1.02	**OK**

Shear Design - ACI Chapter 11

Demand Shear

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$V_{u\ front}$	0.9	*k/ft*	
$V_{u\ back}$	-0.1	*k/ft*	
V_u	**0.9**	***k/ft***	

Concrete Shear Strength

ACI 11.2.1.1

ΦV_c	**10.5**	***k/ft***

Steel Shear Strength

Not required — ACI 11.4.6

ΦV_s	**0**	***k/ft***

Checks

Strength

ΦV_n	**10.5**	***k/ft***	
C/D	**11.7**	**OK**	0.086

Rebar Layout Summary

Back Vertical	**# 5**	**@ 10.0 in.**
Front Vertical	**# 5**	**@ 10.0 in.**
Horizontal	**# 4**	**@ 8.0 in.**

Planter Footing Design (DWL)

Properties

Reinforcing

f_y	60	*ksi*
$Bar_{primary}$	6	
d_{bar}	0.75	*in*
A_{bar}	0.44	in^2
$Bar_{secondary}$	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2

Concrete

f'_c	4	*ksi*
γ_c	155	*pcf*
L	12	*in*
h	16	*in*
b_{total}	16	*ft*
b_{heel}	6.25	*ft*
$b_{planter}$	6	*ft*
b_{toe}	1.75	*ft*
cover	3	*in*
d	12.6	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	4096	in^4
y_t	8.0	*in*

Soil

γ_{sat}	100	*pcf*	Assumed
S_u	250	*psf*	GeoEngineers Table 4
γ_{water}	62.4	*psf*	

Elevations

h_{flood}	14.2	*ft*
$h_{planter\ surface}$	9.70	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ foot}$	9.70	*ft*
$h_{bottom\ foot}$	8.37	*ft*
d_{water}	5.83	*ft*
$d_{planter\ soil}$	0.00	*ft*
d_{soil}	2.33	*ft*

Flexural Design - ACI Chapter 10

Demand Moment

conservatively neglect bearing resistance pressure

Strength Factors				
				ACI 9.2.1
Pressure (F)	1.4			
Dead (D)	1.4			
$M_{u\ heel}$	14.4	*k-ft/ft*		
$M_{u\ toe}$	0.7	*k-ft/ft*		
M_u	**14.4**	***k-ft/ft***		
$M_{s\ heel}$	10.3	*k-ft/ft*		
$M_{s\ toe}$	0.5	*k-ft/ft*		
M_s	**10.3**	***k-ft/ft***		

Minimum Reinforcement

ρ_{min}	0.002			ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft		
$A_{s\ min\ long}$	0.48	in^2/ft		ACI 10.5.1
f_s	19.8	*ksi*		conservative
$s_{max\ liong}$	22.8	*in*		ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.26	in^2/ft	ρ_{req}	0.00169
s_{req}	20.7	*in*		
s_{long}	**10**	***in***		
N_{bars}	1.2	*/ft*		
$A_{s\ long}$	0.53	in^2	ρ	0.00350
a	0.78	*in*		

Crack Control

s_{trans}	**12**	***in***		
$A_{s\ trans}$	0.31	in^2/ft	ρ	0.00160

Checks

Strength			
			AASHTO 5.7.3.2.2-1
ΦM_n	**29.2**	***k-ft/ft***	
C/D	**2.0**	**OK**	
Serviceability			
$A_{s\ long} > A_{s\ min\ long}$	1.11	**OK**	
$s_{long} < s_{max\ long}$	2.28	**OK**	
$A_{s\ trans} > A_{s\ min\ trans}$	1.06	**OK**	

Shear Design - ACI Chapter 11

Demand Shear *conservatively neglect bearing resistance pressure*

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$V_{u\ heel}$	4.6	*k/ft*	
$V_{u\ toe}$	0.8	*k/ft*	
V_u	**4.6**	***k/ft***	

Concrete Shear Strength

ΦV_c	**14.4**	***k/ft***	ACI 11.2.1.1

Steel Shear Strength

Not required			ACI 11.4.6
ΦV_s	**0**	***k/ft***	

Checks

Strength			
ΦV_n	**14.4**	***k/ft***	
C/D	**3.1**	**OK**	

Rebar Layout Summary

Primary	**# 6**	**@ 10.0 in.**
Secondary	**# 5**	**@ 10.0 in.**

Planter Stability

Properties

Concrete

f'_c	4	*ksi*	
γ_c	155	*pcf*	
L_{unit}	1	*ft*	
h_{foot}	16	*in*	
b_{total}	16	*ft*	
b_{heel}	6.25	*ft*	
$b_{planter}$	6	*ft*	
b_{toe}	1.75	*ft*	
t_{wall}	12	*in*	
h_{wall}	5.50	*ft*	

Soil

γ_{sat}	100	*pcf*	Assumed
S_u	250	*psf*	GeoEngineers Table 4
μ	0.6		GeoEngineers Table 4

Elevations

h_{flood}	14.2	*ft*	
$h_{planter\ surface}$	9.70	*ft*	
$h_{ground\ surface}$	10.7	*ft*	
$h_{top\ foot}$	9.70	*ft*	
$h_{bottom\ foot}$	8.37	*ft*	
d_{water}	5.83	*ft*	
$d_{planter\ soil}$	3.00	*ft*	Conservative: available depth = 5.5'
d_{soil}	2.33	*ft*	

Pressures

Flood Wall

Flood Side Water

γ_{water}	62.4	*pcf*
$\sigma_{wall\ bot}$	364	*psf*
P_{water}	1.06	*k/ft*
$h_{P\text{-}water}$	1.94	*ft*

Active Earth

γ_{soil}	18	*psf*
$\sigma_{wall\ bot}$	42	*psf*
P_{soil}	0.05	*k/ft*
$h_{P\text{-}soil}$	0.78	*ft*

Planter Side Water

γ_{water}	62.4 *psf*	
$\sigma_{wall\ bot}$	187 *psf*	
P_{water}	0.28 *k/ft*	
$h_{P\text{-}water}$	2.33 *ft*	

Passive Planter Earth

γ_{soil}	190 *psf*	
$\sigma_{wall\ bot}$	570 *psf*	
P_{soil}	0.86 *k/ft*	
$h_{P\text{-}soil}$	2.33 *ft*	

Protected Wall

Planter Side Water

γ_{water}	62.4 *psf*	
$\sigma_{wall\ bot}$	187 *psf*	
P_{water}	0.28 *k/ft*	
$h_{P\text{-}water}$	2.33 *ft*	

Active Planter Earth

γ_{soil}	18 *psf*	
$\sigma_{wall\ bot}$	54 *psf*	
P_{soil}	0.08 *k/ft*	
$h_{P\text{-}soil}$	2.33 *ft*	

Protected Side Water

γ_{water}	62.4 *psf*	
$\sigma_{wall\ bot}$	146 *psf*	
P_{water}	0.17 *k/ft*	
$h_{P\text{-}water}$	0.78 *ft*	

Passive Exterior Earth

γ_{soil}	190 *psf*	
$\sigma_{wall\ bot}$	443 *psf*	
P_{soil}	0.52 *k/ft*	
$h_{P\text{-}soil}$	0.78 *ft*	

Footing

Water Under Footing

γ_{water}	62.4 *psf*	
$\sigma_{toe\ bot}$	146 *psf*	
$\sigma_{heel\ bot}$	364 *psf*	
P_{water}	4.08 *k/ft*	
$b_{P\text{-}water}$	9.14 *ft*	*From toe*

Overturning

Overturning Moments

Horizontal		
Flood Water	2.06	*k-ft/ft*
Active Soil	0.04	*k-ft/ft*
Vertical		
Footing Water	37.27	*k-ft/ft*
	39.38	***k-ft/ft***

Resisting Moments

Horizontal		
Protected Water	0.13	*k-ft/ft*
Passive Soil	0.40	*k-ft/ft*
Vertical		
Toe Soil	0.15	*k-ft/ft*
Planter Soil	10.35	*k-ft/ft*
Heel Soil	8.05	*k-ft/ft*
Footing	26.45	*k-ft/ft*
Walls	9.80	*k-ft/ft*
Water	5.78	*k-ft/ft*
	61.12	***k-ft/ft***

C/D	**1.55**	**OK**

Sliding

Driving

Active Soil	0.05	*k/ft*
Flood Water	1.06	*k/ft*
	1.11	***k/ft***

Resisting

Passive Soil	0.52	*k/ft*
Protected Water	0.17	*k/ft*
Friction	2.94	*k/ft*
	3.63	***k/ft***

C/D	**3.27**	**OK**	
Required	**1.50**		USACE EM 1110-2-2502 Table 4-2

Bearing

Vertical Forces

Concrete	5.01	*k/ft*
Soil	2.60	*k/ft*
Water Weight	1.37	*k/ft*
Footing Water	-4.08	*k/ft*
P_{total}	4.90	*k/ft*

Moments about Bottom Center of Footing

Vertical		
Walls	-3.84	*k-ft/ft*
Heel Soil	3.05	*k-ft/ft*
Planter Soil	-4.05	*k-ft/ft*
Toe Soil	-1.25	*k-ft/ft*
Flood Water	6.65	*k-ft/ft*
Footing Water	-4.66	*k-ft/ft*
Horizontal		
Passive Soil	0.40	*k-ft/ft*
Active Soil	-0.04	*k-ft/ft*
Protected Water	0.13	*k-ft/ft*
Flood Water	-2.06	*k-ft/ft*
M_{total}	5.66	*k-ft/ft*

Resultant Location and Maximum Pressure

e	**1.15**	***ft***	
σ_{max}	**0.36**	***ksf***	AASHTO 11.6.3.2
Max e (+-)	2.67	*ft*	USACE EM 1110-2-2502 Table 4-2 & Figure 4-4
e C/D	**2.31**	**OK**	
Max σ	1.46	*ksf*	Geotech email
σ C/D	**4.08**	**OK**	
Required	**3.00**		USACE EM 1110-2-2502 Table 4-2

Concrete Flood Wall - Water to Top of Wall (OVT1)

Single Stem T-Wall Design

Dimensions

Wall Height	5.50	*ft*
Depth to T/Ftg	12	*in*
Wall Thickness	12	*in*
Footing Width	13	*ft*
Toe Width	5	*ft*
Heel Width	7.00	*ft*
Footing Thickness	16	*in*

Rebar	**Size**	**Spacing**	
Footing Primary	6	10	*in*
Footing Secondary	5	12	*in*
Wall Front	5	10	*in*
Wall Back	5	10	*in*
Wall Secondary	4	8	*in*

Design Flood (3.5' for DWL, 4.5' for OVT1)

Flood depth	4.5	*ft*

Depths to Bottom of Footing

Depth to Ftg Bot	2.33	*ft*
Flood Level	6.83	*ft*
Top of Wall	6.83	*ft*

Soil

Active	18	*psf/ft*
Passive	190	*psf/ft*
Bearing Capacity	1.46	*ksf*
Saturated Density	100	*pcf*
Cohesion	250	*psf*
Friction Coefficient	0.6	

Design C/D's		**Required**	
Wall Flexure	**6.24**	1	
Wall Shear	**9.04**	1	
Wall Steel	**1.02**	1	
Footing Flexure	**1.45**	1	
Footing Shear	**2.50**	1	
Footing Steel	**1.06**	1	
Overturning	**1.39**	1.33	EM Tbl 4-2
Sliding	**1.65**	1.33	EM Tbl 4-2
Bearing	**5.82**	2	EM Tbl 4-2

2-Stem (Planter) T-Wall Design

Dimensions

Wall Height	5.50	*ft*
Depth to T/Ftg	12	*in*
Wall Thickness	12	*in*
Footing Width	16	*ft*
Toe Width	1.75	*ft*
Planter Width	6	*ft*
Heel Width	6.25	*ft*
Footing Thickness	16	*in*

Rebar	**Size**	**Spacing**	
Footing Primary	6	10	*in*
Footing Secondary	5	12	*in*
Wall Front	5	10	*in*
Wall Back	5	10	*in*
Wall Secondary	4	8	*in*

Design Flood (3.5' for DWL, 4.5' for OVT1)

Flood depth	4.5	*ft*

Depths to Bottom of Footing

Depth to Ftg Bot	2.33	*ft*	
Planter Level	1.33	*ft*	(empty)
Flood Level	6.83	*ft*	
Top of Wall	6.83	*ft*	

Soil Pressures

Active	18	*psf/ft*
Passive	190	*psf/ft*
Bearing Capacity	1.46	*ksf*
Saturated Density	100	*pcf*
Cohesion	250	*psf*
Friction Coefficient	0.6	

Design C/D's		**Required**	
Wall Flexure	**6.08**	1	
Wall Shear	**7.84**	1	
Wall Steel	**1.02**	1	
Footing Flexure	**1.82**	1	
Footing Shear	**2.80**	1	
Footing Steel	**1.06**	1	
Overturning	**1.37**	1.33	EM Tbl 4-2
Sliding	**2.37**	1.33	EM Tbl 4-2
Bearing	**4.07**	2	EM Tbl 4-2

Strength design (wall and footing flexure, shear, and steel) was done using ACI 318-11. Stability checks (overturning, sliding, and bearing) were done using the US Army Corps of Engineers Retaining and Flood Walls Engineer Manual 1110-2-2502. Overturning considers both overturning moments and reaction resultant location.

The planter two wall case assumes a minimum of 3'-0" of soil in planter. The available depth is 5'-6".

Wall Design (OVT1)

Properties

Reinforcing

f_y	60	*ksi*
Bar_{front}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
Bar_{back}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
$Bar_{secondary}$	4	
d_{bar}	0.5	*in*
A_{bar}	0.20	in^2
Ties	4	
d_{bar}	0.50	*in*
A_{bar}	0.20	in^2

Concrete

f'_c	4	*ksi*
L_{unit}	12	*in*
t	12	*in*
h	5.50	*ft*
cover	2	*in*
d	9.2	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	1728	in^4
y_t	6.0	*in*

Soil

γ_{sat}	100	*pcf*	GeoEngineers Figure X1
S_u	250	*psf*	GeoEngineers Figure X1

Elevations

h_{flood}	15.2	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ wall}$	15.2	*ft*
$h_{bottom\ wall}$	9.70	*ft*
d_{water}	5.50	*ft*
d_{soil}	1.00	*ft*

Pressures

Flood Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	343	*psf*
P_{water}	0.94	*k/ft*
$h_{P\text{-}water}$	1.83	*ft*

Active Earth

γ_{soil}	18	*psf*
$\sigma_{wall\ bot}$	18	*psf*
P_{soil}	0.01	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Protected Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	62	*psf*
P_{water}	0.03	*k/ft*
$h_{P\text{-}water}$	0.33	*ft*

Passive Earth

γ_{soil}	190	*psf*
$\sigma_{wall\ bot}$	190	*psf*
P_{soil}	0.10	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Flexural Design - ACI Chapter 10

Moment Demand

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
M_u	**2.4**	***k-ft/ft***	
M_s	**1.7**	***k-ft/ft***	

Minimum Reinforcement

ρ_{min}	0.002			ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft		
$A_{s\ min\ vert}$	0.35	in^2/ft		ACI 10.5.1
f_s	6.4	*ksi*		conservative
$s_{max\ vert}$	74.5	*in*		ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.06	in^2/ft	ρ_{req}	0.00052
s_{req}	64.0	*in*		
s_{vert}	**10**	***in***		
N_{bars}	1.20	*/ft*		
$A_{s\ vert}$	0.37	in^2/ft	ρ	0.00334
a	0.54	*in*		

Crack Control

s_{trans}	**8**	***in***		
$A_{s\ trans}$	0.29	in^2/ft	ρ	0.00204

Checks

Strength

ΦM_n	**15**	***k-ft/ft***
C/D	**6.2**	**OK**

Serviceability

$A_{s\ vert} > A_{s\ min\ vert}$	1.06	**OK**
$s_{vert} < s_{max\ vert}$	7.45	**OK**
$A_{s\ trans} > A_{s\ min\ trans}$	1.02	**OK**

Shear Design - ACI Chapter 11

Demand Shear

Strength Factors — ACI 9.2.1

Pressure (F)	1.4
Dead (D)	1.4

V_u **1.2** ***k/ft***

Concrete Shear Strength

ΦV_c **10.5** ***k/ft*** — ACI 11.2.1.1

Steel Shear Strength

Not required — ACI 11.4.6

ΦV_s **0** ***k/ft***

Checks

Strength

ΦV_n	**10.5**	***k/ft***
C/D	**9.0**	**OK**

Rebar Layout Summary

Back Vertical	**# 5**	**@ 10.0 in.**
Front Vertical	**# 5**	**@ 10.0 in.**
Horizontal	**# 4**	**@ 10.0 in.**

Footing Design (OVT1)

Properties

Reinforcing

f_y	60	*ksi*
$Bar_{primary}$	6	
d_{bar}	0.75	*in*
A_{bar}	0.44	in^2
$Bar_{secondary}$	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2

Concrete

f'_c	4	*ksi*
γ_c	155	*pcf*
L	12	*in*
h	16	*in*
b_{total}	13.0	*ft*
b_{heel}	7.00	*ft*
b_{toe}	5.00	*ft*
cover	3	*in*
d	12.6	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	4096	in^4
γ_t	8.0	*in*

Soil

γ_{sat}	100	*pcf*	Assumed
C	250	*psf*	GeoEngineers Table 4
γ_{water}	62.4	*psf*	

Elevations

h_{flood}	15.2	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ foot}$	9.70	*ft*
$h_{bottom\ foot}$	8.37	*ft*
d_{water}	6.83	*ft*
d_{soil}	2.33	*ft*

Flexural Design - ACI Chapter 10

Demand Moment

conservatively neglect bearing resistance pressure

Strength Factors				
				ACI 9.2.1
Pressure (F)	1.4			
Dead (D)	1.4			
$M_{u\ heel}$	20.2	*k-ft/ft*		
$M_{u\ toe}$	5.4	*k-ft/ft*		
M_u	**20.2**	***k-ft/ft***		
$M_{s\ heel}$	14.4	*k-ft/ft*		
$M_{s\ toe}$	3.8	*k-ft/ft*		
M_s	**3.8**	***k-ft/ft***		

Minimum Reinforcement

ρ_{min}	0.002			ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft		
$A_{s\ min\ long}$	0.48	in^2/ft		ACI 10.5.1
f_s	7.4	*ksi*		conservative
$s_{max\ liong}$	64.9	*in*		ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.36	in^2/ft	ρ_{req}	0.00239
s_{req}	14.6	*in*		
s_{long}	**10**	***in***		
N_{bars}	1.2	*/ft*		
$A_{s\ long}$	0.53	in^2	ρ	0.00350
a	0.78	*in*		

Crack Control

s_{trans}	**12**	***in***		
$A_{s\ trans}$	0.31	in^2/ft	ρ	0.00160

Checks

Strength		
ΦM_n	**29.2**	***k-ft/ft***
C/D	**1.4**	**OK**
Serviceability		
$A_{s\ long} > A_{s\ min\ long}$	1.11	**OK**
$s_{long} < s_{max\ long}$	6.49	**OK**
$A_{s\ trans} > A_{s\ min\ trans}$	1.06	**OK**

Shear Design - ACI Chapter 11

Demand Shear *conservatively neglect bearing resistance pressure*

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$V_{u\ heel}$	5.8	*k/ft*	
$V_{u\ toe}$	2.1	*k/ft*	
V_u	**5.8**	***k/ft***	

Concrete Shear Strength

ΦV_c	**14.4**	***k/ft***	ACI 11.2.1.1

Steel Shear Strength

Not required			ACI 11.4.6
ΦV_s	**0**	***k/ft***	

Checks

Strength			
ΦV_n	**14.4**	***k/ft***	
C/D	**2.5**	**OK**	

Rebar Layout Summary

Primary	**# 6**	**@ 10.0 in.**
Secondary	**# 5**	**@ 10.0 in.**

Stability

Properties

Concrete

f'_c	4 *ksi*	
γ_c	155 *pcf*	
L_{unit}	1 *ft*	
h_{foot}	16 *in*	
b_{total}	13.0 *ft*	
b_{heel}	7.00 *ft*	
b_{toe}	5.00 *ft*	
t_{wall}	12 *in*	
h_{wall}	5.50 *ft*	

Soil

γ_{sat}	100 *pcf*	Assumed
C	250 *psf*	GeoEngineers Table 4
μ	0.6	GeoEngineers Table 4

Elevations

h_{flood}	15.2 *ft*
$h_{ground\ surface}$	10.7 *ft*
$h_{top\ foot}$	9.70 *ft*
$h_{bottom\ foot}$	8.37 *ft*
d_{water}	6.83 *ft*
d_{soil}	2.33 *ft*

Pressures

Flood Side Water

γ_{water}	62.4 *pcf*
$\sigma_{foot\ bot}$	426 *psf*
P_{water}	1.46 *k/ft*
$h_{P\text{-}water}$	2.28 *ft*

Active Earth

γ_{soil}	18 *psf*
$\sigma_{foot\ bot}$	42 *psf*
P_{soil}	0.05 *k/ft*
$h_{P\text{-}soil}$	0.78 *ft*

Protected Side Water

γ_{water}	62.4 *psf*
$\sigma_{foot\ bot}$	146 *psf*
P_{water}	0.17 *k/ft*
$h_{P\text{-}water}$	0.78 *ft*

Passive Earth

γ_{soil}	190 *psf*	
$\sigma_{foot\ bot}$	443 *psf*	
P_{soil}	0.52 *k/ft*	
$h_{P\text{-}soil}$	0.78 *ft*	

Water Under Footing

γ_{water}	62.4 *psf*	
$\sigma_{toe\ bot}$	146 *psf*	
$\sigma_{heel\ bot}$	426 *psf*	
P_{water}	3.72 *k/ft*	
$b_{P\text{-}water}$	7.56 *ft*	*From toe*

Overturning

Overturning Moments

Horizontal		
Flood Water	3.32 *k-ft/ft*	
Active Soil	0.04 *k-ft/ft*	
Vertical		
Footing Water	28.12 *k-ft/ft*	
	31.48 *k-ft/ft*	

Resisting Moments

Horizontal		
Protected Water	0.13 *k-ft/ft*	
Passive Soil	0.40 *k-ft/ft*	
Vertical		
Toe Soil	1.25 *k-ft/ft*	
Heel Soil	6.65 *k-ft/ft*	
Footing	17.46 *k-ft/ft*	
Wall	3.03 *k-ft/ft*	
Flood Water	14.74 *k-ft/ft*	
	43.66 *k-ft/ft*	

C/D	**1.39**	**OK**

Sliding

Driving

Active Soil	0.05 *k/ft*	
Flood Water	1.46 *k/ft*	
	1.51 *k/ft*	

Resisting

Passive Soil	0.52 *k/ft*	
Protected Water	0.17 *k/ft*	
Friction	1.79 *k/ft*	
	2.48 *k/ft*	

C/D	**1.65**	**OK**	
Required	**1.33**		USACE EM 1110-2-2502 Table 4-2

Bearing

Vertical Forces

Concrete	3.54	*k/ft*
Soil	1.20	*k/ft*
Water Weight	1.97	*k/ft*
Footing Water	-3.72	*k/ft*
P_{total}	2.99	*k/ft*

Moments about Bottom Center of Footing

Vertical		
Wall	-0.85	*k-ft/ft*
Heel Soil	2.10	*k-ft/ft*
Toe Soil	-2.00	*k-ft/ft*
Flood Water	5.90	*k-ft/ft*
Footing Water	-3.95	*k-ft/ft*
Horizontal		
Passive Soil	0.40	*k-ft/ft*
Active Soil	-0.04	*k-ft/ft*
Protected Water	0.13	*k-ft/ft*
Flood Water	-3.32	*k-ft/ft*
M_{total}	1.63	*k-ft/ft*

Resultant Location and Maximum Pressure

e	**0.55**	***ft***	
σ_{max}	**0.25**	***ksf***	AASHTO 11.6.3.2
Max e (+-)	3.25	*ft*	USACE EM 1110-2-2502 Table 4-2 & Figure 4-4
e C/D	**5.95**	**OK**	
Max σ	1.46	*ksf*	GeoEngineers Table 3
σ C/D	**5.82**	**OK**	
Required	**2.00**		USACE EM 1110-2-2502 Table 4-2

Planter Wall Design (OVT1)

Properties

Reinforcing

f_y	60	*ksi*
Bar_{front}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
Bar_{back}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
$Bar_{secondary}$	4	
d_{bar}	0.5	*in*
A_{bar}	0.20	in^2
Ties	4	
d_{bar}	0.50	*in*
A_{bar}	0.20	in^2

Concrete

f'_c	4	*ksi*
N_{walls}	2	
$s_{opening}$	6	*ft*
L_{unit}	12	*in*
t	12	*in*
h	5.50	*ft*
cover	2	*in*
d	9.2	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	1728	in^4
y_t	6.0	*in*

Soil

γ_{sat}	100	*pcf*	GeoEngineers Figure X1
S_u	250	*psf*	GeoEngineers Figure X1

Elevations

h_{flood}	15.2	*ft*
$h_{planter\ surface}$	9.70	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ wall}$	15.2	*ft*
$h_{bottom\ wall}$	9.70	*ft*
d_{water}	5.50	*ft*
$d_{planter\ soil}$	0.00	*ft*
d_{soil}	1.00	*ft*

Pressures

Flood Wall

Flood Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	343	*psf*
P_{water}	0.94	*k/ft*
$h_{P\text{-}water}$	1.83	*ft*

Active Earth

γ_{soil}	18	*psf*
$\sigma_{wall\ bot}$	18	*psf*
P_{soil}	0.01	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Planter Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{water}	0.00	*k/ft*
$h_{P\text{-}water}$	0.00	*ft*

Passive Planter Earth

γ_{soil}	190	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{soil}	0.00	*k/ft*
$h_{P\text{-}soil}$	0.00	*ft*

Protected Wall

Planter Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{water}	0.00	*k/ft*
$h_{P\text{-}water}$	0.00	*ft*

Active Planter Earth

γ_{soil}	33.5	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{soil}	0.00	*k/ft*
$h_{P\text{-}soil}$	0.00	*ft*

Protected Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	62	*psf*
P_{water}	0.03	*k/ft*
$h_{P\text{-}water}$	0.33	*ft*

Passive Exterior Earth

γ_{soil}	41	*psf*
$\sigma_{wall\ bot}$	41	*psf*
P_{soil}	0.02	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Flexural Design - ACI Chapter 10

Moment Demand

Strength Factors — ACI 9.2.1

Pressure (F)	1.4
Dead (D)	1.4

$M_{u\ front}$	2.4	*k-ft/ft*
$M_{u\ back}$	0.0	*k-ft/ft*
M_u	**2.4**	***k-ft/ft***
$M_{s\ front}$	1.7	*k-ft/ft*
$M_{s\ back}$	0.0	*k-ft/ft*
M_s	**1.7**	***k-ft/ft***

Minimum Reinforcement

ρ_{min}	0.002		ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft	
$A_{s\ min\ vert}$	0.35	in^2/ft	ACI 10.5.1
f_s	6.6	*ksi*	conservative
$s_{max\ vert}$	72.8	*in*	ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.06	in^2/ft	ρ_{req}	0.00053
s_{req}	62.4	*in*		
s_{vert}	**10**	***in***		
N_{bars}	1.20	*/ft*		
$A_{s\ vert}$	0.37	in^2	ρ	0.00334
a	0.54	*in*		

Crack Control

s_{trans}	**8**	***in***		
$A_{s\ trans}$	0.29	in^2/ft	ρ	0.00204

Checks

Strength

ΦM_n	**14.8**	***k-ft/ft***	
C/D	**6.1**	**OK**	0.164

Serviceability

$A_{s\ vert} > A_{s\ min\ vert}$	1.06	**OK**
$s_{vert} < s_{max\ vert}$	7.28	**OK**
$A_{s\ trans} > A_{s\ min\ trans}$	1.02	**OK**

Shear Design - ACI Chapter 11

Demand Shear

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$V_{u\ front}$	1.3	*k/ft*	
$V_{u\ back}$	-0.1	*k/ft*	
V_u	**1.3**	***k/ft***	

Concrete Shear Strength

ACI 11.2.1.1

ΦV_c	**10.5**	***k/ft***

Steel Shear Strength

Not required — ACI 11.4.6

ΦV_s	**0**	***k/ft***

Checks

Strength

ΦV_n	**10.5**	***k/ft***	
C/D	**7.8**	**OK**	0.128

Rebar Layout Summary

Back Vertical	**# 5**	**@ 10.0 in.**
Front Vertical	**# 5**	**@ 10.0 in.**
Horizontal	**# 4**	**@ 8.0 in.**

Planter Footing Design (OVT1)

Properties

Reinforcing

f_y	60	*ksi*
$Bar_{primary}$	6	
d_{bar}	0.75	*in*
A_{bar}	0.44	in^2
$Bar_{secondary}$	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2

Concrete

f'_c	4	*ksi*
γ_c	155	*pcf*
L	12	*in*
h	16	*in*
b_{total}	16	*ft*
b_{heel}	6.25	*ft*
$b_{planter}$	6	*ft*
b_{toe}	1.75	*ft*
cover	3	*in*
d	12.6	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	4096	in^4
y_t	8.0	*in*

Soil

γ_{sat}	100	*pcf*	Assumed
S_u	250	*psf*	GeoEngineers Table 4
γ_{water}	62.4	*psf*	

Elevations

h_{flood}	15.2	*ft*
$h_{planter\ surface}$	9.70	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ foot}$	9.70	*ft*
$h_{bottom\ foot}$	8.37	*ft*
d_{water}	6.83	*ft*
$d_{planter\ soil}$	0.00	*ft*
d_{soil}	2.33	*ft*

Flexural Design - ACI Chapter 10

Demand Moment

conservatively neglect bearing resistance pressure

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$M_{u\ heel}$	16.1	*k-ft/ft*	
$M_{u\ toe}$	0.7	*k-ft/ft*	
M_u	**16.1**	***k-ft/ft***	
$M_{s\ heel}$	11.5	*k-ft/ft*	
$M_{s\ toe}$	0.5	*k-ft/ft*	
M_s	**11.5**	***k-ft/ft***	

Minimum Reinforcement

ρ_{min}	0.002		ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft	
$A_{s\ min\ long}$	0.48	in^2/ft	ACI 10.5.1
f_s	22.1	*ksi*	conservative
$s_{max\ liong}$	19.6	*in*	ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.29	in^2/ft	ρ_{req}	0.00190
s_{req}	18.4	*in*		
s_{long}	**10**	***in***		
N_{bars}	1.2	*/ft*		
$A_{s\ long}$	0.53	in^2	ρ	0.00350
a	0.78	*in*		

Crack Control

s_{trans}	**12**	***in***		
$A_{s\ trans}$	0.31	in^2/ft	ρ	0.00160

Checks

Strength			AASHTO 5.7.3.2.2-1
ΦM_n	**29.2**	***k-ft/ft***	
C/D	**1.8**	**OK**	
Serviceability			
$A_{s\ long} > A_{s\ min\ long}$	1.11	**OK**	
$s_{long} < s_{max\ long}$	1.96	**OK**	
$A_{s\ trans} > A_{s\ min\ trans}$	1.06	**OK**	

Shear Design - ACI Chapter 11

Demand Shear *conservatively neglect bearing resistance pressure*

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$V_{u\ heel}$	5.1	*k/ft*	
$V_{u\ toe}$	0.8	*k/ft*	
V_u	**5.1**	***k/ft***	

Concrete Shear Strength

ΦV_c	**14.4**	***k/ft***	ACI 11.2.1.1

Steel Shear Strength

Not required			ACI 11.4.6
ΦV_s	**0**	***k/ft***	

Checks

Strength			
ΦV_n	**14.4**	***k/ft***	
C/D	**2.8**	**OK**	

Rebar Layout Summary

Primary	**# 6**	**@ 10.0 in.**
Secondary	**# 5**	**@ 10.0 in.**

Planter Stability

Properties

Concrete

f'_c	4	*ksi*	
γ_c	155	*pcf*	
L_{unit}	1	*ft*	
h_{foot}	16	*in*	
b_{total}	16	*ft*	
b_{heel}	6.25	*ft*	
$b_{planter}$	6	*ft*	
b_{toe}	1.75	*ft*	
t_{wall}	12	*in*	
h_{wall}	5.50	*ft*	

Soil

γ_{sat}	100	*pcf*	Assumed
S_u	250	*psf*	GeoEngineers Table 4
μ	0.6		GeoEngineers Table 4

Elevations

h_{flood}	15.2	*ft*	
$h_{planter\ surface}$	9.70	*ft*	
$h_{ground\ surface}$	10.7	*ft*	
$h_{top\ foot}$	9.70	*ft*	
$h_{bottom\ foot}$	8.37	*ft*	
d_{water}	6.83	*ft*	
$d_{planter\ soil}$	3.00	*ft*	Conservative: available depth = 5.5'
d_{soil}	2.33	*ft*	

Pressures

Flood Wall

Flood Side Water

γ_{water}	62.4	*pcf*
$\sigma_{wall\ bot}$	426	*psf*
P_{water}	1.46	*k/ft*
$h_{P\text{-}water}$	2.28	*ft*

Active Earth

γ_{soil}	18	*psf*
$\sigma_{wall\ bot}$	42	*psf*
P_{soil}	0.05	*k/ft*
$h_{P\text{-}soil}$	0.78	*ft*

Planter Side Water

γ_{water}	62.4 *psf*	
$\sigma_{wall\ bot}$	187 *psf*	
P_{water}	0.28 *k/ft*	
$h_{P\text{-}water}$	2.33 *ft*	

Passive Planter Earth

γ_{soil}	190 *psf*	
$\sigma_{wall\ bot}$	570 *psf*	
P_{soil}	0.86 *k/ft*	
$h_{P\text{-}soil}$	2.33 *ft*	

Protected Wall

Planter Side Water

γ_{water}	62.4 *psf*	
$\sigma_{wall\ bot}$	187 *psf*	
P_{water}	0.28 *k/ft*	
$h_{P\text{-}water}$	2.33 *ft*	

Active Planter Earth

γ_{soil}	18 *psf*	
$\sigma_{wall\ bot}$	54 *psf*	
P_{soil}	0.08 *k/ft*	
$h_{P\text{-}soil}$	2.33 *ft*	

Protected Side Water

γ_{water}	62.4 *psf*	
$\sigma_{wall\ bot}$	146 *psf*	
P_{water}	0.17 *k/ft*	
$h_{P\text{-}water}$	0.78 *ft*	

Passive Exterior Earth

γ_{soil}	190 *psf*	
$\sigma_{wall\ bot}$	443 *psf*	
P_{soil}	0.52 *k/ft*	
$h_{P\text{-}soil}$	0.78 *ft*	

Footing

Water Under Footing

γ_{water}	62.4 *psf*	
$\sigma_{toe\ bot}$	146 *psf*	
$\sigma_{heel\ bot}$	426 *psf*	
P_{water}	4.58 *k/ft*	
$b_{P\text{-}water}$	9.31 *ft*	*From toe*

Overturning

Overturning Moments

Horizontal		
Flood Water	3.32	*k-ft/ft*
Active Soil	0.04	*k-ft/ft*
Vertical		
Footing Water	42.60	*k-ft/ft*
	45.95	***k-ft/ft***

Resisting Moments

Horizontal		
Protected Water	0.13	*k-ft/ft*
Passive Soil	0.40	*k-ft/ft*
Vertical		
Toe Soil	0.15	*k-ft/ft*
Planter Soil	10.35	*k-ft/ft*
Heel Soil	8.05	*k-ft/ft*
Footing	26.45	*k-ft/ft*
Walls	9.80	*k-ft/ft*
Water	7.43	*k-ft/ft*
	62.77	***k-ft/ft***

C/D	**1.37**	**OK**

Sliding

Driving

Active Soil	0.05	*k/ft*
Flood Water	1.46	*k/ft*
	1.51	***k/ft***

Resisting

Passive Soil	0.52	*k/ft*
Protected Water	0.17	*k/ft*
Friction	2.87	*k/ft*
	3.56	***k/ft***

C/D	**2.37**	**OK**	
Required	**1.33**		USACE EM 1110-2-2502 Table 4-2

Bearing

Vertical Forces

Concrete	5.01	*k/ft*
Soil	2.60	*k/ft*
Water Weight	1.76	*k/ft*
Footing Water	-4.58	*k/ft*
P_{total}	4.79	*k/ft*

Moments about Bottom Center of Footing

Vertical		
Walls	-3.84	*k-ft/ft*
Heel Soil	3.05	*k-ft/ft*
Planter Soil	-4.05	*k-ft/ft*
Toe Soil	-1.25	*k-ft/ft*
Flood Water	8.56	*k-ft/ft*
Footing Water	-5.99	*k-ft/ft*
Horizontal		
Passive Soil	0.40	*k-ft/ft*
Active Soil	-0.04	*k-ft/ft*
Protected Water	0.13	*k-ft/ft*
Flood Water	-3.32	*k-ft/ft*
M_{total}	6.34	*k-ft/ft*

Resultant Location and Maximum Pressure

e	**1.32**	***ft***	
σ_{max}	**0.36**	***ksf***	AASHTO 11.6.3.2
Max e (+-)	4.00	*ft*	USACE EM 1110-2-2502 Table 4-2 & Figure 4-4
e C/D	**3.02**	**OK**	
Max σ	1.46	*ksf*	Geotech email
σ C/D	**4.07**	**OK**	
Required	**2.00**		USACE EM 1110-2-2502 Table 4-2

Concrete Flood Wall - Water to Top of Wall (OVT1) - Planter Empty

(Check that planter remains stable if empty)

Single Stem T-Wall Design

Dimensions

Wall Height	5.50	*ft*
Depth to T/Ftg	12	*in*
Wall Thickness	12	*in*
Footing Width	13	*ft*
Toe Width	5	*ft*
Heel Width	7.00	*ft*
Footing Thickness	16	*in*

Rebar	**Size**	**Spacing**	
Footing Primary	6	10	*in*
Footing Secondary	5	12	*in*
Wall Front	5	10	*in*
Wall Back	5	10	*in*
Wall Secondary	4	8	*in*

Design Flood (3.5' for DWL, 4.5' for OVT1)

Flood depth	4.5	*ft*

Depths to Bottom of Footing

Depth to Ftg Bot	2.33	*ft*
Flood Level	6.83	*ft*
Top of Wall	6.83	*ft*

Soil

Active	18	*psf/ft*
Passive	190	*psf/ft*
Bearing Capacity	1.46	*ksf*
Saturated Density	100	*pcf*
Cohesion	250	*psf*
Friction Coefficient	0.6	

Design C/D's		**Required**	
Wall Flexure	**6.24**	1	
Wall Shear	**9.04**	1	
Wall Steel	**1.02**	1	
Footing Flexure	**1.45**	1	
Footing Shear	**2.50**	1	
Footing Steel	**1.06**	1	
Overturning	**1.39**	1.33	EM Tbl 4-2
Sliding	**1.65**	1.33	EM Tbl 4-2
Bearing	**5.82**	2	EM Tbl 4-2

2-Stem (Planter) T-Wall Design

Dimensions

Wall Height	5.50	*ft*
Depth to T/Ftg	12	*in*
Wall Thickness	12	*in*
Footing Width	16	*ft*
Toe Width	1.75	*ft*
Planter Width	6	*ft*
Heel Width	6.25	*ft*
Footing Thickness	16	*in*

Rebar	**Size**	**Spacing**	
Footing Primary	6	10	*in*
Footing Secondary	5	12	*in*
Wall Front	5	10	*in*
Wall Back	5	10	*in*
Wall Secondary	4	8	*in*

Design Flood (3.5' for DWL, 4.5' for OVT1)

Flood depth	4.5	*ft*

Depths to Bottom of Footing

Depth to Ftg Bot	2.33	*ft*	
Planter Level	1.33	*ft*	(empty)
Flood Level	6.83	*ft*	
Top of Wall	6.83	*ft*	

Soil Pressures

Active	18	*psf/ft*
Passive	190	*psf/ft*
Bearing Capacity	1.46	*ksf*
Saturated Density	100	*pcf*
Cohesion	250	*psf*
Friction Coefficient	0.6	

Design C/D's		**Required**	
Wall Flexure	**6.08**	1	
Wall Shear	**7.84**	1	
Wall Steel	**1.02**	1	
Footing Flexure	**1.82**	1	
Footing Shear	**2.80**	1	
Footing Steel	**1.06**	1	
Overturning	**1.14**	1.1	See note.
Sliding	**1.65**	1.33	EM Tbl 4-2
Bearing	**7.06**	2	EM Tbl 4-2

Strength design (wall and footing flexure, shear, and steel) was done using ACI 318-11. Stability checks (overturning, sliding, and bearing) were done using the US Army Corps of Engineers Retaining and Flood Walls Engineer Manual 1110-2-2502. Overturning considers both overturning moments and reaction resultant location.

Note: The planter two wall case assumes planter is empty of soil. Required overturning factor of safety assumed equal to 1.1 for this extreme case.

Planter Wall Design (Planter Empty - OVT1)

Properties

Reinforcing

f_y	60	*ksi*
Bar_{front}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
Bar_{back}	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2
$Bar_{secondary}$	4	
d_{bar}	0.5	*in*
A_{bar}	0.20	in^2
Ties	4	
d_{bar}	0.50	*in*
A_{bar}	0.20	in^2

Concrete

f'_c	4	*ksi*
N_{walls}	2	
$s_{opening}$	6	*ft*
L_{unit}	12	*in*
t	12	*in*
h	5.50	*ft*
cover	2	*in*
d	9.2	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	1728	in^4
y_t	6.0	*in*

Soil

γ_{sat}	100	*pcf*	GeoEngineers Figure X1
S_u	250	*psf*	GeoEngineers Figure X1

Elevations

h_{flood}	15.2	*ft*
$h_{planter\ surface}$	9.70	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ wall}$	15.2	*ft*
$h_{bottom\ wall}$	9.70	*ft*
d_{water}	5.50	*ft*
$d_{planter\ soil}$	0.00	*ft*
d_{soil}	1.00	*ft*

Pressures

Flood Wall

Flood Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	343	*psf*
P_{water}	0.94	*k/ft*
$h_{P\text{-}water}$	1.83	*ft*

Active Earth

γ_{soil}	18	*psf*
$\sigma_{wall\ bot}$	18	*psf*
P_{soil}	0.01	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Planter Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{water}	0.00	*k/ft*
$h_{P\text{-}water}$	0.00	*ft*

Passive Planter Earth

γ_{soil}	190	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{soil}	0.00	*k/ft*
$h_{P\text{-}soil}$	0.00	*ft*

Protected Wall

Planter Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{water}	0.00	*k/ft*
$h_{P\text{-}water}$	0.00	*ft*

Active Planter Earth

γ_{soil}	33.5	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{soil}	0.00	*k/ft*
$h_{P\text{-}soil}$	0.00	*ft*

Protected Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	62	*psf*
P_{water}	0.03	*k/ft*
$h_{P\text{-}water}$	0.33	*ft*

Passive Exterior Earth

γ_{soil}	41	*psf*
$\sigma_{wall\ bot}$	41	*psf*
P_{soil}	0.02	*k/ft*
$h_{P\text{-}soil}$	0.33	*ft*

Flexural Design - ACI Chapter 10

Moment Demand

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$M_{u\ front}$	2.4	*k-ft/ft*	
$M_{u\ back}$	0.0	*k-ft/ft*	
M_u	**2.4**	***k-ft/ft***	
$M_{s\ front}$	1.7	*k-ft/ft*	
$M_{s\ back}$	0.0	*k-ft/ft*	
M_s	**1.7**	***k-ft/ft***	

Minimum Reinforcement

ρ_{min}	0.002		ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft	
$A_{s\ min\ vert}$	0.35	in^2/ft	ACI 10.5.1
f_s	6.6	*ksi*	conservative
$s_{max\ vert}$	72.8	*in*	ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.06	in^2/ft	ρ_{req}	0.00053
s_{req}	62.4	*in*		
s_{vert}	**10**	***in***		
N_{bars}	1.20	*/ft*		
$A_{s\ vert}$	0.37	in^2	ρ	0.00334
a	0.54	*in*		

Crack Control

s_{trans}	**8**	***in***		
$A_{s\ trans}$	0.29	in^2/ft	ρ	0.00204

Checks

Strength			
ΦM_n	**14.8**	***k-ft/ft***	
C/D	**6.1**	**OK**	0.164
Serviceability			
$A_{s\ vert} > A_{s\ min\ vert}$	1.06	**OK**	
$s_{vert} < s_{max\ vert}$	7.28	**OK**	
$A_{s\ trans} > A_{s\ min\ trans}$	1.02	**OK**	

Shear Design - ACI Chapter 11

Demand Shear

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$V_{u\ front}$	1.3	*k/ft*	
$V_{u\ back}$	-0.1	*k/ft*	
V_u	**1.3**	***k/ft***	

Concrete Shear Strength

ACI 11.2.1.1

ΦV_c	**10.5**	***k/ft***

Steel Shear Strength

Not required — ACI 11.4.6

ΦV_s	**0**	***k/ft***

Checks

Strength

ΦV_n	**10.5**	***k/ft***	
C/D	**7.8**	**OK**	0.128

Rebar Layout Summary

Back Vertical	**# 5**	**@ 10.0 in.**
Front Vertical	**# 5**	**@ 10.0 in.**
Horizontal	**# 4**	**@ 8.0 in.**

Planter Footing Design (Planter Empty - OVT1)

Properties

Reinforcing

f_y	60	*ksi*
$Bar_{primary}$	6	
d_{bar}	0.75	*in*
A_{bar}	0.44	in^2
$Bar_{secondary}$	5	
d_{bar}	0.625	*in*
A_{bar}	0.31	in^2

Concrete

f'_c	4	*ksi*
γ_c	155	*pcf*
L	12	*in*
h	16	*in*
b_{total}	16	*ft*
b_{heel}	6.25	*ft*
$b_{planter}$	6	*ft*
b_{toe}	1.75	*ft*
cover	3	*in*
d	12.6	*in*
Φ Flexure	0.9	
Φ Shear	0.75	
β_1	0.85	
λ	1	
ρ_b	0.0285	
I_g	4096	in^4
γ_t	8.0	*in*

Soil

γ_{sat}	100	*pcf*	Assumed
S_u	250	*psf*	GeoEngineers Table 4
γ_{water}	62.4	*psf*	

Elevations

h_{flood}	15.2	*ft*
$h_{planter\ surface}$	9.70	*ft*
$h_{ground\ surface}$	10.7	*ft*
$h_{top\ foot}$	9.70	*ft*
$h_{bottom\ foot}$	8.37	*ft*
d_{water}	6.83	*ft*
$d_{planter\ soil}$	0.00	*ft*
d_{soil}	2.33	*ft*

Flexural Design - ACI Chapter 10

Demand Moment

conservatively neglect bearing resistance pressure

Strength Factors				
				ACI 9.2.1
Pressure (F)	1.4			
Dead (D)	1.4			
$M_{u\ heel}$	16.1	*k-ft/ft*		
$M_{u\ toe}$	0.7	*k-ft/ft*		
M_u	**16.1**	***k-ft/ft***		
$M_{s\ heel}$	11.5	*k-ft/ft*		
$M_{s\ toe}$	0.5	*k-ft/ft*		
M_s	**11.5**	***k-ft/ft***		

Minimum Reinforcement

ρ_{min}	0.002			ACI 14.3.3
$A_{s\ min\ trans}$	0.29	in^2/ft		
$A_{s\ min\ long}$	0.48	in^2/ft		ACI 10.5.1
f_s	22.1	*ksi*		conservative
$s_{max\ liong}$	19.6	*in*		ACI 10.6.4

Flexure Strength

$A_{s\ req}$	0.29	in^2/ft	ρ_{req}	0.00190
s_{req}	18.4	*in*		
s_{long}	**10**	***in***		
N_{bars}	1.2	*/ft*		
$A_{s\ long}$	0.53	in^2	ρ	0.00350
a	0.78	*in*		

Crack Control

s_{trans}	**12**	***in***		
$A_{s\ trans}$	0.31	in^2/ft	ρ	0.00160

Checks

Strength			AASHTO 5.7.3.2.2-1
ΦM_n	**29.2**	***k-ft/ft***	
C/D	**1.8**	**OK**	
Serviceability			
$A_{s\ long} > A_{s\ min\ long}$	1.11	**OK**	
$s_{long} < s_{max\ long}$	1.96	**OK**	
$A_{s\ trans} > A_{s\ min\ trans}$	1.06	**OK**	

Shear Design - ACI Chapter 11

Demand Shear *conservatively neglect bearing resistance pressure*

Strength Factors			ACI 9.2.1
Pressure (F)	1.4		
Dead (D)	1.4		
$V_{u\ heel}$	5.1	*k/ft*	
$V_{u\ toe}$	0.8	*k/ft*	
V_u	**5.1**	***k/ft***	

Concrete Shear Strength

ΦV_c	**14.4**	***k/ft***	ACI 11.2.1.1

Steel Shear Strength

Not required			ACI 11.4.6
ΦV_s	**0**	***k/ft***	

Checks

Strength			
ΦV_n	**14.4**	***k/ft***	
C/D	**2.8**	**OK**	

Rebar Layout Summary

Primary	**# 6**	**@ 10.0 in.**
Secondary	**# 5**	**@ 10.0 in.**

Planter Stability — Planter Empty (OVT1)

Properties

Concrete

f'_c	4 *ksi*	
γ_c	155 *pcf*	
L_{unit}	1 *ft*	
h_{foot}	16 *in*	
b_{total}	16 *ft*	
b_{heel}	6.25 *ft*	
$b_{planter}$	6 *ft*	
b_{toe}	1.75 *ft*	
t_{wall}	12 *in*	
h_{wall}	5.50 *ft*	

Soil

γ_{sat}	100 *pcf*	Assumed
S_u	250 *psf*	GeoEngineers Table 4
μ	0.6	GeoEngineers Table 4

Elevations

h_{flood}	15.2 *ft*
$h_{planter\ surface}$	9.70 *ft*
$h_{ground\ surface}$	10.7 *ft*
$h_{top\ foot}$	9.70 *ft*
$h_{bottom\ foot}$	8.37 *ft*
d_{water}	6.83 *ft*
$d_{planter\ soil}$	0.00 *ft*
d_{soil}	2.33 *ft*

Pressures

Flood Wall

Flood Side Water

γ_{water}	62.4 *pcf*
$\sigma_{wall\ bot}$	426 *psf*
P_{water}	1.46 *k/ft*
$h_{P\text{-}water}$	2.28 *ft*

Active Earth

γ_{soil}	18 *psf*
$\sigma_{wall\ bot}$	42 *psf*
P_{soil}	0.05 *k/ft*
$h_{P\text{-}soil}$	0.78 *ft*

Planter Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{water}	0.00	*k/ft*
$h_{P\text{-}water}$	1.33	*ft*

Passive Planter Earth

γ_{soil}	190	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{soil}	0.00	*k/ft*
$h_{P\text{-}soil}$	1.33	*ft*

Protected Wall

Planter Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{water}	0.00	*k/ft*
$h_{P\text{-}water}$	1.33	*ft*

Active Planter Earth

γ_{soil}	18	*psf*
$\sigma_{wall\ bot}$	0	*psf*
P_{soil}	0.00	*k/ft*
$h_{P\text{-}soil}$	1.33	*ft*

Protected Side Water

γ_{water}	62.4	*psf*
$\sigma_{wall\ bot}$	146	*psf*
P_{water}	0.17	*k/ft*
$h_{P\text{-}water}$	0.78	*ft*

Passive Exterior Earth

γ_{soil}	190	*psf*
$\sigma_{wall\ bot}$	443	*psf*
P_{soil}	0.52	*k/ft*
$h_{P\text{-}soil}$	0.78	*ft*

Footing

Water Under Footing

γ_{water}	62.4	*psf*	
$\sigma_{toe\ bot}$	146	*psf*	
$\sigma_{heel\ bot}$	426	*psf*	
P_{water}	4.58	*k/ft*	
$b_{P\text{-}water}$	9.31	*ft*	*From toe*

Overturning

Overturning Moments

Horizontal		
Flood Water	3.32	*k-ft/ft*
Active Soil	0.04	*k-ft/ft*
Vertical		
Footing Water	42.60	*k-ft/ft*
	45.95	***k-ft/ft***

Resisting Moments

Horizontal		
Protected Water	0.13	*k-ft/ft*
Passive Soil	0.40	*k-ft/ft*
Vertical		
Toe Soil	0.15	*k-ft/ft*
Planter Soil	0.00	*k-ft/ft*
Heel Soil	8.05	*k-ft/ft*
Footing	26.45	*k-ft/ft*
Walls	9.80	*k-ft/ft*
Water	7.43	*k-ft/ft*
	52.42	***k-ft/ft***

C/D	**1.14**	**OK**

Sliding

Driving

Active Soil	0.05	*k/ft*
Flood Water	1.46	*k/ft*
	1.51	***k/ft***

Resisting

Passive Soil	0.52	*k/ft*
Protected Water	0.17	*k/ft*
Friction	1.79	*k/ft*
	2.48	***k/ft***

C/D	**1.65**	**OK**	
Required	**1.33**		USACE EM 1110-2-2502 Table 4-2

Bearing

Vertical Forces

Concrete	5.01	*k/ft*
Soil	0.80	*k/ft*
Water Weight	1.76	*k/ft*
Footing Water	-4.58	*k/ft*
P_{total}	2.99	*k/ft*

Moments about Bottom Center of Footing

Vertical		
Walls	-3.84	*k-ft/ft*
Heel Soil	3.05	*k-ft/ft*
Planter Soil	0.00	*k-ft/ft*
Toe Soil	-1.25	*k-ft/ft*
Flood Water	8.56	*k-ft/ft*
Footing Water	-5.99	*k-ft/ft*
Horizontal		
Passive Soil	0.40	*k-ft/ft*
Active Soil	-0.04	*k-ft/ft*
Protected Water	0.13	*k-ft/ft*
Flood Water	-3.32	*k-ft/ft*
M_{total}	2.29	*k-ft/ft*

Resultant Location and Maximum Pressure

e	**0.77**	***ft***	
σ_{max}	**0.21**	***ksf***	AASHTO 11.6.3.2
Max e (+-)	4.00	*ft*	USACE EM 1110-2-2502 Table 4-2 & Figure 4-4
e C/D	**5.22**	**OK**	
Max σ	1.46	*ksf*	Geotech email
σ C/D	**7.06**	**OK**	
Required	**2.00**		USACE EM 1110-2-2502 Table 4-2

SEISMIC, WIND AND SOIL LOAD CONDITIONS

This section checks flood wall dimensions and reinforcing determined in the “Design Flood Condition” calculations for Reaches 1, 3 and 6, for load combinations that don’t include flood loads.

The following loads are considered for the wind condition:

- Dead
- Soil
- Wind

The following loads are considered for the soil only condition:

- Dead
- Soil

The following loads are considered for the seismic condition:

- Dead
- Soil
- Seismic

Discussion

By inspection, none of these load conditions controls over the flood condition. It is apparent from inspection of the footing sizes determined for the flood condition that neither wind nor seismic forces would require such wide footings for such a short wall.

However, for completeness, the following pages contain checks of the typical “T” wall for wind and seismic forces. These checks are accomplished by comparing the wind and seismic driving forces to those calculated for the flood conditions. It is found that flood loads exceed wind and seismic loads.

In addition, note that the hydrostatic uplift on the footing that occurs in the flood condition has a large effect on required footing size. Since this hydrostatic uplift doesn’t occur in the wind or seismic conditions, this makes those conditions even less severe compared to the flood condition than the simple comparison of driving forces shown on the following pages indicates.

Also, note that lower factors of safety would be required for the seismic condition than for the flood condition by EM 1110-2-2502 Table 4-2.

By inspection, the soil only condition won’t control because the soil active and passive forces are small compared to the flood forces.

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project NORTH LEVEE	by TE	sheet no.
location ABERDEEN	date 3/7/16	
client		job no.

WIND FORCE

CONSERVATIVELY USE 30 PSF PER EM 1110-2-2502 SECTION 3-25

$V = 4.5' (30\ PSF) = 135\ PLF$

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project | by BE | sheet no.
location | date 3/7/15
client | job no.

SEISMIC FORCE

PER ASCE 7-10

SITE CLASS - ASSUME CLASS E (SOFT CLAY)

$S_s = 1.5$ PER ASCE FIG 22-1

$F_a = 1.0$ PER ASCE TABLE 11.4-1

$S_{MS} = F_a S_s = 1.0(1.5) = 1.5$

$S_{DS} = \frac{2}{3} S_{MS} = 1.0$

$V = 0.30 S_{DS} W I_e$ PER ASCE 15.4-5

WHERE:

$W = 1' (155 \text{ PLF})(4.5') = 698 \text{ PLF}$

(1' ↑ WALL THICKNESS; 4.5' ↑ WALL HEIGHT)

$I_e = 1.25$ (RISK CATEGORY III) PER TABLE 1.5-2

"SUBSTANTIAL RISK TO HUMAN LIFE"

$V_u = 0.30(1.0)\,698 \text{ PLF}\,(1.25) = 262 \text{ PLF}$ ULTIMATE

TO CONVERT TO WORKING LEVEL TO COMPARE WITH OTHER FORCES, MULTIPLY BY 0.7 PER ASCE 2.4.1

$V = 0.7 V_u = 262 \text{ PLF}(0.7) = \underline{183 \text{ PLF}}$ FOR WALL MASS

SEISMIC ACTIVE PRESSURE FOR SOIL AT FOOTING LEVEL WILL BE NEGLIGIBLE

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project	by BE	sheet no.
location	date 8/7/15	
client		job no.

HYDROSTATIC

COMPUTE HYDROSTATIC ABOVE GROUND LEVEL ONLY (CONSERVATIVE)

$V = 62.4\ PCF \left(3.5'\right)\left(\frac{3.5'}{2}\right) = 382\ PLF$

→ GREATER THAN { WIND = 135 PLF ; SEISMIC = 183 PLF

∴ HYDROSTATIC CONTROLS