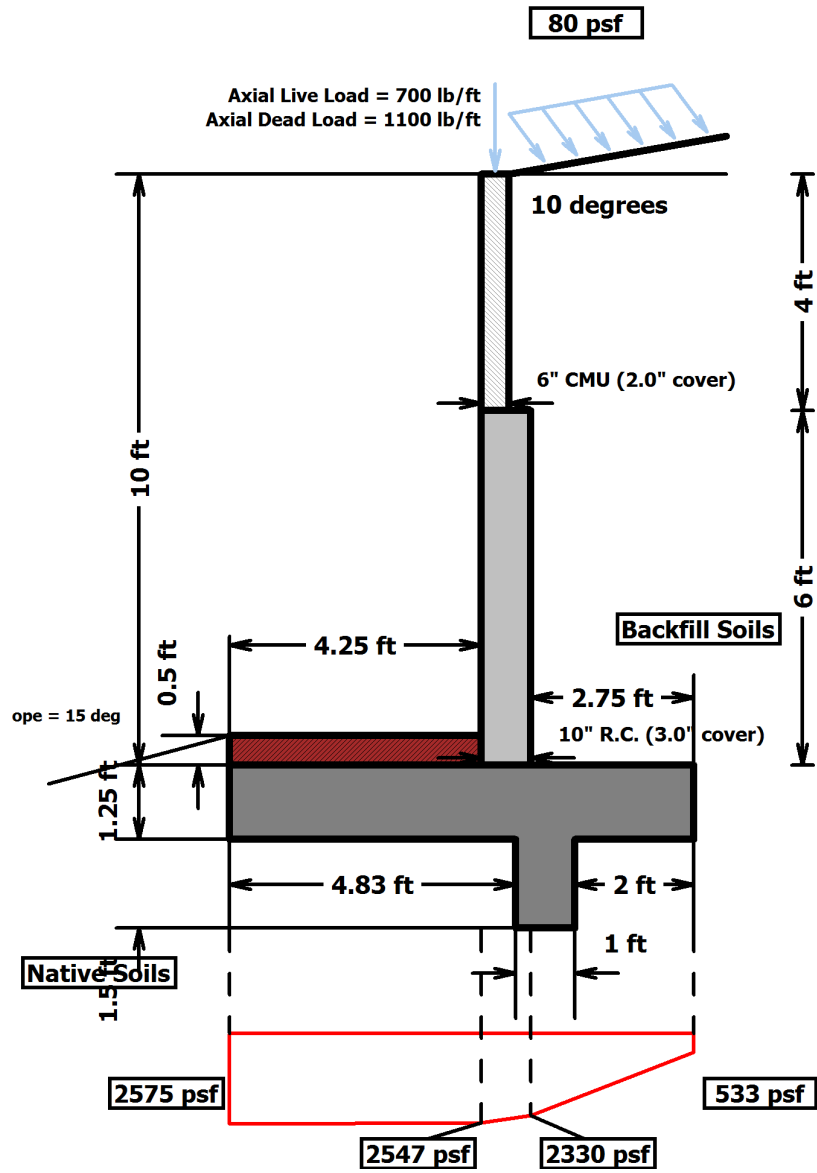


# Cantilever or Restrained Retaining Wall Calculations

Organization: F.E.C.  
 Project Name: Example Report  
 Design by: LAA  
 Job #: 9876  
 Date: 10/21/2013



Codes used: 2010 & 2013 CBC, 2009 & 2012 IBC, ACI 318-08 & 318-11, ACI 530-11



## Input Parameters

### General Data

Number of stem sections	2
Top Restrained	No
Concrete Unit Weight	150 pcf
Rebar Strength (Fy)	60.00 ksi

### Backfill Soils

Friction Angle	33.00 degrees
Slope Backfill Angle	10.00 degrees
Unit Weight	115.0 pcf
Allow Bear. Capacity	3500 psf
Uniform Vert. Surcharge	80.0 psf
Wall Height (Stem+Foot.)	11.25 ft
Seismic Kh	0.22 g
Overconsol. Ratio (OCR)	1.50

### Passive Soils

Soil Cohesion	450.00 psf
Unit Weight	115.00 pcf
Passive Friction Angle	29.50 degrees
Ignore Passive Ht.	1.00 ft
Passive Slope Angle	15.00 degrees
Passive F.S.	1.33

### Stem Section Design - Top

Stem Type	Masonry
Masonry Strength (f'm)	1.80 ksi
Height	4.00 ft
Section Size	6 in
Axial Live Load	700 lb/ft
Axial Dead Load	1100 lb/ft

### Reinforcement

Vert. Bar Size	#5
Rebar Cover	2.0 in
Vert. Spacing	8.0 in
Hor. Bar Size	#5
Exposed Side Spacing	12.0 in

### Stem Section Design - Bottom

Stem Type	Concrete
Concrete Strength (f'c)	3.00 ksi
Height	6.00 ft
Stem Width	10.00 in

### Reinforcement

Vert. Bar Size	#5
Rebar Cover	3.0 in
Vert. Spacing	6.0 in
Hor. Bar Size	#5
Exposed Side Spacing	12.0 in

### Footing Dimensions

Heel Width	2.75 ft
Stem Width Bottom	0.83 ft
Toe Width	4.25 ft
Footing Thickness	1.25 ft
Tot. Footing Width	7.83 ft
Footing Soil Cover	0.50 ft
Concrete Strength (f'c)	3.50 ksi
Sliding Restraint at the Toe	No

### Lateral and Surcharge Loads

Additional Lat. Load	150.00 lb/ft
Height From Stem Top	7.00 ft
Stem + Footing Height	11.25 ft
Surcharge Influence (Is)	16.88 ft
Strip Load (Qs)	0.25 ksf
Dist. to Load Begin (x1)	12.00 ft
Dist. to Load End (x2)	13.50 ft
Line Load (Ql)	0.33 kips/ft
Dist. to Line Load (x)	9.33 ft
Point Load (Qp)	1.67 kips
Dist. to Point Load (x)	11.25 ft

### Base Shear Keyway

Distance from Toe	4.83 ft
Keyway Embedment	1.50 ft
Keyway Width	1.00 ft
Keyway Vert. Bar	#5
Vert. Bar Spacing	12.0 in
Rebar Cover	1.5 in

### Heel Reinforcement

Rebar Size	#5
Rebar Spacing	12.0 in
Rebar Cover	2.0 in

### Toe Reinforcement

Rebar Size	#5
Rebar Spacing	12.0 in
Rebar Cover	3.0 in

### Shrinkage and Temperature Reinforcement

S & T Rebar Size	#4
Number of rebars	6
Rebar Spacing	17.6 in

**Max. spacing is 18.0 in**

### Footing Settlement

Poisson's ratio	0.30
Elastic Soil Modulus	900000 psf
Vert. Subgrade Modulus	150 ton/ft^3

## Analysis and Design Results

### Earth Pressures

Active Earth Pressure Coeff.	0.307
Passive Resistance Coeff.	1.834
Earth Press. - Horiz. Comp.	2474.06 lb
Earth Press. - Vert. Comp.	479.64 lb
Uniform Surcharge Comp.	288.62 lb
Passive Resist. Comp.	1142.79 lb
Equiv. Fluid Pressure Active	35.4 psf/ft
Equiv. Fluid Resistance Passive	158.6 psf/ft
Seismic Pressure Component	1200.76 lb
Sliding Friction Coefficient	0.36

### Retaining Wall Stability

#### Overtuning F.S. Results

Overtuning Moment	17749.75 lb-ft
Resisting Moment	54533.87 lb-ft
F.S. against Overtuning	3.07

#### Sliding F.S. Results

Sliding Force	4368.84 lb
Resisting Force	9806.92 lb
F.S. against Sliding	2.24

### Footing Pressures

Resultant Loc. from Toe	3.04 ft
<b>Resultant in middle third</b>	
Toe Bearing Pressure	2575 psf
Heel Bearing Pressure	533 psf
Max. Bearing Pressure	2575 psf

### Lateral and Surcharge Loads

Additional Lateral Load	150.00 lb/ft
Height From Stem Top	7.00 ft
Strip Load Thrust	104.55 lb/ft
Strip Resultant	6.61 ft
Line Load Thrust	125.06 lb/ft
Line Resultant	6.10 ft
Point Load Thrust	25.79 lb/ft
Point Resultant	7.16 ft
Total Lateral Thrust	405.40 lb/ft
Total Resultant from Stem Top	6.63 ft

### Footing Settlement

Average Bearing Pressure	1996 psf
Distortion Settlement	0.40 in
Consolidation Settlement	0.48 in
Total Settlement	0.88 in

#### Settlement OK

Stronger soil over weaker layer or vice-versa are not considered

### Stem Sections - Top

#### Flexure

Moment Demand (Mu)	1147 lb-ft
Moment Capacity (PhiMn)	5242 lb-ft
Rho Min. Vertical	0.0000
Actual Rho Vertical	0.0069
Vert. Steel Rebar Used	#5 @ 8.0
Area of Steel - Vertical	0.46 in^2
Rho Min. Horizontal	0.0020
Actual Rho Horizontal	0.0046
Horiz. Steel Rebar Used	#5 @ 12.0
Area of Steel - Horizontal	0.31 in^2

#### Shear

Shear Demand (Vu)	781 lb
Shear Capacity (PhiVc)	5710 lb

### Stem Sections - Bottom

#### Flexure

Moment Demand (Mu)	15752 lb-ft
Moment Capacity (PhiMn)	16962 lb-ft
Rho Min. Vertical	0.0018
Actual Rho Vertical	0.0052
Vert. Steel Rebar Used	#5 @ 6.0
Area of Steel - Vertical	0.62 in^2
Rho Min. Horizontal	0.0020
Actual Rho Horizontal	0.0026
Horiz. Steel Rebar Used	#5 @ 12.0
Area of Steel - Horizontal	0.31 in^2

#### Shear

Shear Demand (Vu)	4506 lb
Shear Capacity (PhiVc)	6593 lb

### Heel Design

#### Flexure

Moment Demand (Mu)	5496 lb-ft
Moment Capacity (PhiMn)	17336 lb-ft
Rho Min. Heel	0.0018
Rho Max. Heel	0.0187
Actual Rho Used	0.0020
Heel Steel Used	#5 @ 12.0
Heel Area of Steel	0.31 in^2

#### Shear

Shear Demand (Vu)	7837 lb
Shear Capacity (PhiVn)	13511 lb

### Toe Design

#### Flexure

Moment Demand (Mu)	12019 lb-ft
Moment Capacity (PhiMn)	15941 lb-ft
Rho Min. Toe	0.0018
Rho Max. Toe	0.0187
Actual Rho Used	0.0022
Toe Steel Used	#5 @ 12.0
Toe Area of Steel	0.31 in^2

#### Shear

Shear Demand (Vu)	3430 lb
Shear Capacity (PhiVn)	12446 lb

### Stem - Top of Footing Shear Key

Bearing Stress (10% f'c)	350 psi
Pure Shear Stress	101 psi
Required Key Width	2.0 in
Required Key Depth	0.7 in

### Stem Wall Deflection

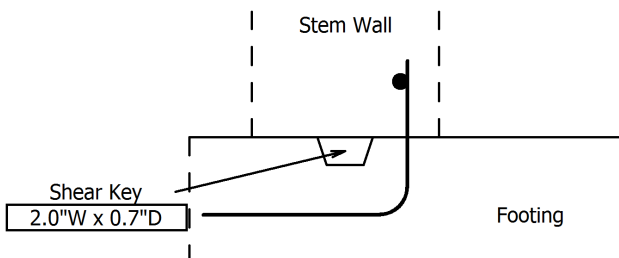
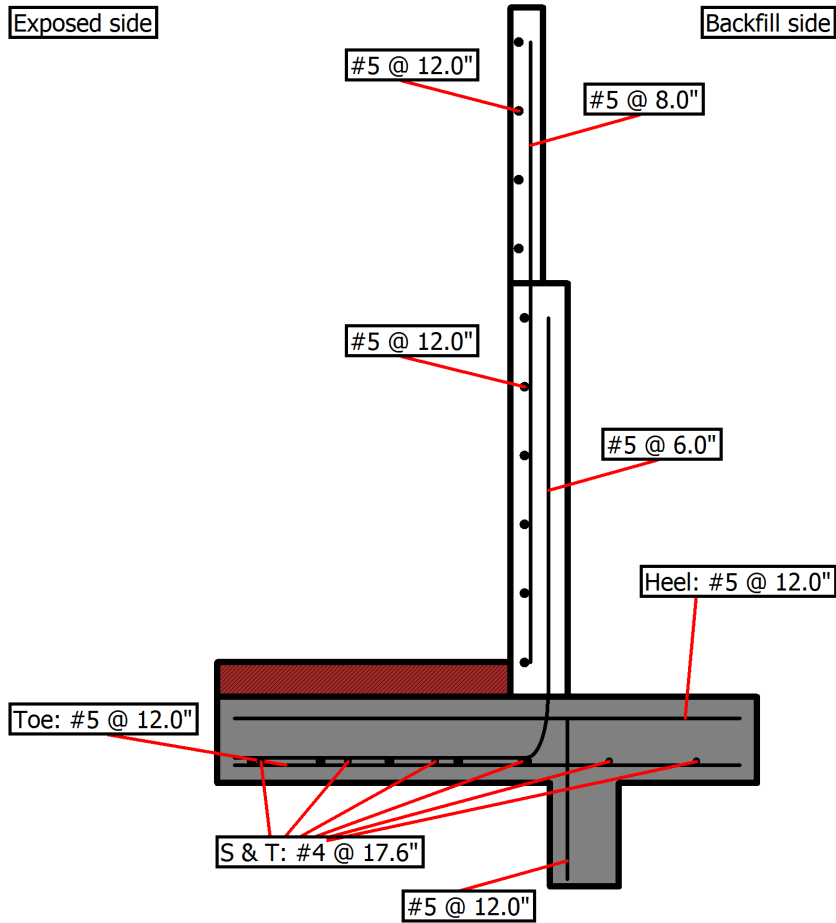
Deflection Req. for Active State	0.14 in
Approx. top of Stem Deflection	0.08 in
<b>Deflection OK</b>	

Design for K between Active and At Rest values

### Global Stability

Req. Cohesion for Toe Circle	292.5 psf
Req. Cohesion for Base Circle	213.8 psf

Only valid for Cohesive Soils, not a comprehensive Slope Stability Analysis



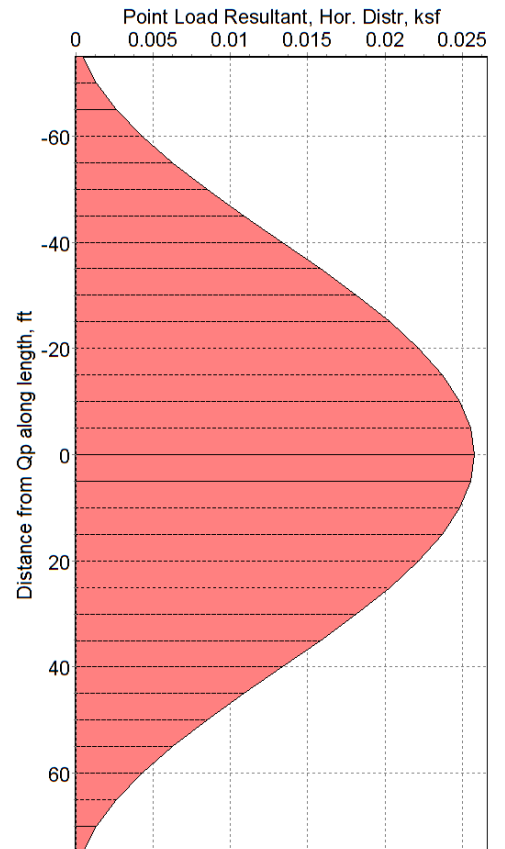
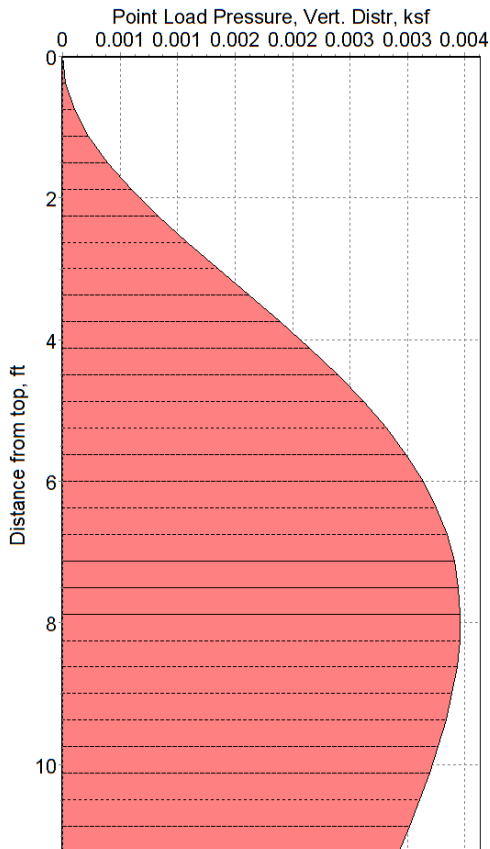
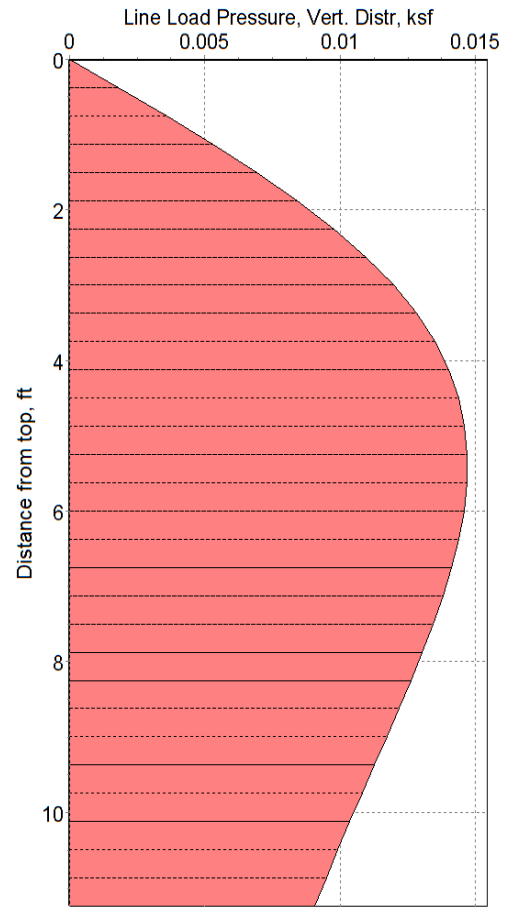
## Table of Test Results - Stem Forces

Node #	Stem Ht, inch	Soil Press, psf	Vu, lb	phiVn, lb	Mu, lb-ft	phiMn, lb-ft
1	2.7	-56.7	-10.7	-5710.3	-1.2	-5242.1
2	5.3	-74.0	-25.2	-5710.3	-5.2	-5242.1
3	8.0	-91.3	-43.5	-5710.3	-12.8	-5242.1
4	10.7	-108.6	-65.8	-5710.3	-25.0	-5242.1
5	13.3	-125.9	-91.8	-5710.3	-42.5	-5242.1
6	16.0	-143.2	-121.7	-5710.3	-66.2	-5242.1
7	18.7	-160.6	-155.5	-5710.3	-97.0	-5242.1
8	21.3	-177.9	-193.1	-5710.3	-135.7	-5242.1
9	24.0	-195.2	-234.5	-5710.3	-183.2	-5242.1
10	26.7	-212.5	-279.8	-5710.3	-240.4	-5242.1
11	29.3	-229.8	-329.0	-5710.3	-308.0	-5242.1
12	32.0	-247.1	-382.0	-5710.3	-387.0	-5242.1
13	34.7	-264.4	-438.8	-5710.3	-478.2	-5242.1
14	37.3	-281.8	-499.5	-5710.3	-582.5	-5242.1
15	40.0	-299.1	-564.0	-5710.3	-700.7	-5242.1
16	42.7	-316.4	-632.4	-5710.3	-833.6	-5242.1
17	45.3	-333.7	-704.7	-5710.3	-982.2	-5242.1
18	48.0	-351.0	-780.7	-5710.3	-1147.2	-5242.1
19	52.0	-377.0	-902.1	-6593.2	-1427.7	-16962.2
20	56.0	-403.0	-1032.1	-6593.2	-1750.0	-16962.2
21	60.0	-428.9	-1170.7	-6593.2	-2117.2	-16962.2
22	64.0	-454.9	-1318.0	-6593.2	-2531.9	-16962.2
23	68.0	-480.9	-1474.0	-6593.2	-2997.3	-16962.2
24	72.0	-506.8	-1638.6	-6593.2	-3516.0	-16962.2
25	76.0	-1181.5	-1920.0	-6593.2	-4109.1	-16962.2
26	80.0	-558.8	-2210.0	-6593.2	-4797.5	-16962.2
27	84.0	-584.8	-2400.6	-6593.2	-5565.9	-16962.2
28	88.0	-610.7	-2599.9	-6593.2	-6399.3	-16962.2
29	92.0	-636.7	-2807.8	-6593.2	-7300.6	-16962.2
30	96.0	-662.7	-3024.3	-6593.2	-8272.6	-16962.2
31	100.0	-688.7	-3249.6	-6593.2	-9318.3	-16962.2
32	104.0	-714.6	-3483.4	-6593.2	-10440.4	-16962.2
33	108.0	-740.6	-3726.0	-6593.2	-11642.0	-16962.2
34	112.0	-766.6	-3977.2	-6593.2	-12925.8	-16962.2
35	116.0	-792.5	-4237.0	-6593.2	-14294.9	-16962.2
36	120.0	-818.5	-4505.5	-6593.2	-15752.0	-16962.2

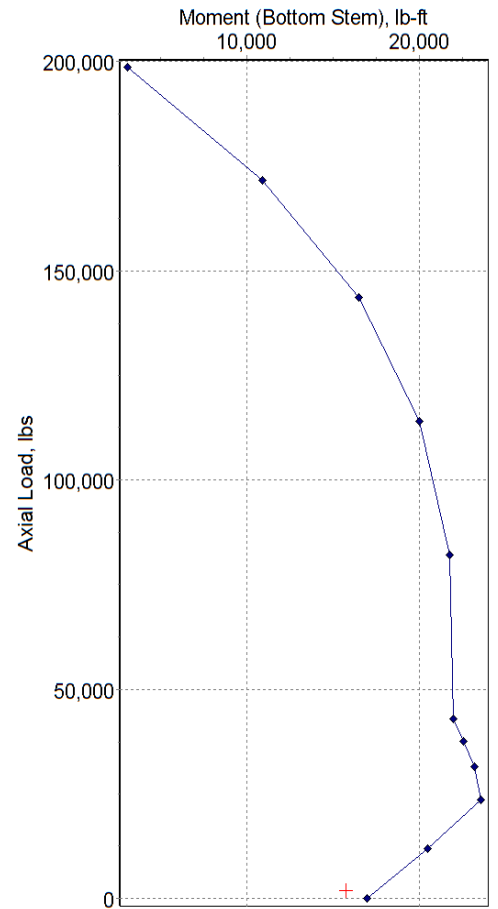
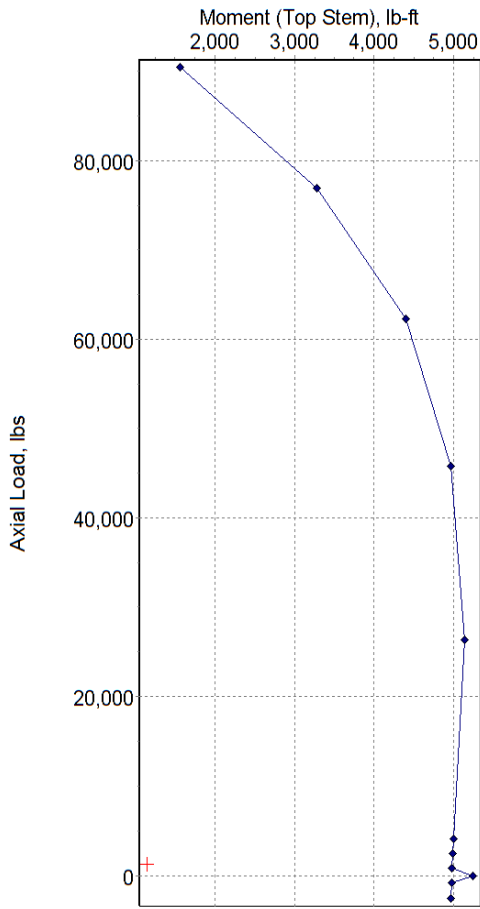
## Table of Test Results - Backfill Surcharge Output

Node #	Vert. Height, ft	Strip Load Pr, ksf	Line Load Pr, ksf	Point Load Pr. (Vert), ksf	Radial Dist (Point), ft	Point Load (Hor), kips
0	0.000	0.000	0.000	0.000	-41.986	0.000
1	0.375	0.001	0.002	0.000	-30.909	0.001
2	0.750	0.002	0.004	0.000	-24.126	0.003
3	1.125	0.003	0.005	0.000	-19.486	0.004
4	1.500	0.004	0.007	0.000	-16.067	0.006
5	1.875	0.005	0.008	0.001	-13.407	0.008
6	2.250	0.006	0.010	0.001	-11.250	0.011
7	2.625	0.007	0.011	0.001	-9.440	0.013
8	3.000	0.008	0.012	0.001	-7.877	0.016
9	3.375	0.009	0.013	0.002	-6.495	0.018
10	3.750	0.009	0.013	0.002	-5.246	0.020
11	4.125	0.010	0.014	0.002	-4.095	0.022
12	4.500	0.010	0.014	0.002	-3.014	0.024
13	4.875	0.011	0.015	0.003	-1.984	0.025
14	5.250	0.011	0.015	0.003	-0.984	0.026
15	5.625	0.012	0.015	0.003	0.000	0.026
16	6.000	0.012	0.015	0.003	0.984	0.026
17	6.375	0.012	0.014	0.003	1.984	0.025
18	6.750	0.012	0.014	0.003	3.014	0.024
19	7.125	0.012	0.014	0.003	4.095	0.022
20	7.500	0.012	0.013	0.003	5.246	0.020
21	7.875	0.012	0.013	0.003	6.495	0.018
22	8.250	0.012	0.013	0.003	7.877	0.016
23	8.625	0.012	0.012	0.003	9.440	0.013
24	9.000	0.012	0.012	0.003	11.250	0.011
25	9.375	0.012	0.011	0.003	13.407	0.008
26	9.750	0.011	0.011	0.003	16.067	0.006
27	10.125	0.011	0.010	0.003	19.486	0.004
28	10.500	0.011	0.010	0.003	24.126	0.003
29	10.875	0.011	0.009	0.003	30.909	0.001
30	11.250	0.010	0.009	0.003	41.986	0.000

# Surcharges

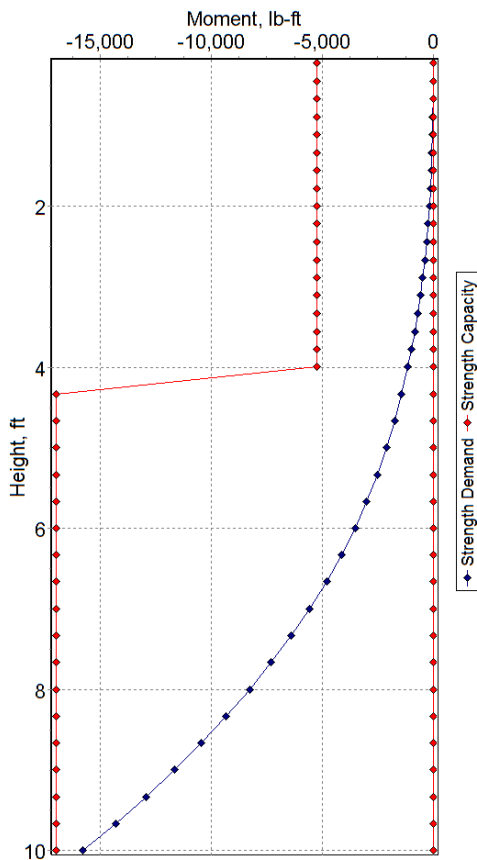
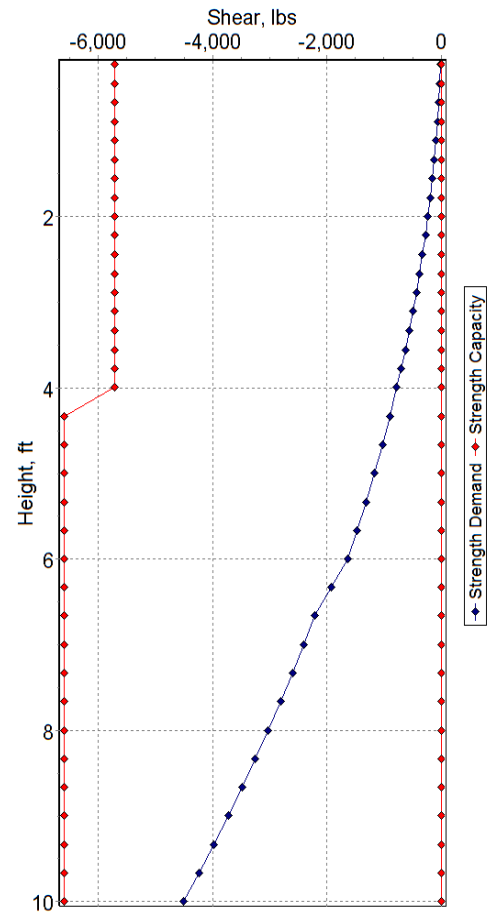
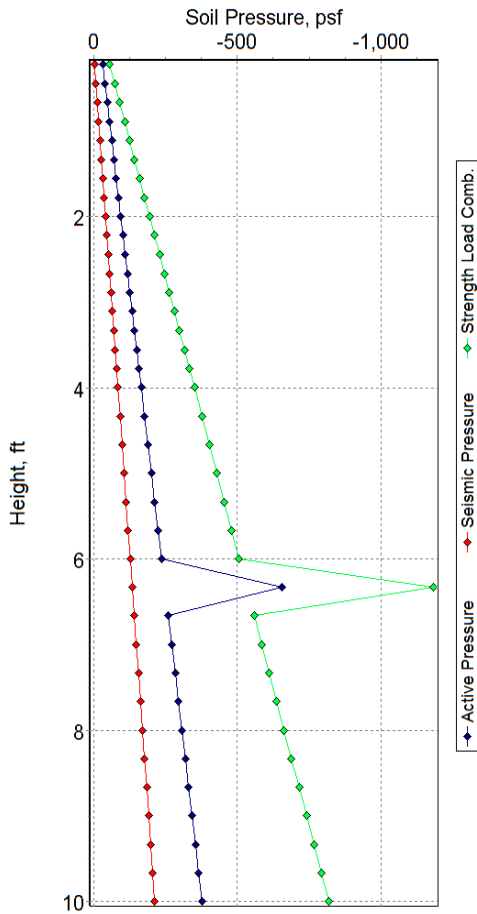


# P-M Diagrams





# Stem Forces



## References:

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