QuickWall 9.0 - RETAINING WALL ANALYSIS AND DESIGN

Job ID :
Job Description : Designed By :

FOOTING DESIGN METHOD: Ultimate Strength ACI 318-14
STEM DESIGN METHOD : Ultimate Strength ACI 318-14 (Concrete)
WALL TYPE : Cantilever Retaining Wall

RETAINING WALL DIMENSIONS:

Wall Stem Height		= 14.00 ft.			
Stem Thickness @ Top		= 12.00 in.			
Stem Thickness @ Bottom		= 12.00 in.			
Footing Thickness		= 14.00 in.			
Heel Width	Min.	= 1.00 ft.	Design Heel Width	=	6.00 ft.
	Max.	= 20.00 ft.			
Toe Width	Min.	= 1.00 ft.	Design Toe Width	=	1.50 ft.
	Max.	= 10.00 ft.			
Footing Key Depth		= 0.00 ft.	Design Key Depth	=	0.00 ft.
Footing Key Width		= 0.00 ft.	Design Key Width	=	0.00 ft.
BackFill Slope (Vert/Horiz)		= 0.00 :12			

RETAINING WALL LOADS:

Horizontal Equivalent Fluid Pressure	= 45.00 pcf.	(Load Case = Soil)
Backfill Height	= 14.00 ft.	
Equivalent Fluid Pressure Angle	= 20.00 deg.	
Vertical Surcharge on Backfill	= 100 psf.	(Load Case = Soil)
Horizontal Surcharge	= 0 psf.	(Load Case = Soil)
Vertical Surcharge on Toe	= 0 psf.	(Load Case = Soil)
Wind Load on Fence	= 0 psf.	(Load Case = Wind)
Fence Height	= 0.00 ft.	

Line Ld. No.	Type (H or V)	Magnitude (plf)	Dist. (x) (ft.)	Load Case
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Notes: 1. "H" = Horizontal loads. "V" = Vertical loads.
2. Vertical loads are positive down.

ULTIMATE STRENGTH LOAD COMBINATIONS (Concrete Design):

1.4D + 1.4H
1.2D + 1.6L + 1.6H + 0.5R
1.2D + 1.6R + 1.6H + 1.0L
1.2D + 1.6R + 1.6H + 0.5W
1.2D + 1.0W + 1.0L + 0.5R
1.2D + 1.0E + 1.0L + 1.6H + 0.2R
0.9D + 1.0W + 1.6H
0.9D + 1.0E + 1.6H

WORKING STRESS LOAD COMBINATIONS (Stability Checks and Masonry Design):

D + L + R + H
D + L + 0.6W + H
D + L + 0.6W + 0.5R + H
D + L + R + 0.3W + H
D + L + R + E/1.4 + H
D + E/1.4 + H

RETAINING WALL RESISTING FORCES:

Allowable Soil Pressure = 3,000 psf.
Passive Equivalent Fluid Press. = 300.00 pcf.
Passive Soil Height = 1.00 ft.
Coefficient of Friction = 0.50
Cohesion = 0 psf.

Use Vertical Surcharge as Resisting Wt.? = Yes

Overturning Safety Factor = 1.50
Sliding Safety Factor = 1.50
Limit Reaction to Mid 1/3? = Yes

MATERIAL DATA:

Concrete Strength, f'c = 4.00 ksi.
Steel Yield Strength, Fy = 60.00 ksi.

Concrete Unit Weight = 145.00 pcf.
Soil Unit Weight = 110.00 pcf.
Fence Weight = 10.00 psf.

REINFORCING STEEL DATA:

Concrete cover to center of steel:
Wall Inside Face = 2.50 in.
Footing Heel (Top Face) = 2.50 in.
Footing Toe (Bottom Face) = 3.50 in.

Minimum Ratios for Shrinkage and Temperature Reinf:
Vertical Stem Reinf. = 0.0018
Horizontal Stem Reinf. = 0.0020
Footing Reinforcement = 0.0018

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S U M M A R Y O F R E S U L T S
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DIMENSIONS:

Stem Height	= 14.00 ft.	Heel Length	= 6.00 ft.
Stem Thick. @ Top	= 12.00 in.	Toe Length	= 1.50 ft.
Stem Thick. @ Base	= 12.00 in.	Total Ftg. Width, B	= 8.50 ft.
Footing Thickness	= 14.00 in.	Key Depth	= 0.00 ft.
		Key Width	= 0.00 ft.

ANALYSIS RESULTS:

Max Brg Press. @ Toe	= 2,933 psf.	Sliding Force	= 5,447 Lb
@ Heel	= 703 psf.	Resisting Force	= 8,282 Lb
Allowable Brg. Press.	= 3,000 psf.	F.O.S.	= 1.52
Resultant Loc From C.L.	= 0.87 ft.	Overturn. Moment	= 29,009 ft-lb
Kern Point Loc., B/6	= 1.42 ft.	Resisting Moment	= 81,265 ft-lb
Limit Resultant To Mid 1/3?	= Yes	F.O.S.	= 2.80

DESIGN RESULTS: Design Method, Stem: USD, ACI 318-14 (Concrete)
Ftg.: Ultimate Strength ACI 318-14

	d (in.)	Mu (ft-k)	Vu (kip)	Phi Vn (kip)	As Flex. (in^2)	As Min. (in^2)	As T+S (in^2)
Stem :	9.50	36.97	7.49	10.81	0.932	0.380	0.496
Toe :	10.50	4.20	2.39	11.95	0.089	0.119	0.302
Heel :	11.50	36.81	6.14	13.09	0.747	0.460	0.302
Key :	0.00	0.00	0.00	0.00	0.000	0.000	0.000

Notes: 1. Stem moments are positive if they cause tension on the soil face.
Negative if they cause tension on the outside face.
Stem shear is positive to the left as measured on a section cut below the top of wall.

2. Heel moments are positive if they cause tension in the top of the footing. Heel shear is positive up as measured on a section cut to the right of the end of the heel.

3. Toe moments are positive if they cause tension in the bottom of the footing. Toe shear is positive up as measured on a section cut to the left of the end of the toe.

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S T A B I L I T Y A N A L Y S I S R E P O R T
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Stability Analysis: Governing Combination = D + L + R + H

RESISTING FORCES				OVERTURNING FORCES			
Element	Weight	x Arm	= Moment	Element	Force	x Arm	= Moment
Soil	9,405		50,944	R at Top			
Ftg.	1,438	4.25	6,111	R at Bot.			
Stem	2,030	2.00	4,060	Horiz. EFP	4,863	5.06	24,588
Vert Sur	600	5.50	3,300	Vert Sur	583	7.58	4,421
Vert EFP	1,982	8.50	16,850	Horiz Sur			
Toe Sur.				Wind			
Fence Wt.				Horiz line			
V. line				Vert. line			
Sum WT =	15,455	MR =	81,265	Sum F =	5,447	MOT =	29,009

Friction Force	= 7,728 Lb	F.O.S. Sliding	= RF / F = 1.52
Passive Pressure	= 554 Lb	F.O.S. Overturn.	= MR / MOT = 2.80
Cohesion	= 0 Lb		
Resist. Force, Sum RF	= 8,282 Lb	Coef. Vert. Surcharge or Line Load to Horiz. = EFP / Soil Dens.	= 0.409

Resultant Loc From Toe,	X = (MR - MOT) / Sum WT	= 3.38 ft.
Eccentricity From Ftg. C.L.,	e = (B / 2) - X	= 0.87 ft.
Soil Pressure @ Toe	= (WT / B) * (1 + 6e/B)	= 2,933 psf.
Soil Pressure @ Heel	= (WT / B) * (1 - 6e/B)	= 703 psf.

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D E T A I L E D D E S I G N R E P O R T
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STEM DESIGN: Steel Design Comb = 1.2D + 1.6L + 1.6H + 0.5R
Shr Strength @ Base, Phi Vn = 10.81 kip

Dist From Top (ft)	d (in.)	Mu (ft-k)	Vu (kip)	As Flex. (in^2)	As Min. (in^2)	As T+S (in^2)	As Reqd (in^2)	Comb
1.40	9.50	0.09	0.15	0.002	0.003	0.259	0.259	2
2.80	9.50	0.49	0.44	0.011	0.015	0.259	0.259	2
4.20	9.50	1.38	0.86	0.032	0.043	0.259	0.259	2
5.60	9.50	2.94	1.41	0.069	0.092	0.259	0.259	2
7.00	9.50	5.37	2.09	0.127	0.169	0.259	0.259	2
8.40	9.50	8.85	2.90	0.211	0.281	0.259	0.281	2
9.80	9.50	13.57	3.85	0.326	0.380	0.259	0.380	2
11.20	9.50	19.70	4.93	0.479	0.380	0.259	0.479	2
12.60	9.50	27.44	6.15	0.677	0.380	0.259	0.677	2
14.00	9.50	36.97	7.49	0.932	0.380	0.496	0.932	2

Vertical Stem Reinforcement:
Shear-Friction Steel Added at Stem Base (ACI 14 22.9), Avf = 0.237 in^2
Available Length for Hook Embedment into Footing = 11.00 in.
Available Length for Straight Embedment into Stem = 166.00 in.

	Development Length Straight (in.)	Hook (in.)	Percent Develop.	Spac. (in.)	50% Cut Off (in.)
#4	12.00	6.64	100.00	2.58	45.24
#5	14.23	8.30	100.00	3.99	45.24
#6	17.08	9.96	100.00	5.67	45.24
#7	24.90	11.62	94.65	7.31	46.24
#8	28.46	13.28	82.82	8.42	47.74
#9	36.21	14.98	73.42	9.45	49.27
#10	45.90	16.87	65.21	10.66	50.98
#11	56.58	18.73	58.74	11.80	56.58

Horizontal Stem Reinforcement:
Area of steel for Shrinkage and Temp. Reinforcement = 0.288 in^2

	-----Spacing, in.----- I.F. Only	EA. Face	------Total Bars------ I.F. Only	EA. Face
#4	8.33	16.67	21.00	11.00
#5	12.92	18.00	14.00	11.00
#6	18.00	18.00	11.00	11.00
#7	18.00	18.00	11.00	11.00
#8	18.00	18.00	11.00	11.00
#9	18.00	18.00	11.00	11.00
#10	18.00	18.00	11.00	11.00
#11	18.00	18.00	11.00	11.00

TOE DESIGN:

* Steel Design Comb. = 1.2D + 1.6L + 1.6H + 0.5R
* Thickness Design Comb. = 1.2D + 1.6L + 1.6H + 0.5R
* Available Length for Hook Embedment into Stem = 10.00 in.
* Available Length for Straight Embed. into Toe = 16.00 in.

d (in.)	Mu (ft-k)	Vu (kip)	Phi Vn (kip)	As Flex. (in^2)	As Min. (in^2)	As T+S (in^2)	As Req'd (in^2)
10.50	4.20	2.39	11.95	0.089	0.119	0.302	0.302

	Development Length Straight (in.)	Hook (in.)	Percent Develop.	Spac. (in.)
#4	12.00	6.64	100.00	7.94
#5	14.23	8.30	100.00	12.30
#6	17.08	9.96	93.70	16.36
#7	24.90	11.62	64.25	15.30
#8	28.46	13.28	56.22	17.62
#9	32.10	14.98	49.84	18.00
#10	36.14	16.87	44.27	18.00
#11	40.42	18.73	39.59	18.00

HEEL DESIGN:

* Steel Design Comb. = 0.9D + 1.0W + 1.6H
* Thickness Design Comb. = 1.2D + 1.6L + 1.6H + 0.5R
* Available Length for Straight Embedment into Toe = 28.00 in.
* Available Length for Straight Embedment into Heel = 70.00 in.

d (in.)	Mu (ft-k)	Vu (kip)	Phi Vn (kip)	As Flex. (in^2)	As Min. (in^2)	As T+S (in^2)	As Req'd (in^2)
11.50	36.81	6.14	13.09	0.747	0.460	0.302	0.747

	Development Length Straight (in.)	Hook (in.)	Percent Develop.	Spac. (in.)
#4	12.00	6.64	100.00	3.21
#5	14.23	8.30	100.00	4.98
#6	17.08	9.96	100.00	7.07
#7	24.90	11.62	100.00	9.64
#8	28.46	13.28	98.38	12.49
#9	36.21	14.98	77.32	12.42
#10	45.90	16.87	61.00	12.45
#11	56.58	18.73	49.49	12.40

LONGITUDINAL FOOTING REINFORCEMENT (TEMP & SHRINK ONLY):

	Spacing (in.)
#4	7.94
#5	12.30
#6	17.46
#7	23.81
#8	31.35
#9	39.68
#10	50.40
#11	61.90