







mike@skeensconsulting.com

423 N. Winnebago Drive Ph: (816) 806-9719
Lake Winnebago, MO 64034

Date: July 18, 2021
To: Mark @ Trumark Homes
Re: Calculations for the new retaining wall

Dear Mark,

As requested here are the plans for the new retaining at 2924 Thoreau, in Lee's Summit, MO. The drawings are based on the current building codes which is the 2018 International Residential Building Codes.

Sheets S1 and S2 must be submitted to the City along with the attached calculations

Please review and let me know if you have any questions.

Sincerely,

Michael H. Skeens

Michael H. Skeens, P.E.

GEOMETRY

Conc. Stem Height	8.00	ft
Stem Thickness Top	10.0	in
Stem Thickness Bot	10.0	in
Footing Thickness	12.0	in
Toe Length	1.25	ft
Heel Length	3.75	ft
Soil Cover @ Toe	2.00	ft
Backfill Height	7.75	ft OK
Backfill Slope Angle	10.0	deg

SEISMIC EARTH FORCES

Hor. Seismic Coeff. k_h	0.00
Ver. Seismic Coeff. k_v	0.00
Seismic Active Coeff. K_{ae}	0.37
Seismic Force $P_{ae}-P_a$	0.0 k/ft

SOIL PRESSURES (Comb. D+H+0.6W)

Allow. Bearing Pressure ..	20.0	ksf	OK
Max. Pressure @ Toe	1.4	ksf	
Min. Pressure @ Heel	0.5	ksf	
Total Footing Length	5.83	ft	
Footing Length / 6	0.97	ft	
Resultant Eccentricity e ...	0.49	ft	
<i>Resultant is Within the Middle Third</i>			

APPLIED LOADS

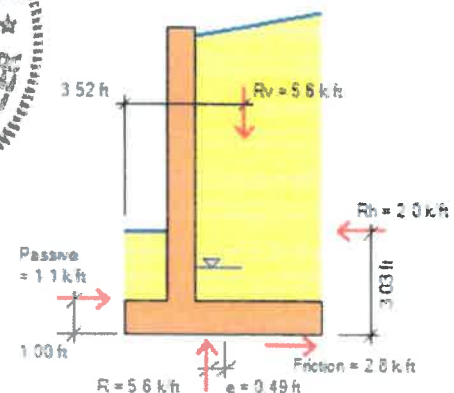
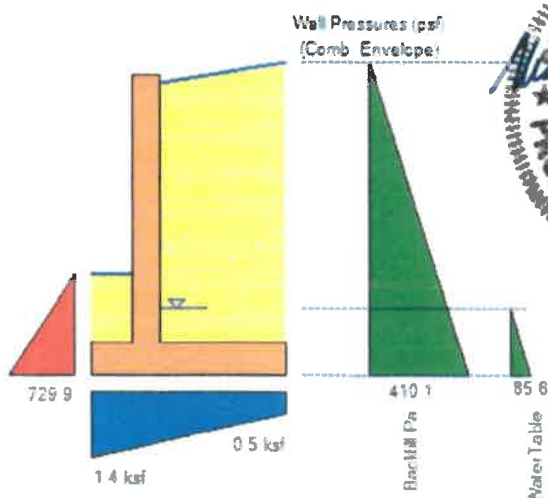
Uniform Surcharge	0.0	psf
Strip Pressure	0.0	psf
<i>Strip 2.0 ft deep, 4.0 ft wide @ 3.0 ft from Stem</i>		
Stem Vertical (Dead)	0.0	k/ft
Stem Vertical (Live)	0.0	k/ft
Vertical Load Eccentricity	6.0	in
Wind Load on Stem	0.0	psf

BACKFILL PROPERTIES

Backfill Density	120	pcf
Earth Pressure Theory	Coulomb Active	
Internal Friction Angle	28	
Active Pressure Coeff. K_a	0.37	
Active Pressure @ Bott	44.9	psf/ft
Active Force @ Wall P_a	2.0	k/ft
Water Table Height	2.00	ft

SHEAR KEY (Comb. 1.2D+1.6(L+H))

Shear Key Depth	0.0	in
Shear Key Thickness	0.0	in
Max. Shear Force @ Key ..	0.0	k/ft
Shear Capacity Ratio	0.00	OK
<i>No shear key has been specified</i>		
Moment Capacity Ratio	0.00	OK



OVERTURNING CALCULATIONS (Comb. D+H+0.6W)

	OVERTURNING				RESISTING		
	Force k/ft	Arm ft	Moment k-ft/ft		Force k/ft	Arm ft	Moment k-ft/ft
Backfill Pa	1.9	3.14	6.1	Stem Top	1.0	1.67	1.7
Water Table	0.1	0.67	0.1	Stem Taper	0.0	2.08	0.0
Surcharge Hor	0.0	4.71	0.0	CMU Stem at Top	0.0	0.00	0.0
Strip Load Hor	0.0	0.00	0.0	Footing Weight	0.9	2.92	2.6
Wind Load	0.0	6.50	0.0	Shear Key	0.0	1.25	0.0
Seismic Backfill	0.0	5.65	0.0	Soil Cover @ Toe	0.3	0.63	0.2
Seismic Water	0.0	0.67	0.0	Stem Wedge	0.0	2.08	0.0
Seismic Selfweight	0.0	0.00	0.0	Backfill Weight	3.5	3.96	13.8
Passive Pressure	0.0	1.00	0.0	Backfill Slope	0.1	4.58	0.7
Rh =	2.0	OTM =	6.1	Water Weight	0.0	3.96	0.1
Arm of Horizontal Resultant = $\frac{6.1}{2.0} = 3.03$ ft				Seismic Backfill	0.0	5.83	0.0
Arm of Vertical Resultant = $\frac{19.7}{5.6} = 3.52$ ft				Pa Vert @ Heel	0.5	5.83	2.8
Overturing Safety Factor = $\frac{19.7}{6.1} = 3.23 > 1.5$ OK				Vertical Load	0.0	1.58	0.0
				Surcharge Ver	0.0	3.96	0.0
				Strip Load Ver	0.0	3.96	0.0
				Water Buoyancy	-0.7	2.92	-2.1
				Rv =	5.6	RM =	19.7

STEM DESIGN (Comb. 1.2D+1.6(L+H))

Height ft	d in	Mu k-ft/ft	φMn k-ft/ft	Ratio
8.00	8.8	0.0	0.0	0.00
7.20	8.8	0.0	3.4	0.00
6.40	8.8	0.0	4.3	0.01
5.60	8.8	0.1	4.3	0.03
4.80	8.8	0.3	4.3	0.07
4.00	8.8	0.6	4.3	0.14
3.20	8.8	1.1	4.3	0.26
2.40	8.8	1.8	6.8	0.26
1.60	8.8	2.7	8.4	0.32
0.80	8.8	3.9	8.4	0.46
0.00	8.8	5.4	8.4	0.64 OK

Shear Force @ Crit. Height .. 1.9 k/ft OK

Resisting Shear φVc 10.0 k/ft

Use vertical bars #4 @ 11 in at backfill side

Cut off alternate bars. Cut off length = 3.00 ft

Vert. Bars Embed. Ldh Req'd .. 6.0 in OK

Vert. Bars Splice Length Ld 12.0 in

Minimum Steel Area Ratio 0.99 OK

Maximum Steel Area Ratio 0.10 OK

SLIDING CALCS (Comb. D+H+0.6W)

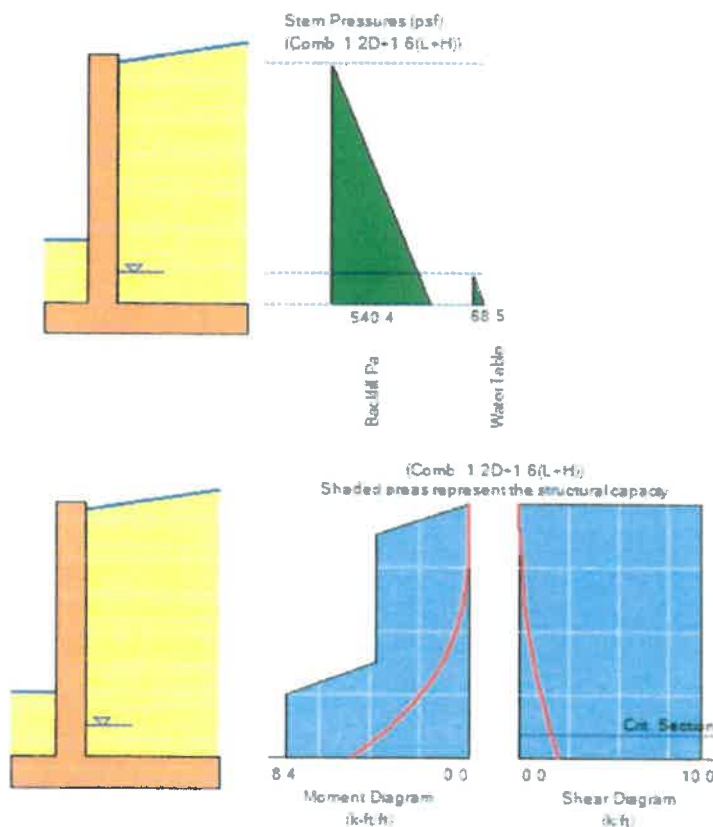
Footing-Soil Friction Coeff. ..	0.50
Friction Force at Base	2.8 k/ft
Passive Pressure Coeff. Kp ..	2.37
Depth to Neglect Passive	0.00 ft
Passive Pressure @ Wall	729.9 psf
Passive Force @ Wall Pp	1.1 k/ft
Horiz. Resisting Force	3.9 k/ft
Horiz. Sliding Force	2.0 k/ft
Sliding Safety Factor = $\frac{3.9}{2.0} = 1.93 > 1.5$ OK	

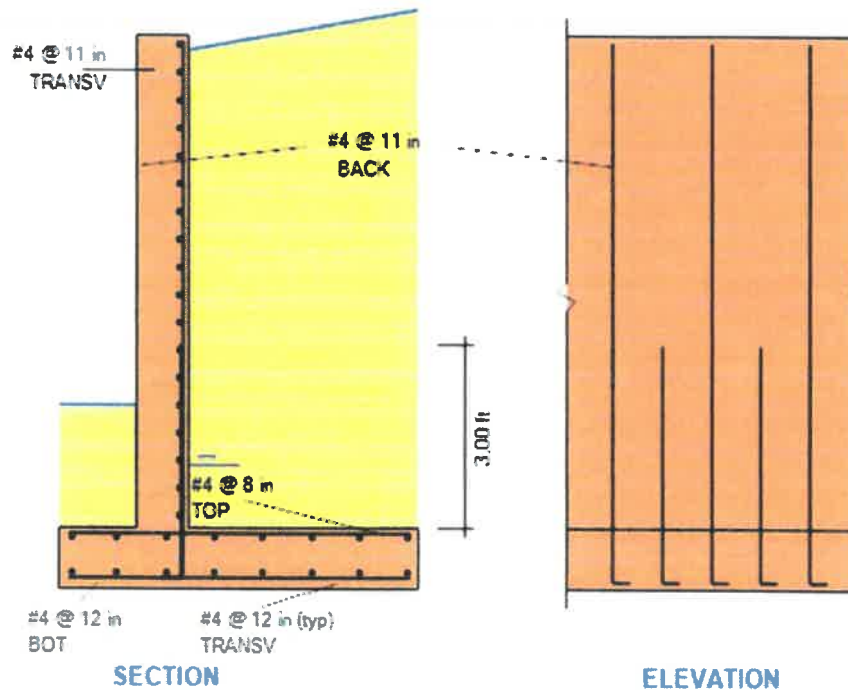
HEEL DESIGN (Comb. 1.4D+0.9H)

	Force k/ft	Arm ft	Moment k-ft/ft
Upward Pressure ..	0.0	1.79	0.0
Concrete Weight ..	0.8	1.88	1.5
Backfill Weight	4.9	1.88	9.2
Backfill Slope	0.2	2.50	0.5
Water Weight	0.1	1.88	0.1
Surcharge Ver.	0.0	1.88	0.0
Strip Load Ver.	0.0	1.88	0.0
	5.9	Mu =	11.3
Shear Force @ Crit. Sect. ..	5.9	k/ft	OK
Resisting Shear ϕV_c	12.2	k/ft	
<i>Use top bars #4 @ 8 in , Transv. #4 @ 12 in</i>			
Resisting Moment ϕM_n	14.9	k-ft/ft	OK
Develop. Length Ratio at End	0.27	OK	
Develop. Length Ratio at Toe	0.50	OK	
Minimum Steel Area Ratio	1.00	OK	

TOE DESIGN (Comb. 1.2D+1.6(L+H))

	Force k/ft	Arm ft	Moment k-ft/ft
Upward Presssure	2.4	0.65	1.5
water Buoyancy ...	0.2	0.63	0.1
Concrete Weight ..	-0.23	0.6	-0.1
Soil Cover	-0.36	0.6	-0.2
	2.0	Mu =	1.3
Shear Force @ Crit. Sect. ..	0.7	k/ft	OK
Resisting Shear ϕV_c	11.1	k/ft	
<i>Use bott. bars #4 @ 12 in , Transv. #4 @ 12 in</i>			
Resisting Moment ϕM_n	8.6	k-ft/ft	OK
Develop. Length Ratio at End	0.92	OK	
Develop. Length Ratio at Stem	0.23	OK	
Minimum Steel Area Ratio	0.65	OK	



**DESIGN CODES**

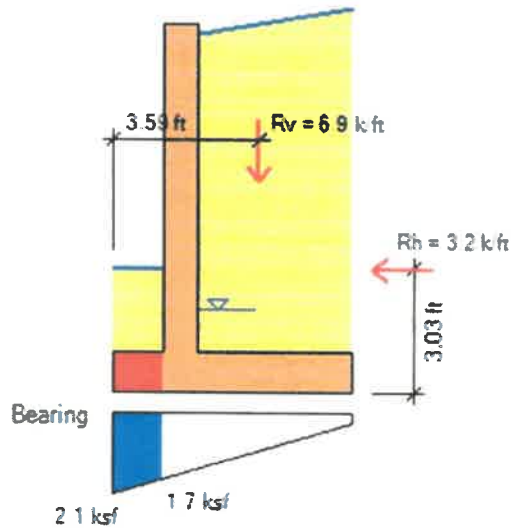
General Analysis	IBC 2012
Concrete Design	ACI 318-11
Masonry Design	MSJC-11
Load Combinations	ASCE 7-10/16

MATERIALS

	Stem	Footing	
Concrete f'_c	4.0	4.0	ksi
Rebars f_y	60.0	60.0	ksi
Masonry f_m	1.5		ksi

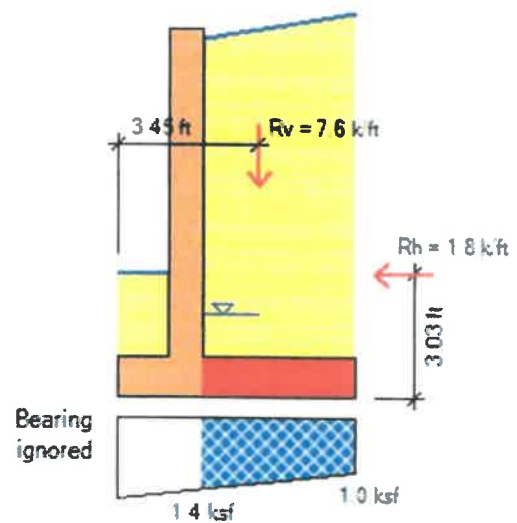
LOAD COMBINATIONS

STABILITY	STRENGTH
① $D+L+0.6H$	① $1.4D+0.9H$
② $D+H+0.6W$	② $1.2D+1.6(L+H)$
③ $D+L+H+0.6W$	③ $1.2D+0.9H+0.5W$
④ $D+H+0.7E$	④ $1.2D+L+0.9H+W$
⑤ $D+L+H+0.7E$	⑤ $1.2D+L+0.9H+E$
	⑥ $0.9D+1.6H+W$
	⑦ $0.9D+1.6H+E$



Toe Design Ratios

Bending	0.15	<	1.00	✓	(1.2D+1.6(L+H))
Shear	0.06	<	1.00	✓	(1.2D+1.6(L+H))



Heel Design Ratios

Bending	0.75	<	1.00	✓	(1.4D+0.9H)
Shear	0.48	<	1.00	✓	(1.4D+0.9H)