

## Flexible Anchored Retaining Wall-Rankine Earth Pressures-Granular Soil

### Free Earth Support Method

#### GIVEN:

##### Retaining Wall Properties

Retained Height, L	28 ft
Yield Strength, $F_y$	50 ksi
Allowable Flexural Strength= $.55 \cdot F_y$	27.5 ksi
Maximum Moment	5432.9 kip-in/ft

##### Required Section Modulus

Required Embedment Depth, D 16.406 ft

Actual Embedment Depth 21.33 30% Safety Factor

##### Total Sheet Pile Length Required

49.33 ft

##### Anchorage Data: Strength Capacity

Anchor Location, $L_a$	5 ft		
Horizontal Anchor Force, $F_a$	10.7 kips/ft of wall		
Angle of Inclination	0 degrees		
Ultimate Anchor force, $P_{ult}$	10.66 kips/ft of wall		
Allowable Anchor Stress	37.5 ksi	FS:	2
Anchor Spacing, S	8 ft	Fy:	75 ksi
Ultimate Anchor Force, $P_{ult}$	85.3 kips		
Anchor area Required, $A_s$	2.27 in <sup>2</sup>		

##### Soil & Ground Water Properties

###### Wall Backfill-Soil 1

unit weight, $\gamma_1$	120 pcf	yw=	62.4 pcf
unit weight, $\gamma_{1sat}$	130 pcf		
effective unit weight, $\gamma_1'$	67.6 pcf		
internal friction angle, $\phi_1'$	34 degrees		
apparent cohesion, $c_1'$	0		
water level behind wall, $L_{1b}$	8 ft		
unbalanced water head, $D_{hw}$	0 ft		
water level front of wall, $L_{1f}$	8 ft		

###### Subgrade- Soil 2

unit weight, $\gamma_2$	pcf
unit weight, $\gamma_{2sat}$	125 pcf
effective unit weight, $\gamma_2'$	62.6 pcf
internal friction angle, $\phi_2'$	28 degrees
apparent cohesion, $c_2'$	0

##### External Load

Infinite surcharge, $q_0$	500 psf
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**Rankine Earth Pressure coefficients**

Wall Backfill- Soil 1

Subgrade- Soil 2

Active

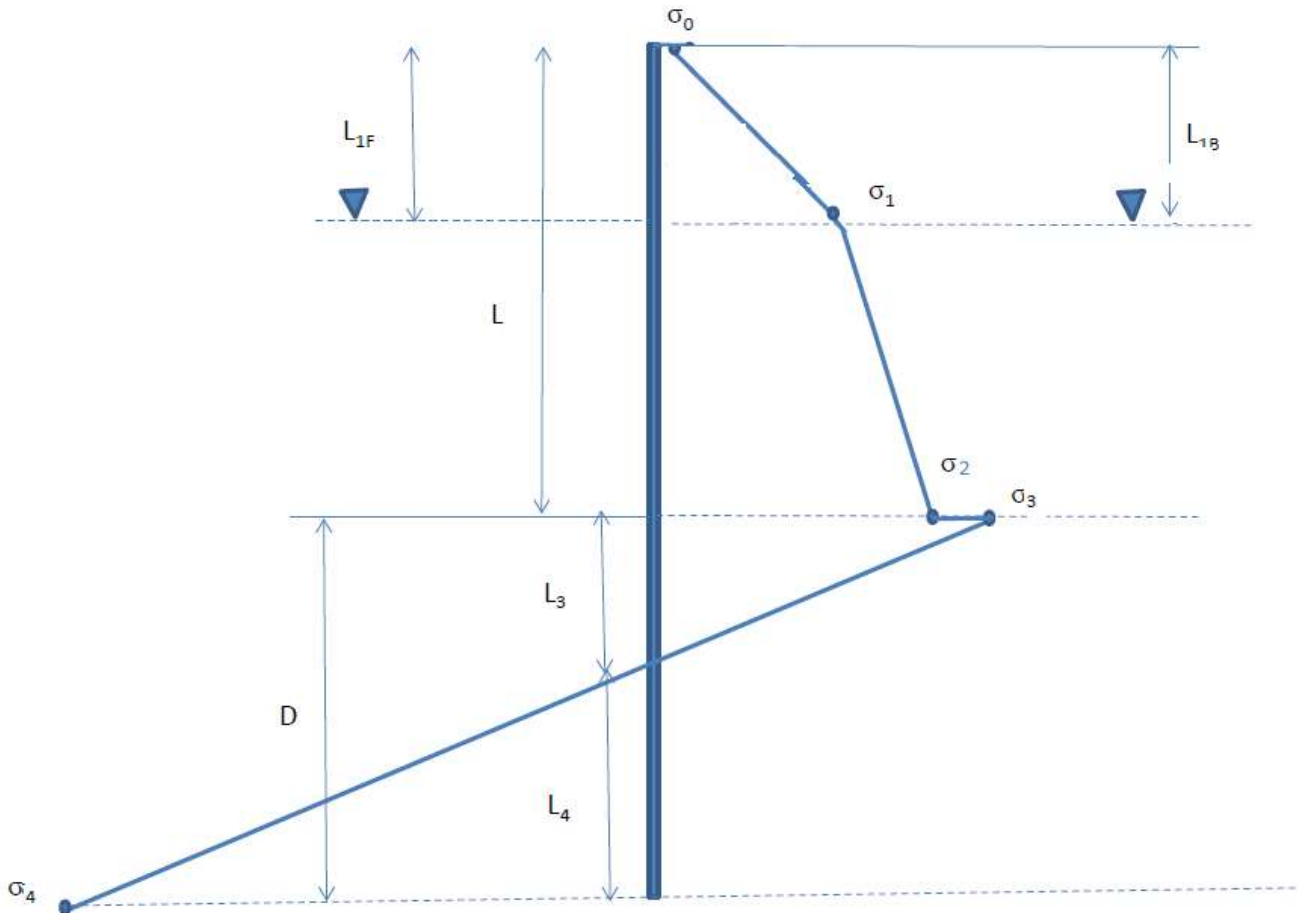
0.282715

0.361033

Passive

3.537132

2.769826

**Net Pressure Diagram****Net Lateral Wall Pressure**

$$\sigma_0 = K_a \cdot q_0$$

141.4 psf

$$\sigma_1 = K_a \cdot (q_0 + L_1 b \cdot y_1)$$

412.8 psf

$$\sigma_1^* = \sigma_1 + K_a \cdot \Delta h_w \cdot y_1' + \Delta h_w \cdot y_w$$

psf

$$\sigma_2^* = \sigma_1 + K_a \cdot (L - L_1 f) \cdot y_1' + \Delta h_w \cdot y_w$$

795.0 psf

$$\sigma_3^* = K_a \cdot ((L - L_1 b) \cdot y_1' + q_0 + L_1 b \cdot y_1) + \Delta h_w \cdot y_w$$

1015.2 psf

$$L_3 = \frac{\sigma_3}{(K_p - K_a) \cdot y_2'}$$

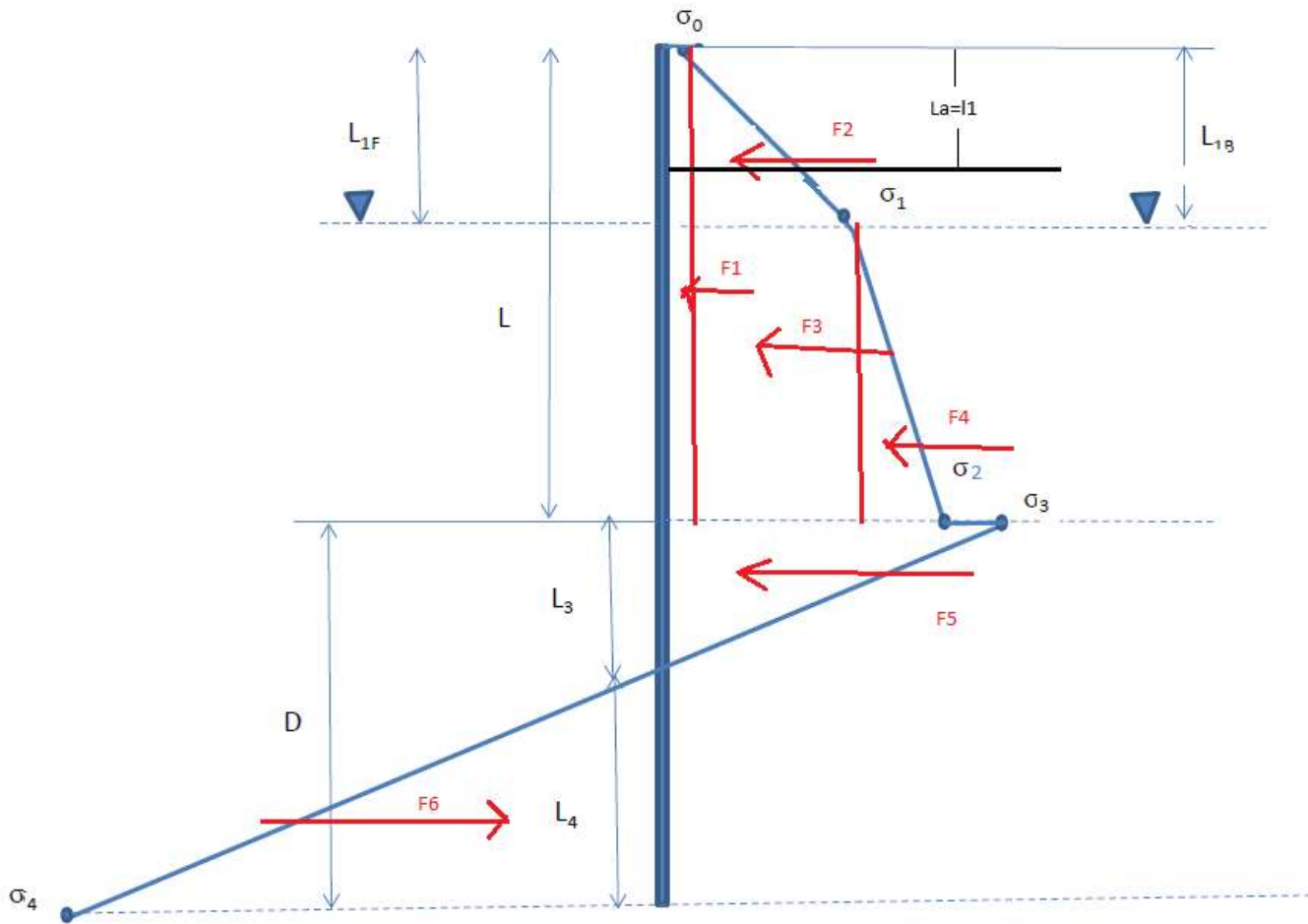
6.73 ft

EQ 9.6

$$\sigma_4 = \sigma_3 - (K_p - K_a) \cdot y_2' \cdot (D - L_3)$$

-1458.6 psf

EQ 9.65

**Net Force Diagram**

			Moment About Anchor Point	
Net Force	Lbs	Distance to Anchor	Ft	K-Ft
$\sigma_0 \cdot L = F1$	3958	$L/2 - La$	9.00	35.62208
$(\sigma_1 - \sigma_0) \cdot 0.5 \cdot L_{1b} = F2$	1086	$2/3 L_{1b} - la$	0.33	0.3618751
$(\sigma_1 - \sigma_0) \cdot (L - L_{1b}) = F3$	5428	$(L - L_{1f})/2 + (L_{1b} - La)$	13.00	70.565644
$(\sigma_2 - \sigma_1) \cdot 0.5 \cdot (L - L_{1b}) = F4$	3822	$(2/3) \cdot (L - L_{1f}) + (L_{1b} - La)$	16.33	62.430993
$(\sigma_3) \cdot 0.5 \cdot L_3 = F5$	3418	$(1/3) \cdot L_3 + L - La$	25.24	86.274809
$(\sigma_4) \cdot 0.5 \cdot (D - L_3) = F6$	-7055	$(2/3) \cdot (D - L_3) + L_3 + L - La$	36.18	-255.2588
Anchor Force =	10657	Sum Moments about toe =0		0.00 OK

**Find Maximum Moment:**

<u>Location</u>	<u>Depth</u>	<u>Stress (psf)</u>	<u>Net Force (lbs)</u>	<u>Shear (lbs)</u>	<u>Moment (lbs-ft)</u>	
<b>S<sub>0</sub></b>	0	141				
	1	175	158	158	79	
	2	209	192	351	334	
	3	243	226	577	797	
Anchor	4	277	260	837	1,504	
	5	311	305	1,142	2,493	*Add anchor force
	6	345	328	1,469	3,799	
	7	379	362	1,831	5,449	
<b>S<sub>1</sub></b>	8	413	396	2,227	7,478	
	9	432	422	2,649	9,917	
	10	451	441	3,091	12,787	
	11	470	461	3,551	16,108	
	12	489	480	4,031	19,899	
	13	508	499	4,530	24,180	
	14	527	518	5,048	28,969	
	15	547	537	5,585	34,285	
	16	566	556	6,141	40,148	
	17	585	575	6,716	46,576	
	18	604	594	7,310	53,589	
	19	623	613	7,924	61,206	
	20	642	633	8,556	69,446	
	21	661	652	9,208	78,328	
	22	680	671	9,879	87,872	
	23	699	690	10,569	98,096	
	24	719	709	11,278	109,019	
	25	738	728	12,006	120,660	
	26	757	747	12,753	133,040	
	27	776	766	13,519	146,176	
<b>S<sub>2</sub></b>	28	795	785	14,305	160,088	
	0	28.01	1,015	0	14,305	160,231
1	29	864	940	15,245	175,006	
2	30	714	789	16,034	190,645	
3	31	563	638	16,672	206,997	
4	32	412	487	17,159	223,913	
5	33	261	337	17,496	241,241	
6	34	110	186	17,682	258,829	
7	35	-40	35	17,717	276,529	
8	36	-191	-116	17,601	294,188	
9	37	-342	-266	17,335	311,656	
10	38	-493	-417	16,917	328,782	
11	39	-643	-568	16,349	345,415	

12	40	-794	-719	15,631	361,405
13	41	-945	-870	14,761	376,601
14	42	-1,096	-1,020	13,740	390,852
15	43	-1,247	-1,171	12,569	404,007
16	44	-1,397	-1,322	11,247	415,915
17	45	-1,548	-1,473	9,774	426,426
18	46	-1,699	-1,624	8,151	435,388
19	47	-1,850	-1,774	6,376	442,652
20	48	-2,001	-1,925	4,451	448,065
21	49	-2,151	-2,076	2,375	451,479
22	50	-2,302	-2,227	148	452,740
23	51	-2,453	-2,378	-2,229	451,700
24	52	-2,604	-2,528	-4,757	448,207

Min:	-4,757	79
Max:	17,717	452,740

Max Shear (kips):  
Max Moment (kip in)/ft:

18
5432.9