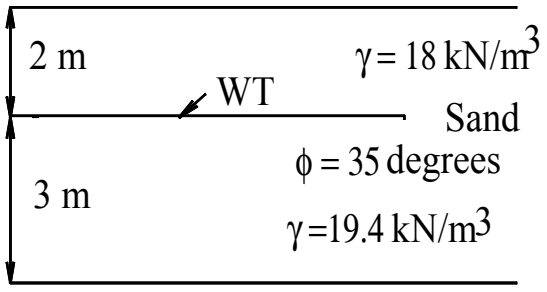
Example 1

a. Plot effective and total horizontal stress distribution for 5m.

b. Show resultant forces and their locations.

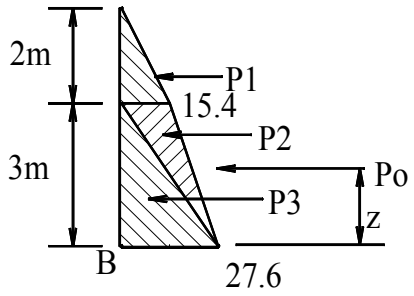
c.



Solution

$K_O = 1 - \sin 35 = 0.4264$ $\quad\quad$ $\sigma'_h = K_o \times \sigma'_v$

Depth m	σ_v kPa	u kPa	σ'_v kPa	σ'_h kPa	σ_h kPa
0	0	0	0	0	0
2	2×18=36	0	36	15.4	15.4
5	36+3×19.4=94.2	3×9.81=29.4	64.8	27.6	57.0



Effective Stress

To locate the resultant, P_0 take moments about B

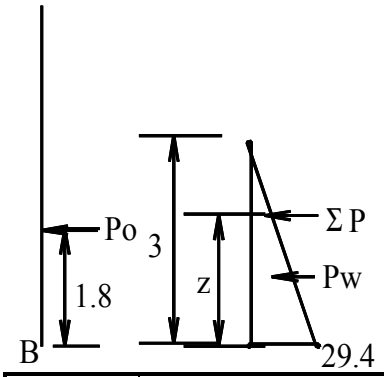
Force	Value kN	from B m	Moment kN-m
P1	15.4×2/2=15.4	3+2/3	56.5
P2	15.4×3/2=23.1	3×2/3	46.2
P3	27.6×3/2=41.4	3/3	41.4
P_0	=79.9	ΣM_B	144.1

z = 144.1/79.9 = 1.8 m

Total forces

Taking moments about B

Force	Value kN	from B m	Moment kN-m
P_o	79.9	1.8	144.1
P_w	29.4×3/2 = 44.1	3/3	44.1



ΣP	124	ΣM_B	188.2

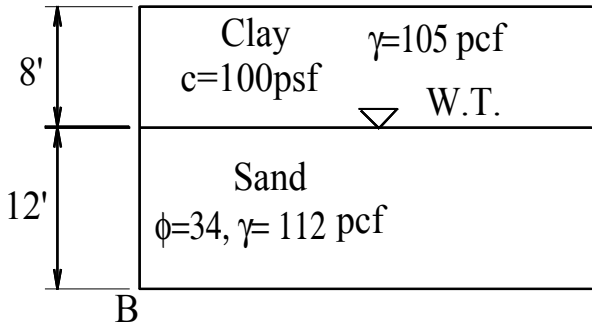
z = 188.2/124 =1.52 m

Example 2

For the soil conditions shown, draw active pressure diagrams and show the location of resultant forces.

a. Without tension cracks

b. After tension cracks have occurred.



Solution

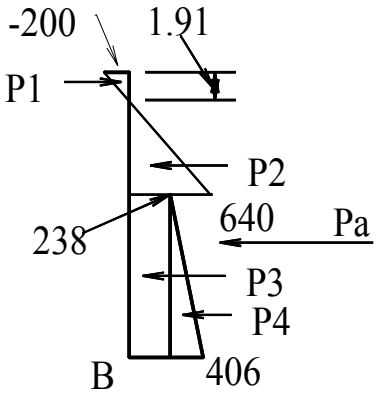
$$K_a = \tan^2\left(45 - \frac{\phi}{2}\right)$$

a) For clay, $K_a = \tan^2(45) = 1$

b) For sand, $K_a = \tan^2\left(45 - \frac{34}{2}\right) = 0.283$

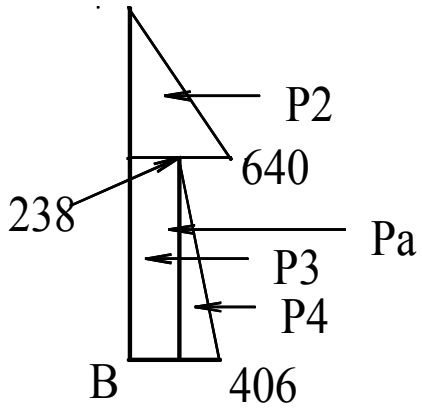
$z_c = 2c/\gamma = 2\times100/105 = 1.91'$

ft	σ'_v psf	$\sigma_a = \sigma_v K_a - 2c\sqrt{K_a}$ psf
0	0	-2×100 = -200
8	105×8 = 840	clay 840-200 = 640
		sand 840×0.283=238
20	840+(112-62.4)×12=1435	1435×0.283= 406



force	magnitude	Force lb.	From B ft	moment ft-lb
P1	-200×1.91÷2	-191	20-1.91/3	-3,698
P2	640(8-1.91)/2	1949	12+(8-0.91) /3	27,342
P3	238×12	2856	12/2	17,136
P4	(406-238)×12/2	1008	12/3	4,032
	ΣP_a	5622	ΣM_B	44,812

Z from bottom of sand 44812/5622 = 7.97'



b. After tension cracks have occurred.

	lb.		From B ft	Moment ft-lb
P2	640(8)/2	2560	12+(8-0.91) /3	37,547
P3	238×12	2856	12/2	17,136
P4	(406-238)×12 /2	1008	12/3	4,032
ΣP_a		6,424	ΣM_B	58,715

Z from bottom of sand = 58,715/6,424 = 9.14'

Example 3

A 4 m high vertical wall retains a sand with $\gamma = 19$ kn/m^3, $\phi = 32°$. Ground surface behind the wall slopes 3 horizontal to one vertical. Compute normal and tangential forces on the wall assuming adequate wall movement to develop Rankine state.

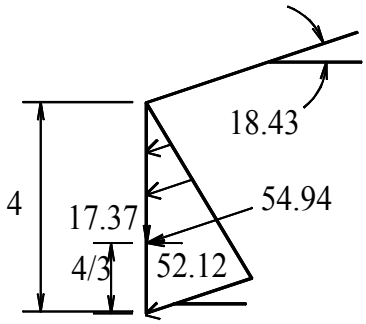
Solution

$\alpha = \tan^{-1}(1/3) = 18.43°$

$$K_a = \cos 18.43 \frac{\cos 18.43 - \sqrt{\cos^2 18.43 - \cos^2 32}}{\cos 18.43 + \sqrt{\cos^2 18.43 - \cos^2 32}}$$

$K_a = 0.361$

$$P_a = 19 \times 4^2 \frac{0.361}{2} = 54.94\text{kN}$$

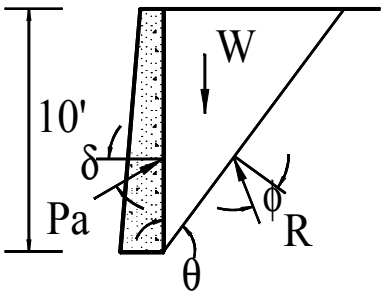


$P_{an} = 54.94 \cos(18.43) = 52.12$ kN

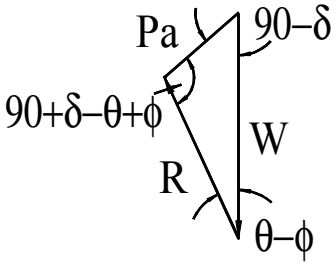
$P_{at} = 54.94 \sin(18.43) = 17.37$ kN

Example 4

Determine active pressure for the conditions shown.



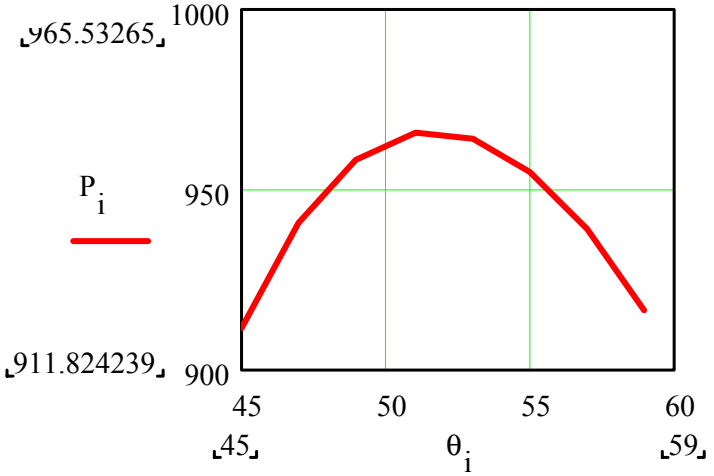
Solution



1. $$\frac{P_a}{\sin(\theta - \phi)} = \frac{W}{\sin(90 + \delta - \theta + \phi)}$$

2. $W = \frac{1}{2}\gamma H^2 \cot\theta$, $P_a = \frac{W \sin(\theta - 34)}{\sin(90 + 20 + 34 - \theta)}$

θ_i	50	50.5	51	51.5	5	52.5	53
P_{ai}	963.1	964.6	965.5	965.9	965.8	965.2	964.1



The wedge with θ = 51.5° yields the maximum value of Pa.

Example 5

A 4 m high vertical wall retains a sand with $\gamma = 19$ kn/m^3, $\phi = 32°$. Ground surface behind the wall has a slope of 3 horizontal to one vertical. Compute normal and tangential forces on the wall assuming Coulomb condition with $\delta = 18.43°$.

Solution

$\alpha = \tan^{-1}(1/3) = 18.43°$

$\beta = 90°$

$$K_a = \frac{\sin^2(90+32)}{\sin^2 90 \cdot \sin(90-18.43)\left[1+\sqrt{\frac{\sin(32+18.43)\cdot\sin(32-18.43)}{\sin(90-18.43)\cdot\sin(18.43+90)}}\right]^2}$$

$K_a = 0.361$

$$P_a = 19 \times 4^2 \frac{0.361}{2} = 54.94\text{kN}$$

Example 6

Calculate the total lateral pressure from surcharge against the vertical wall when the soil behind it is in the active pressure mode of failure given the data: a' = 6 ft; b' = 4 ft ; H = 20 ft; q_s = 1,000 psf; and $\phi = 30°$.

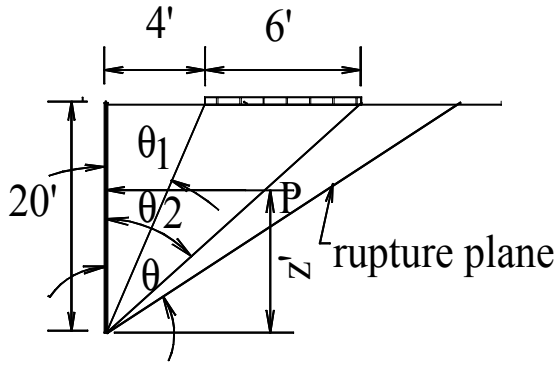
a. Assuming strip load

b. Assuming line load

Solution

a. Since (a' + b') < 20 tan (45° - 15°), i.e., it lies within the active wedge

$\tan \theta_2 = 10/20 = 0.50;\ \theta_2 = 26.57°$



$\tan \theta_1 = 4/20 = 0.20;\ \theta_1 = 11.31°$

P = 1,000/90 [20(26.57 - 11.31)] = 3,390 lb./ft

Location of the resultant:

$(\theta_2 - \theta_1) = 26.57° - 11.31° = 15.26°$

$R = (6 + 4)^2(90\text{-}26.57) = 6,343$

$Q = (4)^2(90\text{-}11.31) = 1,259$

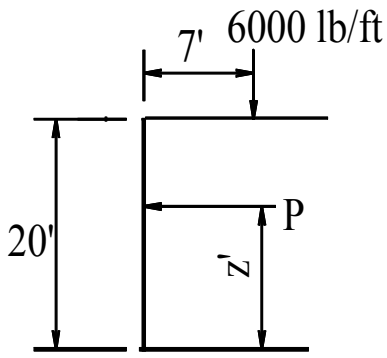
R- Q = 5,084

Substituting

$$z' = \frac{20^2(15.26) - (5084) + 57.3 \times 6 \times 20}{2 \times 20 \times 15.26}$$

= 12.94 ft

b. Line load (Terzaghi's method)



Equivalent line load at the middle of the strip

$q_l = 6\times1000 = 6000$ lb./ft

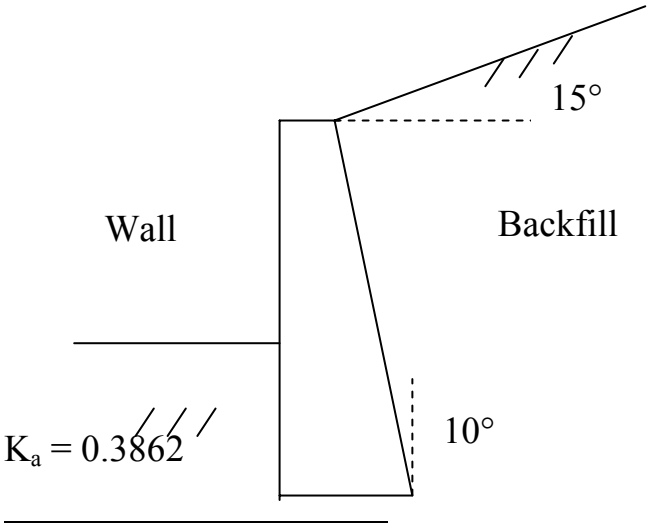
aH = 7, a = 7/20 = 0.35

Since $a \le 0.4$, $P_h = 0.55\times6000 = 3300$lb./ft

z' = 0.59×20 = 11.8'

[1]Example 7

A 5m high wall has a granular backfill with $\phi = 36°$ and $\gamma = 19.5$lkN/m^3. Backfill slopes upwards at 15° and back of the wall slopes away from the fill at 10°. Determine horizontal and vertical components of the active pressure if wall friction $\delta = 2/3\phi$.



[1] *This is an extra problem that may be done as revies*

$P_a = 19.51x\ 0.3862x5^2/2 = 94.2kN$

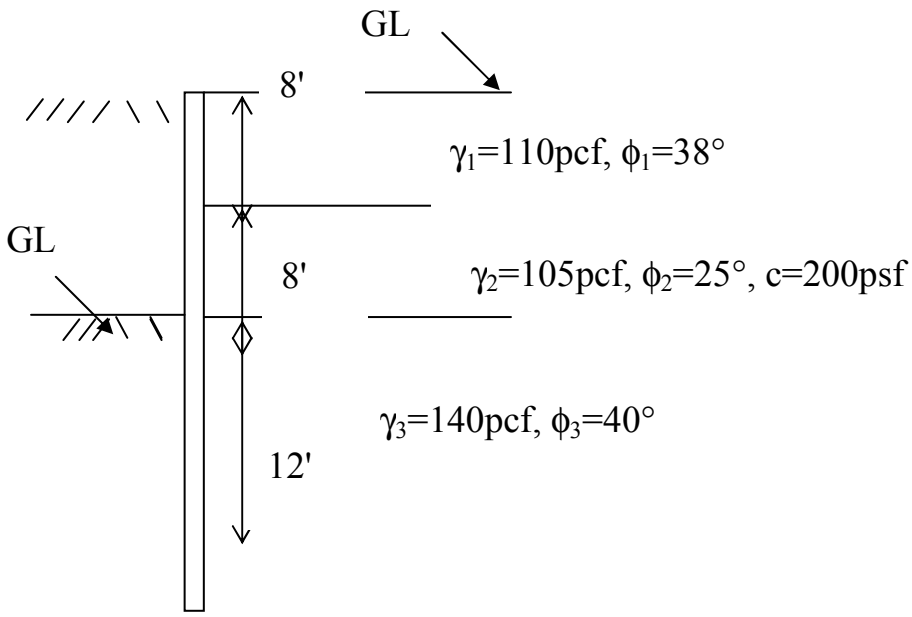
$P_h = 94.2\cos(24+10) = 78.1\ kN$

$P_v = 94.2\sin(24+10) = 52.7kN$

Example 8

Find active pressure and passive resistance for the rigid frictionless wall shown.

Solution

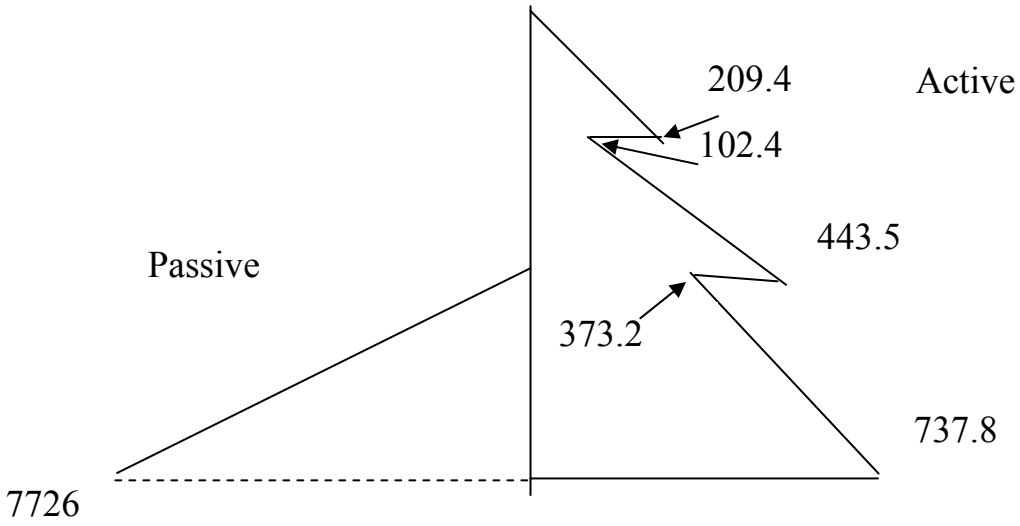


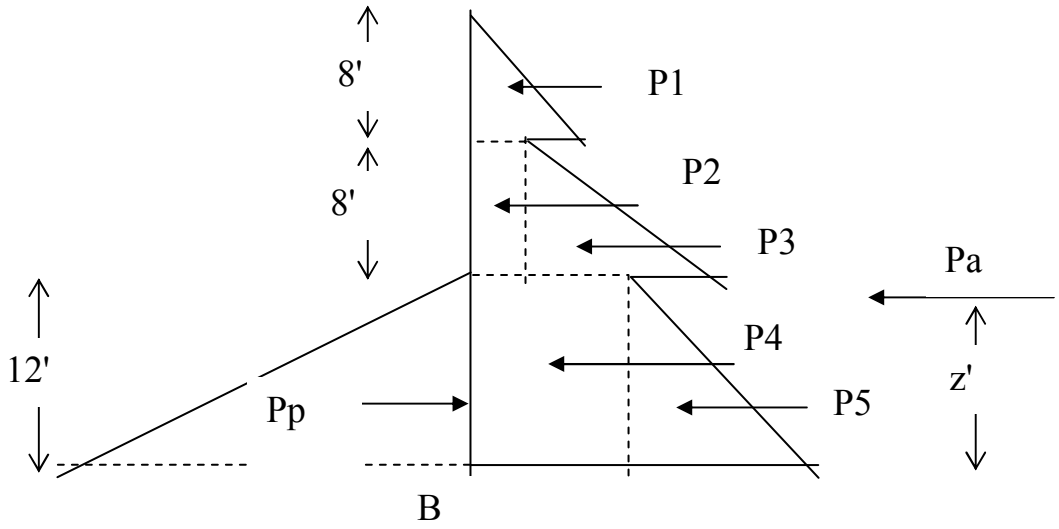
K_{a1} = 0.238 K_{a2} =0.406 K_{a3}=0.217

ft	σ'_v psf	$\sigma_a = \sigma_v K_a - 2c\sqrt{K_a}$ psf
0	0	0
8	110x8=880	209.4 (soil-1)
		102.4 (soil-2)
16	880+8x105=1720	443.5 (soil-2)
		373.2(soil-3)
28	1720+12x140=3400	737.8

$K_{p3} = 4.599$

ft	σ'_v psf	$\sigma_a = \sigma_v K_a + 2c\sqrt{K_a}$ psf
12'	12x140=1680	7726





force	magnitude	Force lb.	From B ft	Moment ft-lb
P1	8x209.4/2	837.6	12+8+8/3	18986
P2	102.4x8	819.2	12+8/2	13107
P3	(443.5-102.4)x8/2	1364.4	12+8/3	20011
P4	373.2x12	4478	12/2	26870
P5	(737.8-373.2)12/2	2187.6	12/3	8750
	ΣP_a	9688	ΣM	87725

z' = 87725/9688 = 9.06'

P_p = 7726x12/2 = 46358 lb., Acts at 4' above the wall base