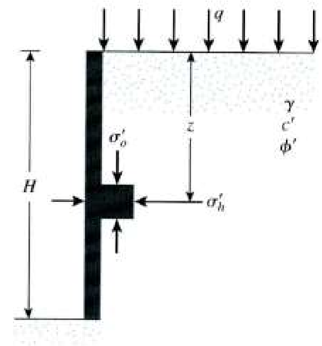
HW#8 Ch.7 Problems 1,6-10, and 15 Due 11/13/13

GIVEN FIND

7.1 Refer to Figure 7.3a. Given: $H = 3.5$ m, $q = 20$ kN/m^2, $\gamma = 18.2$ kN/m^3 $c' = 0$, and $\phi' = 35°$. Determine the at-rest lateral earth force per meter length of the wall. Also, find the location of the resultant. Use Eq. (7.4) and OCR = 1.5.



(a)

$H := 3.5 \quad q := 20 \quad \gamma := 18.2 \quad c' := 0 \quad \phi' := 35\text{deg} \quad OCR := 1.5$

$Ko := (1 - \sin(\phi'))\cdot OCR^{\sin(\phi')} = 0.538$ Eq 7.4

METHOD

1. Calculate Ko using Eq 7.4 since we have overconsolidated soil
2. Calculate effective stress (in this case equal to stress since "no water table"
3. Determine Force Eq 7.5
4. determine Location using Eq 7.6

SOLUTION

Force due to load: $P1 := H\cdot Ko\cdot q = 37.665$ Force due to the soil: $P2 := 0.5\cdot Ko\cdot\gamma\cdot H^2 = 59.982$

The at-rest lateral earth force $Po := P1 + P2 = 97.647$

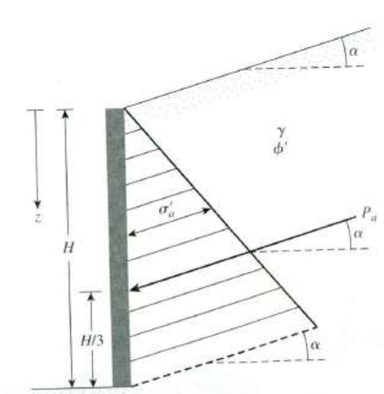
Location : $\bar{z} := \dfrac{\left[P1\cdot\left(\dfrac{H}{2}\right) + P2\cdot\left(\dfrac{H}{3}\right)\right]}{Po} = \blacksquare$ m

GIVEN FIND

7.6 Refer to Figure 7.10. For the retaining wall, $H = 6$ m, $\phi' = 34°$, $\alpha = 10°$, $\gamma = 17$ kN/m^3, and $c' = 0$.

a. Determine the intensity of the Rankine active force at $z = 2$ m, 4 m, and 6 m.

b. Determine the Rankine active force per meter length of the wall and also the location and direction of the resultant.



$H := 6\text{ m} \quad \phi' := 34\text{deg} \quad \alpha := 10\text{deg} \quad \gamma := 17\,\dfrac{kN}{m^3}$

$c' := 0$

PART A: $z1 := 2\text{ m} \quad z2 := 4\text{ m} \quad z3 := 6\text{ m}$

METHOD

1. Determine the Ka, active earth-pressure coefficient using EQ 7.19
2. Determine the Rankine active pressure at any depth z, with Eq 7.20
3. Determine the active force per unit length of the wall using Eq 7.21

SOLUTION

$$Ka := \cos(\alpha)\cdot\frac{\left[\cos(\alpha) - \sqrt{\left[\cos(\alpha)^2 - \left[\cos((\phi'))^2\right]\right]}\right]}{\cos(\alpha) + \sqrt{(\cos(\alpha))^2 - (\cos(\phi'))^2}} = 0.294$$

PART A:

$\sigma'1 := \gamma\cdot z1\cdot Ka = 10.009$

$\sigma'2 := \gamma\cdot z2\cdot Ka = 20.017$ $\frac{kN}{m^2}$

$\sigma'3 := \gamma\cdot z3\cdot Ka = 30.026$

PART B:

$Pa := .5\cdot\gamma\cdot H^2\cdot Ka = 90.078$ $\frac{kN}{m}$

7.7 Refer to Figure 7.10. Given: $H = 22$ ft $\gamma = 115$ lb/ft^3, $\phi' = 25°$, $c' = 250$ lb/ft^2, and $\alpha = 10°$. Calculate the Rankine active force per unit length of the wall after the occurrence of the tensile crack.

GIVEN $H := 22$ $\phi' := 25deg$ $\alpha := 10deg$ $\gamma := 115$ $c' := 250$

METHOD
1. Determine the depth of the tensile crack using Eq 7.24
2. Determine the factor c'/y*z in order to determine Ka with Table 7.2
3. Determine Ka using Table 7.2
4. Determine the rankine active force using equation 7.22

SOLUTION

$$zr := \frac{2c'}{\gamma}\cdot\sqrt{\frac{1+\sin(\phi')}{1-\sin(\phi')}} = 6.825 \quad ft$$ Eq 7.24

$$factor2 := \left(\frac{c'}{\gamma\cdot H}\right) = 0.099$$ $Ka' := 0.297$

$\sigma'a := \gamma\cdot H\cdot Ka'\cdot\cos(\alpha) = 739.994$

$Pa := .5\cdot\sigma'a\cdot(H - zr) = 5.615\times 10^3$ $\frac{lb}{ft^3}$

GIVEN FIND

7.8 Refer to Figure 7.12a. Given: $H = 12$ ft, $\gamma = 105$ lb/ft^3, $\phi' = 30°$, $c' = 0$, and $\beta = 85°$. Determine the Coulomb's active force per foot length of the wall and the location and direction of the resultant for the following cases:

a. $\alpha = 10°$ and $\delta' = 20°$

b. $\alpha = 20°$ and $\delta' = 15°$

$H := 12$ ft $\gamma := 105$ $\phi' := 30$ $c' := 0$ $\beta := 85$

$\alpha a := 10deg$ $\delta'a := 20deg$ $Ka1 := .3857$ Table 7.4

$\alpha b := 20deg$ $\delta'b := 15deg$ $Ka2 := .4708$ Table 7.5

METHOD

1. Determine Ka using Table 7.4/7.5
2. Determine the active force Pa using Eq 7.25
3. Determine location of force given

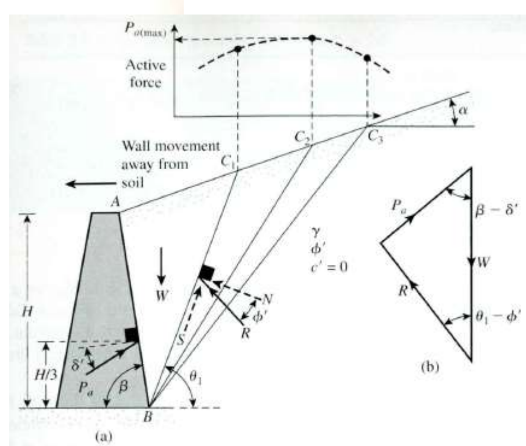


Figure 7.12 Coulomb's active pressure

SOLUTION

PART A:

$Pa := .5 \cdot Ka1 \cdot \gamma \cdot H^2 = 2.916 \times 10^3 \ \frac{lb}{ft}$

$z := \frac{H}{3} = 4 \ \ m$

$angle := 90 - \beta + \delta'a = 5.349$ up from horizontal

PART B:

$Pa := .5 \cdot Ka2 \cdot \gamma \cdot H^2 = 3.559 \times 10^3$

$z := \frac{H}{3} = 4 \ m$

$angle := 90 - \beta + \delta'b = 5.262$ up from horizontal

GIVEN FIND

7.9 Refer to Figure 7.13a. Given $H = 3.5$ m, $\alpha = 0$, $\beta = 85°$, $\gamma = 18$ kN/m³, $c' = 0$, $\phi' = 34°$, $\delta'/\phi' = 0.5$, and $q = 30$ kN/m². Determine the Coulomb's active force per unit length of the wall.

$H := 3.5 \quad q := 30 \quad \gamma := 18 \quad \alpha := 0 \quad \beta := 85deg \quad c' := 0 \quad \phi' := 34deg \quad \frac{\delta'}{\phi'} := 0.5 \quad \delta' := \frac{34}{2} = 17$

METHOD
1. Determine Ka using Table 7.5 (since $\frac{\delta'}{\phi'}$=0.5)
2. Determine γeq using Eq 7.28
3. Determine the active force Pa using Eq 7.27 given the surcharge of intensity q located above the backfill

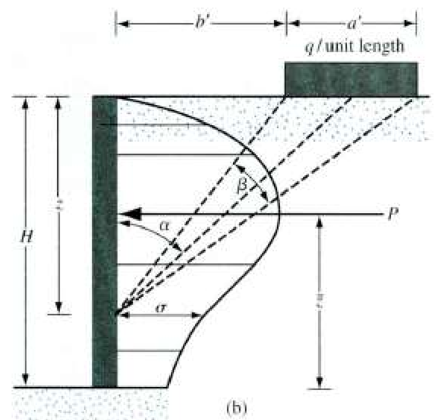
SOLUTION $Ka := 0.2925$

$$\gamma eq := \gamma + \left(\frac{\sin(\beta)}{\sin(\beta + \alpha)}\right) \cdot \left(2 \cdot \frac{q}{H}\right) = 35.143 \ \frac{kN}{m^3}$$

$$Pa := 0.5 \cdot Ka \cdot \gamma eq \cdot H^2 = 62.961$$

GIVEN FIND

7.10 Refer to Figure 7.14b. Given $H = 3.3$ m, $a' = 1$ m, $b' = 1.5$ m, and $q = 25$ kN/m. Determine the lateral force per unit length of the unyielding wall caused by the surcharge loading only.



$H := 3.3 \ m \quad a' := 1 \quad b' := 1.5 \quad q := 25 \ \frac{kN}{m^2}$

METHOD
1. Determine angles θ1 and θ2 using Eq. 7.35 and 7.36
2. Determine force per unit length, using Eq 7.34

SOLUTION

$\theta1' := atan\left(\frac{b'}{H}\right) = 0.427 \qquad \theta2' := atan\left(\frac{a' + b'}{H}\right) = 0.648$

$\theta1 := \theta1' \cdot \frac{180}{\pi} = 24.444 \qquad \theta2 := \theta2' \cdot \frac{180}{\pi} = 37.147$

$$P := [H \cdot (\theta2 - \theta1)] \cdot \frac{q}{90} = 11.644 \ \frac{kN}{m}$$

GIVEN   FIND

7.15 In Figure 7.28, which shows a vertical retaining wall with a horizontal backfill, let $H = 4$ m, $\theta = 25°$, $\gamma = 16.5$ kN/m³, $\phi' = 35°$, and $\delta' = 10°$. Based on Zhu and Qian's work, what would be the passive force per meter length of the wall?

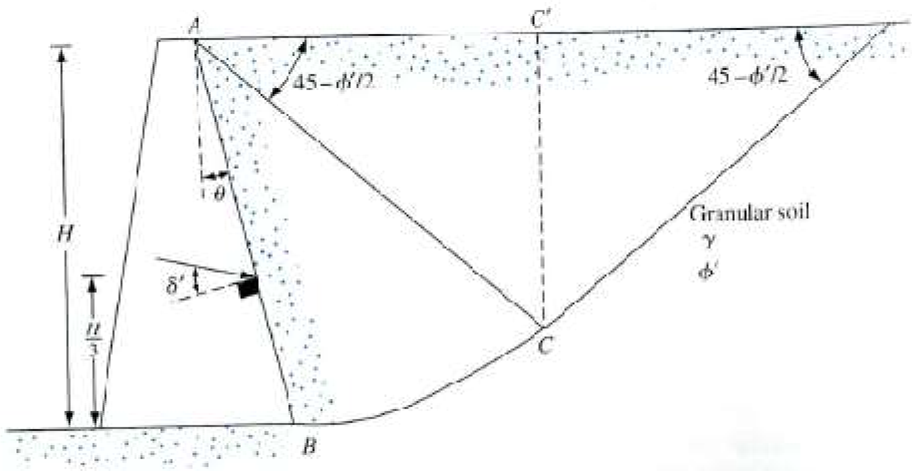


Figure 7.28 Passive pressure solution by the method of triangular slices

$\theta := 25deg$ $\phi' := 35deg$

$\delta' := 10deg$

$H := 4 \quad m^2$ $\gamma := 16.5 \quad \frac{kN}{m^3}$

$\frac{\delta'}{\phi'} = 0.286$

METHOD   1. Determine Kp (passive earth-pressure coefficient for the given angles values above)

$Kp1 := 2.37$ Table 7.11 $R := 1.25$ Table 7.12 $Kp := Kp1 \cdot R = 2.963$ Eq7.73

To determine R, it was necessary interpolate between the values of 0.2 and 0.4 for the angle. Also, in the textbook, a value of θ=25deg is not given on the table, thus the value obtained for R was averaged given the trends on the table.

2. Determine passive force using Eq 7.72

SOLUTION $Pp := .5 \cdot Kp \cdot \gamma \cdot H^2 = 391.05 \quad \frac{kN}{m}$