Problems

12.1–12.6 Assuming that the wall shown in Figure 12.37 is restrained from yielding, find the magnitude and location of the resultant lateral force per unit width of the wall.

Problem	H	γ	ϕ'
12.1	10 ft	110 lb/ft^3	32°
12.2	12 ft	98 lb/ft^3	28°
12.3	18 ft	100 lb/ft^3	40°
12.4	3 m	17.6 kN/m^3	36°
12.5	4.5 m	19.95 kN/m^3	42°
12.6	5.5 m	17.8 kN/m^3	37°

12.7 Consider a 5-m-high retaining wall that has a vertical back face with a horizontal backfill. A vertical point load of 10 kN is placed on the ground surface at a distance of 2 m from the wall. Calculate the increase in the lateral force on the wall for the section that contains the point load. Plot the variation of

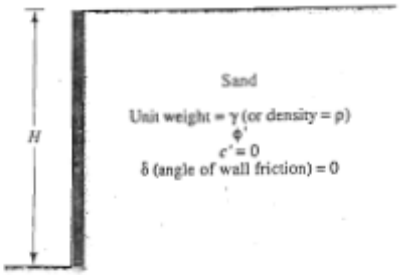

Figure 12.37

the pressure increase with depth. Use the modified equation given in Section 12.4.

12.8–12.11 Assume that the retaining wall shown in Figure 12.37 is frictionless. For each problem, determine the Rankine active force per unit length of the wall, the variation of active earth pressure with depth, and the location of the resultant.

Problem	H	ϕ' (deg)	γ
12.8	15 ft	30	105 lb/ft^3
12.9	18 ft	32	100 lb/ft^3
12.10	4 m	36	18 kN/m^3
12.11	5 m	40	17 kN/m^3

12.12–12.14 A retaining wall is shown in Figure 12.38. For each problem, determine the Rankine active force, P_a, per unit length of the wall and the location of the resultant.

Problem	H	H_1	γ_1	γ_2	ϕ'_1 (deg)	ϕ'_2 (deg)	q
12.12	10 ft	5 ft	105 lb/ft^3	122 lb/ft^3	30	30	0
12.13	20 ft	6 ft	110 lb/ft^3	126 lb/ft^3	34	34	300 lb/ft^2
12.14	6 m	3 m	15.5 kN/m^3	19.0 kN/m^3	30	36	15 kN/m^2

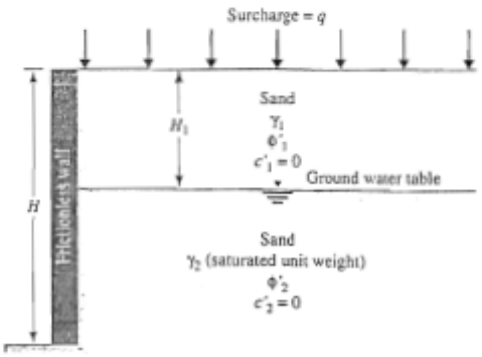

Figure 12.38

12.15 A 15-ft-high retaining wall with a vertical back face retains a homogeneous saturated soft clay. The saturated unit weight of the clay is 122 lb/ft^3. Laboratory tests showed that the undrained shear strength c_u of the clay is equal to 350 lb/ft^2.

- **a.** Make the necessary calculations and draw the variation of Rankine's active pressure on the wall with depth.
- **b.** Find the depth up to which a tensile crack can occur.
- **c.** Determine the total active force per unit length of the wall before the tensile crack occurs.
- **d.** Determine the total active force per unit length of the wall after the tensile crack occurs. Also find the location of the resultant.

12.16 Redo Problem 12.15 assuming that the backfill is supporting a surcharge of 200 lb/ft^2.

12.17 A 5-m-high retaining wall with a vertical back face has a c'-ϕ' soil for backfill. For the backfill, $\gamma = 19$ kN/m^3, $c' = 26$ kN/m^2, and $\phi' = 16°$. Considering the existence of the tensile crack, determine the active force P_a on the wall for Rankine's active state.

12.18 For the retaining wall shown in Figure 12.39, determine the active force P_a for Rankine's state. Also, find the position of the resultant. Assume that the tensile crack exists.

$\rho = 2100$ kg/m^3, $\phi = 0°$, $c = c_u = 30.2$ kN/m^2

12.19 Repeat Problem 12.18 using the following values:

$\rho = 1950$ kg/m^3, $\phi' = 18°$, $c' = 19.4$ kN/m^2

12.20–12.23 Assume that the retaining wall shown in Figure 12.37 is frictionless. For each problem, determine the Rankine passive force per unit length of the wall, the variation of lateral pressure with depth, and the location of the resultant.

Problem	H	ϕ' (deg)	γ
12.20	8 ft	34	110 lb/ft^3
12.21	10 ft	36	105 lb/ft^3
12.22	5 m	35	14 kN/m^3
12.23	4 m	30	15 kN/m^3

12.24 For the retaining wall described in Problem 12.12, determine the Rankine passive force per unit length of the wall and the location of the resultant.

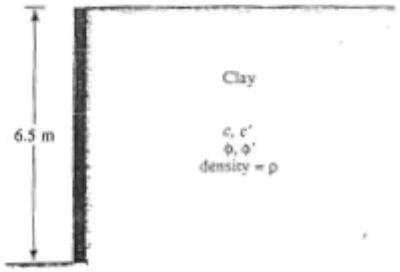

Figure 12.39

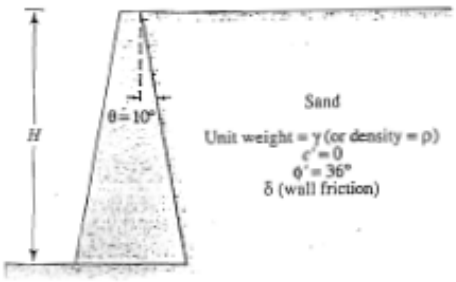

Figure 12.40

12.25 For the retaining wall described in Problem 12.13, determine the Rankine passive force per unit length of the wall and the location of the resultant.

12.26 A retaining wall is shown in Figure 12.40. The height of the wall is 5 m, and the unit weight of the sand backfill is 18 kN/m^3. Using Coulomb's equation, calculate the active force P_a on the wall for the following values of the angle of wall friction:

a. $\delta = 18°$

b. $\delta = 24°$

Comment on the direction and location of the resultant.

12.27 Referring to Figure 12.41, determine Coulomb's active force P_a per unit length of the wall for the following cases:

a. $H = 15$ ft, $\beta = 85°$, $n = 1$, $H_1 = 20$ ft, $\gamma = 128$ lb/ft^3, $\phi' = 38°$, $\delta = 20°$

b. $H = 18$ ft, $\beta = 90°$, $n = 2$, $H_1 = 22$ ft, $\gamma = 116$ lb/ft^3, $\phi' = 34°$, $\delta = 17°$

c. $H = 5.5$ m, $\beta = 80°$, $n = 1$, $H_1 = 6.5$ m, $\gamma = 1680$ kg/m^3, $\phi' = 30°$, $\delta = 30°$

Use Culmann's graphic construction procedure.

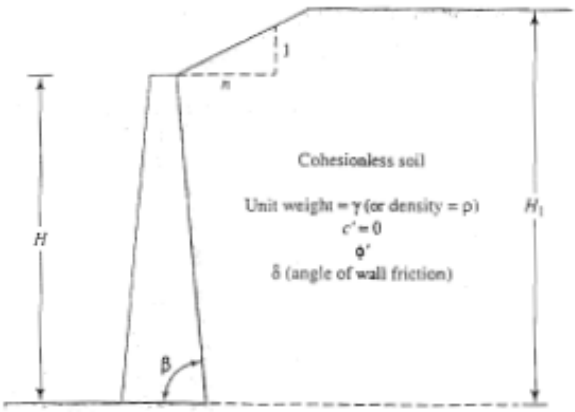

Figure 12.41

12.28 Refer to Figure 12.26. Given that $H = 6$ m, $\theta = 0°$, $\alpha = 0°$, $\gamma = 15$ kN/m^3, $\phi' = 35°$, $\delta = 2/3\ \phi'$, $k_h = 0.3$, and $k_v = 0$, determine the active force P_{ae} per unit length of the retaining wall.

12.29 Refer to Problem 12.28. Determine the location of the point of intersection of the resultant force P_{ae} with the back face of the retaining wall.

12.30 Repeat Problem 12.28 with the following Values: $H = 10$ ft, $\theta = 10°$, $\alpha = 10°$, $\gamma = 110$ lb/ft^3, $\phi' = 30°$, $\delta = 10°$, $k_h = 0.25$, and $k_v = 0$.

12.31 Refer to Figure 12.29. Given that $H = 6$ m, $\theta = 10°$, $\phi' = 15°$, $c' = 20$ kN/m^2, $\gamma = 19$ kN/m^3, and $k_h = 0.15$, using the method described in Section 12.13, determine P_{ae}. Assume that the depth of tensile crack is zero.

12.32 Repeat Problem 12.31 with the following Values: $H = 10$ ft, $\theta = 5°$, $\phi' = 20°$, $c' = 200$ lb/ft^2, $\gamma = 100$ lb/ft^3, and $k_h = 0.25$.