Chapter 14

14.1 $P_p = \frac{1}{2}K_p\gamma H^2$; $K_p = K_{p(\delta'=0)}R$. With $\phi' = 30°$, $\theta = 15°$, and $\alpha = 0$, the value of $K_{p(\delta'=0)} = 2.34$ (Table 14.2). With $\theta = 15°$, $\delta' = 18°$, $\delta'/\phi' = 18/30 = 0.6$, the value of R is 1.55 (Table 14.3). So,

$$P_p = \frac{1}{2}(2.34 \times 1.55)(17.8)(5)^2 \approx \mathbf{807\ kN/m}$$

14.2 $P_p = \frac{1}{2}K_p\gamma H^2$. From Figure 14.5, for $\phi' = 35°$ and $\delta' = 23.33°$, $\delta'/\phi' = 0.666$, the value of K_p is about 6.2. So,

$$P_p = \frac{1}{2}(6.2)(112)(14)^2 = \mathbf{68{,}051\ lb/ft}$$

14.3 $P_p = \frac{1}{2}K_p\gamma H^2$. From Figure 14.4, for $\phi' = 30°$ and $\delta' = 20°$, the value of K_p is about 5.5. So,

$$P_p = \frac{1}{2}(5.5)(19)(4)^2 = \mathbf{836\ kN/m}$$

14.4 From Table 14.2, for $\phi' = 30°$ and $\theta = 0$, the value of $K_{p(\delta'=0)} = 3.0$. For $\theta = 0$ and $\delta'/\phi' = 20/30 = 0.667$, the value of R is about 1.75. So

$$P_p = \frac{1}{2}(3 \times 1.75)(19)(4)^2 \approx \mathbf{798\ kN/m}$$

14.5 From Equation (14.15): $P_p = \frac{1}{2}\gamma H^2 K_p$

Step 1: $\dfrac{\alpha}{\phi'} = \dfrac{10}{30} = 0.333$

Step 2: From Figure 14.7: $K_{p(\delta'=\phi')} \approx 8.5$

Step 3: $\dfrac{\delta'}{\phi'} = \dfrac{18}{30} = 0.6$

Step 4: From Table 14.4: $R' = 0.811$

Step 5: $K_p = (R')\left[K_{p(\delta'=\phi')}\right] = (0.811)(8.5) = 6.893$

$$P_p = \frac{1}{2}(16.8)(4.75)^2(6.893) \approx \mathbf{1306\ kN/m}$$

14.6 Eq. (14.16): $P_{pe} = \left[\dfrac{1}{2}\gamma H^2 K_{p\gamma(e)}\right]\dfrac{1}{\cos\delta'}$

For $k_v = 0$, $k_h = 0.25$, $\delta'/\phi' = 15/30 = 0.5$, the value of $K_{p\gamma(e)} \approx 3.95$.

$$P_{pe} = \left[(0.5)(118)(15)^2(3.95)\right]\frac{1}{\cos 15} = \mathbf{54{,}286\ lb/ft}$$

14.7 $n_a = \dfrac{2.75\text{ m}}{5.5\text{ m}} = 0.5$. $\phi' = 40^\circ$; $\delta' = 15^\circ$. Table 14.5: $\dfrac{P_a}{0.5\gamma H^2} = 0.216$

$P_a = (0.216)(0.5)(15.8)(5.5)^2 = \mathbf{51.61\ kN/m}$

14.8 $n_a = \dfrac{6.5\text{ ft}}{21\text{ ft}} \approx 0.3$; $\dfrac{c'}{\gamma H} = \dfrac{255}{(121)(21)} = 0.1$

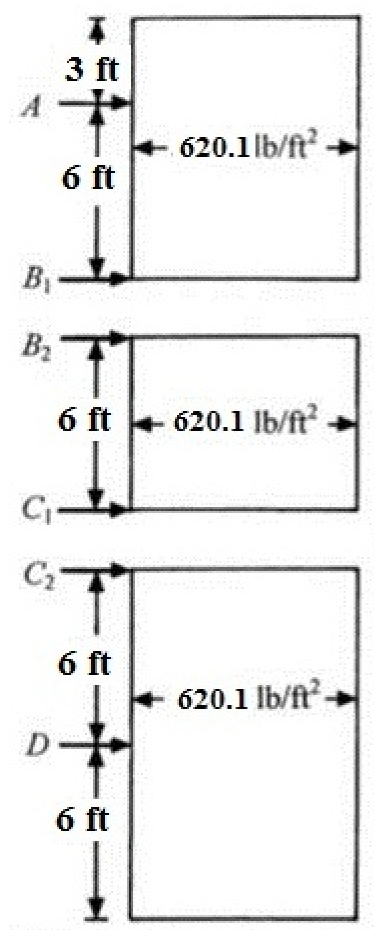
From Table 14.6 for $\phi' = 25^\circ$ and $\delta' = 15^\circ$, $\dfrac{P_a}{0.5\gamma H^2} = 0.085$.

$P_a = (0.085)(0.5)(121)(21)^2 \approx \mathbf{2268\ lb/ft}$

14.9 $\sigma_a = 0.65\gamma H \tan^2\left(45 - \frac{\phi'}{2}\right)$

$$= (0.65)(115)(27)\tan^2\left(45 - \frac{32}{2}\right)$$

$$= \mathbf{620.1\ lb/ft^2}$$



$\sum M_{B_1} = 0$

$$A = \left(\frac{1}{6}\right)\left[(620.1)(9)\left(\frac{9}{2}\right)\right] = 4185.6 \text{ lb/ft}$$

$B_1 = (620.1)(9) - 4185.6 = 1395.3$ lb/ft

$$B_2 = C_1 = \frac{(620.1)(6)}{2} = 1860.3 \text{ lb/ft}$$

$\sum M_{C_2} = 0$

$$D = \left(\frac{1}{6}\right)\left[(620.1)(12)\left(\frac{12}{2}\right)\right] = 7441.2 \text{ lb/ft}$$

$C_2 = (620.1)(12) - 7441.2 = 0$ lb/ft

Strut Loads:

$A = (4185.6)(10) \approx$ **41,856 lb**

$B = (B_1 + B_2)(10)$

$= (1395.3 + 1860.3)(10) \approx$ **32,556 lb**

$C = (C_1 + C_2)(10)$

$= (1860.3 + 0)(10) =$ **18,603 lb**

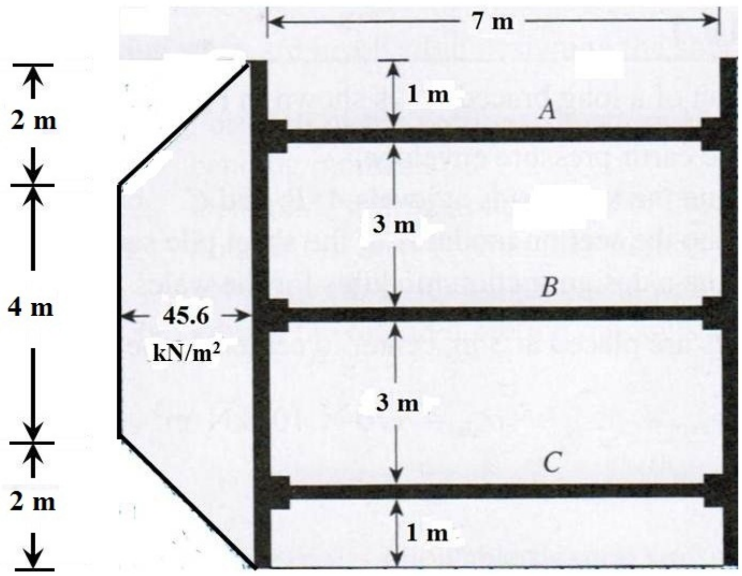
$D = (7441.2)(10) =$ **74,412 lb**

14.10 a. $\dfrac{\gamma H}{c} = \dfrac{(19)(8)}{42} = 3.61 < 4$

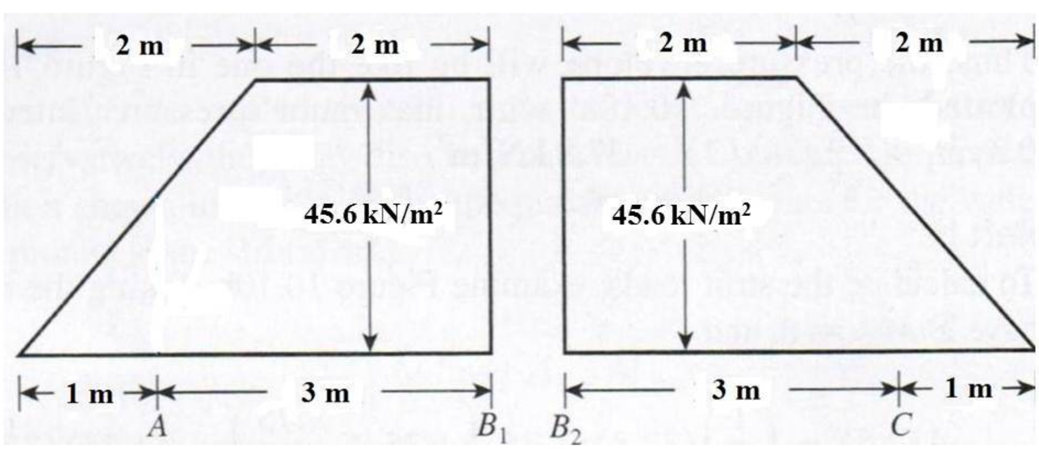
Use Figure 14.14(c) to determine the earth pressure envelope.

Maximum pressure intensity: $\sigma_a = 0.3\gamma H = (0.3)(19)(8) = 45.6 \text{ kN/m}^2$

The pressure envelope is shown below.



b. To determine the strut loads, refer to the following diagram.



$$\sum M_{B_1} = 0$$

$$A(3) - (0.5)(45.6)(2)\left(2 + \frac{2}{3}\right) - (2)(45.6)\left(\frac{2}{2}\right) = 0$$

Therefore, A = 70.93 kN/m

Also, sum of vertical forces, $\sum V = 0$

$$A + B_1 = (0.5)(45.6)(2) + (45.6)(2)$$

or

$$70.93 + B_1 = 136.8$$

Therefore, $B_1 = 65.87$ kN/m

Due to symmetry, $B_2 = 65.87$ kN/m

and

C = 70.93 kN/m

Strut load at A = (70.93)(s) = (70.93)(3.5) = **248.25 kN**

Strut load at B = (B_1 + B_2)(s) = (65.87+65.87)(3.5) = **461.09 kN**

Strut load at C = (70.93)(3.5) = **248.25 kN**