Problem #1: Refer to Figure P9.1. Given: $L_1 = 3m$; $L_2 = 6m$; $\gamma = 17.3\ kN/m^3$; $\phi' = 30^0$; $\gamma_{sat} = 19.4\ kN/m^3$

$\gamma' = \gamma_{sat} - \gamma_w = 19.4 - 9.81 = \underline{9.59\ kN/m^3}$

(a) What is the theoretical depth of embedment, D?

(b) For a 30% increase in D, what should be the total length of the sheet piles?

(c) Determine the theoretical maximum moment of the sheet pile wall.

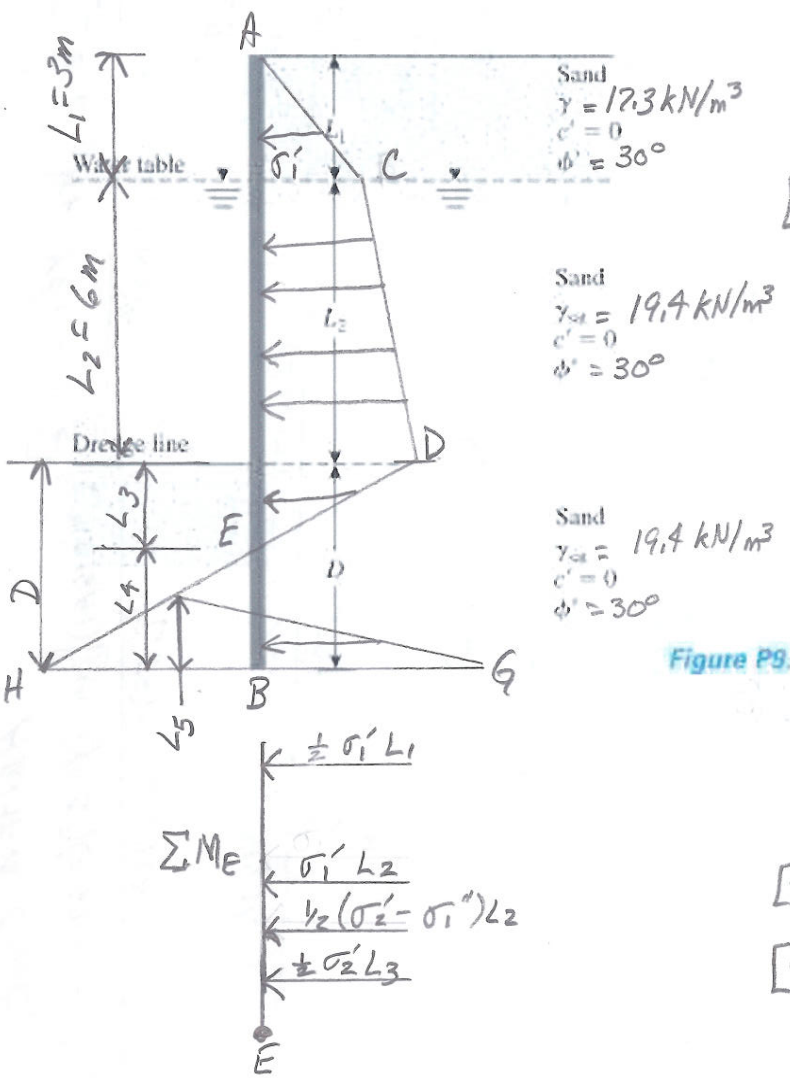

Figure P9.1

$K_a = \tan^2(45 - \frac{\phi'}{2}) = \tan^2(45 - \frac{30}{2}) = \underline{0.33}$

$K_p = \tan^2(45 + \frac{\phi'}{2}) = \tan^2(45 + \frac{30}{2}) = \underline{3}$

$K_p - K_a = 3 - 0.33 = \underline{2.67}$

[9.1] $\sigma_1' = \gamma L_1 K_a = (17.3)(3)(0.33) = \underline{17.13\ kN/m^2}$

[9.2] $\sigma_2' = (\gamma L_1 + \gamma' L_2)K_a = [(17.3)(3) + (9.59)(6)]\,0.33 = \underline{36.12\ kN/m^2}$

[9.6] $L_3 = \dfrac{\sigma_2'}{\gamma'(K_p - K_a)} = \dfrac{36.12}{(9.59)(2.67)} = \underline{1.41\ m}$

$P = \frac{1}{2}\sigma_1' L_1 + \sigma_1' L_2 + \frac{1}{2}(\sigma_2' - \sigma_1')L_2 + \frac{1}{2}\sigma_2' L_3$

$P = \frac{1}{2}(17.13)(3) + (36.12)(6) + \frac{1}{2}(36.12 - 17.13)(6) + \frac{1}{2}(36.12)(1.41)$

$\underline{P = 216.41\ kN/m}$

$\bar{z} = \dfrac{\Sigma M_E}{P} = \dfrac{(.5)(17.13)(3)(8.42) + (17.13)(6)(4.42) + \frac{1}{2}(36.12 - 17.13)(6)(3.42) + \frac{1}{2}(36.12)(1.41)(0.95)}{216.41}$

$\underline{\bar{z} = 4.12\ m}$

[9.11] $\sigma_5' = (\gamma L_1 + \gamma' L_2)K_p + \gamma' L_3(K_p - K_a)$

$\sigma_5' = [(17.3)(3) + (9.59)(6)](3) + (9.59)(1.41)(2.67)$

$\underline{\sigma_5' = 364.42\ kN/m^2}$

[9.17] $A_1 = \dfrac{\sigma_5'}{\gamma'(K_p - K_a)} = \dfrac{364.42}{(9.59)(2.67)} = \underline{14.23\ m^2}$

[9.18] $A_2 = \dfrac{8P}{\gamma'(K_p - K_a)} = \dfrac{(8)(216.41)}{(9.59)(2.67)} = \underline{67.61\ m^2}$

over

HW#4 Cont,

[9.19] $A_3 = \dfrac{6P[2\bar{z}\gamma'(k_p - k_a) + \sigma_5']}{\gamma'^2 (k_p - k_a)^2} = \dfrac{(6)(216.41)[2(4.12)(9.59)(2.67) + 364.42]}{(9.59)^2 (2.67)^2}$

$A_3 = \underline{117.27\ m^2}$

[9.20] $A_4 = \dfrac{P(6\bar{z}\sigma_5' + 4P)}{\gamma'^2 (k_p - k_a)} = \dfrac{(216.41)[6(4.12)(364.42) + 4(216.41)]}{(9.59)^2 (2.67)}$

$A_4 = \underline{3259.23\ m^2}$

[9.16] L_4 $\quad L_4^4 + A_1 L_4^3 - A_2 L_4^2 - A_3 L_4 - A_4 = 0$

$L_4^4 + 14.23 L_4^3 - 67.61 L_4^2 - 117.27 L_4 - 3259.23 = 0$

$\underline{L_4 = 9m}$

a) $D_{theory} = L_3 + L_4 = 1.41 + 9 = \boxed{10.41m}$

b) $L_1 + L_2 + 1.3(L_3 + L_4) = 3 + 6 + 1.3(1.41 + 9) = \boxed{22.53m}$

[9.21] c) $z' = \sqrt{\dfrac{2P}{(k_p - k_a)\gamma'}} = \sqrt{\dfrac{(2)(216.41)}{(2.67)(9.59)}} = \underline{4.11m}$

[9.22] $M_{max} = P(\bar{z} + z') - \left[\frac{1}{2}\gamma' z'^2 (k_p - k_a)\right]\frac{z'}{3}$

$= (216.41)(4.12 + 4.11) - \left[\frac{1}{2}(9.59)(4.11)^2(2.67)\right]\frac{4.11}{3}$

$\boxed{M_{max} = 1{,}485.50\ kN \cdot m/m}$

ENCE 4340 Foundation Engineering Fall 2011 Homework #4 (due: 10-31-2011)

Problem # 2 : Refer to Figure P9.10. Given : $L_1 = 2m; L_2 = 6m; l_1 = 1m; \gamma = 16\ kN/m^3; \phi' = 32^0;$

$\gamma_{sat} = 18.86\ kN/m^3; c = 27 kN/m^2$

(a) Determine the theoretical depth of embedment, D.

(b) Calculate the anchor force per unit length of the sheet pile wall

Use the free earth support method

$\gamma' = 18.86 - 9.81 = \underline{9.05\ kN/m^3}$

$k_a = \tan^2(45 - \frac{\phi'}{2}) = \tan^2(45 - \frac{32}{2}) = \underline{0.307}$

$k_p = \tan^2(45 + \frac{\phi}{2}) = \tan^2(45 + \frac{32}{2}) = \underline{3.255}$

$k_p - k_a = 3.255 - 0.307 = \underline{2.948}$

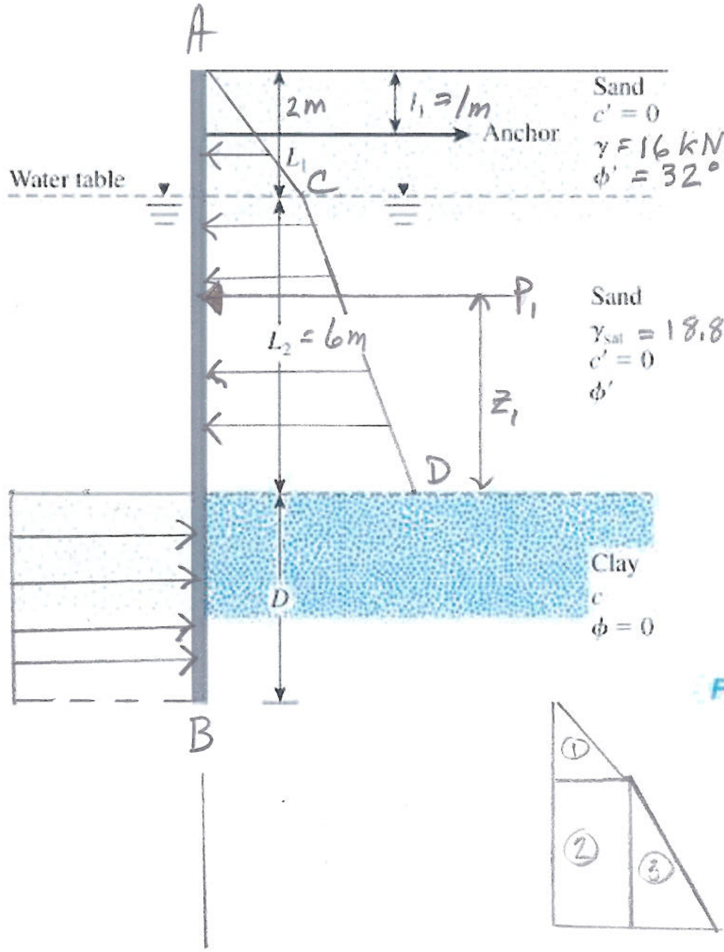

Figure P9.10

[9.1] $\sigma_1' = \gamma L_1 k_a = (16)(2)(0.307) = \underline{9.82\ kN/m^2}$

[9.2] $\sigma_2' = (\gamma L_1 + \gamma' L_2) k_a = [(16)(2) + (9.05)(6)]\, 0.307 = \underline{26.5\ kN/m^2}$

[9.6] $L_3 = \dfrac{\sigma_2'}{\gamma'(k_p - k_a)} = \dfrac{26.5}{(9.05)(2.948)} = \underline{0.99\ m}$

$P_1 =$ areas $1 + 2 + 3 = \frac{1}{2}(2)(9.82) + (9.82)(6) + \frac{1}{2}(26.5 - 9.82)(6)$

$\underline{P_1 = 118.8\ kN/m}$

$\bar{z}_1 = \dfrac{\Sigma M}{P} = \dfrac{(9.82)(6.67) + (58.92)(3) + (50.04)(2)}{118.8}$

$\underline{\bar{z}_1 = 2.88\ m}$

$\sigma_6 = 4c - (\gamma L_1 + \gamma' L_2) = 4(27) - [(16)(2) + (9.05)(6)] = \underline{21.7\ kN/m^2}$

D_{theory}: $\sigma_6' D^2 + L_1 \sigma_6' D (L_1 + L_2 - l_1) - L_1 P_1 (L_1 + L_2 - l_1 - \bar{z}_1') = 0$

$21.7 D^2 + (2)(21.7)(2 + 6 - 1) D - (2)(118.8)(2 + 6 - 1 - 2.88) = 0$

$\boxed{D_{theory} = 2.7\ m}$

[9.84] $F = P_1 - \sigma_6 D = 118.8 - (21.7)(2.7)$

$\boxed{F = 60.2\ kN/m}$