ENCE 4340 Foundation Engineering Fall 2011 Class Test # 2 (11-7-2011) Name: Brandon Nowakowski

Problem 1: Refer to the following figure. Given : $\gamma = 18\ \text{kN/m}^3$; $\phi' = 40^0$; $c' = 0$ and center to center strut spacing in the plan = 4m. Draw the earth pressure envelope and determine the strut loads at levels A, B, and C.

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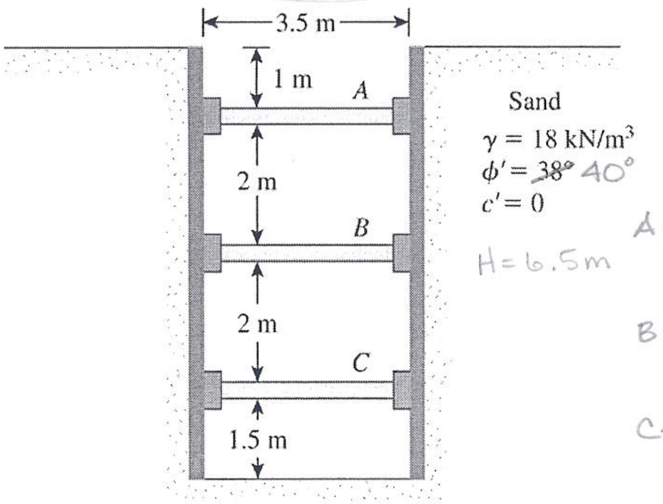
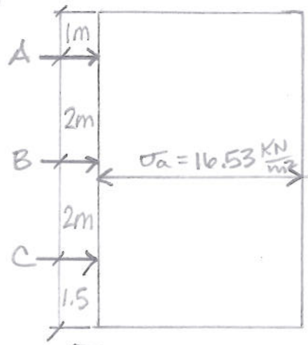
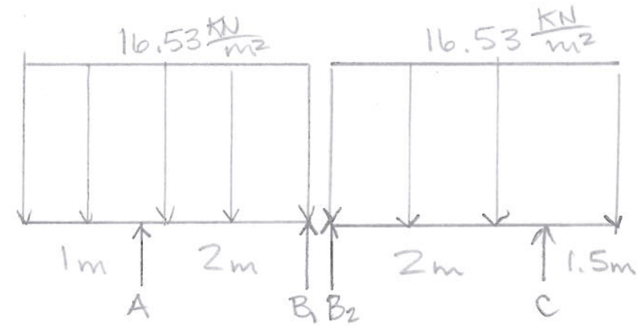


Figure P10.3

$K_a = \tan^2\left(45 - \frac{\phi'}{2}\right) = \tan^2\left(45 - \frac{40}{2}\right) = 0.2174$

$\sigma_a = 0.65\,\gamma H K_a = 0.65(18)(6.5)\,0.2174 = 16.53\ \text{KN/m}^2$





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$\Sigma M_{B1} = 0$

$A = \dfrac{16.53(3)\frac{3}{2}}{2} = 37.19\ \frac{\text{KN}}{\text{m}}$

$B_1 = 16.53(3) - 37.19 = 12.4\ \frac{\text{KN}}{\text{m}}$

$\Sigma M_{B2} = 0$

$C = \dfrac{16.53(3.5)\frac{3.5}{2}}{2} = 50.62\ \frac{\text{KN}}{\text{m}}$

$B_2 = 16.53(3.5) - 50.62 = 7.23\ \frac{\text{KN}}{\text{m}}$

Strut Loads:

@ A; 37.19 (spacing) = 37.19 (4) = 148.76 KN

@ B; $(B_1 + B_2)$(spacing) = 19.63 (4) = 78.52 KN

@ C; 50.62 (Spacing) = 202.5 KN

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Problem 2 : An anchored sheet pile wall bulkhead is shown in the following figure :

Given : $L_1 = 4\text{m}; L_2 = 9\text{m}; l_1 = 2\text{m}; \gamma = 17\text{kN/m}^3; \gamma_{sat} = 19\text{kN/m}^3; \phi' = 34^0$

$\gamma' = 19 - 9.81 = 9.19\ \text{kN/m}^3$

(a) Calculate the theoretical value of the depth of embedment, D

(b) Draw the pressure distribution diagram

(c) Determine the anchor force per unit length of the wall.

Use the free earth - support method.

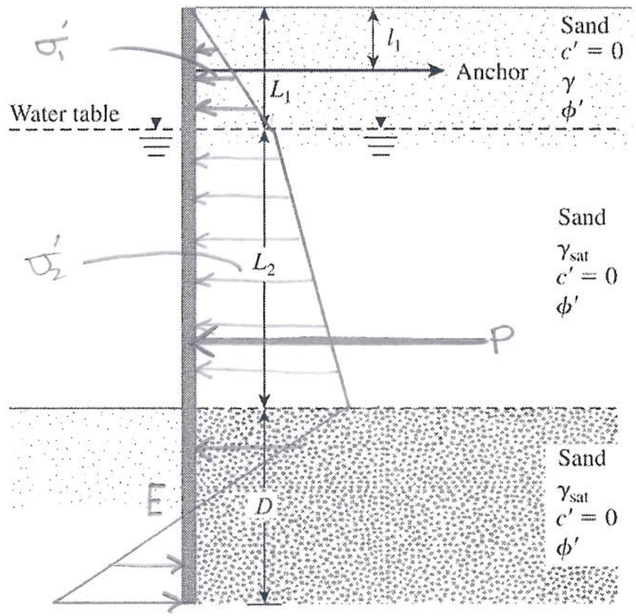


Figure P9.6

① $K_a = \tan^2(45 - \frac{34}{2}) = 0.2827$

$K_p = \tan^2(45 + \frac{34}{2}) = 3.5371$

② σ_1' & σ_2'

$\sigma_1' = \gamma L_1 K_a = 17(4)(0.2827) = 19.22\ \text{kN/m}^2$

$\sigma_2' = (\gamma L_1 + \gamma' L_2)K_a = [(17\times4) + (9.19\times9)]0.2827$

$\sigma_2' = 42.6\ \text{kN/m}^2$

③ Calc. L_3

$L_3 = \frac{\sigma_2'}{\gamma'(K_p - K_a)} = \frac{42.6}{9.19(3.54 - 0.2827)}$

$L_3 = 1.423\text{m}$

④ Calc. P

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

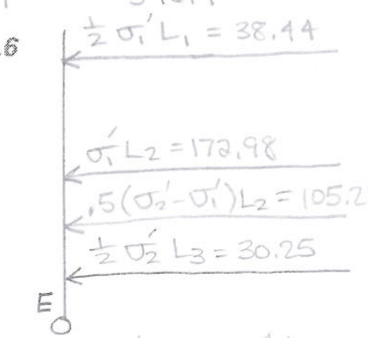
$= \frac{1}{2}(19.22)(4) + 19.22(9) + \frac{1}{2}(23.38)9 + .5(42.6)(1.42)$

$= 38.44 + 172.98 + 105.21 + 30.25$

$P = 346.9\ \text{kN/m}$

⑤ Calc. $\bar{z}$

$\bar{z} = \frac{\Sigma M_E}{P} = \frac{1969.4}{346.9} = 5.67\text{m}$



$\Sigma M_E = 38.44(1.42 + 9 + \frac{4}{3})$
$+ 172.98(1.42 + \frac{9}{2})$
$+ 105.21(1.42 + \frac{9}{3}) + 30.25(\frac{2(1.42)}{3})$

$\Sigma M_E = 451.8 + 1024 + 465.0 + 28.64 = 1969.4$

⑥ Calc. σ_5'

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

$= (17(4) + 9.19(9))3.54 + 9.19(1.42)(3.54 - .283)$

$\sigma_5' = 576\ \text{kN/m}^2$

⑦ Calc. $A_1 - A_4$

$A_1 = \frac{\sigma_5'}{\gamma'(K_p - K_a)} = \frac{576}{9.19(3.54 - .283)} = 19.24\text{m}^2$

$A_2 = \frac{8P}{\gamma'(K_p - K_a)} = \frac{8(346.9)}{9.19(3.54 - .283)} = 92.72\text{m}^2$

$A_3 = \frac{6P[2\bar{z}\gamma'(K_p - K_a) + \sigma_5']}{\gamma'^2(K_p - K_a)^2}$

$= \frac{6(346.9)[2(5.67)9.19(3.54 - .283) + 576]}{9.19^2(3.54 - .283)^2}$

$A_3 = 2126.7\ \text{m}^2$

$A_4 = \frac{P(6\bar{z}\sigma_5' + 4P)}{\gamma'^2(K_p - K_a)^2}$

$= \frac{346.9[(6(5.67)(576) + 4(346.9)]}{9.19^2(3.54 - .283)^2}$

$= 8124.7\text{m}^2$

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D = 4.73 m

⑧ Calc L_4

$L_4^4 + A_1 L_4^3 - A_2 L_4^2 - A_3 L_4 - A_4 = 0$

$L_4^4 + 19.24 L_4^3 - 92.72 L_4^2 - 2126.7 L_4 - 8124 = 0$

$L_4 = 11.3\text{m}$ →

$D = L_3 + L_4 = 11.3 + 1.42 = 12.72\text{m}$

Anchor Force Per unit length of wall

$F = P - .5\gamma'(K_p - K_a)L_4^2 = 346.9 - .5(9.19)(3.54 - 0.283)(11.3)^2$

$F = -1564.09$ kN

This incorrect (I think L_3 is too long)

$F = 184.68$

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Problem #3: For the cantilever retaining wall shown in Figure P8.1, the following data is giver:

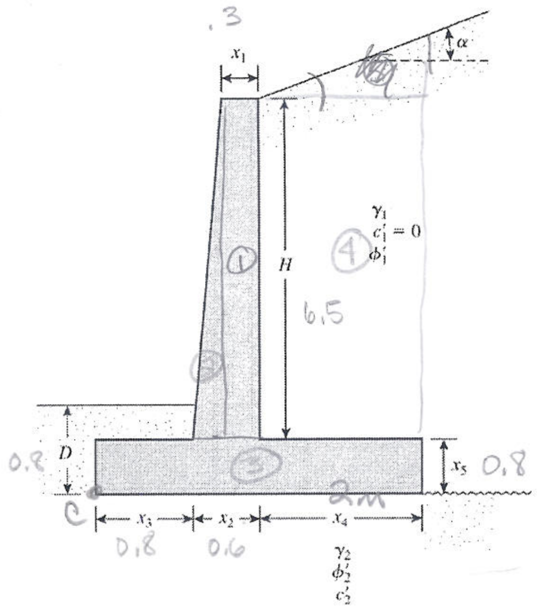

Figure P8.1

$$\text{Wall dimensions}: H = 6.5\text{m}; x_1 = 0.3\text{m}; x_2 = 0.6\text{m}; x_3 = 0.8\text{m};$$

$$x_4 = 2\text{m}; x_5 = 0.8\text{m}; D = 1.5\text{m}; \alpha = 0^\circ$$

23.58 KN/m³

$$\textit{Soil}\ \text{properties}: \gamma_1 = 18.08\ \text{kN/m}^3; \phi_1' = 36^0;$$

$$\gamma_2 = 19.65\ \text{kN/m}^3; \phi_2' = 15^0; c_2' = 30kN/m^2$$

Calculate the factor of safety with respect to overturning.

Table. 7.1 $K_a = 0.2596$

$P_a = \frac{1}{2}(H')^2 \gamma_1 K_a = .5(6.5)^2(18.08)(0.2596) = 99.15\ \frac{KN}{m}$

$P_h = P_a \cos 0^\circ = 99.15\ \frac{KN}{m}$

~~Rv~~

Section	Weight	Moment Arm	Mom about C $\left(\frac{\text{Kip-ft}}{\text{ft}}\right)$
1	(0.3)(6.5)(23.58) = 45.98 KN	$0.8 + 0.3 + \frac{0.3}{2} = 1.25$ m	57.47
2	0.5(0.3)(6.5)(23.58) = 23 KN	$0.8 + \frac{1}{3}(0.3) = 0.9$ m	20.7
3	0.8(2+.6+.8)(23.58) = 64.14 KN	1.7m	109.04
4	2(6.5)(18.08) = 235KN	0.8 + 0.6 + 1m = 2.4m	564

$\Sigma = 751.21$

$\frac{8}{10}$

$M_o = P_h\left(\frac{H}{3}\right) = 99.15\left(\frac{6.5}{3}\right) = 214.83$

$FS_{overturning} = \frac{751.21}{214.83} \approx 3.5$

$FS\ \text{overturning} = \frac{753.61}{304.78} = 2.47$