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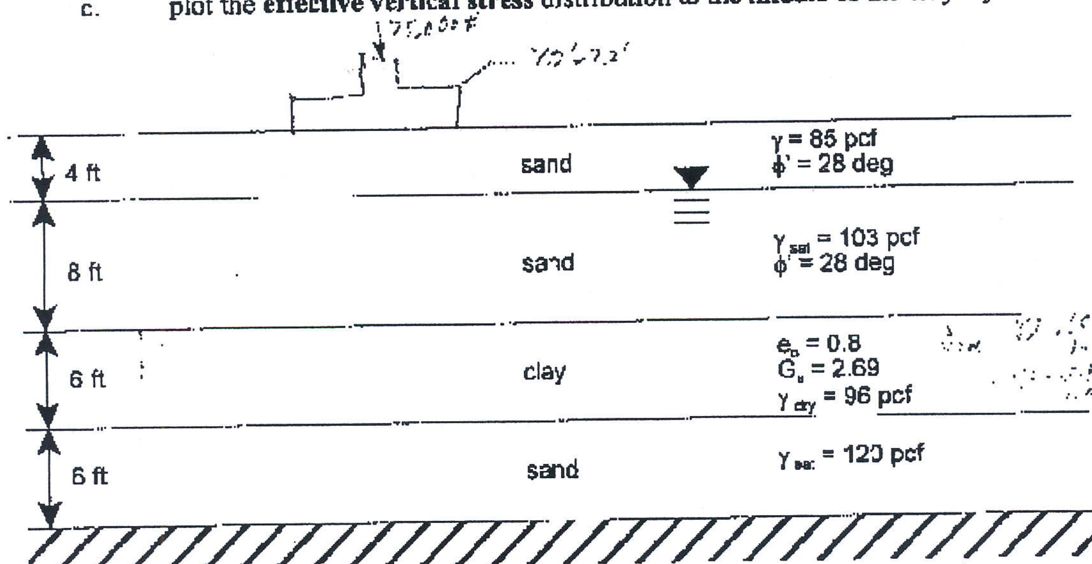
Name ______________________

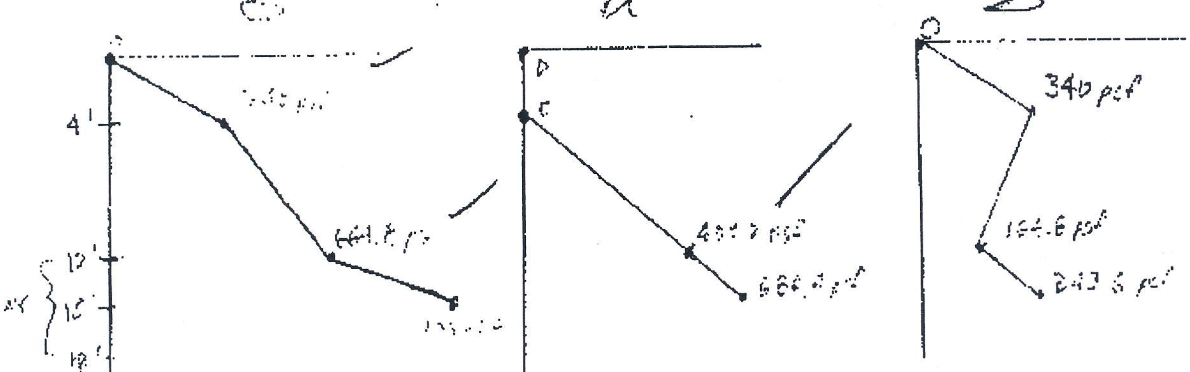
Geotechnical Engineering I (CEG 4011)
[redacted]

*** This test is closed book, closed notes, and closed neighbor. You **must** show all calculations when necessary to receive full credit.

1. Given the soil profile below (water table located 4 ft below the surface),

   a. plot the **total vertical stress distribution** to the middle of the clay layer,
   b. plot the **pore water pressure** distribution to the middle of the clay layer, and
   c. plot the **effective vertical stress** distribution to the middle of the clay layer.





4'(85 pcf) = 340 psf

340 + 8'(103 - 62.4) = 664.8 psf

effective & total mixed-up

-4

2. A 7.2' x 7.2' footing supports a 75,000 lb load (including the self-weight of the footing), and it is to be constructed on the ground surface of the soil profile shown in Figure 1. Calculate the **average** stress increase in the clay layer.

$$q = \frac{75{,}000\ lb}{(7.2\ ft)(7.2\ ft)} \rightarrow q = 1446.759\ psf$$

$$\Delta\sigma'_{av} = \frac{\Delta\sigma'_t + 4\Delta\sigma'_m + \Delta\sigma'_b}{6}$$

Depth (ft)	$m = \frac{B}{z}$	$n = \frac{L}{z}$	I_4 (Fig. 9.9)	$\Delta\sigma'_z = q I_4 \cdot 4$
12'	$\frac{7.2}{12} = 0.6$	0.6	0.1069	618.634 psf
15'	$\frac{7.2}{15} = 0.48$	0.48	0.07892	456.713 psf
18'	$\frac{7.2}{18} = 0.4$	0.4	0.0602	348.380 psf

$\frac{7.2}{2}$

INTERPOLATION

$n = 0.4$

$$\frac{.0711 - .0602}{0.1} = \frac{x - .0602}{0.48 - 0.4} \rightarrow x = 0.06892$$

$n = 0.5$

$$\frac{0.084 - .0711}{0.1} = \frac{y - .0711}{0.48 - 0.4} \rightarrow y = 0.08142$$

$$\frac{y - x}{0.1} = \frac{z - x}{.48 - .4} \rightarrow z = I_{4} = 0.07892$$

$$\Delta\sigma'_{AV} = \frac{[618.634 + 4(456.713) + 348.380]\ psf}{6}$$

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$$\boxed{\Delta\sigma'_{AV} = 465.64\ psf}$$

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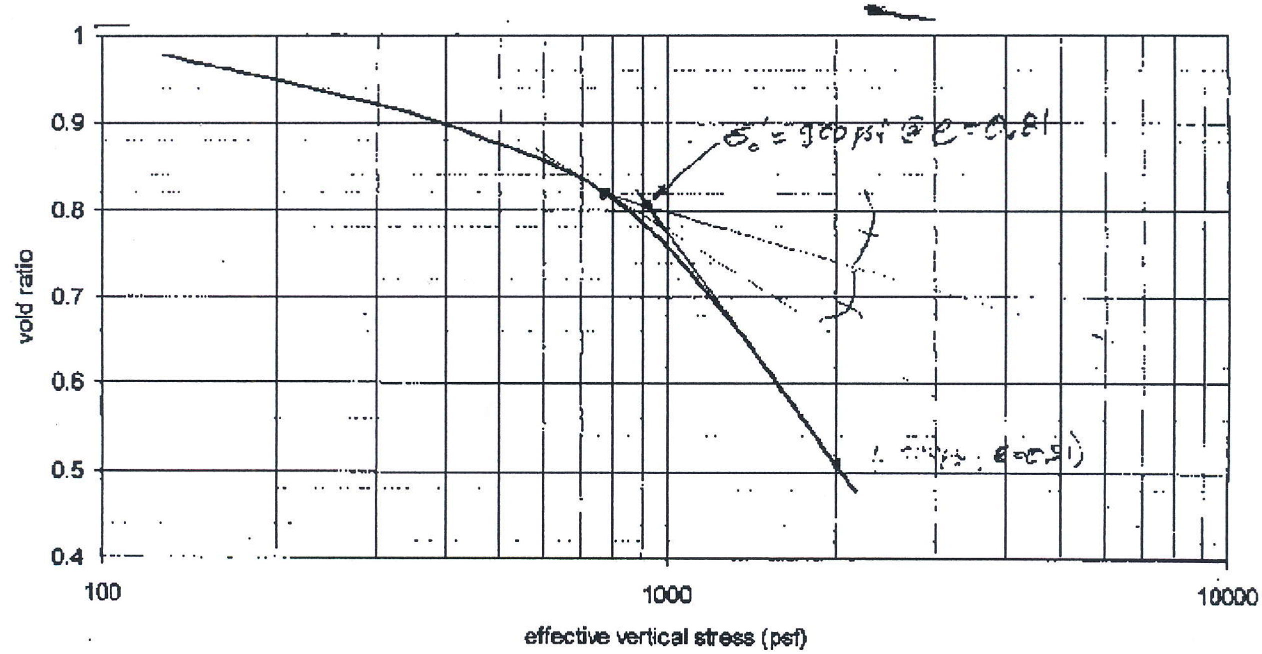
3. For the footing in the previous problem, calculate the primary consolidation settlement in the clay layer using the following results from a consolidation test.



@ MID OF CLAY LAYER

$\sigma_o' = 349.6$ (prob #1) $< \sigma_c' \rightarrow$ OVERCONSOLIDATED

$\Delta\sigma' = 465.64$ psf (prob #2)

$\sigma_o' + \Delta\sigma' = 349.6 + 465.64 = \underline{815.24}$ psf < 900 psf $\Rightarrow \sigma_o' + \Delta\sigma' < \sigma_c'$

$$\therefore S_c = \frac{C_s H}{1 + e_o} \log\left(\frac{\sigma_o' + \Delta\sigma'}{\sigma_o'}\right)$$

$C_c = \dfrac{e_1 - e_2}{\log\left(\frac{\sigma_2'}{\sigma_1'}\right)} = \dfrac{0.81 - 0.51}{\log\left(\frac{2000}{900}\right)} \rightarrow C_c = 0.8651$ AND $C_s \cong \frac{1}{5}$ to $\frac{1}{10} C_c$

WILL ASSUME $C_s = \frac{3}{20} C_c = \frac{3}{20}(0.8651) \rightarrow C_s = 0.12976$

$S_c = \dfrac{0.12976\,(6\,ft)}{1 + 0.8} \log\left(\dfrac{815.24}{349.6}\right) \rightarrow \boxed{S_c = 0.159\ ft = 1.91\ in.}$

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4. For the previous footing, how long will it take to reach a consolidation settlement of 1 inch? Assume $C_v = 0.0005137$ in^2/min.

$$U = \frac{1''}{1.91''} = 5[illegible].39\% \quad @\ U = 52\%,\ T_v = 0.212$$

$$T_v = \frac{c_v t}{H_{dr}^2} \longrightarrow t = T_v \left(\frac{H_{dr}^2}{C_v} \right)$$

$$t = 0.212 \left(\frac{\left[(3\ ft)\left(\frac{12\ in}{ft}\right) \right]^2}{0.0005137\ in^2/min} \right) \longrightarrow \boxed{\begin{array}{l} t = 534649\ min \\ = 371.42\ \text{DAYS} \end{array}}$$

$$min \left(\frac{hr}{60\ min} \right) \left(\frac{d}{24\ h} \right)$$

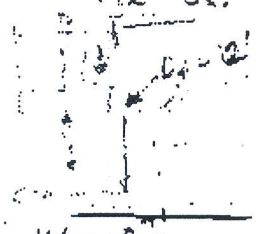
-0

5. For the previous footing and soil conditions, $N_q = 1.0$, $N_\gamma = 0$

a) calculate the **ultimate** bearing capacity assuming general shear failure.

b) calculate the **net allowable** bearing capacity assuming ~~a safety~~ factor of 2.5.

For Sq. $q_{ult} = 1.3c'N_c + qN_q + 0.4\gamma B N_\gamma$ NOT ZERO use γ'



$D_f = 2'$ $D \leq B$ $\therefore$ $q = \gamma(D_f - D) + (\gamma_{sat} - \gamma_w)D$

$q_{ult} = \gamma_d(1 + w_c)(4\,ft) + (123.13\,pcf - 62.4\,pcf)\,4\,ft$

$= 96\,pcf\,(1.2874)(4\,ft) + (123.13 - 62.4)\,4$

$w_c = \frac{0.8}{2.49} = 0.2874$ $q_{ult} =$

$q = \gamma D_f = \cancel{85\,pcf\,(4') + 103\,pcf\,(8')} =$

$q_{net} = \frac{q_{ult}}{FS} = \frac{q_{ult}}{2.5}$

-10

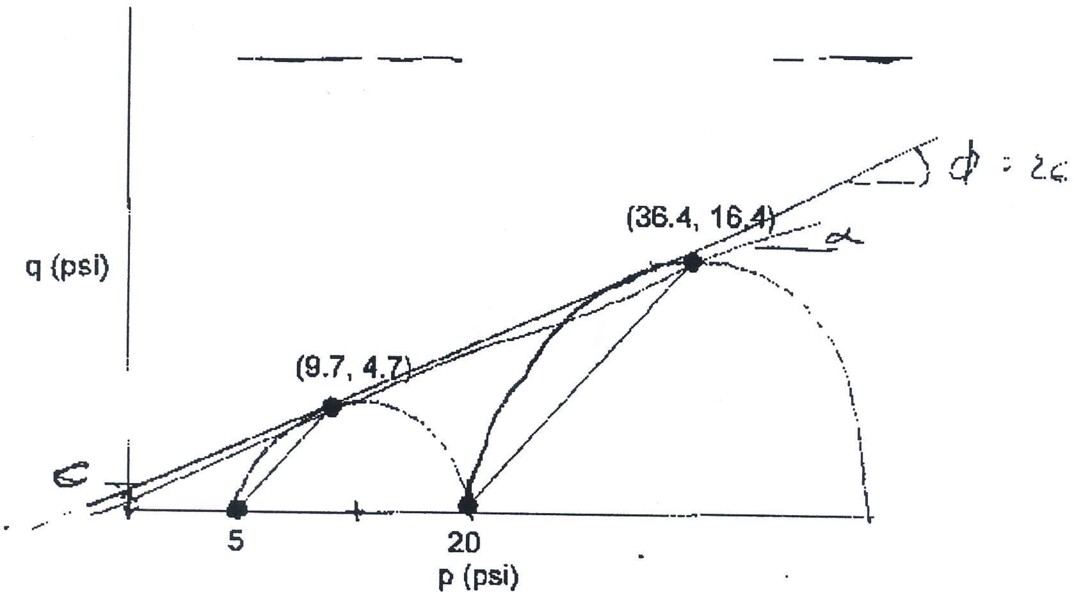
6. Using your previous calculations, is the applied load within the allowable limit? You must validate your response with calculations. If bearing capacity does not govern the design (the applied load is calculated to be within the allowable limit), then how might the primary consolidation settlement be reduced? If the bearing capacity governs the design (the applied load is calculated to be outside the allowable limit), then how might the bearing capacity be increased?

-90

7. The stress path from a CD triaxial test on a soil sample is plotted below.

a) Plot Mohr's circle at failure for the two tests run at confining pressures of 5 and 20 psi.

b) Determine the cohesion and friction angle for the soil sample.



$\tan\alpha = \sin\phi$

$\tan\alpha = \frac{\Delta y}{\Delta x} = \frac{16.4-4.7}{36.4-9.7} = \approx$

$\phi \approx 26°$

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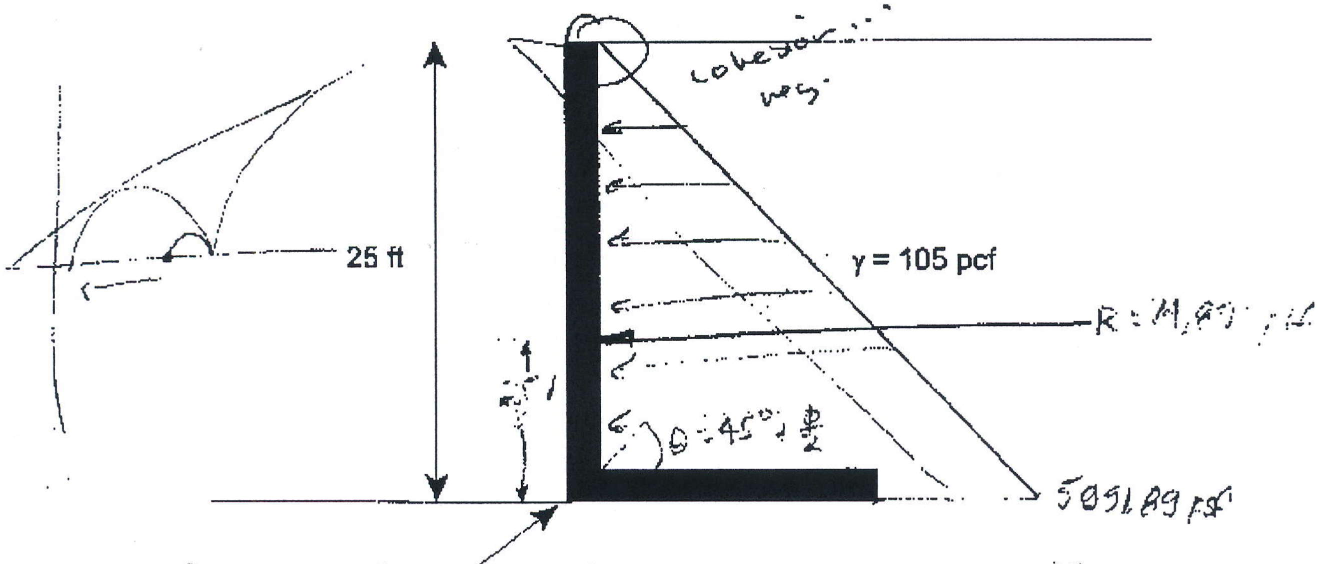
8. Using the results from problem 7,

a) plot the lateral stress distribution along the 25' frictionless, flexible wall shown below and

b) determine the magnitude of the overturning moment about the toe.



$K_A = \tan^2(45° - \frac{\phi}{2})$

$\sigma_A = \gamma H K_A - 2c\sqrt{K_a} = (105\ pcf)(25\ ft)(\ldots) = 5991.89\ psf$

$R = \frac{1}{2}(5991.89)(25) = 74899.57\ plf$

$M_{toe} = (74{,}899\ plf)(\frac{25}{3}\ ft) = \boxed{624{,}155\ plf \cdot ft}$

NOT SO LARGE

(-5)