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Name [redacted]

Geotechnical Engineering I (CEG 4011)
Summer 2009

This test is closed book, closed notes, and closed neighbor. You must show all calculations when necessary to receive full credit. Points will be assigned based on the level of difficulty and length of each problem.

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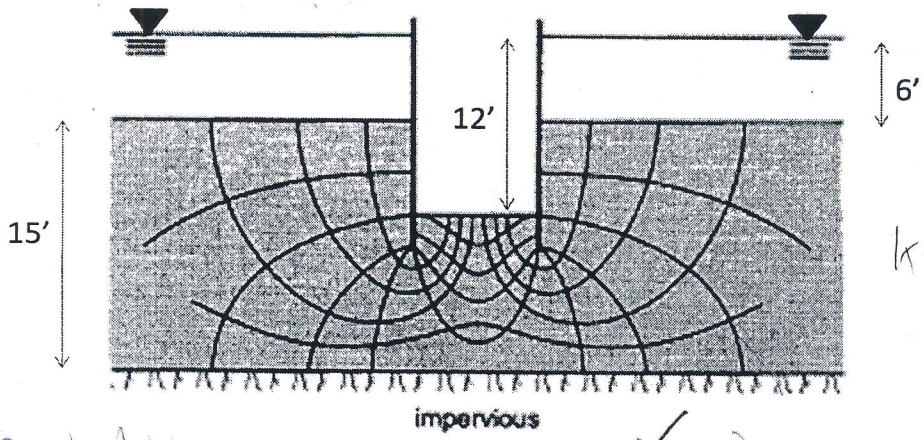
1. A cofferdam is constructed in a river by extending two parallel sheet pile walls below the mud line of a relatively homogeneous, isotropic soil (k = 0.003 ft/min). If the cofferdam floor is unlined (remains permeable), and the water inside the cofferdam remains at the bottom of the excavation via pumping, determine the seepage rate into the cofferdam (ft^3/hr-ft width) in order to size the pump.



$k = 0.003$ ft/min

$q = k\Delta H \frac{\#\text{channels}}{\#\text{drops}} = 0.003 \left(\frac{8}{18}\right) \times \frac{60\text{min}}{1\text{hr}} = 0.48 \frac{ft^3}{hr/ft}$

2. The concrete dam shown is constructed on silt with a hydraulic conductivity of 0.11 ft/hr. Using the flow net provided,

$k = 0.11$ ft/hr

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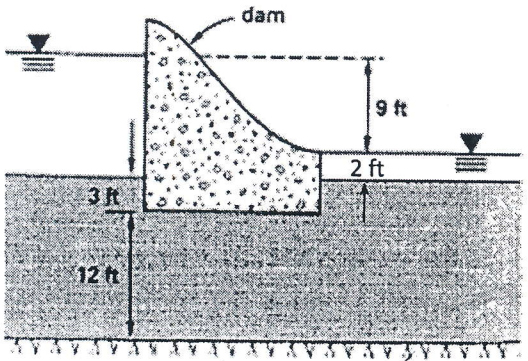
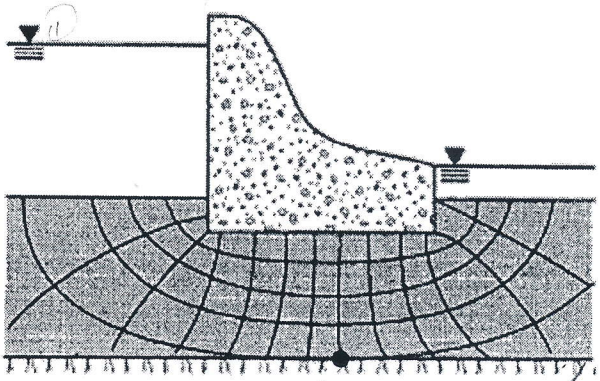
a) determine the head pressure at point **A** and
b) determine the **uplift force** per unit width of the dam assuming a triangular/trapezoidal pressure distribution on the bottom of the dam.





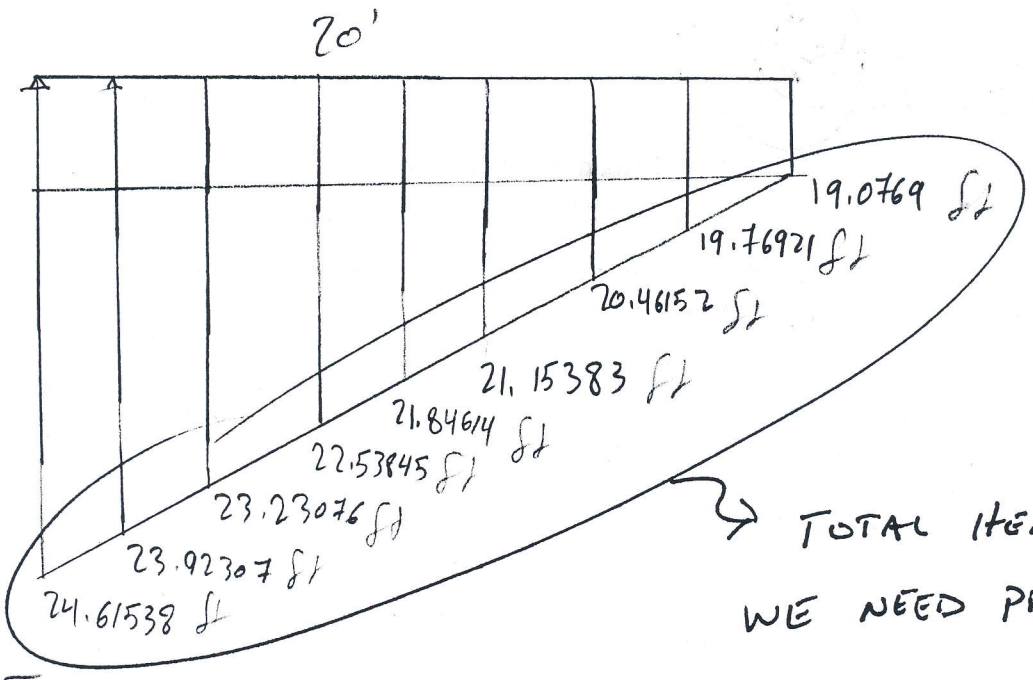
$\Delta h = \frac{\Delta H}{\#\text{drops}} \quad \frac{9}{13} = 0.69231$

$\frac{P_A}{\gamma} + z_A - h_{loss} = \frac{P_A}{\gamma} + z_A$

$26 - 7(0.69231) = \frac{P_A}{\gamma} = 21.15383$ m

Datum

UNITS!!!



TOTAL HEAD ...

WE NEED PRESSURE!

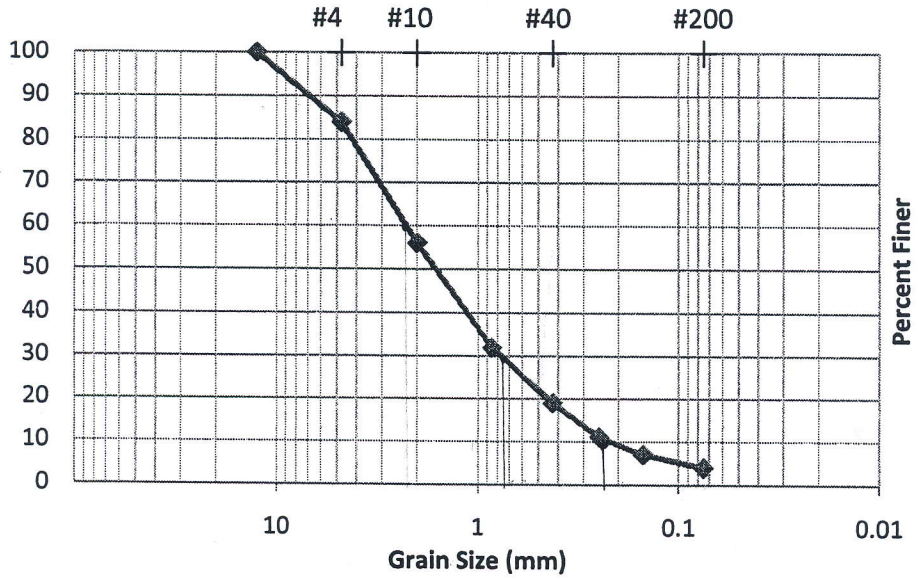
$$F = \left[(19.0769)(20) + (24.61538 - 19.0769)(20)(0.5) \right] 62.4$$

$$F = 27.269 \frac{\text{kip}}{\text{ft}}$$

3. A sample of moist soil was found to have the following characteristics:

Volume	-	0.532 ft^3 (as sampled)
Weight	-	62 lb (as sampled)
		54 lb (after oven drying)
Specific Gravity of solids	-	2.68

After drying, a sieve analysis was performed with the following results.



a) What is the unit weight of the insitu soil?

$\gamma = \frac{62}{0.532} = 116.54 \frac{lb}{ft^3}$ $\gamma = \gamma_d(1+w_c)$

b) What is the void ratio of the insitu soil?

$\gamma_d = \frac{G_s \gamma}{1+e} \Rightarrow e = \frac{(2.68)(62.4)}{103.224} - 1 = 0.62$ $\gamma_d = \frac{116.54}{1+0.1290} = 103.224$ $w_c = \frac{62-54}{62} \times 100 = 12.90\%$

c) What is the degree of saturation of the insitu soil?

$GW = Se \Rightarrow S = \frac{(2.68)(0.1290)}{0.62} \Rightarrow 55.76\%$

d) What is the uniformity coefficient (C_u)?

$C_u = \frac{D_{60}}{D_{10}} = \frac{2.2}{0.23} = 9.5652$

e) What is the coefficient of gradation (C_c or C_z)?

$C_z = \frac{(D_{30})^2}{D_{60} \cdot D_{10}} = \frac{(0.75)^2}{(2.2)(0.23)} = 1.112$

f) Classify the soil according to the AASHTO system.

A-1-b strong fragments, gravel, and sand.

g) Classify the soil according to the USCS system.

SW

4. Soil is excavated from one site and transported to another for compaction. If the insitu void ratio of the borrow soil is 0.8, and the specific gravity of solids is 2.65, determine the **volume of borrow soil** required for 2300 yd^3 of fill compacted to within 95% of the maximum dry unit weight. Results from a laboratory compaction test are shown below.

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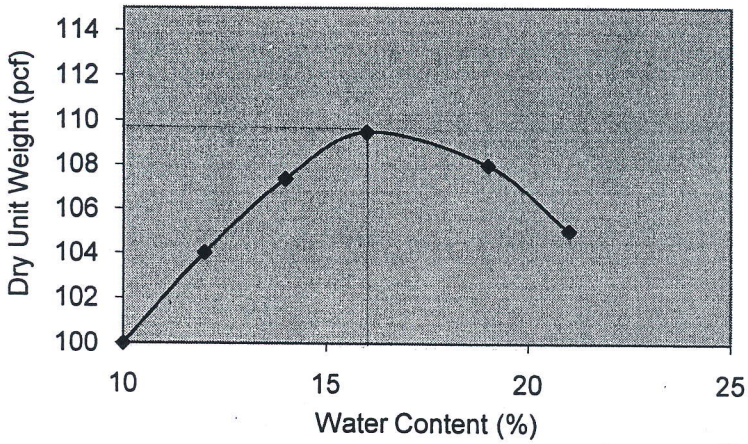


$e_{insitu} = 0.8$

$G_s = 2.65$

$2300\ yd^3 \times 27\ \frac{ft^3}{1\ yd^3} = 62100\ ft^3$

$\gamma_{d_{max}} = 109.5\ \frac{lb}{ft^3}$ optimum $w_c = 16.25\%$

$0.95(109.5) = 104.025$

$\gamma_d = \frac{G_s \gamma}{1+e}$

$\gamma_d = \frac{(2.65)(62.4)}{1+0.8}$

$\gamma_d = 91.867\ \frac{lb}{ft^3}$

$\gamma = \frac{W}{V}$ $\quad W = \gamma V$

$W = 104.025(62100)$

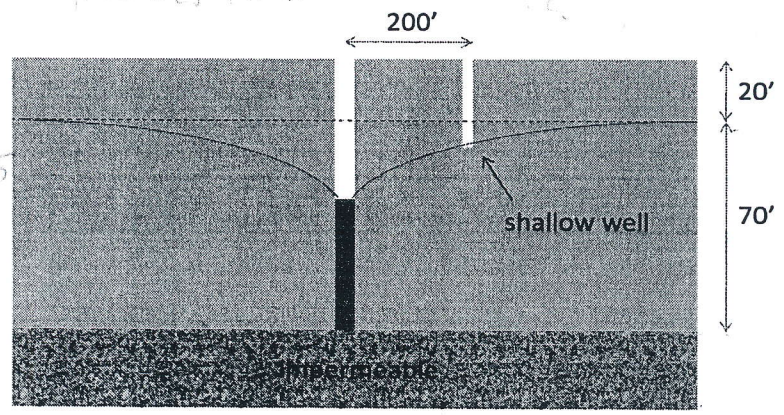
$W = 6459952.5\ lb$

$\gamma = \frac{W}{V}$

$V = \frac{W}{\gamma} = \frac{6459952.5}{91.867} = 70318.53\ ft^3$

$70318.53\ ft^3 \times \frac{1\ yd^3}{27\ ft^3} = \boxed{2604.39\ yd^3}$

5. A 10" diameter well is placed 200' from a neighboring 30' shallow well as shown below. The groundwater table is originally at a depth of 20'; the pump drawdown at the larger well is 37.5'; and the depth to the impermeable layer is 90'. The coefficient of permeability is determined to be 0.02 ft/min. What is the maximum amount of water (in ft^3/min) that may be pumped from the larger well without causing the shallow well to "run dry"?



$k = 0.02\ ft/min$ $\quad i = \frac{\Delta h}{L}$ $\quad q = kiA$

$\frac{10}{12} = 0.8333$

$\frac{1}{2}\left(\frac{10}{12}\right) = 0.4167$

$h_1 = 70$

$h_2 = 90 - 30 = 60$

$$q = \frac{k[\pi(h_1^2 - h_2^2)]}{\ln(r)} = \frac{0.02[\pi(70^2 - 60^2)]}{\ln\left(\frac{200}{r_2}\right)} = 15.4165\ ft^3/min$$

6. What type of device would be best suited for compacting near-surface granular soil at a jobsite located adjacent large, delicate (sensitive) structures.

a) Modified Proctor Hammer
b) Pnuematic Rubber-Tired Roller
c) Vibratory Roller
d) Rockin' Roller

7. An inorganic soil sample was found to have the following characteristics:

Sieve	% Finer
#4	100
#10	86
#40	64
#200	53

PL = 30

LL = 40

$PI = LL - PL = 10$

a) Classify the soil according to the AASHTO system.

A-4 silty soils

b) Classify the soil according to the USCS system.

ML Plots below the "A" line

8. Give the group names that correspond to the following USCS group symbols:

a) GC Claly Gravel

b) SC-SM Silty ~~Sand with~~ Clayey Sand

c) CH fat clay

9. A Modified Proctor Test is performed in the laboratory with the following results:

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$\gamma = \frac{W}{V} = \frac{1.53 \text{ kg}}{943.3 \text{ cm}^3} \cdot \frac{(100)^3 \text{ cm}^3}{\text{m}^3} \cdot 9.81 \frac{\text{m}}{\text{s}^2}$

$\gamma = 15.9115 \frac{\text{kN}}{\text{m}^3}$

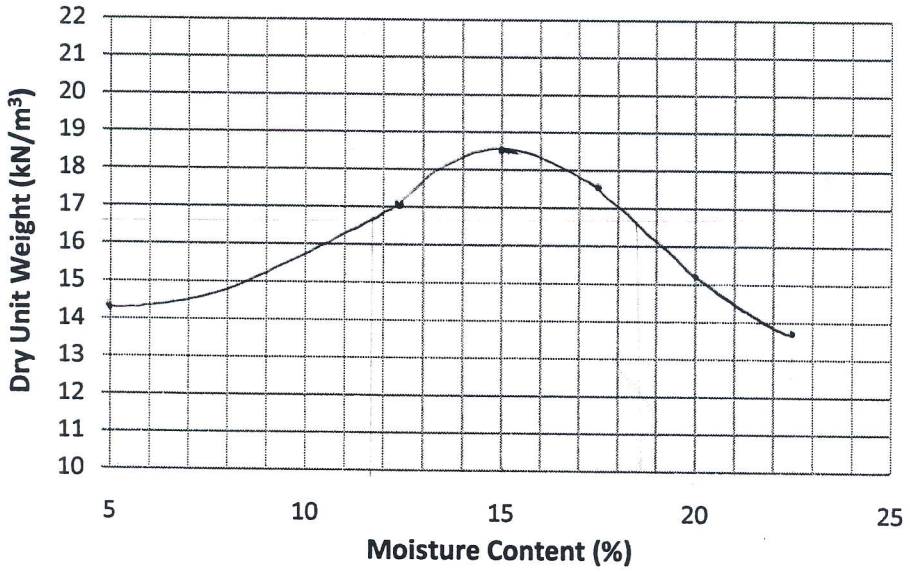
$\gamma = \gamma_d (1 + w_c)$

$\gamma_d = \frac{\gamma}{1 + w_c}$

Volume of mold = 943.3 cm³

γ (kN/m³)	γ_d kN/m³	Mass of wet soil in mold (kg)	Moisture content (%)
15.9115	14.465	1.53	10
19.1354	17.009	1.84	12.5
21.3193	18.539	2.05	15
20.6953	17.613	1.99	17.5
18.1994	15.1662	1.75	20
16.9514	13.858	1.63	22.5

a) Plot the dry unit weight vs. moisture content.



b) Determine the maximum dry unit weight and optimum moisture content.

$\gamma_{d_{max}} = 18.539 \frac{\text{kN}}{\text{m}^3}$ $w_{c_{optimum}} = 15\%$

c) If $G_s = 2.68$, what is the void ratio at the optimum moisture content?

$\gamma_d = \frac{(1 + w_c) G_s \gamma}{1 + e} \Rightarrow 18.539 = \frac{2.68 (9.81)}{1 + e} \Rightarrow e = 0.418$

d) What range of moisture is permitted if a contractor must achieve 90% compaction?

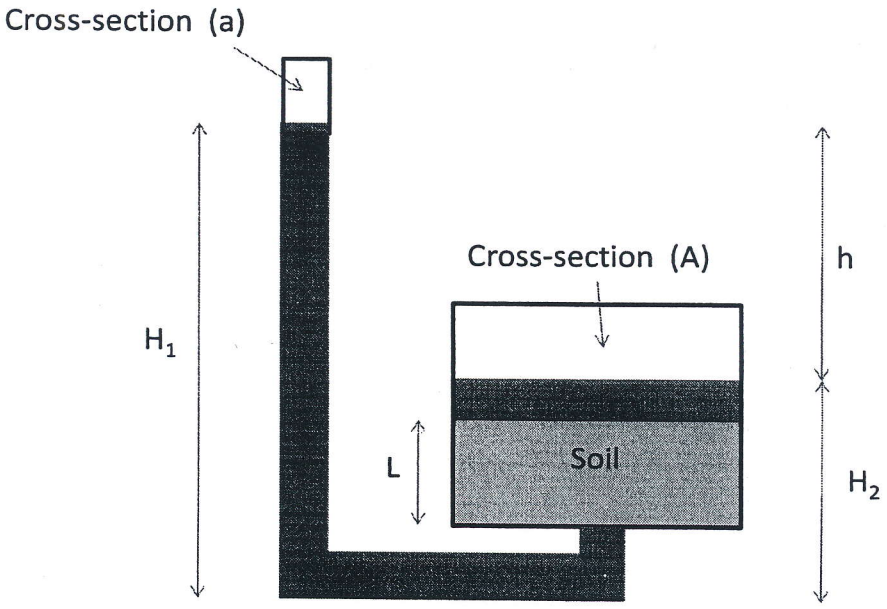
$.90 (18.539) = 16.685$ $11.8\% \leq w_c \leq 18.8\%$

e) If unable to provide the minimum amount of water to fall within this range, how might the contractor still obtain 90% compaction?

He might obtain 90% compaction by adding more energy per cubic foot using different kind of roller.

10. Choose either option, but not both.

Option A – For the Falling-head test setup below, derive the appropriate equation to determine the coefficient of permeability, k.



Option B – In lieu of Option A, you may submit your work for questions 7.7 and 7.8 from the textbook. These two problems will be graded as one, and the points will only count toward this problem. Once you have completed the test, turn it in at the front of the classroom. After submitting your test, return to your seat, grab questions 7.7 and 7.8, and bring them to the front of the classroom. Only after you have submitted your test can you dig through your belongings. You must follow this procedure (for obvious reasons) in order to receive credit for questions 7.7 and 7.8.