HW 224
7.7
7.8

Name [redacted]

Geotechnical Engineering I (CEG 4011)
Summer 2009 Midterm Review

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

1. The particle-size distribution curve for a soil sample is shown below. If the liquid limit is 35 and the plastic limit is 20, calculate:

   a. the uniformity coefficient (C_u);

   $C_u = \frac{D_{60}}{D_{10}} = \frac{0.5\ mm}{0.05\ mm} = \boxed{10}$

   b. the coefficient of gradation (C_c or C_z); and

   $C_z = \frac{D_{30}^2}{D_{60} \cdot D_{10}} = \frac{(0.15)^2}{0.5(0.05)} = \boxed{0.9}$

   c. the plasticity index (PI).

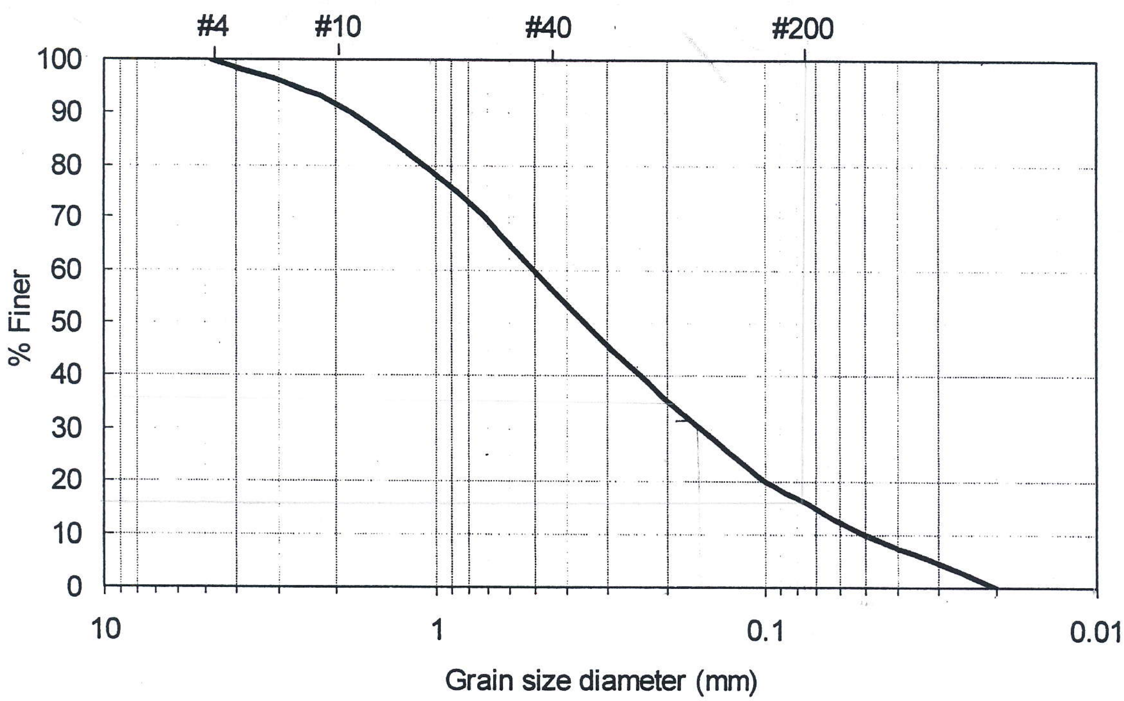
   $PI = LL - PL = 35 - 20 = \boxed{15}$

   d. Classify the soil according to the AASHTO system.

   A-2-6

   e. Classify the soil according to the USCS system.

   SC



2. An inorganic fine-grained soil sample has a liquid limit of 42 and a plastic limit of 12. Using the Plasticity Chart, determine the group symbol and group name.

$LL = 42 \quad PL = 12 \quad PI = 30$

CL, lean clay

3. A construction site requires 4400 ft³ of soil to be excavated and transported to another site using multiple trucks. A single truck has an 18 yd³ capacity. The insitu soil has a void ratio of 0.85, but will have a void ratio of 1.1 when excavated and loaded into each truck. How many trucks must be ordered to remove the soil if the specific gravity of solids is 2.71?

$e_{trans} = 1.1$

$G_s = 2.71$

$e_{insitu} = 0.85$

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

$$\gamma_d = \frac{2.71(62.4)}{1.85} = 91.41 \ \frac{lb}{ft^3}$$

$$W = 91.41 \ \frac{lb}{ft^2} \left(4400 ft^3\right) = 402,193.3 \ lb$$

$$\gamma_{d,trans} = \frac{G_s \gamma_w}{1+e} = \frac{2.71(62.4)}{2.1}$$

$$\gamma_{d,trans} = 80.53 \ \frac{lb}{ft^3}$$

$$V_{trans} = \frac{402,000 \ lb}{80.53 \ lb/ft^3} = 4994 \ ft^3$$

$$4400 ft^3 \left(\frac{1+e_{trans}}{1+e_{insitu}}\right) = 4994 \ ft^3$$

$$4994 \ ft^3 \left(\frac{1 \ yd^3}{27 ft^3}\right) = 185 \ yd^3$$

$$\frac{185 \ yd^3}{18 \ yd^3/truck} = 11 \ trucks$$

4. The results of a Standard Proctor test are shown below.

a. Plot the dry unit weight as a function of water content.

$V = 2400\ ft^3$

$w = 12\%$

b. From the graph, what is the maximum dry unit weight?

$\gamma_{d\,max} = 111.02$

c. From the graph, what is the optimum water content?

w_c (optimum) = 18%

*d. If 2400 ft³ of the compacted soil has a water content of 12%, what is the minimum volume of water that must be added or subtracted to obtain 95% compaction?

@ w 12% $\gamma_d = 92\ pcf$

95% ⇒ 0.95(111.02 pcf) = 105.5 pcf @ 15.5%

2400 ft³

$W_s = 92\ pcf(2400\ ft^3) = 220800$ lb solids

$W_w = 0.12(220800\ lb) = 26496\ lb$

water @ optimal? $= 0.155(220800) = 34224$ lb

$34224 - 26496 = 7728$ lb water

$\gamma = \gamma_d(1+w)$ $\gamma_d = \frac{\gamma}{1+w}$ $\gamma_d = \frac{106}{1+.13}$

Volume $= \frac{7728\ lb}{62.4\ lb/ft^3}$

Volume = 123.85 ft³

$123.85 \times \frac{7.48\ gal}{ft^3}$

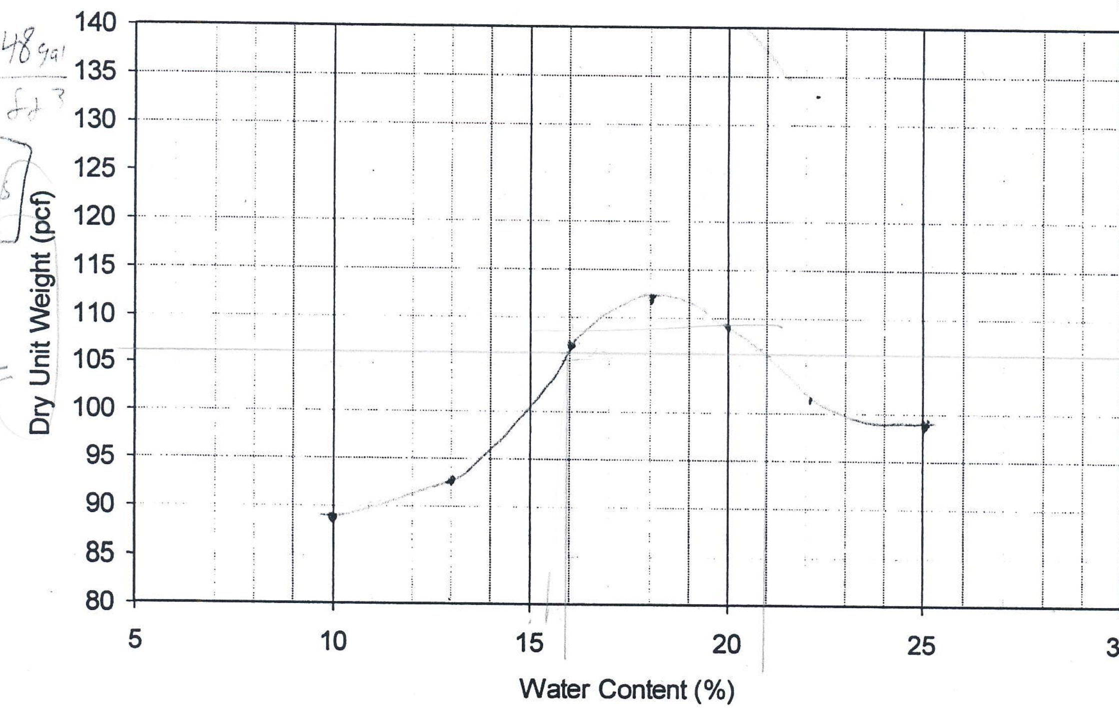
$\boxed{926.4\ \text{gallons}}$

Water Content (%)	Total Unit Weight (pcf)	γ_d
10	97	→ 88.18
13	106	93.81
16	125	
18	131	
20	131	109.17
22	124	101.64
25	123	98.4

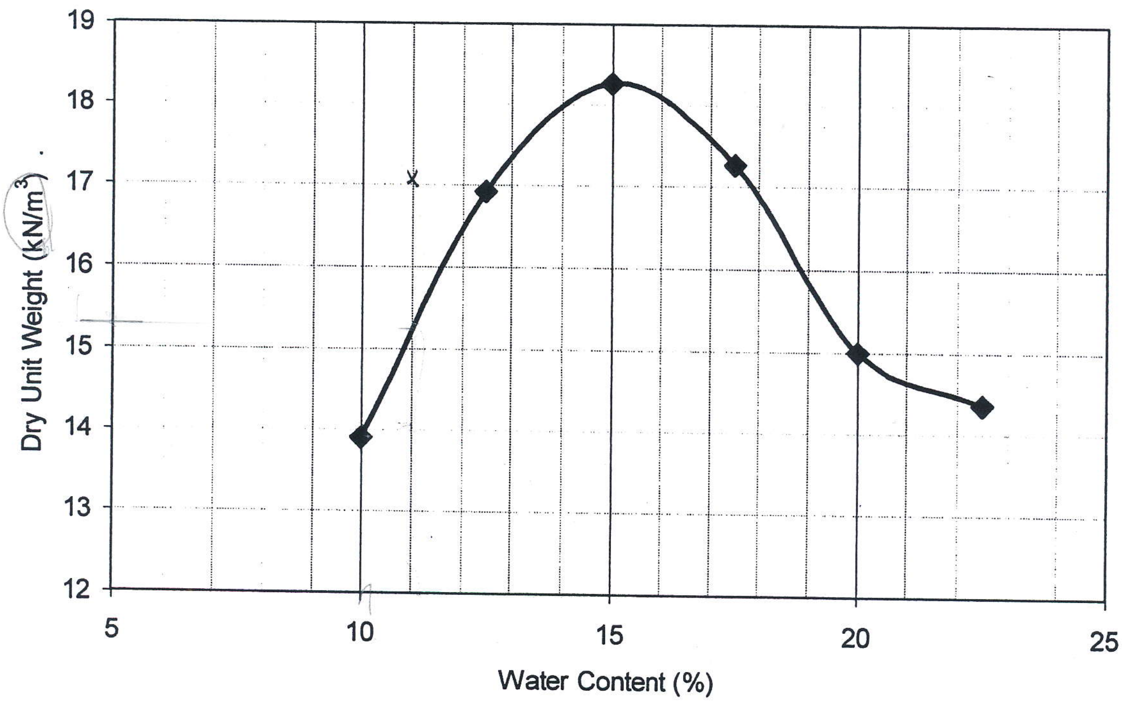
$\gamma_d = \frac{\gamma}{1+w_c}$

$\frac{97}{(1+0.10)} = 88.18$

93.81
107.76
111.02
109.17
101.64
98.4



5. The results of a Standard Proctor test are plotted below.



After several passes in the field with a vibratory roller, a sand cone test is performed to verify the degree of compaction. Given the results below,

10% w_c

879g water

Mass of compacted sample	-	871 g
Mass of sample after drying	-	784 g
Volume of hole	-	452 cm³

$\gamma_d = \frac{784 g}{424 cm^3} \cdot \frac{1 kg}{1000 g} (9.81 \frac{m}{s^2}) \times (\frac{1 kN}{1000 N}) \cdot \frac{(100)^3 cm^3}{1 m^3} = 17.02 \frac{kN}{m^3}$

a. determine the dry unit weight of the field compacted soil, and

$17.02 \frac{kN}{m^3}$

b. determine the water content of the field compacted soil.

$W_c = \frac{W_w}{W_s} = \frac{M_w}{M_s} = \frac{(871-784)}{784} = 11.1\%$

c. What percentage of the maximum dry unit weight did the contractor achieve?

γ_d achieved / $\gamma_{d\,max}$ $(\times 100\%) = \frac{17.02}{18.2}(100\%) = 93.5\%$

d. Plot the value obtained from the sand cone test on the graph above. Do the results coincide with the Standard Proctor test results? Give a reasonable explanation why they either do or do not coincide.

Roller apply more energy per ft³ than the standard test

6. The dam shown below is constructed on a homogeneous, isotropic soil underlain by an impervious layer. The coefficient of permeability for the soil is 1.8 cm/min. k

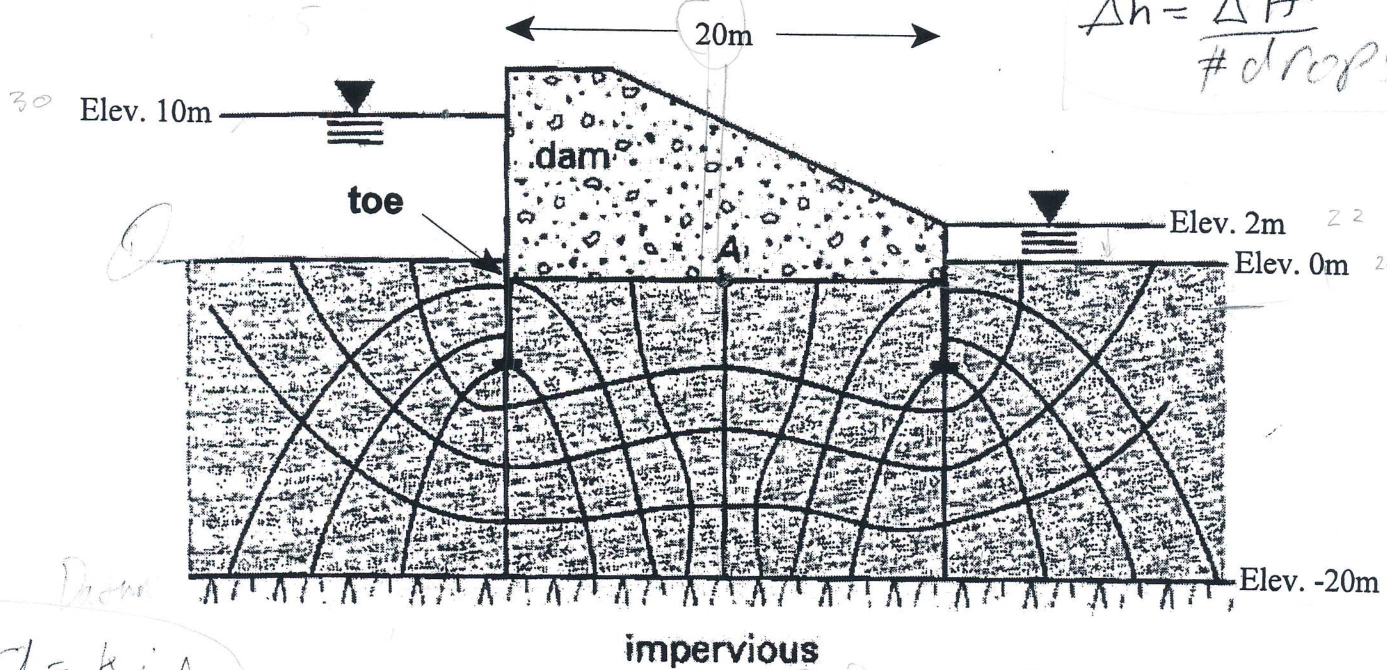
a. Determine the flow rate under the dam in units of $m^3/min/m$ (flow rate per meter length of the dam).

b. If a piezometer were placed at point A (elevation of -0.5m), to what **elevation** would the water level within the piezometer rise?

c. Calculate the magnitude of the resultant uplift **force** per unit length of the dam.

d. Where is the location of the resultant uplift force as measured from the cutoff wall at the toe?

$$\Delta h = \frac{\Delta H}{\# \text{drops}}$$



a) $q = k i A$

$$q = k \Delta H \left(\frac{\# \text{channels}}{\# \text{drops}} \right)$$

$$q = 1.8 \frac{cm}{min} \frac{(10-2)m}{16 \text{ drops}} (4 \text{ channels}) \left(\frac{1m}{100 cm} \right)$$

$$q = 0.036 \frac{m^2}{min} = 0.036 \frac{m^3/min}{m}$$

b)

$$\frac{P_1}{\gamma_w} + z_1 - \text{headlosses} = \frac{P_a}{\gamma_w} + z_w$$

$$\left(\frac{10-2}{16}\right)$$

$$10 + 20 - \Delta h(8) = \frac{P_a}{\gamma_w} + 19.5$$

$$\frac{P_a}{\gamma_w} = 6.5 \text{ m}$$

7. A gravelly clay is to be compacted in the field for use as an impermeable liner in a local landfill. Which of the following pieces of equipment would be best suited for the task?

a. Jumping-jack/Rammer
b. Sheepsfoot roller
c. Smooth-wheel roller
d. Modified Proctor hammer

8. A soil sample is found to have a specific gravity of solids of 2.69 and a dry unit weight of 110 lb/ft³. What is the *degree of saturation* if the moist unit weight (insitu) is 118.8 lb/ft³.

$\gamma_d (1+w_c) = \gamma$ $\quad w_c = 0.08$ $\quad \gamma_d = \frac{G_s \gamma_w}{1+e}$

$110(1+w_c) = 118.8$ $\quad G w_c = Se$ $\quad 110 = \frac{2.69(62.4)}{1+e}$

$e = 0.526$

$S = \frac{2.69(0.08)}{0.526} \times 100\% = 41\%$

9. It is possible for the void ratio to exceed 1.

a. True
b. False

10. It is possible for a soil sample with a $G_s = 2.65$ and a void ratio of 0.4 to have a water content of 16%.

a. True
b. False

$G_s = 2.65$ $\quad e = 0.4$ $\quad w_c = 16\%$

$G_s w_c = Se$

$S = \frac{2.65(0.16)}{0.4} \times 100\% = \cancel{1}06\%$