

**PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
CVEG 3300 GEOTECHNICAL ENGINEERING
Spring 2022**

I. COURSE DESCRIPTION IN ABET FORMAT

II. TESTS

Summary of Topics covered by Test

Original Test Questions & Master Solution/grading scheme used

(Summary of topics can be a separate page or include on the assignment itself)

Above Average (Graded original work)

Average (Graded original work)

Below Average (Graded original work)

III. HOMEWORK ASSIGNMENTS

Summary of Topics covered by Homework

Original Homework Questions & Master Solution/grading scheme used

Above Average (Graded original work)

Average (Graded original work)

Below Average (Graded original work)

IV. LABORATORY REPORTS

Summary of Topics covered by lab

Laboratory Handout/Instructions and Grading Scheme

Above Average (Graded original work)

Average (Graded original work)

Below Average (Graded original work)

(Note: All Pages shown in Yellow should be printed on YELLOW PAPER)

**One or Two-Page Course Description
in ABET Format (Format provided below)**

COURSE DESCRIPTION IN ABET FORMAT

CIVIL AND ENVIRONMENTAL ENGINEERING DEPARTMENT CVEG 3303 GEOTECHNICAL ENGINEERING

1.	Course number and name:	CVEG 3300 Geotechnical Engineering
2.	Credits and contact hours:	3 credit hours
3.	Instructor's or course coordinator's name:	Dr. Md Jobair Bin Alam
4.	Textbook: Title:	Principles of Geotechnical Engineering (8th Edition)
	Author:	Braja M. Das and Khaled Sobhan
	Publisher, Year & Edition:	Cengage
	a. Other Supplemental material	Handouts from US Army Core of Engineers, NAVFAC Manual.
5.	Specific course information	
	a. Brief description of the content of the course (catalog description)	CVEG 3300. Fundamental understanding of the engineering properties and mechanical behavior of soil, including soil classification, compaction, permeability, compressibility (consolidation), and shear strength.
	b. Prerequisites or Co-requisites	CVEG 2332, CVEG 2102 Co-Requisite (None)
	c. *Indicate whether a required, elective, or selected elective (as per definition provided) course in the program	*****Highly Required*****
6.	a. Specific goals for the course specific outcomes of instruction (e.g., The student will be able to explain the significance of current research about a particular topic.) <i>Students will be able to:</i>	b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course. <i>The specific goals for the course specific outcomes listed on the left column will address the following student learning outcomes:</i>
	1. Analyze the wet volume relationship of soil	

	2. Analyze particle size distribution	N/A
	3. Understand the soil consistency	
	4. Compaction characteristics of soil	
	5. Analyze hydraulic behavior of soil	
	6. Stresses in soil mass	
	7. Soil compressibility analysis	
	8. Shear strength properties of soil	
7	Brief list of topics to be covered	1. Wet volume relationship 2. Sieve analysis 3. Soil consistency 4. Compaction characteristics of soil 5. Hydraulic behavior of soil 6. Stresses in soil mass 7. Soil compressibility 8. Shear strength of soil

GEOTECHNICAL ENGINEERING SPRING 2022

Title of Assignment: Test 1

TOPICS COVERED IN LAB 1: Physical Behavior of Soil

1. Wet-Volume Relationship
2. Sieve Analysis
3. Atterberg Limit
4. Soil Classification

**NOTE: Pages T1 through T7 should be repeated for each Test and
Similarly for all the other assignments in the course binder**

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR TEST 1**

NAME: Student ID:

POLICY TO ERADICATE CHEATING (PROTECT INTEGRITY OF EXAMS)

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Mark the correct answer in all the questions. You need to show the solution/schematic graph of the numerical problems in the space provided. Without solution, only the marked correct answers would be provided 50% credit.

1) For a granular soil, effective size (D_{10}) = 0.09 mm, and coefficient of uniformity (C_u) = 4.56. D_{60} =?

- (a) 0.02 mm
- (b) 0.41 mm
- (c) 50.67 mm
- (d) None of the above

2) A soil in which the particle sizes are distributed over a wide range is termed

- (a) Poorly graded soil.
- (b) Well graded soil.
- (c) Gap graded soil.
- (d) Granular soil.

3) Which of the following is not a volume relationship?

- (a) Void ratio
- (b) Porosity
- (c) Degree of saturation
- (d) Water content

4) Select the incorrect statement.

- (a) Void ratio can be greater than unity.
- (b) Porosity lies between 0 and 100%.
- (c) Degree of saturation lies between 0 and 100%.
- (d) Water content is always less than 100%.

5) If the specific gravity of soil solids is 2.67, and water content is 32% for a given soil at the saturated condition, its void ratio will be

- (a) 0.12.
- (b) 0.85.
- (c) 1.00.
- (d) None of the above.

6) In its natural state, a moist soil has a volume of 0.33 ft^3 and weighs 39.93 lb. The oven dried weight of the soil is 34.54 lb. If $G_s = 2.67$, what will be the volume of soil solids?

- (a) 207.0 ft^3
- (b) 20.7 ft^3
- (c) 2.07 ft^3
- (d) 0.207 ft^3

7) The moisture content of soil at the point of transition from semisolid to plastic state is

- (a) Shrinkage limit.
- (b) Plastic limit.
- (c) Liquid limit.
- (d) Atterberg limit.

8) Plasticity index equal to zero refers to

- (a) Non-plastic soil.
- (b) Low plastic soil.
- (c) Medium plastic soil.
- (d) High plastic soil.

9) The soil classification systems are mainly based on

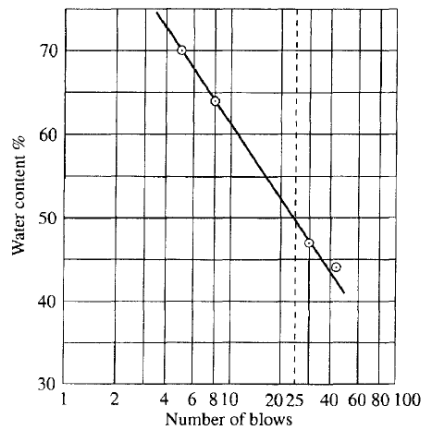
- (a) Grain-size distribution and plasticity of soils.
- (b) Grain-size distribution and strength characteristics of soils.
- (c) Plasticity of soils and strength characteristics of soils.
- (d) Permeability, compressibility and strength characteristics of soil.

10) If the particle size distribution of a soil shows 30% sand, 40% silt and 30% clay-size particles, its textural classification is

- (a) Clay loam.
- (b) Loam.
- (c) Silty clay loam.
- (d) Silty clay.

11) Flow Index of the soil based on the flow curve below is most nearly

- (a) 19
- (b) 29
- (c) 39
- (d) 49



12) The soil passing #200 sieve are

- (a) Silt
- (b) Clay
- (c) Sand
- (d) None of the above is correct

13) A soil has more than 80% finer and LL=60 and PL=30, the soil is

- (a) SP
- (b) MH
- (c) CH
- (d) SC

14) Liquidity index LI is a measure to describe the soil's plasticity behavior

- (a) True
- (b) False
- (c) Partially true
- (d) Both (a) and (c)

15) Hydrometer test is required to classify soil

- (a) False
- (b) True

16) If the LL and the PL of a soil is identical, the soil is:

- (a) Silt
- (b) Clay
- (c) Sand
- (d) Fine grained soil

17) The LL of a soil is 60% and the G_s is 2.75. The void ratio at the liquid state of the soil is:

- (a) 1.61
- (b) 1.63
- (c) 1.65
- (d) 1.67

18) A soil has $w = 14.6\%$, $G_s = 2.81$, $\gamma = 18.2 \text{ kN/m}^3$. The void ratio of the soil is:

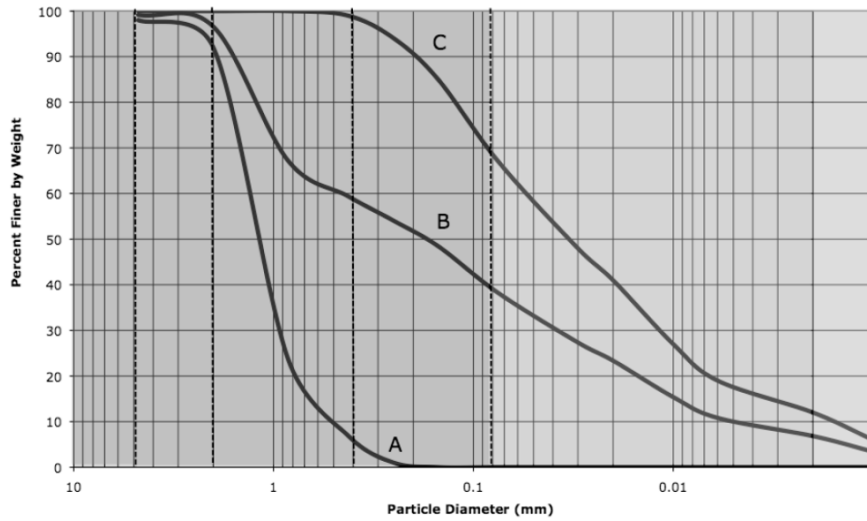
- (a) 0.74
- (b) 0.78
- (c) 0.82
- (d) 0.86

19) At the plastic state of the soil, which of the following is true:

- (a) Degree of saturation (S)=50%, water content (w)=0%, Volume of water (V_w)=0
- (b) Degree of saturation (S)=0%, water content (w)>0%, Volume of water (V_w)=0
- (c) Degree of saturation (S)=100%, water content (w)>0%, Volume of water (V_w)>0
- (d) Degree of saturation (S)=100%, water content (w)>0%, Volume of water (V_w)=0

20) The percent Gravel, sand, silt and clay of Soil B is:

- (a) G=0%, S=45%, M=30%, C=25%
- (b) G=10%, S=50%, M=40%, C=10%
- (c) G=1%, S=61%, M=31%, C=7%
- (d) G=0%, S=30%, M=60%, C=10%



ABOVE AVERAGE

(Note: All Pages shown in Light Blue should be printed on Light Blue Paper)

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NAME: MAALVIKA AGGARWAL Student ID: P

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✓ 1) For a granular soil, effective size (D_{10}) = 0.09 mm, and coefficient of uniformity (C_u) = 4.56. D_{60} = ?

- (a) 0.02 mm
- ✓ (b) 0.41 mm
- (c) 50.67 mm
- (d) None of the above

$$C_u = \frac{D_{60}}{D_{10}}$$
$$\text{So, } D_{60} = C_u \times D_{10}$$
$$= 4.56 \times 0.09$$
$$= \underline{0.41 \text{ mm}}$$

✗ 2) A soil in which the particle sizes are distributed over a wide range is termed

- (a) Poorly graded soil.
- (b) Well graded soil.
- ✓ (c) Gap graded soil.
- (d) Granular soil.

✓ 3) Which of the following is not a volume relationship?

- (a) Void ratio
- (b) Porosity
- (c) Degree of saturation
- ✓ (d) Water content

$$\text{as } w = \frac{W_w}{W_s} \times 100$$

✓ 4) Select the incorrect statement.

- (a) Void ratio can be greater than unity.
- (b) Porosity lies between 0 and 100%.
- (c) Degree of saturation lies between 0 and 100%.
- ✓ (d) Water content is always less than 100%.

✓ 5) If the specific gravity of soil solids is 2.67, and water content is 32% for a given soil at the saturated condition, its void ratio will be

- (a) 0.12.
- ✓ (b) 0.85.
- (c) 1.00.
- (d) None of the above.

$$G_s = 2.67, w = 32\% = 0.32$$

$$e = w G_s$$

$$e = 0.32 \times 2.67$$

$$e = 0.85$$

$$V = V_v + V_s$$

6) In its natural state, a moist soil has a volume of 0.33 ft^3 and weighs 39.93 lb . The oven dried weight of the soil is 34.54 lb . If $G_s = 2.67$, what will be the volume of soil solids?

(a) 207.0 ft^3

(b) 20.7 ft^3

(c) 2.07 ft^3

(d) 0.207 ft^3

$$V = 0.33 \text{ ft}^3 \quad W = 39.93 \text{ lb} \quad W_d = 34.54 \quad G_s = 2.67$$

$$W_w = 5.39 \quad V_w = 0.123$$

$$e = \frac{V_v}{V_s}$$

$$G_s = W_s / V_s \cdot \gamma_w$$

$$V_v = 0.123$$

$$V_s = V - V_v$$

$$V_s = 0.33 - 0.123$$

$$V_s = 0.21$$

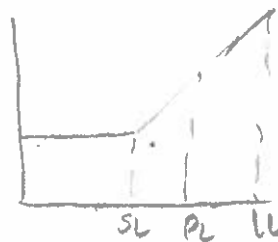
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(b) Low plastic soil.

(c) Medium plastic soil.

(d) High plastic soil.

$$LL - PL = 0$$

9) The soil classification systems are mainly based on

(a) Grain-size distribution and plasticity of soils.

(b) Grain-size distribution and strength characteristics of soils.

(c) Plasticity of soils and strength characteristics of soils.

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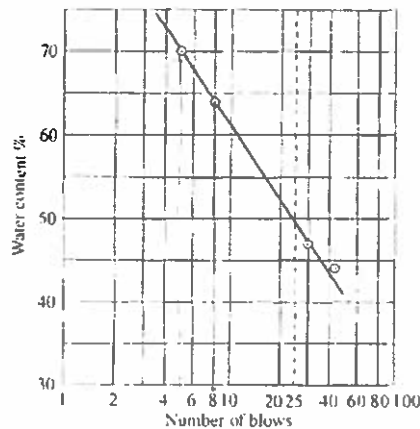
(b) Loam.

(c) Silty clay loam.

(d) Silty clay.

11) Flow Index of the soil based on the flow curve below is most nearly

- (a) 19
 (b) 29
 (c) 39
 (d) 49



$$I_f = \frac{w_1 - w_2}{\log N_2 / N_1}$$

$$= \frac{70 - 64}{\log 8 / 5}$$

$$= \frac{6}{\log 8 / 5} = \boxed{29.39}$$

12) The soil passing #200 sieve are

- (a) Silt
 (b) Clay
 (c) Sand
 (d) None of the above is correct

As silt particles are b/w 0.075 & 0.002

13) A soil has more than 80% finer and LL=60 and PL=30, the soil is

- (a) SP
 (b) MH
 (c) CH
 (d) SC

$$PI = LL - PL = 30 \quad LL \geq 50$$

PI plots on or above A line

$$PI > 7$$

14) Liquidity index LI is a measure to describe the soil's plasticity behavior

- (a) True
 (b) False
 (c) Partially true
 (d) Both (a) and (c)

15) Hydrometer test is required to classify soil

☒ (a) False

(b) True

16) If the LL and the PL of a soil is identical, the soil is:

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(b) Clay

(c) Sand

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17) The LL of a soil is 60% and the G_s is 2.75. The void ratio at the liquid state of the soil is:

☒ (a) 1.61

(b) 1.63

☒ (c) 1.65

(d) 1.67

$w = 60\%$ $G_s = 2.75$

$$\text{Void ratio} = (0.6)(2.75)$$

18) A soil has $w = 14.6\%$, $G_s = 2.81$, $\gamma = 18.2 \text{ kN/m}^3$. The void ratio of the soil is:

☒ (a) 0.74

(b) 0.78

(c) 0.82

(d) 0.86

$$\gamma = \frac{(1+w) G_s \gamma_w}{1+e}$$

$$\gamma (1+e) = (1+0.146)(2.81)(9.81) = 31.59$$

$$1+e = 31.59 / 18.2$$

$$e = 0.735$$

19) At the plastic state of the soil, which of the following is true:

(a) Degree of saturation (S)=50%, water content (w)=0%, Volume of water (V_w)=0

(b) Degree of saturation (S)=0%, water content (w)>0%, Volume of water (V_w)=0

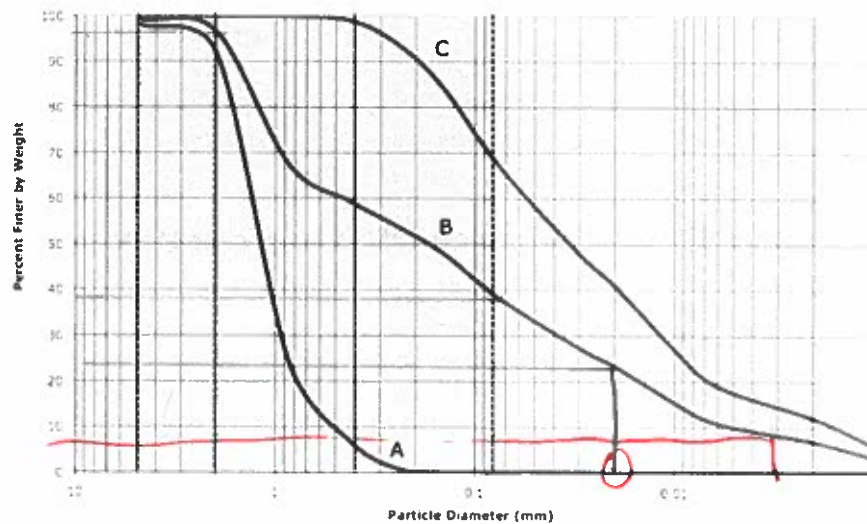
☒ (c) Degree of saturation (S)=100%, water content (w)>0%, Volume of water (V_w)>0

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20) The percent Gravel, sand, silt and clay of Soil B is:

- (a) G=0%, S=45%, M=30%, C=25%
- (b) G=10%, S=50%, M=40%, C=10%
- (c) G=1%, S=61%, M=31%, C=7%
- (d) G=0%, S=30%, M=60%, C=10%

21



0.002 = 25% finer
 80, 1% Clay = 25%

AVERAGE

77

NAME: Denia Leroy

Student ID: 21790456

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- ☒ (b) 0.41 mm
- (c) 50.67 mm
- (d) None of the above

$$C_u = \frac{D_{60}}{D_{10}} \quad 4.56 = \frac{D_{60}}{0.09 \text{ mm}}$$

$$D_{60} = 0.41 \text{ mm}$$

2) A soil in which the particle sizes are distributed over a wide range is termed

- ☒ (a) Poorly graded soil.
- ☒ (b) Well graded soil.
- (c) Gap graded soil.
- (d) Granular soil.

3) Which of the following is not a volume relationship?

- (a) Void ratio, $e = V_v / V_s$
- (b) Porosity, $n = V_v / V$
- (c) Degree of saturation, $S = \frac{V_w}{V_v}$
- ☒ (d) Water content, $w = \frac{W_w}{W_s} \times 100$

4) Select the incorrect statement.

- ☒ (a) Void ratio can be greater than unity.
- ☒ (b) Porosity lies between 0 and 100%.
- (c) Degree of saturation lies between 0 and 100%. ✓ $0 \leq S \leq 1$
- (d) Water content is always less than 100%. ✓

5) If the specific gravity of soil solids is 2.67, and water content is 32% for a given soil at the saturated condition, its void ratio will be

- (a) 0.12.
- ☒ (b) 0.85.
- (c) 1.00.
- (d) None of the above.

$$G_s = 2.67 \quad w = 32\% \quad e = \frac{V_v}{V_s}$$

$$e = w G_s$$

$$= 0.32 \cdot 2.67$$

$$e = 0.854$$

6) In its natural state, a moist soil has a volume of 0.33 ft^3 and weighs 39.93 lb . The oven dried weight of the soil is 34.54 lb . If $G_s = 2.67$, what will be the volume of soil solids?

- (a) 207.0 ft^3
- (b) 20.7 ft^3
- (c) 2.07 ft^3
- (d) 0.207 ft^3

$$G_s = 2.67 \quad V_w = 0.33 \text{ ft}^3 \quad W = 39.93 \text{ lb} \quad \gamma_d = 34.54 \text{ lb/ft}^3$$

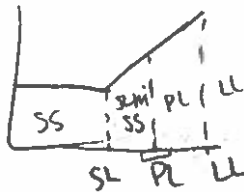
$$V_s = ?$$

$$\gamma = \frac{39.93}{0.33}$$

$$\gamma = 121$$

7) The moisture content of soil at the point of transition from semisolid to plastic state is

- (a) Shrinkage limit.
- (b) Plastic limit.
- (c) Liquid limit.
- (d) Atterberg limit.



8) Plasticity index equal to zero refers to

- (a) Non-plastic soil.
- (b) Low plastic soil.
- (c) Medium plastic soil.
- (d) High plastic soil.

$$PI = 0$$

9) The soil classification systems are mainly based on

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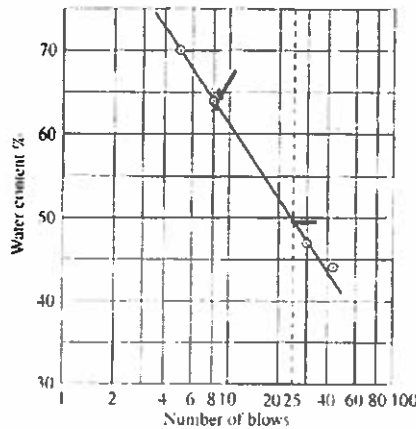
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- (d) Silty clay.

$$\% S = 30\%, \quad \% M = 40\%, \quad \% C = 30\%$$

11) Flow Index of the soil based on the flow curve below is most nearly

- ☒ (a) 19
- (b) 29
- (c) 39
- (d) 49



(-3)

$$I_F = \frac{w_2 - w_1}{\log \left(\frac{N_2}{N_1} \right)}$$

$N = 25$
 $w_{11} = 49$

12) The soil passing #200 sieve are

- ☒ (a) Silt
- ☒ (b) Clay
- ☒ (c) Sand
- (d) None of the above is correct

Gravel
 sand

$C < 0.002 \text{ mm}$

13) A soil has more than 80% finer and $LL=60$ and $PL=30$, the soil is

- ☒ (a) SP
- ☒ (b) MH
- ☒ (c) CH
- (d) SC

$PI = LL - PL$ $LL \geq 50$
 $= 60 - 30$
 $PI = 30$

14) Liquidity index LI is a measure to describe the soil's plasticity behavior

- ☒ (a) True
- (b) False
- (c) Partially true
- (d) Both and (a) and (c)

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(a) False

☒ (b) True

silt clay

16) If the LL and the PL of a soil is identical, the soil is:

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(b) Clay

☒ (c) Sand

(d) Fine grained soil

$$LL = PL \quad PI = 0$$

Pure
Sand

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(a) 1.61

(b) 1.63

☒ (c) 1.65

(d) 1.67

$$LL = 60\%, \quad G_s = 2.75 \quad e = \frac{V_v}{V_s} \quad e = w G_s$$

$$LL \geq 50 \quad PI = 29.2$$

$$PI = LL - PL$$

18) A soil has $w = 14.6\%$, $G_s = 2.81$, $\gamma = 18.2 \text{ kN/m}^3$. The void ratio of the soil is:

☒ (a) 0.74

(b) 0.78

(c) 0.82

(d) 0.86

$$\gamma_d = \frac{\gamma}{1+w} = \frac{18.2 \text{ kN/m}^3}{1+0.146} \quad \gamma_d = 15.88 \quad \gamma_w = 9.81 \frac{\text{kN}}{\text{m}^3}$$

$$\gamma = \frac{(1+w)G_s\gamma_w}{1+e} \quad e = \frac{1+w}{n} \quad (1+e)\gamma = (1+w)G_s\gamma_w$$

$$1 = \frac{\gamma + \gamma_e}{\gamma} \quad \gamma_e = \frac{(1+w)G_s\gamma_w}{1+e} \quad e = \frac{V_v}{V_s} \quad e = \frac{w G_s}{1}$$

19) At the plastic state of the soil, which of the following is true:

(a) Degree of saturation (S)=50%, water content (w)=0%, Volume of water (V_w)=0

(b) Degree of saturation (S)=0%, water content (w)>0%, Volume of water (V_w)=0

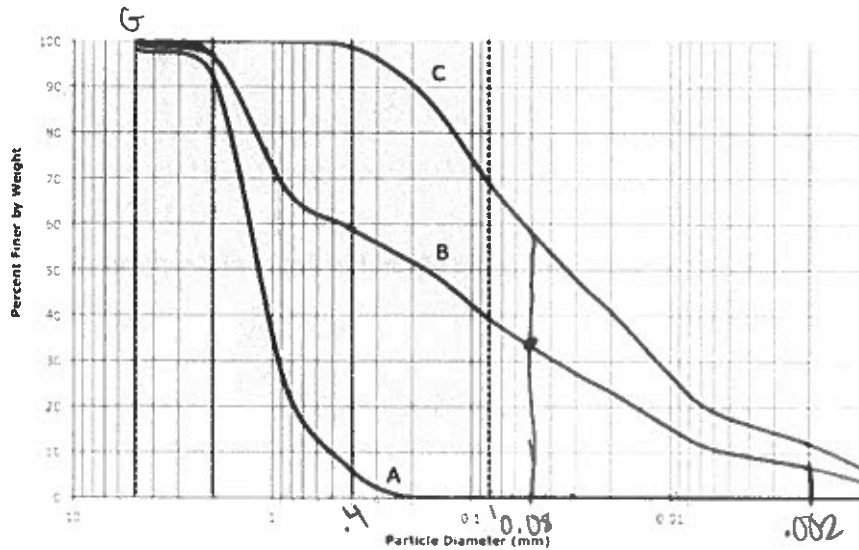
☒ (c) Degree of saturation (S)=100%, water content (w)>0%, Volume of water (V_w)>0

(d) Degree of saturation (S)=100%, water content (w)>0%, Volume of water (V_w)=0



20) The percent Gravel, sand, silt and clay of Soil B is:

- (a) G=0%, S=45%, M=30%, C=25%
 (b) G=10%, S=50%, M=40%, C=10%
 (c) G=1%, S=61%, M=31%, C=7%
 (d) G=0%, S=30%, M=60%, C=10%



Passing 2mm = 100% -

Passing 0.075mm =

Passing 0.002mm =

BELOW AVERAGE

62

NAME: Nyja' Kennedy

Student ID: P21753426

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Mark the correct answer in all the questions. You need to show the solution/schematic graph of the numerical problems in the space provided. Without solution, only the marked correct answers would be provided 50% credit.

✓ 1) For a granular soil, effective size (D_{10}) = 0.09 mm, and coefficient of uniformity (C_u) = 4.56. D_{60} = ?

- (a) 0.02 mm
(b) 0.41 mm
(c) 50.67 mm
(d) None of the above

$$C_u = \frac{D_{60}}{D_{10}}$$

$$4.56 = \frac{D_{60}}{0.09}$$

$$D_{60} = 4.56 \times 0.09 = 0.41 \text{ mm}$$

✗ 2) A soil in which the particle sizes are distributed over a wide range is termed

- (a) Poorly graded soil.
(b) Well graded soil.
(c) Gap graded soil.
(d) Granular soil.

✗ 3) Which of the following is not a volume relationship?

- (a) Void ratio
(b) Porosity
(c) Degree of saturation
(d) Water content

✓ 4) Select the incorrect statement.

- (a) Void ratio can be greater than unity.
(b) Porosity lies between 0 and 100%.
(c) Degree of saturation lies between 0 and 100%.
(d) Water content is always less than 100%.

✓ 5) If the specific gravity of soil solids is 2.67, and water content is 32% for a given soil at the saturated condition, its void ratio will be

- (a) 0.12.
(b) 0.85.
(c) 1.00.
(d) None of the above.

$$2.67 \times 32\% = 0.85$$

- 6) In its natural state, a moist soil has a volume of 0.33 ft^3 and weighs 39.93 lb . The oven dried weight of the soil is 34.54 lb . If $G_s = 2.67$, what will be the volume of soil solids?

- (a) 207.0 ft^3
(b) 20.7 ft^3
(c) 2.07 ft^3
(d) 0.207 ft^3

$$V = 0.33 \text{ ft}^3$$

$$W = 39.93 \text{ lb}$$

$$\gamma_d = 34.54 \text{ lb/ft}^3$$

$$G_s = 2.67$$

$$\gamma_w = \frac{\gamma - \gamma_d}{\gamma_w}$$

- 7) The moisture content of soil at the point of transition from semisolid to plastic state is

- (a) Shrinkage limit.
(b) Plastic limit.
(c) Liquid limit.
(d) Atterberg limit.

- 8) Plasticity index equal to zero refers to

- (a) Non-plastic soil.
(b) Low plastic soil.
(c) Medium plastic soil.
(d) High plastic soil.

- 9) The soil classification systems are mainly based on

- (a) Grain-size distribution and plasticity of soils.
(b) Grain-size distribution and strength characteristics of soils.
(c) Plasticity of soils and strength characteristics of soils.
(d) Permeability, compressibility and strength characteristics of soil.

- 10) If the particle size distribution of a soil shows 30% sand, 40% silt and 30% clay-size particles, its textural classification is

- (a) Clay loam.
(b) Loam.
(c) Silty clay loam.
(d) Silty clay.

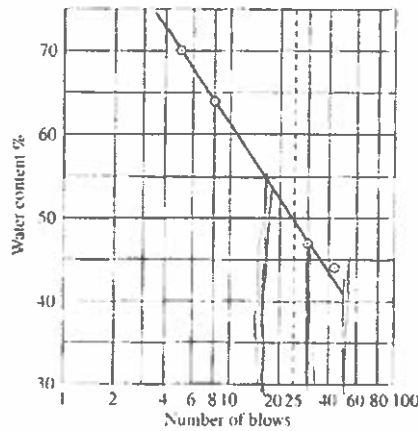
30% sand

40% silt

30% clay size

✓ 11) Flow Index of the soil based on the flow curve below is most nearly

- (a) 19
- ✓ (b) 29
- (c) 39
- (d) 49



-2.5

✗ 12) The soil passing #200 sieve are

- ✓ (a) Silt
- (b) Clay
- (c) Sand
- (d) None of the above is correct

✓ 13) A soil has more than 80% finer and $LL=60$ and $PL=30$, the soil is

- (a) SP
- (b) MH
- ✓ (c) CH
- (d) SC

$$LL - PL$$

$$PL = 30$$

✓ 14) Liquidity index LI is a measure to describe the soil's plasticity behavior

- ✓ (a) True
- (b) False
- (c) Partially true
- (d) Both and (a) and (c)

15) Hydrometer test is required to classify soil

(a) False

(b) True

16) If the LL and the PL of a soil is identical, the soil is:

(a) Silt

(b) Clay

(c) Sand

(d) Fine grained soil

17) The LL of a soil is 60% and the G_s is 2.75. The void ratio at the liquid state of the soil is:

(a) 1.61

(b) 1.63

(c) 1.65

(d) 1.67

-2.5

18) A soil has $w = 14.6\%$, $G_s = 2.81$, $\gamma = 18.2 \text{ kN/m}^3$. The void ratio of the soil is:

(a) 0.74

(b) 0.78

(c) 0.82

(d) 0.86

$$w = 14.6\%$$

$$G_s = 2.81$$

$$\gamma = 18.2$$

(-2)

$$e = \frac{\gamma}{1+w} = \frac{18.2}{1+0.146} = 17.39$$

$$\frac{G_s - \gamma_w}{\gamma_l} = \frac{2.81 - 9810}{17.39}$$

19) At the plastic state of the soil, which of the following is true:

(a) Degree of saturation (S)=50%, water content (w)=0%, Volume of water (V_w)=0

(b) Degree of saturation (S)=0%, water content (w)>0%, Volume of water (V_w)=0

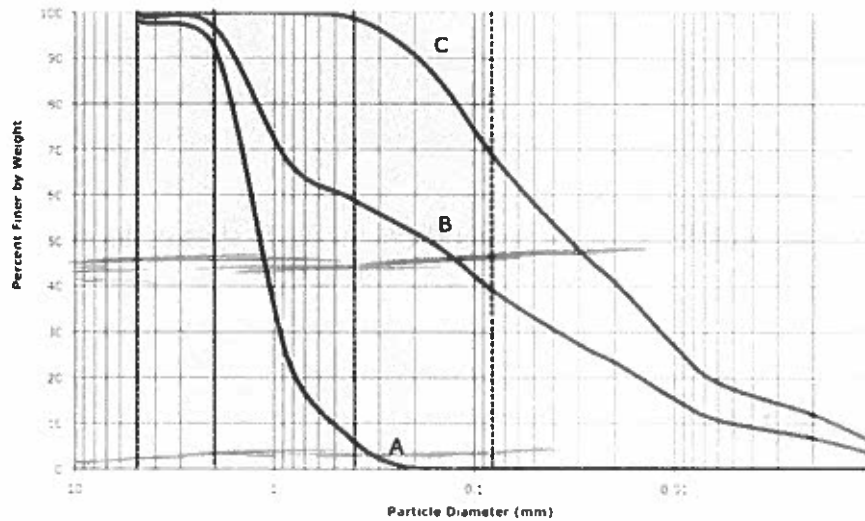
(c) Degree of saturation (S)=100%, water content (w)>0%, Volume of water (V_w)>0

(d) Degree of saturation (S)=100%, water content (w)>0%, Volume of water (V_w)=0

✓ 20) The percent Gravel, sand, silt and clay of Soil B is:

- (a) G=0%, S=45%, M=30%, C=25%
- (b) G=10%, S=50%, M=40%, C=10%
- Ⓒ G=1%, S=61%, M=31%, C=7%
- (d) G=0%, S=30%, M=60%, C=10%

2.5



GEOTECHNICAL ENGINEERING SPRING 2022

Title of Assignment: Test 2

TOPICS COVERED IN TEST 2:

1. Permeability
2. Compaction
3. Atterberg Limit
4. Soil Classification
5. Wet-Volume Relationship
6. Grain Size Distribution

Measuring Moisture Content of Soil

**NOTE: Pages L1 through L7 should be repeated for each Report
and Similarly for all the other assignments in the course binder**

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR TEST 1**

NAME: Student ID:

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CVEG 3300 – Geotechnical Engineering
Mid Term Test, Spring 2022
(1.00 pm – 2.45 pm)

Problem 1 (10 pts)

During a hydrometer analysis a soil with $G_s = 2.6$ is immersed in a water suspension with a temperature of 24°C . $R=43$ (R = Actual hydrometer reading) was obtained after 3600 seconds of sedimentation. What is the particle diameter of the smallest size particles that have settled during that time? Based on the calculated value of the particle diameter, mention what type of fine particle is that clay or silt.

Problem 2 (20 pts)

The data obtained from Liquid Limit Test and Plastic Limit Test is provided in the Tables 1 and 2 respectively. However, the tables are not completed. Some data need to be calculated.

- Complete the tables (1 & 2)
- Determine the Liquid Limit (LL) of the soil using the graph (next page)
- Find the Plastic Limit (PL) value
- Find the plasticity Index of the soil.
- Find the flow index of the soil

(Detail sketch in the flow curve is required, graph given next page)

Table 1: LL Test

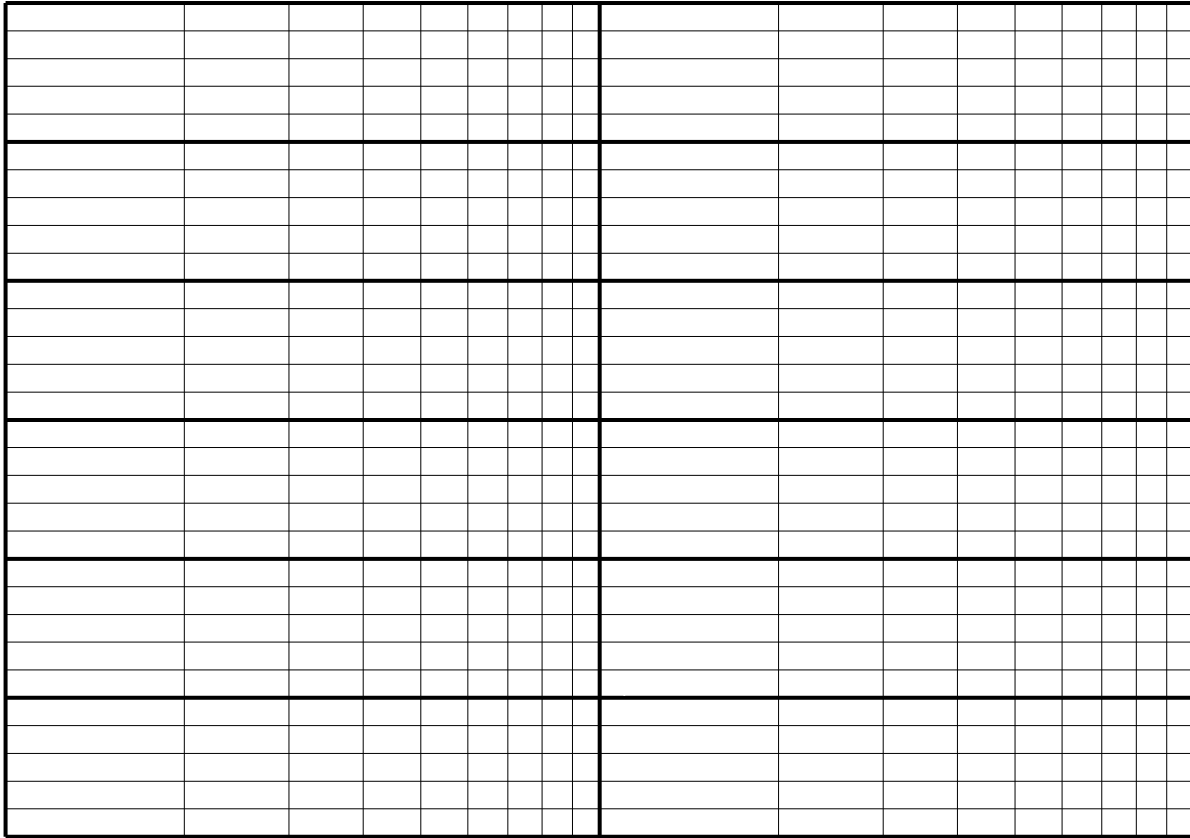
Sample	Weight of can (g)	Weight of can +moist soil (g)	Weight of can +dry soil (g)	Weight of water (g)	Weight of dry soil (g)	Moisture Content %	Number of Blows
A	17.1	25.9	23.3				38
	18.3	30.3	26.4				20
	18.5	26.9	23.9				9

Table 2: PL Test

Weight of can (g)	Weight of can +moist soil (g)	Weight of can +dry soil (g)	Weight of water (g)	Weight of dry soil (g)	Moisture Content %
18.6	19.7	19.5			

CVEG 3300 – Geotechnical Engineering
Mid Term Test, Spring 2022
(1.00 pm – 2.45 pm)

(Write down the specific axis title in the graph, Label X and Y axis properly)



CVEG 3300 – Geotechnical Engineering
Mid Term Test, Spring 2022
(1.00 pm – 2.45 pm)

Problem 3 (20 pts)

Given the following test results:

Volume of Soil: 0.5 ft^3 , Wet Mass: 52.73 lb, Dry Mass: 45.53 lb, and $G_s = 2.7$

Find the following.

- a) Wet unit weight
- b) Dry unit weight
- c) Void ratio (e) of the sample
- d) Porosity, n
- e) Degree of Saturation, S

CVEG 3300 – Geotechnical Engineering
Mid Term Test, Spring 2022
(1.00 pm – 2.45 pm)

CVEG 3300 – Geotechnical Engineering
Mid Term Test, Spring 2022
(1.00 pm – 2.45 pm)

Problem 4 (30 pts)

The following table shows the Standard Proctor Test Results (moisture content and bulk unit weight). The specific gravity of the soil is 2.71.

Find the following.

- (a) Plot the Compaction Curve in the graph provided.
- (b) Find maximum dry density and optimum moisture content from the graph.
- (c) If the relative compaction is 95%, find the required dry unit weight that is to achieve in the field.
- (d) Determine the degree of saturation of the soil at maximum dry unit weight.

w (%)	10	13	16	18	20	22	25
γ (pcf)	98	106	119	125	129	128	123

(Write down the specific axis title in the graph, Label X and Y axis properly)



CVEG 3300 – Geotechnical Engineering
Mid Term Test, Spring 2022
(1.00 pm – 2.45 pm)

CVEG 3300 – Geotechnical Engineering
Mid Term Test, Spring 2022
(1.00 pm – 2.45 pm)

Problem 5 (20 pts)

The results of a constant-head permeability test for a fine sand sample having a diameter of 150 mm and a length of 300 mm. The constant-head difference was 500 mm. Total 350 cm³ water was collected in 5 minutes. The void ratio of the sand sample was 0.61. Determine the following:

- (1) Hydraulic conductivity
- (2) Discharge velocity
- (3) Seepage velocity.

Determine all the parameters in cm/sec unit.

ABOVE AVERAGE

NAME: SANTAY TILLMUTH

100
Student ID: P20432113

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- ✓a) Complete the tables (1 & 2)
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- ✓c) Find the Plastic Limit (PL) value
- ✓d) Find the plasticity Index of the soil.
- ✓e) Find the flow index of the soil

(Detail sketch in the flow curve is required, graph given next page)

Table 1: LL Test

Sample	Weight of can (g)	Weight of can + moist soil (g)	Weight of can + dry soil (g)	Weight of water (g)	Weight of dry soil (g)	Moisture Content %	Number of Blows
A	17.1	25.9	23.3	2.6	6.2	41.9	38
	18.3	30.3	26.4	3.9	8.1	48.1	20
	18.5	26.9	23.9	3.0	5.4	55.6	9

Table 2: PL Test

Weight of can (g)	Weight of can + moist soil (g)	Weight of can + dry soil (g)	Weight of water (g)	Weight of dry soil (g)	Moisture Content %
18.6	19.7	19.5	0.2	0.9	22.2

$$PL = 22.2$$

$$LL = 45.5$$

$$PI = LL - PL$$

$$= 45.5 - 22.2$$

$$= 23.3\%$$

Flow Index = Slope of the Flow Curve

$$= \frac{\text{rise}}{\text{run}} = \frac{48.1 - 41.9}{\log 38 - \log 20} = \frac{6.2}{1.58 - 1.30} = \frac{6.2}{0.28}$$

$$= 22.14$$

Problem 3 (20 pts)

Given the following test results:

Volume of Soil: 0.5 ft^3 , Wet Mass: 52.73 lb , Dry Mass: 45.53 lb , and $G_s = 2.7$

Find the following.

$$w = \frac{52.73 - 45.53}{45.53} = 0.158$$

- ✓ a) Wet unit weight
- ✓ b) Dry unit weight
- ✓ c) Void ratio (e) of the sample
- ✓ d) Porosity, n
- ✓ e) Degree of Saturation, S

$$\gamma = \frac{W = 52.73 \text{ lb}}{V = 0.5 \text{ ft}^3} = 105.46 \text{ lb/ft}^3$$

$$\gamma_d = \frac{W}{V} = \frac{45.53 \text{ lb}}{0.5 \text{ ft}^3} = 91.06 \text{ lb/ft}^3$$

$$\gamma_d = \frac{\gamma}{1+w} = \frac{105.46 \text{ lb/ft}^3}{1.158} = 91.07 \text{ lb/ft}^3$$

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

$$e = \frac{2.7 \times 62.4 \text{ lb/ft}^3}{91.06 \text{ lb/ft}^3} - 1 = 0.85$$

$$n = \frac{e}{1+e} = \frac{0.85}{1.85} = 0.459$$

$$S_r = w G_s \Rightarrow s = \frac{w G_s}{e} = \frac{0.158 \times 2.7}{0.85} = 0.501$$

SAMPLE CALCULATION : $\gamma_{d1} = \frac{\gamma}{1+w} = \frac{98}{1.1} = 89.1 \text{ pcf}$

Problem 4 (30 pts)

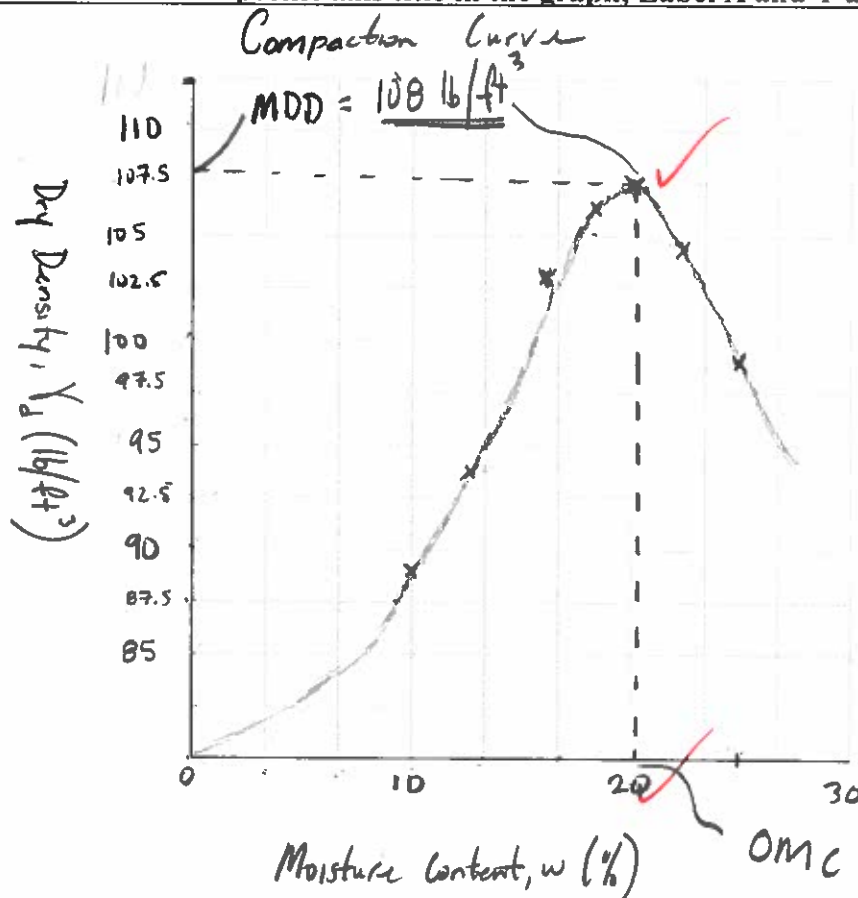
The following table shows the Standard Proctor Test Results (moisture content and bulk unit weight). The specific gravity of the soil is 2.71. ✓

Find the following.

- ✓(a) Plot the Compaction Curve in the graph provided.
- ✓(b) Find maximum dry density and optimum moisture content from the graph.
- ✓(c) If the relative compaction is 95%, find the required dry unit weight that is to achieve in the field.
- ✓(d) Determine the degree of saturation of the soil at maximum dry unit weight.

w (%)	10	13	16	18	20	22	25
γ (pcf)	98	106	119	125	129	128	123
γ_d (pcf)	89.1	93.8	102.6	105.9	107.5	104.9	98.4

(Write down the specific axis title in the graph, Label X and Y axis properly)



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

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

$$S_e = w G_s$$

$$e = \frac{2.71 \times 62.4 \text{ lb/ft}^3}{108 \text{ lb/ft}^3} - 1$$

$$= 0.566$$

$$R(\%) = \frac{\gamma_{d \text{ field}}}{\gamma_{d \text{ (max lab)}}} \times 100 \Rightarrow 95\% = \frac{\gamma_{d \text{ field}}}{108 \text{ lb/ft}^3} \times 100 \therefore \gamma_{d \text{ field}} = 0.95 \times 108$$

$$= 102.6 \text{ pcf}$$

$$S_e = w G_s \Rightarrow S = \frac{w G_s}{e} \Rightarrow S = \frac{0.205 \times 2.71}{0.566}$$

$$S = 0.982 \text{ (Soil is 98.2\% saturated)}$$

Problem 5 (20 pts)

The results of a constant-head permeability test for a fine sand sample having a diameter of 150 mm and a length of 300 mm. The constant-head difference was 500 mm. Total 350 cm³ water was collected in 5 minutes. The void ratio of the sand sample was 0.61. Determine the following:

- (1) Hydraulic conductivity
- (2) Discharge velocity
- (3) Seepage velocity.

Determine all the parameters in cm/sec unit.

Given: $D = 150 \text{ mm} = 15 \text{ cm}$

$L = 300 \text{ mm} = 30 \text{ cm}$

$\Delta h = 500 \text{ mm} = 50 \text{ cm}$

$Q = 350 \text{ cm}^3$

$t = 5 \text{ min} \times \frac{60 \text{ sec}}{1 \text{ min}} = 300 \text{ sec}$

$e = 0.61$

$q = \frac{Q}{t} = \frac{350 \text{ cm}^3}{300 \text{ s}} = 1.167 \text{ cm/s}$

$i = \frac{\Delta h}{L} = \frac{50 \text{ cm}}{30 \text{ cm}} = 1.67$

$A = \frac{\pi}{4} D^2 \text{ or } \pi r^2$
 $= \pi \left(\frac{15}{2}\right)^2$
 $= 176.7 \text{ cm}^2$

FIND: K, V, V_s

APPROACH:

$q = KiA \Rightarrow K = \frac{q}{iA} \Rightarrow K = \frac{1.167 \text{ cm/s}}{1.67 \times 176.7 \text{ cm}^2} = 0.0039 \text{ cm/s}$

$K = \frac{QL}{Aht} = \frac{350 \text{ cm}^3 \times 30 \text{ cm}}{176.7 \text{ cm}^2 \times 50 \text{ cm} \times 300 \text{ s}} = \frac{10500 \text{ cm}^4}{2650500 \text{ cm}^3/\text{s}} = 0.0039 \text{ cm/s}$

$V = Ki \Rightarrow V = 0.0039 \text{ cm/s} \times 1.67$
 $= 0.0066 \text{ cm/s}$

$V = V_s n \therefore V_s = \frac{V}{n} = V \left(\frac{1}{n}\right) = V \left(\frac{1+e}{e}\right)$

$V_s = 0.0066 \text{ cm/s} \left(\frac{1+0.61}{0.61}\right) = 0.0066 \text{ cm/s} \times 2.64$
 $= 0.0174 \text{ cm/s}$

AVERAGE

84

NAME: Alyssa Reynolds

Student ID: 21853043

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Problem 2 (20 pts)

The data obtained from Liquid Limit Test and Plastic Limit Test is provided in the Tables 1 and 2 respectively. However, the tables are not completed. Some data need to be calculated.

- Complete the tables (1 & 2)
- Determine the Liquid Limit (LL) of the soil using the graph (next page)
- Find the Plastic Limit (PL) value
- Find the plasticity Index of the soil.
- Find the flow index of the soil

(Detail sketch in the flow curve is required, graph given next page)

$$\frac{w_3 - w_2}{w_3} \times 100$$

Table 1: LL Test

Sample	w_1 Weight of can (g)	Weight of can + moist soil (g)	Weight of can + dry soil (g)	w_2 Weight of water (g)	w_3 Weight of dry soil (g)	Moisture Content %	Number of Blows
A	17.1	25.9	23.3	2.6	6.2	29.54	38
	18.3	30.3	26.4	3.9	8.1	32.5	20
	18.5	26.9	23.9	3	5.4	35.17	9

Table 2: PL Test

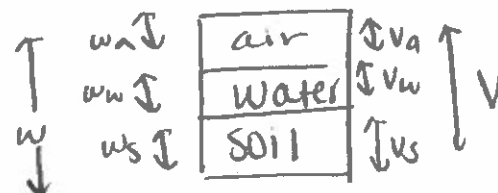
Weight of can (g)	Weight of can + moist soil (g)	Weight of can + dry soil (g)	Weight of water (g)	Weight of dry soil (g)	Moisture Content %
18.6	19.7	19.5	0.2	0.9	18.18

$$w_1 = \frac{0.2 - 2.6}{0.2} \times 100 = 58.06\%$$

$$w_2 = \frac{8.1 - 3.9}{8.1} \times 100 = 51.85\%$$

$$w_3 = \frac{5.4 - 3}{5.4} \times 100 = 44.44\%$$

$$w_4 = \frac{0.9 - 0.2}{0.9} \times 100 = 77.78\%$$



$$w = \frac{w_w}{w_s}$$

$$w = \frac{w_w}{w_w + w_s}$$

$$w_1 = \frac{2.6}{0.2 + 2.6} = 29.54 \quad w_4 = \frac{0.2}{0.9 + 0.2} = 18.18$$

$$w_2 = \frac{3.9}{3.9 + 8.1} = 32.5$$

$$w_3 = \frac{3}{5.4} = 35.17$$

$$b) LL \approx 44\%$$

$$c) PL \approx 22.22\%$$

$$d) PI = 44 - 22 = 22\%$$

$$e) I_F(w_1 - w_2) = \frac{(41.9 - 48.15)}{\log(9/38)} = 10$$

Problem 3 (20 pts)

Given the following test results:

Volume of Soil: 0.5 ft^3 , Wet Mass: 52.73 lb , Dry Mass: 45.53 lb , and $G_s = 2.7$

Find the following.

- a) Wet unit weight
- b) Dry unit weight
- c) Void ratio (e) of the sample
- d) Porosity, n
- e) Degree of Saturation, S

$$a) \frac{52.73 \text{ lb}}{0.5 \text{ ft}^3} = 105.46 \frac{\text{lb}}{\text{ft}^3} = \gamma_{\text{sat}}$$

$$b) \gamma_d = \frac{45.53 \text{ lb}}{0.5 \text{ ft}^3} = 91.06 \frac{\text{lb}}{\text{ft}^3}$$

$$d) e = \frac{(1+w)(\gamma_w)(G_s)}{\gamma} - 1$$

$$\gamma_d = \gamma_{\text{sat}} - (n \cdot \gamma_w)$$

$$91.06 = 105.46 - \left(\frac{e}{1+e} \right) (62.4)$$

$$-105.46 + 105.46$$

$$14.4 = (n)(62.4)$$

$$n = 0.231$$

$$c) n = \frac{e}{1+e} \Rightarrow 0.231 = \frac{e}{1+e}$$

$$0.231 + 0.231e = e$$

$$0.231 = 0.769e$$

$$\frac{0.231}{0.769} = \frac{0.769e}{0.769}$$

$$e = 0.300$$

$$e) S(e) = w(G_s)$$

$$\gamma_{\text{sat}} = \frac{(G_s \cdot e(\gamma_w))(\gamma_w)}{1+e}$$

$$105.46 = \frac{(2.7(62.4))62.4}{1+0.3}$$

$$137.1 = \frac{50.54(S)}{50.54}$$

$$S = 2.71$$

$$\text{or } 271.3\%$$

150 mm
cent = 10^{-2}
milli = 10^{-3}
micro

1m = 1000mm

Problem 5 (20 pts)

The results of a constant-head permeability test for a fine sand sample having a diameter of 150 mm and a length of 300 mm. The constant-head difference was 500 mm. Total 350 cm³ water was collected in 5 minutes. The void ratio of the sand sample was 0.61. Determine the following:

- (1) Hydraulic conductivity
- (2) Discharge velocity
- (3) Seepage velocity.

Determine all the parameters in cm/sec unit.

(1) $K = \frac{Q \cdot L}{(A)(h)(t)}$ = $\frac{(350)(300 \times 0.1)}{(\pi \cdot (\frac{150}{2})^2)(500 \cdot 0.1)(5 \times 60)}$ = $\frac{10500}{56.25 \pi (500 \cdot 0.1)(5 \times 60)}$ = 0.00396 cm/s

$\therefore K = 0.00396 \frac{\text{cm}}{\text{s}}$

$= \frac{(3.5)(300)}{\pi (\frac{150}{2})^2 (500)(5 \times 60)}$

(2) $q = V \cdot A$
= $(V)(A)$
 $i = \frac{\Delta h}{L} = \frac{500 \text{ mm}}{300 \text{ mm}} = 1.67$

$\frac{\text{cm}^3}{\text{s}} = \frac{\text{cm}}{\text{s}}$
 $V = \text{cm/s}$
 $\therefore K = \text{cm/s}$

$q = (V)(A)$
 $V = (V)(A)$
 $V = (0.00396)(1.67)$
= 0.0066 cm/s

Discharge velocity = 0.0066 cm/s
Discharge = 1.169 cm³/s

(3) $n = \frac{V_v}{V}$

$e = 0.61$
 $n = \frac{e}{1+e} \Rightarrow \frac{0.61}{1.61} = 0.379$

$0.379 = \frac{V_v}{0.0066}$ = 0.0025 cm/s

BELOW AVERAGE

71

NAME: Denia Leroy Student ID: _____

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Problem 2 (20 pts)

The data obtained from Liquid Limit Test and Plastic Limit Test is provided in the Tables 1 and 2 respectively. However, the tables are not completed. Some data need to be calculated.

- Complete the tables (1 & 2)
- Determine the Liquid Limit (LL) of the soil using the graph (next page)
- Find the Plastic Limit (PL) value
- Find the plasticity Index of the soil.
- Find the flow index of the soil

(Detail sketch in the flow curve is required, graph given next page)

Table 1: LL Test

Sample	W_1 Weight of can (g)	W_2 Weight of can +moist soil (g)	W_3 Weight of can +dry soil (g)	Weight of water (g)	Weight of dry soil (g)	Moisture Content %	Number of Blows
A	17.1	25.9	23.3	6.8	6.2	41.9	38
	18.3	30.3	26.4	12	8.1	48.14	20
	18.5	26.9	23.9	6.4	5.4	55.6	9

$$W = \frac{W_w - W_s}{W_s} \times 100$$

Table 2: PL Test

Weight of can (g)	Weight of can +moist soil (g)	Weight of can +dry soil (g)	Weight of water (g)	Weight of dry soil (g)	Moisture Content %
18.6	19.7	19.5	1.1	0.9	22.2

Sample calculation

$$W_w = W_2 - W_1 = 25.9 - 17.1 = 8.8$$

$$W_s = W_3 - W_1 = 23.3 - 17.1 = 6.2$$

$W\%$
 $N=25$
 $W=LL$
 $PI = LL - PL$
 $IF = \frac{W_2 - W_1}{\log\left(\frac{N_2}{N_1}\right)}$

Problem 3 (20 pts)

Given the following test results:

Volume of Soil: 0.5 ft³, Wet Mass: 52.73 lb, Dry Mass: 45.53 lb, and $G_s = 2.7$

Find the following.

- a) Wet unit weight γ
- b) Dry unit weight γ_d
- c) Void ratio (e) of the sample
- d) Porosity, n
- e) Degree of Saturation, S

given: $V_s = 0.5 \text{ ft}^3$

$G_s = 2.7$

$M_w = 52.73 \text{ lb}$

$M_D = 45.53 \text{ lb}$

$w = ?$

$$w = \frac{M_w - M_D}{M_D} \times 100$$

$$w = \frac{52.73 - 45.53}{45.53} \times 100$$

$$w = 15.81\% = 0.1581$$

a) $\gamma = \frac{W}{V} = \frac{52.73 \text{ lb}}{0.5 \text{ ft}^3}$

$\gamma = 105.46 \text{ lb/ft}^3$

c) void ratio, e

$$e = \frac{n}{1-n}$$

$$(1+e) \gamma = (1+w) G_s \gamma_w (1+e)$$

$$(1+e) \gamma = (1+w) G_s \gamma_w$$

$$\frac{\gamma + e}{\gamma} = \frac{(1+w) G_s \gamma_w}{\gamma}$$

$$e = \frac{(1+w) G_s \gamma_w}{\gamma} = \frac{(1+0.1581) \cdot 2.7 \cdot 62.4 \frac{\text{lb}}{\text{ft}^3}}{105.46 \frac{\text{lb}}{\text{ft}^3}}$$

$e = 1.85$

$e = 0.85$

b) $\gamma_d = \frac{\gamma}{1+w} = \frac{G_s \gamma_w}{1+e}$

$$\gamma_d = \frac{2.7 \cdot 62.4 \frac{\text{lb}}{\text{ft}^3}}{1 + 1.85}$$

$\gamma_d = 59.1 \frac{\text{lb}}{\text{ft}^3}$

d) Porosity, n

$$n = \frac{V_v}{V}$$

$$n = \frac{1+e}{e} = \frac{1+1.85}{1.85}$$

$n = 1.54$

e) Degree of Saturation

$$S_e = w G_s$$

$$S = \frac{0.1581 \cdot 2.7}{1.85}$$

$S = 0.23$

$S = 0.5$

Problem 4 (30 pts)

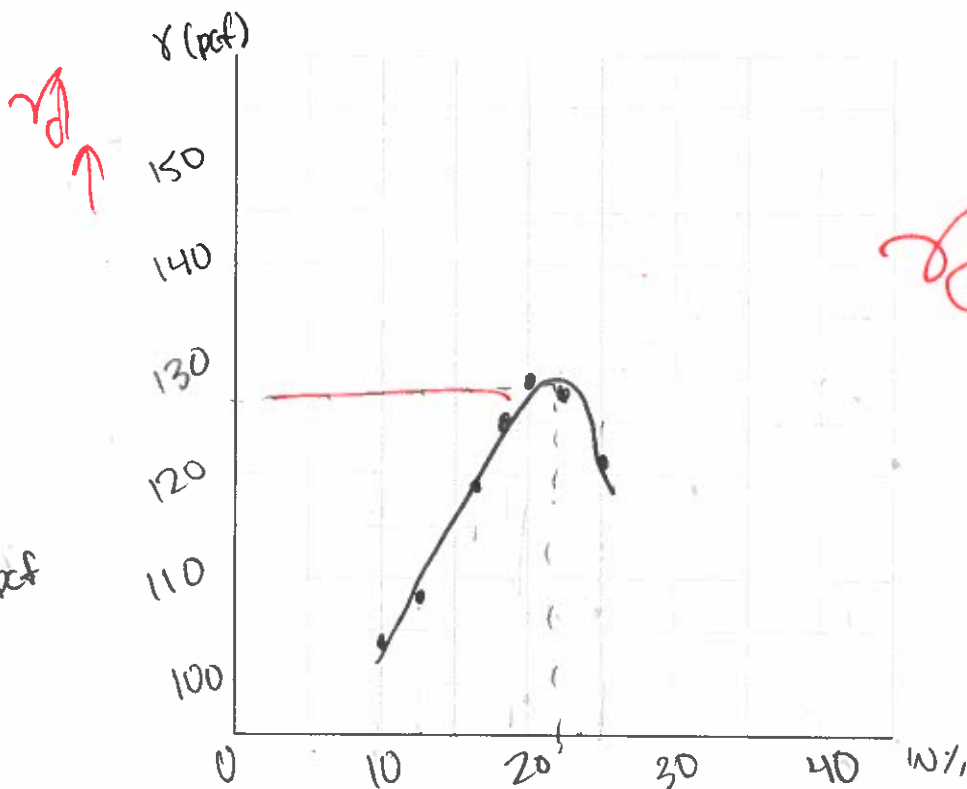
The following table shows the Standard Proctor Test Results (moisture content and bulk unit weight). The specific gravity of the soil is 2.71.

Find the following.

- Plot the Compaction Curve in the graph provided.
- Find maximum dry density and optimum moisture content from the graph.
- If the relative compaction is 95%, find the required dry unit weight that is to achieve in the field.
- Determine the degree of saturation of the soil at maximum dry unit weight.

w (%)	10	13	16	18	20	22	25
γ (pcf)	98	106	119	125	129	128	123

(Write down the specific axis title in the graph, Label X and Y axis properly)



$$G_s = 2.7$$

$$\gamma_{d, \max} = 129 \text{ pcf}$$

$$w_1 = 22$$

c)

$$R(\%) = \frac{\gamma_{d(\text{field})}}{\gamma_{d(\max - \text{lab})}} \times 100$$

Optimum moisture content

$$95\% = \frac{\gamma_{d(\text{field})}}{120} \times 100$$

Problem 5 (20 pts)

The results of a constant-head permeability test for a fine sand sample having a diameter of 150 mm and a length of 300 mm. The constant-head difference was 500 mm. Total 350 cm³ water was collected in 5 minutes. The void ratio of the sand sample was 0.61. Determine the following:

- (1) Hydraulic conductivity
- (2) Discharge velocity
- (3) Seepage velocity.

Determine all the parameters in cm/sec unit.

Given: $1\text{ m} = 100\text{ cm}$ $1\text{ m} = 1000\text{ mm}$

$$D = 150\text{ mm} \Rightarrow \text{cm}$$

$$L = 300\text{ mm} \Rightarrow \text{cm}$$

Formula
 $CH =$

$$\text{Constant-head} = 500\text{ mm} = CH$$

$$V_w = 350\text{ cm}^3$$

$$t = 5\text{ min} = \frac{1\text{ min}}{60\text{ s}} = 0.0833\text{ s}$$

$$e = 0.61$$

$$i = \frac{\Delta h}{L} = \text{hydraulic gradient}$$

$$\text{charge } Q = \frac{V}{t} = \frac{350\text{ cm}^3}{0.0833\text{ s}}$$

(1) hydraulic conductivity

$$K = \frac{QL}{Aht} = \frac{350 \times 300}{A \times 500 \times 0.0833}$$

$$A = \pi r^2$$

(2)

Discharge Velocity

$$q = KiA$$

$$Q = K \left(\frac{500}{300} \right) \pi (75)^2$$

(3)

$$v = n \cdot v_s$$

$$n = \frac{1+e}{e}$$

$$n = \frac{1+0.61}{0.61}$$

$$n = 2.6$$

$$v = 2.6 \cdot$$

-10

GEOTECHNICAL ENGINEERING SPRING 2022

Title of Assignment: Test 3

TOPICS COVERED IN TEST 3:

1. Stresses in Soil
2. Consolidation

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR TEST 3**

NAME: Student ID:

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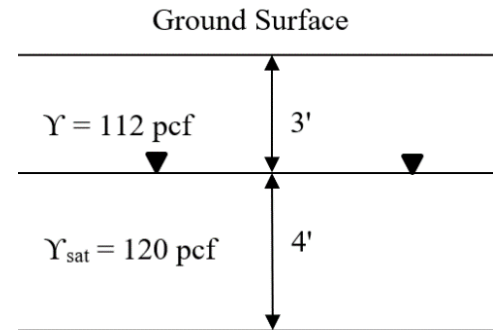
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CVEG 3023 – Geotechnical Engineering
Test-3, Spring 2022
(1.00 pm – 1.50 pm)

Problem 1:

Determine the pore water pressure at a depth of 5 ft. below the ground surface. (10)

Also, determine the effective stress at a depth of 7 ft. on the below ground surface. (10)



CVEG 3023 – Geotechnical Engineering
Test-3, Spring 2022
(1.00 pm – 1.50 pm)

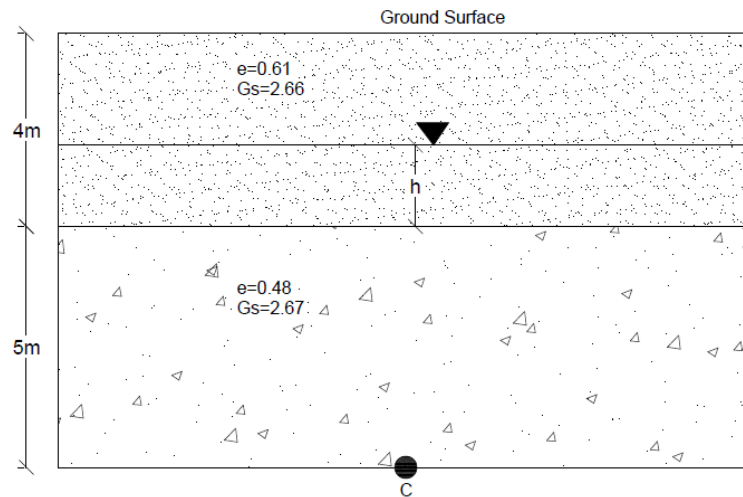
Problem 2:

If the groundwater table coincides with the ground level and the saturated unit weight of soil is 19 kN/m^3 , find the effective stress at a depth of 3 m below the ground level. (20)

CVEG 3023 – Geotechnical Engineering
Test-3, Spring 2022
(1.00 pm – 1.50 pm)

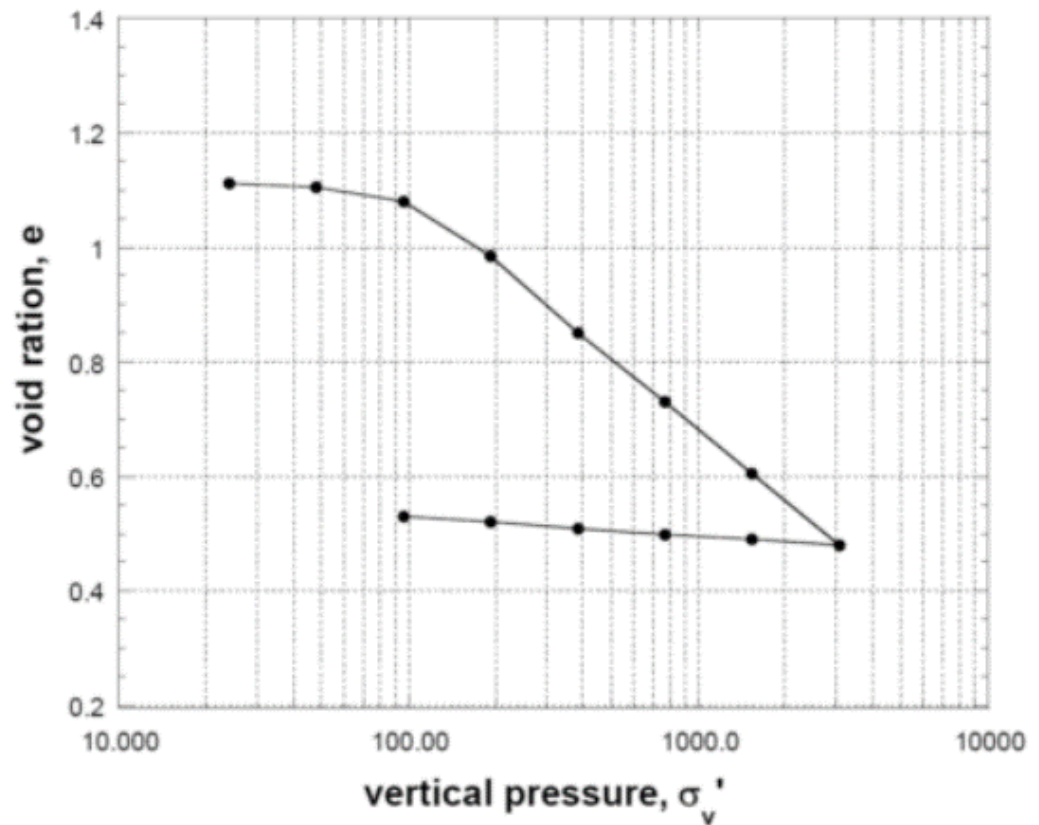
Problem 3:

Consider the soil profile below. If the effective stress at point C is 111 kPa, find the value of h . (30)



Problem 4:

A clay sample was obtained in the field with an existing vertical effective stress $\sigma'_o = 80$ kPa. The clay sample had an initial void ratio $e_o = 1.2$. The e -log p curve is plotted as below. Calculate the following parameters: Pre-consolidation pressure σ'_c ; compression index, C_c ; swelling index, C_s ; over-consolidation ratio, OCR. **(Show sketches in the graph to determine the parameters)** (30)



ABOVE AVERAGE

NAME: MAALVIKA AGGARWAL Student ID:

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Problem 1:

Determine the pore water pressure at a depth of 5 ft. below the ground surface. (10)

Also, determine the effective stress at a depth of 7 ft. on the below ground surface. (10)

$$\sigma \text{ at depth } 3 \text{ ft} = \gamma h = (112)(3) \\ = 336 \text{ psf}$$

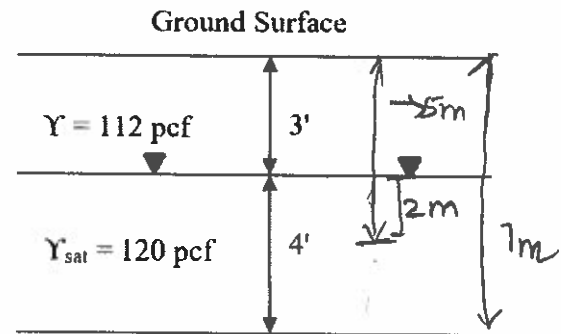
$$\sigma \text{ at depth } 7 \text{ ft} = 336 + (120)(4) \\ = 240 + 336 \\ = 816 \text{ psf}$$

$$u \text{ at } 5 \text{ ft} = \gamma_w h = (62.4)(2) \\ = 124.8 \text{ psf} \quad \checkmark$$

$$\sigma_7 - u_7$$

$$u \text{ at } 7 \text{ ft} = (62.4)(4) \\ = 249.6 \text{ psf}$$

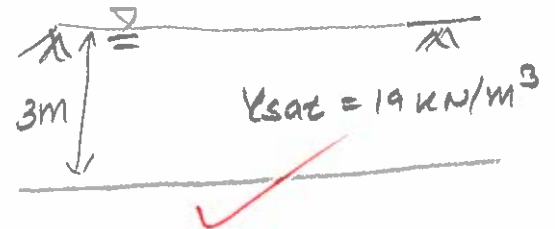
$$\sigma' \text{ at } 7 \text{ ft} = \sigma - u \\ = 816 - 249.6 \\ = 566.4 \text{ psf} \quad \checkmark$$



Problem 2:

If the groundwater table coincides with the ground level and the saturated unit weight of soil is 19 kN/m^3 , find the effective stress at a depth of 3 m below the ground level. (20)

$$\begin{aligned}\sigma' &= h(\gamma_{\text{sat}} - \gamma_w) \\ &= 3(19 - 9.81) \\ &= \boxed{27.57 \text{ kN/m}^2}\end{aligned}$$

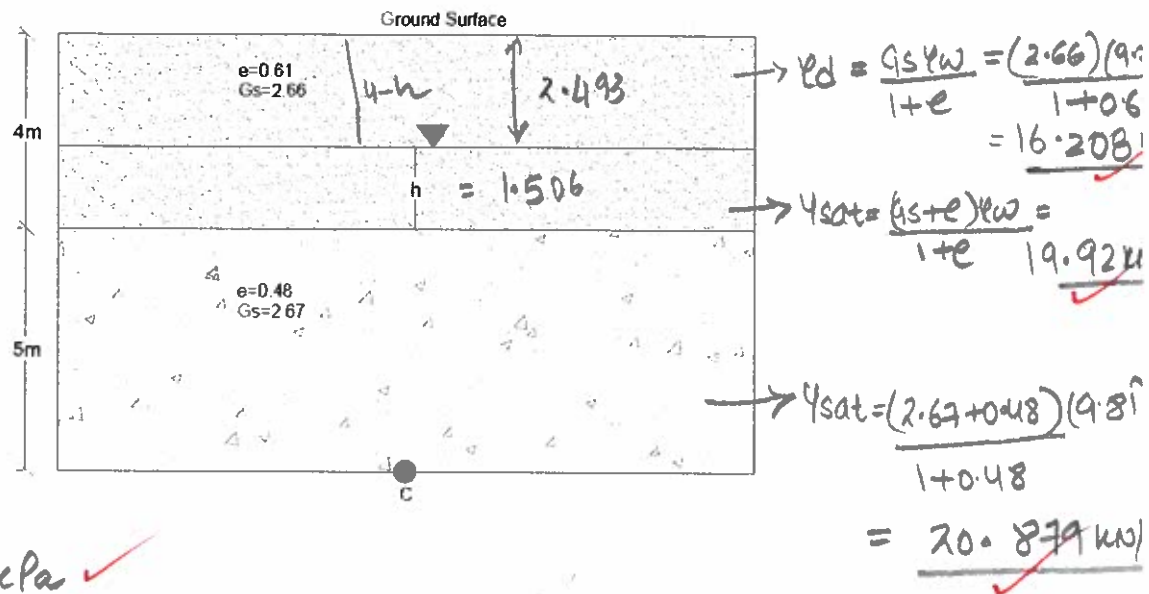


Verification:

$$\begin{aligned}\sigma &= 3\gamma = 57 \text{ kN/m}^2 \\ u &= 3(9.81) = 29.43 \text{ kN/m}^2 \\ \sigma' &= 27.57 \text{ kN/m}^2\end{aligned}$$

Problem 3:

Consider the soil profile below. If the effective stress at point C is 111 kPa, find the value of h. (30)



$$\sigma'_c = 111 \text{ kPa}$$

$$\sigma_c = (4-h)(16.208) + (19.92)(h) + (20.879)(5)$$

$$= 64.83 - 16.208h + 19.92h + 104.397$$

$$= 3.717h + 169.23$$

$$u_c = 9.81(h+5) = 9.81h + 49.05$$

$$\text{Now, } \sigma'_c = \sigma_c - u_c$$

$$111 = (3.717h + 169.23) - 9.81h + 49.05$$

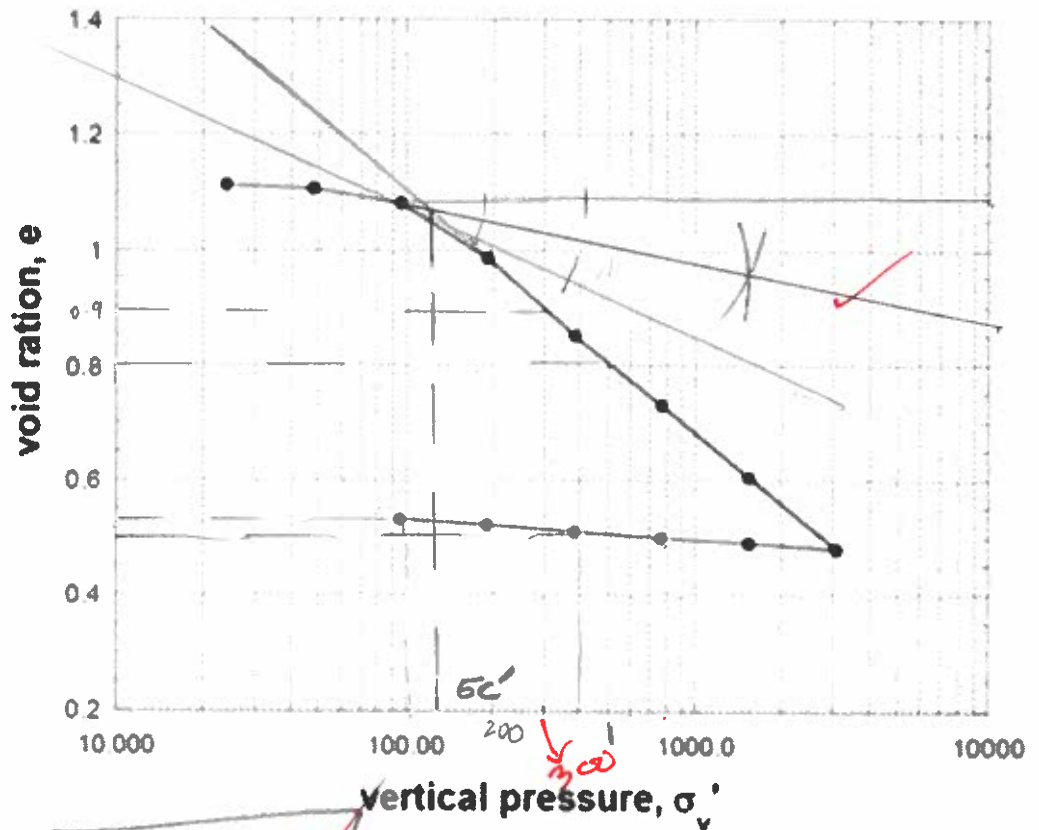
$$111 = -6.09h + 120.178$$

$$-9.178 = -6.09h$$

$$\text{So, } h = 1.506 \text{ m}$$

Problem 4:

A clay sample was obtained in the field with an existing vertical effective stress $\sigma'_o = 80$ kPa. The clay sample had an initial void ratio $e_o = 1.2$. The e -log p curve is plotted as below. Calculate the following parameters: Pre-consolidation pressure σ'_c ; compression index, C_c ; swelling index, C_s ; over-consolidation ratio, OCR. (Show sketches in the graph to determine the parameters) (30)



$\sigma' = 80$ kPa

$e_o = 1.2$

$\checkmark \sigma'_c = ?$

$\checkmark C_c = ?$

$C_s = ?$

$\checkmark OCR = ?$

$\sigma'_c = 140$ kPa
(from graph)

$C_c = \frac{e_1 - e_2}{\log\left(\frac{\sigma'_2}{\sigma'_1}\right)} = \frac{0.8 - 0.9}{\log\left(\frac{300}{500}\right)}$

$C_c = 0.4507$

$C_s = \frac{0.55 - 0.5}{\log\left(\frac{300}{100}\right)}$

$C_s = 0.1047$

$OCR = \frac{\sigma'_c}{\sigma'_o} = \frac{140}{80} = 1.75$

AVERAGE

80

NAME: Austin Bates Student ID: _____

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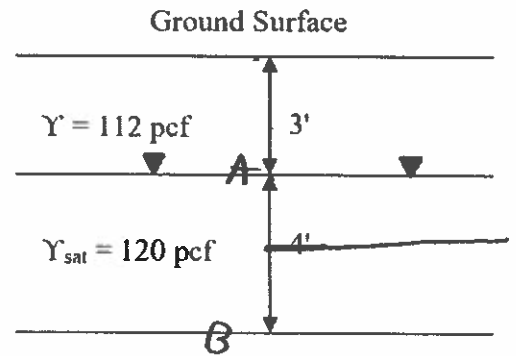
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Problem 1:

Determine the pore water pressure at a depth of 5 ft. below the ground surface. (10)

Also, determine the effective stress at a depth of 7 ft. on the below ground surface. (10)

σ, u, σ'



A

$$\sigma = 3(112) = 336$$

$$u = 0$$

$$\sigma' = 336$$

$$B = 336 + (4 \cdot 120) = 816$$

$$u = (3)(62.4) = 187.2$$

$$\sigma' = 816 - 187.2 = 628.8$$

$$u \text{ at } 5' = \frac{187.2}{2} = 93.6 \text{ lb/ft}^3 \quad \text{X}$$

$$\sigma' \text{ at } 7' = 628.8 \text{ lb/ft}^3 \quad \text{X}$$

(10)

Problem 2:

If the groundwater table coincides with the ground level and the saturated unit weight of soil is 19 kN/m^3 , find the effective stress at a depth of 3 m below the ground level. (20)

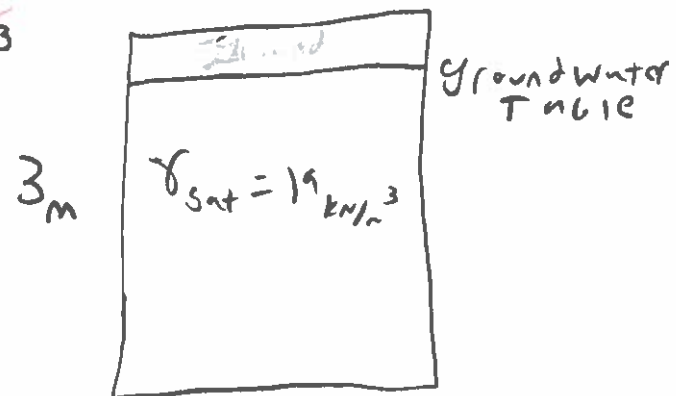
$$\gamma_{\text{sat}} = 19 \text{ kN/m}^3$$

$$\sigma = (19)(3) = 57 \text{ kN/m}^2$$

$$U = (9.81)(3) = 29.43 \text{ kN/m}^2$$

$$\sigma' = 57 - 29.43 = 27.57 \text{ kN/m}^2$$

$$\sigma' = 27.57 \text{ kN/m}^2$$



$\sigma =$

Problem 3:

Consider the soil profile below. If the effective stress at point C is 111 kPa, find the value of h. (30)

Ground Surface

4m

5m

Point A

Point B

Point C

$e=0.61$
 $G_s=2.66$

$e=0.48$
 $G_s=2.67$

h

Water Table

Handwritten calculations:

$\gamma_{sat} = \frac{(2.66 + 0.41) \gamma_w}{1 + 0.61} = 19.9 \text{ kN/m}^3$

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

$\gamma_{sat} = \frac{(G_s + e) \gamma_w}{1 + e}$

A

$\sigma = (4)(19.9) = 79.6$

$u = 0$

$\sigma' = 79.6$

B

$\sigma = 79.6 + h(19.9)$

$u = (4)(9.81) = 39.24$

$\sigma' =$

$h = 1.88 \text{ m}$

C

$\sigma = 79.6 + h(19.9) + (5)(20.88) = 169.232 + h(19.9)$

$u = 39.24 + (h)(9.81)$

$\sigma' = 111$

$111 = (169.232 + 19.9h) - (39.24 + 9.81h)$

$111 = 129.992 + 10.09h$

$10.09h = 111 - 129.992$

$10.09h = -18.992$

$h = \frac{-18.992}{10.09} = -1.88 \text{ m}$

$h = 1.88 \text{ m}$

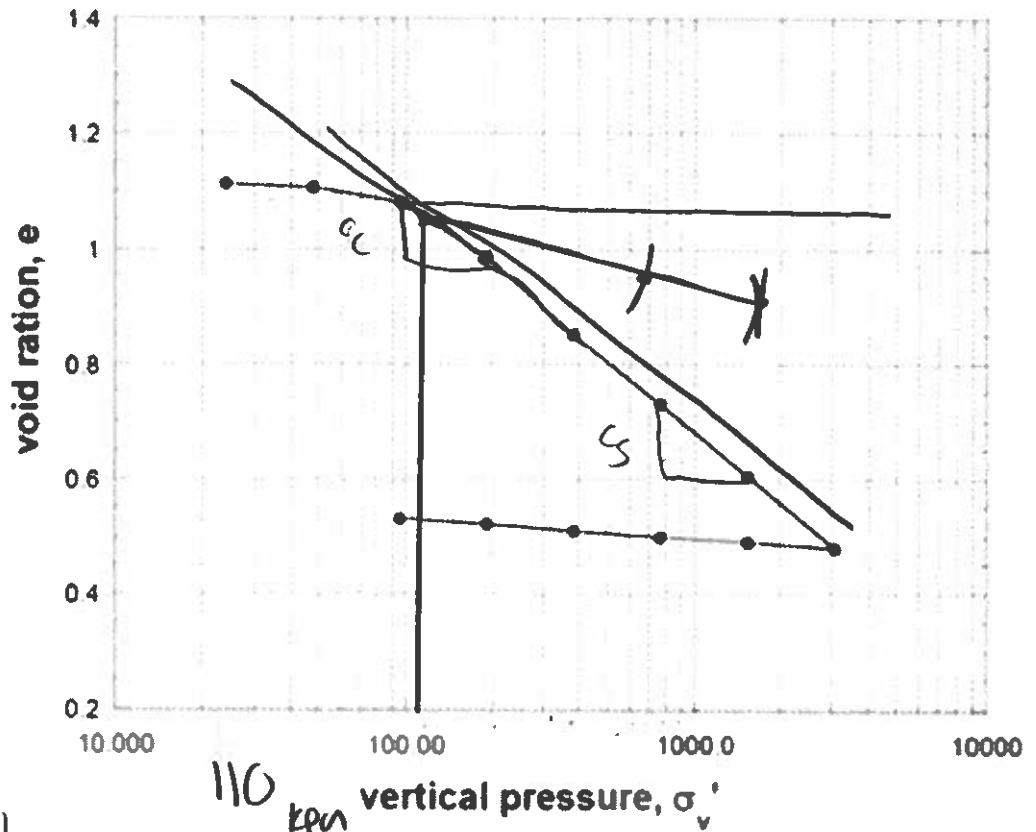
$$CC = 0.009(LL - 10)$$

$$OCR = \frac{\sigma'_c}{\sigma'_0}$$

horizontal
tangent
arc
upward
arc
downward

Problem 4:

A clay sample was obtained in the field with an existing vertical effective stress $\sigma'_0 = 80$ kPa. The clay sample had an initial void ratio $e_0 = 1.2$. The e -log p curve is plotted as below. Calculate the following parameters: Pre-consolidation pressure σ'_c ; compression index, C_c ; swelling index, C_s ; over-consolidation ratio, OCR. (Show sketches in the graph to determine the parameters) (30)



$$e_0 = 1.2$$

$$\sigma'_0 = 80 \text{ kPa}$$

$$\sigma'_c = 110 \text{ kPa}$$

$$\Delta e = 0.30$$

$$OCR = \frac{\sigma'_c}{\sigma'_0} = \frac{110}{80} = 1.375$$

$$OCR = 1.375$$

$$\sigma'_c = 110 \text{ kPa}$$

$$C_c = \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} = \frac{1.14 - 0.99}{\log\left(\frac{1900}{900}\right)}$$

$$C_s = \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} = \frac{0.8 - 0.6}{\log\left(\frac{1700}{800}\right)}$$

$$C_s = 0.611$$

$$C_c = 0.462$$

$$C_s < C_c$$

BELOW AVERAGE

NAME: Jonathan Warrior

Student ID: P213 217 36

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CVEG 3023 – Geotechnical Engineering

Test-3, Spring 2022

(1.00 pm – 1.50 pm)

Problem 1:

Determine the pore water pressure at a depth of 5 ft. below the ground surface. (10)

Also, determine the effective stress at a depth of 7 ft. on the below ground surface. (10)

Pore Water Pressure, $U = ?$

Effective stress, $\sigma' = ?$

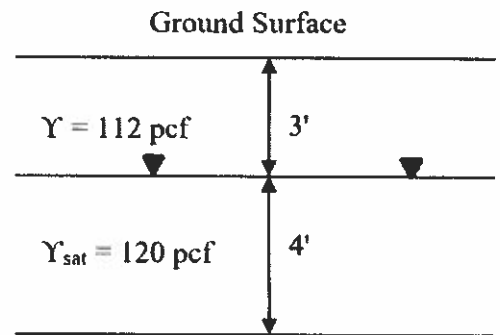
$$\sigma = \gamma h$$

$$\sigma = 112 \text{ pcf} (3 \text{ ft}) + 120 \text{ pcf} (4 \text{ ft}) = 816 \text{ lb/ft}^2$$

$$U = 62.4 \text{ lb/ft}^3 \left(\frac{5 \text{ ft}}{2} \right) = \underline{\underline{312 \text{ lb/ft}^2}}$$

$$\sigma' = 816 \text{ lb/ft}^2 - 249.6 \text{ lb/ft}^2 = \underline{\underline{566.4 \text{ lb/ft}^2}}$$

-5



Problem 2:

If the groundwater table coincides with the ground level and the saturated unit weight of soil is 19 kN/m³, find the effective stress at a depth of 3 m below the ground level. (20)

$$\gamma_{\text{sat}} = 19 \text{ kN/m}^3$$

$$\rho_{\text{water}} = 9.81 \text{ kN/m}^3$$

$$\text{Height} = 3 \text{ m}$$

$$\text{Stress, } \sigma = \gamma h$$

$$\sigma = 19 \text{ kN/m}^3 (3 \text{ m}) = 57 \text{ kN/m}^2$$

$$\text{Pore Water Pressure, } u = \rho_w h$$

$$u = 9.81 \text{ kN/m}^3 (3 \text{ m}) = 29.43 \text{ kN/m}^2$$

$$\text{Effective stress, } \sigma' = \sigma - u$$

$$\sigma' = 57 - 29.43 = \underline{\underline{27.57 \text{ kN/m}^2}}$$

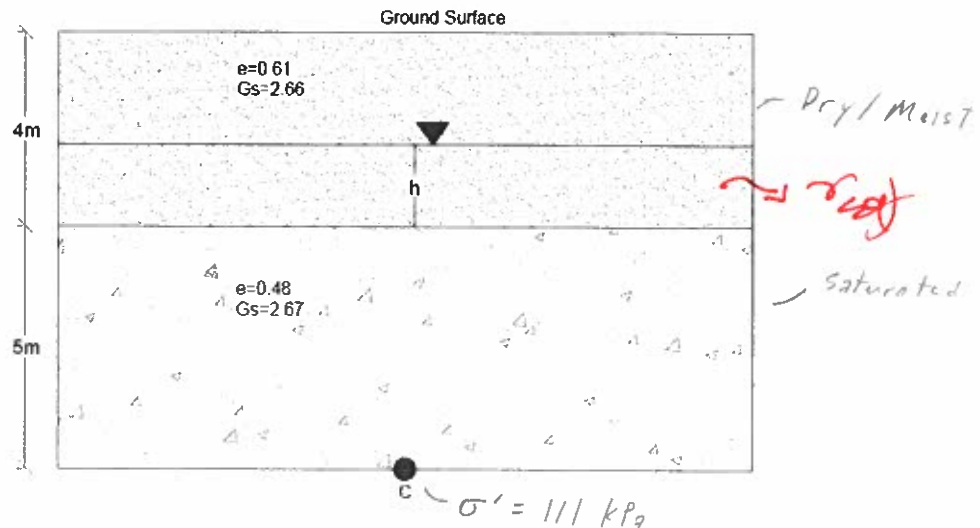
CVEG 3023 – Geotechnical Engineering

Test-3, Spring 2022

(1.00 pm – 1.50 pm)

Problem 3:

Consider the soil profile below. If the effective stress at point C is 111 kPa, find the value of h. (30)



$$e = 0.61, 0.48$$

$$G_s = 2.66, 2.67$$

$$h = ?$$

$$h_1 = 4 \text{ m}, h_2 = 5 \text{ m}$$

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

$$U = h (9.81 \text{ kN/m}^3)$$

$$\sigma' = 111 \text{ kPa}$$

$$\sigma = 20.87(5) + 16.21(4) = 169.19 \text{ kPa}$$

$$\sigma' = \sigma - U$$

$$\gamma_1 = ?$$

$$111 \text{ kPa} = 169.19 \text{ kPa} - h (9.81 \text{ kN/m}^3)$$

$$\gamma_2 = ?$$

$$h = 5.93 \text{ m} \text{ how??}$$

$$\gamma_2 = \frac{(G_s + e) \gamma_w}{1+e} = \frac{(2.67 + 0.48) 9.81 \text{ kN/m}^3}{1 + 0.48} = 20.87 \text{ kN/m}^3$$

$$\gamma_1 = \frac{2.66 (9.81 \text{ kN/m}^3)}{1 + 0.61} = 16.21 \text{ kN/m}^3$$

(-10)

CVEG 3023 – Geotechnical Engineering
Test-3, Spring 2022
(1.00 pm – 1.50 pm)

Problem 4:

A clay sample was obtained in the field with an existing vertical effective stress $\sigma'_o = 80$ kPa. The clay sample had an initial void ratio $e_o = 1.2$. The e -log p curve is plotted as below. Calculate the following parameters: Pre-consolidation pressure σ'_c ; compression index, C_c ; swelling index, C_s ; over-consolidation ratio, OCR. **(Show sketches in the graph to determine the parameters)** (30)

Given:

$$\sigma'_o = 80 \text{ kPa}$$

$$e_o = 1.2$$

Find:

$$\sigma'_c = ? \quad \text{OCR} = ?$$

$$C_c = ?$$

$$C_s = ?$$

$$S_c = H \frac{\Delta e}{1 + e_o}$$

$$\text{OCR} = \frac{\sigma'_c}{\sigma'_o}$$

$$\Delta \sigma' = \sigma'_v - \sigma$$

$$\text{Highest } \sigma'_v = 3000 \text{ kPa}$$

$$\text{OCR} = \frac{25}{3000} = 0.008333$$

$$\text{At } 100.00 \sigma'_v, e = 0.55$$

$$\text{At } 3000.00 \sigma'_v, e = 0.56$$

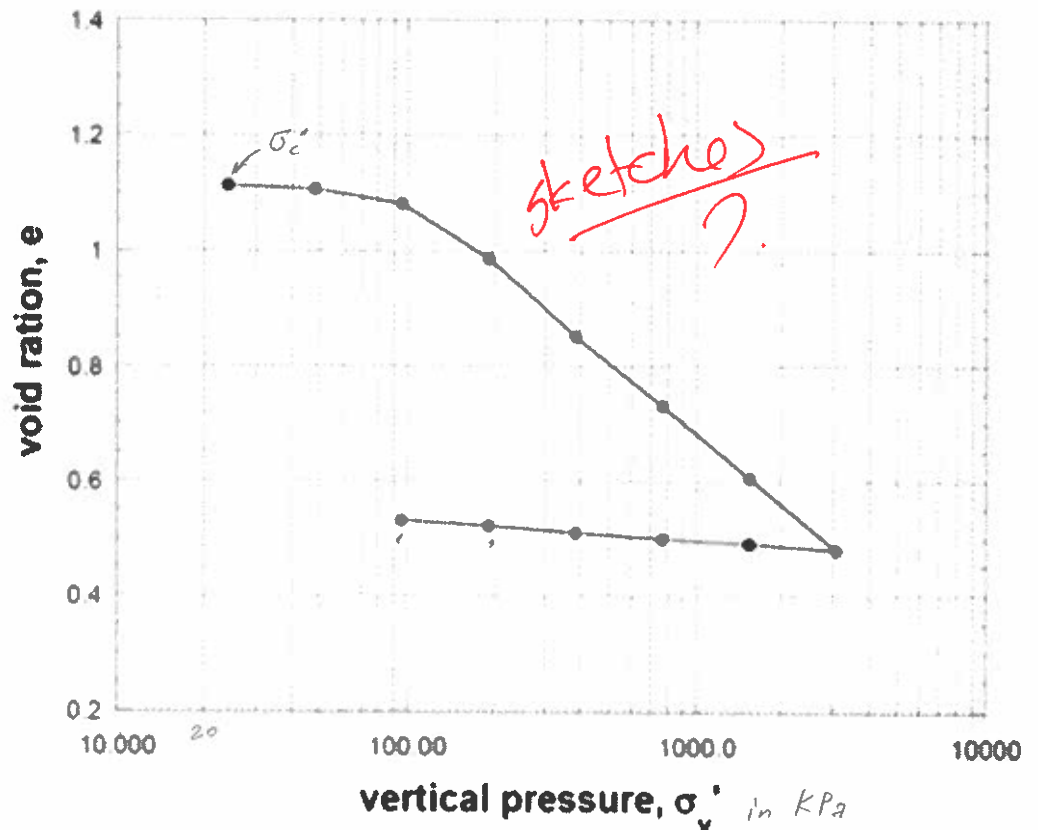
$$\text{At } 25.00 \sigma'_v, e = 1.1$$

$$\sigma'_c = 25 \text{ kPa}$$

$$S_c =$$

$$C_c = ?$$

$$C_s = ?$$



(20)

GEOTECHNICAL ENGINEERING SPRING 2022

Title of Assignment: Final Exam

TOPICS COVERED IN Final:

1. Stresses in Soil
2. Consolidation
3. Shear Strength of Soil

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR FINAL**

NAME: Student ID:

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CVEG 3300 – Geotechnical Engineering
Final Exam - Spring 2022
Exam Duration: 2 hours

Problem 1 (15 pts)

A 15-ft saturated clay layer (2-way drainage) is subjected to surcharge loading and underwent 90% consolidation in 180 days.

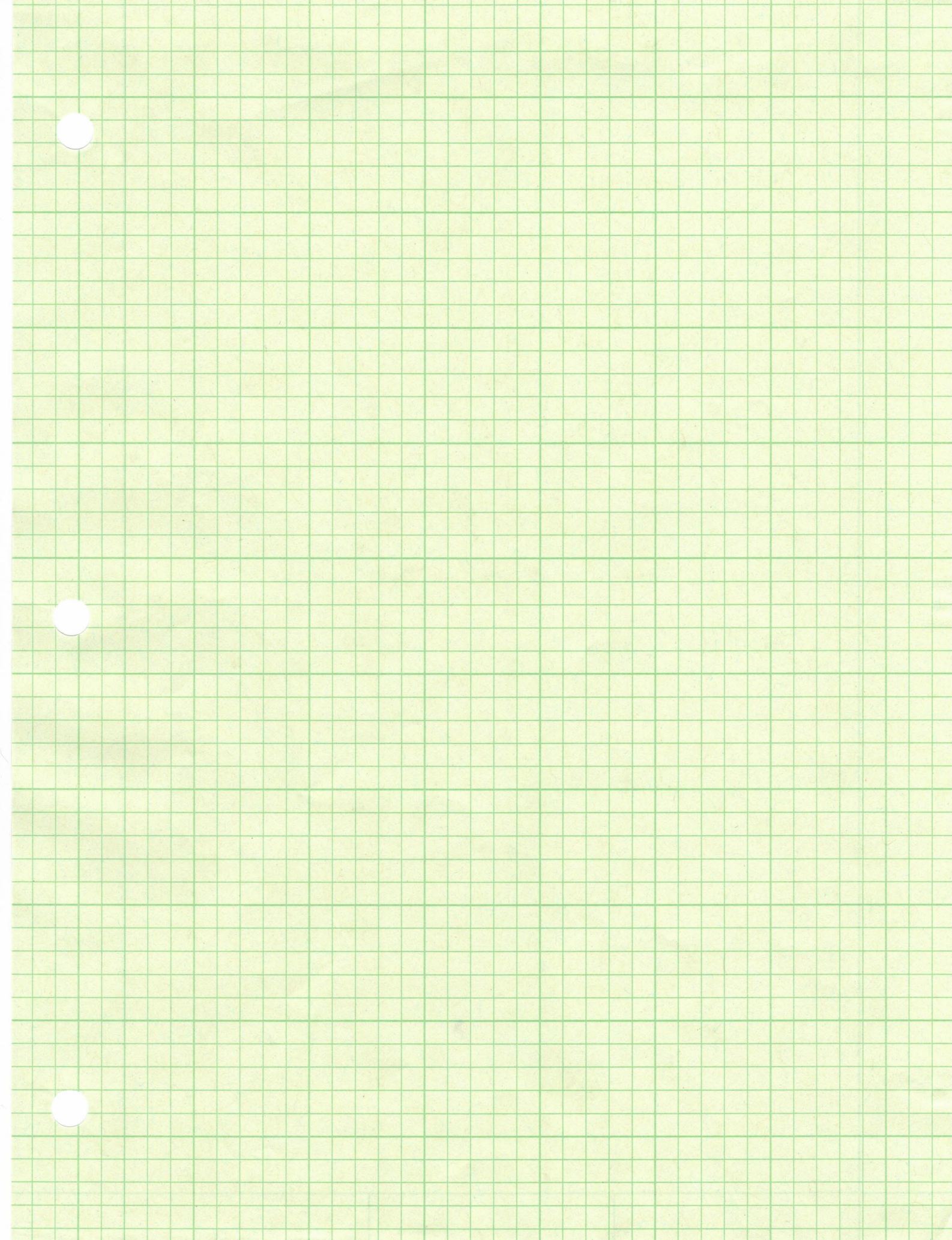
- a) Find C_v .
- b) How long it will take for a 0.75-inch sample to undergo 65% consolidation in the lab (two-way drainage lab test)

CVEG 3300 – Geotechnical Engineering
Final Exam - Spring 2022
Exam Duration: 2 hours

Problem 2 (20 pts)

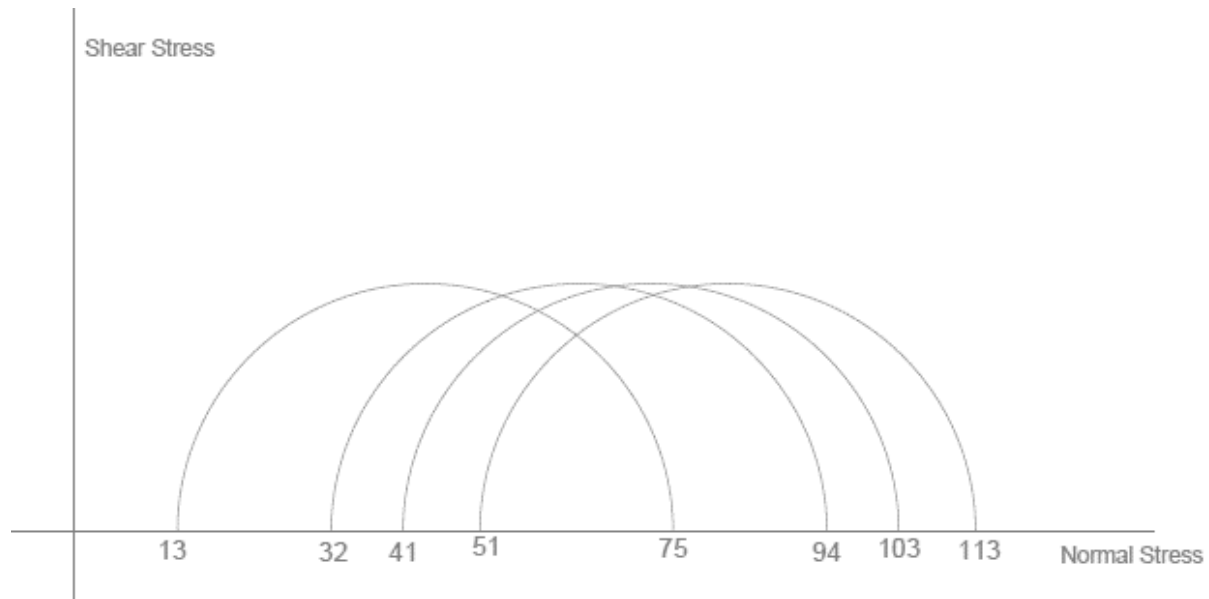
Following are the direct shear test results of the 2-inch diameter and 1-inch height sample. Find the strength parameters of the soil. **You must show detail calculation and graph.**

test No.	Normal Force	Shear Force
	lb	lb
1	15	13.54
2	30	18.95
3	48	26.14
4	83	39.45



Problem 3 (10 pts)

Find the shear strength of the soil based on the UU test results below. **Detail calculation is required.**



Problem 4 (20 pts)

The results of two drained triaxial tests on a saturated clay follow:

Test 1:

Confining Pressure = 78.95 kPa

Deviator stress at failure = 141.12 kPa

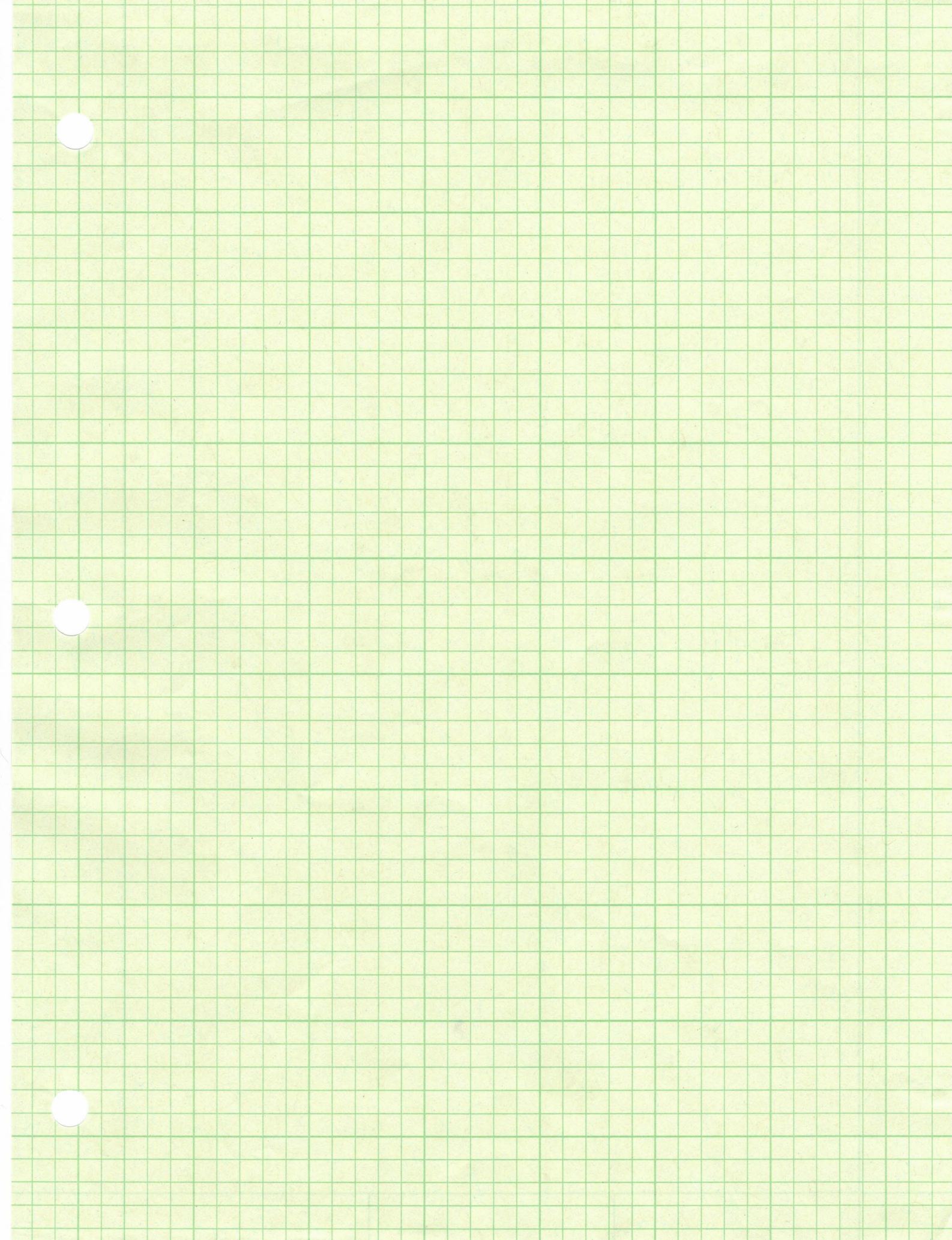
Test 2:

Confining Pressure = 171.51 kPa

Deviator stress at failure = 233.54 kPa

Find the strength parameters of the soil using the Mohr Circle.

The Mohr circle must be drawn to the scale. Answers from an analytical approach will not be accepted.
Show Calculation to find necessary parameters



Problem 5 (20 pts)

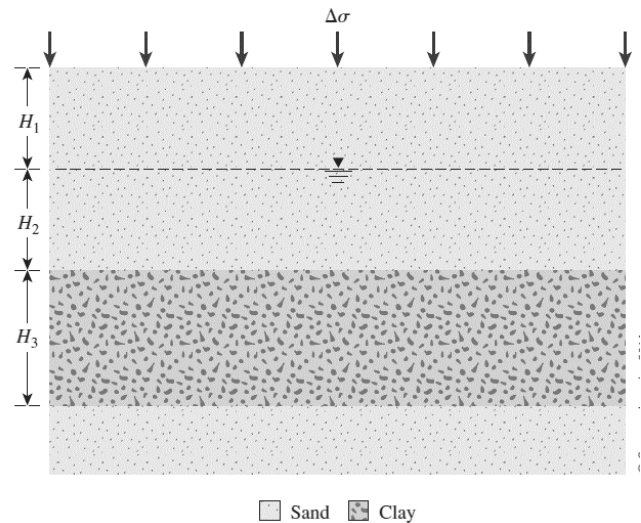
Consider the soil profile shown in Figure 11.44 subjected to the uniformly distributed load, s , on the ground surface. Given: $\Delta\sigma = 26 \text{ kN/m}^2$; $H_1 = 1.83 \text{ m}$; $H_2 = 3.66 \text{ m}$; and $H_3 = 5.5 \text{ m}$. Soil characteristics are as follows:

Sand Layer: $\gamma_d = 17.9 \text{ kN/m}^3$; $\gamma_{\text{sat}} = 18.5 \text{ kN/m}^3$,

Clay Layer: $\gamma_{\text{sat}} = 18.3 \text{ kN/m}^3$; $\text{LL} = 38$; $e = 0.73$.

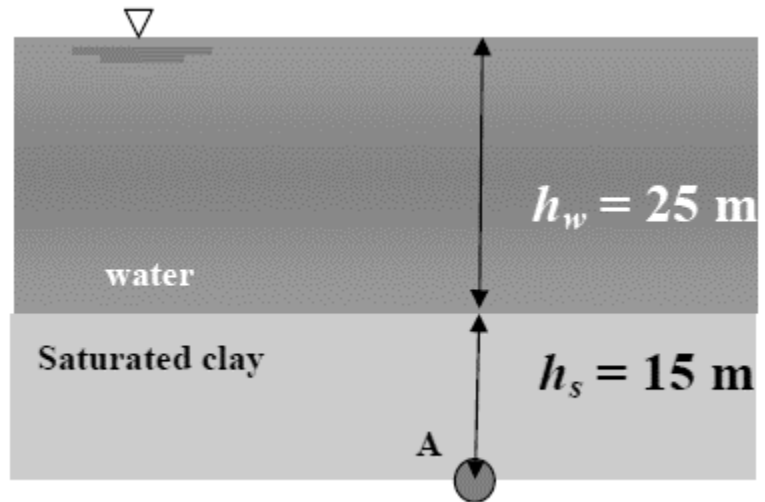
Estimate the primary consolidation settlement in the clay if

- The clay is normally consolidated
- The preconsolidation pressure is 105 kPa



Problem 6 (15 pts)

A sample was obtained from point A in the submerged clay as shown in the figure. It was determined that it had $w=54\%$, and $G_s = 2.78$. What is the effective stress at A? (h_w is height of water, h_s is depth of clay layer)



ABOVE AVERAGE

NAME:

SANTAY TILMUTH

Student ID:

P20432113

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Problem 1 (15 pts)

A 15-ft saturated clay layer (2-way drainage) is subjected to surcharge loading and underwent 90% consolidation in 180 days.

- a) Find C_v .
b) How long it will take for a 0.75-inch sample to undergo 65% consolidation in the lab (two-way drainage lab test)

2 way drainage so $H_{dr} = \frac{H}{2} = \frac{15 \text{ ft}}{2} = 7.5 \text{ ft}$

$t = 180 \text{ days}$ 90% consolidation $\therefore T_v = 0.848$

$$T_v = \frac{C_v t}{H_{dr}^2} \therefore C_v = \frac{T_v H_{dr}^2}{t} = \frac{0.848 \times (7.5 \text{ ft})^2}{180 \text{ days}} = 0.265 \text{ ft}^2/\text{day}$$

b) 0.75 in $\therefore H_{dr} = 0.375 \text{ in}$

65% consolidation $\therefore T_v = 0.340$

$$C_v = \frac{0.265 \text{ ft}^2}{\text{day}} \times \frac{12 \text{ in} \times 12 \text{ in}}{1 \text{ ft} \times 1 \text{ ft}} = 38.16 \text{ in}^2/\text{day}$$

$$t = \frac{T_v H_{dr}^2}{C_v} = \frac{0.340 \times (0.375 \text{ in})^2}{38.16 \text{ in}^2/\text{day}} = 0.00125 \text{ day} \times \frac{24 \text{ hr}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} = 1.804 \text{ min}$$

Problem 2 (20 pts)

Following are the direct shear test results of the 2-inch diameter and 1-inch height sample. Find the strength parameters of the soil. You must show detail calculation and graph.

You must show detail calculation and graph.

test No.	Normal Force lb	Shear Force lb	x Normal Stress psi	y Shear Stress psi
1	15	13.54	4.78	4.31
2	30	18.95	9.55	6.04
3	48	26.14	15.29	8.32
4	83	39.45	26.43	12.56

$$A = \pi r^2 = \pi \times \left(\frac{2}{2}\right)^2 = 3.14 \text{ in}^2$$

SAMPLE CALCULATIONS

$$\text{Normal stress, } \sigma = \frac{F}{A} = \frac{15 \text{ lb}}{3.14 \text{ in}^2} = 4.78 \text{ psi}$$

$$\text{Shear Stress, } \tau = \frac{F}{A} = \frac{13.54 \text{ lb}}{3.14 \text{ in}^2} = 4.31 \text{ psi}$$

$$\begin{aligned} \phi &= \tan^{-1}\left(\frac{\tau}{\sigma}\right) \\ &= \tan^{-1}\left(\frac{4.31}{4.78}\right) \\ &= 42^\circ \approx 48.5^\circ \end{aligned}$$

τ (psi)

15

10

5

2.4

$\phi = 48.5^\circ$

0

5

10

15

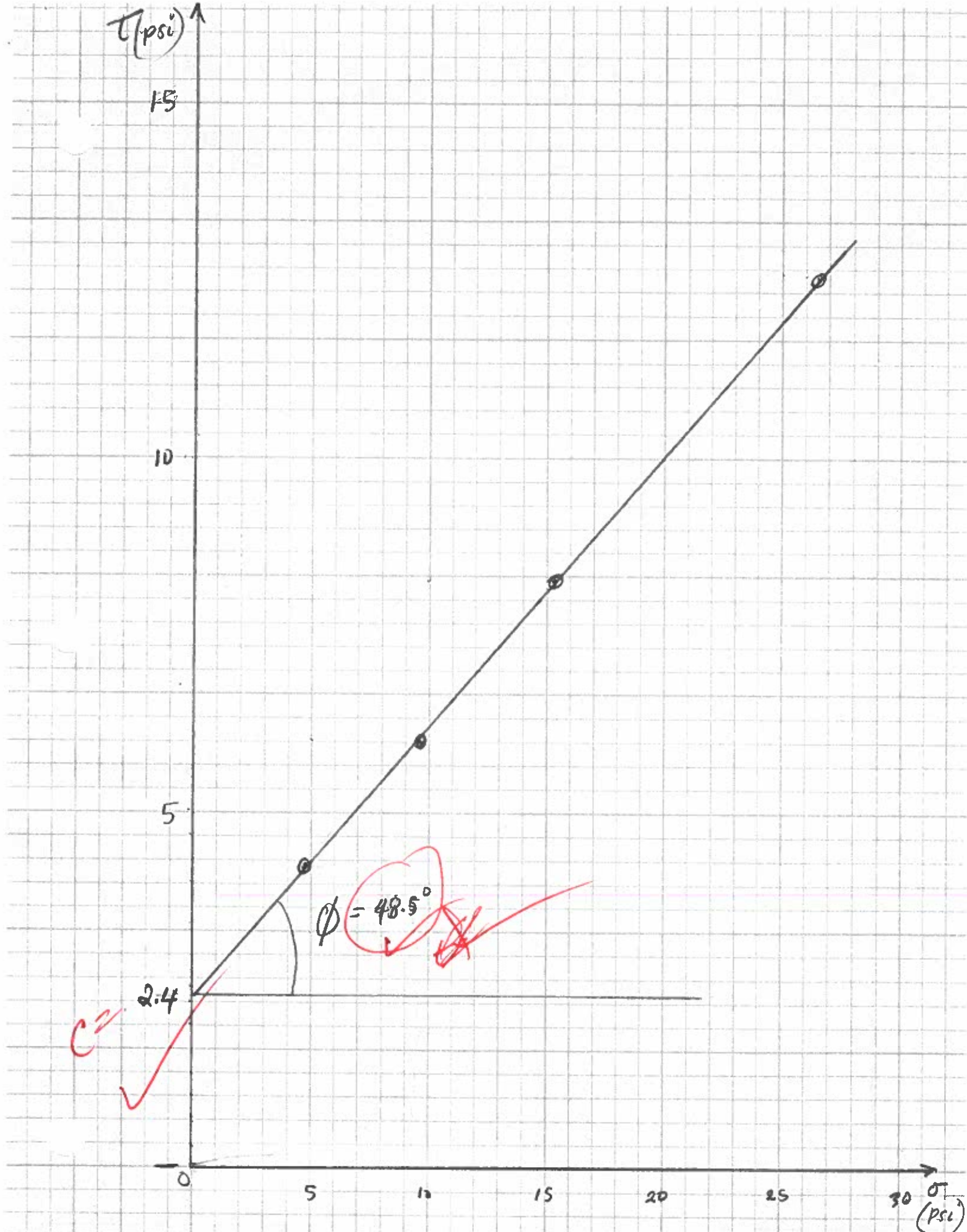
20

25

30

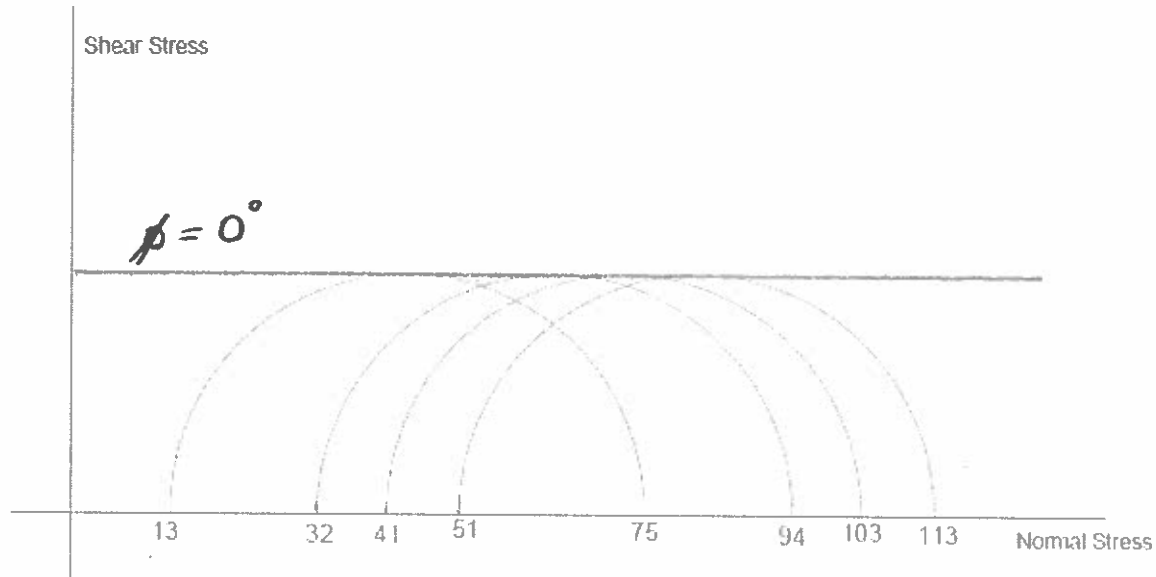
σ (psi)

$C = 2.4$



Problem 3 (10 pts)

Find the shear strength of the soil based on the UU test results below. Detail calculation is required.



CIRCLE 1

$$\sigma_3 = 13 \quad \sigma_1 = 75$$

$$\sigma_1 = \sigma_3 \tan^2(45^\circ) + 2c \tan(45^\circ) \dots \text{since } \phi = 0$$

$$\sigma_1 = \sigma_3 + 2c \Rightarrow 75 = 13 + 2c \Rightarrow 2c = 75 - 13$$

$$c = \frac{75 - 13}{2} = 31 \text{ kPa}$$

$$\tau = c + \sigma \tan \phi$$

Since $\phi = 0^\circ$ then

$$\tau = c \therefore \tau = 31 \text{ kPa or } 31 \text{ psf}$$

Problem 4 (20 pts)

The results of two drained triaxial tests on a saturated clay follow:

Test 1:

Confining Pressure = 78.95 kPa — σ_3

Deviator stress at failure = 141.12 kPa — $\Delta\sigma_d$

$$\sigma_1 = \sigma_3 + \Delta\sigma_d \\ = 78.95 + 141.12 = 220.07 \text{ kPa}$$

Test 2:

Confining Pressure = 171.51 kPa — σ_3

Deviator stress at failure = 233.54 kPa — $\Delta\sigma_d$

$$\sigma_1 = \sigma_3 + \Delta\sigma_d$$

Find the strength parameters of the soil using the Mohr Circle. $= 171.51 + 233.54 = 405.05 \text{ kPa}$

The Mohr circle must be drawn to the scale. Answers from an analytical approach will not be accepted.
Show Calculation to find necessary parameters

$$M_{IDPOINT_1} = \frac{\sigma_1 + \sigma_3}{2} = \frac{220.07 + 78.95}{2} = 149.51 \text{ kPa}$$

$$M_{IDPOINT_2} = \frac{\sigma_1 + \sigma_3}{2} = \frac{405.05 + 171.51}{2} = 288.28 \text{ kPa}$$

From GRAPH

$$C = 23 \text{ kPa}$$

$$\phi = 19^\circ$$

τ
(kPa)

$C=23$

200

100

80

60

40

20

0

20

40

60

80

100

120

140

160

180

200

220

240

260

280

300

320

340

360

380

400

420

440

460

480

500

520

540

560

580

600

620

640

660

680

700

720

740

760

780

800

820

840

860

880

900

920

940

960

980

1000

σ (kPa)

$\phi = 19^\circ$

Problem 5 (20 pts)

Consider the soil profile shown in Figure 11.44 subjected to the uniformly distributed load, s , on the ground surface. Given: $\Delta\sigma = 26 \text{ kN/m}^2$; $H_1 = 1.83 \text{ m}$; $H_2 = 3.66 \text{ m}$; and $H_3 = 5.5 \text{ m}$. Soil characteristics are as follows:

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Clay Layer: $\gamma_{sat} = 18.3 \text{ kN/m}^3$; $LL = 38$; $e = 0.73$.

Estimate the primary consolidation settlement in the clay if

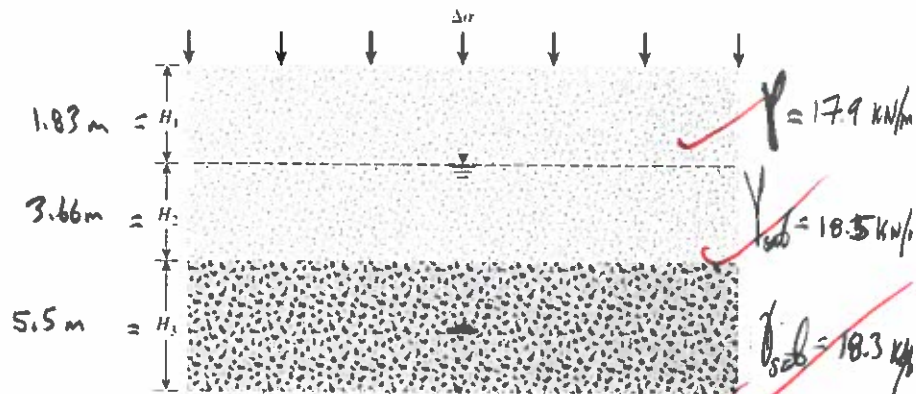
- The clay is normally consolidated
- The preconsolidation pressure is 105 kPa

$$\Delta\sigma' = 26 \text{ kN/m}^2$$

$$C_c = 0.009(LL - 10)$$

$$= 0.009(38 - 10)$$

$$= 0.009 \times 28 = 0.252$$



$$\sigma_o = (1.83 \text{ m} \times 17.9 \text{ kN/m}^3) + (3.66 \text{ m} \times 18.5 \text{ kN/m}^3) + \left(\frac{5.5 \text{ m}}{2} \times 18.3 \text{ kN/m}^3\right) + 26 \text{ kN/m}^2$$

$$= 176.8 \text{ kN/m}^2$$

$$U_o = \left(3.66 \text{ m} + \frac{5.5 \text{ m}}{2}\right) \times 9.81 \text{ kN/m}^3 = 62.9 \text{ kN/m}^2$$

$$\sigma_o' = \sigma_o - U_o = 176.8 - 62.9 = 113.9 \text{ kN/m}^2$$

$$S_c = \frac{C_c H}{1 + e_o} \log\left(\frac{\sigma_o' + \Delta\sigma'}{\sigma_o'}\right) = \frac{0.252 \times 5.5 \text{ m}}{1.73} \log\left(\frac{113.9 + 26}{113.9}\right) = 0.0715 \text{ m} = 71.5 \text{ mm}$$

b) $C_s = \frac{1}{5} C_c$ Since $\sigma_o' + \Delta\sigma' = 139.9 > 105$

$$S_c = \frac{0.252 \times 5.5 \text{ m}}{1.73} \log\left(\frac{105}{113.9}\right) + \frac{0.252 \times 5.5 \text{ m}}{1.73} \log\left(\frac{139.9}{105}\right) = 17 \text{ mm}$$

$$= -0.0057 + 0.0998$$

$$= 0.094 \text{ m} = 94 \text{ mm}$$

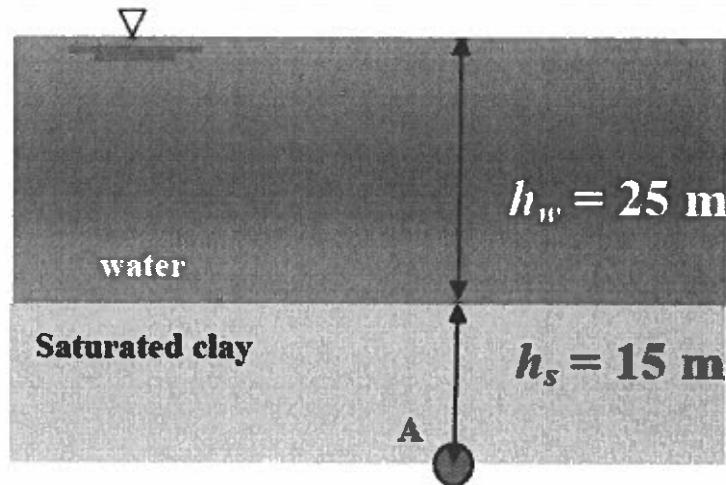
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Problem 6 (15 pts)

A sample was obtained from point A in the submerged clay as shown in the figure. It was determined that it had $w=54\%$, and $G_s = 2.78$. What is the effective stress at A? (h_w is height of water, h_s is depth of clay layer)

$$\gamma_{sat} = \frac{1 + 0.54}{1 + (0.54 \times 2.78)} (2.78 \times 9.81)$$

$$= 16.79 \text{ kN/m}^3$$



$$\sigma_A = (25 \text{ m} \times 9.81 \text{ kN/m}^3) + (15 \text{ m} \times 16.79 \text{ kN/m}^3)$$

$$= 497.1 \text{ kN/m}^2$$

$$U_A = (25 + 15) \text{ m} \times 9.81 \text{ kN/m}^3 = 392.4 \text{ kN/m}^2$$

$$\sigma'_A = \sigma_A - U_A$$

$$= (497.1 - 392.4) \text{ kN/m}^2$$

$$= 104.7 \text{ kN/m}^2$$

AVERAGE



NAME: MAALVIKA AGGARWAL

Student ID:

POLICY TO ERADICATE CHEATING (PROTECT INTEGRITY OF EXAMS)

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Problem 1 (15 pts)

A 15-ft saturated clay layer (2-way drainage) is subjected to surcharge loading and underwent 90% consolidation in 180 days.

- a) Find C_v .
 b) How long it will take for a 0.75-inch sample to undergo 65% consolidation in the lab (two-way drainage lab test)

$$H = 15 \text{ ft}$$

$$H_{dr} = \frac{15}{2} = 7.5 \text{ ft (2-way drainage)}$$

$$U = 90\%, T_v = 0.848 \text{ (at 90\%)}$$

$$t = 180 \text{ days}$$

$$\text{So, } T_v = \frac{C_v \cdot t}{H_{dr}^2} \Rightarrow C_v = \frac{T_v \cdot H_{dr}^2}{t} = \frac{(0.848)(7.5)^2}{180 \text{ days}}$$

$$\boxed{C_v = 0.265 \text{ ft}^2/\text{day}}$$

Now,

$$H = 0.75", H_{dr} = \frac{0.75}{2} = 0.375" = 0.03125 \text{ ft (2-way drainage)}$$

$$U = 65\%, T_v = 0.340 \text{ (at 60\%)}$$

$$C_v = 0.265 \text{ ft}^2/\text{day}$$

$$T_v = \frac{C_v \cdot t}{H_{dr}^2} \Rightarrow t = \frac{T_v \cdot H_{dr}^2}{C_v}$$

$$t = \frac{(0.340)(0.03125)^2 \text{ ft}^2}{0.265 \text{ ft}^2/\text{day}} = 0.001253 \text{ day}$$

$$\boxed{t = 108.255 \text{ seconds}}$$

$$\begin{aligned} &\text{day} \times 24 \times 60 \\ &\times 60 \\ &\text{sec} \end{aligned}$$

Problem 2 (20 pts)

Following are the direct shear test results of the 2-inch diameter and 1-inch height sample. Find the strength parameters of the soil. You must show detail calculation and graph.

test No.	Normal Force	Shear Force
	lb	lb
1	15	13.54
2	30	18.95
3	48	26.14
4	83	39.45

$$d = 2", h = 1"$$

$$\therefore, A = \frac{3.14 d^2}{4} = \frac{3.14 \times 2^2}{4} = 3.14 \text{ in}^2$$

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}, \text{ So Normal stress} = \frac{\text{Normal force}}{\text{Area}} \quad \&$$

$$\text{Shear stress} = \frac{\text{Shear force}}{\text{Area}}$$

$$\therefore,$$

Test NO.	Normal stress (psi)	Shear stress (psi)
1	4.78	4.31
2	9.55	6.04
3	15.29	8.32
4	26.43	12.56

Sample Calculation for Test 1

$$\text{Normal stress} = \frac{15}{3.14} = 4.78$$

$$\text{Shear stress} = \frac{13.54}{3.14} = 4.31$$

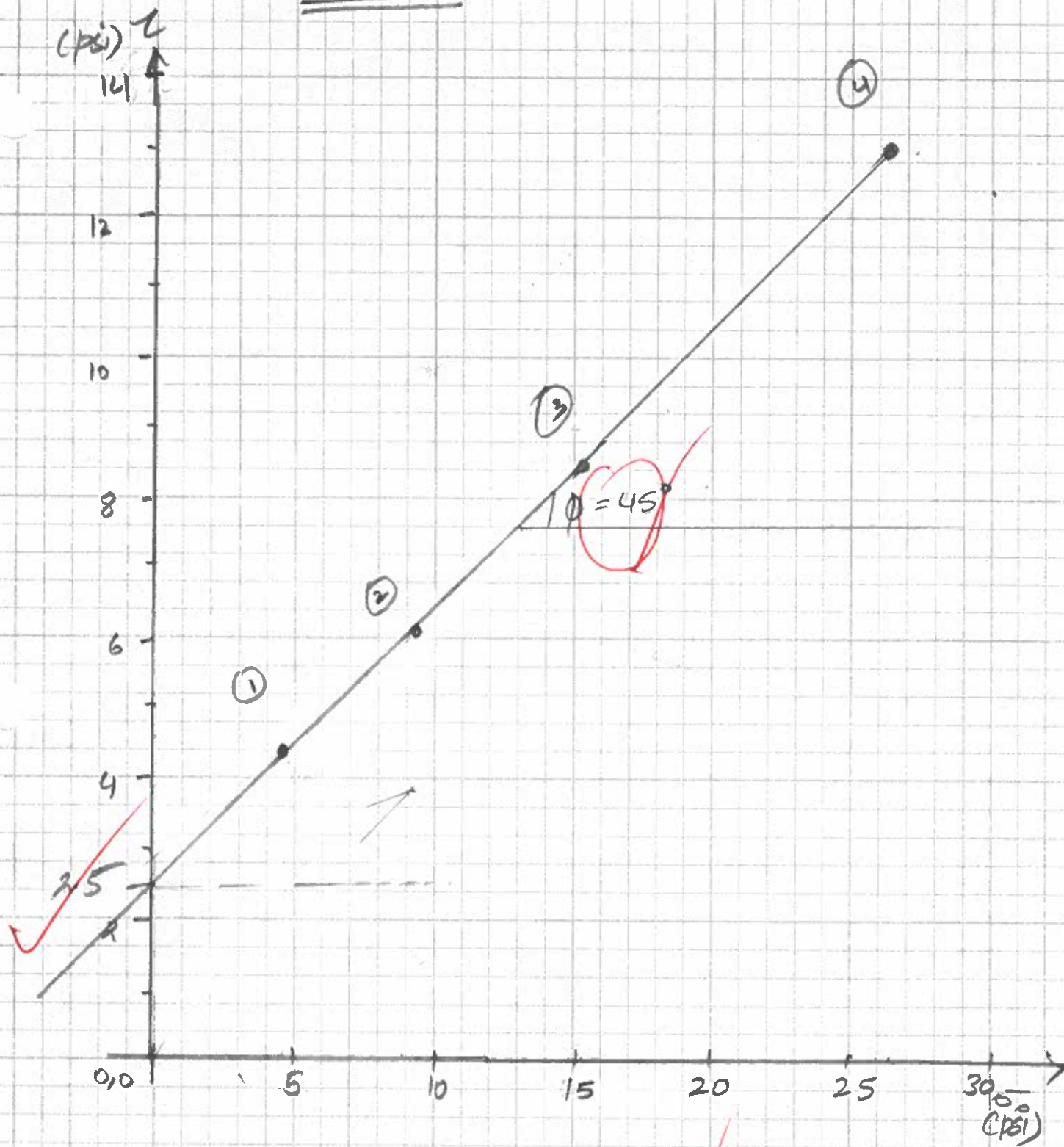
Strength parameters

$$c = 2.5 \text{ in}$$

$$\text{and } \phi = 45^\circ$$

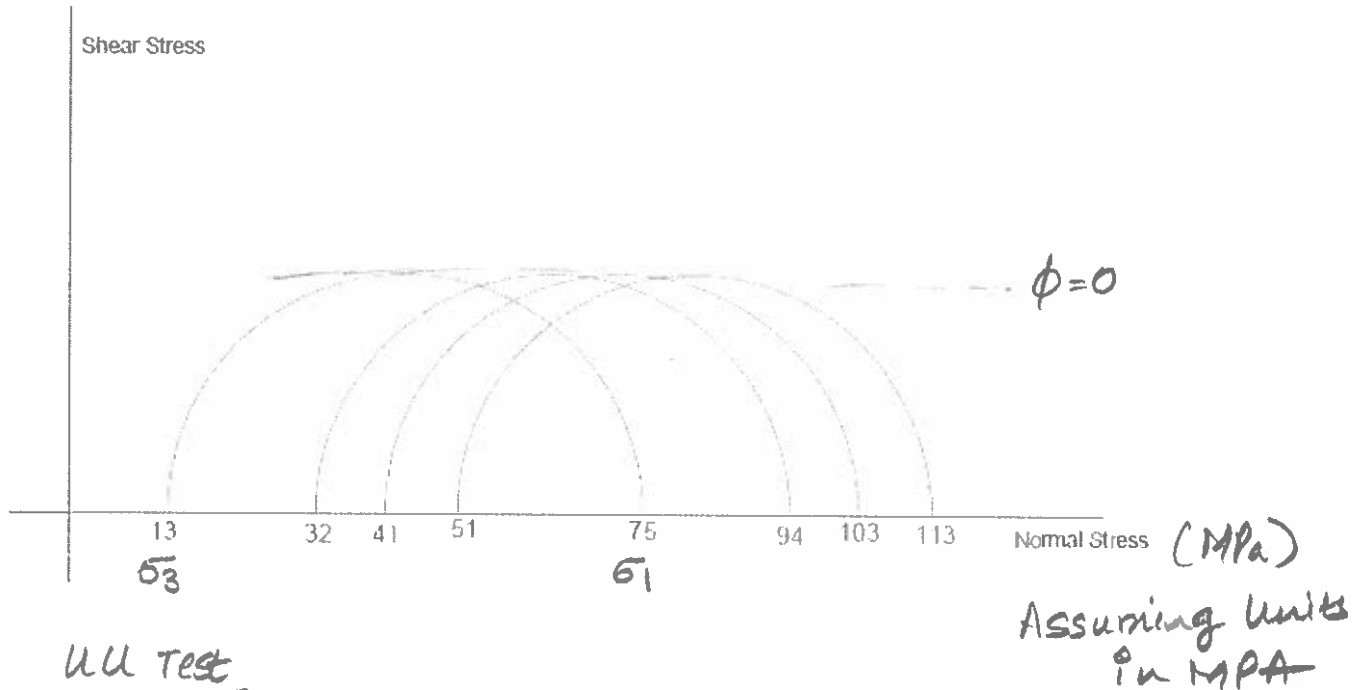
$$\phi = (20 \sim 21)^\circ$$

Problem 2



Problem 3 (10 pts)

Find the shear strength of the soil based on the UU test results below. Detail calculation is required.



UU Test

$$\boxed{\phi = 0}$$

$$\sigma_3 = 13 \text{ MPa}$$

$$\sigma_1 = 75 \text{ MPa}$$

$$C = \frac{\sigma_1 - \sigma_3}{2}$$

$$C = \frac{75 - 13}{2}$$

$$\boxed{C = 31 \text{ MPa}}$$

or

$$\sigma_1 = \sigma_3 \tan^2(45 + \frac{\phi}{2}) + 2c \tan(45 + \frac{\phi}{2}) \quad [\phi = 0]$$

$$\sigma_1, \sigma_1 = \sigma_3 \tan^2(45) + 2c \tan(45)$$

$$75 = 13 + 2c$$

$$\boxed{C = 31 \text{ MPa}}$$

Similarly, for all other tests, value of c is same ⁴

Problem 4 (20 pts)

The results of two drained triaxial tests on a saturated clay follow:

Test 1:

Confining Pressure = 78.95 kPa

Deviator stress at failure = 141.12 kPa

Test 2:

Confining Pressure = 171.51 kPa

Deviator stress at failure = 233.54 kPa

Find the strength parameters of the soil using the Mohr Circle.

The Mohr circle must be drawn to the scale. Answers from an analytical approach will not be accepted.
Show Calculation to find necessary parameters

Test 1

$$\sigma_3 = 78.95 \text{ kPa}$$

$$\Delta \sigma_d = 141.12 \text{ kPa}$$

$$\begin{aligned}\sigma_0, \sigma_1 &= \sigma_3 + \Delta \sigma_d \\ &= 78.95 + 141.12 \\ &= \underline{220.07 \text{ kPa}}\end{aligned}$$

$$\begin{aligned}\text{Midpoint} &= \frac{\sigma_1 + \sigma_3}{2} = \frac{220.07 + 78.95}{2} \\ &= \underline{149.51 \text{ kPa}}\end{aligned}$$

Strength parameters:

$$\begin{aligned}C &= 11 \text{ kPa} \\ \phi &= 18^\circ\end{aligned}$$

Test 2

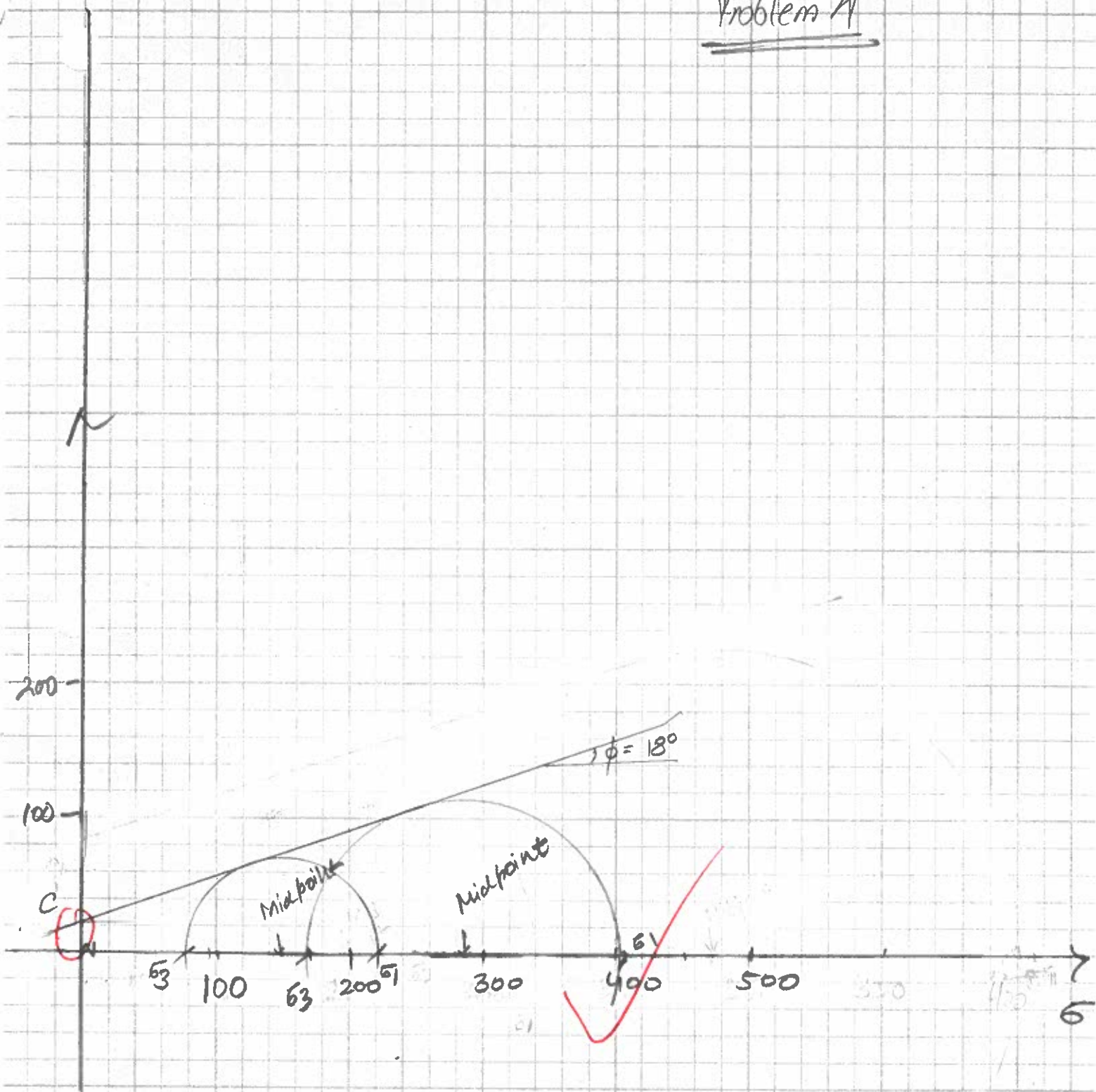
$$\sigma_3 = 171.51 \text{ kPa}$$

$$\Delta \sigma_d = 233.54 \text{ kPa}$$

$$\begin{aligned}\sigma_1 &= 171.51 + 233.54 \\ &= \underline{405.05 \text{ kPa}}\end{aligned}$$

$$\begin{aligned}\text{Midpoint} &= \frac{405.05 + 171.51}{2} \\ &= \underline{288.28 \text{ kPa}}\end{aligned}$$

Problem 4



$$\sigma' = \gamma'(\gamma_{sat} - \gamma_w)$$

Problem 5 (20 pts)

Consider the soil profile shown in Figure 11.44 subjected to the uniformly distributed load, s , on the ground surface. Given: $\Delta\sigma = 26 \text{ kN/m}^2$; $H_1 = 1.83 \text{ m}$; $H_2 = 3.66 \text{ m}$; and $H_3 = 5.5 \text{ m}$. Soil characteristics are as follows:

Sand Layer: $\gamma_d = 17.9 \text{ kN/m}^3$; $\gamma_{sat} = 18.5 \text{ kN/m}^3$,

Clay Layer: $\gamma_{sat} = 18.3 \text{ kN/m}^3$; $LL = 38$; $e = 0.73$.

Estimate the primary consolidation settlement in the clay if

- The clay is normally consolidated
- The preconsolidation pressure is 105 kPa

$$\gamma_w = 9.81$$

(a)

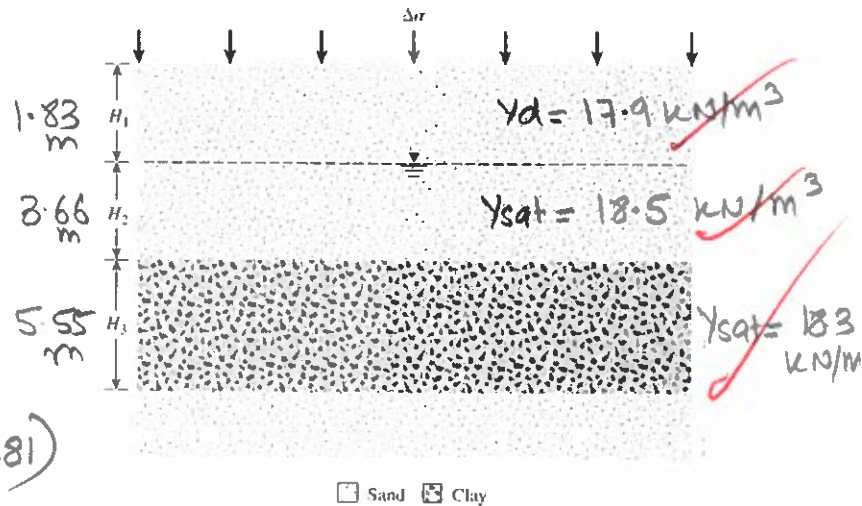
$$\Delta\sigma = 26 \text{ kN/m}^2$$

$$\text{Clay: } e = 0.73, LL = 38$$

$$\begin{aligned} C_c &= 0.009(LL - 10) \\ &= 0.009(38 - 10) \\ &= 0.252 \end{aligned}$$

$$\begin{aligned} \sigma'_v &= 1.83(17.9) + 3.66(18.5 + 9.81) \\ &\quad + \frac{5.5}{2}(18.3 + 9.81) \end{aligned}$$

$$\sigma'_v = 213.674 \text{ kN/m}^2$$



$$\alpha_c = \frac{CcH}{1+e_0} \log \left(\frac{\sigma'_v + \Delta\sigma}{\sigma'_v} \right)$$

$$= \frac{(5.5)(0.252)}{1+0.73} \log \left(\frac{213.674 + 26}{213.674} \right)$$

$$= \frac{0.801}{1} \log(1.21)$$

$$= 0.0399 \text{ m}$$

$$= 39.953 \text{ mm}$$

(b) $\sigma'_c = 105 \text{ kPa}$

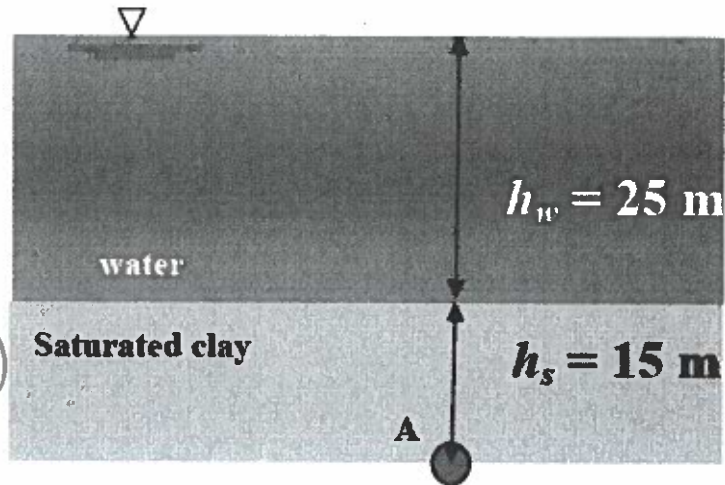
$$\sigma'_v + \Delta\sigma = 213.674 + 26 = 239.674 (> \sigma'_c = 105 \text{ kPa})$$

$$\alpha_c = \frac{CcH}{1+e_0} \log \frac{\sigma'_c}{\sigma'_v} + \frac{CcH}{1+e_0} \log \left(\frac{\sigma'_v + \Delta\sigma}{\sigma'_c} \right)$$

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Problem 6 (15 pts)

A sample was obtained from point A in the submerged clay as shown in the figure. It was determined that it had $w=54\%$, and $G_s = 2.78$. What is the effective stress at A? (h_w is height of water, h_s is depth of clay layer)



$$w = 54\%$$

$$G_s = 2.78$$

$$\gamma_{sat} = \left(\frac{1 + w_{sat}}{1 + w_{sat} G_s} \right) G_s \gamma_w$$

$$\gamma_{sat} = \left(\frac{1 + 0.54}{1 + 0.54(2.78)} \right) (2.78)(9.81)$$

$$\gamma_{sat} = 16.791 \text{ kN/m}^3$$

$$\sigma'_A = 15(16.791 - 9.81)$$

$$\sigma'_A = 104.721 \text{ kN/m}^2$$

Ver

$$\sigma_A = (25)(9.81) + 15(16.791) = 492.121$$

$$u = 9.81(25 + 15) = 392.4$$

$$\sigma'_A = 492.121 - 392.4 = 104.721$$

BELOW AVERAGE

NAME: Omar Rafey Student ID: P22046439

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CVEG 3300 – Geotechnical Engineering
Final Exam - Spring 2022
Exam Duration: 2 hours

Problem 1 (15 pts)

A 15-ft saturated clay layer (2-way drainage) is subjected to surcharge loading and underwent 90% consolidation in 180 days.

a) Find C_v .

b) How long it will take for a 0.75-inch sample to undergo 65% consolidation in the lab (two-way drainage lab test)

* 2-way $\rightarrow \frac{h}{2}$ $t = 180 \text{ days}$

$U = 90\% \therefore T_v = 0.848$

a) $C_v = \frac{T_v \cdot H^2_{dr}}{t} = \frac{(0.848)(7.5^2)}{180} = \boxed{0.265 \text{ ft}^2/\text{day}}$

b) $H = 0.75 \rightarrow 2 \text{ way} \therefore h = 0.375$ $U = 65\% \rightarrow T = 0.340$ $0.75 \text{ in} = 0.0625 \text{ ft}$
 $h/2 = 0.03125 \text{ ft}$

$t = \frac{T_v \cdot H^2_{dr}}{C_v} = \frac{(0.34)(0.03125^2)}{0.265}$

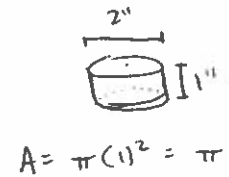
$= \boxed{0.00125 \text{ days}}$ or $\approx 1.8 \text{ minutes}$
 $\swarrow \times 24 \times 60 \rightarrow$

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Problem 2 (20 pts)

Following are the direct shear test results of the 2-inch diameter and 1-inch height sample. Find the strength parameters of the soil. You must show detail calculation and graph.

test No.	Normal Force	Shear Force
	lb	lb
1	15	13.54
2	30	18.95
3	48	26.14
4	83	39.45



test 1

$$\sigma_1 = \frac{15}{\pi} = 4.775 \text{ psi}$$

$$\tau = \frac{13.54}{\pi} = 4.310 \text{ psi}$$

test 2

$$\sigma_2 = \frac{30}{\pi} = 9.549 \text{ psi}$$

$$\tau = \frac{18.95}{\pi} = 6.032 \text{ psi}$$

test 3

$$\sigma_3 = \frac{48}{\pi} = 15.279 \text{ psi}$$

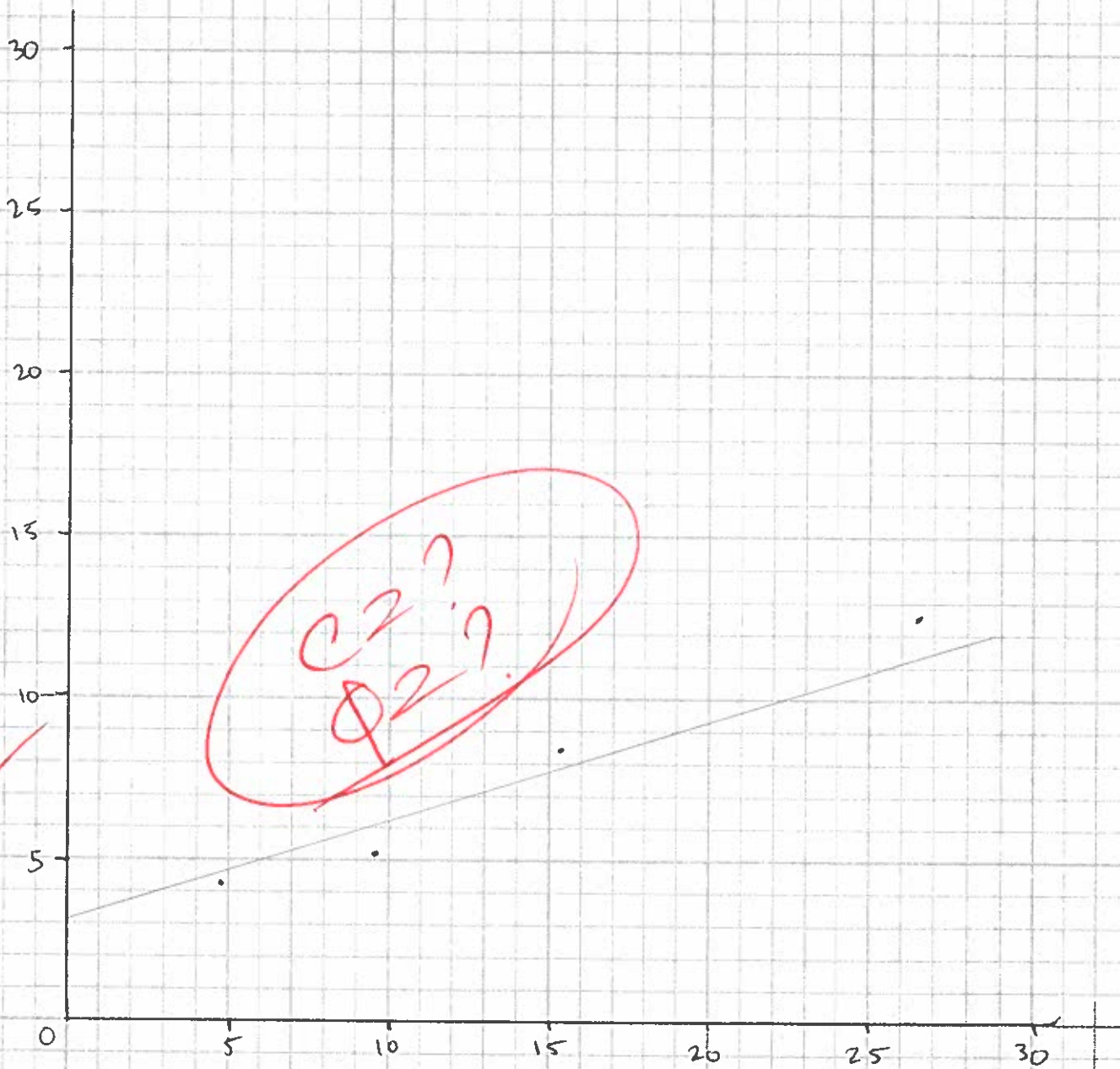
$$\tau = \frac{26.14}{\pi} = 8.321 \text{ psi}$$

test 4

$$\sigma_4 = \frac{83}{\pi} = 26.420 \text{ psi}$$

$$\tau = \frac{39.45}{\pi} = 12.557 \text{ psi}$$

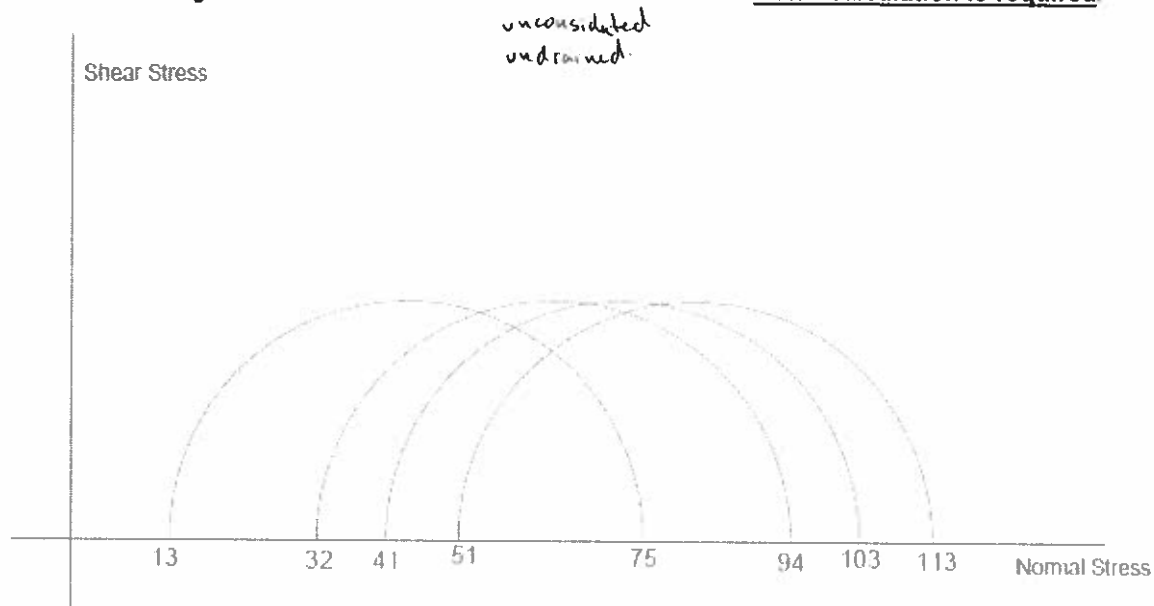
shear
stress
 τ
[psi]



normal stress
 σ
[psi]

Problem 3 (10 pts)

Find the shear strength of the soil based on the UU test results below. Detail calculation is required.



$$\phi = 0 \Rightarrow \text{UU}$$

$$\sigma_1' = \sigma_3' \tan^2(45^\circ) + 2c' \tan(45^\circ)$$

$$\tan 45^\circ = 1$$

$$75 = 13 + 2c'$$

$$62 = 2c' \rightarrow c' = 31$$

$$113 = 51 + 2c' \rightarrow c' = 31 \checkmark$$

$$c' = y\text{-intercept} = \text{shear stress} = \boxed{31}$$

Problem 4 (20 pts)

The results of two drained triaxial tests on a saturated clay follow:

Test 1:

Confining Pressure = 78.95 kPa

Deviator stress at failure = 141.12 kPa

Test 2:

Confining Pressure = 171.51 kPa

Deviator stress at failure = 233.54 kPa

Find the strength parameters of the soil using the Mohr Circle.

The Mohr circle must be drawn to the scale. Answers from an analytical approach will not be accepted.
Show Calculation to find necessary parameters

Test 1

$$78.95 + 141.12 = 220.07 \text{ kPa} \quad \frac{220.07 + 78.95}{2} = 149.51$$

Test 2

$$171.51 + 233.54 = 405.05 \text{ kPa} \quad \frac{405.05 + 171.51}{2} = 288.28$$

~~soil~~ $\phi' =$ from graph, $\phi' \approx 19.5^\circ$, $c \approx 24 \text{ kPa} \approx \tau_0$

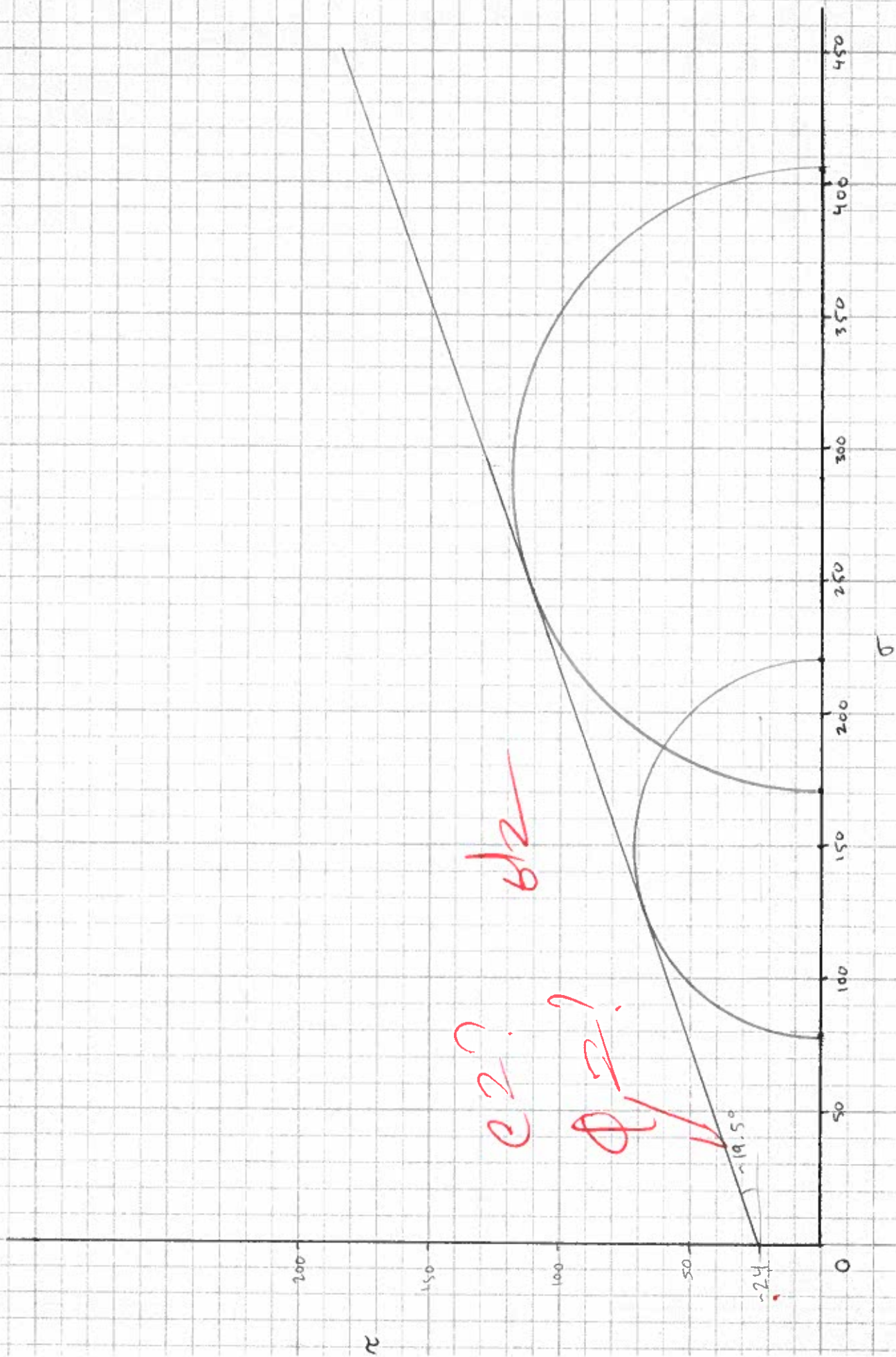
$$\sigma = c + \sigma' \tan \phi$$

$$\sigma_1' = \sigma_3' \tan\left(45 + \frac{\phi'}{2}\right) + 2c' \tan\left(45 + \frac{\phi'}{2}\right)$$

$$45 + \frac{19.5}{2} = 45 + 9.75 = 54.75$$

$$\text{Lb } 220.07 = 78.95 \tan(54.75) + 2c' \tan(54.75)$$

$$141.12 = 2c' (1.4115)$$



ϕ 2? ϕ 2? ϕ 2?

$$\sigma = \sigma' + u$$

Problem 5 (20 pts)

Consider the soil profile shown in Figure 11.44 subjected to the uniformly distributed load, s , on the ground surface. Given: $\Delta\sigma = 26 \text{ kN/m}^2$; $H_1 = 1.83 \text{ m}$; $H_2 = 3.66 \text{ m}$; and $H_3 = 5.5 \text{ m}$. Soil characteristics are as follows:

Sand Layer: $\gamma_d = 17.9 \text{ kN/m}^3$; $\gamma_{\text{sat}} = 18.5 \text{ kN/m}^3$,

Clay Layer: $\gamma_{\text{sat}} = 18.3 \text{ kN/m}^3$; LL = 38; $e = 0.73$.

Estimate the primary consolidation settlement in the clay if

- The clay is normally consolidated
- The preconsolidation pressure is 105 kPa

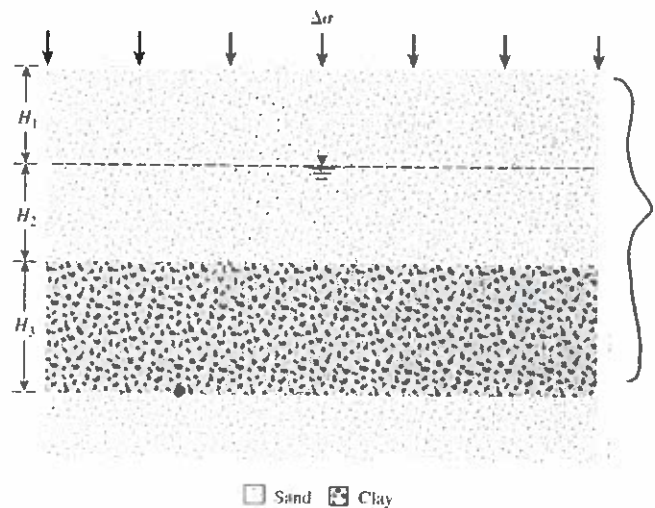
NC clay

$$C_c = 0.009(38 - 10) = 0.252$$

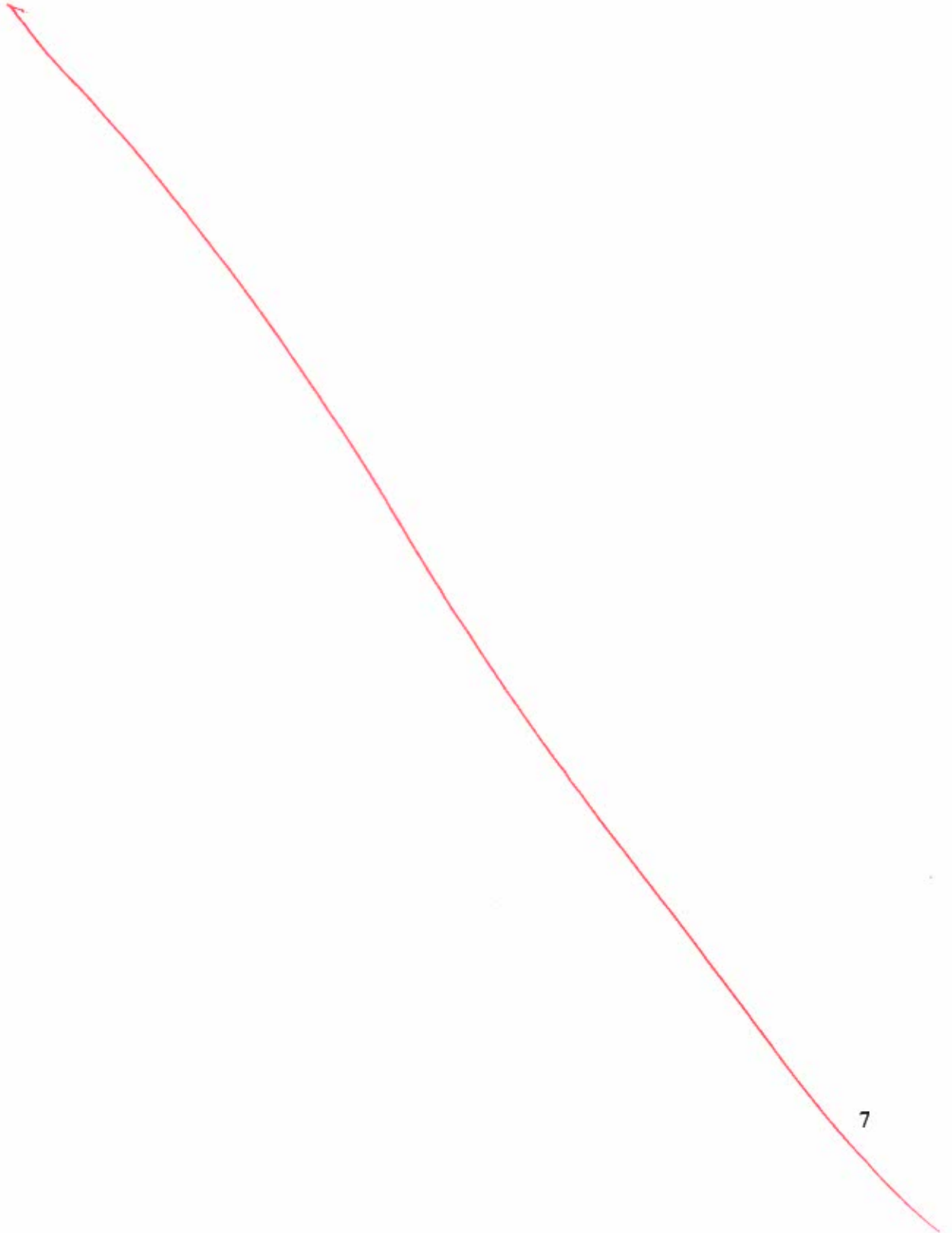
$$\sigma'_0 = 105 \text{ kPa}$$

Stress at bottom of clay layer:

$$\sigma = 1.83(17.9) + 3.66(18.5) + 5.5(18.3) + 9.16(1.81) = 290.977 \text{ kPa}$$



$$S_c = \frac{C_c H}{1 + e_0} \log \left(\frac{\sigma'_0 + \Delta\sigma'}{\sigma'_0} \right) = \frac{(0.252)(10.99)}{1 + 0.73} \log \left(\frac{105 + 26}{105} \right) = (1.6)(0.096) = 0.154 \text{ m}$$

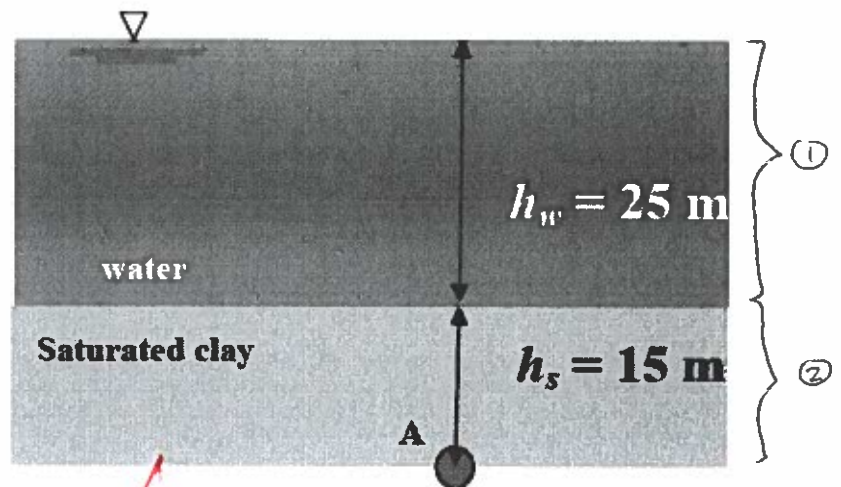


Problem 6 (15 pts)

$$\gamma_w = 9.81 \text{ kN/m}^3$$

A sample was obtained from point A in the submerged clay as shown in the figure. It was determined that it had $w=54\%$, and $G_s = 2.78$. What is the effective stress at A? (h_w is height of water, h_s is depth of clay layer)

$$\begin{aligned}\gamma_{sat} &= \left(\frac{1 + w_{sat}}{1 + w_{sat} G_s} \right) G_s \gamma_w \\ &= \left(\frac{1 + 0.54}{1 + (0.54)(2.78)} \right) 2.78 (9.81) \\ &= (0.616)(2.78)(9.81) \\ &= 16.791 \text{ kN/m}^3\end{aligned}$$



$$\sigma'_2 = h_s \cdot \gamma_{sat} = \underline{251.865 \text{ kN/m}^2}$$

**GEOTECHNICAL ENGINEERING
SPRING 2022**

Title of Assignment: Laboratory Report 1

TOPICS COVERED IN LAB 2: Moisture Content Test

Measuring Moisture Content of Soil

**NOTE: Pages L1 through L7 should be repeated for each Report and
Similarly for all the other assignments in the course binder**

ABOVE AVERAGE

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Prairie View A&M University

College of Engineering

Department of Civil & Environmental Engineering



CVEG 3300 P01 Geotechnical engineering

LABORATORY REPORT ON

"Determination of Moisture Content"

Conducted on

February 16th, 2022

Submitted by: Group 1

Trinity Scott

Denia Leroy

Tyrah Owens

Hunter Rodgers

On

February 23rd, 2022

To

Dr. J. Alam

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Data Presentation.....	4
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✓
very good

Objective: The Moisture Content Test is based on removing soil moisture by oven-drying a soil sample until the weight remains constant. The moisture content (%) is calculated from the sample weight before and after drying.

Apparatus: For this experiment, we used a wet soil sample, spatula, moisture can, and scale to complete the analysis.



Figure title:

Procedure:

1. Clean and dry the container and weigh. Place a sample of soil in the container, replace the lid.
2. Remove the lid and place the container and lid in the oven and dry.
3. After drying, remove the container from the oven, replace the lid and allow it to cool.
4. Weigh the container with contents.



Data:

Moisture content, w%

$$w\% = \left(\frac{W_2 - W_3}{W_3 - W_1} \right) * 100$$

Weight of wet soil,

$$W_w = W_2 - W_3$$

Weight of dry soil,

$$W_s = W_3 - W_1$$

The following table shows the final results of the moisture content test. Only one sample was tested giving us the results of the weight of the can, the weight of the can + wet soil, weight of can + dry soil and moisture content percent.

Sample No.		1	Calculations
1	Can No.		1&2
2	Weight of can, W1 (g)		21.5
3	Weight of can + wet soil, W2 (g)		35.5
4	Weight of can + dry soil, W3 (g)		35
5	Moisture content, w% = (Ww/Ws)		3.7 %

Table 1. Moisture content results

Conclusion

Moisture content is the quantity of water in soil. Calculating the moisture content is essential to the studies of soil mechanics. The moisture content test gives a better understanding of the state of the soil sample. Moisture content is one of the most important index properties used to determine the nature of the soil. The moisture content of the soil is used to express the phase relationships of water, air, and solids in a given volume or weight of the material. It can be concluded from the experiment that the objective was met. The moisture content was calculated by subtracting $W_2 - W_3$, and dividing by $W_3 - W_1$. Then you multiply by 100 to make the value calculated a percent. Using the values, it can be concluded that our soil decreased .5g, and our moisture content is 3.7%.

Reference:

AVERAGE



Department of Civil & Environmental Engineering

CVEG 3300 P81 Geotechnical Engineering Lab Spring 2022

Laboratory Number 01

Water Content Determination

**Experiment conducted: Wednesday, 16 February,
2022 - 1:00 PM**

Group Members

**Allyssa Reynolds
Austin Bates
Jason Garza
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Maurice Bettis**

Submitted to: Dr. Md Jobair Bin Alam

Submitted by: Group 2

Date Submitted: 02/23/2022



Laboratory Number 01 - Water Content Determination

Objective

The goal of the experiment was to estimate the amount of water or moisture present in the given quantity of soil using the oven-drying method.

Introduction

A heating oven is an exceptional way to find the moisture content of a soil. Placing soil in an oven for 24 hours can yield accurate results due to the mass loss of water in the soil. How this is done is by finding the initial mass of the soil and comparing it to the dried mass of the soil, that is how moisture content is found.

Equipment/Apparatus

1. Non-corrodible container/can.
2. Electric oven, able to maintain temperature between 105 C - 115 C.
3. Balance of sufficient sensitivity. (Sensitive to 0.01/g)
4. Mini Spatula

Notice: Certain soils contain gypsum which on heating loses its water if crystallization. If it is suspected that gypsum is present in the soil sample used for moisture content determination it shall be dried at not more than 80°C and possibly for a longer time.

General Remarks:

1. A container without lid can be used, when moist sample is weighed immediately after placing the container and oven dried sample is weighed immediately after cooling in desiccator.
2. As dry soil absorbs moisture from wet soil, dried samples should be removed before placing wet samples in the oven.

Procedure

1. Clean non-corrodible container/can, dry container. After zeroing the scale/balance, weigh the container in grams.
 - a. Record all data. This will be W_1 .
2. Place a sample of wet soil into a non-corrodible container/can using a mini spatula. Container should be about half-way full of the sample. Weigh container in grams.
 - a. Record all data. This will be W_2 .

3. Place container with sample into oven at 145°F. Dry the sample to constant weight for 24 hours.
4. After the 24 hours period has been completed, weigh the container with dried samples in grams on scale after zeroing the scale.
 - a. Record all data. This will be W_3 .

Data Presentation

Table 1: Moisture Content Test

S. No.	Sample No.		Example Calculations
1	Can No.	Group 2	#4
2	Weight of Can, W_1 (g)	14.1	23.4
3	Weight of Can + wet soil W_2 (g)	38.6	188.44
4	Weight of Can + dry soil W_3 (g)	45	166.49
5	Water/Moisture Content	20.71	13.30%

Table 1: Represents data obtained for the moisture content test.

Sample Calculations 1: Represents calculations used to find the theoretical moisture content from sample #4. Data used is obtained from Table 1, Example Calculations.

$$w(\%) = \frac{(W_2 - W_1)}{(W_3 - W_1)} \cdot 100 = \frac{188.44 - 166.49}{188.44 - 23.40} \cdot 100 = 13.30\%$$

Results and Discussion/Interpretation

The natural moisture content of the soil sample is: 20.71%. This was found by using the data obtained from Table 1 and the moisture content equation.

The weight of the can + the dry soil, W_3 , is significantly greater than the weight of the can + wet soil, W_2 . This is impossible, as W_2 has to be greater due to its weight containing the mass of water, mass of the can, and mass of the soil. This means an error was conducted during the weighing of W_3 . This error has been identified within the report, under the section "Sources of Error." Thus, our results for the moisture content are incorrect.

Sources of Error

A potential source of error in this experiment is human error. It is possible for us to have misread the scale and gotten wrong values for the mass. This could have been avoided by double checking the reading from the scale, and conducting numerous trials.

Another human error contributing to incorrect mass values is due to not cleaning the empty container/can before conducting the test. Thus, the weight of the can may have been inaccurate, producing an incorrect moisture content for the given sample. This could have been avoided by washing the container and drying the container before starting the test.



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Our last human error identified was the weighing of the can after the 24 hour drying period. W_1 and W_2 were obtained by weighing the can without the top upon it. Unfortunately, W_3 was obtained by weighing the can with the top. This has resulted in the final dry weight of the container being incorrect. This could have been avoided by communicating better between group members, so all members would be able to notice and notify each other about any errors being conducted during the experiment.

Conclusion

All objectives were met as the moisture content was found for the given sample of soil. Although the moisture content was obtained, due to human error, the moisture content is incorrect. Thus, we must reject the results.

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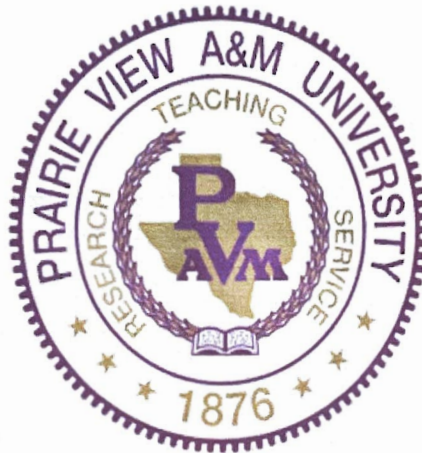
References

Das, Braja M., and Khaled Sobhan. *Principles of Geotechnical Engineering*. Boston: PWS, 2015. Print.

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Prairie View A&M University

Department of Civil & Environmental Engineering



CVEG 3300-P01 Geotechnical Engineering Laboratory

LABORATORY REPORT 1

Moisture Content Test

Conducted on: February 16th, 2022

Submitted by:

Brennen Wright

Daniel Grant

Sophie Tuke

Darrell Patterson

Submitted on : February 23rd, 2022

Submitted to: Dr. Alam

Abstract

The purpose of this lab is to determine the moisture content of a soil as a percentage of its oven-dried weight. The method may be applied to fine, medium and coarse grained soils for particle sizes from 2 mm to >10 mm

Introduction

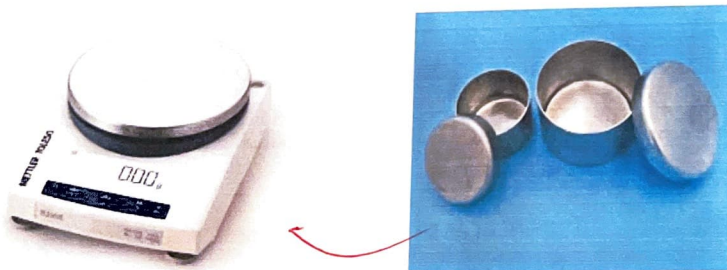
The moisture content test is performed to determine the amount of moisture in a given soil sample. Moisture content has a ratio of the mass of water contained in the pore spaces of soil to the solid mass of particles in that given material. Almost all soil tests help to determine the natural moisture content of soil, and it is essential to understand for all studies of soil mechanics. The natural moisture content provides an idea of the state and behavior of the soil in the field.

Objective

The objective of this experiment is to determine the moisture content of soil in given conditions.

Apparatus

- Non-corrodible container
- Electric oven, with a maintained temperature between 105 degrees Celsius and 115 degrees Celsius
- Balance, with sufficient sensitivity



balance and non- corrodible container example displayed above

Experimental Safety

The rules in place in the lab to ensure safety is to wear the appropriate clothing which is pants, closed toe shoes, and no dangling jewellery. Other rules were, no food or drinks, no horseplay, and there was also a professor or lab technician in the lab to assist with the experiment.

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Test Procedure

1. Clean the container, dry it and weigh (W1) to find weight of container alone
2. Take a specimen and put the sample of soil in the container and weigh it (W2)
3. Allow the container with the sample to stay in the oven for one full day (16-24 hours minimum). Dry the specimen to constant weight, while maintaining temperature between 105°C to 110°C.
4. Record the final constant weight (W3) of the container with the oven- dried soil sample.

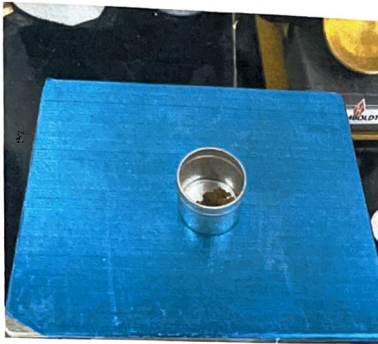
Data

S No.	Sample Number	Weight	Calculations
1	Weight of Can (w1)	0.0215 kg = 21.5 g	
2	Weight of Can + Wet Soil (w2)	0.0305 kg = 30.5 g	
3	Weight of Can + Dry Soil (w3)	0.0300 kg = 30.0 g	
	Water/Moisture content W (%) = [(W2 - W3)/(W3 - W1)] × 100		W (%) = [(30.5g-30.0g)/(30.0-21.5)]*100 = 5.88%

Calculations- Water Content, represented by w, in % = $((W2 - W3) / (W3 - W1)) \times 100$

$$[(30.5g-30.0g) / (30.0-21.5)] \times 100$$

The Natural Moisture Content is = 5.88%



Weighing of Can + Wet Soil (w_2)



Weighing of Can + Dry Soil (w_3)

Conclusion

The moisture content, also referred to as water content, is the main indicator of water present in soil. Our group found that the given soil sample had a moisture content of 5.88%. Meaning the ratio of the mass of water contained in the porous spaces of the soil to its solid mass of particles in that given soil was only 5.88% of the soil.

In Civil Engineering, the determination of moisture content is a major index used for understanding the relationship between the way a soil behaves and its properties. It is key when it comes to construction, finding soil optimum for plant growth, and groundwater recharge.

Using the oven drying method, we were able to find the moisture content of the soil successfully.

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Reference

**GEOTECHNICAL ENGINEERING
SPRING 2022**

Title of Assignment: Laboratory Report 2

TOPICS COVERED IN LAB 2: Atterberg Limit Test

**NOTE: Pages L1 through L7 should be repeated for each Report and
Similarly for all the other assignments in the course binder**

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CVEG 3300 P81 Geotechnical Engineering Lab Spring 2022

Laboratory Number 02

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Atterberg Limit Test

**Experiment conducted: Wednesday, 9 March 2022 -
1:00 PM**

Group Members

**Maalvika Aggarwal
Allyssa Reynolds
Austin Bates
Maurice Bettis
Jason Garza**

Submitted to: Dr. Md Jobair Bin Alam

Submitted by: Group 2

Date Submitted: 03/28/2022

Laboratory Number 01 - Atterberg Limit Test

Objective

The Objective of this experiment is to determine the moisture content at which fine-grained clay and silt soils transition between the different phases. The main goal is to find the plastic limit, liquid limit, and the plasticity and flow index.

Introduction to Theory

☐ Atterberg Limits:

The Atterberg limit refers to the liquid limit and plastic limit of soil. These two limits are used internationally for soil identification, classification, and strength correlations. When clay minerals are present in fine-grained soil, the soil can be remolded in the presence of some moisture without crumbling.

☐ Plastic Limit:

The moisture content at the point of transition from semi-solid to plastic state is the plastic limit (PL)

☐ Liquid Limit:

The moisture content at the point of transition from plastic to liquid state is the liquid limit (LL).

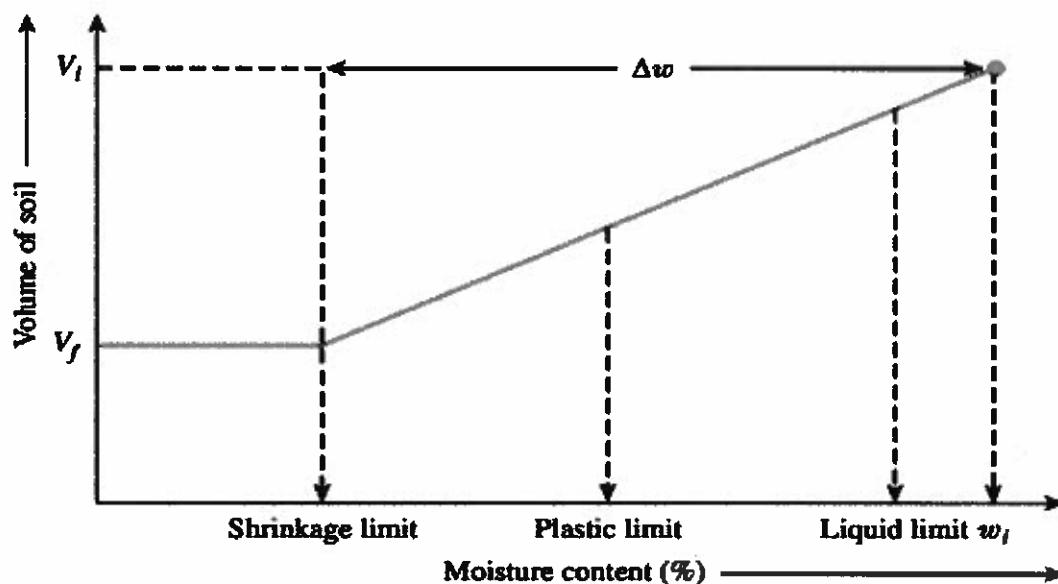


Figure 1: Graphical Representation of Atterberg Limits

☐ **Flow Index:**

Flow Index (If) is defined as the rate at which a soil mass loses its shear strength with an increase in water content. It is obtained by the slope of the curve drawn for Water content versus the Number of blows.

☐ **Plasticity Index:**

The plasticity index (PI) is a measure of the plasticity of a soil. The PI is the difference between the liquid limit and the plastic limit.

Equipment/Apparatus

1. Weighing scale/balance
2. Casagrande's liquid limit device
3. Grooving tool
4. Mixing dishes able to withstand high temperatures (105°C)
5. Spatula
6. Oven
7. Moisture can
8. Plastic limit device (approved/recommended by TXDot)

Procedure

Liquid Limit Test

1. Calibrate the liquid limit device. This will be W1.
 - a. Complete this by using the end of the grooving tool as a measurement of height, and correcting the drop of the cup to match the height of the grooving tool.
 - b. Place the end of the grooving tool under the cup. Cup should sit on top of the device on its own.
 - c. Drop the cup by turning the crank on the device. If there is no movement, the height is correct. If the cup rises, the height is too high. Loosen the sud screw Turn the adjust screw clockwise to move the cup away from the tool. If the cup
2. Weigh moisture using a scale or balance.
 - a. Complete this step three times to measure three cans.
3. Place roughly 250 grams of "air-dried" soil into an evaporating dish. Add water using a plastic squeeze bottle to develop a uniform paste in small amounts. Adequately mix soil and water to develop a uniform paste using the spatula.
 - a. The soil used has to have passed through a #40 sieve.
4. Place the paste into Casagrande's cup using a spatula. Flatten and smooth surface.

- a. The maximum depth of paste should be about 8mm.
5. Cut a groove into the paste at the centerline of the cup using the grooving tool.
6. Crank Casagrande's liquid limit device at 2 revolutions per second. Continue to do this until $\frac{1}{2}$ " or 12.7mm closure is visible in the cup. Count the number of blows, N, immediately after closure has been reached. Paste should be developed such that N is greater than 35.
7. For $N = 15-40$, collect a sample from the cup using a spatula and place it into a can.
8. Weigh the can. This will be W2, the weight of the can + moist soil. You will use this value to determine the moisture content of the soil.
 - a. N will be a higher value if the soil is too dry. Thus, N will reduce when more water is added.
9. Find moisture content after 24 hours, also known as W3, and plot the flow curve, N vs moisture content.

Additional Notes:

1. To make the soil dry, expose the paste to a fan or continue to mix the paste with a spatula.
 - a. Don't add soil to make the paste drier.
2. Clean the cup after every trial.
 - a. At least three trials must be completed with $N = 15-40$.

Plastic Limit Test (TXDOT Methodology)

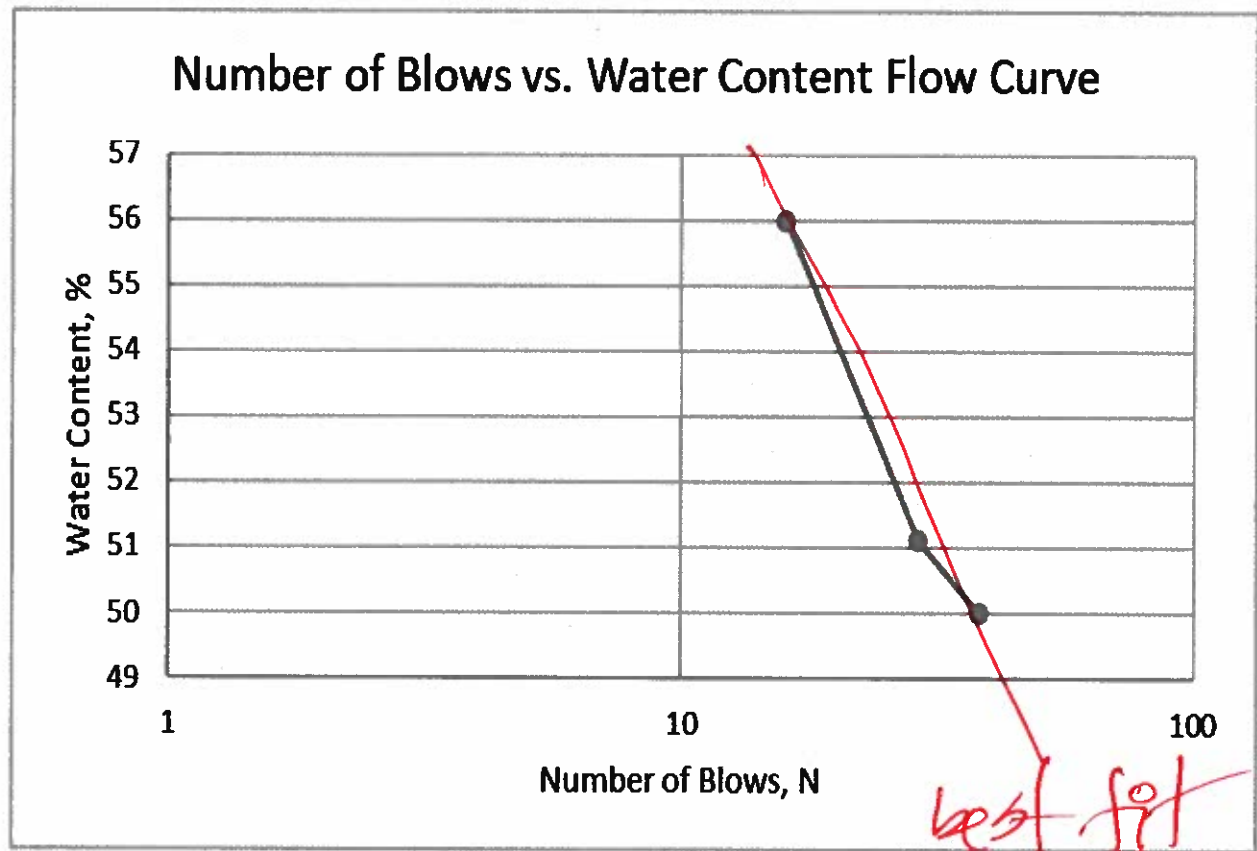
general

1. Weigh moisture can using a scale or balance. This will be W1.
 - a. Complete this step three times to measure three cans.
2. Obtain exactly 20 grams of dry soil. Add water using a plastic squeeze bottle to develop a uniform paste in small amounts. Adequately mix soil and water using the spatula.
3. Prepare multiple small, ellipsoidal-shaped bits of soil. Place them into the plastic limit device. Place two clean sheets of filter paper on the face of the plate. Either side is acceptable.
4. Roll upper half of device, with the calibrated opening of 3.18mm, with the lower half plate. If the soil crumbles and forms a thread, about 3mm diameter, between the plates, collect the sample and weigh it. This will be W2, the weight of the moisture can, and moist soil.
 - a. If soil doesn't crumble, repeat the test with the same soil, but dry the soil by rolling the soil between palms.
5. Obtain the weight of the dry soil and moisture by using the scale or balance. This will be W3.
 - a. The water content found will be the plastic limit.

Data Presentation and Results

Liquid Limit Test Results

Test Number	Trial 1	Trial 2	Trial 3
Can Number	1	2	3
Mass of Can (g)	18.3	17.2	19.9
Mass of Can + Moist Soil (g)	25.4	25	27.1
Mass of Can + Dry Soil (g)	23	22.2	24.7
Number of Blows	29	16	38
Water Content (%)	51.1	56	50



Flow Index= 18.97

LL= 52.6

Plastic Limit Test Results

Test Number	Trial 1	Trial 2
Can Number	1	2
Mass of Can (g)	18.6	20.8
Mass of Can + Moist Soil (g)	19.7	21.7
Mass of Can + Dry Soil (g)	19.5	21.5
Water Content (%)	22.2	28.5

Trial 1 PL = 22.2

Trial 2 PL = 28.5

Sample Calculations

Water Content (%)

$$W\% = (\text{Weight of Water} / \text{Weight of Soil}) * 100$$

$$W\% = ((25.4 - 23) / (23 - 18.3)) * 100 = 51.1\%$$

Flow Index

$$FI = (W1\% - W2\%) / (\text{Log}N2 - \text{Log}N1)$$

$$FI = (51.1 - 56) / (\text{Log}29 - \text{Log}16) = 18.97$$

Plastic Limit, PL

$$PL = (\text{Weight of Water} / \text{Weight of Soil}) * 100$$

$$PL = ((19.7 - 19.5) / (19.5 - 18.6)) * 100 = 22.2\%$$

Plastic Index, PI

$$PI = LL - PL$$

$$PI = 53$$

Sources of Error

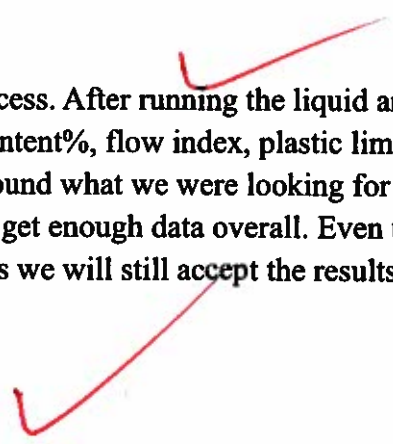
While conducting the liquid limit test human errors were present such as not perfectly grooving the tool into the soil and accurately timing the blows to 2 blows per second. Also while performing the plastic limit test there was human error again due to the rolling of the soil between the hands.

Discussion

The significance of the results found during the experiment is that there is a small buffer zone between the liquid limit and plastic limit. Therefore, very little liquid is able to be held inside. This means that the experiment the soil was conducted on is very poor. Unlike better soils which are able to hold a lot of liquid inside due to a high plastic index. Also had there not been so many human errors we would have collected more accurate data.

Conclusion

In conclusion the experiment we did came out to be a success. After running the liquid and plastic limit tests we needed to run we found the water content%, flow index, plastic limit, and plastic index and the calculations you can easily see we found what we were looking for even though there were a couple human errors we were able to get enough data overall. Even though the soil came out to be very poor and unlike the other soils we will still accept the results.

A large red checkmark is drawn over the conclusion paragraph, indicating that the conclusion is satisfactory or correct.

References

Das, Braja M., and Khaled Sobhan. *Principles of Geotechnical Engineering*. Boston: PWS, 2015. Print.

Gupta, Alinda, et al. "Atterberg Limit Test." *Properties and Behavior of Soil Online Lab Manual*, Mavs Open Press, 14 Jan. 2021,

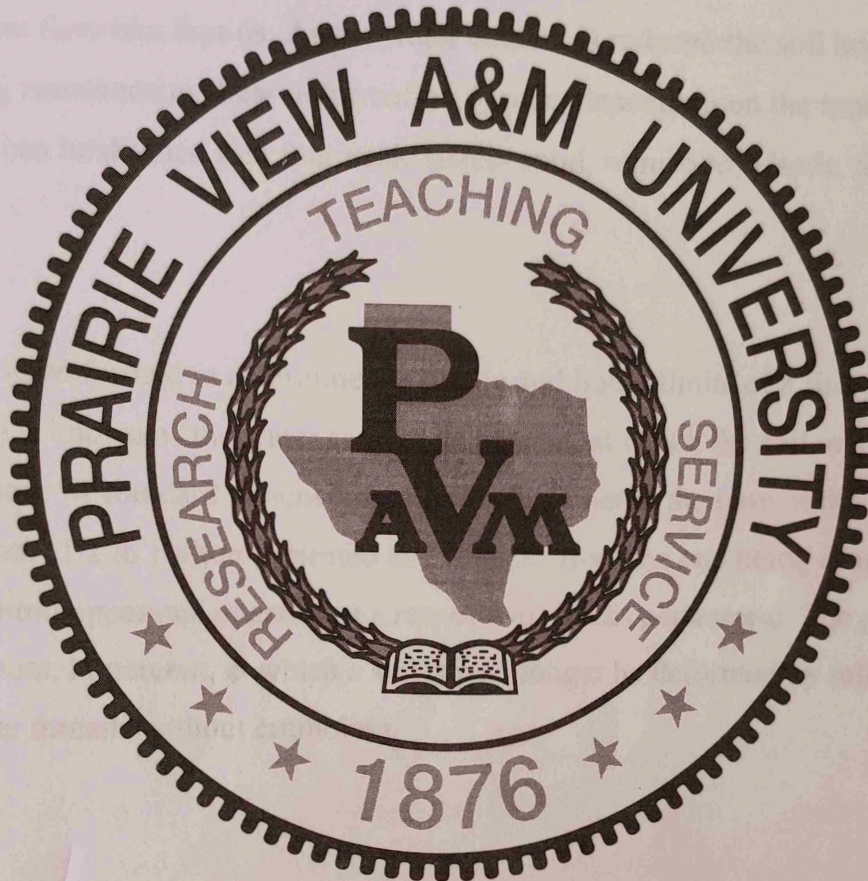
<https://uta.pressbooks.pub/soilmechanics/chapter/atterberg-limit-test/#:~:text=The%20Atterberg%20limit%20refers%20to,of%20some%20moisture%20without%20crumbling.>



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Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department



CVEG 3100 Geotechnical Engineering Lab 2

Spring 2022

Atterberg's Limit Test Laboratory Report

Conducted on March 9, 2022

By: Sanjay Tillmutter, Nyja Kennedy, Erik Smith, Omar Rafey,
Oluwa-timilehin Ogunjobi and Jonathan Warrior

Due: 3/28/22

To: Dr. Alam

Introduction

The liquid and plastic limits have been widely used all over the world. Primarily for soil identification and classification. A soil containing very high water content offers no shearing resistance and can flow like liquids. As the water content is reduced the soil becomes stiffer and starts developing resistance to shear deformation. Hence, depending on the moisture content, the behavior of soil can be divided into four basic states- solid, semisolid, plastic, and liquid.

Objective

This lab is performed to determine the plastic and liquid limits of a fine grained soil. The liquid limit (LL) is known as the water content, in percent, at which the soil in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove for a distance of 13 mm (1/2 in.) when subjected to 25 shocks from the cup being dropped 10 mm in a standard liquid limit apparatus operated at a rate of two shocks per second. The plastic limit (PL) is the water content, in percent, at which a soil can no longer be deformed by rolling into 3.2 mm (1/8 in.) diameter threads without crumbling.

Apparatus

1. Balance
2. Liquid limit device (Casagrande's liquid limit device)
3. Grooving tool
4. Mixing dishes
5. Spatula
6. Oven
7. TxDOT recommended Plastic limit device

Procedure

LIQUID LIMIT TEST

1. Determine the mass of each of the three moisture cans (W1).
2. Make sure to calibrate the drop of the cup using the other end of the grooving tool so that there is a consistency in height of drop.
3. Put about 250 g of air dried soil passing # 40 into an evaporating dish and add a little water with a plastic squeeze bottle to form a uniform paste.
4. Place the soil in the Casagrande's cup and using a spatula, smoothen the surface so that the maximum depth is about 8mm.
5. Using the grooving tool, cut a groove at the center line of the soil cup.
6. Crank the device at a rate of 2 revolutions per second until there is a clear visible closure of 1/2" or 12.7 mm in the soil pat placed in the cup. Count the number of blows (N) that caused the closure (make the paste so that N begins with a value higher than 35).
7. If $N = 15$ to 40, collect the sample from the closed part of the cup using a spatula and determine the water content weighing the weight of the can + moist soil (W2). If the soil is too dry, N will be higher and reduce as water is being added.
8. Additional soil shouldn't be added to make the soil dry, expose the mix to a fan or dry it by continuously mixing it with the spatula.
9. CLEAN THE CUP AFTER EACH TRIAL, obtain a minimum of three trials with values of $N \sim 15$ to 40.
10. Determine the corresponding $w\%$ after 24 hrs (w_3) and plot the N vs $w\%$, called the "flow curve".

PLASTIC LIMIT TEST (TxDOT Procedure)

1. Take approximately 20 g of dry soil and mix some amount of water from the plastic squeeze bottle.
2. Determine the weight of empty moisture can, (W1).
3. Prepare several small, ellipsoidal-shaped masses of soil and place them in the plastic limit device. Place two fresh sheets of filter papers on either face of the plates.
4. Roll the upper half of the device which has a calibrated opening of 3.18 mm with the lower half plate.
5. If the soil crumbles forming a thread of about the size of the opening between the plates (~3 mm diameter), collect the crumbled sample, weigh it in the moisture can (W2) for water content determination. Otherwise repeat the test with the same soil but drying it by rolling between your palms.
6. Determine the weight of the dry soil + moisture can, (W3).
7. The water content obtained is the plastic limit.

Data and Analysis

Liquid Limit Test Results				
Sample Test	Weight of can (g)	Weight of can +moist soil (g)	Weight of can +dry soil (g)	Number of Blows
1	18.3	25.4	23	29
	17.2	25	22.2	16
	19.9	27.1	24.7	38

Plastic Limit Test Results			
Sample	Weight of can (g)	Weight of can +moist soil (g)	Weight of can +dry soil (g)
1	18.6	19.7	19.5
	20.8	21.7	21.5

Calculations

$$\text{Water content, } w\% = \left\{ \frac{W_2 - W_3}{W_3 - W_1} \right\} \times 100$$

$$\text{Flow Index, } F_1 (\text{slope of the flow curve}) = \left[\frac{w_1(\%) - w_2(\%)}{\log N_2 - \log N_1} \right]$$

$$\text{Plastic limit, PL} = \left\{ \frac{W_2 - W_3}{W_3 - W_1} \right\} \times 100$$

$$\text{Plasticity Index, PI} = \text{LL} - \text{PL}$$

$$\begin{aligned} \text{Water Content, } w\% &= (W_2 - W_3 / W_3 - W_1) \times 100 \\ w\%_1 &= [(25.4 - 23) / (23 - 18.3)] \times 100 = 51\% \\ w\%_2 &= [(25 - 22.2) / (22.2 - 17.2)] \times 100 = 56\% \\ w\%_3 &= [(27.1 - 24.7) / (24.7 - 19.9)] \times 100 = 50\% \end{aligned}$$

$$\begin{aligned} \text{Plastic Limit, PL} &= (W_2 - W_3 / W_3 - W_1) \times 100 \\ \text{PL} &= (19.7 - 19.5 / 19.7 - 18.6) \times 100 = 18.1\% \end{aligned}$$

Discussion

At the end of this Atterberg limit test, the value of liquid limit and plastic limit from the conducted test was derived, as well as interpreting the liquid limit and plastic limit by using the plasticity chart.

From the test, we determined the value of the plastic limit and the liquid limit. The value of the plastic limit that we obtained is 18. For the liquid limit, the testing procedure is the Casagrande method. For the Casagrande method, at 25 taps, the moisture content percentage is 22%, according to the graph and the best fit line is obtained.

graph plot

A plasticity chart is needed to find the classification of silt or clay by plotting a graph between plasticity index and liquid limit. To find the plasticity index, we must know the plastic limit and the liquid limit of the soil. So to find its plasticity index, we must know the differences between the liquid limit and the plastic limit.

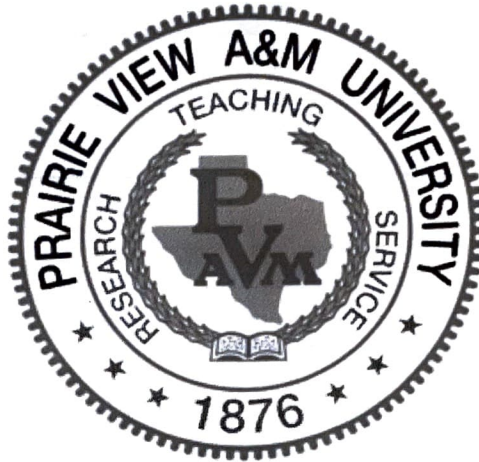
Conclusion

The subject of the study is the liquid limit that is an empirically determined state at which a transition from a softly plastic to liquid state occurs, therefore after its achieving soil starts to behave as a liquid substance. The liquid limit measurement is principal especially for finding consistency states playing a decisive role for determining the key standard characteristics of soils representing important geotechnical parameters of fine-grained soils for investigations of the so-called first geotechnical category.

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Prairie View A&M University
Department of Civil & Environmental Engineering

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CVEG 3300-P01 Geotechnical Engineering Laboratory

LABORATORY REPORT
Atterberg Limit Tests

Conducted on: March 9th, 2022

Submitted by:

Brennen Wright

Daniel Grant

Sophie Tuke

Darrell Patterson

Submitted on : March 28th, 2022

Submitted to: Dr. Alam

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Abstract

The test performed in this lab is the Atterberg Limit Test. Even though this test is simple to perform, errors can still occur while performing this test. If neither the liquid nor the plastic limits can be determined, the plasticity index cannot be measured and should be stated as Nonplastic (NP). If the plastic limit is greater than or equal to the liquid limit, the plasticity index should be stated as "NP."

Introduction

In this experiment, the Liquid Limit and Plastic Limit was calculated. This lab allows students to understand the meaning of the Liquid Limit when working with fine aggregates and learning how different soils act with various amounts of water. Students measured soil and mixed it with small amounts of water and calculated its characteristics after a certain amount of blows. After placing it in the oven and calculating the moisture content, it allows students to classify the soil provided and understand its liquid and plastic limit as a result.

Objective

To determine the liquid limit, plastic limit, linear shrinkage, and plasticity index of the given soil sample.

Apparatus

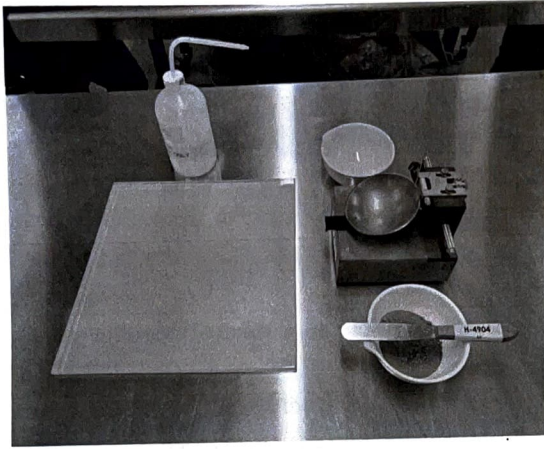


figure title

- Liquid limit device and grooving tool
- Glass plate
- Half cylindrical linear shrinkage mold
- Distilled Water
- Balance
- Drying oven
- Drying containers with lids
- Mixing dish
- Spatula

Experimental Safety

To ensure the safety of each student during the experiment, necessary precautions were taken such as the use of gloves and a mask.

Test Procedure

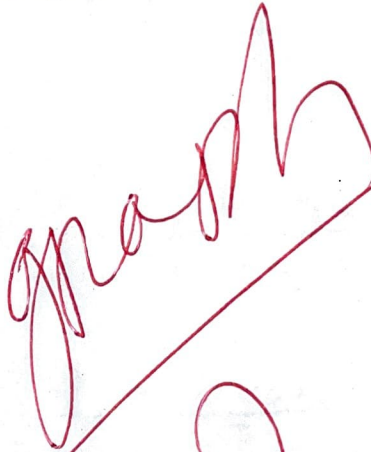
- Step 1- Students used a provided grooving tool to measure and calibrate the height of the bowl on Liquid Limit Testing device to ensure it was only dropping 10mm.
- Step 2- Students weighted all three cans and labeled them accordingly.
- Step 3- Students mixed dry soil in an evaporating dish and added a small amount of water until the soil and water formed a slightly thick paste.
- Step 4- Students used a spatula to evenly spread the paste in the bowl of the Liquid Limit Testing device.
- Step 5- Students then used the provided grooving tool to carve a straight line down the center of the paste.
- Step 6- Students cranked the drive while keeping count until the grove closed about 10mm.
- Step 7- Students recorded the number of blows it took and then collected approximately 50mg of sample and placed it into a can.
- Step 8- Students placed the can into the oven and repeated steps 1-7 two additional times for accuracy

Test Results

Test #	1	2	3
Can #	1	2	3
Mass of Can (W1)(g)	18.3	17.2	19.9
Mass of Can+moist soil (W2)(g)	25.4	25	27.1
Mass of Can+dry soil (W3)(g)	23	22.2	24.7
# of Blows	29	16	38

Conclusion

This report summarizes the results obtained from the Atterberg Limits test. We averaged our Plastic Limit from three tests to be 52.35 %. We also calculated the Flow Index which equated to 19.13 %. It is observed that the Plastic Index (PI), Liquid Limit (LL), and the Plastic Limit (PL) serve a very important cause in the field of engineering, especially when designing footing, determining strength, compaction, and swelling characteristics.

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Calculations

$$\text{Water content, } W_1 = \left[\frac{W_2 - W_3}{W_3 - W_1} \right] \times 100 \rightarrow \frac{25.4 - 23}{23 - 18.3} \times 100 = 51.06\%$$

$$\text{Water content, } W_2 = \left[\frac{W_2 - W_3}{W_3 - W_1} \right] \times 100 \rightarrow \frac{25 - 22.2}{22.2 - 17.2} \times 100 = 56\%$$

$$\text{Water content, } W_3 = \left[\frac{W_2 - W_3}{W_3 - W_1} \right] \times 100 \rightarrow \frac{27.1 - 24.7}{24.7 - 19.9} \times 100 = 50\%$$

$$\text{Flow Index} = \frac{W_1(\%) - W_2(\%)}{\log N_2 - \log N_1} \rightarrow \frac{51.06 - 56}{\log 16 - \log 29} = 19.13$$

$$\text{Plastic Limit} = \text{avg of } w\% \rightarrow \frac{51.06 + 56 + 50}{3} = 52.35$$

~~not accepted~~

**GEOTECHNICAL ENGINEERING
SPRING 2022**

Title of Assignment: Laboratory Report 3

TOPICS COVERED IN LAB 2: Sieve Analysis

**NOTE: Pages L1 through L7 should be repeated for each Report and
Similarly for all the other assignments in the course binder**

ABOVE AVERAGE

CVEG 3300 P81 Geotechnical Engineering Lab Spring 2022

Laboratory Number 03

Sieve Analysis

90

Experiment conducted: Monday, 21 March 2022 - 1:00 PM

Group Members

Maalvika Aggarwal

Allyssa Reynolds

Austin Bates

Maurice Bettis

Jason Garza

Submitted to: Dr. Md Jobair Bin Alam

Submitted by: Group 2

Date Submitted: 04/03/2022

Laboratory Number 03 - Sieve Analysis

Objective

The goal is to obtain the particle size distribution of a solid material by determining the amount of powder retained on a series of sieves with different sized apertures.

Introduction to Theory

- Sieve Analysis:

Sieve analysis consists of shaking the soil sample through a set of sieves that have progressively smaller openings. U.S. standard sieve numbers. The sieve analysis test is also known as the gradation test. It is a fundamental and crucial test for all aggregate technicians. The sieve analysis determines the gradation in order to determine design, production control requirements, and verification specifications.

Sieve Analysis Gradation is evaluated by passing the aggregates through a series of sieves. The sieve retains particles larger than the opening in them, whereas, the smaller particles keep passing through, until they reach the pan, at the bottom., as shown in figure 1.

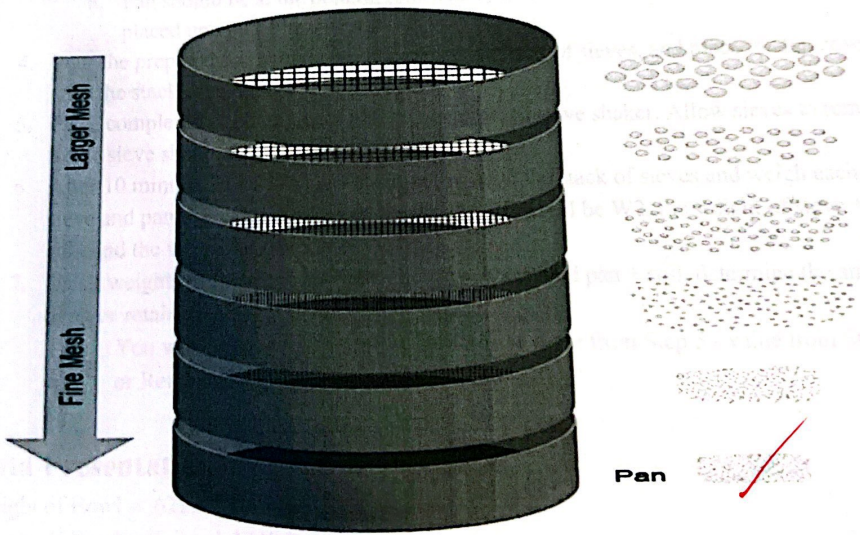


Figure 1: An example of Sieve Analysis

Equipment/Apparatus

1. Soil sample
2. Stackable sieves with the cover
 - a. Common sieves used are sieve no. 4, 10, 20, 40, 60, 100, and 200
3. Measuring scale or balance
 - a. Scale or balance should provide readings to 0.1 grams
4. Oven
5. Mechanical sieve shaker
6. Spatula
7. Brush

Procedure

1. Obtain exactly 500 grams of oven-dried soil sample.
 - a. The sample generally used has particles passing 4.75mm sieve.
 - b. If soil is clumped, use the spatula to remove the clumps.
2. Obtain Sieve No. 4, 8, 30, 40, 60, 100, 200, pan, and top cover.
 - a. If the sieve or pan has lingering soil/dirt, remove particles using a brush, by brushing the sieve/pan lightly. Pour sand/dirt out of the pan and wipe dry with a towel.
3. Weigh each sieve and pan individually, and record the weight. This will be W1, the weight of sieves. Stack sieves upon each other in increasing order.
 - a. Pan should be at the bottom, followed by No. 200, 100, up to 4, and the top cover placed upon the No. 4 sieve.
4. Pour the prepared soil sample into the top of the stack of sieves, and place the top cover onto the stack of sieves.
5. Place completed stack of sieves into the mechanical sieve shaker. Allow sieves to remain in the sieve shaker for 10 minutes.
6. After 10 minutes of shaking has occurred, remove the stack of sieves and weigh each sieve and pan individually. Record the weight. This will be W2, the weight of sieve + soil, and the weight of pan + soil.
7. Using weights of the sieve and pan, and sieve + soil and pan + soil, determine the amount of sieve retained in each sieve.
 - a. You will use the equation: Retained Soil = value from Step 5 - value from Step 3 or Retained soi = $W2 - W1$.

Data Presentation

Weight of Bowl = .6225 kg

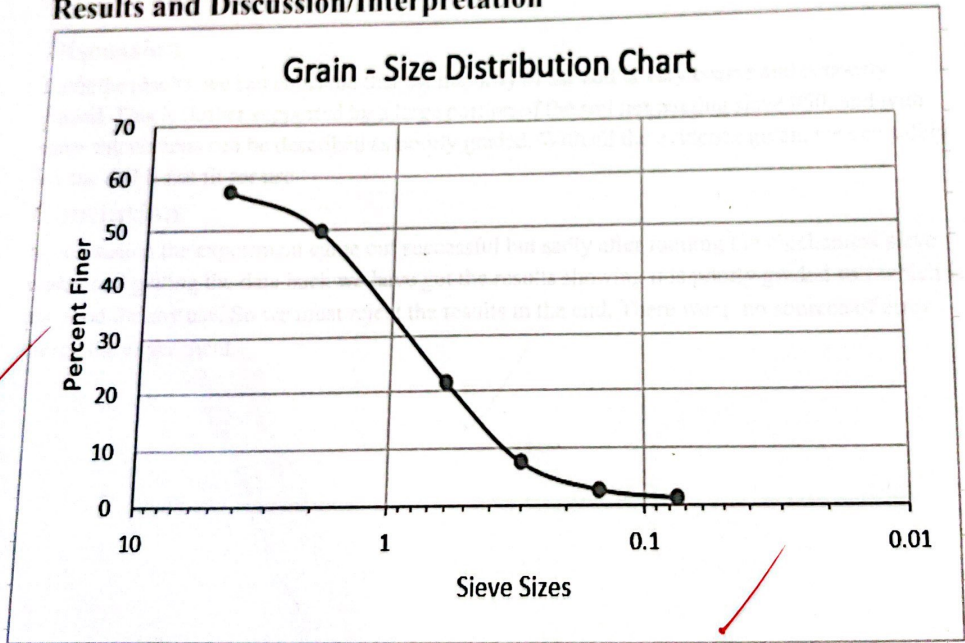
Weight of Bowl + Soil = 1.1240 kg

Weight of Soil = 0.5015 kg

1	2	3	4	5	6	7	8
Sieve #	Sieve Size (mm)	Mass of Each Sieve (g)	Mass of Each sieve + Retained Soil (g)	Mass of Soil Retained	Percentage Retained	Cumulative Percentage Retained	Percent Finer
4	4.75	0.59	0.80	0.20	42.74	42.74	57.26
10	2	0.67	0.71	0.04	7.52	50.26	49.74
30	0.6	0.61	0.75	0.13	28.11	78.37	21.63
50	0.3	0.55	0.62	0.07	14.11	92.48	7.52
100	0.15	0.52	0.54	0.02	4.81	97.28	2.72
200	0.075	0.50	0.51	0.01	1.46	98.75	1.25
Pan		0.48	0.49	0.01	1.25	100.00	0.00
Total =				0.48	100.00		

Results and Discussion/Interpretation

Grain - Size Distribution Chart



Calculations:

and from Grain-Size Distribution Graph)

0.24

$U = 0.80$

$d_{60} = 4.75$

$$C_u = 4.75 / 0.24 = 19.8$$

$$C_c = (0.80)^2 / (4.75 - 0.24) = 0.56$$

Soil is considered Poorly Graded

Well Graded- Soil that has a consistent range of sizes that can fit in all sieves number 4-200.

Poorly Graded- Soil that has particles that are mostly the same size

Gap Graded- Soil that has an excess or deficiency of a certain particle size for the required sieve number.

Sources of Error

No sources of error during the experiment.

Discussion

From the results, we can conclude that the majority of the soil is very coarse and is poorly graded. This is further supported by a large portion of the soil not passing sieve #50, and with some calculations can be described as poorly graded. With all the evidence given, we can safely say the soil is not fit for use.

Conclusion

In conclusion the experiment came out successful but sadly after running the mechanical sieve shaker and getting the data back we have got the results showing it is poorly graded soil which is not good for any use. So we must reject the results in the end. There were no sources of error during the experiment.

References

Das, Braja M., and Khaled Sobhan. *Principles of Geotechnical Engineering*. Boston: PWS, 2015. Print.

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CIVIL ENGINEERING DEPARTMENT

PRAIRIE VIEW A&M UNIVERSITY



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CVEG 3300 GEOTECH LABORATORY

SPRING 2022

"Sieve Analysis"

Conducted on

March 28th, 2022

Submitted by

Luis Guzman

Omar Hajo

Marshall Johnson

Noah Smith

Mouni Yamba

On

April 4th, 2022

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ABSTRACT

very similar
to another
group

Sieve analysis is the test performed. However, errors can still occur, most noticeably with the loss of sample material during the transfer from sample container to first sieve. Group 4 had a small mishap of dropping some of our sample material after we retrieved it from the mechanical shaker. Because of this we dealt with a small loss in material, but we were still able to perform the test in spite of this with the help of our instructor. Based on the results obtained from the sieve analysis test, the soil type is coarse. A very small amount of the sample is fine grained, silt/clay, while nearly $\frac{1}{3}$ of the sample is gravel. The remaining soil in the sample, which is also most of the sample, is classified as sand. By using the data obtained during the test we were also able to access that the soil group symbol is SP and the group name is poorly ~~graded~~ sand.

INTRODUCTION

The engineering properties of soil are influenced by the distribution of various grain sizes. Grain size analysis determines the grain size distribution, which is essential for soil classification. In sieve analysis, the soil is divided into size fractions and the weight of the fractions are calculated. The soil is subjected to horizontal or vertical movement during sieving, depending on the process used. This creates a relative movement between the particles and the sieve. The individual particles either pass through the sieve mesh or are held on the sieve surface, depending on their size. Particles that pass through the sieve mesh are determined by the proportion of the particle size to the sieve openings, the orientation of the particle, and the number of encounters between the particles and the mesh opening. During the sieve test we must determine the percent retained by each sieve mesh using the following equation,

$$\% \text{ Retained} = \frac{M_s}{M_t} \times 100 \quad \text{-----} \quad 1$$

Where,

M_s = Mass of soil retained on each sieve

M_t = Total mass of soil

Since we did not calculate the liquid limit, LL, and the plastic limit, PL, we must find the *Uniformity coefficient (Cu)*: This parameter is defined as:

$$Cu = \frac{D_{60}}{D_{10}} \quad \text{-----} \quad 2$$

Where,

D_{60} = diameter corresponding to 60% finer.

D_{10} = diameter corresponding to 10% finer.

Coefficient of gradation (Cc): This parameter is defined as:

$$Cc = \frac{D_{30}}{D_{60} \times D_{10}} \quad \text{-----} \quad 3$$

Where,

D_{30} = diameter corresponding to 30% finer.

By calculating the uniformity coefficient and coefficient of gradation we can determine the group symbol and group name.

OBJECTIVE

The objective of this lab is to determine the percentage of different grain sizes contained within a soil. Sieve analysis helps calculate the distribution of soil particles throughout the sieves. It also helps with plotting the particle-size distribution curve.

APPARATUS AND MATERIAL

- Stack of sieves with the cover (Sieve No. 4, 30, 50, 80, 100, and 200 are used.)
- Balance sensitive to 0.1 g.
- Mechanical sieve shaker

PROCEDURE

- Collect at least **500 g** of the prepared soil sample.
 - Our sample size is 793g.
- Prepare a stack of sieve. For this test, we use the sieves No. 4, 30, 50, 80, 100, and 200 in the stack (the stacks of sieves have been already prepared by LA).



- Determine the mass of each empty sieve and bottom pan and record in table

- Pour the soil prepared in Step 1 into the first sieve, sieve No. 4.
- Place the cover on the top of the stack of sieves.
- Run the stack of sieves through a sieve shaker for 15 minutes.



Figure title?

- Once the sieve shaker stops, remove the stack of sieves.
- Determine the mass of:
 - each sieve + retained soil and
 - the bottom pan + retained soil
- Calculate the amount of soil retained on each sieve and in the bottom pan by using equation 1.
- Calculate the Uniformity coefficient (C_u) using equation 2 and Coefficient of gradation (C_c) using equation 3.

RESULTS

The following is tabulated results of the moisture content test.

Sieve No.	Sieve size	mass of sieve	mass of sieve soil	mas of soil retained on each sieve	% Retained	Cumulative % retained	% Finer
	mm	g	g	g	g	%	
4	4.75	763	1012.5	249.5	31.5	31.5	68.5
30	0.6	400	708.5	308.5	38.9	70.4	29.6
50	0.3	403.5	540.5	137	17.3	87.6	12.4
80	0.18	358.5	405	46.5	5.9	93.5	6.5
100	0.15	518	529.5	11.5	1.5	95.0	5.0
200	0.075	500	530	30	3.8	98.7	1.3
Pan	0	482.5	492.5	10	1.3	100.0	0.0
Total Sample weight=				793	100		

Table 1: Sieve Analysis Test Results

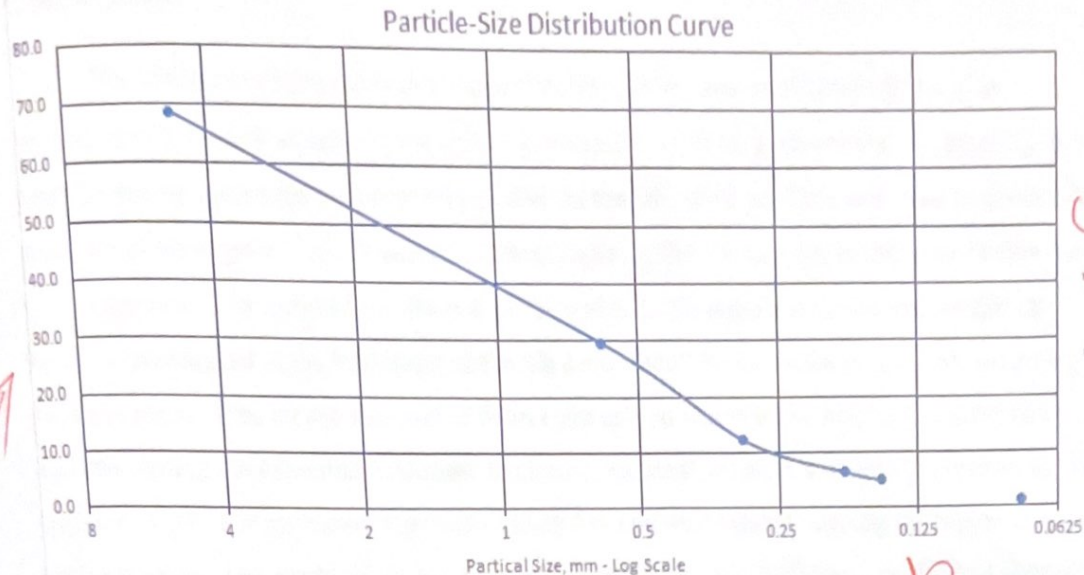


Figure 1: Sieve Analysis Test Results

DISCUSSION

The results from the lab were calculated using the Uniformity coefficient formula, $C_u = \frac{D_{60}}{D_{10}}$ and the Coefficient of gradation formula, $C_c = \frac{D_{30}^3}{D_{60} \times D_{10}^2}$ during the lab only 1.3% passed through sieve no. 200, F_{200} , $1.3\% < 50\%$ meaning the soil type is coarse. In sieve no. 4 the percent retained was 31.5%, this shows that 31.5% is classified as gravel. The remaining 67.2% is classified as sand. Using the particle-size gradation curve, plotted using the sieve analysis table, we determine the C_u , $C_u = \frac{3.15}{0.26} = 12$, $12 > 6$, and the C_c $C_c = \frac{0.6}{3.15 \times 0.26} = 0.733$, $0.733 < 1$. With these two values we determined that the group symbol and name is SP - Poorly graded sands. During the experiment there was a noticeable error that occurred. Some of the sieves that attained soil were spilled, and while some of the soil was able to be recovered some was not. Due to the sieves being spilled some sample numbers were given to us by the professor.

CONCLUSION

The objective of this lab was to determine the percentage of different grain sizes contained within a soil sample. In engineering, and more specific geotechnical engineering, the grain sizes help determine the properties of soil. In the lab, sieve analysis was used to divide the soil into different grain sizes by using the sieve shaker. After 15 minutes in the sieve shaker we took every sieve and weighed the sieve with the soil in it. To ensure accurate soil weight the sieves were weighed at the beginning of the lab experiment. While in the process of weighing the sieve some of the sieves with soil in them were spilled which is the only major error that occurred during the experiment. Despite the loss of material we were still able to perform the test with the help of our instructor. For further study I would recommend keeping the top on as you separate sieves. The results of the lab were calculated using the Uniformity coefficient formula and the Coefficient of gradation formula, and the results showed that the soil type was coarse soil, the group name is poorly graded sand and the symbol is SP.



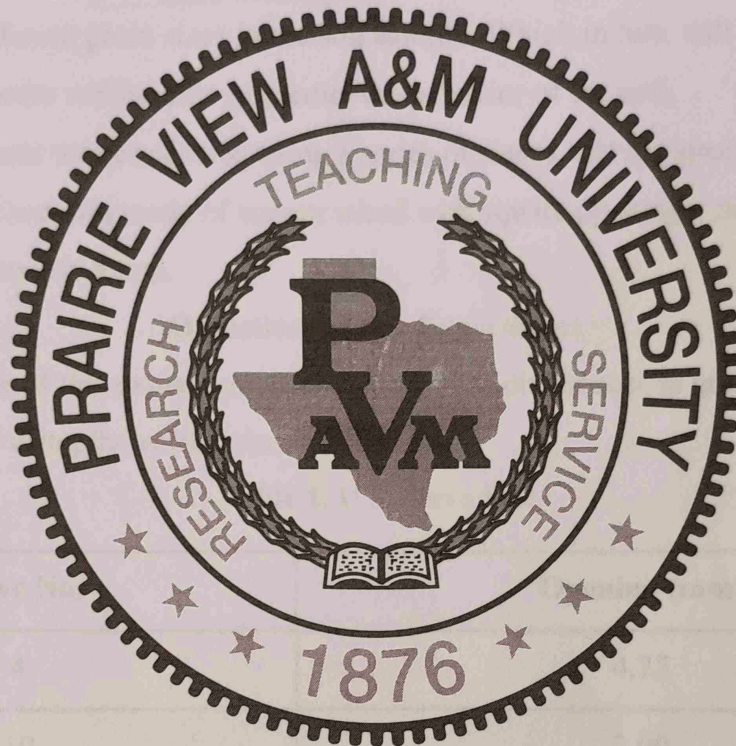
WORK CITED

- Sieve analysis of Coarse Aggregate: From the field to the lab. (n.d.). Retrieved March 15, 2021, from <https://www.globalgilson.com/blog/sieve-analysis-of-coarse-aggregate>

BELOW AVERAGE

Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department

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CVEG 3023 Geotechnical Engineering Lab

Spring 2022

Laboratory Report On

The Sieve Analysis Test

Conducted on March 21, 2022

By: Sanjay Tillmutter, Nyja Kennedy, Erik Smith, Omar Rafey,
Oluwa-timilehin Ogunjobi and Jonathan Warrior

Due: 3/28/22

To: Dr. Alam

Introduction

The purpose of the experiment was for each group to test our soil samples and denote the weight of soil captured in each layer of the sieve. From this you are able to determine the percentage of the different grain sizes in the soil sample. Which in turn will help with classifying the soil so that engineers will be able to predict the behavior of the soil.

This experiment was conducted using a series of sieves that are specially made for this experiment. These sieves are made of woven wired with square openings, these openings vary in size, from 4.75 mm to 0.038 mm.

Objectives of this Experiment

The objective of this experiment is to visualize the differences in grain sizes contained within a soil sample using the various numbered sieves.

Table 1. U.S. Sieve Size

Sieve No.	Opening (mm)
4	4.75
10	2.00
20	0.85
40	0.425
60	0.250
100	0.150
200	0.075

The results of this test showed that our soil sample was sandy, coarse grained soil that was well-graded.

Experimental Safety

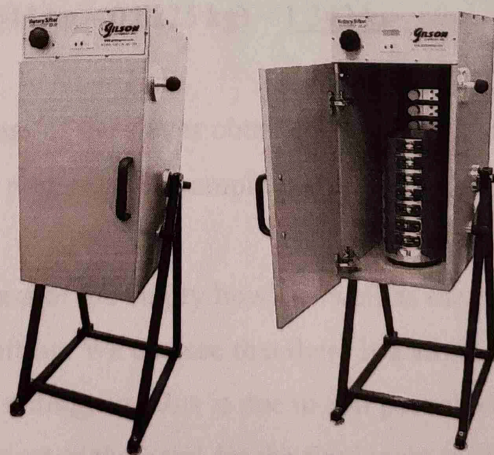
The safety precautions followed during this experiment included making sure that the soil samples that were measured were poured and transported without any spillage, as well as making sure all students performing the laboratory experiment have on lab appropriate clothing.

Experimental Procedure

Our laboratory experiment group was tasked with first collecting a sample of the prepared soil sample provided to the class. Then we gathered the stack of sieves, which included sieve no. 4, 10, 100, 200, as well as sieves with 19 mm and 9.5 mm openings. We then measured the mass of each empty sieve as well as the bottom pan. After that we poured our soil sample into the top of the stack of sieves to be placed into the sieve shaker. After letting the sieve shaker run for 10 minutes, we stop the sieve shaker and remove the stack of sieves. From there we determine the mass of (each sieve + the retained soil) as well as the (bottom pan + the retained soil).

Equipment

- Stack of sieves with the cover (sieve sizes and numbers listed in the Data Table below)
- Balance sensitive to 0.1 g
- Bowl
- Mechanical sieve shaker (pictured below)



Data

The table below shows the data obtained from the experiment.

Table 2

	Initial Mass	Final Mass	Mass of Soil Retained
Stack of sieves	4.4885 kg	5.8295 kg	1.341
19 mm opening	0.7835 kg	0.833 kg	0.050
9.5 mm opening	0.7655 kg	1.0390 kg	0.274
Sieve # 4	0.7595 kg	0.966 kg	0.207
Sieve # 10	0.677 kg	0.764 kg	0.087
Sieve # 100	0.518 kg	1.206 kg	0.688
Sieve # 200	0.502 kg	0.522 kg	0.020
Pan	0.4805 kg	0.4985 kg	0.018

Table 3

	Initial Mass	Final Mass
Empty Bowl	0.6225 kg	0.6225 kg
Bowl + Soil	1.9645 kg	1.9575 kg

$$\text{Mass of soil sample} = (1.9645 \text{ kg} - 0.6225 \text{ kg}) = \underline{1.342 \text{ kg}}$$

Table 2 shows the mass of the sieves obtained before and after soil was sifted through it. We can see that for the most part, our soil sample is well graded, since the soil sizes are spread out.

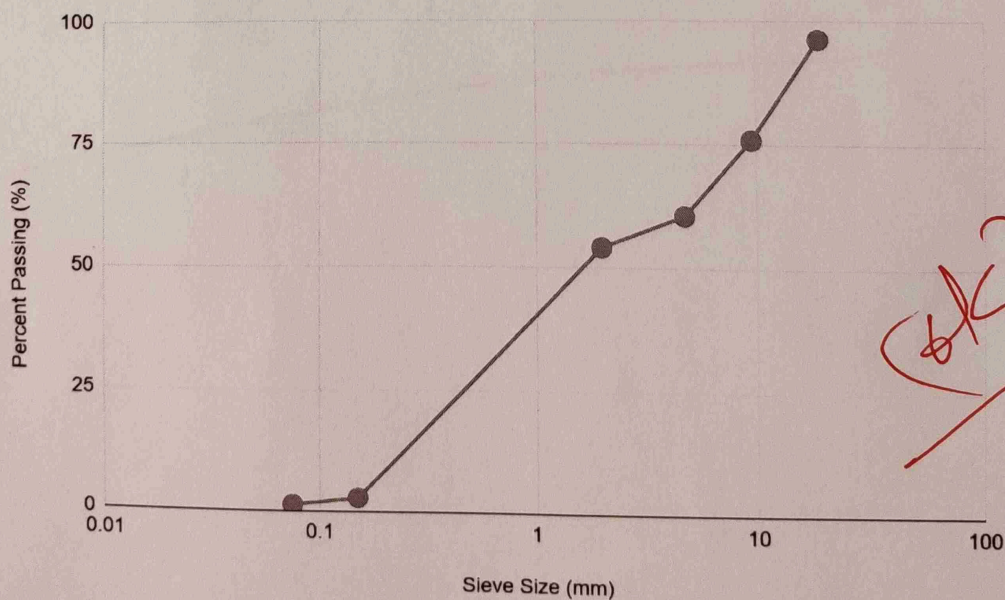
Table 3 shows the mass of the empty bowl, as well as the mass of the bowl with the soil sample before sifting after sifting. We can see that there is a slight difference in the mass of the bowl and soil obtained after sifting, and this is due to soil particles that probably got stuck on the sieves and thus were not present in the bowl for the final mass measurement.

Results & Discussions

Table 4

Sieve Size [mm]	Weight Retained [kg]	% Retained	Cumulative % Retained	% Passing
19	0.05	3.687	3.687	96.313
9.5	0.275	20.375	24.060	75.94
4.75	0.212	15.382	39.441	60.559
2	0.289	6.480	45.922	54.078
0.15	0.688	51.248	97.169	2.831
0.075	0.020	1.490	98.659	1.341
Pan	0.246	1.341	100	
Total	1.343			

From the table above, we can see that about half of the soil sample was roughly between 0.15 mm and 2 mm in diameter. Plotting the sieve size and percent passing on a graph, we can see that the curve does not represent gap-graded soil, and the slope is not steep enough to warrant it being poorly-graded soil either, so that means that our soil sample was more or less well-graded.



Based off of Table 5.2 in the textbook, according to the Unified Soil Classification System, since we have more than 50% retained on Sieve # 200, our soil sample is coarse grained. Furthermore, since more than 50% of the soil passed through Sieve # 4, our soil is more sandy than gravelly. Therefore, the group symbol of our sample ends up being SW, and since there is more than 15% gravel, the group name is well-graded sand with gravel. Referencing Table 5.5 in the textbook, this group is most likely equivalent to the A-1-b soil group for the AASHTO system.

Conclusion

In conclusion, this sieve analysis experiment was conducted in order for us to determine the group for our specific soil sample. The experiment went smoothly, despite the small discrepancy present in the measured soil mass. Since the mass was within 0.001 kg of the initial readings, this error had no impact on the experiment. After figuring out the percent passing and plotting it on a log scale graph, we were able to determine that our soil sample was in group SW, and more specifically well-graded sand with gravel.

$C_u, C_c = ?$
 $D_{10}, D_{60}, D_{100} = ?$

**GEOTECHNICAL ENGINEERING
SPRING 2022**

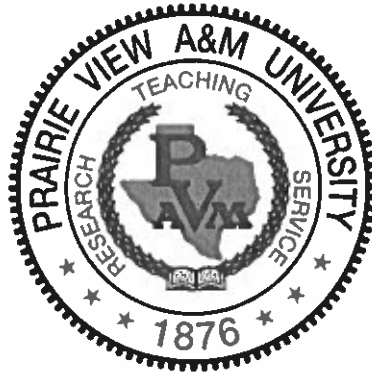
Title of Assignment: Laboratory Report 4

TOPICS COVERED IN LAB 2: Specific Gravity

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CVEG 3300 GEOTECH LABORATORY

SPRING 2022

“Specific gravity”

Conducted on

March 28th, 2022

Submitted by

Luis Guzman

Omar Hajo

Marshall Johnson

Noah Smith

Mouni Yamba

On

April 6th, 2022

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Abstract

The test performed in this lab is the Determination of Specific Gravity of soil. The specific gravity is calculated by comparing the weight in air of a specified volume of soil particles to the weight in air of an equivalent volume of distilled water at the same temperature, which in the case of this laboratory test was 23°C. For a more accurate reading a vacuum pump is used to remove the air in between the soil particles but it is not always necessary to find the specific gravity. Specific gravity typically ranges from 2.6 - 2.9. In our test, we determined that the specific gravity is 2.6, which falls within the common range.

Introduction

Specific gravity is a ratio measured between the unit weight of material, in our case soil, and the unit weight of water. Specific gravity can be used in various calculations and can be determined in a laboratory. Most values for specific gravity fall between a range of 2.6 to 2.9. To find the specific gravity of soil we will use the following equation:

$$G_s = \frac{W_s}{W_w}$$

Where,

W_s = is the weight of the soil

W_w = is the weight of water

The weight of the soil is simply measured by weighing out the amount of soil that will be used in the experiment, it can be anywhere between 100g and 120g. To find the weight of the water we used the following equation:

$$W_w = (W_1 + W_s) - W_2$$

Where,

W_1 = Weight of flask + Water filled to mark

W_2 = Weight of flask + Water filled to mark + soil

To expand the specific gravity equation out we get,

$$G_s = \frac{W_s}{(W_1 + W_s) - W_2}$$

To get a more precise calculation we can use the following:

$$G_s(20^{\circ}\text{C}) = G_s(23^{\circ}\text{C}) \times A$$

Where,

A = is the correction factor of 0.9993

This standard is referenced by the ASTM D 854 - standard test for specific gravity of soil solids.

Objective

The purpose of this laboratory test is to find the specific gravity of granular soil.

Apparatus and Material

- Volumetric flask
- Thermometer
- Balance sensitive to 0.01g
- Distilled water
- Evaporating dishes
- Spatula
- Plastic squeeze bottle

Procedure

1. Measure the mass of dry soil (W_s).
2. Clean and dry the volumetric flask.
3. Carefully fill the flask with distilled water up to 500 ml mark.
4. Measure the mass of the flask and the water filled to the 500 ml mark (W_1).
5. Insert the thermometer into the flask with the water and determine the temperature of the water $T=T_1$.
6. Put approximately 100 grams of air-dry soil into an evaporating dish, in the case of cohesive soil, add distilled water and mix it to form a smooth paste.
7. Transfer the soil or soil paste into the volumetric flask.
8. Add distilled water to the volumetric flask containing the soil/soil paste to make it above $\frac{2}{3}$ full.

9. Add distilled water to the volumetric flask until the bottom of the meniscus touches the 500 ml mark.
10. Determine the combined mass of the bottle with the soil and water (W2).
11. Pour the soil and water into the evaporating dish. Use a plastic squeeze bottle and wash the inside of the flask, making sure there is no soil left inside.

Results

The following table is the raw data from the experiment.

S. No.	Observation Number	Sample 1
1	Weight of flask + Water filled to mark, W1 (g)	338.89
2	Weight of flask + Water filled to mark + soil, W2 (g)	401.33
3	Weight of dry soil, Ws (g)	101.53
4	Weight of equal volume of water as the soil solids, Ww (g) = (W1+Ws) - W2	39.09
5	$G_s (23^{\circ}\text{C}) = W_s / W_w$	2.60
6	$G_s (20^{\circ}\text{C}) = G_s (23^{\circ}\text{C}) * A$	2.5955
7	Average Specific Gravity at 20°C	2.598

Sample calculation

?

Discussion

In this lab, we determined the specific gravity of granular soil. The specific gravity was calculated using the equation $G_s = W_s / W_w$ and the water weight equation $W_w = (W_1 + W_s) - W_2$. when the specific gravity equation is expanded $G_s = W_s / (W_1 + W_s) - W_2$. During the lab when we took the weights of the dish, the weight of the dish plus the soil and the weight of the soil we got the following; dish weight was 161.88g, dish plus soil was 263.38g, and the weight of soil which could be obtained by subtracting the dish plus soil weight by the dish weight. When that is done the soil weight came out as 101.52g and the weight of soil is W_s . when the picometer is cleaned and dried 500mL is added, the weight is measured and is W_1 . The temperature in the room was 23°C and the picometer was in the room for an extended time so the temperature of the water was assumed to also be 23°C. When approximately 100g of soil is added to the evaporating dish you get a paste, that paste is then added to a volumetric flask. While the paste was in the volumetric flask the instructor add water until the water reached 500ml and the weight was taken which equaled 401.33g W_3 . After the weight was recorded the flask was washed out and the soil and water was to be added to an evaporating dish.

Conclusion

The purpose of this laboratory test is to find the specific gravity of granular soil. In geotechnical engineering the specific gravity is calculated by comparing the weight in air of a specified volume of soil particles to the weight in air of an equivalent volume of distilled water at the same temperature. In our lab the temperature was 23°C. Through various procedural steps we found W_1 , W_2 , and W_s . when we found W_s , W_1 , and W_2 , the process of calculating G_s and W_w were just plugging in values. The lab was short and was percist, and there was not any error that greatly affected values and calculations. In the lab we can conclude that when the weight of the soil is greater than the water weight then the specific gravity will be greater.

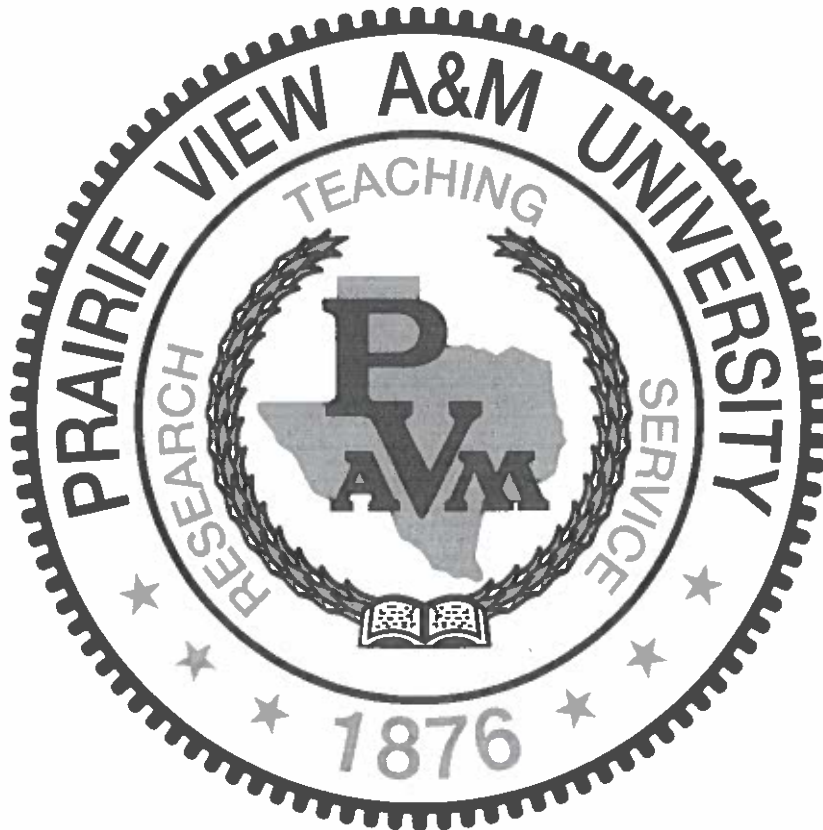
Work Cited

Das, B. M. (2014). 2.6 Specific Gravity (Gs). In 1279068300 943824023 K. Sobhan (Ed.), *Principles of Geotechnical Engineering* (Eighth ed., pp. 47-48). Stamford, CT: Cengage Learning.

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Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department

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CVEG 3023 Geotechnical Engineering Lab

Spring 2022

Laboratory 3

Determination of Specific Gravity of Soil

Conducted on March 23, 2022

By: Sanjay Tillmutter, Nyja Kennedy, Erik Smith, Omar Rafey,

Oluwa-timilehin Ogunjobi and Jonathan Warrior

To: Dr. Alam

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Objective

The objective of this experiment is to determine the specific gravity of soil solids by method. Specific gravity is the ratio of the mass of the unit volume of soil at room temperature to the mass of the same volume of distilled water at room temperature.

Apparatus

1. Volumetric flask (500ml) with stopper pipe hole
2. Thermometer graduates in 0.5 Celsius division scale.
3. Balance sensitive to 0.01 grams.
4. Distilled water
5. Bunsen Burner and Stand (and/or vacuum pump or aspirator)
6. Evaporating dishes
7. Spatula
8. Plastic squeeze bottle
9. Drying Oven

Figure 1. Volumetric Flask



Figure 2. Plastic squeeze bottle



Figure 3. Bunsen Burner

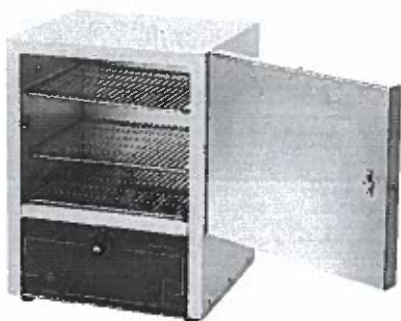


Figure 4. Evaporating dish



Test Procedure

1. Clean and dry the volumetric flask
2. Carefully fill the flask with de-aired, distilled water up to the 500 ml mark (bottom of the meniscus should be at the 500 ml mark)
3. Measure the mass of the flask and the water filled to the 500 ml mark (W1)
4. Insert the thermometer into the flask with the water and determine the temperature of the water $T = 1$ Celsius
5. Put approximately 100 grams of air dry soil into a evaporating dish
6. In the case of cohesive soil, add water (de-aired and distilled) to the soil and mix it to the form of a smooth paste. Keep it soaked for one half to one hour in the evaporating dish.
7. Transfer the soil (if Granular) or the soil paste (if cohesive) into the volumetric flask.
8. Add distilled water to the volumetric flask containing the soil (or the soil paste) to make it about two-thirds full
9. Remove the air from the soil-water mixture. This can be done by applying vacuum by a vacuum pump or aspirator until all of the entrapped air is out. Notice that this is an extremely important step. Most of the errors in the results of the test are due to entrapped air, which is not removed.
10. 10. Add de-aired, distilled water to the volumetric flask until the bottom of the meniscus touches the 500 ml mark. Also dry the outside of the flask and the inside of the neck above the meniscus
11. Determine the combined mass of the bottle plus soil plus water (W2)
12. Pour the soil and water into an evaporating dish. Use a plastic squeeze bottle and wash the inside of the flask. Make sure that no soil is left inside
13. Put the evaporating dish into an oven to dry to a constant weight.
14. Determine the mass of the dry soil in the evaporating dish (Ws).

Data and Results

S. No	Observation No.	Measurements (grams)
1	Weight of flask + Water filled to 500 ml mark (W1)(g)	338.89
2	Weight of the flask + water filled to mark +soil (W2)(g)	401.33
3	Weight of dry soil (W3) (g)	101.52
4	Weight of equal volume of water (Ww)(g)=(W1+W3)-W2	39.08
5	Weight disk	161.89
6	Weight of dish+ soil	263.38
7	Specific Gravity Gs(T1 Celsius)=Ws/w	2.6

$W_s = \text{Weight of dish + soil} - \text{Weight of dish}$

$$W_s = 263.38 - 161.89 = 101.52$$

$$W_w = (W_1 + W_3) - W_2$$

$$W_w = (338.89 + 101.52) - 401.33 = 39.08$$

$$G_s(T_1 \text{ celsius}) = W_s / W_w$$

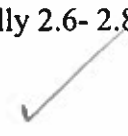
$$G_s(T_1 \text{ Celsius}) = 101.59 / 39.08 = 2.6$$

Results

The specific gravity was calculated to be 2.6

Conclusion

The objective of this experiment was to determine the specific gravity of the experiment and it was found to be 2.6. The specific gravity is important for finding the degree of the saturation, void ratio, and weight of the moist soils. The specific gravity of the soil is generally 2.6- 2.8.



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Prairie View A&M University

College of Engineering

Department of Civil & Environmental Engineering



CVEG 3300 P01 Geotechnical engineering

LABORATORY REPORT ON

“Specific Gravity”

Conducted on

March 23rd, 2022

Submitted by: Group 1

Trinity Scott

Tyrah Owens

Hunter Rodgers

Antonio Little

On

April 6th , 2022

To

Dr. J. Alam

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Introduction: The specific gravity of soils can be described as the mass of unit volume of the soil solids compared to the mass of water at the same volume. Knowing the specific gravity of soil can help understand how porous the soil is or how many voids it contains. It can also be used to help determine the dry and saturated density as well as the degree of saturation.

Objective: The objective of this lab experiment is to determine the specific gravity of the soil using the density bottle method.

Apparatus:

1. Volumetric flask
2. Thermometer graduated in 0.5°C division scale.
3. Balance sensitive to 0.01 g.
4. Distilled water.
5. Bunsen burner and a stand (and/or vacuum pump or aspirator)
6. Evaporating dishes
7. Spatula
8. Plastic squeeze bottle
9. Drying oven

Procedure:

- 1.) Clean and dry the volumetric flask.
- 2.) Carefully fill the flask with de-aired, distilled water up to the 500 ml mark (bottom of the meniscus should be at the 500 ml mark).
- 3.) 3. Measure the mass of the flask and the water filled to the 500 ml mark (W1)
- 4.) Insert the thermometer into the flask with the water and determine the temperature of the water $T=T1$ oC
- 5.) Put approximately 100 grams of air-dry soil into an evaporating dish.
- 6.) In the case of cohesive soil, add water (de-aired and distilled) to the soil and mix it to the form of a smooth paste. Keep it soaked
- 7.) Transfer the soil (if Granular) or the soil paste (if cohesive) into the volumetric flask.
- 8.) Add distilled water to the volumetric flask containing the soil (or the soil paste) to make it about Two-thirds full.
- 9.) Remove the air from the soil-water mixture. This can be done by applying vacuum by
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- 11.) Determine the combined mass of the bottle plus soil plus water (W2).
- 12.) Pour the soil and water into an evaporating dish. Use a plastic squeeze bottle and wash the inside of the flask. Make sure that no soil i
- 13.) Put the evaporating dish into an oven to dry to a constant weight.
- 14.) Determine the mass of the dry soil in the evaporating dish (Ws).

Data presentation and Results

S. No.	Observation Number	1
1	Weigh of flask + Water filled to mark W1 (g)	496.4 g
2	Weigh of flask + Water filled to mark + soil (g) W2	715g
3	Weight of dry soil (g), Ws	245.6 g
4	Weight of equal volume of water as the soil solids, Ww (g) = (W1 +Ws) - W2	27g
5	$G_s(T1 ^0 C) = W_s/W_w$	9.09
6	$G_s (20 ^0 C) = G_s(T1 ^0 C) * A$	9.09
7	Average specific gravity at 20 C	9.09

Sample Calculations:

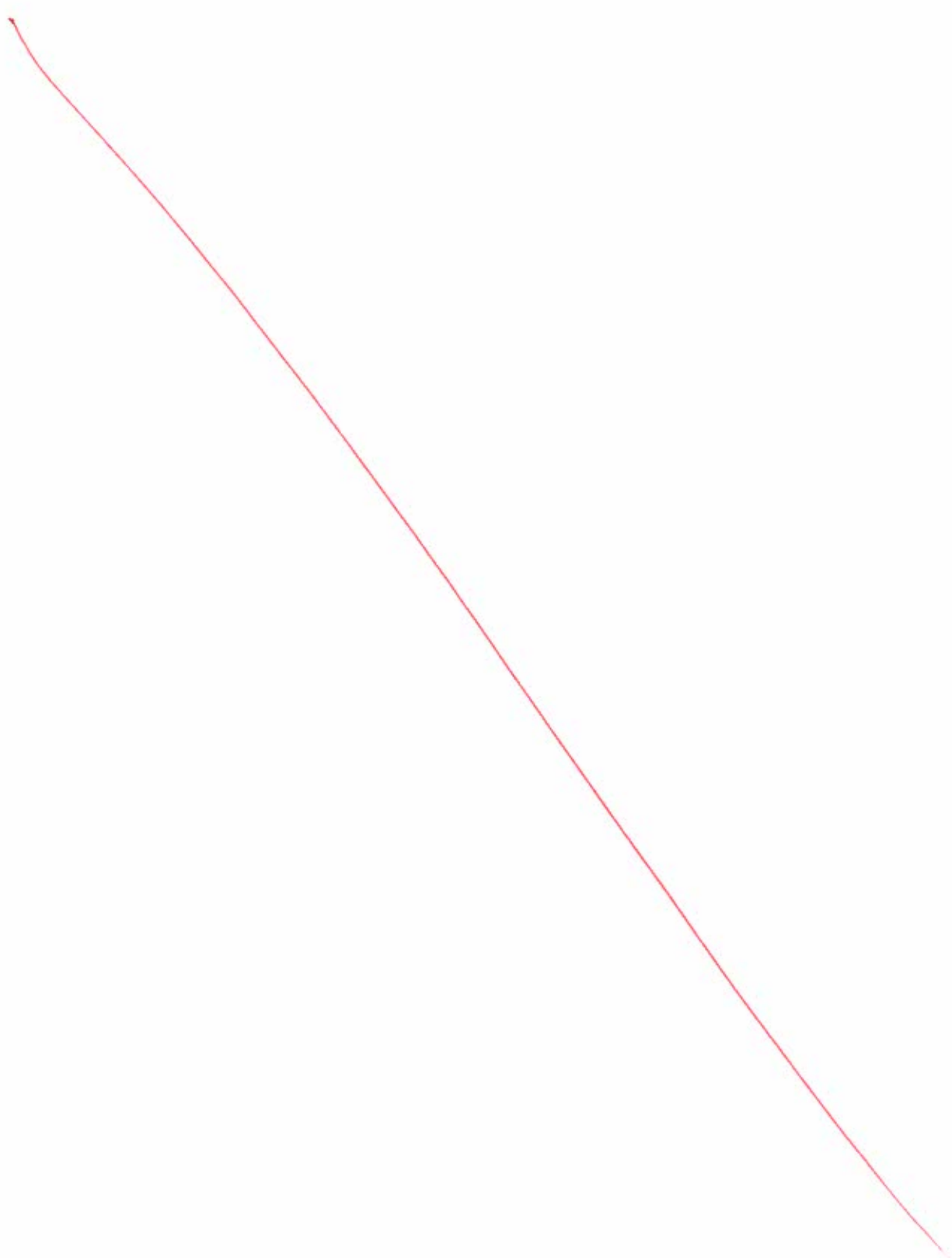
$$W_w = (496.4 + 245.6) - 715$$

$$G_s (T1 ^0 C) = 245.6 / 27$$

$$G_s (20 ^0 C) = 9.09 \times 1.000$$

Discussion: In the collected data, it was found that the weight of equal volume of water as the soil solids was equal to 27 grams. The specific gravity at zero degrees Celsius was calculated to be 9.09 and this value was consistent when the temperature is 20 degrees Celsius.

Conclusion: The determination of specific gravity is a test to measure the mass of solids and the mass of water in soil and compare them at the same volume. Determining the specific gravity of soil helps engineers get a understanding the soil density, voids, and other soil properties. It can be concluded that the lab objective was met. The specific gravity of the soil sample was calculated to be 9.09.



GEOTECHNICAL ENGINEERING SPRING 2022

Title of Assignment: Assignment 1

TOPICS COVERED IN ASSIGNMENT 1:

1. Wet-Volume Relationship

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR HW 1**

CVEG 3023
Geotechnical Engineering
Spring 2020

Assignment-1

Department of Civil & Environmental Engineering
Prairie View A&M University



Problem 1

The moist unit weight of a soil is 105 lb/ft^3 . Given that $w = 15\%$ and $G_s = 2.7$, determine

- Dry unit weight
- Porosity
- Degree of saturation
- Weight of water, in lb/ft^3 , to be added to reach full saturation

Problem 2

The saturated unit weight of a soil is 126 lb/ft^3 . The moisture content of the soil is 18.2% . Determine the following:

- Dry unit weight
- Void ratio
- Specific gravity of soil solids

Problem 3

A sand with $G_s = 2.66$ and $e = 0.60$ is completely dry. It then becomes wetted by a rising groundwater table. Compute the unit weight (lb/ft^3 or kN/m^3) under the following conditions:

- When the sand is completely dry
- When the sand is 40 percent saturated
- When the sand is completely saturated

Problem 4

A dry sand is placed in a container having a volume of 0.30 ft^3 . The dry weight of the sample is 31 lb . Water is carefully added to the container so as not to disturb the condition of the sand. When the container is filled, the combined weight of soil plus water is 38.2 lb . From these data, compute the void ratio of the soil in the container and the specific gravity of the soil particles. Also, determine the wet and dry unit weights, in kN/m^3 and pcf .

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Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department



CVEG 3300 P01 – Geotechnical Engineering

Spring 2022

Homework #1

Maalvika Aggarwal

Dr. Md Jobair Bin Alam

Date Submitted: 02 February 2022

Problem 1

The moist unit weight of a soil is 105 lb/ft^3 . Given that $w = 15\%$ and $G_s = 2.7$, determine

- Dry unit weight
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Problem 1

Given: $\gamma = 105 \text{ lb/ft}^3$, $w = 15\%$, $G_s = 2.7$

Find: a) ρ_d , b) γ , c) S , d) W_{water}

Approach:

$$a) \gamma_d = \frac{\gamma}{1+w} = \frac{105}{1+0.15} = \boxed{91.304 \text{ lb/ft}^3}$$

$$b) \gamma_d = \frac{G_s \cdot \gamma_w}{1+e} = 91.304 = (2.7)(62.4) - 91.304$$

$$e = 0.845$$

$$\text{So, } \gamma = \frac{e}{1+e} = \frac{0.845}{1+0.845} = \boxed{0.458}$$

$$c) S_e = w G_s$$

$$S = \frac{w G_s}{e} = \left(\frac{(0.15)(2.7)}{0.845} \right) 100$$

$$S = (0.4791)(100)$$

$$\boxed{S = 47.91\%}$$

$$d) \gamma_{\text{sat}} = \frac{(G_s + e) \gamma_w}{1+e} = \frac{(2.7 + 0.845) 62.4}{1+0.845}$$

$$\gamma_{\text{sat}} = 119.88 \text{ lb/ft}^3$$

Now,

$$\begin{aligned} W_w &= \gamma_{\text{sat}} - \gamma_d \\ &= 119.88 - 105 \\ &= 14.89 \text{ lb/ft}^3 \end{aligned}$$

$$\text{So, } W_w = \boxed{14.89 \text{ lb/ft}^3}$$

Problem 2

Given: $\gamma_{sat} = 126 \text{ lb/ft}^3$, $w = 18.2\%$

Find: a) γ_d b) e c) G_s

Approach:

$$a) \gamma_d = \frac{\gamma_{sat}}{1+w} = \frac{126}{1+0.182} = \boxed{106.59 \text{ lb/ft}^3}$$

$$b) \gamma_{sat} = \left(\frac{1+w}{1+wG_s} \right) G_s \gamma_w$$

$$126 = \left[\frac{1+0.182}{1+0.182G_s} \right] 62.4 G_s$$

$$126 + 22.93G_s = 73.756G_s$$

$$50.825G_s = 126$$

$$\boxed{G_s = 2.479}$$

c) Since the soil is saturated,

$$e = wG_s$$

$$e = (0.182)(2.479)$$

$$\boxed{e = 0.451}$$

Problem 3

Given: $G_s = 2.66$, $e = 0.60$

Find: γ @ a) sand is dry b) $S = 40\%$ c) Completely saturated

Approach:

a) $S = 0$

$$\gamma_d = \frac{G_s \gamma_w}{1+e} = \frac{(2.66)(9.81)}{1+0.60}$$

$$\gamma_d = 16.309 \text{ kN/m}^3$$

b) $S = 40\% = 0.40$

$$\gamma = \frac{(G_s + Se) \gamma_w}{1+e} = \frac{[2.66 + (0.40 \times 0.60)] 9.81}{1+0.60}$$

$$\gamma = 17.781 \text{ kN/m}^3$$

c) $S = 100\%$

$$\gamma_{sat} = \frac{(G_s + e) \gamma_w}{1+e} = \frac{(2.66 + 0.6) 9.81}{1+0.60}$$

$$\gamma_{sat} = 19.988 \text{ kN/m}^3$$

Problem 4

Given: $V = 0.3 \text{ ft}^3$, $W_d = 31 \text{ lb}$, $W_{\text{sat}} = 38.2 \text{ lb}$

find: G_s , e , γ , γ_d in KN/m^3 & pcf

approach:

$$\gamma_d = \frac{W_d}{V} = \frac{31}{0.3} = 103.33 \text{ lb/ft}^3$$

$$w = \left[\frac{W_{\text{sat}} - W_{\text{dry}}}{W_{\text{dry}}} \right] 100 = \left[\frac{38.2 - 31}{31} \right] 100 = 23.22\%$$

Now, $S_e = w G_s$

$$\text{So, } (1)(e) = (0.232) G_s \quad (S = 1 \text{ for fully saturated soil})$$

$$\text{So, } e = 0.232 G_s \quad \text{--- (1)}$$

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

$$103.33 = \frac{(G_s)(62.4)}{1 + e} = \frac{(G_s)(62.4)}{1 + 0.232 G_s} \quad \text{from (1)}$$

$$103.33 + 23.973 G_s = 62.4 G_s$$

$$G_s = 2.6891$$

$$\text{Therefore, } e = 0.232 G_s = (0.232)(2.6891)$$

$$e = 0.6238$$

$$\gamma_{\text{wet}} = \frac{W_{\text{wet}}}{V} = \frac{38.2}{0.3} = 127.33 \text{ lb/ft}^3$$

$$1 \text{ lb/ft}^3 = 0.1571 \text{ KN/m}^3$$

$$\text{Hence, } \gamma_d = (103.33)(0.1571) = 16.232 \text{ KN/m}^3$$

$$\gamma_{\text{wet}} = (127.33)(0.1571) = 20.002 \text{ KN/m}^3$$

AVERAGE

Daniel Grant
2/1/2022

88/
100

CVEG 3023
Geotechnical Engineering
Spring 2020

Assignment-1

Department of Civil & Environmental Engineering
Prairie View A&M University



Problem 1

The moist unit weight of a soil is 105 lb/ft^3 . Given that $w = 15\%$ and $G_s = 2.7$, determine

- Dry unit weight
- Porosity
- Degree of saturation
- Weight of water, in lb/ft^3 , to be added to reach full saturation

Problem 2

The saturated unit weight of a soil is 126 lb/ft^3 . The moisture content of the soil is 18.2% . Determine the following:

- Dry unit weight
- Void ratio
- Specific gravity of soil solids

Problem 3

A sand with $G_s = 2.66$ and $e = 0.60$ is completely dry. It then becomes wetted by a rising groundwater table. Compute the unit weight (lb/ft^3 or kN/m^3) under the following conditions:

- When the sand is completely dry
- When the sand is 40 percent saturated
- When the sand is completely saturated

Problem 4

A dry sand is placed in a container having a volume of 0.30 ft^3 . The dry weight of the sample is 31 lb . Water is carefully added to the container so as not to disturb the condition of the sand. When the container is filled, the combined weight of soil plus water is 38.2 lb . From these data, compute the void ratio of the soil in the container and the specific gravity of the soil particles. Also, determine the wet and dry unit weights, in kN/m^3 and pcf .

unit weight of soil = 105 lb/ft^3

$$W = 15\%$$

$$G_s = 2.7$$

- A) Dry unit weight

$$\gamma_d = \frac{\gamma}{1+W} = \frac{105}{1+0.15} = \boxed{91.304 \text{ lb/ft}^3} \checkmark$$

- B) porosity

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

$$91.304 = \frac{2.7 \times 62.4}{1+e}$$

$$\therefore e = 0.85$$

$$n = \frac{e}{1+e} = \frac{0.85}{1+0.85} = \boxed{0.46} \checkmark$$

- C) Degree of saturation

$$S_r$$

$$e \cdot S_r = w G_s$$

$$0.85 \times S_r = 0.15 \times 2.7$$

$$S_r = 0.48 = \boxed{48\%} \checkmark$$

— D) weight of water, in lb/ft^3 , to be added to reach full saturation

$$\gamma_{\text{sat}} = \frac{(G + e) \cdot \gamma_w}{1 + e} = \frac{(2.7 + 0.85) \times 62.4}{1 + 0.85}$$

$$\gamma_{\text{sat}} = 119.74 \text{ lb/ft}^3$$

$$e \cdot S_r = w \times G$$

$$0.85 \times 1 = w \times 2.7$$

$$w = 0.315$$

$$w = 31.5\%$$

for full saturation

$$S_r = 1$$

$$\text{water to be added} = 31.5 - 15 = 16.5\%$$

$$\text{In } w = \frac{16.5}{100} \times \gamma_d = \frac{16.5}{100} \times 91.304$$

$$= 15.065 \text{ lb/ft}^3$$



unit weight of a soil = 126 lb/ft^3

moisture content of soil = 18.2%

A). Dry unit weight

$$\text{Dry density, } \gamma_d = \frac{\gamma_{\text{sat}}}{1+w}$$

$$= \frac{126}{1+(18.2/100)} = \boxed{106.6 \text{ lb/ft}^3} \checkmark$$

B). Void ratio

From the relation, $e \cdot S = w \cdot G_s$

Here $S=1 \Rightarrow$ void ratio, $e =$

$$0.182 \times 2.479$$

$$= \boxed{0.451} \checkmark$$

C) specific gravity of soil solids
Dry

For saturated sample,
Unit weight of water,

$$106.6 = \frac{G_s \times 62.4}{1 + \frac{0.182 G_s}{1}}$$

$$106.6 + 19.40 G_s = 62.4 G_s \Rightarrow G_s = \frac{106.6}{62.4 - 19.40} = 2.479 = \boxed{2.48} \checkmark$$

Sand with $G_s = 2.66$

$e = 0.60$ / completely dry

compute the unit weight (lb/ft³ or kN/m³)

A). When sand is completely dry
the unit weight of soil is given by

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

γ_w = unit weight of water
= 9.81 kN/m^3

$$\gamma_d = \frac{G_s \times 9.81}{1+e} = \frac{2.66 \times 9.81}{1+0.60}$$

$$\gamma_d = 16.309 \text{ kN/m}^3$$

B) when the sand is 40 percent saturated
Sand is partially saturated
($S = 40\%$)

S = degree of saturation
= 40%
= 0.40

$$\gamma_t = \frac{(G_s + eS) \gamma_w}{1+e}$$

$$\gamma_t = \frac{(2.66 + 0.60 \times 0.40) \times 9.81}{1 + 0.60}$$

$$\gamma_t = 17.780 \text{ kN/m}^3$$

c) when the sand is completely saturated

$$S = 100\% \text{ or } S = 1$$

$$\gamma_{sat} = \frac{(G + e) \gamma_w}{1 + e}$$

$$= \frac{(2.66 + 0.66) \times 9.81}{1 + 0.66}$$

$$\gamma_{sat} = 19.987 \text{ kN/m}^3 \quad \checkmark$$

volume of soil = 0.30 ft^3
 ↓
 dry → in container

The dry weight of the sample is 31 lb

When container is filled, the combined weight of soil plus water is 38.2 lb

determine the wet and dry unit weights, in KN/m^3 and pcf .

-6
 A). to find the void ratio of the soil in the container

Density of water, $\rho_w = 62.4 \text{ lb/ft}^3$

$$\begin{aligned} \text{volume of water added} &= \frac{\text{mass of water}}{\text{Density of water}} \\ &= \frac{38.2 \text{ lb} - 31 \text{ lb}}{62.4 \text{ lb/ft}^3} \\ &= \frac{3}{26} \text{ lb/ft}^3 \end{aligned}$$

$$\text{void ratio} = \frac{\text{volume of voids, } V_v}{\text{Volume of the dry solids, } V_s}$$

$$\begin{aligned} \text{volume of voids, } V_v &= \text{volume of water added} \\ &= \frac{3}{26} \text{ lb/ft}^3 \end{aligned}$$

$$\begin{aligned} \text{volume of the dry solids, } V_s &= \text{volume of the container} \\ &= \underline{0.3 \text{ ft}^3} \end{aligned}$$

$$\text{void ratio, } e = \frac{\frac{3}{26}}{0.03} = \frac{5}{13} = \boxed{0.385}$$

b) ^{sub} specific gravity of the soil, G_s , is

$$G_s = \frac{m_s}{V_s \times \rho_w}$$

$$\gamma_d = \frac{G_s \gamma_w^{\text{found}}}{1+e} \quad S_e = W G_s$$

$$G_s = \frac{31}{0.3 \times 62.4} = \frac{775}{468} = 1.656$$

The specific gravity of the soil, G_s = $\boxed{1.656}$

c) when void spaces are filled with water, the wet unit weight is given

$$\gamma_t = \gamma_{\text{wet}} = \frac{W_s + W_w}{V} = \frac{38.216}{0.3 \text{ ft}^3} = 127.316/\text{ft}^3$$

The wet unit weight, $\gamma_{\text{wet}} = \underline{127.316/\text{ft}^3}$ ✓

The dry unit weight, γ_d

$$\gamma_d = \frac{W_s}{V} = \frac{3116}{0.3 \text{ ft}^3} = 103.516/\text{ft}^3$$

The dry unit weight = $\gamma_d = \boxed{103.316/\text{ft}^3}$ ✓

in KN/m^3 ??

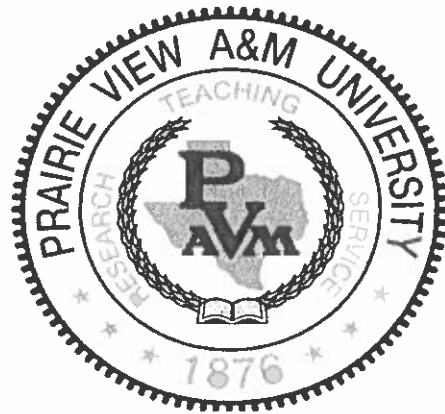
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Prairie View A&M University

College of Engineering

Department of Civil & Environmental Engineering



CVEG 3300: Geotechnical Engineering

Homework 1

Submitted by: Luis Guzman

Submission Date: 02/02/2022

Professor: Dr. Jobair Bin Alam

1) given
weight of soil 105 lb/ft³

$$w = 15\% \quad G_s = 2.7$$

a) Dry unit weight

$$\gamma_d = \frac{\gamma_o}{1+w}$$

$$\gamma_d = \frac{105}{1+0.15} = \boxed{91.304 \text{ lb/ft}^3} \quad \checkmark$$

b) Porosity

$$n = \frac{e}{1+e}$$

$$n = \frac{0.845}{1+0.845}$$

$$n = 45.8\% \quad \checkmark$$

$$1+e = \frac{2.7 \times 64.4}{91.304}$$

$$e = \frac{2.7 \times 64.4}{91.304} - 1$$

$$e = 0.845 \quad \checkmark$$

c) Degree of Saturation

$$S_e = G_s \cdot w$$

$$S(0.845) = 2.7 \times 0.15$$

$$S = \frac{2.7 \times 0.15}{0.845}$$

$$S = 0.475 \rightarrow \boxed{47.9\%} \quad \checkmark$$

-b

X d) weight of water

Saturated 100% = 1

$$\text{porosity } n = \frac{V_v}{V_{\text{total}}} \times 100$$

$$45.8 = \frac{V_v}{1} \times 100$$

$$V_v = 45.8 / 100 = 0.458 \text{ ft}^3$$

→
cont.

Void ratio $\frac{V_v}{V_s} \times 100$

$$84.5 = \frac{V_v}{V_s} \times 100$$

$$84.5 = \frac{0.458}{V_s} \times 100 = V_s = \frac{0.458 \times 100}{84.5}$$

$$V_s = 0.542 \text{ ft}^2$$

$$G_s = \frac{V_s}{V_w} = V_s = G_s \cdot V_w =$$

$$2.7 \times 62.4 = 168.48 \text{ lb/ft}^3$$

$$V_s = \frac{W_s}{V_s} \Rightarrow V_s \cdot V_s = (168.48)(0.542)$$

$$W_s = 91.316 \text{ lb/ft}^3$$

$$24 \times 60 \times 60 = 151(n-1)15$$

$$(1 \times 0.845) = (2.7) \times w$$

$$w = \frac{0.845}{2.7} = 0.3129 = 31.29\%$$

$$w = 31.29\%$$

$$w = \frac{W_w}{W_s} = \frac{W_w}{91.316} = 91.316 \times w$$

$$W_w = 91.316 \times 0.3129 = 28.5715 \text{ lb/ft}^3$$

$$\gamma_{sat} = \frac{(G_s + e) \gamma_w}{1 + e}$$

$$W_w = \gamma_{sat} - \gamma_d$$

a) saturated unit weight of soil 126 lb/ft³
moisture content 18.2%

a) Dry density

$$\gamma_d = \frac{\gamma_{sat}}{1+w} = \frac{126}{1+(18.2/100)} = 106.6 \text{ lb/ft}^3 \quad \checkmark$$

b) Specific Gravity

$$S = 1 \quad \gamma_d = \frac{G_s \gamma_w}{1 + \frac{G_s w}{S}}$$

$$\gamma_w = 62.4 \text{ lb/ft}^3$$

$$106.6 = \frac{G_s \times 62.4}{1 + \frac{G_s \times 18.2}{1}}$$

$$106.6 + 19.40 G_s =$$

$$62.4 G_s$$

$$G_s = \frac{10.6}{62.4 - 19.40} = 2.479 \quad \checkmark$$

c) Void Ratio

$$e \cdot S = w \cdot G_s$$

$$e = 0.182 \times 2.479 = 0.451 \quad \checkmark$$

3) given

Sand $G_s = 2.66$ $e = 0.60$ (completely dry)

Unit weight of water 9.81 kN

a) when completely dry

$$\gamma_d = \frac{G_s \gamma_w}{1+e} = \frac{G_s \times 9.81}{1+e} = \frac{2.66 \times 9.81}{1+0.60}$$

$$\boxed{\gamma_d = 16.309 \text{ kN/m}^3} \checkmark$$

b) when sand is 40 percent saturated

$$\gamma_t = \frac{G_s + eS}{1+e} \gamma_w$$

$$\gamma_t = \frac{(2.66 + 0.60 \times 0.40) \times 9.81}{1+0.60}$$

$$\boxed{\gamma_t = 17.780 \text{ kN/m}^3} \checkmark$$

c) Sand completely saturated

$$\gamma_{sat} = \frac{(G + e) \gamma_w}{1+e}$$

$$= \frac{2.66 + 0.60 \times 9.81}{1+0.60}$$

$$\boxed{\gamma_{sat} = 19.987 \text{ kN/m}^3} \checkmark$$

Problem 4 X

given :

$$Vol = 0.30 \text{ m}^3 = 0.00085$$

$$\text{weight} \cdot 3116 = 1408 \text{ kg}$$

$$\text{dry Sol} + \text{water} = 38.216$$

$$\text{mass of water} = 1734 - 1408 = 326 \text{ kg}$$

Density of water

$$1000 \text{ kg/m}^3$$

$$\text{Volume} = 0.0033 \text{ m}^3$$

$$e = \frac{V_v}{V_s} = \frac{0.0033}{0.0085}$$

$$e = 0.39$$

specific gravity

$$\frac{\text{density of Sol}}{\text{d. of water}}$$

$$= \frac{1408 / 0.0085}{1000} = 1.656$$

$$\text{dry unit weight} = \frac{G \cdot \gamma_w}{1 + e} = \frac{1.656 \cdot 9.81}{1 + 0.39} = 11.6873 \text{ kN/m}^3$$

$$\text{water content} = \frac{m_w}{m_s} = \frac{326}{1408} = 0.2315 \approx 23.15\%$$

$$\text{wet unit weight} = \text{dry (Hw)}$$

$$11.6873(1 + 0.2315)$$

$$= 14.392909 \text{ kN/m}^3$$

GEOTECHNICAL ENGINEERING SPRING 2022

Title of Assignment: Assignment 2

TOPICS COVERED IN ASSIGNMENT 2:

1. Sieve Analysis

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR HW 2**

CVEG 3300
Geotechnical Engineering
Spring 2022

Assignment-2

Department of Civil & Environmental Engineering
Prairie View A&M University



Use the following format for all your homework: Hard copy of your assignment is required in the class.

1. Your homework should be complete, neat, and professionally presented.
2. Use only engineering paper (no graph paper) for submitting your homework.
3. Your homework should have the following on top of the first sheet
4. Your name and Roster Number
5. Course prefix, number, section, and title
6. Homework number
7. Date Given
8. Date Due
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11. Show all steps for arriving to the final answer clearly. Include all appropriate sketches.
12. Reference all figures, tables, constant values, equations, and conversions used to complete the problem.
13. Include all the appropriate units throughout the solution. Points will be deducted for answers presented without the appropriate units.
14. Start a new page for every new problem.
15. Problems should be in the order assigned.

Problem 1

During a hydrometer analysis a soil with a $G_s = 2.60$ is immersed in a water suspension with a temperature of 24°C . An $R = 43$ cm is obtained after 60 minutes of sedimentation. What is the diameter D of the smallest-size particles that have settled during that time? Is it silt or clay?

Problem 2

The following are the results of a sieve analysis:

U.S. sieve no.	Mass of soil retained (g)
4	28
10	42
20	48
40	128
60	221
100	86
200	40
Pan	24

Determine the following:

- Prepare the Table to determine the percent finer of each sieve and plot a grain-size distribution curve (using MS Excel).
- Determine D_{10} , D_{30} , and D_{60} from the grain-size distribution curve.
- Calculate the uniformity coefficient, C_u .
- Calculate the coefficient of gradation, C_c .

Problem 3

The grain-size characteristics of a soil are given in the following table.

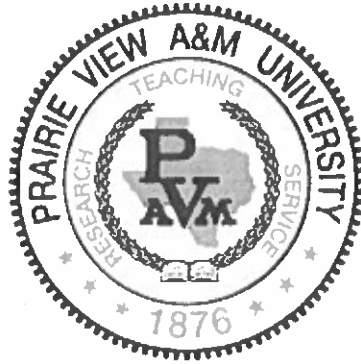
Size (mm)	Percent finer
0.425	100
0.1	92
0.052	84
0.02	62
0.01	46
0.004	32
0.001	22

- Draw the grain-size distribution curve.
- Determine the percentages of gravel, sand, silt, and clay according to the AASHTO/USCS system.

ABOVE AVERAGE

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Civil & Environmental Engineering Department



CVEG 3300 P01 – Geotechnical Engineering

Spring 2022

Homework #2

Maalvika Aggarwal

Dr. Md Jobair Bin Alam

Date Given: 03 February 2022

Date Submitted: 09 February 2022

Problem 1

During a hydrometer analysis a soil with a $G_s = 2.60$ is immersed in a water suspension with a temperature of 24°C . An $R = 43$ cm is obtained after 60 minutes of sedimentation. What is the diameter D of the smallest-size particles that have settled during that time? Is it silt or clay?

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- Draw the grain-size distribution curve.
- Determine the percentages of gravel, sand, silt, and clay according to the AASHTO/USCS system.

Problem 1

Given: $G_s = 2.60$, $T = 24^\circ\text{C}$, $R = 43\text{ cm}$, $t = 60\text{ mins}$

Find: Diameter, D

Approach:

$$\text{We know, } D_{(\text{mm})} = K \sqrt{\frac{h(\text{cm})}{t(\text{min})}}$$

So,

$$K = 0.0132 \quad \left\{ \text{Table 2.6, Principles of Geotech engr} \right\}$$

$$\text{Also, } h = 9.2\text{ cm} \quad \left\{ \text{Table 2.7, Principles of Geotech engr} \right\}$$

$$D = 0.0132 \sqrt{\frac{9.2}{60}} \quad \checkmark$$

$$D = 0.005169$$

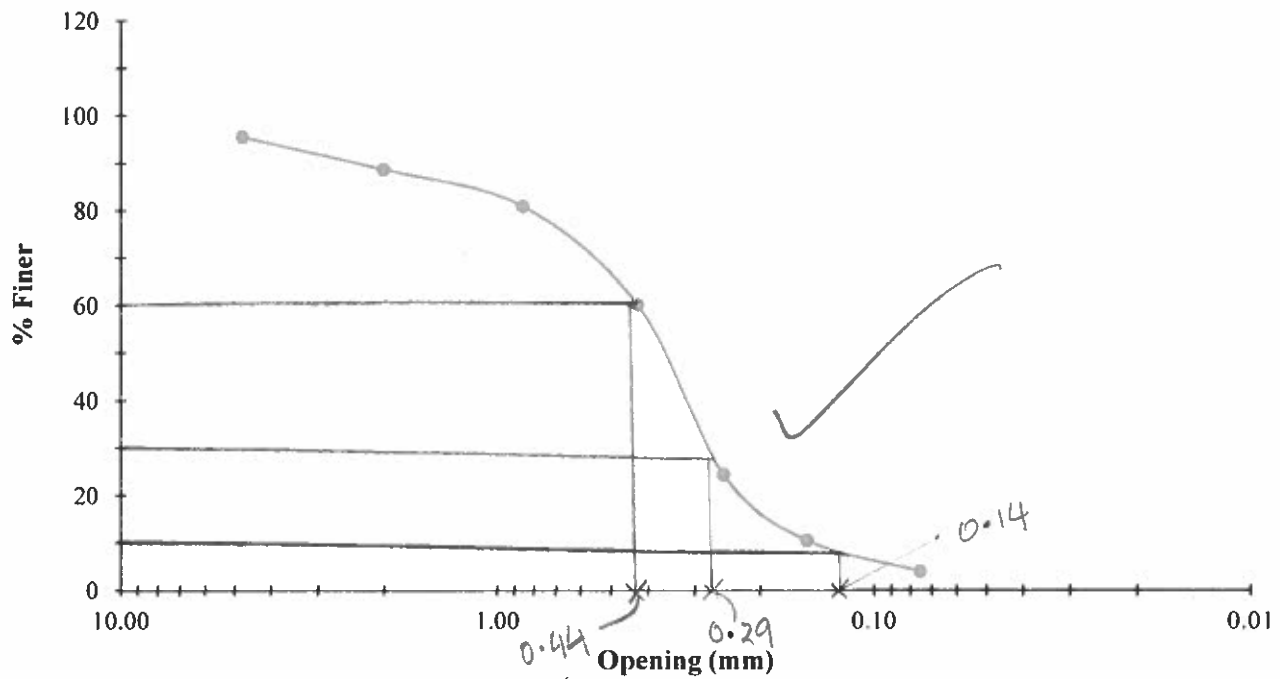
$$D = 5.169 \times 10^{-3}\text{ mm} \quad \checkmark$$

Is it silt or clay? (-5)

It is a silt

PROBLEM 2

Sieve #	Opening (mm)	Mass of Soil Retained (gm)	% Retained (%) [Mass of Soil/Total]*100	Cummalative % Retained (%)	% Finer (%) [100-Cumm % Retained]	
4	4.750	28	4.538	4.538	95.462	✓
10	2.000	42	6.807	11.345	88.655	✓
20	0.850	48	7.780	19.125	80.875	✓
40	0.425	128	20.746	39.870	60.130	✓
60	0.250	221	35.818	75.689	24.311	✓
100	0.150	86	13.938	89.627	10.373	✓
200	0.075	40	6.483	96.110	3.890	✓
Pan		24	3.890	100.000	0.000	✓
TOTAL		617				

Grain Size Distribution Curve

Problem 2 (continue)

b) From the graph attached on page 2,

$$D_{10} = 0.14 \text{ mm} \checkmark$$

$$D_{30} = 0.29 \text{ mm} \checkmark$$

$$D_{60} = 0.44 \text{ mm} \checkmark$$

} Estimated }

$$c) C_u = \frac{D_{60}}{D_{10}} = \frac{0.44}{0.14}$$

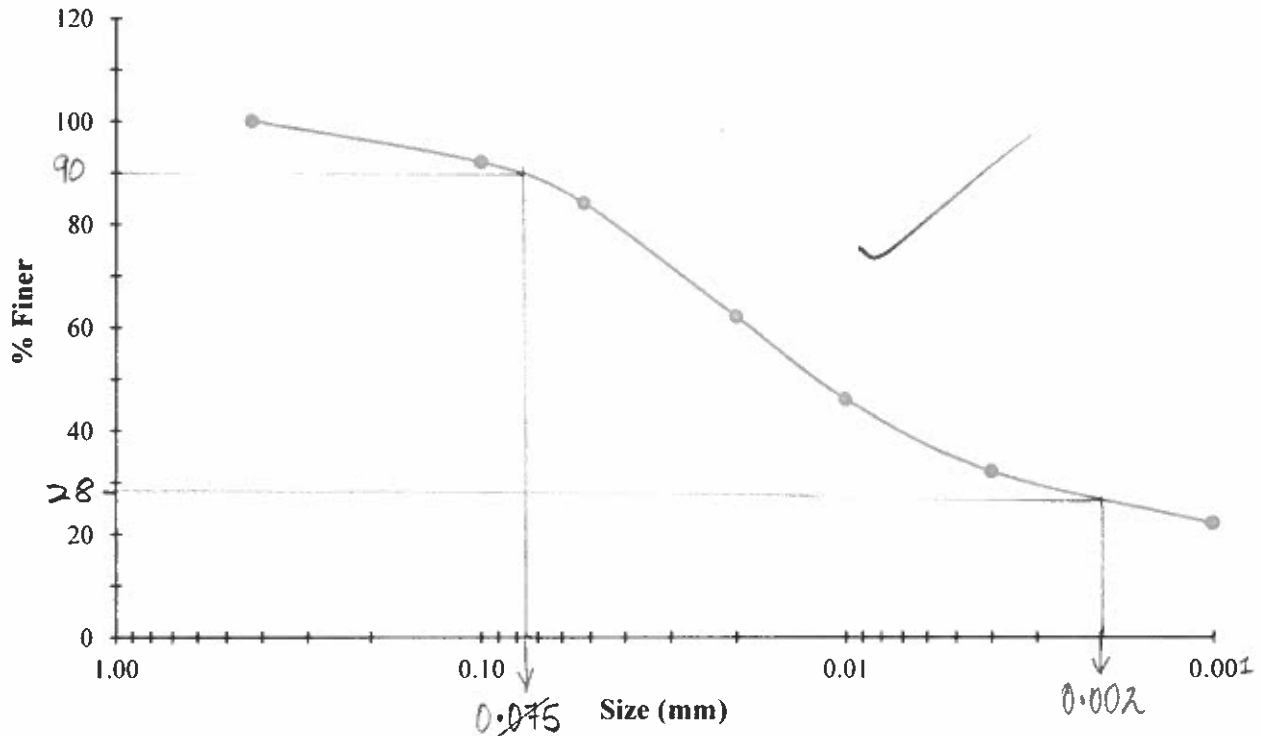
$$\boxed{C_u = 3.14} \checkmark \text{ [uniformity coefficient]}$$

$$d) C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.29^2}{(0.44)(0.14)} = 1.36$$

$$\boxed{C_c = 1.36} \checkmark \text{ [coefficient of gradation]}$$

PROBLEM 3

Opening (mm)	% Finer (%)
0.425	100
0.1	92
0.052	84
0.02	62
0.01	46
0.004	32
0.001	22

Grain Size Distribution Curve

Problem 3 (Continue)

Given:-	Size (mm)	Percent finer
	0.425	100
	0.1	92
	0.075	84
	0.02	62
	0.01	46
	0.004	32
	0.001	22

b) According to the attached graph, based on ASTM system

for 2mm, % finer = 100 %

for 0.075 mm, % finer = 90 %

for 0.002 mm, % finer = 28 %

So, %age of Gravel = $100 - 100 = 0 %$

%age of Sand = $100 - 90 = 10 %$ ✓

%age of Silt = $90 - 28 = 62 %$ ✓

%age of Clay = $28 - 0 = 28 %$ ✓

According to attached graph, based on USCS system

For 4.75 mm, % finer = 100 %

For 0.075 mm, % finer = 90 %

% age of gravel = $100 - 100 = 0\%$

% age of sand = $100 - 90 = 10\%$

% age of silt & clay = $90 - 0 = 90\%$

% silt = ?

% clay = ?

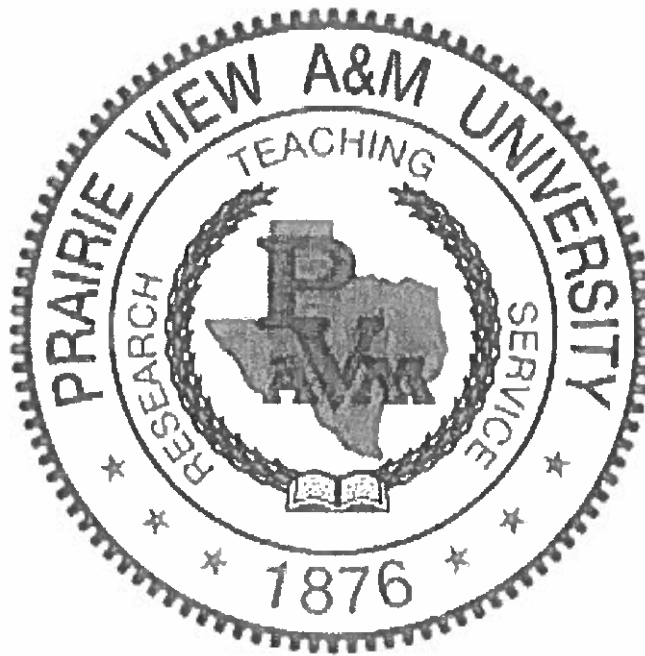
(-5)

silt = 62%

clay = 28%

AVERAGE

Prairie View A&M University
College of Engineering
Department of Civil & Environmental Engineering



HW #2
Geotechnical Engineering
CVEG 3300 P01

Submitted by: Denia Leroy
Submitted to: Dr. Alam
Date given: 2/3/2022
Due Date: 2/9/2022

HW #2

Problem 1

hydrometer Analysis

given:

$$G_s = 2.60, T = 24^\circ\text{C}, R = 43\text{cm}, t = 60\text{min}$$

$$K = 0.01321 \quad L = 9.2\text{cm}$$

Table 2.9 Table 2.10

Find:

 D_{mm}

$$D_{mm} = K \sqrt{\frac{L(\text{cm})}{t(\text{min})}}$$

$$0.01321 \sqrt{\frac{9.2\text{ cm}}{60\text{ min}}}$$

$$D_{mm} = 0.005\text{mm} < 0.002\text{mm}$$

Silt ✓

Denia Leroy

CEG 3300 PO1

2/9/2022

Problem 2

U.S. sieve no. Mass of soil retained (g)

4	28
10	42
20	48
40	128
60	221
100	86
200	40
Pan	24

a)

a	b	c	d	e	f
Sieve No.	Sieve size	Mass of soil retained	% retained (C/Total) x 100	Cumulative % retained	% finer
	mm	g	g	%	%
4	4.75	28	4.54	4.54	95.46
10	2	42	6.81	11.35	88.65
20	0.85	48	7.78	19.13	80.87
40	0.425	128	20.75	39.88	60.12
60	0.25	221	35.82	75.7	24.3
100	0.15	86	13.94	89.64	10.36
200	0.075	40	6.48	96.12	3.88
Pan		24	3.89	100.01	0
			100.01		

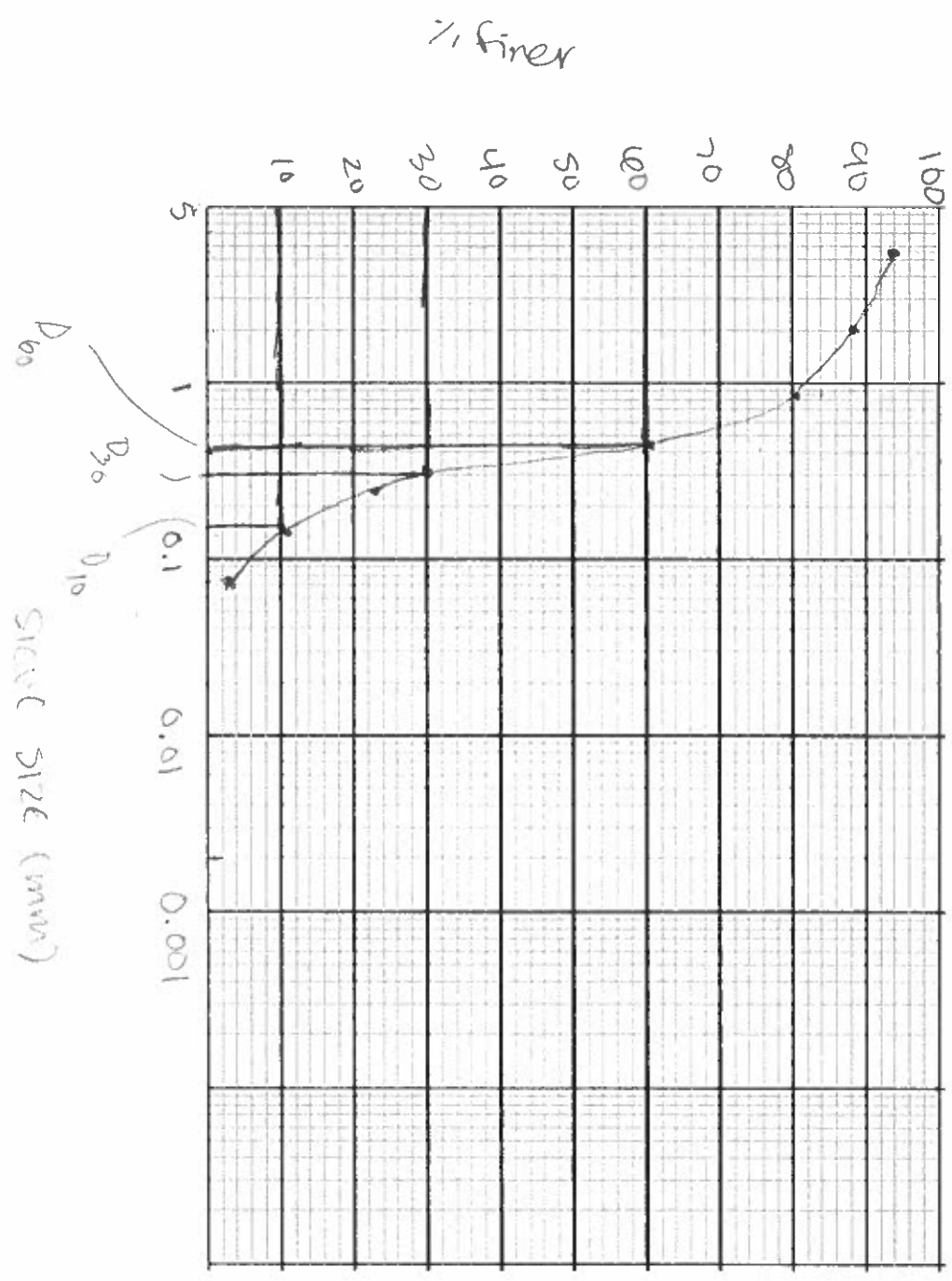
Total sample = 617 weight

Print of graph?

1/1000



Hydrometer analysis



Problem 2

b) Determine D_{10} , D_{30} and D_{60}

$$D_{10} = .17 \text{ mm} \quad \checkmark$$

$$D_{30} = .3 \text{ mm} \quad \checkmark$$

$$D_{60} = .41 \text{ mm} \quad \checkmark$$

c) Calculate the uniformity coefficient (C_u)

$$C_u = \frac{D_{60}}{D_{10}} = \frac{.41 \text{ mm}}{.17 \text{ mm}} = 2.41 \quad \checkmark$$

d) Calculate the coefficient of gradation (C_c)

$$C_c = \frac{D_{30}^2}{(D_{10})(D_{60})} = \frac{(.3)^2}{(.17)(.41)} = 1.29 \quad \checkmark$$

Problem 3

Size (mm)	Percent finer
0.425	100
0.1	92
0.052	84
0.02	62
0.01	46
0.004	32
0.001	22

a) Draw the grain size curve

b) % C = 28%

% S = 12%

% M = 60%

% G = 0

X - 15

88% fine

$$100 - 88 = 12\%$$

$$M = 100 - 28 - 12$$

$$M = 60$$

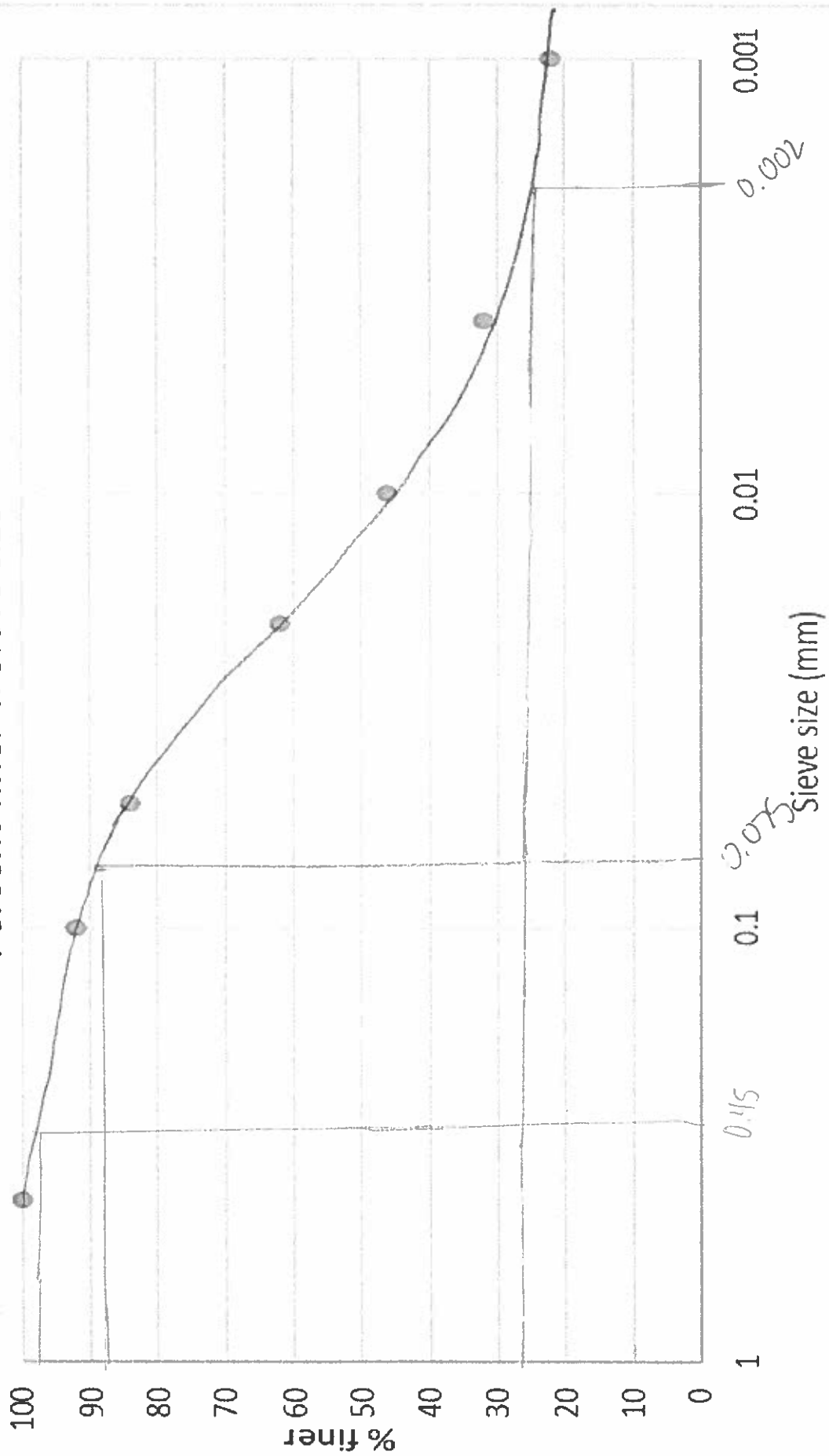
$$\text{Clay} \leq 0.002 \text{ mm}$$

$$0.075 \text{ mm} < M < 0.002 \text{ mm}$$

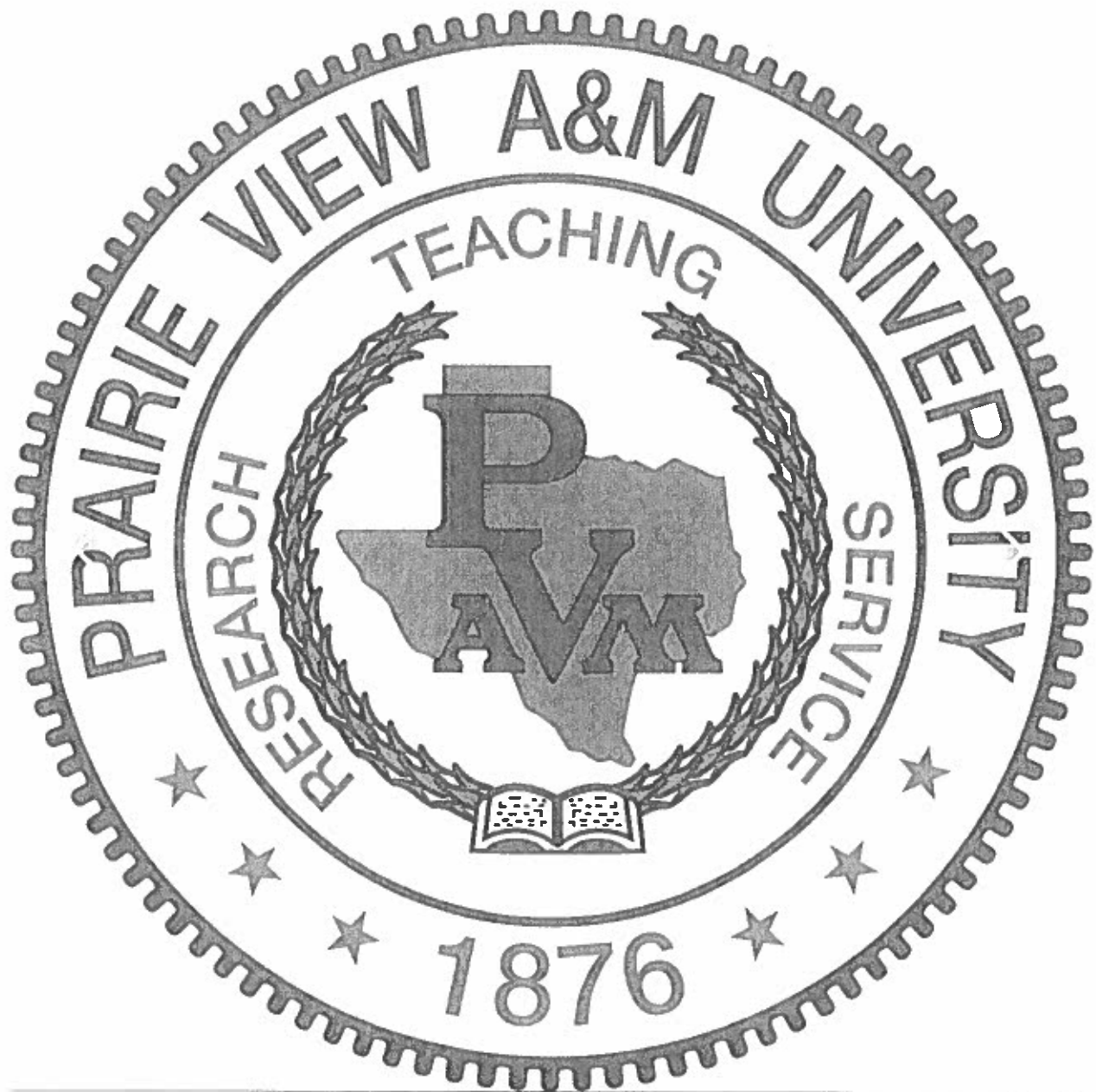
$$g \geq 0.2 \text{ mm}$$

$$4.75 \text{ mm} < S < 0.075 \text{ mm}$$

Percent finer v. Sieve size



BELOW AVERAGE



CVEG3300-P01: Geotechnical Engineering

Dr.Alam

Hw 2

February 9,2022

Tyrah Owens

1. Given,

$$G_s = 2.60 \checkmark$$

$$T = 24^\circ\text{C} \checkmark$$

$$R = 43\text{ cm}$$

$$t = 60\text{ mins}$$

$$D = ?$$

Solution:

$$D(\text{mm}) = K \sqrt{\frac{L(\text{cm})}{t(\text{min})}}$$

$$= 0.013a \sqrt{\frac{43}{60}}$$

$$D(\text{mm}) = 0.011\text{ mm}$$

Is it silt or clay?

Silt

2. b) $D_{10} = 0.13\text{ mm} \checkmark$

$$D_{30} = 0.28\text{ mm} \checkmark$$

$$D_{60} = 0.41\text{ mm} \checkmark$$

c) $C_u = \frac{D_{60}}{D_{10}}$

$$= \frac{0.41}{0.13}$$

$$C_u = 3.154 \checkmark$$

d) $C_c = \frac{D_{30}^2}{D_{10} D_{60}}$

$$= \frac{0.28^2}{0.13 \times 0.41}$$

$$C_c = 1.47 \checkmark$$

3. Gravel = 0%

Clay = 28%

Sand = 10%

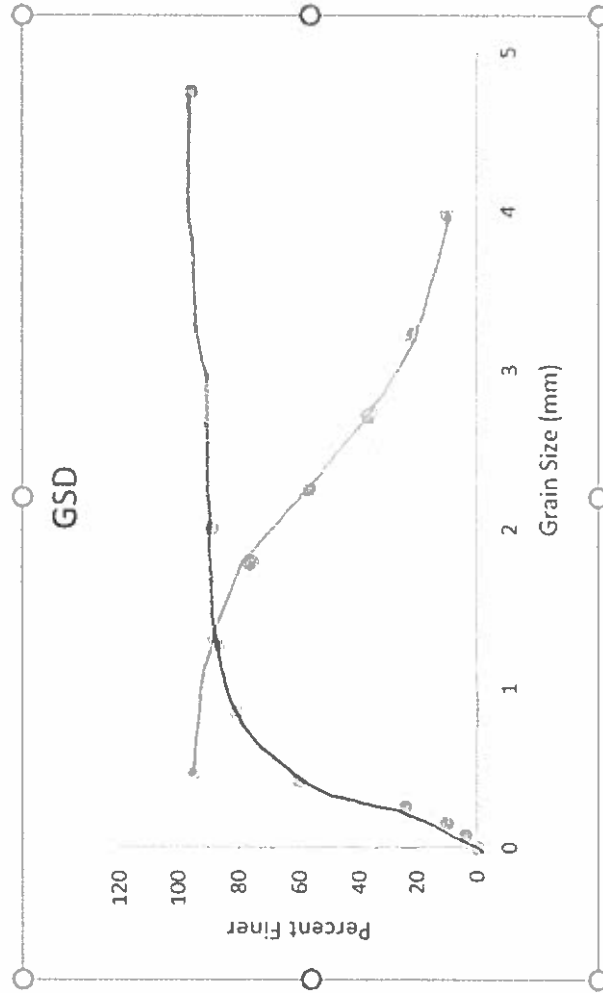
Silt = 62%

Finer



(Size mm)

$k = 9.2$
Table 2.7
in textbook



x axis goes from 1.00 - 0.001

Determine the % of gravel sand silt and clay -10

GEOTECHNICAL ENGINEERING SPRING 2022

Title of Assignment: Assignment 3

TOPICS COVERED IN ASSIGNMENT 3:

1. Atterberg Limit

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR HW 3**

CVEG 3300
Geotechnical Engineering
Spring 2022

Assignment-3

Department of Civil & Environmental Engineering
Prairie View A&M University



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3. Your homework should have the following on top of the first sheet
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15. Problems should be in the order assigned.

Problem 1

The LL, PL and SL of a clay is 38%, 27% and 24% respectively. Its natural water content is 30%. In what state the clay exists in now. Answer this question using both CI and LI, and also show the state of the soil in Volume vs water content graph.

Problem 2

Comment on the validity of the results of Atterberg Limits on soils G and H.

	Soil G	Soil H
LL	55	38
PL	20	42
SL	25	--

Problem 3

The following data were obtained from a liquid limit test on a silty clay.

No. of Blows	Water Content, %
35	41.1
29	41.8
21	43.5
15	44.9

Two plastic limit determinations had water contents of 23.1 and 23.6 percent. Plot the flow curve based on the given data. Determine the LL, PI, the flow index, liquidity index, consistency index and the toughness index. The natural water content of the soil was found 30%.

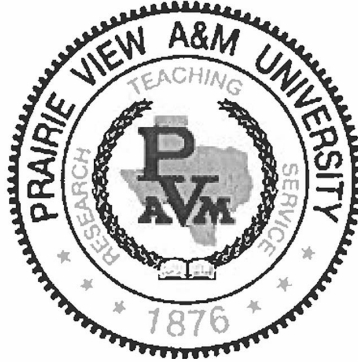
Problem 4

A saturated soil used to determine the shrinkage limit has an initial volume of 20.2 cm³ and final volume was obtained 14.3 cm³. Mass of wet soil was 34 gram, and the mass of dry soil was obtained 24 gram. Determine the shrinkage limit and shrinkage ratio.

ABOVE AVERAGE

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Civil & Environmental Engineering Department



CVEG 3300 P01 – Geotechnical Engineering

Spring 2022

Homework #3

Maalvika Aggarwal

Dr. Md Jobair Bin Alam

Date Given: 10 February 2022

Date Submitted: 16 February 2022

Problem 1

Given: $LL = 38\%$, $PL = 27\%$, $SL = 24\%$, $w = 30\%$.

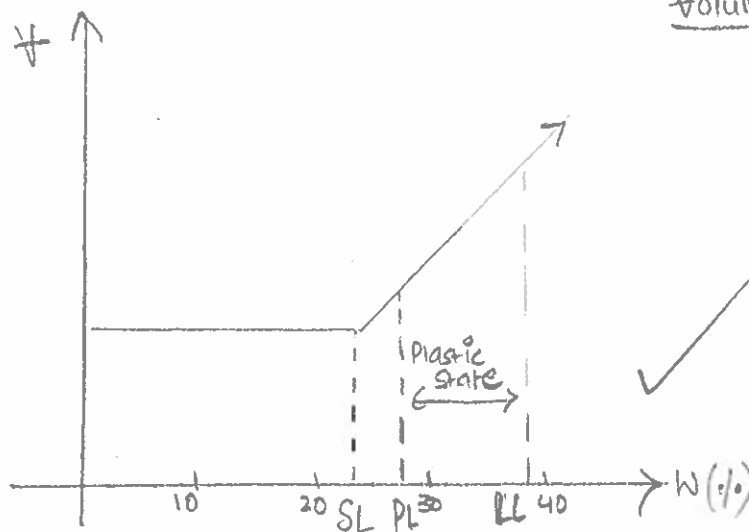
$$CI = \frac{LL - w}{LL - PL} = \frac{38 - 30}{38 - 27} = 0.73 \checkmark$$

So, since $CI < 1$, Soil is in PLASTIC STATE
as $w > PL$ ✓

$$LI = \frac{w - PL}{LL - PL} = \frac{30 - 27}{38 - 27} = 0.27$$

So, since $LI < 1$, soil is in PLASTIC STATE
as $w < LL$ ✓

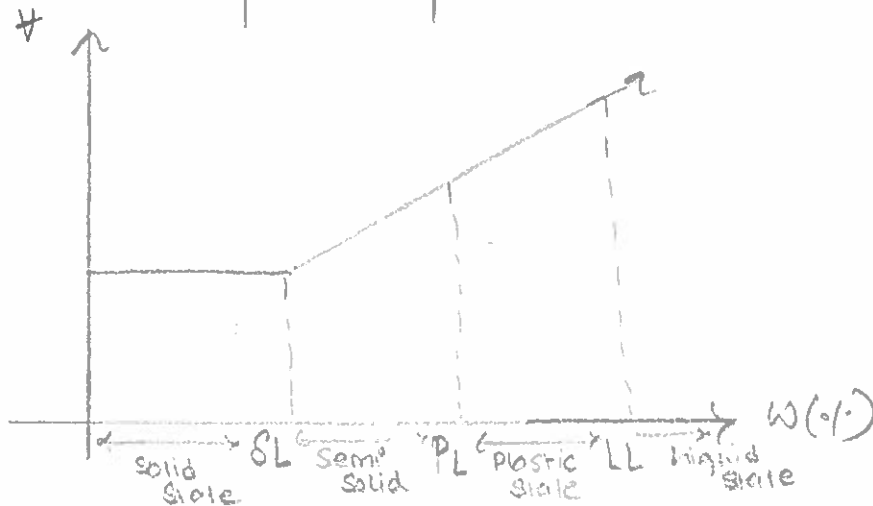
Volume vs. water content graph:



Problem 2

Given

	Soil G	Soil H
LL	55	38
PL	20	42
SL	25	-



As it can be seen from the volume vs. water content graph, in no condition, the plastic limit of a soil can't be higher than the liquid limit. This means something is wrong and soil H cannot be valid.

$$PI \text{ of H} = LL - PL = 38 - 42$$

$$= -4$$

i.e. NOT VALID

Also, for soil G, results are not valid as the shrinkage unit is higher than plastic limit, which is not possible.

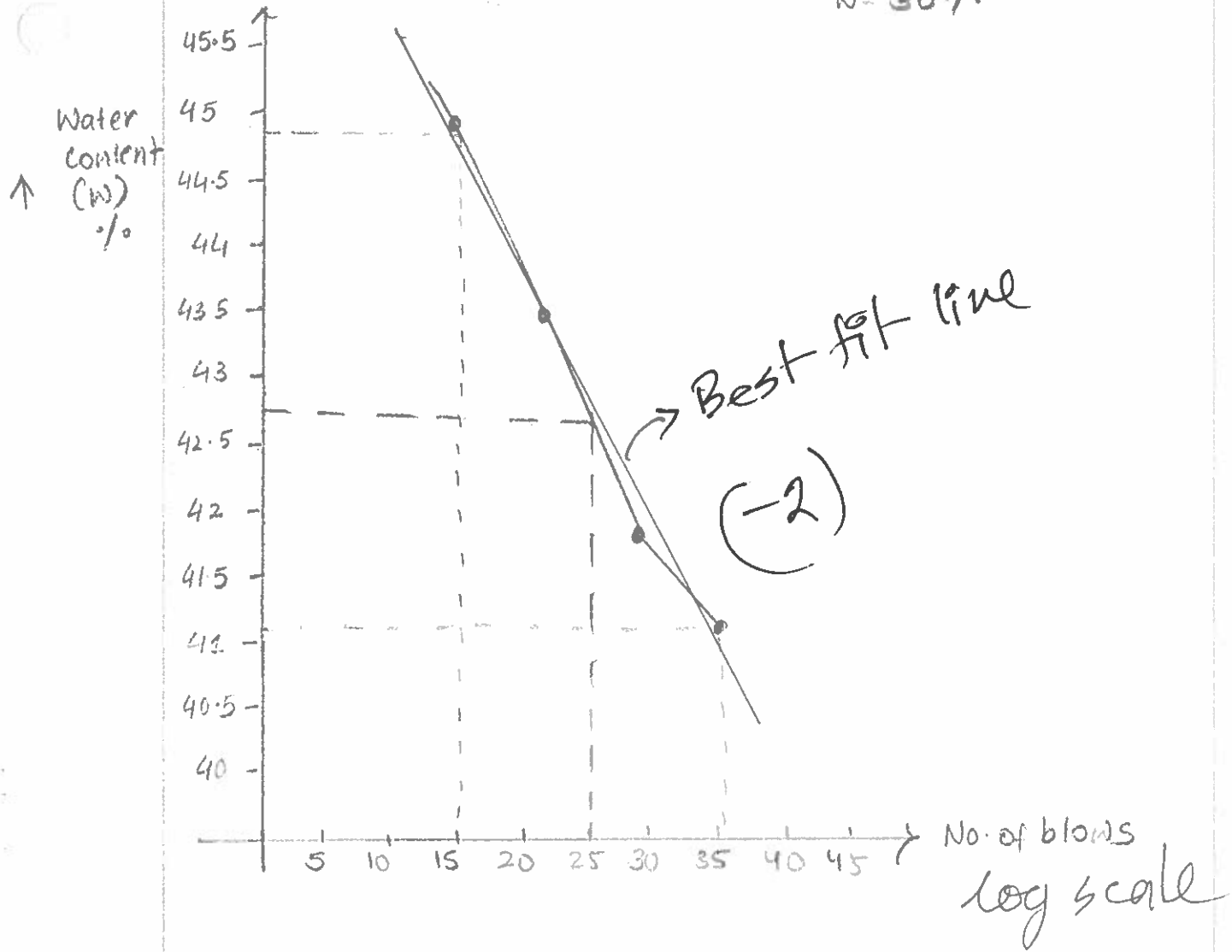
Also, a high PL ^{means} that means it is possible that the soil is highly plastic in nature.

So,

NOT VALID

Problem 3

Given $PL = 23.1 \text{ \& } 23.6 (\%)$
 $W = 30\%$



liquid limit, $LL = 42.8\% \text{ (approx)}$ ✓
 as it corresponds to 25 blows.

$$\text{Plastic limit } (PL) = \frac{23.1 + 23.6}{2} = 23.35\% \quad \checkmark$$

$$\text{liquidity Index } (LI) = \frac{W - PL}{LL - PL} = \frac{30 - 23.35}{42.8 - 23.35} = 0.342\% \quad \checkmark$$

$$\text{Consistency Index } (CI) = \frac{LL - W}{LL - PL} = \frac{42.8 - 30}{42.8 - 23.35} = 0.658\% \quad \checkmark$$

$$\text{Plasticity Index (PI)} = LL - PL = 42.8 - 23.35 = \boxed{19.45 \%}$$

$$\text{Flow Index (IF)} = \text{slope of flow curve} = \frac{w_1 - w_2}{\log(N_2/N_1)}$$

$$\# \text{ blows} = 35, \quad w = 41.1 \%$$

$$\# \text{ blows} = 15, \quad w = 44.9 \%$$

$$\text{So, } I_f = \frac{44.9 - 41.1}{\log\left(\frac{35}{15}\right)} = \boxed{10.326 \%}$$

$$\text{Toughness Index (IT)} = \frac{PI}{I_f} = \frac{19.45}{10.326} = \boxed{1.88}$$

Problem 4

Given: $V_i = 20.2 \text{ cm}^3$, $V_f = 14.3 \text{ cm}^3$

$M_1 = 34 \text{ g}$, $m_2 = 24 \text{ g}$

Find: SL and shrinkage ratio

Approach:

$$SL = \left[\left(\frac{M_1 - M_2}{M_2} \right) 100 - \left(\frac{V_i - V_f}{M_2} \right) \rho_w (100) \right]$$

$$SL = \left[\left(\frac{34 - 24}{24} \right) 100 - \left(\frac{20.2 - 14.3}{24} \right) (1) (100) \right]$$

$$SL = 41.66 - 24.58$$

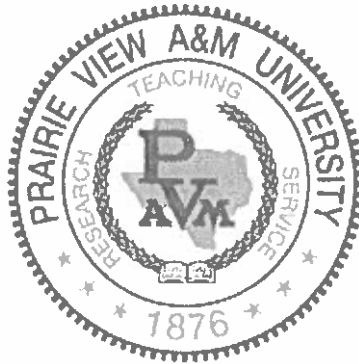
$$SL = 17.083 \%$$

$$SR = \frac{M_2}{V_f \cdot \rho_w} = \frac{24}{14.3(1)}$$

$$SR = 1.678$$

AVERAGE

Department of Civil & Environmental Engineering
Prairie View A&M University



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CVEG 3300 P01 Geotechnical Engineering

Spring 2022

Homework Assignment #3

Given on

February 9, 2022

Submitted by

Sanjay Tillmutter

On

February 16, 2022

To

Dr. Md Jobair Bin Alam

Geotechnical Engineering Instructor

CIVIL & ENVIRONMENTAL ENGINEERING DEPARTMENT

#1

THE LL, PL, AND SL OF A CLAY IS 38%, 27%, AND 24% RESPECTIVELY. ITS NATURAL WATER CONTENT IS 30%. IN WHAT STATE DOES THE CLAY EXIST IN NOW? ANSWER THIS QUESTION USING BOTH CI & LI, AND ALSO SHOW THE STATE OF THE SOIL IN VOLUME VS WATER CONTENT GRAPH.

$$LL = 38\%$$

$$PL = 27\%$$

$$SL = 24\%$$

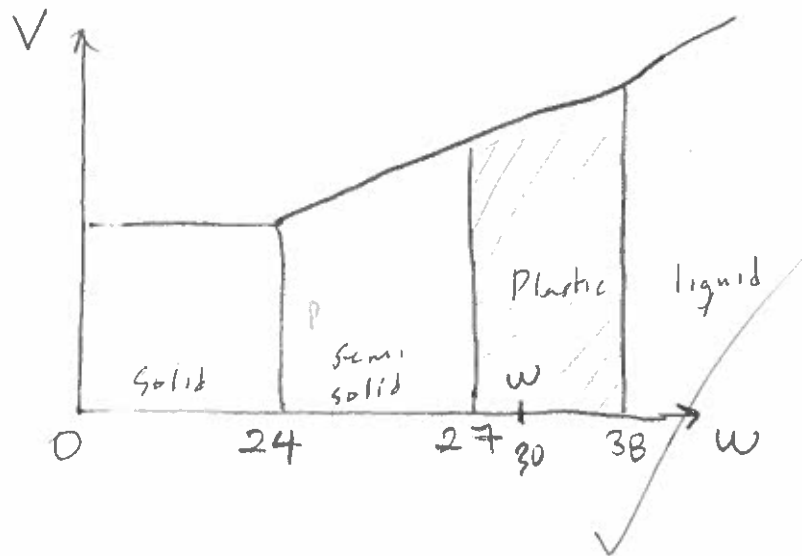
$$W = 30\%$$

$$CI = \frac{LL - W}{LL - PL} = \frac{38 - 30}{38 - 27} = \frac{8}{11} = 0.73$$

$$LI = \frac{W - PL}{LL - PL} = \frac{30 - 27}{38 - 27} = \frac{3}{11} = 0.27$$

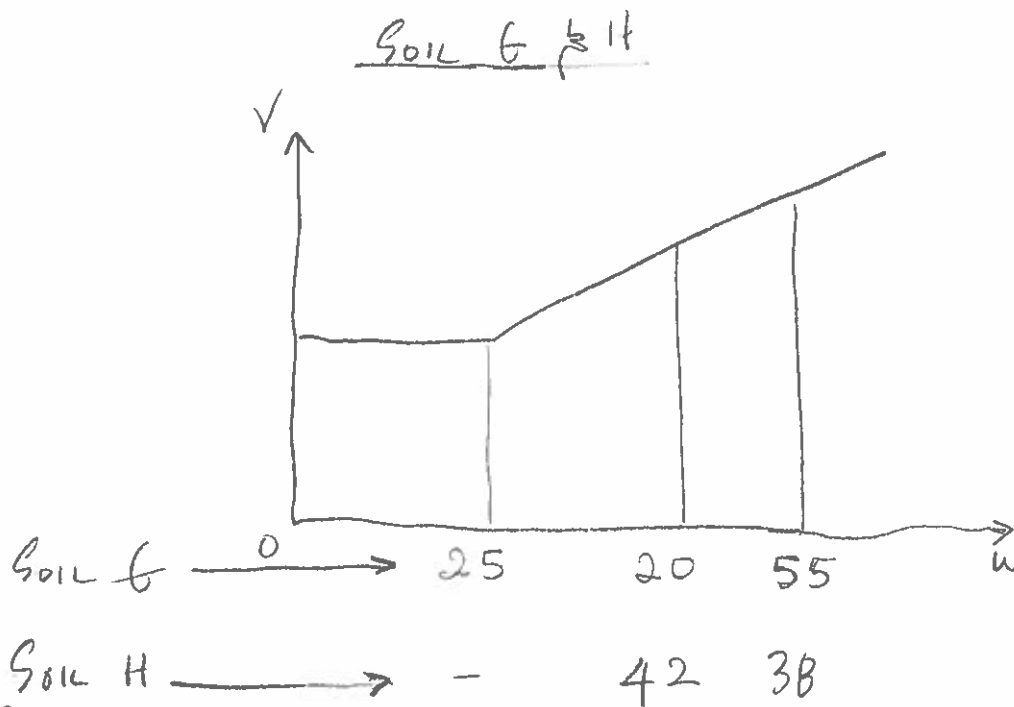
$CI = 0.73 < 1$, SO SOIL IS IN PLASTIC STATE.

$LI = 0.27 < 1$, SO " " " " " "



#2 Comment on the validity of the results of Atterberg's Limits on Soil G & H.

	Soil G	Soil H
LL	55	38
PL	20	42
SL	25	—



For Soil G, the PI value was 35%. This meant that the soil is highly plastic. The shrinkage limit was, however, higher than the plastic limit, meaning this soil would require less change in water content for it to change into solid state.

For Soil H, the PI value was negative since the plastic limit was greater than the liquid limit. This would mean that this soil would require less water content to change to liquid state than it would to change to plastic state. This does not make sense, and so we can question the validity of these test results.

#3

OF BLOWS

WATER CONTENT %

35

41.1

29

41.8

21

43.5

15

44.9

PL WATER CONTENTS : 23.1 % , 23.6 %

 $W = 30\%$

FIND.

LL = FROM THE GRAPH, WATER CONTENT @ 25 blows = 42.6 %

$$PI = LL - PL = 42.6 - \frac{(23.1 + 23.6)}{2} = 19.25\%$$

$$I_F = \text{SLOPE OF THE FLOW CURVE} = \frac{\text{RISE}}{\text{RUN}}$$

$$= \frac{43 - 41.8}{30 - 24} = \frac{1.2}{\log\left(\frac{30}{24}\right)} = 12.38\%$$

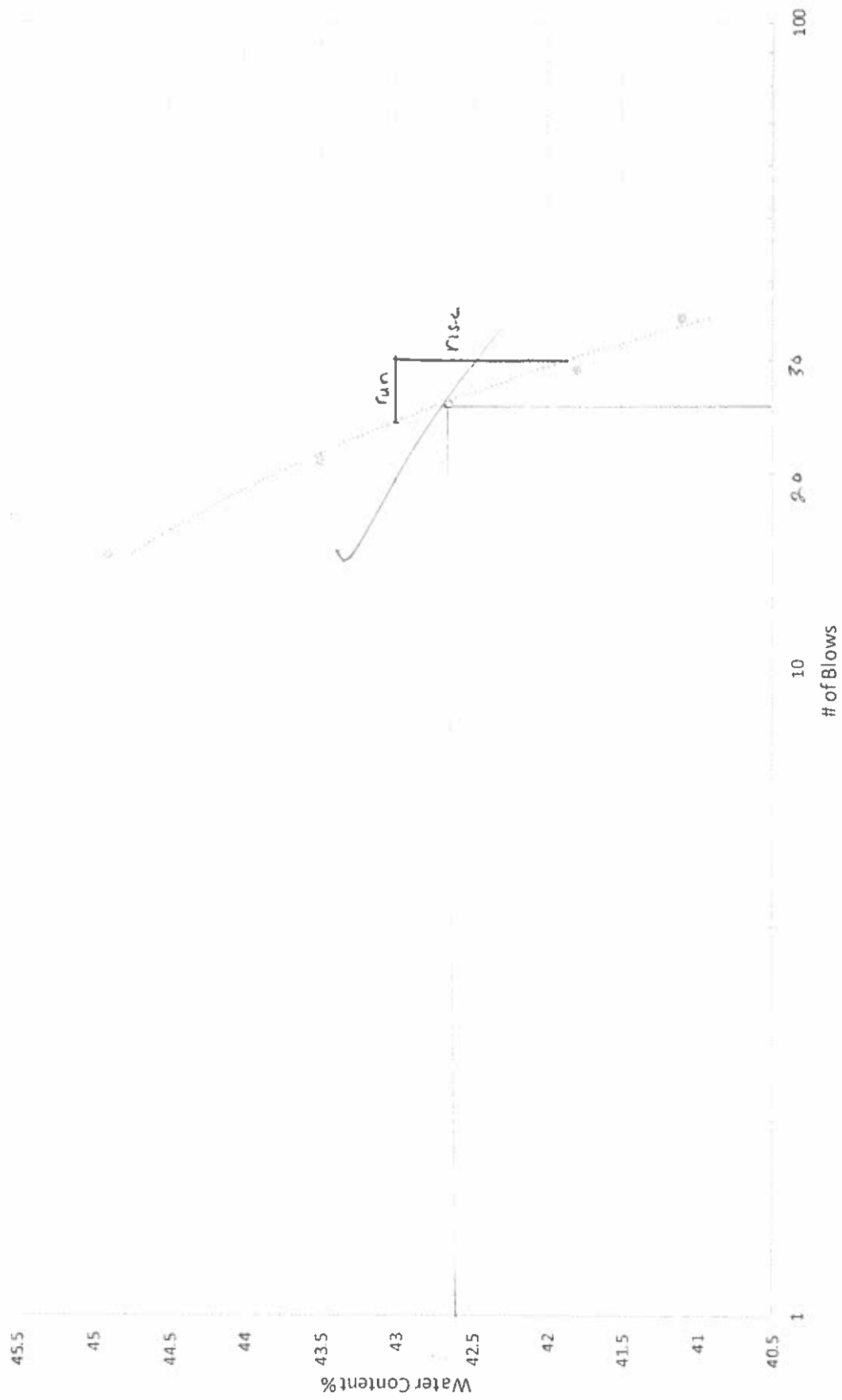
$$I_T = \frac{PI}{I_F} = \frac{19.25\%}{12.38\%} = 1.55\checkmark$$

$$LI = \frac{W - PL}{LL - PL} = \frac{30 - 19.25}{42.6 - 19.25} = \frac{10.75}{23.35} \checkmark = 0.46$$

$$CI = \frac{LL - W}{LL - PL} = \frac{42.6 - 30}{42.6 - 19.25} = \frac{12.6}{23.35} = 0.54$$

SANJAY TILUMATI

Flow Curve



#4

$$M_1 = 34 \text{ g}$$

$$V_L = 20.2 \text{ cm}^3$$

$$M_2 = 24 \text{ g}$$

$$V_f = 14.3 \text{ cm}^3$$

$$\rho = 1 \text{ g/cm}^3$$

$$SL = \left(\frac{M_1 - M_2}{M_2} \times 100 \right) - \left(\frac{V_L - V_f}{M_2} \right) \rho_w \times 100$$

$$= \left(\frac{(34 - 24) \text{ g}}{24 \text{ g}} \times 100 \right) - \left(\frac{20.2 - 14.3 \text{ cm}^3}{24 \text{ g}} \right) 1 \text{ g/cm}^3 \times 100$$

$$= 41.67 - 24.58$$

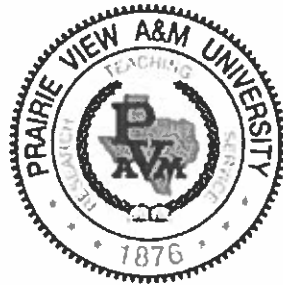
$$= 17.09 \%$$

$$SR = \frac{M_2}{V_f \rho_w} = \frac{24 \text{ g}}{14.3 \text{ cm}^3 \times 1 \text{ g/cm}^3} = 1.68$$

BELOW AVERAGE

70

**CIVIL ENGINEERING DEPARTMENT
PRAIRIE VIEW A&M UNIVERSITY**



CVEG 3300 Geotechnical Engineering

Spring 2022

Assignment-3

Mouni Yamba

Problem 1

The LL, PL and SL of a clay is 38%, 27% and 24% respectively. Its natural water content is 30%. In what state the clay exists in now. Answer this question using both CI and LI, and also show the state of the soil in Volume vs water content graph.

Problem 2

Comment on the validity of the results of Atterberg Limits on soils G and H.

	Soil G	Soil H
LL	55	38
PL	20	42
SL	25	--

Problem 3

The following data were obtained from a liquid limit test on a silty clay.

No. of Blows	Water Content, %
35	41.1
29	41.8
21	43.5
15	44.9

Two plastic limit determinations had water contents of 23.1 and 23.6 percent. Plot the flow curve based on the given data. Determine the LL, PI, the flow index, liquidity index, consistency index and the toughness index. The natural water content of the soil was found 30%.

Problem 4

A saturated soil used to determine the shrinkage limit has an initial volume of 20.2 cm³ and final volume was obtained 14.3 cm³. Mass of wet soil was 34 gram, and the mass of dry soil was obtained 24 gram. Determine the shrinkage limit and shrinkage ratio.

Problem 1

given:

$$\text{liquid limit (LL)} = 38\%$$

$$\text{Plastic limit (PL)} = 27\%$$

$$\text{Shrinkage limit (SL)} = 24\%$$

$$\text{Natural water content (W)} = 30\%$$

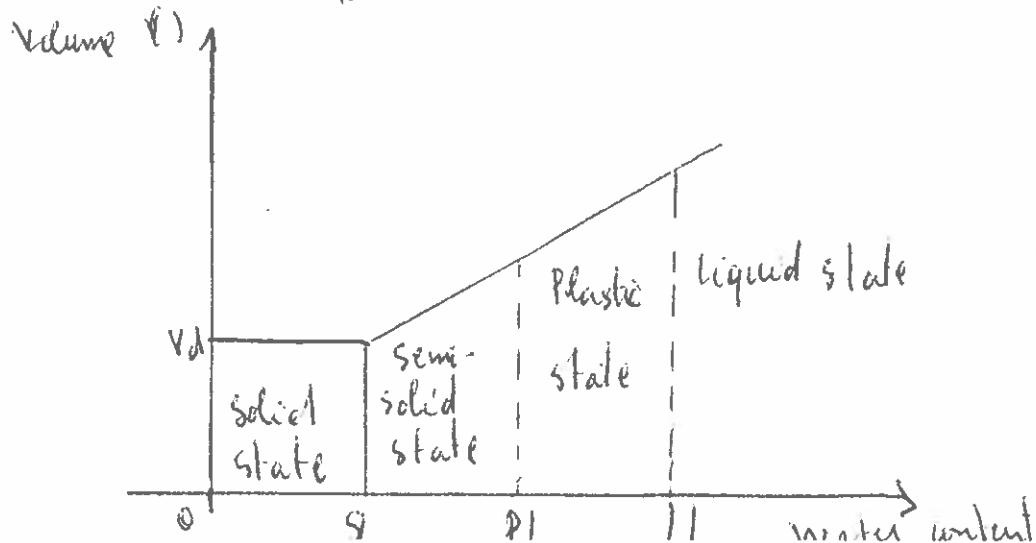
$$\begin{aligned} \text{Consistency Index (CI)} &= \frac{LL - W}{LL - PL} \times 100 \quad (15) \\ &= \frac{(38 - 30)}{(38 - 27)} \times 100 \end{aligned}$$

$$= 72.72\%$$

$$\begin{aligned} \text{liquidity Index (LI)} &= \frac{W - PL}{(LL - PL)} \times 100 \\ &= \frac{(30 - 27)}{(38 - 27)} \times 100 \end{aligned}$$

$$= 27.27\%$$

$$LI + CI = 100\%$$



$$CI = 0.7272 ;$$

$$CI (0.5 - 0.75) \text{ range}$$

consistencyDescriptionCI

Plastic

Medium stiff

(0.5 - 0.75)

Problem 2

step 1

Calculate the Plasticity Index for soil G (PI)

$$PI = LL - PL$$

$$PI = 55 - 20 = 35$$

PI = 35, soil is highly plastic in nature.

Shrinkage limit Plastic in Nature.

The Shrinkage limit for the given sample is 25%, The soil is in fully saturated condition and there is least water content present in that condition.

X

Step 2

calculate the plasticity index for soil H (PI) using the formula,

$$PI = LL - PL$$

$$PI = 38 - 32 = -4$$

PI = -4, negative, the soil is non-plastic in nature.

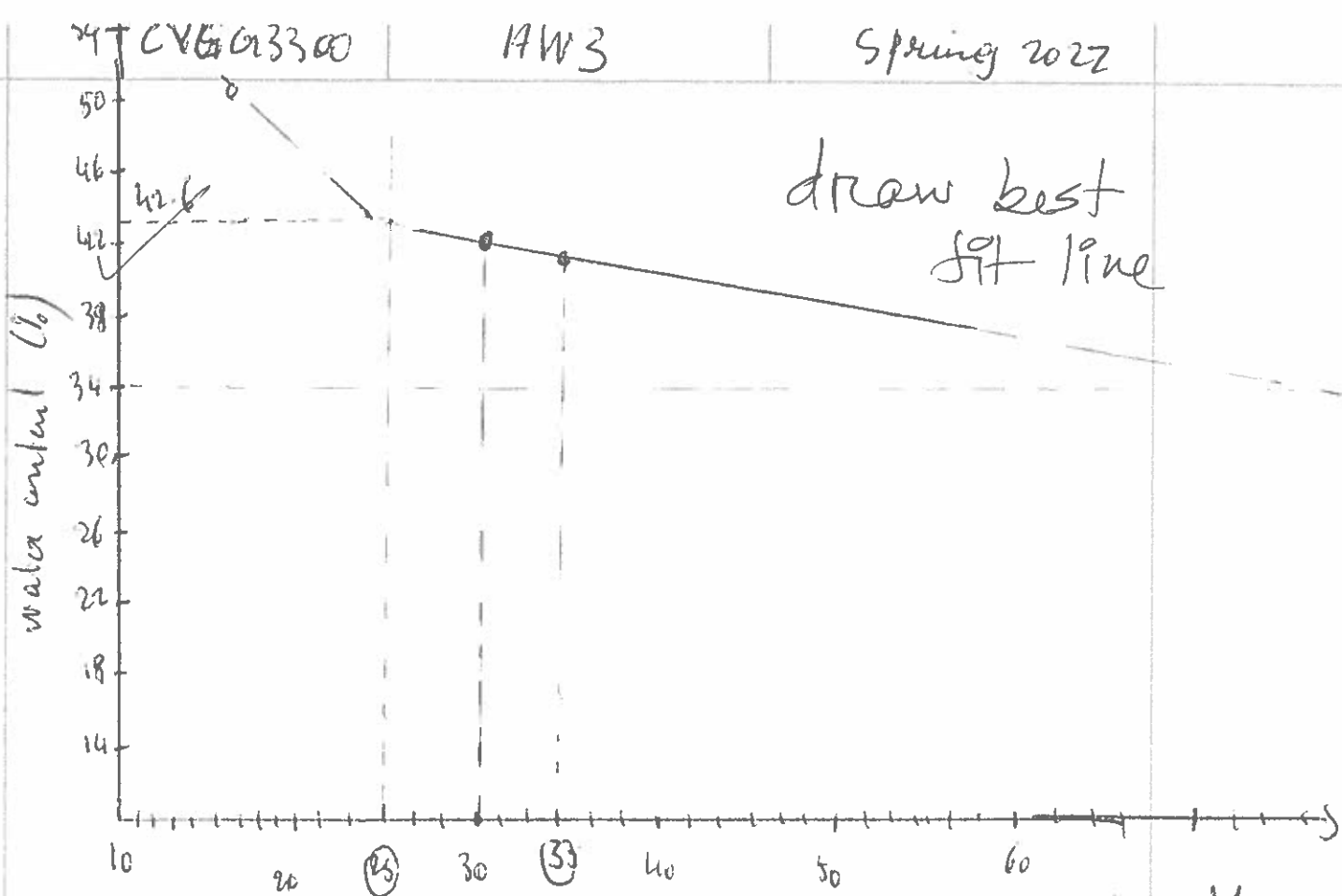
(20)

Problem 3

given data:

N blows	water content (%)
35	41.1
29	41.8
21	43.5
15	44.9

Water contents of plastic limit = 23.1 and 23.6 %



From the above figure the water content corresponding to 25 blows is 42.6%. $\Rightarrow LL = 42.6\%$

Part 2: What is the PI

$$PI = W_L - W_P = LL - PL$$

$$PL = \frac{23.1 + 23.6}{2} = 23.35$$

$$PI = 42.6 - 23.35$$

$$PI = 19.25\%$$

Part 3) Flow index:

$$\text{Flow index} = \frac{W_1 - W_2}{\log\left(\frac{N_2}{N_1}\right)} = \frac{43.6 - 41.7}{\log\left(\frac{30}{20}\right)} = 10.79\%$$

$$\text{Part 4) Toughness index} = \frac{PI}{\text{Flow index}} = \frac{19.25}{10.79}$$

$$\text{Toughness index} = 1.78$$

CI, LI = ?
(-5)

Problem 4

* Calculate the shrinkage limit of the soil using the formula:

$$SL = \left[\left(\frac{M_1 - M_2}{M_2} \right) - \left(\frac{V_L - V_f}{M_2} \right) P_w \right] \times 100$$

$$SL = \left[\left(\frac{34 - 24}{24} \right) - \left(\frac{20.2 - 14.3}{24} \times 1 \right) \right] \times 100$$

$$\boxed{SL = 17.08\%}$$

* The shrinkage ratio

$$SR = \frac{M_2}{V_f P_w}$$

$$SR = \frac{24}{14.3 \times 1}$$

$$\boxed{SR = 1.678}$$

GEOTECHNICAL ENGINEERING SPRING 2022

Title of Assignment: Assignment 4

TOPICS COVERED IN ASSIGNMENT 4:

1. Soil Classification

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR HW 4**

CVEG 3300
Geotechnical Engineering
Spring 2022

Assignment-4

Department of Civil & Environmental Engineering
Prairie View A&M University



Problem 1

The following grain size distribution test results were obtained from sieve analysis test.

U.S. Sieve Number	Percent Passing
4	100
10	90
20	64
40	38
80	18
200	13

Also, the Atterberg test results revealed the following results

LL = 23 and PL = 19

Classify the soil by using

- a) AASHTO soil classification system
- b) USCS soil classification system

Give group names and group symbols. **Show the GSDC and sketch of finding necessary information from GSDC.**

Problem 2

Classify the soil using USCS system. Give the group symbols and group names.

Soil	Sieve Analysis- Percent Finer		LL	PL	C _u	C _c
	#4	#200				
a	70	30	33	12	-	-
b	48	20	41	19	-	-
c	95	70	52	24	-	-
d	100	82	30	11	-	-
e	71	11	32	16	4.8	2.9
f	90	8	39	8	3.9	2.1

Problem 3

Classify the soil based on USDA textural classification

Soil	Particle Size Distribution (%)		
	Sand	Silt	Clay
B	55	5	40
C	45	35	20
D	50	15	35
E	70	15	15

Problem 4

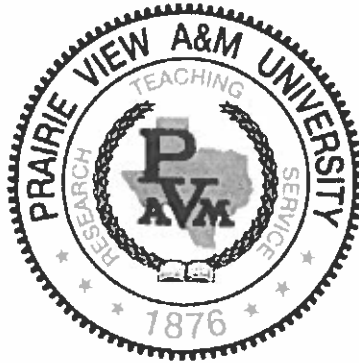
Classify the following soils by AASHTO classification system. Give group index for each soil.

Soil	Sieve Analysis- Percent Finer			LL	PL
	#10	#40	#200		
a	98	80	72	52	31
b	90	74	58	38	26

ABOVE AVERAGE

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Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department



CVEG 3300 P01 – Geotechnical Engineering

Spring 2022

Homework #4

Maalvika Aggarwal

Dr. Md Jobair Bin Alam

Date Given: 14 February 2022

Date Submitted: 21 February 2022

Problem 1

Data:	Sieve #	% Passing
	4	100
	10	90
	20	64
	40	38
	80	18
	200	13

$$LH = 23, PL = 19$$

$$PI = LL - PL = 23 - 19 = 4$$

$$a) F_{10} = 90 \quad F_{40} = 38 \quad F_{200} = 13$$

Referring to the first part of Table 5.1, the soil is classified as A-1-b according to AASHTO system

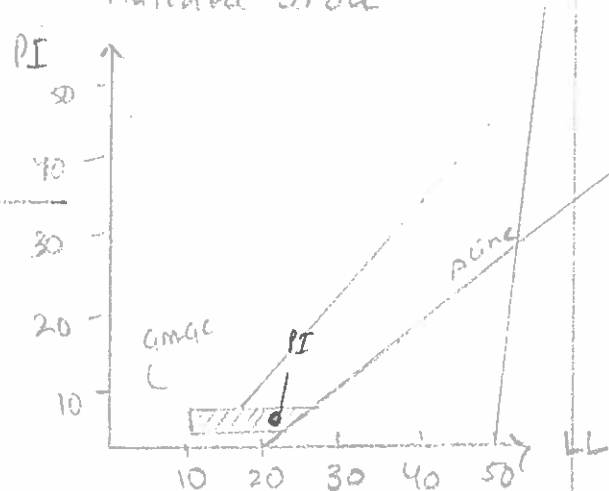
$$b) P_{200} = 13 \quad R_{200} = 87 \quad \frac{R_u}{R_{200}} = \frac{0}{87} = 0$$

$$P_u = 100 \quad R_u = 0 \quad \frac{R_u}{R_{200}} < 0.5$$

Referring to table 4.2, for sands,

the group symbol is SM-SC ($F_{200} > 12$, PI plots in hatched area)

SC clayey sand
 % gravel = 0 %
 So, group name = Silty clayey sand

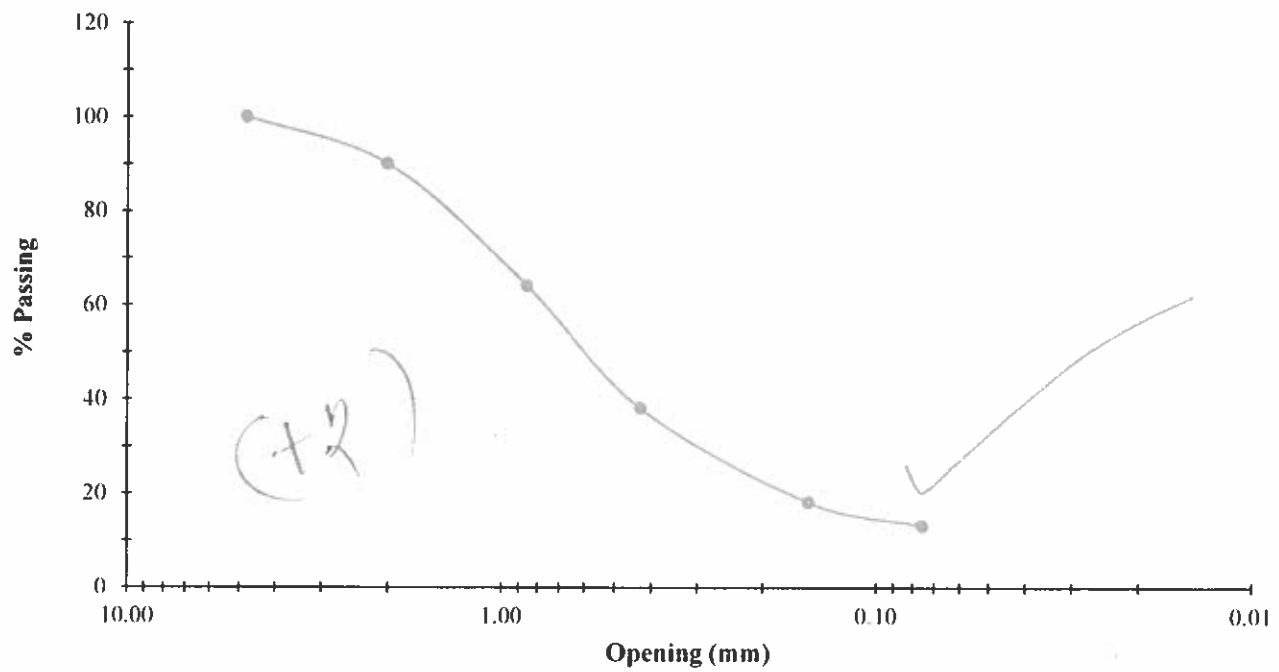


Grain size plot →

Plasticity chart

PROBLEM (2)

Sieve #	Opening mm	% Passing
4	4.750	100.000
10	2.000	90.000
20	0.850	64.000
40	0.425	38.000
80	0.150	18.000
200	0.075	13.000

Grain Size Distribution Curve

Problem 2

1) Soil a

$$f_{200} = 30, f_4 = 70$$

$$R_{200} = 70, R_4 = 30$$

$$\frac{R_4}{R_{200}} = \frac{30}{70} = 0.42 (< 0.5)$$

$$LL = 33, PL = 12$$

$$PI = 21$$

$$\% \text{ gravel} = 30\% (> 15\%)$$

Group symbol = SC ✓Group name = clayey sand with gravel

2) Soil b

$$f_{200} = 20, f_4 = 48$$

$$\frac{R_4}{R_{200}} = \frac{52}{80} = 0.65 (> 0.5)$$

$$PI = LL - PL = 41 - 19 = 22$$

Group symbol = GC ✓

+ sand - 80%

Group name = clayey gravel with sand

3) Soil c

$$f_4 = 95, f_{200} = 70$$

$$LL = 52, PL = 24, PI = 52 - 24 = 28$$

Group symbol = CL eH

$$\% \text{ sand} = 30\%$$

$$\% \text{ gravel} = 5\%$$

So, $\% \text{ sand} > \% \text{ gravel}$

(-2)

Group name = Sandy lean clay
fat

4) Soil d

$$F_4 = 100, F_{200} = 82$$

$$LL = 30, PL = 11, PI = 19$$

$$\text{Group Symbol} = \boxed{CL}$$

$$\% \text{ sand} = 0\%$$

$$\% \text{ gravel} = 18\%$$

So, 1 sand < 1 gravel

Group name = Gravelly lean clay with sand

5) Soil e

$$F_4 = 71, F_{200} = 11$$

$$LL = 32$$

$$PL = 16$$

$$PI = 16$$

SP-SC

$$\frac{R_4}{R_{200}} = \frac{29}{89} = 0.32 (< 0.5)$$

$$\text{Group Symbol} = \boxed{GC}$$

$$\frac{C_u, C_c}{u_{cl}}$$

89% sand + 9%

$$(\% \text{ sand}) = 29\% (> 15\%)$$

$$g = 29, s = 89 - 29 = 60\%$$

Group name = clayey gravel with sand

6) Soil f

$$F_4 = 90, F_{200} = 8$$

$$\frac{R_4}{R_{200}} = \frac{10}{92} = 0.11 (< 0.5)$$

$$C_u = 3.9$$

$$C_c = 2.1$$

$$LL = 39, PL = 8$$

$$PI = 31$$

$$\text{Group Symbol} = \text{SP-SC}$$

$$\% \text{ gravel} = 10\% (< 15\%)$$

Group name: Poorly graded sand with clay

AVERAGE

2.) Classify the soil using USCS system
Give the group

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Soil	#4 Sieve Analysis Percent Finer	#200 Percent Finer	LL	PL	Cu	Cc
a	70	30	33	12	—	—
b	48	20	41	19	—	—
c	95	70	52	24	—	—
d	100	82	30	11	—	—
e	71	11	32	16	4.8	2.9
f	90	8	39	8	3.9	2.1

A) $F_4 = 70\%$ $LL = 33$ $PI = LL - PL = 21$

$F_{200} = 30\%$ $PL = 12$

$F_{200} < 50\%$ $\frac{R_4}{R_{200}} = \frac{100 - 70}{100 - 30} = \frac{30}{70}$

$F_{200} > 12\%$ $PI > 7$ plots Above A-line

Soil 'a' is clayey sand with gravel (SC) ✓

B) $F_4 = 48\%$ $LL = 41\%$ $PI = 41 - 19 = 22$

$F_{200} = 20\%$ $PL = 19\%$

$\frac{R_4}{R_{200}} > 0.5$ $F_{200} > 12\%$ $PI > 7$
plots above A line

$F_{200} < 50\%$ $\frac{R_4}{R_{200}} = \frac{100 - 48}{100 - 20} = \frac{52}{80} = 0.65$

Soil 'b' is Clayey Gravel (GC) with sand -1

C) $F_4 = 95$ $LL = 52\%$ $PI = 52 - 24$
 $PI = 28\%$

$F_{200} \geq 50\%$ $LL \geq 50\%$ $PI = 28\%$

Soil 'c' is high plastic clay (CH) -2
Sandy fat clay

d) $F_4 = 100$ $F_{200} = 82$ $LL = 30$ $PI = 20 - 11$
 $PI = 19$

$F_{200} \geq 50\%$ $LL < 50\%$ $PI > 7$

Soil d is Loam clay with sand (CL) -1
lean clay with sand

2.)

$$F_{200} = 11$$

$$e: F_4 = 71\% \quad LL = 32\% \quad PI = 32 - 16 = 16$$

$$F_{200} < 50 \quad \frac{R_4}{R_{210}} = \frac{100 - 71}{100 - 11} = \frac{29}{89} = 0.33 \leq 0.15$$

Soil e is poorly graded sand with clay and gravel (SP-SC)

$$f.) F_4 = 90\% \quad Cu < 6 \quad C_u > 1$$

$$F_{200} = 81\% \quad PI = LL - PL = 31\% > 7$$

Soil f is poorly graded clayey sand (SP-CP)

SP-SC

3.)

Classify soil based on USDA classification

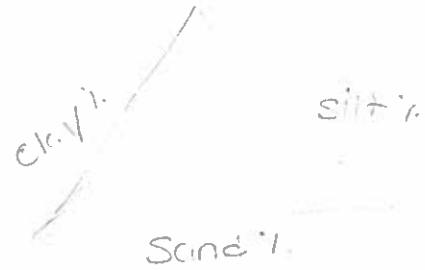
Soil

B: Sandy clay ✓

C: LOAM ✓

D: Sandy Clay Loam ✓

E: Sandy Loam ✓



Classify following soils AASHTO classification system

Soil	#10 Sieve	#40 Analysis	#200 % Finer	LL	PL
a	98	80	72	52	31
b	90	74	58	38	26

Soil a:

$$F_{200} = 72\% : \\ 35 < 72\%$$

$$LL = 52$$

$$PI = LL - PL \\ 52 - 31 \\ PI = 21$$

$$GI = (F_{200} - 35) [0.2 + 0.005 (LL - 40) + 0.01 (72 - 15) (21 - 10)]$$

$21 \leq 52 - 30$
 $21 \leq 22 \quad A-7-5$
 $21 > 22 \quad A-7-6$

$$= (72 - 35) [0.2 + 0.005 (52 - 40)] + [0.01 (72 - 15) (21 - 10)]$$

$$= 15.79 \approx 16 \quad [A-7-6(16)]$$

Soil b:

$$F_{200} = 58 \\ 35 < 58$$

$$\frac{LL}{\geq 3}$$

$$PI = LL - PL \\ 38 - 26 \\ PI = 12$$

Soil will be classified as A-6(9)

$$GI = (F_{200} - 35) [0.2 + 0.005 (LL - 40) + 0.01 (F_{200} - 15) (PI - 10)]$$

$$= (58 - 35) [0.2 + 0.005 (38 - 40) + 0.01 (58 - 15) (12 - 10)]$$

$23 \quad (-2) \quad 43 \quad 11$

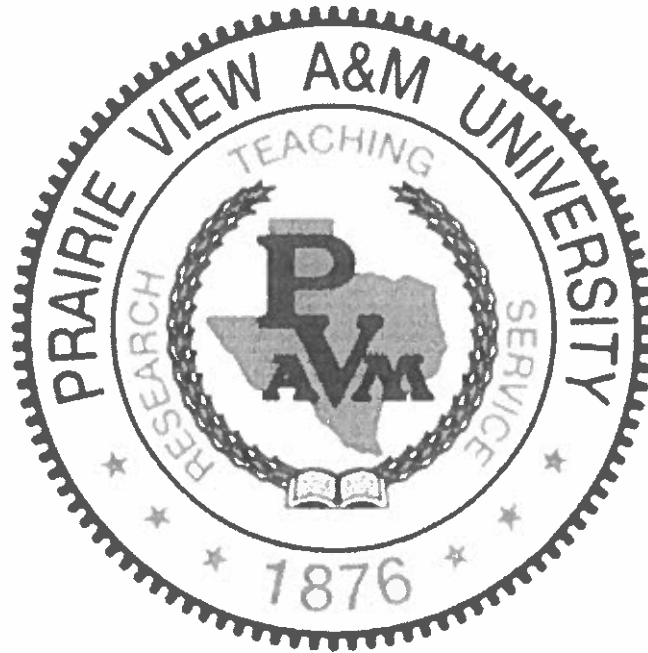
$$= 5.23 \quad \checkmark$$

BELOW AVERAGE

Prairie View A&M University

College of Engineering

Department of Civil & Environmental Engineering



HW #4

CVEG 3300 P01 Geotechnical Engineering

Submitted by: Denia Leroy

Submitted to: Dr. Alam

Date given: 2/14/2022

Due Date: 2/21/2022

HW 4

Problem 1

$$LL = 23$$

$$PL = 19$$

Find:

a) AASHTO soil classification system

Sieve # 200 passing percent 35% or less
according to Data

$$F_{10} = 90\%$$

given:

$$F_{40} = 38\%$$

$$F_{200} = 13\%$$

sieve # 200 = 13% passing

13% < 35% Granular material

$$GI = (F_{200} - 35)[0.2 + 0.005(LL - 40)] + 0.01(F_{200} - 15)(PI - 10)$$

$$PI = LL - PL$$

$$PI = 23 - 19$$

$$GI = (13 - 35)[0.2 + 0.005(23 - 40)] + 0.01(13 - 15)(4 - 10)$$

$$PI = 4$$

$$GI = -4.2613 = 0$$

$$GI = 0$$

$$GI = 0$$

A-2-4(0)

A-1-b

-b

Silty or clayey gravel
and sand

Rule:

if GI equals a negative value, it is taken
as 0

Problem 1

b) USCS soil classification system

$$F_{10} = 90\%$$

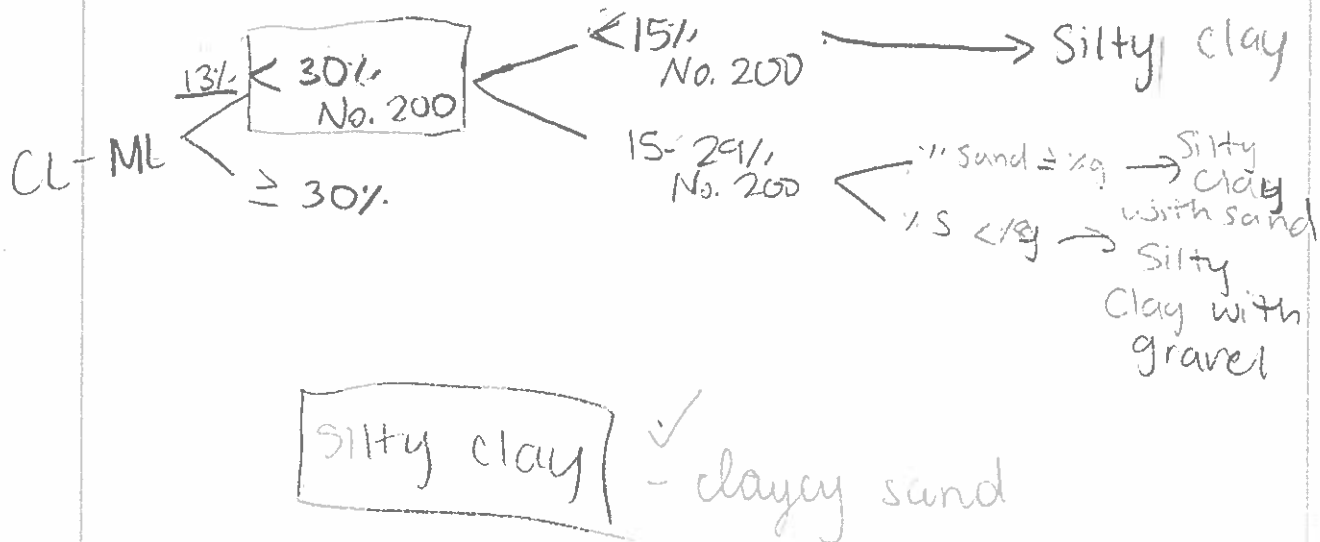
$$LL = 23$$

$$F_{40} = 38\%$$

$$PL = 19$$

$$PI = 4$$

$$F_{200} = 13\%$$



$$\%S = 13\%$$

$$\%g = 10\%$$

$$F_{200} < 50$$

$$12\% < 50\%$$

$$\frac{P_4}{P_{200}}$$

gravel
↓

$$P_4 = 100 - 90 = 10\%$$

$$P_{200} = 100 - 13 = 87\%$$

retained

Graph?
-13

Problem 32

Soil A: $F_4 = 70\%$, $F_{200} = 30\%$, $LL = 33$, $PL = 12$
 $PI = 21$
 $F_{10} = 70\%$

$F_{200} < 50$ coarse-grained soil

$$30 < 50$$

$$R_4 = 100 - 70 = 30\%$$

$$R_{200} = 100 - 30 = 70\%$$

$$\frac{R_4}{R_{200}} = \frac{30}{70} = 0.43 < 0.5$$

Sandy soil

$$F_{200} > 12 \checkmark \quad PI > 7 \checkmark$$

$$30 > 12 \quad 21 > 7$$

group symbol

SM or SC or SM-SC

$$PI < 4$$

$$21 < 4$$

$$F_{200} > 12 \checkmark$$

$$PI > 7$$

$$21 > 7 \checkmark$$

SC $\begin{cases} < 15\% \\ \geq 15\% \text{ gravel} \\ \text{No. 200} \end{cases}$

Group Name

Clayey sand with gravel

Soil B: Gravel Fraction

$$F_4 = 48, F_{200} = 20, LL = 41, PL = 19, PI = 22$$

$F_{200} < 50$ $20 < 50$ $\uparrow$ passing (fine)
coarse-grained soil

$LL < 50$
low plasticity

$$R_4 = 100 - 48 = 52\%$$

$$R_{200} = 100 - 20 = 80\%$$

$$\frac{R_4}{R_{200}} = \frac{52}{80} = 0.65 > .5$$

Group Symbol

GM $F_{200} > 12$ $PI > 4$

GC $F_{200} > 12$ $PI > 7$ ✓

$$20 > 12 \quad 22 > 7$$

Group Symbol

Group Name

GC $< 15\%$

$\geq 15\%$ sand

→ Clayey gravel with sand

$$\%S = 20\%$$

$$\%G = 52\%$$

Soil C: $F_4 = 95\%$, $F_{200} = 70\%$, $LL = 52$, $PL = 24$
 $\uparrow$ $PI = 28$
 Passing %

$F_{200} \geq 50$
 $70\% \geq 50$ fine grained soil

$P_4 = 100 - 95 = 5\%$ $\frac{R_4}{R_{200}} = \frac{5}{30} = 0.16 \leq 0.5$
 $P_{200} = 100 - 70 = 30\%$ $\frac{R_4}{R_{200}}$

Group Symbol $\uparrow$ retained above F_{200} Sandy soil

SM $F_{200} > 12$ $70 > 12 \checkmark$ $PI < 4$ $28 < 4 \times$

SC $F_{200} > 12$ $70 > 12 \checkmark$ $PI > 7$ $28 > 7 \checkmark$

Group Symbol

Group Name

SC

$< 15\%$ gravel $\rightarrow$ Clayey Sand
 $\geq 15\%$ gravel $\rightarrow$ Clayey sand with gravel

-4

Clayey sand

CH - Sandy fat clay

Soil D : $F_4 = 100\%$, $F_{200} = 82$, $LL = 30$, $PL = 11$
 $F_{10} = 100\%$ $\downarrow$ $PI = 19$
 Percent Passing

① $F_{200} > 50$

$82\% > 50$ fine grained soil

No. 10 more accepted for upper limit sand

② $LL < 50$

$30 < 50$

Gravel fraction $R_4 = \% \text{ retained above No. 4}$

$R_{200} = \% \text{ retained above No. 200}$
 Coarse fraction

③ Group symbol

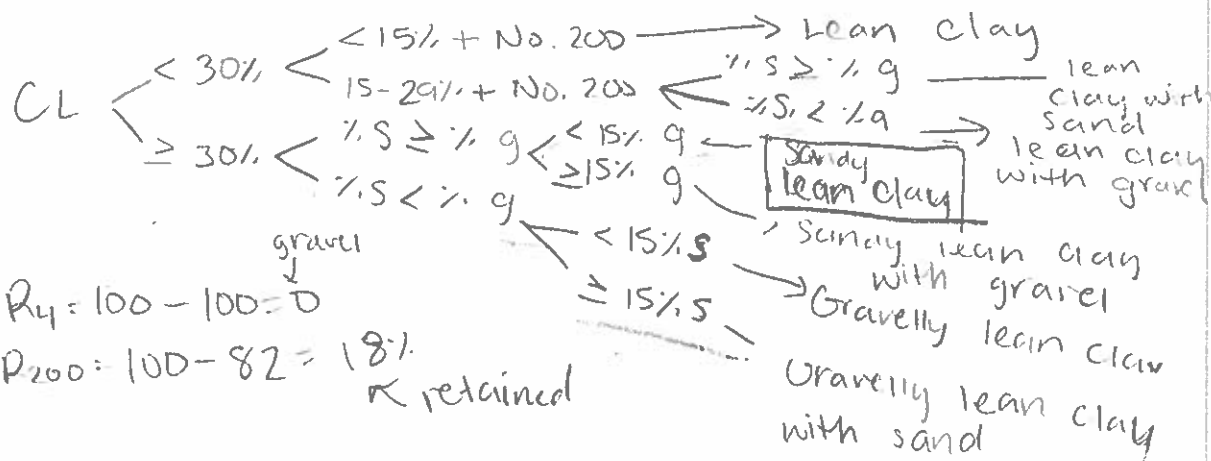
ML $PI < 4$ $19 < 4$ X

CL $PI > 7$ $19 > 7$ ✓

CL-ML PI plots in hatched area

No. 10 separates gravel from sand

④



$g = 0\%$

$S = 82\%$

Sandy lean clay ✓

Soil E:

$$F_4 = 71\% \quad F_{10} = 71\%$$

$$F_{200} = 11\% \quad \leftarrow \text{passing}$$

$$LL = 32 \quad PI = 22$$

$$PL = 16$$

$$C_u = 4.8 < 6$$

$$C_c = 2.1 > 1$$

$$\%S = 11\%$$

$$\%g = 29\%$$

$$R_4 = 100 - 71 = 29$$

$$R_{200} = 100 - 11 = 89$$

$$\frac{R_4}{R_{200}} = \frac{29}{89} = 0.32 \leq 0.5$$

Sandy Soil

meets SW C_u and C_c criteria

$$SW \quad C_u \geq 6; 1 \leq C_c \leq 3$$

$$C_u = 4.8 \times \quad C_c = 2.1 \checkmark \quad \text{not satisfied by SW}$$

SP-SM $5 \leq F_{200} \leq 12$; does not satisfy C_u and C_c criteria of SW and meets PI criteria for SC

SP-SM $< 15\%g \rightarrow$ Poorly graded sand with silt

SP-SC $\geq 15\%g$
 $29\% \geq 15\%g \rightarrow$ Poorly graded sand with silt and gravel

Soil f:

$$F_4 = 90\%$$

$$F_{200} = 8\% \text{ Passing } 200$$

$$LL = 39 \quad PI = 31$$

$$PL = 8$$

$$C_u = 3.9$$

$$C_c = 2.1$$

$$R_4 = 100 - 90 = 10\%$$

$$R_{200} = 100 - 8 = 92\%$$

F_{10} = separate gravel from sand

Gravel fraction

R_4 = % retained above No. 4

R_{200} = % retained above 200

coarse

$$\frac{R_4}{R_{200}} = \frac{10}{92} = 0.109$$

$$0.109 \leq 0.5$$

$$F_{200} < 50$$

$$3.9 \quad C_u \geq 6 \quad \times$$

Sandy soil

$$8\% < 50\%$$

$$1 \leq C_c \leq 3 \quad \checkmark$$

doesn't meet SW

Group Symbols

$$SP \quad F_{200} < 5: 8\% < 5\% \quad \times$$

$$SM \quad F_{200} > 12: 8\% > 5\%; PI < 4: 31 < 4$$

$$SC \quad F_{200} > 12: 8\% > 5\%; PI > 7: 31 > 7 \quad \checkmark \checkmark$$

$$SW \quad F_{200}; C_u \geq 6; 1 \leq C_c \leq 3$$

$$SW-SC \quad 5 \leq F_{200} \leq 12 \quad \checkmark \text{ satisfies } C_u \text{ and } C_c \text{ of SW; PI of SC } \checkmark$$

$$SP-SM \quad 5 \leq F_{200} \leq 12 \quad \checkmark \text{ Not satisfy } C_u \text{ and } C_c \text{ of SW; PI of SM}$$

$$SP-SC \quad 5 \leq F_{200} \leq 12 \quad \checkmark \text{ NA satisfy } C_u \text{ and } C_c \text{ of SW; PI of SC } \checkmark$$

✓ SP-SC $\begin{cases} < 15\%g \rightarrow \boxed{\text{Poorly graded sand with clay (silty clay)}} \\ \geq 15\%g \rightarrow \end{cases}$

Poorly graded sand with clay

silty clay

Poorly graded sand with clay and gravel (silty clay and gravel)

Problem 3

Soil	Particle size distribution		
	sand	silt	clay
B	55	5	40
C	45	35	20
D	50	15	35
E	70	15	15

USDA textural classification

Soil B

S - 55%

M - 5%

C - 40%

sandy clay ✓

Soil C

S - 45%

M - 35%

C - 20%

Loam ✓

Soil D

S - 50%

M - 15%

C - 35%

sandy clay loam -1

Soil E

S - 70%

M - 15%

C - 15%

sandy loam ✓

Problem 4

ASHTO classification system

Soil A:

$$F_{10} = 98\%$$

$$F_{40} = 80\%$$

$$F_{200} = 72\% \text{ more than } 35\% \text{ of total sample passing No. 200}$$

$$LL = 52$$

$$PL = 31$$

$$PI = 21$$

A-7

41 min

11 min

$$A-7-5, PI \leq LL-30 \quad 21 \leq 52-30 = 22 \quad \checkmark \text{ clayey soils}$$

$$A-7-6, PI > LL-30 \quad 21 > 52-30 = 22 \quad \times$$

A-7-5 (16) ✓

$$\begin{aligned} GI &= (F_{200} - 35)[0.2 + 0.005(LL - 40)] + 0.01(F_{200} - 15)(PI - 10) \\ &= (72 - 35)[0.2 + 0.005(52 - 40)] + 0.01(72 - 15)(21 - 10) \end{aligned}$$

$$GI = 15.89$$

$$GI = 16$$

Soil B

$$F_{10} = 90$$

$$F_{40} = 74$$

$$F_{200} = 58 \geq 35\% \text{ total passing } \frac{\text{silt-clay}}{\text{total passing}}$$

$$LL = 38$$

$$PL = 26$$

$$PI = 12$$

A-6

Clayey soils

40 max - LL

11 min - PI

$$GI = (F_{200} - 35)[0.2 + 0.005(LL - 40)] + 0.01(F_{200} - 15)(PI - 10)$$

$$= (58 - 35)[0.2 + 0.005(38 - 40)] + 0.01(58 - 15)(12 - 10)$$

$$GI = 5.23$$

$$GI = 5$$

A-6(5) ✓

**GEOTECHNICAL ENGINEERING SPRING
2022**

Title of Assignment: Assignment 5

TOPICS COVERED IN ASSIGNMENT 5:

Effective Stress

**GEOTECHNICAL ENGINEERING
SPRING 2022**

**SAMPLE ASSIGNMENT QUESTIONS, SOLUTION,
AND GRADING SCHEME FOR HW 5**

CVEG 3300
Geotechnical Engineering
Spring 2022

Assignment-5

Department of Civil & Environmental Engineering
Prairie View A&M University



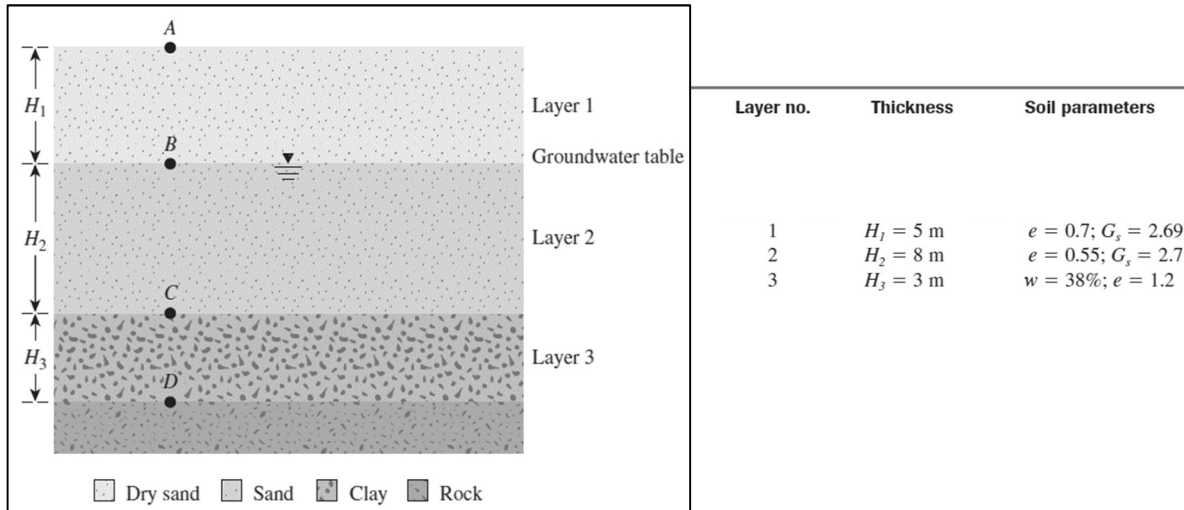
Use the following format for all your homework: Hard copy of your assignment is required in the class.

1. Your homework should be complete, neat, and professionally presented.
2. Use engineering paper for submitting your homework. If graph is required for the home work, use appropriate graph (e.g., arithmetic graph, log or semi-log graph etc.)ss
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11. Show all steps for arriving to the final answer clearly. Include all appropriate sketches.
12. Reference all figures, tables, constant values, equations, and conversions used to complete the problem.
13. Include all the appropriate units throughout the solution. Points will be deducted for answers presented without the appropriate units.
14. Start a new page for every new problem.
15. Problems should be in the order assigned.

Problem 1

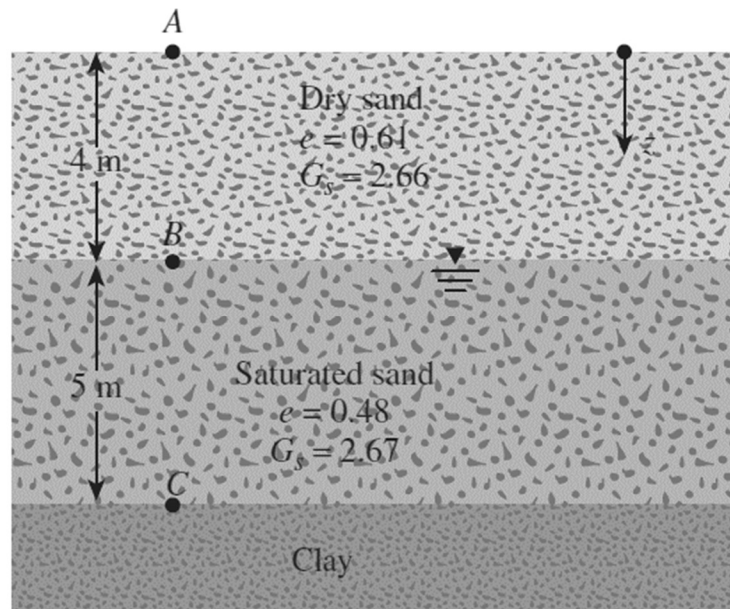
Consider the soil profile below. What is the change in effective stress at point C if:

- the water table drops by 2 m?
- the water table rises to the surface up to point A?
- water level rises 3 m above point A due to flooding?



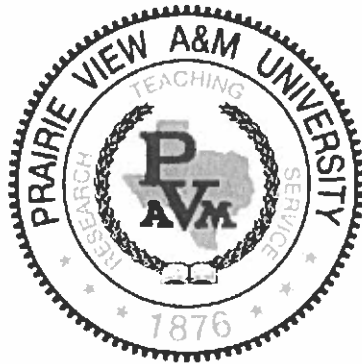
Problem 2

Plot the stress profile for total stress, effective stress and pore water pressure. Show all calculation.



ABOVE AVERAGE

100
Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department



CVEG 3300 P01 – Geotechnical Engineering

Spring 2022

Homework #5

Maalvika Aggarwal

Dr. Md Jobair Bin Alam

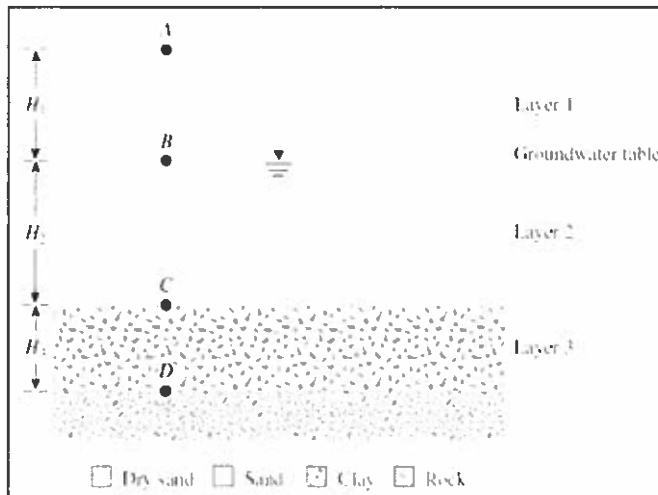
Date Given: 28 March 2022

Date Submitted: 4 April 2022

Problem 1

Consider the soil profile below. What is the change in effective stress at point C if:

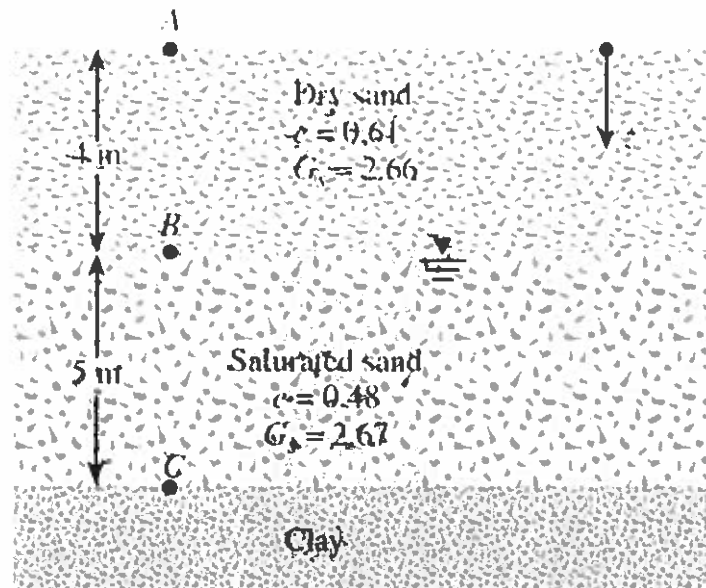
- the water table drops by 2 m?
- the water table rises to the surface up to point A?
- water level rises 3 m above point A due to flooding?

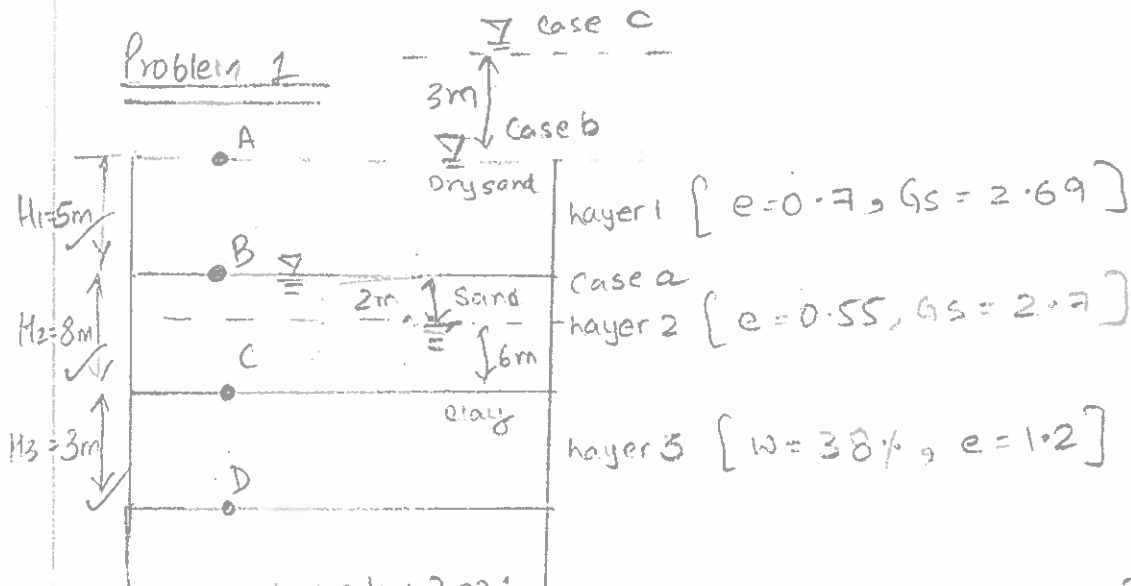


Layer no.	Thickness	Soil parameters
1	H ₁ = 5 m	$e = 0.7$; $G_s = 2.69$
2	H ₂ = 8 m	$e = 0.55$; $G_s = 2.7$
3	H ₃ = 3 m	$w = 38\%$; $e = 1.2$

Problem 2

Plot the stress profile for total stress, effective stress and pore water pressure. Show all calculation.



Problem 1Case a

Water level drops by 2m;

$$q_d = \frac{G_s \rho_w}{1+e} = \frac{(2.69)(9.81)}{1+0.7} = 15.52 \text{ kN/m}^3$$

(Layer 1)

$$q = \frac{G_s \rho_w}{1+e} = \frac{(2.7)(9.81)}{1+0.55} = 17.08 \text{ kN/m}^3$$

(Layer 2)

$$q_{sat} = \frac{G_s + e}{1+e} (q_w) = \frac{2.7+0.55}{1+0.55} (9.81) = 20.57 \text{ kN/m}^3$$

(Layer 2)

At point A, $\sigma_A = u_A = \sigma'_A = 0$ ✓

$$\text{So, At point B, } \sigma_B = q_d(5) = 15.52(5) = 77.6 \text{ kN/m}^2$$

 $u = 0$ (point is above water level) ✓

$$\text{So, } \sigma'_B = \sigma_B - u = 77.6 - 0 = 77.6 \text{ kN/m}^2$$

$$\text{At 2m below water level, } \sigma = (17.08)(2) + 77.6 = 111.76 \text{ kN/m}^2$$

 $u = 0$ (above water level) ✓

$$\text{So, } \sigma'_{2m \text{ below B}} = 111.76 - 0 = 111.76 \text{ kN/m}^2$$

$$\text{So, At point C, } \sigma_C = (20.57)(6) + 111.76 = 235.18 \text{ kN/m}^2$$

$$u_C = \rho_w h = (9.81)(6) = 58.86 \text{ kN/m}^2$$

$$\sigma'_C = 235.18 - 58.86 = 176.32 \text{ kN/m}^2$$

AEO, initially, when water level was at B,

$$\text{At point B, } \sigma_B = q_d \cdot h = 15.52 \times 5 = 77.6 \text{ kN/m}^2$$

 $u = 0$

At point C, $\sigma_B = (20.57)(8) + 77.6 = 242.16$

$u_C = \gamma_w h = (9.81)(8) = 78.48$

So, $\sigma'_C = 242.16 - 78.48 = 163.68 \text{ kN/m}^2$ (original)

Therefore, change in effective stress at C = $176.32 - 163.68$
 $= 12.64 \text{ kN/m}^2$ ✓

Case b Water level of point A.

Now, γ_{sat} (layer 1) = $\frac{(\gamma_{s+e})(\gamma_w)}{1+e} = \frac{2.69 + 0.4(9.81)}{1+0.7}$
 $= 19.56 \text{ kN/m}^3$ ✓

γ_{sat} (layer 2) = $\frac{2.7 + 0.55(9.81)}{1+0.55} = 20.57 \text{ kN/m}^3$ ✓

Now, At point A, $\sigma_A = u_A = \sigma'_A = 0$ ✓

At point B, $\sigma_B = \gamma_{sat}(h) = 19.56(5) = 97.8 \text{ kN/m}^2$ ✓

$u_B = \gamma_w h = 9.81(5) = 49.05 \text{ kN/m}^2$

So, $\sigma'_B = 97.8 - 49.05 = 48.75 \text{ kN/m}^2$ ✓

So, at point C, $\sigma_C = 97.8 + (20.57)(8) = 262.36 \text{ kN/m}^2$ ✓

$u_C = (49.05) + (9.81)(8) = 127.53 \text{ kN/m}^2$

So, $\sigma'_C = 262.36 - 127.53 = 134.83 \text{ kN/m}^2$

So, change in effective stress at C = $163.68 - 134.83$

$= 28.85 \text{ kN/m}^2$ ✓

Case c Water level rises 3m above point A

At point A, $\sigma_A = (\gamma_w)h = (9.81)(3) = 29.43 \text{ kN/m}^2$ (since it's only water) ✓

$u_A = \gamma_w h = (9.81)(3) = 29.43 \text{ kN/m}^2$ ✓

So, $\sigma'_A = 29.43 - 29.43 = 0$ ✓

At point B, $\sigma_B = (\gamma_{sat})_{\text{layer 1}}(h) + 29.43 = 19.56(5) + 29.43 = 127.23 \text{ kN/m}^2$

$u_B = 29.43 + 9.81(5) = 78.48 \text{ kN/m}^2$ ✓

$\sigma'_B = 127.23 - 78.48 = 48.75 \text{ kN/m}^2$ ✓

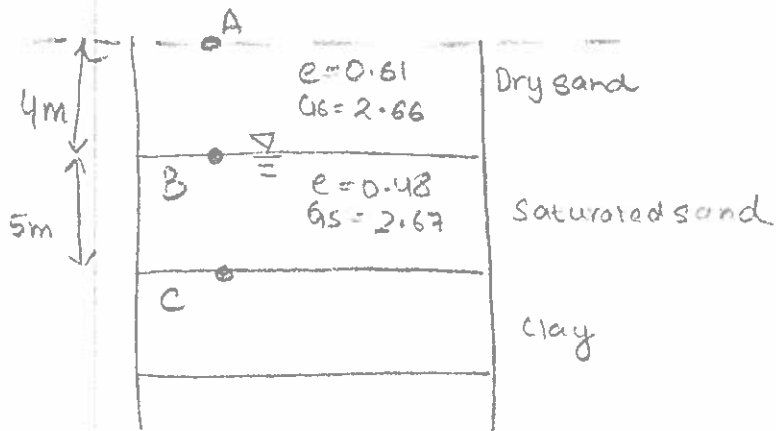
$$\text{At point C, } \sigma_c = 127.23 + (20.57)(8) = 291.79 \text{ kN/m}^2$$

$$u_c = 78.48 + (9.81)(8) = 156.96 \text{ kN/m}^2$$

$$\sigma'_c = 291.79 - 156.96 = \underline{134.83 \text{ kN/m}^2}$$

$$\text{So, change in effective stress at C} = 163.68 - 134.83$$

$$= \boxed{28.85 \text{ kN/m}^2}$$

Problem 2

$$\gamma_d \text{ (layer 1)} = \frac{G_s \gamma_w}{1+e} = \frac{2.66 (9.81)}{1+0.61} = 16.21 \text{ kN/m}^3 \checkmark$$

$$\gamma_{sat} \text{ (layer 2)} = \frac{(G_s + e) \gamma_w}{1+e} = \frac{2.67 + 0.48}{1+0.48} (9.81) = 20.88 \text{ kN/m}^3$$

At point A, $\sigma_A = u_A = \sigma'_A = 0 \text{ kN/m}^2$

At point B, $\sigma_B = \gamma_d(h) = (16.21)(4) = 64.84 \text{ kN/m}^2 \checkmark$

$u_B = 0$ (water level is at B) $\checkmark$

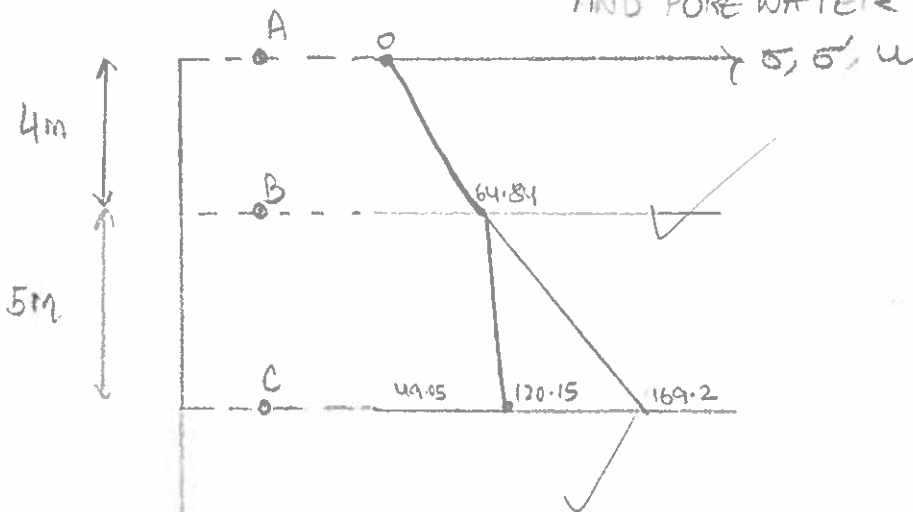
So, $\sigma'_B = 64.84 - 0 = 64.84 \text{ kN/m}^2 \checkmark$

At point C, $\sigma_C = 64.84 + 20.88(5) = 169.2 \text{ kN/m}^2 \checkmark$

$u_C = (\gamma_w)(h) = (9.81)(5) = 49.05 \text{ kN/m}^2 \checkmark$

So, $\sigma'_C = 169.2 - 49.05 = 120.15 \text{ kN/m}^2 \checkmark$

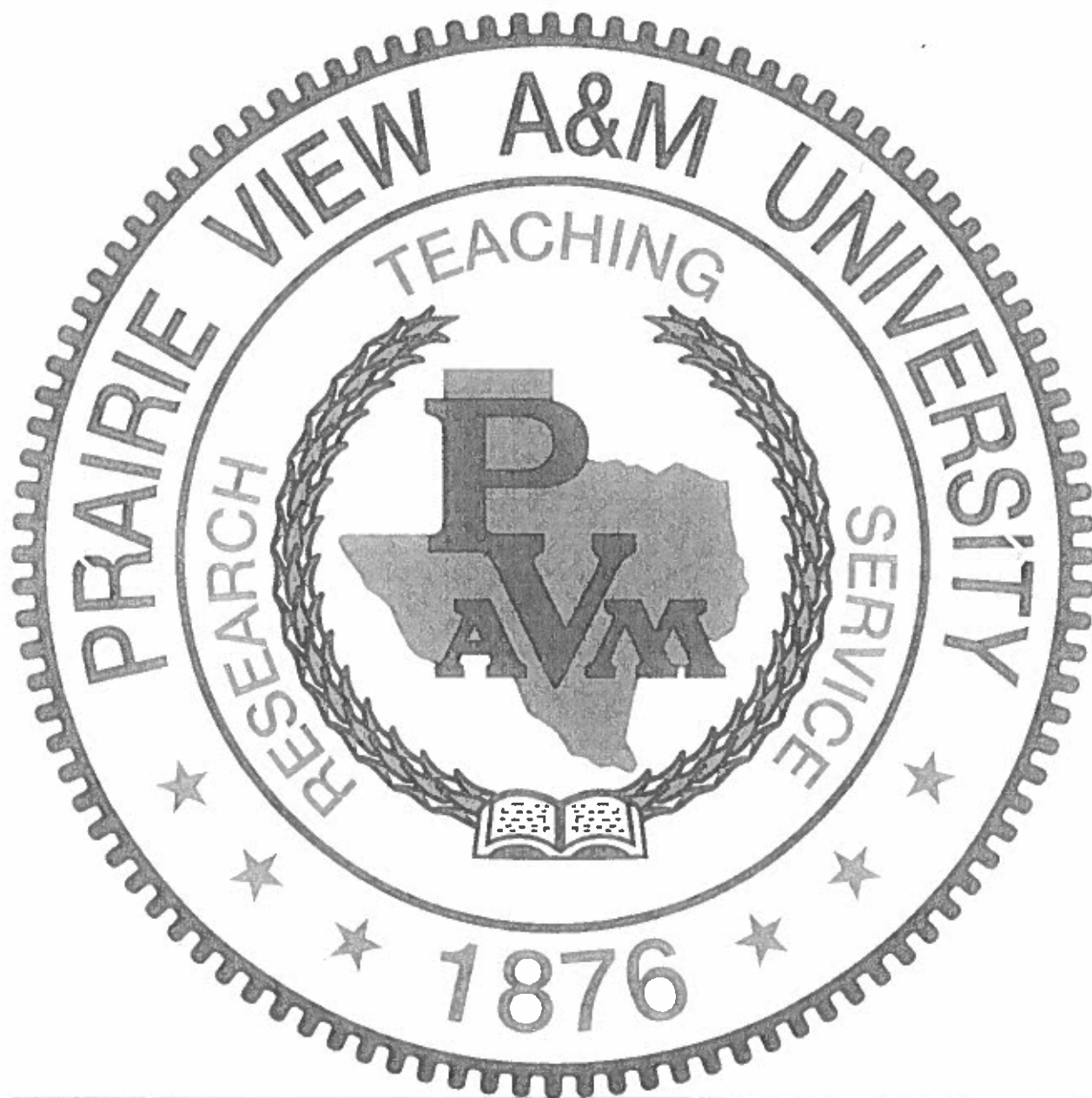
STRESS PROFILE FOR TOTAL EFFECTIVE STRESS AND PORE WATER PRESSURE



[—] TOTAL STRESS

AVERAGE

*Bookstore currently out of Engineering Paper



CVEG3300-P01: Geotechnical Engineering

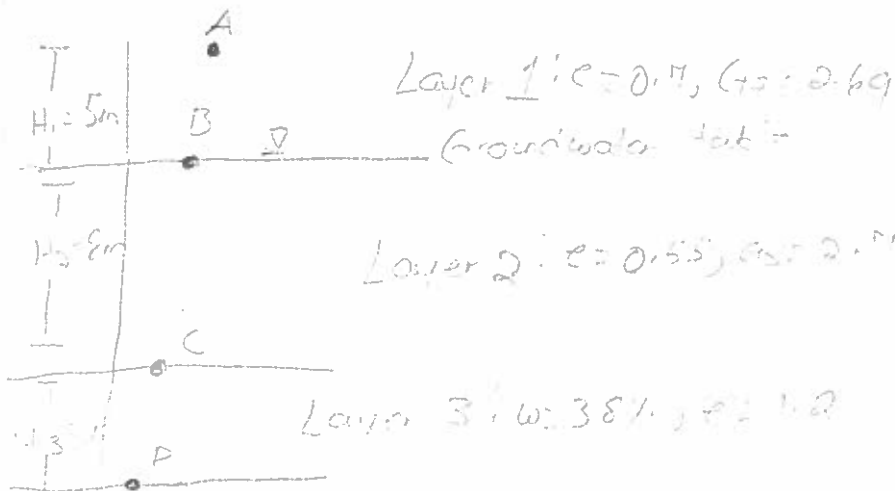
Dr. Alam

Hw 5

April 4, 2022

Tyrah Owens

40/50



$$S_r = \frac{(G_s) \gamma_w}{\gamma_{sat}}$$

$$= \frac{(2.65)(9.81)}{14.5}$$

$$= 15.52\%$$

$$S_r = \frac{(G_s) \gamma_w}{\gamma_{sat}}$$

$$= \frac{(2.7)(9.81)}{14.5}$$

$$= 26.56\%$$

$$S_r = \frac{(G_s) \gamma_w}{\gamma_{sat}} = \frac{\left(\frac{e_3}{w} + e_3\right) \gamma_w}{1 + e_3}$$

$$= \frac{\left(\frac{1.2}{0.38} + 1.2\right)(9.81)}{1 + 1.2}$$

$$= 15.52\%$$

$$S_r = 15.52\%$$

$$U = \frac{(S_r)(15.52)}{(15.52)(5) + (17.08)(2)}$$

$$= 202.08\%$$

$$U = 100\%$$

$$= 15.52\%$$

$$= 15.52\%$$

$$U = 100\%$$

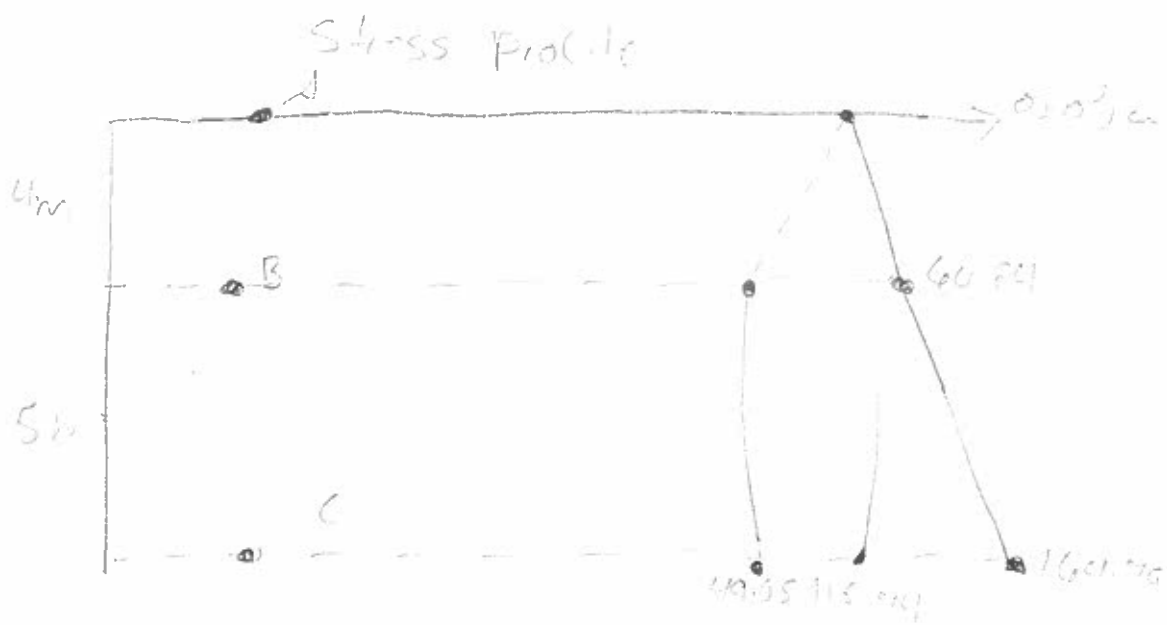
$$\text{At 2m below} = (15.52)(5) + (17.08)(2) = 111.76$$

45/50

2.

4m	A	$\sigma = 3.61$	$\gamma_d = \frac{G_s \cdot 100}{1+e} = \frac{2.66 \cdot 100}{1+0.66} = 16.2$
1	B	$\sigma = 2.66$	
5m	C	$\sigma = 0.08$	$\gamma_d = \frac{G_s \cdot 100}{1+e} = \frac{2.66 \cdot 100}{1+0.66} = 16.2$
1	C	$\sigma = 2.66$	

1. $\sigma_v = 0$
 2. $\sigma_v = 0$
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 4. $\sigma_v = 0$
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 49. $\sigma_v = 0$
 50. $\sigma_v = 0$



BELOW AVERAGE

70/
100

CVEG 3300
Geotechnical Engineering
Spring 2022

Erik Smith

Assignment-5

04/24/22

Department of Civil & Environmental Engineering
Prairie View A&M University



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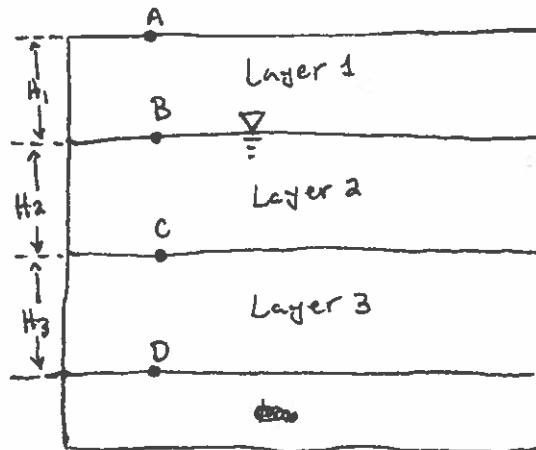
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15. Problems should be in the order assigned.

30/50

problem #1:

Consider the soil profile below. what is the change in effective stress at point C if:

- the water table drops by 2 m?
- the water table rises to the surface up to point A?
- water level rises 3 m above point A due to flooding?



Layer #	Thickness	Soil parameters
1	$H_1 = 5\text{ m}$	$e = 0.7, G_s = 2.69$
2	$H_2 = 8\text{ m}$	$e = 0.85, G_s = 2.7$
3	$H_3 = 3\text{ m}$	$w = 38\%, e = 1.2$

$$\gamma_{L1} = \frac{(2.69 \times 1000) + (0.7 \times 1000)}{1 + 0.7} = 15.53 \text{ kN/m}^3$$

$$\gamma_{L2} = \frac{(2.7 \times 1000) + (0.85 \times 1000)}{1 + 0.85} = 20.56 \text{ kN/m}^3$$

$$\gamma_{L3} = \frac{(2.7 \times 1000) + (1.2 \times 1000)}{1 + 1.2} = 19.41 \text{ kN/m}^3$$

Effective stress: $(\sigma') = \sigma - u$

$$\sigma_{\text{initial}} = (H_1) \gamma_{L1} + (H_2) \gamma_{L2} \Rightarrow (5 \times 15.53) + (8 \times 20.56) = 242.08 \text{ kN/m}^2$$

$$u_{\text{point C}} = H_2 \times \gamma_w = (8 \times 9.81) = 78.48 \text{ kN/m}^2$$

$$\sigma'_{\text{point C}} = (242.08 - 78.48) = 163.6 \text{ kN/m}^2$$

$$A) \sigma'_C = \sigma - u \Rightarrow \gamma_{L1}(H_1) + \gamma_{L2}(H_2 - 2) - \gamma_w(H_2 - 2) = 121.22 \text{ kN/m}^2$$

$$\Delta \sigma'_C = \sigma'_C - \sigma'_{\text{initial}} \Rightarrow (163.6 - 121.22) = 42.38 \text{ kN/m}^2$$

$$B) \gamma_{L1} = \frac{(2.69 + 0.7)(1000)}{1 + 0.7} = 14.56 \text{ kN/m}^3$$

$$\sigma_{\text{initial}} = \sigma - u \Rightarrow \gamma_{L1}(H_1) + \gamma_{L2}(H_2) - \gamma_w(H_2) = 131.18 \text{ kN/m}^2$$

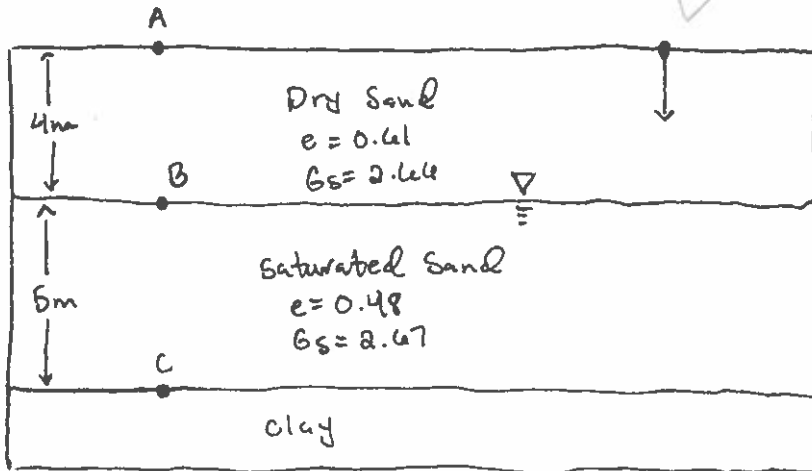
$$\Delta \sigma'_C = \sigma'_C - \sigma'_{\text{initial}} \Rightarrow (163.6 - 131.18) = 32.42 \text{ kN/m}^2$$

$$C) \sigma'_C = \sigma - u \Rightarrow \gamma_w(3\text{ m}) + \gamma_{L1}(H_1) + \gamma_{L2}(H_2) - \gamma_w(3 + H_1 + H_2) = 134.75 \text{ kN/m}^2$$

40/50

Problem 2:

Plot the stress profile for total stress, effective stress and pore water pressure. Show all calculation.



Solution:

$$\gamma_w = 9.81 \text{ kN/m}^3$$

$$\gamma = \frac{(G_s \times \gamma_w)}{1 + e}$$

$$\gamma_{\text{dry sand}} = \frac{(2.65)(9.81 \text{ kN/m}^3)}{1 + (0.61)}$$

$$\gamma_{\text{dry sand}} = 16.21 \text{ kN/m}^3$$

$$\gamma_{\text{sand}} = \frac{(2.67)(9.81 \text{ kN/m}^3)}{1 + (0.48)}$$

$$\gamma_{\text{sand}} = 17.7 \text{ kN/m}^3$$

$$\begin{aligned} G &= \gamma \times h \\ U &= \gamma_w \times h \\ G' &= G - U \end{aligned} \quad 20.88$$

$$\text{At A: } \sigma = 0, \tau = 0, u = 0$$

$$\sigma = 0$$

$$\sigma = (16.21 \text{ kN/m}^3)(4 \text{ m}) = 64.84 \text{ kPa}$$

$$\sigma = (17.7 \text{ kN/m}^3)(5 \text{ m}) = 88.5 \text{ kPa}$$

$$\sigma = 0$$

$$\sigma = (4 \times 16.21) + (5 \times 17.7) = 103.34 \text{ kPa}$$

$$u = (5 \text{ m})(9.81 \text{ kN/m}^3) = 49.05 \text{ kPa}$$

$$\sigma' = (103.34) - (49.05) = 54.29 \text{ kPa}$$

stress profile:

