UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *CIVIL ENGINEERING*
SUBJECT	:	**GEOTECHNICAL ENGINEERING 3A**
CODE	:	**GTG3A11**
DATE	:	31 MAY 2016
DURATION	:	12:30 - 15:30
WEIGHT	:	50:50
TOTAL MARKS	:	100

EXAMINER	:	DR FN OKONTA
MODERATOR	:	DR HA QUAINOO
NUMBER OF PAGES	:	8 PAGES AND 3 ANNEXURES

INSTRUCTIONS : QUESTION PAPERS MUST BE HANDED IN.

INSTRUCTIONS TO CANDIDATES:

PLEASE ANSWER ALL THE QUESTIONS.
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Question1 20 marks

1.1) Discuss the conditions that need to be met for the formation of a residual soil as well as its characteristics.

1.2) In order to determine the specific gravity of a residual soil, an empty gas jar was weighed together with its glass cover plate and the mass was found to be 480g. The mass of the jar completely filled with water with its cover plate fitted was found to be 1510.2 g. An oven dried sample of soil was inserted in the empty dry gas jar, the cover plate was fitted and the total mass was found to be 678.6g. Water was then added to the soil in the gas jar, the jar and its content was shaken and the water was topped up until the gas jar was full to the brim, the cover plate was again fitted and the total mass was found to be 1634.6g.
Determine the particle specific gravity of the soil.

Question 2 20 marks

2.1) Define the adsorbed water layer in clay particles and discuss its effect on the properties of clay soils.

2.2) A profile of a soil: soil F is shown on the figure 2.1. A sample of it was taken 4 m below the natural ground level and a sieve analysis as well as atterberg limits test were performed on it. Figure 2.2 shows the results of the sieve analysis (curve F) and its atterberg limits were found to be:

Plastic limit: 20

Liquid limit: 34

The soil sample was found to be fully saturated. Explain the reason why?

Calculate the pore water pressure 4 m above the ground water table and 4 m below.

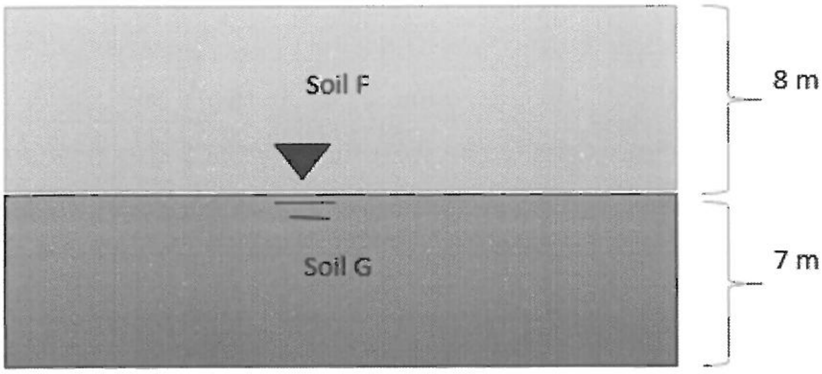

Figure 2.1

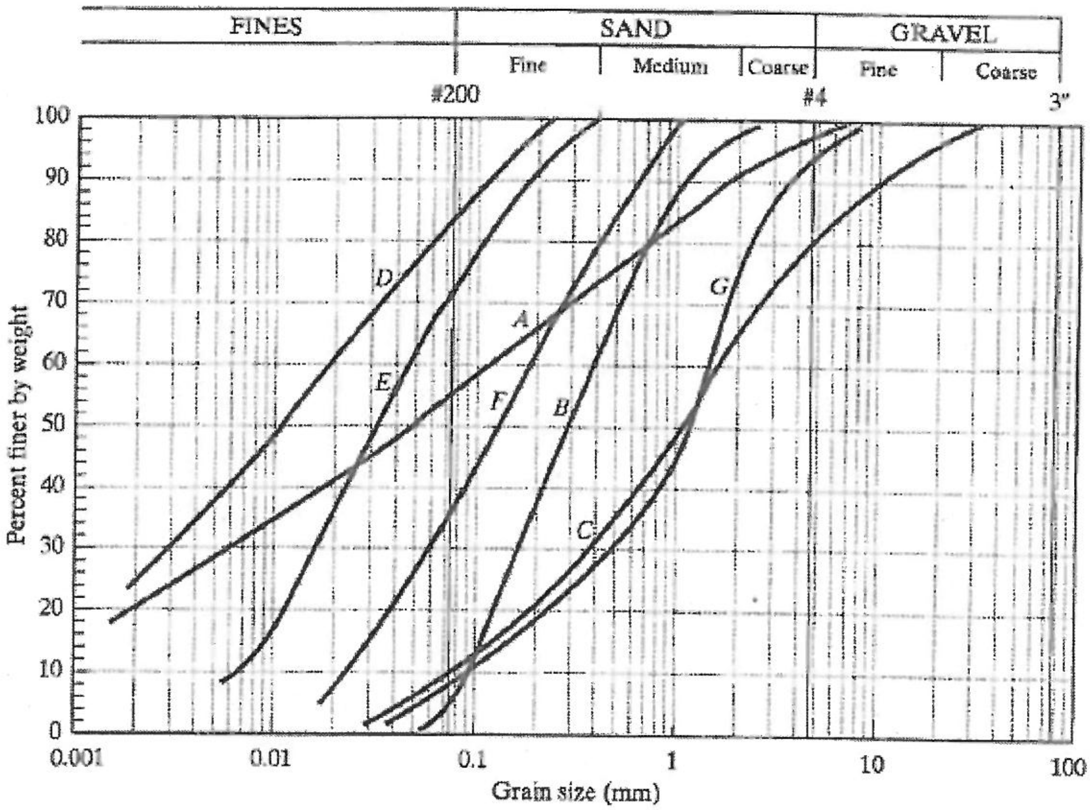

Figure 2.2

Question 3 20 marks

3.1) Additional classifications apart from the common textural ones (AASHTO, USCS...) like the consistency of a soil are very useful supplementary classifications of a soil because they sometimes provide important information about the in-situ condition of the soil. Consistency depends on others factors apart from the water content. Name these factors and discuss how the affect the consistency.

3.2) A sieve analysis and Atterberg limits are done on an inorganic soil: soil A, and the results are shown in the table below. Classify the soil using the USCS classification (group symbol and group name).

		Percent passing
Sieve size	Opening size (mm)	Soil A
No.4	4.75	100
No.10	2	100
No.20	0.85	98
No.40	0.425	93
No.60	0.25	88
No.100	0.15	83
No.200	0.075	77
	0.01	65
	0.002	60
Liquid limit		63
Plasticity index		25

Question 4 20 marks

4.1) Compaction equipment use different methods in order to compact a soil. One of them is manipulation. Define this method of compaction. On which type of soil does it work best and why?

4.2) A contractor is given as a compaction requirement a relative compaction of 90%. Results of a proctor compaction test effectuated on a soil sample taken from the profile are shown below.

volume of proctor mold in cm3	Mass of wet soil in the mold	Moisture content %
943.3	1.71	10.6
943.3	1.77	12.1
943.3	1.83	13.8
943.3	1.86	15.1
943.3	1.88	17.4
943.3	1.87	19.4

If a nuclear density tests results on the compacted field give the following results:

Unit weight: 18 KN/m^3

In-situ moisture content: 13%

Has the contractor met the requirements? If no why.

Question 5 20 marks

5.1) The hydraulic conductivity depends on properties of the soil and the liquid flowing through it. Discuss how 4 of these properties affect the hydraulic conductivity.

5.2) In order to estimate the impacts of seepage from a broken pipe in a sand profile, an undisturbed soil sample from the profile was taken and an hydraulic conductivity test performed on it.

The sample was tested in a constant head permeameter. The sample diameter was 60 mm with a length of 120 mm. The permeameter used had two piezometer whose tips were spaced 15 cm apart. The levels of water in the 2 piezometers from the table where the test was performed were 1.40 m and 0.90 m. 120 cm^3 flowed through the sample in 5 min.

If the sample was taken from an unconfined aquifer and the water table in the profile is flowing at 10 ^{0} from the horizontal. What is the seepage velocity through the profile if the void ratio of the soil sample is 0.6? (Assume the angle at which the water table is flowing is small, cos angle= tan angle).

YOU MAY USE ANY OF THE FOLLOWING EQUATION

$$I_P = w_L - w_P$$

$$I_L = \frac{w - w_P}{I_P}$$

$$S = \frac{wG_s}{e} \times 100\%$$

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

$$\gamma_d = \frac{G_s \gamma_w}{1 + wG_s/S}$$

$$W_s = \frac{W}{1 + w}$$

$$M_s = \frac{M}{1 + w}$$

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

$$w = S\left[\frac{\gamma_w}{\gamma_d} - \frac{1}{G_s}\right] \times 100\%$$

$$S = \frac{w}{\frac{\gamma_w}{\gamma_d} - \frac{1}{G_s}} \times 100\%$$

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

$$n = \frac{V_v}{V} \times 100\%$$

$$n = \frac{e}{1 + e} \times 100\%$$

$$n_w = \frac{V_w}{V} \times 100\%$$

$$D_r = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100\%$$

$$G_s = \frac{M_s}{V_s \rho_w}$$

$$C_R = \frac{\gamma_d}{(\gamma_d)_{max}} \times 100\%$$

$$V = \frac{W_1 - W_2}{\gamma_{sand}} - V_{cone}$$

$$i = -\frac{dh}{dl}$$

$$u = \gamma_w h_p$$

$$u = u_h = \gamma_w z_w$$

$$Q = kiA$$

$$k = \frac{aL}{At} \ln\left(\frac{\Delta h_0}{\Delta h_1}\right)$$

$$k = CD_{10}^2$$

$$k_x = \frac{\sum k_i H_i}{\sum H_i}$$

$$k_z = \frac{\sum H_i}{\sum \left(\frac{H_i}{k_i}\right)}$$

$$T = kH_a$$

$$Q = TiL$$

$$q = \frac{Q}{L} = Ti$$

$$v_s = \frac{ki}{n_e}$$

$$h_c = \frac{0.15}{D_{10}}$$

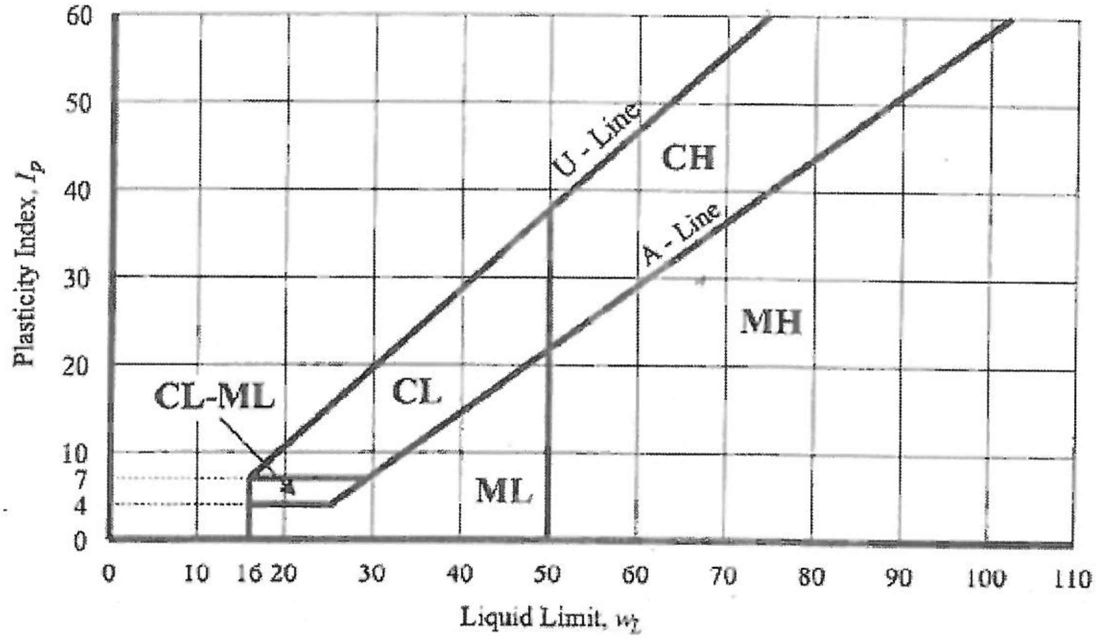

Figure 5.3 Plasticity chart (ASTM D2487). The "A-line" separates silts from clays, while the "U-line" represents the upper limit of recorded test results. Data that plot above the U-line are probably in error. Note how the vertical axis is the plasticity index, not the plastic limit. Soils identified as "non-plastic" (NP) are classified as ML.

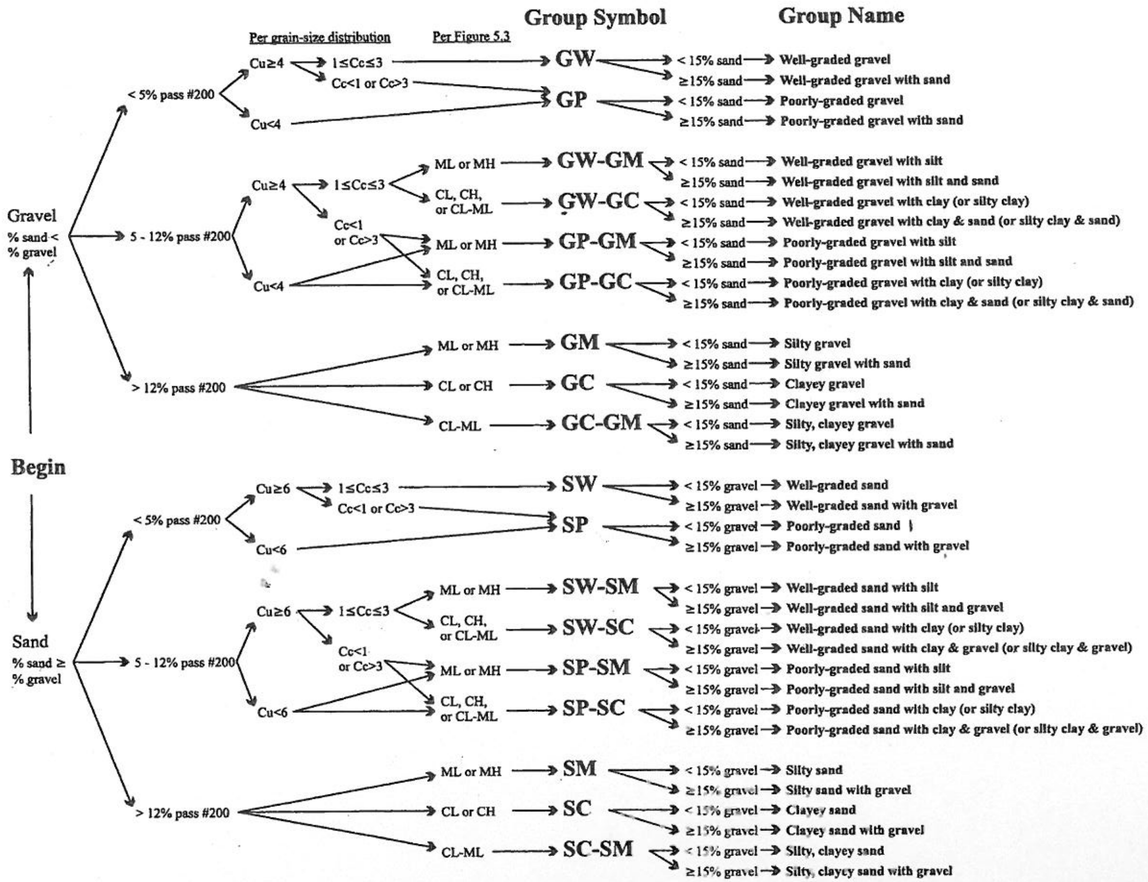

Figure 5.6 Flow chart for classification of coarse-grained soils (< 50% passing #200 sieve) (Adapted from ASTM D2487). C_u and C_c are the coefficients of uniformity and curvature as defined in Chapter 4. The alternative endings for some group names (shown in parenthesis) are for soils that plot as CL-ML on Figure 5.3.

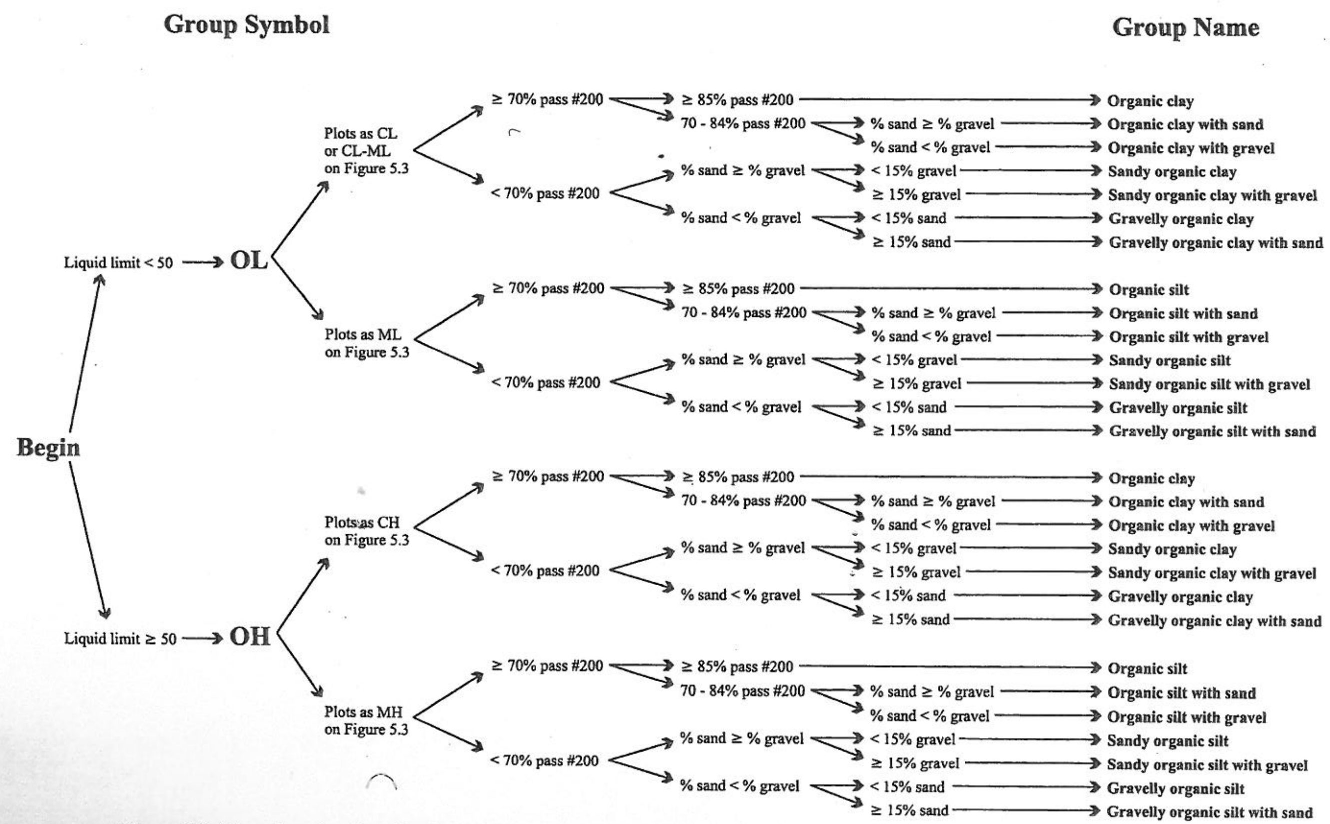

Figure 5.5 Flow chart for classification of organic fine-grained soils (≥50% passing #200 sieve) (Adapted from ASTM D2487).

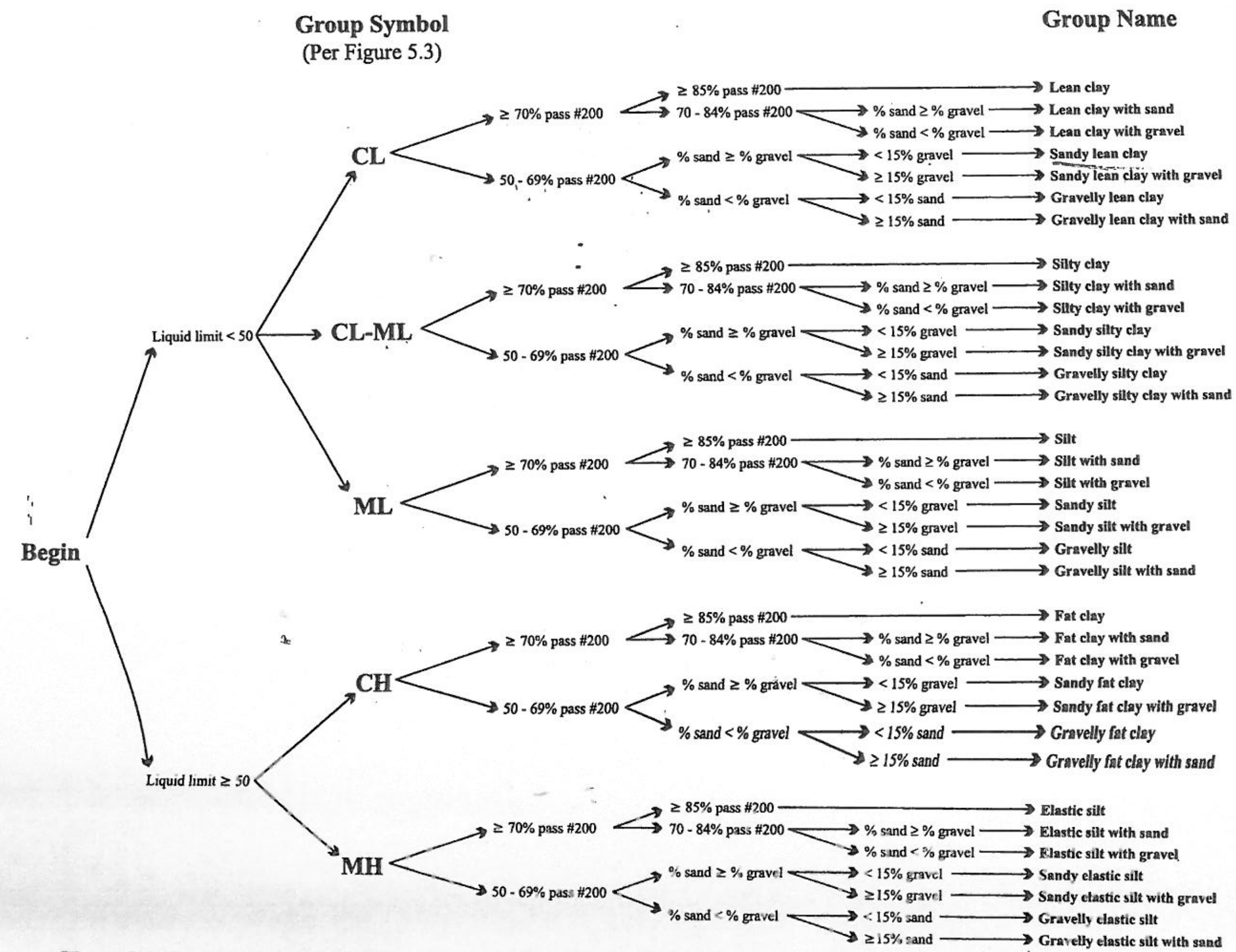

Figure 5.4 Flow chart for classification of inorganic fine-grained soils (≥50% passing #200 sieve) (Adapted from ASTM D2487).

UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *CIVIL ENGINEERING*
SUBJECT	:	**GEOTECHNICAL ENGINEERING 3A**
CODE	:	**GTG3A11**
DATE	:	SUPPLEMENTARY EXAMINATION JULY 2016
DURATION	:	180 MIN
WEIGHT	:	50:50
TOTAL MARKS	:	100

EXAMINER	:	DR FN OKONTA
MODERATOR	:	DR HA QUAINOO
NUMBER OF PAGES	:	4 PAGES AND 6 ANNEXURES

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QUESTION 1 (20 MARKS)

1.1) Earth materials can be divided in 2 categories: rock and soil. List the main differences between these two materials.

(6 marks)

1.2) It is intended to construct an embankment dam such that the porosity of the compacted fill is 0.32. If the approved borrow pit has a moisture content of 13% and density of 1630kg/m^3, what volume of the embankment can be constructed out of 2000m^{3}of the borrow pit. G_s= 2.7.

1.2.1) Calculate the volume of water needed to bring the soil from the borrow pit in its in-situ conditions to 100 saturation?

1.2.2) Will it be the same volume of water needed to bring the soil of the embankment to 100 saturation? (Justify your answer with calculations)

(14 marks)

QUESTION 2 (20 MARKS)

2.1) Clays are soils that are very different from gravels and sands. Two main of their differences have to do with the weathering processes that lead to each of their formation and their affinity for water. Discuss the differences of clays from sand and gravel in those two domains.

(6 marks)

2.2) Figure 3.1 shows the sieve analysis of a fine grained soil: soil A. Atterberg limits test were effectuated on them and gave a Liquid limit of 44 and a plastic limit of 21.

2.2.1) What is the plasticity index of the soil?

2.2.2) If a moisture content determination was effectuated on a soil sample A and was found to be 22%, what is the consistency of the soil?

2.2.3) If the sample is oven dried, will you expect its volume to noticeably decrease? Justify your answer?

2.2.4) If the unit weight of the in-situ soil is found to be 16KN/m^3, What will be the respective unit weights of the soil if the water content is increased to 45% then to 60%.

(14 marks)

QUESTION 3 (20 MARKS)

3.1) Engineers many times have to do without the benefit of laboratory tests to make quick judgments or even to decide on which laboratory test to make. How will you without the aid of laboratory tests distinguish between low plasticity and high plasticity clays?

(6 marks)

3.2) Classify soil C (curve C) from figure 2.1 below using the USCS classification system.

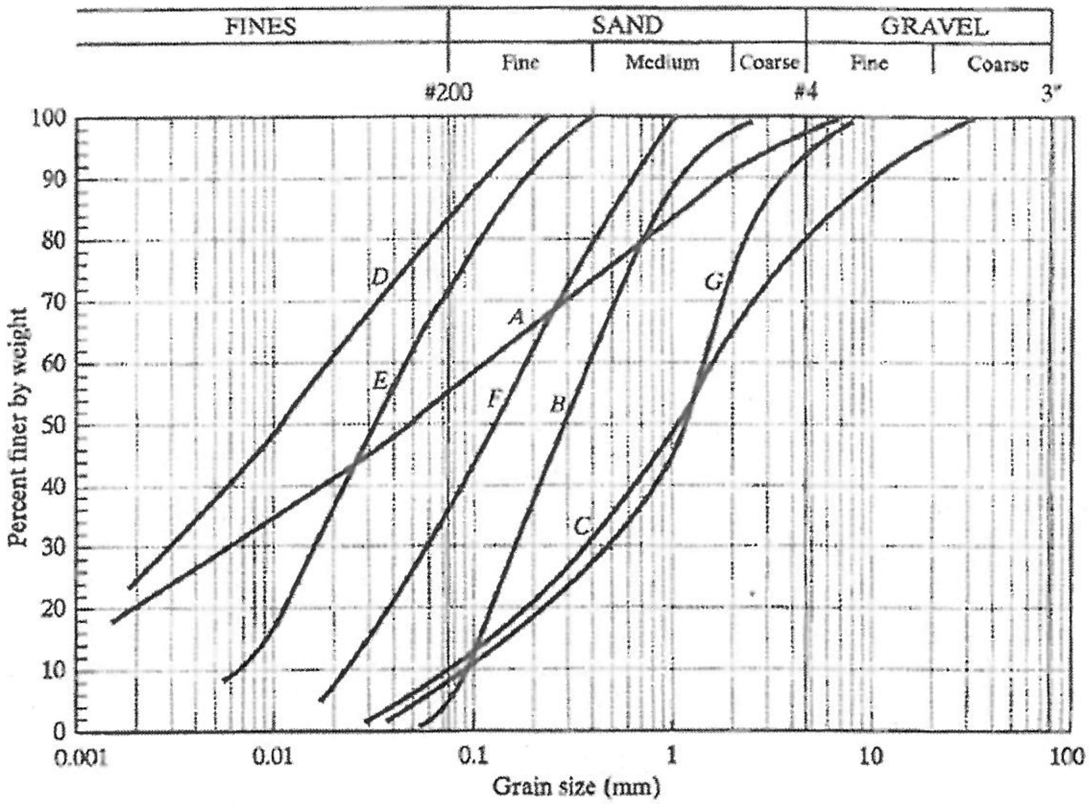

Figure 3.1: Grain-Size distribution curves

(14 marks)

QUESTION 4 (20 MARKS)

4.1) Compaction equipment use different methods in order to compact a soil. Explain the difference between the following two methods of compaction: impact and vibration.

(6 marks)

4.2) The grading plan of a construction site: site A calls for 20 000 m^3 of cut. Undisturbed samples from site A were analysed and their average unit weight were found to be 16.3 KN/m^3 with an average water content of 10% and a bulking factor of 8%. A proctor compaction test was done on a representative bulk sample from site A and produced (γ_d) max = 18 KN/m^3, and an OMC of 12%. Site B is a nearby site with an in-situ unit weight of 14.5 KN/m^3, a water content of 8% and a bulking factor of 10%.

4.2.1) If the compaction specification calls for 90% relative compaction, what must be the volume of fill in order to achieve a balanced earthwork?

4.2.2)The volume of fill needed for the work was latter calculated and found to be equal to 18 000 m^3, if applicable, calculate the net mass of the transported soil (between site A and site B).

(14 marks)

QUESTION 5 (20 MARKS)

5.1) Explain why it is most desirable to dig wells in confined aquifers.

(6 marks)

5.2) During a falling-head permeability test on a sample of soil, the head fell from 50 to 30cm in 4.5 min. The specimen was 5cm diameter and had a length of 90mm. The area of the standpipe was $0.5cm^2$.

5.2.1) Calculate the coefficient of permeability of the soil in cm/sec. What was the probable classification (or nature) of the soil tested (justify your answer with calculations)?

5.2.2) The tested soil was taken from a profile whose plan view is shown in the figure below (Figure 5.1). Open standpipes piezometers have been installed at points A, B and C. The levels of water in the 3 piezometers are respectively 20 m, 10 m and 16 m from a common reference point. What is the direction and the quantity of flow of water per unit width between point A and C if points A, B and C are in a phreatic zone of a saturated depth of 2m?

(14 marks)

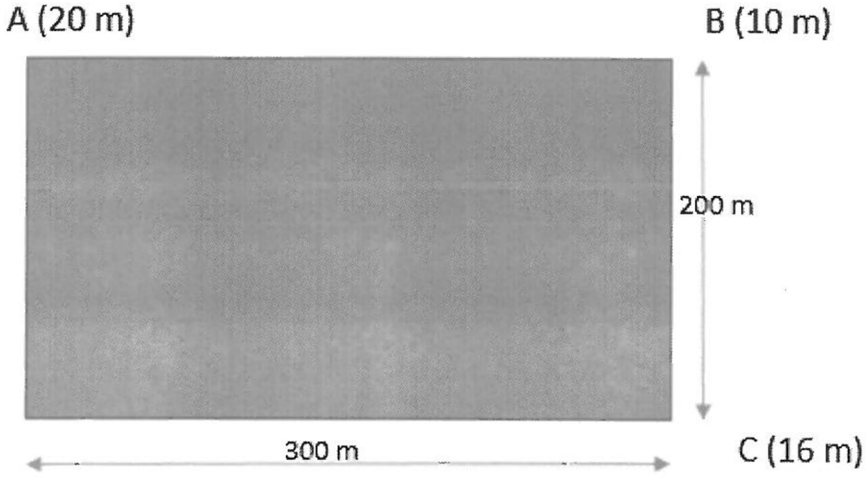

Figure 5.1: Plan view of a profile

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$$I_L = \frac{w - w_P}{I_P}$$

$$S = \frac{wG_s}{e} \times 100\%$$

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$$V = \frac{W_1 - W_2}{\gamma_{sand}} - V_{cone}$$

$$i = -\frac{dh}{dl}$$

$$u = \gamma_w h_p$$

$$u = u_h = \gamma_w z_w$$

$$Q = kiA$$

$$k = \frac{aL}{At} \ln\left(\frac{\Delta h_0}{\Delta h_1}\right)$$

$$k = C D_{10}^2$$

$$k_x = \frac{\sum k_i H_i}{\sum H_i}$$

$$k_z = \frac{\sum H_i}{\sum\left(\frac{H_i}{k_i}\right)}$$

$$T = kH_a$$

$$Q = TiL$$

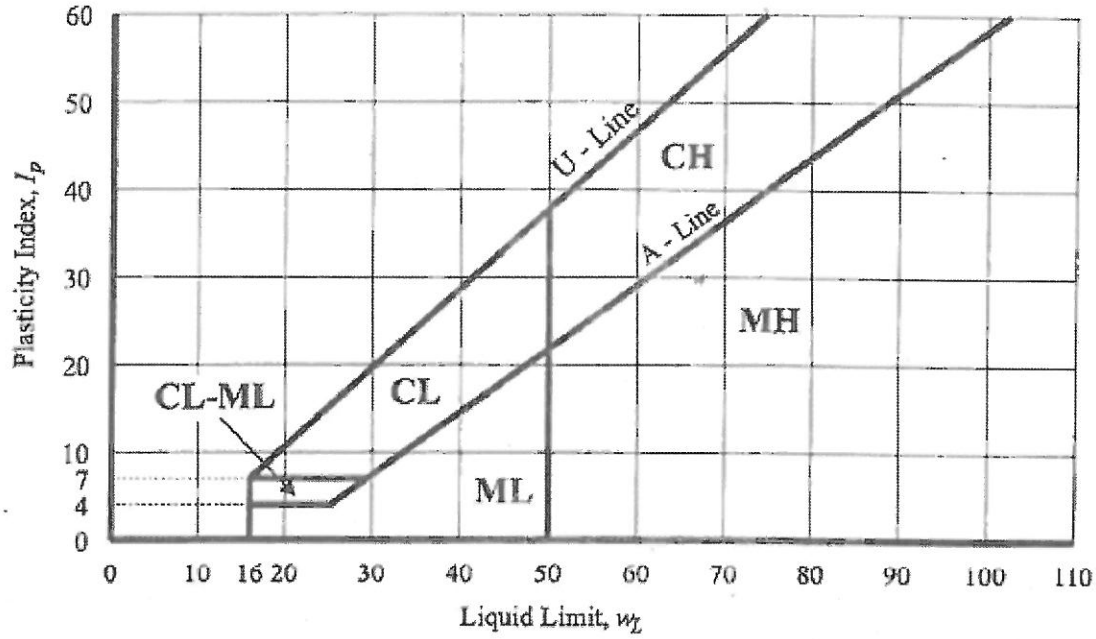
$$q = \frac{Q}{L} = Ti$$

$$v_s = \frac{ki}{n_e}$$

$$h_c = \frac{0.15}{D_{10}}$$

$Cu = D_{60} / D_{10}$

$Cc = (D_{30})^2 / (D_{10}D_{60})$



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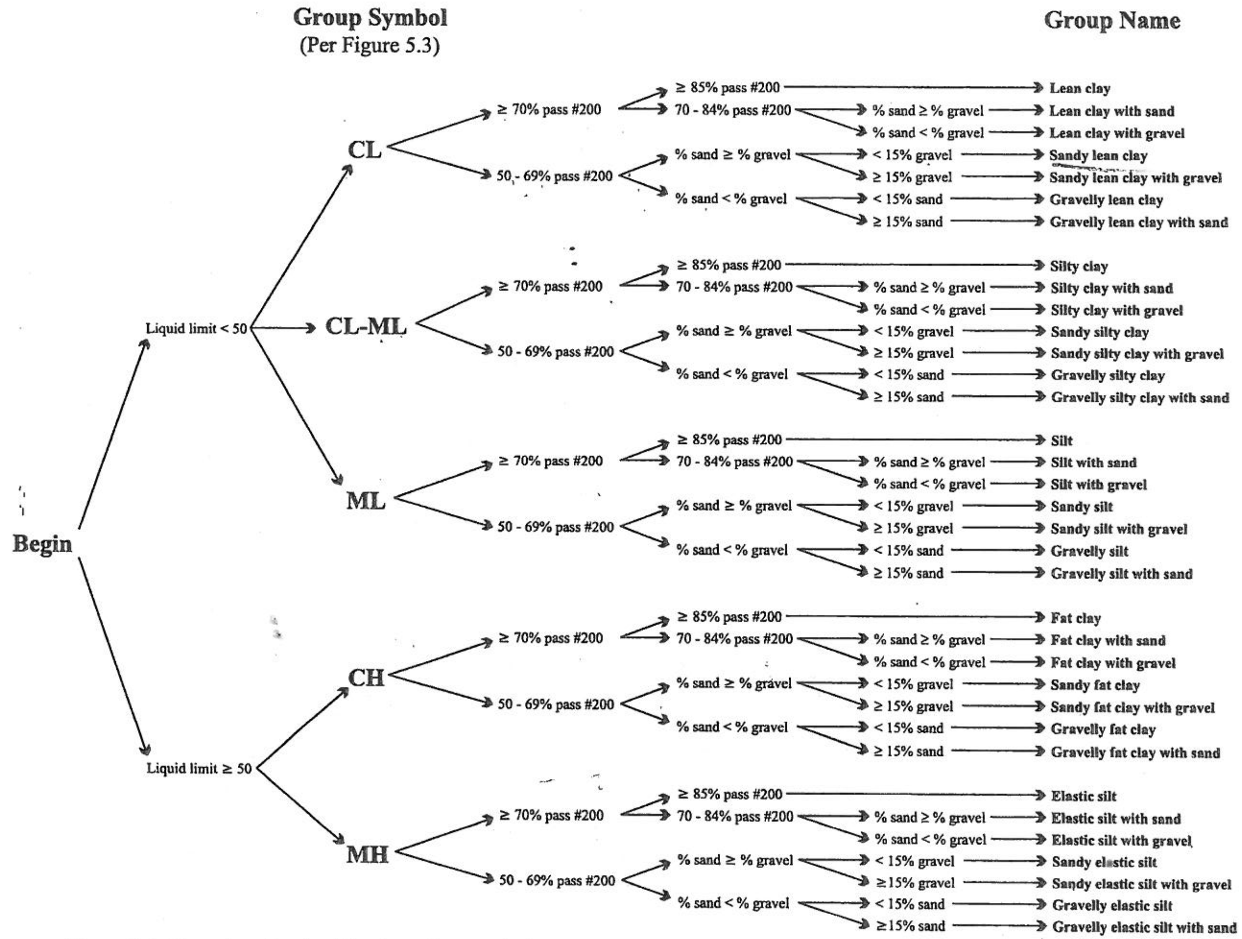

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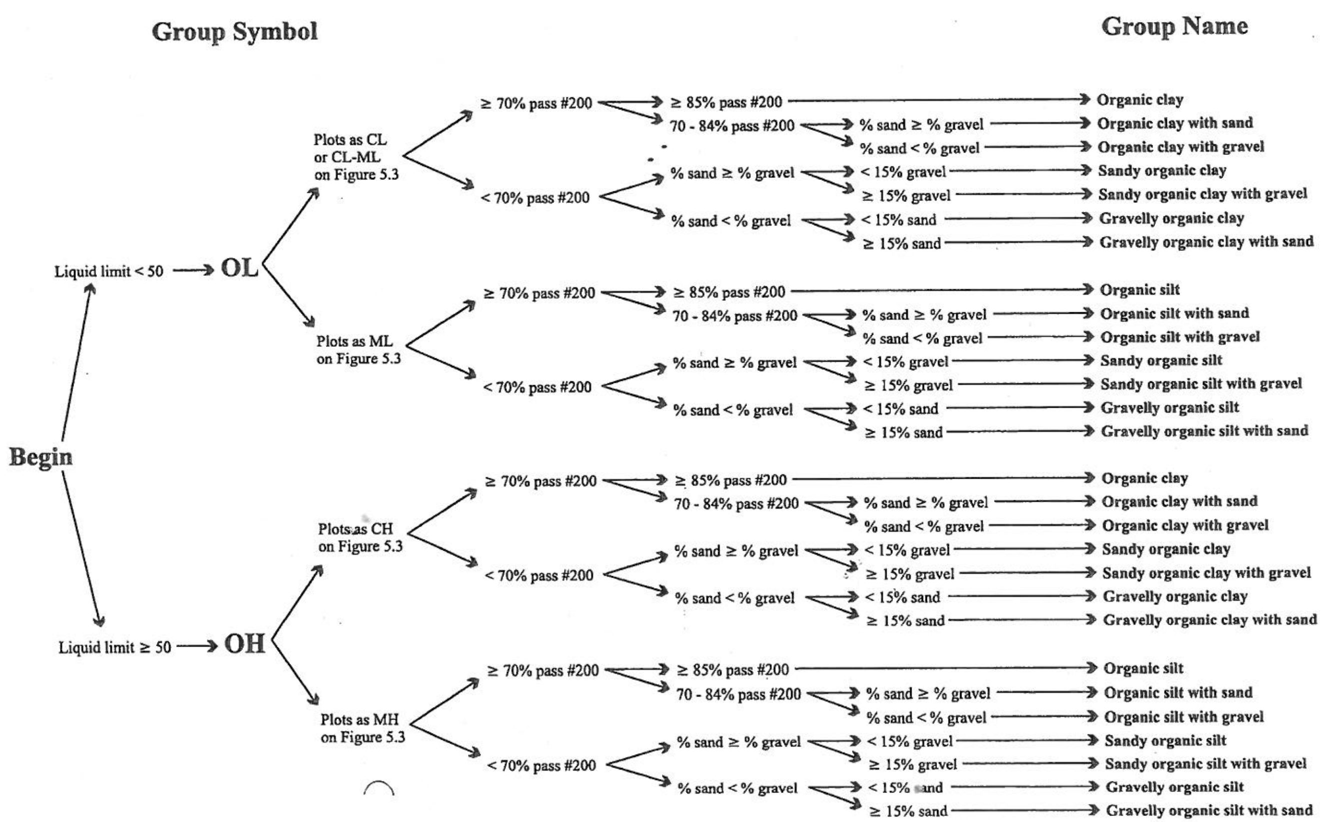

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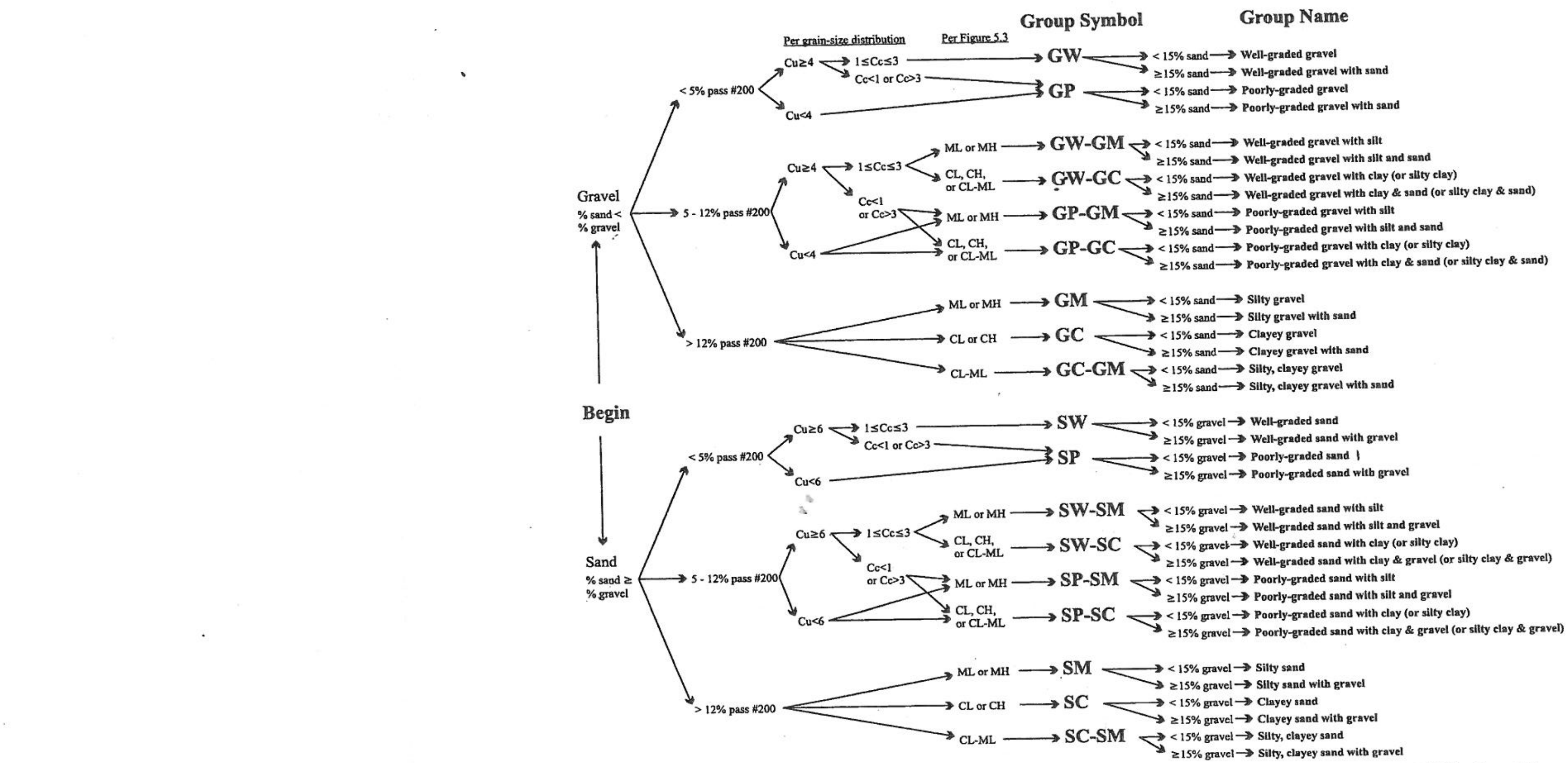

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