

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular), November-December 2016

B. Tech in Civil Engineering, Semester V

Roll No.....

CE508: GEOTECHNICAL ENGINEERING-1

Time: 3 hours

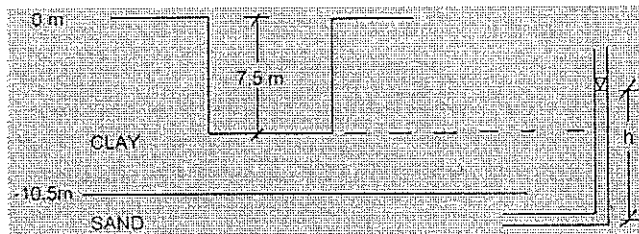
Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.
4. Semi-Graph paper can be requested from the invigilator for solving Q 4A and Q9B and Arithmetic Graph papers for plots necessary for relevant problems.
5. Appendix: Hydrometer Analysis Tables

Q.1A	Objective type multiple choice questions (5 questions @ 1 mark)	10
i	In its natural condition a soil sample has a mass of 1.98 kg and a volume of 0.001m^3 . After being completely dried in an oven; the mass of the sample is 1.80 kg. Specific gravity is 2.7. Unit weight of water is 10 kN/m^3 . The degree of saturation of soil is: (a) 0.65 (b) 0.70 (c) 0.54 (d) 0.61.	
ii	A tetrahedral unit consists of a central silicon atom that is surrounded by ____ number of oxygen atoms located at the corners of a tetrahedron. A. 6 B. 8 C. 10 D. 4	
iii	A borrow pit soil has a dry density of 17 kN/m^3 . How many cubic meters of this soil will be required to construct an embankment of 100 m^3 volume with a dry density of 16 kN/m^3 . A. 94 m^3 B. 106 m^3 C. 100 m^3 D. 90 m^3 .	
iv	A given Cohesionless soil has $e_{\text{max}} = 0.85$, $e_{\text{min}} = 0.5$. In the field, the soil is compacted to a mass density of 1800 kg/m^3 at water content of 8%. Take the mass density of water as 1000 kg/m^3 and $GS = 2.7$. What is the value of relative density, R_D (a) 56.43 (b) 60.25 (c) 62.87 (d) 65.41	
v	A combination of Aluminium-Hydroxyl Octahedrons forms :- (a). Silica sheet (b). Gibbsite sheet (c). Brucite sheet (d). None of the above	
vi	CLAY particles are flaky . Their thickness is very small relative to their length & breadth, in some cases as thin as : (a). $1/1000^{\text{th}}$ of the length. (b). $1/100^{\text{th}}$ of the length. (c). $1/10^{\text{th}}$ of the length. (d). $1/150^{\text{th}}$ of the length.	
vii	Which statement is correct: Shrinkage limit (w_s) – (a). Is the water content at which a soil would just begin to crumble when rolled into a thread of approximately 3 mm diameter (b). Is the water content at which a soil is practically in a liquid state, but has infinitesimal resistance against flow which can be measured by any standardized procedure (c). Is the maximum water content at which a decrease in moisture content does not cause any decrease in the volume of the soil mass. It is also the smallest value of	

	water content at complete saturation of the soil mass. (d). None of these.	
viii	Following statement are made on compacted soil, where DS stands for soil compaction on Dry Side of OMC and WS stands for soil compacted on Wet Side of OMC. Identify incorrect statement: (a) Soil structure is flocculated on DS and dispersed on WS (b) Construction of pore water pressure is low on DS and High on WS. (c) Soil on drying, shrinkage is high on DS and Low on WS. (d) On addition to water, swelling is high on DS and low on WS.	
ix	As per the Indian Standard soil classification system, a sample of silty clay with liquid limit of 40% and plasticity index of 28% is classified as : (A) CH (B) CI (C) CL (D) CL-ML	
x	Two series of compaction tests were performed in the laboratory on an inorganic clayey soil employing two different levels of compaction energy per unit volume of soil. With regard to the above tests, the following two statements are made. I The optimum moisture content is expected to be more for the tests with higher energy. II The maximum dry density is expected to be more for the tests with higher energy. The CORRECT option evaluating the above statements is : (A) Only I is TRUE (B) Only II is TRUE (C) Both I and II are TRUE (D) Neither I nor II is TRUE.	
Q.2	Short answer type questions (4 questions @ 2.5 marks)	10
Q.2A	A 1000 cc core cutter weighing 946.80 gm was used to find out the in situ unit weight of an embankment. The weight of core cutter filled with soil was noted to be 2770.60 gm. Laboratory tests on the sample indicated a water content of 10.45 percent and specific gravity of solids of 2.65. Determine the bulk unit weight, dry unit weight, void ratio and degree of saturation of the sample.	
Q.2B	What is the technical reason that a lot of water may be held as adsorbed water with in a clay mass ?	
Q.2C	Define the following: a). Physical Weathering, b). Chemical Weathering, c). Role of Soil Mechanics or Geotechnical Engineering Specialist in any of the Civil Engineering projects.	
Q.2D	Define activity and liquidity index for a given soil along with its physical significance ?	
Q.3A	What are the factors affecting compaction? Explain it precisely? Explain OMC and Zero Air Void Density? Write the relationship of dry unit weight in terms of water content and Degree of Saturation?	05
Q.3B	Compare the compactive energy used in the IS heavy compaction test with that of the IS light compaction test? Which is giving more compaction effort and what is its ratio?	05

Q.4A	Two soils were tested for their consistency limits in the laboratory. The following data were obtained:	05																												
<table><tr><th colspan="2">Soil A</th><th colspan="2">Soil B</th></tr><tr><th>No. of blows, N</th><th>w%</th><th>No. of blows, N</th><th>w%</th></tr><tr><td>8</td><td>43</td><td>5</td><td>65</td></tr><tr><td>20</td><td>39</td><td>15</td><td>61</td></tr><tr><td>30</td><td>37</td><td>30</td><td>59</td></tr><tr><td>45</td><td>33</td><td>40</td><td>58</td></tr><tr><td colspan="2">Plastic limit =25%</td><td colspan="2">Plastic limit=30%</td></tr></table>			Soil A		Soil B		No. of blows, N	w%	No. of blows, N	w%	8	43	5	65	20	39	15	61	30	37	30	59	45	33	40	58	Plastic limit =25%		Plastic limit=30%	
Soil A		Soil B																												
No. of blows, N	w%	No. of blows, N	w%																											
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45	33	40	58																											
Plastic limit =25%		Plastic limit=30%																												
The natural moisture contents of soils A and B were measured in the field and were found to be 40% and 50% respectively. Determine the liquid limit and plastic limit for both the soils A and B. Which of the soil has greater liquid limit and greater plasticity?																														
Q.4B	Using phase diagram representation in terms of volume and weight define Water Content (w), Void ratio (e), Porosity (n), Degree of Saturation (S) and specific gravity of solids G_s , and also give the mathematical relationship?	05																												
Q.5A	The liquid limit and plastic limit of a soil are 50% and 25% respectively. When the soil was dried from its state at liquid limit, the decrease in volume was 40 percent of the volume at liquid limit. When it was dried from its state at plastic limit, the volume decrease was 20 percent of the volume at plastic limit. Determine the shrinkage limit and shrinkage ratio?	05																												
Q.5B	An excavation was made in a clay stratum having $\gamma_t = 2 \text{ T/m}^3$. When the depth was 7.5m, the bottom of the excavation cracked and the pit was filled by a mixture of sand and water. The thickness of the clay layer was 10.5m, and below it was a layer of pervious water-bearing sand (Figure 1). How much was the artesian pressure in the sand layer?	05																												
																														
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Q.6A	A geotechnical laboratory reported these results of five samples taken from a single boring. Determine which are not correctly reported, if any. Sample #1: $w = 30\%$, $\gamma_d = 14.9 \text{ kN/m}^3$, $\gamma_s = 27 \text{ kN/m}^3$; clay. Sample #2: $w = 20\%$, $\gamma_d = 18 \text{ kN/m}^3$, $\gamma_s = 27 \text{ kN/m}^3$; silt. Sample #3: $w = 10\%$, $\gamma_d = 16 \text{ kN/m}^3$, $\gamma_s = 26 \text{ kN/m}^3$; sand. Sample #4: $w = 22\%$, $\gamma_d = 17.3 \text{ kN/m}^3$, $\gamma_s = 28 \text{ kN/m}^3$; silt. Sample #5: $w = 22\%$, $\gamma_d = 18 \text{ kN/m}^3$, $\gamma_s = 27 \text{ kN/m}^3$; silt.	05																												
Q.6B	The in situ void ratio of a granular soil deposit is 0.50. The maximum and minimum void ratios of the soil were determined to be 0.75 and 0.35. $G_s=2.67$. Determine the relative density and relative compaction of the deposit?	05																												
OR																														

Q.6B Classify soils (A to F) on the basis of the data provided, as per IS:1498-1970 (Figure 2). Where additional information is required, say what data is needed.

05

Soil	WL	WP	% passing through 75 μ sieve	% gravel >4.75mm	% sand (4.75mm - 0.075mm)
A	450	50	100	0	0
B	34	20	80	0	20
C	60	30	90	0	10
D	-	Non-Plastic	100	0	0
E	35	20	20	60	20
F	-	Non-Plastic	10	20	70

Q.7A The compaction of an embankment is carried out in 300 mm thick lifts (layers). The rammer used for compaction has the foot of area 0.05 sq m. The energy developed per drop of the rammer is 40 kg-m. Assuming 50 percent more energy in each pass over the compacted area due to overlap, calculate the number of passes to develop compactive energy equivalent to IS light compaction for each layer ?

05

Q.7B The following test results were obtained for a fine-grained soil:

05

WL= 48% ; WP = 26%

Clay content = 55%

Silt content = 35%

Sand content = 10%

In situ moisture content = w =39%

Classify the soil by refereeing to plasticity chart(Figure 2), and determine its activity and liquidity index

IS : 1498 - 1970

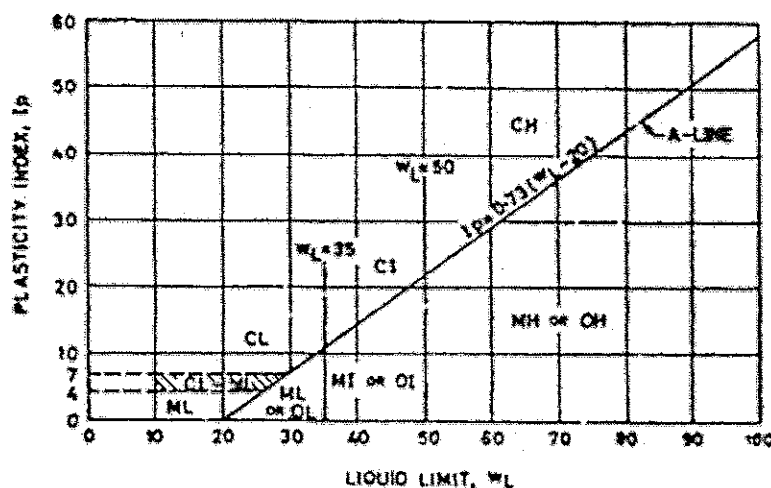


Figure 2: Plasticity chart as per Indian Standard Soil Classification System

OR

Q.7B Establish the following relationships:

05

a). $\gamma_d = (1 - n)G_s \gamma_w$

b). $n_a = \frac{e(1-S)}{1+e}$

Q.8A

Use the grain-size distribution curve shown below to classify soils *A* and *B* using the USCS. Soil *B*'s Atterberg limits are $LL = 49\%$ and $PL = 45\%$.

10

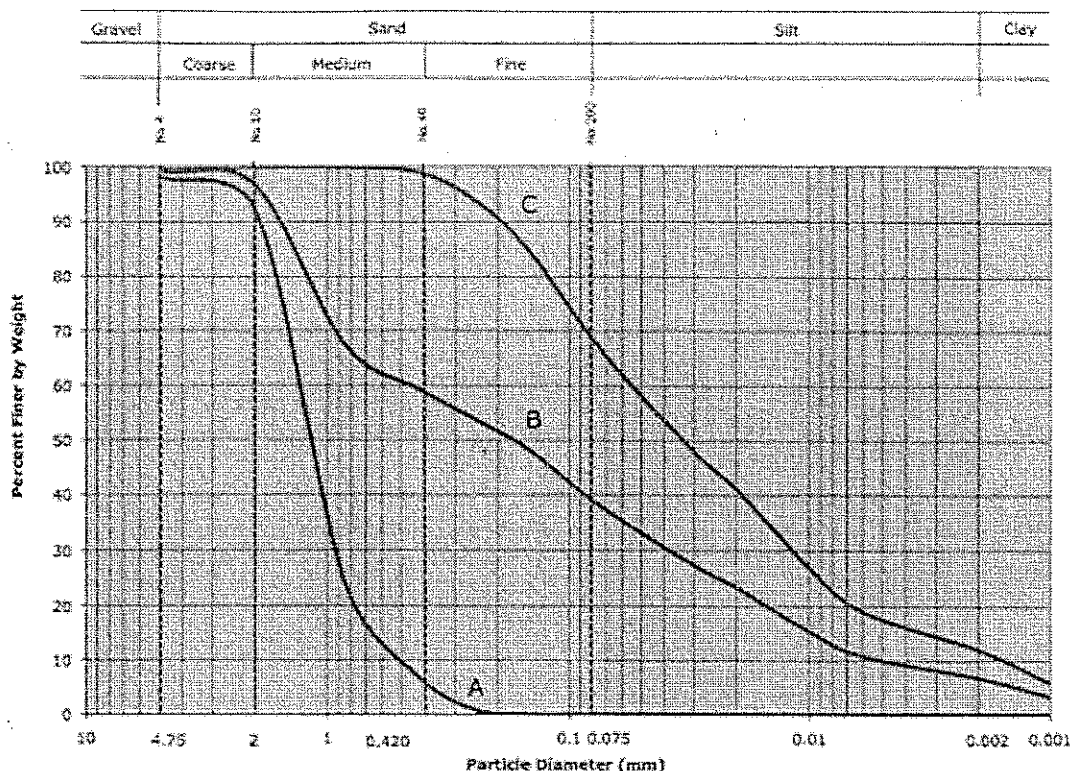


Figure 3

Use the grain size distribution curve shown above (Figure 3) to classify soils *A*, *B* and *C* as per Indian Standard Soil Classification System for both coarse and fine grain sizes. Soil Atterberg limits are:

For Soil *A* - NP, Soil *B* - $LL = 49\%$ and $PL = 45\%$, Soil *C* - $LL = 45\%$ and $I_p = 25$ (Refer to Plasticity chart as per Indian Standard Soil Classification System given in Figure 2: Plasticity Chart).

Q.9A

The following data refers to a compaction test as per Indian Standard (light compaction):

10

Water Content (%)	8.5	12.2	13.75	15.5	18.2	20.2
Weight of wet sample (kg)	1.80	1.94	2.00	2.05	2.03	1.98

If the specific gravity of soil grains was 2.7,

- Plot the compaction curve and obtain the maximum dry unit weight and the optimum moisture content;
- Plot the 80% and 100 percent saturation lines;
- If it is proposed to secure a relative compaction of 95% in the field, what is the range of water content that can be allowed, and
- would the 20 percent air voids curve be the same as the 80 percent saturation curve?

- Q.9B For the Hydrometer analysis carried out using ASTM 152 H using Sodium Hexametaphosphate dispersing agent for soil of specific gravity 2.65 the readings obtained are given below. Construct the GSD for the fine particles? Also, classify the soil. Relevant tables have been given in the Appendix. 10

Date	Time	Elapsed Time (min)	Temp. °C	Actual Hydro. Rdg. R_d
09/15	4:06 PM	0	25	55
	4:07	1	25	47
	4:08	2	25	42
	4:10	4	25	40
	4:14	8	25	37
	4:22	16	25	32
	4:40	34	25	28
	6:22	136	23	22
09/16	5:24 PM	1518	22	15

OR

- Q.9B A compacted fill is to be constructed using one of the two potential borrow areas A and B. The in situ properties of soil at these sites are as follows: 10

Borrow area A: $e_n=0.80$; $w_n=17.5\%$, $G_s=2.65$

Borrow area B: $e_n=0.68$; $w_n=14.0\%$, $G_s=2.65$

The compacted volume of the embankment will be $50,000\text{m}^3$, its unit weight 20 kN/m^3 at a placement water content of 20%.

Soil from the borrow area is to be excavated and transported to the site in trucks of 10 m^3 capacity. During excavation and dumping of soil in the trucks, the soil increases in volume by 10 percent. At the site, the required additional amount of water is added to the soil and compacted to the desired extent by pneumatic rubber tyred rollers. The cost of excavation, transportation and compaction is Rs 400/- per truck for borrow area A and Rs 500/- per truck for borrow area B. Water charges per truck is Rs 150/-. Which of the two borrow areas is more economical ?

Appendix

APPENDIX: Standard Tables and Figures for reference

Table 1. Values of Effective Depth Based on Hydrometer and Sedimentation Cylinder of Specific Sizes

Hydrometer 151H		Hydrometer 152H			
Actual Hydrometer Reading	Effective Depth, L (cm)	Actual Hydrometer Reading	Effective Depth, L (cm)	Actual Hydrometer Reading	Effective Depth, L (cm)
1.000	16.3	0	16.3	31	11.2
1.001	16.0	1	16.1	32	11.1
1.002	15.8	2	16.0	33	10.9
1.003	15.5	3	15.8	34	10.7
1.004	15.2	4	15.6	35	10.6
1.005	15.0	5	15.5	36	10.4
1.006	14.7	6	15.3	37	10.2
1.007	14.4	7	15.2	38	10.1
1.008	14.2	8	15.0	39	9.9
1.009	13.9	9	14.8	40	9.7
1.010	13.7	10	14.7	41	9.6
1.011	13.4	11	14.5	42	9.4
1.012	13.1	12	14.3	43	9.2
1.013	12.9	13	14.2	44	9.1
1.014	12.6	14	14.0	45	8.9
1.015	12.3	15	13.8	46	8.8
1.016	12.1	16	13.7	47	8.6
1.017	11.8	17	13.5	48	8.4
1.018	11.5	18	13.3	49	8.3
1.019	11.3	19	13.2	50	8.1
1.020	11.0	20	13.0	51	7.9
1.021	10.7	21	12.9	52	7.8
1.022	10.5	22	12.7	53	7.6
1.023	10.2	23	12.5	54	7.4
1.024	10.0	24	12.4	55	7.3
1.025	9.7	25	12.2	56	7.1
1.026	9.4	26	12.0	57	7.0
1.027	9.2	27	11.9	58	6.8
1.028	8.9	28	11.7	59	6.6
1.029	8.6	29	11.5	60	6.5
1.030	8.4	30	11.4		
1.031	8.1				
1.032	7.8				
1.033	7.6				
1.034	7.3				
1.035	7.0				
1.036	6.8				
1.037	6.5				
1.038	6.2				
1.039	5.9				

Table 2. Values of k for Use in Equation for Computing Diameter of Particle in Hydrometer Analysis

Temperature °C	Specific Gravity of Soil Particles								
	2.45	2.50	2.55	2.60	2.65	2.70	2.75	2.80	2.85
16	0.01510	0.01505	0.01481	0.01457	0.01435	0.01414	0.0394	0.01374	0.01356
17	0.01511	0.01486	0.01462	0.01439	0.01417	0.01396	0.01376	0.01356	0.01338
18	0.01492	0.01467	0.01443	0.01421	0.01399	0.01378	0.01359	0.01339	0.01321
19	0.01474	0.01449	0.01425	0.01403	0.01382	0.01361	0.01342	0.01323	0.01305
20	0.01456	0.01431	0.01408	0.01386	0.01365	0.01344	0.01325	0.01307	0.01289
21	0.01438	0.01414	0.01391	0.01369	0.01348	0.01328	0.01309	0.01291	0.01273
22	0.01421	0.01397	0.01374	0.01353	0.01332	0.01312	0.01294	0.01276	0.01258
23	0.01404	0.01381	0.01358	0.01337	0.01317	0.01297	0.01279	0.01261	0.01243
24	0.01388	0.01365	0.01342	0.01321	0.01301	0.01282	0.01264	0.01246	0.01229
25	0.01372	0.01349	0.01327	0.01306	0.01286	0.01267	0.01249	0.01232	0.01215
26	0.01357	0.01334	0.01312	0.01291	0.01272	0.01253	0.01235	0.01218	0.01201
27	0.01342	0.01319	0.01297	0.01277	0.01258	0.01239	0.01221	0.01204	0.01188
28	0.01327	0.01304	0.01283	0.01264	0.01244	0.01225	0.01208	0.01191	0.01175
29	0.01312	0.01290	0.01269	0.01269	0.01250	0.01212	0.01195	0.01178	0.01162
30	0.01298	0.01276	0.01256	0.01236	0.01217	0.01199	0.01182	0.01165	0.01149

Table 3. Temperature Correction Factors C_T

Temperature °C	factor C_T
15	1.10
16	-0.90
17	-0.70
18	-0.50
19	-0.30
20	0.00
21	+0.20
22	+0.40
23	+0.70
24	+1.00
25	+1.30
26	+1.65
27	+2.00
28	+2.50
29	+3.05
30	+3.80

Table 4. Correction Factors a for Unit Weight c

Unit Weight of Soil Solids, g/cm ³	Correction factor a
2.85	0.96
2.80	0.97
2.75	0.98
2.70	0.99
2.65	1.00
2.60	1.01
2.55	1.02
2.50	1.04