

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular/Backlog), November-December 2015

B. Tech/ M. Tech (as applicable) 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.

Q.1A Objective type multiple choice questions (5 questions @ 1 mark) 10

- i. 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 .

- ii. Which is the correct relationship between void ratio (e) to porosity (n):-

A. $e = \frac{1-n}{n}$ B. $e = \frac{n}{1+n}$ C. $e = \frac{1}{1-n}$ D. $e = \frac{n}{1-n}$

- iii. What is the correct relationship of specific gravity of solids (G_s) using Pycnometer bottle method: -

A. $\frac{(W_2-W_3)}{(W_2-W_1)-(W_3-W_4)}$ B. $\frac{(W_2-W_1)}{(W_2-W_1)-(W_3-W_4)}$ C. $\frac{(W_2-W_1)-(W_3-W_4)}{(W_2-W_1)}$ D. $\frac{(W_2-W_1)-(W_3-W_4)}{(W_2-W_4)}$

Where, W_1 - Weight of empty Pycnometer, W_2 - Weight of Pycnometer+ Dry Soil
 W_3 - Weight of Pycnometer+Dry Soil+Water, W_4 - Weight of Pycnometer+Water.

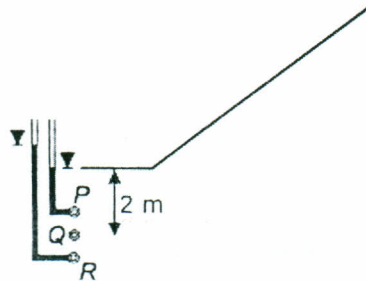
- iv. Casagrande tool apparatus and Cone Penetrometer is used to determine:-

A. Plastic Limit B. Shrinkage Limit C. Liquid Limit D. None of these.

- v. 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.

- vi 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
- vii 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
- viii Steady state seepage is taking place through a soil element at Q, 2 m below the ground surface immediately downstream of the toe of an earthen dam as shown in the sketch. The water level in a piezometer installed at P, 500 mm above Q, is at the ground surface. The water level in a piezometer installed at R, 500 mm below Q, is 100 mm above the ground surface. The bulk saturated unit weight of the soil is 18 kN/m^3 and the unit weight of water is 9.81 kN/m^3 . The vertical effective stress (in kPa) at Q is :



- (A) 14.42 (B) 15.89 (C) 16.38 (D) 18.34
- ix A given cohesionless soil has $e_{\max} = 0.85$, $e_{\min} = 0.5$. 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 $G_s = 2.7$. What is the value of relative density, R_D
 (a) 56.43 (b) 60.25 (c) 62.87 (d) 65.41
- x Which of the rules must be obeyed in drawing the Flownets:
 a). In a homogeneous isotropic system, flow lines and equipotentials are inclined and form curvilinear squares,
 b). Equipotentials are always parallel to constant head boundary, flow lines are always normal to a constant head boundary,
 c). Equipotentials are always parallel to impermeable boundary and flow lines are always normal to an impermeable boundary
 d). None of the above.

Q.2 Short answer type questions (4 questions @ 2.5 marks)

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Q.2A A partially saturated sample from a borrow pit has a natural moisture content of 15 percent and bulk unit weight of 1.9 g/cc . The specific gravity of solids is 2.70. Determine the degree of saturation and void ratio. What will be the unit weight of the sample on saturation ?

Q.2B Define the following:

a). Physical Weathering, b). Chemical Weathering, c). Soil's Mechanical Properties,

Q.4B Define specific gravity of solids, G_s and give its mathematical expression. Find out the relation between e and n . Also, find out the relationship between e , w , G_s and S ? 05

Q.5A An undisturbed sample of clay brought from the field was noted to have a volume of 18.0 cc weight of 30.8 g. On oven drying, the weight of the sample was reduced to 20.5 g. The volume of dried sample as obtained by displacement of mercury was 12.5 cc. Calculate the shrinkage limit and the specific gravity of solids. What is the shrinkage ratio? 05

Q.5B For the soil deposit shown below, draw the total stress pore water pressure and effective stress diagrams. The water table is at ground level as shown in the Figure 1 below. 05

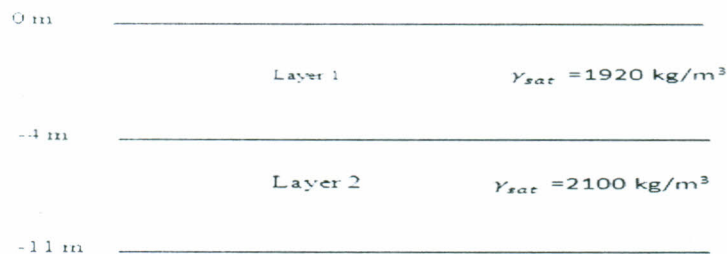


Figure 1

Q.6A A geotechnical laboratory reported these results of five samples taken from a single boring. Determine which are not correctly reported, if any. 05

- 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.

Q.6B Determine the uniformity coefficient C_u and the coefficient of gradation C_c for soil A. 05

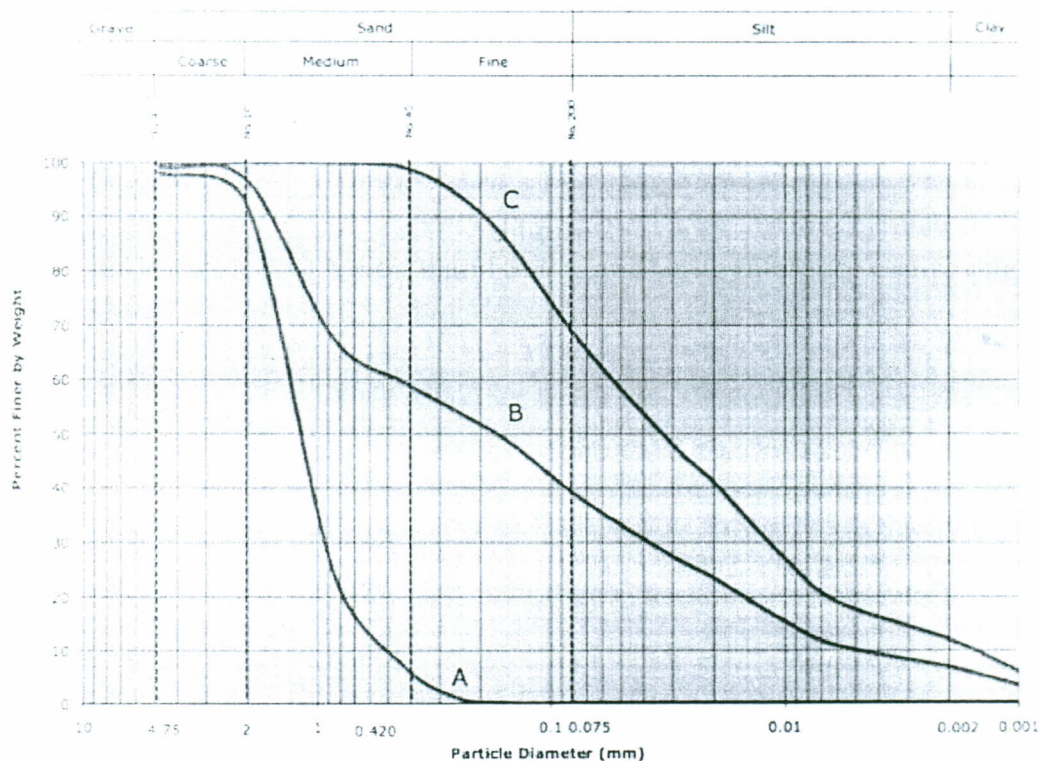


Figure 2

Determine C_u , C_c for Soil A, Soil B and Soil C and write inference comparing the soils.

d). Role of Soil Mechanics or Geotechnical Engineering Specialist in any of the Civil Engineering projects.

Q.2C

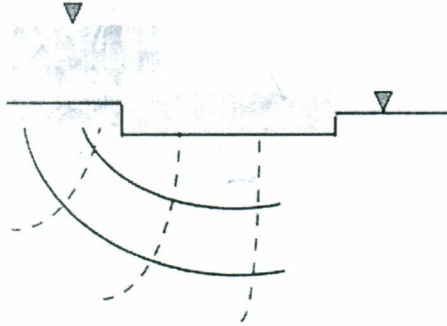
$$w_{sat} = \frac{(n\gamma_w)}{(\gamma_{sat} - n\gamma_w)}$$

Show that at Saturation the moisture (water) content is :

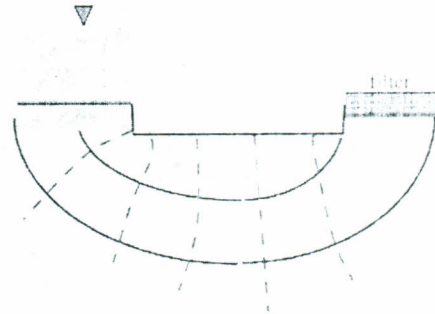
Q.2D

Do you recognize something wrong with each of the following flow-nets?

a)



b)



Q.3A What is quick sand condition? Derive the relation for the critical hydraulic gradient at the bottom of the soil column ? 05

Q.3B 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.4A 500 gm of dry soil was subjected to a sieve analysis. The weight of soil retained on each sieve is as follows: 05

I.S. sieve size	Wt. Of soil, g
4.75 mm	10
2.00 mm	165
1.00 mm	100
425 μ	85
212 μ	40
150 μ	30
75 μ	50

Plot the grain size distribution curve and determine the following:

- Percentages of gravel, coarse sand, medium sand, fine sand and silt-clay fraction in the soil as per IS:1498-1970,
- Effective size, c) Uniformity coefficient, d) Coefficient of curvature and
- The gradation of Soil.

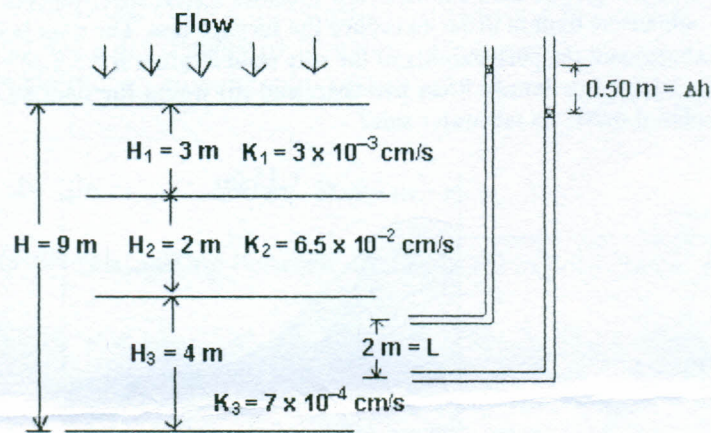
OR

Q.6B Derive the analytical solution of Laplace equation for the seepage flow case for a single soil layer case (permeameter) of length L , the head available at the inlet being " H " and at the outlet being zero (0) ? 05

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 Determine the following: 05

- Equivalent coefficient of vertical permeability of the three layers
- The rate of flow per m^2 of plan area
- The total head loss in the three layers



OR

Q.7B For a field pumping test, a well was sunk through a horizontal stratum of sand 14.5 thick and underlain by a clay stratum. Two observation wells were sunk at horizontal distances of 16 m and 34 m respectively from the pumping well. The initial position of the water table was 2.2 m below ground level. 05

At a steady-state pumping rate of 1850 litres/min, the drawdowns in the observation wells were found to be 2.45 m and 1.20 m respectively. Calculate the coefficient of permeability of the sand.

Q.8A Explain the laboratory measurement of permeability for both constant Head flow method and falling head flow method. Derive the relationship of coefficient of permeability for both constant head flow method and falling head flow method? 10

Q.9A 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

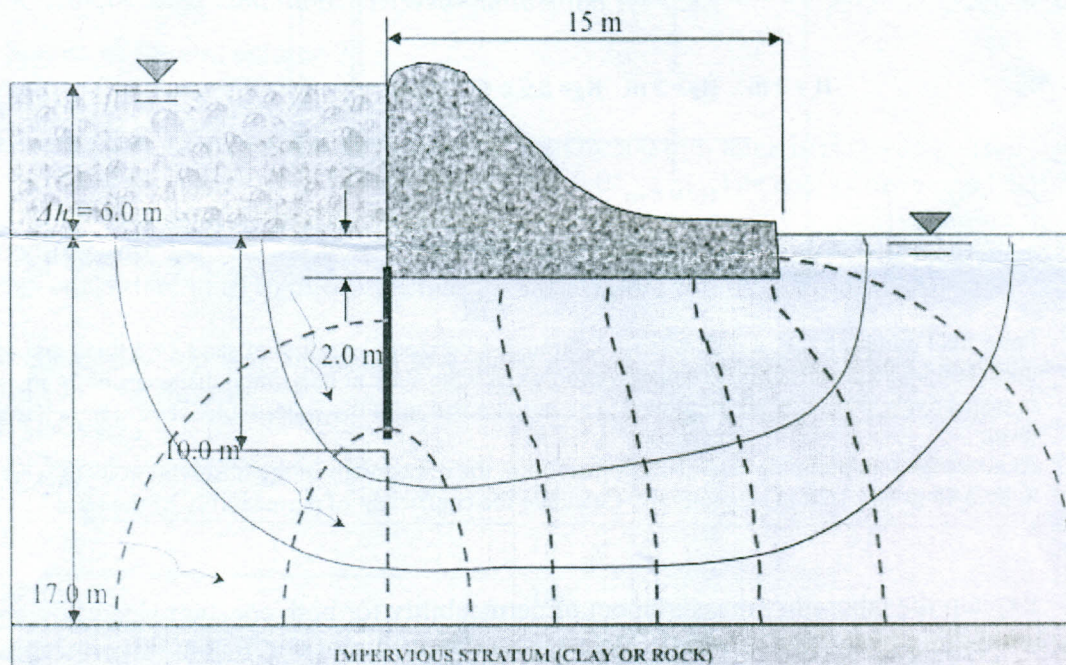
kN/m^3 at a placement water content of 20%.

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 ?

Q.9B

The completed flow net for the dam shown below includes a steel sheet-pile cutoff wall located at the head-water side of the dam in order to reduce the seepage loss. The dam is half a kilometer in width (shore to shore) and the permeability of the silty sand stratum is $3.5 \times 10^{-4} \text{ cm/s}$. Find, (a) the total seepage loss under the dam in liters per year, and (b) would the dam be more stable if the cutoff wall was placed under its tail-water side?

10



OR

Q.9B

Define Flow net and also define stream lines and equipotential lines. Give the steps of constructing the flow nets (graphical solution of 2-D Laplace equation) and its assumptions made for construction Also, prove that stream lines and equipotential lines are orthogonal to each other, give the mathematical proof ?

10