Please check that this question paper contains 09 questions and 03 printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: 03]

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EVENING

07 JAN 2023

Program: **B.Tech. (Batch 2018 onward)**
Semester: **5th**
Name of Subject: **Geotechnical Engineering**
Subject Code: **PCCE – 114**
Paper ID: **16391**
Scientific calculator is Allowed

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) Parts A and B are compulsory
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately

Part – A

[Marks: 02 each]

Q1 **(a)** Sketch grain size distribution curves for uniformily graded, well graded and gap graded soils.

(b) Prove that e.S = G.w, where; e is the void ratio, S is the degree of saturation, G is the specific gravity and w is the natural moisture content of the soil.

(c) Compare the compactive energy used in the IS heavy compaction test with that of the IS light compaction test.

(d) Differentiate between shrinkage ratio and volumetric shrinkage.

(e) Calculate the average coefficient of permeability in the horizontal direction for a deposit consisting of three layers of thickness 5m, 1m and 2.5m and having the coefficients of permeability of 3×10^{-2}mm/sec, 3×10^{-5}mm/sec & 4×10^{-2}mm/sec, respectively. Assume the layers are isotropic.

(f) Define coefficient of compressibility and coefficient of volume change. Write the relation between them.

Part – B

[Marks: 04 each]

Q2 Discuss in brief the effect of compaction on different engineering properties of the soil.

Q3 Explain briefly the different types of shear tests based on drainage conditions.

Q4 A falling head permeability test is carried out on a 15cm long sample of silty clay. The diameters of the sample and the stand pipe are 9.8cm and 0.75cm respectively. The water level in the stand pipe falls from 60cm to 45cm in 12 min. Determine the coefficient of permeability of the soil in m/day and the time required for the water level to drop to 10cm.

Q5 The following results were obtained from a laboratory triaxial test with arrangements for pore pressure measurements

Sample No.	*Cell pressure (kPa)*	*Deviator stress at failure (kPa)*	*Pore pressure at failure (kPa)*
1	*100*	*202.5*	*41.1*
2	*150*	*218.1*	*62.3*
3	*200*	*236.9*	*70.1*

Determine the shear strength parameters of the soil considering the effective stresses.

P.T.O.

Q6 Establish the following relationship:

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

Q7 The soil profile at a site is shown in *Fig.1*. Determine the total stress, pore water pressure and effective stress on the plane X-X situated at a depth of 15m below ground level.

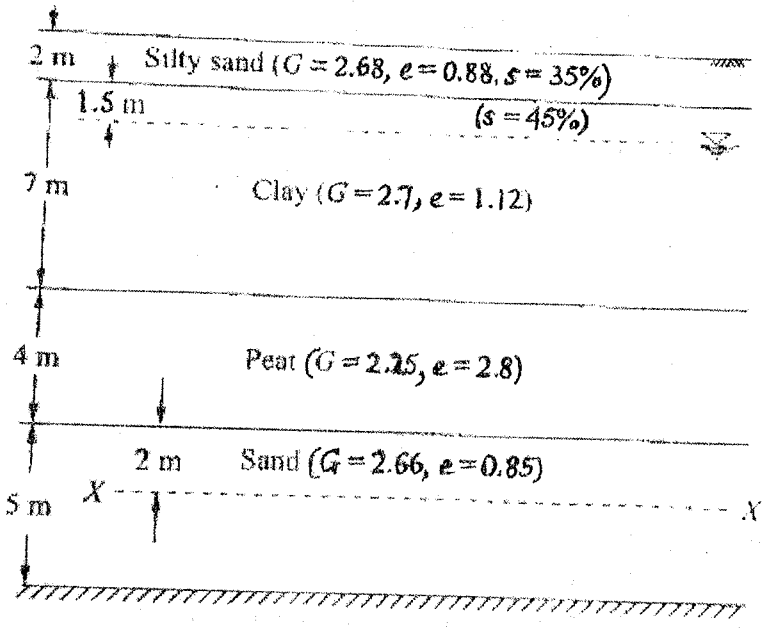

Fig.1

Part – C

[Marks: 12 each]

Q8 Explain in detail the step by step procedure for classification of a soil by Indian standard classification system.

The sub soil below a proposed highway embankment in Fazilka, Punjab has the following grain sizes:

Gravel	*= nil*	*Sand*	*= 2%*
Silt	*= 51%*	*Clay*	*= 47%*

The liquid limit of the soil is 56% and its plastic limit is 25%. What is its general engineering classification? Comment on its use in the embankment.

OR

(a) A series of tests on a sample of silty clay indicated the following index properties: LL = 53.9%, PL = 23.4%, Natural water content = 51.2%, D_{60} = 0.0050mm, D_{10} = 0.0007mm, unconfined compressive strength (undisturbed) = 180kN/m^2, unconfined compressive strength (remoulded) = 85kN/m^2

Compute (i) the uniformity coefficient, (ii) the plasticity index, (iii) the liquidity index, (iv) the sensitivity of this soil, and (v) In what region can the soil be placed on the IS plasticity chart?

(b) A 4m high embankment, with a top width of 5m and side slope of 1:1 is to be constructed by compacting soil collected from nearby borrow pits. The unit weight and natural moisture content of soil are 18.2kN/m^3 and 7.5% respectively. However, the required dry unit weight and moisture content of the finished embankment

should be 16.6kN/m^3 and 18% respectively. Determine the volume of the soil to be excavated from the borrow pits and the quantity of water to be added to it, for each km of finished embankment.

Q9 The following are the results of a standard compaction (light compaction) test performed on a sample of soil.

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

If the specific gravity of the soil grains was 2.7, make necessary calculations and

i. Plot the water content v/s dry density (compaction curve) and obtain the optimum water content and the maximum dry density
ii. Determine the void ratio, the degree of saturation and the theoretical dry density.
iii. Plot the 80% and 100% saturation lines.
iv. 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?
v. Would the 20% air voids curve be the same as the 80% saturation curve?

OR

(a) A 3m thick clay layer beneath a building is overlain by a permeable stratum and is underlain by an impervious rock. The coefficient of consolidation of the clay was found to be 0.025cm^2/minute. The final expected settlement for the layer is 8cm. Determine the following:

i. How much time will it take for 80% of the total settlement to take place?
ii. Determine the time required for a settlement of 2.5cm to occur.
iii. What will be the settlement in 6 months?

(b) A 2m thick clay stratum lies between two pervious strata. The properties of the clay are: liquid limit = 45%, coefficient of permeability = 2.8 x 10^{-7}cm/sec, void ratio = 1.05. The initial effective overburden pressure at the middle of the clay stratum is 25kPa, which is likely to increase to 47kPa due to construction of a new building.

i. What will be the final void ratio of clay at the end of consolidation?
ii. Estimate the consolidation settlement of the building.
iii. Find the time required for 50% consolidation.

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