BENGAL ENGINEERING AND SEIENCE UNIVERSITY, SHIBPUR

B.E. (Civil) Part III, 5th **Semester** Final Examination, Dec 2012

Soil Mechanics-I

(CE 502)

(i) Use separate answer script for each half

(ii) Assume reasonable data if not supplied

Full Marks: 70, Time: 3 hours

FIRST HALF

Attempt ***Q. No. 1*** and **any *two*** from the rest.

Q.1. (a) Draw the phase diagram of a dry soil mass. Hence derive the following equation for the dry density of the soil:

$$\gamma_d = G.(1-n)\gamma_w$$

The notations have their usual meaning.

(b) The composition of a soil sample is given below:

% of sand : 29%

% of silt : 46%

% of clay: 25%

Draw a neat sketch of triangular classification chart and classify the given sample with the help of it.

(c) Distinguish between single-grained structure and honeycombed structure of soils.

[4+5+2=11]

Q.2. (a) How does the volume of a soil sample change with its moisture content? Explain with sketch.

(b) Define relative density. How can you classify soils on the basis of it?

(c) The water content and bulk density of a partly saturated soil sample were 18% and 19.6 kN/m^3 respectively. The sample was kept in an oven at 105°C for some time, resulting in a partial evaporation of the void water. The bulk density of the sample reduced to 18.5 kN/m^3. Assuming the void ratio to remain unchanged, find out the final water content of the sample. What would have been its bulk density if the sample was kept in the oven for 24 hours?

[2+3+7=12]

Q.3.(a) Define consistency index and liquidity index. Comment on the state of a soil if

(i) its consistency index is 0.01

(ii) its liquidity index is negative.

(b) State Boussinesq's equation for stress distribution, explaining all notations used therein.

(c) A concentrated force of 100 kN is applied on the ground surface. Draw the isobar for a stress intensity of 10 kN/m^2 due to this load.

[4+3+5=12]

Q.4.(a) Distinguish between shear stress and shear strength.

(b) An infinitesimally small soil element is subjected to a vertical stress of 100 kPa and a horizontal stress of 30 kPa. Determine graphically the stresses on a plane inclined at an angle of 30° to the major principal plane.

(c) Explain Mohr-Coulomb failure criteria. Hence deduce an expression for the angle of inclination of the failure plane.

[2+4+6=12]

Contd.....

5.(a) State two major advantages of triaxial test over direct shear test.

(b) Consolidated undrained triaxial tests, with arrangements for pore pressure measurement, are performed on 3 identical specimens of a given soil. Following are the results:

Sample No.	Cell pressure (kPa)	Deviator stress at failure (kPa)	Pore pressure at failure (kPa)
1	10	20.2	4.1
2	15	21.8	6.2
3	20	23.7	7.0

Determine the shear strength parameters of the soil considering (i) total stresses (ii) effective stresses.

(c) An unconfined compression test was performed on an undisturbed sample of normally consolidated clay. The height and diameter of the sample were 75 mm and 37.5 mm respectively. The sample failed when the vertical compressive load reached 1.163 kN. The axial deformation recorded at failure was 9.1 mm. When the test was repeated on a remoulded sample of the soil, failure occurred under a load of 0.685 kN, the corresponding axial deformation being 11.5 mm. Determine the unconfined compressive strength and unit cohesion of the soil in (i) undisturbed and (ii) remoulded states.
Also determine the sensitivity of the soil and classify it accordingly.

[2+5+5=12]

SECOND HALF
(Answer *Q.No.6* and any ***Two*** from the rest)

Q.6. (a) A stratum of normally consolidated clay 7 m thick is located at a depth 12 m below ground level. The natural moisture content of the clay is 43 % and its liquid limit is 48 percent. The specific gravity of the solid particles is 2.76. The water table is located a depth 5 m below ground surface. The soil is sand above the clay stratum. The submerged unit weight of the sand is 11 kN / m^3. And the same weighs 18 kN /m^3 above the water table. The average increase in pressure at the centre of the clay stratum is 120 kN /m^3 due to the weight of a building that will be constructed on the sand above the clay stratum. Estimate the expected settlement of the structure.

(b) A sandy soil collected from an excavation showed void ratios of 0.48 and 0.97 in its densest and loosest states, respectively. The range of critical hydraulic gradients at which quick sand condition might occur is needed to decide the depth of excavation. Take G = 2.65 and estimate the range of critical hydraulic gradient.

(c)In order to compute the seepage loss through the foundation of a cofferdam, flows net were constructed. The results of flow net study gives $N_f = 6$, $N_d = 16$. The head of water lost during seepage was 6m. If the coefficient of permeability of the soil is $k = 4 \times 10^{-5}$ m / min, compute the seepage loss per meter length of dam per day.

(d)A rectangular footing 2 m × 3 m in size, has to carry a uniformly distributed load of 100 kN / m^2. Plot the distribution of vertical stress intensity of a horizontal plane at a depth of 2 m below the base of footing by 2: 1 dispersion method.

[5+2+3+3=13]

Q.7. (a) How many boundary conditions can be defined clearly when the flow is confined? Is the flow through an earth dam confined flow or unconfined flow?

(b) Discuss the uses of a flow net.

(c) The water table is lower from a depth of 3.05 m to a depth of 6.10 m in a deposit of silt. All the silt is saturated even after the water table is lowered. Its water content is 26 %. Estimate the increase in effective pressure at a depth of 10.4 m on account of lowering the water table. Assume G =2.7.

(d) The void ratio of a given soil A is twice that of another soil B, while the effective size of particles of soil A is one-third that of soil B. The height of capillary rise of water in soil A on a certain day is found to be 40 cm. Determine the corresponding height of capillary rise in soil B.

[2+2+3+4 = 11]

Q.8. (a) Explain consolidation process with suitable example.

(b)Describe the Casagrande logarithm of time fitting method for determination of coefficient of consolidation.

(c) In the laboratory consolidation test, the void ratio of the sample reduced from 0.85 to 0.73 as the pressure was increased from 100 to 200 kPa. If the coefficient of permeability of the soil be 3.3×10^{-4} cm /sec,

Determine: (i) co-efficient of volume change

(ii) co-efficient of consolidation.

[2+5+4 = 11]

Q.9.(a) Describe the laboratory method for determination of co efficient of permeability of coarse sand.

(b) Discuss the influence of the following factors on coefficient of permeability of soil:

(i) Particle size; (ii) Degree of saturation.

(c) A cylindrical mould of diameter 7.5 cm contains a 15 cm long sample of fine sand. When water flows through the soil under constant head at a rate of 58 cc/ min, the loss of head between two points 8 cm apart is found to be 12.1 cm. Determine the co-efficient of permeability of the soil.

[4 + 4 + 3 = 11]

Q.10.(a) Explain the phenomenon of quick sand condition.

(b)The subsoil at a site consists of a fine sand layer lying in between a clay layer at top and a silt layer at bottom. The coefficient of permeability of the sand is 100 times that of clay and 20 times that of silt, while the thickness of the sand layer is one tenth that of clay and one third that of silt. Find out the equivalent coefficient of permeability of the deposit in directions parallel and perpendicular to the bedding planes, in terms of the co-efficient of permeability of the clay layer.

(c) A pumping out test was carried out in the field in order to determine the average coefficient of permeability of a 18 m thick sand layer. The ground water table was located at a depth of 2.2 m below the ground level. A steady state was reached when the discharge from the well was 21.5 lit/sec. At this stage, the drawdown in the well was 2.54 m, while the draw downs in two observation wells situated at 8 m and 20 m from the test well were found to be 1.76 m and 1.27 m respectively. Determine:

(i) Coefficient of permeability of sand layer in m / day

(ii) radius of influence of the test well

(iii) effective size of the sand.

[2 + 4 + 5 = 11]

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