DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

CVL702— GROUND IMPROVEMENT AND GEOSYNTHETICS

Major | **Date: 09.04.22**

Duration: 120 Minutes | **Max. Marks: 60**

Note: 1. Answer all questions
2. Answer should be concise
3. Include neat sketch wherever necessary
4. Assume suitable data, if required

1. (a) Describe with the help of neat sketch, the Asaoka (1978) method of determining the coefficient of radial consolidation. **[3]**

   (b) Write a short note on how is the magnitude of preloading surcharge decided? **[3]**

2. (a) Distinguish between *Electroosmosis* and *Electrohardening*. **[2]**

   (b) Draw the pore water pressure distribution during electroosmosis, with the boundary condition: Cathode is sealed, and Anode is drained. **[2]**

3. (a) Discuss in brief the various reactions that occur while mixing the lime with soil. How does the pozzolanic action of cement differ from the chemical action of soil-lime mixture? **[4]**

   (b) Sketch any four different geotechnical applications, where grouting is employed. **[2]**

   (c) Can permeation grouting be effective in fine-grained soils? Suggest suitable type of grouting. **[2]**

   (d) Distinguish between *Newtonian Fluid* and *Bingham Fluid*. **[2]**

4. (a) A site predominantly consists of loose sandy gravel of 3.5 m thick is to be improved by permeation grouting using cement grout. The diameter of grout injection source is 75 mm and installed in triangular pattern with centre to centre spacing of 500 mm. Grout flow rate of 0.25 m^3/min. The viscosity of cement grout and water is 30 centipoise and 1 centipoise, respectively. The average porosity and permeability of the ground is 75 % and 3 x 10^{-1} m/sec respectively. The unit weight of grout is 1150 kg/m^3. Determine the net pressure and time required for the grout to penetrate to target from the source, assuming (i) spherical flow model and (ii) radial flow model. **[12]**

   (b) Why do suspension-type chemical grouts require mixing of soils during grouting? What type of soil is preferable? **[3]**

5. (a) List the different types of geosynthetics along with their function(s). **[2]**

   (c) How geomembrane is used for different purposes in landfills. Include neat sketches. **[3]**

6. It is proposed to design a 8 m-high geotextile-wrapped wall for supporting an elevated road on a highway, which is subjected to a surcharge of 20 kPa. The properties of backfill and natural ground are given in Fig. 1. The allowable tensile strength after applying applicable reduction factors is 15 kN/m. Using a factor of safety for tiebreak and pull out failure as 1.5, determine the following: **[12]**

   (a) Vertical spacing (assuming uniform length of geotextile)

   (b) Length of geotextile to avoid pull out failure

   (c) Length of overlapping

   (d) Factor of safety against sliding and overturning.

7. A 10 m-high and 50-degree sloped embankment as shown in Fig. 2 needs to be constructed. Details of properties of embankment, natural soil and critical failure surface are indicated in the figure. Determine the following: **[8]**

   (a) Factor of safety of the slope with no reinforcement.

   (b) If the allowable tensile strength of geogrid is 50 kN/m, (i) Factor of safety of the slope with one geogrid reinforcement layer placed along the surface of natural ground (along '*ed*'), and (ii) Factor of safety of the slope with 10 layers of geogrid reinforcement at 1 m spacing starting from one layer placed along the surface of natural ground. Assume sufficient anchorage length is available beyond the slip surface to avoid pull out failure.

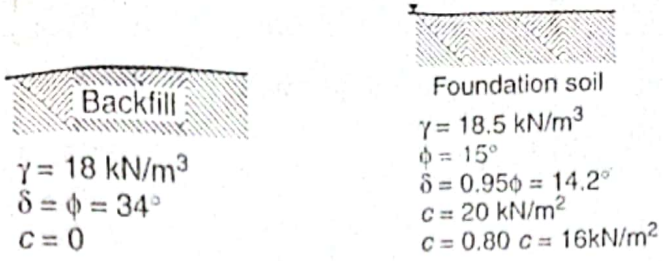

Fig. 1 (Question No. 6)

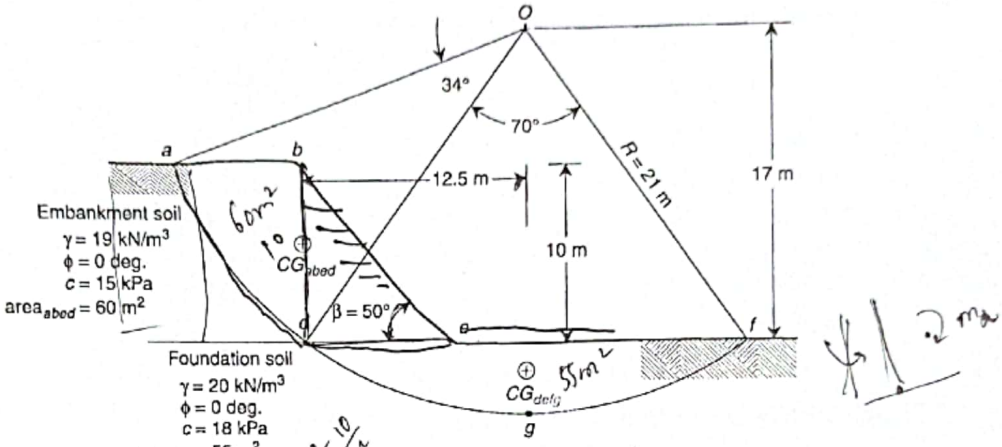

Fig. 2 (Question No. 7)

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FORMULAE

$p_e = \dfrac{Q\gamma}{4\pi R_0 k_G} = \dfrac{Q\gamma\mu}{4\pi R_0 k \mu_w}$	$L_e = \dfrac{S_v \sigma_h \, FS}{2(c_a + \gamma Z \tan \delta)}$
$p_e = \dfrac{Q\gamma\mu}{2\pi m k \mu_w} \ln(R / R_0)$	$L_o = \dfrac{S_v \sigma_h \, FS}{4(c_a + \gamma Z \tan \delta)}$
$t = \dfrac{4\pi n}{3Q}\left(R^3 - R_0^3\right)$	$FS = \dfrac{cL_{arc}R + \sum_{i=1}^{m} T_i y_i}{WX}$
$t = \dfrac{\pi m n}{Q}\left(R^2 - R_0^2\right)$	