GX501

Ollscoil na hÉireann

National University of Ireland, Galway.

Second Semester Examinations

3rd Civil and 3rd Environmental Engineering

Soil Mechanics

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Time allowed: ***Two*** **hours**

Answer ***three*** **questions out of five.**

Question 1

a) Describe briefly the following terms: total stress, effective stress, seepage force, normally consolidated soils and over consolidated soils. **(10 marks)**

b) Describe using diagrams the total stress, pore water pressure, effective stress and volume change associated with the construction of an embankment on 1) loose gravels and 2) an estuarine silt with a low permeability over a long time period. **(10 marks)**

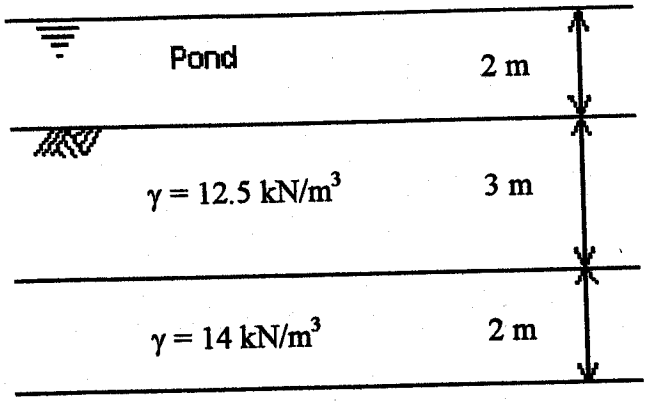


Diagram 1

c) A pond rests on top of the soil shown in diagram 1. Sketch the total stress, pore water pressure and effective stress with depth. Redraw the diagrams for the case when the pond is rapidly drained. **(10 marks)**

Question 2

a) Describe briefly two laboratory methods of determining the undrained shear strength of a soil. **(6 marks)**

b) Show that for a shear vane with diameter D and height H the maximum torque T of the soil may be given by $T = \frac{\pi D^2}{2} \cdot S_u \left[\frac{D}{3} + H \right]$ where S_u is the undrained shear strength of the soil. **(12 marks)**

c) Three unconsolidated undrained triaxial tests were carried out on a sample from the same depth. Plot the total stress and effective stress Mohr circles and determine the undrained shear strength of the soil. **(12 marks)**

Cell pressure (kPa)	Deviator stress (kPa)	Pore water pressure (kPa)
100	210	50
200	210	150
300	210	250

Question 3

a) Describe the four phases of consolidation in soils. **(10 marks)**

b) A soil has a modulus of volume compressibility, m_v, of 0.001 m^2/kN and permeability, k_v, of 0.01 m per year. Determine the coefficient of vertical consolidation c_v. Assume the bulk weight of water to be 10 kN/m^3. **(4 marks)**

c) Ten metres of the soil described above rests on a sand layer which lies on solid bedrock. A two metre high embankment is constructed on the soil. The bulk mass of the fill is 2000 kg/m^3. Determine the length of time for 90 % of the primary consolidation to occur and the magnitude of the settlement. **(8 marks)**

d) Determine the ultimate bearing capacity of the above soil at a depth of 2 meters if the soil is considered to be undrained and the water table is at the surface. Use a bearing capacity factor N of 7.2. Discuss why the foundation is founded at a depth of 2 m. **(8 marks)**

Question 4

a) Describe an experiment to establish a) the liquid limit and b) the plastic limit of a soil. **(10 marks)**

b) Using the particle size distribution in diagram 2 calculate the coefficient of uniformity and the coefficient of curvature of the soil. Comment on whether the fill is well graded or uniformly distributed. Give reasons for your answer. **(10 marks)**

c) The following results were obtained from the specific gravity test:

- Mass of the density bottle, $M_1 = 36.261$ g
- Mass of the density bottle and dry sand, $M_2 = 64.125$ g
- Mass of the density bottle, dry sand and distilled water, $M_3 = 102.458$ g
- Mass of the density bottle and distilled water, $M_4 = 85.459$ g

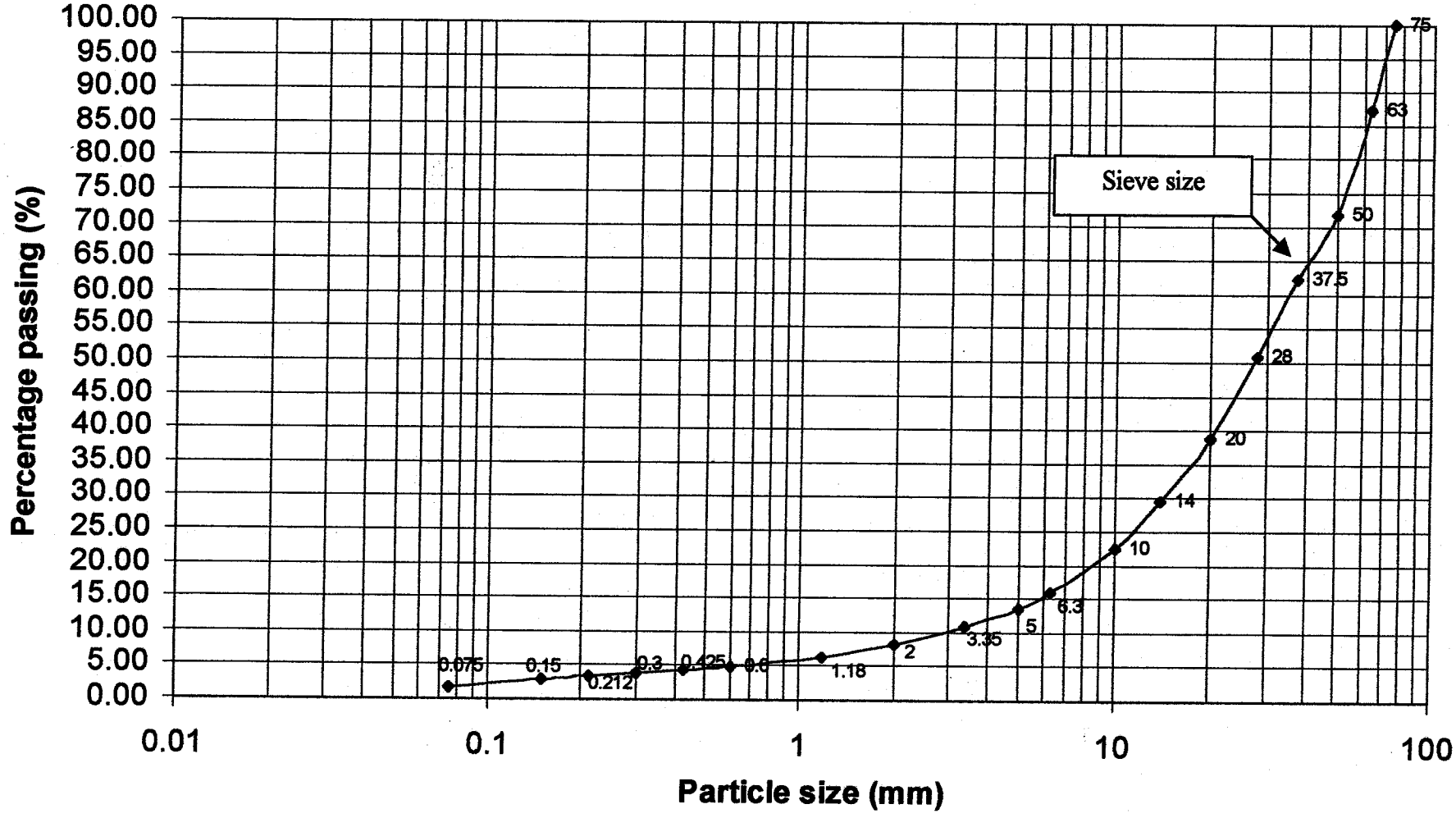
Calculate the specific gravity of the soil, G_s. **(10 marks)**

Question 5

a) Describe two laboratory methods for determining the permeability of a soil. Derive any equations used. Which test is most applicable to soils with a low permeability? **(12 marks)**

b) A soil sample has a mass of 26.4 kg. The volume of the soil is 0.0145 m^3. The sample is dried in an oven at 105° until no further reduction in mass is noted. The sample mass is now 21.4 kg. The specific gravity of the solids is 2.65. Find the bulk densityρ_{bulk}, the dry density ρ_{dry}, moisture content, the saturated bulk density ρ_{sat}, the voids ratio e, the specific volume v, the porosity n and the degree of saturation S_r. **(18 marks)**

Diagram 2


100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Percentage passing (%)
0.01
0.1
1
10
100
Particle size (mm)
Sieve size
0.075
0.15
0.212
0.3
0.425
0.6
1.18
2
3.35
5
6.3
10
14
20
28
37.5
50
63
75