7. (a) (i) Determine the average coefficient of permeability in horizontal and vertical directions for a deposit consisting of three layers of thickness 5 m, 1 m and 2.5 m and having the coefficient of permeability of 3×10^{-2}mm/sec and 4×10^{-4} mm/sec respectively. Assume that the layers are isotropic. 20

(ii) What is Darcy's law ? What are its limitations ? 5

(b) (i) Describe cone penetration tests. How these tests differ from standard penetration test ? 10

(ii) Explain, how you would decide the depth of exploration and lateral extent of investigations. 15

(c) (i) Determine the active pressure on the retaining wall shown in Figure-3. Take $\gamma_w = 10$kN/m^3. Draw pressure distribution diagram, total pressure and its location application from point 'C'. 15

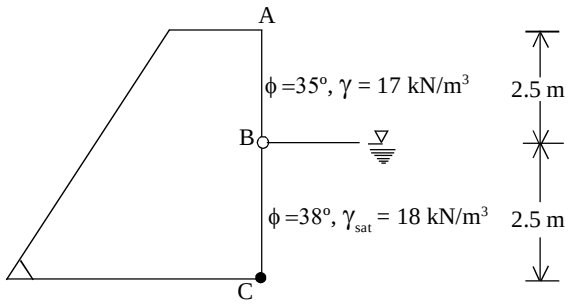

Fig. 3

(ii) A retaining wall is 7 m high with its back face smooth and vertical. It retains sand with its surface horizontal. Using Rankine's theory, determine active earth pressure at the base when the backfill is submerged with water table at the surface. Take dry density of soil $\gamma_{sat} = 21$ kN/m^3 and angle of internal friction = 30^0. 10

Roll No. ..... **Total No. of Pages : 8**

1(CCE.M)3

Civil Engineering–I

(06)

Time : Three Hours] [Maximum Marks : 300

INSTRUCTIONS

(i) Answers must be written in English.

(ii) The number of marks carried by each question is indicated at the end of the question.

(iii) The answer to each question or part thereof should begin on a fresh page.

(iv) Your answer should be precise and coherent.

(v) The part/parts of the same question must be answered together and should not be interposed between answers to other questions.

(vi) Candidates should attempt question no. 1 which is compulsory and **three** more out of remaining questions selecting at least **one** question from each Section.

(vii) If you encounter any typographical error, please read it as it appears in the text-book.

(viii) Candidates are in their own interest advised to go through the General Instructions on the back side of the title page of the Answer Script for strict adherence.

(ix) No continuation sheets shall be provided to any candidate under any circumstances.

(ii) Sketch the velocity gradient along the diameter of a pipe through which a fluid is flowing :

(a) When the flow is laminar

(b) When the flow is turbulent. 10

(b) (i) Calculate the velocity gradient at the distances of 0, 100, 150 mm from the boundary if the velocity profile is a parabola with the vertex 150 mm from the boundary, where the velocity is 1 m/sec. Also calculate the shear stresses at these points if the fluid has a viscosity of 0.804 N-s/m^2. 15

(ii) What are Newtonian and Non-Newtonian fluids ? Give their classification. 10

(c) (i) The velocity distribution in a pipe is given by :

$$\frac{v}{v_{max}} = \left(\frac{y}{r_0}\right)^{1/n}$$

Where, 'v' is the velocity at a distance 'y' from the pipe wall and r_0 the pipe radius.

Determine the average velocity and the momentum correction factor. 10

(ii) A steel pipe of 15 cm diameter carries water at rate of 30 litres/sec from point A to B along the pipe, the point B being 20 m higher than point A and 600 m apart along the pipe. If the pressure at B is to be 2.8 Kg/cm^2, what pressure must be maintained at A, if the friction factor for the pipe is 0.024 ? What will be the capacity of the pipe after 15 years of service, whence the friction factor is tripled ? Assume the same pressures are maintained at A and B. 15

(c) Two wheel loads of 16 and 8 kN are placed at a fixed distance apart of 2 m, across a beam of 10 m span. Draw the influence line of bending moment and shear force for a point 4 m from the left support and find the maximum bending moment and shear force at the point. 25

(d) Design a two way RCC slab for a room of size 4000 × 5000 mm with discontinuous and simply supported edges on all sides with corners prevented from lifting. It carries a live load of 4 kN/m^2. Adopt M-20 grade concrete and Fe-415 HYSD bars. Use limit state method. 25

SECTION-A

2. (a) A reinforced concrete rectangular column 300 × 500 mm supports an axial service load of 1000 kN. The safe bearing capacity of the soil at the site is 200 kN/m^2. Adopt M-20 grade of concrete and Fe-415 HYSD bars. Design a suitable rectangular footing for the column and sketch the details of reinforcement. Apply design checks. 25

(b) A three hinged parabolic arch ACB is hinged at the supports A and B which are at the same level. The span of the arch is 20 m. The arch carries two equal point loads of 20 kN each placed at 5 m and 15 m from the left support. Find maximum positive and negative bending moments. 25

(c) (i) A pre-tensioned beam 300 × 400 mm is pre-stressed by 10 wires of 7 mm diameter initially stressed to 1200 N/mm^2 with their centroids located at 120 mm from the soffit. Find the maximum stress in concrete immediately after transfer, allowing stresses only for elastic shortening of concrete. Take E_s= 200 kN/mm^2, f_{ck}= 40 N/mm^2, E_c= 5000 $\sqrt{f_{ck}}$. 15

(ii) What are various types of losses in pre-stressing process ? Explain in brief the loss due to shortening and creep of concrete. 10

3. (a) Design a cantilever retaining wall with the following data :

(i) Height of horizontal earth embankment 4 m above ground level

(ii) Density of soil = 18 kN/m^3

(iii) Angle of repose = 30^0

(iv) Safe bearing capacity of soil (SBC) = 200 kN/m^2

(v) Coefficient of friction between concrete and soil = 0.5

(vi) Grade of concrete: M-20

(vii) Type of steel : Fe-415 HYSD bars. 25

(b) Analyze the continuous beam shown in Figure-2 using flexibility method and draw bending moment diagram. Assume flexural rigidity EI = constant. 25

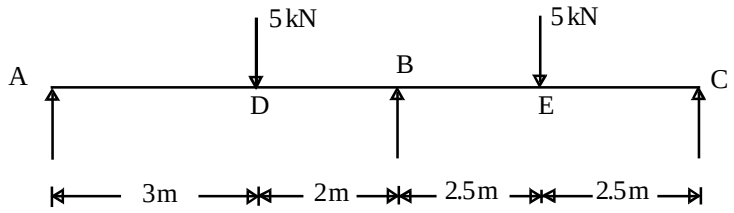

Fig. 2

(c) Design a simply supported riveted plate girder with the following data : 25

(i) Clear Span = 14 m

(ii) Maximum bending moment = 1641 × 10^6 N-mm

(iii) Maximum shear force = 526 kN

(iv) Depth of web plate = 1000 mm

(v) Thickness of web = 6 mm

(vi) Permissible shear stress = 100 MPa

(vii) Permissible bending stress = 165 MPa

Design only web stiffeners and flanges and apply design checks.

SECTION-B

4. (a) Model tests have been conducted to study the energy loss in a pipeline of 1 m diameter required to support kerosene of specific gravity 0.80 and dynamic viscosity 0.02 poise at the rate of 2000 litre/sec. Tests were conducted on a 10 cm pipe using water at 20^0C. What is the flow rate in the model ? If the energy head loss is 30 m, length of model is measured as 44.0 cm of water, what will be the corresponding head loss in the prototype ? What will be the friction factor for the prototype pipe ? 25

(b) (i) In a parallel two dimensional flow in the positive x-direction, the velocity varies linearly from zero at y = 0 to 32 m/sec at y = 1 m. Determine the expression for stream function (ψ) and plot streamlines at intervals of $d\psi$ = 3 m^2/sec. Is the flow irrotational ? 15

(ii) Explain free and forced vortex. Find the general expression for free vortex velocity. 10

(c) (i) A river used for navigation has the cross-section shown in the Figure-1. If the channel cross-section is of the earth (Manning's n = 0.025) and has a slope of 1 in 1000. What rate of flow should it carry at a given depth of 10 m ? 15

(ii) What is meant by hydraulically efficient channel cross-section ? Find the conditions for maximum hydraulic efficiency of a trapezoidal channel. 10

5. (a) (i) Water flows through a horizontal conical pipe 2 m long and having a diameter of 20 cm at the inlet and 15 cm at the discharge end. A constant discharge of 40 litre/sec flows through the pipe. Starting from the first principles, determine the head loss due to pipe friction. Take friction factor of 0.04. 15

(x) Candidates shall put a cross (x) on blank pages of Answer Script.

(xi) No blank page be left in between answers to various questions.

(xii) No programmable Calculator is allowed.

(xiii) No stencil (with different markings) is allowed.

1. Answer any **three** of the following subdivisions, including (d), which is compulsory :

(a) Analyze the structure loaded as shown in Figure-1 by moment distribution method. Draw bending moment diagram. 25

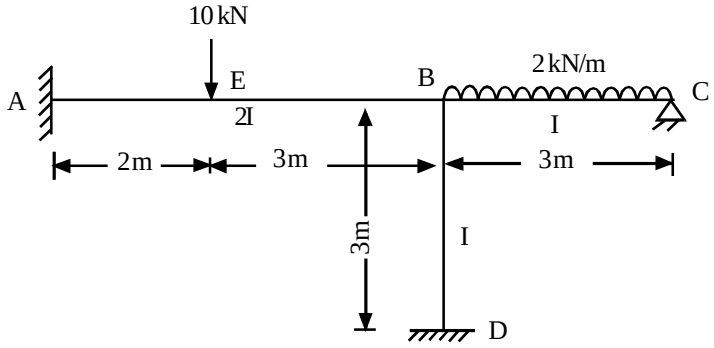

Fig. 1

(b) (i) Explain computed GO TO statement with a suitable example. 5

(ii) Write a FORTRAN program to evaluate the deflection at the centre of a simply supported beam. The input data for the program should include :

(i) Span of beam

(ii) Cross-sectional dimensions (breadth and depth)

(iii) Intensity of uniformly distributed load acting over entire span

(iv) Modulus of elasticity of the beam material. 20

SECTION-C

6. (a) A precise concrete pile (350 × 350 mm) is driven by a single acting steam hammer. Estimate the allowable load using the following data : 25

(i) Maximum rated energy = 3500 kN-cm

(ii) Weight of hammer = 35 kN

(iii) Length of pile = 15 m

(iv) Efficiency of hammer = 0.80

(v) Coefficient of restitution = 0.5

(vi) Weight of pile cap = 3 kN

(vii) Number of blows for last 25.4 mm

(viii) Modulus of elasticity of concrete = 2×10^7 kN/m^2

(ix) Factor of safety = 4.

Assume any other data, if required.

(b) (i) Describe in brief a method for the determination of the mass, spring constant, damping factor and mass of the participating soil. 10

(ii) A machine block of weight 30 kN rests on a soil for which the stiffness may be assumed as 25000 kN/m. The machine is vibrated vertically by an exciting force of 3.0 sin (30 kN). Find the natural frequency, natural period, natural circular frequency and the amplitude of vertical displacement. The damping factor is 0.50. 15

(c) (i) A square footing is required to carry a net load of 1200 kN. Determine the size of the footing if the depth of foundation is 2 m and the tolerable settlement is 40 mm. The soil is sandy with N = 12. Take a factor of safety of 3.0. The water table is very deep. Use Teng's equation. 20

(ii) Derive the Rankine's formula for finding minimum depth of foundation. 5