7. (a) A rectangular channel 2m wide has a flow of 2.2 m^3/s at a depth of 1.20m. Determine whether critical depth occurs for the following conditions :

(i) a section where a small submerged smooth weir 20 cm high is provided across the channel bed to control the sediment.

(ii) a side wall constriction (with no smooth weir) reducing the channel width to 1.7 m.

(iii) both smooth small weir and wall constriction combined. Neglect head losses of the weir and constriction caused by friction, expansion and contraction. 25

(b) (i) Define boundary layer and explain the fundamental causes of its existence. What is the physical significance of displacement thickness of boundary layer ? Is the flow within the boundary layer, rotational or irrotational ? 10

(ii) Water is pumping through a 1 Km length and 0.5m diameter pipe to a sugar factory from a river. The pipe was found to be rough and has an average height of roughness of 0.15 mm. Determine coefficient of friction, wall shear stress and center line velocity and velocity at a distance of 200mm from the pipe wall. 15

(c) (i) A trapezoidal channel with side slopes of 1 to 1 has to be designed to convey $10m^3/sec$ at a velocity of 2 m/s so that the amount of concrete lining for the bed and sides is the minimum. Calculate the area of lining required for one metre length of canal. 15

(ii) Explain the term hydraulic jump. Derive an expression for the depth of hydraulic jump in terms of the uptream Froude number. 10

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

1[CCE.M]1

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 answers 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 any **three** more out of the 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.

(b) (i) How reinforced earth retaining walls are different from conventional retaining walls ? What are their relative merits ? 10

(ii) A timber pile is being driven with a hammer weighing 30 kN and having a free fall of 1m. The total penetration of the pile in the last five blows is 25 mm. Determine the load carrying capacity of the pile using the engineering news formula. Assume a factor of safety of 6. 15

(c) Determine the safe load that can be carried by a square footing of 2m×2m place at a depth of 1.5 m below ground level. The foundation soil has the following properties :

Bulk density = 1.7t/m^3, cohesion, c=1.0t/m^2, angle of internal friction = 20º, factor of safety = 2.5, bearing capacity factors Nc' = 11.8, Na' = 3.8 and Nr' = 1.3. Use Terzaghi's bearing capacity equation. 25

SECTION–C

6. (a) A 225 mm diameter open circular cylinder is 1500 mm long and contains oil of specific gravity 0.8 up to a height of 1050 mm. Determine the speed at which the cylinder may be rotated about its vertical axis so that the axial depth becomes zero. Find the difference in total pressure force due to rotation (i) at the bottom of the cylinder (ii) on the sides of the cylinder. 25

(b) (i) The stream function ψ = 3xy, in which ψ is in cm^2/s and x and y are in meters. Describe the incompressible flow between the boundaries shown in the figure below. Calculate

Effective depth of the reinforcement from the compression fibre, d = 500 mm

Area of tension reinforcement, A_{st} = 4900 mm^2

Area of compression reinforcement, A_{sc} = 2350 mm^2

Characteristic strength of concrete, f_{ck} = 20N/mm^2

Yield or proof strength of steel, f_y = 415N/mm^2 25

(c) (i) Write a FORTRAN program to calculate the slope and midpoint of a line whose X and Y coordinates of the extremities of the line are given. 10

(ii) Write a FORTRAN program to find the mean and standard deviation of 'n' numbers. 10

(iii) Explain in brief the various types of function sub program. 5

(d) Determine the internal moments at the supports of the beam shown in Fig.2 below :

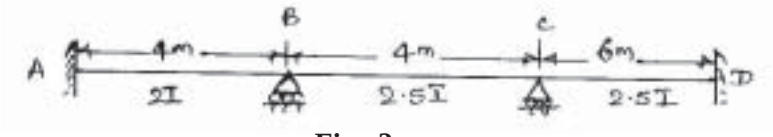

Fig. 2

The support at B, C is displaced (settled) 3.5 mm. Take E = 2×10^5 N/mm^2 and I = 4×10^7 mm^4. 25

SECTION–A

2. (a) Design a slab for a room of clear internal dimensions 3m × 5m supported on walls of 300 mm thickness, with corners held down. Two adjacent edges of the slab are continuous and other two discontinuous. Live load on the slab is 3 kN/m^2. Assume floor finish of 1 kN/m^2. Use M_{20} concrete and Fe 415 steel. Sketch the details of reinforcement. 25

(b) A train of five loads 26 kN, 60 kN, 40 kN, 30 kN and 10 kN spaced 2m apart crosses a girder of 30 m span with 26 kN load leading. Determine the maximum bending moment that can occur in the girder. Also, for the section, where the maximum bending moment occurs. Compute the maximum shear force. 25

(c) Design a combined rectangular footing for an exterior column 400 mm × 400 mm and an interior column 500 mm × 500 mm at a distance 4 m apart, centre to centre, carrying loads of 400 kN and 800 kN respectively. The space available restricts the width of the foundation to 5m and the length should be at its minimum. The safe bearing capacity of soil is 200 kN/m^2. 25

3. (a) A symmetrical parabolic arch AB of span 20 m and rise 4m is pinned at both ends A and B. The arch is subjected to a horizontal UDL of magnitude 20 kN/m from left hand A to the crown. Calculate the horizontal thrust if rib shortening affects are not considered. Draw the bending moment diagram. 25

(b) Design a welded plate girder to carry a superimposed distributed load 50 kN/m. In addition to this girder supports two concentrated loads of 600 kN each at the top flange at 1/3rd points from two secondary beams. The effective span of the girder is 15 m. The compression flange of the girder is laterally un-supported. Assume f_y = 260 N/mm^2. 25

(c) A counterfort retaining wall of 6.8 m is to retain a horizontal earth fill density of 16 kN/m^3. The angle of repose of soil is 300. If a surcharge of 19.20 kN/m^3 is also acting on the earth fill. Design vertical slab and determine the pressure distribution at base. 25

SECTION–B

4. (a) The shear strength parameters of a given soil are c= 30kN/m^2 and φ = 20^o. Undrained triaxial tests are to be carried out on specimens of the soil. Determine

(i) Deviator stress at which the failure occurs, if the cell pressure is 35 kN/m^2.

(ii) The cell pressure during the test, if the sample fails when the deviator stress reaches 170 kN/m^2. 25

(b) A capillary permeability test was conducted in two stages under a head of 60 cm and 180 cm respectively at the entry end. In the first stage, the wetted surface moved from 1.5 cm to 7 cm in 7 minutes. In the second stage it was advanced from 7 cm to 18.5 cm in 24 minutes. The degree of saturation at the end of test was 85% and the porosity was 35%. Determine the capillary head and the coefficient of permeability. 25

(c) In a consolidation test, the void ratio of the specimen which was 1.068 under the effective pressure of 214 kN/m^2, changed to 0.994 when the pressure was increased to 429 kN/m^2. Calculate the coefficient of volume compressibility. Find the settlement of foundation resting on above type of clay if thickness of layer is 8 m and the increase in pressure is 10 kN/m^2. 25

5. (a) The surface of a saturated clay deposit is located permanently below the ground water table. Laboratory tests have indicated that the average natural water content of clay is 40% and specific gravity is 2.7. (i) Determine the vertical intergranular pressure at a depth of 10 m. (ii) How many meters of clay should be removed by dredging, if this pressure at this 10 m is to be reduced to 50 kN/m^2 when the water level remain unchanged ? 25

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

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

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

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

(a) A two hinged parabolic arch of span 20 m and rise 4 m carries a uniformly distributed load 5 t/m on the left half of span as shown in Fig. 1. The moment of inertia I of the arch section at any point is given by $I = I_0 \sec\theta$, where θ = inclination of the tangent at the point with the horizontal and I_0 is the moment of inertia at the crown. Find (i) the reactions at the supports (ii) the position and (iii) the value of the maximum bending moment in the arch. 25

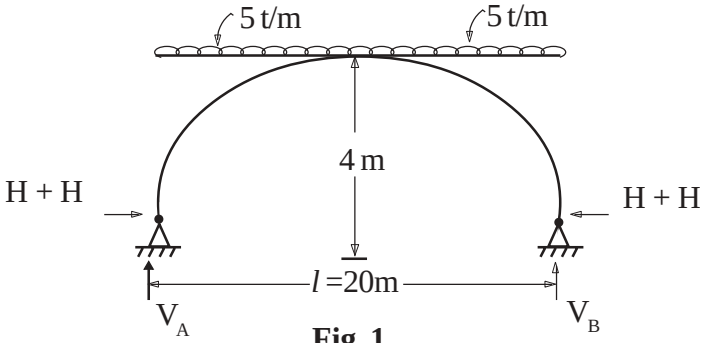

Fig. 1

(b) Determine the limit moment capacity of a doubly reinforced T-section for the following details and specifications :

Effective width of flange b_f = 1000 mm

Thickness of the flange, t = 150 mm

Breadth of the web, b_w = 400 mm

velocity at S, convective accleration at S and flow rate per unit width across RS shown in figure. 15

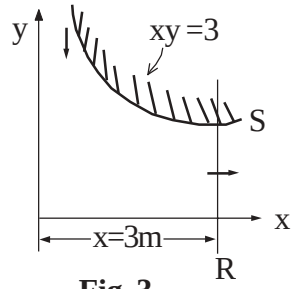

Fig. 3

(ii) Calculate the pressure round an aeroplane which is flying at an altitude of 4200 m. The temperature lapse-rate is 0.0065K/m. The pressure, temperature and density of air at ground level are 101400N/m^2, 150 and 1.285 kg/m^3 respectively. Variation of 'g' with altitude may be neglected. 10

(c) (i) An overflow structure 30 m long discharges water at a rate of 800 m^3/s under a head of 9m. A model test of this structure is to be carried out in a laboratory with a maximum supply available at 50 litres per second. Recommend a suitable scale ratio for the model. 10

(ii) A car plunges into a lake during an accident and lands at the bottom of the lake on its wheels. The door is 1.2 m height and 1m wide and the edge of the door is 8 m below the free surface of the water. Determine the hydrostatic force on the door and the location of the pressure centre and discuss whether the driver can open the door. 15