

CIVIL ENGINEERING

PAPER-I

Time Allowed: **Three Hours**

Maximum Marks: **300**

Question Paper Specific Instructions

Please reach each of the following instruction carefully before attempting questions:

Answers must be written in **ENGLISH** only.

There are **EIGHT** questions divided in **TWO** sections.

Candidate has to attempt **FIVE** questions in all

Questions **No. 1** and **5** are **compulsory** and out of the remaining, any **THREE** are to be attempted choosing at least **ONE** question from each section.

The number of marks carried by a question/part is indicated against it.

Answers must be written in the medium authorized in the Admission Certificate which must be stated clearly on the cover of this Question-cum-Answer (QCA) Booklet in the space provided. No marks will be given for answers written in a medium other than the authorized one.

Wherever any assumptions are made for answering a question, they must be clearly indicated. Diagrams/figures, wherever required, shall be drawn in the space provided for answering the question itself.

Unless otherwise mentioned, symbols and rotations carry their usual standard meanings.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the QCA Booklet must be clearly struck off.

SECTION 'A'

1. (a) A rectangular bar of $30 \text{ mm} \times 60 \text{ mm}$ cross-section and 200 mm length is restrained from expansion along its $30 \text{ mm} \times 200 \text{ mm}$ sides by surrounding material. Find the change in dimensions and volume when a compressive force of 180 kN acts in axial direction. $E = 2 \times 10^5 \text{ MPa}$; $\nu = 0.3$

[12 Marks]

- (b) (i) List the tests for bricks and the corresponding I.S. code.
(ii) What are the various defects in timber? Explain through neat sketches.
(iii) What is CFRP? Indicate its ultimate tensile strength and modulus of elasticity.

[12 Marks]

- (c) A propped cantilever beam is shown in Figure 1. Analyze it using the stiffness matrix method and find the reactions in the spring. Neglect axial deformation in the beam. Show the degrees of freedom.

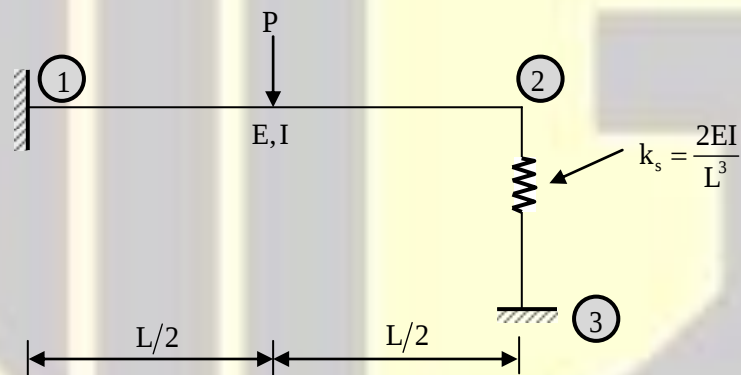


Figure 1

[12 Marks]

- (d) A plane element in a body is subjected to stresses as shown in Figure 2. Determine the principal stresses and maximum shear stresses and the planes on which they act. Indicate them in separate sketches.

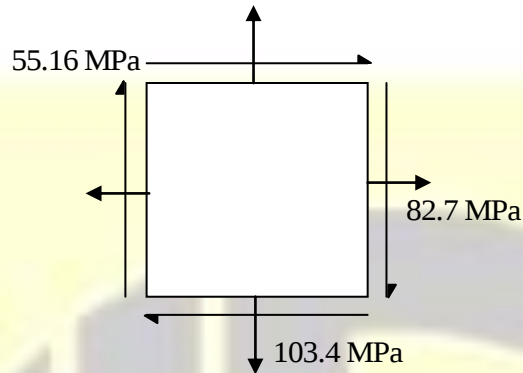


Figure 2

[12 Marks]

- (e) A girder and floor beam construction subjected to concentrated loads is shown in Figure 3. Draw the free body diagrams and determine support reactions.

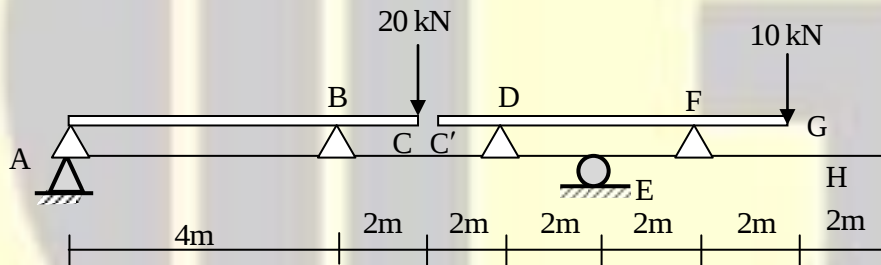


Figure 3

[12 Marks]

2. (a) Find the deflection at C for the beam as shown in Figure 4. $EI = \text{constant}$. Use conjugate beam method.

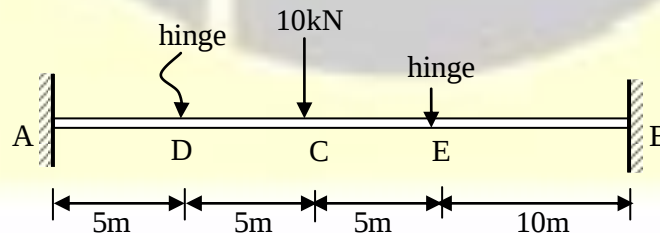


Figure 4

[20 Marks]

- (b) A cylindrical shaft of 75 mm diameter is subjected to a maximum bending moment of 2500 Nm and a twisting moment of 4200 Nm. Find the maximum principal stresses developed in the shaft. If the yield stress of the shaft material is 360 N/sq. mm, determine the factor of safety of the shaft using maximum shear stress theory.

[20 Marks]

- (c) Determine the horizontal deflection at F for the frame shown in Figure 5. Take $EI = \text{constant}$.

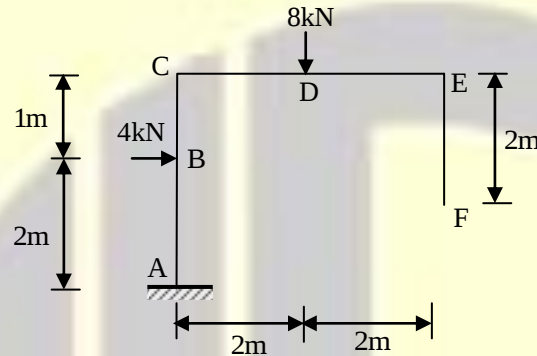


Figure 5

[20 Marks]

3. (a) (i) Name the tests to measure workability of fresh concrete.
(ii) What is a super plasticizing admixture?
(iii) What are the three basic qualities of high performance concrete? Discuss the contradictions.
(iv) What is creep of concrete?

[20 Marks]

- (b) Determine the forces in all the members of the truss as shown in Figure 6 due to a fall of temperature of the member BD by 30°C . Cross-sectional area of all the members = 1500 mm^2 . $\alpha = 0.00001 / ^\circ\text{C}$.

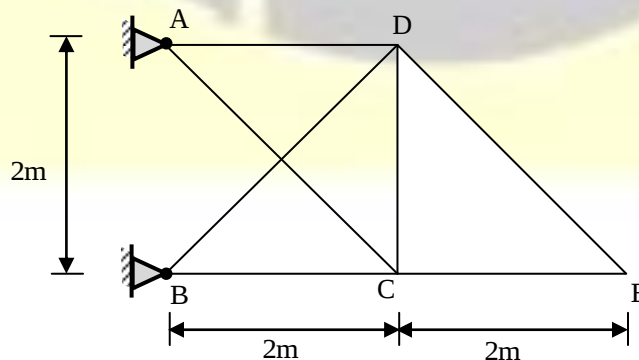


Figure 6

[20 Marks]

- (c) A solid circular shaft has a uniform taper from one end to the other. The ratio of radius at the larger end to that at the smaller end is 1.2. Determine the error that occurs if the angle of twist for a given length is calculated using the mean radius of the shaft.

[20 Marks]

4. (a) The data of material for making a cement concrete mix may be assumed as follows:

(i) Water-cement ratio by mass = 0.46

(ii) Entrained air = 2%

(iii)

S.No.	Material	Specific gravity	Bulk density (kg/m ³)	Proportion in mix by dry volume
1	Cement	3.15	1500	1 part
2.	Fine aggregate	2.61	1620	1.359 part
3.	20 mm nominal size crushed coarse aggregate	2.70	1530	2.79 part

Determine the following for cement concrete:

1. Absolute volume of fully compacted fresh concrete (ignoring air content) produced by one bag of cement of 50 kg.
2. Cement content per cubic metre of concrete.
3. Quantity of materials to make one cubic metre of concrete.

[20 Marks]

- (b) A bar with a square section of side 100 mm is used as a beam and placed in such a way that the diagonal is horizontal. When the section of the beam is subjected to a shear force of 600 kN, determine the maximum shear stress in the section and its location across its depth.

[20 Marks]

- (c) Compute and draw the vertical shear, bending moment and torque diagrams of the cantilever circular bow girder shown in Figure 7 in the shape of a quadrant of a circle of radius 3 m and carrying a uniformly distributed load of 3 kN/m (normal load). The girder lies in the horizontal plane.

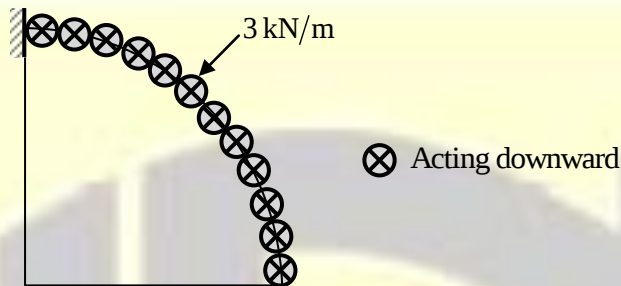


Figure 7

[20 Marks]

SECTION 'B'

5. (a) A 6 m long built-up column carries an axial compressive force and consists of 4 nos. ISMC 350 sections as shown in Figure 8. A lacing is provided in each of the four planes. Explain the principle of design of lacing with the help of a neat sketch.

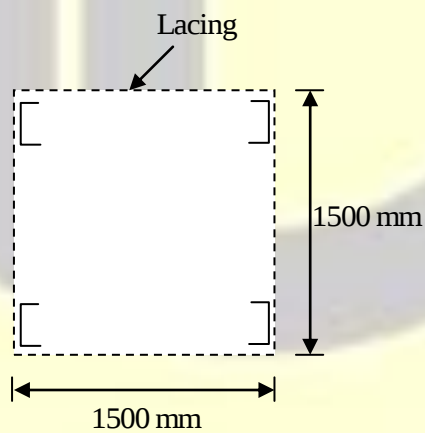


Figure 8

[12 Marks]

- (b) Calculate the expected time t_E and critical path for the following network shown in Figure 9. The optimistic, most likely and pessimistic time for each activity is as shown. 1 is the initial event and 10 is the end event.

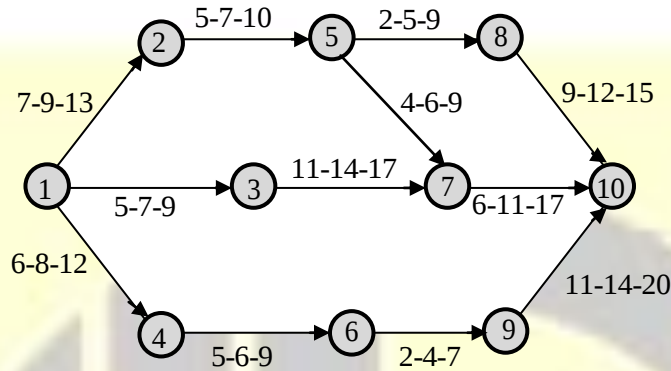


Figure 9

[12 Marks]

- (c) Design a simply supported roof slab (bending and shear only) for a room $3.5 \text{ m} \times 8 \text{ m}$ clear in size if the superimposed dead and live load is 5 kN/m^2 . Use M 25 mix and Fe 415 grade steel. Show reinforcement details. Shear strength of concrete = 0.35 MPa .

[12 Marks]

- (d) A rafter member of a truss consists of double angle ISA, $75 \times 75 \times 6$ welded on the opposite sides of a 10mm gusset plate. Design the fillet weld (shop) for the member. The factored compressive force due to DL + LL = 240 kN and the factored tensile force due to DL + WL = 200 kN. Assume E 250 grade steel. $C_{XX} = C_{YY} = 20.6 \text{ mm}$, $\gamma_{mw} = 1.25$.

[12 Marks]

- (e) A prestressed concrete beam of $150 \text{ mm} \times 300 \text{ mm}$ cross-section supports a live load of 5 kN/m over a simple span of 8m. It has a parabolic cable having an eccentricity of 75mm at the mid-span and zero at the ends. Determine the force of prestress if the net resultant stress at the bottom fibre at mid-span is zero under the action of self-weight, live load and prestress force.

[12 Marks]

6. (a) Design a square footing (bending and shear only) for a column load of 1400 kN at service from a 400 mm square column containing 8 nos. 20 mm bars. The bearing capacity of soil is 100 kN/m^2 at 1m depth below ground level. The unit weight of the Earth is 20 kN/m^3 . Use M 25 grade concrete and Fe 415 grade steel, load factor = 1.5. Show reinforcement details. Shear strength of concrete = 0.35 MPa.

[20 Marks]

- (b) A welded plate girder of span (simply supported) 20 m is subjected to a uniformly distributed load of 100 kN/m including its self-weight. The cross-section of the girder consists of top and bottom flanges ($500 \text{ mm} \times 50 \text{ mm}$) and web plate ($1000 \text{ mm} \times 15 \text{ mm}$). The section is safe against flexure and shear. Design the connection between the flange and web only. Use $\gamma_{mw} = 1.25$, and E 250 grade of steel. Use the limit state method of design.

[20 Marks]

- (c) The floor of a water tank is subjected to a direct pull of 50 kN/m and bending moment of 0.5 kNm/m in the vertical plane. A section of the floor is shown in Figure 10. Find the maximum stresses in concrete and steel. Assume M 30 concrete. Permissible bending stress in concrete = 10 MPa. Use Fe 415.

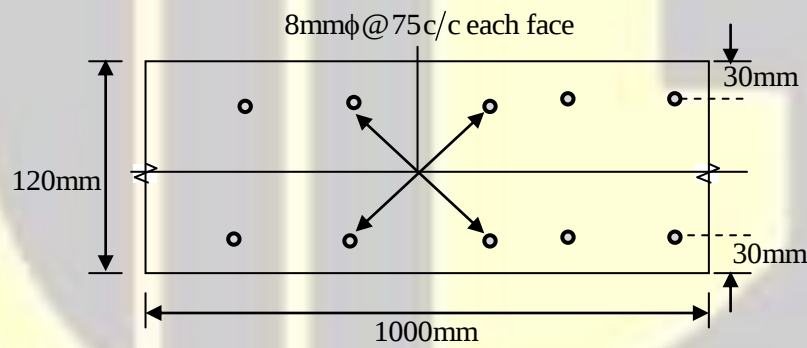


Figure 10

[20 Marks]

7. (a) Briefly answer the following:
- (i) How can an existing bar chart be modified to depict the project progress made ?
 - (ii) Differentiate between the terms 'Activity' and 'Dummy'.
 - (iii) Differentiate between 'Forward Planning' and 'Backward Planning' for network construction.
 - (iv) Differentiate between 'Optimistic time estimate' and 'Pessimistic time estimate'.

[20 Marks]

- (b) A separate two-flight staircase is to be constructed for an old residential house as shown in Figure 11. The floor-to-floor height of the building is 3m. There are 10 nos. of risers of each 150mm and treads of 250mm. Four columns are located at A, B, C, D. The beams AB, CD and AC are located at floor level and the beam BD is located at half landing level. The thickness of waist slab and the landing is 150 mm. Live load = 3 kN/m^2 . Half landing slab is cantilevered from the beam BD. Neglect the line load along the edge of the half landing. Draw the bending moment diagram for the flight for design purpose.

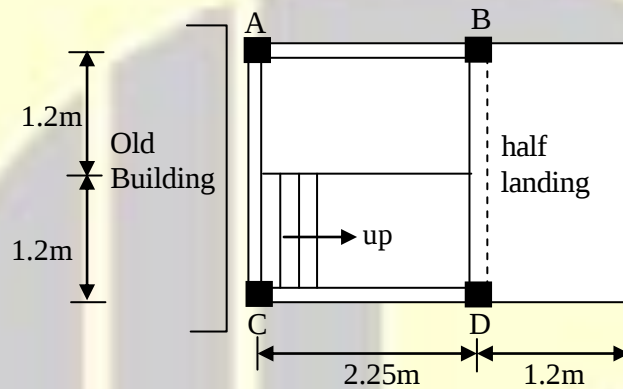


Figure 11

[20 Marks]

- (c) Determine the collapse load in a three-span continuous beam shown in Figure 12. It has a moment capacity of M_p over the exterior spans AB and CD, and $1.5 M_p$ over the interior span BC.

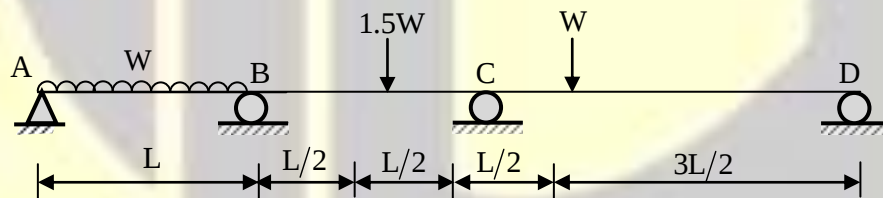


Figure 12

[20 Marks]

8. (a) (i) Briefly explain five important factors which should be considered for selection of equipment for a construction project.
- (ii) The operating time per hour for a bulldozer working in a construction project is 55 minutes to push sandy loam top soil, having swell factor as 1.24, for a hauling distance of 45 m. What will be the output of the bulldozer per hour? Assume the forward speed and the reverse speed of the bulldozer as 2.7 kmph and 5.4 kmph respectively. Rated mold board capacity in loose volume may be assumed as 3.6 cum. The gear shifting time of 0.2 minute may be assumed.

[20 Marks]

- (b) A factory shed is to be constructed using truss having a span of 12 m. The spacing of the truss is 4 m. Galvanised iron sheets are to be placed over purlins located at the nodes as shown in Figure 13. Determine the design load at the nodes due to live load and wind load for an intermediate truss. Assume design wind pressure = 1500 N/m^2 $C_{pe} = -0.7$ (for wind angle 90°), $C_{pi} = \pm 0.2$. Loads are to be shown in the diagram separately.

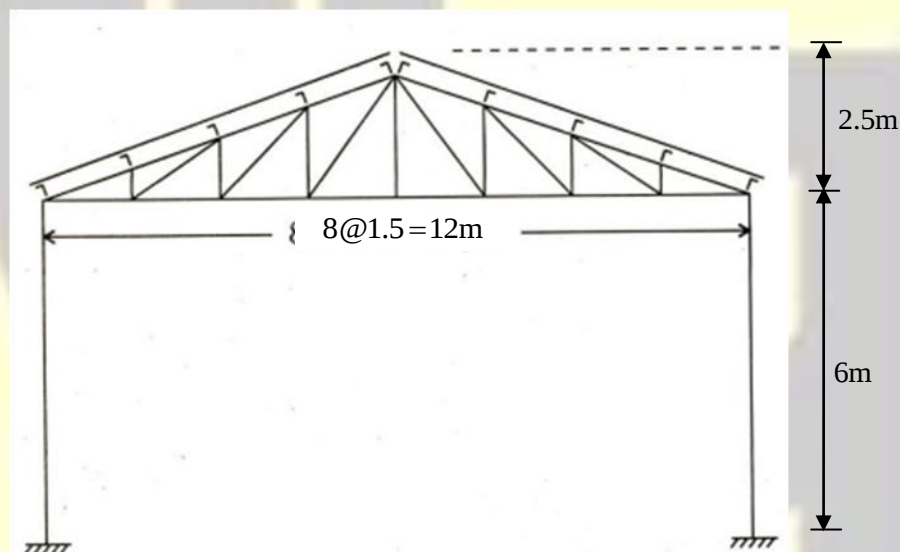


Figure 13

[20 Marks]

- (c) Check the safety and stability of the retaining wall shown in Figure 14. Safe bearing capacity of soil = 80 kN/m^2 , coefficient of friction between soil and concrete = 0.55, angle of repose of earth = 35° , density of earth = 19 kN/m^3 .

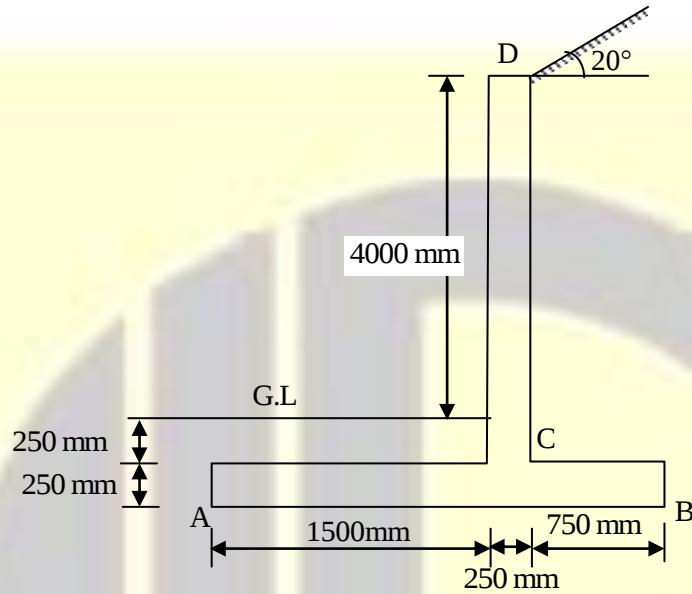


Figure 14

[20 Marks]