PRESTRESSED CONCRETE
(CIVL 3203)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) In post-tensioning system,
(a) wires are first tensioned followed by concreting
(b) tensioning of wires and concreting is simultaneously done
(c) the wires are tensioned against hardened concrete
(d) the wires are tensioned in workshop and transfer it to the site.

(ii) The grade of concrete for prestressed member should be in the range of
(a) M 10 to M 20 (b) M 20 to M 30
(c) M 30 to M 60 (d) M 10 to M 15

(iii) Loss of stress in due to creep of concrete is influenced by
(a) Elastic deformation of concrete (b) Anchorage slip
(c) Modulus of elasticity of steel (d) Area of concrete.

(iv) According to I.S., the total amount of shrinkage for a pretensioned beam is taken as
(a) 3×10^{-4} (b) 3×10^{-5} (c) 3×10^{-6} (d) 3×10^{-7}.

(v) In the design of prestressed concrete sections, the number of fundamental stress conditions to be condieered are
(a) 2 (b) 3 (c) 4 (d) 6.

(vi) Horizontal or axial prestressing of concrete beams
(a) reduces the shear strength of the member
(b) has no effect on the shear strength
(c) increases the shear strength
(d) increases prestressing force.

(vii) In load balancing method, for a parabolic cable prestressed beam, the equivalent distributed load is
(a) $6Pe/L^2$ (b) $8Pe/L^2$ (c) $4Pe/L^2$ (d) $2Pe/L^2$

(viii) A parabolic cable profile with maximum eccentricity at mid-span and concentric at supports when stressed results in
(a) Zero deflection
(b) Downward deflection
(c) Upward deflection
(d) Minimum deflection.

(ix) In composite composition, prestressed elements are used advantageously in the
(a) compression zone
(b) shear zone
(c) tension zone
(d) neutral axis.

(x) The composite action between the precast prestressed and cast in situ elements is achieved by rendering the surface of the prestressing unit
(a) smooth
(b) roughened
(c) with dowels
(d) anchorage ends.

Group – B

2. (a) An unsymmetrical I-section beam is used to support an imposed load of 2 kN/m over a span of 8 m. At the centre of the span, the effective prestressing force of 100 kN is located at 50 mm from the soffit of the beam shown in the Fig.1. Estimate the stress at the centre of span section of the beam for the following load conditions:
(i) Prestress + self weight
(ii) Prestress + self weight + live load

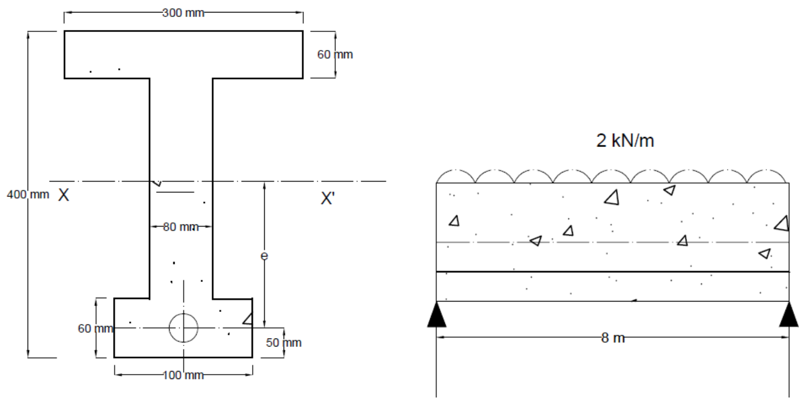

Fig.1

(b) Explain the concept of Pressure-line, C-Line and kern points. Also provide fully explained diagrams.

8 + 4 = 12

3. (a) A rectangular concrete beam of 250 mm wide and 400 mm deep is spanning over 8 m is prestressed by a straight cable carrying an effective prestressing force of 250 kN located at an eccentricity of 40 mm. The beam supports a live load of 5 kN/m.
(i) Calculate the resultant stress distribution for the central cross-section of the beam. The density of concrete is 24 kN/m^3.
(ii) Find the magnitude of the prestressing force with an eccentricity of 40 mm which can balance the stress due to dead and live loads at the bottom fibres of the central section of the beam.

(b) A pretensioned beam of 250 mm wide and 350 mm deep is prestressed by 12 wires each of 7 mm diameter initially stressed to 120 N/mm^2 with their centroids located 100 mm form the soffit. Estimate the final percentage loss of stress due to elastic deformation, creep, shrinkage and relaxation using IS 1343:1980 using following data:

- Relaxation of steel stress = 90 N/mm^2.
- E_s = 210 kN/mm^2, E_c = 35 kN/mm^2.
- Creep coefficient= 1.6
- Residual shrinkage strain = 3×10^{-4}.

7 + 5 = 12

Group – C

4. A prestressed unsymmetrical T-section having overall depth 1400 mm and thickness of web 175 mm. The distance of the top fibre from centroid is 595 mm and distance of the bottom fibre from the centroid is 805 mm. At a particular section, the beam is subjected to an ultimate moment 2200 kN-m. Various required data are given below:
S.F.= 250 kN
Effective depth (d)= 1150mm
Cube strength of concrete (f_{ck})= 45 N/mm^2
Effective prestress at the extreme tension face of the beam (f_{cp})= 1500 N/mm^2.
I = 690×10^8 mm^4.
Area of steel (A_p) = 2400 mm^2.
Tensile strength of the tendons (f_p) = 1500 N/mm^2
Effective stress in tendons after all the losses (f_{pe}) = 895 N/mm^2.
Estimate the flexure-shear resistance of the section (as per IS 1343:1980).

12

5. (a) State strain-compatibility method for prestressed concrete section.

(b) A post-tensioned prestressed concrete beam of rectangular section 250 mm wide is to be designed for an imposed load of 10 kN/m uniformly distributed on a span of 10 m. The stress in the concrete must not exceed 15 N/mm^2 in compression and zero in the tension zone at any stage of loading. The loss of prestress may be assumed to be 15 %.
Calculate,
(i) The minimum possible depth of beam.
(ii) For the section provided, minimum prestressing force and corresponding eccentricity.

3 + 9 = 12

Group – D

6. (a) Briefly describe the following:
(i) Anchorage zone
(ii) Bursting tension with reference to post-tensioned prestressed section.

(b) The end block of a prestressed concrete girder is 200 mm × 400 mm. The beam is post-tensioned by two Freyssinet anchorages each of 100 mm diameter with their centres located at 100 mm top and bottom of the beam. The force transmitted by each anchorage being 2000 kN. Compute the bursting tension and design suitable reinforcement in accordance with IS 1343:1980.

7 + 5 = 12

7. (a) Explain the method of "Theorem of three moments" for the analysis of secondary moments.

(b) A prestressed concrete continuous beam is provided with a tendon as shown in the Fig. 2. The tendon has an eccentricity at A, is parabolic for the span AB, has sharp bends at B, E and C and has an eccentricity at E. The tendon carries a prestressing force of 1500 kN. Draw the resultant B.M. and S.F. diagrams. Locate also the pressure line (C-line) due to the prestress. The beam is 400 mm × 900 mm in section.

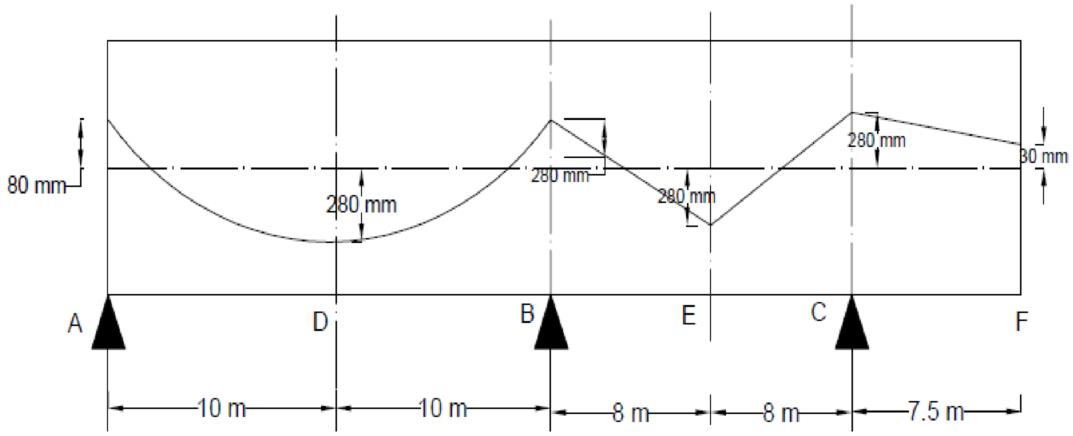

Fig.2

3 + 9 = 12

Group – E

8. (a) Explain the advantages of using composite construction with prestressed and in-situ concrete in structural members.

(b) A precast pretensioned beam of rectangular section has a breadth of 100 mm and a depth of 200 mm. The beam with an effective span of 5 m, is prestressed by tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150 kN. The loss of prestress may be assumed as 15 %. The beam is incorporated in a composite T-beam by casting a top flange of breadth 400 mm and thickness 40 mm. If the composite beam supports a live load of 8 kN/m^2, Calculate the resultant stresses developed in the precast and in situ cast concrete assuming the pretensioned beam as:
(i) umpropped and, (ii) propped during the casting of the slab. Assume the same modulus of elasticity for concrete in precast beam and *in situ* cast slabs.

2 + 10 = 12

9. Design an electric pole of 9 m height to support wires at it's top which can exert a reversible horizontal force of 3 kN. The tendons are initially stressed to 1000 N/mm^2

and the loss of stress due to shrinkage and creep is 15 %. Maximum compressive stress in concrete shall be limited to 12 N/mm^2. Assume,
E_s = 210 kN/mm^2; E_c = 37 kN/mm^2 and $Ø$ = 30^0. Soil unit weight = 18 kN/m^3.

12

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