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) The locus of the centroid of the prestressing force along the structure is known as
(a) thrust line (b) neutral axis
(c) line of prestress (d) transformation profile.

(ii) The grade of concrete for prestressed members 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) In pre-tensioning method
(a) the member is cast followed by tensioning of high tensile wires
(b) the member is prestressed by external anchors.
(c) the high tensile wires are tensioned before placing concrete in forms
(d) the wires are tensioned against hardened concrete.

(iv) In a prestressed concrete beam, the applied loads are resisted by
(a) stress in tendons
(b) a shift in the pressure line from cable line depending upon the moments
(c) an increase in tensile stress in concrete
(d) reducing the stress in tendons.

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

(vi) The loss of stress which is absent in pre-tensioned members is
(a) shrinkage of concrete (b) friction and anchorage slip
(c) creep of concrete (d) elastic deformation of concrete

(vii) 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.

(viii) In post-tensioning method
(a) wires are first tensioned followed by concreting
(b) tensioning of wires and concreting are simultaneously done
(c) the wires are tensioned against hardened concrete
(d) the wires are tensioned immediately after concreting.

(ix) Loss due to shrinkage in pretensioned prestressed members is
(a) 300×10^{-6} (b) 250×10^{-6}
(c) 200×10^{-6} (d) 350×10^{-6}.

(x) In anchorage zone of a post-tensioned beam splitting cracks due to bursting tension develop in the direction of
(a) depth of beam
(b) inclined at 45° to the axis of the beam
(c) horizontal axis of beam
(d) along width of beam.

Group – B

2. (a) A prestressed concrete beam, 200mm wide and 300mm deep, is used over an effective span of 6m to support an imposed load of 4kN/m. The density of concrete is 25kN/m^3. At the central span section find the magnitude of
(i) the concentric prestressing force necessary for zero fibre stress at the soffit when the beam is fully loaded; and
(ii) the eccentric prestressing force located 100mm from the bottom of the beam which would nullify the bottom fibre stress due to loading.

(b) A concrete beam of symmetrical I-section spanning 8m has flange width and thickness of 200mm and 60mm respectively. The overall depth of the beam is 400mm. The thickness of web is 80mm. The beam is prestressed with parabolic cable with an eccentricity of 50mm at the centre and zero at supports with an effective force of 100kN. The live load on the beam is 2kN/m. Determine the stress distribution at the centre section for
(i) prestress + self-weight (density of concrete = 25kN/m^3) and
(ii) prestress + self-weight + live load.

5 + 7 = 12

3. (a) Discuss various type of losses in pre-tensioned and post-tensioned prestressed concrete members.

   (b) A post-tensioned cable of a beam 10m long is initially tensioned to a stress of 1000N/mm^2 at one end. If the tendons are curved so that the slope is 1/15 at each end with a cross-sectional area of 600mm^2, calculate the loss of prestress due to friction, the following data are given:
   Co-efficient of friction between duct and cable = 0.55
   Friction co-efficient for wave effect = 0.0015/m
   During anchoring, if there is a slip of 3mm at the jacking end, calculate the final force in cable and % loss due to friction and anchorage slip.

3 + 9 = 12

Group – C

4. A prestressed unsymmetrical T-section has an overall depth of 1400mm and thickness of web is 175mm. The distance of the top fibre from centroid is 595mm and distance of the bottom fibre from the centroid is 805mm.
   At particular section, the beam is subjected to an ultimate moment of 2200kN-m and shear force of 250kN.
   Effective depth d = 1150mm
   Cube strength of concrete f_{ck} = 45N/mm^2
   Effective prestress at the extreme tension face of the beam (f_{cp}) = 20N/mm^2
   $I = 690 \times 10^8$ mm^4
   Area of steel A_p = 2400mm^2
   Tensile strength of the tendons f_p = 1500N/mm^2
   Effective stress in tendons after all losses f_{pe} = 895N/mm^2
   Estimate the flexure-shear resistance of the section as per IS-1343.

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5. (a) Explain strain-compatibility method of prestressed concrete

   (b) A post-tensioned bonded T-section has a flange width 800mm and thickness 250mm. Thickness of web is 200mm. The area of high tensile steel located at an effective depth of 1200mm is 4000mm^2. The characteristic strength of steel and cube strength of concrete are 1500N/mm^2 and 40N/mm^2. The effective prestress after all losses is 900N/mm^2. Estimate the ultimate flexural strength of T-section using IS:1343.

5 + 7 = 12

Group – D

6. (a) Explain IS code method of computing bursting tension in prestressed concrete section.

   (b) A prestressed concrete girder is 200mm wide by 400mm deep. The end block is post-tensioned by two Freyssinet anchorages each of 100mm diameter with their centres located at 100mm from the top and bottom of the beam. The force transmitted by each anchorage being 2500kN. Compute the bursting force and design suitable reinforcements according to IS : 1343.

3 + 9 = 12

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

   (b) A continuous prestressed concrete beam ABC (AB = BC = 10m) has a uniform rectangular cross-section with a width of 100mm and depth of 300mm. The cable is carrying an effective pre-stressing force of 360kN parallel to the axis of the beam and located at 100mm from the soffit. Determine the resultant moment at central support B due to prestressing only.

4 + 8 =12

Group – E

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

   (b) A pretensioned beam of rectangular section has a width of 150mm and depth of 300mm. The beam with an effective span of 6m is prestressed by tendons with their centroids coincide with the bottom kern. The initial force in tendons is 200kN. The loss of prestress may be assumed as 12%. The beam is incorporated in a composite T-beam by casting a top flange of width 450mm and thickness of 50mm. If the composite beam supports an imposed load of 8kN/m^2, calculate the resultant stress developed in the pre-cast and in-situ cast concrete assuming the pre-tensioned beam as (i) un-propped and (ii) propped during the casting of the slab. Assume the same modulus of elasticity for concrete in pre-cast beam and in-situ slab.

3 + 9 = 12

9. Design an electric pole of 9m height to support wires at its top which can exert a reversible horizontal force of 2.5kN. The tendons are initially stressed to 1000N/mm^2 and the loss of stress due to shrinkage and creep is 15%. Maximum compressive stress in concrete shall be limited to 12N/mm^2. Take E_s = 210kN/mm^2 and E_c = 37kN/mm^2 and $\varphi = 30^\circ$. Soil unit weight = 18kN/m^3.

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