PRESTRESSED CONCRETE STRUCTURES
(CIVL 4141)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Prestress is economical for the members of
(a) Long Span (b) Medium Span
(c) Short Span (d) Any Span

(ii) The locus of the centroid of the prestressing force along the structure is called
(a) Thrust Line (b) Neutral Axis
(c) Line of Prestress (d) Transformation Profile

(iii) The materials used in prestressed concrete must have
(a) High modulus of elasticity of both steel and concrete
(b) Low strength steel and high strength concrete
(c) High water-cement ratio
(d) Low density concrete

(iv) The spacing of stirrups in a prestressed beam should
(a) Not exceed the overall depth
(b) Not be greater than effective depth
(c) Not exceed 0.75 times the effective depth
(d) None of these

(v) In elastic design of prestressed concrete structures
(a) Ultimate loads are considered.
(b) Factor of safety against collapse is assured
(c) Permissible stresses in materials are considered
(d) None of these

(vi) For computing the deflections of a composite beam due to live load, the second moment of area to be used should be based on that of
(a) Cast-in-situ unit (b) Precast unit
(c) Composite section (d) None of the above

(vii) In the anchorage zone of a post-tensioned beam splitting cracks due to bursting tension develops in the direction of:
(a) Depth of beam
(b) Inclined at 45 degrees to the axis of the beam
(c) Horizontal axis of the beam
(d) None of these

(viii) In composite construction, prestressed elements are used advantageously in the
(a) Compression zone (b) Shear zone
(c) Tension zone (d) Torsion zone

(ix) Primary stresses in PSC members are caused by
(a) Dead load only (b) Prestressing force directly applied to concrete
(c) Compatibility conditions (d) Temperature variation

(x) The maximum moment of resistance in a pole is generally requires at
(a) Base (b) Corner (c) Edge (d) Middle

Fill in the blanks with the correct word

(xi) A post-tensioned concrete member subjected to an initial prestress of 400kN. The cross-sectional area of the wires in the cable is 350mm^2. Age of concrete at transfer is 9 days. E_s= 210kN/mm^2. The loss of prestress due to residual shrinkage as per IS 1343 is _____.

(xii) Minimum period of mixing of concrete in prestressed concrete construction should be _____.

(xiii) In composite construction, concrete is mainly used to resist _____.

(xiv) The length of anchorage zone in post-tensioned members is approximately taken as _____.

(xv) The "theorem of three moments" is useful for analysis of _____.

Group - B

2. (a) What is "Pressure or Thrust Line"? Explain its significance with sketches.
[(CO1)(Remember/LOCQ)]

(b) A prestressed concrete beam supports a live load of 4kN/m over a simply supported span of 8m. The beam has an I-section with an overall depth of 400mm. The thickness of the flange and web are 60mm and 80mm respectively. The width of the flange is 200mm. The beam is to be prestressed by an effective prestressing force of 235kN at a suitable eccentricity such that the resultant stress at the soffit of the beam at the centre of the span is zero.
i) Find the eccentricity required for the force.
ii) If the tendon is concentric, what should be the magnitude of the prestressing force for the resultant stress to be zero at the bottom fibre of the central span section?
[(CO2)(Apply/IOCQ)]

3 + 9 = 12

3. (a) Differentiate between Pre-tension and Post-tension Prestressed Concrete Section. *[(CO1)(Remember/LOCQ)]*

(b) A prestressed concrete beam of section 120mm wide by 300mm deep is used over an effective span of 6m to support an uniformly distributed load of 4kN/m which includes the self-weight of the beam. The beam is prestressed by a straight cable carrying a force of 180kN and located at an eccentricity of 50mm. Determine the location of the thrust line in the beam and plot its position at quarter and central span sections. *[(CO2)(Apply/IOCQ)]*

4 + 8 = 12

Group - C

4. (a) Explain with sketches the IS 1343 code method of computing the moment of resistance of rectangular section. *[(CO3)(Remember/LOCQ)]*

(b) A pretensioned prestressed concrete beam having a rectangular section, 150mm wide and 350mm deep, has an effective cover of 50mm. If f_{ck} =40N/mm^2, f_p = 1600N/mm^2 and the area of prestressing steel A_p =461mm^2, Calculate the ultimate flexural strength of the section using IS 1343 code provisions. *[(CO3)(Evaluate/HOCQ)]*

6 + 6 = 12

5. (a) Brief on the criteria of limit state design methods for prestressed concrete section. *[(CO3)(Remember/LOCQ)]*

(b) A pretensioned prestressed concrete beam of rectangular section is required to support a design an ultimate moment of 100kNm. Design the section if f_{ck} is 50N/mm^2 and f_p =1600N/mm^2. If b and d are breadth and effective depth of the section respectively, assuming the ratio (x_u/d)=0.5 *[(CO4)(Evaluate/HOCQ)]*

5 + 7 = 12

Group - D

6. (a) Explain the terms:
(i) End Block (ii) Anchorage zone
(iii) Bursting Tension with reference to post-tensioned prestressed members. *[(CO2)(Remember/LOCQ)]*

(b) The end block of a prestressed concrete girder is 200mm wide by 300mm deep. The beam is post-tensioned by two Freyssinet anchorages each of 100mm diameter with their centres located at 75mm from the top and bottom of the beam. The force transmitted by each anchorage being 2000kN. Compute the bursting force and design the suitable reinforcements according to IS:1343 code provisions. *[(CO4)(Evaluate/HOCQ)]*

6 + 6 = 12

7. (a) What are the advantages of continuous members in prestressed concrete structures? *[(CO4)(Remember/LOCQ)]*

(b) A prestressed beam having a rectangular cross-section with a width of 120mm and a depth of 300mm is continuous over two spans AB=BC=8m. The cable with

zero eccentricity at the ends and an eccentricity of 50mm towards the top fibres of the beam over the central support, carries an effective force of 500kN.
i) Calculate the secondary moment developed at B.
ii) If the beam supports a concentrated load of 20kN at midspan, evaluate the resultant stresses at the central support section B. *[(CO2)(Evaluate/HOCQ)]*

4 + 8 = 12

Group - E

8. (a) Explain the advantages of using composite construction with prestressed and in-situ concrete in structural members. *[(CO5)(Remember/LOCQ)]*

   (b) A precast pretensioned beam of rectangular section has a 200mm x 400mm. The beam with an effective span of 8m is prestressed by tendons with their centroids coincide with the bottom kern. The initial force in tendons is 250kN. The loss of prestress may be assumed as 25%. The beam is incorporated in a composite T-beam by casting a top flange of width 400mm and thickness of 40mm. If the composite beam supports a live load of 10kN/m^2. Calculate the resultant stress developed in the pre-cast and in-situ cast concrete assuming pretensioned beam as un-propped. Assume the same modulus of elasticity for concrete in pre-cast beam and in-situ slab. *[(CO5)(Evaluate/HOCQ)]*

3 + 9 = 12

9. Design an electric pole 10m high to support wires at its top which can exert a reversible horizontal force of 2500N. The tendons are initially stressed at 1000N/mm^2 and the loss of shrinkage and creep is 15%. Maximum compressive stress in concrete shall be limited to 10N/mm^2. Take m=6 and $\varphi = 30°$, self weight=18kN/m^3. *[(CO6)(Evaluate/HOCQ)]*

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	32.29	17.70	50