

PRESTRESSED CONCRETE STRUCTURES
(CIV3231)

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) The minimum grade of concrete used for post-tensioned member is
 - (a) M30
 - (b) M35
 - (c) M40
 - (d) M50
- (ii) High strength steel is used in prestressed concrete because
 - (a) It is cheap
 - (b) It reduces creep
 - (c) It can withstand high tensile stress without large elongation
 - (d) It increases compressive strength of concrete
- (iii) 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
- (iv) Loss of stress due to relaxation of steel is influenced by
 - (a) Shrinkage of Concrete
 - (b) Friction between Steel and Concrete
 - (c) Initial Stress in Steel
 - (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) Excessive upward deflections are likely in the case of members designed as
 - (a) Partially Prestressed
 - (b) Moderately Prestressed
 - (c) Fully Prestressed
 - (d) None of these
- (vii) 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

- (viii) Composite slabs usually consist of
 - (a) RCC slab with steel joists
 - (b) Steel decking sheet with concrete topping
 - (c) Plain concrete slab only
 - (d) Timber slab with steel plate
- (ix) Tendon reaction method of analysing prestressed concrete continuous members involves the principles of

(a) Redundant reactions	(b) Secondary moments
(c) Equivalent loading systems	(d) Primary moments
- (x) Prestress concrete electric poles are generally prestressed with:

(a) Eccentric prestress	(b) Axial prestress
(c) Transverse prestress	(d) All of the above

Fill in the blanks with the correct word

- (xi) Loss of stress due to elastic deformation of concrete depends upon _____.
- (xii) A parabolic cable profile with maximum eccentricity at mid-span and concentric at supports when stressed result in _____ deflection.
- (xiii) According to IS:1343-2012, the bursting tensile force in anchorage zone can be approximately taken as _____.
- (xiv) The clear cover to cables in a PSC post-tensioned girder should not be less than _____.
- (xv) The length of anchorage zone in post-tensioned members is approximately taken as _____.

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) Explain the effect of Parabolic Tendon (with central anchors and eccentric anchors) on deflection of prestressed concrete section. [[CO1](Remember/LOCQ)]
 (b) A rectangular concrete beam of cross-section 150mm wide and 300mm deep is simply supported over a span of 8m and is prestressed by means of symmetric parabolic cable, at a distance of 75mm from the bottom of the beam at mid span

and 125mm from the top of the beam at support sections. If the force in the cable is 350kN and the modulus of elasticity of concrete is 38kN/mm², calculate

- (i) The deflection at mid-span when the beam is supporting its own weight and
- (ii) The concentrated load which must be applied at mid-span to resort it to the level of supports.

[[CO2](Analysis/IOCQ)]

3 + 9 = 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 $f_{ck} = 40\text{N/mm}^2$, $f_p = 1600\text{N/mm}^2$ and the area of prestressing steel $A_p = 461\text{mm}^2$, Calculate the ultimate flexural strength of the section using IS 1343 code provisions.

[[CO3](Evaluate/HOCQ)]

6 + 6 = 12

5. A prestressed girder has to be designed to cover a span of 12m to support an uniformly distributed live load of 15kN/m. M45 grade concrete is used for casting the girder. The permissible stress in compression may be assumed as 14N/mm^2 and 1.4N/mm^2 in tension. Assume 15% losses in prestress during service load conditions. The preliminary section proposed for the girder consists of a symmetrical I section with flanges 300mm wide and 150mm thick. The web is 120mm wide and 450mm deep.
 - (i) Check the adequacy of the section provided to resist the service loads
 - (ii) Design the minimum prestressing force and corresponding eccentricity for the section.

[[CO4](Evaluate/HOCQ)]

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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) Briefly explain the applications of Three Moment Theorem in analysing indeterminate continuous prestressed concrete beams. [[CO3](Remember/LOCQ)]
 - (b) The end block of a prestressed concrete beam, rectangular in section, is 100 mm wide and 200 mm deep. The Prestressing force is 100 kN transmitted to concrete by a distribution plate, 100 mm wide and 50 mm deep, concentrically located at

the ends. Using Guyon's method, compute the position and magnitude of maximum tensile stress and bursting tension for the end block.

Distribution ratio y_{po}/y_o	Position of zero stress $(x/2y_o)$	Position of maximum stress $(x/2y_o)$	Ratio of maximum tensile stress to average stress
0.00	0.00	0.17	0.50
0.1	0.09	0.24	0.43
0.2	0.14	0.30	0.36
0.3	0.16	0.36	0.33
0.4	0.18	0.39	0.27
0.5	0.20	0.43	0.23
0.6	0.22	0.44	0.18
0.7	0.23	0.45	0.13
0.8	0.24	0.46	0.09

[[CO4](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/m². 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 12m high to support wires at its top which can exert a reversible horizontal force of 2200N. The tendons are initially stressed at 1100N/mm² and the loss of shrinkage and creep is 12%. Maximum compressive stress in concrete shall be limited to 10N/mm². Take $m=6$ and $\phi = 30^\circ$, self weight=18kN/m³. [[CO6](Evaluate/HOCQ)]
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	22	19	59