B.TECH/CE/7TH SEM/CIVL 4141/2021

PRESTRESSED CONCRETE STRUCTURES
(CIVL 4141)

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) Resultant stress in the cross-section of a prestressed beam comprises of:
(a) Prestress + Dead load stress + Live load stress
(b) Prestress + Dead load stress
(c) Prestress + Live load stress
(d) Only direct stress + Bending stress.

(ii) The grade of concrete for prestressed members should be in the range of:
(a) M-20 to M-30 (b) M30 to M-60
(c) M-60 to M-80 (d) M-80 to M-100.

(iii) Short term deflection of a prestressed beam can be computed using:
(a) Elastic theory (b) Mohr's theorem
(c) Shear force diagram (d) Bending moment diagram.

(iv) Web-shear cracks are likely to develop in prestressed beams with:
(a) rectangular section (b) T-section
(c) I-section with thin webs (d) circular section.

(v) Maximum permissible final deflection of a beam should not exceed:
(a) span/350 (b) span/250
(c) span/300 (d) span/450.

(vi) 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.

(vii) 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.

(viii) 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 beam
(c) horizontal axis of beam
(d) none of these.

(ix) The anchorage zone in a post-tensioned PSC beam extends over a length of :
(a) ½ the depth of beam (b) twice the depth of beam
(c) depth of beam (d) width of the beam.

(x) For a particular prestressed concrete pole, following data are given:
Height of pole = 10m, Depth of penetration of pole = 2.5m, Lateral force = 20 kN, unit weight of soil = 1600 N/mm^2, Angle of repose= 30^0, then the width of the pole is:
(a) 16 m (b) 12 m (c) 30 m (d) 20m.

Group – B

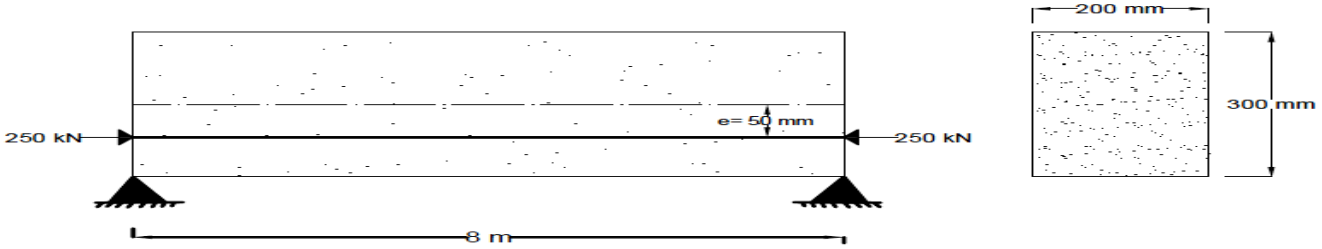
2. (a) A prestressed concrete beam of section 120mm wide and 300mm deep is used over an effective span of 6m to support an uniformly distributed load of 4kN/m, which includes self-weight of the beam. The beam is prestressed by a force of 200kN and located at an eccentricity of 50mm. Determine the location of the thrust line in the beam and plot its position at quarter and central span section. [CO1, Evaluate/HOCQ]

(b) A post-tensioned cable of a beam is 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 an area of 600 mm^2. Calculate the loss of prestress due to friction, given the following data:
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. [CO1, Evaluate/HOCQ]

5 + 7 = 12

3. (a) A prestressed concrete beam produced by pre-tensioning method has a rectangular cross-section of 300 mm X 250 mm. It is prestressed with 9 numbers of straight 7 mm diameter wires at 0.8 times the ultimate strength of 1570 N/mm^2. Estimate the % of loss of stress due to elastic shortening of concrete. Consider m=6. [CO2, Remember/LOCQ]

(b) A prestressed concrete beam of rectangular section 200 mm wide X 300 deep spans over 8m shown in the fig.(ii). The beam is prestressed by a straight cable carrying an effective force of 250 kN at an eccentricity of 50 mm. The modulus of elasticity is 38 kN/m^2.



(i) Compute the deflection at the centre of the span under (prestress + self-weight)

(ii) Find the magnitude of U.D.L. (live load) which will nullify the deflection due to prestress and self-weight. [CO2, Evaluate/HOCQ]

4 + 8 = 12

Group – C

4. (a) Distinguish between web shear, flexural and flexural-shear cracks in concrete beam with sketches. [CO3, Remember/LOCQ]

   (b) A horizontal prestress at the centroid of a concrete beam of rectangular section 120mm × 200mm is 7 N/mm^2 and the maximum shearing force of the beam is 70 kN.

   (i) Calculate the maximum principal tensile stress.

   (ii) Calculate the minimum prestress is required to eliminate this principal tensile stress. [CO3, Evaluate/HOCQ]

4 + 8 = 12

5. (a) A post-tensioned bridge girder with unbonded tendons of box section with dimensions 1200 mm wide by 1800 mm deep with wall thickness of 150 mm. The high tensile steel are of 4000 mm^2 and located at an effective depth of 1600 mm. The effective prestress in steel after all losses is 1000 N/mm^2 and effective span of girder is 24 m.

   If f_{ck} = 40 N/mm^2 and f_p= 1600 N/mm^2, Estimate the ultimate flexural strength of the section. [CO3, Evaluate/HOCQ]

   (b) A post-tensioned prestressed beam of rectangular cross-section 200 mm wide carries uniformly imposed load of 10 kN/m. The span of the beam is 10 m. The stress in concrete is not to exceed 17 N/mm^2 in compression and 0.7 N/mm^2 in tension at any time. Assuming, the loss of prestress as 15%, calculate the following:

   (i) Minimum possible depth of the beam

   (ii) For the section so obtained, calculate the minimum prestressing force and the corresponding eccentricity. [CO3, Evaluate/HOCQ]

5 + 7 = 12

Group – D

6. (a) Describe the following terms: (also provide necessary diagrams)

   (i) End Block (ii) Anchorage zone

   (iii) Bursting Tension (iv) Splitting crack. [CO3, Remember/ LOCQ]

(b) The end block of a prestressed concrete girder is 200 mm X 400 mm. The beam is post tensioned by two Freyssinet anchorages each of 80 mm diameter with their centre located at 100 mm from the top and bottom of the beam. The force transmitted by each anchorages being 2000 kN. Compute the bursting force and design reinforcement as per IS codal regulations. [CO3, Apply/IOCQ]

6 + 6 = 12

7. (a) Mention the various advantages for the application of Indeterminate Continuous beams in Prestressed bridges. [CO4, Remember/ LOCQ]

(b) A two-span continuous prestressed concrete beam ABC (AB=BC=15 m) has a uniform cross-section with a width 250 mm and depth of 600 mm. A cable carrying an effective prestressing force of 500 kN is parallel to the axis of the beam and located at an eccentricity of 200 mm.

(i) Determine the secondary and resultant moment developed at the mid-point section B.

(ii) If the beam supports an imposed load of 2.4 kN/m, calculate the resultant stresses developed at the top and bottom of the beam at B. Also, locate the resultant line of thrust through the beam AB. [CO4, Analyze/ HOCQ]

4 + 8 = 12

Group – E

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

(b) The cross-section of a 6m span composite beam which consists of a 120 mm X 240 mm precast stem and cast-in-situ flange 480 mm X 50 mm. The stem is post-tensioned unit which is subjected to an initial prestressing force 230 kN. The loss of prestress is 15%. The tendons are provided such that their centre of gravity is 80 mm above the soffit. The composite beam has to support a live load of 4kN/m. Determine the resultant stresses in the stem and flange if the beam is: (i) unpropped (ii) propped. [CO5, Analyze/ HOCQ]

4 + 8 = 12

9. Design an electric pole of 18 m height and support wires at it's top which can exert a reversible horizontal force of 5 kN. The tendons are initially stressed to 1000 N/mm^2 and loss of stress due to shrinkage and creep is 12%. Maximum compressive stress in concrete shall be limited to 10 N/mm^2. Take E_s= 210 kN/mm^2 and E_c= 38 kN/mm^2 and Ø= 30^0. Unit weight of soil = 18 kN/m^3. [CO6, Analyze/ HOCQ]

12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.7 %	7.14 %	69.23 %

After the completion of this course, students will be able to:

1: Learn the basic terminologies in Prestressed concrete structures, various methods of prestressing and various losses in prestress in concrete.

2: Develop the design criteria of prestressed concrete section for flexure and shear properties
3: Analyze the anchorage zone stress for post-tensioned members
4. Gain knowledge regarding the methods of Analysis of Statically Indeterminate Structures
5. Gain knowledge regarding the composite construction of Prestress and In-situ concrete
6. Gain knowledge regarding Design of Prestressed concrete poles and sleepers and introduction of partial prestressing.

Department & Section	Submission link:
CE & SEC A	https://classroom.google.com/w/NDA1MzEyNTI4MTU4/t/all
CE & SEC B	https://classroom.google.com/w/NDA1MzMzOTkxNDQ5/t/all