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10CV74

Seventh Semester B.E. Degree Examination, July/August 2022
Design of Prestressed Concrete Structures

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of IS1343-1980 is permitted.***

PART – A

1 a. Distinguish between pre-tensioning and post-tensioning. **(06 Marks)**

b. Define pre-stressed concrete. State advantages as over reinforced concrete. **(06 Marks)**

c. Define the following :
(i) Tendon
(ii) Load balancing
(iii) Anchorage
(iv) Proff stress **(08 Marks)**

2 a. A rectangular concrete beam 300 mm wide and 800 mm deep supports two concentrated loads of 20 kN each at the third point of span of 9 m.
(i) Suggest a cable profile. If the eccentricity of the cable profile is 100 mm for the middle third portion of the beam, calculate the pre-stressing force required to balance the bending effect of the concentrated loads (neglect the self-weight of the beam).
(ii) For the same cable profile, find the effective force in cable if the resultant stress due to self-weight, imposed loads and pre-stressing force is zero at the bottom fibre of mid-span section.
(Assume $D_C = 24$ kN/m^3). **(14 Marks)**

b. A rectangular concrete beam, 250 mm wide and 600 mm deep, is prestressed by means of four 14 mm diameter high tensile bars located 200 mm from the soffit of the beam. If the effective stress in the wires is 700 N/mm^2. What is the maximum bending moment that can be applied to the section without causing tension at the soffit of the beam? **(06 Marks)**

3 a. A pre tensioned beam, 200 mm wide and 300 mm deep, is prestressed by 10 wires of 7 mm diameter initially stressed to 1200 N/mm^2 with their centroids located 100 mm from the soffit. Find the maximum stress in concrete immediately after transfer, allowing only for elastic shortening of concrete.
If the concrete undergoes a further shortening due to creep and shrinkage while there is a relaxation of 5 percent of steel stress, estimate the final percentage loss of stress in wires using the Indian standard code IS[1343-1980] regulations, and the following data:
$E_S = 210$ kN/mm^2
$E_C = 5700 (fcu)^{\frac{1}{2}}$
Fcu = 42 N/mm^2
Creep coefficient (ϕ) = 1.6
Total residual shrinkage strain = 3×10^4. **(14 Marks)**

b. A concrete beam is post-tensioned by a cable carrying an initial stress of 1000 N/mm^2. The slip at the jacking end was observed to be 5 mm. The modulus of elasticity of steel is 210 KN/mm^2. Estimate the percentage loss of stress due to anchorage slip if the length of the beam is (i) 30 m (ii) 3 m. **(06 Marks)**

4 A pre-stressed concrete beam having a rectangular section 100 mm wide and 200 mm deep spans over 2.76 m. The beam is pre-stressed by a straight cable containing 5 wires of 5 mm diameter stressed to 1200 N/mm^2 at an eccentricity of 37 mm. Assume the modular ratio $\alpha_e = 6.2$. If the modulus of elasticity of concrete is 34 kN/mm^2 and modulus of rupture is 4 N/mm^2. Calculate the maximum deflection of the beam at the following stages ;

(i) Prestress + Self weight of the beam.
(ii) Prestress + Self weight + imposed load of 8.4 kN/m
(iii) Cracking load
(iv) 1.46 times the working load.
(v) 1.8 times the working load. **(20 Marks)**

PART – B

5 a. A pre-tensioned, T-section has a flange 1200mm wide and 150mm thick. The width and depth of the rib are 300 and 1500mm respectively. The high tensile steel has an area of 4700mm^2 and is located at an effective depth of 1600mm. If the characteristic cube strength of the concrete and the tensile strength of steel are 40 and 1600N/mm^2 respectively. Calculate the flexural strength of the T-section. **(12 Marks)**

b. A post-tensioned beam with unbounded tendons is of rectangular section 400mm wide with an effective depth of 800mm. The cross-sectional area of the pre-stressing steel is 2840mm^2. The effective prestress in the steel after all losses is 900N/mm^2. The effective span of the beam is 16m. If fck = 40N/mm^2, estimate the ultimate moment of resistance of the section using IS:1343 code recommendations. **(08 Marks)**

6 a. A prestressed concrete beam (span = 10m) of rectangular section, 120mm wide and 300mm deep, is axially prestressed by a cable carrying an effective force of 180kN. The beam supports a total uniformly distributed load of 5kN/m which includes the self weight of the member. Compare the magnitude of the principal tension developed in the beam with and without the axial prestress. **(10 Marks)**

b. The support section of a pre-stressed concrete beam, 100 mm wide and 250 mm deep, is required to support an ultimate shear force of 60 kN. The compressive pre-stress at the cetroidal axis is 5 N/mm^2. The characteristic cube strength of concrete is 40 N/mm^2. The cover to the tension reinforcement is 50 mm. If the characteristic tensile strength of steel in stirrups is 250 N/mm^2. Design suitable reinforcements at the section using the Indian standard code IS 1343 recommendations. **(10 Marks)**

7 a. The end-block of a post-tensioned pre-stressed member is 550 mm wide and 550 mm deep. Four cables, each made up of 7 wires of 12 mm diameter strands and carrying a force of 1000 kN, are anchored by plate anchorages, 150 mm by 150 mm, located with centres at 125 mm from the edges of the end block. The cable duct is of 50 mm diameter. The 28 - day cube strength of concrete fcu is 45 N/mm^2. The cube strength of concrete at transfer, fci is 25 N/mm^2. Permissible bearing stresses behind anchorages should conform with IS 1343. The characteristic yield stress in mild steel anchorage reinforcement is 260 N/mm^2. Design suitable anchorages for the end block. **(12 Marks)**

b. The end block of a post-tensioned bridge girder is 600 mm wide and by 1200 mm deep. Two cables, each comprising 97 high-tensile wires of 7 mm diameter, are anchored using square anchor – plates of side length 410 mm with their centres located at 600 mm from top and bottom edges of the beam. The jacking force in each cable is 4500 kN. Design a suitable anchorage zone reinforcement using fe-415 grade HYSD bars conforming to IS 1343 code provisions. **(08 Marks)**

8 a. Explain End-Zone reinforcement. **(04 Marks)**

b. A pre-stressed concrete beam of rectangular section 120 mm wide and 300 mm deep, spans over 6 m. The beam is pre-stressed by a straight cable carrying an effective force of 180 kN at an eccentricity of 50 mm. If it supports an imposed load of 4 kN/m and modulus of elasticity of concrete is 38 kN/mm^2, compute the deflection at the following stages and check whether they comply with the IS code specifications.

(i) Upward deflection under (pre-stress + self-weight)

(ii) Final downward deflection under (pre-stress + self weight + imposed load) including the effects of creep and shrinkage. Assume the creep coefficient to be 1.80. **(16 Marks)**

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