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10CV74

Seventh Semester B.E. Degree Examination, Feb./Mar.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 IS 1343-1980 is permitted.***

PART – A

1 a. Explain with neat sketch, Magnel Blaron system of post-tensioning. **(08 Marks)**

b. Distinguish between the following terms: (i) Uniaxial and biaxial pre-stressing.
(ii) Concentric and eccentric pre-stressing. **(06 Marks)**

c. Explain how prestressed concrete is more advantageous as compared to reinforced concrete. **(06 Marks)**

2 a. A concrete beam of symmetrical I-section spanning 8 m has the width and thickness of flanges equal to 200 and 60 mm, respectively. The overall depth of beam is 400 mm. The thickness of web is 80 mm. The beam is prestressed by a parabolic cable with an eccentricity of 150 mm at the centre and zero at the supports with an effective force of 100 kN. The live load on the beam is 2 kN/m. Draw the stress distribution diagram at the central section for,
(i) Prestress + self weight (Density of concrete = 24 kN/m^3)
(ii) Prestress + self weight + live load. **(12 Marks)**

b. A prestressed concrete beam, 120 mm wide × 300 mm deep, is prestressed by a cable which has an eccentricity of 100 mm at the centre of span section. The span of the beam is 6 m. If the beam supports two concentrated loads of 10 KN each at one-third span points, determine the magnitude of the prestressing force in the cable for load balancing for the following cases; (i) Considering live loads but neglecting self-weight of beam ; and
(ii) Considering both self-weight of beam and live load (Density of concrete = 24 kN/m^3) . **(08 Marks)**

3 a. A post tensioned cable of a beam 10 m long is initially tensioned to a stress of 1000 N/mm^2 at one end. If the tendons are curved so that the slope is 1 in 24 at each end with an area of 600 mm^2. Calculate the loss of prestress due to friction given, the following data:
Coefficient of friction between duct and cable = 0.55
Friction coefficient for wave effect = 0.0015/m
During anchoring, if there is a slip of 3 mm at the jacking end, calculate the final force in the cable and the percentage loss of prestress due to friction and slip. Take E = 210×10^3 N/mm^2. **(10 Marks)**

b. A post tensioned concrete beam with a cable of 24 parallel wires (total area = 800 mm^2) is tensioned with 2 wires at a time. The cable with zero eccentricity at the ends and 150 mm at the centre is on a circular curve. The span of the beam is 10 m and the cross section is 200 mm wide and 450 mm deep. The wires are to be stressed from one end to a value of f_1 to overcome frictional loss and then released to a value of f_2 so that immediately after anchoring, an initial prestress of 840 N/mm^2 would be obtained. Compute f_1, f_2 and the design stress in steel after all losses, given the following data:
Coefficient of friction for curvature effect = 0.6
Friction coefficient for 'wave' effect = 0.003/m ;
Deformation and slip of Anchorage = 1.25 mm
E_S = 210 kN/mm^2, E_C = 35 kN/mm^2 ;
Shrinkage of concrete = 0.0002
Relaxation of steel stress = 3% of initial stress. **(10 Marks)**

4 a. List the factors influencing deflections of a prestressed concrete beam. **(04 Marks)**

b. Explain the significance of long term deflections in PSC beams and indicate how it is calculated. **(06 Marks)**

c. A concrete beam with a rectangular section, 100 mm wide and 300 mm deep is stressed by a prestressing cable carrying an effective force of 240 kN. The span of the beam is 10 m. The cable is parabolic with an eccentricity of 50 mm below the centroidal axis at centre of span and zero eccentricity at support. If the beam supports a uniformly distributed live load of 5 kN/m and $E_C = 38$ kN/mm^2, estimate the instantaneous deflection at the following stages:

(i) Prestress + Self weight of beam, and (ii) Prestress + self weight + live load **(10 Marks)**

PART – B

5 a. A post tensioned bonded pre-stressed concrete beam of unsymmetrical Tee-section has a flange width of 1500 mm and thickness of flange is 200 mm, and thickness of rib is 300 mm. The area of high tensile steel is 5000 mm^2 located at an effective depth of 1800 mm. If the characteristic strength of concrete and steel are 40 and 1600 N/mm^2, respectively, calculate the flexural strength of Tee-section. **(12 Marks)**

b. A post tensioned prestressed concrete tee-section having a flange width of 1200 mm and flange thickness of 200 mm, thickness of web being 300 mm is prestressed by 2000 mm^2 of high tensile steel located at an effective depth of 1600 mm. If $f_{CK} = 40$ N/mm^2 and $f_p = 1600$ N/mm^2, estimate the ultimate moment capacity of the unbonded tee-section, assuming $\left(L/d\right)$ ratio as 20 and $f_{pe} = 1000$ N/mm^2. **(08 Marks)**

6 a. A concrete beam of rectangular section, 200 mm wide and 600 mm deep is prestressed by a parabolic cable located at an eccentricity of 100 mm at midspan and zero at the supports. If the beam has a span of 10 m and carries a uniformly distributed live load of 4 kN/m, find the effective force necessary in the cable for zero-shear-stress at support section. For this condition calculate the principal stresses. The density of concrete is 24 kN/m^3. **(06 Marks)**

b. A prestressed concrete bridge girder of unsymmetrical I-section has an overall depth of 1300 mm with a cross sectional area of 328500 mm^2. Thickness of web is 150 mm, span of the girder is 25 m. The girder is prestressed by a parabolic cable having an eccentricity of 650 mm at centroid and 285 mm at support sections. The effective prestressing force in the cable is 2070 kN. If $f_t = 1.6$ N/mm^2, estimate the ultimate shear resistance of support section. **(06 Marks)**

c. A prestressed girder of rectangular section 150 mm wide and 300 mm deep is to be designed to support an ultimate shear force of 130 kN. The uniform prestress across the section is 5 N/mm^2. Given the characteristic cube strength of concrete as 40 N/mm^2 and Fe – 415 HYSD bars of 8 mm diameter, design suitable spacing for the stirrups confirming to the Indian Standard Code IS : 1343 recommendations. Assume corner to the reinforcement as 50 mm. **(08 Marks)**

7 a. What is transmission length? List the factors affecting transmission length. **(06 Marks)**

b. Explain end zone reinforcements. **(06 Marks)**

c. Briefly discuss the stress distribution in the end block of post tensioned members. **(08 Marks)**

8 A prestressed concrete Tee-beam is to be designed to support an imposed load of 4.4 kN/m over an effective span of 5 m. The Tee-beam is made up of a flange 400 mm wide and 40 mm thick. The rib is 100 mm wide and 200 mm deep. The stress in the concrete must not exceed 15 N/mm^2 in compression and zero in tension at any stage. Check for the adequancy of the section provided, and calculate the minimum prestressing force necessary and corresponding eccentricity. Assume 20% loss of prestress. **(20 Marks)**

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