Reg No.:_______________ Name:__________________________

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

**Course Code: CE 368**

**Course Name: PRESTRESSED CONCRETE**

Max. Marks: 100 Duration: 3 Hours

***Use of the Code IS 1343 is permitted.***

**PART A**

***Answer any two full questions, each carries 15 marks.*** Marks

1 a) What are the advantages of prestressing? Mention the limitations of prestressing. (5)

b) What is the necessity of using high grade concrete and steel in prestressing? (3)

c) A post-tensioned beam AB of span 25 m is prestressed with an initial prestressing force of 400 kN at the jacking end A of the beam. The cable is having zero eccentricity at the supports A and B and an eccentricity of 400 mm towards the soffit at mid-span. The coefficient of friction $\mu$ = 0.30 and the coefficient of wave effect $K$ = 0.0043/m. Determine: (7)

i) The loss of prestressing force in the cable due to friction.

ii) The effective prestressing force in the cable at the farther end B of the beam.

2 a) What are the criteria concerning prestressed concrete for the ultimate limit state? (3)

b) What are Class 3 – type prestressed members? Mention their advantages. (3)

c) Estimate the ultimate flexural strength at the mid-span section of an I-section bridge girder using IS 1343 Codal provisions. The overall depth of the girder is 1500 mm; The width and thickness of the top flange is 900 mm and 250 mm respectively; The size of the bottom flange is 600 mm x 300 mm; Thickness of the web is 250 mm. The girder is used over a span of 25 m and post-tensioned with effective bond using tendons having an area of 6000 mm$^2$. The tendons are parabolic with an eccentricity of 750 mm at the centre of span and zero at the supports. Take $f_{cu}$ = 45 N/mm$^2$ and $f_{pu}$ = 1700 N/mm$^2$. (9)

3 Design a prestressed concrete I-beam to carry a superimposed load of 12 kN/m over a span of 20 m. The thickness of the flange and web may be taken as 150mm. Loss of prestressing force = 20 %. Allowable compressive strength in concrete = 12 N/mm$^2$. No tension is allowed in concrete. (15)

**PART B**

***Answer any two full questions, each carries 15 marks.***

4 a) Explain with neat sketches the types of shear cracks in structural concrete members. (4)

b) What are the different ways of improving the shear resistance of structural concrete members by prestressing techniques? (3)

c) A concrete beam of rectangular section, 300 mm wide and 800 mm deep is subjected to a twisting moment of 30 kNm and a prestressing force of 150 kN acting at an eccentricity of 220 mm. i) Calculate the maximum principal tensile stress. ii) If the beam is subjected to a maximum bending moment of 100 kNm in addition to the twisting moment, calculate the maximum principal tensile stress. (8)

5 A prestressed concrete beam of rectangular cross-section is subjected to an effective prestressing force of 500 kN provided by 5 numbers of 12.5 mm diameter strands of cross-sectional area 506 $mm^2$. The cross-sectional dimension of the beam is 450 mm × 600 mm. The eccentricity of the post-tensioned tendon is 150 mm. A service load Bending Moment of 176 kNm, Torsional Moment of 56 kNm and Shear Force of 75kN are acting at the section of the beam. Take the cube strength of concrete as 40N/$mm^2$ and the ultimate tensile strength of tendons as 1820 N/$mm^2$. Using IS 1343 codal provisions design the longitudinal and transverse reinforcements of the beam. (15)

6 a) A concrete beam is prestressed by a sloping tendon having an eccentricity of $e_1$ towards the soffit at centre of span and an eccentricity of $e_2$ towards the top at supports. Find the ratio of these eccentricities for zero deflection at the centre of span due to prestress only. (4)

b) Briefly explain the importance of creep and shrinkage of concrete in long-term deflections of prestressed members. (3)

c) A beam of size 200 mm × 350 mm is prestressed with 12 wires of 7 mm diameter straight tendons located at a distance of 75 mm from the soffit of the beam. The wires are stressed to 750 N/$mm^2$. The beam supports an imposed load of 7 kN/m over a span of 8 m. The modulus of elasticity of concrete is 38 kN/$mm^2$, and density of concrete is 24 kN/$m^3$. Estimate the central deflection of the beam under the action of prestress, self-weight and live load. Compare this value with IS 1343 codal provisions (8)

## PART C

***Answer any two full questions, each carries 20 marks.***

7 a) What is the necessity of providing reinforcements in the anchorage zone of a prestressed concrete beam? Give the supporting figures. (5)

b) What are the factors influencing the design of prestressed concrete sleepers (3)

c) Two cables each carrying a prestressing force of 2800 kN are anchored using a square anchor plate of side 305 mm at the end block of a post-tensioned beam of 500 mm wide and 1000 mm deep. The centres of the anchor plate are 250 mm from the top and bottom edges of the beam. Design suitable reinforcements in the end block using IS code provisions. Use Fe-415 grade steel bars. (12)

8 a) List the advantages of prestressed concrete poles. (4)

b) A partially prestressed T-girder designed to support a live load of 8 kN/m over an effective span of 20 m is made up of a top flange 100 mm wide and 120 mm thick with a rib 300 mm thick. The overall depth of the girder is 720 mm. The tensioned steel consists of nine strands of 12.5 mm diameter with a tensile strength of 1750 N/mm$^2$, located at 585 mm from the top. The untensioned steel is of 7 cold worked deformed bars, of 25 mm diameter with $f_y$ = 425 N/mm$^2$, located at 80 mm from the soffit of the girder. The effective prestressing force in the tendon is 830 kN. Calculate the strain ($\varepsilon_o$) at the top fibre of the girder. Also estimate the width of the cracks developed under service loads and check the crack width using the hypothetical tensile stresses provided for in IS 1343-2012. (16)

9 a) Briefly explain the composite construction for T-beams in bridges. (4)

b) Explain, with the help of neat sketches, the following terms used in statically indeterminate prestressed concrete structures. (6)

i. Primary moment
ii. Secondary moment
iii. Resultant moment
iv. Pressure line or thrust line

c) A simply supported composite T-section beam is having a span of 4.5 m. The beam is made composite by casting an in-situ concrete slab of size 300 mm x 50 mm on the top of a rectangular pre-tensioned concrete beam of size 100 mm x 230 mm. The prestress occurred after all losses in the rectangular pre-tensioned beam are 12 N/mm$^2$ at the soffit and zero at the top. Calculate the maximum uniformly distributed live load on the composite beam, without occurring any tensile stresses, if the slab is i) propped, and ii) un-propped while casting. (10)

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