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Total No. of Questions : 08

M.Tech (Structural Design) (2016 & Onwards) (Sem.-1)

PRE-STRESSED CONCRETE DESIGN

Subject Code : MTSD-103

M.Code : 74244

Time : 3 Hrs. Max. Marks : 100

INSTRUCTION TO CANDIDATES :

1. **Attempt any FIVE questions out of EIGHT questions.**
2. **Each question carries TWENTY marks.**
3. **Missing data may be assumed suitably.**
4. **Use of IS : 1343 is permitted.**

Ql. (a) Distinguish between proof stress and ultimate tensile stress of high tensile steel. What is the practical significance of proof stress? (4)

(b) Briefly explain the relation between tendon profile and equivalent loads in prestressed concrete beams with sketches. (4)

(c) Explain with sketches Baur-Leonhardt system of post -tensioning. (4)

(d) A concrete beam of symmetrical I-section spanning 10m has flange width and thickness of 220 and 75mm respectively. The overall depth of the beam is 450mm. The thickness of the web is 75mm. The beam is prestressed by a parabolic cables with an eccentricity of 15mm at the centre and zero at the supports with an effective force of 120kN. The live load on the beam is 4kN/m. Draw the stress distribution diagram at the central section for :

Prestress + Self- weight

Prestress + Self- weight +live load. (8)

Q2 (a) A prestressed concrete beam having a cross-sectional area of 6.5×10^4 mm^2 is simply supported over a span of 10m. It supports a uniformly distributed imposed load of 3.5kN/m. The tendon follows a trapezoidal profile with an eccentricity of 100 mm with a middle third of the span and varies linearly from the third-span points to zero at the supports. The area of the tendons $350mm^2$ have effective prestress of 1500 N/mm^2 immediately after transfer. Calculate the short term and long term deflection using the following data :

$I_g = 5.5 \times l0^8$ mm^4, $E_c = 34$ kN/mm^2, $E_s = 200$ kN/mm^2, Creep coefficient = 2

Concrete shrinkage = 480×10^{-6}, Relaxation of steel = 10%. (12)

(b) A post -tensioned cable of a beam 12m long is initially tensioned to a stress of 1200N/mm at one end. If the tendons are curved so that the slope is 1 in 15 at each end with an area of 600 mm^2. Calculate the loss of friction due to following data :

Coefficient of friction between the duct and cable = 0.55

Friction coefficient for wave effect = 0.0015/m

During Anchoring, if there is slip of 3mm at the jacking end, Calculate the final force in the cable and percentage loss of prestress due to friction and slip. (8)

Q3 (a) A post tensioned bonded prestressed beam of rectangular section 500mm wide by 650mm deep, is subjected to a service load B.M of 180kNm, torsional moment of 45.5kNm, and shear force of 66.5kN. The section has an effective prestressing force 550kN at an eccentricity of 150mm, provided by 5 bars of 12.5mm stress-relieved strands of cross sectional area 505mm^2 with an ultimate tensile stress of 1820 N/mm^2. If cube strength of concrete is 40N/mm^2, design the longitudinal and transverse reinforcement in the beam using skew-bending theory. (16)

(b) Write short note on : (4)

i. Thermo electric prestressing.

ii. Effect of loading on tensile stress in tendons.

Q4 (a) A flat slab, 12m by 9m in overall size is supported by 4 columns which are so placed as to form a symmetrical grid of 7m by 6m with cantilever of 2.5 and 1.5m in long and short direction. The imposed load on the slab is 1.5 kN/m^2. Prestressing cables consisting of four wires of 4mm diameter and stressed to 1000 N/mm^2 are available for the use. Design the number of cables required and indicate their arrangement in the two principal directions. (10)

(b) Differentiate between full prestressing and partial prestressing. (3)

(c) What is the necessity of using supplementary or un-tensioned reinforcement in prestressed concrete members? (3)

(d) Explain the various modes of failure encountered in prestressed concrete beam subjected to bending moment, shear and torsion. (4)

Q5 (a) A prestressed concrete beam (span 12m) 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 6.2kN/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. (8)

(b) List some practical examples of structures subjected to combined bending, shear and torsion. (4)

(c) Distinguish between web shear, flexural and flexural -shear cracks in concrete beams with sketches. (4)

(d) Briefly explain the mechanism by which prestressing force is transferred to concrete in pre- tensioned members. (4)

Q6 (a) Design a post-tensioned symmetrical I-section for an effective span of 32 m to support an superimposed load of 6.5kN/m and dead load of 2kN/m (including self weight). Concrete cube strength = 50N/mm^2, Tensile strength of concrete = 1.7N/mm^2, Ec = 38kN/mm, loss ratio = 0.8.

Permissible stresses :

At transfer : Compressive stress = 15 N/mm^2, Tensile stress = 1 N/mm^2
At working : Compressive stress =17 N/mm , Tensile stress = 0

8 mm high tensile wires having an ultimate tensile strength of 1600 N/mm^2 are available for use. Design the beam and check the safety against deflection only. (15)

(b) Briefly outline the Magnel's method of computing the horizontal and transverse stresses in end blocks subjected to concentrated force from the anchorage. (5)

Q7 (a) Design the thickness and circumferential reinforcement required for a cylindrical tank wall subjected to a design tensile force of 540kN/m. f_{ct} =16N/mm^2, ftw = -0.8N/mm^2, direct tensile strength of concrete = 2.7N/mm^2 and η = 0.85. High tensile wires of 5mm diameter (U.T.S. = 1650 N/mm^2) with an initial stress of 1000N/mm^2 may be used. Desirable load factors against collapse and cracking should not be less than 2 and 1.25 respectively. (10)

(b) A pre-tensioned purlin with a rectangular section of 150 mm width and 370 mm over all depth is stressed by high tensile steel of area 270 mm^2 located at an effective depth of 300 mm. The section is also reinforced with 2 bars of 8 mm diameter, both in tension and compression faces, at an effective cover of 50 mm. Given

fpu = 1600 N/mm^2, fpe = 800 N/mm^2, fy = 415 N/mm^2, fcu = 50N/mm^2,
Es = 210kN/mm^2.

Estimate the moment capacity of the section using strain compatibility method. (10)

Q8 (a) The cross sectional area of an unsymmetrical prestressed I -beam designed to carry a central point load on a simply supported span of 15m is 195000mm^2. The second moment of area is equal to 199 × 10^{8}mm^4. The overall depth of the section is 900mm with the centroid located at 530mm from the soffit. The maximum permissible stresses are 14N/mm^2 in compression and zero in tension. The loss ratio is 0.8. Calculate :

i. The breath of a rectangular section, having the same depth designed for the same loading

ii. The value of the point load

iii. The saving in steel and concrete of the I-section compared to the rectangular section

iv. The maximum eccentricities of the cable at mid span for the two sections. (15)

(b) What are hypothetical tensile stresses? Discuss their use in Class 3 type members. (5)

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.