Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.Tech (CE-NEW)/SEM-8/CE-802/4/2010

2010

PRE-STRESSED CONCRETE

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

   i) Pre-stressing is economical for members of

      a) long span

      b) medium span

      c) short span.

   ii) The grade of concrete for pre-stressed members should be in the range of

      a) M-20 to M-30

      b) M-80 to M-100

      c) M-30 to M-60.

iii) Looping of high tensile tendons around the concrete is used in

a) B. B. R. V. system

b) Magnel-Balton system

c) Lee-Mc call system.

iv) In a pre-stressed concrete beam, the applied loads are resisted by

a) an increase in the stress in tendons

b) a shift in the pressure line from cable line depending upon the moments

c) an increase in the tensile stress in the concrete.

v) Loss of stress due to relaxation of steel is influenced by

a) shrinkage of concrete

b) friction between steel and concrete

c) initial stress in steel.

vi) The deflection of a cracked pre-stressed concrete beam can be computed by

a) stress-strain diagram

b) bending moment diagram

c) bilinear moment-curvature relationships.

vii) Large magnitudes of torsion are better resisted by selecting beams of

a) rectangular section

b) hollow box girder section

c) I-section.

viii) The anchorage zone in a post-tensioned P.S.C. beam extends over a length of

a) half the depth of the beam

b) twice the depth of the beam

c) depth of the beam.

ix) Magnel's graphical solution is helpful in designing minimum pre-stressing force and the corresponding

a) minimum eccentricity

b) maximum eccentricity

c) feasible eccentricity.

x) Stressing concordant cables in continuous structures result in

a) primary reactions

b) zero redundant reactions

c) axial thrust.

xi) Composite construction using P.S.C. and cast in situ concrete is adopted in

a) water tanks

b) pipes

c) bridges.

xii) The Indian P.S.C. sleeper for broad gauge is designed for a moment capacity exceeding

a) 5 kN-m

b) 10 kN-m

c) 8 kN-m.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. In a pre-stressed concrete member, why is it necessary to use high strength concrete and high tensile strength steel wires ? Explain.

3. A rectangular concrete beam of cross-section 30 cm deep and 20 cm wide is pre-stressed by means of 15 wires of 5 mm diameters located 6·5 cm from the bottom of the beam and 3 wires of diameter 5 mm, 2·5 cm from the top. Assuming the pre-stress in the steel as 840 N/mm^2, calculate the stresses at the extreme fibres of the mid-span section when the beam is supported its own weight over span of 6 m. If a uniformly distributed live load of 6 kN is imposed, evaluate the maximum working stress in concrete. The density of concrete is 24 kN/m^3.

4. A concrete box section has an overall depth and width as 800 mm and 600 mm respectively. The concrete walls are 100 mm thick in both horizontal and vertical parts of the box. Determine the maximum permissible torque if the section is uniformly pre-stressed by a force of 200 kN. Assume the maximum permissible diagonal tensile stress is $0{\cdot}7 \text{ N/mm}^2$.

5. A pre-tensioned, T-section has a flange which is 300 mm wide 200 mm thick. The rib is 150 mm wide by 350 mm deep. The effective depth of the cross-section is 500 mm. Given $A_p = 200 \text{ mm}^2$, $fck = 50 \text{ N/mm}^2$ and $f_p = 1600 \text{ N/mm}^2$, estimate the ultimate moment capacity of the *T*-section using the Indian Standard Code Regulations.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

6. A precast pre-tensioned beam of rectangular section has a breadth of 100 mm and depth of 200 mm. The beam with an effective span of 5 m is pre-stressed by tendons with their centroids coinciding with the bottom kern. Compute the resultant stresses developed in the precast pretensioned beam and cast-in-situ slab shown in fig. 1 for propped case if the moduli of elasticity of concrete in slab and beam are 28 kN/mm^2 and 35 kN/mm^2 respectively. Take $P_i = 150 \text{ kN}$, λ (losses) = 15%, $L.L. = 8 \text{ kN/m}^2$.

Fig. 1

7. A two-span continuous pre-stressed concrete beam ABC has a uniform cross-section as shown in fig. 2.

   a) Calculate the secondary moment developed at B.

   b) If the beam supports concentrated loads of 20 kN each at mid-points of span. Evaluate the resultant stresses at the central support section B.

   c) Locate also the position of pressure line at B.

Fig. 2

8. A prestressed road bridge of span 10 m consists of a concrete slab 380 mm thick with parallel post-tensioned cables in each of which the force at transfer to 360 kN. If the bridge is required to support an uniformly distributed applied load of 25 kN/m^2, with the tensile stress in the concrete not exceeding $0{\cdot}7$ N/mm^2 at any time. Calculate the maximum horizontal spacing of the cables, their distance from the soffit of the slab at mid-span and their lowest possible position at the supports. Assume, 20% loss of prestress after transfer.

9. a) Design the longitudinal reinforcements only for shear, torsion and bending in case of a post-tensioned bonded pre-stressed concrete beam subjected to $T_u = 70$ kN - m, $V_u = 100$ kN & $M_u = 250$ kN - m. Take, b = 400 mm, D = 550 mm, $f_{ck} = 40$ N/mm^2, $A_p = 506$ mm^2, $f_p = 1820$ N/mm^2, $P_e = 500$ kN & e = 150 mm. Take $f_y = 250$ N/mm^2 for stirrups. Use IS : 1343-1980.

b) A concrete beam having a rectangular section 100 mm wide and 300 mm deep in pre-stressed by a parabolic cable carrying an initial force of 240 kN. The cable has an eccentricity of 50 mm at the centre of span and is concentric at the supports. If the span of the beam is 10 m and the L.L is 2 kN/m, estimate the short time deflection at the centre of span. Assuming $E = 38$ kN/mm^2 and creep coefficient Φ = 2·0, loss of pre-stress = 20% of the initial stress after six months. Estimate the long time deflection at the centre of span at this stage using the simplified approach of Lin assuming that the dead and live loads are simultaneously applied after the release of pre-stress.

10. a) The end block of a pretensioned beam is 100 mm wide & 200 mm deep. A pre-stressing wire of 8 mm diameter stressed to 1400 N/mm^2 has to be anchored against the end block at centre. Anchorage plate is 60 mm square. The wire bears on the plate through a female cone of 20 mm diameter. Permissible stress in concrete at transfer $f_{ci} = 20$ N/mm^2. Permissible shear stress in steel is 100 N/mm^2. Determine the thickness of anchorage plate. Use IS : 1343-1980.

b) The end block of a post tensioned prestressed member is 600 mm wide and 600 mm deep. One cable comprising 8 wires of 12 mm diameter stands carrying a load of 1160 kN are anchored by plate anchorages, 160 mm square located with their centres at 135 mm from the edges is 50 mm in diameter. Values of $f_{ck} = 45$ N/mm^2, $f_{ci} = 25$ N/mm^2 and $f_y = 250$ N/mm^2. Using IS : 1343-1980, design the suitable anchorage for the end block. 9 + 6

11. a) What are the advantages of partially prestressed pretensioned poles ?

b) List the various design criteria to be considered while designing poles for power transmission lines.

c) What are the different types of pre-stressed concrete sleepers ? Mention their design considerations. 5 + 5 + 5