Name : .....

Roll No. : .....

Invigilator's Signature : .....

2011
PRESTRESSED 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 any *ten* of the following :

$10 \times 1 = 10$

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 M100

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-Blaton system

c) Lee-McCall 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 prestressed by means of 15 wires of 5 mm diameter 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 prestress in the steel as 840 N/mm^2, calculate the stresses at the extreme fibers of the mid-span section when the beam is supported its own weight over span of 6m. If a uniformly distributed live load of 6kN 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 of 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 0.7 N/mm^2.
5. Explain the stresses developed in the anchorage zone with sketch. Also explain bursting tension and splitting crack.
6. What is partial prestressing ? What are the advantages of partial prestressing ? What is the use of non-prestress reinforcement in partial prestressing ?
7. List the various type of losses of prestress in pre-tensioned and post-tensioned members.

GROUP – C

(Long Answer Type Questions)

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

8. a) A pre-stressed concrete beam with a cross-section 120 mm wide and 300 mm deep is used to support a uniformly distributed live load of 3 KN/m over an effective span of 6m. The beam is pre-stressed by a straight cable carrying an effective pre-stressing force of 180 KN at a constant eccentricity of 50 mm. Given E_c = 38KN/mm2, the modulus of rupture=5N/mm^2, area of the cable = 200 mm^2, estimate the deflection of the beam at the following stages :

   i) Working load

   ii) Cracking load

   b) In a pre-stressed concrete beam of cross-section 200mm × 300mm and span 6m, and initial pre-stressing force of 400KN is applied at an eccentricity of 70 mm by tendons of area 400 mm^2.

   Assuming $E_s = 2 \times 10^5$ N/mm^2 and $E_c = 0.333 \times 10^5$ N/mm^2 , anchor slip=1.5 mm, creep coefficient in concrete $\phi = 1$, shrinkage of concrete = 0.0002 and creep loss in steel = 3%, find the total percentage loss of stress in the tendons. 8 + 7

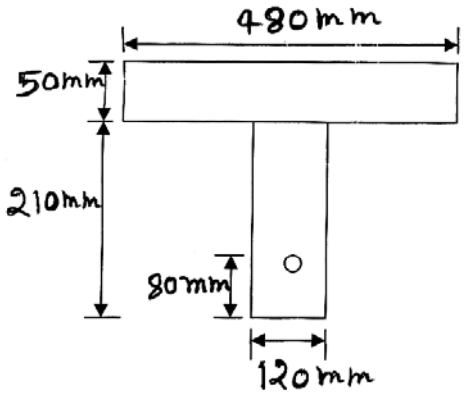
9. A two span continuous concrete beam (AB = BC = 12m) has a rectangular cross-section 300 mm wide and 800mm deep. The beam is pre-stressed by a cable carrying an effective force of 700KN. The cable has a linear profile in the span AB and parabolic profile in span BC. The eccentricities of the cable are + 50 mm at A, - 100 mm at a distance of 7m from A, and + 200 mm at support B and – 200 mm at mid-span of BC (- below & + above centriodal axis).
   a) Evaluate the resultant moment developed at B due to the pre-stressing force.
   b) Sketch the line of thrust in the beam if it supports a uniformly distributed load of 5KN/m which includes the self weight of the beam.
   c) Find the resultant stress distribution at the mid-support section for condition b. 6 + 6 + 3

10. A rectangular section of beam of size 300 mm × 600mm is subjected to an initial anchorage force of 1400 KN. Assume the force is acting at the centriod of the section, design anchor plate and bursting reinforcement. Take the following design data. f_{ck} = 35N/mm^2, f_{ci} = 35N/mm^2, f_y = 415N/mm^2 for ties. Permissible bending stress for the anchor plate = 165 N/mm^2. 15

11. A post tensioned pre-stressed concrete beam (bonded) of rectangular section width of 300 mm and overall depth of 600 mm is pre-stressed by an effective force of 175KN acting at an eccentricity e = 180mm. At service conditions, the section is subjected to B.M = 200KN-m, T = 75 KN-m and transverse shear force of 80KN. If f_{ck} = 40N/mm^2, f_y = 250N/mm^2 and f_p = 1600N/mm^2, design only longitudinal reinforcement in the section using 1.5 1343 code. Assume area of pre-stressed steel = 575 mm^2. 15

12. a) A pre-tensioned beam, 80mm wide and 120mm deep is to be designed to support working loads of 4KN, each concentrated at third points over a span of 3m. If the permissible stresses in tension are zero at transfer and $1.4N/mm_2$ under working loads, design the number of 3mm wires and the corresponding eccentricity required at the mid-span section. Permissible tensile stress in wires is $1400N/mm_2$. The loss of prestress is 20% and the density of concrete is $24KN/m_3$.

b) Figure shows the cross-section of a 6m span composite beam which consists of a 120mm × 210mm precast stem and a cast-in-situ flange 480mm × 50mm. the stem is post-tensioned unit which is subjected to an initial pre-stressing force of 230KN. The loss of pre-stress is 15%. The tendons are provided such that their centre of gravity is 80mm above the soffit. The composite beam has to support a live load of 4KN/m. Determine the resultant stresses in the stem and flange if the beam is unpropped. 7 + 8



13. A post-tensioned prestressed beam of rectangular section 250mm wide is to be designed for an imposed load of 12 kN/m, uniformly distributed on a span of 12 m. The stress in the concrete must not exceed 17 N/mm^2 in compression or 1.4 N/mm^2 in tension at any time and the loss of prestress may be assumed to be 15%. Calculate.

    a) The minimum possible depth of the beam.

    b) For the section provided the minimum prestressing force and the corresponding eccentricity. 8 + 7

14. Design an electric pole 12 m high to support wires at its top which can exert a reversible horizontal force of 3000 N. The tendons are Initially stressed to 1000 N/mm^2 and the loss of stress due to shrinkage and creep is 15%. Maximum compressive stress in concrete shall be limited to 12 N/mm^2. Take m=6 and $\varnothing = 30°$. Soil weighs 18000 N/m^3. 15