QUESTION BANK

CE 6702 – PRESTRESSED CONCRETE STRUCTURES

UNIT 1- INTRODUCTION – THEORY AND BEHAVIOUR

PART – A (2 marks)

1. List out the advantages of prestressed concrete.

(AUC Nov/Dec 2011 & 2012)

a. In case of fully prestressed member, which are free from tensile stresses under working loads, the cross section is more efficiently utilized when compared with a reinforced concrete section which is cracked under working loads.
b. The flexural member is stiffer under working loads than a reinforced concrete member of the same length.

2. What is meant by pretensioned and post tensioned concrete?

(AUC Nov/Dec 2010 & 2011)

1. **Pre tensioning:** A method of Pre stressing concrete in which the tendons are tensioned before the concrete is placed. In this method, the prestress is imparted to concrete by bond between steel and concrete.
2. **Post tensioning:** A method of pre stressing concrete by tensioning the tendons against hardened concrete. In this method, the prestress is imparted to concrete by bearing.

3. Why is high tensile steel needed for prestressed concrete construction?

(AUC Nov/Dec 2012)

1. High strength concrete is necessary for prestress concrete as the material offers highly resistance in tension, shear bond and bearing. In the zone of anchorage the bearing stresses being hired; high strength concrete is invariably preferred to minimizing the cost. High strength concrete is less liable to shrinkage cracks and has

lighter modulus of elasticity and smaller ultimate creep strain resulting in a smaller loss of prestress in steel. The use of high strength concrete results in a reduction in a cross sectional dimensions of prestress concrete structural element with a reduced dead weight of the material longer span become technically and economically practicable.

2. Tensile strength of high tensile steel is in the range of 1400 to 2000 N/mm^2 and if initially stress up to 1400 N/mm^2 there will be still large stress in the high tensile reinforcement after making deduction for loss of prestress. Therefore high tensile steel is made for prestress concrete.

4. What are the various methods of prestressing?

(AUC May/June 2013, Apr/May 2010)

1. Pre tensioning
2. Post tensioning

5. **List the loss of prestress.** **(AUC Nov/Dec 2010 & 2013)**

1. Nature of losses of prestress.
2. Loss due to elastic deformation of concrete.
3. Loss due to shrinkage of concrete.
4. Loss due to creep of concrete.
5. Loss due to relaxation of stress in steel.
6. Loss of stress due to friction.

6. What are the classifications of prestressed concrete structures?

(AUC Nov/Dec 2013)

1. Externally or internally prestressed
2. Pretensioning and post tensioning
3. End-Anchored or Non-End Anchored Tendons

4. Bonded or unbonded tendons
5. Precast, cast-in-place, composite construction
6. Partial or full prestressing

7. Define load balancing concept. **(AUC Apr/May 2011 & 2012)**

It is possible to select cable profiles in a prestressed concrete member such that the traverse component of the cable force balances the given type of external loads. This can be readily illustrated by considering the free body of concrete with the tendon replaced by forces acting on the concrete beam.

8. What are the factors influencing deflections? **(AUC Apr/May 2011)**

1. Length of the deflection field
2. Spacing between the deflection plate
3. Difference of potential between the plates
4. Accelerating voltage of the second anode

9. What are the sources of prestress force? **(AUC Apr/May 2012)**

1. Mechanical
2. Hydraulic
3. Electrical
4. Chemical

10. Define kern distance **(AUC Apr/May 2010)**

Kern is the core area of the section in which if the load applied tension will not be induced in the section $K_t = Z_b / A$, $K_b = Z_t / A$,

If the load applied at K_t compressive stress will be the maximum at the top most fiber and zero stress will be at the bottom most fiber. If the load applied at K_b compressive stress will be the maximum at the bottom most fiber and zero stress will be at the top most fiber.

11. What is Relaxation of steel?

When a high tensile steel wire is stretch and maintained at a constant strain the initially force in the wire does not remain constant but decrease with time. The decrease of stress in steel at constant strain is termed relaxation of steel.

12. What is concordant prestressing?

Pre stressing of members in which the cable follow a concordant profile. In case of statically indeterminate structures. It does not cause any changes in support reaction.

13. Define bonded and non-bonded prestressing concrete.

Bonded prestressing: Concrete in which prestress is imparted to concrete through bond between the tendons and surrounding concrete. Pre tensioned members belong to this group.

Non-bonded prestressing: A method of construction in which the tendons are not bonded to the surrounding concrete. The tendons may be placed in ducts formed in the concrete members or they may be placed outside the concrete section.

14. Define axial prestressing.

Members in which the entire cross-section of concrete has a uniform compressive prestress. In this type of prestressing, the centroid, of the tendons coincides with that of the concrete section.

15. Define prestressed concrete.

It is basically concrete in which internal stresses of a suitable magnitude and distribution are introduced so that the stresses resulting from external loads (or) counteracted to a desire degree in reinforced concrete member the prestress is commonly introduced by tensioning the steel reinforcement.

16. Define anchorage.

A device generally used to enable the tendon to impart and maintain prestress to the concrete is called anchorage. E.g. Fressinet, BBRV systems, etc.

17. What are the main factors for concrete used in PSC?

1. Ordinary Portland cement-based concrete is used but strength usually greater than 50 N/mm^2
2. A high early strength is required to enable quicker application of prestress
3. A larger elastic modulus is needed to reduce the shortening of the member
4. A mix that reduces creep of the concrete to minimize losses of prestress

18. What are the uses of prestressed concrete?

1. Railway Sleepers
2. Communications poles
3. Pre-tensioned precast "hollow core" slabs
4. Pre-tensioned Precast Double T units - for very long spans (e.g., 16 m span for car parks)
5. Pre-tensioned precast inverted T beam for short-span bridges
6. Post-tensioned ribbed slab

19. Define Magnel diagram.

A Magnel Diagram is a plot of the four lines associated with the limits on stress. As can be seen, when these four equations are plotted, a feasible region is found in which points of 1 P and e simultaneously satisfy all four equations. Any such point then satisfies all four stress limits.

PART – B (16 marks)

1. A rectangular prestressed beam 150 mm wide and 300 mm deep is used over an effective span of 10 m. The cable with zero eccentricity at the supports and linearly varying to 50 mm at the centre carries an effective prestressing force of 500 kN. Find the magnitude of the concentrated load located at the centre of the span for the following conditions at the centre of span section:

a) If the load counteracts the bending effect of the prestressing force (neglecting self-weight of beam) and

b) If the pressure line passes through the upper kern of the section under the action of the external load, self-weight and prestress. (**AUC Nov/Dec 2011, Apr/May 2010**)

2. Describe the effect of loading on the tensile stresses in tendons.

(**AUC Nov/Dec 2011**)

3. A concrete beam of 10 m span, 100 mm wide and 300 mm deep is prestressed by 3 cables. The area of each cable is 200 mm^2 and the initial stress in the cable is 1200 N/mm^2. Cable 1 is parabolic with an eccentricity of 50 mm above the centroid at the supports and 50 mm below at the centre of span. Cable 2 is also parabolic with zero eccentricity at supports and 50 mm below the centroid at the centre of span. Cable 3 is straight with uniform eccentricity of 50 mm below the centroid. If the cables are tensioned from one end only. Estimate the percentage loss of stress in each cable due to friction. Assume μ = 0.35 and k = 0.0015 per m. (**AUC Nov/Dec 2011**)

4. A prestressed concrete beam of section 120 mm wide by 300 mm deep is used over an effective span of 6 m to support a uniformly distributed load of 4 kN/m, which includes the self-weight of the beam. The beam is prestressed by a straight cable carrying a force of 180 kN and located at eccentricity of 50 mm. Determine the location of the thrust line in the beam and plot its position at quarter and central span section. (**AUC Apr/May 2012) (AUC May/June 2013, Nov/Dec 20**13)

5. A rectangular concrete beam 360 mm deep and 200 mm wide is prestressed by means of fifteen 5 mm diameter wires located 65 mm from the bottom of the beam and three 5 mm wires, located 25 mm from the top of the beam. If the wires are initially tensioned to a stress of 840 N/mm^2, calculate the percentage loss of stress due to elastic deformation of concrete only. E_S = 210 kN/mm^2 and E_C = 31.5 kN/mm^2. (**AUC Nov/Dec 2013**)

6. A prestressed concrete beam, 200 mm wide and 300 mm deep is used over an effective span of 6 m to support an imposed load of 4 kN/m. the density of concrete is 24 kN/m^3. Find the magnitude of the eccentric prestressing force located at 100 mm from the bottom of the beam which would nullify the bottom fibre stress due to loading. (**AUC Apr/May 2011**)

7. A pretensioned beam 200 mm x 300 mm is prestressed by 10 wires each of 7 mm diameter, initially stressed to 1200 MPa with their centroids located 100 mm from the soffit. Estimate the final percentage loss of stress due to elastic deformation, creep, shrinkage and relaxation. Assume relaxation of steel stress = 60 MPa, E_S = 210 GPa, E_C = 36.9 GPa, creep coefficient = 1.6 and residual shrinkage strain = 3 x 10^{-4}.
(AUC Apr/May 2011)

8. A concrete beam with a rectangular section, 120 mm wide and 300 mm deep, is stressed by a straight cable carrying an effective force of 200 kN. The span of the beam is 6 m. The cable is straight with a uniform eccentricity of 50 mm. if the beam has a uniformly distributed load of 6 kN/m. E_C = 38 kN/mm^2. Estimate the deflection at the centre of span for the following cases:
    i. Prestress + self-weight of the beam
    ii. Prestress + self-weight + live load.
(AUC Nov/Dec 2010, May/Jun 2013, Apr/May 2010)

9. A simply supported PSC beam of cross section 100 mm wide and 250 mm deep is loaded with a uniformly distributed load of magnitude 1.2 kN/m on a span of 8 m. Obtain the stress distribution at mid span by stress and strength concept, if the prestressing force is 250 kN applied eccentrically all along with its centre of gravity at 40 mm. Assuming the density of concrete as 24 kN/m^3.
(AUC Nov/Dec 2012)

10. A straight pretensioned prestressed concrete member 12 m long with a cross section of 400 mm wide and 500 mm deep is concentrically post

tensioned by four tendons of 250 mm^2 each. The tendons are stressed one after another to the stress of 1000 N/mm^2. The eccentricity of prestressing force is 100 mm at the centre of the span. Compute the loss of prestress due to elastic shortening of concrete. How can the loss be counteracted?

(**AUC Nov/Dec 2012**)

11. Explain the factors influencing deflections? (**AUC Apr/May 2012**)
12. What is the necessity of using supplementary or untensioned reinforcement in prestressed concrete members? (**AUC Apr/May 2012**)
13. A prestressed concrete beam of rectangular section 375 mm wide and 750 mm deep has a span of 12.5 m. the effective prestressing force is 1520 kN at an eccentricity of 150 mm. the dead load of the beam is 7 kN/m and the beam has to carry a live load of 12.5 kN/m. determine the extreme stresses in concrete
    - i. At the end section.
    - ii. At the mid-section without the action of the live load.
    - iii. At the mid-section with the action of the live load.

(**AUC Nov/Dec 2010**)