DHANALAKSHMI SRINIVASAN COLLEGE OF ENGINEERING AND TECHNOLOGY
CE6702 – 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)

- 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.
- 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)

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.

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)

- 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.
- Tensile strength of high tensile steel is in the range of 1400 to 2000 N/mm^2 and if initially stress upto 1400 N/mm^2 their 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)

- Pre-tensioning
- Post-tensioning

5. What are the systems of prestressing? (AUC May/June 2013)

- Pre-tensioning system
- Post-tensioning system

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

Nature of losses of prestress.

- Loss due to elastic deformation of concrete.
- Loss due to shrinkage of concrete.
- Loss due to creep of concrete.
- Loss due to relaxation of stress in steel.
- Loss of stress due to friction.
- Loss due to anchorage slip.

7. What are the classifications of prestressed concrete structures? (AUC Nov/Dec 2013)

- Externally or internally prestressed
- Pretensioning and post tensioning
- End-Anchored or Non-End Anchored Tendons
- Bonded or unbonded tendons
- Precast, cast-in-place, composite construction
- Partial or full prestressing

8. 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.

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

- Length of the deflection field
- Spacing between the deflection plate
- Difference of potential between the plates
- Accelerating voltage of the second anode.

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

- Mechanical
- Hydraulic
- Electrical
- Chemical

11. 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.

12. 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.

13. 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.

14. 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.

15. 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.

16. 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.

17. 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.,

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

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

19. What are the uses of prestressed concrete?

- Railway Sleepers;
- Communications poles;
- Pre-tensioned precast "hollow core" slabs;
- Pre-tensioned Precast Double T units – for very long spans (e.g., 16 m span for car parks);
- Pre-tensioned precast inverted T beam for short-span bridges;
- Post-tensioned ribbed slab;
- This is "glued segmental" construction;

20. 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

1.	A rectangular concrete beam 100mm wide & 250mm deep spanning over 8m is prestressed by a straight cable carrying a effective prestressing force of 250kN located at an eccentricity of 40mm. The beam supports a live load of 1.2 kN/m. (i).Calculate the resultant stress distribution for the centre of the span cross section of the beam assuming the density of concrete as 24kN/m2 (ii)Find the magnitude of prestressing force with an eccentricity of 40mm which can	BT4
	balance the stresses due to dead load & live load at the soffit of the centre span section.	
2.	A PSC beam of 120mm wide and 300mm deep is used over a span of 6m to support a udl of 4kN/m including its self weight. The beam is prestressed by a straight cable carrying a force of 180kN & located at an eccentricity of 50mm. Determine the location of the thrust line in beam & plot its position at quarter & central span sections.	BT4
3.	A Prestressed pretensioned beam of 200mm wide and 300mm deep is used over an span of 10m is prestressed with a wires of area 300mm2 at an eccentricity of 60mm carrying a prestress of 1200 N/mm2 Find the percentage of loss of stress, Ec= 35 kN/mm2 Shrinkage of concrete = 300 x 10-6 , creep coefficient =1.6	BT5
4.	A PSC beam of 120mm wide and 300mm deep is used over an span of 6m is prestressed by a straight cable carrying a force of 200 kN & located at an eccentricity of 50mm. Ec= 38 kN/mm2 . (i) Find the deflection at centre span Under prestress + self weight (ii) Find the magnitude of live load udl which will nullify the deflection due to prestress & self weight.	BT3
5.	A PSC beam of 230mm wide and 450mm deep is used over an span of 4m is prestressed by a cable carrying a force of 650kN & located at an eccentricity of 75mm. The beam supports three concentrated loads of 25kN at each quarter span points. Determine the location of the pressure line in beam at centre, quarter & support sections. Neglect the moment due to self weight of the beam.	BT2
6.	A PSC beam with rectangular section, 150mm wide 300mm deep is prestressed by three cables each carrying a effective prestress of 200kN. The span of the beam is 12m. The first cable is parabolic with an eccentricity of 50mm below the centroidal axis at the centre of the span and 50mm above the centroidal axis at the supports.The second cable is parabolic with an eccentricity of 50mm at the centre of the span and zero eccentricity at the supports. The third cable is straight with an eccentricity of 50mm below the centroidal axis.If the beam supports an UDL of 6kN/m and Ec=38kN/mm2 Estimate the instantaneous deflection for the following stages (i) Prestress + self weight of the beam	BT1
7.	(i) Explain why high strength concrete and high strength steel are needed for PSC construction (ii) State different types of prestressing.	BT4
8.	(i) Explain shrinkage of concrete in PSC members (ii) Explain durability, fire resistance and cover requirements for PSC members	BT2
9.	A PSC beam supports an imposed load of 5kN/mm2 over a simply supported span of 10m.The beam has an I section with an overall depth of 450mm.Thickness of flange and web are 75mm and 1000mm respectively. The flange width is 230mm. The beam is prestressed with an effective prestressing force of 350kN at a suitable eccentricity such that the resultant stress at the soffit of the beam at mid span is zero. Find the eccentricity required for the force.	BT6

10	.A PSC beam of section 120mm wide and 300mm deep is used over an effective span of 6m to support an udl of 4kN/m including self weight. The beam is prestressed by a straight cable with a force of 180kN and located at an eccentricity of 50mm. Determine the location of thrust line in the beam and plot its position.	BT2
11	.A pre-stressed concrete beam, 250 mm wide and 350 mm deep, is used over an	BT3

UNIT 2

DESIGN OF FLEXURE AND SHEAR

PART-A

1. What is meant by end block in a post tensioned member?

The zone between the end of the beam and the section where only longitudinal stress exists is generally referred to as the anchorage zone or end block.

2. List any two applications of partial prestressing.

□ Used in large diameter concrete pipes
□ Used in railway sleepers
□ Water tanks
□ Precast concrete piles to counter tensile stress during transport and erection. used in bridges construction

3. What is meant by partial prestressing?

The degree of prestress applied to concrete in which tensile stresses to a limited degree are permitted in concrete under working load. In this case, in addition to tensioned steel, a considerable proportion of untensioned reinforcement is generally used to limit the width of cracks developed under service load.

4. Define degree of prestressing

A measure of the magnitude of the prestressing force related to the resultant stress occurring in the structural member at working load.

5. Define Bursting tension.

The effect of transverse tensile stress is to develop a zone of bursting tension in a direction perpendicular to the anchorage force resulting in horizontal cracking.

6. Define Proof stress

The tensile stress in steel which produces a residual strain of 0.2 percent of the original gauge length on unloading.

7. Define cracking load.

The load on the structural element corresponding to the first visible crack.

8. Define Debonding.

Prevention of bond between the steel wire and the surrounding concrete.

9. Write formula for Moment of resistance in BIS code. Mu =
Apb Aps (d-dn)

10. What are the types of flexural failure?

□ Fracture of steel in tension
□ Failure of under-reinforced section
□ Failure of over-reinforced section
□ Other modes of failure

	PART-B	
1.	A pretensioned T section has a flange width of 1200mm and 150mm thick. The width and depth of the rib are 300mm and 1500mm respectively. The high tension steel has an area of 4700mm2 and is located at an effective depth of 1600mm. If the characteristic cube strength of the concrete and the tensile strengthof steel are 40 and 1600Mpa respectively; calculate the flexural strength of	BT4
2.	A PSC beam of effective span 16m is of rectangular section 400mm wide and 1200mm deep. A tendon consists of 3300mm2 of strands of characteristic strength 1700 N/mm^2 with an effective prestress of 910 N/mm^2 . The strands are located 870mm from the top face of the beam. If fcu =60 N/mm^2 , estimate the flexural strength of the section as per IS1343 provisions for the following cases: (i) Bonded tendons (ii) Unbonded tendons	BT1
3.	A post tensioned bridge girder with unbonded tendons is of size 1200mm wide by 1800mm deep is of box section with wall thickness of 150mm. The high tensile steel has an area of4000mm^2an di slocate da ta neffectiv e depth of 1600mm. Theeffective prestress in steel after loss is 1000 N/mm^2 & effective span is 24m. If fck = 40 N/mm^2, fp = 1600 N/mm^2 Estimate the flexural strength.	BT1
4.	Enumerate the Permissible stresses in steel and concrete as per I.S.1343 Code.	BT2
5.	Layout of cables in post-tensioned beams and Location of wires in pre-tensioned beams.	BT5
6.	The cross section of a prestressed concrete beam is an unsymmetrical T-section with an overall depth of1300 mm. thickness of web is 150 mm. Distance of top and bottom fibres from the centroid are 545 mm and 755 mm respectively. At a particular section, the beam is subjected to an ultimate moment M = 2130 kNm and a shear force V=237 kN. Effective depth d = 1100mm, fck = 45N/mm2, f_{cp}=19.3 N/mm^2 , I= 665X108 mm4,A_p=2310 mm2,fp=1500 N/mm^2 ,fep=890 N/mm^2 .Estimate the flexural-shear	BT4
7.	A symmetrical I section prestressed beam of 300mm wide and 750mm overall depth with flanges and web 100mm thick. The beam is post tensioned with the cables containing 48 wires of 5mm diameter high strength steel wires at an eccentricity of 250mm. The compressive strength of concrete is 40N/mm2 and the ultimate tensile strength of wire is 1700 N/mm^2 . Assuming that the grouting of tendons is 100% effective determine the ultimate moment of section as per IS1343:1980.	BT3
8.	What do you understand by Type I and Type II members? Explain in details.	BT3
9.	(i) Discuss the Basic assumptions for calculating flexural stresses. (ii) Explain concept of limit states.	BT6
10.	b) Explain about the types of shear cracking occurs in prestressed concrete section.	BT1
11.	The cross-section of a symmetrical I-section prestressed beam is 500 mm by 650 mm (overall), with flanges and web 150 mm thick. the beam is post-tensioned by cables containing 45 wires of 5 mm diameter high-tensile steel wires at an eccentricity of 250 mm. The 28-days strength of concrete in compressing is 40 N/mm2 and the ultimate tensile strength of wires is 16500 N/mm2 . Assuming that the grouting of the tendons is 100 percent effective, determine the ultimate moment of the section as per IS 1343.	BT2
12.	Write the recommendations for Design for shear based on I.S. 1343 Code.	BT2

UNIT III DEFLECTION AND DESIGN OF ANCHORAGE ZONE

1. **Define partial prestressing.** **(AUC May/June 2013, Nov/Dec 2011)**

The degree of prestress applied to concrete in which tensile stresses to a limited degree are permitted in concrete under working load. In this case, in addition to tensioned steel, a considerable proportion of untensioned reinforcement is generally used to limit the width of cracks developed under service load.

2. **Mention any two functions of end blocks.** **(AUC May/June 2013, Nov/Dec 2013)**

   - Provide Lateral (horizontal) stability from wind and other horizontal (Racking) loads.
   - Provide additional vertical load capacity for the ends of the joists from point loads above.

3. **Define anchorage zone.** **(AUC Nov/Dec 2011)**

Prestressed concrete contains tendons which are typically stressed to about 1000 MPa. These tendons need to be anchored at their ends in order to transfer (compressive) force to the concrete. The zone of region is called Anchorage zone.

4. **How can PSC beam be considered to carry its own weight?** **(AUC Nov/Dec 2012)**

By providing an external initial stress (the prestress) which compresses the beam. Now they can only separate if the tensile stress induced by the self weight of the beam is greater than the compressive prestress introduced.

5. **Mention the advantages of partial prestressing.** **(AUC Nov/Dec 2012 & 2013)**

   1) Limited tensile stresses are permitted in concrete under service loads with controls on the maximum width of cracks and depending upon the type of prestressing and environmental condition.
   2) Untensioned reinforcement is required in the cross-section of a prestressed member for various reasons, such as to resist the differential shrinkage, temperature effects and handling stresses.
   3) Hence this reinforcement can cater for the serviceability requirements, such as control of cracking, and partially for the ultimate limit state of collapse which can result in considerable reduction in the costlier high tensile steel.
   4) Saving in the cost of overall structure.

6. **Write any two assumptions on the compatibility of strains.** **(AUC Apr/May 2012)**

   - The stress distribution in the compression zone of concrete can be defined by means of coefficients applied to the characteristic compressive strength and the average compressive strength stress and the position of the centre of compression can be assessed.
   - The distribution of concrete strain is linear (plane sections normal to axis remain plane after bending).
   - The resistance of concrete in tension is neglected.
   - The maximum compressive strain in concrete at failure reaches a particular value.

7. **What is effective reinforcement ratio?** **(AUC Apr/May 2012)**

Ratio of effective area of reinforcement to the effective area of concrete at any section of a structural member is known as effective reinforcement ratio.

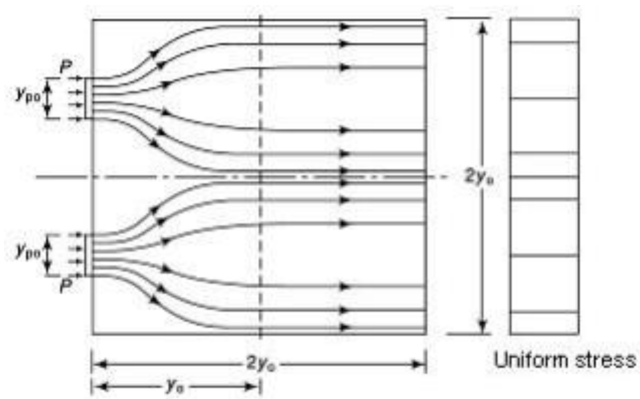
8. At initial stage what forces are considered in prestressed concrete design?
(AUC Apr/May 2011)

Prestressing force is considered in prestressed concrete design at initial stage.

9. Why anchorage zone has to be given special attention in design? (AUC Apr/May 2011)

Because the main reinforcement in the anchorage zone should be designed to withstand the bursting tension, which is determined by the traverse stress distribution on the critical axis, usually coinciding with the line of action of the largest individual force.

10. Draw a sketch showing the stress distribution in end block by double anchor plate. (AUC Apr/May 2010)



Double anchor plate

11. Explain conventional failure of an over reinforced prestressed concrete beam.
(AUC Apr/May 2010)

An Over reinforced members fail by the sudden crushing of concrete. The failure being reinforced members fail by the sudden crushing of concrete. The failure being characterized by small deflections and narrow cracks, the area of steel being comparatively large, the stresses developed in steel at failure of the member may not reach the tensile strength.

12. What is meant by end block in a post tensioned member? (AUC Nov/Dec 2010)

The zone between the end of the beam and the section where only longitudinal stress exists is generally referred to as the anchorage zone or end block.

13. List any two applications of partial prestressing. (AUC Nov/Dec 2010)

- Used in large diameter concrete pipes
- Used in railway sleepers
- Water tanks
- Precast concrete piles to counter tensile stress during transport and erection.
- Used in bridges construction

14. Define degree of prestressing.

A measure of the magnitude of the prestressing force related to the resultant stress occurring in the structural member at working load.

15. Define Bursting tension.

The effect of transverse tensile stress is to develop a zone of bursting tension in a direction perpendicular to the anchorage force resulting in horizontal cracking.

16. Define Proof stress.

The tensile stress in steel which produces a residual strain of 0.2 percent of the original gauge length on unloading.

17. Define cracking load.

The load on the structural element corresponding to the first visible crack.

18. Define Debonding.

Prevention of bond between the steel wire and the surrounding concrete.

19. Write formula for Moment of resistance in BIS code.

$Mu = A_{pb}A_{ps}(d - d_n)$

20. What are the types of flexural failure?

- Fracture of steel in tension
- Failure of under-reinforced section
- Failure of over-reinforced section
- Other modes of failure

	PART – B	
1.	A concrete beam having a rectangular cross section 150mm wide and 300mm deep is prestressed by a parabolic cable of eccentricity 75mm at the at the centre of thespan towards the soffit, and an eccentricity of 25mm towards the top at the support section. The effective force in the cable is 350kN. The beam supports the concentrated load of 20kN at the centre of the span in addition to the self weight. If the modulus of elasticity of the concrete is $38kN/m^2$ and the span is 8m, Evaluate, (i) Short term deflection at the centre of the span under prestress, dead load and live load. (ii) Long term deflection assuming a loss ratio as 0.8 and creep coefficient as	BT-5
2.	A PSC beam with rectangular section, 150mm wide 300mm deep is prestressed by three cables each carrying a effective prestress of 200kN. The span of the beam is 12m. The first cable is parabolic with an eccentricity of 50mm below the centroidal axis at the centre of the span and 50mm above the centroidal axis at the supports. The second cable is parabolic with an eccentricity of 50mm at the centre of the span and zero eccentricity at the supports. The third cable is straight with an eccentricity of 50mm below the centroidal axis. If the beam supports an UDL of 6kN/m and E_c=$38kN/mm^2$. Estimate the instantaneous deflection for the following stages i) Prestress + self weight of the beam ii) Prestress + self weight of the beam+ live load	BT-4
3.	A prestressed concrete bean of span 8m has a section of area 42×10^3 mm^2. The moment of inertia of the section being 1.75×10^8 mm^4. The beam is prestressed with a parabolic cable providing a prestressing force of 245 kN. The cable has an eccentricity of 50mm at the centre and zero eccentricity at the ends. Ignoring all losses, examine the deflection at the centre when (a) The beam carries its own weight and prestress. (b) The beam carries in addition to its own weight and prestress, a superimposed load of 1.8kN/m. consider concrete weight $24kN/m^3$ and $E_c = 40kN/mm^2$.	BT-4

4.	A simply supported beam of 6m span and rectangular section 125mm x 250mm is prestressed by a cable in which the total tensile force as 220kN. The cable is t a constant eccentricity of 75mm above the soffit at the middle third of the beam nd the cable is curved towards the extreme ends and the eccentricity of the cable at oth ends are 50mm above the centre line. Consider concrete weight 24kN/m^3 and E_c 40kN/mm^2. Interpret the deflection of the beam (i) when it is supporting its own weight, (ii) when the beam carries an imposed load of 4.5kN/m.	BT-3
5.	A PSC beam of 120mm wide and 300mm deep is used over an span of 6m is prestressed by a straight cable carrying a force of 200kN & located at an eccentricity of 50mm.E_c=38 kN/mm^2. Estimate the deflection at centre span a) Under prestress + self weight b) Find the magnitude of live load udl which will nullify the deflection due to prestress & self weight	BT-2
6.	The end block of a PSC beam with rectangular cross section is 100mm wide and 200mm deep. The prestressing force of 100kN is transmitted to the concrete by a distribution plate of 100mm x 50mm, concentrically loaded at the ends. Calculate the position and the magnitude of tensile stress on the horizontal section through the centre and edge of the anchor plate. Compute the bursting tension on the horizontal planes.	BT-1
7.	The end block of a post tensioned bridge girder is 500mm wide by 1000mm deep. Two cables, each comprising 90 high tensile wires of 7mm dia are anchored using square plates of side length 400mm with their centres located at 500mm from the top and bottom of the edges of the beam. The jacking force in each cable is 4000kN. Design a suitable anchorage reinforcement using Fe 415 grade HYSD bars conforming to IS: 1343 provision.	BT-6
8.	The end block of a post tensioned concrete beam 300mm X 300mm is subjected to a concentric anchorage force of 832800N by a freyssinet anchorage system of area 117200mm^2. Discuss and detail the anchorage reinforcement for the end block.	BT-2
9.	(i) Define the terms (a) end block (b) Anchorage zone (c) Bursting tension (ii) Explain withsketches the effect of varying the ratio of depth anchorage to the depth of end block on the distribution of bursting tension	BT-1
10.	A PSC beam of 300mm wide and 400mm deep is used over an span of 8m is prestressed by a cable carrying high tensile wires of cross sectional area 2000mm2. If the beam supports a live load of 20kN/m excluding its self weight, examine the initial deflection due to prestress, self weight and live loads for the following: (i) Cable profile is straight with a constant eccentricity of 100mm (ii) Cable profile is parabolic with a dip of 100mm at the mid span and concentric at supports. Assume E_c = 36kN/mm^2.	BT-4
11.	Explain the factors influencing the deflection and the effect of tendon profile in the deflection of PSC members with a neat sketch	BT-2
12.	Explain the various methods used for the investigation of anchorage zone stresses.	BT-3
13.	Write about the Magnel's method and Guyon's method for end block	BT-1
14.	A PSC beam 250mm wide and 650mm deep is subjected to an effective prestressing force of 1360kN along the centroidal axis. The cable is placed symmetrically overthe mild steel anchor plate of area 150mmx 350mm. Design the end block. Take f ck= 30N/mm^2 .Assume initial prestressing force is 1.2 times the effective prestressing force.	BT-1

UNIT IV COMPOSITE BEAMS AND CONTINUOUS BEAMS

1. Define propped construction. **(AUC May/June 2013, Nov/Dec 2013)**

The dead load stress developed in the precast prestressed units can be minimized by propping them while casting the concrete in situ. This method of construction is termed as propped construction.

2. How to achieve compositeness between precast and cast in situ part and show the sketches? (AUC May/June 2013, Nov/Dec 2013)

The composite action between the two components is achieved by roughening the surface of the prestressed unit on to which the concrete is cast in situ, thus giving a better frictional resistance or by stirrups protruding from the prestressed unit into the added concrete or by castellations on the surface of the prestressed unit adjoining the concrete which is cast in situ.

3. What is meant by composite construction of prestressed and in situ concrete?
(AUC Nov/Dec & Apr/May 2011)

In a composite construction, precast prestressed members are used in conjunction with the concrete cast in situ, so that the members behave as monolithic unit under service loads. The high strength prestressed units are used in the tension zone while the concrete, which is the cast in situ of relatively lower compressive strength is used in the compression zone of the composite members.

4. How deflections in composite members are computed? **(AUC Nov/Dec 2011)**

In the case of composite members, deflections are computed by taking into account the different stages of loading as well as the differences in the modulus of elasticity of concrete in the precast prestressed unit and the in situ cast element.

5. What do you mean by unpropped construction? **(AUC Nov/Dec 2012)**

If the precast units are not propped while placing the in situ concrete, stresses are developed in the unit due to the self weight of the member and the dead weight of the in situ concrete. This method of construction is referred to as unpropped construction.

6. What are the forces considered in the calculation of deflection of prestressed concrete beams? **(AUC Apr/May 2010)**

Prestressing force
Self weight of the beam
Dead load of the concrete
Live load acting on the concrete

7. What are the roles played by shear connectors in composite construction?
(AUC Apr/May 2010)

It is generally assumed that the natural bond at the interface contributes a part of the required shear resistance depending upon the strength of the in situ cast concrete and the roughness of the precast element. Any extra shear resistance over and above this should be provided by shear connectors.

8. What are the advantages in using precast prestressed units?
(AUC Apr/May 2011, Nov/Dec 2010 & 2012)

- Saving in the cost of steel in a composite member compared with a reinforced or prestressed concrete member.
- Sizes of precast prestressed units can be reduced due to the effect of composite action.

Low ratio of size of the precast unit to that of the whole composite member.

Composite members are ideally suited for construction bridge decks without the disruption of normal traffic.

9. Name the loadings to be considered for computing initial deflection.

(AUC Nov/Dec 2010)

- Prestress
- Self weight of the beam
- Weight of the in situ cast concrete

10. How do you compute the shrinkage and resultant stresses in composite member?

(AUC Nov/Dec 2012)

The magnitude of differential shrinkage is influenced by the composition of concrete and the environmental conditions to which the composite member is exposed. In the absence of exact data, a general value of 100 micro strains is provided for computing shrinkage stresses.

11. Distinguish between propped and unpropped construction methods.

(AUC Nov/Dec 2012)

S.No	Propped construction	Unpropped construction
1	The dead load stress developed in the precast prestressed units can be minimized by propping them while casting the concrete in situ. This method of construction is termed as propped construction.	If the precast units are not propped while placing them in situ concrete, stresses are developed in the unit due to the self weight of the member and the dead weight of the in situ concrete. This method of construction is referred to as unpropped construction.
2	If the pretensioned beam supports the weight of the slab while casting.	If the slab is externally supported while casting.

12. What are the assumptions made in stresses developed due to differential shrinkage?

- The shrinkage is uniform over the in situ part of the section.
- Effect of creep and increase in modulus of elasticity with age and the component of shrinkage, which is common to both the units are negligible.

13. Name the loadings to be considered for computing deflection if the beam is propped section.

- Prestress
- Self weight of the beam
- Dead weight of the in situ cast concrete
- Live load of the in situ cast concrete

14. Name the loadings to be considered for computing deflection if the beam is unpropped section.

- Prestress
- Self weight of the beam
- Live load of the in situ cast concrete

15. Sketch the typical cross section of precast prestressed concrete beam.

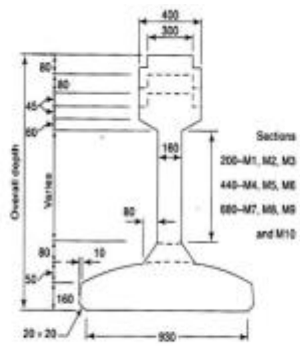


Fig. Cross-section of Standard C and C.A. Beams

	PART – B	
1.	A precast pretensioned beam of rectangular section has a breadth of 100mm and depth of 200mm. The beam with an effective span of 5m is prestressed by the tendons with their centroids coinciding with the bottom kern. The initialforce in the tendons is 150kN. The loss of prestress is 15%. The top flange width is 400mm with the thickness o f 40mm.If the composite beam supports a live load of $7kN/m^2$ calcula the resultant stresses developed if the section is unpropped. M40 and M20 concrete	BT-1
2.	Design a composite slab for the bridge deck using a standard inverted T-section. The top flange is 300mm wide and 110mm thick. The bottom flange is 550mm wide and 250mm thick. The web thickness is 100mm and the overall depth of the inverted T. Section is 655mm. The bridge deck has to support a characteristic imposed load of 50 kN/m_2, over an effective span of 12m. Grade 40 concrete is specified for the precast pretensioned T-with a compressive strength at transfer of 36 N/mm_2. Concrete of	BT-3

	grade-30 is used for the insitupart. Calculate the minimum prestress necessary and check for safety under serviceability limit state.	
3.	Design a composite PSC beam for the following data: Span=12m; live load = $5kN/m^2$; σ_{ci} = 14 N/mm^2; η =85%; Depth of the slab=150mm; f_{pe}= 950 N/mm^2; m=0.6; spacing of beam= 3.5m; Breadth of the web = 150mm; b_f= 1500mm. Assume post tension.	BT-6
4.	A simply Supported PSC beam of span 5m and size l50mm x 300 mm has 15 MPa prestress at soffit and Zero at top after all losesis Prestress. A slab of 450mm wide and 60 mm deep is cast on the top of the beam to induce composite T-beam action. Evaluate the maximum udl that can be supported without any tensile stress at soffit for the following conditions. (i) Slab is externally supported during casting (ii) Slab is supported by the PSC beam during casting	BT-5
5.	i. List the advantage of using precast prestressed elements along with in situ Concrete. ii. List the different types of composite construction with neat sketches	BT-1
6.	The cross-section of a composite beam consists of a 300mm x 900mm precast stem and cast-in-situ flange 900mm x 150mm. The stem is a post-tensioned unit with an initial prestressing force of 2500 kN. The effective prestress available after making deduction for losses is 2200 kN. The dead load moment at mid span due to the weight of the precast section is 250 kNm. The dead load moment due to the weight of the flange is 125 kNm. After hardening of the flange concrete, the composite section has to carry a live load which produces a bending moment of 700 kNm. Examine the stress distribution in concrete at the	BT-4
7.	A composite prestressed concrete beam consists of a prefabricated stem of 300mm X 800mm and a cast insitu slab of 8 0 0 m m X 1 5 the differential shrinkage is 1.2 X 10^{-4} mm/mm, evaluate the shrinkage stresses at the extreme edges of the slab and	BT-1
8.	Briefly explain the necessity of using composite section in PSC structures. Also discuss about the shear in composite beams. What are the provisions usually made to counteract the effects.	BT-2
9.	A composite T-girder of span 5m is made up of a pre-tensioned rib, 100mm wide by 200mm depth, with an insitu cast slab, 400mm wide and 40mm thick. The rib is prestressed by a straight cable having an eccentricity of 33.33 mm and carrying initial forceof,150kN.The loss of prestress is 15%. Check the composite T-beam for the limit state of deflection if its supports an imposed load of 3.2kN/m for (i) unpropped (ii) propped. Assume modulus of Elasticity of 35kN/mm2 for both precast & insitu cast elements.	BT-4
10.	A prestressed beam with rectangular cross section with a width of 120mm and depth of 300mm is continuous over two spans AB=BC= 8m. The cable with zero eccentricity at the ends and an eccentricity of 50mm towards the top fibres of the beam over the central support, carries an effective force of 500kN. (i) Calculate the secondary moments developed at B. (ii) If the beam supports the concentrated load of 20kN each at mid points of the span, evaluvate the resultant stresses at the central support section B. (iii) Also locate the position of pressure line at the section.	BT-4

UNIT V MISCELLANEOUS STRUCTURES

1. **What are the functions of water stopper (water bar) in water tank construction?**

(AUC May/June 2013)

1) The base slab is subdivided by joints which are sealed by water stops.
2) The reinforcement in the slab should be well distributed to control the cracking of the

    a. slab due to shrinkage and temperature.

2. **Differentiate prestressed cylinder and non-cylinder pipe. (AUC May/June 2013) Prestressed cylinder pipe:**
    1) It is developed by the Lock Joint Company.
    2) A welded cylinder of 16 gauge steel is lined with concrete inside and steel pipe wrapped with a highly stressed wire.
    3) Tubular fasteners are used for the splices and for end fixing of the wire and pipe is finished with a coating of rich mortar.
    4) It is suitable upto 1.2 m diameter.

    Prestressed non-cylinder pipe:

    - It is developed by Lewiston Pipe Corporation.
    - At first concrete is cast over a tensioned longitudinal reinforcement.
    - A concrete pipes after curing are circumferentially stressed by means of a spiral wire wound under tension and protected by a coat of mortar.
    - The main function of longitudinal prestress is to prevent cracking in concrete during circumferential winding and cracking due to the bending stresses developed during the handling and installation of pipes.

3. **Define circular prestressing. (AUC Nov/Dec 2011, 2012, 2013, 2010)**

When the prestressed members are curved in the direction of prestressing, the prestressing is called circular prestressing.

For example, circumferential prestressing in pipes, tanks, silos, containment structures and similar structures is a type of circular prestressing.

4. **What are the design criteria for prestressed concrete tanks? (AUC Nov/Dec 2011)**
    1) It is to resist the hoop tension and moments developed are based on the considerations of desirable load factors against cracking and collapse.
    2) It is desirable to have at least a minimum load factor of 1.2 against cracking and 2 against ultimate collapse as per IS code.
    3) It is desirable to have at least a minimum load factor of 1.25 against cracking and 2.5 against ultimate collapse as per BS code.
    4) The principal compressive stress in concrete should not exceed one-third of the characteristic cube strength.
    5) When the tank is full, there should be a residual compressive stress of at least $0.7 n/MM_2$
    6) When the tank is empty, the allowable tensile stress at any point is limited to $1 N/mm^2$.
    7) The maximum flexural stress in the tank walls should be assumed to be numerically equal to 0.3 times the hoop compression.

5. What are the design criteria for prestressed concrete pipes? (AUC Nov/Dec 2012)

- Circumferential prestressing, winding with or without longitudinal prestressing.
- Handling stresses with or without longitudinal prestressing.
- Condition in which a pipe is supported by saddles at extreme points with full water load but zero hydrostatic pressure.
- Full working pressure conforming to the limit state of serviceability.
- The first crack stage corresponding to the limit state of local damage.

6. How are the tanks classified based on the joint? (AUC Nov/Dec 2013)

- Tank wall with fixed base.
- Tank wall with hinged base.
- Tank wall with sliding base.

7. Define two stage constructions. (AUC Apr/May 2012)

In the first the concrete is cast over a tensioned longitudinal reinforcement. In the second stage the concrete pipes after curing are circumferentially stressed by means of a spiral wire wound under tension and protected by a coat of mortar.

8. Write any two general failures of prestressed concrete tanks. (AUC Apr/May 2012)

- Deformation of the pre-cast concrete units during construction.
- Manufacturing inaccuracies led to out of tolerance units being delivered to the site under investigation.
- It May have affected the ability to achieve a good seal.

9. What is the stress induced in concrete due to circular prestressing? (AUC Apr/May 2010)

The circumferential hoop compression stress is induced in concrete by prestressing counterbalances the hoop tension developed due to the internal fluid pressure.

10. Explain the effect of prestressing force in concrete poles. (AUC Apr/May 2010)

It should be reduced in proportion to the cross section by the techniques of debonding or dead ending or looping some of the tendons at mid height.

11. Write the various types of loadings that act on prestressed concrete poles.
(AUC Nov/Dec 2010)

- Bending due to wind load on the cable and on the exposed face.
- Combined bending and torsion due to eccentric snapping of wires.
- Maximum torsion due to skew snapping of wires.
- Bending due to failure of all the wires on one side of the pole.
- Handing and erection stresses.

12. What are the advantages of prestressing water tanks? (AUC Apr/May 2011)

- Water storage tanks of large capacity are invariably made of prestressed concrete.
- Square tanks are used for storage in congested urban and industrial sites where land space is a major constraint.
- This shape is considerable reduction in the thickness of concrete shell.
- The efficiency of the shell action of the concrete is combined with the prestressing at the edges

13. Mention the importance of shrinkage in composite construction?

The time dependent behavior of composite prestressed concrete beams depends upon the presence of differential shrinkage and creep of the concretes of web and deck, in addition to other parameters, such as relaxation of steel, presence of untensioned steel, and compression steel etc.

15. What are the different types of joints used between the slabs of prestressed concrete tanks?

- Movement joint
- Expansion joint
- Construction Joint
- Temporary Open Joints.

16. What are the advantages of partially prestressed concrete poles?

- Resistance to corrosion in humid and temperature climate and to erosion in desert areas.
- Easy handling due to less weight than other poles.
- Easily installed in drilled holes in ground with or without concrete fill.
- Lighter because of reduced cross section when compared with reinforced concrete poles.
- Fire resisting, particularly grassing and pushing fire near ground line.

17. What are the types of prestressed concrete pipes?

- Monolyte construction
- Two stage construction

18. Distinguish between non-cylinder and cylinder pipes. Non-cylinder pipes:

The design principles are used for determining the minimum thickness of concrete required and the pitch of circumferential wire winding on the pipe.

Cylinder pipes:

The design principles of cylinder pipes are similar to those of the non-cylinder pipes except that the required thickness of concrete is computed by considering the equivalent area of the light gauge steel pipe embedded in the concrete.

19. Define the losses of prestress.

Due to elastic deformation of concrete during circumferential wire winding, there is a loss of prestress which depends upon the modular ratio and the reinforcement ratio.

20. What are the advantages of prestressed concrete piles?

- High load and moment carrying capacity.
- Standardization in design for mass production.
- Excellent durability under adverse environmental conditions.
- Crack free characteristics under handling and driving.
- Resistance to tensile loads due to uplift.
- Combined load moment capacity.

PART – B

1.	A cylindrical PSC water tank of internal diameter 30m is required to store water over a depth of 7.5m. The permissible compressive stress in concrete at transfer is 13 N/mm2 and the minimum compressive stress under working pressure is 1 N/mm^2. The loss ratio is 0.75. Wires of 5mm diameter with an initial stress of 1000 N/mm^2 are vailable for circumferential winding and Freyssinet cables made up of 12 wires of 8mm diameter stressed to 1200 N/mm^2 are to be used for vertical prestressing. Design the tank walls assuming the base as fixed. The cube strength of concrete is 40 N/mm^2	BT-6
2.	Design a non cylindrical PSC pipe of 600mm internal diameter to withstand a working hydrostatic pressure of 1.05 N/mm^2 using 2.5mm HYSD stressed to 1000N/mm2 at transfer. Permissible maximum and minimum stresses in concrete at ransfer and service load are 14 N/mm^2 and 0.7 N/mm^2. The loss ratio is 0.75. E_s	BT-1
3.	A prestressed cylindrical pipe is to be designed using a steel cylinder of 700mm diameter and thickness 2.5mm with a layer of spun concrete 35mm thick. If the pipe is required to withstand a hydraulic pressure of 0.85 N/mm^2 , without developing any tensile stress in concrete, evaluate: (i) The required pitch of 4mm wires, wound around the cylinder at the tensile strength of 1000 N/mm^2. (ii) Test pressure to produce a tensile stress of 1.4 N/mm^2 in the concrete immediately after winding, and (iii) The appox bursting pressure, Modular ratio = 6 Tensile strength of the wire = 1700 N/mm^2 Yield stress of the cylinder = 280 N/mm^2 Loss ratio =0.85	BT-5
4.	Design a electric pole 12m high to support wires at its top at which can exert a reversible horizontal force of 3kN. The tendons are initially stressed to 1000N/mm^2 and the loss of stress due to shrinkage and creep is 15%. Maximum compressive stress in concrete is limited to 12N/mm^2 . Assume modular ratio=6, angle of repose=30^o and the specific weight of the soil is 18kN/mm^3.	BT-3
5.	i. With neat sketches, explain the various cross sectional profiles adopted for PSC Poles ii. State the general advantages of PSC poles.	BT-3
6.	A cylindrical PSC water tank of capacity 3.5 X 10^6 litres and ratio of diameter to height is 4.The maximum permissible compressive stress in concrete at transfer is 14N/mm^2 and the minimum compressive stress under working pressure is 1N/mm^2. Prestressed Wires of 5mm diameter are available for circumferential winding and Freyssinet cables made up of 12 wires of 7mm diameter. The stress in wires at transfer is 1000N/mm^2 . Loss ratio is 0.75 Design the tank walls and circumferential wire winding and vertical cables for the following joint condition at the base. Sliding base (assume co efficient of friction as 0.5).	BT-1
7.	(i) Explain the general features of prestressed concrete tanks. (8) (ii) Explain the junctions of tank wall and base slab with neat sketch (8)	BT-2

8.	(i) What is meant by partial prestressing?Discuss the advantages and disadvantages if partial prestressing is done. (6) (ii) Discuss the difference in load deflection behavior of under prestressed, partial prestressed andoverprestressedcases. Whypartial prestressing is preferred in the design (10)	BT-2
9.	Evaluate and design a free edge water tank of diameter 36m to store water for a depth of 5m. Assume ultimate stress in steel = 1500N/mm^2 . Stress in steel at transfer =70% of ultimate stress. Safe stress in concrete = 0.5fck .Compressive stress in concrete at service condition = 0.1f_{ck}. Final stress in steel = 0.8 x stress in steel at transfer. Take modular ratio= 5.5, f_{ck}= 45N/mm^2	BT-4
10.	Explain the criteria of design and design procedure for prestressed concrete circular tanks.	BT-2
11.	A prestressed concrete pipe of 1.2m diameter having a core thickness of 75mm is required to withstand a service pressure intensity of 1.2 N/mm^2. Examine the pitch of 5mm diameter high tensile wire winding if the initial stress is limited to 1000N/mm^2. Permissible stresses in concrete are being 12 N/mm^2 in compression in zero in tension. The loss ratio is 0.8, if the direct tensile strength of concrete is 2.5N/mm^2; Estimate the load factor against cracking.	BT-4
12.	List and explain the types of prestressed concrete pipes with neat sketches.	BT-1
13.	Explain any the methods of circumferential wire winding adopted in circular prestressing with a neat sketch.	BT-1
14.	Examine and design a prestressed concrete pipe of internal diameter 900mm to withstand the internal pressure of 0.8N/mm^2 . The maximum permissible compressive stress in concrete is 18N/mm^{2}and no tensile stress is to be permitted. Modular ratio between steel and concrete is 5.8. Adopt 5mm diameter high tensile wires which can be stressed to 1100 N/mm^2. Expected loss of prestress is 25%.	BT-4