PRESTRESSED CONCRETE STRUCTURES

UNIT-1

INTRODUCTION – THEORY AND BEHAVIOUR

1. Define prestressed concrete.
2. What are the advantages of PSC construction
3. Define Pre tensioning and Post tensioning
4. What is the need for the use of high strength concrete and tensile steel in prestressed Concrete?
5. Define Kern Distance.
6. What is Relaxation of steel?
7. What is concordant prestressing?
8. Define bonded and unbondedprestressing concrete.
9. Define Axial prestressing
10. List the losses of prestress
11. What are the various methods of prestressing the concrete?
12. Enumerate load balancing concept
13. What are the sources of prestress?
14. Differentiate full prestressing and partial prestressing.
15. What is the permissible limit for shrinkage of concrete in pretensioned and post tensioned members as per IS code?
16. State any two advantages of prestressed concrete over reinforced concrete?
17. What are the advantages of pretensioned concrete over post tensioned concrete?
18. What are the grades of concrete to be used in pre tensioned and post tensioned works?
19. What is meant by pressure line?
20. Why loss due shrinkage is more for pretensioned member compared to post tensioned member?

16marks

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.

    a) Calculate the resultant stress distribution for the centre of the span cross section of the beam assuming the density of concrete as $24kN/m^2$

    b) Find the magnitude of prestressing force with an eccentricity of 40mm which can 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 an 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.

3. A Prestressedpretensioned beam of 200mm wide and 300mm deep is used over an span of 10m is prestressed with a wires of area 300mm^2 at an eccentricity of 60mm carrying a prestress of 1200 N/mm^2 Find the percentage of loss of stress, E_c= 35 kN/mm^2 Shrinkage of concrete = 300 x 10^{-6} , creep coefficient =1.6

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/mm^2 . Find the deflection at centre span
   a) Under prestress + self weight
   b) Find the magnitude of live load udl which will nullifythe deflection due to prestress & self weight.

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.

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
   ii) Prestress + self weight of the beam + live load

7. (i) Explain why high strength concrete and high strength steel are needed for PSC construction
   (ii) State different types of prestressing

8. (i) Explain shrinkage of concrete in PSC members

   (ii) Explain durability, fire resistance and cover requirements for PSC members

9. A PSC beam supports an imposed load of 5kN/mm^2 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.

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.

UNIT -2

DESIGN CONCEPTS

1. Mention the functions of end block
2. What are the stages to be considered in the design of prestressed concrete section under flexure?
3. What is the zone of transmission in the end block of prestressed concrete structures?
4. What are the types of flexural failure encountered in prestressed concrete member?
5. How do you compute the ultimate flexural strength of section with tensioned and untensioned reinforcement in tension zone of concrete sections?
6. Explain with neat sketches the IS1343 code method of computing the moment of resistance of rectangular section.
7. What is strain compatibility method?
8. How will you improve the shear resistance of concrete beam using prestressing techniques?
9. Define anchorage zone
10. Sketch the pattern of reinforcement in anchorage zone.
11. What are the methods of stress analysis in anchorage zone?
12. Write the assumptions in strain compatibility method of prestressed concrete sections
13. List the applications of partial prestressing.
14. What is meant by partial prestressing?
15. What is meant by end block in a post tensioned member?
16. Compare the flexure failure of conventional RC beam with PSC beam
17. What is effective reinforcement ratio?
18. What are the code provisions for bond and transmission length?
19. Define Bursting tension
20. Define degree of prestressing.

16marks

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 4700mm^2 and is located at an effective depth of 1600mm. If the characteristic cube strength of the concrete and the tensile strength of steel are 40 and 1600Mpa respectively; calculate the flexural strength of the section.

2. A PSC beam of effective span 16m is of rectangular section 400mm wide and 1200mm deep. Atendons consist of 3300mm^2 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 f_{cu} =60 N/mm^2, estimate the flexural strength of the section as per BS provisions for the following cases:

(i) Bonded tendons

(ii) Unbonded tendons

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 of 4000mm^2 and is located at an effective depth of 1600mm. The effective prestress in steel after loss is 1000 N/mm^2& effective span is 24m. If f_{ck} = 40 N/mm^2, f_p = 1600 N/mm^2 Estimate the flexural strength.

4. 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.

5. The end block of a post tensioned concrete beam 300mm X 300mm is subjected to a concentric anchorage force of 800kN by a freyssinet anchorage system of area 1100mm^2. Discuss and detail the anchorage reinforcement for the end block.

6. Discuss the advantages and disadvantages of partial prestressing.

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/mm^2 and the ultimate tensile strength of wire is 1700N/mm^2. Assuming that the grouting of tendons is 100% effective determine the ultimate moment of section as per IS1343:1980.

8. 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 over the mild steel anchor plate of area 150mm x 350mm. design the end block.Take f_{ck} = 30N/mm^2. Assume initial prestressing force is 1.2 times the effective prestressing force.

9. (i) Discuss the load deflection behavior of under prestressed, partially prestressed and over prestressed members in detail.

(ii) Explain concept of limit states, partial safety factor.

10. a) What is meant by partial prestressing? Discuss the advantages and disadvantages when partial prestressing is done

b) Explain about the types of flexure failure occurs in prestressed concrete section

UNIT-3
CIRCULAR PRESTRESSING

2-marks

1. List the different types of prestressing adopted to the walls of the water tank
2. Define circular prestressing.
3. What are the applications of prestressed concrete tanks?
4. State the principle involved in circular prestressing.
5. What are the different types of joints used in the prestressed tanks?
6. What are the stages involved in the design of prestressed concrete pipes?
7. What are different shapes of PSC tanks?
8. What is the need of vertical prestressing in water tanks?
9. Differentiate cylindrical and non cylindrical PSC pipes.
10. What are the different types of joints used in the prestressed tanks?
11. What is the effect of circumferential wire winding in longitudinal stresses?
12. List the advantages of PSC pipes
13. Write any two general failures of prestressed concrete tanks

16 marks

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/mm^2 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 available 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

2. A prestressed cylindrical pipe is to be designed using a steel cylinder of 1000mm diameter and thickness 1.6mm. The circumferential wire winding consist of a 4mm high tensile wire initially tensioned to a stress of 1000 N/mm^2. The ultimate tensile strength of wire is 1600 N/mm^2. The yield stress of the steel cylinder is 280 N/mm^2. f_{ct}=14 N/mm^2, W_w =0.8 N/mm^2. Determine the thickness of concrete lining required. Fmin = 0; modular ratio = 6

3. 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 = $0.5f_{ck.}$ 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

4. Explain the different types of joints between the walls and floor slab of prestressed concrete tanks.

5. Write the design criteria of PSC pipes in detail

6. Explain the step by step design procedure of circular tanks.

7. Explain the types of PSC pipes with neat sketch

8. A non cylindrical PSC pipe of 1000mm diameter and thickness of concrete shell is 75mm is required to convey water at a working pressure of 1.5 N/mm^2. The length of the pipe is 6m. The loss ratio is 0.8. Determine the circumferential wire winding of using 5mm diameter wires stretched to 1000 N/mm^2. The maximum permissible tensile stress is 11.2 N/mm^2

9. Design a non cylindrical PSC pipe of 600mm internal diameter to withstand a working hydrostatic pressure of 1.05 N/mm^2using 2.5mm HYSD stressed to 1000N/mm^2 at transfer. Permissible maximum and minimum stresses in concrete at transfer and service load are 14 N/mm^2 and 0.7 N/mm^2. The loss ratio is 0.75. E_s = 210kN/mm^2 and E_c = 35kN/mm^2

10. Explain any one method of circumferential wire winding adopted in circular prestressing with a neat sketch

UNIT-4
COMPOSITE CONSTRUCTION

2 marks

1. Define composite construction
2. Define the concept of composite in PSC
3. What are the advantages of composite construction in PSC?
4. How the composite action is achieved between precast and cast in situ concrete?
5. Explain the effect of differential shrinkage in composite construction.
6. What is propped construction in composite PSC construction?
7. What is unpropped construction in composite PSC construction?
8. What are the assumptions made in the stress analysis of composite section?
9. Draw any four type of composite PSC sections
10. Explain the effect of deflection in composite member
11. Explain the effect of shear in composite member
12. Write the construction techniques in the of composite construction in PSC members
13. How do you compute shrinkage and resultant stresses in composite members?
14. Enumerate failure due to web shear cracks
15. Specify the various steps involved in the analysis of composite PSC members
16. Explain the method of computing the ultimate flexure strength in composite PSC members.
17. Explain the method of computing the ultimate shear strength in composite PSC members.
18. Draw the stress diagram for a composite PSC section if it is under propped construction.

19. Draw the stress diagram for a composite PSC section if it is under unpropped construction.
20. Sketch some typical cross sections of composite bridge decks with precast prestressed elements.

16 marks

1. Explain the design procedure of Prestressed composite section

2. 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 initial force in the tendons is 150kN. The loss of prestress is 15%. The top flange width is 400mm with the thickness of 40mm.If the composite beam supports a live load of $8kN/m^2$ calculate the resultant stresses developed if the section is propped and unpropped.

3. A composite T beam is made up of pretensioned rib of 100mm wide and 200mm deep and a cast insitu slab of 400mm wide and 40mm thick. Having the modulus of elasticity as $28kN/m^2$, if the differential shrinkage is 100×10^{-6} determine the shrinkage stresses developed in precast and cast insitu units.

4. A composite T-girder of span 5 m is made up of a pre-tensioned rib, 100 mm wide by 200 mm depth, with an in situ cast slab, 400 mm wide and 40 mm thick. The rib is prestressed by a straight cable having an eccentricity of 33.33 mm and carrying initial force of, 150 kN. The loss of prestress is 15%. Check the composite T-beam for the limit state of deflection if its supports an imposed load of 3.2 kN/m for (i) unpropped(ii) propped. Assume modulus of Elasticity of 35 kN/mm^2 for both precast & in situ cast elements.

5. i) Explain the types of composite construction with neat sketch.
   (ii) Explain the precast prestressed concrete stresses at serviceability limit state.

6. A PSC beam of cross section 150 mm x 300 mm is SS over a 6pan of 8m and is prestressed by means of symmetric parabolic cables @ a distance of 76 mm from the soffit @ mid span and 125 mm @ top @ support section. If the force in the cable i.e 350 KN. Calculate deflection @ midspan the beam is supporting its own weight The point load which must be applied at midspan to restore the beam to the level of its support.

Unit-5

PRE-STRESSED CONCRETE BRIDGES

2 marks

1. Write short notes on post tensioned prestressed concrete bridge decks
2. What is the principle involved in pre tensioned prestressed decks.
3. What are the span range for solid slab and for T beam slab bridge decks?
4. Draw the cross section of pre tensioned prestressed bridge decks
5. Draw the cross section of post tensioned prestressed bridge decks
6. What is the principle involved in post tensioned prestressed decks.
7. List any four mechanical prestressing systems adopted for bridges in India

16 marks

1. What are the advantages of prestressed concrete bridges?
2. Explain the pre tensioned and post tensioned bridge decks commonly used in construction of bridges.
3. Write the design procedure for post tensioned prestressed concrete slab bridge deck.
4. Write the design procedure for pre tensioned prestressed concrete slab bridge deck.
5. Write the design procedure for post tensioned PSC T beam slab bridge deck.
6. State the significance of adopting the combination of pre tensioned and post tensioned tendons in bridge construction.
7. Write the design procedure for post tensioned bridge girders.
8. Explain the methods involved in utilizing precast pretensioned members in bridge construction.