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QUESTION BANK

Subject with Code : DPCS (18CE1021) **Course & Specialization**: M.Tech – Structures

Year & Sem: II-M.Tech & I-Sem **Regulation:** R18

UNIT -1
METHODS OF PRESTRESSING

1. (a) Briefly outline the advantages of using high strength concrete & high strength steel in prestressed concrete structures.
   (b) Define the following terms:
      (i) Externally prestressed members.
      (ii) Internally prestressed members
      (iii) Circular prestressing.
   (c) Explain in detail Gifford Udall system of post tensioning with the help of neat sketch.

2. (a) Explain Pretensioning and Post tensioning of concrete members. What are the advantages of prestressed concrete members over reinforced concrete members?
   (b) Explain Gifford Udall system of Post tensioning with the help of neat sketch.

3. (a) What is the need for using high tension steel instead of mild steel in PSC.
   (b) Why do you go for high grade concrete instead of ordinary concrete in PSC.

4. (a) Explain the Magnel Blaton system of prestressing with the help of a neat sketch.
   (b) Discuss the various losses that take place in post tensioned members.

5. (a) Explain with sketches Hoyer systems of pre tensioning.
   (b) What are supple monetary anchoring devices?

6. (a) Differentiate between pretensioning and post tensioning systems? How is prestress Transmitted to the concrete in (i) pretensional members and (ii) post tensioned members
   (b) What are the general principals of prestressing? What are the advantages of using high Strength concrete and high strength steel?

7. Write short note on
   (a) Prestressed concrete versus Reinforced concrete.

(b) Merits and demerits of Prestressed Concrete.
(c) Pre-tensioning versus post tensioning.
(d) Advantages of High strength concrete in prestressing concrete.

8. Write short note on
(a) Freyssinet system
(b) P.S.C Mono wire system.
(c) Lee-McCall system.

9. (a) What is the minimum concrete strength requirements prescribed for prestressed concrete Members in IS: 1343 code?
(b) What are post-tensioning anchorages?
(c) Where do you adopt circular prestressing?

10. (a) What are the principles of prestressing in pretensioning and post tensioning?
(b) What are the various states of loading stages to be considered in the design of prestressed concrete structures?

UNIT –II

LOSSES OF PRESTRESS

1. A straight post tensioned concrete member 18 meters long with a cross section of 425 x 425 mm^2 is prestressed with 920 mm^2 of steel wires. This steel is made up of four tendons. With 230 mm^2 per tendon. The tendons are tensioned to a stress of 1025 N/mm^2. Determine the loss of prestress in each tendon due to elastic shortening of concrete. Find also the average percentage loss of prestress. If it is desired that after the last tendon is tightened a stress of 1025 N/mm^2 be maintained in each tendon. Calculate the actual stresses to which the individual tendons should be tightened. Take m = 6.

2. 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 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 an 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 the effects of friction. Assume K=0.0015/M.

3. A straight post tensioned concrete member 15m long with a cross section of 400 * 400mm^2 is prestressed with 900mm^2 of steel wires. This steel is made of four tendons with 225 mm^2 per tendon. The tendons are tensioned to a stress of 1050N/mm^2. Determine the loss of prestress in each tendon due to elastic shortening of concrete. Find also the average percentage loss of prestress. If it is desired that after the last tendon is tightened, a stress of 1050 N/mm^2 be maintained in each tendon, compute the actual stresses to which the individual tendons should be tightened. Take m=16.

4. A pre tensioned beam 200mm wide and 300mm deep is prestressed by 10 wires of 7mm diameter initially stressed to 1200N/mm^2, with their centroid located at 100mm from the soffit. Find the maximum stress in concrete immediately after transfer, allowing only for elastic shortening of concrete. If the concrete undergoes a further shortening due to creep and shrinkage while there is relaxation of 5 percent of steel stress, estimate the final percentage loss of stress in the wires using the Indian standard code (IS: 1343-1980) regulations, and the following data: creep coefficient = 1.6; Total residual shrinkage strain = 3x10^{-4}

5. A prestressed concrete beam 200mm wide and 300mm deep is prestressed with wires of area 320 mm^2 located at a constant eccentricity of 50 mm and carrying an initial stress of 1000 N/mm^2. The span of the beam is 10m. calculate the percentage loss of stress in the wires if the beam is (a) pretensioned and (b) post tensioned, using the following data: Es =210kN/mm^2 and Ec = 35 kN/mm^2; relaxation of steel stress = 5 percent of the initial stress; shrinkage of concrete = 300*10^{-6} for pretensioning and 200*10^{-6} for post tensioning; creep coefficient =1.6; slip at anchorage = 1 mm; frictional coefficient for wave effect = 0.00154 per m.

6. A post-tensioned concrete beam, 100mm wide and 300mm deep, is prestressed by three cables, each with a cross-sectional area 50mm^2 and with an initial stress of 1200=mm^2. All the cables are straight and located 100mm from the soffit of the beam. If the modular ratio is 6, calculate the loss of stress in the three cables due to elastic deformation of concrete for the only the following cases. Simultaneous tensioning and anchoring of all three cables and successive tensioning of the three cables, one at a time.

7. A post tensioned concrete beam 200mm wide and 450mm deep, is prestressed by a circular cable (Total area = 800 mm^2) with zero eccentricity at the ends and 150mm at the centre. The span of the beam is 10m. The cable is to be stressed from one end such that an initial stress of 840N/mm^2 is available in the un jacked end immediately after anchoring. determines the stress in the wires at the jacking end and the percentage loss of stress due to friction. Coefficient of friction for curvature effect = 0.6 Friction coefficient for wave effect = 0.003/m

8. A post-tensioned cable of beam 10m long is initially tensioned to a stress of 1000N/mm^2 at one end. If the tendons are curved so that the slope is 1 in 24 at each end, with an area of 600mm^2, Calculate the loss of prestress due to friction given the following data. Coefficient of friction between duct and cable = 0.55, friction coefficient for wave effect = 0.015 per m. During anchoring, if there is a slip of 3mm at the jacking end, calculate the final force in the cable and the percentage due to friction and slip Es = 210kN/mm^2.

9. A rectangular prestressed concrete beam has a span of 12m and has to carry a live load of 15KN/m excluding the self-weight of beam. Given f_c= 16N/mm^2 and f_s=1050N/mm^2, design the beam using 6mm tendons. Weight of concrete is 24KN/m^3. Assume depth= 2 times of width.

10. A concrete beam of 9m span 125mm wide and 300mm deep is prestressed by 3 cables. The area of each cable is 200mm^2 and the initial stress in the cable is 1200N/mm^2. Cables 1 is parabolic with an eccentricity of 50mm above the centroid at the supports and 50mm below at the centre of span. Cable 2 is also parabolic with zero eccentricity at supports and 50mm below the centroid at the centre of span. Cable 3 is straight with uniform eccentricity of 50mm below the centroid. Is the cables are tensioned from one end only, estimate the Percentage loss of stress in each cable due to friction. Assume =0.35 and K=0.0015 per m.

UNIT -3
FLEXURE

1. A prestressed concrete bridge deck comprises any unsymmetrical-I section beams spanning over 20m has dimensions of depth and width of top flange is 200mm, 1200mm, depth and width of web is 900mm, 200mm and depth and width of bottom flange is 400mm, 500mm.The cross-section of a typical beam is shown in figure .The beam is prestressed by seven freyssinet cables, each carrying an effective force of 600kN located 200mm from the soffit at the centre of span section. If the total maximum bending moment at the centre of span of the girder is 4000kN-M. Estimate the resultant stress developed at the section using the internal resisting couple method.

2. An unsymmetrical I - section beam is used to support an imposed load of 2 kN/m over a span of 8 m. The sectional details are top flange, 300 mm wide and 60 mm thick, bottom flange, 100 mm wide and 60 mm thick, thickness of web is 80 mm; overall depth of the beam is 400 mm. At the centre of the span, the effective prestressing force of 100 kN is located at 50 mm from the soffit of the beam, estimate the stresses at the centre of span section of the beam for the following load conditions:

   a) Prestress + Self weight.

   b) Prestress + Self weight + Live load

3. A pre-tensioned beam of rectangular section 400mm wide and 1000mm overall depth is pre-stressed by 800mm^2 of high tensile steel wires at an eccentricity of 300mm. If f_{ck}=1600mpa. Estimate the ultimate flexural strength of the section.

4. A prestressed concrete I beam has its upper flange 750 mm wide and 200 mm deep, lower flange 400 mm wide and 300 mm deep and a web of depth 500 mm and width 150 mm. It is supported over a span of 30 meters and carries a uniformly distributed load of 4000 KN/m, exclusive of self weight. It is prestressed with 120 wires of 5mm diameter, with their centroid 100mm the bottom wedge and Initially tensioned to 1000 N/mm^2. Assuming 15 percent loss in prestress, determine the extreme fiber stresses at mid span at various stages. Take density of concrete as 25 kN/m^3.

5. A concrete beam of rectangular beam section, 100 mm wide and 300 mm deep, is prestressed by 3 cables each carrying an effective force of 240 kN The span of the beam is 10 m. The first cable is parabolic with an eccentricity of 50 mm below the centroidal axis at the centre of span and 50 mm

above the centroidal axis the supports. The second cable is parabolic with zero eccentricity at the supports and an eccentricity of 50 mm at the centre of span. The third cable is straight with an uniform eccentricity of 50 mm below the centroidal axis. If the beam supports a uniformly distributed live load of 5 kN/m and EC = 38 kN/mm^2, estimate the resultant stresses.

(a) Prestress + self weight of the beam.

(b) Prestress + self weight + live load.

6. A rectangular concrete beam 250mm wide by 300mm deep is pre-stressed by a force of 540kN at a constant eccentricity of 60mm. The beam supports a concentrated load of 68KN at the center of a span of 3m. Determine the location of the pressure line at the centre, quarter span and support sections of the beam. Neglect the self-weight of the beam.

7. A prestressed concrete beam of section 120mm wide by 300mm deep is used over Effective span of 6m to support a U.D.L of 4kN/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 an eccentricity of 50mm. Determine the location of the thrust line in the beam and plot its position at quarter and central span sections.

8. A prestressed concrete beam 150mm wide by 300mm deep, is prestressed by cable which has an parabolic eccentricity of 80 mm at centre of span section. The span of the beam is 6m. If the beam supports two concentrated loads of 10kN each at one-third span points. Determine magnitude of prestressing force in cable for load balancing for the following cases

   i) if the bending effect of the prestressing force is nullified by the imposed load for the mid span section (neglecting self weight of beam)

   ii) If the resultant stress due to self weight, imposed load and prestressing force is zero at the soffit of the beam for the mid span section (assume $D_{c\,=}$ 24 kN/m^3)

9. A rectangular prestressed concrete beam has a span of 12m and has to carry a live load of 15KN/m excluding the self-weight of beam. Given f_c= 16N/mm^2 and f_s=1050N/mm^2, design the beam using 6mm tendons. Weight of concrete is 24KN/m^3. Assume depth= 2Xwidth.

10. A prestressed T-section has flange 1200mm wide and 150 mm thick. The width and depth of rib are 300 and 1500 mm respectively. The high tensile steel has an area of 4700 mm^2 and is located at an effective depth of 1600mm. if the characteristic cube strength of the concrete and tensile strength of steel are 40 and 1600N/mm^2, calculate the flexural strength of the T-section.

UNIT-4

SHEAR, BOND, BEARING AND ANCHORAGE,DEFLECTIONS

1. A prestressed concrete beam span of 10m of rectangular section, 120mm wide and 300mm deep, is axially prestressed by a cable carrying an effective force of 180kN. The beam supports a total uniform distributed load of 5kN/m which includes the self-weight of beam. Compare the magnitude of the principal tension developed in the beam with and without the axial prestress?

2. A cantilever portion of a prestressed concrete bridge with a rectangular cross-section, 600mm wide and 1650mm deep is 8m long and carries a reaction of 350kN from the suspended span at the free end, together with a uniform distributed load of 60kN/m inclusive of its own-weight. The beam is prestressed by seven cables each carrying a force of 1000KN, of which three are located at 150mm, 3 at 400mm, and one at 750mm, from the top edge. Calculate the magnitude of the principle stresses at a point 550mm from the top of cantilever at the support section.

3. A post tensioned beam of rectangular cross section, 200 mm wide and 400 mm deep, is 10m long and carries an applied load of 8 kN/m, uniformly distributed on the beam. The effective prestressing force in the cable is 500kN. The cable is parabolic with zero eccentricity at the supports and a maximum eccentricity of 140 mm at the centre of span.
   i) Calculate the principal stresses at the supports
   ii) What will be the magnitude of the principal stresses at the supports in the absence of prestress?

4. a) Write about importance of control of deflections and list the various factors influencing the deflection of prestressing concrete members?
   b) Write about short-term and long-term deflections of un-cracked members?

5. Explain Guyon's method of computing bursting tension in the case of end blocks subjected to Forces not evenly distributed with multiple anchorages?

6. Explain the following methods to study the stress distribution in the end block
   Magnel Method
   Guyon Method
   I.S. code Method

7. A concrete beam with a rectangular section 300mm wide and 500mm deep is prestressed by 2 post-tensioned cables of area 600mm^2 each. Initially stressed to 1600N/mm^2. The cables are located at a constant eccentricity of 100mm throughout the length of the beam having a span of 10m. The modulus of elasticity of steel and concrete is 210 and 38KN/mm^2 respectively.

   (a) Neglecting all losses, find the deflection at the center of span when it is supporting its own weight.
   (b) Allowing for 20% loss in prestress, find the final deflection at the center of the span when it carries an imposed load of 18KN/m. D_c=24KN/mm.

8. A prestressed I section has the following properties
   Area=55x103mm^2,
   Second moment of area =189x107mm^4
   Statical moment about the centroid =468 x 104mm ^{3}
   Thickness of web=50mm.
   It Is prestressed horizontally by 24 wires of 5mm diameter and vertically by similar wires

at150 mm centers. All the wires carry a tensile stress of 900N/mm^2. Calculate the principal stresses at the centroid when a shearing force of 80kN acts upon this section

9. A concrete beam with a cross section area of 32*10mm^3 and radius of gyration of 72mm is prestressed by a parabolic cable carrying an effective stress of 1000 N/mm^2. The span of the beam is 8m. The cable, composed of 6 wires of 7mm diameter has an eccentricity of 50mm at the centre and zero at the supports. Neglecting all the losses, and the central defection of the beam as follows:

   a) Self weight + prestress and

   b) self weight + prestress + live load of 2 kN/m.

10. A concrete beam having a rectangular section of 100mm wide and 300mm deep is prestressed by a parabolic cable carrying an initial force of 240KN. The cable has an eccentricity of 50mm at the center of the span and is concentric at the supports. If the span of the beam is 10m and the live load is 2KN/m, estimate the short time deflection at the center of the span.

    Assuming E=38KN/mm^2 and creep co-efficient is 2.0, loss of prestress =20 percent of the initial stress after 6 months. Estimate the long time deflection at the center of span at this stage, assuming that the dead and live loads are simultaneously applied after ate release of prestress.

UNIT -5
COMPOSITE CONSTRUCTION AND CIRCULAR PRESTRESSING.

1. Design a non-cylindrical prestressed concrete pipe of 600mm internal diameter to withstand a working hydrostatic pressure of 1.05N/mm^2, using a 2.5mm high-tensile wire stressed to 1000N/mm^2 at transfer. Permissible maximum and minimum stresses in concrete at transfer and service loads are 14 and 0.7N/mm^2.The loss ratio is 0.8. Calculate also the test pressure required to produce a tensile stress of 0.7N/mm^2 in concrete when applied immediately after tensioning and also the winding stress in steel if E_s=210KN/mm^2 and E_c=35KN/mm^2.

2. A reinforced concrete dome of 30m base diameter and a raise of 3.75m is to be designed for a prestressed concrete cylindrical tank. The shell dome is to be provided with prestressed concrete ring beam, radius of the shell dome=32m, and thickness of the shell 75mm. Design the dome and the ring beam for a super-imposed load of 1.5KN/m^2. The 5mm diameter high tensile wires initially stressed to 1000N/mm^2, are available for prestressing the ring beam. The loss ratio is 0.75. The permissible compressive stress in concrete at transfer is 14N/mm^2. Take semi-central angle=$28^o4'$.

3. A precast pre-tensioned beam of rectangular section has a breadth of 100mm and depth of 200mm. The beam, with an effective span of 5m, is prestressed by tendons with their centroid coinciding with the bottom kern. The initial force in the tendons is 150KN. The loss of prestress may be assumed to be 15 percent. The beam is incorporated in a composite T-beam by casting a top flange of breadth 400mm and thickness 40mm. If the composite beam supports a live load of 8KN/m^2, calculate the resultant stresses developed in the precast and in situ cast concrete assuming the pre-tensioned beam

as: (a) unpropped, and (b)propped during the casting of the slab. Assume the same modulus of elasticity for concrete in precast beam in situ cast slab.

4. A cylindrical prestressed concrete water tank of internal diameter 30 m is required to store water over a depth of 7.5 m. 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 5 mm diameter with an initial stress of 1000 N/mm^2 are available for circumferential winding and Freyssinet cables made of 12 wires of 8 mm 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 compressive strength of concrete is 40 N/mm^2.

5. A prestressed cylindrical pipe is to be designed using a steel cylinder of 1000mm internal diameter and thickness 1.6mm. The circumferential wire winding consists of a 4mm high tensile wire, initially tensioned to a stress of 1000N/mm^2. Ultimate tensile strength of the wire=1600N/mm^2. Yield stress of the steel cylinder=280N/mm$^{2.}$ The maximum permissible compressive stress in concrete at transfer is 14N/mm^2 and no tensile stresses are permitted under working pressure of 0.8N/mm^2. Determine the thickness of the concrete lining required, the number of turns of circumferential wire winding and the factor of safety against bursting. Assume modular ratio as 6.

6. A prestressed concrete circular cylindrical tank is required to store 24500 million litres of water. The permissible compressive stress in concrete at transfer should not exceed 13N/mm^2 and the minimum compressive stress under working pressure should not be less than 1N/mm^2. Te loss ratio is 0.75. High-tensile steel wires of 7mm diameter with an initial stress of 1000N/mm^2 are available for winding round the tank. Freyssinet cables of 12 wires of 8mm diameter which are stressed to 1200N/mm^2 are available for vertical prestressing. The cube strength of concrete is 40N/mm^2. Design the tank walls supported on elastometric pads. Assume the coefficient of friction as 0.5.

7. A beam of composite section consists of cast in situ flange 325mmX50mm over a 100mmX250mm precast pre-tension unit. The stress distribution for the precast unit alone due to prestressing force is 12.5N/mm^2. Find the uniformly distributed load for the composite beam on a simply supported span of 6m, for the following two cases:
   i) The flange is supported independently while it is caste
   ii) The weight of the flange and shuttering is supported by the pre-tensioned unit at the stage of casting.
   The weight of the shuttering is removed after the hardening of the flange concrete. The modular ration between flange concrete and the precast concrete is 0.60, the weight of the shuttering is 0.25KN/m, weight of concrete=24KN/m^3.

8. Explain the design procedure for circular tanks.

9. A non-cylinder prestressed concrete pipe of 1.6m diameter with a core thickness of 100mm is required to withstand a working pressure of $1N/mm^2$. Determine the pitch of a 5mm diameter wire winding if the high-tensile initial stress in the wire is limited to $1000N/mm^2$. The permissible maximum and minimum stresses in concrete are $12N/mm^2$ (compression) and zero (tension). The loss ratio is 0.8. If the direct tensile strength of concrete is 2 kN/mm^2, estimate the load factor against cracking.

10. A spherical dome is to be designed to cover a circular tank of 36m base diameter and a raise of the dome is 1/8th of diameter. The shell dome is to be provided with prestressed concrete ring beam, radius of the shell dome is 32m, and thickness of the shell is 1/500th diameter. Design the dome and the ring beam for a super imposed load of 1.5 kN/mm^2. The 5 mm diameter high tensile wires initially stressed to $1000N/mm^2$, are available for prestressing the ring beam. The loss ratio is 0.8. The permissible compressive stress in concrete at transfer is 14 N/mm^2. Take semi central angle is $28^{o}4'$.

Paper set by

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