Course Code: 20CE0142 **R20**

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR
(AUTONOMOUS)
Siddharth Nagar, Narayanavanam Road, Puttur – 517583

QUESTION BANK (DESCRIPTIVE)

Subject with Code: Prestressed Concrete (20CE0142) **Course & Branch**: B.Tech - Civil
Year & Sem: IV–B.Tech & I–Sem **Regulation:** R20

UNIT – I
INTRODUCTION TO PRESTRESSED CONCRETE AND METHOD OF PRESTRESSING

1	a) Define the term prestressed concrete and state some of its application.	[L2][CO1]	**[6M]**
	b) What are the types of prestressing? Enumerate some of its advantages and limitations of prestressing system.	[L1][CO1]	**[6M]**
2	a) Discuss on some of the historical development in prestressed concrete. Why high strength steel/concrete are required in prestressing?	[L2][CO1]	**[6M]**
	b) Differentiate between pre-tensioning and post-tensioning of prestressing.	[L2][CO1]	**[6M]**
3	a) Explain Hoyer's method of pre-tensioning system with a neat sketch.	[L2][CO1]	**[6M]**
	b) Write a short note on various types of devices used for prestressing steel.	[L1][CO1]	**[6M]**
4	A rectangular concrete beam 100 mm wide by 250 mm deep spanning over 8 m is prestressed by a straight cable carrying an effective prestressing force of 250 kN located at an eccentricity of 40 mm. The beam supports a live load of 1.2 kN/m (i) Calculate the resultant stress distribution for the centre-of-span cross section of the beam assuming the unit weight of concrete as 24 kN/m^3 (ii) Find the magnitude of the prestressing force with an eccentricity of 40 mm which can balance the stresses due to dead and live loads at the soffit of the centre span section	[L4][CO1]	**[12M]**
5	A rectangular concrete beam of cross-section 30 cm deep and 20 cm wide is prestressed by means of 15-wires of 5 mm diameter located 6.5cm from the bottom of the beam and 3-wires of 5 mm diameter 2.5 cm from the top. Assuming the prestress in the steel as 840 N/mm^2, calculate the stresses at the extreme fibres of the mid-span section when the beam is supporting its own weight over a span of 6m. If a uniformly distributed live load of 6 kN/m is imposed, evaluate the resultant stress in concrete. Take unit weight of concrete as 24 kN/m^3	[L4][CO1]	**[12M]**
6	An uni-symmetrical I-section beam is used to support an imposed load of 2 kN/m over a span of 8 m. The sectional details are a) top flange: 300 mm wide and 60 mm thick; b) bottom flange 100 mm wide and 60 mm thick; c) thickness of web = 80 mm and overall depth of the beam = 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 for the following condition. (i) Prestress + self-weight (ii) Prestress + self-weight + live load.	[L4][CO1]	**[12M]**

7	A prestressed concrete beam of section 200 mm wide by 300 mm deep is used over an effective span of 6 m to support an imposed load of 4 kN/m. The unit weight of concrete is 24 kN/m^3. At the centre-of-span section of the beam, find the magnitude of (i) the concentric prestressing force necessary for zero fibre stress at the soffit when the beam is fully loaded; and (ii) the eccentric prestressing force located 100mm from the bottom of the beam which would nullify the bottom fibre stresses due to loading.	[L4][CO1]	**[12M]**
8	A prestressed concrete beam supports a live load of 4 kN/m over a simply supported beam of 8 m. The beam has an I-section with an overall depth of 400 mm. The thickness of the flange and web are 60 mm and 80 mm respectively. The width of the flange is 200 mm. The beam is to be prestressed by an effective prestressing force of 235 kN at a suitable eccentricity such that the resultant stress at the soffit of the beam at the centre of the span is zero. (i) Find the eccentricity required for the force. (ii) If the tendon is concentric, what should be the magnitude of the prestressing force for the resultant stress to be zero at the bottom fibre of the central span section.	[L4][CO1]	**[12M]**
9	a) Explain in detail with a neat sketch on Freyssinet system of prestressing	[L2][CO1]	**[7M]**
	b) Explain in detail with a neat sketch on Gifford-Udall system of prestressing	[L2][CO1]	**[5M]**
10	a) Explain in detail with a neat sketch Lee-McCall system of prestressing	[L2][CO1]	**[6M]**
	b) Explain in detail with a neat sketch on Magnel-Blanton system of prestressing	[L2][CO1]	**[6M]**

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UNIT – II
LOSSES OF PRESTRESS

1	What are the various losses of prestress? Briefly explain the losses in pre-tensioned prestressed concrete members.	[L2][CO2]	**[12M]**
2	What are the various losses of prestress? Briefly explain the losses in post-tensioned prestressed concrete members.	[L2][CO2]	**[12M]**
3	A rectangular concrete beam 300 mm deep and 200 mm wide, is prestressed by means of 15# of 5 mm diameter wires located 65 mm from the bottom of the beam and 3# of 5 mm diameter 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 in steel immediately after the transfer, allowing for the loss of stress due to elastic deformation of concrete only.	[L3][CO2]	**[12M]**
4	a) A concrete beam is prestressed by a cable carrying an initial prestressing force of 300 kN. The cross-sectional area of the wires in the cable is 300 mm^2. Calculate the percentage loss of stress in the cable only due to shrinkage of concrete using IS 1343 recommendations assuming the beam to be i) pre-tensioned and ii) post-tensioned. Assume E_s = 210 kN/mm^2 and age of concrete at transfer = 8 day.	[L3][CO2]	**[4M]**
	b) A concrete beam of rectangular section, 100 mm wide and 300 mm deep, is prestressed by five wires of 7 mm diameter located at an eccentricity of 50 mm, the initial stress in the wires being 1200 N/mm^2. Estimate the loss of stress in steel due to creep of concrete using ultimate creep strain method and creep co-efficient method. Take E_s = 210 kN/mm^2; E_c = 35 kN/mm^2, ε_{cc} = 41 x 10^{-6} mm/mm per N/mm^2, Creep coefficient (ϕ) = 1.6.	[L3][CO2]	**[8M]**
5	A concrete beam of 10 m span, 100 mm wide and 300 mm deep, is prestressed by three 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 50mm 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'. (*Note*: Equation of the parabola is given by: $y = (4e/L^2).x.(L-x)$)	[L3][CO2]	**[12M]**
6	A post-tensioned cable of beam 10 m long is initially tensioned to a stress of 1000 N/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 600 mm^2, calculate the loss of prestress due to friction given a) Co-efficient of friction between duct and cable = 0.55 b) Friction co-efficient for 'wave' effect = 0.0015 per 'm' c) E_s = 210 kN/mm^2 During anchoring, if there is a slip of 3 mm at the jacking end, calculate the final force in the cable and the percentage loss of prestress due to friction and slip.	[L3][CO2]	**[12M]**

7	A pretensioned beam 250 mm wide and 300 mm deep is prestressed by 12 wires each of 7 mm diameter initially stressed to 1200 N/mm^2 with their centroids located 100 mm from the soffit. Estimate the final percentage loss of stress due to elastic deformation, creep, shrinkage and relaxation using IS 1343 code. Use the following data. i. Relaxation of steel stress = 90 N/mm^2 ii. E_S = 210 kN/mm^2; E_C = 35 kN/mm^2 iii. Creep co-efficient (ϕ) = 1.6 iv. Residual shrinkage strain = 3 x 10^{-4}	[L3][CO2]	**[12M]**
8	A pretensioned beam, 200 mm wide and 300 mm deep is prestressed by 10 wires of 7 mm diameter initially prestressed to 1200 N/mm^2 with their centroids located 100 mm 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 a relaxation of 5% of steel stress, estimate the final percentage loss of stress in the wires using IS 1343 regulation. Take E_s = 210 kN/mm^2; f_{cu} = 42 N/mm^2, creep co-efficient (ϕ) = 1.6, total residual shrinkage strain = 3 x 10^{-4}	[L3][CO2]	**[12M]**
9	A prestressed concrete pile, 250 mm square, contains 60 pretensioned wires, each of 2 mm diameter, uniformly distributed over the section. The wires were initially tensioned on the prestressing bed with a total force of 300 kN. Calculate the final stress in concrete and the percentage loss of stress in steel after all losses. Take E_s = 210 kN/mm^2; E_c = 32 kN/mm^2, shortening due to creep = 30 x 10^{-6} mm/mm per N/mm^2 of stress, total shrinkage = 200 x 10^{-6} per unit length.	[L3][CO2]	**[12M]**
10	A prestressed concrete beam 200 mm wide and 300 mm deep is prestressed with wires (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 10 m. Calculate the percentage loss of stress in wires if (a) the beam is pretensioned and (b) the beam is post-tensioned, using the following data. a) E_s = 210 kN/mm^2 and E_c = 32 kN/mm^2 b) Relaxation of steel stress = 5% of initial stress c) Shrinkage of concrete = 300 x 10^{-6} (pre-tensioning) and 300 x 10^{-6} (post tensioning) d) Creep coefficient (ϕ) = 1.6 e) Slip at anchorage = 1 mm f) Frictional co-efficient for wave effect = 0.0015 per m	[L3][CO2]	**[12M]**

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UNIT – III
ANALYSIS AND DESIGN OF SECTIONS FOR FLEXURE AND SHEAR

1	Explain various modes of flexural failure in detail	[L2][CO3]	**[12M]**
2	A pre-tensioned prestressed concrete beam having a rectangular section, 150 mm wide and 350 mm deep, has an effective cover of 50 mm. If f_{ck} = 40 N/mm^2, f_p = 1600 N/mm^2 and the area of prestressing steel A_p = 461 mm^2, calculate the ultimate flexural strength of the section using IS 1343 code provisions.	[L3][CO3]	**[12M]**
3	A pre-tensioned T-section has a flange which is 300 mm wide and 200 mm thick. The rib is 150 mm wide by 350 mm deep. The effective depth of the cross-section is 500 mm. Given A_p = 200 mm^2, f_{ck} = 50 N/mm^2, f_p = 1600 N/mm^2, estimate the ultimate moment capacity of the T-section using the IS code regulation.	[L3][CO3]	**[12M]**
4	A pre-tensioned T-section has a flange which is 1200 mm wide and 150 mm thick. The width and depth of the rib are 300 mm and 1500 mm respectively. The high-tensile steel has an area of 4700 mm^2 and is located at an effective depth of 1600 mm. If the characteristic cube strength of the concrete and the tensile strength of steel are 40 N/mm^2 and 1600 N/mm^2 respectively, calculate the flexural strength of the T-section.	[L3][CO3]	**[12M]**
5	A post-tensioned bridge girder with unbonded tendons is of box section of overall dimensions 1200 mm wide by 1800 mm deep, with wall thickness of 150 mm. The high-tensile steel has an area of 4000 mm^2 and is located at an effective depth of 1600 mm. The effective prestress in steel after all losses is 1000 N/mm^2 and the effective span of the girder is 24 m. If f_{ck} = 40 N/mm^2 and f_p = 1600 N/mm^2, estimate the ultimate flexural strength of the section.	[L3][CO3]	**[12M]**
6	A prestressed concrete beam of span 10 m is of rectangular section, 120 mm wide and 300 mm deep is axially prestressed by a cable carrying an effective force of 180 kN. The beam supports a total uniformly distributed load of 5 kN/m (including self-weight). Compare the magnitude of the principal tension developed in the beam with and without the axial prestress.	[L3][CO4]	**[12M]**
7	A cantilever portion of a prestressed concrete bridge with a rectangular cross section, 600 mm wide and 1650 mm deep is 8 m long and carries a reaction of 350 kN from the suspended span at the free end, together with a uniform distributed load of 60 kN/m inclusive of its own-weight. The beam is prestressed by seven cables each carrying a force of 1000 kN, of which 3# are located at 150 mm, 3# at 400 mm, & one at 750 mm, from top edge. Calculate the magnitude of the principal stresses at a point 550 mm from the top of cantilever at support section.	[L3][CO4]	**[12M]**
8	A prestressed girder of rectangular section 150 mm wide by 300 mm deep is to be designed to support an ultimate shear force of 130 kN. The uniform prestress across the section is 5 N/mm^2. Given the characteristic cube strength of concrete as 40 N/mm^2 and Fe-415 HYSD bars of 8mm diameter, design suitable spacing for the stirrups conforming to the Indian standard code IS 1343 recommendations. Assume cover to the reinforcement as 50mm.	[L4][CO4]	**[12M]**

9	A prestressed girder has to be designed to cover a span of 12 m, to support an uniformly distributed live load of 15 kN/m. M45 grade concrete is used for casting the girder. The permissible stress in compression may be assumed as 14 N/mm^2 and 1.4 N/mm^2 in tension. Assume 15% losses in prestress during service load conditions. The preliminary section proposed for the girder consists of a symmetrical I-section with flanges 300 mm wide and 150 mm thick. The web is 120 mm wide and 450 mm deep. a) Check the adequacy of the section provided to resist the service loads. b) Design the minimum prestressing force and the corresponding eccentricity for the section.	[L4][CO4]	**[12M]**
10	A pre-tensioned beam, 80 mm wide and 120 mm deep, is to be designed to support a working load of 4 kN, each concentrated at the third points over a span of 3 m. If the permissible stresses in tension are zero at transfer and 1.4 N/mm^2 under working loads, design the number of 3 mm wires and the corresponding eccentricity required at the mid-span section. Permissible tensile stress in wires is 1400 N/mm^2. The loss of prestress is 20% and unit weight of concrete is 24 kN/m^3.	[L4][CO4]	**[12M]**

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UNIT – IV
DEFLECTIONS OF PRESTRESSED CONCRETE BEAMS

1	a) State the importance of control of deflection.	[L1][CO5]	**[4M]**
	b) Explain in detail about factors affecting deflection.	[L2][CO5]	**[8M]**
2	Explain with a neat sketch in detail on the effect of tendon profile on deflection.	[L2][CO5]	**[12M]**
3	A prestressed concrete beam of rectangular section 120 mm wide by 300 mm deep, spans over 6 m. The beam is prestressed by a straight cable carrying an effective force of 200 kN at an eccentricity of 50 mm. The modulus of elasticity of concrete is 38 kN/m^2. Compute the deflection at the centre of span for the following cases. a) Deflection under prestress + self-weight b) Find the magnitude of the uniformly distributed live load which will nullify the deflection due to prestress and self-weight.	[L3][CO5]	**[12M]**
4	A rectangular concrete beam of cross-section 150 mm wide and 300 mm deep is simply supported over a span of 8 m and is prestressed by means of symmetric parabolic cable, at a distance of 75 mm from the bottom of the beam at mid-span and 125 mm from the top of the beam at support sections. If the force in the cable is 350 kN and the modulus of elasticity of concrete is 38 kN/mm^2, calculate a) The deflection of mid-span when the beam is supporting its own weight and b) The concentrated load which must be applied at mid-span to restore it to the level of supports.	[L3][CO5]	**[12M]**
5	A concrete beam with a symmetrical I-section has flange width and depth of 200 mm and 60 mm respectively. The thickness of the web is 80 mm and the overall depth is 400 mm. the beam is prestressed by a cable carrying a force of 1000 kN. The span of the beam is 8 m. The centre line of the cable is 150 mm from the soffit of the beam at the centre of span, linearly varying to 250 mm at the supports. Compute the initial deflection at mid-span due to prestress and the self-weight of the beam assuming E_c = 38 kN/mm^2. Compare the deflection with the limiting deflection permitted in IS 1343. Take unit weight of concrete = 24 kN/m^3	[L3][CO5]	**[12M]**
6	A concrete beam with rectangular section 100 mm wide and 300 mm deep is stressed by three 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 at 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 a uniform eccentricity of 50 mm below the centroidal axis. If the beam supports a uniformly distributed live load of 5 kN/m and E_c = 38 kN/mm^2, estimate the instantaneous deflection for the following stages. a) Pre-stress + self-weight of beam b) Prestress + self-weight + live load	[L3][CO5]	**[12M]**

7	A prestressed concrete beam having a cross-sectional area (A) of 5 x 10^4 mm^2 is simply supported over a span of 10 m. It supports a uniformly distributed imposed load of 3 kN/m, half of which is non-permanent. The tendon follows a trapezoidal profile with an eccentricity of 100 mm within the middle-third of the span and varies linearly from the third-span points to zero at the supports. The area of tendons A_p = 350 mm^2 having effective prestress of 1290 N/mm^2 immediately after transfer. Use the following data, I_g = 4.5 x 10^8 mm^4, E_c = 34 kN/mm^2 and unit weight of concrete = 23.6 kN/m^3 calculate the short-term deflection.	[L3][CO5]	**[12M]**
8	A post-tensioned prestressed concrete beam of span 8 m with rectangular section 300 mm wide by 400 mm deep is prestressed by a cable containing high-tensile wires stressed to 1200 N/mm^2 with cross-sectional area 200 mm^2. If the beam supports a live load of 20 kN/m excluding its self-weight, compute the initial deflection due to prestress, self-weight and live loads for the following cases: a. The cable profile is straight with a constant eccentricity of 100 mm. b. The cable profile is parabolic with a dip of 100mm at mid-span and concentric at supports. Assume unit weight of concrete as 36 kN/mm^2	[L3][CO5]	**[12M]**
9	A concrete beam having a rectangular section 100 mm wide and 300 mm deep is prestressed by a parabolic cable carrying an initial force of 240 kN. The cable has an eccentricity of 50 mm at the centre of span and is concentric at the supports. If the span of the beam is 10 m and the live load is 2 kN/m, estimate the short time deflection at the centre of span. Assuming E = 38 kN/mm^2 and creep co-efficient (ϕ) = 2.0, loss of prestress = 20% of initial stress after 6-months, estimate the long-time deflection at the centre of span at this stage, assuming that the dead and live loads are simultaneously applied after the release of prestress.	[L3][CO5]	**[12M]**
10	A prestressed concrete beam of rectangular section, 120 mm wide and 300 mm deep spans over 6 m. The beam is prestressed by a straight cable carrying an effective force of 180 kN at an eccentricity of 50 mm. If it supports an imposed load of intensity 4 kN/m and the modulus of elasticity of concrete is 38 kN/mm^2, compute the deflection at the following stages and check whether they comply with IS code specifications. a) Upward deflection under (prestress + self-weight) and b) Final downward deflection under (prestress + self-weight + imposed load) including the effects of creep and shrinkage. Assume the creep co-efficient to be 1.80	[L3][CO5]	**[12M]**

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UNIT – V
COMPOSITE SECTIONS

1	What is meant by composite section? Enumerate some of the advantages of it.	[L1][CO6]	**[12M]**
2	a) What is meant by propped & unpropped construction in composite section?	[L1][CO6]	**[6M]**
	b) Explain about various types of composite construction	[L2][CO6]	**[6M]**
3	A pre-cast pre-tensioned beam of rectangular section has a breadth of 100 mm and depth of 200 mm. The beam with an effective span of 5 m is prestressed by tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150 kN. The loss of prestress may be assumed to be 15%. The beam is incorporated in a composite T-beam by casting a top flange of breadth 400 mm and thickness 40 mm. If the composite beam supports a live load of 8 kN/m^2, calculate the resultant stresses developed in the pre-cast and *in*-situ cast concrete assuming the pre-tensioned beam as (a) unpropped and (b) propped during the casting of slab. Take same modulus of elasticity for concrete in pre-cast beam and *in*-situ slab.	[L4][CO6]	**[12M]**
4	A pre-cast pre-tensioned beam of rectangular section has a breadth of 150 mm and depth of 250 mm. The beam with an effective span of 5 m is prestressed by tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 200 kN. The loss of prestress may be assumed to be 15%. The beam is incorporated in a composite T-beam by casting a top flange of breadth 450 mm and thickness 45 mm. If the composite beam supports a live load of 10 kN/m^2, calculate the resultant stresses developed in the pre-cast and *in*-situ cast concrete assuming the pre-tensioned beam as unpropped during the casting of slab. Take E_c(prestressed beam) = 35 kN/mm^2 and E_c(*in*-situ slab) = 28 kN/mm^2.	[L4][CO6]	**[12M]**
5	A rectangular pre-tensioned concrete beam has a breadth of 100 mm and depth of 230 mm, and the prestress after all losses have occurred is 12 N/mm^2 at the soffit and zero at the top. The beam is incorporated in a composite T-beam by casting a top flange of breadth 300 mm and depth 50 mm. Calculate the maximum uniformly distributed live load that can be supported on a simply supported span of 4.5 m, without any tensile stresses occurring, if a) the slab is externally supported while casting and b) the pre-tensioned beam supports the weight of the slab while casting.	[L4][CO6]	**[12M]**
6	A composite T-beam is made up of a pre-tensioned rib 100 mm wide and 200 mm deep, and a cast *in*-situ slab 400 mm wide and 40 mm thick having a modulus of elasticity of 28 kN/mm^2. If the differential shrinkage is 100 x 10^{-6} units, determine the shrinkage stresses developed in the pre-cast and cast *in*-situ units	[L4][CO6]	**[12M]**

7	A composite tee beam is made up of a pre-tensioned rib 300 mm thick and 1000 mm deep and a cast *in*-situ slab of 200 mm thickness and 1500 mm width. The modulus of elasticity of cast *in*-situ slab is 28 kN/mm^2. If the differential shrinkage is 0.0001 units, estimate the shrinkage stresses developed in precast and cast *in*-situ units.	[L4][CO6]	**[12M]**
8	A composite T-girder of span 5m is made up of a pre-tensioned rib, 100mm wide by 200mm deep, with an *in*-situ cast slab, 400mm wide and 40mm thick. The rib is prestressed by a straight cable having an eccentricity of 33.33mm and carrying an initial force of 150 kN. The loss of prestress may be assumed to be 15 percent. Check the composite T-beam for the limit state of deflection if it supports an imposed load of 3.2 kN/m for (a) unpropped construction and (b) propped construction. Assume a modulus of elasticity of 35 kN/mm^2 for both precast and *in*-situ cast elements.	[L3][CO6]	**[12M]**
9	A composite T-girder of span 5 m is made up of a pre-tensioned rib, 150 mm wide by 250 mm deep, with an *in*-situ cast slab, 450mm wide and 45mm thick. The rib is prestressed by a straight cable having an eccentricity of 33.33mm and carrying an initial force of 150 kN. The loss of prestress may be assumed to be 15 percent. Check the composite T-beam for the limit state of deflection if it supports an imposed load of 3.2 kN/m for (a) unpropped construction and (b) propped construction. Assume a modulus of elasticity of concrete in pre-cast beam and *in*-situ cast slab are 35 kN/mm^2 and 28 kN/mm^2 respectively	[L3][CO6]	**[12M]**
10	Write in detail about the general design consideration of composite members.	[L1][CO6]	**[12M]**

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