ASSIGNMENT 1
ANALYSIS OF PRESTRESS AND BENDING STRESS
BFS 40303

Instruction : Answer all question

1. 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.
   (a) Calculate the resultant stress distribution for the central cross section of the beam. The density of concrete is 25 kN/m^3.
   (b) 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 bottom fiber of the central section of the beam.

   [**Ans**: (a) *Stress at top = 14.2 N/mm^2 (compression), stress at the bottom = 5.8 N/mm^2 (compression);* (b) *Prestressing force = 170 kNJ.]*

2. A prestressed concrete beam supports a live load of 4 kN/m over a simply supported span of 8 m. The beam has an I-section with an overall depth of 400 mm. width of the flange is 200mm. The beam is to be prestressed by an effective presstressing force of 235 kN at a suitable eccentricity such that the resultant stress at the soffit of the beam at the central of the span is zero.
   (a) Find the eccentricity required for the force.
   (b) If the tendon is concentric, what should be the magnitude of the prestressing force for the resultant stress to be zero at the bottom fiber of the central span section.

   [**Ans**: (a) *e = 84 m*; (b) *450 kNJ*]

3. A prestressed concrete beam, 200 mm wide and 300 mm deep, is used over an effective span of 6 m to support an imposed load of 4 kN/m. The density of concrete is 24 kN/m^3. At the quarter-span section of the beam, find the magnitude of:
   (a) The concentric prestressing force necessary for zero fiber-stress at the soffit when the beam is fully loaded; and
   (b) The eccentric prestressing force located 100 mm from the bottom of the beam which would nullify the bottom fiber stress due to loading.

   [**Ans**: (a) *367.2* kN: (b) *183.6 kN*]

4. A concrete beam of symmetrical I-section spanning 8 m has flange width and thickness of 200 and 60 mm respectively. The overall depth of the beam is 400 mm. The thickness of the web is 80 mm. The beam is prestressed by a parabolic cable

with an eccentricity of 15 mm at the centre and zero at the supports with an effective force of 100 kN. The live load on the beam is 2kN/m. Draw the stress distribution diagram at the central section for:

(a) Prestress + self-weight (density of concrete = 24 kN/m^3); and

(b) Prestress + self-weight + live load.

[**Ans**: *(a) 0.7 N/mm^2 at top and 3.6 N/mm^2 at bottom (compression); (b) 7.4 N/mm^2 (compression) at top and -0.2 N/mm^2 (tension at bottom)]*

5. A concrete beam with a double overhang has the middle-span equal to 10 m and the equal overhang on either side is 2.5 m. Determine the profile of the prestressing cable with an effective force of 250 kN which can balance a uniformly distributed load of 8 kN/m on the beam, which includes the self-weight of the beam. Sketch the cable profile marking the eccentricity of cable at the support and mid span.

   [**Ans**: *e (support) = 100 mm; e (centre of span) = 300 mmJ*]

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ASSIGNMENT 2
LOSSES OF PRESTRESS
BFS 40303

Instruction : Answer all question

1. A pre-tensioned beam of rectangular cross-section, 150 mm wide and 300 mm deep, is prestressed by 8, 7 mm wires located 100 mm from the soffit of the beam. If the wire are initially tensioned to a stress of 1100 N/mm^2, calculate their stress at transfer and the effective stress after all losses, given the following data:

	Up to time of transfer	Total
Relaxation of steel	35 N/mm^2	70 N/mm^2
Shrinkage of concrete	100×10^{-6}	300×10^{-6}
Creep coefficient	-	1.6
E_s = 210 kN/mm^2	E_c = 31.5 kN/mm^2	

[**Ans**: *977.5 N/mm^2, 793.6 N/mm^2*]

2. A prestressed concrete pile of cross-section, 250 mm by 250 mm, contains 60 pre-tensioned wires, each of 2 mm diameter, distributed uniformly over the section. The wires are initially tensioned on the prestressing bed with a total force of 300 kN. If E_s = 210 kN/mm^2 and E_c = 32 kN/mm^2, calculate the respective stresses in steel and concrete immediately after the transfer of prestress, assuming that up to this point the only loss of stress is that due to elastic shortening. If the concrete undergoes a further shortening due to shrinkage of 200×10^{-6} per unit length, while there is a relaxation of 5 per cent of steel stress due to creep of steel, find the greatest tensile stress which can occur in a pile 20 m long when lifted at two points 4 m from each end. Assume creep coefficient as 1.6.

[**Ans**: *1389.3 N/mm^2, 4.7 N/mm^2, -0.42 N/mm^2*]

3. A post-tensioned cable of a 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 15 at each end with an area of 600 mm^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 = 0.0015/m
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.

[**Ans**: *526.6 kN; 12.3 percent*]

4. A post-tensioned concrete beam with a cable of 24 parallel wires (total area = 800 mm^2) is tensioned with 2 wires at a time. The cable with zero eccentricity at the ends

and 150 mm at the centre is on a circular curve. The span of the beam is 10 m. The cross-section is 200 mm wide and 450 mm deep. The wires are to be stressed from one end to a value of f_1 to overcome froctional loss and then released to a value of f_2 so that immediately after anchoring, an initial prestress of 840 N/mm^2 would be obtained. Compute f_1 amd f_2 and the final design stress in steel after all losses given the following data:

Coefficient of friction for curvature effect = 0.6
Friction coefficient for "wave" effect = 0.003/m
Deformation and slip of anchorage = 1.25 mm
E_s = 210 kN/mm^2 E_c = 28 kN/mm^2
Shrinkage of concrete = 0.0002
Relaxation of steel stress = 3 per cent of the initial stress

[**Ans**: *f_1 = 954 N/mm^2; f_2 =866.2 N/mm^2; 668.4 N/mm^2*]

5. 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 form the soffit. Estimate the final percentage loss of stress due to elastic deformation, creep, shrinkage and relaxation using IS: 1343-80 code and the following data:

   Relaxation of steel stress = 90 N/mm^2
   E_s = 210 kN/mm^2 E_c = 35 kN/mm^2
   Creep coefficient (ϕ) = 1.6
   Residual shrinkage strain = 3 x 10^{-4}

   [**Ans**: *22%*]

ASSIGNMENT 3
ULTIMATE LIMIT STATE DESIGN /ANCHORAGE ZONE STRESS
BFS 40303

Instruction : Answer all question

1. The end block of prestressed concrete beam, rectangular in section, is 120 mm wide and 300 mm deep. The prestressing force 250 kN is transmitted to concrete by a distribution plate, 120 mm wide and 75 mm deep, concentrically located at the ends. Calculate the position and magnitude of the maximum tensile stress on horizontal section through the centre of the end block using the methods of (a) Magnel (b) Guyon and (c) Rowe. Design the reinforcement for the end block for the maximum transverse tension. Yield stress in steel = 260 N/mm^2.

   [ANS: (a) 3.3N/mm^2 (150 mm); (b) 2.415N/mm^2 (99 mm); 8N/mm^2 (30 mm);A_s= 252mm^2]

2. A prestressing force of 250 kN is transmitted through a distribution plate 120 mm wide and 120 mm deep, the centre of which is located at 100 mm from the bottom of an end block having a section 120 mm wide and 300 mm deep. Evaluate the position and magnitude of the maximum tensile stress on a horizontal section through the centre of the distribution plate using the methods of (a) Magnel (b) Guyon and (c) Rowe. Find the area of steel necessary to resist the largest tensile force resulting from any of their methods. Yield stress in steel = 250 N/mm^2.
   [ANS: (a) 1.72N/mm^2 (150 mm); (b) 1.975N/mm^2 (88 mm); 5.04N/mm^2 (50 mm); A_s= 265mm^2]

3. The end block of a prestressed concrete beam, 200 mm wide and 400 mm deep, has two anchor plates, 200 x 50 mm deep, at 80 mm from the top and 200 x 80 mm deep located 100 mm from the bottom of the beam, transmitting forces of 250 and 300 kN respectively.
   a. Find the position and magnitude of the maximum tensile stress on a horizontal section passing through the centre of the beam using Guyon's method,
   b. Evaluate the maximum tensile stress on section passing through the larger and smaller prestressing forces using Guyon's and Rowe's method.

   [ANS: (a) 5.515 N/mm^2; (b) 2.09N/mm^2 section through larger force 4.9 N/mm^2]

4. The end block pf a prestressed beam, 250 mm wide 500 mmm deep in section, is prestressed by two cables carrying forces of 450 kN each. One pf the cable is parabolic, located 125 mm below the centre line at the centre of span (10 m) and anchored at a point 125 mm above the centre line at the ends. The second cable is straight and located 100 mm from the bottom of the beam. The distribution plates for the cables are 100 mm deep nd 250 mm wide. Calculate the maximum tensile stress along the axis of the beam using Guyon's method. Also evaluate the maximum tensile stress on horizontal sections passing through the centre an anchor plates using Guyon's method and Rowe's method.

5. A Freyssinet anchorage (125mm diameter), carrying 12 wires of 7 mm diameter stressed to 950 N/mm^2, is embedded concentrically in web of an I-section beat at the ends. The thickness of the web is 225 mm. Evaluate the maximum tensile stress and the bursting tensile force in the end block using Rowe's method. Design the reinforcement for the end block.
   [ANS: 5 N/mm^2; 125 kN ;550 mm^2]

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ASSIGNMENT 4
PRESTRESS DESIGN CONCRETE SECTION
BFS 40303

Instruction : Answer all question

1. A prestressed concrete beam of rectangular section, 90 mm wide and 180 mm deep, is to be designed to support two imposed loads of 3.5kN, each located at one-third points over a span of 3 m. If there is to be no tensile stress in the concrete at transfer and service loads, calculate the minimum prestressing force and the corresponding eccentricity. D_c=24 kN/m^3. Loss ratio= 0.8.
   [Answer: P= 74.5 kN: *e*=35.6 mm]

2. A prestressed concrete T-beam is to be designed to support an imposed load of 4.4kN/m over an effective span of 5 m. The T-beam is made up of a flange 400 mm wide and 40 mm thick. The rib is 100 mm wide and 200 mm deep. The stress in the concrete must not exceed 15 N/mm^2 in compression and zero in tension at any stage. Check for the adequacy of the section provided, and calculate the minimum prestressing force necessary and the corresponding eccentricity. Assume 20% loss of prestress.
   [Answer: P= 181 kN: *e*=78 mm]

3. A post-tensioned beam of span 15 m and overall depth 900 mm has uniform symmetrical cross-section of area 2 x 10^5 mm^2 and the second moment of area of 212 x 10^8 mm^4 units. The prestress is provided by a cable tensioned to a force of 1450 kN at transfer. If the beam is to support a uniformly distributed live load of 21kN/m and the minimum load is that due to the self-weight of the beam, calculate the vertical limits within which the cable must lie along the beam length. The permissible compressive stresses at transfer and working load are 14 and 16.8 N/mm^2 respectively. The tensile stresses at transfer working load ate zero and 1.75 N/mm^2 respectively. D_c=24 kN//m^3. Loss of prestress = 20%.
   [Answer: at midspan: e_a= 312 mm; e_b =249 mm; At support: e_a =219 mm; e_b =376 mm]

4. A prestressed I-section of minimum overall depth 300 mm is required to have an ultimate flexural strength of 86kN m. Find:

   (a) Suitable minimum dimensions of the top flange

   (b) The total number of 5 mm wires required in the bottom flange.

   The cube strength of concrete is 60 N/mm^2 and the tensile strength of steel is 1600 N/mm^2.

   [Answer: (a) 160 mm; (b) 13 numbers]

5. Design the prestressing force required for the tie member of reinforced concrete truss. The service-load tension in the tie member is 360kN and the thickness of the member is fixed as 150 mm. The permissible compressive stress in concrete at transfer is 15 N/mm^2 and tension is not permitted under service loads. The loss ratio is 0.8. High-tensile wire of 7 mm diameter, tensioned to a stress of 1000 N/mm^2 and having an f_{pu}= 1500 N/mm^2 are available for use. The tensile strength if concrete is 2.5 N/mm^2. A load factor of 1.7 at the limit state of collapse and 1.2 against cracking is to be provided in the design.

   [Answer: Section150 mm by 200 mm; Prestressing force = 450 kN, Number of 7 mm wires= 12]