Birla Institute of Technology & Science, Pilani, Pilani Campus

Midsemester Examination: 2023 – 2024

Subject: Prestressed Concrete Structure (CE G614)

Total marks: 50 (Closed book) **Time: 90 minutes**

Date: 14/10/2023

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Instructions

- *Answer all the questions.*
- *Use of the hard copies of IS: 1343 (2012) and IS: 456 (2000) are permitted.*
- *Assume any missing data suitably.*

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1) A prestressed concrete beam of size 200 mm × 300 mm is 10 m long. It is prestressed with wires of a total cross-sectional area 250 mm^2. The wires are placed in a parabolic profile with an eccentricity of zero at the supports and 100 mm below the CGC at mid-span. For the post-tensioned beam, a duct of diameter 20 mm is carrying these wires. The initial prestress in the wires is 1200 N/mm^2. Calculate the total loss in the prestressing wires at the mid-span of the beam after 5 years if the beam is post-tensioned. **(18 Marks)**

(**Data:** Grade of concrete = M40, Modulus of elasticity of prestressing wire (E_p) = 2 × 10^5 MPa, concrete is exposed on three sides to the environment, relative humidity (RH) = 50%, age of concrete at transfer of prestressing force (both pretensioned and post-tensioned) = 28 days, slip at anchorage = 2 mm, coefficient of friction between cable duct and concrete (μ) = 0.35, friction coefficient for wobble effect (k) = 0.0025/m, loss due to relaxation of prestressing wires = 5%)

2) A post-tensioned beam of size 250 mm × 500 mm is 10 m long. It is subjected to an imposed load of 10 kN/m. The effective prestressing force in the cable after all the losses is 650 kN. The cable is parabolic with zero eccentricity at the supports and maximum eccentricity of 150 mm at the mid-span. Calculate the principal stresses at a depth of 300 mm from the top fibre of the quarter span. What will be the magnitude of principal stresses at the same location of the beam in the absence of prestress? **(15 Marks)**

(**Data:** Density of concrete = 24 kN/m^3, Principal stresses = $\sigma_{1,2} = \frac{\sigma_x+\sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2 + \tau_{xy}^2}$, First moment of area ($Q$) = $\frac{b}{2}\left(\frac{h^2}{4} - y^2\right)$; where b = width of the beam, h = depth of the beam, and y = distance of the intended fibre location from the neutral axis)

3) A pretensioned concrete beam of size 100 mm × 300 mm is simply supported over a span of 6 m. The prestressing tendon is located at a constant eccentricity of 50 mm. The prestress in the tendon after the immediate losses is 1000 N/mm^2. The cross-sectional area of the tendon is 100 mm^2. Find the percentage increase in stress in the tendon when the beam supports a live load of 4 kN/m and its self-weight. **(8 Marks)**

(**Data:** Density of concrete = 24 kN/m^3, Modulus of elasticity of tendon = 2 × 10^5 MPa)

4) Answer the following questions. **(3 × 3 = 9 Marks)**

a) Define kern distance. How the limit kern (boundary of upper kern and bottom kern) of a simply supported prestressed beam will vary along its length for parabolic tendon and straight tendon profiles?

b) "Elastic strain immediately after loading is equal to elastic recovery when the load is removed after 5 years". Is it true or false? Justify your claim.

c) What is the maximum allowable stress in prestressing steel as per IS: 1343 (2012)? Why is it necessary to be followed?

******All the Best******