Birla Institute of Technology & Science, Pilani, Pilani Campus

Comprehensive Examination: 2023 – 2024

Subject: Prestressed Concrete Structure (CE G614)

Total marks: 75 (Open notebook) **Time: 3 Hours**

Date: 20/12/2023

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Instructions

- *Answer all the questions.*
- *Use of the hard copy of IS: 1343 (2012), and own handwritten class notes are permitted.*
- *Assume any missing data suitably.*

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1) A simply supported rectangular prestressed concrete beam of size 150 mm × 300 mm is prestressed by three cables each carrying an effective prestress of 200 kN. The span of the beam is 12 m. The first cable is parabolic with an eccentricity of 50 mm 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 50 mm at the centre of the span and zero eccentricity at the supports. The third cable is straight with an eccentricity of 50 mm below the centroidal axis. The beam supports a live load of 6 kN/m and E_c = 38 kN/mm^2. Estimate the final deflection of the beam after one year if the loss ratio for each cable and creep coefficient are 0.8 and 1.6, respectively. **(14 Marks)**

2) A simply supported rectangular prestressed concrete beam of size 300 mm × 600 mm is subjected to a live load of 10 kN/m. The effective span of the beam is 15 m. The grade of concrete used for the beam is M45. The beam has been prestressed using five post-tensioning straight tendons of 12.5 mm diameter at a constant eccentricity of 150 mm below the CGC. The effective prestressing force applied is 600 kN. Evaluate the shear strength of the sections present at a distance of 100 mm from the supports. Comment on the adequacy of these critical sections under transverse shear force.

(12 Marks)

3) A post-tensioned bridge girder of hollow box-section with an overall outer dimension of 1200 mm wide and 1800 mm deep. The thickness of the wall is 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 while the effective span of the girder is 24 m. The characteristic strength of concrete is 40 MPa and the characteristic strength of steel tendon is 1600 N/mm^2. Estimate the ultimate flexural strength of the section using IS: 1343 (2012) method. **(12 Marks)**

4) Design an efficient and economical simply supported Type – 3 pretensioned beam using the minimum required section modulus method and Magnel's graphical method. Use M40 grade of concrete for the design. The effective span of the beam is 10 m, and it must be designed to carry a total moment (moment due to live load, dead load, and self-weight) of 300 kNm. Assume the moment due to the self-weight of the beam is 20% of the total moment. The allowable compressive stresses at the transfer and service stages are 14 N/mm^2 and 12 N/mm^2, respectively. The allowable tensile stress at the transfer stage is 2 N/mm^2 and the allowable limiting crack width is 0.2 mm at the service stage. The supplier provides 5 mm diameter high-tensile wires of characteristic strength 1600 N/mm^2. Initially, the wires can be stressed to 1200 N/mm^2 and the loss in prestress due to short-term and long-term effects is 25%. **(25 Marks)**

5) Answer the following questions. **(4 × 3 = 12 Marks)**

a) Write a short note on Hoyer effect. Draw a neat diagram to show the stress distribution in the end block region of a post-tension member.

b) Discuss different types of cracks in a prestressed concrete beam through a neat diagram. Which type of crack leads to diagonal compression failure and why it happens?

c) Which type of sections will be efficient as well as economical in designing a prestressed girder if (i) the moment due to self-weight is less than 30% of the total moment, and (ii) the moment due to self-weight is greater than 30% of the total moment.

d) What is limiting zone for the prestressing force and how can it be determined?

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