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B. Sc. Engg. (CEE)/6th Semester — 04 May 2023 (Group-B)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination — **Summer Semester: 2021–2022**
Course Number: CEE 4613 — **Full Marks: 150**
Course Title: Design of Pre-Stressed Concrete Structures — **Time: 3.0 Hours**

There are **6 (SIX)** questions. Answer **all** of them. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Assume reasonable value for any missing data.

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1. The 40 ft simply supported T beam shown in **Fig. 1** is prestressed with a force of 314 kips, using a parabolic tendon with an eccentricity of 3 in. above the concrete centroid at the supports and 7.9 in. below the centroid at midspan. After time-dependent losses have occurred, this prestress is reduced to 267 kips. In addition to its own weight of 330 lb/ft, the girder must carry a short-term superimposed live load of 900 lb/ft. Estimate the deflection at all critical stages of loading. The creep coefficient C_c= 2.0, E_c= 4×10^{6} psi, and modulus of rupture=530 psi. CO2, PO2: [25]

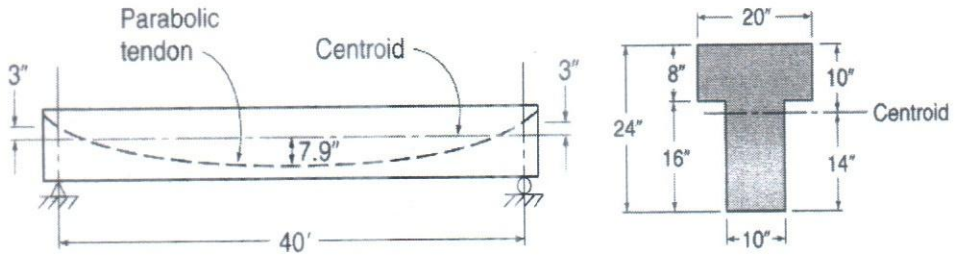

Fig. 1 for Question 1

2. Determine the ultimate moment capacity of the rectangular section shown in **Fig. 2**. It contains mild steel rebars in addition to prestressing steel. Use $f_c' = 40$ MPa, $E_s = E_p = 2\times10^5$ MPa, $E_c = 3\times10^4$ MPa, $f_{pu} = 1860$ MPa, $f_y = 415$ MPa, $\varepsilon_{cu} = 0.003$ and effective prestress, $f_{se} = 1100$ MPa. Follow any method of calculation. CO2, PO2: [25]

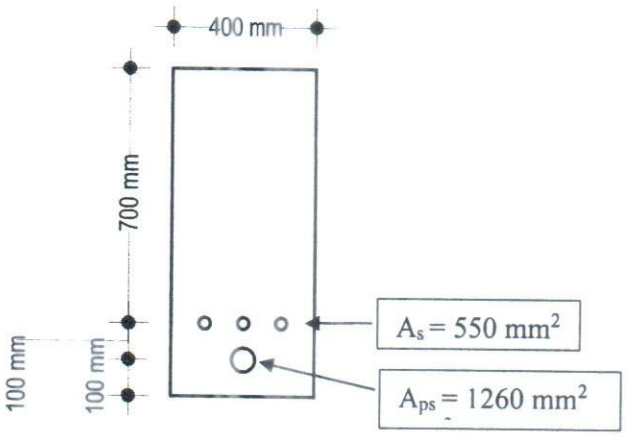

Fig. 2 for Question 2

3. A pretensioned prestressed beam has a rectangular cross section of 6 in. width and 20 in. total depth. It is built using normal-density concrete with a specified strength $f_c' = 4000$ psi and a strength at transfer of $f_{ci}' = 3000$ psi. Allowable stress limits are as follows: CO2, PO2: [25]

At transfer: Allowable tensile stress 165 psi

Allowable compressive stress −1800 psi,

At Service: Allowable tensile stress 475 psi

Allowable compressive stress −1800 psi,

If the effective prestress force is 80% of the initial prestress force, then for both conditions (transfer and service) find the prestress force **"P"** and eccentricity **"e"** to maximize the moment that can be carried without exceeding the stress limits. What uniformly distributed load can be carried on a 30 ft simple span? What tendon profile would you recommend?

4. Design a symmetrical I-shape section with h = 1000 mm for a simply supported beam (**Fig. 3**) carrying the following service loads: (a) Self weight, W_G, Super imposed Dead load, W_D = 12 kN/m and Live Load, W_L = 5 kN/m. Assume normal weight concrete with f_c' = 42 MPa, f_{ci}' = 32 MPa, and 12.7 mm diameter 1860 MPa Grade strands; A_{ps} = 100 mm^2/strand, f_{pu} = 1860 MPa and transfer stress of $0.7f_{pu}$. Loss = 20%. Use two stage prestressing if a lighter section results and consider no tension to be allowed in concrete. Second stage post-tensioned strands to be grouted for perfect bond. CO3, PO3: [25]

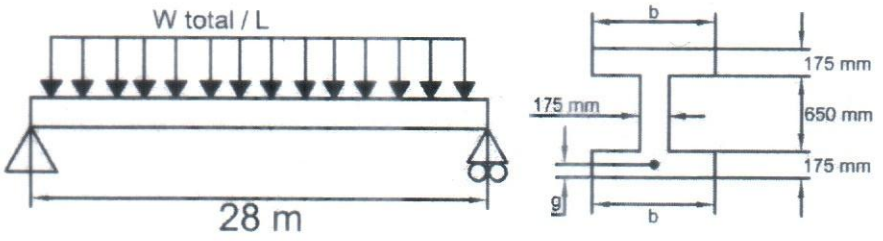

Fig. 3 for Question 4

5. (a) Make a preliminary design for section of a prestressed concrete beam to resist total moment of 700 kN-m. Assume effective prestress for steel to be 940 MPa and allowable concrete stress of -13 MPa. M_G = 150 kN-m. Make a trial depth of $42\sqrt{M_T}$ (mm) where M_T in kN-m. CO3, PO3: [10]

   (b) Prepare the final design for the preliminary section obtained from the above solution allowing and considering tension in concrete. Given, f_b' = 2.1 MPa, f_t' = = 2.4 MPa, f_o = 1080 MPa. CO3, PO3: [15]

6. The unsymmetrical I beam shown in **Fig. 4** carries an effective prestress force of 288 kips and supports a superimposed dead load of 345 lb/ft and service live load of 900 lb/ft, in addition to its own weight of 255 lb/ft, on a 50 ft simple span. At the maximum moment section, the effective depth to the main steel is 24.5 in. (eccentricity 11.4 in.). The strands are deflected upward starting 15 ft from the support, and eccentricity is reduced linearly to zero at the support. If concrete with f_c' = 5000 psi and stirrups with f_y = 60,000 psi are used, and if CO3, PO3: [25]

the pre-stressed strands have strength f_{pu} = 270 ksi, what is the required stirrup spacing at a point 10 ft from the support?

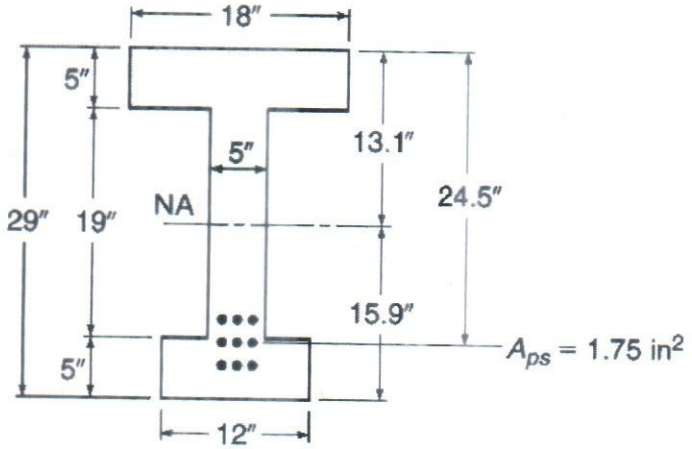

Fig. 4 for Question 6