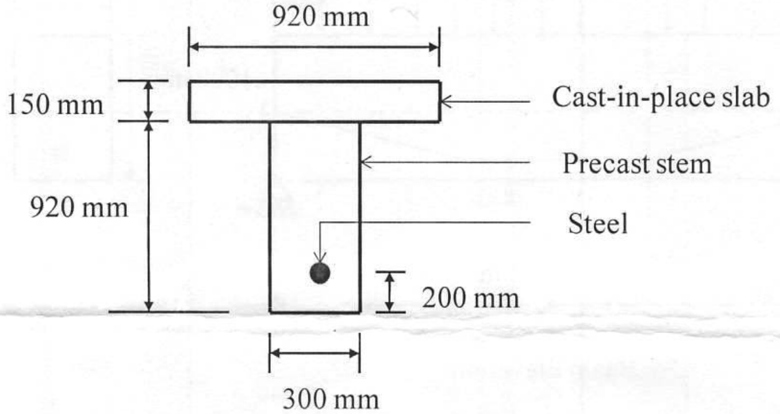
University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2012
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering V — Course Code: CE 415
Time: 2 Hours — Full Marks: 50

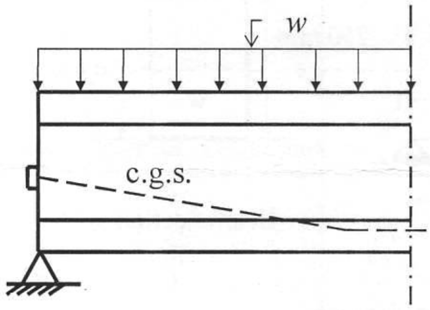
[There are seven questions. Answer any **Five**. ($5\times10 = 50$)]
[Symbols carry their conventional meanings.]

1. (a) The midspan section of a composite beam is shown in the following figure. The precast stem is posttensioned with an initial prestressing force of 2450 kN. The effective prestress after losses is 2150 kN. Moment due to the weight of precast section is 270 kN-m at midspan. The top slab is to be cast-in-place above the stem producing a moment of 135 kN-m at midspan. The composite section is to carry a maximum live load moment of 750 kN-m. Compute stresses in the section at various stages. (07)

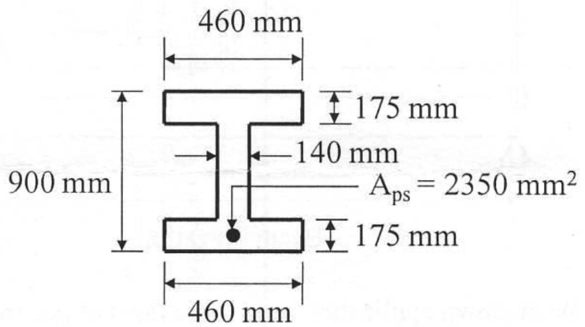


(b) Explain, with a neat sketch, the variation of steel stress with load in a prestressed concrete beam. (03)

2. (a) An I-shaped beam is prestressed with an effective prestress of 1100 MPa as shown in the following figure. The cgs of the strands which supply the prestress is 115 mm above the bottom of the beam. Material properties are: f_{pu} = 1860 MPa, f'_c = 48 MPa. Find the ultimate resisting moment of the section for design following the ACI Code. (07)



Beam Elevation



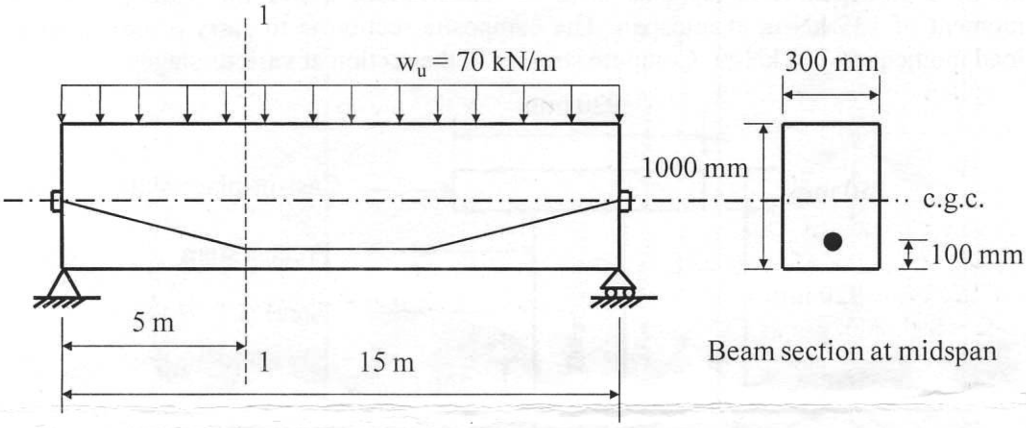
Beam Section

(b) Explain stress distribution in concrete according to elastic theory. (03)

3. (a) Make a preliminary design for section of a prestressed concrete beam to resist a total moment of 435 kN-m and girder moment of 55 kN-m. The overall depth of the beam is 920 mm. Assume thickness of web and flange as 100 mm. The effective prestress for steel is 860 MPa, and allowable stress for concrete under working load is -11 MPa. (05)

(b) For the preliminary section of (a) above, make a final design allowing no tension in concrete. Given: f_b = -12.5 MPa, f_o = 1035 Mpa. (05)

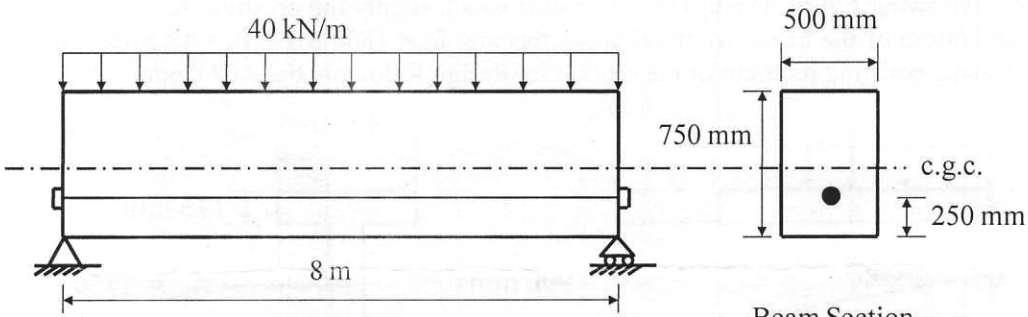
4. Check shear strength for the following beam at (a) a section h/2 distance apart from support and (b) at section 1-1. Given that this section is adequate for w_u = 70 kN/m, f'_c = 40 MPa. F_e = 1989 kN, A_{ps} = 1800 mm^2. Assume reasonable values for missing data, if any. (10)



Beam section at midspan

Beam Elevation

5. (a) A prestressed concrete rectangular beam 500 mm by 750 mm has a simple span of 8 m and is loaded by a uniform load of 40 kN/m **excluding self-weight** as shown in the following figure. The prestressing tendon is located as shown and produces an effective prestress of 1620 kN. Compute fiber stresses in the concrete at the mid-span section using the first concept. (07)



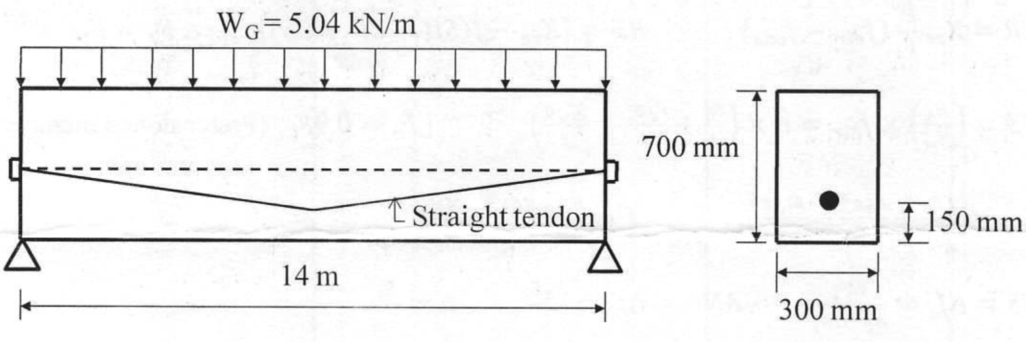
Beam Section

Beam Elevation

(b) Write down applications and limitations of prestressed concrete. (03)

6. (a) Write down the name of different types of loss that occur in a prestressed concrete beam. (05)

(b) A pretensioned concrete member 14.0 m long is eccentrically prestressed with 900 mm^2 of steel wires which are anchored to the bulkheads with a stress of 1000 MPa. Compute the loss of prestress at the mid span section due to the elastic shortening of concrete at the transfer of prestress. Assume n=7. (20)

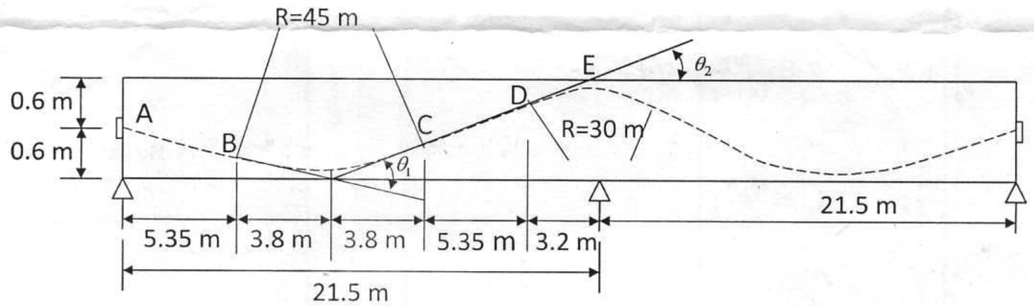


Beam Elevation

Mid Span Section

7. (a) Explain the difference between the behavior of a prestressed- and of a reinforced-concrete-beam section. (03)

(b) A prestressed concrete beam is continuous over two spans, as shown in the following figure, and its curved tendon is to be tensioned from both ends. Compute the percentage of loss due to friction, from one end to the center of the beam (A to E). The coefficient of friction between the cable and the duct is 0.4, and the average 'wobble' or length effect is 0.0026 per meter. Use exact method. (07)



Annexure - I: Formulas

- $CR = K_{cr}\frac{E_s}{E_c}(f_{cir} - f_{cds})$; $RE = [K_{re} - J(SH + CR + ES)]C$; $F_2 = F_1 e^{-\mu\alpha - KL}$
- $ES = \left(\frac{E_s}{E_{ci}}\right) \times f_{cir} = n \times \left(\frac{F_o}{A} + \frac{F_o e^2}{I} - \frac{M_G e}{I}\right)$ [$F_o = 0.9F_i$ (Pretensioned member)]
- $f_{cir} = \left(\frac{F_o}{A} + \frac{F_o e^2}{I} - \frac{M_G e}{I}\right)$; $f = \frac{F}{A} \pm \frac{Fey}{I} \pm \frac{My}{I}$; $w_b = \frac{8Fh}{L^2}$
- $ES = \Delta f_s = \frac{nF_i}{A_c + nA_s}$; $ANC = \Delta f_s = \frac{\Delta_a E_s}{L}$; $n = \frac{E_s}{E_{ci}}$
- $f_{ps} = f_{pu}\left(1 - 0.5\rho_p \frac{f_{pu}}{f_c'}\right)$;
- $\rho_p = \frac{A_{ps}}{bd}$; $w_p = \rho_p \frac{f_{ps}}{f_c'} \leq 0.3$;
- $T' = A_{ps} f_{ps}$; $C' = 0.85 f_c' ba$;
- $M_u = \emptyset A_{ps} f_{ps}\left(d - \frac{a}{2}\right)$; $A_{pf} = \frac{0.85 f_c'(b - b_w)h_f}{f_{ps}}$
- $M_u = \emptyset\left[A_{pw} f_{ps}\left(d - \frac{a}{2}\right) + 0.85 f_c'(b - b_w)h_f\left(d - \frac{h_f}{2}\right)\right]$;
- $e = \frac{M_G}{F_o} + k_b$; $F = \frac{M_T}{(e + k_t)}$;
- $A_c = \frac{Fh}{f_t c_b}$; $A_c = \frac{F_o h}{f_b c_t}$;
- $A_c = \frac{F_o}{f_b}\left(1 + \frac{e - \left(\frac{M_G}{F_o}\right)}{k_t}\right)$;
- $k_t = \frac{r^2}{c_b}$; $k_b = \frac{r^2}{c_t}$
- $V_{ci} = 0.05\sqrt{f_c'} b_w d + V_d + \frac{V_i M_{cr}}{M_{max}} \geq 0.14\sqrt{f_c'} b_w d$
- $M_{cr} = \left(\frac{I}{y_t}\right)\left(0.5\sqrt{f_c'} + f_{pe} - f_d\right)$
- $V_{cw} = \left(0.29\sqrt{f_c'} + 0.3 f_{pc}\right) b_w d + V_p$
- $\frac{M}{V} = \frac{lx - x^2}{l - 2x}$