

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2013
Program: B. Sc. Engineering (Civil)

Course Title: Structural Engineering V (Prestressed Concrete)
Time : 2 Hours

Course Code : CE 415
Full Marks : 100

(There are SIX Questions. Answer any FOUR Questions)

1. (a) A simply supported concrete beam of 12 m span is post tensioned with 820 mm² steel to a initial prestress of 1000 MPa. A concentrated load of 50 KN is applied at midspan immediately after prestressing. Compute the initial deflection at midspan due to prestress and beam's self weight. Cross section of the rectangular beam is of 300 mm width and 500 mm depth. c.g of cable is 150 mm from bottom at midspan and 300 mm from top at end of section. $E_c = 30000$ MPa. Also estimate the deflection after 3 months assuming creep factor of 2.0. Given that 18% Loss of prestress occur (16)
 (b) Draw three undesirable positions of cable profile(c.g.s zone limit). How the problem can be solved? (5)
 (c) Draw four layouts of tendons in simple prestressed concrete beam. (4)

2. A section of a simply supported composite beam of 20m span is shown in Figure 1. The precast stem is prestressed with an effective force of 1200 kN assuming a total loss as 20%. After this precast portion is erected in place, a top slab of 120 mm by 1000 mm wide is cast in place. After the slab concrete has hardened the composite section is to carry a uniformly distributed live load of 50 kN/m. Self weight of precast stem is 10kN/m. Moment at midspan due to top slab is 120 kN-m. Compute the stresses in the section at different stage of loading. Also draw the stress distribution at different stage of loading for the section. (18+7)

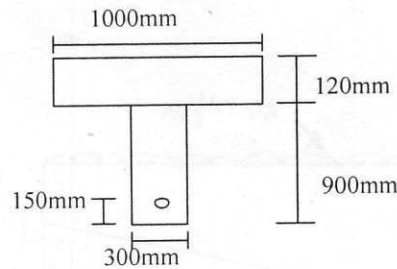


Figure 1

3. (a) Make a preliminary design for section of a prestressed concrete beam to resist a total moment of 480 kN-m including girder self weight moment of 70 kN-m. Assume a trial depth of $42\sqrt{M_T}$ in mm (where M_T is in kN-m). (7)
 Given: $f_{se} = 850$ MPa & $f'_c = 28$ MPa.
 (b) Make a final design for the preliminary section obtained from 3(a) for the following given data: (18)
 $f'_{ci} = 35$ MPa, $f'_c = 28$ MPa, $f_0 = 1050$ MPa and tension is allowed in the section.

4. (a) Determine the ultimate moment capacity of the section (Figure 2) of a prestressed concrete system. Use $f'_c = 38 \text{ MPa}$, $E_{\text{prestressing}} = 220000 \text{ MPa}$, $E_c = 30000 \text{ MPa}$, $f_{pu} = 1860 \text{ MPa}$, $f_y = 415 \text{ MPa}$ and effective prestress $f_{se} = 1000 \text{ MPa}$. $A_s = 1400 \text{ mm}^2$. (16)

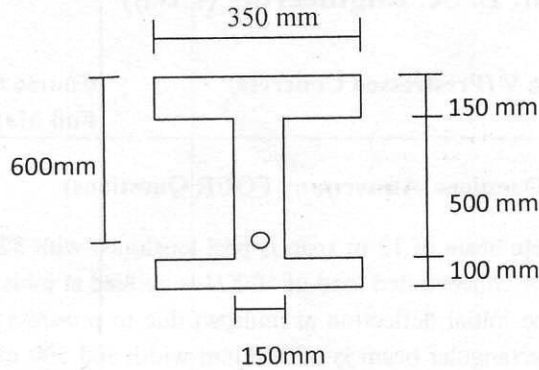


Figure 2

- (b) Write the factors that affect the transfer length of prestressing steel? (4)
 (c) Show the stress distribution in a prestressed concrete beam section for different location of compressive force 'C' with respect to kern points. (5)
5. (a) Why is the shear capacity of prestressed concrete beam higher than corresponding R.C beam? (5)
 (b) Check shear strength of the beam shown in Figure 3 at section 1-1 which is at 3 m from the left support. Use both equation (web shear crack and inclined shear crack) for shear strength evaluation. Effective prestress with 20% loss = 1300 kN. Use $f'_c = 40 \text{ MPa}$, $A_s = 920 \text{ mm}^2$. Self weight of beam is 6.5 kN/m. c.g of the T beam section is located at 354 mm below the top fiber. (20)

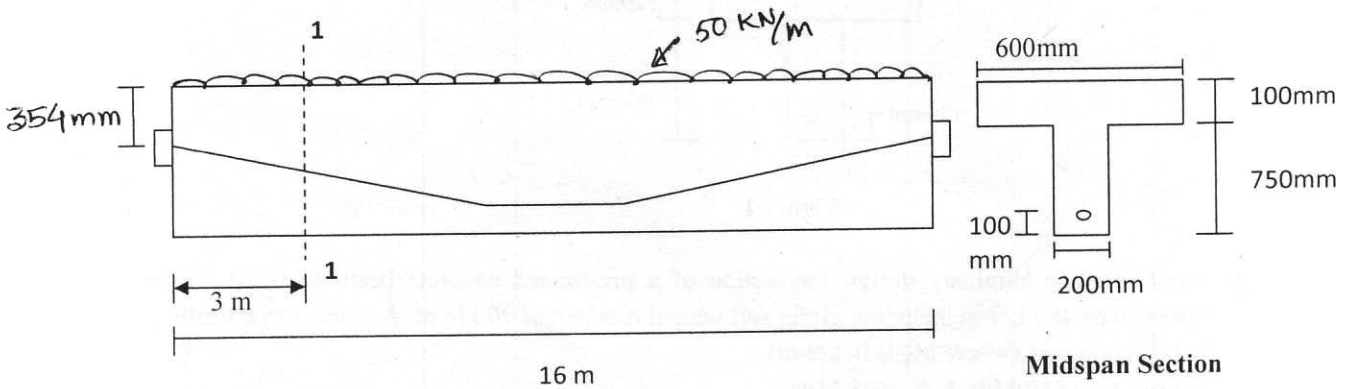


Figure 3

Formula:

$$f = -(F/A) \pm (Fey/I) \pm (My/I)$$

$$w_p = (\rho_p f_{ps}) / f'_c$$

$$f_{ps} = f_{pu} (1 - 0.5 \rho_p f_{pu} / f'_c)$$

$$\text{For rectangular beam, } M_u = \phi A_{ps} f_{ps} (d - a/2)$$

$$\text{For T beam, } M_u = \phi [A_{pw} f_{ps} (d - a/2) + 0.85 f'_c (b - b_w) h_f (d - h_f/2)]$$

$$A_{pf} = 0.85 f'_c (b - b_w) h_f / f_{ps}$$

Elastic design:

$$\text{For } M_G / M_T < 0.2;$$

$$F = M_L / 0.5h$$

$$A_c = F / 0.5f'_c$$

$$e_1 + e_2 = (M_G + f'_t A k_b) / F_0$$

$$F = (M_T - f'_b A k_t) / a$$

$$a = k_1 + e_1 + e_2$$

$$A_c = (F_0 h) / (f_b c_t - f'_t c_b)$$

$$A_c = (Fh) / (f_t c_b - f'_b c_t)$$

Shear Check:

$$\text{Shear stress, } v_{cw} = 0.29 \sqrt{f'_c} + 0.3 f_{pe} + V_p / b_w d$$

$$\text{Shear Stress, } v_{ci} = 0.05 \sqrt{f'_c} + [V_d + (V_i M_{cr} / M_{max}) / b_w d] > 0.14 \sqrt{f'_c}$$

$$M_{cr} = (I / y_t) (0.5 \sqrt{f'_c} + f_{pe} - f_d)$$

$$M_{max} / V_i = (Lx - x^2) / (L - 2x)$$

Bearing Plate :

$$\text{At service load : } f_{cp} = 0.6 f'_c \sqrt{(A'_b / A_b)} < f'_c$$

$$\text{At transfer load : } f_{cp} = 0.8 f'_{ci} \sqrt{[(A'_b / A_b) - 0.2]} < 1.25 f'_{ci}$$

$$\text{Moment of inertia of triangular section with respect to centroidal axis} = bh^3 / 36$$

6. (a) Determine the bearing plate area required for the tendons shown in figure 4. Follow the specifications of the post tensioning institute for allowable bearing stresses in concrete. Use $f_{ci} = 28$ MPa, $f_c = 35$ MPa, Maximum jacking force = 1700 kN, Force at service load = 1300 kN. Diameter of hole = 120 mm. (17)

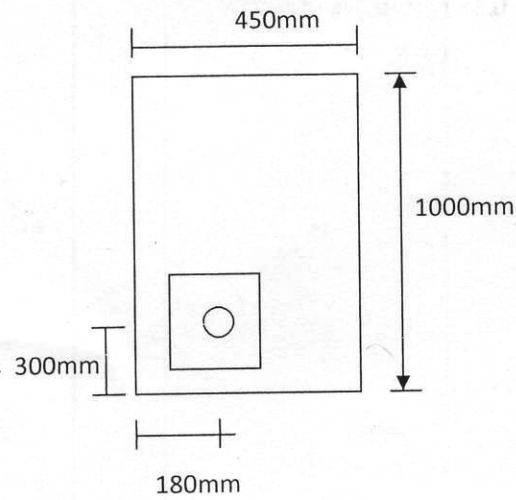


Figure 4

- (b) Determine k_b and k_t of the following section (Figure 5) (8)

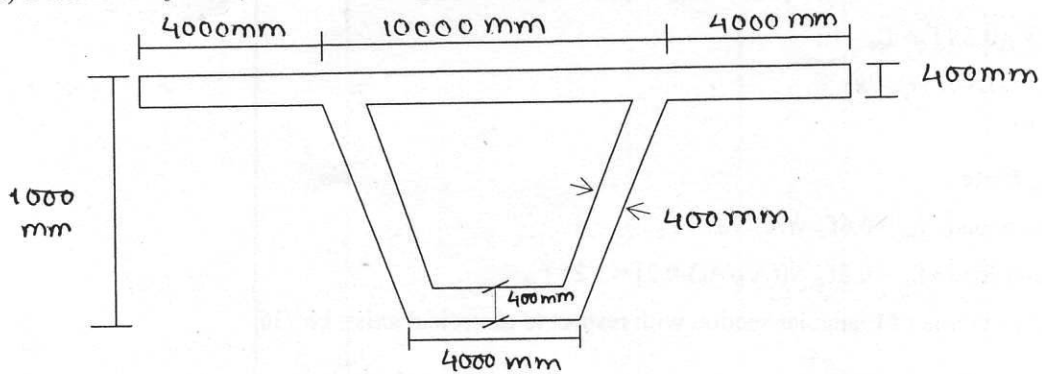


Figure 5