UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	PRESTRESSED CONCRETE DESIGN
COURSE CODE	:	BFS 4033 / BFS 40303
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Figure **Q1** shows a double-T section for a precast pre-tensioned floor unit. The unit was designed as the simply supported class 2 structure with the span of 8.0 m. The tendons consist of 4 groups 7-super wire strands of 12.9 mm diameter with relaxation class 2. The tendons are straight and located at 130 mm below the neutral axis of the section and stressed with an initial prestressing force of 540 kN. Given the following data:

Concrete:

28 days concrete strength	=	50 N/mm^2
Concrete strength at transfer (7 days)	=	36 N/mm^2
Cross section area (double-T)	=	134×10^3 mm^2
Moment of inertia	=	115×10^6 mm^4
Shrinkage	=	350×10^{-6}
Creep coefficient	=	1.8

Tendon:

Nominal area	=	100 mm^2
Young's Modulus	=	200 kN/mm^2
Relaxation factor	=	1.2
1000 hours relaxation value for 70% initial force	=	2.5
1000 hours relaxation value for 80% initial force	=	4.5

Determine the prestress losses.

(20 marks)

(b) If the tendons need to be tensioned before 7 days, what are the required design parameters and how can the parameters be achieved?

(5 marks)

Q2 Figure **Q2** shows the cross section of a class 1 post-tensioned concrete beam of 10 m span carries a total service load of 10 kN/m. The 28 days concrete strength is 40 N/mm^2 and the tendon will be transferred when the concrete achieved the minimum strength of 25 N/mm^2. The total short and long term losses are 12% and 20%, respectively.

(a) Determine the minimum dimension required for the beam.

(16 marks)

(b) Determine the range of the prestress force if the maximum eccentricity of the tendons at mid-span is 30 mm above the bottom soffit. Use basic inequalities given in the Appendix.

(9 marks)

Q3 A bonded prestressed concrete beam is of T section 400 mm by 1200 mm, as shown in Figure **Q3**. The tendon consists of 3300 mm^2 of standard strands with the characteristic strength of 1700 N/mm^2 and Young's modulus equal to 200 kN/mm^2 was stressed to an effective prestress of 910 N/mm^2. The strands are located 870 mm from the top face of the beam. The concrete characteristic strength is 60 N/mm^2 and its modulus of elasticity is 36 kN/mm^2.

(a) Calculate the ultimate moment of resistance of the beam section based on the first principles.

(17 marks)

(b) Due to the site error, the strands have not been tensioned (the effective tendon prestress is zero). Calculate the ultimate moment of resistance of the beam section.

(8 marks)

Q4 (a) Explain the distribution of stresses at the anchorage zone (D-region) for prestressed concrete structures with the aid of sketches.

(6 marks)

(b) The end of a post-tensioned beam shown in Figure **Q4(a)** containing two anchorages of 100 mm x 75 mm bearing plate is divided into two prisms. Each bearing is subjected to 800 kN bursting force. Design the reinforcement for the end block. The characteristics strength of steel is 460 N/mm^2.

(10 marks)

(c) The cross section of the composite bridge deck shown in Figure **Q4(b)** has a span of 24 m and the thickness of the deck slab is 180 mm. The steel reinforcement is grade 460 and the concrete is grade C35. Design the horizontal shear link. Assume deck slab is cast in-situ on top of the precast concrete beam.

(9 marks)

- END OF QUESTION-

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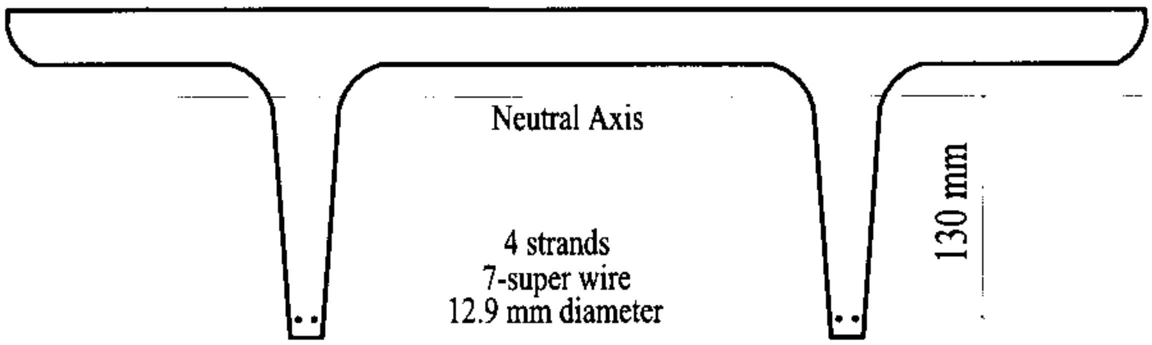

FIGURE Q1

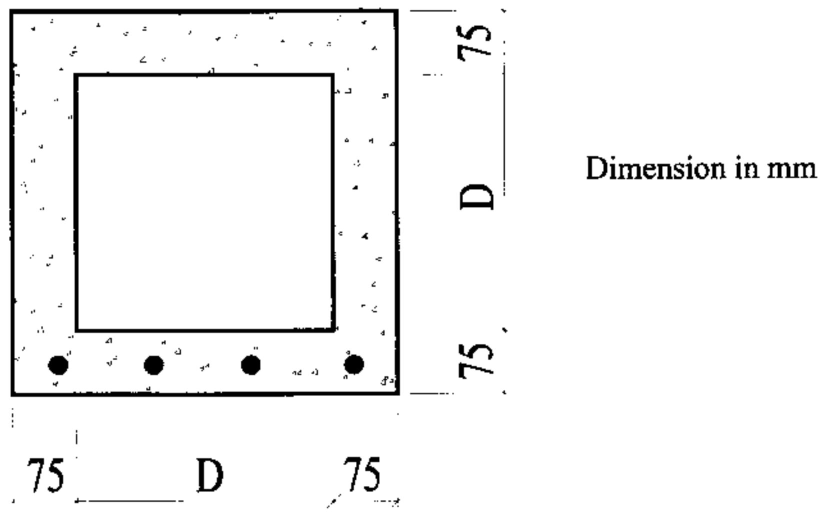

FIGURE Q2

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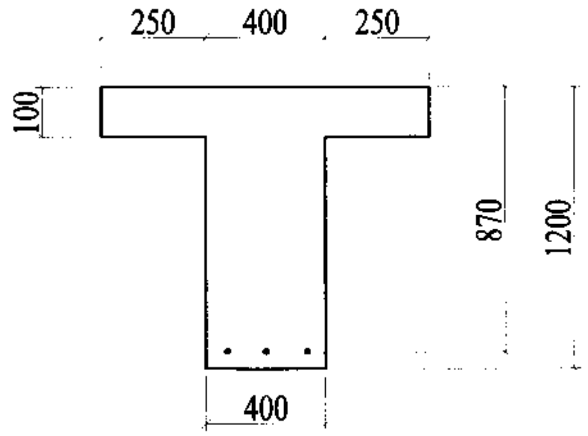

FIGURE Q3

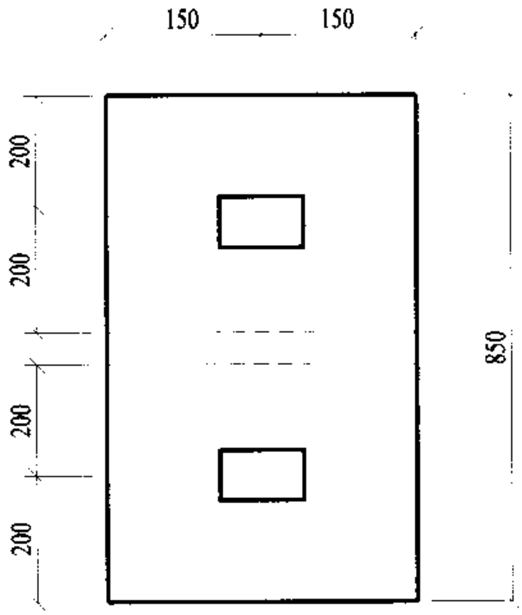

FIGURE Q4(a)

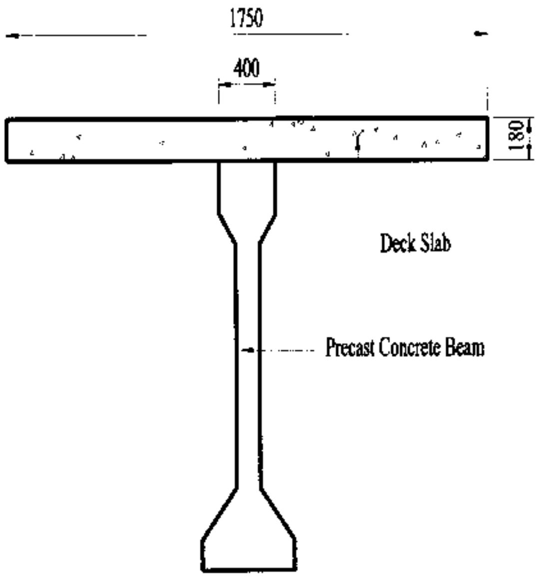

FIGURE Q4(b)

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APPENDIX

Basic Inequalities:

$$Z_t \geq \frac{\alpha M_s - \beta M_i}{\alpha f_{max} - \beta f'_{min}}$$

$$Z_b \geq \frac{\alpha M_s - \beta M_i}{\alpha f'_{max} - \beta f_{min}}$$

$$P_i \geq \frac{Z_t f'_{min} - M_i}{\alpha(\frac{Z_t}{A_c} - e)}$$

$$P_i \leq \frac{Z_b f'_{max} + M_i}{\alpha(\frac{Z_b}{A_c} + e)}$$

$$P_i \leq \frac{Z_t f_{max} - M_s}{\alpha(\frac{Z_t}{A_c} - e)}$$

$$P_i \geq \frac{Z_b f_{min} + M_s}{\alpha(\frac{Z_b}{A_c} + e)}$$

Strain Compatibility Analysis:

$$\varepsilon_{pb} = \varepsilon_{pe} + \varepsilon_{pa}$$

$$\varepsilon_{pe} = \frac{\beta P}{A_{ps} E_s}$$

$$\varepsilon_{pa} = \beta_1 \varepsilon_e + \beta_2 \varepsilon_u$$

Where;
β_1 and β_2 = bond coefficients
β_1 and β_2 = 1.0 for fully bonded tendon

$\varepsilon_e = \frac{1}{E_c}$ x stress in concrete at tendon level due to effective prestress.

$$\varepsilon_e = \frac{\beta}{E_c}\left[\frac{P}{A} + \frac{Pe^2}{I}\right]$$

$$x = \left[\frac{\beta_2 \varepsilon_{cu}}{\beta_2 \varepsilon_{cu} + \varepsilon_{pb} - \varepsilon_{pe} - \beta_1 \varepsilon_e}\right] d$$

For rectangular section and flange section with neutral axis in the flange;

$$f_{pb} = \frac{0.4 f_{cu} bd}{A_{ps}}\left[\frac{\beta_2 \varepsilon_{cu}}{\beta_2 \varepsilon_{cu} + \varepsilon_{pb} - \varepsilon_{pe} - \beta_1 \varepsilon_e}\right]$$

$$M_u = A_{ps} f_{pb}(d - 0.45x)$$