UTHM
Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## (ONLINE)
## SEMESTER II
## SESSION 2019/2020

| | | |
|---|---|---|
| COURSE NAME | : | PRESTRESSED CONCRETE DESIGN |
| COURSE CODE | : | BFS40303 |
| PROGRAMME CODE | : | BFF |
| EXAMINATION DATE | : | JULY 2020 |
| DURATION | : | 6 HOURS |
| INSTRUCTION | : | ANSWER **ALL** QUESTIONS |

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

**Q1** (a) Explain the need of high strength concrete and high tensile steel in pre stressed concrete construction.

(4 marks)

(b) Consider a simply supported rectangular beam carrying uniformly distributed load. Based on the basic theory of prestressing equation at transfer and service, answer the following:

(i) Compute the basic inequalities in conjunction with stress limit to their class member

(9 marks)

(ii) Identify **FOUR (4)** equations of prestressed force at yielded range for value P from prestressing force

(9 marks)

(c) A precast prestressed of Y section has the following properties:

| | | |
|---|---|---|
| Beam Depth, d | : | 700 mm |
| Area, A | : | 309202 $mm^2$ |
| $Y_b$ | : | 255 mm |
| I | : | 1.11x108 |
| $f_{ci}$ | : | 30MPa |
| $f_{cu}$ | : | 40MPa |
| $f_{pu}$ | : | 1800MPa |
| Tendon eccentricity | : | 200 mm |
| Span | : | 10 m |

Design the maximum value for initial prestressing force required to satisfy the allowable stresses at transfer.

(18 marks)

**Q2** (a) Differentiate between concentric and eccentric prestressing tendons in the context of their applications in construction.

(5 marks)

(b) Briefly explain why mild steel cannot be used for prestressing method.

(7 marks)

(c) A prestressed post-tensioned beam length 27.3m is stressed using 33 super strands of 7 wire diameter size 15.2 mm (Class 2 relaxation) with initial prestressing force of 6452 kN. The tendon profile is parabolic with 900 mm eccentricity at mid span and zero at support. The beam carries uniformly distributed permanent and imposed load of 19.9 kN/m and 21.1 kN/m respectively. Determine the short-term and long-

term prestress losses. Given the characteristic strength of concrete is 50 N/mm$^2$ and concrete strength after transfer is 40 N/mm$^2$

(11 marks)

(d) A prestressed concrete pile, 400 mm square, contains 60 pre-tension wires are initially tensioned on the prestressing bed with a total force of 400 kN Given the following data:

| | |
|---|---|
| $E_s$ | : 210 kN/mm$^2$ |
| $E_c$ | : 32 kN/mm$^2$ |
| Shortening due to creep | : 20 X $10^{-6}$ mm/mm per N/mm$^2$ of stress |
| Total Shrinkage | : 190 X $10^{-6}$/m |
| Relaxation Steel stress | : 3% |

Calculate the final stress in concrete and the percentage stress losses in steel

(7 marks)

**Q3** (a) Discuss with the aid of sketch the provision of prestressing losses stage.

(4 marks)

(b) A post-tensioned prestressed I- beam of 27m span as presented in **Figure 3(b)** is to be designed with an uniformly service load of 40 kN/m (excluding self-weight). The short-term and long-term losses are given as 10% and 20% respectively.

(i) Determine the eccentricity and appropriate prestressing force for prestress concrete beam

(8 marks)

(ii) Generate the results for case (i) by using Magnel's graphical method.

(15 marks)

(iii) Propose a suitable number of strands required for 7 wire super strands.

(3 marks)

**- END OF QUESTIONS -**

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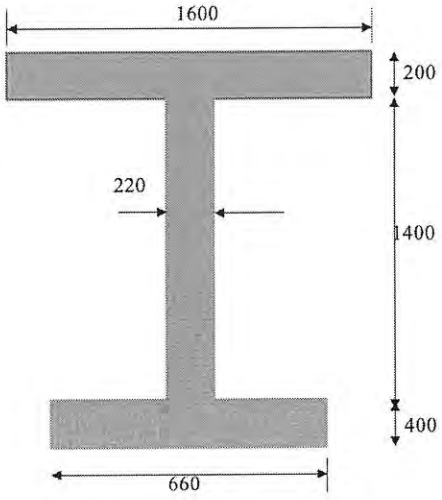


Unit in mm

**FIGURE Q3(a)**

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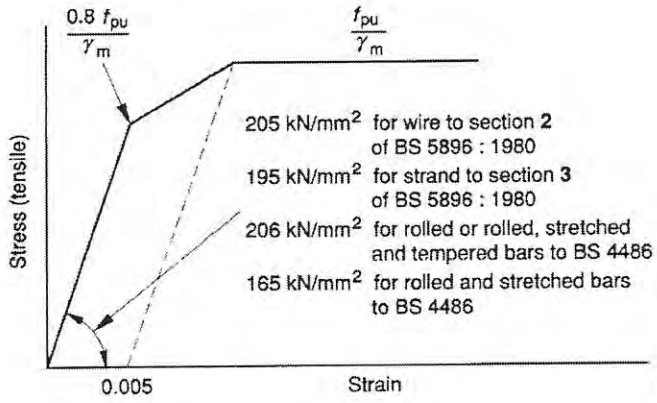
## APPENDIX

### (A) Stress-Strain Curve of Prestressing Tendons




Note: $f_{pu}$ : N/mm²

### (B) 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;

$\beta_1$ and $\beta_2$ = bond coefficients

$\beta_1$ and $\beta_2$ = 1.0 for fully bonded tendon

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

$$\varepsilon_e = \frac{\beta}{E_c}\left[\frac{P}{A} + \frac{Pe^2}{I}\right], \quad \varepsilon_u = \frac{d-x}{x}\varepsilon_{cu}$$

where $\varepsilon_{cu} = 0.0035$

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