



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023**

COURSE NAME : STRUCTURAL STEEL AND
TIMBER DESIGN /
STRUCTURAL STEEL DESIGN

COURSE CODE : BFC 43003 / BFC 44903

PROGRAMME CODE : BFF

EXAMINATION DATE : JULY/AUGUST 2023

DURATION : 3 HOURS

INSTRUCTION

1. ANSWER **ALL** QUESTIONS
2. THIS FINAL EXAM IS
CONDUCTED VIA **OPEN BOOK**.

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

- Q1** **Figure Q1(a)** shows the elevation of two buildings interconnected with a 6 m wide link bridge. The 8 m long main beams are dual span (with each span $l = 4$ m) supported in the middle by 45° support struts. The structural floor system for the deck is precast concrete Hollow Core Unit (HCU) spanning between the 8 m main beams. The fixture between the main beam and HCU is similar to that in **Figure Q1(b)**.

Precast Concrete Hollow Core Unit	=	100 mm
Finishes and services	=	1 kPa
Variable action	=	4 kPa
Maximum hogging moment	=	$w_{uls}l^2/8$
Maximum sagging moment at $3l/8$ from end	=	$9w_{uls}l^2/128$

- (a) Calculate the possible ULS and SLS design load in kN/m for the 8 m long main beam.
(6 marks)
- (b) Determine the smallest possible UB for the 8 m long main beam based on strength requirement.
(9 marks)
- (c) If the 45° support struts are taken out, comment on the percentage of moment and UB mass increment. Show all calculations that lead to the commented percentages.
(10 marks)
- Q2** A column with a 305 x 305 x 97 UC grade S 275 and a height of 7.50 m is shown in **Figure Q2**. The two ends of the column have not the possibility of a relative movement in both directions, and they are pinned for buckling about z-z axis and fixed for buckling about y-y axis. The horizontal intermediate supports provided by the side rails, is to ensure a lateral support of the column in the thirds of its height. Steel grade S 275. Determine the maximum design axial compressive load, N_{Ed} that the column can support.
(25 marks)
- Q3** A fin plate connection used to support a loaded beam is shown in **Figure Q3**. The beam, column and the connecting plate are in Grade S275. The connecting plate is 100 x 10 mm thickness. The bolts used are M20 Grade 8.8 and the weld size is 8 mm. From the loading analysis, the reaction at the beam support is 200 kN.

- (a) Check the bolt resistance connecting fin plate and beam web.
(13 marks)
- (b) Check the weld resistance connecting fin plate and column flange.
(12 marks)

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Q4 (a) Define **THREE (3)** advantages of using portal frame in steel construction design.

(3 marks)

(b) **Figure Q4** shows a typical front view of a portal frame. The design output from the software suggests using a 533 x 312 x 151 UB for the column size. As a structural engineer, you need to check whether the design output is suitable or not by performing the manual calculations. The data analysis provided by the software is as follows:

Maximum Moment at eaves, M	=	1548.5 kNm
Shear Force, V_{ED}	=	217.5 kN
Axial Force, N_{ED} (base)	=	320.7 kN
Steel Grade	=	S355

(i) Calculate the maximum moment at underside of haunch.

(2 marks)

(ii) Check the adequacy of cross section under bending and axial force.

(10 marks)

(iii) Calculate the bending moment at the intermediate restraint if the proposed position of intermediate restraint, L_m is 2.5 m.

(2 marks)

(iv) Calculate and propose intermediate restraint position by taking trial position as 2.5 m.

(8 marks)

- END OF QUESTIONS -

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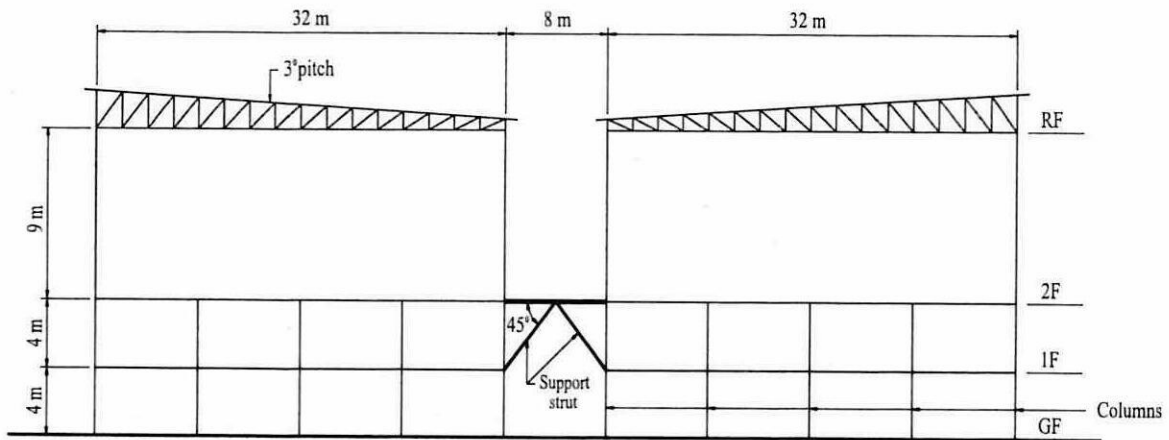


Figure Q1(a)

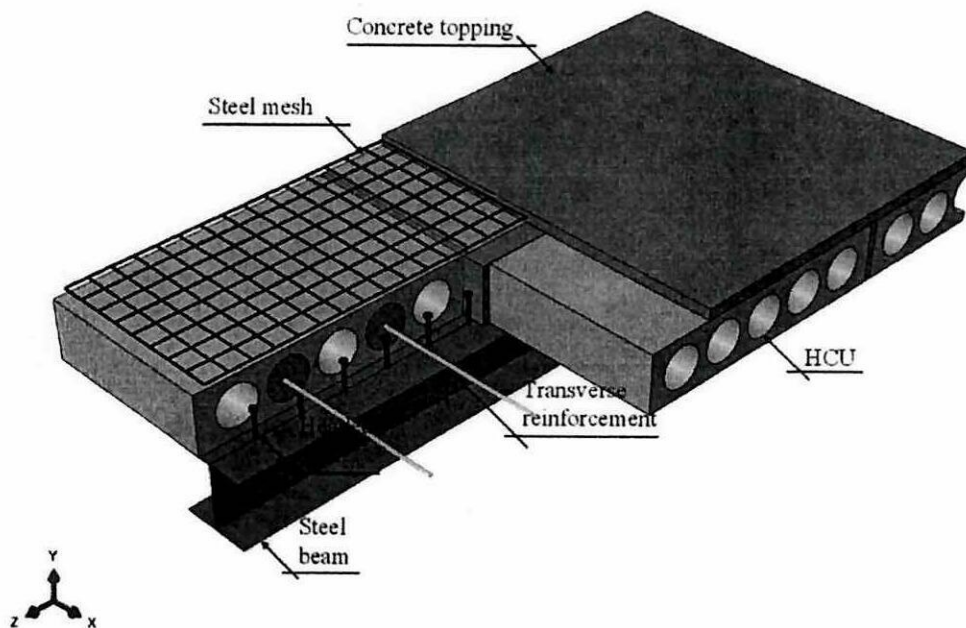


Figure Q1(b)

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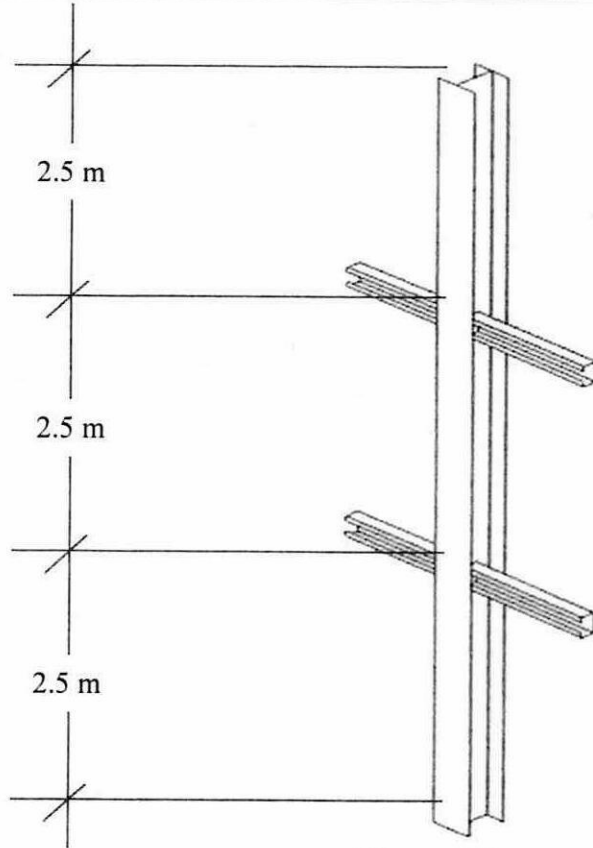


Figure Q2

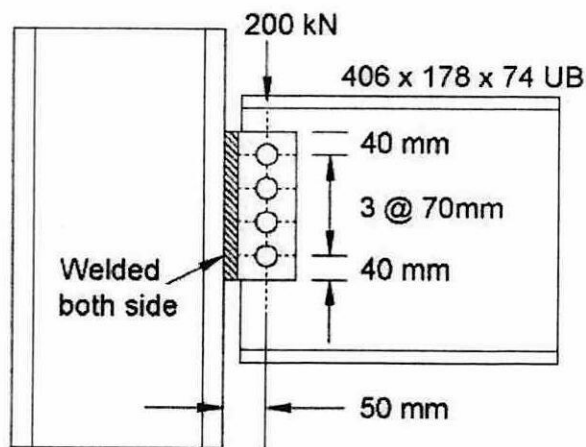


Figure Q3

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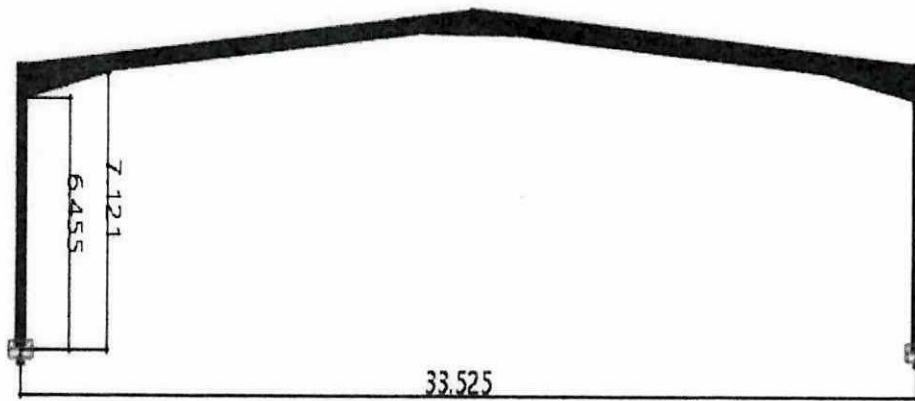
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All units in m

Figure Q4

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APPENDIX

$$C_1 = 1.77 - 0.88\psi + 0.11\psi^2$$

$$L_m = \frac{38i_z}{\sqrt{\frac{1}{57.4} \left(\frac{N_{Ed}}{A} \right) + \frac{1}{756C_1^2} \left(\frac{W_{pl,y}}{A I_T} \right) \left(\frac{f_y}{235} \right)^2}}$$

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