Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

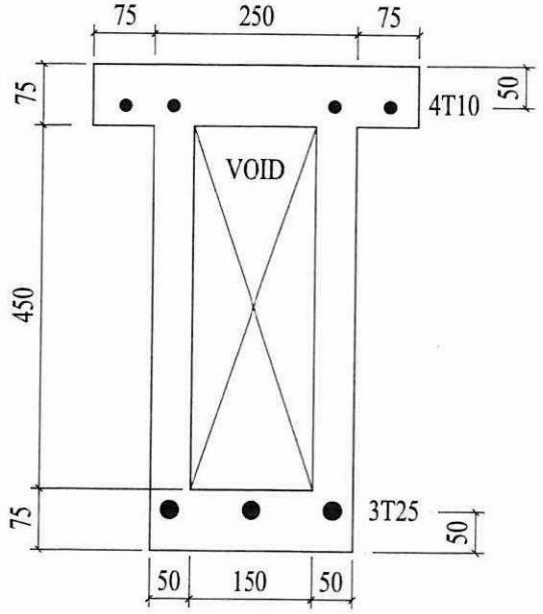
FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	STRUCTURAL DESIGN
COURSE CODE	:	BFC 34702
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2024
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☒ Open book ☐ Closed book 3. STUDENTS ARE **ALLOWED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA OPEN BOOK.

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

Q1 **Figure Q1.1** shows the cross section for a simply supported reinforced concrete beam. Given the following data:

Characteristic strength of concrete, f_{ck}	=	25 N/mm^2
Characteristic strength of steel, f_{yk}	=	460 N/mm^2
Modulus of elasticity of steel, E_s	=	200 kN/mm^2
Partial factor for concrete, γ_c	=	1.5
Partial factor for steel, γ_s	=	1.05
Ultimate strain of concrete, ε_{cu}	=	0.0035



All unit in mm

Figure Q1.1

(a) Based on the equivalent rectangular stress block in section 3.1.7, EN 1992-1, prove that all steel reinforcements have yielded.

(20 marks)

(b) **Figure Q1.2(a)** shows the first-floor plan of an office building subjected to moderate humidity. The detailing of the edge beam (FB 1) is shown in **Figure Q1.2(b)**. The concrete for the beams and slabs is cast monolithically.

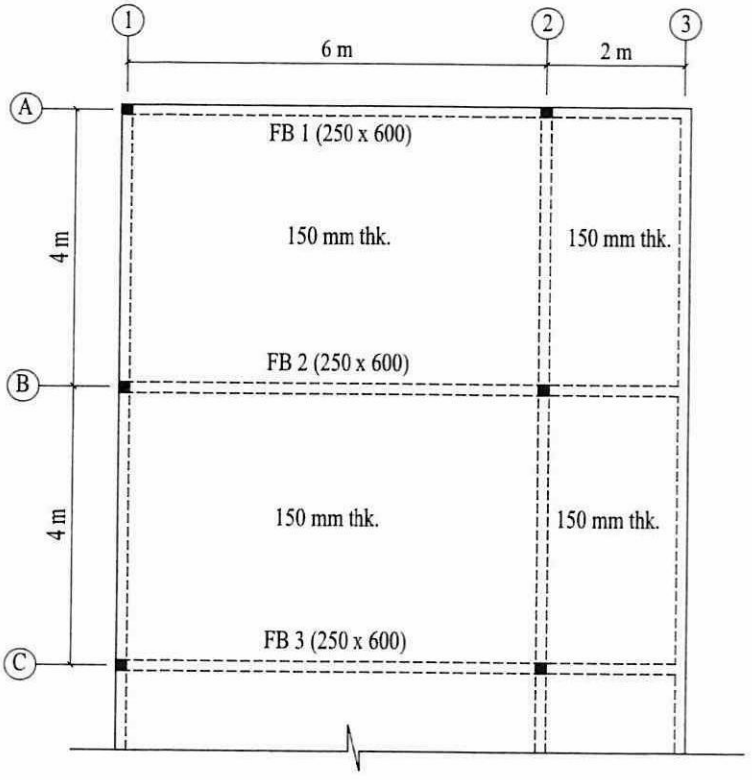


Figure Q1.2(a)

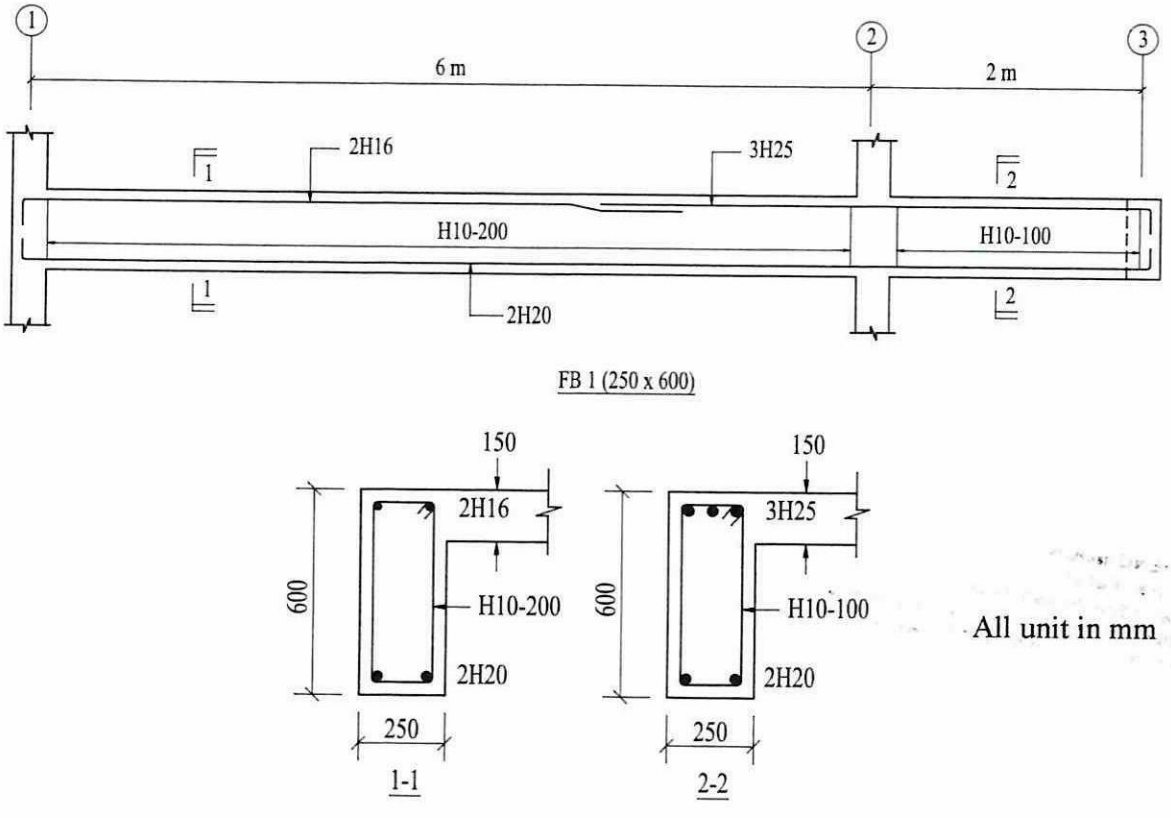


Figure Q1.2(b)

(i) Calculate the effective flange width of FB 1.

(10 marks)

(ii) Determine the minimum nominal concrete cover for the first-floor beams. Ignore the requirement of fire resistance.

(10 marks)

Q2 **Figure Q2.1** shows the analysis of a continuous flanged beam for a first-floor industrial building which has been designed completely. However, after 5 years in service, span A-B has failed. The provided tension reinforcement at span A-B was 4H25. The construction materials consist of Grade C25 concrete and Grade 500 steel reinforcement.

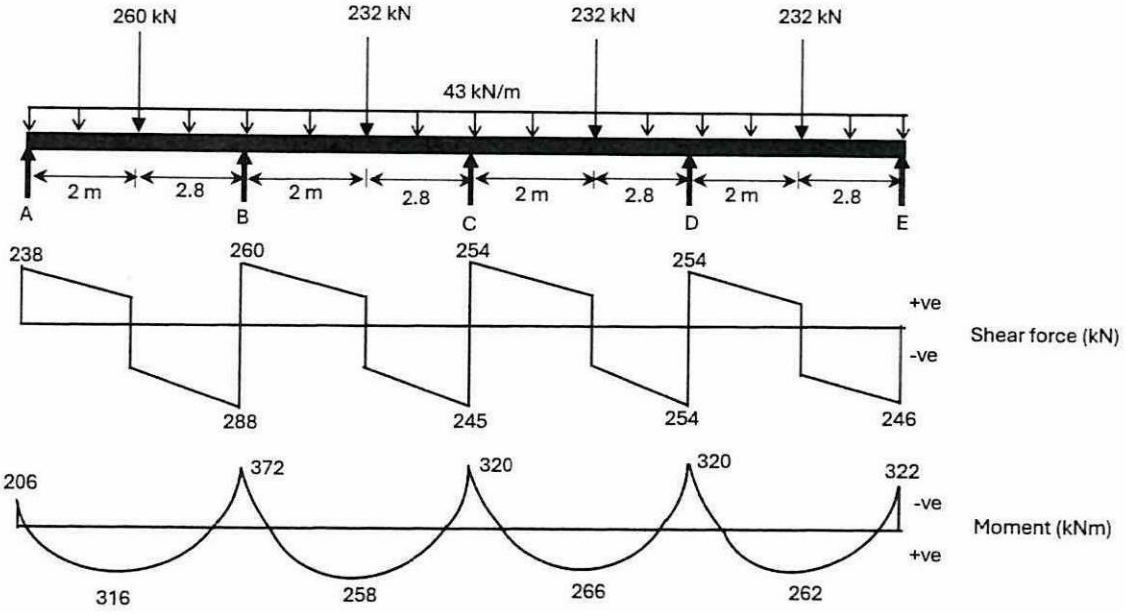


Figure Q2.1

Based on given data,

Nominal concrete cover, C_{nom}	=	25 mm
Slab thickness, h_f	=	110 mm
Overall depth of cross-section, h	=	400 mm
Effective flanged width, b_{eff}	=	650 mm
Web width, b_w	=	250 mm
Diameter bar in tension	=	25 mm

Diameter of bar in compression	=	12 mm
Diameter of link	=	6 mm
Quasi permanent/ultimate load ratio	=	0.6

(a) Conduct a comprehensive flexural design checking on span A-B and compare your findings with existing bar provided.

(10 marks)

(b) Design vertical shear link at span A-B by taking the maximum shear force as V_{Ed}.

(10 marks)

(c) Based on the existing bar, conduct serviceability checks (deflection and cracking) for span A-B to ensure the beam is safe along its service life.

(8 marks)

(d) Propose a strengthening method to enhance flexural capacity for span A-B.

(2 marks)

Q3 **Figure Q3.1** depicts the construction of a shelter outside the door of the house. The shelter is a timber construction with rafters (member A) and beam (member B). The rafter is notched on the underside at the beam support. The depth of the notch is 75 mm. The owner of the house intends to install solar panels weight at 0.2 kN/m^2 on top of the roof. Multiple checks will be conducted to determine if the existing frame structure able to support load from solar panel without requiring demolition.

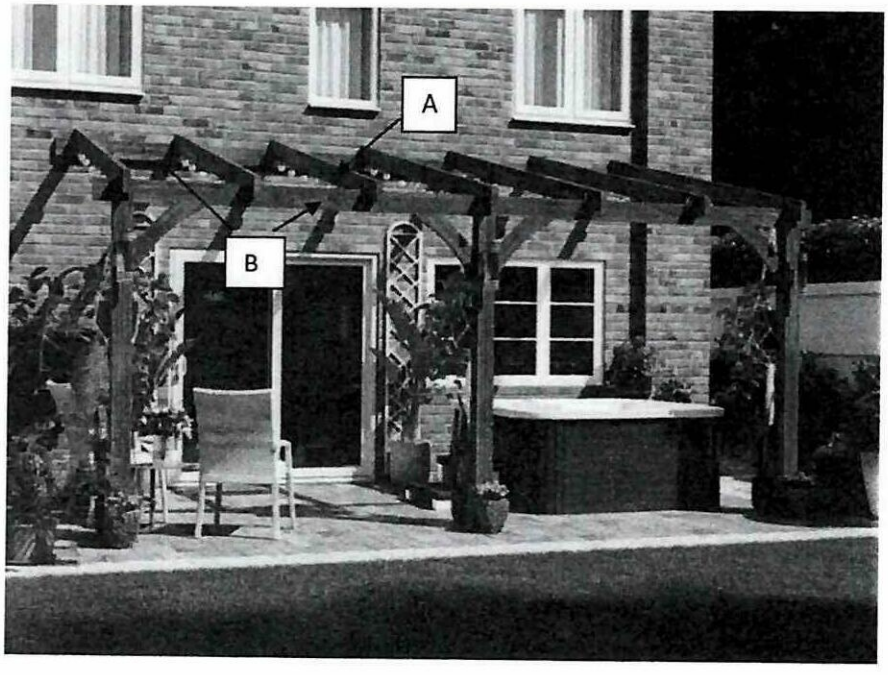


Figure Q3.1

With the given data and using MS544: Part 2:2001 answer the following questions.

Timber type	=	SG3 (Dry) Standard
Timber density	=	910 kg/m^3
Effective span of rafter	=	3000 mm
Spacing of rafter	=	800 mm
Nominal size of rafter	=	38 mm x 125 mm
Nominal size of beam	=	38 mm x 150 mm
Nominal size of column	=	100 mm x 100 mm
Weight of solar panel with mounting system	=	0.2 kN/m^2
Variable action	=	0.25 kN/m^2

(a) Draw the free body diagram of the rafter include dimensions and load values. Ignore the slope and overhang. Load should include permanent and variable actions.

(7 marks)

(b) Check the bending stress of the rafter and comment on your analysis.

(5 marks)

(c) Check the shear capacity of the rafter and comment on your analysis.

(6 marks)

(d) Check the deflection of the rafter and comment on your analysis.

(5 marks)

(e) Determine K_8 for the middle column, considering the column height is 3500 mm and end of the column is embedded in concrete.

(7 marks)

- END OF QUESTIONS -