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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

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

- COURSE NAME : ADVANCED STRUCTURAL TIMBER DESIGN
COURSE CODE : BFK 40303
PROGRAMME CODE : BFF
EXAMINATION DATE : JULY/AUGUST 2023
DURATION : 3 HOURS
INSTRUCTIONS : 1. ANSWER ALL QUESTIONS
2. THIS FINAL EXAMINATION IS CONDUCTED VIA **OPEN BOOK**.
3. STUDENTS ARE ONLY **ALLOWED** TO BRING THEIR OWN CODE OF PRACTICE BS EN 1995-1-1:2004, SPECIFIC ENGINEERING DESIGN GUIDE, AND FORMULA SHEET.

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

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- Q1** A twin residential apartment building structural key plan with $8\text{ m} \times 6\text{ m}$ column grid is given in **Figure Q1**. Each building measures $32\text{ m} \times 42\text{ m}$ interconnected by an 8 m long pedestrian bridge.

All design in this question and subsequent questions are to be in accordance to BS EN 1995-1-1. Relevant Eurocodes for actions and relevant specific engineering design guides can be used.

Data for design such as values of actions, service class, load duration, structural member types and geometry are to be proposed by you with correct engineering judgement and reasoning. Such engineering judgement and reasoning must be written clearly in your answer script. Marks will be given based on the suitability of your reasons and decisions. This applies to **all** questions in this Final Examination.

- (a) The floor system required by the architect in the apartment building is precast Hollow Core Unit (HCU). Propose by way of sketches the direction of this precast HCU in the $8\text{ m} \times 6\text{ m}$ grid. For clarity, the sketches should include plan, elevation and cross-section views. (5 marks)
- (b) Based on your proposal in Q1(a), calculate the ULS design load in kN/m for Beam 5/B-C and Beam B/5-6. The design loads to be considered must include permanent actions from self-weight, finishes and services, and variable actions. (10 marks)
- (c) Calculate and draw the shear force diagram and bending moment diagram for the Beams in Q1(b). (10 marks)

- Q2** Refer to **Figure Q1** and **Figure Q2**. This question concerns the design for Beam A/7-8. This beam carries the external perimeter wall. The wall is Cross Laminated Timber (CLT) panel with 5 layers at a thickness of 150 mm and panel self-weight of 0.75 kPa .

- (a) Based on your proposal in Q1(a), calculate the ULS and SLS design load in kN/m for Beam A/7-8. (9 marks)
- (b) Using Laminated Veneer Lumber (LVL), make a first estimation of size for Beam A/7-8 based on deflection requirement and carry out limit state design deflection check for the estimated size. (8 marks)
- (c) Propose a commonly practiced beam-column support connection with well-drawn sketches and design for a suitable bearing length at the beam support. (8 marks)

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Q3 Refer to **Figure Q1** and **Figure Q2**. This question concerns the structural elements that make up the interconnecting 8 m long pedestrian bridge.

(a) The bridge deck is to be built from Timber Concrete Composite (TCC) floor system where the TCC Joist spans in the direction of gridline 1-8 (**Figure Q1**) which is transverse to the 8 m pedestrian bridge main beam. Present a well-labelled drawing for cross-section B-B. Propose the layout and orientation of this TCC floor with sufficient sketches / drawings. The drawing must be well labeled for the different important components of the TCC floor. Make decision on the spacing of New Structural Beam whether you want to maintain at 2 m centre to centre or change it to a different spacing. Explain your decision.
(8 marks)

(b) Calculate the ULS design load in kN/m for the 8 m pedestrian bridge main beam and present the free body diagram.
(8 marks)

(c) Based on your answer in Q3(a), propose the connection type and connection spacing to be used in the design and construction of the TCC floor on the interconnecting bridge. Your proposal must include explanation to the choice of connection and spacing given. Clear drawing and design values such as K_u , K_s , and F_k of the connection are required in your proposal.
(9 marks)

Q4 Refer to **Figure Q2** and answer the following questions.

(a) Based on your answer in Q3(b), calculate the axial demand in kN for the Support Strut shown in **Figure Q2**.
(5 marks)

(b) Prepare a design for the Support Strut and propose a suitable LVL size for this element.
(15 marks)

(c) The Second Floor is meant to be a communal and sports hall for the apartment residents. The inter-floor height between Second Floor to Roof is 9 m. Provide suitable 2-D and 3-D drawings to show the possible Column solution from Second Floor to Roof.
(5 marks)

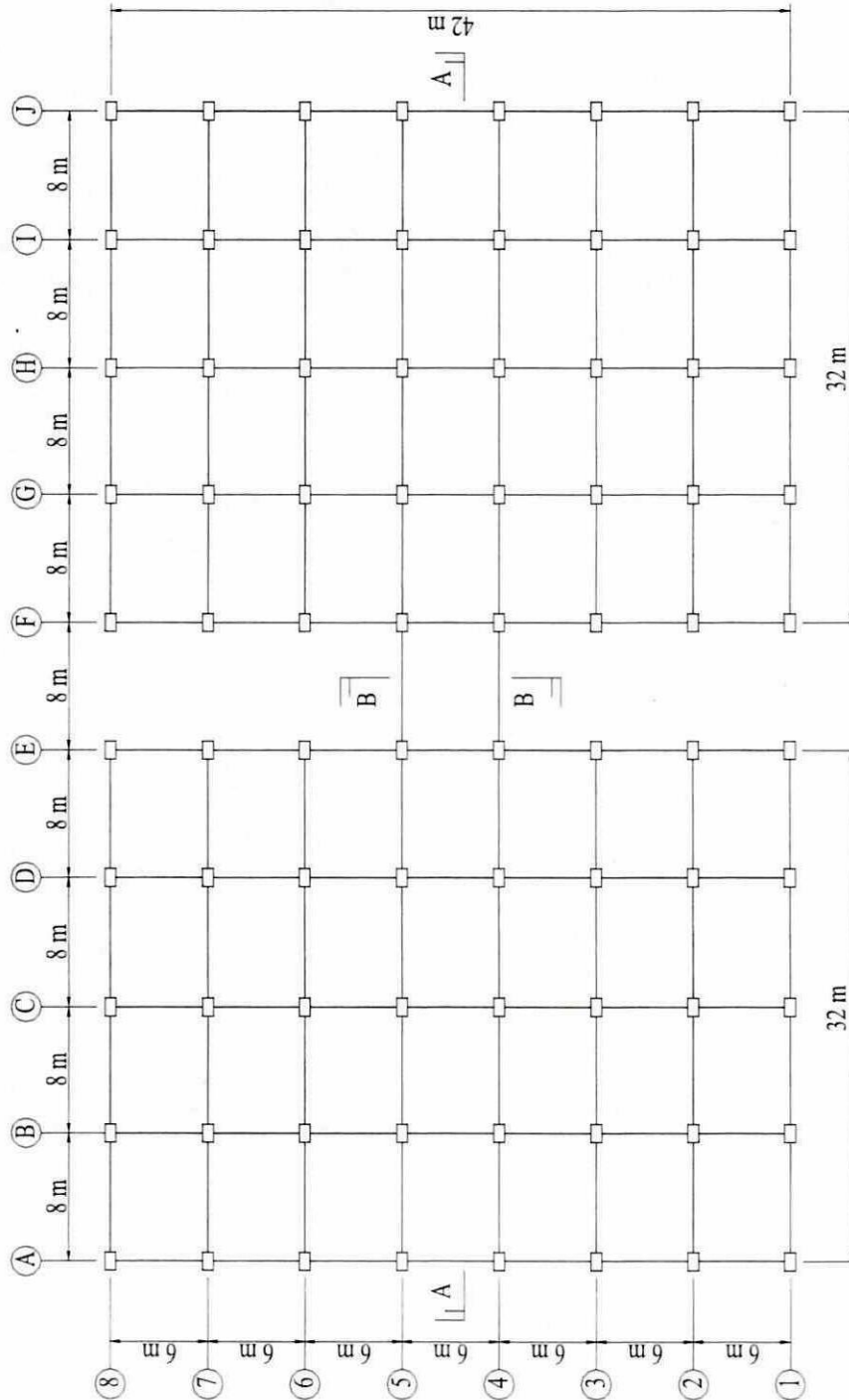
- END OF QUESTIONS-

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Structural Key Plan for First Floor

Figure Q1

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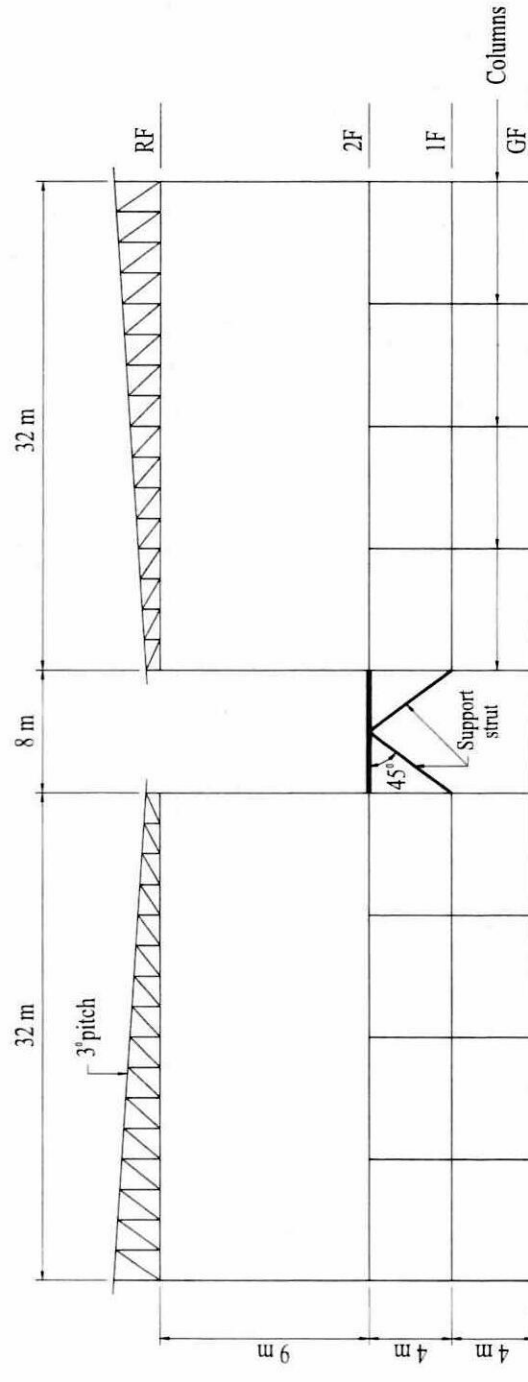
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Section A-A

Figure Q2

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