Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	ADVANCED STRUCTURAL TIMBER DESIGN
COURSE CODE	:	BFK 40303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	DECEMBER 2018/JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS OPEN BOOK EXAMINATION

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

Q1 **Figure Q1(a)** shows the structural key plan layout at First Floor for a local community building sized at 24 m × 15 m. The ground floor (GF) has column grids of 7.5 m × 6 m while the first floor (1F) is column free suitable for a communal hall. The building will be constructed using laminated veneer lumber (LVL) engineered timber while timber-concrete composite (TCC) system forms the floor on 1F. Basically, the building will be built from LVL mono-pitched portal frames with moment resisting connections at roof level spaced at 6 m centre to centre.

Figure Q1(b) shows the structural key plan layout of the Roof. The roofing material is metal deck lightweight roofing together with standard purlins and insulation materials. **Figure Q1(c)** shows the corresponding cross-section for the whole building.

The location of this building is in Malaysia where the temperature will be in the range of 30°C most of the time of the year and the relative humidity is in close range to 85 % throughout the year. The inside of the building will be air-conditioned in most time of the year. The Service Class used for the following design exercises shall be decided based of these given conditions.

Given as follows are design data to be used in your design solutions based on BS EN 1995-1-1:

Recommended actions for design:

Variable action on GF	=	4 kN/m^2
Variable action on 1F	=	4 kN/m^2
Variable action on RF	=	0.5 kN/m^2
Permanent action for finishes and services at GF and 1F	=	1 kN/m^2
Permanent action for roofing elements and finishes at RF	=	0.5 kN/m^2
Density of concrete	=	24 kN/m^3
Concrete thickness in TCC	=	75 mm
LVL Type Nelson-Pine	=	LVL11

Proposed LVL member sizes:

Portal rafter	=	90 mm × 610 mm
Primary beam 7.5 m	=	90 mm × 1220 mm
Primary tie beam 6.0 m	=	63 mm × 400 mm
Column	=	90 mm × 610 mm
TCC LVL joist	=	Double 63 mm × 300 mm

TCC design data:

Mean compressive strength of concrete	=	48 MPa
Mean Young's modulus of concrete	=	35 GPa
Characteristic strength of connection, F_k	=	275 kN
Connection stiffness for SLS, K_{SLS}	=	400,000 N/mm
Connection stiffness for SLS, K_{ULS}	=	300,000 N/mm
Effective spacing of connection, s_{eff}	=	250 mm

(a) Determine the Service Class to be used for the design of all primary beams and columns. Support your answer with an explanation.

(4 marks)

(b) Consider the roof rafter of an intermediate frame 3/A-C. Calculate the load demand of the roof rafter in kN/m.

(5 marks)

(c) Calculate the axial load demand in kN of Column C3 from 1F to RF.

(7 marks)

(d) Calculate the total axial load demand in kN of Column C3 from GF to 1F.

(9 marks)

Q2 Consider Column C3 from GF to 1F. Based on the information given in **Q1** and your solution for **Q1(d)**, attempt the following questions.

(a) Provide a 3-D sketch at the beam-column intersection. Label the structural members clearly.

(5 marks)

(b) Perform a design check that includes combined bending and axial compression for Column C3 from GF to 1F. Make a summary comment on your design with regards to the suitability of the proposed column size given in **Q1**.

(20 marks)

Q3 Consider an intermediate Primary Beam 7.5 m on the First Floor. The 6 m × 7.5 m floor panel shown in **Figure Q1(a)** is a TCC floor system, meaning it is a one way slab system spanning 6m. Based on the information given in **Q1**, attempt the following questions

(a) Calculate the load demand on an intermediate Primary Beam 7.5 m in kN/m.
(5 marks)

(b) Perform a design check for this Primary Beam 7.5 m. The design check should only include checks for bending, shear and deflection. Make a summary comment on your design with regards to the suitability of the proposed size given in **Q1**.
(20 marks)

Q4 Consider the tie member along the gridline C/1-5 as shown in **Figure Q1(c).** This tie member supports the entrance roof shelter at the front of the building as shown in **Figure Q1(b)**. The proposed tie member is a Double 90 mm × 200 mm LVL11 spaced at 1 m centre to centre. The length of the tie member is 6000 mm and is connected at both ends with each connection inducing a bending moment of 30 kNm. Based on these information, attempt the following questions.

(a) Calculate the tensile resistance of this tie member in MPa.
(6 marks)

(b) Calculate the bending resistance and bending stress demand of this tie member in MPa.
(12 marks)

(c) Based on combined bending and axial tension verifications, determine the maximum tensile force each tie member can carry in kN.
(7 marks)

- END OF QUESTIONS-

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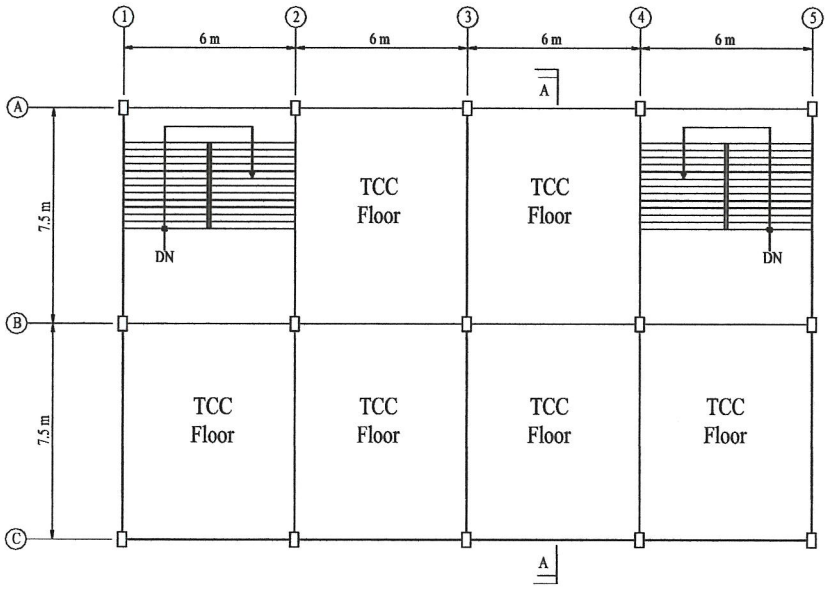
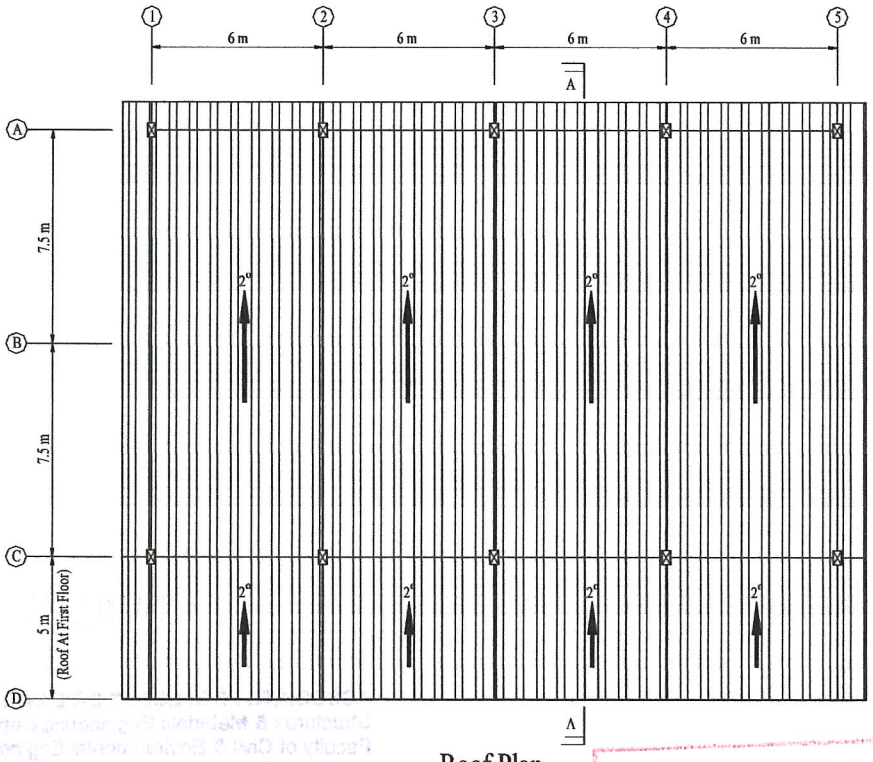


First Floor Plan

FIGURE Q1(a)



Roof Plan

FIGURE Q1(b)

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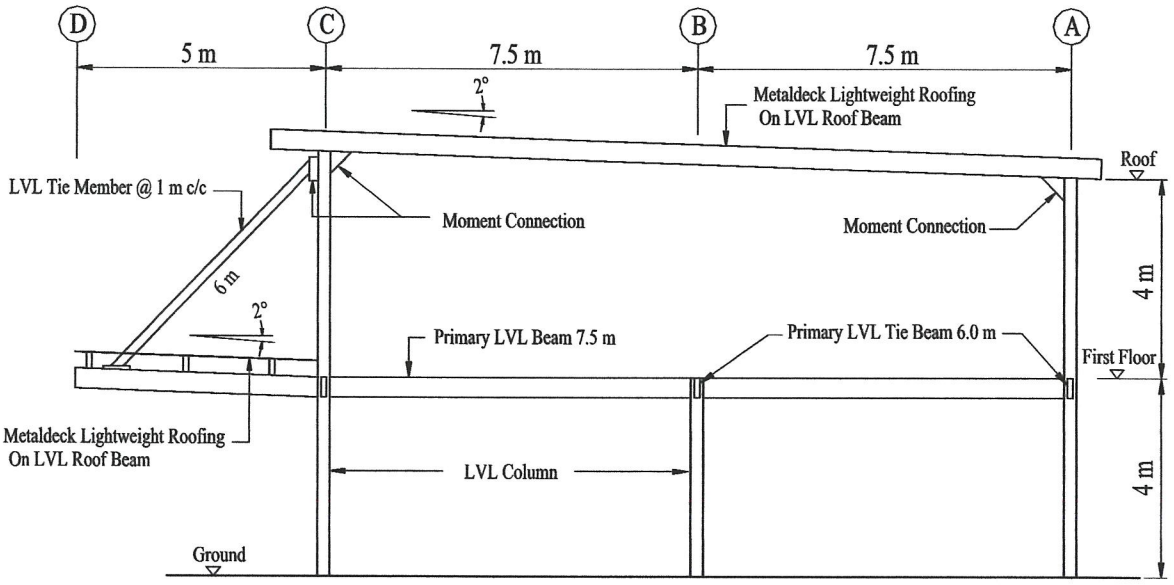

Section A-A

FIGURE Q1(c)