UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	ADVANCED STRUCTURAL TIMBER DESIGN
COURSE CODE	:	BFK 4033/ BFK 40303
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ONE (1)** QUESTION FROM **PART A** AND **THREE (3)** QUESTIONS FROM **PART B** DESIGN SHOULD BE BASED ON: **MS 544: PART 2: 2001** **MS 544: PART 3: 2001** **MS 544: PART 4: 2001** **MS 544: PART 5: 2001**

THIS PAPER CONSISTS OF **THIRTEEN (13)** PAGES

PART A: **ANSWER ONE (1) QUESTION ONLY**

Q1 (i) List **FOUR (4)** characteristics influencing timber design.

(4 marks)

(ii) Describe **TWO (2)** advantages of screw compared to nail.

(6 marks)

(iii) Explain why the centroids of all members in a truss connection design should ideally intersect at a point.

(5 marks)

(iv) Recommend **TWO (2)** methods to encourage people to choose timber as their structural material. Answer the question in terms of what, why and how to justify your proposed method.

(10 marks)

Q2 (i) List **FOUR (4)** types air seasoning defect.

(4 marks)

(ii) Describe **TWO (2)** advantages of plyweb beam compared to glulam beam.

(6 marks)

(iii) Explain how to reduce the slenderness of a column without changing their cross section or timber stress grade.

(5 marks)

(iv) Recommend **TWO (2)** methods to increase the application of timber composite in structure and at the same time protecting forest against extinction. Answer the question in terms of what, why and how to justify your proposed method.

(10 marks)

PART B: **ANSWER THREE (3) QUESTIONS ONLY**

Instruction: For question **Q3** to **Q6**, all questions must be referred to Figure **Q1**, and the following data:

A timber structure podium is constructed by using the following materials and design data:

Primary beam	: Glulam
Primary column	: Glulam
Joist & truss member	: Solid sawn timber
Type of exposure	: Wet
Size of each member	: Finished size
Duration of loading	: Long term

Type of fasteners:

Beam to column	: Steel plate and bolted
Truss member	: Metal plate (single face)
Truss to hanger	: Steel plate and bolted

Produce additional 10% diameter from the nominal bolt diameter for clearance hole

Floor loads:

Dead load (including selfweight)	: 2.5 kN/m^2
Imposed load	: 2.0 kN/m^2

Roof loads on rafter (on slope):

Dead load (including truss and purlin selfweight)	: 2.0 kN/m^2
Imposed load	: 0.75 kN/m^2

Q3 (a) Analyze the loading that subjected to beam B/1-3 and calculate the reactions, maximum shear force and bending moment of the simply supported beam.

(6 marks)

(b) Figure **Q2** shows the detailing of beam B/1-3 in terms of timber grade, dimension, number of laminates and orientation. Produce design calculations for:

(i) bending stresses.

(7 marks)

(ii) shear stresses.

(5 marks)

(iii) deflection.

(7 marks)

Q4 (a) Figure **Q2** shows the detailing of column B3 in terms of timber grade, dimension, number of laminates and orientation. Analyze loading subjected to the column? Then, calculate the total axial load and eccentric moments of M_x and M_y due to the eccentricities of e_x = 137.5 mm and e_y = 200 mm.

(6 marks)

(b) Produce design calculations for:

(i) bending stresses, by only considering the maximum eccentric moment of M_x or M_y.

(7 marks)

(ii) axial stresses.

(8 marks)

(iii) combine stresses of axial and bending.

(4 marks)

Q5 (a) Figure **Q3** shows an elevation of Truss X. Distribute all loading to the node of the truss, calculate the internal forces and the reactions.

(8 marks)

(b) Produce design calculations for:

(i) critical tension member of the truss only.

(6 marks)

(ii) bending stresses if given M_{max} = PL/6 where P is the nodal load and L is the node spacing.

(6 marks)

(iii) interaction quantity.

(5 marks)

Q6 Some modifications have been made on the materials and dimensions of existing truss specification. Figure **Q4** shows the amendment, with the following new design data:

<u>Roof loads on rafter (on slope):</u>

Dead load (including truss and purlin selfweight)	: 1.5 kN/m^2
Imposed load	: 0.75 kN/m^2
Truss spacing	: 2 m
Purlin spacing	: 0.6 m

(a) Distribute all loading to the node of the truss. Then, calculate the internal forces and the reactions.

(8 marks)

(b) Produce design calculations for:

(i) metal plate at *joint a* only.

(10 marks)

(ii) bolts capacity of $\phi_{bolt} = 95$ mm for *member bc.*

(7 marks)

BAHAGIAN A: **JAWAB SATU (1) SOALAN SAHAJA**

S1 (i) Senaraikan **EMPAT (4)** ciri yang mempengaruhi rekabentuk kayu.

(4 markah)

(ii) Terangkan **DUA (2)** kelebihan skru berbanding paku.

(6 markah)

(iii) Terangkan mengapa sentroid semua anggota kekuda pada sesuatu sambungan lebih ideal bersilang pada satu titik.

(5 markah)

(iv) Cadangkan **DUA (2)** kaedah untuk menggalakkan orang ramai memilih kayu sebagai bahan struktur mereka. Jawapan soalan merangkumi apa, mengapa dan bagaimana untuk menjustifikasikan kaedah yang dicadangkan.

(10 markah)

S2 (i) Senaraikan **EMPAT (4)** jenis kecacatan pengeringan udara.

(4 markah)

(ii) Terangkan **DUA (2)** kelebihan rasuk *plyweb* berbanding rasuk *glulam*.

(6 markah)

(iii) Terangkan bagaimana mengurangkan kelangsingan sesuatu tiang tanpa mengubah keratan rentas atau gred tegasan kayu.

(5 markah)

(iv) Cadangkan **DUA (2)** kaedah untuk meningkatkan penggunaan kayu komposit dalam struktur dan pada masa yang sama memelihara hutan dari kepupusan. Jawapan soalan merangkumi apa, mengapa dan bagaimana untuk menjustifikasikan kaedah yang dicadangkan.

(10 markah)

BAHAGIAN B: **JAWAB TIGA (3) SOALAN SAHAJA**

Arahan : Untuk soalan **S3** sehingga **S6**, semua soalan perlu merujuk kepada Rajah **Q1**, dan data-data berikut:

Satu struktur pentas dibina dengan menggunakan bahan-bahan dan data rekabentuk berikut:

Rasuk utama	: *Glulam*
Tiang utama	: *Glulam*
Alang & anggota kekuda	: Kayu gergaji pejal
Jenis pendedahan	: Basah
Saiz setiap anggota	: Saiz terakhir
Tempoh pembebanan	: Jangka panjang

Jenis-jenis penyambung:

Rasuk ke tiang	: Plat keluli dan dibolt
Anggota kekuda	: *Metal plate* (satu muka)
Kekuda ke penggantung	: Plat kekuli dan dibolt

Sediakan tambahan 10% diameter dari diameter nominal bolt untuk lubang kelegaan

Beban lantai:

Beban mati (termasuk berat kendiri)	: 2.5 kN/m^2
Beban kenaan	: 2.0 kN/m^2

Beban bumbung pada kasau (pada cerun):

Beban mati (termasuk berat kendiri kekuda dan gulung-gulung)	: 2.0 kN/m^2
Beban kenaan	: 0.75 kN/m^2

S3 (a) Analisis beban yang bertindak ke atas rasuk B/1-3 dan kirakan tindakbalas, daya ricih dan momen lentur maksimum rasuk sokong mudah tersebut.

(6 markah)

(b) Rajah **Q2** menunjukkan perincian rasuk B/1-3 dari aspek gred kayu, dimensi, bilangan laminasi dan orentasi. Sediakan pengiraan rekabentuk untuk:

(i) tegasan-tegasan lenturan.

(7 markah)

(ii) tegasan-tegasan ricihan.

(5 markah)

(iii) pesongan.

(7 markah)

S4 (a) Rajah **Q2** menunjukkan perincian tiang B3 dari aspek gred kayu, dimensi, bilangan laminasi dan orentasi. Analisis beban yang bertindak pada tiang? Kemudian kirakan jumlah keseluruhan beban paksi dan momen kesipian M_x dan M_y disebabkan oleh nilai sipi e_x = 137.5 mm dan e_y = 200 mm.

(6 markah)

(b) Sediakan pengiraan rekabentuk untuk:

(i) tegasan-tegasan lenturan, dengan hanya mempertimbangkan momen kesipian maksimum M_x atau M_y.

(7 markah)

(ii) tegasan-tegasan paksi.

(8 markah)

(iii) gabungan tegasan paksi dan lenturan.

(4 markah)

S5 (a) Rajah **Q3** menunjukkan satu pandangan Kekuda X. Agihkan semua beban ke semua nod kekuda, kemudian kirakan daya dalaman dan tindakbalas.

(8 markah)

(b) Sediakan pengiraan rekabentuk untuk:

(i) anggota tegangan kritikal pada kekuda sahaja.

(6 markah)

(ii) tegasan-tegasan lenturan sekiranya diberi M_{mak} = PL/6 di mana P ialah beban nod dan L ialah jarak nod.

(6 markah)

(iii) kuantiti interaksi.

(5 markah)

S6 Beberapa perubahan telah dilakukan terhadap bahan-bahan dan dimensi kekuda sediada. Rajah **Q4** menunjukkan pindaan-pindaan yang dimaksudkan, dengan data rekabentuk baru seperti berikut:

<u>Beban bumbung pada kasau (pada cerun):</u>

Beban mati (termasuk berat kendiri kekuda dan gulung-gulung)		: 1.5 kN/m^2
Beban kenaan		: 0.75 kN/m^2
Jarak kekuda	: 2 m	
Jarak gulung-gulung	: 0.6 m	

(a) Agihkan semua beban ke semua nod kekuda. Kemudian, kirakan daya dalaman dan tindakbalas.

(8 markah)

(b) Sediakan pengiraan rekabentuk untuk:

(i) *metal plate* pada *sambungan a* sahaja.

(10 markah)

(ii) keupayaan bolt ϕ_{bolt} = 95 mm bagi *anggota bc*.

(7 markah)

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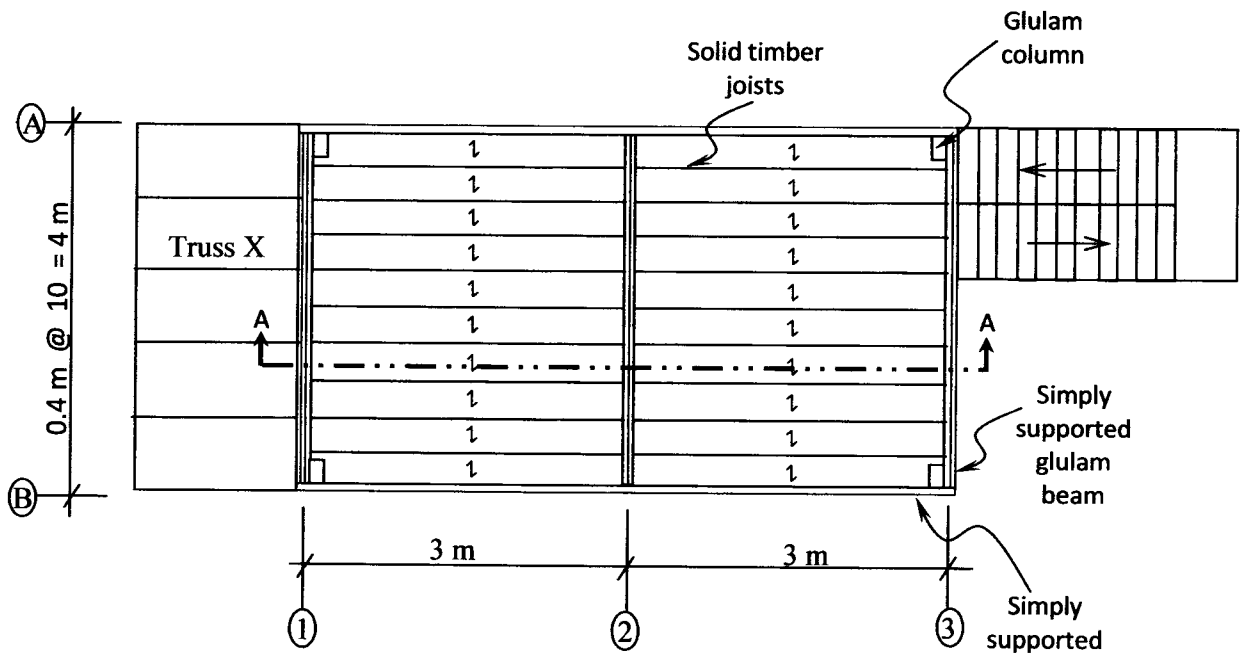
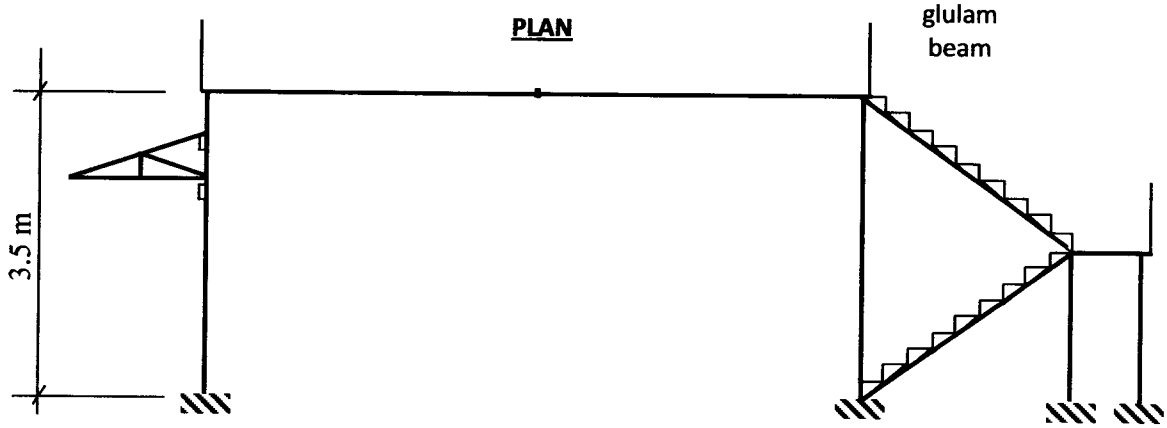


PLAN



A-A CROSS SECTION

FIGURE Q1

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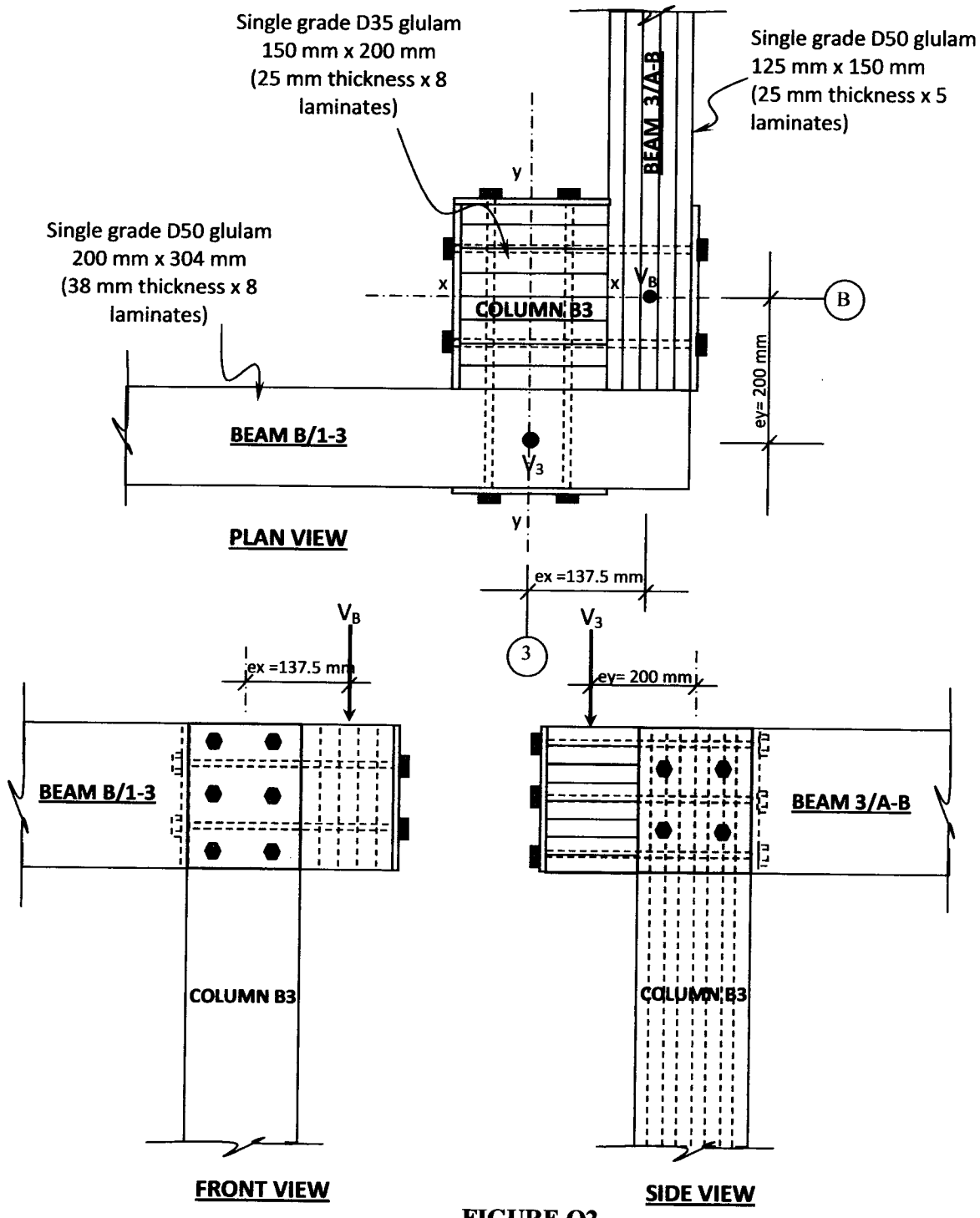

FIGURE Q2

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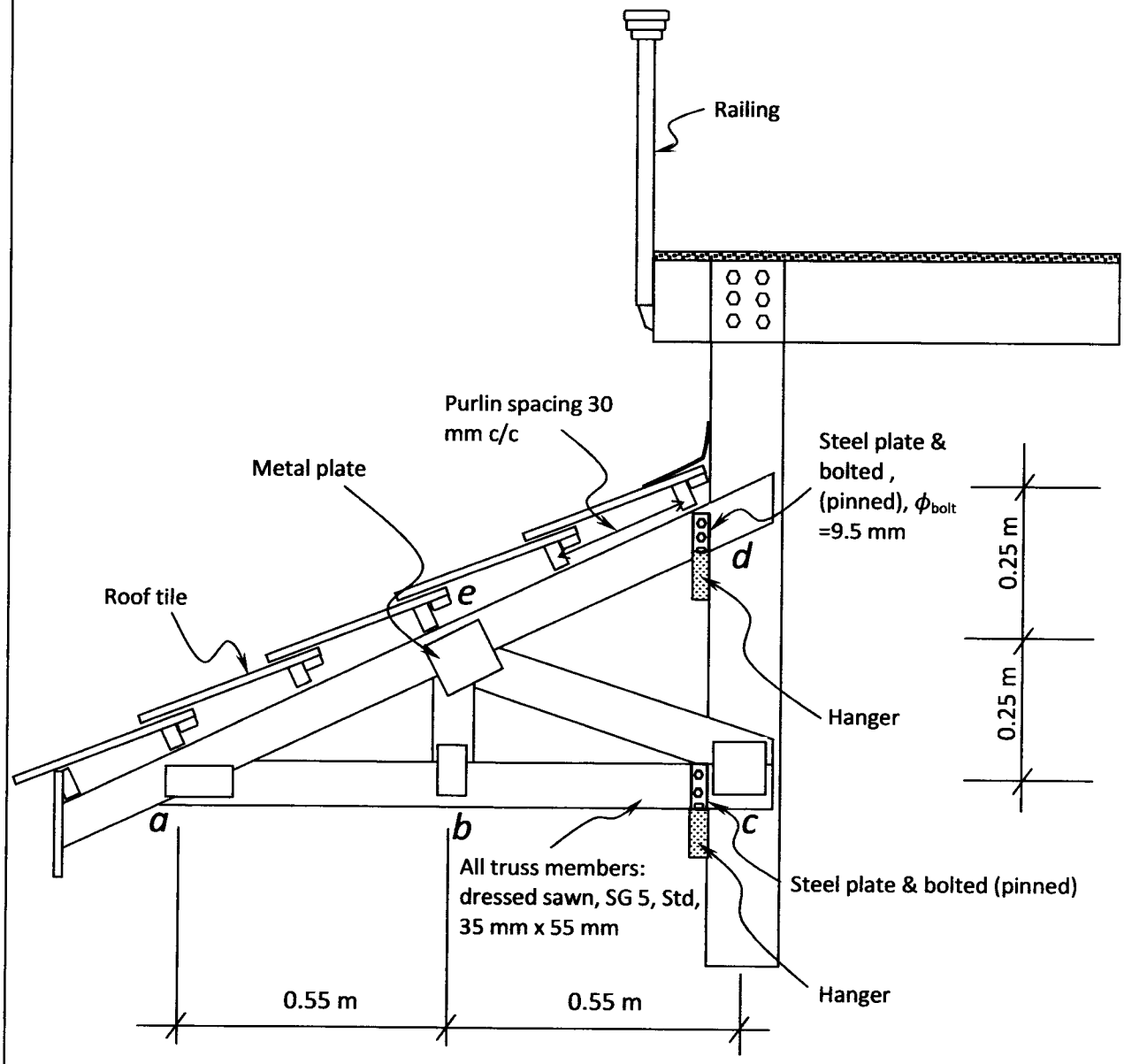

ELEVATION TRUSS X

FIGURE Q3

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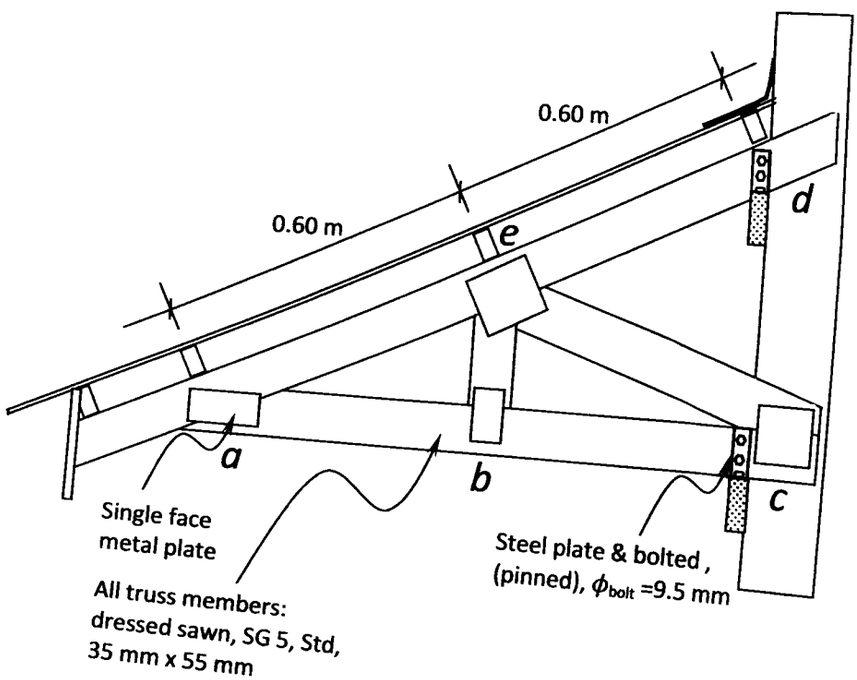

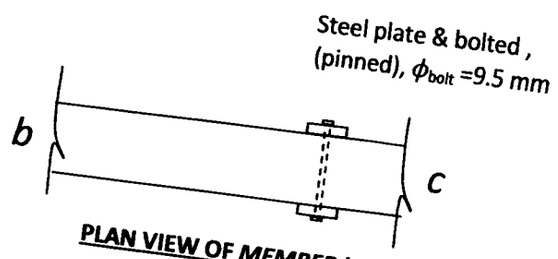

PLAN VIEW OF MEMBER bc

Permissible load per tooth (N) for MPC

Angle of load to fastener length direction, α	Angle of load to grain member, β	
	0°	30°
0°	142	110
30 °	128	104

** Interpolation is permitted*

FIGURE Q4