UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2008/2009

April/May 2009

EAS 354/3 – Design Of Timber And Steel Structures
[Rekabentuk Struktur Kayu & Keluli]

Duration: 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **THIRTEEN (13)** printed pages including appendix before you begin the examination.
*[Sila pastikan kertas peperiksaan ini mengandungi **TIGA BELAS (13)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: This paper consists of **SIX (6)** questions. Answer **FIVE (5)** questions only. All questions carry the same marks.

*[**Arahan**: Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

You may answer the question either in Bahasa Malaysia or English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

All questions **MUST BE** answered on a new page.
*[Semua soalan **MESTILAH** dijawab pada muka surat baru.]*

Write the answered question numbers on the cover sheet of the answer script.
[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

1. A welded plate girder of grade S275 is required to carry out a concentrated load of 1500 kN. The position of the concentrated load is at the mid-span. The load is transmitted to the girder from 203 x 203 x 167 kg/m UC that is located on the top of flange. The girder is simply supported with a span of 15m. The girder and the compression flange is adequately restrained laterally. Assume the weight of the girder is 60 kN.

   a) Design a section for the plate girder.

   [8 Marks]

   b) Design the load – bearing stiffeners and web – to – flange weld.

   [7 Marks]

   c) Sketch all details and the arrangements of the plate girder.

   [5 Marks]

2. A roof truss is required to carry an additional load on the bottom cord as shown in Figure 1. The additional load is located at the middle part of the cord with concentrated load of 2.5 kN. Check the suitability of the section used for the bottom cord.

   Data :

   Timber Strength group, SG 3

   Size of bottom cord, 50 mm x 125 mm. Medium term axial loading in bottom cord before additional load = 10 kN

   [20 Marks]

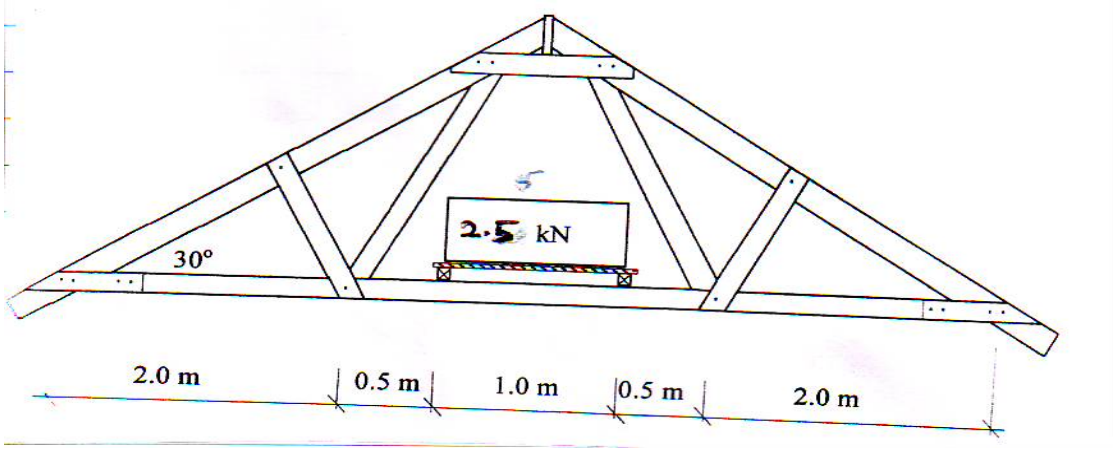


Figure 1

3 a) Timber jointing is very important because all timber structures are made of elements that must be connected together for the transfer of loads between them. Briefly describe **FIVE (5)** factors that should be considered in determining the strength of a timber joint.

[5 Marks]

b) A bolted joint of three-member with two side members connected to a main member at an angle of 45 degrees as shown in Figure 2. The joint has four bolts having a diameter of 12.7mm. The direction of load is parallel to the grain and in the direction of 45 degrees to the grain for side member and main member, respectively. The timber joint belongs to Group J1 which has to be kept dry during services.

i) Check the detail at required bolt spacing

ii) Calculate the total load capacity at the joint

[15 Marks]

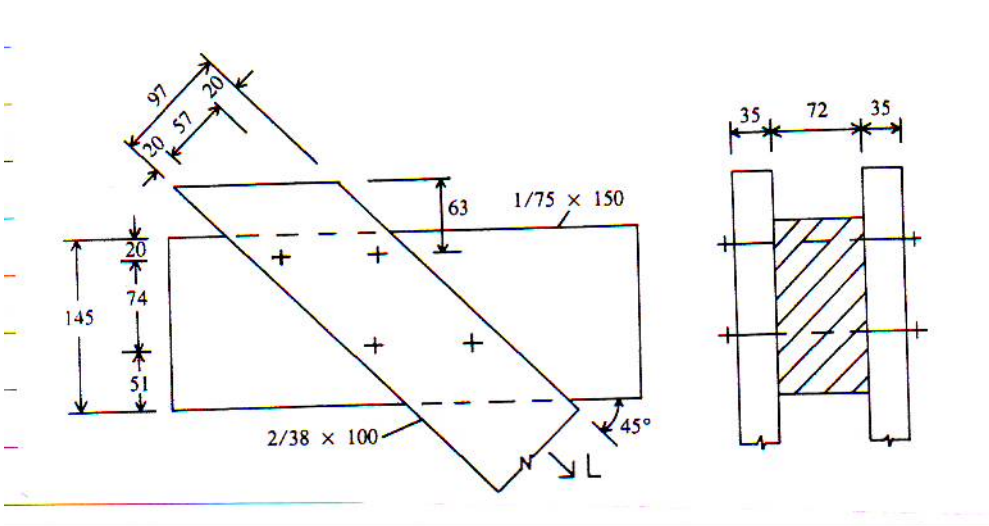


Figure 2

4. a) Briefly describe the following phrases:

   i) Section Classification

   ii) Unrestrained Beam

[5 Marks]

b) Figure 3 shows a part of plan view for a steel crane building project using concrete slab. The details loading acting on slab and beam are as follows :

Specific density of concrete	= 24.0 kN/m^3
Finishes	= 0.5 kN/m^2
Ceiling	= 1.0 kN/m^2
Self-weight of beam	= 0.7 kN/m^2 s/w always in kN/m
Live load	= 2.5 kN/m^2
Concrete slab thickness	= 150 mm

Use steel grade S275. The beam is fully restrained by the concrete slab. No lateral torsional buckling check is required. Design beam 3/B-C, the calculation must include:

i) Shear capacity

ii) Moment capacity

iii) Deflection check

Refer Appendix 1 for section properties of universal beam.

[15 Marks]

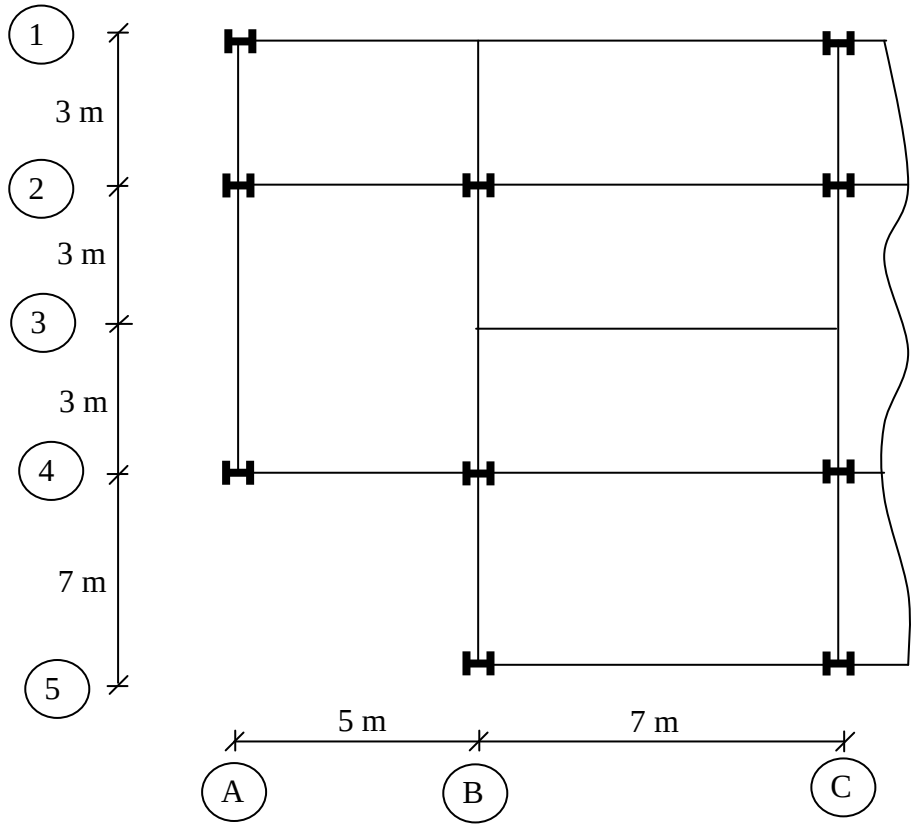


Figure 3 : A part of plan view for a building

5. A steel column, constructed from 203 x 203 x 52 UC S275 section is restrained in one direction and subjected to load as shown in Figure 4. Check the adequacy of the section, assuming that both ends of the column are pin jointed. Refer Appendix 2 for section properties.

[20 Marks]

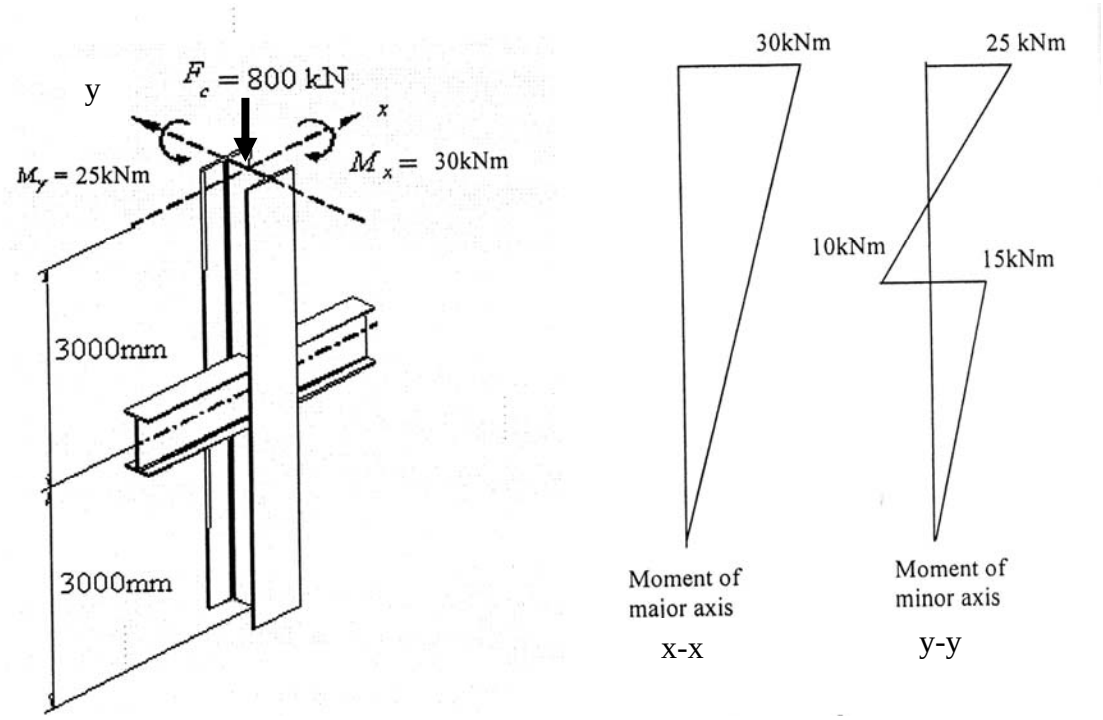


Figure 4 : Moment and axial load applied on column

6. a) Discuss the design consideration for a flexural member for the following cases :

   i) Shear stress

   ii) Flexural stress

   iii) Deflection

[10 Marks]

b) Consider a column with axial load (live load and dead load) of 60kN. Length of the column is 4.7m. The column is fixed at one end and pinned at the other end. Timber used belongs to SG3, green (wet) > 19%. Column is carrying medium term load and no load sharing. Determine the column size. Assume E_{min} = 9800 N/mm^2.

[10 Marks]

(TERJEMAHAN)

1. *Sebuah galang plat gred S275 diperlukan untuk membawa beban tumpu sebesar 1500 kN. Kedudukan beban tumpu adalah di pertengahan rentang. Beban tumpu dipindahkan kepada galang plat daripada anggota tiang 203x 203 x 167 kg/m UC yang terletak di bahagian atas bebibir plat. Panjang galang plat ialah 15 m disokong mudah dikedua-dua hujung dan dikekang pada arah sisi bebibir mampatan. Anggap berat galang plat 60 kN.*

   a) Rekabentukan keratan galang plat

   [8 Markah]

   b) Rekabentukan pengukuh beban-galas dan kimpalan web kepada bebibir.

   [7 Markah]

   c) Lakarkan perincian dan susunatur galang plat.

   [5 Markah]

2. *Sebuah kerangka kekuda bumbung diperlukan untuk membawa beban tambahan pada perentas bawah seperti yang ditunjukkan dalam Rajah 1. Beban tambahan tersebut terletak di bahagian tengah perentas membawa beban tumpu sebesar 2.5 kN. Semak kesesuaian keratan yang digunakan untuk perentas bawah.*

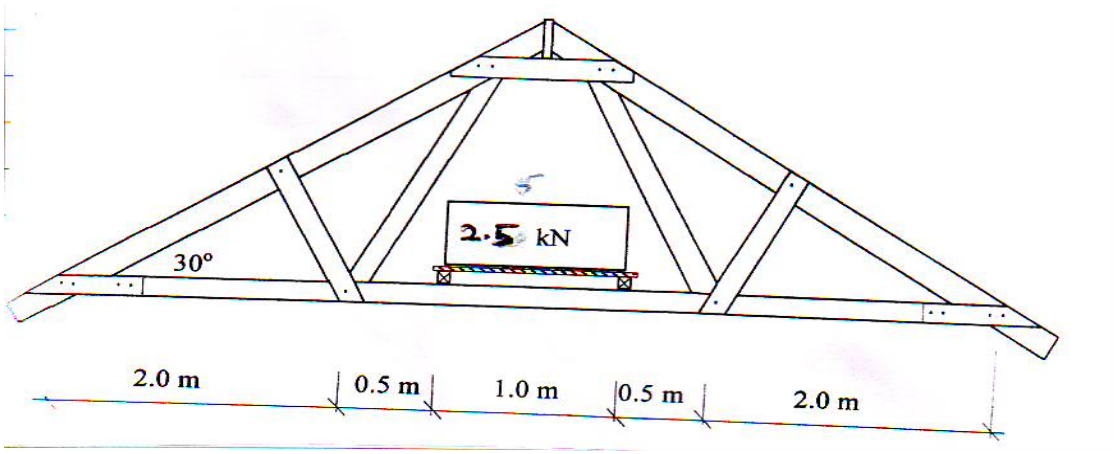
   Data:

   Kumpulan kekuatan kayu, SG3

   Saiz perentas bawah 50 mm x 125 mm.

   Beban jangka sederhana perentas bawah sebelum membawa beban tambahan ialah 10 kN

   [20 Markah]



3. a) *Sambungan kayu sangat penting kerana semua sktruktur kayu dibina secara sambungan antara elemen yang mesti disambung bersama untuk membolehkan pemindahan beban berlaku daripada satu anggota kepada anggota yang lain. Terangkan dengan ringkas* ***LIMA (5)*** *faktor yang perlu dipertimbangkan untuk menentukan kekuatan sambungan kayu.*

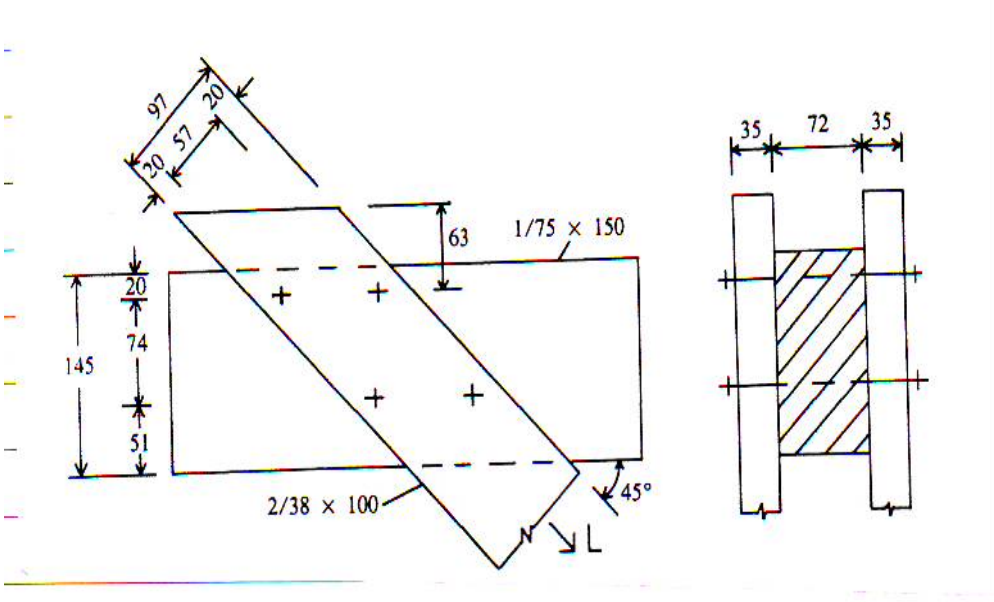
[5 Markah]

b) *Satu sambungan bolt untuk tiga-anggota yang terdiri daripada dua anggota sisi di sambung kepada anggota utama pada sudut 45 darjah. Sambungan mempunyai empat bolt dan setiap bolt bergarispusat 12.7mm. Arah beban bagi anggota sisi adalah selari dengan ira manakala anggota utama pula pada arah 45 darjah kepada ira. Kumpulan sambungan kayu ialah J1 dan berada dalam keadaan kering semasa berkhidmat seperti yang ditunjukkan dalam Rajah 2.*

i) Semak perincian jarak ruang bolt yang diperlukan.

ii) Kirakan jumlah keupayan beban pada sambungan

[15 Markah]



Rajah 2

4. a) *Terangkan dengan ringkas tentang frasa berikut:*

i) Pengelasan keratan

ii) Rasuk tidak dihalang sisi

[5 Markah]

1. *Rajah 3 menunjukkan sebahagian daripada pandangan pelan bagi sebuah bangunan kerangka keluli yang menggunakan papak konkrit. Perincian tentang beban yang bertindak pada papak dan rasuk adalah seperti berikut:*

Kemasan	*= 0.5 kN/m^2*
Siling	*= 1.0 kN/m^2*
Berat sendiri rasuk	*= 0.7 kN/m*
Beban hidup	*= 2.5 kN/m^2*
Tebal papak konkrit	*= 150 mm*
Ketumpatan tentu konkrit	*= 24.0 kN/m^3*

Gunakan keluli gred S275. Anggap rasuk dikekang sepenuhnya oleh papak konkrit. Rekabentuk rasuk 3/B-C. Abaikan semakan lengkokan kilasan sisi. Pengiraan mesti mengandungi semakan berikut:

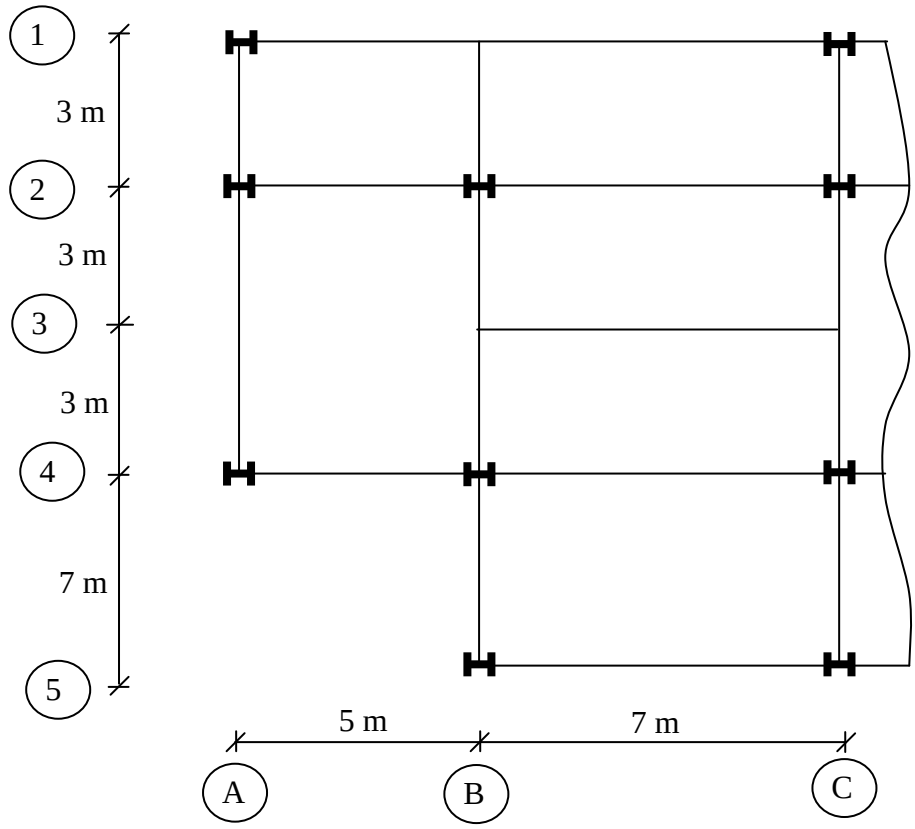
i) Keupayaan ricih

ii) Keupayaan momen

iii) Semakan pesongan

Rujuk Lampiran 1 untuk ciri-ciri keratan rasuk universal.

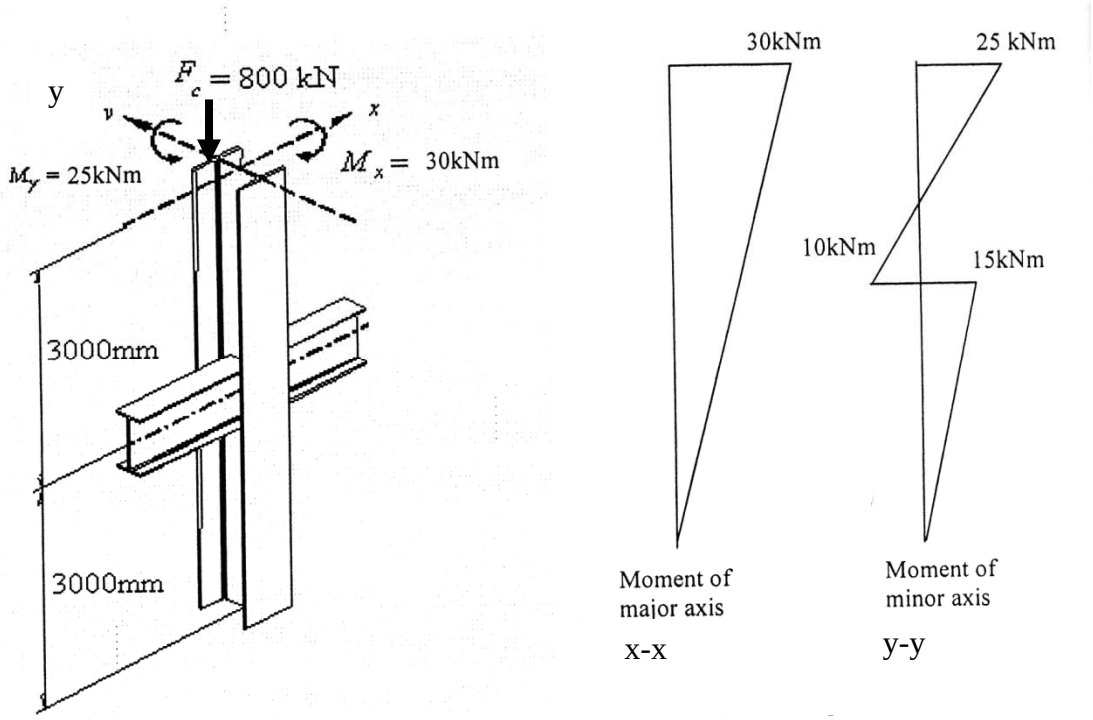
[15 Markah]



Rajah 3: Sebahagian daripada pandangan pelan bangunan

5. *Satu tiang keluli 203 x 203 x 52 UC S275 dikekang pada satu arah seperti dalam Rajah 4. Semak samada keratan 203 x 203 x 52 UC S275 mencukupi untuk tiang tersebut. Anggap kedua-dua hujung tiang adalah sambungan pin. Rujuk Lampiran 2 untuk data ciri-ciri keratan (Section Properties).*

[20 Markah]



Rajah 4 : Moment dan beban paksi yang dikenakan pada tiang

6. a) *Bincangkan pertimbangan rekabentuk anggota lenturan bagi perkara-perkara berikut:*

   i) Tegasan ricih

   ii) Tegasan lenturan

   iii) Pesongan

[10 Markah]

b) *Pertimbangkan sebuah tiang yang dibebani dengan beban paksi (beban hidup dan beban mati) sebanyak 60 kN. Panjang sebenar tiang adalah 4.7 m. Tiang diikat tegar pada satu hujung dan dipin pada satu hujung lagi. Kayu adalah gred standard, SG3, hijau (basah) >19%. Tiang menanggung beban jangka sederhana dan tiada kongsi beban. Tentukan saiz tiang. Anggap* E_{min} *= 9800 N/mm*^{2}.

[10 Markah]

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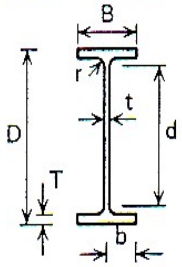
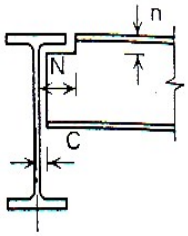
APPENDIX 1 / LAMPIRAN 1

BS 5950-1: 2000
BS 4-1: 1993

UNIVERSAL BEAMS



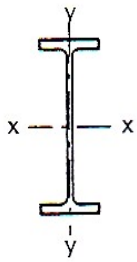


DIMENSIONS

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
											N	n		
	kg/m	D mm	B mm	t mm	T mm	r mm	d mm	b/T	d/t	C mm	mm	mm	m^2	m^2
406x140x46	46.0	403.2	142.2	6.8	11.2	10.2	360.4	6.35	53.0	5	78	22	1.34	29.2
406x140x39	39.0	398.0	141.8	6.4	8.6	10.2	360.4	8.24	56.3	5	78	20	1.33	34.2
356x171x67	67.1	363.4	173.2	9.1	15.7	10.2	311.6	5.52	34.2	7	94	26	1.38	20.6
356x171x57	57.0	358.0	172.2	8.1	13.0	10.2	311.6	6.62	38.5	6	94	24	1.37	24.1
356x171x51	51.0	355.0	171.5	7.4	11.5	10.2	311.6	7.46	42.1	6	94	22	1.36	26.7
356x171x45	45.0	351.4	171.1	7.0	9.7	10.2	311.6	8.82	44.5	6	94	20	1.36	30.1

BS 5950-1: 2000
BS 4-1: 1993

UNIVERSAL BEAMS



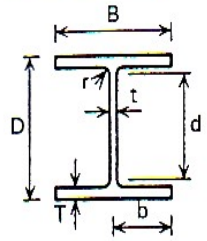
PROPERTIES

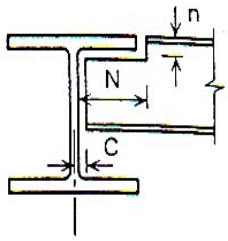
Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y					
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	u	x	H dm^6	J cm^4	A cm^2
406x140x46	15700	538	16.4	3.03	778	75.7	888	118	0.872	39.0	0.207	19.0	58.6
406x140x39	12500	410	15.9	2.87	629	57.8	724	90.8	0.858	47.5	0.155	10.7	49.7
356x171x67	19500	1360	15.1	3.99	1070	157	1210	243	0.886	24.4	0.412	55.7	85.5
356x171x57	16000	1110	14.9	3.91	896	129	1010	199	0.882	28.8	0.330	33.4	72.6
356x171x51	14100	968	14.8	3.86	796	113	896	174	0.881	32.1	0.286	23.8	64.9
356x171x45	12100	811	14.5	3.76	687	94.8	775	147	0.874	36.8	0.237	15.8	57.3

APPENDIX 2 / LAMPIRAN 2

BS 5950-1: 2000
BS 4-1: 1993

UNIVERSAL COLUMNS





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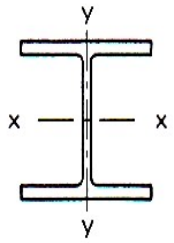
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		D	B	t	T	r	d	b/T	d/t	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
203x203x52	52.0	206.2	204.3	7.9	12.5	10.2	160.8	8.17	20.4	6	110	24	1.20	23.0

BS 5950-1: 2000
BS 4-1: 1993

UNIVERSAL COLUMNS



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Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y					
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	u	x	H dm^6	J cm^4	A cm^2
203x203x52	5260	1780	8.91	5.18	510	174	567	264	0.848	15.8	0.167	31.8	66.3