UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2006/2007

April 2007

EAS 354/3 – REKABENTUK STRUKTUR KAYU & KELULI

Masa : 3 jam

Please check that this examination paper consists of FOURTEEN pages of printed material including appendices before you begin the examination.
[Sila pastikan kertas peperiksaan ini mengandungi EMPAT BELAS muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]

Instructions: Answer **FIVE** questions only. All questions carry the same marks.
[**Arahan**: Jawab ***LIMA*** soalan sahaja. Semua soalan membawa jumlah markah yang *sama.]*

You may answer the question in English except one question should be answered in Bahasa Malaysia.
[Anda dibenarkan menjawab soalan dalam Bahasa Inggeris kecuali satu soalan mestilah dijawab dalam Bahasa Malaysia.]

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. Ruang pejalan kaki berbumbung kaca dibina menggunakan sebaris tiang dan rasuk kayu. Rasuk digunakan untuk menyokong bumbung kaca manakala tiang membawa beban daripada rasuk seperti yang ditunjukkan dalam Rajah 1(a) dan (b). Semak kesesuaian tiang jika kayu bergergaji (50 x 100) digunakan.

   Data:

   Tiang: SG 3, kering, standard

Beban mati termasuk berat sendiri dan panel kaca	0.32 kN/m^2
Beban kenaan	0.75 kN/m^2

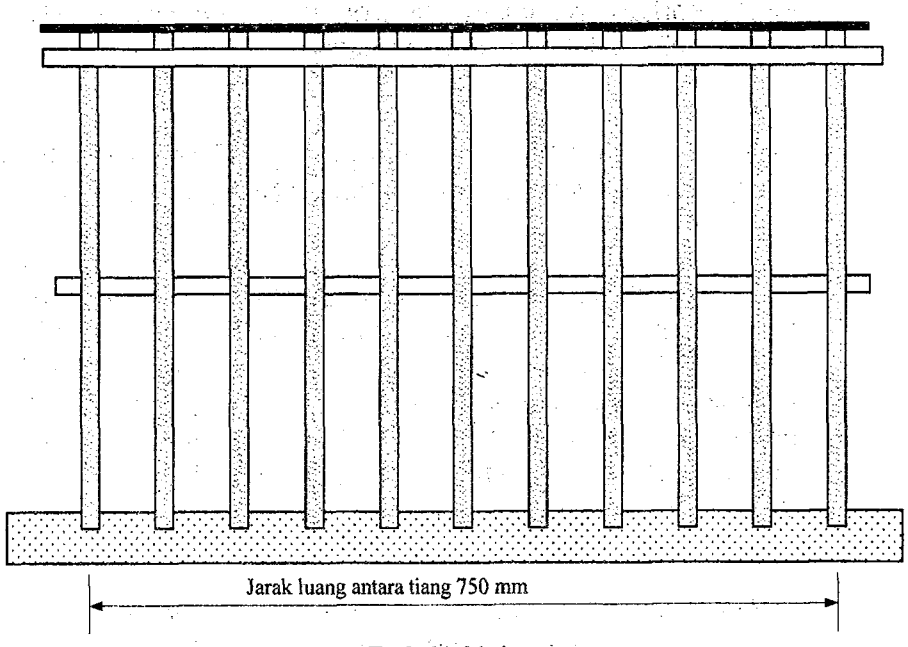
   (20 markah)

   A glazed covered walkway is to be constructed using a series of timber columns and timber beams as shown in Figure 1(a) and (b). The beams are supporting the glazed roof while the columns are carrying loads from the beams. Check the suitability of the columns (50 x 100) if the fullsawn timber is to be used.

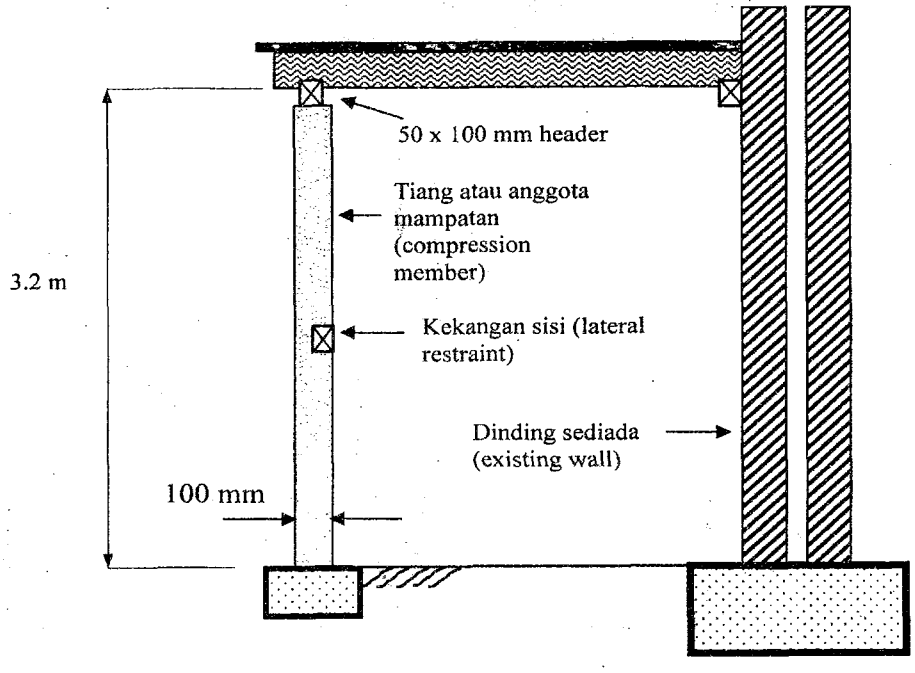
   Data:

   Columns: SG3, dry, Standard

Dead load including selfweight of glazing panels	*0.32 kN/m^2*
Imposed load	*0.75 kN/m^2*



Rajah 1(a)



Rajah 1(b)

2. (a) Huraikan dengan ringkas tujuan pengredan struktur kayu dilakukan berdasarkan penilaian ciri-cirinya seperti kecacatan, kecerunan ira, penyerpihan, lubang dan sebagainya.

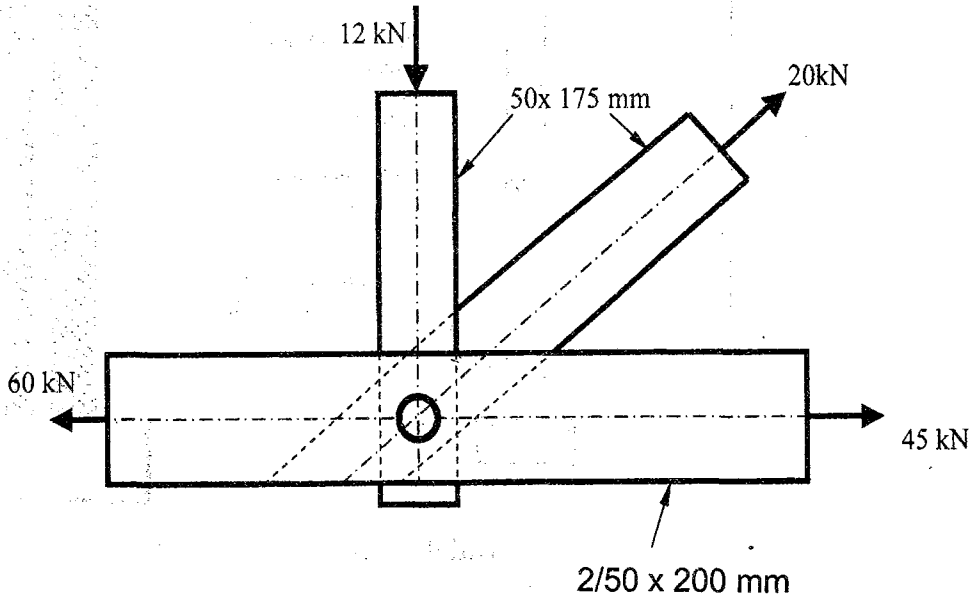
(5 markah)

Briefly describe the purpose of grading of structural timbers by assessing its characteristics such as defects, slope of grain, wane, holes etc.

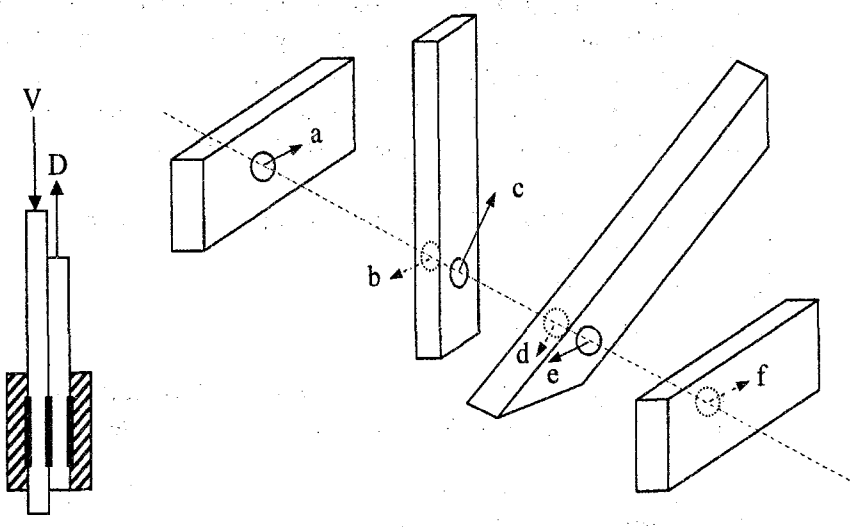
(b) Rajah 2(a) dan (b) menunjukkan sambungan pengikat gelang-belah untuk kekuda menggunakan kumpulan sabungan SG1 kayu kering dan gelang belah, 102 mm. Daya 'a' dan 'f' seperti yang ditunjukkan dalam rajah berasingan adalah bertindak selari terhadap dengan anggota manakala daya-daya anggota yang lain adalah bersudut terhadap paksi anggota. Daya 'b' adalah bersudut 90° dengan ira. Isikan nilai-nilai yang diperlukan dalam Jadual 1 di Lampiran.

(15 markah)

Figure 2(a) and (b) show the split-ring connector joint of trusses using joint group SG2 dry timber and 102 mm split rings. Forces 'a' and 'f' as shown in the isolated view of the joint are acting parallel to the outer members, while the other forces are at an angle to the axis of each member. For force 'b', the angle to the grain is 90°. Fill in all the required values as shown in Table 1. (in Appendix).



Rajah 2.0 (a)



Rajah 2.0 (b)

3. [a] Berdasarkan pada jejari legaran, PAKSI manakah antara berikut akan menyebabkan lengkokan setempat.

(i) Keratan-I (254 x 254 x 107 UC)
(r_{xx} = 11.3 cm, r_{yy} = 6.57cm)

(ii) Keratan sesiku (200 x 200 x 20)
(r_{xx} = 6.11 cm, r_{yy} = 6.11cm, r_{uu} = 7.70 cm, r_{vv} = 3.93cm)

(iii) Channnel-C PEWAJA STEEL (150 x 75 x 18.6)
(r_{xx} = 6.03 cm, r_{yy} = 2.22cm)

(3 markah)

Based on the radius of gyration which of the following AXIS will cause a local buckling.

(i) I-Section (254 x 254 x 107 UC)
(r_{xx} = 11.3 cm, r_{yy} = 6.57cm)

(ii) Angle Section (200 x 200 x 20)
(r_{xx} = 6.11 cm, r_{yy} = 6.11cm, r_{uu} = 7.70 cm, r_{vv} = 3.93cm)

(iii) C- Channel PEWAJA STEEL (150 x 75 x 18.6)
(r_{xx} = 6.03 cm, r_{yy} = 2.22cm)

3. [b] Rasuk keluli disokong mudah yang mempunyai rentang 7m diperlukan untuk menanggung beban mati 30kN/m dan beban kenaan 20kN/m teragih seragam. Papak menyediakan sistem kekangan sepenuhnya untuk rasuk tersebut. Jika keratan 457 x 191 x 82 UB (rasuk semesta) keluli Gred 275 (keratan terkimpal) digunakan untuk tujuan rekabentuk, semak kesesuaian keratan tersebut terhadap:

(i) Jenis kelas keratan (plastik, padat, separa padat atau langsing)
(ii) Ricihan
(iii) Lenturan
(iv) Pesongan

Untuk tujuan rekabentuk, abaikan lengkokan kilasan sisi. Pesongan maksimum disebabkan beban teragih seragam adalah $5\ wL^3/384EI$.

(Data asas rekabentukan untuk 457 x 191 x 82 rasuk semesta (UB) keluli Gred 275 adalah seperti berikut):

dalam keratan	(D) = 460.2 mm,
lebar keratan	(B) = 191.3mm,
ketebalan web	(t) = 9.9 mm,
ketebalan bebibir	(T) = 16.0 mm,
nisbah bebibir lengkokan setempat	(b/ T) = 5.98,
nisbah web lengkokan setempat	(d/t) = 41.2,
momen luas kedua	(I_{xx} = 37100 cm^4, I_{yy} = 1870 cm^4),
jejari kisaran	(r_{xx} =18.8 cm, r_{yy} = 4.23 cm),
modulus elastik	(Z_x = 1610 cm^3, Z_y = 196 cm^3),
modulus plastik	(S_x = 1830 cm^3, S_y = 304 cm^3),
luas keratan	(A_g = 105cm^2)

(17 markah)

A simply supported steel beam of 7 m span is required to carry uniformly distributed dead load and imposed load of 30 kN/m and 20kN/m, respectively. The floor slab provides fully restrained system to the beam. If a 457 x 191 x 82 UB Grade 275 steel (welded section) is used for design purpose, check the adequacy of the section in term of:

(i) Types of Class Section (plastic, compact, semi-compact or slender)
(ii) Shear
(iii) Bending
(iv) Deflection

For design purpose, the lateral torsional buckling of the section may be neglected. Maximum deflection due to UDL is $5\ wL^3/384EI$*).*

(The basic design data of 457 x 191 x 82 UB Grade 275 steel are as follows):

depth of section	*(D) = 460.2 mm,*
width of section	*(B) = 191.3mm,*
web thickness	*(t) = 9.9 mm,*
flange thickness	*(T) = 16.0 mm,*
ratio of flange for local buckling	*(b/ T) = 5.98,*
ratio of web for local buckling	*(d/t) = 41.2,*
second moment of area	*(I_{xx} = 37100 cm^4, I_{yy} = 1870 cm^4),*
radius of gyration	*(r_{xx} =18.8 cm, r_{yy} = 4.23 cm),*
elastic modulus	*(Z_x = 1610 cm^3, Z_y = 196 cm^3),*
plastic modulus	*(S_x = 1830 cm^3, S_y = 304 cm^3),*
area of section	*(A_g = 105cm^2)*

4. [a] Lakarkan hubungan di antara Momen (M) dan Kelengkungan (Φ) untuk tiang keluli yang dikenakan momen lenturan.

(2 markah)

Sketch the relationship between Moment (M) and Curvature (Φ) for steel column subjected to bending moment.

[b] Menggunakan graf yang sama, lukis hubungan antara tegasan dan terikan untuk jenis keratan keluli berikut.

(i) Keratan plastik
(ii) Keratan padat
(iii) Keratan separa padat
(iv) Keratan langsing

(4 markah)

Using the same graph, draw the relationship between stress and strain for the following types of steel section classification.

(i) Plastic section
(ii) Compact section
(iii) Semi-compact section
(iv) Slender section

4. [c] Tiang keluli Gred 275 mempunyai panjang berkesan 5.0 m pada kedua-dua paksi direkabentuk untuk menanggung beban paksi dari papak. Jika keratan 356 x 368 x 129 UC (rasuk semesta) digunakan, tentukan momen muktamad beban yang boleh dikenakan pada tiang tersebut. Swa-berat rasuk tersebut boleh diabaikan.

(14 markah)

(Data asas rekabentuk untuk 356 x 368 x 129 tiang semesta (UC) keluli Gred 275 adalah seperti berikut)

dalam keratan	(D) = 355.6 mm,
lebar keratan	(B) = 368.3 mm,
ketebalan web	(t) = 10.7 mm,
ketebalan bebibir	(T) = 17.5 mm,
nisbah bebibir lengkokan setempat	(b/ T) = 10.5,
nisbah web lengkokan setempat	(d/t) = 27.1,
luas momen kedua	(I_{xx} = 40200 cm^4, I_{yy} = 14600 cm^4),
jejari legaran	(r_{xx} =15.6 cm, r_{yy} = 9.36 cm),
modulus elastik	(Z_x = 2260 cm^3, Z_y = 790 cm^3),
modulus plastik	(S_x = 2480 cm^3, S_y = 1200 cm^3),
luas keratan	(A_g = 165cm^2)

A Grade 275 steel column having 5.0 m effective length for both axes is to carry pure axial loads from the floor. If a cross section of 356 x 368 x 129 UC is used, determine the ultimate moment load that can be imposed on the column. The self weight of the column may be neglected.

(14 marks)

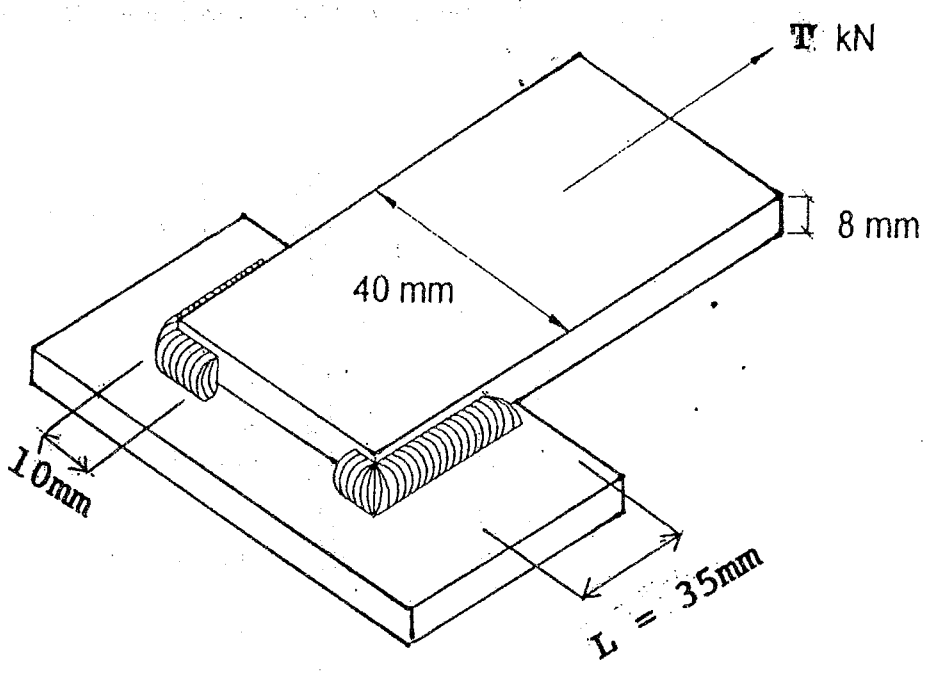
(The basic design data of 356 x 368 x 129 UC Grade 275 steel)

depth of section	*(D) = 355.6 mm,*
width of section	*(B) = 368.3 mm,*
web thickness	*(t) = 10.7 mm,*
flange thickness	*(T) = 17.5 mm,*
ratio of flange for local buckling	*(b/ T) = 10.5,*
ratio of web for local buckling	*(d/t) = 27.1,*
second moment of area	*(I_{xx} = 40200 cm^4, I_{yy} = 14600 cm^4),*
radius of gyration	*(r_{xx} =15.6 cm, r_{yy} = 9.36 cm),*
elastic modulus	*(Z_x = 2260 cm^3, Z_y = 790 cm^3),*
plastic modulus	*(S_x = 2480 cm^3, S_y = 1200 cm^3),*
area of section	*(A_g = 165cm^2)*

5. [a] Rajah 3 menunjukkan perincian tipikal kimpalan kambi yang menyambungkan 2 plat keluli. Nyatakan **DUA (2)** kesalahan perincian sekiranya panjang kaki kimpalan kambi adalah 6 mm.

(4 markah)

*Figure 3 shows the detailing of a typical fillet weld joining 2 mild steel plates. State **TWO (2)** detailing mistakes if the fillet weld leg length is 6 mm.*

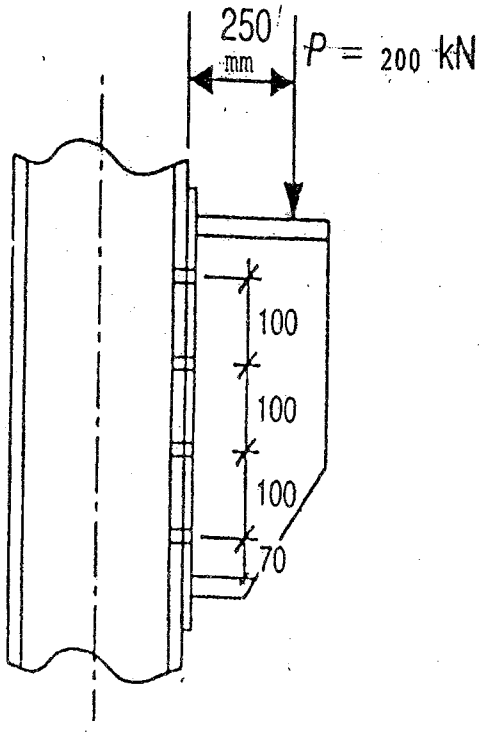


Rajah 3

5. [b] Rajah 4 menunjukkan sambungan tegar antara pendakap dan tiang keluli. Semak keupayaan **lapan (8)** bolt bersaiz namaan 16 mm dan gred 8.8 untuk merintang daya ricih 300 kN serta momen yang terhasil dari beban tumpu 200 kN. Anggap As (luas ricih bolt) dan At (luas tegangan bolt) sebagai 167mm^2.

(10 markah)

*Figure 4 shows a rigid connection of a corbel to column connection. Check the capacity of **eight (8)** bolts with 16 mm nominal diameter and grade 8.8 are capable to resist shear force 300 kN and moment due to point load 200 kN. Assume As (bolt shear area) and At (bolt tension area) as 167mm^2.*

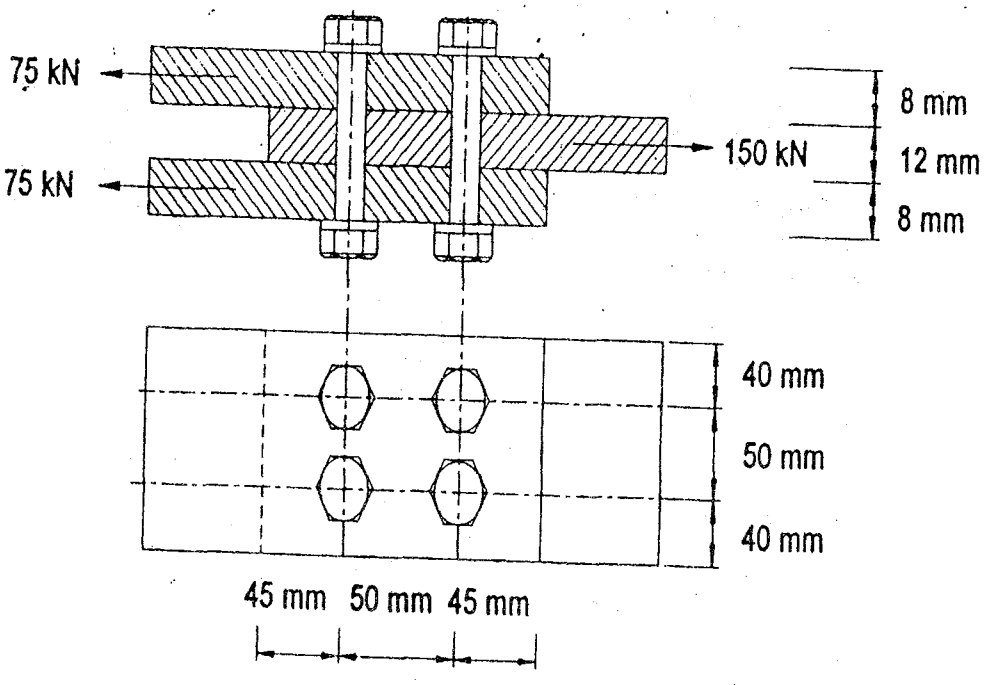


Rajah 4

5. [c] Salah satu mod kegagalan sambungan bolt pada plat keluli yang dikenakan daya tegangan adalah galas pada plat atau bolt. Tentukan keupayaan galas muktamad sambungan tersebut seperti di Rajah 5. Anggap penggunaan bolt bersaiz namaan 20 mm, gred 8.8, As (luas ricih bolt) dan At (luas tegangan bolt) sebagai 254 mm^2.

(6 markah)

One of the modes of failure for a bolt and mild steel plate connection is plate or bolt bearing. Determine the final bearing capacity of such connection as shown in Figure 5. Assume bolt nominal size 20 mm, grade 8.8, As (bolt shear area) and At (bolt tension area) as 254 mm^2.



Rajah 5

6. [a] Kedudukan sebenar gulung-gulung pada kekuda bumbung adalah penting. Sekiranya kedudukan gulung-gulung ini tidak dapat ditentukan secara relatif terhadap titik sambungan antara kasau dan anggota-anggota dalaman, terangkan kaedah mudah yang dibenarkan oleh Kod Amalan BS 5950 – 1 : 2000 untuk mengira momen lentur maksima anggota perentas. Sediakan lakaran yang bersesuaian

(5 markah)

The exact locations of purlins on a roof truss is important. If the exact locations of the purlins are not fixed relative to the points where the rafter is connected to the internal members, explain the simplified method allowed in the Code of Practice BS 5950 – 1 : 2000 to calculate maximum bending moment of the chord. Provide suitable sketch.

[b] Satu anggota perentas galang kekisi mengalami daya mampatan 400 kN dan momen lentur 30 kNm. Semak kesesuaian penggunaan keratan geronggang tergelek panas segiempat sama 150 mm x 150 mm x 5 mm SHS gred keluli S 275 sebagai anggota perentas. **Abaikan semakan keupayaan lengkokan anggota**. Gunakan data-data yang diberikan:-

i) L_{Ex} = 3000 mm
ii) L_{Ey} = 1200 mm
iii) Jenis sambungan = kimpalan

(15 markah)

*A chord member of a lattice truss experiencing compression force 400 kN and bending moment 30 kN. Check the adequacy of using 150 mm x 150 mm x 5 Hot Formed Square Hollow Section (SHS) grade S 275 as chord member. **Ignore the member buckling resistance check**. Use the data given:-*

i) L_{Ex} = *3000 mm*
ii) L_{Ey} = *1200 mm*
iii) Type of connection = welding

LAMPIRAN

Jadual 1

Bil. Pengikat			
1. Daya ke atas pengikat *(Force on member)* 2. Anggota *(Member)*			
3. Beban ke atas pengikat *(Load on connector)*			
4. Sudut beban terhadap ufuk *(Angle of load to horizontal)* 5. Sudut anggota terhadap ufuk *(Angle of member to horizontal)* 6. Sudut beban terhadap ira *(Angle of load to grain)* 7. Paksi sudut pengikat terhadap ira *(Angle of connector axis to grain)*			
8. Ketebalan anggota *(Member thickness)* 9. Bilangan muka pengikat *(No. of connector axis to grain)*			
10. Beban asas (kN) *(Basic load [kN])* Selari *(Par)* P Serenjang *(Perp)* Q Digunakan *(To use)* N			
11. Jarak hujung [mm] *(End distance [mm])* Dibebani *(Loaded)* Tanpa dibebani *(Unloaded)* Faktor *(factor)*			
12. Jarak Tepi [mm] *(Edge distance [mm])* Dibebani *(Loaded)* Tanpa dibebani *(Unloaded)* Faktor *(Factor)* 13. Ruang *(Spacing)* 14. Faktor yang kurang antara 11, 12 dan 13 *(Least of factor in 11, 12 and 13)* 15. Beban pengikat yang diizinkan (kN) *(Permissible connector load [kN])*			
16. Beban yang dibenarkan (kN) *(Allowable load [kN])*			

...14/-

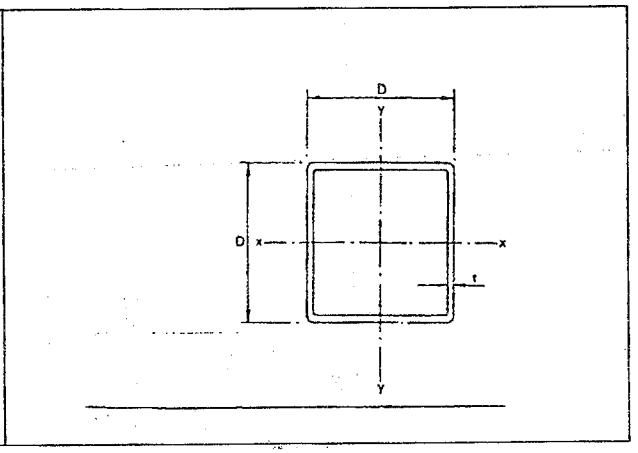
LAMPIRAN

-000O000-

SQUARE HOLLOW SECTIONS

To BS4848 : Part 2
Unless marked +

DIMENSIONS AND PROPERTIES



Designation		Mass Per Metre	Area Of Section	Second Moment Or Area	Radius Of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants	
Size	Thickness								
D D mm	t mm	kg	A cm^2	I cm^4	r cm	Z cm^3	S cm^3	J cm^4	C cm^3
150x150	5.0	22.7	28.9	1010	5.91	135	157	1550	197
	6.3	28.3	36.0	1240	5.86	165	194	1910	240
	8.0	35.4	45.1	1510	5.78	201	240	2350	291
	10.0	43.6	55.5	1800	5.70	240	290	2830	345
	12.5	53.4	68.0	2120	5.59	283	348	3370	403
	16.0	66.4	84.5	2500	5.44	333	421	4030	468