SULIT

Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER 1
SESI 2013/2014

NAMA KURSUS	:	REKABENTUK STRUKTUR
KOD KURSUS	:	DAC 31903
PROGRAM	:	3 DAA
TARIKH PEPERIKSAAN	:	DISEMBER 2013/JANUARI 2014
JANGKA MASA	:	3 JAM
ARAHAN	:	JAWAB **SEMUA** SOALAN DALAM BAHAGIAN A DAN **SATU(1)** SOALAN SAHAJA DARIPADA BAHAGIAN B.

KERTAS SOALAN INI MENGANDUNGI **DUA PULUH DUA (22)** MUKA SURAT

SULIT

SOALAN DI DALAM BAHASA MELAYU

BAHAGIAN A

S1 (a) Tentukan momen rintangan muktamad keratan rasuk seperti dalam **Rajah S1(a)** menggunakan blok tegasan dipermudah seperti dalam EC2. Diberi data seperti berikut:

Kekuatan ciri tetulang, f_{yk}	=	500 N/mm^2
Kekuatan ciri konkrit, f_{ck}	=	25 N/mm^2

(10 markah)

(b) Satu siri rasuk konkrit bertetulang pada sela 5.0 m dan panjang rentang 8.0 m ditupang mudah di atas dinding setebal 300 mm seperti dalam **Rajah S2 (b).** Saiz rasuk ialah 600 mm dalam dan 250 mm lebar serta membawa lantai konkrit bertetulang setebal 175 mm yang dianggap sebagai tupang mudah. Data lain diberi seperti berikut:

Kekuatan ciri tetulang, f_{yk}	=	500 N/mm^2
Kekuatan ciri konkrit, f_{ck}	=	30 N/mm^2
Berat konkrit	=	25 kN/m^3
Berat kemasan lantai	=	1.4 kN/m^2
Berat beban kenaan	=	3.0 kN/m^2
Penutup konkrit	=	30 mm

(i) Kirakan beban rekabentuk yang ditanggung oleh rasuk A dalam kN/m.

(5 markah)

(ii) Kirakan momen rekabentuk dan tindakbalas pada tupang.

(2 markah)

(iii) Kirakan tetulang utama yang diperlukan oleh rasuk.

(4 markah)

(iv) Semak luas tetulang tegangan minimum dan jarak maximum antara tetulang.

(4 markah)

S2 (a) Namakan **empat(4)** kelas keratan keluli mengikut BS5950.
(4 markah)

(b) **Rajah S2(b)** menunjukkan rasuk keluli utama AC bersaiz UB 406 x 78 x 74 kg/m yang ditupang mudah di atas sesiku pada dua tiang serta membawa satu rasuk sekunder di B. Beban rekabentuk bagi rasuk utama AC adalah seperti yang ditunjukkan.

(i) Lakarkan gambarajah daya ricih dan momen lentur bagi rasuk AC serta tentukan nilai maksimum daya ricih dan momen lenturnya.
(6 markah)

(ii) Klasifikasi keratan rasuk.
(2 markah)

(iii) Semak keupayaan ricih rasuk pada tupang.
(3 markah)

(iv) Semak keupayaan momen rasuk.
(5 markah)

(v) Semak pesongan rasuk AC di bawah bebanan kebolehkhidmatan berdasarkan nilai berikut:

Beban kenaan, w_d(tidak difaktor) = 6 kN/m
Beban tumpu kenaan, W_i (tidak difaktor) = 18 kN

(Diberi formula pesongan maksimum, $\partial = \frac{5w_d L^4}{384EI} + \frac{W_i a^2 b^2}{3EIL}$)
(5 markah)

S3 (a) Namakan **empat (4)** jenis gred tegasan yang digunakan untuk kayu dalam MS544. Apakah maksud bagi setiap gred tegasan tersebut?

(6 markah)

(b) **Rajah S3 (b)** menunjukkan rasuk kayu utama yang rentangnya 4.5 m dan berada pada sela 3.0 m antara satu sama lain. Rasuk adalah ditupang mudah di atas dinding bata dan menanggung lantai kayu yang terdiri daripada papan dan gelegar berserta dengan plaster siling. Data rekabentuk lain diberi seperti berikut:

Jenis kayu	=	Kumpulan A, kering, gred standard.
Berat papan dan gelegar	=	0.23 kN/m^2
Berat siling	=	0.22 kN/m^2
Beban kenaan atas lantai	=	1.5 kN/m^2
Berat rasuk kayu(andaian)	=	0.6 kN

(i) Tentukan jumlah beban yang ditanggung oleh rasuk A.

(6 markah)

(ii) Kirakan momen lentur maksimum rasuk

(2 markah)

(iii) Tentukan saiz rasuk yang sesuai menggunakan tegasan lentur rasuk.

(5 markah)

(iv) Semak pesongan.
(Diberi formula untuk pesongan rasuk; $\mathbf{\Delta_{mak} = 5wL^4/384EI}$)

(4 markah)

(v) Semak kestabilan sisi rasuk.

(2 markah)

BAHAGIAN B

S4 (a) **Rajah S4(a)** menunjukkan satu tiang berembat bersaiz 400 mm x 300 mm dan ketinggian lantai ke lantai ialah 3000 mm. Tiang disambung ke rasuk yang secara monolitik. Diberi data seperti berikut:

$f_{ck} = 25$ N/mm^2
Beban paksi muktamad, $N_{ed} = 1280$ kN

Tentukan samada tiang adalah pendek atau langsing?

(8 markah)

(b) **Rajah S4(b)** menunjukkan sebatang tiang pendek yang dirembat bersaiz 300 mm x 275 mm dikenakan beban paksi muktamad 1280 kN dan momen 35 kNm pada paksi z-z dan 25 kNm pada paksi y-y. Data berikut diberi:

f_{yk}	= 500 N/mm^2
f_{ck}	= 30 N/mm^2
diameter link (andaian)	= 8 mm
main reinforcement (andaian)	= 20 mm
penutup konkrit	= 35 mm

(i) Tentukan samada tiang perlu direkabentuk sebagai lenturan satu paksi atau dwi-paksi.

(3 markah)

(ii) Rekabentuk tetulang utama dan link untuk tiang tersebut.

(7 markah)

(iii) Tentukan tetulang minimum yang diperlukan dan jarak antara link.

(5 markah)

(iv) Lakarkan butiran tiang.

(2 markah)

S5 **Rajah S5** menunjukkan satu kekuda bumbung yang disambung ke tiang di A dan J. Gulung-gulung diletakkan pada nod atas dan menanggung beban bumbung. Jarak antara kekuda ialah 5 m. Semua nod sambungan adalah dikimpal. Beban yang ditanggung oleh gulung-gulung dan kekuda diberi seperti berikut:

Berat pelapisan bumbung dan gulung-gulung(atas cerun) = 0.3 kN/m^2
Berat Kekuda(atas pelan) = 0.2 kN/m^2
Beban kenaan = 0.75 kN/m^2

(a) Rekabentuk gulung-gulung menggunakan keratan sesiku yang sesuai.
(8 markah)

(b) Kirakan beban rekabentuk pada nod atas kekuda.
(4 markah)

(c) Analisis menunjukkan anggota AB mengalami daya tegangan 59.1 kN. Rekabentukkan anggota AB menggunakan keratan geronggang segi-empat sama (SHS) dari gred S275.
(5 markah)

(d) Analisis juga menunjukkan anggota JH mengalami daya mampatan maksimum iaitu 76.5 kN. Semak samada keratan geronggang segi-empat sama (SHS) dari gred S275 bersaiz 50 x 50 x 3 adalah mencukupi. Kekuda di halang sisi di nod G dan E.
(8 markah)

S6 (a) (i) Plotkan hubungan antara kekuatan/kekukuhan dan kandungan lembapan kayu dan tunjukan titik tepu fiber (FSP).
(3 markah)

(ii) Berikan **empat (4)** faktor ubahsuai yang biasa digunakan dalam rekabentuk kayu.
(2 markah)

(b) Satu tiang kayu bersaiz 100 x 100 mm dan dikekang pada kedua hujungnya pada posisi tetapi bukan pada arah dikenakan beban paksi 10 kN serta momen lentur 350 kNm.. Diberi data berikut:

Jenis kayu = Meranti Bakau, kering
Bebanan = Jangka panjang
Tinggi tiang = 3.75 m

(i) Semak nisbah kelangsingan tiang.
(4 markah)

(ii) Semak kesesuaian tiang untuk menanggung beban di atas.
(16 markah)

SOALAN TAMAT

QUESTIONS IN ENGLISH

PART A

Q1 (a) Determine the ultimate moment of resistance of a cross-section of a beam as shown in **Figure S1(a)** using the simplified stress block in accordance to EC2. Given the following data:

Characteristic strength of steel, f_{yk} = 500 N/mm^2
Characteristic strength of concrete, f_{ck} = 25 N/mm^2

(10 marks)

(b) A series of reinforced concrete beams at 5 m centres and spanning 8.0 m are simply supported on walls of 300 mm thick. The size each beam is 600 mm deep and 250 mm width and carry a reinforced concrete floor slab of 175 mm thick and is assumed to be simply supported. Given the following data:

Characteristic strength of steel, f_{yk}	=	500 N/mm^2
Characteristic strength of concrete, f_{ck}	=	30 N/mm^2
Weight of concrete	=	25 kN/m^3
Weight of floor finishes	=	1.4 kN/m^2
Imposed load on floor	=	3.0 kN/m^2
Concrete cover	=	30 mm

(i) Calculate the design load on beam A in kN/m.

(5 marks)

(ii) Calculate the design moment and reaction on the supports.

(2 marks)

(iii) Determine the main reinforcement needed for the beam.

(4 marks)

(iv) Check the minimum tension reinforcement and the maximum distance between bars.

(4 marks)

Q2 (a) Name the four(4) classes of steel section according to BS 5950.
(4 marks)

(b) **Figure S2(b)** shows a main beam AC of size UB 406 x 78 x 74 kg/m which is simply supported on angles between two columns and carries a secondary beam at B. The design loading on the main beam AC is as shown.

(i) Sketch the shear force and bending moment diagram of the main beam and calculate the maximum shear force and bending moment.
(6 marks)

(ii) Classify the beam cross-section.
(2 marks)

(iii) Check the shear capacity of the beam at the support.
(3 marks)

(iv) Check the moment capacity of the beam.
(5 marks)

(v) Check the deflection of beam AC under serviceability load based on the following values:

Imposed load, w_d (unfactored) = 6 kN/m
Point load, W_i (unfactored) = 18 kN

(Given the maximum deflection, $\partial = \frac{5w_d L^4}{384EI} + \frac{W_i a^2 b^2}{3EIL}$)
(5 marks)

Q3 (a) Name **four(4)** types of stress grade used for timber in MS544. What is the meaning for each stress grade?

(6 marks)

(b) **Figure S3(b)** shows timber beams spanning 4.5 m and spaced at 3.0 m centres. The beams are simply supported on brick walls and support a timber floor comprising of joists and boards with plaster ceiling. Given the following data:

Timber type	= Group A, dry, standard grade.
Weight of joists and boards	= 0.23 kN/m^2
Weight of plaster ceiling	= 0.22 kN/m^2
Imposed load on floor	= 1.5 kN/m^2
Weight of beam (assumed)	= 0.6 kN

(i) Determine the total load on beam A.

(6 marks)

(ii) Calculate the maximum bending moment.

(2 marks)

(iii) Determine the size of the beam based on the bending stress of the beam.

(5 marks)

(iv) Check the deflection.
(Given formula for deflection; $\mathbf{\Delta_{mak} = 5wL^4/384EI}$)

(4 marks)

(v) Check the lateral stability of the beam.

(2 marks)

PART B

Q4 (a) **Figure Q4(a)** shows a braced column of size 400 mm x 300 mm and has a floor to floor height of 3000 mm. The column is monolithically connected to the beams as shown . Given the following data:

$f_{ck} = 25$ N/mm^2
Ultimate axial load, $N_{ed} = 1280$ kN

Determine whether the column is short or slender.

(8 marks)

(b) **Figure Q4(b)** shows a short-braced column of size 300 x 275 mm is subjected to an ultimate axial load of 1280 kN and bending moments of 35 kNm about z-z axis and 25 kNm about y-y axis. Given the following data:

f_{yk}	= 500 N/mm^2
f_{ck}	= 30 N/mm^2
diameter of link(assume)	= 8 mm
main reinforcement (assume)	= 20 mm
Cover	= 35 mm

(i) Determine whether the column should be design as unaxial bending or biaxial biaxial bending.

(3 marks)

(ii) Design the main reinforcement and link for the column.

(7 marks)

(iii) Determine the minimum reinforcement required and the spacing between ties.

(5 marks)

(iv) Sketch the column details.

(2 marks)

Q5 **Figure Q5** shows a roof truss which is connected to a column at A and J. The purlins are positioned at the top nodes and support roof loads. The spacing of the truss is 5 m centre to centre. Welded connections are used at all nodes. The loads supported by purlins and truss are given as follows:

Roof cladding and purlin = 0.3 kN/m^2 (on slope)
Truss = 0.2 kN/m^2 (on plan)
Imposed load = 0.75 kN/m^2 (on plan)

(a) Design the purlin using suitable angle section.

(8 marks)

(b) Calculate the design load on the node on the upper chord.

(4 marks)

(c) An analysis shown that member AB is subjected to a tension force of 59.1 kN. Design member AB using hollow square section (SHS) of grade S275.

(5 marks)

(d) The analysis also shown that member JH is subjected to a maximum compression force of 76.5 kN. Check whether a hollow square section (SHS) of grade S275 and size 50 x 50 x 3 is sufficient. The truss is laterally restrained at node G and E.

(8 marks)

Q6 (a) (i) Plot a relationship between strength/stiffness and moisture content and show the Fibre Saturated Point (FSP) point .

(3 marks)

(ii) Give **four(4)** modification factors usually used in timber design.

(2 marks)

(b) A timber column of size 100 x 100 mm and is restrainted at both ends in position but not in direction is subjected to an axial load of 10 kN and bending moment of 350 kNm. Given the following data:

Timber species	= Meranti Bakau, dry
Loading	= Long term
Column height	= 3.75 m

(i) Check the slenderness ratio.

(4 marks)

(ii) Check the adequacy of the column to carry the loads.

(16 marks)

END OF QUESTION

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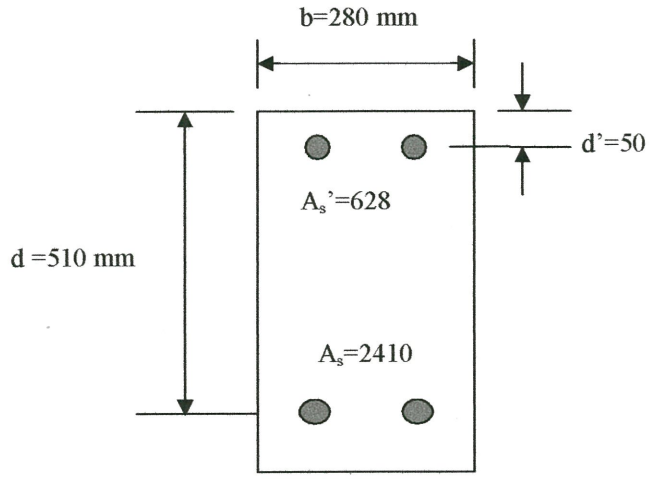
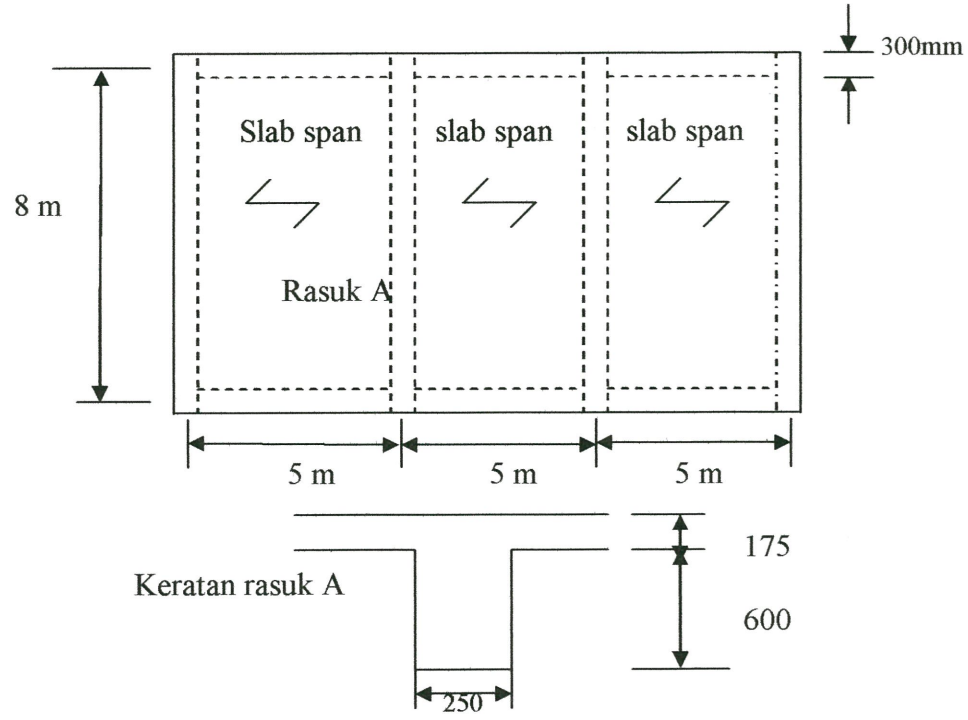


Rajah S1(a)/Figure Q1(a)



Semua ukuran dalam mm

Rajah S1(b)/Figure Q1(b)

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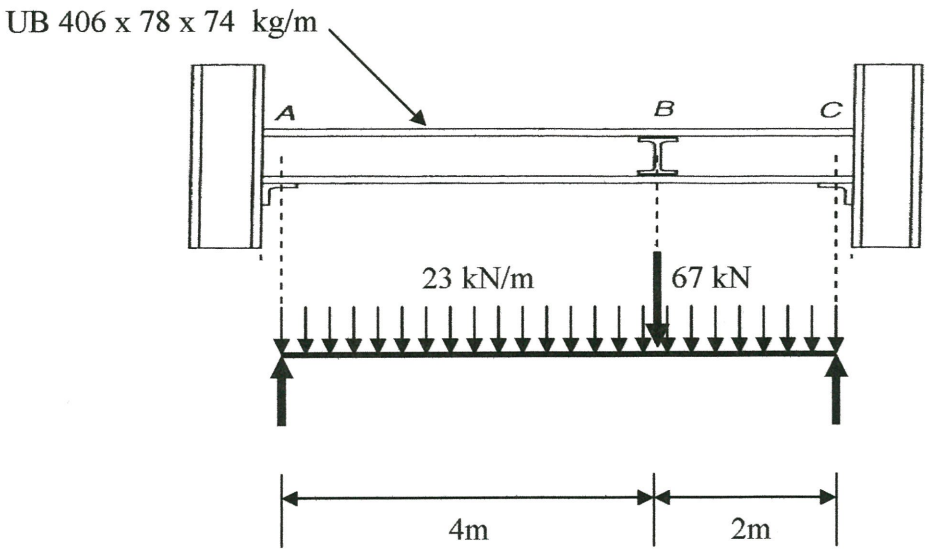
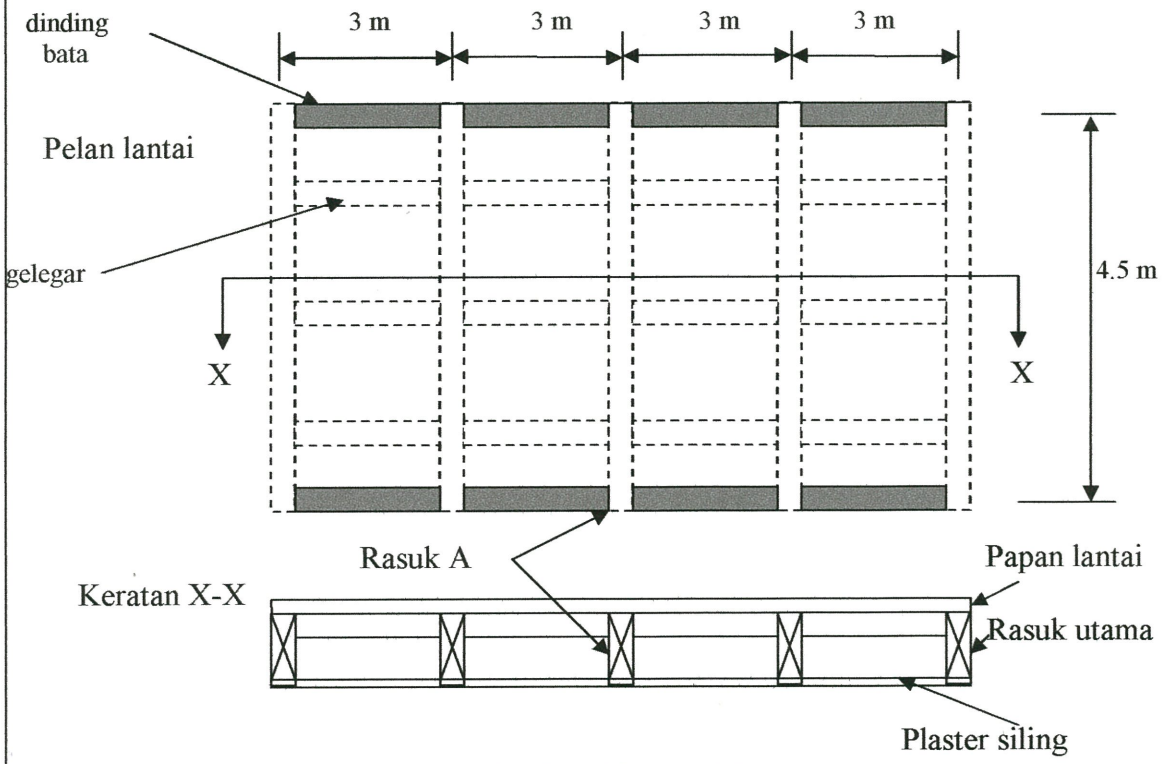


Rajah S2(b)/Figure Q2(b)



Rajah S3(b)/Figure Q3(b)

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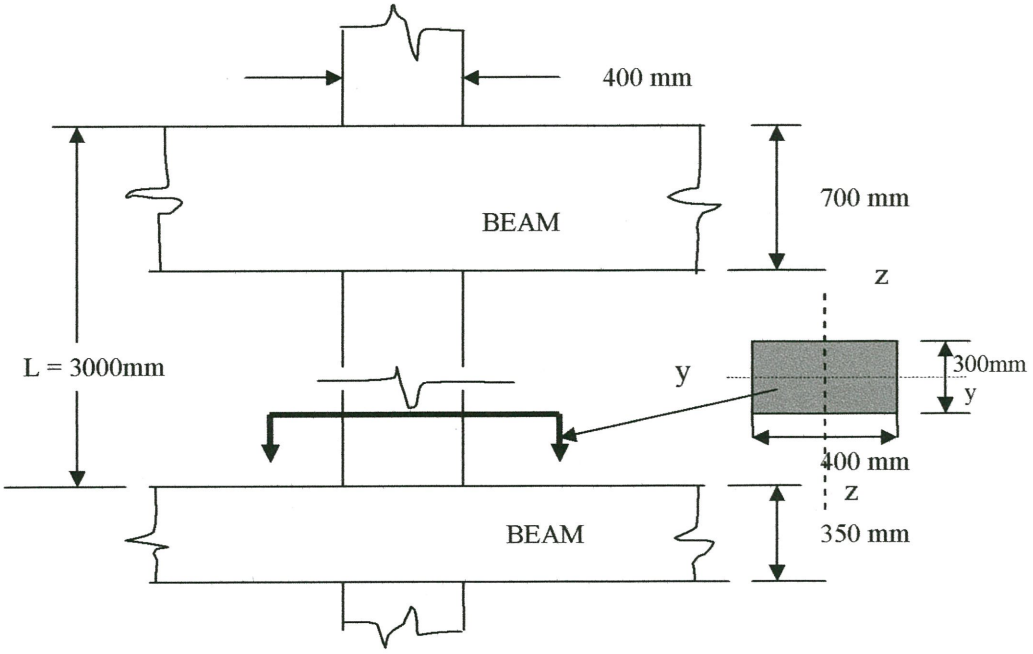
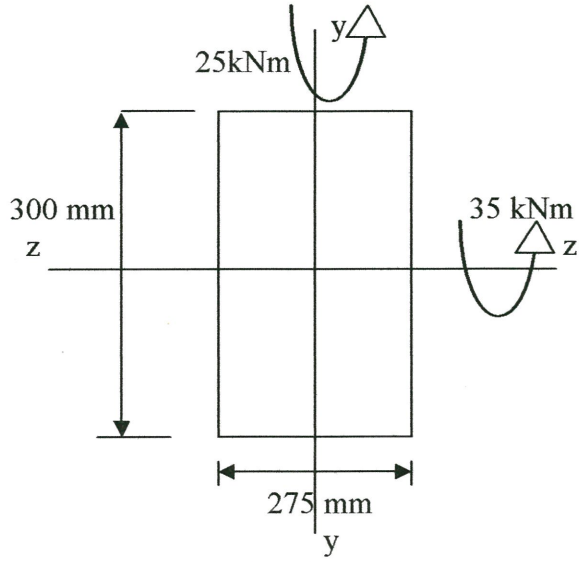


Rajah S4(a)/Figure Q4(a)



Rajah S4(b)/Figure Q4(b)

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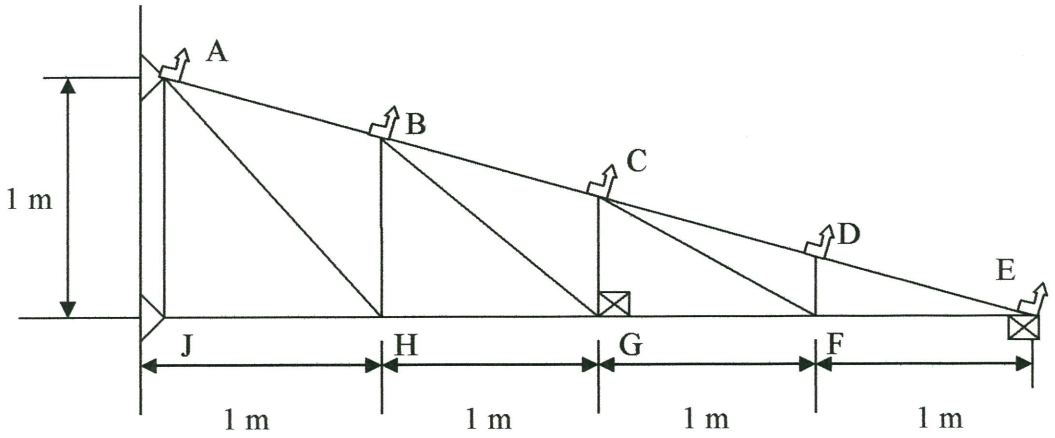

Rajah S5/Figure Q5

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LAMPIRAN 1

Jadual 1: Luas Keratan Rentas Menurut Saiz serta Bilangan Bar

Saiz Bar (mm)	Bilangan Bar								Ukur Lilit (mm)
	1	2	3	4	5	6	7	8	
6	28.3	56.6	84.9	113	141	170	198	226	*18.9*
8	50.3	101	151	201	251	302	352	402	*25.1*
10	78.6	157	236	314	393	471	550	629	*31.4*
12	113	226	339	453	566	679	792	905	*37.7*
16	201	402	603	805	1006	1207	1408	1609	*50.3*
20	314	629	943	1257	1571	1886	2200	2514	*62.9*
25	491	982	1473	1964	2455	2946	3438	3929	*78.6*
32	805	1609	2414	3218	4023	4827	5632	6437	*100.6*
40	1257	2514	3771	5029	6286	7543	8800	10057	*125.7*

Design Formula For Beam

$$K = M/bd^2f_{ck}$$

$$z = \frac{d}{2}\left[1+\sqrt{1-3.53K}\right] \le 0.95d$$

$$A_s = \frac{M_d}{0.87\, f_{yk}\, z}$$

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LAMPIRAN 2

If K > 0.167

$$z = \frac{d}{2}\left[1+\sqrt{1-3.53K'}\right]$$

$$A_s' = \frac{(K-K')f_{ck}bd^2}{0.87f_{yk}(d-d')}$$

$$A_s = \frac{K'f_{ck}bd^2}{0.87f_{yk}z_{bal}} + A_s'$$

Jadual 2: Minimum percentage of tensile reinforcement in beams and slabs

Conc. strength f_{ck} (N/mm^2)	25	28	30	32	35	40	45	50
Minimum % of reinforcement	0.14	0.15	0.15	0.16	0.17	0.19	0.20	0.22

This table uses $0.016f_{ck}^{2/3}$ as recommended by the *IStructE manual for the design of concrete building structures to Eurocode 2* in place of $0.0156f_{ck}^{2/3}$ in EC2.

Jadual 3: Maximum bar size or maximum bar spacing for 0.3-mm crack width limit for load-induced cracking in beams and in slabs more than 200 mm thick

Steel stress (N/mm^2): see note 1	**160**	**200**	**240**	**280**	**320**	**360**	**400**
Max. bar size	H32	H25	H16	H12	H10	H8	H6
Max. bar spacing (mm)	300	250	200	150	100	50	–

Notes:
(1) These rules do not apply to secondary or distribution reinforcement.
(2) The steel stress can be taken as $435(G_k + 0.8Q_k)/(1.35G_k + 1.50Q_k)$ N/mm^2, or conservatively as 320 N/mm^2.
(3) Cracks may be controlled by meeting either the max. bar spacing requirement *or* the max. bar size requirement. It is not necessary to meet both requirements. For example, if the steel stress is 280 N/mm^2 then either bars of size H12 or smaller can be used at any spacing or bars of any size can be used at a spacing of 150 mm or less.
(4) Data are from Tables 7.2N and 7.3N of EC2 Part 1-1.

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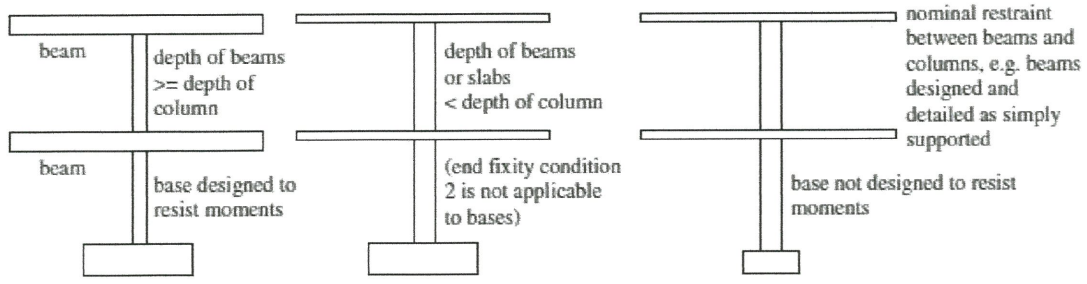
LAMPIRAN 3

Column Design

Jadual 4: Ends Fixity of reinforced concrete column

End condition at bottom	End condition at top		
	1	2	3
1	0.75	0.80	0.90
2	0.80	0.85	0.95
3	0.90	0.95	1.00

End fixity conditions, see Figure 3.26.
Condition 1: Column is connected monolithically to beams on each side that are at least as deep as the overall depth of the column in the plane considered. Where column is connected to a foundation this should be designed to carry moment.
Condition 2: Column connected monolithically to beams or slabs on each side that are shallower than the overall depth of the column in the plane considered but generally not less than half the column depth.
Condition 3: Column connected to members that do not provide more than nominal restraint to rotation.
Values taken from *IStructE Manual for the Design of Reinforced Concrete Building Structures to Eurocode 2.*



End fixity condition 1 End fixity condition 2 End fixity condition 3

Limiting l_0/b ratio = $\mathbf{6.19\sqrt{(bhf_{ck}/N_{Ed})}}$

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LAMPIRAN 4

Jadual 5 : Limits on longitudinal reinforcement in columns

Area of longitudinal reinforcement.	Not less than or Not more than or	$0.12N/f_{yk}$ $0.002bh$ $0.04bh$ generally $0.08bh$ at laps
Size of longitudinal reinforcement	Not less than	12 mm
Number of longitudinal bars	Not fewer than	4 in a square column 6 in a circular column

Jadual 6 : Limits on ties in reinforced concrete columns

Size of ties	Not less than or	main bar size/4 6 mm
Spacing of ties generally	Not less than or or	20 × main bar diameter the least column dimension 400 mm
Spacing of ties over a height equal to the larger dimension of the column above or below a beam or slab	Not more than or or	12 × main bar diameter 0.6 × the least column dimension 240 mm
Spacing of ties where longitudinal bars exceeding 12 mm in size are lapped	Not more than or or	12 × main bar diameter 0.6 × the least column dimension 240 mm

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LAMPIRAN 5

$\frac{e_z}{h} / \frac{e_y}{b} \geq 0.2$ and $\frac{e_y}{b} / \frac{e_z}{h} \geq 0.2$

(a) if $\frac{M_z}{h'} \geq \frac{M_y}{b'}$

then the increased single axis design moment is

$M'_z = M_z + \beta \frac{h'}{b'} \times M_y$

(b) if $\frac{M_z}{h'} < \frac{M_y}{b'}$

then the increased single axis design moment is

$M'_y = M_y + \beta \frac{b'}{h'} \times M_z$

Jadual 7: Coefficient of β

$\frac{N_{ED}}{bhf_{ck}}$	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	≥0.75
β	1.00	0.91	0.81	0.72	0.63	0.53	0.44	0.35	0.3

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LAMPIRAN 6

CHART NO 1

Column design chart for rectangular columns $d_2/h = 0.05$

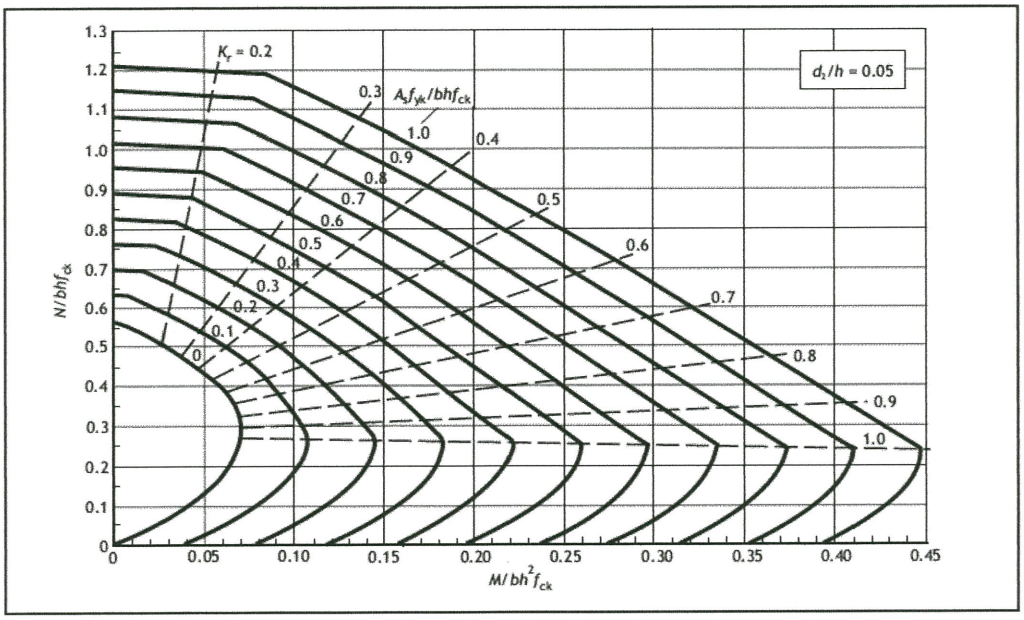
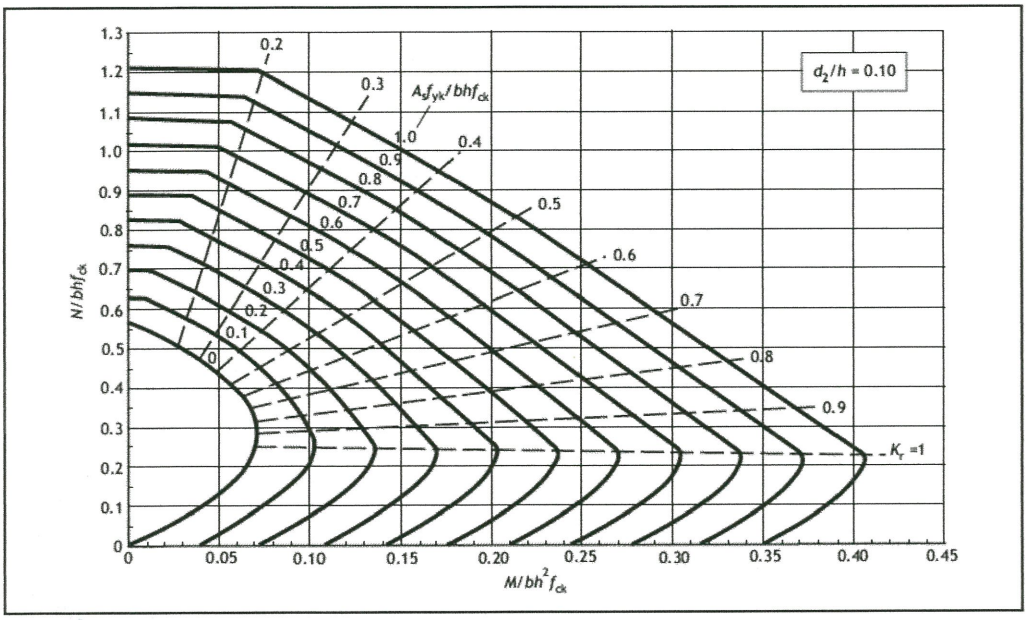


CHART NO 2

Column design chart for rectangular columns $d_2/h = 0.10$



PEPERIKSAAN AKHIR

SEMESTER/SESI : SEMESTER I/2013/2014 PROGRAM : 3DAA
KURSUS : REKABENTUK STRUKTUR KOD KURSUS : DAC31903

LAMPIRAN 7

CHART NO 3

Column design chart for rectangular columns $d_2/h = 0.15$

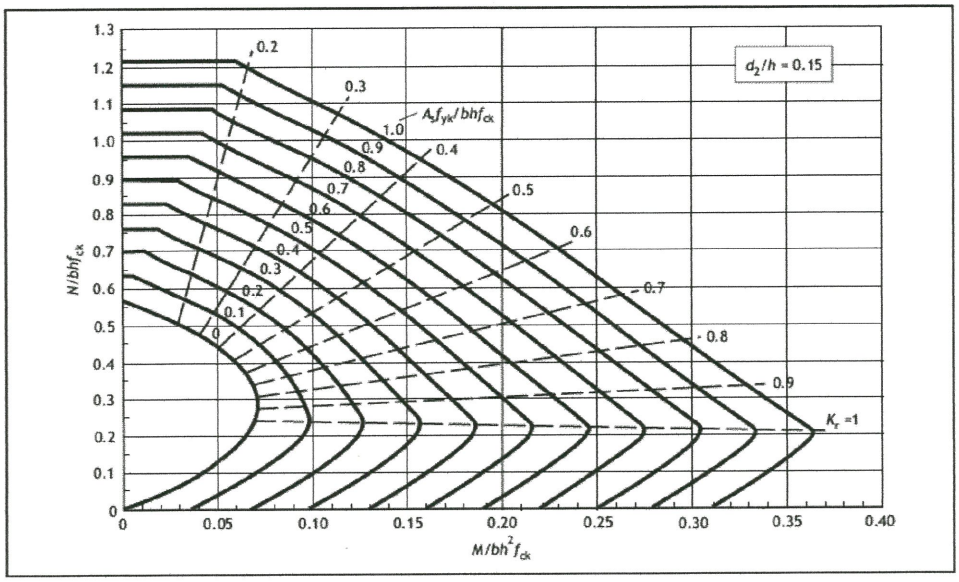


CHART NO 4

Column design chart for rectangular columns $d_2/h = 0.20$