UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2009/2010

SUBJECT NAME	:	REINFORCED CONCRETE DESIGN 1
SUBJECT CODE	:	BFC 3142
COURSE	:	3 BFF / 3 BFI
EXAMINATION DATE	:	APRIL 2010
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **THREE (3)** QUESTION ONLY

DESIGN SHOULD BE BASED ON:
BS 8110:PART 1:1997
BS 8110:PART 2:1985
BS 8110:PART 3:1985
BS 6399:PART 1:1996

THIS PAPER CONSIST OF FIFTEEN (15) PAGES

Q1 (a) What is structural design?

(2 marks)

(b) Why deflection and cracking are necessary to check in design process of reinforced concrete structures?

(2 marks)

(c) Explain the following phrases:

(i) Design load
(ii) Design strength
(iii) Serviceability

(6 marks)

(d) Given the following equations:

$$E_{c,28} = 20 + 0.2 f_{cu\ 28}\ (\text{kN/mm}^2) \quad \text{and} \quad E_c = 5.5\sqrt{\left(\frac{f_{cu}}{\gamma_m}\right)}\ (\text{kN/mm}^2)$$

Explain the meaning of the equations above (include notation used in that equation).

(5 marks)

(e) State the processes involve in design of reinforced concrete structure and briefly explain each of them.

(10 marks)

(f) Why do we use rectangular stress distribution in design? (Explain by using stress distribution in a concrete section)

(3 marks)

(g) From your opinion, why partial safety factor of concrete (γ_m = 1.50) greater than partial safety factor of steel reinforcement (γ_m – 1.05)? Discuss your opinion.

(2 marks)

Q2 Figure **Q2** shows a three span of continuous beam with span AB, BC and CD are 4 m, 6 m and 8 m respectively. The beam subjected to uniformly distributed dead load (including selfweight of beam) of 30 kN/m and imposed load of 24 kN/m on the whole span AB, BC and CD.

(a) Analyse the beam by considering maximum load case only. Use Moment Distribution Method with modified stiffness.

(10 marks)

(b) Draw the shear force and bending moment diagram of the beam by showing the importance values.

(8 marks)

(c) If end moment at support B and C are 20% reduced. Draw the bending moment diagram of the beam after moment redistribution.

(9 marks)

(d) Compare the results obtained from Q2(b) and Q2(c) and discuss the results.

(3 marks)

Q3 (a) Figure **Q3(a)** shows a cross section of reinforced concrete rectangular and flange beams. Draw the stress block diagram of each cross section and show all the important values.

(10 marks)

(b) Figure **Q3(b)** show a cross section of reinforced concrete T-beam. The beams is designed using concrete grade 30 and reinforcement grade 460.

(i) Calculate moment resistance of the section by using stress block diagram.

(8 marks)

(ii) If the applied moment increase 25% than the moment resistance obtained from Q3(b)(i), determine the area of reinforcement required.

(8 marks)

(c) In analysis of section, the neutral axis depth, x is the most important value either in singly or doubly reinforced section. As a design engineer, give your opinion why the neutral axis depth value is very important and how to determine that value?

(4 marks)

Q4 (a) The section of concrete block with a starter bar are shown in Figure **Q4(a)**. The anchorage length provided for the starter bar is 750 mm. If the concrete grade 30 and the reinforcement (Deformed type 2) grade 460 with diameter of 25 mm are used,

(i) calculate the bond stress, f_b between concrete and starter bar.

(3 marks)

(ii) calculate the maximum forces, f_s that can be resist by the anchorage length.

(4 marks)

(b) Figure **Q4(b)** shows the longitudinal section of reinforced concrete beam with different types of support condition. Sketch the curtailment of bars for each beams as suggested by *'Simplified Rules of Curtailment'* given in Clause 3.12.10, BS 8110: Part 1: 1997.

(9 marks)

(c) Figure **Q4(c)** shows a cross section of a rectangular beam subjected to the design moment of 210 kNm. Given the following data:

f_{cu} = 35 N/mm^2
Concrete cover, c = 25 mm

E_c = 13 kN/mm^2
E_s = 200 kN/mm^2

(i) Calculate the crack width at the bottom fibre of the beam.

(11 marks)

(ii) From the crack width obtained from Q4(c)(i), discuss your result if the required crack width is limited to 0.2 mm.

(3 marks)

Q5 (a) Figure **Q5(a)** shows a continuous beam supported at A, B and C with span AB and BC are 3.5 m and 6.5 m respectively. The beam is subjected to a uniformly distributed design load of 54 kN/m at span AB and 46 kN/m at span BC. From the result of analysis, the end moment at support B is 120 kNm. The cross section at mid span is shown in Figure **Q5(b)**. Given the following data:

f_{cu}	= 30 N/mm^2
f_y	= 460 N/mm^2
f_{yv}	= 250 N/mm^2
Concrete cover	= 30 mm
Diameter of main bar	= 20 mm
Diameter of compression bar	= 12 mm
Diameter of shear link	= 10 mm

(i) Sketch the shear force and bending moment diagrams of the beam by showing the important values.

(5 marks)

(ii) Design all required longitudinal reinforcement of the beam. Use effective width of 900 mm.

(9 marks)

(iii) Design the shear reinforcement at span BC.

(6 marks)

(iv) Check the deflection of span BC.

(4 marks)

(v) Draw the detailing of the beam for longitudinal section.

(4 marks)

(b) You are assigned to design a new convocation hall for Universiti Tun Hussein Onn Malaysia. From the design results obtained, the use of reinforced concrete beam for a very long span requires a very large cross section and it is not suitable to be used. As an engineer, suggest an alternative method to solve the problem.

(2 marks)

Q6 A continuous one-way slab as shown in Figure **Q6** is simply supported at A, B, C and D. The slab is subjected to uniformly distributed load of 20 kN/m (including self-weight). Given grade of concrete and reinforcement are C30 and 460 respectively. By considering the width of the slab is 1 m and exposed to mild conditions,

(a) determine the shear force and bending moment in the slab by using Table 3.12, BS 8110: Part 1: 1997.

(4 marks)

(b) design all the reinforcement required in slab.

(10 marks)

(c) check the shear resistance of the slab.

(7 marks)

(d) check the deflection and cracking of the slab.

(6 marks)

(e) From the visual inspection, some cracks were found at the bottom of slab panel. Give your opinion about the crack and suggest a suitable rectification method.

(3 marks)

S1 (a) Apakah yang dimaksudkan dengan rekabentuk struktur?

(2 markah)

(b) Mengapa semakan terhadap pesongan dan keretakan perlu dilakukan di dalam proses rekabentuk struktur konkrit bertetulang?

(2 markah)

(b) Terangkan penyataan berikut:

(i) Beban rekabentuk
(ii) Kekuatan rekabentuk
(iii) Kebolehkhidmatan

(6 markah)

(c) Diberi persamaan-persamaan berikut:

$$E_{c,28} = 20 + 0.2 f_{cu.28}\ (\text{kN/mm}^2) \quad \text{dan} \quad E_c = 5.5\sqrt{\left(\frac{f_{cu}}{\gamma_m}\right)}\ (\text{kN/mm}^2)$$

Terangkan maksud persamaan di atas (termasuk tetanda yang digunakan di dalam persamaan tersebut).

(5 markah)

(d) Nyatakan proses yang terlibat di dalam rekabentuk konkrit bertetulang dan terangkan setiap satu daripadanya.

(10 markah)

(e) Kenapa kita menggunakan taburan tegasan segiempat di dalam rekabentuk? (Terangkan dengan menggunakan taburan tegasan di dalam keratan konkrit).

(3 markah)

(f) Pada pendapat anda, mengapa faktor keselamatan separa bagi konkrit (γ_m = 1.50) lebih besar berbanding faktor keselamatan separa bagi tetulang keluli (γ_m = 1.05)? Bincangkan pendapat anda.

(2 markah)

Q2 Rajah **Q2** menunjukkan tiga rentang rasuk selanjar dengan rentang AB, BC dan CD masing-masing 4 m, 6 m dan 8 m. Rasuk dikenakan beban teragih seragam mati (termasuk berat sendiri) 30 kN/m dan beban kenaan 24 kN/m di atas keseluruhan rentang AB, BC dan CD.

(a) Analisis rasuk dengan mempertimbangkan beban maksimum sahaja. Gunakan Kaedah Agihan Momen dengan kekukuhan terubahsuai.

(10 markah)

(b) Lukiskan gambarajah daya ricih dan momen lentur bagi rasuk dengan menunjukkan nilai-nilai penting.

(8 markah)

(c) Sekiranya momen hujung pada penyokong B dan C dikurangkan sebanyak 20%. Lukiskan gambarajah momen lentur bagi rasuk selepas agihan semula.

(9 markah)

(d) Bandingkan keputusan yang diperolehi daripada Q2(b) dan Q2(c) dan bincangkan keputusan tersebut.

(3 markah)

S3 (a) Rajah **Q3(a)** menunjukkan keratan rentas rasuk konkrit bertetulang segiempat dan bebibir. Lukiskan gambarajah blok tegasan bagi setiap keratan rentas rasuk dan tunjukkan semua nilai-nilai penting.

(10 markah)

(b) Rajah **Q3(b)** menunjukkan keratan rentas rasuk T konkrit bertetulang. Rasuk direkabentuk menggunakan gred konkrit 30 dan gred tetulang 460.

(i) Kirakan momen rintangan bagi keratan dengan menggunakan gambarajah blok tegasan.

(8 markah)

(ii) Sekiranya momen yang dikenakan meningkat sebanyak 25% berbanding momen rintangan yang diperolehi daripada Q3(b)(i), tentukan luas tetulang yang diperlukan.

(8 markah)

(c) Di dalam analisis keratan, ukur dalam paksi neutral, x merupakan nilai yang sangat penting samada dalam keratan rasuk bertetulang tunggal atau keratan bertetulang berganda. Sebagai jurutera rekabentuk, berikan pendapat anda mengapa nilai ukur dalam paksi neutral adalah sangat penting dan bagaimana untuk menentukan nilai tersebut?

(4 markah)

S4 (a) Keratan blok konkrit dengan bar pemula ditunjukkan dalam Rajah **Q4(a)**. Panjang tambatan yang disediakan bagi bar pemula adalah 750 mm. Sekiranya gred konkrit 30 dan gred tetulang *(Deformed type 2)* 460 digunakan,

(i) kirakan tegasan ikatan, f_b yang wujud diantara konkrit dan bar pemula.

(3 markah)

(ii) kira daya maksimum, f_s yang boleh dirintangi oleh panjang tambatan tersebut.

(4 markah)

(b) Rajah **Q4(b)** menunjukkan keratan memanjang rasuk konkrit bertetulang dengan keadaan penyokong yang berbeza. Lakarkan pemotongan bar bagi setiap rasuk seperti yang telah dicadangkan oleh *'Simplified Rules of Curtailment'* yang dinyatakan pada Fasal 3.12.10, BS 8110: Part 1: 1997.

(9 markah)

(c) Rajah **Q4(c)** menunjukkan keratan rentas rasuk segiempat yang dikenakan momen rekabentuk sebesar 210 kNm. Diberikan data-data berikut:

f_{cu}	= 35 N/mm^2
Penutup konkrit, c	= 25 mm
E_c	= 13 kN/mm^2
E_s	= 200 kN/mm^2

(i) Kirakan lebar retak pada permukaan bawah rasuk.

(11 markah)

(ii) Daripada lebar retak yang diperolehi daripada Q4(c)(i), bincangkan keputusan anda sekiranya lebar retak yang dibenarkan telah dihadkan pada 0.2 mm.

(3 markah)

S5 (a) Rajah **Q5(a)** menunjukkan rasuk selanjar yang disokong di A, B dan C dengan rentang AB dan BC masing-masing 3.5 m dan 6.5 m. Rasuk dikenakan beban rekabentuk teragih seragam sebesar 54 kN/m pada rentang AB dan 46 kN/m pada rentang BC. Daripada keputusan analisis, momen hujung pada penyokong B adalah 120 kNm. Keratan rentas rasuk di pertengahan rentang ditunjukkan pada Rajah **Q5(b)**. Diberikan data-data berikut:

f_{cu}	= 30 N/mm^2
f_y	= 460 N/mm^2
f_{yv}	= 250 N/mm^2
Penutup konkrit	= 30 mm
Diameter tetulang utama	= 20 mm
Diameter tetulang mampatan	= 12 mm
Diameter tetulang ricih	= 10 mm

(i) Lakarkan gambarajah daya ricih dan momen lentur bagi rasuk dengan menunjukkan nilai-nilai penting.

(5 markah)

(ii) Rekabentuk semua tetulang memanjang yang diperlukan bagi rasuk. Gunakan lebar berkesan 1200 mm.

(9 markah)

(iii) Rekabentuk tetulang ricih pada rentang BC.

(6 markah)

(iv) Semak pesongan pada rentang BC.

(4 markah)

(v) Lukiskan perincian keratan memanjang bagi rasuk.

(4 markah)

(b) Anda telah ditugaskan untuk merekabentuk dewan konvokesyen yang baru bagi Universiti Tun Hussein Onn Malaysia. Daripada keputusan rekabentuk yang

diperolehi, penggunaan rasuk konkrit bertetulang bagi rentang yang sangat panjang memerlukan keratan rentas yang sangat besar dan ianya kurang bersesuaian untuk digunakan. Sebagai seorang jurutera, cadangkan kaedah alternatif untuk menyelesaikan masalah tersebut.

(2 markah)

S6 Papak sehala selanjar seperti yang tunjukkan pada Rajah **Q6** adalah disokong mudah pada A, B, C dan D. Papak dikenakan beban teragih seragam sebesar 20 kN/m (termasuk berat sendiri). Diberi gred konkrit dan tetulang masing-masing ialah C30 dan 460. Dengan mempertimbangkan lebar papak adalah 1 m dan keadaan dedahan adalah ringan,

(a) tentukan daya ricih dan momen lentur bagi papak dengan menggunakan Jadual 3.12, BS 8110: Part 1: 1997.

(4 markah)

(b) rekabentuk semua tetulang yang diperlukan oleh papak.

(10 markah)

(c) semak rintangan ricih bagi papak.

(6 markah)

(d) semak pesongan dan keretakan bagi papak.

(7 markah)

(e) Daripada pandangan kasar, terdapat beberapa retakan di bawah panel papak. Apakah pendapat anda tentang keretakan ini dan cadangkan satu kaedah untuk membaikinya.

(3 markah)

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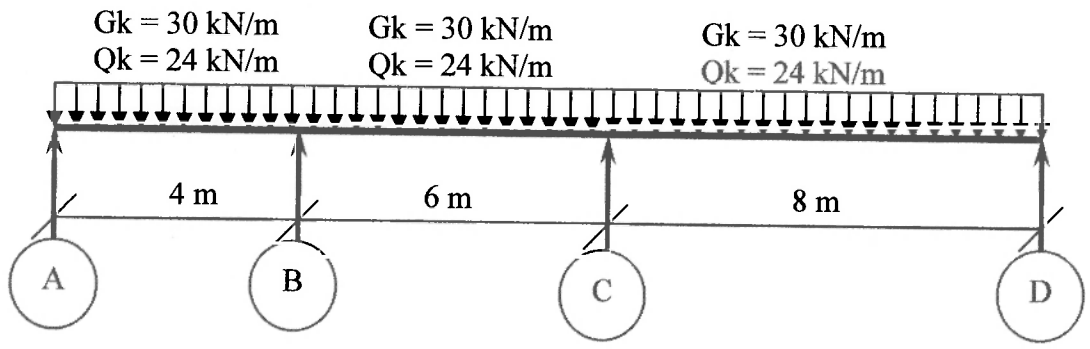

FIGURE O2

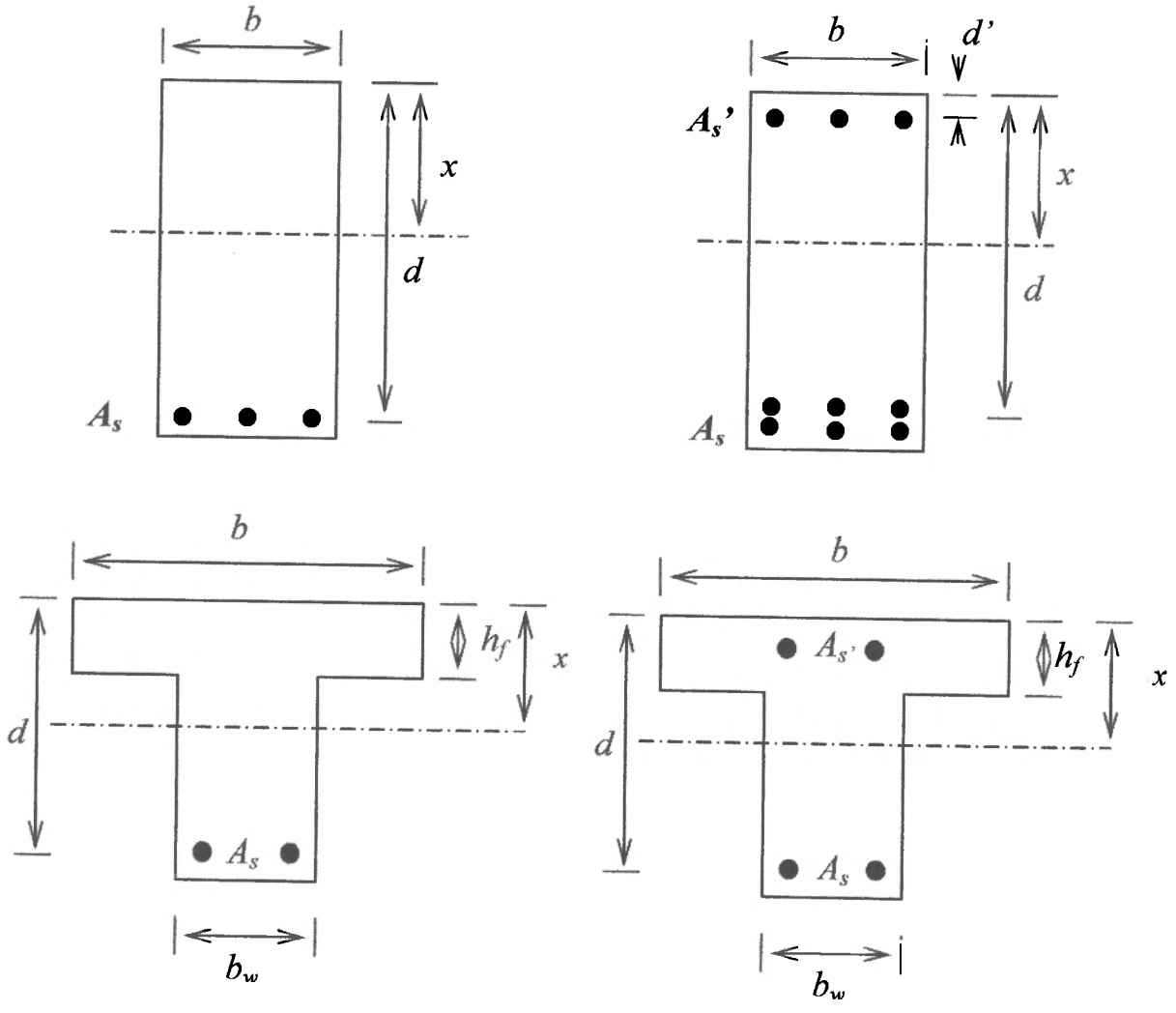

FIGURE O3(a)

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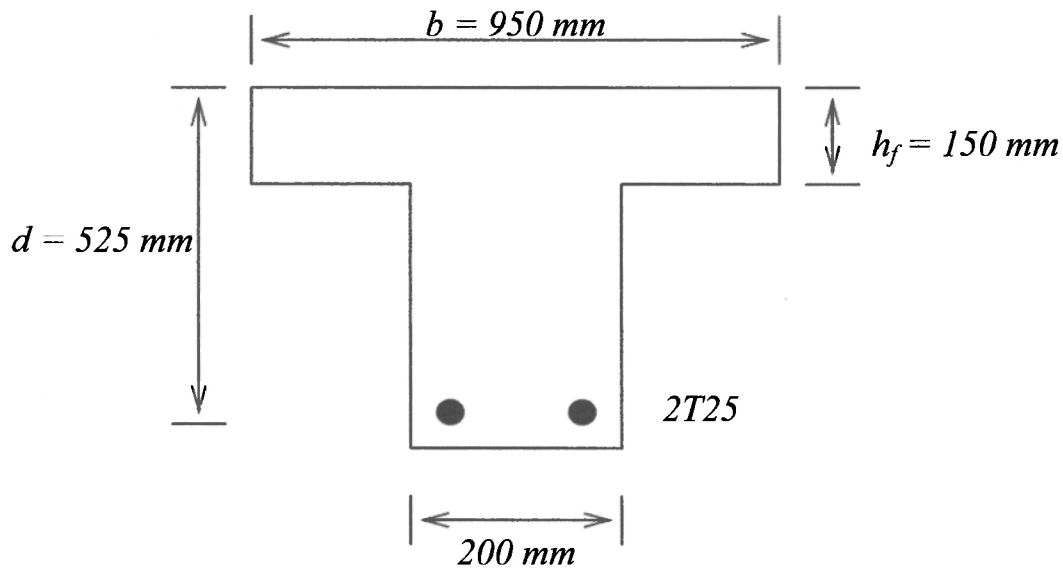

FIGURE Q3(b)

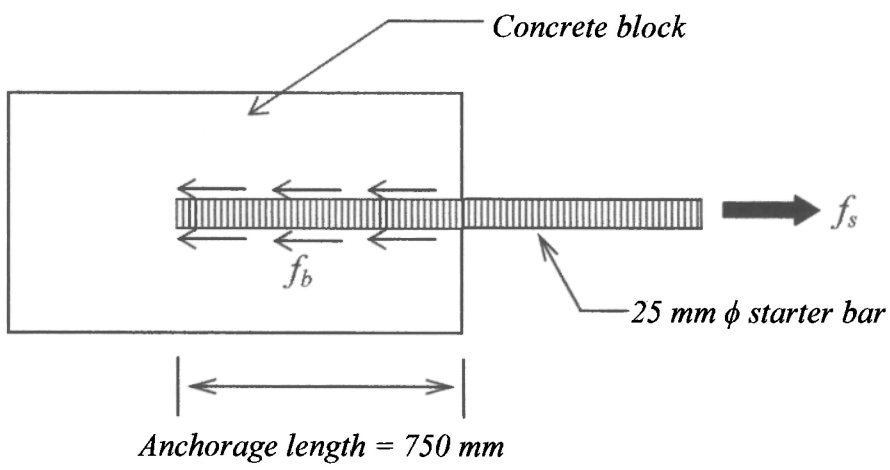

FIGURE Q4(a)

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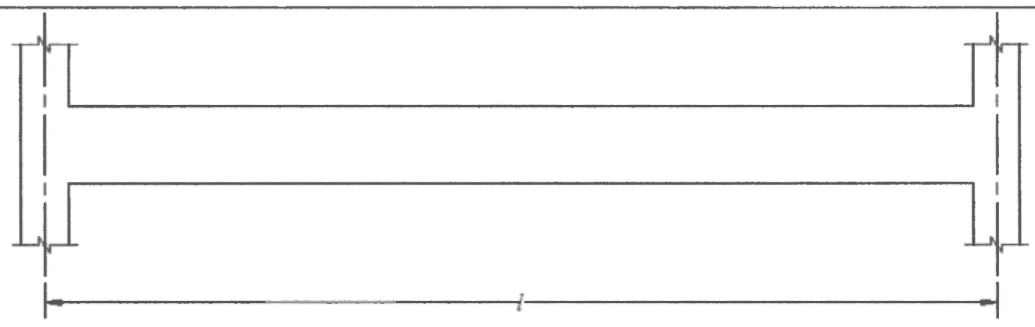
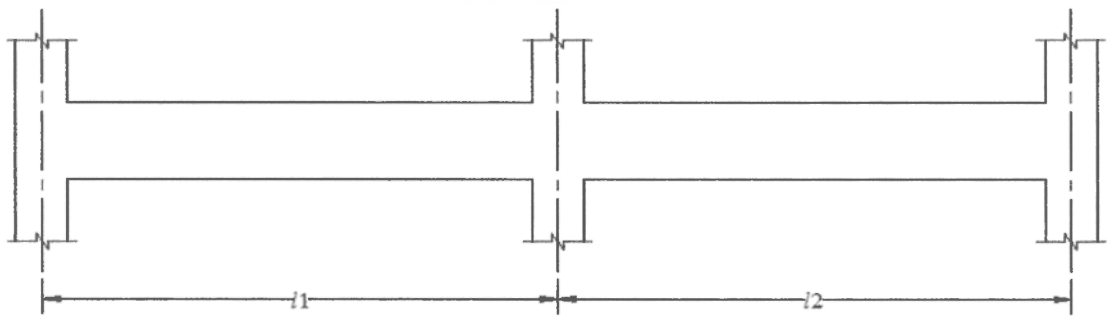
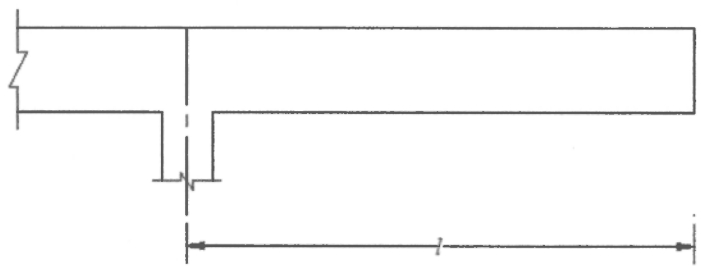


Simply supported beam

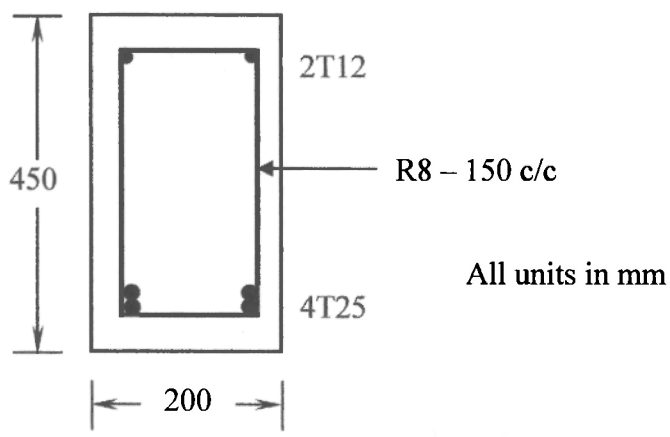


Continuous beam



Cantilever beam

FIGURE Q4(b)



All units in mm

FIGURE Q4(c)

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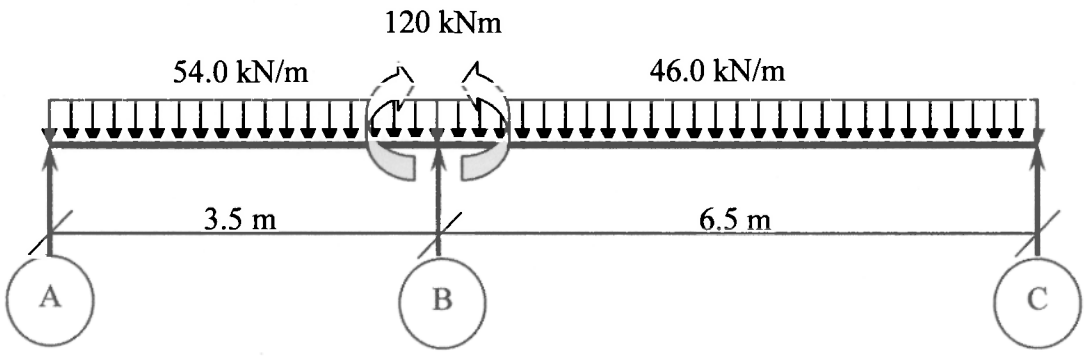

FIGURE Q5(a)

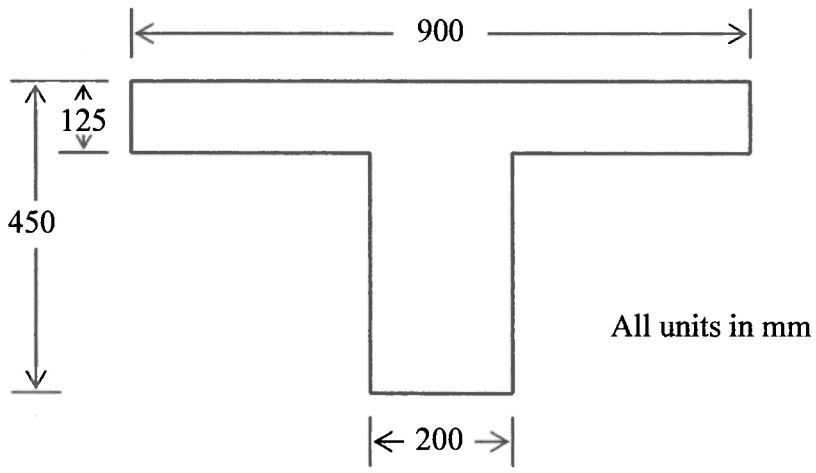

FIGURE Q5(b)

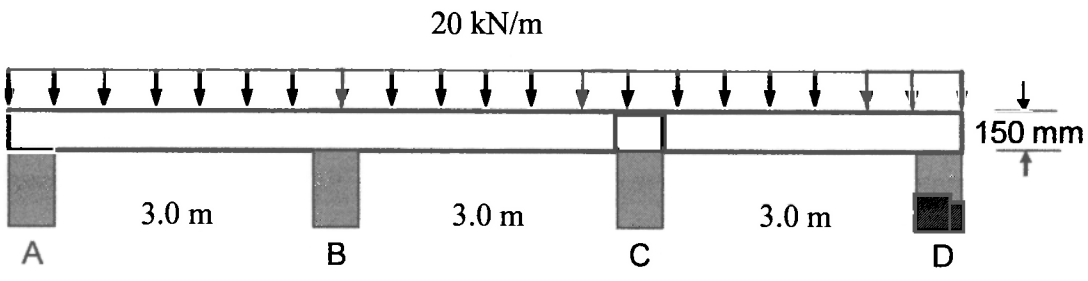

FIGURE Q6

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Table 1: Cross Sectional Area (mm^2) according to Size and Numbers of Bar

Bar Size (mm)	Number of bar								Perimeter (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

Table 2: Cross Sectional Area (mm^2) for every meter width at distance between bar

Bar Size (mm)	Distance between Bar (mm)								
	50	75	100	125	150	175	200	250	300
6	566	377	283	226	189	162	141	113	94
8	1006	670	503	402	335	287	251	201	168
10	1571	1048	786	629	524	449	393	314	262
12	2263	1509	1131	905	754	647	566	453	377
16	4023	2682	2011	1609	1341	1149	1006	805	670
20	6286	4190	3143	2514	2095	1796	1571	1257	1048
25	9821	6548	4911	3929	3274	2806	2455	1964	1637
32	16091	10728	8046	6437	5364	4598	4023	3218	2682
40	25143	16762	12571	10057	8381	7184	6286	5029	4190

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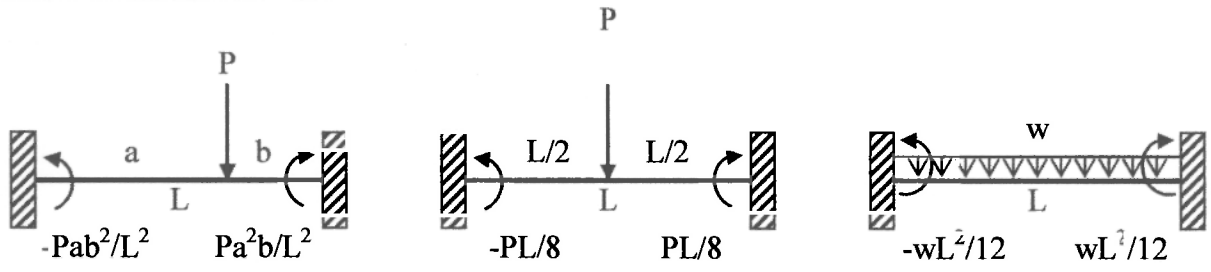
Fixed End Moment, FEM:



Crack width of flexural member

Depth of neutral axis, *x*

$$x = \left[-\alpha_e.\rho + \sqrt{\alpha_e.\rho(2+\alpha_e.\rho}\right]d$$

or;

$$\frac{1}{2}bx^2 + \frac{E_s}{E_c}A_s x - \frac{E_s}{E_c}A_s d = 0$$

Surface strain, ε_1

$$\varepsilon_1 = \left(\frac{h-x}{d-x}\right)\varepsilon_s$$

Strain due to stiffening effect, ε_2

$$\varepsilon_2 = \frac{1.0b_t(h-x)(a'-x)}{3E_s As(d-x)}$$

Crack width, *w*

$$w = \frac{3a_{cr}\varepsilon_m}{1+2\left(\frac{a_{cr}-c_{\min}}{h-x}\right)}$$