Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	REINFORCED CONCRETE DESIGN II
COURSE CODE	:	BFC 32803
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	A) ANSWER **ALL** QUESTIONS IN **SECTION A** AND **TWO (2)** QUESTIONS FROM **SECTION B.** B) ALL CALCULATION SHOULD BE BASED ON EN 1992-1.

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

SECTION A: ANSWER ALL QUESTIONS (40 MARKS)

Q1 Propose a suitable structural system for the staircase shown in Figure **Q1**. Provide necessary sketches or cross sections to show the system.

(8 marks)

Q2 (a) Discuss the failure modes for short and slender columns.

(4 marks)

(b) Explain the load combination to be considered in the analysis of an unbraced reinforced concrete frame.

(4 marks)

Q3 Suggest a foundation system with necessary sketches for the building extension shown in Figure **Q3**.

(5 marks)

Q4 (a) State **TWO (2)** methods to alter the prestress force for a pre-tensioned beam.

(4 marks)

(b) Figure **Q4** shows the cross section of a 10 m span simply supported pre-tensioned concrete beam with an effective jacking force of 750 kN. The beam is carrying a uniformly distributed load (including self-weight) of 8 kN/m. Calculate the total stresses at the mid-span.

(15 marks)

SECTION B: ANSWER TWO QUESTIONS ONLY (60 MARKS)

Q5 (a) A typical pad footing is shown in Figure **Q5(a)**. Sketch the critical sections for bending, direct shear and punching shear.

(6 marks)

(b) A two-pile cap supports a factored load of 1800 kN as shown in Figure **Q5(b)**. The column is 400 mm x 400 mm and the piles are 400 mm in diameter spaced at 1200 mm centres to centres. The materials are grade C35 concrete and grade 500 reinforcement. The overall depth is 750 mm and the effective depth is 650 mm.

(i) Based on theory of beam, design the pile cap.

(8 marks)

(ii) Check the shear.

(11 marks)

(iii) Provide the detailing.

(5 marks)

Q6 An internal reinforced concrete column 'C1' of 300 x 350 mm carries the total factored axial load of 1050 kN is shown in Figure **Q6**. The height of the column in both axes is 4 m. The column is braced and the pad footing is not designed to restrain moment. Given the following data:

Characteristics strength of concrete	=	35 N/mm^2
Characteristics strength of main reinforcement	=	500 N/mm^2
Characteristics strength of shear reinforcement	=	250 N/mm^2
Concrete cover	=	40 mm
Diameter of main reinforcement	=	20 mm
Diameter of shear reinforcement	=	6 mm

(a) Classify the column as short or slender. Use effective length conservative factors given in the appendix.

(6 marks)

(b) Determine the minimum moments.

(6 marks)

(c) Design column 'C1'.

(18 marks)

Q7 Figure **Q7** shows a four storey building frame subjected to a maximum wind action of 8 kN per metre height of the frame. By using cantilever method:

(a) Locate the neutral axis for the building frame.

(4 marks)

(b) Determine axial force in the columns between ground level and level 1, and between level 3 and roof.

(8 marks)

(c) Determine horizontal shearing forces in the columns between level 3 and roof.

(7 marks)

(d) Determine vertical shearing forces in the roof beams.

(7 marks)

(e) Calculate the moments for the roof beams and columns between level 3 and roof.

(4 marks)

- END OF QUESTION-

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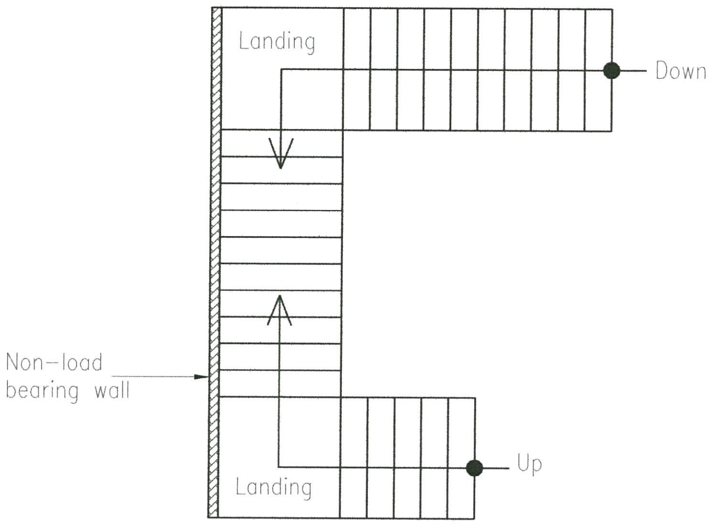

FIGURE Q1

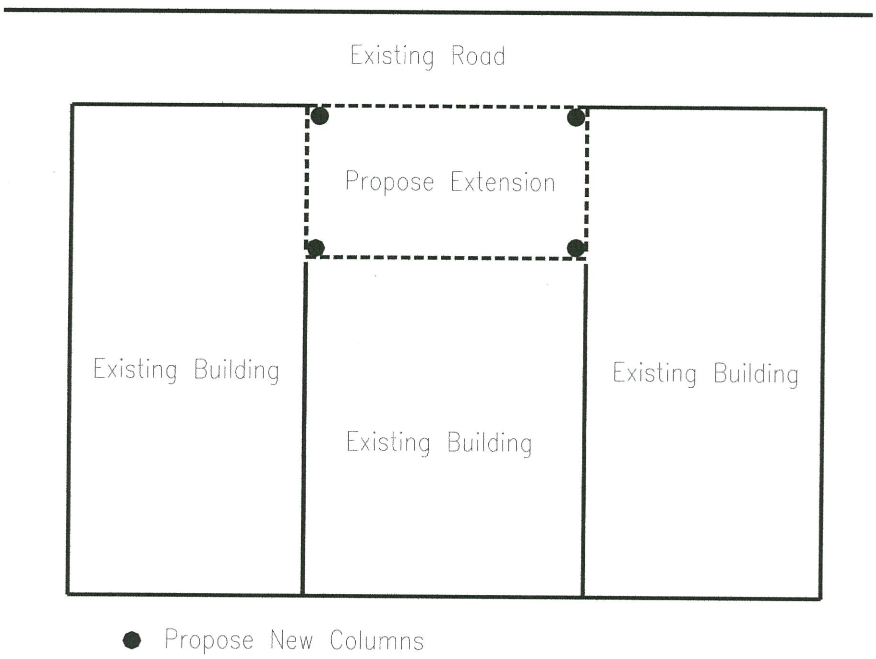

FIGURE Q3

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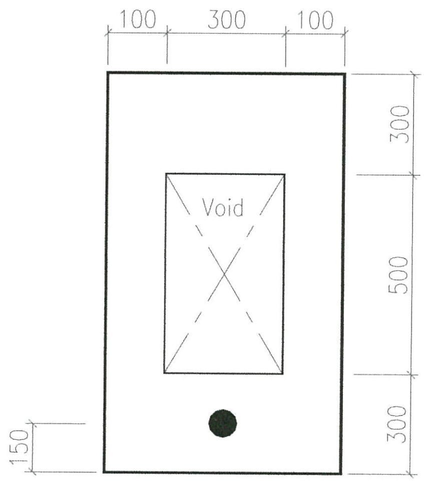

FIGURE Q4

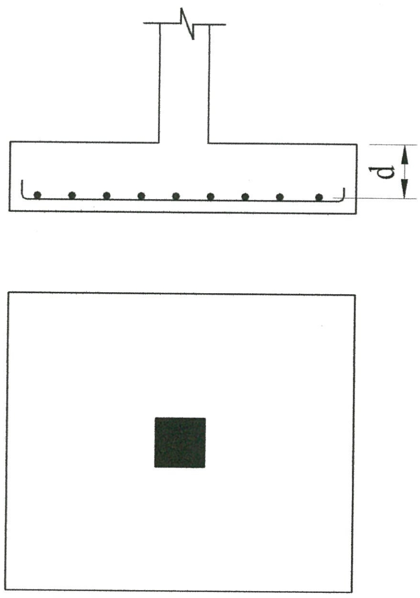

FIGURE Q5(a)

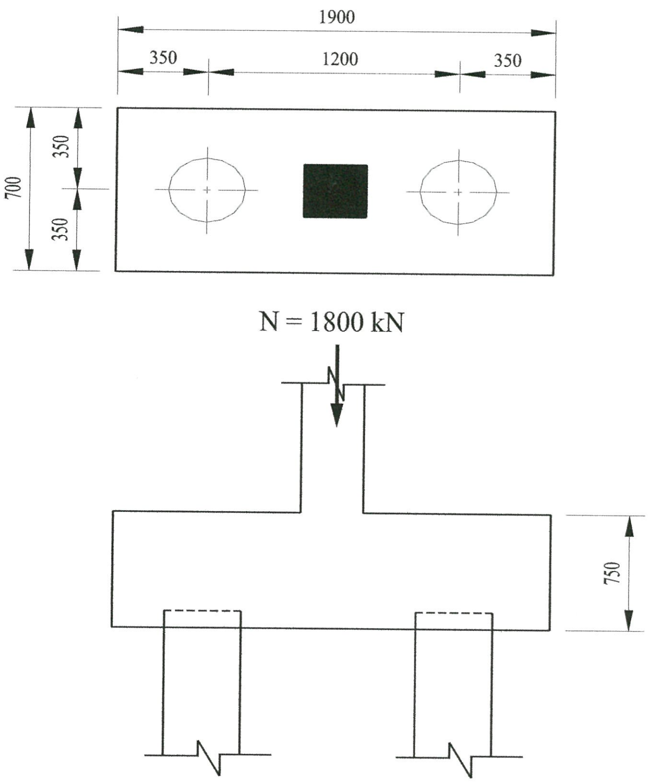

FIGURE Q5(b)

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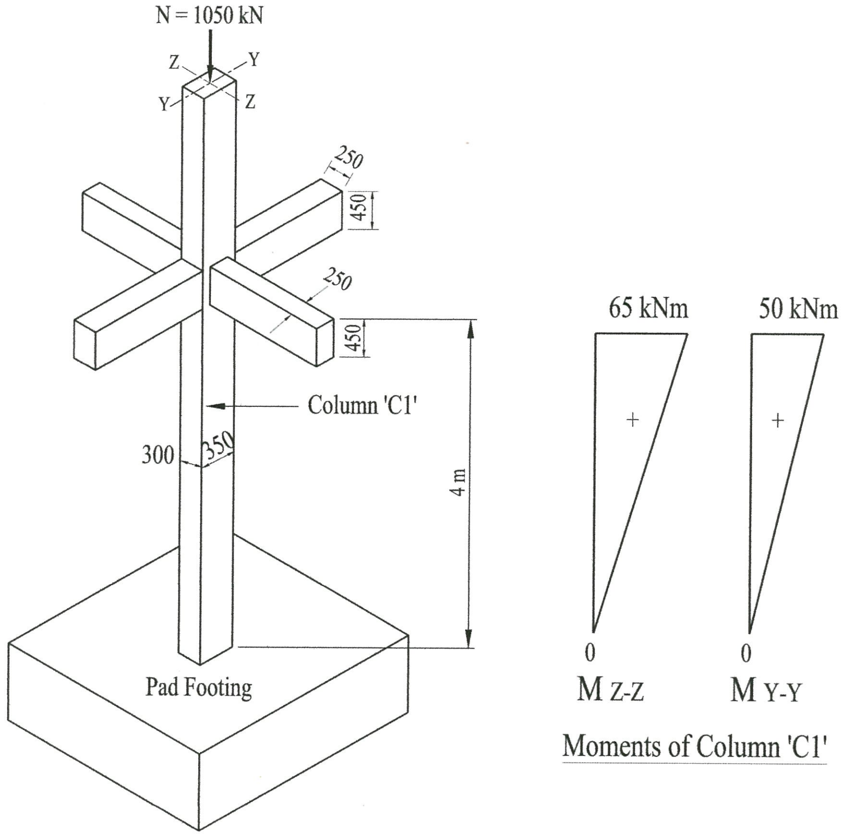

FIGURE Q6

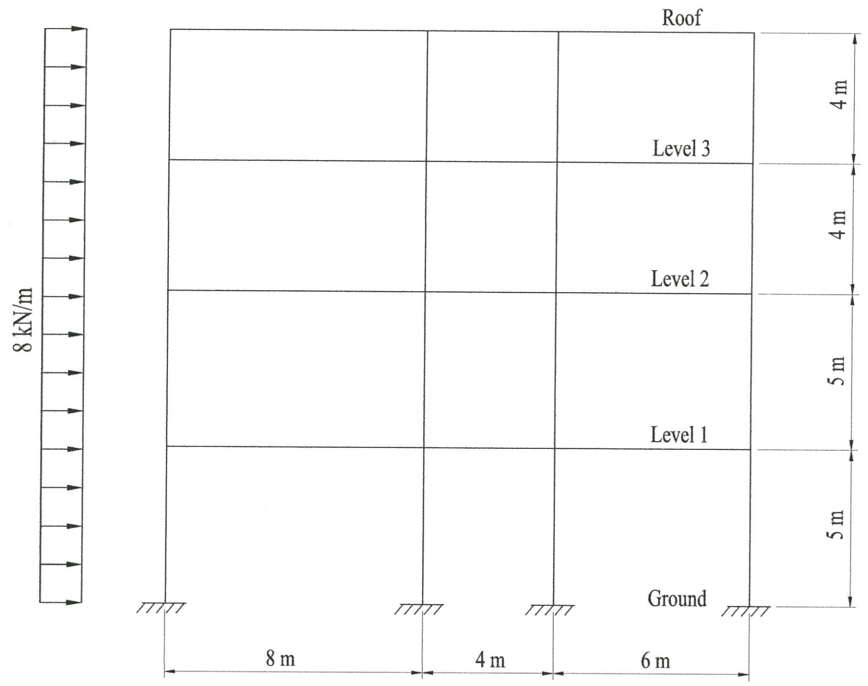

FIGURE Q7

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BASIC DESIGN EQUATIONS

(A) Design for Bending

For a singly reinforced section:

$$A_s = \frac{M}{0.87 f_{yk} z}$$

$$z = d\left\{0.5 + (0.25 - K/1.134)^{1/2}\right\}$$

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

For a doubly reinforced section ($K > K_{bal}$) – see figure A.3:

$$A'_s = \frac{(K - K_{bal}) f_{ck} bd^2}{0.87 f_{yk}(d - d')}$$

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

(B) Members Not Requiring Shear Reinforcement

Shear capacity of concrete, $V_{Rd,c} = [0.12k(100\rho_1 f_{ck})^{1/3}]bd$

Minimum $V_{Rd,c} = [0.035k^{3/2} f_{ck}^{1/2}]bd$

where, $k = 1 + \sqrt{\frac{200}{d}} \leq 2.0$

$\rho_1 = \frac{A_s}{bd} \leq 0.02$

(C) Maximum Shear Resistance at Column Face for Pile Spacing ≤ 3 times pile diameter

$$V_{Rd,\,max} = 0.5ud[0.6(1 - \frac{f_{ck}}{250})]\,\frac{f_{ck}}{1.5}$$

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(D) COLUMN DESIGN

Effective length l_0: conservative factors for braced columns

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

Key

Condition 1 Column 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 the column is connected to a foundation this should be designed to carry moment in order to satisfy this condition

Condition 2 Column connected monolithically to beams on each side that are shallower than the overall depth of the column in the plane considered by generally not less than half the column depth

Condition 3 Column connected to members that do not provide more than nominal restraint to rotation

Note: Effective Length = clear height (l) x factor

Biaxial Bending of Short Columns

- If $\frac{M_z}{h'} \geq \frac{M_y}{b'}$ then increased single axis design moment is $M_z' = M_z + \beta\frac{h'}{b'} \times M_y$
- If $\frac{M_z}{h'} < \frac{M_y}{b'}$ then increased single axis design moment is $M_y' = M_y + \beta\frac{b'}{h'} \times M_z$
- $\beta = 1 - \frac{N_{Ed}}{bhf_{ck}}$

Values of coefficient β for biaxial bending

$\frac{N_{Ed}}{bhf_{ck}}$	0	0.1	0.2	0.3	0.4	0.5	0.6	≥ 0.7
β	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3

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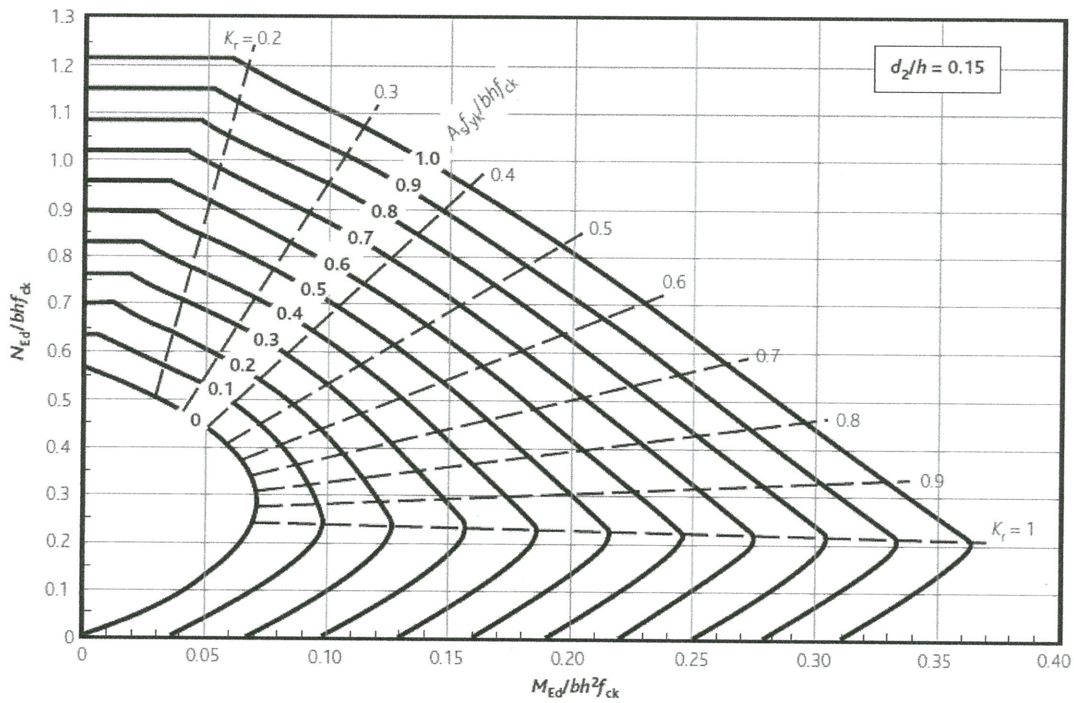
Column Design Chart



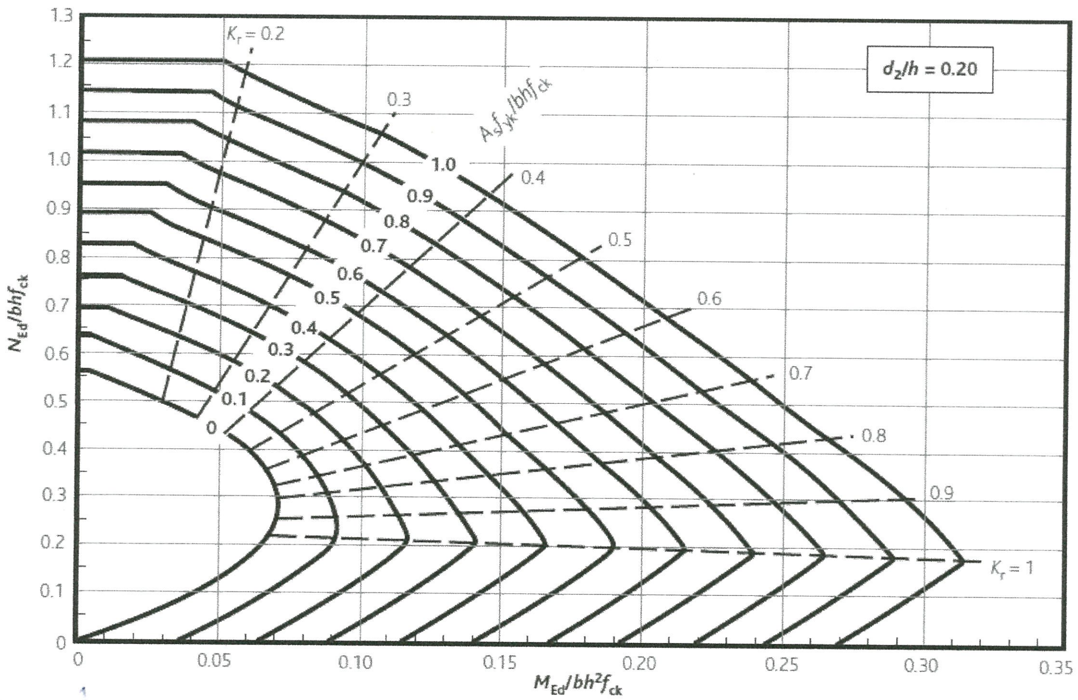


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Table 1: Cross Sectional Area (mm^2) according to Size and Numbers of Bar

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