CONFIDENTIAL

UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	REINFORCED CONCRETE DESIGN II
COURSE CODE	:	BFC 32803
PROGRAMME	:	BACHELOR OF CIVIL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015/JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **FOUR (4)** QUESTIONS ONLY 2. DESIGN SHOULD BE BASED ON: BS EN 1990:2002+A1:2005 BS EN 1991-1-1:2002 BS EN 1992-1-1:2004

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

CONFIDENTIAL

Q1 A straight longitudinal reinforced concrete stairs supported by reinforced concrete beams at both ends is shown in **FIGURE Q1**. The staircase is specifically for the public building. Landing slabs at both ends of the stairs are monolithically connected to the stairs. The flight of staircase consists of 10 steps. The average thicknesses of staircase are 189 mm and 279 mm. Given the following data:

Design action of landing	= 12.89 kN/m^2
Design action of flight	= 17.04 kN/m^2
Characteristic strength of concrete	= 25 N/mm^2
Characteristic strength of steel	= 500 N/mm^2
Unit weight of reinforced concrete	= 25 kN/m^3
Nominal concrete cover	= 25 mm
Beam size	= 220 mm x 400 mm
Upper Landing area	= 1200 mm x 1000 mm
Lower Landing area	= 1500 mm x 1000 mm
Diameter of reinforcement	= 16 mm

(a) The design concept of longitudinal span staircase mainly depends on the condition between flight and landing. If the flight and landing should be designed separately, describe the characteristics of the staircase. Give one example of the staircase.

(4 marks)

(b) Determine the suitable size of riser, going and waist.

(5 marks)

(c) Determine the total action, bending moment and shear force.

(5 marks)

(d) Design shear resistance of the staircase if required longitudinal reinforcement is only 20% of maximum main reinforcement.

(11 marks)

Q2 (a) Name and explain briefly, **TWO (2)** levels of sub-frame analysis.

(4 marks)

(b) **FIGURE 2(a)** shows a four-storey braced frame while **FIGURE 2(b)** shows the bending moment diagram for column A from first to third floor. By using the given data, calculate moment of inertia and stiffness for beam and column in **FIGURE 2(b)**.

Size of all columns: 300 x 300 mm
Size of all beams: 150 x 300 mm

(5 marks)

(c) Determine the design load, *w* (in unit kN/m) for beam 2/A-B by using value of upper and lower column moment in **FIGURE 2(b)**. Consider simplified sub-frame at a point analysis.

(5 marks)

(d) Analyze Beam 2/A-B using the design load of 30 kN/m and 25 kN/m for span A-B and B-C respectively. Present your end results by drawing the shear force and bending moment diagram for Beam 2/A-B. The distribution factor is given as follows:

Joint A: $F_{AB} = 0.12$
$F_{cu} = 0.47$
$F_{cl} = 0.41$

Joint B: $F_{BA} = 0.12$
$F_{BC} = 0.06$
$F_{cu} = 0.44$
$F_{cl} = 0.38$

(11 marks)

Q3 (a) Define a slender column in the reinforced concrete building.

(1 mark)

(b) Explain how to design a short column with **TWO (2)** bending moments.

(3 marks)

(c) **FIGURE Q3** shows a braced frame structure of a building.

(i) Classify the column B either short or slender. The connection between column and footing is assumed to be fixed. The calculation of effective height, l_o should be based on BS 8110 approach. N_{Ed} = 320 kN, f_{ck} = 30 N/mm^2.

(5 marks)

(ii) Calculate the M_{Ed} for column A and B. The loading condition must be based on critical loading. Use l_o as in **(i)**

(5 marks)

(iii) From **(ii)**, design the main reinforcement and the link for column A and B. (f_{yk} = 500 N/mm^2, d_2 /h = 0.15)

(11 marks)

Q4 (a) List **FOUR (4)** steps that need to be considered in pile design.

(4 marks)

(b) Describe briefly **TWO (2)** theories in pile cap design.

(5 marks)

(c) A pile foundation needs to be designed for an office building at soft soil area. It is required to support permanent axial action 4000 kN and variable action 3000 kN from a 450 x 450 mm rectangular reinforced concrete column. Service load capacity for the pile is 2000 kN. The diameter of pile is 600 mm.

(i) Determine the suitable number of pile and size of pile cap. Draw the detail size of pile cap with the exact dimensions.

(11 marks)

(ii) Design the main reinforcement of the pile.

(5 marks)

Q5 (a) Specific the function of retaining wall and describe the compulsory elements that should be designed for a retaining wall to retain well-drained soil with depth more than 5 m.

(4 marks)

(b) A cantilever wall as shown in **FIGURE Q5** support a bank earth 5.0 m height. The soil behind the wall has density of 1900 kg/m^3 with angle of internal friction of 30°. Given the following data:

Characteristic strength of concrete	= 35 N/mm^2
Characteristic strength of steel	= 500 N/mm^2
Coefficient of friction	= 0.5
Soil cohesion	= 0
Soil bearing pressure	= 150 kN/m^2
Earth pressure	= 31.67 kN/m^2

(i) Determine the total horizontal load and moment of the retaining wall.

(5 marks)

(ii) Check the soil pressure at the toe of retaining wall.

(5 marks)

(iii) Predict the ability of retaining wall toward stability against overturning and resistance to sliding.

(11 marks)

- END OF QUESTIONS –

FINAL EXAM

SEMESTER/ SESSION: SEM I 2015/2016 PROGRAMME: BFF

COURSE NAME: REINFORCED CONCRETE DESIGN II COURSE CODE: BFC 32803

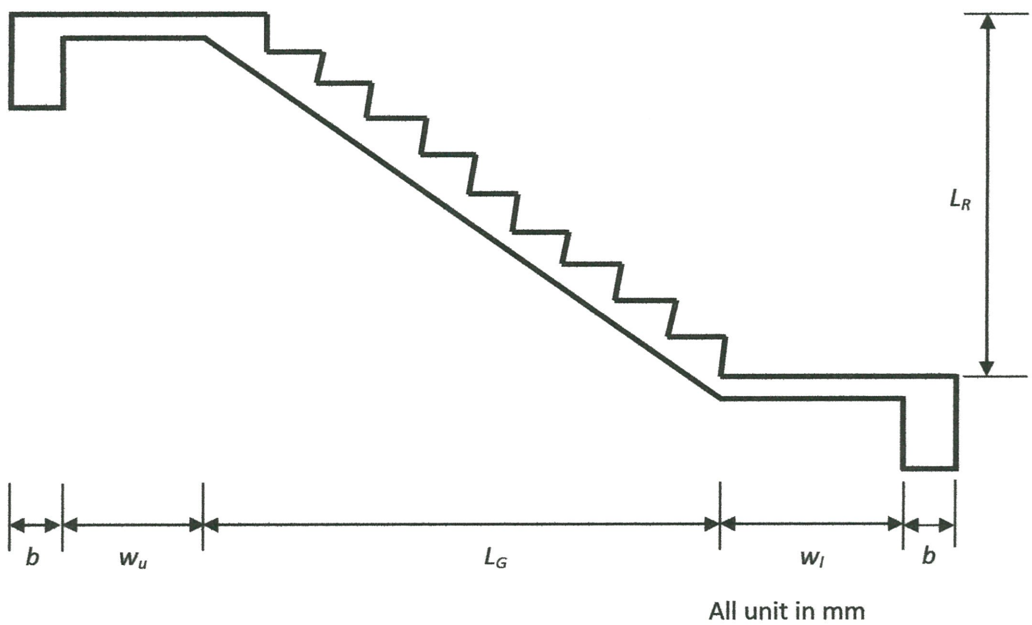


FIGURE Q1

FINAL EXAM

SEMESTER/ SESSION: SEM I 2015/2016 PROGRAMME: BFF

COURSE NAME: REINFORCED CONCRETE DESIGN II COURSE CODE: BFC 32803

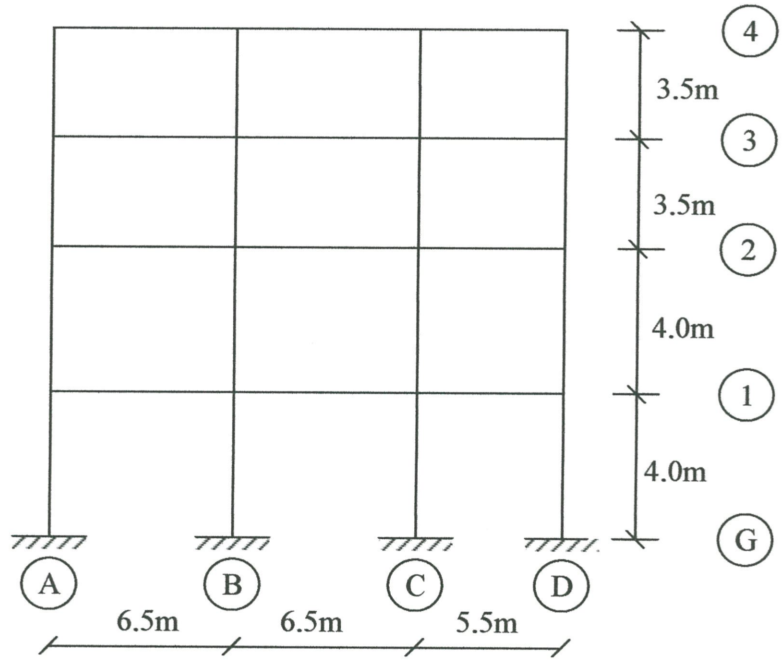


FIGURE 2(a)

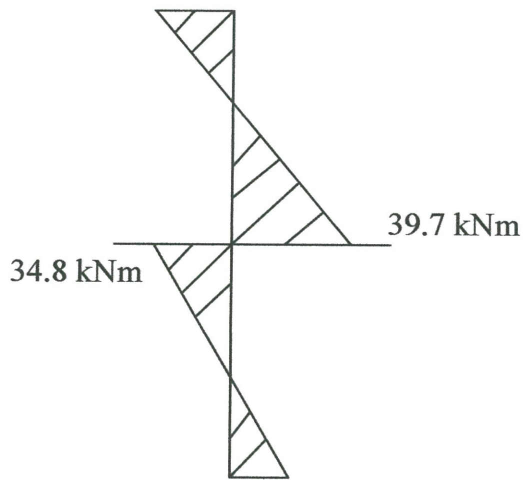


FIGURE 2(b)

FINAL EXAM

SEMESTER/ SESSION: SEM I 2015/2016 PROGRAMME: BFF
COURSE NAME: REINFORCED CONCRETE DESIGN II COURSE CODE: BFC 32803

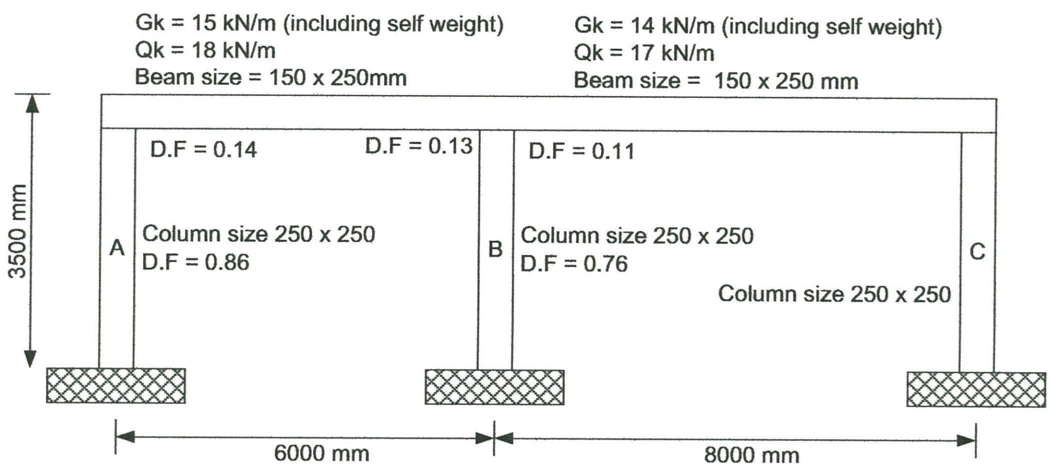


FIGURE Q3

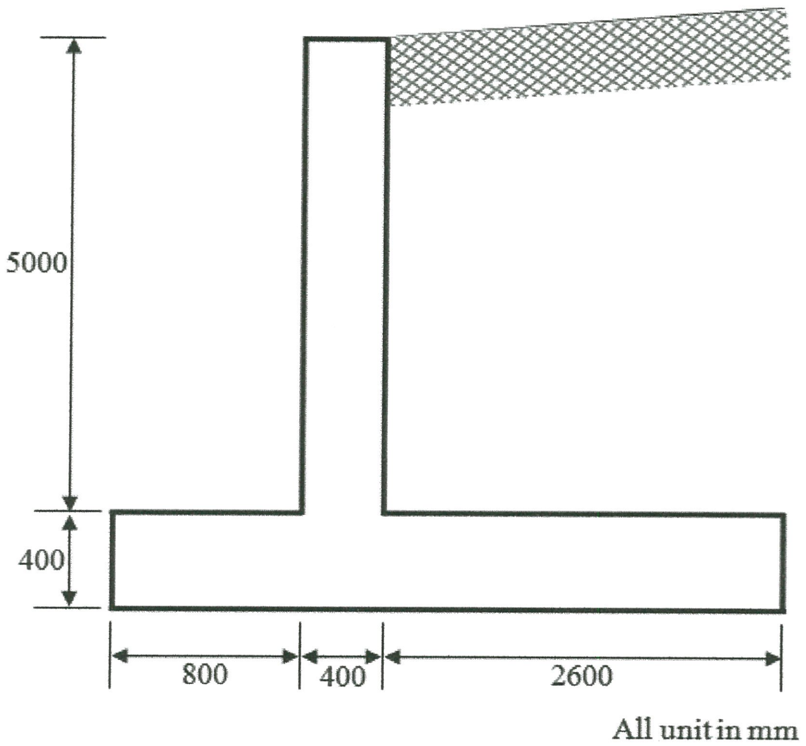


FIGURE Q5

FINAL EXAM

SEMESTER/ SESSION: SEM I 2015/2016 PROGRAMME: BFF
COURSE NAME: REINFORCED CONCRETE DESIGN II COURSE CODE: BFC 32803

APPENDIX

Table 1.0: Comfort criteria of staircase

Type	Riser	Going
Public Building	Not more than 180mm	Not be less than 255mm
Private Building	Not more than 200mm	Varies between 250mm to 400mm

$$t = h\left[\frac{(G^2 + R^2)^{1/2}}{G}\right] + \frac{R}{2}$$

$$z = d\left[0.5 + \sqrt{0.25 - \left(\frac{K}{1.134}\right)}\right]$$

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

$$A_{s,min} = 0.26\left(\frac{f_{ctm}}{f_{yk}}\right)bd$$

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

$$k = 1 + \left(\frac{200}{d}\right)^{1/2}$$

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

$$P = \gamma z\left(\frac{1 - \sin\phi}{1 + \sin\phi}\right)$$

$$P_{max} = \frac{\sum W}{A} \pm \frac{\sum M}{Z}$$

$$P_1 = 0.5\gamma H_1^2\left(\frac{1 - \sin\phi}{1 + \sin\phi}\right) \qquad P_2 = 0.5\gamma H_2^2\left(\frac{1 + \sin\phi}{1 - \sin\phi}\right)$$

FINAL EXAM

SEMESTER/ SESSION: SEM I 2015/2016 PROGRAMME: BFF

COURSE NAME: REINFORCED CONCRETE DESIGN II COURSE CODE: BFC 32803

Table 2.0: Cross Sectional Area (mm^2) according to Size and Numbers of Bar

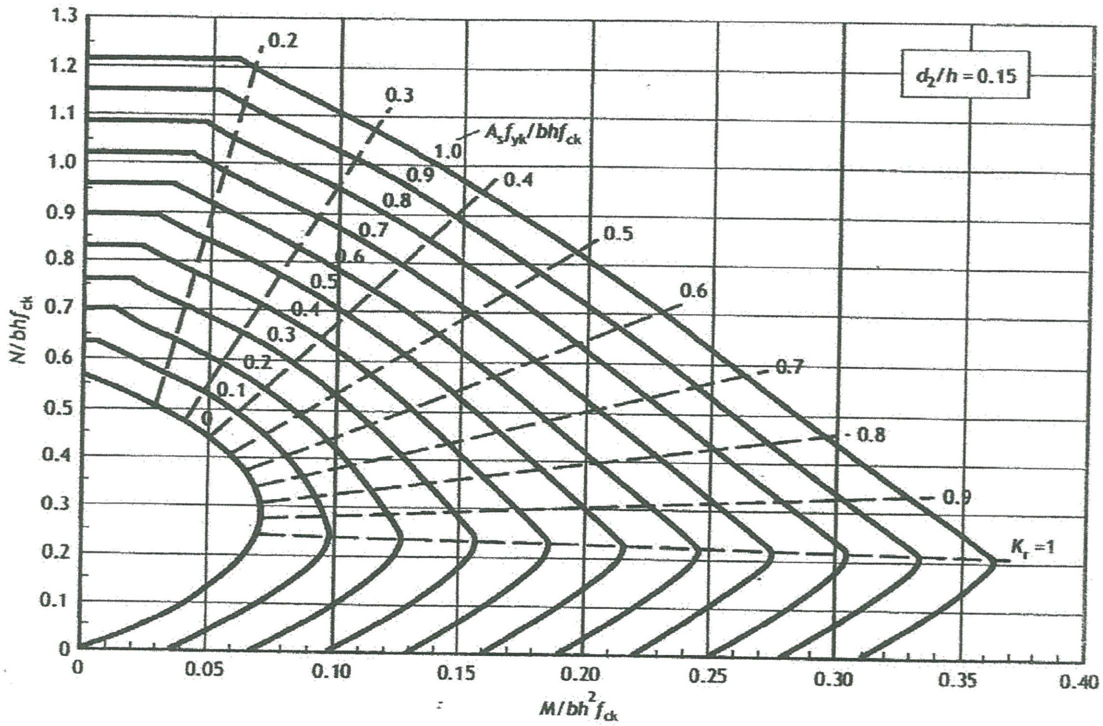
Bar Size (mm)	Number of Bar								Perimeter (mm)
	1	2	3	4	5	6	7	8	
6	28.3	56.6	84.9	113	141	170	198	226	18.9
8	50.3	101	151	201	251	302	352	402	25.1
10	78.6	157	236	314	393	471	550	629	31.4
12	113	226	339	453	566	679	792	905	37.7
16	201	402	603	805	1006	1207	1408	1609	50.3
20	314	629	943	1257	1571	1886	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

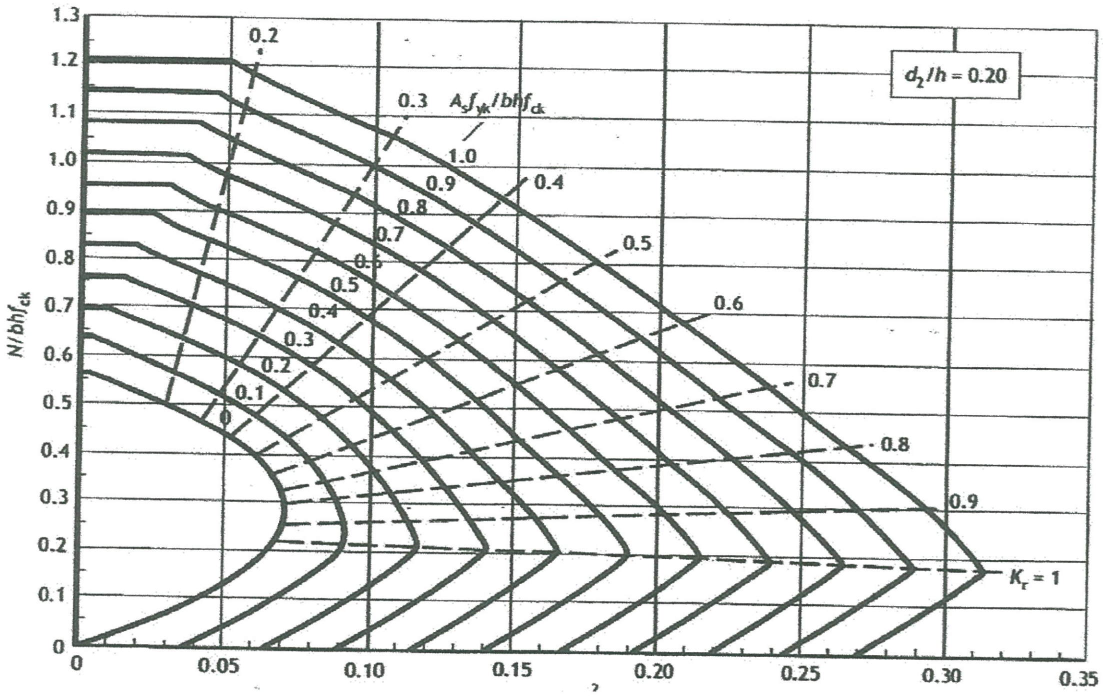
Table 3.0: Cross Sectional Area (mm^2) for every meter width at distance between Bar

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

SEMESTER/ SESSION: SEM I 2015/2016
COURSE NAME: REINFORCED CONCRETE DESIGN II

PROGRAMME: BFF
COURSE CODE: BFC 32803



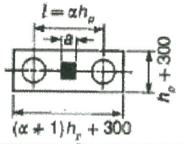
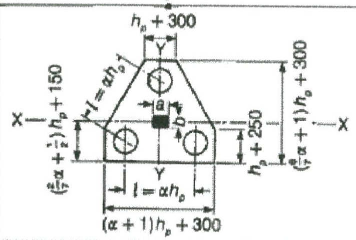
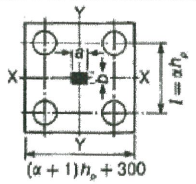
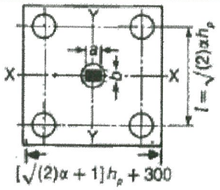


FINAL EXAM

SEMESTER/ SESSION: SEM I 2015/2016
COURSE NAME: REINFORCED CONCRETE DESIGN II

PROGRAMME: BFF
COURSE CODE: BFC 32803

If $h_p \ngtr 550$ mm: $h = 2h_p + 100$; If $h_p > 550$ mm: $h = \frac{1}{3}(8h_p - 600)$

Number of piles	Dimensions of pile cap	Tensile force to be resisted by reinforcement: Neglecting size of column	Tensile force to be resisted by reinforcement: Taking size of column into consideration
2		$\frac{Nl}{4d}$	$\frac{N}{12ld}(3l^2 - a^2)$
3		$\frac{Nl}{9d}$	Parallel to X-X: $\frac{N}{36ld}(4l^2 + b^2 - 3a^2)$ Parallel to Y-Y: $\frac{N}{18ld}(2l^2 - b^2)$
4		$\frac{Nl}{8d}$	Parallel to X-X: $\frac{N}{24ld}(3l^2 - a^2)$ Parallel to Y-Y: $\frac{N}{24ld}(3l^2 - b^2)$
5		$\frac{Nl}{10d}$	Parallel to X-X: $\frac{N}{30ld}(3l^2 - a^2)$ Parallel to Y-Y: $\frac{N}{30ld}(3l^2 - b^2)$

Notation h_p diameter of pile; a, b dimensions of column; α spacing factor of piles (normally between 2 and 3 depending on ground conditions)