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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	REINFORCED CONCRETE DESIGN 2
COURSE CODE	:	BFC 32802 / BFC 3172
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	DECEMBER 2014 / JANUARY 2015
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS IN **SECTION A** AND **TWO (2)** QUESTIONS IN **SECTION B** 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

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SECTION A

Q1 (a) Describe the procedures for pre-tensioning of concrete members.

(6 marks)

(b) Figure **Q1** shows post-tensioned concrete beams that support a concrete slab. Both beams with span 7 m are subjected to an initial prestress force of 4250 kN at an eccentricity of 500 mm below centroid. Each beam carries an uniformly distributed service load excluding selfweight of 18 kN/m at 7 days after casting. Given the following data:

Short and long term losses	= 0.9 and 0.8
Characteristic strength of concrete	= 40 N/mm^2
Strength of concrete at 7 days	= 28 N/mm^2

(i) Describe the losses of prestress in short-term and long-term.

(4 marks)

(ii) Determine the required section modulus for the beam if $Z_{top} = 48.51 \times 10^6$ mm^3 and $Z_{bot} = 66.55 \times 10^6$ mm^3.

(8 marks)

(iii) Analyse the limiting stress at transfer and at service.

(7 marks)

Q2 A rectangular footing is designed to support two columns. Center to center distance between the columns is 2.5 m. Given the following data:

Column 1:

Dimension	= 350 mm $\times$ 350 mm
Permanent action	= 1110 kN and variable action = 160 kN

Column 2:

Dimension	= 400 mm $\times$ 400 mm
Permanent action	= 1430 kN and variable action = 220 kN

If the width of the base should not exceed 2.5 m, the safe bearing pressure on the ground = 300 kN/m^2, h = 850 mm, f_{ck} = 30 N/mm^2, f_{yk} = 500 N/mm^2, cover = 40 mm, ϕ_{bar} = 12 mm, z = 0.95d and footing selfweight = 250 kN,

(a) Determine the suitable size of the footing and centerline of the load.

(6 marks)

(b) Design the main and transverse reinforcements for the footing.

(14 marks)

(c) Check the critical shear at 2.0d from the column face.

(5 marks)

SECTION B

Q3 A staircase supported by landing spanning perpendicular to flight is shown in Figure **Q3**. The slab of landing has a thickness of 150 mm and monolithically connected to the wall. The height of riser and the width of going are 170 mm and 255 mm, respectively. Given the following data:

Variable action	= 3.0 kN/m^2
Permanent action	= 1.0 kN/m^2
Charactreistic strength of concrete	= 25 N/mm^2
Characteristic strength of steel	= 500 N/mm^2
Nominal cover	= 25 mm

(a) Determine the design actions on the landing and flight.

(5 marks)

(b) Design the longitudinal and secondary reinforcements of the staircase.

(14 marks)

(c) Draw the complete detailing of the reinforcements.

(6 marks)

Q4 A four-storey braced frame used as an office building is given in Figure **Q4**. The frame is subjected to 3 kN/m lateral load. Given the following data:

Column size	= 350 mm × 300 mm
Beam size	= 300 mm × 500 mm

(a) Define and sketch **THREE (3)** methods of frame analysis for sub-frame ABCD.

(7 marks)

(b) Calculate the design wind action at each level of the frame.

(10 marks)

(c) Determine the axial load and shear force of beams and columns for sub-frame ABCD.

(8 marks)

Q5 (a) Specify the requirements of longitudinal bar, link and spacing in column design.

(6 marks)

(b) A three-storey commercial building has a similar floor plan at every level as shown in Figure **Q5**. The floor height is 4 m for the first floor and 3.5 m for the next floors. All beams are designed with size 250 mm × 600mm, while the columns have standard size of 300 mm × 400 mm. Given the following data:

Permanent action, G_k	= 12 kN/m^2
Variable action, Q_k	= 15 kN/m^2
Grade of concrete, f_{ck}	= 30 N/mm^2
Grade of steel, f_{yk}	= 500 N/mm^2
Nominal cover, C	= 30 mm
Diameter bar, $Ø_{bar}$	= 16 mm
Diameter link, $Ø_{link}$	= 8 mm

(i) Classify the slenderness of column C/4 at the ground floor level (x-direction) by using Appendix 1.

(7 marks)

(ii) By neglecting the action from related slab, design the main reinforcement of the critical column C/4.

(12 marks)

- END OF QUESTION -

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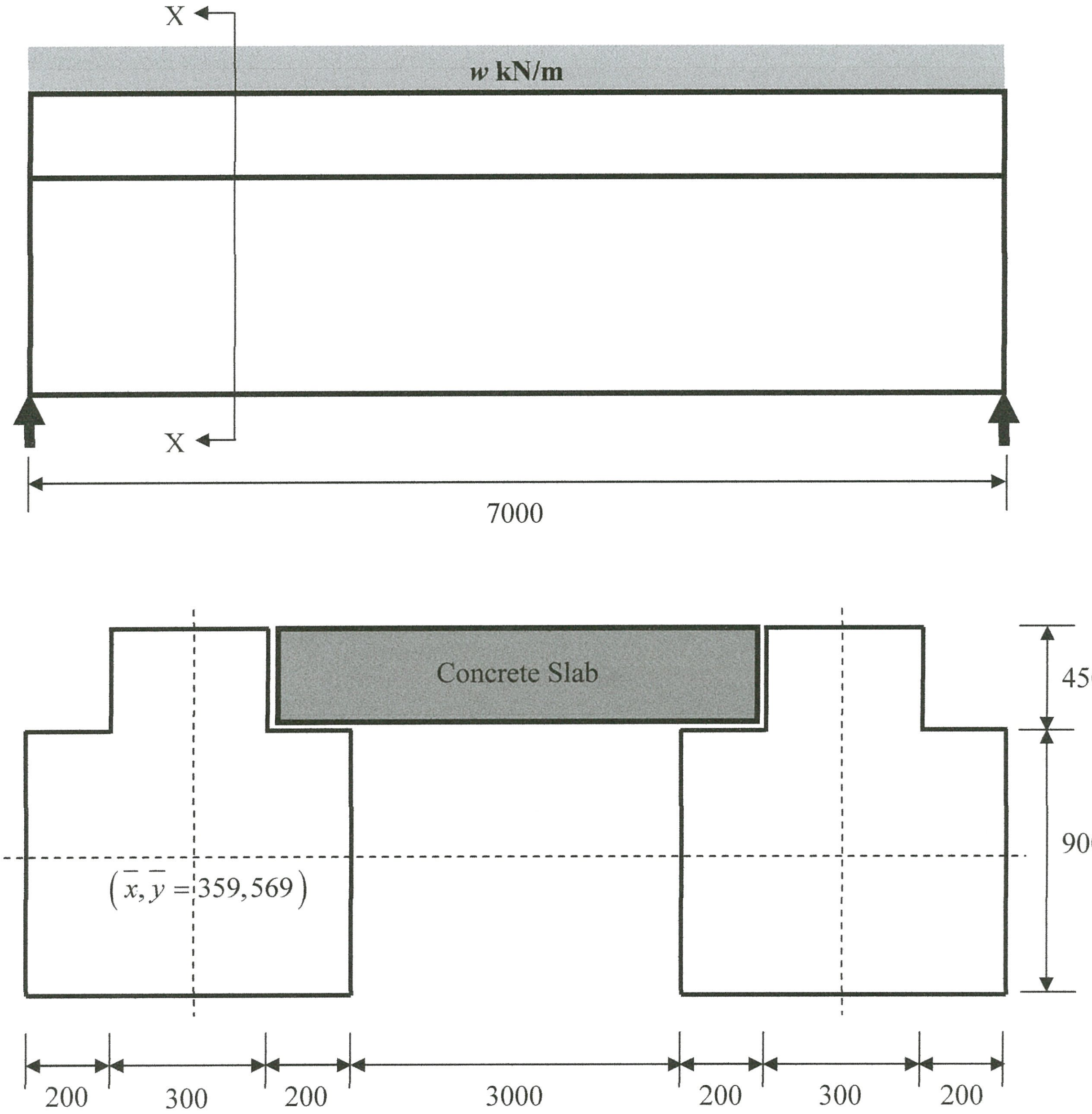

Section X-X

All unit in mm

FIGURES Q1

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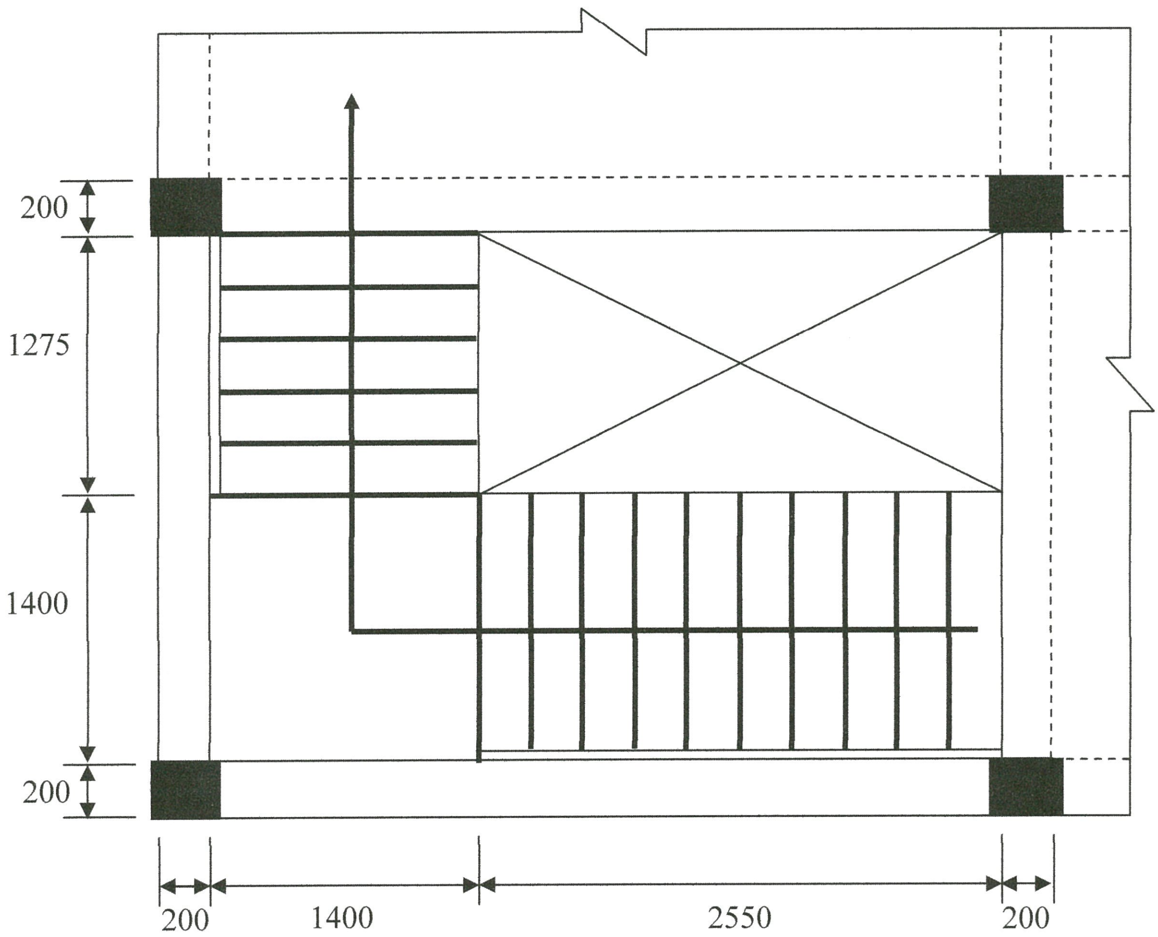

FIGURES Q3

All unit in mm

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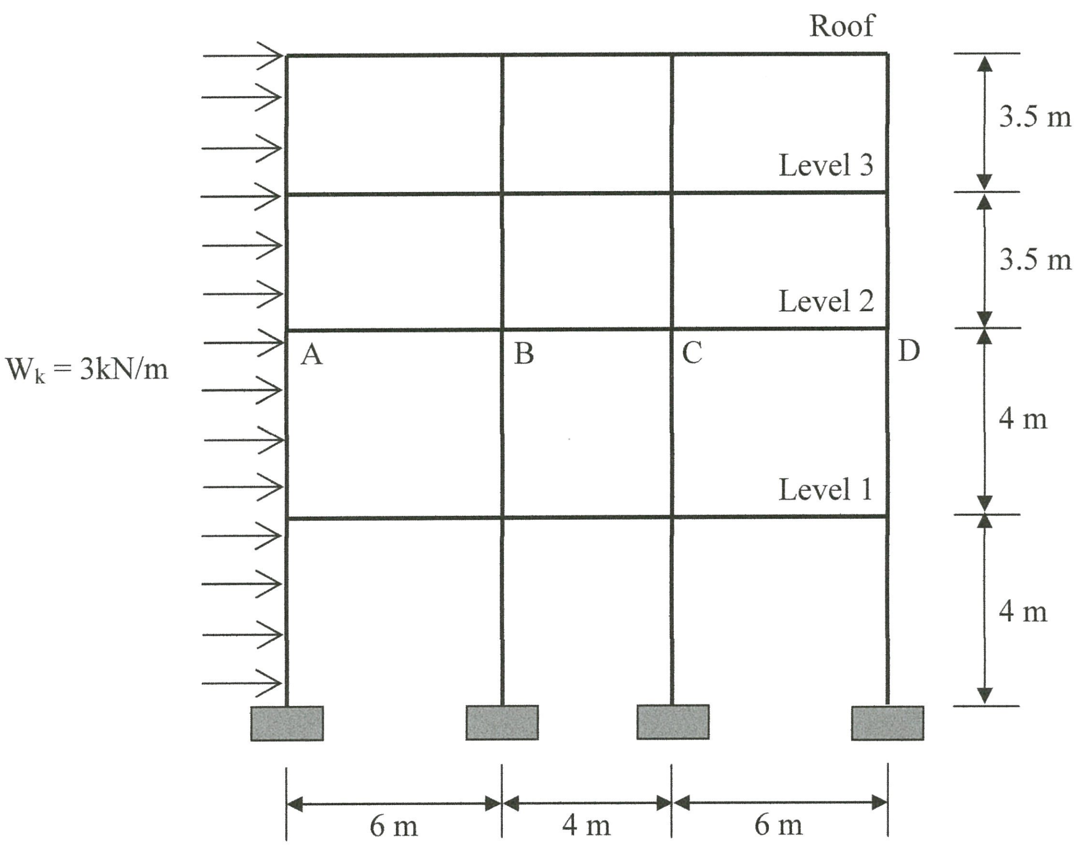

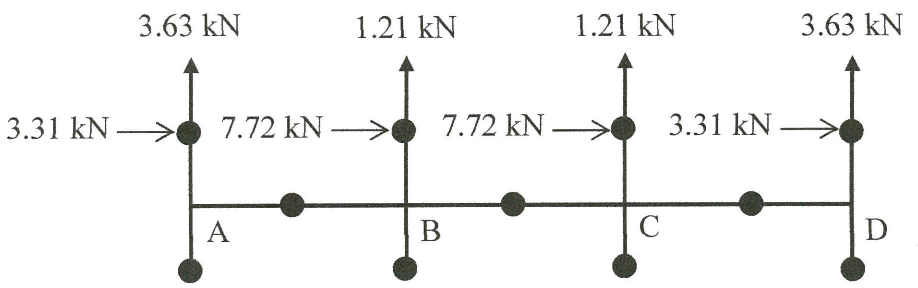

FIGURES Q4

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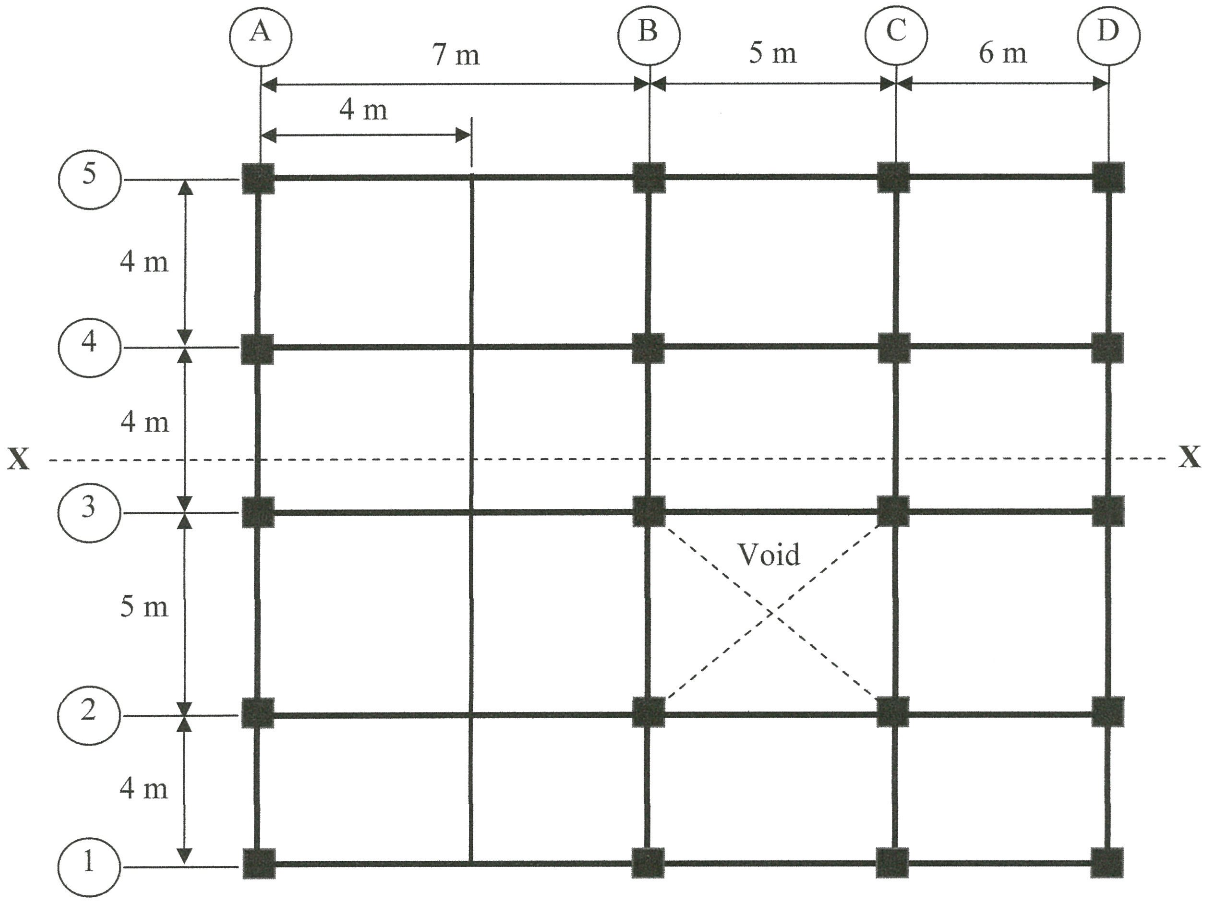

FIGURES Q5

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APPENDIX 1

Table 1: Values of β for braced columns (Table 3.19, BS8110)

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

Table 2: Values of β for unbraced columns (Table 3.20, BS8110)

End condition at top	End condition at bottom		
	1	2	3
1	1.2	1.3	1.6
2	1.3	1.5	1.8
3	1.6	1.8	-
4	2.2	-	-

Column end conditions (BS8110, Cl.3.8.1.6.2 BS 8110):

a) *Condition 1*: The end of column is connected monolithically to beams on either side which are at least as deep as the overall dimension of the column in the plane considered. Where the column is connected to a foundation structure, this should be of a form specifically designed to carry moment.
b) *Condition 2*: The end of the column is connected monolithically to beams or slabs on either side which are shallower than the overall dimension of the column in the plane considered.
c) *Condition 3*: The end of the column is connected to members which, while not specifically designed to provide restraint to rotation of the column will, nevertheless, provide some nominal restraint.
d) *Condition 4*: The end of the column is unrestrained against both lateral movement and rotation (e.g. the free end a cantilever column in unbraced structure).

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APPENDIX 2

If $h_p \leq 550$ mm : $\quad h = 2h_p + 100$

If $h_p > 550$ mm : $\quad h = \frac{1}{3}(8h_p - 600)$

where, h is the depth of pile cap and h_p is the diameter of pile.

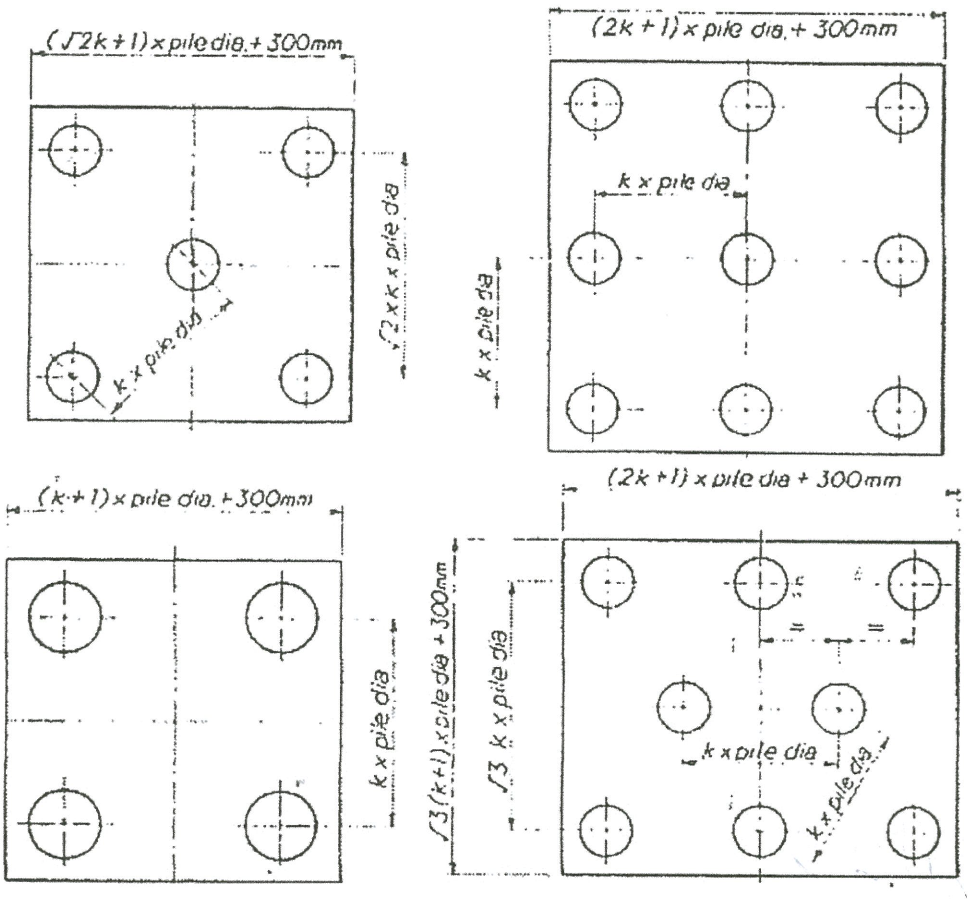

Figure 1: Typical size of pile cap

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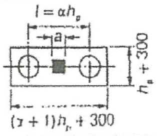
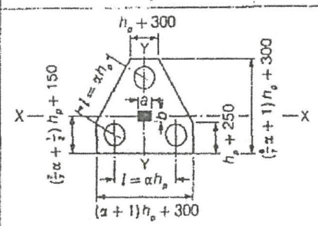
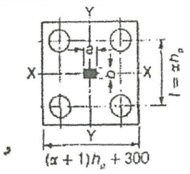
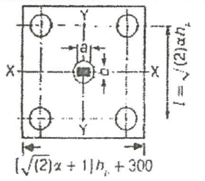
Table 3: Tensile force in pile cap

Number of piles	Dimensions of pile cap	Tensile force to be resisted by reinforcement: Neglecting 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)