UNIVERSITY OF JOHANNESBURG

DEPARTMENT OF CIVIL ENGINEERING SCIENCE

COURSE	:	STRUCTURAL ENGINEERING (REINFORCED CONCRETE DESIGN)
CODE	:	SUS4A11
EXAM	:	JUNE 2016
DURATION	:	3 HOURS
EXAMINERS:		Prof. SO. Ekolu
		Dr. Alvin Masarira

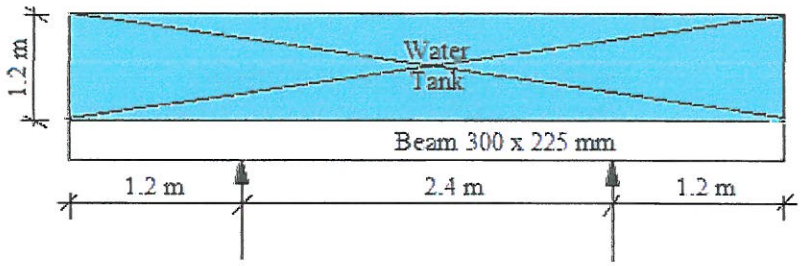
INSTRUCTIONS: ***Open Book - Lecture Notes, Design Tables Etc. are Allowed***
Calculators are Allowed; Computers /Laptops, Tablets, Cellphones are Not Allowed
Attempt All Questions
Take Note of the Mark Allocations

AT END OF EXAM, STUDENTS ARE REQUIRED TO RETURN THIS PAPER TO THE INVIGILATOR, ALONG WITH ANSWER SCRIPTS

Total of 6 Pages

QUESTION 1. BEAMS

An elevated water tank is supported on two reinforced concrete beams. Each beam is 300 mm wide and 225 mm deep spanning 3.6 m as shown in the diagram. The empty tank of size 4.8x1.2 x1.2 m height weighs 1350 N and water density = 10 kN/m^3. High yield and mild steel strengths = 450 and 250 N/mm^2 respectively, 1:1½:3 concrete, 25 mm cover to steel. Use appropriate bar sizes throughout your calculations. *HINT: no live loads.*



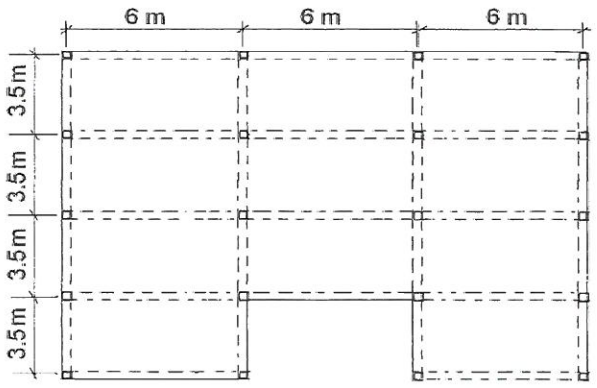
(i) Determine the design shear forces and bending moments acting on the beam **[9]**

(ii) Design the required steel reinforcement including shear reinforcement, if necessary **[14]**

(iii) Provide a clearly labelled sketch of the designed beam section **[2]**

QUESTION 2. SLABS

A 125 mm thick RC floor slab is to be designed for an office building of the floor plan shown. The dead load due to finishes and partitions is equal to self-weight of slab. Assuming the slab is simply supported on all sides. Cover to steel = 30 mm, f_y = 450 MPa, f_{cu} = 30 MPa. Design tension steel reinforcement and determine whether slab deflection is satisfactory.



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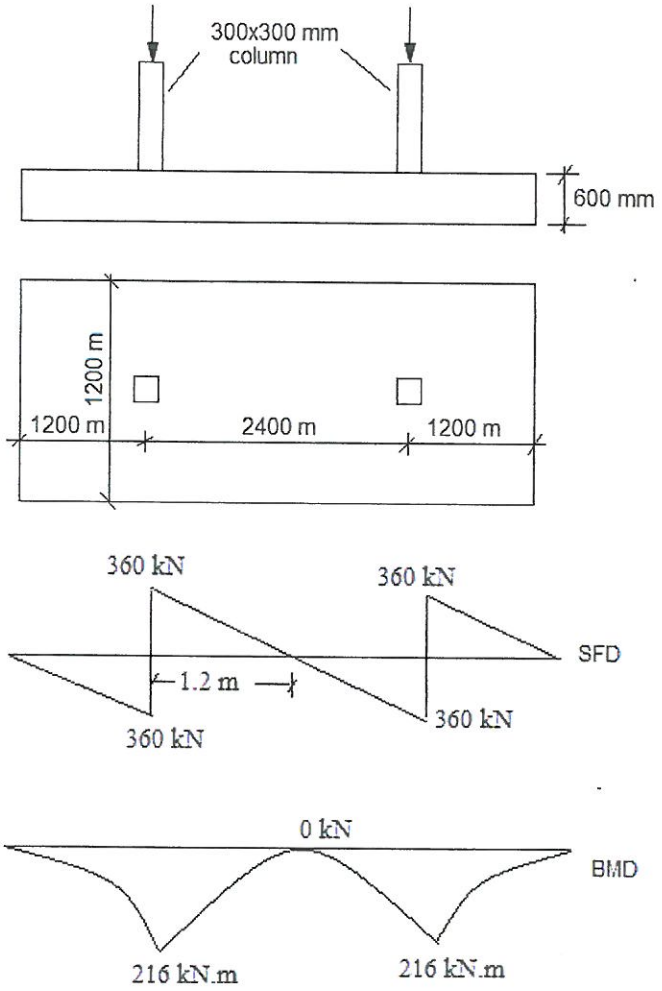
QUESTION 3. FOOTINGS

Two 300 mm square columns spaced 2.4 m apart are supported on a combined footing 4.8 x 1.2 x 0.6 m as shown. The column loads result in the shear force and bending moment diagrams given. f_{cu} = 25 MPa, $f_y = f_{yv}$ = 450 MPa, cover to steel = 40 mm. For preliminary estimate of dimensions 20 mm and 8 mm bar sizes may be used.



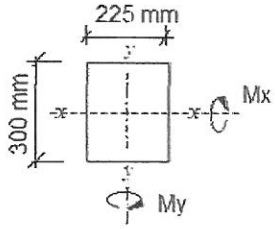
(i) Design the longitudinal (tension) reinforcement **[11]**

(ii) Check for punching shear at column face and at 1.5d from column face and determine if shear reinforcement is necessary and if so, design the shear reinforcement **[10]**

(iii) Sketch a clearly labeled cross-section of the footing section designed **[4]**

QUESTION 4. COLUMNS

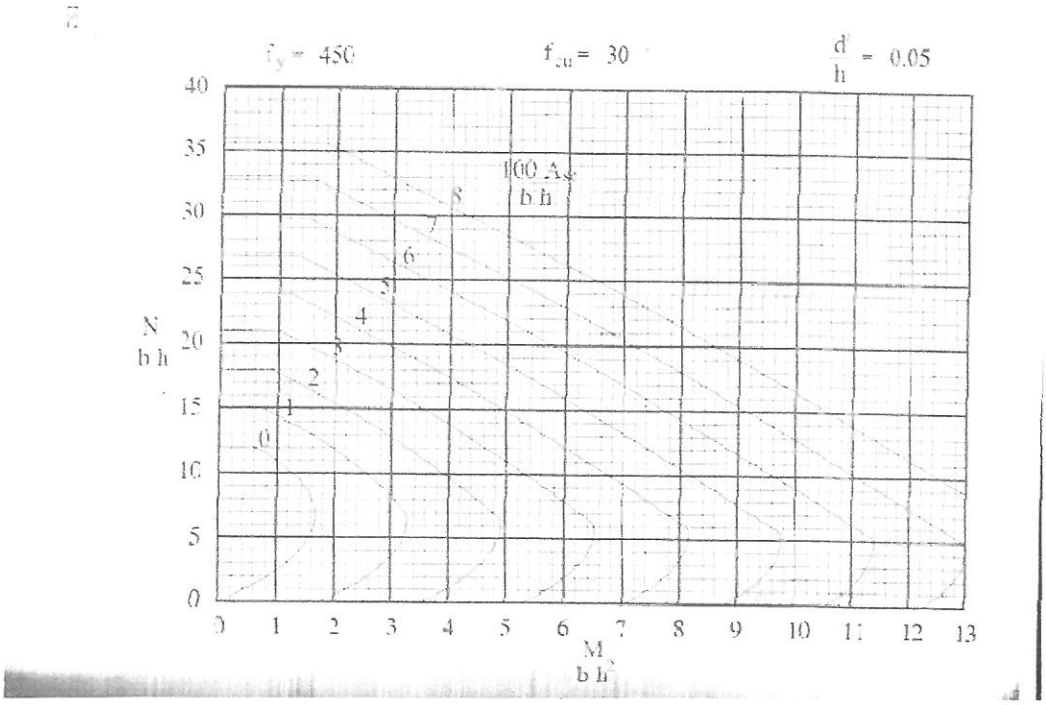
A rectangular column of width 225 mm and depth 300 mm is reinforced with Y20 mm bars placed at the corners and along mid-sides of the column section. f_y = 450 MPa, f_{cu} = 30 MPa,. Use 20 mm and 8 mm bars throughout your calculations.

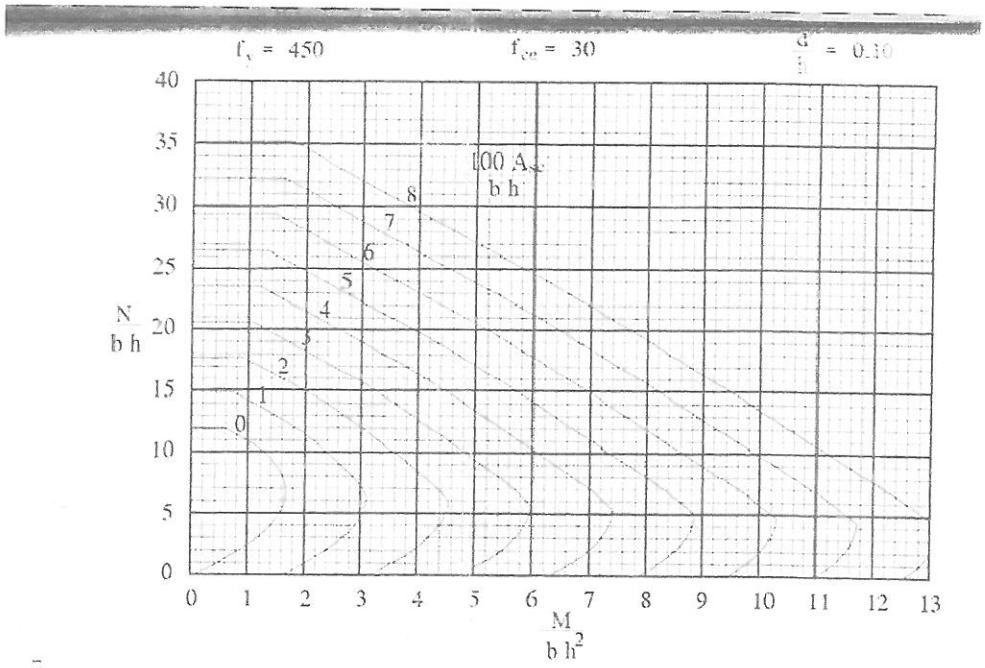


Determine if the column capacity is adequate for the following loading combinations:

(i) N = 938 kN, Mx = 37 kN.m, My = 21 kN.m, severe exposure **[14]**

(ii) N = 1767 kN, Mx = 34 kN.m, moderate exposure **[11]**

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f_{cu} = 30
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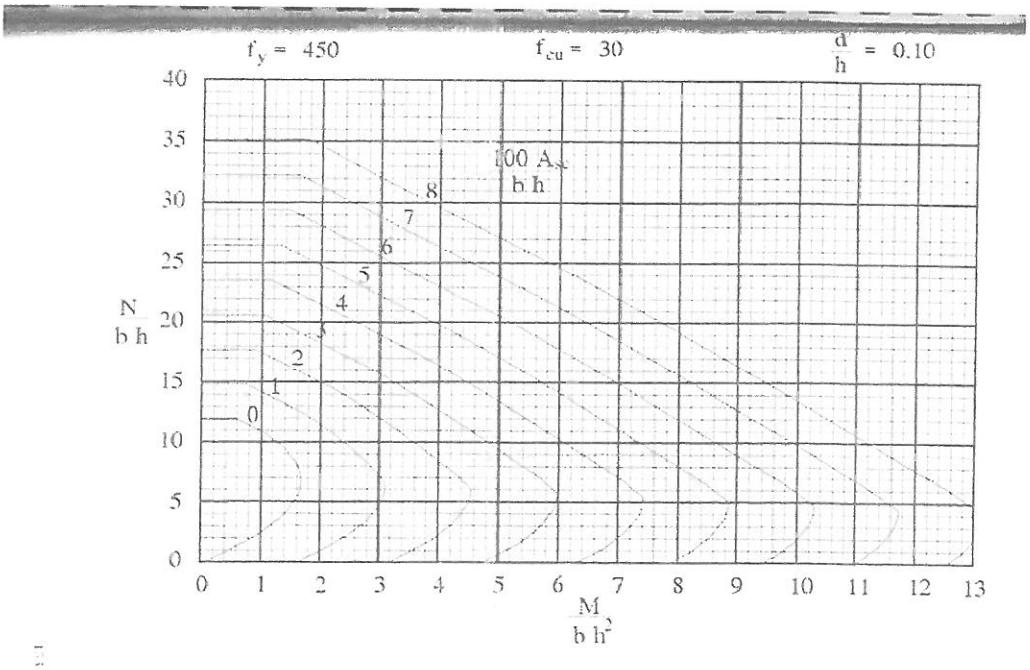
100 $\frac{A_s}{b\,h}$
$\frac{N}{b\,h}$
$\frac{M}{b\,h^2}$
0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 5 10 15 20 25 30 35 40
0 1 2 3 4 5 6 7 8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0 5 10 15 20 25 30 35 40
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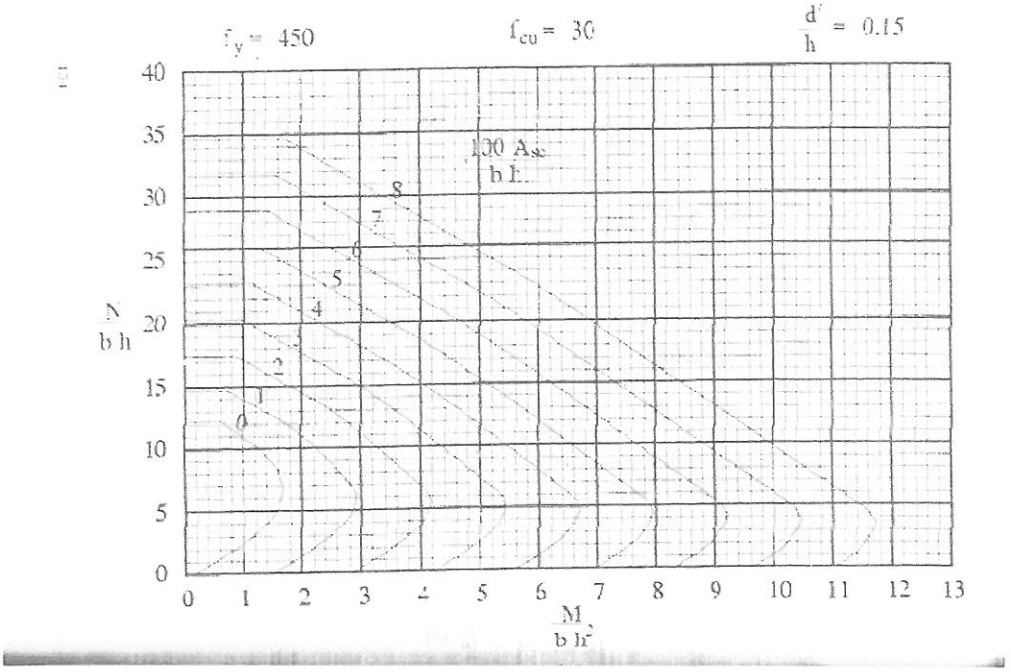
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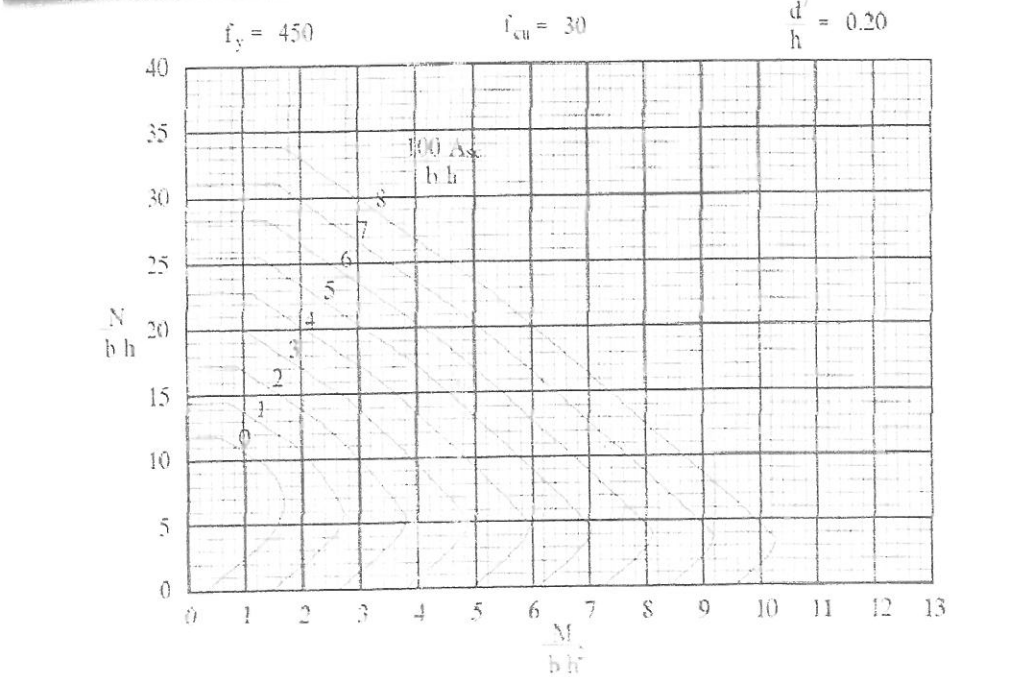
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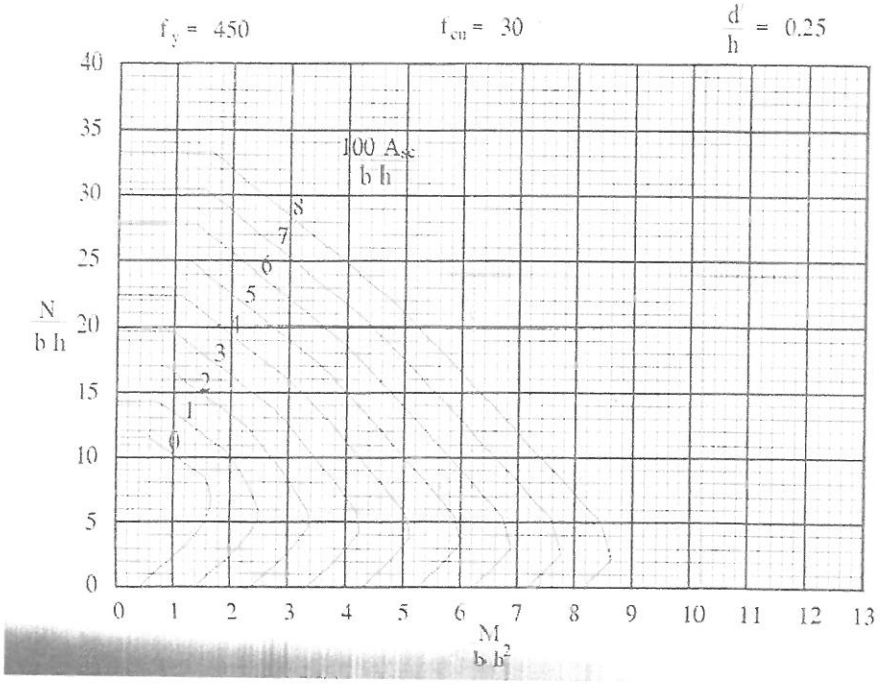
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$\frac{N}{b\ h}$
$\frac{M}{b\ h^2}$
0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 5 10 15 20 25 30 35 40
0 1 2 3 5 6 7 8

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Exam	SUPPLEMENTARY, JULY 2016
Duration	THREE (3) HOURS
Examiners	Prof SO. Ekolu Dr Alvin Masarira

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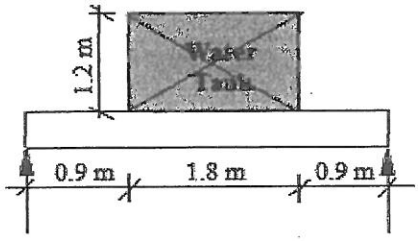
Total of 4 Pages

QUESTION 1.

Two RC beams spanning 3.6 m carry an elevated water tank of size 1.8 x 1.8 x 1.2 m high as shown in the diagram. Design the beam's tension and shear reinforcement taking its size to be 200 mm square. Sketch a clearly labeled section. Assume an empty tank weighs 1360 N and water density = 10 kN/m^3. fy = 450 for high yield steel, fy =250 N/mm^2 for mild steel, 1:1½:3 concrete, 25 mm cover to steel. *HINT: no live loads.*



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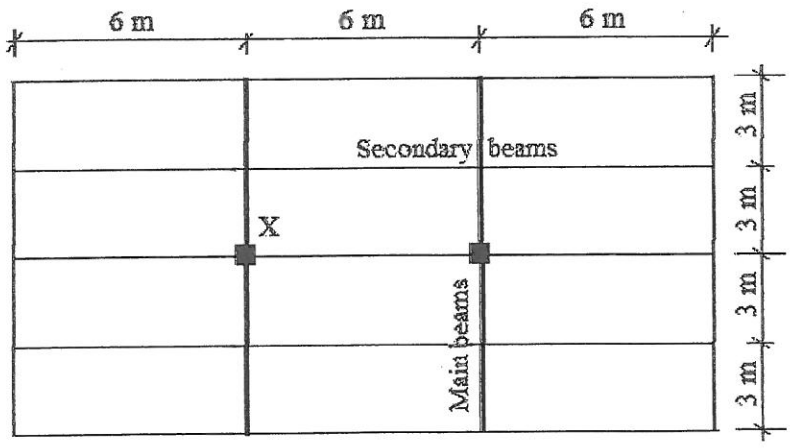
QUESTION 2.

The roof plan of a single storey RC building shows the layout of slab, beams and columns. The roof dead load is 6 kN/m^2 and 0.54 kN per m run may be taken as dead load estimate for beams. Assuming a braced square column of 3 m height, estimate the total load acting on each column and design the column X. Ignore column self-weight. f_{cu} = 25 N/mm^2, f_y = 410 N/mm^2.



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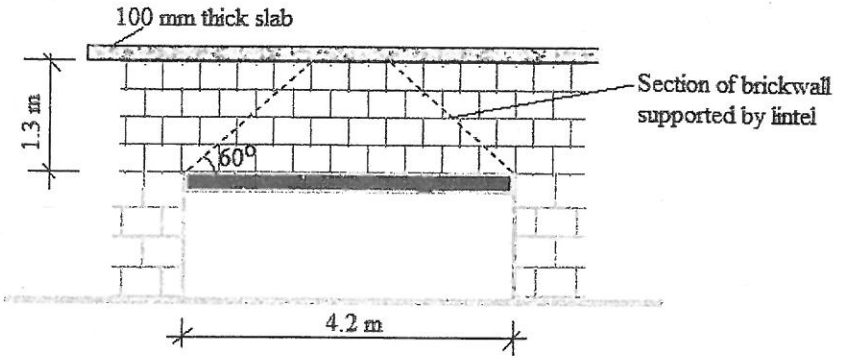
QUESTION 3.

A lintel is to be designed to support a brickwall of a flat roof double garage 4.2 m wide x 5.2 long. The dead load supported by the lintel is due to 100 mm thick RC roof slab and 1.3 m high brickwall 225 mm thick with density 20 kN/m^3. The weight of brickwall supported by the lintel is represented by the trapezoidal shape given in dotted lines. To allign the lintel with the brick courses, it becomes purposeful to make a lintel depth to be 225 mm. Ignore the lintel self-weight. Cover to steel = 25 mm.

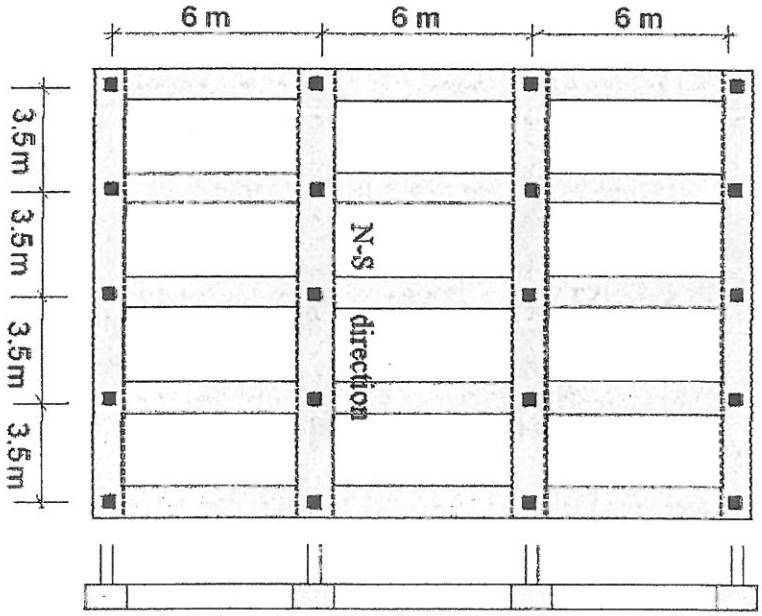
(i) Calculate the lintel dimmensions so as to ensure a singly reinforced design **[17]**

(ii) Design the tension reinforcement and provide a clearly labelled sketch of the section **[8]**



QUESTION 4.

The floor plan of a building shows a strip foundation to be designed to minimize settlement due to collapsible soil. Design a strip footing in the N-S direction for interior columns 300x300 mm equally spaced at 3.5m c/c. Assume each column carries DL = 1000 kN and LL = 360 kN. Soil bearing pressure = 150 kPa, fcu = 30 MPa, fy = 450 MPa, cover to steel = 40 mm.



Check for punching shear at column face and if shear reinforcement is required, design the shear reinforcement

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