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ANALYSIS AND DESIGN FOR

Proposed Construction Of Commercial Building Stilt+ 5 Floors at plot No 11 door no 173/64, Habibullah road, T.Nagar, Chennai-600017 Re S/No 96/1 Town survey no 6797, Block No 106 of Zamin Mambalam





STRUCTURAL STABILITY CERTIFICATE

The Detailed Engineering and structure design of the proposed Building Comprising of Stilt+ 5 Floors at plot No 11 door no 173/64, Habibullah road, T.Nagar, Chennai-600017 Re S/No 96/1 Town survey no 6797, Block No 106 of Zamin Mambalam. Has been done by me/ Us based on the report of geotechnical investigation(Soil Test) done by Minerva Civil Testing Lab Private Ltd

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GREATER CHENNAI CORPORATION WORKS DEPARTMENT

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that Thiru. Padmanabhan K has been enrolled as Registered Structural Engineer Grade- I (RSE) in Greater Chennai Corporation (GCC) who has the qualification of M.E.,(Structural Engg.,) with minimum of 5 years experience in the relevant field.

The Registration No. is RSE101122020 dated 01.09.2020. It is informed herewith to comply with the scope of work, duties and responsibilities as prescribed by the Government of Tamil Nadu in Part - V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O. (Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto 12.08.2025.



RGN No: RSE101122020

Dated: 01.09.2020

Superintending Engineer (Works)
Greater Chennai Corporation.

K. Padmanabhan
Registered Structural Engineer Grade-I (RSE)
GCC Regn. No.: RSE101122020
Greater Chennai Corporation



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TYPICAL STRUCTURAL DESIGN CALCULATION

GENERAL:

The *proposed Building Comprising of Stilt+ 5 Floors at plot No 11 door no 173/64, Habibullah road, T.Nagar, Chennai-600017*
Re S/No 96/1 Town survey no 6797, Block No 106 of Zamin Mambalam. designed as per the following floor requirements.

1. Proposed Construction For Office Cum Warehouse

DESIGN BASIS:

Latest Design codes of IS-456, IS-875 and IS-1893 are followed with SP-16 Design Aid books are used for the purpose of calculations.

Since the maximum storey of building is Three Floors, wind load is also taken into account. The structural element is designed for M25 grade of concrete for Column, M20 Grade for Slab & Beams and Fe-500 grade of steel is used for main and secondary reinforcement.

The following are the Clear cover to the main steel adopted:

1. For Footing – 50 mm
2. For Columns – 40 mm
3. For Beams – 25 mm
4. For Slab – 20 mm

CALCULATION OF LOADS:

1. EARTHQUAKE LOAD:

The Earthquake load for this structure is calculated as per IS:1893 as follows:

Design horizontal seismic coefficient, $A_h = Z/I R/2 S_a/g$	
Z = Zone factor	= 0.16 (for Chennai)
I = Importance factor	= 1
R = Response reduction factor	= 5.00
S_a/g , Average response acceleration co-efficient	= 1.0

2. LIVE LOAD:

The Live load for this structure is calculated as per IS:875 (Part 2) as follows:

The structure is designed for Live loads of 4 KN/Sq.m for Commercial

3. DEAD LOAD:

Loads from self weight of Slab, Beams, Columns, Walls, Staircase and Water Tank are taken as Dead load of the structure.

a. Dead Load due to Slab:

The dead load of slab can be calculated based on the slab thickness and that should be calculated based on span.

Maximum Slab Thickness provided for this structure is 150 mm.



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Therefore,	Load due to slab = 0.20×25	= 5.00 KN/Sq.m.
	Load due to Floor Finish	= 0.500 KN/Sq.m.
	Load due to Unknown Partition wall	= 1.000 KN/Sq.m.
	Total Load	= 6.5 KN/Sq.m. .

b. Dead Load due to Wall:

The dead load of the wall can be calculated based on the wall thickness.

Maximum Wall Thickness provided for this structure is 230 mm.

Therefore,

Load due to 230 mm Thk solid block masonry = $0.230 \times 20 \times 1.925 = 8.855$ KN/m

Load due to 115 mm Thk solid block masonry = $0.115 \times 20 \times 1.925 = 4.428$ KN/m

c. Dead Load due to Self Weight of Beams:

The dead load of the beam can be calculated based on the size of the beams provided and that should be decided based on the span.

Maximum Beam Size in this structure provided is 600 x 450 mm.

Therefore, Load due to Beam Self weight = $0.45 \times 0.600 \times 25 = 6.75$ KN/m

d. Dead Load due to Self Weight of Column:

The dead load of the column can be calculated based on the size of the columns provided.

Maximum Column Size in this structure provided is 600*600 mm.

Therefore,

Load due to Column Self weight = $0.6 \times 0.6 \times 1.925 \times 25 = 17.325$ KN/floor

e. Dead Load due to Water Tank:

The dead load of the water Tank is calculated as follows.

Load due to base slab	= 0.175×25	= 4.375 KN/Sq.m.
Load due to cover slab	= 0.175×25	= 4.375 KN/Sq.m.
Load due to Floor Finish		= 1.000 KN/Sq.m.
Load due to water	= 1.35×10	= 13.5 KN/Sq.m.
Load due to Imposed load		= 0.750 KN/Sq.m.
Total Load		= 24 KN/Sq.m.

f. Dead Load due to Fillings:

The dead load of the Fillings on sunken area is calculated as follows.

Load due to filling on Toilet area = $0.3 \times 20 = 6.00$ KN/Sq.m.



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LOAD COMBINATIONS:

The following are the load combinations provided for the structure for design purpose as per code.

By considering Earthquake:

1. 1.5DL+1.5LL
2. 1.5DL+1.5ELX
3. 1.5DL+1.5EL-X
4. 1.5DL+1.5ELZ
5. 1.5DL+1.5EL-Z
6. 0.9DL+1.5ELX
7. 0.9DL+1.5EL-X
8. 0.9DL+1.5ELZ
9. 0.9DL+1.5EL-Z
10. 1.2DL+1.2ELX+1.2LL
11. 1.2DL+1.2EL-X+1.2LL
12. 1.2DL+1.2ELZ+1.2LL
13. 1.2DL+1.2EL-Z+1.2LL
14. DL+LL
15. 1.0DL+1.0ELX
16. 1.0DL+1.0EL-X
17. 1.0DL+1.0ELZ
18. 1.0DL+1.0EL-Z
19. 1.0DL+0.8ELX+0.8LL
20. 1.0DL+0.8EL-X+0.8LL
21. 1.0DL+0.8ELZ+0.8LL
22. 1.0DL+0.8EL-Z+0.8LL



By considering WindLoad:

23. 1.5DL+1.5WLX
24. 1.5DL+1.5WL-X
25. 1.5DL+1.5WLZ
26. 1.5DL+1.5WL-Z
27. 0.9DL+1.5WLX
28. 0.9DL+1.5WL-X
29. 0.9DL+1.5WLZ
30. 0.9DL+1.5WL-Z
31. 1.2DL+1.2WLX+1.2LL
32. 1.2DL+1.2WL-X+1.2LL
33. 1.2DL+1.2WLZ+1.2LL
34. 1.2DL+1.2WL-Z+1.2LL
35. 1.0DL+1.0ELX
36. 1.0DL+1.0EL-X
37. 1.0DL+1.0ELZ
38. 1.0DL+1.0EL-Z
39. 1.0DL+0.8ELX+0.8LL
40. 1.0DL+0.8EL-X+0.8LL
41. 1.0DL+0.8ELZ+0.8LL
42. 1.0DL+0.8EL-Z+0.8LL



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DESIGN CALCULATION

Proposed Construction Of Commercial Building (Ground+02) At Old No:190, New No:38 survey No:4693/60, North road, T.nagar, Chennai-600017. A model calculation for the design of the structural elements like Beam, Slab, Column and Foundation is submitted here.



DESIGN OF SLAB

INPUT

Slab thickness	=	200	mm
Longer Span	=	6.20	m
Shorter Span	=	5.75	m
Grade of concrete	=	30	N/mm ²
Grade of steel	=	500	N/mm ²
Clear cover	=	20	mm
Load factor	=	1.5	
Boundary condition	=	Two adjacent edges discontinuous	

EFFECTIVE SPAN

Longer Span	l_y	=	6.365	m
Shorter Span	l_x	=	5.925	m
Span Ratio		=	1.07	TWO WAY SLAB



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Effective Depth: Longer Span side = 165 mm

Shorter Span side = 175 mm

LOAD CALCULATION

Self weight of slab = $25 \times (200/1000) = 5 \text{ kN/m}^2$

Floor finish and Partition = 1 kN/m²

Live Load = 5 kN/m²

TOTAL LOAD (w) = 11.00 kN/m²

MOMENT CALCULATION

Factd Bending Moment = $1.5 w \alpha l_x^2$

Shorter Span: -ve mmt coefficient = 0.051

+ve mmt coefficient = 0.039

-ve B.M = $1.5 \times 10 \times 0.054 \times 4.63^2 = 29.54 \text{ kN-m}$ kN-m

+ve B.M = $1.5 \times 10 \times 0.039 \times 4.63^2 = 22.59 \text{ kN-m}$ kN-m

Longer Span -ve mmt coefficient = 0.047

+ve mmt coefficient = 0.035

-ve B.M = $1.5 \times 10.75 \times 0.047 \times 6.59^2 = 27.22 \text{ kN-m}$ kN-m

+ve B.M = $1.5 \times 10 \times 0.028 \times 4.63^2 = 20.27 \text{ kN-m}$ kN-m

DEPTH CHECK

i) W.r.t to moment:

$\mu = 0.1389 f_{ck} b d^2$

$d = \sqrt{29.54 \times 10^6 / (0.1339 \times 30 \times 200)} = 86 \text{ mm}$

D = 111 mm

ii) W.r.t to deflection:

$d = \text{Span} / (\text{Span-depth ratio} \times k_t) = 131 \text{ mm}$

D = 156 mm



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REINFORCEMENT REQUIRED

			Mu/bd ²	Pt reqd	Ast reqd	Min Ast Reqd
				%	mm ²	
Shorter Span	-ve		0.96	0.231	404	240
	+ve		0.74	0.175	306	240
Longer span	-ve		1.00	0.239	395	240
	+ve		0.74	0.176	291	240

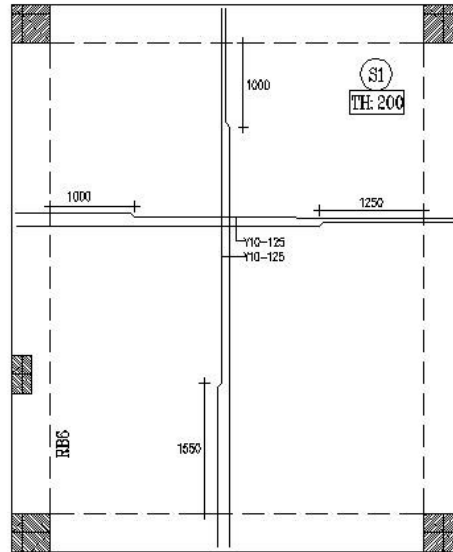
REINFORCEMENT PROVIDED

								Ast provided (mm ²)
Shorter Span:	Support			Y-	10	@	125	628
	Span			Y-	10	@	125	628
Longer span:	Support			Y-	10	@	128	628
	Span			Y-	10	@	128	628



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Structural Slab Details

DESIGN OF BEAM

A model calculation of Beam is given below.

General Data:

Breadth of beam,	b	=	450	mm
Depth of beam,	D	=	450	mm
Clear cover for reinforcement		=	25	mm
Diameter of main bars,	Y	=	25	mm
Diameter of stirrups,	Y1	=	8	mm
Effective depth of beam,	d	=	382.5	mm
Dist from beam edge to centre of main steel,	d'	=	67.5	mm
Ratio,	d' / d		0.18	



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Characteristic strength of concrete,	fck	=	25	N/mm ²
Characteristic strength of steel,	fy	=	500	N/mm ²

Results from STAAD Analysis:

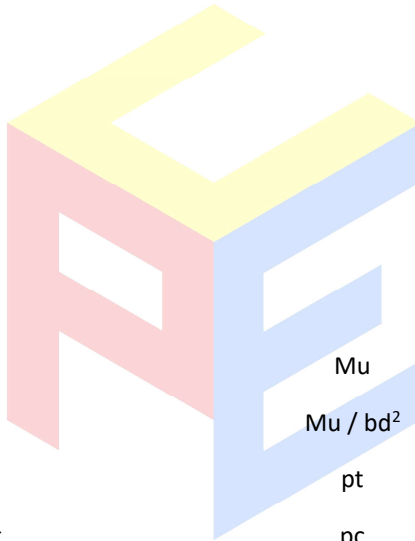
The following are the results taken from the STAAD analysis,

Critical values due to combination of loads by Earth quake and Wind is taken for the calculation

Maximum positive moment	=	275.04	kN-m
Negative moment at support	=	573.47	kN-m
Maximum shear force	=	365.74	kN

Design for Positive moment

Ultimate positive moment,	Mu	=	275.04	kN-m
	Mu / bd ²	=	2.263	N/mm ²
Percentage of reinforcement,	pt	=	0.71	
Percentage of compressive reinforcement,	pc	=	0.42	
Area of tensile steel,	Ast	=	1884	mm ²
Provide	4 nos Y 25 mm as Tensile steel	=	1962.56	mm²





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Design for Negative moment

Ultimate Negative moment at support	=	573.45	kN-m
	M_u / bd^2	=	5.55
Percentage of reinforcement,	pt	=	1.64
Percentage of reinforcement,	pc	=	0.44
Area of tensile steel,	Ast	=	1754.62 mm ²
Provide	4 nos Y 25mm Compressive Steel	=	1954.56 mm²

Design for shear

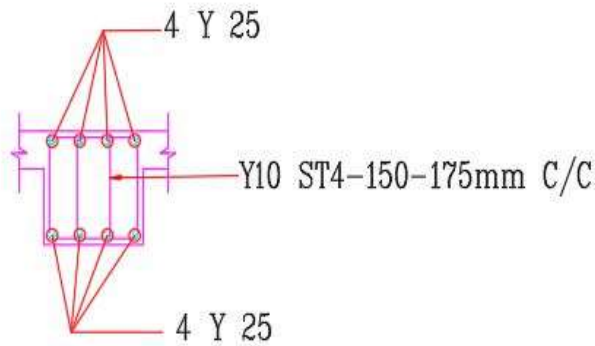
Ultimate shear,	V_u	=	365.74	kN
Shear stress,	τ_{vc}	=	0.77	N/mm ²
Area of tensile steel provided,	Ast	=	3703	mm ²
For $p = 100 A_s / bd$	pt	=	1.56	
	τ_c	=	0.73	N/mm ²
Allowable shear stress, Shear force to be taken by stirrups,	V_{us}	=	$(\tau_{vc} - \tau_c) \times bd / 1000$	
		=	480	kN
Maximum spacing @ 0.75d		162	mm	

Provide 4 leg 10mm dia at 150mm C/C



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CS OF BEAM 450mm X 450mm

Design of Column

A model calculation of column given below

Grade of Concrete	(fck)	=	30	N/mm ²
Grade of steel	(fy)	=	500	N/mm ²
Factored Axial load on the column	(Pu)	=	2200	kN
Factored Moment parallel to X-axis	(Mux)	=	33.28	kNm
Factored Moment parallel to Y-axis	(Muy)	=	77.71	kNm
Assumed size of the column	Width (b)	=	45.00	cm
	Depth (D)	=	45.00	cm
Assuming percentage of Reinforcement	pt	=	2.50	%

$$p_t / f_{ck} = 0.08$$



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Uniaxial moment capacity of the section about XX-axis

$$\begin{aligned} d' / D &= 5.25/60 = 0.12 \\ \text{Chart for } d' / D &= 0.1 \text{ will be used} \\ P_u / f_{ck} b D &= 1972.113 \times 10^3 / 25 \times 60 \times 60 = 0.36 \\ M_u / f_{ck} b D^2 &\text{ Ref. chart } 44 = 0.09 \\ M_{ux1} &= 0.09 \times 25 \times 60 \times 60^2 / 10^6 = 246.04 \text{ KN} \end{aligned}$$

Uniaxial moment capacity of the section about YY-axis

$$\begin{aligned} d' / D &= 5.25/45 = 0.12 \\ \text{Chart for } d' / D &= 0.2 \text{ will be used} \\ M_u / f_{ck} D B^2 &\text{ Ref. chart } 46 = 0.07 \\ M_{uy1} &= 0.07 \times 25 \times 60 \times 60^2 / 10^6 = 191.36 \text{ KN} \end{aligned}$$

Calculation of P_{uz}

$$\begin{aligned} \text{Referring to chart } 63 \\ \text{There fore } P_{uz} &= 13.38397740142 \times 60 \times 60 / 10 \\ P_{uz} / A_g &= 19.00 \text{ N/mm}^2 \\ &= 3847.48 \text{ KN} \end{aligned}$$



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$$P_u / P_{uz} = 0.57$$

$$M_{ux} / M_{ux1} = 0.14$$

$$M_{uy} / M_{uy1} = 0.41$$

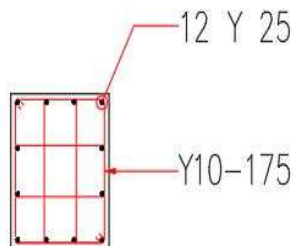
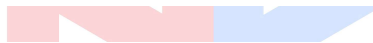
Referring to chart **64**, the permissible value of M_{ux}/M_{ux1} corresponding to the above values of M_{uy}/M_{uy1} and P_u/P_{uz} is

$$= 0.41 < 0.98$$

$$\text{Area of Steel Required} = 50.608 \text{ Sqcm}$$

Provide **6** Nos of **Y 25** + **6** Nos of **Y 25**

$$\text{Area of Steel Provided} = 58.88 \text{ Sqcm}$$



CS OF COLUMN 450mm X 450mm



DESIGN OF STRIP RAFT

COLUMN SIZE a
= 0.45 m
b
= 0.45 m
SPACING OF COLUMN, a = 5.75 m

SPACING OF COLUMN, b = 5.75 M

SBC OF SOIL w
= 150 KN/m²

AXIAL LOAD P1
= 1300 KN

AXIAL LOAD P2
= 1300 KN

AXIAL LOAD P3
= 1700 KN

TOTAL LOAD
P1+P2 = 4300 KN

10 % AXIAL LOAD
= 430 KN

TOTAL LOAD Pu
= 4730 KN

AREA REQUIRED
A= 31.53333 m²

LET BREADTH OFFOOTING,B
= 2.5 m

BREADTH OF BEAM Bb = 0.6 m

LENGTH OF FOOTING

REQUIRED L = 12.61 m

LET LENGTH OF



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FOOTING L = 13 m

AREA PROVIDED

A = 32.5 m²

CHECK FOR SOIL PRESSURE = $P/A =$ 137.6 KN/ m²

SAFE

MOMENT CALCULATION

Shorter side length B = 0.95 m

Longer side length L = 0.275 m

Ada 93.138 KNm neg. moment

Depth required d = 183.70 mm

Provide overall depth D = 367.40

Say overall depth D = 450 mm enter value for depth

Effective depth d = 345 mm

REINFORCEMENT

Bottom reinforcement for slab

$M/bd^2 =$ 0.78

% Ast required pt = 0.2 Enter value From TABLE 2 IS 456 DESIGN AIDS



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Ast required = 1725 mm²

Let diameter of bar = 10 mm

Spacing of bars
using = 10 mm **113.77** mm

Say 100 mm

Provide
@ 10 **100** mm c/c both ways

No. of bars using 10 mm = **125** nos. in SD bottom reinforcement
Ast provide Ast = **9812.5** mm²

DISTRIBUTION

Min Ast
= 1200 mm²

Let diameter of bar = 10 mm

Spacing of bars
using = 10 mm **163.54** mm

Say 150 mm

Provide
@ 10 **150** mm c/c both ways

No. of bars using 10 mm = **17** nos. in LD bottom reinforcement
Ast provide Ast = **1334.5** mm²

Reinforcement for RIBBED BEAM

Moment at P1 & P2 ,Mxx= **19.51125** KNm neg. moment



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$X_c = 3.15$ m
Moment at center of span
 $M_c = 1177.50$ KNm positive moment
Depth required $d = 653.16814$ mm

Provide overall depth $D = 698.17$

Say overall depth
 $= 750$ mm enter value for depth

Effective depth $d = 695$ mm

bottom
reinforcement

$M/bd^2 = 0.07$
% Ast required $p_t = 0.12$ Enter value From TABLE 2 IS 456 DESIGN AIDS
Ast required $= 500.4$ mm²
Let diameter of bar $= 25$ mm
No. of bars at support 1.02

Provide
@ 25 4 nos as bottom reinforcement fir beam

No. of bars using 25 mm = 4 nos. in bottom reinforcement
Ast provide Ast = 1962.5 mm²

top reinforcement

$M/bd^2 = 4.06$
% Ast required $p_t = 0.47$ Enter value From TABLE 2 IS 456 DESIGN AIDS



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Ast required = 1959.9 mm²

Let diameter of bar = 25 mm

No. of bars at mid span 3.99

Provide

@ 25 4.00 nos as bottom reinforcement fir beam

No. of bars using 25 mm = 4 nos. in bottom reinforcement

Ast provide Ast = 1962.5 mm²

CHECK FOR BENDING SHEAR

Length of the section

0.95

m

Area of the section A

0.95

m²

Shear force

=

196.08

KN

0.36

0.25

0.465899

0.48

0.5

Tv =

0.470

N/mm²

For 100 Ast / bd =

0.47

Tc =

0.465899

enter value form table 61 of IS 456 - 1978

Shear force

=

141.90

KN

0.36

0.25

0.465899

0.48

0.5

Tv =

0.340

N/mm²

For 100 Ast / bd =

0.47



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Tc = 0.465899 enter value form table 61 of IS 456 - 1978

Vus = 141900 1.020863

S = 0.565497

S = 277.6319 10 mm 4 legged stirrups

for slab

SIZE = 2.5 X 13 m D = 450 mm

Provide 10 mm # 125.00 mm spacing

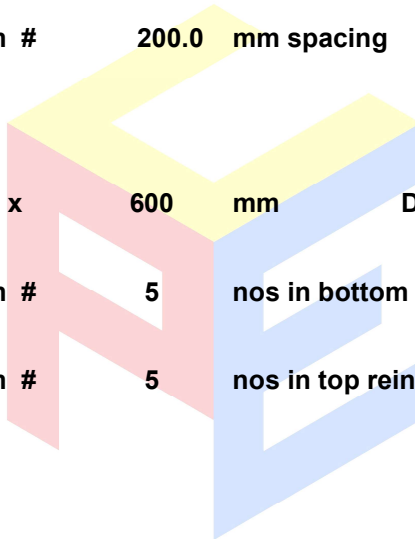
Provide 10 mm # 200.0 mm spacing

for beam

SIZE = 600 x 600 mm D = 600 mm

Provide 20 mm # 5 nos in bottom reinforcement

Provide 20 mm # 5 nos in top reinforcement





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