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METIS structures

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FORM - A

STABILITY CERTIFICATE

FOR RESIDENTIAL BUILDING, KALAPATTI.

1. Location (Street Number, Ward Name of Place, i.e. Corporation Municipality/ Panchayat Union / Township Cantonment) : M/S.EIVAA HOMES INDIA LLP, S.F No: 83/1B, 1D, 1F, 1G & 94/1A. Kalapatti, Coimbatore – 641048. Coimbatore city Municipal Corp.,
2. Year of Construction : **Proposed 2024-2025**
3. Purpose for which the building being used or proposed to be used : **Residential building.**
4. Purpose for which building has either to : **Residential building.**
5. Details of construction of the building

   (Particulars of the foundation soil,

   Specification of various parts under)

   1. Foundation : **RCC Isolated / Strip Footing**
   2. Super Structure : **RCC Framed**
   3. Roof Covering : **RCC Roof slab**

6.Structural specifications:

A) Framed structure with reinforced

1) Maximum unsupported length of column : **3.05 m to 3.5 m**

2) Minimum size of the column : **0.23m * 0.30 m**

B) Design load on the structure

1) Live load at floor level : **2 kN/ Sq.m**
2) Live load at Terrace level : **1.5 kN/ Sq.m**
3) Live load for stair and corridor : **3 kN/ Sq.m**

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GSTIN : 33AAXFM9597P1ZT

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C)Dead loads assumed other than self-weight

1) For Floor finishes : **1.5 kN/ Sq.m**
2) For partitions : **1.0 kN/ Sq.m**
3) For terrace finish : **1.5 kN/ Sq.m**

D) Number of Storey : **Ground + 2**

E) Area Details (In sqm)

Ground Floor	:	**176.00**
First Floor	:	**162.00**
Second Floor	:	**78.50**
Total	:	**416.50 Sqm**

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APPLICANT **ENGINEER**

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FORM "B"

(Form of certificate of structural soundness under sub section (4) of section 4 of the Madras Public Building (Licensing) act 1965 (Madras Act 13 of 1965) referred as in rule 4 of the Madras Public Buildings (Licensing) rules 1965).

I certify that I have verified the building plan mentioned in the statement below. A License may be granted for the period from the 07/08/2024 to 07/08/2027

STATEMENT TO ACCOMPANY THE CERTIFICATE OF STRUCTURAL SOUNDNESS

Location of the building (Door number, Street Number and name of place	Age of the building	Purpose for which the building can be used	The period of License	Number of per-sons to be accom -modated	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
S.F No: 83/1B, 1D, 1F, 1G & 94/1A, Kalapatti Coimbatore - 641048	New	Residential	3 Years	06	

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Date: 07-08-2024

Signature of the Engineer

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STATEMENT TO ACCOMPANY THE CERTIFICATE OF STRUCTURAL SOUNDNESS

1.	Location (Street Number, Ward	: M/S.EIVAA HOMES INDIA LLP, S.F No: 83/1B, 1D, 1F, 1G & 94/1A. Kalapatti, Coimbatore – 641048.
	Municipality/ Panchayat Union / Township	: **Coimbatore city Municipal**
	Cantonment)	**Corporation**
	Life of building	: **100 Years**
2.	Purpose for which the building will be	: **Residential Building**
	Structurally sound	
3.	Period for which the building structurally	: **100 Years**
	Sound	

Structural design calculation are verified to standards and we confirm the structure proposed is safe and sound.

Place: Coimbatore

Date: 07-08-2024

S. ARUN KUMAR, ME., (Str
CBE Rgn./SE/Gr-I/2019/07/
METIS STRUCTURE
9,9-1,Lakshmi Garden, Sankara Collag
Saravanampatti, Coimbatore-35
GSTIN : 33AAXFM9597P1ZT
ENGINEER

APPLICANT

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FORM – C

(Form of Certificate of structural soundness under sub – section (4) of section 4 of the Tamil Nadu public building (licensing) Act, 1965. (Tamil Nadu Act, 12 of 1965) referred to in rule 4 of the Tamil Nadu Public building (Licensing) Rule 1966)

1. Foundation

i. Depth below ground level : **3.0 m Depth from NGL**

ii. Nature of soil met with at Foundation level : **Soft disintegrated rock**

iii. Probable safe bearing capacity of the strata met with at foundation : **270 KN/m ^{2}.**

iv. Pressure at foundation : **175 kN/m ^{2}**

2. Superstructure

I. Maximum stress in the most Critical section of masonry and Concrete : **0.4 X 20= 8 MPa**

II. Nature of masonry and concrete : **Brickwork in cm 1:6 – 0.35 N/ mm**

III. Its safe permissible stress : **RCC M 20 mix – 2.8 N/ mm ^{2}**

This is stated that the building will be designed to take seismic forces and other loads as the relevant Indian Standard Codes.

Structural design calculations are verified to standards and we confirm the structure proposed is safe and sound.

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APPLICANT

ENGINEER

METIS structures

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DECLARATION

I, **Mr.Arun Kumar.S ,** Hereby declare that I possess the qualification and experience specified in G.O. (Ms.No.484, Education, dated 24.4.91. As amended in G.O. (Ms.) No.349, Education dated 31.01.1993 for issuing the certificate of structural soundness of the building covered by the certificate C.

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GSTIN : 33AAXFM9507P1ZT

Station : Coimbatore
Date : 07/08/2024

Signature of the certifying Engineer

i). Name and Address (in block letters)

Er. S. Arun Kumar,
Metis Structures, 9, 9-1, Lakshmi Garden,Sankara College Road, Saravanampatti, Coimbatore-641 035.

ii). Engineering Qualification — **M.E**

iii) Number of years of experience and nature there of — **20 years.**

DESIGN BASIS REPORT

ON

EIVALL HOMES

PROPOSED VILLA

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3	**LIST OF CODES USED**	01
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PREAMBLE

TABLE 1. GENERAL INFORMATION ABOUT THE STRUCTURE

1.	NATURE OF BUILDING	Residential Building
2.	TYPE OF STRUCTURE	Framed
3.	TOTAL NO. OF FLOORS	2 Floors
4.	PLINTH LEVEL	At 1 m
5.	NUMBER OF FLOORS ABOVE G.L WITH HEIGHT	Ground Floor = 3.50 m
		First Floors = 3.50 m
		Second Floor = 3.05 m
6.	TOTAL HEIGHT OF THE BUILDING	10.5m

2. MODEL AND ANALYSIS

The Model of the structure is created using STAAD.Pro V8i and the Structural analysis is carried out under the following considerations.

2.1 Material Used

Concrete = M20 (For All Concrete Structural Members)
Rebar = HYSD500 (For Structural Members)

2.2 Member Properties

a) Column Sizes (in mm)

C1 = 230x230
C2 = 230x380
C3 = 230x450

3. LIST OF CODES USED

1. IS 456 – 2000 - Plain and reinforced concrete- code of practice
2. IS 875 – (Part –I) -1987 Code of practice for design loads (other than earthquake) for buildings and structures - Dead loads
3. IS 875 – (Part- II) -1987 - Code of practice for design loads (other than earthquake) for buildings and structures. - Imposed loads.

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4. LOADING PARAMETERS

i. Self-Weight is default in Staad.pro and it is considered as dead load.
ii. Apart from self-weight, all other dead loads are considered as super dead loads.

TABLE 2. GRAVITY LOADS

S.No	Floor	Load Type		Load	Reference
1.	**Ground Floor**	**Super Imposed Load**	Brick Wall Load (9")	13.7kN/m	$H_w * t_w * \gamma_b * 0.85$ H_w, Height of Wall = 3.5 m t_w Thickness of Wall = 0.23 m γ_b, Unit Weight of Brick = 20kN/m^3
			Brick Wall Load (4½")	6.85kN/m	$H_w * t_w * \gamma_b * 0.85$ H_w, Height of Wall = 3.5m t_w Thickness of Wall = 0.115 m γ_b, Unit Weight of Brick = 20kN/m^3
2.	**First Floor**	**Super Imposed Load**	Brick Wall Load (9")	13.7kN/m	$H_w * t_w * \gamma_b * 0.85$ H_w, Height of Wall = 3.5 m t_w Thickness of Wall = 0.23 m γ_b, Unit Weight of Brick = 20kN/m^3
			Brick Wall Load (4½")	6.85 kN/m	For Inner walls $H_w * t_w * \gamma_b * 0.85$ H_w, Height Of Wall = 3.5 m t_w Thickness of Wall = 0.115 m γ_b, Unit Weight of Brick = 20kN/m^3

			Slab Dead load	5.25 kN/m^2 4.625 kN/m^2	Self-weight 6" = 0.15 *25 = 3.75 kN/m^2 Floor Finish = 1.5 kN/m^2 Total Load = 5.25 kN/m^2 Self-weight 5" = 0.125 *25 = 3.125 kN/m^2 Floor Finish = 1.5 kN/m^2 Total Load =4.625 kN/m^2
			Sunken Load	3.5 kN/m^2	Sunken Load 10" = 0.175 *20 = 3.5 kN/m^2
		Live Load	Floor Load	2 kN/m^2	IS -875(Part -2)-1987
3.	**Terrace Floor**	**Super Dead**	Brick Wall Load (9")	11.95kN/m	H_w * t_w * γ_b* 0.85 H_w, Height of Wall = 3.05 m t_w Thickness of Wall = 0.23 m γ_b,Unit Weight of Brick = 20kN/m^3
			Brick Wall Load (4½")	6 kN/m	For Inner walls H_w * t_w * γ_b* 0.85 H_w, Height Of Wall = 3.05 m t_w Thickness of Wall = 0.115 m γ_b,Unit Weight of Brick = 20kN/m^3
			Slab Dead load	5.25 kN/m^2 4.625 kN/m^2	Self-weight 6" = 0.15 *25 = 3.75 kN/m^2 Floor Finish = 1.5 kN/m^2 Total Load = 5.25 kN/m^2 Self-weight 5" = 0.125 *25 = 3.125 kN/m^2 Floor Finish = 1.5 kN/m^2 Total Load =4.625 kN/m^2
		Live Load	Floor Load	2 kN/m^2	IS -875(Part -2)-1987

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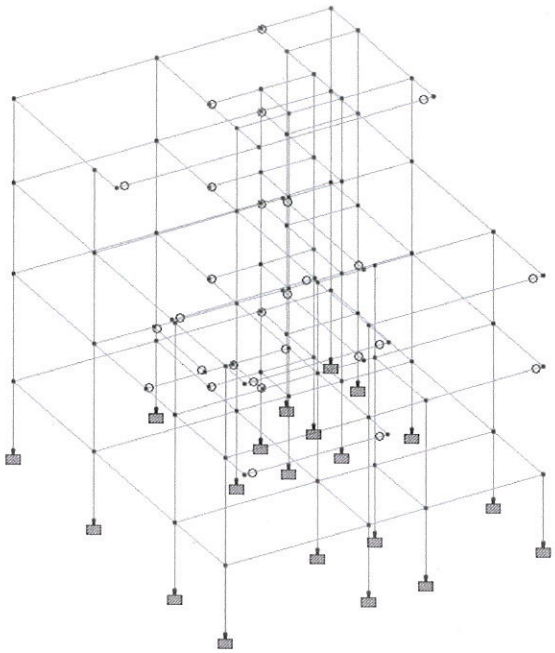
5. LOAD COMBINATIONS

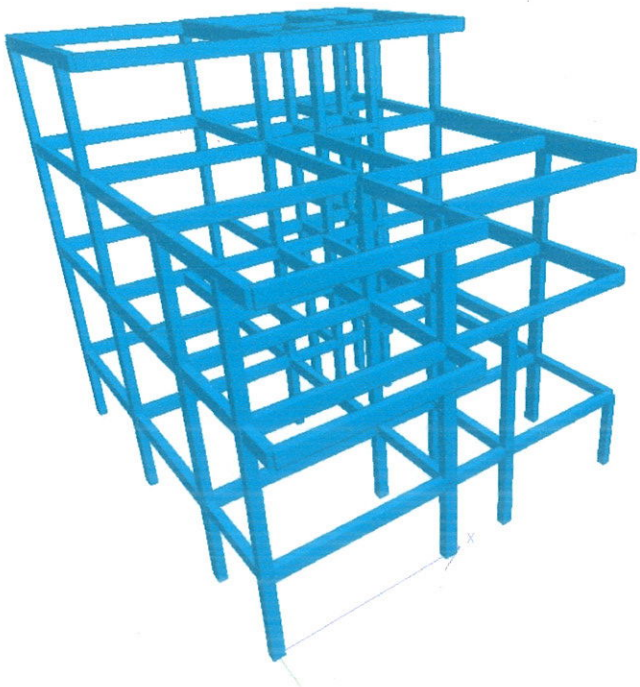
The load combinations producing the most critical conditions on the frames are taken into account. The load combinations indicated in IS 875:1987 (Part 5) are adopted for the design of the framed structure. The load combinations with appropriate load factor a given below.

1. D.L + L.L
2. 1.5D.L + 1.5 L.L

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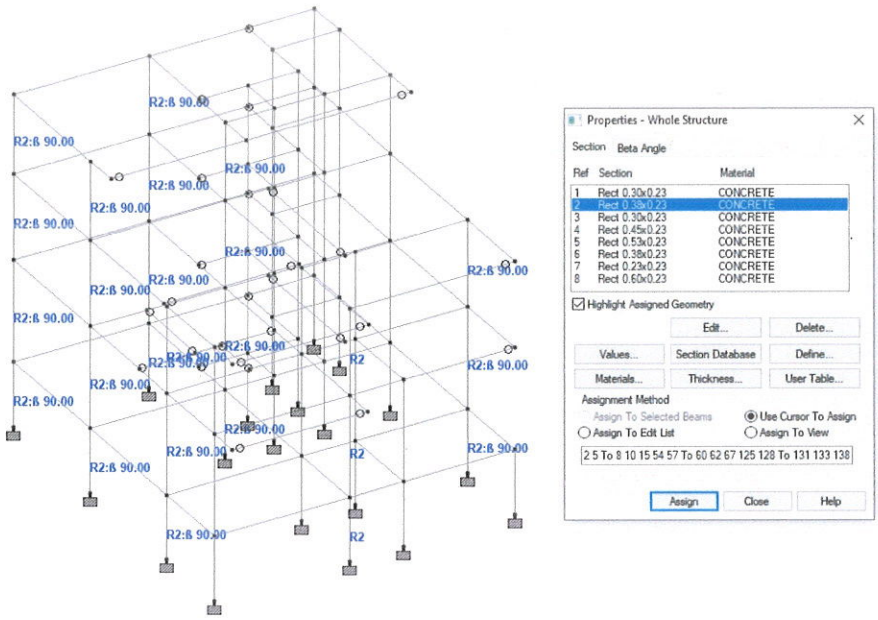
6.STAAD IMAGES



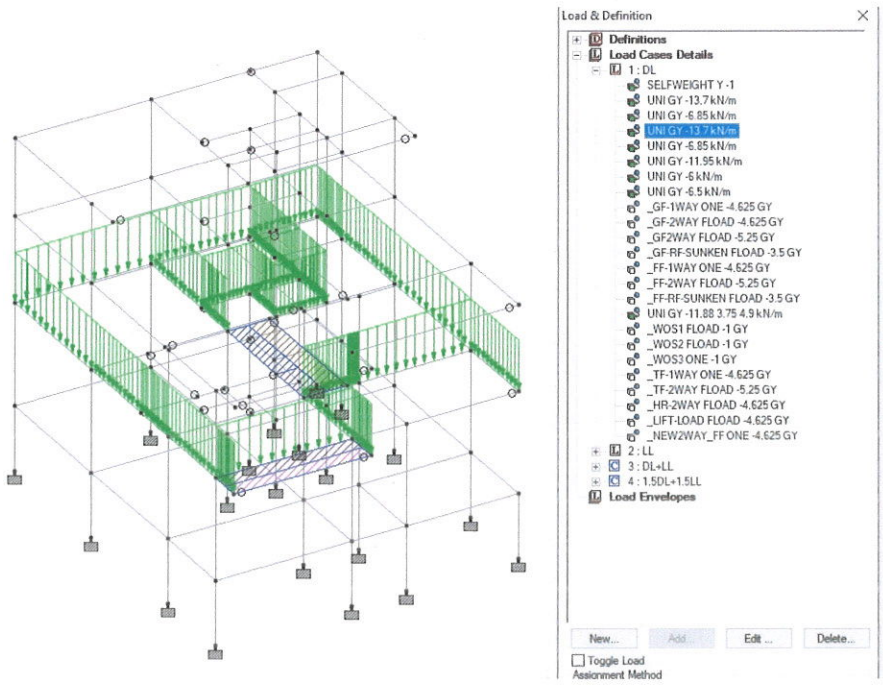


WHOLE STRUCTURE

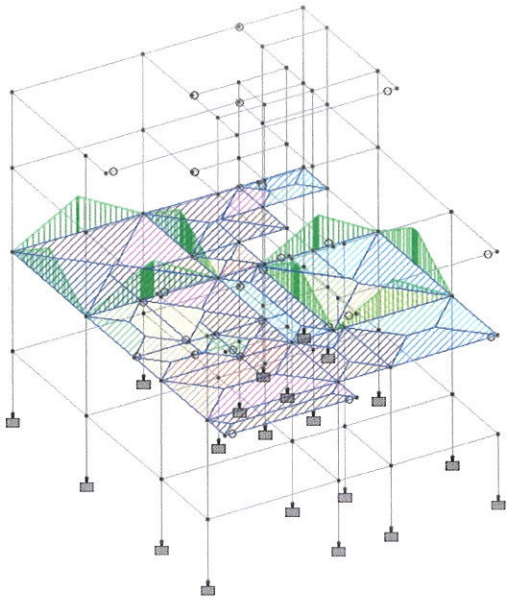
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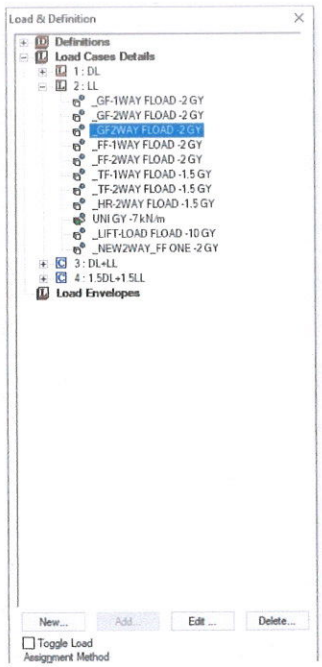


PROPERTIES OF THE STRUCTURE



DEAD LOAD OF STRUCTURE

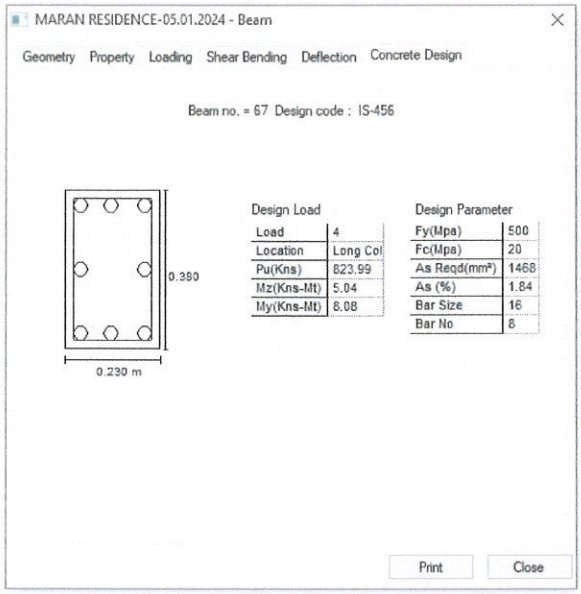




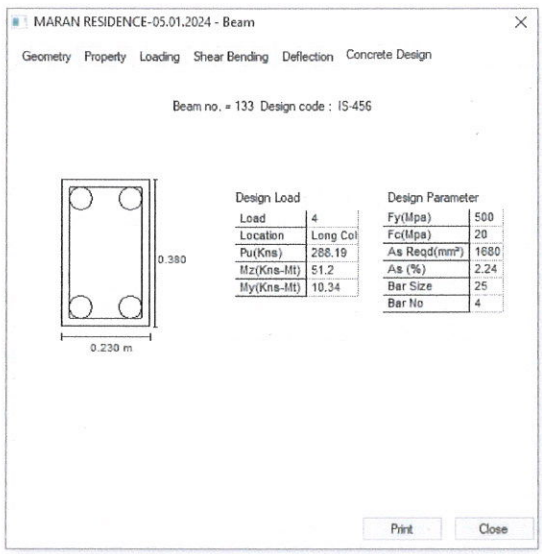
LIVE LOAD OF STRUCTURE

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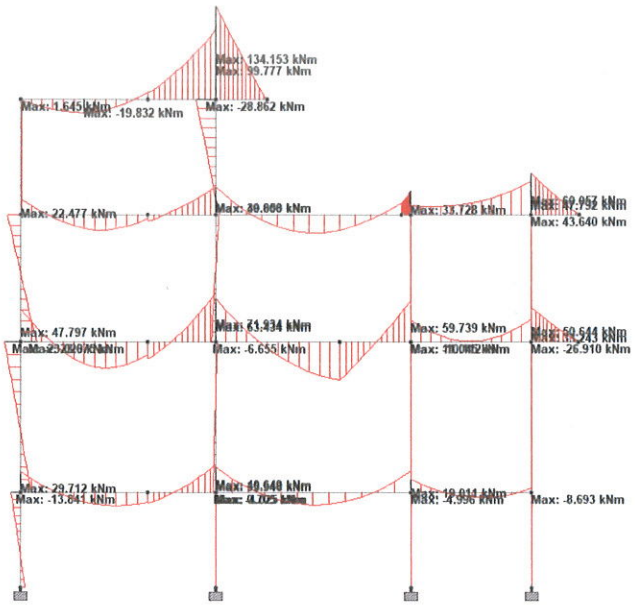




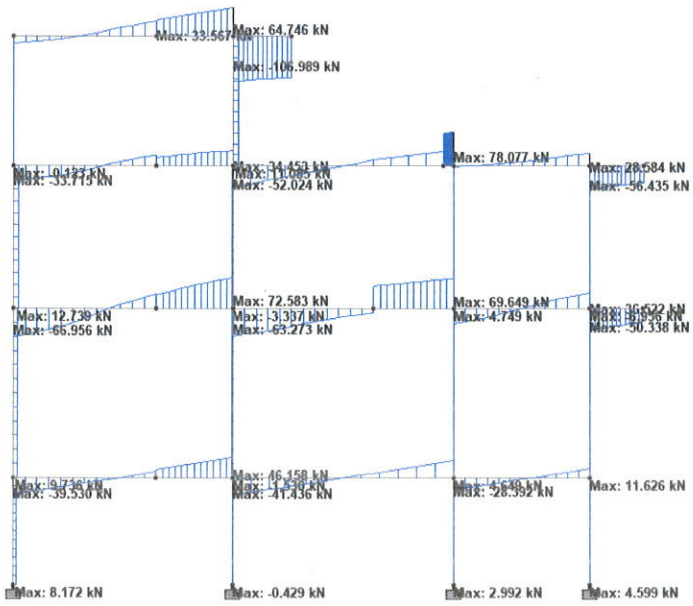


COLUMN REINFORCEMENT FROM STAAD

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BENDING MOMENT OF BEAMS



SHEAR FORCE OF BEAMS

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7. DESIGN OF FOOTINGS

ISOLATED FOOTING DESIGN

Data

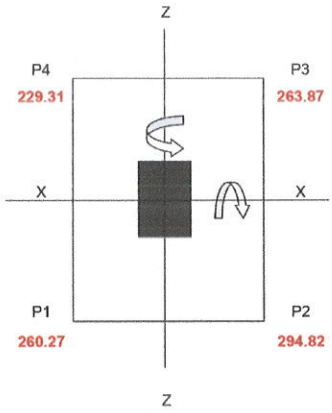
Grade of concrete	f_{ck}	=	20 N/mm^2	
Grade of steel	f_y	=	500 N/mm^2	
Lateral load at X-axis	Hx	=	5 kN	
Lateral load at Z -axis	Hz	=	5 kN	
Axial load	P	=	415 kN	
Moment at column base (about X axis)	M_x	=	5 kNm	
Moment at column base (about Z axis)	M_z	=	5 kNm	
$M_{x1} = M_x+H_z.D$	M_{x1}	=	6.90 kNm	
$M_{z1} = M_z+H_x.D$	M_{z1}	=	6.90 kNm	
Net S.B.C of soil		=	270.00 kN/m^2	
Gross S.B.C of soil	q_a	=	306.00 kN/m^2	
Column dimension along X- axis		=	230.00 mm	
Column dimension along Z- axis		=	380.00 mm	
Unit weight of Soil		=	18.00 kN/m^3	
Depth of footing below NGL		=	2.00 m	
Volume of footing		=	0.706 m^3	
Volume of filling		=	3.009 m^3	
Weight of footing		=	17.647 kN	
Weight of filling		=	54.168 kN	
Clear cover		=	50.00 mm	
Moment of resistance		=	0.133 $f_{ck}bd^2$	

Area of footing

Weight of footing + backfill		=	17.30 % of P_u	
Eccentricity along Z direction	e_z	=	10.27 mm	
Eccentricity along X direction	e_x	=	10.27 mm	
Width assumed (B, dim. || X axis)		=	1.29 m	4.23
Length of the footing required (L, dim. || Z axis)		=	1.23 m	
Length of the footing provided (L, dim. || Z axis)		=	1.44 m	4.72
Area of footing required		=	1.59 m^2	
Area of footing provided		=	1.8576 m^2	
Cantilever Projection in the shorter direction		=	0.530 m	
Cantilever Projection in the longer direction		=	0.530 m	

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Pressure Values at all four corners



$P1 = P/A + 6*M_x/B*L^2 - 6*M_y/L*B^2$

$P2 = P/A + 6*M_x/B*L^2 + 6*M_y/L*B^2$

$P3 = P/A - 6*M_x/B*L^2 + 6*M_y/L*B^2$

$P4 = P/A - 6*M_x/B*L^2 - 6*M_y/L*B^2$

Pressure calculation about X - axis

Maximum upward intensity of Soil pressure	q_{max}	=	294.820 kN/m^2	
Minimum upward intensity of Soil pressure	q_{min}	=	229.313 kN/m^2	No tension
Length of footing in contact with soil	L	=	1.440 m	
Maximum loss of contact		=	0.0%	< 30% ok
Effective area of footing		=	1.858 m^2	> Required
Effective upward intensity of Soil pressure	q_{max}		294.82 kN/m^2	< SBC
Overturning moment (M)		=	6.90 kN.m	
Eccentricity of resultant vertical force		=	0.02 m	< L/6
Factor of Safety against overturning	F.S	=	84.663	> 1.50 Ok
Factored Maximum pressure(Pmax) for M_x	P_{max-x}	=	384.240 kN/m^2	
Factored Minimum pressure(Pmin) for M_x	P_{min-x}	=	285.979 kN/m^2	

Pressure calculation about Z - axis

Maximum upward intensity of Soil pressure	q_{max}	=	294.820 kN/m^2	
Minimum upward intensity of Soil pressure	q_{min}	=	229.313 kN/m^2	No tension
Length of footing in contact with soil	L	=	1.290 m	
Maximum loss of contact		=	0.0%	< 30% ok
Effective area of footing		=	1.858 m^2	> Required
Effective upward intensity of Soil pressure	q_{max}		294.82 kN/m^2	<SBC
Overturning moment (M)		=	6.90 kN.m	
Eccentricity of resultant vertical force		=	0.02 m	< L/6
Factor of Safety against overturning	F.S	=	12.117	> 1.50 Ok
Factored Maximum pressure(Pmax) for M_x	P_{max-x}	=	384.240 kN/m^2	
Factored Minimum pressure(Pmin) for M_x	P_{min-x}	=	285.979 kN/m^2	

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Bending moment about X - axis

Pressure Intensity at the face of the Column		=	348.075 kN/m^2
Bending moment about X-axis		=	67.43 kNm
Design Bending moment	M_{ux}	=	67.43 kNm

Bending moment about Z - axis

Pressure Intensity at the face of the Column		=	343.87 kN/m^2
Bending moment about Z-axis		=	74.98 kNm
Design Bending moment	M_{uy}	=	74.98 kNm
Effective depth required along longer span	d_{req}	=	140.17 mm
Effective depth required along shorter span	d_{req}	=	139.90 mm
Overall depth required		=	195.17 mm
Overall depth provided	D	=	380.00 mm
Overall depth at the end		=	380.00 mm
Effective depth provided along longer span		=	325.00 mm
Effective depth provided along shorter span		=	315.00 mm

Area of reinforcement

Longer span

Percentage of reinforcement required	=	0.117 %
Area of reinforcement required	=	491.40 mm^2
Mimimum area of reinforcement required	=	588.24 mm^2
Diameter of reinforcement	=	10 mm
Spacing of reinforcement required	=	172.2 mm
Spacing provided	=	150.0 mm
Area of reinforcement provided	=	675.7 mm^2
Percentage of reinforcement provided	=	0.161 %

Provide 10 mm diameter bars at 150 mm C/C spacing

Shorter span

Percentage of reinforcement required	=	0.125 %
Area of reinforcement	=	564.85 mm^2
Mimimum area of reinforcement	=	656.64 mm^2
Diameter of reinforcement	=	10 mm
Spacing of reinforcement required	=	172.2 mm
Spacing provided	=	150.0 mm
Area of reinforcement provided	=	754.3 mm^2
Percentage of reinforcement provided	=	0.166 %

Provide 10 mm diameter bars at 150 mm C/C spacing

Check for one way Shear

Longer span:

Shear force V1	=	111362.99 N
Nominal shear stress	=	0.238 N/mm^2
Permissible Shear stress for Pt	=	0.297 N/mm^2

Safe in one way Shear

Shorter span:

Shear force V1		=	104297.96 N
Nominal shear stress		=	0.257 N/mm^2
Permissible Shear stress for Pt		=	0.301 N/mm^2

Safe in one way Shear

Check for two way Shear

Distance of section from the face of the column		=	162.50 mm
width of punching square shorter direction	b1	=	555.00 mm
Width of punching square longer direction	b2	=	705.00 mm
Effective depth of section	d1	=	325.00 mm
Shear force at the critical section	V_{u2}	=	491.38 kN
Nominal shear stress	τ_v	=	0.600 N/mm^2
Permissible Shear stress	$ks*\tau_{cz}$	=	1.118 N/mm^2

Safe in two way shear

Transfer of forces at Column base

Design Bond stress		=	1.20 N/mm^2
Required development Length		=	453.13 mm
Length available		=	385.00 mm
Minimum extension of Column bars into footing beyond bend		=	108.13 mm

Quantity report

Volume of footing		=	0.7059 m^3
Total approximate steel quantity		=	16.922 Kg

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8. DESIGN OF PLINTH BEAM

DETAILS OF BEAM SECTION:

Grade of Concrete	f_{ck}	20.00
Grade of Steel (Main bar)	f_y	500.00
Grade of Steel (Stirrups)	f_{ys}	500.00
Young's modulus of steel	E_s	######
Modulus of elasticity of concrete	E_o	######
Modulus of rupture of concrete	f_{cr}	3.13
Shrinkage strain of concrete	ε_{cs}	0.0003
Creep coefficient (After 28 days)	θ	1.60
Clear Cover	d_c	25.00
End Panel Cover	d_{ce}	25.00

SYMBOLS USED:

M_u = Moment from Analysis M_e = Equivalent moment at column face = M_u -(V_u* Nominal Shear Stress (S_v) = V_u/bd

Where B_c-Column dimension

Percentage of Steel (P_t=A_{st}x100/bd)

Depth of Balanced N.A - $X_{u,max}$ = 0.0035/(0.0055+fy/1.15*E_s)d

S_c - Design Shear Stress ,$S_{v\,Max}$ - Maximum Shear Stress (Page:73, IS 456:2000)

Moment of Resistance - M_{ur} = 0.36 f_{ck} b $X_{u,max}$(d-0.42X_{umax})

Shear Resistance of Beam Section (V_c) = S_c.b.d/1000

For Singly Reinforced Beams (M_{ur} > M_u)

Spacing of Stirrups (S_t) = 0.87.f_{ys}.d.A_{sv}/(V_u-V_c)1000 & Max Spacing(S_{Max}) = 0.75d

Area of Tension Steel (A_{st}) = 0.5 f_{ck}/f_y(1-SQRT(1-4.6.M_u.10^6/f_{ck} b.d^2)).b.d

Minimum Steel Required $A_{st,min}$=0.85/f_y *bd

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SECONDARY BEAM DESIGN

Beam No / Moment Location		MAIN REINFORCEMENT																		SHEAR REINFORCEMENT			
		Max.BM (M_u)		Max. SF (V_u)	Beam Size/Span		Ast Provided		Bottom Reinforcement					Top Reinforcement									
		Bottom	Top		b	D	A_{stp}	A_{scp}	Thro# (Ist Layer)		Curtail (Ist Layer)		Total Layer	Thro# (Ist Layer)		Curtail (Ist Layer)		Total Layer	Dia of bar	S_v	S_{Max}	S_p
		kNm	kNm	kN	mm	mm	mm^2	mm^2	No	Dia	No	Dia		No	Dia	No	Dia		mm	mm	mm^2	mm^2
PB16	S		10	30	230	300	226	226	2	12			1	2	12			1	8	2995.0	201.8	175
	M	15			230	300	226	226	2	12			1	2	12			1	8			175
	S		25	40	230	300	452	226	2	12			1	2	12	2	12	1	8	2069.3	201.8	175
PB17	S		50	60	230	380	452	226	2	12			1	2	12	2	12	1	8	773.5	261.8	200
	M	25			230	380	226	226	2	12			1	2	12			1	8			200
	S		50	60	230	380	452	226	2	12			1	2	12	2	12	1	8	773.5	261.8	200
PB18	S		55	60	230	380	452	226	2	12			1	2	12	2	12	1	8	773.5	261.8	200
	M	30			230	380	226	226	2	12			1	2	12			1	8			200
	S		40	55	230	380	452	226	2	12			1	2	12	2	12	1	8	1036.1	261.8	200
PB19	S		10	30	230	300	226	226	2	12			1	2	12			1	8	2995.0	201.8	175
	M	15			230	300	226	226	2	12			1	2	12			1	8			175
	S		30	40	230	300	452	226	2	12			1	2	12	2	12	1	8	2069.3	201.8	175
PB20	S		45	55	230	380	452	226	2	12			1	2	12	2	12	1	8	1036.1	261.8	200
	M	30			230	380	226	226	2	12			1	2	12			1	8			200
	S		55	60	230	380	628	226	2	12			1	2	12	2	16	1	8	1047.5	260.3	200
PB21	S		60	65	230	380	628	226	2	12			1	2	12	2	16	1	8	778.7	260.3	200
	M	30			230	380	226	226	2	12			1	2	12			1	8			200
	S		45	60	230	380	452	226	2	12			1	2	12	2	12	1	8	773.5	261.8	200
PB22	S		10	25	230	300	226	226	2	12			1	2	12			1	8	-10970.9	201.8	175
	M	10			230	300	226	226	2	12			1	2	12			1	8			175
	S		10	20	230	300	226	226	2	12			1	2	12			1	8	-1937.3	201.8	175
PB23	S		15	35	230	300	226	226	2	12			1	2	12			1	8	1317.6	201.8	175
	M	15			230	300	226	226	2	12			1	2	12			1	8			175
	S		15	35	230	300	226	226	2	12			1	2	12			1	8	1317.6	201.8	175
PB24	S		10	20	230	300	226	226	2	12			1	2	12			1	8	-1937.3	201.8	175
	M	10			230	300	226	226	2	12			1	2	12			1	8			175
	S		10	25	230	300	226	226	2	12			1	2	12			1	8	-10970.9	201.8	175
PB25	S		10	20	230	300	226	226	2	12			1	2	12			1	8	-1937.3	201.8	175
	M	10			230	300	226	226	2	12			1	2	12			1	8			175
	S		10	20	230	300	452	226	2	12			1	2	12	2	12	1	8	-821.8	201.8	175
PB26	S		35	30	230	300	452	226	2	12			1	2	12	2	12	1	8	-2726.1	201.8	175
	M	10			230	300	226	226	2	12			1	2	12			1	8			175
	S		1	15	230	300	226	226	2	12			1	2	12			1	8	-1062.4	201.8	175
PB27	S		10	10	230	300	226	226	2	12			1	2	12			1	8	-731.9	201.8	175
	M	10			230	300	226	226	2	12			1	2	12			1	8			175
	S		20	20	230	300	452	226	2	12			1	2	12	2	12	1	8	-821.8	201.8	175
PB28	S		40	55	230	380	452	226	2	12			1	2	12	2	12	1	8	1036.1	261.8	200
	M	35			230	380	452	226	2	12	2	12	1	2	12			1	8			200
	S		50	60	230	380	452	226	2	12			1	2	12	2	12	1	8	773.5	261.8	200
PB29	S		30	45	230	300	452	226	2	12			1	2	12	2	12	1	8	1101.0	201.8	175
	M	10			230	300	226	226	2	12			1	2	12			1	8			175
	S		20	35	230	300	226	226	2	12			1	2	12			1	8	1317.6	201.8	175
PB30	S		10	25	230	300	226	226	2	12			1	2	12			1	8	-10970.9	201.8	175
	M	10			230	300	226	226	2	12			1	2	12			1	8			175
	S		10	20	230	300	226	226	2	12			1	2	12			1	8	-1937.3	201.8	175

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9. DESIGN OF GROUND FLOOR (TYPICAL) ROOF BEAM

DETAILS OF BEAM SECTION:

Grade of Concrete	f_{ck}	20.00
Grade of Steel (Main bar)	f_y	500.00
Grade of Steel (Stirrups)	f_{ys}	500.00
Young's modulus of steel	E_s	200000.00
Modulus of elasticity of concrete	E_c	22360.68
Modulus of rupture of concrete	f_{cr}	3.13
Shrinkage strain of concrete	ε_{cs}	0.0003
Creep coefficient (After 28 days)	θ	1.60
Clear Cover	d_c	25.00
End Panel Cover	d_{ce}	25.00

SYMBOLS USED:

M_u = Moment from Analysis M_e = Equivalent moment at column face = M_u -(V_u*B_c/3)+ T_u(Nominal Shear Stress (S_v) = V_u/bd

Where B_c-Column dimension

Percentage of Steel (P_t=A_{st}x100/bd)

Depth of Balanced N.A - $X_{u\,max}$ = 0.0035/(0.0055+fy/1.15*E_s)d

S_c - Design Shear Stress ,$S_{v\,Max}$ - Maximum Shear Stress (Page:73, IS 456:2000)

Moment of Resistance - M_{ur} = 0.36 f_{ck} b $X_{u\,max}$(d-0.42X_{umax})

Shear Resistance of Beam Section (V_{cj}) = S_c.b.d/1000

For Singly Reinforced Beams (M_{ur} > M_u)

Spacing of Stirrups (S_v) = 0.87.f_{ys}.d.A_{sv}/(V_u-V_c)1000 & Max Spacing(S_{Max}) = 0.75d

Area of Tension Steel (A_{st}) = 0.5 f_{ck}/f_y(1-SQRT(1-4.6.M_u.1 A_{sc} = 0.87.f_y.A_{st2}/(f_{sc}-f_{cc})

Minimum Steel Required $A_{st\,min}$=0.85/f_y *bd

SECONDARY BEAM DESIGN

Beam No / Moment Location		Max.BM (M_u)		Max. SF (V_u)	Beam Size/Span		M_u/bd^2	Ast Provided		MAIN REINFORCEMENT											SHEAR REINFORCEMENT			
		Bottom	Top		b	D		A_{stp}	A_{scp}	Bottom Reinforcement					Top Reinforcement						Dia of bar	S_v	S_{Max}	S_p
										Thro# (Ist Layer)		Curtail (Ist Layer)		Total Layer	Thro# (Ist Layer)		Curtail (Ist Layer)		Total Layer				
										No	Dia	No	Dia		No	Dia	No	Dia						
		kNm	kNm	kN	mm	mm	N/mm^2	mm^2	mm^2												mm	mm	mm^2	mm^2
GFB1	S		55	75	230	380	1.99	628	402	2	16			1	2	16	2	12	1		8	514.6	260.3	200
	M	55			230	380	1.99	628	402	2	16	2	12	1	2	16			1		8			200
	S		95	90	230	380	3.43	804	402	2	16			1	2	16	2	16	1		8	377.7	260.3	200
GFB2	S		105	100	230	450	2.63	804	402	2	16			1	2	16	2	16	1		8	414.4	300	200
	M	55			230	450	1.38	402	402	2	16			1	2	16			1		8			200
	S		55	70	230	450	1.38	402	402	2	16			1	2	16			1		8	669.2	300	200
GFB3	S		20	55	230	300	1.20	226	226	2	12			1	2	12			1		8	406.7	201.8	175
	M	20			230	300	1.20	226	226	2	12			1	2	12			1		8			175
	S		15	50	230	300	0.90	226	226	2	12			1	2	12			1		8	491.6	201.8	175
GFB4	S		1	10	230	380	0.04	226	226	2	12			1	2	12			1		8	-750.4	261.8	200
	M	10			230	380	0.36	226	226	2	12			1	2	12			1		8			200
	S		65	75	230	380	2.35	628	226	2	12			1	2	12	2	16	1		8	514.6	260.3	200
GFB5	S		45	55	230	380	1.62	628	226	2	12			1	2	12	2	16	1		8	1599.5	260.3	200
	M	10			230	380	0.36	226	226	2	12			1	2	12			1		8			200
	S		10	10	230	380	0.36	226	226	2	12			1	2	12			1		8	-750.4	261.8	200
GFB6	S		80	105	230	380	2.89	804	402	2	16			1	2	16	2	16	1		8	275.0	260.3	200
	M	90			230	380	3.25	804	402	2	16	2	16	1	2	16			1		8			200
	S		95	100	230	380	3.43	804	402	2	16			1	2	16	2	16	1		8	302.4	260.3	200
GFB7	S		40	30	230	380	1.44	804	402	2	16			1	2	16	2	16	1		8	-765.5	260.3	200
	M	10			230	380	0.36	402	402	2	16			1	2	16			1		8			200
	S		20	45	230	380	0.72	402	402	2	16			1	2	16			1		8	2268.2	260.3	200
GFB8	S		15	25	230	380	0.54	402	402	2	16			1	2	16			1		8	-1140.6	260.3	200
	M	10			230	380	0.36	402	402	2	16			1	2	16			1		8			200
	S		20	35	230	380	0.72	402	402	2	16			1	2	16			1		8	-4592.9	260.3	200
GFB9	S		30	65	230	380	1.08	402	402	2	16			1	2	16			1		8	568.4	260.3	200
	M	20			230	380	0.72	402	402	2	16			1	2	16			1		8			200
	S		10	35	230	380	0.36	402	402	2	16			1	2	16			1		8	-4592.9	260.3	200
GFB10	S		1	105	230	450	0.03	402	402	2	16			1	2	16			1		8	292.9	300	200
	M	155			230	450	3.91	1030	402	2	16	2	20	1	2	16			1		8			200
	S		1	95	230	450	0.03	402	402	2	16			1	2	16			1		8	349.0	300	200
GFB11	S		40	60	230	380	1.44	402	402	2	16			1	2	16			1		8	699.4	260.3	200
	M	55			230	380	1.99	628	402	2	16	2	12	1	2	16			1		8			200
	S		60	65	230	380	2.17	628	402	2	16			1	2	16	2	12	1		8	778.7	260.3	200
GFB12	S		35	30	230	380	1.26	628	402	2	16			1	2	16	2	12	1		8	-978.2	260.3	200
	M	20			230	380	0.72	402	402	2	16			1	2	16			1		8			200
	S		50	80	230	380	1.81	628	402	2	16			1	2	16	2	12	1		8	440.0	260.3	200
GFB13	S		75	100	230	380	2.71	628	402	2	16			1	2	16	2	12	1		8	278.5	260.3	200
	M	55			230	380	1.99	628	402	2	16	2	12	1	2	16			1		8			200
	S		40	80	230	380	1.44	402	402	2	16			1	2	16			1		8	363.9	260.3	200
GFB14	S		50	90	230	380	1.78	452	226	2	12			1	2	12	2	12	1		8	306.9	261.8	200
	M	75			230	380	2.71	628	226	2	12	2	16	1	2	12			1		8			200
	S		65	95	230	380	2.35	628	226	2	12			1	2	12	2	16	2		8	306.6	260.3	200
GFB15	S		15	10	230	380	0.54	628	226	2	12			1	2	12	2	16	1		8	-427.3	260.3	200
	M	10			230	380	0.36	226	226	2	12			1	2	12			1		8			200
	S		40	25	230	380	1.43	452	226	2	12			1	2	12	2	12	1		8	-999.5	261.8	200
GFB16	S		55	50	230	380	1.96	452	226	2	12			1	2	12	2	12	1		8	1568.4	261.8	200
	M	25			230	380	0.89	226	226	2	12			1	2	12			1		8			200
	S		1	25	230	380	0.04	226	226	2	12			1	2	12			1		8	-2858.9	261.8	200
GFB17	S		1	35	230	380	0.04	226	226	2	12			1	2	12			1		8	3274.1	261.8	200
	M	45			230	380	1.61	452	226	2	12	2	12	1	2	12			1		8			200
	S		1	35	230	380	0.04	226	226	2	12			1	2	12			1		8	3274.1	261.8	200

10. DESIGN OF GROUND FLOOR (TYPICAL) ROOF SLAB

TWO WAY SLAB

Data

Grade of concrete					f_{ck}	=	20.00 N/mm²
Grade of steel					f_y	=	500.00 N/mm²
Density of concrete						=	25 kN/m³
Clear cover						=	20.00 mm
Classification of slab							
Clear Size of Room/Panel	5.235 m	x	5.135 m				
Longer span	5.235 m	+	0.000 m		l_y	=	5.235 m
shorter span	5.135 m	+	0.000 m		l_x	=	5.135 m
Aspect ratio					l_y/l_x	=	1.019 < 2
Slab to be designed as Two way slab							
Assumed Span/effective depth ratio						=	26.00
Required effective depth of the slab						=	151.92 mm
Overall depth provided					D	=	150.00 mm
Effective depth provided					d	=	125.00 mm
Effective span					L	=	5.135 m
Design load							
Self weight of the slab						=	3.750 kN/m²
Weight of finishes over slab for water proofing						=	1.50 kN/m²
Other loads						=	0.00 kN/m²
Total dead load						=	5.25 kN/m²
Live load						=	2.00 kN/m²
Total load						=	7.25 kN/m²
Factored load					W_u	=	10.88 kN/m²

Calculation of reinforcement required

Type : Two Adjacent Edges Discontinuous

		Shorter direction		Longer direction		
		αx(-ve) support	αx(+ve) mid span	αy(-ve) support	αy(+ve) mid span	
Bending moment Coefficient		0.0530	0.0400	0.047	0.035	
Bending moment		15.198	11.470	13.477	10.036	kNm
Percentage of reinforcement req	$P_{t,req}$	0.238	0.177	0.209	0.154	%
Area of reinforcement required	A_{st}	297.19	220.70	261.560	191.96	mm²
Minimum area of reinforcement	$A_{st,min}$	180.00	180.00	180.00	180.00	mm²
Area of reinforcement required	$A_{st,req}$	297.19	220.70	261.56	191.96	mm²
Diameter of Reinforcement	Φ	10.00	10.00	10.00	10.00	mm
Spacing of Reinforcement required		250.00	250.00	250.00	250.00	mm
Spacing of Reinforcement provided		200.00	200.00	200.00	200.00	mm
Area of main reinforcement provi	$A_{st,pro}$	392.86	392.86	392.86	392.86	
Percentage of reinforcement pro	$P_{t,pro}$	0.314	0.314	0.314	0.314	%

Check for Deflection

Span / effective depth ratio			=	26.00
Service stress in steel		f_s	=	162.92 N/mm²
Modification factor			=	2.00
Effective depth required for deflection limit			=	98.75 mm
Effective depth provided		d	=	125 mm
Overall depth provided		D	=	150.00 mm

Hence the limit state of deflection is satisfied

Check for Shear

Factored Shear force		V_u	=	27.92 kN
Nominal shear stress		τ_v	=	0.223 N/mm²
Percentage of steel		p_t	=	0.314 %
Designed shear stress		τ_c	=	0.396 N/mm²

Safe in Shear

Check for Crack width

Modular ratio		m	=	8.94
Modulus of elasticity of steel		E_s	=	200000 N/mm²
Tension steel percentage provided		p_t	=	0.314 %
Neutral axis depth factor		k	=	0.211
Depth of neutral axis		x	=	26.332 mm
Area of steel provided		$A_{st,pro}$	=	392.86 mm²
Cracked moment of inertia		I_{cr}	=	4.03E+07 mm⁴
Service load moment		$M_{(+)}$	=	7.65 kNm/m
Service stress in steel		f_{st}	=	167.48 N/mm²
Strain in concrete at the level considered		ε_1	=	0.001050
Average strain in concrete		ε_{1m}	=	0.000392

Distance of point from surface of reinforcing bar	a_{cr}	=	98.078	mm
Crack width	w_{cr}	=	**0.051**	< 0.2 mm

Crack width is within limit, Hence Safe

Check for long term deflection

Short term modulus of elasticity	E_c	=	22361	N/mm²
Flexural strength	f_{cr}	=	3.130	N/mm²
Second moment of area of cracked and gross section				
Distance of centroid of steel from neutral axis	r	=	98.67	mm
Second moment of area of cracked section	I_r	=	4.029E+07	mm⁴
Gross second moment of area	I_{gr}	=	2.813E+08	mm⁴
Service load and cracking moment				
Moment due to deal load and live load	M_{DL+LL}	=	7.647	kNm
Distance of extreme fibre in tension from centroidal axes of gross section	y_t	=	75.00	mm
Cracking moment	M_r	=	1.174E+07	Nmm
	$0.7*M_r$	=	8.218E+06	Nmm
Lever arm	z	=	116.223	mm
Effective moment of Inertia	I_{eff}	=	9.797E+07	mm⁴

$I_r < I_{eff} < I_{gr}$ Hence ok

Maximum short term deflection

	$a_{i\,(perm)}$	=	9.588	mm
	a_i	=	6.943	mm

Long term deflection

Deflection due to shrinkage

constant	k_3	=	0.063	
Total shrinkage strain	ε_{cs}	=	0.0003	
	k_4	=	0.404	< 1
Shrinkage curvature	ψ_{cs}	=	8.073E-07	
Deflection due to shrinkage	a_{cs}	=	1.341	mm

Deflection due to creep

Creep deflection due to permanent loads $a_{cc(perm)} = a_{i,cc(perm)} - a_{i(perm)}$

creep coefficient	θ	=	1.600	
Effective modulus of elasticity	E_{ce}	=	8600.261	N/mm²
	m =		23.255	
	x	=	39.521	mm
	I_r	=	8.733E+07	mm⁴
Lever arm	z	=	111.826	mm
Effective moment of Inertia	I_{eff}	=	1.610E+08	mm⁴
Moment due to deal load	M_{DL}	=	5.537	kNm
	$a_{i,cc(perm)}$	=	10.987	mm
	$a_{cc(perm)}$	=	4.044	mm
Long term deflection	a_{LD}	=	14.973	mm
Maximum permissible long term deflection		=	20.540	mm

Safe with regard to limit state of deflection

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11. CONCLUSION

1. All the Columns are designed using Staad pro and manually checked using Excel sheets.

2. The design of Beams, Slabs and other Structural elements were done using Excel sheets where the Moments & Shear forces values are taken from Staad pro

LIST OF TABLES

1. General information about the structure 01
2. Gravity loads 02



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