STRUCTURAL STABILITY CERTIFICATE

The detailed engineering and structure design of the proposed building comprising of Silt +3 floors at Plot No 63,64 with 12 Dewiling Units in approved layout L.P/DTCP No.02/2022 Extent of 548.00 Sq mtrs with 12 Units situated in Achettipalli Village and Panchayat Hosur Taluk and Panchayat union Krishnagiri District Tamil nadu. S.No. 309/40,41 has been done by me based on the report of geotechnical investigation (soil test) done by **Srb Civil Laboratory** Report No **SRB/CIVIL/GT/2023-24/186** Dated **14-08-2024** and considering the functional requirement of the building.

2. It is certified that among other factors, the proposed building has been designed to resist earthquake. I/We have checked various parameters and found that the proposed building would be safe.

3. I/We further certify that:

(i) The minimum grade of concrete is M25

(ii) The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS Codes No IS 875:1987 Part II and Design of earthquake resistant structure as per IS Code No: 1893:2016.

4. The building will be safe and sound when used for the purpose for which it is designed.

Stamp and Signature

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Encl.: Structural Design Calculation

HOSUR (ICON-3)

Date : 17.03.2025

DESIGN BASIS REPORT

THE PROPOSED CONSTRUCTION OF STILT FLOOR + 3 FLOORS RESIDENTIAL BUILDING (APPARTMENT) FOR M/S G SQUARE PRISTINE , AT PLOT NO : 63 & 64,, SY NO : 309, NEAR TITAN TOWNSHIP ,NEXT TO SOPPATI VILLAGE ,MATHIGIRI POST, HOSUR, KRISHNAGIRI (ICON-3)

This is to Certify that the Proposed Building (RCC Roof) consists of stilt +3 Floor only.

This Proposed building site has been inspected on by me and the required details such as soil Report & other details etc. have been collected and foundation details are enclosed here with.

The Proposed Building which has been designed as per IS code IS 875 and structures of stilt +3 floor only. So, I here by certify that the Building will be structurally safe. No more future Vertical expansion will be allowed except stair head room etc, if necessary.

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SUBMITTED BY

GCON ENGINEERS

G1 , Ekambaram street,
Pammal, Chennai-75.

DBR –R0 DATE : 17-03-2025				
DESCRIPTION	**COMMENTS**	**GCON (STRUCTURAL CONSULTANT) SIGN & STAMP**	**ARCHITECT SIGN & STAMP**	**CLIENT SIGN & STAMP**

STRUCTURAL DESIGN BASIS REPORT
CONTENTS

1) GENERAL PROJECT DETAILS

Structural Design Introduction

The proposed structure is STILT+3Storey residential apartment building situated at achettipalli village, hosur taluk, krishnagiri district ,India. In this brief report we are presenting the data and assumptions related to the project, which has lead to the conceptual design at this preliminary stage. The document attempts to record all inputs assumed in design and will form the basis for all future detailed structural work.

The report most importantly clarifies the load criteria assumed in the design and it is therefore expected that all related consultants, including the architects, would go through the document and refer to it at every stage of detailed design. Recommendations or revisions on assumed parameters are requested at this stage.

Besides this the report will also form the outline of the design criteria and methods of both analysis and design to be adopted in this project with the aim of achieving a design that satisfies all sorts of seismic, and serviceability requirements.

2. List of References:

IS 456-2000	Plain and reinforced concrete-code of practice
IS 875	Code Of practice for design loads for buildings and structures
Part 1: 1987	dead loads- unit weights of building material and stored material
Part 2: 1987	Imposed loads
Part 3: 1987	Wind loads
IS 1893: 2016	Criteria for earthquake resistant design of structures
IS1904-1986 (Reaffirmed 2006)	Code of practice for design & construction of foundation in soils
IS 4326:1993	Code of practice for earthquake resistant design and construction of buildings
IS 13920: 1993	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces
BS 8110 : 1997	Plain and reinforced concrete-code of practice(British standard)
ACI 318	Plain and reinforced concrete-code of practice (American standard)
CP65	Plain and reinforced concrete-code of practice (Singapore standard)
IS 800:1984 & 2007	Code of practice for general construction in steel
IS 1343:2012	Code of practice for pre-stressed concrete (First Revision)
Reynolds Handbook	
IS 3414	Code of practice for joints in the buildings
IS 3370 Part 1 TO 4	Code of practice for liquid retaining structures
BS-8007	Code of practice for liquid retaining structures for crack width calculation
Soil Report	

3. Material, Workmanship, Inspection and Testing:

The proposed RCC structure will consists of concrete and steel reinforcement as the two main materials used for construction of the structure. The specifications for these materials are discussed in this chapter

3.1 Concrete:

The concrete shall be in grades designated as per Table 2 IS 456-2000.
Recommended grades for the different members is as follows:

Footing/column	M25
Shear wall/lift	M25
Beams/Slabs	M25

Any other structural member will be in general designed in M25.

3.2 Durability of concrete

The structure is located in Coimbatore, where the climatic conditions are considered as moderate. Concrete grade of submerged structural elements will be a minimum of M25. Nominal covers shall not be less than 30 mm from a durability point of view.

The cover to the various structural elements is to be as follows,

Structural Element	Clear Cover in mm
Slabs	25
Beams	30
Shear walls/Shear wall	40
Footings	50
Structural elements under ground	50

3.3 Reinforcement:

The reinforcement shall be high strength deformed steel bars with yield strength of 550 N/mm^2 confirming to IS: 1786.

3.4 Structural Steel

The structural steel to be used shall confirm to IS 800

4) Foundation system:

SHALLOW FOUNDATION: Isolated Footing at 2.550 m from the natural ground level with 317.59 KN safe bearing capacity.

5) General design considerations:

5.1 Method of Design

The aim of design is the achievement of an acceptable probability that structures being designed will perform satisfactorily during their intended life. With an appropriate degree of safety, they should sustain all the loads and deformations of normal construction and use and have adequate durability and adequate resistance to the effects of earthquake, wind and fire.

Structures and structural elements will be designed by Limit State Method. Due consideration will give to the accepted theories, experience and modern philosophy of design.

5.2 Loads and Forces

In structural design, account is taken of the dead, imposed and wind loads and forces such as those caused by earthquake etc., where applicable.

5.2(a) Dead Loads

The dead loads are calculated on the basis of unit weights of materials given in IS 875 (Part 1) the data provided by consultant and other service consultants will be used for the specific materials/equipment.

Unless otherwise specified the unit weight of materials will be used as follows.

Reinforced Concrete	25 kN/cum
Plain concrete	24 kN/cum
Brickwork	20 kN/cum
Soil dry	16 kN/cum
Floor finishes	20 kN/cum
Structural steel	78.5 kN/cum
Water	9.81 kN/cum

5.2 b Load Combinations considered:

1. 1.5D+1.5L
2. 1.2D+1.2L+1.2WX
3. 1.2D+1.2L-1.2WX
4. 1.2D+1.2L+1.2WZ
5. 1.2D+1.2L-1.2WZ
6. 0.9D+1.5WX
7. 0.9D-1.5WX
8. 0.9D+1.5WZ
9. 0.9D-1.5WZ
10. 1.5D+1.5WX
11. 1.5D-1.5WX
12. 1.5D+1.5WZ
13. 1.5D-1.5WZ
14. 1.2D+1.2L+1.2SX
15. 1.2D+1.2L-1.2SX
16. 1.2D+1.2L+1.2SZ
17. 1.2D+1.2L-1.2SZ

18. 0.9D+1.5SX
19. 0.9D-1.5SX
20. 0.9D+1.5SZ
21. 0.9D-1.5SZ
22. 1.5D+1.5SX
23. 1.5D-1.5SX
24. 1.5D+1.5SZ
25. 1.5D-1.5SZ
26. 1.2DL+1.2TL
27. 1.2DL+1.2LL+1.2TL
28. 1.2DL+1.2LL+1.2WX+1.2TL
29. 1.2DL+1.2LL +1.2WY+1.2TL
30. 1.2DL+1.2LL +1.2SX+1.2TL
31. 1.2DL+1.2LL +1.2SY+1.2TL

Following **Service load** combinations will be considered for the analysis of the structure.

1. DL+ LL
2. DL + 0.8 LL ± 0.8WX
3. DL + 0.8 LL ± 0.8WY
4. DL ± WX
5. DL ± WY
6. DL + 0.8 LL ± 0.8SX
7. DL + 0.8 LL ± 0.8SY
8. DL± SX
9. DL± SY

Software's for the analysis & design:

a. ETABS
b. Adapt / Safe
c. Excel program sheet
d. RCDC

6.0 Residential building

6.1 Residential building:

The special features for this building are listed as below.

The proposed building is residential building. Stilt floor is intended for parking, and toilets, drive ways. Above stilt floor typical floors are intended for Residential purpose which includes 1st to 3rd floors and terrace , LMR & head room floor above it.

6.1a Imposed Loads:

Imposed loads are assumed in accordance with IS 875 part 2, as follows. The table listed below is a summary of these loads.

Sr.No.	Area Description	Floor Finish	Live load	Super imposed dead load	Remark / comment
		kN/sq.m	kN/sq.m		
1	Room	1.5	2	-	
2	Staircase	1.5	3	3	-
3	Lobby/corridor/passage	1.5	3	-	-
4	Living room	1.5	2	-	-
5	Balcony	1.5	3	3	-
7	Kitchen	1.5	2	-	-
8	Toilet	1.5	2	0	-
9	Dining	1.5	2	0	-
10	Utility	1.5	3	0	
11	Store room	1.5	5	0	
12	Terrace	3	2	0	150 mm water proofing considered.
13	Water Tank	1.5	12	-	1.5 m depth of tank is considered.

6.1b Analysis Approach

Structural Geometry:

The structure consists of 4 slabs. The slabs with their description, levels, heights and approximate areas are given in table below:

Floor	Height
Head room	3
Terrace	3
3rd	3
2nd	3
1st	3
Total	15

Structural Frames

The proposed building is RCC frame structure, with Column & RCC beam framing is proposed for the typical floor system. After taking into considerations the feasibility of particular system, clear height available for particular floor, mobility of the services below slab, cost estimation, provision of openings in the slab, approval of architects, other consultants and client, the final framing system has been arrived.

6.1c Seismic Analysis:

6.1c (i) General Principles and design criteria

The structure is located in the seismic zone II. The design lateral force will calculated as per the method described in the following paragraphs. The structure is primarily shear wall and beam framing system although due considerations will be given to the major suggestions/clauses from IS:13920, the basic frame is assumed to be as column structure, as per Table 7.

6.1c (ii) Design Spectrum

Seismic Analysis (Initial analysis for preliminary shear wall sizing) The design Horizontal seismic coefficient for a structure

$$Ah = \frac{Z\ I\ Sa}{2\ R\ g}$$ IS:1893-2016 Clause 6.4.2

Where,

Z = Zone factor 0.16 for Zone II — Table 2

I = Importance Factor (1.5) — Table 6

R = Response reduction factor 5 — For Shear wall building from Table 7

Sa/g = Average Response acceleration coefficient

$T = 0.075\ h^{0.75}$ For RC frame building Clause 7.6

Where,

T is Fundamental natural period h = Height of the structure

$T = 0.075 \times 12^{0.75}$

$= 0.48$

Sa/g = 2.45

Design Seismic Base shear $V_b = A_h W$

Where, W = seismic weight Ah = 0.06

6.1(d) Wind Loads

Wind load for design of structures shall be based on the design wind speed arrived from IS: 875 (Part3)-1987.

The parameters for calculation of design wind speed as per IS: 875 (Part 3)-1987.

Basic wind speed, V_b : 33 m/ sec.
Risk Coefficient, K1 : 1
(If design life of structure taken as 50 yrs.)
Terrain, Height, Structure size factor, K2 : To suit the height of the structure for Terrain category-2 & class c is 1.11
Topography factor, K3. : 1.0.
K4 factor value : 1.0
Design Wind Speed Vz : 36.6 m/s.
Design Wind Pressure Pz : 0.6x (36.6) ^{2}= 803.7 N/m^2

7 Conclusions.

7.1 Other loads: Any other loads like those of services; storage etc. will be obtained from time to time from the relevant consultants and incorporated. The top slab of the lift shaft will be designed for lift loads as obtained from the manufacturer.

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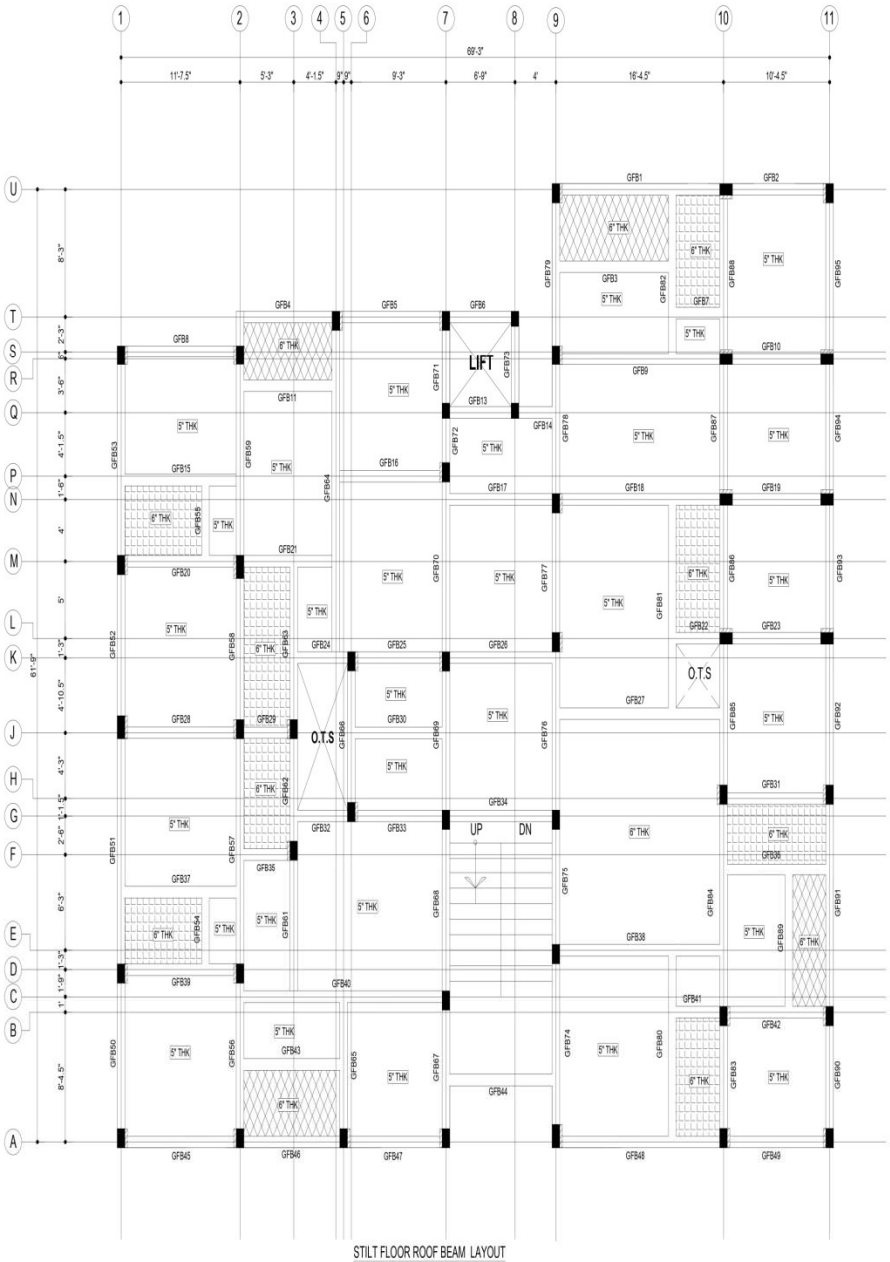
8 Layout.



STILT FLOOR ROOF BEAM LAYOUT

(SCALE:1:50) SUNK BY 3" SUNK BY 6"

NOTES:

1. CONTRACTOR TO CHECK AND VERIFY ALL DIMENSIONS BEFORE THE EXECUTION OF WORK.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH THE KEY PLAN AND ALL OTHER RELEVANT DRAWINGS.
3. ALL DIMENSIONS ARE IN FEET AND INCHES UNLESS OTHERWISE SPECIFIED.
4. USE CONCRETE - M25.
5. ALL REINFORCEMENTS SHALL BE OF GRADE Fe550 CONFIRMING IS-1786
6. FOOTING DESIGNED FOR S-3 ONLY.
7. NO ADMIXTURES SHALL BE ADDED WITHOUT PERMISSION OF CONSULTANT
8. CLEAR COVER TO REINFORCEMENT FOR
   a) FOUNDATION - 2". c) COLUMN - 1½"
   b) BEAM - 1". d) SLAB - ¾"
9. SBC OF SOIL CONSIDERED AS 328.91kn/SQM AS PER SOIL REPORT
10. LAPPING SHALL BE 50 TIMES DIA. OF THE BAR
11. STRUCTURAL DETAILED DRAWINGS ARE ISSUED FOR S+3 ONLY.
12. DE-SHUTTERING PERIOD AS PER IS 456
13. ALL SORTS OF PRECAUTIONARY MEASURES WILL BE TAKEN AT THE TIME OF CONSTRUCTION.
14. ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.

Rev.	Description	DATE
R0	ISSUE FOR APPROVAL	09-11-2024

CLIENT:

ARCHITECT:

G SQUARE PRISTINE

CONSULTANT:

GCON ENGINEERS

email: gconchennai@gmail.com

PROJECT TITLE:

PROPOSED RESIDENTIAL BUILDING AT ACHETTIPALLI VILLAGE, HOSUR TALUK, KRISHNAGIRI DISTRICT.
GS PRISTINE PLOT NO -60,64 (ICON -03)

DRAWING TITLE:

STILT FLOOR ROOF BEAM LAYOUT

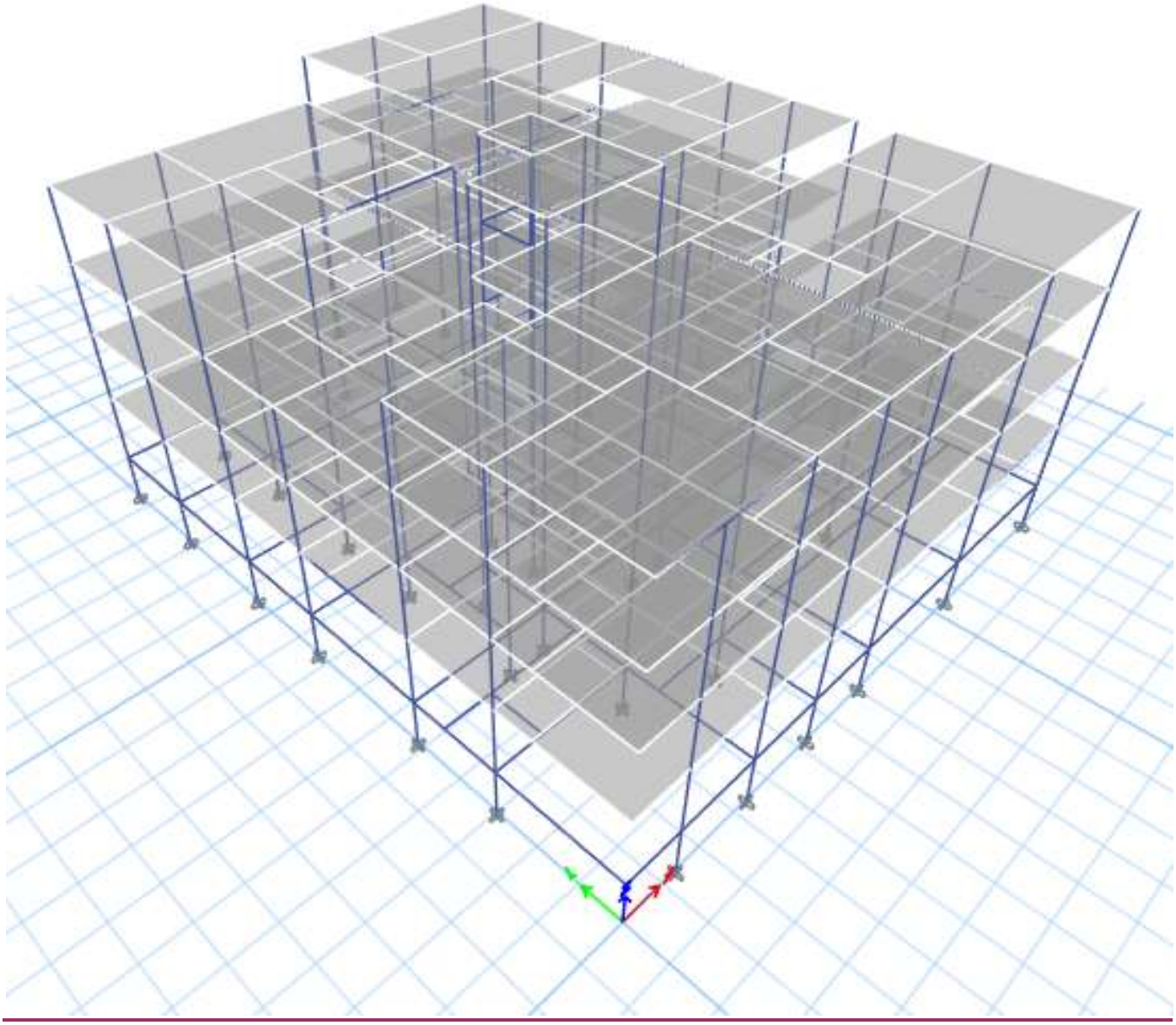
DRAWN:	DESIGNED:	APPROVED:	STAGE:
M.CHITRA	HMR	G G	APPROVAL
SCALE:	DATE:	E-MAIL:	
1:4"	09-11-2024	gconchennai@gmail.com	

DRAWING NO: GC/24217/SD/RCC/STFL/11

REVISION: R0

ORIGINAL SIZE OF THIS DRAWING IS A1

9 Etab model.



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10 DESIGN.

10.1 FOOTING DESIGN:

Design Code	:	IS 456 : 2000 + IS 13920 : 2016	
Footing No	:	F1	
Column No	:	C47,C44,C11,C5,C18,C46,C39,C23,C24,C33,C27,C28,C31	(300 mm X 375 mm)
Analysis No	:	C47,C44,C11,C5,C18,C46,C39,C23,C24,C33,C27,C28,C31	
Concrete Grade	:	M25	N/sqmm
Steel Grade	:	Fe550	N/sqmm
Clear Cover	:	40	mm
Df	:	4 M	
Dw	:	1 M	
Density of Soil	=	18	kN/cum
Soil Bearing Capacity	=	299	kN/sqm
Gross Bearing Capacity	=	371	kN/sqm
Permissible SBC Increase for EQ	=	25	%
Permissible SBC Increase for Wind	=	25	%
Live Load Reduction	=	50	%
Permissible area of loss of contact	=	0	%
Cross Section designed by	:	Maximum pressure	
Consider overburden pressure			

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HOSUR (ICON-3)

Footing Type	:	Pad	
Footing Size (L x B x D)	:	1500mm X 1400mm X 425mm	
Without considering Effect of Water Table			
Footing Self Wt., F1	=	22.31	kN
Soil Weight, S1	=	127.90	kN
Total Weight, W1	=	F1 + S1	
	=	150.21	kN
Considering Effect of Water Table			
Footing Self Wt., F2	=	13.39	kN
Soil Weight, S2	=	76.72	kN
Weight of Water (Submerged column), Wc	=	2.90	kN
Total Weight, W2	=	F2 + S2 - Wc	
	=	87.21	kN
Offset Along L (Loff)	=	562.5	mm
Offset Along B (Boff)	=	550	mm

Check For Maximum Soil Pressure:

Critical Column No	=	C5	
Critical Analysis Load Combination	=	DConS14	
Critical Load Combination	=	[14] : (Dead) +(SDL) +(Live) +(RLL)	
Pcomb	=	604.83	kN
P	=	Pcomb + W1	
P	=	755.04	kN
Mx	=	0.64	kNm
My	=	-0.22	kNm
P/A	=	359.54	kN/sqm
Mx/Zx	=	1.22	kN/sqm
My/Zy	=	-0.46	kN/sqm
Maximum Soil Pressure	=	361.22	kN/sqm
Allowable Soil Pressure	=	(1 X 299) + 72	kN/sqm
	=	371	kN/sqm

Check For Minimum Soil Pressure:

Critical Column No	=	C11	
Critical Analysis Load Combination	=	DConS14	
Critical Load Combination	=	[14] : (Dead) +(SDL) +(Live) +(RLL)	
Pcomb	=	442.32	kN
P	=	Pcomb + W2	
P	=	529.52	kN
Mx	=	2.63	kNm
My	=	-1.04	kNm

P/A	=	252.15	kN/sqm
Mx/Zx	=	5.01	kN/sqm
My/Zy	=	-2.12	kN/sqm
Minimum Soil Pressure	=	245.02	kN/sqm
	>	0	

Design For Bending:

Bottom Reinforcement Along L:

Critical Column No	=	C23	
Critical Analysis Load Combination	=	DConS10	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+Y)	
Pu	=	870.79	kN
Mux	=	-44.2	kNm
Muy	=	0.05	kNm
P/A	=	414.66	kN/sqm
Mx/Zx	=	-84.18	kN/sqm
My/Zy	=	0.11	kN/sqm
Deff	=	377	mm
Beff	=	1400	mm
SPu	=	498.95	kN/sqm
Mu	=	SPu X B X Loff X Loff / 2	
	=	110.51	kNm
Pt	=	0.135	%
Ast Rqd (BM)	=	714	sqmm
Ast Prv (Distributed Across Total Width)	=	11 - T10 @ 150	
	=	864	sqmm

Bottom Reinforcement Along B:

Critical Column No	=	C23	
Critical Analysis Load Combination	=	DConS10	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+Y)	
Pu	=	870.79	kN
Mux	=	-44.2	kNm
Muy	=	0.05	kNm
P/A	=	414.66	kN/sqm
Mx/Zx	=	-84.18	kN/sqm
My/Zy	=	0.11	kN/sqm
Deff	=	361	mm
Leff	=	1500	mm
SPu	=	498.95	kN/sqm
Mu	=	SPu X L X Boff X Boff / 2	

	=	113.2	kNm
Pt	=	0.141	%
Ast Rqd (BM)	=	765	sqmm
Ast Prv (Distributed Across Total Length)	=	10 - T10 @ 175	
	=	785	sqmm

Design For Shear:

One Way Shear Along L:

Critical Section @ d from Column Face

	=	377	mm
Critical Column No	=	C23	
Critical Analysis Load Combination	=	DConS10	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+Y)	
Pu	=	870.79	kN
Mux	=	-44.2	kNm
Muy	=	0.05	kNm
P/A	=	414.66	kN/sqm
Mx/Zx	=	-84.18	kN/sqm
My/Zy	=	0.11	kN/sqm
Deff	=	377	mm
Beff	=	1400	mm
SPu	=	498.95	kN/sqm
Vu	=	SPu X (Loff - d) X B	
	=	129.58	kN
Tv	=	Vu / (Beff X Deff)	
	=	0.25	N/sqmm
Tc	=	0.28	N/sqmm
Tv	<	Tc	

One Way Shear Along B:

Critical Section @ d from Column Face

	=	361	mm
Critical Column No	=	C23	
Critical Analysis Load Combination	=	DConS10	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+Y)	
Pu	=	870.79	kN
Mux	=	-44.2	kNm
Muy	=	0.05	kNm
P/A	=	414.66	kN/sqm

Mx/Zx	=	-84.18	kN/sqm
My/Zy	=	0.11	kN/sqm
Deff	=	361	mm
Leff	=	1500	mm
SPu	=	498.95	kN/sqm
Vu	=	SPu X (Boff - d) X L	
	=	141.45	kN
Tv	=	Vu / (Leff X Deff)	
	=	0.26	N/sqmm
Tc	=	0.28	N/sqmm
Tv	<	Tc	

Design For Punching Shear:

Critical Section @ d/2 from Column Face

	=	184	mm
Critical Column No	=	C23	
Critical Analysis Load Combination	=	DConS10	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+Y)	
Pu	=	870.79	kN
Mux	=	-44.2	kNm
Muy	=	0.05	kNm
P/A	=	414.66	kN/sqm
Mx/Zx	=	-84.18	kN/sqm
My/Zy	=	0.11	kN/sqm
Deff	=	369	mm
Leff	=	744	mm
Beff	=	669	mm
Punching Perimeter	=	2826	mm
Punching Area	=	1042794	sqmm
SPu	=	Max Pressure	
	=	498.95	kN/sqm
Vu	=	SPu X ((L X B)-(Leff X Beff))	
	=	799.45	kN
Tv	=	Vu / Punching Area	
	=	0.767	N/sqmm
Tc	=	1.25	N/sqmm
Tv	<	Tc	

Load Transfer Check For Load Transfer From Column To Footing

Critical Column No	=	C23	
Critical Analysis Load Combination	=	DConS10	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+Y)	
Pu	=	870.79	kN
A2	=	0.11	sqm
A1	=	4.15	sqm
Base Area	=	2.1	sqm
A1	>	Base Area	
Thus, A1	=	2.1	
Modification Factor	=	SquareRoot(A1/A2) < = 2	
SquareRoot(A1/A2)	=	4.3693	
Thus, Modification Factor	=	2	
Concrete Bearing Capacity	=	0.45 X Fck X Modification Factor X Column Area	
	=	2531.25	kN
Concrete Bearing Capacity	>	Pu, Hence Safe.	

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10.2 COLUMN DESIGN

General Data

Column No.	:	C1	
Level	:	Base To GROUND ROOF	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe550	N/sqmm
Grade Of Steel (Shear)	=	Fe550	N/sqmm
Grade Of Steel - Flexural Design	=	Fe550	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	300	mm
Column D	=	375	mm
Clear Cover	=	40	mm
Clear Floor Height @ B	=	2625	mm
Clear Floor Height @ D	=	2625	mm
No Of Floors	=	2	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	

D/B Ratio : 1.25 <= 4 Hence, Design as Column

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C47	
Critical Analysis Load Combination	:	DConS8	
Load Combination	=	[8] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+X)	
Critical Location	=	Top Joint	
Pu	=	657.31	kN
Mux	=	-15.17	kNm
Muy	=	44.84	kNm
Vux	=	-31.16	kN
Vuy	=	8.06	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	43.945	No Beam	No Beam	-	-	0.785
Top	43.945	No Beam	3350 x 230 x 375	-	30.171	0.72

Sway Condition (as per Stability Index) = Sway

Effective Length Factor along Major Axis = 2.16

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	28.125	No Beam	No Beam	-	-	0.776
Top	28.125	4975 x 230 x 375	No Beam	20.316	-	0.668

Sway Condition (as per Stability Index) = Sway

Effective Length Factor along Minor axis = 2.04

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	17.75	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	13.15	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	8.75	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	2.16	
Slenderness Ratio	=	Effective Length / D	
	=	15.12, Column Slender Along D	
Slenderness moment along D	=	(Pu D/ 2000) (Lex/D)^2	
	=	28.18 kNm	

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	2.04	
Slenderness Ratio	=	Effective Length / B	
	=	17.85, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	31.41	kNm

Design slenderness moment along D

Puz	=	2072.38	kN
Pd	=	639.51	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pd) < = 1	
	=	0.99 < = 1, Hence k=0.99	
Mslndx	=	k x 28.18	
	=	27.83	kNm

Design slenderness moment along B

Puz	=	2072.38	kN
Pb	=	583.24	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pb) < = 1	

	=	0.95 < = 1, Hence k=0.95	
Mslndy	=	k x 31.41	
	=	29.85	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	-15.17	13.15	-15.17	27.83	-43
Minor Axis - Muy	44.84	---	44.84	29.85	74.69

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	657.31	kN
Mux	=	-43	kNm
Muy	=	74.69	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	1.79	
Reinforcement Provided	=	10-T16	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	60.07	deg
MRes	=	86.18	kNm
MCap	=	93.41	kNm
Capacity Ratio	=	MRes/ MCap	
		0.92 <= 1	

HOSUR (ICON-3)

Shear Calculation	**Along D**	**Along B**
Critical Analysis Load Combination	DConS14	DConS8
Critical Load Combination	[14] : 0.9 (Dead) +0.9 (SDL) -1.5 (EQ+Y)	[8] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+X)
Design shear force, Vu (kN)	-19.3066	-31.1581
Pu (kN)	294.04	657.31
Deff , Beff (mm)	327	252
Aeff (sqmm)	98100	94500
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.1968	0.3297
Pt (%)	0.894	0.894
Design shear strength, Tc (N/sqmm)	0.6148	0.6148
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	1.3597	1.8347
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.3597	1.5
Enhanced shear strength, Tc-e (N/sqmm)	0.836	0.9222
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link = 8 mm

> Max. longitudinal bar dia / 4

= 4 mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16 = 256 mm

Min. dimension of column = 300 mm

Max. 300 mm = 300 mm

Provided spacing = 250 mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	250	---	---	250	---

General Data

Column No.	:	C1	
Level	:	GROUND ROOF To TERRACE	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe550	N/sqmm
Grade Of Steel (Shear)	=	Fe550	N/sqmm
Grade Of Steel - Flexural Design	=	Fe550	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	230	mm
Column D	=	375	mm
Clear Cover	=	40	mm
Clear Floor Height @ B	=	2625	mm
Clear Floor Height @ D	=	2625	mm
No Of Floors	=	3	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	1.63 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C47
Critical Analysis Load Combination	:	DConS8
Load Combination	=	[8] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+X)
Critical Location	=	Bottom Joint

Pu	=	474.71	kN
Mux	=	22.18	kNm
Muy	=	-46.2	kNm
Vux	=	-31.71	kN
Vuy	=	14.43	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	33.691	No Beam	3350 x 230 x 375	-	30.171	0.72
Top	33.691	No Beam	3350 x 230 x 375	-	30.171	0.691

Sway Condition (as per Stability Index) = Sway

Effective Length Factor along Major Axis = 1.97

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	12.674	4975 x 230 x 375	No Beam	20.316	-	0.668
Top	12.674	4975 x 230 x 375	No Beam	20.316	-	0.555

Sway Condition (as per Stability Index) = Sway

Effective Length Factor along Minor axis = 1.71

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	17.75	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	9.49	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	11.41	
	<	60	(Hence Ok)
Column Is Unbraced Along D			
Slenderness Check Along D:			
Effective Length Factor	=	1.97	
Slenderness Ratio	=	Effective Length / D	
	=	13.79, Column Slender Along D	
Slenderness moment along D	=	(Pu D/ 2000) (Lex/D)^2	
	=	16.93 kNm	
Column Is Unbraced Along B			
Slenderness Check Along B:			
Effective Length Factor	=	1.71	
Slenderness Ratio	=	Effective Length / B	
	=	19.52, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	20.79	kNm
Design slenderness moment along D			
Puz	=	2262.39	kN
Pd	=	530.17	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pd) < = 1	
	=	1.03 > = 1, Hence k=1	
Mslndx	=	k x 16.93	
	=	16.93	kNm
Design slenderness moment along B			
Puz	=	2262.39	kN
Pb	=	339.93	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	0.93 < = 1, Hence k=0.93	
Mslndy	=	k x 20.79	
	=	19.34	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	22.18	9.49	22.18	16.93	39.11
Minor Axis - Muy	-46.2	---	-46.2	19.34	-65.53

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	474.71	kN
Mux	=	39.11	kNm
Muy	=	-65.53	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	3.73	
Reinforcement Provided	=	4-T25 + 4-T20	
Load Angle	=	$Tan^{-1}(Muy/Mux)$	
	=	59.17	deg
MRes	=	76.32	kNm
MCap	=	91.13	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.84 <= 1	

Shear Calculation	Along D	Along B
Critical Analysis Load Combination	DConS9	DConS8
Critical Load Combination	[9] : 1.5 (Dead) +1.5 (SDL) +1.5 (EQ+Y)	[8] : 1.5 (Dead) +1.5 (SDL) -1.5 (EQ+X)
Design shear force, Vu (kN)	21.4871	-27.6473
Pu (kN)	95.06	89.44

Deff , Beff (mm)	322.5	177.5
Aeff (sqmm)	74175	66562.5
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.2897	0.4154
Pt (%)	1.867	1.867
Design shear strength, Tc (N/sqmm)	0.7995	0.7995
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	1.1538	1.1612
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.1538	1.1612
Enhanced shear strength, Tc-e (N/sqmm)	0.9224	0.9284
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	6.25	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	320	mm
Min. dimension of column	=	230	mm
Max. 300 mm	=	300	mm
Provided spacing	=	225	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	225	---	---	225	---

10.3 BEAM DESIGN:

Group	:	**G1**	
Beam No	:	**B1**	
Analysis Reference (Member)	:	B85 (GROUND ROOF)	
Beam Length	:	4638	mm
Breadth (B)	:	230	mm
Depth (D)	:	375	mm
Effective Depth (d)	:	340	mm
Design Code	:	IS 456	
Beam Type	:	Regular Beam	
Grade Of Concrete (Fck)	:	M25	N/sqmm
Grade Of Steel (Main)	:	Fe550	N/sqmm
Grade Of Steel (Shear)	:	Fe550	N/sqmm
Top/Bottom Clear Cover (Cmin)	:	25	mm
Side Clear Cover	:	25	mm
Es	:	2x10^5	N/sqmm
Ptnominal (%) (Bn)	:	0.2	%

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Flexure Design						
	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Critical L/C - Analysis	DConS7	DConS2	DConS12	DConS8	DConS11	DConS7
Critical L/C - RCDC	7	2	12	8	11	7
Mu (kNm)	22.78	38.27	8.45	69.33	3.54	75.42
Tu (kNm)	0	0.12	0	0.15	0.11	0.24
M_{Tu} (kNm)	0	0.19	0	0.23	0.17	0.37
Mud (kNm)	22.78	38.46	8.45	69.55	3.71	75.79
MuLim (kNm)	87	87	87	87	87	87
R	0.857	1.446	0.318	2.616	0.139	2.85
Ptmin (%) (A)	0.2	0.2	0.2	0.2	0.2	0.2
Ptclc (%) (B')	0.2	0.326	0.2	0.636	0.2	0.706
Pcclc (%) (C)	0	0	0	0	0	0
PtPrv (%)	0.434	0.434	0.434	0.771	0.301	0.771
AstCalc (sqmm)	156.4	254.73	156.4	497.48	156.4	551.99
AstPrv (sqmm)	339.3	339.3	339.3	603.18	235.62	603.18
Reinforcement Provided	3-T12	3-T12	3-T12	3-T16	3-T10	3-T16

Note: Calculation of Ast

AstCalc = Max {B',C} x B X d (for Mu > 0)
AstCalc = Bn x B X d (for Mu = 0)
Where,

A	=	Ptmin	=	Min % area of flexural reinforcement
B'	=	Ptclc	=	Maximum of % reinforcement required for Bending Moment and Min % area of flexural reinforcement (A)
Bn	=	Ptnominal	=	Nominal % area of reinforcement
C	=	Pcclc	=	% area of compression reinforcement required
D	=	AstCrack	=	Area of reinforcement required for Crackwidth

Shear Design			
	Left	**Mid**	**Right**
Critical L/C - Analysis	DConS8	DConS8	DConS7
Critical L/C - RCDC	8	8	7
PtPrv (%)	0.771	0.434	0.771
Vu (kN)	88.81	19.38	99.19
Tu (kNm)	0.15	0.16	0.24
V_{Tu} (kN)	1.01	1.1	1.66
Vut (kN)	89.82	20.48	100.85
Tv (N/sqmm)	1.15	0.26	1.29
Tc (N/sqmm)	0.58	0.46	0.58
Vc (kN)	45.44	36.06	45.44
Vus=Vut-Vc (kN)	44.38	0	55.41
Legs	2	2	2
Stirrup Rebar	8	8	8
Asv Torsion (sqmm)	326.381	76.917	368.702
Asv Torsion Prv (sqmm)	804.32	502.7	804.32
Asv Reqd (sqmm/m)	361.55	254.81	451.42
SvCalc (mm)	125	200	125
SvPrv (mm)	125	200	125
Asv Total Prv (sqmm)	804.32	502.7	804.32

Maximum Spacing Criteria

Basic

Spc1 =0.75d = 255 mm

Spc2 = 300 mm

For Torsion

(X1 = 190, Y1 = 335)

Spc3 = X1 = 190 mm

Spc4=(X1+Y1)/4 = 125 mm

SFR Design

Beam Width = 230 mm

Beam Depth = 375 mm

Web Depth = 375 <= 750 mm

Side Face Reinforcement not required.

Group	:	**G1**	
Beam No	:	**B2**	
Analysis Reference (Member)	:	B86 (GROUND ROOF)	
Beam Length	:	2800	mm
Breadth (B)	:	230	mm
Depth (D)	:	300	mm
Effective Depth (d)	:	265	mm
Design Code	:	IS 456	
Beam Type	:	Regular Beam	
Grade Of Concrete (Fck)	:	M25	N/sqmm
Grade Of Steel (Main)	:	Fe550	N/sqmm
Grade Of Steel (Shear)	:	Fe550	N/sqmm
Top/Bottom Clear Cover (Cmin)	:	25	mm
Side Clear Cover	:	25	mm
Es	:	2x10^5	N/sqmm
Ptnominal (%) (Bn)	:	0.2	%

Flexure Design

	Beam Bottom			Beam Top		
	Left	**Mid**	**Right**	**Left**	**Mid**	**Right**
Critical L/C - Analysis	DConS11	DConS8	DConS12	DConS8	DConS8	DConS7
Critical L/C - RCDC	11	8	12	8	8	7
Mu (kNm)	9.82	13.95	15.76	31.53	15.47	25.84
Tu (kNm)	0	0	0	0	0	0
M_{Tu} (kNm)	0	0	0	0	0	0
Mud (kNm)	9.82	13.95	15.76	31.53	15.47	25.84
MuLim (kNm)	53	53	53	53	53	53
R	0.608	0.864	0.976	1.952	0.958	1.6
Ptmin (%) (A)	0.2	0.2	0.2	0.2	0.2	0.2
Ptclc (%) (B')	0.2	0.2	0.214	0.453	0.21	0.364
Pcclc (%) (C)	0	0	0	0	0	0
PtPrv (%)	0.387	0.387	0.387	0.99	0.387	0.387
AstCalc (sqmm)	121.9	121.9	130.48	276.33	127.93	221.63
AstPrv (sqmm)	235.62	235.62	235.62	603.18	235.62	235.62
Reinforcement Provided	3-T10	3-T10	3-T10	3-T16	3-T10	3-T10

Note: Calculation of Ast

AstCalc = Max {B',C} x B X d (for Mu > 0)
AstCalc = Bn x B X d (for Mu = 0)
Where,

A	=	Ptmin	=	Min % area of flexural reinforcement
B'	=	Ptclc	=	Maximum of % reinforcement required for Bending Moment and Min % area of flexural reinforcement (A)
Bn	=	Ptnominal	=	Nominal % area of reinforcement
C	=	Pcclc	=	% area of compression reinforcement required
D	=	AstCrack	=	Area of reinforcement required for Crackwidth

Shear Design			
	Left	**Mid**	**Right**
Critical L/C - Analysis	DConS8	DConS8	DConS7
Critical L/C - RCDC	8	8	7
PtPrv (%)	0.99	0.387	0.387
Vu (kN)	41.95	25.75	39.25
Tu (kNm)	0	0	0
V_{Tu} (kN)	0	0	0
Vut (kN)	41.95	25.75	39.25
Tv (N/sqmm)	0.69	0.42	0.64
Tc (N/sqmm)	0.64	0.44	0.44
Vc (kN)	38.94	26.78	26.78
Vus=Vut-Vc (kN)	3.01	0	12.47
Legs	2	2	2
Stirrup Rebar	8	8	8
Asv Torsion (sqmm)	-	-	-
Asv Torsion Prv (sqmm)	-	-	-
Asv Reqd (sqmm/m)	254.81	254.81	254.81
SvCalc (mm)	175	175	175
SvPrv (mm)	175	175	175
Asv Total Prv (sqmm)	574.51	574.51	574.51

Maximum Spacing Criteria

Basic

Spc1 =0.75d	= 199	mm
Spc2	= 300	mm

SFR Design

Beam Width	= 230	mm
Beam Depth	= 300	mm
Web Depth	= 300 <= 750	mm

Side Face Reinforcement not required.

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