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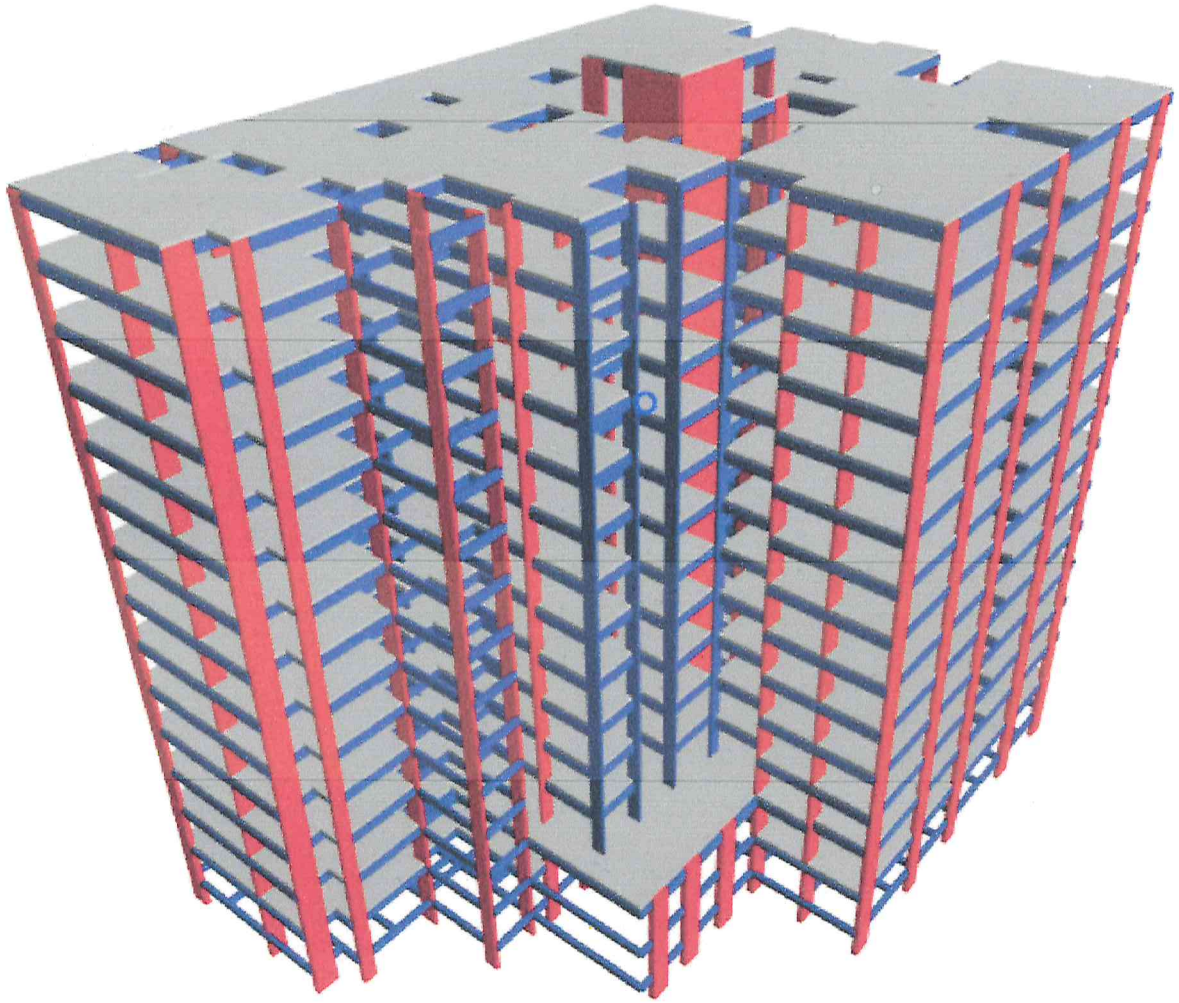
Vision Structural Design Aid

MOOLAKADAI - REPORT

PROJECT: SILT+13+TERRACE RESIDENTIAL BUILDING (CHENNAI)



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1. PROJECT INFORMATION

Location	Chennai
Number of floors	SILT+13+TERRACE
Height of project	46.7m
Length of project	44.62m
Width of project	33.064m
Construction materials	Concrete and steel
Grade of concrete	M40,M35,M30
Grade of steel	Fe415 & Fe550
Typical floor height	3.0 m

2. CODAL PROVISIONS

- IS 456:2000 – Code of practice for plain and reinforced concrete.
- IS 875:1987 (Part1) – Code for practice for design load for building and structures- unit weights of building materials and stored materials.
- IS 875:1987 (Part-2)-Code of practice for design load for building and structures-imposed loads.
- IS 875:2015 (Part -3) - Design Loads (Other Than Earthquake) For Buildings and Structures - Code of Practice
- IS 1893:2016 (Part 1) - Indian standard criteria for earthquake resistant.
- IS: 875(PART-1)-1987 Code of Practice for Design Loads (Other than earthquake) for Buildings and structure .

- PART-1 DEAD LOADS - Unit Weights of Building Materials and Stored Materials.
- PART-2 - IMPOSED LOADS
- PART-4 - SNOW LOADS.

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□ PART-5 - SPECIAL LOADS AND COMBINATIONS.

- IS: 875, 2015 (PART-3) - Wind Loads – Code of Practice for design loads (other than earthquake) for Buildings and structure.

Foundations:

- IS: 1080 Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
- IS: 1904 Code of Practice for design and construction of foundations in soils general requirement
- IS: 2950 Code of Practice for design and construction of raft foundations
- IS: 2974 Code of Practice for design and construction of machine foundations (All parts)
- IS: 8009 Code of Practice for calculation of settlement of foundations (All parts)
- IS: 11089 Code of Practice for design and construction of ring foundation □ IS2911-PART2 Code of Practice for design and construction of Pile foundation.

RCC:

- IS: 456 Code of Practice for plain and reinforced concrete
- IS: 458 Specification for precast concrete pipes
- IS: 3370 Code of Practice for concrete structures for the storage of liquids: (All parts)
- IS: 3414 Code of Practice for design and installation of joints in buildings
- IS: 3935 Code of Practice for composite construction
- IS: 4326 Code of Practice for earthquake resistant design and construction of buildings
- IS: 5525 Recommendation for detailing of reinforced concrete works
- IS: 1786 Specification for high strength deformed steel bars and wires for concrete reinforcement
- IS: 10262 recommended guidelines for concrete mix design
- IS: 11384 Code of Practice for composite construction in structural steel and concrete
- IS: 1893, 2016 (Part-1)Criteria for earthquake resistant design of structures (General provisions and building).

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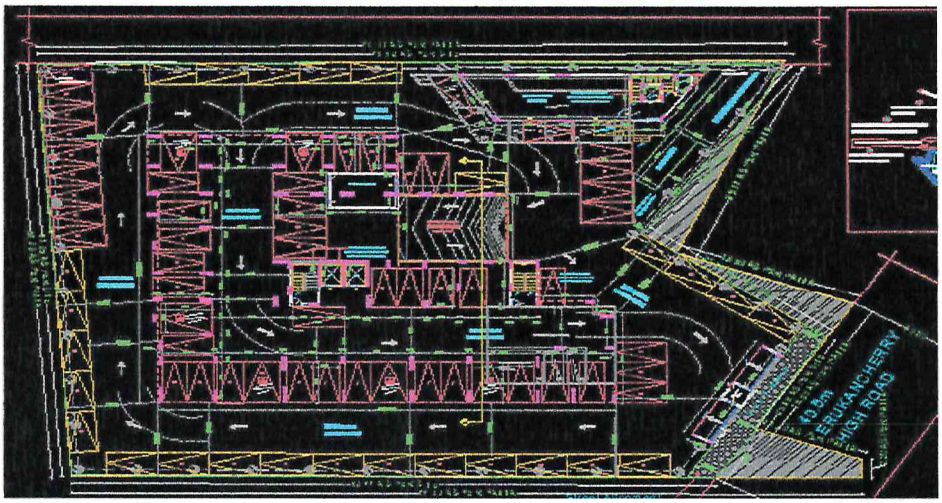
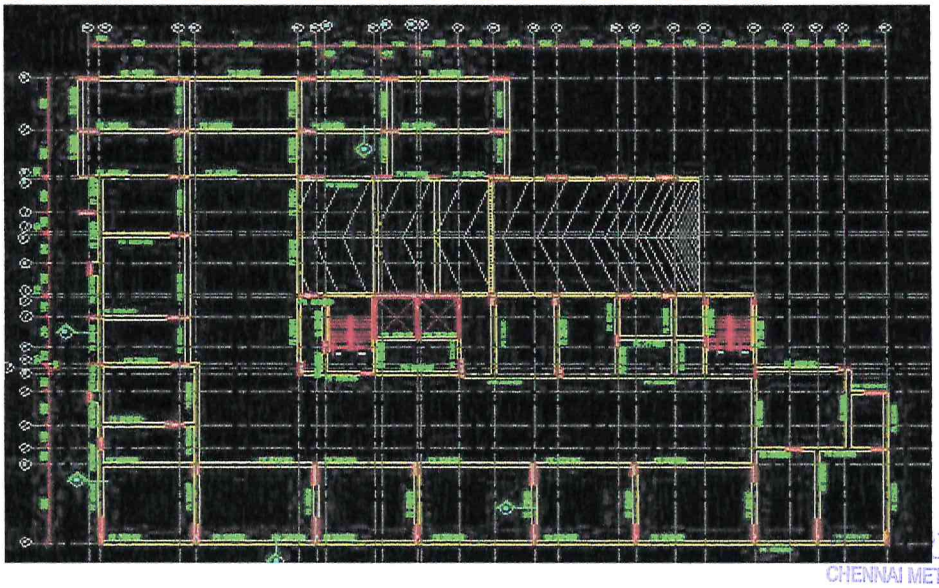
- IS: 1893(Part-4) Criteria for earthquake resistant design of structures (Industrial structures including stack-like structures).
- IS: 13920 Ductile Detailing of reinforced concrete structures subjected to seismic forces
- IS: 16700-2017 Criteria for Structural Safety of Tall concrete

3. PLANS

3.1 ARECHITECTURAL PLAN SILT FLOOR



3.2 STRCTURAL FRAMING PLAN SILT FLOOR



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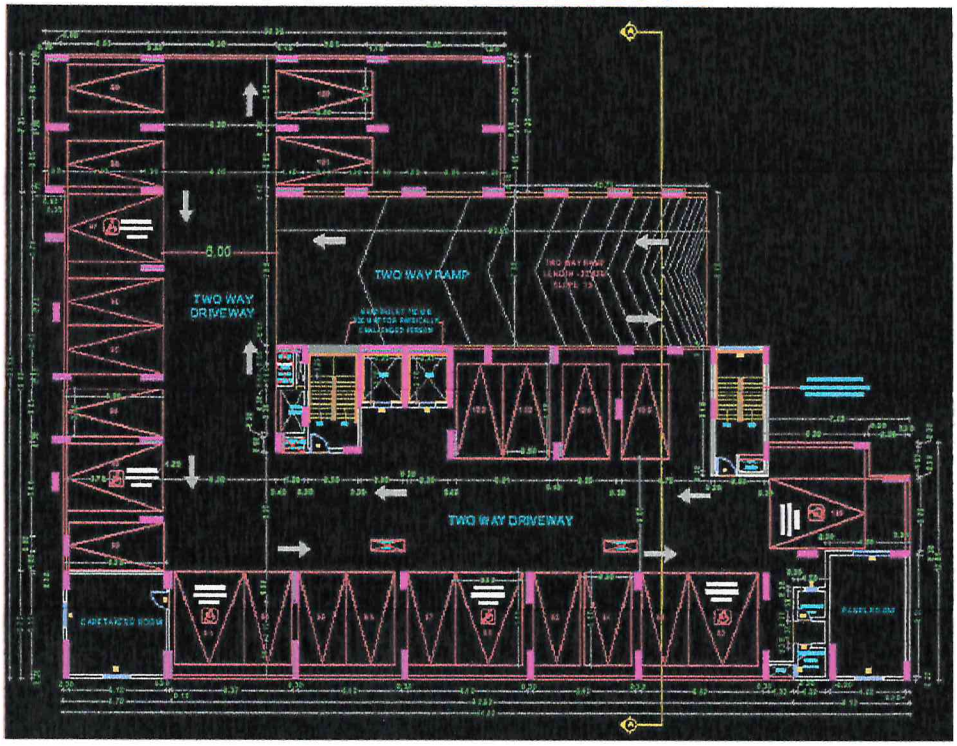
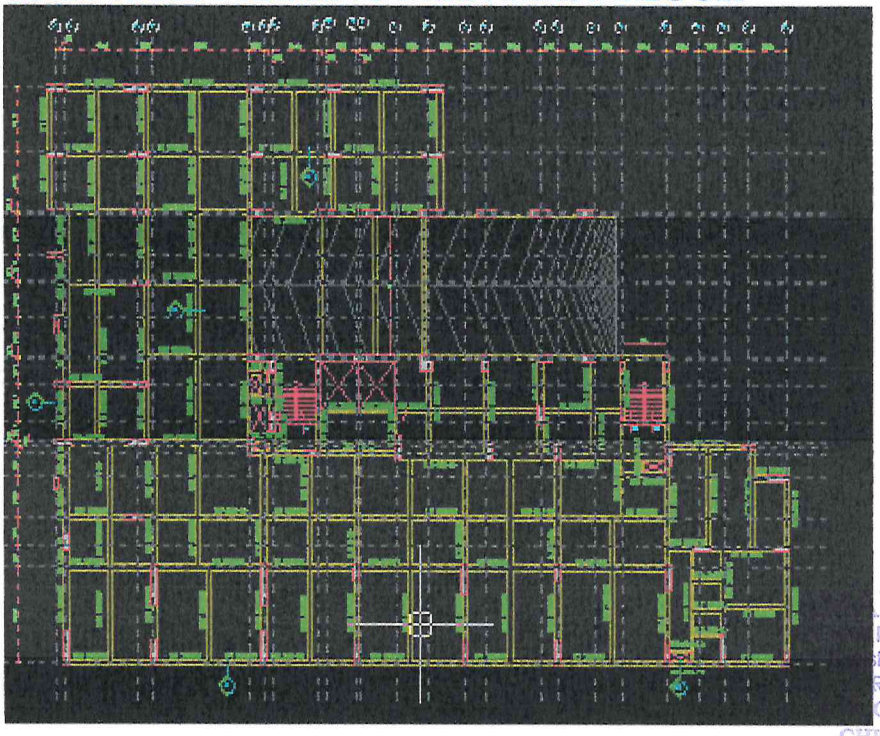
3.1ARECHITECTURAL PLAN FIRST FLOOR



3.2 STRCTURAL FRAMING PLAN FIRST FLOOR



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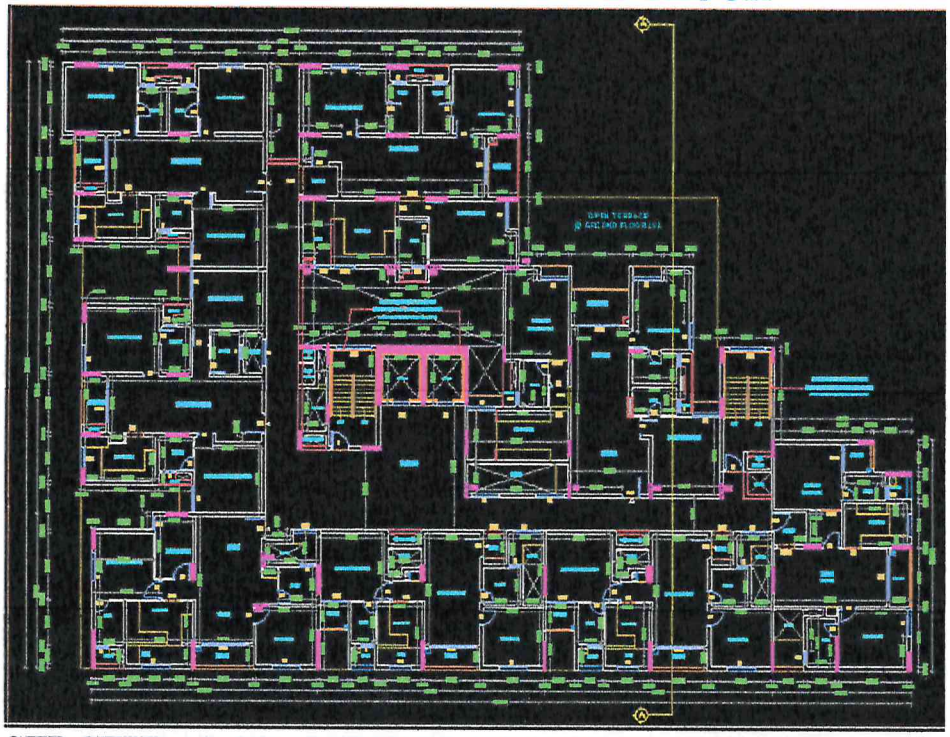
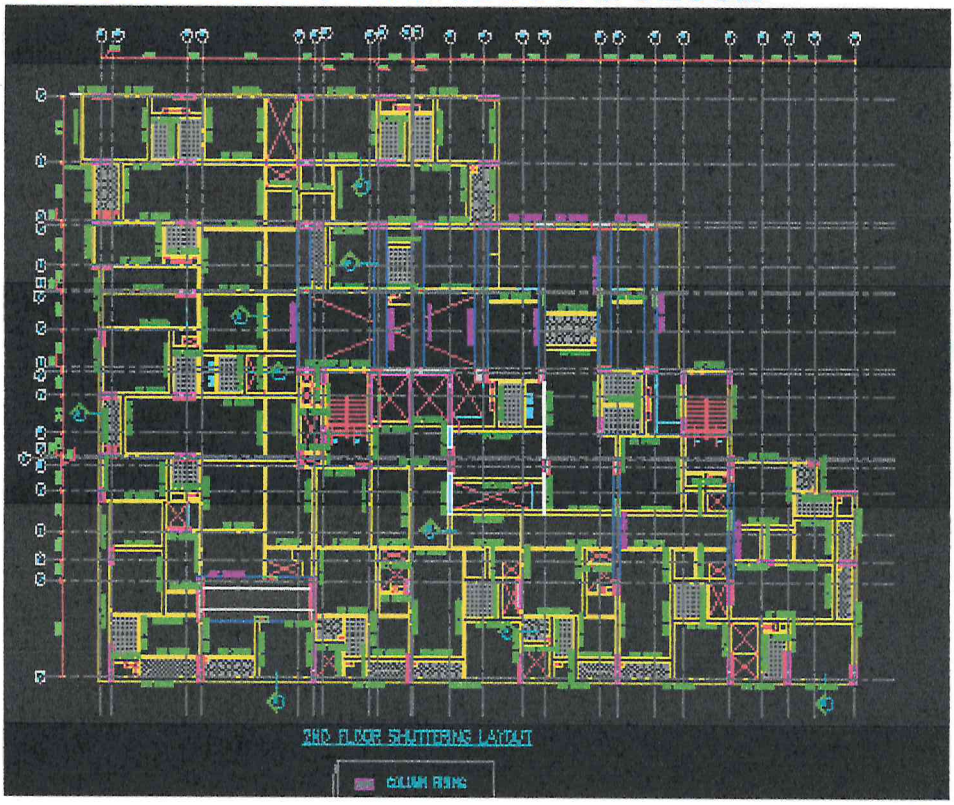
3.1 ARECHITECTURAL PLAN SECOUND FLOOR



3.2 STRCTURAL FRAMING PLAN SECOUND FLOOR



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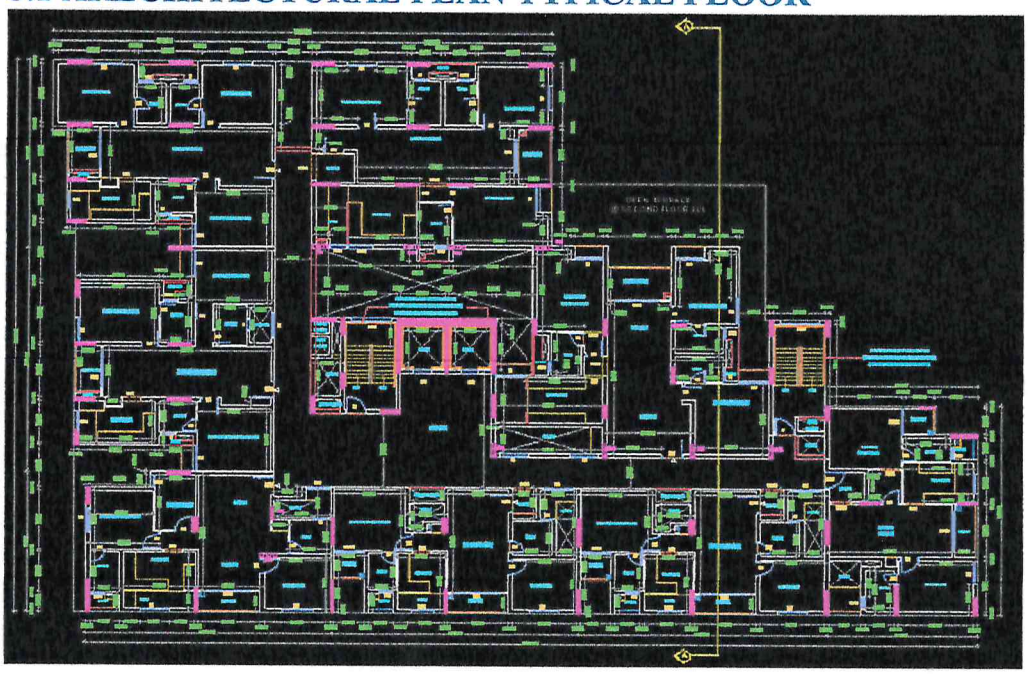
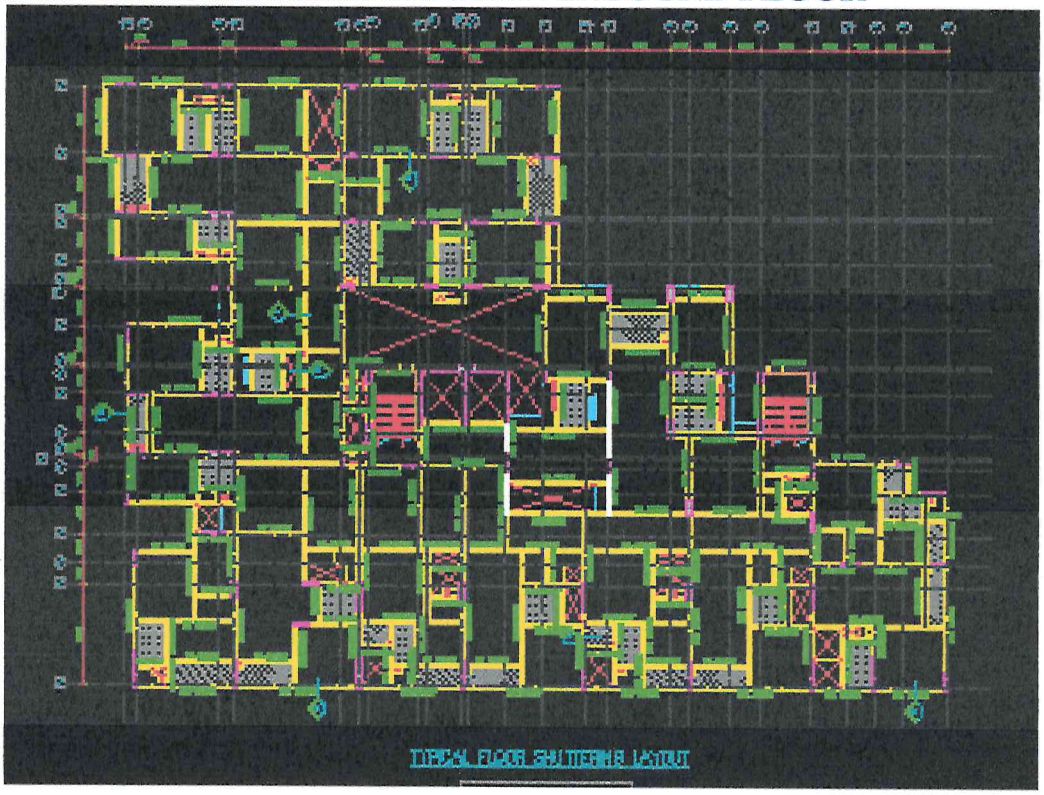
3.1 ARECHITECTURAL PLAN TYPICAL FLOOR



3.2 STRCTURAL FRAMING PLAN SECOUND FLOOR



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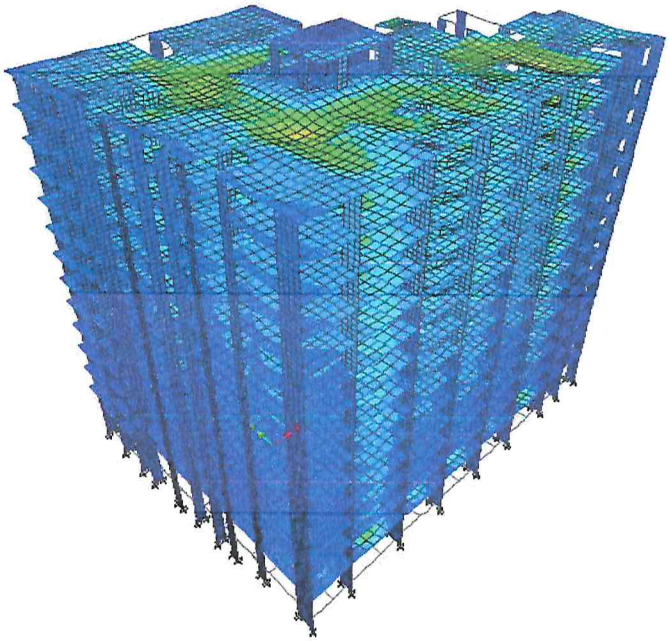
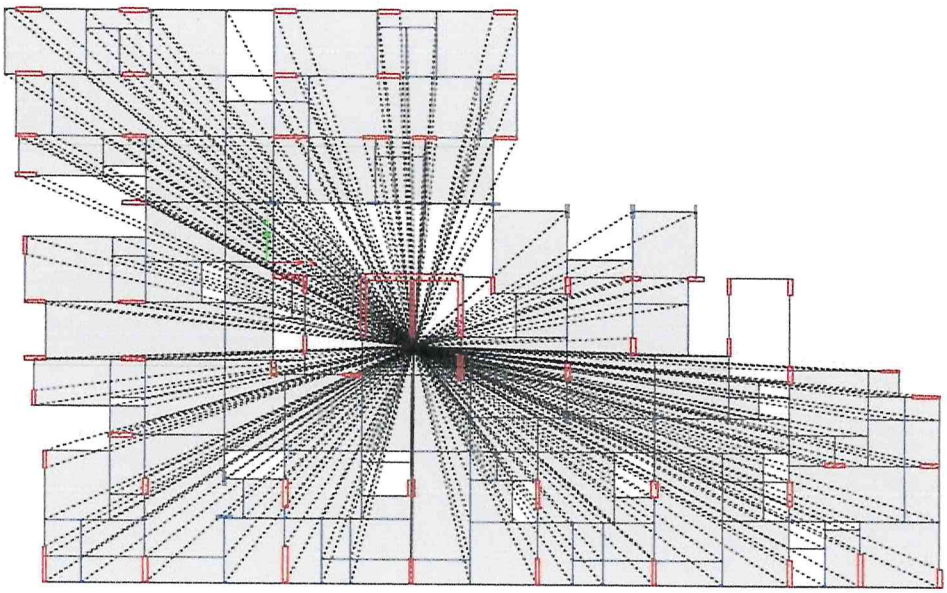
3.3 DEFLECTED SHAPE (ISOMETRIC)



3.4 DIAPHRAGAM



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4. SECTION PROPERTIES

4.1 FRAME SECTIONS □ BEAMS

SR.NO	SIZE (mm)	GRADE OF CONCRETE
1	200X450	M30
2	200X600	M30
3	300X450	M30
4	400X750	M30
5	400X750	M40
6	700X750	M40
7	800 X 750	M40

COLUMN

SR.NO	SIZE (mm)	GRADE OF CONCRETE
1	800 X 300/200	M30,M35,M40
2	850 X 300/200	M30,M35,M40
3	850 X 400/200	M30,M35,M40
4	870 X 400/300	M30,M35,M40
5	900 X 400/200	M30,M35,M40
6	1000 X 300/200	M30,M35,M40
7	1000 X 400/200	M30,M35,M40
8	1100 X 300/200	M30,M35,M40
9	1200 X 300/200	M30,M35,M40
10	1200 X 400/200	M30,M35,M40
11	1380 X 400/200	M30,M35,M40

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12	1400 X 300/200	M30,M35,M40
13	1400 X 400/200	M30,M35,M40
14	1450 X 400/200	M30,M35,M40
15	1500 X 300/200	M30,M35,M40
16	1600 X 300/200	M30,M35,M40
17	1850 X 300/200	M30,M35,M40
18	2000 X 300/200	M30,M35,M40
19	900 X 200	M30,M35,M40
20	1000 X 200	M30,M35,M40
21	1100 X 200	M30,M35,M40
22	1200 X 400	M30,M35,M40
23	800 X 200`	M30,M35,M40

4.2 SHELL SECTIONS

□ SLABS

SR.NO	DESIGNATION	THICKNESS	SLAB TYPE	GRADE OF CONCRETE
1	GENERAL	125 / 150	Shell-Thin	M30
2	STAIRCASE	200	Shell-Thin	M30
3	OHT/LMR	200	Shell-Thin	M30
4	PARKING	200	Shell-Thin	M30

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WALL

SR.NO	DESIGNATION	THICKNESS	SLAB TYPE	GRADE OF CONCRETE
1	W1	200	Shell-Thin	M25,M30,M35,M40
2	W2	300	Shell-Thin	M25,M30,M35,M40
3	W3	400	Shell-Thin	M25,M30,M35,M40
4	W4	800	Shell-Thin	M25,M30,M35,M40

5. LOAD ASIGNMENTS

5.1 FRAME LOADS

Frame load formula = Thickness of the wall× (Floor to floor height–Depth of the beam) × Density.

1. Unit weight of RCC =25 kN/m2
2. Unit weight of light weight brick (AAC)= 10 kN/m2
3. Loading on typical floors

   0.2 X 10 X (3-0.45) = 5.1 KN/M
4. Loading on terrace floor

   0.2 X 10 X 1.2 = 2.4 KN/M

Calculations of Dead Loads

1. Terrace loads

Considering water proofing thickness: 100 mm.

Density of cement concrete : 24 kN/m^3.

Load of waterproof course : 0.1 × 24 = 2.4 kN/m^2. Load of waterproof course : 3 kN/m^2

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5.2 SHELL LOADS

SR.NO	TYPE OF LOADS	DEAD LOAD (kN/m^2)	LIVE LOAD
1	General	1.5	2
2	Ramp	5	15
3	OHT	25	0.75
4	LMR	28	0.75
5	Terrace	3	2
6	Balcony	2	3
7	Corridor	1.5	3
8	Drive way	5	15
9	Parking	3	5
10	Toilets	2	2
11	Utility	3	2

6. EARTHQUAKE ANALYSIS

Remarks	Symbol/Formula	Value	Code Reference
Seismic zone	Z	III	Fig. 1 pg.11 IS 1893 (Part 1): 2016
Seismic zone factor		0.16	Table 3 cl.6.4.2 pg.10 IS 1893 (Part 1): 2016
Soil type		II	Table 1 cl.6.3.5.2 pg.10 and Table 4 cl.6.4.2.1 pg.13 IS 1893 (Part 1): 2016
Importance factor	I	1.2	Table 8 cl.7.2.3 pg.19 IS 1893 (Part 1): 2016

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Response reduction factor	R	4	Table 9 cl.7.2.6 pg.20 IS 1893 (Part 1): 2016
Mass source		Dead =1, SDL=1 Live (<3)=0.25 Live (>3) =0.5	
Base dimension	dx in meters	44.62	
	dy in meters	33.064	
Height of the building	h in meters	45.45 m	value obtained from software
fundamental translation natural period of oscillation	Tx = (0.075 x (h) ^0.75)	1.25	cl.7.6.2 pg.21 IS 1893 (Part 1): 2016
	Ty = (0.075 x (h) ^0.75)	1.25	
Static base shear (Vb = Ah x W)	EX	6083.88	cl.7.6.1 pg.21 IS 1893 (Part 1): 2016
	EY	6571.68	
Dynamic base shear	SPEC X	6083.88	
	SPEC Y	6571.68	

7. WIND ANALYSIS

PARAMETER	VALUE	CODE REFARENCES BASED ON IS 875 PART 3 (2015)
Basic Wind Speed	50	Annex-A
Terrain category	2	Clause 6.3.2.1
Importance factor	1	Clause 6.3.2.4
Risk Coefficient (k1)	1	Table no.1
Topography factor(k3)	1	Appendix-C

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BUILDING HEIGHT RATIO	BUILDING PLAN RATIO	WIND ANGLE	CPS FOR SURFACE			
			A	B	C	D
(1/2) <(H÷W) < (3/2)	(3/2) <=(L÷W) < (3/2)	0	+0.7	-0.25	-0.5	-0.5
		90	-0.6	-0.6	+0.7	-0.25

8. TEMPERATURE ANALYSIS

□ Maximum day temperature – Minimum night temperature

= 30 degrees

SI NO	STRUCTURAL ELEMENT	UN-FACTORED LOADS	FACTORED LOADS
1	SLABS	$0.35I_g$	$0.25I_g$
2	BEAMS	$0.7I_g$	$0.35I_g$
3	COLUMNS	$0.9I_g$	$0.7I_g$
4	WALLS	$0.9I_g$	$0.7I_g$

- Stability checks (Drifts, Deflection, Displacement, Soft storey, Torsional irregularity) are checked in UN-Factored Loads.
- Design checks are checked in Factored Loads.9. DEFLECTION CHECK

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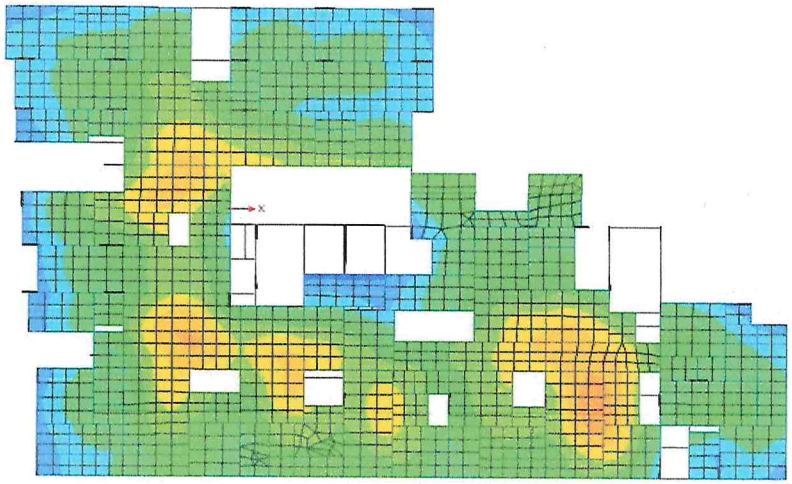

As per IS 456:2000 Cl no. 23.2(b)

1) Deflection at terrace floor is 36.54 mm.

10. MODAL ANALYSIS

As per IS 1893:2016,

1) The number of modes to be used in analysis should be such that the sum total of modal masses of these modes considered is at least 90% of total seismic mass (Cl.7.7.5.2)

2) To ensure there is no lateral storey irregularity in principal plan direction, (Table 6, IS 1893)

Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY	RZ
Modal	1.00	2.88	0.24	0.01	0.00	0.24	0.01	0.47
Modal	2.00	2.39	0.02	0.66	0.00	0.27	0.67	0.00
Modal	3.00	1.91	0.42	0.01	0.00	0.69	0.69	0.25
Modal	4.00	0.88	0.04	0.00	0.00	0.73	0.69	0.08
Modal	5.00	0.68	0.00	0.14	0.00	0.73	0.83	0.00
Modal	6.00	0.67	0.00	0.00	0.00	0.73	0.83	0.00
Modal	7.00	0.58	0.04	0.00	0.00	0.78	0.83	0.02
Modal	8.00	0.53	0.06	0.00	0.00	0.84	0.83	0.03
Modal	9.00	0.47	0.02	0.00	0.00	0.86	0.83	0.03
Modal	10.00	0.44	0.00	0.00	0.00	0.86	0.83	0.00
Modal	11.00	0.34	0.00	0.00	0.00	0.86	0.84	0.00

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Modal	12.00	0.33	0.00	0.06	0.00	0.86	0.89	0.00
Modal	13.00	0.31	0.01	0.00	0.00	0.87	0.90	0.02
Modal	14.00	0.28	0.05	0.00	0.00	0.92	0.90	0.01
Modal	15.00	0.25	0.00	0.00	0.33	0.92	0.90	0.00
Modal	16.00	0.22	0.00	0.00	0.16	0.92	0.90	0.00
Modal	17.00	0.21	0.00	0.04	0.00	0.92	0.93	0.00
Modal	18.00	0.19	0.03	0.00	0.05	0.95	0.93	0.00
Modal	19.00	0.18	0.01	0.00	0.16	0.95	0.93	0.00
Modal	20.00	0.14	0.00	0.03	0.00	0.95	0.96	0.00
Modal	21.00	0.13	0.00	0.00	0.12	0.96	0.96	0.00
Modal	22.00	0.10	0.03	0.00	0.00	0.99	0.96	0.01
Modal	23.00	0.08	0.00	0.03	0.00	0.99	0.99	0.00
Modal	24.00	0.07	0.00	0.00	0.11	0.99	0.99	0.00

Time period of mode 1 = 2.88> 0.1N (N=31)

1) Sum UX & Sum UY for mode 3 is 65% it should be minimum 65%. 4) Sum UX & Sum UY for mode 15 is 90% it should be minimum 90%.

11.1 Stability Checks

Name of Response	Loading type	Parameter	Obtained value in Analysis	IS Code	Limiting Valueas per code	Remarks
1. Storey Drift	SPECX	-	0.002979	Cl. 7.11.1.1 of IS 1893:2016	0.004	SAFE
	SPECY	-	0.002615	Cl. 7.11.1.1 of IS 1893:2016	0.004	SAFE
	EX	-	0.003663	Cl. 7.11.1.1 of IS 1893:2016	0.004	SAFE

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11.2 Torsional Irregularity check:

1) If the ratio of maximum displacement vs. Average displacement is greater than 1.2 then building is said to be Torsional irregular (1. ASCE-7 2016, 2. China GB50011:2010, 3.UBC 1997 VOL-2

	EY	-	0.003532	Cl. 7.11.1.1 of IS 1893:2016	0.004	SAFE
2.Lateral Sway	Wind X	H=46.7m	38.89mm	Cl. 20.5 of IS 456:2000	H/500 =93mm	SAFE
	Wind Y	H=46.7m	37.89mm	Cl. 20.5 of IS 456:2000	H/500 =93mm	SAFE
3.Storey Displacement	SPECX	H=46.7m	91.82mm	Cl.5.4.1 of IS 16700:2017	H/250 =186mm	SAFE
	SPECY	H=46.7m	87.57mm	Cl.5.4.1 of IS 16700:2017	H/250 =186mm	SAFE

Torsional Irregularity check in X direction

TABLE: Story Max/Avg Displacements

Story	Load Case/Combo	Direction	Maximum	Average	Ratio
			mm	mm	
OHT	SPECX Max	X	61.727	59.516	1.037
TERAC	SPECX Max	X	84.679	69.196	1.224
13F	SPECX Max	X	80.991	65.821	1.23
12F	SPECX Max	X	76.659	61.916	1.238
11F	SPECX Max	X	71.712	57.564	1.246
10F	SPECX Max	X	66.206	52.831	1.253
9F	SPECX Max	X	60.183	47.753	1.26
8F	SPECX Max	X	53.675	42.361	1.267
7F	SPECX Max	X	46.741	36.701	1.274
6F	SPECX Max	X	39.512	30.881	1.279
5F	SPECX Max	X	32.026	24.937	1.284
4F	SPECX Max	X	24.407	18.967	1.287
3F	SPECX Max	X	16.914	13.155	1.286

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2F	SPECX Max	X	10.223	7.964	1.284
1F	SPECX Max	X	4.74	3.699	1.281

Torsional Irregularity check in Y direction

TABLE: Story Max/Avg Displacements

Story	Load Case/Combo	Direction	Maximum	Average	Ratio
			mm	mm	
OHT	SPECY Max	Y	78.097	74.915	1.042
TERAC	SPECY Max	Y	88.49	78.343	1.13
13F	SPECY Max	Y	84.35	74.414	1.134
12F	SPECY Max	Y	79.672	70.014	1.138
11F	SPECY Max	Y	74.43	65.155	1.142
10F	SPECY Max	Y	68.669	59.877	1.147
9F	SPECY Max	Y	62.452	54.22	1.152
8F	SPECY Max	Y	55.83	48.225	1.158
7F	SPECY Max	Y	48.85	41.933	1.165
6F	SPECY Max	Y	41.593	35.428	1.174
5F	SPECY Max	Y	34.079	28.752	1.185
4F	SPECY Max	Y	26.397	22.046	1.197
3F	SPECY Max	Y	18.758	15.428	1.216
2F	SPECY Max	Y	11.692	9.451	1.237
1F	SPECY Max	Y	5.373	4.305	1.248

11.3 Soft Story Check

1) Soft story is one in which the lateral stiffness is less than 70 percent of that in the story above or less than 80 percent of the average lateral stiffness of the three story above

2) As per 1. Cl 4.20 and Table 5 of IS 1893:2002, 2. ASCE 7-2016, 3. UBC 1997 Vol-2, 4. China GB50011:2010

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Story	Output Case	Shear X	Drift X	Stiff X	70%	CHECK	80%	CHECK
OHT	SPECX	244.5247	3.532	69231.24	48461.87	NO		
TERAC	SPECX	1351.336	4.862	277921.1	194544.8	NO		
13F	SPECX	2177.019	6.573	331199.7	231839.8	NO	180893.9	NO
12F	SPECX	2682.176	7.618	352064.7	246445.3	NO	256316.1	NO
11F	SPECX	2998.208	8.04	372915.7	261041	NO	281648	NO
10F	SPECX	3213.589	7.702	417233	292063.1	NO	304590.2	NO
9F	SPECX	3389.522	6.803	498256.9	348779.8	NO	343574.8	NO
8F	SPECX	3578.761	6.126	584202.6	408941.9	NO	399918	NO
7F	SPECX	3800.491	6.196	613382.9	429368.1	NO	452224.7	NO
6F	SPECX	4059.943	6.231	651579.9	456105.9	NO	493110.8	NO
5F	SPECX	4364.591	6.591	662207.8	463545.5	NO	513912.2	NO
4F	SPECX	4722.029	7.259	650542.4	455379.7	NO	523821.4	NO
3F	SPECX	5114.308	6.463	791378.8	553965.2	NO	561101.1	NO
2F	SPECX	5584.724	4.154	1344365	941055.3	NO	743009.6	NO
1F	SPECX	6062.895	2.818	2151619	1506134	NO	1143297	NO
UPPER STILT	SPECX	6111.278	0.844	7240851	5068596	SS	2863156	SS

Story	Output Case	Shear Y	Drift Y	Stiff Y	70%	CHECK	80%	CHECK
OHT	SPECY	283.6671	4.225	67137.6	46996.32	NO		
TERAC	SPECY	1596.602	5.012	318555.8	222989.1	NO		
13F	SPECY	2539.613	5.55	457601	320320.7	NO	224878.5	NO
12F	SPECY	3103.515	6.009	516438.8	361507.2	NO	344692.2	NO
11F	SPECY	3454.179	6.381	541344.8	378941.4	NO	404102.6	NO
10F	SPECY	3686.271	6.661	553422.5	387395.7	NO	429655	NO
9F	SPECY	3852.82	6.864	561293	392905.1	NO	441616.1	NO
8F	SPECY	4018.62	7.001	573994.1	401795.9	NO	450322.5	NO
7F	SPECY	4237.203	7.044	601522.5	421065.7	NO	463149.2	NO
6F	SPECY	4519.316	7.039	642084.6	449459.3	NO	484693.7	NO
5F	SPECY	4877.586	6.936	703179	492225.3	NO	519143	NO
4F	SPECY	5280.865	6.703	787869.3	551508.5	NO	568835.4	NO
3F	SPECY	5692.926	6.014	946646	662652.2	NO	650051.8	NO
2F	SPECY	6125.386	4.727	1295891	907123.6	NO	808108.3	NO
1F	SPECY	6539.445	3.491	1873121	1311184	NO	1097509	NO
UPPER STILT	SPECY	6602.181	1.023	6452280	4516596	SS	2565678	SS

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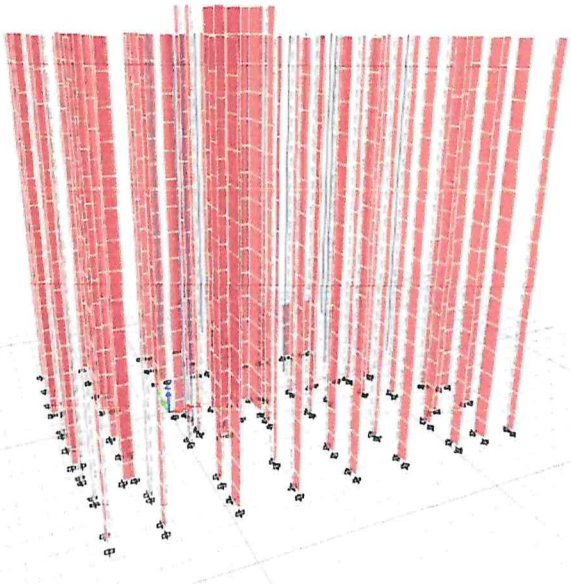
11.4 Beam Design

11.5 Column Design



11.5 Design of Super structure load combinations

1) The design life of structure is assumed as 50 years.

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2) All RCC members are designed as per limit state method as specified in IS 456:2000.

3) Load combinations as per Table 18, IS 456:2000 is taken into consideration for design of frame

Load Combination

No s.	COMBINATIONS	No s.	COMBINATIONS	No s.	COMBINATIONS
1	1.5DL+1.5SDL	12	0.9DL+0.9SDL-1.5WX	23	0.9DL+0.9SDL+1.5EY
2	1.5DL+1.5SDL+1.5LL+1.5LL >3	13	0.9DL+0.9SDL+1.5WY	24	0.9DL+0.9SDL-1.5EY
3	1.2DL+1.2SDL+1.2LL1.2LL>3+1.2WX	14	0.9DL+0.9SDL-1.5WY	25	1.5DL+1.5SDL+1.5EX
4	1.2DL+1.2SDL+1.2LL1.2LL>3-1.2WX	15	1.2DL+1.2SL1.2LL+1.2LL>3+1.2SPECX	26	1.5DL+1.5SDL-1.5EX
5	1.2DL+1.2SDL+1.2LL1.2LL>3+1.2WY	16	1.2DL+1.2SL1.2LL+1.2LL>3+1.2SPECY	27	1.5DL+1.5SDL+1.5EY
6	1.2DL+1.2SDL+1.2LL1.2LL>3-1.2WY	17	1.5DL+1.5SDL+1.5SPECX	28	1.5DL+1.5SDL-1.5EY
7	1.5DL+1.5SDL+1.5WX	18	1.5DL+1.5SDL+1.5SPECY	29	1.2 DL+1.2SDL+1.2LL+1.2LL >3+1.2EX
8	1.5DL+1.5SDL-1.5WX	19	0.9DL+0.9SDL+1.5SPECX	30	1.2 DL+1.2SDL+1.2LL+1.2LL >3+1.2EX
9	1.5DL+1.5SDL+1.5WY	20	0.9DL+0.9SDL+1.5SPECY	31	1.2 DL+1.2SDL+1.2LL+1.2LL >3-1.2EX
10	1.5DL+1.5SDL-1.5WY	21	0.9DL+0.9SDL+1.5EX	32	1.2 DL+1.2SDL+1.2LL+1.2LL >3-1.2EX
11	0.9DL+0.9SDL+1.5WX	22	0.9DL+0.9SDL-1.5EX		

Where,

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1) 0.9,1.2,1.5 are load factors
2) DL = Dead Load
3) LL = Live Load
4) SDL = Super Dead Load
5) WX = Wind Load in X direction
6) WY = Wind Load in Y direction
7) EX = Static Seismic Load in Y direction
8) EY = Static Seismic Load in Y direction
9) SPECX = Dynamic Seismic Load in X direction 10) SPECY = Dynamic Seismic Load in Y direction

12. FOUNDATION DESIGN

Type of Foundation	Pile Foundation
Grade of concrete	M30
Grade of steel	Fe500
Concrete cover	50mm
Soil Type	II (Medium soil)
Pile capacity recommended by GEOTECH consultant	450mm Dia. = 79 Tonne 500mm Dia. = 98 Tonne 600mm Dia. = 129 Tonne
Soil spring type	Point Spring

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