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STABILITY CERTIFICATE

(to be furnished while filling application for registration of building)

It is certified that the proposed construction of two blocks, namely Block No.1 is Stilt + 9 and 10th floor part and Block-2 is Stilt + 12 floor in "GOLDEN TOWER" situate at New Kumaran Nagar Main Road, Sholinganallur Village, Chennai comprised in S.No. 270/1 admeasuring Acre 1 26 cents of land is designed to resist earthquake. Check has been made and found safe and I hereby certify that;

1. The minimum grade of concrete is M30 for all RCC work.

2. The design and analysis using the code of practice for plain and reinforced concrete as per IS 456, Design Loads as per IS 875 and Design of Earthquake resistant Structure as per IS 1893- Part 1 and carried out.

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

Encl: Structural Design Calculation

24/10/24

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

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Ammapet, Salem-636003

MRN ASSOCIATES

STRUCTURAL DESIGN CALCULATION REPORT

PROPOSED RESIDENTIAL APARTMENTS (G+9)
AT SHOLINGANALLUR, KANCHEEPURAM, INDIA.

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

DESIGN BRIEF OF RESIDENTIAL BUILDING

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A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

1.0 STRUCTURAL DESIGN BASIS

1.1 INTRODUCTION

This Report describes in brief the Structural aspects and Design Philosophy. The Report also deals with considerations relating to seismic design of the building in addition to the structural system of the building.

The structural design is primarily based on the current Indian Codes of practice.

The objective of this document is to present an abstractive view about the structural engineering aspects of the project, like building system its analysis and design methodology. The document highlights the structural concept and the adopted design philosophy.

The structural design of the project has been governed by the architectural concept and the requirement for services. 3D wire frame models of the building are generated and analyzed for various loads and load combinations using ETABS design software. The loads and load combinations were considered as per relevant IS codes.

1.2 STRUCTURAL SCHEME

The structural system adopted is as below, based on preliminary analysis and design, which have been elucidated later in this report: The buildings are RC framed structures are as follows,

- The **PROPOSED RESIDENTIAL APARTMENT** consists of G+9 Floors
- The analysis and design are done using ETABS software.
- Slabs and beam are designed as conventional beam & slabs arrangement.

1.3 ALL DESIGN WORK SHALL BE BASED ON FOLLOWING IS CODE LATEST REVISIONS WITH AMENDMENTS IF ANY, AS ON DATE.

S.NO.	CODE	TITLE
1.	IS: 456: 2000	Code of practice for plain and Reinforced Concrete
2.	IS: 1893: 2016 Part 1	Criteria for Earthquake Resistant Design of structures
3.	IS: 875: 1987 Part 1,2and 5	Code of practice for Design Loads (other than Earthquake) for Building and structures
4.	IS: 875: 2016 Part 3	Code of Practice for Design Loads – Part 3 Wind Loads
5.	IS: 1080: 1985	Design and construction of shallow foundations in soils (other than Raft, Ring & Shell)
6.	IS: 1904: 2021	Design and construction of foundations in soils General Requirements
7.	IS: 8009: 1976 Part 1	Calculation of settlement of shallow foundation
8.	IS: 3370: 2021 Part 1,2,3	Code of Practice for Concrete Structures for the Storage of Liquids

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

9.	SP: 16	Handbook on Design Aids for reinforcement and detailing
10.	IS: 800- 2007	Code of Practice for General Construction in Steel
11.	IS 13920: 2016	Ductile detailing of Reinforced Concrete.
12.	IS 4326: 2013	Earthquake Resistant Design and Construction of Buildings
13.	IS:1905-1987	Code of practice for use of unreinforced masonary
14.	IS:1343: 2012	Code of practice for Prestressed Concrete
15.	IS 16700: 2017	Criteria for Structural Safety of Tall buildings
16.	IS 2950: 1981	Code of Practice for Design & Construction of Raft Foundation
17.	IS 6313: 2022 Part 2	Code of Practice for Technical Specification for building Foundation Treatment.
18.	IS 2911: 2010 Part 1	Code of Practice for Technical Specification for building Pile Foundation

1.4 DESIGN BASIS

1.4.1 General

The structure of the project is designed in accordance with the Indian Code IS: 456-2000, IS 800 -2007 & IS 13920-2016, which is considered mandatory for concrete and steel.

1.5 GRADE OF CONCRETE AND COVER TO THE REINFORCEMENT ACCORDING TO THE PROVISIONS OF THE INDIAN CODE

The appropriate grade of concrete and nominal cover to reinforcement is governed by the following main considerations:

i) Durability of Concrete
ii) Corrosion Protection of the Reinforcement
iii) Bar Size
iv) Nominal maximum aggregate size
v) Fire Resistance

The Indian Code IS: 456-2000, permits a minimum grade of concrete for reinforced concrete members as M25 and the following nominal cover to all reinforcement for "normal" conditions (clause 26.4 of the code)

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

1.6 REINFORCEMENT

The following types of reinforcement bars are used:

1.	High Yield Strength Deformed Bars (TMT) (fy = 500 N/sq mm)	To conform to IS: 1786-2008

Reinforcement Bars of 8, 10, 12, 16, 20, and 25 & 32mm dia only are used for the project. Only lapped splices shall be used. Welded splices or mechanical couplers shall not be used for splicing of reinforcement. Except for 32 mm dia, which shall be welded or mechanically splices as per IS 456, Amendment No.3.

1.7 STRUCTURAL DIMENSIONING

In addition to the requirements governed by loads and forces the minimum structural dimensions are also governed by other considerations like size of aggregates, reinforcement detailing, etc.

1.8 FOUNDATION SYSTEM:

Cast-in-situ pile foundation is adopted, and the foundation form is cap foundation.

This project adopts dry operation bored piles, and the pile length is 13 meters. The pile diameter is 600mm, and the characteristic value of the vertical bearing capacity of a single pile is Ra=750kN.

Since, chlorides and sulphates are well within the permissible limits, no special steel or cement is required for the construction

The results of the soil investigation report are as mentioned below –

S.No	Block Name	Pile Diameter	Pile Length	Bearing Capacity
1	**BLOCK-1**	600mm	13m	750kN

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammanu[illegible]

2.0 CONSTRUCTION MATERIALS

2.1 CONCRETE

Concrete mix design grades of specified cube strength to satisfy codal norms, will be adopted as per design requirement of the structure. The following grade of concrete is used in the design of RCC Building

S. No.	Element	Concrete Grade
1	Pile & Pile Cap	M30
2	Beams	M30
3	Shear Wall	M30
4	Slab	M30
5	PCC	M15

Minimum cement content, water cement ratio etc. shall conform to IS 456:2000 provisions for durability and strength criteria.

2.2 CEMENT

Chemical and physical requirements for Ordinary Portland Cement of Grade 43, Grade 53 and Portland Pozzolana Cement shall be in accordance with IS 8112, IS 12269, IS 1489 (Part1) respectively.

2.3 AGGREGATE

2.3.1 FINE AGGREGATE:

Fine aggregate shall be clean hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with IS 383. The material shall pass through a 4.75 mm IS sieve and the grading shall be in accordance with IS 383.

2.3.2 COARSE AGGREGATE:

Coarse aggregate shall be clean hard and durable crushed rock, crushed gravel or natural gravel.

It shall be graded aggregate of nominal size 20 mm and 12 mm in accordance with IS 383.

2.4 ADMIXTURES AND ADDITIVES

Admixtures of approved quality shall be mixed with concrete conforming to IS 9103. Self-compacting agents shall be used to enhance the performance of concrete in both fresh and hardened state.

2.5 WATER

Water used for mixing and curing shall be clean and free from injurious quantities of alkalis, acids, oils, salts, sugar, organic materials, vegetable growth or other substance that may be deleterious to bricks, stone, concrete or steel and shall comply with the requirements of IS 456:2000. The pH value of water shall be not less than 6.

2.6 REINFORCEMENT

For design of concrete elements, High Yield Strength Deformed (HYSD) having yield strength of 500 MPa and minimum percentage elongation of 14.5% shall be used. It shall conform to IS 1786:2008..

2.7 AAC Blocks

For masonry works, Autoclaved Cellular Aerated Concrete (AAC) blocks having compressive strength of 5kN/m2 shall be used. It shall conform to IS 2185(Part 3):1984 & IS 6041:1985.

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

3.0 LOAD CALCULATION AND LOAD COMBINATION

3 DESIGN LOADS:

- Dead Load (DL)
- Superimposed dead load (SDL)
- Live load (LL)
- Seismic load (EQ/Spec)
- Wind load (WL)

3.1 DEAD LOAD:

Self weight of the materials shall be calculated on the basis of unit weights given in **(IS: 875 PART I).**

- Unit weight of Plain cement concrete - 24.00kN / m^3.
- Unit weight of Reinforced cement concrete - 25.00kN / m^3.
- Unit weight of brick wall - 20.00kN / m^3.
- Unit weight of Light block wall - 8.00kN / m^3.
- Unit weight of Solid block wall - 24.00kN / m^3.
- Unit weight of steel - 78.50kN / m^3.
- Floor finish considered - 1.00 kN / m^2.

3.2 SUPERIMPOSED DEAD LOADS (SDL)

- Thickness of the floor finish mortar & plastering - 1.50 kN / m^2.
- Thickness of the floor tiles - 0.50 kN / m^2.
- Thickness of the filling - 2.00 kN / m^2.
- Thickness of the floor tiles and finishes - 1.00 kN / m^2.

3.3 LIVE LOAD:

On the basis of intended occupancy and use, the loading shall be based on **IS: 875 (PART II).**

- Rooms -2.0KN/m^2.
- Toilet -2.0KN/m^2.
- Stairs, Balcony & Corridors -3 kN/m^2.
- Elevator room -10.00kN/m^2.
- Terraces -2.5kN/m^2.

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE/GR 1/19/07/177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

3.4 WIND LOAD:

Wind loads for design of structures shall be based on the design wind speeds arrived based on **IS: 875 (PART III).**

The parameters for calculation of design wind speed as per **IS: 875 (PART III)** are as follows:

- Basic wind speed (V_b) - 50 m/sec
- Risk Coefficient, K1
- (If design life of structure is taken as 50 yrs) - 1.0
- Terrain, Height, Structure Size factor, K2 - To suit the height of the structure for terrain category-2 and class C
- Topography factor, K3 - 1.0
- Design wind speed (Vz) - Vb x K1 x K2 x K3
- Design wind pressure (Pz) - 0.6 Vz^2

The design life span of all structures shall be taken as 50 years.

3.5 SEISMIC LOAD:

Seismic design methodology

The design methodology adopted is that contained within Indian Standard IS 1893:(Part 1):2016 "Criteria for earthquake resistant design of structures". Essentially the weight of the entire building, the "seismic weight", is determined and the lateral earthquake load at the base of this building, the "base shear" computed. This "base shear" force is then redistributed to each floor level according to the mass at that level and its height above the base. This force is then applied to the floor slabs and columns at that level considering design eccentricity as per IS: 1893 –2016.

The base shear is determined by multiplying the building seismic weight by a parameter called the horizontal seismic coefficient "Ah", which is given by the formula:

$$A_h = \frac{Z.I.\ S_a}{2.\ R.g}$$

The other parameters in this formula are:

Z	=	Seismic zone factor
I	=	building importance factor
R	=	building response reduction factor
Sa/g	=	average response acceleration Coefficient

3.5.1 SEISMIC ZONE:

India is divided into four seismic zones (zones II to V) according to the anticipated intensity of earthquake. The zonal map of India has been updated following the Bhuj earthquake of January 2001 and this revision is reflected in IS 1893: (Part 1): 2016. The seismic zones are illustrated in Figure 3 of IS 1893: (Part 1): 2016,

As per IS: 1893 – 2016, Kancheepuram lies within zone III and so the parameter "Z" is given as 0.16 for this location.

3.5.2 TIME PERIOD:

RCC Block – Time Period			
S.No.	Block No	Time Period	
		X direction	Y direction
1.	Block-1	0.47	0.73

3.5.3 IMPORTANCE FACTOR:

The Indian Standard gives two values for the importance factor "I". One is applicable to important service and community buildings such as hospitals, schools, emergency buildings, power stations etc.; and the other applies to "all other buildings". The proposed Admin building falls in the former category and so the importance factor "I" is given as 1.2

3.5.4 RESPONSE REDUCTION FACTOR:

The value of this parameter depends upon the nature of the building structure. As this is to be SMRF, relying on RC columns for stability, the value of "R" is given by the standard as 4.0

3.5.5 AVERAGE RESPONSE ACCELERATION COEFFICIENT:

The average response acceleration coefficient "Sa/g" is determined by the nature of the founding soil and the natural period of vibration of the building. The building is to be founded on a "soft disintegrated rock". The value Sa is found in terms of g.

The Response spectrum method is used for Seismic Analysis. Ductile detailing will be adopted as per IS: 13920 – 2016.

3.6 GRAVITY LOADS

Gravity loads develop by virtue of self-weight of the structure and superimposed loads due to occupancy, architectural features, services, etc. Resistance to gravity loads shall be provided by concrete slabs supported by a network of beams. Beams will transfer the loads to vertical elements like columns and walls.

3.7 LATERAL LOADS

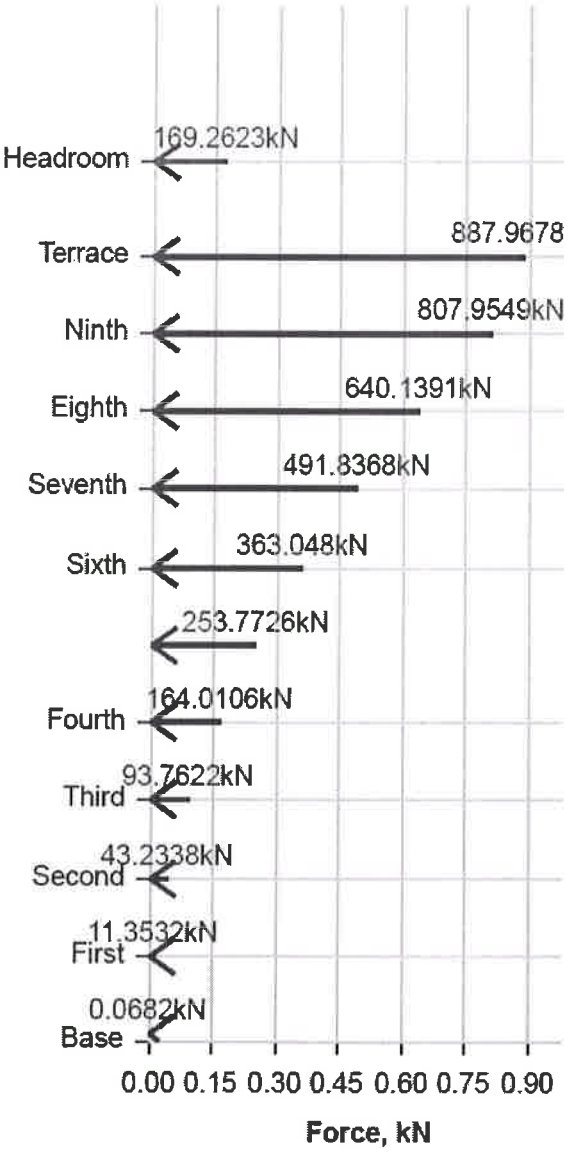
Lateral loads on the structure develop primarily due to wind and seismic activity. Resistance to lateral loads shall be provided by reinforced concrete ductile shear walls

Design of shear walls and columns will incorporate ductile reinforcement detailing in accordance with IS 13920:2016.

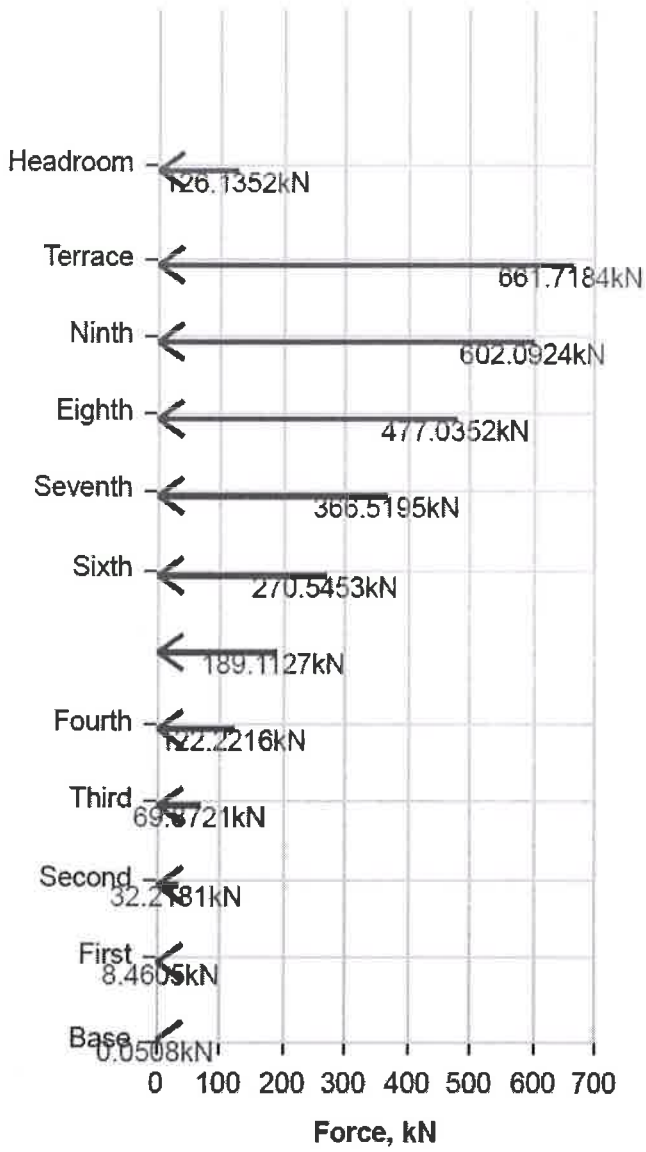
Design for seismic loads shall be based on response spectrum analysis of the three-dimensional model of the structures as per IS 1893: 2016. Design for wind loads shall be based on IS 875:2015-PART -III.

Retaining walls and all other sub-structure members shall be designed based on the soil parameters specified in geo-technical report, with the aid of in-house design spreadsheets.

Lateral Load to Stories - X



Lateral Load to Stories - Y



A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

3.8 DESIGN LOAD COMBINATIONS:

The building is designed using the limit state method with appropriate load factors as per **IS: 456-2000.IS875-part-v**

The load combinations are as follows:

S. No.	Load Combination	Load Factors					
		DL	LL	WLX	WLY	Scaled	
						SpecX	SpecY
1.	1.5 (DL+LL)	1.5	1.5	-	-	-	-
2.	1.2 (DL+LL±SpecX)	1.2	1.2	-	-	±1.2	-
3.	1.2 (DL+LL±SpecY)	1.2	1.2	-	-	-	± 1.2
4.	1.5 (DL ± SpecX)	1.5	-	-	-	±1.5	-
5.	1.5 (DL ± SpecY)	1.5	-	-	-	-	± 1.5
6.	0.9 DL ± 1.5(SpecX)	0.9	-	-	-	±1.5	-
7.	0.9 DL ± 1.5(SpecY)	0.9	-	-	-	-	± 1.5
8.	1.2 (DL+LL ± WLX)	1.2	1.2	±1.2	-	-	-
9.	1.2 (DL + LL ± WLY)	1.2	1.2	-	±1.2	-	-
10.	1.5 (DL ± WLX)	1.5	-	±1.5	-	-	-
11.	1.5 (DL ± WLY)	1.5	-	-	±1.5	-	-
12.	0.9 DL ± 1.5WLX	0.9	-	±1.5	-	-	-
13.	0.9 DL ± 1.5 WLY	0.9	-	-	±1.5	-	-

Where

- DL - Dead Load
- LL - Live Load
- WLX, WLY - Wind load in X and Y direction.
- SpecX, SpecY - Seismic load in X and Y direction.

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

3.8.1 SERVICEABILITY LOAD COMBINATIONS:

The load combinations are as follows:

S. No.	Load Combination	Load Factors					
		DL	LL	WLX	WLY	SpecX	SpecY
1.	1.0 (DL + LL)	1.0	1.0	-	-	-	-
2.	1.0DL+0.8LL±0.8SpecX	1.0	0.8	-	-	± 0.8	-
3.	1.0DL+0.8LL±0.8SpecY	1.0	1.0	-	-	-	± 0.8
4.	1.0 (DL ± SpecX)	1.0	-	-	-	± 1.0	-
5.	1.0 (DL ± SpecY)	1.0	-	-	-	-	± 1.0
6.	1.0 (DL ± WLX)	1.0	-	± 1.0	-	-	-
7.	1.0 (DL ± WLY)	1.0	-	-	± 1.0	-	-
8.	1.0 DL + 0.8 LL ± 0.8 WLX	1.0	0.8	± 0.8	-	-	-
9.	1.0 DL + 0.8 LL ± 0.8 WLY	1.0	0.8	-	± 0.8	-	-

Where

- DL - Dead Load
- LL - Live Load
- WLX, WLY - Wind load in X and Y direction.
- SpecX, SpecY - Seismic load in X and Y direction.

Suffixes X, Y and Z in the above table indicate the direction in which the force is applied.

All members will be designed for the largest value of the design forces obtained due to positive as well as negative values of reversible combination of forces (Earthquake and wind).

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

3.9 DURABILITY AND FIRE RESISTANCE

Concrete cover requirement for a fire rating of 2 hours for Shear wall/Columns, beams and slabs shall be as follows:

S. No.	Element	Cover Adopted (mm)
a	Pile cap at bottom	75
b	Pile cap on other side	50
c	Beams & Shear walls	30
d	Slabs	25

Minimum dimensions of reinforced concrete members for fire 2hr resistance shall be as follows:

S. No.	Element	Minimum thickness (mm)(Fire Criteria)	Minimum reinforcement
1	Shear wall	200	**0.25 % of cross section area**
2	Floor Slabs	120	**0.12% of cross section area**
3	Floor Beams	200	**0.283% c/s area for Ductile beams** **0.17 % of c/s area for Non-Ductile beams**

Minimum water cement ratio and minimum cement content shall confirm to IS 456:2000 provisions of durability and strength.

3.10 CONTROL OF DEFLECTION

In order to control deflection of structural elements, two alternative methods in the Serviceability Limit State Design are envisaged in the code. The first is by way of calculating the actual deflection as per clause 23.2 (a), (b) of IS:456-2000 and restricting it to specified values. The second method envisages "deemed-to-satisfy" provisions such as limiting the span / depth ratio as per 23.2.1 of IS:456-2000.

The first method indicated above is possible as the output in terms of joint displacements can be and are obtained from ETABS and checked to satisfy that deflection is under control.

• **Short term deflection due to SDL+ Live load**	**<L /350 or 20 mm whichever is less**
• **Long term deflection**	< L /250

Creep coefficients shall be taken as:

7 days	**2.2**
• Shrinkage coefficient	0.0003

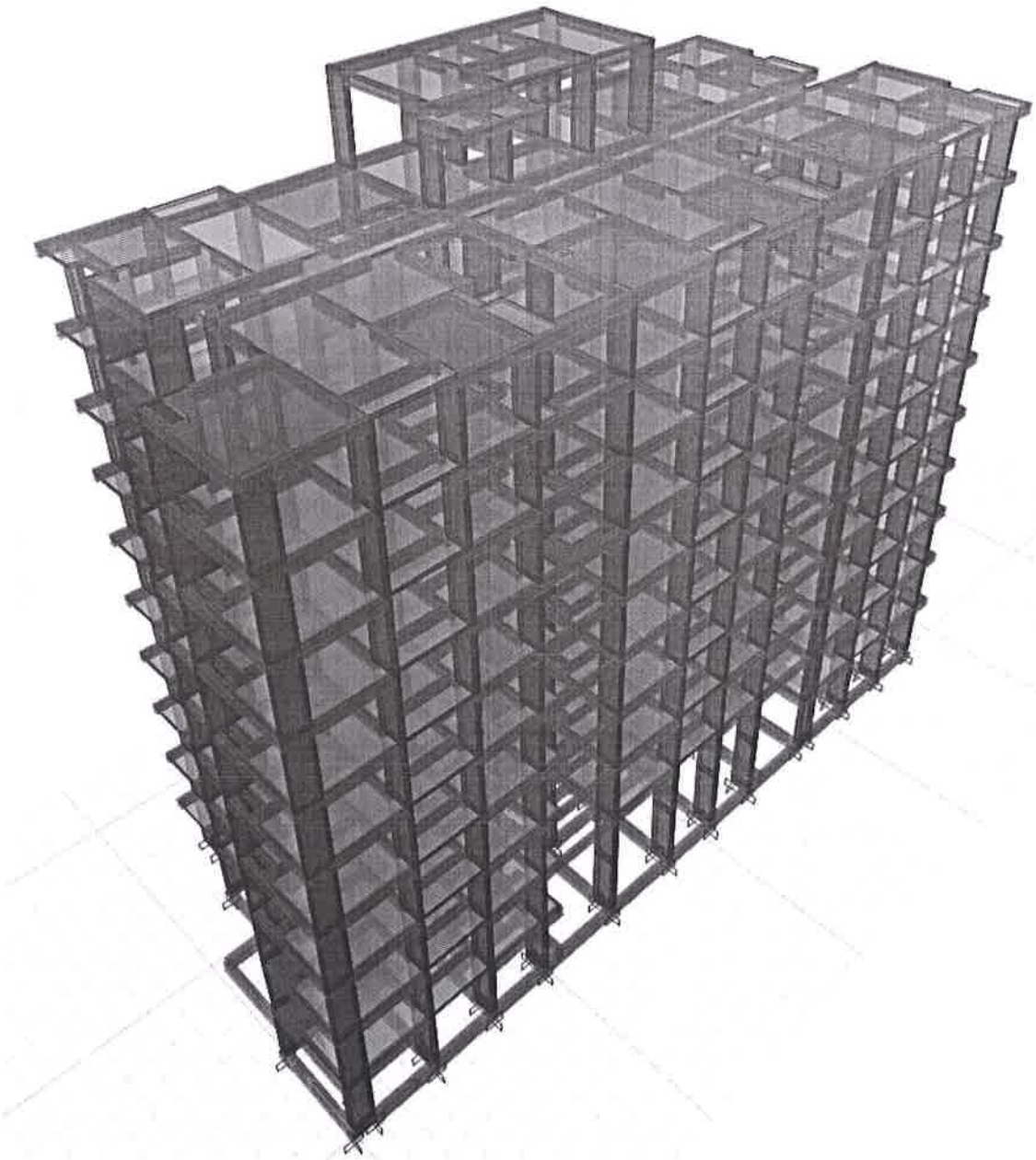
3.11 CONTROL OF CRACKING

In order to avoid excessive cracking in the flexural members, maximum diameter and spacing of the reinforcement is restricted as per the detailing rules indicated in clause 26.3 of IS:456-2000, The detailing rules incorporated in the design are considered as "deemed-to-satisfy" provision. Therefore, no separate calculations relating to crack width shall be made.

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

4. ANALYSIS:

1. The structure is idealized as 3D frame and analyzed using Software Package (ETABS) for both Vertical and Lateral loads.



2. The lateral loads include wind loads and earthquake loads.
3. Seismic loads of moderate intensity of Zone III are considered for analysis and design purpose.
4. Forces and moments from the 3-dimensional analysis output for the critical combination are used for the design of the structure. The foundation is designed for critical un-factored load combinations.
5. The super structure members are designed for actual flexure, shear and other forces.
6. The structure is analyzed for specific loads (Dead and Live loads) and for the load combinations as given in the relevant codes.
7. The bottoms of all the columns are assumed to be fixed being independent footing.

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

4.1 Input

4.1.1 Story Data

Table 4.1 - Story Definitions

Tower	Name	Height m	Master Story	Similar To	Splice Story	Color
T1	Headroom	3.6	No	None	No	White
T1	Terrace	3	No	Second	No	White
T1	Ninth	3	No	Second	No	White
T1	Eighth	3	No	Second	No	White
T1	Seventh	3	No	Second	No	White
T1	Sixth	3	No	Second	No	White
T1	Fifth	3	No	Second	No	White
T1	Fourth	3	No	Second	No	White
T1	Third	3	No	Second	No	White
T1	Second	3	Yes	None	No	White
T1	First	3	No	None	No	Gray8Dark
T1	Plinth	0.3	No	None	No	Blue

4.1.2 Line Connectivity

Table 4.2 - Beam Bays

Label	PointBayI	PointBayJ
B1	1	11
B2	117	99
B3	3	22
B4	243	171
B5	189	47
B6	162	163
B7	9	169
B8	26	95
B9	94	97
B10	208	20
B11	30	165
B12	166	88
B13	91	84
B14	167	168
B15	25	104
B16	5	2
B17	174	112
B18	148	113
B19	106	109
B20	173	48
B21	50	213
B22	214	54
B23	70	64
B24	124	123
B25	175	176
B26	176	177
B27	177	178
B28	178	179
B29	179	180
B30	180	181

Label	PointBayI	PointBayJ
B31	181	182
B32	182	183
B33	184	185
B34	186	187
B35	188	189
B36	46	190
B37	191	192
B38	83	125
B39	120	193
B40	193	194
B41	194	195
B42	195	196
B43	196	197
B44	197	198
B45	198	199
B46	130	127
B47	128	131
B48	134	133
B49	200	201
B50	201	202
B51	138	137
B52	140	139
B53	203	141
B54	144	143
B55	68	67
B56	69	14
B57	152	155
B58	15	165
B59	206	205
B60	156	207
B61	14	305
B62	209	210
B63	210	211
B64	212	83
B65	32	212
B66	34	75
B67	74	79
B68	165	290
B69	213	214
B70	327	328
B71	55	51
B72	192	280
B73	199	281
B74	185	283
B75	62	215
B76	329	330
B77	40	63
B78	42	61
B79	60	217
B80	58	72
B81	44	59
B82	218	219

Label	PointBayI	PointBayJ
B83	219	220
B85	36	77
B86	76	81
B87	38	222
B88	223	57
B89	7	6
B90	226	227
B91	86	228
B92	8	12
B93	13	15
B94	15	16
B95	17	18
B96	18	19
B97	171	172
B98	102	298
B99	53	71
B100	52	82
B101	82	29
B103	154	183
B104	110	89
B105	114	111
B106	118	115
B107	170	119
B108	224	225
B109	230	229
B110	231	230
B111	232	145
B112	233	234
B113	236	235
B114	238	237
B115	240	239
B116	241	242
B117	204	335
B118	116	244
B119	146	245
B120	246	247
B121	249	248
B122	251	250
B123	253	252
B124	254	253
B126	339	173
B128	341	107
B129	163	342
B130	268	269
B131	271	270
B132	277	129
B133	279	278
B134	228	284
B135	22	184
B136	185	186
B137	186	188
B139	190	191

Label	PointBayI	PointBayJ
B141	283	166
B142	56	285
B143	286	58
B144	287	288
B145	221	289
B147	290	291
B148	13	16
B153	291	293
B154	294	295
B155	295	296
B156	371	70
B157	296	293
B160	300	299
B161	164	374
B162	302	303
B163	303	304
B165	307	306
B166	308	302
B167	375	221
B168	216	376
B169	299	294
B170	98	309
B171	96	310
B172	78	311
B173	80	312
B174	220	313
B175	73	314
B176	217	315
B177	316	226
B178	318	317
B179	320	319
B180	321	322
B181	322	323
B182	324	325
B183	325	326
B186	331	332
B187	334	333

4.1.3 Area Connectivity

Table 4.3 - Floor Bays

Label	NumPoints	PointNumber	PointBay
F1	4	1	17
F1		2	18
F1		3	171
F1		4	243
F2	4	1	18
F2		2	19
F2		3	172
F2		4	171
F3	4	1	263
F3		2	102
F3		3	18
F3		4	264
F4	4	1	102
F4		2	169
F4		3	19
F4		4	18
F5	4	1	175
F5		2	176
F5		3	244
F5		4	172
F6	4	1	173
F6		2	174
F6		3	176
F6		4	175
F7	4	1	167
F7		2	173
F7		3	169
F7		4	168
F8	4	1	53
F8		2	82
F8		3	29
F8		4	176
F9	4	1	174
F9		2	52
F9		3	82
F9		4	53
F10	4	1	82
F10		2	71
F10		3	177
F10		4	29
F11	4	1	194
F11		2	195
F11		3	202
F11		4	200
F12	4	1	233
F12		2	241
F12		3	242
F12		4	181
F13	4	1	241

Label	NumPoints	PointNumber	PointBay
F13		2	234
F13		3	182
F13		4	242
F14	4	1	182
F14		2	183
F14		3	204
F14		4	245
F15	4	1	208
F15		2	206
F15		3	205
F15		4	204
F16	4	1	209
F16		2	210
F16		3	207
F16		4	208
F17	4	1	210
F17		2	258
F17		3	257
F17		4	207
F18	4	1	197
F18		2	198
F18		3	183
F18		4	182
F19	4	1	198
F19		2	199
F19		3	210
F19		4	209
F20	4	1	7
F20		2	2
F20		3	14
F20		4	6
F21	4	1	1
F21		2	22
F21		3	2
F21		4	5
F22	4	1	8
F22		2	12
F22		3	163
F22		4	162
F23	4	1	164
F23		2	166
F23		3	88
F23		4	163
F24	7	1	2
F24		2	14
F24		3	6
F24		4	7
F24		5	5
F24		6	1
F24		7	22
F25	4	1	268
F25		2	83

Label	NumPoints	PointNumber	PointBay
F25		3	193
F25		4	269
F26	7	1	218
F26		2	190
F26		3	248
F26		4	221
F26		5	250
F26		6	251
F26		7	249
F27	4	1	203
F27		2	232
F27		3	196
F27		4	195
F28	4	1	232
F28		2	271
F28		3	270
F28		4	196
F29	4	1	216
F29		2	62
F29		3	215
F29		4	217
F30	4	1	246
F30		2	247
F30		3	217
F30		4	70
F31	7	1	186
F31		2	187
F31		3	115
F31		4	228
F31		5	119
F31		6	170
F31		7	118
F32	4	1	190
F32		2	191
F32		3	247
F32		4	246
F33	4	1	254
F33		2	253
F33		3	63
F33		4	216
F34	4	1	253
F34		2	256
F34		3	255
F34		4	63
F35	4	1	191
F35		2	192
F35		3	253
F35		4	254
F36	4	1	218
F36		2	190
F36		3	248
F36		4	249

Label	NumPoints	PointNumber	PointBay
F37	4	1	219
F37		2	221
F37		3	70
F37		4	220
F38	4	1	201
F38		2	202
F38		3	180
F38		4	179
F39	4	1	251
F39		2	248
F39		3	221
F39		4	250
F40	4	1	223
F40		2	226
F40		3	227
F40		4	214
F41	4	1	231
F41		2	230
F41		3	222
F41		4	223
F42	4	1	230
F42		2	260
F42		3	259
F42		4	222
F43	4	1	188
F43		2	189
F43		3	230
F43		4	231
F44	4	1	224
F44		2	225
F44		3	214
F44		4	213
F45	4	1	187
F45		2	188
F45		3	225
F45		4	224
F46	4	1	186
F46		2	187
F46		3	115
F46		4	118
F47	4	1	212
F47		2	228
F47		3	213
F47		4	83
F48	4	1	170
F48		2	115
F48		3	228
F48		4	119
F49	4	1	184
F49		2	185
F49		3	15
F49		4	13

Label	NumPoints	PointNumber	PointBay
F50	4	1	13
F50		2	15
F50		3	165
F50		4	164
F51	4	1	15
F51		2	262
F51		3	261
F51		4	165
F52	4	1	277
F52		2	194
F52		3	193
F52		4	83
F53	4	1	277
F53		2	203
F53		3	195
F53		4	194
F54	4	1	193
F54		2	194
F54		3	178
F54		4	177
F55	4	1	195
F55		2	196
F55		3	181
F55		4	180
F56	4	1	22
F56		2	184
F56		3	12
F56		4	8
F57	4	1	192
F57		2	280
F57		3	252
F57		4	253
F58	4	1	199
F58		2	281
F58		3	211
F58		4	210
F59	4	1	189
F59		2	282
F59		3	229
F59		4	230
F60	4	1	185
F60		2	283
F60		3	16
F60		4	15
F61	4	1	318
F61		2	317
F61		3	178
F61		4	177
F62	4	1	320
F62		2	319
F62		3	181
F62		4	180

Label	NumPoints	PointNumber	PointBay
F63	6	1	19
F63		2	172
F63		3	171
F63		4	18
F63		5	102
F63		6	169
F64	6	1	53
F64		2	82
F64		3	71
F64		4	177
F64		5	29
F64		6	176
F65	6	1	233
F65		2	241
F65		3	234
F65		4	182
F65		5	242
F65		6	181
F66	6	1	210
F66		2	207
F66		3	208
F66		4	209
F66		5	198
F66		6	199
F67	6	1	253
F67		2	63
F67		3	216
F67		4	254
F67		5	191
F67		6	192
F68	6	1	230
F68		2	222
F68		3	223
F68		4	231
F68		5	188
F68		6	189
F69	6	1	184
F69		2	185
F69		3	15
F69		4	165
F69		5	164
F69		6	13
F70	4	1	324
F70		2	325
F70		3	322
F70		4	321
F71	4	1	325
F71		2	326
F71		3	333
F71		4	334
F72	4	1	200
F72		2	201

Label	NumPoints	PointNumber	PointBay
F72		3	179
F72		4	178

Table 4.4 - Wall Bays

Label	NumPoints	PointNumber	PointBay	PointStory
W1	4	1	298	Below
W1		2	301	Below
W1		3	301	Same
W1		4	298	Same
W2	4	1	112	Below
W2		2	116	Below
W2		3	116	Same
W2		4	112	Same
W3	4	1	113	Below
W3		2	146	Below
W3		3	146	Same
W3		4	113	Same
W4	4	1	183	Below
W4		2	150	Below
W4		3	150	Same
W4		4	183	Same
W5	4	1	335	Below
W5		2	158	Below
W5		3	158	Same
W5		4	335	Same
W6	4	1	104	Below
W6		2	117	Below
W6		3	117	Same
W6		4	104	Same
W7	4	1	4	Below
W7		2	3	Below
W7		3	3	Same
W7		4	4	Same
W8	4	1	103	Below
W8		2	9	Below
W8		3	9	Same
W8		4	103	Same
W9	4	1	20	Below
W9		2	160	Below
W9		3	160	Same
W9		4	20	Same
W10	4	1	127	Below
W10		2	126	Below
W10		3	21	Same
W10		4	328	Same
W11	4	1	101	Below
W11		2	339	Below
W11		3	339	Same
W11		4	101	Same
W12	4	1	328	Same
W12		2	21	Same
W12		3	126	Same

Label	NumPoints	PointNumber	PointBay	PointStory
W12		4	127	Same
W13	4	1	48	Below
W13		2	120	Below
W13		3	120	Same
W13		4	48	Same
W14	4	1	105	Below
W14		2	341	Below
W14		3	341	Same
W14		4	105	Same
W15	4	1	24	Below
W15		2	25	Below
W15		3	25	Same
W15		4	24	Same
W16	4	1	27	Below
W16		2	26	Below
W16		3	26	Same
W16		4	27	Same
W17	4	1	342	Below
W17		2	91	Below
W17		3	91	Same
W17		4	342	Same
W18	4	1	31	Below
W18		2	30	Below
W18		3	30	Same
W18		4	31	Same
W19	4	1	33	Below
W19		2	32	Below
W19		3	32	Same
W19		4	33	Same
W20	4	1	35	Below
W20		2	34	Below
W20		3	34	Same
W20		4	35	Same
W21	4	1	37	Below
W21		2	36	Below
W21		3	36	Same
W21		4	37	Same
W22	4	1	39	Below
W22		2	38	Below
W22		3	38	Same
W22		4	39	Same
W23	4	1	41	Below
W23		2	40	Below
W23		3	40	Same
W23		4	41	Same
W24	4	1	43	Below
W24		2	42	Below
W24		3	42	Same
W24		4	43	Same
W25	4	1	45	Below
W25		2	44	Below
W25		3	44	Same

Label	NumPoints	PointNumber	PointBay	PointStory
W25		4	45	Same
W26	4	1	47	Below
W26		2	46	Below
W26		3	46	Same
W26		4	47	Same
W27	4	1	84	Below
W27		2	50	Below
W27		3	50	Same
W27		4	84	Same
W28	4	1	54	Below
W28		2	55	Below
W28		3	55	Same
W28		4	54	Same
W29	4	1	131	Below
W29		2	130	Below
W29		3	327	Same
W29		4	23	Same
W30	4	1	64	Below
W30		2	68	Below
W30		3	68	Same
W30		4	64	Same
W31	4	1	57	Below
W31		2	56	Below
W31		3	56	Same
W31		4	57	Same
W32	4	1	59	Below
W32		2	58	Below
W32		3	58	Same
W32		4	59	Same
W33	4	1	61	Below
W33		2	60	Below
W33		3	60	Same
W33		4	61	Same
W34	4	1	23	Same
W34		2	327	Same
W34		3	130	Same
W34		4	131	Same
W35	4	1	67	Below
W35		2	66	Below
W35		3	66	Same
W35		4	67	Same
W36	4	1	10	Below
W36		2	69	Below
W36		3	69	Same
W36		4	10	Same
W37	4	1	133	Below
W37		2	132	Below
W37		3	28	Same
W37		4	330	Same
W38	4	1	330	Same
W38		2	28	Same
W38		3	132	Same

Label	NumPoints	PointNumber	PointBay	PointStory
W38		4	133	Same
W39	4	1	72	Below
W39		2	73	Below
W39		3	73	Same
W39		4	72	Same
W40	4	1	75	Below
W40		2	74	Below
W40		3	74	Same
W40		4	75	Same
W41	4	1	77	Below
W41		2	76	Below
W41		3	76	Same
W41		4	77	Same
W42	4	1	79	Below
W42		2	78	Below
W42		3	78	Same
W42		4	79	Same
W43	4	1	81	Below
W43		2	80	Below
W43		3	80	Same
W43		4	81	Same
W44	4	1	135	Below
W44		2	134	Below
W44		3	329	Same
W44		4	85	Same
W45	4	1	85	Same
W45		2	329	Same
W45		3	134	Same
W45		4	135	Same
W46	4	1	87	Below
W46		2	86	Below
W46		3	86	Same
W46		4	87	Same
W47	4	1	51	Below
W47		2	371	Below
W47		3	371	Same
W47		4	51	Same
W48	4	1	137	Below
W48		2	136	Below
W48		3	90	Same
W48		4	332	Same
W49	4	1	332	Same
W49		2	90	Same
W49		3	136	Same
W49		4	137	Same
W50	4	1	95	Below
W50		2	94	Below
W50		3	94	Same
W50		4	95	Same
W51	4	1	97	Below
W51		2	96	Below
W51		3	96	Same

Label	NumPoints	PointNumber	PointBay	PointStory
W51		4	97	Same
W52	4	1	99	Below
W52		2	98	Below
W52		3	98	Same
W52		4	99	Same
W53	4	1	139	Below
W53		2	138	Below
W53		3	331	Same
W53		4	93	Same
W54	4	1	93	Same
W54		2	331	Same
W54		3	138	Same
W54		4	139	Same
W56	4	1	107	Below
W56		2	106	Below
W56		3	106	Same
W56		4	107	Same
W57	4	1	109	Below
W57		2	108	Below
W57		3	108	Same
W57		4	109	Same
W60	4	1	374	Below
W60		2	92	Below
W60		3	92	Same
W60		4	374	Same
W62	4	1	49	Below
W62		2	375	Below
W62		3	375	Same
W62		4	49	Same
W64	4	1	123	Below
W64		2	122	Below
W64		3	122	Same
W64		4	123	Same
W65	4	1	125	Below
W65		2	124	Below
W65		3	124	Same
W65		4	125	Same
W66	4	1	127	Below
W66		2	126	Below
W66		3	126	Same
W66		4	127	Same
W67	4	1	129	Below
W67		2	128	Below
W67		3	128	Same
W67		4	129	Same
W68	4	1	131	Below
W68		2	130	Below
W68		3	130	Same
W68		4	131	Same
W69	4	1	133	Below
W69		2	132	Below
W69		3	132	Same

Label	NumPoints	PointNumber	PointBay	PointStory
W69		4	133	Same
W70	4	1	135	Below
W70		2	134	Below
W70		3	134	Same
W70		4	135	Same
W71	4	1	137	Below
W71		2	136	Below
W71		3	136	Same
W71		4	137	Same
W72	4	1	139	Below
W72		2	138	Below
W72		3	138	Same
W72		4	139	Same
W73	4	1	141	Below
W73		2	140	Below
W73		3	140	Same
W73		4	141	Same
W74	4	1	143	Below
W74		2	142	Below
W74		3	142	Same
W74		4	143	Same
W75	4	1	145	Below
W75		2	144	Below
W75		3	144	Same
W75		4	145	Same
W77	4	1	149	Below
W77		2	148	Below
W77		3	148	Same
W77		4	149	Same
W79	4	1	153	Below
W79		2	152	Below
W79		3	152	Same
W79		4	153	Same
W80	4	1	155	Below
W80		2	154	Below
W80		3	154	Same
W80		4	155	Same
W81	4	1	157	Below
W81		2	156	Below
W81		3	156	Same
W81		4	157	Same
W84	4	1	376	Below
W84		2	65	Below
W84		3	65	Same
W84		4	376	Same

4.1.4 Mass

Table 4.5 - Mass Source Definition

Name	Is Default	Include Lateral Mass?	Include Vertical Mass?	Lump Mass?	Source Self Mass?	Source Added Mass?	Source Load Patterns?	Move Mass Centroid?	Load Pattern	Multiplier
MsSrc1	Yes	Yes	No	Yes	No	No	Yes	No	Dead	1
MsSrc1									Live	0.25
MsSrc1									SDL	1

Table 4.6 - Centers Of Mass And Rigidity

Story	Diaphragm	Mass X kg	Mass Y kg	XCM m	YCM m	Cum Mass X kg	Cum Mass Y kg	XCCM m	YCCM m	XCR m	YCR m
First	D1	504731.66	504731.66	19.763	8.3216	504731.66	504731.66	19.763	8.3216	19.2724	7.62
Second	D2	556670.44	556670.44	19.6638	7.5264	556670.44	556670.44	19.6638	7.5264	19.3439	7.619
Third	D3	554437.92	554437.92	19.6668	7.5489	554437.92	554437.92	19.6668	7.5489	19.4106	7.6309
Fourth	D4	554437.92	554437.92	19.6668	7.5489	554437.92	554437.92	19.6668	7.5489	19.4548	7.6224
Fifth	D5	554437.92	554437.92	19.6668	7.5489	554437.92	554437.92	19.6668	7.5489	19.5499	7.6154
Sixth	D6	554437.92	554437.92	19.6668	7.5489	554437.92	554437.92	19.6668	7.5489	19.6663	7.6267
Seventh	D7	554437.92	554437.92	19.6668	7.5489	554437.92	554437.92	19.6668	7.5489	19.776	7.6458
Eighth	D8	554437.92	554437.92	19.6668	7.5489	554437.92	554437.92	19.6668	7.5489	19.8707	7.6666
Ninth	D9	554437.92	554437.92	19.6668	7.5489	554437.92	554437.92	19.6668	7.5489	19.9528	7.6868
Terrace	D10	495588.1	495588.1	19.6533	7.6572	495588.1	495588.1	19.6533	7.6572	20.0222	7.7031
Headroom	D11	0	0	19.1331	12.9662	0	0	0	0	19.9186	8.603
Headroom	D12	80622.63	80622.63	19.2904	12.1047	80622.63	80622.63	19.2904	12.1047	19.7971	9.6514

4.1.5 Materials

Table 4.7 - Material Properties - General

Material	Type	SymType	Grade	Color	Notes
A416Gr270	Tendon	Uniaxial	Grade 270	Magenta	
Fe250	Steel	Isotropic	Fe250	Gray8Dark	
HYSD500	Rebar	Uniaxial	HYSD Grade 500	Red	
M30	Concrete	Isotropic	M30	Green	

4.1.6 Frame Sections

Table 4.8 - Frame Section Property Definitions - Summary (Part 1 of 3)

Name	Material	Shape	Color	Area cm2	J cm4	I33 cm4	I22 cm4	As2 cm2	As3 cm2	S33Pos cm3
B200x200	M30	Concrete Rectangular	White	400	22533.3	13333.3	13333.3	333.3	333.3	1333.3
B200x450	M30	Concrete Rectangular	Magenta	900	86509.3	151875	30000	750	750	6750
B200x600	M30	Concrete Rectangular	Yellow	1200	126434.6	360000	40000	1000	1000	12000
B200x750	M30	Concrete Rectangular	Blue	1500	166414.2	703125	50000	1250	1250	18750
B300x450	M30	Concrete Rectangular	Gray8Dark	1350	237700	227812.5	101250	1125	1125	10125
B300x600	M30	Concrete Rectangular	Blue	1800	370785.9	540000	135000	1500	1500	18000

Table 4.9 - Frame Section Property Definitions - Summary (Part 2 of 3)

Name	S33Neg cm3	S22Pos cm3	S22Neg cm3	Z33 cm3	Z22 cm3	R33 mm	R22 mm	CG Offset 3 mm	CG Offset 2 mm	PNA Offset 3 mm	PNA Offset 2 mm	Area Modifier
B200x200	1333.3	1333.3	1333.3	2000	2000	57.7	57.7	0	0	0	0	1
B200x450	6750	3000	3000	10125	4500	129.9	57.7	0	0	0	0	1
B200x600	12000	4000	4000	18000	6000	173.2	57.7	0	0	0	0	1
B200x750	18750	5000	5000	28125	7500	216.5	57.7	0	0	0	0	1
B300x450	10125	6750	6750	15187.5	10125	129.9	86.6	0	0	0	0	1
B300x600	18000	9000	9000	27000	13500	173.2	86.6	0	0	0	0	1

Table 4.10 - Frame Section Property Definitions - Summary (Part 3 of 3)

Name	As2 Modifier	As3 Modifier	J Modifier	I33 Modifier	I22 Modifier	Mass Modifier	Weight Modifier
B200x200	1	1	0.01	0.35	0.35	1	1
B200x450	1	1	0.01	0.35	0.35	1	1
B200x600	1	1	0.01	0.35	0.35	1	1
B200x750	1	1	0.01	0.35	0.35	1	1
B300x450	1	1	0.01	0.35	0.35	1	1
B300x600	1	1	0.01	0.35	0.35	1	1

4.1.7 Shell Sections

Table 4.11 - Area Section Property Definitions - Summary

Name	Type	Element Type	Material	Total Thickness mm	Deck Material	Deck Depth mm
S120Thin	Slab	Membrane	M30	120		
S140Thin	Slab	Membrane	M30	140		
S200Thin	Slab	Membrane	M30	200		
Stair175	Slab	Membrane	M30	175		
Wall200	Wall	Shell-Thin	M30	200		
Wall300	Wall	Shell-Thin	M30	300		

4.1.8 Load Patterns

Table 4.12 - Load Pattern Definitions

Name	Is Auto Load	Type	Self Weight Multiplier	Auto Load
~LLRF	Yes	Other	0	
Dead	No	Dead	1	
EQX	No	Seismic	0	IS 1893:2016
EQY	No	Seismic	0	IS 1893:2016
Live	No	Live	0	
SDL	No	Super Dead	0	
WindX	No	Wind	0	Indian IS 875:2015
WindY	No	Wind	0	Indian IS 875:2015

4.1.9 Load Sets

Table 4.13 - Shell Uniform Load Sets

Name	Load Pattern	Load Value kN/m2
Balcony	SDL	2
Balcony	Live	3
Corr	SDL	2
Corr	Live	3
Lift	SDL	3
Lift	Live	10
OHT	SDL	2
OHT	Live	15
Room	SDL	1.5
Room	Live	2
Stair	SDL	4
Stair	Live	3
Terrace	SDL	3
Terrace	Live	2.5
Toilet	SDL	3
Toilet	Live	2

4.1.10 Load Cases

Table 4.14 - Load Case Definitions - Summary

Name	Type
Modal	Modal - Eigen
Dead	Linear Static
Live	Linear Static
SDL	Linear Static
EQX	Linear Static
EQY	Linear Static
WindX	Linear Static
WindY	Linear Static
SpecX	Response Spectrum
SpecY	Response Spectrum

Table 4.15 - Load Case Definitions - Linear Static

Name	Exclude Group	Mass Source	Stiffness Type	Load Type	Load Name	Load SF	Design Type	Notes
Dead	None	MsSrc1	P-Delta	Load	Dead	1	Program Determined	
EQX	None	MsSrc1	P-Delta	Load	EQX	1	Program Determined	
EQY	None	MsSrc1	P-Delta	Load	EQY	1	Program Determined	
Live	None	MsSrc1	P-Delta	Load	Live	1	Program Determined	
SDL	None	MsSrc1	P-Delta	Load	SDL	1	Program Determined	
WindX	None	MsSrc1	P-Delta	Load	WindX	1	Program Determined	
WindY	None	MsSrc1	P-Delta	Load	WindY	1	Program Determined	

Table 4.16 - Modal Case Definitions - Eigen

Name	Exclude Group	Mass Source	Stiffness Type	Max Modes	Min Modes	Freq Shift cyc/sec	Cutoff Freq cyc/sec	Convergence Tol	Auto Shift?	Design Type	Notes
Modal	None	MsSrc1	P-Delta	24	3	0	0	0	Yes	Program Determined	

Table 4.17 - Load Case Definitions - Response Spectrum (Part 1 of 2)

Name	Design Type	Mass Source	Load Name	Function	Trans Accel SF mm/sec2	Coordinate System	Angle deg	Modal Case	Modal Combo Method
SpecX	Program Determined	Previous (MsSrc1)	U1	IS1893	45514	Global	0	Modal	CQC
SpecY	Program Determined	Previous (MsSrc1)	U2	IS1893	32696	Global	0	Modal	CQC

Table 4.18 - Load Case Definitions - Response Spectrum (Part 2 of 2)

Name	Design Type	Rigid Response?	Directional Combo Type	Eccentricity Ratio	Notes
SpecX	Program Determined	No	SRSS	0	
SpecY	Program Determined	No	SRSS	0	

4.2 BASE REACTION

Base Reactions

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Filter: None

Output Case	Case Type	Step Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
Dead	LinStatic		-7.117E-06	6.816E-06	36704	285741.8722	-718647.2801	-3.3326	0	0	0
Live	LinStatic		-3.498E-06	3.169E-06	10515	83651.202	-207020.4178	-1.7493	0	0	0
SDL	LinStatic		-8.803E-06	7.7E-06	26183	219052.9151	-504418.5465	-2.5618	0	0	0
EQX	LinStatic		-3926	-2.259E-05	-7.435E-06	-104.9625	-99182.717	31955.412	0	0	0
EQY	LinStatic		4.133E-05	-2926	7.922E-05	74017.9492	74.9062	-57284.0789	0	0	0
WindX	LinStatic		-1291	-5.149E-06	-2.487E-06	-24.2201	-25156.7791	10688.4057	0	0	0
WindY	LinStatic		2.689E-05	-2642	6.029E-05	50729.7648	46.4992	-50977.369	0	0	0
SpecX	LinRespSpec	Max	3926	454	3.729E-05	9951.8248	74394.3175	39936.7316	0	0	0
SpecY	LinRespSpec	Max	326	2926	7.161E-05	54810.4468	7143.1091	55850.827	0	0	0

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4.3 MODAL PARTICIPATING MASS RATIO

As per IS1893 (Part1) :2016, In Buildings located in seismic Zone II and III, it should be ensured that the first three modes together contribute at least 65 percent mass participation factor in each principal plan direction.

Modal Participating Mass Ratios

File Edit Format-Filter-Sort Select Options

Units: As Noted Hidden Columns: No Sort: None Modal Participating Mass Ratios
Filter: None

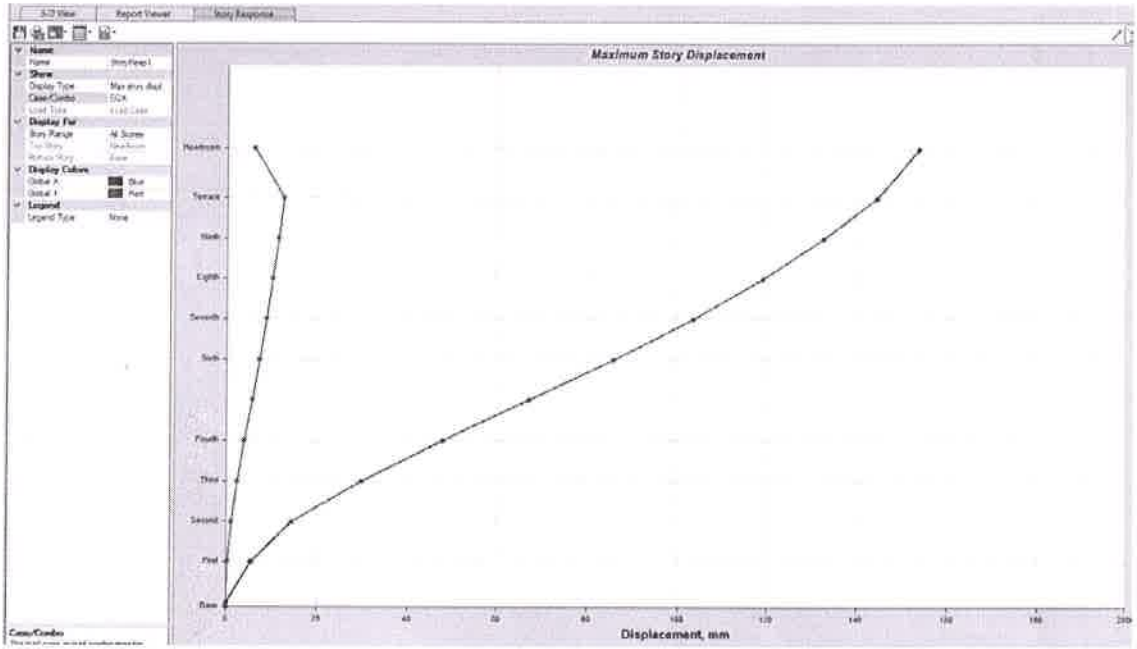
Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
Modal	1	2.083	0.5533	0.1046	0	0.5533	0.1046	0	0.0492	0.2656	0.0195	0.0492	0.2656	0.0195
Modal	2	2.04	0.0737	0.5379	0	0.627	0.6425	0	0.2547	0.036	0.0603	0.3039	0.3016	0.0798
Modal	3	1.922	0.0497	0.0365	0	0.6767	0.679	0	0.0152	0.0204	0.5979	0.3191	0.3219	0.6777
Modal	4	0.58	0.1069	0.0006	0	0.7836	0.6796	0	0.0015	0.2363	0.0076	0.3206	0.5582	0.6853
Modal	5	0.543	0.0002	0.1016	0	0.7838	0.7812	0	0.2259	0.0002	0.0167	0.5466	0.5585	0.702
Modal	6	0.531	0.0092	0.015	0	0.793	0.7962	0	0.0394	0.0196	0.0898	0.586	0.578	0.7918
Modal	7	0.344	0.013	0	0	0.806	0.7962	0	0	0.0127	0.0016	0.586	0.5907	0.7934
Modal	8	0.256	0.0018	0.0516	0	0.8078	0.8478	0	0.059	0.0024	0.0002	0.645	0.5931	0.7936
Modal	9	0.255	0.0014	0.0006	0	0.8092	0.8484	0	0.0007	0.0022	0.0507	0.6457	0.5953	0.8443
Modal	10	0.251	0.0443	0.0016	0	0.8535	0.85	0	0.0018	0.0595	0.0027	0.6475	0.6548	0.847
Modal	11	0.148	0.0014	0.0232	0	0.8549	0.8732	0	0.0455	0.0027	0.0051	0.693	0.6575	0.8522
Modal	12	0.146	0.0063	0.0058	0	0.8613	0.8789	0	0.0112	0.0122	0.0188	0.7042	0.6697	0.8709
Modal	13	0.143	0.0232	7.803E-06	0	0.8845	0.879	0	9.406E-06	0.0447	0.0076	0.7042	0.7144	0.8785
Modal	14	0.102	4.098E-05	0.0002	0	0.8845	0.8791	0	0.0003	0.0001	0.0062	0.7045	0.7144	0.8847
Modal	15	0.098	1.733E-06	0.0158	0	0.8845	0.8949	0	0.0291	3.287E-06	2.246E-05	0.7336	0.7145	0.8847
Modal	16	0.09	0.0172	1.897E-06	0	0.9017	0.8949	0	3.359E-06	0.0333	0.002	0.7336	0.7477	0.8867
Modal	17	0.087	0.0023	0	0	0.904	0.8949	0	0	0.0043	0.0148	0.7336	0.752	0.9015
Modal	18	0.072	0	0.012	0	0.904	0.9069	0	0.0247	0	1.5E-05	0.7583	0.752	0.9015
Modal	19	0.061	0.0013	0	0	0.9052	0.9069	0	0	0.0028	4.043E-05	0.7583	0.7548	0.9016
Modal	20	0.061	0.0076	7.775E-06	0	0.9128	0.9069	0	1.81E-05	0.0164	0.0039	0.7583	0.7712	0.9055
Modal	21	0.06	0.0002	1.608E-06	0	0.913	0.9069	0	3.865E-06	0.0004	0.0011	0.7583	0.7716	0.9066
Modal	22	0.059	0.0013	8.117E-06	0	0.9143	0.9069	0	1.933E-05	0.0029	0.0048	0.7583	0.7746	0.9113
Modal	23	0.059	0.0005	2.329E-06	0	0.9149	0.9069	0	5.373E-06	0.0012	0.0011	0.7583	0.7758	0.9124
Modal	24	0.058	0.0021	9.881E-06	0	0.9169	0.9069	0	2.385E-05	0.0042	0.003	0.7583	0.78	0.9154

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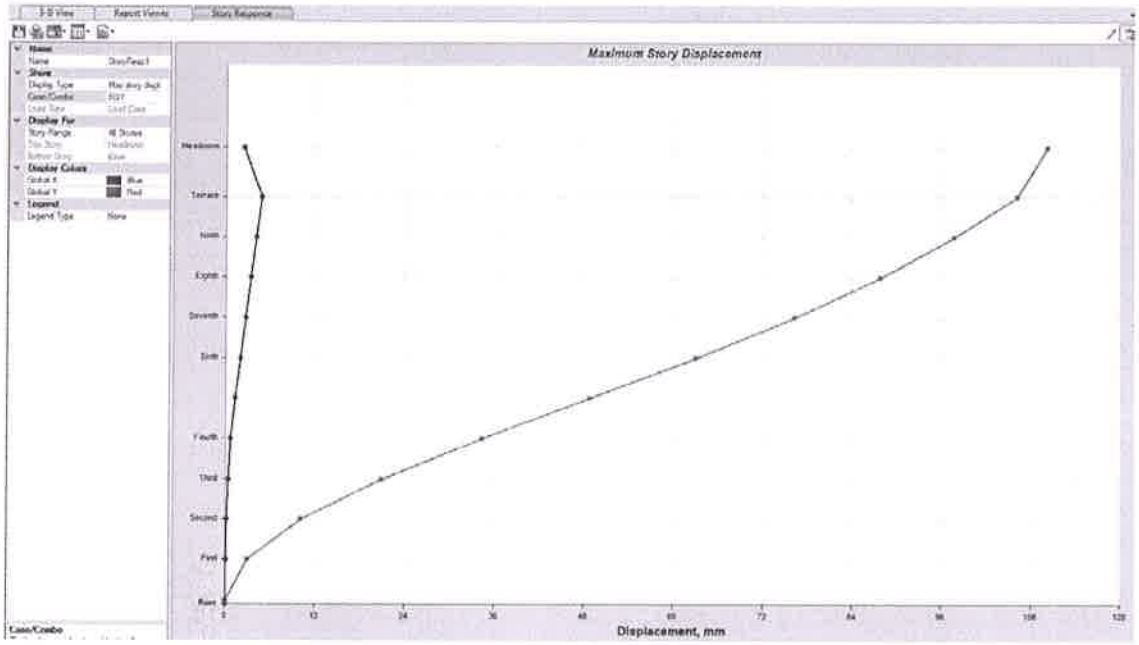
4.4 PERMISSIBLE DRIFT LIMITS

As per IS1893 (Part1) :2016 & IS 16700: 2017, Storey drift in any storey due to minimum specified design seismic lateral force shall not exceed 0.004 times the storey height or hi/250.

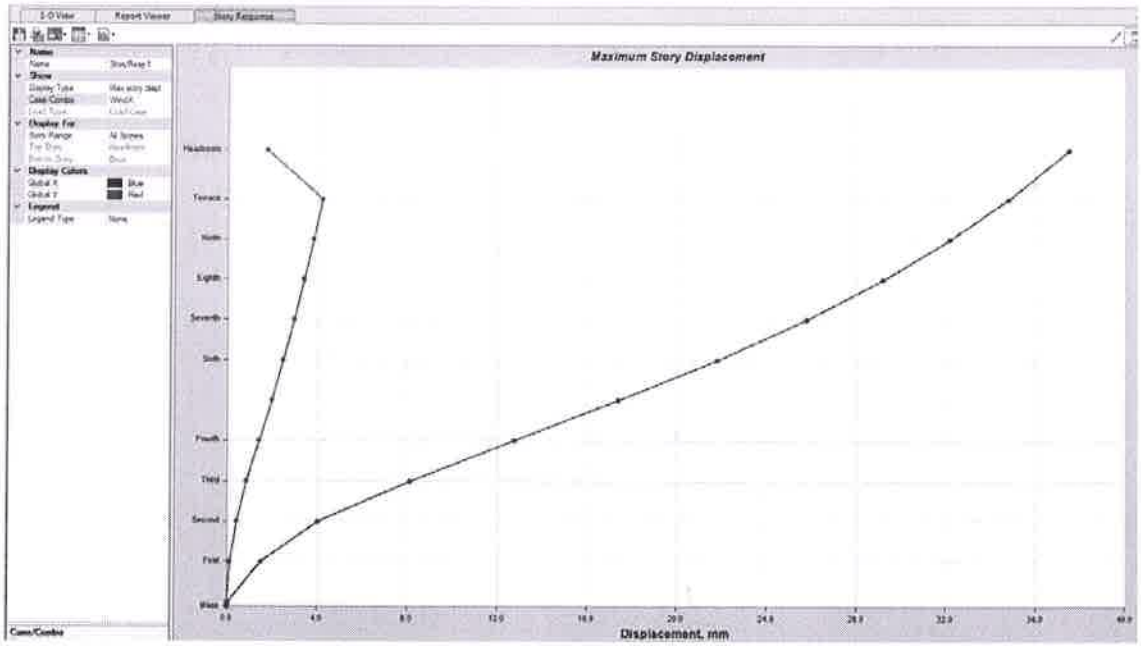
MAXIMUM STORY DISPLACEMENT IN EQX



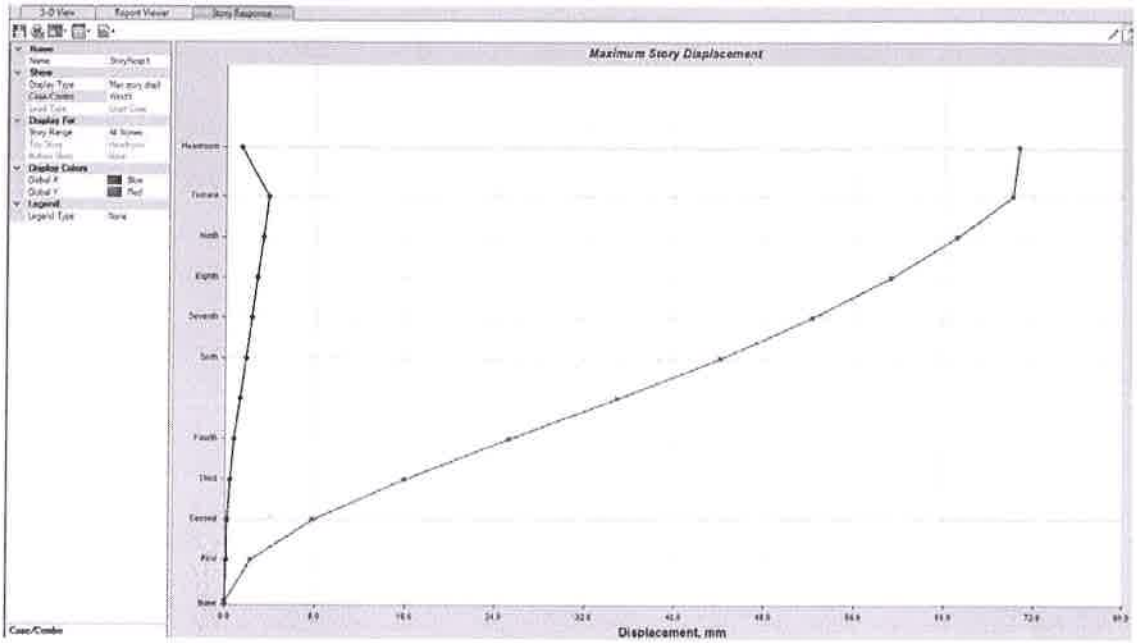
MAXIMUM STORY DISPLACEMENT IN EQY



MAXIMUM STORY DISPLACEMENT IN WINDX



MAXIMUM STORY DISPLACEMENT IN WINDY



5. DESIGN

The steel reinforcements in the foundation, columns, shear walls, beams and slabs are calculated for maximum forces obtained from the static and dynamic analyses for the critical load combinations.

5.1 DESIGN OF SUB STRUCTURE

Pile foundation was recommended in the soil test report for this RCC building. The maximum axial load and moments acting on each column were obtained from ETABS output. Based on the soil test report, the foundation was designed for the maximum axial load and moments by using SAFE design software.

5.2 DESIGN OF SUPER STRUCTURE

All structural members shall be designed following the guidelines of the codes mentioned in section 3.1. Structural design will be in conformance to the stability criteria prescribed in clause 20 of IS 456:2000.

5.3 DESIGN OF COLUMN

Columns were designed for the maximum axial load and moments obtained from the analyses for the critical load combinations. The area of steel reinforcements obtained for columns/shear walls from ETABS output were checked manually.

5.4 DESIGN OF BEAM

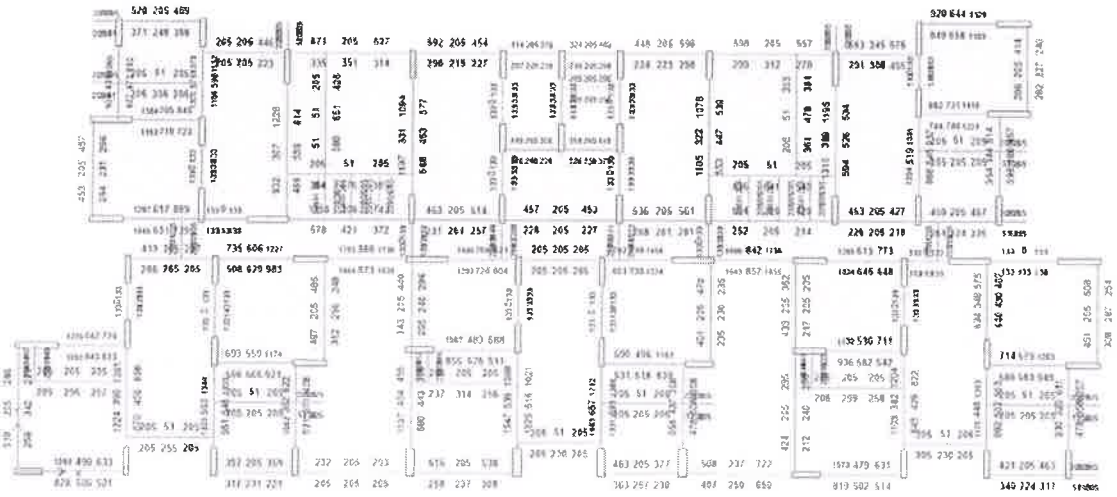
Beams were designed for the maximum moments and shear forces obtained from analyses for the critical load combinations. The area of steel reinforcements obtained for beams from ETABS output were checked manually.

5.5 DESIGN OF SLAB AND STAIRCASE

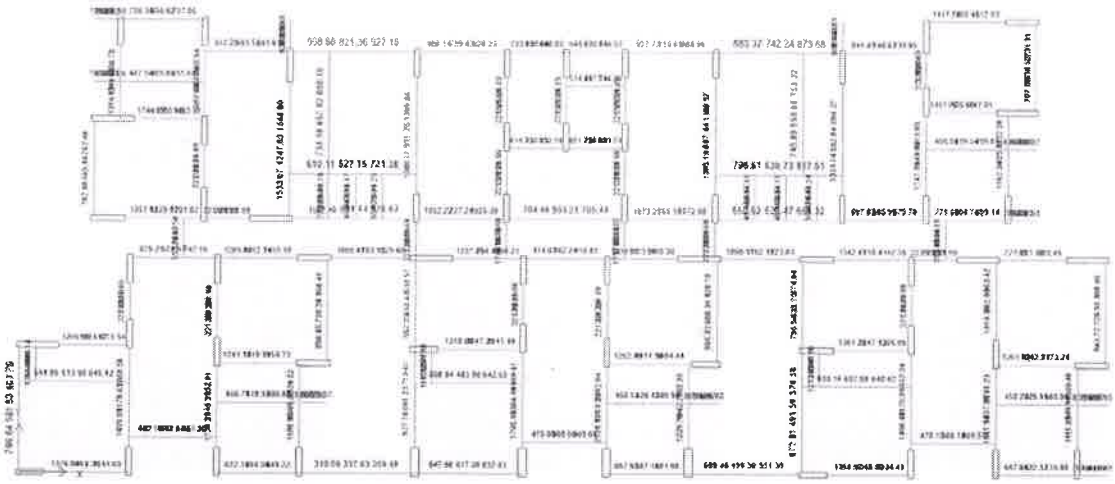
All slabs and staircase were designed as per IS 456:2000 with the aid of in-house design spreadsheets.

All other structural elements and Retaining walls shall be designed based on the soil parameters specified in geo-technical report, with the aid of in-house design spreadsheets.

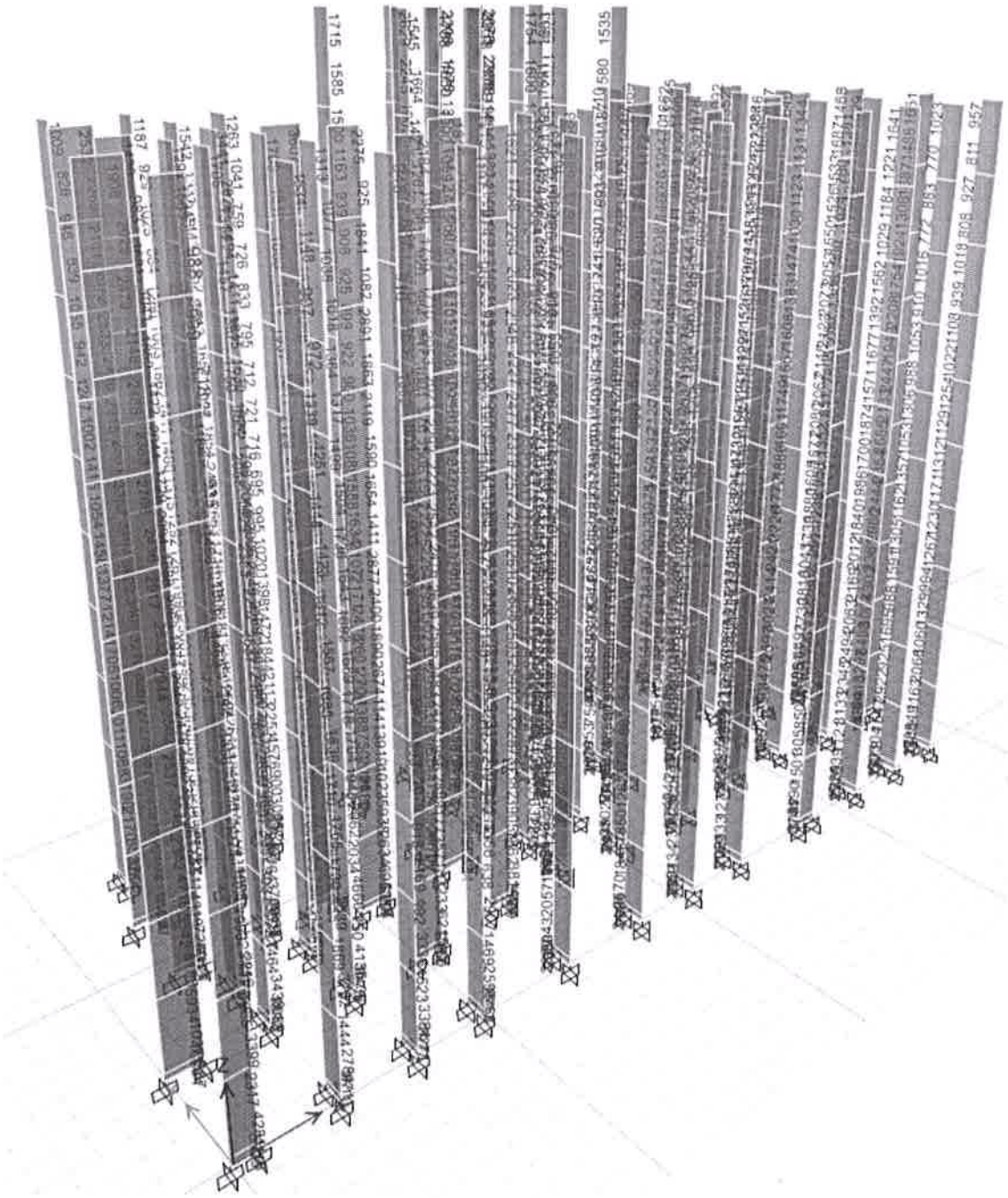
RCC Beam Main Reinforcement in ETABS



RCC Beam Shear Reinforcement in ETABS



RCC Shear Wall Reinforcement in ETABS



6. FOUNDATION DESIGN

6.1 DESIGN OF PILE REINFORCEMENT

DESIGN OF PILE REINFORCEMENT

Input Data

Type of Soil strata		=	Clay soil		
Pile End condition		=	Fixed Head		
Grade of Concrete		=	30	N/mm^2	
Grade of Steel		=	500	N/mm^2	
Pile Dia		=	600	mm	
Pile clear cover		=	50	mm	
Pile Main reinforcement		=	20	mm	
Helical Reinforcement		=	8	mm	
Pile Length below NGL	L	=	13	m	(As per soil report)
Pile Length above NGL	L1	=	0	m	(As per site condition)
Pile Capacity as per soil report					
Vertical compression	P	=	809.5	kN	
Latreal Load	H	=	79	kN	
Uplift Load	T	=	0	kN	
Uplift Load requirement		=	Not Required		

Calculation

Pile area		=	0.282743339	m^2	
Pile Noment of Inertia	I	=	0.006361725	m^4	
Length of Fixity calculation					
Young's modulus	E	=	27386127.88	kN/m^2	
	Lf/R		L1/R		(where L1/R to be refered from graph)
	R	=	$\sqrt[4]{(EI/KB)}$		
	K	=	18000	kN/m^2	(Ref Annex C of IS 2911-1/(2):Fig 4)
	R	=	2.00		
L1/R=	0		1.8		(Ref Annex C:Fig 4 of IS 2911-1/(2))
	Lf	=	3.61	m	

Pile Design Case 1: Max Vertical Load

Eccentrcity e =((L/500)+(D/30)	e	=	20.026	mm	
Moment due to Ecc. E	Me	=	16.211047	kN-m	
	$Pu/(fckD^{2})$	=	0.112430556		d'/d= 0.107011
	$Mu/(fckD^3)$	=	0.003752557		
	p/fck	=	0.01		

	Min p	=	0.4	%	
Case 2:Max Vertical load and Max Horiz. Load					
Bending Moment due to Lateral load Mh		=	H(L1+Lf)/2		
	Mh	=	142.4918565		
Moment reduction factor	m	=	0.8		(Ref Annex C:Fig 5A/5B of IS 2911-1/(2))
	Mh	=	113.9934852		
	$Pu/(fckD^{2})$	=	0.112430556		d'/d= 0.107011
	$Mhu/(fckD^{3})$	=	0.026387381		
	p/fck	=	0.02		
	Min p	=	0.60	%	

Case 3:Max Tensile Load

Area of Reinforcement		=	Tu/(0.87*fy)	
		=	0.00	
Percentage of reinforcement	p	=	0.00	%

Case 4:Max Tensile load and Max Horiz. Load

The analysis is carried out by converting circular pile section to an equivalaent square pile section

Size of equivalaent square section		=	532	mm	d'/B= 0.122363
	Tu/(fckBD)	=	0.00000		Perc
	$Mhu/(fckBD^{2})$	=	0.023838621		
	p/fck	=	0.01		
	p	=	0.30	%	

Summary

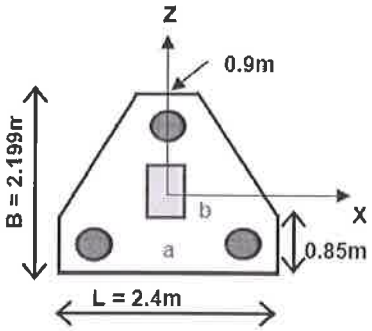
Pile reinforcement % required	p	=	0.60	%
Area of Pile reinforcement	Ast	=	1696.460033	
	Req		6Nos-Y20	Longitudinal Reinforecement
			Y8 @ 150mm c/c	Helical Reinforcement
	Provided		8-Y120	Longitudinal Reinforecement

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE/GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

6.2 DESIGN OF PILECAP REINFORCEMENT

Given data:

Number of pile	=	3	
Breath of pedestal (a)	=	300	mm
Width of pedestal (b)	=	1200	mm
Diameter of pile (Dp)	=	600	mm
Grade of concrete (fck)	=	30	N/mm^2
Grade of steel (fy)	=	500	N/mm^2
Clear cover	=	75	mm
Diameter of rod	=	16	mm



Axial load from column	=	1709	kN (Unfactor)
Lateral force in X direction (Fx)	=	131	kN (Unfactor)
Lateral force in Z direction (Fz)	=	14	kN (Unfactor)
Moment in XX Direction (Mx)	=	12.68	kN.m (Unfactor)
Moment in ZZ Direction (Mz)	=	11.73	kN.m (Unfactor)
Mu limit/bd^2	=	3.982	

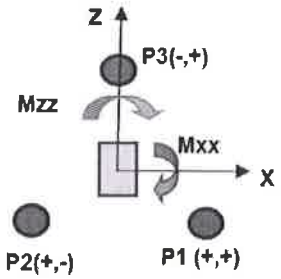
Solution:

1.Size of pile cap:

C/C distance between piles 2.5 Dp	=	1.500	m
Edge distance from outer face of exterior pile	=	0.150	m (min 150mm)
Length of pile cap (L)	=	**2.400**	**m**
Width of pile cap (B)	=	**2.199**	**m**
Required effective depth	=	0.750	m
Depth of pile cap (D)	=	0.833	~ **1.20 m**
Effective depth of pile cap (d)	=	1117.0	mm

2.Load calculation:

Total axial load on pile cap	=	1837.01	kN
Moment due to Fx (Mz1)	=	157.28	kN.m
Moment due to Fz (Mx1)	=	16.58	kN.m
Total moment about XX direction (Mxx)	=	29.26	kN.m
Total moment about ZZ direction (Mzz)	=	169.01	kN.m
Total design load on pile P1	=	1068.11	kN
Total design load on pile P2	=	1068.11	kN
Total design load on pile P3	=	1068.11	kN



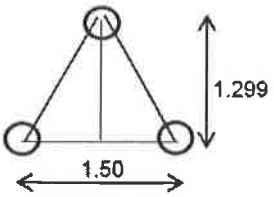
3.Check for truss action:

Shear span in XX direction (av)	=	0.420	m
av/d value	=	0.376	

Truss action in XX direction

Shear span in ZZ direction (av)	=	-0.030	m
av/d value	=	-0.027	

Truss action in ZZ direction



4.Design bending moment:

Cantilever length in XX direction	=	0.600	m
Cantilever length in ZZ direction	=	0.866	m
Bending moment about ZZ direction	=	640.87	kN.m
Bending moment about XX direction	=	925.01	kN.m
Required depth for moment	=	325.03	mm

The depth of pilecap is enough

5.Reinforcement:

$$\text{Area of steel (Ast)} = \frac{0.5 \times fck}{fy}\left(1 - \sqrt{1 - \frac{4.6 \times Mu}{fck \times b \times d^2}}\right) b \times d$$

Bottom reinforcement:

Ast in XX direction	=	1334.06	mm^2
Required spacing	=	300.00 ~ 150	mm

Provide 20 mmø @ 150 mm c/c

% of reinforcement	=	0.188	% (Min 0.12%)

Area of steel is enough, Hence safe

Ast in ZZ direction	=	1967.49	mm^2
Required spacing	=	300.00 ~ 150	mm

Provide 20 mmø @ 150 mm c/c

% of reinforcement	=	0.191	% (Min 0.12%)

Area of steel is enough, Hence safe

Top reinforcement:

Minimum % of steel	=	0.120	%
Minimum of steel	=	1338.00	mm^2
Required spacing	=	150.27 ~ 125	mm

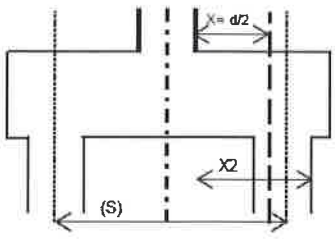
Provide 16 mmø @ 125 mm c/c at both side top

Area of steel is enough, Hence safe

6.Check for One-way shear:

In XX direction,

The critical section for one-way shear is located at a distance of



d/2 from the face of the column (x)	=	557.5	mm
x2 value	=	900.00	mm
Shear force (Vu)	=	609.71	kN
Nominal shear stress (τv)	=	0.249	N/mm^2
% of reinforcement	=	0.188	%
Permissible shear stress (τc)	=	0.325	N/mm^2
Enhanced shear stress ($\tau c'$) = (τc x 2d /av)	=	1.726	N/mm^2

Shear stress is within permissible limit

7.Check for Two-way shear:

The critical section for punching shear is located at a distance of d/2 from the face of the column

Perimeter at the critical section (bo)	=	7228.0	mm
Shear force (Vu)	=	3204.3	kN
Punching shear stress (τv)	= (Vu/ bo x d)		
	=	0.398	N/mm^2
Permissible shear stress (Ks)	= (0.5 +Bc) <1		
	=	0.75	
Max.Per.shear stress ($\tau cmax$)	= 0.25 x √(fck)		
	=	1.369	N/mm^2
Ks *τc	=	1.027	N/mm^2

Shear stress is within permissible limit

8.Results:

Size of pile cap is 2.4 x 2.199

Depth of pile cap is 1.2 m

Bottom reinforcement:

In XX direction , Provide 20mmø @ 150 mm c/c

In ZZ direction , Provide 20mmø @ 150 mm c/c

Top reinforcement:

Provide 16mmø @ 125 mm c/c at both side top

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

7. Shear Wall Design

IS 456:2000 Pier Design (C1)

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
Second	P1	3500	15600	1000	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	3500	15100	3500	16100	1000	200
Bottom	Leg 1	3500	15100	3500	16100	1000	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	1088	0.0054	0.0025	0.9(DL+SDL)+1.5SpecY	-157	-2.3491	-130.8902	200000
Bottom	3190	0.0159	0.0025	1.5(DL+SDL-SpecY)	1790	42.744	452.2292	200000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	1.5(DL+SDL-SpecY)	246	101.3619	126	69	213
Bottom	Leg 1	500	1.5(DL+SDL-SpecY)	268	452.2292	126	79	223

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	300	1.5(DL+SDL+SpecY)	1768	-138.2723	12.99	6
Top–Right	Leg 1	300	1.5(DL+SDL+SpecY)	1768	101.3619	11.88	6
Bottom–Left	Leg 1	300	1.5(DL+SDL+SpecY)	1790	-420.4209	21.56	6
Botttom–Right	Leg 1	400	1.5(DL+SDL+SpecY)	1790	452.2292	22.52	6

7.1 Shear Wall Design

IS 456:2000 Pier Design (C4)

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
Third	P19	3100	9000	1200	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

Γ_s	Γ_c	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	2500	9000	3700	9000	1200	200
Bottom	Leg 1	2500	9000	3700	9000	1200	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	1892	0.0079	0.0025	0.9(DL+SDL)+1.5SpecX	-263	15.5399	246.7617	240000
Bottom	3543	0.0148	0.0025	0.9(DL+SDL)+1.5SpecX	-247	-17.6899	-558.7522	240000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	1.5(DL+SDL-SpecX)	37	252.0087	-175	87	260
Bottom	Leg 1	500	1.5(DL+SDL-SpecX)	64	550.9372	-175	110	284

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top-Left	Leg 1	200	1.5(DL+SDL+SpecX)	1466	-225.7736	10.81	6
Top-Right	Leg 1	200	1.5(DL+SDL+SpecX)	1466	252.0087	11.36	6
Bottom-Left	Leg 1	300	1.5(DL+SDL+SpecX)	1493	-560.7059	17.9	6
Botttom-Right	Leg 1	300	1.5(DL+SDL+SpecX)	1493	550.9372	17.7	6

7.2 Shear Wall Design

IS 456:2000 Pier Design (C7)

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
First	P39	37850	7600	1500	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	37100	7600	38600	7600	1500	300
Bottom	Leg 1	37100	7600	38600	7600	1500	300

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	4493	0.01	0.0024	0.9(DL+SDL)+1.5SpecX	398	-16.3442	1248.3484	450000
Bottom	10544	0.0234	0.0024	0.9(DL+SDL)+1.5SpecX	429	49.2077	2322.0489	450000

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	750	1.5(DL+SDL-SpecX)	808	1250.1027	372	212	537
Bottom	Leg 1	750	1.5(DL+SDL-SpecX)	859	2325.8104	372	266	591

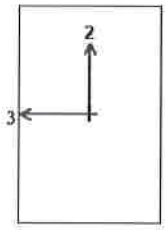
Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	300	1.5(DL+SDL+SpecX)	1240	-1241.3313	13.79	6
Top–Right	Leg 1	300	1.5(DL+SDL+SpecX)	1240	1250.1027	13.87	6
Bottom–Left	Leg 1	300	1.5(DL+SDL+SpecX)	1291	-2307.003	23.37	6
Botttom–Right	Leg 1	300	1.5(DL+SDL+SpecX)	1291	2325.8104	23.54	6

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1, CMDA,
Reg No : SE/GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet

8. Beam Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
First	B26	336	B300x450	1.5(DL+SDL-SpecX)	0	4500	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
300	450	300	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

γc	γs
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-92.7351	2.015	91	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-92.7351	2.9633	0	-95.6984

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-95.6984		620	0	620	308
Bottom (-2 Axis)		0	310	0	0	310

Shear Force and Reinforcement for Shear, V_{u2} & T_u

Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
121	0	132	46	936.97

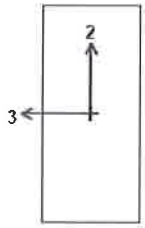
Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
2.015	91	200	350	368.64

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

Beam Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
Sixth	B41	1130	B200x450	1.5(DL+SDL-SpecX)	0	4200	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	450	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

γ_c	γ_s
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-78.2609	2.5208	55	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-78.2609	4.8192	20.3709	-83.0802

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-83.0802		557	0	557	205
Bottom (-2 Axis)		20.3709	279	123	0	279

Shear Force and Reinforcement for Shear, V_{u2} & T_u

Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
77	0	97	44	690.98

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
2.5208	55	100	350	374.62

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet
Ammapet, Salem-63

9 DESIGN OF SLAB

Design of Two-Way slab (S3)

Given data:

Shorter span (clear dimension)	=	3500	mm
Longer span (clear dimension)	=	3700	mm
Live load	=	2.0	KN/m^2
Width of support	=	200	mm
Clear cover	=	25	mm
Grade of concrete (fck)	=	30	N/mm^2
Grade of steel (fy)	=	500	N/mm^2
Load factor	=	1.5	
Xumax/d	=	0.456	
Mu limit (Qu)	=	3.982	
bd^2			

Solution:

1.Thickness of slab:

Assume modification factor	=	1.6	(% of steel is 0.2%)
Span/depth	=	26	Refer Fig.4 - IS 456-2000
Span/depth	=	41.6	~ 42
Required effective depth	=	83.333	~ 112 mm
Adopt thickness of slab is	=	140	mm
Effective depth of slab (d)	=	111.0	mm

2.Effective span:

Least of followig			
C/C of support	=	3700.0	mm
Clear span + d	=	3611.0	mm
For shorter span (lx)	=	3611.0	mm

3.Load calculation:

Self weight of slab	=	3.5	KN/m^2
Floor finish	=	1.5	KN/m^2
Partition load	=	0.0	KN/m^2
Sunken filling	=	0.0	KN/m^2
Live load	=	2.0	KN/m^2
Total load	=	7	KN/m^2
Total design load (W)/m	=	10.500	KN/m

4.Types of slab

Ly/Lx value	=	1.06	< 2

The slab is to be designed as Two way

5.Bending moments coefficents:

Support condition = 4.Two Adjacent Edges Discontinuous

For shorter span, ∝x -ve = 0.050

∝x +ve = 0.038

For longer span, ∝x -ve = 0.047

∝x +ve = 0.035

6.Design moments:

Sl.No	Design moments (KN.m)	For shorter span	For long span
1	Negative Moment at continuous edge	6.904	6.435
2	Positive Moment at mid span	5.183	4.792
3	d required = √Mu/Quxb	41.641	40.201

The slab depth is enough

7.Reinforcements:

$$\text{Area of steel (Ast)} = \frac{0.5 \times fck}{fy}\left(1 - \sqrt{1 - \frac{4.6 \times Mu}{fck \times 1000 \times d^2}}\right) 1000 \times d$$

Minimum area of steel (Ast_{min}) = 0.12 %

= 168.00 mm^2

Sl.No	For shorter span	Ast in mm^2	Dia	Spacing		Provided
1	At top (-ve)	168.00	8	299.0	125	8 mmØ @ 125 mm c/c at top
2	Bottom (+ve)	168.00	8	299.0	125	8 mmØ @ 125 mm c/c at bottom
	For longer span					
3	At top (-ve)	168.00	8	299.0	125	8 mmØ @ 125 mm c/c at top
4	Bottom (+ve)	168.00	8	299.0	125	8 mmØ @ 125 mm c/c at bottom

8.Check for deflection:

% of steel at mid span = 0.362 %

fs value = 121.2

Modification factor = 2.000 (Ref Fig 4 IS 456-2000)

Required effective depth = 69.44 < 111.0 mm

The slab depth is enough

9.Check for crack width:



Level at which crack width is to be calculated (a') = 115 mm

Modulas of elasticity of steel (Es) = 200000 N/mm^2

Long term modulas of elasticity of concrete (Ec) = 13693 N/mm^2

Modular ratio (m) = 15

% of steel at mid span = 0.362 %

Neutral axis depth factor (k) = 0.277

Neutral axis depth (Xu) = 30.711 mm

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35 Sundaraganapathy Sreet,
Salem 636003

Design of One way Slab (Continuous)

Given data:

Shorter span (clear dimension)	=	2900	mm
Longer span (clear dimension)	=	6150	mm
Live load	=	2.0	KN/m^2
Width of support	=	200	mm
Clear cover	=	25	mm
Grade of concrete (fck)	=	30	N/mm^2
Grade of steel (fy)	=	500	N/mm^2
Load factor	=	1.5	
Xumax/d	=	0.456	
Mu limit (Qu)	=	3.982	
bd^2			

Solution:

1.Thickness of slab:

Assume modification factor	=	1.6	(% of steel is 0.2%,Refer Fig.4 - IS 456-2000)
Span/depth	=	26	
Span/depth	=	41.6 ~ 42	
Required effective depth	=	69.048 ~ 98.05	mm
Adopt thickness of slab is	=	140	mm
Effective depth of slab (d)	=	111.0	mm

2.Effective span:

Least of followig

C/C of support	=	3100.0	mm
Clear span + d	=	3011.0	mm
For shorter span (lx)	=	3011.0	mm

3.Load calculation:

Self weight of slab	=	3.5	KN/m^2
Floor finish	=	1.5	KN/m^2
Partition load	=	0.0	KN/m^2
Sunken filling	=	0.0	KN/m^2
Total load	=	5	KN/m^2
Design dead load (W)/m	=	7.500	KN/m
Design live load	=	3.000	KN/m^2

4.Types of slab

Ly/Lx value = 2.12 > 2

The slab is to be designed as One way

5.Design moments:

Sl.No	For mid span	Dead load	Live load	Design moment
1	Near middle of end span	1/12	1/10	8.386
2	At middle of Interior span	1/16	1/12	6.516
	For support			
3	At Support next to the end support	1/10	1/9	9.822
4	At Other Interior support	1/12	1/9	8.688

6.Depth required moment:

d required = $\sqrt{Mu/Quxb}$ 49.665 mm

The slab depth is enough

7.Reinforcements:

$$\text{Area of steel (Ast)} = \frac{0.5 \times fck}{fy}\left(1- \sqrt{1- \frac{4.6 \times Mu}{fck \times 1000 \times d^2}}\right)1000 \times d$$

Minimum area of steel (Ast_{min}) = 0.12 %

= 168.00 mm^2

Sl.No	For mid span	Ast in mm^2	Dia	Spacing		Provided
1	Near middle of end span	178.55	8	281.37	125	8 mmØ @ 125 mm c/c at bottom
2	At middle of Interior span	168.00	8	299.05	125	8 mmØ @ 125 mm c/c at bottom
	For support					
3	At Support next to the end support	210.14	8	239.08	125	8 mmØ @ 125 mm c/c at top
4	At Other Interior support	185.18	8	271.31	125	8 mmØ @ 125 mm c/c at top

8.Check for deflection:

% of steel at mid span = 0.362 %

fs value = 121.2

Modification factor = 2.000 (Ref Fig 4 IS 456-2000)

Required effective depth = 57.90 < 111.0 mm

The slab depth is enough

9.Check for crack width:



Level at which crack width is to be calculated (a') = 90 mm

Modulas of elasticity of steel (Es) = 200000 N/mm^2

Long term modulas of elasticity of concrete (Ec) = 13693 N/mm^2

Modular ratio (m) = 15

% of steel at mid span = 0.362 %

Neutral axis depth factor (k) = 0.277

Neutral axis depth (Xu) = 30.711 mm

Area of steel provided (Ast) = 401.92 mm^2

Cracked moment of inertia (Icr) = 47497794.66 mm^4

Service load moment (M) = 4.344 KN.m/m

Service stress in steel (fst) = 107.26 N/mm^2

Strain in concrete at the bottom face (ε1) = 0.00073

Mean tensile strain in concrete (εm) = 0.00040 > 0

The slab is cracked section

Distance of point from surface of bar (a_{cr}) = 68.90 mm

Crack width (W_{cr}) = 0.045 mm < 0.2 mm

The slab depth is enough

10. Results:

Size of slab is 2900 x 6150 mm

Thickness of slab is 140 mm

Reinforcement:

Provide 8 mmØ @ 125 mm c/c at bottom near middle of end span

Provide 8 mmØ @ 125 mm c/c at bottom middle of Interior span

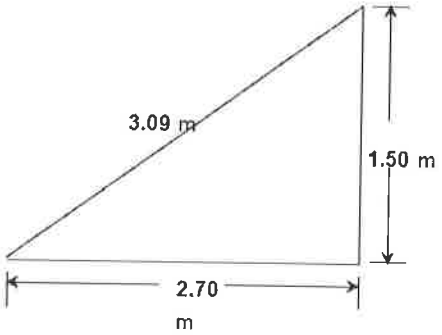
Provide 8 mmØ @ 125 mm c/c at top support next to the end support

Provide 8 mmØ @ 125 mm c/c at top other Interior support

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA
Reg No : SE / GR 1 / 19 / 07 / 17
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003

10 DESIGN OF STAIRCASE

Number of rise in flight	=	10
Number of tread in flight	=	9
Height of flight	=	1.50 m
Tread	=	0.30 m
Rise	=	0.17 m
Length of Flight	=	2.70 m
Length of landing 1	=	1.00 m
Length of landing 2	=	1.00 m
Thickness of waist	=	0.175 m
Span	=	4.70 m



Fy	=	500 N/mm^2
Concrete Grade	=	30
Depth	=	175
Concrete Cover	=	25 mm
Diameter of Bar	=	16 mm

Unit Weight of RCC	=	25 kN/m^3
Unit Weight of Cement Plaster	=	20 kN/m^3
Unit Weight of Floor Finish	=	20 kN/m^3

LOAD

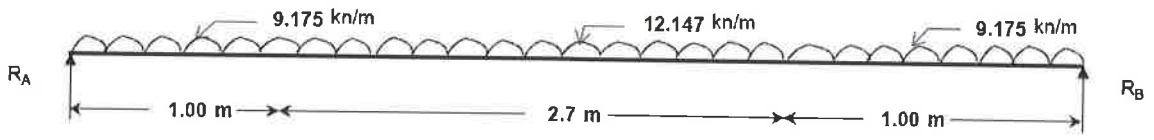
Self weight of Slab		=	4.375
Plastering	15 mm	=	0.300
Finishing	75 mm	=	1.500
	Total	=	**6.175**

Load on horizontal plan	=	7.064 kN/m^2
Dead load of steps	=	2.083 kN/m^2
Total Dead load	=	9.147 kN/m^2
Live load	=	3.00 kN/m^2
Total load	=	12.147 kN/m^2

LOAD ON LANDING

Dead load		=	4.375 kN/m^2
Plastering	15 mm	=	0.300 kN/m^2
Finishing	75 mm	=	1.500 kN/m^2
Total Dead load		=	6.175 kN/m^2
Live load		=	3.00 kN/m^2
	Total load	=	9.175 kN/m^2

Considering 1m width

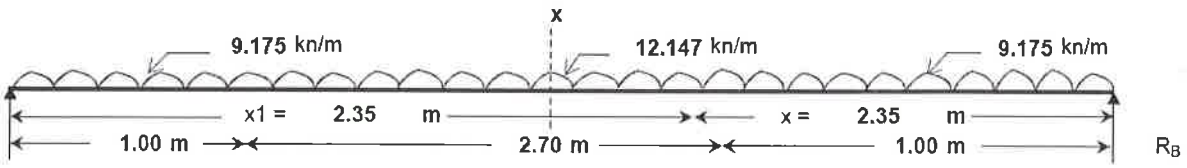


R_B	=	25.574 kN
R_A	=	25.574 kN

Max Bending moment at "x"

x = 2.35 m

x1 = 2.35 m



Moment @ XX, (From R_B)

M_{max} = 32.056 kNm

Moment @ XX, (From R_A)

M_{max} = 32.056 kNm

Effective depth d = 142 mm

M_u/bd^2 = 2.385

Moment and Area of Steel calculations:

Mu kN.m	Mu/bd² N/mm²	Pt %	Ast reqd mm²	Min Ast mm²	Dia of bar mm	Spacing mm	Ast pro mm²	
48.08	2.38	0.611%	867.05	170.4	16	125	1608.50	safe

Provide 16 mm diameter rod @ 125 mm c/c spacing

Distribution Steel

Minimum Steel required Ast, = 262.5 mm²

Provide 8 mm diameter rod @ 150 mm c/c spacing

Check for Deflection

The effective depth provided = 142 mm

Fs $= \frac{Ast_{reqd} \times 0.87 \times fy}{Ast_{prov} \times 1.5}$ = 156.32 N/mm²

M.F.$= \frac{1}{0.225+0.00322\,F_s - 0.625\log_{10}(bd/100Ast)}$ = 1.31

Modification factor MF = 1.312

Required depth under deflection consideration $= \frac{L_x}{26 \cdot MF}$ = 137.78 mm

HENCE SAFE

11. RESULTS

The design basis outlined in this document is based on currently available data issued by the client and architect and it covers all the codal norms for the geometry and usage of the structure. It will need to be updated if design objectives or assumptions are revised.

All other guidelines or specific details will be given along with the working drawing and general drawing. Any perceived non-conformance with the project standards or expectations should be brought to our attention as early as possible.

A. VIJAYAKUMAR, M.E.,
Structural Engineer, GR-1,CMDA,
Reg No : SE / GR 1 / 19 / 07 / 177
73/35, Sundaraganapathy Sreet,
Ammapet, Salem-636003



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3/350/2 Mettukuppam,
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www.verified.realestate