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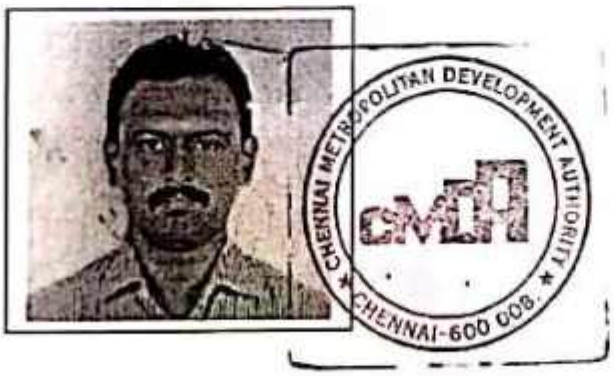
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
'ThalamuthuNatarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Thiru S.SOUNDRAPANDIAN** has enrolled as **RegisteredStructural Engineer Grade-I (SE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Structural Engg.)**and experience in the relevant field for **10years**.

He has been given the Registration No.**SE/GR-I/19/03/028** Renewed on **22.03.2024.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto**21.03.2029**.



22/3/24.

(A. MEGANATHAN)
Superintendent

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S. Soundrapandian. M.E., (Structural)
Structural engineer Grade-I CMDA , DTCP Chengalpattu / Corporation of Chennai
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sounthar.associate81@gmail.com | Mobile: +91 99520 46424

28.01.2023

CERTIFICATE

It is certified that the plan showing the proposed construction of stilt +8 floors with 32 dwelling units of residential high rise building with a height of 28.92m at Block No:371, Temple Colony, 15th Main road, Anna Nagar, Chennai-600 040 comprised in Old Survey No:207 (Part), T.S.No:20/2, Block No:10 of Koyambedu Village, Aminjikarai Taluk, within the limits of Greater Chennai Corporation.is designed by us is safe and stable against all possible loads and Combination of loads as per IS Code, also check has been made and found safe and I hereby certify that,

1. The minimum grade of concrete is M30
2. The least dimension of column is 300 mm. in stilt floor other than lift area.
3. The design and analysis using code of practice IS 875, IS 456, IS13920 and IS1893, is carried out.

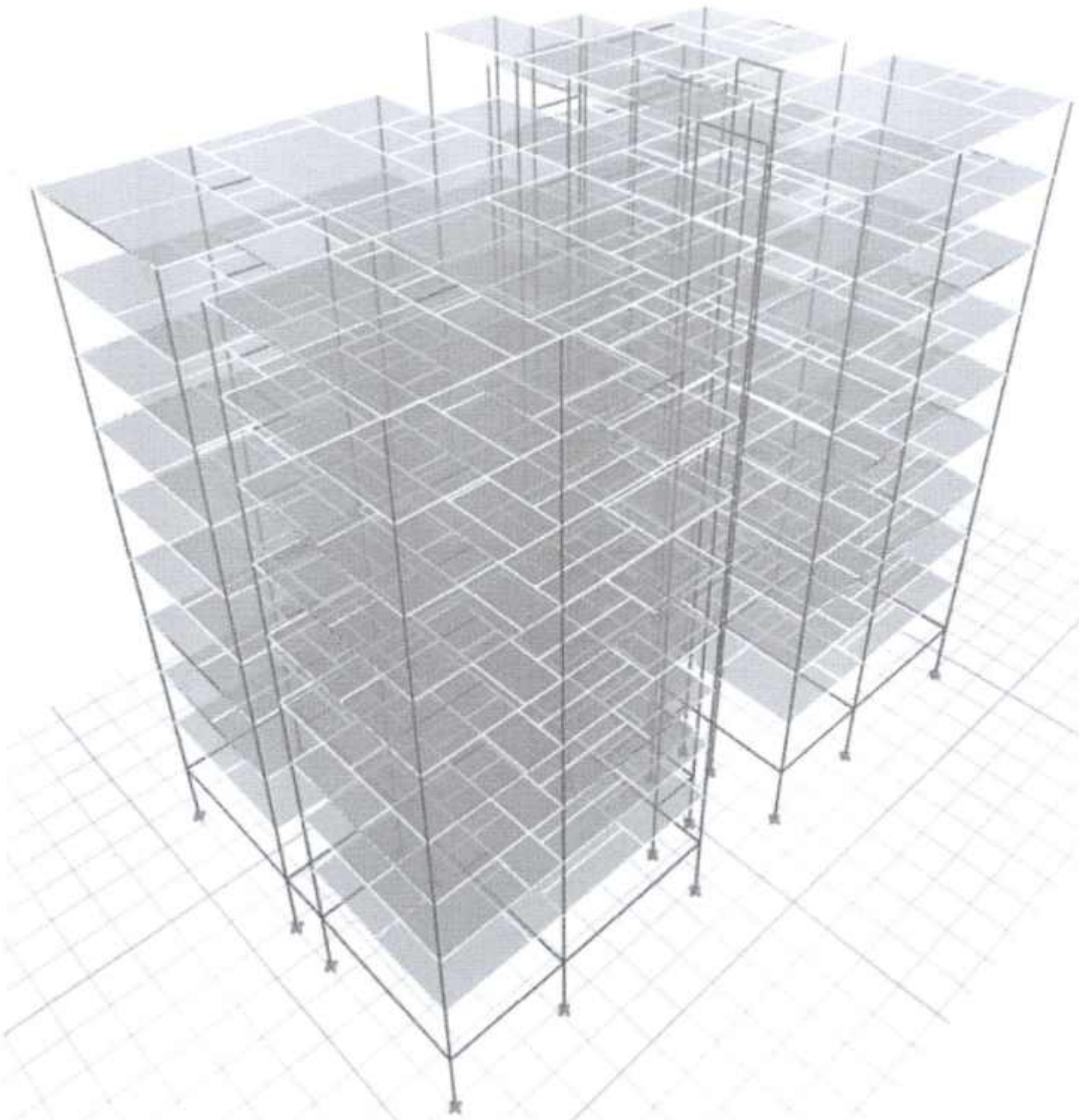
The building will be sound and stable when used for the purpose for which it is designed.

S.SOUNDRAPANDIAN

ENGINEER,

STRUCTURAL

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18.Column Reinforcement as per Etabs

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THE PROPOSED RESIDENTIAL BUILDING AT ANNANAGAR, CHENNAI

1.PROJECT BRIEF

This report sets out the basic parameter used for the structural design of the proposed construction of **Commercial and Residential Building at Annanagar, CHENNAI.**

1.2 STRUCTURAL SYSTEM

The structural system adopted is as below, based on preliminary analysis and design, which have been elucidated later in this report

- The building is basically a RCC framed structure comprising of **Stilt+8** floor.
- The foundation system comprises of open foundation is adopted
- All slab are designed as conventional RCC design

2.CODES AND STANDARDS

All structural design is carried out conforming to the provision in national building code of India and other relevant Indian code and standards.

1. I.S. 456-2000
2. I.S. 875-PART I to II
3. I.S. 1893 – 2002
4. I.S. 13920 – 2016

3.Description of Structure

3.1.Location

The proposed residential building at annanagar, chennai

3.2Building Description

Project Consist of

Gound+8 Floors

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Floors	Details
Stilt Floor	Car Parking & Services
Typical Floor 8-Floors	Residential Apartment
Terrace	Space for Lift Machine Room, Overhead Tank Staircase head Room.

3.3.Structural Arrangements:

The Structural System for the Appartment Comparises of RCC Slab Supported by Rc Shear Wall, Column and Beams.

Floor Slab Considered to act as a rigid diaphragm to transfer the lateral forces to the lateral load resisting elements.

The Cut-out in slab are on the provisions given in Clause 31.8 of IS 456-2000. Core Cutting/Sleeves Shal be Considered to accommodate utility services if any. Staircase are provided with mid-landing between the floors as per architectural layout.

4.Design Approach:

4.1.Design Brief

This structure has physical interface with almost all the disciplines like Geotechnical, MEP Services and

Landscape etc. The Structure proposed is of cast in-situ concrete construction with walls/columns suitably placed. The Structural design of the proposed project is based on Indian Standard Codes and is analyzed for Dead, Live, Wind and Seismic Load conditions taking into relevant load combinations recommended by the codes. The Vertical Loads including the dead and super imposed loads are transferred to the soil through columns, RC walls and footings. Footings are sized with consideration to the safe bearing capacity of soil at the level of transfer of load recommended by specialist soil investigation consultants. The Lateral loads due to wind and seismic forces are dissipated to soil through the proposed Reinforced Concrete columns.

4.2.Material Properties.

Materials specified will confirm to the latest edition of the relevant Indian Standard or other accepted standard. Specifications for materials will include sampling and testing as stipulated in the design standards. Detailed material specifications will be included in the Technical Specification.

Concrete:

All structural concrete shall have cube crushing strength of M40 to M25 N/sq.mm at 28 days.

Plain cement concrete shall have cube crushing strength of 15 N/sq.mm (M15) at 28 days.

Concrete Mix

Concrete Grade

Foundation	M30

Columns	M30
Shear walls	M30
Beams, slabs	M30

Note: Grade of concrete for beam/column junction shall be same as column concrete grade.

Minimum grade of concrete requirement in Column – Slab/Beam joint:

As per cl: 5.7.1.2 & Annex-B of IS-16700:2017, Grade of concrete used in slabs/beams junction shall not be less than 70% of that used in columns. And if, the grade of concrete used in slab/ beams is less than 70% of the column concrete grade, puddling of the concrete shall be done in such a way that column concrete is placed in slab – column junction also for a minimum of 600mm from face of the column and this concrete is well integrated with slab concrete.

Reinforcement steel:

All reinforcement shall confirm to IS: 1786 – 1985 having minimum yield strength of 500 N/sq.mm.

Structural Steel:

All structural steel shall confirm to IS: 2062 with minimum yield strength of 250 N/sq.mm

Mechanical Splicing Material:

Moment Coupler of threaded type as per IS-16172 Shall be used for diameter of reinforcement 16mm and higher size for extending the bars. If lapping of the bars is required in exceptional case, relevant clauses of IS-13920 shall be followed.

4.3.Foundation:

Foundations are designed depending upon Geo technical investigation report and will dissipate all the vertical and horizontal loads safely to the soil. As per the soil investigation report received from geotechnical consultants Pile Foundation is designed by using CSI SAFE v12.

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4.4.Design Loads

Live load for commercial – 2kN / sq.m

Load Calculations

Floor Loads for 125th Slab

Thickness of Slab		125	mm
Unit Weight of Concrete		25.000	kN/m³
Calculations			
Dead Load of Slab		3.125	kN/m²
Floor Finishes		2.500	kN/m²
		5.625	kN/m²
	Say	**5.625**	kN/m²

Wall Loads

230mm thick wall for 3.20m height

Thickness of wall 'b'	**0.230**	m
Height of Walls 'h'	3.200	m
Depth of Beams 'd'	0.450	m
Unit Weight of Brick 'γ'	19.200	kN/m³
Height=(h-d)	2.750	m
(h-d)*b*γ	12.144	
Say	**11.000**	kN/m

115mm thick wall for 3.20m height

Thickness of wall 'b'	**0.115**	m
Height of Walls 'h'	3.200	m
Depth of Beams 'd'	0.150	m
Unit Weight of Brick 'γ'	19.200	kN/m³
Height=(h-d)	3.050	m
(h-d)*b*γ	6.734	
Say	**6.800**	kN/m

Head room Wall load

Thickness of wall 'b'	**0.230**	m
Height of Walls 'h'	2.500	m
Depth of Beams 'd'	0.425	m
Unit Weight of Brick 'γ'	19.200	kN/m³
Height=(h-d)	2.075	m
(h-d)*b*γ	9.163	
Say	**9.200**	kN/m

Parapet Wall load

Thickness of wall 'b'	**0.230**	m
Parapet wall 'h' 0.9m	0.900	m
Unit Weight of Brick 'γ'	19.200	kN/m³
h*b*γ	3.974	
Say	**4.000**	kN/m

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The following reductions in total live load on floors are made in designing of columns, walls and foundation as per IS-875(part-2)-1987.

No. of floors (including the roof) to be carried by member under consideration	Reduction in total distributed live load on all floors to be carried by member under consideration (percent)
1	0
2	10
3	20
4	30
5 to 10	40
Over 10	50

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Wind Loads:

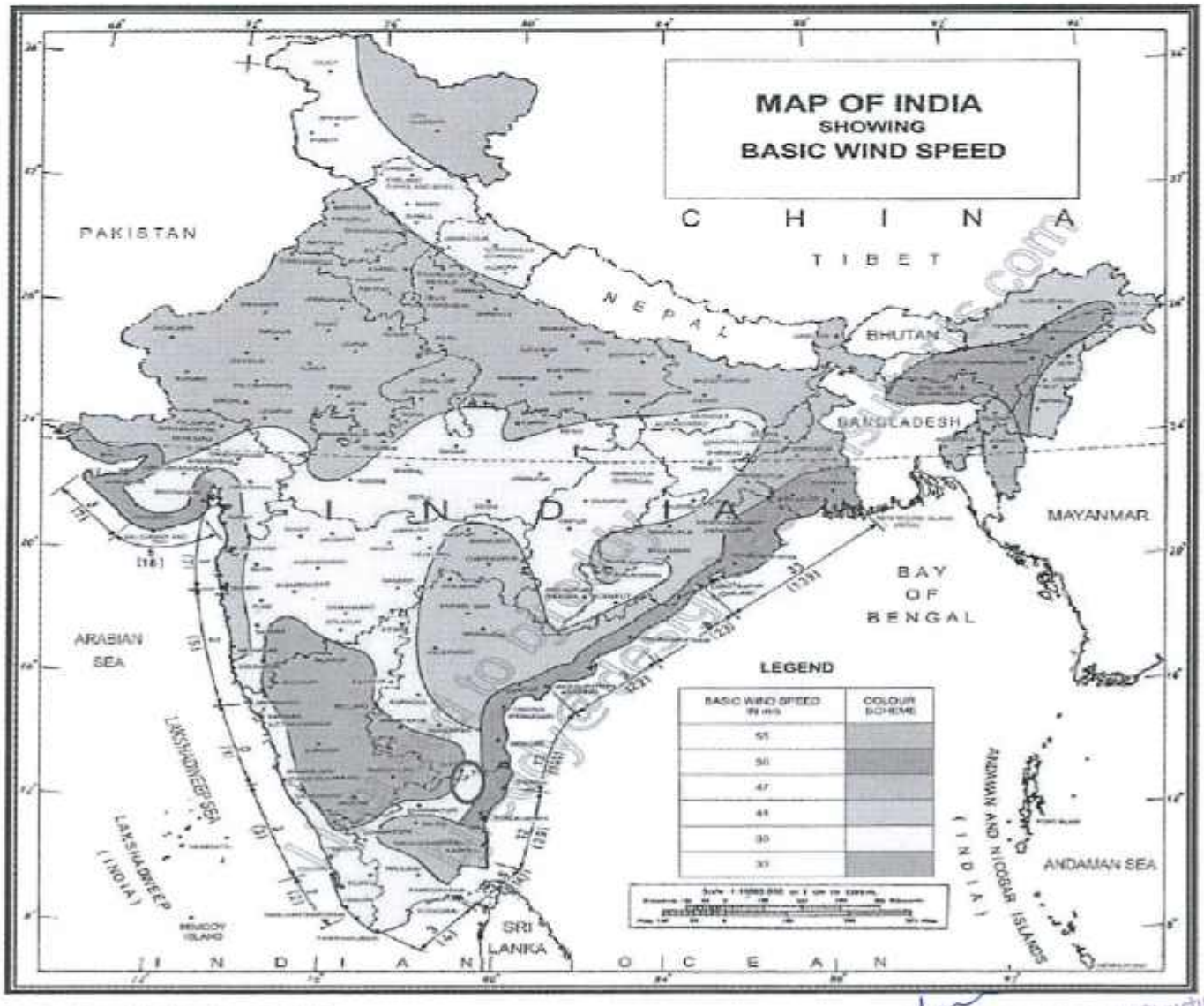
The Wind pressure shall be calculated in accordance with IS: 875 (Part-3)-

2015. Basic wind speed for Chennai is 50m/s.

Basic Wind Speed Vb		: 50 m/s
Terrain Category		: 2
Risk Coefficient (Design Life of Structure)	k1	: 1.00 (k1 corresponds to 50 years Mean Probable
Factor per Table -02.	k2	: Variation of wind speed with heights in different terrains as
Topography factor	k3	: 1.00
Importance factor Cyclone	k4	: 1.00

Design wind speed Vz: $Vb \times k1 \times k2 \times k3 \times k4$

Design wind pressure pz: $0.6 \times Vz^2$



Based upon Survey of India Outline Map printed in 1993.

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The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.
The boundary of Meghalaya shown on this map is as interpreted from the North-Eastern Areas (Reorganisation) Act, 1971, but has yet to be verified.
Responsibility for correctness of internal details shown on the map rests with the publisher.
The state boundaries between Uttaranchal & Uttar Pradesh, Bihar & Jharkhand and Chhattisgarh & Madhya Pradesh have not been verified by Government of the concerned state.

FIG. 1 BASIC WIND SPEED IN M/S (BASED ON 50-YEARS RETURN PERIOD)

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Seismic Forces:

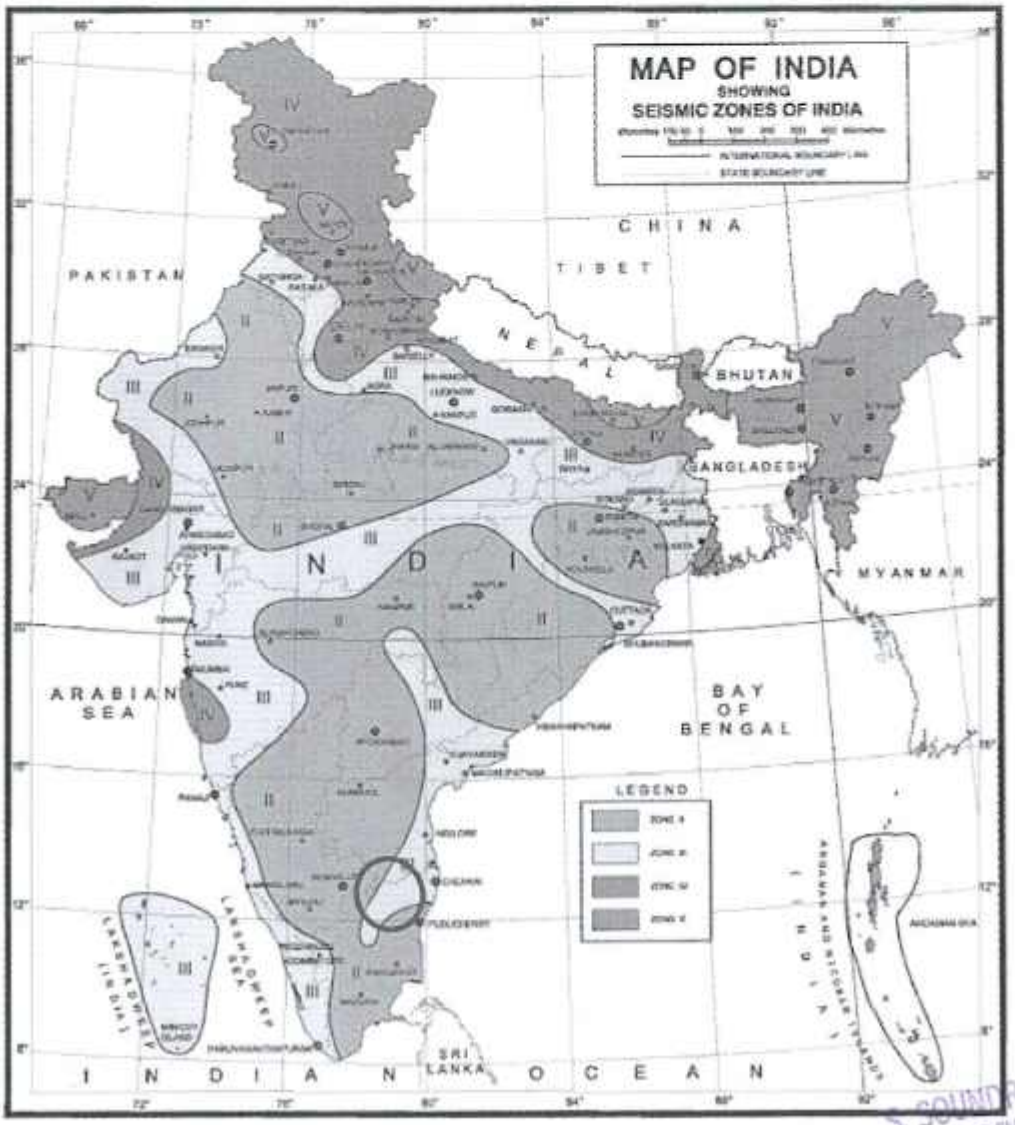
Chennai falls under seismic zone III as per IS 1893-2016 (Part 1) and has the following factors to be considered for designs. Ductile detailing is required. (Please refer attached map)

Seismic Zone	: III
Seismic Zone factor, Z	: 0.16 (As per Table 3-IS: 1893-2016)
Design horizontal seismic coefficient (Ah)	: (Z/2)*(Sa/g)*(I/R)
I -Importance factor	: 1.2 (Ref Table 8-IS: 1893-2016)
Response reduction Factor	: 5(Building with ordinary RC structural columns)
Soil type along the depth is considered)	: I (Weighted average of N value of all soil layers
Damping Ratio for RCC	: 5 %

R as per Table 9 of IS: 1893-2016 is based on building with ductile RC structural walls.

Sa/g – Design acceleration coefficient for soil type as per Fig.2 of IS: 1893-2016 and it is arrived based on appropriate fundamental natural period of structure using program calculated time period.

Design horizontal seismic coefficient (Ah)	: (Z/2)*(I/R)*(Sa/g)
	: (0.16/2)*(1.2/5) *
(Sa/g) Ah	: 0.024 * (Sa/g)
Design seismic base shear, Vb	: Ah * W where, W - seismic weight of building
Dynamic Analysis	: Considered in the analysis



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Table No: 03				
Zone Factor, Z				
Seismic Zone	II	III	IV	V
Z	**0.10**	**0.16**	**0.24**	**0.36**

Durability Considerations:

Environmental conditions, Corrosion and Fire protection for concrete and structural steel

Environment : Moderate

Exposure conditions : Concrete surfaces sheltered from severe rain or freezing whilst wet environment.

Minimum grade of concrete for RCC : Moderate exposure – M25

Minimum grade of concrete for PCC : Moderate exposure – M15

Nominal cover to reinforcement : For moderate Exposure Nominal cover should not be less Than 40 mm for columns & 50mm for footings.

Fire Rating: Nominal covers for 2 hr. fire resistance:

Nominal Cover						
Beams		Slabs		Ribs		Columns
Simply supported	Continuous	Simply supported	Continuous	Simply supported	Continuous	
mm	mm	mm	mm	mm	mm	mm
40	30	35	25	45	35	40

Minimum dimensions of all structural RCC members will be followed as per IS-456: 2000 for 2 hours fire resistance.

5.ANALYSIS METHODOLOGY:

This structure has physical interface with almost all the disciplines like Geotechnical, MEP Services and Landscape etc. The Structure proposed is of cast in-situ concrete construction with Columns suitably placed. The Structural design of the proposed project is based on Indian Standard Codes and is analyzed for Dead, Live, Wind and Seismic Load conditions taking into relevant load combinations recommended by the codes.

The Vertical Loads including the dead and super imposed loads are transferred to the soil through slabs, beams, columns, and footings. Footings are sized with consideration to the safe bearing capacity of soil at the level of transfer of load recommended by specialist soil investigation consultants. The Lateral loads due to wind and seismic forces are dissipated to soil through the proposed Reinforced Concrete columns.

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5.1Assumptions:

The structure is idealized as 3D space frame and analyzed using ETABS software package (Version 20.3.0)

for both vertical and lateral loads.

The structure is analyzed for specific loads like dead load, live load, wind and seismic loads and for the load combinations as given in the relevant codes.

5.2Mathematical model: Mass Modelling:

Mass Source as per IS: 1893_2016 is considered as follows.

(i) Mass source considered for LL <= 3 kN/m2 is

Mass source = DL+SDL+ 0.25LL

(ii) Mass source considered for LL > 3 kN/m2 is

Mass source = DL+SDL+ 0.5LL Where DL - Dead Load;

SDL – Super Imposed Dead

Load; LL - Live Load

Stiffness Modelling:

Cracked cross section properties as per Table: 6 of IS-16700:2017 shall be considered for computer modelling.

Table 6 Cracked RC Section Properties

(Clause 7.2)

Sl No.	Structural Element	Un-factored Loads		Factored Loads	
		Area	Moment of Inertia	Area	Moment of Inertia
(1)	(2)	(3)	(4)	(5)	(6)
i)	Slabs	1.0 A_g	0.35 I_g	1.00 A_g	0.25 I_g
ii)	Beams	1.0 A_g	0.7 I_g	1.00 A_g	0.35 I_g
iii)	Columns	1.0 A_g	0.9 I_g	1.00 A_g	0.70 I_g
iv)	Walls	1.0 A_g	0.9 I_g	1.00 A_g	0.70 I_g

5.3.Static Analysis:

Following Static loads cases are considered in the analysis

DL - Dead Load: Includes self-weight of the structure.

SDL – Super Imposed Dead Load: Includes Finishes, wall Loads, Soil filling

loads etc... LL - Live Load: Includes Live loads based on functionality as per

IS: 875 (Part-2)

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5.4.Dynamic Analysis:

Earthquake:

Response spectrum method of Dynamic Analysis is considered. Following are the details pertaining to dynamic analysis.

Base Shear Enhancement : Initial Scale factor of Ig/2R is used to enhance the base shear. Number of modes Considered : Number of modes considered should be enough to obtain 90% mass participation in each principle plan direction.

Modal Combination Method Used : Complete Quadratic combination (CQC).

Spatial Combination Method used : Square root of the sum of Square (SRSS).

Modal case type : Ritz vector Method

Orthogonal directional seismic effect : Not applicable

Accidental torsion considered : 5% of the building plan dimension

Missing mass correction : Missing mass correction is taken care with Ritz vector method.

Wind:

Dynamic wind response – Along wind response (Gust Factor Analysis) and Across wind response as per Clause 10 of IS 875 (part 3)-2015 shall be followed. if

Case (i) – Ratio of height of the building to minimum lateral dimension is exceeding 5

Case (ii) – Fundamental natural frequency in first mode is less than 1.0Hz

For the given building heights & size, Dynamic Effects of wind need not be considered in the analysis. Also, Time period is marginally exceeding the above frequency limit, hence it is ok.

6. LOAD COMBINATIONS:

Load combinations Used for Strength, Serviceability are tabulated below:

Load Combination	Limit State of Collapse				Limit State of Serviceability		
	DL+SDL	*LL*	*WL/EL*	*TL*	*DL+SDL*	*LL*	*WL/EL/TL*
DL + LL (X/Y)	1.5	1.5	—	—	1	1	—
DL ± WL (X/Y)	1.5 or 0.9*	—	1.5	—	1	—	1
DL ± EL (X/Y)	1.5 or 0.9*	—	1.5	—	1	—	1
DL ± TL (X/Y)	1.4	—	—	1.4	1	—	1
DL+LL±WL (X/Y)	1.2	1.2	1.2	—	1	0.8	0.8
DL+LL±EL (X/Y)	1.2	1.2	1.2	—	1	0.8	0.8
DL+LL±TL (X/Y)	1.05	1.28	—	1.05	1	1	1

DL+WL±TL (X/Y)	1.05	—	1.28	1.05	1	—	1
DL±EL±TL (X/Y)	1.05	—	1.28	1.05	1	—	1
DL+LL+WL(X/Y)+TL	1.05	1.28	1.28	1.05	1	1	1
DL+LL± EL(x/y)+TL	1.05	1.28	1.28	1.05	1	1	1

The various loads are combined in accordance with the stipulations in IS: 875 (Part 5)-1987; whichever combination produces the most unfavorable effect in the building foundation or structural member concerned may be adopted.

*This value is to be considered when stability against overturning and stress reversal is critical where

DL/LL/WL/EL denote.

DL - Dead Load; LL - Live Load; TL - Temperature Load; WL - Wind Load; EL - Earthquake Load

Wind load and earthquake loads are considered for both x & y directions. Whenever imposed load is combined with earthquake load, the appropriate part of imposed load as specified in IS: 1893-2016 / Clause 7.3.1 of seismic code will be used both for evaluating earthquake effect and for combined load effects used in such combination. Load combinations with suitable live load reduction factors as per IS:875(Part-2) will be used for design of columns &foundations.

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7. DESIGN METHODOLOY:

All R.C.C structures shall be designed according to the Limit State Method as specified in IS: 456 – 2000.

Forces and moments from the 3D analysis output for the worst combinations are used for the design of the structure.

The foundations are designed for critical load combination.

The structure is analyzed for specific loads like dead load, live load, wind and seismic loads and for the load combinations as given in the relevant codes.

The slab is analyzed as two-way and one-way slabs.

Design of special members like retaining wall, water tanks will be done in accordance with the relevant IS Codes.

8.ACCEPTANCE CRITERIA:

8.1.Deflection Limits:

For Reinforced concrete works:

Limiting values of deflection (Short and Long term) as per clause 35.3 of IS: 456-2000 is followed in the design.

Limiting value for total long-term deflection is considered as span/250 and for the long-term deflection after erection of partitions & finishes is considered as span/350 or 20mm whichever less as per IS 456 –2000.

8.2.Cracking Limits:

Limiting values of crack width as per clause 35.3 of IS: 456-2000 is followed in the design.

In general, for slabs and beams, the crack width is limited to 0.3mm.

For basement retaining wall and water retaining structures

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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. Table Below show Modal Participating Mass Ratio of Proposed Building

Modal Participating Mass Ratios

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Units: As Noted
Filter:

Modal Participating Mass Ratios

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX
Modal	1	1.701	0.5392	0.0055	0	0.5392	0.0055	0	0.001
Modal	2	1.534	0.2853	0.0057	0	0.8246	0.0113	0	0.0009
Modal	3	1.249	0.0004	0.7814	8.504E-07	0.825	0.7927	1.327E-06	0.1462
Modal	4	0.502	0.0766	0.0008	2.545E-06	0.8017	0.7935	3.872E-06	0.0017
Modal	5	0.431	0.0457	0.0018	5.931E-07	0.8474	0.7953	4.465E-06	0.0069
Modal	6	0.364	0.0002	0.1357	5.535E-06	0.8476	0.929	1E-05	0.3819
Modal	7	0.258	1.226E-05	1.728E-05	0.1964	0.8476	0.929	0.1964	0.0013
Modal	8	0.213	0.0445	0.0026	5.859E-07	0.8921	0.9316	0.1964	0.0018
Modal	9	0.193	0.0004	0.0006	0.0502	0.8925	0.9322	0.2467	0.0002
Modal	10	0.166	0.0068	0.0035	0.0134	0.8993	0.9357	0.2601	0.05
Modal	11	0.121	0.0029	0.0169	0.0975	0.9022	0.9526	0.3575	0.0599
Modal	12	0.099	0.0014	0.002	0.3675	0.9036	0.9546	0.725	0.0131

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Modal Participating Mass Ratios

File Edit Format-Filter-Sort Select Options

Units: As Noted
Filter:

Modal Participating Mass Ratios

	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
055	0	0.5392	0.0055	0	0.001	0.0552	0.2701	0.001	0.0552	0.2701
057	0	0.8046	0.0113	0	0.0009	0.0295	0.5375	0.0019	0.0847	0.8076
514	8.504E-07	0.805	0.7927	1.327E-06	0.1462	1.051E-05	0.0111	0.1471	0.0847	0.8187
000	2.545E-06	0.8017	0.7935	3.872E-06	0.0017	0.1605	0.034	0.1488	0.2452	0.8527
018	5.931E-07	0.8314	0.7953	4.465E-06	0.0069	0.0624	0.0078	0.1557	0.3077	0.8605
307	5.535E-06	0.8316	0.926	1E-05	0.3819	0.0001	0.0023	0.5376	0.3078	0.8628
-05	0.1964	0.8316	0.926	0.1964	0.0013	0.0457	1.533E-05	0.5389	0.3735	0.8628
026	5.859E-07	0.8761	0.9286	0.1964	0.0018	0.0654	0.0069	0.5407	0.4388	0.8697
086	0.2502	0.8765	0.9292	0.4467	0.0002	0.0469	0.0002	0.5409	0.4857	0.8699
365	0.0134	0.8933	0.9357	0.4601	0.05	0.014	0.0001	0.5908	0.4998	0.924
169	0.0975	0.8983	0.9526	0.5575	0.0599	0.0021	3.34E-05	0.6506	0.5019	0.924
003	0.3675	0.8976	0.9546	0.925	0.0131	0.0048	0.0002	0.6638	0.5084	0.9242

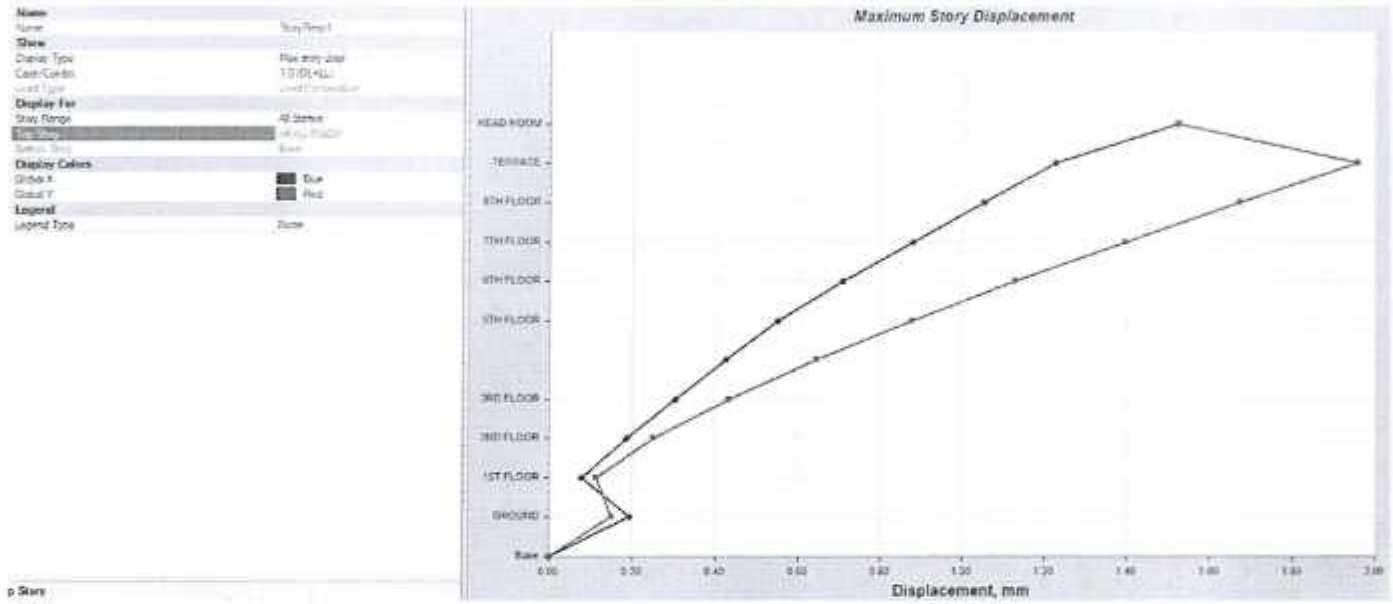
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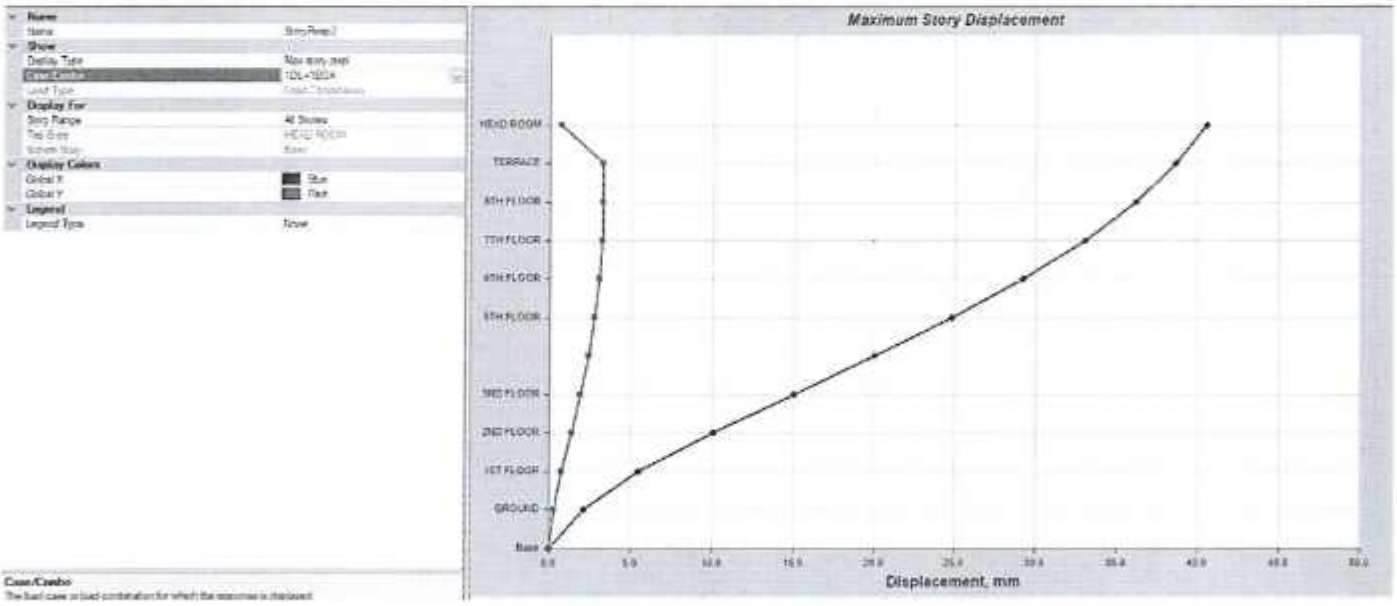
4.Permissible Drift Limits (INTER-STOREY DRIFT):

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 DL+LL

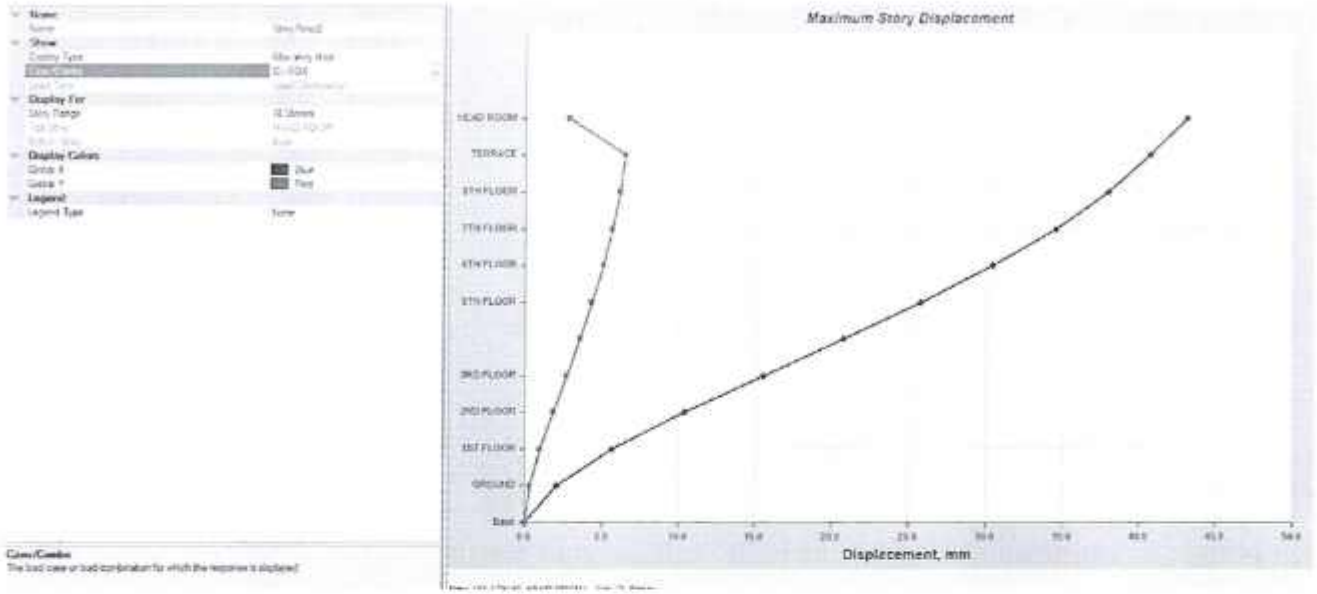


MAXIMUM STORY DISPLACEMENT IN DL+EQX

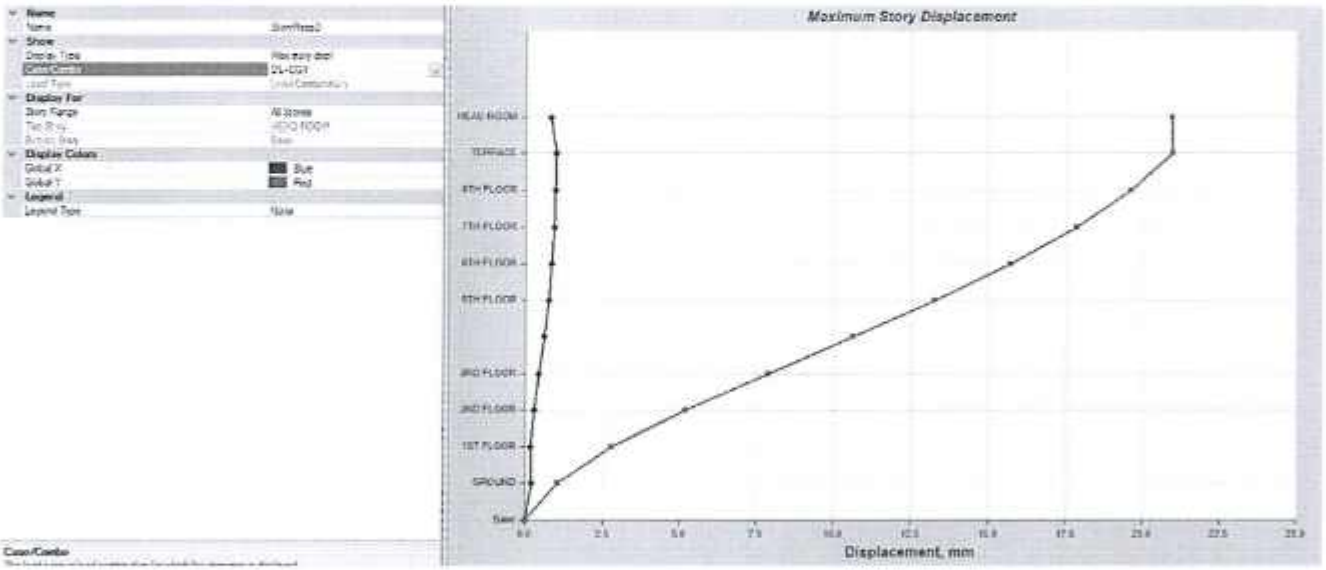


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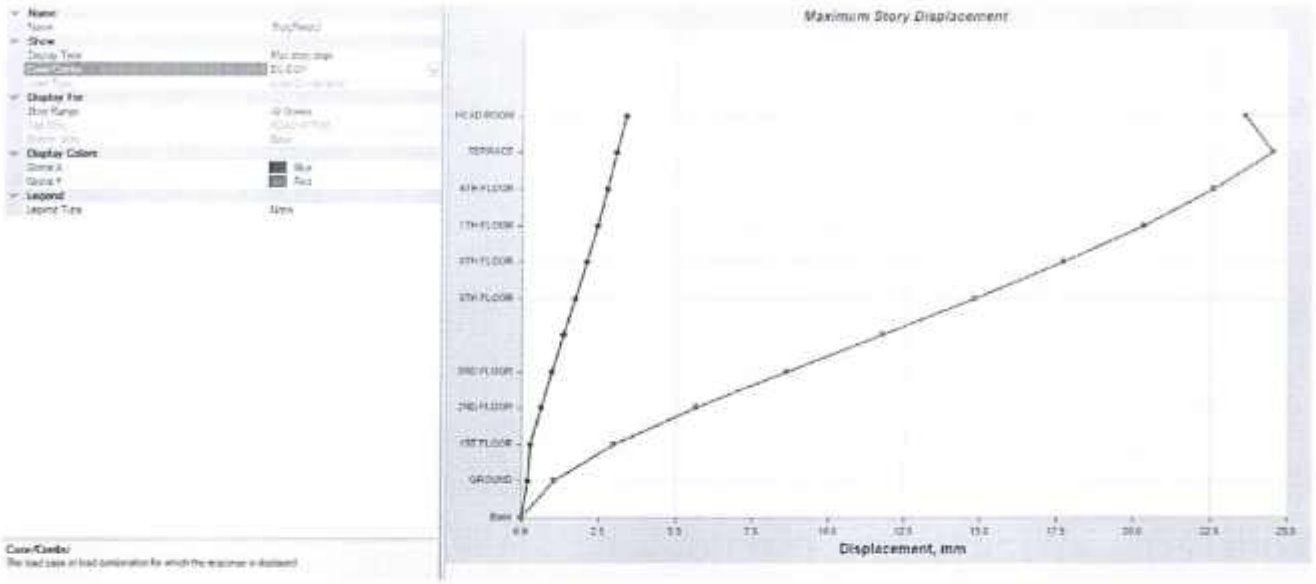
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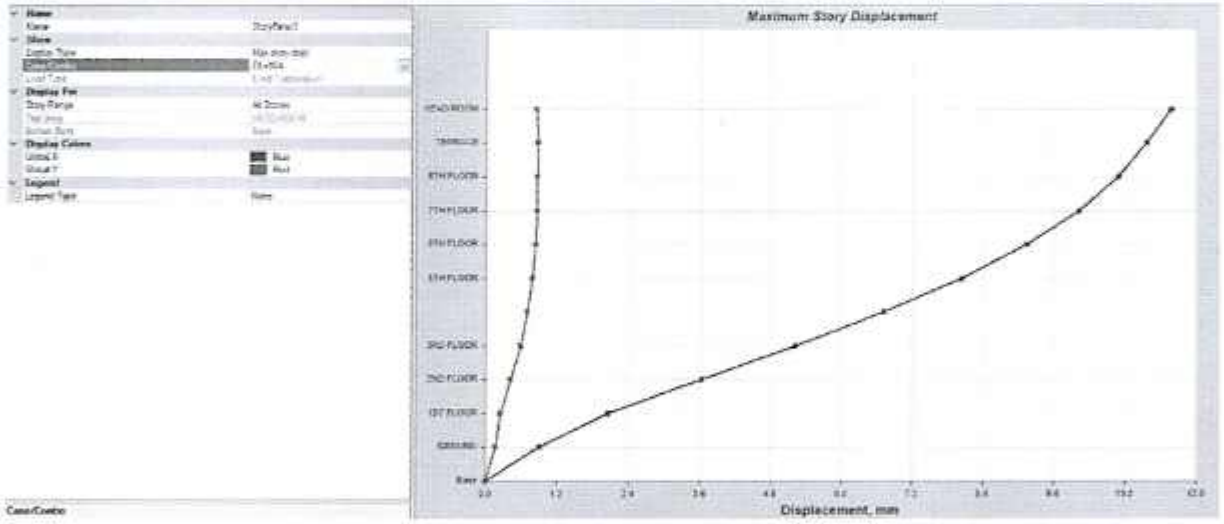
MAXIMUM STORY DISPLACEMENT IN DL+EQY



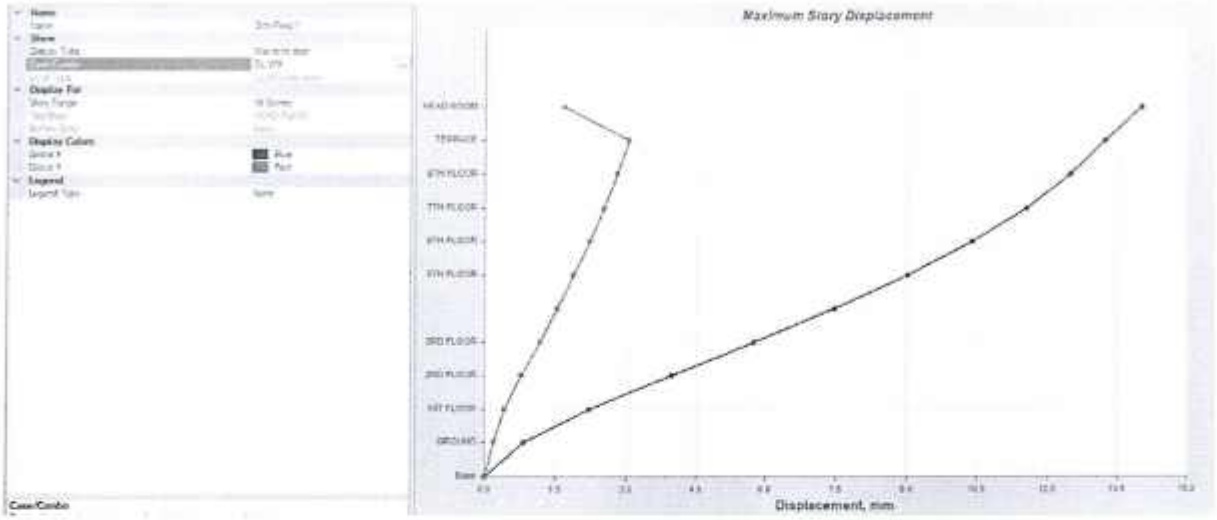
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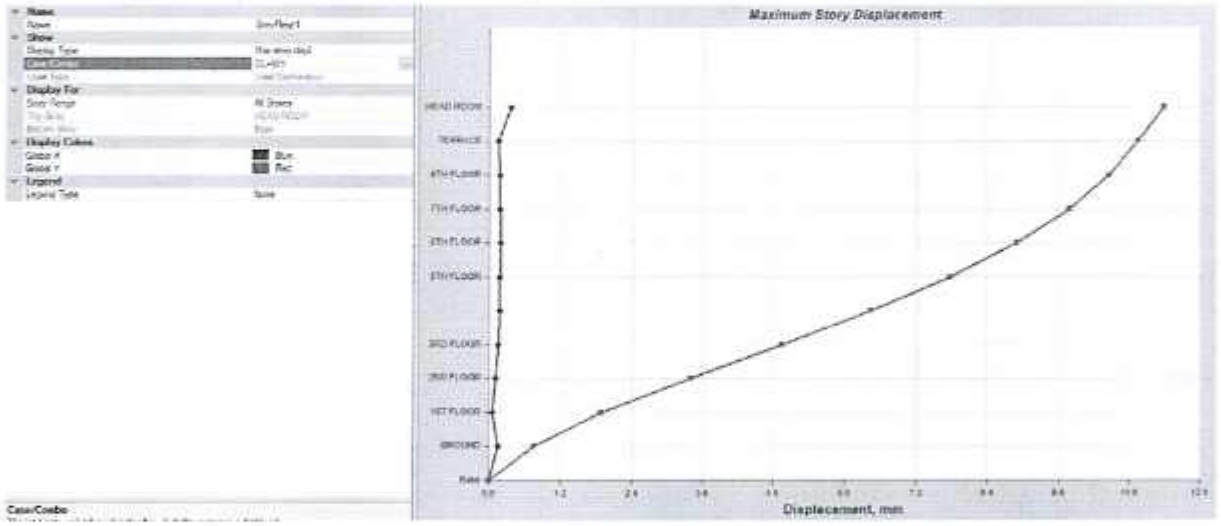
MAXIMUM STORY DISPLACEMENT IN DL+WX



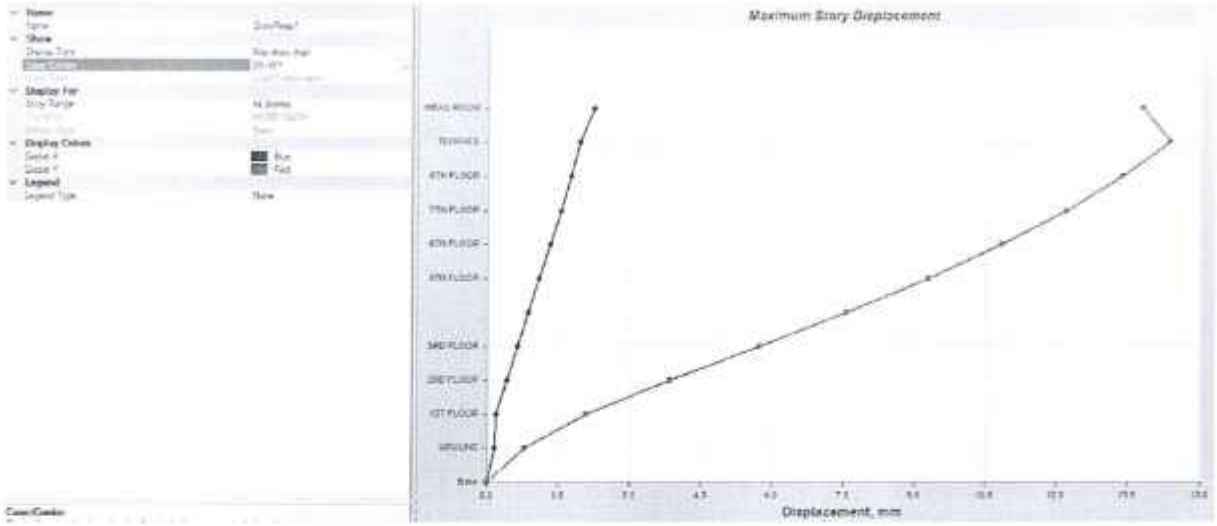
MAXIMUM STORY DISPLACEMENT IN DL-WX



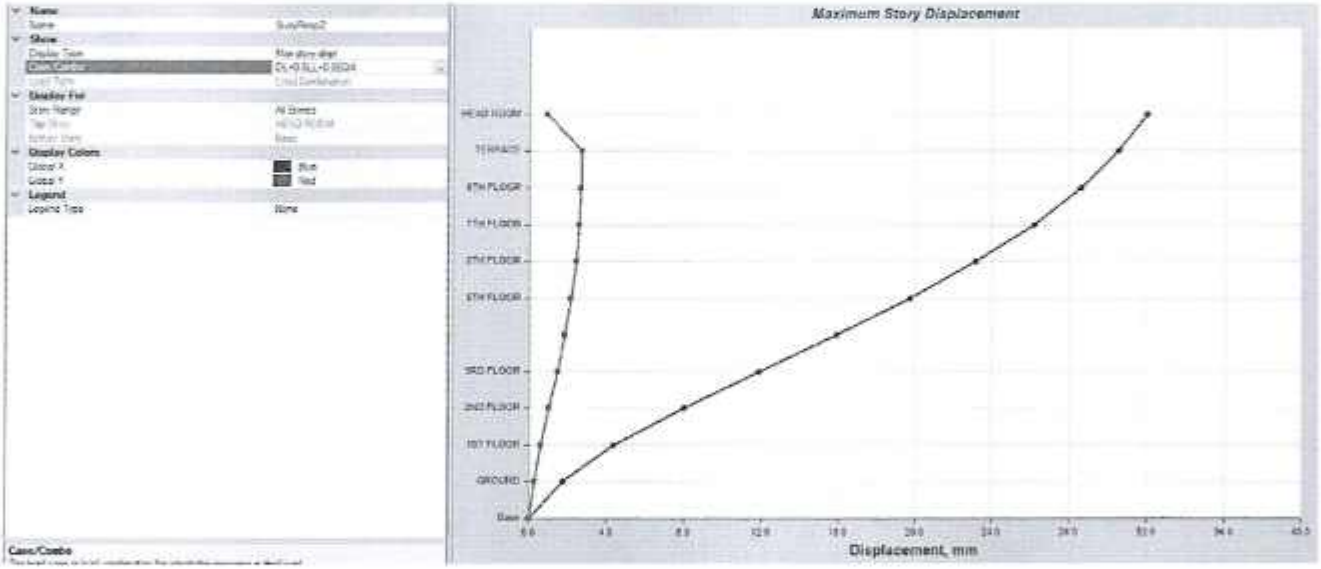
MAXIMUM STORY DISPLACEMENT IN DL+WY



MAXIMUM STORY DISPLACEMENT IN DL-WY

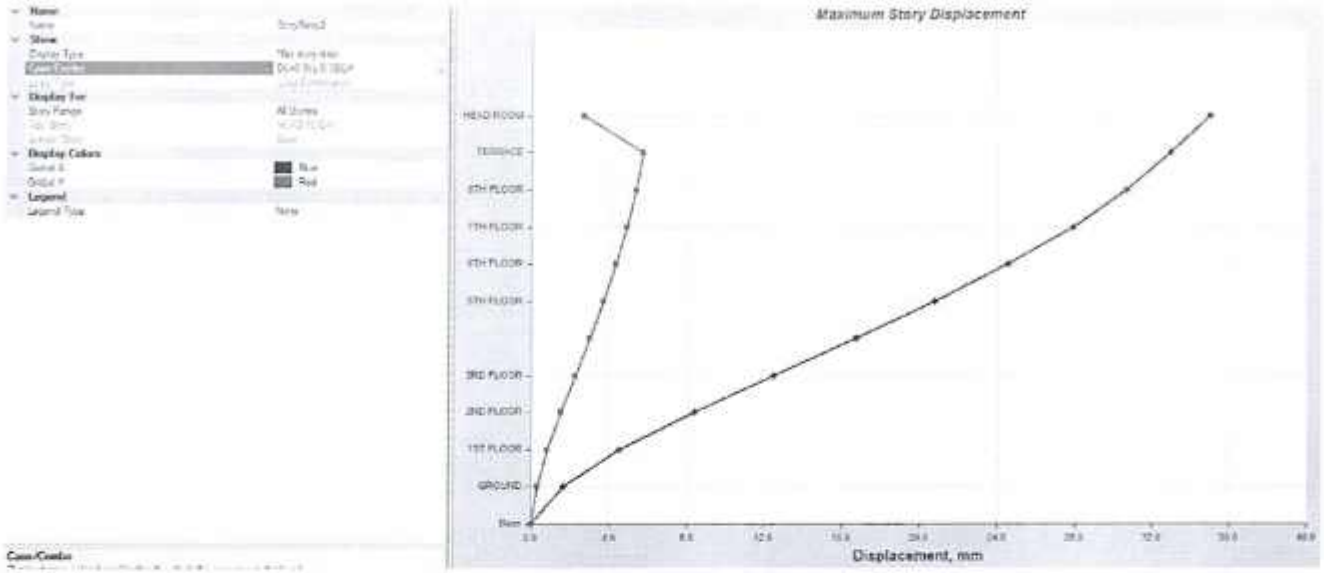


MAXIMUM DISPLACEMENT IN DL+0.8LL+0.8EQX

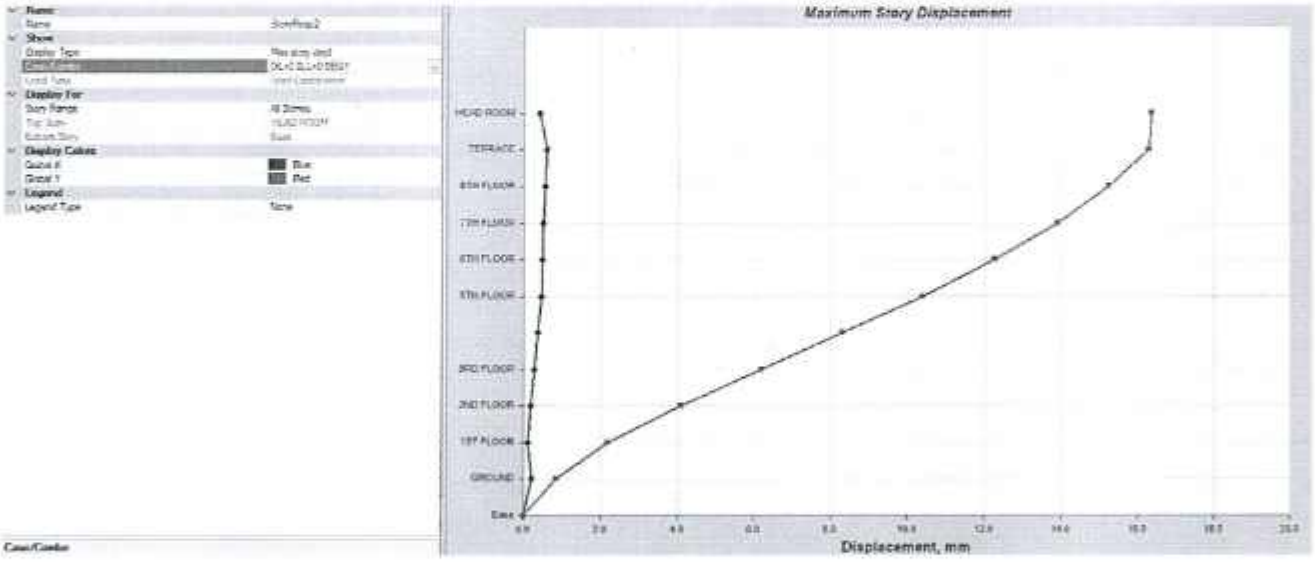


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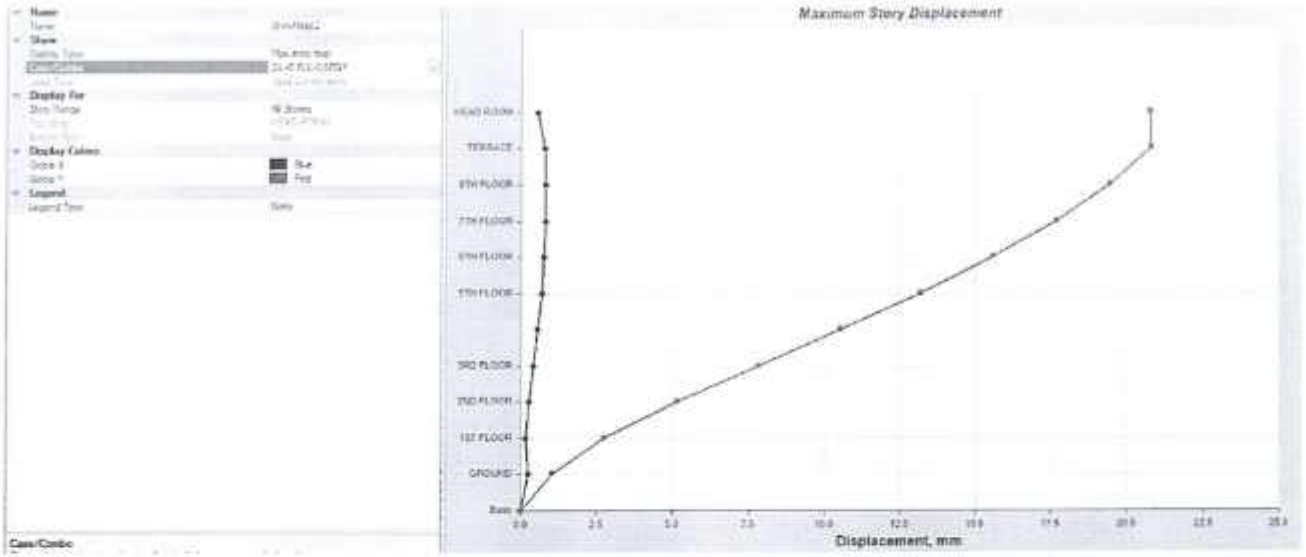
MAXIMUM DISPLACEMENT IN DL+0.8LL-0.8EQX



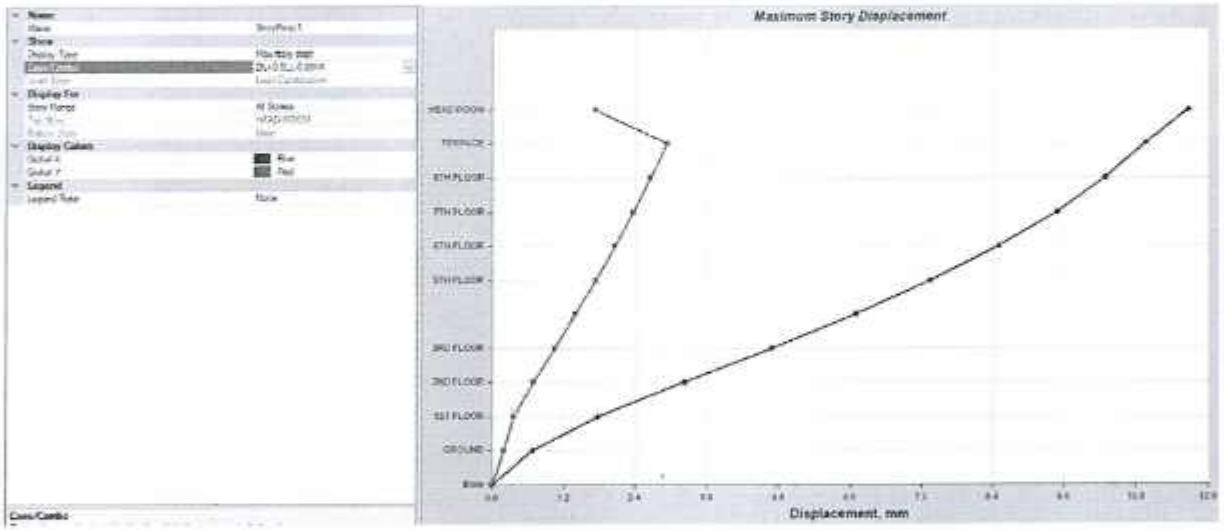
MAXIMUM DISPLACEMENT IN DL+0.8LL+0.8EQY



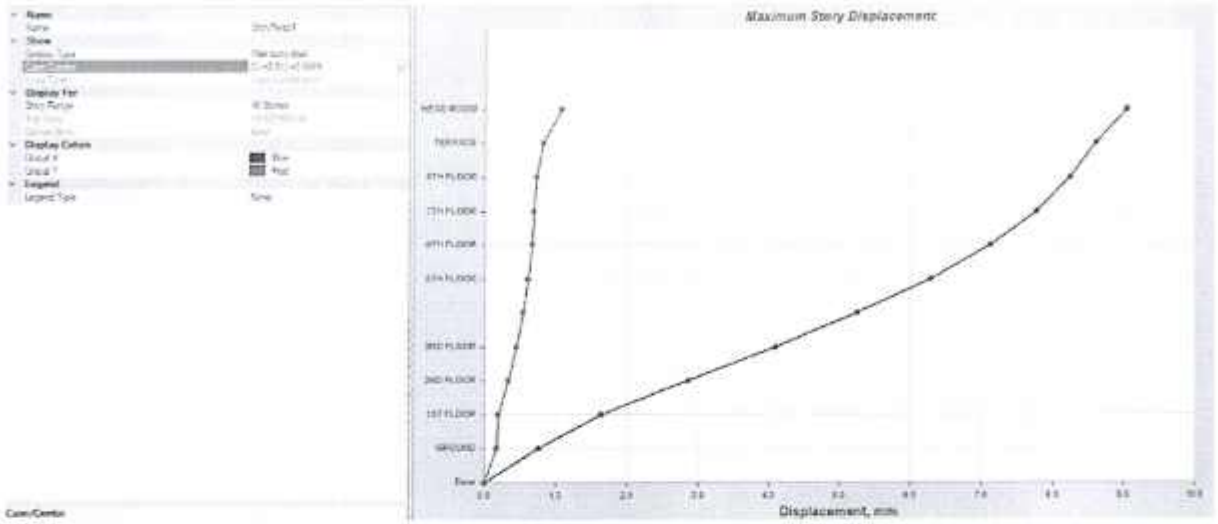
MAXIMUM STORY DISPLACEMENT IN DL+0.8LL-0.8EQY



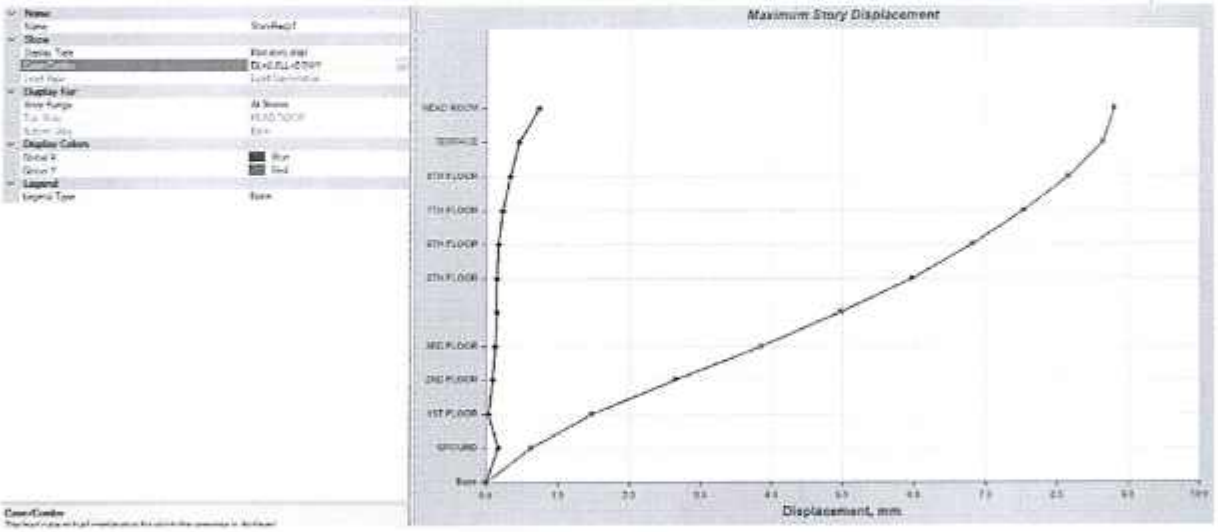
MAXIMUM STORY DISPLACEMENT IN DL+0.8LL+0.8WX



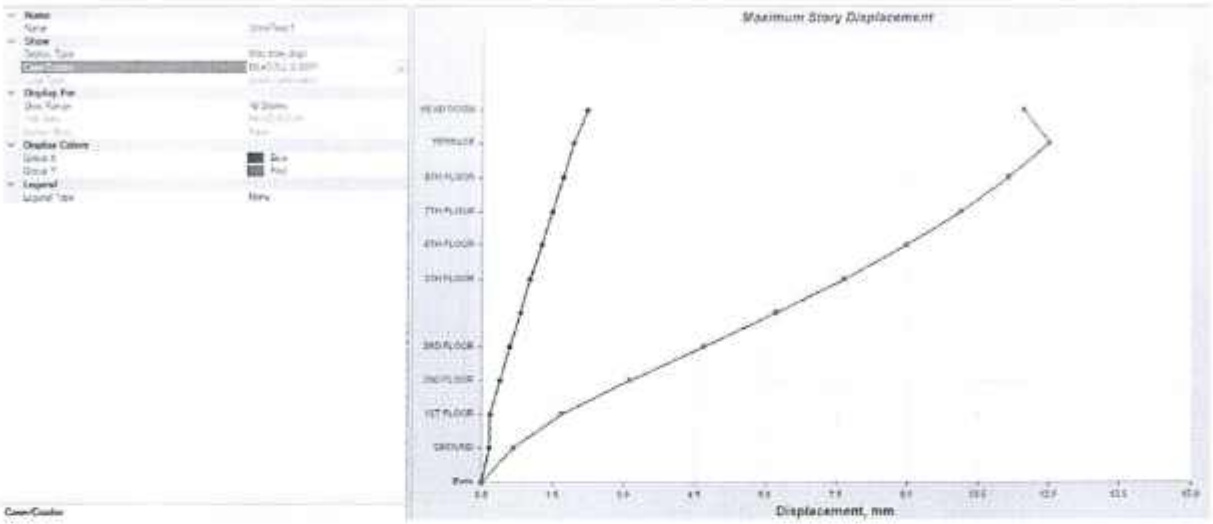
MAXIMUM STORY DISPLACEMENT IN DL+0.8LL-0.8WX



MAXIMUM STORY DISPLACEMENT IN DL+0.8LL+0.8WY



MAXIMUM STORY DISPLACEMENT IN DL+0.8LL-0.8WY



8.5.Permissible Drift Limits (OVERALL DRIFT):

Lateral sway due to wind load should not exceed H/500 (H is the total height of structure)

TABLE: Story Drifts					
Story	Output Case	Direction	Drift	H/500	CHECK
TERRACE	DL+WX	X	0.00021	0.06	OK
TERRACE	DL+WX	Y	0.000084	0.06	OK
TERRACE	DL+WY	Y	0.000217	0.06	OK
TERRACE	DL-WX	X	0.000253	0.06	OK
TERRACE	DL-WX	Y	0.000086	0.06	OK
TERRACE	DL-WY	X	0.000064	0.06	OK
TERRACE	DL-WY	Y	0.000334	0.06	OK
TERRACE	DL+0.8LL+0.8WX	X	0.000154	0.06	OK
TERRACE	DL+0.8LL+0.8WX	Y	0.00009	0.06	OK
TERRACE	DL+0.8LL-0.8WX	X	0.000223	0.06	OK
TERRACE	DL+0.8LL-0.8WX	Y	0.000092	0.06	OK
TERRACE	DL+0.8LL+0.8WY	X	0.000041	0.06	OK
TERRACE	DL+0.8LL+0.8WY	Y	0.000161	0.06	OK
TERRACE	DL+0.8LL-0.8WY	X	0.000072	0.06	OK
TERRACE	DL+0.8LL-0.8WY	Y	0.000291	0.06	OK

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8.6.Storey Stiffness and Strength(Soft Storey Check):

As PER 16700 : 2017 Parameters influencing stiffness and strength of the building should be so proportioned, that the following are maintained: a) Lateral translational stiffness of any storey shall not be less than 70 percent of that of the storey above. b) Lateral translational strength of any storey shall not be less than that of the storey above.

TABLE: Story Stiffness						
Story	Output Case	Stiff X	Shear Y	Check %	Required	Check
TERRACE	EQX	173834.185	0	178.6695		
8TH FLOOR	EQX	310588.588	0	120.3902	70%	Ok
7TH FLOOR	EQX	373918.244	0	108.4767	70%	Ok
6TH FLOOR	EQX	405614.33	0	106.0377	70%	Ok
5TH FLOOR	EQX	430104.174	0	104.8941	70%	Ok
4TH FLOOR	EQX	451154.06	0	106.8553	70%	Ok
3RD FLOOR	EQX	482081.849	0	112.1723	70%	Ok
2ND FLOOR	EQX	540762.063	0	130.9197	70%	Ok
1ST FLOOR	EQX	707963.83	0	181.9821	70%	Ok
GROUND	EQX	1288367.106	0	3.44E-08	70%	Ok
TERRACE	EQY	0	270356.264			
8TH FLOOR	EQY	0	495395.455	183.238	70%	Ok
7TH FLOOR	EQY	0	607911.82	122.7124	70%	Ok
6TH FLOOR	EQY	0	670877.164	110.3576	70%	Ok
5TH FLOOR	EQY	0	719361.756	107.227	70%	Ok
4TH FLOOR	EQY	0	766266.557	106.5203	70%	Ok
3RD FLOOR	EQY	0	832363.887	108.6259	70%	Ok
2ND FLOOR	EQY	0	953443.022	114.5464	70%	Ok
1ST FLOOR	EQY	0	1232299.175	129.2473	70%	Ok
GROUND	EQY	0	2605465.426	211.4312	70%	Ok

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8.7.Torsion Irregularity:

As per 1893 : 2016 In torsionally irregular buildings, When the ratio of maximum horizontal displacement at one end and the minimum horizontal displacement at the other end is, (i) In the range 1.5-2.0

Minimum Displacement in X 26.96 < 1.5	1.215 Ok
Maximum Displacement in X 32.77	
Minimum Displacement in Y 20.89 < 1.5	1.194 Ok
Maximum Displacement in Y 24.94	

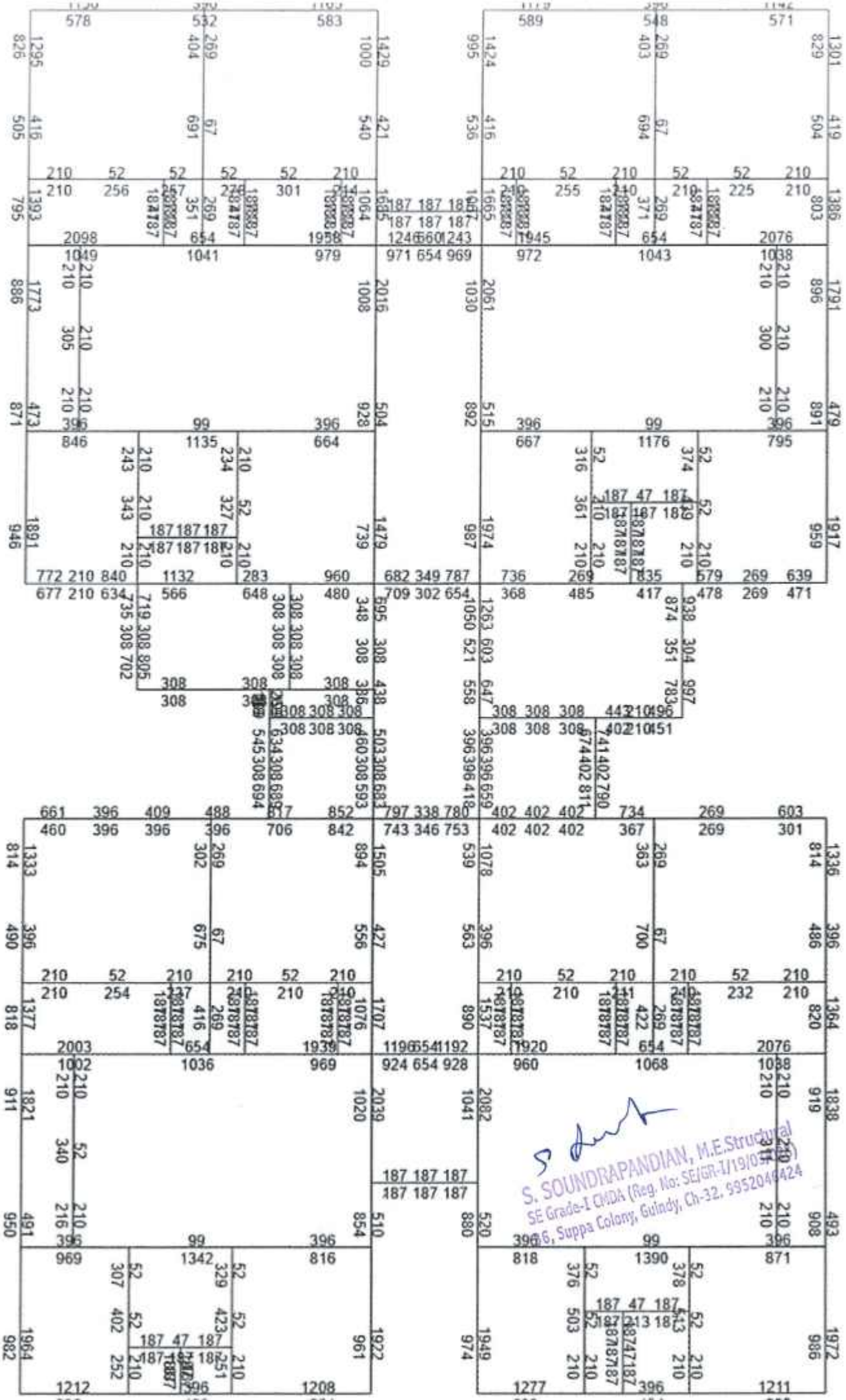
9.Detailing Requirements:

Detailing for the structural members shall be done in accordance with IS:456, SP:34, IS: 1893-2016, IS:13920-2016 taking R=5.

10.Value Engineering Exercise:

In order to optimize the material consumption, sample analysis and design exercises were undertaken with different combinations of member sizes and the required reinforcement and formwork. In short, these studies were undertaken to identify and analyze various options for a particular solution opportunity. 1.11 ANNEXURE: Kindly refer Cad drawings for all floors framing plans.

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18.COLUMN REINFORCEMENT FROM ETABS

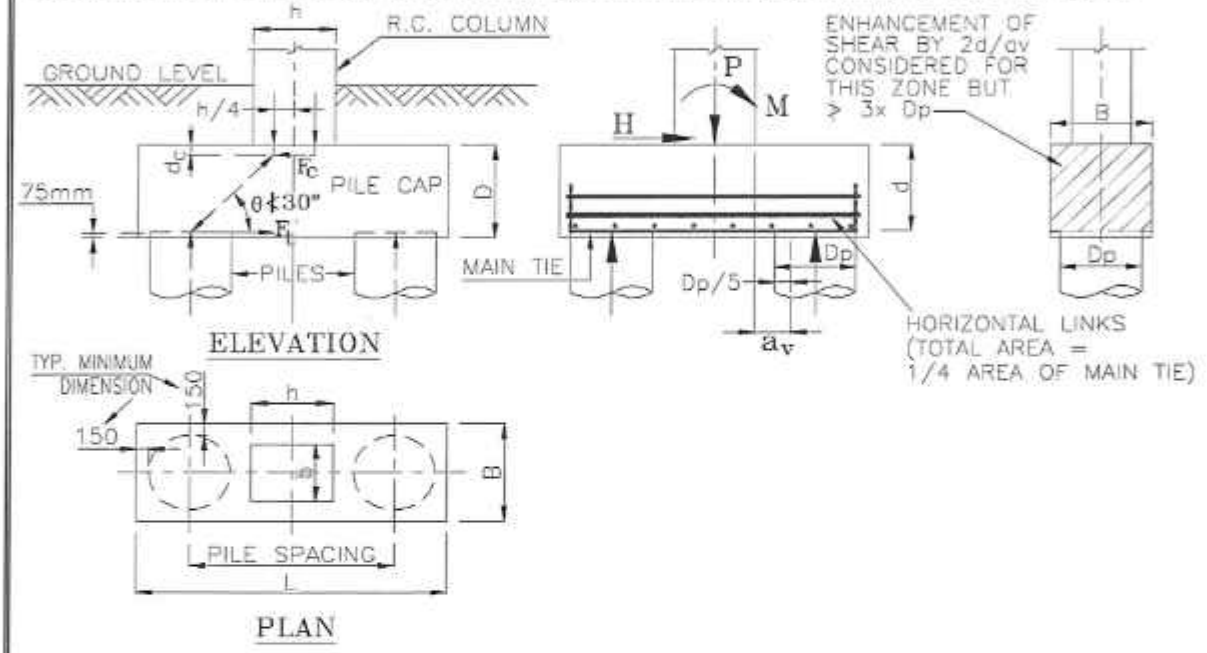
Command: Corner Columns Terrace Floor Reinforcement has been extended till foundation since terrace floor Reinforcement is being higher than the lower floors.

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Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.: Design by:	ABC U
Client:	India Builders	Date:	28-J
Project:	Temple colony	Page No.	PC

SPREADSHEET OF R.C. PILE CAP FOR 2 PILES AS PER IS:456-2000

Checks the adequacy of Pile Cap section for the applied loads, with the given concrete grade and type of



Pile Cap Size:

Pile Cap Mk.	Pile Cap Size (mm) L	B	D	Col. size(mm) h	b	Pile Details (mm) Dia.	Spacing	Cover (mm)	Pile capacity (kN)	Col. Loads (Service condn.) P(kN)	H(kN)	M(kNm	L C
2P1	2400	900	1300	300	600	600	1500	75	1000	1220	41	52	DL+IL+EQL
													DL +WL
													DL + EQL
													DL+IL+WL
													DL+IL+EQL
													DL + IL
													DL +WL
													DL + IL
													DL+IL+WL
													DL+IL+EQL

R

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		Design by:	U
Client:	India Builders	Date:	28-J
Project:	Temple colony	Page No.	PC

Reaction on Piles (Service Load condition):

Pile Cap Mk.	Soil Pressure on Pile Cap (kN/m²)	Soil Wt.over Pile cap (kN)	Pile Cap Weight (kN)	Total Vertica Load (kN)	Reaction on Piles (kN) Maximum	Minimum	Pile C St
2P1	0.0	0.00	70.20	1290.20	713.25	576.95	C
0		-	-	-	-	-	
0		-	-	-	-	-	
0		-	-	-	-	-	
0		-	-	-	-	-	
0		-	-	-	-	-	
0		-	-	-	-	-	
0		-	-	-	-	-	
0		-	-	-	-	-	
0		-	-	-	-	-	

Main Steel at bottom by Limit State Design

Pile Cap Mk.	Max. Pile Reaction, Pu (kN)	Conc. Gr. M	Steel, f_y (N/mm²)	Eff. d (mm)	d_c (mm)	θ (deg) ≥ 30°	Eff. width (mm)	Steel Tension F_t (kN)	A_{st}(mm²) reqd.	Steel(mm units) in Eff Nos	Φ(mm	A_{st}
2P1	855.90	30	500	1217	22.39	60.5	900	483.6	1112	6	16	1206
0	-	30	500	0	#####	#####	0	######	######			-
0	-	30	500	0	#####	#####	0	######	######			-
0	-	30	500	0	#####	#####	0	######	######			-
0	-	25	415	0	#####	#####	0	######	######			-
0	-	40	415	0	#####	#####	0	######	######			-
0	-	25	415	0	#####	#####	0	######	######			-
0	-	30	415	0	#####	#####	0	######	######			-
0	-	25	415	0	#####	#####	0	######	######			-
0	-	25	415	0	#####	#####	0	######	######			-

OTE: The transverse steel at bottom to be 0.15% of the total cross-sectional area for steel $f_y \leq 250$ and 0.12% of the total cross-sectional area for steel $f_y \geq 415$ N/mm², and the spacing of bars not to exceed 300mm

Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.:	ABC
		Design by:	U
Client:	India Builders	Date:	28-J
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Pile Cap Top Main Steel - Limit State Design

Pile Cap Mk.	Min. Pile Reaction, Pu (kN)	-ve BM at face of Col., Mu(kNm)	Eff.'d' (mm) provided	Ast reqd (mm^2)	Provide Top Main Steel Φ(mm)	Nos. Spacing(mm)	Min. Transver along B at top w Φ(mm	Spaci
2P1	692.34	0.00	1144	324.0	12	4 - 250	12	3
0	-	-	-	-	12	-	12	
0	-	-	-	-		-		
0	-	-	-	-		-		
0	-	-	-	-		-		
0	-	-	-	-	12	-	12	
0	-	-	-	-		-		
0	-	-	-	-		-		
0	-	-	-	-		-		
0	-	-	-	-		-		

Check for Shear:

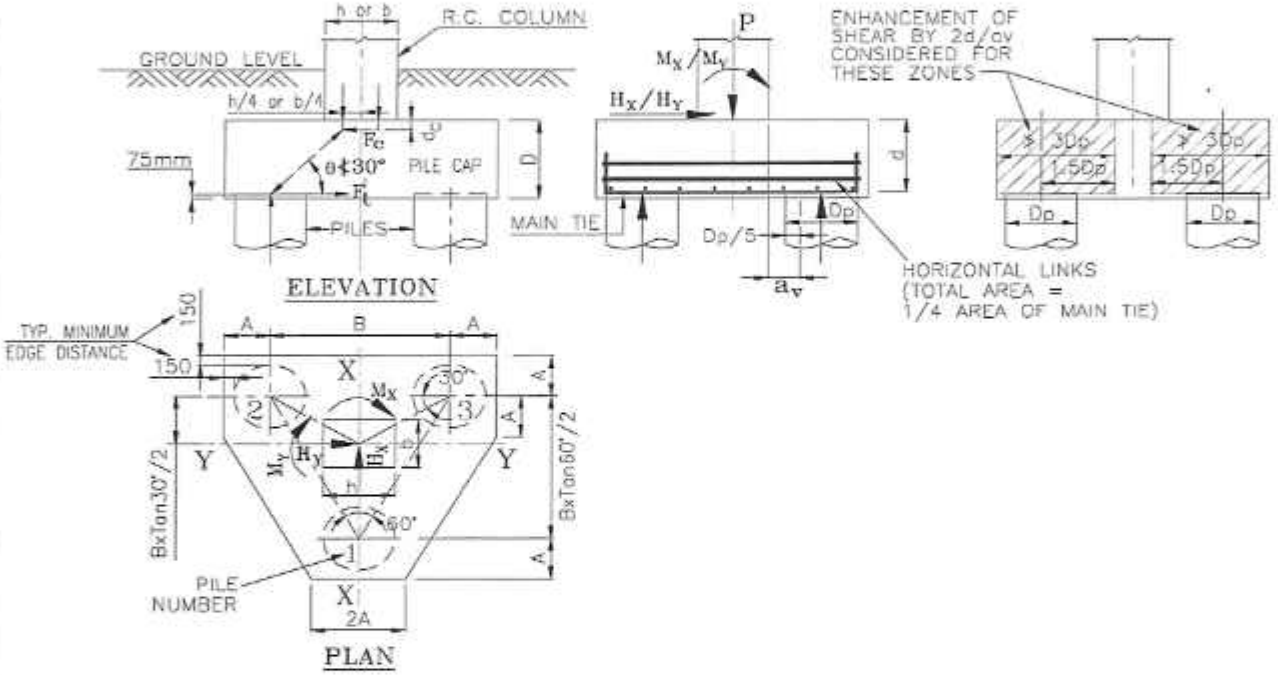
Pile Cap Mk.	Shear Force (kN)	Shear Stress τ_v (N/mm^2)	$100A_{st}$ / bd	a_v (mm)	Perm. Shear Stress $2d\tau_c/a_v$	Punching Shear (kN)	τ_v N/mm^2	Perm. τ_c (N/mm^2)	De St
2P1	402.91	0.368	0.110	420	1.477	1464	1.68	1.37	Secti
0	-	-	-	-	-	-	-	-	
0	-	-	-	-	-	-	-	-	
0	-	-	-	-	-	-	-	-	
0	-	-	-	-	-	-	-	-	
0	-	-	-	-	-	-	-	-	
0	-	-	-	-	-	-	-	-	
0	-	-	-	-	-	-	-	-	
0	-	-	-	-	-	-	-	-	
0	-	-	-	-	-	-	-	-	

Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.:	ABC
		Design by:	U
Client:	India Builders	Date:	28-J
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Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.:	ABC/1001
		Design by:	UVW
Client:	India Builders	Date:	28-Jan-23
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SPREADSHEET OF R.C. PILE CAP FOR 3 PILES AS PER IS:456-2000

Checks the adequacy of Pile Cap section for the applied loads, with the given concrete grade and type of Steel.



Pile Cap Size:

Pile Cap Mk.	Pile Cap Size (mm) A	B	D	Col. Size(mm) h	b	Pile Φ (mm)	Pile capacity (kN)	Column Loads (Service condn.) P (kN)	H_x (kN)	H_y (kN)	M_x (kNm)	M_y (kNm)	Load Case
3p1	450	1500	1300	300	900	600	1250	2556	157	50	36	52	DL+IL+EQL
3p2	500	1750	1500	300	900	700	1562	3192	52	61	156	66	DL+IL+EQL
													DL + EQL
													DL+IL+WL
													DL+IL+EQL
													DL + IL
													DL +WL
													DL + IL
													DL+IL+WL
													DL+IL+EQL

RCDesignCD

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35, Sriram Colony, Guindy, Ch.32. 9952046424

Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.:	ABC/1001
		Design by:	UVW
Client:	India Builders	Date:	28-Jan-23
Project:	Temple colony	Page No.	PC/102

Reaction on Piles (Service Load condition):

Pile Cap Mk.	Soil Pressure on Pile Cap (kN/m²)	Soil Wt.over Pile cap (kN)	Pile Cap Weight (kN)	Total Vertical Load (kN)	Reaction on Piles (kN)				Pile Capacity Status
					Max.-1	Max-2,3	Min.-1	Min-2,3	
3p1	18.0	72.60	139.86	2768.46	1110.9	1110.9	734.7	763.9	O.K.
3p2	18.0	95.79	209.69	3497.48	1258.3	1350.9	1073.4	980.8	O.K.
0		-	-	-	-	-	-	-	-
0		-	-	-	-	-	-	-	-
0		-	-	-	-	-	-	-	-
0		-	-	-	-	-	-	-	-
0		-	-	-	-	-	-	-	-
0		-	-	-	-	-	-	-	-
0		-	-	-	-	-	-	-	-
0		-	-	-	-	-	-	-	-

Main Steel at bottom by Limit State Design

Pile Cap Mk.	Max. Pile Reaction, Pu (kN)	Conc. Gr. M	Steel, f_y (N/mm²)	Eff. d (mm)	d_c (mm)	θ (deg) ≥ 30°	Eff. width (mm)	Steel Tension F_t (kN)	A_{st}(mm²) reqd.	Steel(mm units) in Eff. Width			
										Nos	ϕ (mm	A_{st}	Spacing
3p1	1333.08	30	500	#####	35.31	56.5	900	762.8	1753	6	20	1885	150
3p2	1621.03	30	500	#####	39.28	56.1	1000	942.7	2167	8	20	2513	120
0	-	25	415	-	-	-	0	-	-	5	32	-	-
0	-	25	415	-	-	-	0	-	-	9	25	-	-
0	-	25	415	-	-	-	0	-	-	9	25	-	-
0	-	40	415	-	-	-	0	-	-	8	32	-	-
0	-	25	415	-	-	-	0	-	-	5	25	-	-
0	-	30	415	-	-	-	0	-	-	4	25	-	-
0	-	25	415	-	-	-	0	-	-	5	25	-	-
0	-	25	415	-	-	-	0	-	-	8	32	-	-

RCDesignCD

Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.:	ABC/1001
		Design by:	UVW
Client:	India Builders	Date:	28-Jan-23
Project:	Temple colony	Page No.	PC/103

Pile Cap Top Main Steel by Limit State Design

Pile Cap Mk.	Min. Pile Reaction, Pu (kN)	-ve BM at face of Col., Mu(kNm)	Eff.'d' (mm) provided	Ast reqd (mm^2)	Top Steel in Eff. Width	
					Φ(mm)	Nos. Spacing(mm
3p1	881.69	0.00	1205	324.0	12	4 - 275
3p2	1288.06	0.00	1405	360.0		#DIV/0!
0	-	-	-	-	12	-
0	-	-	-	-		-
0	-	-	-	-		-
0	-	-	-	-	12	-
0	-	-	-	-		-
0	-	-	-	-		-
0	-	-	-	-		-
0	-	-	-	-		-

Check for Shear X-X:

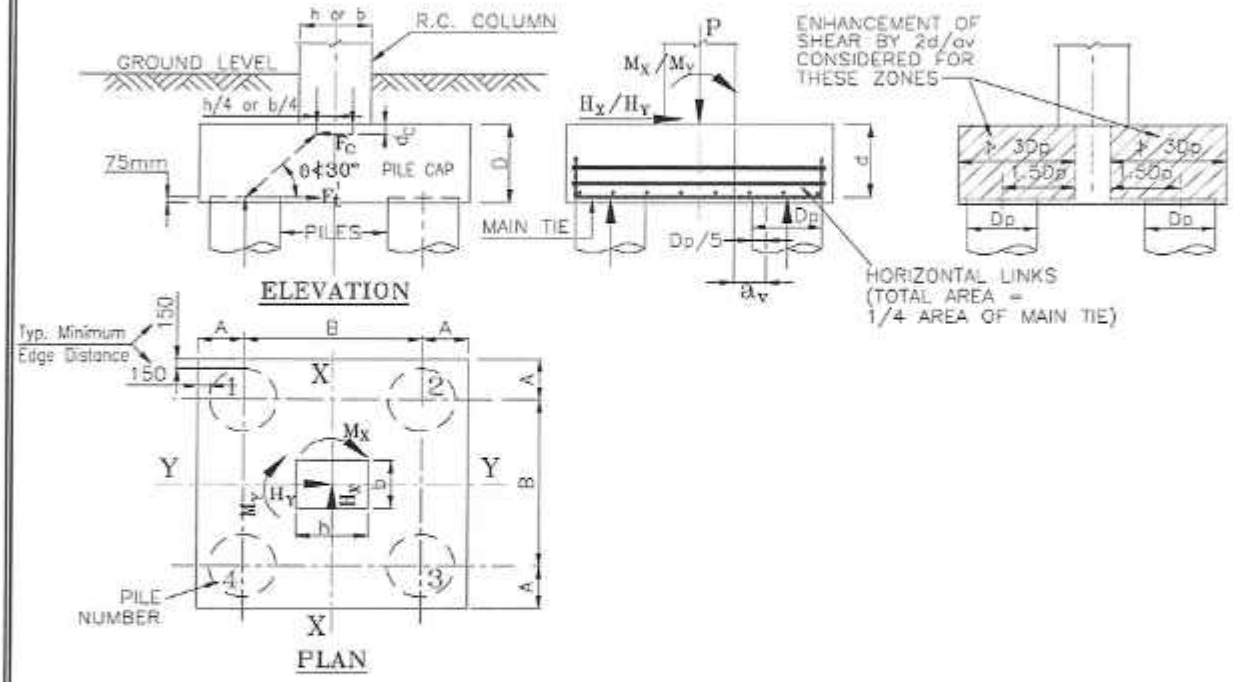
Pile Cap Mk.	Shear Force (kN)	Shear Stress τ_v (N/mm^2)	$100A_{st}$ / bd	a_v (mm)	Perm. Shear Stress $2d\tau_c/a_v$	Punching Shear (kN)	τ_v (N/mm^2)	Perm τ_c (N/mm^2)	Design Status
3p1	-8.82	-0.006	0.172	236	3.500	3067	N/A	-	Section O.K.
3p2	421.65	0.212	0.178	350	3.500	3830.4	0.34	1.14	Section O.K.
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-

RCDesignCD

Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.:	ABC/1001
		Design by:	UVW
Client:	India Builders	Date:	28-Jan-23
Project:	Temple colony	Page No.	PC/101

SPREADSHEET OF R.C. PILE CAP FOR 4 PILES AS PER IS:456-2000

Checks the adequacy of Pile Cap section for the applied loads, with the given concrete grade and type of Steel.



Pile Cap Size:

Pile Cap Mk.	Pile Cap Size (mm) A	B	D	Col. Size(mm) h	b	Pile Φ (mm)	Pile capacity (kN)	Column Loads (Service condn.) P (kN)	H_x (kN)	H_y (kN)	M_x (kNm)	M_y (kNm)	Load Case
4p2	500	1750	1500	300	900	700	1562	4545	95	142	369	182	DL+IL+EQL
4p3	600	2250	1900	300	900	900	2250	5745	150	144	371	295	DL +WL
													DL + EQL
													DL + IL
													DL+IL+EQL
													DL + IL
													DL +WL
													DL + IL
													DL+IL+WL
													DL + IL

RCDesignCD

S. SOUNDRAPANDIAN, M.E.Structural
SE Grade-I CMDA (Reg. No: SE/GR-1/19/03/028)
36, Suppa Colony, Guindy, Ch-32. 9952046424

Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.:	ABC/1001
		Design by:	UVW
Client:	India Builders	Date:	28-Jan-23
Project:	Temple colony	Page No.	PC/102

Reaction on Piles (Service Load condition):

Pile Cap Mk.	Soil Pressure on Pile Cap (kN/m^2)	Soil Wt.over Pile cap (kN)	Pile Cap Weight (kN)	Total Vertical Load (kN)	Reaction on Piles (kN)				Pile Capacity Status
					Pile-1	Pile-2	Pile-3	Pile-4	
4p2	18.0	131.27	283.59	4959.86	1167.4	1493.9	1312.5	986.0	O.K.
4p3	0.0	0.00	565.37	6310.37	1563.1	1844.8	1592.0	1310.4	O.K.
0	0.0	-	-	-	-	-	-	-	-
0	0.0	-	-	-	-	-	-	-	-
0	12.0	-	-	-	-	-	-	-	-
0	18.0	-	-	-	-	-	-	-	-
0	18	-	-	-	-	-	-	-	-
0	15	-	-	-	-	-	-	-	-
0	18	-	-	-	-	-	-	-	-
0	0	-	-	-	-	-	-	-	-

Main Steel at bottom by Limit State Design

Pile Cap Mk.	Max. Pile Reaction, Pu (kN)	Conc. Gr. M	Steel,f_y N/mm^2	Eff. d (mm)	d_c (mm)	θ (deg) $\geq 30^o$	Eff. width (mm)	Steel Tension F_t (kN)	A_{st}(mm^2) reqd.	Steel(mm units) in Eff. Width			
										Nos	Φ(mm	A_{st}	Spacing
4p2	1792.66	30	500	#####	31.4	50.7	1375	1036.5	2383	8	20	2513	185
4p3	2767.24	30	500	#####	39.5	50.1	1725	1636.5	3762	12	20	3770	150
0	-	40	415	-	-	-	0	-	-	21	32	-	-
0	-	35	415	-	-	-	0	-	-	9	16	-	-
0	-	25	415	-	-	-	0	-	-	9	16	-	-
0	-	40	415	-	-	-	0	-	-	17	20	-	-
0	-	25	415	-	-	-	0	-	-	9	12	-	-
0	-	30	415	-	-	-	0	-	-	11	12	-	-
0	-	25	415	-	-	-	0	-	-	8	16	-	-
0	-	35	415	-	-	-	0	-	-	9	16	-	-

Company's Name:	SOUNTHAR ASSOCIATES Guindy chennai-32	Job No.:	ABC/1001
		Design by:	UVW
Client:	India Builders	Date:	28-Jan-23
Project:	Temple colony	Page No.	PC/103

Pile Cap Top Main Steel - Limit State Design

Pile Cap Mk.	Min. Pile Reaction, Pu (kN)	-ve BM at face of Col, Mu(kNm)	Eff.'d' (mm) provided	Ast reqd (mm^2)	Top Main Steel each way	
					Φ(mm)	Nos. Spacing(mm)
4p2	2584.13	0.00	1419	990.0	12	10 - 285
4p3	4310.24	0.00	1819	1242.0	12	12 - 300
0	-	-	-	-	12	-
0	-	-	-	-		-
0	-	-	-	-		-
0	-	-	-	-	12	-
0	-	-	-	-		-
0	-	-	-	-		-
0	-	-	-	-		-
0	-	-	-	-		-

Check for Shear

Pile Cap Mk.	Shear Force (kN)	Shear Stress τ_v (N/mm^2)	$\frac{100A_{st}}{bd}$	a_v (mm)	Perm. Shear Stress $2d\tau_c/a_v$	Punching Shea (kN)	τ_v (N/mm^2)	τ_c (N/mm^2)	Design Status
4p2	291.55	0.075	0.129	215	3.500	5454	0.478	1.14	Section O.K.
4p3	1185.64	0.189	0.120	405	2.656	8618	0.49	1.14	Section O.K.
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-
0	-	-	-	-	-	-	-	-	-

17.SLAB DESIGN

		lg. Span (L_y)	sh. Span(L_x)
Panal size	=	**7.20**	**4.20**
f_{ck}	=	**20**	N/mm^2
f_y	=	**500**	N/mm^2

EDGE COND. **8** *ONE SHORT EDGE CONT.*

L_y/L_x	=	1.72		
(Assume D=	=	**140**	mm	
Dead load of the slab	=	D*25 =	3.50	*Kn/m^2*
Floor finishes	=		**2.00**	*Kn/m^2*
Live load	=		**2.00**	*Kn/m^2*
Total load (w)	=		7.50	*Kn/m^2*

α_x(-ve) = 0.0000

α_x(+ve) = 0.0857

α_y(-ve) = 0.0570

α_y(+ve) = 0.0430

The Factored Moments are

			Moment in KNm	*Ast in m^2*	*8 tor mm c/c*	*10 tor mm c/c*	*12 tor mm c/c*
Mx(-ve) =	α_x(-ve) *$w*l_x^2*1.5$	=	0.00	0	#DIV/0!	#DIV/0!	#DIV/0!
Mx(+ve) =	α_x(+ve) *$w*l_x^2*1.5$	=	17.00	390	129	201	515
My(-ve) =	α_y(-ve) *$w*l_x^2*1.5$	=	11.31	280	180	281	719
My(+ve) =	α_y(+ve) *$w*l_x^2*1.5$	=	8.53	207	243	379	971
			min Ast	168	299	467	673
			max spacing		300	300	300

d_{req} = *SQRT($(M_u*10^6)/(0.138*f_{ck}*b)$)* = 78 *mm*

D_{prov} = 140 *mm*

dx_{prov} = 110 *mm*

dy_{prov} = 100 *mm*

Provide **140** mm Thk **10** tor @ **100** mm c/c in Shorter direction &
10 tor @ **200** mm c/c in longer direction

Check for Deflection :

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Percentage of Tension renforcement @ mid span	=	0.71			
f_s $=0.58*f_y*$ *Area of c/s of steel required* / *Area of c/s of steel provided*	=	144	N/mm^2		
asic span/eff depth ratio for continuous abs	=	26.00			
Modification factor	=	1.60			
Coefficient for max ratio of span/eff depth	=	42			
Effective Depth required	=	101	<	110	*mm*

SAFE

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