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A. PERAMAIYAN (M.E. Struct., M.I.E.,)
Registered Structural Engineer,
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STABILITY CERTIFICATE

1. The detailed engineering and structure design of the proposed Residential Building comprising of Stilt Floor + 5 Floors + Roof at New Door No: 1/4 , Old Door No: 9, Kothari Road, Nungambakkam, Chennai -600034, Comprised in old R.S No: 537/1 and R.S No: 537/15, Block No: 30, Nungambakkam Village, Greater Chennai Corporation, Division: 110, Zone: IX, has been done by me/us based on the Soil Investigation Report No. GEC-JC-GT-6015/2024-2025 dated 17-05-2025, carried out by M/s. Geo Engineering Consultants, Chennai.

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

3. I/We further certify that:

(i) The minimum grade of concrete is M30.

(ii) The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS Codes No. IS 875 Part 1 to 2, wind forces as per IS 875-2015 (Part3) and design of earthquake resistant structure as per IS Code No. IS 1893-2016.

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

Date : 10-07-2025
Place : Chennai-600 020

Encl.: Structural Design Calculation

Stamp and Signature

A. PERAMAIYAN, M.E., (Struct.), M.I.E.
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No. SE/GR-I/19/03/026
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STRUCTURAL DESIGN BASIS REPORT

THE PROPOSED RESIDENTIAL BUILDING CONSIST OF STILT FLOOR + 5 FLOORS + ROOF AT NEW DOOR NO: 1/4 , OLD DOOR NO: 9, KOTHARI ROAD, NUGAMBAKKAM, CHENNAI -600034. COMPRISED IN OLD R.S NO:537/1 AND R.S NO: 537/15, BLOCK NO: 30, NUNGAMBAKKAM VILLAGE, GREATER CHENNAI CORPORATION. DIVISION: 110, ZONE: IX.

CLIENT:	M/S AMARA HOMES, CHENNAI.
ARCHITECT:	KASA DESIGN COLLECTIVE ADYAR , CHENNAI.
STRUCTURAL CONSULTANT:	**BURO ENGINEERS (I) PVT LTD,** CHENNAI.

A. PERAMAIYAN, M.E., (Struct.), M.I.E.
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R0	01-07-2025	Design Basis Report	OKAY	PRATHAP	PERAM	PERAM
REV NO.	DATE	DESCRIPTION	STATUS	PREPARED BY	REVIEWED BY	APPRVD. BY

Index

- Design Information and criteria
- 3D Model & Analysis summary report
- Design of Pile cap
- Design of Shear Wall
- Design of Beam
- Design of Slab

DESIGN INFORMATION AND CRITERIA

1.0 INTRODUCTION

M/s. Amara Homes, proposed to construct a Residential building at T.Nagar, Chennai within the limits of Greater Chennai Corporation. Architecturally it is designed with ground floor +5 floors in which the ground are designed to facilitate car parking. All other floors are designed for Residential use.

1.1 Scope of the Report

This report provides the information on Codes of Practice, Design loads, Materials considered for the Design and Analysis of the building. In addition, this report summaries the main design criteria, Structural system, Foundation system, Parameters & Methodology to be adopted in the design.

1.2 Project Overview

The proposed Residential Apartment building comprises of stilt floor+ 5 floors + Roof. Plan dimension of the building at ground it is 14.13mx26.05m. Vertical access systems like Lift & Staircases are provided adequately & at the right location in order to fulfil the NBC norms and to satisfy the functional requirements as well. The building height & its storey details are as follows,

Sl. No.	No. Of Storey	Building Height	Plan dimension at Stilt /Typical floor Level	Remarks
1	Stilt Floor	18.3 (measuring from Stilt floor to roof)	25.32X24.47	With covered car parking
2	1st floors +Typical floor+ Roof	18.3 (measuring from Stilt floor to roof)	26.24X26.13	Without covered car parking

Building Floor Height Details	Stilt + 5 Floors + Roof
Stilt Floor (Car Parking)	3.05m
1st Floor to roof Floors	3.05m
Head Room	3.05m
LMR	2.50m (from head room)

1.3 Proposed Structures and its Usage.

1.3.1 Structural Type

The building structures are mainly cast in situ reinforced concrete structure. The structural system comprises of R.C walls/Columns as vertical supporting structural elements with RC conventional

Beam-slab system. Foundation is designed with Bored Cast In-situ Pile foundation as per sub-soil condition.

1.3.2 Foundation Type

The foundation system For the kind of proposed structure and the sub soil conditions, it is not possible to adopt any kind of open foundation system from both shear and settlement considerations. Hence, it is advisable to adopt deep pile foundation system.

The Foundation will be designed for the recommended Working compression Capacity as laid down in the Soil Investigation report no GEC-JC-GT-6015/2024-2025 dated 17-05-2025, is carried out by M/s. Geo Engineering Consultants situated at # 15, 2ndFloor, Murphy Das Street, Dr. Seethapathy Nagar, Velachery, Chennai.

1.4 Concrete

Characteristic concrete strength (concrete grade) for the project shall be based on exposure condition and forces to be supported by specified structural elements. The minimum cement content and maximum water–cement ratio shall be as per IS code 456:2000. The minimum 28-day compressive strength of concrete for specified structural elements shall be as follows

Table 1.4.1 Grade of Concrete for Individual Structural elements of Tower/Non-Tower areas

Sl.No.	Structural Elements	Grade of Concrete
1.	Pile	M30
2.	Pile Cap	M30
3.	RC Shear wall	M30
4.	RC Columns	M30
5.	RC Beams	M30
6.	RC Slabs	M30
7.	PT Slab/PT Beams	M35

Table 1.4.2 Concrete Properties

Young's Modulus of Elasticity of Concrete	$5000\sqrt{fck}$
Poisson Ratio's Ratio v =	0.2
Coefficient of Thermal expansion	5.5x10-6

1.4.3 Reinforcement

The characteristic tensile properties of steel used in design shall be as follows.

Reinforcement Characteristic yield strength f_{yk} (N/mm²)	**550 N/mm²**
Welded Steel Fabric yield strength $f_{0.2k}$ (N/mm²)	485 N/mm²
Young's Modulus E (kN/mm²)	200 kN/mm²
Poisson's ratio	0.3
Coefficient of Thermal expansion, α (°C⁻¹)	$12x10^{-6}$

1.4.4 Structural steel

All structural steel shall conform to Indian standard IS: 2062-2011.

Structural steel	Grade E=250	Grade E-350
Tensile strength	410 N/mm^2	490 N/mm^2
Yield stress t<20mm	250 N/mm^2	350 N/mm^2
Yield stress t = 20mm to 40mm	240 N/mm^2	330 N/mm^2
Yield stress t> 40mm	230 N/mm^2	320 N/mm^2
Young's Modulus (E)	200,000 N/mm^2	200,000 N/mm^2
Density	78.5 kN/m^3	78.5 kN/m^3

1.5 SUB-SOIL CONDITION

Soil Investigation report no. GEC-JC-GT-6015/2024-2025 dated 17-05-2025 was carried out by M/s. Geo Engineering Consultants, Chennai. Field investigation carried out for three (3) soil investigation boreholes of 150mm . diameter up to 24m depth or up to the refusal strata with SPT>100 Taking the recommendation given by the soil consultant in to consideration, the building is designed with deep pile foundation system i.e. Bored Cast in situ piles are recommended as the suitable foundation system.

As per the evaluation reported by the geotechnical consultant the sub-soil in the project site is not susceptibility to "Liquefaction".

Refer the soil report for detailed profile of boreholes and the sub soil conditions.

2.0 DESIGN CRITERIA

2.1 DESIGN LIFE

The design life of the building is assumed as 50 years. This requirement is applicable only for concrete works and not applicable to replaceable finishing materials, water proofing and thermal insulation, facades etc. Hence periodic maintenance/refurbishment is required for all replaceable materials.

2.2 CODES, STANDARDS & REFERENCES

All design of structures shall comply with the requirements specified in the following.

a. Relevant Indian Standard Codes of Practice
b. National Building Code.
c. Local Building regulations.
d. Other relevant International codes where required.

All applicable latest editions of codes and standards will be referred and adopted in the analysis of structures and the design and detailing of structural members. All structural elements design shall be carried out primarily based on Indian Standards and Codes with latest revision, with amendments if any, as on date. In addition, other international codes and standards shall also be referred when required and relevant.

In the analysis, design and detailing of the building, the following Indian Standard codes of latest amendment will be used.

Table 2.2.1 Codes and Standards for Design Loads (Other Than Earthquake loads)

IS Code	Description
IS 875 (Part 1): 1987	Dead Loads (Unit Weight of Building Material and Stored Material)
IS 875 (Part 2): 1987	Imposed Load
IS 875 (Part 3): 2015	Wind Load
IS 875 (Part 5): 1987	Special Loads and Combinations

Table 2.2.2 Codes and Standards for Design of Earthquake Resistance structures

IS Code	Description
IS 1893(Part-1) :2016	Criteria for Earthquake Resistance design of structures.
IS 4326: 1993	Earthquake Resistant Design and Construction of Buildings – Code of Practice
IS 13920: 2016	Ductile Detailing of Reinforced Concrete Structures subject to Seismic Forces - Code of Practice.

Table 2.2.3 Codes and Standards for Design of Concrete Structures

IS Code	Description
IS 456: 2000	Plain and Reinforced Concrete - Code of practice
IS 6403 -1981	Code of practice for determination of bearing capacities of shallow foundations.
IS 8009-1976 (Part I):	Code of practice for calculation of settlement of foundations – Shallow foundation
IS 1904-1986(RA-2015)	Indian Standard Code of practice for design & construction foundations in Soil: General Requirements
IS 2950-1981(RA-2018)	Code of practice for design and construction of raft foundations : Part 1 Design (second revision).
IS 1080-1985(Raf.2011)	Code of Practice for Design and Construction of Shallow foundation in Soils
IS 6403-1981(Raf.2011)	Code of practice for determination of bearing capacity of Shallow foundations
IS 2950-1981(Raf.2011)	Code of Practice for Design and Construction of Raft foundations
SP 16	Structural use of concrete, Design charts for singly reinforced beams, doubly reinforced beams and columns.
SP 34	Hand book on Concrete Reinforcement & Detailing
SP 7(Part IV)	National Building code of India
IS 1786-2008(RA-2018)	Specification for high strength deformed bars and wires for concrete Reinforcement.
IS 432 (Part 2) 1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete reinforcement – Hard Drawn Steel Wire
IS 3370 (part I)-2009	Code of practice for concrete structure for the storage of liquids

The building is a RCC structure designed with Structural wall System. The slabs of all floor is used as diaphragms in redistribution of lateral forces.

Materials specified will conform 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.

2.3 LOADS

Table A: Unit Weight of Materials:

Material	Density
Reinforced Cement Concrete	25.00 kN/m^3
Plain Cement Concrete	24.00 kN/m^3
Screed Concrete	24.00 kN/m^3
Cement Mortar	20.00 kN/m^3
AAC	**7.5 kN/m^3**
Structural Steel	78.50 kN/m^3
Cinder Concrete (Filling material)	08.00 kN/m^3
Dry soil	18.00 kN/m^3
Wet Soil	22.00 kN/m^3
Landscape soil	16.00 kN/m^3
Glass	28.00 kN/m^3
water	10.00 kN/m^3

2.3.1 Superimposed Dead Loads and Live Loads

The following are the imposed loads such as SDL and LL to be considered for the design of floor system depending usage floor. In addition to these loads, self-weight of structural elements will be considered depending on member sizes shown in the floor plans.

First Floor (1st Floor) to (5th floor) (Living/Bedroom/Dining/Kitchen)		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.2	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition/Filling Load	0.0	0.0
Total	**1.2**	**2.0**
First Floor (1st Floor) to (5th floor) (Toilet)		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes + Filling Load	3.2	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition Load	0.0	0.0
Total	**3.2**	**2.0**
First Floor (1st Floor) to (5th floor) (Corridor/Lobby)		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.2	0.0

Services load (ceiling)	0.0	0.0
Live Load	0.0	3.0
Partition Load	0.0	0.0
Total	**1.2**	**3.0**
First Floor (1st Floor) to (5th floor) (Servant Room)		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes + Filling Load	1.2	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition Load	0.0	0.0
Total	**1.2**	**2.0**
First Floor (1st Floor) to (5th floor) (Balcony)		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes + Filling Load	4.2	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	3.0
Partition Load	0.0	0.0
Total	**4.2**	**3.0**
Roof		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes (weathering courses)	3.0	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	3.0
Partition Load	0.0	0.0
Total	**3.0**	**3.0**
LMR		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	15.0	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition Load	0.0	0.0
Total	**15.0**	**2.0**
OHT		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	25.0	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition Load	0.0	0.0
Total	**25.0**	**2.0**

In the analysis and design reduction to imposed load (Live load) shall be considered as per IS 875 Part (2), clause.3.2 where it is applicable.

2.4 WIND LOAD

Design wind load for the buildings shall be estimated as per IS 875 (Part 3): 2015. Design wind speed (Vz) is based on such as location, basic wind speed, terrain, cyclone condition and topography.

Location of the building	Chennai
Basic Wind speed - Vb m/sec	50 m/sec
Risk Coefficient (Probability factor) -k1	1.0
Terrain factor (Terrain-2) – k2	1.062
Topography factor – k3	1.0
Importance factor (Cyclonic region) – k4	1.0

Design wind speed (Vz) = Vb*k1*k2*k3*k4 =50x1.0x1.062x1.0x1.0 = 53.1m/sec

Wind pressure (Pz) = 0.6 Vz^2 = 0.6x 53.1^2 =1692 N/m^2

For design of building wind pressure 1.69 kN/m^2 is considered.

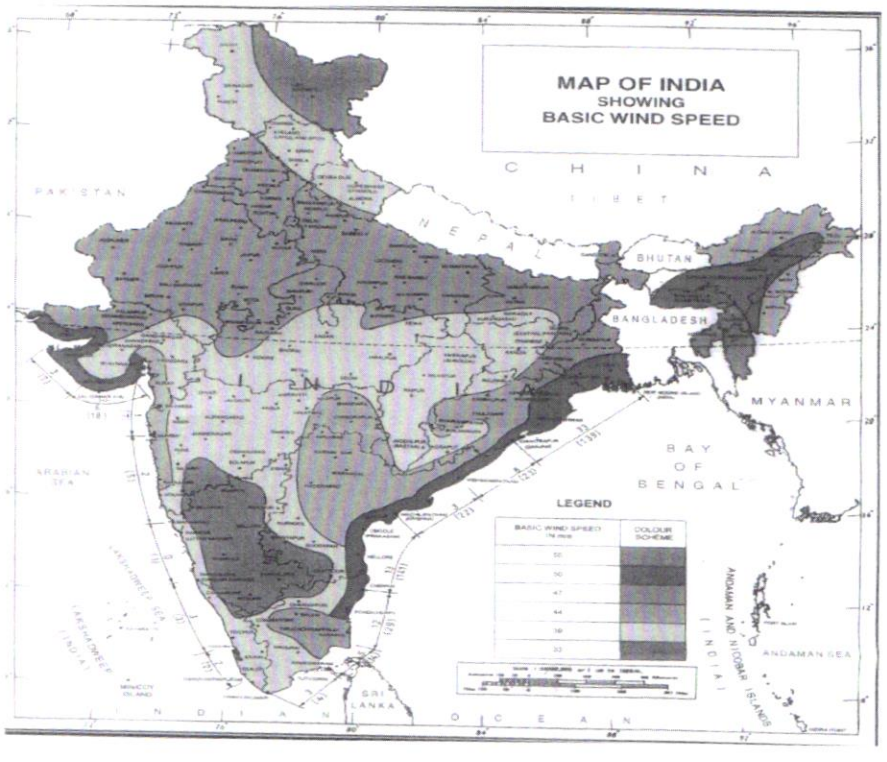
Design wind pressure (P_d) = K_d*K_a*K_c*P_z

Where K_d - Wind Directionality factor = 1.0

Ka – Area averaging factor = 0.9

Kc – Combination factor = 0.9

Design Wind pressure = 2.05x1.0x0.9x0.9 = 1.66 kN/m^2



2.5 SEISMIC LOAD

Design of lateral force under seismic condition shall be as per IS1893 – 2016. Total lateral force (base shear) of the building shall be estimated as per clause 7.2.1 of IS1893 – 2016 which provides by

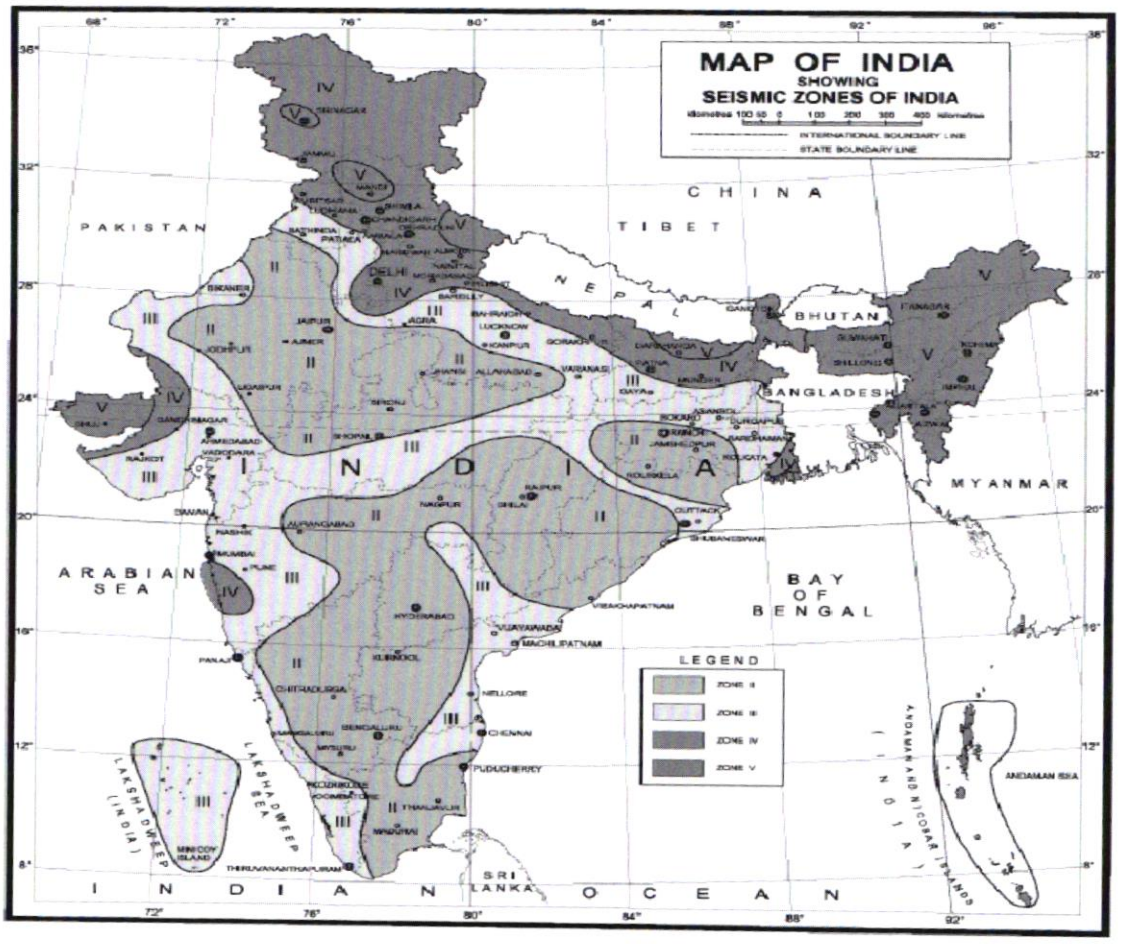
Base shear $V_b = A_h W$

A_h is horizontal seismic coefficient and W is seismic weight of the building, Horizontal seismic coefficient depends on location of the building (Zone factor Z), usage of the building (Importance factor, I), building lateral resisting system (Response reduction factor, R) and design acceleration coefficient (Sa /g) which is based on subsoil condition and fundamental natural period (Ta).

For the proposed development is for residential use. Considering it, the seismic weight is summation of total dead load and 25% of live load where live load is less than 3 kN/sq.mt. The fundamental natural period (Ta) for building

$Ta = 0.09h/(d)^{0.5}$

Where h- height of the building & d – width of the building under consideration of earthquake.



2.5.1 Design Parameters for estimation of seismic loading

Sl.No.	Description	Parameters as per IS-1893-2016
1.	Location - Chennai	Seismic zone III
2.	Seismic Zone Factor	0.16
3.	**Response Reduction Factor: Structural Wall System**	**5**
4	Importance factor	1.2
5	Type of Soil (Medium)	Type II
6	Damping coefficient	5%

2.5.2 Base Shear

Height of the building (h) (measured from Stilt floor)
d (along the length of the building)
b (along the breadth of the building)

a) Ta (along x) = Refer - 2.6.2

b) Ta (along y) = Refer - 2.6.2

From IS 1893: 2002, Clause 6.4.2, Design horizontal seismic coefficient

$$Ah = \frac{Z}{2} \times \frac{I}{R} \times \frac{Sa}{g}$$

Where,

Z for Zone III = 0.16
I for Residential Building = 1.2 (Refer to IS 1893-2016, Table.9)
R for Structural wall system = 4.0 as per (Table 9)
Sa/g (For Rocky) x direction = (Refer to IS 1893-2016, page 13, Fig 1)

Sa/g (For Rocky) y direction = (Refer to IS 1893-2016, page 13, Fig 1)

Design horizontal seismic coefficient and base shear

X- direction Vbx = Ahx * W
Y- direction Vby = Ahy * W

2.5.3 Dynamic Analysis

Response spectrum method of Dynamic Analysis carried out with following parameters pertaining to dynamic analysis.

Time period : Calculated with the assumption of wall system

Number of modes Considered : 12 Numbers (Min)

Modal Combination Method Used	: Complete Quadratic combination (CQC).
Spatial Combination Method used	: Square root of the sum of Square (SRSS).
Modal case type	: Ritz Method.
Orthogonal directional seismic effect	: Not applicable.

3.0 Structural Analysis and design

3.1 Assumptions considered in the design

The assumptions for structural analysis and design are as below

- Elastic analysis (plane remains plane).
- Structure shall be analysed for the most adverse load conditions and envelope of forces shall be designed for.
- Cracked section properties of structural RC structural elements are used in the analysis as per IS 16700-2017, clause 7.2, Table 6.

3.2 Concrete Cover

Concrete cover to the reinforcement in structural elements is based on durability and fire rating. The fire rating of 2hrs is considered for structural elements for the commercial development.

Sl. No.	Structural Elements	Cover in mm
1.	Pile/Pile Cap	75
2.	RC Wall	30
3.	Column	40
4.	RC Beams/PT Beam	30
5.	Slabs/PT Slab	25/40
6.	UG Tank Base Slab/Wall	40

3.3 Method for analysis

Computer-aided analysis using finite element method (FEM) shall be carried out for the design of structural elements. For 3D or 2D structural frame analysis latest version of software ETABS, SAFE shall be used, Prokon, RCDC and verified in-house spread sheets will be used for the design of reinforced concrete (RC) and steel elements in consideration of flexure, shear and axial forces.

3.4 Assumptions for 3D model analysis using ETABS

Column:	Frame Element
RC Wall:	Wall (Shell) Element
Beam Element:	Frame Element
Slab:	membrane Element

The following are general parameters adopted in the analysis and design,

Modulus of Elasticity of Concrete -5000√fck

Consideration of Diaphragm - Rigid Diaphragm.

Slab element considered as membrane element

Stiffness modification factors are adopted in the analysis as per IS -16700-2017, Table.6.

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

The following parameters and methods are adopted in creating ETABS 3D model for the buildings and design of structural elements.

- The 3D ETABS model generated based on the preliminary floor plans (shuttering drawings) prepared using preliminary sizes.
- Sectional properties are assigned to all the structural elements as per the preliminary floor plans (shuttering drawings).
- External & Internal in fill wall loads are assigned as uniformly distributed line load on beams and as area load if the wall is intend to distribute on slab directly. These loads are assigned under SIDL type load case.
- Slabs are modelled as shell element if floor system is Flat slab and the slab has been modelled as membrane in Beam-slab as floor system and slabs are assigned with horizontal diaphragms.
- Live Load reduction is considered in the design of Foundation and Column as per the Code: IS 875-1987 (Part-II), clause.3.2.1.
- Area design load i.e. Live load/SIDL or any other load is applied at floor relevant to its usage.
- All lateral loads & parameters are assigned as per Codes IS 1893-2016 & IS 875-2015.
- Temperature loads are applied on to the terraces and to areas directly exposed to sun.
- Beams under Torsion is required to maintain Equilibrium will be designed for Torsion in accordance with IS 456-2000, clause 41.1 to 41.4 and for all other beams torsional stiffness is neglected in the analysis by applying stiffness modifier as 0.0001 to torsional constant "J". Hence no specific design for Torsion is required for these beams.
- Chennai falls under zone-III. Hence ductile detailing is followed in the design and detailing of structural elements.
- Concrete cover to reinforcement complied accordance with IS 456-2000, Tabl.16 & 16A.
- UG Sump is designed for the crack width of 0.2mm.
- Secondary beams are not designed for ductile detailing.
- Long term deflections are checked by manual calculation using excel spread sheet wherever necessary. Crack width calculation will be done using spread sheet wherever necessary.

Area Load & Application: Applied as uniformly distributed area load with intensity proportionate to its usage as mentioned in the Loading items in the DBR.

Line (Wall) Load & Application: non load bearing or infill wall loads are calculated appropriately and Applied as uniformly distributed line load.

Lateral Load Resisting Systems: The proposed structure is a Structural RC wall with Beam-slab system.

4.0 LOAD COMBINATIONS

The various loads shall be combined in accordance with the stipulations in IS 875 (Part 5) 1987 and IS 456: 2000. The structure will be checked for serviceability Limit State and Ultimate Limit State (Limit State of Collapse) conditions. The load factors to be used for the load combinations are shown in the Table below. The structural elements shall be designed and checked for the critical forces from the combinations.

Load Combination	LOAD FACTORS								
	D.L.	I.L.	T.L	EQX	EQY	SPECX	SPECY	WX	WY
Limit State Of Serviceability (LSS) Combinations									
LC1	1.0	-	1.0	-	-	-	-	-	-
LC2	1.0	1.0	1.0	-	-	-	-	-	-
LC3	1.0	-	1.0	1.0	-	-	-	-	-
LC4	1.0	-	1.0	-1.0	-	-	-	-	-
LC5	1.0	-	1.0	-	1.0	-	-	-	-
LC6	1.0	-	1.0	-	-1.0	-	-	-	-
LC7	1.0	-	1.0	-	-	-	-	1.0	-
LC8	1.0	-	1.0	-	-	-	-	-1.0	-
LC9	1.0	-	1.0	-	-	-	-	-	1.0
LC10	1.0	-	1.0	-	-	-	-	-	-1.0
LC11	1.0	-	1.0	-	-	1.0	-	-	-
LC12	1.0	-	1.0	-	-	-1.0	-	-	-
LC13	1.0	-	1.0	-	-	-	1.0	-	-
LC14	1.0	-	1.0	-	-	-	-1.0	-	-
LC15	1.0	0.8	1.0	0.8	-	-	-	-	-
LC16	1.0	0.8	1.0	-0.8	-	-	-	-	-
LC17	1.0	0.8	1.0	-	0.8	-	-	-	-
LC18	1.0	0.8	1.0	-	-0.8	-	-	-	-
LC19	1.0	0.8	1.0	-	-	-	-	0.8	-
LC20	1.0	0.8	1.0	-	-	-	-	-0.8	-
LC21	1.0	0.8	1.0	-	-	-	-	-	0.8
LC22	1.0	0.8	1.0	-	-	-	-	-	-0.8
LC23	1.0	0.8	1.0	-	-	0.8	-	-	-
LC24	1.0	0.8	1.0	-	-	-0.8	-	-	-
LC25	1.0	0.8	1.0	-	-	-	0.8	-	-
LC26	1.0	0.8	1.0	-	-	-	-0.8	-	-
Limit State Of Collapse (LSC) Combinations									
COMB1	1.5	-	1.0	-	-	-	-	-	-

COMB2	1.5	1.5	1.0	-	-	-	-	-	-
COMB3	1.2	1.2	1.0	1.2	-	-	-	-	-
COMB4	1.2	1.2	1.0	-1.2	-	-	-	-	-
COMB5	1.2	1.2	1.0	-	1.2	-	-	-	-
COMB6	1.2	1.2	1.0	-	-1.2	-	-	-	-
COMB7	1.2	1.2	1.0	-	-	-	-	1.2	-
COMB8	1.2	1.2	1.0	-	-	-	-	-1.2	-
COMB9	1.2	1.2	1.0	-	-	-	-	-	1.2
COMB10	1.2	1.2	1.0	-	-	-	-	-	-1.2
COMB11	1.2	1.2	1.0	-	-	1.2	-	-	-
COMB12	1.2	1.2	1.0	-	-	-1.2	-	-	-
COMB13	1.2	1.2	1.0	-	-	-	1.2	-	-
COMB14	1.2	1.2	1.0	-	-	-	-1.2	-	-
COMB15	1.5	-	1.0	1.5	-	-	-	-	-
COMB16	1.5	-	1.0	-1.5	-	-	-	-	-
COMB17	1.5	-	1.0	-	1.5	-	-	-	-
COMB18	1.5	-	1.0	-	-1.5	-	-	-	-
COMB19	1.5	-	1.0	-	-	-	-	1.5	-
COMB20	1.5	-	1.0	-	-	-	-	-1.5	-
COMB21	1.5	-	1.0	-	-	-	-	-	1.5
COMB22	1.5	-	1.0	-	-	-	-	-	-1.5
COMB23	1.5	-	1.0	-	-	1.5	-	-	-
COMB24	1.5	-	1.0	-	-	-1.5	-	-	-
COMB25	1.5	-	1.0	-	-	-	1.5	-	-
COMB26	1.5	-	1.0	-	-	-	-1.5	-	-
COMB27	0.9	-	1.0	1.5	-	-	-	-	-
COMB28	0.9	-	1.0	-1.5	-	-	-	-	-
COMB29	0.9	-	1.0	-	1.5	-	-	-	-
COMB30	0.9	-	1.0	-	-1.5	-	-	-	-
COMB31	0.9	-	1.0	-	-	-	-	1.5	-
COMB32	0.9	-	1.0	-	-	-	-	-1.5	-
COMB33	0.9	-	1.0	-	-	-	-	-	1.5
COMB34	0.9	-	1.0	-	-	-	-	-	-1.5
COMB35	0.9	-	1.0	-	-	1.5	-	-	-
COMB36	0.9	-	1.0	-	-	-1.5	-	-	-
COMB37	0.9	-	1.0	-	-	-	1.5	-	-
COMB38	0.9	-	1.0	-	-	-	-1.5	-	-

5.0 ACCEPTANCE CRITERIA

Under Serviceability Limit State the limiting structural deflection shall be as follows.

Total deflection under all imposed loads including temperature, creep and shrinkage shall not exceed **L/250.**

In the above limiting value, the deflection contribution due to temperature, creep and shrinkage shall not be more than **L/350**.

Lateral deflection (sway) due to wind shall not exceed **H/500 (0.002 H)** where H is the height of the building above ground.

5.1 Crack width Limits

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

- In general, for slabs crack width is limited to 0.3mm.
- For water retaining structures, sump slab crack width is limited to 0.2mm

6.0 Design of Structural Elements and Foundation

6.1. Pile Foundation

The load intensity of column is moderate and it is proportionate to the no. of stories. Bored Cast In-situ Pile Foundation is designed taking the sub-soil condition reported in the soil investigation report no. GEC-JC-GT-6015/2024-2025 dated 17-05-2024, was carried out by M/s. Geo Engineering Consultants, Chennai. The working compression capacity used as 100t, 135t & 180t for Pile diameters of 500mm, 600mm & 750mm respectively. The expected pile length shall be 22m from EGL and it is to be around 18.5m to 19m (approx).

6.2. RC Walls/Column

RC walls/Columns which are supporting both vertical loads and lateral forces are designed for the most adverse load conditions and envelope of the forces which will be the maximum for that structural element from the load combinations considered in the 3D analysis. The design of structural elements are designed in ETABS for the maximum forces obtained from the load combinations. As the buildings are located in Zone III, ductile design & detailing is followed in the design & detailing.

6.3. Beams

Each Beam will be designed for maximum forces from the 3D analysis using ETABS or RCDC concrete design software shall be used to design of RC members. Also, the detailing shall be followed as per SP-34 & IS-456 etc.

6.4. Slabs

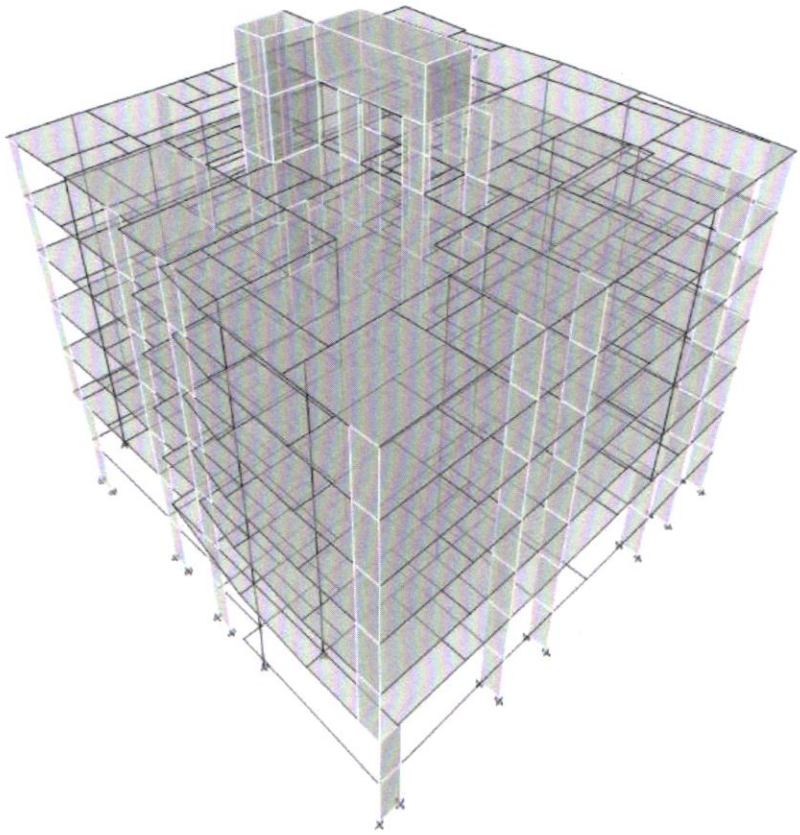
Slabs are designed using SAFE 20 for irregular shaped slabs and regular slabs are designed using in house spread sheet formed as per IS-456 Annexe-D, Table-26.

3D MODEL

&

ANALYSIS SUMMARY REPORT

ETABS®



User Report 2

Model File: AMARA -REV_0, Revision 0
01-07-2025

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1 Structure Data

This chapter provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

1.1 Story Data

Table 1.1 - Story Definitions

Tower	Name	Height m	Master Story	Similar To	Splice Story	Color
T1	LMR COVER	2.5	No	None	No	Yellow
T1	LMR BASE	3.05	No	None	No	Blue
T1	ROOF	3.05	No	2nd	No	Cyan
T1	5th	3.05	No	2nd	No	Magenta
T1	4th	3.05	No	2nd	No	Gray8Dark
T1	3rd	3.05	No	2nd	No	Green
T1	2nd	3.05	Yes	None	No	Red
T1	1st	3.05	No	None	No	Yellow
T1	STILT	3	No	None	No	Blue

2 Properties

This chapter provides property information for materials, frame sections, shell sections, and links.

2.1 Materials

Table 2.1 - Material Properties - General

Material	Type	SymType	Grade	Color	Notes
DUMMY	Other	Isotropic	Fe345	Green	
HYSD415	Rebar	Uniaxial	HYSD Grade 415	Cyan	
HYSD500	Rebar	Uniaxial	HYSD Grade 500	Gray8Dark	
M30	Concrete	Isotropic	M30	Blue	
Tendon	Tendon	Uniaxial	Unknown	Magenta	

2.2 Frame Sections

Table 2.2 - Frame Section Property Definitions - Summary (Part 1 of 3)

Name	Material	Shape	Color	Area cm2	J cm4	I33 cm4	I22 cm4	I23 cm4	As2 cm2
B 1000X800	M30	Concrete Rectangular	Cyan	8000	8811036.5	4266666.7	6666666.7	0	6666.7
B 1100X800	M30	Concrete Rectangular	Red	8800	10413702.3	4693333.3	8873333.3	0	7333.3
B 1200X800	M30	Concrete Rectangular	Blue	9600	12051100.7	5120000	11520000	0	8000
B 200X500	M30	Concrete Rectangular	Blue	1000	99917.8	208333.3	33333.3	0	833.3
B 200X600	M30	Concrete Rectangular	Red	1200	126597.2	360000	40000	0	1000
B 300X500	M30	Concrete Rectangular	Yellow	1500	282174.6	312500	112500	0	1250
B 300X600	M30	Concrete Rectangular	Magenta	1800	371118.1	540000	135000	0	1500
B 450X800	M30	Concrete Rectangular	Green	3600	1578033.6	1920000	607500	0	3000
B 500X850	M30	Concrete Rectangular	Green	4250	2245295.2	2558854.2	885416.7	0	3541.7
B 600 X 850	M30	Concrete Rectangular	Gray8Dark	5100	3467016.4	3070625	1530000	0	4250
B 600X600	M30	Concrete Rectangular	Cyan	3600	1825874.6	1080000	1080000	0	3000
B 800 X 850	M30	Concrete Rectangular	Magenta	6800	6502725.9	4094166.7	3626666.7	0	5666.7
B 900X850	M30	Concrete Rectangular	Red	7650	8231575.7	4605937.5	5163750	0	6375
C 200 X 1000	M30	Concrete Rectangular	Yellow	2000	233406.7	1666666.7	66666.7	0	1666.7
C 200X1100	M30	Concrete Rectangular	Cyan	2200	260092.4	2218333.3	73333.3	0	1833.3
C 500X800	M30	Concrete Rectangular	Red	4000	2041366.6	2133333.3	833333.3	0	3333.3
C 600 X 600	M30	Concrete Rectangular	Red	3600	1825874.6	1080000	1080000	0	3000
C 600X1000	M30	Concrete Rectangular	Gray8Dark	6000	4514793.6	5000000	1800000	0	5000
C 600X850	M30	Concrete Rectangular	Blue	5100	3467016.4	3070625	1530000	0	4250
C 800X1100	M30	Concrete Rectangular	Green	8800	10413702.3	8873333.3	4693333.3	0	7333.3
DUMMY	DUMMY	Concrete Rectangular	Magenta	0	0	0	0	0	0
FC 200X1000	M30	Concrete Rectangular	Red	2000	233406.7	1666666.7	66666.7	0	1666.7
FC 200X1200	M30	Concrete Rectangular	Cyan	2400	286777.5	2880000	80000	0	2000
FC 200X600	M30	Concrete Rectangular	Gray8Dark	1200	126597.2	360000	40000	0	1000
FC 200X800	M30	Concrete Rectangular	Blue	1600	180007	853333.3	53333.3	0	1333.3
FC 200X900	M30	Concrete Rectangular	Yellow	1800	206687	1215000	60000	0	1500
FC 300X800	M30	Concrete Rectangular	Yellow	2400	550813.4	1280000	180000	0	2000

Table 2.2 - Frame Section Property Definitions - Summary (Part 2 of 3)

Name	As3 cm2	S33Pos cm3	S33Neg cm3	S22Pos cm3	S22Neg cm3	Z33 cm3	Z22 cm3	R33 mm	R22 mm	CG Offset 3 mm	CG Offset 2 mm
B 1000X800	6666.7	106666.7	106666.7	133333.3	133333.3	160000	200000	230.9	288.7	0	0
B 1100X800	7333.3	117333.3	117333.3	161333.3	161333.3	176000	242000	230.9	317.5	0	0
B 1200X800	8000	128000	128000	192000	192000	192000	288000	230.9	346.4	0	0
B 200X500	833.3	8333.3	8333.3	3333.3	3333.3	12500	5000	144.3	57.7	0	0
B 200X600	1000	12000	12000	4000	4000	18000	6000	173.2	57.7	0	0
B 300X500	1250	12500	12500	7500	7500	18750	11250	144.3	86.6	0	0
B 300X600	1500	18000	18000	9000	9000	27000	13500	173.2	86.6	0	0
B 450X800	3000	48000	48000	27000	27000	72000	40500	230.9	129.9	0	0
B 500X850	3541.7	60208.3	60208.3	35416.7	35416.7	90312.5	53125	245.4	144.3	0	0
B 600 X 850	4250	72250	72250	51000	51000	108375	76500	245.4	173.2	0	0
B 600X600	3000	36000	36000	36000	36000	54000	54000	173.2	173.2	0	0
B 800 X 850	5666.7	96333.3	96333.3	90666.7	90666.7	144500	136000	245.4	230.9	0	0
B 900X850	6375	108375	108375	114750	114750	162562.5	172125	245.4	259.8	0	0
C 200 X 1000	1666.7	33333.3	33333.3	6666.7	6666.7	50000	10000	288.7	57.7	0	0
C 200X1100	1833.3	40333.3	40333.3	7333.3	7333.3	60500	11000	317.5	57.7	0	0
C 500X800	3333.3	53333.3	53333.3	33333.3	33333.3	80000	50000	230.9	144.3	0	0
C 600 X 600	3000	36000	36000	36000	36000	54000	54000	173.2	173.2	0	0
C 600X1000	5000	100000	100000	60000	60000	150000	90000	288.7	173.2	0	0
C 600X850	4250	72250	72250	51000	51000	108375	76500	245.4	173.2	0	0
C 800X1100	7333.3	161333.3	161333.3	117333.3	117333.3	242000	176000	317.5	230.9	0	0
DUMMY	0	0	0	0	0	0	0	0	0	0	0
FC 200X1000	1666.7	33333.3	33333.3	6666.7	6666.7	50000	10000	288.7	57.7	0	0
FC 200X1200	2000	48000	48000	8000	8000	72000	12000	346.4	57.7	0	0
FC 200X600	1000	12000	12000	4000	4000	18000	6000	173.2	57.7	0	0
FC 200X800	1333.3	21333.3	21333.3	5333.3	5333.3	32000	8000	230.9	57.7	0	0
FC 200X900	1500	27000	27000	6000	6000	40500	9000	259.8	57.7	0	0
FC 300X800	2000	32000	32000	12000	12000	48000	18000	230.9	86.6	0	0

Table 2.2 - Frame Section Property Definitions - Summary (Part 3 of 3)

Name	PNA Offset 2 mm	Area Modifier	As2 Modifier	As3 Modifier	J Modifier	I33 Modifier	I22 Modifier	Mass Modifier	Weight Modifier
B 1000X800	0	1	1	1	1	1	1	1	1
B 1100X800	0	1	1	1	1	1	1	1	1
B 1200X800	0	1	1	1	1	1	1	1	1
B 200X500	0	1	1	1	1	1	1	1	1
B 200X600	0	1	1	1	1	1	1	1	1
B 300X500	0	1	1	1	1	1	1	1	1
B 300X600	0	1	1	1	1	1	1	1	1
B 450X800	0	1	1	1	1	1	1	1	1
B 500X850	0	1	1	1	1	1	1	1	1
B 600 X 850	0	1	1	1	1	1	1	1	1
B 600X600	0	1	1	1	1	1	1	1	1
B 800 X 850	0	1	1	1	1	1	1	1	1
B 900X850	0	1	1	1	1	1	1	1	1
C 200 X 1000	0	1	1	1	1	1	1	1	1
C 200X1100	0	1	1	1	1	1	1	1	1

Table 2.2 - Frame Section Property Definitions - Summary (Part 3 of 3, continued)

Name	PNA Offset 2 mm	Area Modifier	As2 Modifier	As3 Modifier	J Modifier	I33 Modifier	I22 Modifier	Mass Modifier	Weight Modifier
C 500X800	0	1	1	1	1	1	1	1	1
C 600 X 600	0	1	1	1	1	1	1	1	1
C 600X1000	0	1	1	1	1	1	1	1	1
C 600X850	0	1	1	1	1	1	1	1	1
C 800X1100	0	1	1	1	1	1	1	1	1
DUMMY	0	1	1	1	1	1	1	1	1
FC 200X1000	0	1	1	1	1	1	1	1	1
FC 200X1200	0	1	1	1	1	1	1	1	1
FC 200X600	0	1	1	1	1	1	1	1	1
FC 200X800	0	1	1	1	1	1	1	1	1
FC 200X900	0	1	1	1	1	1	1	1	1
FC 300X800	0	1	1	1	1	1	1	1	1

2.3 Shell Sections

Table 2.3 - Area Section Property Definitions - Summary

Name	Type	Element Type	Material	Total Thickness mm	Deck Material	Deck Depth mm
S 125	Slab	Shell-Thin	M30	125		
S 200	Slab	Shell-Thin	M30	200		
W 200	Wall	Shell-Thin	M30	200		
W 300	Wall	Shell-Thin	M30	300		
W 450	Wall	Shell-Thin	M30	450		
W 600	Wall	Shell-Thin	M30	600		
W 650	Wall	Shell-Thin	M30	650		
W 750	Wall	Shell-Thin	M30	750		

3 Loads

This chapter provides loading information as applied to the model.

3.1 Load Patterns

Table 3.1 - Load Pattern Definitions

Name	Is Auto Load	Type	Self Weight Multiplier	Auto Load
~LLRF	Yes	Other	0	
~SPX - SERECC	Yes	Other	0	
~SPXECC	Yes	Other	0	
~SPY - SERECC	Yes	Other	0	
~SPYECC	Yes	Other	0	
Dead	No	Dead	1	
Eqx	No	Seismic	0	IS 1893:2016
Eqy	No	Seismic	0	IS 1893:2016
Filling	No	Super Dead	0	
Live<3	No	Reducible Live	0	
Live>3	No	Reducible Live	0	
Roof Live	No	Roof Live	0	
Sidl	No	Super Dead	0	
TEMP	No	Temperature	0	
Wall	No	Super Dead	0	
Wx	No	Wind	0	Indian IS 875:2015
Wy	No	Wind	0	Indian IS 875:2015

3.2 Load Sets

Table 3.2 - Shell Uniform Load Sets

Name	Load Pattern	Load Value kN/m2
balcony	Sidl	1.2
balcony	Live>3	3
balcony	Filling	3
liv/bed/kit	Sidl	1.8
liv/bed/kit	Live<3	2
LMR	Sidl	15
LMR	Live>3	2
lobby	Sidl	2.4
lobby	Live>3	3
OHT	Sidl	25
OHT	Live>3	2
roof	Sidl	3
roof	Live>3	3
store room	Sidl	1.8
store room	Live>3	3
toilet	Sidl	1.2
toilet	Live<3	2
toilet	Filling	2

3.3 Auto Wind Loading

Table 3.3 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 1 of 3)

Name	Exposure Set	Is Auto Load	Exposure Source	Top Story	Bottom Story	Include Parapet	Parapet Height m	Cp Windward	Cp Leeward	Wind Speed meter/sec
Wx	1	No	Diaphragms	ROOF	Base	Yes	1.35	0.8	0.5	50
Wx	1	No								
Wx	1	No								
Wx	1	No								
Wx	1	No								
Wx	1	No								
Wy	1	No	Diaphragms	ROOF	Base	Yes	1.35	0.8	0.5	50
Wy	1	No								
Wy	1	No								
Wy	1	No								
Wy	1	No								
Wy	1	No								

Table 3.3 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 2 of 3)

Name	Exposure Set	Terrain Category	Importance Factor	Risk Coefficient	Topography	Width Type	Direction Angle deg	Story	Diaphragm
Wx	1	2	1.00	1	1	Auto	0	ROOF	roof
Wx	1							5th	5th
Wx	1							4th	4th
Wx	1							3rd	3rd
Wx	1							2nd	2nd
Wx	1							1st	1st
Wy	1	2	1.00	1	1	Auto	90	ROOF	roof
Wy	1							5th	5th
Wy	1							4th	4th
Wy	1							3rd	3rd
Wy	1							2nd	2nd
Wy	1							1st	1st

Table 3.3 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 3 of 3)

Name	Exposure Set	Depth m	X m	Y m
Wx	1	27.45	10.929	25.0725
Wx	1	27.45	10.929	25.0725
Wx	1	27.45	10.929	25.0725
Wx	1	27.45	10.929	25.0725
Wx	1	27.45	10.929	25.0725
Wx	1	27.45	10.929	25.0725
Wy	1	25.871	10.929	25.0725
Wy	1	25.871	10.929	25.0725
Wy	1	25.871	10.929	25.0725
Wy	1	25.871	10.929	25.0725
Wy	1	25.871	10.929	25.0725
Wy	1	25.871	10.929	25.0725

3.4 Auto Seismic Loading

Table 3.4 - Load Pattern Definitions - Auto Seismic - IS 1893 2016 (Part 1 of 3)

Name	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN	Is Auto Load	X Dir?	X Dir Plus Ecc?	X Dir Minus Ecc?	Y Dir?	Y Dir Plus Ecc?	Y Dir Minus Ecc?
Eqx	0.327	0.048	58793.4735	2822.0867	No	Yes	No	No	No	No	No
Eqy	0.321	0.048	58793.4735	2822.0867	No	No	No	No	Yes	No	No

Table 3.4 - Load Pattern Definitions - Auto Seismic - IS 1893 2016 (Part 2 of 3)

Name	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN	Ecc Ratio	Top Story	Bottom Story	Period Type	User T sec	Z
Eqx	0.327	0.048	58793.4735	2822.0867	0	ROOF	Base	User Defined	0.327	0.16
Eqy	0.321	0.048	58793.4735	2822.0867	0	ROOF	Base	User Defined	0.321	0.16

Table 3.4 - Load Pattern Definitions - Auto Seismic - IS 1893 2016 (Part 3 of 3)

Name	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN	I	R
Eqx	0.327	0.048	58793.4735	2822.0867	1.2	5
Eqy	0.321	0.048	58793.4735	2822.0867	1.2	5

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern Eqx according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = X

Eccentricity Ratio = 0% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.327\ sec$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{Z\, I \frac{S_a}{g}}{2\, R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X	0.327	58793.4735	2822.0867

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR COVER	26.85	0	0
LMR BASE	24.35	0	0
ROOF	21.3	1038.4739	0
5th	18.25	697.7017	0
4th	15.2	483.9843	0
3rd	12.15	309.2407	0
2nd	9.1	173.5074	0
1st	6.05	110.8786	0
STILT	3	8.3001	0
Base	0	0	0

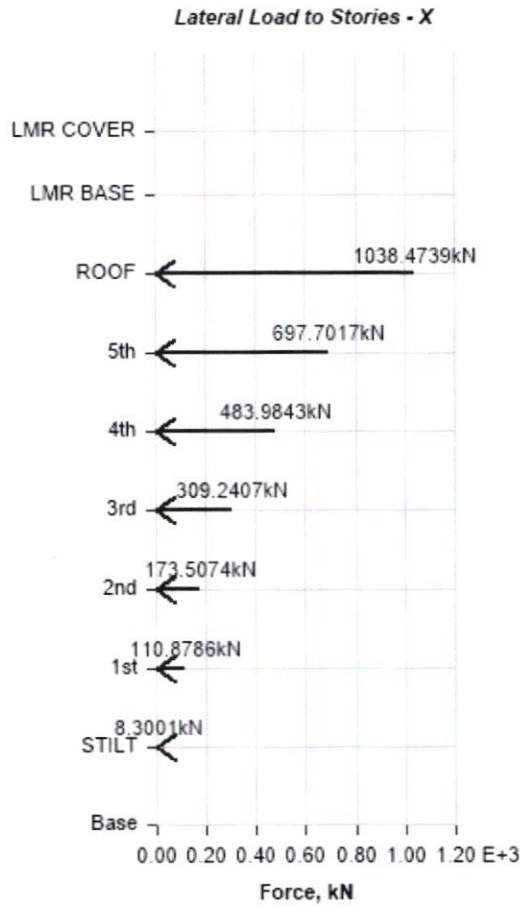


Figure 3-1-Set 1

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern Eqy according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = Y

Eccentricity Ratio = 0% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.321\ sec$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{Z\, I \frac{S_a}{g}}{2\, R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y	0.321	58793.4735	2822.0867

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR COVER	26.85	0	0
LMR BASE	24.35	0	0
ROOF	21.3	0	1038.4739
5th	18.25	0	697.7017
4th	15.2	0	483.9843
3rd	12.15	0	309.2407
2nd	9.1	0	173.5074
1st	6.05	0	110.8786
STILT	3	0	8.3001
Base	0	0	0

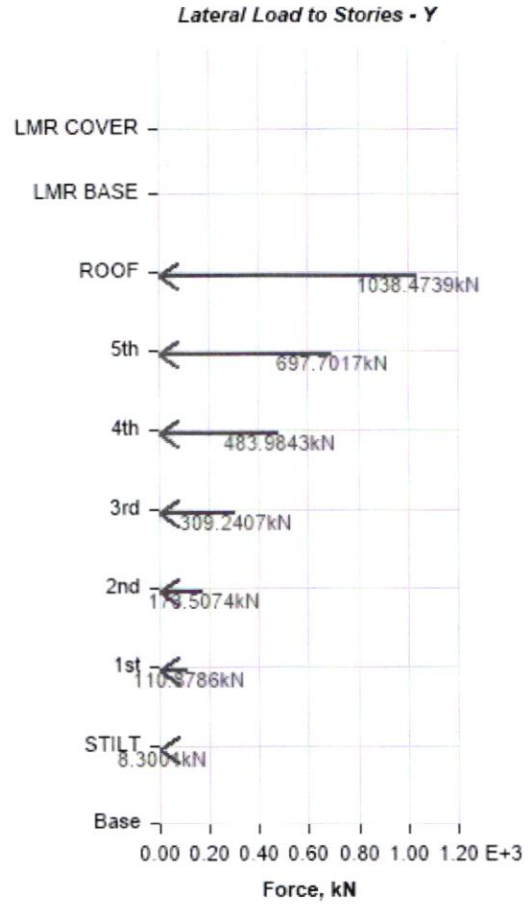


Figure 3-2-Set 1

3.5 Load Cases

Table 3.5 - Load Case Definitions - Summary

Name	Type
Modal	Modal - Eigen
Dead	Linear Static
ROOF LIVE	Linear Static
Live>3	Linear Static
Live<3	Linear Static
SidI	Linear Static
Eqx	Linear Static
Eqy	Linear Static
Wx	Linear Static
Wy	Linear Static
Wall	Linear Static
Filling	Linear Static
TEMP	Linear Static
SPX	Response Spectrum
SPY	Response Spectrum
SPX - SER	Response Spectrum
SPY - SER	Response Spectrum

4 Analysis Results

This chapter provides analysis results.

4.1 Story Results

Table 4.1 - Story Stiffness

Story	Output Case	Case Type	Step Type	Shear X kN	Drift X mm	Stiff X kN/m	Shear Y kN	Drift Y mm	Stiff Y kN/m
LMR COVER	Eqx	LinStatic	Step By Step	0	0	0	0	0	0
LMR BASE	Eqx	LinStatic	Step By Step	0	0	0	0	0	0
ROOF	Eqx	LinStatic	Step By Step	1038.4565	2.536	409517.658	1.379E-06	0.46	0
5th	Eqx	LinStatic	Step By Step	1736.1583	3.329	521474.122	1.83E-06	0.642	0
4th	Eqx	LinStatic	Step By Step	2220.1427	3.82	581182.057	1.934E-06	0.771	0
3rd	Eqx	LinStatic	Step By Step	2529.3834	3.754	673817.833	1.765E-06	0.788	0
2nd	Eqx	LinStatic	Step By Step	2702.8909	2.614	1034032.138	1.803E-06	0.565	0
1st	Eqx	LinStatic	Step By Step	1211.5778	0.164	7372283.904	141.9979	0.043	3290867.187
STILT	Eqx	LinStatic	Step By Step	1203.2777	0.164	7321779.012	141.9979	0.043	3290867.187
LMR COVER	Eqy	LinStatic	Step By Step	0	0	0	0	0	0
LMR BASE	Eqy	LinStatic	Step By Step	0	0	0	0	0	0
ROOF	Eqy	LinStatic	Step By Step	6.094E-07	0.552	0	1038.4565	1.857	559280.124
5th	Eqy	LinStatic	Step By Step	6.585E-06	0.73	0	1736.1582	2.428	715184.443
4th	Eqy	LinStatic	Step By Step	1.286E-05	0.878	0	2220.1425	2.831	784293.956
3rd	Eqy	LinStatic	Step By Step	1.671E-05	0.868	0	2529.3832	2.855	886000.588
2nd	Eqy	LinStatic	Step By Step	1.571E-05	0.601	0	2702.8906	2.035	1328481.681
1st	Eqy	LinStatic	Step By Step	54.8033	0.039	0	901.7971	0.14	6436816.812
STILT	Eqy	LinStatic	Step By Step	54.8033	0.039	0	893.497	0.14	6377572.721

4.2 Modal Results

Table 4.2 - Modal Participating Mass Ratios (Part 1 of 2)

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ
Modal	1	-63425194	0.0042	0	0	0.0042	0	0	0	0.0234	0.0002
Modal	2	29006534.813	0	0.0043	0	0.0042	0.0043	0	0.0238	0	0.0002
Modal	3	24886772.327	0.0019	0.0012	0	0.0062	0.0055	0	0.0068	0.0107	0.0003
Modal	4	24886772.327	0.0012	0.0019	0	0.0074	0.0075	0	0.0107	0.0068	0.0002
Modal	5	24886772.288	0.0008	0.0044	0	0.0082	0.0119	0	0.0246	0.0044	5.689E-06
Modal	6	24886772.288	0.0046	0.0001	0	0.0128	0.012	0	0.0007	0.0257	0.0001
Modal	7	24886772.288	0.0007	0.0017	0	0.0135	0.0138	0	0.0097	0.0041	0.0001
Modal	8	24886772.288	0.0002	9.234E-06	0	0.0137	0.0138	0	0.0001	0.0009	0.0006
Modal	9	11659772.058	0.0004	0.0003	0	0.0141	0.014	0	0.0014	0.0025	0.0002
Modal	10	11659772.058	0.0003	0.0004	0	0.0144	0.0145	0	0.0025	0.0014	0
Modal	11	10672171.595	0.0002	0.0004	0	0.0146	0.0148	0	0.0014	0.0008	0.0002
Modal	12	10672171.595	0.0004	0.0002	0	0.015	0.0151	0	0.0008	0.0014	3.048E-06

Table 4.2 - Modal Participating Mass Ratios (Part 2 of 2)

Case	Mode	SumRX	SumRY	SumRZ
Modal	1	0	0.0234	0.0002
Modal	2	0.0238	0.0234	0.0005
Modal	3	0.0306	0.0341	0.0007
Modal	4	0.0413	0.0409	0.0009
Modal	5	0.0659	0.0453	0.0009
Modal	6	0.0666	0.071	0.001

Table 4.2 - Modal Participating Mass Ratios (Part 2 of 2, continued)

Case	Mode	SumRX	SumRY	SumRZ
Modal	7	0.0763	0.075	0.0011
Modal	8	0.0764	0.0759	0.0017
Modal	9	0.0777	0.0784	0.0018
Modal	10	0.0802	0.0798	0.0018
Modal	11	0.0816	0.0806	0.002
Modal	12	0.0824	0.082	0.002

DESIGN OF PILE CAP

Project : ANTHARA	BURO ENGINEERS		
	Made by	Date	Page
Location : CHENNAI	PRATHAP	30-Jun-25	1
	Checked by	Revision	Job No
Subject : Pilecap Design		-	BEI755

Marking : SW6

TYPE : **2-Pile Group**

Material			Pile (1 = Rect, 2=Circular)			Column (1 = Rect, 2=Circular)		
fcu	=	30 N/mm^2	Pile type	=	2	Col. type	=	1
fy	=	500 N/mm^2	Diameter	=	600 mm	Bc	=	600 mm
Cover	=	75 mm	Capacity	=	1350 kN	Lc	=	600 mm
Reinfocement								
B1	=	20 mm						
B2	=	20 mm						

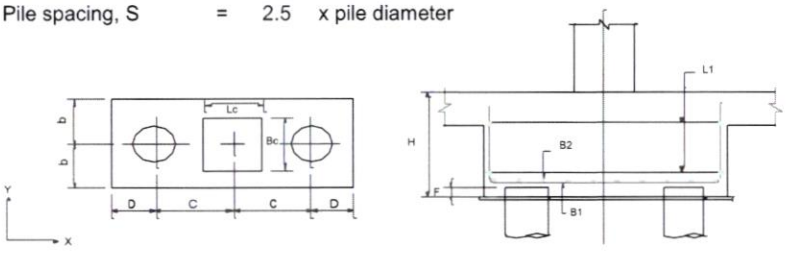
Load factor = **1.5**

Ultimate Column Load = 4050 kN

Pilecap Dimensions — Pile spacing, S = 2.5 x pile diameter

B = 450 mm
C = 750 mm
D = 450 mm
F = 75 mm
H = 1300 mm

L1 = 3T12



Bending Moment & Rinforcement (By bending theory)

Choice of moment - 1 =column face, 2 = center of column **1**

	About Y - Y axis		About X - X axis	
Moment arm(mm)	525			
Maximum Moment (kNm)	1063			
Width, b	900			
Effective depth, d	1215			
K = M/bd^{2}fcu	0.027			
Lever arm, Z	1154		Provide min. reinf't = 0.12%bH	
As$_{req}$ (mm^2)	2117 or 2353 mm^2/m		3744 or 1560 mm^2/m	
No. of bars & spacing required	7 T 20 @ 122		12 T 20 @ 203	
No. of bars & spacing provided	**8 T 20 @** 104 (B1)		**12 T 20 @** 203 (B2)	
As$_{prov}$ (mm^2)	**2514** or 2793.7 mm^2/m		3771 or 1571 mm^2/m	

Shear Check

Shear force	2025 kN		
(100As/bd)	0.23		
(400/d)$^{1/4}$	1.00		
Allowable shear stress, v_c	0.35 mm^2/m		
Shear span, a_v	345.00 mm		
Enhancement factor = 2d/a_v	7.04		
Enhanced shear stress (N/mm^2), v_c	2.47 mm^2/m		

i) Shear at column face

v = 1.39 < 3.50 ***ok!***

ii) Shear along a vertical section at 20% inside pile across the full width of pilecap

v = 1.85 < 2.47 ***ok!***

iii) Since pile spacing less or equal to 3 x pile diameter, no check is required

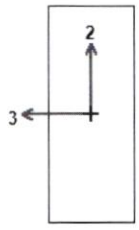
iv) Punching shear check

3.2942 Punching Area
7260 Perimeter bo
0.4591 Punching Shear Stress tv
1.3693 Permissible shear stress
O.K

DESIGN OF BEAM

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
1st	B40	43	B 200X500	Comb2 1.5 DL+LL	5414	5414	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	500	200	0	45	45

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	415

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
-95.9481	3.4736	81.4098	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-95.9481	7.1515	0	-103.0996

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)	-103.0996		585	0	585	239
Bottom (-2 Axis)		0	292	0	0	292

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
81.4098	50.1685	59.0299	35.0855	359.51

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
3.4736	81.4098	130	430	382.05

DESIGN OF SHEAR WALL

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	Pier Ductility	LLRF
2nd	SW10	11023	23799	1200	200	Special Wall	1

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	415

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	11023	23199	11023	24399	1200	200
Bottom	Leg 1	11023	23199	11023	24399	1200	200

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	608	0.0025	0.0025	Comb19 - 0.9DL + 1.5 SPX	425.7342	42.1278	-134.0797	240000
Bottom	1972	0.0082	0.0025	Comb18 - 1.5LL + 1.5 SPY	1474.0087	55.6394	466.2041	240000

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	500	Comb18 - 1.5LL + 1.5 SPY	1003.6023	209.4112	223.0631	78.9636	252.181
Bottom	Leg 1	500	Comb18 - 1.5LL + 1.5 SPY	1031.0442	466.2041	223.0631	124.5286	297.746

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	Comb17 - 1.5LL + 1.5 SPX	1534.4011	-135.2011	9.21	6
Top–Right	Leg 1	200	Comb17 - 1.5LL + 1.5 SPX	1534.4011	129.5941	9.09	6
Bottom–Left	Leg 1	300	Comb17 - 1.5LL + 1.5 SPX	1561.843	-249.0384	11.7	6
Botttom–Right	Leg 1	300	Comb17 - 1.5LL + 1.5 SPX	1561.843	276.92	12.28	6

DESIGN OF SLAB

PROJECT AMARA

	DESIGN OF SLAB No:				
1.00	Grade of concrete	=	*30.00*	N/mm^2	
2.00	Grade of steel	=	*500.00*	N/mm^2	
3.00	Cover to reinforcement	=	*25.00*	mm	
	Diameter of bar		*8.00*	mm	
4.00	Aspect ratio $\frac{l_y}{l_x}$ = *4.81* / *4.56*	4.93 / 4.68	1.053	< 2	
5.00	Edge condition: One Short Edge Continuous		Two way slab		
6.00	Modification factor assumed		*1.70*		
	119.80				
7.00	Depth required for deflection:	D =	*150.00*	mm	
			150.00	mm	
		d =	121.00	mm	ok
8.00	Dead Load	=	3.60	kN/m^2	qa
9.00	Live load	=	*2.00*	kN/m^2	
10.00	Partitions & FF	=	*1.20*	kN/m^2	
11.00	Total load	=	6.80	kN/m^2	
12.00	Factored load	=	10.20	kN/m^2	

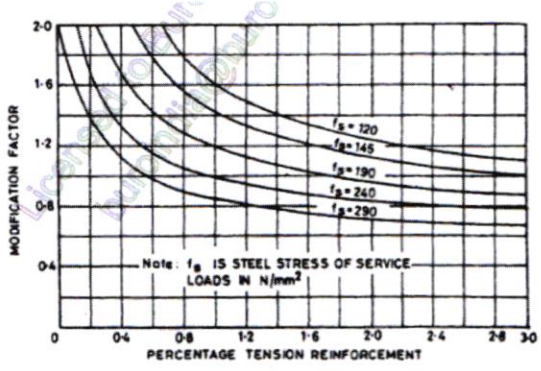
Case No:	*8*	
D+(C-D)*(E-A)/(B-A)		
	Negative	Positive
A	*1.00000*	*1.00000*
B	*1.10000*	*1.10000*
C	*0.00000*	*0.04300*
D	*0.00000*	*0.05100*
E	*1.05273*	*1.05273*
Value	**0.00000**	**0.04722**

STEP 1	Details	S- SPAN (-ve) support(α_x)	S- SPAN (+ve) span(α_x)	L-SPAN (-ve) support(α_y)	L-SPAN (+ve) span (α_y)
	Co-efficent (IS:456, Table :26)	0.000	0.047	0.057	0.043
	M_u=Co-efficient*w* l_x^2	0.00	10.57	12.76	9.62
	K= Mu/bd2	0.00	0.72	0.87	0.66
	Percentage of steel required	0.00	0.17	0.21	0.16
	Ast required(in mm^2)	*0.00*	*206.65*	*251.04*	*187.69*
	Ast min (in mm^2)	180.00	180.00	180.00	180.00
	Ast to be provided (in mm2)	180.00	206.65	251.04	187.69
	Provided bars spacing (c/c)	279.37	243.33	200.31	267.93
	max spacing	250.00	250.00	250.00	250.00
	spacing	250.00	243.33	200.31	250.00
	Reqd bars spacing (c/c)	**250.00**	**240.00**	**200.00**	**250.00**
	Pvd bars spacing (c/c)	*200.00*	*150.00*	*150.00*	*200.00*
	Ast Provided(in mm^2)	**251.43**	**335.24**	**335.24**	**251.43**
	Percentage of steel provided	**0.21**	**0.28**	**0.28**	**0.21**

STEPII			
	F_s=0.58 *f_y * (Ast required/ Ast provided)		
	F_s	178.77	
	M.F	*2.00*	
	if assumed modification factor is less than or equal to calculated the section is safe for deflection	safe	

	OVERALL DEPTH	D	150.00	mm
	EFFECTIVE DEPTH	d	121.00	mm

STEPIII	Crack width calculation			
	m	=	7.3	
	E_s	=	200000.0	
	Ec	=	27386.1	
	Pt	=	0.3	
	k	=	0.2	
	x	=	22.0	
	A_{st}	=	335.2	
	I_{cr}	=	27544458.15	
	M	=	10.6	
	f_{st}	=	277.3	
	ε_m	=	0.0	
	Spacing		150.0	
	a_{cr}	=	79.1	
	ω_{cr}	=	0.12 < 0.20	mm (safe)



$f_s = 0.58\, f_y \frac{\text{Area of cross-section of steel required}}{\text{Area of cross-section of steel provided}}$

FIG. 4 MODIFICATION FACTOR FOR TENSION REINFORCEMENT

A. PERAMAIYAN, M.E., (Struct.), M.I.E.
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No. SE/GR-I/19/03/026
NEW No. 31 (OLD No.14), BESANT AVENUE ROAD,
ADYAR, CHENNAI - 600 020.
E-Mail: peram@buroengineers.in
Mobile: +91 99625 45630

THE LANDLENS SUITE

Eight ways to know a piece of land before you pay for it.

This report covers one part of the picture. These cover the rest, drawn from the same government records, for any property in Tamil Nadu.

LandLens One
Ask anything about a property and get an answer grounded in live government records, with the sources shown.
/landlens/one

Verify My Land
Every record check run on one property and returned as a single report.
/landlens/verify-my-land

Legal Opinion
An advocate's written opinion on the title, built on the records we pull for it.
/landlens

One Map
Every layer on one map: the parcel, its boundary, zoning, water bodies and what sits around it.
/landlens/one/map

PriceMap
What land actually changed hands for around this plot, taken from the registered deeds.
/landlens/pricemap

Build Scope
What you are allowed to build here: floor space, height, coverage and setbacks.
/landlens/build-scope

Property Tracker
Watch a property and hear about it when something new is registered against it.
/landlens/property-tracker

Deal Room
Run the transaction in one place: documents, stamping, signatures and the parties.
/landlens/deal-room

FREE TOOLS · NO ACCOUNT NEEDED

Twenty-four checks you can run yourself, at no cost.

Records and verification

The registers themselves, read for you.

- Encumbrance Certificate
- Patta and Chitta
- Field Measurement Sketch
- EC Analyzer
- Bank charge check
- Court case search
- Seller background check
- Approval check by survey

Value and duty

What it is worth and what it costs to register.

- Guideline value by street
- Guideline value by survey
- Stamp duty and registration fees
- Capital gains
- Floor space index
- Area unit converter

Zoning and land use

What the plan says can happen on this land.

- Land use zone finder
- CMDA land use check
- Coastal regulation zone
- Master plan check
- Water bodies finder
- Airport height clearance

Registers and directories

Who holds it, and which office keeps the record.

- Find your registering office
- Temple property check
- Waqf property check
- RERA register

Every free tool
/tools

Services we run for you
/services

The LandLens suite
/landlens/one

Verified RealEstate™

Every claim in this document traces back to a government record.

- Legal opinions, due diligence and title verification
- Building plan, layout and sub-division approvals
- Completion and occupancy certificates, regularisation
- Escrow, negotiation and NRI property management
- Land survey, soil testing, architecture and construction

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