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DIGITALLY VERIFIED RECORD

BURO ENGINEERS (I) PRIVATE LTD.,
Civil & Structural Consultants
New No.31, (Old No.14), Besant Avenue Road, Adyar, Chennai - 600 020, TN, India. Tel : 91 44 2491 2755
e-mail : buroindia@buroengineers.in, admin@buroengineers.in
CIN : U45201TN2005PTC055334

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,
Adayar, Chennai – 600 020.

E-mail: peram@buroengineers.in
Mobile: +91 9962545630

STABILITY CERTIFICATE

1. The detailed engineering and structure design of the proposed building comprising of stilt floor (Parking) + 5 Floors +Roof residential building with 12 Dwelling Units at Old No.16, 16/1, 17, New Door No. 24/67, Halls Road, Kilpauk, Chennai – 600 010, comprised in Old S. No. 139 Part, T.S. No. 139/2, 139/7 and 139/8, Block No.10 of Egmore Village within the limits of greater Chennai Corporation, has been done by GEO MARINE CONSULTANTS (P) LTD., Report No. GT-2820 dated 24.07.2024 and considering the functional requirement of the building.
2. It is certified that among other factors, the proposed building has been designed to resist earthquake. I/We have checked various parameters and found that the proposed building will be safe.
3. I/We further certify that:
   a. The minimum grade of concrete is M30.
   b. The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS456, design loads as per IS Code No.875 and design of earthquake resistance structure as per IS Code No. 1893 and 13920.
4. The building will be safe and sound when used for the purpose for which it is designed

Date: 8th October 2025

Place: Chennai – 600020

Stamp and Signature

Encl: Structural Design Calculations

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

STRUCTURAL DESIGN BASIS REPORT

THE PROPOSED CONSTRUCTION OF STILT FLOOR (FOR PARKING USE) + 5 FLOORS RESIDENTIAL BUILDING WITH 12 DWELLING UNITS AT OLD DOOR NO. 16, 16/1, 17, NEW DOOR NO.24/67 HALLS ROAD, KILPAUK, CHENNAI – 600010, COMPRISED IN OLD NO. 139Part, T.S. No. 139/2, 139/7 & 139/8 BLOCK NO. 10 OF EGMORE VILLAGE WITHIN THE LIMITS OF GREATER CHENNAI CORPORATION.

CLIENT:	**M/S SALMA CONSTRUCTIONS**, CHENNAI.
ARCHITECT:	**ANSARI ARCHITECTS**, T.NAGAR, CHENNAI.
STRUCTURAL CONSULTANT:	**BURO ENGINEERS (INDIA) PRIVATE LIMITED,** Chennai

R0	09-09-2024	Design Basis Report	OKAY	PRAGATHEESWARAN	HARI	PERAM
REV NO.	**DATE**	**DESCRIPTION**	**STATUS**	**PREPARED BY**	**REVIEWED BY**	**APPRVD. BY**

Index

- Design Information and criteria
- 3D Model & Analysis summary report
- Design of Footing
- Design of Column
- Design of Wall
- Design of Beam
- Design of Slab
- Structural Drawings

DESIGN INFORMATION AND CRITERIA

1.0 INTRODUCTION

M/s. Salma Constructions, pproposed to construct a Residential building at Taylors road, Kilpauk within the limits of Greater Chennai Corporation. Architecturally it is designed with Stilt + 5 Floors + Roof. In which the Stilt is 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 development is a Multi-storied High Rise Residential Apartment building comprises of Stilt + 5 Floors + Roof. Plan dimension of the building at the Stilt level is 28.5mx19.50m. 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 Basement Level	Remarks
1	Stilt (Parking) + 5 floors + Roof	18.28m (measuring from FGL to Terrace)	28.5mx19.50m	With covered car parking

Building Floor Height Details	Stilt + 5 floors + Roof
Stilt Floor (Car Parking)	2.90m
1st Floor to 5th Floors	3.00m
Head Room	2.50m
LMR	2.90m(from Terrace floor)

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 to be Isolated/Combined footing as a cast in situ concrete structure.

1.3.2 Foundation Type

The foundation system is to be Isolated/combined Footings. The Footing is to be rest over the clayey silty sand layer encountered at a depth about 2.4m down from Natural Ground Level, having "N" value more than 20. The Footing will be designed for the recommended Safe Bearing Capacity as laid down in the Soil Investigation report No. GT-2820 dated 24-07-2024, is carried out by M/s. Geo Marine Engineering (P) Ltd, Thiruvanmiyur, 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

SI.No.	Structural Elements	Grade of Concrete
1.	Footings	M30
2.	RC Shear wall	M30
3.	RC Columns	M30
4.	RC Beams	M30
5.	RC Slabs	M30
6.	UG Sump	M30
7.	Structural members in external services	M25

Table 1.4.2 Concrete Properties

Young's Modulus of Elasticity of Concrete	$5000\sqrt{fck}$
Poisson Ratio's Ratio ν =	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/mm^2)	550 N/mm^2
Welded Steel Fabric yield strength $f_{0.2k}$ (N/mm^2)	485 N/mm^2
Young's Modulus E (kN/mm^2)	200 kN/mm^2
Poisson's ratio	0.3
Coefficient of Thermal expansion, α ($^oC^{-1}$)	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. GT-2820 dated 24-07-2024 was carried out by M/s. Geo Marine Consultants (P) Ltd, Chennai. Field investigation carried out for Two (2) boreholes to ascertain subsoil condition in the proposed site. Bore hole-1 is terminated at 28m below ground level where shale formation encountered with a N value >100. Borehole-2 is terminated at 11m below the ground level where silty sandy encountered with the N value >50. During the time of soil investigation (July 2024), the water table is met at 3.5m from EGL.

The report has proposed Isolated/Combined Footing as foundation system with Safe bearing capacity of 25 t/m^2 at a depth of 2.0m from EGL. Taking the recommendation given by the soil consultant in to consideration, the building is designed with Isolated/Combined footing as 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 insulations, 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.

T**able 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
Solid Block	**20.00 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.

Stilt Floor (Parking) (Non-structural Grade slab)		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	2.4	0.0
Services load (ceiling)	0.0	0.0
Live Load Parking	0.0	2.5
Partition Load	0.0	0.0
Total	**2.4**	**2.5**
First Floor (1st Floor) to Fifth Floor (5th floor) (Living/Bedroom/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 Fifth Floor (5th floor) (Toilet)		
	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	1.8	0.0
Total	**3.0**	**2.0**
Lobby /Corridor		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.2	0.0
Live Load	0.0	3.0
Partition Load	0.0	0.0
Total	**1.2**	**3.0**
Head Room		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	2.0	0.0
Live Load	0.0	2.0
Partition Load	0.0	0.0
Total	**2.0**	**2.0**
LMR		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	0.0	0.0
Live Load	0.0	3.0
Lift load	15.0	0.0
Total	**15.0**	**3.0**
OHT loads		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	0.0	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Water load	15.0	0.0
Total	**15.0**	**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 for the height of 18.28m	1.06
Topography factor – k3	1.0
Importance factor (Cyclonic region) – k4	1.0

Design wind speed (Vz) = Vb*k1*k2*k3*k4 =50x1x1.06x1.0x1.0 = 53.0m/sec

Wind pressure (Pz) = 0.6 Vz^2 = 0.6x 53.0^2 =1685.4 N/m^2

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

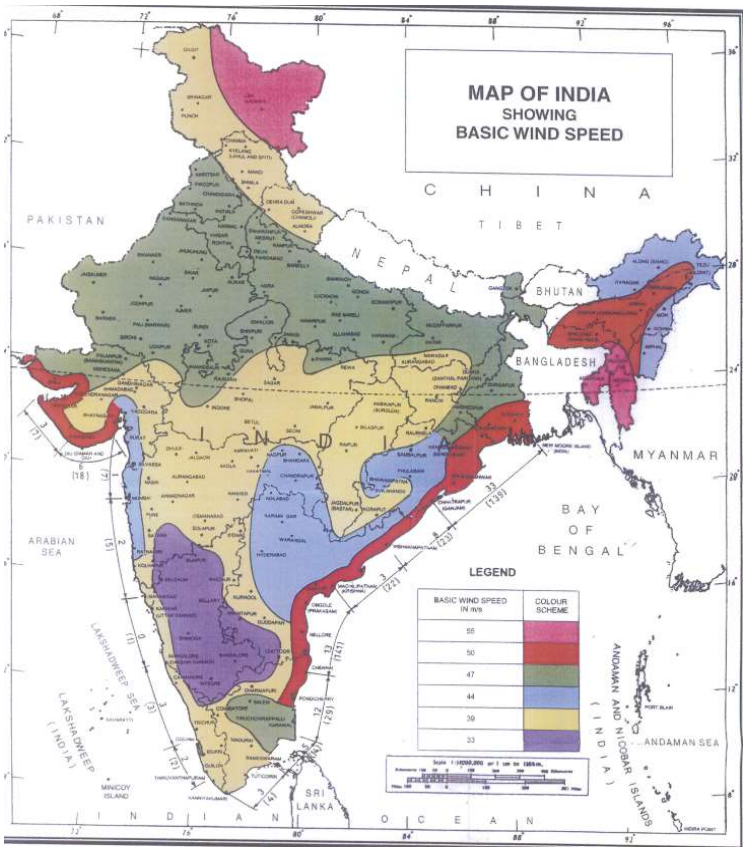
Design wind pressure (P_d) = K_d*K_a*K_c*P_z

Where K_d - Wind Directionality factor = 1.0

Ka – Area averaging factor = 0.9

Kc – Combination factor = 0.9

Design Wind pressure = 1.69x1.0x0.9x0.9 = 1.369 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

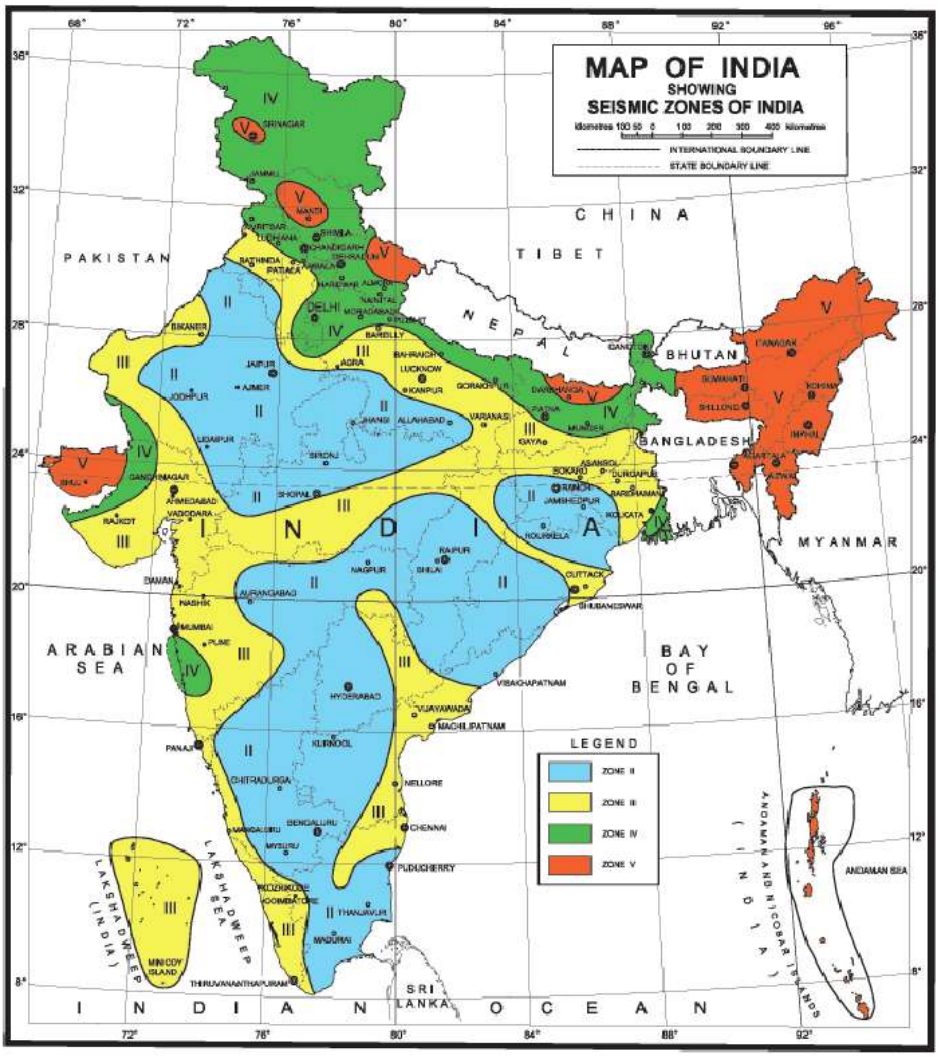
Base shear $V_b = A_h W$

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.m. 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	5.0
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

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

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.	Isolated/Combined Footings	50
2.	RC Wall	30
3.	Column	40
4.	Beams	30
5.	Slabs	25
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 required to follow in the design and detailing of structural elements, is adopted.
- 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								
	D.L.	I.L.	EQX	EQY	WX	WY	SPECX	SPECY
Limit State Of Serviceability (LSS) Combinations								
LC1	1.0	-	-	-	-	-	-	-
LC2	1.0	1.0	-	-	-	-	-	-
LC3	1.0	-	1.0	-	-	-	-	-
LC4	1.0	-	-1.0	-	-	-	-	-
LC5	1.0	-	-	1.0	-	-	-	-
LC6	1.0	-	-	-1.0	-	-	-	-
LC7	1.0	-	-	-	1.0	-	-	-
LC8	1.0	-	-	-	-1.0	-	-	-
LC9	1.0	-	-	-	-	1.0	-	-
LC10	1.0	-	-	-	-	-1.0	-	-
LC11	1.0	-	-	-	-	-	1.0	-
LC12	1.0	-	-	-	-	-	-1.0	-
LC13	1.0	-	-	-	-	-	-	1.0
LC14	1.0	-	-	-	-	-	-	-1.0
LC15	1.0	0.8	0.8	-	-	-	-	-
LC16	1.0	0.8	-0.8	-	-	-	-	-
LC17	1.0	0.8	-	0.8	-	-	-	-
LC18	1.0	0.8	-	-0.8	-	-	-	-
LC19	1.0	0.8	-	-	0.8	-	-	-
LC20	1.0	0.8	-	-	-0.8	-	-	-
LC21	1.0	0.8	-	-	-	0.8	-	-
LC22	1.0	0.8	-	-	-	-0.8	-	-
LC23	1.0	0.8	-	-	-	-	0.8	-
LC24	1.0	0.8	-	-	-	-	-0.8	-
LC25	1.0	0.8	-	-	-	-	-	0.8
LC26	1.0	0.8	-	-	-	-	-	-0.8
Limit State Of Collapse (LSC) Combinations								
COMB1	1.0	-	-	-	-	-	-	-
COMB2	1.5	1.5	-	-	-	-	-	-

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

The load intensity of column is moderate and its proportionate to the no. of stories. As per the bore log data of 1 &2 Isolated/combined Footings are designed as foundation system which is required to support the load within the acceptable settlement. The foundation is designed for the Safe Bearing capacity of 25 t/m^2 to be rest at a depth of 2.4m, on clayey silty sand with a “N” more than 20, based on the recommendation given in the Soil Investigation report no. GT- 2820 dated 24-07-2024, was carried out by M/s. Geo Marine Engineering (P) Ltd, Chennai.

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

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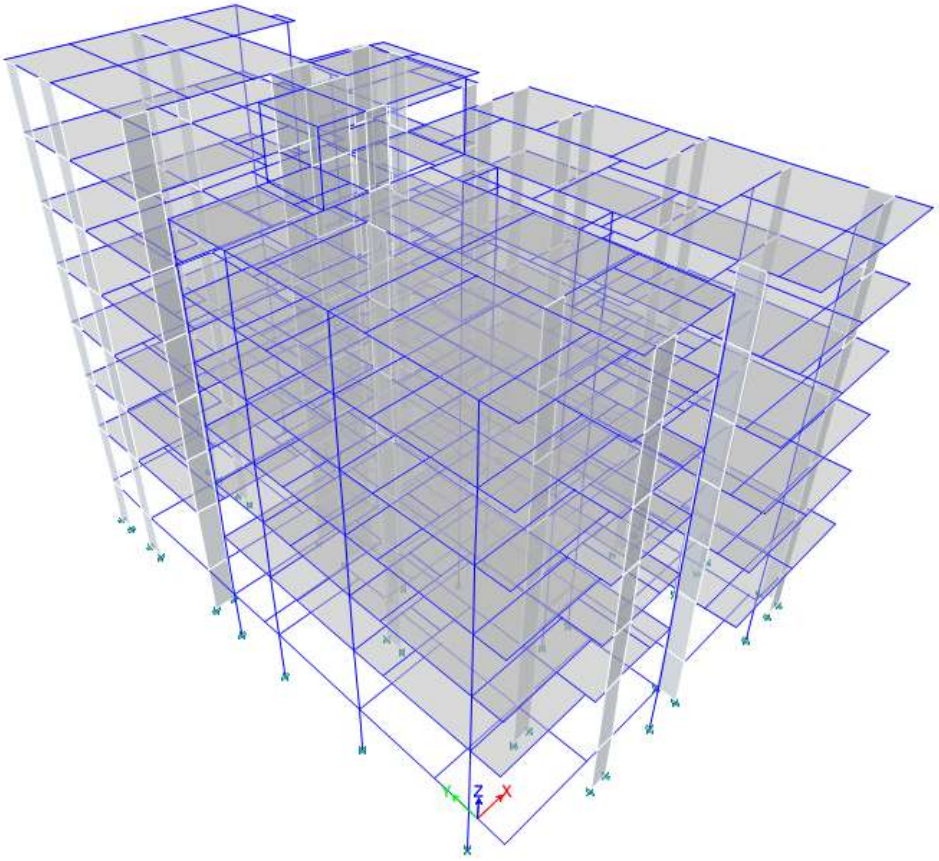


Table of Contents

1. Structure Data 4
   1.1 Story Data 4
2. Properties 5
   2.1 Materials 5
   2.2 Frame Sections 5
   2.3 Shell Sections 6
3. Loads 7
   3.1 Load Patterns 7
   3.2 Auto Wind Loading 7
   3.3 Auto Seismic Loading 10
4. Analysis Results 16
   4.1 Story Results 16
   4.2 Modal Results 16

List of Tables

Table 1.1 Story Definitions 4

Table 2.1 Material Properties - General 5

Table 2.2 Frame Section Property Definitions - Summary 5

Table 2.3 Area Section Property Definitions - Summary 6

Table 3.1 Load Pattern Definitions 7

Table 3.2 Load Pattern Definitions - Auto Wind - Indian IS 875 2015 7

Table 3.3 Load Pattern Definitions - Auto Seismic - IS 1893 2016 10

Table 4.1 Story Stiffness 16

Table 4.2 Modal Participating Mass Ratios 16

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	HEAD ROOM	3	No	None	No	Yellow
T1	ROOF LEVEL	3	No	None	No	Yellow
T1	5TH FLOOR LEVEL	3	No	None	No	Yellow
T1	4TH FLOOR LEVEL	3	No	None	No	Yellow
T1	3RD FLOOR LEVEL	3	No	None	No	Yellow
T1	2ND FLOOR LEVEL	3	No	None	No	Gray8Dark
T1	1ST FLOOR LEVEL	3.6	No	None	No	Blue
T1	GROUND FLOOR	2.6	No	None	No	Green

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	HYSD Grade 550	Red	
HYSD415	Rebar	Uniaxial	HYSD Grade 415	Yellow	
HYSD550	Rebar	Uniaxial	HYSD Grade 550	Cyan	
M30	Concrete	Isotropic	M30	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	As2 cm2	As3 cm2	S33Pos cm3
B 230X450	M30	Concrete Rectangular	Cyan	1035	124072.6	174656.3	45626.3	862.5	862.5	7762.5
B 230X600	M30	Concrete Rectangular	Magenta	1380	184679.1	414000	60835	1150	1150	13800
B 230X750	M30	Concrete Rectangular	Blue	1725	245451.7	808593.8	76043.8	1437.5	1437.5	21562.5
B 230X800	M30	Concrete Rectangular	Cyan	1840	265720.2	981333.3	81113.3	1533.3	1533.3	24533.3
C 230X300	M30	Concrete Rectangular	Yellow	690	64595.3	51750	30417.5	575	575	3450
C 230X380	M30	Concrete Rectangular	Red	874	96006	105171.3	38528.8	728.3	728.3	5535.3
C 230X600	M30	Concrete Rectangular	Blue	1380	184679.1	414000	60835	1150	1150	13800
C 230X700	M30	Concrete Rectangular	Cyan	1610	225187.1	657416.7	70974.2	1341.7	1341.7	18783.3
C 230X750	M30	Concrete Rectangular	Magenta	1725	245451.7	808593.8	76043.8	1437.5	1437.5	21562.5
C 230X800	M30	Concrete Rectangular	Blue	1840	265720.2	981333.3	81113.3	1533.3	1533.3	24533.3
C 230X900	M30	Concrete Rectangular	Yellow	2070	306264.3	1397250	91252.5	1725	1725	31050
C 300X600	M30	Concrete Rectangular	Green	1800	370785.9	540000	135000	1500	1500	18000
C 300X700	M30	Concrete Rectangular	Cyan	2100	460378.2	857500	157500	1750	1750	24500
C 300X750	M30	Concrete Rectangular	Red	2250	505262.9	1054687.5	168750	1875	1875	28125
C 300X900	M30	Concrete Rectangular	Magenta	2700	640075	1822500	202500	2250	2250	40500
DUMMY	DUMMY	Concrete Rectangular	Yellow	100	1408.3	833.3	833.3	83.3	83.3	166.7

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

Name	S33Neg cm3	S22Pos cm3	S22Neg cm3	Z33 cm3	Z22 cm3	R33 mm	R22 mm	Cw cm6	CG Offset 3 mm	CG Offset 2 mm	PNA Offset 3 mm
B 230X450	7762.5	3967.5	3967.5	11643.8	5951.3	129.9	66.4		0	0	0
B 230X600	13800	5290	5290	20700	7935	173.2	66.4		0	0	0
B 230X750	21562.5	6612.5	6612.5	32343.8	9918.8	216.5	66.4		0	0	0
B 230X800	24533.3	7053.3	7053.3	36800	10580	230.9	66.4		0	0	0
C 230X300	3450	2645	2645	5175	3967.5	86.6	66.4		0	0	0
C 230X380	5535.3	3350.3	3350.3	8303	5025.5	109.7	66.4		0	0	0
C 230X600	13800	5290	5290	20700	7935	173.2	66.4		0	0	0
C 230X700	18783.3	6171.7	6171.7	28175	9257.5	202.1	66.4		0	0	0
C 230X750	21562.5	6612.5	6612.5	32343.8	9918.8	216.5	66.4		0	0	0
C 230X800	24533.3	7053.3	7053.3	36800	10580	230.9	66.4		0	0	0
C 230X900	31050	7935	7935	46575	11902.5	259.8	66.4		0	0	0
C 300X600	18000	9000	9000	27000	13500	173.2	86.6		0	0	0
C 300X700	24500	10500	10500	36750	15750	202.1	86.6		0	0	0

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

Name	S33Neg cm3	S22Pos cm3	S22Neg cm3	Z33 cm3	Z22 cm3	R33 mm	R22 mm	Cw cm6	CG Offset 3 mm	CG Offset 2 mm	PNA Offset 3 mm
C 300X750	28125	11250	11250	42187.5	16875	216.5	86.6		0	0	0
C 300X900	40500	13500	13500	60750	20250	259.8	86.6		0	0	0
DUMMY	166.7	166.7	166.7	250	250	28.9	28.9		0	0	0

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

Name	Area Modifier	As2 Modifier	As3 Modifier	J Modifier	I33 Modifier	I22 Modifier	Mass Modifier	Weight Modifier
B 230X450	1	1	1	1	1	1	1	1
B 230X600	1	1	1	1	1	1	1	1
B 230X750	1	1	1	1	1	1	1	1
B 230X800	1	1	1	1	1	1	1	1
C 230X300	1	1	1	1	1	1	1	1
C 230X380	1	1	1	1	1	1	1	1
C 230X600	1	1	1	1	1	1	1	1
C 230X700	1	1	1	1	1	1	1	1
C 230X750	1	1	1	1	1	1	1	1
C 230X800	1	1	1	1	1	1	1	1
C 230X900	1	1	1	1	1	1	1	1
C 300X600	1	1	1	1	1	1	1	1
C 300X700	1	1	1	1	1	1	1	1
C 300X750	1	1	1	1	1	1	1	1
C 300X900	1	1	1	1	1	1	1	1
DUMMY	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 150	Slab	Shell-Thin	M30	150		
W 230	Wall	Shell-Thin	M30	230		
W 300	Wall	Shell-Thin	M30	300		

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	
~SPEC X (D)ECC	Yes	Other	0	
~SPEC X (S)ECC	Yes	Other	0	
~SPEC Y (D)ECC	Yes	Other	0	
~SPEC Y (S)ECC	Yes	Other	0	
DEAD	No	Dead	1	
EQ X	No	Seismic	0	IS 1893:2016
EQ Y	No	Seismic	0	IS 1893:2016
LIVE <3	No	Reducible Live	0	
LIVE >3	No	Reducible Live	0	
ROOF	No	Roof Live	0	
SDL	No	Super Dead	0	
TEMP	No	Temperature	0	
WALL	No	Super Dead	0	
WL X	No	Wind	0	Indian IS 875:2015
WL Y	No	Wind	0	Indian IS 875:2015

3.2 Auto Wind Loading

Table 3.2 - 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
WL X	1	No	Diaphragms	HEAD ROOM	GROUND FLOOR	Yes	1.2	0.8	0.5
WL X	1	No							
WL X	1	No							
WL X	1	No							
WL X	1	No							
WL X	1	No							
WL X	1	No							
WL Y	1	No	Diaphragms	HEAD ROOM	GROUND FLOOR	Yes	1.2	0.8	0.5
WL Y	1	No							
WL Y	1	No							
WL Y	1	No							
WL Y	1	No							
WL Y	1	No							
WL Y	1	No							

Table 3.2 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 2 of 3)

Name	Exposure Set	Wind Speed meter/sec	Terrain Category	Importance Factor	Risk Coefficient	Topography	Width Type	Direction Angle deg
WL X	1	50	2	1.00	1	1	Auto	0
WL X	1							
WL X	1							

Table 3.2 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 2 of 3, continued)

Name	Exposure Set	Wind Speed meter/sec	Terrain Category	Importance Factor	Risk Coefficient	Topography	Width Type	Direction Angle deg
WL X	1							
WL X	1							
WL X	1							
WL X	1							
WL Y	1	50	2	1.00	1	1	Auto	90
WL Y	1							
WL Y	1							
WL Y	1							
WL Y	1							
WL Y	1							
WL Y	1							

Table 3.2 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 3 of 3)

Name	Exposure Set	Diaphragm	Width m	Depth m	X m	Y m
WL X	1	D2	8.725	11.165	5.5825	21.3985
WL X	1	D2	28.845	19.185	9.5925	11.3385
WL X	1	D2	28.845	19.185	9.5925	11.3385
WL X	1	D2	28.845	19.185	9.5925	11.3385
WL X	1	D2	28.845	19.185	9.5925	11.3385
WL X	1	D2	28.845	19.185	9.5925	11.3385
WL X	1	D2	28.845	19.185	9.5925	11.3385
WL Y	1	D2	11.165	8.725	5.5825	21.3985
WL Y	1	D2	19.185	28.845	9.5925	11.3385
WL Y	1	D2	19.185	28.845	9.5925	11.3385
WL Y	1	D2	19.185	28.845	9.5925	11.3385
WL Y	1	D2	19.185	28.845	9.5925	11.3385
WL Y	1	D2	19.185	28.845	9.5925	11.3385
WL Y	1	D2	19.185	28.845	9.5925	11.3385

3.3 Auto Seismic Loading

Table 3.3 - 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?
EQ X	0.367	0.048	48256.0067	2316.2883	No	Yes	No	No	No	No	No
EQ Y	0.309	0.048	48256.0067	2316.2883	No	No	No	No	Yes	No	No

Table 3.3 - 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
EQ X	0.367	0.048	48256.0067	2316.2883	0.05	HEAD ROOM	Base	User Defined	0.367	0.16
EQ Y	0.309	0.048	48256.0067	2316.2883	0.05	HEAD ROOM	Base	User Defined	0.309	0.16

Table 3.3 - 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
EQ X	0.367	0.048	48256.0067	2316.2883	1.2	5
EQ Y	0.309	0.048	48256.0067	2316.2883	1.2	5

IS 1893:2016 Auto Seismic Load Calculation

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

Direction and Eccentricity

Direction = X

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.367\ sec$

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] = III

Seismic Response

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

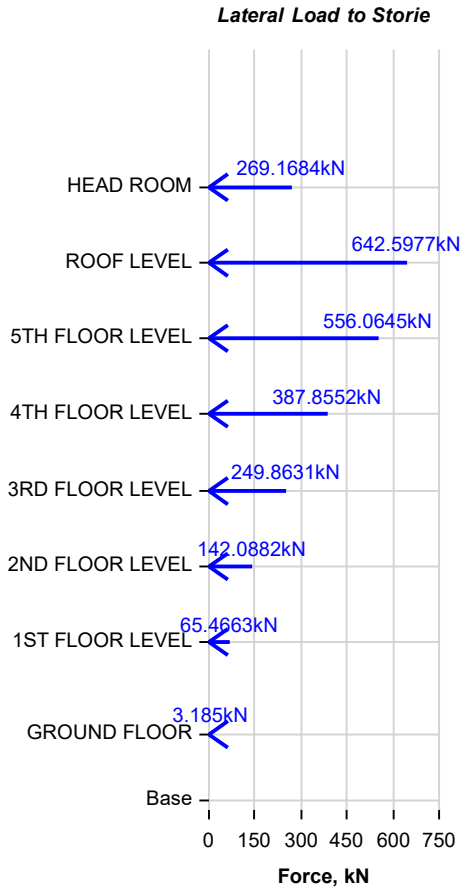
Equivalent Lateral Forces

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	0.367	48256.0067	2316.2883

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HEAD ROOM	21.6	269.1684	0
ROOF LEVEL	18.6	642.5977	0
5TH FLOOR LEVEL	15.6	556.0645	0
4TH FLOOR LEVEL	12.6	387.8552	0
3RD FLOOR LEVEL	9.6	249.8631	0
2ND FLOOR LEVEL	6.6	142.0882	0
1ST FLOOR LEVEL	3.6	65.4663	0
GROUND FLOOR	0	3.185	0
Base	-2.6	0	0

IS 1893:2016 Auto Seismic Load Calculation

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

Direction and Eccentricity

Direction = Y

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.309\ sec$

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] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

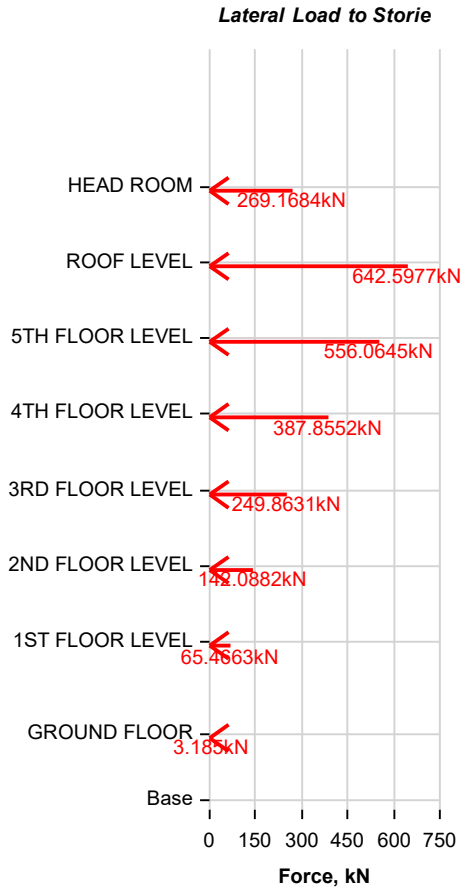
Equivalent Lateral Forces

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	0.309	48256.0067	2316.2883

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HEAD ROOM	21.6	0	269.1684
ROOF LEVEL	18.6	0	642.5977
5TH FLOOR LEVEL	15.6	0	556.0645
4TH FLOOR LEVEL	12.6	0	387.8552
3RD FLOOR LEVEL	9.6	0	249.8631
2ND FLOOR LEVEL	6.6	0	142.0882
1ST FLOOR LEVEL	3.6	0	65.4663
GROUND FLOOR	0	0	3.185
Base	-2.6	0	0

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
HEAD ROOM	EQ X	LinStatic	Step By Step	269.1684	4.015	67047.241	0	0.354	0
ROOF LEVEL	EQ X	LinStatic	Step By Step	911.766	4.436	205532.981	4.498E-06	0.368	0
5TH FLOOR LEVEL	EQ X	LinStatic	Step By Step	1467.8304	5.197	282425.682	3.596E-06	0.413	0
4TH FLOOR LEVEL	EQ X	LinStatic	Step By Step	1855.6856	5.657	328007.793	4.16E-06	0.429	0
3RD FLOOR LEVEL	EQ X	LinStatic	Step By Step	2105.5486	5.78	364292.253	5.665E-06	0.41	0
2ND FLOOR LEVEL	EQ X	LinStatic	Step By Step	2247.6368	5.526	406736.617	5.747E-06	0.369	0
1ST FLOOR LEVEL	EQ X	LinStatic	Step By Step	2313.103	5.652	409221.696	5.957E-06	0.424	0
GROUND FLOOR	EQ X	LinStatic	Step By Step	2316.288	1.866	1241317.999	5.957E-06	0.123	0
HEAD ROOM	EQ Y	LinStatic	Step By Step	0	0.28	0	269.1684	4.6	58509.224
ROOF LEVEL	EQ Y	LinStatic	Step By Step	1.319E-06	0.134	0	911.7661	5.109	178472.203
5TH FLOOR LEVEL	EQ Y	LinStatic	Step By Step	5.275E-06	0.11	0	1467.8306	6.036	243195.118
4TH FLOOR LEVEL	EQ Y	LinStatic	Step By Step	4.152E-06	0.171	0	1855.6858	6.84	271308.069
3RD FLOOR LEVEL	EQ Y	LinStatic	Step By Step	7.286E-06	0.234	0	2105.5488	7.147	294586.637
2ND FLOOR LEVEL	EQ Y	LinStatic	Step By Step	7.425E-06	0.329	0	2247.637	7.002	320994.376
1ST FLOOR LEVEL	EQ Y	LinStatic	Step By Step	7.425E-06	0.539	0	2313.1033	7.42	311743.469
GROUND FLOOR	EQ Y	LinStatic	Step By Step	7.425E-06	0.213	0	2316.2883	2.375	975295.711

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	1.427	0.0131	0.7871	0	0.0131	0.7871	0	0.172	0.0047	0.0329
Modal	2	1.304	0.4967	0.0396	0	0.5099	0.8267	0	0.0065	0.1492	0.279
Modal	3	1.184	0.3083	0.0047	0	0.8182	0.8314	0	0.0004	0.0437	0.5135
Modal	4	0.435	0.0009	0.1028	0	0.819	0.9342	0	0.573	0.0033	0.005
Modal	5	0.391	0.0488	0.0068	0	0.8678	0.941	0	0.0301	0.2423	0.0554
Modal	6	0.353	0.0508	0.0019	0	0.9186	0.9428	0	0.0079	0.2528	0.0202
Modal	7	0.326	0.0189	0	0	0.9376	0.9428	0	0.0001	0.0755	0.0338
Modal	8	0.237	0.001	0.0189	0	0.9386	0.9618	0	0.0505	0.0029	0.001
Modal	9	0.204	0.0191	0.0027	0	0.9577	0.9645	0	0.0083	0.0556	0.0052
Modal	10	0.163	0.0042	0.0109	0	0.9619	0.9754	0	0.0458	0.0143	9.797E-06
Modal	11	0.112	0.0227	0.0032	0	0.9846	0.9786	0	0.0147	0.087	0.0019
Modal	12	0.085	0.0026	0.014	0	0.9872	0.9927	0	0.0593	0.0107	0.0001

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

Case	Mode	SumRX	SumRY	SumRZ
Modal	1	0.172	0.0047	0.0329
Modal	2	0.1785	0.1539	0.3118
Modal	3	0.1789	0.1976	0.8253
Modal	4	0.7519	0.2008	0.8303
Modal	5	0.782	0.4431	0.8857
Modal	6	0.7899	0.6958	0.9059
Modal	7	0.79	0.7713	0.9397
Modal	8	0.8405	0.7742	0.9407

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

Case	Mode	SumRX	SumRY	SumRZ
Modal	9	0.8487	0.8299	0.9459
Modal	10	0.8945	0.8441	0.9459
Modal	11	0.9093	0.9312	0.9478
Modal	12	0.9686	0.9419	0.9478

FOUNDATION DESIGN

FOOTING DESIGN CALCULATIONS

Project Name	:	1
Client Name	:	3
Engineer Name	:	4
Design File	:	D:\BURO PROJECTS\PRAKATHISH\01-PROJECTS\JULY-2024\04-SALMA CONSTRUCTION\29-08-2024-FINAL\GRAVITY-29-08-2024\RCDC GRAVITY\06-09-2024\ddr.rcdx
Analysis File	:	D:\BURO PROJECTS\PRAKATHISH\01-PROJECTS\JULY-2024\04-SALMA CONSTRUCTION\29-08-2024-FINAL\GRAVITY-29-08-2024\RCDC GRAVITY\06-09-2024\SALMA.accdb
Analysis Last Modified	:	06-09-2024 17:58:56

Definitions:

1.	α	=	Coefficient of Thermal Expansion
2.	ε1	=	Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
3.	εm	=	Average steel strain at level considered
4.	ρact	=	Percentage steel provided
5.	ρcrit	=	Percentage steel critical as per code
6.	A	=	Plan area of footing base
7.	Acr	=	Distance from the point considered to the surface of the nearest longitudinal bar
8.	AstPrv	=	Area of tensile reinforcement provided
9.	Astrqd	=	Area of tensile reinforcement required
10.	Asv	=	Area of shear reinforcement required
11.	AsvPrv	=	Area of shear reinforcement provided
12.	A1	=	Bearing area of footing at slope of 1:2
13.	A2	=	C/s Area of column
14.	B	=	Width of footing base
15.	Beff	=	Effective width of footing
16.	BoffB	=	Footing offset along B below column in plan
17.	BoffT	=	Footing offset along B above column in plan
18.	B1	=	Width of sloped footing at top
19.	ColOff	=	Column offset in sloped footing
20.	D	=	Depth of footing
21.	Deff	=	Effective Depth of footing
22.	Df	=	Depth of founding layer
23.	Dw	=	Ground water level
24.	Ec	=	Modulus of elasticity of concrete
25.	Es	=	Modulus of elasticity of steel
26.	Foss	=	Safety factor against sliding
27.	Fosu	=	Safety factor against uplift
28.	Fst	=	Stress in steel

29.	L	=	Length of footing base
30.	Leff	=	Effective length of footing
31.	LoffL	=	Footing offset along L on left side of column
32.	LoffR	=	Footing offset along L on right side of column
33.	L1	=	Length of sloped footing at top
34.	Mx	=	Bending Moment along column D
35.	Mx'	=	Bending Moment along column D due to odd shaped column
36.	Mex	=	Eccentricity moment along column D
37.	Mxx	=	Total Bending Moment along column D (Mx + Mx' + Mex)
38.	My	=	Bending Moment along column B
39.	My'	=	Bending Moment along column B due to odd shaped column
40.	Mey	=	Eccentricity moment along column B
41.	Myy	=	Total Bending Moment along column B (My + My' + Mey)
42.	Muy	=	Factored moment along column B
43.	Muy'	=	Factored Moment along column B due to odd shaped column
44.	Mux	=	Factored moment along column D
45.	Mux'	=	Factored Moment along column D due to odd shaped column
46.	Netdown	=	Net downward load
47.	OB	=	Maximum permissible offset on bottom side of column in plan
48.	OL	=	Maximum permissible offset on left side of column in plan
49.	OR	=	Maximum permissible offset on right side of column in plan
50.	OT	=	Maximum permissible offset on top side of column in plan
51.	P	=	Axial load for footing sizing
52.	P1	=	Soil pressure at corner 1
53.	P2	=	Soil pressure at corner 2
54.	P3	=	Soil pressure at corner 3
55.	P4	=	Soil pressure at corner 4
56.	Pdelta	=	Column Load to be transferred by reinforcement
57.	Pt	=	Calculated percentage tensile reinforcement
58.	Pu	=	Factored axial load
59.	q	=	Surcharge Load
60.	sp	=	Spacing Between bars at outer most layer
61.	SPu	=	Upward Soil Pressure
62.	SPuL	=	Upward Soil Pressure from left
63.	SPuR	=	Upward Soil Pressure from right
64.	SPuB	=	Upward Soil Pressure from bottom
65.	SPuT	=	Upward Soil Pressure from top
66.	Tc	=	Design shear strength of concrete

67.	Temp1	=	Peak Hydration temperature
68.	Temp2	=	Seasonal Temperature Variations
69.	Tv	=	Nominal shear stress
70.	Vu	=	Design shear force
71.	Vus	=	Strength of shear reinforcement
72.	Vx	=	Shear along major axis
73.	Vy	=	Shear along minor axis
74.	Waterpr	=	Upward water pressure
75.	Waterup	=	Upward force due to water
76.	Wcr	=	Surface Crack Width
77.	WFoot	=	Add. Wt. due to difference in concrete and soil density
78.	WFootc	=	Weight of footing and column with concrete density
79.	WSoil	=	Weight of soil covering footing area
80.	Zx	=	Section modulus of footing base along L
81.	Zy	=	Section modulus of footing base along B

Code References:

IS 456

	Parameter		Reference
1.	Ptmax	:	Cl. 26.5.2.1
2.	Ptmin	:	Cl. 26.5.2.1
3.	Pt	:	Cl. 38
4.	Tc	:	Cl. 40.2.1
5.	Tcmax	:	Cl. 40.2.3
6.	Asv	:	Cl. 40.4
7.	Min Shear Reinf	:	Cl. 26.5.1.6
8.	Max Stirrup Spacing	:	Cl. 26.5.1.5
9.	Punching Shear design	:	Cl. 31.6.3
10.	Load transfer	:	Cl. 34.4
11.	Ptnominal	:	Cl. 34.5.2
12.	Crack width calculation	:	Annex-F
13.	Cracking	:	Cl. 35.3.2

BS 8007 (For Early / Initial Thermal Cracking)

1.	Surface Zone for suspended slab	:	Figure A.1
2.	Surface Zone for ground slab	:	Figure A.2
3.	Factors for the calculation of minimum reinforcement	:	Table A.1

Design Code	:	IS 456 : 2000 + IS 13920 : 2016
Footing No	:	FC2

Column No	:	C2	(300 mm X 900 mm)
Analysis No	:	C2	
Concrete Grade	:	M25	N/sqmm
Steel Grade	:	Fe550	N/sqmm
Clear Cover	:	50	mm
Df	:	2 M	
Dw	:	2 M	
Density of Soil	=	18	kN/cum
Soil Bearing Capacity	=	250	kN/sqm
Permissible SBC Increase for EQ	=	25	%
Permissible SBC Increase for Wind	=	25	%
Live Load Reduction	=	0	%
Permissible area of loss of contact	=	0	%
Design cross section by	:	Average pressure	

Footing Type	:	Pad	
Footing Size (L x B x D)	:	3250mm X 2650mm X 775mm	
Without considering Effect of Water Table			
Footing Self Wt., F1	=	166.87	kN
Soil Weight, S1	=	0.00	kN
Total Weight, W1	=	F1 + S1	
	=	166.87	kN
Offset Along L (Loff)	=	1175	mm
Offset Along B (Boff)	=	1175	mm

<u>Check For Maximum Soil Pressure:</u>

Critical Load Combination	=	[10] : (Dead) +(SDL) +(WALL) +(LIVE <3) + (LIVE >3) +(ROOF) +(TEMP) -(EQ Y)	
Pcomb	=	1793.22	kN
P	=	Pcomb + W1	
P	=	1960.08	kN
Mx	=	-336	kNm
My	=	33.69	kNm
P/A	=	227.59	kN/sqm
Mx/Zx	=	-72.02	kN/sqm
My/Zy	=	8.86	kN/sqm
Maximum Soil Pressure	=	308.47	kN/sqm
Allowable Soil Pressure	=	1.25x250	kN/sqm

	=	312.5	kN/sqm

Check For Minimum Soil Pressure:

Critical Load Combination	=	[9] : (Dead) +(SDL) + (WALL) +(LIVE <3) + (LIVE >3) +(ROOF) + (TEMP) +(EQ Y)	
Pcomb	=	1598.40	kN
P	=	Pcomb + W1	
P	=	1765.27	kN
Mx	=	319.61	kNm
My	=	28.77	kNm
P/A	=	204.97	kN/sqm
Mx/Zx	=	68.51	kN/sqm
My/Zy	=	7.56	kN/sqm
Minimum Soil Pressure	=	128.89	kN/sqm
	>	0	

Check For Buoyancy:

Depth of Water Table is below Depth of Foundation, hence Buoyancy check Not Applicable

Check For Sliding:

Critical Load Combination	=	[9] : (Dead) +(SDL) +(WALL) +(LIVE <3) + (LIVE >3) +(ROOF) +(TEMP) +(EQ Y)	
Coefficient Of Friction	=	0.4	
Factor of safety	=	1.2	
Pcomb	=	1598.4	
Shear Vx	=	14.47	kN
shear Vy	=	94.45	kN
Resultant sliding force	=	95.55	kN
Downward force	=	Pcomb + (F1 + S1)	
	=	1765.27	kN
Upward water pressure	=	0.00	kN
Net downward force	=	1765.27	kN
Force resisting sliding	=	Friction Coeff X Net Downward Force	
	=	706.11	kN
Factor of safety available	=	Resisting Force / Sliding Force	
	=	7.39	
	>	1.2	

Check For Overturning:

Along Width:

Critical Load Combination	=	(Dead) +(SDL) +(WALL) +(LIVE <3) +(LIVE >3) +(ROOF) +(EQ Y)	
Factor of safety	=	1.50	
Pcomb	=	1597.51	kN
Moment Mx	=	324.16	kNm
P	=	Pcomb + (F1 + S1)	
	=	1764.37	kN
Stabilizing Moment for P	=	2867.1	kNm
DeStabilizing Moment	=	324.16	kNm
Overturning Factor of safety	=	8.84	
Safe in Overturning	>	1.50	

Along Length:

Critical Load Combination	=	(Dead) +(SDL) +(WALL) +(LIVE <3) +(LIVE >3) +(ROOF) -(WL X) +(TEMP)	
Factor of safety	=	1.50	
Pcomb	=	1726.96	kN
Moment My	=	45.88	kNm
P	=	Pcomb + (F1 + S1)	
	=	1893.82	kN
Stabilizing Moment for P	=	2509.32	kNm
DeStabilizing Moment	=	45.88	kNm
Overturning Factor of safety	=	54.69	
Safe in Overturning	>	1.50	

Design For Bending:

Bottom Reinforcement Along L:

Critical Load Combination	=	[42] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) + (TEMP) -1.5 (EQ Y)	
Pu	=	2362.98	kN
Mux	=	-499.67	kNm
Muy	=	42.08	kNm
P/A	=	274.37	kN/sqm
Mx/Zx	=	-107.11	kN/sqm
My/Zy	=	11.06	kN/sqm
Deff	=	717	mm
Beff	=	2650	mm
SPu	=	381.47	kN/sqm
Mu	=	SPu X B X Loff X Loff / 2	
	=	697.84	kNm
Pt	=	0.13	%
Ast Rqd (BM)	=	2465	sqmm
Ast Prv (Distributed Across Total Width)	=	22 - T12 @ 130	

	=	2488	sqmm

Bottom Reinforcement Along B:

Critical Load Combination	=	[34] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (LIVE <3) +1.5 (LIVE >3) +1.5 (ROOF) + (TEMP)	
Pu	=	2543.26	kN
Mux	=	-10.02	kNm
Muy	=	44.5	kNm
P/A	=	295.3	kN/sqm
Mx/Zx	=	-2.15	kN/sqm
My/Zy	=	11.7	kN/sqm
Deff	=	701	mm
Leff	=	3250	mm
SPu	=	307	kN/sqm
Mu	=	SPu X L X Boff X Boff / 2	
	=	688.76	kNm
Pt	=	0.133	%
Ast Rqd (BM)	=	3023	sqmm
Ast Prv (Distributed Across Total Length)	=	27 - T12 @ 125	
	=	3054	sqmm

Design For Shear:

One Way Shear Along L:

Critical Section @ d from Column Face

	=	717	mm
Critical Load Combination	=	[42] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) + (TEMP) -1.5 (EQ Y)	
Pu	=	2362.98	kN
Mux	=	-499.67	kNm
Muy	=	42.08	kNm
P/A	=	274.37	kN/sqm
Mx/Zx	=	-107.11	kN/sqm
My/Zy	=	11.06	kN/sqm
Deff	=	717	mm
Beff	=	2650	mm
SPu	=	381.47	kN/sqm
Vu	=	SPu X (Loff - d) X B	
	=	462.99	kN
Tv	=	Vu / (Beff X Deff)	

	=	0.24	N/sqmm
Tc	=	0.27	N/sqmm
Tv	<	Tc	

One Way Shear Along B:

Critical Section @ d from Column Face

	=	701	mm
Critical Load Combination	=	[34] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (LIVE <3) +1.5 (LIVE >3) +1.5 (ROOF) +(TEMP)	
Pu	=	2543.26	kN
Mux	=	-10.02	kNm
Muy	=	44.5	kNm
P/A	=	295.3	kN/sqm
Mx/Zx	=	-2.15	kN/sqm
My/Zy	=	11.7	kN/sqm
Deff	=	701	mm
Leff	=	3250	mm
SPu	=	307	kN/sqm
Vu	=	SPu X (Boff - d) X L	
	=	472.93	kN
Tv	=	Vu / (Leff X Deff)	
	=	0.21	N/sqmm
Tc	=	0.28	N/sqmm
Tv	<	Tc	

Design For Punching Shear:

Critical Section @ d/2 from Column Face

	=	354	mm
Critical Load Combination	=	[34] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (LIVE <3) +1.5 (LIVE >3) +1.5 (ROOF) + (TEMP)	
Pu	=	2543.26	kN
Mux	=	-10.02	kNm
Muy	=	44.5	kNm
P/A	=	295.3	kN/sqm
Mx/Zx	=	-2.15	kN/sqm
My/Zy	=	11.7	kN/sqm
Deff	=	709	mm

Leff	=	1609	mm
Beff	=	1009	mm
Punching Perimeter	=	5236	mm
Punching Area	=	3712324	sqmm
SPu	=	Average Pressure	
	=	295.3	kN/sqm
Vu	=	SPu X ((L X B)-(Leff X Beff))	
	=	2063.85	kN
Tv	=	Vu / Punching Area	
	=	0.556	N/sqmm
Tc	=	1.042	N/sqmm
Tv	<	Tc	

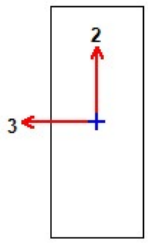
Load Transfer Check For Load Transfer From Column To Footing

Critical Load Combination	=	[34] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (LIVE <3) +1.5 (LIVE >3) +1.5 (ROOF) +(TEMP)	
Pu	=	2543.26	kN
A2	=	0.27	sqm
A1	=	13.6	sqm
Base Area	=	8.61	sqm
A1	>	Base Area	
Thus, A1	=	8.61	
Modification Factor	=	SquareRoot(A1/A2) < = 2	
SquareRoot(A1/A2)	=	5.647	
Thus, Modification Factor	=	2	
Concrete Bearing Capacity	=	0.45 X Fck X Modification Factor X Column Area	
	=	6075	kN
Concrete Bearing Capacity	>	Pu, Hence Safe.	

COLUMN DESIGN

ETABS Concrete Frame Design

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



Column Element Details (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)
1ST FLOOR LEVEL	C1	23	C 300X750	14 1.5DL+1.5SPEC Y(D)	0	3600

Column Element Details (Part 2 of 2)

LLRF	Type
0.7	Ductile Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
300	750	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	550	415

Design Code Parameters

γ_c	γ_s
1.5	1.15

Axial Force and Biaxial Moment Design For P_u , M_{u2} , M_{u3}

Design P_u kN	Design M_{u2} kN-m	Design M_{u3} kN-m	Minimum M_2 kN-m	Minimum M_3 kN-m	Rebar Area mm²	Rebar % %
2008.4435	89.215	-202.3004	42.579	62.2617	1800	0.8

Axial Force and Biaxial Moment Factors

	K Factor Unitless	Length mm	Initial Moment kN-m	Additional Moment kN-m	Minimum Moment kN-m
Major Bend(M3)	1.2	3000	-100.3725	0	62.2617
Minor Bend(M2)	0.8	5600	-19.5934	46.636	42.579

Shear Design for V_{u2} , V_{u3}

	Shear V_u kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv}/s mm²/m
Major, V_{u2}	124.6764	144.7202	82.8002	124.6764	332.53
Minor, V_{u3}	57.1707	135.0005	72.0006	57.1707	831.33

Joint Shear Check/Design

	Joint Shear Force kN	Shear V_{Top} kN	Shear $V_{u,Tot}$ kN	Shear V_c kN	Joint Area cm²	Shear Ratio Unitless
Major Shear, V_{u2}	N/N	N/N	N/N	N/N	N/N	N/N
Minor Shear, V_{u3}	N/N	N/N	N/N	N/N	N/N	N/N

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/N	N/N

Additional Moment Reduction Factor k (IS 39.7.1.1)

A_g cm²	A_{sc} cm²	P_{uz} kN	P_b kN	P_u kN	k Unitless
2250	18	3780	1227.8985	2008.4435	0.694156

Additional Moment (IS 39.7.1)

	Consider M_a	Length Factor	Section Depth (mm)	KL/Depth Ratio	KL/Depth Limit	KL/Depth Exceeded	M_a Moment (kN-m)
Major Bending (M_3)	Yes	0.833	750	4.8	12	No	0
Minor Bending (M_2)	Yes	1.556	300	14.933	12	Yes	67.1838

WALL DESIGN

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)	LLRF
1ST FLOOR LEVEL	P2	5450	25261	1000	230	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	550	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	5450	24761	5450	25761	1000	230
Bottom	Leg 1	5450	24761	5450	25761	1000	230

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	6084	0.0265	0.0041	14 1.5DL+1.5SPEC Y(D)	3221.2815	115.919	372.3332	230000
Bottom	7274	0.0316	0.0041	14 1.5DL+1.5SPEC Y(D)	3252.3224	116.7935	-538.172	230000

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	575	14 1.5DL+1.5SPEC Y(D)	637.6396	372.3332	-251.8835	151.1714	317.1714
Bottom	Leg 1	575	14 1.5DL+1.5SPEC Y(D)	668.6805	452.3228	-251.8835	151.1714	317.1714

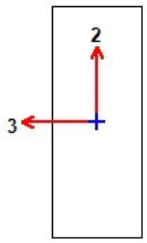
Boundary Element Check

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	345	14 1.5DL+1.5SPEC Y(D)	3221.2815	-318.8949	22.32	6
Top–Right	Leg 1	460	14 1.5DL+1.5SPEC Y(D)	3221.2815	372.3332	23.72	6
Bottom–Left	Leg 1	460	14 1.5DL+1.5SPEC Y(D)	3252.3224	-538.172	28.18	6
Botttom–Right	Leg 1	460	14 1.5DL+1.5SPEC Y(D)	3252.3224	452.3228	25.94	6

BEAM DESIGN

ETABS Concrete Frame Design

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



Beam Element Details (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)
1ST FLOOR LEVEL	B53	285	B 230X600	14 1.5DL+1.5SPEC Y(D)	6820	6820

Beam Element Details (Part 2 of 2)

LLRF	Type
1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
230	600	230	0	30	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	550	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
-342.2572	0.0276	205.8928	-48.4259

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-342.2572	0.0585	0	-342.3157

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)	-342.3157		1511	51	1511	378
Bottom (-2 Axis)		0	755	51	202	755

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
279.8631	0	280.0549	107.1252	1361.5

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
0.0276	205.8928	190	560	0

SLAB DESIGN

PROJECT

DESIGN OF SLAB No:

1.00	Grade of concrete		=	30.00	N/mm^2
2.00	Grade of steel		=	550.00	N/mm^2
3.00	Cover to reinforcement		=	25.00	mm
	Diameter of bar			8.00	mm
4.00	Aspect ratio $\frac{l_y}{l_x}$ =	5.20	5.32	1.167	< 2
		4.44	4.56		
5.00	Edge condition: Two Adjacent Edges Discontinuous		Two way slab		
6.00	Modification factor assumed			1.70	
		116.65			
7.00	Depth required for deflection:		D =	150.00	mm
				150.00	mm
			d =	121.00	mm
8.00	Dead Load		=	3.60	kN/m^2
9.00	Live load		=	2.00	kN/m^2
10.00	Partitions & FF		=	1.70	kN/m^2
11.00	Total load		=	7.30	kN/m^2
12.00	Factored load		=	10.95	kN/m^2

Case No: 4

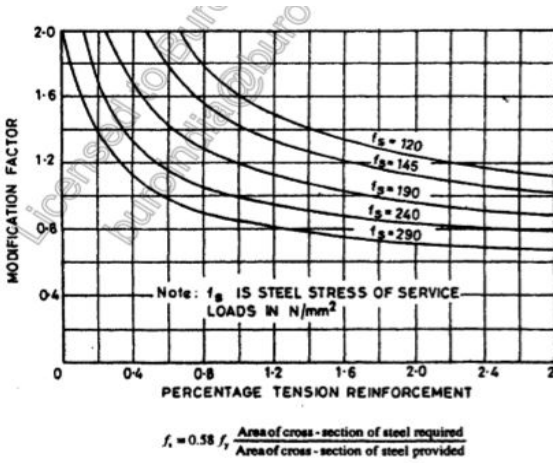
D+(C-D)*(E-A)/(B-A)

	Negative	Positive
A	1.10000	1.10000
B	1.20000	1.20000
C	0.05300	0.04000
D	0.06000	0.04500
E	1.16663	1.16663
Value	0.05766	0.04333

ok

qa

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	0.058	0.043	0.047	0.035
M_u=Co-efficient*w* l_x^2	13.14	9.87	10.71	7.97
K= Mu/bd2	0.90	0.67	0.73	0.54
Percentage of steel required	0.19	0.14	0.16	0.12
Ast required(in mm^2)	235.27	175.14	190.42	140.71
Ast min (in mm^2)	180.00	180.00	180.00	180.00
Ast to be provided (in mm2)	235.27	180.00	190.42	180.00
Provided bars spacing (c/c)	213.74	279.37	264.08	279.37
max spacing	250.00	250.00	250.00	250.00
spacing	213.74	250.00	250.00	250.00
Reqd bars spacing (c/c)	**210.00**	**250.00**	**250.00**	**250.00**
Pvd bars spacing (c/c)	**200.00**	**150.00**	**200.00**	**200.00**
Ast Provided(in mm^2)	**251.43**	**335.24**	**251.43**	**251.43**
Percentage of steel provided	**0.21**	**0.28**	**0.21**	**0.21**



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

FIG. 4 MODIFICATION FACTOR FOR TENSION REINFORCEMENT

STEPII

F_s=0.58 *f_y * (Ast required/ Ast provided)

F_s		166.65
M.F		1.80
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 DEPT 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	=	9.9
f_{st}	=	259.0
ε_m	=	0.0
Spacing		150.0
a_{cr}	=	79.1
ω_{cr}	=	0.11
	<	0.20 mm (safe)

STRUCTURAL DRAWINGS

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

Verified RealEstate
3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai 600 097, India
hello@verified.realestate
+91 9996 12 9996

Prepared from the registers named on the page each finding sits on. Where a register could not be read, this document says so in its place rather than leaving the gap to be read as a clean result.