STRUCTURAL DESIGN BASIS REPORT

THE PROPOSED CONSTRUCTION OF HIGH RISE RESIDENTIAL APPARTMENT CONSISTS OF EXTENDED DOUBLE BASEMENT FLOOR + STILT FLOOR/ GROUND FLOOR + 24 RESIDENTIAL FLOORS WITH 136 DWELLING UNITS WITH OPEN SWIMMING POOL AT TERRACE LEVEL AVAILING PREMIUM FSI WITH TOD SITUADED AT POOMAMALLEE HIGH ROAD, KOYAMBEDU, CHENNAI-600107. COMPRISED IN S.NO.169/1, 2, 3 & 4, AS PER PATTA T.S.NO.4/3 &5, BLOCK.NO.37, OF KOYAMBEDU VILLAGE, AMINJIKARAI TALUK, AND WITHIN THE LIMITS OF GREATER CHENNAI CORPORATION AT POOMAMALLEE HIGH ROAD, KOYAMBEDU, CHENNAI-600107.

CLIENT:	M/S AMARA, CHENNAI.
ARCHITECT:	FHD INDIA CONSULTANT LLP, CHENNAI.
STRUCTURAL CONSULTANT:	**BURO ENGINEERS (INDIA) PRIVATE LIMITED,** Chennai

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Index

- Design Information and criteria
- 3D Model & Analysis summary report
- Design of Pile Cap
- Design of Column
- Design of Shear wall
- Design of Beam
- Design of Slab

DESIGN INFORMATION AND CRITERIA

1.0 INTRODUCTION

M/s.AMARA Pvt Ltd proposed a construction of High rise Residential Building is located at Koyembedu village, Chennai. Architecturally it is designed with a double Basement floor+Stilt floor/Ground floor + 24 residential Floors + Roof. In which the 2 Basement floor+ Stilt floors are designed to facilitate car parks as per norms. Rest of all floors are designed to accommodate to be Residential units. The building is architecturally designed to be a Rectangle in shape which has been designed in line with the land shape.

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 Residential Apartment building comprises double Basement + Stilt + 24 Floors + Roof. Plan dimension of the building at the Stilt level is 53mx24.145m respectively. 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	Double Basement + Stilt + 24 floors + Terrace	77.95m (measuring from stilt to Terrace)	53mx24.145m	With car parking

Building Floor Height Details	
2 Basement Floor (Car Park)	3.30m
1 Basement Floor (Car Park)	4.40m
Stilt Floor (Car Park)	3.10m
1st Floor (Car Park)	4.70m
2nd Floor to 24th Floor	3.05m
Head Room	3.25m
LMR	4.35m(from Terrace floor)

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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 shear wall-Beam/slab system. Foundation is designed to be Cast In-situ Bored Pile.

1.3.2 Foundation Type

The foundation system is to be Cast In-situ Bored Pile Foundation system. The Pile depth is about 33m from Existing Ground Level and the pile shaft length is to be around 25m from Pile cut off level. The Pile will be designed for the recommended Working Compression Capacity as laid down in the Soil Investigation report No. GEC-JC-GT-7007/2025-2026_KOYEMBEDU VILLAGE dated 26th April 2025, was carried out by M/s. GEO ENGINEERING CONSULTANT, 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

Sl.No.	Structural Elements	Grade of Concrete
1.	Pile/Pile Caps	M35
2.	**RC Shear wall**	**M50**
3.	**RC Columns**	**M50**
4.	RC Beams	M35
5.	RC Slabs	M35
6.	UG Sump & STP	M35
7.	Structural members in external services	M25

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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/mm^2)	**550D** 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. GEC-JC-GT-7007/2025-2026_KOYEMBEDU VILLAGE dated 26th April 2025, was carried out by M/s. GEO ENGINEERING CONSULTANT, Velachery, Chennai. Field investigation carried out for Five (5) boreholes at different locations to ascertain subsoil condition in the proposed site. All the bore holes are terminated between 36m to 40m respectively in dense layer with "N" value more than 100 where very Hard Compacted Clay/Shale Formation encounters. In which, Bore Hole-BH1 Clayey Sand, Silty Sand, Silty Clay, Clayey Sand, Silty Clay, Silty Clay, Silty Sand, Silty Clay, Clayey Sand , Sandy Clay, Compacted Clay, Compacted Clay/ Shale encounters, Bore Hole-BH2 Sandy Clay, Silty Sand, Silty Clay, Silty Sand, Silty Clay, Silty Sand, Silty Clay, Clayey Sand, Compacted Clay/ Shale encounters, Bore Hole-BH3 Clayey Sand, Sandy Clay, Silty Sand, Silty Clay, Sandy Clay, Silty Sand, Silty Clay, Silty Sand, Compacted Clay, Sandy Clay, Clayey Sand, Compacted Clay/ Shale encounters, Bore Hole-BH4 Sandy Clay, Silty Clay, Clayey Sand, Silty Sand, Clayey Sand, Sandy Clay, Silty Sand, Silty Clay, Compacted Clay/ Shale encounters, Bore Hole-BH5 Sandy Clay, Silty Sand, Clayey Sand, Silty Clay, Clayey Sand, Silty Sand, Silty Clay, Sandy Clay, Compacted Clay/ Shale encounters. Based on bore hole data, the top soil is filled up Clayey Sand stuff which is extended up to 1.5m. From 1.5m to 8.0m, the soil layer is Silty Clay with "N" value varies from 4 to 13. From 8.0m the soil is clay of low plasticity with "N" Values varies from 4 to 35 continuous up to 20m. From 20m, it is a Greyish black, moist, medium stiff Sandy clay exist up to 30m with "N" value 35 to 80. From 30m to 36m, it is Compacted Clay with "N" value is 100. Below 36m, it is a Compacted Clay with "N" value is more than 100. All the two bore hole terminated at this level.However, it is advisable to design the ground below structure like STP & UG Sump etc. for the head of water up to Ground level as the water table likely to raises up to ground during peak monsoon.

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

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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.

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

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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

Table 2.2.4 Design of Steel Structural Elements

IS Code	Description
IS 800: 2007(RA-2017)	Code of Practice for General Construction in Steel
IS 2062: 2011(RA-2016)	Steel for General structural purposes

Table 2.2.5 Design of Concrete Elements - International codes

IS Code	Description
BS 8110: 1997	Structural use of concrete. Code of Practice for design and construction
ACI 318	Building Code requirements for Structural Concrete

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 Block	**07.50 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

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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.

1Basement to Stilt Floor (Parking)		
	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	5.0
Partition Load	0.0	0.0
Total	**2.4**	**5.0**
Second Floor to Twenty Fourth Floor (Living/Bedroom/Kitchen)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.8	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition/Filling Load	0.0	0.0
Total	**1.8**	**2.0**
Second Floor (Toilet)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.8	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition/Filling Load	2.5	0.0
Total	**4.3**	**2.0**
Second Floor (Balcony)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.8	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition/Filling Load	1.2	0.0
Total	**3**	**2.0**
Third Floor to Twenty Fourth Floor (Toilet)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.8	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition/Filling Load	1	0.0
Total	**2.8**	**2.0**
Third Floor to Twenty Fourth Floor (Balcony)		

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	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.8	0.0
Services load (ceiling)	0.0	0.0
Live Load	0.0	2.0
Partition/Filling Load	1.2	0.0
Total	**3.0**	**2.0**
Lobby /Corridor		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.8	0.0
Live Load	0.0	3.0
Partition Load	0.0	0.0
Total	**1.8**	**3.0**
Gym / Games / Multipurpose Hall		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	5.0	0.0
Live Load	0.0	3.0
Partition Load	0.0	0.0
Total	**5.0**	**3.0**
Swimming pool		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.8	0.0
Live Load	0.0	3.0
Water Load	18.2	0.0
Total	**20**	**3.0**
Fire Tender		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	2.4	0.0
Live Load	0.0	15.0
Partition/Filling Load	3.0	0.0
Total	**5.4**	**15.0**
Landscape		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	2	0.0
Live Load	0.0	3.0
Partition/Filling Load	8	0.0
Total	**10**	**3.0**
Terrace		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.8	0.0
Live Load	0.0	3.0
Partition/Filling Load	1.2	0.0
Total	**3.0**	**3.0**
Head Room		

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	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	20.0	0.0
Total	**20.0**	**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.

2.5 TEMPERATURE EFFECTS

Temperature changes can cause additional stresses to the structure and has potential to increase in loads will be considered in the design of structural elements. Temperature effects will be considered for an ambient temperature variation from temperature during construction.

The maximum and minimum temperature for city of Chennai as recorded by Indian Metrological Department is as follows.

Maximum mean Temperature	45°C
Minimum mean Temperature	15°C
Average ambient Temperature during construction	30°C

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The structural system will be designed for the effect of temperature variation. A temperature variation of **±15° C** will be considered in the structural analysis over the Roof & Terraces for the consideration of thermal effect on structural elements.

Expansion Joints

Expansion joints are normally provided when the structure is more than 45m length as per IS-456-2000, clause 27.2. In this case the length of the building is to be 32.90m which is falls well within the limitation stimulated in IS 456: 2000, clause.27.2. Hence no expansion joint is provided.

2.6 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 77.95m	1.21
Topography factor – k3	1.0
Importance factor (Cyclonic region) – k4	1.0

Design wind speed (Vz) = Vb*k1*k2*k3*k4 =50x1x1.21x1.0x1.0 = 60.5m/sec

Wind pressure (Pz) = 0.6 Vz^2 = 0.6x 60.5^2 =2196.15 N/m^2

For design of building wind pressure 2.196 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 = 2.196x1.0x0.9x0.9 = 1.778 kN/m^2

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2.6.1 Dynamic wind analysis

As per IS 875 (Part 3) - 2015, clause 9.1 Dynamic wind analysis has to be carried out if the buildings meet the following criteria.

a). Buildings and closed structures with a height to minimum lateral dimension ratio (H/Wmin) is more than 5. (or)

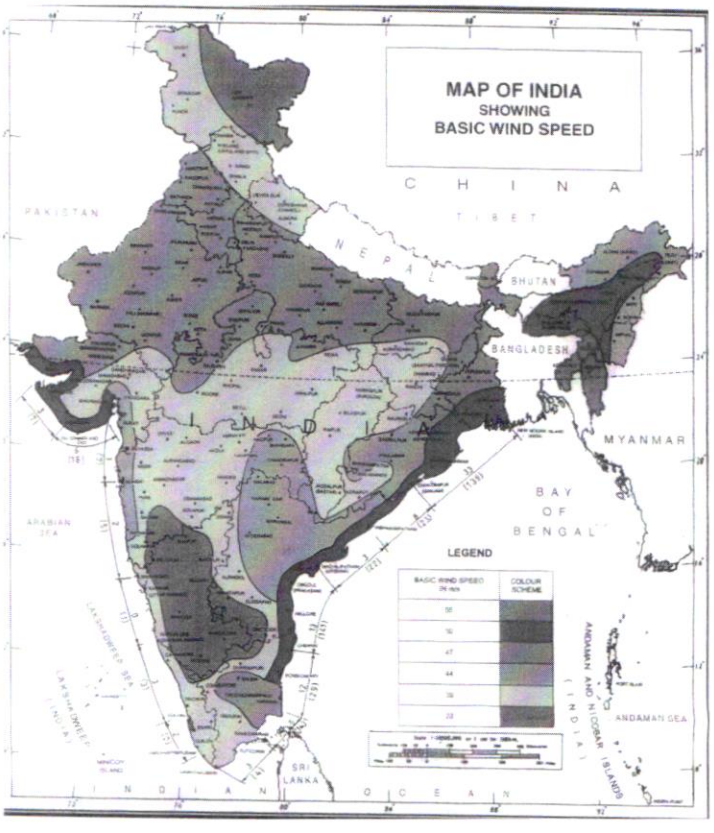
b). Building and structures whose natural frequency is less than 1.0 Hz.

Fundamental period of the building = Ta = 0.09H/(D)^0.5. Fundamental natural frequency 1/Ta >1.0

2.6.2 Time period

Sl.No	Height(m)	B(m)	D(m)	Tax(sec)	Tay(sec)	1/Tax	1/Tay
1	77.95	53	24.125	1.763	1.763	0.567	0.567

From the above, it is evident that Dynamic wind analysis for the proposed building is required, since the ratio of H/B & H/D < 5. Also, the natural frequency is 1/Ta >1.0.



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2.7 Seismic Lateral Force

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

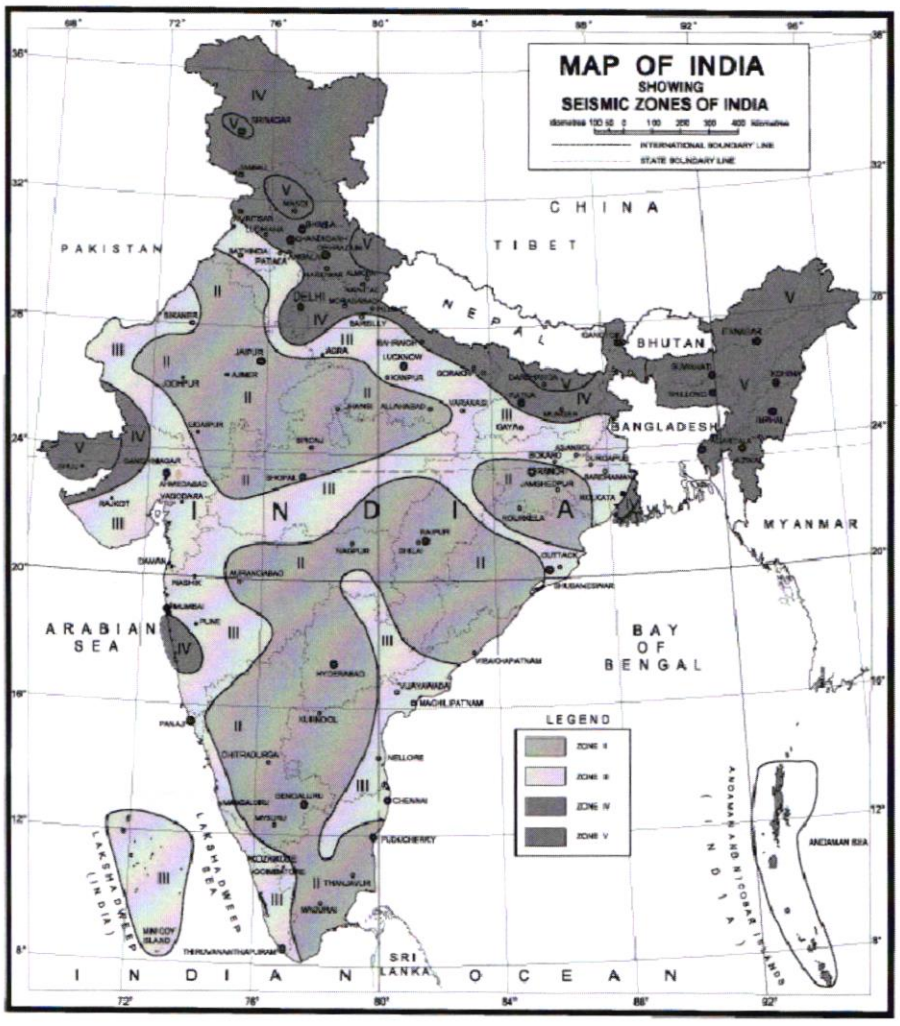
Base shear $V_b = A_h W$

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, 25% of live load where live load is less than 3 kN/sq.mt and 50% of live load where live load is greater 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.



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2.7.1 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: Buildings with ductile RC Structural wall system	4.0
4	Importance factor	1.2
5	Type of Soil	Type II
6	Damping coefficient	5%

2.8 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 medium) X-direction = (Refer to IS 1893-2016, page 13, Fig 1)

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

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Design horizontal seismic coefficient and base shear

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

2.9 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 Shear Wall	30
3.	Columns	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: Shell Element

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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

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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 SDL 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, Table.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 Buildings with ductile 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

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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.

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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. Piled Foundation

The proposed Residential building comprises double Basement + Stilt Floor + 1st to 24th Floor (Residential use) Storey structure located in Koyembedu, Chennai.

Based on the soil report No. GEC-JC-GT-7007/2025-2026 date 26 April 2025, there are 5 nos. Of bore holes were done at different locations of the plot spread across the building foot print. Laboratory data, the geo-technical consultant laid down in his recommendation deep foundation is the suitable one which transfers the load safely at the deeper level where the hard layer is encountered with higher "N" value.

Taking the soil condition and the structural load intensity of individual vertical member in to account and based on the soil consultant recommendation which laid down in his report, the building is designed with Bored cast-In-Situ pile foundation to ensure the load is safely transferred in to the ground.

- Bored Cast In-situ Pile Foundation with combined Pile cap designed with Pile length in the range of 25m from pile cut of level and around 33m measured from EGL and the empty boring shall be in the range of 8m.
- No. of Piles provided under each vertical elements according to its load intensity & as per the Pile capacity of each diameter.
- Pile diameter intended to use 600mm, 900mm with its working capacity of 1300kN & 2300kN respectively and a Tension pile capacity of 650kN for 600mm dia piles.

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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.

7. Computer programs used

The following Software/ Spreadsheet are used to carry out Structural design

7.1 PROKON Ver 2.3 - Wall & Beam design

7.2 ETABS Ver 2017 -Three Dimensional FEM analysis and Design Programs

7.3 SAFE 2016 Ver 16.1.1 - Used mainly for Pile cap Group Analysis and some Irregular shaped floor slab designs.

7.4 In-House Spreadsheet - One way/ Two way slab design

7.5 RCDC V.8.0 - Design Software for all Structural Elements except Raft

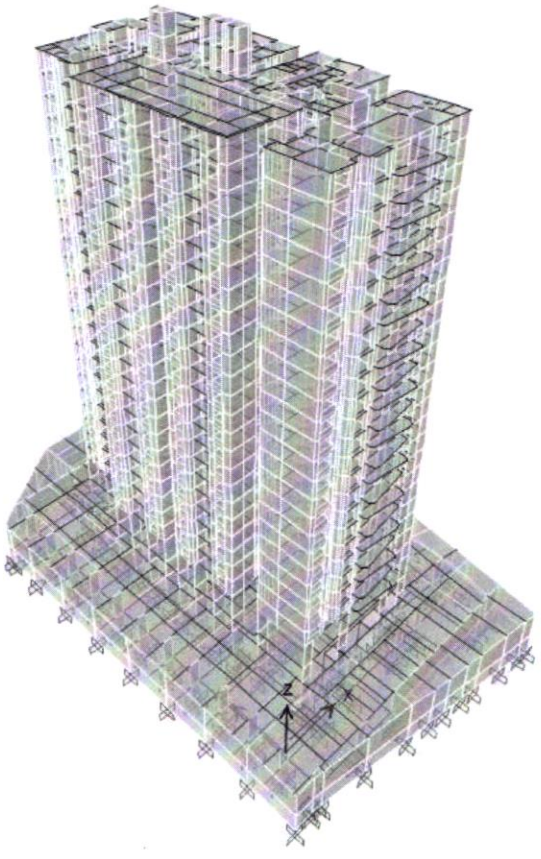
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3D MODEL

&

ANALYSIS SUMMARY REPORT

ETABS®



User Report 1

Model File: ETABS BASE MODEL, Revision 0
30-06-2025

Table of Contents

1. Structure Data 5
   1.1 Story Data 5
2. Properties 6
   2.1 Materials 6
   2.2 Frame Sections 6
   2.3 Shell Sections 7
3. Loads 9
   3.1 Load Patterns 9
   3.2 Load Sets 9
   3.3 Auto Wind Loading 10
   3.4 Auto Seismic Loading 16
   3.5 Load Cases 21
4. Analysis Results 22
   4.1 Story Results 22
   4.2 Modal Results 24

List of Figures

Figure 3-1 Set 1 12

Figure 3-2 Set 1 14

Figure 3-3 Set 1 18

Figure 3-4 Set 1 20

List of Tables

Table 1.1 Story Definitions 5

Table 2.1 Material Properties - General 6

Table 2.2 Frame Section Property Definitions - Summary 6

Table 2.3 Area Section Property Definitions - Summary 8

Table 3.1 Load Pattern Definitions 9

Table 3.2 Shell Uniform Load Sets 9

Table 3.3 Load Pattern Definitions - Auto Wind - User Loads 10

Table 3.4 Load Pattern Definitions - Auto Seismic - IS 1893 2016 16

Table 3.5 Load Case Definitions - Summary 21

Table 4.1 Story Stiffness 22

Table 4.2 Modal Participating Mass Ratios 24

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	Splice Height m	Color
T1	LMR COVER	2.9	No	None	No		Yellow
T1	LMR BASE	2.9	No	None	No		Blue
T1	TERRACE	3.05	No	None	No		Cyan
T1	24th FLOOR	3.05	No	None	No		Magenta
T1	23th FLOOR	3.05	No	None	No		Gray8Dark
T1	22nd FLOOR	3.05	No	None	No		Green
T1	21th FLOOR	3.05	No	None	No		Red
T1	20th FLOOR	3.05	No	None	No		Yellow
T1	19th FLOOR	3.05	No	None	No		Blue
T1	18th FLOOR	3.05	No	None	No		Cyan
T1	17th FLOOR	3.05	No	None	No		Magenta
T1	16th FLOOR	3.05	No	None	No		Gray8Dark
T1	15th FLOOR	3.05	No	None	No		Green
T1	14th FLOOR	3.05	No	None	No		Red
T1	13th FLOOR	3.05	No	None	No		Yellow
T1	12th FLOOR	3.05	No	None	No		Blue
T1	11th FLOOR	3.05	No	None	No		Cyan
T1	10th FLOOR	3.05	No	None	No		Magenta
T1	9th FLOOR	3.05	No	None	No		Gray8Dark
T1	8th FLOOR	3.05	No	None	No		Green
T1	7th FLOOR	3.05	No	None	No		Red
T1	6th FLOOR	3.05	No	None	No		Yellow
T1	5th FLOOR	3.05	No	None	No		Blue
T1	4th FLOOR	3.05	No	None	No		Cyan
T1	3rd FLOOR	3.05	No	None	No		Magenta
T1	2nd FLOOR	4.7	No	None	No		Gray8Dark
T1	1st FLOOR	3.1	No	None	No		Green
T1	STILT	4.7	No	None	No		Red
T1	BASEMENT 1	3.3	No	None	No		Yellow

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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	Unknown	Red	
HYSD415	Rebar	Uniaxial	HYSD Grade 415	Blue	
HYSD550	Rebar	Uniaxial	HYSD Grade 550	Gray8Dark	
M30	Concrete	Isotropic	M30	Yellow	
M35	Concrete	Isotropic	M35	Magenta	
M50	Concrete	Isotropic	M50	Gray8Dark	
Tendon	Tendon	Uniaxial	Unknown	Cyan	

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2.2 Frame Sections

Table 2.2 - Frame Section Property Definitions - Summary (Part 1 of 4)

Name	Material	Shape	Color	Area cm2	J cm4	I33 cm4	I22 cm4	I23 cm4	IMajor cm4
B 165X450	M30	Concrete Rectangular	Red	742.5	51898.4	125296.9	16845.5	0	
B 175X175	M30	Concrete Rectangular	Cyan	306.3	13213.5	7815.8	7815.8	0	
B 175X450	M35	Concrete Rectangular	Green	787.5	60799.9	132890.6	20097.7	0	
B 200X450	M30	Concrete Rectangular	Cyan	900	86596.1	151875	30000	0	
B 200X600	M30	Concrete Rectangular	Red	1200	126597.2	360000	40000	0	
B 200X900	M30	Concrete Rectangular	Red	1800	206687	1215000	60000	0	
B 300X600	M30	Concrete Rectangular	Gray8Dark	1800	371118.1	540000	135000	0	
B 300X800	M30	Concrete Rectangular	Red	2400	550813.4	1280000	180000	0	
B 450x600	M30	Concrete Rectangular	Green	2700	988600.1	810000	455625	0	
B 450X800	M30	Concrete Rectangular	Gray8Dark	3600	1578033.6	1920000	607500	0	
B 600X1200	M30	Concrete Rectangular	Green	7200	5937889.2	8640000	2160000	0	
B 600X600	M30	Concrete Rectangular	Red	3600	1825874.6	1080000	1080000	0	
B 600X800	M30	Concrete Rectangular	Gray8Dark	4800	3124464.4	2560000	1440000	0	
B 700X1300	M30	Concrete Rectangular	Cyan	9100	9866932.4	12815833.3	3715833.3	0	
C 300X900	M30	Concrete Rectangular	Cyan	2700	640898.3	1822500	202500	0	
Dummy	Dummy	Concrete Rectangular	Yellow	0	0	0	0	0	

Table 2.2 - Frame Section Property Definitions - Summary (Part 2 of 4)

Name	IMinor cm4	MajorAngle deg	As2 cm2	As3 cm2	S33Pos cm3	S33Neg cm3	S22Pos cm3	S22Neg cm3	Z33 cm3	Z22 cm3	R33 mm
B 165X450			618.7	618.7	5568.8	5568.8	2041.9	2041.9	8353.1	3062.8	129.9
B 175X175			255.2	255.2	893.2	893.2	893.2	893.2	1339.8	1339.8	50.5
B 175X450			656.2	656.2	5906.3	5906.3	2296.9	2296.9	8859.4	3445.3	129.9
B 200X450			750	750	6750	6750	3000	3000	10125	4500	129.9
B 200X600			1000	1000	12000	12000	4000	4000	18000	6000	173.2
B 200X900			1500	1500	27000	27000	6000	6000	40500	9000	259.8
B 300X600			1500	1500	18000	18000	9000	9000	27000	13500	173.2
B 300X800			2000	2000	32000	32000	12000	12000	48000	18000	230.9
B 450x600			2250	2250	27000	27000	20250	20250	40500	30375	173.2
B 450X800			3000	3000	48000	48000	27000	27000	72000	40500	230.9
B 600X1200			6000	6000	144000	144000	72000	72000	216000	108000	346.4
B 600X600			3000	3000	36000	36000	36000	36000	54000	54000	173.2

Table 2.2 - Frame Section Property Definitions - Summary (Part 2 of 4, continued)

Name	IMinor cm4	MajorAngle deg	As2 cm2	As3 cm2	S33Pos cm3	S33Neg cm3	S22Pos cm3	S22Neg cm3	Z33 cm3	Z22 cm3	R33 mm
B 600X800			4000	4000	64000	64000	48000	48000	96000	72000	230.9
B 700X1300			7583.3	7583.3	197166.7	197166.7	106166.7	106166.7	295750	159250	375.3
C 300X900			2250	2250	40500	40500	13500	13500	60750	20250	259.8
Dummy			0	0	0	0	0	0	0	0	0

Table 2.2 - Frame Section Property Definitions - Summary (Part 3 of 4)

Name	Cw cm6	Fillet Radius mm	CG Offset 3 mm	CG Offset 2 mm	PNA Offset 3 mm	PNA Offset 2 mm	SC Offset 3 mm	SC Offset 2 mm	Area Modifier	As2 Modifier	As3 Modifier
B 165X450			0	0	0	0			1	1	1
B 175X175			0	0	0	0			1	1	1
B 175X450			0	0	0	0			1	1	1
B 200X450			0	0	0	0			1	1	1
B 200X600			0	0	0	0			1	1	1
B 200X900			0	0	0	0			1	1	1
B 300X600			0	0	0	0			1	1	1
B 300X800			0	0	0	0			1	1	1
B 450x600			0	0	0	0			1	1	1
B 450X800			0	0	0	0			1	1	1
B 600X1200			0	0	0	0			1	1	1
B 600X600			0	0	0	0			1	1	1
B 600X800			0	0	0	0			1	1	1
B 700X1300			0	0	0	0			1	1	1
C 300X900			0	0	0	0			1	1	1
Dummy			0	0	0	0			1	1	1

Table 2.2 - Frame Section Property Definitions - Summary (Part 4 of 4)

Name	I33 Modifier	I22 Modifier	Mass Modifier	Weight Modifier
B 165X450	1	1	1	1
B 175X175	1	1	1	1
B 175X450	1	1	1	1
B 200X450	1	1	1	1
B 200X600	1	1	1	1
B 200X900	1	1	1	1
B 300X600	1	1	1	1
B 300X800	1	1	1	1
B 450x600	1	1	1	1
B 450X800	1	1	1	1
B 600X1200	1	1	1	1
B 600X600	1	1	1	1
B 600X800	1	1	1	1
B 700X1300	1	1	1	1
C 300X900	1	1	1	1
Dummy	1	1	1	1

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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
M 200	Slab	Membrane	M30	200		
S 125	Slab	Shell-Thin	M30	125		
S 150	Slab	Shell-Thin	M30	150		
S 175	Slab	Shell-Thin	M30	175		
S 200	Slab	Shell-Thin	M30	200		
S 250	Slab	Shell-Thin	M30	250		
W 175	Wall	Shell-Thin	M50	175		
W 200	Wall	Shell-Thin	M50	200		
W 300	Wall	Shell-Thin	M50	300		
W 350	Wall	Shell-Thin	M50	350		
W 450	Wall	Shell-Thin	M50	450		
W 600	Wall	Shell-Thin	M50	600		

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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 (Ser)ECC	Yes	Other	0	
~SpxECC	Yes	Other	0	
~Spy (Ser)ECC	Yes	Other	0	
~SpyECC	Yes	Other	0	
~SpzECC	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	
Sdl	No	Super Dead	0	
Temp	No	Temperature	0	
Wall	No	Super Dead	0	
Wx	No	Wind	0	User Loads
Wy	No	Wind	0	User Loads

3.2 Load Sets

Table 3.2 - Shell Uniform Load Sets

Name	Load Pattern	Load Value kN/m2
Balcony	Sdl	1.8
Balcony	Live>3	3
Balcony	Filling	3
Banqute	Sdl	2.4
Banqute	Live>3	5
Bed/Kit/Liv	Sdl	1.8
Bed/Kit/Liv	Live<3	2
Deck Slab	Sdl	2.4
Deck Slab	Live<3	5
DG Room	Sdl	15
DG Room	Live<3	2
FCC Room	Sdl	2.4
FCC Room	Live>3	5
Fire Tender	Sdl	2.4
Fire Tender	Live>3	15
Fire Tender	Filling	4
Foyer/Lobby/Corridor	Sdl	1.8
Foyer/Lobby/Corridor	Live>3	3
Gym	Sdl	5

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Table 3.2 - Shell Uniform Load Sets (continued)

Name	Load Pattern	Load Value kN/m2
Gym	Live>3	3
Indoor Games	Sdl	5
Indoor Games	Live>3	3
LMR Base	Sdl	2.4
LMR Base	Live>3	15
LMR Cover	Sdl	2.4
LMR Cover	Live>3	15
Parking	Sdl	2.4
Parking	Live>3	5
Podium Landscape	Sdl	2
Podium Landscape	Live>3	3
Podium Landscape	Filling	8
Ramp	Sdl	2.4
Ramp	Live<3	5
Recpection	Sdl	1.8
Recpection	Live>3	3
Services	Sdl	1.8
Services	Live>3	5
Staircase	Sdl	3
Staircase	Live>3	4
Sump	Sdl	31
Sump	Live<3	2
Swimming pool	Sdl	20
Swimming pool	Live<3	3
Terrace	Sdl	3
Terrace	Live>3	3
Toilet	Sdl	1.8
Toilet	Live<3	2
Toilet	Filling	3
Utility	Sdl	1.8
Utility	Live<3	2
Utility	Filling	3
Water Body	Sdl	10
Water tank	Sdl	20

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3.3 Auto Wind Loading

Table 3.3 - Load Pattern Definitions - Auto Wind - User Loads

Name	Number Load Sets	Reversible?	Load Set Number	Story	Diaphragm	Fx kN	Fy kN	Mz kN-m	X m	Y m
Wx	1	Yes	1	TERRACE	D2	445.9955	375.1742	0	19.23	28.799
Wx			1	24th FLOOR	D1	492.6435	360.4946	0	19.23	28.799
Wx			1	23th FLOOR	D1	485.9819	345.8149	0	19.23	28.799
Wx			1	22nd FLOOR	D1	479.1906	331.1352	0	19.23	28.799
Wx			1	21th FLOOR	D1	472.2564	316.4555	0	19.23	28.799
Wx			1	20th FLOOR	D1	465.1641	301.7758	0	19.23	28.799
Wx			1	19th FLOOR	D1	457.8965	287.0961	0	19.23	28.799
Wx			1	18th FLOOR	D1	450.4336	272.4164	0	19.23	28.799

Table 3.3 - Load Pattern Definitions - Auto Wind - User Loads (continued)

Name	Number Load Sets	Reversible?	Load Set Number	Story	Diaphragm	Fx kN	Fy kN	Mz kN-m	X m	Y m
Wx			1	17th FLOOR	D1	442.7522	257.7368	0	19.23	28.799
Wx			1	16th FLOOR	D1	434.8249	243.0571	0	19.23	28.799
Wx			1	15th FLOOR	D1	426.619	228.3774	0	19.23	28.799
Wx			1	14th FLOOR	D1	418.0953	213.6977	0	19.23	28.799
Wx			1	13th FLOOR	D1	409.2063	199.018	0	19.23	28.799
Wx			1	12th FLOOR	D1	399.8935	184.3383	0	19.23	28.799
Wx			1	11th FLOOR	D1	390.0839	169.6587	0	19.23	28.799
Wx			1	10th FLOOR	D1	379.6855	154.979	0	19.23	28.799
Wx			1	9th FLOOR	D1	368.5795	140.2993	0	19.23	28.799
Wx			1	8th FLOOR	D1	356.6095	125.6196	0	19.23	28.799
Wx			1	7th FLOOR	D1	343.5634	110.9399	0	19.23	28.799
Wx			1	6th FLOOR	D1	329.1444	96.2602	0	19.23	28.799
Wx			1	5th FLOOR	D1	312.9171	81.5805	0	19.23	28.799
Wx			1	4th FLOOR	D1	294.2048	66.9009	0	19.23	28.799
Wx			1	3rd FLOOR	D1	271.8639	52.2212	0	19.23	28.799
Wx			1	2nd FLOOR	D1	309.6282	57.8508	0	19.23	28.799
Wx			1	1st FLOOR	D1	222.189	15.1649	0	18.805	28.76
Wx			1	STILT	D1	0	0	0	19.1545	27.6715
Wx			1	BASEMENT 1	D1	0	0	0	19.1545	27.6715
Wy	1	Yes	1	TERRACE	D2	193.8	201.89	0	19.23	28.799
Wy			1	24th FLOOR	D1	186.3	222.74	0	19.23	28.799
Wy			1	23th FLOOR	D1	178.7	219.44	0	19.23	28.799
Wy			1	22nd FLOOR	D1	171.1	216.08	0	19.23	28.799
Wy			1	21th FLOOR	D1	163.5	212.66	0	19.23	28.799
Wy			1	20th FLOOR	D1	155.9	209.16	0	19.23	28.799
Wy			1	19th FLOOR	D1	148.3	205.59	0	19.23	28.799
Wy			1	18th FLOOR	D1	140.7	201.93	0	19.23	28.799
Wy			1	17th FLOOR	D1	133.2	198.19	0	19.23	28.799
Wy			1	16th FLOOR	D1	125.6	194.36	0	19.23	28.799
Wy			1	15th FLOOR	D1	118	190.41	0	19.23	28.799
Wy			1	14th FLOOR	D1	110.4	186.34	0	19.23	28.799
Wy			1	13th FLOOR	D1	102.8	182.12	0	19.23	28.799
Wy			1	12th FLOOR	D1	95.2	177.74	0	19.23	28.799
Wy			1	11th FLOOR	D1	87.7	173.16	0	19.23	28.799
Wy			1	10th FLOOR	D1	80.1	168.34	0	19.23	28.799
Wy			1	9th FLOOR	D1	72.5	163.23	0	19.23	28.799
Wy			1	8th FLOOR	D1	64.9	157.76	0	19.23	28.799
Wy			1	7th FLOOR	D1	57.3	151.84	0	19.23	28.799
Wy			1	6th FLOOR	D1	49.7	145.33	0	19.23	28.799
Wy			1	5th FLOOR	D1	42.2	138.06	0	19.23	28.799
Wy			1	4th FLOOR	D1	34.6	129.7	0	19.23	28.799
Wy			1	3rd FLOOR	D1	27	119.78	0	19.23	28.799
Wy			1	2nd FLOOR	D1	29.9	136.34	0	19.23	28.799
Wy			1	1st FLOOR	D1	7.8	97.77	0	18.805	28.76
Wy			1	STILT	D1	0	0	0	19.1545	27.6715
Wy			1	BASEMENT 1	D1	0	0	0	19.1545	27.6715

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User Loads Auto Wind Load Calculation

This calculation presents the user defined lateral wind loads for load pattern Wx.

Lateral Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR COVER	91.75	0	0
LMR BASE	88.85	0	0
TERRACE	85.95	445.9955	375.1742
24th FLOOR	82.9	492.6435	360.4946
23th FLOOR	79.85	485.9819	345.8149
22nd FLOOR	76.8	479.1906	331.1352
21th FLOOR	73.75	472.2564	316.4555
20th FLOOR	70.7	465.1641	301.7758
19th FLOOR	67.65	457.8965	287.0961
18th FLOOR	64.6	450.4336	272.4164
17th FLOOR	61.55	442.7522	257.7368
16th FLOOR	58.5	434.8249	243.0571
15th FLOOR	55.45	426.619	228.3774
14th FLOOR	52.4	418.0953	213.6977
13th FLOOR	49.35	409.2063	199.018
12th FLOOR	46.3	399.8935	184.3383
11th FLOOR	43.25	390.0839	169.6587
10th FLOOR	40.2	379.6855	154.979
9th FLOOR	37.15	368.5795	140.2993
8th FLOOR	34.1	356.6095	125.6196
7th FLOOR	31.05	343.5634	110.9399
6th FLOOR	28	329.1444	96.2602
5th FLOOR	24.95	312.9171	81.5805
4th FLOOR	21.9	294.2048	66.9009
3rd FLOOR	18.85	271.8639	52.2212
2nd FLOOR	15.8	309.6282	57.8508
1st FLOOR	11.1	222.189	15.1649
STILT	8	0	0
BASEMENT 1	3.3	0	0
Base	0	0	0

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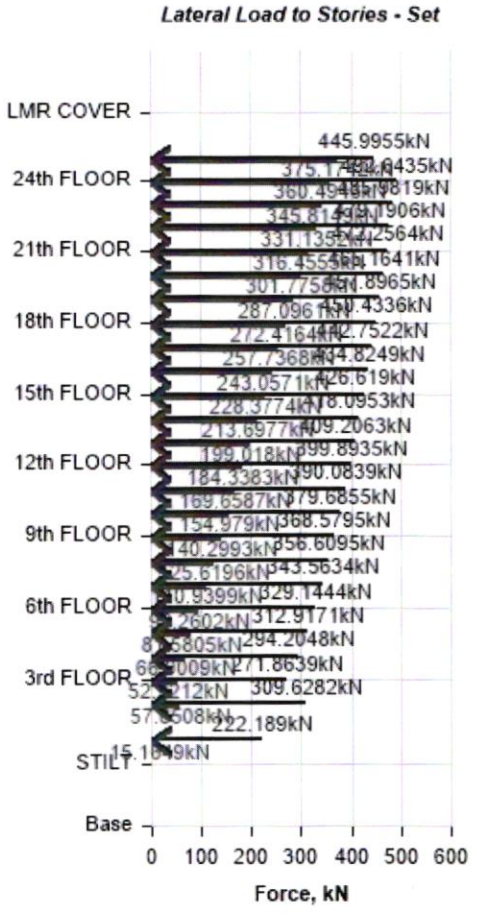


Figure 3-1-Set 1

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User Loads Auto Wind Load Calculation

This calculation presents the user defined lateral wind loads for load pattern Wy.

Lateral Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR COVER	91.75	0	0
LMR BASE	88.85	0	0
TERRACE	85.95	193.8	201.89
24th FLOOR	82.9	186.3	222.74
23th FLOOR	79.85	178.7	219.44
22nd FLOOR	76.8	171.1	216.08
21th FLOOR	73.75	163.5	212.66
20th FLOOR	70.7	155.9	209.16
19th FLOOR	67.65	148.3	205.59
18th FLOOR	64.6	140.7	201.93
17th FLOOR	61.55	133.2	198.19
16th FLOOR	58.5	125.6	194.36
15th FLOOR	55.45	118	190.41
14th FLOOR	52.4	110.4	186.34
13th FLOOR	49.35	102.8	182.12
12th FLOOR	46.3	95.2	177.74
11th FLOOR	43.25	87.7	173.16
10th FLOOR	40.2	80.1	168.34
9th FLOOR	37.15	72.5	163.23
8th FLOOR	34.1	64.9	157.76
7th FLOOR	31.05	57.3	151.84
6th FLOOR	28	49.7	145.33
5th FLOOR	24.95	42.2	138.06
4th FLOOR	21.9	34.6	129.7
3rd FLOOR	18.85	27	119.78
2nd FLOOR	15.8	29.9	136.34
1st FLOOR	11.1	7.8	97.77
STILT	8	0	0
BASEMENT 1	3.3	0	0
Base	0	0	0

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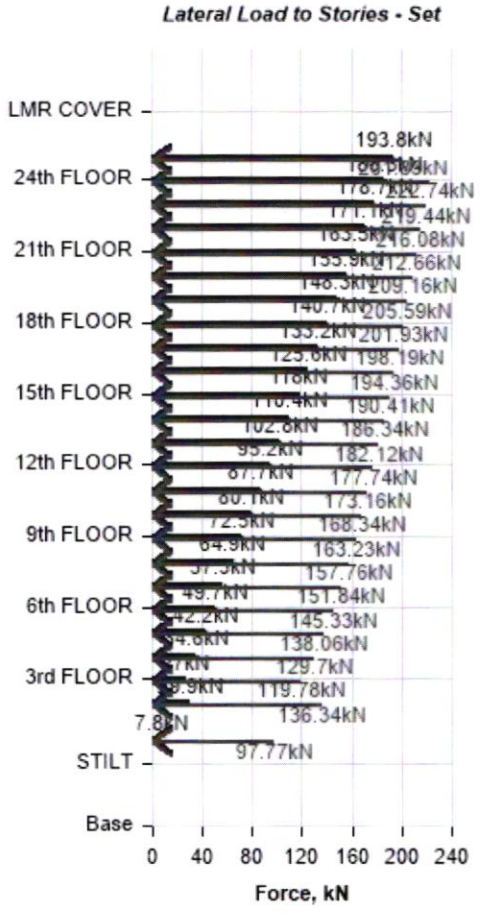


Figure 3-2-Set 1

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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	1.763	0.018514	479092.153	8869.8627	No	Yes	No	No	No	No	No
Eqy	1.763	0.018514	479092.153	8869.8627	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	Ecc Overwrite Story	Ecc Overwrite Diaphragm	Ecc Overwrite Length m
Eqx	1.763	0.018514	479092.153	8869.8627	0	TERRACE	STILT			
Eqy	1.763	0.018514	479092.153	8869.8627	0	TERRACE	STILT			

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	Ct	User T sec	Z	Site Type	I	R
Eqx	1.763	0.018514	479092.153	8869.8627		1.763	0.16	II	1.2	4
Eqy	1.763	0.018514	479092.153	8869.8627		1.763	0.16	II	1.2	4

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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

Structural Period

Period Calculation Method = User Specified

User Period $T = 1.763\ sec$

Factors and Coefficients

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

Response Reduction Factor, R [IS Table 9] $R = 4$

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] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 0.771412$

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	1.763	479092.153	8869.8627

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR COVER	91.75	0	0
LMR BASE	88.85	0	0
TERRACE	85.95	1008.6012	0
24th FLOOR	82.9	1000.455	0
23th FLOOR	79.85	819.6912	0
22nd FLOOR	76.8	751.5772	0
21th FLOOR	73.75	686.4174	0
20th FLOOR	70.7	624.2116	0
19th FLOOR	67.65	564.9599	0
18th FLOOR	64.6	508.6624	0
17th FLOOR	61.55	455.3189	0
16th FLOOR	58.5	404.9296	0
15th FLOOR	55.45	357.4943	0
14th FLOOR	52.4	313.0132	0
13th FLOOR	49.35	271.4862	0
12th FLOOR	46.3	233.0455	0

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Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
11th FLOOR	43.25	197.2945	0
10th FLOOR	40.2	164.6298	0
9th FLOOR	37.15	134.9192	0
8th FLOOR	34.1	108.1628	0
7th FLOOR	31.05	84.3604	0
6th FLOOR	28	64.4923	0
5th FLOOR	24.95	46.9724	0
4th FLOOR	21.9	31.5837	0
3rd FLOOR	18.85	19.8551	0
2nd FLOOR	15.8	15.694	0
1st FLOOR	11.1	2.0346	0
STILT	8	0	0
BASEMENT 1	3.3	0	0
Base	0	0	0

Lateral Load to Stories - X

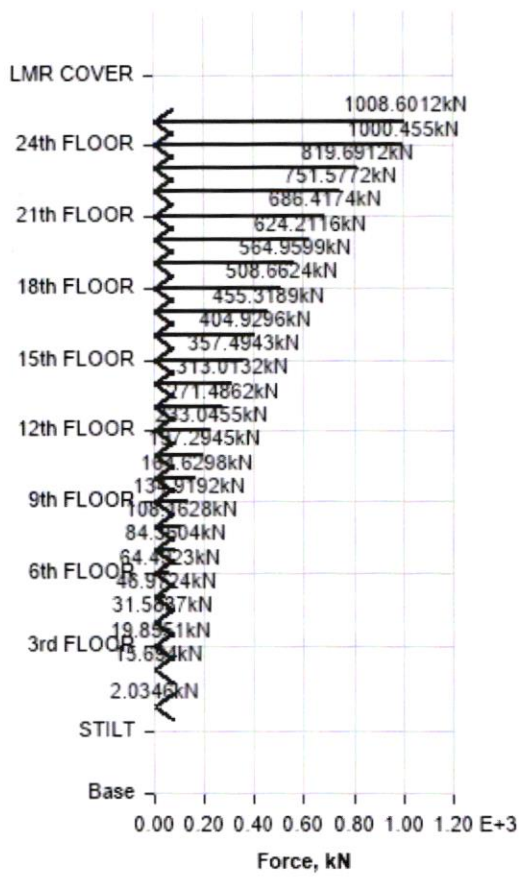


Figure 3-3-Set 1

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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

Structural Period

Period Calculation Method = User Specified

User Period $T = 1.763\ sec$

Factors and Coefficients

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

Response Reduction Factor, R [IS Table 9] $R = 4$

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] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 0.771412$

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	1.763	479092.153	8869.8627

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR COVER	91.75	0	0
LMR BASE	88.85	0	0
TERRACE	85.95	0	1008.6012
24th FLOOR	82.9	0	1000.455
23th FLOOR	79.85	0	819.6912
22nd FLOOR	76.8	0	751.5772
21th FLOOR	73.75	0	686.4174
20th FLOOR	70.7	0	624.2116
19th FLOOR	67.65	0	564.9599
18th FLOOR	64.6	0	508.6624
17th FLOOR	61.55	0	455.3189
16th FLOOR	58.5	0	404.9296
15th FLOOR	55.45	0	357.4943
14th FLOOR	52.4	0	313.0132
13th FLOOR	49.35	0	271.4862
12th FLOOR	46.3	0	233.0455

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Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
11th FLOOR	43.25	0	197.2945
10th FLOOR	40.2	0	164.6298
9th FLOOR	37.15	0	134.9192
8th FLOOR	34.1	0	108.1628
7th FLOOR	31.05	0	84.3604
6th FLOOR	28	0	64.4923
5th FLOOR	24.95	0	46.9724
4th FLOOR	21.9	0	31.5837
3rd FLOOR	18.85	0	19.8551
2nd FLOOR	15.8	0	15.694
1st FLOOR	11.1	0	2.0346
STILT	8	0	0
BASEMENT 1	3.3	0	0
Base	0	0	0

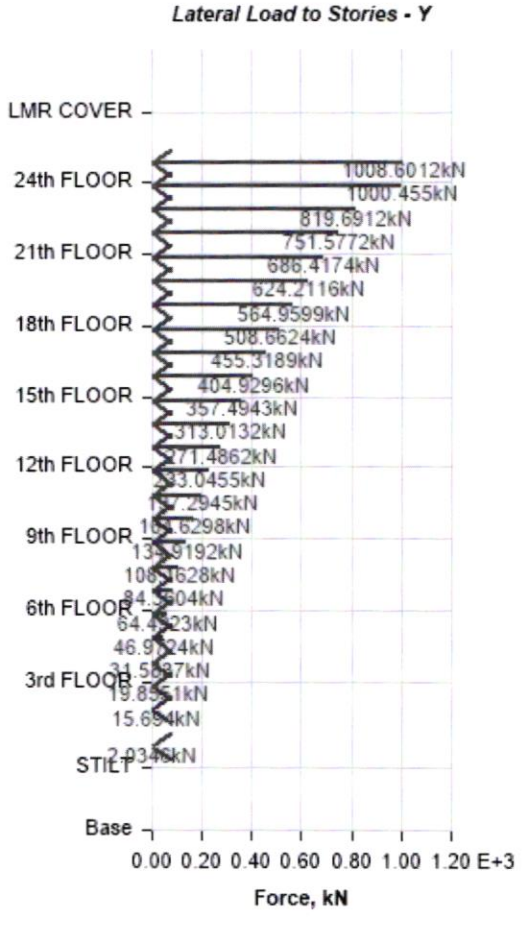


Figure 3-4-Set 1

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3.5 Load Cases

Table 3.5 - Load Case Definitions - Summary

Name	Type	Notes
Modal	Modal - Ritz	
Dead	Linear Static	
Live<3	Linear Static	
Live>3	Linear Static	
Roof Live	Linear Static	
Sdl	Linear Static	
Wall	Linear Static	
Filling	Linear Static	
Temp	Linear Static	
Eqx	Linear Static	
Eqy	Linear Static	
Wx	Linear Static	
Wy	Linear Static	
Spx	Response Spectrum	
Spy	Response Spectrum	
Spz	Response Spectrum	
Spx (Ser)	Response Spectrum	
Spy (Ser)	Response Spectrum	

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4 Analysis Results

This chapter provides analysis results.

4.1 Story Results

Table 4.1 - Story Stiffness (Part 1 of 2)

Story	Output Case	Case Type	Step Type	Step Number	Step Label	Shear X kN	Drift X mm	Stiff Xh kN	Stiff X kN/m
LMR COVER	Eqx	LinStatic	Step By Step			0	0.77		0
LMR BASE	Eqx	LinStatic	Step By Step			9.708E-07	0.728		0.001
TERRACE	Eqx	LinStatic	Step By Step			1008.6013	0.825		1222435.071
24th FLOOR	Eqx	LinStatic	Step By Step			2009.0555	0.851		2360642.835
23th FLOOR	Eqx	LinStatic	Step By Step			2828.7461	0.872		3245111.178
22nd FLOOR	Eqx	LinStatic	Step By Step			3580.3225	0.893		4009448.064
21th FLOOR	Eqx	LinStatic	Step By Step			4266.7391	0.914		4669506.33
20th FLOOR	Eqx	LinStatic	Step By Step			4890.9501	0.932		5245126.031
19th FLOOR	Eqx	LinStatic	Step By Step			5455.9094	0.949		5750846.547
18th FLOOR	Eqx	LinStatic	Step By Step			5964.5713	0.962		6201021.981
17th FLOOR	Eqx	LinStatic	Step By Step			6419.8897	0.971		6609750.799
16th FLOOR	Eqx	LinStatic	Step By Step			6824.8186	0.977		6987158.819
15th FLOOR	Eqx	LinStatic	Step By Step			7182.3125	0.978		7344377.342
14th FLOOR	Eqx	LinStatic	Step By Step			7495.3253	0.976		7680913.997
13th FLOOR	Eqx	LinStatic	Step By Step			7766.8111	0.969		8017161.455
12th FLOOR	Eqx	LinStatic	Step By Step			7999.8562	0.957		8361541.666
11th FLOOR	Eqx	LinStatic	Step By Step			8197.1504	0.939		8726128.215
10th FLOOR	Eqx	LinStatic	Step By Step			8361.7799	0.916		9125980.711
9th FLOOR	Eqx	LinStatic	Step By Step			8496.6989	0.891		9539195.852
8th FLOOR	Eqx	LinStatic	Step By Step			8604.8614	0.835		10301373.897
7th FLOOR	Eqx	LinStatic	Step By Step			8689.2215	0.792		10970346.802
6th FLOOR	Eqx	LinStatic	Step By Step			8753.7137	0.732		11951413.388
5th FLOOR	Eqx	LinStatic	Step By Step			8800.686	0.677		13001944.347
4th FLOOR	Eqx	LinStatic	Step By Step			8832.2697	0.606		14584086.849
3rd FLOOR	Eqx	LinStatic	Step By Step			8852.1247	0.524		16894497.149
2nd FLOOR	Eqx	LinStatic	Step By Step			8867.8187	0.686		12923900.813
1st FLOOR	Eqx	LinStatic	Step By Step			8869.8533	0.301		29473440.993
STILT	Eqx	LinStatic	Step By Step			8869.8533	0.107		82556210.454
BASEMENT 1	Eqx	LinStatic	Step By Step			8869.8533	0.042		211896084
LMR COVER	Eqy	LinStatic	Step By Step			0	0.035		0
LMR BASE	Eqy	LinStatic	Step By Step			0	0.088		0.001
TERRACE	Eqy	LinStatic	Step By Step			1.789E-06	0.087		0
24th FLOOR	Eqy	LinStatic	Step By Step			0.0001	0.07		0
23th FLOOR	Eqy	LinStatic	Step By Step			0.0001	0.071		0
22nd FLOOR	Eqy	LinStatic	Step By Step			0.0001	0.07		0
21th FLOOR	Eqy	LinStatic	Step By Step			0.0002	0.07		0
20th FLOOR	Eqy	LinStatic	Step By Step			0.0002	0.071		0
19th FLOOR	Eqy	LinStatic	Step By Step			0.0003	0.07		0
18th FLOOR	Eqy	LinStatic	Step By Step			0.0003	0.07		0
17th FLOOR	Eqy	LinStatic	Step By Step			0.0003	0.069		0
16th FLOOR	Eqy	LinStatic	Step By Step			0.0004	0.069		0
15th FLOOR	Eqy	LinStatic	Step By Step			0.0004	0.068		0
14th FLOOR	Eqy	LinStatic	Step By Step			0.0004	0.066		0
13th FLOOR	Eqy	LinStatic	Step By Step			0.0004	0.065		0
12th FLOOR	Eqy	LinStatic	Step By Step			0.0005	0.063		0

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Table 4.1 - Story Stiffness (Part 1 of 2, continued)

Story	Output Case	Case Type	Step Type	Step Number	Step Label	Shear X kN	Drift X mm	Stiff Xh kN	Stiff X kN/m
11th FLOOR	Eqy	LinStatic	Step By Step			0.0005	0.06		0
10th FLOOR	Eqy	LinStatic	Step By Step			0.0005	0.057		0
9th FLOOR	Eqy	LinStatic	Step By Step			0.0005	0.055		0
8th FLOOR	Eqy	LinStatic	Step By Step			0.0005	0.051		0
7th FLOOR	Eqy	LinStatic	Step By Step			0.0005	0.049		0
6th FLOOR	Eqy	LinStatic	Step By Step			0.0006	0.045		0
5th FLOOR	Eqy	LinStatic	Step By Step			0.0006	0.044		0
4th FLOOR	Eqy	LinStatic	Step By Step			0.0006	0.06		0
3rd FLOOR	Eqy	LinStatic	Step By Step			0.0006	0.028		0
2nd FLOOR	Eqy	LinStatic	Step By Step			0.0006	0.063		0
1st FLOOR	Eqy	LinStatic	Step By Step			0.0006	0.028		0
STILT	Eqy	LinStatic	Step By Step			0.0006	0.006		0
BASEMENT 1	Eqy	LinStatic	Step By Step			0.0006	0.003		0

Table 4.1 - Story Stiffness (Part 2 of 2)

Story	Shear Y kN	Drift Y mm	Stiff Yh kN	Stiff Y kN/m	Irregular	Modifier
LMR COVER	0	0.049		0		
LMR BASE	0	0.081		0		
TERRACE	1.219E-05	0.056		0		
24th FLOOR	0.0003	0.071		0		
23th FLOOR	0.0007	0.071		0		
22nd FLOOR	0.0009	0.072		0		
21th FLOOR	0.0009	0.072		0		
20th FLOOR	0.001	0.072		0		
19th FLOOR	0.0009	0.072		0		
18th FLOOR	0.0006	0.072		0		
17th FLOOR	0.0003	0.071		0		
16th FLOOR	0.0006	0.071		0		
15th FLOOR	0.0007	0.065		0		
14th FLOOR	0.0009	0.103		0		
13th FLOOR	0.0007	0.101		0		
12th FLOOR	0.0005	0.134		0		
11th FLOOR	0.0003	0.056		0		
10th FLOOR	0.0003	0.064		0		
9th FLOOR	0.0002	0.056		0		
8th FLOOR	0.0001	0.097		0		
7th FLOOR	0.0002	0.096		0		
6th FLOOR	0.0003	0.128		0		
5th FLOOR	0.0003	0.054		0		
4th FLOOR	0.0003	0.074		0		
3rd FLOOR	0.0003	0.036		0		
2nd FLOOR	0.0003	0.063		0		
1st FLOOR	0.0003	0.079		0		
STILT	0.0003	0.013		0		
BASEMENT 1	0.0003	0.002		0		
LMR COVER	0	0.393		0		
LMR BASE	0	0.423		0.001		
TERRACE	1008.6014	0.407		2475612.144		

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Table 4.1 - Story Stiffness (Part 2 of 2, continued)

Story	Shear Y kN	Drift Y mm	Stiff Yh kN	Stiff Y kN/m	Irregular	Modifier
24th FLOOR	2009.0532	0.484		4154898.302		
23th FLOOR	2828.7403	0.511		5532144.744		
22nd FLOOR	3580.3153	0.538		6658236.237		
21th FLOOR	4266.7321	0.564		7567504.414		
20th FLOOR	4890.9432	0.589		8305678.611		
19th FLOOR	5455.9046	0.612		8910452.083		
18th FLOOR	5964.5701	0.633		9416234.611		
17th FLOOR	6419.8924	0.652		9849180.405		
16th FLOOR	6824.8184	0.667		10230701.091		
15th FLOOR	7182.3108	0.679		10578991.613		
14th FLOOR	7495.3218	0.687		10908524.901		
13th FLOOR	7766.8106	0.748		10377858.824		
12th FLOOR	7999.8591	0.673		11880824.585		
11th FLOOR	8197.156	0.689		11890497.724		
10th FLOOR	8361.7868	0.677		12348833.707		
9th FLOOR	8496.7073	0.661		12846411.424		
8th FLOOR	8604.8709	0.639		13462400.38		
7th FLOOR	8689.2299	0.647		13437796.84		
6th FLOOR	8753.7212	0.549		15943534.54		
5th FLOOR	8800.6933	0.516		17061392.807		
4th FLOOR	8832.2766	0.437		20228616.71		
3rd FLOOR	8852.1324	0.414		21390871.357		
2nd FLOOR	8867.829	0.647		13701525.077		
1st FLOOR	8869.8645	0.421		21091019.802		
STILT	8869.8641	0.117		75809326.237		
BASEMENT 1	8869.8639	0.064		138884364		

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	1.446	0.4754	0.0309	1.641E-06	0.4754	0.0309	1.641E-06	0.0206	0.4262	0.0052
Modal	2	1.386	0.0069	0.011	0	0.4823	0.0419	1.748E-06	0.0074	0.007	0.3345
Modal	3	1.227	0.0267	0.5042	0.0001	0.509	0.5461	0.0001	0.3174	0.0234	0.01
Modal	4	0.373	0.0528	0.0932	0.0001	0.5618	0.6393	0.0002	0.0824	0.0298	0.0009
Modal	5	0.36	0.0906	0.0473	0.0001	0.6525	0.6865	0.0004	0.0445	0.0618	0.0019
Modal	6	0.294	0.0008	0.0029	0.0018	0.6532	0.6895	0.0022	0.0012	0.0006	0.0143
Modal	7	0.264	0.0045	0.0138	0.0015	0.6577	0.7033	0.0037	0.0115	0.0027	0.0465
Modal	8	0.202	0	0.0001	0.66	0.6577	0.7033	0.6637	0.0013	4.018E-06	4.938E-06
Modal	9	0.185	0.0429	0.0367	0.0002	0.7006	0.7401	0.6639	0.0199	0.0257	0.0007
Modal	10	0.127	0.0705	0.1241	0.0042	0.7711	0.8641	0.6681	0.0896	0.0586	0.0069
Modal	11	0.107	0.0012	0.004	0.1774	0.7723	0.8681	0.8456	0.0374	0.0021	3.31E-06
Modal	12	0.091	0.14	0.063	2.282E-05	0.9123	0.9311	0.8456	0.0635	0.1527	0.0007

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

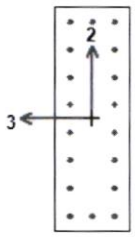
Case	Mode	SumRX	SumRY	SumRZ
Modal	1	0.0206	0.4262	0.0052
Modal	2	0.0281	0.4332	0.3397
Modal	3	0.3454	0.4566	0.3497
Modal	4	0.4278	0.4865	0.3506
Modal	5	0.4724	0.5483	0.3525
Modal	6	0.4736	0.549	0.3668
Modal	7	0.4851	0.5517	0.4133
Modal	8	0.4864	0.5517	0.4133
Modal	9	0.5063	0.5773	0.414
Modal	10	0.5959	0.636	0.4209
Modal	11	0.6333	0.638	0.4209
Modal	12	0.6967	0.7907	0.4217

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COLUMN DESIGN

ETABS Concrete Frame Design

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



Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
STILT	C1	647	C 300X900	02) 1.5DL+1.5LL	4700	4700	1	Ductile Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
300	900	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 % %
569.2399	-80.5573	-166.3083	11.3848	22.4281	2160	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	4700	-71.7152	0	22.4281
Minor Bend(M2)	1	4700	-23.8399	20.9575	11.3848

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}	50.3202	141.2313	100.8002	0	332.53
Minor, V_{u3}	19.5503	130.7701	86.4007	0	997.59

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30-06-2025

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
2700	21.6	4536	1526.4988	569.2399	1

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	1	900	5.222	12	No	0
Minor Bending (M_2)	Yes	1	300	15.667	12	Yes	20.9575

Notes:

N/A: Not Applicable

N/C: Not Calculated

N/N: Not Needed

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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 FLOOR	P30	5895	27840	1800	600	Special Wall	0.5

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	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	4995	27840	6795	27840	1800	600
Bottom	Leg 1	4995	27840	6795	27840	1800	600

Flexural Design for P_u, M_{u2} and M_{u3} (Part 1 of 2)

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m
Top	2700	0.0025	0.0014	29) 0.9DL+1.5Spz+0.45Spx+0.45Spy	5873.7429	-172.688
Bottom	2700	0.0025	0.0014	29) 0.9DL+1.5Spz+0.45Spx+0.45Spy	5987.834	-176.0423

Flexural Design for P_u, M_{u2} and M_{u3} (Part 2 of 2)

M_{u3} kN-m	Pier A_g mm²
180.8916	1080000
-139.5652	1080000

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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	1500	24) 1.5DL+1.5Spx+0.45Spy+0.45Spz	6547.8749	484.2006	-148.4556	353.4894	1132.9677
Bottom	Leg 1	1500	24) 1.5DL+1.5Spx+0.45Spy+0.45Spz	6738.0522	47.7548	-148.4556	356.228	1135.7062

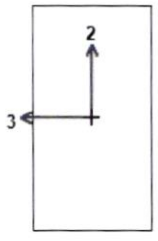
Boundary Element Check

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	0	01) DL+LL	0	0	0	0
Top–Right	Leg 1	600	24) 1.5DL+1.5Spx+0.45Spy+0.45Spz	9934.3017	484.2006	10.69	10
Bottom–Left	Leg 1	600	24) 1.5DL+1.5Spx+0.45Spy+0.45Spz	10124.7119	-284.8567	10.25	10
Botttom–Right	Leg 1	0	24) 1.5DL+1.5Spx+0.45Spy+0.45Spz	10124.7119	47.7548	9.52	10

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)
2nd FLOOR	B350	94	B 700X1300	29) 0.9DL+1.5Spz+0.45Spx+0.45Spy	7210	7210

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)
700	1300	700	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	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
-150.9671	0.1112	408.5129	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-150.9671	0.1869	0	-151.154

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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)	-151.154		2100	0	253	2100
Bottom (-2 Axis)		0	525	0	0	525

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
665.664	0	665.9181	298.1826	1470.37

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
0.1112	408.5129	630	1230	0

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SLAB DESIGN

AMARA SECOND FLOOR LEVEL SLAB

	DESIGN OF SLAB No:					
1.00	Grade of concrete			=	***35.00***	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 $\frac{l_y}{l_x}$ =	***3.95***	4.05		1.083	< 2
		3.64	3.74			
5.00	Edge condition: **Two Adjacent Edges Discontinuous**				Two way slab	
6.00	Modification factor assumed				***1.70***	
		95.55				
7.00	Depth required for deflection:			D =	***125.00***	mm
					125.00	mm
				d =	96.00	mm
8.00	Dead Load			=	3.00	kN/m^2
9.00	Live load			=	***2.00***	kN/m^2
10.00	Partitions & FF			=	***2.40***	kN/m^2
11.00	Total load			=	7.40	kN/m^2
12.00	Factored load			=	11.10	kN/m^2

Case No:	4	
D+(C-D)*(E-A)/(B-A)		
	Negative	Positive
A	*1.00000*	*1.00000*
B	*1.10000*	*1.10000*
C	*0.04700*	*0.03500*
D	*0.05300*	*0.04000*
E	*1.08298*	*1.08298*
Value	**0.05198**	**0.03915**

ok

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 :2	0.052	0.039	0.047	0.035
	M_u=Co-efficient*w* l_x^2	8.05	6.07	7.28	5.42
	K= Mu/bd2	0.87	0.66	0.79	0.59
	Percentage of steel required	0.19	0.14	0.17	0.13
	Ast required(in mm^2)	*180.66*	*135.03*	*162.87*	*120.43*
	Ast min (in mm^2)	150.00	150.00	150.00	150.00
	Ast to be provided (in mm2)	180.66	150.00	162.87	150.00
	Provided bars spacing (c/c)	278.34	335.24	308.74	335.24
	max spacing	250.00	250.00	250.00	250.00
	spacing	250.00	250.00	250.00	250.00
	Reqd bars spacing (c/c)	**250.00**	**250.00**	**250.00**	**250.00**
	Pvd bars spacing (c/c)	***200.00***	***200.00***	***200.00***	***200.00***
	Ast Provided(in mm^2)	**251.43**	**251.43**	**251.43**	**251.43**
	Percentage of steel provided	**0.26**	**0.26**	**0.26**	**0.26**

STEPII					
	F_s=0.58 *f_y * (Ast required/ Ast provided)				
	F_s			171.32	
	M.F			***1.85***	
	if assumed modification factor is less than or equal to calculated the section is safe for deflection			safe	
	OVERALL DEPTH	**D**	**125.00**	**mm**	
	EFFECTIVE DEPT	**d**	**96.00**	**mm**	

STEPIII	Crack width calculation			
	m	=	6.8	
	E_s	=	200000.0	
	Ec	=	29580.4	
	Pt	=	0.3	
	k	=	0.2	
	x	=	16.4	
	A_{st}	=	251.4	
	I_{cr}	=	12241541.49	
	M	=	6.1	
	f_{st}	=	266.5	
	ε_m	=	0.0	
	Spacing		200.0	
	a_{cr}	=	103.1	
	ω_{cr}	=	0.11	
			<	
			0.20	mm (safe)

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PILECAP DESIGN

Project : AMARA KOYAMBEDU	BURO ENGINEERS		
	Made by	Date 30-Jun-25	Page 1
Location : CHENNAI	Checked by	Revision -	Job No BEI793
Subject : Pilecap Design			

Marking : PC2A

TYPE : **3-Pile Group**

Material		Pile (1 = Rect, 2=Circular)		Column (1 = Rect, 2=Circular)	
fcu =	35 N/mm^2	Pile type =	2	Col. type =	1
fy =	550 N/mm^2	Diameter =	600 mm	Bc =	450 mm
Cover =	75 mm	Capacity =	1300 kN	Lc =	1800 mm
Reinfocement					
B1 =	20 mm				
B2 =	20 mm				

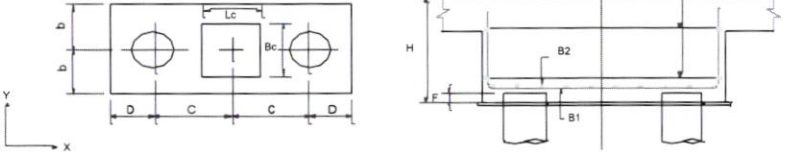
Load factor = **1.5**

Ultimate Column Load = 3900 kN

Pilecap Dimensions — Pile spacing, S = 1.3 x pile diameter

B = 450 mm
C = 375 mm
D = 1500 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)	Column Overlaps the piles	
Maximum Moment (kNm)	0	
Width, b	900	
Effective depth, d	1215	
K = M/bd^{2}fcu	0.000	
Lever arm, Z	1154	
		Provide min. reinf't = 0.12%bH
As$_{req}$ (mm^2)	As min. 1521 or 1690 mm^2/m	5850 or 1560 mm^2/m
No. of bars & spacing required	5 T 20 @ 183	19 T 20 @ 199
No. of bars & spacing provided	**6 T 20 @ 146 (B1)**	**20 T 20 @ 188 (B2)**
As$_{prov}$ (mm^2)	**1886** or 2095.2 mm^2/m	6286 or 1676 mm^2/m

Shear Check

Shear force	1950 kN
(100As/bd)	0.17
(400/d)$^{1/4}$	1.00
Allowable shear stress, v_c	0.306 mm^2/m
Shear span, a_v	1.00 mm
Enhancement factor = 2d/a_v	2430.00
Enhanced shear stress (N/mm^2), v_c	4.73 mm^2/m

i) Shear at column face

v = 0.71 < 3.70 ***ok!***

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

v = 1.78 < 4.73 ***ok!***

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

iv) Punching shear check

5.02 Punching Area
9360 Perimeter bo
0.3429 Punching Shear Stress tv
1.479 Permissible shear stress
O.K

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