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# 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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| REV NO. | DATE | DESCRIPTION | STATUS | PREPARED BY | REVIEWED BY | APPRVD. BY |
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| R0 | 07-10-2025 | Design Basis Report | | ARUN | PERAM | PERAM |

# 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)

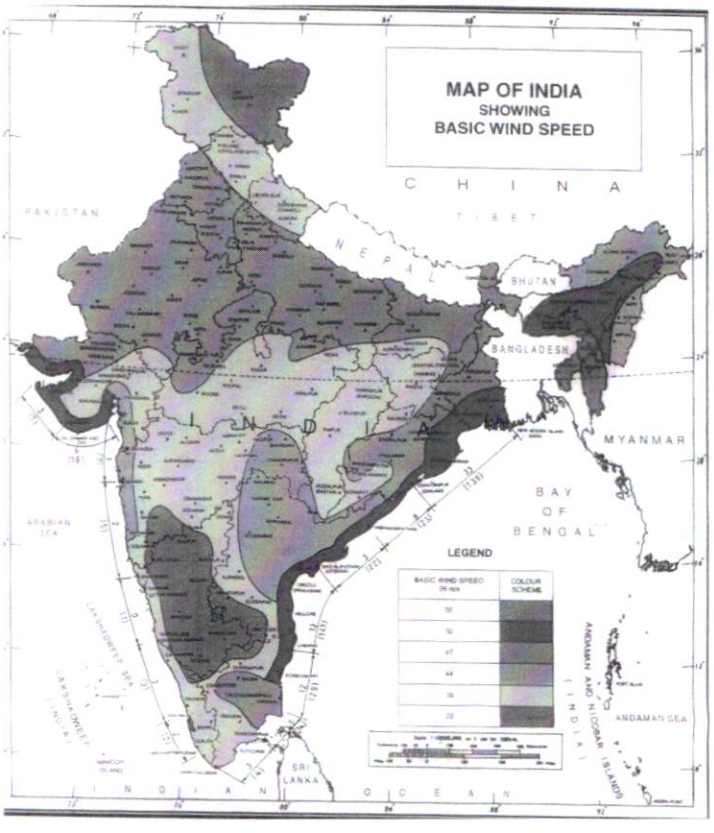
b). Building and structures whose natural frequency is less than 1.0 Hz.

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

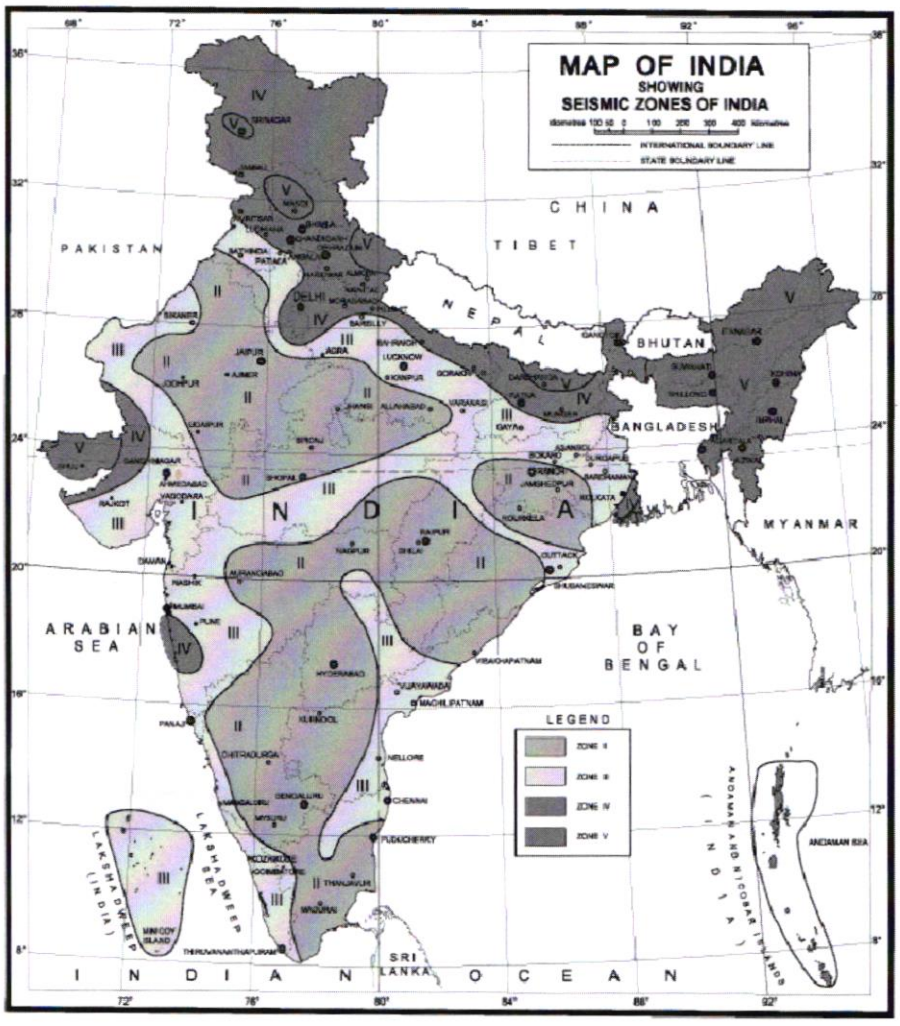
Base shear $V_b = A_h W$

$A_h$ 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:<br>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

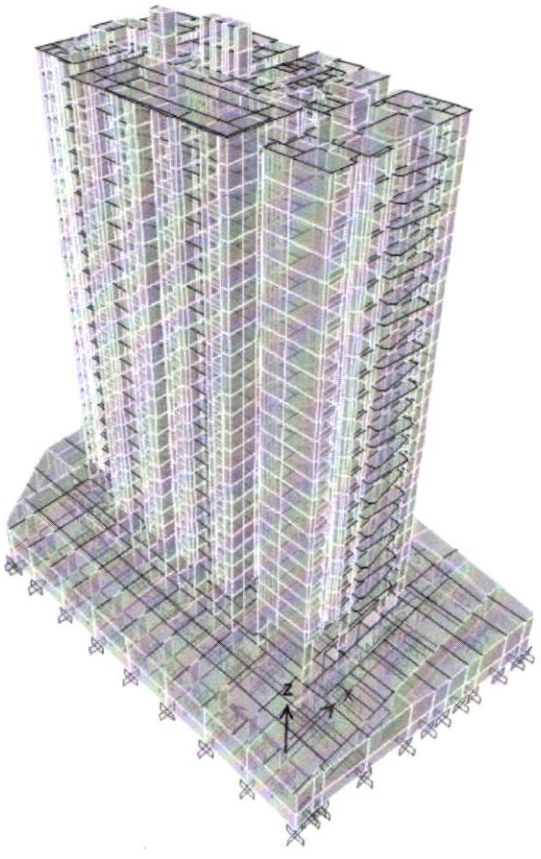
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# 3D MODEL

# &

# 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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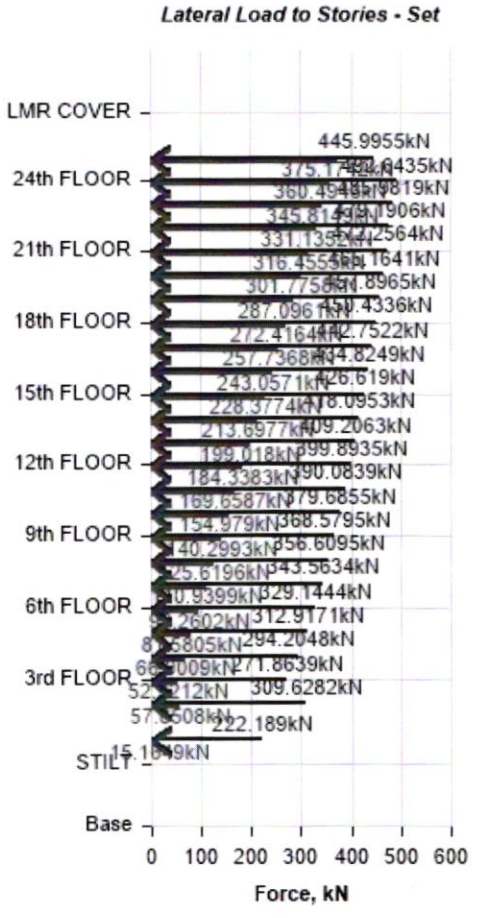



Figure 3-1-Set 1

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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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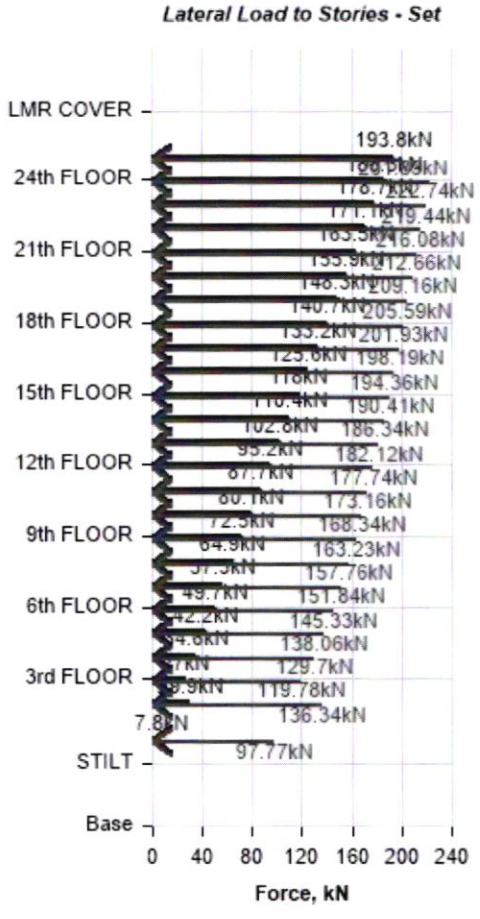



Figure 3-2-Set 1

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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***

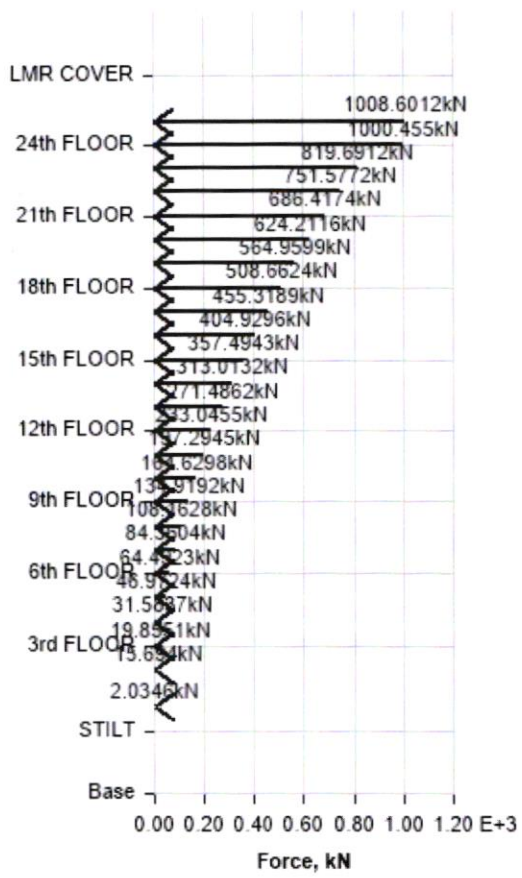



Figure 3-3-Set 1

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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 |

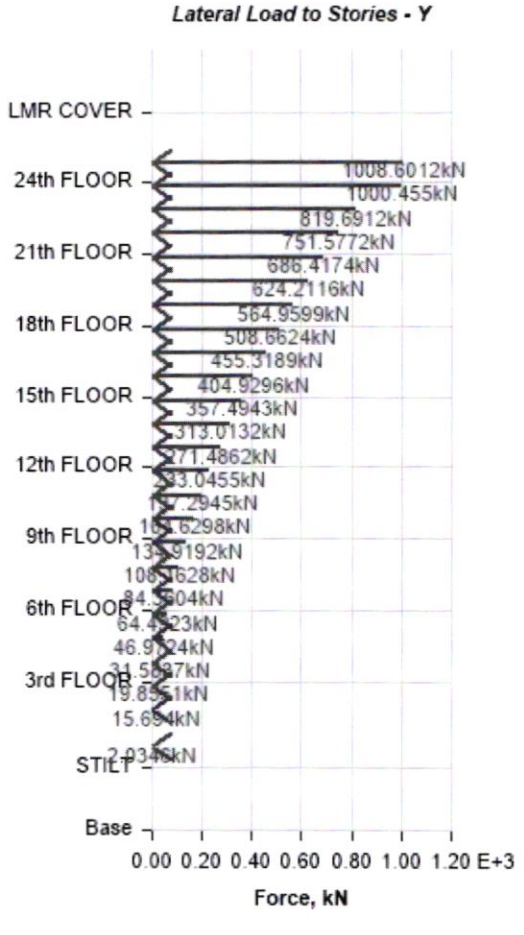



Figure 3-4-Set 1

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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)**

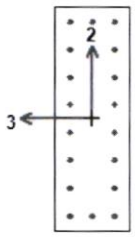
| Case | Mode | SumRX | SumRY | SumRZ |
|---|---|---|---|---|
| Modal | 1 | 0.0206 | 0.4262 | 0.0052 |
| Modal | 2 | 0.0281 | 0.4332 | 0.3397 |
| Modal | 3 | 0.3454 | 0.4566 | 0.3497 |
| Modal | 4 | 0.4278 | 0.4865 | 0.3506 |
| Modal | 5 | 0.4724 | 0.5483 | 0.3525 |
| Modal | 6 | 0.4736 | 0.549 | 0.3668 |
| 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

| $\gamma_c$ | $\gamma_s$ |
|---|---|
| 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

| $\Gamma_S$ | $\Gamma_C$ | $IP_{MAX}$ | $IP_{MIN}$ | $P_{MAX}$ | 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 |

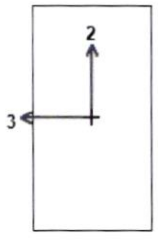
### Boundary Element Check

| 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

| $\gamma_c$ | $\gamma_s$ |
|---|---|
| 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($\alpha_x$) | S- SPAN (+ve) span($\alpha_x$) | L-SPAN (-ve) support($\alpha_y$) | L-SPAN (+ve) span ($\alpha_y$) |
|---|---|---|---|---|---|
| | 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 | |
| | $\varepsilon_m$ | = | 0.0 | |
| | Spacing | | 200.0 | |
| | $a_{cr}$ | = | 103.1 | |
| | $\omega_{cr}$ | = | 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 | | | | |

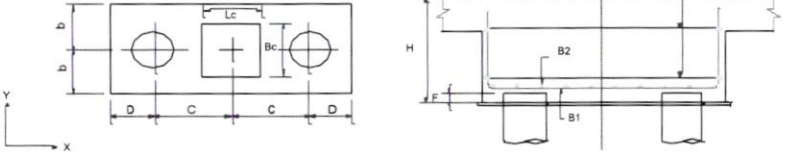
Load factor = **1.5**

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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THE LANDLENS SUITE

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

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

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

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

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

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

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

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

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

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

FREE TOOLS · NO ACCOUNT NEEDED

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

## Records and verification

The registers themselves, read for you.

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

## Value and duty

What it is worth and what it costs to register.

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

## Zoning and land use

What the plan says can happen on this land.

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

## Registers and directories

Who holds it, and which office keeps the record.

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

**Every free tool**
/tools

**Services we run for you**
/services

**The LandLens suite**
/landlens/one

Verified RealEstate™

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

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

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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.