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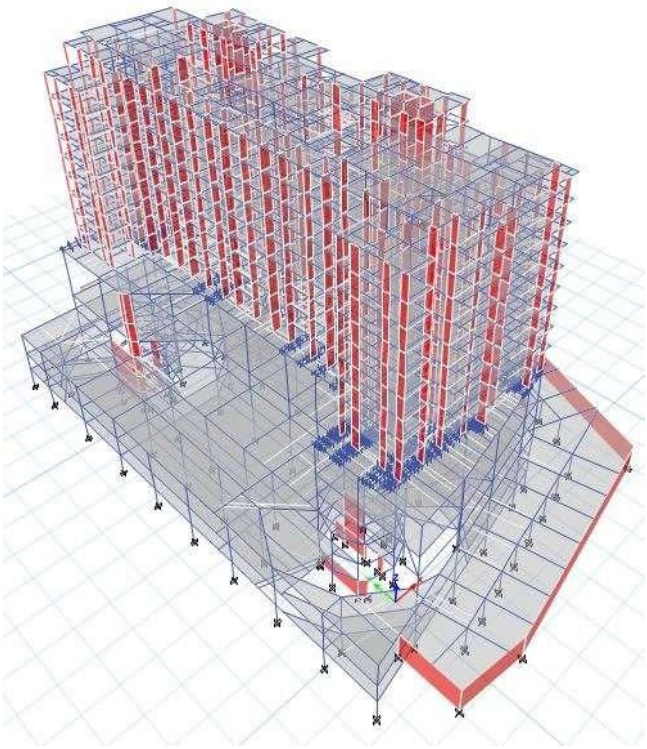
# STRUCTURAL DESIGN CALCULATION REPORT

## (CONSTRUCTION OF COMMERCIAL MALL, MULTIPLEX, HOTEL AND RESIDENTIAL APARTMENT BUILDING AT S.No. 13/1A, EGATUR VILLAGE, THIRUPORUR TALUK, CHENGALPATTU DIST.)

**REPORT NO -** BEI_054/TMC/Resi. Tower/R3

**CLIENT:**

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**ARCHITECT:**

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| | | | | | | |
|---|---|---|---|---|---|---|
| R3 | 25-08-2025 | Design Basis Report | OK | AVINASH | PERAM | PERAM |
| R2 | 04-06-2020 | Design Basis Report | OK | RAMKI | YUVARAJ | PERAM |
| R1 | 14-07-2017 | Design Basis Report | OK | NAVEEN | YUVARAJ | PERAM |
| R0 | 22-07-2014 | Design Basis Report | OK | SELVA | YUVARAJ | PERAM |
| **REV NO.** | **DATE** | **DESCRIPTION** | **STATUS** | **PREPARED BY** | **REVIEWED BY** | **APPRVD. BY** |

# 1. INTRODUCTION

The Marina Mall a Commercial Mall, Multiplex, Hotel and Residential Apartment Building constructed at S.No. 13/1A, Egatur Village, Thiruporur Taluk, Kanchipuram. Architecturally, it is designed to have multiple facilities includes Mall, Hotel, Apartment and it is configured with three (3) Basements + LGF + UGF+10/11 storey+Roof. The Building is divided in to two parts by an expansion joint which splits the building right from the third basement to Roof. It includes Mall with Hotel structure in the front side and the rear part is an Apartment Building. All the three basements are combines these two buildings together functionally. But with an expansion joint splits the building into two structural buildings.

The Front Building (Mall+Hotel) configured with Three (3) Basements+Ground+4 Storey+5$^{th}$ Floor + 6 to 11 Storey. In which Ground floor to 3$^{rd}$ Floor Designed as Mall space includes Retails/shopping, fun center, food court etc. and the 4$^{th}$ floor designed to be a Multiplexes, 5$^{th}$ floor is having back office, lounge, restaurant & swimming pool facilities of Hotel. 6$^{th}$ Floor to 11$^{th}$ Floor has Hotel Rooms with housekeeping services in every level.

**This Report for the rear side Building (Apartment Building)** has LGF & UGF designed to accommodate car/bike parks whereas the First Floor is designed to accommodate Amenities like Multi-purpose hall, Gym, Swimming pool etc. Second floor to 11$^{th}$ floor is designed for Residential units. This is the transfer floor level where the transition of columns happens. All the basements-3, 2 & 1 are designed to accommodate Car & two wheeler parking. The plan dimension of the Building at the ground level and in the basement level are as follows,

**Basement Level:** Building-1 is 122m x 106.5m & Building-2 is 74.76m x 34.41m

**Above Ground Floor:** Building-1 (Mall+Hotel) is 121m x 95m &
Building-2 (Apartment) is 67.31m x 25.51m.

Roof is designed to accommodate services which includes Solar panel. Vertical access systems like Lift & Staircase are provided adequately to ensure the human circulation and the services as well.

This report provides the information on Codes of Practice, Design loadings, Material Strength considered for the Design and Analysis of the building. In addition, this report includes description of Structural system, Foundation system, Method statement of structural analysis adopted for design and analysis of the **Apartment Building.**

## 2. CODES OF PRACTICE

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

### 2.1 Design Loads (Other Than Earthquake Loads)

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

### 2.2 Design for Earthquake Resistance

| IS Code | Description |
|---|---|
| IS 1893 | Criteria for Earthquake Resistance design of structures. |
| IS 4326 | Earthquake Resistant Design and Construction of Buildings – Code of Practice |
| IS 13920 | Ductile Detailing of Reinforced Concrete Structures subject to Seismic Forces - Code of Practice. |

### 2.3 Design of Steel Structural Elements

| IS Code | Description |
|---|---|
| IS 800: 2007 | Code of Practice for General Construction in Steel |
| IS 2062: 1999 | Steel for General structural purposes |

## 2.4 Design of Concrete Elements

| 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 | Indian Standard Code of practice for design & construction foundations in Soil: General Requirements |
| IS 2950(Part 1):1981 (Reaff. Nov 2013) | Code of practice for design and construction of raft foundations: Part 1 Design (second revision). |
| IS 2974 | Code of practice for design & construction of machine foundation |
| SP 34 | Handbook on Concrete Reinforcement & Detailing |
| SP 7(Part IV) | National Building code of India |
| IS 1786 | 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) | Code of practice for concrete structure for the storage of liquids |

## 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 |

## Compliances to the Codes:

| Checked Item | Code Reference | Remarks / Compliance |
|---|---|---|
| Floating Column/Transfer Beams | IS 1893:2002 | Concept of Floating columns-transfer Beams were adopted as per IS-1893-2002 as envisaged during the original designs & carried over the same. |
| Soft Storey | IS 1893:2016, Cl. 7.10 | Storey stiffness checked in ETABS; soft storey condition evaluated and complied to the specified version of IS-1893 |
| Displacement / Drift | IS 1893:2016, Cl. 7.11.1 | Storey drift limited to 0.004h; results within permissible limits as per the specified version of IS-1893 |
| Torsional Irregularity/Modal Participation | IS 1893:2016, Cl. 7.11.2 | Torsional response checked; structure satisfies code requirements<br>As per the specified version of IS-1893 |

# 3. DESIGN PARAMETERS

## 3.1 Materials of Construction

The whole structure is conventional Beam Slab system except the Transfer Level. The transfer Level is designed as PT Transfer Beams with RC Beam/Slab which supports the Floating Columns. Both RC Walls and RC columns are provided to form the lateral load resisting systems to its proportion of each individual member stiffness in the direction of lateral loads. The RC shear wall and Columns are connected by beams & slab in orthogonal direction. The slabs of each floors are acts as diaphragms to distribute the lateral forces to the Lateral Load resisting elements.

### 3.1.1 Concrete Grade

Few grades of Concrete has been employed in the design considering the stresses are borne by the structural elements which are varying in nature due to its spans, loadings, structural system like conventional Beam slab system. The grade of concrete used IS M35 for designing Footings/Mat (Existing), basement Slab, Basement Wall with minimum 28 day strength as 35 MPa.

From Basement to Ground floor level column (Part) the structure is existing. The design report submitted & it complies the design report of both the existing structure & the proposed structure.

In the **Apartment Building**, all the vertical structural elements includes Column, RC shear wall are designed using M40 with minimum 28 day strength as 40 MPa, RC Beams & RC slabs are designed using M35 with minimum 28 day strength as 35 MPa, PT Beam are designed using M45 with minimum 28 day strength as 45 MPa.

Concrete Mix M10 has been used in filling, plum concrete, leveling courses (PCC) and other non-structural items. Density of reinforced concrete is assumed as 25 kN/cu.m.

Minimum cement content, water cement ratio etc. shall conform to IS 456:2000 code provisions for durability and strength criteria. The approved design mix shall be used for producing concrete.

**Grade of Concrete for various structural elements:**

**Apartment Building:**

| | |
|---|---|
| Footing/Mat | M35 (Existing structure) |
| Basement Slab & Wall | M30 (Existing structure) |
| R.C Shear Wall/Columns | M40 (Existing structure till Ground Floor) |
| R.C Shear Wall/Columns | M40 (Proposed structure from G.F part to terrace) |
| R.C.C. Beams/Slabs | M35 |
| PT Transfer Beams | M45 |
| Water Tanks | M30 |
| Grade slab & Parapet Wall | M25 |

### 3.1.2 Cement

Ordinary Portland cement of grade 43 or higher confirming to IS 8112 and IS 12269 is specified for concrete M30 (Footing, Basement wall, Basement Slab, UG Sump, STP, OHT) and PT Beam/slab & RC Beam/RC slab, RC Column & Shear Walls shall be designed with M40 Grade of concrete up to Ground Floor and it is M30 from 1$^{st}$ floor to Roof in Building-1 and M40 for Building-2, with cement content used appropriate to the grades of concrete specified. The design mix using the intended brand of cement together with material trail mix report including raw material test report of coarse aggregate, fine aggregate etc. shall be approved upon submission to the consultant's for review.

### 3.1.3 Aggregates

The sizes of coarse aggregates confirm to IS 383. Nominal maximum size of coarse aggregate to be 20/12 mm, suitably graded as per the requirement of mix design. The fine aggregates confirm to the specifications of IS 383.

### 3.1.4 Water

Water used for construction shall complied with stipulations given in IS 456: 2000.

### 3.1.5 Reinforcement

High yield strength deformed bars conforming to IS 1786 with $f_y$ = 550 N/ sq.mm has been used with elongation not less than 16%.

### 3.1.6 Structural Steel

MS steel with yield strength $f_y$ = 250 N/ sq.mm has been used for Structural steel work shall conform to IS 226 and IS 2062 for Indian steel sections.

### 3.1.7 Concrete Cover

Cover to reinforcement considered for various elements with Fire rating considered - 2hrs. are as follows.

a. Footing/Mat = 60mm
b. Basement Slab & Wall = 40mm
c. Column = 40mm
d. Shear Wall = 30mm
e. Transfer Beams = 40mm
f. Beam = 30mm (Bottom and sides)
g. Slab = 25mm (Top and Bottom)
h. Overhead Water tanks/Sump tank/STP
   On water face = 40mm (Top and Bottom)
   On other face = 30mm (Top and Bottom)

### 3.1.8 Development Length

Unless otherwise specified in the good for construction drawing, the Development length of 50 times diameter of bar is to be considered in the BBS & Facbrication.

### 3.1.9 Soil Parameters

The soil investigation carried out by **M/s. Geotechnical solutions** and some additional

bore holes are carried out by **M/s. Geo marine** later. But both bore hole data are matching in results which indicates that the thickness of top 2.0m soil is Brownish medium to fine sand. Beneath this layer is fine to medium coarse sand layer having thickness of 2.0m to 5.0m. Below this silty fine to medium coarse sand with pebbles layer having thickness of 4 m. Weathered soft rock encountered with SPT of about 100 is at depth about 10.0m from existing ground level. The Combined/Isolated/Mat Foundation is designed and it was rest at this hard layer in the depth around 11m. As per the Soil report, the ground water table reported with varying depth of 1.5m to 2.0m measured from NGL from the bore hole to bore holes. Open cut excavation was carried out proper well point drainage system to control the water table well below the raft until the desired level of counter weight generated by constructing the floors above. However there are pockets especially in the Atrium area where there is no sufficient self weight available to counter the uplift possibility likely to arise in the peak monsoon period, has been provided with active rock anchor designed and installed to restrain the lower basement slab against the water uplift.

## 3.2 Loading Standards

**Table: Structural Configuration and Floor heights (Apartment Building):**

| **Floors** | **3B+LGF+UGF+11+Terrace** |
|---|---|
| Basement-3 Floor height | 3.20m |
| Basement-2 Floor height | 3.20m |
| Basement-1 Floor height | 3.80m |
| Lower Ground Floor height | 3.05m |
| Upper Ground Floor height | 3.35m |
| First Floor (Transfer) height | 5.39m |
| Second Floor to 11$^{th}$ Floor height | 3.03m |
| LMR/Head Room | 4.9/3.0m |
| Type of Foundation | **Strip Raft** |
| Grade of concrete for Strip Raft/footings/Mat | M35 |
| Grade of concrete for Basement wall/Slab | M35 |
| Grade of concrete for RC beams/Slabs, PT Beams/PT Slab up to Ground floor | M40 |
| Grade of Concrete for RC Column, Shear wall | M40 |
| Grade of concrete for Transfer Floor (2$^{nd}$ Floor) | M45 |
| Grade of concrete for Apartment Floors | M35 |
| Grade of Steel for proposed structure | Fe 550 |

**Table: Unit Weight of Materials:**

| Material | Floor Heights |
|---|---|
| Reinforced Cement Concrete | 25.00 kN/Cu.m |
| AAC Block Work | 07.50 kN/Cu.m |
| Mortar Finishing | 20.00 kN/Cu.m |
| Dry soil | 18.00 kN/Cu.m |
| Saturated soil | 10.00 kN/Cu.m |
| Glass | 33.00 kN/Cu.m |
| water | 09.81 kN/Cu.m |

**Table: Gravity Load Calculations:**

| **Floor Slab:** | |
|---|---|
| Self weight of 125 mm thick Slab | 0.125x25 = 3.125 kN/Sq.mt. |
| Self weight of 150 mm thick Slab | 0.150x25 = 3.75 kN/Sq.mt. |
| Self weight of 180 mm thick Slab | 0.180x25 = 4.50 kN/Sq.mt. |
| Self weight of 200 mm thick Slab | 0.200x25 = 5.00 kN/Sq.mt. |
| Self weight of 225 mm thick Slab | 0.225x25 = 5.625 kN/Sq.mt. |
| Self weight of 250 mm thick Slab | 0.250x25 = 6.25 kN/Sq.mt. |
| Self weight of 275 mm thick Slab | 0.275x25 = 6.875 kN/Sq.mt. |

| **External/Elevation Glass/Wall Line Load on Internal/External Beams:** | |
|---|---|
| ***Wall Line Load on Beams (Basement-2&1 Floor):*** | |
| 200mm thick wall Load on Beam for 3.2m | =(0.03x3.2x20)+(0.2x2.6x19) =6.08 kN/m |
| 100mm thick wall Load on Beam for 3.2m | =(0.03x3.2x20)+( 0.1x2.6x19) = 6.4 kN/m |
| ***Wall Line Load on Beams (LG Floor):*** | |
| 200mm thick wall Load on Beam for 3.05m | =(0.03x3.45x20)+(0.2x3.45x19) =15.18 kN/m |
| 100mm thick wall Load on Beam for 3.05m | =(0.03x3.45x20)+( 0.1x3.45x19) =8.63 kN/m |
| ***Wall Line Load on Beams (UG Floor):*** | |
| 200mm thick wall Load on Beam for 3.35m | =(0.03x4.0x20)+(0.2x4.0x19) =17.6 kN/m |
| 100mm thick wall Load on Beam for 3.35m | =(0.03x4.0x20)+( 0.1x4.0x19) =10.0 kN/m |
| ***Wall Line Load on Beams (First Floors):*** | |
| 200mm thick wall Load on Beam for 5.39m | =(0.03x5.39x20)+(0.2x5.39x7.5) =11.319 kN/m |
| 100mm thick wall Load on Beam for 5.39m | =(0.03x5.39x20)+( 0.1x5.39x7.5) =7.28 kN/m |
| ***Wall Line Load on Beams ($2^{nd}$ to $11^{th}$ Floors):*** | |
| 200mm thick wall Load on Beam for 3.03m | =(0.03x3.03x20)+(0.2x2.58x7.5) =5.688 kN/m |
| 100mm thick wall Load on Beam for 3.0m | =(0.03x3.03x20)+( 0.1x2.58x7.5) =3.753 kN/m |
| | |

### 3.2.1 Imposed Loads on Slab

The following are the imposed loads in the structural slabs, in addition to the self-weight and the floor finishes. *(Self-weight of slab will be as per the thickness mentioned in the respective drawings Floor finishes of 50/75 mm thickness have been considered on all floors)*

**Table: Superimposed Dead Load (SDL) & Live Load (LL) – APARTMENT BUILDING:**

| **Car & Two wheeler Parking (Basement Parking, LGF, UGF)** | | |
|---|---|---|
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 2.4 | 0.0 |
| Live Load | 0.0 | 2.5 |
| Partition Load | - | 0.0 |
| **Total** | **2.4** | **2.5** |
| **Electrical / Store (UGF)** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 2.4 | 0.0 |
| Live Load | 0.0 | 7.5 |
| Partition Load | 0.0 | 0.0 |
| **Total** | **2.4** | **7.5** |
| | | |
| **Multi-Purpose Hall / Gym / Indoor games (First Floor)** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 2.4 | 0.0 |
| Live Load | 0.0 | 5.0 |
| Partition Load | 0.0 | 0.0 |
| **Total** | **2.4** | **5.0** |
| **Pantry (First Floor)** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 2.4 | 0.0 |
| Live Load | 0.0 | 4.0 |
| Partition Load | 2.0 | 0.0 |
| **Total** | **4.4** | **4.0** |
| **Swimming Pool (First Floor)** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 2.4 | 0.0 |
| Live Load (1.2m Liquid Depth) | 12.0 | 5.0 |
| Partition Load | 0.0 | 0.0 |
| **Total** | **14.4** | **5.0** |
| **Staff room (First Floor)** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 2.4 | 0.0 |
| Live Load | 0.0 | 2.0 |
| Partition Load | 2.0 | 0.0 |
| **Total** | **4.4** | **2.0** |

| **Toilet** | | |
|---|---|---|
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 1.2 | 0.0 |
| Live Load | 0.0 | 2.0 |
| Partition Load | 2.4 | 0.0 |
| **Total** | **3.6** | **2.0** |
| **Bed Rooms / Dining / Living / Dress / Kitchen** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 1.2 | 0.0 |
| Live Load | 0.0 | 2.0 |
| Partition Load | - | 0.0 |
| **Total** | **1.2** | **2.0** |
| **Lobby / Corridor** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 1.2 | 0.0 |
| Live Load | 0.0 | 3.0 |
| Partition Load | 0.0 | 0.0 |
| **Total** | **1.2** | **3.0** |
| **LMR** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 2.4 | 0.0 |
| Live Load | 0.0 | 15.0 |
| Partition Load | 0.0 | 0.0 |
| **Total** | **2.4** | **15.0** |
| **Head Room** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 2.4 | 0.0 |
| Live Load | 0.0 | 4.0 |
| Partition Load | 0.0 | 0.0 |
| **Total** | **2.4** | **4.0** |
| **Staircases** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 1.8 | 0.0 |
| Live Load | 0.0 | 3.0 |
| Step Load | 1.2 | 0.0 |
| **Total** | **3.0** | **3.0** |
| **Balcony / Utility** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 1.2 | 0.0 |
| Live Load | 0.0 | 2.0 |
| Partition Load | 3.6 | 0.0 |
| **Total** | **4.8** | **2.0** |
| **Roof** | | |
| | **SDL (kN/Sq.mt.)** | **LL (kN/Sq.mt.)** |
| Finishes | 3.0 | 0.0 |
| Live Load | 0.0 | 3.0 |
| Partition Load | 0.0 | 0.0 |
| **Total** | **3.0** | **3.0** |

Permissible reduction in imposed load on each floor is considered for design of columns and foundation as per IS 875 Part (2), clause.3.2.

The building is Conventional Beam-Slab structure and the building is existing from basements to Ground floor level and it is a framed structure with external/Internal RC Beam-RC Slab/PT Slab with RC shear wall provided around the Lift Core & staircase. The second floor level acts as a Transfer level to support all the RC Shear walls of the Residential Tower. Both RC Walls and RC columns are provided to form the lateral load resisting systems. The RC shear wall and Columns are connected by beams & slab in orthogonal direction. The slabs of each floors are used as diaphragms in distribution of lateral forces to the Lateral Load resisting elements.

## 3.3 Thermal Effects

Temperature variation produces stresses in the structure, as it tends to expand and contract. In the structures, with large geometrical dimensions, the effect of temperature is important in the behavior and final design. Due to deformation of expansion & contraction - between Day time and nights, and between winter and summer - the effect on the durability of structure and on the supported finishes is significant to produce considerable results.

The shape of the building is very linear and its size at above ground level is about 67.31m X 25.51m which is very close to the limitation laid down in IS 456. Hence taking functionality of the building in to consideration, providing no expansion joint is avoided. However this building is separated from the Mall building by an expansion joint. But the structure has been designed for the regional Temperature variations.

### 3.3.1 Shrinkage Effects

The Building length is about 67.31m and the width is around 25.51m which shall be cast with adequate no. of pour joints. Hence possibility of occurring shrinkage is less. However care is to be taken to control shrinkage by way of early sprinkling just after the initial setting is over put the floor under immersed curing condition subsequently other than the care shall be taken in terms of cement properties and its content in the m^3 concrete, weather at the time of concreting etc. may increases the possibility of shrinkage cracks.

### 3.3.2 Expansion Joints

Expansion joints are normally provided when the structure is more than 45m length as per IS-456-2000, clause 27.1. The width of expansion joint shall be calculated as per IS-1893-2002, clause 7.11.3. In this case, we have provided no expansion within the Apartment Building taking the advantage of the length of Building of 68m falls close to limit prescribed in the said code & clause and also it has been avoided taking the functionality of the building in to

consideration. However the said apartment building is separated from the Mall building and the thermal analysis performed in the 3D analysis & its structural members are designed for the worst effect resulted load combinations.

## 4. PROPOSED APPROACH OF STRUCTURAL ANALYSIS

The building is predominantly a Flat Slab structure in the basements and it is a framed structure with external/Internal RC Beam-RC Slab/PT Slab with centrally located Lift Core wall for one axis. Both RC Walls and RC columns are provided to form the lateral load resisting systems. The RC shear wall and Columns are connected by beams & slab in orthogonal direction. The slabs of each floors are used as diaphragms in distribution of lateral forces to the Lateral Load resisting elements.

The building structure has been analyzed using the ETABS software for the following computer models of the building floor analysis of all floors - for vertical loads with the entire building space frame. ETABS have been thoroughly tested, validated and recognized internationally by several organizations and are well suited for the analysis of building systems.

Geometrical dimensions, member properties and member-node connectivity, including eccentricities will be modeled in the analysis problem. Variation in material grades, if present, will also be considered. The permissible values of the load factors and stresses will be utilized within the purview of the Indian Standards.

The computer analysis will produce accurate individual member forces, reactions at foundation level and deflection pattern of the entire structure as well as individual members. This data will then be used to confirm/review the member sizes and arrive at the most appropriate design of the structural members. Some re-runs of the analysis program might be required for arriving at the optimum structural space frame characteristics that satisfy the strength and stability criteria in all respects.

Design of different structural elements will be carried out using In-house developed spreadsheets and packages.
The following model assumptions used in E-TABS 3D modeling and the load applications are done as listed below,

**Column** : Frame Element
**RC Wall** : Wall Element
**Beam Element** : Frame Element
**Slab** : Shell Element

- Modulus of Elasticity of Concrete -5000√fck
- Consideration of Diaphragm - (Semi-Rigid Diaphragm). The vertical elements like Shear Wall/Column designed
- Slab/Wall element considered as Shell element

The structural model and its behavior will be checked for the following

a) Storey Drift.

b) Storey Weight/Column Loading.

c) Soft Storey Effect, if any.

d) Deformation.

e) Design Forces.

**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:** Filler wall loads are calculated appropriately and Applied as uniformly distributed line load.

**Lateral Load Resisting Systems:** The building is predominantly a Flat Slab structure in the basements and it is a framed structure with external/Internal RC Beam-RC Slab/PT Slab with RC shear wall provided around Lift Core wall & staircases. Both RC Walls and RC columns are provided to form the lateral load resisting systems. The RC shear wall and Columns are connected by beams & slab in orthogonal direction which are designed transfer the lateral forces in proportion to its stiffness in the direction of load considered. The slabs of each floors are act as diaphragms and distribute its lateral forces to the Lateral Load resisting elements.

## 5.0 LATERAL LOADS

### 5.1 Wind Loads

The wind pressure shall be calculated based on the basic wind speed and other provisions laid in IS 875 (part 3) – 1987. The wind speed is considered in the analysis for Chennai is 50 m/sec. The design parameters for wind load calculation are as follows,

**Apartment Building**

Design Wind Pressure Vz = 0.6 Vz^2

But Vz = Vb*k1*k2*k3

Where Vz - Design Wind Speed

k1 – 1.0, probability factor or risk coefficient

k2 – 1.10, Terrain height (39m), structure size factor (measured from Ground floor)

Terrain Category –3 and Structure Class-C

k3 – 1.0, Topography factor

k4 – 1.0, Importance factor for the cyclonic region, for all other Structure as per IS 875-1987 (Part3),

Hence Design Wind Pressure = 0.6x (50x1.0*1.10*1.0*1)^2

= 1815 N/m^2

≈ 1.82 kN/m^2

The design wind load will be calculated based on the surface area with the calculated design wind pressure and it shall be applied on surface area of the building in both the orthogonal direction.

## 5.2 Earthquake Loads

Salem is classified under Earthquake Zone III (Moderate) as per the latest classification. The loading due to earthquake shall be assessed based on the provisions of IS 1893 – 2002.

The design parameters adopted are as follows: Seismic Zone III with seismic zone factor Z = 0.16 (Moderate) and Response reduction factor is to be 5.0 considering RC Beam-Slab Structural ductile RC wall system as per IS: 1893-2002, Table-7 and applied ductile detailing as per code IS 13920: 1993. Soil considered as Type-I Hard soil.

**Base Shear Calculation for Static Analysis**

As per IS 1893:2002, the total design lateral force or design seismic base shear ($V_b$) is determined by the following expression.

$$V_b = A_h W$$

Where Ah is Design horizontal acceleration spectrum value using fundamental natural period and W is Seismic weight of the building.

The Seismic weight is estimated based on Full dead load + 25 % Live for Apartment Building.

The Fundamental natural period of vibration (Ta) in seconds of a RC building is estimated by using the following formula, Ta = 0.09*h/(d)^0.5

Where h is the height of the building in meters. d is the base dimension of the building at the plinth level in m, along the considered direction of the lateral force.

**APARTMENT BUILDING**

Height of the building = 39.00m

d(along the length of the building) = 74.76m

b(along the breadth of the building)=34.41m

Ta (along x) = 0.09x39/(74.76)^0.5

= 0.405 Sec.

Ta (along y) = 0.09x39/(34.41)^0.5

= 0.597 Sec.

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

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

Where,

Z for Seismic Zone III = 0.16

I for Residential Building = 1.0 (Refer to IS 1893, Table.8)

R for Buildings with ductile RC Structural wall = 4.0 as

per (Table 9)

Sa/g (Medium Stiff soil) = 2.5 (Refer to IS 1893, page 9, clause.6.4.2.)

Design horizontal seismic coefficient Ah = 0.04

Base Shear = 0.04 W

## 6. LOAD COMBINATIONS

The various loads shall be combined in accordance with the stipulations in IS 875 (Part 5) 1987 and IS 456: 2000. The structural elements shall be designed for the combination that produces most unfavorable effect out of the following combinations.

The results obtained from the computer analysis in the form of member forces and reactions will be used for design the structural members. Following load combinations of the member forces will be considered for arriving at the design forces. The analysis considered load factor is as follows,

| Load Combination | LOAD FACTORS | | | | | | |
|---|---|---|---|---|---|---|---|
| | D.L. | I.L. | T.L | SPECX | SPECY | WX | WY |
| **Limit State Of Serviceability (LSS) Combinations** | | | | | | | |
| LC1 | 1.0 | - | 1.0 | - | - | - | - |
| LC2 | 1.0 | 1.0 | 1.0 | - | - | - | - |
| LC7 | 1.0 | - | 1.0 | - | - | 1.0 | - |
| LC8 | 1.0 | - | 1.0 | - | - | -1.0 | - |
| LC9 | 1.0 | - | 1.0 | - | - | - | 1.0 |
| LC10 | 1.0 | - | 1.0 | - | - | - | -1.0 |
| LC11 | 1.0 | - | 1.0 | 1.0 | - | - | - |
| LC12 | 1.0 | - | 1.0 | -1.0 | - | - | - |
| LC13 | 1.0 | - | 1.0 | - | 1.0 | - | - |
| LC14 | 1.0 | - | 1.0 | - | -1.0 | - | - |
| LC19 | 1.0 | 0.8 | 1.0 | - | - | 0.8 | - |
| LC20 | 1.0 | 0.8 | 1.0 | - | - | -0.8 | - |
| LC21 | 1.0 | 0.8 | 1.0 | - | - | - | 0.8 |
| LC22 | 1.0 | 0.8 | 1.0 | - | - | - | -0.8 |
| LC23 | 1.0 | 0.8 | 1.0 | 0.8 | - | - | - |
| LC24 | 1.0 | 0.8 | 1.0 | -0.8 | - | - | - |
| LC25 | 1.0 | 0.8 | 1.0 | - | 0.8 | - | - |
| LC26 | 1.0 | 0.8 | 1.0 | - | -0.8 | - | - |

| Limit State Of Collapse (LSC) Combinations | | | | | | | |
|---|---|---|---|---|---|---|---|
| COMB1 | 1.5 | - | 1.0 | - | - | - | - |
| COMB2 | 1.5 | 1.5 | 1.0 | - | - | - | - |
| COMB3 | 1.2 | 1.2 | 1.0 | - | - | 1.2 | - |
| COMB4 | 1.2 | 1.2 | 1.0 | - | - | -1.2 | - |
| COMB5 | 1.2 | 1.2 | 1.0 | - | - | - | 1.2 |
| COMB6 | 1.2 | 1.2 | 1.0 | - | - | - | -1.2 |
| COMB7 | 1.5 | - | 1.0 | - | - | - | - |
| COMB8 | 1.5 | - | 1.0 | - | - | - | - |
| COMB 9 | 1.5 | - | 1.0 | - | - | 1.5 | - |
| COMB10 | 1.5 | - | 1.0 | - | - | -1.5 | - |
| COMB11 | 1.5 | - | 1.0 | - | - | - | 1.5 |
| COMB12 | 1.5 | - | 1.0 | - | - | - | -1.5 |
| COMB13 | 1.5 | - | 1.0 | 1.5 | - | - | - |
| COMB14 | 1.5 | - | 1.0 | - | 1.5 | - | - |
| COMB15 | 0.9 | - | 1.0 | - | - | - | - |
| COMB16 | 0.9 | - | 1.0 | - | - | - | - |
| COMB17 | 0.9 | - | 1.0 | - | - | 1.5 | - |
| COMB18 | 0.9 | - | 1.0 | - | - | -1.5 | - |
| COMB19 | 0.9 | - | 1.0 | - | - | - | 1.5 |
| COMB20 | 0.9 | - | 1.0 | - | - | - | -1.5 |
| COMB21 | 0.9 | - | 1.0 | 1.5 | - | - | - |
| COMB22 | 0.9 | - | 1.0 | - | 1.5 | - | - |

**DL**: Dead Load **SPEX**: Earthquake Load in X-dir. **WX**: Wind Load in X-dir. **TL:** Temperature Load
**IL**: Imposed Load **SPECY**: Earthquake Load in Y-dir.**WY**: Wind Load in Y-dir.

## 7. DEFLECTION CRITERIA

### 7.1. Lateral Deflection (Wind)

Overall Deflection< Height/500

Storey Deflection < Storey height/500

### 7.2. Lateral Deflection (Seismic)

Overall Drift < H / 250

Storey Drift < 0.004 times Storey height

### 7.3. Vertical Deflection of Beams and Slabs due to Gravity Loads

Total Deflection (DL + LL) < Span/250 up to 20 maximum

Deflection including the effects of

Temperature, Creep and Shrinkage

Occurring after erection of partitions

and the application of finishes < Span/350 or 20mm whichever is less

## 8. CONSTRUCTION JOINT

Construction joints and shrinkage strips will be planned with the contractor and only be used in locations pre-approved by consultants.

1) No construction joint is allowed in the sunken portion

2) Construction joint shall be provided in slab/beam at l/3 from support.

3) Construction joint shall be placed at accessible location for maintenance purpose.

4) Joints are common source of weakness, therefore it is desirable to avoid or at least minimize them.

## 9. DESIGN OF STRUCTURAL ELEMENTS

For the design of R.C.C. elements, the Limit State Method will be used as per IS 456-2000. Materials of construction will be predominantly concrete with consideration for strength and durability. The grade of concrete is suggested as M35 for Raft Footings, Basement Wall, Basement Slab, RC Beams & RC Slabs and M40 for RC Shear wall & Columns, M45 for PT transfer Beams considering the level of stresses to be borne by the members both in compression as well as flexural. High Yield Strength Deformed bars conforming to IS: 1786 with $F_y$ = 550 MPa will be used as reinforcement. Structural steel, if any with Fy = 250 Grade shall be used.

## 10. FOUNDATION

Based on the analysis results, it is noticed that the vertical elements are considerably loaded in proportionate to its span, influence area.

The soil investigation carried out by **M/s. Geotechnical solutions** and some additional bore holes are carried out by **Ms. Geo marine** later. But both bore hole data are matching in results which indicates that the thickness of top 2.0 m soil is Brownish medium to fine

sand. Beneath this layer is fine to medium coarse sand layer having thickness of 2.0m to 5.0m. Below this silty fine to medium coarse sand with pebbles layer having thickness of 4 m. Weathered soft rock encountered with SPT of about 100 is at depth about 10.0m from existing ground level. The Mat Foundation is designed and it was rest at this hard layer in the depth around 11m. As per the Soil report, the ground water table reported with varying depth of 1.5m to 2.0m measured from NGL from the bore hole to bore holes. Open cut excavation was carried out proper well point drainage system to control the water table well below the raft until the desired level of counter weight generated by constructing the floors above. However there are pockets especially in the Atrium area where there is no sufficient self weight available to counter the uplift possibility likely to arise in the peak monsoon period, has been provided with active rock anchor designed and installed to restrain the lower basement slab against the water uplift.

As per the column load intensity and the Soil consultant recommendation laid down in the report, the building is designed with Strip Raft footings. The Footings are designed with the recommended SBC of 50 t/Sq.mt. at depth about 9m & below NGL. The thickness of footing vary from column to column depends upon its load intensity with 1250mm to 2250mm. The strip Raft is analysed and designed with SAFE.

## 11. OTHER DATA

Specific requirements of floor and wall cutouts for services, sinking (extent & depth) of floors in services, kitchen, utility and toilet areas, external architectural features, and entrance canopies are provided as required by Architects and Service Consultants. The relevant information is obtained from them in the form of drawings.

Lift loads and lift machine room equipment and cut out layouts will be obtained from the lift manufacturers. An impact factor of 100% will be considered in the lift supporting structures.

## 12. R.C Design

The structures are analyzed for the various load combinations as per IS: 456-2000. Etabs/SAFE/RCDC/In house spread sheet is being used for the structural element like Shear wall, Column, Beam, Slab etc. for the forces extracted from the ETABS analysis output. For the design of the R.C.C structures the recommendations of IS: 456-2000 is followed. Limit State design is adopted with appropriate load factors with the various load combinations for the different structural elements.

## 13. P.T Design

### 13.1 PRESTRESSING SYSTEMS

The pre-stressing system is incorporating strands with 12.70 mm dia. strand /15.20 mm dia strand. Prestressing strands shall be of class-2, confirming to IS 14268-1995

**Materials Data**

| | | |
|---|---|---|
| Strands | 0.5” | 0.6” |
| Nominal Diameter | 12.7mm | 15.2mm |
| Nominal Area | 98.7mm | 141mm$^2$ |
| Nominal weight | 0.775 kg/m | 1.15 kg/m |
| Tensile strength | 1860 N/mm$^2$ | 1860 N/mm$^2$ |
| Modulus of elasticity | 195 N/mm$^2$ | 195 N/mm$^2$ |
| Min breaking load of strand | 184kN | 263kN |
| Strand quality in accordance with | IS 14268 | IS 14268 |

### 13.2 GENERAL ASSUMPTIONS FOR PT SLAB & BEAM DESIGN

1) Strength design of prestressed member for flexure and axial loads shall be based on assumptions given in IS1343/ Clause 18.3 (Chapter 18) ACI-318.

2) Design moment strength of flexural members shall be computed by the strength design method of the code IS1343/ACI-318

3) Prestressed flexural members shall be classified as class U, Class T or Class C based on extreme fiber stress (Ft) in tension in pre compressed tensile zone calculated at service loads.

4) Serviceability Design Requirements are as per clause 18.3 ACI-318/ IS1343

5) Deflection of prestressed flexural members shall be calculated in accordance with Clause 18.3.5- ACI-318 / IS1343

6) Permissible tensile stresses in flexural member are as per Class-C (Table 18.3.3- ACI-318) / IS1343

7) Permissible stresses in prestressing steel shall not exceed the following

a. Due to prestressing steel jacking force 0.94 Fpy (specified yield strength of prestressing steel in psi) but not greater than the lesser of 0.80 (Fpu specified tensile strength of Prestressing steel)and the maximum value recommended by the manufacturer of prestressing steel or anchorage devices.

b. Immediate after prestress transfer 0.82 Fpy but not greater than 0.74 Fpu (specified tensile strength of prestressing steel)

8) Minimum Bonded reinforcement shall be provided in all prestressed flexural members is as per Clause 18.9-ACI-318 / IS1343.

9) Minimum average effective prestress of 125 psi on the slab section tributary to the tendon or tendon group.

10) Required elongation shall be determined from average load-elongation curves for the prestressing steel used. Generally 7% tolerance in prestressing steel force determined by gauge pressure and elongation measurements for post tension construction.

## 14.0 COMPUTER PROGRAMS USED

The following Software / spreadsheet are used to carry out Structural design.

14.1 PROKON Ver 3.0 - Wall & Beam design

14.2 ETABS Ver 21 -Three Dimensional FEM analysis and Design Programs

14.3 SAFE Ver 20 - Raft Analysis

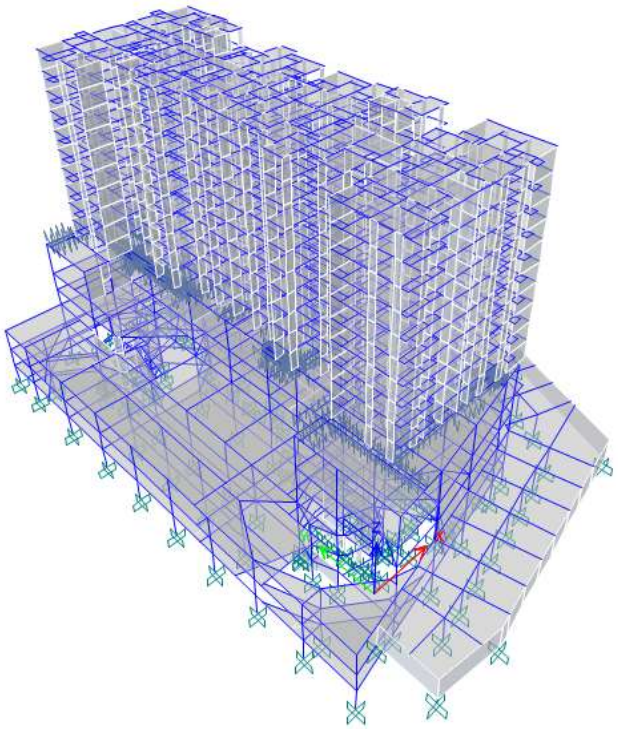
14.4 In-House Spreadsheet - one way/ two way slab design

14.5 RAPT V.6.0 - Post Tensioning Analysis & Design

14.6 RCDC Ver 23 - Design Software for all Structural Elements except Raft

# 3D MODEL
# &
# ANALYSIS SUMMARY REPORT

ETABS®



# User Report 1

# Table of Contents


1. Properties 4
   - 1.1 Materials 4
   - 1.2 Frame Sections 4
   - 1.3 Shell Sections 13
2. Loads 14
   - 2.1 Load Patterns 14
   - 2.2 Load Cases 14
3. Analysis Results 16
   - 3.1 Modal Results 16

# List of Tables


Table 1.1 Material Properties - General 4

Table 1.2 Frame Section Property Definitions - Summary 4

Table 1.3 Area Section Property Definitions - Summary 13

Table 2.1 Load Pattern Definitions 14

Table 2.2 Load Case Definitions - Summary 14

Table 2.3 Load Case Definitions - Linear Static 14

Table 2.4 Modal Case Definitions - Ritz 15

Table 2.5 Load Case Definitions - Response Spectrum 15

Table 3.1 Modal Periods And Frequencies 16

Table 3.2 Modal Participating Mass Ratios 16

Table 3.3 Modal Participation Factors 17

Table 3.4 Modal Load Participation Ratios 17

# 1 Properties

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

## 1.1 Materials

**Table 1.1 - Material Properties - General**

| Material | Type | SymType | Grade | Color | Notes |
|---|---|---|---|---|---|
| A416Gr270 | Tendon | Uniaxial | Unknown | Yellow | |
| HYSD415 | Rebar | Uniaxial | HYSD Grade 415 | Cyan | |
| HYSD500 | Rebar | Uniaxial | Unknown | Red | |
| M30 | Concrete | Isotropic | Unknown | Gray8Dark | |
| M40 | Concrete | Isotropic | M40 | Blue | |
| M40-1 | Concrete | Isotropic | M40 | Magenta | |
| STEEL | Steel | Isotropic | Unknown | Blue | |

## 1.2 Frame Sections

**Table 1.2 - Frame Section Property Definitions - Summary (Part 1 of 3)**

| Name | Material | Shape | Color | Area cm2 | J cm4 | I33 cm4 | I22 cm4 | I23 cm4 | As2 cm2 | As3 cm2 |
|---|---|---|---|---|---|---|---|---|---|---|
| A-LatBm | | Auto Select | | | | | | | | |
| B-300X750 | M30 | Concrete Rectangular | Yellow | 2250 | 505834.1 | 1054687.5 | 168750 | 0 | 1875 | 1875 |
| B-400X500 | M30 | Concrete Rectangular | Cyan | 2000 | 550689.8 | 416666.7 | 266666.7 | 0 | 1666.7 | 1666.7 |
| B-400X600 | M30 | Concrete Rectangular | Green | 2400 | 753193.8 | 720000 | 320000 | 0 | 2000 | 2000 |
| B-400X750 | M30 | Concrete Rectangular | Magenta | 3000 | 1067125 | 1406250 | 400000 | 0 | 2500 | 2500 |
| B-450X450 | M30 | Concrete Rectangular | Gray8Dark | 2025 | 577718.1 | 341718.8 | 341718.8 | 0 | 1687.5 | 1687.5 |
| B-450X600 | M30 | Concrete Rectangular | Red | 2700 | 988600.1 | 810000 | 455625 | 0 | 2250 | 2250 |
| B1-200X450 | M30 | Concrete Rectangular | Yellow | 900 | 86596.1 | 151875 | 30000 | 0 | 750 | 750 |
| B10-500X600 | M30 | Concrete Rectangular | Blue | 3000 | 1248479.7 | 900000 | 625000 | 0 | 2500 | 2500 |
| B11-600X600 | M30 | Concrete Rectangular | Green | 3600 | 1825874.6 | 1080000 | 1080000 | 0 | 3000 | 3000 |
| B12-600X750 | M30 | Concrete Rectangular | Cyan | 4500 | 2787867 | 2109375 | 1350000 | 0 | 3750 | 3750 |
| B13-800X600 | M30 | Concrete Rectangular | Red | 4800 | 3124464.4 | 1440000 | 2560000 | 0 | 4000 | 4000 |
| B15-900X600 | M30 | Concrete Rectangular | Magenta | 5400 | 3813043.6 | 1620000 | 3645000 | 0 | 4500 | 4500 |
| B16-900X750 | M30 | Concrete Rectangular | Yellow | 6750 | 6320428.3 | 3164062.5 | 4556250 | 0 | 5625 | 5625 |
| B17-1000X600 | M30 | Concrete Rectangular | Gray8Dark | 6000 | 4514793.6 | 1800000 | 5000000 | 0 | 5000 | 5000 |
| B2-200X600 | M30 | Concrete Rectangular | Gray8Dark | 1200 | 126597.2 | 360000 | 40000 | 0 | 1000 | 1000 |
| B20-230X450 | M30 | Concrete Rectangular | Magenta | 1035 | 124193.4 | 174656.3 | 45626.3 | 0 | 862.5 | 862.5 |
| B21-230X600 | M30 | Concrete Rectangular | Yellow | 1380 | 184887.1 | 414000 | 60835 | 0 | 1150 | 1150 |
| B22-1000X900 | M30 | Concrete Rectangular | Gray8Dark | 9000 | 11351912 | 6075000 | 7500000 | 0 | 7500 | 7500 |
| B24-400X600 | M30 | Concrete Rectangular | Blue | 2400 | 753193.8 | 720000 | 320000 | 0 | 2000 | 2000 |
| B26-900X500 | M30 | Concrete Rectangular | Cyan | 4500 | 2450883.4 | 937500 | 3037500 | 0 | 3750 | 3750 |
| B27-2500X500 | M30 | Concrete Rectangular | Red | 12500 | 9117447.7 | 2604166.7 | 65104166.7 | 0 | 10416.7 | 10416.7 |
| B28-1500X500 | M30 | Concrete Rectangular | Magenta | 7500 | 4945203.2 | 1562500 | 14062500 | 0 | 6250 | 6250 |
| B29-1000X500 | M30 | Concrete Rectangular | Yellow | 5000 | 2863565.4 | 1041666.7 | 4166666.7 | 0 | 4166.7 | 4166.7 |
| B3-200X750 | M30 | Concrete Rectangular | Blue | 1500 | 166638.5 | 703125 | 50000 | 0 | 1250 | 1250 |
| B30-400X500 | M30 | Concrete Rectangular | Gray8Dark | 2000 | 550689.8 | 416666.7 | 266666.7 | 0 | 1666.7 | 1666.7 |
| B31-1250X500 | M30 | Concrete Rectangular | Blue | 6250 | 3903040.9 | 1302083.3 | 8138020.8 | 0 | 5208.3 | 5208.3 |
| B32-1700X500 | M30 | Concrete Rectangular | Green | 8500 | 5779740.4 | 1770833.3 | 20470833.3 | 0 | 7083.3 | 7083.3 |
| B33-1000X1000 | M30 | Concrete Rectangular | Gray8Dark | 10000 | 14088538.7 | 8333333.3 | 8333333.3 | 0 | 8333.3 | 8333.3 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 1 of 3, continued)**

| Name | Material | Shape | Color | Area cm2 | J cm4 | I33 cm4 | I22 cm4 | I23 cm4 | As2 cm2 | As3 cm2 |
|---|---|---|---|---|---|---|---|---|---|---|
| B35-1500X1000 | M30 | Concrete Rectangular | Green | 15000 | 29421632.5 | 12500000 | 28125000 | 0 | 12500 | 12500 |
| B36-600X500 | M30 | Concrete Rectangular | Magenta | 3000 | 1248479.7 | 625000 | 900000 | 0 | 2500 | 2500 |
| B4-300X450 | M30 | Concrete Rectangular | Green | 1350 | 238315.2 | 227812.5 | 101250 | 0 | 1125 | 1125 |
| B5-300X600 | M30 | Concrete Rectangular | Cyan | 1800 | 371118.1 | 540000 | 135000 | 0 | 1500 | 1500 |
| B50-600X900 | M30 | Concrete Rectangular | Gray8Dark | 5400 | 3813043.6 | 3645000 | 1620000 | 0 | 4500 | 4500 |
| B6-300X900 | M30 | Concrete Rectangular | Red | 2700 | 640898.3 | 1822500 | 202500 | 0 | 2250 | 2250 |
| B7-300X500 | M30 | Concrete Rectangular | Magenta | 1500 | 282174.6 | 312500 | 112500 | 0 | 1250 | 1250 |
| B8-200X500 | M30 | Concrete Rectangular | Yellow | 1000 | 99917.8 | 208333.3 | 33333.3 | 0 | 833.3 | 833.3 |
| B9-450X900 | M30 | Concrete Rectangular | Gray8Dark | 4050 | 1878785.3 | 2733750 | 683437.5 | 0 | 3375 | 3375 |
| C 1100X1100 | M40 | Concrete Rectangular | Green | 12100 | 20627029.6 | 2200833.3 | 12200833.3 | 0 | 10083.3 | 10083.3 |
| C 16 a - 1200 X 1400 | M40 | Concrete Rectangular | Green | 16800 | 39323812.5 | 27440000 | 20160000 | 0 | 14000 | 14000 |
| C 230 X 650 | M40 | Concrete Rectangular | Gray8Dark | 1495 | 205192.2 | 526364.6 | 65904.6 | 0 | 1245.8 | 1245.8 |
| C 300 X 800 | M40 | Concrete Rectangular | Yellow | 2400 | 550813.4 | 180000 | 1280000 | 0 | 2000 | 2000 |
| C 400 X 900 | M40 | Concrete Rectangular | Green | 3600 | 1385537.3 | 480000 | 2430000 | 0 | 3000 | 3000 |
| C 500 X 900 | M40 | Concrete Rectangular | Red | 4500 | 2450883.4 | 937500 | 3037500 | 0 | 3750 | 3750 |
| C 800 X 1200 | M40 | Concrete Rectangular | Yellow | 9600 | 12051100.7 | 11520000 | 5120000 | 0 | 8000 | 8000 |
| C 800 X 1300 | M40 | Concrete Rectangular | Cyan | 10400 | 13711789 | 5546666.7 | 14646666.7 | 0 | 8666.7 | 8666.7 |
| C 800 X 1400 | M40 | Concrete Rectangular | Yellow | 11200 | 15386634.8 | 8293333.3 | 5973333.3 | 0 | 9333.3 | 9333.3 |
| C 900 X 1100 | M40 | Concrete Rectangular | Blue | 9900 | 13550844.3 | 9982500 | 6682500 | 0 | 8250 | 8250 |
| C1-300X450 | M40 | Concrete Rectangular | Cyan | 1350 | 238315.2 | 227812.5 | 101250 | 0 | 1125 | 1125 |
| C11-800X800 | M40 | Concrete Rectangular | Yellow | 6400 | 5770665.5 | 3413333.3 | 3413333.3 | 0 | 5333.3 | 5333.3 |
| C12-800X900 | M40 | Concrete Rectangular | Gray8Dark | 7200 | 7255881.3 | 4860000 | 3840000 | 0 | 6000 | 6000 |
| C13-900X900 | M40 | Concrete Rectangular | Blue | 8100 | 9243490.3 | 5467500 | 5467500 | 0 | 6750 | 6750 |
| C14-900X1000 | M40 | Concrete Rectangular | Green | 9000 | 11351912 | 7500000 | 6075000 | 0 | 7500 | 7500 |
| C15-1000X1000 | M40 | Concrete Rectangular | Green | 10000 | 14088538.7 | 8333333.3 | 8333333.3 | 0 | 8333.3 | 8333.3 |
| C16-1000X1200 | M40 | Concrete Rectangular | Cyan | 12000 | 19975674.6 | 14400000 | 10000000 | 0 | 10000 | 10000 |
| C17-1200X1200 | M40 | Concrete Rectangular | Red | 14400 | 29213993.9 | 17280000 | 17280000 | 0 | 12000 | 12000 |
| C19-600X900 | M40 | Concrete Rectangular | Yellow | 5400 | 3813043.6 | 3645000 | 1620000 | 0 | 4500 | 4500 |
| C1aa - 900 X 1300 | M40 | Concrete Rectangular | Yellow | 11700 | 18132653.7 | 16477500 | 7897500 | 0 | 9750 | 9750 |
| C20-500X1600 | M40 | Concrete Rectangular | Gray8Dark | 8000 | 5362086.1 | 7066666.7 | 1666666.7 | 0 | 6666.7 | 6666.7 |
| C21-300X900 | M40 | Concrete Rectangular | Blue | 2700 | 640898.3 | 1822500 | 202500 | 0 | 2250 | 2250 |
| C22-500X1200 | M40 | Concrete Rectangular | Green | 6000 | 3695006.9 | 7200000 | 1250000 | 0 | 5000 | 5000 |
| C23-300X750 | M40 | Concrete Rectangular | Cyan | 2250 | 505834.1 | 1054687.5 | 168750 | 0 | 1875 | 1875 |
| C24-450X550 | M40 | Concrete Rectangular | Red | 2475 | 846927.8 | 623906.3 | 417656.3 | 0 | 2062.5 | 2062.5 |
| C25-500X1000 | M40 | Concrete Rectangular | Magenta | 5000 | 2863565.4 | 4166666.7 | 1041666.7 | 0 | 4166.7 | 4166.7 |
| C26-500X900 | M40 | Concrete Rectangular | Yellow | 4500 | 2450883.4 | 3037500 | 937500 | 0 | 3750 | 3750 |
| C27-500X1400 | M40 | Concrete Rectangular | Gray8Dark | 7000 | 4528396.5 | 1433333.3 | 1458333.3 | 0 | 5833.3 | 5833.3 |
| C27a-600X1400 | M40 | Concrete Rectangular | Red | 7000 | 4528396.5 | 1433333.3 | 1458333.3 | 0 | 5833.3 | 5833.3 |
| C31-400X600 | M40 | Concrete Rectangular | Red | 2400 | 753193.8 | 720000 | 320000 | 0 | 2000 | 2000 |
| C33-800X1200 | M40 | Concrete Rectangular | Red | 9600 | 12051100.7 | 11520000 | 5120000 | 0 | 8000 | 8000 |
| C34-900X1200 | M40 | Concrete Rectangular | Magenta | 10800 | 15817601.3 | 12960000 | 7290000 | 0 | 9000 | 9000 |
| C38-600X1000 | M40 | Concrete Rectangular | Magenta | 6000 | 4514793.6 | 5000000 | 1800000 | 0 | 5000 | 5000 |
| C8-600X600 | M40 | Concrete Rectangular | Cyan | 3600 | 1825874.6 | 1080000 | 1080000 | 0 | 3000 | 3000 |
| PTB 1800X1000 | M40 | Concrete Rectangular | Green | 18000 | 39214134.7 | 15000000 | 48600000 | 0 | 15000 | 15000 |
| PTB-1000X1000 | M40 | Concrete Rectangular | Red | 10000 | 14088538.7 | 8333333.3 | 8333333.3 | 0 | 8333.3 | 8333.3 |
| PTB-1200X1000 | M40 | Concrete Rectangular | Cyan | 12000 | 19975674.6 | 10000000 | 14400000 | 0 | 10000 | 10000 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 1 of 3, continued)**

| Name | Material | Shape | Color | Area cm2 | J cm4 | I33 cm4 | I22 cm4 | I23 cm4 | As2 cm2 | As3 cm2 |
|---|---|---|---|---|---|---|---|---|---|---|
| PTB-1200X1300 | M40 | Concrete Rectangular | Green | 15600 | 34180267.6 | 21970000 | 18720000 | 0 | 13000 | 13000 |
| PTB-1200X600 | M40 | Concrete Rectangular | Magenta | 7200 | 5937889.2 | 2160000 | 8640000 | 0 | 6000 | 6000 |
| PTB-1400X1000 | M40 | Concrete Rectangular | Magenta | 14000 | 26220781.4 | 1666666.7 | 22866666.7 | 0 | 11666.7 | 11666.7 |
| PTB-1400X700 | M40 | Concrete Rectangular | Blue | 9800 | 11000672.9 | 4001666.7 | 16006666.7 | 0 | 8166.7 | 8166.7 |
| PTB-1500X1000 | M40 | Concrete Rectangular | Blue | 15000 | 29421632.5 | 12500000 | 28125000 | 0 | 12500 | 12500 |
| PTB-1500X1300 | M40 | Concrete Rectangular | Blue | 19500 | 53059807.4 | 27462500 | 36562500 | 0 | 16250 | 16250 |
| PTB-1800X1300 | M40 | Concrete Rectangular | Yellow | 23400 | 73492948.2 | 32955000 | 63180000 | 0 | 19500 | 19500 |
| PTB-200X1300 | M40 | Concrete Rectangular | Cyan | 2600 | 313508 | 3661666.7 | 86666.7 | 0 | 2166.7 | 2166.7 |
| PTB-2200X1000 | M40 | Concrete Rectangular | Blue | 22000 | 52459562.5 | 8333333.3 | 38733333.3 | 0 | 18333.3 | 18333.3 |
| PTB-2500X1300 | M40 | Concrete Rectangular | Yellow | 32500 | 123593089.4 | 5770833.3 | 69270833.3 | 0 | 27083.3 | 27083.3 |
| PTB-300X1000 | M40 | Concrete Rectangular | Yellow | 3000 | 731032.4 | 2500000 | 225000 | 0 | 2500 | 2500 |
| PTB-300X1300 | M40 | Concrete Rectangular | Red | 3900 | 1001331.1 | 5492500 | 292500 | 0 | 3250 | 3250 |
| PTB-400X1000 | M40 | Concrete Rectangular | Yellow | 4000 | 1598685.6 | 3333333.3 | 533333.3 | 0 | 3333.3 | 3333.3 |
| PTB-450X1000 | M40 | Concrete Rectangular | Green | 4500 | 2181472.9 | 3750000 | 759375 | 0 | 3750 | 3750 |
| PTB-500X1000 | M40 | Concrete Rectangular | Blue | 5000 | 2863565.4 | 4166666.7 | 1041666.7 | 0 | 4166.7 | 4166.7 |
| PTB-500X1300 | M40 | Concrete Rectangular | Red | 6500 | 4111169.4 | 9154166.7 | 1354166.7 | 0 | 5416.7 | 5416.7 |
| PTB-600X1000 | M40 | Concrete Rectangular | Gray8Dark | 6000 | 4514793.6 | 5000000 | 1800000 | 0 | 5000 | 5000 |
| PTB-600X1300 | M40 | Concrete Rectangular | Yellow | 7800 | 6655152 | 10985000 | 2340000 | 0 | 6500 | 6500 |
| PTB-700X1000 | M40 | Concrete Rectangular | Yellow | 7000 | 6514312.3 | 5833333.3 | 2858333.3 | 0 | 5833.3 | 5833.3 |
| PTB-750X1000 | M40 | Concrete Rectangular | Yellow | 7500 | 7628087 | 6250000 | 3515625 | 0 | 6250 | 6250 |
| PTB-750X1300 | M40 | Concrete Rectangular | Green | 9750 | 11712650.9 | 13731250 | 4570312.5 | 0 | 8125 | 8125 |
| PTB-800X1000 | M40 | Concrete Rectangular | Gray8Dark | 8000 | 8811036.5 | 6666666.7 | 4266666.7 | 0 | 6666.7 | 6666.7 |
| PTB-800X1300 | M40 | Concrete Rectangular | Red | 10400 | 13711789 | 14646666.7 | 5546666.7 | 0 | 8666.7 | 8666.7 |
| PTB-850X1000 | M40 | Concrete Rectangular | Gray8Dark | 8500 | 10054108 | 7083333.3 | 5117708.3 | 0 | 7083.3 | 7083.3 |
| PTB-900X1000 | M40 | Concrete Rectangular | Cyan | 9000 | 11351912 | 7500000 | 6075000 | 0 | 7500 | 7500 |
| PTB-900X1300 | M40 | Concrete Rectangular | Magenta | 11700 | 18132653.7 | 16477500 | 7897500 | 0 | 9750 | 9750 |
| PTB-900X950 | M40 | Concrete Rectangular | Blue | 8550 | 10283993.9 | 6430312.5 | 5771250 | 0 | 7125 | 7125 |
| PTB1300X1000 | M40 | Concrete Rectangular | Cyan | 13000 | 23065380 | 10833333.3 | 18308333.3 | 0 | 10833.3 | 10833.3 |
| W18X50 | STEEL | Steel I/Wide Flange | Red | 94.8 | 51.6 | 33298.5 | 1669.1 | 0 | 41.2 | 46 |
| W18X55 | STEEL | Steel I/Wide Flange | Magenta | 104.5 | 69.1 | 37044.6 | 1868.9 | 0 | 45.5 | 51 |
| W18X60 | STEEL | Steel I/Wide Flange | Yellow | 113.5 | 90.3 | 40957.2 | 2085.3 | 0 | 48.7 | 56.5 |
| W21X55 | STEEL | Steel I/Wide Flange | Blue | 104.5 | 51.6 | 47450.4 | 2014.6 | 0 | 50.3 | 46.1 |
| W21X57 | STEEL | Steel I/Wide Flange | Gray8Dark | 107.7 | 73.7 | 48699.1 | 1273.7 | 0 | 55.1 | 45.8 |
| W21X62 | STEEL | Steel I/Wide Flange | Green | 118.1 | 76.2 | 55358.8 | 2393.3 | 0 | 54.2 | 54.5 |
| W21X68 | STEEL | Steel I/Wide Flange | Cyan | 129 | 102 | 61602.3 | 2693 | 0 | 58.5 | 60.9 |
| W24X62 | STEEL | Steel I/Wide Flange | Red | 117.4 | 71.2 | 64515.9 | 1436 | 0 | 65.7 | 44.7 |
| W24X76 | STEEL | Steel I/Wide Flange | Magenta | 144.5 | 111.6 | 87408.6 | 3433.9 | 0 | 67.8 | 65.7 |
| W24X84 | STEEL | Steel I/Wide Flange | Yellow | 159.4 | 154 | 98646.8 | 3929.2 | 0 | 73.1 | 74.7 |
| W24X94 | STEEL | Steel I/Wide Flange | Gray8Dark | 178.7 | 218.9 | 112382.5 | 4536.9 | 0 | 80.7 | 85.3 |
| W27X102 | STEEL | Steel I/Wide Flange | Green | 193.5 | 219.8 | 150675.8 | 5785.6 | 0 | 90 | 89.2 |
| W27X114 | STEEL | Steel I/Wide Flange | Cyan | 216.8 | 305.1 | 169822.4 | 6618.1 | 0 | 100.4 | 101 |
| W27X129 | STEEL | Steel I/Wide Flange | Red | 243.9 | 462 | 198126.2 | 7658.7 | 0 | 108.6 | 118.3 |
| W27X94 | STEEL | Steel I/Wide Flange | Blue | 178.1 | 167.7 | 136107.7 | 5161.3 | 0 | 85 | 80.1 |
| W30X108 | STEEL | Steel I/Wide Flange | Magenta | 204.5 | 207.7 | 186055.4 | 6077 | 0 | 104.8 | 85.8 |
| W30X116 | STEEL | Steel I/Wide Flange | Yellow | 220.6 | 267.6 | 205202.1 | 6826.2 | 0 | 109.4 | 96 |
| W30X124 | STEEL | Steel I/Wide Flange | Gray8Dark | 235.5 | 332.6 | 223100 | 7533.8 | 0 | 114 | 105 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 1 of 3, continued)**

| Name | Material | Shape | Color | Area cm2 | J cm4 | I33 cm4 | I22 cm4 | I23 cm4 | As2 cm2 | As3 cm2 |
|---|---|---|---|---|---|---|---|---|---|---|
| W30X132 | STEEL | Steel I/Wide Flange | Blue | 250.3 | 404.6 | 240165.5 | 8158.1 | 0 | 120.2 | 112.9 |
| W33X130 | STEEL | Steel I/Wide Flange | Green | 247.1 | 306.8 | 279291.3 | 9073.8 | 0 | 123.9 | 105.7 |
| W33X141 | STEEL | Steel I/Wide Flange | Cyan | 267.7 | 403.7 | 310092.4 | 10239.3 | 0 | 130 | 118.7 |
| W33X152 | STEEL | Steel I/Wide Flange | Red | 289.7 | 516.1 | 339644.8 | 11363.1 | 0 | 137.2 | 132.2 |
| W36X150 | STEEL | Steel I/Wide Flange | Magenta | 285.8 | 420.4 | 376273.2 | 11238.2 | 0 | 144.8 | 121.3 |
| W36X160 | STEEL | Steel I/Wide Flange | Yellow | 303.2 | 516.1 | 406241.9 | 12278.8 | 0 | 151 | 131.6 |
| W36X170 | STEEL | Steel I/Wide Flange | Gray8Dark | 322.6 | 628.5 | 437043 | 13319.4 | 0 | 158.8 | 141.9 |
| W36X182 | STEEL | Steel I/Wide Flange | Blue | 345.8 | 770 | 470341.5 | 14443.2 | 0 | 169.8 | 153.5 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 2 of 3)**

| Name | S33Pos cm3 | S33Neg cm3 | S22Pos cm3 | S22Neg cm3 | Z33 cm3 | Z22 cm3 | R33 mm | R22 mm | Cw cm6 | Fillet Radius mm | CG Offset 3 mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A-LatBm | | | | | | | | | | | |
| B-300X750 | 28125 | 28125 | 11250 | 11250 | 42187.5 | 16875 | 216.5 | 86.6 | | | 0 |
| B-400X500 | 16666.7 | 16666.7 | 13333.3 | 13333.3 | 25000 | 20000 | 144.3 | 115.5 | | | 0 |
| B-400X600 | 24000 | 24000 | 16000 | 16000 | 36000 | 24000 | 173.2 | 115.5 | | | 0 |
| B-400X750 | 37500 | 37500 | 20000 | 20000 | 56250 | 30000 | 216.5 | 115.5 | | | 0 |
| B-450X450 | 15187.5 | 15187.5 | 15187.5 | 15187.5 | 22781.3 | 22781.3 | 129.9 | 129.9 | | | 0 |
| B-450X600 | 27000 | 27000 | 20250 | 20250 | 40500 | 30375 | 173.2 | 129.9 | | | 0 |
| B1-200X450 | 6750 | 6750 | 3000 | 3000 | 10125 | 4500 | 129.9 | 57.7 | | | 0 |
| B10-500X600 | 30000 | 30000 | 25000 | 25000 | 45000 | 37500 | 173.2 | 144.3 | | | 0 |
| B11-600X600 | 36000 | 36000 | 36000 | 36000 | 54000 | 54000 | 173.2 | 173.2 | | | 0 |
| B12-600X750 | 56250 | 56250 | 45000 | 45000 | 84375 | 67500 | 216.5 | 173.2 | | | 0 |
| B13-800X600 | 48000 | 48000 | 64000 | 64000 | 72000 | 96000 | 173.2 | 230.9 | | | 0 |
| B15-900X600 | 54000 | 54000 | 81000 | 81000 | 81000 | 121500 | 173.2 | 259.8 | | | 0 |
| B16-900X750 | 84375 | 84375 | 101250 | 101250 | 126562.5 | 151875 | 216.5 | 259.8 | | | 0 |
| B17-1000X600 | 60000 | 60000 | 100000 | 100000 | 90000 | 150000 | 173.2 | 288.7 | | | 0 |
| B2-200X600 | 12000 | 12000 | 4000 | 4000 | 18000 | 6000 | 173.2 | 57.7 | | | 0 |
| B20-230X450 | 7762.5 | 7762.5 | 3967.5 | 3967.5 | 11643.8 | 5951.3 | 129.9 | 66.4 | | | 0 |
| B21-230X600 | 13800 | 13800 | 5290 | 5290 | 20700 | 7935 | 173.2 | 66.4 | | | 0 |
| B22-1000X900 | 135000 | 135000 | 150000 | 150000 | 202500 | 225000 | 259.8 | 288.7 | | | 0 |
| B24-400X600 | 24000 | 24000 | 16000 | 16000 | 36000 | 24000 | 173.2 | 115.5 | | | 0 |
| B26-900X500 | 37500 | 37500 | 67500 | 67500 | 56250 | 101250 | 144.3 | 259.8 | | | 0 |
| B27-2500X500 | 104166.7 | 104166.7 | 520833.3 | 520833.3 | 156250 | 781250 | 144.3 | 721.7 | | | 0 |
| B28-1500X500 | 62500 | 62500 | 187500 | 187500 | 93750 | 281250 | 144.3 | 433 | | | 0 |
| B29-1000X500 | 41666.7 | 41666.7 | 83333.3 | 83333.3 | 62500 | 125000 | 144.3 | 288.7 | | | 0 |
| B3-200X750 | 18750 | 18750 | 5000 | 5000 | 28125 | 7500 | 216.5 | 57.7 | | | 0 |
| B30-400X500 | 16666.7 | 16666.7 | 13333.3 | 13333.3 | 25000 | 20000 | 144.3 | 115.5 | | | 0 |
| B31-1250X500 | 52083.3 | 52083.3 | 130208.3 | 130208.3 | 78125 | 195312.5 | 144.3 | 360.8 | | | 0 |
| B32-1700X500 | 70833.3 | 70833.3 | 240833.3 | 240833.3 | 106250 | 361250 | 144.3 | 490.7 | | | 0 |
| B33-1000X1000 | 166666.7 | 166666.7 | 166666.7 | 166666.7 | 250000 | 250000 | 288.7 | 288.7 | | | 0 |
| B35-1500X1000 | 250000 | 250000 | 375000 | 375000 | 375000 | 562500 | 288.7 | 433 | | | 0 |
| B36-600X500 | 25000 | 25000 | 30000 | 30000 | 37500 | 45000 | 144.3 | 173.2 | | | 0 |
| B4-300X450 | 10125 | 10125 | 6750 | 6750 | 15187.5 | 10125 | 129.9 | 86.6 | | | 0 |
| B5-300X600 | 18000 | 18000 | 9000 | 9000 | 27000 | 13500 | 173.2 | 86.6 | | | 0 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 2 of 3, continued)**

| Name | S33Pos cm3 | S33Neg cm3 | S22Pos cm3 | S22Neg cm3 | Z33 cm3 | Z22 cm3 | R33 mm | R22 mm | Cw cm6 | Fillet Radius mm | CG Offset 3 mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B50-600X900 | 81000 | 81000 | 54000 | 54000 | 121500 | 81000 | 259.8 | 173.2 | | | 0 |
| B6-300X900 | 40500 | 40500 | 13500 | 13500 | 60750 | 20250 | 259.8 | 86.6 | | | 0 |
| B7-300X500 | 12500 | 12500 | 7500 | 7500 | 18750 | 11250 | 144.3 | 86.6 | | | 0 |
| B8-200X500 | 8333.3 | 8333.3 | 3333.3 | 3333.3 | 12500 | 5000 | 144.3 | 57.7 | | | 0 |
| B9-450X900 | 60750 | 60750 | 30375 | 30375 | 91125 | 45562.5 | 259.8 | 129.9 | | | 0 |
| C 1100X1100 | 221833.3 | 221833.3 | 221833.3 | 221833.3 | 332750 | 332750 | 317.5 | 317.5 | | | 0 |
| C 16 a - 1200 X 1400 | 392000 | 392000 | 336000 | 336000 | 588000 | 504000 | 404.1 | 346.4 | | | 0 |
| C 230 X 650 | 16195.8 | 16195.8 | 5730.8 | 5730.8 | 24293.8 | 8596.3 | 187.6 | 66.4 | | | 0 |
| C 300 X 800 | 12000 | 12000 | 32000 | 32000 | 18000 | 48000 | 86.6 | 230.9 | | | 0 |
| C 400 X 900 | 24000 | 24000 | 54000 | 54000 | 36000 | 81000 | 115.5 | 259.8 | | | 0 |
| C 500 X 900 | 37500 | 37500 | 67500 | 67500 | 56250 | 101250 | 144.3 | 259.8 | | | 0 |
| C 800 X 1200 | 192000 | 192000 | 128000 | 128000 | 288000 | 192000 | 346.4 | 230.9 | | | 0 |
| C 800 X 1300 | 138666.7 | 138666.7 | 225333.3 | 225333.3 | 208000 | 338000 | 230.9 | 375.3 | | | 0 |
| C 800 X 1400 | 261333.3 | 261333.3 | 149333.3 | 149333.3 | 392000 | 224000 | 404.1 | 230.9 | | | 0 |
| C 900 X 1100 | 181500 | 181500 | 148500 | 148500 | 272250 | 222750 | 317.5 | 259.8 | | | 0 |
| C1-300X450 | 10125 | 10125 | 6750 | 6750 | 15187.5 | 10125 | 129.9 | 86.6 | | | 0 |
| C11-800X800 | 85333.3 | 85333.3 | 85333.3 | 85333.3 | 128000 | 128000 | 230.9 | 230.9 | | | 0 |
| C12-800X900 | 108000 | 108000 | 96000 | 96000 | 162000 | 144000 | 259.8 | 230.9 | | | 0 |
| C13-900X900 | 121500 | 121500 | 121500 | 121500 | 182250 | 182250 | 259.8 | 259.8 | | | 0 |
| C14-900X1000 | 150000 | 150000 | 135000 | 135000 | 225000 | 202500 | 288.7 | 259.8 | | | 0 |
| C15-1000X1000 | 166666.7 | 166666.7 | 166666.7 | 166666.7 | 250000 | 250000 | 288.7 | 288.7 | | | 0 |
| C16-1000X1200 | 240000 | 240000 | 200000 | 200000 | 360000 | 300000 | 346.4 | 288.7 | | | 0 |
| C17-1200X1200 | 288000 | 288000 | 288000 | 288000 | 432000 | 432000 | 346.4 | 346.4 | | | 0 |
| C19-600X900 | 81000 | 81000 | 54000 | 54000 | 121500 | 81000 | 259.8 | 173.2 | | | 0 |
| C1aa - 900 X 1300 | 253500 | 253500 | 175500 | 175500 | 380250 | 263250 | 375.3 | 259.8 | | | 0 |
| C20-500X1600 | 213333.3 | 213333.3 | 66666.7 | 66666.7 | 320000 | 100000 | 461.9 | 144.3 | | | 0 |
| C21-300X900 | 40500 | 40500 | 13500 | 13500 | 60750 | 20250 | 259.8 | 86.6 | | | 0 |
| C22-500X1200 | 120000 | 120000 | 50000 | 50000 | 180000 | 75000 | 346.4 | 144.3 | | | 0 |
| C23-300X750 | 28125 | 28125 | 11250 | 11250 | 42187.5 | 16875 | 216.5 | 86.6 | | | 0 |
| C24-450X550 | 22687.5 | 22687.5 | 18562.5 | 18562.5 | 34031.3 | 27843.8 | 158.8 | 129.9 | | | 0 |
| C25-500X1000 | 83333.3 | 83333.3 | 41666.7 | 41666.7 | 125000 | 62500 | 288.7 | 144.3 | | | 0 |
| C26-500X900 | 67500 | 67500 | 37500 | 37500 | 101250 | 56250 | 259.8 | 144.3 | | | 0 |
| C27-500X1400 | 163333.3 | 163333.3 | 58333.3 | 58333.3 | 245000 | 87500 | 404.1 | 144.3 | | | 0 |
| C27a-600X1400 | 163333.3 | 163333.3 | 58333.3 | 58333.3 | 245000 | 87500 | 404.1 | 144.3 | | | 0 |
| C31-400X600 | 24000 | 24000 | 16000 | 16000 | 36000 | 24000 | 173.2 | 115.5 | | | 0 |
| C33-800X1200 | 192000 | 192000 | 128000 | 128000 | 288000 | 192000 | 346.4 | 230.9 | | | 0 |
| C34-900X1200 | 216000 | 216000 | 162000 | 162000 | 324000 | 243000 | 346.4 | 259.8 | | | 0 |
| C38-600X1000 | 100000 | 100000 | 60000 | 60000 | 150000 | 90000 | 288.7 | 173.2 | | | 0 |
| C8-600X600 | 36000 | 36000 | 36000 | 36000 | 54000 | 54000 | 173.2 | 173.2 | | | 0 |
| PTB 1800X1000 | 300000 | 300000 | 540000 | 540000 | 450000 | 810000 | 288.7 | 519.6 | | | 0 |
| PTB-1000X1000 | 166666.7 | 166666.7 | 166666.7 | 166666.7 | 250000 | 250000 | 288.7 | 288.7 | | | 0 |
| PTB-1200X1000 | 200000 | 200000 | 240000 | 240000 | 300000 | 360000 | 288.7 | 346.4 | | | 0 |
| PTB-1200X1300 | 338000 | 338000 | 312000 | 312000 | 507000 | 468000 | 375.3 | 346.4 | | | 0 |
| PTB-1200X600 | 72000 | 72000 | 144000 | 144000 | 108000 | 216000 | 173.2 | 346.4 | | | 0 |
| PTB-1400X1000 | 233333.3 | 233333.3 | 326666.7 | 326666.7 | 350000 | 490000 | 288.7 | 404.1 | | | 0 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 2 of 3, continued)**

| Name | S33Pos cm3 | S33Neg cm3 | S22Pos cm3 | S22Neg cm3 | Z33 cm3 | Z22 cm3 | R33 mm | R22 mm | Cw cm6 | Fillet Radius mm | CG Offset 3 mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PTB-1400X700 | 114333.3 | 114333.3 | 228666.7 | 228666.7 | 171500 | 343000 | 202.1 | 404.1 | | | 0 |
| PTB-1500X1000 | 250000 | 250000 | 375000 | 375000 | 375000 | 562500 | 288.7 | 433 | | | 0 |
| PTB-1500X1300 | 422500 | 422500 | 487500 | 487500 | 633750 | 731250 | 375.3 | 433 | | | 0 |
| PTB-1800X1300 | 507000 | 507000 | 702000 | 702000 | 760500 | 1053000 | 375.3 | 519.6 | | | 0 |
| PTB-200X1300 | 56333.3 | 56333.3 | 8666.7 | 8666.7 | 84500 | 13000 | 375.3 | 57.7 | | | 0 |
| PTB-2200X1000 | 366666.7 | 366666.7 | 806666.7 | 806666.7 | 550000 | 1210000 | 288.7 | 635.1 | | | 0 |
| PTB-2500X1300 | 704166.7 | 704166.7 | 1354166.7 | 1354166.7 | 1056250 | 2031250 | 375.3 | 721.7 | | | 0 |
| PTB-300X1000 | 50000 | 50000 | 15000 | 15000 | 75000 | 22500 | 288.7 | 86.6 | | | 0 |
| PTB-300X1300 | 84500 | 84500 | 19500 | 19500 | 126750 | 29250 | 375.3 | 86.6 | | | 0 |
| PTB-400X1000 | 66666.7 | 66666.7 | 26666.7 | 26666.7 | 100000 | 40000 | 288.7 | 115.5 | | | 0 |
| PTB-450X1000 | 75000 | 75000 | 33750 | 33750 | 112500 | 50625 | 288.7 | 129.9 | | | 0 |
| PTB-500X1000 | 83333.3 | 83333.3 | 41666.7 | 41666.7 | 125000 | 62500 | 288.7 | 144.3 | | | 0 |
| PTB-500X1300 | 140833.3 | 140833.3 | 54166.7 | 54166.7 | 211250 | 81250 | 375.3 | 144.3 | | | 0 |
| PTB-600X1000 | 100000 | 100000 | 60000 | 60000 | 150000 | 90000 | 288.7 | 173.2 | | | 0 |
| PTB-600X1300 | 169000 | 169000 | 78000 | 78000 | 253500 | 117000 | 375.3 | 173.2 | | | 0 |
| PTB-700X1000 | 116666.7 | 116666.7 | 81666.7 | 81666.7 | 175000 | 122500 | 288.7 | 202.1 | | | 0 |
| PTB-750X1000 | 125000 | 125000 | 93750 | 93750 | 187500 | 140625 | 288.7 | 216.5 | | | 0 |
| PTB-750X1300 | 211250 | 211250 | 121875 | 121875 | 316875 | 182812.5 | 375.3 | 216.5 | | | 0 |
| PTB-800X1000 | 133333.3 | 133333.3 | 106666.7 | 106666.7 | 200000 | 160000 | 288.7 | 230.9 | | | 0 |
| PTB-800X1300 | 225333.3 | 225333.3 | 138666.7 | 138666.7 | 338000 | 208000 | 375.3 | 230.9 | | | 0 |
| PTB-850X1000 | 141666.7 | 141666.7 | 120416.7 | 120416.7 | 212500 | 180625 | 288.7 | 245.4 | | | 0 |
| PTB-900X1000 | 150000 | 150000 | 135000 | 135000 | 225000 | 202500 | 288.7 | 259.8 | | | 0 |
| PTB-900X1300 | 253500 | 253500 | 175500 | 175500 | 380250 | 263250 | 375.3 | 259.8 | | | 0 |
| PTB-900X950 | 135375 | 135375 | 128250 | 128250 | 203062.5 | 192375 | 274.2 | 259.8 | | | 0 |
| PTB1300X1000 | 216666.7 | 216666.7 | 281666.7 | 281666.7 | 325000 | 422500 | 288.7 | 375.3 | | | 0 |
| W18X50 | 1456.6 | 1456.6 | 175.2 | 175.2 | 1655.1 | 272 | 187.4 | 42 | 817418.5 | 10.2 | 0 |
| W18X55 | 1611.5 | 1611.5 | 195.4 | 195.4 | 1835.4 | 303.2 | 188.3 | 42.3 | 918549 | 10.2 | 0 |
| W18X60 | 1772 | 1772 | 217.2 | 217.2 | 2015.6 | 337.6 | 189.9 | 42.9 | 1029592.8 | 10.3 | 0 |
| W21X55 | 1796.3 | 1796.3 | 193 | 193 | 2064.8 | 301.5 | 213.1 | 43.9 | 1333912.2 | 12.6 | 0 |
| W21X57 | 1817.3 | 1817.3 | 152.9 | 152.9 | 2113.9 | 242.5 | 212.6 | 34.4 | 858623.1 | 12.7 | 0 |
| W21X62 | 2075.7 | 2075.7 | 228.7 | 228.7 | 2359.7 | 355.6 | 216.5 | 45 | 1599813.1 | 12.8 | 0 |
| W21X68 | 2298.8 | 2298.8 | 256.4 | 256.4 | 2621.9 | 399.8 | 218.5 | 45.7 | 1806745.3 | 12.8 | 0 |
| W24X62 | 2143.5 | 2143.5 | 160.6 | 160.6 | 2507.2 | 257.3 | 234.4 | 35 | 1230158.1 | 12.7 | 0 |
| W24X76 | 2879.7 | 2879.7 | 300.8 | 300.8 | 3277.4 | 468.7 | 245.9 | 48.7 | 2980598.5 | 12.7 | 0 |
| W24X84 | 3223 | 3223 | 343 | 343 | 3670.7 | 534.2 | 248.8 | 49.7 | 3441366.1 | 12.7 | 0 |
| W24X94 | 3641.6 | 3641.6 | 393.9 | 393.9 | 4162.3 | 614.5 | 250.8 | 50.4 | 4008484.2 | 12.8 | 0 |
| W27X102 | 4377.9 | 4377.9 | 455.6 | 455.6 | 4998.1 | 711.2 | 279 | 54.7 | 6408985.6 | 15.2 | 0 |
| W27X114 | 4898.1 | 4898.1 | 515.9 | 515.9 | 5620.8 | 807.9 | 279.9 | 55.3 | 7455184.4 | 15.2 | 0 |
| W27X129 | 5652.3 | 5652.3 | 603 | 603 | 6472.9 | 943.9 | 285 | 56 | 8643218.5 | 15.2 | 0 |
| W27X94 | 3984.1 | 3984.1 | 406.4 | 406.4 | 4555.6 | 635.8 | 276.5 | 53.8 | 5702388.2 | 15.1 | 0 |
| W30X108 | 4916.1 | 4916.1 | 455.7 | 455.7 | 5669.9 | 719.4 | 301.6 | 54.5 | 8301675.8 | 16.5 | 0 |
| W30X116 | 5385.9 | 5385.9 | 511.9 | 511.9 | 6194.3 | 806.2 | 305 | 55.6 | 9355241.4 | 16.5 | 0 |
| W30X124 | 5816.9 | 5816.9 | 565 | 565 | 6685.9 | 884.9 | 307.8 | 56.6 | 10320181.8 | 16.5 | 0 |
| W30X132 | 6241.1 | 6241.1 | 611.8 | 611.8 | 7161.1 | 957 | 309.7 | 57.1 | 11119728.8 | 16.5 | 0 |
| W33X130 | 6643.9 | 6643.9 | 621.3 | 621.3 | 7652.8 | 975 | 336.2 | 60.6 | 15127788.9 | 17.9 | 0 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 2 of 3, continued)**

| Name | S33Pos cm3 | S33Neg cm3 | S22Pos cm3 | S22Neg cm3 | Z33 cm3 | Z22 cm3 | R33 mm | R22 mm | Cw cm6 | Fillet Radius mm | CG Offset 3 mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| W33X141 | 7332.3 | 7332.3 | 701.1 | 701.1 | 8423 | 1096.3 | 340.3 | 61.8 | 17085820.6 | 17.8 | 0 |
| W33X152 | 7983.2 | 7983.2 | 771.3 | 771.3 | 9160.4 | 1211 | 342.4 | 62.6 | 19481957.1 | 17.8 | 0 |
| W36X150 | 8252.9 | 8252.9 | 737.4 | 737.4 | 9520.9 | 1161.8 | 362.8 | 62.7 | 22212912.1 | 19.1 | 0 |
| W36X160 | 8885.4 | 8885.4 | 805.7 | 805.7 | 10225.5 | 1266.7 | 366 | 63.6 | 24130958.8 | 19.1 | 0 |
| W36X170 | 9506.3 | 9506.3 | 874 | 874 | 10946.6 | 1373.2 | 368.1 | 64.3 | 26202438.7 | 19.1 | 0 |
| W36X182 | 10202.4 | 10202.4 | 939.9 | 939.9 | 11765.9 | 1486.3 | 368.8 | 64.6 | 28849493.4 | 19.1 | 0 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 3 of 3)**

| Name | PNA Offset 3 mm | PNA Offset 2 mm | Area Modifier | As2 Modifier | As3 Modifier | J Modifier | I33 Modifier | I22 Modifier | Mass Modifier | Weight Modifier |
|---|---|---|---|---|---|---|---|---|---|---|
| A-LatBm | | | | | | | | | | |
| B-300X750 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B-400X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B-400X600 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| B-400X750 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B-450X450 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B-450X600 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| B1-200X450 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B10-500X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B11-600X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B12-600X750 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B13-800X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B15-900X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B16-900X750 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B17-1000X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B2-200X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B20-230X450 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B21-230X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B22-1000X900 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B24-400X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B26-900X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B27-2500X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B28-1500X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B29-1000X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B3-200X750 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B30-400X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B31-1250X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B32-1700X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B33-1000X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B35-1500X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B36-600X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B4-300X450 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B5-300X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B50-600X900 | 0 | 0 | 1 | 1 | 1 | 1E-07 | 1 | 1 | 1 | 1 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 3 of 3, continued)**

| Name | PNA Offset 3 mm | PNA Offset 2 mm | Area Modifier | As2 Modifier | As3 Modifier | J Modifier | I33 Modifier | I22 Modifier | Mass Modifier | Weight Modifier |
|---|---|---|---|---|---|---|---|---|---|---|
| B6-300X900 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B7-300X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B8-200X500 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| B9-450X900 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| C 1100X1100 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 16 a - 1200 X 1400 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 230 X 650 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 300 X 800 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 400 X 900 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 500 X 900 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 800 X 1200 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 800 X 1300 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 800 X 1400 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C 900 X 1100 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C1-300X450 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C11-800X800 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C12-800X900 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C13-900X900 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C14-900X1000 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C15-1000X1000 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C16-1000X1200 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C17-1200X1200 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C19-600X900 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C1aa - 900 X 1300 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C20-500X1600 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C21-300X900 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C22-500X1200 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C23-300X750 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C24-450X550 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C25-500X1000 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C26-500X900 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C27-500X1400 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C27a-600X1400 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C31-400X600 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C33-800X1200 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C34-900X1200 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C38-600X1000 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C8-600X600 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| PTB 1800X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-1000X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-1200X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-1200X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-1200X600 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-1400X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 3 of 3, continued)**

| Name | PNA Offset 3 mm | PNA Offset 2 mm | Area Modifier | As2 Modifier | As3 Modifier | J Modifier | I33 Modifier | I22 Modifier | Mass Modifier | Weight Modifier |
|---|---|---|---|---|---|---|---|---|---|---|
| PTB-1400X700 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-1500X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-1500X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-1800X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-200X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-2200X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-2500X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-300X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-300X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-400X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-450X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-500X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-500X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-600X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-600X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-700X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-750X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-750X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-800X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-800X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-850X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-900X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-900X1300 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB-900X950 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| PTB1300X1000 | 0 | 0 | 1 | 1 | 1 | 1E-06 | 1 | 1 | 1 | 1 |
| W18X50 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W18X55 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W18X60 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W21X55 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W21X57 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W21X62 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W21X68 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W24X62 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W24X76 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W24X84 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W24X94 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W27X102 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W27X114 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W27X129 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W27X94 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W30X108 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W30X116 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W30X124 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W30X132 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Table 1.2 - Frame Section Property Definitions - Summary (Part 3 of 3, continued)**

| Name | PNA Offset 3 mm | PNA Offset 2 mm | Area Modifier | As2 Modifier | As3 Modifier | J Modifier | I33 Modifier | I22 Modifier | Mass Modifier | Weight Modifier |
|---|---|---|---|---|---|---|---|---|---|---|
| W33X130 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W33X141 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W33X152 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W36X150 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W36X160 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W36X170 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W36X182 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## 1.3 Shell Sections

**Table 1.3 - Area Section Property Definitions - Summary**

| Name | Type | Element Type | Material | Total Thickness mm | Deck Material | Deck Depth mm |
|---|---|---|---|---|---|---|
| S11X125 | Slab | Shell-Thin | M30 | 125 | | |
| S1X125 | Slab | Membrane | M30 | 125 | | |
| S22X150 | Slab | Shell-Thin | M30 | 150 | | |
| S2X150 | Slab | Membrane | M30 | 150 | | |
| S33X175 | Slab | Shell-Thin | M30 | 175 | | |
| S44X200 | Slab | Shell-Thin | M30 | 200 | | |
| S4X200 | Slab | Membrane | M30 | 200 | | |
| S55X225 | Slab | Shell-Thin | M30 | 225 | | |
| S66X250 | Slab | Shell-Thin | M30 | 250 | | |
| S77X275 | Slab | Shell-Thin | M30 | 275 | | |
| S88X300 | Slab | Shell-Thin | M30 | 300 | | |
| W1X200 | Wall | Shell-Thin | M40-1 | 200 | | |
| W2X300 | Wall | Shell-Thin | M40-1 | 300 | | |
| W3X230 | Wall | Shell-Thin | M40-1 | 230 | | |

# 2 Loads

This chapter provides loading information as applied to the model.

## 2.1 Load Patterns

**Table 2.1 - Load Pattern Definitions**

| Name | Is Auto Load | Type | Self Weight Multiplier | Auto Load |
|---|---|---|---|---|
| ~LLRF | Yes | Other | 0 | |
| ~SPEC-X(D)ECC | Yes | Other | 0 | |
| ~SPEC-Y(D)ECC | Yes | Other | 0 | |
| DEAD | No | Dead | 1 | |
| EQX | No | Seismic | 0 | IS 1893:2016 |
| EQY | No | Seismic | 0 | IS 1893:2016 |
| LIVE | No | Reducible Live | 0 | |
| SDL | No | Super Dead | 0 | |
| TEMP | No | Temperature | 0 | |
| WINDX | No | Wind | 0 | Indian IS 875:2015 |
| WINDY | No | Wind | 0 | Indian IS 875:2015 |
| WL | No | Super Dead | 0 | |

## 2.2 Load Cases

**Table 2.2 - Load Case Definitions - Summary**

| Name | Type |
|---|---|
| Modal | Modal - Ritz |
| DEAD | Linear Static |
| LIVE | Linear Static |
| SDL | Linear Static |
| WL | Linear Static |
| EQX | Linear Static |
| EQY | Linear Static |
| WINDX | Linear Static |
| WINDY | Linear Static |
| SPEC-X(D) | Response Spectrum |
| SPEC-Y(D) | Response Spectrum |
| TEMP | Linear Static |
| SPEC-X(S) | Response Spectrum |
| SPEC-Y(S) | Response Spectrum |

**Table 2.3 - Load Case Definitions - Linear Static**

| Name | Exclude Group | Mass Source | Stiffness Type | Load Type | Load Name | Load SF | Design Type | Notes |
|---|---|---|---|---|---|---|---|---|
| DEAD | None | MsSrc1 | P-Delta | Load | DEAD | 1 | Program Determined | |
| EQX | None | MsSrc1 | P-Delta | Load | EQX | 1 | Program Determined | |
| EQY | None | MsSrc1 | P-Delta | Load | EQY | 1 | Program Determined | |
| LIVE | None | MsSrc1 | P-Delta | Load | LIVE | 1 | Program Determined | |
| SDL | None | MsSrc1 | P-Delta | Load | SDL | 1 | Program Determined | |
| TEMP | None | MsSrc1 | P-Delta | Load | TEMP | 1 | Program Determined | |

**Table 2.3 - Load Case Definitions - Linear Static (continued)**

| Name | Exclude Group | Mass Source | Stiffness Type | Load Type | Load Name | Load SF | Design Type | Notes |
|---|---|---|---|---|---|---|---|---|
| WINDX | None | MsSrc1 | P-Delta | Load | WINDX | 1 | Program Determined | |
| WINDY | None | MsSrc1 | P-Delta | Load | WINDY | 1 | Program Determined | |
| WL | None | MsSrc1 | P-Delta | Load | WL | 1 | Program Determined | |

**Table 2.4 - Modal Case Definitions - Ritz**

| Name | Exclude Group | Mass Source | Stiffness Type | Load Type | Load Name | Max Cycles | Target Ratio % | Max Modes | Min Modes | Design Type | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Modal | None | MsSrc1 | P-Delta | Accel | Accel UX | 0 | 99 | 15 | 15 | Program Determined | |
| Modal | | | | Accel | Accel UY | 0 | 99 | | | | |
| Modal | | | | Link | All | 0 | 99 | | | | |

**Table 2.5 - Load Case Definitions - Response Spectrum (Part 1 of 2)**

| Name | Design Type | Mass Source | Load Name | Function | Trans Accel SF mm/sec2 | Coordinate System | Angle deg | Modal Case | Modal Combo Method | Rigid Response? |
|---|---|---|---|---|---|---|---|---|---|---|
| SPEC-X(D) | Program Determined | Previous (MsSrc1) | U1 | Func2 | 26051 | Global | 0 | Modal | CQC | No |
| SPEC-X(S) | Program Determined | Previous (MsSrc1) | U1 | Func2 | 9806.65 | Global | 0 | Modal | CQC | No |
| SPEC-Y(D) | Program Determined | Previous (MsSrc1) | U2 | Func2 | 35078 | Global | 0 | Modal | CQC | No |
| SPEC-Y(S) | Program Determined | Previous (MsSrc1) | U2 | Func2 | 9806.65 | Global | 0 | Modal | CQC | No |

**Table 2.5 - Load Case Definitions - Response Spectrum (Part 2 of 2)**

| Name | Design Type | Directional Combo Type | Eccentricity Ratio | Notes |
|---|---|---|---|---|
| SPEC-X(D) | Program Determined | SRSS | 0.05 | |
| SPEC-X(S) | Program Determined | SRSS | 0 | |
| SPEC-Y(D) | Program Determined | SRSS | 0.05 | |
| SPEC-Y(S) | Program Determined | SRSS | 0 | |

# 3 Analysis Results

This chapter provides analysis results.

## 3.1 Modal Results

**Table 3.1 - Modal Periods And Frequencies**

| Case | Mode | Period sec | Frequency cyc/sec | CircFreq rad/sec | Eigenvalue rad2/sec2 |
|---|---|---|---|---|---|
| Modal | 1 | 1.678 | 0.596 | 3.7449 | 14.0245 |
| Modal | 2 | 1.579 | 0.633 | 3.9782 | 15.8261 |
| Modal | 3 | 1.553 | 0.644 | 4.0455 | 16.3664 |
| Modal | 4 | 0.785 | 1.273 | 7.9997 | 63.9948 |
| Modal | 5 | 0.64 | 1.563 | 9.8201 | 96.4353 |
| Modal | 6 | 0.553 | 1.807 | 11.3526 | 128.8804 |
| Modal | 7 | 0.294 | 3.399 | 21.3574 | 456.1405 |
| Modal | 8 | 0.286 | 3.491 | 21.933 | 481.0551 |
| Modal | 9 | 0.276 | 3.628 | 22.7948 | 519.6024 |
| Modal | 10 | 0.258 | 3.87 | 24.318 | 591.3654 |
| Modal | 11 | 0.177 | 5.646 | 35.4764 | 1258.5759 |
| Modal | 12 | 0.159 | 6.28 | 39.4607 | 1557.1438 |
| Modal | 13 | 0.14 | 7.123 | 44.7555 | 2003.0587 |
| Modal | 14 | 0.061 | 16.31 | 102.4812 | 10502.4032 |
| Modal | 15 | 0.059 | 16.854 | 105.8975 | 11214.287 |

**Table 3.2 - Modal Participating Mass Ratios (Part 1 of 2)**

| Case | Mode | Period sec | UX | UY | UZ | SumUX | SumUY | SumUZ | RX | RY | RZ | SumRX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Modal | 1 | 1.678 | 0.3401 | 0.025 | 0 | 0.3401 | 0.025 | 0 | 0.0375 | 0.477 | 0.0839 | 0.0375 |
| Modal | 2 | 1.579 | 0.0289 | 0.3912 | 0 | 0.3689 | 0.4162 | 0 | 0.6275 | 0.0412 | 0.0026 | 0.665 |
| Modal | 3 | 1.553 | 0.1036 | 0.0029 | 0 | 0.4725 | 0.4191 | 0 | 0.0053 | 0.1254 | 0.3119 | 0.6703 |
| Modal | 4 | 0.785 | 1.317E-05 | 0.009 | 0 | 0.4725 | 0.4281 | 0 | 0.0068 | 0.0006 | 0.032 | 0.6771 |
| Modal | 5 | 0.64 | 0.2387 | 0.0031 | 0 | 0.7112 | 0.4311 | 0 | 0.0007 | 0.0686 | 0.0007 | 0.6778 |
| Modal | 6 | 0.553 | 0.0033 | 0.2509 | 0 | 0.7145 | 0.682 | 0 | 0.0315 | 0.0003 | 0.03 | 0.7093 |
| Modal | 7 | 0.294 | 0.0021 | 0.0059 | 0 | 0.7166 | 0.6879 | 0 | 0.0046 | 0.0011 | 0.0029 | 0.7139 |
| Modal | 8 | 0.286 | 0.0146 | 0.0016 | 0 | 0.7312 | 0.6895 | 0 | 0.0011 | 0.0063 | 0.0016 | 0.715 |
| Modal | 9 | 0.276 | 0.0178 | 0.0116 | 0 | 0.7491 | 0.7011 | 0 | 0.0044 | 0.0098 | 0.0011 | 0.7194 |
| Modal | 10 | 0.258 | 0.0003 | 0.0299 | 0 | 0.7494 | 0.731 | 0 | 0.0068 | 0.0011 | 0.0042 | 0.7262 |
| Modal | 11 | 0.177 | 0.0368 | 0.0008 | 0 | 0.7862 | 0.7318 | 0 | 0.0001 | 0.0399 | 0.001 | 0.7263 |
| Modal | 12 | 0.159 | 0.0009 | 0.0648 | 0 | 0.7871 | 0.7966 | 0 | 0.0462 | 0.0001 | 0.0431 | 0.7725 |
| Modal | 13 | 0.14 | 0.014 | 0.0002 | 0 | 0.8011 | 0.7967 | 0 | 0.0033 | 0.0052 | 0.0727 | 0.7757 |
| Modal | 14 | 0.061 | 0.1562 | 0.0301 | 0 | 0.9573 | 0.8268 | 0 | 0.0302 | 0.1657 | 0.005 | 0.8059 |
| Modal | 15 | 0.059 | 0.0321 | 0.1489 | 0 | 0.9894 | 0.9758 | 0 | 0.1392 | 0.0333 | 0.0006 | 0.9451 |

**Table 3.2 - Modal Participating Mass Ratios (Part 2 of 2)**

| Case | Mode | SumRY | SumRZ |
|---|---|---|---|
| Modal | 1 | 0.477 | 0.0839 |
| Modal | 2 | 0.5182 | 0.0865 |
| Modal | 3 | 0.6436 | 0.3983 |
| Modal | 4 | 0.6442 | 0.4303 |

**Table 3.2 - Modal Participating Mass Ratios (Part 2 of 2, continued)**

| Case | Mode | SumRY | SumRZ |
|---|---|---|---|
| Modal | 5 | 0.7128 | 0.431 |
| Modal | 6 | 0.7131 | 0.461 |
| Modal | 7 | 0.7142 | 0.4638 |
| Modal | 8 | 0.7205 | 0.4655 |
| Modal | 9 | 0.7303 | 0.4665 |
| Modal | 10 | 0.7314 | 0.4708 |
| Modal | 11 | 0.7713 | 0.4718 |
| Modal | 12 | 0.7714 | 0.5149 |
| Modal | 13 | 0.7767 | 0.5875 |
| Modal | 14 | 0.9424 | 0.5926 |
| Modal | 15 | 0.9757 | 0.5931 |

**Table 3.3 - Modal Participation Factors**

| Case | Mode | Period sec | UX kN-m | UY kN-m | UZ kN-m | RX kN-m | RY kN-m | RZ kN-m | ModalMass kN-m-s2 | ModalStiff kN-m |
|---|---|---|---|---|---|---|---|---|---|---|
| Modal | 1 | 1.678 | 124.325655 | 33.725309 | 0 | 595.7709462 | 125.467146 | 442.107385 | 1 | 14.02454 |
| Modal | 2 | 1.579 | 36.213854 | 33.520174 | 0 | -2437.97145 | 624.504923 | 252.118078 | 1 | 15.82613 |
| Modal | 3 | 1.553 | -68.624138 | 11.429732 | 0 | -223.752118 | 1090.017929 | 780.336151 | 1 | 16.36637 |
| Modal | 4 | 0.785 | 0.773705 | -20.239742 | 0 | -253.968476 | 73.981045 | 890.451585 | 1 | 63.99483 |
| Modal | 5 | 0.64 | 104.149981 | 11.790941 | 0 | -79.708823 | -806.12913 | -128.390877 | 1 | 96.43531 |
| Modal | 6 | 0.553 | 12.300071 | 106.915552 | 0 | 546.333382 | -52.048535 | 862.479922 | 1 | 128.88041 |
| Modal | 7 | 0.294 | -9.668793 | 16.410026 | 0 | 208.190363 | 100.16604 | 266.590974 | 1 | 456.14049 |
| Modal | 8 | 0.286 | -25.801663 | 8.515393 | 0 | 104.284186 | 244.63559 | 202.142479 | 1 | 481.05515 |
| Modal | 9 | 0.276 | 28.483018 | 23.014029 | 0 | 204.519292 | -304.420136 | 161.448883 | 1 | 519.60242 |
| Modal | 10 | 0.258 | 3.671183 | -36.916526 | 0 | -254.01144 | -102.094475 | -322.722631 | 1 | 591.36544 |
| Modal | 11 | 0.177 | 40.890948 | 5.851202 | 0 | 25.637047 | -615.115885 | -159.000466 | 1 | 1258.57586 |
| Modal | 12 | 0.159 | 6.552912 | -54.341664 | 0 | -661.231623 | -36.315333 | 1033.719646 | 1 | 1557.14383 |
| Modal | 13 | 0.14 | 25.210646 | 2.842765 | 0 | 175.947147 | -222.970097 | 1341.991784 | 1 | 2003.0587 |
| Modal | 14 | 0.061 | -84.261483 | 37.025062 | 0 | 534.4297651 | 252.784431 | 353.537213 | 1 | 10502.40325 |
| Modal | 15 | 0.059 | -38.194632 | 82.379421 | 0 | -1148.271507 | 561.732519 | -119.013786 | 1 | 11214.28701 |

**Table 3.4 - Modal Load Participation Ratios**

| Case | ItemType | Item | Static % | Dynamic % |
|---|---|---|---|---|
| Modal | Acceleration | UX | 100 | 98.94 |
| Modal | Acceleration | UY | 100 | 97.58 |
| Modal | Acceleration | UZ | 0 | 0 |

# RC SHEAR WALL DESIGN

# ETABS Shear Wall Design

## IS 456:2000 Pier Design

### Pier Details

| Story ID | Pier ID | Centroid X (mm) | Centroid Y (mm) | Length (mm) | Thickness (mm) | Pier Ductility | LLRF |
|---|---|---|---|---|---|---|---|
| 3RD FLOOR. | PW75 | 5473.3 | 22727.3 | 1600 | 200 | Special Wall | 0.5 |

### Material Properties

| $E_c$ (MPa) | $f_{ck}$ (MPa) | Lt.Wt Factor (Unitless) | $f_y$ (MPa) | $f_{ys}$ (MPa) |
|---|---|---|---|---|
| 31622.78 | 40 | 1 | 500 | 415 |

### Design Code Parameters

| $\Gamma_S$ | $\Gamma_C$ | $IP_{MAX}$ | $IP_{MIN}$ | $P_{MAX}$ | MinEcc Major | MinEcc Minor |
|---|---|---|---|---|---|---|
| 1.15 | 1.5 | 0.02 | 0.0025 | 0.8 | Yes | No |

### 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 | 4673.3 | 22727.3 | 6273.3 | 22727.3 | 1600 | 200 |
| Bottom | Leg 1 | 4673.3 | 22727.3 | 6273.3 | 22727.3 | 1600 | 200 |

### Flexural Design for $P_{u,}$ $M_{u2}$ and $M_{u3}$

| Station Location | Required Rebar Area (mm²) | Required Reinf Ratio | Current Reinf Ratio | Flexural Combo | $P_u$ kN | $M_{u2}$ kN-m | $M_{u3}$ kN-m | Pier $A_g$ mm² |
|---|---|---|---|---|---|---|---|---|
| Top | 1058 | 0.0033 | 0.0016 | 18) 1.5DL + 1.5SPY | 2299.0273 | 107.7949 | 485.063 | 320000 |
| Bottom | 9930 | 0.031 | 0.0016 | 17) 1.5DL + 1.5SPX | 2722.0006 | 81.1934 | -2606.5596 | 320000 |

### 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 | 1816.5 | 17) 1.5DL + 1.5SPX | 1564.451 | 574.1601 | -948.3008 | 109.238 | 948.3008 |
| Bottom | Leg 1 | 1527.21 | 17) 1.5DL + 1.5SPX | 1601.0402 | -1320.4717 | -948.3008 | 242.8629 | 948.3008 |

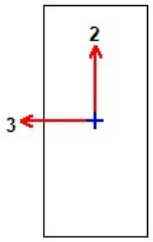
### Boundary Element Check

| 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 | 1 ) DL + LL | 0 | 0 | 0 | 0 |
| Top–Right | Leg 1 | 400 | 17) 1.5DL + 1.5SPX | 2685.4114 | 574.1601 | 15.12 | 8 |
| Bottom–Left | Leg 1 | 700 | 17) 1.5DL + 1.5SPX | 2722.0006 | -2606.5596 | 39.05 | 8 |
| Botttom–Right | Leg 1 | 0 | 1 ) DL + LL | 0 | 0 | 0 | 0 |

# BEAM DESIGN

# ETABS Concrete Frame Design

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




### Beam Element Details

| Level | Element | Unique Name | Section ID | Combo ID | Station Loc | Length (mm) | LLRF | Type |
|---|---|---|---|---|---|---|---|---|
| 3RD FLOOR. | B841 | 4342 | B1-200X450 | 17) 1.5DL + 1.5SPX | 2918.7 | 2957 | 1 | Ductile Frame |

### Section Properties

| b (mm) | h (mm) | $b_f$ (mm) | $d_s$ (mm) | $d_{ct}$ (mm) | $d_{cb}$ (mm) |
|---|---|---|---|---|---|
| 200 | 450 | 200 | 0 | 45 | 45 |

### Material Properties

| $E_c$ (MPa) | $f_{ck}$ (MPa) | Lt.Wt Factor (Unitless) | $f_y$ (MPa) | $f_{ys}$ (MPa) |
|---|---|---|---|---|
| 29580.4 | 35 | 1 | 500 | 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 |
|---|---|---|---|
| 2.2397 | 0 | 92.0494 | 0 |

### Design Moments, $M_{u3}$ & $M_t$

| Factored Moment kN-m | Factored $M_t$ kN-m | Positive Moment kN-m | Negative Moment kN-m |
|---|---|---|---|
| 2.2397 | 0 | 2.2397 | -91.1542 |

**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) | -91.1542 | | 599 | 0 | 599 | 204 |
| Bottom (-2 Axis) | | 2.2397 | 204 | 13 | 0 | 204 |

**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 |
|---|---|---|---|---|
| 113.8918 | 0 | 113.8918 | 55.9928 | 779.27 |

**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 | 92.0494 | 130 | 380 | 0 |

# SLAB DESIGN

| | DESIGN OF SLAB No: S1 | | | | | |
|---|---|---|---|---|---|---|
| 1.00 | Grade of concrete | | | = | ***30.00*** | $N/mm^2$ |
| 2.00 | Grade of steel | | | = | ***500.00*** | $N/mm^2$ |
| 3.00 | Cover to reinforcement | | | = | ***25.00*** | mm |
| | Diameter of bar | | | | ***8.00*** | mm |
| 4.00 | Aspect ratio $\frac{l_y}{l_x}$ = | | ***7.49*** | 7.61 | 1.794 | < 2 |
| | | | ***4.12*** | 4.24 | | |
| 5.00 | Edge condition: | **One Short Edge Discontinuous** | | | Two way slab | |
| 6.00 | Modification factor assumed | | | | ***1.55*** | |
| | | | 118.96 | | | |
| 7.00 | Depth required for deflection: | | | D = | ***150.00*** | mm |
| | | | | | 150.00 | mm |
| | | | | d = | 121.00 | mm |
| 8.00 | Dead Load | | | = | 3.60 | $kN/m^2$ |
| 9.00 | Live load | | | = | ***2.00*** | $kN/m^2$ |
| 10.00 | Partitions & FF | | | = | ***1.20*** | $kN/m^2$ |
| 11.00 | Total load | | | = | 6.80 | $kN/m^2$ |
| 12.00 | Factored load | | | = | 10.20 | $kN/m^2$ |

| **STEP 1** | **Details** | **S- SPAN** | | | **L-SPAN** | |
|---|---|---|---|---|---|---|
| | | (-ve) support($\alpha_x$) | (+ve) span($\alpha_x$) | | (-ve) support($\alpha_y$) | (+ve) span ($\alpha_y$) |
| | Co-efficent ( IS:456, Table :26) | 0.065 | 0.049 | | 0.037 | 0.028 |
| | $M_u$=Co-efficient*w* $l_x^2$ | 11.87 | 8.94 | | 6.79 | 5.14 |
| | K= Mu/bd2 | 0.81 | 0.61 | | 0.46 | 0.35 |
| | Percentage of steel required | 0.19 | 0.14 | | 0.11 | 0.08 |
| | Ast required(in $mm^2$) | ***233.03*** | ***173.94*** | | ***131.35*** | ***98.95*** |
| | Ast min (in $mm^2$) | 180.00 | 180.00 | | 180.00 | 180.00 |
| | Ast to be provided (in mm2) | 233.03 | 180.00 | | 180.00 | 180.00 |
| | Provided bars spacing (c/c) | 215.79 | 279.37 | | 279.37 | 279.37 |
| | max spacing | 250.00 | 250.00 | | 250.00 | 250.00 |
| | spacing | 215.79 | 250.00 | | 250.00 | 250.00 |
| | Reqd bars spacing (c/c) | **210.00** | **250.00** | | **250.00** | **250.00** |
| | Pvd bars spacing (c/c) | ***200.00*** | ***200.00*** | | ***200.00*** | ***200.00*** |
| | Ast Provided(in $mm^2$) | **251.43** | **251.43** | | **251.43** | **251.43** |
| | Percentage of steel provided | **0.21** | **0.17** | | **0.21** | **0.21** |
| **STEPII** | $F_s$=0.58 *$f_y$ * (Ast required/ Ast provided) | | | | | |
| | $F_s$ | | | | 200.63 | |
| | M.F | | | | ***1.80*** | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | if assumed modification factor is less than or equal to calculated the section is safe for deflection | | | | safe | |
| | **OVERALL DEPTH** | **D** | **150.00** | **mm** | | |
| | **EFFECTIVE DEPTH** | **d** | **121.00** | **mm** | | |
| **STEPIII** | **Crack width calculation** | | | | | |
| | m | | | = | 7.3 | |
| | $E_s$ | | | = | 200000.0 | |
| | Ec | | | = | 27386.1 | |
| | Pt | | | = | 0.2 | |
| | k | | | = | 0.1 | |
| | x | | | = | 17.6 | |
| | $A_{st}$ | | | = | 251.4 | |
| | $I_{cr}$ | | | = | 21447195.48 | |
| | M | | | = | 8.9 | |
| | $f_{st}$ | | | = | 314.5 | |
| | $\varepsilon_m$ | | | = | 0.0 | |
| | Spacing | | | | 200.0 | |
| | $a_{cr}$ | | | = | 103.1 | |
| | $\omega_{cr}$ | | | = | 0.13 | |
| | | | | | < | |
| | | | | | 0.20 | mm (safe) |

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.