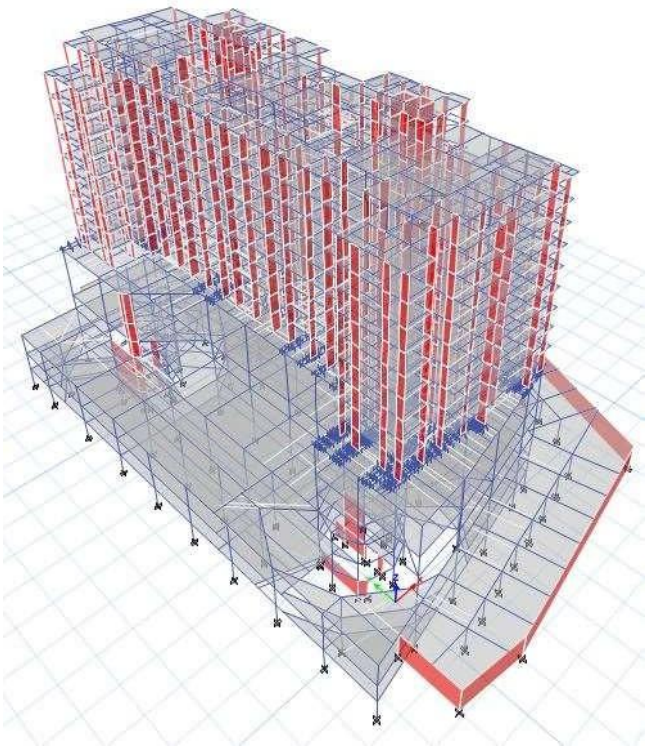
STRUCTURAL DESIGN CALCULATION REPORT

(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:

M/s. DRA HOMES,
ROYAPETTAH, CHENNAI.



ARCHITECT:

M/s. CHERALATHAN & ASSOCIATES, CHENNAI.

STRUCTURAL CONSULTANT:

M/s. BURO ENGINEER (I) PVT LTD.
Civil & Structural Consultants,
#31, Besant Avenue, Adyar,
Chennai - 600 020, India
Tel:42658573/74
Email:buroindia@buroengineers.in

R3	25-08-2025	Design Basis Report	OK	AVINASH	PERAM	PERAM
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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+5th Floor + 6 to 11 Storey. In which Ground floor to 3rd Floor Designed as Mall space includes Retails/shopping, fun center, food court etc. and the 4th floor designed to be a Multiplexes, 5th floor is having back office, lounge, restaurant & swimming pool facilities of Hotel. 6th Floor to 11th 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 11th 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 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 1st 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 11th 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 (2nd 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

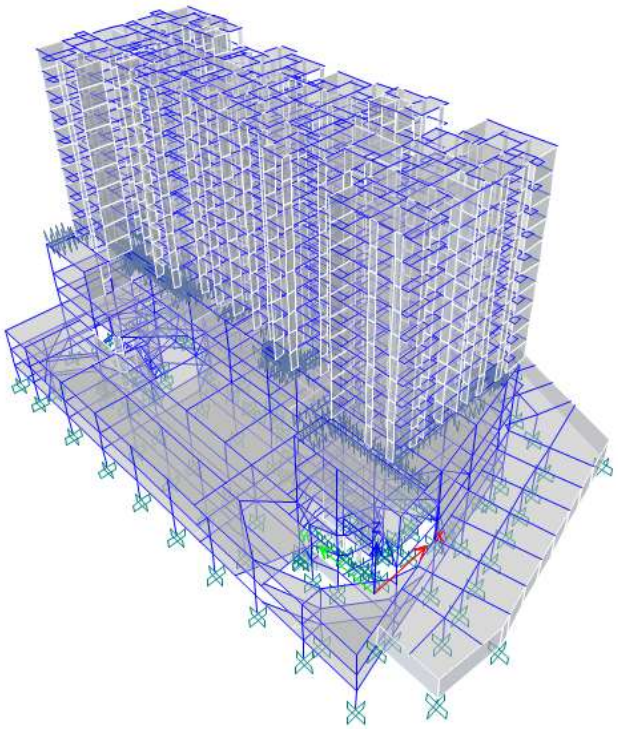
14.4 In-House Spreadsheet - one way/ two way slab design

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

Γ_S	Γ_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

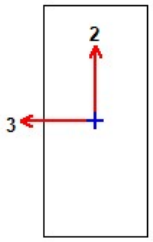
Boundary Element Check

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

γ_c	γ_s
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
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(α_x)	(+ve) span(α_x)		(-ve) support(α_y)	(+ve) span (α_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	
	ε_m			=	0.0	
	Spacing				200.0	
	a_{cr}			=	103.1	
	ω_{cr}			=	0.13	
					<	
					0.20	mm (safe)