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

20th Jan 2024

To,

M/S. MAYFLOWER ENTERPRISES Pvt Ltd

No.72, Dr. Balasundaram Road,

Coimbatore- 641018.

STRUCTURAL STABILITY CERTIFICATE

This is to certify that the Structural design for the proposed residential building having 1 Basement + Stilt floor + 9 Typical floors and roof of **HMVC HOUSING for M/S MAYFLOWER ENTERPRISES P Ltd**, Old S.F. No:418/2 PT, New T.S.No:5/1, Block No.7, Ward No.Z(26), Gurusamy Nagar, Vilankurichi Village, Coimbatore North Taluk, Coimbatore Corporation, Coimbatore District, Promoted by **M/S. MAYFLOWER ENTERPRISES Pvt Ltd** No.72, Dr. Balasundaram Road, Coimbatore- 641018.

The Building in the above site have been designed as per National Building Code, IS 456, IS 1893-2016 and other IS codes. The Building is designed for Gravity loads and Lateral loads (wind and earthquake forces) refer to latest seismic code design "criteria for earthquake resistant design of structures IS 1893-2016". I hereby certify that the proposed building is structurally safe and sound as per National Building Code.

This Certificate is issued for the purpose of RERA Registration.

Name of the Structural Engineer

Signature

License No

Date

Place

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@buroengineers.in
Mobile : +91 9962546631

PROPOSED RESIDENTIAL APARTMENT - CODISSIA AT VILANKURICHI VILLAGE, COIMBATORE

DESIGN BRIEF REORT FOR STRUCTURAL SERVICES

Client :		**Ms. MAYFLOWER ENTERPRISES Pvt Ltd**
Project Information :		T.S.No. 5/1, BLOCK No.7, WARD No.Z (26), VILANKURICHI VILLAGE, COIMBATORE CORPORATION, COIMBATORE DISTRICT.
Structural Consultant :		**BURO ENGINNERS (I) PVT LTD** Civil & Structural Consultants New No.31, (old No. 14), Besant Avenue, Adyar, Chennai 600 020.

DOCUMENT NO : STR - DBR/Rev-R0

DATE	ISSUE	PREPARED	CHECKED	REVISION
06/11/2023	Approval	S.J	P.J	R0

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No. R.A/CE/2019/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegathees@burongineers.in
Mobile : +91 9962545531

1.0 INTRODUCTION

This Design Brief Report (DBR) is for the Proposed Residential Apartment - Codissia at Vilankurichi Village, Coimbatore, for M/s. Mayflower Enterprises Pvt Ltd.

The proposed residential building having 1 Basement + Ground + 9 storey + Roof.

This report provides the information on Codes of Practice, Design loading's, Material Strength considered for the Design and Analysis of the building. In addition this report includes Structural system, Foundation system, Method statement of structural analysis which will be adopted for design and analysis for the building.

1.1 Facilities:

Basement and Ground floor : Parking, Lobby.

1st Floor to 8th floor: Residential units.

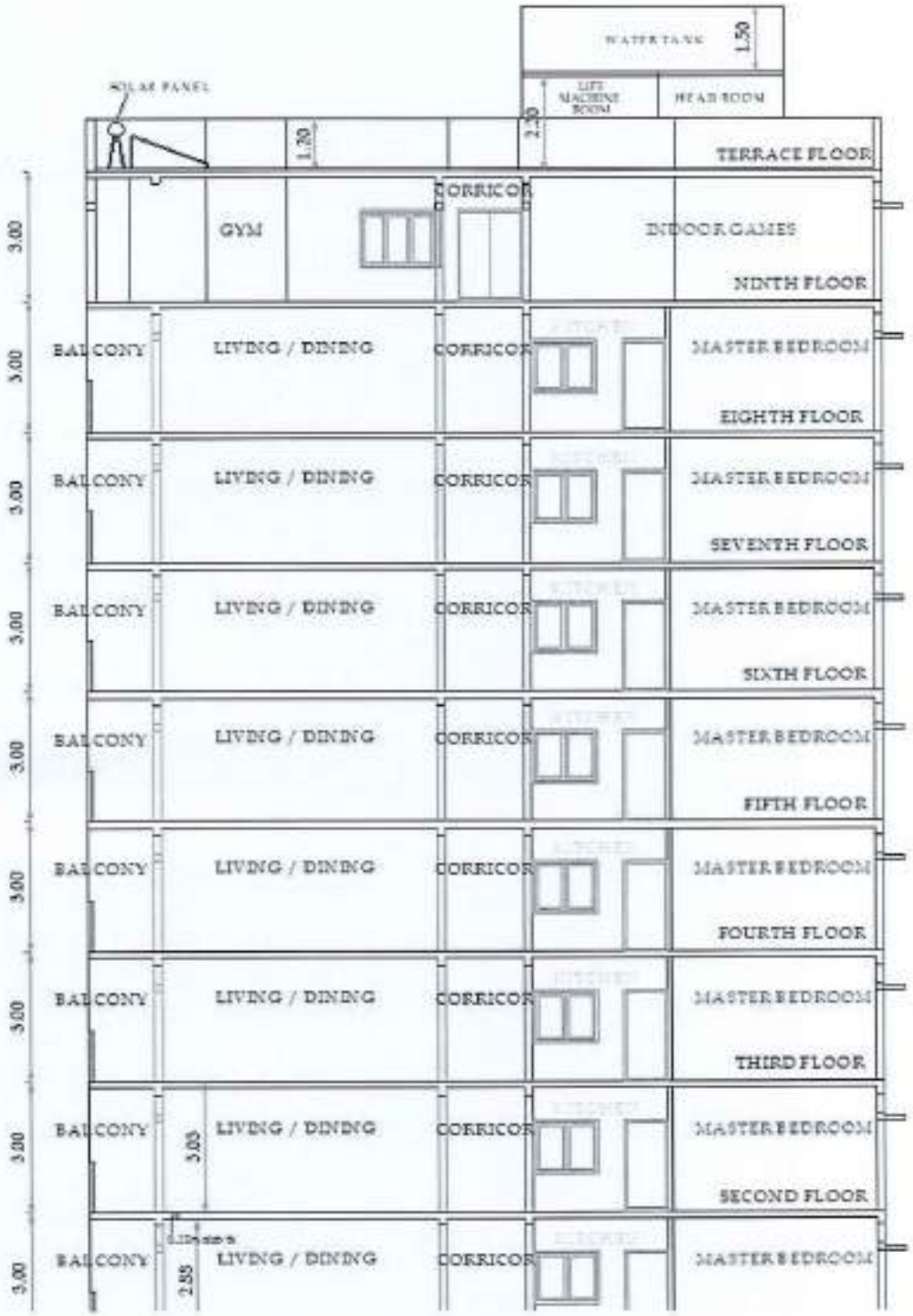
9th floor: Residential units and Club house.

Terrace: Open terrace, OHT & LMR.

1.2 Floor to floor height:

Basement floor	- 3.00m
Ground floor	- 3.00m
1st to 9th floor each floor height	- 3.00m

P. JEGATHEESAN, M.E.,
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/[illegible]/27
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burgengineers.in
Mobile : +91 9962545631



SECTION

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.(S)/GR-I/1903/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@buroengineers.in
Mobile : +91 9962540631

2.0 CODES OF PRACTICE

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burcengineers.in
Mobile : +91 9962548631

The relevant Indian Standard codes below are followed.

2.1 CODES, STANDARDS & REFERENCES

All design of structures shall comply with the requirements specified in the following.

a. Relevant Indian Standard Codes of Practice
b. National Building Code.
c. Local Building regulations.
d. Other relevant International codes where required.

All applicable latest edition of codes and standards will be referred and adopted in the analysis of structures and the design and detailing of structural members. All structural elements design shall be carried out primarily based on. Indian Standards and Codes with latest revision, with amendments if any, as on date.In addition, other international codes and standards shall also be referred when required and relevant.

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

CODE	DESCRIPTION
IS 875(Part 1) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Unit weights of buildings materials and stored material
IS 875 (Part 2) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Imposed Loads
IS 875 (Part 3) 2015	Code of practice for Design Loads (other than earthquake) for buildings and structures – Wind Loads
IS 875 (Part 5) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Special Loads and load combinations
IS 456 – 2000	Code of Practice for Plain and Reinforced Concrete
IS 16700 – 2017	Criteria for Structural Safety of Tall Concrete Buildings
IS 1343 – 2012	Code of Practice for Prestressed Concrete
IS 1893 – 2016	Criteria for earthquake resistant design of structures
IS 4326 –1993	Code of practice for Earthquake Resistant Design and Construction of Buildings

IS 3370 – 2009	Code of Practice for Concrete structures for the storage of liquids
IS 1904-1995	Code of Practice for design and construction of Foundation
IS 1080 – 1997	Code of Practice for design and construction of shallow Foundation
IS 2950 - 1998	Code of Practice for design and construction of Raft Foundation
IS 800 – 2007	Code of practice for General Construction in steel
BS 8110 : 1997	Plain and reinforced concrete-code of practice(British standard)
ACI 318	Plain and reinforced concrete-code of practice (American standard)
IS 13920: 2016	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces
SP24	Explanatory Hand book on Indian standard code of practice
SP34	Handbook on concrete reinforcement and detailing

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@structengineers.in
Mobile : +91 9962545531

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burjengineers.in
Mobile : +91 9962546631

3.0 DESIGN OF LOADINGS

a) SUPERIMPOSED DEAD LOADS AND LIVE LOADS

The following are the imposed loads such as SDL and LL to be considered for the design of floor system depending usage floor. In addition to these loads, self-weight of structural elements will be considered depending member sizes shown in the floor plans.

LOADINGS	DEAD LOAD (KN/m2)				LIVE LOAD (KN/m2
	FINISHES	SERVICES	SDL / Non Reduce LL	PARTITION	
STAIRCASE	1.80	0.00	1.80 (STEP)	0.00	3.00
TOILET	2.40	0.00	0.00	0.00	2.00
BALCONY	1.80	0.00	0.00	0.00	3.00
UTILITY ROOM	3.60	0.00	0.00	0.00	2.00
LOBBY & CORRIDOR	1.80	0.00	0.00	0.00	3.00
BED,LIVING & DINNING	1.20	0.00	0.00	0.00	2.00
KITCHEN	1.80	0.00	0.00	0.00	2.00
TERRACE	3.60	0.00	0.00	0.00	3.00
LMR	3.60	0.00	12.40	0.00	0.00
OHT	1.80	0.00	10 X WATER HEIGHT	0.00	0.00

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

b) SUPER IMPOSED DEAD LOADS (kN/m^2)

For apartment floor Finishes of 50 mm thickness have been considered on all the typical floors. Filling is considered for toilet 100mm (typical floor), utility=150mm, balcony=150mm.

TERRACES (Load in kN/m2)

Waterproofing + Screed 3.60 (0.15(average finishes Thk.) x 24=3.60)

c) SELF-WEIGHT OF SOLID BLOCK WALLS (KN/m)

Infill walls (20mm for External wall & internal wall 15mm plastering on Either side)

(i) 200mm thick wall 4.40kN/m

(ii) 100mm thick wall	2.20kN/m	
Water Tank	Water height x 10	

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/18/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@bucoengineers.in
Mobile : +91 9962546631

d) **Material Density**

Unit weight of materials are as per IS: 875 (Part-I) 1987.

Unit weight of concrete	-	25 KN / Cum.
Unit weight of steel	-	78.5 KN / Cum.
Screed concrete	-	24 KN / Cum.
Unit weight of dry soil	-	18 KN / Cum.
Unit weight of saturated soil	-	20 KN / Cum.
Unit weight of Glass	-	27.2 KN / Cum.
Unit weight of water	-	9.81 KN / Cum.
Unit weight of Solid block wall	-	22 KN / Cum.
Light weight concrete filling	-	16 KN / Cum.

e) SEISMIC LATERAL FORCE

Design of lateral force under seismic condition shall be as per IS1893 – 2016. Total lateral force (base shear) of the building shall be estimated at ground floor level as per clause 7.2.1 of IS1893 – 2016 which provides by

Base shear Vb = Ah W

Ah is horizontal seismic coefficient and W is seismic weight of the building, Horizontal seismic coefficient depends on location of the building (Zone factor Z), usage of the building (Importance factor, I), building lateral resisting system (Response reduction factor, R) and design acceleration coefficient (Sa /g) which is based on subsoil condition and fundamental natural period (Ta).

For the proposed development is for Residential use. Considering it, the seismic weight is summation of total dead load and 25% of live load where live load is equal and less than 3 kN/sq.m.

1) The lateral load resisting system of the buildings is ordinary shear wall with ordinary moment resisting frames.
2) As per IS 1893:2016 code, Coimbatore lies in Zone III with Zone factor Z = 0.16
3) The Design Base Shear is given by V_b = Ah x W, Where

   $Ah = Z / 2 \times I / R \times S_a / g$

I = Importance Factor = 1.2

Soil Type 1 (Weathered Rock)

R (Response reduction factor) = 4.0. Building with Ductile RC structural walls with reference to IS: 1893-2016, Table-9 and the frames are designed to carry the design lateral load.

Sa/g = Average Response acceleration coefficient

With reference to IS 1893 - 2016 clause 7.6.2 (c) the time period for building each directions are as follows,

The fundamental natural period (Ta) for building,

For X and Y direction the time period is calculated

7.6.2 The approximate fundamental translational natural period T_a of oscillation, in second, shall be estimated by the following expressions:

a) Bare MRF buildings (without any masonry infills):

$$T_a = \begin{cases} 0.075h^{0.75} & \text{(for RC MRF building)} \\ 0.080h^{0.75} & \text{(for RC-Steel Composite MRF building)} \\ 0.085h^{0.75} & \text{(for steel MRF building)} \end{cases}$$

b) Buildings with RC structural walls:

$$T_a = \frac{0.075h^{0.75}}{\sqrt{A_c}}$$

where A_c is total effective area (m^2) of walls in the first storey of the building given by:

$$A_c = \sum_{i=1}^{N_w} \left[A_{wi} \left\{ 0.2 + \left(\frac{L_{wi}}{h} \right)^2 \right\} \right]$$

c) All other buildings:

$$T_a = \frac{0.09h}{\sqrt{d}}$$

dx = 18.35m,

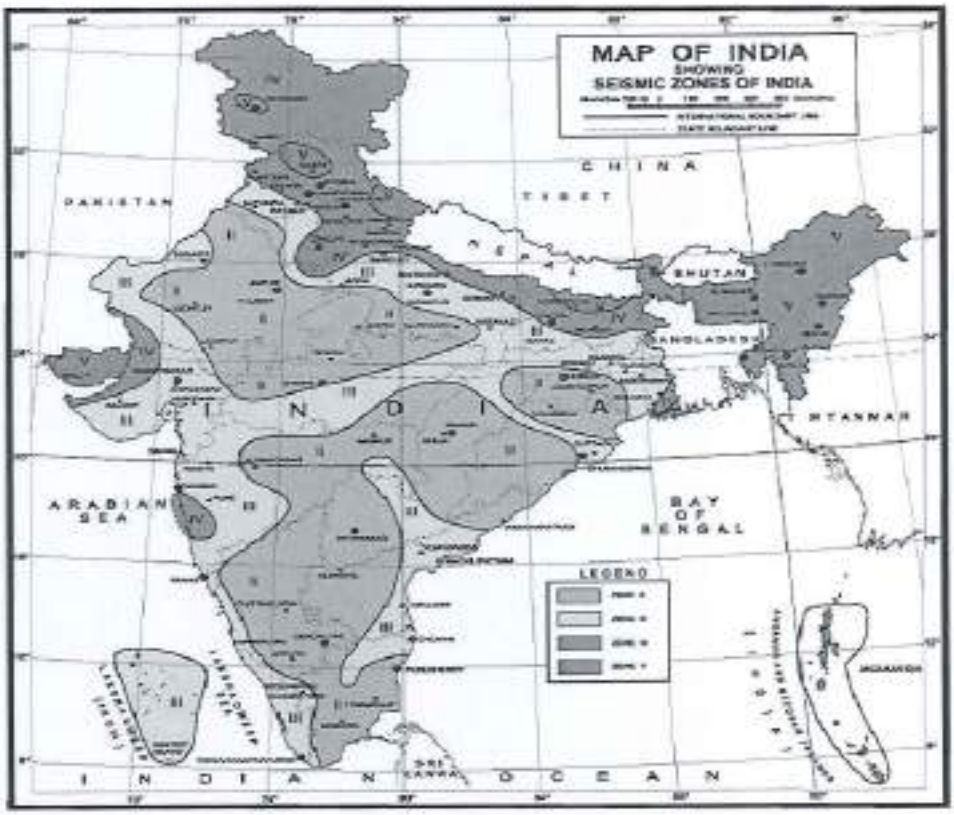
dy = 44.50m,

H = 30.00m (Ground to Roof)

T_a = 0.705 (along X direction)

T_a = 0.961 (along Y direction)

P. JEGATHEESAN, M.E.,
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/CR/1[illegible]/2027
NEW No.31 (OLD No.141, BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@buroengineers.in
Mobile : +91 9962546631



Dynamic Analysis

Response spectrum method of Dynamic Analysis carried out with following parameters pertaining to dynamic analysis.

Number of modes Considered	: 20 Numbers (Min)
Modal Combination Method Used	: Complete Quadratic combination (CQC).
Directional Combination Method used	: Square root of the sum of Square (SRSS).
Modal case type	: Ritz vector Method

Cut off frequency in case response spectrum method of analysis - 33 Hz.

Mass participation is 90% as per our analysis

Damping 5%is used for seismic analysis

Dynamic analysis of building is carried out. The members are designed accordingly.

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/CR-I/15/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@buroengineers.in
Mobile : +91 9962546531

f) WIND LOADS

The wind pressure shall be calculated based on the basic wind speed and other provisions laid in IS 875 Part(3) - 2015

Design Wind speed $V_z = V_b x k_1 x k_2 x k_3 x k4$

V_b → Basic Wind velocity for Coimbatore = 39m/s

k_1 → Risk coefficient for all general buildings = 1.00

k_2 → Terrain category 2 = To suit the height of the structure for terrain

[k_2 (H=31.2m -GF to Roof including parapet wall) = 1.10]

k_3 → Topography factor = 1.00

k_4 → Importance Factor = 1.00

Based on the above,

Max. design wind speed (V_z) ($V_b x k_1 x k_2 x k_3 x k4$) = 42.9m/s

Max. design wind pressure (Pz) $= 0.6 \times V_z^2$ = 1104.25 N/m2

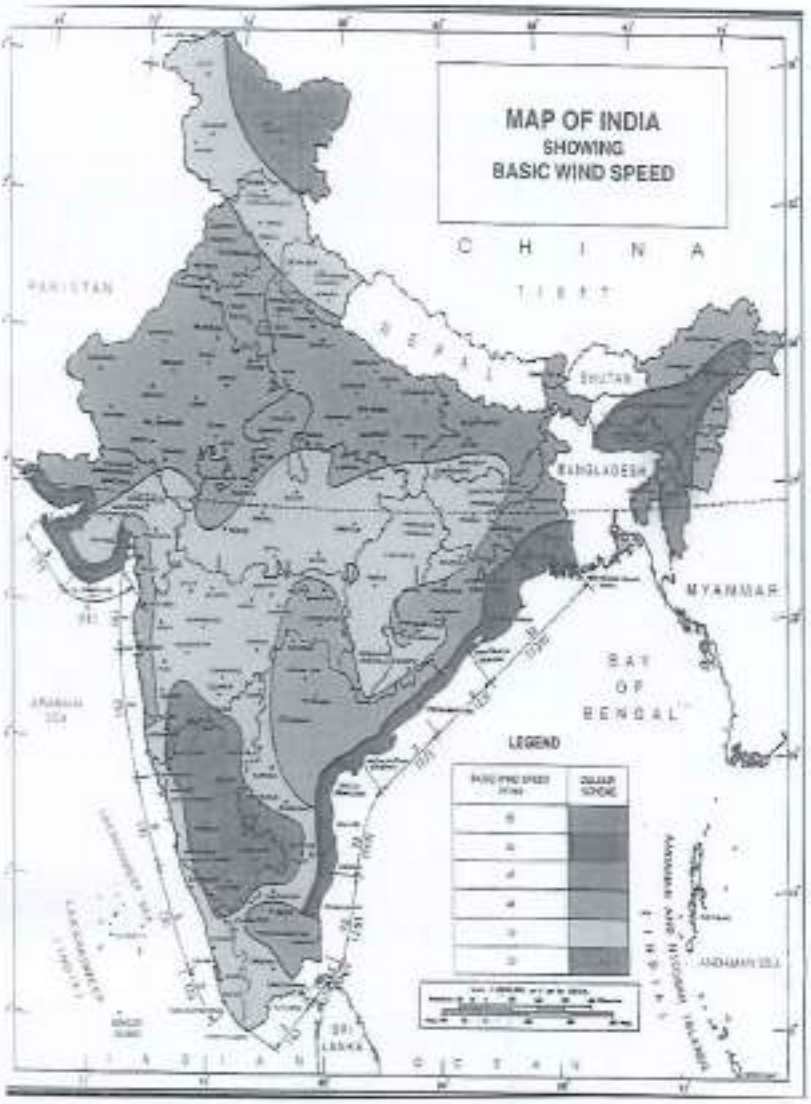
Design wind pressure: pd = Pz x Kax Kd x Kc = 805N/m2

Kd → Wind directionality factor = 0.90

ka → Area averaging factor = 0.90

k_c → Combination factor = 0.90

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No. [illegible]
NEW No.31 (OLD No.14), [illegible] AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@duroengineers.in
Mobile : +91 9962845631



g) TEMPERATURE LOAD

The building is completely covered with brick work on the sides. So there will be no appreciable differential temperature during the service life of building. The roof slab and the podium of building is to be analysed for ± 15°C difference in temperature is applied to Etabs model and necessary load combinations are considered in analysis & Design of the building. The roof slab is assign as semi rigid diaphragm for ultimate load combination.

M.E., (Struct.)
L ENGINEER
AUTHORITY
AVENUE,
E-Mail

3.1 LOAD COMBINATIONS

The various loads combinations used for design in accordance with IS 1893-2016 are as follows

1. 1.5 (DL + LL)
2. 1.2 (DL + LL ± SPECX-D) ± 0.36 SPECY-D ± 0.36 SPECZ-D
3. 1.2 (DL + LL ± SPECY-D) ± 0.36 SPECX-D ± 0.36 SPECZ-D
4. 1.2 (DL + LL ± SPECZ-D) ± 0.36 SPECX-D ± 0.36 SPECY-D
5. 1.2 (DL + LL ± WindX)
6. 1.2 (DL + LL ± WindY)
7. 1.5 (DL ± SPECX-D) ± 0.45 SPECY-D ± 0.45 SPECZ-D
8. 1.5 (DL ± SPECY-D) ± 0.45 SPECX-D ± 0.45 SPECZ-D
9. 1.5 (DL ± SPECZ-D) ± 0.45 SPECX-D ± 0.45 SPECY-D
10. 1.5 (DL ± WindX)
11. 1.5 (DL ± WindY)
12. 0.9DL ± 1.5 SPECX-D ± 0.45 SPECY-D ± 0.45 SPECZ-D
13. 0.9DL ± 1.5 SPECY-D ± 0.45 SPECX-D ± 0.45 SPECZ-D
14. 0.9DL ± 1.5 SPECZ-D ± 0.45 SPECX-D ± 0.45 SPECY-D
15. 0.9DL ± 1.5WindX
16. 0.9DL ± 1.5WindY

The various service loads combinations of structure as per IS 456 are as follows

17. 1.0DL +1.0 LL
18. 1.0DL ± 1.0SPECX-D ± 0.3 SPECY-D ± 0.3 SPECZ-D
19. 1.0DL ± 1.0SPECY-D ± 0.3 SPECX-D ± 0.3 SPECZ-D
20. 1.0DL ± 1.0SPECZ-D ± 0.3 SPECX-D ± 0.3 SPECY-D
21. 1.0DL ± 1.0WindX
22. 1.0DL ± 1.0WindY
23. 1.0DL + 0.8LL ± 0.8SPECX-D ± 0.24 SPECY-D ± 0.24 SPECZ-D
24. 1.0DL + 0.8LL ± 0.8SPECY-D ± 0.24 SPECX-D ± 0.24 SPECZ-D
25. 1.0DL + 0.8LL ± 0.8SPECZ-D ± 0.24 SPECX-D ± 0.24 SPECY-D
26. 1.0DL + 0.8LL ± 0.8WindX
27. 1.0DL + 0.8LL ± 0.8WindY

Where,	DL	- Dead load,
	LL	- Live load (Live>3kN/m2, Live1<=3kN/m2)
	WindX	- Wind load in x - direction
	WindY	- Wind load in y-direction
	SPECX	- Earthquake load in x-direction
	SPECY	- Earthquake load in y-direction
	TEMP	- Temperature load

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/DP-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
R, CHENNAI - 600 020.
E-Mail: ...@...neers.in
Ph: +91 ...31

4.0 MATERIAL GRADES

i) CONCRETE

Grade M30 (fck = 30 N/mm²) for Raft foundation, Overhead Water Tank, UG Water Tank, Pump Room, Beam & Slab

Grade M35 (fck = 35 N/mm²) for Shear wall, Column,

ii) REINFORCEMENT

Reinforcement bars of grade Fe550D conform to IS 1786-2008.

5.0 COVER AND FIRE RATING

Fire rating considered - 2hrs.

Cover to reinforcement considered for various element

Raft footing	50 mm (Very severe exposure condition)
Columns	40 mm (2 hours fire resistance)
Tank walls	45 mm (Severe exposure condition)
Shear Walls	30 mm (2 hours fire resistance)
Beams (simply supported)	40 mm (2 hours fire resistance & Moderate)
Beams (continuous)	30 mm (2 hours fire resistance & Moderate)
Slabs (simply supported)	35 mm (2 hours fire resistance & Moderate)
Slabs (continuous)	25 mm (2 hours fire resistance & Moderate)

6.0 STRUCTURAL SYSTEM

SUPER STRUCTURE

The structural system for the super structure is R.C.C Beam with R.C.C slab. The slab thickness is 125mm.

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION NO. S/1903/027
NEW No.31 (OLD No.11) PRASANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@structengineers.in
Mobile : +91 9840041031

7.0 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
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

8.0 STRUCTURAL ANALYSIS

Computer-aided analysis using finite element method (FEM) shall be carried out for the design of structural elements. For 3D or 2D structural frame analysis latest version of software ETABS or SAFE shall be used, Prokon, RCDC and verified in-house spreadsheets will be used for the design of reinforced concrete (RC) and steel elements in consideration of flexure, shear and axial forces.

Assumptions for 3D model analysis using ETABS

Column	:	Frame Element
RC Wall	:	Wall (Shell) Element
Beam Element	:	Frame Element
Slab	:	Shell Element

The following are general parameters adopted in the analysis and design,
Modulus of Elasticity of Concrete -5000√fck
Consideration of Diaphragm - Rigid Diaphragm.
Slab/Wall element considered as Shell element

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/CR/1103/027
NEW No.31 (OLD No.14), BRODIE AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burcengineers.in
Mobile : +91 9962540631

Stiffness modification factors are adopted in the analysis as per IS -16700-2017, Table.6.

Table 6 Cracked RC Section Properties

(Clause 7.2)

Sl No.	Structural Element	Un-factored Loads		Factored Loads	
		Area	Moment of Inertia	Area	Moment of Inertia
(1)	(2)	(3)	(4)	(5)	(6)
i)	Slabs	$1.0\,A_g$	$0.35\,I_g$	$1.00\,A_g$	$0.25\,I_g$
ii)	Beams	$1.0\,A_g$	$0.7\,I_g$	$1.00\,A_g$	$0.35\,I_g$
iii)	Columns	$1.0\,A_g$	$0.9\,I_g$	$1.00\,A_g$	$0.70\,I_g$
iv)	Walls	$1.0\,A_g$	$0.9\,I_g$	$1.00\,A_g$	$0.70\,I_g$

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@buroengineers.in
Mobile : +91 9962545631

The following parameters and methods are adopted in creating ETABS 3D model for the buildings and design of structural elements.,

- The 3D ETABS model generated based on the preliminary floor plans (shuttering drawings) prepared using preliminary sizes.
- Sectional properties are assigned to all the structural elements as per the preliminary floor plans (shuttering drawings).
- External & Internal in fill wall loads are assigned as uniformly distributed line load on beams and as area load if the wall is intending to distribute on slab directly.
- Slabs are modelled as shell element if floor system and slabs are assigned with horizontal diaphragms.
- Live Load reduction is considered in the design of Foundation and Column as per the Code: IS 875-1987 (Part-II), clause.3.2.1.
- Area design load i.e. Live load/SDL or any other load is applied at floor relevant to its usage.
- All lateral loads & parameters are assigned as per Codes IS 1893-2016 & IS 875-Part-3, 2015.
- Temperature loads are applied on to the terraces and to areas directly exposed to atmosphere.
- Beams under Torsion is required to maintain Equilibrium will be designed for Torsion in accordance with IS 456-2000, clause 41.1 to 41.4 and for all other beams torsional stiffness is neglected in the analysis by applying stiffness modifier as 0.000001 to torsional constant "J". Hence no specific design for Torsion is required for these beams.
- Concrete cover to reinforcement complied accordance with IS 456-2000, Tabl.16 & 16A.
- All vertical wall elements are assigned with auto meshing/manual messing appropriately in order to achieve accuracy in results.

Design approach of structural elements

Shear wall/Column:

RC Structural Walls & Columns which are supporting both vertical loads and lateral forces are designed for the most adverse load conditions and envelope of the forces which will be the maximum for that structural element from the load combinations considered in the 3D Etabs Model.

RCDC a design software will be used to design the element for the maximum forces obtained from the Etabs model analysis results.

Beams:

Each Beam will be designed for maximum forces from the 3D analysis using Etabs and RCDC Software.

Area Load & Application:

Applied as uniformly distributed area load with intensity proportionate to its usage as mentioned in the Loading items in the DBR.

Line (Wall) Load & Application:

Non load bearing or infill wall loads are calculated appropriately and applied as uniformly distributed line load.

9.0 FOUNDATION

Proposed Foundation system is Raft footing and the SBC considered for the design is 300kN/m2 and the founding depth is to be 3.0m from the natural ground level with reference to the soil investigation report No-SSTS/GT/200223/16 from M/s.Sastha Soil Testing Services.

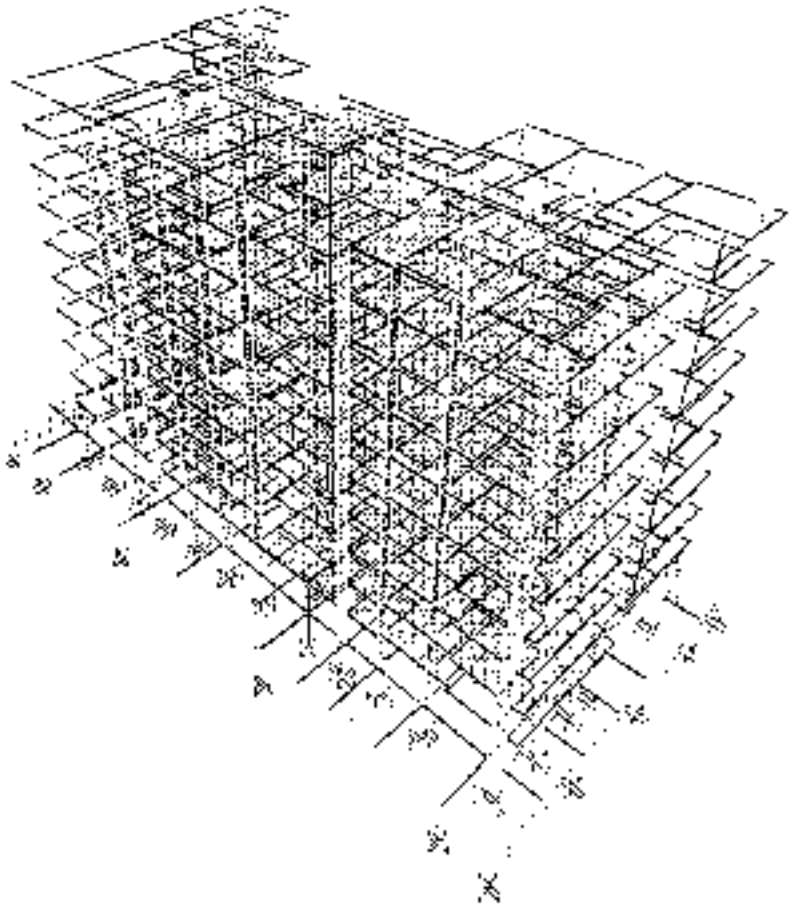
10.0 COMPUTER PROGRAMS

The following Software / spreadsheet to be used to carry out Structural analysis and design.

1. PROKON Ver 2.3 - Wall & Beam design
2. ETABS Ver 21.0.1 - Three Dimensional Program
3. SAFE Ver 20.0 - Raft Analysis / Strip Analysis
4. In-House Spreadsheet - one way/ two way slab design
5. Rapt-6 - Post Tensioning Analysis & Design
6. RCDC - Beam Design, Column design and Wall design
7. STAAD PRO & ETABS - Structural Steel Design.

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/13/2007
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burosengineers.in
Mobile : +91 9962546631

ETABS®



Summary Report

1 Structure Data

This chapter provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

1.1 Story Data

Table 1.1 - Story Definitions

Tower	Name	Height m	Master Story	Similar To	Splice Story	Color
T1	LMR	3	No	None	No	Yellow
T1	TERRACE	3	No	None	No	Blue
T1	9TH FLOOR	3	No	2ND FLOOR	No	Cyan
T1	8TH FLOOR	3	No	2ND FLOOR	No	Magenta
T1	7TH FLOOR	3	No	2ND FLOOR	No	Gray8Dark
T1	6TH FLOOR	3	No	2ND FLOOR	No	Green
T1	5TH FLOOR	3	No	2ND FLOOR	No	Red
T1	4TH FLOOR	3	No	2ND FLOOR	No	Yellow
T1	3RD FLOOR	3	No	2ND FLOOR	No	Blue
T1	2ND FLOOR	3	Yes	None	No	Cyan
T1	1ST FLOOR	3	No	None	No	Magenta
T1	STILT	3	No	None	No	Gray8Dark

P. JEGA[illegible]ESAN, M.E., (Struct.)
REG[illegible]TURAL ENGINEER
CHENNAI [illegible]T AUTHORITY
REG[illegible]5/03/027
NEW N[illegible]NT AVENUE,
E-Mai[illegible]020.
[illegible]neers.in

2 LOADS

This chapter provides loading information as applied to the model.

2.1 Auto Seismic Loading

IS 1893:2016 Auto Seismic Load Calculation

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

Direction and Eccentricity

Direction = X

Structural Period

Period Calculation Method = User Specified

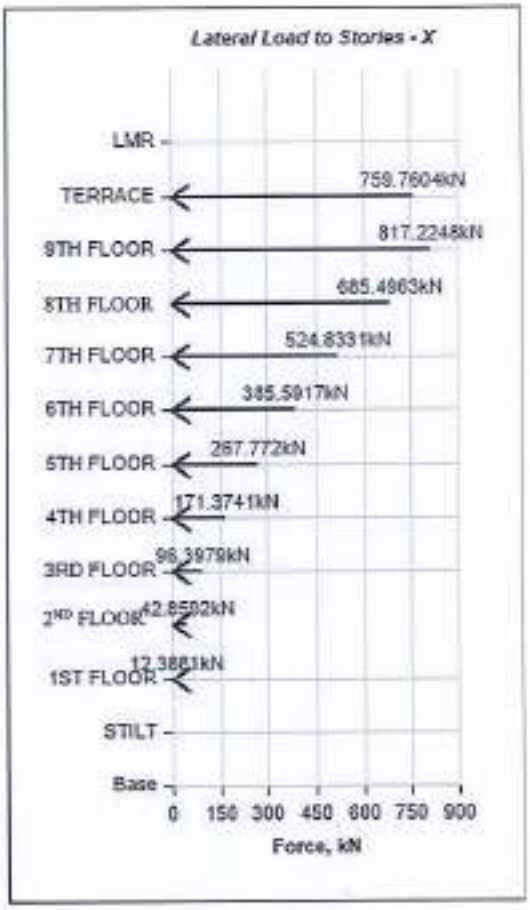
User Period	T= 0.705sec
Factors and Coefficients	
Seismic Zone Factor, Z [IS Table 3]	Z= 0.16
Response Reduction Factor, R [IS Table 9]	R= 4
Importance Factor, I [IS Table 8]	I= 1.2
Site Type [IS Table 1] = I	
Seismic Response	
Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g}=\frac{1}{T}$	$\frac{S_a}{g}=1.41844$
Equivalent Lateral Forces	
Seismic Coefficient, A_h [IS 6.4.2] $A_h=\frac{ZI\frac{S_a}{g}}{2R}$	

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X	0.705	110558.6195	3763.6977

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No. SE/GR-I/15/03/027
NEW No. [illegible], BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail: [illegible]engineers.in
Mob: [illegible]

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR	36	0	0
TERRACE	33	759.7604	0
9TH FLOOR	30	817.2248	0
8TH FLOOR	27	685.4963	0
7TH FLOOR	24	524.8331	0
6TH FLOOR	21	385.5917	0
5TH FLOOR	18	267.772	0
4TH FLOOR	15	171.3741	0
3RD FLOOR	12	96.3979	0
2ND FLOOR	9	42.8592	0
1ST FLOOR	6	12.3881	0
STILT	3	0	0
Base	0	0	0

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-II/9903/027
NEW No.31, OLD No.141, BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jega@bureengineers.in
Mob : 9952545631

IS 1893:2016 Auto Seismic Load Calculation

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

Direction and Eccentricity

Direction = Y

Structural Period

Period Calculation Method = User Specified

User Period — $T = 0.961$ sec

Factors and Coefficients

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

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

Importance Factor, I [IS Table 8] — $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] — $\frac{S_a}{g} = \frac{1}{T}$ — $\frac{S_a}{g} = 1.040583$

Equivalent Lateral Forces

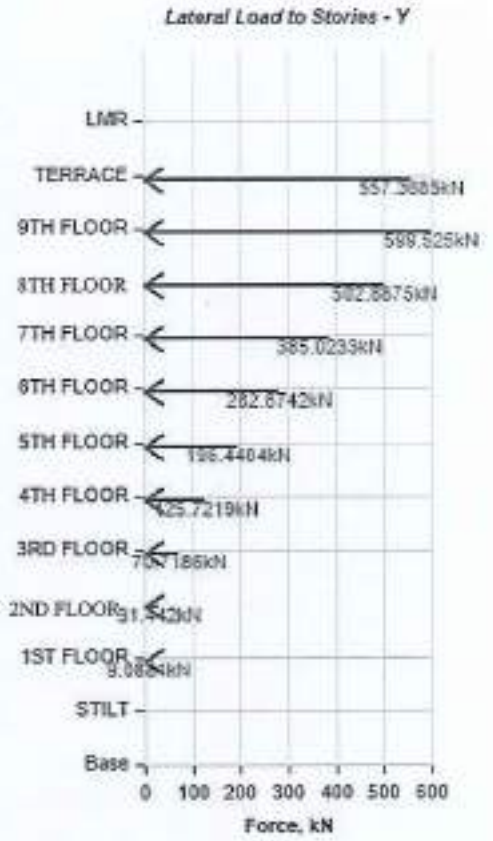
Seismic Coefficient, A_h [IS 6.4.2] — $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y	0.961	110558.6195	2761.0894

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REG No.SE/GR-I/19/03/027
NEW No. 14, BESANT AVENUE,
E-Mail

Applied Story Forces

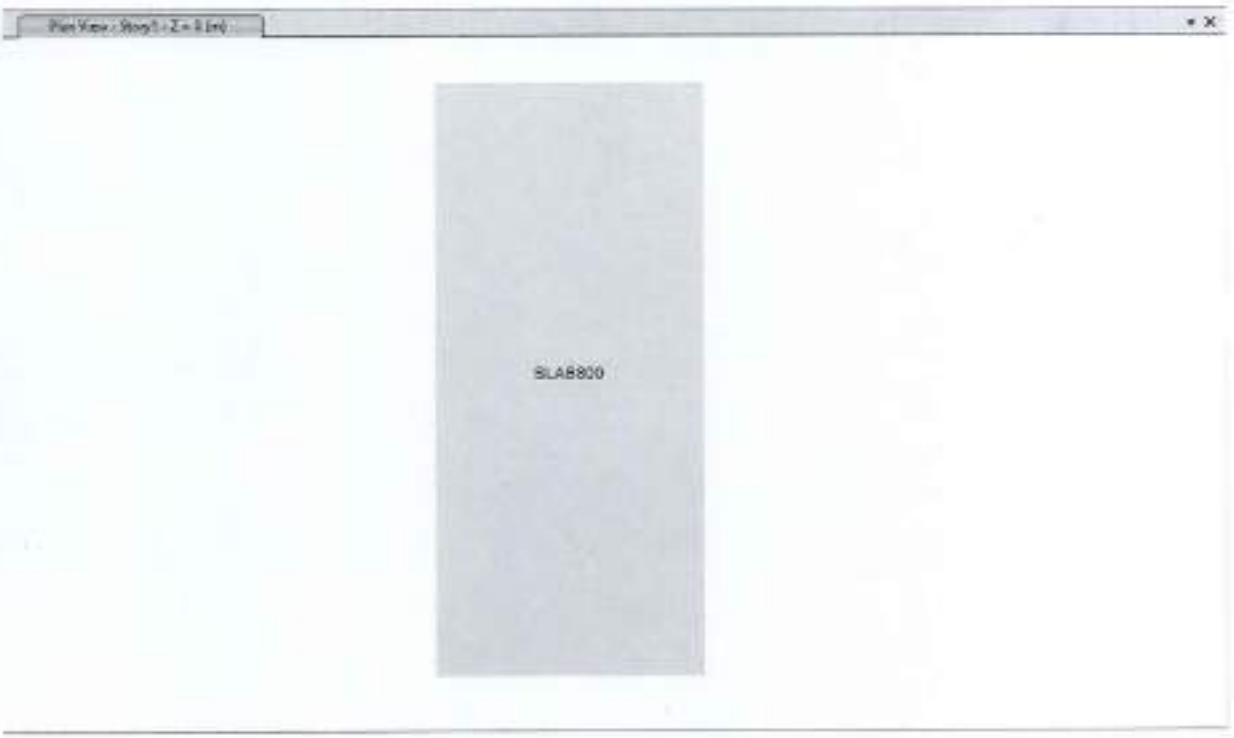


Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR	36	0	0
TERRACE	33	0	557.3685
9TH FLOOR	30	0	599.525
8TH FLOOR	27	0	502.8875
7TH FLOOR	24	0	385.0233
6TH FLOOR	21	0	282.8742
5TH FLOOR	18	0	196.4404
4TH FLOOR	15	0	125.7219
3RD FLOOR	12	0	70.7186
2ND FLOOR	9	0	31.442
1ST FLOOR	6	0	9.0881
STILT	3	0	0
Base	0	0	0

P. JEGATH
REGISTERED
CHENNAI METROPO
REGISTRATIO
NEW No.31 (OLD
ADYAR, CH
E-Mail : jegath
Mobile : +91 95
AUTHORITY
AVENUE,

DESIGN OF FOOTING/RAFT

1. Depth of raft.



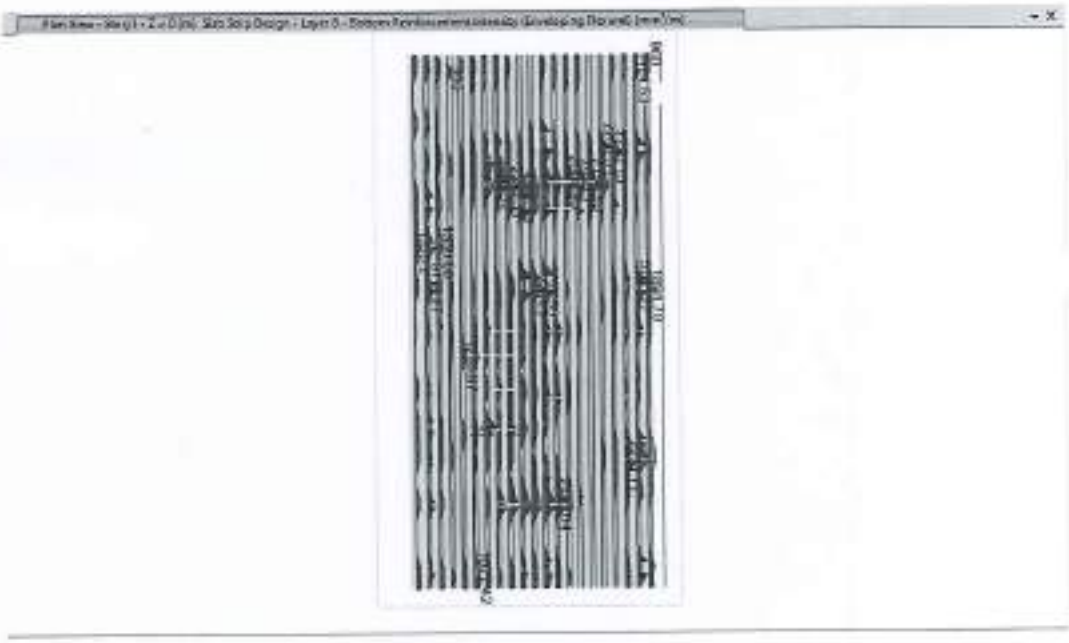
2. SBC considered for the design of Raft.



P. JEGATHEESAN, M.E., (Struct.)
REGISTERED ... ENGINEER
CHENNAI MET... AUTHORITY
REGIST... 03/027
NEW No.31 ... AVENUE,
ADY... 20.
E-Mail : je... .in
Mobile ...

3. Required bottom reinforcement in X-direction & Y-direction.

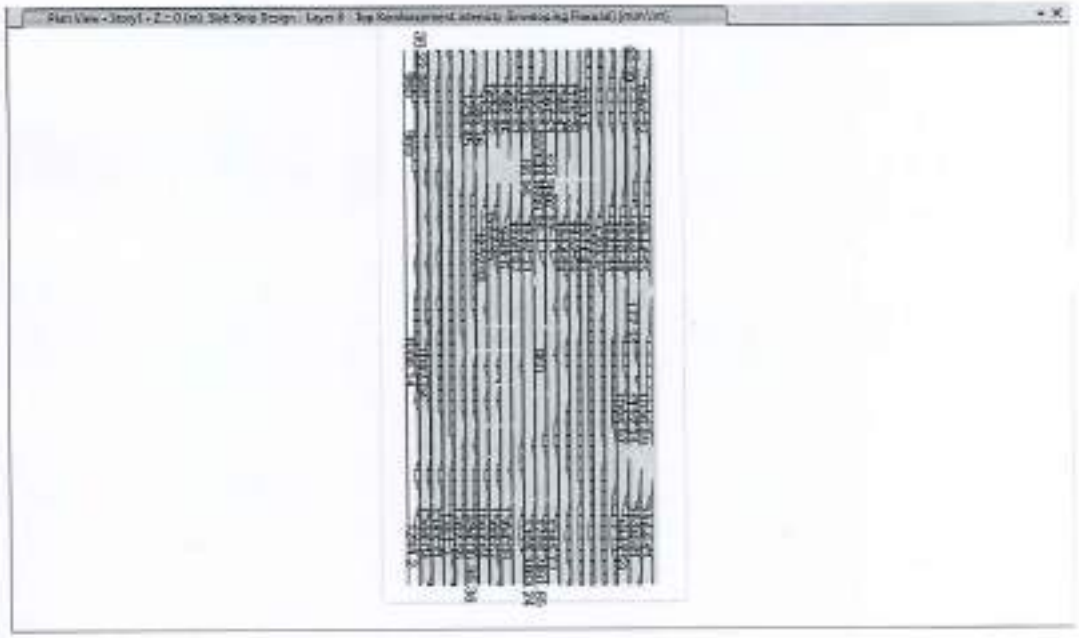




P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION NO.S/03/027
NEW No.31, OLD No.11, KAMARAJAR SALAI, ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesans@yahoo.co.in
Mobile : 9840...

4. Required top reinforcement in X-direction & Y-direction.





P. JEGATHEE (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION
NEW No.31 (OLD
ADYAR, CHE
E-Mail :
Mobile : +91

DESIGN OF WALL

ETABS Shear Wall Design
WALL NO. C1 at STILT LEVEL

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	HW1	12950	56702.5	1000	400	0.5

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	550	415

Design Code Parameters

Γ_s	Γ_c	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	12450	56702.5	13450	56702.5	1000	400
Bottom	Leg 1	12450	56702.5	13450	56702.5	1000	400

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

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN
Top	1000	0.0025	0.0034	1.5 (DL+SPEC-WZ+0.3SPEC-WX+0.3SPEC-WY)	2708.005
Bottom	1000	0.0025	0.0034	1.5 (DL+SPEC-WZ+0.3SPEC-WX+0.3SPEC-WY)	2758.972

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

M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
54.1601	-105.8746	400000
-55.1794	-57.2887	400000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	1000	1.5 (DL+SPEC-Y+0.3SPEC-X+0.3SPEC-Z)	2026.086	258.6515	-129.4527	133.0902	421.7858
Bottom	Leg 1	1000	1.5 (DL+SPEC-Y+0.3SPEC-X+0.3SPEC-Z)	2069.2134	130.9659	-129.4527	133.9478	422.6434

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m
Top-Left	Leg 1	400	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2746.0533	-220.4665
Top-Right	Leg 1	400	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2746.0533	239.148
Bottom-Left	Leg 1	400	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2792.885	-106.7436
Botttom-Right	Leg 1	400	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2792.885	105.9377

Boundary Element Check (Part 2 of 2)

Stress Comp MPa	Stress Limit MPa
10.17	7
10.46	7
8.58	7
8.57	7

P. JEGATHEESAN, M.E., (Struct.)
REGIS... STRUCTURAL ENGINEER
CHENNAI M... DEVELOPMENT AUTHORITY
REG... E/GR-I/19/03/027
NEW No... 41, RESANT AVENUE,
A... 600 020.
E-Ma... ...engineers.in

ETABS Shear Wall Design
WALL NO. C1 at 2ND FLOOR LEVEL

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
2ND FLOOR	HW1	12950	56702.5	1000	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	550	415

Design Code Parameters

Γ_s	Γ_c	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	12450	56702.5	13450	56702.5	1000	200
Bottom	Leg 1	12450	56702.5	13450	56702.5	1000	200

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

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN
Top	887	0.0044	0.0025	1.5 (DL+SPEC-Y+0.3SPEC-X+0.3SPEC-Z)	2003.0974
Bottom	4038	0.0202	0.0025	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2068.1581

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

M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
-66.8137	94.8572	200000
58.0649	-555.9265	200000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	1348.0249	108.1495	-199.4108	83.3774	227.7253
Bottom	Leg 1	500	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	1370.1579	346.564	-199.4108	141.9859	286.3337

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m
Top–Left	Leg 1	200	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2045.2911	-11.2037
Top–Right	Leg 1	300	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2045.2911	108.1495
Bottom–Left	Leg 1	400	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2068.1581	-555.9265
Botttom–Right	Leg 1	300	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	2068.1581	346.564

Boundary Element Check (Part 2 of 2)

Stress Comp MPa	Stress Limit MPa
10.56	7
13.47	7
27.02	7
20.74	7

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/15/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burcengineers.in
Mobile : +91 9962545631

ETABS Shear Wall Design
WALL NO. C1 at TERRACE FLOOR LEVEL

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
TERRACE	HW1	12950	56702.5	1000	200	1

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	550	415

Design Code Parameters

Γ_s	Γ_c	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	12450	56702.5	13450	56702.5	1000	200
Bottom	Leg 1	12450	56702.5	13450	56702.5	1000	200

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

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN
Top	2320	0.0116	0.0025	1.5 (DL+SPEC-Y+0.3SPEC-X+0.3SPEC-Z)	131.7575
Bottom	1080	0.0054	0.0025	1.2 (DL+LL+SPECY+0.3SPEC-X+0.3SPEC-Z)	149.358

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

M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
-69.562	234.4652	200000
41.2994	-119.6682	200000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_s kN	$V_c + V_s$ kN
Top	Leg 1	500	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	127.5048	286.22	-150.1072	92.1018	236.4496
Bottom	Leg 1	500	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	149.7015	-12.8542	-150.1072	64.7783	209.1261

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m
Top-Left	Leg 1	0	0.9 DL+1.5(SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	125.8941	-46.5227
Top-Right	Leg 1	200	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	189.2438	286.22
Bottom-Left	Leg 1	0	1.5 (DL+SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	212.047	-12.8542
Bottom-Right	Leg 1	0	0.9 DL+1.5(SPEC-WX+0.3SPEC-WY+0.3SPEC-WZ)	139.6973	22.982

Boundary Element Check (Part 2 of 2)

Stress Comp MPa	Stress Limit MPa
2.03	7
9.53	7
1.45	7
1.39	7

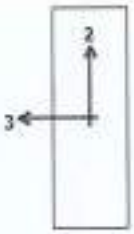
P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burcengineers.in
Mobile : +91 9962545631

DESIGN OF BEAM

ETABS Concrete Frame Design

BEAM NO. THB4

IS 456:2000 Beam Section Design (Summary)



P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/13903/07
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burconsgroup.in
Mobile : +91 9962545021

Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
2ND FLOOR	B110	195	B 200X600	ENVELOPE	2924.4	5599.1	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{cc} (mm)	d_{sb} (mm)
200	600	200	0	35	35

Material Properties

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

Design Code Parameters

γ_c	γ_s
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
221.9732	7.986E-06	6.7534	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
221.9732	1.879E-05	221.9732	0

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)	0		0	0	0	0
Bottom (-2 Axis)		221.9732	979	979	0	175

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
6.7534	70.3609	45.2	0	221.69

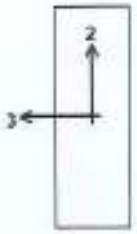
Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{u2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{sxt} /s mm²/m
7.986E-06	6.7534	150	550	0

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/15/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@buroengineers.in
Mobile : +91 9962545631

ETABS Concrete Frame Design
BEAM NO. THB6

IS 456:2000 Beam Section Design (Summary)



P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/CR-[illegible]/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burdengineers.in
Mobile : +91 9962545031

Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
2ND FLOOR	B20	54	B 200X600	ENVELOPE	4750	4750	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	600	200	0	35	35

Material Properties

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

Design Code Parameters

γ_c	γ_s
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-168.6567	0.0001	172.1621	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-168.6567	0.0003	0	-168.657

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)	-168.657		706	0	706	175
Bottom (-2 Axis)		0	0	0	0	0

Shear Force and Reinforcement for Shear, V_{u2} & T_u

Shear V_p kN	Shear V_s kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m

Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
172.1621	61.585	110.5781	51.6889	542.34

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
2.165E-05	172.1621	150	550	0

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@bursengineers.in
Mobile : +91 9962546031

DESIGN OF SLAB

DESIGN OF SLAB : TS1

Panel Name : Three edges; one long edge continuous

Clear Longer span, ly = 3650 mm

Clear Shorter span, lx = 3600 mm

ly / lx = 1.01 < 2, Hence, Two-way slab.Effective Longer span = 3746.00 mm

Effective Shorter span = 3696.00 mm

Assume thickness of slab = 125.00 mm

Effective depth available = 96.00 mm

Loads :

Dead Load and Imposed Load (fixed) :

Floor finish = 1.200 kN/m²

Self weight = 3.000 kN/m²

w_{DL} = 4.200 kN/m²

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/CR-I/18/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.
E-Mail : jegatheesan@burconginaers.in
Mobile : +91 9962548631

Imposed Load (Not fixed) :

Occupancy classification as per IS: 875(Part 2) - 1987 :

Live load = 2.000 kN/m²

w_{LL} = 2.000 kN/m²

Total load, w = w_{DL} + w_{LL} = 6.200 kN/m²

Span Moments:

Along Shorter span: BM = a_x $w l_x^2$ 0.044 x 6.20 x 3.696^2 = 3.71 kNm M_{ux1} = 5.56 kNm

Along Longer span: BM = a_y $w l_x^2$ = 0.043 x 6.20 x 3.696^2 = 3.64 kNm M_{uy1} = 5.46 kNm

Support Moments:

Along Shorter span: BM = a_x $w l_x^2$ = 0.000 x 6.20 x 3.696^2 = 0.00 kNm M_{ux2} = 0.00 kNm

Along Longer span: BM = a_y $w l_x^2$ = 0.057 x 6.20 x 3.696^2 = 4.83 kNm M_{uy2} = 7.24 kNm

Check for section :

Factored Max. BM, Mu = 7.24 kNm / m

For M30 grade concrete & Fe550 grade steel , Mu, lim / bd^2 = 4.139

Effective depth required = 41.83 mm < Effective depth available, OK

Along the Shorter span

A_{st} reqd at midspan :

A_{st} = [0.5f_{ck}/f_y] {1 -Õ(1- [4.6 M_{ux1} /(f_{ck} bd^2)])} b d = 124.14 mm² / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm² / m OK

A_{st} reqd at support :

A_{st} = [0.5f_{ck}/f_y] { 1 -Õ(1- [4.6 M_{ux2} / (f_{ck} bd^2)])} b d = 0.00 mm² / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm² / m OK

Along the Longer span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5 f_{ck}/f_y\ ]\ \{1 - Ö(\ 1 - [4.6\ M_{uy1}/(f_{ck}\ bd^2)]\ )\}\ b\ d =$ 121.82 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

A_{st} reqd at support :

$A_{st} = [\ 0.5 f_{ck}/f_y\ ]\ \{\ 1 - Ö(\ 1 - [4.6\ M_{uy2}/(f_{ck}\ bd^2)])\}\ b\ d =$ 162.78 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

Min Ast = 0.12% Gross section area = 150 mm^2 / m

Distribution steel = 0.5 x (0.12/100) x 1000 x 125 = 75.00 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

Max Spacing = 3d or 300 mm whichever is less = 288 mm or 300 mm

Check for deflection:

fs = 0.58 x fy x (Ast req/Ast pro) = 157.56 MPa

MF = 1/(0.225+0.00322 fs – 0.625 log 10 (1/pt)) £ 2 = 2.000

Type of Slab = Continuous

Effective Shorter span = 3696.00 mm

Basic Value = 26

Allowable l/d = 52.00

Actual l/d = 38.50 Hence OK

PP. JEGATHEESAN M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN AUTHORITY
REGISTRATION No.
NEW No.31 (OLD No.
ADYAR, CHENNAI
E-Mail : jegatheesan
Mobile : +91

DESIGN OF SLAB : TS5

Panel Name : Four edges discontinuous

Clear Longer span, ly = 4550 mm

Clear Shorter span, lx = 3900 mm

ly / lx = 1.17 < 2, Hence, Two-way

slab.Effective Longer span = 4671.00 mm

Effective Shorter span = 4021.00 mm

Assume thickness of slab = 150.00 mm

Effective depth available = 121.00 mm

Loads :

Dead Load and Imposed Load (fixed) :

Floor finish = 1.200 kN/m²

Self weight = 3.600 kN/m²

w_{DL} = 4.800 kN/m²

Imposed Load (Not fixed) :

Occupancy classification as per IS: 875(Part 2) - 1987 :

Live load = 2.000 kN/m²

w_{LL} = 2.000 kN/m²

Total load, $w = w_{DL} + w_{LL}$ = 6.800 kN/m²

Span Moments:

Along Shorter span: $BM = a_x w l_x^2$ 0.069 x 6.80 x 4.021^2 = 7.56 kNm M_{ux1} = 11.35 kNm

Along Longer span: $BM = a_y w l_x^2$ = 0.056 x 6.80 x 4.021^2 = 6.16 kNm M_{uy1} = 9.24 kNm

Support Moments:

Along Shorter span: $BM = a_x w l_x^2$ = 0.000 x 6.80 x 4.021^2 = 0.00 kNm M_{ux2} = 0.00 kNm

Along Longer span: $BM = a_y w l_x^2$ = 0 x 6.80 x 4.021^2 = 0.00 kNm M_{uy2} = 0.00 kNm

Check for section :

Factored Max. BM, Mu = 11.35 kNm / m

For M30 grade concrete & Fe550 grade steel, $Mu, lim / bd^2$ = 4.139

Effective depth required = 52.36 mm < Effective depth available, OK

P. JEGATHEESAN, M.E.
REGISTERED STRUCTURAL
CHENNAI METROPOLITAN DEVELOP
REGISTRATION No.SE/GR
NEW No.31 (OLD No.14), BE
ADYAR, CHENNAI - 60
E-Mail : jegatheesan@bur
Mobile : +91 99625

Along the Shorter span

A_{st} reqd at midspan :

A_{st} = [$0.5f_{ck}/f_y$] {1 -Ö(1- [4.6 M_{ux1} /(f_{ck} bd^2)])} b d = 202.27 mm^2 / m

Provide 10 mm dia bars @ 175 mm c/c As = 392.70 mm^2 / m OK

A_{st} reqd at support :

A_{st} = [$0.5f_{ck}/f_y$] { 1 -Ö(1- [4.6 M_{ux2} / (f_{ck} bd^2)])} b d = 0.00 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

Along the Longer span

A_{st} reqd at midspan :

A_{st} = [$0.5f_{ck}/f_y$] {1 -Ö(1- [4.6 M_{uy1} /(f_{ck} bd^2)])} b d = 163.65 mm^2 / m

Provide 8 mm dia bars @ 175 mm c/c As = 251.33 mm^2 / m OK

A_{st} reqd at support :

A_{st} = [$0.5f_{ck}/f_y$] { 1 -Ö(1- [4.6 M_{uy2} / (f_{ck} bd^2)])} b d = 0.00 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

Min Ast = 0.12% Gross section area = 180 mm^2 / m

Distribution steel = 0.5 x (0.12/100) x 1000 x 150 = 90.00 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

Max Spacing = 3d or 300 mm whichever is less = 363 mm or 300 mm

Check for deflection:

fs = 0.58 x fy x (Ast req/Ast pro) = 164.31 MPa

MF = 1/(0.225+0.00322 fs – 0.625 log 10 (1/pt)) £ 2 = 2.000

Type of Slab = Simply Supported

Effective Shorter span = 4021.00 mm

Basic Value = 20

Allowable l/d = 40.00

Actual l/d = 33.23 Hence OK

P. JEGATHEES... M.E., (Struct.)
REGISTERED STRU... ENGINEER
CHENNAI METROPOLITAN ... AUTHORITY
REGISTRATION No. .../03/027
NEW No.31 (OLD No.14... AVENUE,
ADYAR, CHENN... 20.
E-Mail : jegatheesan... ...ons.in
Mobile : +91 96...

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3/350/2 Mettukuppam,
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Chennai, India

hello@verified.realestate
+91 9996 12 9996
www.verified.realestate