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CIN : U45201TN2005PTC055334

13th June 2024

To,
Mayflower Infrastructures,
No. 72, Balasundaram Road,
Coimbatore - 641018.

STRUCTURAL STABILITY CERTIFICATE

This is to certify that the Structural design for the proposed residential building having 1 Basement + Ground floor + 9 Upper floors + Terrace of Sri Andal Layout, Located at S.F Nos. 181 and 182, T.S Ward: Ward - AC Sowripalayam, Block No.10, T.S No.68, Sowripalayam Village, Coimbatore Taluk, Coimbatore District.

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

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1.0 INTRODUCTION

This Design Brief Report (DBR) is for the Proposed Residential Apartment - HMR Housing at Trichy road, Ramanathapuram, Coimbatore, for M/s. Mayflower [redacted].

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 floor : Parking, Lobby, Ramp.

Ground floor : Parking, Lobby, EB room, Drivers Toilet, Ramp, Meter room, Driveway.

1st Floor : Residential units, Multi purpose hall.

2nd floor : Residential units, Gym, Indoor games.

3rd to 9th floor : Residential units.

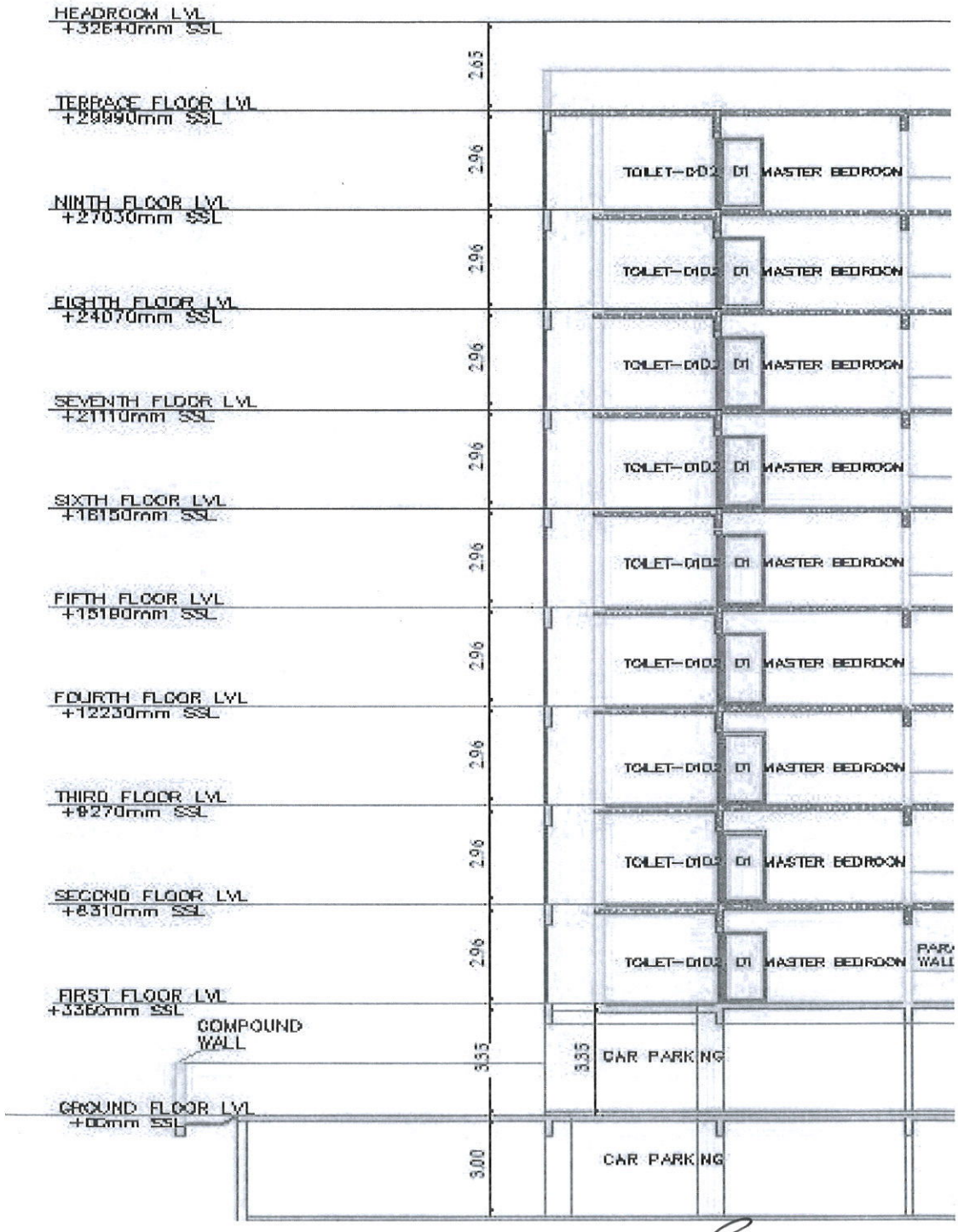
Terrace : Open terrace, OHT & LMR.

1.2 Floor to floor height:

Basement floor	- 3.00m
Ground floor	- 3.35m
1st to 9th floor each floor height	- 2.96m

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BURO ENGINEERS	HMR RAMANATHAPURAM, COIMBATORE	DESIGN BRIEF REPORT-R0



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SECTION

2.0 CODES OF PRACTICE

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

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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

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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
EB ROOM	1.80	0.50	0.00	0.00	5.00
TERRACE	3.60	0.00	0.00	0.00	3.00
LMR	3.60	0.00	12.40	0.00	0.00
MULTI PURPOSE HALL	1.80	0.00	0.00	0.00	5.00
PARKING & DRIVEWAY	2.40	0.00	0.00	0.00	3.00
GYM	2.40	0.50	0.00	0.00	5.00
INDOOR GAMES	2.40	0.50	0.00	0.00	5.00
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/m²)

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=75mm.

TERRACES (Load in kN/m2)

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

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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

d) **Material Density**

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

Material	Density
Reinforced Cement Concrete	25.00 kN/m^3
Plain Cement Concrete	24.00 kN/m^3
Screed Concrete	24.00 kN/m^3
Light weight AAC block	9.00 KN/m^3
Structural Steel	78.50 kN/m^3
Dry soil	18.00 kN/m^3
Saturated soil	20.00 kN/m^3
Glass	27.20 kN/m^3
water	09.81 kN/m^3
Light weight filling	16.00 kN/m^3
Solid block wall	22.00 kN/m^3

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).

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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 Ductile 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 x I / R x 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:

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

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

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

c) All other buildings:

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

H = 30.00m (Ground to Roof)

Building is splitted in to two portion, that is top and bottom portion.

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For top portion

dx = 41.40m,

dy = 39.35m,

T_a = 0.624 (along X direction)

T_a = 0.851 (along Y direction)

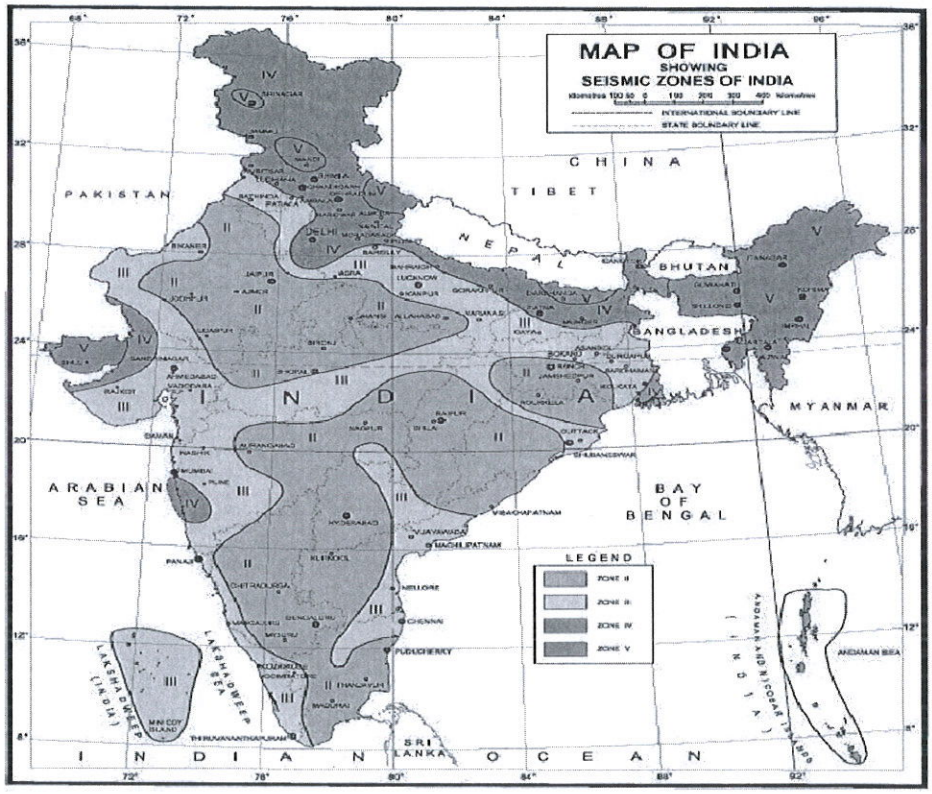
For bottom portion

dx = 41.40m,

dy = 54.55m,

T_a = 0.569 (along X direction)

T_a = 0.738 (along Y direction)



Dynamic Analysis

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

Number of modes Considered : 15 Numbers (Min)

Modal Combination Method Used : Complete Quadratic combination (CQC).

Directional Combination Method used : Square root of the sum of Square (SRSS).

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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.

f) WINDS 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 $V_Z = V_b x k_1 x k_2 x k_3 x k_4$

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) ($V_b x k_1 x k_2 x k_3 x k_4$) = 42.9m/s

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

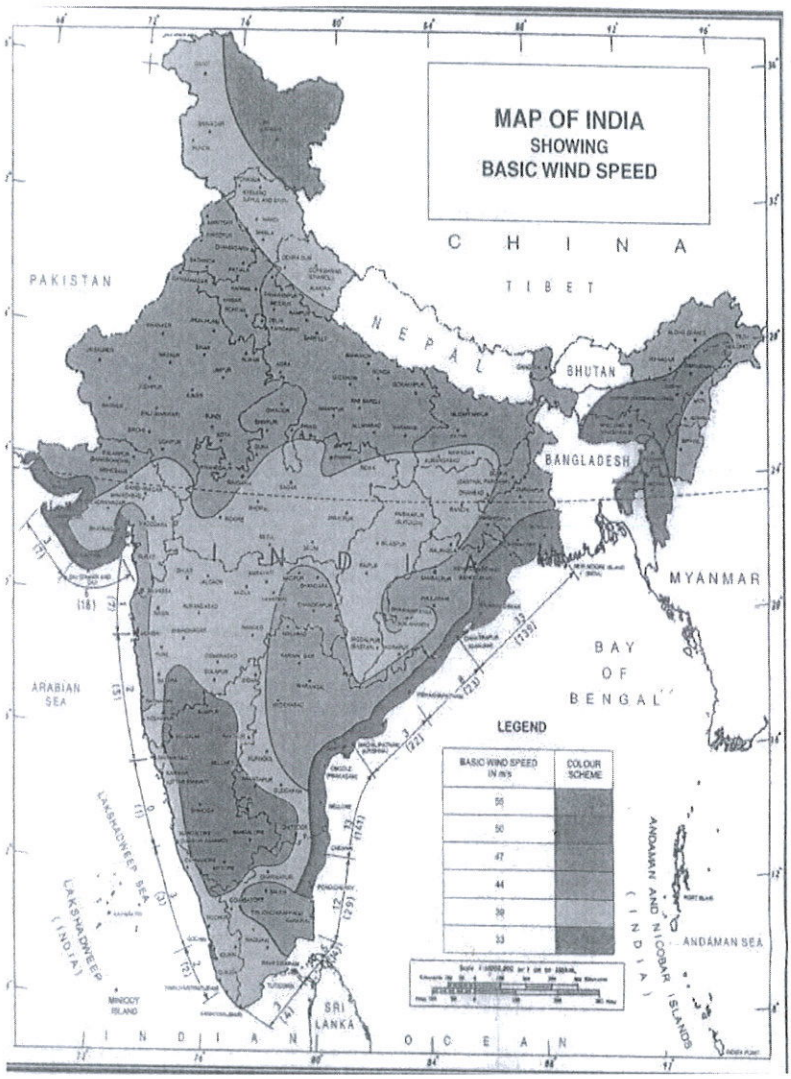
Design wind pressure: pd = Pz x Kax Kd x Kc = 805N/m2

Kd ⟶ Wind directionality factor = 0.90

ka ⟶ Area averaging factor = 0.90

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k_c ⟶ Combination factor = 0.90



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 analyzed 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.

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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. 1.5 (DL + LL) + 1.0 TEMP
3. 1.2 (DL + LL ± SPECX-D) ± 0.36 SPECY-D ± 0.36 SPECZ-D
4. 1.2 (DL + LL ± SPECY-D) ± 0.36 SPECX-D ± 0.36 SPECZ-D
5. 1.2 (DL + LL ± SPECZ-D) ± 0.36 SPECX-D ± 0.36 SPECY-D
6. 1.2 (DL + LL ± SPECX-D) ± 0.36 SPECY-D ± 0.36 SPECZ-D + 1.0 TEMP
7. 1.2 (DL + LL ± SPECY-D) ± 0.36 SPECX-D ± 0.36 SPECZ-D + 1.0 TEMP
8. 1.2 (DL + LL ± SPECZ-D) ± 0.36 SPECX-D ± 0.36 SPECY-D + 1.0 TEMP
9. 1.2 (DL + LL ± WindX)
10. 1.2 (DL + LL ± WindY)
11. 1.2 (DL + LL ± WindX) + 1.0 TEMP
12. 1.2 (DL + LL ± WindY) + 1.0 TEMP
13. 1.5 (DL ± SPECX-D) ± 0.45 SPECY-D ± 0.45 SPECZ-D
14. 1.5 (DL ± SPECY-D) ± 0.45 SPECX-D ± 0.45 SPECZ-D
15. 1.5 (DL ± SPECZ-D) ± 0.45 SPECX-D ± 0.45 SPECY-D
16. 1.5 (DL ± SPECX-D) ± 0.45 SPECY-D ± 0.45 SPECZ-D + 1.0 TEMP
17. 1.5 (DL ± SPECY-D) ± 0.45 SPECX-D ± 0.45 SPECZ-D + 1.0 TEMP
18. 1.5 (DL ± SPECZ-D) ± 0.45 SPECX-D ± 0.45 SPECY-D + 1.0 TEMP
19. 1.5 (DL ± WindX)
20. 1.5 (DL ± WindY)
21. 1.5 (DL ± WindX) + 1.0 TEMP
22. 1.5 (DL ± WindY) + 1.0 TEMP
23. 0.9DL ± 1.5 SPECX-D ± 0.45 SPECY-D ± 0.45 SPECZ-D
24. 0.9DL ± 1.5 SPECY-D ± 0.45 SPECX-D ± 0.45 SPECZ-D
25. 0.9DL ± 1.5 SPECZ-D ± 0.45 SPECX-D ± 0.45 SPECY-D
26. 0.9DL ± 1.5 SPECX-D ± 0.45 SPECY-D ± 0.45 SPECZ-D + 1.0 TEMP
27. 0.9DL ± 1.5 SPECY-D ± 0.45 SPECX-D ± 0.45 SPECZ-D + 1.0 TEMP
28. 0.9DL ± 1.5 SPECZ-D ± 0.45 SPECX-D ± 0.45 SPECY-D + 1.0 TEMP
29. 0.9DL ± 1.5WindX
30. 0.9DL ± 1.5WindY
31. 0.9DL ± 1.5WindX + 1.0 TEMP
32. 0.9DL ± 1.5WindY + 1.0 TEMP

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

33. 1.0DL +1.0 LL
34. 1.0DL ± 1.0SPECX-D ± 0.3 SPECY-D ± 0.3 SPECZ-D
35. 1.0DL ± 1.0SPECY-D ± 0.3 SPECX-D ± 0.3 SPECZ-D
36. 1.0DL ± 1.0SPECZ-D ± 0.3 SPECX-D ± 0.3 SPECY-D
37. 1.0DL ± 1.0WindX
38. 1.0DL ± 1.0WindY
39. 1.0DL + 0.8LL ± 0.8SPECX-D ± 0.24 SPECY-D ± 0.24 SPECZ-D

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40. 1.0DL + 0.8LL ± 0.8SPECY-D ± 0.24 SPECX-D ± 0.24 SPECZ-D
41. 1.0DL + 0.8LL ± 0.8SPECZ-D ± 0.24 SPECX-D ± 0.24 SPECY-D
42. 1.0DL + 0.8LL ± 0.8WindX
43. 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

4.0 MATERIAL GRADES

i) CONCRETE

Grade M30 (fck = 30 N/mm²) for Isolated & Combined 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

Isolated 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)

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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 thicknesses are to be 125mm.

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.

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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

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

Table 6 Cracked RC Section Properties
(Clause 7.2)

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

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

- The 3D ETABS model generated based on the preliminary floor plans (shuttering drawings) prepared using preliminary sizes.
- Sectional properties are assigned to all the structural elements as per the preliminary floor plans (shuttering drawings).
- External & Internal in fill wall loads are assigned as uniformly distributed line load on beams and as area load if the wall is 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 Softwares.

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 EXPANSION JOINT

Expansion joints are recommended when structure exceeds 45m length. The width of the joints is being calculated as per IS-1893-2016, clause 7.11.3.The expansion joint will be provided in between the building. The buildings are analyse and designed separately.

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10.0 FOUNDATION

Proposed Foundation system is Isolated & combined footing and the SBC considered for the design is 500kN/m2 the founding depth is to be 3.0m from the natural ground level with reference to the soil investigation report No-SSTS/LT/160923/16 from M/s.Sastha Soil Testing Services.

11.0 COMPUTER PROGRAMS

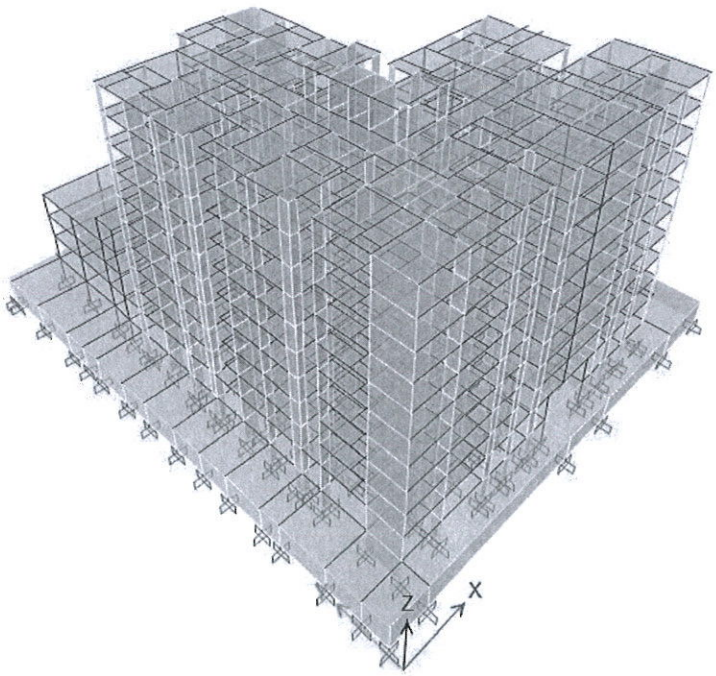
The following Software / spreadsheet to be used to carry out Structural analysis and design.

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, Isolated footing design, Column design and Wall design
7. STAAD PRO & ETABS - Structural Steel Design.+

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ETABS®



ETABS MODEL

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	2.96	No	None	No	Blue
T1	9TH FLOOR	2.96	No	2ND FLOOR	No	Cyan
T1	8TH FLOOR	2.96	No	2ND FLOOR	No	Magenta
T1	7TH FLOOR	2.96	No	2ND FLOOR	No	Gray8Dark
T1	6TH FLOOR	2.96	No	2ND FLOOR	No	Green
T1	5TH FLOOR	2.96	No	2ND FLOOR	No	Red
T1	4TH FLOOR	2.96	No	2ND FLOOR	No	Yellow
T1	3RD FLOOR	2.96	No	2ND FLOOR	No	Blue
T1	2ND FLOOR	2.96	Yes	None	No	Cyan
T1	1ST FLOOR	3.35	No	None	No	Magenta
T1	GROUND	3	No	None	No	Gray8Dark

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 WECC	Yes	Other	0	
~SPEC-XECC	Yes	Other	0	
~SPEC-Y WECC	Yes	Other	0	
~SPEC-YECC	Yes	Other	0	
~SPEC-Z WECC	Yes	Other	0	
~SPEC-ZECC	Yes	Other	0	
Dead	No	Dead	1	
EQX	No	Seismic	0	IS 1893:2016
EQY	No	Seismic	0	IS 1893:2016
FL	No	Live	0	
Live<3	No	Live	0	
Live>3	No	Live	0	
SDL	No	Super Dead	0	
WALL	No	Super Dead	0	
WX	No	Wind	0	Indian IS 875:2015
WY	No	Wind	0	Indian IS 875:2015

2.2 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 $T = 0.573 \text{sec}$

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] $\frac{S_a}{g} = \frac{1}{T}$ $\frac{S_a}{g} = 1.745201$

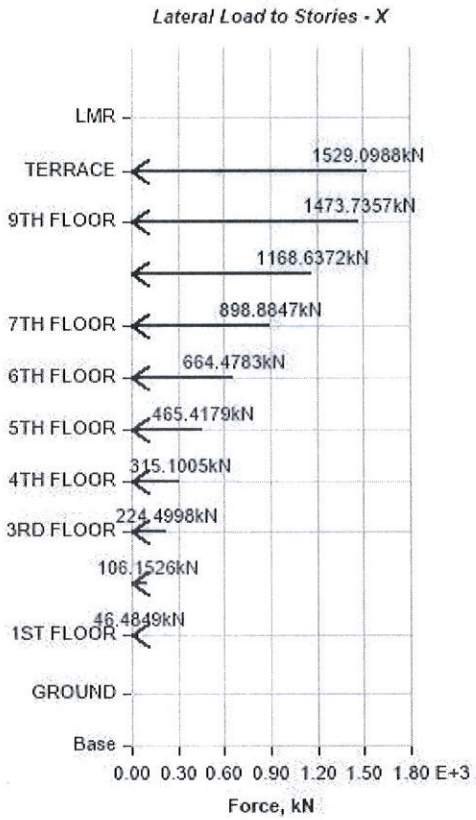
Equivalent Lateral Forces

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	0.573	164558.2075	6892.4904

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR	35.99	0	0
TERRACE	32.99	1529.0988	0
9TH FLOOR	30.03	1473.7357	0
8TH FLOOR	27.07	1168.6372	0
7TH FLOOR	24.11	898.8847	0
6TH FLOOR	21.15	664.4783	0
5TH FLOOR	18.19	465.4179	0
4TH FLOOR	15.23	315.1005	0
3RD FLOOR	12.27	224.4998	0
2ND FLOOR	9.31	106.1526	0
1ST FLOOR	6.35	46.4849	0
GROUND	3	0	0
Base	0	0	0

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 $T = 0.718 \text{sec}$

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] $\frac{S_a}{g} = \frac{1}{T}$ $\frac{S_a}{g} = 1.392758$

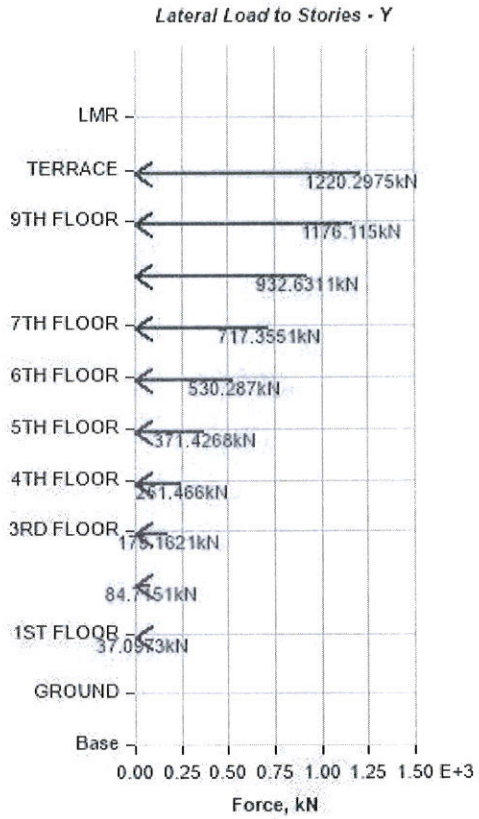
Equivalent Lateral Forces

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	0.718	164558.2075	5500.5529

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
LMR	35.99	0	0
TERRACE	32.99	0	1220.2975
9TH FLOOR	30.03	0	1176.115
8TH FLOOR	27.07	0	932.6311
7TH FLOOR	24.11	0	717.3551
6TH FLOOR	21.15	0	530.287
5TH FLOOR	18.19	0	371.4268
4TH FLOOR	15.23	0	251.466
3RD FLOOR	12.27	0	179.1621
2ND FLOOR	9.31	0	84.7151
1ST FLOOR	6.35	0	37.0973
GROUND	3	0	0
Base	0	0	0

2.3 Functions

2.3.1 Response Spectrum Functions

Table 2.4 - Functions - Response Spectrum - IS1893 2016

Name	Period sec	Value	Seismic Zone	I	Soil Type	R	Damping Ratio
IS 1893	0	0.024	III	1.2	I	4	0.05
IS 1893	0.1	0.06					
IS 1893	0.4	0.06					
IS 1893	0.6	0.04					
IS 1893	0.8	0.03					
IS 1893	1	0.024					
IS 1893	1.2	0.02					
IS 1893	1.4	0.017143					
IS 1893	1.6	0.015					
IS 1893	1.8	0.013333					
IS 1893	2	0.012					
IS 1893	2.5	0.0096					
IS 1893	3	0.008					
IS 1893	3.5	0.006857					
IS 1893	4	0.006					
IS 1893	4.5	0.006					
IS 1893	5	0.006					
IS 1893	5.5	0.006					
IS 1893	6	0.006					
IS 1893	6.5	0.006					
IS 1893	7	0.006					
IS 1893	7.5	0.006					
IS 1893	8	0.006					
IS 1893	8.5	0.006					
IS 1893	9	0.006					
IS 1893	9.5	0.006					
IS 1893	10	0.006					

Table 2.5 - Functions - Response Spectrum - User Defined

Name	Period sec	Value	Damping Ratio
Z FUNCTION	0	0.04	0.05
Z FUNCTION	10	0.04	

2.4 Load Cases

Table 2.6 - Load Case Definitions - Summary

Name	Type
Modal	Modal - Ritz
Dead	Linear Static
Live<3	Linear Static
SDL	Linear Static
WALL	Linear Static
WX	Linear Static
WY	Linear Static
EQX	Linear Static
EQY	Linear Static
Live>3	Linear Static
FL	Linear Static
SPEC-X	Response Spectrum
SPEC-Y	Response Spectrum
Seq	Nonlinear Static Staged Construction
SPEC-X W	Response Spectrum
SPEC-Y W	Response Spectrum
SPEC-Z	Response Spectrum
SPEC-Z W	Response Spectrum

DESIGN OF FOOTING

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Design Code	:	IS 456 : 2000 + IS 13920 : 2016	
Footing No	:	FTHW1	
Column No	:	THW1	(300 mm X 1200 mm)
Analysis No	:	THW1	
Concrete Grade	:	M30	N/sqmm
Steel Grade	:	Fe550	N/sqmm
Clear Cover	:	50	mm
Df	:	3 M	
Dw	:	0 M	
Density of Soil	=	18	kN/cum
Soil Bearing Capacity	=	500	kN/sqm
Permissible SBC Increase for EQ	=	50	%
Permissible SBC Increase for Wind	=	25	%
Live Load Reduction	=	50	%
Permissible area of loss of contact	=	0	%
Design cross section by	:	Average pressure	

Footing Type	:	Pad	
Footing Size (L x B x D)	:	3100mm X 2200mm X 750mm	
Without considering Effect of Water Table			
Footing Self Wt., F1	=	127.88	kN
Soil Weight, S1	=	0.00	kN
Total Weight, W1	=	F1 + S1	
	=	127.88	kN
Offset Along L (Loff)	=	950	mm
Offset Along B (Boff)	=	950	mm

Check For Maximum Soil Pressure:

Critical Load Combination	=	[3] : (Dead) +(FL) +(SDL) +(WALL) -(SPEC-XMax) +(Live<3) +(Live>3)	
Pcomb	=	3394.80	kN
P	=	Pcomb + W1	
P	=	3522.67	kN
Mx	=	-106.06	kNm
My	=	14.99	kNm
P/A	=	516.52	kN/sqm
Mx/Zx	=	-30.1	kN/sqm
My/Zy	=	6	kN/sqm
Maximum Soil Pressure	=	552.61	kN/sqm
Allowable Soil Pressure	=	1.5x500	kN/sqm
	=	750	kN/sqm

Check For Minimum Soil Pressure:

Critical Load Combination	=	[2] : (Dead) +(FL) +(SDL) + (WALL) +(SPEC-XMax) + (Live<3) +(Live>3)	
Pcomb	=	2674.58	kN
P	=	Pcomb + W1	
P	=	2802.45	kN
Mx	=	130.98	kNm
My	=	16.17	kNm
P/A	=	410.92	kN/sqm
Mx/Zx	=	37.17	kN/sqm
My/Zy	=	6.47	kN/sqm
Minimum Soil Pressure	=	367.28	kN/sqm
	>	0	

Design For Bending:

Bottom Reinforcement Along L:

Critical Load Combination	=	[74] : 1.5 (Dead) +1.5 (FL) +1.5 (SDL) +1.5 (WALL) -1.5 (SPEC-XMax) -0.45 (SPEC-ZMax) -0.45 (SPEC-YMax)	
Pu	=	4869.84	kN
Mux	=	-184.45	kNm

Muy	=	18.34	kNm
P/A	=	714.05	kN/sqm
Mx/Zx	=	-52.35	kN/sqm
My/Zy	=	7.33	kN/sqm
Deff	=	692	mm
Beff	=	2200	mm
SPu	=	766.4	kN/sqm
Mu	=	SPu X B X Loff X Loff / 2	
	=	760.84	kNm
Pt	=	0.155	%
Ast Rqd (BM)	=	2365	sqmm
Ast Prv (Distributed Across Total Width)	=	16 - T16 @ 150	
	=	3217	sqmm

Top Reinforcement Along L:

D	=	750	mm
	<=	1000	mm, Hence
Ast	=	Min Pt For Top Reinforcement X D X B	
	=	0.06% X 750 X 2200	
	=	990	sqmm
Ast Prv (Distributed Across Total Width)	=	16 - T10 @ 150 c/c	
	=	1257	sqmm

Bottom Reinforcement Along B:

Critical Load Combination	=	[74] : 1.5 (Dead) +1.5 (FL) +1.5 (SDL) +1.5 (WALL) -1.5 (SPEC-XMax) -0.45 (SPEC-ZMax) -0.45 (SPEC-YMax)	
Pu	=	4869.84	kN
Mux	=	-184.45	kNm
Muy	=	18.34	kNm
P/A	=	714.05	kN/sqm
Mx/Zx	=	-52.35	kN/sqm
My/Zy	=	7.33	kN/sqm
Deff	=	676	mm
Leff	=	3100	mm
SPu	=	721.38	kN/sqm
Mu	=	SPu X L X Boff X Boff / 2	
	=	1009.13	kNm
Pt	=	0.153	%
Ast Rqd (BM)	=	3210	sqmm
Ast Prv (Distributed Across Total Length)	=	22 - T16 @ 150	
	=	4423	sqmm

Top Reinforcement Along B:

D	=	750	mm

	<=	1000	mm, Hence
Ast	=	Min Pt For Top Reinforcement X D X L	
	=	0.06% X 750 X 3100	
	=	1395	sqmm
Ast Prv (Distributed Across Total Length)	=	22 - T10 @ 150 c/c	
	=	1728	sqmm

Design For Shear:

One Way Shear Along L:

Critical Section @ d from Column Face

	=	692	mm
Critical Load Combination	=	[74] : 1.5 (Dead) +1.5 (FL) +1.5 (SDL) +1.5 (WALL) -1.5 (SPEC-XMax) -0.45 (SPEC-ZMax) -0.45 (SPEC-YMax)	
Pu	=	4869.84	kN
Mux	=	-184.45	kNm
Muy	=	18.34	kNm
P/A	=	714.05	kN/sqm
Mx/Zx	=	-52.35	kN/sqm
My/Zy	=	7.33	kN/sqm
Deff	=	692	mm
Beff	=	2200	mm
SPu	=	766.4	kN/sqm
Vu	=	SPu X (Loff - d) X B	
	=	435.01	kN
Tv	=	Vu / (Beff X Deff)	
	=	0.29	N/sqmm
Tc	=	0.3	N/sqmm
Tv	<	Tc	

One Way Shear Along B:

Critical Section @ d from Column Face

	=	676	mm
Critical Load Combination	=	[74] : 1.5 (Dead) +1.5 (FL) +1.5 (SDL) +1.5 (WALL) -1.5 (SPEC-XMax) -0.45 (SPEC-ZMax) -0.45 (SPEC-YMax)	
Pu	=	4869.84	kN
Mux	=	-184.45	kNm
Muy	=	18.34	kNm
P/A	=	714.05	kN/sqm
Mx/Zx	=	-52.35	kN/sqm
My/Zy	=	7.33	kN/sqm
Deff	=	676	mm

Leff	=	3100	mm
SPu	=	721.38	kN/sqm
Vu	=	SPu X (Boff - d) X L	
	=	612.74	kN
Tv	=	Vu / (Leff X Deff)	
	=	0.29	N/sqmm
Tc	=	0.3	N/sqmm
Tv	<	Tc	

Design For Punching Shear:

Critical Section @ d/2 from Column Face

	=	342	mm
Critical Load Combination	=	[74] : 1.5 (Dead) +1.5 (FL) +1.5 (SDL) +1.5 (WALL) -1.5 (SPEC-XMax) -0.45 (SPEC-ZMax) -0.45 (SPEC-YMax)	
Pu	=	4869.84	kN
Mux	=	-184.45	kNm
Muy	=	18.34	kNm
P/A	=	714.05	kN/sqm
Mx/Zx	=	-52.35	kN/sqm
My/Zy	=	7.33	kN/sqm
Deff	=	684	mm
Leff	=	1884	mm
Beff	=	984	mm
Punching Perimeter	=	5736	mm
Punching Area	=	3923424	sqmm
SPu	=	Average Pressure	
	=	714.05	kN/sqm
Vu	=	SPu X ((L X B)-(Leff X Beff))	
	=	3546.09	kN
Tv	=	Vu / Punching Area	
	=	0.904	N/sqmm
Tc	=	1.027	N/sqmm
Tv	<	Tc	

Load Transfer Check For Load Transfer From Column To Footing

Critical Load Combination	=	[74] : 1.5 (Dead) +1.5 (FL) +1.5 (SDL) +1.5 (WALL) -1.5 (SPEC-XMax) -0.45 (SPEC-ZMax) -0.45 (SPEC-YMax)	
Pu	=	4869.84	kN
A2	=	0.36	sqm
A1	=	13.86	sqm
Base Area	=	6.82	sqm
A1	>	Base Area	

Thus, A1	=	6.82
Modification Factor	=	SquareRoot(A1/A2) <= 2
SquareRoot(A1/A2)	=	4.3525
Thus, Modification Factor	=	2
Concrete Bearing Capacity	=	0.45 X Fck X Modification Factor X Column Area
	=	9720 kN
Concrete Bearing Capacity	>	Pu, Hence Safe.

WALL DESIGN

ETABS Shear Wall Design (THW10)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
FOUNDATION - 1ST FLOOR	THW10	31650	90300	900	300	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	31200	90300	32100	90300	900	300
Bottom	Leg 1	31200	90300	32100	90300	900	300

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	675	0.0025	0.0029	1.5 DL+(SPEC-ZW+0.3SPEC-XW+0.3SPEC-YW)	2584.5517
Bottom	1450	0.0054	0.0029	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	3016.3235

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
51.691	-146.8401	270000
60.3265	384.1933	270000

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	750	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1669.4965	-22.5547	171.3497	93.96	288.8296
Bottom	Leg 1	750	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1703.3909	384.1933	171.3497	123.003	317.8726

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	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2982.3804	-22.5547
Top–Right	Leg 1	300	0.9DL + 1.5(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2052.005	21.7778

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m
Bottom–Left	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	3016.3235	-245.2905
Botttom–Right	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	3016.3235	384.1933

Boundary Element Check (Part 2 of 2)

Stress Comp MPa	Stress Limit MPa
11.6	7
8.14	7
17.23	7
20.66	7

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)	LLRF
1ST -2ND FLOOR	THW10	31650	90300	900	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	31200	90300	32100	90300	900	200
Bottom	Leg 1	31200	90300	32100	90300	900	200

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

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN
Top	3794	0.0211	0.0028	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2616.9543
Bottom	4397	0.0244	0.0028	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2636.9563

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 mm²

M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
72.4546	-238.582	180000
72.8928	317.2378	180000

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	500	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1497.9966	59.9743	186.11	127.7873	257.7004
Bottom	Leg 1	500	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1517.9546	317.2378	186.11	127.7873	257.7004

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2616.9543	-238.582	23.38
Top–Right	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2616.9543	59.9743	16.76
Bottom–Left	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2636.9563	-132.2879	19.55
Botttom–Right	Leg 1	400	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2636.9563	317.2378	26.4

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
7
7
7
7

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)	LLRF
3RD FLOOR	THW10	31650	90300	900	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	31200	90300	32100	90300	900	200
Bottom	Leg 1	31200	90300	32100	90300	900	200

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

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN
Top	3181	0.0177	0.0028	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2280.8696
Bottom	3385	0.0188	0.0028	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2300.8809

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 mm²
68.2956	-263.6625	180000
68.7339	286.252	180000

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	500	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1368.3084	96.6619	184.0391	127.7873	257.7004
Bottom	Leg 1	500	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1388.2572	286.252	184.0391	127.7873	257.7004

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2280.8696	-263.6625	22.44
Top–Right	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2280.8696	96.6619	16.25
Bottom–Left	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2300.8809	-133.1075	17.71
Botttom–Right	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	2300.8809	286.252	23.38

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
7
7
7
7

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)	LLRF
4TH -7TH FLOOR	THW10	31650	90300	900	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	31200	90300	32100	90300	900	200
Bottom	Leg 1	31200	90300	32100	90300	900	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	2364	0.0131	0.0028	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1955.6513
Bottom	2458	0.0137	0.0028	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1975.6761

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
62.1719	-268.6716	180000
62.6105	273.3995	180000

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-XW+0.3SPEC-YW+0.3SPEC-ZW)	1223.6038	98.0221	181.0702	120.1861	250.0992
Bottom	Leg 1	500	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1243.539	273.3995	181.0702	122.2061	252.1192

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1955.6513	-268.6716	20.82

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Right	Leg 1	200	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1955.6513	98.0221	14.5
Bottom–Left	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1975.6761	-108.8062	15.01
Botttom–Right	Leg 1	300	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	1975.6761	273.3995	21.1

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
7
7
7
7

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)	LLRF
7TH - TERRACE	THW10	31650	90300	900	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	31200	90300	32100	90300	900	200
Bottom	Leg 1	31200	90300	32100	90300	900	200

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

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN
Top	1444	0.008	0.0028	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	140.9698
Bottom	921	0.0051	0.0028	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	160.8264

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 mm²
25.7841	-248.6842	180000
26.1588	179.3914	180000

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	500	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	140.9698	27.2066	144.434	68.9306	198.8437
Bottom	Leg 1	500	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	160.8264	179.3914	144.434	57.8402	187.7532

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-XW+0.3SPEC-YW+0.3SPEC-ZW)	202.56	-248.6842
Top–Right	Leg 1	0	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	202.56	27.2066
Bottom–Left	Leg 1	0	0.9DL + 1.5(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	145.9654	-31.3827
Botttom–Right	Leg 1	200	1.5 DL+(SPEC-XW+0.3SPEC-YW+0.3SPEC-ZW)	222.6633	179.3914

Boundary Element Check (Part 2 of 2)

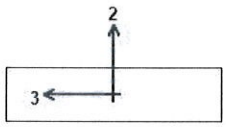
Stress Comp MPa	Stress Limit MPa
10.34	7
2.13	7
1.97	7
7.88	7

COLUMN DESIGN

ETABS Concrete Frame Design

IS 456:2000 Column Section Design (Summary)

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Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
GROUND	C10	118	C 200X800	1.5 DL+LL	2400	3000	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
800	200	56	30

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_c	γ_s
1.5	1.15

Axial Force and Biaxial Moment Design For P_u , M_{u2} , M_{u3}

Design P_u kN	Design M_{u2} kN-m	Design M_{u3} kN-m	Minimum M_2 kN-m	Minimum M_3 kN-m	Rebar Area mm²	Rebar % %
404.395	26.3829	-10.175	12.725	8.0879	1280	0.8

Axial Force and Biaxial Moment Factors

	K Factor Unitless	Length mm	Initial Moment kN-m	Additional Moment kN-m	Minimum Moment kN-m
Major Bend(M3)	1	2400	-4.07	0	8.0879
Minor Bend(M2)	1	2400	10.5532	0	12.725

Shear Design for V_{u2} , V_{u3}

	Shear V_u kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
Major, V_{u2}	7.2268	72.8805	46.0789	0	886.75
Minor, V_{u3}	17.7524	83.9382	59.5197	0	221.69

Joint Shear Check/Design

	Joint Shear Force kN	Shear V_{Top} kN	Shear $V_{u,Tot}$ kN	Shear V_c kN	Joint Area cm²	Shear Ratio Unitless
Major Shear, V_{u2}	N/N	N/N	N/N	N/N	N/N	N/N
Minor Shear, V_{u3}	N/N	N/N	N/N	N/N	N/N	N/N

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/N	N/N

Additional Moment Reduction Factor k (IS 39.7.1.1)

A_g cm²	A_{sc} cm²	P_{uz} kN	P_b kN	P_u kN	k Unitless
1600	12.8	3048	1004.1938	404.395	1

Additional Moment (IS 39.7.1)

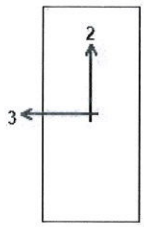
	Consider M_a	Length Factor	Section Depth (mm)	KL/Depth Ratio	KL/Depth Limit	KL/Depth Exceeded	M_a Moment (kN-m)
Major Bending (M_3)	Yes	0.8	200	12	12	No	0
Minor Bending (M_2)	Yes	0.8	800	3	12	No	0

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BEAM DESIGN

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design (Summary)



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Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
TYPICAL FLOOR	B73	1148	B 200X450	BEAM ENVELOPE	1782.9	1945	1	Ordinary 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)
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
2.8723	0.0001	16.6815	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
2.8723	0.0003	2.8725	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)		2.8725	125	15	0	125

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
16.6815	23.7845	32.4	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_{svt} /s mm²/m
0.0001	16.6815	130	380	0

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SLAB DESIGN

DESIGN OF SLAB : **TS22**

Panel Name : Two adjacent edges discontinuous Code : 8

Clear Longer span, ly = 4650 mm

Clear Shorter span, lx = 3600

ly / lx = 1.29 < 2, Hence, Twoway slab.

Effective Longer span = 4746.00 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) :

Weathering course =	0.000	kN/m^2
Floor finish =	1.200	kN/m^2
Partitions =	0.000	kN/m^2
	0.000	kN/m^2
Self weight =	3.125	kN/m^2
w_{DL} =	4.325	kN/m^2

Imposed Load (Not fixed) :

Assuming the Roof is inaccessible,

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

Live load =	2.000	kN/m^2
w_{LL} =	2.000	kN/m^2
Total load, $w = w_{DL} + w_{LL}$ =	6.325	kN/m^2

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Span Moments:

Along Shorter span: BM = $\alpha_x w l_x^2$ = 0.049 x 6.33 x 3.696^2 = 4.20 kNm M_{ux1} = 6.30 kNm

Along Longer span: BM = $\alpha_y w l_x^2$ = 0.035 x 6.33 x 3.696^2 = 3.02 kNm M_{uy1} = 4.54 kNm

Support Moments:

Along Shorter span: BM = $\alpha_x w l_x^2$ = 0.065 x 6.33 x 3.696^2 = 5.57 kNm M_{ux2} = 8.36 kNm

Along Longer span: BM = $\alpha_y w l_x^2$ = 0.047 x 6.33 x 3.696^2 = 4.06 kNm M_{uy2} = 6.09 kNm

Check for section :

Factored Max. BM, Mu = 8.36 kNm / m

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

Effective depth required = 44.94 mm < Effective depth available, OK

Along the Shorter span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{1 - \sqrt{(\ 1 - [4.6\ M_{ux1}/(f_{ck}\ bd^2)]\ )}\}\ b\ d =$ 140.98 mm^2 / m

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

A_{st} reqd at support :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{\ 1 - \sqrt{(\ 1 - [4.6\ M_{ux2}/(f_{ck}\ bd^2)])}\}\ b\ d =$ 188.88 mm^2 / m

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

Along the Longer span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{1 - \sqrt{(\ 1 - [4.6\ M_{uy1}/(f_{ck}\ bd^2)]\ )}\}\ b\ d =$ 100.74 mm^2 / m

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

A_{st} reqd at support :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{\ 1 - \sqrt{(\ 1 - [4.6\ M_{uy2}/(f_{ck}\ bd^2)])}\}\ b\ d =$ 136.21 mm^2 / m

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

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 /

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) = 178.95 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

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our services doesn't just end there

Buying & Selling Services

Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.



empowering your real estate decisions with smart tools

Property Valuation & Cost Estimation

Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

Ownership, Compliance & Legal Verification

Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

Verified RealEstate™

We're honored to be part of your real estate journey

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