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CIN : U45201TN2005PTC055334

21 years Service of Excellence

STRUCTURAL STABILITY CERTIFICATE

The detailed engineering and structure design of the proposed building **"ASTA AVM NOVA"** comprising with 3 Basement + Ground/Stilt part + 22 Upper floors and Terrace S. Nos. 14/3, 14/9, 15/2, 15/16, 24/2 and 24/5, Arcot Road, Sailigramam Village,Vadapalani, Chennai 600026,TN. of **M/s. SAPTHRISHI BUILDCON Pvt. Ltd.** having office at No.2, Radisson Blu Hotel, Ethiraj Salai, Egmore, Chennai-600008 within the limits of Greater Chennai Corporation has been done by us based on the report of the geotechnical investigation (soil test) done by Dr. B. Ram Prasad, Report No. 029/BRP/24-25 dated March 19th 2025 and considering the functional requirements of the building.

It is certified that among other factors, the proposed building has been designed to resist earthquake. We have checked various parameters and found that the proposed building would be safe.

We further certify that:

i. The minimum grade of concrete is M30

ii. The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS Code 875 and the design of earthquake resistant structure as per IS Code 1893:2016

The building will be safe and sound when used for the purpose for which it is designed.

Encl.: Structural Design Calculations

P. JEGATHEESAN, M.Tech. (Struct.)
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CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
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PROPOSED RESIDENTIAL DEVELOPMENT ASTA AVM AT VADAPALANI, CHENNAI

DESIGN BRIEF REPORT FOR STRUCTURAL SERVICES

Client:	ASTA	**M/s. ASTA PROPERTIES**
Structural Consultant:		**BURO ENGINEERS (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
19-11-2025	Primary Report	SUMANTH.K	P.J	R0

CONTENTS

1.0 PROJECT INFORMATION

1.1 Introduction:

This Design Brief Report (DBR) is for the Proposed Residential Development **ASTA AVM** at VADAPALANI, Chennai, for **M/s. ASTA Properties.**

The proposed **Residential Building** having 3 Basement + Ground floor + 22 Upper floors.
This report provides the information on Codes of Practice, Design loading, 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.

1.2 Facilities:

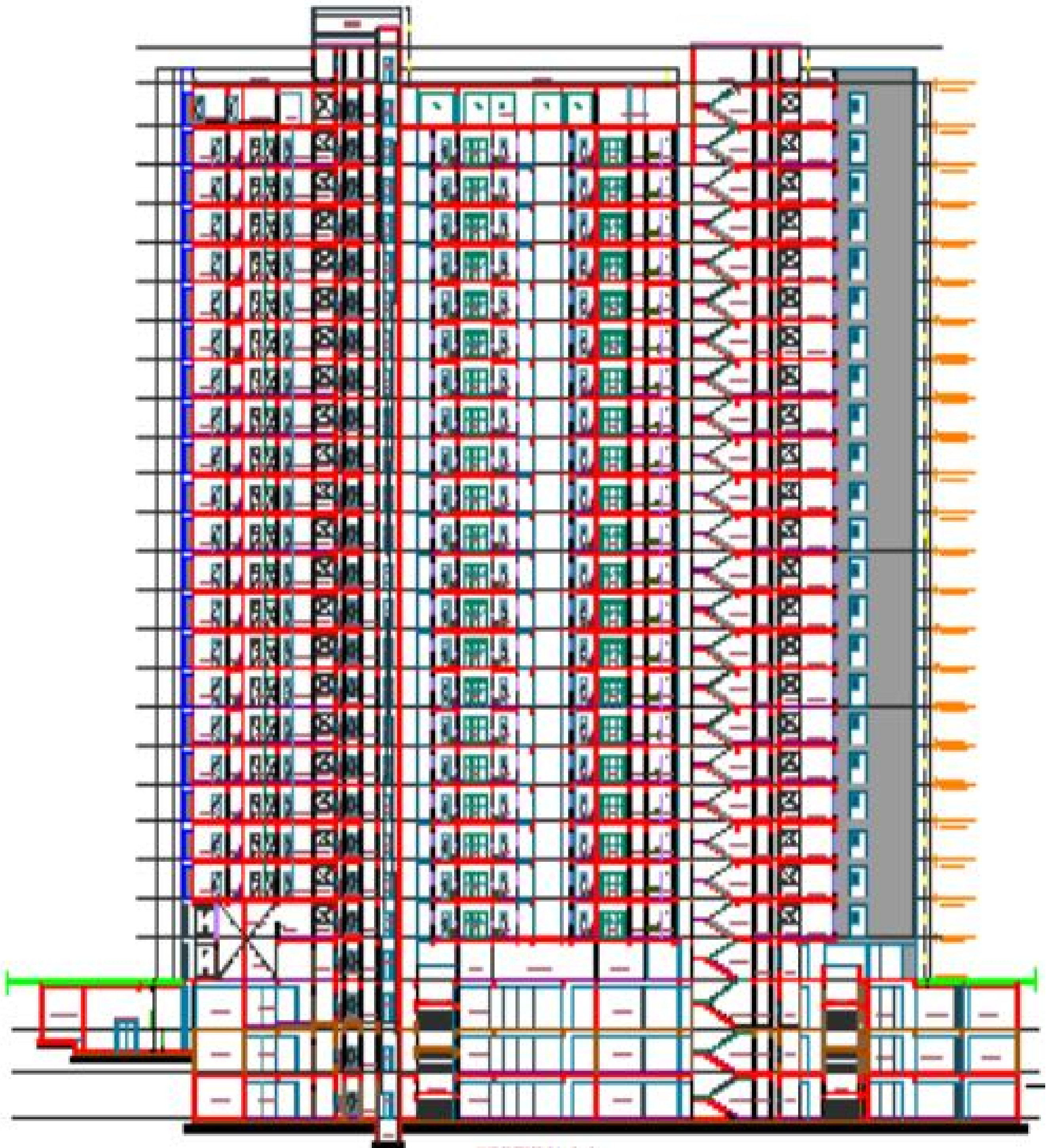
The proposed building, ASTA AVM, is primarily a residential building housing apartments, amenities such as party hall and car parking facilities at the substructure (Basement 1 to Basement 3).

2.0 STORY INFORMATION

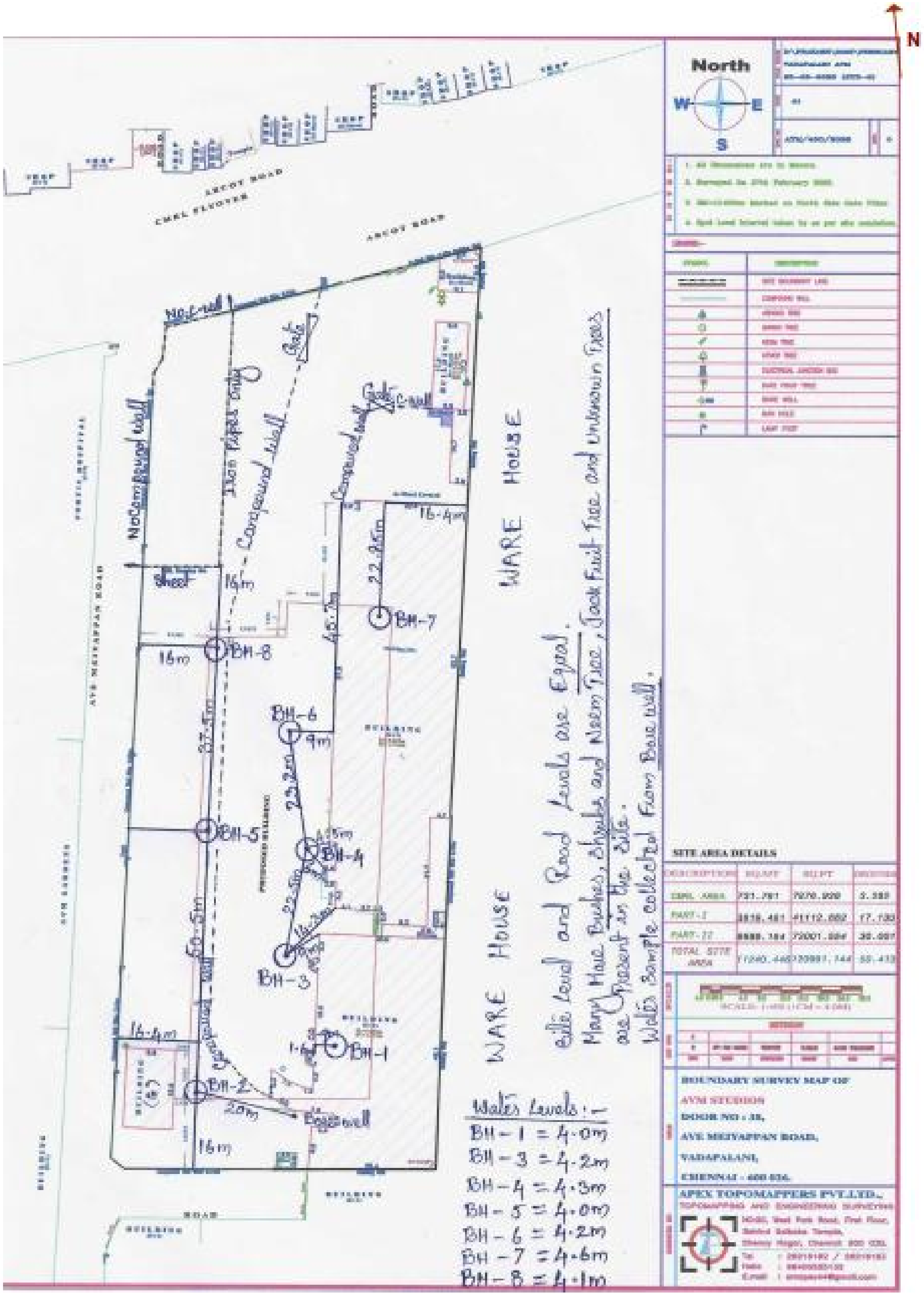
Story	**Facilities**
Basement-3, Basement-2 & Basement-1	Car parking, STP & UG Sump
Ground Floor	Entrance lobby, car parking, electrical room. Play area.
Extended Podium	Landscape & Fire drive way.
1st floor to 22nd floor	Residential units with each floor consists of eleven flats

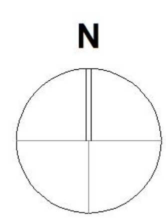
2.1 Floor to Floor Height:

Basement 3 & 2	3.6m
Basement 1	3.6m
Ground Floor	4m
1st to Roof	3.1m



SECTIONAL VIEW


North
W
E
S
N
ARCOT ROAD
CMRL FLYOVER
AVM MEIYAPPAN ROAD
No C-wall
No Compound wall
Iron Pipes only
Compound Wall
Gate
Compound wall
C-wall
WARE HOUSE
16-4m
22.85m
BH-7
Shed
16m
BH-8
45.7m
37.5m
BH-6
9m
23.2m
BH-5
BH-4
BH-3
50.5m
16-4m
BH-2
BH-1
20m
Bore well
WARE HOUSE
Site Level and Road Levels are Equal.
Many More Bushes, Shrubs and Neem Tree, Jack Fruit Tree and Unknown Trees are present in the site.
Water Sample collected From Bore well.
Water Levels:-
BH-1 = 4.0m
BH-3 = 4.2m
BH-4 = 4.3m
BH-5 = 4.0m
BH-6 = 4.2m
BH-7 = 4.6m
BH-8 = 4.1m
SITE AREA DETAILS
BOUNDARY SURVEY MAP OF
AVM STUDIOS
DOOR NO : 38,
AVE MEIYAPPAN ROAD,
VADAPALANI,
CHENNAI - 600 026.
APEX TOPOMAPPERS PVT.LTD.,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SITE PLAN

3 Ground Condition:

We have reviewed the following reports to understand the stratigraphy and ground conditions at the site.
Dr. B. Ram Prasad Consultants (P) Limited, , Group Housing Development at Arcot road, saligramam village vadapalani, Chennai, Geo-technical Investigation Report_2025.

The general geological sequence identified by the record of the borehole is as follows:

Stratum	**(Depth in m : from - to -) from existing ground level**
Brown Silty Fine to Medium Sand with brick and stone pieces - filledup soil	0 to 1.75m
Brown grey stiff clay - Medium sand with clay binder	1.75m to 5.0m
Gray soft to Stiff Clay	5.0m to 9.0m
Gray fine to Medium Sand with Silt.	9.0m to 10m
Gray soft to Stiff clay with shell fragments	10.0m to 28.5m
Gray fine to Medium sand with silt	28.5m to 29m
Blue brown Gray shale	29.0m to 34.5+

The geotechnical implications indicates the soil profile contains heterogeneous conditions **requiring deep foundation.**

4.0 CODES OF PRACTICE

The relevant Indian Standard codes below are followed.

4.1 Code, Standards and 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 – 2023	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

5.0 COVER AND FIRE RATING

Cover to reinforcement considered for various elements

Structural element	Exposure condition	Fire rating in hours	Cover	
Pile Cap	Severe		75 (Bottom)	75 (Top)
Basement- 3 Floor slab	Severe		50 (Bottom)	25 (Top)
Basement wall	Severe		45 (Soil side)	30 (Building side)
Column		2	40	
Shear wall		2	30	
Beam (Simply supported)		2	40	
Beam (Continuous)		2	30	
Slab (Simply supported)		2	35	
Slab (Continuous)		2	25	

6.0 STRUCTURAL SYSTEM

Floor system:- The structural Floor system for the super structure is R.C.C Beam with R.C.C Slab. The slab thicknesses are to be 125mm/150mm/175mm. And for the Sub structure floor system is RCC Beam and RCC Slab.

Lateral load resisting system:

Building with ductile RC structural walls.

7.0 FOUNDATION SYSTEM

The following are inferred from the Geo-technical investigation report.

A total of 8 boreholes were terminated after drilling approximately +28m depth in refusal/rock strata. Refusal strata encountered is in the form of **Brown Gray veryHard Clay**. The N value recorded at this depth is more than 100.

The report has also stated the **ground water table is encountered at 4m from road level.** We have considered design water head from the ground level for the pile-cap and stitch-slab design. For stitch slab **anchors** are used to counter the uplift force due to water pressure.

Heavy duty hydraulic Rotary Rig Bored Cast In-Situ Pile

Pile Dia. M	Compressive Capacity		Uplift Capacity		Lateral Capacity @ 5 mm Defl.
	Ultimate Tons	Allowable Tons	Ultimate Tons	Allowable Tons	Allowable Tons
0.60	344.58	125	228.97	76	2.17
0.75	470.50	171	289.87	97	3.30
0.90	612.33	223	352.22	117	4.62
1.00	715.73	260	394.60	132	5.60
1.20	943.73	343	481.31	160	7.78

Hence Foundation system adopted is **Combined Pile-cap for Tower and Isolated & combined Pile-cap with Stitch slab for extended basement.** The Pile capacity considered for the design is 260**T for 1000mm diameter Pile (As per the results inferred from the Pile Load Test)** with reference to the soil investigation report. And basement stitch slabs are designed for water **uplift pressure of 112.0kN/m2.**

8.0 MATERIAL GRADES

Materials specified will confirm to the latest edition of the relevant Indian Standards. Specifications for materials will include for sampling and testing as stipulated in the design standards. Detailed material specifications will be included in the Technical specifications.

8.1 Concrete

Durability provisions for concrete structures shall be as per **'Extreme'** conditions of environment in accordance with IS 456:2000.
Keeping the durability and structural requirements, the proposed Compressive Strength of structural concrete at 28 days, for various structural elements/members are as indicated in the below table

Structural Elements		**Compressive Strength at 28 days**	**Concrete grade**
Minimum grade of concrete for any structural member is considered as		30 N/Sq.mm	M30
All Structural concrete for :			
Columns, Shear walls & Core walls	Foundation to 22th Floor level	50 N/Sq.mm	M50
Pile		30 N/Sq.mm	M30
Pilecap		30 N/Sq.mm	M30
Beams and slabs	Basement to roof Floor level	35 N/Sq.mm	M35
Overhead Water Tank, UG Water Tank, STP & Pump room		30 N/Sq.mm	M30

8.2 Reinforcement

All reinforcement shall confirm to IS: 1786-2008 having minimum yield strength of 550 N/sq mm (Fe 550D).

Youngs' Modulus (Es)	200,000N/Sq.mm
Yield Stress (fy)	550 N/Sq.mm
Diameters {in mm} (d)	8, 10, 12, 16, 20, 25 & 32
Density (ϒ)	78.5 kN/cum

9.0 DESIGN OF LOADINGS

9.1 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.
Aerated block masonry	-	10.0 KN / Cum.

9.2 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.

Usage	SDL (kN/m2)				LL (kN/m2)
	Partition Wall	Services	Finishes	Total	
Parking - Cars	0.00	0.50	2.40	2.90	3.00
Staircase	0.00	0.00	3.60	3.00	3.00
Toilet	0.00	0.50	1.80	2.30	2.00
Bed, Living, Dinning & Kitchen (Rooms)	0.00	0.00	1.50	1.50	2.00
Balcony	0.00	0.60	1.80	2.40	3.00
Lobby & Corridor	0.00	0.00	2.40	2.40	3.00
Refuge	0.00	0.00	2.40	2.40	5.00

ROOF	0.00	0.00	3.60	3.60	5.00
OHT	0.00	10xWater Height	1.80	0.00	0.00
Fire Driveway	0.00	15.00		15.00	15.00

* (GF) - Ground floor

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

a) **SUPER IMPOSED DEAD LOADS (kN/m^2)**

Floor Finishes of 50 mm thickness have been considered on all the typical floors, Basement floors 100mm, toilet-50mm, balcony-75mm,

TERRACES (Load in kN/m2)

Waterproofing + Screed 3.60 (0.15(average floor finish.) x 24=3.60)

b) **SELF-WEIGHT OF LIGHT WEIGHT WALLS (kN/m^2)**

Infill walls (15mm plastering on either side)

(i) 200mm thick light weight block wall - 2.60kN/m^2
(ii) 100mm thick light weight block wall - 1.60kN/m^2

RCC walls

(i) 200mm thick RCC wall - 5.00kN/m^2
(ii) 100mm thick RCC wall - 2.50kN/m^2

Water Tank Water height x 10

9.3 Seismic Design Parameters:

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 and 50% of live load greater that 5 kN/sq.m

1) The lateral load resisting system of the buildings is **ductile shear wall.**
2) As per IS 1893:2016 code, Chennai 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 (Rock or Dense soil)
4) Seismic Force-Resisting System:

   The building employs **ductile RC structural walls** as the primary lateral load-resisting system. Accordingly, the **Response Reduction Factor (R) = 4.0** is adopted, based on **IS 1893 (Part 1): 2016,** Table 9, Sl. No. (iii)(c). As per **Note 3** of the same table, the moment-resisting frames do not fulfill the requirements of a “dual system”.

   Sa/g = Average Response acceleration coefficient

   For the building height with reference to IS: 1893-2016, since the buildings are well connected with basement walls so for the time period calculation the heights are considered ground floor to roof that is 105.05m.

The fundamental natural period (Ta) for building is calculated based on the empirical formula,

$T_a = 0.0672\ H^{0.75}$ (As per IS 16700:2023 Cl.6.3.4)

Where,

Base Dimension along X Direction, dx = 75.35m

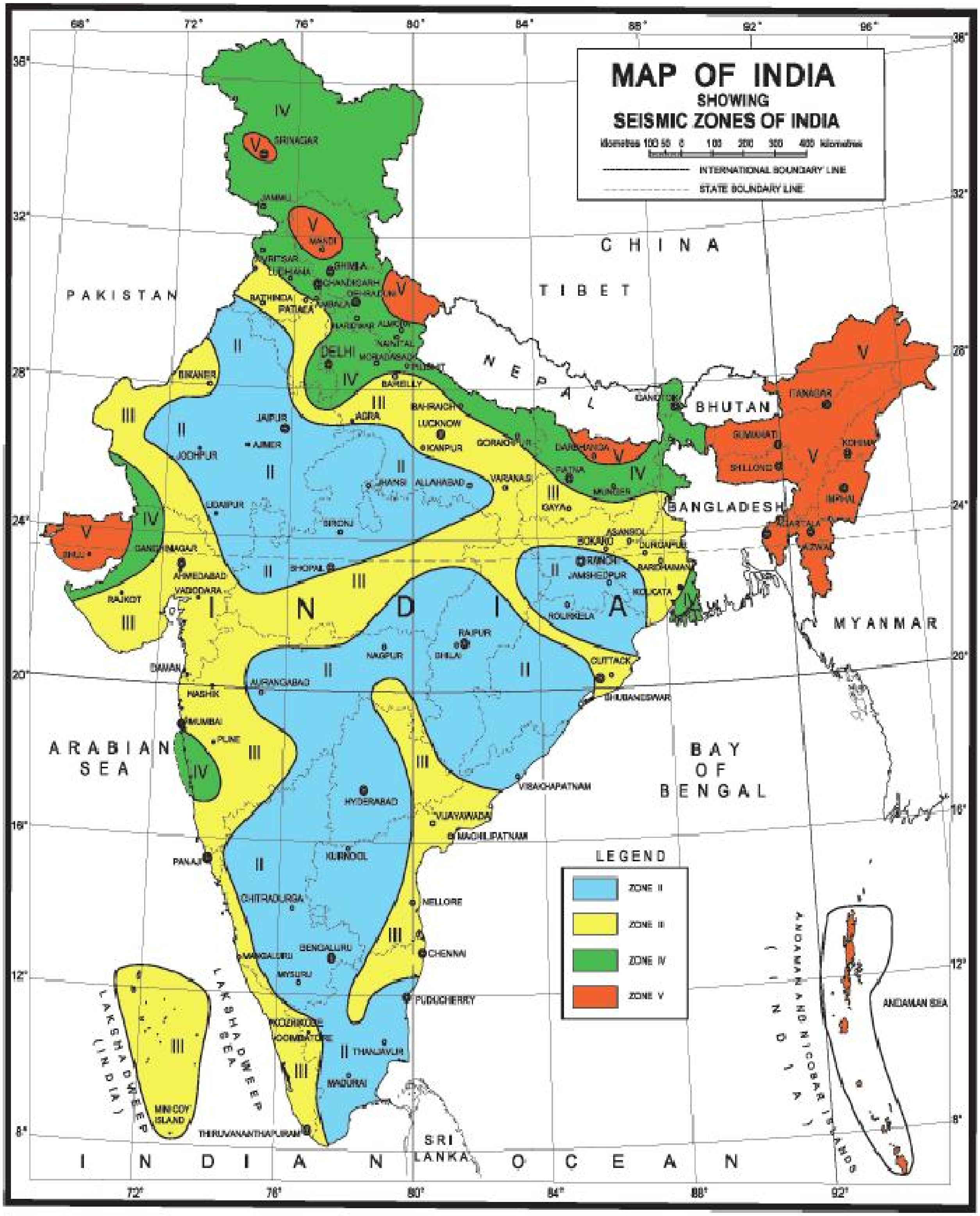
Base Dimension along Y Direction, dy = 35.6m

H = 74.6m

Min Ah = 1.1 (As per Table 7 of IS 1893(Part 1:2016)

T_a = 1.67 (along X direction)

T_a = 1.67 (along Y direction)



<u>***SEISMIC ZONE CLASSIFICATION FROM IS 1893 : 2016***</u>

Dynamic Analysis

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

Number of modes Considered	: 10 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.

9.5 Wind Loads

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

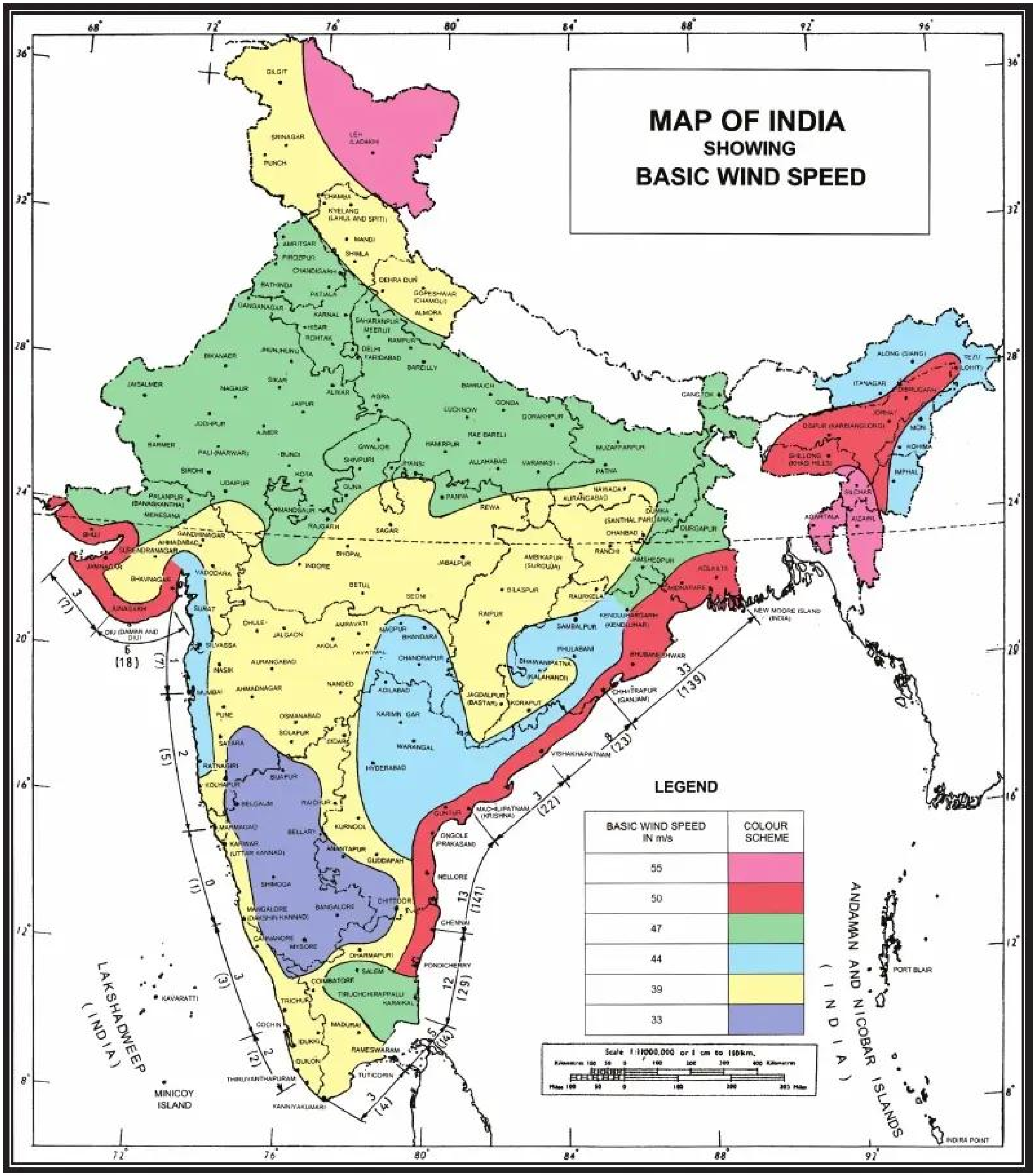
Design Wind Speed, VZ		= Vbxk1x k2x k3x k4
Vb	→ Basic Wind velocity for Chennai	= 50m/s
K1	→ Risk coefficient for all general buildings	= 1.00
k2	→ Terrain category 2	= To suit the height of the structure for terrain
k2 (H=74.6m -GF to Roof including parapet wall)		= 1.15
k3	→ Topography factor	= 1.00
k4	→ Importance Factor for cyclonic Region	= 1.00

Based on the above,

Max. design wind speed (VZ) (Vbxk1x k2x k3x k4) = 57.5 m/s

Max. design wind pressure (Pz)	= 0.6 x Vz2	= 1983.75 N/m2
Design wind pressure: pd	= Pz x Kax Kd x Kc	= 1446.15 N/m2

Kd	→ Wind directionality factor	= 0.90
ka	→ Area averaging factor	= 0.90
Kc	→ Combination factor	= 0.90



Based upon Survey of India Outline Map printed in 1993.

The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.
The boundary of Meghalaya shown on this map is as interpreted from the North-Eastern Areas (Reorganisation) Act, 1971, but has yet to be verified.
Responsibility for correctness of internal details shown on the map rests with the publisher.
The state boundaries between Uttaranchal & Uttar Pradesh, Bihar & Jharkhand and Chhatisgarh & Madhya Pradesh have not been verified by Governments concerned.

FIG. 1 BASIC WIND SPEED IN m/s (BASED ON 50-YEARS RETURN PERIOD)

INDIAN WIND SPEED CLASSIFICATION FROM IS 875 PART (III)

9.6 Temperature Loads:

The building is completely covered with block 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.

10.0 LOAD COMBINATION

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 ± 30%SPECY ± 30%SPECZ)
3. 1.2 (DL + LL ± SPECY ± 30%SPECX ± 30%SPECZ)
4. 1.2 (DL + LL ± SPECZ ± 30%SPECX ± 30%SPECY)
5. 1.2 (DL + LL ± WindX)
6. 1.2 (DL + LL ± WindY)
7. 1.5 (DL ± SPECX ± 30%SPECY ± 30%SPECZ)
8. 1.5 (DL ± SPECY ± 30%SPECX ± 30%SPECZ)
9. 1.5 (DL ± SPECZ ± 30%SPECX ± 30%SPECY)
10. 1.5 (DL ± WindX)
11. 1.5 (DL ± WindY)
12. 0.9DL ± 1.5(SPECX ± 30%SPECY ± 30%SPECZ)
13. 0.9DL ± 1.5(SPECY ± 30%SPECX ± 30%SPECZ)
14. 0.9DL ± 1.5(SPECZ ± 30%SPECX ± 30%SPECY)
15. 0.9DL ± 1.5WindX
16. 0.9DL ± 1.5WindY

Where accidental / fire tender load case is applicable, the following load combination is considered

17. 1.5 DL + 1.05 AL + 1.50 LL

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

18. 1.0DL +1.0 LL
19. 1.0DL ± 1.0SPECX
20. 1.0DL ± 1.0SPECY
21. 1.0DL ± 1.0WindX
22. 1.0DL ± 1.0WindY
23. 1.0DL ± 1.0TEMP
24. 1.0DL + 0.8LL ± 0.8SPECX
25. 1.0DL + 0.8LL ± 0.8SPECY
26. 1.0DL + 0.8LL ± 0.8WindX
27. 1.0DL + 0.8LL ± 0.8WindY
28. 1.0DL + 0.75LL ± 0.75TEMP
29. 1.0DL + 0.5LL ± 0.75TEMP ± 0.75SPECX

30. 1.0DL + 0.5LL ± 0.75TEMP ± 0.75SPECY
31. 1.0DL + 0.5LL ± 0.75TEMP ± 0.75WindX
32. 1.0DL + 0.5LL ± 0.75TEMP ± 0.75WindY

Where,	DL	- Dead load,
	LL	- Live load (Live>3kN/m2, Live<=3kN/m2)
	Wind X	- Wind load in X - direction
	Wind Y	- Wind load in Y - direction
	SPECX	- Earthquake load in X - direction
	SPECY	- Earthquake load in Y - direction
	TEMP	- Temperature load
	AL	- Accidental Load (such as fire tender load)

11.0 SERVICIBILITY LIMITS

11.1 Lateral Deflection (Wind)

Overall Deflection	<	Height/500
Storey Deflection	<	Storey height/500

11.2 Lateral Deflection (Seismic)

Overall Drift	<	H / 250
Storey Drift	<	0.004 times storey height

11.3 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.

12.0 STRUCTURAL ANALYSIS AND DESIGN APPROACH

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 - Semi Rigid Diaphragm.
Slab/Wall element considered as Shell element

Stiffness modification factors are adopted in the analysis as per IS -16700-2023, Table5.

Table 5 Cracked Section Properties of RC members

(*Clauses* 5.5.2,7.3.6, 8.1.3.2.1 *and* 7.2)

Sl No.	Structural Element	Serviceability Design		Strength Design	
		Cross-Sectional Area	Moment of Inertia	Cross-Sectional Area	Moment of Inertia
(1)	(2)	(3)	(4)	(5)	(6)
i)	Slabs	$1.0A_g$	$0.35I_g$	$1.00A_g$	$0.25\ I_g$
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	$1.0\ A_g$	$0.9\ I_g$	$1.00\ A_g$	$0.70\ I_g$

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 infill 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 modeled 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, Table.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

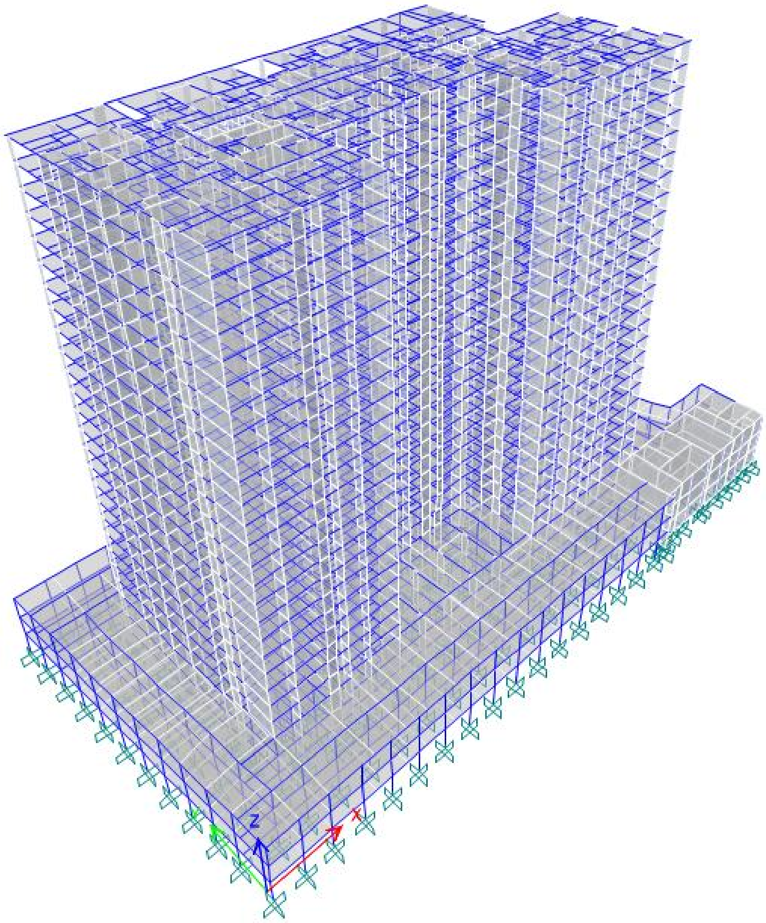
Shear wall/Column:
RC Structural Walls & Columns which are supporting both vertical loads and lateral forces are designed for the most adverse load conditions and envelope of the forces which will be the maximum for that structural element from the load combinations considered in the 3D ETABS Model.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

13.0 COMPUTER PROGRAMS

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

1.	PROKON Ver 3.0	- 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 Tension Analysis & Design
6.	RCDC	- Beam Design, Isolated footing design, Column design and Wall design
STAAD PRO & ETABS		- Structural Steel Design.

ETABS®



ASTA AVM NOVA

Model File: AVM-1, Revision 0
12-Dec-25

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	UPPER ROOF	3.1	No	None	No	Green
T1	ROOF	3.1	No	1ST	No	Red
T1	22TH	3.1	No	1ST	No	Yellow
T1	21TH	3.1	No	1ST	No	Blue
T1	20TH	3.1	No	1ST	No	Cyan
T1	19TH	3.1	No	1ST	No	Magenta
T1	18TH	3.1	No	1ST	No	Gray8Dark
T1	17TH	3.1	No	1ST	No	Green
T1	16TH	3.1	No	1ST	No	Red
T1	15TH	3.1	No	1ST	No	Yellow
T1	14TH	3.1	No	1ST	No	Blue
T1	13TH	3.1	No	1ST	No	Cyan
T1	12TH	3.1	No	1ST	No	Magenta
T1	11TH	3.1	No	1ST	No	Gray8Dark
T1	10TH	3.1	No	1ST	No	Green
T1	9TH	3.1	No	1ST	No	Red
T1	8TH	3.1	No	1ST	No	Yellow
T1	7TH	3.1	No	1ST	No	Blue
T1	6TH	3.1	No	1ST	No	Cyan
T1	5TH	3.1	No	1ST	No	Magenta
T1	4TH	3.1	No	None	No	Gray8Dark
T1	3RD	3.1	No	1ST	No	Green
T1	2ND	3.1	No	1ST	No	Red
T1	1ST	3.3	Yes	None	No	Yellow
T1	GF	4	No	BASEMENT-1	No	Blue
T1	BASEMENT-1	3.6	Yes	None	No	Cyan
T1	BASEMENT-2	3.6	No	BASEMENT-1	No	Magenta

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

Eccentricity Ratio = 0% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period   T=1.67 sec

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3]

Response Reduction Factor, R [IS Table 9]   Z=0.16

Importance Factor, I [IS Table 8]

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.2]   <Sa>/<g>=<1>/<T>   <Sa>/<g>=0.598802

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2]   Ah=<Z<I><<Sa>/<g>>>/<2<R>>

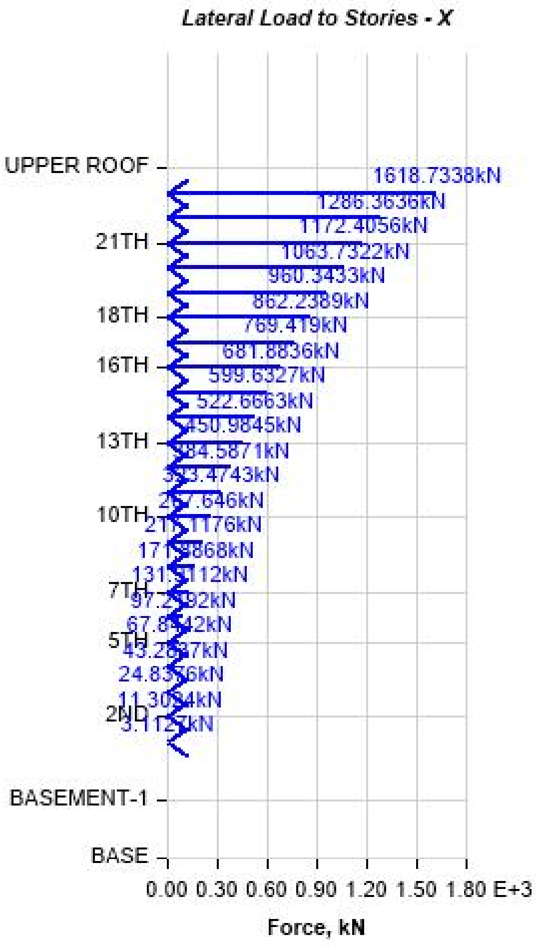
Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X	1.67	816395.2386	11732.6262

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
UPPER ROOF	85.8	0	0
ROOF	82.7	1618.7338	0
22TH	79.6	1286.3636	0
21TH	76.5	1172.4056	0
20TH	73.4	1063.7322	0
19TH	70.3	960.3433	0
18TH	67.2	862.2389	0
17TH	64.1	769.419	0
16TH	61	681.8836	0

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
15TH	57.9	599.6327	0
14TH	54.8	522.6663	0
13TH	51.7	450.9845	0
12TH	48.6	384.5871	0
11TH	45.5	323.4743	0
10TH	42.4	267.646	0
9TH	39.3	217.1176	0
8TH	36.2	171.8868	0
7TH	33.1	131.9112	0
6TH	30	97.2192	0
5TH	26.9	67.8442	0
4TH	23.8	43.2837	0
3RD	20.7	24.8376	0
2ND	17.6	11.3024	0
1ST	14.5	3.1127	0
GF	11.2	0	0
BASEMENT-1	7.2	0	0
BASEMENT-2	3.6	0	0
BASE	0	0	0



Set 1

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

Eccentricity Ratio = 0% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period T=1.67 sec

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3]

Response Reduction Factor, R [IS Table 9]

Z=0.16

Importance Factor, I [IS Table 8]

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.2] <Sa>/<g>=<1>/<T> <Sa>/<g>=0.598802

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] Ah=<Z<I><<Sa>/<g>>>/<2<R>>

Calculated Base Shear

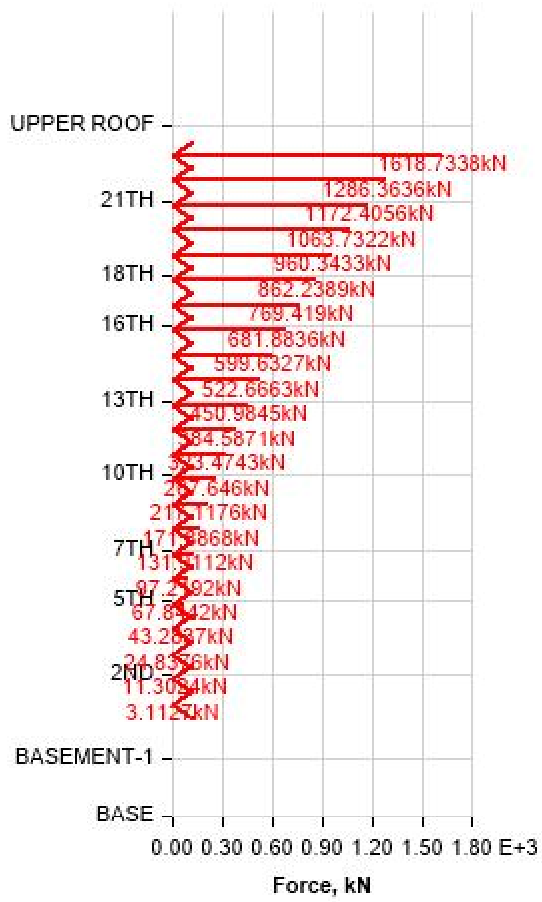
Direction	Period Used (sec)	W (kN)	V_b (kN)
Y	1.67	816395.2386	11732.6262

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
UPPER ROOF	85.8	0	0
ROOF	82.7	0	1618.7338
22TH	79.6	0	1286.3636
21TH	76.5	0	1172.4056
20TH	73.4	0	1063.7322
19TH	70.3	0	960.3433
18TH	67.2	0	862.2389
17TH	64.1	0	769.419
16TH	61	0	681.8836
15TH	57.9	0	599.6327
14TH	54.8	0	522.6663
13TH	51.7	0	450.9845
12TH	48.6	0	384.5871
11TH	45.5	0	323.4743
10TH	42.4	0	267.646

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
9TH	39.3	0	217.1176
8TH	36.2	0	171.8868
7TH	33.1	0	131.9112
6TH	30	0	97.2192
5TH	26.9	0	67.8442
4TH	23.8	0	43.2837
3RD	20.7	0	24.8376
2ND	17.6	0	11.3024
1ST	14.5	0	3.1127
GF	11.2	0	0
BASEMENT-1	7.2	0	0
BASEMENT-2	3.6	0	0
BASE	0	0	0

Lateral Load to Stories - Y



Set 1

2.2 Load Combinations

Table 2.1 - Load Combination Definitions

Name	Type	Is Auto	Load Name	SF	Notes
1) 1.5DL+1.5LL	Linear Add	No	Dead	1.5	
1) 1.5DL+1.5LL			Live	1.5	
1) 1.5DL+1.5LL			sdl	1.5	
1) 1.5DL+1.5LL			wall	1.5	
1) 1.5DL+1.5LL			Live>3	1.5	
1) 1.5DL+1.5LL			TEMP	1	
2) 0.9 DL-1.5WX	Linear Add	No	Dead	0.9	
2) 0.9 DL-1.5WX			WINDX	-1.5	
2) 0.9 DL-1.5WX			sdl	0.9	
2) 0.9 DL-1.5WX			wall	0.9	
2) 0.9 DL-1.5WX			TEMP	1	
3) 0.9 DL-1.5WY	Linear Add	No	Dead	0.9	
3) 0.9 DL-1.5WY			WINDY	-1.5	
3) 0.9 DL-1.5WY			sdl	0.9	
3) 0.9 DL-1.5WY			wall	0.9	
3) 0.9 DL-1.5WY			TEMP	1	
4) 0.9DL+1.5SPECX	Linear Add	No	Dead	0.9	
4) 0.9DL+1.5SPECX			SPEC-X	1.5	
4) 0.9DL+1.5SPECX			sdl	0.9	
4) 0.9DL+1.5SPECX			wall	0.9	
4) 0.9DL+1.5SPECX			SPEC-Y	0.45	
4) 0.9DL+1.5SPECX			SPEC-Z	0.45	
4) 0.9DL+1.5SPECX			TEMP	1	
5) 0.9DL+1.5SPECY	Linear Add	No	Dead	0.9	
5) 0.9DL+1.5SPECY			SPEC-Y	1.5	
5) 0.9DL+1.5SPECY			sdl	0.9	
5) 0.9DL+1.5SPECY			wall	0.9	
5) 0.9DL+1.5SPECY			SPEC-X	0.45	
5) 0.9DL+1.5SPECY			SPEC-Z	0.45	
5) 0.9DL+1.5SPECY			TEMP	1	
5 A) 0.9DL+1.5SPECZ	Linear Add	No	Dead	0.9	
5 A) 0.9DL+1.5SPECZ			SPEC-Z	1.5	
5 A) 0.9DL+1.5SPECZ			sdl	0.9	
5 A) 0.9DL+1.5SPECZ			wall	0.9	
5 A) 0.9DL+1.5SPECZ			SPEC-X	0.45	
5 A) 0.9DL+1.5SPECZ			SPEC-Y	0.45	
5 A) 0.9DL+1.5SPECZ			TEMP	1	
6) 0.9 DL+1.5WX	Linear Add	No	Dead	0.9	
6) 0.9 DL+1.5WX			WINDX	1.5	
6) 0.9 DL+1.5WX			sdl	0.9	
6) 0.9 DL+1.5WX			wall	0.9	
6) 0.9 DL+1.5WX			TEMP	1	
7) 0.9 DL+1.5WY	Linear Add	No	Dead	0.9	
7) 0.9 DL+1.5WY			WINDY	1.5	
7) 0.9 DL+1.5WY			sdl	0.9	
7) 0.9 DL+1.5WY			wall	0.9	
7) 0.9 DL+1.5WY			TEMP	1	
8) 1.2 DL-1.2WX	Linear Add	No	Dead	1.2	
8) 1.2 DL-1.2WX			WINDX	-1.2	
8) 1.2 DL-1.2WX			sdl	1.2	
8) 1.2 DL-1.2WX			wall	1.2	
8) 1.2 DL-1.2WX			Live	1.2	
8) 1.2 DL-1.2WX			Live>3	1.2	
8) 1.2 DL-1.2WX			TEMP	1	
9) 1.2 DL-1.2WY	Linear Add	No	Dead	1.2	
9) 1.2 DL-1.2WY			WINDY	-1.2	
9) 1.2 DL-1.2WY			sdl	1.2	
9) 1.2 DL-1.2WY			wall	1.2	

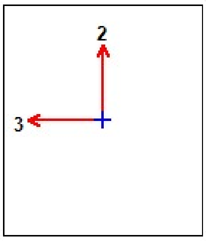
Name	Type	Is Auto	Load Name	SF	Notes
9) 1.2 DL-1.2WY			Live	1.2	
9) 1.2 DL-1.2WY			Live>3	1.2	
9) 1.2 DL-1.2WY			TEMP	1	
10) 1.2 DL+1.2WX	Linear Add	No	Dead	1.2	
10) 1.2 DL+1.2WX			WINDX	1.2	
10) 1.2 DL+1.2WX			sdl	1.2	
10) 1.2 DL+1.2WX			wall	1.2	
10) 1.2 DL+1.2WX			Live	1.2	
10) 1.2 DL+1.2WX			Live>3	1.2	
10) 1.2 DL+1.2WX			TEMP	1	
11) 1.2 DL+1.2WY	Linear Add	No	Dead	1.2	
11) 1.2 DL+1.2WY			WINDY	1.2	
11) 1.2 DL+1.2WY			sdl	1.2	
11) 1.2 DL+1.2WY			wall	1.2	
11) 1.2 DL+1.2WY			Live	1.2	
11) 1.2 DL+1.2WY			Live>3	1.2	
11) 1.2 DL+1.2WY			TEMP	1	
12) 1.5 DL-1.5WX	Linear Add	No	Dead	1.5	
12) 1.5 DL-1.5WX			WINDX	-1.5	
12) 1.5 DL-1.5WX			sdl	1.5	
12) 1.5 DL-1.5WX			wall	1.5	
12) 1.5 DL-1.5WX			TEMP	1	
13) 1.5 DL-1.5WY	Linear Add	No	Dead	1.5	
13) 1.5 DL-1.5WY			WINDY	-1.5	
13) 1.5 DL-1.5WY			sdl	1.5	
13) 1.5 DL-1.5WY			wall	1.5	
13) 1.5 DL-1.5WY			TEMP	1	
14) 1.5 DL+1.5WX	Linear Add	No	Dead	1.5	
14) 1.5 DL+1.5WX			WINDX	1.5	
14) 1.5 DL+1.5WX			sdl	1.5	
14) 1.5 DL+1.5WX			wall	1.5	
14) 1.5 DL+1.5WX			TEMP	1	
15) 1.5 DL+1.5WY	Linear Add	No	Dead	1.5	
15) 1.5 DL+1.5WY			WINDY	1.5	
15) 1.5 DL+1.5WY			sdl	1.5	
15) 1.5 DL+1.5WY			wall	1.5	
15) 1.5 DL+1.5WY			TEMP	1	
16) 1.5 DL+1.5 SPECX	Linear Add	No	Dead	1.5	
16) 1.5 DL+1.5 SPECX			SPEC-X	1.5	
16) 1.5 DL+1.5 SPECX			sdl	1.5	
16) 1.5 DL+1.5 SPECX			wall	1.5	
16) 1.5 DL+1.5 SPECX			SPEC-Z	0.45	
16) 1.5 DL+1.5 SPECX			SPEC-Y	0.45	
16) 1.5 DL+1.5 SPECX			TEMP	1	
17) 1.5 DL+1.5 SPECY	Linear Add	No	Dead	1.5	
17) 1.5 DL+1.5 SPECY			SPEC-Y	1.5	
17) 1.5 DL+1.5 SPECY			sdl	1.5	
17) 1.5 DL+1.5 SPECY			wall	1.5	
17) 1.5 DL+1.5 SPECY			SPEC-X	0.45	
17) 1.5 DL+1.5 SPECY			SPEC-Z	0.45	
17) 1.5 DL+1.5 SPECY			TEMP	1	
17 A) 1.5 DL+1.5 SPEC Z	Linear Add	No	Dead	1.5	
17 A) 1.5 DL+1.5 SPEC Z			SPEC-Z	1.5	
17 A) 1.5 DL+1.5 SPEC Z			sdl	1.5	
17 A) 1.5 DL+1.5 SPEC Z			wall	1.5	
17 A) 1.5 DL+1.5 SPEC Z			SPEC-X	0.45	
17 A) 1.5 DL+1.5 SPEC Z			SPEC-Y	0.45	
17 A) 1.5 DL+1.5 SPEC Z			TEMP	1	
18) 1.2 DL+1.2SPECX	Linear Add	No	Dead	1.2	
18) 1.2 DL+1.2SPECX			SPEC-X	1.2	
18) 1.2 DL+1.2SPECX			sdl	1.2	

Name	Type	Is Auto	Load Name	SF	Notes
18) 1.2 DL+1.2SPECX			wall	1.2	
18) 1.2 DL+1.2SPECX			Live	1.2	
18) 1.2 DL+1.2SPECX			Live>3	1.2	
18) 1.2 DL+1.2SPECX			SPEC-Y	0.36	
18) 1.2 DL+1.2SPECX			SPEC-Z	0.36	
18) 1.2 DL+1.2SPECX			TEMP	1	
19) 1.2 DL+1.2SPECY	Linear Add	No	Dead	1.2	
19) 1.2 DL+1.2SPECY			SPEC-Y	1.2	
19) 1.2 DL+1.2SPECY			sdl	1.2	
19) 1.2 DL+1.2SPECY			wall	1.2	
19) 1.2 DL+1.2SPECY			Live	1.2	
19) 1.2 DL+1.2SPECY			Live>3	1.2	
19) 1.2 DL+1.2SPECY			SPEC-X	0.36	
19) 1.2 DL+1.2SPECY			SPEC-Z	0.36	
19) 1.2 DL+1.2SPECY			TEMP	1	
19 A) 1.2 DL+1.2SPEC Z	Linear Add	No	Dead	1.2	
19 A) 1.2 DL+1.2SPEC Z			SPEC-Z	1.2	
19 A) 1.2 DL+1.2SPEC Z			sdl	1.2	
19 A) 1.2 DL+1.2SPEC Z			wall	1.2	
19 A) 1.2 DL+1.2SPEC Z			Live	1.2	
19 A) 1.2 DL+1.2SPEC Z			Live>3	1.2	
19 A) 1.2 DL+1.2SPEC Z			SPEC-X	0.36	
19 A) 1.2 DL+1.2SPEC Z			SPEC-Y	0.36	
19 A) 1.2 DL+1.2SPEC Z			TEMP	1	
ENVELOPE	Envelope	No	1) 1.5DL+1.5LL	1	
ENVELOPE			2) 0.9 DL-1.5WX	1	
ENVELOPE			3) 0.9 DL-1.5WY	1	
ENVELOPE			4) 0.9DL+1.5SPECX	1	
ENVELOPE			5) 0.9DL+1.5SPECY	1	
ENVELOPE			6) 0.9 DL+1.5WX	1	
ENVELOPE			7) 0.9 DL+1.5WY	1	
ENVELOPE			8) 1.2 DL-1.2WX	1	
ENVELOPE			9) 1.2 DL-1.2WY	1	
ENVELOPE			10) 1.2 DL+1.2WX	1	
ENVELOPE			11) 1.2 DL+1.2WY	1	
ENVELOPE			12) 1.5 DL-1.5WX	1	
ENVELOPE			13) 1.5 DL-1.5WY	1	
ENVELOPE			14) 1.5 DL+1.5WX	1	
ENVELOPE			15) 1.5 DL+1.5WY	1	
ENVELOPE			16) 1.5 DL+1.5 SPECX	1	
ENVELOPE			17) 1.5 DL+1.5 SPECY	1	
ENVELOPE			18) 1.2 DL+1.2SPECX	1	
ENVELOPE			19) 1.2 DL+1.2SPECY	1	
ENVELOPE			5 A) 0.9DL+1.5SPECZ	1	
ENVELOPE			17 A) 1.5 DL+1.5 SPEC Z	1	
ENVELOPE			19 A) 1.2 DL+1.2SPEC Z	1	

BEAM DESIGN

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
BASEMENT-2	B604	8064	B 600X700	ENVELOPE	300	5449.9	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
600	700	600	0	45	45

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	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
-231.7548	0.0058	228.2332	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-231.7548	0.0074	0	-231.7623

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)	-231.7623		763	0	763	607
Bottom (-2 Axis)		0	0	0	0	0

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

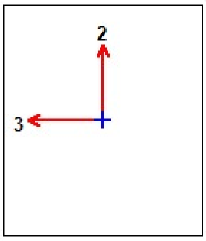
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
228.2332	127.8887	157.2	63.6758	665.06

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
0.0058	228.2332	530	630	0

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
BASEMENT-1	B27	128	B 600X700	ENVELOPE	5407.2	5407.2	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
600	700	600	0	45	45

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	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
-233.7363	0.0015	164.07	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-233.7363	0.0019	0	-233.7382

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)	-233.7382		770	0	770	607
Bottom (-2 Axis)		0	0	0	0	0

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

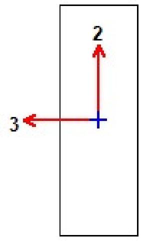
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
164.07	128.4268	157.2	109.6214	665.06

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
0.0015	164.07	530	630	0

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
1ST	B637	396	B200X600	ENVELOPE	1840	4600	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	45	45

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

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-20.5971	0.0001	2.8608	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-20.5971	0.0002	88.0848	-20.5973

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)	-20.5973		172	0	78	172
Bottom (-2 Axis)		88.0848	349	349	0	172

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

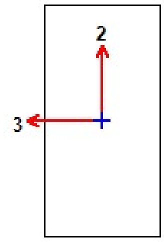
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
2.8608	44.8079	44.4	0	221.69

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	2.8608	130	530	0

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
GF	B176	6409	B 300X600	ENVELOPE	5092.8	5092.8	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
300	600	300	0	45	45

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	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
1.8546	0.0001	47.8004	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
1.8546	0.0001	1.8547	-139.5782

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)	-139.5782		555	0	555	257
Bottom (-2 Axis)		1.8547	257	7	0	257

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

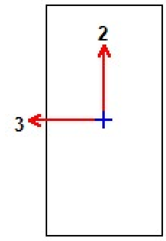
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv}/s mm²/m
47.8004	68.8398	66.6	50.8724	332.53

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	47.8004	230	530	0

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
GF	B29	6404	B 300X600	ENVELOPE	0	5650	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
300	600	300	0	45	45

Material Properties

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

Design Code Parameters

γ_C	γ_S
1.5	1.15

Factored Forces and Moments

Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
0.0001	41.6083	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-134.7375	0.0002	80.1739	-134.7377

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)	-134.7377		535	0	535	257
Bottom (-2 Axis)		80.1739	311	311	0	257

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
41.6083	53.2112	66.6	50.6334	332.53

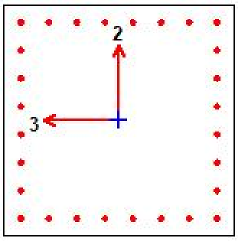
Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.0001	41.6083	230	530	0

COLUMN DESIGN

ETABS Concrete Frame Design

IS 456:2000 Column Section Design (Summary)



Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
1ST	C82	7401	C 800X800	1) 1.5DL+1.5LL	1350	3300	0.6	Ordinary Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
800	800	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

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 % %
16633.161	11.2141	533.37	533.37	533.37	12811	2

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	2700	52.1007	0	533.37
Minor Bend(M2)	1	2700	18.4237	0	533.37

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}	86.6675	621.3261	236.8006	0	886.75
Minor, V_{u3}	25.2287	621.3261	236.8006	0	886.75

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

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
6400	128.1	19684.7007	6599.4794	16633.161	0.233205

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	0.818	800	3.375	12	No	0
Minor Bending (M_2)	Yes	0.818	800	3.375	12	No	0

Notes:

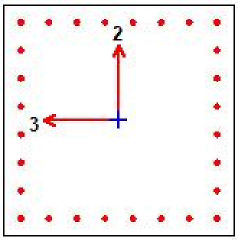
N/A: Not Applicable

N/C: Not Calculated

N/N: Not Needed

ETABS Concrete Frame Design

IS 456:2000 Column Section Design (Summary)



Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
BASEMENT-1	C82	7378	C 800X800	1) 1.5DL+1.5LL	1500	3600	0.6	Ordinary Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
800	800	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

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 % %
17377.7756	567.674	-2.9123	567.674	567.674	15282	2.39

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	3000	-23.4404	0	567.674
Minor Bend(M2)	1	3000	14.3481	0	567.674

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}	37.5855	664.3498	236.8006	0	886.75
Minor, V_{u3}	18.3328	664.3498	236.8006	0	886.75

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
6400	152.8	20703.7894	6695.5389	17377.7756	0.237432

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	0.833	800	3.75	12	No	0
Minor Bending (M_2)	Yes	0.833	800	3.75	12	No	0

Notes:

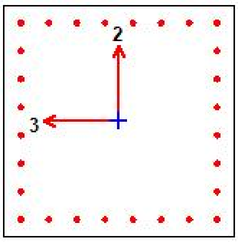
N/A: Not Applicable

N/C: Not Calculated

N/N: Not Needed

ETABS Concrete Frame Design

IS 456:2000 Column Section Design (Summary)



Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
GF	C82	7402	C 800X800	1) 1.5DL+1.5LL	1700	4000	0.6	Ordinary Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
800	800	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

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 % %
16993.7157	9.4181	-568.723	568.723	568.723	14085	2.2

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	3400	-19.9651	0	568.723
Minor Bend(M2)	1	3400	12.8417	0	568.723

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}	24.3607	644.2546	236.8006	0	886.75
Minor, V_{u3}	10.4203	644.2546	236.8006	0	886.75

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
6400	140.9	20210.1443	6649.0078	16993.7157	0.23718

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	0.85	800	4.25	12	No	0
Minor Bending (M_2)	Yes	0.85	800	4.25	12	No	0

Notes:

N/A: Not Applicable

N/C: Not Calculated

N/N: Not Needed

SLAB DESIGN

DESIGN OF SLAB : **S1**

Panel Name : Four edges discontinuous Code : 18

Clear Longer span, ly = 5100 mm

Clear Shorter span, lx = 3550 mm

ly / lx = 1.44 < 2, Hence, Twoway slab.

Effective Longer span = 5195.00 mm

Effective Shorter span = 3645.00 mm

Assume thickness of slab = 125.00 mm

Effective depth available = 95.00 mm

Loads :

Dead Load and Imposed Load (fixed) :

Floor finish =	1.500	kN/m^2
Partitions =	0.000	kN/m^2
	0.000	kN/m^2
Self weight =	3.125	kN/m^2
w_{DL} =	4.625	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, $w = w_{DL} + w_{LL}$ =	6.625	kN/m^2

Span Moments:

Along Shorter span: BM = $\alpha_x w l_x^2$ = 0.086 x 6.63 x 3.645^2 = 7.59 kNm M_{ux1} = 11.38 kNm

Along Longer span: BM = $\alpha_y w l_x^2$ = 0.056 x 6.63 x 3.645^2 = 4.93 kNm M_{uy1} = 7.39 kNm

Support Moments:

Along Shorter span: BM = $\alpha_x w l_x^2$ = 0.000 x 6.63 x 3.645^2 = 0.00 kNm M_{ux2} = 0.00 kNm

Along Longer span: BM = $\alpha_y w l_x^2$ = 0 x 6.63 x 3.645^2 = 0.00 kNm M_{uy2} = 0.00 kNm

Check for section :

Factored Max. BM, Mu = 11.38 kNm / m

For M35 grade concrete & Fe550 grade steel , Mu, lim / bd^2 = 4.829

Effective depth required = 48.55 mm < Effective depth available, OK

Along the Shorter span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{1 - \sqrt{(\ 1 - [4.6\ M_{ux1}/(f_{ck}\ bd^2)]\ )}\}\ b\ d =$ 261.83 mm^2 / m

Provide 10 mm dia bars @ 150 mm c/c As = 523.60 mm^2 / m OK

A_{st} reqd at support :

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

Provide 10 mm dia bars @ 125 mm c/c As = 628.32 mm^2 / m OK

Along the Longer span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{1 - \sqrt{(\ 1 - [4.6\ M_{uy1}/(f_{ck}\ bd^2)]\ )}\}\ b\ d =$ 167.36 mm^2 / m

Provide 10 mm dia bars @ 150 mm c/c As = 523.60 mm^2 / m OK

A_{st} reqd at support :

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

Provide 10 mm dia bars @ 125 mm c/c As = 628.32 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 = 285 mm or 300 mm

Check for deflection:

fs = 0.58 x fy x (Ast req/Ast pro) = 159.52 MPa

MF = 1/(0.225+0.00322 fs – 0.625 log 10 (1/pt)) ≤ 2 = 1.733

Type of Slab = Continuous

Effective Shorter span = 3645.00 mm

Basic Value = 26

Allowable l/d = 45.06

Actual l/d = 38.37 Hence OK

DESIGN OF SLAB : **S2**

Panel Name : Three edges; one longer edge discor Code : 14

Clear Longer span, ly = 3850 mm

Clear Shorter span, lx = 3600 mm

ly / lx = 1.07 < 2, Hence, Twoway slab.

Effective Longer span = 3945.00 mm

Effective Shorter span = 3695.00 mm

Assume thickness of slab = 125.00 mm

Effective depth available = 95.00 mm

Loads :

Dead Load and Imposed Load (fixed) :

Floor finish =	1.500	kN/m^2
Partitions =	0.000	kN/m^2
	0.000	kN/m^2
Self weight =	3.125	kN/m^2
w_{DL} =	4.625	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, $w = w_{DL} + w_{LL}$ =	6.625	kN/m^2

Span Moments:

Along Shorter span: $BM = \alpha_x w l_x^2$ = 0.046 x 6.63 x 3.695^2 = 4.16 kNm M_{ux1} = 6.24 kNm

Along Longer span: $BM = \alpha_y w l_x^2$ = 0.043 x 6.63 x 3.695^2 = 3.89 kNm M_{uy1} = 5.83 kNm

Support Moments:

Along Shorter span: $BM = \alpha_x w l_x^2$ = 0.061 x 6.63 x 3.695^2 = 5.54 kNm M_{ux2} = 8.30 kNm

Along Longer span: $BM = \alpha_y w l_x^2$ = 0 x 6.63 x 3.695^2 = 0.00 kNm M_{uy2} = 0.00 kNm

Check for section :

Factored Max. BM, Mu = 8.30 kNm / m

For M35 grade concrete & Fe550 grade steel , Mu, lim / bd^2 = 4.829

Effective depth required = 41.47 mm < Effective depth available, OK

Along the Shorter span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{1 - \sqrt{(\ 1- [4.6\ M_{ux1}/(f_{ck}\ bd^2)]\ )}\}\ b\ d =$ 140.64 mm^2 / m

Provide 10 mm dia bars @ 150 mm c/c As = 523.60 mm^2 / m OK

A_{st} reqd at support :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{\ 1 - \sqrt{(\ 1- [4.6\ M_{ux2}/(f_{ck}\ bd^2)])}\}\ b\ d =$ 188.64 mm^2 / m

Provide 10 mm dia bars @ 125 mm c/c As = 628.32 mm^2 / m OK

Along the Longer span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{1 - \sqrt{(\ 1- [4.6\ M_{uy1}/(f_{ck}\ bd^2)]\ )}\}\ b\ d =$ 131.26 mm^2 / m

Provide 10 mm dia bars @ 150 mm c/c As = 523.60 mm^2 / m OK

A_{st} reqd at support :

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

Provide 10 mm dia bars @ 125 mm c/c As = 628.32 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 = 285 mm or 300 mm

Check for deflection:

fs = 0.58 x fy x (Ast req/Ast pro) = 85.68 MPa

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

Type of Slab = Continuous

Effective Shorter span = 3695.00 mm

Basic Value = 26

Allowable l/d = 41.60

Actual l/d = 38.89 Hence OK

SHEAR WALL DESIGN

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	Pier Ductility	LLRF
1ST	VW29	34747.8	37675	1850	300	Special Wall	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

$Γ_S$	$Γ_C$	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	34747.8	36750	34747.8	38600	1850	300
Bottom	Leg 1	34747.8	36750	34747.8	38600	1850	300

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	7253	0.0131	0.0025	1) 1.5DL+1.5LL	12178.6494	-243.573	233.0346	555000
Bottom	7349	0.0132	0.0025	1) 1.5DL+1.5LL	12247.3103	244.9462	-152.0219	555000

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	750	17) 1.5 DL+1.5 SPECY	10315.1358	381.8638	-168.2425	376.436	777.0013
Bottom	Leg 1	750	17) 1.5 DL+1.5 SPECY	10383.5148	254.6546	-168.2425	378.5279	779.0931

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	450	5) 0.9DL+1.5SPECY	6984.5771	-48.6818	12.87	10
Top–Right	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	11464.5705	282.0246	22.3	10
Bottom–Left	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	11533.5861	-292.6103	22.49	10
Botttom–Right	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	11533.5861	45.0949	21.04	10

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	Pier Ductility	LLRF
BASEMENT-1	VW29	34747.8	37675	1850	300	Special Wall	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

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	34747.8	36750	34747.8	38600	1850	300
Bottom	Leg 1	34747.8	36750	34747.8	38600	1850	300

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	9664	0.0174	0.0025	1) 1.5DL+1.5LL	12944.1175	-258.8823	145.5781	555000
Bottom	9986	0.018	0.0025	1) 1.5DL+1.5LL	13019.0203	260.3804	-82.1302	555000

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	750	17) 1.5 DL+1.5 SPECY	10815.0572	282.7652	-116.1826	425.2999	825.8651
Bottom	Leg 1	750	17) 1.5 DL+1.5 SPECY	10889.7529	276.7388	-116.1826	431.4978	832.063

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	600	17) 1.5 DL+1.5 SPECY	11957.2822	-49.9235	21.84	10
Top–Right	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	12060.1777	191.1987	22.85	10
Bottom–Left	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	12135.1673	-195.9725	23.01	10
Botttom–Right	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	12135.1673	80.4973	22.34	10

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	Pier Ductility	LLRF
BASEMENT-2	VW29	34747.8	37675	1850	300	Special Wall	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

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	34747.8	36750	34747.8	38600	1850	300
Bottom	Leg 1	34747.8	36750	34747.8	38600	1850	300

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	11196	0.0202	0.0025	1) 1.5DL+1.5LL	13397.9062	-267.9581	117.1733	555000
Bottom	11614	0.0209	0.0025	1) 1.5DL+1.5LL	13472.809	269.4562	9.0779	555000

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	750	17) 1.5 DL+1.5 SPECY	11142.2169	343.1352	-207.0724	454.2567	854.8219
Bottom	Leg 1	750	17) 1.5 DL+1.5 SPECY	11216.8598	812.4829	-207.0724	460.2761	860.8413

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	750	17 A) 1.5 DL+1.5 SPEC Z	12420.7345	-11.935	22.45	10
Top–Right	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	12420.7345	197.9917	23.54	10
Bottom–Left	Leg 1	750	17) 1.5 DL+1.5 SPECY	12408.9728	-788.9352	26.97	10
Botttom–Right	Leg 1	750	17) 1.5 DL+1.5 SPECY	12408.9728	812.4829	27.11	10

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	Pier Ductility	LLRF
GF	VW29	34747.8	37675	1850	300	Special Wall	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

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	34747.8	36750	34747.8	38600	1850	300
Bottom	Leg 1	34747.8	36750	34747.8	38600	1850	300

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	11132	0.0201	0.0025	1) 1.5DL+1.5LL	12525.4854	336.4592	872.6088	555000
Bottom	11402	0.0205	0.0025	1) 1.5DL+1.5LL	12608.7108	338.6786	-878.4069	555000

Shear Design

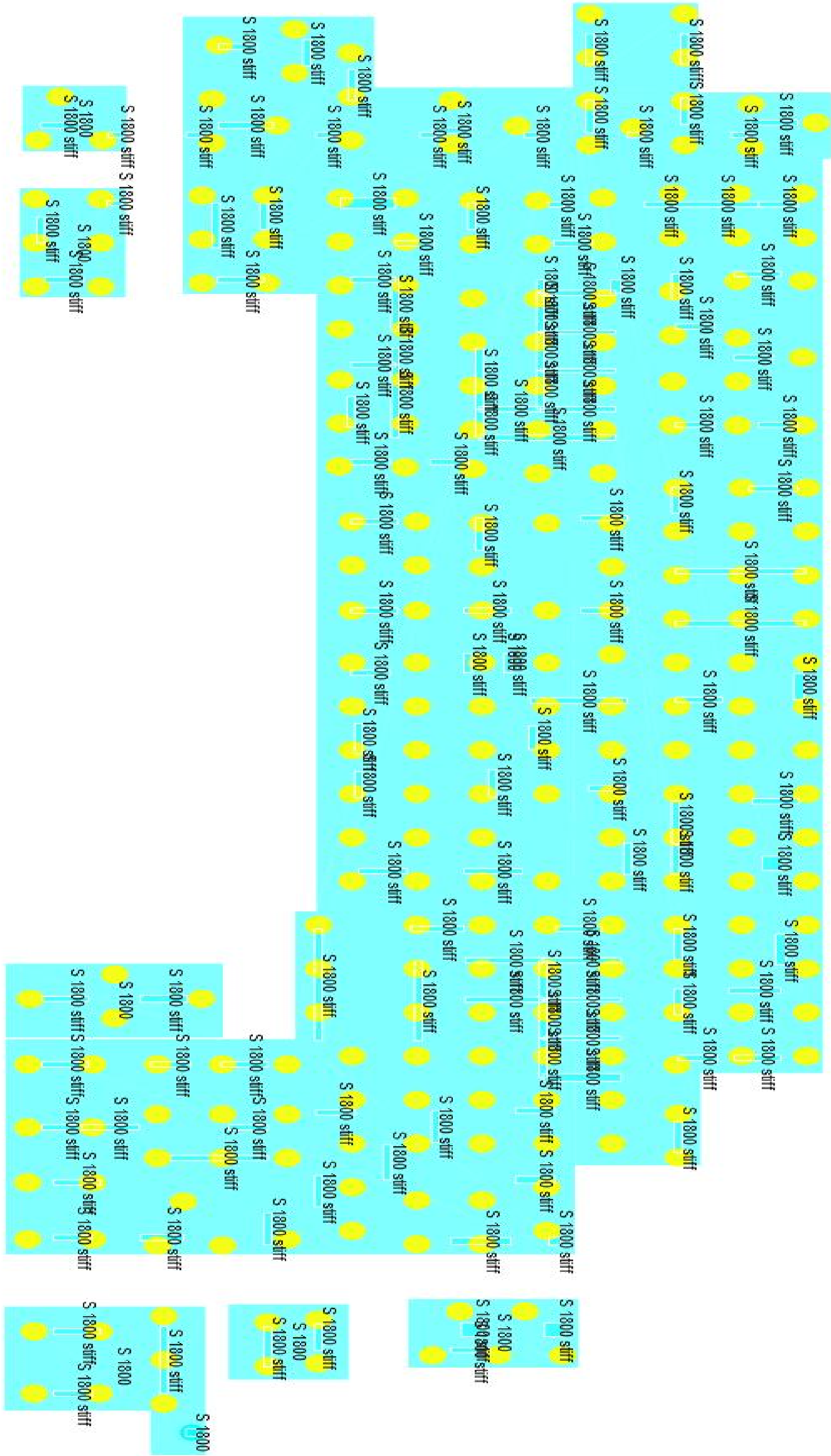
Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	750	16) 1.5 DL+1.5 SPECX	10638.8918	336.3432	-103.9619	453.3462	853.9114
Bottom	Leg 1	750	16) 1.5 DL+1.5 SPECX	10721.7428	112.8807	-103.9619	457.2326	857.7978

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	11729.2937	-55.8372	21.46	10
Top–Right	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	11729.2937	218.3398	22.41	10
Bottom–Left	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	11812.7762	-165.8971	22.25	10
Botttom–Right	Leg 1	600	17 A) 1.5 DL+1.5 SPEC Z	11812.7762	45.5138	21.55	10

FOUNDATION

SECTION IN SAFE MODEL



PILE REACTIONS