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CIN : U45201TN2005PTC055334

21 years Service of Excellence

STABILITY CERTIFICATE

The detailed engineering and structure design of the proposed construction of stilt floor (Two level puzzle parking) + 4 Floors (18.30 Height), IT/ITES Use Building at Plot No.164, Industrial Estate Perungudi, Chennai Comprised In S.No.129/1A1B & 129/1B of Pallavakkam Village within the limit of Greater Chennai Corporation has been done by me/us based on the report of geotechnical investigation (soil test) done by *M/s Geo Marine Consultants (P) Ltd.* Report No.*GT-2772 dated 12-04-2024* and considering the functional requirement of the building.

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

3. I/We further certify that:

(i) The minimum grade of concrete is M35.

(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 Codes No IS: 875-(Part-1 to 5) and design of earthquake resistant structure as per IS Code No IS: 1893-201.

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

Date : 24-01-2026

Place ; Chennai

Stamp and Signature

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PROPOSED COMMERCIAL (OFFICE) DEVELOPMENT AT PERUNGUDI, CHENNAI

DESIGN BRIEF REPORT FOR STRUCTURAL SERVICES

Client:	Arihant memorable spaces	**M/s. ARIHANT**
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
05/06/2024	Primary Report	S.M	P.J	R0

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1.0 PROJECT INFORMATION

1.1 Introduction:

This Design Brief Report (DBR) is for the Proposed Commercial (Office) Building (Stilt+4) at Plot No. 164, Developed Plots Estate, Estate 2nd Main Road, Thiruvalluvar Nagar, Perungudi, Chennai - 600096, Comprised in Survey Nos, 129/1B & 130/1B, situated at Palavakkam Village, Sholinganallur Taluk, within the limits of Greater Chennai Corporation - Zone No:14, Division No:185

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 Commercial Building, is primarily a office building housing car parking, AHU rooms & toilets.

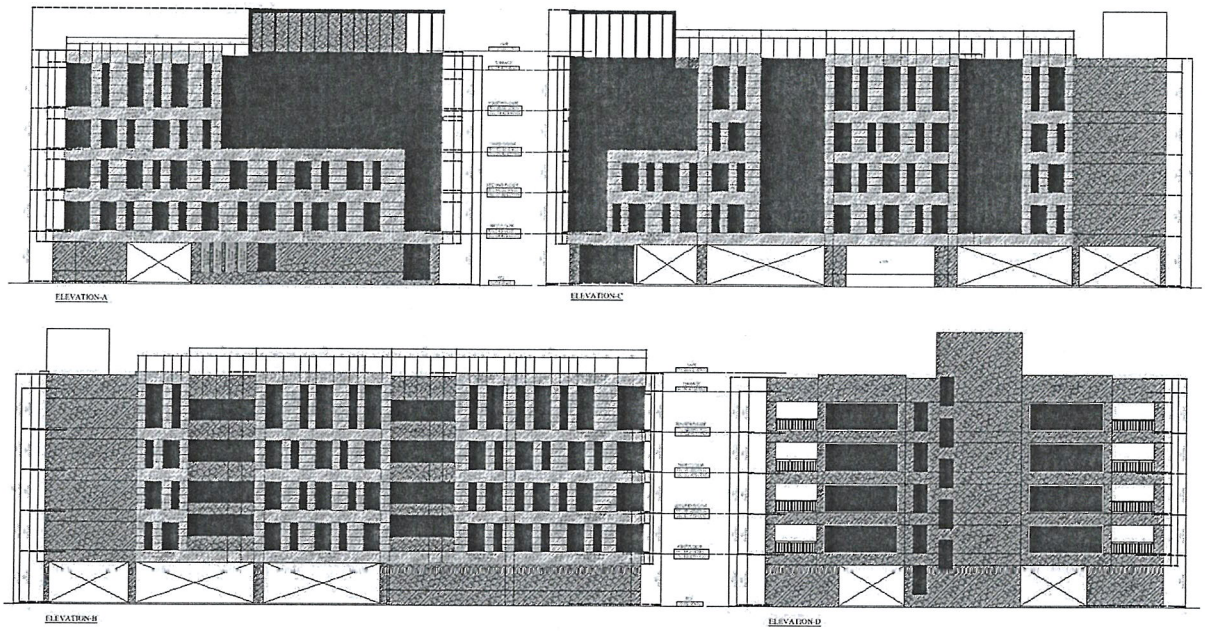
2.0 STOREY INFORMATION

Storey	Facilities
Ground Floor	Car Parking & Electrical Rooms.
1st to 4th Floor	Office Space, AHU, Toilets.
Terrace	Open terrace, OHT & LMR

2.1 Floor to Floor Height:

Ground Floor	4.3m
1st to Roof	3.5m

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SECTIONAL VIEW

3.0 CODES OF PRACTICE

The relevant Indian Standard codes below are followed.

3.1 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.

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CODE	DESCRIPTION
IS 875(Part 1) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Unit weights of buildings materials and stored material
IS 875 (Part 2) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Imposed Loads
IS 875 (Part 3) 2015	Code of practice for Design Loads (other than earthquake) for buildings and structures – Wind Loads
IS 875 (Part 5) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Special Loads and load combinations
IS 456 – 2000	Code of Practice for Plain and Reinforced Concrete
IS 16700 – 2017	Criteria for Structural Safety of Tall Concrete Buildings
IS 1343 – 2012	Code of Practice for Prestressed Concrete
IS 1893 – 2016	Criteria for earthquake resistant design of structures
IS 4326 –1993	Code of practice for Earthquake Resistant Design and Construction of Buildings
IS 3370 – 2009	Code of Practice for Concrete structures for the storage of liquids
IS 1904-1995	Code of Practice for design and construction of Foundation
IS 1080 – 1997	Code of Practice for design and construction of shallow Foundation
IS 2950 - 1998	Code of Practice for design and construction of Raft Foundation

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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

4.0 COVER AND FIRE RATING

Cover to reinforcement considered for various elements

Structural element	Fire rating in hours	Cover
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

5.0 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 200mm/250mm with Drop Panel. And for the Sub structure floor system is RCC Beam and slab system.

Lateral load resisting system:

Flat Slab with structural wall system.

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6.0 FOUNDATION

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

A total of 3 boreholes were terminated after drilling approximately 11m depth. Encountered layer was in the form of hard rock. The N value recorded at this depth is more than 100.

Deep foundation system is recommended by the report for foundation design purpose, with pile Safe Load Carrying Capacity for the following diameters.

Diameter	Working Compression Capacity (Tons)
600	180
750	230
900	360

7.0 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.

7.1 Concrete

Durability provisions for concrete structures shall be as per 'Severe' 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		35 N/Sq.mm	M35
All Structural concrete for :			
Columns, Shear walls & Core walls	Foundation to Terrace	35 N/Sq.mm	M35
Beams and slabs	Ground to Terrace	35 N/Sq.mm	M35
Overhead Water Tank, UG Water Tank, STP & Pump room		30 N/Sq.mm	M30

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7.2 Reinforcement

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

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 ('Y)	78.5 kN/cum

8.0 DESIGN OF LOADINGS

8.1 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	-	8.65 KN / Cum.
Light weight concrete filling	-	16.0 KN / Cum (Supplier - Nuvoco)

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8.2 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	
Office	0.00	0.00	3.40	3.40	4.00
AHU	0.00	0.00	7.90	7.90	0.00
Lobby	0.00	0.00	2.90	2.90	4.00
Toilet	0.00	0.00	3.60	3.60	3.00
Staircase	0.00	0.00	3.60	3.60	4.00
Roof	0.00	0.00	3.60	3.60	4.00
LMR	0.00	0.00	10.00	10.00	2.00
OHT	0.00	10xWater Height	0.00	30.00	0.00

* (G) - Ground floor (OHT) - Over Head Tank
(AHU) - Air Handling Unit (LMR) - Lift Machine Room

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/m²)**

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/m²)**

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

(i) 200mm thick light weight block wall 14.85kN/m

Water Tank Water height x 10

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8.3 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 commercial 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 3 kN/sq.m

1) The lateral load resisting system of the buildings are Flat slab with structural shear wall system. The structural shear walls are designed for 100% of lateral load and the Periphery vertical elements & beams are design for 25% of the lateral load. All other internal columns, beams are designed as gravity columns
2) The lateral load resisting system of the buildings is "Flat Slab with structural wall system" – All the periphery frames are designed as ductile columns and the inner columns are designed for gravity loads.
3) As per IS 1893:2016 code, Chennai lies in Zone III with Zone factor Z = 0.16
4) 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)

   R (Response reduction factor) = 3 (Flat slab with structural wall 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 18.3m.

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

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The fundamental natural period (Ta) for building,

b) Buildings with RC structural walls:

$$T_a = \frac{0.075h^{0.75}}{\sqrt{A_w}} \geq \frac{0.09h}{\sqrt{d}}$$

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

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

where

h = height of building as defined in **7.6.2**(a), in m;

A_{wi} = effective cross-sectional area of wall i in first storey of building, in m^2;

L_{wi} = length of structural wall i in first storey in the considered direction of lateral forces, in m;

d = base dimension of the building at the plinth level along the considered direction of earthquake shaking, in m; and

N_w = number of walls in the considered direction of earthquake shaking.

The value of L_{wi}/h to be used in this equation shall not exceed 0.9.

where,

Base Dimension along X Direction, dx = 51.05m (Longer length)

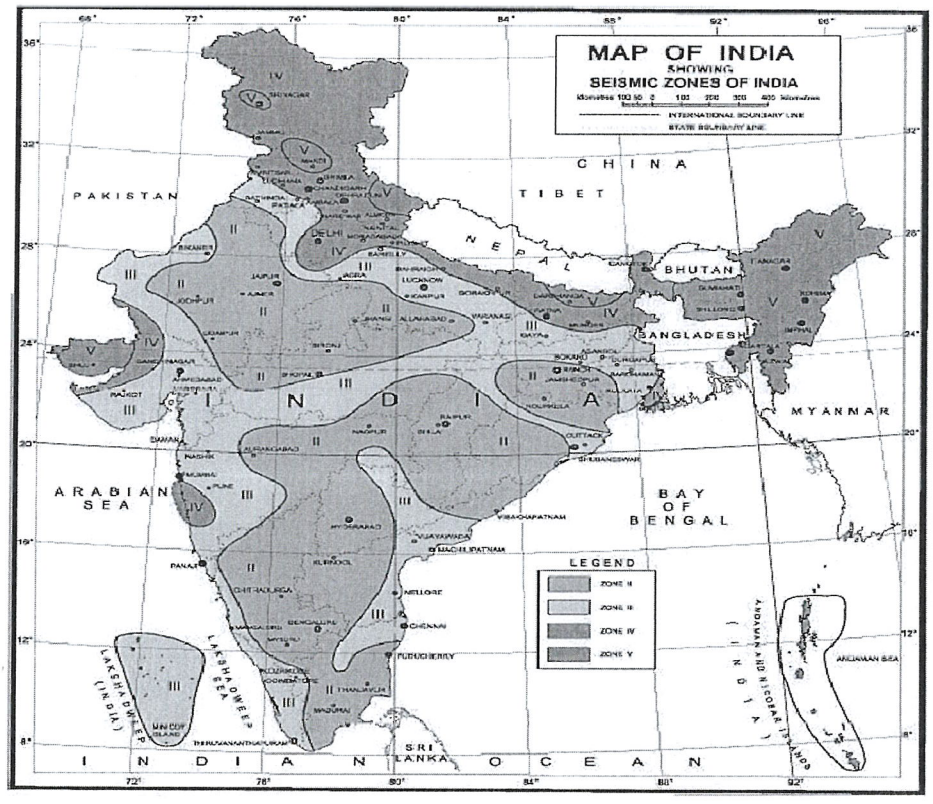
Base Dimension along Y Direction, dy = 34.30m (Longer length)

H = 18.3m

T_a = 0.662 sec (along X direction)

T_a = 0.644 sec (along Y direction)

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SEISMIC ZONE CLASSIFICATION FROM IS 1893: 2016

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.

8.4 Wind Loads

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

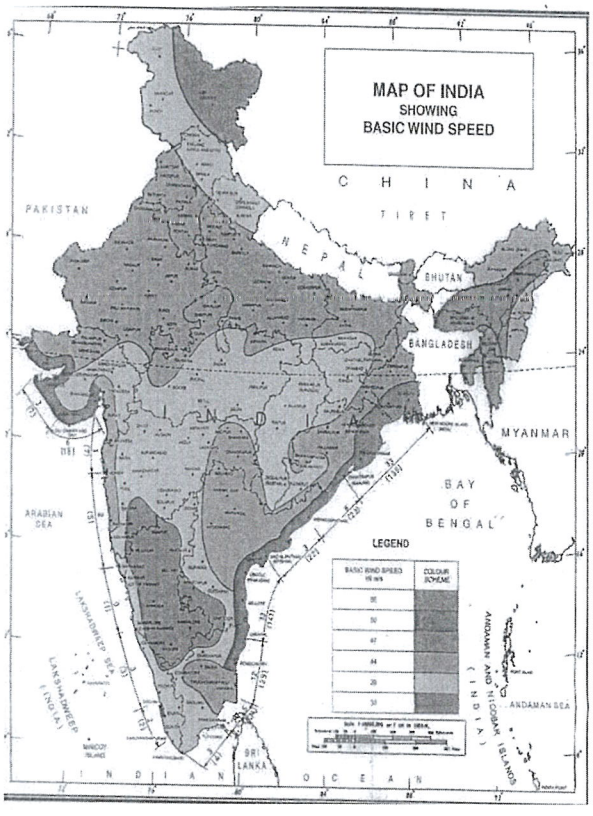
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Design Wind Speed, VZ			= Vbxk1x k2x k3x k4
Vb	→	Basic Wind velocity for Chennai	= 50m/s
K1	→	Risk coefficient for all general buildings	= 1.00
k2	→	Terrain category 2	= To suit the height of the structure for terrain
k2		(H=18.3m -GF to Roof)	= 1.06
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)	=53.0m/s
Max. design wind pressure (Pz)	= 0.6 x Vz^2	=1685.4 N/m2
Design wind pressure: pd		=Pz x Kax Kd x Kc =1228.65 N/m2

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



INDIAN WIND SPEED CLASSIFICATION FROM IS 875 PART (III)

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9.0 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)
3. 1.2 (DL + LL + SPECY)
4. 1.2 (DL + LL ± WindX)
5. 1.2 (DL + LL ± WindY)
6. 1.5 (DL + SPECX)
7. 1.5 (DL + SPECY)
8. 1.5 (DL ± WindX)
9. 1.5 (DL ± WindY)
10. 0.9DL + 1.5SPECX
11. 0.9DL + 1.5SPECY
12. 0.9DL ± 1.5WindX
13. 0.9DL ± 1.5WindY

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

14. 1.0DL +1.0 LL
15. 1.0DL + 1.0SPECX
16. 1.0DL + 1.0SPECY
17. 1.0DL ± 1.0WindX
18. 1.0DL ± 1.0WindY
19. 1.0DL ± 1.0TEMP
20. 1.0DL + 0.8LL + 0.8SPECX
21. 1.0DL + 0.8LL + 0.8SPECY
22. 1.0DL + 0.8LL ± 0.8WindX
23. 1.0DL + 0.8LL ± 0.8WindY

Where,

DL	- Dead load,
LL	- Live load
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

10.0 SERVICEABILITY LIMITS

11.1 Lateral Deflection (Wind)

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

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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.

11.0 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 calculations for manual design of elements 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$\sqrt{}$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 -16700-2017, 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, 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 Softwares.

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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 aappropriately and Applied as uniformly distributed line load.

12.0 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 19.1	- 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
STAAD PRO & ETABS		- Structural Steel Design.

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