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

STABILITY CERTIFICATE

The detailed engineering and structure design of the proposed building comprising of Bearing Survey Nos. 36/1B, 36/2B,36/3A2A & 262/1A, T.S. No. 19/1,19/2,19/6 & 19/7 of Block No. 19, Ward–C of Tambaram Village, Tambaram Taluk, within the limits of Tambaram Corporation, submited for planning permission consisting of 2 Blocks, Block -1 Extended Basement Floor + Stilt Floor cum Ground Floor + 13 Floors – Residential Building with 175 Dwelling Units (Height: 42.00m) Block -2 Basement Floor + Stilt Floor + 5 Floors – Club House Building with Multipurpose Hall, Nursery, Indoor Games, Home Theatre, Gym, Games room and Guest Room (Height: 18.00 m) at Kishkinta Main Road, Kannadapalayam, Tambaram, Chennai has been done by us based on the report of geotechnical investigation (Soil Test Report No. AA/DEC/2021/65 DATED 11.01.2022) done by M/s Aravind Associates (K. Rajeshwari, Geotechnical Engineer) 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 456-2000, design loads as per IS Codes No and design of earthquake resistant structure as per IS Code No.IS-13920-2016.

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

Date : 17-01-2025
Place : Chennai-600 020

Encl.: Structural Design Calculation

A. PERAMAIYAN, M.E., (Struct.), M.I.E.
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No. SE/GR-I/19/03/026
NEW No. 31 (OLD No.14), BESANT AVENUE ROAD,
ADYAR, CHENNAI - 600 020.
E-Mail: peram@buroengineers.in
Mobile: +91 99625 45630

STRUCTURAL DESIGN CALCULATION REPORT

PLANNING PERMISSION FOR THE PROPOSED CONSTRUCTION CONSISTING OF 2 BLOCKS, BLOCK-1 EXTENDED BASEMENT FLOOR+STILT FLOOR CUM GROUND FLOOR+13 FLOORS–RESIDENTIAL BUILDING WITH 175 DWELLING UNITS (HEIGHT:42.00m) BLOCK-2 BASEMENT FLOOR+STILT FLOOR+5 FLOORS – CLUB HOUSE BUILDING WITH MULTIPURPOSE HALL, NURSERY, INDOOR GAMES, HOME THEATRE, GYM, GAMES ROOM AND GUEST ROOM (HEIGHT:18.00m) AT KISHKINTA MAIN ROAD, KANNADAPALAYAM, TAMBARAM, CHENNAI BEARING SURVEY NOS. 36/1B, 36/2B, 36/3A2A & 262/1A, T.S. No: 19/1, 19/2, 19/6, 19 /7 OF BLOCK NO. 19, WARD-C OF TAMBARAM TALUK WITHIN THE LIMITS OF TAMBARAM CORPORATION

CLIENT:

LML HOMES
No.271, Mc Nichols Road,
Poonamalli High Road, Kilpauk,
Chennai-600 010.

ARCHITECT:

CHERALATHAN ASSOCIATES
No.13,Shanthi Enclave,
25,Venkatakrishna Road,
Raja Annamalai Puram,
Chennai-600 028.



STRUCTURAL CONSULTANT:

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

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ADYAR, CHENNAI - 600 020.
E-Mail: peram@buroengineers.in
Mobile: +91 99625 45630

R0	17-01-2025	Design Basis Report	OK	**SATHISHKUMAR M**	PERAM	PERAM
REV	**DATE**	**DESCRIPTION**	**STATUS**	**PREPARED BY**	**REVIEWED BY**	**APPRVD. BY**

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- Design Information and Criteria
- 3D Model & Analysis summary report
- Design of Raft Footing
- Design of Columns
- Design of Beams
- Design of Slabs

1. INTRODUCTION

M/s. LML Homes has proposed to construct Residential Building comprises Basement + Stilt Floor + 13 Floors +Roof at Kiskinta Main Road, Kannadapalayam, Tambaram, Chennai- 600 045. Architecturally, it is designed with single Basement + Stilt + 13 Floors + Roof structure. In which, the basement floor and Stilt floors are designed to facilitate parking whereas 1st floor to 13th floor are designed for Residential use.

This report covers design basis of Residential development which includes two buildings, comprises a Residential Tower having single Basement+Stilt Floor+1st Floor to 13th Floor+Roof and a commercial building which is a Ground+2 Storey structure. In the Residential tower the Basement & Stilt floors accommodates car/two-wheeler parking and 1st floor to 13 floors are designed for residential use. Architecturally, the tower is designed to be a linear & rectangular in shape. Structurally the building is designed to be a framed structure with Shear walls & Colums, Beams and slabs are directly connected to the shear walls/columns which are together forms a lateral load resisting system. Foundation is designed to be Raft with depth of foundation around 4.5m below existing ground level. The raft is connected monolithically with Basement wall forms the water tight basement structure shall be protected by applying the approved water proofing on positive side.

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

2. CODES OF PRACTICE

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

2.1 Design Loads (Other Than Earthquake Loads)

IS Code	Description
IS 875 (Part 1): 1987	Dead Loads (Unit Weight of Building Material and Stored Material)
IS 875 (Part 2): 1987	Imposed Load
IS 875 (Part 3): 2015	Wind Load
IS 875 (Part 5): 1987	Special Loads and Combinations

A. PERAMAIYAN, M.E., (Struct.), M.I.E.
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CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
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E-Mail: peram@buroengineers.in
Mobile: +91 99625 45630

2.2 Design for Earthquake Resistance

IS Code	Description
IS 1893(Part-1):2016	Criteria for Earthquake Resistance design of structures.
IS 4326: 1993	Earthquake Resistant Design and Construction of Buildings – Code of Practice
IS 13920: 2016	Ductile Detailing of Reinforced Concrete Structures subject to Seismic Forces - Code of Practice.

2.3 Design of Steel Structural Elements

IS Code	Description
IS 800: 2007	Code of Practice for General Construction in Steel
IS 2062: 1999	Steel for General structural purposes

2.4 Design of Concrete Elements

IS Code	Description
IS 456: 2000	Plain and Reinforced Concrete - Code of practice
IS 6403 -1981	Code of practice for determination of bearing capacities of shallow foundations.
IS 8009 -1976 (Part I):	Code of practice for calculation of settlement of foundations – Shallow foundation
IS 1904	Indian Standard Code of practice for design & construction foundations in Soil : General Rééquipements
IS 2950 (Part 1):1981 (Reaff. Nov 2013)	Code of practice for design and construction of raft foundations : Part 1 Design (second revision).
IS 2911-(Part1-Sec2)	**Indian Standard Code of Practice for Design and Construction of Pile Foundation-Bored Cast In situ Piles**
IS 2911-(Part-4)	Load Tests on Pile
IS 2974	Code of practice for design & construction of machine foundation
SP 16	Structural use of concrete, Design charts for singly reinforced beams, doubly reinforced beams and columns.
SP 34	Handbook on Concrete Reinforcement & Detailing
SP 7(Part IV)-2015	National Building code of India
IS 1786-2007	Specification for high strength deformed bars and wires for

	concrete Reinforcement.
IS 432 (Part 2) 1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete reinforcement – Hard Drawn Steel Wire
IS 3370 (part I)	Code of practice for concrete structure for the storage of liquids

3. DESIGN PARAMETERS

3.1 Materials of Construction

The building comprises of Columns connected with frame/slab. The lateral load resisting system of Columns/Shear walls are well connected in orthogonal direction. All vertical elements comprise Shear Walls/Columns are connected by floor slab which acts as diaphragm in redistribution of lateral forces.

3.1.1 Concrete Grade

Concrete grade shall be M35 all structural elements which includes Raft, Shear wall, Column, Beam, slab, Basement wall, underground sump etc., with minimum 28-day strength of 35 MPa.

Concrete Mix M10 has been used in filling, plum concrete, leveling courses (PCC) and other non-structural items.

Density of reinforced concrete is assumed as 25 kN/cu.m.

Minimum cement content, water cement ratio etc. shall conform to IS 456:2000 code provisions for durability and strength criteria. The approved design mix shall be used for producing concrete.

Grade of Concrete for various structural elements:

Raft	M35
R.C Columns/Beams	M35
Shear Wall	M35
R.C Slab	M35
Basement Wall	M35
Underground sump	M35
Parapet Wall & any other Structural members	M25

3.1.2 Cement

Ordinary Portland cement of grade 43 or higher confirming to IS 8112 and IS 12269 is specified for concrete M35 for all structural elements including Raft, Shear wall, Column, Beam, slab, Basement wall etc., with cement content appropriate to the grade. The design mix using the intended brand of cement together with material test report including test report on other raw materials shall be submitted to the consultant's review and obtain the consent before the construction.

3.1.3 Aggregates

The sizes of coarse aggregates confirm to IS 383. Nominal maximum size of coarse aggregate to be 20 mm, suitably graded as per the requirement of mix design. The fine aggregates confirm to the specifications of IS 383.

3.1.4 Water

Water used for construction shall complied with stipulations given in IS 456: 2000.

3.1.5 Reinforcement

High yield strength deformed bars conforming to IS 1786 with f_y = 500 N/ sq.mm has been used with elongation not less than 14.5 %.

3.1.6 Structural Steel

MS steel with yield strength f_y = 250 N/ sq.mm has been used for Structural steel work shall conform to IS 226 and IS 2062 for Indian steel sections.

3.1.7 Concrete Cover

Cover to reinforcement considered for various elements with Fire rating considered - 2hrs. are as follows.

a. Raft = 60mm
b. Column = 40mm
c. Shear Wall = 30mm
d. Beam = 30mm (Bottom and sides)
e. Slab = 25mm (Top and Bottom
f. Water tanks / Sump tank
   On water face = 40mm (Top and Bottom)
   On other face = 40mm (Top and Bottom)

3.1.8 Development Length

Unless otherwise specified in the good for construction drawing, the Development length of 50 times diameter of bar is to be considered in the BBS & Fabrication.

3.1.9 Soil Parameters

Based on the soil report No. AA/DEC/2021/65 dated 11th Jan, 2022, there are 5 no. of bore holes were done at different locations of the plot spreaded across the building foot print. In which BH-1 is located in Groudn+2 storey of commercial building and BH-2 to BH-5 are located in the 13-storey residential tower structure. The bore holes are terminated in the range of 7m to 11.7m at very dense layer with "N" value more than 100. As per the bore log data, the top layer upto 1.5m is filled up soil and loose to medium dense silty gravel exists up to 3m with "N" value ranging from 11 to 21. Below 3m and up to 4.5m, it is very dense clayey sand layer exists with "N" value ranging from 70 to 100. Weathered rock encountered from the depth of 4.5m with a "N" value more than 100 and it continues up to the termination depth. there is very dense partially to completely weathered rock having "N" value more than 100. From the depth of 6.5m, there is Soft rock drilled using diamond bit. From the depth of 7.22m there is Hard rock drilled by T.C bit. The boreholes were terminated at very dense stratum with "N" value more than 100. Ground water table was met with at the depth of 1.5m from existing ground level during the borehole operations.

3.2 Loading Standards

Table: Structural Configuration and Floor heights:

Residential Apartment building	**Basement + Stilt + 13 Floors + Roof**
Basement Floor height	3.6m
Stilt Floor height	3.0m
1st to 13th Floor height	3.0m
Roof	3.0m
Head Room	3.0m
OHT	3.0m
Type of Foundation	**Raft**
Grade of concrete Raft	M35
Grade of concrete for Columns/Shear Walls	M35
Grade of concrete for RC beams	M35
Grade of concrete for RC slabs	M35
Grade of Steel	**Fe 500**

Table: Unit Weight of Materials:

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
Cement Mortar	20.00 kN/m^3
Structural Steel	78.50 kN/m^3
Concrete Solid Block works	**20.00 kN/m^3**
Dry soil	18.00 kN/m^3
Wet Soil	22.00 kN/m^3
Landscape soil	16.00 kN/m^3
Glass	28.00 kN/m^3
water	10.00 kN/m^3

Table: Gravity Load Calculations:

Floor Slab:	
Self weight of 125 mm thick Slab	0.125x25 = 3.125 kN/Sq.mt.
Self weight of 150 mm thick Slab	0.150x25 = 3.750 kN/Sq.mt.
Self weight of 175mm thick slab	0.175x25 = 4.375 kN/Sq.mt.
Self weight of 200mm thick slab	0.200x25 = 5.000 kN/Sq.mt.

Residential building External/Internal Wall Line Load:	
Stilt Floor to 13th Floor	= (0.20x2.55x20) +(0.03x2.55x20) = 12.00kN/m
Stilt Floor to 13th Floor	= (0.10x2.55x20) +(0.03x2.55x20) = 6.6 kN/m
Terrace Parapet Wall	= (0.2x1.2x20)+(0.03x2.55x20) = 5.5 kN/m

3.2.1 Imposed Loads on Slab

The following are the imposed loads in the structural slabs, in addition to the self-weight and the floor finishes. *(Self-weight of slab will be as per the thickness mentioned in the respective drawings Floor finishes of 50/75 mm thickness have been considered on all floors)*

Table: Superimposed Dead Load (SDL) & Live Load (LL)

Basement & Stilt Floors (Car/Two wheeler Parking)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	0.0	0.0
Services	2.4	-
Live Load	0.0	3.0
Partition Load	-	0.0
Total	**2.4**	**3.0**
Basement Floor (Electrical Room)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	0.0	0.0
Services	7.5	-
Live Load	0.0	3.0

Partition Load	-	0.0
Total	**7.5**	**3.0**
Extended Basement Roof (Fire Driveway)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	3.0	0.0
Services	0.0	-
Live Load	0.0	15.0
Partition Load	-	0.0
Total	**3.0**	**15.0**
Stilt to 13th Floor (Lobby / Corridor)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	2.4	0.0
Services	0.0	-
Live Load	0.0	4.0
Partition Load	-	0.0
Total	**2.4**	**4.0**

1st to 13th Floor (Rooms)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.2	0.0
Services	0.0	-
Live Load	0.0	2.0
Partition Load	0.0	0.0
Total	**1.2**	**2.0**
1st to 13th Floor (Toilet)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	4.0	0.0
Services	0.0	-
Live Load	0.0	2.0
Partition Load	-	0.0
Total	**4.0**	**2.0**
1st to 13th Floor (Balcony/Service)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	4.0	0.0
Services	0.0	-
Live Load	0.0	3.0
Partition Load	-	0.0
Total	**4.0**	**3.0**
1st Floor (Courtyard)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	6.6	0.0
Services	0.0	-
Live Load	0.0	5.0
Partition Load	-	0.0

Total	**6.6**	**5.0**
Stilt Floor (STP Pump Room)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	1.2	0.0
Services	0.0	-
Live Load	0.0	7.5
Partition Load	-	0.0
Total	**1.2**	**7.5**
Roof Terraces		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes (weathering courses)	3.0	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**3.0**	**3.0**
LMR		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	3.0	-
Services	-	-
Live Load	-	15.0
Partition Load	-	-
Total	**3.0**	**15.0**
OHT		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	3.0	-
Services	-	-
Live Load	-	20.0
Partition Load	-	-
Total	**3.0**	**20.0**

Permissible reduction in imposed load on each floor is considered for design of columns and foundation as per IS 875 Part (2), clause.3.2.

The proposed structure is a RCC framed structure, with columns and shear walls forming vertical components. In which, the vertical structural systems are formed such that the RC wall & columns are transfers its base shear in proportion to its stiffness in their loading direction of wind & seismic.

3.3 Thermal Effects

Temperature variation produces stresses in the structure, as it tends to expand and contract. In the structures, with large geometrical dimensions, the effect of temperature is important in the behavior and final design. Due to deformation of expansion & contraction - between Day

time and nights, and between winter and summer - the effect on the durability of structure and on the supported finishes is significant to produce considerable results.

3.3.1 Expansion Joints

Expansion joints are normally provided when the structure is more than 45m length as per IS-456-2000, clause 27.2. In this building the size of superstructure is 65m x 55m. The temperature effect over the building design has been captured by applying the differential temperature over the exposed area like roof & terraces as the length of the building falls close to the limitation stimulated in IS 456: 2000, clause.27.2. The differential temperature of 15° C has been applied over the exposed areas like Roof & Terraces.

4. PROPOSED APPROACH OF STRUCTURAL ANALYSIS

The building comprises of R.C.C columns connected by beams as framed structure. Slabs acting as rigid in-plane diaphragms have been considered. After preliminary sizing of various structural members, a computer model of the structural frame of the building is generated for carrying out computer analysis for the effects of vertical and lateral loads that are likely to be imposed on the structure.

The building structure has been analyzed using the ETABS v21 software for the following computer models of the building floor analysis of all floors - for vertical loads with the entire building space frame. ETABS v21 have been thoroughly tested, validated and recognized internationally by several organizations and are well suited for the analysis of building systems.

Geometrical dimensions, member properties and member-node connectivity, including eccentricities will be modeled in the analysis problem. Variation in material grades, if present, will also be considered. The permissible values of the load factors and stresses will be utilized within the purview of the Indian Standards.

The computer analysis will produce accurate individual member forces, reactions at foundation level and deflection pattern of the entire structure as well as individual members. This data will then be used to confirm/review the member sizes and arrive at the most appropriate design of the structural members. Some re-runs of the analysis program might be required for arriving at the optimum structural space frame characteristics that satisfy the strength and stability criteria in all respects.

Design of different structural elements will be carried out using In-house developed spreadsheets and packages.

The following model assumptions used in E-TABS 3D modeling and the load applications are done as listed below,

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

- Modulus of Elasticity of Concrete -5000$\sqrt{fck}$
- Consideration of Diaphragm - Rigid Diaphragm.
- Slab/Wall element considered as Shell element

The structural model and its behavior have been checked for the following

a) Storey Drift.

b) Storey Weight/Column Loading.

c) Soft Storey Effect.

d) Deformation.

e) Design Forces.

The following methods of modeling are adopted in creating ETABS 3D model,

- The 3D ETABS model generated based on the shuttering drawing prepared using preliminary sizes.
- Sectional properties are assigned to all the structural elements as per the preliminary shuttering drawing.
- Mesh size assigned in size of 1m x 1m appx.
- External & Internal filler wall loads are assigned as uniformly distributed line load on beams and as area load if the wall is intended to distribute on slab directly. These loads are assigned under SDL type load case.
- Slabs are modelled as shell element in Flat slab area and the same has been modelled as membrane in Beam-slab system which 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/SIDL 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 875-2015.
- Temperature loads are applied on to the terraces which are directly exposed to sun includes podium, Roof etc.
- 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 0.01 to torsional constant "J". Hence no specific design for Torsion is required for these beams.

- **Chennai is Zone-III**. Hence ductile detailing is followed in the design and detailing of structural elements.
- Concrete cover to reinforcement complied accordance with IS 456-2000, Table16 & 16A.
- All vertical wall elements are assigned with auto meshing/manual meshing appropriately in order to achieve accuracy in results.
- UG Sump is designed for 0.2mm and STP is designed for the crack width of 0.1mm.
- Secondary beams are not designed for ductile detailing.
- Long term deflections are checked by manual calculation using excel spread sheet wherever necessary. Crack width calculation will be done using spread sheet wherever necessary.

Area Load & Application: Applied as uniformly distributed area load with intensity proportionate to its usage as mentioned in the Loading items in the DBR.

Line (Wall) Load & Application: Filler wall loads are calculated appropriately considering Solid block Blocks and Applied as uniformly distributed line load.

Lateral Load Resisting Systems: The vertical structural systems are formed by both RC wall & columns which are responsible in transferring its base shear in proportion to its stiffness in their loading direction for both wind & seismic forces.

5.0. LATERAL LOADS

5.1 Wind Loads

The wind pressure shall be calculated based on the basic wind speed and other provisions laid in IS 875 (part 3) – 2015. The basis wind speed considered in the analysis for **Chennai, TN** is 50 m/sec. The design parameters for wind load calculation are as follows,

Design Wind Pressure Vz = 0.6 Vz^2

But Vz = Vb*k1*k2*k3*k4

Where Vz - Design Wind Speed

k1 – 1.0 probability factor or risk coefficient

k2 – 1.16, Terrain height (45.6m), structure size factor

(measured from Basement floor) with terrain Category–2

k3 – 1.0, Topography factor

k4 – 1.0, Importance factor for the cyclonic region, for all other

Structure as per IS 875-Part3, clause 6.3.4.

Hence the Wind Pressure = 0.6x (50x1.0*1.16*1.0*1.0)^2
= 2019 N/m^2 ≈ 2.02 kN/m^2

Design Wind Pressure (Pd) = Kd*Ka*Kc*Pz

Where Kd - 0.9, wind directionality factor

Ka - 0.8, area averaging factor

Kc - 0.9 , combination factor

Design Wind Pressure (Pd) = 0.9*0.8*0.9*2.02

= 1.41 kN/m^2

The design wind load will be calculated based on the surface area with the calculated design wind pressure and it shall be applied on surface area of the building in both the orthogonal direction.

5.2 Earthquake Loads

Chennai is classified under Earthquake **Zone III** (Moderate) as per the latest classification. The loading due to earthquake shall be assessed based on the provisions of IS 1893 – 2016 The design parameters adopted are as follows:

Seismic Zone III with seismic zone factor Z = 0.16 (Moderate) and Response reduction factor is to be 5.0 considering RC Building with SMRF as per IS: 1893-2016, Table-7 and Soil considered as Type-I Hard soil.

Base Shear Calculation for Static Analysis

As per IS 1893:2016, the total design lateral force or design seismic base shear (V_b) is determined by the following expression.

$$V_b = A_h W$$

Where Ah is Design horizontal acceleration spectrum value using fundamental natural period and W is Seismic weight of the building.

The Seismic weight is estimated based on Full dead load + 25 % Live load for Residential building i.e. for Live Load < 3 kN/Sq.mt. the reduction considered is 25%.

The Fundamental natural period of vibration (Ta) in seconds of a RC building is estimated by using the following formula, Ta = 0.09*h/(d)^0.5.

Where h is the height of the building in meters. d is the base dimension of the building at the plinth level, in m along the considered direction of the lateral force.

Height of the building = 45.6 m (measured from Basement floor)
d (along-y, length of the building) =35.05 m
b (along-x breadth of the building) = 65.53 m
Ta (along x) = 0.09 x45.6/(65.53)^0.5
= 0.5 Sec.
Ta (along y) = 0.09 x45.6/(35.05)^0.5
= 0.7 Sec.

From IS 1893: 2002, Clause 6.4.2, Design horizontal seismic coefficient

$$Ah = \frac{Z\ I\ Sa}{2\ R\ g}$$

Where,
Z for Zone III = 0.16
I for Important buildings = 1.2 (Refer to IS 1893-2016, Table.8)
R for RC Building with Special Moment resisting Frame i.e. SMRF = 5.0 as per (Table 9).
Sa/g (Hard soil) X-Dir. = 2.12 (Refer to IS 1893-2016, page 13, Fig 1)
Sa/g (Hard soil) Y-Dir. = 1.67 (Refer to IS 1893-2016, page 13, Fig 1)

Design horizontal seismic coefficient Ah_x = 0.041
Base Shear Vb_x = 0.041W

Design horizontal seismic coefficient Ah_y = 0.032
Base Shear Vb_y = 0.032W

5. LOAD COMBINATIONS

The various loads shall be combined in accordance with the stipulations in IS 875 (Part 5) 1987 and IS 456: 2000. The structural elements shall be designed for the combination that produces most unfavorable effect out of the following combinations.

The results obtained from the computer analysis in the form of member forces and reactions will be used for design the structural members. Following load combinations of the member forces will be considered for arriving at the design forces. The analysis considered load factor is as follows,

Load Combination	LOAD FACTORS								
	D.L.	I.L.	T.L	EQX	EQY	SPECX	SPECY	WX	WY
Limit State Of Serviceability (LSS) Combinations									
LC1	1.0	-	1.0	-	-	-	-	-	-
LC2	1.0	1.0	1.0	-	-	-	-	-	-
LC3	1.0	-	1.0	1.0	-	-	-	-	-
LC4	1.0	-	1.0	-1.0	-	-	-	-	-
LC5	1.0	-	1.0	-	1.0	-	-	-	-
LC6	1.0	-	1.0	-	-1.0	-	-	-	-
LC7	1.0	-	1.0	-	-	-	-	1.0	-
LC8	1.0	-	1.0	-	-	-	-	-1.0	-
LC9	1.0	-	1.0	-	-	-	-	-	1.0
LC10	1.0	-	1.0	-	-	-	-	-	-1.0
LC11	1.0	-	1.0	-	-	1.0	-	-	-
LC12	1.0	-	1.0	-	-	-1.0	-	-	-
LC13	1.0	-	1.0	-	-	-	1.0	-	-
LC14	1.0	-	1.0	-	-	-	-1.0	-	-
LC15	1.0	0.8	1.0	0.8	-	-	-	-	-
LC16	1.0	0.8	1.0	-0.8	-	-	-	-	-
LC17	1.0	0.8	1.0	-	0.8	-	-	-	-

LC18	1.0	0.8	1.0	-	-0.8	-	-	-	-
LC19	1.0	0.8	1.0	-	-	-	-	0.8	-
LC20	1.0	0.8	1.0	-	-	-	-	-0.8	-
LC21	1.0	0.8	1.0	-	-	-	-	-	0.8
LC22	1.0	0.8	1.0	-	-	-	-	-	-0.8
LC23	1.0	0.8	1.0	-	-	0.8	-	-	-
LC24	1.0	0.8	1.0	-	-	-0.8	-	-	-
LC25	1.0	0.8	1.0	-	-	-	0.8	-	-
LC26	1.0	0.8	1.0	-	-	-	-0.8	-	-
Limit State Of Collapse (LSC) Combinations									
COMB1	1.5	-	1.0	-	-	-	-	-	-
COMB2	1.5	1.5	1.0	-	-	-	-	-	-
COMB3	1.2	1.2	1.0	1.2	-	-	-	-	-
COMB4	1.2	1.2	1.0	-1.2	-	-	-	-	-
COMB5	1.2	1.2	1.0	-	1.2	-	-	-	-
COMB6	1.2	1.2	1.0	-	-1.2	-	-	-	-
COMB7	1.2	1.2	1.0	-	-	-	-	1.2	-
COMB8	1.2	1.2	1.0	-	-	-	-	-1.2	-
COMB9	1.2	1.2	1.0	-	-	-	-	-	1.2
COMB10	1.2	1.2	1.0	-	-	-	-	-	-1.2
COMB11	1.2	1.2	1.0	-	-	1.2	-	-	-
COMB12	1.2	1.2	1.0	-	-	-1.2	-	-	-
COMB13	1.2	1.2	1.0	-	-	-	1.2	-	-
COMB14	1.2	1.2	1.0	-	-	-	-1.2	-	-
COMB15	1.5	-	1.0	1.5	-	-	-	-	-
COMB16	1.5	-	1.0	-1.5	-	-	-	-	-
COMB17	1.5	-	1.0	-	1.5	-	-	-	-
COMB18	1.5	-	1.0	-	-1.5	-	-	-	-
COMB19	1.5	-	1.0	-	-	-	-	1.5	-
COMB20	1.5	-	1.0	-	-	-	-	-1.5	-
COMB21	1.5	-	1.0	-	-	-	-	-	1.5
COMB22	1.5	-	1.0	-	-	-	-	-	-1.5
COMB23	1.5	-	1.0	-	-	1.5	-	-	-
COMB24	1.5	-	1.0	-	-	-1.5	-	-	-
COMB25	1.5	-	1.0	-	-	-	1.5	-	-
COMB26	1.5	-	1.0	-	-	-	-1.5	-	-
COMB27	0.9	-	1.0	1.5	-	-	-	-	-
COMB28	0.9	-	1.0	-1.5	-	-	-	-	-
COMB29	0.9	-	1.0	-	1.5	-	-	-	-
COMB30	0.9	-	1.0	-	-1.5	-	-	-	-
COMB31	0.9	-	1.0	-	-	-	-	1.5	-
COMB32	0.9	-	1.0	-	-	-	-	-1.5	-
COMB33	0.9	-	1.0	-	-	-	-	-	1.5
COMB34	0.9	-	1.0	-	-	-	-	-	-1.5
COMB35	0.9	-	1.0	-	-	1.5	-	-	-
COMB36	0.9	-	1.0	-	-	-1.5	-	-	-
COMB37	0.9	-	1.0	-	-	-	1.5	-	-
COMB38	0.9	-	1.0	-	-	-	-1.5	-	-

DL: Dead Load **EQX** : Earthquake Load in X-dir. **WX**: Wind Load in X-dir.
IL: Imposed Load **EQY** : Earthquake Load in Y-dir. **WY**: Wind Load in Y-dir. **TL**: Temperature Load

6. COVER AND FIRE RATING

Fire rating considered - 2hrs. Cover to reinforcement considered for various elements are as follows.

Raft	60 mm
Columns	40 mm
Shear Wall	30 mm
Beams	30 mm
Slabs	25 mm

7. DEFLECTION CRITERIA

7.1 Lateral Deflection (Wind)

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

7.2 Lateral Deflection (Seismic)

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

7.3 Vertical Deflection of Beams and Slabs due to Gravity Loads

Total Deflection (DL + LL)	< Span/250 up to 20 maximum
Deflection including the effects of Temperature, Creep and Shrinkage Occurring after erection of partitions and the application of finishes	< Span/350 or 20mm whichever is less

8. CONSTRUCTION JOINT

Construction joints and shrinkage strips will be planned with the contractor and only be used in locations pre-approved by consultants.

1) No construction joint is allowed in the sunken portion
2) Construction joint shall be provided in slab/beam at l/3 from support.
3) Construction joint shall be placed at accessible location for maintenance purpose.
4) Joints are common source of weakness, therefore it is desirable to avoid or at least minimize them.

9. DESIGN OF STRUCTURAL ELEMENTS

For the design of R.C.C. elements, the Limit State Method will be used as per IS 456-2000. Materials of construction will be predominantly concrete with consideration for strength and durability. The grade of concrete adopted in the Analysis and Design is M35 for all structural elements which includes Raft, Shear wall, Column, Beam, slab, basement wall, underground sump etc., considering the level of stresses to be borne by the members both in compression as well as flexural.

High Yield Strength Deformed bars conforming to IS: 1786 with F_y = 500 MPa will be used as reinforcement. Structural steel, if any with Fy = 250 Grade shall be used.

Covers to reinforcement shall be in accordance with IS: 456:2000 corresponding to **moderate exposure conditions** for the super-structure or severe exposure conditions for the sub-structure and to satisfy a fire rating of 2 hrs as per National building code of India- SP7 (part IV).

10. FOUNDATION

As per the column load intensity and the Soil consultant recommendation laid down in the report, the building is designed with Raft Foundation. The foundation is designed to be a Raft with the thickness of 1000mm with the plan size of 75m X 55m over weathered Rock stratum with the "N" value more than 100 at a depth of 3m & below from existing ground level. If any soft layer below the base of the Raft will be removed and it will be back filled using GSB or plum concrete such that the load is transferred to the suitable dense soil layer. Raft Foundation has been designed in SAFE software considering Safe Bearing Capacity of 250 kN/m^2 and with using the subgrade modulus of reaction of 25000 kN/m/m^2.

For the extended basement roof area necessary amount of filling will be done to resist the possible uplift pressure for the permanent condition. If necessary, ground anchors or its equivalent system shall be deployed to prevent the base slab from uplift due to hydrostatic water pressure. The tower area has adequate self-weight to prevent the uplift in the permanent condition. However, the possibility of uplifting of structure shall be protected by lowering ground water table by deploying the suitable dewatering system.

11. STABILITY OF STRUCTURES

1. For the purpose of stability of the structure as a whole against overturning, the restoring moment shall not be less than 1.2 times the maximum overturning moments due to dead load plus 1.4 times the maximum overturning moments due to imposed loads. In case where dead load provides the restoring moments only 0.9 times in dead

load shall be considered. The restoring moments due to imposed loads shall be ignored.

2. The factor of safety against sliding shall not be less than 1.40.
3. Factor of safety against buoyancy shall be not less than 1.20 ignoring the superimposed loading.

12.0 OTHER DATA

Specific requirements of floor and wall cutouts for services, sinking (extent & depth) of floors in services, kitchen, utility and toilet areas, external architectural features, and entrance canopies are provided as required by Architects and Service Consultants. The relevant information is obtained from them in the form of drawings.

Lift loads and lift machine room equipment and cut out layouts will be obtained from the lift manufacturers. An impact factor of 100% will be considered in the lift supporting structures.

13.0 R.C Design

The structures are analyzed for the various load combinations as per IS: 456-2000. The design of structural elements are carried out by ETABS/ RCDC Connect V11 for all structural elements for the worst forces extracted from the ETABS analysis output whereas the slab design is being done using in house spread sheet. For the design of R.C.C structural elements carried out, the recommendations stipulated in IS: 456-2000 is followed. Limit State method of design is adopted with appropriate load factors with the various load combinations for the different structural elements appropriately.

13.1. Foundation

The building is designed with Raft Foundation. The foundation is designed to be a Raft with the thickness of 1000mm with the plan size of 75m X 55m over weathered Rock stratum with the "N" value more than 100 at a depth of 4.6m from existing ground level. Raft Foundation has been designed using Safe Bearing Capacity of 250 kN/m^2 with using the subgrade modulus of reaction of 25000 kN/m/m^2. The foundation is designed considering the load intensity of the columns and the SBC recommended in the soil Investigation Report No. AA/DEC/2021/65 dated 11th Jan, 2022. Soil Investigation carried out by Aravind Associates, Chennai.

13.2. Column/Wall

Vertical elements carry both gravity and lateral loads like Columns/RC Walls are designed for the worst combination results using ETABS/RCDC/in house spread sheet.

13.3. Beam

Beams are designed for the worst combination results using ETABS/RCDC/in house spread sheet.

13.4. Slab

Slabs are designed using in house spread sheet as per IS-456 Annexe-D, Table-26.

14.0 COMPUTER PROGRAMS USED

The following Software / spreadsheet are used to carry out Structural design.

14.1 PROKON Ver 3.0 - Basement Wall & STP design

14.2 ETABS V21 - Three-Dimensional FEM analysis and Design Programs

14.3 SAFE Ver 20.3.0 - Raft Slab Analysis & Design

14.4 In-House Spreadsheet - One way/ Two-way slab design

14.5 RCDC Connect Edition V11 - Design Software for all Structural Elements except Raft

A. PERAMAIYAN, M.E., (Struct.), M.I.E.
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No. SE/GR-I/19/03/026
NEW No. 31 (OLD No.14), BESANT AVENUE ROAD,
ADYAR, CHENNAI - 600 020.
E-Maii: peram@buroengineers.in
Mobile: +91 99625 45630



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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

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Verified RealEstate™

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

3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai, India

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