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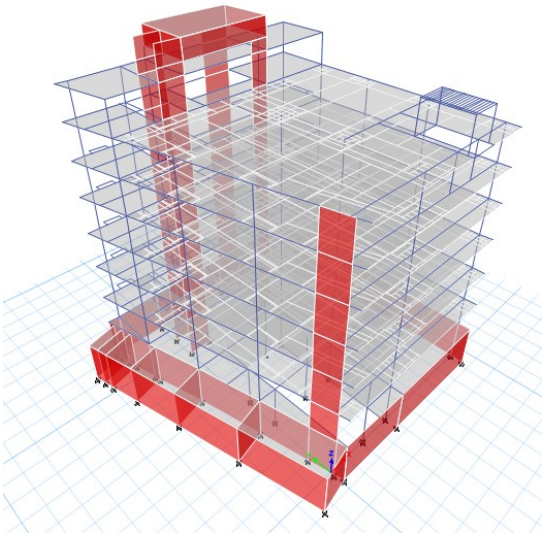
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CLIENT:

M/s. Lifestyle Housing & Infrastructure (P) Ltd.
CHENNAI, TAMILNADU.

ARCHITECT:



DESIGN REALM,
NO.9,WEST CLUB ROAD
SHENOY NAGAR
CHENNAI-600 030, TAMILNADU.

STRUCTURAL CONSULTANT:

BURO ENGINEER (I) PVT LTD.
Civil & Structural Consultants,
#31, Besant Avenue, Adyar,
Chennai - 600 020, India
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STRUCTURAL DESIGN CALCULATION REPORT

R1	25-09-2021	Design Basis Report	OK	JEYARAMAN	PURUSOTHAMAN	PERAM
REV	**DATE**	**DESCRIPTION**	**STATUS**	**PREPARED BY**	**REVIEWED BY**	**APPRVD. BY**

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- Design Information and Criteria
- Analysis summary report
- Design of Footing
- Design of Column
- Design of RCC Beam
- Design of RCC Slab

Appendix (Refer drawings)

a. Structural Framing Plans

b. Column Layout & Column Schedule

c. Beam Schedule

d. Footing Details

PLAN SHOWING THE PROPOSED OFFICE BUILDING AT DOOR NO. 13, BALFOUR ROAD, KILPAUK, CHENNAI 600 010. COMPRISED IN O.S.NO;8,R.S NO:3132/5, BLOCK NO:52, PURASAWALKAM VILLAGE, PURASAWALKAM TALUK, CHENNAI DISTRICT, GREATER CHENNAI CORPORATION, ZONE - VIII, DIVISION -103.

DESIGN INFORMATION AND CRITERIA

1. INTRODUCTION

M/s. Lifestyle Housing & Infrastructure (P) Ltd., a Chennai based Developer proposed a construction of a Proposed Office Building comprises Single basement + Stilt + 5 Storey + Roof structure is located at Door No. 13, Balfour Road ,Kilpauk , Chennai 600 010. Architecturally it is designed with Single (1) Basement + Stilt + 5 Storey+1 additional floor for future. In which, basement floor and Stilt floors are designed to facilitate car parks whereas 1st floor to 5th floors are designed for commercial use. Partly, the 5th floor is designed as Office with open terrace. Stilt Floor accommodates mainly car parks & driveway with ramp leads to basement.

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

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 Requipements
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

1. DESIGN PARAMETERS

3.1 Materials of Construction

The building is predominantly Shear wall connected with frame/slab. The lateral load resisting system of Shear walls/Columns are well connected in orthogonal direction to the centrally located Lift Core wall/columns which are connected by floor slab is act as diaphragm in redistribution of lateral forces.

3.1.1 Concrete Grade

Concrete grade shall be M35 for Raft Slab, RC Wall, Colum, RC/PT Beam and RC/PT slab all structural elements with minimum 28-day strength 35 MPa.

Concrete Mix M10 has been used in filling, plum concrete, labelling 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 Slab	M35
Columns	M35
R.C Wall	M35
R.C.C. Beams/Slabs	M35
PT Beam/Slab	M35
Water Tanks	M35
Basement Retaining Wall	M35
Parapet Wall & any other Structural members	M35

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 Raft Slab, RC Wall, Column, RC/PT Beam and RC/PT slab all structural elements 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 coarse aggregate, fine aggregate etc. shall be submitted to the consultant's review and approval.

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 Slab = 60mm
b. Column = 40mm
c. Shear Wall = 30mm
d. Beam = 30mm (Bottom and sides)
e. Slab = 25mm (Top and Bottom)
f. Basement wall/Water tanks / Sump tank
   On water face = 40mm (Top and Bottom)
   On other face = 30mm (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. TJE/001531/2020 dated 02nd FEB 2020, there are 2 no. of bore holes were done at different locations of the plot spread across the site to carry out field tests. All the bore holes are terminated at 22.5m of dense layer with "N" value more than 100. The top 1.1m is the filled-up soil. Below which, the soil is Loose Clayey Silty Sand exists up to 2.2m with "N" value in the range of 4 to 5. Followed by the soil layer is a Medium dense silty sand which is exists up to 8.3m with "N" Value is in the range of 13 to 25. From 8.3m below and up to 11m, it is a Stiff Sandy silty clay encountered with "N" values in the range of 6 to 9. From 11m below and up to 15.5m, it is a medium dense silty clay Sand encountered with "N" value from 13 to 23. From 15.5m below and up to 20.5m, it is a Dense to Very Dense Silty Sand encountered with "N" value from 37 to 55.Very Dense Sandy Gravel is encountered with "N" value more than 100 at depth below 20.5m and up to 22.5m where the bore hole is terminated. Ground water table is reported during the investigation period of February 2019 is at 3m below EGL. However, it is advisable to design the basement structure for the head of water up to Ground level as the water table likely to raises up to ground during peak monsoon.

3.2 Loading Standards

Table: Structural Configuration and Floor heights:

Commercial Building	**B+Stilt+4+Terrace**
Basement1 floor height (Car Park)	3.00m
Stilt floor height (Car Park)	3.05m
1st floor height (Office)	3.05m
2nd floor height (Office)	3.05m
3rd Floor height (Office)	3.05m
4/5th Floor height (Office/Terrace)	3.05m
Terrace	2.50m
LMR & OHT	2.50m
Type of Foundation	**Raft Slab**
Grade of concrete Raft Slab	M35
Grade of concrete for Wall	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	Fe500

Table: Unit Weight of Materials:

Material	**Density**
Plain Cement Concrete	25.00 kN/Cu.m

Light weight Block Work (Aerocon)	7.50 kN/Cu.m
Mortar Finishing	20.00 kN/Cu.m
Dry soil	18.00 kN/Cu.m
Saturated soil	20.00 kN/Cu.m
Glass	33.00 kN/Cu.m
water	10.00 kN/Cu.m

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 if 175mm thick slab	0.175x25 = 4.375 kN/Sq.mt.
Self weight if 200mm thick slab	0.200x25 = 5.000 kN/Sq.mt.
Self weight if 225mm thick slab	0.225x25 = 5.625 kN/Sq.mt.
Self weight if 250mm thick slab	0.250x25 = 6.250 kN/Sq.mt.

External/Internal Wall Line Load:		
Basement-1	= (0.2x2.6x7.5)+(0.03x2.6x24)	= 6 kN/m
Stilt Floor	=(0.2x2.6x7.5)+(0.03x2.6x24)	= 6 kN/m
First Floor	= (0.2x2.6x7.5)+(0.03x2.6x24)	= 6 kN/m
Second Floor	= (0.2x2.6x7.5)+(0.03x2.6x24)	= 6 kN/m
Third Floor	= (0.2x2.6x7.5)+(0.03x2.6x24)	= 6 kN/m
Fourth/Fifth Floor	= (0.2x2.6x7.5)+(0.03x2.6x24)	= 6 kN/m
Terrace	= (0.2x2.25x7.5)+(0.03x2.25x24)	= 5 kN/m
LMR & OHT	= (0.2x2.25x7.5)+(0.03x2.25x24)	= 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 75 mm thickness have been considered on all floors)*

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

BASEMENT-1 & STILT (Car Parks)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.9	0.0
Services	0.5	-
Live Load	0.0	2.5
Partition Load	-	0.0
Total	**2.4**	**2.5**
BASEMENT-1 & STILT (Lobby)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.9	0.0
Services	0.5	-

Live Load	0.0	4.0
Partition Load	-	0.0
Total	**2.4**	**4.0**
First Floor , Second Floor,Third Floor, Fourth & Fifth Floor (OFFICE)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.9	0.0
Services	0.5	-
Live Load	0.0	4.0
Partition Load	1.0	0.0
Total	**3.4**	**4.0**
First Floor , Second Floor,Third Floor, Fourth & Fifth Floor (TOILET)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.9	0.0
Services	0.5	-
Live Load Gym/ MP Hall	0.0	2.0
Partition Load	3.75	0.0
Total	**6.15**	**2.0**

First Floor, Second Floor, Third Floor, Fourth & Fifth Floor (LOBBY)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.9	0.0
Services	0.5	-
Live Load	0.0	4.0
Partition Load	-	0.0
Total	**2.4**	**4.0**
TERRACE		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes+Filling	1.9	0.0
Services	0.5	-
Live Load	0.0	5.0
Partition Load	-	0.0
Total	**3.2**	**5.0**

LMR		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.9	0.0
Services	0.5	-
Live Load	0.0	15.0
Partition Load	0.0	0.0
Total	**2.4**	**15.0**

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 Shear wall/Column & PT flat slab 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 behaviour 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.

In this case, the size of the structure below ground level is about 22.14mx20.90m whereas the size of the super structure is 22.14mx20.90m. It is fall well within the stimulated limit in IS 456: 2000, clause.27.2. Hence there is no need of thermal analysis requires to be performed.

3.3.1 Shrinkage Effects

The Building length is only 22.14m on both above and below ground level which does not fall to the stimulated length. Hence there is no special care required to control shrinkage as it is not a demanding requirement except the regular precautions like early sprinkling and membrane water curing for not less than 7 days from the date of concreting.

3.3.2 Expansion Joints

Expansion joints are normally provided when the structure is more than 45m length as per IS-456-2000, clause 27.2. The size of the structure below ground level is about 22.14mx20.90m whereas the size in the superstructure is i.e. above ground is 22.14mx20.90m which falls well within the limitation stimulated in IS 456: 2000, clause.27.2. Hence there is no need of expansion joint.

4. PROPOSED APPROACH OF STRUCTURAL ANALYSIS

The building is a R.C.C shear walls/columns are connected by PT flat slab with RC peripheral beams. 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 analysed using the ETABS v2018 software for the following computer models of the building floor analysis of all floors - for vertical loads with the entire building space frame. ETABS v2018 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 modelled 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 modelling and the load applications are done as listed below,

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

- Modulus of Elasticity of Concrete -5000√fck
- Consideration of Diaphragm - Rigid Diaphragm.
- Slab/Wall element considered as Shell element

The structural model and its behaviour has 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 0.0001 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, Tabl.16 & 16A.
- All vertical wall elements are assigned with auto meshing/manual messing 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 light weight Aerocon Blocks and Applied as uniformly distributed line load.

Lateral Load Resisting Systems: The proposed structure is a RCC Shear wall/Columns & PT flat slab structure, with columns and shear walls forming vertical components. The vertical structural systems are formed such that the RC Wall & Column Frames are Transfer lateral base shear in proportion to its stiffness in its direction of 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 is 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 – 1.0632, Terrain height (18.3m), structure size factor

(Measured from Ground 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 Design Wind Pressure = 0.6x (50x1.0*1.0632*1.0*1.0)^2
= 1695.795 N/m^2 ≈ 1.695 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 3.0 considering Flat Slab Structural Wall System as per IS: 1893-2016, Table-7 and Soil considered as Type-II Medium 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 + 50 % Live load for Commercial building i.e. Live Load > 3 kN/Sq.mt. the reduction considered in the seismic weight calculation is 50%.

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 and Aw is wall area as below,

Height of the building = 18.30 m (measured from Ground floor)
d (along-y, length of the building) = 22.14 m
b (along-x breadth of the building) = 20.90 m

Ta (along x) = 0.36 Sec.
Ta (along y) = 0.35 Sec.

From IS 1893: 2016, 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 Business Continuity Structures = 1.2 (Refer to IS 1893-2016, Table.8)
R for Flat Slab System i.e. = 3.0
as per (Table 9).

Sa/g (Medium soil) X-Dir. = 2.5 (Refer to IS 1893-2016, page 9, Clause 6.4.2)
Sa/g (Medium soil) Y-Dir. = 2.5 (Refer to IS 1893-2016, page 9, Clause 6.4.2)

Design horizontal seismic coefficient Ah_x = 0.08
Base Shear Vb_x = 0.08 W

Design horizontal seismic coefficient Ah_y = 0.08
Base Shear Vb_y = 0.08 W

2. 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.	EQX	EQY	SPECX	SPECY	WX	WY
Limit State Of Serviceability (LSS) Combinations								
LC1	1.0	-	-	-	-	-	-	-
LC2	1.0	1.0	-	-	-	-	-	-
LC3	1.0	-	1.0	-	-	-	-	-
LC4	1.0	-	-1.0	-	-	-	-	-
LC5	1.0	-	-	1.0	-	-	-	-
LC6	1.0	-	-	-1.0	-	-	-	-
LC7	1.0	-	-	-	-	-	1.0	-
LC8	1.0	-	-	-	-	-	-1.0	-
LC9	1.0	-	-	-	-	-	-	1.0
LC10	1.0	-	-	-	-	-	-	-1.0
LC11	1.0	-	-	-	1.0	-	-	-
LC12	1.0	-	-	-	-1.0	-	-	-
LC13	1.0	-	-	-	-	1.0	-	-
LC14	1.0	-	-	-	-	-1.0	-	-
LC15	1.0	0.8	0.8	-	-	-	-	-
LC16	1.0	0.8	-0.8	-	-	-	-	-
LC17	1.0	0.8	-	0.8	-	-	-	-
LC18	1.0	0.8	-	-0.8	-	-	-	-
LC19	1.0	0.8	-	-	-	-	0.8	-
LC20	1.0	0.8	-	-	-	-	-0.8	-
LC21	1.0	0.8	-	-	-	-	-	0.8
LC22	1.0	0.8	-	-	-	-	-	-0.8
LC23	1.0	0.8	-	-	0.8	-	-	-
LC24	1.0	0.8	-	-	-0.8	-	-	-
LC25	1.0	0.8	-	-	-	0.8	-	-
LC26	1.0	0.8	-	-	-	-0.8	-	-
Limit State Of Collapse (LSC) Combinations								
COMB1	1.5	-	-	-	-	-	-	-
COMB2	1.5	1.5	-	-	-	-	-	-
COMB3	1.2	1.2	1.2	-	-	-	-	-
COMB4	1.2	1.2	-1.2	-	-	-	-	-
COMB5	1.2	1.2	-	1.2	-	-	-	-
COMB6	1.2	1.2	-	-1.2	-	-	-	-
COMB7	1.2	1.2	-	-	-	-	1.2	-
COMB8	1.2	1.2	-	-	-	-	-1.2	-
COMB9	1.2	1.2	-	-	-	-	-	1.2
COMB10	1.2	1.2	-	-	-	-	-	-1.2
COMB11	1.2	1.2	-	-	1.2	-	-	-
COMB12	1.2	1.2	-	-	-1.2	-	-	-
COMB13	1.2	1.2	-	-	-	1.2	-	-
COMB14	1.2	1.2	-	-	-	-1.2	-	-
COMB15	1.5	-	1.5	-	-	-	-	-
COMB16	1.5	-	-1.5	-	-	-	-	-
COMB17	1.5	-	-	1.5	-	-	-	-
COMB18	1.5	-	-	-1.5	-	-	-	-
COMB19	1.5	-	-	-	-	-	1.5	-

COMB20	1.5	-	-	-	-	-	-1.5	-
COMB21	1.5	-	-	-	-	-	-	1.5
COMB22	1.5	-	-	-	-	-	-	-1.5
COMB23	1.5	-	-	-	1.5	-	-	-
COMB24	1.5	-	-	-	-1.5	-	-	-
COMB25	1.5	-	-	-	-	1.5	-	-
COMB26	1.5	-	-	-	-	-1.5	-	-
COMB27	0.9	-	1.5	-	-	-	-	-
COMB28	0.9	-	-1.5	-	-	-	-	-
COMB29	0.9	-	-	1.5	-	-	-	-
COMB30	0.9	-	-	-1.5	-	-	-	-
COMB31	0.9	-	-	-	-	-	1.5	-
COMB32	0.9	-	-	-	-	-	-1.5	-
COMB33	0.9	-	-	-	-	-	-	1.5
COMB34	0.9	-	-	-	-	-	-	-1.5
COMB35	0.9	-	-	-	1.5	-	-	-
COMB36	0.9	-	-	-	-1.5	-	-	-
COMB37	0.9	-	-	-	-	1.5	-	-
COMB38	0.9	-	-	-	-	-1.5	-	-

DL: Dead Load **SPECX** : Earthquake Load in X-dir. **WX**: Wind Load in X-dir.
IL: Imposed Load **SPECY** : Earthquake Load in Y-dir. **WY**: Wind Load in Y-dir.

3. COVER AND FIRE RATING

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

Raft Slab	60 mm
Columns	40 mm
Retaining/Basement wall (Outside face)	40 mm
Retaining/Basement wall (Inner face)	30 mm
Shear Wall	40 mm
Beams	30 mm
Slabs	25 mm

4. 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

5. 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.

6. 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 Raft Slab, RC Wall Column, RC/PT Beam and RC/PT slab all structural elements 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).

7. FOUNDATION

The Proposed Office Building comprises Single basement + Stilt + 5 Storey + Roof structure is located at Door No. 13, Balfour Road ,Kilpauk , Chennai 600 010. Based on the analysis results, it is noticed that the vertical elements are considerably loaded. .

As per the column load intensity and the Soil consultant recommendation laid down in the report, the building is designed with Raft foundation. The raft is designed with uniform thickness 0.85m and few columns are provided with 1100mm with a foundation depth of around 3m measured from EGL as recommended in the soil report. The thickness of the Raft varies in the range of 1100/850mm provided depends upon the stress concentration with 1200mm toe projection from the peripheral columns on all four sides.

It is recommended to go with mass excavation up to the base of the raft except the bottom 300mm shall be done manually in order to avoid disturbing the bearing layer by the pock line teeth.

Foundation & Excavation Assumptions:

- Raft/Mat Foundation is designed with thickness varies in the range of 1100/850mm. The Foundation is rest over at around 3m depth measured from EGL.
- The Raft/Mat has been analyzed & designed using SAFE-Ver.14.1.1 considering Subgrade modulus of reaction as 14,000 kN/m^3 and the safe Bearing Capacity used in the Footing design is 140 kN/Sq.mt
- Necessary retaining system for the safe excavation and construction of basement structure against the nearest property & Road shall be taken care which is the responsibility of Contractor & Client.

8. 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.

13.0 OTHER DATA

Specific requirements of floor and wall cut outs 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.

14.0 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 Ver.6.1 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.

14.1. 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 raft is designed with thickness 850mm and few columns are designed 1100mm thick with a toe projection of 1200mm provided all around the building. The Raft is to be rest over at medium dense silty sand with depth of about 3.0 measured from EGL as recommended in the soil report. The Raft is designed using SAFE-Ver14.1.1 considering the SBC of 14t/Sq.mt. and the subgrade modulus of reaction about 14,000 kN/m^3 for the actual load intensity of the vertical members (columns & Shear wall) as per the recommendation laid down in the soil Investigation reports carried out by M/s.T.J.ENGINEERS (P) Ltd.

14.2. 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.

14.3. Beam

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

14.4. Slab

Flat slab is being designed using SAFE and conventional Slabs are designed using in house spread sheet as per IS-456 Annexe-D, Table-26.

15.0 COMPUTER PROGRAMS USED

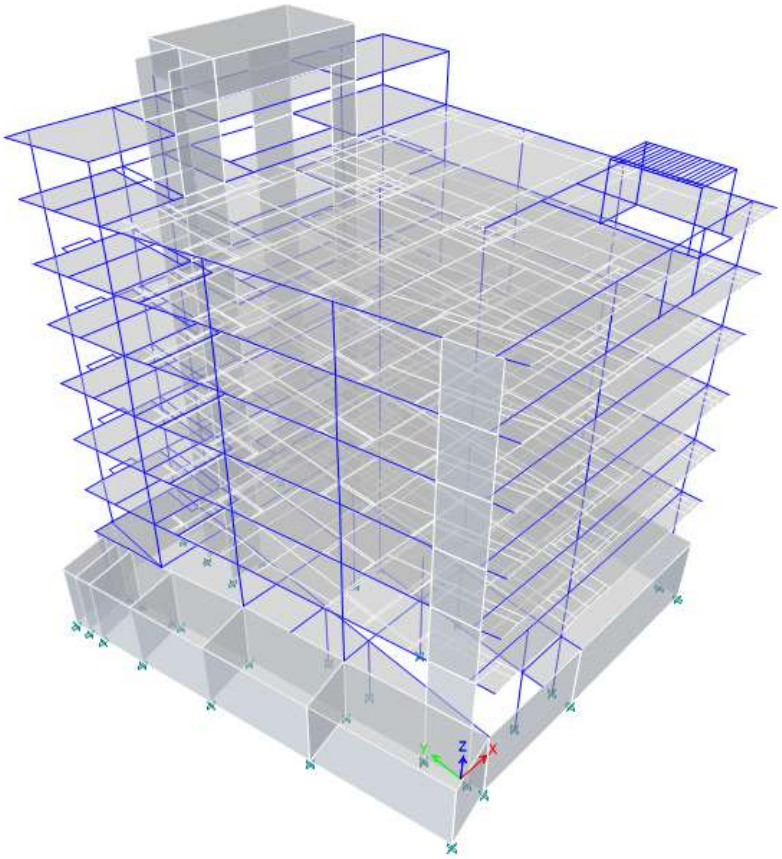
The following Software / spreadsheet are used to carry out Structural design.

15.1	PROKON Ver 2.3	- Wall & Beam design
15.2	ETABS Ver 2017	-Three Dimensional FEM analysis and Design Programs
15.3	SAFE 2014 Ver 14.1.1	- Basewment-2 Slab Analysis & Design
15.4	In-House Spreadsheet	- One way/ Two way slab design
15.5	RCDC V.8.0	- Design Software for all Structural Elements except Raft

PLAN SHOWING THE PROPOSED OFFICE BUILDING AT DOOR NO. 13, BALFOUR ROAD, KILPAUK, CHENNAI 600 010. COMPRISED IN O.S.NO;8,R.S NO:3132/5, BLOCK NO:52, PURASAWALKAM VILLAGE, PURASAWALKAM TALUK, CHENNAI DISTRICT, GREATER CHENNAI CORPORATION, ZONE - VIII, DIVISION -103.

3D MODEL
&
ANALYSIS SUMMARY REPORT

ETABS®



User Report 2

Model File: MODEL, Revision 0
25-09-2021

1 Loads

This chapter provides loading information as applied to the model.

1.1 Auto Seismic Loading

Table 1.1 - Load Pattern Definitions - Auto Seismic - IS 1893 2016 (Part 1 of 2)

Name	Is Auto Load	X Dir?	X Dir Plus Ecc?	X Dir Minus Ecc?	Y Dir?	Y Dir Plus Ecc?	Y Dir Minus Ecc?	Ecc Ratio	Top Story	Bottom Story	Period Type
Eq X	No	Yes	No	No	No	No	No	0	Terrace	STILT	User Defined
Eq Y	No	No	No	No	Yes	No	No	0	Terrace	STILT	User Defined

Table 1.1 - Load Pattern Definitions - Auto Seismic - IS 1893 2016 (Part 2 of 2)

User T sec	Z	Site Type	I	R	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN
0.36	0.16	II	1.2	3	0.36	0.08	36418.697	2913.4958
0.35	0.16	II	1.2	3	0.35	0.08	36418.697	2913.4958

IS 1893:2016 Auto Seismic Load Calculation

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

Direction and Eccentricity

Direction = X

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.36\ sec$

Factors and Coefficients

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

Response Reduction Factor, R [IS Table 9] $R = 3$

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

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

Equivalent Lateral Forces

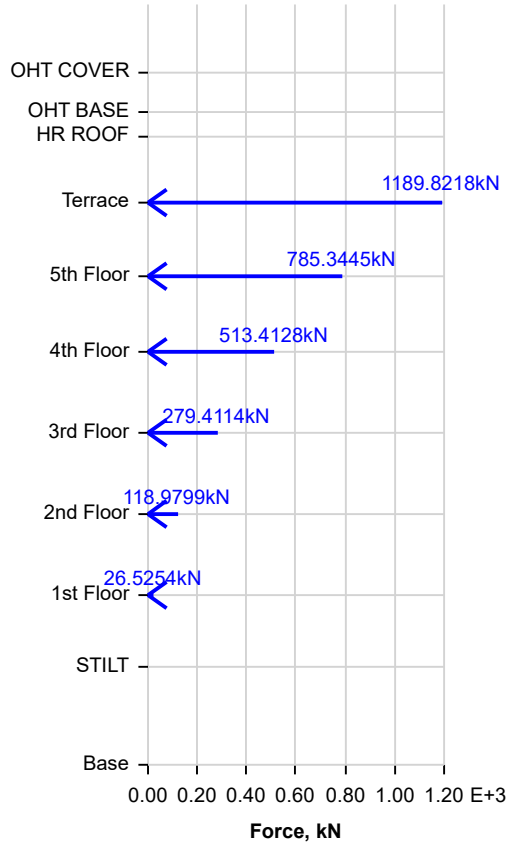
Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{Z\, I \frac{S_a}{g}}{2\, R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X	0.36	36418.697	2913.4958

Applied Story Forces

Lateral Load to Stories - X



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
OHT COVER	27.31	0	0
OHT BASE	25.76	0	0
HR ROOF	24.81	0	0
Terrace	22.21	1189.8218	0
5th Floor	19.26	785.3445	0
4th Floor	16.31	513.4128	0
3rd Floor	13.11	279.4114	0
2nd Floor	9.91	118.9799	0
1st Floor	6.71	26.5254	0
STILT	3.9	0	0
Base	0	0	0

IS 1893:2016 Auto Seismic Load Calculation

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

Direction and Eccentricity

Direction = Y

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.35\ sec$

Factors and Coefficients

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

Response Reduction Factor, R [IS Table 9] $R = 3$

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

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

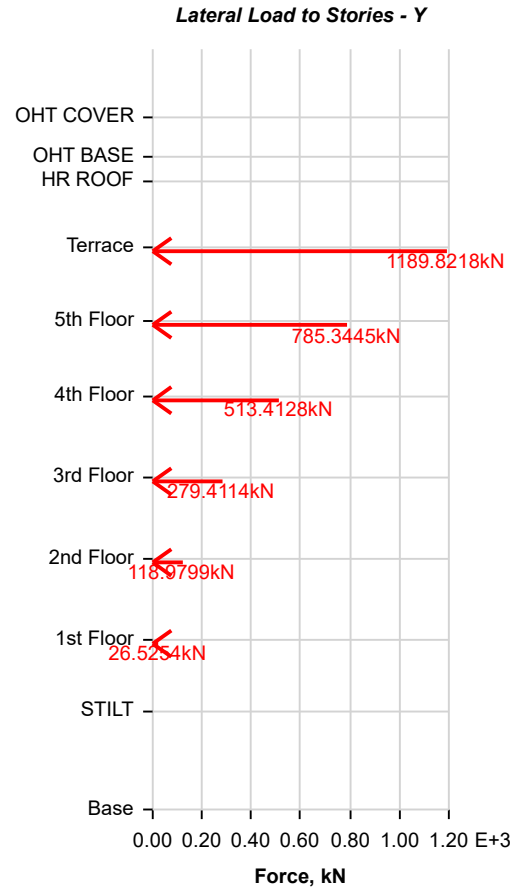
Equivalent Lateral Forces

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

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y	0.35	36418.697	2913.4958

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
OHT COVER	27.31	0	0
OHT BASE	25.76	0	0
HR ROOF	24.81	0	0
Terrace	22.21	0	1189.8218
5th Floor	19.26	0	785.3445
4th Floor	16.31	0	513.4128
3rd Floor	13.11	0	279.4114
2nd Floor	9.91	0	118.9799
1st Floor	6.71	0	26.5254
STILT	3.9	0	0
Base	0	0	0

1.2 Functions

1.2.1 Response Spectrum Functions

Table 1.4 - Functions - Response Spectrum - IS1893 2016

Name	Period sec	Value	Seismic Zone	I	Soil Type	R	Damping Ratio
Func1	0	0.032	III	1.2	II	3	0.05
Func1	0.1	0.08					
Func1	0.55	0.08					
Func1	0.8	0.0544					
Func1	1	0.04352					
Func1	1.2	0.036267					
Func1	1.4	0.031086					
Func1	1.6	0.0272					
Func1	1.8	0.024178					
Func1	2	0.02176					
Func1	2.5	0.017408					
Func1	3	0.014507					
Func1	3.5	0.012434					
Func1	4	0.01088					
Func1	4.5	0.01088					
Func1	5	0.01088					
Func1	5.5	0.01088					
Func1	6	0.01088					
Func1	6.5	0.01088					
Func1	7	0.01088					
Func1	7.5	0.01088					
Func1	8	0.01088					
Func1	8.5	0.01088					
Func1	9	0.01088					
Func1	9.5	0.01088					
Func1	10	0.01088					

Table 1.5 - Functions - Response Spectrum - User Defined

Name	Period sec	Value	Damping Ratio
UnifRS	0	1	0.05
UnifRS	1	1	

1.2.2 Time History Functions

Table 1.6 - Functions - Time History - User Defined

Name	Time sec	Value
RampTH	0	0
RampTH	1	1
RampTH	4	1
UnifTH	0	1
UnifTH	1	1

2 Analysis Results

This chapter provides analysis results.

2.1 Modal Results

Table 2.1 - Modal Periods And Frequencies

Case	Mode	Period sec	Frequency cyc/sec	CircFreq rad/sec	Eigenvalue rad2/sec2
Modal	1	1.765	0.567	3.5608	12.6793
Modal	2	1.465	0.683	4.2885	18.3912
Modal	3	0.947	1.056	6.6357	44.033
Modal	4	0.485	2.062	12.954	167.8061
Modal	5	0.362	2.761	17.3465	300.8997
Modal	6	0.273	3.667	23.0422	530.9444
Modal	7	0.268	3.737	23.4785	551.2399
Modal	8	0.25	3.997	25.1158	630.8031
Modal	9	0.25	4.007	25.175	633.783
Modal	10	0.25	4.008	25.1826	634.1622
Modal	11	0.249	4.01	25.1984	634.9606
Modal	12	0.248	4.029	25.3148	640.8405

Table 2.2 - Modal Participating Mass Ratios (Part 1 of 2)

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY
Modal	1	1.765	0.1121	0.4508	0	0.1121	0.4508	0	0.2977	0.0587
Modal	2	1.465	0.2965	0.1743	0	0.4086	0.6251	0	0.143	0.1761
Modal	3	0.947	0.2226	0.0003	0	0.6312	0.6254	0	0.0025	0.2051
Modal	4	0.485	0.0149	0.074	0	0.6461	0.6994	0	0.1264	0.0243
Modal	5	0.362	0.0502	0.02	0	0.6962	0.7193	0	0.0279	0.0713
Modal	6	0.273	0.0001	0.0054	0	0.6964	0.7247	0	0.0032	0.0006
Modal	7	0.268	0.0055	0.03	0	0.7019	0.7547	0	0.0176	0.012
Modal	8	0.25	0.0027	0.0001	0	0.7045	0.7548	0	4.066E-06	0.003
Modal	9	0.25	2.488E-05	0.0001	0	0.7046	0.7548	0	0.0001	4.946E-05
Modal	10	0.25	0.0001	5.937E-07	0	0.7046	0.7548	0	1.631E-06	0.0001
Modal	11	0.249	0.0001	0.0001	0	0.7047	0.7549	0	3.528E-05	1.987E-05
Modal	12	0.248	0.0005	0.0002	0	0.7052	0.7551	0	0.0001	0.0008

Table 2.2 - Modal Participating Mass Ratios (Part 2 of 2)

RZ	SumRX	SumRY	SumRZ
0.0937	0.2977	0.0587	0.0937
0.1173	0.4407	0.2348	0.211
0.395	0.4432	0.4399	0.606
0.0083	0.5696	0.4643	0.6143
0.0287	0.5975	0.5356	0.6429
0.0011	0.6007	0.5361	0.644
0.0028	0.6184	0.5481	0.6468
0.0001	0.6184	0.5511	0.6469
0.0001	0.6184	0.5511	0.647
2.149E-05	0.6184	0.5512	0.647
3.701E-06	0.6185	0.5513	0.647
8.5E-07	0.6186	0.5521	0.647

Table 2.3 - Modal Participation Factors

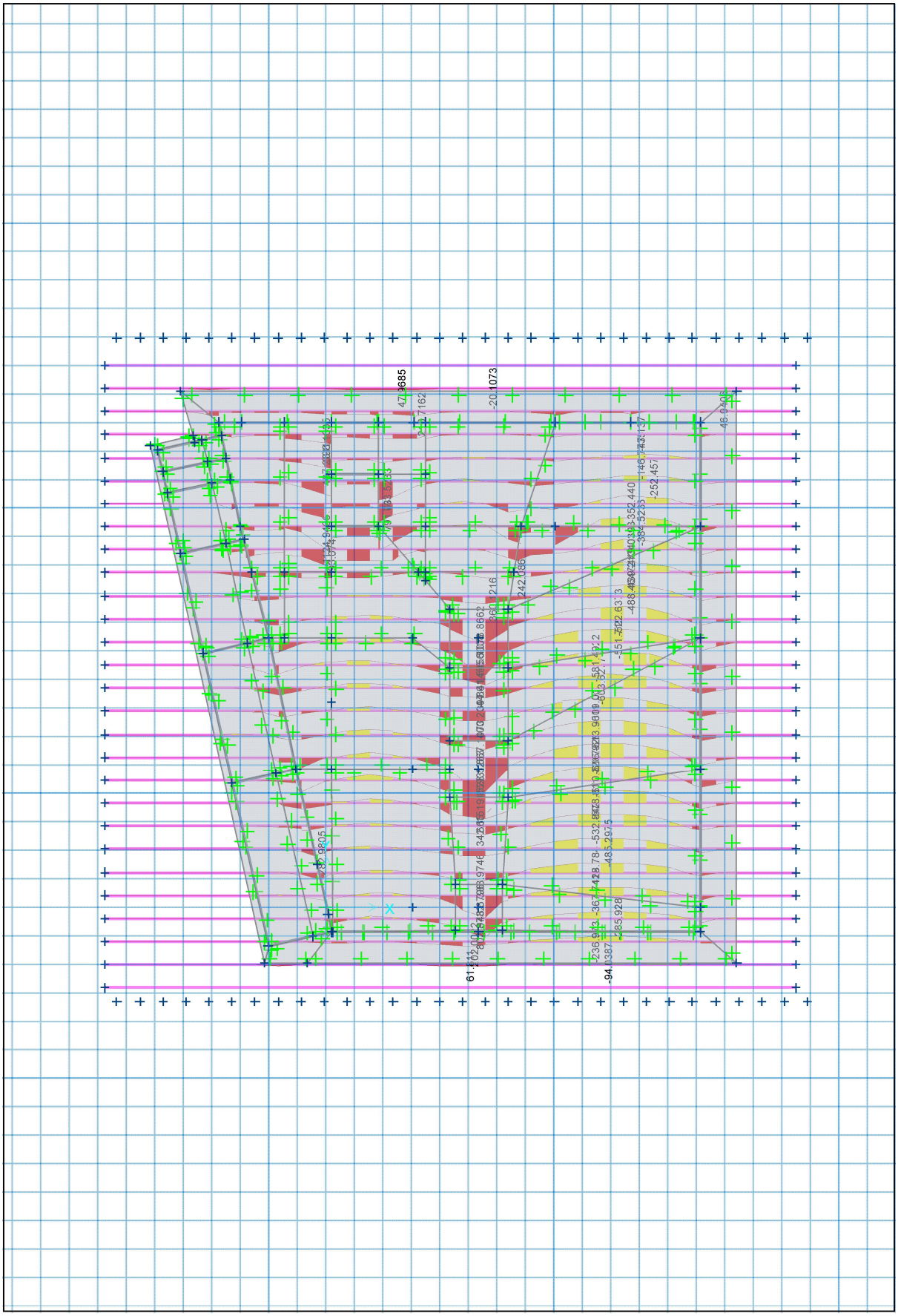
Case	Mode	Period sec	UX kN-m	UY kN-m	UZ kN-m	RX kN-m	RY kN-m	RZ kN-m	ModalMass kN-m-s2	ModalStiff kN-m
Modal	1	1.765	-2.3E-05	-4.6E-05	0	0.257268	-0.114266	-0.198654	1E-06	1E-05
Modal	2	1.465	-3.8E-05	2.9E-05	0	-0.178273	-0.197845	-0.222221	1E-06	2E-05
Modal	3	0.947	-3.3E-05	-1E-06	0	0.023462	-0.213531	0.407823	1E-06	4E-05
Modal	4	0.485	8E-06	1.9E-05	0	0.167648	-0.073531	0.059146	1E-06	0.00017
Modal	5	0.362	1.5E-05	-1E-05	0	-0.078761	-0.125894	0.109875	1E-06	0.0003
Modal	6	0.273	1E-06	-5E-06	0	-0.026739	-0.01109	-0.02136	1E-06	0.00053
Modal	7	0.268	-5E-06	1.2E-05	0	0.062591	0.051663	0.034382	1E-06	0.00055
Modal	8	0.25	4E-06	-1E-06	0	-0.000951	-0.025746	0.006199	1E-06	0.00063
Modal	9	0.25	-3.444E-07	-1E-06	0	-0.003894	0.003316	-0.006165	1E-06	0.00063
Modal	10	0.25	1E-06	5.32E-08	0	0.000602	-0.004429	0.003008	1E-06	0.00063
Modal	11	0.249	-1E-06	1E-06	0	0.0028	0.002102	0.001248	1E-06	0.00063
Modal	12	0.248	-2E-06	1E-06	0	0.005345	0.013413	-0.000598	1E-06	0.00064

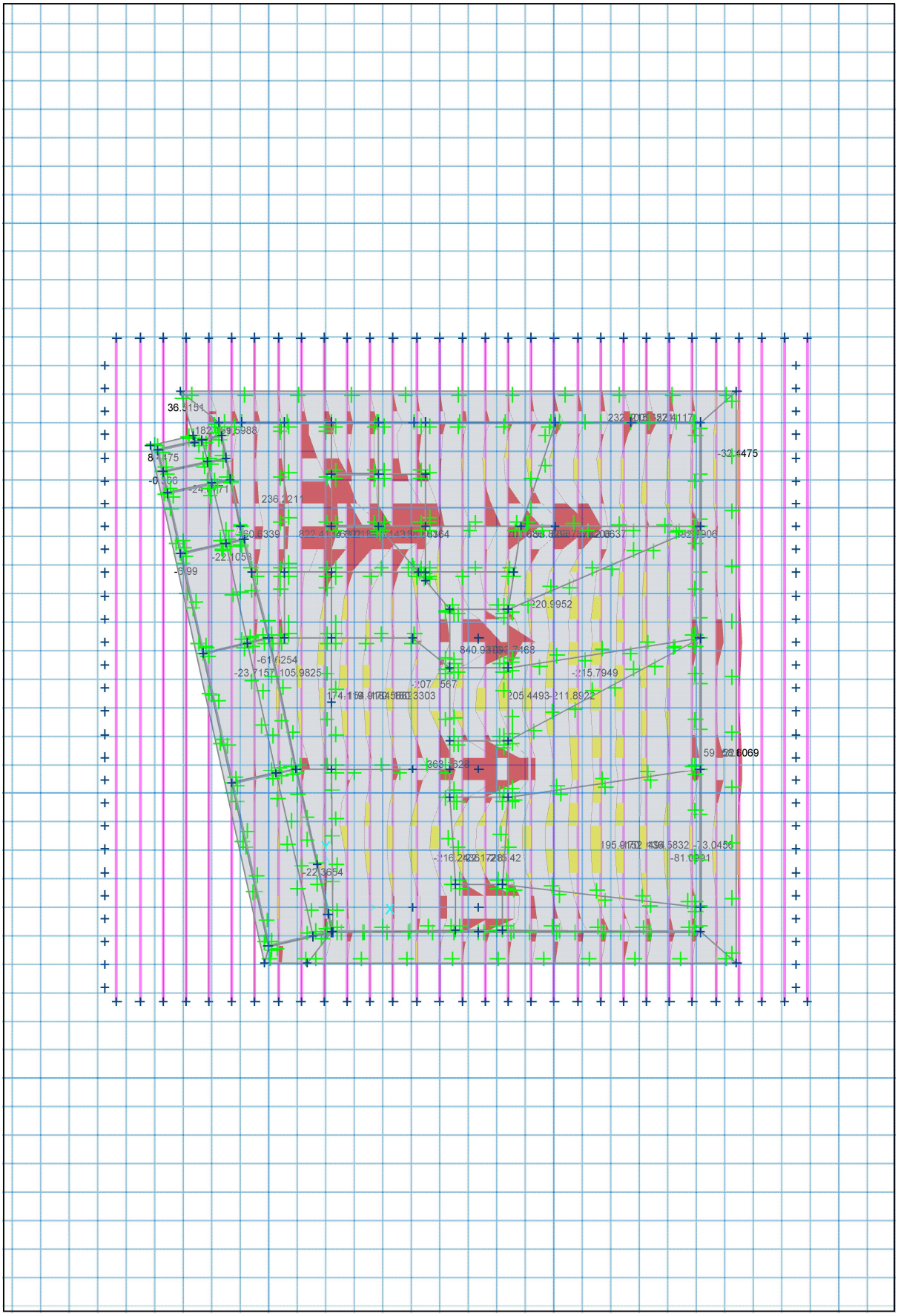
Table 2.4 - Modal Load Participation Ratios

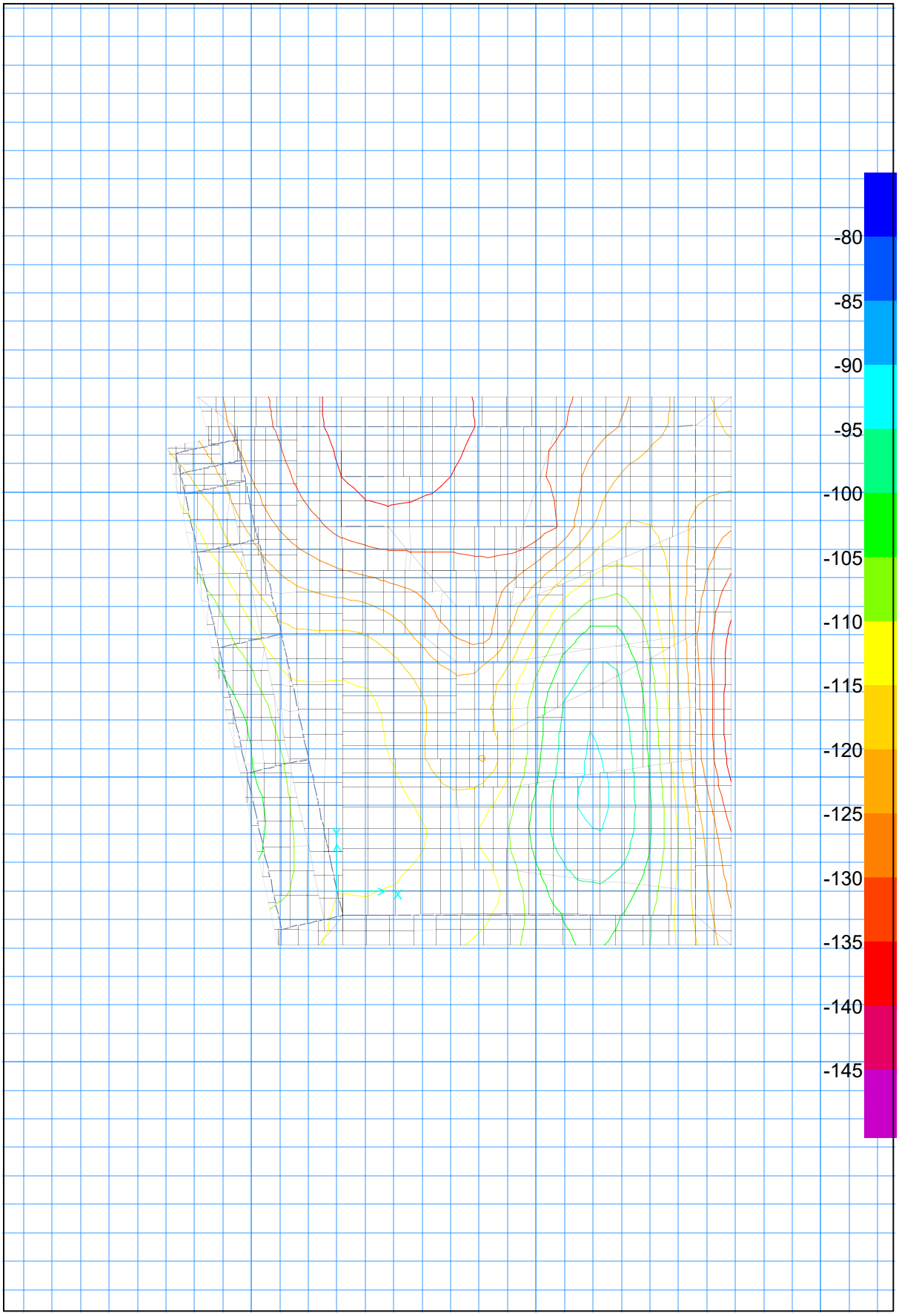
Case	ItemType	Item	Static %	Dynamic %
Modal	Acceleration	UX	99.66	70.52
Modal	Acceleration	UY	99.9	75.51
Modal	Acceleration	UZ	0	0

PLAN SHOWING THE PROPOSED OFFICE BUILDING AT DOOR NO. 13, BALFOUR ROAD, KILPAUK, CHENNAI 600 010. COMPRISED IN O.S.NO;8,R.S NO:3132/5, BLOCK NO:52, PURASAWALKAM VILLAGE, PURASAWALKAM TALUK, CHENNAI DISTRICT, GREATER CHENNAI CORPORATION, ZONE - VIII, DIVISION -103.

RAFT MOMENT DIAGRAM


47.3685
-20.1073
61.5611
-94.0387


36.5151
-32.4475
236.1211
-22.1053
-9.99
220.9952
-611.1254
-23.7157
105.9825
-215.7949
205.4493
-211.8922
-22.3654
-81.0791

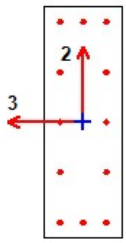

-80
-85
-90
-95
-100
-105
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-115
-120
-125
-130
-135
-140
-145
Y
X

PLAN SHOWING THE PROPOSED OFFICE BUILDING AT DOOR NO. 13, BALFOUR ROAD, KILPAUK, CHENNAI 600 010. COMPRISED IN O.S.NO;8,R.S NO:3132/5, BLOCK NO:52, PURASAWALKAM VILLAGE, PURASAWALKAM TALUK, CHENNAI DISTRICT, GREATER CHENNAI CORPORATION, ZONE - VIII, DIVISION -103.

DESIGN OF COLUMN

ETABS Concrete Frame Design

IS 456:2000 Column Section Design



Column Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
STILT	C42	347	C-300X900	Comb12	2550	3050	0.6

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
300	900	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	500	500

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 % %
2756.9794	106.7162	-498.0183	55.1396	96.77	3167	1.17

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)	0.8	2550	-200.1284	0	96.77
Minor Bend(M2)	0.8	2550	2.474	0	55.1396

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}	292.0372	206.4568	100.8002	88.4326	332.53
Minor, V_{u3}	69.9778	189.1774	86.4007	69.9778	997.59

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}	0	63.1661	371.5819	1916.8098	2700	0.194
Minor Shear, V_{u3}	0	49.9841	290.782	1331.118	2250	0.218

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
0.155	0.407

Additional Moment Reduction Factor k (IS 39.7.1.1)

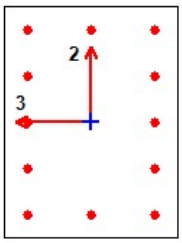
A_g cm²	A_{sc} cm²	P_{uz} kN	P_b kN	P_u kN	k Unitless
2700	31.7	5439.9519	1925.7021	2756.9794	0.763455

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	0.836	900	2.267	12	No	0
Minor Bending (M_2)	Yes	0.836	300	6.8	12	No	0

ETABS Concrete Frame Design

IS 456:2000 Column Section Design



Column Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
1st Floor	C11	8	C-450X600	Comb14	0	3050	0.6

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
450	600	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	500	500

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 % %
2510.9169	-267.6977	-448.6312	50.5821	63.1367	6501	2.41

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)	0.8	2572.4	-206.7401	0	63.1367
Minor Bend(M2)	0.8	2572.4	-139.9236	0	50.5821

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}	183.4413	272.48	97.2003	30.9278	498.8
Minor, V_{u3}	134.4324	266.0002	93.6005	134.4324	665.06

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/A	N/A	N/A	N/A	N/A	N/A
Minor Shear, V_{u3}	N/A	N/A	N/A	N/A	N/A	N/A

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/A	N/A

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
2700	65	6690.4841	2023.3489	2510.9169	0.895532

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	0.843	600	3.43	12	No	0
Minor Bending (M_2)	Yes	0.843	450	4.573	12	No	0

Notes:

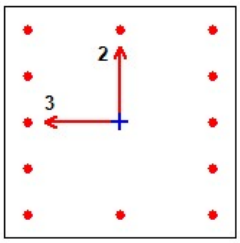
N/A: Not Applicable

N/C: Not Calculated

N/N: Not Needed

ETABS Concrete Frame Design

IS 456:2000 Column Section Design



Column Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
1st Floor	C6	5	C-600X600	Comb14	0	3050	0.6

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
600	600	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	500	500

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 % %
4376.2664	525.3686	-489.6937	112.47	112.47	8338	2.32

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)	0.8	2850	-253.9	0	112.47
Minor Bend(M2)	0.8	2850	270.6524	0	112.47

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}	176.1044	358.3496	129.6005	0	665.06
Minor, V_{u3}	180.4521	358.3496	129.6005	8.5412	665.06

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/A	N/A	N/A	N/A	N/A	N/A
Minor Shear, V_{u3}	N/A	N/A	N/A	N/A	N/A	N/A

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/A	N/A

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
3600	83.4	8796.7186	2792.1134	4376.2664	0.736177

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	0.934	600	3.8	12	No	0
Minor Bending (M_2)	Yes	0.934	600	3.8	12	No	0

Notes:

N/A: Not Applicable

N/C: Not Calculated

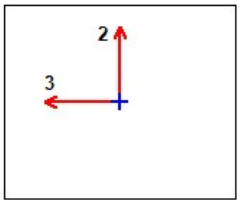
N/N: Not Needed

PLAN SHOWING THE PROPOSED OFFICE BUILDING AT DOOR NO. 13, BALFOUR ROAD, KILPAUK, CHENNAI 600 010. COMPRISED IN O.S.NO;8,R.S NO:3132/5, BLOCK NO:52, PURASAWALKAM VILLAGE, PURASAWALKAM TALUK, CHENNAI DISTRICT, GREATER CHENNAI CORPORATION, ZONE - VIII, DIVISION -103.

DESIGN OF RCC BEAM

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
STILT	B6	400	B-600X500	Comb2	300	9600	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
600	500	600	0	40	40

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	500	500

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
-401.8862	0.1718	301.3816	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-401.8862	0.1852	0	-402.0714

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)	-402.0714		2284	0	2284	571
Bottom (-2 Axis)		0	1142	0	0	1142

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

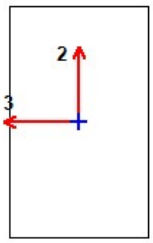
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv}/s mm²/m
301.3816	169.6999	132.1397	95.4433	796.02

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
0.1718	301.3816	540	440	0

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
1st Floor	B100	21	B-300X500	Comb12	375	5800	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
300	500	300	0	40	40

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	500	500

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
-192.3481	0.1767	245.3073	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-192.3481	0.2772	103.5988	-192.6252

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)	-192.6252		1087	0	1087	272
Bottom (-2 Axis)		103.5988	550	550	0	544

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

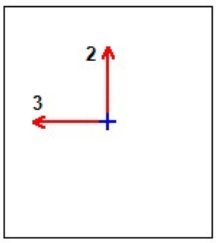
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv}/s mm²/m
245.3073	0	246.2496	85.965	1483.43

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
0.0078	245.3073	240	440	0

ETABS Concrete Frame Design

IS 456:2000 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
1st Floor	B37	29	B-450X500	Comb14	300	5990	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
450	500	450	0	40	40

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	500	500

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
-414.6678	0.6679	231.2764	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-414.6678	0.8294	306.3342	-415.4971

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)	-415.4971		2523	0	2523	631
Bottom (-2 Axis)		306.3342	1745	1745	0	1262

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
264.2364	0	266.611	196.8291	1606.09

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
0.6679	231.2764	390	440	606.83

PLAN SHOWING THE PROPOSED OFFICE BUILDING AT DOOR NO. 13, BALFOUR ROAD, KILPAUK, CHENNAI 600 010. COMPRISED IN O.S.NO;8,R.S NO:3132/5, BLOCK NO:52, PURASAWALKAM VILLAGE, PURASAWALKAM TALUK, CHENNAI DISTRICT, GREATER CHENNAI CORPORATION, ZONE - VIII, DIVISION -103.

DESIGN OF RCC SLAB

PROJECT-BALFOUR ROAD

	DESIGN OF SLAB No:	**ROOF**			
1.00	Grade of concrete		=	***35.00***	N/mm^2
2.00	Grade of steel		=	***500.00***	N/mm^2
3.00	Cover to reinforcement		=	***25.00***	mm
	Diameter of bar			***10.00***	mm
4.00	Aspect ratio $\frac{l_y}{l_x}$ =	***6.35***	6.50	1.626	< 2
		3.85	4.00		
5.00	Edge condition: **One Long Edge Continuous**			Two way slab	
6.00	Modification factor assumed			***1.50***	
		115.80		*1.50*	
7.00	Depth required for deflection:		D =	***175.00***	mm
				175.00	mm
			d =	145.00	mm
8.00	Dead Load		=	4.20	kN/m^2
9.00	Live load		=	***5.00***	kN/m^2
10.00	Partitions & FF		=	***2.40***	kN/m^2
11.00	Total load		=	11.60	kN/m^2
12.00	Factored load		=	17.40	kN/m^2

	Details	**S- SPAN**			**L-SPAN**	
STEP 1		(-ve) support(α_x)	(+ve) span(α_x)		(-ve) support(α_y)	(+ve) span (α_y)
	Co-efficent (IS:456, Table :26	0.088	0.067		0.000	0.043
	M_u=Co-efficient*w* l_x^2	24.31	18.47		0.00	11.94
	K= Mu/bd2	1.16	0.88		0.00	0.57
	Percentage of steel required	0.28	0.21		0.00	0.13
	Ast required(in mm^2)	***401.22***	***301.85***		***0.00***	***193.00***
	Ast min (in mm^2)	210.00	210.00		210.00	210.00
	Ast to be provided (in mm2)	401.22	301.85		210.00	210.00
	Provided bars spacing (c/c)	195.83	260.30		374.15	374.15
	max spacing	250.00	250.00		250.00	250.00
	spacing	195.83	250.00		250.00	250.00
	Reqd bars spacing (c/c)	**190.00**	**250.00**		**250.00**	**250.00**
	Pvd bars spacing (c/c)	***150.00***	***150.00***		***200.00***	***200.00***
	Ast Provided(in mm^2)	**523.81**	**523.81**		**392.86**	**392.86**
	Percentage of steel provided	**0.36**	**0.36**		**0.27**	**0.27**
STEPII	F_s=0.58 *f_y * (Ast required/ Ast provided)					
	F_s				167.11	
	M.F				***2.00***	
	if assumed modification factor is less than or equal to calculated the section is safe for deflection				safe	
	OVERALL DEPTH **D**	**175.00**	**mm**			
	EFFECTIVE DEPT **d**	**145.00**	**mm**			

STEPIII	**Crack width calculation**			
	m	=	6.8	
	E_s	=	200000.0	
	Ec	=	29580.4	
	Pt	=	0.4	
	k	=	0.2	
	x	=	28.7	
	A_{st}	=	523.8	
	I_{cr}	=	55782534.84	
	M	=	18.5	
	f_{st}	=	260.4	
	ε_m	=	0.0	
	Spacing		150.0	
	a_{cr}	=	79.1	
	ω_{cr}	=	0.14 < 0.20	mm (safe

PROJECT-BALFOUR ROAD

	DESIGN OF SLAB No:	**STILT**		SS3		
1.00	Grade of concrete			=	***35.00***	N/mm^2
2.00	Grade of steel			=	***500.00***	N/mm^2
3.00	Cover to reinforcement			=	***25.00***	mm
	Diameter of bar				***8.00***	mm
4.00	Aspect ratio $\frac{l_y}{l_x}$ =		***4.05***	4.17	1.106	< 2
			3.65	3.77		
5.00	Edge condition:	**One Short Edge Discontinuous**			Two way slab	
6.00	Modification factor assumed				***1.50***	
			109.30		*1.50*	
7.00	Depth required for deflection:			D =	***150.00***	mm
					150.00	mm
				d =	121.00	mm
8.00	Dead Load			=	3.60	kN/m^2
9.00	Live load			=	***2.40***	kN/m^2
10.00	Partitions & FF			=	***7.50***	kN/m^2
11.00	Total load			=	13.50	kN/m^2
12.00	Factored load			=	20.25	kN/m^2

STEP 1	**Details**	**S- SPAN**			**L-SPAN**	
		(-ve) support(α_x)	(+ve) span(α_x)		(-ve) support(α_y)	(+ve) span (α_y)
	Co-efficent (IS:456, Table :26	0.043	0.032		0.037	0.028
	M_u=Co-efficient*w* l_x^2	12.47	9.28		10.65	8.06
	K= Mu/bd2	0.85	0.63		0.73	0.55
	Percentage of steel required	0.20	0.15		0.17	0.13
	Ast required(in mm^2)	***243.95***	***180.25***		***207.52***	***156.07***
	Ast min (in mm^2)	180.00	180.00		180.00	180.00
	Ast to be provided (in mm2)	243.95	180.25		207.52	180.00
	Provided bars spacing (c/c)	206.13	278.98		242.31	279.37
	max spacing	250.00	250.00		250.00	250.00
	spacing	206.13	250.00		242.31	250.00
	Reqd bars spacing (c/c)	**200.00**	**250.00**		**240.00**	**250.00**
	Pvd bars spacing (c/c)	***200.00***	***200.00***		***200.00***	***200.00***
	Ast Provided(in mm^2)	**251.43**	**251.43**		**251.43**	**251.43**
	Percentage of steel provided	**0.21**	**0.21**		**0.21**	**0.21**

STEPII	F_s=0.58 *f_y * (Ast required/ Ast provided)					
	F_s				207.90	
	M.F				***2.00***	
	if assumed modification factor is less than or equal to calculated the section is safe for deflection				safe	
	OVERALL DEPTH	**D**	**150.00**	**mm**		
	EFFECTIVE DEPT	**d**	**121.00**	**mm**		

STEPIII	**Crack width calculation**			
	m	=	6.8	
	E_s	=	200000.0	
	Ec	=	29580.4	
	Pt	=	0.2	
	k	=	0.2	
	x	=	18.7	
	A_{st}	=	251.4	
	I_{cr}	=	19970343.13	
	M	=	9.3	
	f_{st}	=	321.7	
	ε_m	=	0.0	
	Spacing		200.0	
	a_{cr}	=	103.1	
	ω_{cr}	=	0.13	
			<	
			0.20	mm (safe

BALFOUR ROAD STILT

TOP **AT SUPPORT NEXT TO THE END SUPPORT**

		SLAB THK			DEAD LOAD		LIVE LOAD						REQUIRED		PROVIDED		
Concrete grade	steel grade	D	d	dia of bar	LOAD KN/M2	LOAD KN/M2	LOAD KN/M2	CLEAR SPAN	EFF.LENGTH	WU	MU	PT	AST mm^2	dia of bar	spacing	AST mm^2	
35	500	125	96	8	2.4	5.4	5	2	2.096	7	0.78	0.18	178	8	200	251.33	OK

BOTTOM **NEAR MIDDLE OF END SPAN**

		SLAB THK			DEAD LOAD		LIVE LOAD						REQUIRED		PROVIDED			DEFLECTION CHECK					
Concrete grade	steel grade	D	d	dia of bar	LOAD KN/M2	LOAD KN/M2	LOAD KN/M2	CLEAR SPAN	EFF.LENGTH	WU	MU	PT	AST mm^2	dia of bar	spacing	AST mm^2		f_s	MF	Basic Value	Allowable	Actual	DEFLECTION
35	500	125	96	8	2.4	5.4	5	2	2.096	6	0.68	0.16	153	8	200	251.33	OK	177.03	2.000	20	40.00	21.83333333	Hence OK

0

TOP **AT OTHER INTERIOR SUPPORTS**

		SLAB THK			DEAD LOAD		LIVE LOAD						REQUIRED		PROVIDED		
Concrete grade	steel grade	D	d	dia of bar	LOAD KN/M2	LOAD KN/M2	LOAD KN/M2	CLEAR SPAN	EFF.LENGTH	WU	MU	PT	AST mm^2	dia of bar	spacing	AST mm^2	
35	500	125	96	8	2.4	5.4	5	2	2.096	7	0.72	0.17	163	8	200	251.33	OK

BOTTOM **AT MIDDLE OF INTERIOR SPAN**

		SLAB THK			DEAD LOAD		LIVE LOAD						REQUIRED		PROVIDED			DEFLECTION CHECK					
Concrete grade	steel grade	D	d	dia of bar	1	LOAD KN/M2	LOAD KN/M2	CLEAR SPAN	EFF.LENGTH	WU	MU	PT	AST mm^2	dia of bar	spacing	AST mm^2		f_s	MF	Basic Value	Allowable	Actual	DEFLECTION
35	500	125	96	8	2.4	5.4	5	2	2.096	5	0.54	0.13	121	8	200	251.33	OK	139.85	2.000	26	52.00	21.83333333	Hence OK

PROJECT-BALFOUR ROAD

	DESIGN OF SLAB No:	**TYP**			
1.00	Grade of concrete		=	***35.00***	N/mm^2
2.00	Grade of steel		=	***500.00***	N/mm^2
3.00	Cover to reinforcement		=	***25.00***	mm
	Diameter of bar			***10.00***	mm
4.00	Aspect ratio $\frac{l_y}{l_x}$ =	***6.35***	6.50	1.626	< 2
		3.85	4.00		
5.00	Edge condition: **Four Edges Discontinuous**			Two way slab	
6.00	Modification factor assumed			***1.50***	
		115.80		*1.50*	
7.00	Depth required for deflection:		D =	***175.00***	mm
				175.00	mm
			d =	145.00	mm
8.00	Dead Load		=	4.20	kN/m^2
9.00	Live load		=	***2.00***	kN/m^2
10.00	Partitions & FF		=	***6.15***	kN/m^2
11.00	Total load		=	12.35	kN/m^2
12.00	Factored load		=	18.53	kN/m^2

STEP 1	**Details**	**S- SPAN**			**L-SPAN**	
		(-ve) support(α_x)	(+ve) span(α_x)		(-ve) support(α_y)	(+ve) span (α_y)
	Co-efficent (IS:456, Table :26	0.000	0.095		0.000	0.056
	M_u=Co-efficient*w* l_x^2	0.00	27.95		0.00	16.56
	K= Mu/bd2	0.00	1.33		0.00	0.79
	Percentage of steel required	0.00	0.32		0.00	0.19
	Ast required(in mm^2)	***0.00***	***464.40***		***0.00***	***269.68***
	Ast min (in mm^2)	210.00	210.00		210.00	210.00
	Ast to be provided (in mm2)	210.00	464.40		210.00	269.68
	Provided bars spacing (c/c)	374.15	169.19		374.15	291.35
	max spacing	250.00	250.00		250.00	250.00
	spacing	250.00	169.19		250.00	250.00
	Reqd bars spacing (c/c)	**250.00**	**160.00**		**250.00**	**250.00**
	Pvd bars spacing (c/c)	***200.00***	***100.00***		***200.00***	***200.00***
	Ast Provided(in mm^2)	**392.86**	**785.71**		**392.86**	**392.86**
	Percentage of steel provided	**0.27**	**0.54**		**0.27**	**0.27**

STEPII	F_s=0.58 *f_y * (Ast required/ Ast provided)				
	F_s			171.41	
	M.F			***1.65***	
	if assumed modification factor is less than or equal to calculated the section is safe for deflection			safe	
	OVERALL DEPTH	**D**	**175.00**	**mm**	
	EFFECTIVE DEPT	**d**	**145.00**	**mm**	

STEPIII	**Crack width calculation**			
	m	=	6.8	
	E_s	=	200000.0	
	Ec	=	29580.4	
	Pt	=	0.5	
	k	=	0.2	
	x	=	34.3	
	A_{st}	=	785.7	
	I_{cr}	=	78551931.95	
	M	=	27.9	
	f_{st}	=	266.3	
	ε_m	=	0.0	
	Spacing		100.0	
	a_{cr}	=	55.9	
	ω_{cr}	=	0.15 < 0.20	mm (safe

PLAN SHOWING THE PROPOSED OFFICE BUILDING AT DOOR NO. 13, BALFOUR ROAD, KILPAUK, CHENNAI 600 010. COMPRISED IN O.S.NO;8,R.S NO:3132/5, BLOCK NO:52, PURASAWALKAM VILLAGE, PURASAWALKAM TALUK, CHENNAI DISTRICT, GREATER CHENNAI CORPORATION, ZONE - VIII, DIVISION -103.

APPENDIX



our services doesn't just end there

Buying & Selling Services

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

Legal & Documentation Services

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

Property Development & Approvals

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

NRI & Investment Services

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

Compliance & Special Services

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



empowering your real estate decisions with smart tools

Property Valuation & Cost Estimation

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

Ownership, Compliance & Legal Verification

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

Zoning & Land Use Analysis

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

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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