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Civil and Structural consultants

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Date: 20/09/2023
Place: Chennai

STRUCTURAL STABILITY CERTIFICATE

This is to certify that the proposed construction of Single basement + stilt + 4 floors + 1 additional floor + roof commercial building located at Survey No: 255/1B, 255/2, T.S.NO.34, WARD-D, BLOCK-49 at Plot No. OLD NO. 251 & NEW NO.21, 200ft. PALLAVARAM TO THORAIPAKKAM RADIAL RING ROAD (OPPOSITE TO MANTRI SERENE), JOTHI COLONY, ZAMIN PALLAVARAM, KANCHEEPURAM DISTRICT, CHENNAI-600 043 is designed to resist all possible Gravity, Wind loads, Seismic loads and other Combination of loads as per the relevant IS Codes and other Codes in vogue which the structure is intended to with stand.

Check has been made & found the structure is safe and sound, hereby certify that the,

1. Foundation & Columns are designed for Single basement + Stilt + 4 floors + 1 Additional floor + roof with RCC Framed Structure as per the Architectural plans considering relevant commercial structural loadings.

2. The grade of concrete used in the structural design of Building is M35.

3. The Analysis and design carried out for the intended commercial Building loading as per the code of practice IS 875 Part 1 to 2, wind forces as per IS 875 (Part-3) and seismic forces as per the seismic code of practice IS 1893.

4. Design of Structural elements carried out as per the stipulations made in latest code of practice IS 456-2000 and ductile detailing is adopted as per the stipulations given in IS-13920.

5. Isolated Footing is designed considering the sub soil condition reported and based on the recommendation laid down in the soil Investigation Report No. SI/CHN/18/1404/02 dated February, 2018 carried out by M/s. Geo Foundations & Structures Pvt. Ltd., Chennai

Signature of the Structural Engineer,

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STRUCTURAL DESIGN CALCULATION REPORT

PROPOSED CONSTRUCTION OF A SINGLE BASEMENT+STILT+4 STOREYS+1 ADD.FLOOR+ROOF FOR COMMERCIAL BUILDING AT SURVEY NO: 255/1B, 255/2, T.S.NO.34, WARD-D, BLOCK-49 AT PLOT NO. OLD NO. 251 & NEW NO.21, 200ft. PALLAVARAM TO THORAIPAKKAM RADIAL RING ROAD (OPPOSITE TO MANTRI SERENE), JOTHI COLONY, ZAMIN PALLAVARAM, KANCHEEPURAM DISTRICT, CHENNAI-600 043.

FOR M/s. BRILLIANT CORPORATE SERVICE PVT LTD, CHENNAI.

STRUCTURAL DESIGN CALCULATION REPORT OF THE PROPOSED CONSTRUCTION OF A SINGLE BASEMENT+STILT+4 STOREYS+1 ADD.FLOOR+ROOF FOR COMMERCIAL BUILDING AT SURVEY NO: 255/1B, 255/2, T.S.NO.34, WARD-D, BLOCK-49 AT PLOT NO. OLD NO. 251 & NEW NO.21, 200ft. PALLAVARAM TO THORAIPAKKAM RADIAL RING ROAD (OPPOSITE TO MANTRI SERENE), JOTHI COLONY, ZAMIN PALLAVARAM, KANCHEEPURAM DISTRICT, CHENNAI-600 043.

FOR

M/s. BRILLIANT CORPORATE SERVICE PVT LTD, CHENNAI.

R0	13-10-2020	Design Basis Report	OK	PRABHU	KALEEM	PERAM
REV NO.	**DATE**	**DESCRIPTION**	**STATUS**	**PREPARED BY**	**REVIEWED BY**	**APPRVD. BY**

STRUCTURAL CONSULTANT

A P ENGINEERS

 # NO : K28, 1st MAIN ROAD, ANNA NAGAR EAST,
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CLIENT

M/s. BRILLIANT CORPORATE SERVICE PVT. LTD., CHENNAI.

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TABLE OF CONTENTS

1. FOREWORD

The intent of this document is to identify and record all the pertinent input requirements, analysis & design criteria for structural design of the building. It is aimed at formulating the basis of the structural analysis, design & detailing work that the Structural Engineer is planning in delivering the structural scheme of the building. The scheme will be compatible with the architectural theme, satisfy the functional needs, at the same time conforming to the Indian Standards and other applicable building norms to achieve safe, stable, strong and yet optimally economical structures.

The parameters adopted in this report are going to be the basis of the structural design calculations. This report covers the minimum design requirement to establish the unified design basis that will form the overall design philosophy to be adopted in the structural design of the proposed building.

The design will aim to achieve

- Structural & functional integrity.
- Desirable Structural performance under characteristic service design loads.
- Resistance to loads due to natural phenomena i.e. wind and earthquakes.
- Structural durability & maintainability.

2. PROJECT DESCRIPTION

Project : Proposed single Basement+Stilt+5 Storeys Commercial Building.
Location : Zamin Pallavaram, Chennai.

2.1. Agencies

Owner: M/s. Brilliant Corporate Services Pvt. Ltd., Chennai.

Architects: M/s. Design & Architecture Studio, Chennai.

Structural Consultants: A P Engineers, Chennai.

Services Consultants:
Electrical: -
Plumbing: -
HVAC: -
Project Consultant: -
Landscape consultants: -

2.2. The Building

The proposed construction of a Commercial (Office) Building is located at Plot no. Old No.251 & New No.21, 200ft pallavaram to thoraipakkam radial ring road, Zamin Pallavaram, Chennai. It comprises Single Basement+Stilt +4 Storey+1Add.Floor+Roof. In which the Stilt Floor accommodates Car Parks whereas the superstructure of Five Floors are designed to accommodate Commercial (Office) use.

Architecturally, it is designed as non-linear building with trapezoidal in shape with the size of (32m/28m) x (17.95/6.5m). It has been designed with a lift & staircase which are located in the front which makes smooth access to the respective flats and the rest of the office area is efficient. The vertical access systems like Lifts & Staircases are positioned to ensure the circulation of occupants of each floor smooth even in the case of multi-tenant and it complies to the fire requirements as well. Toilet area designed with conventional sunk of 300mm. Terrace is designed as RCC roof with the loadings to cater the 150mm thickness of weathering course and equipment like A/C outdoor units, VRV, solar panel etc. Above Terrace, staircase head room is provided and the OHT is designed for about 15,000 litre Capacity for fire. Structurally, the building is essentially a R.C.C. Columns connected to the RC/PT Beam and RC/PT Slab. The columns are connected to each other with a network of R.C.C/PT beams and RC/PT slabs with the slabs acting as in-plane rigid diaphragms for each of the floors. All vertical elements i.e. Columns and the beams are designed as ductile Frames. The column sizes are to be (600mmx600mm), (300mmx600mm) & (200mmx600mm) and the Beams sizes vary from (230mmx450mm), (200mmx450mm), (200mmx500mm), (300mmx600mm) & (200mmx600mm). The Slab thickness varies from (125mm), (150mm), (175mm), (200mm) & (250mm).

Architectural/Structural Configuration:

Table: Architectural Floor heights/Structural & Details:

BUILDING CONFIGURATION	**Trapezoidal in Shape**
Building Dimension in Plan	**(32m/22m) x (17.95/6.5m)**
No. Of Floors	**1 Basement+Stilt+5 Storey+Roof**
Basement floor height	3.25m
Ground floor height	2.95m
1st Floor to 5th Floor height	3.45m
LMR Slab	4.15m
Head Room Slab	2.85m
Foundation System	**Isolated Footing**
Grade of concrete for Footing	M35
Grade of concrete for RC Columns	M35
Grade of concrete for RC beams/RC slabs	M35
Grade of concrete for PT beams/PT slabs	M35
Grade of Steel	Fe 500

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3. LIST OF CODES

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

3.1 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): 2005	Wind Load

3.2 Design for Earthquake Resistance

IS Code	Description
IS 1893: 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.

3.3 Design of Steel Structural Elements

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

3.4 Design of Concrete Elements

IS Code	Description
IS 456: 2000	Plain and Reinforced Concrete - Code of practice
IS 1904	Indian Standard Code of practice for design & construction foundations in Soil: General Requirements
IS 6403 -1981	Code of practice for determination of bearing capacities of shallow foundations.
IS 8009-1976 (Pt -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 Requirements

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)	National Building code of India
IS 1786-2008	Specification for high strength deformed bars and wires for concrete Reinforcement.
IS 3370 (part I)	Code of practice for concrete structure for the storage of liquids

4. DESIGN PARAMETERS

4.1 Materials of Construction

The Building is essentially R.C.C. framed structure the vertical member i.e. columns are connected to the RC/PT Beams which are rigidly connected by PT/RC slabs. The columns are connected to each other with a network of R.C.C beams & RC slabs and slabs acting as in-plane rigid diaphragms for each of the floors which distribue the lateral forces to the lateral load resisting elements.

4.1.1 Concrete Grade

Concrete grade used is M35 with minimum 28 day strength of 35 MPa for all structural elements which includes Footings, Plinth Beams, Columns, RC Beams & Slabs, PT Beams & Slabs etc.

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 25.00 kN/cu.m.

Minimum cement content, water cement ratio etc. shall conform to IS 456:2000 code provisions for durability and strength criteria. The cementitious content shall be in the range of 350 to 360 kg/m^3 for M35 grade concrete. However trial mix shall be carried out and the cube tests are to be conducted in order to establish its design compressive strength achieved. The design mix shall be approved by the Structural Engineer based on the evaluation of trial mix results before adopt in to the construction. The slump shall not be less than 100 and it shall be in the range of 110 to 125 for pumbable concrete.

4.1.2 Cement

Ordinary Portland Cement of grade 43 or higher confirming to IS 8112 and IS 12269 is specified for concrete M35 with cement content appropriate to the grade.

4.1.3 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.

4.1.4 Water

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

4.1.5 Reinforcement

High yield strength deformed bars conforming to IS 1786-2008 with f_y = 500 N/ sq.mm has been used.

4.1.6 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.

4.1.7 Concrete Cover

Following clear cover to all reinforcement is used in the design.

a. Footing = 50mm
b. Column = 40mm
c. Beam = 30mm (Bottom and sides)
d. Slab = 25mm (Top and Bottom)
e. Water tanks/Sump tank/Septic Tank
   On water face/other face = 40mm (Top and Bottom)

4.1.8 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 & Facbrication.

4.1.9 Soil Parameters

The Soil Investigation Report No. SI/CHN/18/1404/02 dated Feburary, 2018 carried out by M/s. Geo Foundations & Structures Pvt. Ltd., Chennai. Based on the soil report made available to us, there are three (3) bore holes were drilled for field testing and to collect the soil samples for lab testing. Standard penetration tests were conducted at change of layers and at specified intervals, commencing the test at 1.0m below the existing ground level. Bore hole nos. 1&3 are terminated at

depth around 6m and the Bore hole no.2 has been terminated at a depth about 5m. The relative density of different soil layers obtained from the N-Values. Disturbed and un-disturbed soil samples were collected from all the layers for visual observation, classification tests and strength characteristics of the soil layers. It is found that the sub-soil stratigraphy is relatively uniform i.e. difference between depth of occurrence and thickness of different layers are within normal range. The bore holes are drilled from the said EGL for soil investigation. From the bore log data, the top soil is loose up to 1m. The nature of soil layer is clayey sand at the depth of 1m and it continues up to 2m with the « N » value in the range of 16 of 29. Below 2.0m and up to 3m it is a silty sand with « N » value of 79. Between 3m to 4m, it is a silty sandy gravel exists up to 5m with « N » value of 100. Weathered rock encountered at 5m to 6m and it continues as hard layer with « N » value more than 100. The Bore holes are terminated due to hammer rebound or refusal strata whichever is reached earlier. As reported in the soil Investigation, the Ground water table is met at 2.5 during the investigation period of Feburary, 2018. However all the substructure and the under ground tanks are designed for the head of water considering up to the Ground level as the water table likely to raise in the peak monsoon period.

4.2 Loading Standards

Table: Unit Weight of Materials:

Material	Density
Reinforced Cement Concrete	25.00 kN/m^3
Plain Cement/Screed Concrete	24.00 kN/m^3
Cement Mortar	20.00 kN/m^3
AAC Block (Infill walls)	09.00 kN/m^3
Concrete Solid Block (Infill walls)	20.00 kN/m^3
Structural Steel	78.50 kN/m^3
Cinder Concrete (Filling material)	08.00 kN/m^3
Dry soil	18.00 kN/m^3
Wet Soil	22.00 kN/m^3
Landscape soil	16.00 kN/m^3
Saturated soil	10.00 kN/m^3
Glass	28.00 kN/m^3
water	10.00 kN/m^3

5 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 0f 200mm thick slab	0.200x25 = 5.000 kN/Sq.mt.
Self weight 0f 250mm thick slab	0.250x25 = 6.250 kN/Sq.mt.
External/Internal Wall Line Load:	
For 200mm Thick. Wall	

Ground Floor	= (0.20x2.45x9.0)+(0.04x2.45x9.0)=5.3 kN/m
1st Floor to 5th Floors	= (0.20x3.00x9.0)+(0.04x3.00x9.0)=6.5 kN/m
LMR	=(0.20x3.65x9.0)+(0.04x3.65x9.0)=7.9kN/m
Head Room	=(0.20x2.35x9.0)+(0.04x2.35x9.0)=5.1kN/m
For 100mm Thick. Wall	
Ground Floor	=(0.100x2.45x9.0)+(0.04x2.45x9.0)=3.1kN/m
1st Floor to 5th Floors	=(0.100x3.00x9.0)+(0.04x3.00x9.0)=3.8kN/m

4.1.2 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 and the Floor finishes of 50 mm thickness have been considered on all floors).*

Structural steel work shall conform to IS 226 and IS 2062 for Indian steel sections.

Table 4. 2.1.1 Office Space

Load Component	Thickness (mm)	Load	Units
Floor Finishes		2.4	kN/m2
Live Load		5.0	kN/m2

Table 4. 2.1.2 Driveway

Load Component	Thickness (mm)	Load	Units
Floor Finishes		2.4	kN/m2
Live Load		15.0	kN/m2

Table 4. 2.1.3 Toilets

Load Component	Thickness (mm)	Load	Units
Finishes		1.20	kN/m2
Sunk & Filled	300 mm	6.00	kN/m2
Live Load		2.00	kN/m2

Table 4. 2.1.4 Terraces

Load Component	Thickness (mm)	Load	Units
Weathering course with Water-Proofing		3.0	kN/m2
Live Load		4.0	kN/m2

Table 4. 2.1.5 Corridors, Passage, Lobbies, balcony

Load Component	Thickness (mm)	Load	Units
Finishes		1.2	kN/m2
Live Load		3.0	kN/m2

Table 4. 2.1.6 Staircases

Load Component	Thickness (mm)	Load	Units
Steps	150 (Riser) Assuming 75mm Avg thickness	1.8	kN/m2
Finishes	-	1.2	kN/m2
Live Load	-	3.0	kN/m2

Table 4. 2.1.7 Lift Machine Rooms

Load Component	Thickness (mm)	Load	Units
Finishes		1.8	kN/m2
Live Load		10.0	kN/m2

4.2 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.

4.2.2 Shrinkage Effects

The Building length is 32m which falls well within the limit prescribed in IS 456: 2000, clause.27.2. Hence it is not required to perform detailed thermal analysis. However the shrinkage crack control shall be taken care by adopting the construction sequences with pour joints. In addition to it, also care is to be taken to control Shrinkage by way of early sprinking just after the initial setting is over and put the floor under proper immersed curing subsequently other than the care shall be taken in terms of cement properties and content, the weather at which the concreting is done etc.

4.2.3 Expansion Joints

Expansion joints are normally provided when the structure is more than 45m length as per IS-456-2000, clause 27.2. The width of expansion joint shall be calculated as per IS-1893-2002, clause 7.11.3. In this case, building length is 32m only & the width is about 17.95m. Hence no expansion joint required. Hence the stresses developed due to expansive forces by temperature variations has been ignored in the Analysis and Design of structural elements as it would have negligible effect. However, the stresses developed by expansive forces caused due to temperature variation has been taken care by providing additional re-bars on the slabs at re-entrant corners and on the exposed terrace slabs appropriately.

5. PROPOSED APPROACH OF STRUCTURAL ANALYSIS

The building is a R.C.C columns connected by beams as frame structure. Slab is acting as rigid in-plane diaphragms have been considered in the model & analysis. 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 software for stimulating computer models of all floors - for vertical loads with the entire building space frame. ETABS 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 ETABS analysis model summary report and views are presented in **Annexure B.**

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

Column	: Frame Element
Beam Element	: Frame Element
Slab	: Shell Element
RC Wall	: 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 behavior 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 modelling 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 approx.
- External & Internal filler wall loads are assigned as uniformly distributed line load on beams and as area load if the wall is intend to distribute on slab directly. These loads are assigned under SIDL 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, 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 area load with intensity proportionate to its usage as mentioned in the Loading caluse in the DBR.

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

Lateral Load Resisting Systems: The proposed building is a R.C.C Framed buildings with vertical elements like RC Columns are connected by Slab. Slab is acting as rigid in-plane diaphragms have been considered in the model & analysis. Being a low rise Residential Building with columns forms vertical components which are designed to transfers the lateral Shear in proportion to its stiffness in their loading direction of wind & seismic.

6. LATERAL LOADS

Wind Loads

The wind pressure shall be calculated based on the basic wind speed and other provisions laid in IS 875 (part 3) – 1987. The wind speed is considered in the analysis for Chennai is 50 m/sec. The design parameters for wind load calculation is 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 – 1.01, Terrain height (20.50m), structure size factor

Terrain Category –3 and Structure Class-A

k3 – 1.0, Topography factor

k4 – 1.0, Importance factor for the cyclonic region, for all Other Structure as per IS 875-2015 (Part3), clause 6.3.4.

Hence Design Wind Pressure = 0.6x (50x1.0*1.01*1.0*1.0)^2

= 1530 N/m^2 ≈ 1.53 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.

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 considering Special Moment resisting Frame as per IS: 1893-2016, Table-7 and applied ductile detailing as per code IS 13920: 2016. Soil considered as Type-II Medium or Stiff 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 % of Live load for Office use i.e. for Live Load > 3 kN/Sq.mt., it is to be considered 50% of live load and for Residential use if the Live Load < 3 kN/Sq.mt. will be considered 25% Live Lod respectively. Hence in our case, the Live load percentage considered in the seismic calculation is 50% of Live load.

The Time period has been calculated considering ductile Frames. 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 = 20.50m (measured from Stilt floor)

d (along the length of the building) = 30.00 m

b (along the breadth of the building) = 17.95 m

Ta (along-x) = 0.09 x20.50/(30.00)^0.5

= 0.337 Sec.

Ta (along-y) = 0.09 x20.50/(17.95)^0.5

= 0.435 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 Commercial Building for < 200 Occupants = 1.2

R for SMRF = 5.0

As per IS-1893-2016 (Table 9)

Sa/g (x&y) = 2.5 (Refer to IS 1893-2016, page 9)

Design horizontal Seismic coefficient Ah = 0.04

Base Shear = 0.04 W

7. LOAD COMBINATION

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	-	-

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.

8. 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 used is M35 for all structural members which includes Footings, Plinth Beams, RC Columns, RC Beams/Slab, PT Beams/Slabs etc. The grade of concrete is adopted appropriately for different 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).

9. FOUNDATION FOR THE BUILDING

The proposed Commercial (Office use) Building comprises single Basement+Stilt+4 Storey+1add. Floor+Roof. The vertical elements like Columns are moderately loaded. The structure is provided with columns only in the periphery except in the Staircase & Lift core area in order to satisfy the functional requirement and the Structural requirement has been taken care for both gravity and lateral loads.

As per the recommandation laid down in the soil test Report No. SI/CHN/18/1404/02 dated Feburary, 2018 carried out by M/s. Geo Foundations & Structures (P) LTD., Chennai, Foundation is designed as Isolated Footings as suggested with the recommended SBC of 25t/m^2. The Footings are rest at the depth of 2.5m from EGL.

10. 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

4. Loading.

11. 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.

12 R.C Design

The structures are analyzed for the various load combinations as per IS: 456-2000. In house spread sheet is being used for the structural element like slab, beam, column etc. for the forces extracted from the ETABS analysis output. For the design of the R.C.C structures the recommandations of IS: 456-2000 is followed. Limit State design is adopted with appropriate load factors with the various load combinations for the different structural elements as follows. The General arrangement drawing is given in **Annexure A.**

12.1 Design of Foundation

Isolated/Combined footings are designed for the recommended SBC of 25t/m^2 as laid down in the Soil Investigation Report No. SI/CHN/18/1404/02 dated Feburary 2018 carried out by M/s. Geo Foundations & Structures Private Ltd, Chennai. The Footings as rest at the depth of 2.5m from

EGL. The design of footings are carried out using in-house spread sheet as per the guide lines of IS: 456-2000 adopting limit state method. The Footing layout drawing is given in **Annexure C.**

12.2 Design of Columns

R.C Columns will be designed for uni-axial/bi-axial bending for the forces of critical load combination depends upon the nature of behavior. The designs are made using ETABS/in-house spread sheet as per the guide lines of IS: 456-2000 adopting limit state method. The RC design of Column design is given in **Annexure D.**

12.3 Design of Beams

Beams will be designed for the results of critical load combination as per IS: 456-2000 using ETABS/in-house spread sheet. Design forces have been extracted from the analysis and the same being used for the design of beam elements. The design procedure takes in to account all the member forces like axial, shear, torsion and bending and lists out the area of the reinforcement required for all the members. The RC design of Beam design is given in **Annexure E.**

12.4 Design of Suspended floor/Roof Slabs

Slab elements will be designed for the forces obtained from the coefficients given in Annex D in IS code 456:2000 and using the limit state design method. Wall load on slab is taken as uniformly distributed over entire area. Based on yield line theory, slab loads are transferred on to supporting beams. The RC design of Slab design is given in **Annexure F.**

13.0 P T DESIGN BASIS REPORT

13.1 PRESTRESSING SYSTEMS

The pre-stressing system is incorporating strands with 12.70 mm dia. strand /15.20 mm dia strand. Prestressing strands shall be of class-2, confirming to IS 14268-1995

Materials Data

Strands	0.5"	0.6"
Nominal Diameter	12.7mm	15.2mm
Nominal Area	98.7mm	141mm^2
Nominal weight	0.775 kg/m	1.15 kg/m
Tensile strength	1860 N/mm^2	1860 N/mm^2

Modulus of elasticity	195 N/mm^2	195 N/mm^2
Min breaking load of strand	184kN	263kN
Strand quality in accordance with	IS 14268	IS 14268

13.2 GENERAL ASSUMPTIONS FOR PT SLAB & BEAM DESIGN

1) Strength design of prestressed member for flexure and axial loads shall be based on assumptions given in IS1343/ Clause 18.3 (Chapter 18) ACI-318

2) Design moment strength of flexural members shall be computed by the strength design method of the code IS1343/ACI-318

3) Prestressed flexural members shall be classified as class U, Class T or Class C based on extreme fiber stress (Ft) in tension in pre compressed tensile zone calculated at service loads.

4) Serviceability Design Requirements are as per clause 18.3 ACI-318/ IS1343

5) Deflection of prestressed flexural members shall be calculated in accordance with Clause 18.3.5- ACI-318 / IS1343

6) Permissible tensile stresses in flexural member are as per Class-C (Table 18.3.3- ACI-318) / IS1343

7) Permissible stresses in prestressing steel shall not exceed the following

a. Due to prestressing steel jacking force 0.94 Fpy (specified yield strength of prestressing steel in psi) but not greater than the lesser of 0.80(Fpu specified tensile strength of Prestressing steel)and the maximum value recommended by the manufacturer of prestressing steel or anchorage devices.

b. Immediate after prestress transfer 0.82 Fpy but not greater than 0.74 Fpu (specified tensile strength of prestressing steel)

8) Minimum Bonded reinforcement shall be provided in all prestressed flexural members is as per Clause 18.9-ACI-318 / IS1343.

9) Minimum average effective prestress of 125 psi on the slab section tributary to the tendon or tendon group.

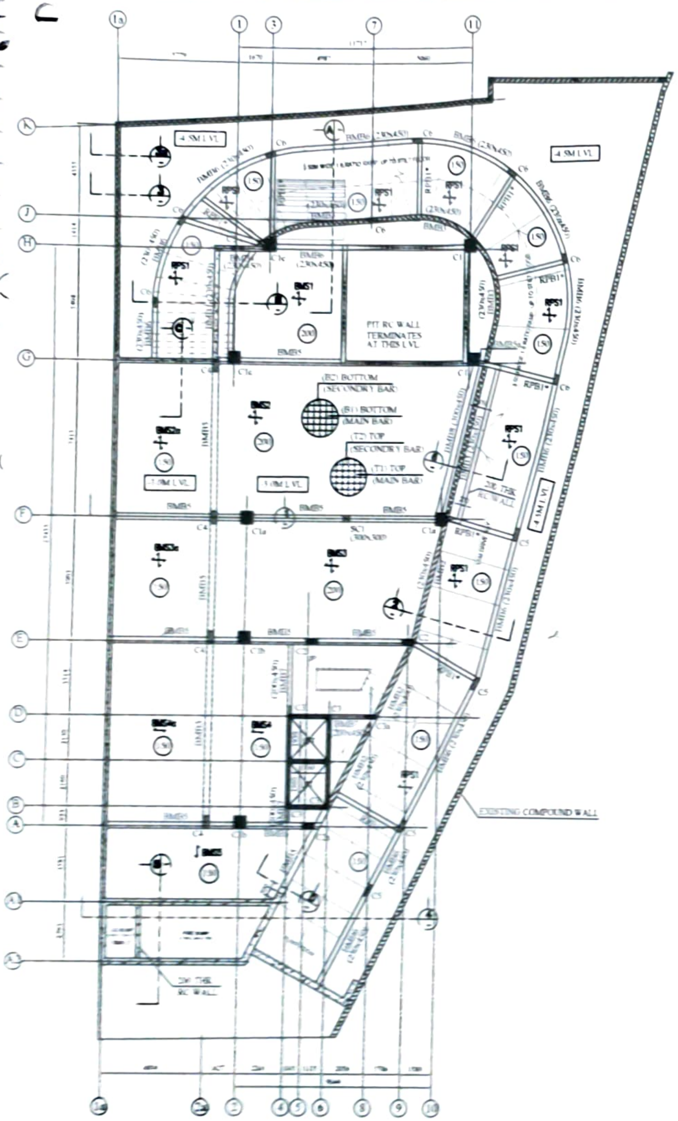
10) Required elongation shall be determined from average load-elongation curves for the prestressing steel used. Generally 7% tolerance in prestressing steel force determined by gauge pressure and elongation measurements for post tension construction.

14.0 COMPUTER PROGRAMS USED

The following Software/Spreadsheet are used to carry out structural element design,

14.1	PROKON Ver 2.3	- Wall & Beam design
14.2	ETABS Ver 9.7.2	-Three Dimensional FEM analysis and Design Programs
14.3	In-House Spread sheet	- Footing Design/One way/Two way slab design
14.4	RAPT	- RAPT-Post tensioning Flat slab design

ANNEXURE-A
STRUCTURAL DRAWINGS



BASEMENT FLOOR FRAMING PLAN & SLAB REINFORCEMENT DETAIL

NOTES

UNLESS OTHERWISE SPECIFIED

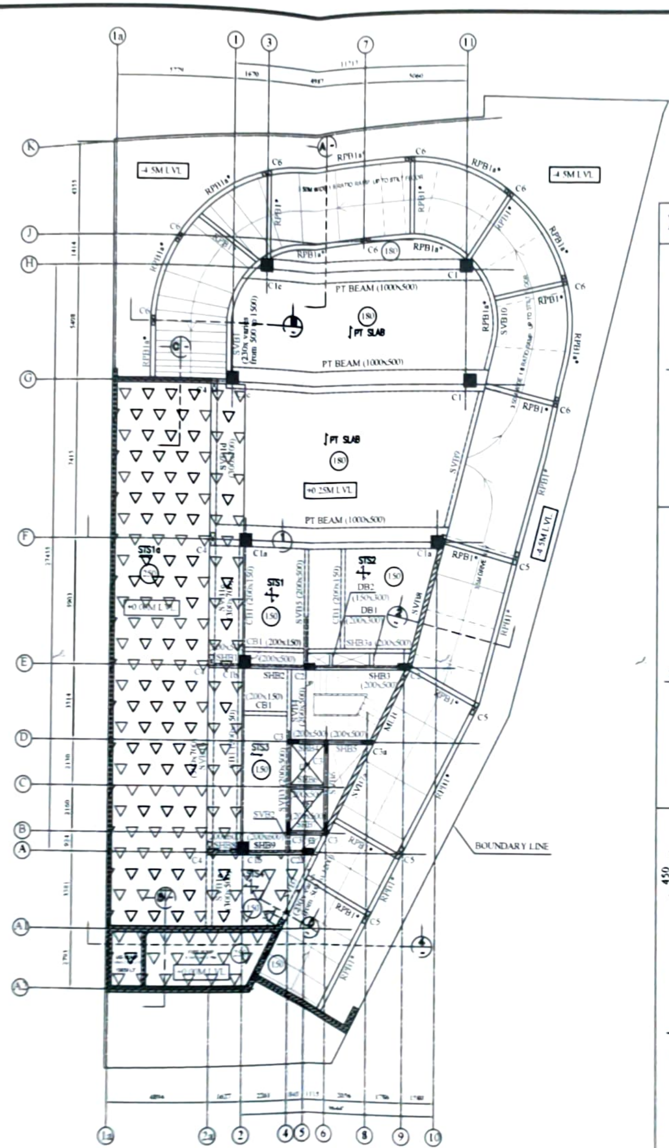
1. ALL BEAMS IS TO BE [illegible]
2. ALL SLAB THICKNESS IS TO BE [illegible]
3. GRADE OF CONCRETE IS TO BE M25
4. GRADE OF STEEL IS TO BE Fe500

ALL SLAB REINFORCEMENT T8@200mm c/c (TOP & BOTTOM)

- BASEMENT RC WALL
- COLUMN TERMINATES AT THIS LVL

LOAD TABLE

LOADS	COMMERCIAL
Live Load	3.0 kN/m^2
Super imposed Dead Load	2.4 kN/m^2
Filling Load	-
TOTAL AREA LOAD	5.4 kN/m^2



STILT FLOOR FRAMING PLAN

NOTES

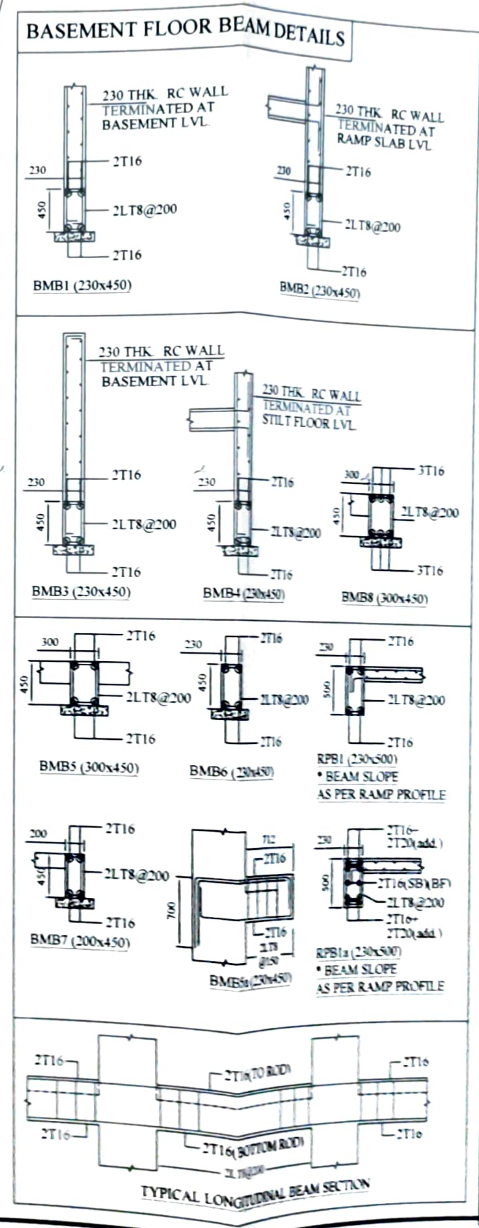
UNLESS OTHERWISE SPECIFIED

1. ALL BEAMS IS TO BE 230x500
2. GRADE OF CONCRETE IS TO BE M35
3. GRADE OF STEEL IS TO BE Fe500

- RC WALL TERMINATES AT THIS LVL

LOAD TABLE

LOADS	COMMERCIAL	DRIVE WAY
Live Load	5.0 kN/m^2	15.0 kN/m^2
Super imposed Dead Load	2.4 kN/m^2	2.4 kN/m^2
Filling Load	-	-
TOTAL AREA LOAD	7.4 kN/m^2	17.4 kN/m^2



NO.	AMENDMENTS	BY	DATE

CLIENT:
M/s.BRILLIANT CORPORATE SERVICES Pvt. Ltd.,

ARCHITECTS:
Design and Architecture studio
#8/4, 2nd Floor, 1st Street, Indira Colony, Ashok Nagar | Chennai - 600083.
T : 91 44 2471 8835
e-mail ID: projects@dastudio.co.in

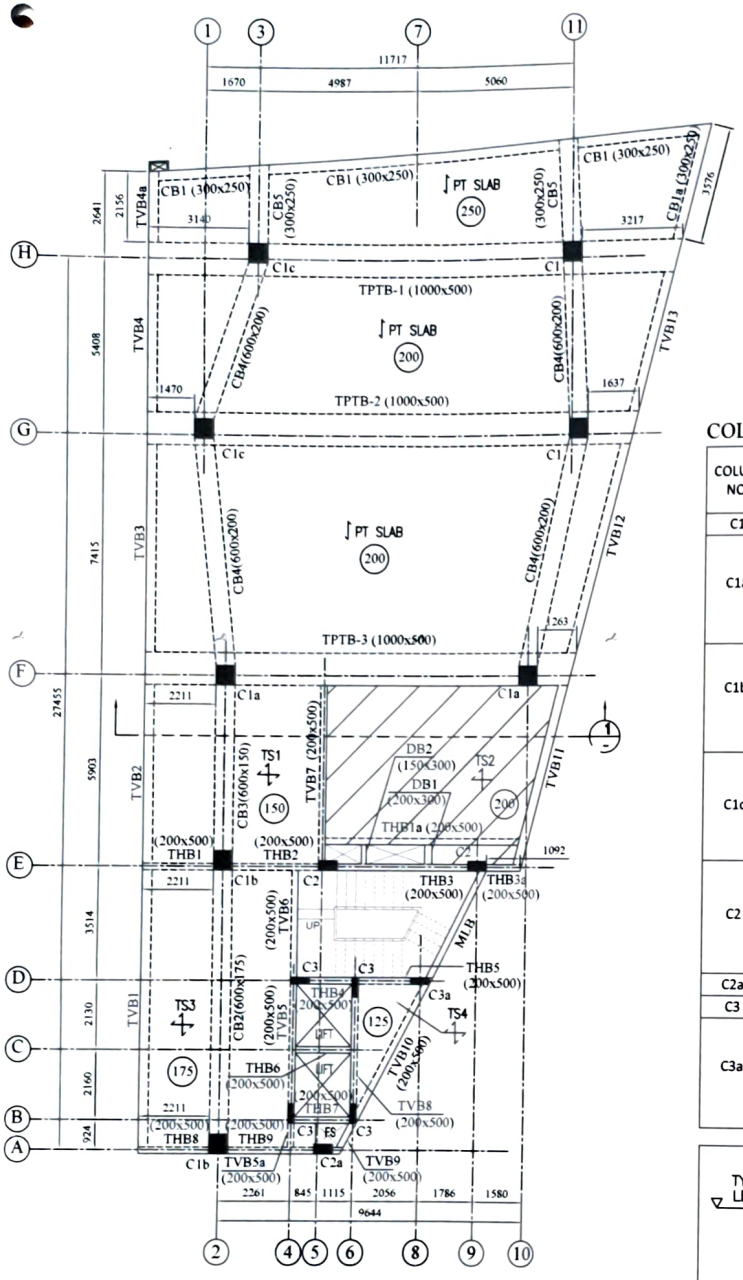
MEP CONSULTANTS:

CIVIL & STRUCTURAL CONSULTANT
A P ENGINEERS

PROJECT TITLE:
PLAN SHOWING THE PROPOSED CONSTRUCTION OF BASEMENT FLOOR +STILT +5 FLOORS +ROOF COMMERCIAL BUILDING(OFFICE) AT DOOR NO: 158/21,200 ft ROAD PALLAVARAM TO THORAIPAKKAM RADIAL ROAD (MMRD ROAD), ZAMIN PALLAVARAM CHENNAI 600 043

DRAWING TITLE:
BASEMENT FLOOR & STILT FLOOR FRAMING PLAN (SHEET 01 OF 02)

scale	1/4"=1'-0"	design by	[illegible]
drawn by	[illegible]	checked by	AP
date	FEBRUARY 2018	approved by	AP
drawing no.	[illegible]	revision	



TYPICAL (1st,2nd,3rd & 4th) FLOOR FRAMING PLAN

COLUMN SIZES:

COLUMN NOS:	SIZES			
	FOUNDATION to BASEMENT FLOOR	BASEMENT FLOOR to GROUND FLOOR	GROUND FLOOR to ROOF	ROOF to UPPER ROOF
C1	600 x 600	600 x 600	600 x 600	-
C1a	1000 x 1000 (terminated at 750mm from footing top lvl.)	600 x 600	600 x 600	-
	600 x 600 (from 750mm to basement lvl.)			
C1b	900 x 900 (terminated at 750mm from footing top lvl.)	600 x 600	600 x 600	600 x 600
	600 x 600 (from 750mm to basement lvl.)			
C1c	1000 x 1000 (terminated at 750mm from footing top lvl.)	600 x 600	600 x 600	600 x 600
	600 x 600 (from 750mm to basement lvl.)			
C2	600 x 900 (terminated at 750mm from footing top lvl.)	300 x 600	300 x 600	300 x 600
	300 x 600 (from 750mm to basement lvl.)			
C2a	300 x 600	300 x 600	300 x 600	300 x 600
C3	200 x 600	200 x 600	200 x 600	200 x 600
C3a	500 x 900 (terminated at 750mm from footing top lvl.)	200 x 600	200 x 600	200 x 600
	200 x 600 (from 750mm to basement lvl.)			

LOAD TABLE

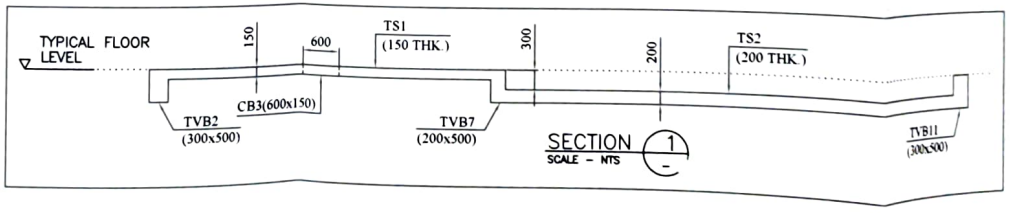
LOADS	COMMERCIAL	TOILET
Live Load	5.0 kN/m^2	2.0 kN/m^2
Super Imposed Dead Load	2.4 kN/m^2	1.2 kN/m^2
Filling Load	-	6.0 kN/m^2
TOTAL AREA LOAD	7.4 kN/m^2	9.2 kN/m^2

NOTES

UNLESS OTHERWISE SPECIFIED

1. ALL COLUMN SIZE IS TO BE 600x600
2. ALL BEAMS IS TO BE 300x500
3. ALL SLAB THICKNESS IS TO BE 150
4. GRADE OF CONCRETE IS TO BE M25
5. GRADE OF STEEL IS TO BE Fe500

- INDICATE 300MM SUNKEN



N

CLIENT:
M/s.BRILLIANT CORPORATE SERVICES Pvt. Ltd.,

ARCHITECTS:
Design and Architecture studio
#8/4, 2nd Floor, 1st Street, Indira Colony, Ashok Nagar | Chennai - 600083.
T : 91 44 2471 8935
e-mail ID: projects@dasstudio.co.in

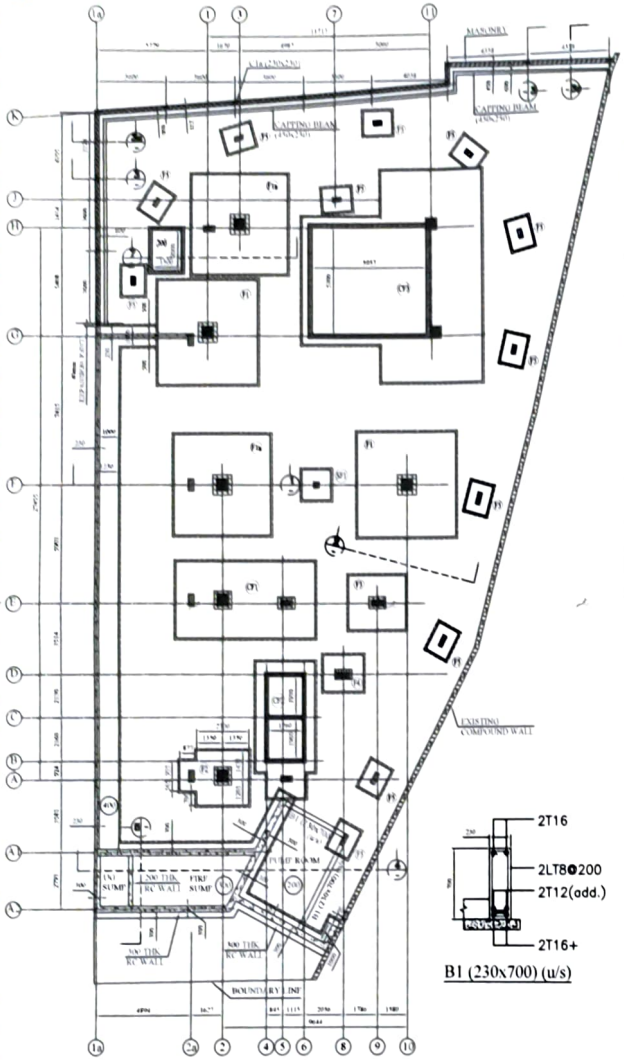
MEP CONSULTANTS:

CIVIL & STRUCTURAL CONSULTANT :
A P ENGINEERS

PROJECT TITLE:
PLAN SHOWING THE PROPOSED CONSTRUCTION OF BASEMENT FLOOR +STILT+5 FLOORS -ROOF COMMERCIAL (BUILDING/OFFICE) AT DOOR NO: 158/21,200 ft ROAD, PALLAVARAM TO THORAIPAKKAM RADIAL ROAD (MMRD ROAD), ZAMIN PALLAVARAM CHENNAI -600 043.

DRAWING TITLE:
TYPICAL(1st to 4th) FLOOR FRAMING PLAN

scale	1/4"=1'-0"	design by	
drawn by		checked by	
date	FEBRUARY 2018	approved by	
drawing no.	APE-PALLAVARAM-3-FFP_01	revision	-



FOOTING LAYOUT PLAN

B1 (230x700) (u/s)

ISOLATED FOOTING SCHEDULE | FLAT

SL. NO	FOOTING MARK	FOOTING NOS	FOOTING SIZE Lr	Br	D	FOOTING REINFORCEMENT B1	B2	T1	T2	SIDE BARS (SB)
1	F1	2	5200	5200	1000	T16@100mm c/c	T16@100mm c/c	T10@200mm c/c	T10@200mm c/c	T12@150mm c/c
1	F1a	2	5000	5000	1000	T16@125mm c/c	T12@150mm c/c	T10@200mm c/c	T10@200mm c/c	T12@150mm c/c
2	F2	1	REFER PLAN		500	T12@150mm c/c	T12@150mm c/c	T10@200mm c/c	T10@200mm c/c	T10@150mm c/c
3	F3	1	3000	2700	550	T12@150mm c/c	T12@150mm c/c	–	–	T10@150mm c/c
4	F4	1	2100	1800	500	T12@150mm c/c	T12@150mm c/c	–	–	T10@150mm c/c
5	F5	12	1500	1200	400	T10@200mm c/c	T10@200mm c/c	–	–	T10@150mm c/c
6	SF1	1	1500	1500	375	T10@200mm c/c	T10@200mm c/c	–	–	–

COMBINED FOOTING SCHEDULE

SL. NO	FOOTING MARK	FOOTING NOS	FOOTING SIZE Lr	Br	D	FOOTING REINFORCEMENT B1	B2	T1	T2	SIDE BARS (SB)
1	CF1	1	7197	3800	800	T12@100mm c/c	T12@100mm c/c	T10@125mm c/c	T10@125mm c/c	T10@150mm c/c
2	CF2	1	REFER PLAN		550	T12@150mm c/c	T12@150mm c/c	T10@150mm c/c	T10@150mm c/c	T10@150mm c/c
3	CF3	1	REFER PLAN		1100	T16@125mm c/c	T16@125mm c/c	T12@125mm c/c	T12@125mm c/c	T12@150mm c/c

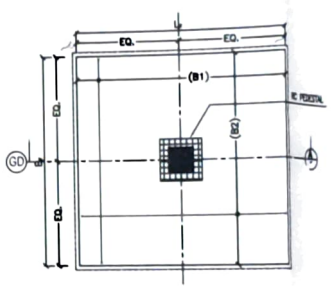
NOTES:

UNLESS OTHERWISE NOTED

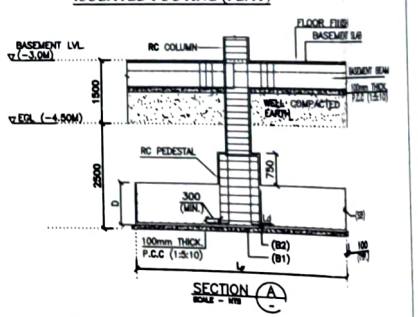
1. GRADE OF CONCRETE IS TO BE M35 WITH CEMENTETIOUS CONTENT NOT LESS THAN 350 kg/m^3 FOR FOOTING, RC COLUMN,RC BEAM,RC SLAB,PT BEAM etc. M25 FOR BASEMENT SLAB,BASEMENT BEAM,BASEMENT RC WALL etc. M10 FOR MASS CONCRETE FILLING.
2. GRADE OF STEEL Fe500
3. THE SAFE BEARING CAPACITY OF THE SOIL CONSIDERED IN THE DESIGN AS PER SOIL REPORT SI/CHN/18/1404/02 IS 25 t/Sq.mt (DATED ON FEBRUARY 2018) AT DEPTH ABOUT 2.5M MEASURED FROM NGL.

   THE BEARING LAYER SHALL BE PROTECTED BY LAYING PCC IMMEDIATELY AFTER REACHING THE FOUNDING DEPTH.

   THE FOOTING EXCAVATED PIT IS TO BE WET FREE AND THE WATER TABLE IS TO BE MAINTAINED WELL BELOW THE PCC BOTTOM DURING CONCRETING AND UP TO THE TIME OF FOOTING CONCRETE ATTAINS ITS STRENGTH.



TYPICAL PLAN OF ISOLATED FOOTING (FLAT)



NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH THE FOUNDATION, COLUMN LAYOUT AND THE SLAB LAYOUT PLAN.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH THE KEY PLAN AND ALL OTHER RELEVANT ARCHITECTURAL AND SERVICES DRAWINGS.
3. GRADE OF CONCRETE IS TO BE AS PER SPECIFICATION CONTENT NOT LESS THAN 350 kg/m^3 FOR FOOTING, RC COLUMN,RC BEAM,RC SLAB,PT BEAM etc. M25 FOR BASEMENT SLAB,BASEMENT BEAM,BASEMENT RC WALL etc. M10 FOR MASS CONCRETE FILLING.
4. GRADE OF STEEL SHALL BE Fe500
5. DEVELOPMENT/ANCHORAGE LENGTH SHALL NOT BE LESS THAN 50DIA/LAP 60D
6. CONCRETE CLEAR COVER
   FOOTING-50MM
   COLUMN-40MM
   R.C WALL-30MM
   BEAM-30MM
   SLAB-20MM
7. STRUCTURE TO BE CONSTRUCTED IN ACCORDANCE WITH I.S.456-2000, SP(34)-1987 AND RELEVANT INDIAN CODE STIPULATIONS
8. CODE OF CONSTRUCTION LIES WITH CONTRACTOR/ PROMOTER / BUILDER / OWNER.

NO.	AMENDMENTS	BY	DATE

CONSTRUCTION DRAWING

CLIENT:
M/s.BRILLIANT CORPORATE SERVICES Pvt. Ltd.,
NO. 18, 2nd FLOOR, ELANGO THALAIVAR GARDEN, CHOLAMANDAL MAIN ROAD, ECHANJU NAGAR, CHROMEPET, CHENNAI - 600 044.

ARCHITECTS:
Design and Architecture studio
#8/4, 2nd Floor, 1st Street, Indira Colony,
Ashok Nagar | Chennai - 600083.
T : 91 44 2471 8835
e-mail ID: projects@dasrtudio.co.in

MEP CONSULTANTS:

CIVIL & STRUCTURAL CONSULTANT :
A P ENGINEERS
NO. 162, MADHA KOIL STREET, THIRUVALLUVAR NAGAR, KOVILAMBAKKAM, CHENNAI - 600 033. PH - +91 8489 2843
EMAIL: apengineers.india@gmail.com

PROJECT TITLE:
PLAN SHOWING THE PROPOSED CONSTRUCTION OF BASEMENT FLOOR + STILT + 5 FLOORS + ROOF COMMERCIAL BUILDING(OFFICE) AT DOOR NO: 158/21,200 ft ROAD PALLAVARAM TO THORAIPAKKAM RADIAL ROAD (MMRD ROAD). ZAMIN PALLAVARAM,CHENNAI -600 043

DRAWING TITLE:
FOOTING LAYOUT PLAN & DETAIL
(SHEET 01 OF 03)

scale	1/4"=1'-0"	design by	MK
drawn by	MALIK	checked by	KP
date	FEBRUARY 2018	approved by	KP
drawing no.	APE-PALLAVARAM_5-FTDT_01	revision	

ANNEXURE-B
ETABS SUMMARY REPORT & MODEL PLOTS

PROJECT INFORMATION

Company Name = admin

S T O R Y D A T A

STORY	SIMILAR TO	HEIGHT	ELEVATION
OHT COVER	None	1.000	32.750
LMR ROOF	None	1.400	31.750
HEAD ROOM	None	2.900	30.350
ROOF	None	3.450	27.450
5TH FLOOR	None	3.450	24.000
4TH FLOOR	None	3.450	20.550
3RD FLOOR	None	3.450	17.100
2ND FLOOR	None	3.450	13.650
1ST FLOOR	None	2.950	10.200
STILT	None	3.250	7.250
BASEMENT	STILT	4.000	4.000
BASE	None		0.000

S T A T I C L O A D C A S E S

STATIC CASE	CASE TYPE	AUTO LAT LOAD	SELF WT MULTIPLIER	NOTIONAL FACTOR	NOTIONAL DIRECTION
DEAD	DEAD	N/A	1.0000		

LIVE5	REDUCE LIVE	N/A	0.0000
WL	SUPER DEAD	N/A	0.0000
SDL	SUPER DEAD	N/A	0.0000
EQX	QUAKE	IS1893 2002	0.0000
EQY	QUAKE	IS1893 2002	0.0000
WX	WIND	IS875 1987	0.0000
WY	WIND	IS875 1987	0.0000
LIVE3	REDUCE LIVE	N/A	0.0000
LIVEROOF	LIVE	N/A	0.0000

M A S S S O U R C E D A T A

MASS FROM	LATERAL MASS ONLY	LUMP MASS AT STORIES
Loads	Yes	Yes

M A S S S O U R C E L O A D S

LOAD	MULTIPLIER
LIVE5	0.5000
LIVE3	0.2500

A S S E M B L E D P O I N T M A S S E S

STORY	UX	UY	UZ	RX	RY	RZ
OHT COVER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LMR ROOF	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

HEAD ROOM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ROOF	8.144E+01	8.144E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5TH FLOOR	8.144E+01	8.144E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4TH FLOOR	8.144E+01	8.144E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3RD FLOOR	7.900E+01	7.900E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2ND FLOOR	8.144E+01	8.144E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1ST FLOOR	8.144E+01	8.144E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
STILT	2.166E+02	2.166E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BASEMENT	1.842E+02	1.842E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BASE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Totals	8.869E+02	8.869E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00

M O D A L P E R I O D S A N D F R E Q U E N C I E S

MODE NUMBER	PERIOD (TIME)	FREQUENCY (CYCLES/TIME)	CIRCULAR FREQ (RADIANS/TIME)
Mode 1	0.78946	1.26669	7.95883
Mode 2	0.74658	1.33944	8.41592
Mode 3	0.37743	2.64953	16.64749
Mode 4	0.24082	4.15255	26.09123
Mode 5	0.22231	4.49826	28.26340
Mode 6	0.12974	7.70794	48.43044
Mode 7	0.11627	8.60066	54.03956
Mode 8	0.11244	8.89393	55.88219
Mode 9	0.08770	11.40254	71.64427
Mode 10	0.07228	13.83541	86.93045
Mode 11	0.06931	14.42800	90.65383
Mode 12	0.06218	16.08306	101.05286

M O D A L P A R T I C I P A T I N G M A S S R A T I O S

MODE NUMBER	X-TRANS %MASS <SUM>	Y-TRANS %MASS <SUM>	Z-TRANS %MASS <SUM>	RX-ROTN %MASS <SUM>	RY-ROTN %MASS <SUM>	RZ-ROTN %MASS
Mode 1	13.63 < 14>	29.31 < 29>	0.00 < 0>	59.55 < 60>	26.77 < 27>	15.71
< 16>						
Mode 2	23.43 < 37>	14.87 < 44>	0.00 < 0>	30.98 < 91>	46.85 < 74>	8.24
< 24>						
Mode 3	9.70 < 47>	0.11 < 44>	0.00 < 0>	0.15 < 91>	18.49 < 92>	11.59
< 36>						
Mode 4	5.20 < 52>	2.50 < 47>	0.00 < 0>	0.34 < 91>	0.64 < 93>	3.11
< 39>						
Mode 5	1.66 < 54>	4.71 < 52>	0.00 < 0>	0.74 < 92>	0.14 < 93>	0.26
< 39>						
Mode 6	6.80 < 60>	1.08 < 53>	0.00 < 0>	0.32 < 92>	1.72 < 95>	0.82
< 40>						
Mode 7	3.33 < 64>	1.77 < 54>	0.00 < 0>	0.68 < 93>	0.65 < 95>	1.42
< 41>						
Mode 8	0.51 < 64>	1.17 < 56>	0.00 < 0>	0.48 < 93>	0.02 < 95>	1.61
< 43>						
Mode 9	12.21 < 76>	0.83 < 56>	0.00 < 0>	0.12 < 93>	1.81 < 97>	0.01
< 43>						
Mode 10	5.89 < 82>	1.81 < 58>	0.00 < 0>	0.40 < 94>	0.97 < 98>	2.15
< 45>						
Mode 11	3.99 < 86>	1.36 < 60>	0.00 < 0>	0.27 < 94>	0.53 < 99>	1.48
< 46>						
Mode 12	0.75 < 87>	0.13 < 60>	0.00 < 0>	0.01 < 94>	0.02 < 99>	0.57
< 47>						

M O D A L L O A D P A R T I C I P A T I O N R A T I O S
(STATIC AND DYNAMIC RATIOS ARE IN PERCENT)

TYPE	NAME	STATIC	DYNAMIC
Load	DEAD	1.7877	0.0000
Load	LIVE5	1.5988	0.0000
Load	WL	2.9022	0.0000
Load	SDL	0.8505	0.0000
Load	EQX	99.9997	99.8711
Load	EQY	99.9987	99.4426
Load	WX	0.0000	0.0000
Load	WY	0.0000	0.0000
Load	LIVE3	5.1465	0.0000
Load	LIVEROOF	1.1940	0.0000
Accel	UX	99.9197	87.1195
Accel	UY	99.8159	59.6613
Accel	UZ	0.0000	0.0000
Accel	RX	99.9856	94.0533
Accel	RY	99.9960	98.6169
Accel	RZ	40.7570	46.9648

TOTAL REACTIVE FORCES (RECOVERED LOADS) AT ORIGIN

LOAD	FX	FY	FZ	MX	MY	MZ
DEAD	-6.854E-04	-2.257E-04	2.935E+04	4.682E+05	-1.119E+05	1.058E-03
LIVE5	-1.533E-04	-1.563E-04	1.648E+04	2.718E+05	-4.167E+04	-1.013E-03
WL	-1.070E-03	-5.127E-05	1.547E+04	1.827E+05	-7.378E+04	5.069E-03
SDL	-1.471E-04	-5.884E-05	1.288E+04	1.939E+05	-7.091E+04	9.333E-05
EQX	-7.004E+02	-4.806E-04	-1.200E-05	2.976E-03	-1.478E+04	1.387E+04
EQY	-2.452E-04	-6.624E+02	-2.702E-06	1.398E+04	-7.008E-03	-3.223E+03
WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LIVE3	-4.776E-04	3.054E-06	1.838E+03	1.185E+04	-4.940E+03	2.572E-03
LIVEROOF	-7.727E-05	-1.124E-05	1.442E+03	2.187E+04	-6.693E+03	2.813E-04

S T O R Y F O R C E S

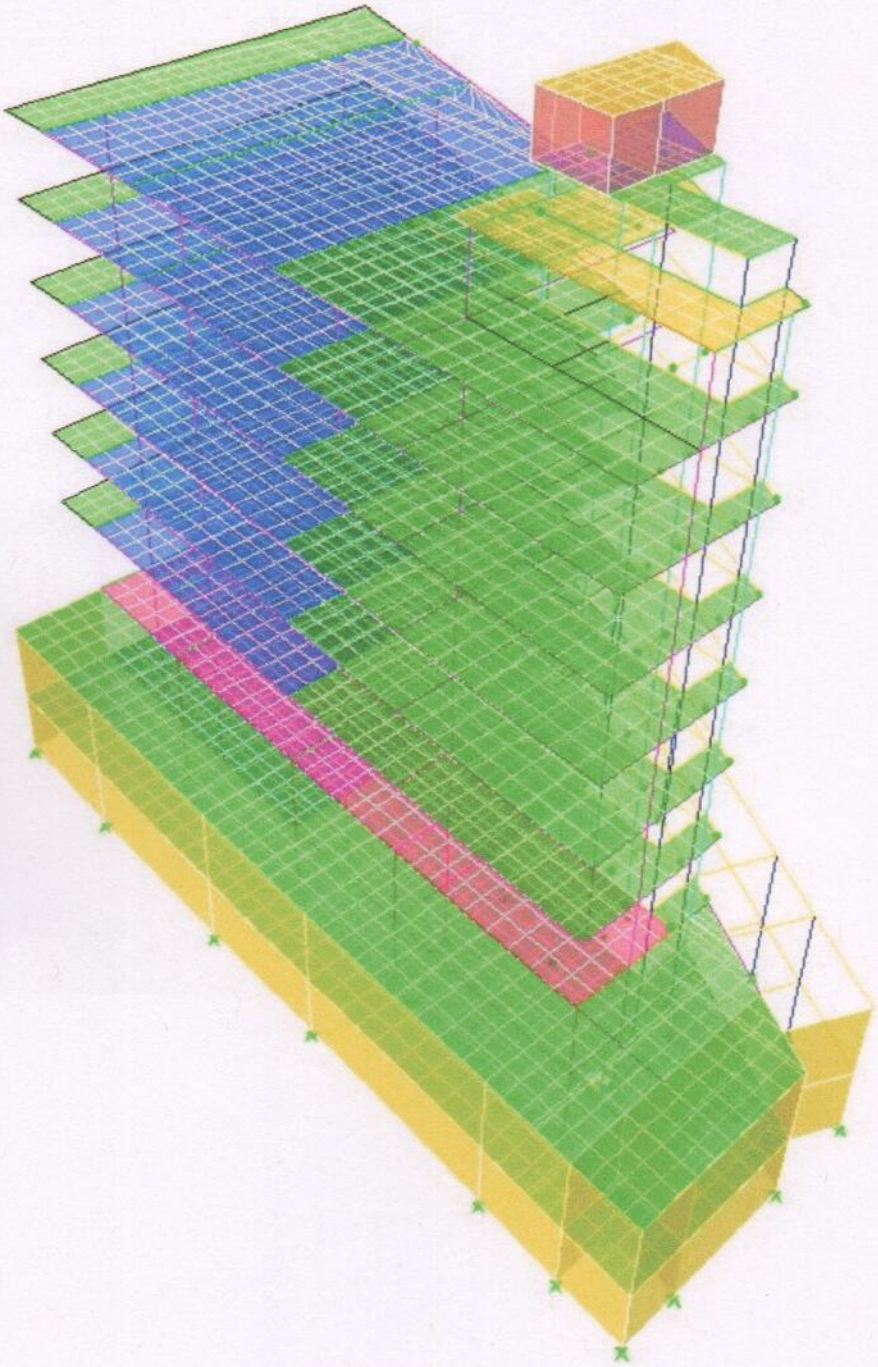
STORY	LOAD	P	VX	VY	T	MX	MY
OHT COVER	EQX	-2.163E-12	-2.180E-10	5.946E-11	2.305E-09	-9.343E-11	-1.895E-10
LMR ROOF	EQX	-1.489E-12	-3.742E-10	7.311E-12	3.032E-09	-1.203E-10	-6.545E-10
HEAD ROOM	EQX	-2.220E-07	9.467E-04	-3.673E-09	-5.018E-03	-1.165E-06	2.746E-03
ROOF	EQX	-2.220E-07	-2.110E+02	-4.582E-09	4.320E+03	-1.150E-06	-7.278E+02
5TH FLOOR	EQX	-2.220E-07	-3.722E+02	-5.593E-09	7.622E+03	-1.131E-06	-2.012E+03
4TH FLOOR	EQX	-2.220E-07	-4.904E+02	-6.476E-09	1.004E+04	-1.109E-06	-3.704E+03
3RD FLOOR	EQX	-2.221E-07	-5.699E+02	-6.975E-09	1.169E+04	-1.086E-06	-5.670E+03
2ND FLOOR	EQX	-2.221E-07	-6.220E+02	-7.279E-09	1.276E+04	-1.062E-06	-7.816E+03
1ST FLOOR	EQX	-2.222E-07	-6.512E+02	-7.552E-09	1.335E+04	-1.040E-06	-9.737E+03
STILT	EQX	-9.562E-06	-6.903E+02	-3.711E-04	1.377E+04	1.089E-03	-1.198E+04
BASEMENT	EQX	-1.200E-05	-7.004E+02	-4.806E-04	1.387E+04	2.976E-03	-1.478E+04
OHT COVER	EQY	-3.768E-11	1.272E-10	5.434E-10	1.267E-09	-8.444E-10	2.811E-10
LMR ROOF	EQY	-8.733E-12	9.363E-11	5.978E-10	1.156E-09	-1.433E-09	2.430E-10
HEAD ROOM	EQY	-2.933E-08	-2.287E-04	-3.979E-08	1.212E-03	-4.104E-08	-6.633E-04
ROOF	EQY	-2.933E-08	-2.287E-04	-1.995E+02	-1.056E+03	6.883E+02	-1.452E-03
5TH FLOOR	EQY	-2.933E-08	-2.287E-04	-3.520E+02	-1.863E+03	1.903E+03	-2.241E-03
4TH FLOOR	EQY	-2.933E-08	-2.287E-04	-4.638E+02	-2.455E+03	3.503E+03	-3.031E-03
3RD FLOOR	EQY	-2.931E-08	-2.287E-04	-5.389E+02	-2.854E+03	5.362E+03	-3.820E-03
2ND FLOOR	EQY	-2.931E-08	-2.287E-04	-5.882E+02	-3.115E+03	7.392E+03	-4.609E-03
1ST FLOOR	EQY	-2.930E-08	-2.287E-04	-6.158E+02	-3.260E+03	9.208E+03	-5.283E-03
STILT	EQY	-2.412E-06	-2.375E-04	-6.528E+02	-3.231E+03	1.133E+04	-6.030E-03
BASEMENT	EQY	-2.702E-06	-2.452E-04	-6.624E+02	-3.223E+03	1.398E+04	-7.008E-03
OHT COVER	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LMR ROOF	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HEAD ROOM	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ROOF	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5TH FLOOR	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4TH FLOOR	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3RD FLOOR	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

2ND FLOOR	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1ST FLOOR	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
STILT	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BASEMENT	WX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OHT COVER	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LMR ROOF	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HEAD ROOM	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ROOF	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5TH FLOOR	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4TH FLOOR	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3RD FLOOR	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2ND FLOOR	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1ST FLOOR	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
STILT	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BASEMENT	WY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

STORY DRIFTS

STORY	DIRECTION	LOAD	MAX DRIFT
OHT COVER	X	EQX	1/11206
OHT COVER	Y	EQX	1/18032
LMR ROOF	X	EQX	1/8628
HEAD ROOM	X	EQX	1/5002
ROOF	X	EQX	1/893
5TH FLOOR	X	EQX	1/580
4TH FLOOR	X	EQX	1/448
3RD FLOOR	X	EQX	1/395
2ND FLOOR	X	EQX	1/405
1ST FLOOR	X	EQX	1/682
STILT	X	EQX	1/4764
STILT	Y	EQX	1/7610
BASEMENT	X	EQX	1/11081
BASEMENT	Y	EQX	1/20189

OHT COVER	Y	EQY	1/11039
LMR ROOF	X	EQY	1/3752
LMR ROOF	Y	EQY	1/4152
HEAD ROOM	Y	EQY	1/1770
ROOF	Y	EQY	1/975
5TH FLOOR	Y	EQY	1/674
4TH FLOOR	Y	EQY	1/539
3RD FLOOR	Y	EQY	1/489
2ND FLOOR	Y	EQY	1/519
1ST FLOOR	Y	EQY	1/792
STILT	Y	EQY	1/5036
BASEMENT	X	EQY	1/24847
BASEMENT	Y	EQY	1/25201



3D-VIEW

TYPICAL FLOOR PLAN

ANNEXURE-C
RC DESIGN OF FOOTING

OFFICE BUILDING AT PALLAVARAM CHENNAI -FOOTING DESIGN

Footing data:

Axial load = 6000 kN

SBC = 250 kn/m^2

Grade of conc. = M35

Grade of steel. = Fe 500

Column size = 1000mm x 1000mm

Design of Footing

Area of Footing = 6000/250 = 24.00M^2

Size of Footing = 5.0M x 5.0M

Net Pressure = 6000*1.5/5.0*5.0 = 360 kn/m^2

Bending Moment Mu = 360*1.8^2 /2 = 583 kn/m

Effective depth req. = $\sqrt{583*10^6 / 4.66*1000}$ = 354mm

Provide Overall Depth = 1000mm

Effective depth = 942mm

Tension Reinforcement

Mu = 583 kn/m

Mu/bd^2 = 0.657

Pt = 0.154 %

Ast = 1450 mm^2

Provide = T16 @ 125mm c/c

pro. Pt = 0.169 %

Check one way Shear

Vu_1 = 360*1.8-0.942 = 308 N

tv = $308*10^3/1000*942$ = 0.326 N/mm^2

tc = 0.33 N/mm^2

tc =0.33 > tv = 0.326 Hence safe

Check Two way Shear

Vu_2 $= 360*(5.0^2 - 1.942^2) = 7642$ N

tvz $= 7642*10^3/5.0*1942*942 = 0.835$ N/mm^2

ks $= 1$ N/mm^2

ks $=1$ $>$ tvz $= 0.835$ Hence safe

Result

Footing size = 5000mm x 5000mm

Footing Depth = 1000mm

Reinforcement = T16@125mm c/c

ANNEXURE-D
RC DESIGN OF COLUMN

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3

DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3250	mm
Unsupported length (shorter direction)	L_y	3250	mm
Eff. length (longer direction)	L_{ex}	2762.5	mm
Eff. length (shorter direction)	L_{ey}	2762.5	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	1200	kN
Factored moment (longer direction)	M_{ix}	24	kNm
Factored moment (shorter direction)	M_{iy}	6	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction			
Slenderness ratio	L_{ex}/D	4.60	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	13.81	**slender**
Additional moment due to slenderness	M_{ay}	22.894219	kN-m
Calculation of P_{uz}			
Assumed percentage of reinforcement	p_t	0.900	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2278	kN
Calculation of P_b:			
Longer Direction			
Coefficient k_1(from TABLE 60 of SP:1980)	d'/D	0.067	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Axial load corresponding to balanced failure	k_{2x}	0.1996667	
Reduction factor for additional moments	P_{bx}	925	kN
Moment due to slenderness	k_x	0.796	
Shorter Direction	M_{ax}	**0.00**	kN-m
Coefficient k_1(from TABLE 60 of SP:1980)	d'/b	0.200	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Axial load corresponding to balanced failure	k_{2y}	0.093	
Reduction factor for additional moments	P_{by}	779	kN
Moment due to slenderness	k_y	0.719	
	M_{ay}	**16.46**	kN-m

Check for moments due to min. eccentricity

Longer Direction			
Minimum eccentricity	e_x	26.50	mm
Moment due to min. eccentricity	M_x	31.80	kN-m
Moment in longer direction	M_{ux}	31.8	kNm
Shorter direction			
Minimum eccentricity	e_y	13.17	mm
Moment due to min. eccentricity	M_y	15.80	kN-m
Moment in shorter direction	M_{uy}	15.8	kNm

Final design moments

Moment in longer direction	M_{ux}	**31.80**	kNm
Moment in shorter direction	M_{uy}	**32.26**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.026	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.286	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD^2$	0.05	
Uniaxial moment capacity (longer direction)	M_{ux1}	**126**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD^2$	0.05	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**42**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.527**	
Value of exponent	α_n	1.545	
Interaction ratio		**0.784**	
Percentage reinforcement satisfactory or not		**safe**	

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3

DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3250	mm
Unsupported length (shorter direction)	L_y	3250	mm
Eff. length (longer direction)	L_{ex}	2762.5	mm
Eff. length (shorter direction)	L_{ey}	2762.5	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	1150	kN
Factored moment (longer direction)	M_{ix}	125	kNm
Factored moment (shorter direction)	M_{iy}	15	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction

Slenderness ratio	L_{ex}/D	4.60	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	13.81	**slender**
Additional moment due to slenderness	M_{ay}	21.940293	kN-m
Calculation of P_{uz}			
Assumed percentage of reinforcement	p_t	1.100	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2364	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.067	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.1996667	
Axial load corresponding to balanced failure	P_{bx}	929	kN
Reduction factor for additional moments	k_x	0.846	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.200	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.093	
Axial load corresponding to balanced failure	P_{by}	781	kN
Reduction factor for additional moments	k_y	0.767	
Moment due to slenderness	M_{ay}	**16.83**	kN-m

Check for moments due to min. eccentricity

Longer Direction

Minimum eccentricity	e_x	26.50	mm
Moment due to min. eccentricity	M_x	30.48	kN-m
Moment in longer direction	M_{ux}	125	kNm
Shorter direction			
Minimum eccentricity	e_y	13.17	mm
Moment due to min. eccentricity	M_y	15.14	kN-m
Moment in shorter direction	M_{uy}	15.141667	kNm

Final design moments

Moment in longer direction	M_{ux}	**125.00**	kNm
Moment in shorter direction	M_{uy}	**31.97**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.031	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.274	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD$	0.08	
Uniaxial moment capacity (longer direction)	M_{ux1}	**201.6**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD$	0.08	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**67.2**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.486**	
Value of exponent	α_n	1.478	
Interaction ratio		**0.827**	
Percentage reinforcement satisfactory or not		**safe**	

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3

DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3000	mm
Unsupported length (shorter direction)	L_y	3000	mm
Eff. length (longer direction)	L_{ex}	2550	mm
Eff. length (shorter direction)	L_{ey}	2550	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	1090	kN
Factored moment (longer direction)	M_{ix}	148	kNm
Factored moment (shorter direction)	M_{iy}	11	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction

Slenderness ratio	L_{ex}/D	4.25	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	12.75	**slender**
Additional moment due to slenderness	M_{ay}	17.719313	kN-m

Calculation of P_{uz}

Assumed percentage of reinforcement	p_t	2.000	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2752	kN

Calculation of P_b:

Longer Direction

	d'/D	0.067	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.1996667	
Axial load corresponding to balanced failure	P_{bx}	951	kN
Reduction factor for additional moments	k_x	0.923	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.200	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.093	
Axial load corresponding to balanced failure	P_{by}	791	kN
Reduction factor for additional moments	k_y	0.848	
Moment due to slenderness	M_{ay}	**15.02**	kN-m

Check for moments due to min. eccentricity

Longer Direction

Minimum eccentricity	e_x	26.00	mm
Moment due to min. eccentricity	M_x	28.34	kN-m
Moment in longer direction	M_{ux}	148	kNm
Shorter direction			
Minimum eccentricity	e_y	12.67	mm
Moment due to min. eccentricity	M_y	13.81	kN-m
Moment in shorter direction	M_{uy}	13.806667	kNm

Final design moments

Moment in longer direction	M_{ux}	**148.00**	kNm
Moment in shorter direction	M_{uy}	**28.82**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.057	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.260	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD$	0.1	
Uniaxial moment capacity (longer direction)	M_{ux1}	**252**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD$	0.1	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**84**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.396**	
Value of exponent	α_n	1.327	
Interaction ratio		**0.735**	
Percentage reinforcement satisfactory or not		**safe**	

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3

DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3450	mm
Unsupported length (shorter direction)	L_y	3450	mm
Eff. length (longer direction)	L_{ex}	2932.5	mm
Eff. length (shorter direction)	L_{ey}	2932.5	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	860	kN
Factored moment (longer direction)	M_{ix}	169	kNm
Factored moment (shorter direction)	M_{iy}	9	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction

Slenderness ratio	L_{ex}/D	4.89	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	14.66	**slender**
Additional moment due to slenderness	M_{ay}	18.489046	kN-m
Calculation of P_{uz}			
Assumed percentage of reinforcement	p_t	1.700	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2623	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.067	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.1996667	
Axial load corresponding to balanced failure	P_{bx}	944	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.200	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.093	
Axial load corresponding to balanced failure	P_{by}	788	kN
Reduction factor for additional moments	k_y	0.961	
Moment due to slenderness	M_{ay}	**17.76**	kN-m

Check for moments due to min. eccentricity

Longer Direction

Minimum eccentricity	e_x	26.90	mm
Moment due to min. eccentricity	M_x	23.13	kN-m
Moment in longer direction	M_{ux}	169	kNm
Shorter direction			
Minimum eccentricity	e_y	13.57	mm
Moment due to min. eccentricity	M_y	11.67	kN-m
Moment in shorter direction	M_{uy}	11.667333	kNm

Final design moments

Moment in longer direction	M_{ux}	**169.00**	kNm
Moment in shorter direction	M_{uy}	**29.43**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.049	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.205	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD$	0.1	
Uniaxial moment capacity (longer direction)	M_{ux1}	**252**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD$	0.1	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**84**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.328**	
Value of exponent	α_n	1.214	
Interaction ratio		**0.896**	
Percentage reinforcement satisfactory or not		**safe**	

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3

DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3450	mm
Unsupported length (shorter direction)	L_y	3450	mm
Eff. length (longer direction)	L_{ex}	2932.5	mm
Eff. length (shorter direction)	L_{ey}	2932.5	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	630	kN
Factored moment (longer direction)	M_{ix}	144	kNm
Factored moment (shorter direction)	M_{iy}	7	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction

Slenderness ratio	L_{ex}/D	4.89	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	14.66	**slender**
Additional moment due to slenderness	M_{ay}	13.544301	kN-m
Calculation of P_{uz}			
Assumed percentage of reinforcement	p_t	1.200	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2407	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.067	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.1996667	
Axial load corresponding to balanced failure	P_{bx}	932	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.200	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.093	
Axial load corresponding to balanced failure	P_{by}	782	kN
Reduction factor for additional moments	k_y	1.000	
Moment due to slenderness	M_{ay}	**13.54**	kN-m

Check for moments due to min. eccentricity

Longer Direction

Minimum eccentricity	e_x	26.90	mm
Moment due to min. eccentricity	M_x	16.95	kN-m
Moment in longer direction	M_{ux}	144	kNm
Shorter direction			
Minimum eccentricity	e_y	13.57	mm
Moment due to min. eccentricity	M_y	8.55	kN-m
Moment in shorter direction	M_{uy}	8.547	kNm

Final design moments

Moment in longer direction	M_{ux}	**144.00**	kNm
Moment in shorter direction	M_{uy}	**22.09**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.034	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.150	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD$	0.09	
Uniaxial moment capacity (longer direction)	M_{ux1}	**226.8**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD$	0.09	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**75.6**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.262**	
Value of exponent	α_n	1.103	
Interaction ratio		**0.863**	
Percentage reinforcement satisfactory or not		**safe**	

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3

DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3450	mm
Unsupported length (shorter direction)	L_y	3450	mm
Eff. length (longer direction)	L_{ex}	2932.5	mm
Eff. length (shorter direction)	L_{ey}	2932.5	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	530	kN
Factored moment (longer direction)	M_{ix}	107	kNm
Factored moment (shorter direction)	M_{iy}	5	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction

Slenderness ratio	L_{ex}/D	4.89	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	14.66	**slender**
Additional moment due to slenderness	M_{ay}	11.394412	kN-m
Calculation of P_{uz}			
Assumed percentage of reinforcement	p_t	1.000	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2321	kN
Calculation of P_b:			
Longer Direction			
Coefficient k_1(from TABLE 60 of SP:1980)	d'/D	0.067	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Axial load corresponding to balanced failure	k_{2x}	0.1996667	
Reduction factor for additional moments	P_{bx}	927	kN
Moment due to slenderness	k_x	1.000	
Shorter Direction	M_{ax}	**0.00**	kN-m
Coefficient k_1(from TABLE 60 of SP:1980)	d'/b	0.200	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Axial load corresponding to balanced failure	k_{2y}	0.093	
Reduction factor for additional moments	P_{by}	780	kN
Moment due to slenderness	k_y	1.000	
	M_{ay}	**11.39**	kN-m

Check for moments due to min. eccentricity

Longer Direction

Minimum eccentricity	e_x	26.90	mm
Moment due to min. eccentricity	M_x	14.26	kN-m
Moment in longer direction	M_{ux}	107	kNm
Shorter direction			
Minimum eccentricity	e_y	13.57	mm
Moment due to min. eccentricity	M_y	7.19	kN-m
Moment in shorter direction	M_{uy}	7.1903333	kNm

Final design moments

Moment in longer direction	M_{ux}	**107.00**	kNm
Moment in shorter direction	M_{uy}	**18.58**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.029	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.126	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD$	0.07	
Uniaxial moment capacity (longer direction)	M_{ux1}	**176.4**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD$	0.07	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**58.8**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.228**	
Value of exponent	α_n	1.048	
Interaction ratio		**0.891**	
Percentage reinforcement satisfactory or not		**safe**	

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3

DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3450	mm
Unsupported length (shorter direction)	L_y	3450	mm
Eff. length (longer direction)	L_{ex}	2932.5	mm
Eff. length (shorter direction)	L_{ey}	2932.5	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	410	kN
Factored moment (longer direction)	M_{ix}	78	kNm
Factored moment (shorter direction)	M_{iy}	6	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction

Slenderness ratio	L_{ex}/D	4.89	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	14.66	**slender**
Additional moment due to slenderness	M_{ay}	8.8145452	kN-m
Calculation of P_{uz}			
Assumed percentage of reinforcement	p_t	1.000	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2321	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.067	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.1996667	
Axial load corresponding to balanced failure	P_{bx}	927	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.200	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.093	
Axial load corresponding to balanced failure	P_{by}	780	kN
Reduction factor for additional moments	k_y	1.000	
Moment due to slenderness	M_{ay}	**8.81**	kN-m

Check for moments due to min. eccentricity

Longer Direction

Minimum eccentricity	e_x	26.90	mm
Moment due to min. eccentricity	M_x	11.03	kN-m
Moment in longer direction	M_{ux}	78	kNm
Shorter direction			
Minimum eccentricity	e_y	13.57	mm
Moment due to min. eccentricity	M_y	5.56	kN-m
Moment in shorter direction	M_{uy}	6	kNm

Final design moments

Moment in longer direction	M_{ux}	**78.00**	kNm
Moment in shorter direction	M_{uy}	**14.81**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.029	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.098	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD$	0.06	
Uniaxial moment capacity (longer direction)	M_{ux1}	**151.2**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD$	0.06	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**50.4**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.177**	
Value of exponent	α_n	1.000	
Interaction ratio		**0.810**	
Percentage reinforcement satisfactory or not		**safe**	

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3
DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3450	mm
Unsupported length (shorter direction)	L_y	3450	mm
Eff. length (longer direction)	L_{ex}	2932.5	mm
Eff. length (shorter direction)	L_{ey}	2932.5	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	280	kN
Factored moment (longer direction)	M_{ix}	55	kNm
Factored moment (shorter direction)	M_{iy}	9	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction

Slenderness ratio	L_{ex}/D	4.89	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	14.66	**slender**
Additional moment due to slenderness	M_{ay}	6.0196894	kN-m
Calculation of P_{uz}			
Assumed percentage of reinforcement	p_t	1.000	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2321	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.067	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.1996667	
Axial load corresponding to balanced failure	P_{bx}	927	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.200	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.093	
Axial load corresponding to balanced failure	P_{by}	780	kN
Reduction factor for additional moments	k_y	1.000	
Moment due to slenderness	M_{ay}	**6.02**	kN-m

Check for moments due to min. eccentricity

Longer Direction

Minimum eccentricity	e_x	26.90	mm
Moment due to min. eccentricity	M_x	7.53	kN-m
Moment in longer direction	M_{ux}	55	kNm
Shorter direction			
Minimum eccentricity	e_y	13.57	mm
Moment due to min. eccentricity	M_y	3.80	kN-m
Moment in shorter direction	M_{uy}	9	kNm

Final design moments

Moment in longer direction	M_{ux}	**55.00**	kNm
Moment in shorter direction	M_{uy}	**15.02**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.029	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.067	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD$	0.05	
Uniaxial moment capacity (longer direction)	M_{ux1}	**126**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD$	0.05	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**42**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.121**	
Value of exponent	α_n	1.000	
Interaction ratio		**0.794**	
Percentage reinforcement satisfactory or not		**safe**	

DESIGN OF RECTANGULAR/SQUARE COLUMN

COLUMNSIZE : 200x600
COLUMN N0 : C3

DATA

Length of column	D	600	mm
Breadth of column	b	200	mm
Unsupported length (longer direction)	L_x	3000	mm
Unsupported length (shorter direction)	L_y	3000	mm
Eff. length (longer direction)	L_{ex}	2550	mm
Eff. length (shorter direction)	L_{ey}	2550	mm
Braced/Unbraced		**Braced**	
Factored axial load	P_u	120	kN
Factored moment (longer direction)	M_{ix}	77	kNm
Factored moment (shorter direction)	M_{iy}	13	kNm
Charac. comp strength of concrete	f_{ck}	35	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Effective cover	d'	40	mm

Check for slenderness

Longer Direction

Slenderness ratio	L_{ex}/D	4.25	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	12.75	**slender**
Additional moment due to slenderness	M_{ay}	1.95075	kN-m
Calculation of P_{uz}			
Assumed percentage of reinforcement	p_t	1.000	%
Area of concrete	Ag	120000	mm^2
Ultimate axial load (without moments)	P_{uz}	2321	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.067	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.215	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.1996667	
Axial load corresponding to balanced failure	P_{bx}	927	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.200	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.183	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.093	
Axial load corresponding to balanced failure	P_{by}	780	kN
Reduction factor for additional moments	k_y	1.000	
Moment due to slenderness	M_{ay}	**1.95**	kN-m

Check for moments due to min. eccentricity

Longer Direction

Minimum eccentricity	e_x	26.00	mm
Moment due to min. eccentricity	M_x	3.12	kN-m
Moment in longer direction	M_{ux}	77	kNm
Shorter direction			
Minimum eccentricity	e_y	12.67	mm
Moment due to min. eccentricity	M_y	1.52	kN-m
Moment in shorter direction	M_{uy}	13	kNm

Final design moments

Moment in longer direction	M_{ux}	**77.00**	kNm
Moment in shorter direction	M_{uy}	**14.95**	kNm

Check for interaction

p/f_{ck}	p/f_{ck}	0.029	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.029	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD$	0.05	
Uniaxial moment capacity (longer direction)	M_{ux1}	**126**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD$	0.05	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**42**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.052**	
Value of exponent	α_n	1.000	
Interaction ratio		**0.967**	
Percentage reinforcement satisfactory or not		**safe**	

ANNEXURE-E
RC DESIGN OF BEAM

PALLAVARAM - BEAM DESIGN

Beam: THB

Beam Size: 200x500mm, Grade of Concrete: M35, Grade of Steel: Fe500

Mu @ Span = 185 kN-m Vu= 91 kN

Mu @ Span = 135 kN-m

Mu/bd^2 = 4.37 Pt= 1.21% Ast= 1350 mm^2

Reinforcement required 3T20+2T20 (ADDITIONAL)

SFD = 179, Φ of Bar = 8mm, Leg = 2

Spacing of Shear with 8Φ = 0.87*500*2*50.3*460/(179*1000)

= 100mm

Hence provided Shear Reinforcement = 2LT8@100c/c

ANNEXURE-F
RC DESIGN OF SLAB

PROJECT: PALLAVARAM

DESIGN OF SLAB No: TS

1.00	Grade of concrete		=	35.00	N/mm²
2.00	Grade of steel		=	500.00	N/mm²
3.00	Cover to reinforcement		=	25.00	mm
	Diameter of bar			12.00	mm
4.00	Aspect ratio $\frac{l_y}{l_x}$ =	8.53 / 4.37	8.67 / 4.52	1.950	< 2
5.00	Edge condition:	1 short edge continuous		Two way slab	
6.00	Modification factor assumed			1.40	
7.00	Depth required for deflection:	140.28	D =	175.00	mm
				175.00	mm
			d =	144.00	mm
8.00	Dead Load		=	4.20	kN/m²
9.00	Live load		=	5.00	kN/m²
10.00	Partitions & FF		=	2.40	kN/m²
11.00	Total load		=	11.60	kN/m²
12.00	Factored load		=	17.40	kN/m²

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	0.094	0.057	0.043
M_u=Co-efficient*w* l_x^2	0.00	33.44	20.24	15.27
K= Mu/bd2	0.00	1.61	0.98	0.74
Percentage of steel required	0.00	0.39	0.23	0.17
Ast required(in mm²)	0.00	565.70	334.15	249.92
Ast min (in mm²)	210.00	210.00	210.00	210.00
Ast to be provided (in mm2)	210.00	565.70	334.15	249.92
Provided bars spacing (c/c)	538.78	200.01	338.60	452.72
max spacing	250.00	250.00	250.00	250.00
spacing	250.00	200.01	250.00	250.00
Reqd bars spacing (c/c)	**250.00**	**200.00**	**250.00**	**250.00**
Pvd bars spacing (c/c)	200.00	125.00	200.00	200.00
Ast Provided(in mm²)	**565.71**	**905.14**	**565.71**	**565.71**
Percentage of steel provided	**0.39**	**0.63**	**0.39**	**0.39**

STEPII

F_s=0.58 *f_y * (Ast required/ Ast provided)				
F_s			181.24	
M.F			1.45	
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 DEPTH	**d**	**144.00**	**mm**	

STEPIII **Crack width calculation**

m	=	6.8	
E_s	=	200000.0	
Ec	=	29580.4	
Pt	=	0.6	
k	=	0.3	
x	=	36.3	
A_{st}	=	905.1	
I_{cr}	=	86930341.47	
M	=	33.4	
f_{st}	=	280.1	
ε_m	=	0.0	
Spacing	=	125.0	
a_{cr}	=	67.3	
ω_{cr}	=	0.18	
	<	0.20	mm (safe)

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PROJECT INFORMATION

PROJECT ADDRESS:	Completed Construction of Basement Floor + Stilt Floor + 4 Floors Commercial (Office) Building at Door No. 158/21, MMRD Road, Zamin Pallavaram, Chennai Comprised in Old S.No 255/1B & 255/2, New T.S. No. 34/2, 34/3, Ward No. D, Block No.49 of Zamin Pallavaram Village.
USAGE OF BUILDING:	Commercial Building (Office use)
EXTENT OF THE LAND:	890.29 SQM

our services doesn't just end there

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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.

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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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