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DIGITALLY VERIFIED RECORD

PLAN SHOWING THE PROPOSED CONSTRUCTION OF COMMERCIAL BUILDING CONSISTS OF BASEMENT + GROUND FLOOR + 7 FLOORS (HEIGHT 29.95M) DOOR NO: 27. PLOT NO: 48(PART), 69 & 70, GST ROAD, CHROMPET, CHENNAI - 600 044. WITHIN THE LIMITS OF GREATER CHENNAI CORPORATION.

COMMERCIAL BUILDING - Structural Design Report

JANUARY -2025



STRUCTURAL CONSULTANT

C.KANNAN B.E., M.E (STRUCTURE)
INDIRA NAGAR, CHENNAI-20.

C. KANNAN, B.E.,M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
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Indira Nagar, Chennai-600 020.

1.1 FOREWORD

1.1.1 - Description of Project

M/s.Vignesh Properties Pvt. Ltd., Chennai is developing a High rise commercial building (Basement + Ground +7 upper floors) at Door No: 27. Plot No: 48(Part), 69 & 70, GST Road, Chrompet, Chennai - 600 044. This project offers spacious office spaces, meeting rooms and common areas for productive and collaborative work environment. The project construction is carried out as RCC framed structure with Shear wall and PT Slab system. The building is designed with accessibility in mind as well as earthquake-resistant construction to ensure the well-being of occupants.

1.1.2 – Objective of the Report

The objective of this report is to provide and furnish complete details related to Project and structural analysis and design considerations.

1.1.2 – Scope of the Report

The Structural Report covers the complete Structural Elements design considerations for analysis of lateralloads & gravity loads.

1.2 CODES, STANDARDS AND REFERENCES

Statutory Requirements:

The design of structural and other building services will comply with the following requirements:

- National Building Code The Building Regulations
- The Environmental Protection Act in liaison with the Environmental Agency.
- Fire prevention and detection in compliance with the local Fire Regulation.

DESIGN STANDARDS:

Specific applicable codes and standards will be identified and adopted in the design philosophies as appropriate to the structural elements. The latest editions of the Codes and Standards will be used indesigns. All design work shall be based on Indian Standards and Codes with latest revision, with amendments if any, as on date.

Loads:

IS: 875 -2015	-	Code of Practice for design loads (other than earthquake) for Buildings & structure (All parts)
IS: 1893-2016	-	Criteria for earthquake resistant design of structure

Foundations:

IS: 1080-1985(2016)	-	Code of Practice for design and construction of shallow foundations on soils(other than raft, ring and shell)
IS: 1904-1986(2015)	-	Code of Practice for design and construction of foundations in soils general requirement
IS: 2911-1980(2013)	-	Code of Practice for design and construction of pile foundations (All parts)
IS: 2911-1980(2013)	-	Code of Practice for design and construction of pile foundations (All parts)
IS: 2950-1981(2013)	-	Code of Practice for design and construction of raft foundations
IS: 2974-1998(2013/2015)	-	Code of Practice for design and construction of machine Foundations(All parts)
IS: 8009-1976/1980(2013/2015)	-	Code of Practice for calculation of settlement of foundations (All parts)

RCC:

IS: 456 -2000(2016)	-	Code of Practice for plain and reinforced concrete
IS: 458 -1988	-	Specification for precast concrete pipes
IS: 3370-2009	-	Code of Practice for concrete structures for the storage of liquids:(All parts)
IS: 4326-2013	-	Code of Practice for earthquake resistant design and construction of building
IS: 5525-1969(2013)	-	Recommendation for detailing of reinforced concrete works
IS: 1786-2008	-	Code of Practice for design and construction of machine Foundations(All parts)
IS: 5525-1969(2013)	-	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS: 1786-2008	-	Recommended guidelines for concrete mix design
IS: 10262-2009	-	Criteria for earthquake resistant design of structures (General provisions and building).
IS: 1893 (Part-1)-2016	-	Criteria for structural safety of Tall Concrete buildings
IS: 16700 – 2017	-	Ductile design and Detailing of Reinforced concrete structures subjected to Seismic forces – Code of practice
IS: 13920 – 2016	-	Ductile design and Detailing of Reinforced concrete structures subjected to Seismic forces – Code of practice
IS: 1343 – 1980	-	Code of practice for Prestressed concrete

Miscellaneous:

IS: 432(part 2)-1995	-	Specification for mild steel and medium tensile steel bars and hard-drawnsteel wire for concrete reinforcement
IS: 6313(part II)-2001	-	Standards for anti-termite treatment
IS: 1905-1998	-	Code of Practice for structural use of unreinforced masonry
IS: 3067-1995	-	Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
SP: 6 -1998	-	Handbook for structural engineers (all parts)
SP: 7 -2005	-	National Building Code of India
SP: 16-1999	-	Design Aids for reinforced concrete to IS:456-1978
SP: 22-1982	-	Explanatory handbook on codes for earthquake engineering (IS:1982-1975and IS:4326-1976)
SP: 24-1983	-	Explanatory handbook on Indian Standard code of Practice for plain andreinforced concrete
SP: 34-1987	-	Handbook of concrete reinforcement and detailing (SCIP)

Material:

IS: 269 -2015	-	Specification for Ordinary, rapid hardening and low heat Portland cement'
.IS: 455 -1995	-	Specification for Portland blast furnace slag cement.
IS: 1489-1991	-	Specification for Portland pozzolana cement
IS: 4031-1991	-	Method of physical tests for Portland cement.
IS: 383 - 2016	-	Specification for coarse and fine aggregates from natural sources for concrete.
IS: 516 – 1999	-	Method of test for strength of concrete
IS: 1199-1999	-	Method of sampling and analysis of concrete.
IS: 1566-2000	-	Specification for plain hard drawn steel wire fabric for concrete reinforcement
IS: 4990-1998	-	Specification for plywood for concrete shuttering works.
IS: 2645-1999	-	Specification for integral cement water proofing compounds.

1.3 DESCRIPTION OF STRUCTURE

1.3.1 Building Description

The Development consists of the following:

a. Commercial building floor covered with RCC roofing.

The usages of individual floors are as given below:

Floors	Details
Main Commercial Building	Space for Office Purpose

1.3.2 Structural Arrangement:

The Structural System for the commercial buildings comprises of RCC column and beam and PT slab.

S.No.	Description	Details
1.	Column Grids	10.00 m x 10.00 m (Varies for some grids)
2.	Structural System	RCC Shear Wall & Column
3.	Slab Thickness RCC Slab PT Slab	 Min. 150mm (Varies on span) 250mm (Varies on span)
4.	Foundation	Shallow Foundation
5.	Column	As per design
6.	Beams	As per design

1.4 DESIGN APPROACH

1.4.1 – Design Life.

The design life of the building is assumed as 50 years. This requirement is applicable only for concrete works and not applicable to replaceable finishing materials, water proofing membrane and thermal insulations (if any). Hence periodic maintenance / refurbishment are required for all replaceable material for longer life.

1.4.2 – Material Properties.

Materials specified will conform to the latest edition of the relevant Indian Standard or other accepted standard. Specifications for materials will include sampling and testing as stipulated in the design standards. Detailed material specifications will be included in the Technical Specification.

Concrete:

All structural concrete shall have cube crushing strength of 35 N/sq.mm (M35) at 28 days.Plain cement concrete shall have cube crushing strength of 10 N/sq.mm (M10) at 28 days.

Concrete Mix:

Concrete Item	Grade
Shallow Foundation	M30
Columns	M40
Slabs & Beams	M35

Reinforcement steel:

- All reinforcement shall confirm to IS: 1786 – 1985 having minimum yield strength of 500 N/sq.mm.Corrosion resistant steel is not required.

1.4.3 – Design loads

Dead loads:

Dead load shall include weight of all structural and Architectural components. Self-weight of the materials shall be calculated on the basis of unit weights given in IS: 875.

- Floor finish of 75 mm thickness : 75 kg/sqm
- Self-weight of Plain concrete : 2400 kg/cum (24 kN/cum)
- Self-weight of RCC : 2500 kg/cum (25 kN/cum)
- Aerocon block masonry : 700 kg/cum (7 kN/cum) [For walls]
  (With additional 15mm thick plastering on external surface and 12mm plastering on internal wallsurfaces)
- Soil (Dry) : 1800 kg/cum (18 kN/cum)
- Soil (Wet : 2000 kg/cum (20 kN/cum)
- Water : 1000 kg/cum (10 kN/cum)
- Masonry with plastering : 2200 kg/cum (22 kN/cum)
- Wall loads : As per actuals

Live loads:

The superimposed loads shall be calculated in accordance with IS: 875(Part-2) based on Occupancy Classification. For multiple occupancies of use in the building shall be referred with the other appropriate comparable occupancy classification as per Table.1 of IS 875(Part-2)-1987.

Following live loads are considered while designing the structural elements apart from the dead loads asper codes.

Floor Live loads:

- Office Space : 400 kg/sqm (4.0 kN/sqm)
- Stairs : 400 kg/sqm (4.0kN/sqm)
- Corridors / Balcony : 400 kg/sqm (4.0 kN/sqm)
- Toilets : 200 kg/sqm (2.0kN/sqm)
- Terrace with Access : 200 kg/sqm (2.0 kN/sqm)
- Electrical rooms : 400 kg/sqm (4.0 kN/sqm)
- AHU : 500 kg/sqm (5.0 kN/sqm)

Sunken Details:

- Toilet : 250mm

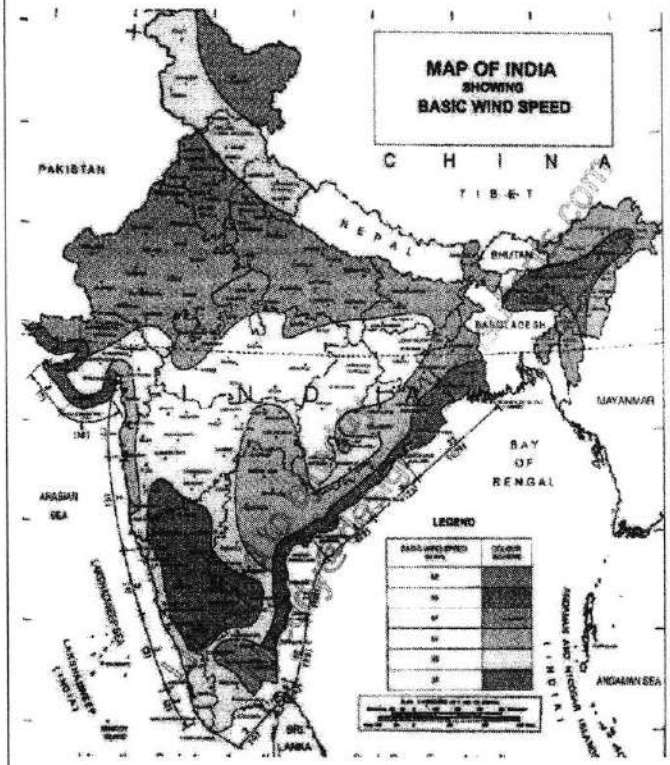
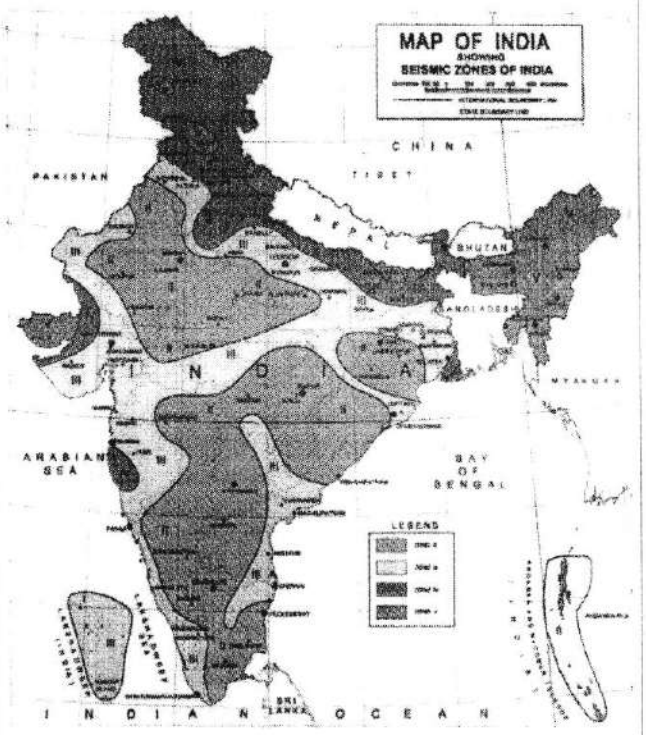
Wind Loads

The Wind pressure shall be calculated in accordance with IS: 875 (Part-3):2015.Chennai has a high wind speed of 50m/s.

Basic Wind Speed V_b	: 50 m/s
Risk Coefficient k_1	: 1.00 (k_1 corresponds to 50 years Mean Probable Design Life of Structure)
Terrain, height, structure size factor k_2	: To suit the height of the structure for terrain category 2
Topography factor k_3	: 1.0
Importance factor for cyclonic region k_4	: 1.00

The external and internal pressure co-efficient shall be as per respective clauses of IS: 875 (Part 3):2015 Design

Wind speed V_z	: $V_b \times k_1 \times k_2 \times k_3 \times k_4$
Design Wind Pressure, P_z	: $0.6V_z^2$

Map showing basic wind speed	Map showing seismic zones
	
Basic wind speed in m/s (based on 50-year return period)	Seismic zones of India

Seismic Forces:

Chennai falls under seismic zone III as per IS 1893-2016 (Part 1) (Sixth Revision) and has the following factors to be considered for designs. Ductile detailing is required. (Please refer attached map above)

Seismic Zone	: III
Seismic Zone factor, Z	: 0.16 (As per Table 3; IS: 1893-2016)
Design horizontal seismic coefficient (Ah)	: $(Z/2)*(S_a/g)*(I/R)$
I -Importance factor	: 1.2 (Ref Table 8; IS: 1893-2016)
Response reduction Factor	: 5
Soil type	: Type -1
Damping Ratio for RCC	: 5 %

Sa/g – Average response acceleration coefficient for soil sites as per Fig.2 of IS: 1893-2016 and it is arrivedbased on appropriate fundamental natural period of structure as per Cl 7.6.2 (b)

Design horizontal seismic coefficient (A_h)	: $(Z/2)*(S_a/g)*(I/R)$
	: $(0.16/2)*(1.2/5) * (S_a/g)$
A_h	: $0.024 * (S_a/g)$
Design seismic base shear, V_b	: $A_h * w$ where, w - seismic weight of building
Effect of infill panels	: Not considered in the analysis

Table No : 03

Seismic Zone Factor Z

(Clause 6.4.2)

Seismic Zone	II	III	IV	V
Seismic Intensity	Low	Moderate	Severe	Very Severe
Z	0.10	0.16	0.24	0.36

Temperature Loads:

The effect of temperature will be considered wherever applicable in accordance with relevant Indian Codes. Minimum & maximum temperatures considered are as shown in the table below. Same will be used for the analysis & design. The coefficient for thermal expansion and contraction will be in accordance with IS: 456 and IS: 800 for concrete and steel respectively.

Station Name	Month	Period	No. of Years	Mean Temperature in Degree C		Mean rainfall in mm
				Maximum	Minimum	
Chennai (Minambakkam)	January	1901-2000	100	28.8	20.4	35.3
Chennai (Minambakkam)	February	1901-2000	100	30.5	21.1	13.0
Chennai (Minambakkam)	March	1901-2000	100	32.6	23.0	14.5
Chennai (Minambakkam)	April	1901-2000	100	34.7	25.8	15.9
Chennai (Minambakkam)	May	1901-2000	100	37.4	27.6	42.4
Chennai (Minambakkam)	June	1901-2000	100	37.3	27.4	53.9
Chennai (Minambakkam)	July	1901-2000	100	35.3	26.1	99.6
Chennai (Minambakkam)	August	1901-2000	100	34.5	25.5	129.9
Chennai (Minambakkam)	September	1901-2000	100	33.9	25.2	123.5
Chennai (Minambakkam)	October	1901-2000	100	31.8	24.2	284.6
Chennai (Minambakkam)	November	1901-2000	100	29.4	22.6	353.0
Chennai (Minambakkam)	December	1901-2000	100	28.4	21.2	146.3

[Source: National Data Centre: ndc@imdpune.gov.inDGM (Sectt.): dgm.hq@imd.gov.in]

Considering the average **daily** maximum temperature as 34 degrees and minimum as 24 degrees, the variation in temperature for analysis is considered as **10 degrees**. [Source https://www.wunderground.com/history/airport/VOMM/2016/1/4/CustomHistory.html?dayend=5&monthend=2&yearend=2017&req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo=]

Temperature and shrinkage effect:

Horizontal floor displacement due to differential temperatures and shrinkage is of importance in long concrete buildings. It can be taken care of by either providing expansion joints at an appropriate spacing or designing structural members for the additional moments caused by the temperature and shrinkage effects. Pour strips at suitable locations shall also be considered where required.

Exceptional Loads:

Loads due to the following catastrophe scenarios are not considered in the design:

- Exceptional loads due to terrorist attacks (Explosions)
- Accidental loads (Falling of aircraft on the building)
- Accidental collision of vehicles on the façade of the building

Durability Considerations:

Environmental conditions, Corrosion and Fire protection for concrete and structural steel

- Environment : Moderate
- Exposure conditions : Concrete surfaces exposed to moderate environment
- Minimum grade of Concrete : Moderate Exposure – M30

Table 5 Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum Size

(Clauses 6.1.2, 8.2.4.1 *and* 9.1.2)

Sl No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Mild	220	0.60	–	300	0.55	M 20
iii)	Moderate	240	0.60	M 15	300	0.50	M 25
iii)	Severe	250	0.50	M 20	320	0.45	M 30
iv)	Very severe	260	0.45	M 20	340	0.45	M 35
v)	Extreme	280	0.40	M 25	360	0.40	M 40

NOTES

1 Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in 5.2. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2 Minimum grade for plain concrete under mild exposure condition is not specified.

1.4.4 Fire Rating

Thickness of the structural elements as per table 15, 16 & 16A clause 26.4 of IS 456-2000.

Fire Resistance h	*Minimum Beam Width b*	*Rib Width of Slabs b_w*	*Minimum Thickness of Floors D*	*Column Dimension (b or D)*			*Minimum Wall Thickness*		
				Fully Exposed	50% Exposed	One Face Exposed	$p<0.4\%$	$0.4\% \le p \le 1\%$	$p>1\%$
	mm	mm	mm	mm	mm	mm	mm	mm	mm
0.5	200	125	75	150	125	100	150	100	100
1	200	125	95	200	160	120	150	120	100
1.5	200	125	110	250	200	140	175	140	100
2	200	125	125	300	200	160	–	160	100
3	240	150	150	400	300	200	–	200	150
4	280	175	170	450	350	240	–	240	180

NOTES

1 These minimum dimensions relate specifically to the covers given in Table 16A.

2 p is the percentage of steel reinforcement.

FIG. 1 MINIMUM DIMENSIONS OF REINFORCED CONCRETE MEMBERS FOR FIRE RESISTANCE

Nominal covers for 2 hr. fire resistance:

Nominal Cover						
Beams		Slabs		Ribs		Columns
Simply supported	Continuous	Simply supported	Continuous	Simply supported	Continuous	
mm	mm	mm	mm	mm	mm	mm
40	30	35	25	45	35	40

1.5 ANALYSIS METHODOLOGY:

This structure has a physical interface with almost all the disciplines like geotechnical works, MEP services,etc. The structure proposed is of cast in-situ concrete construction with columns suitably placed. The vertical loads including the dead and super imposed loads are transferred to the soil through columns and foundation. Foundations are sized with consideration to the safe bearing capacity of soil at the level of transfer of load recommended by specialist soil investigation consultants.

1.5.1 Assumptions:

- The structure is idealized as 3D space frame and analyzed using ETABS software package for both vertical and lateral loads.
- The structure is analyzed for specific loads like dead load, live load, wind, and seismic loads and forthe load combinations as given in the relevant codes.
- The foundation is represented in analysis model using fixed end conditions.

1.5.2 Mathematical model

Mass Modelling:

Mass Source as per IS: 1893_2016 is considered as follows.

Mass source = DL+SDL+ 0. 5LLWhere DL - Dead Load;

SDL – Super Imposed Dead Load;LL - Live Load

1.5.3 Static Analysis:

The following Static loads cases are considered in the analysis.

DL - Dead Load which includes self-weight of the structure.

SDL – Super Imposed Dead Load, including load due to finishes, wall Loads, Soil filling loads etc.

LL - Live Load

1.6 LOAD COMBINATIONS:

Load combinations Used for Strength, Serviceability are tabulated below:

Load Combination	Limit State of Collapse			Limit State of Serviceability		
	DL+SDL	*LL*	*WL/EL/TL*	*DL+SDL*	*LL*	*WL/EL/TL*
DL + LL	1.5	1.5	—	1	1	—
DL + WL	1.5 or 0.9*	—	1.5	1	—	1
DL + EL	1.5 or 0.9*	—	1.5	1	—	1
DL + TL	1.5	—	1.5	1	—	1
DL+LL+WL	1.2	1.2	1.2	1	0.8	0.8
DL+LL+EL	1.2	1.2	1.2	1	0.8	0.8
DL+LL+TL	1.2	1.2	1.2	1	1	1
DL+WL+TL	1.2	—	1.2	1	—	1
DL+EL+TL	1.2	—	1.2	1	—	1
DL+LL+EL+TL	1.2	1.2	1.2	1	1	1

Response spectrum combinations:

- 1.2[DL+LL+(SPECX+0.3 SPECY+0.3 SPECZ)]
- 1.2[DL+LL+(SPECY+0.3 SPECX+0.3 SPECZ)]
- 1.5[DL+(SPECX+0.3 SPECY+0.3 SPECZ)]
- 1.5[DL+(SPECY+0.3 SPECX+0.3 SPECZ)]
- 0.9DL+1.5(SPECX+0.3 SPECY+0.3 SPECZ)]
- 0.9DL+1.5(SPECY+0.3 SPECX+0.3 SPECZ)]

The various loads are combined in accordance with the stipulations in IS: 875 (Part 5)-1987; whichever combination produces the most unfavorable effect in the building foundation or structural member concerned may be adopted.

*This value is to be considered when stability against overturning and stress reversal is critical where DL/LL/WL/EL denotes,DL - Dead Load; LL - Live Load; TL - Temperature Load; WL - Wind Load;EL - Earthquake Load , SPEC- Response spectrum Wind load and earthquake loads are considered for both x & y directions. Whenever imposed load is combined with earthquake load, the appropriate part of imposed load as specified in IS: 1893-2016 / Clause 7.3.3 of seismic code will be used both for evaluating earthquake effect and for combined load effects usedin such combination. Serviceability loads combinations with suitable live load reduction factor as per IS: 875(Part-2) will be used for foundation design.

1.7 DESIGN METHODOLOGY:

- All R.C.C structures shall be designed according to the Limit State Method as specified in IS: 456 – 2000.
- Forces and moments from the 3D analysis output for the worst combinations are used for the design of the structure.
- The foundations are designed for critical load combination.
- The structure is analyzed for specific loads like dead load, live load, wind and seismic loads and for the load combinations as given in the relevant codes.
- The slab is analyzed as two-way and one way slabs.
- Design of special members like retaining wall, water tanks will be done in accordance with the relevant IS Codes.

1.8 ACCEPTANCE CRITERIA:

1.8.1 Deflection Limits:

For Reinforced concrete works:

- Limiting values of deflection (Short and Long term) as per clause 35.3 of IS: 456-2000 is followed in the design.
- Limiting value for long term deflection is considered as span/250 and for the long term deflection after erection of partitions & finishes is considered as span/350 or 20mm whichever less as per IS 456 – 2000.

1.8.2 Cracking Limits:

- Limiting values of crack width as per clause 35.3 of IS: 456-2000 is followed in the design.In general for slabs and beams, the crack width is limited to 0.3mm.
- For water retaining structures, crack width is limited to 0.2mm.

1.8.3 Soil data:

Foundations are designed based on Geo Technical investigation report and will dissipate all the vertical and horizontal loads safely to the soil below. The soil investigation report recommends shallow foundation system.

1.9 DETAILING REQUIREMENTS:

RC walls, which are considered as lateral load resisting elements are detailed as ductile RC walls along with perimeter SMRFs (both columns and beams). Rest of the columns and beams are detailed as per normal detailing requirement. Detailing for all structural members shall be in accordance with IS: 456 & SP: 34.

On behalf of CMDA M&B panel, the structural design Calculations are generally reviewed.

Superintending Engineer, P.W.D.,
Planning and Designs Circle,
Chepauk, Chennai-5.

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 + Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3]	Z=0.16
Response Reduction Factor, R [IS Table 9]	R=5
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]

$$\frac{Sa}{g} = \frac{1.36}{T} \qquad \frac{Sa}{g} = 0.6236$$

Equivalent Lateral Forces

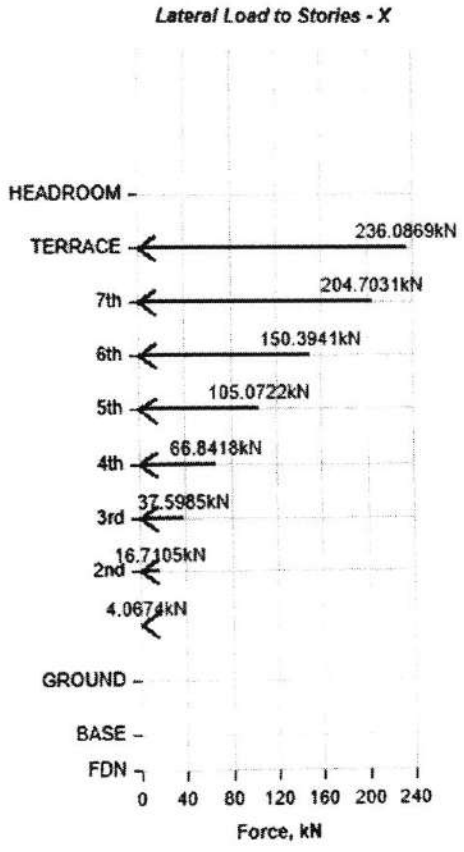
Seismic Coefficient, A_h [IS 6.4.2]

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

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X + Ecc. Y	2.117	66606.1409	821.4746

Applied Story Forces



Story	Elevation	X-Dir
	m	kN
HEADROOM	32	0
TERRACE	29	236.0869
7th	26	204.7031
6th	23	150.3941
5th	20	105.0722
4th	17	66.8418
3rd	14	37.5985
2nd	11	16.7105
1st	8	4.0674
GROUND	5	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 + Eccentricity X
Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3]	Z=0.16
Response Reduction Factor, R [IS Table 9]	R=5
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]

$$\frac{Sa}{g} = \frac{1.36}{T} \qquad \frac{Sa}{g} = 0.51146$$

Equivalent Lateral Forces

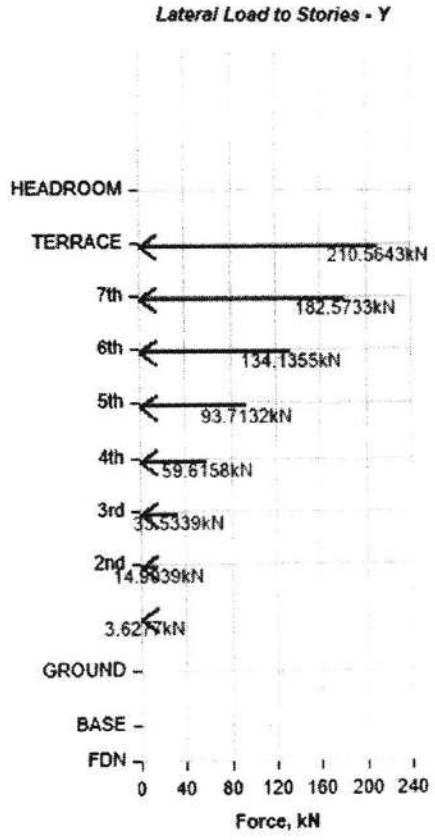
Seismic Coefficient, A_h [IS 6.4.2]

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

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y + Ecc. X	1.955	66606.1409	732.6675

Applied Story Forces



Story	Elevation	Y-Dir
	m	kN
HEADROOM	32	0
TERRACE	29	210.5643
7th	26	182.5733
6th	23	134.1355
5th	20	93.7132
4th	17	59.6158
3rd	14	33.5339
2nd	11	14.9039
1st	8	3.6277
GROUND	5	0

MODAL PARTICIPATING MASS RATIOS

Case	Mode	Period	UX	UY	UZ	Sum UX	Sum UY	Sum UZ	RX	RY	RZ	Sum RX	Sum RY	Sum RZ
		sec												
Modal	1	2.117	0.6586	0.014	0.00003	0.6586	0.014	0.00003	0.0022	0.1633	0.0487	0.0022	0.1633	0.0487
Modal	2	1.955	0.036	0.6099	0.00002	0.6946	0.6239	0.00001	0.1051	0.0087	0.0652	0.1073	0.1719	0.1139
Modal	3	1.629	0.0358	0.0785	0.00001	0.7304	0.7024	0.00001	0.0156	0.0084	0.5698	0.1229	0.1803	0.6837
Modal	4	0.617	0.1251	0.0003	0.0001	0.8555	0.7027	0.00001	0.0003	0.2681	0.009	0.1232	0.4484	0.6926
Modal	5	0.53	0.0027	0.1181	0.0002	0.8582	0.8208	0.00003	0.1094	0.0053	0.025	0.2326	0.4537	0.7176
Modal	6	0.475	0.0037	0.0339	0	0.862	0.8547	0.00003	0.0347	0.0084	0.115	0.2672	0.4621	0.8327
Modal	7	0.411	0.000007568	0.0002	0.0461	0.862	0.8549	0.0464	0.0638	0.0039	0	0.331	0.466	0.8327
Modal	8	0.409	0.000001984	0.00000223	0.0101	0.862	0.8549	0.0565	0.0107	0.0008	0	0.3417	0.4667	0.8327
Modal	9	0.409	0	0	0.0002	0.862	0.8549	0.0566	0.0002	0.00001322	0	0.3419	0.4668	0.8327
Modal	10	0.408	0.000001676	0.00001966	0.0005	0.862	0.8549	0.0571	0.0003	0.00002233	0	0.3422	0.4668	0.8327
Modal	11	0.408	0.000003159	0.00000764	0.0002	0.862	0.8549	0.0573	0.0001	0.00000793	0	0.3423	0.4668	0.8327
Modal	12	0.408	0.00001662	0.0001	0.0008	0.862	0.8551	0.0581	0.0004	0.00001527	0	0.3428	0.4668	0.8327
Modal	13	0.408	0.00001334	0.00004563	0.0002	0.862	0.8551	0.0582	0	0.00000478	0	0.3428	0.4668	0.8327
Modal	14	0.408	0.00003882	0.0003	0.001	0.8621	0.8554	0.0591	0.0003	0.00000073	0	0.3431	0.4668	0.8327
Modal	15	0.374	0.0002	0.00000344	0.0253	0.8622	0.8554	0.0844	0.0048	0.0073	0.00000305	0.3479	0.4741	0.8327
Modal	16	0.354	0.00001225	0.00001552	0.0317	0.8623	0.8554	0.1162	0.0273	0.0074	6.297E-07	0.3752	0.4815	0.8327
Modal	17	0.351	0.0007	0.0001	0.0005	0.8629	0.8555	0.1166	0.0001	0.0002	0.00001995	0.3754	0.4817	0.8327
Modal	18	0.351	0.0001	0.00001614	0.0004	0.863	0.8556	0.1167	6.799E-07	0.0001	0.00000377	0.3754	0.4818	0.8327
Modal	19	0.351	0.00004318	0.00001688	0.0001	0.8631	0.8556	0.1168	0.00000384	0.00001099	0	0.3754	0.4818	0.8327
Modal	20	0.35	0.00001044	0	0.0001	0.863	0.8556	0.1168	0.00002473	0.00002436	9.225E-07	0.3754	0.4818	0.8327
Modal	21	0.35	0.00002808	0.00002	0.0001	0.8631	0.8556	0.1169	0.00004166	7.571E-07	0	0.3754	0.4818	0.8327
Modal	22	0.345	0.00003149	0.0002	0.0113	0.8632	0.8558	0.1282	0.0032	0.0022	0.0001	0.3786	0.4848	0.8328
Modal	23	0.335	0.0001	0.00000713	0.0034	0.8632	0.8558	0.1316	0.0023	0.001	0.00000517	0.3809	0.4851	0.8328
Modal	24	0.328	0.0006	0.00000158	0.0835	0.8638	0.8558	0.2151	0.0009	0.009	0.0001	0.3818	0.4944	0.8328
Modal	25	0.325	0.0094	0.0001	0.0002	0.8733	0.856	0.2151	0.0001	0.0103	0.0001	0.3819	0.5043	0.833
Modal	26	0.324	0.0001	0.00003162	0.0002	0.8734	0.856	0.2152	0.0001	0.00004466	0.00001915	0.382	0.5043	0.833
Modal	27	0.324	0.00001916	0.00000236	0.0001	0.8734	0.856	0.2154	0.00001542	0.0001	0.00000830	0.382	0.5044	0.833
Modal	28	0.324	0.0001	0.00001673	0.0001	0.8735	0.856	0.2155	0.00000350	0.0001	0.00001053	0.382	0.5045	0.833
Modal	29	0.323	0.00001109	0.00000356	0.0003	0.8735	0.856	0.2158	0.00000348	0.0001	0.00000958	0.382	0.5046	0.833
Modal	30	0.323	0.0001	0.00002743	0.0005	0.8736	0.856	0.2163	0.0000022	0.00001034	0.00004079	0.382	0.5046	0.8331
Modal	31	0.318	0.0013	0.00002073	0.007	0.8749	0.8561	0.2234	0.0007	0.0073	0.0003	0.3827	0.5119	0.8334
Modal	32	0.313	0.0526	0.0001	0.0003	0.9275	0.8561	0.2237	0.00002377	0.0588	0.0056	0.3828	0.5707	0.839

Modal	33	0.298	0.0001	0	0.0179	0.9276	0.8561	0.2416	0.0132	0.0005	0.00000979	0.3959	0.5712	0.839
Modal	34	0.282	0.0001	0.00000271	0.0067	0.9276	0.8561	0.2483	0.002	0.0007	0.00000318	0.398	0.5718	0.839
Modal	35	0.252	0.0017	0.0178	0.0001	0.9294	0.8739	0.2483	0.0126	0.0017	0.0576	0.4106	0.5735	0.8966
Modal	36	0.241	0.0003	0.0548	0.0001	0.9297	0.9288	0.2483	0.0416	0.0002	0.0269	0.4522	0.5737	0.9235

STORY DRIFT

Story	Output Case	Direction	Drift	Drift/	X	Y	Z
					m	m	m
TERRACE	EQ +X	X	0.000753	1/1328	11.65	34.25	29
7th	EQ +X	X	0.000926	1/1079	2.45	34.25	26
6th	EQ +X	X	0.001107	1/903	11.65	34.25	23
5th	EQ +X	X	0.001255	1/797	11.65	34.25	20
4th	EQ +X	X	0.001346	1/743	11.65	34.25	17
3rd	EQ +X	X	0.001366	1/732	11.65	34.25	14
2nd	EQ +X	X	0.001293	1/773	11.65	34.25	11
1st	EQ +X	X	0.001091	1/916	11.65	34.25	8
GROUND	EQ +X	X	0.000716	1/1398	2.45	34.25	5
TERRACE	EQ +Y	Y	0.000584	1/1711	0	0	29
7th	EQ +Y	Y	0.000659	1/1518	0	0	26
6th	EQ +Y	Y	0.000735	1/1361	0	0	23
5th	EQ +Y	Y	0.000792	1/1263	0	0	20
4th	EQ +Y	Y	0.000817	1/1224	0	0	17
3rd	EQ +Y	Y	0.0008	1/1249	0	0	14
2nd	EQ +Y	Y	0.000732	1/1366	0	0	11
1st	EQ +Y	Y	0.000596	1/1679	0	0	8
GROUND	EQ +Y	Y	0.000382	1/2621	0.35	11.4	5
TERRACE	RSA - X	X	0.000539	1/1856	11.65	34.25	29
7th	RSA - X	X	0.000619	1/1617	2.45	34.25	26
6th	RSA - X	X	0.000694	1/1440	11.65	34.25	23
5th	RSA - X	X	0.000764	1/1309	11.65	34.25	20
4th	RSA - X	X	0.000822	1/1216	11.65	34.25	17
3rd	RSA - X	X	0.000855	1/1170	11.65	34.25	14
2nd	RSA - X	X	0.000844	1/1185	11.65	34.25	11
1st	RSA - X	X	0.000754	1/1326	11.65	34.25	8
GROUND	RSA - X	X	0.00053	1/1886	2.45	34.25	5
TERRACE	RSA -Y	X	0.000221	1/4532	0	0	29
7th	RSA -Y	X	0.000258	1/3871	0	0	26
6th	RSA -Y	X	0.000292	1/3426	0	0	23
5th	RSA -Y	X	0.000316	1/3167	0	0	20
4th	RSA -Y	X	0.000333	1/3003	0	0	17
3rd	RSA -Y	X	0.000344	1/2903	0	0	14
2nd	RSA -Y	X	0.000341	1/2931	0	0	11
1st	RSA -Y	X	0.000301	1/3319	0	0	8
GROUND	RSA -Y	X	0.000221	1/4523	0.35	-2.3493	5

STORY MAX OVER AVG DISPLACEMENTS:

Story	Output Case	Case Type	Direction	Maximum	Average	Ratio
				mm	mm	
TERRACE	EQ +X	LinStatic	X	30.03	23.617	1.272
7th	EQ +X	LinStatic	X	27.771	21.886	1.269
6th	EQ +X	LinStatic	X	24.992	19.725	1.267
5th	EQ +X	LinStatic	X	21.67	17.122	1.266
4th	EQ +X	LinStatic	X	17.907	14.161	1.265
3rd	EQ +X	LinStatic	X	13.869	10.977	1.263
2nd	EQ +X	LinStatic	X	9.772	7.742	1.262
1st	EQ +X	LinStatic	X	5.893	4.676	1.26
GROUND	EQ +X	LinStatic	X	2.739	2.105	1.301
TERRACE	EQ +Y	LinStatic	Y	18.522	17.643	1.05
7th	EQ +Y	LinStatic	Y	16.772	15.982	1.049
6th	EQ +Y	LinStatic	Y	14.799	14.101	1.05
5th	EQ +Y	LinStatic	Y	12.599	12.002	1.05
4th	EQ +Y	LinStatic	Y	10.228	9.742	1.05
3rd	EQ +Y	LinStatic	Y	7.781	7.413	1.05
2nd	EQ +Y	LinStatic	Y	5.384	5.133	1.049
1st	EQ +Y	LinStatic	Y	3.192	3.047	1.048
GROUND	EQ +Y	LinStatic	Y	1.421	1.341	1.06
TERRACE	RSA - X	LinRespSpec	X	18.234	14.026	1.3
7th	RSA - X	LinRespSpec	X	16.922	13.042	1.298
6th	RSA - X	LinRespSpec	X	15.38	11.872	1.295
5th	RSA - X	LinRespSpec	X	13.566	10.486	1.294
4th	RSA - X	LinRespSpec	X	11.481	8.887	1.292
3rd	RSA - X	LinRespSpec	X	9.164	7.104	1.29
2nd	RSA - X	LinRespSpec	X	6.695	5.198	1.288
1st	RSA - X	LinRespSpec	X	4.21	3.276	1.285
GROUND	RSA - X	LinRespSpec	X	2.081	1.571	1.325
TERRACE	RSA -Y	LinRespSpec	Y	14.249	12.096	1.178
7th	RSA -Y	LinRespSpec	Y	12.982	10.986	1.182
6th	RSA -Y	LinRespSpec	Y	11.587	9.777	1.185
5th	RSA -Y	LinRespSpec	Y	10.044	8.456	1.188
4th	RSA -Y	LinRespSpec	Y	8.361	7.029	1.19
3rd	RSA -Y	LinRespSpec	Y	6.566	5.519	1.19
2nd	RSA -Y	LinRespSpec	Y	4.715	3.971	1.187
1st	RSA -Y	LinRespSpec	Y	2.911	2.463	1.182
GROUND	RSA -Y	LinRespSpec	Y	1.396	1.163	1.201

STORY STIFFNESS:

Story	Output Case	Case Type	Shear X	Drift X	Stiff X	Shear Y	Drift Y	Stiff Y
			kN	mm	kN/m	kN	mm	kN/m
TERRACE	EQ +X	LinStatic	243.1839	1.716	141711.328	0.0202	0.164	0
7th	EQ +X	LinStatic	454.7232	2.143	212164.933	0.13	0.192	0
6th	EQ +X	LinStatic	612.0844	2.583	236972.313	0.2438	0.223	0
5th	EQ +X	LinStatic	724.1651	2.938	246475.134	0.368	0.249	0
4th	EQ +X	LinStatic	797.7766	3.159	252534.196	0.4822	0.266	0
3rd	EQ +X	LinStatic	841.7484	3.21	262199.305	0.5915	0.271	0
2nd	EQ +X	LinStatic	864.1811	3.043	284027.191	0.6913	0.258	0
1st	EQ +X	LinStatic	872.899	2.58	338275.79	0.7659	0.214	0
GROUND	EQ +X	LinStatic	879.075	1.635	537814.978	0.7315	0.149	0
TERRACE	EQ +Y	LinStatic	0.0365	0.085	0	216.088	1.663	129930.179
7th	EQ +Y	LinStatic	0.0777	0.088	0	403.8732	1.883	214494.926
6th	EQ +Y	LinStatic	0.1164	0.099	0	543.207	2.101	258604.784
5th	EQ +Y	LinStatic	0.1499	0.108	0	642.0411	2.262	283871.695
4th	EQ +Y	LinStatic	0.1814	0.114	0	706.5157	2.331	303064.631
3rd	EQ +Y	LinStatic	0.2077	0.114	0	744.539	2.281	326457.814
2nd	EQ +Y	LinStatic	0.2275	0.104	0	763.3994	2.088	365604.543
1st	EQ +Y	LinStatic	0.2351	0.085	0	770.1691	1.698	453663.273
GROUND	EQ +Y	LinStatic	0.2243	0.057	0	774.1977	1.05	737618.755



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Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

STORY FORCES:

Story	Output Case	Case Type	P	VX	VY	T	MX	MY
TERRACE	EQ +X	LinStatic	0	-243.1839	-0.0202	4073.4224	-0.158	-733.3147
TERRACE	EQ +Y	LinStatic	0	0.0365	-216.088	-2228.5962	651.1695	0.1074
TERRACE	RSA - X	LinRespSpec	8.5691	238.2311	32.7974	4169.7962	157.9836	906.767
TERRACE	RSA -Y	LinRespSpec	8.3464	33.7317	266.9562	2836.621	977.7871	147.7494
7th	EQ +X	LinStatic	0	-454.7232	-0.13	7607.8195	0.232	-2097.4843
7th	EQ +Y	LinStatic	0	0.0777	-403.8732	-4161.8943	1862.7892	0.3405
7th	RSA - X	LinRespSpec	19.5879	338.0626	53.0196	5907.7355	374.0478	1917.2632
7th	RSA -Y	LinRespSpec	15.3066	55.9776	372.3934	3814.5343	2030.6005	334.4678
6th	EQ +X	LinStatic	0	-612.0844	-0.2438	10237.6073	0.9634	-3933.7374
6th	EQ +Y	LinStatic	0	0.1164	-543.207	-5594.3538	3492.4103	0.6898
6th	RSA - X	LinRespSpec	27.2768	383.7471	66.4949	6696.9122	590.9228	3009.4457
6th	RSA -Y	LinRespSpec	21.0155	69.608	411.8191	4165.501	3103.2951	551.6381
5th	EQ +X	LinStatic	0	-724.1651	-0.368	12121.2762	2.0675	-6106.2328
5th	EQ +Y	LinStatic	0	0.1499	-642.0411	-6601.2437	5418.5336	1.1393
5th	RSA - X	LinRespSpec	26.9669	429.0699	76.5294	7491.3328	773.1791	4117.4301
5th	RSA -Y	LinRespSpec	24.0381	78.2078	446.8502	4486.0706	4155.7506	777.0334
4th	EQ +X	LinStatic	0	-797.7766	-0.4822	13352.5758	3.5141	-8499.5625
4th	EQ +Y	LinStatic	0	0.1814	-706.5157	-7260.3328	7538.0808	1.6836
4th	RSA - X	LinRespSpec	21.6179	478.6629	85.6842	8382.1704	966.0307	5269.3028
4th	RSA -Y	LinRespSpec	24.5098	85.4982	490.16	4919.2561	5253.6864	1004.2778
3rd	EQ +X	LinStatic	0	-841.7484	-0.5915	14088.8172	5.2885	-11024.807
3rd	EQ +Y	LinStatic	0	0.2077	-744.539	-7646.5333	9771.6978	2.3067
3rd	RSA - X	LinRespSpec	20.6552	516.4047	95.0892	9069.8246	1212.8385	6491.7504
3rd	RSA -Y	LinRespSpec	23.1281	94.1011	532.1047	5343.6233	6450.3413	1235.9634
2nd	EQ +X	LinStatic	0	-864.1811	-0.6913	14465.16	7.3625	-13617.351
2nd	EQ +Y	LinStatic	0	0.2275	-763.3994	-7835.4545	12061.8959	2.9893
2nd	RSA - X	LinRespSpec	24.554	557.6183	104.5544	9771.6307	1496.817	7802.2697
2nd	RSA -Y	LinRespSpec	20.7006	104.5273	589.1988	5887.4341	7763.4232	1482.8169
1st	EQ +X	LinStatic	0	-872.899	-0.7659	14614.5091	9.6603	-16236.048
1st	EQ +Y	LinStatic	0	0.2351	-770.1691	-7901.2691	14372.4032	3.6945
1st	RSA - X	LinRespSpec	23.2006	616.9981	112.4162	10766.4124	1785.3699	9240.9071
1st	RSA -Y	LinRespSpec	17.1328	113.3401	665.6177	6645.0759	9240.2552	1755.1986
GROUND	EQ +X	LinStatic	0	-879.075	-0.7315	14731.9264	11.8548	-18873.271
GROUND	EQ +Y	LinStatic	0	0.2243	-774.1977	-7941.5745	16694.9962	4.3675
GROUND	RSA - X	LinRespSpec	17.6156	723.4956	120.8501	12835.3118	2093.4289	10883.7563
GROUND	RSA -Y	LinRespSpec	16.2586	121.0037	788.3233	8289.9366	10978.0534	2058.6203
TERRACE	EQ +X	LinStatic	0	-243.1839	-0.0202	4073.4224	-0.158	-733.3147
TERRACE	EQ +Y	LinStatic	0	0.0365	-216.088	-2228.5962	651.1695	0.1074
TERRACE	RSA - X	LinRespSpec	8.5691	238.2311	32.7974	4169.7962	157.9836	906.767
TERRACE	RSA -Y	LinRespSpec	8.3464	33.7317	266.9562	2836.621	977.7871	147.7494

ETABS Shear Wall Design

IS 456:2000 Pier Design (F1)

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
BASE	P7	18850	22000	800	200	0.5

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	1	500	500

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	18850	21600	18850	22400	800	200
Bottom	Leg 1	18850	21600	18850	22400	800	200

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

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	2835	0.0177	0.0025	101 1.5 DL+1.5 LL	2842.9548	56.8591	-65.4258	160000
Bottom	2706	0.0169	0.0025	101 1.5 DL+1.5 LL	2854.9513	-57.099	20.5806	160000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	109 -0.45 SL X+1.5 SL Z+1.5 DL	1621.9417	-24.5898	52.4006	121.4315	236.9097
Bottom	Leg 1	500	109 -0.45 SL X+1.5 SL Z+1.5 DL	1633.9382	79.7619	52.4006	121.0841	236.5624

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	200	104 0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	2409.8656	-35.5785	16.73	8
Top–Right	Leg 1	0	101 1.5 DL+1.5 LL	0	0	0	0
Bottom–Left	Leg 1	300	104 0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	2419.4628	-32.1126	16.63	8
Botttom–Right	Leg 1	200	104 0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	2419.4628	65.0415	18.17	8

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Column Section Design (F2)

Column Element Details (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)
GROUND	C9	355	C300X900	103 1.2 SL X+-0.36 SL Z+1.2 DL+1.2 LL	2300	3000

Column Element Details (Part 2 of 2)

LLRF	Type
0.6	Ductile Frame

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)
31622.78	40	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 % %
4033.8096	-209.9043	-46.8982	80.6762	139.5698	4297	1.59

Axial Force and Biaxial Moment Factors

	K Factor Unitless	Length mm	Initial Moment kN-m	Additional Moment kN-m	Minimum Moment kN-m
Major Bend(M3)	1	2300	-25.7884	0	139.5698
Minor Bend(M2)	1	2300	-11.3607	0	80.6762

Axial Compression Check for Seismic Design per IS 13920:2016 Section 7.1

Limit Compression Factor Unitless	Limit Compression Strength kN	Compression D/C Ratio Unitless	Status
0.4	4320	0.933752	OK

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}	136.9516	239.2186	100.8002	136.9516	332.53
Minor, V_{u3}	139.9362	219.7792	86.4007	139.9362	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	97.8226	384.9517	1707.6299	2700	0.225
Minor Shear, V_{u3}	0	99.9544	385.8265	664.0783	1050	0.581

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
0.289	0.958

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	43	6471.5356	2221.1359	4033.8096	0.573529

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	0.767	900	2.556	12	No	0
Minor Bending (M_2)	Yes	0.767	300	7.667	12	No	0

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Column Section Design (F3)

Column Element Details (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
TERRACE	C35	443	C300X900	113 -0.45 SL X+1.5 SL Z+0.9 DL	2300	3000	1

Column Element Details (Part 2 of 2)

Type
Ductile Frame

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)
31622.78	40	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	Design M_{u2}	Design M_{u3}	Minimum M_2	Minimum M_3	Rebar Area	Rebar %
kN	kN-m	kN-m	kN-m	kN-m	mm^2	%
164.0707	263.1786	-19.1431	3.2814	5.6768	6117	2.27

Axial Force and Biaxial Moment Factors

	K Factor	Length	Initial Moment	Additional Moment	Minimum Moment
	Unitless	mm	kN-m	kN-m	kN-m
Major Bend(M3)	0.946802	2300	13.9648	0	5.6768
Minor Bend(M2)	0.641935	2300	-9.9927	0	3.2814

Axial Compression Check for Seismic Design per IS 13920:2016 Section 7.1

Limit Compression Factor	Limit Compression Strength	Compression D/C Ratio	Status
Unitless	kN	Unitless	
0.4	4320	0.042568	OK

Shear Design for V_{u2} , V_{u3}

	Shear V_u	Shear V_c	Shear V_s	Shear V_p	Rebar A_{sv} /s
	kN	kN	kN	kN	mm^2/m
Major, V_{u2}	195.7203	192.6836	100.8002	195.7203	332.53
Minor, V_{u3}	175.4524	174.6228	86.4007	175.4524	997.59

Joint Shear Check/Design

	Joint Shear Force	Shear V_{Top}	Shear $V_{u,Tot}$	Shear V_c	Joint Area	Shear Ratio
	kN	kN	kN	kN	cm^2	Unitless
Major Shear, V_{u2}	0	0	337.589	1707.6299	2700	0.198
Minor Shear, V_{u3}	0	0	300.9386	664.0783	1050	0.453

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
0.308	0.943

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	61.2	7153.8917	2285.2455	164.0707	1

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	0.767	900	2.42	12	No	0
Minor Bending (M_2)	Yes	0.767	300	4.922	12	No	0

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Column Section Design (F4)

Column Element Details (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)
BASE	C31	541	C400X800	105 -0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	1300	2000

Column Element Details (Part 2 of 2)

LLRF	Type
0.5	Ductile Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
400	800	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	1	500	500

Design Code Parameters

ɣc	ɣs
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 % %
5408.5886	108.1718	3.3203	108.1718	158.2914	2560	0.8

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)	0.670891	1300	56.4301	0	158.2914
Minor Bend(M2)	0.652737	1300	1.2008	0	108.1718

Axial Compression Check for Seismic Design per IS 13920:2016 Section 7.1

Limit Compression Factor Unitless	Limit Compression Strength kN	Compression D/C Ratio Unitless	Status
0.4	5120	1.056365	O/S #61

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}	137.7156	284.3483	118.4003	137.7156	443.37
Minor, V_{u3}	55.0862	271.3887	108.8006	55.0862	886.75

Joint Shear Check/Design

	Joint Shear Force kN	Shear V_{Top} kN	Shear $V_{u,Tot}$ kN	Shear V_c kN	Joint Area cm²	Shear Ratio Unitless
Major Shear, V_{u2}	0	98.3683	296.7229	2023.8577	3200	0.147
Minor Shear, V_{u3}	0	39.3473	118.6892	1011.9289	1600	0.117

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
0.278	0.224

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
3200	51.9	7705.4353	2676.2918	5408.5886	0.456707

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	0.65	800	1.09	12	No	0
Minor Bending (M_2)	Yes	0.65	400	2.121	12	No	0

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design (FB13)

Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
5th	B9	840	B450X700	101 1.5 DL+1.5 LL	11350	11850	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
450	700	450	0	60	60

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
-908.4816	147.0618	496.3121	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-908.4816	221.0732	0	-1129.5548

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)	-1129.5548		4890	0	4890	1223
Bottom (-2 Axis)		0	2445	0	1116	2445

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
496.3121	233.7617	785.4367	180.5473	3400.8

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
147.0618	496.3121	350	600	3400.8

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Column Section Design (F5)

Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
BASE	C1	51	C1000x1000	116 1.5 DL+1.5 WL +X	0	2000	0.6	Ductile Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
1000	1000	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	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 % %
5680.8982	-204.1336	1070.6486	204.1336	204.1336	8000	0.8

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)	0.693692	1300	1010.4069	0	204.1336
Minor Bend(M2)	0.695225	1300	-20.5898	0	204.1336

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}	115.8495	631.7485	376.0008	82.6294	1108.43
Minor, V_{u3}	6.139	631.7485	376.0008	55.0862	1108.43

Joint Shear Check/Design

	Joint Shear Force kN	Shear V_{Top} kN	Shear $V_{u,Tot}$ kN	Shear V_c kN	Joint Area cm²	Shear Ratio Unitless
Major Shear, V_{u2}	N/N	N/N	N/N	N/N	N/N	N/N
Minor Shear, V_{u3}	N/N	N/N	N/N	N/N	N/N	N/N

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/N	N/N

Additional Moment Reduction Factor k (IS 39.7.1.1)

A_g cm²	A_{sc} cm²	P_{uz} kN	P_b kN	P_u kN	k Unitless
10000	80	21000	8709.1612	5680.8982	1

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	0.65	1000	0.902	12	No	0
Minor Bending (M_2)	Yes	0.65	1000	0.904	12	No	0

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Column Section Design (F6)

Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
GROUND	C4	86	C1000x1000	101 1.5 DL+1.5 LL	2200	3000	0.6	Ductile Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
1000	1000	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	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 % %
8839.1867	333.532	656.7313	333.532	333.532	8000	0.8

Axial Force and Biaxial Moment Factors

	K Factor Unitless	Length mm	Initial Moment kN-m	Additional Moment kN-m	Minimum Moment kN-m
Major Bend(M3)	1	2200	499.3285	0	333.532
Minor Bend(M2)	1	2200	-90.3473	0	333.532

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}	178.8668	664.5007	376.0008	509.4585	1108.43
Minor, V_{u3}	164.5243	664.5007	376.0008	534.3107	1108.43

Joint Shear Check/Design

	Joint Shear Force kN	Shear V_{Top} kN	Shear $V_{u,Tot}$ kN	Shear V_c kN	Joint Area cm²	Shear Ratio Unitless
Major Shear, V_{u2}	N/N	N/N	N/N	N/N	N/N	N/N
Minor Shear, V_{u3}	N/N	N/N	N/N	N/N	N/N	N/N

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/N	N/N

Additional Moment Reduction Factor k (IS 39.7.1.1)

A_g cm²	A_{sc} cm²	P_{uz} kN	P_b kN	P_u kN	k Unitless
10000	80	21000	8709.1612	8839.1867	0.989421

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	0.733	1000	2.2	12	No	0
Minor Bending (M_2)	Yes	0.733	1000	2.2	12	No	0

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Column Section Design (F7)

Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
BASE	C7	99	C1000x1000	101 1.5 DL+1.5 LL	0	2000	0.6	Ductile Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
1000	1000	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	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 % %
10049.2361	-361.1026	387.9624	361.1026	361.1026	8000	0.8

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)	0.69301	1300	359.1393	0	361.1026
Minor Bend(M2)	0.689626	1300	-184.1794	0	361.1026

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}	55.429	664.5007	376.0008	0	1108.43
Minor, V_{u3}	61.1949	664.5007	376.0008	110.1725	1108.43

Joint Shear Check/Design

	Joint Shear Force kN	Shear V_{Top} kN	Shear $V_{u,Tot}$ kN	Shear V_c kN	Joint Area cm²	Shear Ratio Unitless
Major Shear, V_{u2}	N/N	N/N	N/N	N/N	N/N	N/N
Minor Shear, V_{u3}	N/N	N/N	N/N	N/N	N/N	N/N

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/N	N/N

Additional Moment Reduction Factor k (IS 39.7.1.1)

A_g cm²	A_{sc} cm²	P_{uz} kN	P_b kN	P_u kN	k Unitless
10000	80	21000	8709.1612	10049.2361	0.89097

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	0.65	1000	0.901	12	No	0
Minor Bending (M_2)	Yes	0.65	1000	0.897	12	No	0

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Column Section Design (F8)

Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
BASE	C3	75	C1000x1000	101 1.5 DL+1.5 LL	650	2000	0.6	Ductile Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
1000	1000	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	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 % %
13064.8648	-469.4641	49.7867	469.4641	469.4641	8000	0.8

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)	0.687844	1300	77.7908	0	469.4641
Minor Bend(M2)	0.694332	1300	-168.3058	0	469.4641

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}	215.4161	664.5007	376.0008	137.7156	1108.43
Minor, V_{u3}	26.6963	664.5007	376.0008	55.0862	1108.43

Joint Shear Check/Design

	Joint Shear Force kN	Shear V_{Top} kN	Shear $V_{u,Tot}$ kN	Shear V_c kN	Joint Area cm²	Shear Ratio Unitless
Major Shear, V_{u2}	N/N	N/N	N/N	N/N	N/N	N/N
Minor Shear, V_{u3}	N/N	N/N	N/N	N/N	N/N	N/N

(1.4) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/N	N/N

Additional Moment Reduction Factor k (IS 39.7.1.1)

A_g cm²	A_{sc} cm²	P_{uz} kN	P_b kN	P_u kN	k Unitless
10000	80	21000	8709.1612	13064.8648	0.645614

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	0.65	1000	0.894	12	No	0
Minor Bending (M_2)	Yes	0.65	1000	0.903	12	No	0

ETABS Shear Wall Design

IS 456:2000 Pier Design (C1)

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
BASE	P6	15450	20100	800	200	0.5

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	1	500	500

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	15450	19700	15450	20500	800	200
Bottom	Leg 1	15450	19700	15450	20500	800	200

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

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	834	0.0052	0.0025	101 1.5 DL+1.5 LL	2248.0179	44.9604	52.943	160000
Bottom	1049	0.0066	0.0025	101 1.5 DL+1.5 LL	2260.0144	-45.2003	-87.0508	160000

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	105 -0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	1578.2589	60.636	-101.7985	74.0301	189.5084
Bottom	Leg 1	500	105 -0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	1587.856	5.376	-101.7985	80.7159	196.1942

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	200	108 0.45 SL X+1.5 SL Z+1.5 DL	1910.5986	-19.5856	12.86	8
Top–Right	Leg 1	200	104 0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	2018.5698	60.636	15.46	8
Bottom–Left	Leg 1	300	104 0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	2028.167	-144.6573	19.46	8
Botttom–Right	Leg 1	200	104 0.36 SL X+1.2 SL Z+1.2 DL+1.2 LL	2028.167	5.376	12.93	8

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design (FB15)

Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
5th	B5	834	B450X700	101 1.5 DL+1.5 LL	10500	11000	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
450	700	450	0	60	60

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
-524.2125	63.2123	234.4677	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-524.2125	95.0251	0	-619.2376

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)	-619.2376		2554	0	2554	818
Bottom (-2 Axis)		0	1277	0	0	1277

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
234.4677	182.5121	276.7106	113.0467	1198.11

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
63.2123	234.4677	350	600	1267.28

C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai - 600 020.

SOIL EXPLORATION AND FOUNDATION REPORT

FOR THE PROPOSED BUILDING

AT

PLOT NO. 48 (PART), 69 (PART) & 70 (PART)

OLD DOOR NO. 8 & 27, NEW DOOR NO. 27

GRAND SOUTHERN TRUNK ROAD, PALLAVARAM

CHENNAI-600 044, COMPRISED IN T.S. NO. 73, BLOCK NO. 21

WARD-E OF ZAMIN PALLAVARAM VILLAGE

PALLAVARAM TALUK, CHENGALPATTU DISTRICT

AND WITHIN THE LIMITS IF PALLAVARAM MUNICIPALITY

PROJECT NO. TJE/003100/2024

T.J.ENGINEERS

SOIL EXPLORATION AND FOUNDATION DESIGN DIVISION
T.J.HOUSE
NO.4, ANNA NAGAR, 1ST STREET,
VELACHERY, CHENNAI-42.
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tjengineers1998@gmail.com
Ph : 42 33 41 94.

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2.0 SCOPE OF WORK

3.0 LOCATION AND NUMBER OF BORE HOLES

4.0 GEO TECHNICAL INVESTIGATION

- 4-1. Field Investigation of Bore Holes
- 4.2. Grain Size Analysis
- 4-3. Laboratory Test for Bore Hole Sample

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EXPLORATION REPORT

PROJECT NO. TJE/003100/2024

1.INTRODUCTION:

M/S VIGNESH PROPERTEES has proposed to construct a Basement Floor + Ground Floor + Eight Floors Building at Plot No. 48 (Part), 69 (Part) & 70 (Part), Old Door No. 8 & 27, New Door No. 27, Grand Southern Trunk Road, Pallavaram, Chennai-600 044, Comprised in T.S. No. 73, Block No. 21, Ward-E of Zamin Pallavaram Village, Pallavaram Taluk, Chengalpattu District and within the Limits if Pallavaram Municipality. The work was entrusted to T.J. Engineers by the promoter. The location is shown in Fig No.1. The object of the soil exploration work done is to determine the soil properties of the proposed area and to arrive at a most suitable type of foundation system for the proposed structure.

2.0 SCOPE OF WORK

The Scope of Work includes the following

Boreholes

- Drilling of borehole at the proposed borehole locations as per the direction of the client.
- Collection of disturbed and undisturbed soil samples and carrying out the relevant laboratory test on soils.
- Conducting of standard penetration test (SPT) within the borehole at every 1.00m depth interval or as required.
- Collection of soil sample from bore hole.
- Preparation of geotechnical investigation Report.

3.0. LOCATION & NUMBER OF BORE HOLES

For this purpose two bore holes were bored up to maximum depth of 8.00m below existing ground level. The bore hole location is shown in Fig No.1 and bore log details are given in Fig No. 2&3. The bore hole was terminated in the Very Dense Sandy Gravel (Disintegrated Rock) layer.

4.0. GEOTECHNICAL INVESTIGATIONS

4.1. Filed Investigations of Boreholes

Rotary drilling boring technique was adopted for boring in this area. The Standard penetration tests were conducted at change of layers and at specified intervals, commencing the test at 1.00m below the existing ground level. The relative density of different soil layers obtained from the N-Values are given in the Fig No. 2&3. Disturbed and un disturbed samples were collected from all the layers for visual observation, classification tests and strength characteristics of the soil layers.

Standard Penetration Test (SPT)

Standard Penetration Tests were conducted using a split spoon sampler, as per relevant codal provision (IS: 2131 – 1981). The SPT is generally conducted in sandy and completely weathered rock strata till 45 cm penetration with number of blows recorded for every 15 cm penetration. The number of blows required for first 15 cm in neglected. The blows for last 30 cm penetration or refusal 'N' value of 100 whichever is earlier is taken as the 'N' value. In the clayey strata, when driving of sampling tube is not possible, SPT was conducted to know the consistency of the soil strata and to retrieve the disturbed soil sample. The soil samples obtained in the split spoon sampler are carefully packed in

polythene bags for testing in the laboratory. The SPT values obtained at every 1.00m interval are given in the bore logs.

4.2. Grain Size Analysis

Combined sieve and hydrometer analyses were conducted on the various samples collected. The results are given in Table-1. Based on the proportion of the different soil constituents, the soil is classified.

4.3. Laboratory Tests for Borehole samples

The following laboratory tests were conducted on collected Soil Samples.

I. Moisture Content as per IS: 2720 (Part 2)

II. Specific Gravity as per IS: 2720 (Part 2)

III. Sieve Analysis as per IS: 2720 (Part 4)

IV. Hydrometer Analysis as per IS: 2720 (Part 4)

V. Liquid Limit as per IS: 2720 (Part 5)

VI. Plastic Limit as per IS: 2720 (Part 5)

VII. Swelling Index as per IS: 2720 (Part 40)

5.0. BORE LOG DATA

The Summary of bore hole log data for BH-01 & BH-02 is given in Fig-2&3. Bore hole location is given in Fig.1.

6.0. LABORATORY TEST RESULTS

The laboratory test results of boreholes samples are presented in Table-1 and Table-2.

7.0. GROUND WATER TABLE

The ground water table was encountered at the **depth of 3.00m**, below the existing ground level at the time of soil exploration. It was noticed from the existing well at the site.

8.0. SUB SOIL PROFILE

From the visual identification from field test results, it is concluding that soil strata is not similar in BH-01 & BH-02 location.

In BH-01 Location the soil strata is made-up of four distinctive layers.

i. Filled Up Soil 0.00m to 0.80m

ii. Medium Dense to Very Dense Silty Clayey Gravelly Sand, 0.80m to 4.80m

SPT's N= 14-51

iii. Very Dense Silty Clayey Gravelly Sand, 4.80m to 7.00m

SPT's N= >100

iv. Very Dense Sandy Gravel, 7.00m to 8.00m SPT's N = >100

In BH-02 Location the soil strata is made-up of four distinctive layers.

i. Filled Up Soil 0.00m to 0.90m

ii. Medium Dense Clayey Silty Gravelly Sand, 0.90m to 1.80m

SPT's N= 14

iii. Very Dense Silty Clayey Gravelly Sandy, 1.80m to 5.50m

SPT's N= >100

iv. Very Dense Sandy Gravel, 5.50m to 8.00m SPT's N = >100

The soil profile details are presented in the Bore logs, Presented in Fig. 2&3.

9.0. FOUNDATION ANALYSIS

From the bore log data at the top from 0.00m to 0.90m Filled Up Soil layer is present. From 0.90m to 5.50m/7.00m medium dense to very dense Silty Clayey Gravelly Sand/Clayey Silty Gravelly Sand layer is present. Below 5.50m/7.00m very dense Sandy Gravel (Disintegrated Rock) layer is seen, this layer is fair to rest pile foundation for heavy loaded structure.

The layer up to 4.80m is the critical zone for open foundation system, with in the critical zone medium dense to very dense Sandy layer is present. For light loaded structure Open Foundation of **Isolated Footing** (or) **Continuous Strip Footing** (or) **Raft Foundation** can be adopted. The open foundation can be placed at the minimum depth of 2.00m below the existing ground level. The existing ground level was same as the road level at the time of soil investigation. The proposed structure has got Basement Floor + Ground Floor + Eight Floors, the Safe Bearing Capacity (SBC) at different depths have been worked out and given below.

For heavy loaded structure, if the SBC is not sufficient for the expected loading intensity, it is advisable to provide deep foundation of **Pile cum Raft foundation**. The pile foundation can be Bored Cast in situ pile. The pile foundation should be terminated at the minimum depth 8.00m. The pile should be anchored into the very dense Sandy Gravel layer for minimum of 1.00m depth.

9.1. COMPUTATION OF THE SAFE BEARING CAPACITY AT 2.00m DEPTH

Based on the standard penetration test value the ultimate bearing capacity (qu) could be calculated from the following formula.

$qu = \gamma\ Df\ Nq + 0.4\ \gamma'\ B\ N\gamma$

The observed N-Value is taken as 22 from Fig. 2&3.

The corresponding bearing capacity factors are,

$Nq = 21.25$

$N\gamma = 20.10$

Where,

γ = Bulk density = 1.50 t/m 3

γ' = Submerged density = 0.50 t/m 3

Df = Depth of footing = Considered minimum of 2.00 m.

Dw = Depth of water table = 3.00m

B = Breadth of the footing = Consider minimum of 1.00m.

Substitute all the above values in the formula,

Qu = 1.50 x 2.00 x 21.25 + 0.40 x 0.50 x 1.00 x 20.10

= 63.75 + 4.02

= 67.77 t/m ^{2}

Safe bearing capacity could be considered with a factor of safety of 2.5

Hence, safe bearing capacity q s = 67.77 / 2.50 = 27.108 t/m ^{2}. Say 27.00 t/m ^{2}.

Therefore, Safe Bearing Capacity of the soil at the depth of 2.00m is 27.00 t/m ^{2}

9.2. COMPUTATION OF THE SAFE BEARING CAPACITY AT 4.00m DEPTH

Based on the standard penetration test value the ultimate bearing capacity (qu) could be calculated from the following formula.

$qu = (\gamma' Df + (\gamma - \gamma') Dw) \; Nq + 0.4 \; \gamma' \; B \; N\gamma$

The observed N-Value is taken as 22 from Fig. 2&3.

The corresponding bearing capacity factors are,

$Nq = 21.25$

$N\gamma = 20.10$

Where,

γ = Bulk density = 1.50 t/m 3

γ' = Submerged density = 0.50 t/m 3

Df = Depth of footing = Considered minimum of 4.00 m.

Dw = Depth of water table = 3.00m

B = Breadth of the footing = Consider minimum of 1.00m.

Substitute all the above values in the formula,

Qu = (0.50 x 4.00 + (1.50- 0.50)3.00) 21.25 + 0.4 x 0.50 x 1.00 x 20.10

= 106.25 + 4.02

= 110.27 t/m ^{2}

Safe bearing capacity could be considered with a factor of safety of 2.5

Hence, safe bearing capacity q s = 110.27 / 2.50 = 44.108 t/m ^{2}.

Therefore, Safe Bearing Capacity of the soil at the depth of 4.00m is 44.00 t/m ^{2}

9.3. SETTLEMENT ANALYSIS FOR THE INTENSITY OF 44.00 t/m ^{2}

LAYER -1, SILTY CLAYEY GRAVELLY SAND

The Settlement of the Sand layer can be calculated using the following formula.

$$S_1 = (H/C)\text{Log}_e\ (\sigma'_0 + \Delta\sigma / \sigma'_0)$$

Where

H =The thickness of the compressible layer

= 2.80m

C $= 1.5q_c/ \sigma'_0$

q_c = Static cone resistance

$= 440t/m^2$

C = 1.5x440/4.70

= 140.425

σ'_0 =The original effective over burden pressure at the centre of the layer

$= 4.70\ t/m^2$

$\Delta\sigma$ = The stress increases at the centre of the layer due to foundation loads (or) pressure

$= 2.27\ t/m^2$

S_1 $= (2.80 /140.425) \times \text{Log}_e (4.70 +2.27/4.70)$

$= 0.0199x\ 10^{-3} \times 0.394$

$= 7.841 \times 10^{-3}m$

= 7.841mm

TOTAL SETTLEMENT

= 7.841mm < 50mm

The maximum allowable settlement as per IS: 1904-1986 for R.C.C structure with Isolated footing foundation is 50mm. **The settlement is within the permissible limit. Hence it is Safe.**

9.4. LOAD CARRYING CAPACITY OF THE CONVENTIONAL PILE

Based on the standard penetration test value the ultimate load carrying capacity (q_u) could be calculated from the following formula.

$$\mathbf{Qu = Qb + Qs}$$

Qs = Ultimate unit skin friction on an individual layer

$$= Ks\ \sigma'_{vo} \tan\delta\ \pi\ D\ L$$

Where

Ks = Co-efficient of horizontal soil stress = 0.471

σ'_{vo} = average effective overburden pressure = 3.375 t/m^2

δ = angle of wall friction = 32

D = Dia meter of pile = 0.40m

L = Length of individual layer = 0.50m

= 0.471 x 3.375 x 0.624 x 3.14 x 0.40 x 0.50

= 0.622 t

$q_b = Nq\sigma'_{vo}Ab$

where

Nq = Bearing Capacity Factor =145

σ'_{vo} = effective overburden pressure at the toe = 3.50 t/m^2

Ab = Cross sectional area at the base

D = Dia of Pile = 0.40m

= 145 x 3.50 x 3.14 x 0.40^2 /4

= 63.742 t

Qu = Qb + Qs

= 63.742 + 0.622 = 64.364 t

Q safe = Qu/F.S = 64.364/2.5 = 25.745 say 26.00 t

The safe load carrying capacity for five different diameter of piles for the **depth of 8.00m** are worked and are given below.

Dia of Pile	Depth of Pile	Safe Load (Tones)
400mm	**8.00m**	**26**
450mm	**8.00m**	**33**
500mm	**8.00m**	**40**
600mm	**8.00m**	**58**
750mm	**8.00m**	**90**

The above safe loads are provisional and shall be confirmed by conducting pile load test as per the guide line laid down in IS: 2911 (Part: IV).

10.0. CONCLUSIONS

1. Soil in the shallow depth is fair to adopt open foundation system for light loaded structure.
2. For light loaded structure open Foundation of **Isolated Footing** (or) **Continuous Strip Footing** (or) **Raft Foundation** can be adopted.
3. The open foundation can be placed at the minimum depth of 2.00m below the existing ground level. The existing ground level was same as the road level at the time of soil investigation.
4. The proposed structure has got Basement Floor + Ground Floor + Eight Floors, the Safe Bearing Capacity (SBC) at different depths have been worked out and given below.

Sl.No.	DEPTH (m)	SBC (t/m^2)
1.	**2.00**	**27.00**
2.	**3.00**	**39.00**
3.	**4.00**	**44.00**

5. The minimum width of footing should be maintained as 1.00m to avoid any punching shear failure and to achieve suggested SBC.
6. All the foundation should rest on 100 mm thick 1:4:8 concrete mat, over 100mm thick River Sand or M Sand layer.
7. The shallow foundation should rest on natural undisturbed stratum, proper shoring should be done for the earth work excavation.

8. **For heavy loaded structure,** if the SBC is not sufficient for the expected loading intensity it is advisable to provide deep foundation of **Pile cum Raft foundation**. The pile foundation can be Bored Cast in situ pile. The pile should be terminated at the minimum **depth of 8.00m (Including Anchorage depth)** below existing ground level.

9. The load carrying capacity for five different diameter of pile for the **minimum depth of 8.00m** are worked out and given below.

Dia of Pile	Depth of Pile	Safe Load (Tones)
400mm	**8.00m**	**26**
450mm	**8.00m**	**33**
500mm	**8.00m**	**40**
600mm	**8.00m**	**58**
750mm	**8.00m**	**90**

The above safe loads are provisional and shall be confirmed by conducting pile load test as per the guide line laid down in IS: 2911 (Part: IV)

10. The pile should be anchored into the very dense Sandy Gravel (Disintegrated Rock) layer for minimum of 0.50m depth.

11. Proper precaution should be taken while boring the pile against sliding of bore hole, by maintaining the proper dense bentonite slurry or providing temporary casing or permanent casing and pile concreting should be done as soon as boring is over.

12. The bore hole should be flushed properly before laying concrete. It has to be ensured by comparing the depth of pile bore hole and Tremie Pipe. The depth of Tremie Pipe lowered can be 300mm less than borehole depth. If the gap between bore hole bottom and Tremie Pipe bottom is more than 300mm, there is a possibility of slush deposit in the bore hole.
13. The pile boring should be done with **Percussion drilling or Hydraulic Rotary Drilling with DMC method.**
14. For foundation design, **Stress due to any eccentricity, stress due to horizontal force** should be considered, and **stability** should be checked.
15. All suggested foundation recommendations and precautions should be adopted while undertaking the design aspects and construction activities.

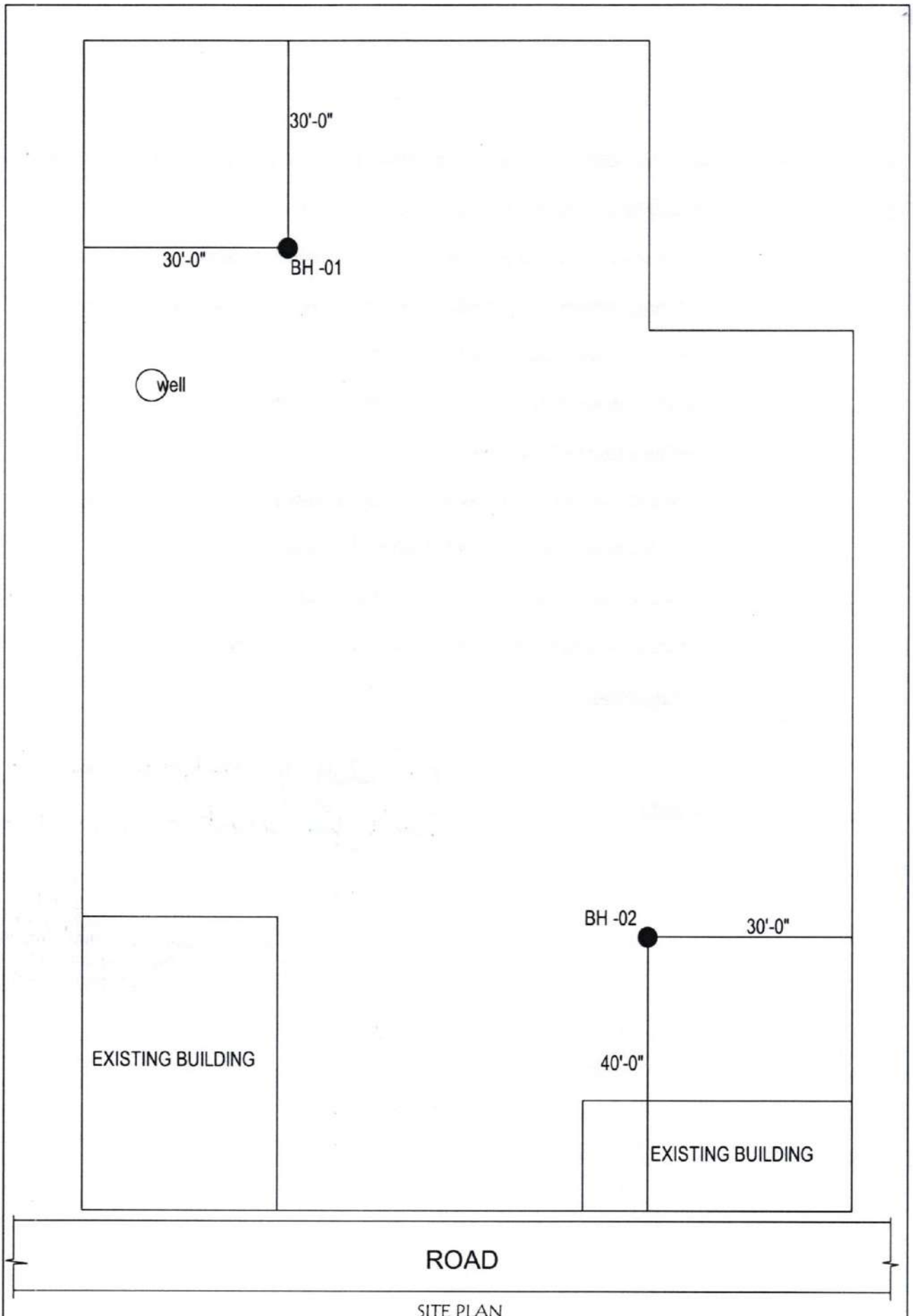
For T.J. Engineers

23– 01 - 2024

on behalf of amot, MSB Pond, the Geotechnical investigation report is generally received.

6.1.25

Superintending Engineer, P.W.D.,
Planning and Designs Circle,
Chepauk, Chennai-5.



SITE PLAN
FIG.1

NOT TO SCALE

CLIENT:-	PROJECT:-	
M/S VIGNESH PROPERTEES CHENNAI.	PROPOSED BUILDING AT PLOT NO. 48 (PART), 69 (PART) & 70 (PART), OLD DOOR NO. 8 & 27, NEW DOOR NO. 27, GRAND SOUTHERN TRUNK ROAD, PALLAVARAM, CHENNAI-600 044, COMPRISED IN T.S. NO. 73, BLOCK NO. 21, WARD-E OF ZAMIN PALLAVARAM VILLAGE, PALLAVARAM TALUK, CHENGALPATTU DISTRICT AND WITHIN THE LIMITS IF PALLAVARAM MUNICIPALITY.	T.J. ENGINEERS soil investigation and foundation design division T.J. HOUSE PLOT NO. 4, ANNA NAGAR, 1ST STREET, VELACHERY, CHENNAI-42. tjengineers@yahoo.com tjengineers1998@gmail.com OFF: 044-42334194

BORE LOG

PROJECT : Proposed Building at Plot No. 48 (Part), 69 (Part) & 70 (Part), Old Door No. 8 & 27, New Door No. 27, Grand Southern Trunk Road, Pallavaram, Chennai-600 044, Comprised in T.S. No. 73, Block No. 21, Ward-E of Zamin Pallavaram Village, Pallavaram Taluk, Chengalpattu District and within the Limits if Pallavaram Municipality.

BORE HOLE NO : B.H:01

TYPE OF BORING : Rotary Drilling

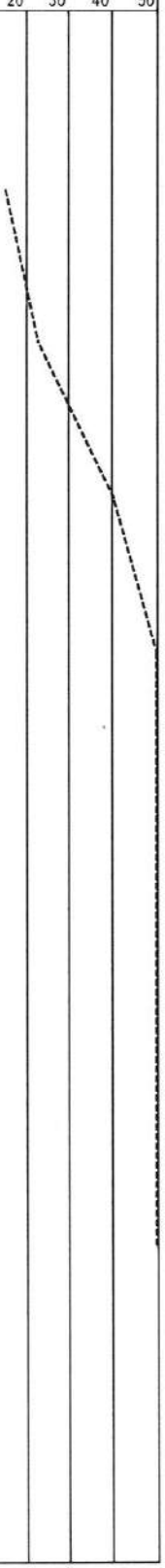
DATE OF COMMENCEMENT : 13 - 01 - 2024

DATE OF COMPLETION : 13 - 01 - 2024

G.W.L : 3.00m (Well)

Depth below G.L	Soil profile	Description of soil	Thickness of layer	Depth at witch samples are collected D.S	Depth at witch samples are collected U.D.S	Standard penetration testdata: Depth at witch test is conducted	Standard penetration testdata: N-Value	Standard penetration testdata: Relative density/ Consistency
0.00		Filled Up Soil	0.80	0.80				
1.00		Silty Clayey Gravelly Sand-SLCGS1 (Reddish Brown)	4.00			1.00	14	Medium Dense
2.00						2.00	22	Medium Dense
3.00						3.00	40	Dense
4.00				4.80		4.00	51	Very Dense
5.00		Silty Clayey Gravelly Sand-SLCGS2 (Gray Yellowish Brown)	2.20			5.00	>100	Very Dense
6.00						6.00	>100	Very Dense
7.00		Sandy Gravel-SG1 (Disintegrated Rock) (Grayish Brown)		7.00		7.00	>100	Very Dense
8.00						8.00	>100	Very Dense
9.00								
10.00								

Graphical representation of penetration resistance



Remark: All Dimensions in meters

→ End of Boring

FIG: 2

BORE LOG

PROJECT : **Proposed Building at Plot No. 48 (Part), 69 (Part) & 70 (Part), Old Door No. 8 & 27, New Door No. 27, Grand Southern Trunk Road, Pallavaram, Chennai-600 044, Comprised in T.S. No. 73, Block No. 21, Ward-E of Zamin Pallavaram Village, Pallavaram Taluk, Chengalpattu District and within the Limits if Pallavaram Municipality.**

BORE HOLE NO : **B.H:02**

TYPE OF BORING : **Rotary Drilling**

DATE OF COMMENCEMENT : **14 - 01 - 2024**

DATE OF COMPLETION : **14 - 01 - 2024**

G.W.L : **3.00m (Well)**

Depth below G.L	Soil profile	Description of soil	Thickness of layer	Depth at witch samples are collected D.S	Depth at witch samples are collected U.D.S	Standard penetration testdata: Depth at witch test is conducted	Standard penetration testdata: N-Value	Standard penetration testdata: Relative density/ Consistency	Graphical representation of penetration resistance (10 20 30 40 50)
0.00		**Filled Up Soil**	0.90						
				0.90					
1.00		**Clayey Silty Gravelly Sand-CSLGS1 (Reddish Brown)**	0.90			1.00	18	Medium Dense	
				1.80					
2.00						2.00	>100	Very Dense	
3.00		**Silty Clayey Gravelly Sand-SLCGS1 (Gray Yellowish Brown)**	3.70			3.00	>100	Very Dense	
4.00						4.00	>100	Very Dense	
5.00						5.00	>100	Very Dense	
				5.50					
6.00		**Sandy Gravel-SG1 (Disintegrated Rock) (Whtiish Yellowish Brown)**				6.00	>100	Very Dense	
7.00						7.00	>100	Very Dense	
8.00	→					8.00	>100	Very Dense	
9.00									
10.00									

Remark: All Dimensions in meters

→ End of Boring

FIG: 3

Project: Proposed Building at Plot No. 48 (Part), 69 (Part) & 70 (Part), Old Door No. 8 & 27, New Door No. 27, Grand Southern Trunk Road, Pallavaram, Chennai-600 044, Comprised in T.S. No. 73, Block No. 21, Ward-E of Zamin Pallavaram Village, Pallavaram Taluk, Chengalpattu District and within the Limits if Pallavaram Municipality.

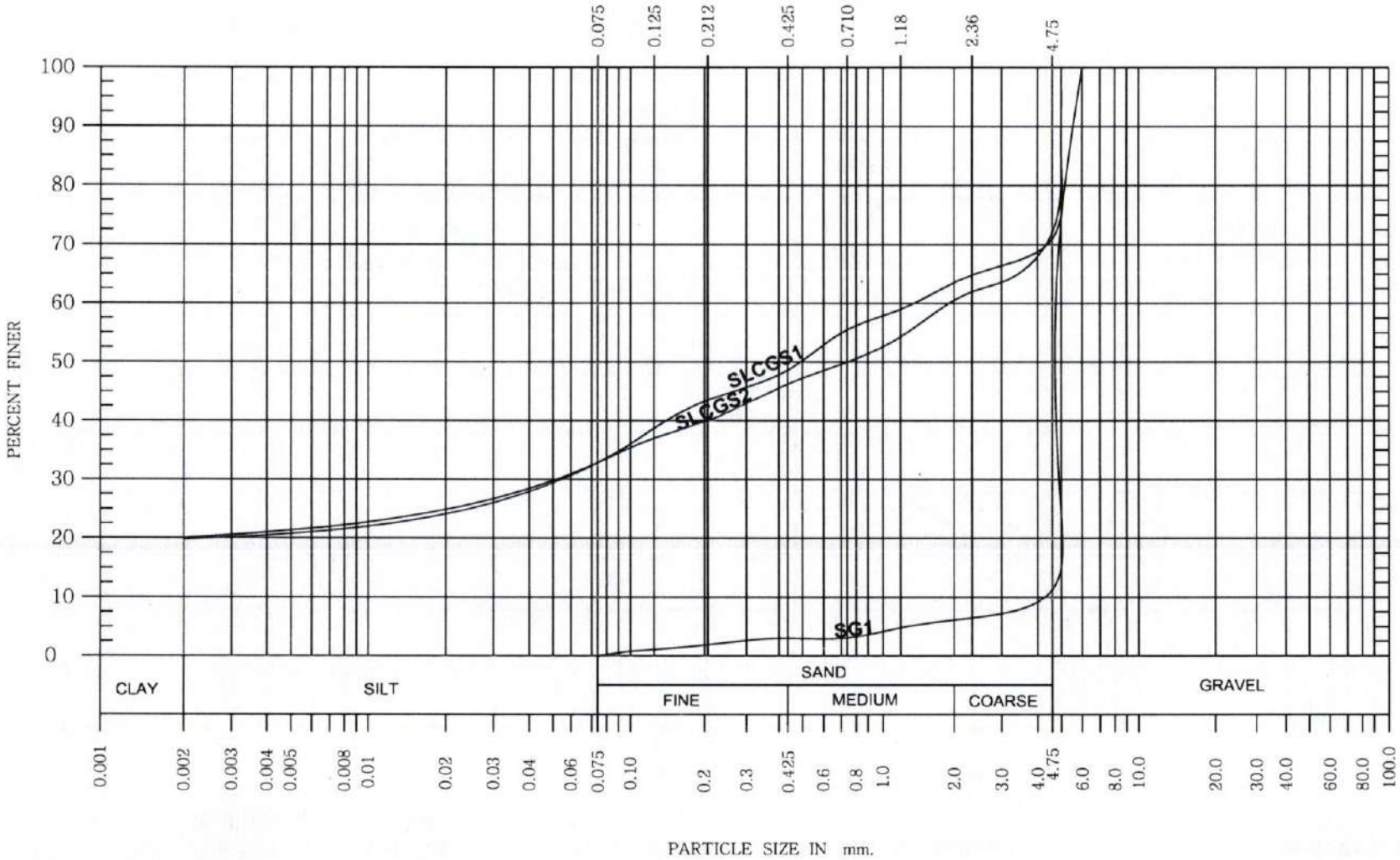


FIG. 4 GRAIN SIZE DISTRIBUTION CURVE-BH-01

Project: Proposed Building at Plot No. 48 (Part), 69 (Part) & 70 (Part), Old Door No. 8 & 27, New Door No. 27, Grand Southern Trunk Road, Pallavaram, Chennai-600 044, Comprised in T.S. No. 73, Block No. 21, Ward-E of Zamin Pallavaram Village, Pallavaram Taluk, Chengalpattu District and within the Limits if Pallavaram Municipality.

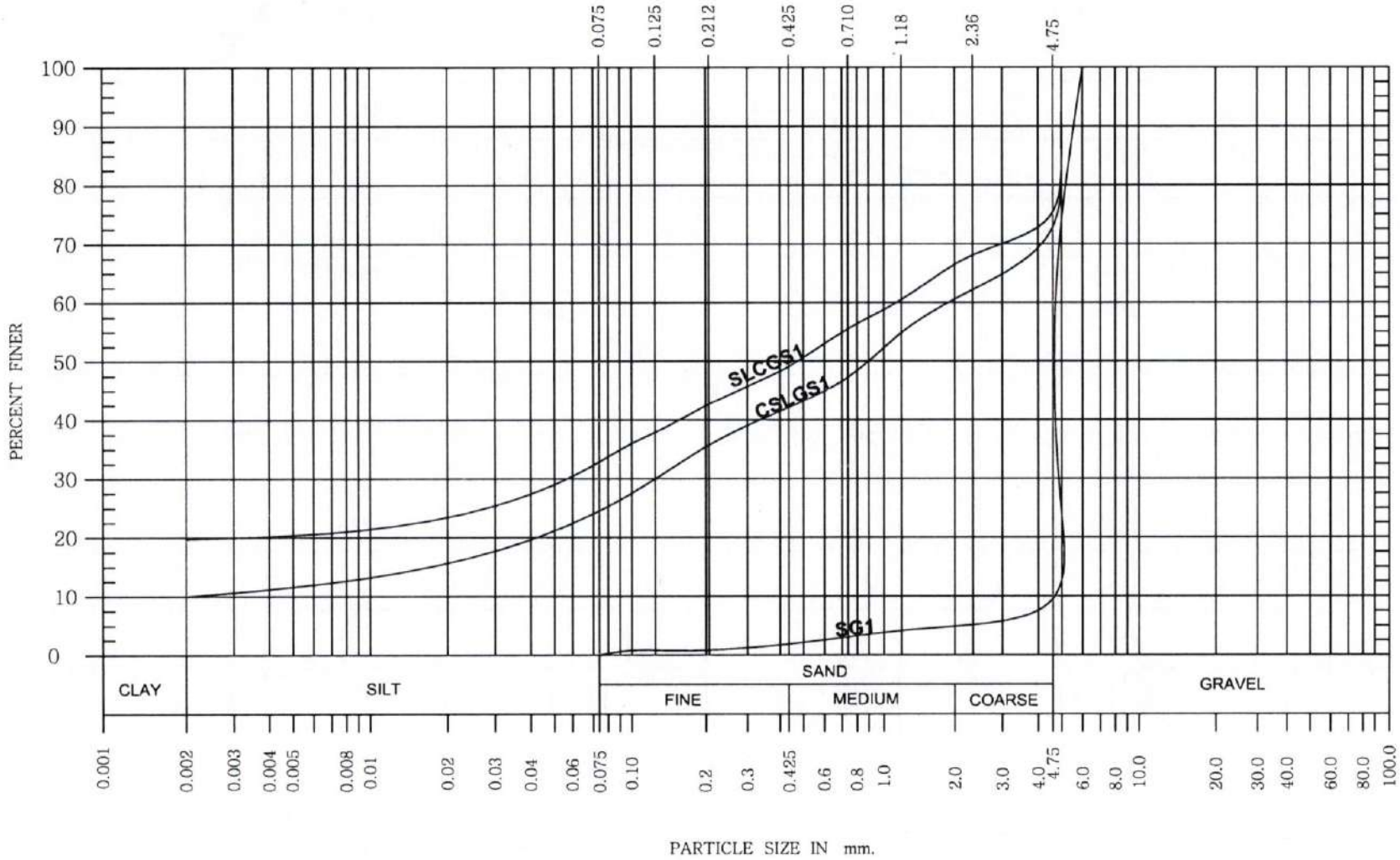


FIG. 5 GRAIN SIZE DISTRIBUTION CURVE-BH-02

LABORATARY TEST RESULTS

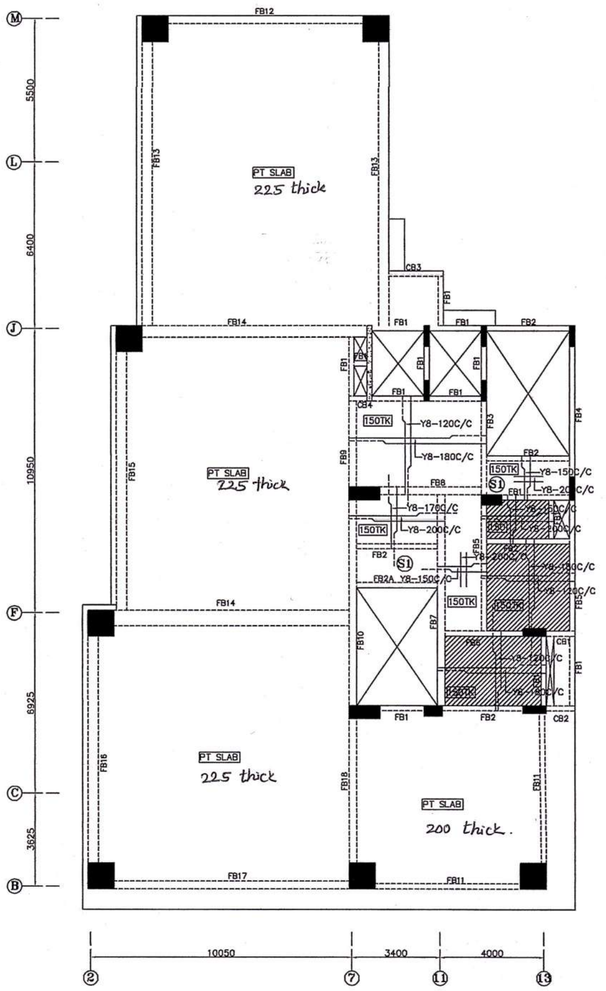
TABLE-1

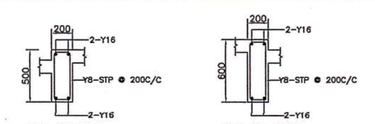
B.H No	Layer thickness	Soil classification	Depth of sample collected		SP. gravity	%of free swell	Grain size distribution				Remarks
			DS / SPT	UDS			Clay	Silt	Sand	Gravel	
	m		m	m		%	%	%	%	%	
1	0.00 - 0.80	Filled Up Soil	–	–	–	–	–	–	–	–	–
	0.80 - 4.80	Silty Clayey Gravelly Sand-SLCGS1	1.00	–	2.65	–	19	14	38	29	–
	4.80 - 7.00	Silty Clayey Gravelly Sand-SLCGS2	2.00	–	2.64	–	20	13	40	27	–
	7.00 - 8.00	Sandy Gravel-SG-1	8.00	–	2.63	–	0	0	12	88	–
2	0.00 - 0.90	Filled Up Soil	–	–	–	–	–	–	–	–	–
	0.90 - 1.80	Clayey Silty Gravelly Sand-CSLGS1	1.00	–	2.65	–	10	16	48	26	–
	1.80 - 5.50	Silty Clayey Gravelly Sand-SLCGS1	2.00	–	2.64	–	19	14	42	25	–
	5.50 - 8.00	Sandy Gravel-SG-1	8.00	–	2.63	–	0	0	9	91	–

LABORATARY TEST RESULTS

TABLE -2

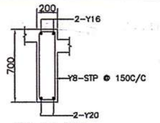
B.H No	Layer thickness	Soil classification	Depth of sample collected		LL	PL	Bulk density	Consolidation Parameters		Shear Strength Parmeters		Remarks
			DS / SPT	UDS				e_o	Cc	Cu	Ø	
	m		m	m	%	%	t/m^3			t/m^2	degree	
1	0.00 - 0.80	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	0.80 - 4.80	Silty Clayey Gravelly Sand-SLCGS1	1.00	–	–	–	1.50	–	–	–	32	–
	4.80 - 7.00	Silty Clayey Gravelly Sand-SLCGS2	2.00	–	–	–	1.58	–	–	–	38	–
	7.00 - 8.00	Sandy Gravel-SG-1	8.00	–	–	–	1.62	–	–	–	41	–
2	0.00 - 0.90	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	0.90 - 1.80	Clayey Silty Gravelly Sand-CSLGS1	1.00	–	–	–	1.52	–	–	–	33	–
	1.80 - 5.50	Silty Clayey Gravelly Sand-SLCGS1	2.00	–	–	–	1.58	–	–	–	39	–
	5.50 - 8.00	Sandy Gravel-SG-1	8.00	–	–	–	1.62	–	–	–	42	–



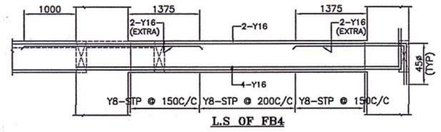


C.S OF FB1

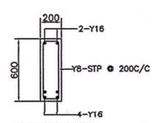
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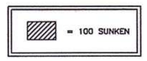
C.S OF FB3

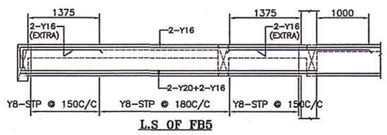


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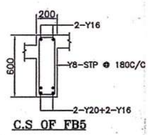


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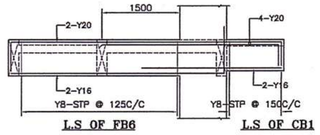




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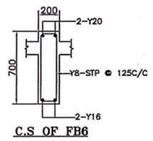


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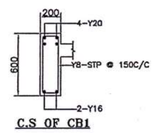


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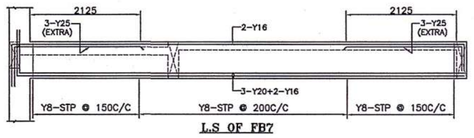
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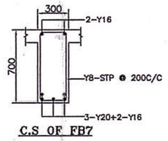
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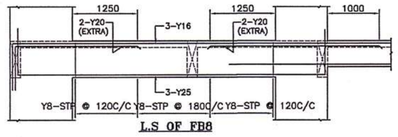
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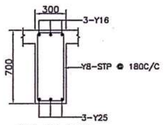
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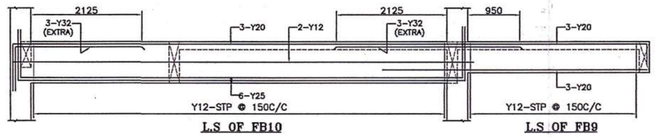
C.S OF FB7



L.S OF FB8

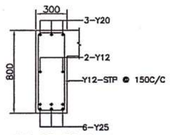


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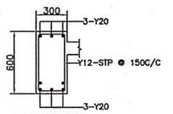


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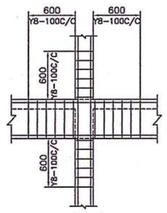
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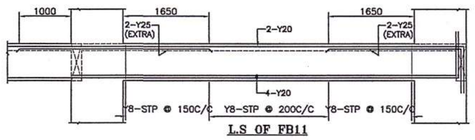
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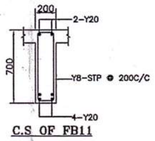
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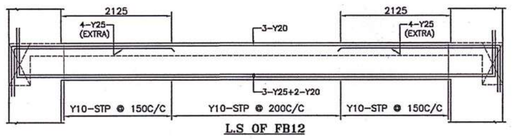
TYP. SEC. FOR STP. DETAILS



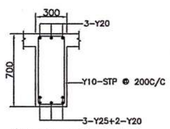
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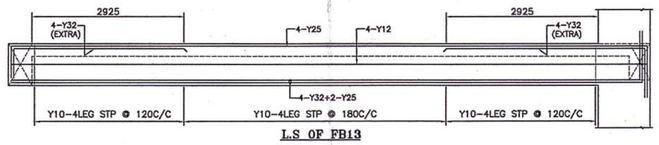
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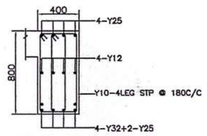
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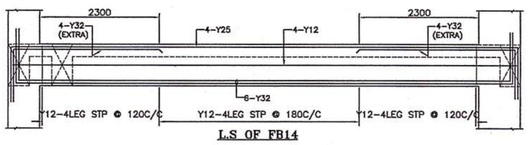
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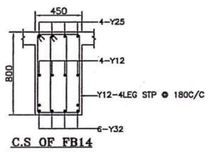
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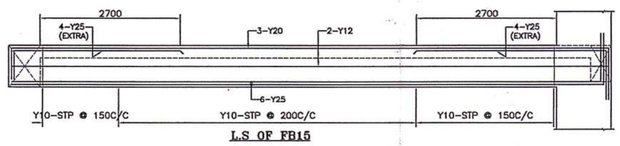
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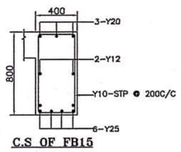
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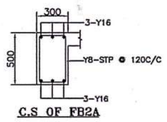
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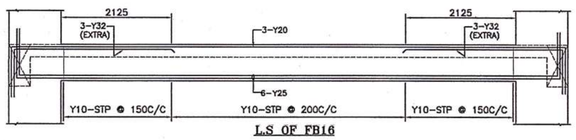
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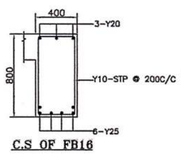
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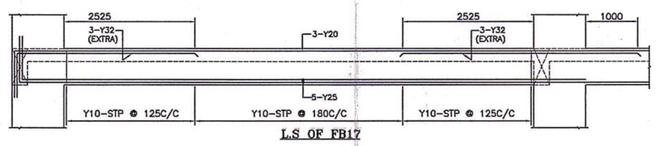
C.S OF FB2A



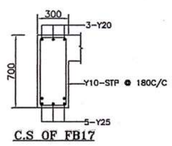
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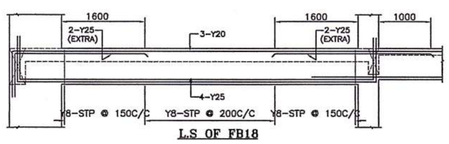
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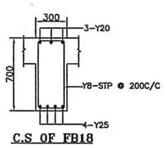
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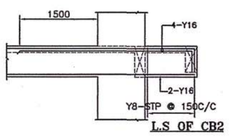
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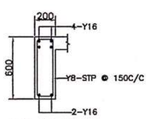
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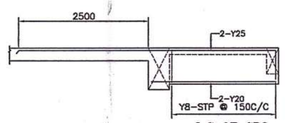
C.S OF FB18



L.S OF CB2



C.S OF CB2



L.S OF CB3

C.S OF CB3

L.S OF CB4

C.S OF CB4

Notes:–

1. This drawing should be read along with architectural drawings.
2. Grade of R.C.C. items shall be M40 for column & M35 for all other R.C.C works
3. Y Denotes TOR50 Steel confirming to I.S. 1786 – 2008. Grade – Fe 500
4. Clear cover to the main steel
   50 for Footings , Raft Slabs & Raft Beams.
   40 for Columns.
   25 for Lintel & Beams.
   20 for Sunshade & Slab.
5. Lap length shall be 50 d (Max. dia) for all bars.
6. ——— Bottom Reinforcement
7. ------ Top Reinforcement
8. Provide Continuous Chairs to keep the top Reinforcement in position
9. Provide Y 8 at 200 as Distribution steel for all top Reinforcement.
10. Spacer Bar to be Provided in Between Two Layers Of Reinforcement of Same Dia at Every 1000 C/ C.
11. Not more than 40% of Reinforcement shall be Lapped at any particular junction.
12. Cantilever props should not be released until the roof is concreted.
13. Foundation is designed for Basement plus Ground plus Seven upper floor only.
14. For Earthquake analysis Zone III is taken as per IS : 1893–2016 code.
15. Removal of formworks :
    i) For Slabs :
    a. Slabs spanning upto 4.5 m (15'–0") – 7 days
    b. Slabs spanning over 4.5 m (15'–0") – 14 days
    ii) For Beams and Arches :
    c. Beams and Arches spanning upto 6 m (20'–0") –14days
    d. Beams and Arches spanning over 6 m (20'–0") –21days

R.NO	DATE	DESCRIPTION

PROJECT

PLAN SHOWING THE PROPOSED CONSTRUCTION OF HIGH RISE BUILDING (HRB) WITH 29.95M HEIGHT CONSISTING OF EXTENDED BASEMENT FLOOR + GROUND FLOOR + 8 FLOORS – COMMERCIAL OFFICE BUILDING AT PLOT NO. 48 (PART), 69 (PART) & 70 (PART), OLD DOOR NO. 8 & 70 NEW DOOR NO: 27, GRAND SOUTHERN TRUNK ROAD, PALLAVARAM, CHENNAI–600 044 COMPRISED IN OLD S.NO. 508/64 (PART) & 66 (PART), T.S. NO. 73, BLOCK NO. 21, WARD–E OF ZAMIN PALLAVARAM VILLAGE, PALLAVARAM TALUK, CHENGALPET DISTRICT AND WITHIN THE LIMITS OF PALLAVARAM MUNICIPALITY.

TYPICAL FLOOR DETAILS

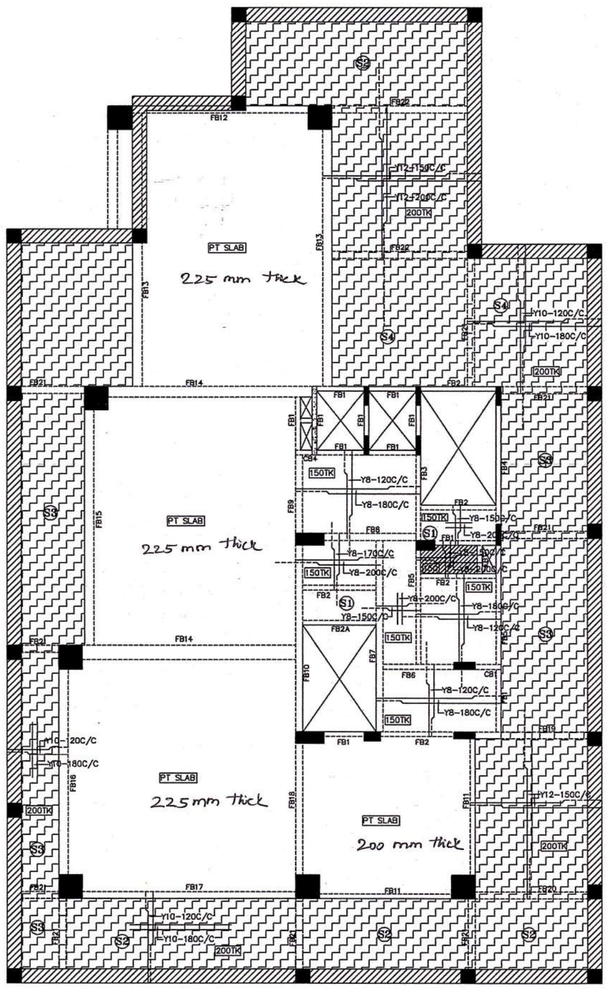
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DRAWN	BALAJI		DATE	16–12–2024

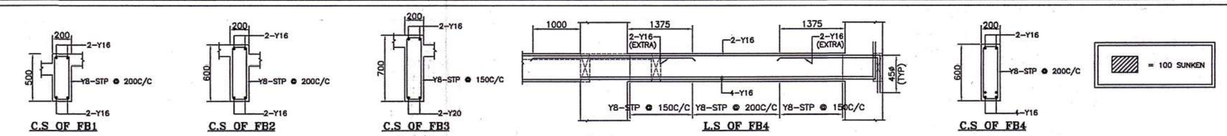
STRUCTURAL CONSULTANTS:

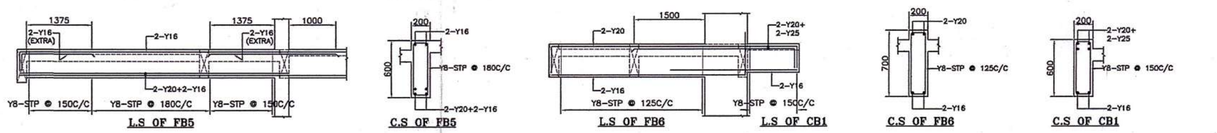
C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

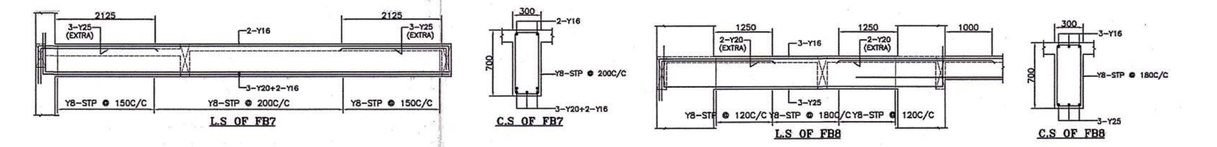
C.KANNAN B.E., M.E(STRUCTURE)
DOOR NO:21, PLOT NO:257–W,
FLAT NO:2B, "UTOPIA APARTMENTS",
2nd FLOOR, 4th MAIN ROAD,
INDIRA NAGAR, CHENNAI–20.
MOBILE NO: 098412 49815.
E–MAIL:kannankds2007@gmail.com

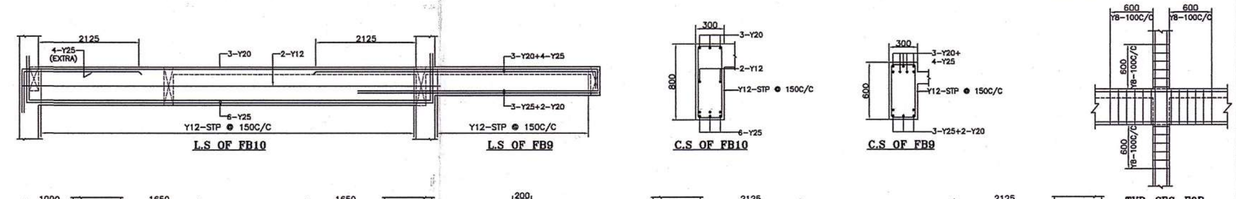
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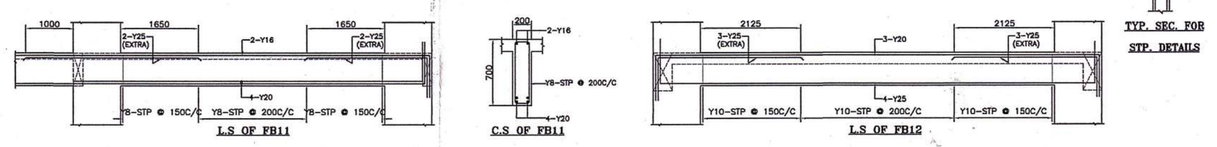


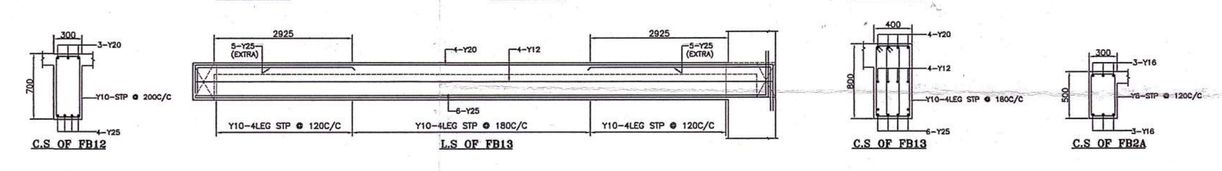


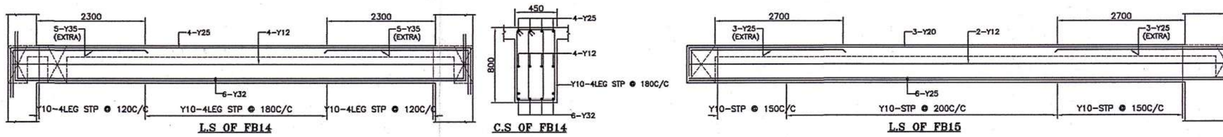


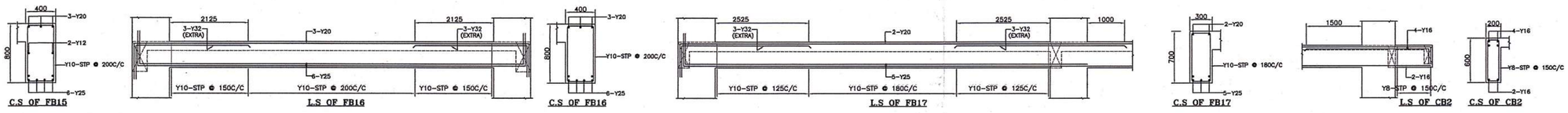


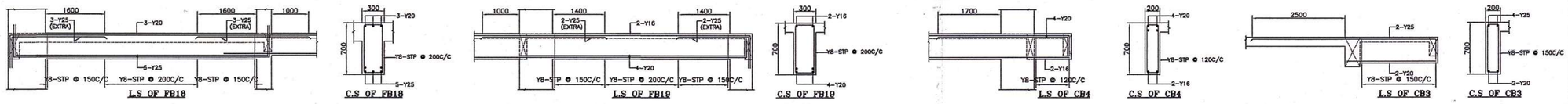


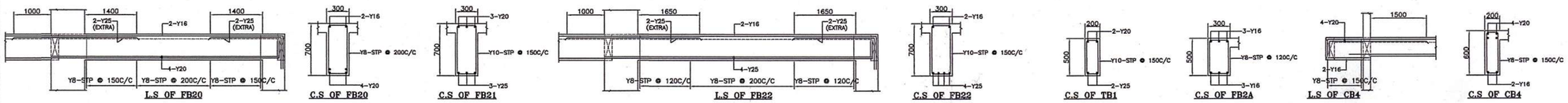












Notes:-

1. This drawing should be read along with architectural drawings.
2. Grade of R.C.C. items shall be M40 for column & M35 for all other R.C.C works
3. Y Denotes TOR50 Steel confirming to I.S. 1786 – 2008. Grade – Fe 500
4. Clear cover to the main steel
   - 50 for Footings , Raft Slabs & Raft Beams.
   - 40 for Columns.
   - 25 for Lintel & Beams.
   - 20 for Sunshade & Slab.
5. Lap length shall be 50 d (Max. dia) for all bars.
6. ——— Bottom Reinforcement
7. ------ Top Reinforcement
8. Provide Continuous Chairs to keep the top Reinforcement in position
9. Provide Y 8 at 200 as Distribution steel for all top Reinforcement.
10. Spacer Bar to be Provided in Between Two Layers Of Reinforcement of Same Dia at Every 1000 C/ C.
11. Not more than 40% of Reinforcement shall be Lapped at any particular junction.
12. Cantilever props should not be released until the roof is concreted.
13. Foundation is designed for Basement plus Ground plus Seven upper floor only.
14. For Earthquake analysis Zone III is taken as per IS : 1893–2016 code.
15. Removal of formworks :
    - i) For Slabs :
    - a. Slabs spanning upto 4.5 m (15'–0") – 7 days
    - b. Slabs spanning over 4.5 m (15'–0") – 14 days
    - ii) For Beams and Arches :
    - c. Beams and Arches spanning upto 6 m (20'–0") –14days
    - d. Beams and Arches spanning over 6 m (20'–0") –21days

R.NO	DATE	DESCRIPTION

PROJECT

PLAN SHOWING THE PROPOSED CONSTRUCTION OF HIGH RISE BUILDING (HRB) WITH 29.95M HEIGHT CONSISTING OF EXTENDED BASEMENT FLOOR + GROUND FLOOR + 8 FLOORS – COMMERCIAL OFFICE BUILDING AT PLOT NO. 48 (PART), 69 (PART) & 70 (PART), OLD DOOR NO. 8 & 70 NEW DOOR NO: 27, GRAND SOUTHERN TRUNK ROAD, PALLAVARAM, CHENNAI–600 044 COMPRISED IN OLD S.NO. 508/64 (PART) & 66 (PART), T.S. NO. 73, BLOCK NO. 21, WARD–E OF ZAMIN PALLAVARAM VILLAGE, PALLAVARAM TALUK, CHENGALPET DISTRICT AND WITHIN THE LIMITS OF PALLAVARAM MUNICIPALITY.

BASEMENT ROOF DETAILS

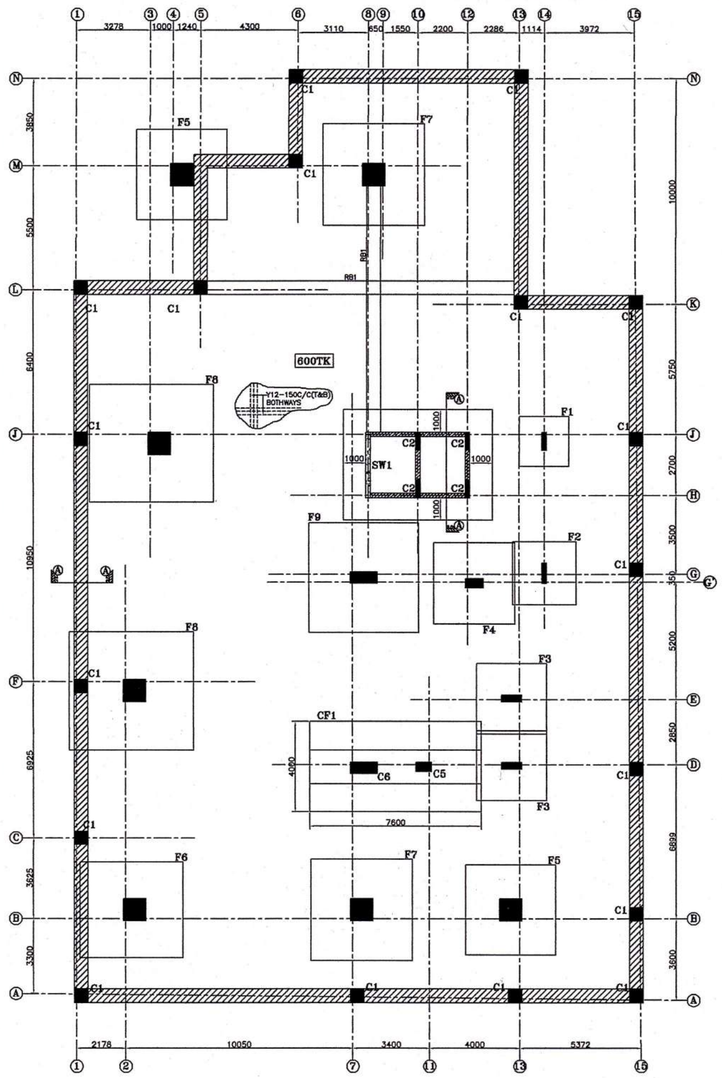
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DRAWN	BALAJI		DATE	16–12–2024

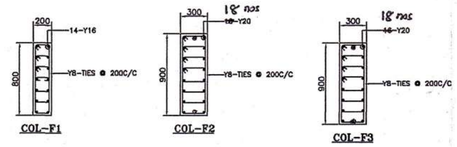
STRUCTURAL CONSULTANTS:

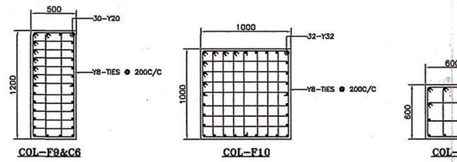
C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

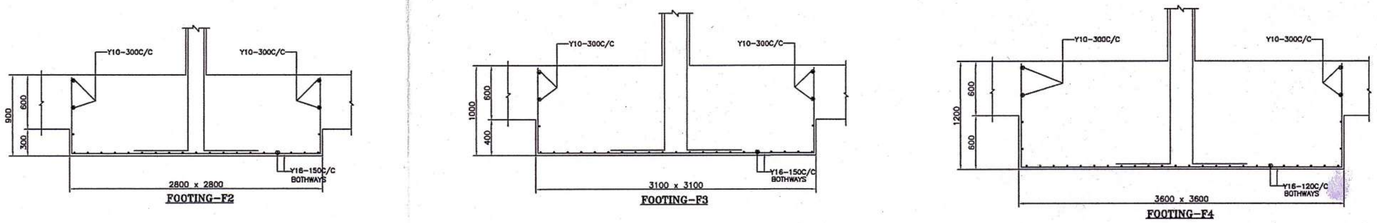
C.KANNAN B.E., M.E(STRUCTURE)
DOOR NO:21, PLOT NO:257–W,
FLAT NO:2B, "UTOPIA APARTMENTS",
2nd FLOOR, 4th MAIN ROAD,
INDIRA NAGAR, CHENNAI–20.
MOBILE NO: 098412 49815.
E–MAIL:kannankds2007@gmail.com

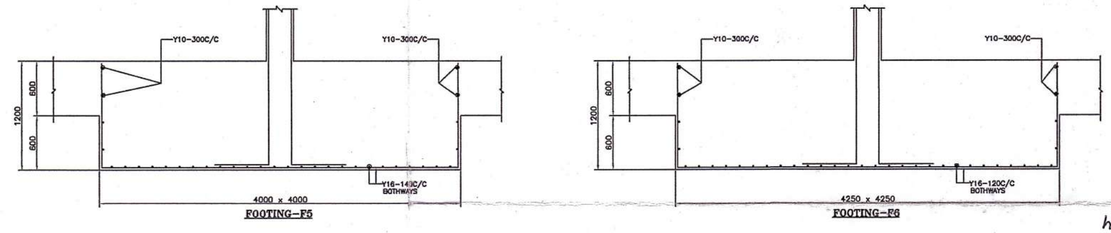
FILE NAME : D:\BALAJI\OTHERS\VIGNESH PROPERTIES



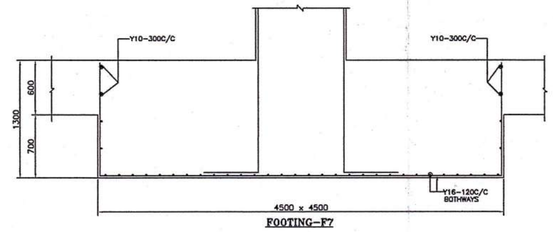


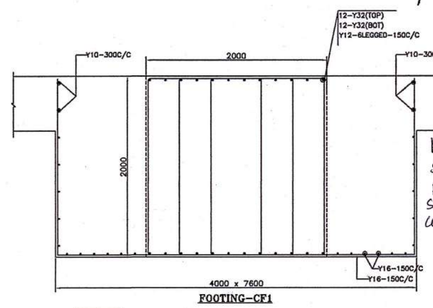




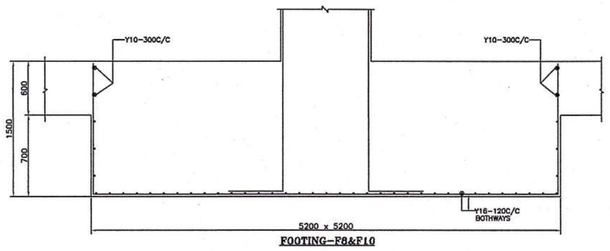


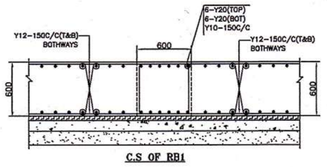
NOTE: Superstructure Design has been evolved by considering PT slabs having 225 mm thick as seen in superstructure beam/slab drawing. This has to be ensured during execution.

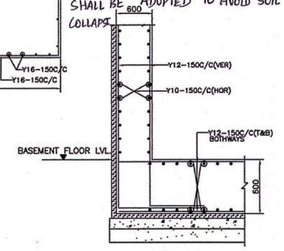


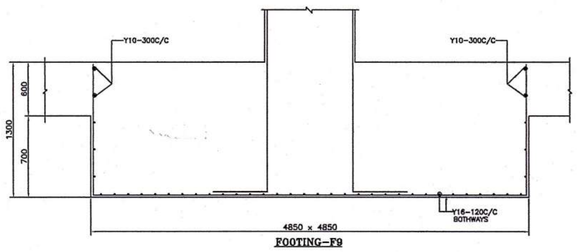


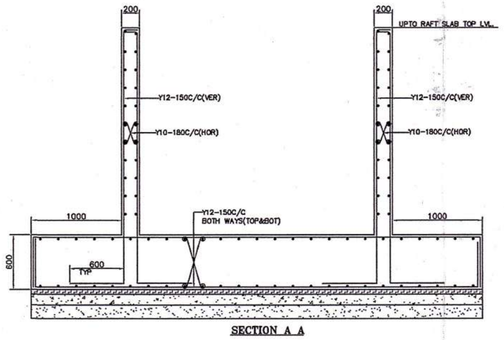
NOTE: DURING BASEMENT EXCAVATION & CONSTRUCTION PROPER PROTECTION MEASURES SUCH AS CONTINOUS PILE/SECANT PILES WALL WITH PROPER LOCKING SHALL BE ADOPTED TO AVOID SOIL COLLAPSE

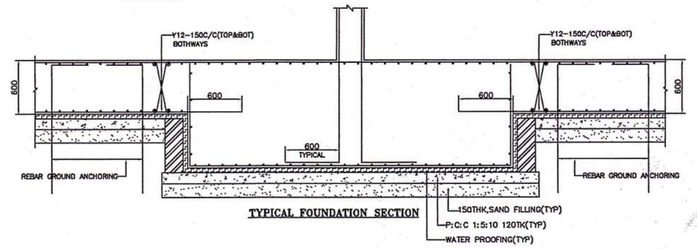












on behalf of CMDA MSB Panel, the structural drawings are reviewed & found generally in order. It is the responsibility of the site/structural engineer concerned to scrutinise the details and implement at site as per the detailed drawings and specifications

6/11/25

Superintending Engineer, P.W.D., Planning and Designs Circle, Chepauk, Chennai-5.

RMG	DATE	DESCRIPTION

Note:- SBC 200 kN/m²

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PROJECT

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FOUNDATION LAYOUT

DESIGNED	KANNAN		SCALE	1 : 100
DRAWN	CHITRA		DATE	16-12-2024

STRUCTURAL CONSULTANTS:

C.KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

C.KANNAN B.E., M.E.(STRUCTURE)
DOOR NO:21, PLOT NO:537-A,
FLAT NO:2B, "UTOPIA APARTMENTS",
2nd FLOOR, 4th MAIN ROAD,
INDIRA NAGAR, CHENNAI-20.
MOBILE NO: 098412 49815.
E-MAIL:kannanks2007@gmail.com

FILE NAME : D/CHITRA/2018-2020/

THE LANDLENS SUITE

Eight ways to know a piece of land before you pay for it.

This report covers one part of the picture. These cover the rest, drawn from the same government records, for any property in Tamil Nadu.

LandLens One
Ask anything about a property and get an answer grounded in live government records, with the sources shown.
/landlens/one

Verify My Land
Every record check run on one property and returned as a single report.
/landlens/verify-my-land

Legal Opinion
An advocate's written opinion on the title, built on the records we pull for it.
/landlens

One Map
Every layer on one map: the parcel, its boundary, zoning, water bodies and what sits around it.
/landlens/one/map

PriceMap
What land actually changed hands for around this plot, taken from the registered deeds.
/landlens/pricemap

Build Scope
What you are allowed to build here: floor space, height, coverage and setbacks.
/landlens/build-scope

Property Tracker
Watch a property and hear about it when something new is registered against it.
/landlens/property-tracker

Deal Room
Run the transaction in one place: documents, stamping, signatures and the parties.
/landlens/deal-room

FREE TOOLS · NO ACCOUNT NEEDED

Twenty-four checks you can run yourself, at no cost.

Records and verification

The registers themselves, read for you.

- Encumbrance Certificate
- Patta and Chitta
- Field Measurement Sketch
- EC Analyzer
- Bank charge check
- Court case search
- Seller background check
- Approval check by survey

Value and duty

What it is worth and what it costs to register.

- Guideline value by street
- Guideline value by survey
- Stamp duty and registration fees
- Capital gains
- Floor space index
- Area unit converter

Zoning and land use

What the plan says can happen on this land.

- Land use zone finder
- CMDA land use check
- Coastal regulation zone
- Master plan check
- Water bodies finder
- Airport height clearance

Registers and directories

Who holds it, and which office keeps the record.

- Find your registering office
- Temple property check
- Waqf property check
- RERA register

Every free tool
/tools

Services we run for you
/services

The LandLens suite
/landlens/one

Verified RealEstate™

Every claim in this document traces back to a government record.

- Legal opinions, due diligence and title verification
- Building plan, layout and sub-division approvals
- Completion and occupancy certificates, regularisation
- Escrow, negotiation and NRI property management
- Land survey, soil testing, architecture and construction

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OMR Thoraipakkam,
Chennai 600 097, India
hello@verified.realestate
+91 9996 12 9996

Prepared from the registers named on the page each finding sits on. Where a register could not be read, this document says so in its place rather than leaving the gap to be read as a clean result.