Verified RealEstate™

RE REGULATORY RECORD

# RERA Document

The document as the regulator published it, reproduced in full behind this page.

Published for reference. The authority's own register is the operative record.

Verified RealEstate™
3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai 600 097, India

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

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
Door No: 21, 4th Main Road,
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<br>RCC Slab<br>PT Slab | <br>Min. 150mm (Varies on span)<br>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

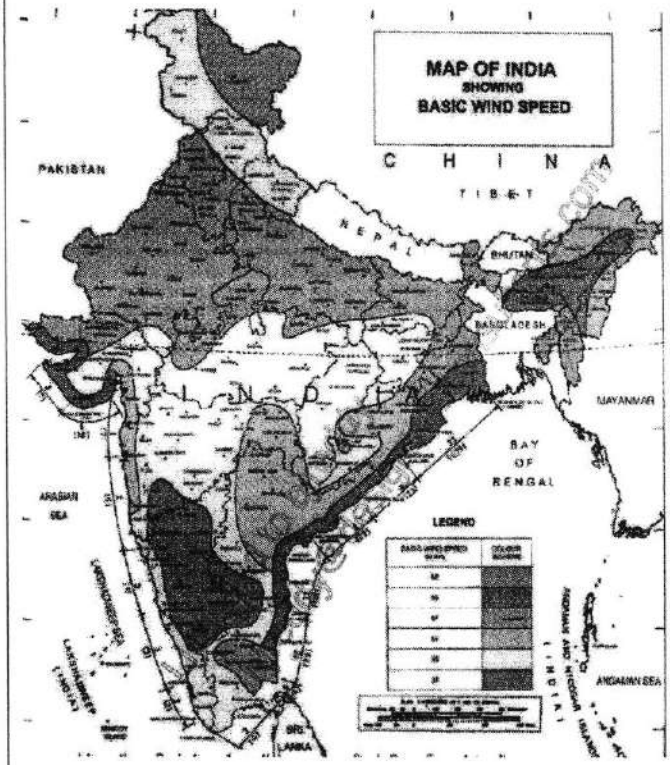
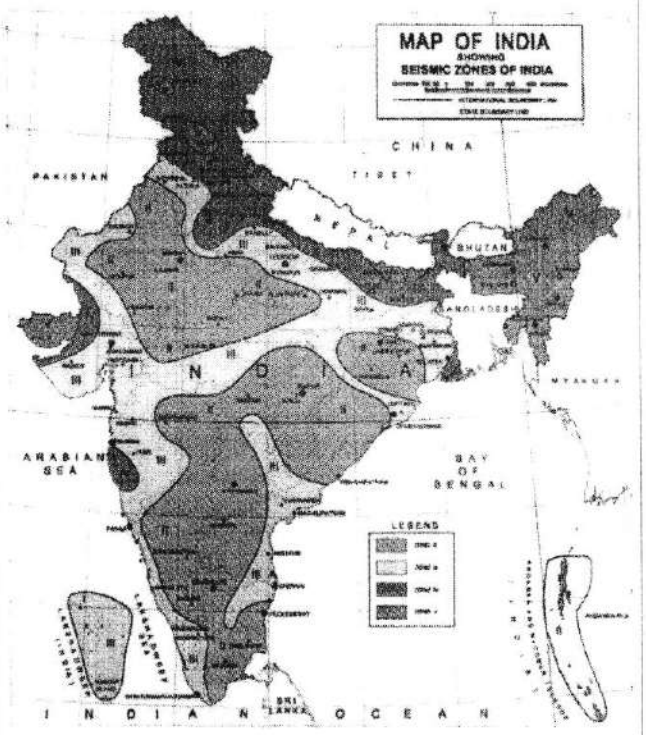
### Wind Loads

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**

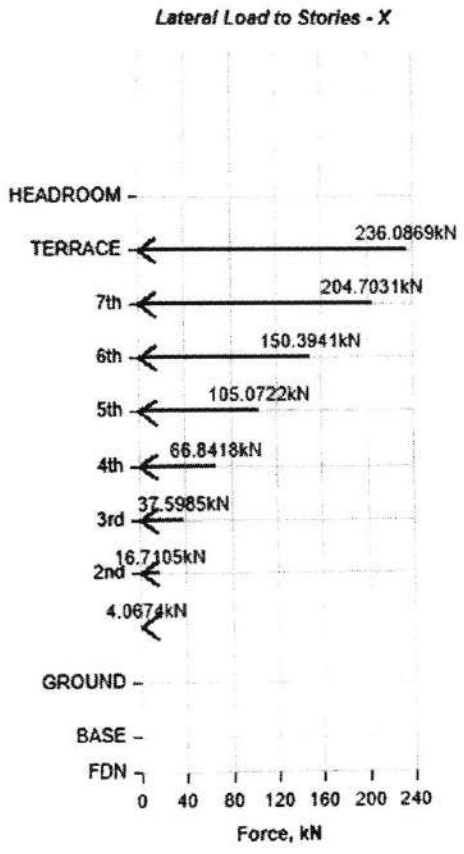
Seismic Coefficient, $A_h$ [IS 6.4.2]

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

**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**

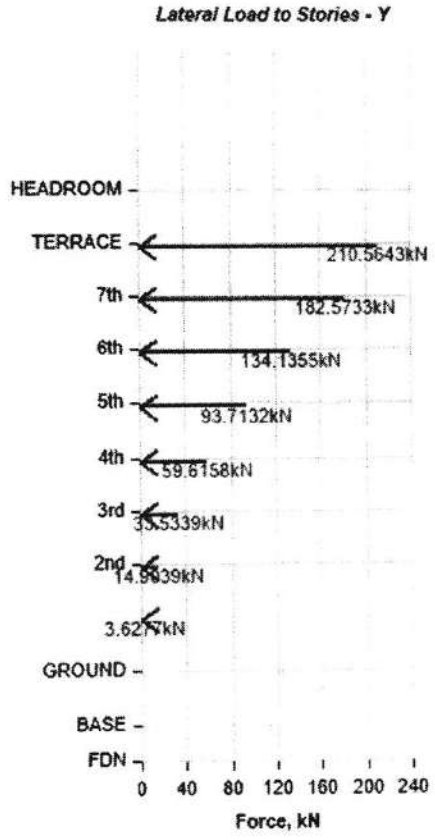
Seismic Coefficient, $A_h$ [IS 6.4.2]

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

**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 |



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.

**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**

| $\Gamma_S$ | $\Gamma_C$ | $IP_{MAX}$ | $IP_{MIN}$ | $P_{MAX}$ | 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**

| $\gamma_C$ | $\gamma_S$ |
|---|---|
| 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

| $\gamma_c$ | $\gamma_s$ |
|---|---|
| 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**

| $\gamma_C$ | $\gamma_S$ |
|---|---|
| 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**

| $\gamma_C$ | $\gamma_S$ |
|---|---|
| 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**

| $\gamma_C$ | $\gamma_S$ |
|---|---|
| 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**

| $\gamma_C$ | $\gamma_S$ |
|---|---|
| 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**

| $\gamma_C$ | $\gamma_S$ |
|---|---|
| 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**

| $\Gamma_S$ | $\Gamma_C$ | $IP_{MAX}$ | $IP_{MIN}$ | $P_{MAX}$ | 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

| $\gamma_C$ | $\gamma_S$ |
|---|---|
| 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.**
**tjengineers@yahoo.com**
**tjengineers1998@gmail.com**
**Ph : 42 33 41 94.**

# CONTENTS OF THE REPORT


1.0 INTRODUCTION

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

5.0 BORE HOLE DATA

6.0 LABORATORY TEST RESULTS

7.0 GROUND WATER TABLE

8.0 SUB SOIL PROFILE

9.0 FOUNDATION ANALYSIS AND DESIGN

- 9.1. Computation of the Safe Bearing Capacity at 2.00m depth
- 9.2. Computation of the Safe Bearing Capacity at 4.00m depth
- 9.3. Settlement Analysis
- 9.4. Load Carrying Capacity of pile

10.0 CONCLUSIONS

11.0 TABLES AND FIGURES

## 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,

$\gamma$ = Bulk density = 1.50 t/m 3

$\gamma'$ = 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,

$\gamma$ = Bulk density = 1.50 t/m 3

$\gamma'$ = 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

$\sigma'_0$ =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

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

$\delta$ = 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

$\sigma'_{vo}$ = 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.

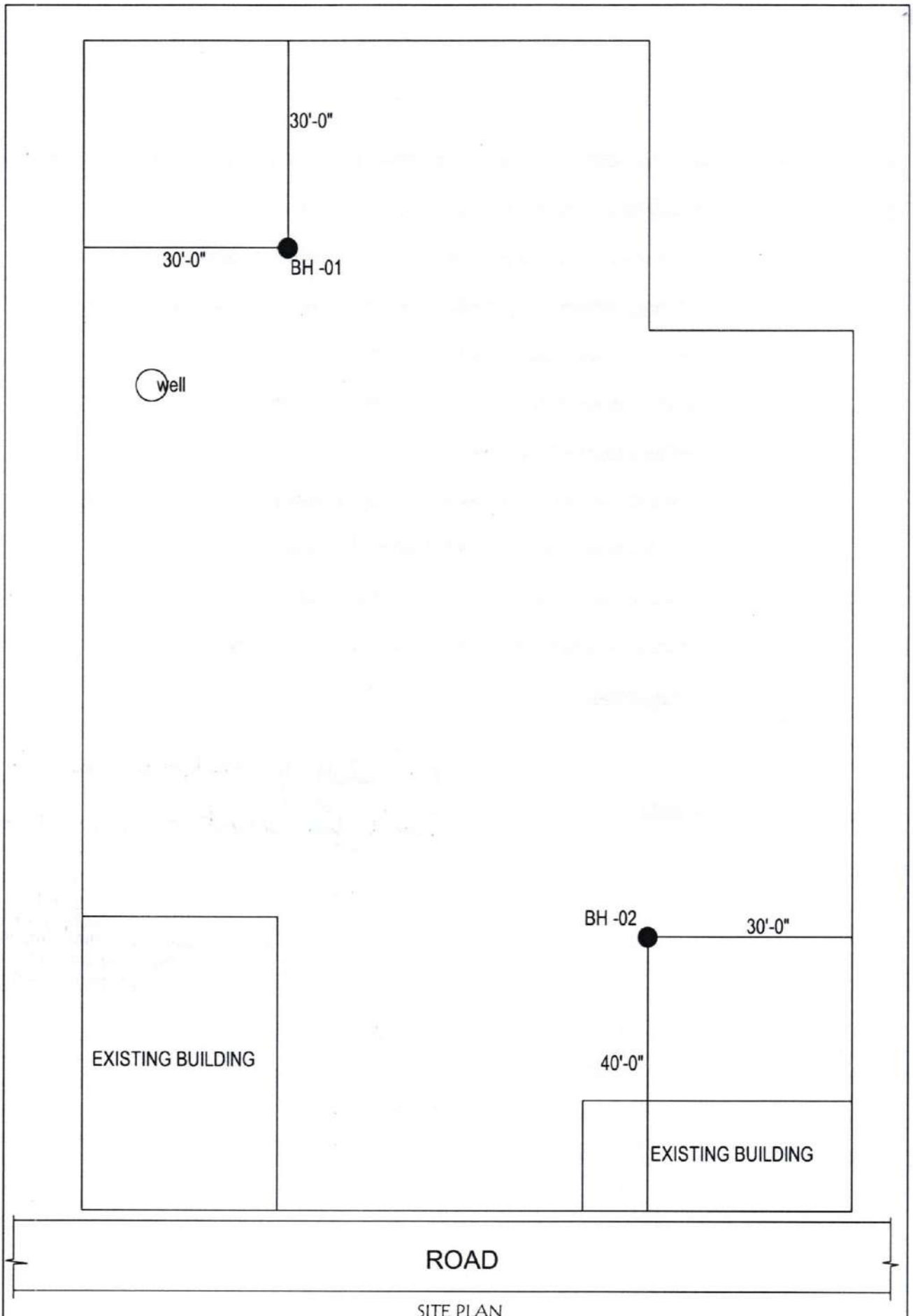
**For T.J. Engineers**

**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<br>soil investigation and foundation design division<br>T.J. HOUSE<br>PLOT NO. 4, ANNA NAGAR,<br>1ST STREET, VELACHERY, CHENNAI-42.<br>tjengineers@yahoo.com<br>tjengineers1998@gmail.com<br>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

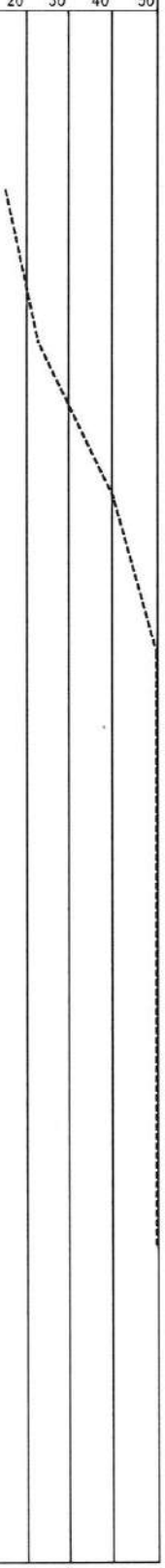
DATE OF COMMENCEMENT : 13 - 01 - 2024

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.

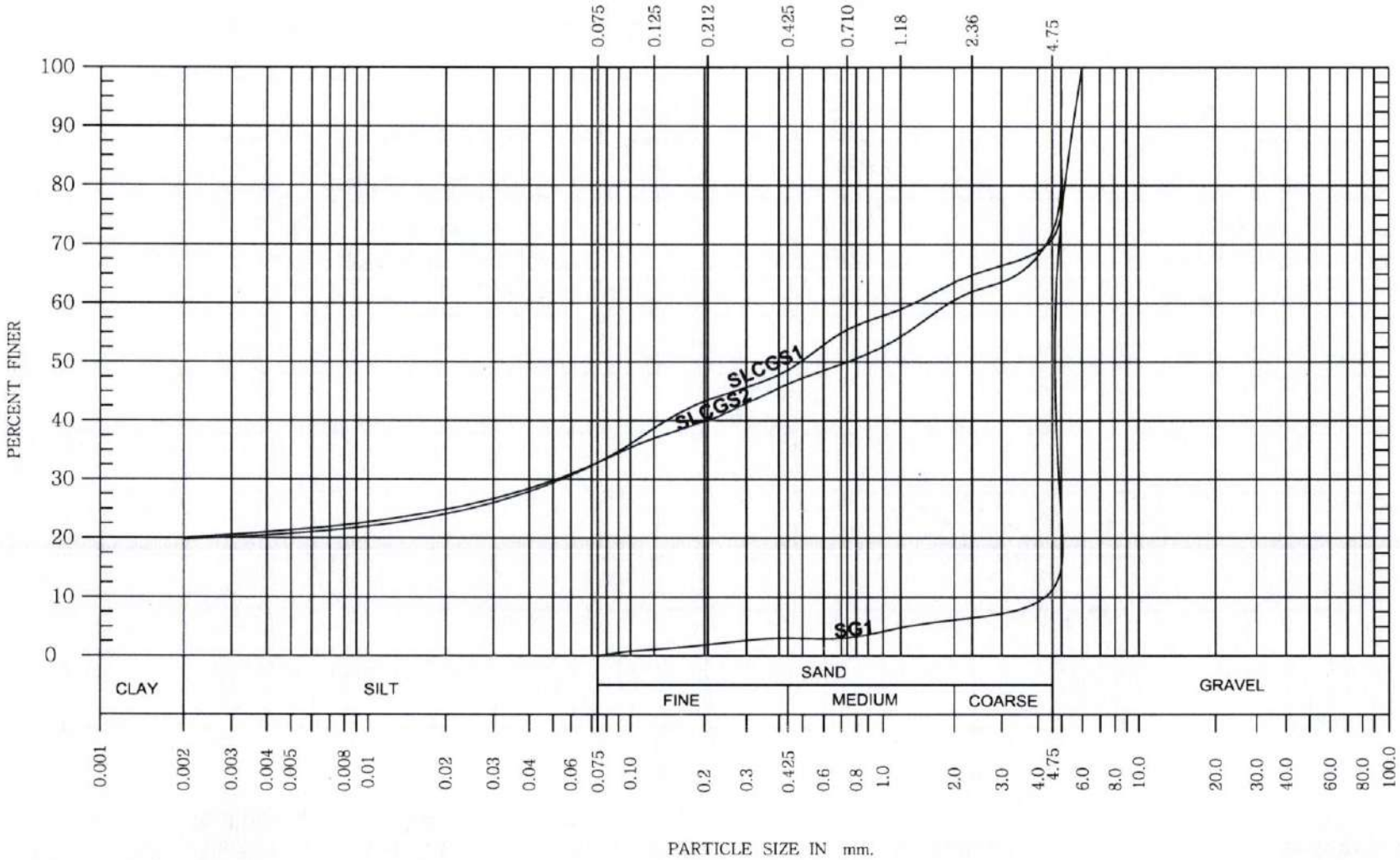



FIG. 4 GRAIN SIZE DISTRIBUTION CURVE-BH-01

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.

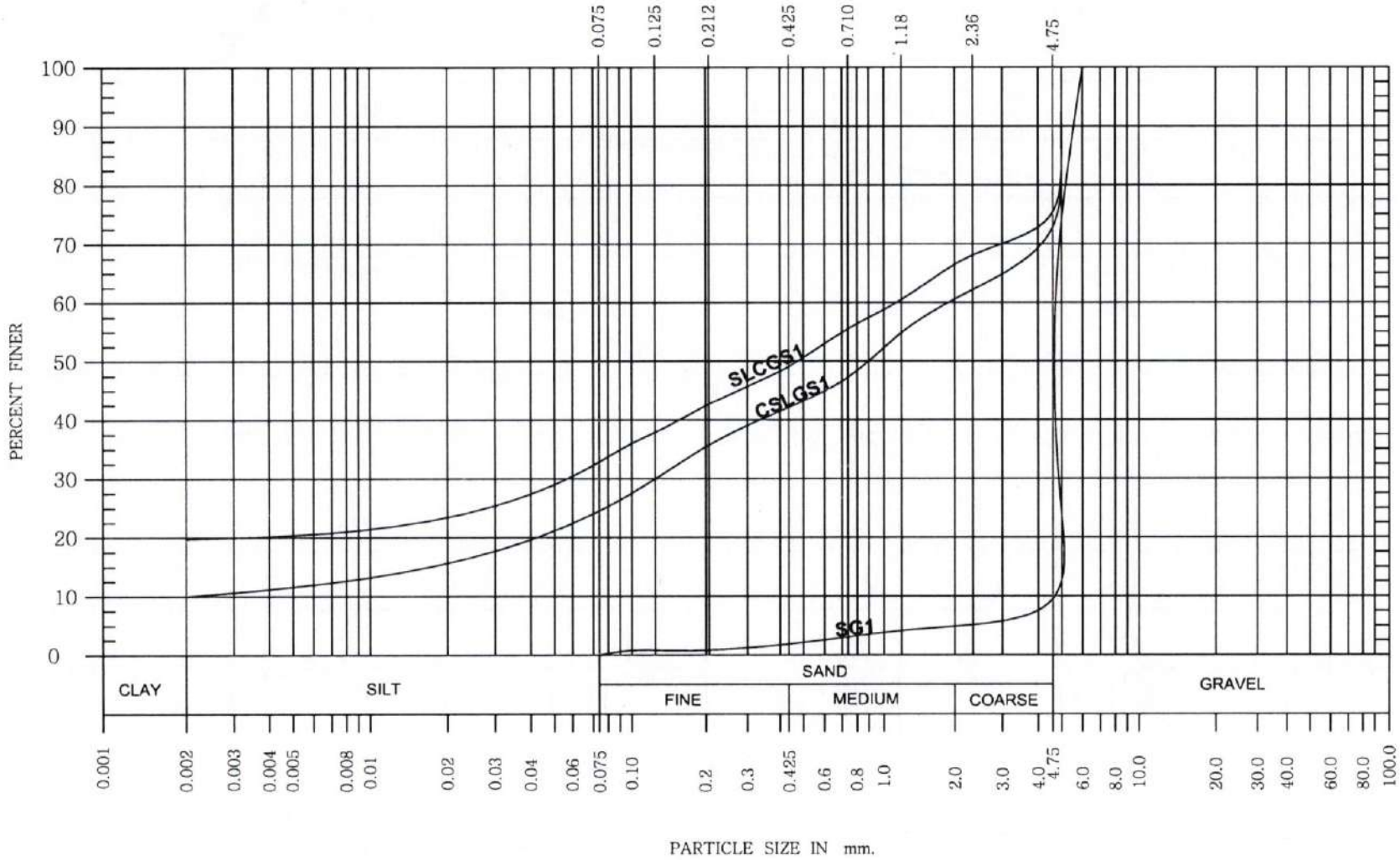



FIG. 5 GRAIN SIZE DISTRIBUTION CURVE-BH-02

# LABORATARY TEST RESULTS

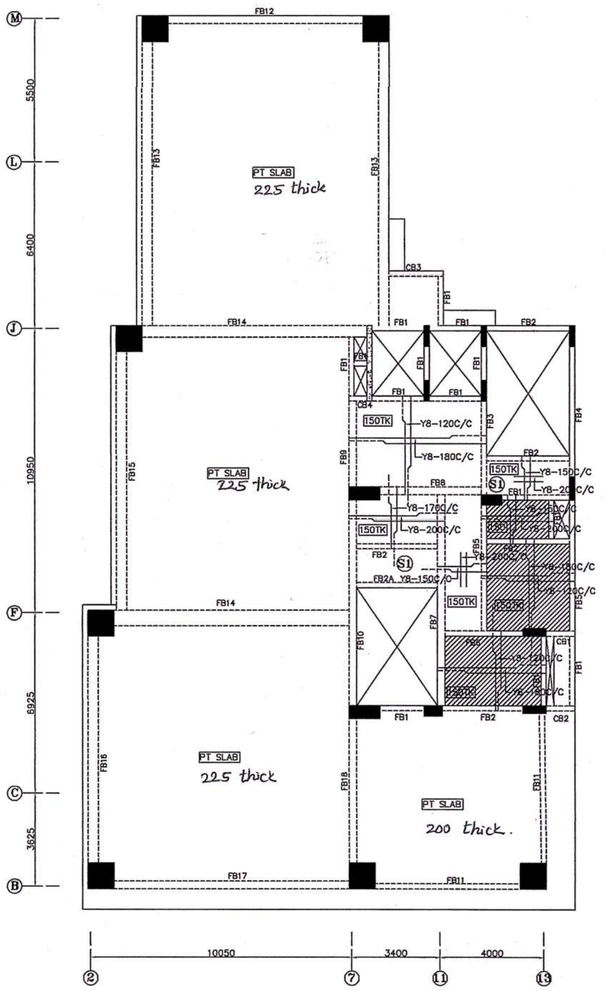
TABLE-1

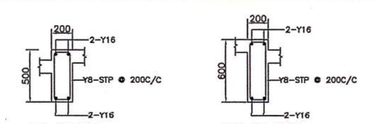
| B.H No | Layer thickness | Soil classification | Depth of sample collected | | SP. gravity | %of free swell | Grain size distribution | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DS / SPT | UDS | | | Clay | Silt | Sand | Gravel | |
| | m | | m | m | | % | % | % | % | % | |
| 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 | – |

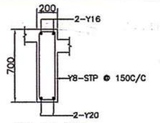


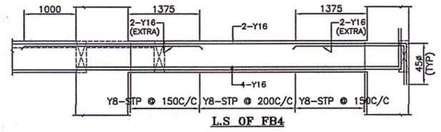

C.S OF FB1



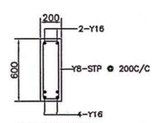

C.S OF FB2



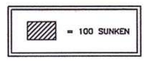

C.S OF FB3

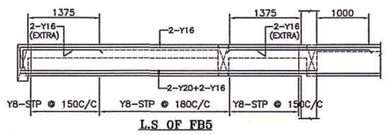



L.S OF FB4

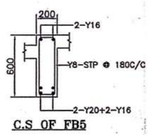



C.S OF FB4

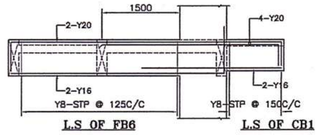



L.S OF FB5

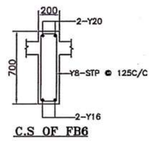



C.S OF FB5

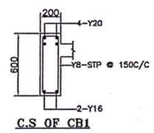



L.S OF FB6

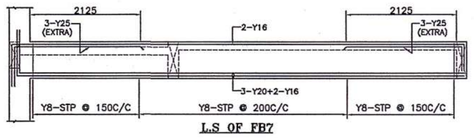
L.S OF CB1



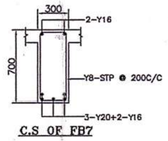

C.S OF FB6



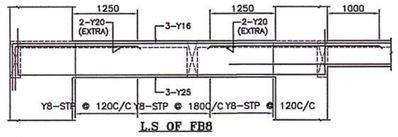

C.S OF CB1



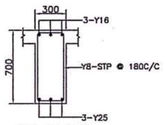

L.S OF FB7



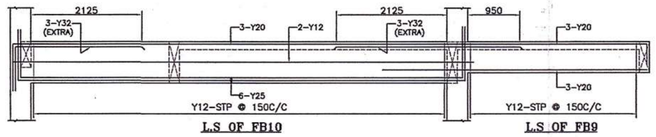

C.S OF FB7




L.S OF FB8

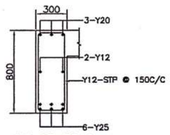



C.S OF FB8

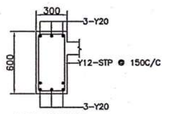



L.S OF FB10

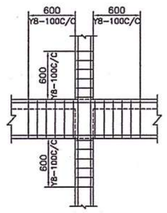
L.S OF FB9



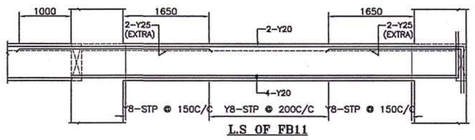

C.S OF FB10



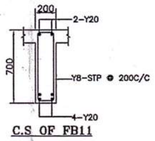

C.S OF FB9



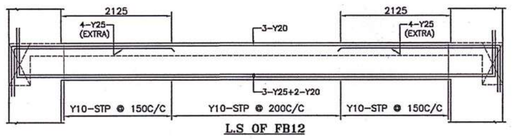

TYP. SEC. FOR STP. DETAILS



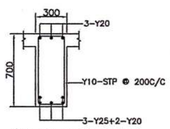

L.S OF FB11



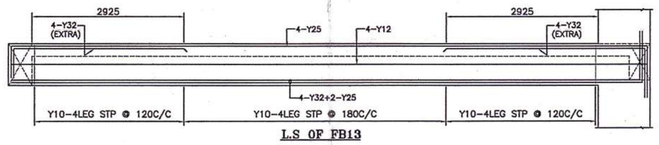

C.S OF FB11



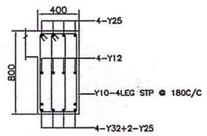

L.S OF FB12



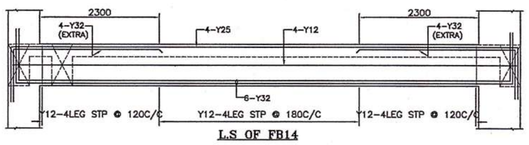

C.S OF FB12



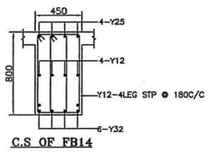

L.S OF FB13



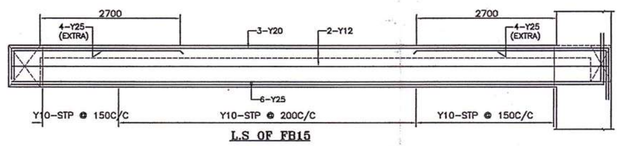

C.S OF FB13



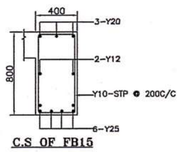

L.S OF FB14



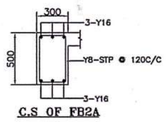

C.S OF FB14



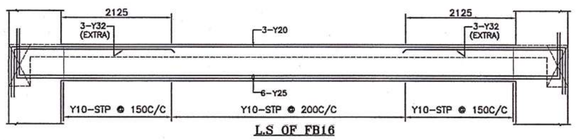

L.S OF FB15



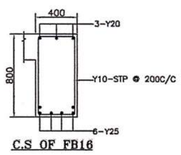

C.S OF FB15



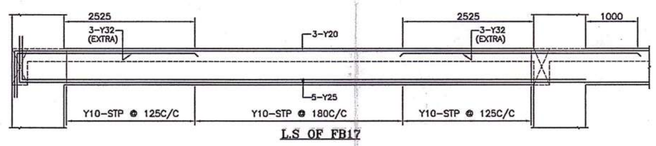

C.S OF FB2A



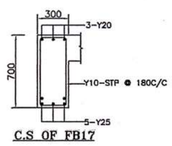

L.S OF FB16



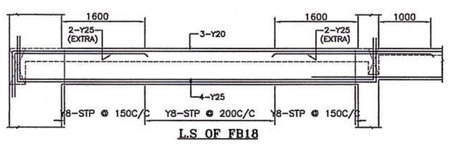

C.S OF FB16



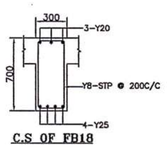

L.S OF FB17



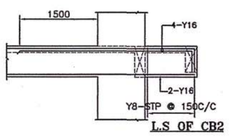

C.S OF FB17



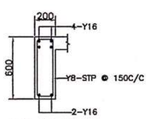

L.S OF FB18



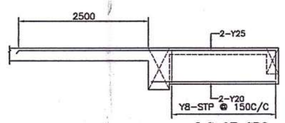

C.S OF FB18




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

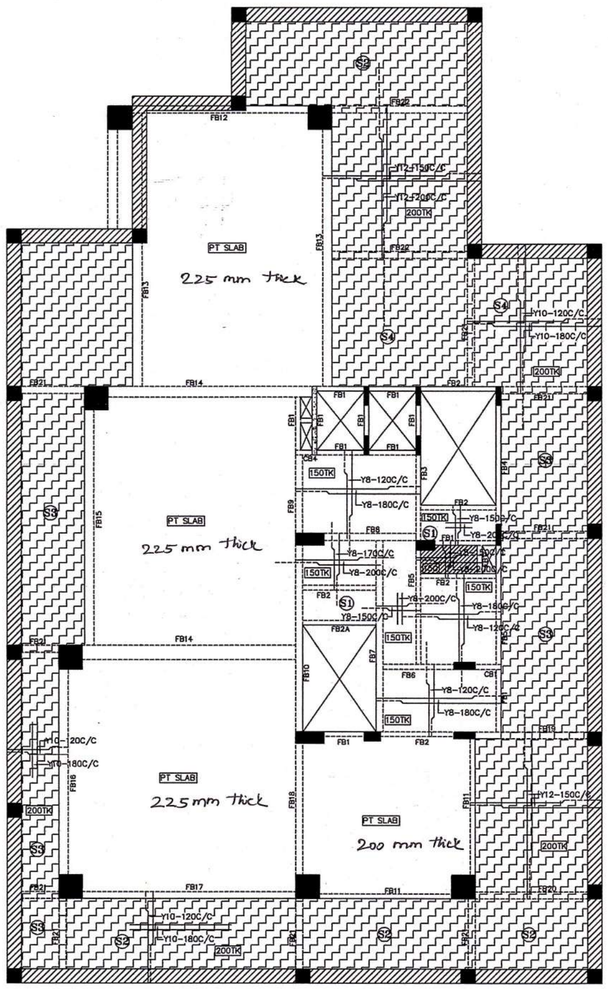
| DESIGNED | KANNAN | | SCALE | 1 : 100 |
|---|---|---|---|---|
| DRAWN | BALAJI | | DATE | 16–12–2024 |

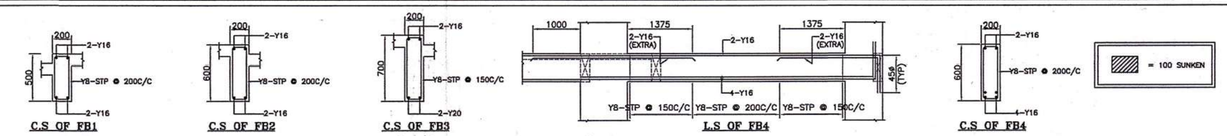
STRUCTURAL CONSULTANTS:

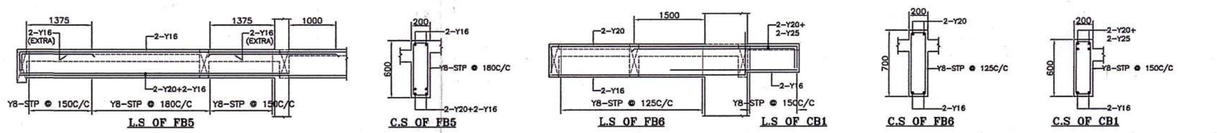
C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

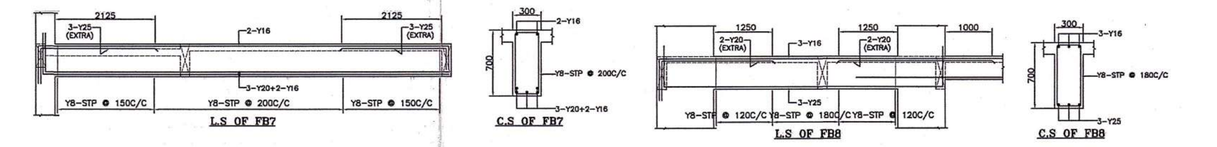
C.KANNAN B.E., M.E(STRUCTURE)
DOOR NO:21, PLOT NO:257–W,
FLAT NO:2B, "UTOPIA APARTMENTS",
2nd FLOOR, 4th MAIN ROAD,
INDIRA NAGAR, CHENNAI–20.
MOBILE NO: 098412 49815.
E–MAIL:kannankds2007@gmail.com

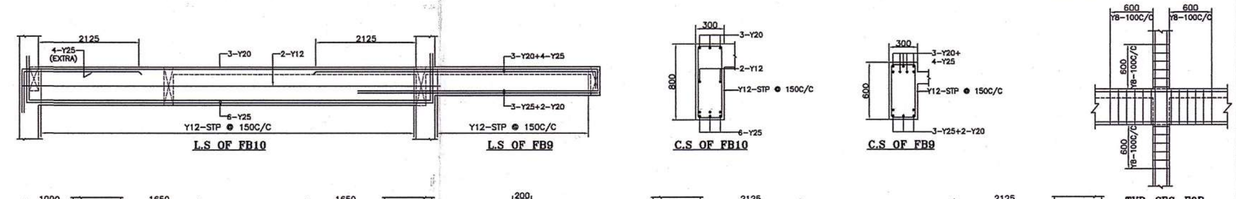
FILE NAME : D:\BALAJI\OTHERS\VIGNESH PROPERTIES

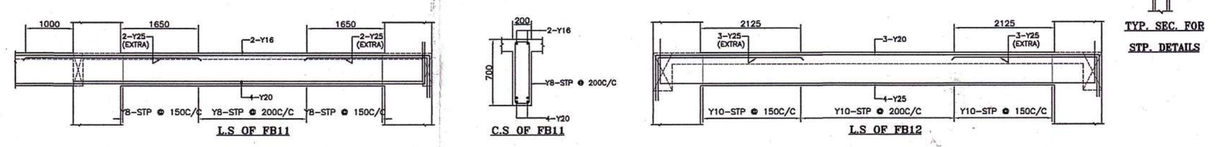


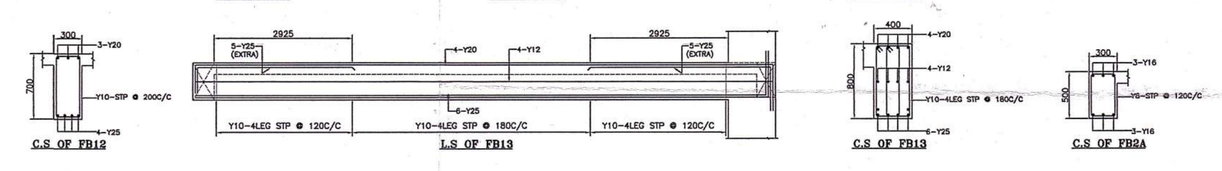



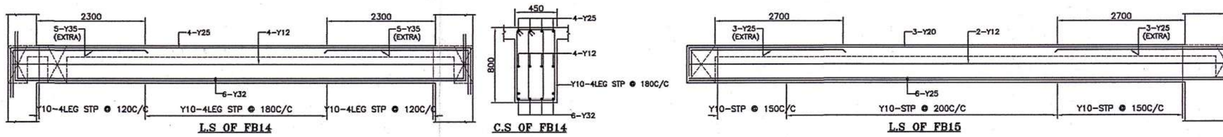



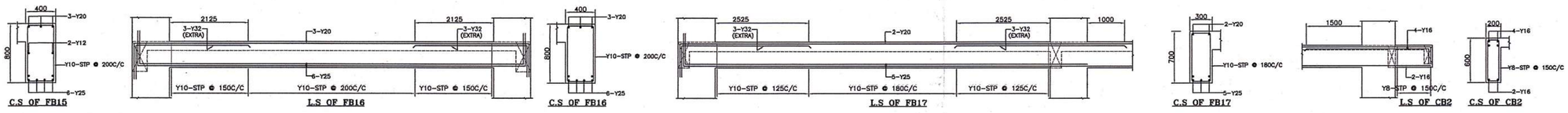



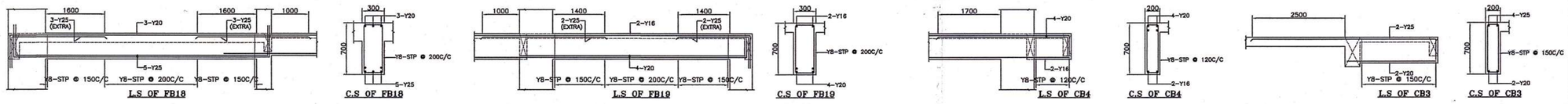



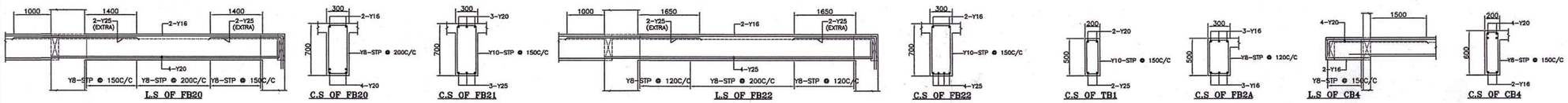




**Notes:-**

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

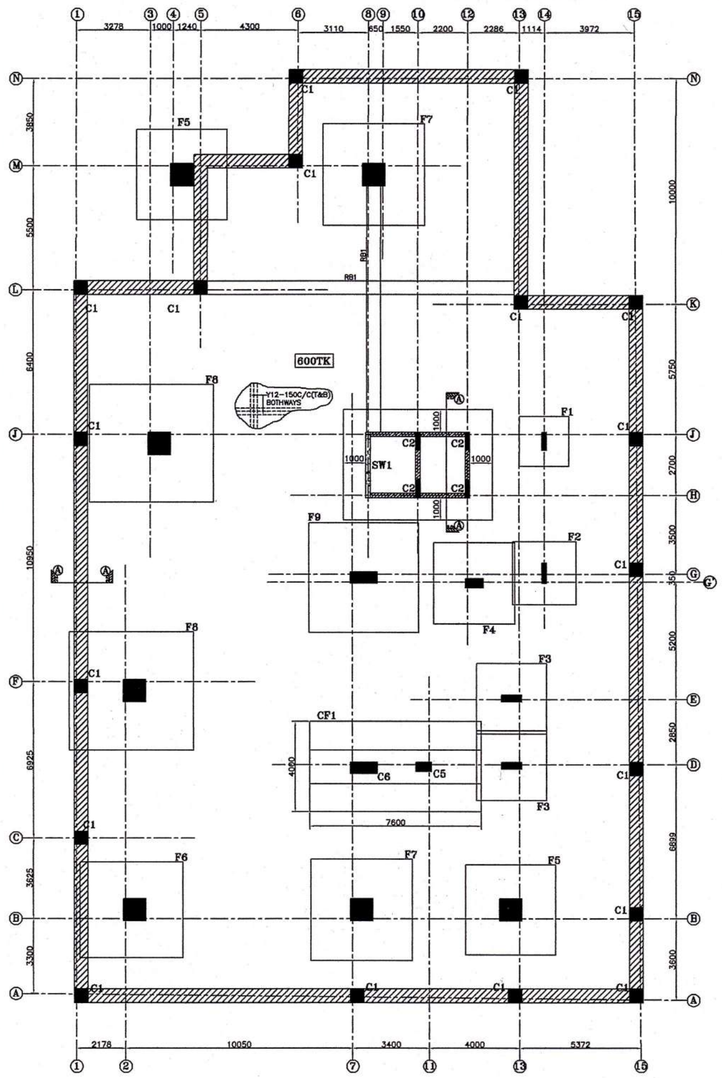
| DESIGNED | KANNAN | | SCALE | 1 : 100 |
|---|---|---|---|---|
| DRAWN | BALAJI | | DATE | 16–12–2024 |

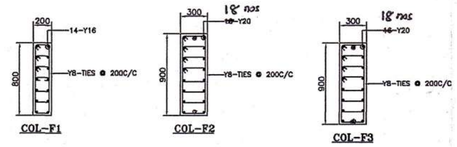
STRUCTURAL CONSULTANTS:

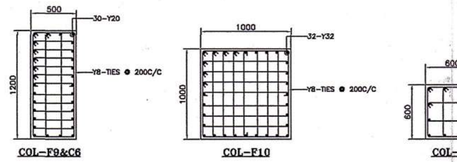
C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

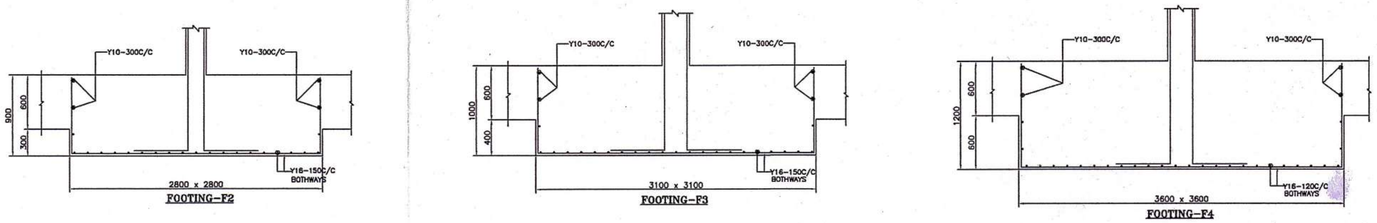
C.KANNAN B.E., M.E(STRUCTURE)
DOOR NO:21, PLOT NO:257–W,
FLAT NO:2B, "UTOPIA APARTMENTS",
2nd FLOOR, 4th MAIN ROAD,
INDIRA NAGAR, CHENNAI–20.
MOBILE NO: 098412 49815.
E–MAIL:kannankds2007@gmail.com

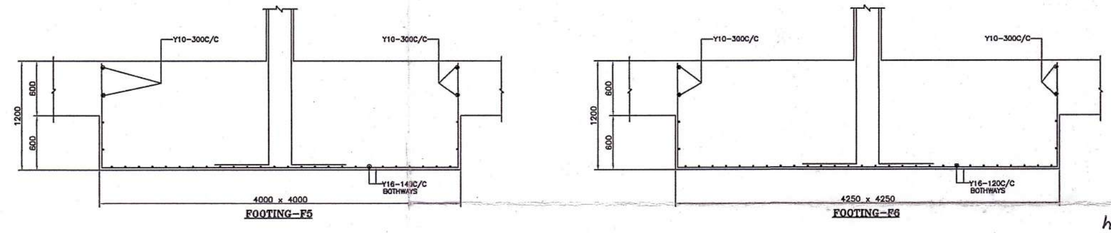
FILE NAME : D:\BALAJI\OTHERS\VIGNESH PROPERTIES



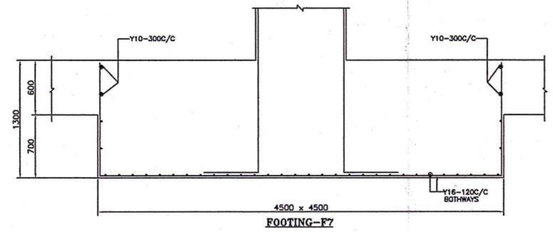



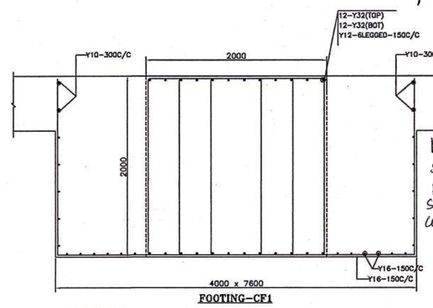



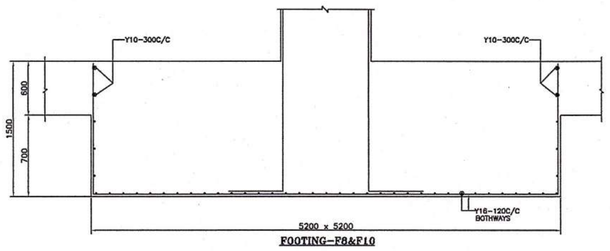



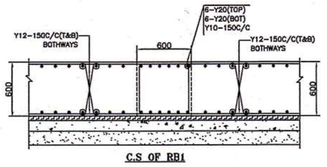

NOTE: Superstructure Design has been evolved by considering PT slabs having 225 mm thick as seen in superstructure beam/slab drawing. This has to be ensured during execution.

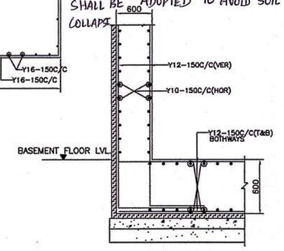


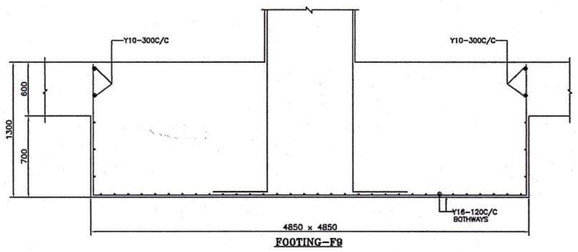



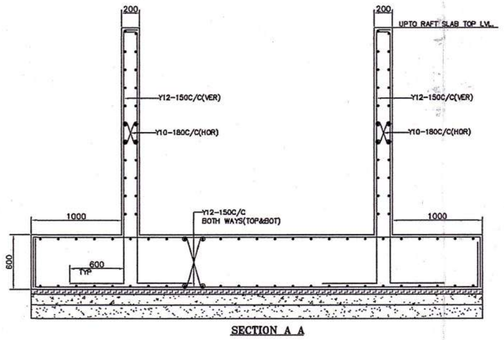

NOTE: DURING BASEMENT EXCAVATION & CONSTRUCTION PROPER PROTECTION MEASURES SUCH AS CONTINOUS PILE/SECANT PILES WALL WITH PROPER LOCKING SHALL BE ADOPTED TO AVOID SOIL COLLAPSE

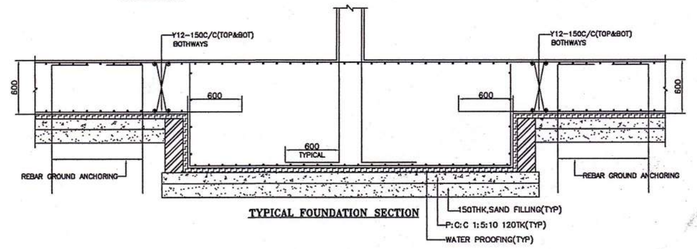



on behalf of CMDA MSB Panel, the structural drawings are reviewed & found generally in order. It is the responsibility of the site/structural engineer concerned to scrutinise the details and implement at site as per the detailed drawings and specifications

6/11/25

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

| | | |
|---|---|---|
| | | |
| | | |
| RMG | DATE | DESCRIPTION |

Note:- SBC 200 kN/m²

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 – 1985. Grade – Fe 500
4. Clear cover to the main steel
   - 50 for Footings , Raft Slabs & Raft Beams.
   - 40 for Columns.
   - 25 for Lintel & Beams.
   - 15 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 ct 200 cs 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 Stilt 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

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.**

**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

**Verified RealEstate**
3/350/2 Mettukuppam,
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.