# STRUCTURAL DESIGN REPORT

## PROPOSED AFFORDABLE RESIDENTIAL APARTMENT BUILDING STILT, FIRST, SECOND, THIRD, FOURTH, FIFTH & TERRACE FLOOR IN S.F.NO: 144/1B2, 144/2A1B, 144/1B1B, 144/2A1A2, 144/1B1A2, 144/1B1A1B, 144/14A1B, 144/14A2, 144/15, 144/2A1A1B, 144/14B, 144/16, MADAMPATTY VILLAGE, PERUR TALUK, COIMBATORE DISTRICT.

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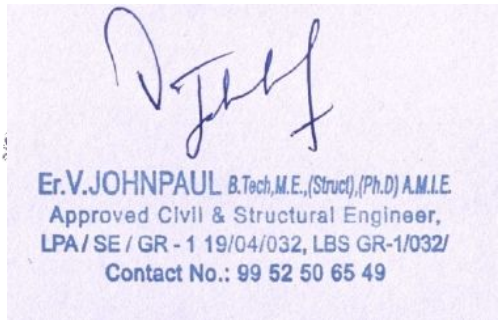

## 1.1 FOREWORD

### 1.1.1 - Description of Project

PROPOSED AFFORDABLE RESIDENTIAL APARTMENT BUILDING STILT, FIRST, SECOND, THIRD, FOURTH, FIFTH & TERRACE FLOOR IN S.F.NO: 144/1B2, 144/2A1B, 144/1B1B, 144/2A1A2, 144/1B1A2, 144/1B1A1B, 144/14A1B, 144/14A2, 144/15, 144/2A1A1B, 144/14B, 144/16, MADAMPATTY VILLAGE, PERUR TALUK, COIMBATORE DISTRICT

### 1.1.2 – Objective of the Report.

The objective of the report is to provide and furnish details related to Project and structural considerations.

### 1.1.3 – Scope of the Report.

The Structural Report covers the complete Structural Elements design(column) considerations for analysis of lateral loads & 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 theCodes and Standards will be used in designs. All design work shall be based onIndian Standards and Codes with latest revision, with amendments if any, as on date.

**Loads:**

IS:875 -1893 Code of Practice for design loads (other than earthquake) for Buildings and structure (All parts)

IS:1893-2016 Criteria for earthquake resistant design of structure

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**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: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: 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 buildings

IS:5525-1969(2013) Recommendation for detailing of reinforced concrete works IS:1786-2008 Specification for high strength deformed steel bars and wires for concrete reinforcement

IS:10262-2009 Recommended guidelines for concrete mix design

IS: 1893 (Part-1)-2016 Criteria for earthquake resistant design of structures (General provisions and building).

IS:13920-1993: Ductile detailing of reinforced concrete structures.

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**Miscellaneous:**

IS: 432(part 2)-1995 Specification for mild steel and medium tensile steel bars and hard-drawn steel 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- 1975 and IS:4326-1976)

SP:24-1983 Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete

SP:34-1987 Handbook of concrete reinforcement and detailing (SCIP)

Wherever appropriate Indian Regulation does not exist for any particular item, appropriate British standards will be used.

**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 – Location

PROPOSED AFFORDABLE RESIDENTIAL APARTMENT BUILDING STILT, FIRST, SECOND, THIRD, FOURTH, FIFTH & TERRACE FLOOR IN S.F.NO: 144/1B2, 144/2A1B, 144/1B1B, 144/2A1A2, 144/1B1A2, 144/1B1A1B, 144/14A1B, 144/14A2, 144/15, 144/2A1A1B, 144/14B, 144/16, MADAMPATTY VILLAGE, PERUR TALUK, COIMBATORE DISTRICT

### 1.3.2 – Building Description.

The Residential Building Consists of the following: Kindly study the architectural drawings for better understanding

- Block 1 – Stilt + 5 floors + Terrace

### 1.3.3 – Structural Arrangement:

- The Structural System is a RCC framed Structure comprising of C o nventional RCC Slab & RCC Beam supported by RC structural columns/walls with Primary & Secondary beams. Flat slabs beams and Columns are considered to actas a rigid diaphragm to transfer the lateral forces to the lateral load resisting elements.

## 1.4 – DESIGN APPROACH

### 1.4.1 – Design data

**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 75mm thickness
  For floors : 180 kg/sq.m (1.8 kN/sq.m)
- False ceiling / ducting + Sprinklers : 20 kg/sq.m (0.2 kN/sq.m)
- Dry Partition : 100 kg/sq.m (1.0 kN/sq.m)
- Self-weight of Plain concrete : 2400 kg/cu.m (24 kN/cu.m)
- Self-weight of RCC : 2500 kg/cu.m (25 kN/cu.m)
- Solid block masonry : 2500 kg/cu.m (25 kN/cu.m)
- Soil (Dry) : 1800kg /cu.m (18KN/cu.m)
- Soil (Wet) : 2000 kg/cu.m (20 kN/cu.m)
- Water : 1000 kg/cu.m (10 kN/cu.m)

**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

**Floors**

- Typical floors : 200 kg/sq.m (2.0 kN/sq.m)
- Terrace : 150 kg/sq.m (1.5 kN/sq.m)

Actual loading due to lifts loads shall be ascertained and design live loads are suitably modified (if required) and considered.

**Load calculation:**

| Roof Slab Load | | Thickness in m | Unit Weight - kN/m3 | Load | |
|---|---|---|---|---|---|
| **Dead Load- Floor** | | | | | |
| False ceiling | | | | 0.200 | kN/sq.m |
| Partition | | | | 1 | |
| Floor finishes | | 0.075 | 24 | 1.800 | kN/sq.m |
| | | | Total= | **3** | kN/sq.m |
| **Live Load - Floor** | | a) For Typical floors | | **2.0** | kN/sq.m |
| **Live Load – Roof accessible** | | | | **1.5** | kN/sq.m |

All sunken areas additional sunken filling load of 0.75 kN/$m^2$ is considered in Dead load.

200mm Solid Block wall Load on Grade Beam = (4.114-0.3)x0.2x25= 19.1 kN/m

Solid Block wall @ Typical floor = (3-0.3)x0.2x25= 13.5 kN/m

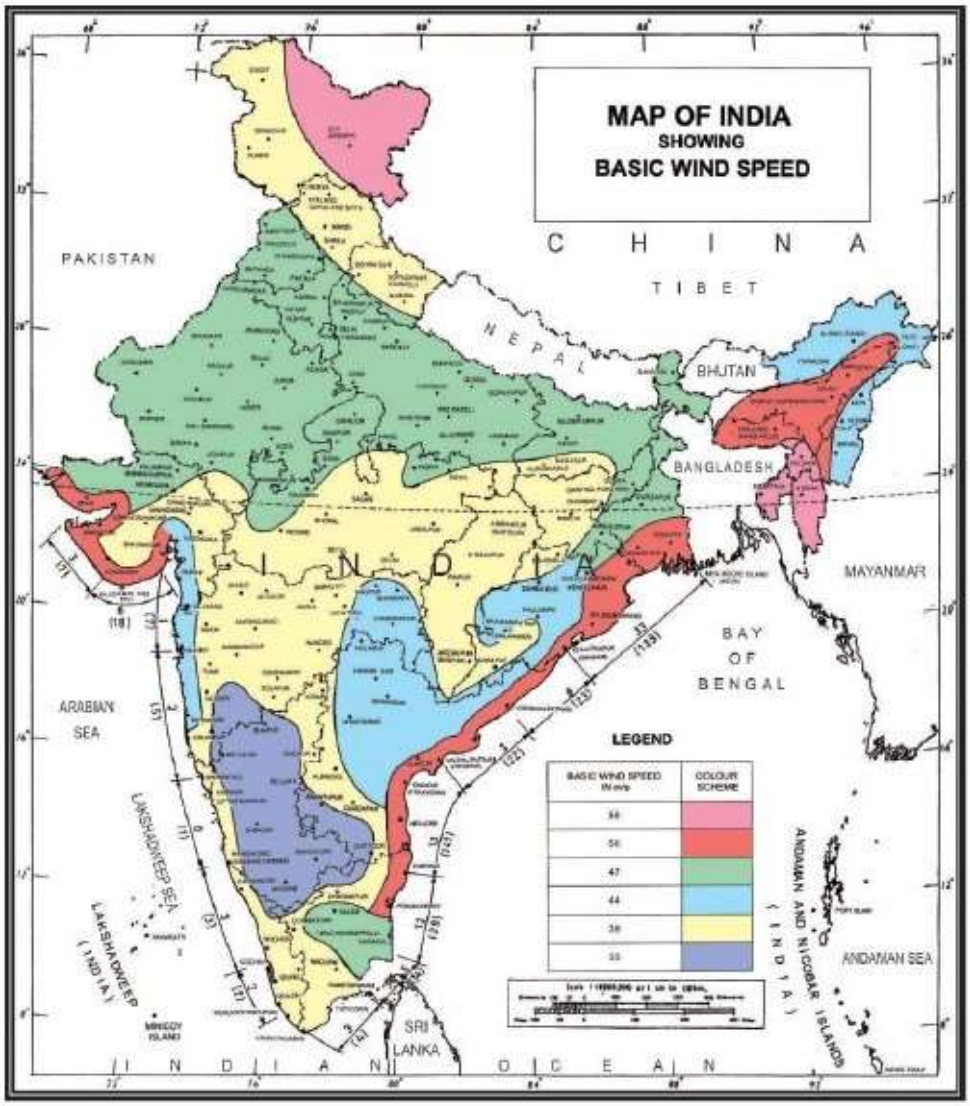
Parapet wall load on terrace = 1.2x0.2x25=6.0 kN/m

Headroom load = 2.5x0.2x25=12.5kN/m

**Wind Loads**

The Wind pressure shall be calculated in accordance with IS: 875 (Part-3)-2015. For Coimbatore, the basic wind speeds are considered at 39 m/sec.

| | | |
|---|---|---|
| Basic Wind Speed | Vb | : 39 m/s |
| Risk Coefficient | k1 | : 1 (k1corresponds to 50 years Mean Probable Design Life of Structure) |
| Terrain, height, structure size factor | k2 | : To suit the height of the structure for terrain category 2 |
| Topography factor | k3 | : 1.00 |
| Cyclone region factor | k4 | : 1.00 |
| Design mean hourly wind speed | Vh, d | : Vb × k2 × k2 × k3 X k4 |
| Design hourly wind pressure | pd | : 0.6 × $Vz^2$ |


MAP OF INDIA
SHOWING
BASIC WIND SPEED
C H I N A
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PAKISTAN
NEPAL
BHUTAN
BANGLADESH
MAYANMAR
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**Seismic Forces:**

Coimbatore 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 forthe structural elements.

(Please refer attached map)

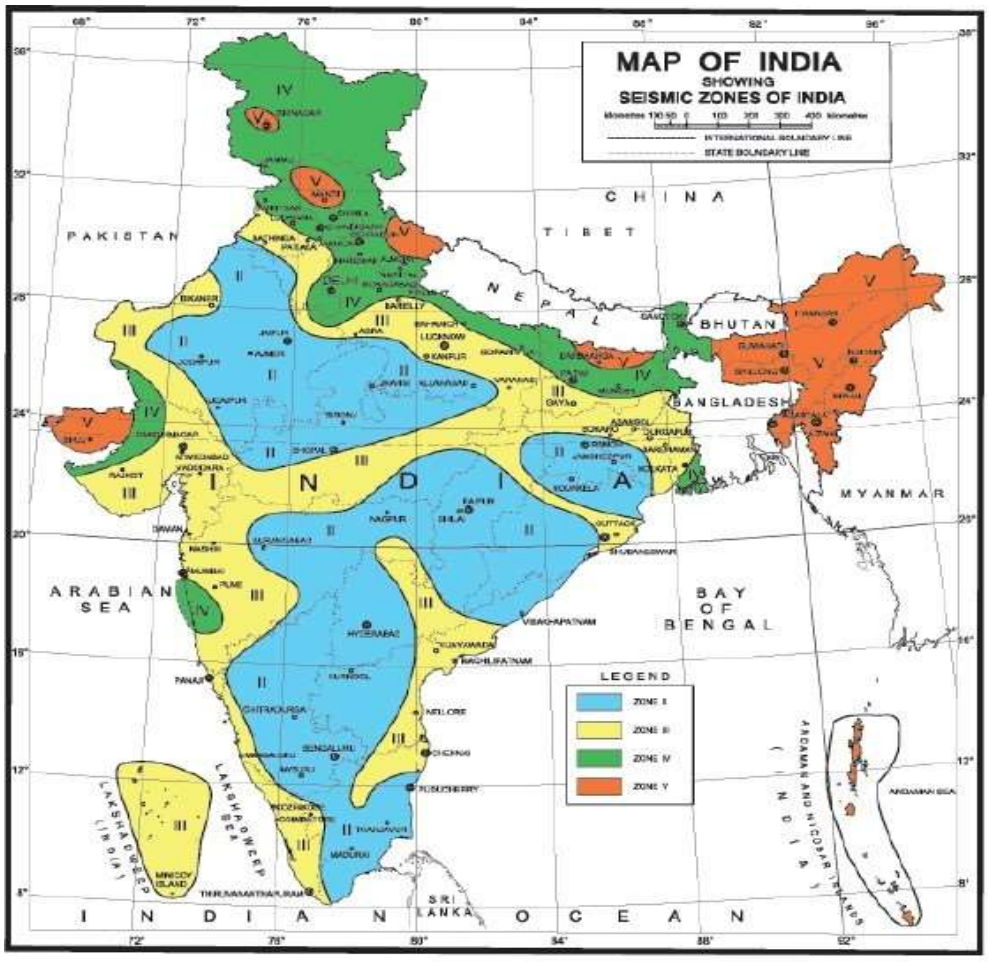
| | |
|---|---|
| Seismic Zone | : III |
| Seismic Zone factor (Z) | : 0.16 (As per Table 3-IS: 1893-2016 CL-6.4.2) |
| Design horizontal seismic coefficient (Ah) | : (Z/2) *(Sa/g) *(I/R) |
| Importance factor (I) | : 1.5 (Ref Table 8-IS: 1893-2016 CL 7.2.3) |
| Response reduction Factor (R) | : 4 (Ref Table 9 (iv)-IS-1893-2016 CL 7.2.6) |
| Soil type | : 1 (Weighted average of N value of soil layers from depth of founding is considered.) |
| Damping Ratio for RCC | : 5 % |

R as per Table 9 (v) of IS: 1893-2016 is based on Building with ductile RC structural walls with RC OMRF

Sa/g – Average response acceleration coefficient for soil sites as per Fig.2 of IS: 1893-2016 and it is arrived based on appropriate fundamental natural period of structure calculated as per clause: 7.6.2.

| | |
|---|---|
| Design horizontal seismic coefficient (Ah) | : (Z/2) *(Sa/g) *(I/R) |
| | : (0.16/2) *(1.5/4) * (Sa/g) |
| Ah | : 0.03 * (Sa/g) |
| Design seismic base shear, Vb | : Ah * W where, W - seismic weightof building |
| Time Period considered | : Building with RC Structural Walls |
| Dynamic Analysis with P-Delta effect(IS 1893-2016 CL 6.4.3) | : Not considered in the analysis |

| Table No: 03 | | | | |
|---|---|---|---|---|
| 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 |



## Expansion joint

Expansion joints are not provided in building.

### 1.4.2 - Durability Considerations:

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

Environment : Moderate

Exposure conditions : Concrete surfaces exposed to severe rain or Occasional freezing whilst wet or severe Condensation.

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

Minimum grade of concrete : Moderate exposure – M20

Nominal cover to reinforcement : For Moderate Exposure Nominal cover should not be less than 30 mm for walls, 50mm for footings, 40mm for column, 25mm for beams and 20mm for slabs.

### 1.4.3- Fire Rating:

- Thickness of the structural elements as per table 15, 16 & 16A clause 26.4 of IS 456-2000. Two Hours fire rating is considered with wall thickness of 160mm & withminimum percentage of steel 0.4% (including both vertical and horizontal reinforcement) as per IS:456-2000, Cl:21, Fig:1.
- Nominal covers for 1.5 hr. fire resistance:

| Nominal Cover | | | | | | |
|---|---|---|---|---|---|---|
| **BEAM** | | **Slabs** | | **Ribs** | | **Columns / shear wall** |
| Simply support | continuous | Simply supported | continuous | Simply support | Continuous | |
| mm | mm | mm | mm | mm | mm | mm |
| 20 | 20 | 25 | 20 | 35 | 20 | 40 / 25 |

## 1.5 - ANALYSIS METHODOLOGY:

This structure has physical interface with almost all the disciplines like Geotechnical, MEP Services and Landscape etc. The Structure proposed is of cast in-situ concrete construction with shear walls suitably placed. The core walls around lifts are of cast in-situ concrete to resist lateral forces. The Structural design of the proposed project is based on Indian Standard Codes and is analysed for Dead,Live, Wind and Seismic Load conditions taking into relevant load combinations recommended by the codes.

The Vertical Loads including the dead and super imposed loads are transferred to the soil through beams, core walls and footings. Footings are sized with consideration to the safe bearing capacity of soil at the level of transfer of load recommended by specialist soil investigation consultants. The Lateral loads due to wind and seismic forces are dissipated to soil through the proposed Reinforced Concrete Core Walls/columns.

## 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+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 |

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

## 1.7 - DESIGN METHODOLOGY:

- All R.C.C structures shall be designed according to the Limit State Method as specified in IS: 456 – 2000 and in accordance with clauses mentioned for structural element sizes in IS 13920-2016.
- 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 analysed for specific loads like dead load, live load, wind and seismic loads and for the load combinations as given in the relevant 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 0.2mm.
- For basement retaining wall and water retaining structures, crack width is limited to 0.1mm.

### 1.8.3 - Permissible Drift Limits:

- As per IS-1893 (Part1) :2016, clause 7.11.1, Storey drift in any storey due to minimum specified design seismic lateral force shall not exceed 0.004 times the storey height design.
- As per IS-456-2000 clause 20.5, Lateral sway due to wind load should notexceed H/500 (H is the total height of structure).

### 1.8.4 - 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. As per the soil investigation report received from geotechnical consultants is **Isolated Footing and Combined footing**.



## 5. RECOMMENDATION

For the site, "SOIL INVESTIGATION FOR THE PROPOSED CONSTRUCTION OF APARTMENT BUILDING WITH STILT + 5 FLOORS OF PLINTH AREA 5,838 SQ.FT., @ SF.NO.: 144/1B2, 2A1B, 144/1B1B, 2A1A2, 144/1B1A2, 144/1B1A1B, 144/14A1B, 144/14A2, 144/15, 2A1A1B, 144/14B, 16, MADAMPATTY VILLAGE, PERUR TALUK, COIMBATORE DISTRICT – 641010." The borehole investigation was conducted and SBC was determined.

- In this site, up to 12.00m, SOFT DISINTEGRATED ROCK is obtained.
- The **ISOLATED FOOTING** is recommended for this site.
- **Rest the Foundation at 3.00m from the Natural Ground Level.**
- The **SBC at 3.00m is 34.63 Ton/m$^2$** is determined in All Borehole Locations @ Foundation Level.

### 1.9 - Detailing Requirements:

- Detailing for the structural elements shall be done in accordance with IS: 13920-2016, taking R=3 as per Table 9 (v) of IS: 1893-2016 is based on perimeter RC Ordinary Moment-Resisting Frames
- Detailing for all structural members shall be in accordance with IS: 456 & SP:34.

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