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# STRUCTURAL DESIGN BASIS REPORT

## PROPOSED RESIDENTIAL APARTMENTS BUILDINGS AT KUNDRATHUR, CHENNAI.

VASTECH
Consultants & Engineers LLP®

**VASTECH CONSULTANTS & ENGINEERS LLP**
**407,4th floor, Orville Business Port ph Airport Terminal-2**
**Road, Opp. Konark Campus,**
**Viman Nagar, Pune 411 014.**

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| DBR-R0<br>DATE 24-07-23 | | | | |
| **DESCRIPTION** | **PEER REVIEW IIT MUMBAI.** | **VASTECH (STRUCTURAL CONSULTANTS) SIGN & STAMP** | **ARCHITECT SIGN & STAMP** | **CLIENT SIGN &STAMP** |

CONTENTS

## 1) GENERAL PROJECT DETAILS -

### Structural Design Introduction:

Plan showing the proposed construction of residential building- high rise group development with extented combined basement of 3 blocks Consists of
Block 1: ground floor + 21 floors (342 dwelling units, height – 65.35m),
Block 2: ground floor + 21 floors (169 dwelling units, height – 65.35m) with amenities (open swimming pool on the ground floor level),
Block 3: ground floor + 21 floors (342 dwelling units, height – 65.35m)
Totally 853 dwelling units.
Comprised in survey nos: 15/2A2, 15/2A3,15/2A4, 15/2B1,15/2B2, 15/2B3A, 15/2B3B & 16/1 of Moondramkattalai Village, Kundrathur taluka, Kancheepuram district.

In this brief report we are presenting the data and assumptions related to the project, which has lead to the conceptual design at this preliminary stage. The document attempts to record all inputs assumed in design and will form the basis for all future detailed structural work.

The report most importantly clarifies the load criteria assumed in the design It will be primarily based on the current Indian Codes of practice and their latest amendments and Other international codes where certain requirements are not available in Indian code, it is therefore expected that all related consultants, including the architects, would go through the document and refer to it at every stage of detailed design.
Recommendations or revisions on assumed parameters are requested at this stage.

Besides this the report will also form the outline of the design criteria and methods of both analysis and design to be adopted in this project with the aim of achieving a design that satisfies all sorts of seismic, and serviceability requirements.

## 2) LIST OF REFERENCES:

| | |
|---|---|
| IS 16700-2017 | Criteria for Structural Safety of Tall Concrete Buildings. |
| IS 456-2000 | Plain and reinforced concrete-code of practice |
| IS 875 | Code Of practice for design loads for buildings and structures |
| Part 1: 1987 | dead loads- unit weights of building material and stored material |
| Part 2: 1987 | Imposed loads |
| Part 3: 2015 | Wind loads |
| IS 1893: 2016 | Criteria for earthquake resistant design of structures |
| IS 4326:1993 | Code of practice for earthquake resistant design and construction of buildings |
| IS 13920: 2016 | Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces |
| BS 8110: 1997 | Plain and reinforced concrete-code of practice<br>British standard |
| ACI 318 | Plain and reinforced concrete-code of practice American standard |
| CP65 | Plain and reinforced concrete-code of practice Singapore standard |
| IS 800:2007 | Code of practice for general construction in steel |
| IS 1343:2012 | Code of practice for prestessed concrete |
| Reynolds Handbook | |
| IS 3414 | Code of practice for joints in the buildings |
| IS 3370 Part 1 TO 4 | Code of practice for liquid retaining structures |
| BS-8007 | Code of practice for liquid retaining structures for crack width calculation |
| IS 2911 Part-1 Sec-1 Reff. 2020 | Design and construction of pile foundations — code of practice<br>Driven Cast In-situ Concrete Piles |
| Part-1 Sec-2 Reff. 2020 | Design and construction of pile foundations — code of practice<br>Bored Cast In-situ Concrete Piles |
| Part-3: 2021 | Design and construction of pile foundations — code of practice<br>Under-reamed piles |
| Part-4: 2018 | Design and construction of pile foundations — code of practice<br>Load Test on Piles |

## 3) MATERIAL, WORKMANSHIP, INSPECTION AND TESTING:

The proposed structure consists of the following mentioned main materials to be used during the construction.

### 3.1 Concrete:

The concrete shall be in grades designated as per Table 2 IS 456-2000. Recommended grades for the different members are as follows:

| | |
|---|---|
| Columns/Shear wall | M50/M40/M35. |
| Beams/Slabs | M30 |
| Retaining Walls | M30 |
| Water Tanks | M30 |
| Pile Foundation | M30 |
| Pile Cap | M30 |
| Staircase | M30 |
| P.C.C | M10 |
| Filling Plum Concrete | M10 |

Any other structural member will be in general designed in M30.

### 3.2 Durability of concrete

The structure is located in Chennai, where the climatic conditions are considered moderate. The concrete grade of submerged structural elements will be a minimum of M30. Nominal covers shall not be less than 30mm from a durability point of view.
The cover to the various structural elements is to be as follows,

| Structural Element | Clear Cover in mm |
|---|---|
| Pile | 75 |
| Pile Cap | 75 |
| Slabs | 30 |
| Beams | 30 |
| Columns | 40 |
| Shear Wall | 30 |
| Retaining wall | 40 (Outer side)<br>30 (Inner side) |

**3.3 Fire Rating:**

Building Block 1, 2 and Block 3 considered. The fire rating 2.0 Hours for slab & beam & 2 Hours for vertical element is considered.

**3.4 Reinforcement:**

The reinforcement shall be high strength deformed steel bars with yield strength of Fe550.

**3.5 Structural Steel**

The structural steel to be used shall confirm to IS 800.

Hot rolled and built-up sections of grade E350 (fy=350 Mpa) / E450 (fy=450 Mpa) will be used for structural elements.

The properties of steel are,

Modulus of Elasticity, $E = 2 \times 10^5$ N/mm2

Poissons ratio, $\mu = 0.3$

Co-efficient of thermal expansion, $\alpha = 12 \times 10^{-6}/\ ^0C$

**3.6 Construction Joint**

Construction joints and shrinkage strips will be planned with the contractor and Only be used in locations pre-approved by consultants.

**3.7 Expansion Joint**

Block 1 & 3 each are having approximately 114 m length. Both are divided into 2 Blocks by providing an expansion joint at approximately mid length. The width of expansion joint is kept in such a way to avoid pounding effect in earthquake. Clause No. 7.11.1 is referred to arrive at expansion joint width. As per Clause No. 27 of IS 456-2000 the length of Building without expansion joint shall be 45 m. However as in this case length is increasing upto approx. 66m, thermal analysis shall be done to take intoconsideration the thermal stresses.

## 4) FOUNDATION SYSTEM:

With reference to the soil Investigation report mentioned below.

For the expected column loads and encountered soil profiles, it was recommended to provide "Bored Cast-In-Situ Pile" foundation with at least 2.0 m drilling into hard strata weathered rock formation or at least 1.0 m into hard rock formation. For this site pile capacities were estimated using the lower bound soil profiles of Boring 12. In the design it was considered that the piles will be installed with at least 2.0 m pile penetration into the hard rocky strata. The total and effective pile length will be 10-, and 9.0 m below EGL with 1.0 m pile cut-off for basement floor. Pile capacity was estimated as per the IS 2911-2010 (Part 1/sction 2) Code gauidlines. Ultimate and allowable pile capacities of various pile diameters are summarized below.

| Pile Dia. (M) | Ultimate Compressive Capacity (Tonns) | Allowable Compressive Capacity (Tonns) | Ultimate Uplift Capacity (Tonns) | Allowable Uplift Capacity (Tonns) | Lateral Capacity @ 4mm Defl. Allowable (Tonns) |
|---|---|---|---|---|---|
| 0.60 | 272.12 | 109 | 72.16 | 24 | 2.00 |
| 0.75 | 408.06 | 163 | 91.31 | 30 | 2.56 |
| 0.90 | 573.23 | 229 | 110.91 | 37 | 2.72 |
| 1.00 | 700.09 | 280 | 124.22 | 41 | 3.04 |
| 1.20 | 985.76 | 394 | 151.44 | 50 | 3.69 |

- Basement Raft shall be designed for at least 2 T/m2 uplift pressure due to water.

## 5) GENERAL DESIGN CONSIDERATIONS:

### 5.1 Method of Design

The aim of design is the achievement of an acceptable probability that structures being designed will perform satisfactorily during their intended life. With an appropriate degree of safety, they should sustain all the loads and deformations of normal construction and use and have adequate durability and adequate resistance to the effects of misuse and fire.

Structures and structural elements will be designed by Limit State Method. Due consideration will give to the accepted theories, experience and modern philosophy of design.

**Retaining walls** will be designed to resist backfill loads as per the section at the wall. Saturated soil density is 20 KN/m3. The angle of shear resistance is assumed to be 30°. The water pressure due to the static water between the clay and the wall is also considered in design.

## 5.2 Loads and Forces

In structural design, account is taken of the dead, imposed and wind loads and forces such as those caused by earthquake etc, where applicable.

## 5.2.a Dead Loads

Dead load-imposed loads & super imposed load and wind load shall be as per IS 875 depending upon the finishes and occupancy classifications. Seismic Coefficients applicable to Seismic Zone III shall be considered as per IS 1893-2016. The Equipment Load on the roof of the building shall be as per Vendor's data. Water tank loads shall be as per MEP Consultants requirement.

Self Weight: Self- weight of the materials shall be calculated based on unit weights given in IS: 875(part 1)-1987.

### Wall Load

**200 mm thk Non-structural wall load.**

0.20 x (2.95-0.6) x 10 = 4.7kN/m + 0.03 x 2.95 x 20 = 1.77 kN/m (Plaster Load)

**100 mm thk Non-Structural wall load.**

0.10 x (2.95-0.6) x 10 = 2.35kN/m + 0.03 x 2.95 x 20 = 1.77 kN/m (Plaster Load)

Unless otherwise specified the unit weight of materials will be used as follows.

| | |
|---|---|
| Reinforced Concrete | 25 kN/cum |
| Plain concrete | 24 kN/cum |
| Brickwork | 20 kN/cum |
| Concrete block work | 24 kN/cum |
| Siporex Blocks | 10 kN/cum |
| Stone cladding | 25 kN/cum |
| Soil dry | 18 kN/cum |
| Soil wet | 20 kN/cum |
| Floor finishes | 20 kN/cum |

## 5.2.b Temperature Loads

As per IS 875 part-5 1987, Fig no-1 & 2 Average temperature in Chennai City is 27.5°C (max 45 and Min 10 so average is 27.5). Temperature load shall be applied in ETABS model along with necessary load combinations to take their effect into analysis and design.

5.2.c Wind Loads:-

Wind load for design of structures shall be based on the design wind speed arrived from IS: 875 (Part3)-2015.

The parameters for calculation of design wind speed as per IS: 875 (Part 3)-2015.

| | |
|---|---|
| Basic wind speed, Vb | : 50 m/ sec. |
| Risk Coefficient, K1 | : 1 (Table no.1), Clause no. 6.3.1<br>For design life of 50 years. |
| Terrain roughness & height factor, K2 | :1.44 (Table no.3. Clause. 6.3.2.2)<br>Terrain category - 1, Max. Ht 69.1 m. |
| Topography factor K3. | : 1.0 (upwind slope < 3 degree. |
| Importance factor K4. | : 1.0 (Other structure) Clause. 6.3.4. |
| Design Wind Speed Vz | : VbxK1xK2xK3XK4<br>= 50x1x1.44X1X1<br>= 72.0 m/sec. |
| Design Wind Pressure Pz | : 0.6x $(60.0)^2$= 3110 N/$m^2$ |

The external & internal pressure coefficients shall be as per respective clauses of IS: 875 (Part 3)

Height of Building above Ground level (H) = 64.9 m.

| | |
|---|---|
| Width of X direction (d) | = 50.7 m. |
| Width of Y direction (d) | = 22.22 m. |
| Time Period in X | = 0.09 H / $d^{0.5}$.<br>= 0.09x64.9/ $50.7^{0.5}$.<br>= 0.820 sec. |
| Time Period in Y | =0.09 H / $d^{0.5}$.<br>= 0.09x64.9/ $22.22^{0.5}$.<br>= 1.23 sec. |
| Aspect Reatio | = 64.9 / 22.22<br>= 2.92 < 5 |
| Natural Freq X. | = 1/Tx = 1/0.82<br>1.22 > 1.0 |
| Natural Freq Y. | = 1/ Ty = 1/1.23<br>0.813 < 1.0 |

It is necessary to calculate wind forces by Gust Factor method as per IS 875-2015 (Part-3)

Load Combinations considered:

| | | | |
|---|---|---|---|
| 1 | 1.5(DL+IL) | 14 | 1.5(DL+IL)+TL |
| 2 | 1.2(DL+IL ±EQX)±0.36EQY | 15 | 1.2(DL+IL ±EQX)+TL |
| 3 | 1.2(DL+IL ±EQY))±0.36EQX | 16 | 1.2(DL+IL ±EQY)+TL |
| 4 | 1.2(DL+IL ±WLX) | 17 | 1.2(DL+IL ±WLX)+TL |
| 5 | 1.2(DL+IL ±WLY) | 18 | 1.2(DL+IL ±WLY)+TL |
| 6 | 1.5(DL ±EQX))±0.45EQY | 19 | 1.5(DL ±EQX)+TL |
| 7 | 1.5(DL ±EQY)±0.45EQX | 20 | 1.5(DL ±EQY)+TL |
| 8 | 1.5(DL ±WLX) | 21 | 1.5(DL ±WLX)+TL |
| 9 | 1.5(DL ±WLY) | 22 | 1.5(DL ±WLY)+TL |
| 10 | 0.9DL ±1.5EQX±0.45EQY | 23 | 0.9DL ±1.5EQX+TL |
| 11 | 0.9DL ±1.5EQY±0.45EQX | 24 | 0.9DL ±1.5EQY+TL |
| 12 | 0.9DL ±1.5WLX | 25 | 0.9DL ±1.5WLX+TL |
| 13 | 0.9DL ±1.5WLY | 26 | 0.9DL ±1.5WLY+TL |

The various service loads combinations of structure as per IS 456 are as follows

| | | | |
|---|---|---|---|
| 27 | (DL+IL) | 32 | 1.0DL+0.8IL ±0.8EQX |
| 28 | (DL ±EQX) | 33 | 1.0DL+0.8IL ±0.8EQY |
| 29 | (DL ±EQY) | 34 | 1.0DL+0.8IL ±0.8WLX |
| 30 | (DL ±WLX) | 35 | 1.0DL+0.8IL ±0.8WLY |
| 31 | (DL ±WLY) | | |

Software's for the Analysis & Design:

1. ETAB
2. Safe-12.4
3. STAAD-Pro
4. Plan win & Frame win
5. PROKON
6. RCDC
7. Excel program sheets.

6.0 Block 1, 2 & 3

## 6.1 Imposed Loads:

Imposed loads are assumed in accordance with IS 875 part 2, as follows.
The table listed below is a summary of this load.

**Basement Podium:**

| Sr.No. | Area Description | Floor Finish | Services | Live load | Super imposed dead load | Remark / comment |
|---|---|---|---|---|---|---|
| | | kN/sq.m | kN/sq.m | kN/sq.m | | |
| 1 | Fire tender route | 3 | 0.5 | 12 | - | 150mm waterproofing |
| 2 | Parking | 2 | 0.5 | 3 | - | |
| 3 | Driveway/Ramp | 1.5 | 0.5 | 3 | 3 | 150mm waterproofing |
| 4 | Swimming Pool | 3.0 | 0.5 | 15 | - | 150mm waterproofing |
| 5 | Landscape | 12 | 0.5 | 3 | - | 450 mm soil fill & 150 mm waterproofing |

**Club House:**

| Sr.No. | Area Description | Floor Finish | Services | Live load | Super imposed dead load | Remark / comment |
|---|---|---|---|---|---|---|
| | | kN/sq.m | kN/sq.m | kN/sq.m | | |
| 1 | Loundry | 1.5 | 0.5 | 3 | - | |
| 2 | Gym | 1.5 | 0.5 | 5 | - | |
| 3 | Playing Area | 1.5 | 0.5 | 3 | - | |
| 4 | Auditorium room | 1.5 | 0.5 | 4 | - | |
| 5 | Waiting Launge | 1.5 | 0.5 | 3 | - | |
| 6 | Toilet | 1.5 | 0.5 | 2 | 2 | 100 mm sunk |

**Typical Floor (1st TO 22th floor):**

| Sr.No. | Area Description | Floor Finish | Services | Live load | Super imposed dead load | Remark / comment |
|---|---|---|---|---|---|---|
| | | kN/sq.m | kN/sq.m | kN/sq.m | | |
| 1 | Room | 1.5 | - | 2 | - | - |
| 2 | Staircase | 1.5 | - | 3 | 3 | - |
| 3 | Passage | 1.5 | - | 3 | - | - |
| 4 | Deck/Balcony | 1.5 | - | 3 | 3.0 | 150mm thk filling |
| 5 | Toilet | 1.5 | - | 2 | 2.0 | 100mm thk filling |
| 6 | Service slab | 1.5 | 0.5 | 3 | - | - |
| 7 | Chajja | 1.5 | - | 2 | - | - |

- For AAC walls on slab, Load is calculated with density of 10 kN/cum.

**Terrace Floor:**

| Sr.No. | Area Description | Floor Finish | Services | Live load | Super imposed dead load | Remark / comment |
|---|---|---|---|---|---|---|
| | | kN/sq.m | kN/sq.m | kN/sq.m | | |
| 1 | Terrace | 3 | | 2 | - | (150thk. Waterproofing assumed |
| 2 | Solar panel level | 3 | | 3 | - | (150thk. Waterproofing assumed |
| 3 | LMR | 2 | 0 | 2 | 10 | |
| 4 | OHT | 3 | 0 | - | 36 | (3600mm ht water load considered |

## 6.2 Analysis Approach

### 6.2.a. Structural Geometry:

The structure consists of B+G+22 slabs. The slabs with their description, levels, heights and approximate areas of single tower are given in table below:

| Floor | Height | APPROXIMATE |
|---|---|---|
| | M | AREA IN SQ.M. |
| OHT level | 3.1 | 84 |
| LMR | 4.0 | 28 |
| Terrace floor | 2.95 | 2516 |
| 21st floor | 2.95 | 2516 |
| 20th floor | 2.95 | 2516 |
| 19th floor | 2.95 | 2516 |
| 18th floor | 2.95 | 2516 |
| 17th floor | 2.95 | 2516 |
| 16th floor | 2.95 | 2516 |
| 15th floor | 2.95 | 2516 |
| 14th floor | 2.95 | 2516 |
| 13th floor | 2.95 | 2516 |
| 12th floor | 2.95 | 2516 |
| 11th floor | 2.95 | 2516 |
| 10th floor | 2.95 | 2516 |
| 9th floor | 2.95 | 2516 |
| 8th floor | 2.95 | 2516 |
| 7th floor | 2.95 | 2516 |
| 6th floor | 2.95 | 2516 |
| 5th floor | 2.95 | 2516 |
| 4th floor | 2.95 | 2516 |
| 3rd floor | 2.95 | 2516 |
| 2nd floor | 2.95 | 2516 |
| 1st floor | 2.95 | 2516 |
| Ground | 3.8 | 2516 |

### 6.2.b. Stiffness modifier:

For structural analysis and Design at Ultimate loads, following are the values of stiffness Modifiers that must be used as per clauses 7.2 in IS 16700: 2017(Table no.6)

**TABLE NO.6 CRACKED RC SECTION PROPERTIES**

| S. No | Structural element | Un-factored Loads | | Factored Loads | |
|---|---|---|---|---|---|
| i) | Slabs | 1.0 Ag | 0.35 Ig | 1.00 Ag | 0.25 Ig |
| ii) | Beams | 1.0 Ag | 0.7 Ig | 1.00 Ag | 0.35 Ig |
| iii) | Columns | 1.0 Ag | 0.9 Ig | 1.00 Ag | 0.70 Ig |
| iv) | Walls | 1.0 Ag | 0.9 Ig | 1.00 Ag | 0.70 Ig |

**6.2.c. Structural Frames**

The proposed structure is designed for Building with ductile RC structural shear walls with R = 4 as per IS 1893-2016. Floor slabs are considered horizontal diaphragms transferring earthquake & wind loads to the walls.

a) Structural walls shall be found at raft level.
b) AAC Block walls shall be used for partitions.

**6.3. Seismic Analysis:**

**6.3.(i) General Principles and design criteria**

The structure is located in seismic zone III. The design lateral force will have calculated as per the method described in the following paragraphs. The structure is primarily shear wall and beam framing system although due considerations will be given to the major suggestions/clauses from IS 13920, the basic structure is ductile RC structural walls as per table 9 (IS1893).

**6.3.(ii) Design Spectrum**

Seismic Analysis (Initial analysis for preliminary wall sizing)

The design Horizontal seismic coefficient for a structure

$$Ah = \frac{Z\,I\,S}{2\,R\,g}$$ IS 1893-2016 Clause 6.4.2

Where,

Z = Zone factor 0.16 for Zone III — Table 3

I = Importance Factor (1.20) — Table 8

R = Response reduction factor 4

For Building with ductile RC structural walls — Table 9

Design Seismic Base shear in X-direction

Tx = 0.075H^0.75/((Awx)^0.5).....For RC frame building Clause 7.6

Where,

Tx is Fundamental natural period in X-Direction

h = Height of the structure= 69.1 m

d = Base dimension of the building at plinth lvl.

Awx = Total effective area (m2) of walls in the first story of the building.

Design Seismic Base shear in Y-direction

Ty = 0.075H^0.75/((Awx)^0.5).....For RC frame building Clause 7.6

Sa/g = 1/Ty

Where,

Ty is Fundamental natural period in Y-Direction

h = Height of the structure= 64.9 m

d = Base dimension of the building at plinth lvl.

Aw = Total effective area (m2) of walls in the first story of the building.

Base shear in Y-direction

$V_b = A_h W$

Where,

W = Seismic weight in KN

Ah= Horizontal. Seismic coefficient value

## 6.4. Control of Deflection

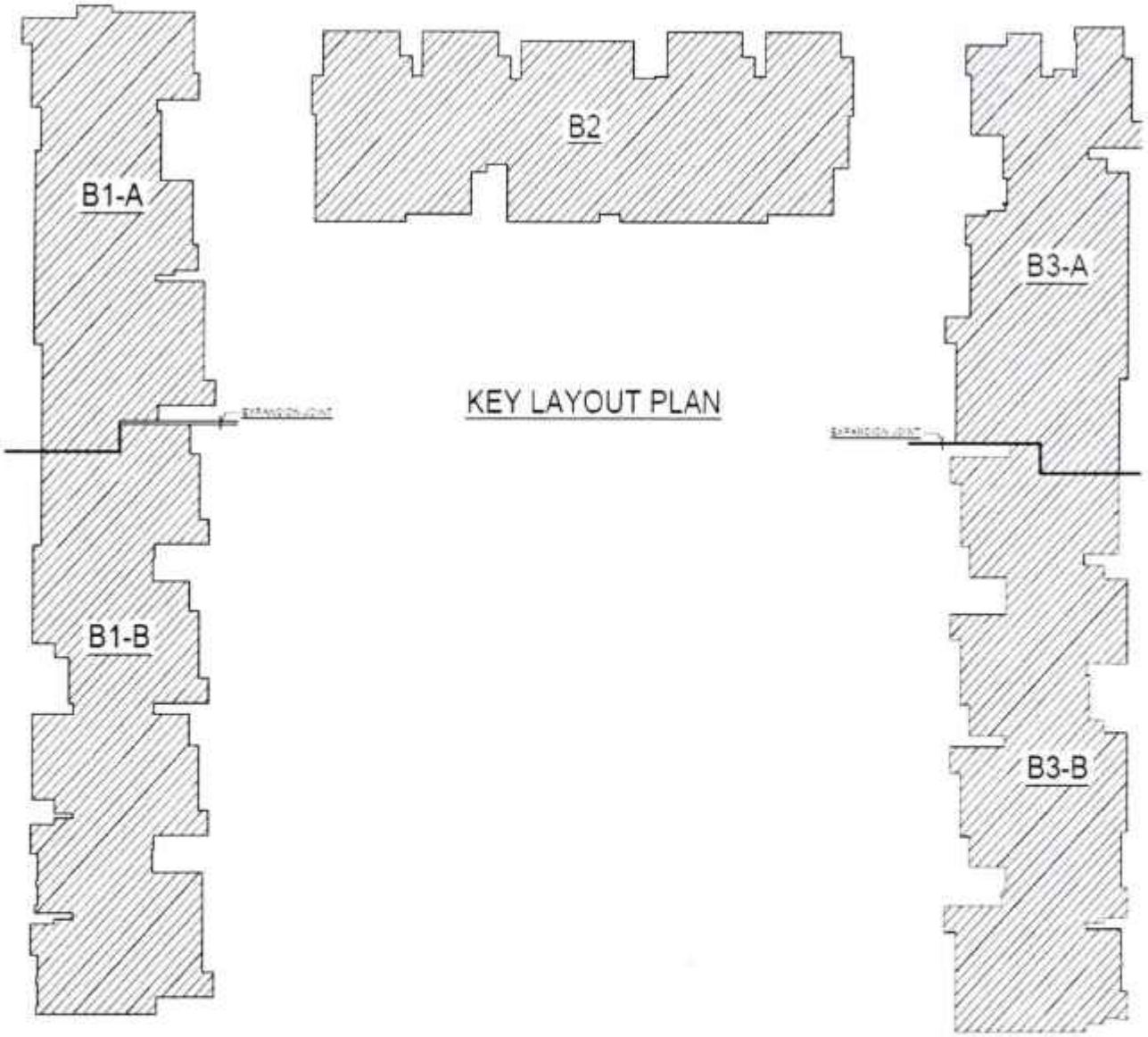
The Deflection of a structure or part thereof shall not adversely affect the appearance or efficiency of the strcture or finishes or partitions. The deflection shall generally be limited to the following:

a) The final deflection due to all loads including the effects of temperature, creep and shrinkage and measured from the as-cast level of the supports of floors, Roofs and all other horizontal members should not normally exceed span/250 or 20mm whichever is less.

b) The deflection including the effects of temperature, creep and shrinkage occurring after erection of partition and the application of finishes should not normally exceed span/350 or 20mm whichever is less.

## 7.0 KEY PLAN AND MODELLING:

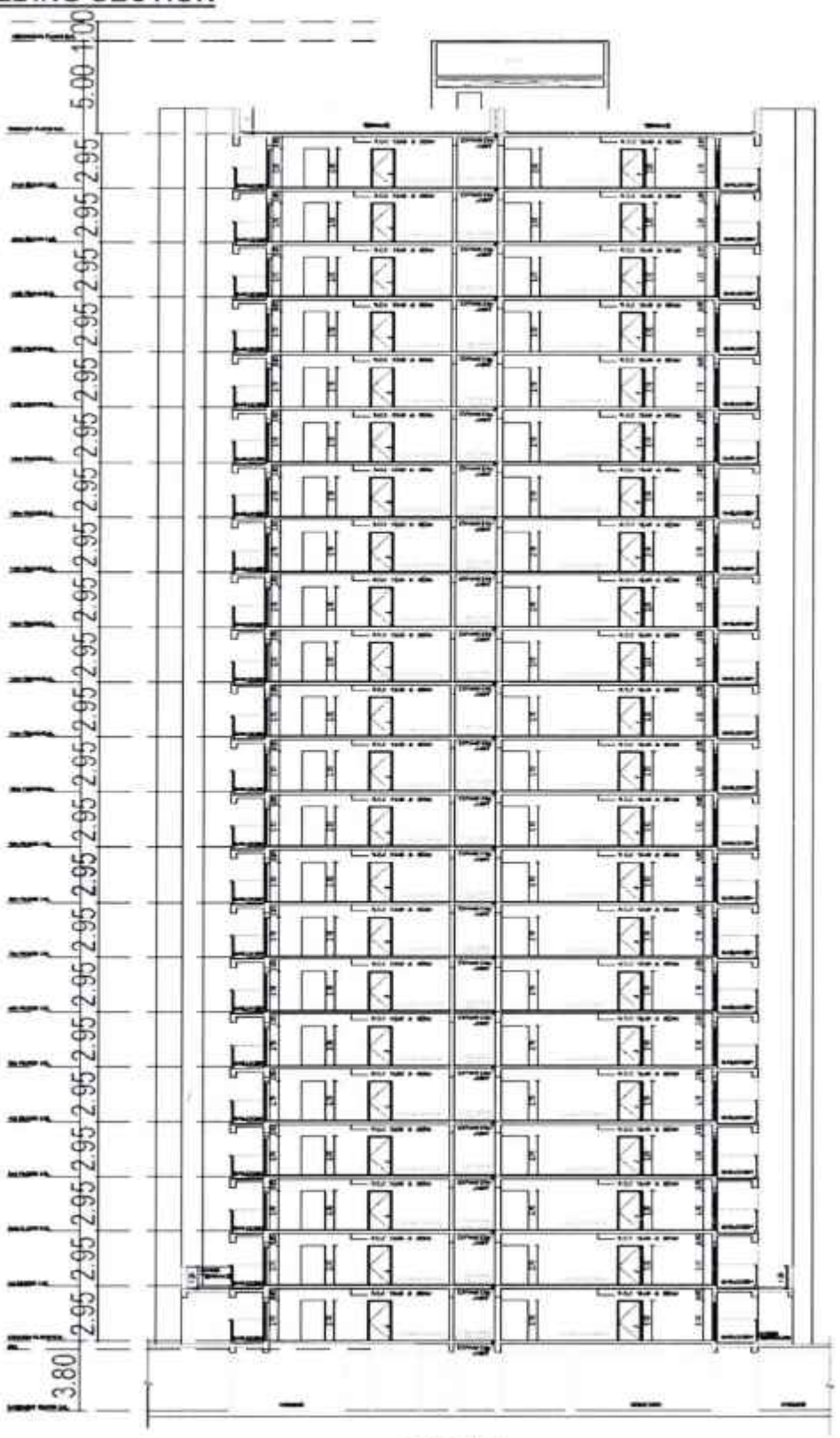
### 7.1 KEY LAYOUT PLAN:




KEY LAYOUT PLAN

## 7.2 STRUCTURAL FRAMING

### 7.2 A) BUILDING SECTION




SECTION - 1

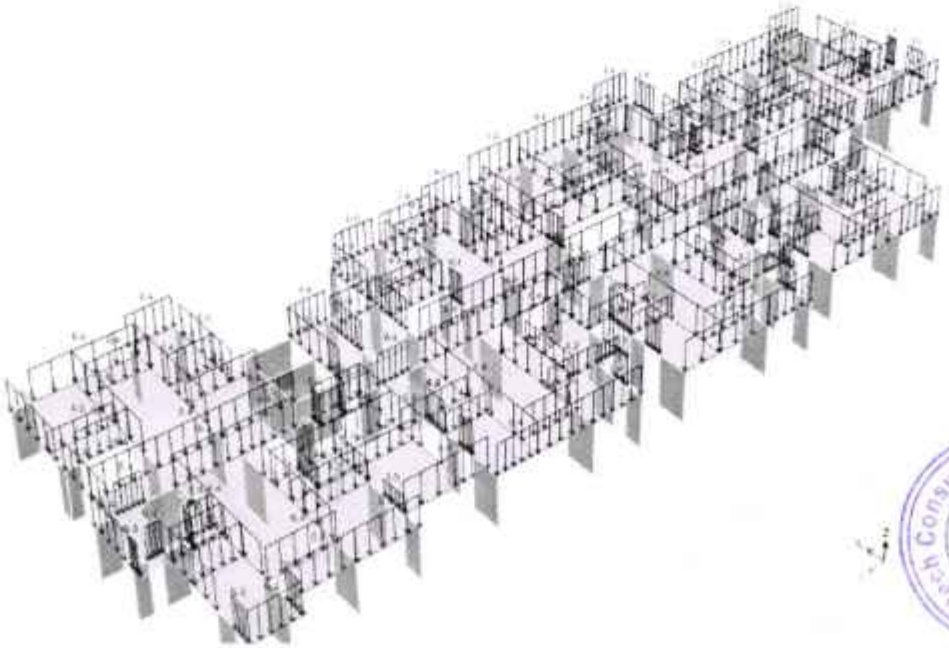
## 7.2 b) Typical Floor Beam & Slab Framing Plan:

## 7.3 Model Description:

The structure is modeled using finite element software ETABS. Fixed support condition is considered at bottom of raft. All the slab, beams, Shear walls & raft are proposed as RCC elements. The structural system mainly consists of moment resisting reinforced concrete frame. Beams are modeled as line element, conventional slab as membrane/ shell & shear wall as shell. The diaphragm is assigned to slab element to apply wind load & seismic load. The analysis is carried out in ETABS software.

A) 3D- View :

B) Typical Floor Distributed Loads:



# 8 CONCLUSIONS:

## 8.1 Other loads:

Any other loads like those of services; storage etc will be obtained from time to time from the relevant consultants an d incorporated. The top slab of the lift shaft will be designed for lift loads as obtained from the manufacturer.

## 8.2 Shear wall locations:

The locations of the shear wall are retained as per conceptual drawings received. Although additional shear walls are added wherever required, final orientation of the shear walls and their sizing has been decided after discussion with the architects and mutually agreed upon. The structural model will be developed after this process. Any changes with regards to shear wall sizes or locations requested would have to be studied on a case-to-case basis with possible effects on other shear walls.

This DBR attempts to briefly cover all design related methods and assumptions at this stage of the project. As the project progresses certain revisions to the DBR might be warranted and such timely revisions of this report will be promptly provided by us.

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