DESIGN BASIS REPORT

(FOR RESIDENTIAL TOWERS)

NOVEMBER 24, 2022

REV. R3

PROPOSED RESIDENTIAL PROJECT FOR SATATYA RESI.

AT

TRAGAD, AHMEDABAD

STRUCTURAL CONSULTANT:

DUCON CONSULTANTS PVT. LTD.
A3/A4, SAFAL PROFITAIRE,
CORPORATE ROAD,
PRAHLADNAGAR AUDA GARDEN,
SATELLITE AHMEDABAD – 380058

PREPARED BY:

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ARCHITECT:

ARTHAM ARCH ,AHMEDABAD.

PROJECT NO : 4622

PROJECT NAME : PROPOSED RESIDENTIAL PROJECT FOR SATATYA RESI. @ TRAGAD, AHMEDABAD

TOWER – A (4bhk) 2B+G+ 22FLOORS+TERRACE

TOWER – B (3bhk) 2B+G+ 22FLOORS+TERRACE

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1. INTRODUCTION

"SATATYA" has appointed **DUCON CONSULTANTS Pvt. Ltd.** to develop structural schemes and design for proposed construction of **Residential Project at TRAGAD, AHMEDABAD.**

The objectives of these reports are stated as follows:

- Identify and record all input requirements, Analysis and design criteria.
- Develop safe and stable structural scheme pertaining to Indian Standards compatible with Architectural vision, services requirements and client's needs.
- Prepare structural design that will aim to actual structural durability and integrity.
- Desirable structural performance under characteristic services load.

2. PROJECT DESCRIPTION

Project	:	**RESIDENTIAL PROJECT FOR SATATYA RESI.**
Location	:	**TRAGAD,AHMEDABAD**

2.1 AGENCIES

Client	:	SATATYA RESI
Design Architects	:	ARTHAM,AHMEDABAD,GUJARAT,INDIA
Structural Consultants	:	**DUCON Consultants Private Limited** A3-A4, 3rd floor, Safal Profitaire, Corporate Road, Near prahladnagar garden, S. G. Road, Ahmedabad. Ph: 079-40073196, 079-29705245 E-mail: **utsav@duconconsultants.in** **contact@duconconsultants.in**

2.2 PROJECT

The project comprise of 2 towers(A AND B) 2 Basement floor + Ground floor+ 22 Floors+ OHWT being used for residential purpose. Structural system for both towers will primarily be ductile shear wall system with beam grids.

There are two basements in the project. Structural system of all basements for tower area shall be same as upper floors (i.e. Shear walls with beam grid). And for non-tower area, structural system for all basements is moment frame (columns with beam grid) system and basement walls on periphery. Ground floor diaphragm will transfer the lateral load to basement walls.

Basements are very large and connected with both towers at ground floor level. **As per provisions of IS 16700 Clause No. 8.1.3,** entire basements shall be modeled as one single unit as per actual framing plans to check backstay effect and sensitivity analysis. Corresponding storey shears at ground floor of both towers shall be applied in basement model at respective tower diaphragms. For each tower, separate lateral load case will be generated to apply ground floor storey shear of each tower. Then required load combinations will be generated to design basement framing elements for worst combination condition.

An expansion joint of 50mm is provided between 2 towers to avoid pounding effect between 2 towers and also to control lateral sway effect. Structural form should contribute to the building character and identity, while being efficient, cost effective and simple to construct. Provisions will be done in design such a way that services can be laid without any major obstructions and maximum head room is achieved along with the basic criterion of cost-effectiveness.

2.3 BUILDING DIMENSION

2.3.1 Plan dimensions(Typical Floors) : (Refer Relevant Architectural Plans)

Tower-A : 28.205 m X 23.991 Meters
Tower-B : 28.355 m X 30.420 Meters

2.3.2 Floor Heights

Tower A & B (2B+G+22 floors)

Total Height of building : 73.420m (From Ground Floor to Terrace)
2nd Basement Roof Slab level : 4 m
1st Basement Roof Slab level : 4 m
Ground Floor Roof Slab level : 3.8 m
1st Floor Roof Slab level : 3.67 m
Typical Floor Slab level : 3.14 m

2.3.3 Plan Aspect Ratio

1) Length of Building/Width of Building : 28.205/23.991 =1.175< 5 (3bhk Tower-B) Hence O.K (IS 16700:2017:5.2)
2) Length of Building/Width of Building : 28.355/30.420 =0.932< 5 (4bhk Tower-A) Hence O.K (IS 16700:2017:5.2)

2.3.4 Structural System

Well distributed RC Structural Wall System : Hence O.K (IS 16700:2017: Table 1)

Table 1 Maximum Value of Height, *H* Above Top of Base Level of Buildings with Different Structural Systems for Lateral Loads, in metre

(*Clause* 5.1.1)

Sl No.	Seismic Zones	Structural System				
		Moment Frame	Structural Wall Well-Distributed[1)]	Structural Wall + Moment Frame	Structural Wall + Perimeter Frame	Structural Wall + Framed Tube
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	V	NA	120	150	150	180
ii)	IV	NA	150	200	200	225
Iii)	III	60	200	225	225	250
iv)	II	80	250	250	250	250

2.3.5 Slenderness Ratio

Height of Building/Width of Building : 73.420/23.991=3.05<8(3bhk-Tower-B) Hence O.K (IS 16700:2017: Table 2)

Height of Building/Width of Building : 73.420/30.420=2.41<8(4bhk-Tower-A) Hence O.K (IS 16700:2017: Table 2)

Table 2 Maximum Slenderness Ratio (H_t/B_t)
(*Clause* 5.1.2)

Sl No.	Seismic Zones	Structural System				
		Moment Frame	Structural Wall	Structural Wall + Moment Frame	Structural Wall + Perimeter Frame	Structural Wall + Framed Tube
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	V	NA	8	8	9	9
ii)	IV	NA	8	8	9	9
Iii)	III	4	8	8	9	10
iv)	II	5	9	9	10	10

3. STRUCTURAL DESIGN STANDARDS AND CODES

Following Indian codes shall here to be used for detailed design.

3.1 INDIAN CODES

3.1.1 LOADS

IS 875(Part 1):1987	-	Dead Loads - Unit Weight of Building Material and Stored Material
IS 875(Part 2):1987	-	Imposed Loads
IS 875(Part 3):2015	-	Wind Loads
IS 875(Part 5):1987	-	Special loads and load combinations
IS 1893(Part 1):2016	-	Criteria for earthquake resistance design of structure
IS 16700: 2017	-	Criteria for Structural Safety of Tall Concrete Buildings
NBC:2016	-	National building code of India

3.1.2 CONCRETE DESIGN

IS 456:2000	-	Plain and Reinforced Concrete - Code of practice
SP16	-	Structural use of concrete. Design charts for singly reinforced beams, doubly reinforced beams and columns
SP 34	-	Handbook on Concrete Reinforcement & Detailing
IS 1904	-	Indian Standard Code of practice for design & construction of foundations in Soil: General Requirements
IS 13920:2016	-	Ductile design and detailing of Reinforced Concrete Structures subjected to Seismic Forces
IS 16700:2017	-	Criteria for Structural Safety of tall concrete Building
IS 3370:2009	-	Code of practice for concrete structure for storage of liquid

3.1.3 STEEL DESIGN

IS: 800-2007	-	Code of practice for general construction in steel
IS: 2062-2011	-	Hot rolled medium & high tensile structural steel specification
IS: 806-1968	-	Code of practice for use of steel tubes in general building Construction
IS: 4000-1992	-	Code of practice for high strength bolt in steel structure
IS: 816-1969	-	Code of practice for use of metal arc welding for general Construction in mild steel

3.1.4 COMPOSITE DESIGN

AISC 360-10	-	Specification for Structural Steel Buildings

4. DESIGN PARAMETERS

4.1 Material of Construction

4.1.1 RCC WORKS

The building will primarily be RCC wall frame structure with shear walls, lift walls and beams. Floor slabs of this structure are being used as diaphragms in distribution of lateral forces.

- Density of reinforced concrete shall be **25 kN/m³**.

Structural Elements	Design grade of concrete	Recommended grade of concrete
Concrete mix for Columns and Shear wall from foundation to 2FRS	**M45**	**M50**
Concrete mix for Columns and Shear wall from 3RD^{t} floor roof slab to 6th floor roof slab.	**M40**	**M45**
Concrete mix for Columns and Shear wall from 7th floor roof slab to 11th floor slab.	**M35**	**M40**
Concrete mix for Columns and Shear wall from 12th floor roof slab to TERRACE	**M30**	**M35**
Concrete mix for non-tower Columns from foundation to 1st Basement floor roof slab.	**M45**	**M50**
Concrete mix for slabs and beams from Basement floor roof slab to 2ND FRS.	**M35**	**M40**
Concrete mix for slabs and beams above 2nd FRS	**M30**	**M35**
Concrete mix for slabs and beams above TERRACE slab to OHWT top slab.	**M30**	**M35**
Concrete mix for U.G.W.T / STP	**M30**	**M30**
Concrete mix for Retaining walls and pilasters	**M30**	**M30**
Concrete mix for footing	**M30**	**M30**
Deck slab Concrete	**M30**	**M30**
Concrete mix for 150mm thick grade slab	**M30**	**M30**

- Grade of Concrete **M:15** will be used in filling, plum concrete, leveling courses and other non-structural items. Density of reinforced concrete is assumed as 25 kN/m^3.
- Minimum cement content, water cement ratio etc. will conform to ***IS 456:2000*** provisions for durability and strength criteria. (As per approved mix design from concrete supplier and contractor)

- Ordinary Portland cement of **grade 43** or higher confirming **to *IS 8112*** and ***IS 12269*** are specified for concrete grades.
- The sizes of aggregates conform to ***IS 383***. Nominal maximum size of coarse aggregate is 20 mm, suitably graded as per the requirement of mix design.
- Mixing Water will conform to ***IS 456: 2000***.
- High yield strength deformed TMT bars **Fe 500D** conforming to ***IS 1786 : 2008*** with **F_y = 500 N/mm^2** will be used as Reinforcing-bars in concrete elements.
- Elongation of reinforcement should not be less than 16% as per ***IS 1786 : 2008.***
- All mix design of concrete should be got approved prior to execution of work.
- Take out 6 cubes from every batch of concrete and report of the same of 7 days and 28 days must be submitted to us.
- For reinforcement, test report should be carried out at every 30 ton for each category.

4.1.2 STRUCTURAL STEEL

- All structural steel shall conform to ***IS -2062-2011.***
- Grade of Structural steel for different Built-up members shall be as follows:
  Steel beams - S350 (i.e. fy=350 N/mm2)
- Grade of Structural steel for Hot rolled members shall be S350 (i.e. fy=350 N/mm2)
- Grade of Structural steel for MS plates & MS bars shall be S350 (i.e. fy=350 N/mm2)
- Grade of profiled metal deck TR60 or Equivalent shall be S350 (i.e. fy=350 N/mm2)
- Grade of shear stud shall be S350 (i.e. fy=350 N/mm2)
- High strength structural bolts, nuts and washers shall confirm to ***IS 3757, IS 6623, IS 6649 & IS 4000.***
- All weld shall confirm to ***IS 816***.

4.1.3 COMPOSITE ELEMENTS

- **Composite slab**

  Composite slabs comprise reinforced concrete cast on top of profiled metal decking 1 mm thk, which acts as formwork during construction and external reinforcement at the final stage. Metal deck is connected on top flange of beams by through deck welded shear studs and intended to transmit to horizontal shear between steel sections and cast in situ concrete. It also prevents vertical separation at the interface.

- **Composite beams**

  Composite beam is one where a composite slab sits on top of a down stand beam, connected by the use of through deck welded shear studs. This form of construction offers a number of advantages - the decking acts as external reinforcement at the composite stage, and during the construction stage as formwork and a working platform. It may also provide lateral restraint to the beams during construction.

4.2 LOADING PARAMETERS

4.2.1 SELF WEIGHTS

Self-weight of the structural members shall here to be considered on the basis of the following properties.

- Density of Reinforced Concrete : 25.0 kN/m^3
- Density of Plain Concrete : 24.0 kN/m^3
- Density of Steel : 78.5 kN/m^3
- Density of Floor Finishes / Plasters : 20.0 kN/m^3
- Density of Soil (Unsaturated) : 18.0 kN/m^3
- Density of Soil (Saturated) : 21.0 kN/m^3
- Density of Light Weight Cinder Filling Material : 12.0 kN/m^3
- Density of Light weight aerated concrete block : 8.0 kN/m^3

4.2.2 IMPOSED GRAVITY LOADS

The following imposed gravity loads shall be adopted in addition to the self-weight of the structure. (Self-weight of slab / beam / columns and wall will be as per the dimensions adopted in the respective drawings.)

4.2.2.1 LIVE LOAD

2nd Basement floor roof slab

- Parking, Driveway, Ramp,Foyer = 5 kN/m^2
- Tower area = 5 kN/m^2
- Staircase = 5 kN/m^2
- Non-Tower Area = 5 kN/m^2

1st Basement floor roof slab

- Parking (Tower Area) = 3 kN/m^2
- Parking and Driveways (Non tower area) = 5 kN/m^2
- Ramp and Foyer = 5 kN/m^2
- Security Cabin = 5 kN/m^2
- Fire Tender driveway - 15T (Non tower area) = 15 kN/m^2
  (Considering 300mm filling, though filling load will be extra)

Bifurcation of 15 kN/m^2 Fire tender load adopted in ETABS Model	
Partial BLL	= 5 kN/m^2 (Not Considered in Mass source)
Partial Fire tender	= 15 kN/m^2 (Not Considered in Mass source)

Ground floor roof slab

- Liberary = 3 kN/m^2
- Salon = 3 kN/m^2
- Cafe = 3kN/m^2
- Salon = 3 kN/m^2
- Home Theatre = 3kN/m^2
- Sitout = 3kN/m^2
- Staircase = 3 kN/m^2
- Foyer = 3kN/m^2
- Toddler Play Area = 3 kN/m^2
- Indoor Children Play Area = 3 kN/m^2
- Walk Way = 3KN/m^2
- Multipurpose Court = 3KN/m^2
- Open garden = 3KN/m^2
- Pocket garden = 3KN/m^2
- Gym = 3KN/m^2
- Banquet Hall = 3KN/m^2
- Open Terrace = 3KN/m^2

Typical Floor Roof Slab

- Bed room = 2 kN/m^2
- Living room = 2 kN/m^2
- Drawing room = 2 kN/m^2
- Toilets & Bathrooms = 2 kN/m^2
- kitchen = 2 kN/m^2
- Lift Lobby area = 3 kN/m^2
- Staircase = 3 kN/m^2
- Refuge area = 5 kN/m^2

Terrace floor slab

- Terrace live = 3 kN/m^2
- Lift Lobby area = 3kN/m^2
- Staircase = 3 kN/m^2

Upper Terrace (Staircabin/LMR/OHWT level)

- Stair cabin slab = 2 kN/m^2
- OHWT top slab = 2kN/m^2

Live load reduction is carried out as per the design code IS: 875:1987

Number of Floors (Including the Roof) to be Carried by Member under Consideration	Reduction in Total Distributed Imposed Load on all Floors to be Carried by the Member under Consideration (Percent)
1	0
2	10
3	20
4	30
5 to 10	40
Over 10	50

4.2.2.2 DEAD LOAD (Both Towers)

2nd Basement floor roof slab

- Floor Finish – Parking, Driveway, Ramp,Foyer = 2.5 kN/m^2
- Floor Finish –Tower area = 2.5 kN/m^2
- Floor Finish – Staircase (Including step concrete) = 4.6 kN/m^2
- Floor Finish –Non-Tower Area = 2.5 kN/m^2
- Suspended MEP services = 0.5 kN/m^2
- Treated U.G.W.T Tank
  (3000mm Height of water-10kN/m^2 = 30kN/m^2
- Water load on U.G.W.T domestic tank = 39kN/m^2
  (3900mm Height of water-10kN/m^2)
- Water load on U.G.W.T fire tank = 39kN/m^2
  (3900mm Height of water-10kN/m^2)
- Water load collection tank = 20kN/m^2
  (2000mm Height of water-10kN/m^2)

1st Basement floor roof slab

- Parking (Tower Area) = 2.5 kN/m^2
- Parking and Driveways (Non tower area) = 2.5 kN/m^2
- Ramp and Foyer (Non tower area) = 2.5 kN/m^2
- Security Cabin = 2.5 kN/m^2
- Fire Tender = 15 kN/m^2
- Filling(300mm soil filling) = 6.3 kN/m^2

Ground Floor Roof Slab

- Liberary = 3.6 kN/m^2
- Salon = 3.6 kN/m^2
- Cafe = 3.6kN/m^2
- Salon = 3.6 kN/m^2
- Home Theatre = 3.6kN/m^2
- Sitout = 3.6kN/m^2
- Staircase = 4.6 kN/m^2
- Foyer = 3.6kN/m^2
- Toddler Play Area = 3.6 kN/m^2
- Indoor Children Play Area = 3.6 kN/m^2
- Walk Way = 3.6KN/m^2
- Multipurpose Court = 3.6KN/m^2
- Open garden = 3.6KN/m^2
- Pocket garden = 3.6KN/m^2
- Gym = 3.6KN/m^2
- Banquet Hall = 3.6KN/m^2
- Open Terrace = 3.6KN/m^2
- Services = 0.5KN/m^2
- Floor Finish = 1.5KN/m^2

Typical floor slab

- Floor finish(All Area) = 1.5 kN/m^2
- Service(All Area) = 0.25kN/m^2
- Floor Finish – Staircase (Including step concrete) = 4.6 kN/m^2

- Filling Load On Balcony = 0.6 kN/m^2
- 225mm sunk in toilet = 2.7 kN/m^2
- Floor Finish On Chajja = 1.25kN/m^2
- Refugee Area = 2.5kN/m^2

Terrace/Upper Terrace (Staircabin/LMR/OHWT level)

- Floor Finish – Stair cabin slab (Including water proofing) = 1.5 kN/m^2
- Floor Finish OHWT bottom slab (Including water proofing) = 1.5 kN/m^2
- Floor Finish OHWT top slab (Including water proofing) = 1.5 kN/m^2
- Floor Finish – LMR bottom slab = 1.5 kN/m^2
- Floor Finish – LMR top slab (Including water proofing) = 1.5 kN/m^2
- Water load on OHWT bottom slab = 20kN/m^2
- LMR top slab = 15 kN/m^2
- Floor finish on Terrace = 2.5kN/m^2

Note:

1. Floor finish load on Staircase is derived as mentioned below;
   Floor finish of slab = 1.875 kN/m^2
   Floor finish of steps = 1.8 x 1.5 = 2.7 kN/m^2
   Total floor finish load on stair = 2.7 + 1.875 = 4.57 kN/m^2 = 4.6 kN/m^2
2. Specific loads given by vendors will be adopted wherever applicable.
3. U.G.W.T, STP, D.G. Area and Substation area loads will be considered in basements as per final plans.
4. Vibration isolation pad shall be used for MEP Equipment's wherever necessary to avoid transmitting vibrations to main structure.

4.2.2.4 SELF - WEIGHT OF DIFFERENT WALLS (For Both the Towers)

- **Floor height 4000mm: (At 2nd Basement floor roof slab level)**
  230mm thick AAC Block wall
  = (4-0.6) X (0.230 x 8)+(0.032x20) = 8.432kN/m
  230mm thick non-structural RCC wall
  = (4-0.6) X (0.230 x 25)+(0.024x20) = 24kN/m
  300mm thick non-structural RCC wall
  = (4-0.6) X (0.30 x 25)+(0.024x20) = 27.132kN/m
- **Floor height 3800mm: (At 1st Basement floor roof slab level)**
  230mm thick AAC Block wall
  = (3.8-0.6) X (0.230 x 8)+(0.032x20) = 7.936kN/m
  115mm thick AAC block wall
  = (3.8-0.6) x (0.115 x 8)+(0.032x20) = 4.992kN/m
  230mm thick non-structural RCC wall
  = (3.8-0.6) X (0.230 x 25)+(0.024x20) = 20kN/m
  300mm thick non-structural RCC wall
  = (3.8-0.6) X (0.30 x 25)+(0.024x20) = 25.536kN/m
- **Floor height 3670mm: (At Ground floor roof slab level)**
  115mm thick AAC Block wall
  = (3.67-0.6) X (0.115 x 8)+(0.032x20) = 4.8 kN/m

230mm thick AAC Block wall
= (3.67-0.6) X (0.230 x 8)+(0.032x20) = 7.636kN/m

230mm thick non-structural RCC wall

= (3.67-0.6) X (0.230 x 25)+(0.024x20) = 19.12kN/m

300mm thick non-structural RCC wall

= (3.67-0.6) X (0.30 x 25)+(0.024x20) = 24.986kN/m

- **Floor height 3140mm: (At Typical floor roof level)**

115mm thick AAC Block wall
= (3.14-0.6) X (0.115 x 8)+(0.032x20) = 4kN/m

230mm thick AAC Block wall
= (3.14-0.6) X (0.230 x 8)+(0.032x20) = 6.3kN/m

230mm thick non-structural RCC wall

= (3.14-0.6) X (0.230 x 25)+(0.024x20) = 15.82kN/m

300mm thick non-structural RCC wall

= (3.14-0.6) X (0.30 x 25)+(0.024x20) = 20.26kN/m

- **Terrace Parapet 2300mm:**

230mm thick R.C.C. Parapet wall
= (1.8) X [(0.230 x 25) + (0.032X20)] = 10 kN/m

150mm thick R.C.C. Parapet wall(OHWT)
= (1.8) X [(0.15 x 25) + (0.024X20)] = 9.864 kN/m

*Wall loads are considered as per architectural plans at respective levels.

4.2.3 SEISMIC LOADS

The seismic load calculations will be carried out in accordance with *IS 1893(Part 1): 2016.* As per the code, **Ahmedabad** lies in **Zone III**, zone factor **Z = 0.16.**

The Design of Base Shear is given by $V_b = (Z/2) \times (I/R) \times (Sa/g) \times W$ *w*here, Importance factor, I will be taken as **1.2** as it is residential building with occupancy more than 200 person as per *IS 1893 : 2016* and response reduction factor **R will be taken as '4'**, as RCC Structural walls are used as lateral load resisting elements.

S_a / g is the normalized Response Spectrum value for the structure which is the function of the fundamental time period of vibration of the structure and the type of the founding soil. *W* is the Seismic Weight of the building, which will be calculated in accordance with the relevant clause in, *IS 1893(Part 1):2016.*

The design vertical earthquake effects is considered as per IS-1893-2016 cl. 6.3.3.1 and the parameters to be consider in the analysis of model are as follows.

The design seismic acceleration spectral value A_v for vertical motions of the building as per IS 1893-2016 cl.6.4.6 is given by

$$A_v = \frac{\frac{2}{3} X \frac{Z}{2} X 2.5}{\frac{R}{I}}$$ For buildings governed by IS 1893 (Part 1)

- **Time period calculation**

Time period in both directions will be evaluated for following three conditions and appropriate time period will be chosen for building design.

With infill wall equation = $0.09 \times h/(Dx)^{0.5}$

With shear wall equation = $0.075 \times (h)^{0.75}/(Aw)^{0.5}$

Without infill wall equation = $0.075 \times (h)^{0.75}$

> Note: Shear wall time period should fall in between Infill wall time period and without infill wall time period. In case shear wall time period is less than with infill wall time period than with infill wall time period shall be used.

A. With Infill Wall.(TOWER B - 3BHK)

Time period in X direction = $0.09 \times h/(Dx)^{0.5}$ (h=From 1st Basement roof slab to Terrace)
= $0.09 \times 73.420/(28.205)^{0.5}$
= 1.244sec

Time period in Y direction = $0.09 \times h/(Dy)^{0.5}$ (h=From 1st Basement roof slab to Terrace)
= $0.09 \times 73.420/(23.991)^{0.5}$
= 1.331sec

B. With Infill Wall.(TOWER A - 4BHK)

Time period in X direction = $0.09 \times h/(Dx)^{0.5}$ (h=From 1st Basement roof slab to Terrace)
= $0.09 \times 73.420/(28.355)^{0.5}$
= 1.24 sec

Time period in Y direction = $0.09 \times h/(Dy)^{0.5}$ (h=From 1st Basement roof slab to Terrace)
= $0.09 \times 73.420/(30.420)^{0.5}$
= 1.197 sec

C. Without Infill Wall (TOWER A - 4BHK)

Time period in X direction = $0.075x (h)^{0.75}$ (h=From 1st Basement roof slab to Terrace)
= $0.075 \times (73.420)^{0.75}$
= 1.88 sec

Time period in Y direction = $0.075x (h)^{0.75}$ (h=From 1st Basement roof slab to Terrace)
= $0.075 \times (73.420)^{0.75}$
= 1.88sec

D. Without Infill Wall (TOWER B - 3BHK)

Time period in X direction = $0.075x (h)^{0.75}$ (h=From 1st Basement roof slab to Terrace)
= $0.075 \times (73.420)^{0.75}$
= 1.88 sec

Time period in Y direction = $0.075x (h)^{0.75}$ (h=From 1st Basement roof slab to Terrace)
= $0.075 \times (73.420)^{0.75}$
1.88 sec

E. Shear wall(TOWER A - 4BHK)

Time period in x direction = $0.075x\ (h)^{0.75} / (Awx)^{0.5}$
= $0.075x\ (73.420)^{0.75} / (1.53)^{0.5}$
= 1.517 sec

Time period in y direction = $0.075x\ (h)^{0.75} / (Awy)^{0.5}$
= $0.075x\ (73.420)^{0.75} /(3.77)^{0.5}$
= 1.198 sec

Therefore considering ,

Time period in X direction = 1.517 sec.
Time period in Y direction = 1.198 sec.

Considering Type-1 Soil (N>30) as per Geotech. Report,
Sa/g for X direction for time period $0.4 \leq T \leq 4$ = 1/ Tx = 1/1.517 = 0.659
Sa/g for Y direction for time period $0.4 \leq T \leq 4$ = 1/ Ty = 1/1.198 = 0.834

F. Shear wall(TOWER B - 3BHK)

Time period in x direction = $0.075x\ (h)^{0.75} / (Awx)^{0.5}$
= $0.075x\ (73.420)^{0.75} / (1.29)^{0.5}$
= 1.65 sec

Time period in y direction = $0.075x\ (h)^{0.75} / (Awy)^{0.5}$
= $0.075x\ (73.420)^{0.75} /(2.9)^{0.5}$
= 1.198sec

Therefore considering ,

Time period in X direction = 1.65 sec. (With Infill)
Time period in Y direction = 1.331 sec. (With Infill)

Considering Type-1 Soil (N>30) as per Geotech. Report,
Sa/g for X direction for time period $0.4 \leq T \leq 4$ = 1/ Tx = 1/1.65 = 0.606
Sa/g for Y direction for time period $0.4 \leq T \leq 4$ = 1/ Ty = 1/1.331 = 0.75

Design Horizontal seismic co-efficient Ah for Building:(TOWER A - 4BHK)

Design Horizontal seismic co-efficient Ah in X direction = (0.16/2) x (1.2/4) x 0.659
= 0.0158

Design Horizontal seismic co-efficient Ah in Y direction = (0.16/2) x (1.2/4) x 0.834
= 0.020

Design Horizontal seismic co-efficient Ah for Building:(B BLOCK)

Design Horizontal seismic co-efficient Ah in X direction = (0.16/2) x (1.2/4) x 0.606
= 0.014

Design Horizontal seismic co-efficient Ah in Y direction = (0.16/2) x (1.2/4) x 0.75
= 0.018

Design Vertical seismic co-efficient Av for Building:

Av = (2/3 x Z/2)/(R/I) x 2.5
= (2/3 x 0.16/2) / (4/1.2) x 2.5
= 0.04

Since the structure is a Reinforced Concrete structure, an approximate damping value of 5% will be considered.

4.2.4 WIND LOADS

IS 875-Part.III-2015 is used to find wind force.
Basic wind speed (V_b) = 39 m/s (Considered value is of Gandhinagar)
The Design Wind Speed is given by $V_z = k_1 \times k_2 \times k_3 \times k_4 \times V_b$

Where, k_1 = Probability factor = 1;
k_2 = Terrain, height and structure size factor;
k_3 = Topography factor,
k_4 = Important factor for cyclonic region,

The structure falls under Category-3 (Terrain with numerous closely space obstructions having size of buildings up to 10m in height with or without a few isolated tall structures.)
Hence,
k_2 = 1.2101 for 112.625 m height. (Vary as per Height)
Hence,
$V_z = V_b \times k_1 \times k_2 \times k_3 \times k_4 = 39 \times 1 \times 1.1 \times 1 \times 1 = 42.9\ m/s^2$
$p_z = 0.6 \times (V_z)^2 = 0.6 \times (47.194)^2 = 1104.246.364\ N/m^2$

The Design Wind Pressure is given by $P_d = k_a \times k_d \times k_c \times p_z$
Where, k_a = Area averaging factor = 0.9;
k_d = Wind directionality factor = 0.9;
k_c = Combination factor = 0.9;

The Design Wind Pressure is given by $P_d = k_a \times k_d \times k_c \times p_z$
= 0.9*0.9*0.9*1104.246
= 805 N/m^2

However, value of Pd shall not be taken less then 0.7*p_z, = 772.97.45 N/m^2

The Design Wind Pressure, P_d = 805 N/m^2

- **Dynamic effects (as per IS875-part-III clause-9)**

Building Minimum width = 23.991 m and height = 73.420 m
h /d =73.420/23.991 = 3.05 < 5 (B BLOCK)

Building Minimum width = 30.420 m and height = 73.420 m
h /d =73.420/30.420= 2.41<5 (A BLOCK)

5. STRUCTURAL ANALYSIS

The structure is modeled for concrete frames and analyzed. Structure will be checked for earthquake forces by using minimum column section at floors. Structure will be analyzed using **ETABS 18.1.1.** The analysis results generated by software will be cross verified by hand calculations for critical members.

5.1 Dynamic Analysis

The 3D Dynamic Analysis of the structure has been performed to include the effect of Higher Modes by using ETABS. It gives the results of various parameters to be checked for the stability & serviceability of the structure like storey drifts, torsion effects, etc.

SDD Method:

Step 1 (S)

In this method, first of all Static Analysis is carried out with considering without infill Time Period.

Step 2 (D)

Then, 1st Dynamic Analysis is carried out with Response spectrum functions and cases for Spectrum are taken as SpecX & SpecY with basic scale factor. Scale factor is taken as 9806.65

Step 3 (D)

Now, 2nd Dynamic Analysis is carried out by multiplying Basic Scale factor by ratio of Static base shear & 1st Dynamic base shear.

5.2 P-Delta Analysis

P-Delta Analysis shall be carried out for accurate results.

Iterative -- Based on Load Cases: The load is computed from a specified nonlinear analysis load cases created by combining load patterns as required for initial P-Delta analysis. This is called the P-Delta load combinations. This is an iterative method which considers P-Delta on an element-by-element basis. Local buckling is captured more effectively.

Scale factors of 1.2 for D. L. and 0.5 for L. L. is used for gravity load analysis case used for initial P-Delta analysis.

As per clause 7.2 (d) of IS 16700, scale factor of 1.5 for Earthquake/Wind shall be used and another load cases shall be created as specified in the clause for initial P-Delta analysis.

5.3 Crack width 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 and element in contact with soil / water, crack width is limited to 0.2mm.

5.4 Stiffness Modifiers

According to **IS 16700-2017**, For service case, the moment of inertia shall be taken as 35 percent of I_{gross} of slabs,70 percent of I_{gross} of beams and 90 percent of I_{gross} of walls and columns for flexural capacity only as per IS.

For structural design the moment of inertia shall be taken as 25 percent of I_{gross} of slabs, 35 percent of I_{gross} of beams and 70 percent of I_{gross} of shear walls and columns for flexural capacity only. (refer table below)

Table 6 Cracked RC Section Properties
(*Clause* 7.2)

Sl No.	Structural Element	Un-factored Loads		Factored Loads	
		Area	Moment of Inertia	Area	Moment of Inertia
(1)	(2)	(3)	(4)	(5)	(6)
i)	Slabs	1.0 A_g	0.35 I_g	1.00 A_g	0.25 I_g
ii)	Beams	1.0 A_g	0.7 I_g	1.00 A_g	0.35 I_g
iii)	Columns	1.0 A_g	0.9 I_g	1.00 A_g	0.70 I_g
iv)	Walls	1.0 A_g	0.9 I_g	1.00 A_g	0.70 I_g

6. LOAD COMBINATIONS

The results obtained from the computer analysis in the form of member forces and reactions will be used for designing the structural members. Following are the load combinations and the member forces will be considered for arriving at the design forces.

LIMIT STATE LOAD COMBINATIONS: (DYNAMIC)

1.5 (Dead Load + Live Load)+1.05FIRE TENDER

1.2 (DL + LL ± SPECX)

1.2 (DL + LL ± SPECY)

1.5 (DL ± SPECX)

1.5 (DL ± SPECY)

0.9 DL ± 1.5 SPECX

0.9 DL ± 1.5 SPECY

LIMIT STATE LOAD COMBINATIONS: (STATIC)

1.2(DL+LL+EQX)

1.2(DL+LL-EQX)

1.2(DL+LL+EQY)

1.2(DL+LL-EQY)

1.5(DL+EQX)

1.5(DL+-EQX)

1.5(DL+EQY)

1.5(DL-EQY)

0.9DL+1.5EQX

0.9DL-1.5EQX

0.9DL+1.5EQY

0.9DL-1.5EQY

7. STRUCTURAL DESIGN

7.1 DESIGN METHOD

For the design of R.C.C. elements, the Limit State Method will be used as per IS: 456:2000 Materials of construction will be predominantly concrete and steel with consideration for strength and durability. The Reinforcing bars to be used in concrete elements are conforming to IS:1786-2008 with fy=500 N/mm^2 (Fe500D)

7.2 COVERS TO REINFORCEMENT

Clear cover for all RCC members shall be in accordance with;

- IS: 456:2000 Table 16 corresponding to moderate exposure conditions for the super-structure as well as the sub-structure
- IS: 456:2000 Table 16A and NBC: 2016 Table 1 corresponding to Type 2 construction, structural shear wall , columns and beams shall have cover for **fire rating of 2 hrs.**

Accordingly minimum clear cover is to be provided to main steel for;

● For Footing	: 75 mm for Sides & Bottom
● For Column	: 40mm
● For Beam	: 30mm for Sides & Bottom
● For Slab	: 25 mm for Continuous
	: 35 mm for Simply supported
● For Retaining wall	: 30 mm
● For RCC shear wall	: 40 mm

8. SOIL INVESTIGATION & BEARING CAPACITY(WAITING FOR GEOTECH REPORT)

9. VALUE ENGINEERING

The parameters adopted in this report are going to be the basis of the structural design. Hence it is requested that all team members give their feedback and approval to the parameters, suggestions, recommendations mentioned in this report. Certain additional parametric changes may be adopted due to some conditional changes in plans or requirements. Structural consultant shall have full freedom to add value to any aspect of design parameters mentioned here in this DBR to maintain the sound integrity of the structure.

10. CONCLUSIONS & RECOMMENDATIONS

This brief concept has been formulated based on the architectural scheme provided by **ARTHAM AHMEDABAD GUJARAT INDIA** . The report suggests a concept level structural design of proposed residential project for **SATATYA** at TRAGAD,AHMEDABAD and must be read keeping in mind these limitations.

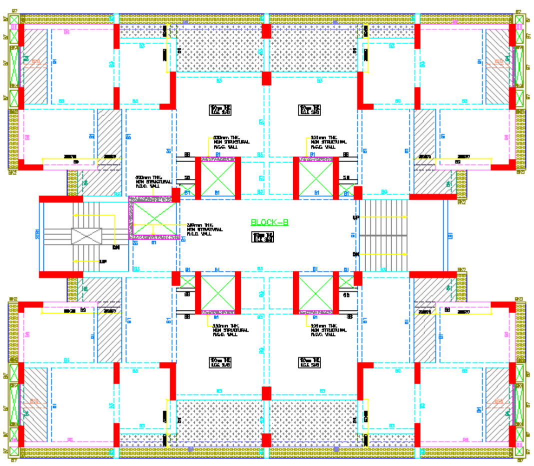
It focuses only on the overall structural design and durability of the building and does not aim to address the details of the structural design of building. As the next logical step towards scheme design, following is recommended:

1. Concept design of superstructure to be finalized by Client and Architects followed by final architectural drawings (Plans, Elevations & Sections) to be sent across for Structural Consultants to re-initiate the drawing process.

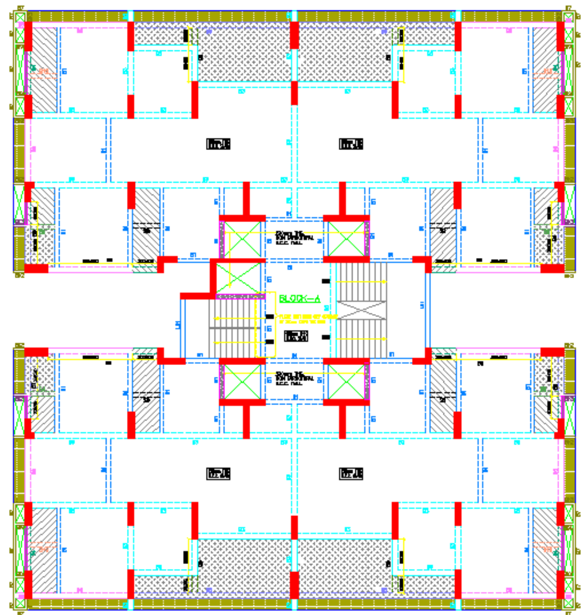
2. Approvals/Comments and sign-off of the structural system and structural framing plans.

3. Development of Construction Drawings.

11. STRU LAYOUT AT TYPICAL (7th, 10th, 13th,16th,20th, & 21th.) FLOOR ROOF SLAB LVL,

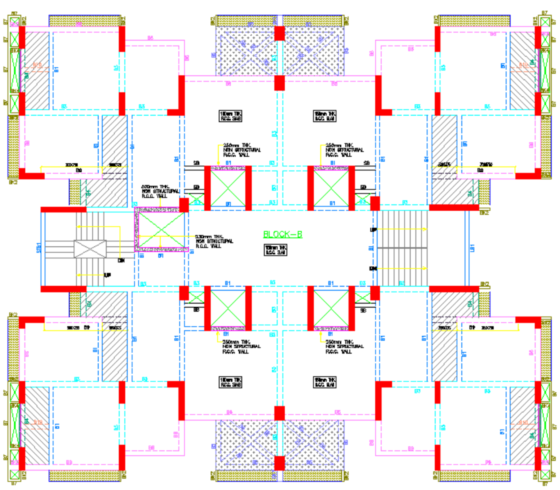


BLOCK B



BLOCK A

STRU LAYOUT AT TYPICAL (2nd,3rd, 5th, 8th,9th, 12th, 14th, 17th, 18th.) FLOOR ROOF SLAB LEVEL.



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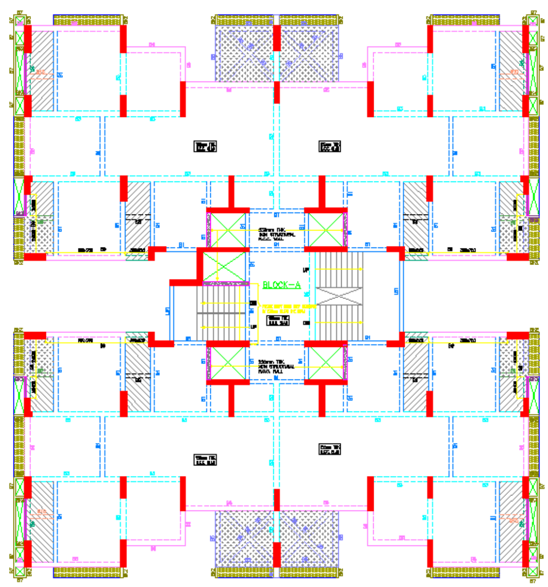
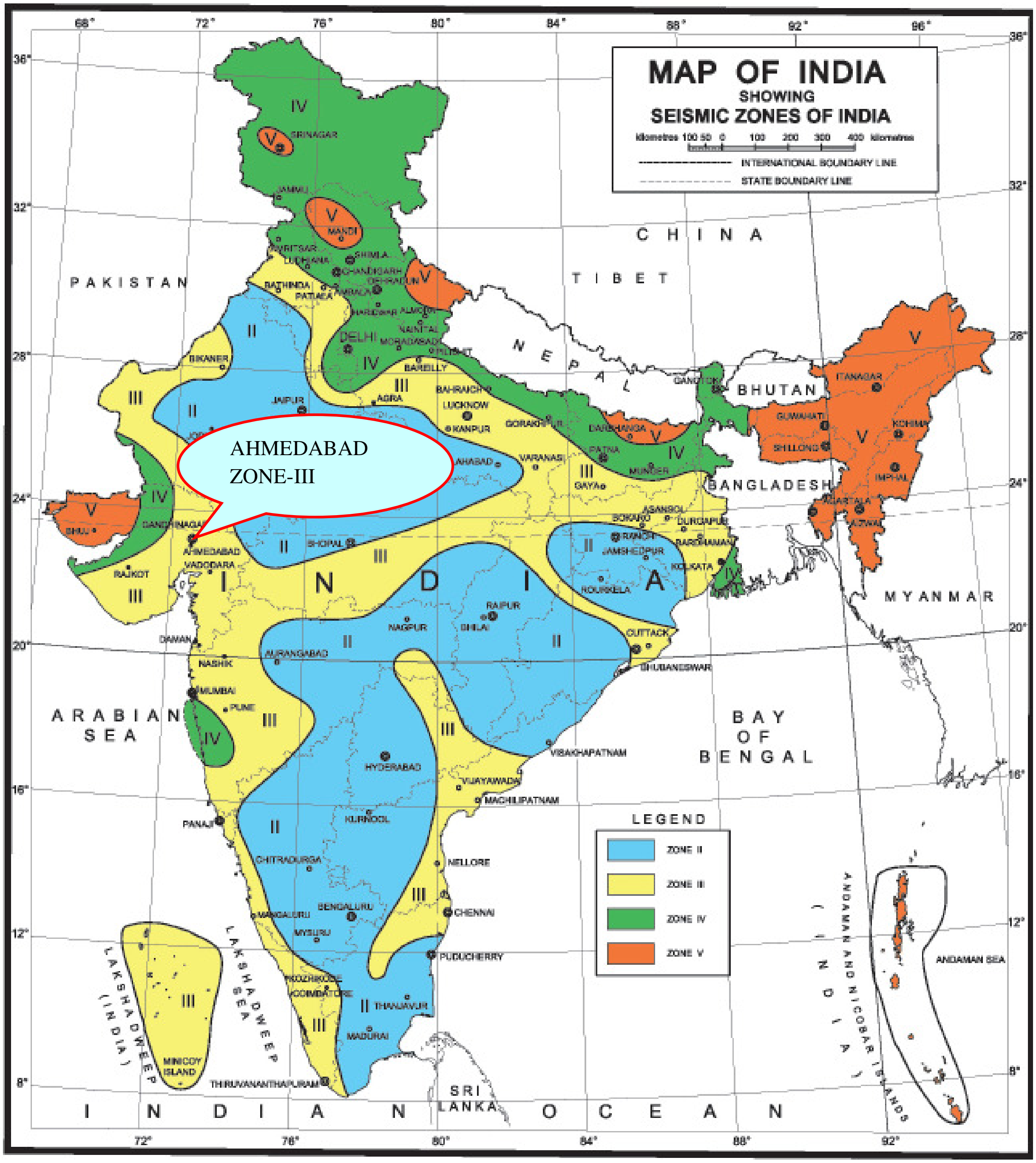
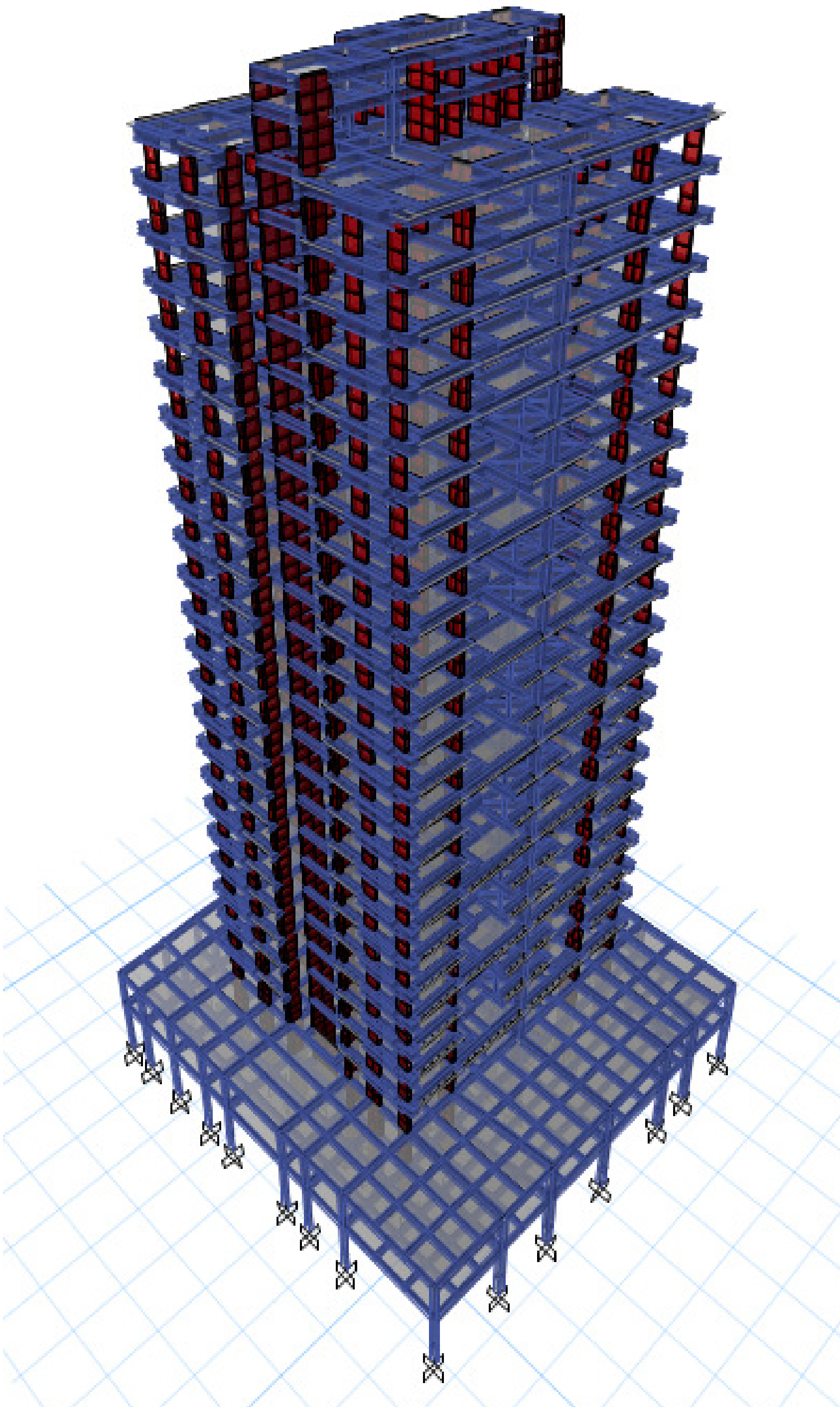


BLOCK A

12. REFERENCE FOR SEISMIC ZONE



13. ETABS MODEL(B BLOCK)



13.ETABS MODEL (A BLOCK)