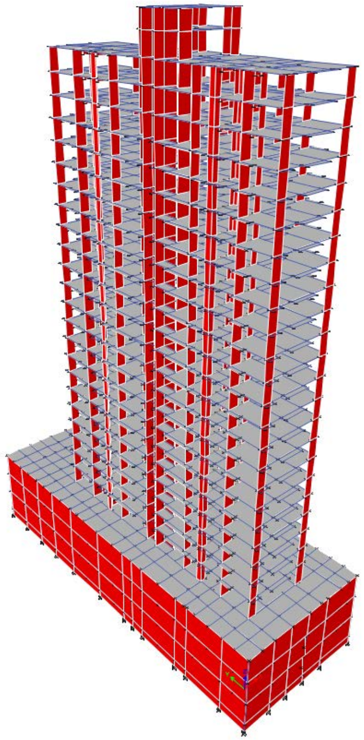
STRUCTURAL DESIGN BASIS REPORT
STATUS LUXE @SCIENCEPARK
AHMEDABAD, GUJARAT



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1. INTRODUCTION

The project consists of high-rise buildings By **STATUS LUXE, of 69.94m (Approx.)** high above the Ground Level (Stilt floor), having **3 - Storey Basement + 1 Ground floor + 22 Residential Floors + Terrace.**

The involvement of the structural design team has provided a challenge in accommodating the architectural form that has developed to an advanced stage with little structural input. As a result, some elements of the architecture may need to be reviewed by architect to fit in the requirements.

From our understanding, the following schemes have been worked out considering the **premium tower** and the flexibility given to the end user. This flexibility is obtained by proposed **Beam-slab with shear wall structural system** for super structure & flat slab with shear wall with periphery beam-column system for sub- structure or Beam-Slab with Shear Wall System, as basements that will eliminate all internal beams& appropriate for the services too. Looking to the Client's requirement/Demand **Beam-Slab with Conventional RC System has been considered for Sub-Structure.**

The Structure is analysed with all the relevant code of practice as per Indian Standard codal provision & considering the appropriate safety parameters some of the international code of practice will also be due marked where Indian codes are silent or step back.

2. FOREWORD

This report forms the basis of the structural design process, by way of familiarizing with the requirements of the project. This report aims at formulating the design parameters that the structural consultant has adopted in developing the structural analysis, design and detailing work of the building, which will be compatible with the architectural theme, satisfy the functional needs, adhering to other applicable building norms & Indian Standards provisions to achieve safe, stable, strong & earth-quake/wind resistant structure, which is economical also.

This report covers the minimum design requirement to establish the untitled design basis that will form the overall design philosophy to be adopted in the structural design of the proposed building.

The design will aim to achieve,

- Structural And Functional Integrity
- Desirable Structural Performance Under Characteristic Service & Design Loads
- Resistance To Loads Due To Natural Phenomena i.e. Wind And Earthquakes
- Structural Durability And Maintainability
- Structural Safety, Performance During Fire And Fire Safety Measures
- Compatible With All The Relevant Codes Of Practice

PROJECT NAME	**STATUS LUXE**
LOCATION	**AHMEDABAD, GUJARAT**
CLIENT	**STATUS LUXE DEVELOPERS**
ARCHITECT	**Tranquil, The design wave**
STRUCTURAL ENGINEER	**HNBS ASSOCIATES**

3. PROJECT DESCRIPTION

The project consists of high-rise buildings By **STATUS LUXE, of 73.46m (Approx.)** high above the Ground Level (Stilt floor), having **3 - Storey Basement + 1 Ground floor + 22 Residential Floors + Terrace.**

ITEAM NO.	TOWER
BUILDING DIMENSION (X DIR. X Y DIR.)	11.86m X 43.01m
BUILDING HEIGHT (h)	69.94 m
TYPICAL FLOORS HEIGHT (hi)	3.02 m

***Height Is Considered From - (Plinth Level to Terrace Level)**

BASEMENT AREAS	**1- Storey Basement Area Has Been Proposed To Cater For Parking Requirements. The Floor Height Of Basement-1 is 4.20m.**
GROUND AREAS	**Ground Floor Area Has Been Proposed To Cater Parking Requirements. The Floor Height Is 3.5m.**

<u>**TYPICAL FLOOR PLAN OF TOWERS**</u>

TYPICAL FLOOR HEIGHT OF TOWERS

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4. STRUCTURAL SYSTEM DESCRIPTION

A. GENERAL

The structural scheme of the building will be of cast in situ reinforced concrete (RC). The structure consists of cast in situ RCC shear walls, columns, beams and slabs.

B. VERTICAL LOAD PATH

The vertical gravity loads are carried by the RC slab - beam system and transferred to the load bearing structural RCC walls and columns. The floor slabs are supported by the beams and eventually by RC shear walls and columns in the tower areas.

The complete load bearing RC structure is going directly down to the ground floor level and further to the foundation and will bring all the vertical loads down to the foundation. The load bearing structure is continuous from top to bottom and has no structural interruptions.

C. LATERAL LOAD PATH

The lateral load resisting system is formed by cast in - situ RC shear walls, columns with perimeter & internal beams frames in x and y plan directions which are located inside the building in required configuration. The shear walls & Columns shall be designed and detailed **as per IS: 13920 - 2016 and are considered as ductile shear walls & Columns.**

The RC slab - beams provides continuity and connection with the shear walls and columns which are able to transfer in-plane shear forces as well as overturning moments to the lateral load resisting system. The slab behaves as a rigid floor diaphragm as the in plane stiffness is much high, **however to address the actual in plane distortion the diaphragms are model as semi-rigid configuration using Membrane or Shell-Thin formulation.**

Due to the large stiffness of the shear walls they are resisting almost all the lateral forces in addition of gravity loads and therefore the total system as such shall be classified as a building with ductile shear walls. As per IS: 1893 - 2016 (PART-I) the Response Reduction factor of the lateral load resisting system of this building shall be taken as **R = 4.0 (Ductile Shear Walls).**

5. METEROLOGICAL CONDITIONS

The environmental conditions to which the structural elements are considered to be exposed to as per Clause 8.2.2.1 Table-3 of IS: 456 - 2000 are as follows:

EXPOSURECONDITION	ELEMENTS
MODERATE	SLABS, BEAMS& COLUMNS/WALLSABOVE GROUND
MODERATE	FOUNDATION & STRUCTURES BELOW GROUND

MILD: Exposure condition shall be explained as one where concrete surfaces are protected against weather or aggressive conditions, except those situated in coastal areas.
MODERATE: Exposure condition shall be explained as one where concrete surfaces are sheltered from severe rain or freezing whilst wet; concrete exposed to condensation and rain; concrete continuously under water; concrete in contact under non-aggressive soil; concrete surfaces sheltered from saturated salt in coastal areas.

6. FIRE RATING

A structural element is required to have fire resistance and should be designed to possess an appropriate degree of resistance to flame penetration; heat transmission and failure.

The fire rating considered for various structural elements are as follows,

STRUCTURAL ELEMENT	FIRE RESISTANCE
LOAD BEARING WALLS	2.0 Hours
COLUMNS & BEAMS	2.0 Hours
FLOOR SLABS	1.5 Hours
STAIRCASE WALLS & LIFT WALLS	2.0 Hours
SHEAR WALLS	4.0 Hours

Minimum dimensions for fire resistance of reinforced concrete members in accordance as per Clause 21.2, Figure-1 of IS: 456 - 2000 are as follows,

STRUCTURAL ELEMENTS	MINIMUM DIMESIONS	
	1.5 Hrs.	2.0 Hrs.
BEAM WIDTH	200 mm	200 mm
FLOOR THICKNESS	110 mm	125 mm
COLUMN: FULLY EXPOSED	250 mm	300 mm

COLUMN: 50% EXPOSED	**200 mm**	**200 mm**
COLUMN: ONE FACE EXPOSED	**140 mm**	**160 mm**
WALL THICKNESS: (r/f- 0.4 %< P<1.0%)	**140 mm**	**160 mm**

Structural member sizes are decided conforming to the above mentioned requirements for fire resistance as per Indian Standard Code IS: 456 - 2000 and NBC 2016 Type-II requirement.

7. NOMINAL COVER

Minimum values of nominal cover to outermost reinforcement of normal weight aggregate concrete, which should be provided to all reinforcement, depends on the exposure condition and fire rating considered. Cover to the reinforcement shall be in accordance with IS: 456 - 2000 corresponding to MODERATE exposure conditions for the superstructure and MODERATE exposure conditions for the substructure and to satisfy the specified fire rating.

The nominal cover to meet specified period of fire resistance as per Table16A, Clause 21.4 of IS: 456 – 2000& NBC 2016 are as follows,

STRUCTURALELEMENT	EXPOSURECONDITION		FIRE RESISTANCE	
	MILD	MODERATE	1.5Hours	2.0Hours
BEAMS (Simply Supported)	20mm	30mm	--	40mm
BEAMS (Continuous)	20mm	30mm	--	30mm
FLOORS (Simply Supported)	20mm	30mm	25mm	--
FLOORS (Continuous)	20mm	30mm	20mm	--
COLUMNS	40mm	40mm	--	40mm
WALLS	20mm	30mm	--	30mm
FOUNDATION	50 mm	75mm	--	--

*Cover to the Shear Wall will be considered as 40mm to maintain same typology for Construction Activity.

In case of slabs, for main reinforcement upto 12mm diameter bar for moderate exposure the nominal cover may be reduced by 5mm.Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by ±10mm.

8. MATERIAL GRADES

The preliminary minimum grade of concrete to be used depends on the exposure conditions to which the structural elements are subjected to. The final concrete grade for each element will be confirmed once the concept/schematic stage framing layout & analysis shall be conclude.

STRUCTURAL ELEMENT	CONCRETE GRADE
FOUNDATION	**M35**
RETAINING WALL	**M35**
COLUMNS & SHEAR WALLS	**M45/M40/M35 (REDUCTION IF REQUIRED)**
SLABS	**M35**
BEAMS	**M35**

All reinforcing steel (Longitudinal) to be used shall be of Grade Fe 500, Fe500D or Fe550 with Minimum Yield strength of Fy = 500 N/mm^2 and tensile strength not less than Fu = 545 N/mm^2 having elongation of more than 14.5% and conforming to IS: 1786 – 2008 and Reinforcing steel (Shear) shall be of Grade Fe 500, Fe 500D or Fe550 with Minimum Yield strength of Fy = 415 N/mm^2 for Design purpose.

9. GEOTECHNICAL PARAMETERS

The Geotechnical Investigation has been carried out by K.C.T. Consultancy Services, Report No. ST/23/03/17739 and the report has been submitted to us. Based on this report: -

- We are considering the Allowable Bearing Capacity for the Foundation as Avg.**510kN/m^2** for Avg.50mm settlement.
- The ground water table has been not encountered up to 20m. Depth below ground level.
- The modulus of sub-grade reaction is considered from geo-technical report mentioned on Pg No.52 considering Zoned Spring Approach.
- Differential Settlement between the Tower and Non-Tower shall be limited to the H/500 as per IS: 1904-1986. I case of the value exceeding the permissible one as prescribed by Code the relevant structural members will be design for the Additional Moments & Shear Forces caused by the Sinking of Support with respect to each-other.

The Foundation System for the Towers have been proposed as Raft Foundation with Uniform Thickness and Localized thickening where required. For Non-Tower Area/Columns/Walls, Isolated Slopes/Pad Footings have been proposed.

Soil Retention System has been considered as Diaphragm Walls (As Permanent Structure) at all Sides which have been design by specialized Consultant (By Other).

10. MODELLING/ANALYTICAL/DESIGN APPROACH

A.NUMERICAL MODEL

The Purpose of Modelling of building follow a simple approach, which reflects the distribution of mass and stiffness properties to properly account for all significant inertial forces under seismic actions and deformation shapes. Analytical model of a building reflect the true behaviour of its members as well of the whole structure. Modelling adopt lumped modelling that is frame element modelling, distributed modelling that is finite element modelling or a combination of the two.

- A comprehensive 3-dimensional finite element analysis of the superstructure shall be carried out with ETABS software tool using ultimate version 2019 or latest edition.
- For foundation depending upon geotechnical criteria, a series of combined footing and raft foundation shall be proposed below tower columns/walls and isolated footing for the columns in non-tower area. Finite Element Analysis for same shall be carried out in SAFE 2016 or latest edition software tool.
- Buildings shall be assessed for a combination of gravity and lateral loads, and detailed appropriately
- For the design of various structural elements like foundations, columns, beams, slab etc. in - house developed spreadsheets & Programs will be used wherever applicable.

B. APPROACH FOR STRUCTURAL ANALYSIS

After preliminary sizing of various structural members, a computer model of the structure is generated for carrying out computer analysis to analyse the effects of vertical and lateral loads that are likely to be imposed on the structure.

FEM computer software ETABS will be used for the structural analysis of the building. Geometrical dimensions, member properties and member-node connectivity are modelled in the FEM computer program to generate the simplified analytical model and the following structural analysis will be performed:

- Equivalent Linear Static Analysis (ELF Procedure)
- Second-Order-Delta Analysis (Elastic Softening Analysis)
- Modal Analysis (Inherent Dynamic Configuration of Structure)
- Linear Dynamic Analysis (Response Spectrum Analysis)

The seismic analysis shall account for torsion effects, including accidental torsion. The accidental torsion has been taken into account by applying eccentricity to all the floor diaphragms in x-direction and y-direction with eccentricity ratio of 0.05. As the diaphragm have been considered as Semi-rigid, the eccentricity ratio will be considered at every nodes on the analytical model itself.

C. APPROACH FOR FLOOR &BEAM ANALYSIS& MODELLING

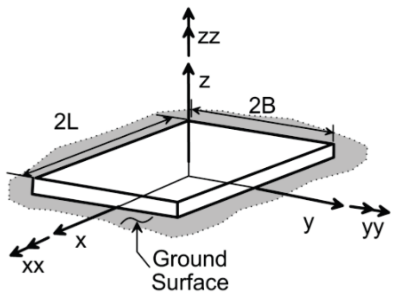
Several configurations like flat plate, flat slab, slabs supported by beams etc. have been investigated and a brief synopsis of the results were presented. The best option is considered to be the option that is closest to delivering the architectural intent whilst enabling a rational structural solution. **Conventional Floor system, i.e.: slab supported by beams have been considered.**

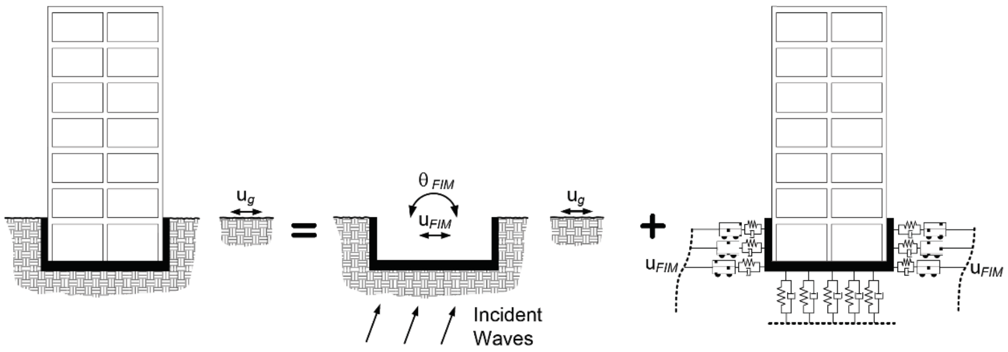
To considered In-plane stiffness of floor slabs, the Slabs will be Modelled as Shell-Thin Definition with Semi-Rigid Diaphragm to Considered the Poisson Expansion and Floor Distortion to address Interaction between Wall Elements and Slab Elements. For Simplified Approach, the Stair Slab will be modelled using Membrane Definition with One-way Load Distribution. Automated General Mesh/Rectangular Mesh Will be used for load distribution over the supporting elements.

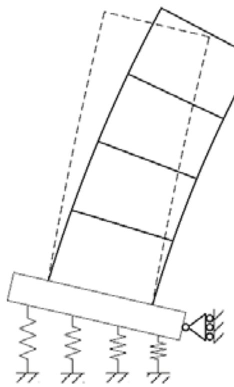
The Beams will be modelled as 1-D frame element where the depth of beam is limited to 600mm. As and where required to control the dynamic behaviour of structure (mode shapes/modal behaviour) the beam will be modelled as 2-D element to capture the realistic solid element. The beams those having the depth equal to or more than 750mm shall be modelled as Line element or Area element depending to achieve the Structural Performance. The beam Elements those are modelled as area elements will be detailed as a column with all face reinforcement considering the Axial force & Bi-axial Moments along with both two direction of shear force. Point locations where, The 1-D Line Elements meets to the 2-D Wall Elements, the beam will be embedded into the wall elements by 2xDepth of Beam or 1000mm Which-ever is More to generate the Moment Continuity.

D. APPROACH FOR FOUNDATION ANALYSIS& MODELLING

Conventional building design is most often performed based on the assumptions that the building is fixed to the ground at its base and the ground itself is rigid. These assumptions are not strictly true but are often considered to be acceptable and conservative. The flexibility of the foundation system, including both the foundation's structural components and the supporting soil, can have a significant effect on the building's dynamic properties and its overall response. For the Modelling of Foundation on Grade/Soil, Vertical Soil Spring will be modelled based of Modulus of Subgrade Reaction recommended by Geo-Tech Consultant. Passive Resistance from the Basement







Walls will be neglected in Analytical Model. As the Foundation Base having much in-plane stiffness because of its geometry it will not deform in its own plane, also there is high frictional resistance between soil surface and foundation base thus foundation will be restrain against the lateral translation & Rotation about Vertical Axis. Foundation will be analyzed considering the degree of freedom of Vertical Traslation & Rotation abount two planner axis.

To meet with design demands, if needed the foundation will be modelled as Shell-Thin or Shell-Thick formulation with Vertical Soil Springs (represent flexibility of soil) as well as translational Soil Springs (represents the frictional resistance between soil & base) along with the edge restrain against lateral translations (represent passive soil resistance from basement walls at base) to capture the more in depth realistic half-space soil-structure interaction.

E. DESIGN PHILOSOPHY

Design of the RCC residential structure shall be carried out by limit state method conforming to IS: 456-2000. Design of all the structural elements of the residential complex shall be based on its three dimensional (3D) analysis results. Individual member section of this space (3D) frame structure shall be designed for the section forces generated under various load combinations.

Main Reinforcement provided in design of member will be of grade Fe500D or Fe550 (with minimum yield strength=500 N/mm^2) and Shear Reinforcement will be of grade Fe415 for Shear Walls Design Only (with minimum yield strength = 415N/mm^2) as per IS: 1786-2008.

For RC slab, IS: 456 - 2000 (limit state method) would be used for the long term deflection check and design.

Ductile detailing norms will be adopted to make the building earthquake resistant in accordance with the relevant Indian Standard Codes. Since the building is in **Zone III**, the recommendations of IS: 13920–2016 shall be applicable.

F. STIFFNESS MODIFIERS

For Ultimate Limit State: (ULS)

STRUCTURAL ELEMENT	MODIFIERS	EQUIVALENT STIFFNESS MODIFIER (SOFTWARE APPLICATION)
Slabs	0.25 Ig	M11 = M22 = M12 = 0.25
Beams	0.35 Ig	I22 = I33 =0.35, J = 0.50
Coupling Beams	0.35 Ig	I22 = I33 = 0.35, J = 0.50 (As Frame Element)
Columns	0.70 Ig	I22 = I33 = J = 0.70
Shear Wall	0.70 Ig	F11 = F22 = F12 = M11 = M22 = M12 = 0.70
Coupling Beams	0.70 Ig	F11 = F22 = F12 = M11 = M22 = M12 = 0.70 (As Area Element)

Basement Walls	0.15 Ig	F11 = F22 = F12 = M11 = M22 = M12 = 0.15

For Serviceability Limit State: (SLS)

STRUCTURAL ELEMENT	MODIFIERS	EQUIVALENT STIFFNESS MODIFIER (SOFTWARE APPLICATION)
Slabs	0.35 Ig	M11 = M22 = M12 = 0.35
Beams	0.70Ig	I22 = I33 = J = 0.70
Coupling Beams	0.70Ig	I22 = I33 = J = 0.70 (As Frame Element)
Columns	0.90Ig	I22 = I33 = J = 0.90
Shear Wall	0.90Ig	F11 = F22 = F12 = M11 = M22 = M12 = 0.90
Coupling Beams	0.90 Ig	F11 = F22 = F12 = M11 = M22 = M12 = 0.90 (As Area Element)
Basement Walls	0.15 Ig	F11 = F22 = F12 = M11 = M22 = M12 = 0.15

Where, Ig - Gross Moment of Inertia, *Reference: IS-16700, ATC-72, LATBSDC-2020

11. LOADING PARAMETERS

A. UNIT WEIGHTS

SR. NO.	DESCRIPTION	UNIT WEIGHT
1.	PLAIN CEMENT CONCRETE	= 24.0 kN/m^3
2.	REINFORCED CEMENT CONCRETE	= 25.0 kN/m^3
3.	STRUCTURAL STEEL	= 78.5 kN/m^3
4.	SAND BASE AAC BLOCKS (MASONARY WORK)	= 7 kN/m^3
5.	SUNK FILLING MATERIAL (AAC BLOCK + BRICKBAT)	= 12.0 kN/m^3
6.	MASONARY WORK WITH MORTAR LAYERS	= 8.0 kN/m^3
7.	WATER	= 10.0 kN/m^3

8.	FLOOR FINISH	= 18.0 kN/m^3
9.	WATER PROOFING	= 20.0 kN/m^3
10.	PLASTER FINISH	= 20.0 kN/m^3
11.	SOIL FILLING	= 18.0 kN/m^3

Fire Tender Load on Ground Floor (As per NBC 2016/AUDA) = 16 kN/m^2

Bifurcated as 12.0 kN/m^2 for fire fighter loading and 4.0 kN/m^2 as Live Load to supress the presence of loading at ground floor level.

Single Wheel Load shall be taken as 100kN as Point Load as per IRC-6:2017 to check & design of Particular Slab Panel. Presence of More than two wheels at a time on slab panel will be also considered to check the slab capacity for said demand. Hence that slabs/beams shall be locally designed for actual wheel loads as per the available data.

Calculation for Weight of Masonry Walls: -

Unit Weight for AAC Block Masonry	= 8.0kN/m^3
Unit Weight for Plaster finish **(12mm thick on each face)**	= 20.0 kN/m^3
Typical Line Load Calculation for walls **(100mm thk. wall)**	**= (3.02-0.575) x 0.100 x 7.0 + (2 x 0.012 x 3.180 x 20)= 1.82 + 1.526 ≈ 3.8kN/m**
Typical Floor-OUTER WALL **(12mm Inside& 24mm Out Side Plaster)**	**= (3.02-0.575) x 0.150 x 7.0 + (3 x 0.012 x 3.180 x 20) = 2.55+ 2.29 ≈ 5kN/m**

B. LOADS ON DIFFERENT UNITS OF STRUCUTRE

Item No.	Item Description	SELF WEIGHT OF SLAB (kN/m^2)	SDL (FLOOR FINISH) (kN/m^2)	LIVE (kN/m^2)	CAR (kN/m^2)	MACHINE (kN/m^2)
1.	**TYPICAL RESIDENTIAL FLOOR**	**= 25.0 X SLAB THICKNESS**	FLOOR FINISHES (65mm THICK) = 1.2 kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL = **1.5 kN/m^2**	**2.0**	-	-
2.	**PARKING AREA (BASEMENTS LEVEL)**	**= 25.0 X SLAB THICKNESS**	FLOOR FINISHES (75mm THICK) = 1.5 kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL = **1.8 kN/m^2**	-	**4.0**	-

3.	PARKING AREA (GROUND LEVEL)	= 25.0 X SLAB THICKNESS	FLOOR FINISHES (120mm THICK) = 2.2 kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL = **2.5 kN/m^2**	4.0	-	-
4.	FOYER / PASSAGE / LOBBY	= 25.0 X SLAB THICKNESS	FLOOR FINISHES (65mm THICK) = 1.2 kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL = **1.5 kN/m^2**	3.0	-	-
5.	LIFT MACHINE ROOM	= 25.0 X SLAB THICKNESS	FLOOR FINISHES (120mm THICK) = 2.2 kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL = **2.5 kN/m^2**	-	-	10.0
6.	WET AREA / SUNK PORTION 150MM SUNK	= 25.0 X SLAB THICKNESS	**150mm Sunk** (0.010X25) + (0.065X18) + (0.205X12.0) = 3.0kN/m^2 ≈ 3.0kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL ≈ **3.3kN/m^2**	2.0	-	-
7.	STAIRCASE	= 25.0 X SLAB THICKNESS	SELF WEIGHT OF STEPS = 2.0 kN/m^2 FLOOR FINISHES (55mm THICK) = 2.0 kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL ≈ **4.3 kN/m^2**	3.0	-	-
8.	CHAJJAS & PROJECTIONS	= 25.0 X SLAB THICKNESS	Total SDL ≈ **1.5 kN/m^2**	0.5	-	-
9.	RAMPS	= 25.0 X SLAB THICKNESS	FLOOR FINISH (75mm THICK) = 1.35 kN/m^2 Total SDL ≈ **1.8 kN/m^2**	-	4.0	-
10.	NON-TOWER AREA (GROUND FLOOR)	= 25.0 X SLAB THICKNESS	FLOOR FINISH/SOIL FILLING (350mm THICK) = 6.3 kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL ≈ **6.6 kN/m^2**	4.0	-	-
11.	NON-TOWER AREA (GARDEN/LANDSCAPE AREA)	= 25.0 X SLAB THICKNESS	SOIL FILLING (600mm THICK) = 12.6 kN/m^2 SERVICES & CEILING = 0.3 kN/m^2 Total SDL ≈ 1**4.6kN/m^2**	4.0	-	-
12.	SWMIMNG POOL AREA	= 25.0 X SLAB THICKNESS	WATER PROOFING (125mm THICK) = 2.5 kN/m^2 Total SDL ≈ **2.5 kN/m^2**	-	27.0	-

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Item No.	Item Description	SELF WEIGHT OF SLAB (kN/m^2)	SDL (FLOOR FINISH) (kN/m^2)	LIVE (kN/m^2)	WATER (kN/m^2)	TEMP. (C)
13.	**WATER TANK**	**= 25.0 X SLAB THICKNESS**	WATER PROOFING (125mm THICK) = 2.5 kN/m^2 Total SDL ≈ **2.5 kN/m^2**	**-**	**20.0**	**-**
14.	**TERRACE**	**= 25.0 X SLAB THICKNESS**	WATER PROOFING (125mm THICK) = 2.5 kN/m^2 Total SDL ≈ **2.5 kN/m^2**	**2.0**		**+/- 20.0° C**

12. SEISMIC LOADS AS PER IS: 1893 - 2016 (PART-I)

The proposed development is located at **Ahmedabad**, Gujarat. As per Figure 1 of IS: 1893 - 2016 (Part-1), **Ahmedabad falls under Zone III, (Z=0.16)**

SR. NO.	DESCRIPTION	TOWER
1.	BUILDING DIMENSION (X-DIRECTION)	11.860 m
2.	BUILDING DIMENSION (Y-DIRECTION)	43.01 m
3.	HEIGHT OF BUILDING (GR TO TERRACE)	69.94 m
4.	IMPORTANCE FACTOR (I) (TABLE-8)	1.2
5.	RESPONSE REDUCTION FACTOR (R) (TABLE-9)	4.0
6.	SOIL TYPE (TABLE-4)	I (MEDIUM SOIL)
7.	Bare Frame - $T = 0.075\ h^{0.75}$	1.814 sec
8.	*Masonry Infill* - $T = \frac{0.09\,h}{\sqrt{d}}$,	Tx = 1.828 sec Ty = 0.960 sec

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9.	*RC Shear Wall* - $T = \frac{0.075\, h^{0.75}}{\sqrt{A_w}}$, *where* $A_w = \sum_{i=1}^{n}\left[A_{wi}\left\{0.2+\left(\frac{L_{wi}}{h}\right)^2\right\}\right]$	Tx = 0.857 sec Ty = 2.759 sec
10.	TIME PERIOD CONSIDERED FOR DESIGN OF STRUCTURE	Tx = 1.625 sec Ty = 1.625 sec

13. WIND LOADS AS PER IS: 875 – 2015 (PART – III)

SR. NO.	DESCRIPTION	TOWER C
1.	BUILDING DIMENSION (X-DIRECTION)	11.860 m
2.	BUILDING DIMENSION (Y-DIRECTION)	43.01 m
3.	HEIGHT OF BUILDING (GR TO TERRACE)	73.46 m
4.	BASIC WIND SPEED (CL 6.2 & ANNEX-A)	39 m/s
5.	TERRAIN CATEGORY (CL 6.3.2.1)	3
6.	PROBABILITY FACTOR (K1) (TABLE-1)	0.99
7.	TOPOGRAPHY FACTOR (K3) (CL 6.3.3 & ANNEX-C)	1.0
8.	IMPORTANCE FACTOR (K4) (CL 6.3.4)	1.0
9.	DRAG FORCE-COEFFECIENT IN X-DIRECTION (CFx) (CL 7.4.2 & FIG-4)	1.24
10.	DRAG FORCE-COEFFECIENT IN X-DIRECTION (CFy) (CL 7.4.2 & FIG-4)	1.10

For Linear Dynamic Wind Analysis, as per clause 7.1 of IS: 875 (Part-III) -2015,Building and closed structures with a height to minimum lateral dimension ratio of more than about 5.0Building and closed structures whose natural frequency in the first mode is less than 1.0Hz. Any building or structure which does not satisfy either of the above two criteria shall be examined for dynamic effects of wind.

14. TEMPERATURE LOADS (THERMAL LOADS)

Temperature variation produces stresses in the structure, as it expands and contracts with the gain and loss of thermal energy. In the structures, with large geometrical dimensions, the effect of temperature may be important in the behaviour and final design of particular slabs & beams for local thermal effect. Due to cyclic deformation–between day time and nights, and between winter and summer the effect on the durability of structure and the supported finishes may be significant to produce fatigue.

The structure will be analysed for the following temperature variation condition. Podium, roof and other similar exposed slabs to the sunlight shall be checked for the uniform seasonal temperature variation +/-20.0 degrees, based on a maximum temperature of 45.0 degrees and a minimum temperature of 25.0 degrees in summer and maximum temperature of 30.0 degrees and a minimum temperature of 10.0 degrees in Winter, in accordance with as per clause 2.0 of IS: 875 - 1987 (Part 5). The ambient temperature will be maintain during the concreting will be approx. around 25.0 degrees to 30.0 degrees have been recommended.

15. CRACK WIDTH (FOR WATER RETAINING STRUCTURES)

Indian code IS: 3370-2009 shall be applicable (Design of concrete structures for retaining aqueous liquids) with control on crack width. The crack width will be restricted to 0.2 mm.

16. LOAD CASES & COMBINATIONS

STATIC LOAD CASES

LOAD PATTERN	LOAD TYPE
DEAD	DEAD LOAD
SDL	SUPER DEAD LOAD
LIVE/BLL	REDUCEABLE LIVE LOAD
WATER	SUPER DEAD LOAD
MACHINE	SUPER DEAD LOAD
WALL	WALL/LINE LOAD
CAR	LIVE LOAD
EQX	EARTHQUAKE LOAD IN X-DIRECTION
EQY	EARTHQUAKE LOAD IN Y-DIRECTION
WLX	WIND LOAD IN X-DIRECTION
WLY	WIND LOAD IN Y-DIRECTION
WLL	WIND TUNNEL LOAD
TEMPERATURE	OTHER LOAD
FIRE TENDER	OTHER LOAD (ACCIDENTAL LOADING)

DYNAMICRESPONSE SPECTRUMCASES

LOAD CASE	LOAD TYPE
SPECX	RESPONSE SPECTRUM LOAD IN X- DIRECTION
SPECY	RESPONSE SPECTRUM LOAD IN Y- DIRECTION

DYNAMIC WIND (GUST) LOAD CASES

LOAD CASE	LOAD TYPE
GUSTX	GUST WIND LOAD IN X-Direction
GUSTY	GUST WIND LOAD IN Y-Direction

ULTIMATE LOAD COMBINATIONS

D1	1.5DL + 1.5 SDL
D2	1.5DL + 1.5 SDL + 1.5 LL
D3	1.2DL + 1.2 SDL + 1.2 LL* ± 1.2SPECX
D4	1.2DL + 1.2 SDL + 1.2 LL* ± 1.2SPECY
D5 / D6	1.2DL + 1.2 SDL + 1.2 LL± 1.2WLx or GUSTX
D7 / D8	1.2DL + 1.2 SDL + 1.2 LL± 1.2WLy or GUSTY
D9	1.5DL + 1.5 SDL ± 1.5 SPECX
D10	1.5DL + 1.5 SDL ± 1.5 SPECY
D11/D12	1.5DL + 1.5 SDL ± 1.5 WLxor GUSTX
D13/D14	1.5DL + 1.5 SDL ± 1.5 WLyor GUSTY
D15	0.9DL + 0.9 SDL ± 1.5 SPECX
D16	0.9DL + 0.9 SDL ± 1.5 SPECY
D17/D18	0.9DL + 0.9 SDL ± 1.5 WLxor GUSTX
D19/D20	0.9DL + 0.9 SDL ± 1.5 WLyor GUSTY
*D21	1.2DL + 1.2 SDL + 1.2 LL + 1.2WTT (*WTT-WIND TUNNEL TEST IF APPLICABLE)
*D22	1.5DL + 1.5 SDL +1.5 WTT (*WTT-WIND TUNNEL TEST IF APPLICABLE)
*D23	0.9DL + 0.9 SDL +1.5 WTT (*WTT-WIND TUNNEL TEST IF APPLICABLE)
FIRE TENDER	1.2DL + 1.2 SDL + 1.2 LL + 1.05 FIRE TENDER

ULTIMATE LOAD COMBINATIONS WITHTEMPERATURE

T1/T2	T1/T2 - 1.4DL + 1.4 SDL ± 1.4 TL
T3/T4	T3/T4 - 1.4DL + 1.4 SDL + 1.4 LL ± 1.4 TL
T5/T6	T5/T6 - 1.05DL + 1.05 SDL + 1.28 LL ± 1.28 SPECX ± 1.05 TL
T7/T8	T7/T8 - 1.05DL + 1.05 SDL + 1.28 LL ± 1.28 SPECY ± 1.05 TL
T9/T10/T11/T12	T9/T10/T11/T12 - 1.05DL + 1.05 SDL + 1.28 LL ± 1.28 WLyor GUSTX ± 1.05TL
T13/T14/T15/T16	T13/T14/T15/T16 - 1.05DL + 1.05 SDL + 1.28 LL ± 1.28 WLyor GUSTY ± 1.05 TL
T17/T18	T17/T18 - 0.9DL + 0.9 SDL ± 1.28 SPECX ± 1.05 TL
T19/T20	T19/T20 - 0.9DL + 0.9 SDL ± 1.28 SPECY ± 1.05 TL
T21/T22/T23/T24	T21/T22/T23/T24 - 0.9DL+ 0.9 SDL ± 1.28 WLx or GUSTX ± 1.05 TL
T25/T26/T27/T28	T25/T26/T27/T28 - 0.9DL + 0.9 SDL ± 1.28 WLyor GUSTY ± 1.05 TL
*T29/T30	1.05DL + 1.05 SDL + 1.28 LL + 1.28 WTT ± 1.05TL(*WTT-WIND TUNNEL TEST IF APPLICABLE)
*T31/T32	0.9DL+ 0.9 SDL + 1.28 WTT ± 1.05 TL (*WTT-WIND TUNNEL TEST IF APPLICABLE)

SERVICELOAD COMBINATIONS

S1	1.0DL + 1.0 SDL + 1.0 LL
S2/S3	1.0DL + 1.0 SDL + 0.8 LL* ± 0.8 SPECX or EQX
S4/S5	1.0DL + 1.0 SDL + 0.8 LL* ± 0.8 SPECY or EQY
S6/S7	1.0DL + 1.0 SDL + 0.8 LL ± 0.8 WLx or GUSTX
S8/S9	1.0DL + 1.0 SDL + 0.8 LL ± 0.8 WLy or GUSTY
S10/S11	1.0DL + 1.0 SDL ± 1.0 SPECX or EQX
S12/S13	1.0DL + 1.0 SDL ± 1.0 SPECY or EQY
S14/S15	1.0DL + 1.0 SDL ± 1.0 WLx or GUSTX
S16/S17	1.0DL + 1.0 SDL ± 1.0 WLy or GUSTY
S18/S19/S20/S21	1.0DL + 1.0 SDL + 1.0 LL ± 1.0 SPECX or EQX ± 1.0 TL
S22/S23/S24/S25	1.0DL + 1.0 SDL + 1.0 LL ± 1.0 SPECY or EQY ± 1.0 TL
S26/S27/S28/S29	1.0DL + 1.0 SDL + 1.0 LL ± 1.0 GUSTX or WLX ± 1.0 TL

S30/S31/S32/S33	1.0DL + 1.0 SDL + 1.0 LL ± 1.0 GUSTY or WLY ± 1.0 TL
*S34	1.0DL + 1.0 SDL + 0.8 LL +0.8 WTT
*S35	1.0DL + 1.0 SDL +1.0 WTT
*S36/*S37	1.0DL + 1.0 SDL + 1.0 LL + 1.0 WTT ± 1.0 TL
FIRE TENDER	1.0DL + 1.0 SDL + 1.0 LL + 1.05 FIRE TENDER

Whenever live load (LL*) is combined with seismic load, the appropriate part of live load as specified in IS: 1893 - 2016 shall be used both for evaluating earthquake effect and for combined load effects used in such combination.

Wind load and Seismic load shall not be considered to act simultaneously. The effect of both the forces shall be considered separately.

Load combination is necessary to ensure the required safety and economy in the design of structure. It considers the probability of individual loads acting together, the disposition in relation to other loads and severity of stresses or deformations caused by combinations of various loads. Whichever combination produces worst effect in building, foundation and structural member shall be adopted in analysis and design.

*Live loads for Designing of columns, shear walls and foundations will be reduced as allowed by IS: 875 Part 2.
*Dynamic wind load for Along and Across responses will be considered simultaneously in Design.
*Preset P-Delta Option Will be used with 1.2DL+0.5LL in ETABS Definition and the same will be used as DL+LL±EQ/±WL for Load Combination

PARTIAL SAFETY FACTOR FOR MATERIALS

Concrete (Compression)	ym = 1.50	IS 456- Clause 36.4.2.1
Reinforcing Steel	ym = 1.15	IS 456- Clause 36.4.2.1
Structural Steel yielding stress	ym = 1.10	IS 800 - 2007 Table 5 (Clause 5.4.1)
Structural Steel buckling	ym = 1.10	IS 800 - 2007 Table 5 (Clause 5.4.1)
Structural Steel ultimate stress	ym = 1.25	IS 800 - 2007 Table 5 (Clause 5.4.1)
Welds-shops fabrications	ym = 1.25	IS 800 - 2007 Table 5 (Clause 5.4.1)
Welds-Field fabrications	ym = 1.50	IS 800 - 2007 Table 5 (Clause 5.4.1)

17. SERVICABILITY CONSIDERATIONS

Vertical Deflection:

As per Clause 23.2 of IS: 456 - 2000,

The deflection due to all loads including effects of temperature, creep, shrinkage and measured from as-cast level of the supports of floors, roofs and all other horizontal members shall not normally exceed **SPAN/250**.

The deflection including effects of temperature, creep and shrinkage occurring after erection of partitions and the application of finishes shall not normally exceed **SPAN/350**or **20mm** whichever is less.

Lateral Deflection:

As per Clause 5.4.1 of IS: 16700 - 2017, the lateral deflection or Diaphragm Drift of the structure under the lateral forces shall be limited as follows,

- For Wind Loads -- H/500 (For 20 year Return Period of Serviceability State)
- For Earthquake Loads -- Storey Drift <= H/250 (For 50 year Return Period of Design State)

The Serviceability criteria will be check using the ULS model, if found exceeding the codified values then only the SLS model will be generated to check the relevant parameters. Structural stability under gravity load is equally important as placing of structural elements having different axial stiffness causes the differential elastic shortening in high-rise building. To ensure the flexibility of structure the stability co-efficient shall be limited to 0.2. This check becomes more important if the lateral sway of building under gravity load exceeds H/1000.

Stability of Structure:

The minimum Factor of Safety against overturning, sliding and hydrostatic uplift shall be as per relevant Indian Standard Codes.

As per Clause 20.1 of IS: 456 - 2000, the stability of a structure as a whole against overturning shall be ensured so that the restoring moment shall be not less than the sum of 1.2 times the maximum overturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In cases where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Restoring moment due to imposed loads shall be ignored.

As per Clause 20.2 of IS: 456 - 2000, the structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load shall be taken into account.

18. DESIGN LIFE OF STRUCTURE

As it has been mentioned in the main body of the DBR report, if the code requirements are followed automatically the requirements of 50-year design life is incorporated in the design. For the wind and seismic load cases, for more years of design life loading can be accommodated but other issues still has to be considered. These include the following:

• Durability requirements: this could be in the form of: Enhance Concrete Performance by using especially designed concrete mix to improve the concrete quality and durability to protect reinforcement in the concrete. Implement other measures to improve durability of concrete to protect reinforcement from corrosion. These measures included concrete admixtures and coatings etc. Extended testing would be required to come up with a proper mix and understand the environmental conditions on site and within the ground.

• Installation a Cathodic Protection system during the construction to significantly reduce the corrosion of the reinforcement in the concrete.

• Structural Design with Repair & Strengthening: The structural design to be carried out and detailed in such a way that there are redundancies in the structural system and all the elements including major elements can be maintained, repaired, strengthened, or replaced if necessary (but not necessarily for the major elements). Those elements which cannot be replaced should be design with a higher factor of safety that potential reductions in capacity could still not impair their structural functionality to support the intended service loads. This could have cost implication, but such a decision would be made by assessing time and cost for the replacement of such elements as compared to the increased cost due to over sizing of that element at the start.

• Preparation of Method Statements Repair and Strengthening: it can be developed as part of the tender documents that the contractors should follow.

• Implementation of an inspection regime to implement necessary repairs and maintenance requirements such as mentioned below:

• Visual inspection: Yearly to identify the overall performance of the structure.

• Principal Inspection: Every 6 years to be conducted within touching distance to identify cracks, deformation, corrosion etc. where non-destructive or semi-destructive testing might be needed. The above is related to Structural Engineering work. Please also note that the above procedure is not. A similar approach should also be considered for Architectural (finishes), MEP equipment or Façade of the Temple by having a regime of inspection and maintenance would be required. The design of the MEP system should be carried out in such a way to allow for future replace of the components which have a specific service life. There should be access chambers, shafts and services walkways provided as part of the architectural design (or making sure access to such elements are without hindrance) which can be opened for inspection and potentially large enough for people able to walk inside them both for inspection and repair/replacement work. MEP systems should be designed in a loop system that each point can be reached from two sides, or redundancies put in place as part of the design. Please also note that provisions and space should be allowed for monitoring stations and operations rooms where all the information received from the instrumentation are gathered. The system should be such designed that remotely the MEP system can be controlled and switched off.

- Specialists to get the necessary input and associated cost for some of points in the introduction, Structural Consultants needs the following specialists to be appointed by the client:

- Specialist concrete material and testing
- Cathodic Protection Specialist
- As mentioned earlier for Architectural, MEP/Façade systems, other specialists are needed.

19. ADDRESSING NON-STRUCTURAL ELEMENTS

NSEs in tall buildings shall be protected against the effects of Acceleration-sensitive NSEs, Deformation-sensitive NSEs, and Acceleration-and-deformation-sensitive NSEs. Major NSEs shall be protected based on engineered calculations as per relevant clauses of IS-16700:2017. Mechanical equipment those having located at top height of the structure and having certain operating frequency will be check for the Acceleration – sensitivity as per IS:16700.

The Non-Structural Walls like masonry walls/partition walls will be check for the Displacement – sensitivity as per relevant codal provision. Stiffness Contributions of Non-Structural Elements will not be considered for Analysis and Design of Principal Lateral Load Resisting System. In general, Acceleration sensitivity is performed to measure the additional seismic demand imposed on the equipment and accordingly its connections and supporting system have been designed, whereas for Displacement sensitivity is performed to measure the relative displacement between Structural members and Non-Structural Elements. GSDMA Guidelines on Non-Structural Elements explicitly explain the design principal and execution approach. The same will be considered wherever applicable to address the Non-Structural Elements.

20. RECOMMENDATIONS FOR MONITORING DEFORMATIONS IN BUILDINGS

All tall buildings in Seismic Zone V and tall buildings exceeding 150 m in Seismic Zones III and IV shall be instrumented with tri-axial accelerometers to capture translational and twisting behaviour of buildings during strong earthquake shaking. Buildings over 150 m in height may be instrumented with anemometers and accelerometers to measure wind speed, acceleration and direction on top of the buildings. Permanent settlement markers (at corners and centre) should be provided at raft top level and referenced to a permanent benchmark. Records of settlement should be maintained till completion of the building and preferably even after completion.Raft or Piled-raft shall be instrumented for monitoring long-term pressure imposed by soil on the raft, at appropriate number (at least 5) of pressure pads below the raft. Alternatively, piles can be instrumented with strain gauges at their top to measure the load on them.

21. GENERAL DETAILING REQUIREMENTS

Minimum reinforcement and spacing requirements as per IS: 456 – 2000 would be considered to control shrinkage and temperature stresses.

Structural Member	Minimum Reinforcement	References/Remarks
Beams	(0.85/Fy) %	Clause 26.5.1.1 of IS: 456 - 2000
Slabs	0.12 %	Clause 26.5.2.1 of IS: 456 - 2000

Columns	0.80 %	Clause 26.5.3.1 of IS: 456 - 2000
Walls – Horizontal Reinf.	0.25 %	Clause 32.5 of IS: 456 – 2000
Walls – Vertical Reinf.	0.15 %	Clause 32.5 of IS: 456 - 2000
Structural Member	**Maximum Allowable Spacing**	**References/Remarks**
Beams	For Main Reinf – Table 15	Clause 26.3.3 of IS: 456 - 2000
	For Shear Reinf – 300 mm	Clause 26.5.1.5 of IS: 456 - 2000
Slabs	Flat Slabs, 2 x Slab Thickness	Clause 31.7.1 of IS: 456 - 2000
	Slab Main Reinforcement, 3 x Effective Depth OR 300 mm, whichever is least	Clause 26.3.3 of IS: 456 - 2000
	Slab Main Reinforcement, 5 x Effective Depth OR 450 mm, whichever is least	Clause 26.3.3 of IS: 456 - 2000
Columns	Main Bars, < 300 mm	Clause 26.5.3.1 of IS: 456 - 2000
	Links, Least Column Dim. OR 16x Smallest Vertical Bar DiaOR 300mm, whichever is least	Clause 26.5.3.1 of IS: 456 - 2000
Walls – Horizontal Reinf.	450mm OR 3 x Wall Thickness	Clause 32.5 of IS: 456 – 2000
Walls – Vertical Reinf.	450mm OR 3 x Wall Thickness	Clause 32.5 of IS: 456 - 2000

Minimum reinforcement and spacing requirements as defined in IS: 13920 shall be adopted for ductile detailing of the structure.

Structural Member	Minimum Reinforcement	References/Remarks
Beams	(0.24√Fck/Fy) %	Clause 6.2.1 of IS: 13920 - 2016

Slabs	0.12%	Clause 26.5.2.1 of IS: 456 - 2000
Columns	0.80%	Clause 26.5.3.1 of IS: 456 - 2000
Walls – Horizontal Reinf.	0.25%	Clause 10.1.6 of IS: 13920 - 2016
Walls – Vertical Reinf.	0.25%	Clause 10.1.6 of IS: 13920 -2016

Structural Member	Maximum Allowable Spacing	References/Remarks
Beams	For Shear Reinf – 0.5d	Clause 26.5.1.5 of IS: 456 - 2000
Columns	Main Bars, < 300 mm	Clause 26.5.3.1 of IS: 456 - 2000
	Links, Least Column Dim. OR 16x Smallest Vertical Bar DiaOR 300mm, whichever is least	Clause 26.5.3.1 of IS: 456 - 2000
Walls – Horizontal Reinf.	450mm OR 3 x Wall Thickness OR 0.2Lw , whichever is least	Clause 10.1.6 of IS: 13920 - 2016
Walls – Vertical Reinf.	450mm OR 3 x Wall Thickness OR 0.2Lw , whichever is least	Clause 10.1.6 of IS: 13920 - 2016

22. INDIAN STANDARD CODES& OTHER REFERENCES

The following Indian Codes and Standards shall generally be used for design of structural work. All applicable Indian Standard (IS) Codes shall be used. In all cases, the latest revisions with amendments, if any, shall be followed (as on date of LOI):

LOADS:

IS: 875 - 1987 (PART - I, II, IV, V)	Code of Practice for Design Loads (other than Earthquake) for Buildings and Structures
IS: 875 - 2015 (PART-III)	Design Loads (Other Than Earthquake) For Buildings and Structures (Wind Loads)

IS: 1893 - 2016 (PART-I)	Criteria for Earthquake Resistant Design of Structures
IS: 16700 - 2017	Criteria for Structural Safety of Tall Concrete Buildings

FOUNDATION:

IS: 1080 - 1997	Code of Practice for Design and Construction of Shallow Foundations in Soils (other than Raft, Ring and Shell)
IS: 1904 - 1986	Code of Practice for Design and Construction of Foundations in Soils: General Requirements
IS: 2911 - 1997 (PART - I TO IV)	Code of Practice for Design and Construction of Pile Foundations
IS: 2950 - 1988	Code of Practice for Design and Construction of Raft Foundations - Part 1: Design.

REINFORCED CEMENT CONCRETE:

IS: 456 - 2000	Code of Practice for Plain and Reinforced Concrete
IS: 13920 - 2016	Code of Practice for Ductile Design and Detailing of Reinforced Structures Subjected to Seismic Forces
ACI: 318 – 19	Building Code Requirements for Structural Concrete
ASCE: 7-16/ 7-22	Minimum Design Loads and Associated Criteria for Buildings and Other Structures
IS: 3370 - 2009	Code of Practice for Concrete Structure for The Storage of Liquids

STRUCURAL STEEL:

IS: 800 - 2007	Code of Practice for General Construction in Steel
IS: 1642 - 2000	Code of Practice for Fire Safety of Buildings (General): Details of Construction

IS: 1786 - 2008	Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement

HANDBOOK & SPECIAL PUBLICATIONS:

SP: 6 - 1964	Handbook for Structural Engineering
SP: 16 - 1980	Design Aids for Reinforced Concrete
SP:24 - 1980	Explanatory Hand Book on IS:456-2000
SP: 34 - 1987	Handbook of Concrete Reinforcement and Detailing
NBC - 2016	National Building Code of India
GSDMA Guidelines	General Guidelines & Criteria for Structural Safety and Assessment
CEB-FIP-34	Model Code for Service Life Design

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