Proposed Residential Building

At KOLATHUR for CASAGRAND

CHENNAI

PRELIMINARY DESIGN BRIEF REPORT

Client	:	CASAGRAND	**Casagrand Premier Builder Limited** CIN No. - U70101TN2003PLC051989 5th floor, NPL Devi, New No -111, OLD NO 59 L.B.Road, Thiruvanmiyur, Chennai, Tamil Nadu, India, 600041.
Architects	:	SDC	**Srishti Design Consultants** Flat A, 1st floor, SN Enclave No.38/5 Vellan Nagar, Valluvar Road, Arumbakkam, Chennai 600 106.
Structural Consultants	:	esigntree	**Design Tree Service Consultants Pvt Ltd** 3rd Floor, GJ Complex, 17/8, CIT 1st Main Rd, CIT Nagar, Chennai, Tamil Nadu 600035.

N. ARUN KARANTH, M.Tech.
Registered Structural Engineer Grade-I (SE)
CMDA Registration No. SE / GR / 19 / 03 / 074
10, 3rd Floor, GJ Complex, 1st Main Road,
CIT Nagar, Chennai-600 035.
Phone: 9741110384

1.0 STRUCTURAL SERVICE

N. ARUN KARANTH, M.Tech.
Registered Structural Engineer Grade-I (SE)
CMDA Registration No. SE \ GR \ 19 \ 03 \ 074
10, 3rd Floor, CL Complex, 1st Main Road,
CIT Nagar, Chennai-600 035.
Phone: 9741110364

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1. STRUCTURAL SERVICES

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N. ARUN KARANTH, M.Tech.
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PROJECT BRIEF

1.1 Introduction

The client M/S **Casagrand Premier Builder Limited** intends to develop a Residential Building at Kolathur, Chennai. Project is architecture by M/S Srishti Design Consultants (SDC) Chennai. Structures Engineering Services are provided by M/S Design Tree Service Consultants Pvt. Ltd, Chennai.

1.1.1Objective of the Report

The objective of the report is to identify and record all the pertinent input requirements, analysis & design criteria for structural design of the various buildings in the proposed residential project at Chennai. It is aimed at consolidating the basis of the work that the structural designer is going to carry out in delivering the structural framework of the buildings which will be compatible with the architectural theme, satisfy the functional needs, adhering to the building norms and Indian Standards provisions and which will be safe, stable, strong and yet optimally economical.

This report covers the minimum design requirement to establish the unified design basis that will form the overall design philosophy to be adopted in the structural design of the RCC buildings.

The design basis will aim to achieve:

- Structural & functional integrity.
- Desirable Structural performance under characteristic service design loadings.
- Ability to sustain design basis loads due to natural phenomena such as wind, earthquakes, seasonal variation in ground water table and thermal effects.
- Structural durability & maintainability.

Brief of the project

Residential Building:

This project consists of **Three Residential Blocks**.

The Residential building Block 1 consists of 2 Basement + Ground + 26 floors + Terrace (29 Slabs), Block 2 consists of 1 Basement + Ground + 26 floors + Terrace (28 Slabs), Block 3 consists of 1 Basement + Ground + 28 floors + Terrace (30 Slabs) and the Club house is coming at ground floor level (double height).

The height of the proposed Block 1 Building is 96.75 meter from Basement 02 level to Terrace Floor.

Building floor heights as below for Block 1

B2 to B1	-	3.25 m
B1 to GROUND	-	4.40 m
GROUD to First floor	-	3.30 m
First floor to Terrace (Typical floors)	-	3.30 m.

The height of the proposed Block 2 Building is 93.5 meter from Basement 01 level to Terrace Floor.

Building floor heights as below for Block 2

B1 to GROUND	-	4.40 m
GROUD to First floor	-	3.30 m
First floor to Terrace (Typical floors)	-	3.30 m.

The height of the proposed Block 3 Building is 103.40 meter from Basement 01 level to Terrace Floor.

Building floor heights as below for Block 3

B1 to GROUND	-	4.40 m
GROUD to First floor	-	6.60 m
First floor to Terrace (Typical floors)	-	3.30 m.

The proposed Towers has

- Car parking, Pump room, UG sump, fire tank at basements,
- Typical floor Residential purposes.
- Space for Staircase head room, lift machine room, overhead tank etc in the terrace floor.
- The clubhouse is coming on the ground floor (double height) of Block 3; it consists of a multipurpose hall, entertainment lounge, association room, kids' play area, dormitory, video games, home theater, yoga/meditation area, indoor games, gym, and laundry.

Statutory Requirements:

The design of structural and other building services will comply with the following requirements:

- National Building Code
- The Building Regulations
- The Environmental Protection Act in liaison with the Environmental Agency.
- Fire prevention and detection in compliance with the local Fire Regulation.

1.2 DESIGN STANDARDS:

Specific applicable codes and standards will be identified and adopted in the design philosophies as appropriate to the structural elements. The latest editions of the Codes and Standards will be used in designs. All design work shall be based on Indian Standards and Codes with latest revision, with amendments if any, as on date.

Loads:

IS:875 -1997 Code of Practice for design loads for Buildings and structure (Part- 1, 2, 4 & 5)
IS:875 -2015 Code of Practice for design loads for Buildings and structure (Part- 3 - Wind Loads)
IS:1893 -2016 Criteria for earthquake resistant design of structure (Part-1)

Foundations:

IS:1080-1997 Code of Practice for design and construction of shallow foundations on soils
IS:1904-2021 Code of Practice for design and construction of foundations in soils general requirement
IS:2950-1998 Code of Practice for design and construction of raft foundations
IS:2974-1998 Code of Practice for design and construction of machine foundations (All parts)
IS:8009-1998 Code of Practice for calculation of settlement of foundations (All parts)

RCC:

IS:456 -2000 Code of Practice for plain and reinforced concrete
IS:16700 -2023 Criteria for structural safety of tall concrete buildings
IS:458 -2021 Specification for precast concrete pipes
IS:3370-2021 Code of Practice for concrete structures for the storage of liquids: (All parts)
IS:4326-2013 Code of Practice for earthquake resistant design and construction of buildings
IS:5525-1999 Recommendation for detailing of reinforced concrete works
IS:1786-2008 Specification for high strength deformed steel bars and wires for concrete reinforcement
IS:10262-2019 Recommended guidelines for concrete mix design
IS 13920-2016 Ductile detailing of reinforced concrete structures subjected to seismic forces - code of practice

Structural steel:

IS:800 -2007 Code of Practice for general construction in steel
IS:806 -1968 Code of Practice for use of steel tubes in general building construction
IS:808 -2021 Dimensions for hot rolled steel beam, column channel and angle section
IS:816 -1969 Code of Practice for use of metal arc welding for general construction in mild steel
IS:1161-2014 Steel tubes for structural purposes
IS:4000-1992 High Strength bolts in steel structures - Code of Practice
IS:7215-1974 Tolerances for fabrication of steel structures

Miscellaneous:

IS: 432(part 2)-1995Specification for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement
IS: 6313(part II)-2022 Standards for anti-termite treatment
IS:1905-1987 Code of Practice for structural use of unreinforced masonry

IS:3067-1988 Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
SP:6 -1998 Handbook for structural engineers (All parts)
SP:7 -2016 National Building Code of India
SP:16-1980 Design Aids for reinforced concrete to IS:456-1978
SP:22-1982 Explanatory handbook on codes for earthquake engineering (IS:1982-1975 and IS:4326-1976)
SP:24-1983 Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete
SP:34-1987 Handbook of concrete reinforcement and detailing (SCIP)
Wherever appropriate Indian Regulation does not exist for any particular item, appropriate British standards or American will be used.

Material:

IS: 269 -2015 Specification for Ordinary, rapid hardening and low heat Portland cement.
IS: 455 -2015 Specification for Portland blast furnace slag cement.
IS: 1489-2015 Specification for Portland pozzolana cement
IS: 4031 Method of physical tests for Portland cement.
IS: 383 - 2016 Specification for coarse and fine aggregates from natural sources for concrete.
IS: 516 - 2021 Method of test for strength of concrete.
IS: 1199-2018 Method of sampling and analysis of concrete.
IS: 1566-1982 Specification for plain hard drawn steel wire fabric for concrete reinforcement.
IS: 4990-2024 Specification for plywood for concrete shuttering works.
IS: 2645-2003 Specification for integral cement water proofing compounds.

1.3 DESIGN DATA:

1.3.1 Dead loads:

Dead load shall include weight of all structural and Architectural components. Self-weight of the materials shall be calculated on the basis of unit weights given in IS: 875.

Dead loads:

- Floor finish of 50mm thick for Residential floors : Tiles -0.05x24=1.2 kN/sq.m.
- False ceiling/Ceiling Finish for Residential floors : 30 kg/sq.m (0.3 kN/sq.m).
- Floor finish of 100mm thick for Parking Areas : 240 kg/sq.m (0.1x24=2.4 kN/sq.m).
- Ducting + Sprinklers for Basements : 50 kg/sq.m (0.5 kN/sq.m).
- Partition walls : As per actuals.
- Wall loads : As per actuals.
- Staircase load including step weight : As per actuals.

  Sunken loads :
- Toilets & Balconies/Utilities : 100mm/150mm

  : For 100mm (0.10x20) +1.5 = 3.5kN /sq.m.

  For 150mm (0.15x20) +1.5 = 4.5kN /sq.m.

Material Density

- Density of Plain concrete : 2400 kg/cu.m (24 kN/cu.m).
- Density of Cement mortar : 2000 kg/cu.m (20 kN/cu.m).
- Density of RCC : 2500 kg/cu.m (25 kN/cu.m).
- Solid block masonry : 2000 kg/cu.m (20 kN/cu.m).
- Brick Wall : 1900 kg/cu.m (19 kN/cu.m).
- Aerated block masonry : 865 kg/cu.m (8.65 kN/cu.m).
- Soil (Dry) : 1800 kg/cu.m (18 kN/cu.m).
- Soil (Wet) : 2000 kg/cu.m (20 kN/cu.m).
- Water : 1000 kg/cu.m (10 kN/cu.m).
- Glass : 2800 kg/cu.m (28 kN/cu.m).
- Structural steel : 7850 kg/cu.m (78.5 kN/cu.m).
- Masonry with plastering : 2200 kg/cu.m (22 kN/cu.m).
- Filling for sunken portion : 2000 kg/cu.m (20 kN/cu.m)
- Waterproofing (membrane). : 15kg/sq.m (0.15kN/sq.m).
- Floor finishes including WPC@terrace lvl : 360kg/sq.m (3.6kN/sq.m).
- Staircase steps load : 387.5kg/sq.m (3.875kN/sq.m)

  : (0.5x0.15x25)+2 = 3.875 kN/sq.m

1.3.2 Live loads:

The superimposed loads shall be calculated in accordance with IS: 875(Part-2) based on Occupancy Classification. For multiple occupancies of use in the building shall be referred with the other appropriate comparable occupancy classification as per Table.1 of IS 875(Part-2)-1987.

- Parking Area : 250 kg/ sq.m (2.5 kN/sq.m) + 25% Impact(3.125KN per sqm)
- Fire tender Loading : 2000 kg/sq.m (20.0 kN/sq.m).
- Living/dining/kitchen/bed rooms/Foyer : 200 kg/sq.m (2.0 kN/sq.m)
- Stairs : 300 kg/sq.m (3.0 kN/sq.m)
- Corridors/Balcony/Utility : 300 kg/sq.m (3.0 kN/sq.m)
- Toilets : 200 kg/sq.m (2.0 kN/sq.m)
- Lift Machine room : 1000 kg/ sq.m or as per actuals.
- Terraces : 300 kg/ sq.m (3 kN/sq.m).
- Ramps : 500 kg/sq.m (5 kN/sq.m) (Without fire truck movement).
- Generator : 1000 kg/ sq.m (10 kN/sq.m) or as per actuals.
- Pump & Electrical Rooms : 750 kg/ sq.m (7.5 kN/sq.m)
- Gardening / Landscape Loads : 600mm filling - (0.6*20=12 kN/sq.m) 1200 kg/sq.m or as per actuals.
- Entertainment Lounge : 400 kg/ sq.m (4.0 kN/sq.m)
- Multipurpose Hall : 500 kg/ sq.m (5.0 kN/sq.m)
- Dormitory : 500 kg/ sq.m (5.0 kN/sq.m)
- Store : 300 kg/ sq.m (3.0 kN/sq.m)
- Kids Play : 500 kg/ sq.m (5.0 kN/sq.m)
- Gym/Indoor Games : 500 kg/ sq.m (5.0 kN/sq.m)
- DG Room : 1000 kg/ sq.m (10 kN/sq.m)
- Laundry Room : 500 kg/sq.m (5.0 kN/sq.m)
- Refuge Floor Load : 300 kg/sq.m (3.0 kN/sq.m)
- Learning Centre : 500 kg/sq.m (5.0 kN/sq.m)
- Home Theatre : 400 kg/sq.m (4.0 kN/sq.m)
- Meter Room : 500 kg/sq.m (5.0 kN/sq.m)
- Overhead Tank Top : 200 kg/sq.m (2.0 kN/sq.m)

1.3.3 Wind Loads

The Wind pressure shall be calculated in accordance with IS: 875 (Part-3).

Chennai, which is located in Tamilnadu, is having wind speed of 50m/sec.

- Basic Wind Speed Vb : 50 m/sec
- Risk Coefficient K1 : 1.00 (k1 corresponds to 50 years Mean Probable Design Life of Structure)
- Terrain, height, structure size factor K2 : To suit the height of the structure for terrain Category 2 and also it varies with the height of the structure.
- Topography factor K3 : 1.00
- Importance factor for the cyclonic region K4 : 1.00
- The external and internal pressure co-efficient shall be as per respective clauses of IS: 875 (Part 3)
- Design wind speed Vz : Vb x k1 x k2 x k3 x k4
- Design wind pressure Pz : $0.6 \times Vz^2$

NOTE: Refer ANNEX -A for the wind load calculation

Height of the building (m)	K2	Vz = Vb x k1 x k2 x k3 xk4 (m/s)	Pz = 0.6 x Vz^2 (kN/m^2)
10	1.00	50.00	1.50
15	1.05	52.50	1.65
20	1.07	53.50	1.72
30	1.12	56.00	1.88
50	1.17	58.50	2.05
100	1.24	62.00	2.31
150	1.28	64.00	2.46
200	1.30	65.00	2.54
200	1.32	66.00	2.61

Dynamic wind response - Along wind response (Gust Factor Analysis) and across wind response as per Clause10 of IS 875 (part 3)-2015 shall be followed. If

a) Buildings and closed structures with a height to minimum lateral dimension ratio of more than about 5.0 or
b) Buildings and structures whose natural frequency in the first mode is less than 1.0 Hz.

For Block 1

Case (a) - Height to minimum lateral dimension ratio = 96.75/49.90=1.94 < 5.

Case (b) - Natural frequency = 1/Ta

Time period = 0.0672 H^0.75 = 0.0672*96.75^0.75 = 2.0730 seconds.

Natural frequency = 1/2.0730 = 0.4823 Hz < 1.0Hz.

For Block 2

Case (a) - Height to minimum lateral dimension ratio = 93.50/50.12=1.865 < 5.

Case (b) - Natural frequency = 1/Ta

Time period = 0.0672 H^0.75 = 0.0672*93.50^0.75 = 2.0205 seconds.

Natural frequency = 1/2.0205 = 0.495 Hz < 1.0Hz.

For Block 3

Case (a) - Height to minimum lateral dimension ratio = 103.4/48.91 =2.114 < 5.

Case (b) - Natural frequency = 1/Ta

Time period = 0.0672 H^0.75 = 0.0672*103.4^0.75 = 2.179 seconds.

Natural frequency = 1/2.179 = 0.4589 Hz < 1.0Hz.

Hence, for the given building heights & size, dynamic Effects of wind need is considered in the analysis.

1.3.4 Seismic Forces

Chennai falls under seismic zone III as per IS 1893-2016 (Part 1) (Fifth Revision) and has the following factors to be considered for designs. Ductile detailing is not required. (Please refer attached map)

- Seismic Zone : III (Annexure E) : IS 1893 (Part-1) : 2016
- Seismic Zone factor, Z : 0.16 (Annexure E) : IS 1893 (Part-1) : 2016
- Design horizontal seismic coefficient (Ah) : (Z/2)*(Sa/g)*(I/R).
- I -Importance factor : 1.2 (Ref Table 6-IS: 1893-2016)
- Response reduction Factor : 5 (SMRF)
- Soil type : 1
- Damping Ratio for RCC : 5 %
- R as per Table 9 of IS: 1893-2016 is based on Ductile RC Structural Walls with RC SMRFs.
- Sa/g - Average response acceleration coefficient for soil sites as per Fig.2 of IS: 1893-2016 and it is arrived based on approximate fundamental natural time period as per clause 6.3.4 of IS: 16700-2023.

Clause: 6.3.4 - Approximate fundamental natural time period of structure is

Ta = 0.0672 H^0.75 for all other concrete structural systems.

Where, h = Height of the building in meters.

- Design horizontal seismic coefficient (Ah) : (Z/2)*(Sa/g)*(I/R).
  : (0.16/2)*(1.2/5) * (Sa/g).
  Ah : 0.0192 * (Sa/g).
- Design seismic base shear, Vb : Ah * W where, W - seismic weight of building.
- Detailing as per IS 13920:2016, IS 456:2000 & SP 34 : Special moment resistant frame with ductile detailing.

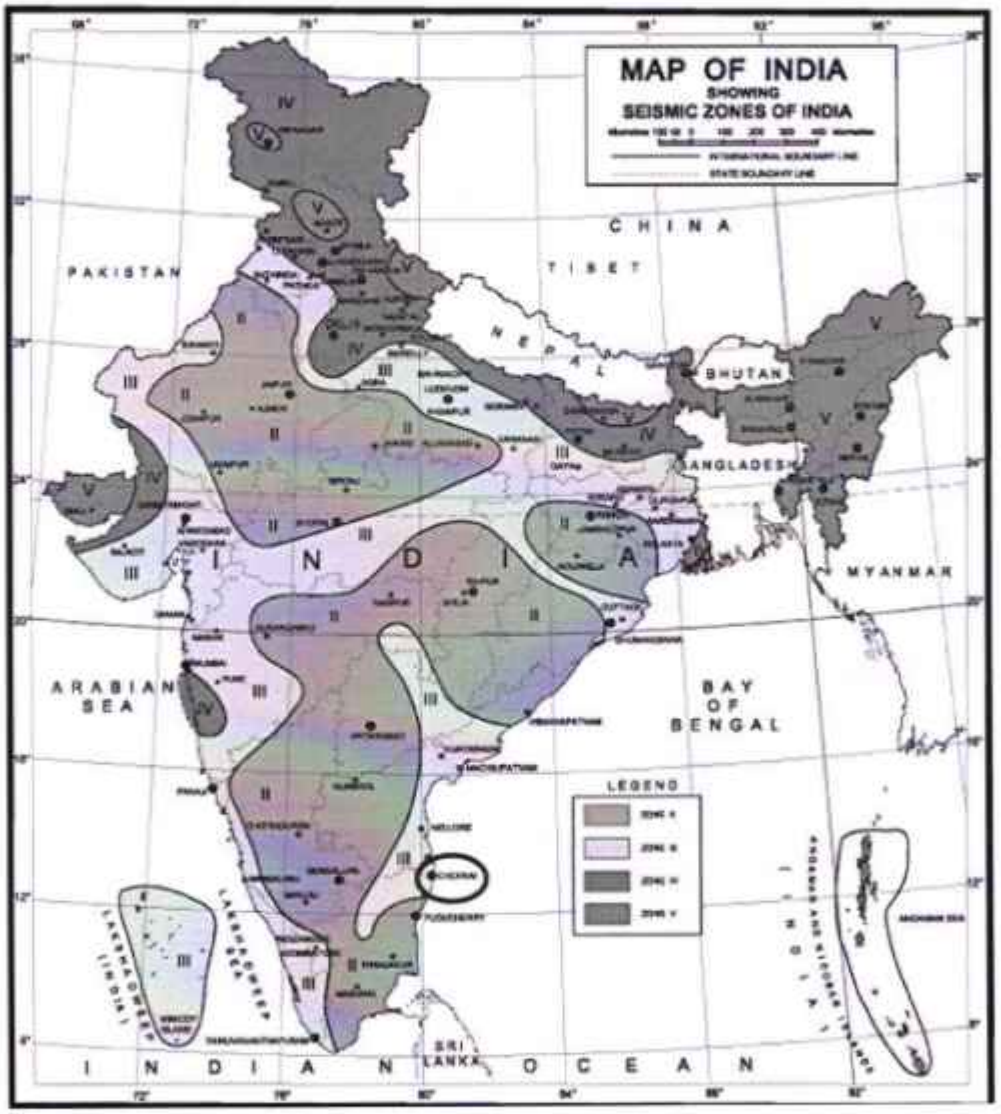
Vertical Dynamic Analysis:

- Since the building falls under high rise building and irregular geometry, So Vertical acceleration shall be consider as per IS 1893-2016(Part-01).
- **Seismic weight :**

Sl No.	Imposed Uniformity Distributed Floor Loads kN/m²	Percentage of Imposed Load
(1)	(2)	(3)
i)	Up to and including 3.0	25
ii)	Above 3.0	50

- When fire tender load is combined with gravity loads partial safety factor shall be considered 1.05 times. This is not combined with lateral loads as per NBC-2016.

Table No : 02				
Zone Factor, Z				
(Clause 6.4.2)				
Seismic Zone	II	III	IV	V
Seismic Intensity	Low	Moderate	Severe	Very Severe
Z	0.10	0.16	0.24	0.36



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

- Environment : Mild for Super Structure and Moderate for Sub Structure.
- Exposure conditions : Concrete surfaces sheltered from severe rain or freezing whilst wet environment
- Fire protection : Thickness of the structural elements as per table 15, 16 & 16A clause 26.4 of IS 456-2000.
- Minimum grade of concrete : M30 Grade for Tower area & podium area.
- Nominal cover to reinforcement : For Moderate Exposure Nominal cover should not be less than 30 mm
- Nominal covers for 2 hr. fire resistance : As per IS 456:2000, Table 16A Clause 21.4 & 26.4.3

Nominal Cover						
Beams		Slabs		Ribs		Columns
Simply supported	Continuous	Simply supported	Continuous	Simply supported	Continuous	
40 mm	30 mm	35 mm	25 mm	45 mm	35 mm	40 mm

1.3.6 Temperature and shrinkage effect:

Horizontal floor displacement due to differential temperatures and shrinkage is of importance in concrete buildings. It can be taken care of by either providing expansion joints at an appropriate spacing or designing structural members for the additional moments caused by the temperature and shrinkage effects. Pour strips at suitable locations shall also be considered where required.

1.3.7 Temperature Loads:

The effect of temperature will be considered wherever applicable in accordance with relevant Indian Codes. The coefficient for thermal expansion and contraction will be in accordance with IS: 456 and IS: 800 for concrete and steel respectively.

The design temperature Differential is given by Indian road congress (IRC: SP:62-2014) at ± 17 degree centigrade for moderate climates and at ±25degree centigrade for extreme climates.

Controlling of temperature stress we are providing shrinkage strips at every 40 mts.

1.3.8 Exceptional Loads:

Loads due to the following catastrophe scenarios are not considered in the design.

- Exceptional loads due to terrorist attacks (Explosions)
- Accidental loads (Falling of aircraft on the building)
- Accidental hitting of vehicle on the façade
- Snow Load.

1.4. MATERIALS

Materials specified conform to the latest edition of the relevant Indian Standard or other accepted standard. Specifications for materials will include sampling and testing as stipulated in the design standards. Detailed material specifications will be included in the Technical Specification.

1.4.1. Concrete

- All structural concrete shall have cube crushing strength of M50 to M30 N/sq.mm at 28 days.
- Plain cement concrete shall have cube crushing strength of 10 N/sq.mm (M10) at 28 days.

Concrete Mix

Concrete item	Grade
Tower Foundation	M35
Tower Columns & Walls	M50 to M30
Podium footings	M30
Podium column and walls	M30
Drop Panel	Same as column grade
Slab, beams	M30
Retaining walls, Grade slab, & Ramps	M30

Puddling of concrete:

- Flat Slabs- Grade of Drops shall be same as column grade below.
- Flat Plate/Beam/Slab Junction-Grade of concrete for 600 mm all-round from face of column/Shear wall shall be same as Column or Shear wall Grade. Concrete shall be well integrated with Beam/Slab and Column(as per IS 16700-2017 Annex B -4).

1.4.2. Reinforcement steel

1) All reinforcement shall confirm to IS: 1786 - 2008 having minimum yield strength of 500D N/sq.mm. (Fe 550 rebars can be looked into)
2) Shear reinforcement to be designed for Fe-415 N/sq.mm.

Structural Steel

All structural steel shall confirm to IS: 2062 and shall be grade of E350 preferably, else E250.

Cement:

- Cement for the construction shall be chosen as per the guidelines of IS456 and based on thorough soil investigation.
- For general works, ordinary Portland cement (OPC) of either 43 Grade or 53 Grade with C3A content ranging from 5-8%, conforming to IS 8112 and IS 12269, respectively shall be used.
- It shall be insured that the cement used must be of one brand and from same source, as far as possible. The cement shall conform to all the specifications laid down in IS codes.
- If the concrete is exposed to Sulphate attack, Sulphate Resisting Portland Cement (SRPC) confirming to IS12230 shall be used as per IS 456 guidelines.

- In all cases, the cement shall meet the 28 day strength requirement of IS 8112 or IS 12269.
- Mineral Admixtures like Fly ash, Silica fume, or Granulated Slag cement are not to be used.

Use of bulk cement can be permitted only with the approval of the engineer

Water Proofing Material

Waterproofing for Basement including retaining walls shall be done by using 2mm thick, self-adhesive self-protected and self-healing type waterproofing membrane depending on the water table and site conditions.

Mechanical Splicing Material

Moment Coupler - Threaded Type (As per IS 16172: 2014)

As per IS16700:2017 clause 5.7.2.3 no lapping of bars is allowed in RC columns and walls, when diameter of bars is 20mm or higher.

1.5. STRUCTURAL CONCEPT

- The Structural System for the residential towers comprises of RCC slabs supported by RC Structural walls. Floor slabs and walls are considered to act as a rigid diaphragm to transfer the lateral forces to the lateral load resisting elements
- The extended podium area apart from tower portion has been proposed with flat slab system
- The slabs for toilet areas are sunk as per PHE requirement. The cut outs in slab are based on the provisions given in Clause 31.8 of IS 456-2000. Predetermined sleeves shall be considered to accommodate utility services. Staircases are provided with mid-landing between the floors as per architectural layout.

This structure has physical interface with almost all the disciplines like Geotechnical, MEP Services and Landscape etc. The Structure proposed is of cast in-situ concrete construction with walls/columns suitably placed. The core walls around lifts, stairs are of cast in-situ concrete to resist lateral forces. The Structural design of the proposed project is based on Indian Standard Codes and is analyzed for Dead, Live, Wind and Seismic Load conditions taking into relevant load combinations recommended by the codes. The Vertical Loads including the dead and super imposed loads are transferred to the soil through columns, core walls and footings. Footings are sized with consideration to the safe bearing capacity of soil at the level of transfer of load recommended by specialist soil investigation consultants. The Lateral loads due to wind and seismic forces are dissipated to soil through the proposed Reinforced Concrete Core Walls/shear walls/moment resisting frame.

	Description	Podium	Tower
b)	Structural system	Flat slab and RC column/RC walls	RC Shear Wall structure with transfer structure
c)	Slab thickness	225/250mm	125/150/175/200mm
e)	Column size	varies	As per the design (varies)
f)	Slab drop	450/500mm	
g)	Rc walls/Mivan walls		300/250/200/160mm

STRUCTURAL ANALYSIS AND DESIGN

1.5.1. General

All R.C.C structures shall be designed according to the Limit State Method as specified in IS: 456 - 2000.

- The structure is idealized as 3D space frame and analyzed using ETABS software package for both vertical and lateral loads.
- Forces and moments from the 3D analysis output for the worst combinations are used for the design of the structure.
- The foundations are designed for critical load combination.
- The structure is analyzed for specific loads like dead load, live load, wind and seismic loads and for the load combinations as given in the relevant codes.
- The slab is analyzed as two-way and one way slabs.

1.5.2. Deflection Limits:

For Reinforced concrete works:

- Limiting values of deflection (Short and Long term) as per clause 35.3 of IS: 456-2000 is followed in the design.
- Limiting value for short term deflection is considered as span/250 and for the long term deflection is considered as span/350 or 20mm whichever less as per IS 456 - 2000.
- As per IS 1893 (Part1):2016, Story drift in any storey due to minimum specified design seismic lateral force shall not exceed 0.004 times the storey height design.
- Lateral sway due to earthquake load should not exceed H/250 (H is the total height of structure).
- Lateral sway due to wind load should not exceed H/500 (H is the total height of structure).

1.5.3. Cracking Limits:

Limiting values of crack width as per clause 35.3 of IS: 456-2000 is followed in the design.

In general for slabs and beams, the crack width is limited to 0.3mm.

For basement retaining wall and water retaining structures, crack width is limited to 0.2mm.

1.5.4. Load Combinations:

The various loads are combined in accordance with the stipulations in IS: 875 (Part 5)-2015; whichever combination produces the most unfavorable effect in the building foundation or structural member concerned may be adopted.

	Limit State of Collapse				Limit State of Serviceability		
	DL	LL	WL/EL	SPEC	DL	LL	WL/EL
DL + LL	1.5	1.5	–		1	1	–
DL + WL	1.5 or 0.9*	–	1.5		1	–	1
DL + SPEC	1.5 or 0.9*	-	1.5	1.5	1		1
DL+LL+WL	1.2	1.2	1.2		1	0.8	1
DL+LL+SPEC	1.2	1.2	1.2	1.2	1	0.8	1

The following load combinations for temperature considered in analyis as per Cl 35.4 of SP24:1983.

a. 1.05DL+1.05TL+1.275LL

b. 1.05DL-1.05TL+1.275LL

c. 1.4DL+1.4TL

d. 1.4DL+1.4TL

***This value is to be considered when stability against overturning and stress reversal is critical where DL/LL/WL/EL denotes,**

DL - Dead Load; LL - Live Load; TL-Temperature Load; WL - Wind Load; EL - Earthquake Load

Wind load and earthquake loads are considered for both X & Y directions. Whenever imposed load is combined with earthquake load, the appropriate part of imposed load as specified in IS: 1893-2002 / Clause 7.3.1 of seismic code will be used both for evaluating earthquake effect and for combined load effects used in such combination.

1.5.5 SOIL DATA

Foundations are designed based on Geo Technical investigation report and will dissipate all the vertical and horizontal loads safely to the soil below. Isolated, Combined, & Raft footings are envisaged depending on the soil load bearing capacity.

1.6 DESIGN PHILOSOPHY:

Design Life

The design life of the building is assumed as 50 years. This requirement is applicable only for concrete works and not applicable to replaceable finishing materials, water proofing membrane and thermal insulations (if any). Hence periodic maintenance / refurbishment is required for all replaceable material for longer life.

Design Interface:

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

- The Vertical Loads including the dead and super imposed loads are transferred to the soil through columns, core walls and footings. Footings are sized with consideration to the safe bearing capacity of soil at the level of transfer of load recommended by specialist soil investigation consultants.
- The Lateral loads due to wind and seismic forces are dissipated to soil through the proposed Reinforced Concrete Core Walls/columns.
- The type of footings proposed is either individual, combined or raft depending on the Soil investigation report

➢ **CRACKED RC SECTION PROPERTIES AS PER IS 16700(2016):**

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	$1.0\,A_g$	$0.9\,I_g$	$1.00\,A_g$	$0.70\,I_g$