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24.08.2024

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Proposed Construction of High Rise Building Consisting of 2 Blocks Combined Extended Double Basement Floor (Tower –A & B) ; Tower –A: Stilt Floor +8 Floors (8 Dwellings units); Tower-B: Stilt Floor + 12 Floors (35 Dwelling Units) - Totally 43 Dwelling units Indoor Games, Gym, Home theatre, Party Hall in 12th Floor and Swimming Pool at Terrace Floor Level at Door No.3/1,196/1,196/2 and 2/3D, Arcot Road (N.S.K. Salai), Vadapalani, Chennai-600 026, Comprising in old S.No.5/11 (Part), New T.S.NO.5/49,and old S.No.177 and 177/1A New T.S.No.5/13, Block No.5, Saligramam Village, Mambalam Taluk, within the limits of Greater Chennai Corporation

"The proposed structure is safe and sound"

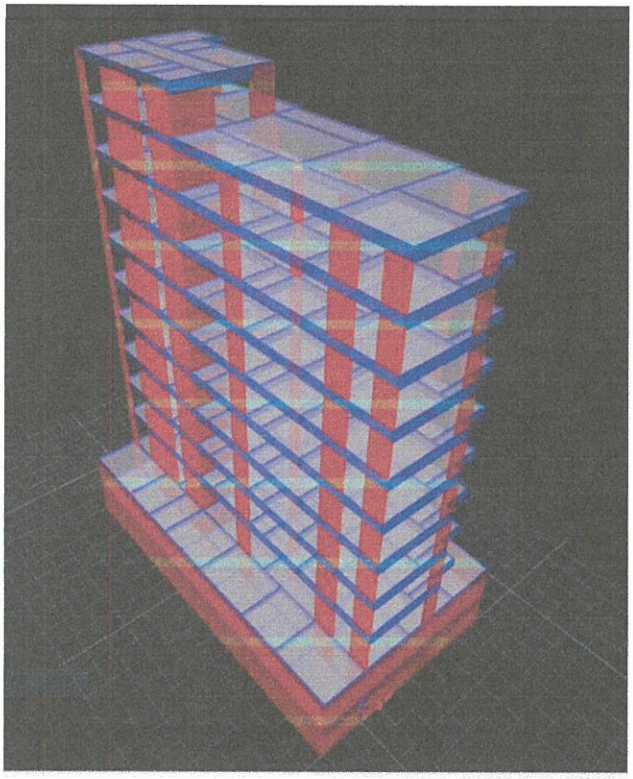
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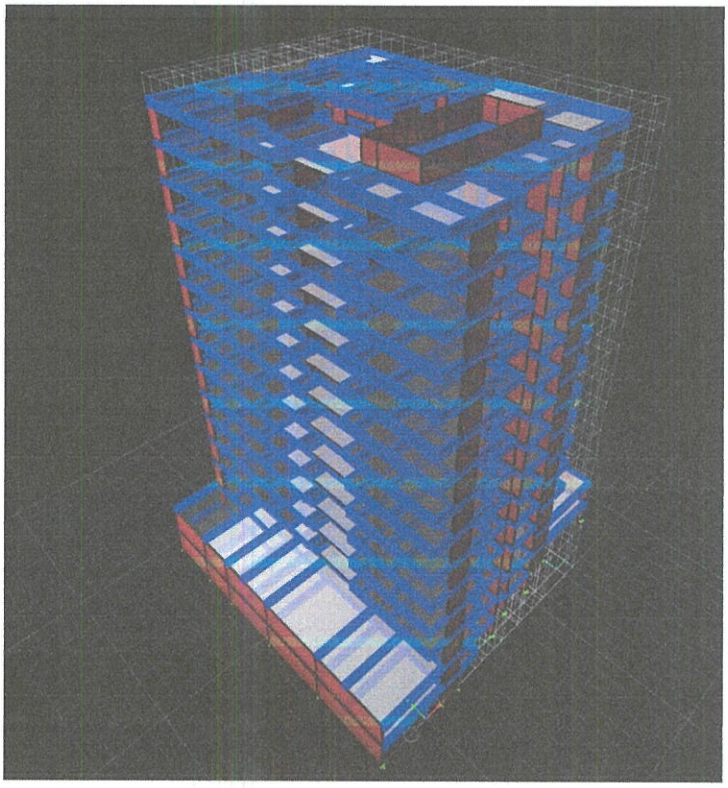
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PLAN SHOWING THE PROPOSED CONSTRUCTION OF HIGH RISE BUILDING (HRB) FOR RESIDENTIAL PURPOSE CONSIST OF 2 BLOCKS: EXTENDED DOUBLE BASEMENT FLOOR (TOWER-A & B) TOWER-A ; STILT FLOOR + 8 FLOORS,(8 DWELLING UNITS); TOWER-B; STILT FLOOR + 12 FLOORS, (35 DWELLING UNITS) ;(TOTALLY OF 43 DWELLING UNITS), INDOOR GAMES, GYM, HOME THEATRE, PARTY HALL IN TWELETH FLOOR & SWIMMING POOL AT TERRACE FLOOR LEVEL WITH AVAILING WITH PREMIUM FSI AT DOOR NO:3/1,196/1,196/2 and 2/3D,ARCOT ROAD (N.S.K. SALAI) VADAPALANI, CHENNAI-600 026,COMPRISING IN OLD SURVEY NO:5/11(part),NEW T.S.NO. 5/49 ,AND OLD S.NO. 177 AND 177/1A NEW T.S.NO.5/13 , BLOCK NO. 5 SALIGRAMAM VILLAGE, MAMBALAM TALUK, CHENNAI DISTRICT.

RESIDENTIAL BUILDING - Structural Design

Report MAY -2024





STRUCTURAL CONSULTANT

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ARCHITECT

M/s NATARAJ AND VENKAT
Chennai.

1.1 FOREWORD

1.1.1 - Description of Project

M/s. Ivar Estates private limited construction developing a High rise residential building consist of 2 blocks: extended double basement floor (Tower-A & B) Tower-A stilt floor + 8 floors, Tower-b stilt floor + 12 floors, atsaligramam, Chennai. Project is architecture by M/s Nataraj and venkat architects, Chennai.

1.1.2 - Objective of the Report.

The objective of this report is to provide and furnish complete details related to Project and structural analysis and design considerations.

1.1.2 - Scope of the Report.

The Structural Report covers the complete Structural Elements design considerations for analysis of lateral loads & gravity loads.

1.2 CODES, STANDARDS AND REFERENCES

Statutory Requirements:

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

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

DESIGN STANDARDS:

Specific applicable codes and standards will be identified and adopted in the design philosophies as appropriate to the structural elements. The latest editions of 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 -2015	Code of Practice for design loads (other than earthquake) for Buildings and structure (All parts)
IS:1893-2016	Criteria for earthquake resistant design of structure

Foundations:

IS:1080-1985(2016)	Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
IS:1904-1986(2015)	Code of Practice for design and construction of foundations in soils general requirement
IS:2911-1980(2013)	Code of Practice for design and construction of pile foundations(All parts)
IS:2950-1981(2013)	Code of Practice for design and construction of raft foundations
IS:2974-1998(2013/2015)	Code of Practice for design and construction of machine foundations (All parts)

IS:8009-1976/1980(2013/2015) Code of Practice for calculation of settlement of foundations (All parts)

RCC:

IS:456 -2000(2016)	Code of Practice for plain and reinforced concrete
IS:458 -1988	Specification for precast concrete pipes
IS:3370-2009	Code of Practice for concrete structures for the storage of liquids: (All parts)
IS:4326-2013	Code of Practice for earthquake resistant design and construction of buildings
IS:5525-1969(2013)	Recommendation for detailing of reinforced concrete works
IS:1786-2008	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS:10262-2009	Recommended guidelines for concrete mix design
IS: 1893 (Part-1)-2016	Criteria for earthquake resistant design of structures (General provisions and building).
IS:16700 - 2017	Criteria for structural safety of Tall Concrete buildings
IS:13920 - 2016	Ductile design and Detailing of Reinforced concrete structures subjected to Seismic forces - Code of practice
IS:1343 - 1980	Code of practice for Prestressed concrete

Structural steel:

IS:800 -2007(2012)	Code of Practice for general construction in steel
IS:802 -1995	Code of Practice for use of structural steel in overhead transmission line towers: (All parts)
IS:806 -1968(2013)	Code of Practice for use of steel tubes in general building construction
IS:808 -1989	Dimensions for hot rolled steel beam, column channel and angle section
IS:816 -1998	Code of Practice for use of metal arc welding for general construction in mild steel
IS:1161-1998	Steel tubes for structural purposes
IS:4000-1998	High Strength bolts in steel structures - Code of Practice
IS:7215 -1995	Tolerances for fabrication of steel structures

Miscellaneous:

IS: 432(part 2)-1995	Specification for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement
IS: 6313(part II)-2001	Standards for anti-termite treatment
IS:1905-1998	Code of Practice for structural use of unreinforced masonry
IS:3067-1995	Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
SP:6 -1998	Handbook for structural engineers (all parts)
SP:7 -2005	National Building Code of India
SP:16-1999	Design Aids for reinforced concrete to IS:456-1978
SP:22-1982	Explanatory handbook on codes for earthquake engineering (IS:1982-1975 and IS:4326-1976)
SP:24-1983	Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete
SP:34-1987	Handbook of concrete reinforcement and detailing (SCIP)

Material :

IS: 269 -2015	Specification for Ordinary, rapid hardening and low heat Portland cement.
IS: 455 -1995	Specification for Portland blast furnace slag cement.
IS: 1489-1991	Specification for Portland pozzolana cement
IS: 4031-1991	Method of physical tests for Portland cement.
IS: 383 - 2016	Specification for coarse and fine aggregates from natural sources for concrete.

IS: 516 - 1999	Method of test for strength of concrete.
IS: 1199-1999	Method of sampling and analysis of concrete.
IS: 1566-2000	Specification for plain hard drawn steel wire fabric for concrete reinforcement.
IS: 4990-1998	Specification for plywood for concrete shuttering works.
IS: 2645-1999	Specification for integral cement water proofing compounds.

1.3 - DESCRIPTION OF STRUCTURE

1.3.1 - Location



1.3.2 - Building Description.

The Development consists of the following:

1. Residential building floor covered with RCC roofing.

The usages of individual floors are as given below:

Floors	Details
Main Residential building	Space for residential

1.3.3 - Structural Arrangement:

- The Structural System for the residential buildings comprises of rcc column and beam, where ground floor podium is designed fire tendor loading for given loading input.

	Description	Main Building
a)	Column grids	5 m x 4 m (Varies for some grids)
b)	Structural system	RCC Shear wall & column
c)	Slab thickness	Minimum 130mm Varies depends on span
e)	Foundation	Pile Foundation
f)	Column size	As per design
g)	Beams	As per design.

1.4 DESIGN APPROACH

1.4.1 - 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 are required for all replaceable material for longer life.

1.4.2 - Material Properties.

Materials specified will 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.

Concrete:

- All structural concrete shall have cube crushing strength of 25 N/sq.mm (M25) 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
Pile Foundation	M30 for Pile
Columns	M45-M30
Slab, beams	M30

Reinforcement steel:

- All reinforcement shall confirm to IS: 1786 - 1985 having minimum yield strength of 500 N/sq.mm. Corrosion resistant steel is not required

Structural Steel

- All structural steel shall confirm to IS: 2062 with minimum yield strength of 250 N/sq.mm

1.4.3 - Design loads.

Loads:

Dead loads:

Dead load shall include weight of all structural and Architectural components. Self-weight of the materials.

Shall be calculated on the basis of unit weights given in IS: 875.

- Floor finish of 75 mm thickness: 175 kg/sqm
- Self-weight of Plain concrete : 2400 kg/cum (24 kN/cum)
- Self-weight of RCC : 2500 kg/cum (25 kN/cum)
- Aerocon block masonry : 700 kg/cum (7 kN/cum) [For walls]
  (With additional 15mm thick plastering on external surface and 12mm plastering on internal wall surfaces)
- Soil (Dry) : 1800 kg/cum (18 kN/cum)
- Soil (Wet) : 2000 kg/cum (20 kN/cum)
- Water : 1000 kg/cum (10 kN/cum)
- Masonry with plastering : 2200 kg/cum (22 kN/cum)
- Wall loads : As per actuals

Live loads:

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

Following live loads are considered while designing the structural elements apart from the dead loads as per codes.

Floor Live loads:

- Living, kitchen, Dining : 200 kg/sqm (2.0 kN/sqm)
- Stairs : 300 kg/sqm (3.0 kN/sqm)
- Corridors / Balcony : 300 kg/sqm (3.0 kN/sqm)
- Toilets : 200 kg/sqm (2.0 kN/sqm)
- Terrace with Access : 200 kg/sqm (2.0 kN/sqm)
- Electrical rooms and club house : 400 kg/sqm (4.0 kN/sqm)

Sunken Details:

- Toilet : 100mm
- Balcony : 150mm
- Utility : 150mm

Wind Loads

The Wind pressure shall be calculated in accordance with IS: 875 (Part-3):2015.

Vellore has a high wind speed of 50m/s.

Basic Wind Speed V_b : 50 m/s

Risk Coefficient k_1 : 1.00 (k_1 corresponds to 50 years Mean Probable Design Life of Structure)

Terrain, height, structure size factor k_2 : To suit the height of the structure for terrain category 2

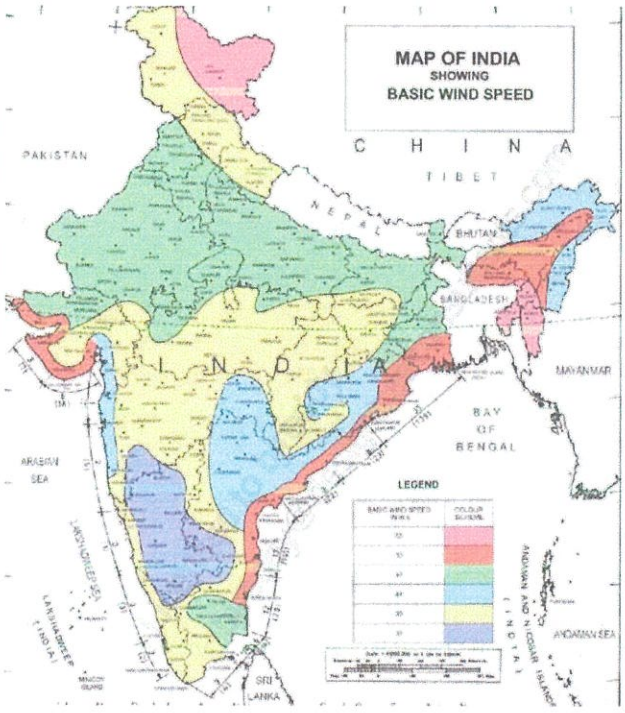
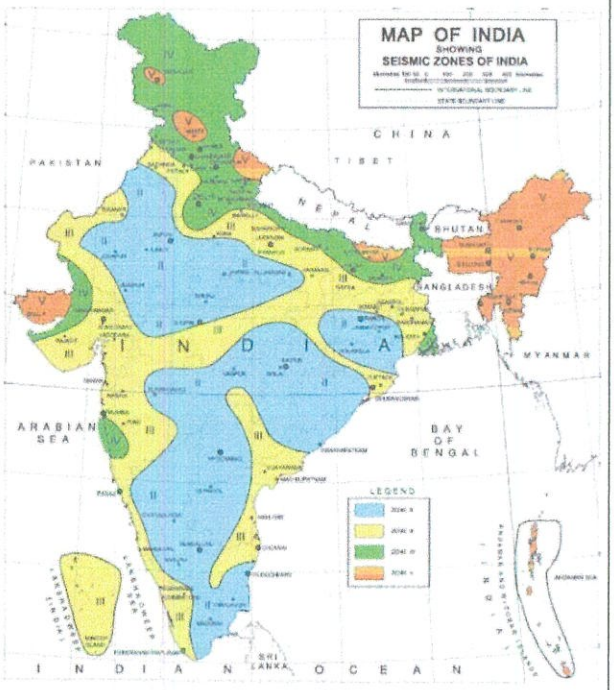
Topography factor k_3 : 1.0

Importance factor for cyclonic region k_4 : 1.00

The external and internal pressure co-efficient shall be as per respective clauses of IS: 875 (Part 3):2015

Design wind speed V_z : $V_b \times k_1 \times k_2 \times k_3 \times k_4$

Design wind pressure p_z : $0.6 \times V_z^2$

Map showing basic wind speed	Map showing seismic zones
	
Basic wind speed in m/s (based on 50-year return period)	Seismic zones of India

Seismic Forces:

Chennai falls under seismic zone III as per IS 1893-2016 (Part 1) (Sixth Revision) and has the following factors to be considered for designs. Ductile detailing is required. (Please refer attached map above)

Seismic Zone	: III
Seismic Zone factor, Z	: 0.16 (As per Table 3; IS: 1893-2016)
Design horizontal seismic coefficient (Ah)	: $(Z/2)*(S_a/g)*(I/R)$
I -Importance factor	: 1.2 (Ref Table 8; IS: 1893-2016)
Response reduction Factor	: 4
Soil type	: Type -1 with N>100 at the founding levels of about 9m
Damping Ratio for RCC	: 5 %

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

Design horizontal seismic coefficient (A_h) : $(Z/2)*(S_a/g)*(I/R)$

: $(0.16/2)*(1.2/5) * (S_a/g)$

A_h : $0.024 * (S_a/g)$

Design seismic base shear, V_b : $A_h * w$ where, w - seismic weight of building

Effect of infill panels : Not considered in the analysis

Table No : 03

Seismic 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

Temperature Loads:

The effect of temperature will be considered wherever applicable in accordance with relevant Indian Codes. Minimum & maximum temperatures considered are as shown in the table below. Same will be used for the analysis & design. The coefficient for thermal expansion and contraction will be in accordance with IS: 456 and IS: 800 for concrete and steel respectively.

Station Name	Month	Period	No. of Years	Mean Temperature in Degree C		Mean rainfall in mm
				Maximum	Minimum	
Chennai (Minambakkam)	January	1901-2000	100	28.8	20.4	35.3
Chennai (Minambakkam)	February	1901-2000	100	30.5	21.1	13.0
Chennai (Minambakkam)	March	1901-2000	100	32.6	23.0	14.5
Chennai (Minambakkam)	April	1901-2000	100	34.7	25.8	15.9
Chennai (Minambakkam)	May	1901-2000	100	37.4	27.6	42.4
Chennai (Minambakkam)	June	1901-2000	100	37.3	27.4	53.9
Chennai (Minambakkam)	July	1901-2000	100	35.3	26.1	99.6
Chennai (Minambakkam)	August	1901-2000	100	34.5	25.5	129.9
Chennai (Minambakkam)	September	1901-2000	100	33.9	25.2	123.5
Chennai (Minambakkam)	October	1901-2000	100	31.8	24.2	284.6
Chennai (Minambakkam)	November	1901-2000	100	29.4	22.6	353.0
Chennai (Minambakkam)	December	1901-2000	100	28.4	21.2	146.3

[Source: National Data Centre : ndc@imdpune.gov.in
DGM (Sectt.) : dgm.hq@imd.gov.in]

Considering the average **daily** maximum temperature as 34 degrees and minimum as 24 degrees, the variation in temperature for analysis is considered as **10 degrees.**

[Source:https://www.wunderground.com/history/airport/VOMM/2016/1/4/CustomHistory.html?dayend=5&monthend=2&yearend=2017&req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo=]

Temperature and shrinkage effect:

Horizontal floor displacement due to differential temperatures and shrinkage is of importance in long 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.

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 collision of vehicles on the façade of the building

1.4.4 Durability Considerations:

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

- Environment : moderate

Table 5 Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum Size

(Clauses 6.1.2, 8.2.4.1 and 9.1.2)

Sl No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Mild	220	0.60	-	300	0.55	M 20
iii)	Moderate	240	0.60	M 15	300	0.50	M 25
iii)	Severe	250	0.50	M 20	320	0.45	M 30
iv)	Very severe	260	0.45	M 20	340	0.45	M 35
v)	Extreme	280	0.40	M 25	360	0.40	M 40

NOTES

1 Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in 5.2. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2 Minimum grade for plain concrete under mild exposure condition is not specified.

- Exposure conditions : Concrete surfaces exposed to moderate environment
- Minimum grade of concrete : Moderate exposure - M25

1.4.5 Fire Rating:

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

Fire Resistance h	*Minimum Beam Width b*	*Rib Width of Slabs b_w*	*Minimum Thickness of Floors D*	*Column Dimension (b or D)*			*Minimum Wall Thickness*		
				Fully Exposed	50% Exposed	One Face Exposed	$p<0.4\%$	$0.4\% \le p \le 1\%$	$p>1\%$
	mm	mm	mm	mm	mm	mm	mm	mm	mm
0.5	200	125	75	150	125	100	150	100	100
1	200	125	95	200	160	120	150	120	100
1.5	200	125	110	250	200	140	175	140	100
2	200	125	125	300	200	160	–	160	100
3	240	150	150	400	300	200	–	200	150
4	280	175	170	450	350	240	–	240	180

NOTES

1 These minimum dimensions relate specifically to the covers given in Table 16A.

2 p is the percentage of steel reinforcement.

FIG. 1 MINIMUM DIMENSIONS OF REINFORCED CONCRETE MEMBERS FOR FIRE RESISTANCE

Nominal covers for 2 hr. fire resistance:

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

1.5 ANALYSIS METHODOLOGY:

This structure has a physical interface with almost all the disciplines like geotechnical works, MEP services, etc. The structure proposed is of cast in-situ concrete construction with columns suitably placed.
The Vertical Loads including the dead and super imposed loads are transferred to the soil through columns, pedestal, and Pile caps. Pile caps are sized with consideration to the safe carrying capacity of pile at the level of transfer of load recommended by specialist soil investigation consultants.

1.5.1 Assumptions:

- The structure is idealized as 3D space frame and analyzed using Etabs software package for both vertical and lateral loads.
- 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 foundation is represented in analysis model using fixed end conditions.

1.5.2 Mathematical model

Mass Modeling:

Mass Source as per IS: 1893_2016 is considered as follows.

Mass source = DL+SDL+ 0. 3LL

Where DL - Dead Load;

SDL - Super Imposed Dead Load;

LL - Live Load

1.5.3 Static Analysis:

The following Static loads cases are considered in the analysis.

DL - Dead Load which includes self-weight of the structure.

SDL - Super Imposed Dead Load, including load due to finishes, wall Loads, Soil filling loads etc.

LL - Live Load

1.6 LOAD COMBINATIONS:

Load combinations Used for Strength, Serviceability are tabulated below:

Load Combination	Limit State of Collapse			Limit State of Serviceability		
	DL+SDL	*LL*	*WL/EL/TL*	*DL+SDL*	*LL*	*WL/EL/TL*
DL + LL	1.5	1.5	--	1	1	--
DL + WL	1.5 or 0.9*	--	1.5	1	--	1
DL + EL	1.5 or 0.9*	--	1.5	1	--	1
DL + TL	1.5	--	1.5	1	--	1
DL+LL+WL	1.2	1.2	1.2	1	0.8	0.8
DL+LL+EL	1.2	1.2	1.2	1	0.8	0.8
DL+LL+TL	1.2	1.2	1.2	1	1	1
DL+WL+TL	1.2	--	1.2	1	--	1
DL+EL+TL	1.2	--	1.2	1	--	1
DL+LL+EL+TL	1.2	1.2	1.2	1	1	1

Response spectrum combinations:

- 1.2[DL+LL+(SPECX+0.3 SPECY+0.3 SPECZ)]
- 1.2[DL+LL+(SPECY+0.3 SPECX+0.3 SPECZ)]
- 1.5[DL+(SPECX+0.3 SPECY+0.3 SPECZ)]
- 1.5[DL+(SPECY+0.3 SPECX+0.3 SPECZ)]
- 0.9DL+1.5(SPECX+0.3 SPECY+0.3 SPECZ)]
- 0.9DL+1.5(SPECY+0.3 SPECX+0.3 SPECZ)]

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

*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 , SPEC- Response spectrum

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: 1893-2016 / Clause 7.3.3 of seismic code will be used both for evaluating earthquake effect and for combined load effects used in such combination. Serviceability loads combinations with suitable live load reduction factor as per IS: 875(Part-2) will be used for foundation design.

1.7 DESIGN METHODOLOGY:

- All R.C.C structures shall be designed according to the Limit State Method as specified in IS: 456 - 2000.
- 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.
- Design of special members like retaining wall, water tanks will be done in accordance with the relevant IS Codes.
- Design of structural steel members are done using elastic method as per IS: 800 with relevant allowable stresses.

1.8 ACCEPTANCE CRITERIA:

1.8.1 Deflection Limits:

For Reinforced concrete works:

- Limiting values of deflection (Short and Long term) as per clause 35.3 of IS: 456-2000 is followed in the design.
- Limiting value for long term deflection is considered as span/250 and for the long term deflection after erection of partitions & finishes is considered as span/350 or 20mm whichever less as per IS 456 - 2000.

1.8.2 Cracking Limits:

- Limiting values of crack width as per clause 35.3 of IS: 456-2000 is followed in the design.
- In general for slabs and beams, the crack width is limited to 0.3mm.
- For water retaining structures, crack width is limited to 0.2mm.

1.8.3 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. The soil investigation report recommends Pilefoundation system.

1.9 DETAILING REQUIREMENTS:

- RC walls, which are considered as lateral load resisting elements are detailed as ductile RC walls along with perimeter SMRFs (both columns and beams). Rest of thecolumns and beams are detailed as per normal detailing requirement.
- Detailing for all structural members shall be in accordance with IS: 456 & SP: 34.

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQX according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = X + Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.163 \text{ sec}$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X + Ecc. Y	0.163	34813.3461	1671.0406

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
H.R. , OHT	39.15	389.8795	0
8 TH TERRACE	36.1	500.0938	0
7TH	32.8	273.454	0
6TH	29.5	200.0472	0
5TH	26.2	139.5174	0
4TH	22.9	89.2911	0
3RD	19.6	50.2263	0
2ND	16.3	22.8162	0
1ST	13	5.7151	0
STILT	9.7	0	0
BASE- 2	6.1	0	0
BASE -1	3.05	0	0
Base	0	0	0

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQY according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = Y + Eccentricity X

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.49 \text{ sec}$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

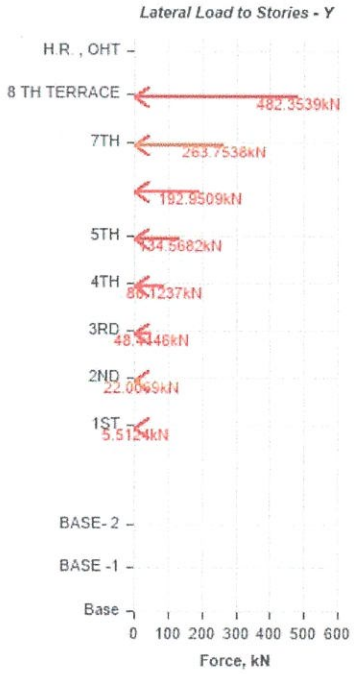
Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y + Ecc. X	0.49	31536.459	1235.7143

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
H.R. , OHT	39.15	0	0
8 TH TERRACE	36.1	0	482.3539
7TH	32.8	0	263.7538
6TH	29.5	0	192.9509
5TH	26.2	0	134.5682
4TH	22.9	0	86.1237
3RD	19.6	0	48.4446
2ND	16.3	0	22.0069
1ST	13	0	5.5124
STILT	9.7	0	0
BASE- 2	6.1	0	0
BASE -1	3.05	0	0
Base	0	0	0

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQX according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = X + Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 1.03$ sec

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

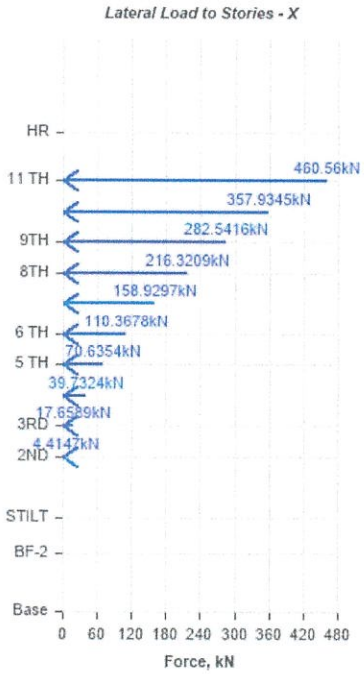
Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X + Ecc. Y	1.03	92222.3343	1719.0959

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HR	50.1	0	0
12 TH	48.3	0	0
11 TH	45.1	460.56	0
10TH	41.9	357.9345	0
9TH	38.7	282.5416	0
8TH	35.5	216.3209	0
7TH	32.3	158.9297	0
6 TH	29.1	110.3678	0
5 TH	25.9	70.6354	0
4 TH	22.7	39.7324	0
3RD	19.5	17.6589	0
2ND	16.3	4.4147	0
1ST	13.1	0	0
STILT	9.9	0	0
BF-2	6.1	0	0
BF -1	3.05	0	0
Base	0	0	0

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQY according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = Y + Eccentricity X

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.88\ sec$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

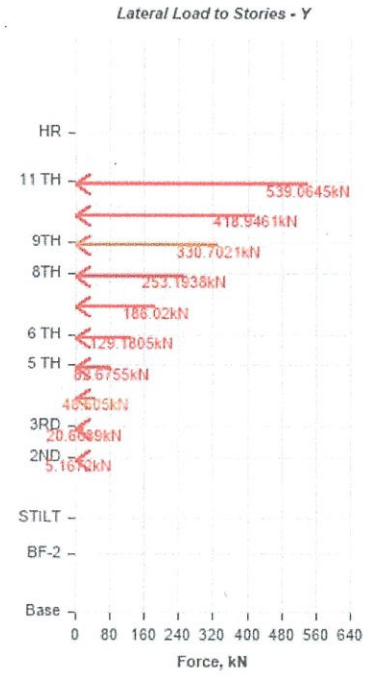
Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y + Ecc. X	0.88	92222.3343	2012.1237

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HR	50.1	0	0
12 TH	48.3	0	0
11 TH	45.1	0	539.0645
10TH	41.9	0	418.9461
9TH	38.7	0	330.7021
8TH	35.5	0	253.1938
7TH	32.3	0	186.02
6 TH	29.1	0	129.1805
5 TH	25.9	0	82.6755
4 TH	22.7	0	46.505
3RD	19.5	0	20.6689
2ND	16.3	0	5.1672
1ST	13.1	0	0
STILT	9.9	0	0
BF-2	6.1	0	0
BF -1	3.05	0	0
Base	0	0	0

TABLE: Modal Participating Mass Ratios							
Case	Mode	Period	UX	UY	UZ	SumUX	SumUY
		sec					
Modal	1	2.119	0.2406	0.084	0	0.2406	0.084
Modal	2	1.767	0.1225	0.4003	0	0.3631	0.4843
Modal	3	1.422	0.1748	0.0366	0	0.5379	0.5209
Modal	4	0.571	0.0448	0.0132	0	0.5827	0.5341
Modal	5	0.48	0.013	0.0842	0	0.5956	0.6183
Modal	6	0.335	0.0799	0.0011	0	0.6756	0.6194
Modal	7	0.267	0.0123	0.0058	0	0.6879	0.6252
Modal	8	0.235	0.0052	0.028	0	0.6931	0.6532
Modal	9	0.157	0.025	0.0089	0	0.7181	0.6621
Modal	10	0.15	0.0535	0.0057	0	0.7717	0.6678
Modal	11	0.141	0.0031	0.0055	0	0.7748	0.6733
Modal	12	0.105	0.0004	0.0153	0	0.7752	0.6886
Modal	13	0.098	0.0636	0.0012	0	0.8388	0.6899
Modal	14	0.09	0.0369	0.001	0	0.8756	0.6908
Modal	15	0.075	0.0002	0.016	0	0.8759	0.7068
Modal	16	0.068	0.0147	0.0065	0	0.8905	0.7133
Modal	17	0.065	0.0323	0.0032	0	0.9229	0.7165
Modal	18	0.058	0.001	0.0119	0	0.9239	0.7284
Modal	19	0.051	0.0002	0.0815	0	0.9241	0.8098
Modal	20	0.046	0.0238	0.0048	0	0.9479	0.8146
Modal	21	0.044	0.0009	0.1008	0	0.9488	0.9155
Modal	22	0.042	0.0001	0.0424	0	0.9489	0.9578
Modal	23	0.038	0.02	0.0036	0	0.9689	0.9615
Modal	24	0.035	0.0015	0.0121	0	0.9705	0.9735

SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
0	0.0802	0.1805	0.1621	0.0802	0.1805	0.1621
0	0.3867	0.1069	0.0006	0.4668	0.2873	0.1627
0	0.0341	0.1997	0.3109	0.5009	0.4871	0.4736
0	0.0082	0.0446	0.0293	0.5091	0.5317	0.5029
0	0.0664	0.0097	0.001	0.5755	0.5414	0.5039
0	0.001	0.0552	0.0689	0.5765	0.5966	0.5728
0	0.0027	0.0061	0.0168	0.5793	0.6027	0.5896
0	0.0117	0.0033	0.0022	0.5909	0.606	0.5918
0	0.0063	0.0239	0.0003	0.5972	0.6298	0.5921
0	0.0046	0.0517	0.0136	0.6018	0.6815	0.6057

0	0.0041	0.0033	0.026	0.6059	0.6848	0.6317
0	0.0115	0.0003	0.001	0.6174	0.6852	0.6327
0	0.0009	0.0742	0.0001	0.6183	0.7594	0.6328
0	0.0007	0.0511	0.0191	0.619	0.8105	0.6519
0	0.0138	0.0004	0.0016	0.6328	0.8109	0.6535
0	0.0061	0.0183	0.0098	0.6389	0.8291	0.6633
0	0.003	0.0462	0.0002	0.6419	0.8753	0.6635
0	0.0119	0.0023	0.0075	0.6538	0.8777	0.671
0	0.0878	0.0001	0.0071	0.7416	0.8778	0.678
0	0.0053	0.0327	0.0413	0.7469	0.9105	0.7193
0	0.1195	0.002	0.0028	0.8664	0.9125	0.7222
0	0.0522	0.0007	0.0198	0.9186	0.9132	0.742
0	0.0044	0.0234	0.1941	0.923	0.9366	0.9361
0	0.0176	0.0025	0.0031	0.9406	0.9391	0.9392

Table_6 of IS1893 (Part_1)_2016_Irregular Modes of Oscillation in Two Principal Directions_(Vii):

Mode No.	Fundamental Lateral Natural Period	Ux	Uy	Rz
	(Sec)			
	(T)			
MODE - 1	2.119	0.2406	0.084	0.1621
MODE - 2	1.767	0.1225	0.4003	0.0006
MODE - 3	1.422	0.1748	0.0366	0.3109
TOTAL %age		**53.79**	**52.09**	**47.36**

TABLE: Story Drifts						
Story	Output Case	Case Type	Step Type	Step Number	Direction	Drift
H.R. , OHT	EQX	LinStatic			X	0.000596
H.R. , OHT	EQY	LinStatic			X	0.000345
H.R. , OHT	EQY	LinStatic			Y	0.001072
H.R. , OHT	WIND X	LinStatic	Step By Step	1	X	0.001188
H.R. , OHT	WIND X	LinStatic	Step By Step	1	Y	0.000349
H.R. , OHT	WIND X	LinStatic	Step By Step	2	X	0.000127
H.R. , OHT	WIND X	LinStatic	Step By Step	2	Y	0.000395
H.R. , OHT	WIND Y	LinStatic	Step By Step	1	X	0.001188
H.R. , OHT	WIND Y	LinStatic	Step By Step	1	Y	0.000349
H.R. , OHT	WIND Y	LinStatic	Step By Step	2	X	0.000127
H.R. , OHT	WIND Y	LinStatic	Step By Step	2	Y	0.000395
H.R. , OHT	RESPX	LinRespSpec	Max		X	0.000479
H.R. , OHT	RESPX	LinRespSpec	Max		Y	0.000318
H.R. , OHT	RESPY	LinRespSpec	Max		X	0.000423
H.R. , OHT	RESPY	LinRespSpec	Max		Y	0.000726
TERRACE	EQX	LinStatic			X	0.000993
TERRACE	EQY	LinStatic			X	0.000705
TERRACE	EQY	LinStatic			Y	0.001412
TERRACE	WIND X	LinStatic	Step By Step	1	X	0.002387
TERRACE	WIND X	LinStatic	Step By Step	1	Y	0.000444
TERRACE	WIND X	LinStatic	Step By Step	2	X	0.000249
TERRACE	WIND X	LinStatic	Step By Step	2	Y	0.000513
TERRACE	WIND Y	LinStatic	Step By Step	1	X	0.002387
TERRACE	WIND Y	LinStatic	Step By Step	1	Y	0.000444
TERRACE	WIND Y	LinStatic	Step By Step	2	X	0.000249
TERRACE	WIND Y	LinStatic	Step By Step	2	Y	0.000513
TERRACE	RESPX	LinRespSpec	Max		X	0.000736
TERRACE	RESPX	LinRespSpec	Max		Y	0.000345
TERRACE	RESPY	LinRespSpec	Max		X	0.000667
TERRACE	RESPY	LinRespSpec	Max		Y	0.00079
8F	EQX	LinStatic			X	0.001182
8F	EQY	LinStatic			X	0.000765
8F	EQY	LinStatic			Y	0.001625
8F	WIND X	LinStatic	Step By Step	1	X	0.002884
8F	WIND X	LinStatic	Step By Step	1	Y	0.000553
8F	WIND X	LinStatic	Step By Step	2	X	0.000271
8F	WIND X	LinStatic	Step By Step	2	Y	0.000596
8F	WIND Y	LinStatic	Step By Step	1	X	0.002884
8F	WIND Y	LinStatic	Step By Step	1	Y	0.000553
8F	WIND Y	LinStatic	Step By Step	2	X	0.000271
8F	WIND Y	LinStatic	Step By Step	2	Y	0.000596
8F	RESPX	LinRespSpec	Max		X	0.000819
8F	RESPX	LinRespSpec	Max		Y	0.000373
8F	RESPY	LinRespSpec	Max		X	0.000755
8F	RESPY	LinRespSpec	Max		Y	0.000844
7F	EQX	LinStatic			X	0.001379
7F	EQY	LinStatic			X	0.000824
7F	EQY	LinStatic			Y	0.001807
7F	WIND X	LinStatic	Step By Step	1	X	0.003507

7F	WIND X	LinStatic	Step By Step	1	Y	0.000692
7F	WIND X	LinStatic	Step By Step	2	X	0.000299
7F	WIND X	LinStatic	Step By Step	2	Y	0.000684
7F	WIND Y	LinStatic	Step By Step	1	X	0.003507
7F	WIND Y	LinStatic	Step By Step	1	Y	0.000692
7F	WIND Y	LinStatic	Step By Step	2	X	0.000299
7F	WIND Y	LinStatic	Step By Step	2	Y	0.000684
7F	RESPX	LinRespSpec	Max		X	0.000894
7F	RESPX	LinRespSpec	Max		Y	0.000394
7F	RESPY	LinRespSpec	Max		X	0.000838
7F	RESPY	LinRespSpec	Max		Y	0.000876
6F	EQX	LinStatic			X	0.001543
6F	EQY	LinStatic			X	0.000868
6F	EQY	LinStatic			Y	0.001939
6F	WIND X	LinStatic	Step By Step	1	X	0.004151
6F	WIND X	LinStatic	Step By Step	1	Y	0.000835
6F	WIND X	LinStatic	Step By Step	2	X	0.000327
6F	WIND X	LinStatic	Step By Step	2	Y	0.000769
6F	WIND Y	LinStatic	Step By Step	1	X	0.004151
6F	WIND Y	LinStatic	Step By Step	1	Y	0.000835
6F	WIND Y	LinStatic	Step By Step	2	X	0.000327
6F	WIND Y	LinStatic	Step By Step	2	Y	0.000769
6F	RESPX	LinRespSpec	Max		X	0.000954
6F	RESPX	LinRespSpec	Max		Y	0.00041
6F	RESPY	LinRespSpec	Max		X	0.000907
6F	RESPY	LinRespSpec	Max		Y	0.000891
5F	EQX	LinStatic			X	0.001643
5F	EQY	LinStatic			X	0.000881
5F	EQY	LinStatic			Y	0.001994
5F	WIND X	LinStatic	Step By Step	1	X	0.004709
5F	WIND X	LinStatic	Step By Step	1	Y	0.00096
5F	WIND X	LinStatic	Step By Step	2	X	0.000347
5F	WIND X	LinStatic	Step By Step	2	Y	0.000837
5F	WIND Y	LinStatic	Step By Step	1	X	0.004709
5F	WIND Y	LinStatic	Step By Step	1	Y	0.00096
5F	WIND Y	LinStatic	Step By Step	2	X	0.000347
5F	WIND Y	LinStatic	Step By Step	2	Y	0.000837
5F	RESPX	LinRespSpec	Max		X	0.000996
5F	RESPX	LinRespSpec	Max		Y	0.000417
5F	RESPY	LinRespSpec	Max		X	0.000957
5F	RESPY	LinRespSpec	Max		Y	0.000892
4F	EQX	LinStatic			X	0.001663
4F	EQY	LinStatic			X	0.000856
4F	EQY	LinStatic			Y	0.001963
4F	WIND X	LinStatic	Step By Step	1	X	0.005085
4F	WIND X	LinStatic	Step By Step	1	Y	0.001046
4F	WIND X	LinStatic	Step By Step	2	X	0.000355
4F	WIND X	LinStatic	Step By Step	2	Y	0.000878
4F	WIND Y	LinStatic	Step By Step	1	X	0.005085
4F	WIND Y	LinStatic	Step By Step	1	Y	0.001046
4F	WIND Y	LinStatic	Step By Step	2	X	0.000355
4F	WIND Y	LinStatic	Step By Step	2	Y	0.000878
4F	RESPX	LinRespSpec	Max		X	0.001017

4F	RESPX	LinRespSpec	Max		Y	0.000415
4F	RESPY	LinRespSpec	Max		X	0.000982
4F	RESPY	LinRespSpec	Max		Y	0.00088
3F	EQX	LinStatic			X	0.001561
3F	EQY	LinStatic			X	0.000775
3F	EQY	LinStatic			Y	0.001814
3F	WIND X	LinStatic	Step By Step	1	X	0.005079
3F	WIND X	LinStatic	Step By Step	1	Y	0.001048
3F	WIND X	LinStatic	Step By Step	2	X	0.000339
3F	WIND X	LinStatic	Step By Step	2	Y	0.000866
3F	WIND Y	LinStatic	Step By Step	1	X	0.005079
3F	WIND Y	LinStatic	Step By Step	1	Y	0.001048
3F	WIND Y	LinStatic	Step By Step	2	X	0.000339
3F	WIND Y	LinStatic	Step By Step	2	Y	0.000866
3F	RESPX	LinRespSpec	Max		X	0.000981
3F	RESPX	LinRespSpec	Max		Y	0.000394
3F	RESPY	LinRespSpec	Max		X	0.00095
3F	RESPY	LinRespSpec	Max		Y	0.000839
2F	EQX	LinStatic			X	0.001293
2F	EQY	LinStatic			X	0.000622
2F	EQY	LinStatic			Y	0.001497
2F	WIND X	LinStatic	Step By Step	1	X	0.004459
2F	WIND X	LinStatic	Step By Step	1	Y	0.000917
2F	WIND X	LinStatic	Step By Step	2	X	0.000288
2F	WIND X	LinStatic	Step By Step	2	Y	0.000765
2F	WIND Y	LinStatic	Step By Step	1	X	0.004459
2F	WIND Y	LinStatic	Step By Step	1	Y	0.000917
2F	WIND Y	LinStatic	Step By Step	2	X	0.000288
2F	WIND Y	LinStatic	Step By Step	2	Y	0.000765
2F	RESPX	LinRespSpec	Max		X	0.00084
2F	RESPX	LinRespSpec	Max		Y	0.000335
2F	RESPY	LinRespSpec	Max		X	0.000816
2F	RESPY	LinRespSpec	Max		Y	0.000727
1F	EQX	LinStatic			X	0.00064
1F	EQY	LinStatic			X	0.000299
1F	EQY	LinStatic			Y	0.000767
1F	WIND X	LinStatic	Step By Step	1	X	0.002292
1F	WIND X	LinStatic	Step By Step	2	X	0.000145
1F	WIND X	LinStatic	Step By Step	2	Y	0.000414
1F	WIND Y	LinStatic	Step By Step	1	X	0.002292
1F	WIND Y	LinStatic	Step By Step	2	X	0.000145
1F	WIND Y	LinStatic	Step By Step	2	Y	0.000414
1F	RESPX	LinRespSpec	Max		X	0.000423
1F	RESPX	LinRespSpec	Max		Y	0.000173
1F	RESPY	LinRespSpec	Max		X	0.000411
1F	RESPY	LinRespSpec	Max		Y	0.000395
Stilt	EQX	LinStatic			X	0.000134
Stilt	EQY	LinStatic			X	0.00002
Stilt	EQY	LinStatic			Y	0.000032
Stilt	WIND X	LinStatic	Step By Step	1	X	0.000348
Stilt	WIND X	LinStatic	Step By Step	2	X	0.000008
Stilt	WIND X	LinStatic	Step By Step	2	Y	0.000018
Stilt	WIND Y	LinStatic	Step By Step	1	X	0.000348

Stilt	WIND Y	LinStatic	Step By Step	2	X	0.000008
Stilt	WIND Y	LinStatic	Step By Step	2	Y	0.000018
Stilt	RESPX	LinRespSpec	Max		X	0.000092
Stilt	RESPX	LinRespSpec	Max		Y	0.000022
Stilt	RESPY	LinRespSpec	Max		X	0.000071
Stilt	RESPY	LinRespSpec	Max		Y	0.000029
Base-1	EQX	LinStatic			X	0.000042
Base-1	EQY	LinStatic			X	0.000007
Base-1	EQY	LinStatic			Y	0.000005
Base-1	WIND X	LinStatic	Step By Step	1	X	0.000114
Base-1	WIND X	LinStatic	Step By Step	2	X	0.000003
Base-1	WIND X	LinStatic	Step By Step	2	Y	0.000004
Base-1	WIND Y	LinStatic	Step By Step	1	X	0.000114
Base-1	WIND Y	LinStatic	Step By Step	2	X	0.000003
Base-1	WIND Y	LinStatic	Step By Step	2	Y	0.000004
Base-1	RESPX	LinRespSpec	Max		X	0.000036
Base-1	RESPX	LinRespSpec	Max		Y	0.000008
Base-1	RESPY	LinRespSpec	Max		X	0.000023
Base-1	RESPY	LinRespSpec	Max		Y	0.000009

TABLE: Story Max Over Avg Drifts								
Story	Output Case	Case Type	Step Type	Step Number	Direction	Max Drift	Avg Drift	Ratio
						mm	mm	
H.R., OHT	EQX	LinStatic			X	1.817	1.637	1.11
H.R., OHT	EQY	LinStatic			X	1.053	0.498	2.115
H.R., OHT	EQY	LinStatic			Y	3.269	2.766	1.182
H.R., OHT	RESPX	LinRespSpec	Max		X	1.461	1.194	1.224
H.R., OHT	RESPX	LinRespSpec	Max		Y	0.97	0.777	1.248
H.R., OHT	RESPY	LinRespSpec	Max		X	1.289	1.1	1.172
H.R., OHT	RESPY	LinRespSpec	Max		Y	2.216	2.048	1.082
TERRACE	EQX	LinStatic			X	3.276	2.445	1.34
TERRACE	EQY	LinStatic			X	2.325	0.561	4.143
TERRACE	EQY	LinStatic			Y	4.659	4.069	1.145
TERRACE	RESPX	LinRespSpec	Max		X	2.43	1.768	1.375
TERRACE	RESPX	LinRespSpec	Max		Y	1.138	0.933	1.22
TERRACE	RESPY	LinRespSpec	Max		X	2.201	1.649	1.334
TERRACE	RESPY	LinRespSpec	Max		Y	2.606	2.469	1.056
8F	EQX	LinStatic			X	3.901	2.79	1.398
8F	EQY	LinStatic			X	2.523	0.632	3.991
8F	EQY	LinStatic			Y	5.363	4.73	1.134
8F	RESPX	LinRespSpec	Max		X	2.703	1.939	1.394
8F	RESPX	LinRespSpec	Max		Y	1.23	1.015	1.212
8F	RESPY	LinRespSpec	Max		X	2.491	1.832	1.359
8F	RESPY	LinRespSpec	Max		Y	2.784	2.664	1.045
7F	EQX	LinStatic			X	4.551	3.129	1.454
7F	EQY	LinStatic			X	2.721	0.708	3.84
7F	EQY	LinStatic			Y	5.962	5.289	1.127
7F	RESPX	LinRespSpec	Max		X	2.949	2.078	1.419
7F	RESPX	LinRespSpec	Max		Y	1.302	1.079	1.207
7F	RESPY	LinRespSpec	Max		X	2.765	1.996	1.385
7F	RESPY	LinRespSpec	Max		Y	2.889	2.786	1.037
6F	EQX	LinStatic			X	5.091	3.394	1.5
6F	EQY	LinStatic			X	2.865	0.774	3.704
6F	EQY	LinStatic			Y	6.397	5.698	1.123
6F	RESPX	LinRespSpec	Max		X	3.147	2.18	1.443
6F	RESPX	LinRespSpec	Max		Y	1.352	1.123	1.204
6F	RESPY	LinRespSpec	Max		X	2.992	2.12	1.411

6F	RESPY	LinRespSpec	Max	Y	2.939	2.849	1.032
5F	EQX	LinStatic		X	5.422	3.532	1.535
5F	EQY	LinStatic		X	2.907	0.809	3.594
5F	EQY	LinStatic		Y	6.58	5.879	1.119
5F	RESPX	LinRespSpec	Max	X	3.286	2.24	1.467
5F	RESPX	LinRespSpec	Max	Y	1.376	1.145	1.202
5F	RESPY	LinRespSpec	Max	X	3.157	2.196	1.437
5F	RESPY	LinRespSpec	Max	Y	2.942	2.867	1.026
4F	EQX	LinStatic		X	5.487	3.511	1.563
4F	EQY	LinStatic		X	2.824	0.807	3.5
4F	EQY	LinStatic		Y	6.478	5.804	1.116
4F	RESPX	LinRespSpec	Max	X	3.355	2.251	1.49
4F	RESPX	LinRespSpec	Max	Y	1.371	1.143	1.2
4F	RESPY	LinRespSpec	Max	X	3.241	2.21	1.466
4F	RESPY	LinRespSpec	Max	Y	2.905	2.847	1.02
3F	EQX	LinStatic		X	5.15	3.264	1.578
3F	EQY	LinStatic		X	2.556	0.747	3.424
3F	EQY	LinStatic		Y	5.985	5.38	1.112
3F	RESPX	LinRespSpec	Max	X	3.238	2.152	1.505
3F	RESPX	LinRespSpec	Max	Y	1.299	1.085	1.197
3F	RESPY	LinRespSpec	Max	X	3.136	2.104	1.491
3F	RESPY	LinRespSpec	Max	Y	2.767	2.728	1.014
2F	EQX	LinStatic		X	4.266	2.709	1.575
2F	EQY	LinStatic		X	2.054	0.604	3.403
2F	EQY	LinStatic		Y	4.941	4.454	1.109
2F	RESPX	LinRespSpec	Max	X	2.773	1.848	1.501
2F	RESPX	LinRespSpec	Max	Y	1.106	0.927	1.193
2F	RESPY	LinRespSpec	Max	X	2.694	1.793	1.503
2F	RESPY	LinRespSpec	Max	Y	2.398	2.372	1.011
1F	EQX	LinStatic		X	2.302	1.616	1.425
1F	EQY	LinStatic		X	1.078	0.286	3.766
1F	EQY	LinStatic		Y	2.76	2.497	1.105
1F	RESPX	LinRespSpec	Max	X	1.522	1.097	1.388
1F	RESPX	LinRespSpec	Max	Y	0.623	0.529	1.179
1F	RESPY	LinRespSpec	Max	X	1.481	1.053	1.407
1F	RESPY	LinRespSpec	Max	Y	1.421	1.401	1.014
Stilt	EQX	LinStatic		X	0.41	0.274	1.494
Stilt	EQY	LinStatic		X	0.061	0.037	1.628
Stilt	EQY	LinStatic		Y	0.097	0.082	1.173
Stilt	RESPX	LinRespSpec	Max	X	0.28	0.181	1.545
Stilt	RESPX	LinRespSpec	Max	Y	0.068	0.042	1.626
Stilt	RESPY	LinRespSpec	Max	X	0.218	0.147	1.483

Stilt	RESPY	LinRespSpec	Max		Y	0.089	0.068	1.309
Base-1	EQX	LinStatic			X	0.127	0.083	1.529
Base-1	EQY	LinStatic			X	0.021	0.012	1.768
Base-1	EQY	LinStatic			Y	0.017	0.011	1.488
Base-1	RESPX	LinRespSpec	Max		X	0.108	0.071	1.527
Base-1	RESPX	LinRespSpec	Max		Y	0.025	0.014	1.814
Base-1	RESPY	LinRespSpec	Max		X	0.071	0.046	1.528
Base-1	RESPY	LinRespSpec	Max		Y	0.028	0.023	1.19

TABLE: Story Stiffness

Story	Output Case	Case Type	Shear X	Stiff X	Shear Y	Stiff Y	
			kN	kN/m	kN	kN/m	
H.R., OHT	EQX	LinStatic	0	0	0	0.0003425	CHECK X
TERRACE	EQX	LinStatic	163.9615	67061.841	0	0	no soft storey
8F	EQX	LinStatic	290.3229	104068.073	0	0	no soft storey
7F	EQX	LinStatic	387.3791	123800.954	0	0	no soft storey
6F	EQX	LinStatic	458.9908	135224.441	0	0	no soft storey
5F	EQX	LinStatic	509.0185	144104.862	0	0	no soft storey
4F	EQX	LinStatic	541.3227	154175.989	0	0	no soft storey
3F	EQX	LinStatic	559.775	171494.073	0	0	no soft storey
2F	EQX	LinStatic	568.214	209723.855	0	0	no soft storey
1F	EQX	LinStatic	570.4238	352964.975	0	0	no soft storey
Stilt	EQX	LinStatic	570.4238	2078695.837	0	0	no soft storey
Base-1	EQX	LinStatic	570.4238	6840872.452	0	0	no soft storey
H.R., OHT	EQY	LinStatic	0	0	0.000002217	0.001	no soft storey
TERRACE	EQY	LinStatic	0	0	283	69644.248	no soft storey
8F	EQY	LinStatic	0	0	501.7854	106075.454	no soft storey
7F	EQY	LinStatic	0	0	669.5345	126584.648	no soft storey
6F	EQY	LinStatic	0	0	793.3061	139231.221	no soft storey
5F	EQY	LinStatic	0	0	879.7724	149650.306	no soft storey
4F	EQY	LinStatic	0	0	935.6061	161211.463	no soft storey
3F	EQY	LinStatic	0	0	967.4985	179823.499	no soft storey
2F	EQY	LinStatic	0	0	982.0842	220478.114	no soft storey
1F	EQY	LinStatic	0	0	985.9035	394574.362	no soft storey

Stilt	EQY	LinStatic	0	0	985.9035	11954750.23	no soft storey
Base-1	EQY	LinStatic	0	0	985.9035	88649549.72	no soft storey
H.R., OHT	RESPX	LinRespSpec	124.8785	104606.895	55.6755	71638.276	no soft storey
TERRACE	RESPX	LinRespSpec	161.5333	91380.895	85.221	91310.075	no soft storey
8F	RESPX	LinRespSpec	191.7533	98904.066	108.3748	106797.398	no soft storey
7F	RESPX	LinRespSpec	207.5388	99851.637	123.5343	114536.532	no soft storey
6F	RESPX	LinRespSpec	216.8917	99489.382	134.4217	119700.144	no soft storey
5F	RESPX	LinRespSpec	236.7012	105686.319	145.4892	127018.125	no soft storey
4F	RESPX	LinRespSpec	263.4086	116999.997	160.3361	140333.641	no soft storey
3F	RESPX	LinRespSpec	300.3677	139561.587	175.9461	162112.586	no soft storey
2F	RESPX	LinRespSpec	340.1559	184082.109	191.083	206144.975	no soft storey
1F	RESPX	LinRespSpec	382.4833	348584.339	200.2978	378626.546	no soft storey
Stilt	RESPX	LinRespSpec	506.0871	2789925.22	202.7347	4882897.407	no soft storey
Base-1	RESPX	LinRespSpec	578.3298	8139708.969	203.7139	14582948.44	no soft storey
H.R., OHT	RESPY	LinRespSpec	58.3069	53011.467	187.8474	91731.686	no soft storey
TERRACE	RESPY	LinRespSpec	129.865	78735.487	319.9611	129595.321	no soft storey
8F	RESPY	LinRespSpec	170.6172	93108.79	382.3305	143532.298	no soft storey
7F	RESPY	LinRespSpec	196.6473	98529.866	411.6301	147763.334	no soft storey
6F	RESPY	LinRespSpec	217.459	102553.936	430.6905	151180.182	no soft storey
5F	RESPY	LinRespSpec	234.7159	106865.722	454.3766	158481.868	no soft storey
4F	RESPY	LinRespSpec	256.6448	116107.86	502.9361	176635.183	no soft storey
3F	RESPY	LinRespSpec	279.4261	132833.031	568.8423	208503.126	no soft storey
2F	RESPY	LinRespSpec	303.374	169239.522	635.4857	267887.834	no soft storey
1F	RESPY	LinRespSpec	319.1052	303178.714	680.8124	485671.383	no soft storey
Stilt	RESPY	LinRespSpec	328.6106	2236468.885	832.5317	12209353.58	no soft storey
Base-1	RESPY	LinRespSpec	332.8944	7202927.134	978.6939	41840578.71	no soft storey

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
BASE -1	P12	0	13150	1500	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
33541.02	45	1	413.69	413.69

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	0	12400	0	13900	1500	300
Bottom	Leg 1	0	12400	0	13900	1500	300

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	1125	0.0025	0.0024	UDWal58	1729.4051	34.5881	-18.687	450000
Bottom	1125	0.0025	0.0024	UDWal58	1760.2772	-35.2055	17.8548	450000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	750	UDWal47	2672.0703	-117.3049	80.3223	150.7531	474.507
Bottom	Leg 1	750	UDWal47	2723.5238	127.8169	80.3223	151.5764	475.3302

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top-Left	Leg 1	0	UDWal28	3704.4396	-8.0326	8.3	9
Top-Right	Leg 1	0	UDWal28	3131.7689	62.5018	7.52	9
Bottom-Left	Leg 1	0	UDWal44	3172.9317	-64.5128	7.62	9
Botttom-Right	Leg 1	0	UDWal44	3755.8931	17.418	8.5	9

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P11	6890	18685	2100	285.7	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
33541.02	45	1	413.69	413.69

Design Code Parameters

γ_s	γ_c	ρ_{MAX}	ρ_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	5900	18700	7700	18700	1800	300
Top	Leg 2	7700	18400	7700	18700	300	200
Bottom	Leg 1	5900	18700	7700	18700	1800	300
Bottom	Leg 2	7700	18400	7700	18700	300	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	1463	0.0025	0.0039	UDWal58	3405.2594	-68.1052	298.9112	585000
Bottom	4820	0.0082	0.0039	UDWal45	8894.0603	177.8812	1583.3126	585000

Shear Design

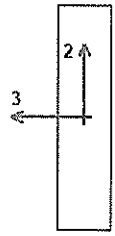
Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	750	UDWal32	3319.444	334.7358	-370.5021	391.2225	779.7271
Top	Leg 2	1080.54	UDWal28	710.7606	-197.1047	110.412	17.1242	110.412
Bottom	Leg 1	750	UDWal32	3377.7468	-1005.5658	-370.5021	391.2225	779.7271
Bottom	Leg 2	1080.54	UDWal28	718.8582	200.3541	110.412	17.1242	110.412

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	0	UDWal50	425.3258	-31.9778	0.99	9
Top–Right	Leg 1	600	UDWal50	7596.0663	691.9905	18.34	9
Top–Left	Leg 2	150	UDWal45	1217.0179	-72.2117	44.35	9
Top–Right	Leg 2	0	UDWal45	0	0	0	0
Bottom–Left	Leg 1	450	UDWal28	5928.7354	-108.794	11.65	9
Botttom–Right	Leg 1	600	UDWal28	7668.9448	1279.5665	22.1	9
Bottom–Left	Leg 2	0	UDWal27	0	0	0	0
Botttom–Right	Leg 2	150	UDWal27	1225.1155	72.7651	44.67	9

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
4TH	B37	699	TYP BM 200X 850 M30	UDCon47	7900	7900	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	850	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

γ_c	γ_s
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-301.1396	0.4354	189.6008	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-301.1396	1.3447	0	-302.4843

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-302.4843		984	0	984	415
Bottom (-2 Axis)		0	492	0	0	492

Shear Force and Reinforcement for Shear, V_{u2} & T_u

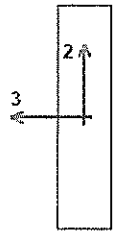
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
254.7596	0	258.243	89.36	905.84

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.4354	189.6008	100	750	375.63

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
4TH	B32	694	TYP BM 200X 850 M30	UDCon47	7300	7300	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	850	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

Yc	Ys
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-372.1565	1.4198	198.0178	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-372.1565	4.3848	0	-376.5413

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-376.5413		1268	0	1268	415
Bottom (-2 Axis)		0	634	0	0	634

Shear Force and Reinforcement for Shear, V_{u2} & T_u

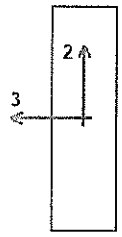
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
257.6537	0	269.0124	109.4501	943.62

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
1.4198	198.0178	100	750	399.25

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary) (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc
3RD	B36	2377	TYP BM 200 X 700 M30	UDCon2	2800

Beam Element Details Type: Ductile Frame (Summary) (Part 2 of 2)

Length (mm)	LLRF
5900	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	700	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

Yc	Ys
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
234.5404	0.485	30.3118	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
234.5404	1.2838	235.8242	0

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	0		108	0	0	108
Bottom (-2 Axis)		235.8242	972	972	0	337

Shear Force and Reinforcement for Shear, V_{u2} & T_u

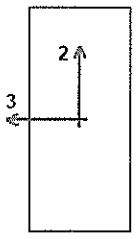
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
30.3118	75.8671	51.2	49.0967	221.69

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.485	30.3118	100	600	0

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary) (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc
3RD	B45	2381	Typ bm 200x 450 m30	UDCon22	0

Beam Element Details Type: Ductile Frame (Summary) (Part 2 of 2)

Length (mm)	LLRF
4200	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	450	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

γ_c	γ_s
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-79.3912	0.1912	80.1791	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-79.3912	0.3656	0	-79.7568

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-79.7568		532	0	532	205
Bottom (-2 Axis)		0	266	0	0	266

Shear Force and Reinforcement for Shear, V_{u2} & T_u

Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
115.0989	0	116.6289	38.9871	828.69

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.1912	80.1791	100	350	269.07

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
3RD	P24	10550	8900	1500	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
33541.02	45	1	500	500

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	9800	8900	11300	8900	1500	200
Bottom	Leg 1	9800	8900	11300	8900	1500	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	750	0.0025	0.0023	UDWal26	1673.2725	33.4654	-2.0916	300000
Bottom	750	0.0025	0.0023	UDWal26	1694.8661	-33.8973	-10.9335	300000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	UDWal20	2660.8128	44.0219	-38.0596	108	324.5217
Bottom	Leg 1	500	UDWal20	2696.8022	-81.4771	-38.0596	108	324.5217

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top-Left	Leg 1	300	UDWal2	3385.8924	-8.8799	11.4	9
Top-Right	Leg 1	300	UDWal2	2660.8128	44.0219	9.46	9
Bottom-Left	Leg 1	300	UDWal2	3421.8818	-3.6724	11.46	9
Botttom-Right	Leg 1	300	UDWal2	3210.3196	64.753	11.56	9

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
3RD	P21	7200	12600	1800	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
33541.02	45	1	500	500

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	7200	11700	7200	13500	1800	200
Bottom	Leg 1	7200	11700	7200	13500	1800	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	900	0.0025	0.0022	UDWal26	2291.9449	-75.8637	70.7577	360000

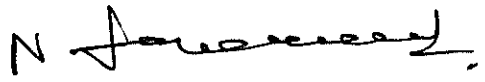
Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Bottom	900	0.0025	0.0022	UDWal26	2317.8573	76.527	-200.7162	360000

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	UDWal21	1922.4299	-160.2163	133.1769	117.1589	376.985
Bottom	Leg 1	500	UDWal21	1965.6171	273.4344	133.1769	117.8499	377.676

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	300	UDWal2	3163.5622	-61.1542	9.35	9
Top–Right	Leg 1	300	UDWal2	3345.5386	48.393	9.74	9
Bottom–Left	Leg 1	300	UDWal22	3388.7259	-182.5367	11.1	9
Botttom–Right	Leg 1	300	UDWal22	3206.7494	51.652	9.39	9

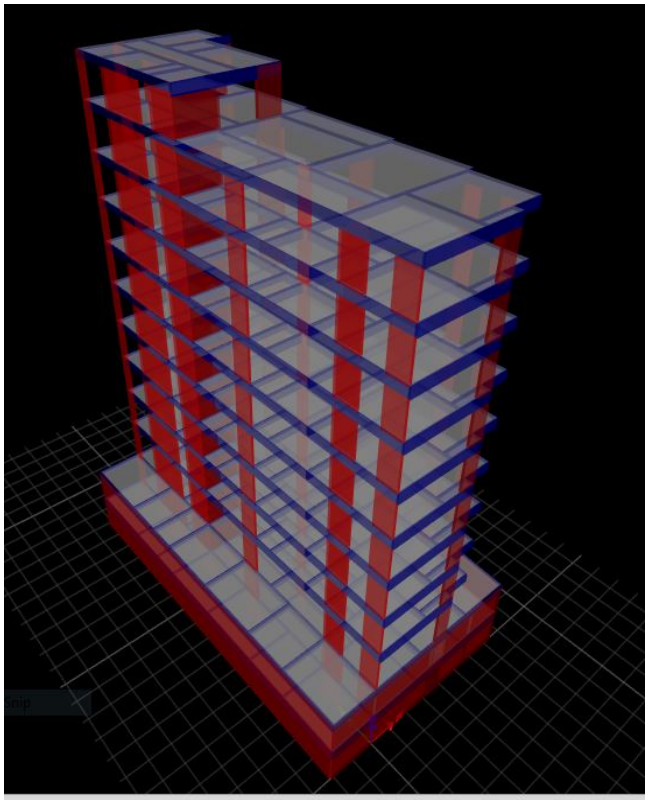


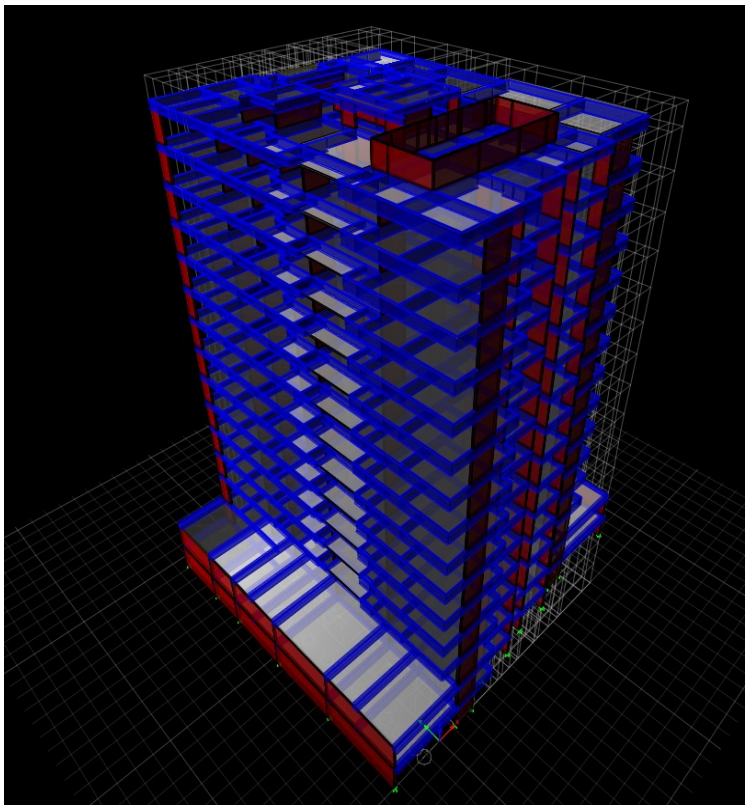
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PLAN SHOWING THE PROPOSED CONSTRUCTION OF HIGH RISE BUILDING (HRB) FOR RESIDENTIAL PURPOSE CONSIST OF 2 BLOCKS: EXTENDED DOUBLE BASEMENT FLOOR (TOWER-A & B) TOWER-A ; STILT FLOOR + 8 FLOORS,(8 DWELLING UNITS); TOWER-B; STILT FLOOR + 12 FLOORS, (35 DWELLING UNITS) ;(TOTALLY OF 43 DWELLING UNITS), INDOOR GAMES, GYM, HOME THEATRE, PARTY HALL IN TWELETH FLOOR & SWIMMING POOL AT TERRACE FLOOR LEVEL WITH AVAILING WITH PREMIUM FSI AT DOOR NO:3/1,196/1,196/2 and 2/3D,ARCOT ROAD (N.S.K. SALAI) VADAPALANI, CHENNAI-600 026,COMPRISING IN OLD SURVEY NO:5/11(part),NEW T.S.NO. 5/49 ,AND OLD S.NO. 177 AND 177/1A NEW T.S.NO.5/13 , BLOCK NO. 5 SALIGRAMAM VILLAGE, MAMBALAM TALUK, CHENNAI DISTRICT.

RESIDENTIAL BUILDING - Structural Design

Report MAY -2024





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ARCHITECT

M/s NATARAJ AND VENKAT
Chennai.

1.1 FOREWORD

1.1.1 - Description of Project

M/s. Ivar Estates private limited construction developing a High rise residential building consist of 2 blocks: extended double basement floor (Tower-A & B) Tower-A stilt floor + 8 floors, Tower-b stilt floor + 12 floors, atsaligramam, Chennai. Project is architecture by M/s Nataraj and venkat architects, Chennai.

1.1.2 - Objective of the Report.

The objective of this report is to provide and furnish complete details related to Project and structural analysis and design considerations.

1.1.2 - Scope of the Report.

The Structural Report covers the complete Structural Elements design considerations for analysis of lateral loads & gravity loads.

1.2 CODES, STANDARDS AND REFERENCES

Statutory Requirements:

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

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

DESIGN STANDARDS:

Specific applicable codes and standards will be identified and adopted in the design philosophies as appropriate to the structural elements. The latest editions of 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 -2015	Code of Practice for design loads (other than earthquake) for Buildings and structure (All parts)
IS:1893-2016	Criteria for earthquake resistant design of structure

Foundations:

IS:1080-1985(2016)	Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
IS:1904-1986(2015)	Code of Practice for design and construction of foundations in soils general requirement
IS:2911-1980(2013)	Code of Practice for design and construction of pile foundations(All parts)
IS:2950-1981(2013)	Code of Practice for design and construction of raft foundations
IS:2974-1998(2013/2015)	Code of Practice for design and construction of machine foundations (All parts)

IS:8009-1976/1980(2013/2015) Code of Practice for calculation of settlement of foundations (All parts)

RCC:

IS:456 -2000(2016)	Code of Practice for plain and reinforced concrete
IS:458 -1988	Specification for precast concrete pipes
IS:3370-2009	Code of Practice for concrete structures for the storage of liquids: (All parts)
IS:4326-2013	Code of Practice for earthquake resistant design and construction of buildings
IS:5525-1969(2013)	Recommendation for detailing of reinforced concrete works
IS:1786-2008	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS:10262-2009	Recommended guidelines for concrete mix design
IS: 1893 (Part-1)-2016	Criteria for earthquake resistant design of structures (General provisions and building).
IS:16700 – 2017	Criteria for structural safety of Tall Concrete buildings
IS:13920 – 2016	Ductile design and Detailing of Reinforced concrete structures subjected to Seismic forces – Code of practice
IS:1343 – 1980	Code of practice for Prestressed concrete

Structural steel:

IS:800 -2007(2012)	Code of Practice for general construction in steel
IS:802 -1995	Code of Practice for use of structural steel in overhead transmission line towers: (All parts)
IS:806 -1968(2013)	Code of Practice for use of steel tubes in general building construction
IS:808 -1989	Dimensions for hot rolled steel beam, column channel and angle section
IS:816 -1998	Code of Practice for use of metal arc welding for general construction in mild steel
IS:1161-1998	Steel tubes for structural purposes
IS:4000-1998	High Strength bolts in steel structures – Code of Practice
IS:7215 -1995	Tolerances for fabrication of steel structures

Miscellaneous:

IS: 432(part 2)-1995	Specification for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement
IS: 6313(part II)-2001	Standards for anti-termite treatment
IS:1905-1998	Code of Practice for structural use of unreinforced masonry
IS:3067-1995	Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
SP:6 -1998	Handbook for structural engineers (all parts)
SP:7 -2005	National Building Code of India
SP:16-1999	Design Aids for reinforced concrete to IS:456-1978
SP:22-1982	Explanatory handbook on codes for earthquake engineering (IS:1982-1975 and IS:4326-1976)
SP:24-1983	Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete
SP:34-1987	Handbook of concrete reinforcement and detailing (SCIP)

Material :

IS: 269 -2015	Specification for Ordinary, rapid hardening and low heat Portland cement.
IS: 455 -1995	Specification for Portland blast furnace slag cement.
IS: 1489-1991	Specification for Portland pozzolana cement
IS: 4031-1991	Method of physical tests for Portland cement.
IS: 383 - 2016	Specification for coarse and fine aggregates from natural sources for concrete.

IS: 516 – 1999	Method of test for strength of concrete.
IS: 1199-1999	Method of sampling and analysis of concrete.
IS: 1566-2000	Specification for plain hard drawn steel wire fabric for concrete reinforcement.
IS: 4990-1998	Specification for plywood for concrete shuttering works.
IS: 2645-1999	Specification for integral cement water proofing compounds.

1.3 - DESCRIPTION OF STRUCTURE

1.3.1 - Location



1.3.2 - Building Description.

The Development consists of the following:

1. Residential building floor covered with RCC roofing.

The usages of individual floors are as given below:

Floors	Details
Main Residential building	Space for residential

1.3.3 - Structural Arrangement:

- The Structural System for the residential buildings comprises of rcc column and beam, where ground floor podium is designed fire tendor loading for given loading input.

	Description	Main Building
a)	Column grids	5 m x 4 m (Varies for some grids)
b)	Structural system	RCC Shear wall & column
c)	Slab thickness	Minimum 130mm Varies depends on span
e)	Foundation	Pile Foundation
f)	Column size	As per design
g)	Beams	As per design.

1.4 DESIGN APPROACH

1.4.1 - 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 are required for all replaceable material for longer life.

1.4.2 - Material Properties.

Materials specified will 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.

Concrete:

- All structural concrete shall have cube crushing strength of 25 N/sq.mm (M25) 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
Pile Foundation	M30 for Pile
Columns	M45-M30
Slab, beams	M30

Reinforcement steel:

- All reinforcement shall confirm to IS: 1786 – 1985 having minimum yield strength of 500 N/sq.mm. Corrosion resistant steel is not required

Structural Steel

- All structural steel shall confirm to IS: 2062 with minimum yield strength of 250 N/sq.mm

1.4.3 – Design loads.

Loads:

Dead loads:

Dead load shall include weight of all structural and Architectural components. Self-weight of the materials.

Shall be calculated on the basis of unit weights given in IS: 875.

- Floor finish of 75 mm thickness: 175 kg/sqm
- Self-weight of Plain concrete : 2400 kg/cum (24 kN/cum)
- Self-weight of RCC : 2500 kg/cum (25 kN/cum)
- Aerocon block masonry : 700 kg/cum (7 kN/cum) [For walls]
  (With additional 15mm thick plastering on external surface and 12mm plastering on internal wall surfaces)
- Soil (Dry) : 1800 kg/cum (18 kN/cum)
- Soil (Wet) : 2000 kg/cum (20 kN/cum)
- Water : 1000 kg/cum (10 kN/cum)
- Masonry with plastering : 2200 kg/cum (22 kN/cum)
- Wall loads : As per actuals

Live loads:

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

Following live loads are considered while designing the structural elements apart from the dead loads as per codes.

Floor Live loads:

- Living, kitchen, Dining : 200 kg/sqm (2.0 kN/sqm)
- Stairs : 300 kg/sqm (3.0 kN/sqm)
- Corridors / Balcony : 300 kg/sqm (3.0 kN/sqm)
- Toilets : 200 kg/sqm (2.0 kN/sqm)
- Terrace with Access : 200 kg/sqm (2.0 kN/sqm)
- Electrical rooms and club house : 400 kg/sqm (4.0 kN/sqm)

Sunken Details:

- Toilet : 100 mm
- Balcony : 150mm
- Utility : 150mm

Wind Loads

The Wind pressure shall be calculated in accordance with IS: 875 (Part-3):2015.

Vellore has a high wind speed of 50m/s.

Basic Wind Speed V_b : 50 m/s
Risk Coefficient k_1 : 1.00 (k_1 corresponds to 50 years Mean Probable Design Life of Structure)
Terrain, height, structure size factor k_2 : To suit the height of the structure for terrain category 2

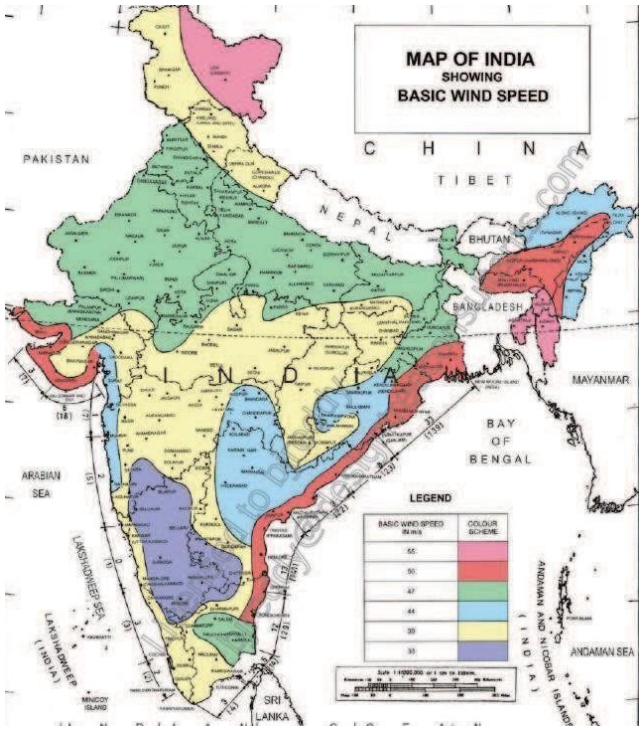
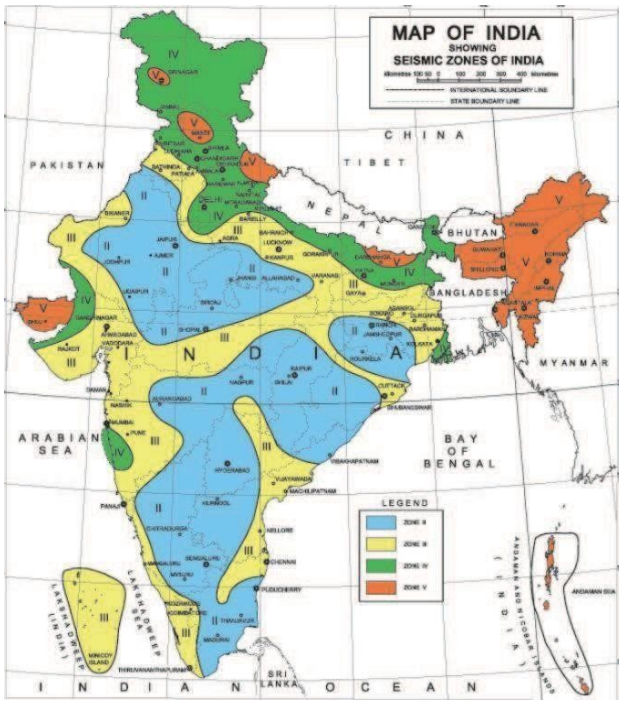
Topography factor k_3 : 1.0

Importance factor for cyclonic region k_4 : 1.00

The external and internal pressure co-efficient shall be as per respective clauses of IS: 875 (Part 3):2015

Design wind speed V_z : $V_b \times k_1 \times k_2 \times k_3 \times k_4$

Design wind pressure p_z : $0.6 \times V_z^2$

Map showing basic wind speed	Map showing seismic zones
	
Basic wind speed in m/s (based on 50-year return period)	Seismic zones of India

Seismic Forces:

Chennai falls under seismic zone III as per IS 1893-2016 (Part 1) (Sixth Revision) and has the following factors to be considered for designs. Ductile detailing is required. (Please refer attached map above)

Seismic Zone	: III
Seismic Zone factor, Z	: 0.16 (As per Table 3; IS: 1893-2016)
Design horizontal seismic coefficient (Ah)	: $(Z/2)*(S_a/g)*(I/R)$
I -Importance factor	: 1.2 (Ref Table 8; IS: 1893-2016)
Response reduction Factor	: 4
Soil type	: Type -1 with N>100 at the founding levels of about 9m
Damping Ratio for RCC	: 5 %

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

Design horizontal seismic coefficient (A_h) : $(Z/2)*(S_a/g)*(I/R)$

: $(0.16/2)*(1.2/5) * (S_a/g)$

A_h : $0.024 * (S_a/g)$

Design seismic base shear, V_b : $A_h * w$ where, w - seismic weight of building

Effect of infill panels : Not considered in the analysis

Table No : 03

Seismic 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

Temperature Loads:

The effect of temperature will be considered wherever applicable in accordance with relevant Indian Codes. Minimum & maximum temperatures considered are as shown in the table below. Same will be used for the analysis & design. The coefficient for thermal expansion and contraction will be in accordance with IS: 456 and IS: 800 for concrete and steel respectively.

Station Name	Month	Period	No. of Years	Mean Temperature in Degree C		Mean rainfall in mm
				Maximum	Minimum	
Chennai (Minambakkam)	January	1901-2000	100	28.8	20.4	35.3
Chennai (Minambakkam)	February	1901-2000	100	30.5	21.1	13.0
Chennai (Minambakkam)	March	1901-2000	100	32.6	23.0	14.5
Chennai (Minambakkam)	April	1901-2000	100	34.7	25.8	15.9
Chennai (Minambakkam)	May	1901-2000	100	37.4	27.6	42.4
Chennai (Minambakkam)	June	1901-2000	100	37.3	27.4	53.9
Chennai (Minambakkam)	July	1901-2000	100	35.3	26.1	99.6
Chennai (Minambakkam)	August	1901-2000	100	34.5	25.5	129.9
Chennai (Minambakkam)	September	1901-2000	100	33.9	25.2	123.5
Chennai (Minambakkam)	October	1901-2000	100	31.8	24.2	284.6
Chennai (Minambakkam)	November	1901-2000	100	29.4	22.6	353.0
Chennai (Minambakkam)	December	1901-2000	100	28.4	21.2	146.3

[Source: National Data Centre :ndc@imdpune.gov.in
DGM (Sectt.) : dgm.hq@imd.gov.in]

Considering the average **daily** maximum temperature as 34 degrees and minimum as 24 degrees, the variation in temperature for analysis is considered as **10 degrees**.

[Source:https://www.wunderground.com/history/airport/VOMM/2016/1/4/CustomHistory.html?dayend=5&monthend=2&yearend=2017&req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo=]

Temperature and shrinkage effect:

Horizontal floor displacement due to differential temperatures and shrinkage is of importance in long 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.

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 collision of vehicles on the façade of the building

1.4.4 Durability Considerations:

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

- Environment : moderate

Table 5 Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum Size

(Clauses 6.1.2, 8.2.4.1 *and* 9.1.2*)*

Sl No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Mild	220	0.60	–	300	0.55	M 20
iii)	Moderate	240	0.60	M 15	300	0.50	M 25
iii)	Severe	250	0.50	M 20	320	0.45	M 30
iv)	Very severe	260	0.45	M 20	340	0.45	M 35
v)	Extreme	280	0.40	M 25	360	0.40	M 40

NOTES

1 Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in 5.2. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2 Minimum grade for plain concrete under mild exposure condition is not specified.

- Exposure conditions : Concrete surfaces exposed to moderate environment
- Minimum grade of concrete : Moderate exposure – M25

1.4.5 Fire Rating:

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

Fire Resistance h	*Minimum Beam Width b*	*Rib Width of Slabs b_w*	*Minimum Thickness of Floors D*	*Column Dimension (b or D)*			*Minimum Wall Thickness*		
				Fully Exposed	50% Exposed	One Face Exposed	$p<0.4\%$	$0.4\% \le p \le 1\%$	$p>1\%$
	mm	mm	mm	mm	mm	mm	mm	mm	mm
0.5	200	125	75	150	125	100	150	100	100
1	200	125	95	200	160	120	150	120	100
1.5	200	125	110	250	200	140	175	140	100
2	200	125	125	300	200	160	–	160	100
3	240	150	150	400	300	200	–	200	150
4	280	175	170	450	350	240	–	240	180

NOTES

1 These minimum dimensions relate specifically to the covers given in Table 16A.

2 p is the percentage of steel reinforcement.

FIG. 1 MINIMUM DIMENSIONS OF REINFORCED CONCRETE MEMBERS FOR FIRE RESISTANCE

- Nominal covers for 2 hr. fire resistance:

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

1.5 ANALYSIS METHODOLOGY:

This structure has a physical interface with almost all the disciplines like geotechnical works, MEP services, etc. The structure proposed is of cast in-situ concrete construction with columns suitably placed.

The Vertical Loads including the dead and super imposed loads are transferred to the soil through columns, pedestal, and Pile caps. Pile caps are sized with consideration to the safe carrying capacity of pile at the level of transfer of load recommended by specialist soil investigation consultants.

1.5.1 Assumptions:

- The structure is idealized as 3D space frame and analyzed using Etabs software package for both vertical and lateral loads.
- 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 foundation is represented in analysis model using fixed end conditions.

1.5.2 Mathematical model

Mass Modeling:

Mass Source as per IS: 1893_2016 is considered as follows.

Mass source = DL+SDL+ 0. 3LL

Where DL - Dead Load;

SDL – Super Imposed Dead Load;

LL - Live Load

1.5.3 Static Analysis:

The following Static loads cases are considered in the analysis.

DL - Dead Load which includes self-weight of the structure.

SDL – Super Imposed Dead Load, including load due to finishes, wall Loads, Soil filling loads etc.

LL - Live Load

1.6 LOAD COMBINATIONS:

Load combinations Used for Strength, Serviceability are tabulated below:

Load Combination	Limit State of Collapse			Limit State of Serviceability		
	DL+SDL	*LL*	*WL/EL/TL*	*DL+SDL*	*LL*	*WL/EL/TL*
DL + LL	1.5	1.5	—	1	1	—
DL + WL	1.5 or 0.9*	—	1.5	1	—	1
DL + EL	1.5 or 0.9*	—	1.5	1	—	1
DL + TL	1.5	—	1.5	1	—	1
DL+LL+WL	1.2	1.2	1.2	1	0.8	0.8
DL+LL+EL	1.2	1.2	1.2	1	0.8	0.8
DL+LL+TL	1.2	1.2	1.2	1	1	1
DL+WL+TL	1.2	—	1.2	1	—	1
DL+EL+TL	1.2	—	1.2	1	—	1
DL+LL+EL+TL	1.2	1.2	1.2	1	1	1

Response spectrum combinations:

- 1.2[DL+LL+(SPECX+0.3 SPECY+0.3 SPECZ)]
- 1.2[DL+LL+(SPECY+0.3 SPECX+0.3 SPECZ)]
- 1.5[DL+(SPECX+0.3 SPECY+0.3 SPECZ)]
- 1.5[DL+(SPECY+0.3 SPECX+0.3 SPECZ)]
- 0.9DL+1.5(SPECX+0.3 SPECY+0.3 SPECZ)]
- 0.9DL+1.5(SPECY+0.3 SPECX+0.3 SPECZ)]

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

*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 , SPEC- Response spectrum

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: 1893-2016 / Clause 7.3.3 of seismic code will be used both for evaluating earthquake effect and for combined load effects used in such combination. Serviceability loads combinations with suitable live load reduction factor as per IS: 875(Part-2) will be used for foundation design.

1.7 DESIGN METHODOLOGY:

- All R.C.C structures shall be designed according to the Limit State Method as specified in IS: 456 – 2000.
- 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.
- Design of special members like retaining wall, water tanks will be done in accordance with the relevant IS Codes.
- Design of structural steel members are done using elastic method as per IS: 800 with relevant allowable stresses.

1.8 ACCEPTANCE CRITERIA:

1.8.1 Deflection Limits:

For Reinforced concrete works:

- Limiting values of deflection (Short and Long term) as per clause 35.3 of IS: 456-2000 is followed in the design.
- Limiting value for long term deflection is considered as span/250 and for the long term deflection after erection of partitions & finishes is considered as span/350 or 20mm whichever less as per IS 456 – 2000.

1.8.2 Cracking Limits:

- Limiting values of crack width as per clause 35.3 of IS: 456-2000 is followed in the design.
- In general for slabs and beams, the crack width is limited to 0.3mm.
- For water retaining structures, crack width is limited to 0.2mm.

1.8.3 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. The soil investigation report recommends Pilefoundation system.

1.9 DETAILING REQUIREMENTS:

- RC walls, which are considered as lateral load resisting elements are detailed as ductile RC walls along with perimeter SMRFs (both columns and beams). Rest of thecolumns and beams are detailed as per normal detailing requirement.
- Detailing for all structural members shall be in accordance with IS: 456 & SP: 34.

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQX according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = X + Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.163 \text{ sec}$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X + Ecc. Y	0.163	34813.3461	1671.0406

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
H.R. , OHT	39.15	389.8795	0
8 TH TERRACE	36.1	500.0938	0
7TH	32.8	273.454	0
6TH	29.5	200.0472	0
5TH	26.2	139.5174	0
4TH	22.9	89.2911	0
3RD	19.6	50.2263	0
2ND	16.3	22.8162	0
1ST	13	5.7151	0
STILT	9.7	0	0
BASE- 2	6.1	0	0
BASE -1	3.05	0	0
Base	0	0	0

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQY according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = Y + Eccentricity X

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.49 \text{ sec}$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

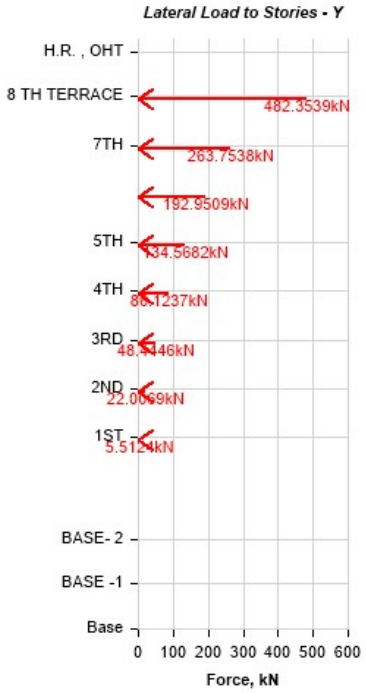
Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y + Ecc. X	0.49	31536.459	1235.7143

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
H.R. , OHT	39.15	0	0
8 TH TERRACE	36.1	0	482.3539
7TH	32.8	0	263.7538
6TH	29.5	0	192.9509
5TH	26.2	0	134.5682
4TH	22.9	0	86.1237
3RD	19.6	0	48.4446
2ND	16.3	0	22.0069
1ST	13	0	5.5124
STILT	9.7	0	0
BASE- 2	6.1	0	0
BASE -1	3.05	0	0
Base	0	0	0

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQX according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = X + Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 1.03 \text{ sec}$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

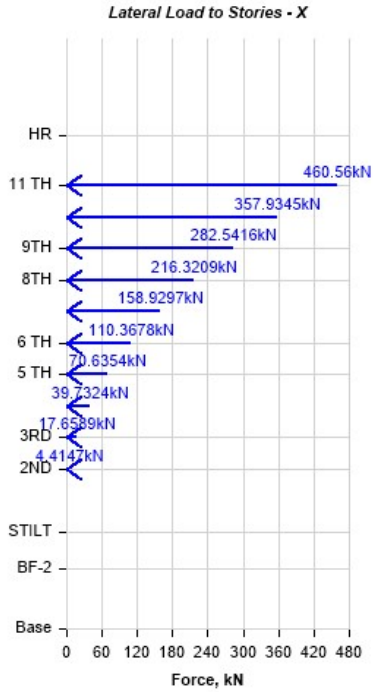
Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X + Ecc. Y	1.03	92222.3343	1719.0959

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HR	50.1	0	0
12 TH	48.3	0	0
11 TH	45.1	460.56	0
10TH	41.9	357.9345	0
9TH	38.7	282.5416	0
8TH	35.5	216.3209	0
7TH	32.3	158.9297	0
6 TH	29.1	110.3678	0
5 TH	25.9	70.6354	0
4 TH	22.7	39.7324	0
3RD	19.5	17.6589	0
2ND	16.3	4.4147	0
1ST	13.1	0	0
STILT	9.9	0	0
BF-2	6.1	0	0
BF -1	3.05	0	0
Base	0	0	0

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQY according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = Y + Eccentricity X

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.88 \text{ sec}$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 5$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = I

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

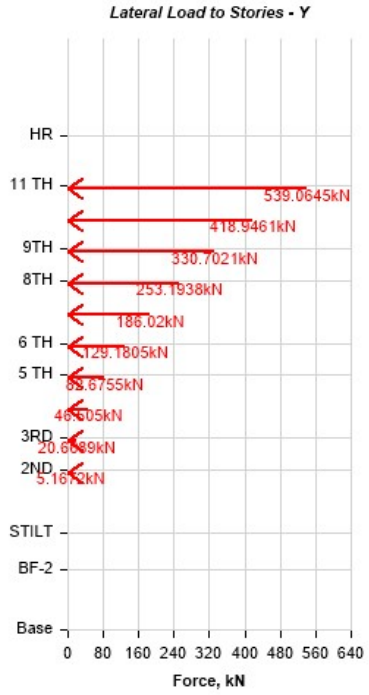
Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y + Ecc. X	0.88	92222.3343	2012.1237

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HR	50.1	0	0
12 TH	48.3	0	0
11 TH	45.1	0	539.0645
10TH	41.9	0	418.9461
9TH	38.7	0	330.7021
8TH	35.5	0	253.1938
7TH	32.3	0	186.02
6 TH	29.1	0	129.1805
5 TH	25.9	0	82.6755
4 TH	22.7	0	46.505
3RD	19.5	0	20.6689
2ND	16.3	0	5.1672
1ST	13.1	0	0
STILT	9.9	0	0
BF-2	6.1	0	0
BF -1	3.05	0	0
Base	0	0	0

TABLE: Modal Participating Mass Ratios

Case	Mode	Period	UX	UY	UZ	SumUX	SumUY
		sec					
Modal	1	2.119	0.2406	0.084	0	0.2406	0.084
Modal	2	1.767	0.1225	0.4003	0	0.3631	0.4843
Modal	3	1.422	0.1748	0.0366	0	0.5379	0.5209
Modal	4	0.571	0.0448	0.0132	0	0.5827	0.5341
Modal	5	0.48	0.013	0.0842	0	0.5956	0.6183
Modal	6	0.335	0.0799	0.0011	0	0.6756	0.6194
Modal	7	0.267	0.0123	0.0058	0	0.6879	0.6252
Modal	8	0.235	0.0052	0.028	0	0.6931	0.6532
Modal	9	0.157	0.025	0.0089	0	0.7181	0.6621
Modal	10	0.15	0.0535	0.0057	0	0.7717	0.6678
Modal	11	0.141	0.0031	0.0055	0	0.7748	0.6733
Modal	12	0.105	0.0004	0.0153	0	0.7752	0.6886
Modal	13	0.098	0.0636	0.0012	0	0.8388	0.6899
Modal	14	0.09	0.0369	0.001	0	0.8756	0.6908
Modal	15	0.075	0.0002	0.016	0	0.8759	0.7068
Modal	16	0.068	0.0147	0.0065	0	0.8905	0.7133
Modal	17	0.065	0.0323	0.0032	0	0.9229	0.7165
Modal	18	0.058	0.001	0.0119	0	0.9239	0.7284
Modal	19	0.051	0.0002	0.0815	0	0.9241	0.8098
Modal	20	0.046	0.0238	0.0048	0	0.9479	0.8146
Modal	21	0.044	0.0009	0.1008	0	0.9488	0.9155
Modal	22	0.042	0.0001	0.0424	0	0.9489	0.9578
Modal	23	0.038	0.02	0.0036	0	0.9689	0.9615
Modal	24	0.035	0.0015	0.0121	0	0.9705	0.9735

SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
0	0.0802	0.1805	0.1621	0.0802	0.1805	0.1621
0	0.3867	0.1069	0.0006	0.4668	0.2873	0.1627
0	0.0341	0.1997	0.3109	0.5009	0.4871	0.4736
0	0.0082	0.0446	0.0293	0.5091	0.5317	0.5029
0	0.0664	0.0097	0.001	0.5755	0.5414	0.5039
0	0.001	0.0552	0.0689	0.5765	0.5966	0.5728
0	0.0027	0.0061	0.0168	0.5793	0.6027	0.5896
0	0.0117	0.0033	0.0022	0.5909	0.606	0.5918
0	0.0063	0.0239	0.0003	0.5972	0.6298	0.5921
0	0.0046	0.0517	0.0136	0.6018	0.6815	0.6057

0	0.0041	0.0033	0.026	0.6059	0.6848	0.6317
0	0.0115	0.0003	0.001	0.6174	0.6852	0.6327
0	0.0009	0.0742	0.0001	0.6183	0.7594	0.6328
0	0.0007	0.0511	0.0191	0.619	0.8105	0.6519
0	0.0138	0.0004	0.0016	0.6328	0.8109	0.6535
0	0.0061	0.0183	0.0098	0.6389	0.8291	0.6633
0	0.003	0.0462	0.0002	0.6419	0.8753	0.6635
0	0.0119	0.0023	0.0075	0.6538	0.8777	0.671
0	0.0878	0.0001	0.0071	0.7416	0.8778	0.678
0	0.0053	0.0327	0.0413	0.7469	0.9105	0.7193
0	0.1195	0.002	0.0028	0.8664	0.9125	0.7222
0	0.0522	0.0007	0.0198	0.9186	0.9132	0.742
0	0.0044	0.0234	0.1941	0.923	0.9366	0.9361
0	0.0176	0.0025	0.0031	0.9406	0.9391	0.9392

Table_6 of IS1893 (Part_1)_2016_Irregular Modes of Oscillation in Two Principal Directions_(Vii):

Mode No.	Fundamental Lateral Natural Period	Ux	Uy	Rz
	(Sec)			
	(T)			
MODE - 1	2.119	0.2406	0.084	0.1621
MODE - 2	1.767	0.1225	0.4003	**0.0006**
MODE - 3	1.422	0.1748	0.0366	**0.3109**
TOTAL %age		**53.79**	**52.09**	**47.36**

TABLE: Story Drifts						
Story	Output Case	Case Type	Step Type	Step Number	Direction	Drift
H.R. , OHT	EQX	LinStatic			X	0.000596
H.R. , OHT	EQY	LinStatic			X	0.000345
H.R. , OHT	EQY	LinStatic			Y	0.001072
H.R. , OHT	WIND X	LinStatic	Step By Step	1	X	0.001188
H.R. , OHT	WIND X	LinStatic	Step By Step	1	Y	0.000349
H.R. , OHT	WIND X	LinStatic	Step By Step	2	X	0.000127
H.R. , OHT	WIND X	LinStatic	Step By Step	2	Y	0.000395
H.R. , OHT	WIND Y	LinStatic	Step By Step	1	X	0.001188
H.R. , OHT	WIND Y	LinStatic	Step By Step	1	Y	0.000349
H.R. , OHT	WIND Y	LinStatic	Step By Step	2	X	0.000127
H.R. , OHT	WIND Y	LinStatic	Step By Step	2	Y	0.000395
H.R. , OHT	RESPX	LinRespSpec	Max		X	0.000479
H.R. , OHT	RESPX	LinRespSpec	Max		Y	0.000318
H.R. , OHT	RESPY	LinRespSpec	Max		X	0.000423
H.R. , OHT	RESPY	LinRespSpec	Max		Y	0.000726
TERRACE	EQX	LinStatic			X	0.000993
TERRACE	EQY	LinStatic			X	0.000705
TERRACE	EQY	LinStatic			Y	0.001412
TERRACE	WIND X	LinStatic	Step By Step	1	X	0.002387
TERRACE	WIND X	LinStatic	Step By Step	1	Y	0.000444
TERRACE	WIND X	LinStatic	Step By Step	2	X	0.000249
TERRACE	WIND X	LinStatic	Step By Step	2	Y	0.000513
TERRACE	WIND Y	LinStatic	Step By Step	1	X	0.002387
TERRACE	WIND Y	LinStatic	Step By Step	1	Y	0.000444
TERRACE	WIND Y	LinStatic	Step By Step	2	X	0.000249
TERRACE	WIND Y	LinStatic	Step By Step	2	Y	0.000513
TERRACE	RESPX	LinRespSpec	Max		X	0.000736
TERRACE	RESPX	LinRespSpec	Max		Y	0.000345
TERRACE	RESPY	LinRespSpec	Max		X	0.000667
TERRACE	RESPY	LinRespSpec	Max		Y	0.00079
8F	EQX	LinStatic			X	0.001182
8F	EQY	LinStatic			X	0.000765
8F	EQY	LinStatic			Y	0.001625
8F	WIND X	LinStatic	Step By Step	1	X	0.002884
8F	WIND X	LinStatic	Step By Step	1	Y	0.000553
8F	WIND X	LinStatic	Step By Step	2	X	0.000271
8F	WIND X	LinStatic	Step By Step	2	Y	0.000596
8F	WIND Y	LinStatic	Step By Step	1	X	0.002884
8F	WIND Y	LinStatic	Step By Step	1	Y	0.000553
8F	WIND Y	LinStatic	Step By Step	2	X	0.000271
8F	WIND Y	LinStatic	Step By Step	2	Y	0.000596
8F	RESPX	LinRespSpec	Max		X	0.000819
8F	RESPX	LinRespSpec	Max		Y	0.000373
8F	RESPY	LinRespSpec	Max		X	0.000755
8F	RESPY	LinRespSpec	Max		Y	0.000844
7F	EQX	LinStatic			X	0.001379
7F	EQY	LinStatic			X	0.000824
7F	EQY	LinStatic			Y	0.001807
7F	WIND X	LinStatic	Step By Step	1	X	0.003507

7F	WIND X	LinStatic	Step By Step	1	Y	0.000692
7F	WIND X	LinStatic	Step By Step	2	X	0.000299
7F	WIND X	LinStatic	Step By Step	2	Y	0.000684
7F	WIND Y	LinStatic	Step By Step	1	X	0.003507
7F	WIND Y	LinStatic	Step By Step	1	Y	0.000692
7F	WIND Y	LinStatic	Step By Step	2	X	0.000299
7F	WIND Y	LinStatic	Step By Step	2	Y	0.000684
7F	RESPX	LinRespSpec	Max		X	0.000894
7F	RESPX	LinRespSpec	Max		Y	0.000394
7F	RESPY	LinRespSpec	Max		X	0.000838
7F	RESPY	LinRespSpec	Max		Y	0.000876
6F	EQX	LinStatic			X	0.001543
6F	EQY	LinStatic			X	0.000868
6F	EQY	LinStatic			Y	0.001939
6F	WIND X	LinStatic	Step By Step	1	X	0.004151
6F	WIND X	LinStatic	Step By Step	1	Y	0.000835
6F	WIND X	LinStatic	Step By Step	2	X	0.000327
6F	WIND X	LinStatic	Step By Step	2	Y	0.000769
6F	WIND Y	LinStatic	Step By Step	1	X	0.004151
6F	WIND Y	LinStatic	Step By Step	1	Y	0.000835
6F	WIND Y	LinStatic	Step By Step	2	X	0.000327
6F	WIND Y	LinStatic	Step By Step	2	Y	0.000769
6F	RESPX	LinRespSpec	Max		X	0.000954
6F	RESPX	LinRespSpec	Max		Y	0.00041
6F	RESPY	LinRespSpec	Max		X	0.000907
6F	RESPY	LinRespSpec	Max		Y	0.000891
5F	EQX	LinStatic			X	0.001643
5F	EQY	LinStatic			X	0.000881
5F	EQY	LinStatic			Y	0.001994
5F	WIND X	LinStatic	Step By Step	1	X	0.004709
5F	WIND X	LinStatic	Step By Step	1	Y	0.00096
5F	WIND X	LinStatic	Step By Step	2	X	0.000347
5F	WIND X	LinStatic	Step By Step	2	Y	0.000837
5F	WIND Y	LinStatic	Step By Step	1	X	0.004709
5F	WIND Y	LinStatic	Step By Step	1	Y	0.00096
5F	WIND Y	LinStatic	Step By Step	2	X	0.000347
5F	WIND Y	LinStatic	Step By Step	2	Y	0.000837
5F	RESPX	LinRespSpec	Max		X	0.000996
5F	RESPX	LinRespSpec	Max		Y	0.000417
5F	RESPY	LinRespSpec	Max		X	0.000957
5F	RESPY	LinRespSpec	Max		Y	0.000892
4F	EQX	LinStatic			X	0.001663
4F	EQY	LinStatic			X	0.000856
4F	EQY	LinStatic			Y	0.001963
4F	WIND X	LinStatic	Step By Step	1	X	0.005085
4F	WIND X	LinStatic	Step By Step	1	Y	0.001046
4F	WIND X	LinStatic	Step By Step	2	X	0.000355
4F	WIND X	LinStatic	Step By Step	2	Y	0.000878
4F	WIND Y	LinStatic	Step By Step	1	X	0.005085
4F	WIND Y	LinStatic	Step By Step	1	Y	0.001046
4F	WIND Y	LinStatic	Step By Step	2	X	0.000355
4F	WIND Y	LinStatic	Step By Step	2	Y	0.000878
4F	RESPX	LinRespSpec	Max		X	0.001017

4F	RESPX	LinRespSpec	Max		Y	0.000415
4F	RESPY	LinRespSpec	Max		X	0.000982
4F	RESPY	LinRespSpec	Max		Y	0.00088
3F	EQX	LinStatic			X	0.001561
3F	EQY	LinStatic			X	0.000775
3F	EQY	LinStatic			Y	0.001814
3F	WIND X	LinStatic	Step By Step	1	X	0.005079
3F	WIND X	LinStatic	Step By Step	1	Y	0.001048
3F	WIND X	LinStatic	Step By Step	2	X	0.000339
3F	WIND X	LinStatic	Step By Step	2	Y	0.000866
3F	WIND Y	LinStatic	Step By Step	1	X	0.005079
3F	WIND Y	LinStatic	Step By Step	1	Y	0.001048
3F	WIND Y	LinStatic	Step By Step	2	X	0.000339
3F	WIND Y	LinStatic	Step By Step	2	Y	0.000866
3F	RESPX	LinRespSpec	Max		X	0.000981
3F	RESPX	LinRespSpec	Max		Y	0.000394
3F	RESPY	LinRespSpec	Max		X	0.00095
3F	RESPY	LinRespSpec	Max		Y	0.000839
2F	EQX	LinStatic			X	0.001293
2F	EQY	LinStatic			X	0.000622
2F	EQY	LinStatic			Y	0.001497
2F	WIND X	LinStatic	Step By Step	1	X	0.004459
2F	WIND X	LinStatic	Step By Step	1	Y	0.000917
2F	WIND X	LinStatic	Step By Step	2	X	0.000288
2F	WIND X	LinStatic	Step By Step	2	Y	0.000765
2F	WIND Y	LinStatic	Step By Step	1	X	0.004459
2F	WIND Y	LinStatic	Step By Step	1	Y	0.000917
2F	WIND Y	LinStatic	Step By Step	2	X	0.000288
2F	WIND Y	LinStatic	Step By Step	2	Y	0.000765
2F	RESPX	LinRespSpec	Max		X	0.00084
2F	RESPX	LinRespSpec	Max		Y	0.000335
2F	RESPY	LinRespSpec	Max		X	0.000816
2F	RESPY	LinRespSpec	Max		Y	0.000727
1F	EQX	LinStatic			X	0.00064
1F	EQY	LinStatic			X	0.000299
1F	EQY	LinStatic			Y	0.000767
1F	WIND X	LinStatic	Step By Step	1	X	0.002292
1F	WIND X	LinStatic	Step By Step	2	X	0.000145
1F	WIND X	LinStatic	Step By Step	2	Y	0.000414
1F	WIND Y	LinStatic	Step By Step	1	X	0.002292
1F	WIND Y	LinStatic	Step By Step	2	X	0.000145
1F	WIND Y	LinStatic	Step By Step	2	Y	0.000414
1F	RESPX	LinRespSpec	Max		X	0.000423
1F	RESPX	LinRespSpec	Max		Y	0.000173
1F	RESPY	LinRespSpec	Max		X	0.000411
1F	RESPY	LinRespSpec	Max		Y	0.000395
Stilt	EQX	LinStatic			X	0.000134
Stilt	EQY	LinStatic			X	0.00002
Stilt	EQY	LinStatic			Y	0.000032
Stilt	WIND X	LinStatic	Step By Step	1	X	0.000348
Stilt	WIND X	LinStatic	Step By Step	2	X	0.000008
Stilt	WIND X	LinStatic	Step By Step	2	Y	0.000018
Stilt	WIND Y	LinStatic	Step By Step	1	X	0.000348

Stilt	WIND Y	LinStatic	Step By Step	2	X	0.000008
Stilt	WIND Y	LinStatic	Step By Step	2	Y	0.000018
Stilt	RESPX	LinRespSpec	Max		X	0.000092
Stilt	RESPX	LinRespSpec	Max		Y	0.000022
Stilt	RESPY	LinRespSpec	Max		X	0.000071
Stilt	RESPY	LinRespSpec	Max		Y	0.000029
Base-1	EQX	LinStatic			X	0.000042
Base-1	EQY	LinStatic			X	0.000007
Base-1	EQY	LinStatic			Y	0.000005
Base-1	WIND X	LinStatic	Step By Step	1	X	0.000114
Base-1	WIND X	LinStatic	Step By Step	2	X	0.000003
Base-1	WIND X	LinStatic	Step By Step	2	Y	0.000004
Base-1	WIND Y	LinStatic	Step By Step	1	X	0.000114
Base-1	WIND Y	LinStatic	Step By Step	2	X	0.000003
Base-1	WIND Y	LinStatic	Step By Step	2	Y	0.000004
Base-1	RESPX	LinRespSpec	Max		X	0.000036
Base-1	RESPX	LinRespSpec	Max		Y	0.000008
Base-1	RESPY	LinRespSpec	Max		X	0.000023
Base-1	RESPY	LinRespSpec	Max		Y	0.000009

TABLE: Story Max Over Avg Drifts								
Story	Output Case	Case Type	Step Type	Step Number	Direction	Max Drift	Avg Drift	Ratio
						mm	mm	
H.R. , OHT	EQX	LinStatic			X	1.817	1.637	1.11
H.R. , OHT	EQY	LinStatic			X	1.053	0.498	2.115
H.R. , OHT	EQY	LinStatic			Y	3.269	2.766	1.182
H.R. , OHT	RESPX	LinRespSpec	Max		X	1.461	1.194	1.224
H.R. , OHT	RESPX	LinRespSpec	Max		Y	0.97	0.777	1.248
H.R. , OHT	RESPY	LinRespSpec	Max		X	1.289	1.1	1.172
H.R. , OHT	RESPY	LinRespSpec	Max		Y	2.216	2.048	1.082
TERRACE	EQX	LinStatic			X	3.276	2.445	1.34
TERRACE	EQY	LinStatic			X	2.325	0.561	4.143
TERRACE	EQY	LinStatic			Y	4.659	4.069	1.145
TERRACE	RESPX	LinRespSpec	Max		X	2.43	1.768	1.375
TERRACE	RESPX	LinRespSpec	Max		Y	1.138	0.933	1.22
TERRACE	RESPY	LinRespSpec	Max		X	2.201	1.649	1.334
TERRACE	RESPY	LinRespSpec	Max		Y	2.606	2.469	1.056
8F	EQX	LinStatic			X	3.901	2.79	1.398
8F	EQY	LinStatic			X	2.523	0.632	3.991
8F	EQY	LinStatic			Y	5.363	4.73	1.134
8F	RESPX	LinRespSpec	Max		X	2.703	1.939	1.394
8F	RESPX	LinRespSpec	Max		Y	1.23	1.015	1.212
8F	RESPY	LinRespSpec	Max		X	2.491	1.832	1.359
8F	RESPY	LinRespSpec	Max		Y	2.784	2.664	1.045
7F	EQX	LinStatic			X	4.551	3.129	1.454
7F	EQY	LinStatic			X	2.721	0.708	3.84
7F	EQY	LinStatic			Y	5.962	5.289	1.127
7F	RESPX	LinRespSpec	Max		X	2.949	2.078	1.419
7F	RESPX	LinRespSpec	Max		Y	1.302	1.079	1.207
7F	RESPY	LinRespSpec	Max		X	2.765	1.996	1.385
7F	RESPY	LinRespSpec	Max		Y	2.889	2.786	1.037
6F	EQX	LinStatic			X	5.091	3.394	1.5
6F	EQY	LinStatic			X	2.865	0.774	3.704
6F	EQY	LinStatic			Y	6.397	5.698	1.123
6F	RESPX	LinRespSpec	Max		X	3.147	2.18	1.443
6F	RESPX	LinRespSpec	Max		Y	1.352	1.123	1.204
6F	RESPY	LinRespSpec	Max		X	2.992	2.12	1.411

6F	RESPY	LinRespSpec	Max	Y	2.939	2.849	1.032
5F	EQX	LinStatic		X	5.422	3.532	1.535
5F	EQY	LinStatic		X	2.907	0.809	3.594
5F	EQY	LinStatic		Y	6.58	5.879	1.119
5F	RESPX	LinRespSpec	Max	X	3.286	2.24	1.467
5F	RESPX	LinRespSpec	Max	Y	1.376	1.145	1.202
5F	RESPY	LinRespSpec	Max	X	3.157	2.196	1.437
5F	RESPY	LinRespSpec	Max	Y	2.942	2.867	1.026
4F	EQX	LinStatic		X	5.487	3.511	1.563
4F	EQY	LinStatic		X	2.824	0.807	3.5
4F	EQY	LinStatic		Y	6.478	5.804	1.116
4F	RESPX	LinRespSpec	Max	X	3.355	2.251	1.49
4F	RESPX	LinRespSpec	Max	Y	1.371	1.143	1.2
4F	RESPY	LinRespSpec	Max	X	3.241	2.21	1.466
4F	RESPY	LinRespSpec	Max	Y	2.905	2.847	1.02
3F	EQX	LinStatic		X	5.15	3.264	1.578
3F	EQY	LinStatic		X	2.556	0.747	3.424
3F	EQY	LinStatic		Y	5.985	5.38	1.112
3F	RESPX	LinRespSpec	Max	X	3.238	2.152	1.505
3F	RESPX	LinRespSpec	Max	Y	1.299	1.085	1.197
3F	RESPY	LinRespSpec	Max	X	3.136	2.104	1.491
3F	RESPY	LinRespSpec	Max	Y	2.767	2.728	1.014
2F	EQX	LinStatic		X	4.266	2.709	1.575
2F	EQY	LinStatic		X	2.054	0.604	3.403
2F	EQY	LinStatic		Y	4.941	4.454	1.109
2F	RESPX	LinRespSpec	Max	X	2.773	1.848	1.501
2F	RESPX	LinRespSpec	Max	Y	1.106	0.927	1.193
2F	RESPY	LinRespSpec	Max	X	2.694	1.793	1.503
2F	RESPY	LinRespSpec	Max	Y	2.398	2.372	1.011
1F	EQX	LinStatic		X	2.302	1.616	1.425
1F	EQY	LinStatic		X	1.078	0.286	3.766
1F	EQY	LinStatic		Y	2.76	2.497	1.105
1F	RESPX	LinRespSpec	Max	X	1.522	1.097	1.388
1F	RESPX	LinRespSpec	Max	Y	0.623	0.529	1.179
1F	RESPY	LinRespSpec	Max	X	1.481	1.053	1.407
1F	RESPY	LinRespSpec	Max	Y	1.421	1.401	1.014
Stilt	EQX	LinStatic		X	0.41	0.274	1.494
Stilt	EQY	LinStatic		X	0.061	0.037	1.628
Stilt	EQY	LinStatic		Y	0.097	0.082	1.173
Stilt	RESPX	LinRespSpec	Max	X	0.28	0.181	1.545
Stilt	RESPX	LinRespSpec	Max	Y	0.068	0.042	1.626
Stilt	RESPY	LinRespSpec	Max	X	0.218	0.147	1.483

Stilt	RESPY	LinRespSpec	Max		Y	0.089	0.068	1.309
Base-1	EQX	LinStatic			X	0.127	0.083	1.529
Base-1	EQY	LinStatic			X	0.021	0.012	1.768
Base-1	EQY	LinStatic			Y	0.017	0.011	1.488
Base-1	RESPX	LinRespSpec	Max		X	0.108	0.071	1.527
Base-1	RESPX	LinRespSpec	Max		Y	0.025	0.014	1.814
Base-1	RESPY	LinRespSpec	Max		X	0.071	0.046	1.528
Base-1	RESPY	LinRespSpec	Max		Y	0.028	0.023	1.19

TABLE: Story Stiffness

Story	Output Case	Case Type	Shear X	Stiff X	Shear Y	Stiff Y	
			kN	kN/m	kN	kN/m	
H.R. , OHT	EQX	LinStatic	0	0	0	0.0003425	CHECK X
TERRACE	EQX	LinStatic	163.9615	67061.841	0	0	no soft storey
8F	EQX	LinStatic	290.3229	104068.073	0	0	no soft storey
7F	EQX	LinStatic	387.3791	123800.954	0	0	no soft storey
6F	EQX	LinStatic	458.9908	135224.441	0	0	no soft storey
5F	EQX	LinStatic	509.0185	144104.862	0	0	no soft storey
4F	EQX	LinStatic	541.3227	154175.989	0	0	no soft storey
3F	EQX	LinStatic	559.775	171494.073	0	0	no soft storey
2F	EQX	LinStatic	568.214	209723.855	0	0	no soft storey
1F	EQX	LinStatic	570.4238	352964.975	0	0	no soft storey
Stilt	EQX	LinStatic	570.4238	2078695.837	0	0	no soft storey
Base-1	EQX	LinStatic	570.4238	6840872.452	0	0	no soft storey
H.R. , OHT	EQY	LinStatic	0	0	0.0000022107	0.001	no soft storey
TERRACE	EQY	LinStatic	0	0	283	69644.248	no soft storey
8F	EQY	LinStatic	0	0	501.7854	106075.454	no soft storey
7F	EQY	LinStatic	0	0	669.5345	126584.648	no soft storey
6F	EQY	LinStatic	0	0	793.3061	139231.221	no soft storey
5F	EQY	LinStatic	0	0	879.7724	149650.306	no soft storey
4F	EQY	LinStatic	0	0	935.6061	161211.463	no soft storey
3F	EQY	LinStatic	0	0	967.4985	179823.499	no soft storey
2F	EQY	LinStatic	0	0	982.0842	220478.114	no soft storey
1F	EQY	LinStatic	0	0	985.9035	394574.362	no soft storey

Stilt	EQY	LinStatic	0	0	985.9035	11954750.23	no soft storey
Base-1	EQY	LinStatic	0	0	985.9035	88649549.72	no soft storey
H.R. , OHT	RESPX	LinRespSpec	124.8785	104606.895	55.6755	71638.276	no soft storey
TERRACE	RESPX	LinRespSpec	161.5333	91380.895	85.221	91310.075	no soft storey
8F	RESPX	LinRespSpec	191.7533	98904.066	108.3748	106797.398	no soft storey
7F	RESPX	LinRespSpec	207.5388	99851.637	123.5343	114536.532	no soft storey
6F	RESPX	LinRespSpec	216.8917	99489.382	134.4217	119700.144	no soft storey
5F	RESPX	LinRespSpec	236.7012	105686.319	145.4892	127018.125	no soft storey
4F	RESPX	LinRespSpec	263.4086	116999.997	160.3361	140333.641	no soft storey
3F	RESPX	LinRespSpec	300.3677	139561.587	175.9461	162112.586	no soft storey
2F	RESPX	LinRespSpec	340.1559	184082.109	191.083	206144.975	no soft storey
1F	RESPX	LinRespSpec	382.4833	348584.339	200.2978	378626.546	no soft storey
Stilt	RESPX	LinRespSpec	506.0871	2789925.22	202.7347	4882897.407	no soft storey
Base-1	RESPX	LinRespSpec	578.3298	8139708.969	203.7139	14582948.44	no soft storey
H.R. , OHT	RESPY	LinRespSpec	58.3069	53011.467	187.8474	91731.686	no soft storey
TERRACE	RESPY	LinRespSpec	129.865	78735.487	319.9611	129595.321	no soft storey
8F	RESPY	LinRespSpec	170.6172	93108.79	382.3305	143532.298	no soft storey
7F	RESPY	LinRespSpec	196.6473	98529.866	411.6301	147763.334	no soft storey
6F	RESPY	LinRespSpec	217.459	102553.936	430.6905	151180.182	no soft storey
5F	RESPY	LinRespSpec	234.7159	106865.722	454.3766	158481.868	no soft storey
4F	RESPY	LinRespSpec	256.6448	116107.86	502.9361	176635.183	no soft storey
3F	RESPY	LinRespSpec	279.4261	132833.031	568.8423	208503.126	no soft storey
2F	RESPY	LinRespSpec	303.374	169239.522	635.4857	267887.834	no soft storey
1F	RESPY	LinRespSpec	319.1052	303178.714	680.8124	485671.383	no soft storey
Stilt	RESPY	LinRespSpec	328.6106	2236468.885	832.5317	12209353.58	no soft storey
Base-1	RESPY	LinRespSpec	332.8944	7202927.134	978.6939	41840578.71	no soft storey

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
BASE -1	P12	0	13150	1500	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
33541.02	45	1	413.69	413.69

Design Code Parameters

γ_S	γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	0	12400	0	13900	1500	300
Bottom	Leg 1	0	12400	0	13900	1500	300

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	1125	0.0025	0.0024	UDWal58	1729.4051	34.5881	-18.687	450000
Bottom	1125	0.0025	0.0024	UDWal58	1760.2772	-35.2055	17.8548	450000

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	750	UDWal47	2672.0703	-117.3049	80.3223	150.7531	474.507
Bottom	Leg 1	750	UDWal47	2723.5238	127.8169	80.3223	151.5764	475.3302

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	0	UDWal28	3704.4396	-8.0326	8.3	9
Top–Right	Leg 1	0	UDWal28	3131.7689	62.5018	7.52	9
Bottom–Left	Leg 1	0	UDWal44	3172.9317	-64.5128	7.62	9
Botttom–Right	Leg 1	0	UDWal44	3755.8931	17.418	8.5	9

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P11	6890	18685	2100	285.7	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
33541.02	45	1	413.69	413.69

Design Code Parameters

γ_S	γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	5900	18700	7700	18700	1800	300
Top	Leg 2	7700	18400	7700	18700	300	200
Bottom	Leg 1	5900	18700	7700	18700	1800	300
Bottom	Leg 2	7700	18400	7700	18700	300	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	1463	0.0025	0.0039	UDWal58	3405.2594	-68.1052	298.9112	585000
Bottom	4820	0.0082	0.0039	UDWal45	8894.0603	177.8812	1583.3126	585000

Shear Design

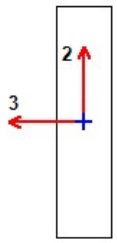
Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	750	UDWal32	3319.444	334.7358	-370.5021	391.2225	779.7271
Top	Leg 2	1080.54	UDWal28	710.7606	-197.1047	110.412	17.1242	110.412
Bottom	Leg 1	750	UDWal32	3377.7468	-1005.5658	-370.5021	391.2225	779.7271
Bottom	Leg 2	1080.54	UDWal28	718.8582	200.3541	110.412	17.1242	110.412

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	0	UDWal50	425.3258	-31.9778	0.99	9
Top–Right	Leg 1	600	UDWal50	7596.0663	691.9905	18.34	9
Top–Left	Leg 2	150	UDWal45	1217.0179	-72.2117	44.35	9
Top–Right	Leg 2	0	UDWal45	0	0	0	0
Bottom–Left	Leg 1	450	UDWal28	5928.7354	-108.794	11.65	9
Botttom–Right	Leg 1	600	UDWal28	7668.9448	1279.5665	22.1	9
Bottom–Left	Leg 2	0	UDWal27	0	0	0	0
Botttom–Right	Leg 2	150	UDWal27	1225.1155	72.7651	44.67	9

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
4TH	B37	699	TYP BM 200X 850 M30	UDCon47	7900	7900	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	850	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

ɣc	ɣs
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-301.1396	0.4354	189.6008	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-301.1396	1.3447	0	-302.4843

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-302.4843		984	0	984	415
Bottom (-2 Axis)		0	492	0	0	492

Shear Force and Reinforcement for Shear, V_{u2} & T_u

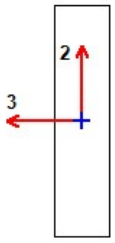
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
254.7596	0	258.243	89.36	905.84

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.4354	189.6008	100	750	375.63

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
4TH	B32	694	TYP BM 200X 850 M30	UDCon47	7300	7300	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	850	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

ɣc	ɣs
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-372.1565	1.4198	198.0178	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-372.1565	4.3848	0	-376.5413

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-376.5413		1268	0	1268	415
Bottom (-2 Axis)		0	634	0	0	634

Shear Force and Reinforcement for Shear, V_{u2} & T_u

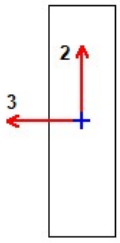
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
257.6537	0	269.0124	109.4501	943.62

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
1.4198	198.0178	100	750	399.25

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary) (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc
3RD	B36	2377	TYP BM 200 X 700 M30	UDCon2	2800

Beam Element Details Type: Ductile Frame (Summary) (Part 2 of 2)

Length (mm)	LLRF
5900	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	700	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

ɣc	ɣs
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
234.5404	0.485	30.3118	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
234.5404	1.2838	235.8242	0

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	0		108	0	0	108
Bottom (-2 Axis)		235.8242	972	972	0	337

Shear Force and Reinforcement for Shear, V_{u2} & T_u

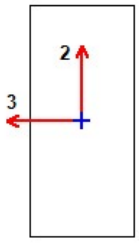
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
30.3118	75.8671	51.2	49.0967	221.69

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.485	30.3118	100	600	0

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design



Beam Element Details Type: Ductile Frame (Summary) (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc
3RD	B45	2381	Typ bm 200x 450 m30	UDCon22	0

Beam Element Details Type: Ductile Frame (Summary) (Part 2 of 2)

Length (mm)	LLRF
4200	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	450	200	0	60	60

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	500	500

Design Code Parameters

ɣc	ɣs
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-79.3912	0.1912	80.1791	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-79.3912	0.3656	0	-79.7568

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-79.7568		532	0	532	205
Bottom (-2 Axis)		0	266	0	0	266

Shear Force and Reinforcement for Shear, V_{u2} & T_u

Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
115.0989	0	116.6289	38.9871	828.69

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.1912	80.1791	100	350	269.07

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
3RD	P24	10550	8900	1500	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
33541.02	45	1	500	500

Design Code Parameters

γ_S	γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	9800	8900	11300	8900	1500	200
Bottom	Leg 1	9800	8900	11300	8900	1500	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	750	0.0025	0.0023	UDWal26	1673.2725	33.4654	-2.0916	300000
Bottom	750	0.0025	0.0023	UDWal26	1694.8661	-33.8973	-10.9335	300000

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	UDWal20	2660.8128	44.0219	-38.0596	108	324.5217
Bottom	Leg 1	500	UDWal20	2696.8022	-81.4771	-38.0596	108	324.5217

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	300	UDWal2	3385.8924	-8.8799	11.4	9
Top–Right	Leg 1	300	UDWal2	2660.8128	44.0219	9.46	9
Bottom–Left	Leg 1	300	UDWal2	3421.8818	-3.6724	11.46	9
Botttom–Right	Leg 1	300	UDWal2	3210.3196	64.753	11.56	9

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
3RD	P21	7200	12600	1800	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
33541.02	45	1	500	500

Design Code Parameters

γ_S	γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	7200	11700	7200	13500	1800	200
Bottom	Leg 1	7200	11700	7200	13500	1800	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	900	0.0025	0.0022	UDWal26	2291.9449	-75.8637	70.7577	360000

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Bottom	900	0.0025	0.0022	UDWal26	2317.8573	76.527	-200.7162	360000

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	UDWal21	1922.4299	-160.2163	133.1769	117.1589	376.985
Bottom	Leg 1	500	UDWal21	1965.6171	273.4344	133.1769	117.8499	377.676

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	300	UDWal2	3163.5622	-61.1542	9.35	9
Top–Right	Leg 1	300	UDWal2	3345.5386	48.393	9.74	9
Bottom–Left	Leg 1	300	UDWal22	3388.7259	-182.5367	11.1	9
Botttom–Right	Leg 1	300	UDWal22	3206.7494	51.652	9.39	9



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