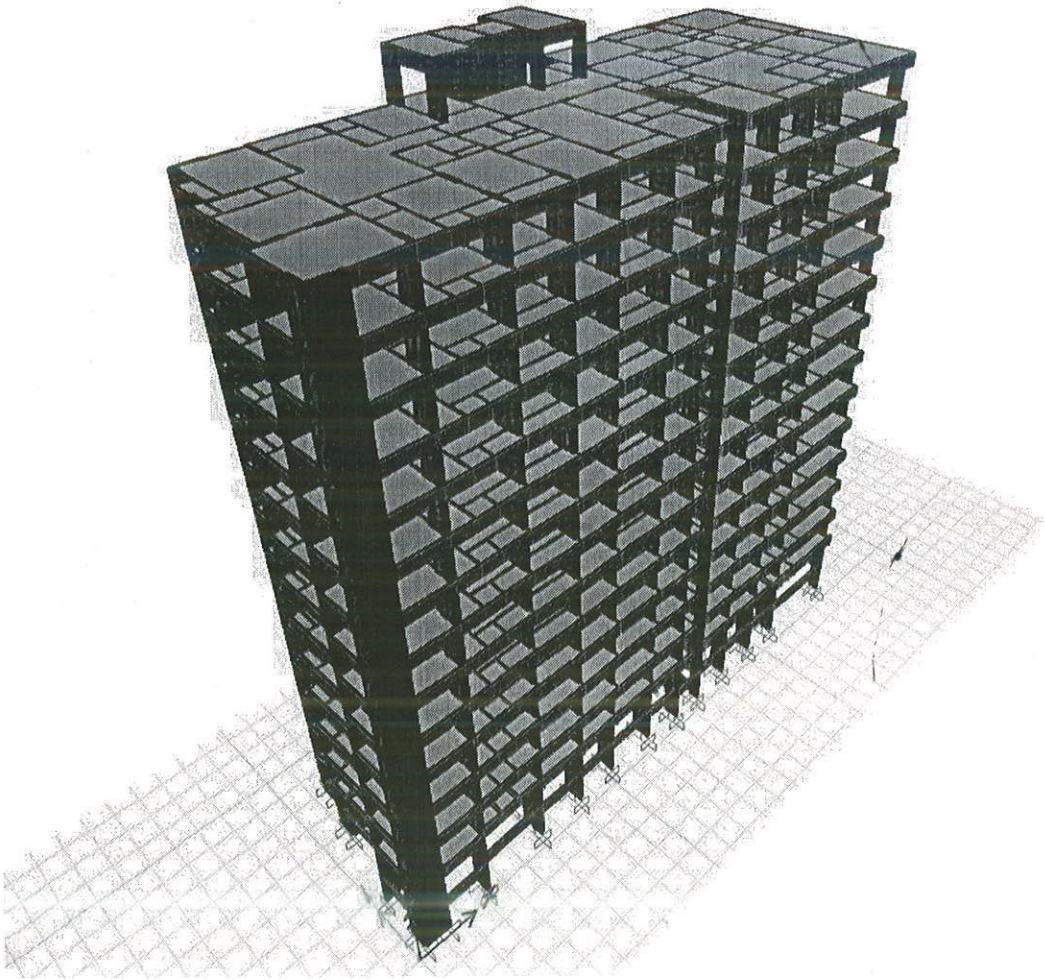
PLAN SHOWING THE PROPOSED CONSTRUCTION OF HIGH RISE RESIDENTIAL BUILDING CONSISTING OF GROUND FLOOR + 13 FLOORS

TONDIARPET, CHENNAI

RESIDENTIAL BUILDING - Structural Design Report

FEBRUARY -2025



STRUCTURAL CONSULTANT

C.KANNAN B.E., M.E (STRUCTURE)
INDIRA NAGAR, CHENNAI-20.

1.1 FOREWORD

1.1.1 - Description of Project

M/s. Voora Property Devolopers Pvt. Ltd., Chennai is developing a high rise residential building (Ground +13 upper floors) at Tondiarpet, Chennai. The project construction is carried out as RCC framed structure with Shear wall, Beam and Slab system. The building is designed with accessibility in mind as well as earthquake-resistant construction to ensure the well-being of occupants.

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 indesigns. 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 & 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: 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)

C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

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 building
IS: 5525-1969(2013)	-	Recommendation for detailing of reinforced concrete works
IS: 1786-2008	-	Code of Practice for design and construction of machine Foundations(All parts)
IS: 5525-1969(2013)	-	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS: 1786-2008	-	Recommended guidelines for concrete mix design
IS: 10262-2009	-	Criteria for earthquake resistant design of structures (General provisions and building).
IS: 1893 (Part-1)-2016	-	Criteria for structural safety of Tall Concrete buildings
IS: 16700 – 2017	-	Ductile design and Detailing of Reinforced concrete structures subjected to Seismic forces – Code of practice
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

Miscellaneous:

IS: 432(part 2)-1995	-	Specification for mild steel and medium tensile steel bars and hard-drawnsteel 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:1982-1975and IS:4326-1976)
SP: 24-1983	-	Explanatory handbook on Indian Standard code of Practice for plain andreinforced 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 Building Description

The Development consists of the following:

a. Residential building floor covered with RCC roofing.

The usages of individual floors are as given below:

Floors	Details
Main Residential Building	Space for Residential Purpose

1.3.2 Structural Arrangement:

The Structural System for the residential buildings comprises of RCC column and beam and PT slab.

S.No.	Description	Details
1.	Column Grids	10.80 m x 8.80 m (Varies for some grids)
2.	Structural System	RCC Shear Wall & Beam
3.	Slab Thickness RCC Slab	Min. 150mm (Varies on span)
4.	Foundation	Pile Foundation
5.	Column	As per design
6.	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 35 N/sq.mm (M35) 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
Shear wall	M40
Slabs & 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.

1.4.3 – Design 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 : 75 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 wallsurfaces)
- 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 asper codes.

Floor Live loads:

- Office space : 400 kg/sqm (4.0 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 : 400 kg/sqm (4.0 kN/sqm)
- AHU : 500 kg/sqm (5.0 kN/sqm)

Sunken Details:

- Toilet : 250 mm

Wind Loads

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

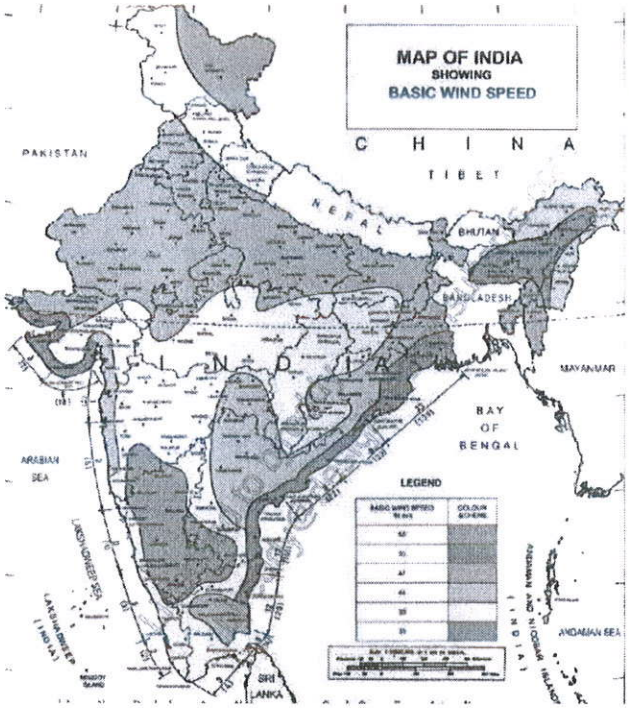
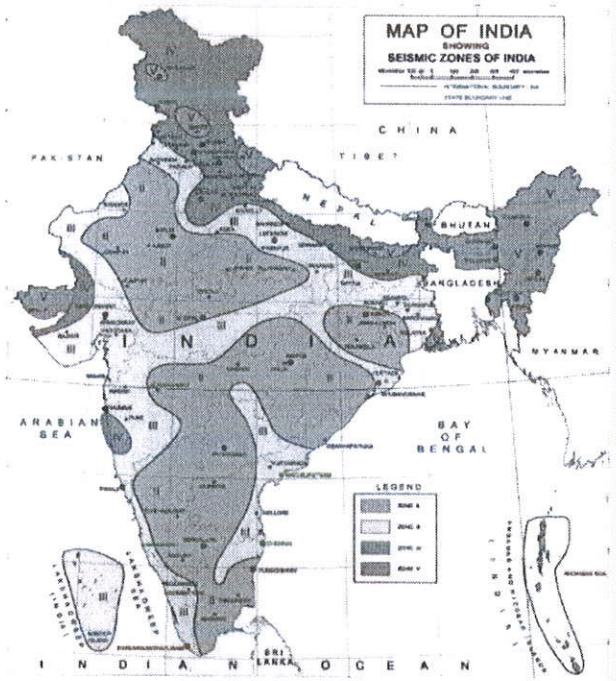
Topography factor k_3 : 1.0

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 : $0.6V_z^2$

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	: 5
Soil type	: Type -I
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 arrivedbased 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.inDGM (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

C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai - 600 020.

1.4.4 Durability Considerations:

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

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

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.

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 and foundation. Foundations are sized with consideration to the safe bearing capacity of soil 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 forthe 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 Modelling:

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

Mass source = DL+SDL+ 0. 5LLWhere 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 usedin 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.

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 pile foundation 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 the columns and beams are detailed as per normal detailing requirement. Detailing for all structural members shall be in accordance with IS: 456 & SP: 34.

On behalf of CMDA MSB Panel, the Structural Design Calculations are generally reviewed

Superintending Engineer, P.W.D.,
Planning and Designs Circle,
Chepauk, Chennai-5.

C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQ +X 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 = Program Calculated

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] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 0.691378$

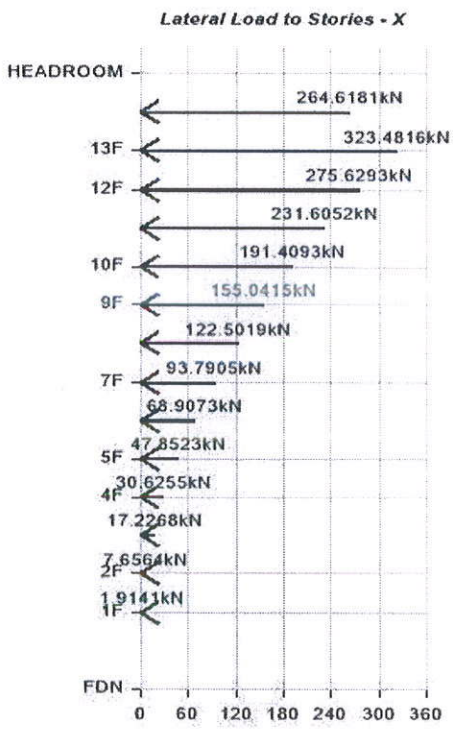
Equivalent Lateral Forces

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	1.967	138196	1834

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HEADROOM	48	0	0
TERRACE	45	264.6181	0
13F	42	323.4816	0
12F	39	275.6293	0
11F	36	231.6052	0
10F	33	191.4093	0
9F	30	155.0415	0
8F	27	122.5019	0
7F	24	93.7905	0
6F	21	68.9073	0
5F	18	47.8523	0
4F	15	30.6255	0
3F	12	17.2268	0
2F	9	7.6564	0
1F	6	1.9141	0
STILT	3	0	0
FDN	0	0	0

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQ +Y 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 = Program Calculated

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] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 0.802378$

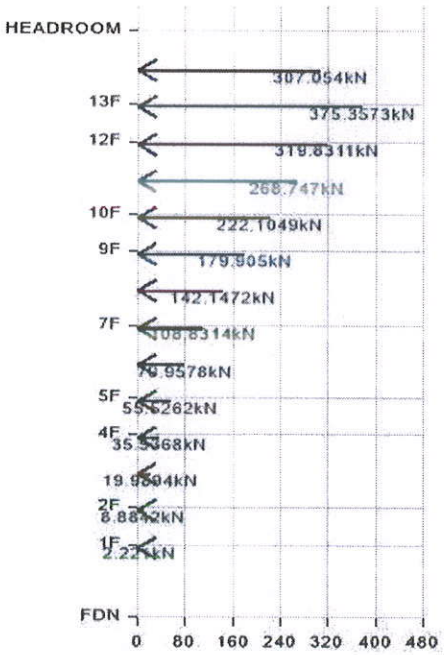
Equivalent Lateral Forces

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	1.695	138196	2129

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HEADROOM	48	0	0
TERRACE	45	0	307.054
13F	42	0	375.3573
12F	39	0	319.8311
11F	36	0	268.747
10F	33	0	222.1049
9F	30	0	179.905
8F	27	0	142.1472
7F	24	0	108.8314
6F	21	0	79.9578
5F	18	0	55.5262
4F	15	0	35.5368
3F	12	0	19.9894
2F	9	0	8.8842
1F	6	0	2.221
STILT	3	0	0
FDN	0	0	0

Modal Participating Mass Ratios

Case	Mode	Period	UX	UY	UZ	Sum UX	Sum UY	Sum UZ	RX	RY	RZ	Sum RX	Sum RY	SumRZ
		sec												
Modal	1	1.967	0.6119	0.0394	8.403E-06	0.6119	0.0394	8.403E-06	0.0142	0.1028	0.0959	0.0142	0.1028	0.0959
Modal	2	1.695	0.1099	0.4933	3.818E-06	0.7218	0.5327	1.222E-05	0.1581	0.0193	0.1393	0.1723	0.1221	0.2352
Modal	3	1.412	0.0241	0.2108	1.166E-06	0.746	0.7435	1.339E-05	0.0663	0.0067	0.5262	0.2386	0.1288	0.7613
Modal	4	0.538	0.122	0.0035	3.83E-05	0.8679	0.7469	0.0001	0.004	0.1781	0.0204	0.2426	0.3069	0.7817
Modal	5	0.465	0.0138	0.1062	2.084E-05	0.8818	0.8531	0.0001	0.2812	0.0236	0.0276	0.5238	0.3306	0.8093
Modal	6	0.408	0.012	0.0407	7.701E-06	0.8938	0.8937	0.0001	0.1226	0.0176	0.0932	0.6464	0.3481	0.9025
Modal	7	0.259	0.0398	0.0002	1.477E-05	0.9336	0.894	0.0001	0.0007	0.0457	0.0071	0.6471	0.3938	0.9097
Modal	8	0.222	0.0031	0.0356	3.97E-05	0.9367	0.9296	0.0001	0.0665	0.0028	0.0098	0.7136	0.3966	0.9195
Modal	9	0.203	0.0068	0.0112	0.0002	0.9435	0.9408	0.0003	0.0178	0.0061	0.0264	0.7314	0.4028	0.9459
Modal	10	0.188	2.471E-05	1.144E-05	0.2847	0.9435	0.9408	0.2851	0.0079	0.0017	1.832E-06	0.7393	0.4044	0.9459
Modal	11	0.182	4.586E-06	0	0.2299	0.9435	0.9408	0.5149	0.0022	0.1543	6.804E-06	0.7415	0.5587	0.9459
Modal	12	0.163	0.0045	0.0002	0.0026	0.948	0.941	0.5175	0.0114	0.0011	0.0018	0.7529	0.5598	0.9477
Modal	13	0.16	0.0106	1.148E-05	0.005	0.9586	0.941	0.5226	0	0.0133	0.0026	0.7529	0.5731	0.9503
Modal	14	0.158	0.0022	0.0001	0.0521	0.9608	0.9412	0.5747	0.0055	0.0993	2.747E-05	0.7585	0.6723	0.9503
Modal	15	0.153	0.0019	0.0006	0.0606	0.9628	0.9417	0.6353	0.0107	0.0097	1.008E-06	0.7692	0.682	0.9503
Modal	16	0.148	0.0001	2.489E-05	0.066	0.9629	0.9418	0.7012	0.0144	0.0066	3.954E-06	0.7836	0.6886	0.9503
Modal	17	0.143	0.0002	0.0002	2.526E-05	0.9631	0.942	0.7013	0.0202	0.0001	3.194E-06	0.8039	0.6887	0.9503
Modal	18	0.142	0.0015	1.087E-05	0.0001	0.9646	0.942	0.7014	1.775E-05	0.0041	1.806E-05	0.8039	0.6928	0.9504
Modal	19	0.138	0.0005	0.0018	0.0088	0.9651	0.9438	0.7102	0.0201	0.0325	0.0016	0.824	0.7253	0.952
Modal	20	0.136	0.0002	0.0146	0.002	0.9652	0.9584	0.7122	0.0276	0.0006	0.0024	0.8516	0.726	0.9544
Modal	21	0.135	0.0003	0.0009	0.0007	0.9656	0.9593	0.713	6.666E-06	0.0521	0.0009	0.8517	0.7781	0.9553
Modal	22	0.13	1.505E-06	0.0001	0.0456	0.9656	0.9594	0.7586	0.0003	0.0045	0.0002	0.8519	0.7825	0.9555
Modal	23	0.128	0.0033	0.0033	0.0002	0.9688	0.9627	0.7588	0.0073	0.008	0.0109	0.8592	0.7905	0.9664
Modal	24	0.124	1.08E-05	3.943E-05	0.0007	0.9688	0.9628	0.7594	1.503E-06	0.0043	0.0001	0.8592	0.7949	0.9665
Modal	25	0.122	7.499E-06	0.0001	0.0021	0.9689	0.9628	0.7615	0.0009	0.0002	0.0002	0.8601	0.7951	0.9667
Modal	26	0.12	0.0001	0.0001	3.565E-05	0.9689	0.9629	0.7616	0.0011	0.0259	0.0002	0.8612	0.821	0.967
Modal	27	0.118	5.468E-06	4.992E-05	0.0003	0.9689	0.963	0.7619	0	3.415E-05	1.535E-05	0.8612	0.821	0.967
Modal	28	0.118	2.893E-05	6.977E-06	0.0004	0.9689	0.963	0.7623	0.0025	0.0012	2.633E-06	0.8637	0.8222	0.967

Modal	29	0.116	1.483 E-06	0.0001	0.0065	0.9689	0.9631	0.7689	0.0008	0.0009	2.837E-05	0.8645	0.8231	0.967
Modal	30	0.111	0.0048	0.0001	0.0012	0.9737	0.9632	0.7701	0.0008	0.0016	0.0011	0.8653	0.8246	0.9681
MODAL - RITZ	1	1.967	0.6119	0.0394	8.403 E-06	0.6119	0.0394	8.403 E-06	0.0142	0.1028	0.0959	0.0142	0.1028	0.0959
MODAL - RITZ	2	1.695	0.1099	0.4933	3.818 E-06	0.7218	0.5327	1.222 E-05	0.1581	0.0193	0.1393	0.1723	0.1221	0.2352
MODAL - RITZ	3	1.412	0.0241	0.2108	1.166 E-06	0.746	0.7435	1.339 E-05	0.0663	0.0067	0.5262	0.2386	0.1288	0.7613
MODAL - RITZ	4	0.538	0.122	0.0035	3.829 E-05	0.8679	0.7469	0.0001	0.004	0.1781	0.0204	0.2426	0.3069	0.7817
MODAL - RITZ	5	0.465	0.0138	0.1062	2.084 E-05	0.8818	0.8531	0.0001	0.2812	0.0236	0.0276	0.5238	0.3306	0.8093
MODAL - RITZ	6	0.408	0.012	0.0407	7.701 E-06	0.8938	0.8937	0.0001	0.1226	0.0176	0.0932	0.6464	0.3481	0.9025
MODAL - RITZ	7	0.259	0.0398	0.0002	1.477 E-05	0.9336	0.894	0.0001	0.0007	0.0457	0.0071	0.6471	0.3938	0.9097
MODAL - RITZ	8	0.222	0.0031	0.0356	3.969 E-05	0.9367	0.9296	0.0001	0.0665	0.0028	0.0098	0.7136	0.3966	0.9195
MODAL - RITZ	9	0.203	0.0068	0.0112	0.0002	0.9435	0.9408	0.0003	0.0178	0.0061	0.0264	0.7314	0.4028	0.9459
MODAL - RITZ	10	0.188	2.471 E-05	1.144 E-05	0.2847	0.9435	0.9408	0.2851	0.0079	0.0017	1.832E-06	0.7393	0.4044	0.9459
MODAL - RITZ	11	0.182	4.586 E-06	0	0.2299	0.9435	0.9408	0.5149	0.0022	0.1543	6.804E-06	0.7415	0.5587	0.9459
MODAL - RITZ	12	0.163	0.0045	0.0002	0.0026	0.948	0.941	0.5175	0.0114	0.0011	0.0018	0.7529	0.5598	0.9477
MODAL - RITZ	13	0.16	0.0106	1.148 E-05	0.005	0.9586	0.941	0.5226	0	0.0133	0.0026	0.7529	0.5731	0.9503
MODAL - RITZ	14	0.158	0.0022	0.0001	0.0521	0.9608	0.9412	0.5747	0.0055	0.0993	2.747E-05	0.7585	0.6723	0.9503
MODAL - RITZ	15	0.153	0.0019	0.0006	0.0606	0.9628	0.9417	0.6353	0.0107	0.0097	1.009E-06	0.7692	0.682	0.9503
MODAL - RITZ	16	0.148	0.0001	2.483 E-05	0.066	0.9629	0.9418	0.7012	0.0144	0.0066	3.933E-06	0.7836	0.6886	0.9503
MODAL - RITZ	17	0.143	0.0004	0.0002	0.0001	0.9633	0.942	0.7014	0.0127	0.0023	4.613E-05	0.7964	0.6909	0.9504
MODAL - RITZ	18	0.14	0.0007	0.0036	0.0001	0.964	0.9456	0.7015	0.0334	0.0083	0.0001	0.8298	0.6992	0.9504
MODAL - RITZ	19	0.138	0.0004	0.0006	0.0092	0.9644	0.9462	0.7107	0.011	0.0261	0.0017	0.8407	0.7254	0.9521
MODAL - RITZ	20	0.135	0.0006	0.011	0.0023	0.965	0.9572	0.713	0.0124	0.0114	0.005	0.8532	0.7368	0.9571
MODAL - RITZ	21	0.13	2.802 E-06	0.0001	0.0457	0.965	0.9573	0.7587	0.0002	0.0057	5E-05	0.8533	0.7424	0.9572
MODAL - RITZ	22	0.123	0.0007	0.0007	0.0018	0.9657	0.958	0.7606	2.602 E-05	0.0026	0.001	0.8533	0.7451	0.9581

MODAL - RITZ	23	0.12	0.0012	0.0013	0.0017	0.9669	0.9593	0.7623	0.0002	1.131E-06	0.0021	0.8535	0.7451	0.9602
MODAL - RITZ	24	0.115	0.0002	0.0004	0.0072	0.9672	0.9597	0.7695	0.0011	0.0021	0.0001	0.8546	0.7472	0.9604
MODAL - RITZ	25	0.108	3.23E-06	1.511E-06	0.0387	0.9672	0.9597	0.8083	0.0005	0.0019	1.266E-05	0.8552	0.7491	0.9604
MODAL - RITZ	26	0.104	1.011E-05	0.0001	0.0194	0.9672	0.9598	0.8277	0.0001	0.0045	0.0001	0.8552	0.7536	0.9605
MODAL - RITZ	27	0.098	2.724E-05	2.298E-06	0.0163	0.9672	0.9598	0.844	0.0009	0.0009	0.0003	0.8561	0.7545	0.9607
MODAL - RITZ	28	0.093	2.198E-05	1.092E-05	0.0071	0.9672	0.9598	0.8511	0.0016	0.0009	0.0009	0.8577	0.7554	0.9616
MODAL - RITZ	29	0.086	2.003E-06	0.0007	0.0133	0.9672	0.9605	0.8643	0.0016	0.0016	0.0001	0.8593	0.757	0.9617
MODAL - RITZ	30	0.081	1.256E-05	0.0003	0.0191	0.9672	0.9608	0.8834	0.0015	0.0001	2.686E-05	0.8607	0.7571	0.9617

STORY DRIFT

Story	Output Case	Direction	Drift	X	Y	Z
				m	m	m
HEADROOM	EQ +X	X	0.000491	22.9679	10.967	48
TERRACE	EQ +X	X	0.000503	2.6273	0.492	45
13	EQ +X	X	0.000543	2.6273	0.492	42
12	EQ +X	X	0.000586	2.6273	0.492	39
11	EQ +X	X	0.000629	2.6273	0.492	36
10	EQ +X	X	0.000666	2.6273	0.492	33
9	EQ +X	X	0.000694	2.6273	0.492	30
8	EQ +X	X	0.000712	2.6273	0.492	27
7	EQ +X	X	0.000717	2.6273	0.492	24
6	EQ +X	X	0.000708	2.6273	0.492	21
5	EQ +X	X	0.000684	2.6273	0.492	18
4	EQ +X	X	0.000643	2.6273	0.492	15
3	EQ +X	X	0.000581	2.6273	0.492	12
2	EQ +X	X	0.000494	2.6273	0.492	9
1	EQ +X	X	0.000369	0.8273	0.492	6
STILT	EQ +X	X	0.000491	37.268	2.392	3
HEADROOM	EQ +Y	Y	0.000424	0.8273	1.692	42
TERRACE	EQ +Y	Y	0.000475	0.8273	1.692	39
13	EQ +Y	Y	0.000499	0.8273	1.692	36
12	EQ +Y	Y	0.000528	0.8273	1.692	33
11	EQ +Y	Y	0.000557	0.8273	1.692	30
10	EQ +Y	Y	0.000583	0.8273	1.692	27
9	EQ +Y	Y	0.000601	0.8273	1.692	24
8	EQ +Y	Y	0.000611	0.8273	1.692	21
7	EQ +Y	Y	0.00061	0.8273	1.692	18
6	EQ +Y	Y	0.000597	0.8273	1.692	15
5	EQ +Y	Y	0.000571	0.8273	1.692	12
4	EQ +Y	Y	0.00053	20.668	14.8258	9
3	EQ +Y	Y	0.00047	44.1717	14.592	6
2	EQ +Y	Y	0.000388	32.9179	8.292	3
1	EQ +Y	Y	0.000304	0.8273	1.692	42
STILT	EQ +Y	Y	0.000141	0.8273	1.692	39
HEADROOM	RSA- X	X	0.000378	2.6273	0.492	42
TERRACE	RSA- X	X	0.000449	2.6273	0.492	39
13	RSA- X	X	0.000485	2.6273	0.492	36
12	RSA- X	X	0.000522	2.6273	0.492	33
11	RSA- X	X	0.000554	2.6273	0.492	30
10	RSA- X	X	0.000577	2.6273	0.492	27
9	RSA- X	X	0.000593	2.6273	0.492	24
8	RSA- X	X	0.000601	2.6273	0.492	21
7	RSA- X	X	0.000605	2.6273	0.492	18
6	RSA- X	X	0.000603	2.6273	0.492	15
5	RSA- X	X	0.000595	2.6273	0.492	12
4	RSA- X	X	0.000578	2.6273	0.492	9
3	RSA- X	X	0.000544	0.8273	0.492	6

2	RSA- X	X	0.000483	37.268	0.992	3
1	RSA- X	X	0.000378	2.6273	0.492	42
STILT	RSA- X	X	0.000199	2.6273	0.492	39
HEADROOM	RSA-Y	Y	0.000682	0.8273	1.692	42
TERRACE	RSA-Y	Y	0.000729	0.8273	1.692	39
13	RSA-Y	Y	0.000771	0.8273	1.692	36
12	RSA-Y	Y	0.000804	0.8273	1.692	33
11	RSA-Y	Y	0.000828	0.8273	1.692	30
10	RSA-Y	Y	0.000844	0.8273	1.692	27
9	RSA-Y	Y	0.00085	0.8273	4.592	24
8	RSA-Y	Y	0.000848	0.8273	1.692	21
7	RSA-Y	Y	0.000834	0.8273	1.692	18
6	RSA-Y	Y	0.000803	0.8273	1.692	15
5	RSA-Y	Y	0.000747	0.8273	1.692	12
4	RSA-Y	Y	0.000652	0.8273	1.692	9
3	RSA-Y	Y	0.000498	0.8273	0.492	6
2	RSA-Y	Y	0.000213	0.8273	4.592	3
1	RSA-Y	Y	0.000771	0.8273	1.692	36
STILT	RSA-Y	Y	0.000804	0.8273	1.692	33

STORY MAX OVER AVG DISPLACEMENTS:

Story	Output Case	Direction	Maximum	Average	Ratio
			mm	mm	
HEADROOM	EQ +X	X	25.744	25.347	1.016
TERRACE	EQ +X	X	26.047	24.782	1.051
13	EQ +X	X	24.538	23.334	1.052
12	EQ +X	X	22.91	21.772	1.052
11	EQ +X	X	21.151	20.088	1.053
10	EQ +X	X	19.263	18.283	1.054
9	EQ +X	X	17.264	16.376	1.054
8	EQ +X	X	15.181	14.39	1.055
7	EQ +X	X	13.047	12.357	1.056
6	EQ +X	X	10.897	10.312	1.057
5	EQ +X	X	8.773	8.294	1.058
4	EQ +X	X	6.722	6.348	1.059
3	EQ +X	X	4.794	4.523	1.06
2	EQ +X	X	3.05	2.878	1.06
1	EQ +X	X	1.569	1.482	1.058
HEADROOM	EQ +Y	Y	22.452	22.075	1.017
TERRACE	EQ +Y	Y	22.202	20.723	1.071
13	EQ +Y	Y	20.776	19.493	1.066
12	EQ +Y	Y	19.279	18.17	1.061
11	EQ +Y	Y	17.695	16.745	1.057
10	EQ +Y	Y	16.023	15.223	1.053
9	EQ +Y	Y	14.275	13.618	1.048
8	EQ +Y	Y	12.472	11.954	1.043
7	EQ +Y	Y	10.64	10.254	1.038
6	EQ +Y	Y	8.811	8.55	1.031
5	EQ +Y	Y	7.019	6.871	1.021
4	EQ +Y	Y	5.305	5.255	1.01
3	EQ +Y	Y	3.765	3.74	1.007
2	EQ +Y	Y	2.443	2.374	1.029
1	EQ +Y	Y	1.295	1.22	1.061
HEADROOM	RSA- X	X	18.199	17.559	1.036
TERRACE	RSA- X	X	21.892	18.915	1.157
13	RSA- X	X	20.654	17.832	1.158
12	RSA- X	X	19.337	16.681	1.159
11	RSA- X	X	17.935	15.457	1.16
10	RSA- X	X	16.449	14.163	1.161
9	RSA- X	X	14.888	12.805	1.163
8	RSA- X	X	13.265	11.394	1.164
7	RSA- X	X	11.59	9.938	1.166
6	RSA- X	X	9.875	8.45	1.169
5	RSA- X	X	8.134	6.944	1.171
4	RSA- X	X	6.392	5.443	1.174
3	RSA- X	X	4.682	3.978	1.177
2	RSA- X	X	3.061	2.597	1.179

1	RSA- X	X	1.616	1.371	1.178
HEADROOM	RSA-Y	Y	21.554	18.688	1.153
TERRACE	RSA-Y	Y	31.039	22.968	1.351
13	RSA-Y	Y	29.234	21.645	1.351
12	RSA-Y	Y	27.325	20.24	1.35
11	RSA-Y	Y	25.293	18.742	1.35
10	RSA-Y	Y	23.141	17.155	1.349
9	RSA-Y	Y	20.883	15.488	1.348
8	RSA-Y	Y	18.534	13.756	1.347
7	RSA-Y	Y	16.115	11.972	1.346
6	RSA-Y	Y	13.649	10.152	1.345
5	RSA-Y	Y	11.163	8.316	1.342
4	RSA-Y	Y	8.697	6.492	1.34
3	RSA-Y	Y	6.306	4.72	1.336
2	RSA-Y	Y	4.072	3.058	1.332
1	RSA-Y	Y	2.119	1.599	1.325

C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.

STORY STIFFNESS:

Story	Output Case	Shear X	Drift X	Stiff X	Shear Y	Drift Y	Stiff Y
		kN	mm	kN/m	kN	mm	kN/m
HEADROOM	EQ +X	0.5037	1.451	347.211	0.0272	0.135	0
TERRACE	EQ +X	269.3605	1.447	186200.841	0.1681	0.141	0
13	EQ +X	598.8447	1.561	383674.738	0.3529	0.149	0
12	EQ +X	880.4458	1.683	523222.782	0.5261	0.156	0
11	EQ +X	1117.9669	1.803	620124.241	0.6873	0.166	0
10	EQ +X	1315.2035	1.905	690240.29	0.8358	0.177	0
9	EQ +X	1475.9457	1.984	744091.378	0.9708	0.182	0
8	EQ +X	1603.9788	2.031	789810.287	1.0912	0.19	0
7	EQ +X	1703.0832	2.043	833692.933	1.1959	0.187	0
6	EQ +X	1777.0336	2.015	881820.633	1.2836	0.184	0
5	EQ +X	1829.5981	1.944	941337.669	1.3532	0.182	0
4	EQ +X	1864.5354	1.822	1023223.532	1.4039	0.169	0
3	EQ +X	1885.5908	1.644	1147294.956	1.4353	0.157	0
2	EQ +X	1896.4863	1.394	1360904.846	1.4486	0.133	0
1	EQ +X	1900.9099	1.011	1880196.702	1.4468	0.099	0
STILT	EQ +X	1901.477	0.494	3851395.691	1.4499	0.045	0
HEADROOM	EQ +Y	0.1101	0.103	0	311.179	1.231	252876.949
TERRACE	EQ +Y	0.244	0.097	0	691.7164	1.323	522961.148
13	EQ +Y	0.3621	0.088	0	1016.6705	1.425	713568.563
12	EQ +Y	0.4645	0.079	0	1290.4638	1.522	847754.367
11	EQ +Y	0.551	0.071	0	1517.5133	1.604	945850.584
10	EQ +Y	0.6214	0.063	0	1702.232	1.665	1022457.825
9	EQ +Y	0.6751	0.054	0	1849.0292	1.699	1088088.779
8	EQ +Y	0.7116	0.046	0	1962.3104	1.705	1151105.929
7	EQ +Y	0.7303	0.039	0	2046.4769	1.678	1219482.751
6	EQ +Y	0.731	0.031	0	2105.9243	1.616	1302824.134
5	EQ +Y	0.7139	0.02	0	2145.0402	1.515	1415942.478
4	EQ +Y	0.6811	0.008	0	2168.2	1.366	1587247.601
3	EQ +Y	0.637	0.012	0	2179.7588	1.155	1886579.893
2	EQ +Y	0.5901	0.022	0	2184.0497	0.857	2548534.724
1	EQ +Y	0.5802	0.017	0	2184.4847	0.373	5858372.88
STILT	EQ +Y	0.5037	1.451	347.211	0.0272	0.135	0

STORY FORCES:

Story	Output Case	Case Type	P	VX	VY	T	MX	MY
TERRACE	EQ +X	LinStatic	0	-269.3605	0.1681	2416.8038	-0.5861	-809.5925
TERRACE	EQ +Y	LinStatic	0	0.1101	-311.179	-7897.9276	934.8515	0.3513
TERRACE	RSA- X	LinRespSpec	3.3245	329.1514	101.7662	3472.8722	375.2592	1173.0983
TERRACE	RSA-Y	LinRespSpec	2.8331	124.2514	377.1177	8961.8662	1398.3407	487.7713
13	EQ +X	LinStatic	0	-598.8447	0.3529	5308.902	-1.6447	-2606.1267
13	EQ +Y	LinStatic	0	0.244	-691.7164	-17605.8811	3010.0008	1.0833
13	RSA- X	LinRespSpec	7.1014	629.9042	200.5895	6532.8709	1003.3044	3095.7478
13	RSA-Y	LinRespSpec	7.2282	233.6745	712.9346	17457.2385	3650.649	1204.9827
12	EQ +X	LinStatic	0	-880.4458	0.5261	7779.2661	-3.2229	-5247.4641
12	EQ +Y	LinStatic	0	0.3621	-1016.6705	-25894.1567	6060.0123	2.1697
12	RSA- X	LinRespSpec	9.9317	838.3633	277.2965	8677.7564	1854.1494	5624.525
12	RSA-Y	LinRespSpec	11.1774	318.0165	947.3297	23575.5128	6564.3049	2162.818
11	EQ +X	LinStatic	0	-1117.9669	0.6873	9861.4083	-5.2847	-8601.3648
11	EQ +Y	LinStatic	0	0.4645	-1290.4638	-32875.7644	9931.4037	3.5633
11	RSA- X	LinRespSpec	13.0991	977.0837	336.1743	10179.0466	2863.9948	8517.7665
11	RSA-Y	LinRespSpec	14.3972	382.1346	1108.9547	27955.2188	9882.7092	3296.907
10	EQ +X	LinStatic	0	-1315.2035	0.8358	11588.7878	-7.792	-12546.9752
10	EQ +Y	LinStatic	0	0.551	-1517.5133	-38663.5967	14483.9436	5.2163
10	RSA- X	LinRespSpec	17.0775	1067.7265	382.4509	11308.4998	3990.7334	11602.0705
10	RSA-Y	LinRespSpec	17.1016	431.4189	1224.6346	31219.6806	13436.1732	4556.6869
9	EQ +X	LinStatic	0	-1475.9457	0.9708	12994.8227	-10.7043	-16974.8123
9	EQ +Y	LinStatic	0	0.6214	-1702.232	-43370.4593	19590.6397	7.0805
9	RSA- X	LinRespSpec	20.5978	1130.3532	421.0098	12239.3944	5205.423	14763.2177
9	RSA-Y	LinRespSpec	19.9935	471.4131	1312.342	33787.9604	17116.9931	5908.4792
8	EQ +X	LinStatic	0	-1603.9788	1.0912	14112.8902	-13.9779	-21786.7488
8	EQ +Y	LinStatic	0	0.6751	-1849.0292	-47109.0813	25137.7272	9.1058
8	RSA- X	LinRespSpec	22.2178	1185.0459	456.0489	13097.7333	6491.1749	17938.3222
8	RSA-Y	LinRespSpec	23.0866	507.4492	1388.661	36032.3144	20863.1894	7331.8353
7	EQ +X	LinStatic	0	-1703.0832	1.1959	14976.3306	-17.5656	-26895.9984
7	EQ +Y	LinStatic	0	0.7116	-1962.3104	-49992.1136	31024.6583	11.2406
7	RSA- X	LinRespSpec	23.4289	1248.9624	490.5773	14006.4952	7841.5148	21116.8306
7	RSA-Y	LinRespSpec	25.7873	543.5893	1472.4936	38372.9178	24660.8615	8818.2401
6	EQ +X	LinStatic	0	-1777.0336	1.2836	15618.4474	-21.4164	-32227.0991
6	EQ +Y	LinStatic	0	0.7303	-2046.4769	-52132.1137	37164.0889	13.4316
6	RSA- X	LinRespSpec	25.079	1333.3235	526.0515	15030.5395	9258.0427	24335.3623
6	RSA-Y	LinRespSpec	28.009	581.8395	1575.4195	41075.743	28546.3916	10370.1908
5	EQ +X	LinStatic	0	-1829.5981	1.3532	16072.5074	-25.4761	-37715.8933
5	EQ +Y	LinStatic	0	0.731	-2105.9243	-53641.5149	43481.8617	15.6244
5	RSA- X	LinRespSpec	26.7464	1440.0801	562.4444	16157.2477	10746.9828	27664.6335
5	RSA-Y	LinRespSpec	29.9944	622.1599	1695.7368	44117.2071	32589.337	11997.1219
4	EQ +X	LinStatic	0	-1864.5354	1.4039	16371.7367	-29.6877	-43309.4996
4	EQ +Y	LinStatic	0	0.7139	-2145.0402	-54632.5701	49916.9823	17.7663
4	RSA- X	LinRespSpec	28.2682	1560.868	598.253	17345.1857	12315.1693	31187.8036
4	RSA-Y	LinRespSpec	32.0335	662.6586	1826.2393	47348.9818	36867.2014	13709.9648
3	EQ +X	LinStatic	0	-1885.5908	1.4353	16549.3158	-33.9937	-48966.2721

3	EQ +Y	LinStatic	0	0.6811	-2168.2	-55217.2505	56421.5822	19.8096
3	RSA- X	LinRespSpec	30.0156	1683.3922	630.6278	18532.746	13965.873	34980.7218
3	RSA-Y	LinRespSpec	33.8256	699.9018	1958.904	50601.2943	41447.6411	15514.8548
2	EQ +X	LinStatic	0	-1896.4863	1.4486	16638.3426	-38.3395	-54655.7311
2	EQ +Y	LinStatic	0	0.637	-2179.7588	-55507.0495	62960.8586	21.7205
2	RSA- X	LinRespSpec	31.4009	1793.6582	656.0719	19595.7265	15695.7066	39093.1313
2	RSA-Y	LinRespSpec	35.1986	729.7182	2078.0612	53519.7137	46373.3407	17410.404
1	EQ +X	LinStatic	0	-1900.9099	1.4468	16671.7396	-42.68	-60358.4608
1	EQ +Y	LinStatic	0	0.5901	-2184.0497	-55612.9924	69513.0077	23.4907
1	RSA- X	LinRespSpec	31.5554	1871.7127	671.7349	20336.7085	17493.0329	43525.6986
1	RSA-Y	LinRespSpec	35.9014	748.5249	2159.9815	55541.531	51639.6313	19385.0754
STILT	EQ +X	LinStatic	0	-1901.477	1.4499	16676.0523	-47.0297	-66062.8917
STILT	EQ +Y	LinStatic	0	0.5802	-2184.4847	-55622.5763	76066.4617	25.2314
STILT	RSA- X	LinRespSpec	31.7276	1884.7271	673.7712	20440.3876	19335.2423	48215.1554
STILT	RSA-Y	LinRespSpec	36.2047	751.2276	2170.6533	55756.094	57161.8558	21417.6966

ETABS Shear Wall Design (C1)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P59	44171.7	1392	800	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	44171.7	992	44171.7	1792	800	200
Bottom	Leg 1	44171.7	992	44171.7	1792	800	200

Flexural Design for P_u, M_{u2} and M_{u3} (Part 1 of 2)

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m
Top	2950	0.0184	0.0025	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	2712.3163	63.8457
Bottom	3192	0.02	0.0025	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	2730.311	64.2506

Flexural Design for P_u, M_{u2} and M_{u3} (Part 2 of 2)

M_{u3} kN-m	Pier A_g mm²
88.6024	160000
-119.117	160000

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	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	1370.5419	36.1018	-51.3223	121.4315	236.9098
Bottom	Leg 1	500	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	1388.5366	85.3568	-51.3223	121.4315	236.9098

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	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	2712.3163	-5.361	17.2	8
Top–Right	Leg 1	300	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	2712.3163	36.1018	18.64	8
Bottom–Left	Leg 1	300	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	2730.311	-119.117	22.65	8
Botttom–Right	Leg 1	300	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	2730.311	85.3568	21.07	8

ETABS Shear Wall Design (C2)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P39	27567.9	8792	1000	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	27567.9	8292	27567.9	9292	1000	200
Bottom	Leg 1	27567.9	8292	27567.9	9292	1000	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	6923	0.0346	0.0025	304 1.5(DL+IL)-WLY	4328.2733	-97.7069	170.2454	200000
Bottom	7103	0.0355	0.0025	304 1.5(DL+IL)-WLY	4350.7666	98.213	-189.171	200000

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	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3186.3404	73.664	-83.0057	151.7893	296.1372
Bottom	Leg 1	500	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3208.8338	107.6644	-83.0057	151.7893	296.1372

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	400	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3943.0952	-11.4457	20.06
Top–Right	Leg 1	400	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3943.0952	73.664	21.93
Bottom–Left	Leg 1	400	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3965.5886	-176.2537	25.12
Botttom–Right	Leg 1	400	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3965.5886	107.6644	23.06

ETABS Shear Wall Design (C3)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P44	33160.1	15192	1200	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	33160.1	14592	33160.1	15792	1200	200
Bottom	Leg 1	33160.1	14592	33160.1	15792	1200	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	7535	0.0314	0.0025	303 1.5(DL+IL)+WLY	4968.2732	112.0559	228.5406	240000
Bottom	7623	0.0318	0.0025	303 1.5(DL+IL)+WLY	4995.2653	-112.6633	229.7822	240000

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	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3449.1774	33.6308	-46.0023	182.1472	355.3646
Bottom	Leg 1	500	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3476.1694	160.3204	-46.0023	182.1472	355.3646

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	400	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4648.5529	-37.3012	20.15
Top–Right	Leg 1	400	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4648.5529	33.6308	20.07
Bottom–Left	Leg 1	500	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4675.5449	-171.9039	23.06
Botttom–Right	Leg 1	500	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4675.5449	160.3204	22.82

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8
8

ETABS Shear Wall Design (C4)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P17	5868	1092	1200	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	5868	492	5868	1692	1200	300
Bottom	Leg 1	5868	492	5868	1692	1200	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	900	0.0025	0.0026	304 1.5(DL+IL)-WLY	4491.4503	-89.829	-90.799	360000
Bottom	900	0.0025	0.0026	304 1.5(DL+IL)-WLY	4531.9384	-90.6388	-287.2541	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	750	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	2567.0466	119.649	-85.1767	129.6	389.4262
Bottom	Leg 1	750	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	2607.5347	350.7638	-85.1767	129.6	389.4262

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	300	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	4475.4222	-86.2858	13.63
Top–Right	Leg 1	300	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	4475.4222	83.3913	13.59
Bottom–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4451.3222	-374.7698	17.57
Botttom–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4451.3222	350.7638	17.24

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8
8

ETABS Shear Wall Design (C5)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P45	33760.2	11792	1200	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	33160.2	11792	34360.2	11792	1200	300
Bottom	Leg 1	33160.2	11792	34360.2	11792	1200	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	4325	0.012	0.0026	304 1.5(DL+IL)-WLY	6395.7331	127.9147	19.6086	360000
Bottom	4501	0.0125	0.0026	304 1.5(DL+IL)-WLY	6436.2211	-128.7244	-7.1438	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	750	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	5122.8296	101.8368	-57.7601	235.9702	495.7963
Bottom	Leg 1	750	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	5163.3177	232.3498	-57.7601	239.7855	499.6116

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5945.3228	-36.47	17.02
Top–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5945.3228	77.691	17.59
Bottom–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5985.8108	-159.4048	18.84
Botttom–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5985.8108	159.5109	18.84

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8
8

ETABS Shear Wall Design (C6)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P28	18217.9	1692	1400	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	18217.9	992	18217.9	2392	1400	300
Bottom	Leg 1	18217.9	992	18217.9	2392	1400	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	3557	0.0085	0.0026	304 1.5(DL+IL)-WLY	6933.6751	138.6735	135.2935	420000
Bottom	4476	0.0107	0.0026	304 1.5(DL+IL)-WLY	7035.919	-140.7184	-487.7806	420000

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	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5602.9956	293.8173	-145.1547	236.9893	540.1197
Bottom	Leg 1	750	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5650.2316	210.1197	-145.1547	263.006	566.1364

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6409.5689	-53.352	15.81
Top–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6409.5689	293.8173	18.26
Bottom–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6456.8049	-479.9449	20.27
Botttom–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6456.8049	210.1197	17.52

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8
8

ETABS Shear Wall Design (C7)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P18	10967.9	14092	1600	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	10967.9	13292	10967.9	14892	1600	200
Bottom	Leg 1	10967.9	13292	10967.9	14892	1600	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	7447	0.0233	0.0025	303 1.5(DL+IL)+WLY	5898.3289	-130.2787	-349.9675	320000
Bottom	8653	0.027	0.0025	307 1.5(DL+WLY)	5809.4035	128.1433	730.6418	320000

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	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3002.5461	20.3796	201.0248	242.8629	473.8194
Bottom	Leg 1	500	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3038.5354	605.9973	201.0248	242.8629	473.8194

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	600	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5613.2896	-210.5875	20.01
Top–Right	Leg 1	500	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5613.2896	20.3796	17.78
Bottom–Left	Leg 1	600	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5649.2789	-421.4702	22.59
Botttom–Right	Leg 1	600	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	5649.2789	605.9973	24.76

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8
8

ETABS Shear Wall Design (C8)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P60	11117.9	4692	1400	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	11117.9	3992	11117.9	5392	1400	300
Bottom	Leg 1	11117.9	3992	11117.9	5392	1400	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	2916	0.0069	0.0026	303 1.5(DL+IL)+WLY	6835.7759	-136.7155	-17.777	420000
Bottom	4218	0.01	0.0026	307 1.5(DL+WLY)	6607.6613	-132.1532	762.9458	420000

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	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3895.8559	21.955	209.8178	216.9834	520.1139
Bottom	Leg 1	750	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	3943.092	627.6608	209.8178	257.4261	560.5565

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6400.9876	-135.8718	16.63
Top–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6400.9876	21.955	15.46
Bottom–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6448.2236	-491.315	20.37
Botttom–Right	Leg 1	600	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6448.2236	627.6608	21.76

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8
8

ETABS Shear Wall Design (C9)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P22	11117.9	1692	1600	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	11117.9	892	11117.9	2492	1600	300
Bottom	Leg 1	11117.9	892	11117.9	2492	1600	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	3931	0.0082	0.0026	304 1.5(DL+IL)-WLY	7992.957	-159.8591	-2.4774	480000
Bottom	6251	0.013	0.0026	308 1.5(DL-WLY)	7896.213	-157.9243	-1103.6923	480000

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	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4122.1691	331.8518	-290.9801	266.6582	613.093
Bottom	Leg 1	750	109 -0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4176.1532	563.9597	-290.9801	325.1123	671.5471

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	7597.2629	-61.2862	16.31
Top–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	7597.2629	331.8518	18.42
Bottom–Left	Leg 1	600	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	7651.247	-917.3794	23.11
Botttom–Right	Leg 1	600	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	7651.247	563.9597	20.35

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8
8

ETABS Shear Wall Design (C10)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P11	1727.3	4592	1800	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	827.3	4592	2627.3	4592	1800	300
Bottom	Leg 1	827.3	4592	2627.3	4592	1800	300

Flexural Design for P_u, M_{u2} and M_{u3} (Part 1 of 2)

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m
Top	1350	0.0025	0.0023	304 1.5(DL+IL)-WLY	4048.3602	80.9672
Bottom	1584	0.0029	0.0023	111 1.5 RSX-0.45 RSY-0.45 RSZ+0.9 DL-	682.1665	-30.299

Flexural Design for P_u, M_{u2} and M_{u3} (Part 2 of 2)

M_{u3} kN-m	Pier A_g mm²
249.9293	540000
-985.5702	540000

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	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	2237.3518	454.5828	-331.4779	169.8724	559.6116
Bottom	Leg 1	750	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	2298.0839	753.1551	-331.4779	170.9655	560.7047

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	450	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	5720.7711	-64.8772	10.99
Top–Right	Leg 1	300	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	5720.7711	454.5828	13.4
Bottom–Left	Leg 1	450	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	5781.5032	-1043.674	17.15
Botttom–Right	Leg 1	450	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	5781.5032	753.1551	15.36

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8

ETABS Shear Wall Design (C11)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P13	1727.3	492	1800	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	827.3	492	2627.3	492	1800	300
Bottom	Leg 1	827.3	492	2627.3	492	1800	300

Flexural Design for P_u, M_{u2} and M_{u3} (Part 1 of 2)

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m
Top	1350	0.0025	0.0023	304 1.5(DL+IL)-WLY	3933.7849	-78.6757
Bottom	2900	0.0054	0.0023	111 1.5 RSX-0.45 RSY-0.45 RSZ+0.9 DL-	168.1175	-17.1419

Flexural Design for P_u, M_{u2} and M_{u3} (Part 2 of 2)

M_{u3} kN-m	Pier A_g mm²
0.5367	540000
1058.8919	540000

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	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	1168.4699	281.4293	-314.8812	150.6325	540.3717
Bottom	Leg 1	750	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	1229.202	1061.3235	-314.8812	197.052	586.7912

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	300	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4243.6001	-126.9372	8.64
Top–Right	Leg 1	300	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4243.6001	231.8026	9.29
Bottom–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4304.3321	-660.5734	12.05
Botttom–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	4304.3321	672.731	12.12

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8

ETABS Shear Wall Design (C12)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P61	43371.7	4492	1600	300	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	42571.7	4492	44171.7	4492	1600	300
Bottom	Leg 1	42571.7	4492	44171.7	4492	1600	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	1200	0.0025	0.0026	304 1.5(DL+IL)-WLY	6159.0366	123.1807	-91.7514	480000
Bottom	1200	0.0025	0.0026	304 1.5(DL+IL)-WLY	6213.0206	-124.2604	155.4562	480000

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	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	3736.7892	255.4299	154.026	172.8	519.2348
Bottom	Leg 1	750	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	3790.7733	648.2007	154.026	172.8	519.2348

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6062.7136	-250.8916	14.59
Top–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6062.7136	208.5226	14.26
Bottom–Left	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6116.6976	-267.76	14.83
Botttom–Right	Leg 1	450	108 0.45 RSX+1.5 RSY+1.5 RSZ+1.5 DL	6116.6976	398.09	15.85

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8
8

ETABS Shear Wall Design (C13)

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P56	43371.7	8292	1600	200	0.6

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	40	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	42571.7	8292	44171.7	8292	1600	200
Bottom	Leg 1	42571.7	8292	44171.7	8292	1600	200

Flexural Design for P_u, M_{u2} and M_{u3} (Part 1 of 2)

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m
Top	800	0.0025	0.0025	304 1.5(DL+IL)-WLY	3300.5086	72.3442
Bottom	1025	0.0032	0.0025	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	3544.9261	84.1573

Flexural Design for P_u, M_{u2} and M_{u3} (Part 2 of 2)

M_{u3} kN-m	Pier A_g mm²
-72.1566	320000
520.6963	320000

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	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	2345.9379	4.6505	176.5089	115.2	346.1565
Bottom	Leg 1	500	107 1.5 RSX -0.45 RSY -0.45 RSZ+1.5 DL	2381.9273	520.6963	176.5089	118.3331	349.2896

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa
Top–Left	Leg 1	300	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	3508.9368	-149.412	12.72
Top–Right	Leg 1	400	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	3508.9368	4.6505	11.02
Bottom–Left	Leg 1	400	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	3544.9261	-316.2835	14.78
Botttom–Right	Leg 1	400	106 1.5 RSX+0.45 RSY+0.45 RSZ+1.5 DL	3544.9261	520.6963	17.18

Boundary Element Check (Part 2 of 2)

Stress Limit MPa
8
8
8

ETABS Concrete Frame Design (FB13)

IS 456:2000 + IS 13920:2016 Beam Section Design (Summary)

Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
1F	B191	42	B200x800	304 1.5(DL+IL)-WLY	3153.8	6903.8	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	800	200	0	25	25

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
184.3886	0.4794	14.1176	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
184.3886	1.41	185.7986	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		102	0	0	102
Bottom (-2 Axis)		185.7986	589	589	0	408

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

Shear V_c kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
14.1176	67.8427	62	54.0395	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
0.3795	12.8547	170	770	0

ETABS Concrete Frame Design (FB20)

IS 456:2000 + IS 13920:2016 Beam Section Design (Summary)

Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
1F	B37	3250	B200x800	304 1.5(DL+IL)-WLY	0	6500	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	800	200	0	25	25

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
-318.4989	0.1781	226.594	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-318.4989	0.524	0	-319.0229

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)	-319.0229		1072	0	1072	408
Bottom (-2 Axis)		0	536	0	0	536

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
226.594	88.1984	139.8207	90.8205	499.94

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
0.1781	226.594	170	770	0

Design of Two way Slab (Continuous)

Given Data:

Shorter span		=	**5250**	**mm**
Longer Span		=	**7700**	**mm**
Live Load (w)		=	**2**	**KN/m²**
Width of Support		=	**230**	**mm**
Grade of Concrete		=	**25**	**N/mm²**
Grade of Steel		=	**500**	**N/mm²**
Mu limit / bd^2	**(Qu)**	=	**3.33**	

Solution:

1.Thickness of Slab:

Assume % of steel is 0.2%,

Modification Factor		=	1.6	Refer Fig.4 (IS 456-2000)
Span/Depth		=	26	
Span/Depth		=	41.6	~ 42
Effective Depth (d)		=	125	~ 150 mm
Adopt Thickness of Slab is			**150**	**mm**

2.Effective Span:

c/c of support	=	5480	mm
Clear Span + d	=	5375	mm
For shorter span (lx)	=	5375	mm

3.Load Calculation:

Self weight of Slab	=	3.75	KN/m²
Floor finish	=	2	KN/m²
Weathering Coarse filling	=	0	KN/m²
Live Load	=	2	KN/m²
Total Load	=	7.75	KN/m²
Total Design Load(W)/m	=	7.750	KN/m

4.Types of Slab

Ly/Lx = 1.47 < 2

The Slab is to be designed as Two way

5.Bending Moments coefficents:

Refer IS 456-2000 Table No. 26

Support condition = 9

For shorter span

αx -ve	=	0.089
αx +ve	=	0.089

For Longer span

αx -ve	=	0.089
αx +ve	=	0.089

6.Design Moments:

Sl.No	Design Moments	For shorter span	For Long span			
1	Negative Moment at continuous edge	19.927	19.927			
2	Positive Moment at mid span	19.927	19.927			
3	d required $= \sqrt{Mu/Quxb}$	77.357	77.357	<	125.00	mm **O.K**

The Slab depth is enough

7.Reinforcements:

Ast_{min} = 0.12 %

= **150.00** mm^2

$$Ast = \frac{0.5 \times fck}{fy}\left(1-\sqrt{1-\frac{4.6 \times Mu}{fck \times 1000 \times d^2}}\right) 1000 \times d$$

For shorter span

Sl.No	Reinforcements	Ast in mm^2	Dia	Spacing					
1	At Top (-ve)	391.14	10	200.69	150	**10**	**mmØ @**	**120**	**mm c/c at Top**
2	Bottom (+ve)	391.14	10	200.69	150	**10**	**mmØ @**	**120**	**mm c/c at Bottom**
3	At Top (-ve)	391.14	10	200.69	200	**10**	**mmØ @**	**200**	**mm c/c at Top**
4	Bottom (+ve)	409.95	10	191.49	200	**10**	**mmØ @**	**200**	**mm c/c at Bottom**

8.Check for Deflection:

% of Steel at Mid span = **0.523** %

fs = **173.40**

Modification Factor = 1.70 (Ref Fig 4 Pg 38 - IS 456-2000)

d required = 121.61 mm

d provide = 125.00 mm

The Slab is Safe

9. Results:

Size of Slab is = 5250 x 7700 mm

Depth of Slab is = 150 mm

For shorter span	**Provide**	**10**	**mmØ @**	**120**	**mm c/c at Top**
	Provide	**10**	**mmØ @**	**120**	**mm c/c at Bottom**
For longer span	**Provide**	**10**	**mmØ @**	**200**	**mm c/c at Top**
	Provide	**10**	**mmØ @**	**200**	**mm c/c at Bottom**

C. KANNAN, B.E., M.E, (Structure)
Structural Engineer,
CMDA Reg. No: SE/I/2024/2/0047
Door No: 21, 4th Main Road,
Indira Nagar, Chennai-600 020.