

STRUCTURAL DESIGN CRITERIA

OF

**DEVELOPMENT OF MHAPURUSH SRI SRI ANIRUDDHADEVA
JANMAKHETRA AT NARAAYANPUR, LAKHIMPUR, ASSAM**

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DEVELOPMENT OF MHAPURUSH SRI SRI ANIRUDDHADEVA JANMAKHETRA AT NARAAYANPUR, LAKHIMPUR, ASSAM

1. SCOPE

This criterion covers the structural design basis for Proposed **DEVELOPMENT OF MHAPURUSH SRI SRI ANIRUDDHADEVA JANMAKHETRA AT NARAAYANPUR, LAKHIMPUR, ASSAM**

The buildings will be made with RCC framed structure with cast-in-situ columns, beams and slabs to suit the approved/ finalised architectural drawings. The buildings are multi-storey buildings with floors at different levels, as per various architectural drawings.

The buildings shall be as per the Architectural requirement for civil and structural works, standard specifications, relevant I.S. codes and local regulations.

2. CODES AND STANDARDS

All the design shall be based on Indian standard & codes as specified here.

List of commonly used Codes and Standards:

- IS-875 (Part 1, 2, 4, & 5)-1987: Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures
- IS-875 (Part 3)-2015: Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures
- IS1893-2016: Criteria for Earthquake Resistant Design of Structures
- IS-456-2000: Plain and Reinforced Concrete - Code of Practice
- IS-13920-2016: Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice
- IS-800-2007: Code of Practice for General Construction, In Steel
- Code IS 1786-2008: Specification for high strength deformed steel bars and wires for concrete reinforcement
- SP-34: Handbook on Concrete reinforcement and Detailing
- SP-16: Design aids for IS-456
- IS 1904: Indian Standard Code of Practice for Design and Construction of Foundation in Soils: General requirements.
- IS 11384: Code of practice for composite construction in structural steel and concrete.
- National Building Code of India. NBC-2016

- In addition to above any additional code wherever applicable to be followed. In absence of Indian codes, international codes to be followed. In case of revisions in code, latest codes to be followed.

3. LOADS AND FORCES

Loads and forces used for design shall be as defined in IS875, and is specified below.

The following type of loads and forces shall be considered.

- Dead load (DL)
- Live load (LL)
- Wind load (WL)
- Earthquake load (EQ)

3.1 Dead Load (DL)

Dead load is the load of the structure itself

Following are the unit weight of major construction materials.

- Reinforced Cement Concrete 25.0 kN/m^3
- Plain Cement Concrete 24.0 kN/ m^3
- Floor Finish density 24.0 kN/ m^3
- Structural Steel 78.5 kN/ m^3
- Saturated soil density 19.5 kN/ m^3
- Masonry wall including plaster 20.0 kN/ m^3
- AAC Wall 8 kN/m^3
- Floor finish margin of 50mm will be considered for design.

Sunk load shall be taken considering the density of filling above 150mm as 8 kN/ m^3 and filling below 150mm as 20 kN/ m^3 , wherever required.

3.2 Live Load (LL)

Live load for building and structure shall be in accordance with IS875 part 2 unless otherwise specified or required by the user or equipment requirement for areas not covered underneath.

Live Load

a) Ward	3 kN/m ²	
b) Laboratory	3 kN/m ²	
c) Staff room	3 kN/m ²	
d) Passage, Balcony, Stairs	4 kN/m ²	
e) Toilet	2 kN/m ²	
f) Bedrooms/ Dorms	2 kN/m ²	
h) Lift M/C Room (Impact Loading)	10 kN/m ²	
i) Terrace	1.5 kN/m ²	(Accessible Roof)
j) Resident doctor	3 kN/m ²	

3.3 Wind Load (WL)

Wind load to be applied for structures shall be in accordance with IS875 part 3, and noted below.

- Basic wind speed, V_b , shall be 50m/sec
- Risk coefficient ' K_1 ' shall be equal to 1.0. (Design Life considered is 50 years.)
- Terrain Height & Structure Height factor ' K_2 ' shall be obtained from Table 2 IS 875 part 3. Terrain Category – 3(Considering scattered buildings around the project structure).
- Topographic factor $K_3 = 1.0$
- Importance factor for the cyclonic region, $K_4 = 1.0$

Design wind speed V_z at any height z in m/sec

$$V_z = V_b \times K_1 \times K_2 \times K_3 \times K_4$$

Wind pressure p_z at any height z in N/m²

$$p_z = 0.6 V_z^2$$

- Wind Directionality Factor, $K_d = 0.9$ (for buildings, solid signs, open signs, lattice frameworks, and trussed towers (triangular, square, rectangular))
- Wind Directionality Factor, $K_d = 1.0$ (for circular or near-circular forms)
- Area averaging Factor, K_a (as per Cl. 7.2.2, IS 875 Part 3:2016)
- Combination Factor (as per Cl. 7.3.3.13, IS 875 Part 3:2016)

Design wind pressure p_d at any height z in N/m² $p_d =$

$$K_d \times K_a \times K_c \times p_z$$

The value of p_d shall not be taken as less than 0.70 p_z .

Force coefficient as per Fig. 4 of IS-875 Part-3 shall be used to calculate wind force.

3.4 Seismic Load (EQ)

Seismic loads to be applied for structures shall be in accordance with the applicable

Provision of the IS 1893, 2016 and noted below.

- Seismic Zone Factor, Z , shall be 0.36.
- Importance factor I , shall be 1.2 (for buildings with occupancy greater than 200 persons), 1.5 (for important buildings like hospital, library, academic, admin buildings etc.) and 1 (for other buildings) depending on the usage of building as per table 8 IS 1893: 2016.
- Response reduction factor shall be 5.0 for RC building with SMRF & ductile RC structural walls with SMRF (dual system) or 4 for ductile RC wall building.
- Average response acceleration factor

$$A_h = Z/2 \times I/R \times S_a/g$$

$$E = A_h \times W$$

Where 'W' is seismic weight of structure with appropriate live load.

The approximate fundamental natural period of vibration (T_a) in seconds, of buildings, shall be estimated by the empirical expression,

$$T = 0.075 \times h^{0.75} \text{ (For moment-resisting frame buildings without any masonry infill)}$$

$$T = 0.09 \times h / (d)^{0.5} \text{ (For moment-resisting frame buildings with brick infill panels)}$$

Where d = length of the building the considered direction of
earthquake h = height of the building

4. COMBINATION OF LOADS

Concrete structural members shall be designed to have, at all sections, a calculated strength necessary to carry the following factored loads and forces as per table 18 of IS 456.

Load Combination	Limit State of Collapse			Limit States of Serviceability		
	<i>DL</i>	<i>IL</i>	<i>WL</i>	<i>DL</i>	<i>IL</i>	<i>WL</i>
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>DL + IL</i>	1.5		1.0	1.0	1.0	–
<i>DL + WL</i>	1.5 or 0.9 ⁰	–	1.5	1.0	–	1.0
<i>DL + IL + WL</i>	1.2			1.0	0.8	0.8

Wind load & earthquake load will not act in tandem & each one to be checked with provisions of combinations as per design/loading codes. In the above combinations, wind to be substituted for earthquake & checked in additional combinations.

5. CONCRETE AND FOUNDATIONS

All concrete design shall conform to IS456-2000, unless noted otherwise. The detailing of concrete reinforcement shall be in accordance with the requirements given in IS13920.

RCC retaining walls will be provided in accordance with Architectural drawings in the basement periphery considering cracked section. Water proofing lining/layer for wall area under water and active earth pressure along with 1 T/m² surcharge loading will be considered.

6. DESIGN PARAMETERS

RCC structures shall be designed based on limit state method of design as given in IS: 456-2000 & ductility provision in detailing of RCC structures shall be considered judiciously based on IS: 13920-2016 for Lateral force resisting elements or the structure. The following parameters shall be used:

RCC grade shall base per drawings in accordance with clause 6.0 (Table 5) of IS 456-2000 for all. Minimum grade shall be M25 for all structural elements.

Reinforcement steel grade 500 N/mm²: High yield strength deformed bars conforming to IS 1786 with minimum elongation of 14.5%.

Environmental Exposure condition for all structure shall be considered as Moderate as per Clause 8.2.2.1 of IS456:2000 except mild for plastered surfaces.

7. BUILDING MOVEMENT

Vertical Deflection

The deflection shall generally be limited to the following:

- a) The final deflection due to all loads including the effects of temperature, creep and shrinkage and measured from the as-cast level of the supports of floors, roofs and all other horizontal members, should not normally exceed span/250.
- b) The deflection including the effects of temperature, creep and shrinkage occurring after erection of partitions and the application of finishes should not normally exceed span/350 or 20 mm whichever is less.

8. HORIZONTAL DEFLECTION

Horizontal movement will occur due to creep shrinkage, temperature effect and Drift due to Earthquake& Lateral Sway due to wind are also considered.

These movements will occur throughout construction and during the life of the building.

Drift:

The storey drifts in any storey due to the minimum specified design lateral force, with partial load factor of 1.0 shall not exceed 0.004 times the storey height.

Lateral sway:

Under transient wind load the lateral sway at the top should not exceed H/500, where H is the total height of the building.

9. SOFTWARE USED

ETABS& SAFE, a Product of Computers and Structures Inc. &STAAD Pro a product of Bentley Engineers, along with MS Excel shall be used for the analysis & design of the structure.

10. SOIL PARAMETERS

Allowable bearing pressures and pile capacities shall be in accordance with the soil report given as below:

Isolated load test/ Strip/ Raft foundation may be adopted at a founding depth given below,

Depth (M) below EGL	Average Safe bearing pressure in MT/SM (Approx.) from BH-1, 2, 3 & 4
2.00	8.70
2.50	10.90
3.00	13.00
3.50	13.50

For higher bearing value, Bored cast in-situ RCC pile foundation with suitable dia & length may be adopted based on the theoretical estimation shown in the Table No. 1. Piles shall however be load tested as per IS: 2911. Adequate numbers of piles may be accommodated in a group so as to provide uniform anchorage under the worst condition of seismic forces.

However, the founding depth & type of foundation to be adopted may be decided by the design engineer keeping in view various investigated data furnished in this report so as to ensure structural safety & economy of the proposed construction.

SAFE BEARING PRESSURE IN MT/SM (Approx.)

(Computed as per IS: 6403)

Comparative Chart at different Depths.

Depth (M) From E.G.L. .	BH No. 1 (One)		BH No. 2 (Two)		BH No. 3 (Three)	
	From C & ϕ (FOS=3.0 0)	From C & ϕ (FOS=2.5 0)	From C & ϕ (FOS=3.0 0)	From C & ϕ (FOS=2.5 0)	From C & ϕ (FOS=3.0 0)	From C & ϕ (FOS=2.5 0)
1.50	7.10	8.52	--	--	6.30	7.55
2.00	--	--	7.97	9.57	--	--
2.50	10.88	13.06	--	--	9.66	11.60
3.00	--	--	12.78	15.34	--	--
3.50	13.57	16.29	--	--	14.50	17.37
4.50	--	--	14.10	16.90	--	--
5.50	20.85	25.02	--	--	20.50	24.60
7.50	--	--	22.45	26.94	--	--
10.00	30.45	36.54	--	--	31.70	38.28

SAFE BEARING PRESSURE IN MT/SM (Approx.)

(Computed as per IS: 6403)

Comparative Chart at different Depths.

Depth (M) From E.G.L.	BH No. 4 (Four)					
	From C & ϕ (FOS=3.00)	From C & ϕ (FOS=2.50)				
1.50	--	--				
2.00	10.14	10.17				
2.50	--	--				
3.00	14.40	17.28				
3.50	--	--				
4.50	19.06	22.87				
5.50	--	--				
7.50	38.18	45.26				
10.00	--	--				

R.C.C PILE FOUNDATION

Table showing Ultimate & Safe bearing capacity of Board cast in-situ R.C.C.
Pile Foundation (Uniform shaft as per IS:2911).

Dia (mm)	Pile length (M) From E.G.L.	Minimum Spacing C/C (M)	Effective Pile Length	Qu Ton/Pile (Approx.)	Q safe Ton/Pile FOS=2.50	Q safe Ton/Pile FOS=2.00
400	6.00	1.20	5.00	23.46	9.88	11.73
400	7.00	1.20	6.00	30.67	12.27	15.33
400	8.00	1.20	7.00	38.74	15.50	19.37
450	6.00	1.35	5.00	28.25	11.30	14.12
450	7.00	1.35	6.00	26.70	14.68	18.34
450	8.00	1.35	7.00	46.12	18.44	23.06
500	6.00	1.50	5.00	33.46	13.38	16.73
500	7.00	1.50	6.00	43.22	17.29	21.61
500	8.00	1.50	7.00	54.07	21.63	27.04

Note: The above data is based on theoretical estimation. In order to ascertain actual load carrying capacity, Piles shall however be load tested as per as IS:2911. Cut off from EGL 1.00M (Assumed).