

STRUCTURAL DESIGN CRITERIA

OF

BHUPEN HAZARIKA MUSEUM

AT

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BHUPEN HAZARIKA MUSEUM AT GUWAHATI, ASSAM

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BHUPEN HAZARIKA MUSEUM AT GUWAHATI, ASSAM

1. SCOPE

This intent of this document covers the structural design basis for Structural Work for Proposed "BHUPEN HAZARIKA MUSEUM AT GUWAHATI, ASSAM".

This design basis report covers the minimum design requirement to establish safe, durable & functional design basis that will form the overall design philosophy to be adopted in the structural design of this project.

All the structures/buildings shall be as per the Architectural requirement for civil and structural works, standard specifications, National Building Code (NBC-2016), CPWD 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/m³
- Plain Cement Concrete 24.0 kN/ m³
- Floor Finish density 24.0 kN/ m³
- Structural Steel 78.5 kN/ m³
- Saturated soil density 19.5 kN/ m³
- Masonry wall including plaster 20.0 kN/ m³
- AAC Wall 8 kN/m³
- Floor finish margin of 50mm will be considered for design.

Sunk load shall be taken considering the density of filling.

3.2 Live Load (LL)

Live load for building and structure shall be in accordance with IS 875 part 2 unless otherwise specified or required by the user or equipment requirement for areas not covered underneath. Lesser specified loads will have to be considered as per code if code values are more.

Live Load

Live Load

Office blocks, chambers	4 kN/ m ²
Assembly areas-with seating	4 kN/ m ²
Assembly areas-without seating	5 kN/ m ²
Passage, Balcony, Stairs	4 kN/ m ²
Toilets	2 kN/ m ²
Stores/Record rooms/Library	6 kN/m ²
Lift M/C room	10 kN/ m ²
Service areas/Plant rooms	As/actual (minimum 5 kN/ m ²)
Terrace	1.5 kN/ m ² /as per service Loads

Car Parking Areas

3 kN/m² (5 kN/m² for double stack)

Live Load (Ground Floor Extended Basement Area)

Fire Tender load for design of foundations and columns	10 kN/m ²
Fire Tender load for design of beams & slabs	15 kN/m ²
Live load where fire tender load is not applicable	5 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, K_c (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. (Zone V)
- Importance factor I , shall be 1.5
- 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,

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

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

$$T = 0.075 \times h^{0.75} / (A_w)^{0.5} \text{ (For buildings with RC structural walls)}$$

Where

d = length of the building the considered direction of earthquake

h = height of the building

A_w = Effective cross-sectional area walls in the first story of building as per Cl. 7.6.2 (b)

Cracked RC Section Properties as per Cl. 6.4.3.1 of IS 1893 (Part 1) 2016 and table 6 IS 16700 shall be considered for strength design.

Sl. No.	Structural Element	Percentage of Moment of Inertia (For Design Check)	Percentage of Moment of Inertia (For Serviceability Check)
1	Slabs	25	35
2	Beams	35	70
3	Columns	70	90
4	Walls	70	90

3.5 Temperature Load (TL)

The buildings wherever having length of more than 45m, shall be analysed for thermal effects.

A temperature variation of $\pm 10^\circ\text{C}$ shall be considered for intermediate floors whereas a temperature variation of $\pm 20^\circ\text{C}$ shall be considered for terrace floors.

3.6 Fire Safety

The structures shall be designed for adequate Fire safety provisions as per applicable fire rating. All member thickness & details should comply with the norms as given in NBC-2016

Minimum Size of Structural Elements for Fire Safety Requirements to be accordingly considered as provided to meet adequate fire safety.

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		
	DL	IL	WL	DL	IL	WL
(1)	(2)	(3)	(4)	(5)	(6)	(7)
DL + IL	1.5		1.0	1.0	1.0	-
DL + WL	1.5 or 0.9 ^{b)}	-	1.5	1.0	-	1.0
DL + IL + WL	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 be as per drawings in accordance with clause 6.0 (Table 5) of IS 456-2000 for all. Minimum grade shall be M30 for all structural elements.

Reinforcement steel grade shall be minimum 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 with updated codes for design.

10. SOIL PARAMETERS

Allowable bearing pressures and pile capacities shall be in accordance with soil report.

