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Comparing Seismic Analysis Of Peb Shed Based On Is Codes

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Keywords: Stress analysis, Load Cases, Pre-Engineered Building, Loading, etc.

I. INTRODUCTION

This thesis is about analysis and design of a warehouse (Location: Bhuj) using Pre-Engineered Building concept based on different assumption as per IS codes , which is widely used in modern-day construction. We will be using Staad Pro software to analysis and design building components like columns, rafters, bracing members, etc. With reference to Indian standard codes we are designing this warehouse/Shed. The major load action on the building will be Dead load, Live load, Wind load & Seismic load. Using Staad pro analysis will be carried out along with seismic forces auto calculated and stresses of the member will be auto calculated. Based on the stress levels & forces calculated, members will be reshaped for better usage and cost effectiveness. In this thesis we will be comparing the forces and cost impact of the structure which occurs due to following IS 1893 Part-1, Part-4 and IS 800 chapter-12 considerations.

A. Pre-Engineered Building

These are steel buildings which are pre designed at office by experts and created / manufactured using various methods at factory and assembled at site. In simple words, as per the requirement building components are prefabricated at one place and erected at another place.

Table 1 – Advantages & Disadvantages of PEB

Advantages	Disadvantages
Reduced Construction time	Low Thermal Resistivity
Less Manpower at Site	Low Fire Resistance
Reduction in Cost	Sensitive to corrosion
Flexibility in Design	Finishing Details May Take Time
Scope for Future Expansion	Limited Architectural Freedom
Low Maintenance	Technical Expertise
Seismic Resistance	

Structural analysis is necessary as the reliability of the structure is investigated for all the requirements and loadings on the structure. Structural analysis/Design is plays a very important role to identify the critical member/load and take necessary action to enhance the requirement and supply in a effectively manner.

B. Warehouse

A structure or room for the storage of merchandise or commodities. A warehouse is a commercial space vital in the supply chain that is used to store finished goods and raw materials and is widely used in industries such as manufacturing and distribution. Warehouses are used for storing goods for an extended period and are typically equipped with storage areas, loading docks, conveyors, and other material-handling equipment.

II. PROBLEM STATEMENT

The Client wanted to construct a warehouse/shed extended over the existing property and the architect proposed to go for steel warehouse/shed.

The proposal was for the warehouse which is rectangular in shape. And the Steel structural designer has approached to design the warehouse and provide the reaction for RCC foundation design.

Consulting Engineers were approached to undertake a feasibility scheme to design the necessary support to the shed (roof and columns), ensuring the safety and durability of the structure.

The key issue is predicting the effects of wind on the building, as typical wind design regulations make little reference to the layout provided by Architect. Wind will apply uplift or down pressure on any solid object depending on what kind of conditions.

We designed a rigid frame which transfers the loads effectively to the base of the support. The supports at base are designed properly, taking care of all the required specifications, making the warehouse structure more useful for a longer period during the period.

Additional to the above points there were some concerns about the consideration of IS code of simple warehouse located at seismic zone IV & V, so we have decided to prepare the comparison for 4Nos. of cases.

Case – 1, Seismic analysis based on IS 1893 Part-1, Excluding IS 800-2007 Chapter 12
Case – 2, Seismic analysis based on IS 1893 Part-4, Excluding IS 800-2007 Chapter 12
Case – 3, Seismic analysis based on IS 1893 Part-1, Including IS 800-2007 Chapter 12
Case – 4, Seismic analysis based on IS 1893 Part-4, Including IS 800-2007 Chapter 12

Figure – 1 Warehouse Picture

III. MODELLING

Table 2 – Modelling details for the structure

Description	Specifications
Type of Structure	Multi Span
Plan Dimensions	42 m x 33 m C/C of Steel Column
Height	5.0 m Clear Height
Brick Wall	1.25m
Column Base Level	+0.2m from FFL
Location	Bhuj
Roof/ Wall Sheeting	0.50mm Color Coated Galvalume Sheet
Wall light	1Nos. per Bay
Roof Access	1Nos. of Cage Ladder
Ventilator	Roof Monitor at Ridge

IV. CONSULTANT/ ARCHITECT DRAWING

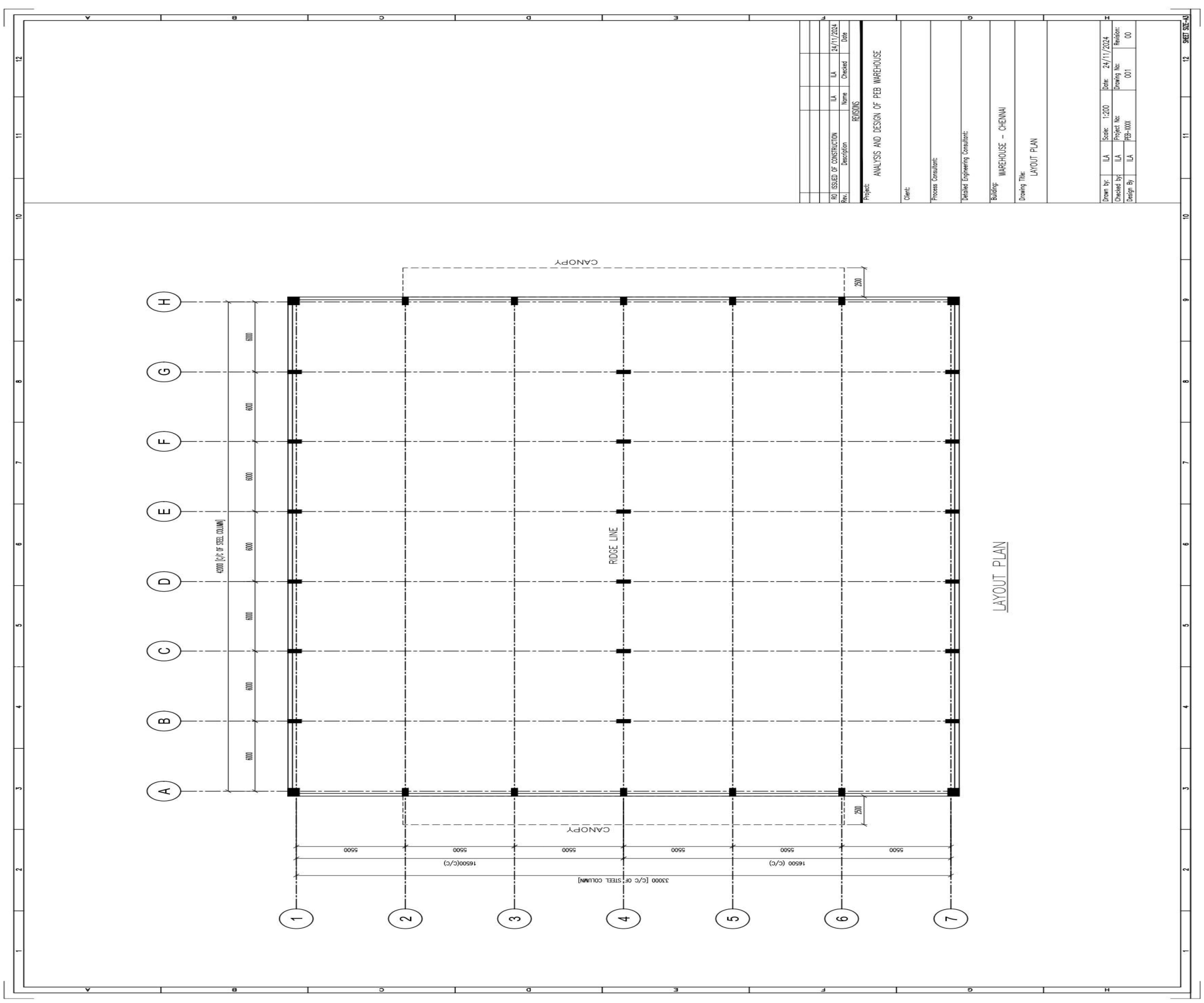
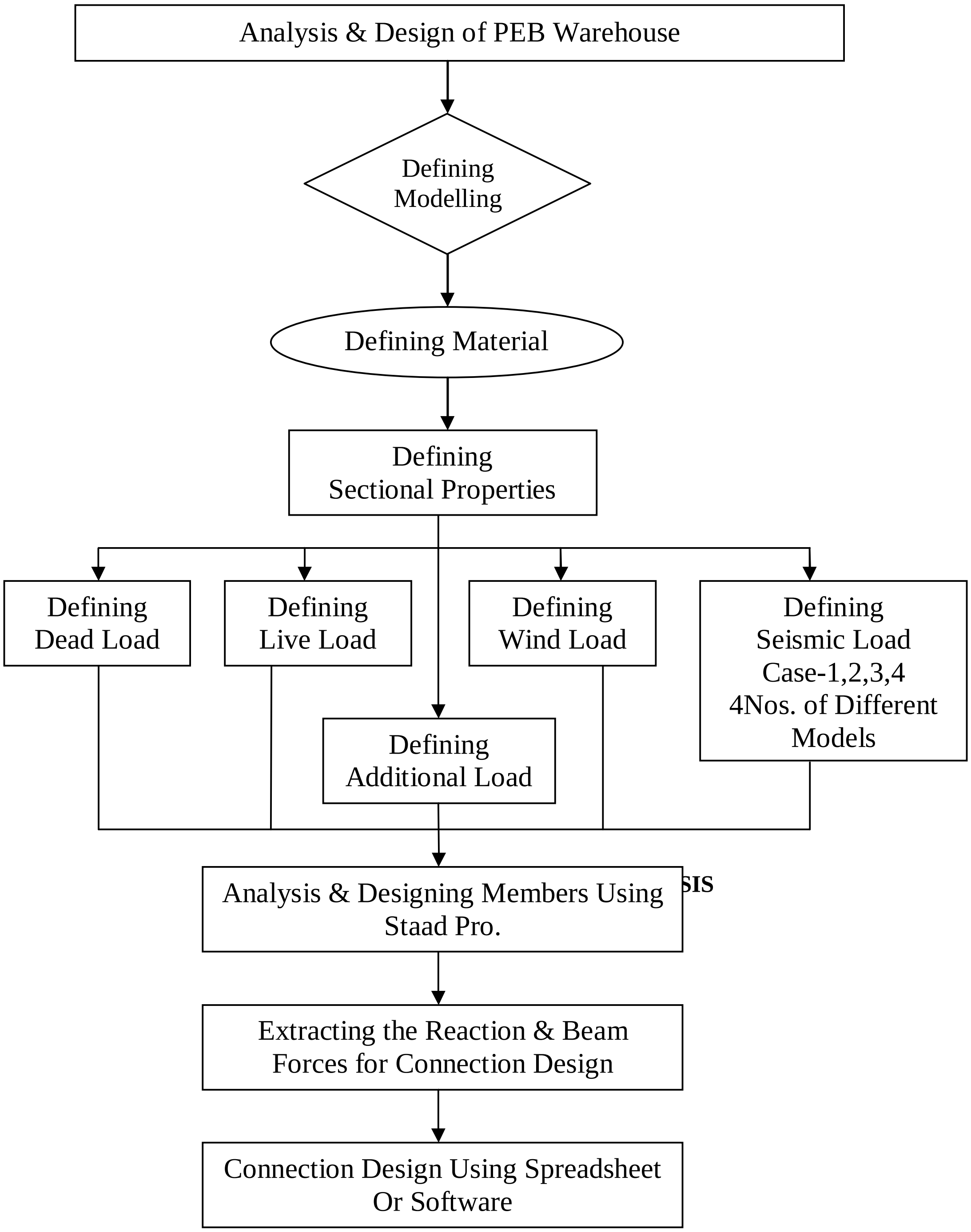


Figure – 2 Customer/ Architect Layout

V. MODELLING FLOW CHAT



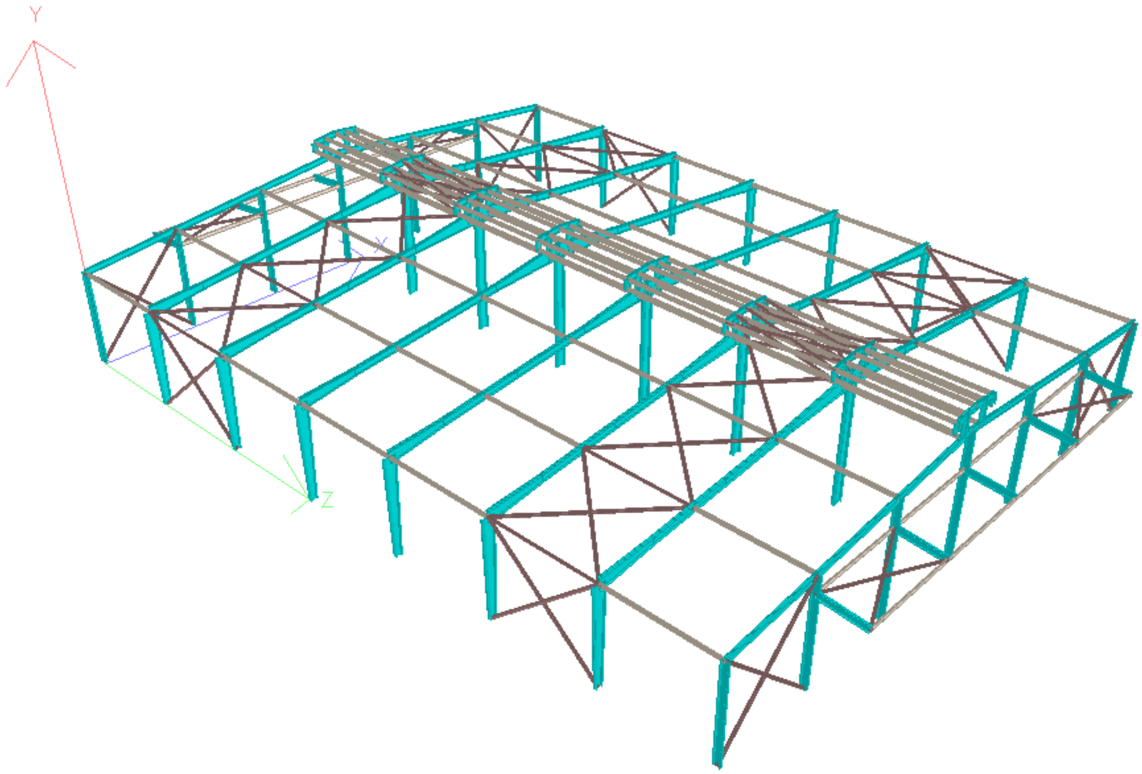


Figure – 3 Staad Pro rendered model

VII. MATERIAL SPECIFICATIONS

Table – 3 Material Specifications

Sl. No.	Materials		Specifications
1	3 - Plate Welded Sections		ASTM A572Gr50 and IS2062 E350A.
	Built-Up Sections		IS2062E350 Grade
2	Hot Rolled Sections	*Beams, Angles*	ASTM A36 Gr.36 or IS 2062 – 2011 Gr A
		Rods	IS 2062 E250A or SAE 1018 with minimum 250MPa yield strength.
		Pipes	IS 1161 – 1998 and IS 806 – 1968 (240 MPa)
3	Cold Formed sections		ASTM A570 Gr 50 (painted), min. yield 340MPa
4	Anchor Bolts		IS:5624 (minimum 240 MPa), material MS confirming IS:2062
5	High Strength Bolts		ASTM A325M or IS 1367 Part 3 – 2002 Gr. 8.8 min.
6	Machine or Mild Steel Bolts		IS1367 Part 3 -2002 class 4.6, Grade-B of IS1367 Part-2 & IS-5624
7	Nuts & washers		Grade 8.8 as per IS: 1367 and shall be hot dip galvanized

VIII. LOAD CALCULATIONS

Following Basic Loads shall be considered in Design of Structure and its elements

- Dead Loads (DL)
- Imposed Loads or Live Loads (LL)
- Wind loads (WL)
- Earthquake Loads (EQ)

A. Dead Load Calculation

Dead Load comprises permanent weight construction on the structure including frames, columns, beams, walls, roofing elements, cladding elements, sheeting and other steel elements permanently attached to building or structure. Dead loads for the materials evaluated as per IS: 875-1987(Part-1) - "Weight of Building Materials" or as per the manufacturer's literature. The following unit weights shall be used for the materials listed.

Table 4 – Unit weight of Materials

Material	Unit weight	Unit
Structural Steel	78.50	kN/m^3
RCC Structure	25.00	kN/m^3
Brick Wall including plaster	21.00	kN/m^3

Self-weight of elements which are modelled in analysis programs shall be computed automatically. For other elements computation shall be carried out as per listed unit weights.

B. Live Load

Imposed Load or otherwise Live Load is assessed based on the occupancy type and use of floor. Considered Non-Accessible Roof – $0.75kN/m^2$ (IS875-Part2_Table-2)

C. Additional Load (Collateral Load)

Sprinkler Load on Roof = $25kg/m^2 = 0.25kN/m^2$

D. Wind Load Calculation

IS 875 (Part 3): 2015 is used to determine wind loads.

- Identify the basic wind speed (V) for your location from the wind map provided in the standard.
- Determine the importance factor (I) and the exposure factor (K) based on the building's characteristics.
- As per IS875-2015 guidance, Cyclone factor considered for Chennai Location.
- Calculate the wind pressure (Pd)
- Once you have wind pressure, determine the design wind force (F_d) using the formula:
- The effective area is calculated based on the projected area of the structure perpendicular to the wind direction.

Figure – 4 Dead Load Calculation

DEAD LOAD CALCULATION

Width of the building (W) -	33.84	m
Building Tributory (T) -	6	m
No of Purlins in One Bay (N) -	24	Nos
Purlin Section -	200Z1.5	
Purlin Lapping -	Cont.\385 Lap	
Roof Sheeting -	0.50 mm Thk. CCGL	

Weight of Purlins - $$\frac{\text{N x Unit Wt. of Purlins x Length of Purlin Including Lap}}{\text{W x T}}$$

Weight of Purlins -	3.25	Kg/m^2
Weight of Panel -	4.49	Kg/m^2
Total Dead Load on Roof -	**7.74**	Kg/m^2
	or	
	0.08	kN/m^2
	=	
	0.10	kN/m^2

Figure – 5 & 6 Wind Load

WIND LOAD CALCULATION

AS PER IS : 875 (PART 3) - 2015

User Input

Basic Wind Speed =	50	m/ sec	
Building Eave Height (H) =	10	m	Building Mean Height (H) = 10.846 m
Roof Slope =	1	: 10	5.71 *Degrees*
Length of the building (L) =	42.84	m	
Width of the building (W) =	33.84	m	
Class of Structure =	1	*All general buildings and structures*	
Probablity Factor (k_1) =	1.00		------------ *IS875(Part-3)-2015, Clause 6.3.1, Table - 1*
Terrain Category =	2	*Open terrain with well scattered obstructions having heights generally between 1.5 to 10m*	
Terrain Factor (k_2) =	1.000		------------ *IS875(Part-3)-2015, Clause 6.3.2.2, Table -2*
Topography Factor (k_3) =	1.00		------------ *IS875(Part-3)-2015, Clause 6.3.3.1*
Cyclone Zone =	Yes		
Cyclone Factor (k4) =	1.15		------------ *IS875(Part-3)-2015, Clause 6.3.4*
Design Wind Pressure (p_z) =	**1.984**	KN/m^2	

$$P_Z = 0.6 \times (V_b \times K1 \times K2 \times K3 \times K4)^2$$ **KN/m^2** ------------ *IS875(Part-3)-2015, Clause 7.2*

For Frame

Wind Directionality Factor (kd) =	1.00	------------ *IS875(Part-3)-2015, Clause 7.2.1*
Max. Frame Tributary=	6.00	
Effective Frame Area =	33.96	
Area Averaging Factor (ka) =	0.89	------------ *IS875(Part-3)-2015, Clause 7.2.2*
Combination Factor (kc) =	0.90	------------ *IS875(Part-3)-2015, Clause 7.3.3.13*

Design Wind Pressure (p_d) = **1.586** KN/m^2

$P_d = kd \times ka \times kc \times P_z$ **KN/m^2** ------------ *IS875(Part-3)-2015, Clause 7.2*

Not Less Than

Design Wind Pressure (p_d) = **1.389** KN/m^2 **KN/m^2**

$P_d = 0.7 \times P_z$ **KN/m^2** ------------ *IS875(Part-3)-2015, Clause 7.2*

Therefore Design Wind Pressure (p_d) = **1.586** **KN/m^2**

<u>For Sheeting & Coldform</u>

Wind Directionality Factor (kd) = 1.00 ------------ *IS875(Part-3)-2015, Clause 7.2.1*

Max. Purlin / Girts Tributary= 1.50

Effective Purlin Area = 9.00

Area Averaging Factor (ka) = 1.00 ------------ *IS875(Part-3)-2015, Clause 7.2.2*

Combination Factor (kc) = 0.90 ------------ *IS875(Part-3)-2015, Clause 7.2.3.3.13*

Design Wind Pressure (p_d) = **1.786** KN/m^2

$P_d = kd \times ka \times kc \times P_z$ **KN/m^2** ------------ *IS875(Part-3)-2015, Clause 7.2*

Not Less Than

Design Wind Pressure (p_d) = **1.389** KN/m^2 **KN/m^2**

$P_d = 0.7 \times P_z$ **KN/m^2** ------------ *IS875(Part-3)-2015, Clause 7.2*

Therefore Design Wind Pressure (p_d) = **1.786** **KN/m^2**

Permeability Condition = **Low Permeability** *Opening Area - Below 5%*

Internal Press.Co-efficient Cpi= **±0.2** ------------ *IS875(Part-3)-2015, Clause 7.3.2*

Wind Load on Individual members F = **(Cpe - Cpi) x A P_d** **KN**

------------ *IS875(Part-3)-2015, Clause 7.3.1*

Where, C_{pi} = *Internal Pressure Co-efficient*

C_{pe} = *External Pressure Co-efficient*

A = *Surface area of structural element or cladding unit*

P_z = *Design Wind Pressure*

E. Seismic Load Calculation

Case – 1, Seismic analysis based on IS 1893 Part-1, Excluding IS 800-2007 Chapter 12

The following parameters shall be considered as per IS: 1893-2016 (Part-1)
Seismic Zone = V
Seismic Zone Factor Z = 0.36
Structure Importance Factor (Table -8, IS1893-2016 (Part-1))
I = 1
Response Reduction Factor (Table-9, IS1893-2016 (Part-1))
R = 4 (For OMF)
Response Reduction Factor R = 4 (For OCBF)
= 4 In Staad
Damping factor (Steel) = 5 %
Soil type for Spectral Acceleration Co-efficient (As Per Tender) = Medium
Fundamental period of vibration in seconds, T shall be estimated by Eigen value analysis using analysis model.

Design Horizontal Seismic Coefficient
Design Seismic Base Shear $V_b = A_h \times W$

Where,
"W" is the seismic weight of the building
"A_h" is Design Horizontal Seismic Coefficient
"Sa/g" is Average response acceleration co-efficient

For computing design seismic forces, following factors shall be considered

- 100% Dead load of structure, collateral loads,

Case – 2, Seismic analysis based on IS 1893 Part-4, Excluding IS 800-2007 Chapter 12

The following parameters shall be considered as per IS: 1893-2024 (Part-4)
Seismic Zone = V
Seismic Zone Factor Z = 0.36
Structure Importance Factor (Table-3, IS1893-2024 (Part-4))
I = 1
Response Reduction Factor (Table-4, IS1893-2024 (Part-4))
R = 4 (For OMF)
Response Reduction Factor R = 4 (For OCBF)
= 4 In Staad
Damping factor (Steel) = 2 %
Soil type for Spectral Acceleration Co-efficient (As Per Tender) = Medium
Fundamental period of vibration in seconds, T shall be estimated by Eigen value analysis using analysis model.

Design Horizontal Seismic Coefficient
Design Seismic Base Shear $V_b = A_h \times W$

Where,
"W" is the seismic weight of the building
"A_h" is Design Horizontal Seismic Coefficient
"Sa/g" is Average response acceleration co-efficient
For computing design seismic forces, following factors shall be considered

- 100% Dead load of structure, collateral loads,

Case – 3, Seismic analysis based on IS 1893 Part-1, Including IS 800-2007 Chapter 12

The following parameters shall be considered as per IS: 1893-2016 (Part-1)
Seismic Zone = V
Seismic Zone Factor Z = 0.36
Structure Importance Factor (Table -8, IS1893-2016 (Part-1))
I = 1
Response Reduction Factor (Table-23, Chapter-12 – IS800-2007)
R = 5 (For OMF)
Response Reduction Factor R = 4.5 (For OCBF)
= 4.5 In Staad (Conservative Side)
Damping factor (Steel) = 5 %
Soil type for Spectral Acceleration Co-efficient (As Per Tender) = Medium
Fundamental period of vibration in seconds, T shall be estimated by Eigen value analysis using analysis model.

Design Horizontal Seismic Coefficient
Design Seismic Base Shear $V_b = A_h \times W$

Where,
"W" is the seismic weight of the building
"A_h" is Design Horizontal Seismic Coefficient
"Sa/g" is Average response acceleration co-efficient

For computing design seismic forces, following factors shall be considered

- 100% Dead load of structure, collateral loads,

Case – 4, Seismic analysis based on IS 1893 Part-4, Including IS 800-2007 Chapter 12
The following parameters shall be considered as per IS: 1893-2024 (Part-4)
Seismic Zone = V
Seismic Zone Factor Z = 0.36
Structure Importance Factor (Table-3, IS1893-2024 (Part-4))
I = 1
Response Reduction Factor (Table-23, Chapter-12 – IS800-2007)
R = 5 (For OMF)
Response Reduction Factor R = 4.5 (For OCBF)
= 4.5 In Staad (Conservative Side)
Damping factor (Steel) = 2 %
Soil type for Spectral Acceleration Co-efficient (As Per Tender) = Medium
Fundamental period of vibration in seconds, T shall be estimated by Eigen value analysis using analysis model.

Design Horizontal Seismic Coefficient
Design Seismic Base Shear $V_b = A_h \times W$

Where,
"W" is the seismic weight of the building
"A_h" is Design Horizontal Seismic Coefficient
"Sa/g" is Average response acceleration co-efficient
For computing design seismic forces, following factors shall be considered

- 100% Dead load of structure, collateral loads,

F. Serviceability Requirements

Deflection limits followed as per table 6 of IS800-2007.

Table 5 – Deflection Limitation

Column (Lateral)	Lateral Deflection-Height/150
Rafter (Vertical)	Vertical deflection-Span/180
Girt	Vertical deflection-Span/150
Purlin	Vertical deflection-Span/150
Cantilever Canopy beam	Vertical deflection-Span/120

G. Analysis and Design considerations

- The lateral stability of the building is provided through the frame action of the rigid frame Structure.
- The longitudinal stability of the building is provided through the system of cross bracing.
- The sidewall girts are by pass beams (Continuous) supported at frame column location and span the bay spacing of the building.
- The end wall girts are by pass beams (Continuous) supported at end wall column locations.
- All columns are pinned to the base.
- End frame frames are considered as non-expandable (Post & Beam).

1) *Case – 1, Seismic analysis based on IS 1893 Part-1, Excluding IS 800-2007 Chapter 12*
- Damping percentage for seismic analysis 5%.
- Connection design based on Actual forces.
- High strength Connection bolts considered for Primary connection.
- All the braced members are designed as truss members.
- Slenderness of all braced member 250.

2) *Case – 2, Seismic analysis based on IS 1893 Part-4, Excluding IS 800-2007 Chapter 12*
- Damping percentage for seismic analysis 2%. Which enhancing the seismic force by 1.4 times.
- Connection design based on Actual forces.
- High strength Connection bolts considered for Primary connection.
- All the braced members are designed as truss members.
- Slenderness of all braced member 250.

3) *Case – 3, Seismic analysis based on IS 1893 Part-1, Including IS 800-2007 Chapter 12*
- Damping percentage for seismic analysis 5%.
- Connection design based on sectional capacity.
- High strength friction bolt has been considered for Primary connection.
- All the braced members are designed as truss members.
- Slenderness of all braced members 160.

4) *Case – 4, Seismic analysis based on IS 1893 Part-4, Including IS 800-2007 Chapter 12*
- Damping percentage for seismic analysis 2%. Which enhancing the seismic force by 1.4 times.
- Connection design based on sectional capacity.
- High strength friction bolt has been considered for Primary connection.
- All the braced members are designed as truss members.
- Slenderness of all braced members 160.

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IX. LOAD COMBINATION

Figure – 7 Load Combination as per IS 800-2007

Table 4 Partial Safety Factors for Loads, γ_f, for Limit States
(*Clauses* 3.5.1 *and* 5.3.3)

Combination	Limit State of Strength					Limit State of Serviceability			
	DL	LL[1]		WL/EL	AL	DL	LL[1]		WL/EL
		Leading	Accompanying				Leading	Accompanying	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
DL+LL+CL	1.5	1.5	1.05	—	—	1.0	1.0	1.0	—
DL+LL+CL+	1.2	1.2	1.05	0.6	—	1.0	0.8	0.8	0.8
WL/EL	1.2	1.2	0.53	1.2					
DL+WL/EL	1.5 (0.9)[2]	—	—	1.5	—	1.0	—	—	1.0
DL+ER	1.2 (0.9)[2]	1.2	—	—	—	—	—	—	—
DL+LL+AL	1.0	0.35	0.35	—	1.0	—	—	—	—

[1] When action of different live loads is simultaneously considered, the leading live load shall be considered to be the one causing the higher load effects in the member/section.
[2] This value is to be considered when the dead load contributes to stability against overturning is critical or the dead load causes reduction in stress due to other loads.
Abbreviations:
DL = Dead load, LL = Imposed load (Live loads), WL = Wind load, CL = Crane load (Vertical/Horizontal), AL = Accidental load, ER = Erection load, EL = Earthquake load.
NOTE — The effects of actions (loads) in terms of stresses or stress resultants may be obtained from an appropriate method of analysis as in **4**.

X. BASE SHEAR COMPARISON

Table-6

		Case - 1			Case-2			Case-3			Case-4		
		Horizontal		Vertical	Horizontal		Vertical	Horizontal		Vertical	Horizontal		Vertical
Node	L/C	Fx kN	Fz kN	Fy kN	Fx kN	Fz kN	Fy kN	Fx kN	Fz kN	Fy kN	Fx kN	Fz kN	Fy kN
1	1 EQ X	-2.3	0.0	-4.9	-2.6	0.0	-5.5	-2.0	0.0	-4.3	-2.5	0.0	-5.3
	2 EQ -X	2.3	0.0	4.9	2.6	0.0	5.5	2.0	0.0	4.3	2.5	0.0	5.3
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
3	1 EQ X	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
	2 EQ -X	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	3 EQ Z	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	-0.1	0.0	0.0	-0.2	0.0
	4 EQ-Z	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.2	0.0
6	1 EQ X	-2.3	0.0	4.9	-2.6	0.0	5.5	-2.0	0.0	4.3	-2.5	0.0	5.3
	2 EQ -X	2.3	0.0	-4.9	2.6	0.0	-5.5	2.0	0.0	-4.3	2.5	0.0	-5.3
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
22	1 EQ X	-2.4	0.0	4.6	-2.8	0.0	5.3	-2.1	0.0	4.0	-2.7	0.0	5.0
	2 EQ -X	2.4	0.0	-4.6	2.8	0.0	-5.3	2.1	0.0	-4.0	2.7	0.0	-5.0
	3 EQ Z	0.0	-0.2	-0.1	0.0	-0.3	-0.1	0.0	-0.1	-0.1	0.0	-0.2	-0.1
	4 EQ-Z	0.0	0.2	0.1	0.0	0.3	0.1	0.0	0.1	0.1	0.0	0.2	0.1
23	1 EQ X	-0.1	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0
	2 EQ -X	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0
	3 EQ Z	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.1	0.1
	4 EQ-Z	0.0	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.1	-0.1
24	1 EQ X	-2.4	0.0	-4.6	-2.8	0.0	-5.3	-2.1	0.0	-4.0	-2.7	0.0	-5.0
	2 EQ -X	2.4	0.0	4.6	2.8	0.0	5.3	2.1	0.0	4.0	2.7	0.0	5.0

	3 EQ Z	0.0	-0.2	-0.1	0.0	-0.3	-0.1	0.0	-0.1	-0.1	0.0	-0.2	-0.1
	4 EQ-Z	0.0	0.2	0.1	0.0	0.3	0.1	0.0	0.1	0.1	0.0	0.2	0.1
25	1 EQ X	-0.1	0.0	0.1	-0.1	0.1	0.0	0.0	0.0	0.1	-0.1	0.1	0.0
	2 EQ -X	0.1	0.0	-0.1	0.1	-0.1	0.0	0.0	0.0	-0.1	0.1	-0.1	0.0
	3 EQ Z	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.1	0.1
	4 EQ-Z	0.0	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.1	-0.1
34	1 EQ X	-4.1	-0.2	-2.8	-4.2	-0.2	-2.8	-3.6	-0.2	-2.5	-4.0	-0.2	-2.7
	2 EQ -X	4.1	0.2	2.8	4.2	0.2	2.8	3.6	0.2	2.5	4.0	0.2	2.7
	3 EQ Z	-0.1	-12.4	-22.0	-0.1	-16.2	-28.7	-0.1	-11.0	-19.5	-0.1	-14.3	-25.2
	4 EQ-Z	0.1	12.4	22.0	0.1	16.2	28.7	0.1	11.0	19.5	0.1	14.3	25.2
36	1 EQ X	-5.9	0.0	0.0	-6.2	0.0	0.0	-5.4	0.0	0.0	-6.1	0.0	0.0
	2 EQ -X	5.9	0.0	0.0	6.2	0.0	0.0	5.4	0.0	0.0	6.1	0.0	0.0
	3 EQ Z	0.0	-0.1	-9.9	0.0	-0.1	-10.8	0.0	-0.1	-8.9	0.0	-0.1	-9.6
	4 EQ-Z	0.0	0.1	9.9	0.0	0.1	10.8	0.0	0.1	8.9	0.0	0.1	9.6
39	1 EQ X	-4.1	0.2	2.8	-4.2	0.2	2.8	-3.6	0.2	2.5	-4.0	0.2	2.7
	2 EQ -X	4.1	-0.2	-2.8	4.2	-0.2	-2.8	3.6	-0.2	-2.5	4.0	-0.2	-2.7
	3 EQ Z	0.1	-12.4	-22.0	0.1	-16.2	-28.7	0.1	-11.0	-19.5	0.1	-14.3	-25.2
	4 EQ-Z	-0.1	12.4	22.0	-0.1	16.2	28.7	-0.1	11.0	19.5	-0.1	14.3	25.2
63	1 EQ X	-4.1	0.2	-2.7	-4.2	0.2	-2.8	-3.6	0.2	-2.5	-4.0	0.2	-2.7
	2 EQ -X	4.1	-0.2	2.7	4.2	-0.2	2.8	3.6	-0.2	2.5	4.0	-0.2	2.7
	3 EQ Z	0.1	-12.4	22.0	0.1	-16.2	28.7	0.1	-11.0	19.5	0.1	-14.2	25.2
	4 EQ-Z	-0.1	12.4	-22.0	-0.1	16.2	-28.7	-0.1	11.0	-19.5	-0.1	14.2	-25.2
65	1 EQ X	-5.9	0.0	0.0	-6.2	0.0	0.0	-5.4	0.0	0.0	-6.1	0.0	0.0
	2 EQ -X	5.9	0.0	0.0	6.2	0.0	0.0	5.4	0.0	0.0	6.1	0.0	0.0
	3 EQ Z	0.0	-0.1	9.9	0.0	-0.1	10.8	0.0	-0.1	8.9	0.0	-0.1	9.6
	4 EQ-Z	0.0	0.1	-9.9	0.0	0.1	-10.8	0.0	0.1	-8.9	0.0	0.1	-9.6
68	1 EQ X	-4.1	-0.2	2.7	-4.2	-0.2	2.8	-3.6	-0.2	2.5	-4.0	-0.2	2.7
	2 EQ -X	4.1	0.2	-2.7	4.2	0.2	-2.8	3.6	0.2	-2.5	4.0	0.2	-2.7
	3 EQ Z	-0.1	-12.4	22.0	-0.1	-16.2	28.7	-0.1	-11.0	19.5	-0.1	-14.2	25.2
	4 EQ-Z	0.1	12.4	-22.0	0.1	16.2	-28.7	0.1	11.0	-19.5	0.1	14.2	-25.2
92	1 EQ X	-3.6	0.0	-2.4	-3.7	0.0	-2.4	-3.1	0.0	-2.1	-3.4	0.0	-2.3
	2 EQ -X	3.6	0.0	2.4	3.7	0.0	2.4	3.1	0.0	2.1	3.4	0.0	2.3
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94	1 EQ X	-5.2	0.0	0.0	-5.4	0.0	0.0	-4.6	0.0	0.0	-5.3	0.0	0.0
	2 EQ -X	5.2	0.0	0.0	5.4	0.0	0.0	4.6	0.0	0.0	5.3	0.0	0.0
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97	1 EQ X	-3.6	0.0	2.4	-3.7	0.0	2.4	-3.1	0.0	2.1	-3.4	0.0	2.3
	2 EQ -X	3.6	0.0	-2.4	3.7	0.0	-2.4	3.1	0.0	-2.1	3.4	0.0	-2.3
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
121	1 EQ X	-3.6	0.0	-2.4	-3.7	0.0	-2.4	-3.1	0.0	-2.1	-3.4	0.0	-2.3
	2 EQ -X	3.6	0.0	2.4	3.7	0.0	2.4	3.1	0.0	2.1	3.4	0.0	2.3
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
123	1 EQ X	-5.2	0.0	0.0	-5.4	0.0	0.0	-4.6	0.0	0.0	-5.3	0.0	0.0
	2 EQ -X	5.2	0.0	0.0	5.4	0.0	0.0	4.6	0.0	0.0	5.3	0.0	0.0
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
126	1 EQ X	-3.6	0.0	2.4	-3.7	0.0	2.4	-3.1	0.0	2.1	-3.4	0.0	2.3
	2 EQ -X	3.6	0.0	-2.4	3.7	0.0	-2.4	3.1	0.0	-2.1	3.4	0.0	-2.3
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
150	1 EQ X	-4.1	-0.2	-2.7	-4.2	-0.2	-2.8	-3.6	-0.2	-2.5	-4.0	-0.2	-2.7
	2 EQ -X	4.1	0.2	2.7	4.2	0.2	2.8	3.6	0.2	2.5	4.0	0.2	2.7
	3 EQ Z	-0.1	-12.4	-22.0	-0.1	-16.2	-28.7	-0.1	-11.0	-19.5	-0.1	-14.2	-25.2
	4 EQ-Z	0.1	12.4	22.0	0.1	16.2	28.7	0.1	11.0	19.5	0.1	14.2	25.2
152	1 EQ X	-5.9	0.0	0.0	-6.2	0.0	0.0	-5.4	0.0	0.0	-6.1	0.0	0.0

	2 EQ -X	5.9	0.0	0.0	6.2	0.0	0.0	5.4	0.0	0.0	6.1	0.0	0.0
	3 EQ Z	0.0	-0.1	-9.9	0.0	-0.1	-10.8	0.0	-0.1	-8.9	0.0	-0.1	-9.6
	4 EQ-Z	0.0	0.1	9.9	0.0	0.1	10.8	0.0	0.1	8.9	0.0	0.1	9.6
155	1 EQ X	-4.1	0.2	2.7	-4.2	0.2	2.8	-3.6	0.2	2.5	-4.0	0.2	2.7
	2 EQ -X	4.1	-0.2	-2.7	4.2	-0.2	-2.8	3.6	-0.2	-2.5	4.0	-0.2	-2.7
	3 EQ Z	0.1	-12.4	-22.0	0.1	-16.2	-28.7	0.1	-11.0	-19.5	0.1	-14.2	-25.2
	4 EQ-Z	-0.1	12.4	22.0	-0.1	16.2	28.7	-0.1	11.0	19.5	-0.1	14.2	25.2
179	1 EQ X	-4.1	0.2	-2.8	-4.2	0.2	-2.8	-3.6	0.2	-2.5	-4.0	0.2	-2.7
	2 EQ -X	4.1	-0.2	2.8	4.2	-0.2	2.8	3.6	-0.2	2.5	4.0	-0.2	2.7
	3 EQ Z	0.1	-12.4	22.0	0.1	-16.2	28.7	0.1	-11.0	19.5	0.1	-14.3	25.2
	4 EQ-Z	-0.1	12.4	-22.0	-0.1	16.2	-28.7	-0.1	11.0	-19.5	-0.1	14.3	-25.2
181	1 EQ X	-5.9	0.0	0.0	-6.2	0.0	0.0	-5.4	0.0	0.0	-6.1	0.0	0.0
	2 EQ -X	5.9	0.0	0.0	6.2	0.0	0.0	5.4	0.0	0.0	6.1	0.0	0.0
	3 EQ Z	0.0	-0.1	9.9	0.0	-0.1	10.8	0.0	-0.1	8.9	0.0	-0.1	9.6
	4 EQ-Z	0.0	0.1	-9.9	0.0	0.1	-10.8	0.0	0.1	-8.9	0.0	0.1	-9.6
184	1 EQ X	-4.1	-0.2	2.8	-4.2	-0.2	2.8	-3.6	-0.2	2.5	-4.0	-0.2	2.7
	2 EQ -X	4.1	0.2	-2.8	4.2	0.2	-2.8	3.6	0.2	-2.5	4.0	0.2	-2.7
	3 EQ Z	-0.1	-12.4	22.0	-0.1	-16.2	28.7	-0.1	-11.0	19.5	-0.1	-14.3	25.2
	4 EQ-Z	0.1	12.4	-22.0	0.1	16.2	-28.7	0.1	11.0	-19.5	0.1	14.3	-25.2
208	1 EQ X	-2.3	0.0	-4.9	-2.6	0.0	-5.5	-2.0	0.0	-4.3	-2.5	0.0	-5.3
	2 EQ -X	2.3	0.0	4.9	2.6	0.0	5.5	2.0	0.0	4.3	2.5	0.0	5.3
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
210	1 EQ X	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
	2 EQ -X	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	3 EQ Z	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	-0.1	0.0	0.0	-0.2	0.0
	4 EQ-Z	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.2	0.0
213	1 EQ X	-2.3	0.0	4.9	-2.6	0.0	5.5	-2.0	0.0	4.3	-2.5	0.0	5.3
	2 EQ -X	2.3	0.0	-4.9	2.6	0.0	-5.5	2.0	0.0	-4.3	2.5	0.0	-5.3
	3 EQ Z	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
	4 EQ-Z	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
229	1 EQ X	-2.4	0.0	4.6	-2.8	0.0	5.3	-2.1	0.0	4.0	-2.7	0.0	5.0
	2 EQ -X	2.4	0.0	-4.6	2.8	0.0	-5.3	2.1	0.0	-4.0	2.7	0.0	-5.0
	3 EQ Z	0.0	-0.2	0.1	0.0	-0.3	0.1	0.0	-0.1	0.1	0.0	-0.2	0.1
	4 EQ-Z	0.0	0.2	-0.1	0.0	0.3	-0.1	0.0	0.1	-0.1	0.0	0.2	-0.1
230	1 EQ X	-0.1	0.0	-0.1	-0.1	0.1	0.0	0.0	0.0	-0.1	-0.1	0.1	0.0
	2 EQ -X	0.1	0.0	0.1	0.1	-0.1	0.0	0.0	0.0	0.1	0.1	-0.1	0.0
	3 EQ Z	0.0	0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.1
	4 EQ-Z	0.0	-0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1
231	1 EQ X	-2.4	0.0	-4.6	-2.8	0.0	-5.3	-2.1	0.0	-4.0	-2.7	0.0	-5.0
	2 EQ -X	2.4	0.0	4.6	2.8	0.0	5.3	2.1	0.0	4.0	2.7	0.0	5.0
	3 EQ Z	0.0	-0.2	0.1	0.0	-0.3	0.1	0.0	-0.1	0.1	0.0	-0.2	0.1
	4 EQ-Z	0.0	0.2	-0.1	0.0	0.3	-0.1	0.0	0.1	-0.1	0.0	0.2	-0.1
232	1 EQ X	-0.1	0.0	0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	-0.1	-0.1	0.0
	2 EQ -X	0.1	0.0	-0.1	0.1	0.1	0.0	0.0	0.0	-0.1	0.1	0.1	0.0
	3 EQ Z	0.0	0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.1
	4 EQ-Z	0.0	-0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1

XI. COMPARING THE CONSIDERATION

Sl. No.	Description		Case - 1	Case - 2	Case - 3	Case - 4
1	Wind Load	Wind Speed	50	50	50	50
		k1	1	1	1	1
		k2	1	1	1	1
		k3	1	1	1	1
		k4	1.15	1.15	1.15	1.15
2	Seismic Load	Zone	V	V	V	V
		Importance Factor	1	1	1	1
		Damping	5	2	5	2
		Method	Equivalent static Method	Equivalent static Method	Equivalent static Method	Equivalent static Method
3	Section Classification		Semi-Compact	Semi-Compact	Plastic, Compact	Plastic, Compact
4	Slenderness Ratio		180	180	160	160
5	Connection Bolt		High Strength	High Strength	High Strength Friction Grip	High Strength Friction Grip
6	Steel Take Off from STAAD (MT)		22.38	22.38	29.63	29.63
7	Connection and Bolt weight (MT)		2.68	3.36	6.52	6.52
8	Overall Structural Steel (MT)		25.06	25.74	36.15	36.15
9	Cost Impact of Super Structure (%)		0	2.7	44	44
10	Cost Impact of Sub Structure (%)		0	5	50	52

XII. CONCLUSION

In this paper we have effectively noticed that the warehouse structure designed as per IS 1893 part-1 & IS 800 (LSD) excluding chaper-12 was most economical and likeably safe. Other options like PEB design as per IS 800 with chapter 12 are comparatively uneconomical and likeably safe. PEB structures can be easily designed effortlessly using software and simple calculations for connection design. The opinion of choosing the code is purely based on the structural requirement and customer requirements. We have just compared which options are better for customers when it comes to simple warehouses. The final decision to adopt the option as to be taken between the consultant and the customer.

XIII. ACKNOWLEDGEMENT

I would like to express my deepest gratitude to our Project Guide Mr. Shubham Singh, Assistant Professor, Department of Civil Engineering, Mangalayatan University-Aligarh, who have contributed to the completion of this project "Comparing Seismic Analysis of PEB Shed based on IS Code". Your support, guidance, and encouragement have been invaluable throughout this journey.

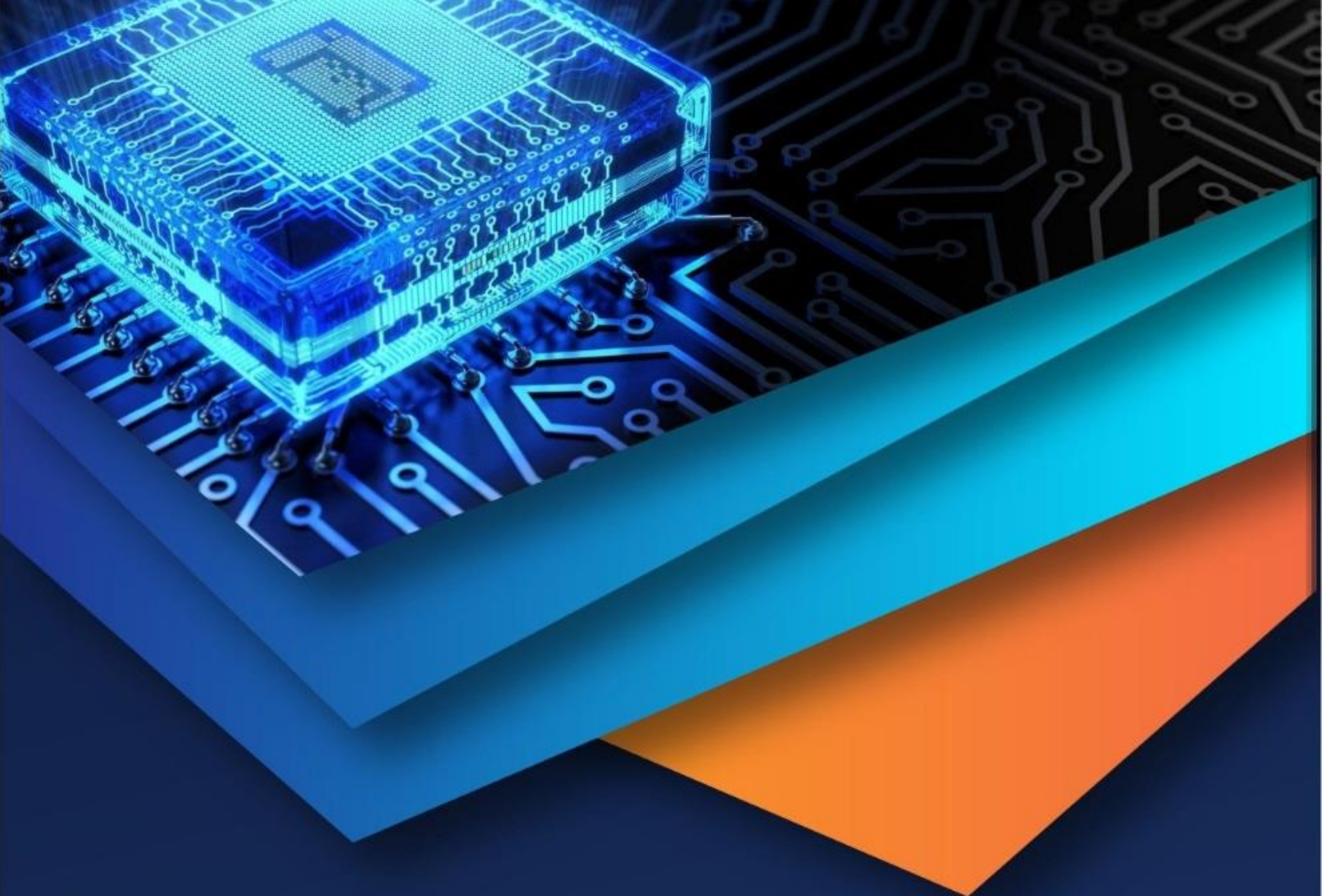
I extend my sincere appreciation to my Guide, for his unwavering support, mentorship, and insightful feedback.
Lastly, I extend my gratitude to all the individuals, resources, and institutions that have in any way contributed to the successful completion of this Course Project. Thank you all for being an integral part of this journey.

REFERENCES

[1] N. Subramanian,2010 "Steel Structures Design and Practice" oxford University press.
[2] The relevant Standard/Codes used for the design for various elements and components of the building are given below

Table 8 – IS Code used in Building Design

S. No	Code	Description
1.	IS:875(Part-1)-1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Unit weights of buildings materials and stored material.
2.	IS:875(Part-2)-1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Imposed loads.
3.	IS:875(Part-3)-2015	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Wind loads.
4.	IS:1893(Part-1)-2016	Criteria for Earthquake Resistant Design of Structures-General Provisions and Buildings
5.	IS:1893(Part-4)-2015	Criteria for Earthquake Resistant Design of Structures-Industrial Structures including Stack-Like Structure
6.	IS: 800-2007	Code of Practice for General Construction in Steel
7.	IS:2062-2011	Hot rolled low, medium and high tensile Structural Steel.
8.	IS: 1161-1998	Specification for Steel tubes for Structural Purposes.
9.	IS:4923-1997	Hollow Steel Sections for Structural use
10.	IS:808-1989	Dimensions for hot rolled steel beams, columns, channels and angle sections
11.	IS: 801-1975	Code of practice for Cold-formed Light gauge steel structural members in General Building Construction
12.	SP	Special Publications of Bureau of Indian Standards



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