International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 01 | Jan 2025 www.irjet.net p-ISSN: 2395-0072

DESIGN AND ANALYSIS OF TWO STEEL BUILDINGS WITH DIFFERENT SECTIONS IN STAAD PRO

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Abstract - *This paper presents a study that analyzes and designs steel members or sections used in the construction of steel structures, focusing on a comparative study of two different sections. Modern steel buildings are increasingly being constructed as high-rise structures in metropolitan areas. These buildings are designed to support vertical gravity loads and lateral loads, such as seismic and wind loads.In this project, we consider a G+10 framed steel structure. The analysis and design are carried out using STAAD.Pro V8i software, with the results discussed in detail. The analysis and design of the steel sections include calculations for dead load, live load, wind load, seismic load, temperature load, and load combinations, all in accordance with the Indian Standard Code of Practice: IS 800:2007, which governs general construction in steel. IS 875 (Part 1) - 1987, which specifies design dead loads (unit weights of building and stored materials) for buildings and structures, and IS 875 (Part 2) - 1987 are among the pertinent codes., which outlines conservatively imposed loads for buildings and structures; IS 875 (Part 3) - 1987, which details design wind loads for buildings and structures; and IS 1893 - 2002/2005, which specifies the design of seismic loads for buildings and structures. According to the Bureau of Indian Standards (BIS) code (i.e., IS: 875), thermal forces are combined with other loads using a load factor of 1.0. In this study, we compare and discuss the nodal displacement, axial force, shear force, bending moment, and storey drift that occur in the overall structure under different loading conditions in the +X direction.*

Keywords: Steel Framed building, Staad Pro V8i, Wind Load, Seismic Load, Bending Moment, Shear Force, Axial Forces, storey drift, Nodal displacement, Multi-storey.

1.INTRODUCTION

1.1 General

Our project focuses on the analysis and design of a G+10 high-rise building using STAAD Pro V8i, chosen for its user-friendly interface, compliance with Indian Standard Codes, and versatility.

We will design a steel structure with S and W sections. For the S section, we will use ISMB 200 beams and ISMB250 columns, while the W section will feature IW500350×2040 beams and IW600350×2040 columns. Both designs will have a 150 mm thick concrete slab and will account for various loads, including live, dead, seismic, wind, and temperature loads. We will compare the models based on nodal displacement, axial forces, shear forces, bending moments, and story drift.

Structural design combines art and science to create safe and durable structures, requiring creativity and a strong understanding of engineering principles and design codes.

Our focus is on a G+10 residential building with a floor-to-floor height of 3 meters, utilizing STAAD Pro for analysis. Typical design problems have been addressed to demonstrate the software's application per IS codes.

STAAD Pro is equipped with advanced visualization tools and analysis capabilities, suitable for various structures, including buildings and bridges. Engineers gather essential data on loads, geometry, and materials to conduct accurate analyses, with results informing assessments of stresses, displacements, and stability.

1.2 Steel

Steel is a crucial construction material known for its rigidity and high strength-to-weight ratio. It is commonly used in buildings, including houses, warehouses, hangars, educational facilities, bridges, and stadiums. The advantages of structural steel include its adaptability, high strength, cost-effectiveness, quick construction, ease of repair or modification, and reliability.

1.2.1 Properties of Steel

Key properties of structural steel include:

Density: Ranges from 7750 to 8100 kg/m^3.
Young's Modulus of Elasticity: Between 190 and 210 GPa.
Poisson's Ratio: Ranges from 0.27 to 0.3.
Tensile Strength: High tensile strength preferred over other materials.
Yield Strength: Ranges from 187 to 758 MPa for carbon steel and 366 to 1793 MPa for alloyed steel.
Shear Strength: About 0.57 times the yield stress.

Hardness: Varies for alloys, typically from 149 to 627 kg for structural steel.
Specific Heat: For carbon steel, ranges from 450 to 2081 J/kg·K.

1.2.2 Types of Steel

1) Based on Carbon Content
Carbon Steel: Contains up to 2% carbon; ultimate tensile strength of 410–440 MPa.
High-Strength Carbon Steel: Used in transmission lines; tensile strength of 480–550 MPa.
Micro-Alloyed Steel: Enhanced ductility; tensile strength of 440–590 MPa.
Quenched and Tempered Steel: Heat-treated for strength; tensile strength of 440–590 MPa.
Weathering Steel: Corrosion-resistant; tensile strength of 480 MPa.
Fire-Resistant Steel: Thermo-mechanically treated for fire resistance.

2) Based on Shapes and Forms
Structural steel members include:

- I-Sections (Beam Sections)
- Channel Sections
- Tee Sections
- Angle Sections
- Bars
- Tubes
- Flats
- Sheets

This condensed version maintains the essence of the original content while being more concise.

1.3 Steel Structure

Steel structures are assemblies of structural steel shapes that are connected by welding, bolting, or riveting. While steel constructions must be chosen from the market, the majority of concrete structures are cast in-situ. In concrete constructions, joints are monolithic, while in steel structures, individual elements must be joined using specific techniques. Connections and features in steel constructions must be engineered to withstand anticipated forces. Almost any kind of structure, including skyscrapers, bridges, industrial buildings, high-rise buildings, etc., is made of steel.

1.4 STAAD PRO V8i

Originally, STAAD Pro was developed by Research Engineers International in Yorba Linda, California. Late in 2005, Bentley Systems purchased Research Engineers International. Structures such as bridges, towers, skyscrapers, transit systems, industrial facilities, and utility structures may all be evaluated and constructed with STAAD Pro, a tool for structural analysis and design. With STAAD Pro V8i, you can evaluate and design any engineering structure.

This software makes it easier to create 3D models, multi-material designs, and framed buildings. In line with the grid-like structure architecture, it offers modeling tools and templates, code-based prescriptions, analysis techniques, and solution approaches. The STAAD Pro V8i version supports both simple and complex systems and enables evaluations in both static and dynamic scenarios. Applications of various complexity can be easily created because to its integration features and intuitive UI. For designs ranging from basic 2D frames to intricate contemporary high-rises, STAAD Pro is a well-structured and effective tool because of its connectivity with multiple design and documentation platforms. The following details are included in this chapter:

1. Structural System Modeling
2. Design, Analysis, and Loading
3. Interoperability and Output Versatility

1.5 Terms and Definitions

1.5.1 Storey Drift

The storey height divided by the storey drift—the lateral displacement of one level relative to the floor below—is the storey drift ratio. When analyzing the effects of lateral stress brought on by seismic or wind loads on a multi-story building, the storey shear and storey drift graphs offer a useful narrative. There are graphs that show the displacement distribution by altitude.

1.5.2 BENDING MOMENT

When a structural member is exposed to an external force or moment, it reacts by bending, a phenomenon known as a bending moment. The most common or fundamental structural element that is subject to bending moments is the beam. In other words, the resistance to a member's rotation that arises from applying load to the structure at a distance from the reference point is known as the bending moment. The kind, intensity, and distance of the load from the reference point all affect the applied moment. The bending moment is also influenced by the type of support.

1.5.3 SHEAR FORCE

Shear force, like the airflow pressure across an airplane wing, is a force that acts parallel to a surface or cross section of a body. It alludes to this force's capacity to sever surfaces. The tangential component of an applied force is what causes shear force, which operates tangentially. Through shear resistance, the body opposes this force, causing its cross-section to deform and generating shear strain and shearing stresses. The parts that follow will provide more information on shear force.

1.5.4 AXIAL FORCE

Axial force is a force that acts along the axis of a body. This type of force can be either tensile, which pulls the body apart, or compressive, which pushes the body together.

1.5.5 MULTI-STOREY

Multi-storey buildings provide an effective solution for affordable living spaces and dense settlements.

The structure of a multi-storey building typically incorporates the following elements:

- Framed structure: Forms the basic foundation of the building.
- Propped structure: Provides a platform for supporting columns.
- Suspended structure: Features horizontal floors supported by high-strength steel cables.
- Cantilever structure: Eliminates the need for columns in certain areas.
- Braced structure: Uses braced frames to reduce lateral displacement and bending moments in columns.
- Shear wall structure: Counteracts lateral forces and wind pressures.
- Core structure: Houses lifts, stairs, and other vertical services.
- Tube-in-tube structure: Consists of the central tube that houses the building's utilities and services.

1.5.6 PLAN OF THE BUILDING

Building plans are detailed graphical representations that depict how a building will look after construction. They are essential for builders and contractors in constructing various types of structures. Additionally, building plans help estimate project costs and prepare budgets by outlining the design, materials, and dimensions needed, allowing for effective financial planning and resource allocation.

1.5.7 ELEVATION OF THE BUILDING

An image that depicts a building or structure's height, length, width, and look is called an elevation.

2. SCOPES AND OBJECTIVES

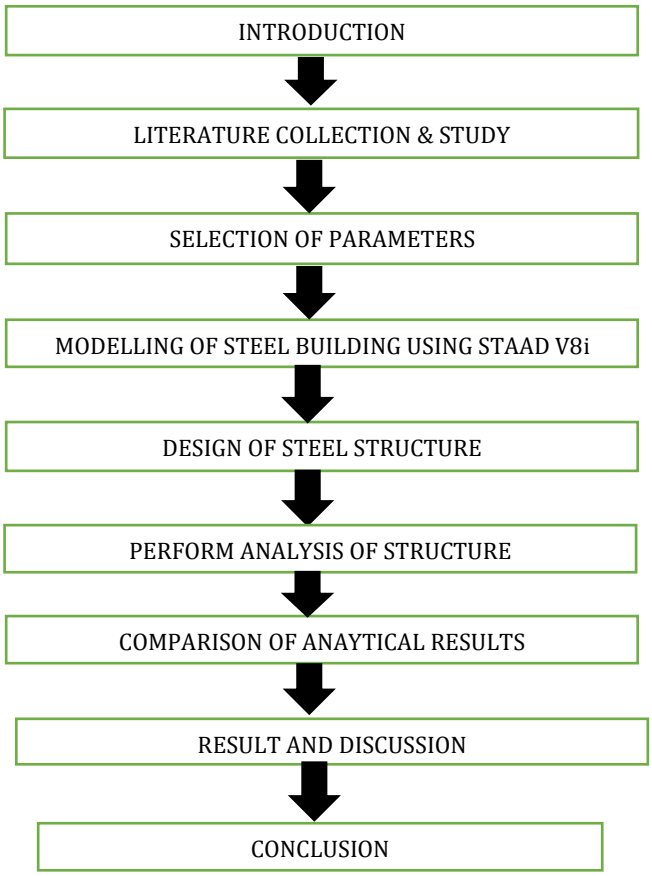
2.1 Scope Of The Project

- The structure should be safe, stable and don't collapse under applied load.
- Provide complete set of drawing for practical uses.
- Study and analysis of output of steel structure in staad pro V8i software.
- To evaluate the response of Steel framed structure in terms of displacement, Support reaction, storey drift.
- To study about node displacement, axial force, shear force, bending moment and storey drift.

2.2 Objective of The Project

- To use software to gather data for modelling
- Steel Multi-storeyed building with two different sections using Staad pro V8i
- To perform analysis of the multi-storeyed steel building in Zone II
- To understand the behaviour of two steel structures with different sections.
- To know the behaviour of steel structures under different loads such as Dead load, Live load, Wind load, Temperature loads, Seismic load and combinations of loads for a given area.
- To compare both the results obtained from Staad pro V8i software with different sections.

3.METHODOLOGY



4.IS CODES AND LOADS CONSIDERATIONS

4.1 Is Codes

- IS 800:2007 - Guidelines for general steel construction.
- IS 875 (part 1) - 1987The design dead loads (unit weights of building and storage materials) for buildings and structures are provided by Indian Standard Codes.
- IS 875 (part 2) - 1987: Indian Standard Codes specify conservative load limits for buildings and structures.
- IS 875 (part 3) - 1987: Indian Standard Codes specifies wind loads for building and structure design.
- IS1893-2002/2005: Indian Standard Codes provides design of seismic loads for building and structures.
- As per the BIS code (i.e. IS:875), The thermal forces are displayed with a load factor of 1.0 when paired with other loads

4.2 Loads on Structure

Structural loads play an essential role in the design of buildings. Building regulations require that structures are designed and built to endure all possible forces they might face throughout their operational lifespan; while ensuring they remain functional and suitable for use.

4.2.1 Dead Loads

All fixed components of a building contribute to dead loads, which include the weights of walls, partitions, floor finishes, and other permanent features. These loads are calculated based on the dimensions and unit weights of elements, with typical unit weights being 24 kN/m^3 for plain concrete and 25 kN/m^3 for reinforced concrete. Dead loads are considered static or permanent and are counted only after materials are permanently installed. The standard IS 875 (Part 1) – 1987 provides guidelines on unit weights of building materials.

4.2.2 Imposed Loads

Imposed loads, or live loads, are created by how a building is used, including the weight of movable partitions and changing factors like impact, vibration, and maintenance activities. These temporary loads also account for occupants, tools, and items like planters. In bridges, live loads come from vehicles passing over. It's important to note that imposed loads exclude environmental factors such as wind, seismic forces, snow loads, and temperature changes, as well as structural issues like creep or uneven settling.

4.2.3 Wind Load

Air in motion with respect to the earth's surface is called wind. The earth's rotation and variations in terrestrial radiation are thought to be the main causes of wind. Convection, either upward or downhill, is mostly caused by radiation impacts. At high wind speeds, the wind often travels horizontally toward the ground. Vertical winds are always labeled as such since the name "wind" virtually solely refers to the horizontal wind due to the comparatively minor vertical components of atmospheric motion. Wind speeds are measured with anemometers, sometimes referred to as anemographs. They are often placed at meteorological observatories at elevations between 10 and 30 meters above the ground.

Design Wind Speed (V_z)

To get the design wind velocity at any height (Vz) for the selected structure, the fundamental wind speed (Vb) for any site must be derived from or altered to incorporate the following effects: degree of risk; local topography, structure height and size, and terrain roughness.

A mathematical expression for it is as follows:

$$V_z = V_b \times k_1 \times k_2 \times k_3$$

Where,

V_z = design wind speed in meters per second at any height z

k_1 = probability factor (risk coefficient)

k_2 = terrain, elevation, and the structure's size, and

k_3 = topography factor

a. The Risk Coefficient (k1 Factor) indicates fundamental wind speeds for Category 2 terrain at 10 meters above ground level, based on a 50-year mean return period. Buildings must be designed using a regional basic wind speed for this timeframe.

b. When evaluating wind impacts, the k2 factor takes topography, height, and structural size into account.

Terrain types are crucial for design and include: Category 1: Unobstructed open landscape with objects under 1.5 m.

Category 2: Open terrain with sparse obstacles 1.5–10 m high.
Category 3: Areas with closely spaced obstacles up to 10 m.
Category 4: Terrain with many large, closely spaced obstacles.

c. The topography (k3 factor) influences wind speed, accounting for site elevation but not local features like hills or valleys. Wind can accelerate on hilltops and decelerate in valleys.

Wind Pressures and Forces on Buildings/Structures:

A building's wind load must be determined for the following reasons:

a. the building overall,
b. specific structural components such walls and roofs
c. Separate cladding units, complete with glazing and fasteners.

Design Wind Pressure

The wind pressure at any height above mean ground level will be calculated using the relationship between wind speed and wind pressure as follows:

$$p_z = 0.6V_z^2$$

Where,

p_z= wind pressure at height z in N/m2.

V_z= design wind speed at height z in m/s

One can determine the design wind pressure p_d as follows:

$$p_d = K_d K_a K_c p_z$$

Where,

K_d = Wind directionality factor

K_a= Area averaging factor

K_c= Combination factor

Pressure Coefficients - The pressure coefficients are always given for a specific surface or area of a building's surface. The area of a surface or a suitable piece of it is multiplied by the pressure coefficient (C) and the design wind pressure at the surface's elevation above the ground to determine the wind load acting normal to that surface. Next, the wind load, F, acting perpendicular to the individual cladding unit or structural element is:

$$F = (C_{pe} - C_{pi})Ap_d$$

Where,

$C_{pe=}$ External pressure coefficient,

C_{pi} = internal pressure coefficient

A = surface area of a structural component

p_d= design wind pressure

4.2.4 Seismic Load

Seismic loading refers to the application of earthquake-like forces on structures, primarily at their contact points with the ground or nearby structures. The first step in earthquake engineering is to calculate the overall design lateral force, which is then distributed across different floor levels based on diaphragm action. Dynamic analysis, which determines the design seismic force distribution, applies to:

1. Regular Buildings: Structures over 90 meters in Zones II and III. - Structures over 40 meters in Zones IV and V.

2.Irregular Buildings: Framed structures over 12 meters in Zones IV and V, and over 40 meters in Zones II and III.

Although not required, dynamic analysis is suggested for irregular buildings under 40 meters in Zones II and III, using either the Response Spectrum Method or the Time History Method, while comparing design base shear (VB) from both methods.

Earthquake Zones in India.

India has four seismic zones (II, III, IV, and V), with Zone I being excluded from classification.

Zone V: High-risk area for earthquakes with intensity MSK IX or higher, with a zone factor of 0.36. It includes regions like the Andaman and Nicobar Islands and the Himalayas.

Zone IV: Prone to MSK VIII intensity earthquakes, classified as a High Damage Risk Zone, with a zone factor of 0.24.

Zone III: Similar to Zone IV, also experiencing MSK VIII earthquakes with a zone factor of 0.24.

Zone II: Low Damage Risk Zone for earthquakes with intensity MSK VI or lower, with a zone factor of 0.10, indicating a maximum horizontal acceleration of 10% of gravitational acceleration.

4.2.5 Thermal Load

The term "thermal load" refers to high temperatures that have an impact on any construction,

including the temperature of the air outside, the temperature of the air inside, the temperature of the air underground, the temperature of the heat source equipment inside the building, and the temperature of the material storage tanks. Thermal stress, which is the result of thermal load, is caused by temperature changes in both structural and non-structural members.

5.MODELLING OF BUILDING

5.1 Building Configuration

The model of the following buildings is developed to perform the response in Staad Pro.V8i :

1. Steel framed building with S-Section
2. Steel framed building with W-Section

SL.NO	DESCRIPTION	REMARKS
1.	Structure Type	Framed
2.	Length of the building	15 m
3.	Width of the building	12 m
4.	Height of the building	33 m
5.	No. of Storey	G+10
6.	Grade of Concret	M35
7.	Grade of Steel	Fe 500
8.	Bay Width along X direction	3 m
9.	Bay Width along Y direction	3 m
10.	Bay Width along Z direction	3 m
11.	No. of bay along X direction	5
12.	No. of bay along Y direction	4
13.	No. of bay along Z direction	11
14.	Floor to Floor height	3 m
15.	Thickness of Slab	150 mm

Table 5.1 Building Configuration

With the above-mentioned data, two types of Steel framed buildings are modelled:

1. MODEL 1- Steel framed building with S-Section
2. MODEL 2- Steel framed building with W-Section

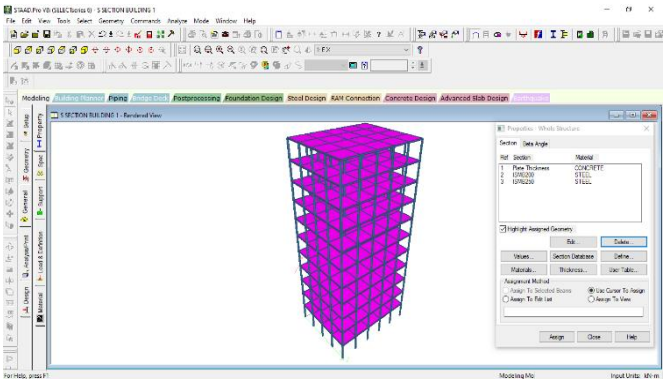


Figure 5.1 Steel Framed Building with S-Section

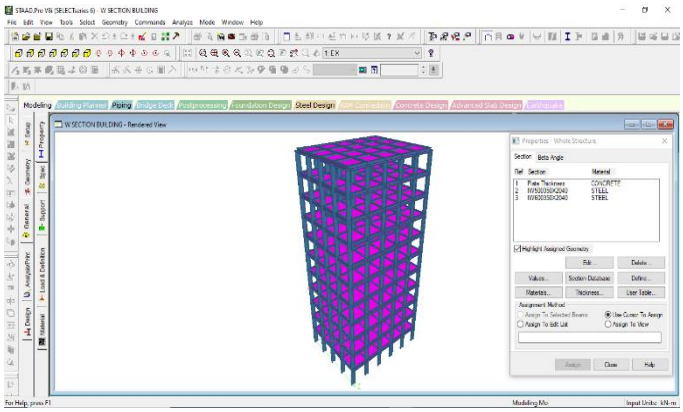


Figure 5.2 Steel Framed Building with W-Section

5.2 Plan Of The Building:

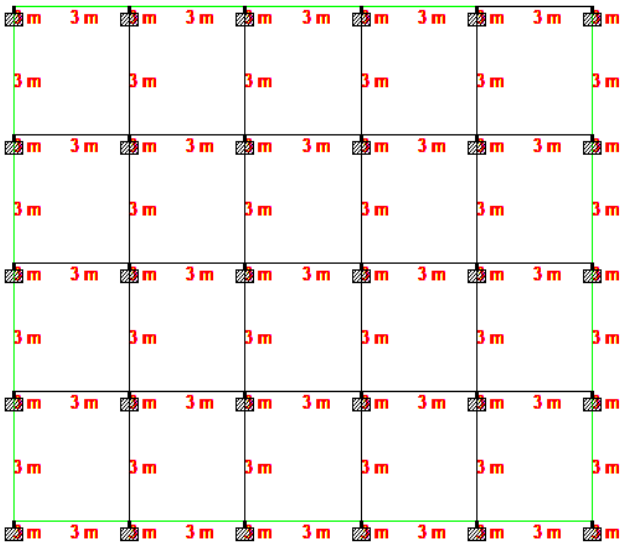


Figure 5.3 Plan of the Building

5.3 Elevation Of The Building:

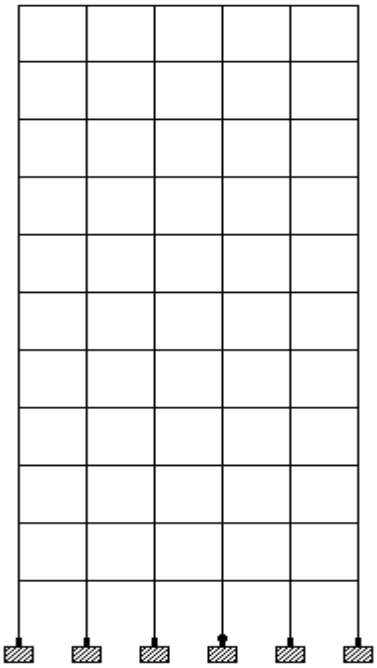


Figure 5.4 Elevation of the Building

6.DESIGN AND ANALYSIS

6.1 Step by Step Procedure for Analysis Steel Framed Building in Staad Pro V8i

Step 1: Start Project:

Start New Project >Write down file name >Select space, location and units >Add beam >Finish.

STEP 2: Create a new model:

To Select geometry > Run Structure Wizard > Model type Frame Model> Bay Frame> Apply > ok.

i. Length of the bay along X- direction, L =15 m

ii. Width of the bay along Y- direction, W =12 m

iii. Height of the building, H = 33 m

iv. No of bays along X- direction = 5

v. No of bays along Y- direction = 4

vi. No of bays along Height = 11 (G +10)

Transfer the model.

STEP 3: To create Continuous slab for the flat slab

Go to Front view > Cut section > select to view > Ok > Cut bottom section

Add Plate > Select all the 4 node points using Node Cursor > Display whole structure command

Select plate cursor > Select plate > Translational repeat > Select Y direction, no. of steps = 10, spacing =03m > Ok

STEP 4: Assign the property of the beam, column, and slab:

Go to general > Section database > Select Indian > Select section > Close > Thickness (0.15m) > Add > Close

Go to Tools > Create new group > Group name: beam, column, and slab > Select the members > Associate the property

STEP 5: Assign the support

Go to front view > Support > Create > Fixed support > Assign all the bottom nodes>ok.

STEP 6: Define Load

Load and definitions > Definitions > Seismic definitions > Add > Select type: IS1893-2002/2005 > Include 1893 part 4 > Generate

Seismic parameters > Select: city, zone-2 (Z=0.1), response reduction (steel moment resisting frame design =5, building type=all general building (IF=1.0), soil type= soft soil, structure type= steel frame structure and damping ratio=5% > Add

Click on zone 2, RF=5…. > Add.

Self-weight > Factor 1 >Add Member weight > Loading type > UNI > Write the value of weight > Assign the selected beam > Assign.

Definitions > Wind definitions > Wind >Add

Select wind load > Add > Select custom > Select cal. As per ASCE 7-2010 > Category II > Basic wind speed= 50m/s >Exposure –B > Apply > Select main building data: height, length and width >Apply > Select windward for design pressure > Apply > Ok

Add > Exposure factor 1 > Assign to view > Close

STEP 7: Load Case Details

Load Case Details > Add > Define > Loading Type = Seismic Load > EX, EZ > Add > X&Z direction, factor= 1> Close

Define > Load type = Dead Load > DL> Self-weight = 1> ok

Define > Load Type = Live Load > LL > Self weight = -4.5> ok

Load case Details > Define > Load type= Wind load –WX, WZ > Add > Wind factor > Add > Close

Define > Load Type = Temperature Load > TL > Select TL >Add> Temperature Differential from Top to Bottom > Add >Close.

STEP 8: Assigning of Loads

Select EX, EZ > Assign to selected > Assign > Yes

Select DL > Assign to view > Assign > Yes

Select LL > Assign to view > Assign > Yes

Select WXWZ Load > Assign to view > Assign > Yes

Select TL> Assign to view > Assign > Yes

6.2 Design of The Steel Structures

6.2.1 Parameters of Steel Sections

For W-Section

W-SECTION		
PARAMETER (UNITS)	BEAM IW500350×2040	COLUMN IW600350×2040
A_x (cm^2)	353.00	402.00
D (mm)	568.00	668.00
B_f (mm)	250	250
T_f (mm)	15	21.0
T_w (mm)	10	11
I_z (cm^4)	21279.00	333343.00
I_x (cm^4)	839.00	958.00
I_y (cm^4)	26523.00	28237.00
Z_x (cm^3)	7732.00	10147.00
Z_y (cm^3)	2074.00	2286.00

Table 6.1 Parameters of W-section

For S-Section

S-SECTION		
PARAMETER (UNITS)	BEAMS ISMB 200	COLUMNS ISMB 250
A_x (cm^2)	30.80	47.60
D (mm)	200	250
B_f (mm)	100	125
T_f (mm)	10	12.50
T_w (mm)	5.70	6.90
I_z (cm^4)	2115.00	5132.00
I_x (cm^4)	10.60	25
C_t (cm)	2.20	2.70
I_y (cm^4)	137.00	335.00
Z_x (cm^3)	240.00	466.00
Z_y (cm^3)	46.00	89.70

Table 6.2 Parameters of S-section

6.2.2 Calculation of Member Weight

i. **ISMB 200:**

Area =30.80cm^2= 30.80×$10^{-4}m^2$

Unit weight of steel= 78.50kN/m^3

Member weight= $\frac{30.80}{10000} \times 78.50$ kN/m =0.24178kN/m

ii. **ISMB 250:**

Area =47.60cm^2= 47.60×$10^{-4}m^2$

Unit weight of steel= 78.50kN/m^3

Member weight=$\frac{47.60}{10000} \times 78.50$ kN/m=0.37366 kN/m

iii. **IW500350×2040:**

Area =353.00cm^2= 353×$10^{-4}m^2$

Unit weight of steel= 78.50kN/m^3

Member weight=$\frac{353}{10000} \times 78.50$ kN/m=2.77105 kN/m

iv. **IW600350×2040**

Area =402.00cm^2= 402×$10^{-4}m^2$

Unit weight of steel= 78.50kN/m^3

Member weight=$\frac{402}{10000} \times 78.50$ kN/m= 3.1557 kN/m

6.2.3 Design for Bolted Connection

Bolted connection to column

For, M20 grade 4.6 bolts and an 8mm thick end plate

i. The shear capacity of the bolt in single-shear

$$V_{dsb} = \frac{f_{ub}}{\sqrt{3}\gamma_{mb}}(n_n A_{ns} + n_s A_{sb})$$

$$= \frac{410}{\sqrt{3}\times 1.25}(1 \times 0.78 \times \frac{\pi}{4} \times 20^2)$$

= 46.38 kN

ii. Bearing capacity of bolt-on an 8mm thick end plate

d = 20mm

$d_0 = 20 + 2$= 22mm

e =1.5×d_0 = 1.5×22 = 33mm

p =2.5×d = 2.5×20 = 50mm

K_b Is smaller of the following:

$K_b = \frac{e}{3d_o} = \frac{33}{3\times 22} = 0.50$

$K_b = \frac{p}{3d_0} - 0.25 = \frac{50}{3\times 22} - 0.25 = 0.50$

$K_b = \frac{f_u}{f_{ub}} = \frac{400}{410} = 0.97$

$K_b = 1.0$

Hence, $K_b = 0.50$

$$V_{dpb} = \frac{2.5 \times k_b \times d \times t \times f_{ub}}{\gamma_{mb}}$$

$$V_{dpb} = \frac{2.5 \times 0.50 \times 20 \times 8 \times 410}{1.25}$$

= 65.6 kN

∴Bolt value = 46.38 kN

No. of bolts = $\frac{150}{46.38} = 3.23 \approx 4$

End plate calculation

Use a 140×8mm plate, 125mm deep

Length of fillet weld connecting the end plate to the beam web

=125-10-11

=104 mm on each side.

Shear on weld

$= \frac{150 \times 10^3}{2 \times 104}$

= 721.153 N/mm

Use an 8mm fillet weld

Strength of weld

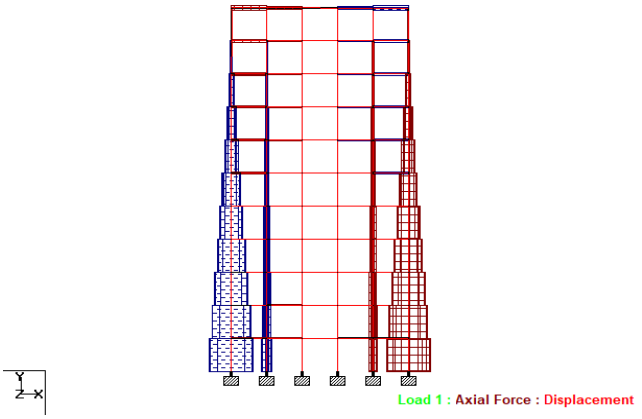
$= \frac{8\times 0.7\times 410}{\sqrt{3}\times\gamma_{mw}} = \frac{8\times 0.7\times 410}{\sqrt{3}\times 1.5}$ = 883.75 N/mm

Strength of weld > Shear on weld

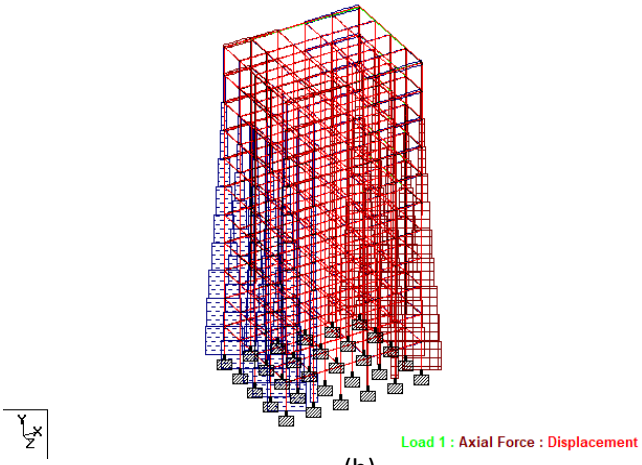
Hence, the connection is safe.

6.3 Analysis of Building

6.3.1 axial force:

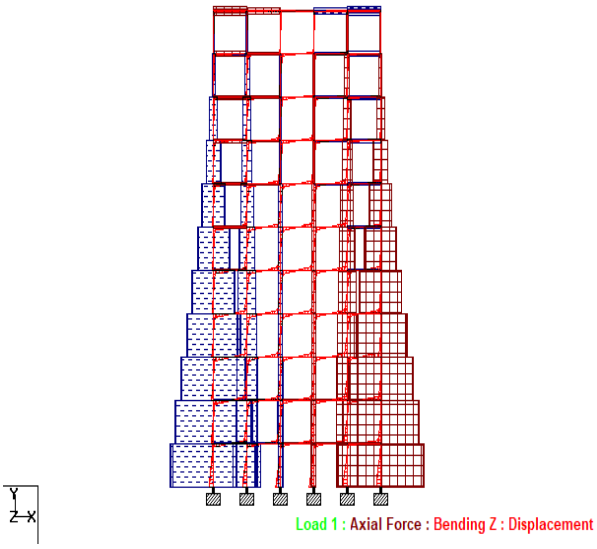


(a)

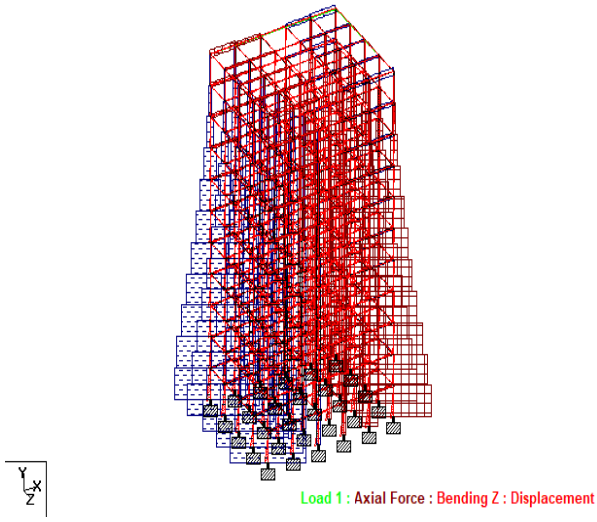


(b)

Figure 6.1 Axial Force Of S-Section Building: (a)Front View, (b) 3D View



(a)

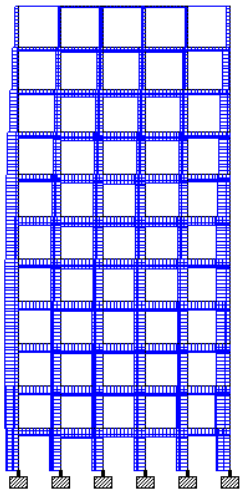


(b)

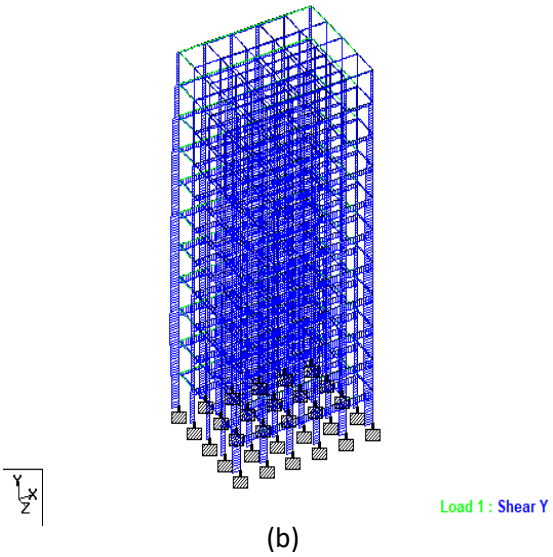
Figure 6.2 Axial Force Of W-Section Building:

(a)Front View, (b) 3D View

6.3.2 Shear Force:



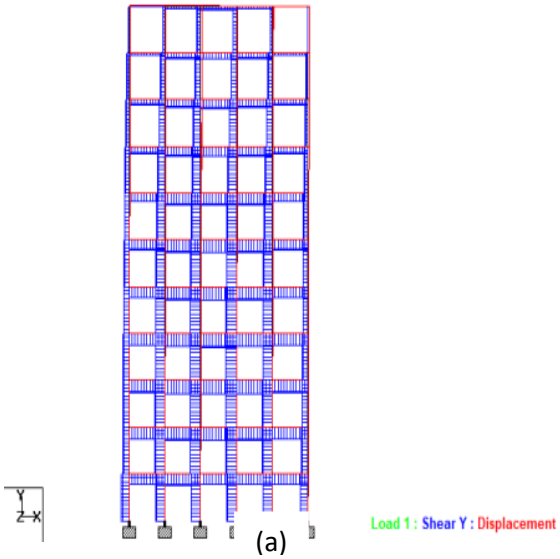
(a)



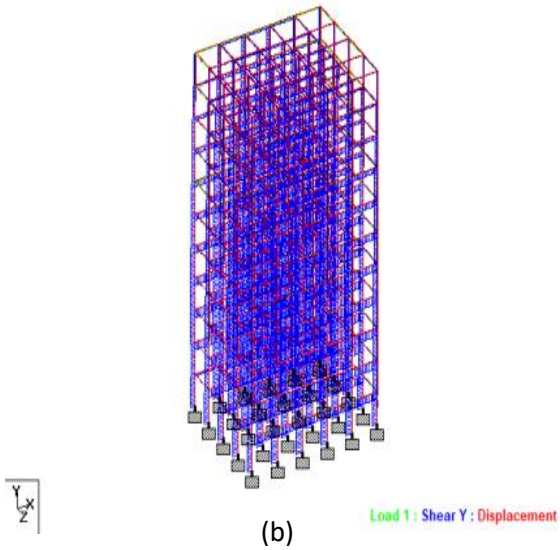
(b)

Figure 6.3 Shear Force Of S-Section Building:

(a)Front View, (b) 3D View

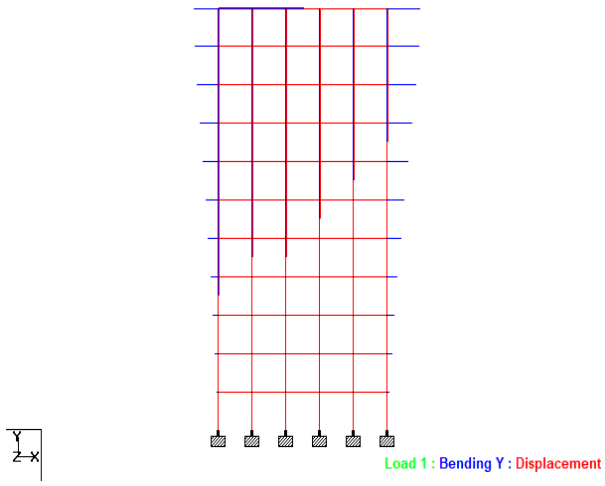


(a)

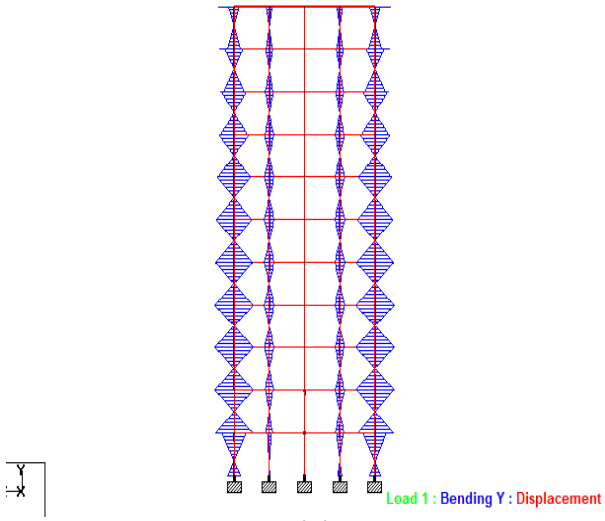


(b)

6.3.3 Bending Moment:



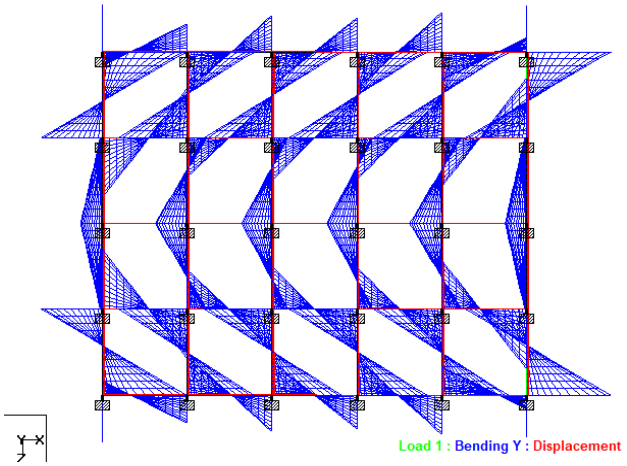
(a)



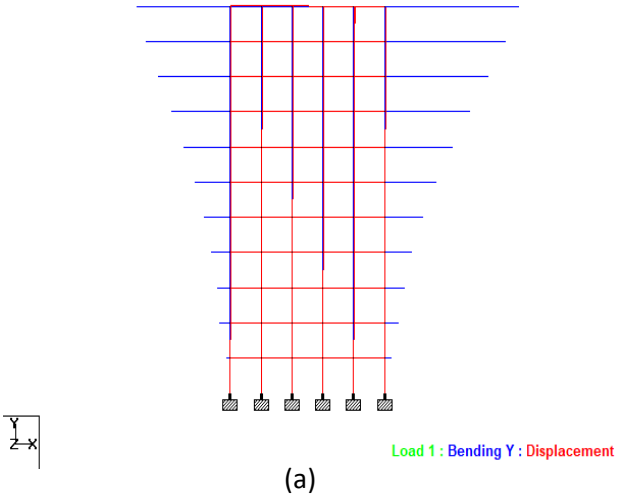
(d)

Figure 6.4 Shear Force Of W-Section Building

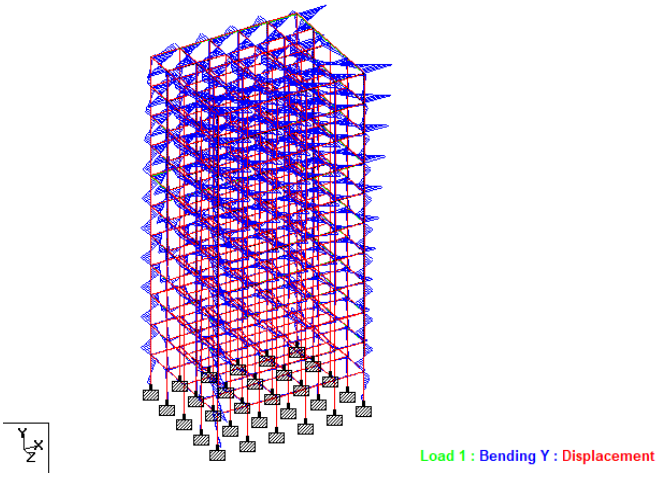
(a) Front View, (b) 3D View



(c)



(a)



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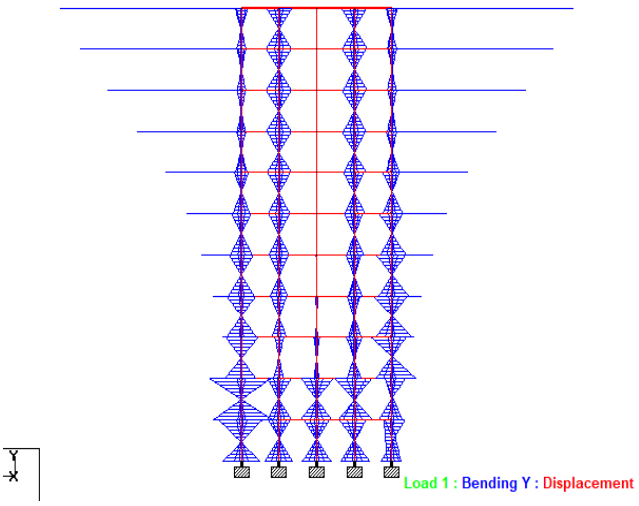
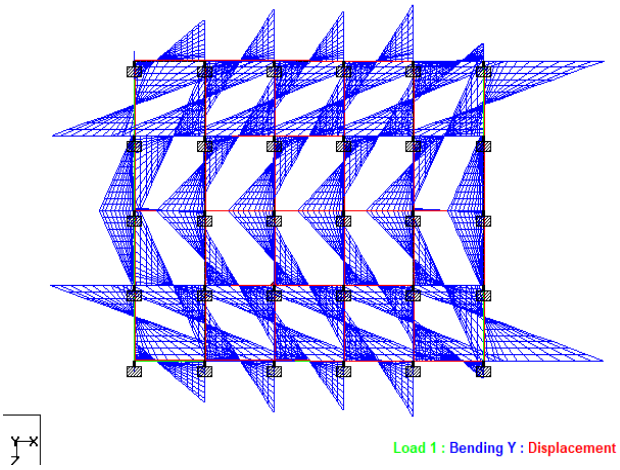


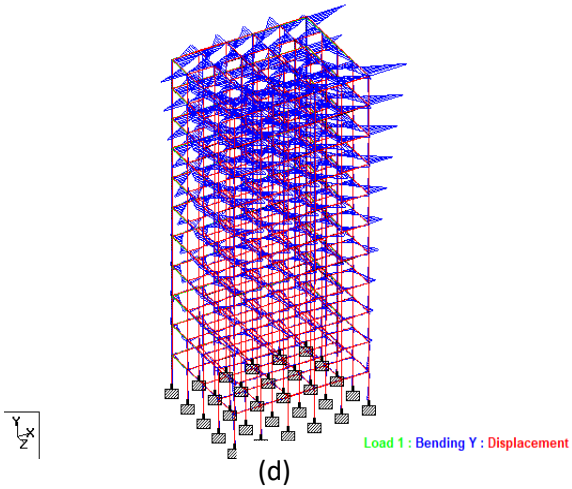
(b)

Figure 6.5 Bending Moment Of S-Section Building:

(a) Front View, (b) Side View, (c) Top View, And (d) 3d View



(c)



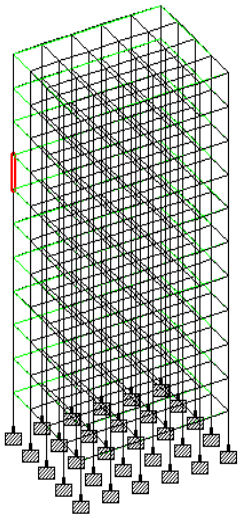
(d)

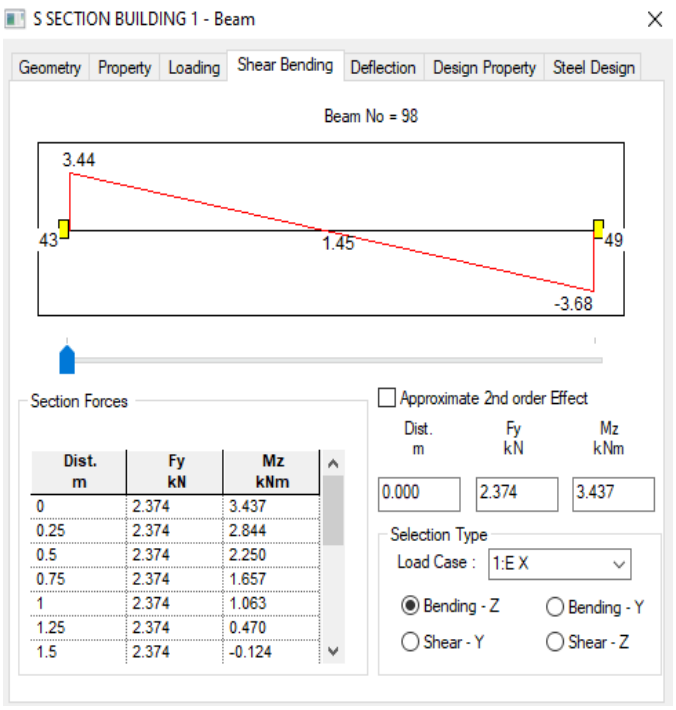
Figure 6.6 Bending Moment Of W-Section Building:

(a) Front View, (b) Side View, (c) Top View And (d) 3d View

6.3.4 Shear, Bending Moment, and Deflection of a Beam:

Beam No. 98:





Dist. m	Fy kN	Mz kNm
0	2.374	3.437
0.25	2.374	2.844
0.5	2.374	2.250
0.75	2.374	1.657
1	2.374	1.063
1.25	2.374	0.470
1.5	2.374	-0.124

Figure 6.7 Bending Moment of A Beam Of S-Section Building

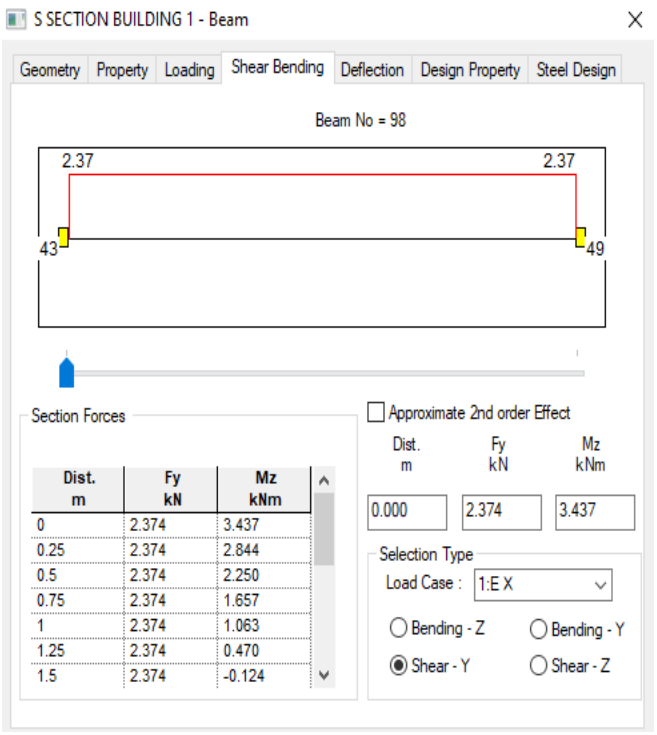


Figure 6.8 Shear Force of a Beam Of S-Section Building

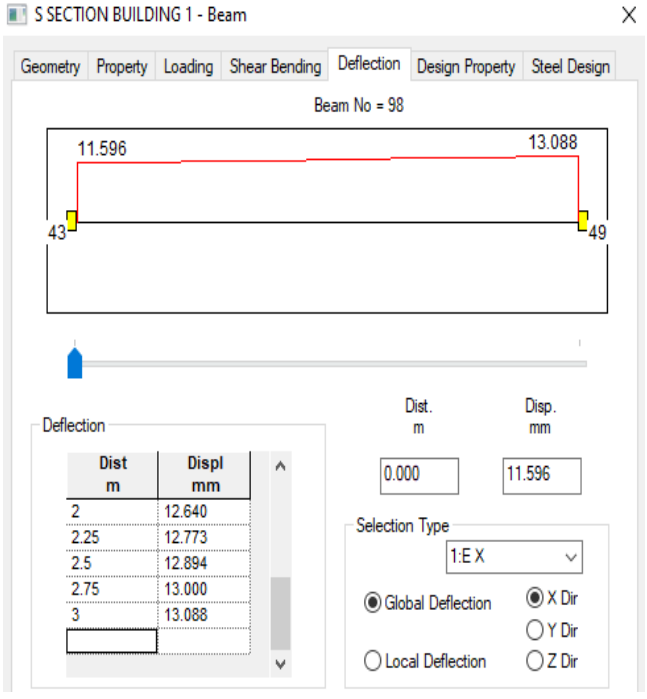


Figure 6.9 Deflection of A Beam Of S-Section Building

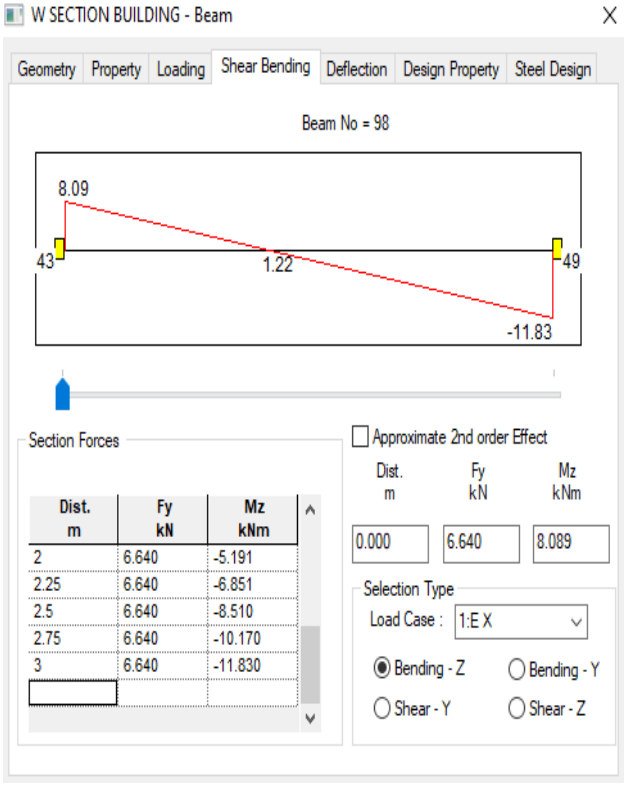


Figure 6.10 Bending Moment of A Beam Of W-Section Building

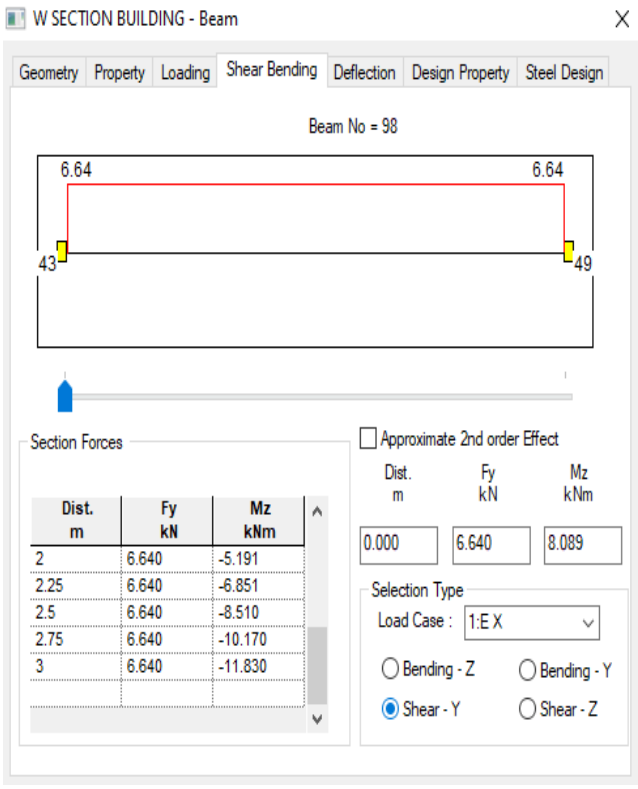


Figure 6.11 Shear Force of A Beam Of W-Section Building

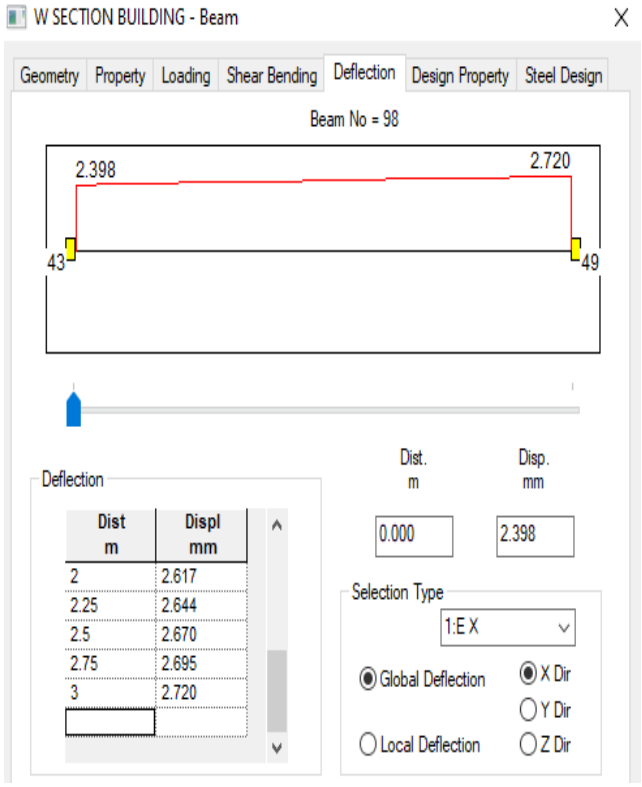


Figure 6.12 Deflection of A Beam Of W-Section Building

7. RESULT AND DISCUSSION

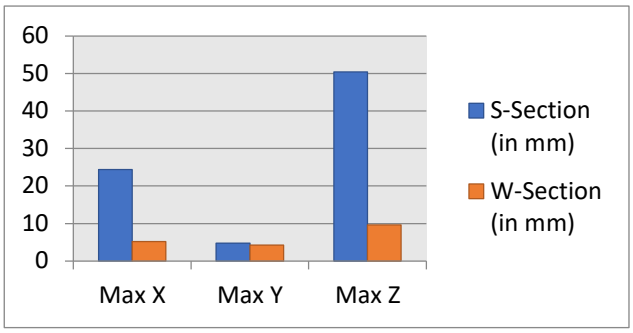
For both W-Section and S-Section Steel Frame Buildings: displacements, Shear forces, and bending moments were calculated and they are tabulated below:

7.1 Node Displacement

7.1.1 Maximum Node Displacement:

Maximum Node Displacement		
Parameter	S-Section (in mm)	W-Section (in mm)
Max X	24.371	5.153
Max Y	4.770	4.254
Max Z	50.402	9.635

Table 7.1 Maximum Node Displacement



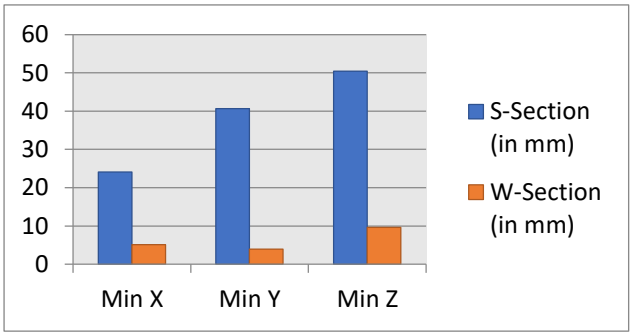
Graph 7.1 Maximum Node Displacement

From the above graph of Maximum Node Displacement, it can be observed that W–section steel structure shows less displacement values when compared to S-section steel structures in all direction. Lesser Node Displacement shows higher Stability.

7.1.2 Minimum Node Displacement:

Minimum Node Displacement		
Parameter	S-Section (in mm)	W-Section (in mm)
Min X	24.063	5.118
Min Y	40.648	3.944
Min Z	50.423	9.633
All values are negative and it indicates the downward direction.		

Table 7.2 Minimum Node Displacement



Graph 7.2 Minimum Node Displacement

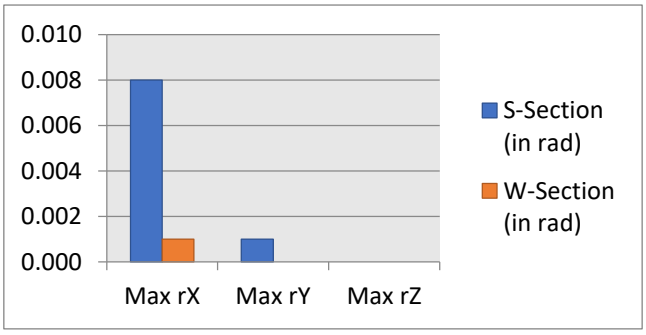
Graph of Minimum Node Displacement shows that W–section steel structure show less displacement values when compared to S-section steel structures in all direction. If Node Displacement value is less then it gives higher Stability.

Also, it can be concluded that from displacement point of view S-section steel structures are not suitable in high rise construction of building and if used special displacement controls measure should be followed.

7.1.3 Maximum Rotational Node Displacement:

Table 7.3 Maximum Rotational Node Displacement

Maximum Rotational Node Displacement		
Parameter	S-Section (in rad)	W-Section (in rad)
Max rX	0.008	0.001
Max rY	0.001	0.000
Max rZ	0.000	0.000



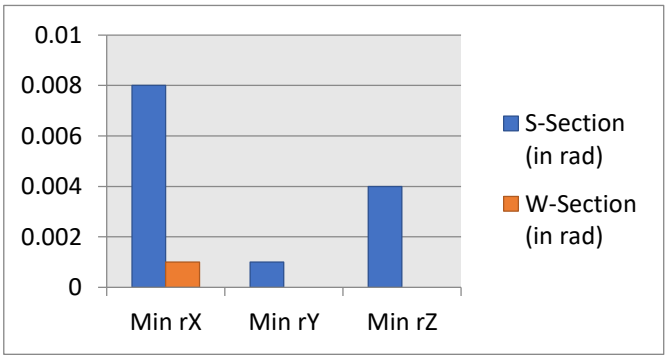
Graph 7.3 Maximum Rotational Node Displacement.

From the above graph of Maximum Rotational Node Displacement, it can be observed that W–section steel structure shows less rotational displacement values when compared to S-section steel structures in all direction. Lesser Rotational Node Displacement shows higher Stability.

7.1.4 Minimum Rotational Node Displacement:

Minimum Rotational Node Displacement		
Parameter	S-Section (in rad)	W-Section (in rad)
Min rX	0.008	0.001
Min rY	0.001	0.000
Min rZ	0.004	0.000
All values are in negative and it indicates the downward direction		

Table 7.4 Minimum Rotational Node Displacement



Graph 7.4 Minimum Rotational Node Displacement

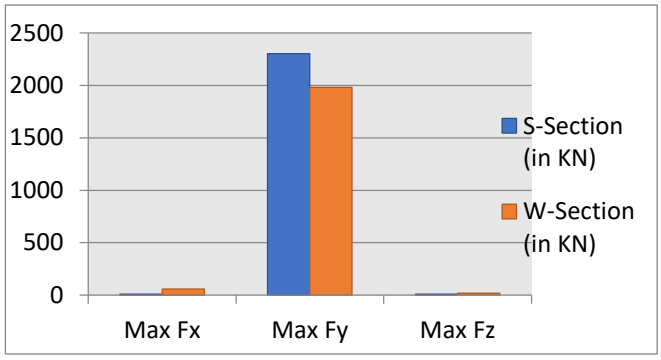
Graph of Minimum Rotational Node Displacement shows that W–section steel structure show less displacement values when compared to S-section steel structures in all direction. If Rotational Node Displacement value is less then it gives higher Stability.

7.2 Axial Forces, Shear Forces and Bending Moment

7.2.1 Maximum Axial Forces and Shear Forces:

Maximum Axial Forces and Shear Forces		
Parameter	S-Section (in KN)	W-Section (in KN)
Max Fx	9.016	58.260
Max Fy	2300.437	1982.674
Max Fz	8.453	19.506

Table 7.5 Maximum Axial Forces and Shear Forces



Graph 7.5 Maximum Axial Forces and Shear Forces

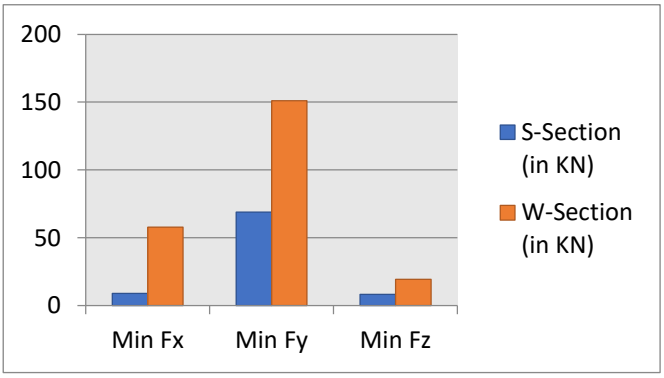
Graph of maximum axial forces and shear forces shows that there is no considerable difference in magnitude of forces in X direction and Z direction but has significant change in Y direction. W-Section has high horizontal values but have lower values on in Y direction. In W-Section, Shear Force value is less when compared to

S-Section. For higher stability of structure, shear force should be less.

7.2.2 Minimum Axial Forces and Shear Forces:

Minimum Axial Forces and Shear Forces		
Parameter	S-Section (in KN)	W-Section (in KN)
Min Fx	9.073	57.917
Min Fee	69.043	151.027
Min Fz	8.452	19.505
All values are in negative and it indicates the downward direction		

Table7.6 Minimum Axial Forces and Shear Forces



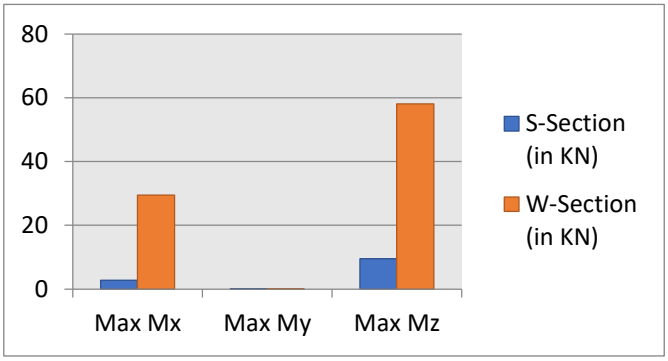
Graph 7.6 Minimum Axial Forces and Shear Forces

From the above graph of minimum axial forces and shear forces, it can be observed that S–section steel structure shows less axial forces and shear forces values when compared to W-section steel structures in all direction. Lesser axial forces and shear forces shows higher Stability.

7.2.3 Maximum Bending Moment:

Maximum Bending Moment		
Parameter	S-Section (in KN)	W-Section (in KN)
Max Mx	2.746	29.495
Max My	0.001	0.008
Max Mz	9.483	58.027

Table 7.7 Maximum Bending Moment



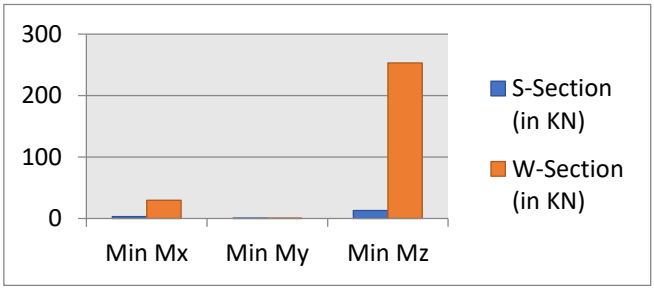
Graph 7.7 Maximum Bending Moment

Graph of Maximum bending moment shows that S-section steel structure show less bending moment values when compared to W-section steel structures in all direction. If bending moment value is less then it gives higher Stability.

7.2.4 Minimum Bending Moment:

Minimum Bending Moment		
Parameter	S-Section (in KN)	W-Section (in KN)
Min Mx	2.741	29.494
Min My	0.001	0.005
Min Mz	12.877	252.959
All values are in negative and it indicates the downward direction		

Table 7.8 Minimum Bending Moment



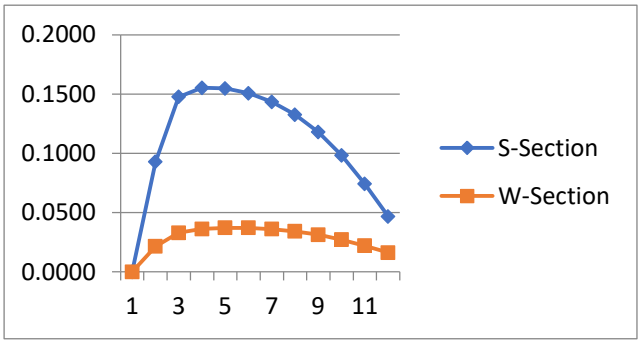
Graph 7.8 Minimum Bending Moment

From the above graph of minimum bending moment, it can be observed that S–section steel structure shows less bending moment values when compared to W-section steel structures in all direction. Lesser bending moment shows higher Stability.

7.3 Storey Drift

Storey	Load	Height (m)	Storey Drift	
			S-Section (cm)	W-Section (cm)
1	1	0.00	0.0000	0.0000
2	1	3.00	0.0928	0.0215
3	1	6.00	0.1475	0.0330
4	1	9.00	0.1552	0.0362
5	1	12.00	0.1547	0.0372
6	1	15.00	0.1507	0.0371
7	1	18.00	0.1434	0.0361
8	1	21.00	0.1326	0.0342
9	1	24.00	0.1178	0.0313
10	1	27.00	0.0983	0.0272
11	1	30.00	0.0741	0.0220
12	1	33.00	0.0467	0.0162

Table 7.9 Storey Drift



Graph 7.9 Storey Drift

From the graph, we observed that the storey drift are more in S-section steel structure as compare W-section structure. Storey drift more varies at each floor in S-section structure in zone 2. The storey drift values are not more fluctuating in W-section. It concludes that W-section is more preferable according to storey drift.

8.CONCLUSION

- Node displacements are very less for W-section steel structure when compared to S-section in all direction.
- It can be concluded that from displacement point of view S-section steel structures are not suitable in high rise construction of building and if used special displacement controls measure should be followed.
- Shear forces and axial forces are very less for S-section steel structure when compared to W-section steel structure in all direction except in Y-direction. The value of maximum shear force in Y-direction of S-section structure is 14.84% greater than W-section structure.
- Bending moments are very less for S-section steel structure when compared to W-section steel structure in all direction.
- According to axial forces, shear forces and bending moment, S-section steel structure is better than W-section steel structure.
- The storey drift values are high in S-section steel structure as compare to W-section structure.
- Storey drift are more fluctuating at each floor in S-section steel structure in zone II compare to W-section steel structure.
- It concludes that W-section is more preferable based on storey drift values.
- Result shows that W-section steel structures in G+10 building gives less storey drift and displacement which helps to reduce intensity of lateral earthquake forces. So, W-section steel structures should be used in case of buildings in low as well as high risk zones under dynamic loading.

REFERENCE

1. ***V. M. Sounthararajan, S. Sivasankar, R. Vinodh Kumar, Nabajyoti Modak(2019),***"Significant Effect on the Mortar Studies Containing various Supplementary Cementations Materials to act as Green Building Materials", journal of Green Engineering,Vol.9,no.3,pp. 360-370.
2. ***Shrikant M. Harle (2017)*** "Analysis by Staad-pro and design of structural elements by MATLAB", Journal of Asian Scientific Research vol-7 pp. 145-164.
3. ***Er.eev Kumar, Brahmjeet Singh, Er. Bhupinder Singh (2016)*** "Optimization of Roof Truss Using STAAD PRO V8i", International Journal of Recent Research Aspects vol-3 pp. 86-90.
4. ***K Venu manikanta, Dr. Dumpa Venkateswarlu (2016)*** "Comparative study on design results of a multi-storied building using Staad Pro and Etabs for regular and irregular plan configuration", International Journal of Research Sciences and Advanced Engineering vol-2 pp 204-215.
5. ***Tejashree Kulkarni, Sachin Kulkarni, Anjum Algur, M. H. Kolhar (2016)*** "Analysis and design of high rise building frame using Staad Pro", International Journal of Research in Engineering and Technology vol-5 pp 235-237.
6. ***Ankita Rode, Dr P. Y. Pawade (2016)*** "Comparative Study of Seismic Behavior of Honeycomb Structure with Conventional

Structure by using Staad Pro", International Journal of Science Technology & Engineering Vol-2 pp. 108-112 .

7. ***Salem R.S Ghdoura, Vikas Srivastava (2016)*** "Analysis of Steel Framed Structure using STAAD Pro and ROBOT Software", International Journal of Scientific Engineering and Technology Vol-5 pp 1442-1449.
8. ***Heera Lal Bhardwaj,Ajit, Yogesh Kaushik (2015)*** "Analysis and Design of Four Leg Steel Transmission Tower using Staad. Pro", International Journal of Advanced Engineering, Management and Science vol-1 pp. 7-13.
9. ***Riya Dey, Sagnik Sen Sarma, Abhirup Bhattacharjee (2015)*** "Wind and Earthquake effect on R.C.C & Steel Structure", International Journal of Civil Engineering and Technology vol-6 pp. 43-52.
10. ***D V Swathi (2014)*** "Design and analysis of pre-engineered steel frame", International Journal of Research Sciences and Advanced Engineering vol-2 pp 250-255.
11. ***Bijan Samali, Ulrike Dackermann and Jianchun Li (2012)*** "Location and Severity Identification of Notch-Type Damage in a Two-Storey Steel Framed Structure Utilising Frequency Response Functions and Artificial Neural Network", Advances in Structural Engineering Vol. 15 pp 743-757.
12. ***X.H. Dai, Y.C. Wang, C.G. Bailey (2010)*** "Numerical modelling of structural fire behaviour of restrained steel beam-column assemblies using typical joint types", Engineering Structures Vol-32 pp 2337-2351
13. ***Sang-Wook Bae, Roger A. LaBoube, Abdeldjelil Belarbi, Ashraf Ayoub (2008)*** "Progressive collapse of cold-formed steel framed structures", Thin-Walled Structures Vol-46 pp 706– 719 .
14. ***Mar´ıa Bel´ en Prendes Gero, Antonio Bello Garc´ıa, Juan Jos´ edelCozD´ıaz (2006)*** "Design optimization of 3D steel structures: Genetic algorithms vs. classical techniques", Journal of Constructional Steel Research vol-62 pp 1303–1309.
15. ***IS: 1893(Part-1) -2002***, "Criteria for Earthquake Resistant Design of Structure, Part -1 General Provisions and Building", Fifth revision, Bureau of Indian Standards, New Delhi.
16. ***IS: 875 (Part 1)***, "Code of practice for Design Loads (other than Earthquake) for buildings and structures Part 1 Dead Loads – Unit Weight of building materials and stored material", second revision, Bureau of Indian Standards, New Delhi.
17. ***IS: 875(Part 2)-1987***, "Code of Practice for Design Loads (other than Earthquake) for buildings and structures Part 2 Imposed Loads", Second revision, Bureau of Indian Standards, New Delhi.
18. ***IS: 875(Part 3)-1987,*** "Code of Practice for Design Loads (other than Earthquake) for buildings and structures, Part 3 Wind Loads", Second revision, Bureau of Indian Standards, New Delhi.