DESIGN AND ANALYSIS OF FRAMED STEEL STRUCTURE FOR WAREHOUSE

A PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY
IN
CIVIL ENGINEERING

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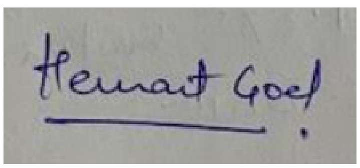
HIMACHAL PRADESH, INDIA MAY-

2021

STUDENT DECLARATION

I hereby declare that the work presented in the project report entitled "design and analysis of framed steel structure for warehouse" submitted for partial fulfilment of the requirements for the degree of bachelor of technology in civil engineering at Jaypee University of Information Technology, Waknaghat is an authentic record of my work carried out under the supervision of Dr. Ashish Kumar. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.



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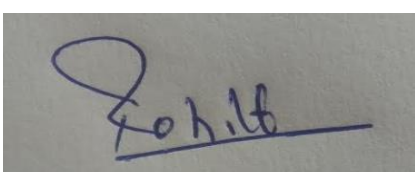

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" Design and Analysis of framed steel structure for Warehouse " in partial fulfilment of the requirements for the award of the degree of bachelor of technology in civil engineering and submitted to department of civil engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Hemant goel**(enrollment no. 171602) and **Rohit kumar** (Enrolment no. 171636) for a period from July 2020 to May 2021under the supervision of **Dr. Ashish Kumar** (Professor), Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

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ACKNOWLEDGEMENT

For the successful completion of my project firstly we would like to express our heartfelt gratitude to our project guide Dr. Ashish kumar (professor) for taking me under his guidance and whose continuous support and encouragement lead to the completion of this project report. We feel fortunate to be taught by him as his coherent guidance motivated and encouraged us throughout the work. His valuable ideas and support have helped us reach to the final display of the project as it is now.

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Lastly, we would also like to thank our college **Jaypee University of Information Technology, Waknaghat**.

ABSTRACT

Our report gives a brief overview about how a warehouse can be designed and it also describes about the various parts of the warehouse which includes roof truss ,column and the joints required to build the warehouse structure these are some of the most important parts required to construct a warehouse .the next comes major loads that have an impact on the structure the loads are dead load ,wind load, seismic load ,live load and collateral load .we have gone through each and every part of the structures and have done the redesigning of those structures that undergo a lot of stress .by increasing the cross-section properties of truss we came across a fact that it can increase the second moment of area.

KEYWORDS: STAAD PRO, STEEL STRUCTURE.

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INTRODUCTION

1.1 General

This chapter discuss on the analysis, focused on the “skeleton” part of the warehouse building. This includes the truss column assembly, beams connecting truss, bracings and joints. The analysis starts by simplifying the structure and assuming the warehouse building in a two-dimensional view. It also explains the various type of load acting on the steel framed structure and also tell about the importance of applying load in calculating the stability of our structure. This chapter also draws the need of steel framed warehouse in the advanced world today.

1.2 Pre-Engineered Buildings

Pre-Engineered Buildings (PEB) fulfills this requirement along with reduced time and cost. Design of the structure is being done in STAAD Pro software and compared in terms of weight which in turn reduces the cost Pre-engineered buildings are nothing but steel buildings in which excess steel is avoided by tapering the sections as per the bending moment’s requirement. In pre-engineered buildings, the total design is done in the factory, and as per the design, members are prefabricated and then transported to the site where they are erected in a time less than 6 to 8 weeks. Pre-engineered buildings can be shifted and/or expanded as per the requirements in future.

1.3 Steel frame structure and its various parts

Steel frame is a building technique with a frame of vertical steel columns and horizontal I-beams constructed in a rectangular grid to support the floors, roof and walls of a building which are all attached to the frame. The frame needs to be Protected from fire because steel softens at high temperature. Steel structure warehouse is generally done with a series of steel structure, including steel columns, steel beams, purlin and so on. These main components constitute the load-bearing structure of the warehouse. Due to light weight and easy construction, there is a great demand for the structural steel warehouse.

Figure 1. 1 Steel framed structure

1.4 Various parts in steel framed structure –

- **PURLINS**

Purlin is a horizontal beam or bar used for structural support in structures, most often below the roof. Purlins are supported either by the building's rafters or its walls. These are most commonly used in steel frames. Purlins carry the roof deck or sheathing loads and are supported by large rafters and/or building walls, steel beams, etc. In comparison to closely spaced rafters, the use of purlins is common in Pre engineered buildings.

Figure 1. 2 Steel purlin

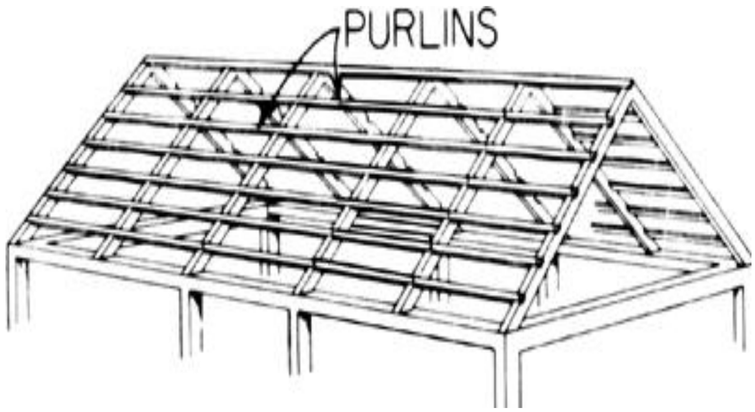

Figure 1. 3 Steel purlin in roof truss

- **RAFTERS**

Rafter is a structural component that is used as part of a roof construction. Typically, it runs from the ridge of the roof. Rafters are generally laid in series, side by side, Providing a base to support roof coverings. Rafters are typically made of steel and can be concealed within the roof structure. Rafters can be used as a key component of various types of roof design. The rafters sit on a wall plate which is an efficient means of spreading the load exerted by the roof structure down through the walls without creating pressure points where each rafter meets the wall and columns of steel framed structure.

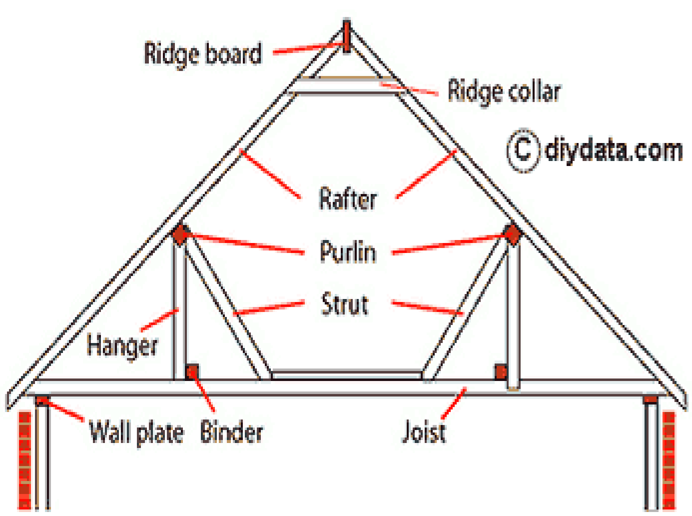

Figure 1. 4 Steel rafter in roof truss

- **JOIST**

Joist, ceiling or floor support in building construction. Joists may be of timber, steel, or reinforced concrete are laid in a parallel series across or abutting girders, to which they are attached, usually by metal supports called joist hangers, or anchors.

The ends of the joists are grooved or notched so that they are flush with the weight-bearing elements to Provide a smooth horizontal. Before the floor is laid above or the ceiling laths hung below the principal joists, additional strength may be given in the form of bridging joists—diagonal braces between the horizontal beam .

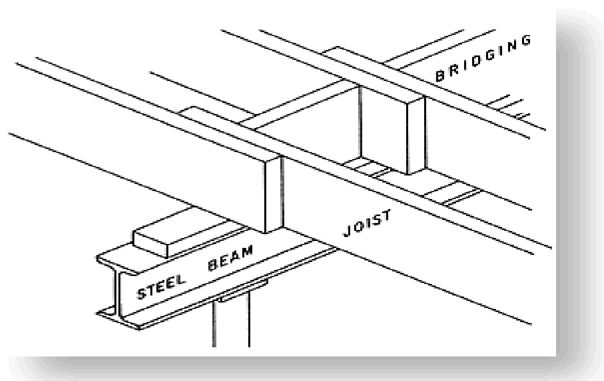

Figure 1. 5 Joist in roof truss

- **GIRDER**

Steel girders are a type of steel beams. Girders are collector beams; they are the main horizontal supports of a structure which support the smaller beams. So “all girders are beams but all beams are not girders”. Steel girders and beams differ from each other in various aspects like large beams are known as girders. If a large beam horizontally supports a structure then it is a steel girder. Beams are usually smaller in size compared to girders. They are responsible for the support function of any structure. Girders carry dynamic loads and rolling loads. This is typical of steel girders. Due to its high load bearing capability steel girders are widely used in the construction industry. Girders have an I-shaped cross section or they can be box-shaped or Z-shaped. The main function of a steel girder is to transfer the load to the columns on which it rests. A steel beam transfers load to the steel girder.

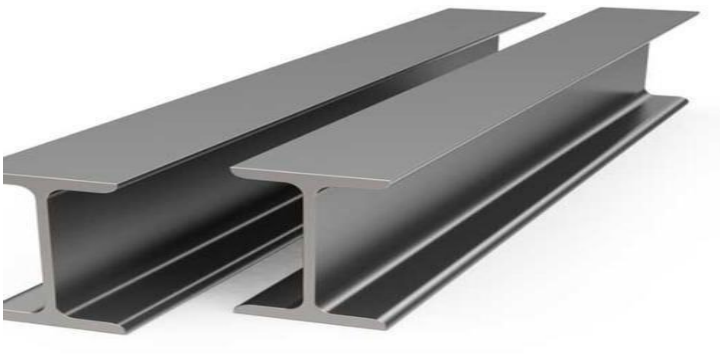

Figure 1. 6 Girder bf

- ## BRACING

Permanent bracing of individual truss members prevents certain members of individual trusses from buckling under compressive loads. During the design Process of the truss, the members are checked for buckling and for slenderness restrictions. If a member is found to buckle in the narrow direction, a brace is added. If a member is found to buckle in the wide direction, the size of the member is increased.

Under normal gravity loads the top chord of a typical truss is in compression and tends to buckle in its narrow direction. The plywood roof sheathing prevents the top chord from bucking sideways. Other members of the truss, such as various web members and the bottom chord may also experience compressive forces under different load conditions. Under certain combinations of member length and magnitude of the compressive force, the member may buckle in the narrow direction. When this combination is reached, bracing of the web member or bottom chord is required.

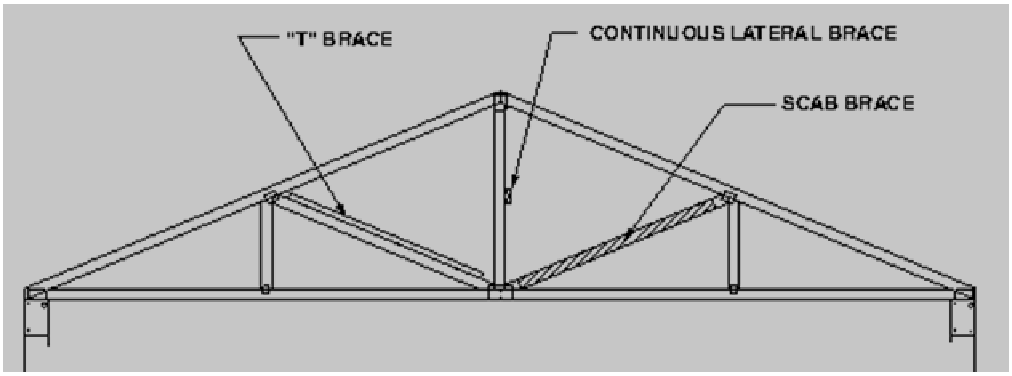

Figure 1. 7 Bracing in roof truss

1.5 Various type of loading acting on structure

- **DEAD LOAD**

A constant load in a structure (such as a bridge, building, or machine) that is due to the weight of the members, the supported structure, and permanent attachments or accessories.

IN CASE OF WAREHOUSE the dead load consists of purlins, bracing accessories. Can be calculate as follows by considering certain weights of individual accessories and their average weight.

Table 1.1: Dead load assumptions

WEIGHT OF SHEETING	=	5 KG/M2
WEIGHT OF PURLINS	=	4.12 KG/M2
WEIGHT OF SAG ROD, BRACINGS, CLIPS,etc.	=	5.75 KG/M2
TOTAL	=	15 KG/M2

Dead load cab be calculated = TOTAL * BAY SPACING

- **LIVE LOAD**

Live loads include any temporary or transient forces. that act on a building or structural element. Typically, they include people, furniture, vehicles, and almost everything else that can be moved throughout a building.

Live loading warehouse can be calculated as per IS CODE 875 it is .75 KN/M2 for the non-accessible roof.

LIVE LAOD CAN BE CALCULTED = BAY SPACING * .75

- **COLLETRAL LOAD**

Collateral load is a subset of dead load that includes the weight of any materials other than permanent construction. These materials can include pipes, sprinklers, mechanical ducts, electrical conduits, ceilings, and finishes.

As assuming the weight of solar panel as .25 KN/M2 for warehouse.

COLLETRAL LOAD CABE BE CALCULATED AS = BAY SPACING * .25

- **WIND LOAD**

Wind Load is used to refer to any pressures or forces that the wind exerts on a building or structure. There are actually three types of wind forces that would be exerted on a building.

Uplift Wind Load: -

Uplift Wind Load is an upwards force of the wind that would affect roof structures or similar horizontal structures in a building, such as canopies or awnings. The wind flow under a roof structure pushes the roof upwards, the wind flow over the horizontal structure pulls the roof upwards.

Shear Wind Load: -

Shear Wind Load is a horizontal pressure or force that can cause walls or vertical structural elements to tilt or crack, causing a building to tilt.

Lateral Wind Load: -

Lateral Wind Load is another horizontal wind pressure that can make a structure move off its foundations or overturn.

WIND LOAD CALCULATIONS AS PER IS:875 part-3-2015

P =F/A

Force, F= P X A

Wind Force = C_P X P_d X A

where,

C_{P}= pressure coefficient ($C_{pe} – C_{pi}$)

P_d= design wind pressure

A= surface area of structural element

C_{pe} = External pressure coefficient

C_{pi} = Internal pressure coefficient

C_{pi} value as per IS code 7.3.2.1

7.3.2.1 In the case of buildings where the claddings permit the flow of air with openings not more than about 5 percent of the wall area but where there are no large openings, it is necessary to consider the possibility of the internal pressure being positive or negative. Two design conditions shall be examined, one with an internal pressure coefficient of +0.2 and another with an internal pressure coefficient of –0.2.

Figure 1. 8 Clause7.3.2.1 IScode

7.3.2.2 *Buildings with medium and large openings*

Buildings with medium and large openings may also exhibit either positive or negative internal pressure depending upon the direction of wind. Buildings with medium openings between about 5 and 20 percent of wall area shall be examined for an internal pressure coefficient of +0.5 and later with an internal pressure coefficient of –0.5, and the analysis which produces greater distress of the member shall be adopted. Buildings with large openings, that is, openings larger than 20 percent of the wall area shall be examined once with an internal pressure coefficient of +0.7 and again with an internal pressure coefficient of –0.7, and the analysis which produces greater distress of the member shall be adopted.

Buildings with one open side or opening exceeding 20 percent of wall area may be assumed to be subjected to internal positive pressure or suction similar to those of buildings with large openings. A few examples of

Figure 1. 9 Clause 7.3.2.2 IS code

So according the size of the opening of our building we choose the recommended value of the coefficient of pressure as mentioned in IS code.

<u>P_d (designed wind pressure) value as per IS code</u>

It can be calculated by the following formula: -

$$P_d = K_c.K_a.K_d.P_z$$

K_d= wind directionality factor

K_a = area averaging factor, and

K_c = combination factor (see 7.3.3.13)

K_d can be calculated as per IS code Clause 7.2.1

7.2.1 ***Wind Directionality Factor, K_d***

Considering the randomness in the directionality of wind and recognizing the fact that pressure or force coefficients are determined for specific wind directions, it is specified that for buildings, solid signs, open signs, lattice frameworks, and trussed towers (triangular, square, rectangular) a factor of 0.90 may be used on the design wind pressure. For circular or near-circular forms this factor may be taken as 1.0.

For the cyclone affected regions also the factor K_d shall be taken as 1.0.

Figure 1. 10 Clause 7.2.1 IS code

Since, our warehouse is rectangular k_d=0.9

K_a can be calculated as per IS code Clause 7.2.2

7.2.2 *Area Averaging Factor, K_a*

Pressure coefficients given in **7.3** are a result of averaging the measured pressure values over a given area. As the area becomes larger, the correlation of measured values decrease and *vice-versa*. The decrease in pressures due to larger areas may be taken into account as given in Table 4.

Figure 1. 11 Clause 7.2.2 IS code

Table 1.2 Area averaging factor

Table 4 Area Averaging Factor (K_a)
(*Clause* 7.2.2)

Sl No. (1)	Tributary Area (A) m^2 (2)	Area Averaging Factor (Ka)* (3)
i)	≤10	1.0
ii)	25	0.9
iii)	≥100	0.8

* Linear interpolation for intermediate values of a is permitted.

The value depends upon the tributary area. Hence tributary area calculated as the Product of bay spacing and height of the warehouse. By calculating the tributary area we choose the averaging factor as mentioned in the above table.

<u>K_c can be calculated as per IS code Clause 7.3.13</u>

7.3.3.13 *Frames*

When taking wind loads on frames of clad buildings it is reasonable to assume that the pressures or suctions inside and outside the structure shall not be fully correlated. Therefore when taking the combined effect of wind loads on the frame, a reduction factor of K_c = 0.90 may be used over the building envelope when roof is subjected to pressure and internal pressure is suction, or *vice-versa*.

Figure 1. 12 Clause 7.3.1.3 IS code

Since our warehouse is subjected to both pressure and internal pressure suction so its value is considered as 0.9.

<u>P_z can be calculated as per IS code</u>

P_z=0.6 V^2_z

V_Z= $V_b.K_1.K_2.K_3.K_4$

<u>V_b is the basic wind speed which is given IS code or in the ANNEX A (Clause 6.2)</u>

<u>According to the city of India</u>

K_1 is the risk coefficient given for different classes of structure in different wind speed zones

Table 1 Risk Coefficients for Different Classes of Structures in Different Wind Speed Zones
(*Clause* 6.3.1)

Sl No.	Class of Structure	Mean Probable Design Life of Structure in Years	k_1 Factor for Basic Wind Speed m/s					
			33	39	44	47	50	55
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	All general buildings and structures	50	1.0	1.0	1.0	1.0	1.0	1.0
ii)	Temporary sheds, structures such as those used during construction operations (for example, formwork and false work), structures during construction stages and boundary walls	5	0.82	0.76	0.73	0.71	0.70	0.67
iii)	Buildings and structures presenting a low degree of hazard to life and property in the event of failure, such as isolated towers in wooded areas, farm buildings other than residential buildings	25	0.94	0.92	0.91	0.90	0.90	0.89
iv)	Important buildings and structures such as hospitals communication buildings/towers, power plant structures	100	1.05	1.06	1.07	1.07	1.08	1.08

Table 1.3 Risk coefficient

Since our warehouse lays under first category i.e. (all general buildings and structure) so accordingly we will take values ffrom the table

K_2 terrain height factor can be calculated from the clause (6.3.2.1 IS code 875 part 3)

This factor is different for each and every category of terrain give in IS Code under the above mentioned clause and if nothing is given about terrain then it falls in category 2 in which we assume the nearby structures have the height of 1.5 meters to 10 meters .

And the K_2 value can be calculated from the clause 6.3.2.2 Table 2 of IS code 875

Table 1.4 Terrain & height multiplier

Table 2 Factors to Obtain Design Wind Speed Variation with Height in Different Terrains

(*Clause* 6.3.2.2)

Sl No.	Height z m	Terrain and Height Multiplier (k_2)			
		Terrain Category 1	Terrain Category 2	Terrain Category 3	Terrain Category 4
(1)	(2)	(3)	(4)	(5)	(6)
i)	10	1.05	1.00	0.91	0.80
ii)	15	1.09	1.05	0.97	0.80
iii)	20	1.12	1.07	1.01	0.80
iv)	30	1.15	1.12	1.06	0.97
v)	50	1.20	1.17	1.12	1.10
vi)	100	1.26	1.24	1.20	1.20
vii)	150	1.30	1.28	1.24	1.24
viii)	200	1.32	1.30	1.27	1.27
ix)	250	1.34	1.32	1.29	1.28
x)	300	1.35	1.34	1.31	1.30
xi)	350	1.35	1.35	1.32	1.31
xii)	400	1.35	1.35	1.34	1.32
xiii)	450	1.35	1.35	1.35	1.33
xiv)	500	1.35	1.35	1.35	1.34

NOTE — For intermediate values of height z in a given terrain category, use linear interpolation.

K_3 can be calculated from the IS code Clause 6.3.3.1

Topography Factor

The effect of topography shall be significant at a sight when the upwind slope is more than 3 degree and below that the value of k_3 maybe taken as1. If slope more than 3 degree than the value may vary from 1.0 to 1.36 as mentioned in annex C .

K_4 can be calculated from the IS code Clause 6.3.4

Factor for Cyclonic Region

The cyclonic factor will be considered when the building is constructed within the 60km width at the east and west coast so for industrial structures k_4 value should be taken as 1.15 if it is not in the range then the k_4 will be taken 1.0

- **SEISMIC LOAD**

To assign the seismic load we have some components-

a) Seismic zone according to the city vise given in ANNEX E in IS Code .There are 4 zones available in India ; containing from Zone 2 to Zone 5.
b) Response Reduction Factor, R in steel building with OMRF is 3.0 (only for 2^{nd} Zone). If, there is building in other Zone than factor have value of 5.
c) Importance Factor, I for steel building warehouse is 1.0
d) Rock/Soil Type, we have to iidentify the soil on which the building has to be placed;
    - Soil Type I – Rock or Hard soils
    - Soil Type II – Medium or Stiff soils
    - Soil Type III – Soft soils

Damping Ratio, for steel structure it ranges from 2-3%.

- **MOMENT RESISTING FRAME**

1. Moment Resisting Frame is rectilinear assemblages of beams and columns with the beams rigidly connected to the columns.
2. Resistance to lateral forces is Provided primarily by rigid frame action, i.e., by the development of bending moment and shear force in the frame members and joints.
3. Under the rigid beam-column connections, a moment resisting frame cannot displace laterally without bending the beams or columns depending on the geometry of the association.
4. 4 . In moment resisting frames, the structural members are joined together using rigid joints, so that the moment-opposing framework relies on the joints to transfer the lateral load to the foundation.
5. EXAMPLE, – In case of reinforced cement concrete structured all frame members are designed as moment resisting frame .

- **BRACED FRAMES**
- The Braced Frame is a structured system designed to withstand wind and earthquake forces, tall column with braces is more stable and rigid.
- The braced framing is generally used for the development of metal and wooden buildings.
- Beams and columns are estimated under the vertical loads, assuming that the bracing system helps all lateral loads.
- The braced frames resist the wind and seismic forces more than the non-braced buildings.
- It is cost-effective, easy to erect and flexible to design to get required strength and stiffness.

  EXAMPLE,- the steel structure , the wooden structure

TYPES OF BRACING USED

The beams and columns are generally arranged in an orthogonal pattern in both elevation and on plan.

The resistance In a braced frame building to horizontal forces is Provided by two orthogonal bracing systems

1. Verticle bracing
2. Horizotal bracing

VERTICLE BRACING

- Bracing in vertical planes (between lines of columns) Provides load paths to transfer horizontal forces to ground level and Provide lateral stability
- The planes of vertical bracing are usually Provided by diagonal bracing between two lines of columns,
- The vertical bracing must be designed to resist the forces due to the Wind loads , effects due to sway .

HORIZINTAL BRACING

- A horizontal bracing system is needed to transfer horizontal forces to the planes of vertical bracing that

Provide resistance to horizontal forces.

- The horizontal forces on perimeter columns are generated because of wind force pressure on the cladding of the structure**.**

1.6. NEED OF STUDY

- A warehouse is a place for storing surplus goods which customers and clients do not need immediately.
- Due to rapid growth of industrialisation, warehouse is a great option for storing of good and materials which require Protection from environmental factors as well as from theft.
- Warehouse structures are easy to erect and have been Proved to be efficient in terms of durability and strength
- There are mainly two type of industrial building ,one is conventional and other is pre-engineered buildings which can be used as warehouse.
- In pre-engineered buildings, complete designing is done in the factory, as per design, members are pre-fabricated and then transported to the site where they are erected in less time.

CHAPTER 2
LITERATURE REVIEW

2.1 General

This chapter presents a summary of different studies by researchers on the Warehouse design and analysis of different members of the steel framed structure and also consist the load calculations based on their researches.

2.2 Reviews on research

ASHAYER and L.F. GELDERS "Storage design" Storage is an important component of financial activity within the initial levels designed to grow the industry, due to the low cost of hard work, workers are used more freely, with less dedication given to working in space utilization, strategic choice of design or general fabric management. In the aftermath of the global crisis administrative care was closely monitored for the growth of effective operations in justification of common retention.

Upendra Pathak, Dr. Vivek Garg ADVERTISING AND RESTRUCTURING OF TRUSS DESIGN

In the construction of metal machines various types of geometry (a-type truss, fink truss, Pratt truss, Howe truss, king post truss, queen publish truss etc.) and sections (part section, tube section, rectangular hole section etc.)

are widely used. in the present drawings, the 16m space ceiling has undergone an analysis of abnormal geometries and phases to find the final design of your choice. more structure is prepared for the various slopes of the spear. support conditions (fixed / hinge) and the type of connection (welded / tied) between track providers are also strong in spear joints.

Author **C.M. Meera** conducted a comparative study between the Pre-Engineered Building (PEB) and the Conventional Steel Building (CSB) and analyzes design frames using structural analysis and software to build STAAD

SubrakantMohakul designed an industrial warehouse and conducted extensive research on the conduct of members as a result of the failure to unite members.

Manan D. Maisuri said the use of steel throughout the industrial building could be reduced by determining the appropriate geometry of the spear and by using the bare metal component compared to the standard metal part. Therefore, the sections of the mean tubes save the most.

Shaiv Parikh's research paper emphasizes the importance of members of oppression and provides an overview an explanation of the characteristics and behaviours of metal pressure joints.

A. **Jayaraman** presents research on the behaviour and savings of roof roads and channel section purlins by comparing LSM and WSM.

Yash Patel points out the importance of tubular segments and concludes the economic benefits of tubular segments.

Aijaz Ahmad Zende, Prof. AV Kulkarni, Aslam Hutagi (2013), "Comparative Study of Analysis and Construction of Pre-Developed Buildings and General Frames", ISSN: 2278-1684 Volume 5, Issue 1 (Jan. - Feb. 2013), PP 32-43 Work current includes a comparative study of static and dynamic analysis with the construction of Pre-Engineered Buildings (PEB) and standard steel frame. The construction of the structure is done in STAAD Pro software and the same is compared in standard, weighted and cost-effective. THREE EXAMPLES, were taken to conduct research. Comparing Pre-Engineered Buildings (PEB) with a standard steel frame is done with two examples, and in EXAMPLE 3, it takes longer to build a Pre-Engineered Building for this study. In the process, the Pre-Engineered Buildings (PEB) and the standard steel frame are designed for dynamic forces, including wind power and ground forces. Air analysis was performed manually as one Is 875 (Part III) - 1987 and seismic analysis was performed in accordance with IS 1893 (2002). Conclusion “Pre-Engineering Construction Builders provides end users with a cost-effective and best solution for long-distance buildings where large, column-free spaces are required”.

CM Meera (2013), "Design Pre-Engineered Building of an Industrial warehouse", International Journal of Engineering Sciences & Emerging Technologies, June 2013. Volume 5, Issue 2, pages.: 75-82 This paper is a comparative study of PEB concept and concept of CSB. The research is based on the design of a standard Industrial Storage framework using concepts and analysis frames designed using the STAAD Pro analysis and design software. He concluded that PEB buildings could be easily constructed with simple construction procedures according to national standards. Based on research, it can be concluded that PEB buildings are more profitable than CSB buildings in terms of cost, speed of quality control in construction and ease of construction. This paper also conveys simple and economical ideas of the original concepts of PEBs. The concept presented helps to understand the PEB conceptual framework.

M.G.Kalyanshetti, G.S.Mirajkar, "Comparisons between Typical Metal Structures and Tubular Structural Structures" International Journal of Engineering Research and Application (Ijera) Vol. 2, Issue 6, November-December 2012 This study covers economics, the burden of responsibility for all building members and their associated safety measures. Economics was the main goal of this study which included comparing standard tubular-grade structures with a given need. For the purpose of studying the superstructure-part of the industrial structure is observed and comparisons are made. Studies show that, up to 40 to 50% of cost savings are achieved in the form of rectangular clusters.

Trilok Gupta, Ravi K. S Harma, "Industrial Shed Analysis using Different Design Philosophies" International Journal of Research In Advent Technology, Vol. 1, Issue 5, Dec Ember 2013 The study covers various types of industrial roof traces using computer software. Includes information on steel roof traces and design philosophies with practical examples. From the point of view they conclude that the sections designed to use the limitations are more economical than the sections that use the pressure method. It was noted that the tubular section formed by the state border was the most economical among the three categories used.

2.3 Summary of Literacy Review

The necessary and appropriate loads and loading combinations were adopted. AUTOCAD plan was prepared followed by load calculations. The entire process was completed as per the standards laid down by Indian Standard. The industrial warehouse can be easily designed by simple design procedure in accordance with the country standards. The support reactions are more for conventional building as compared to other structures for various spacing of trusses. PEB gives lesser support reactions. Bending moment and shear force in column are maximum for PEB structure.

Live Load Live loads on the roof truss are estimated as per the Indian standard code IS:875-Part-II.

Wind loads on the roof truss are calculated as per the Indian standard code IS:875-Part-III

Dead loads on the roof truss are estimated as per the Indian standard code IS:875-Part-I

CHAPTER 3
METHODOLOGY

3.1 General

The following chapter contracts with the designing of steel framed structure with help of STADD Pro. STAAD Pro software can be used for a vast variety of work like to design structures and buildings, as well as to create simulations that test a structure's service life, load calculations, max absolute stresses, displacements etc.

For the analysis of the warehouse, many methods have been Proposed by numerous researchers for the load calculations and redesigning of the steel members for the cost effectiveness.

It also displays the sequential method and steps of designing under various types of loads and is application on the structure. And also consist of optimization of steel frame.

As per the Indian standard codes' recommendation, IS CODE -875 Part 3 the various load have been applied on the steel frame used for 2-dimensional analysis.

3.2 Modelling considerations

A Steel framed structure for warehouse is considered as follows –

- Length = 45 m (Centre to center)
- Width=18 m (Centre to center)
- Clear height=7.0 m
- Basic wind speed= 47 m/s
- Roof slope = 1:10
- Solar panel load=25 kg/sqm on roof

The above steel frame is first designed in two-dimensional view with two columns and two rafters attached to it and the loads and load combination is applied on that two-dimensional frame and after that we optimize that part of our warehouse.

3.3 Procedure Used

The following chart displays the sequential steps or commands with a pictorial description that are used in STAAD Pro for the designing.

Step 1- First we define two nodes at a distance of 18 m in x direction and then two nodes above in y direction at distance of 7m.

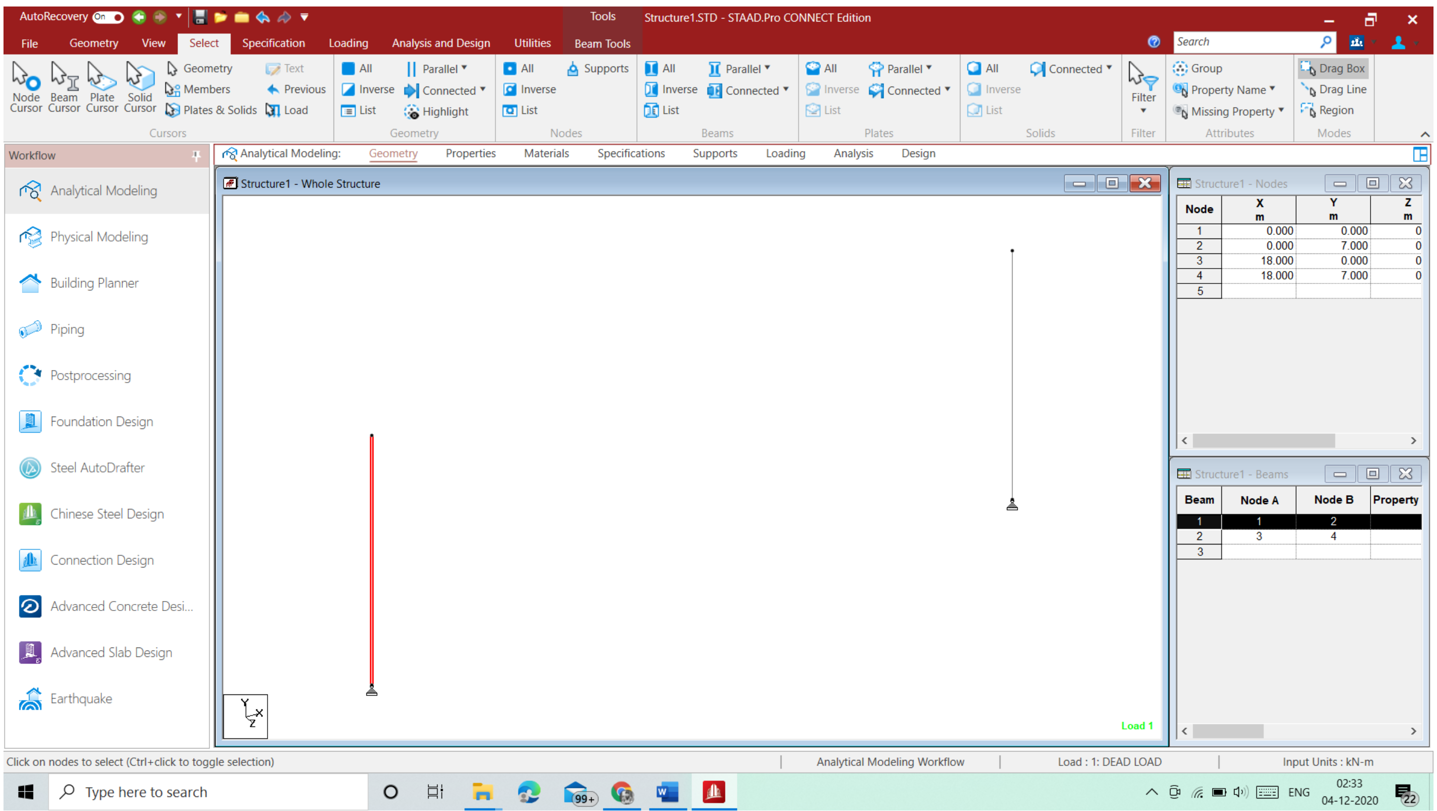

Fig. 3. 1- (The picture shows a 3-d rendering view of the box made, so if any flow is present in the structure can be fixed)

Step 2- Then nodes are connected to each other to form rafter and then assigning Property of section of steel section.

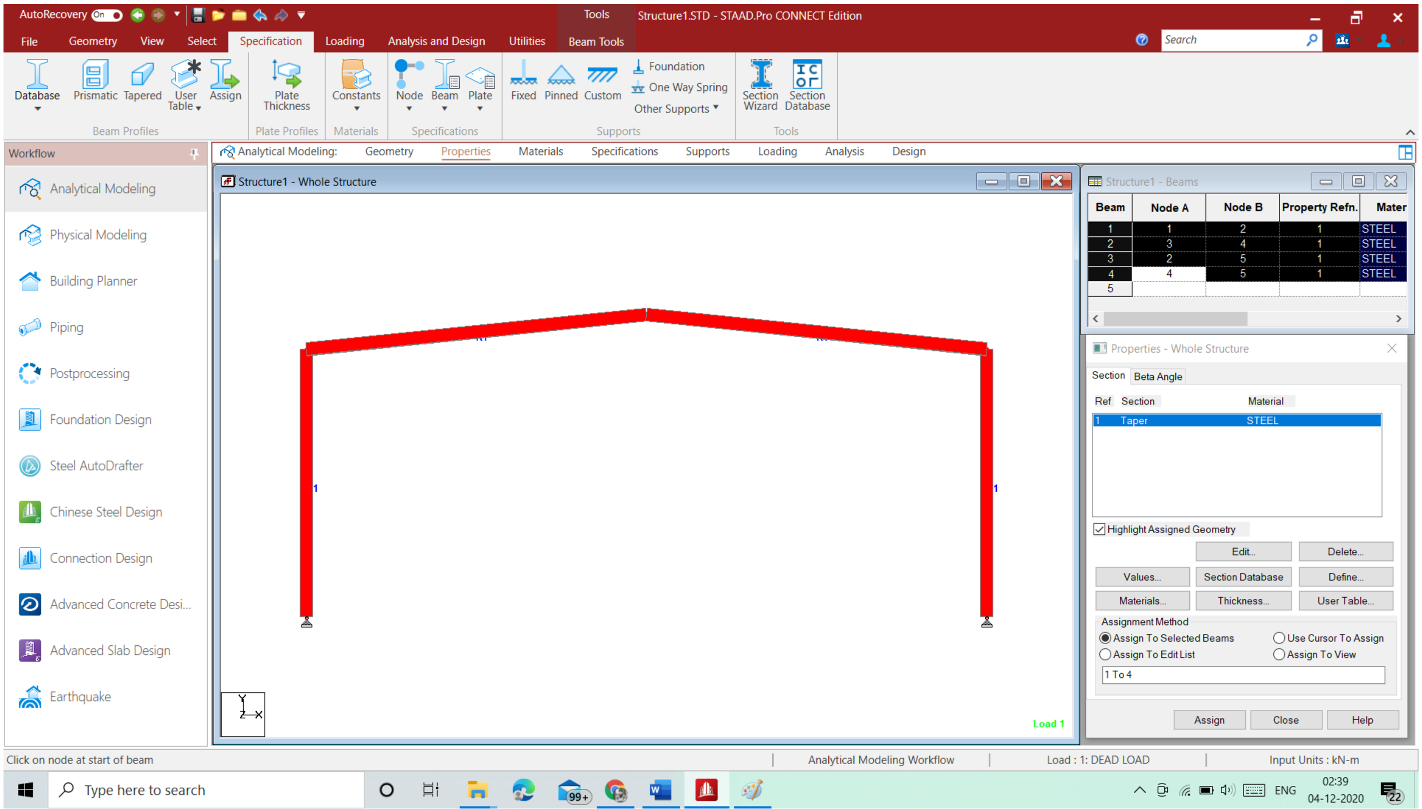

Fig. 3. 2 – figure showing Property assigned to steel frame .

Step 3- Assigning the dead, live and collateral load to the steel frame.

Table 3.1: Dead load calculation

WEIGHT OF SHEETING	=	5 KG/M2
WEIGHT OF PURLINS	=	4.12 KG/M2
WEIGHT OF SAG ROD, BRACINGS, CLIPS, etc.	=	5.75 KG/M2
TOTAL	=	15 KG/M2

Dead load cab be calculated = .15 * 7.5

=1.125 KN/m

LIVE LAOD CAN BE CALCULTED = BAY SPACING * .75

= 7.5 * .75

=5.625 KN/m

COLLETRAL LOAD CABE BE CALCULATED AS = 7.5 * .25

=1.875 KN/m

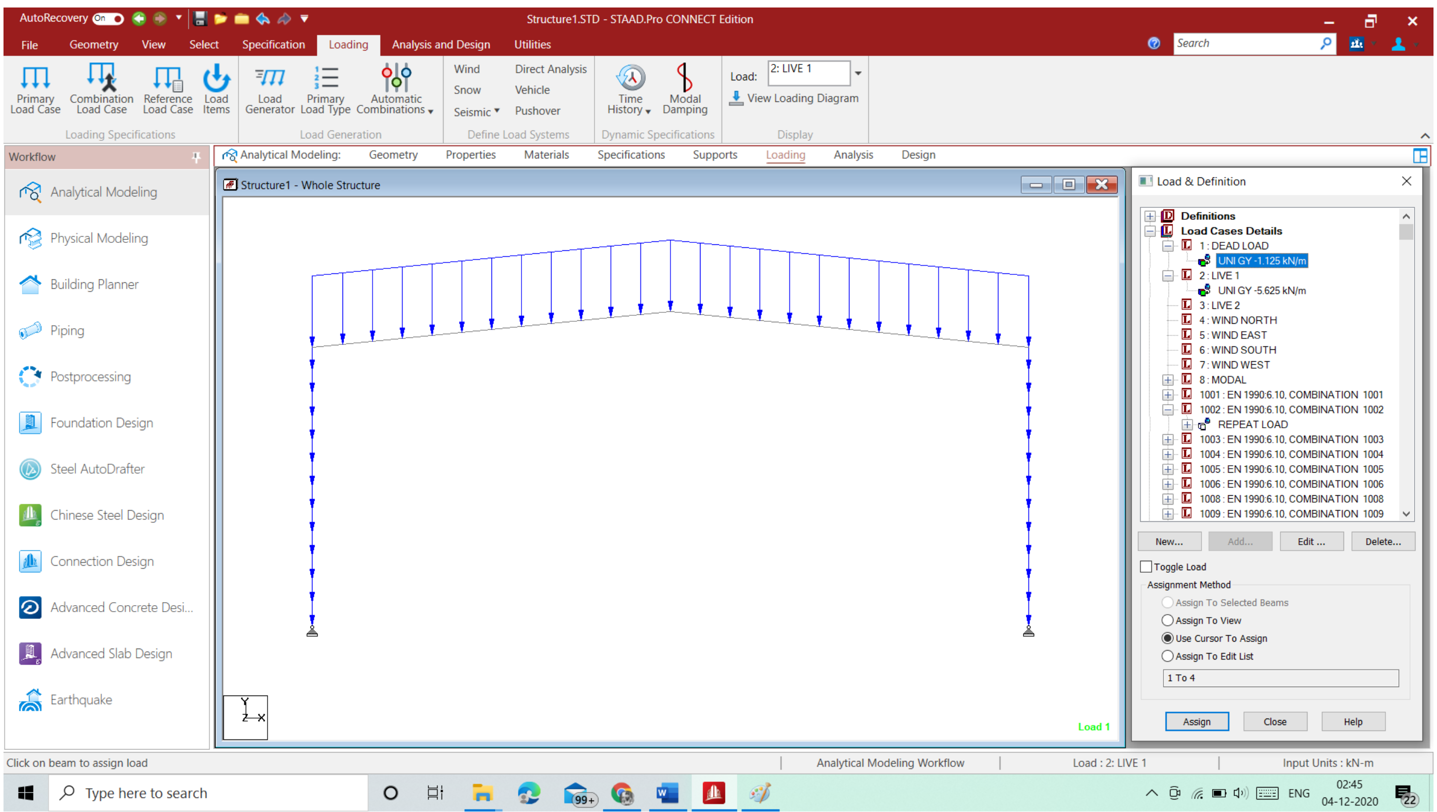

Fig. 3. 3 – figure showing load assigned to steel frame .

Step 4- Assigning wind load the steel frame by calculating wind from left and right direction.

Wind Force = C_P X P_d X A

$P_d = K_c.K_a.K_d.P_z$

By using the above formula, we calculated the wind load as follows.

CASE 1: Wind load across the ridge with positive Cpi

Table 3.2: wl 1 & wl 2 calculations

Surface	Cpe	Cpi	Cp= ($C_{pe} - C_{pi}$)	Wind load on frame	
Column 1	0.70	0.2	-.50	.5*097*7.5 =	3.64
Rafter 1	0.00	0.2	-.20	-.2*.97*7.5 =	-1.46
Rafter 2	0.00	0.2	-.20	-.2*.97*7.5 =	-1.46
Column 2	-0.25	0.2	-.45	-.45*.97*7.5 =	-3.27

CASE 2: Wind load across the ridge with negative Cpi

Table 3.3: wl 3 & wl 4 calulations

Surface	Cpe	Cpi	Cp= ($C_{pe} - C_{pi}$)	Wind load on frame	
Column 1	0.70	-0.2	0.9	.9*097*7.5 =	6.55
Rafter 1	0.00	-0.2	.20	.2*.97*7.5 =	1.46
Rafter 2	0.00	-0.2	.20	.2*.97*7.5 =	1.46
Column 2	-0.25	-0.2	-.05	-.05*.97*7.5 =	-0.36

CASE 3: Wind parallel to ridge 90 degree with positive Cpi

Table 3.4: wl 5 calculations

Surface	Cpe	Cpi	Cp= ($C_{pe} - C_{pi}$)	Wind load on frame	
Column 1	-0.50	0.2	-0.7	-.7*097*7.5 =	-5.09
Rafter 1	-0.80	0.2	-1	-1*.97*7.5 =	-7.28
Rafter 2	-0.80	0.2	-1	-1*.97*7.5 =	-7.28
Column 2	-0.50	0.2	-0.7	-.7*.97*7.5 =	-5.09

CASE 4: Wind parallel to ridge 90 degree with negative Cpi

Table 3.5: wl 6 calculations

Surface	Cpe	Cpi	Cp= ($C_{pe} - C_{pi}$)	Wind load on frame	
Column 1	-0.50	-0.2	-0.3	-.3*097*7.5 =	-2.18
Rafter 1	-0.80	-0.2	-0.6	-.6*.97*7.5 =	-4.37
Rafter 2	-0.80	-0.2	-0.6	-.6*.97*7.5 =	-4.37
Column 2	-0.50	-0.2	-0.3	-.3*.97*7.5 =	-2.18

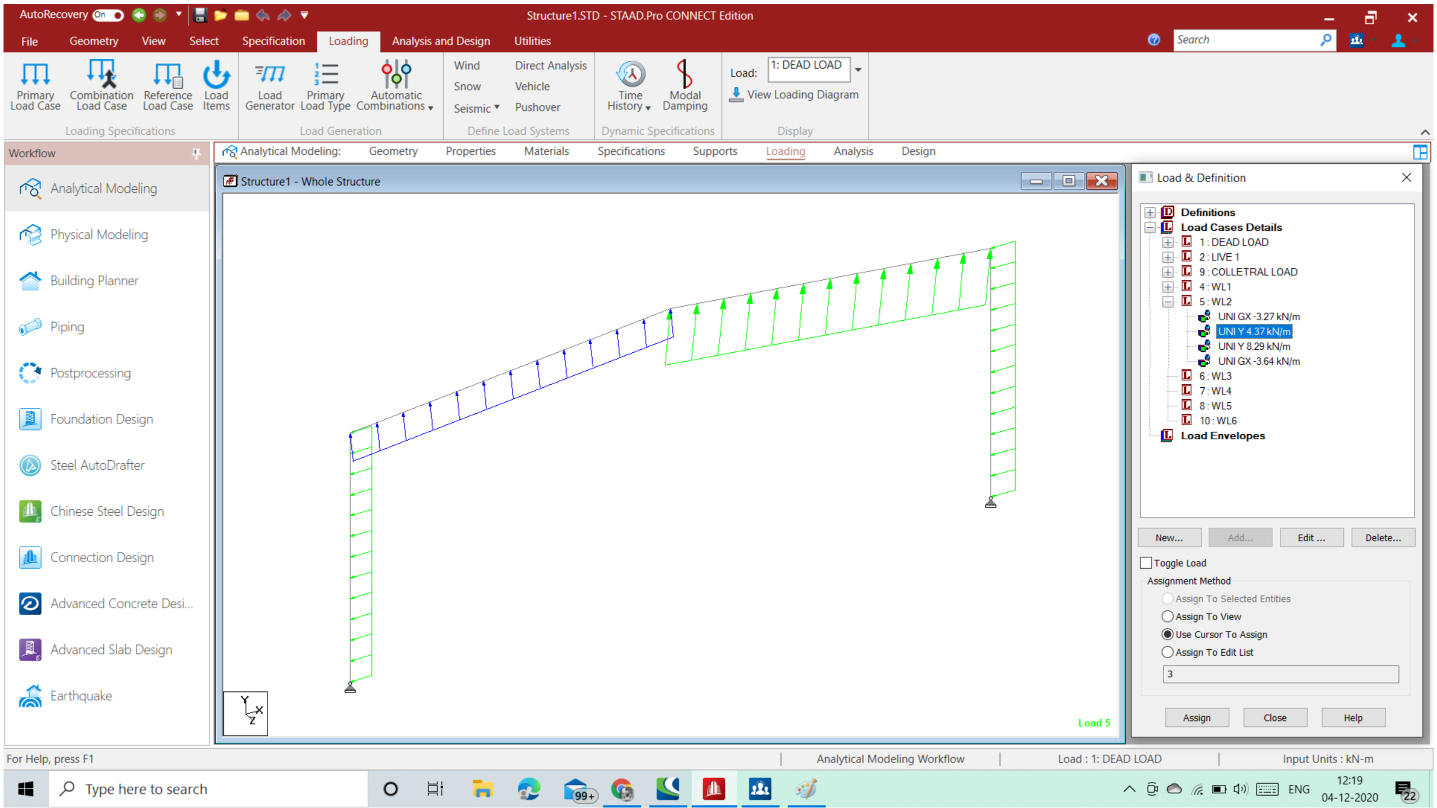

Fig. 3. 4 – figure showing wind load assigned to steel frame .

Step 5- Assigning seismic load the steel frame by generating through STADD Pro by selecting various parameters.

Table 3.6: seismic load selection

Zone factor (Delhi)	0.24
Response reduction	5
Importance factor (all general building)	1
Soil type	Medium soil

Damping ratio	2%

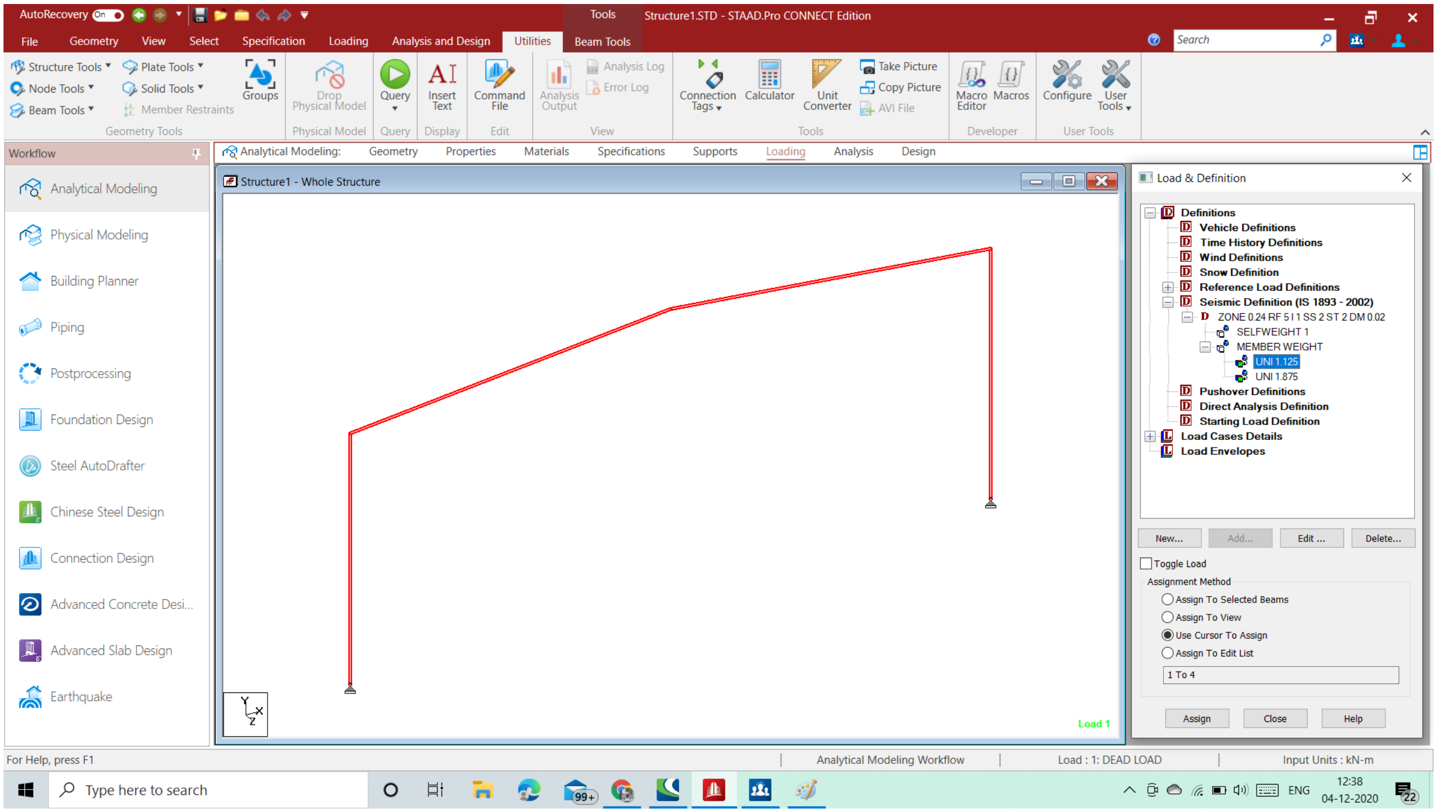

Fig. 3. 5 – figure showing seismic load assigned to steel frame

Step 6- Now we perform analysis and then after applying parameters to the steel frame. Parameters like IS CODE is selected and then after we have to apply check code all command to STADD Pro so that it can check all load combinations is applied according to the selected IS CODE.

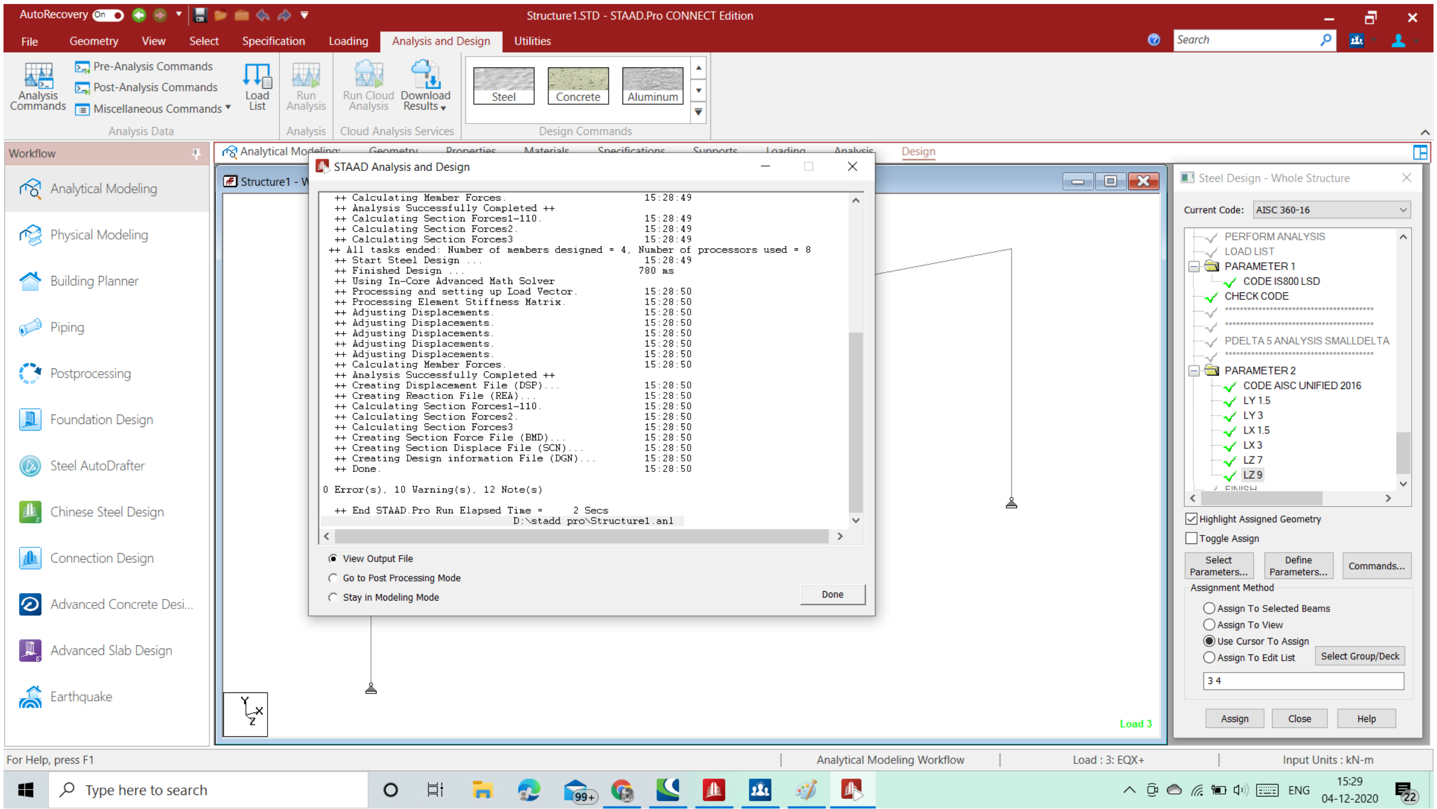

Fig. 3. 6 – Analysis is performed with 0 errors anf parameters assigned Properly

Step 7-Now checking the stress ratios of both columns and rafters.

The stress ratio of all members should be less than 1 for our designed section of steel to be safe section for our warehouse.

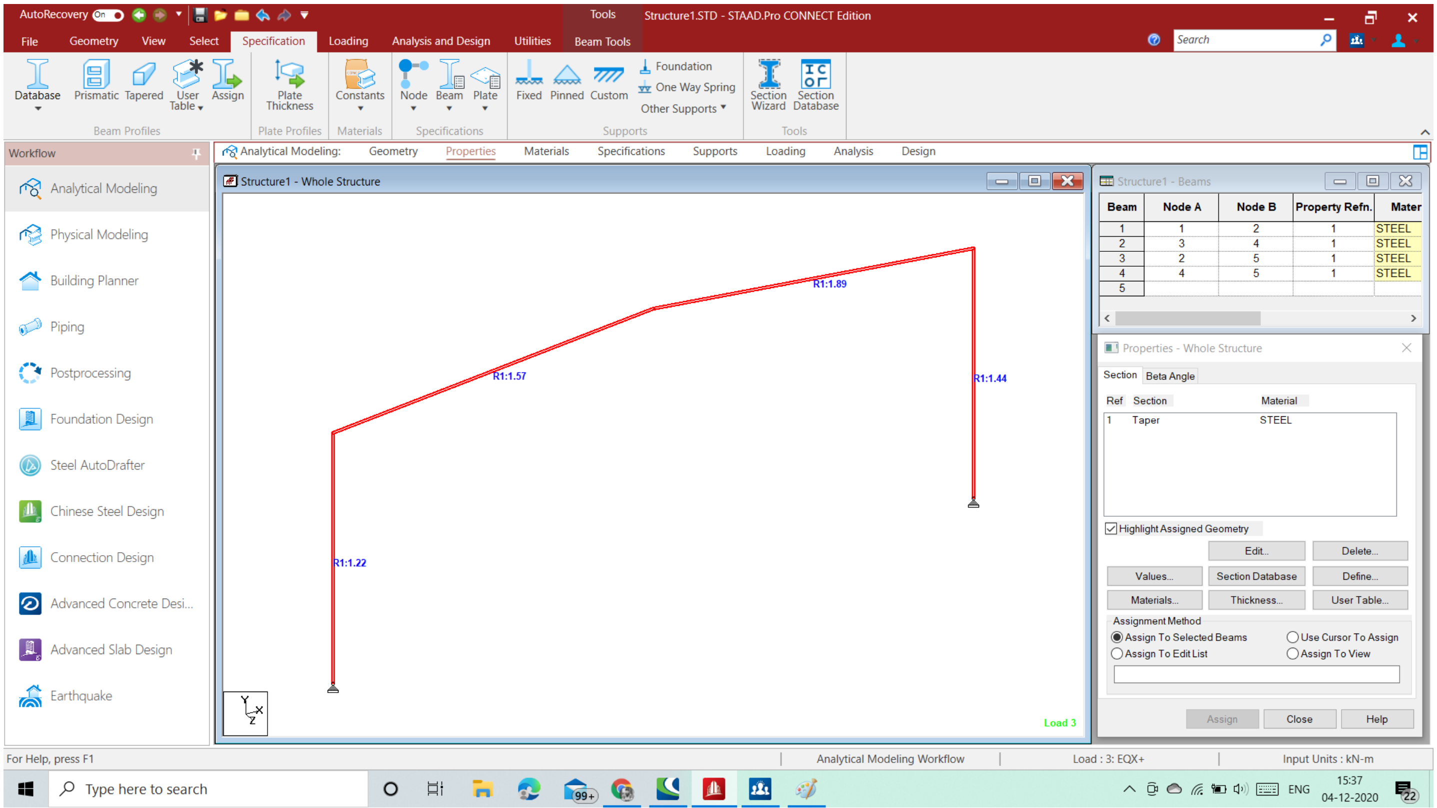

Fig. 3. 7– figure showimg the value of stress ratio with the applied section of tapered I beam.

Then after that we will change the dimension of section of steel frame selected by changing its web ,flange thickness , and then preform analysis to see the stress ratio again with the altered section ,if all members have less than 1 then it is ok otherwise again change it and do the same.

Step 8: Steel take off of a frame before optimization

The steel take off of a frame before optimization is 46.423 KN which is nearly equal to 4733 kg.

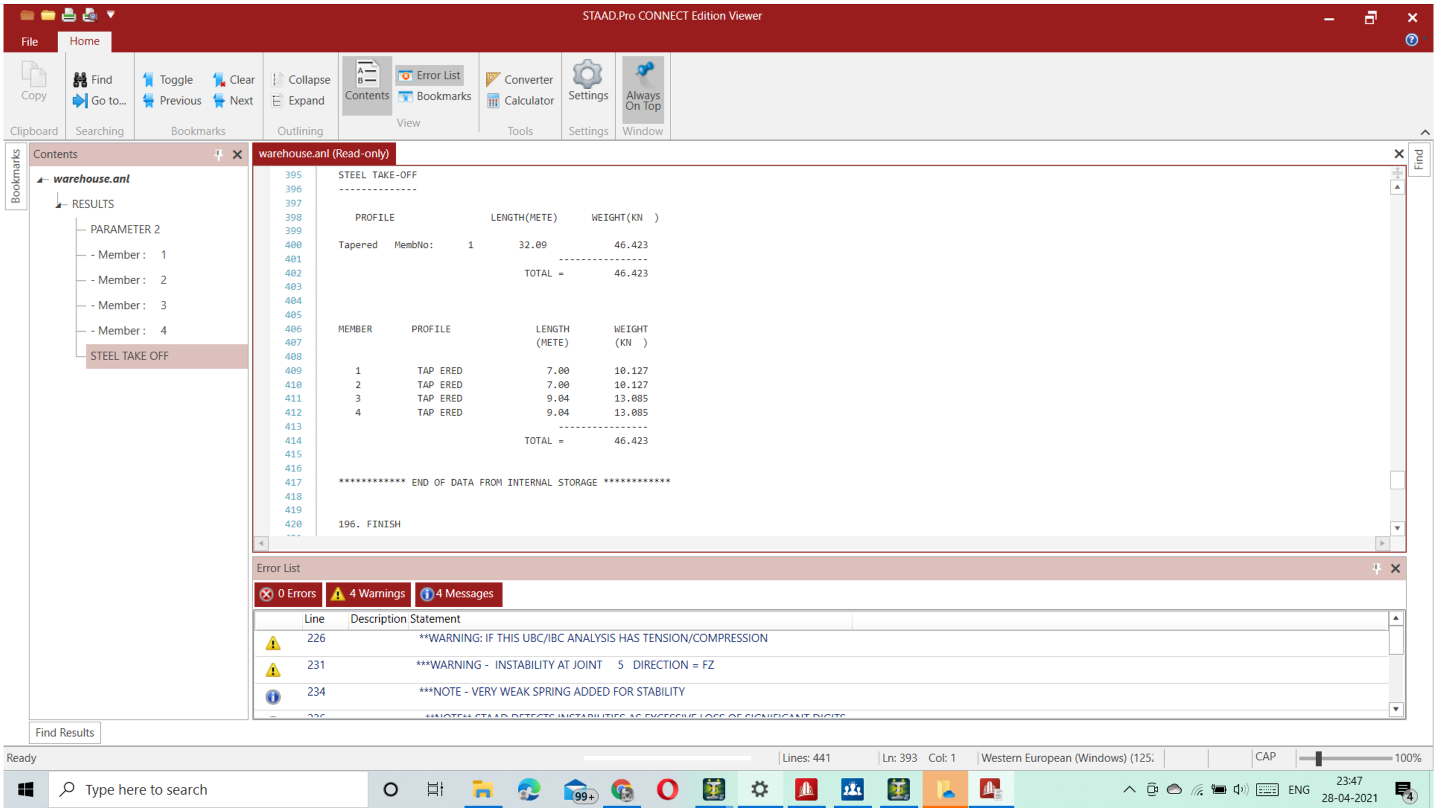

Fig. 3. 8– steel take off a frame before optimization

Step 9: Now optimization of our steel structure has to be done.

First, we will see the bending moment diagram of any load in **<u>My direction</u>**.

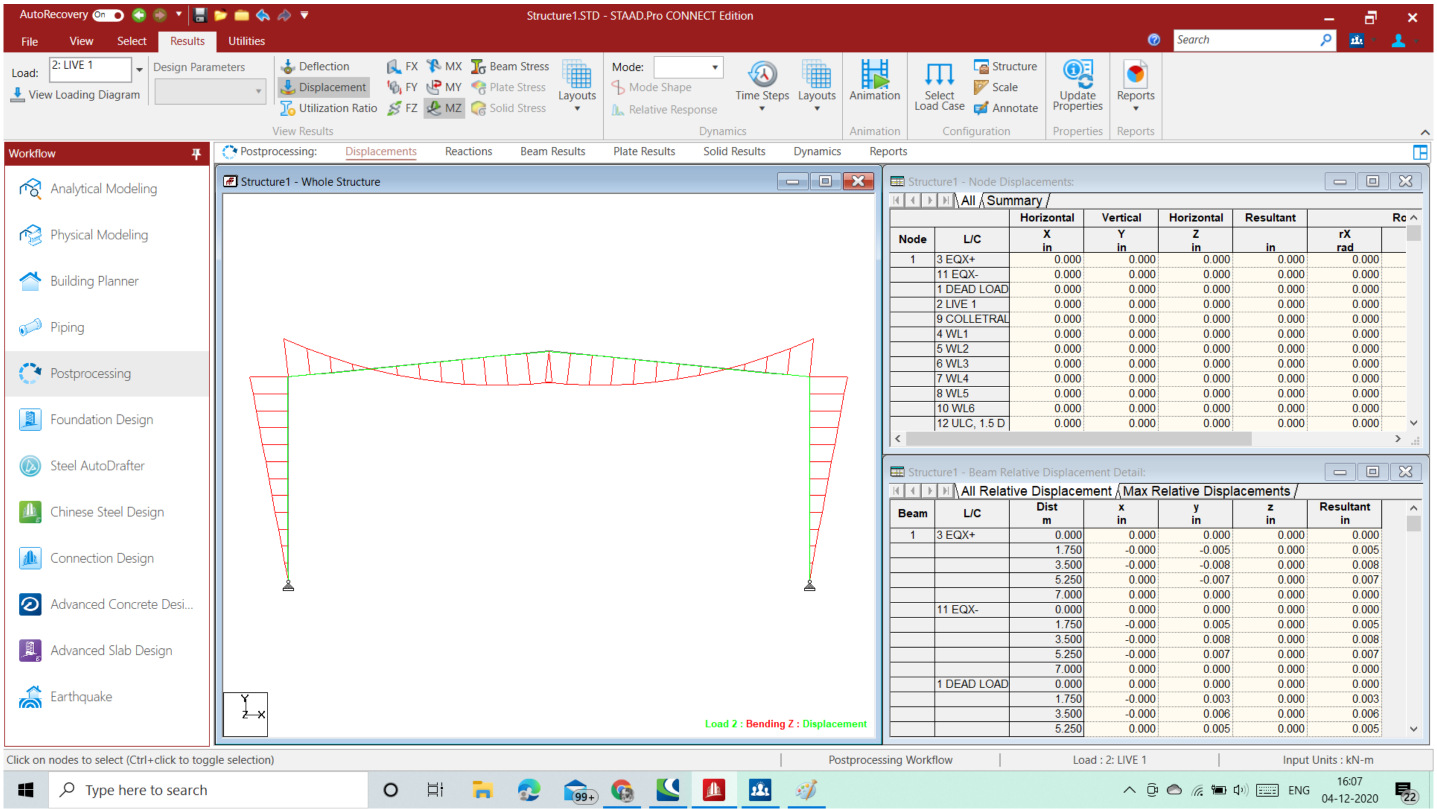

Fig. 3. 9– Bending moment diagram along the y direction on steel frame.

Now we have to find the location of point of zero moment with the help of view result in the STAAD Pro . In our frame the location of point of zero bending moment of rafter part comes at distance of 2.89m from the left side. So first insert two nodes at these two loactions on the rafter.

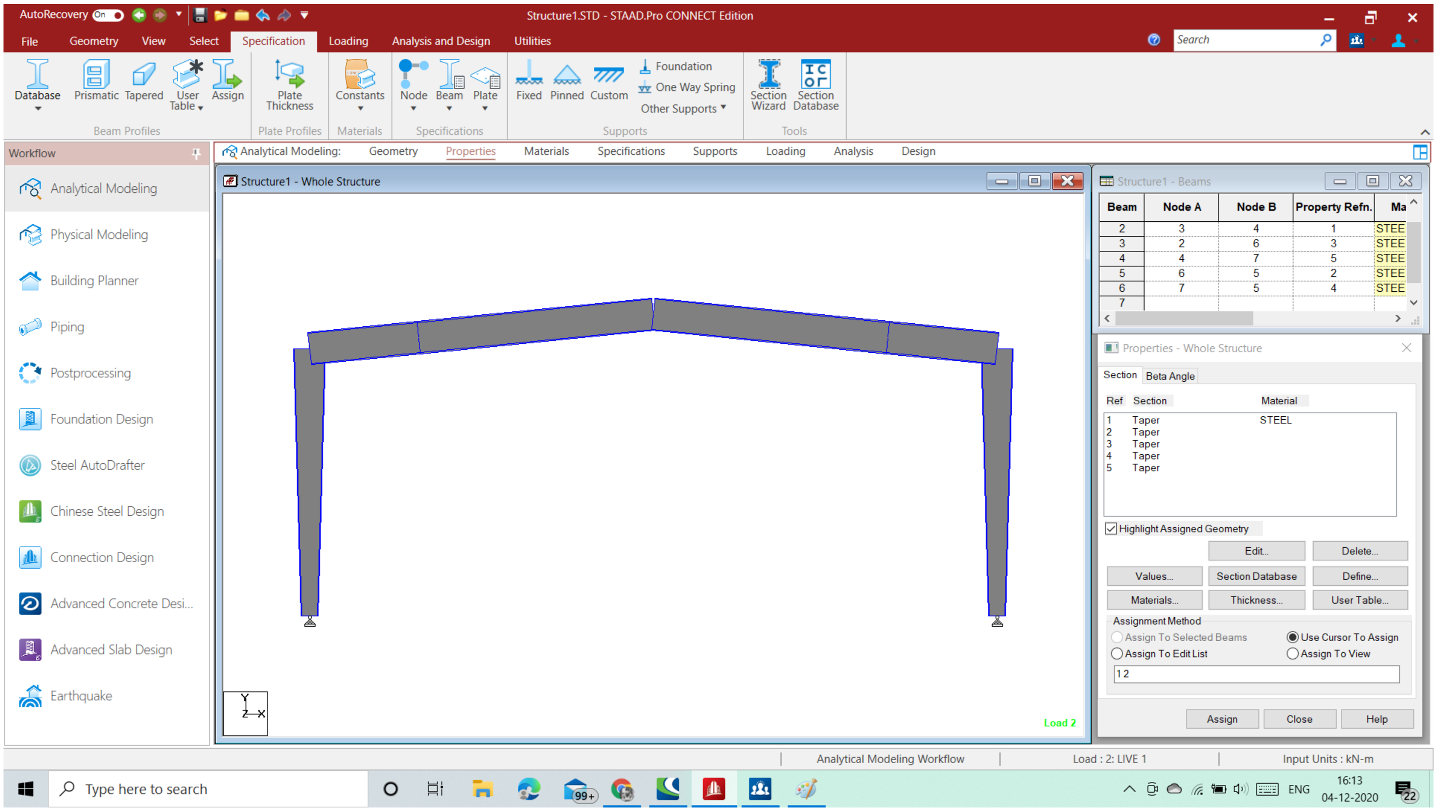

Fig. 3. 10- node is inserted at the loaction of 2.89 m on rafter.

We know that,

$$\text{Stress} = M * y / I$$

So if we increse the value of I then we can able to minimize stress on the section to section to be safe and economical both. So we can decrese the dimension of our steel tapered section at the location where there is less bending moment and incresing the dimension of section at the location where there is high bending moment.

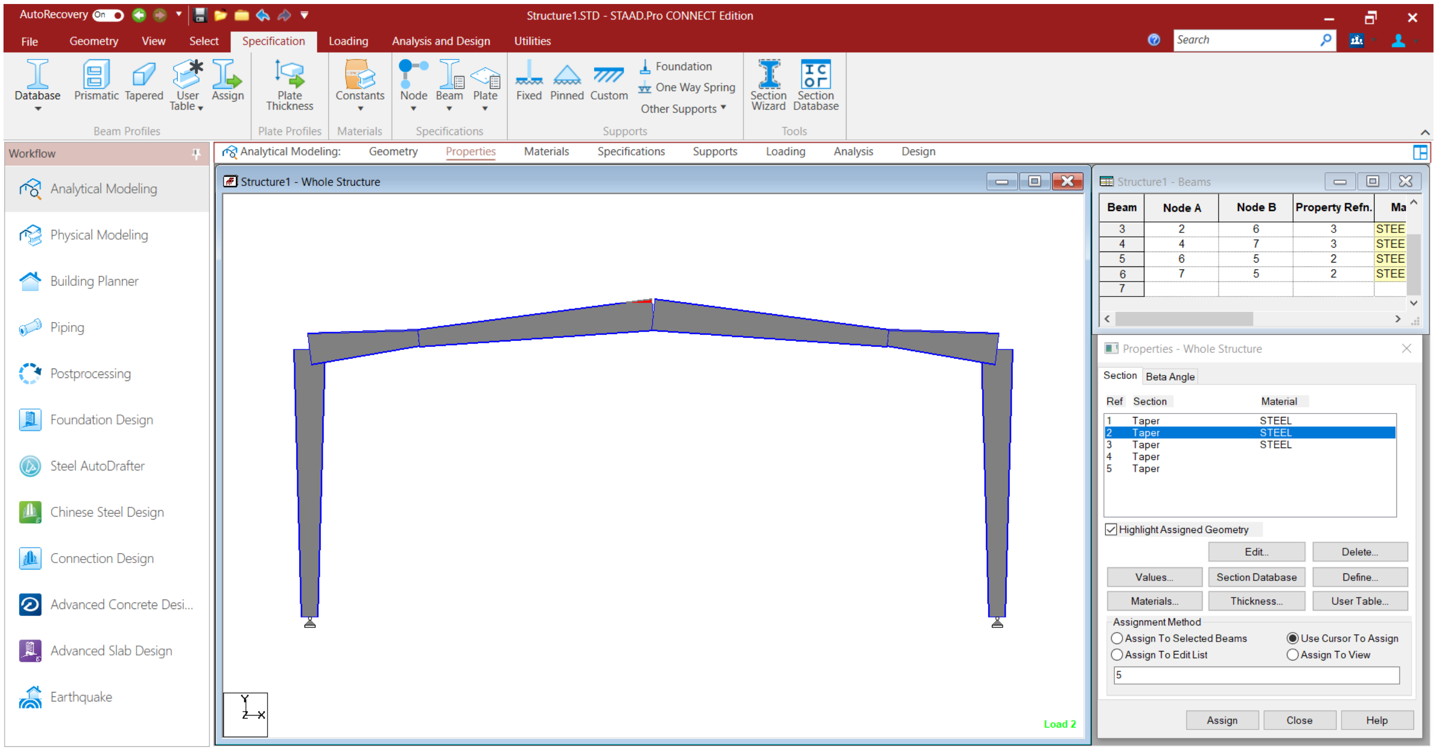

Fig. 3. 11- optimized view of steel frame

Step 10: Optimizing the steel structure

The steel takes off of a frame before optimization is 25.751 KN which is nearly equal to 2625 kg.

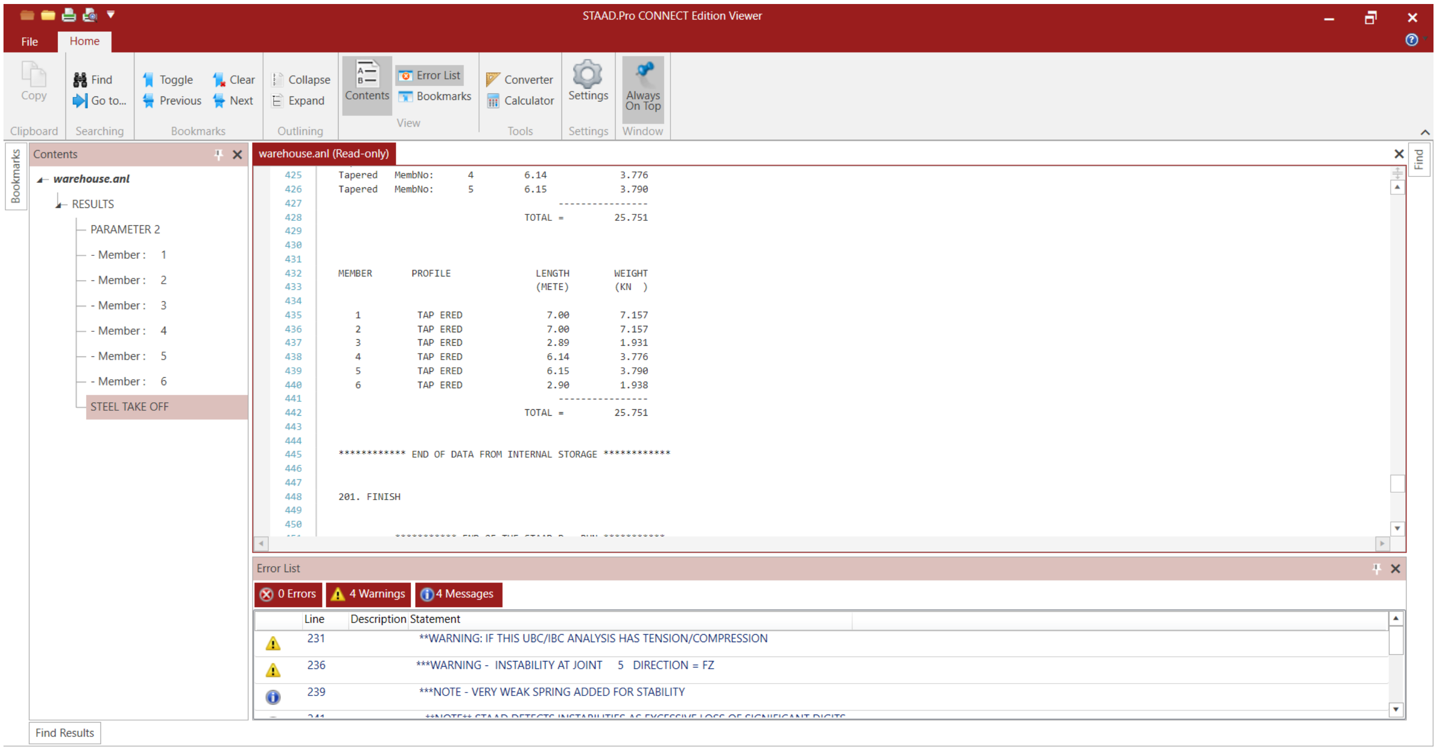

Fig. 3. 12– steel take off a frame before optimization

Step 11: Optimizing the steel structure

Transational repeat of pure 2 D frame in the Z direction in order to make a 3 D frame according to our modelling considerations.

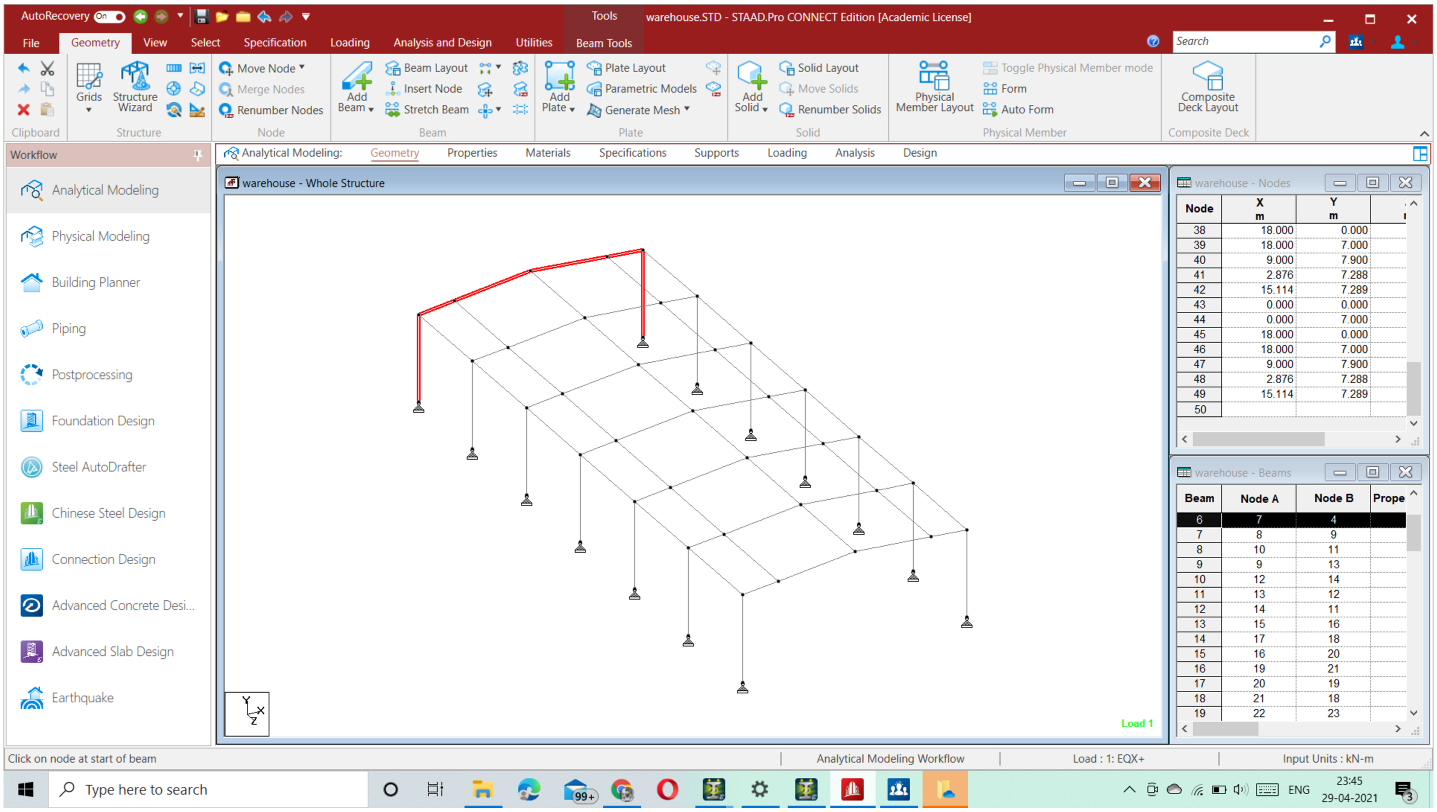

Fig. 3. 13– 3D frame according to modelling considerations.

Step 12: Adding horizontal and vertical bracing

These bracings are added in order to make a frame stable against wind and seismic load .

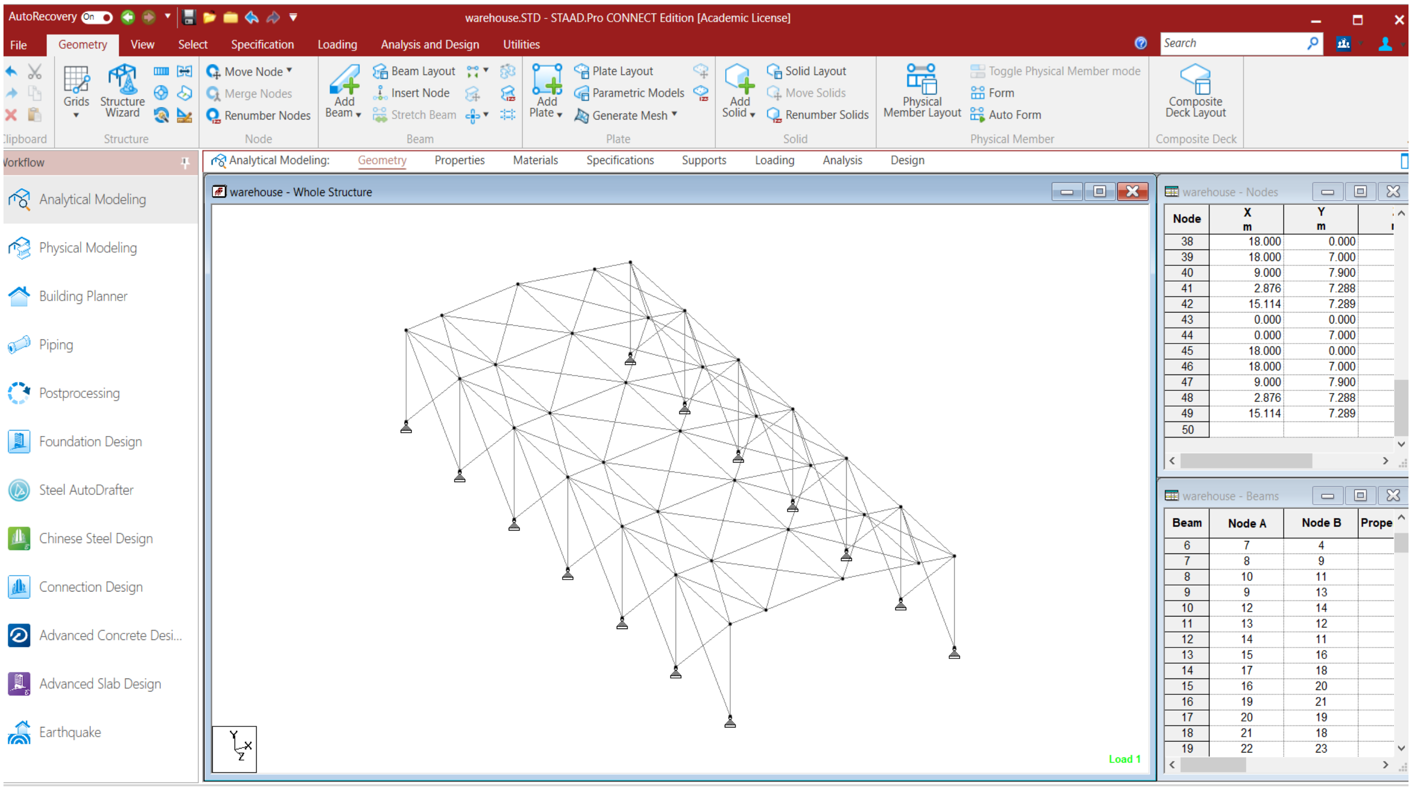

Fig. 3. 14– view of braced frame.

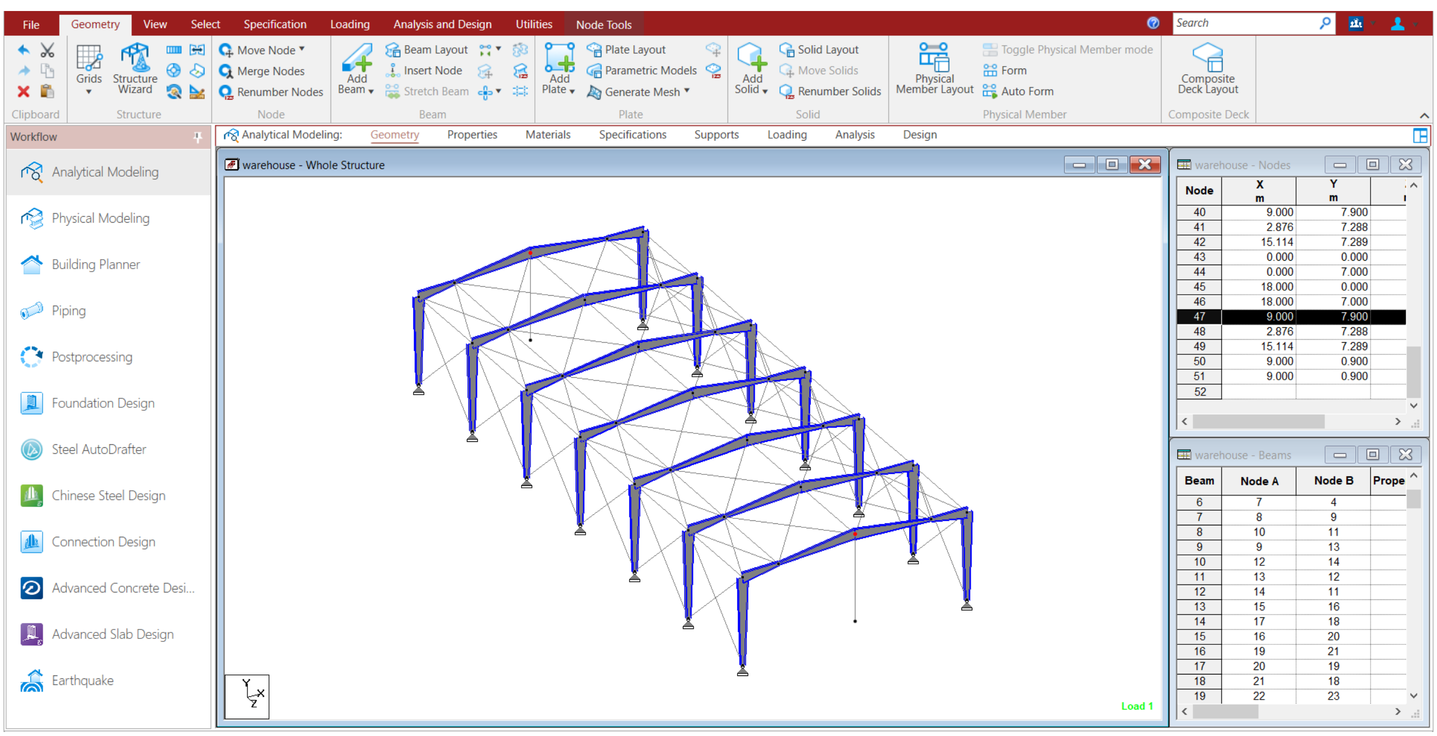

Fig. 3. 15– addition of bracings to frame

Step 13: Defining the bracings as a truss member.

Defining the bracings as a truss member in order to make the structure stable for the loading conditions.

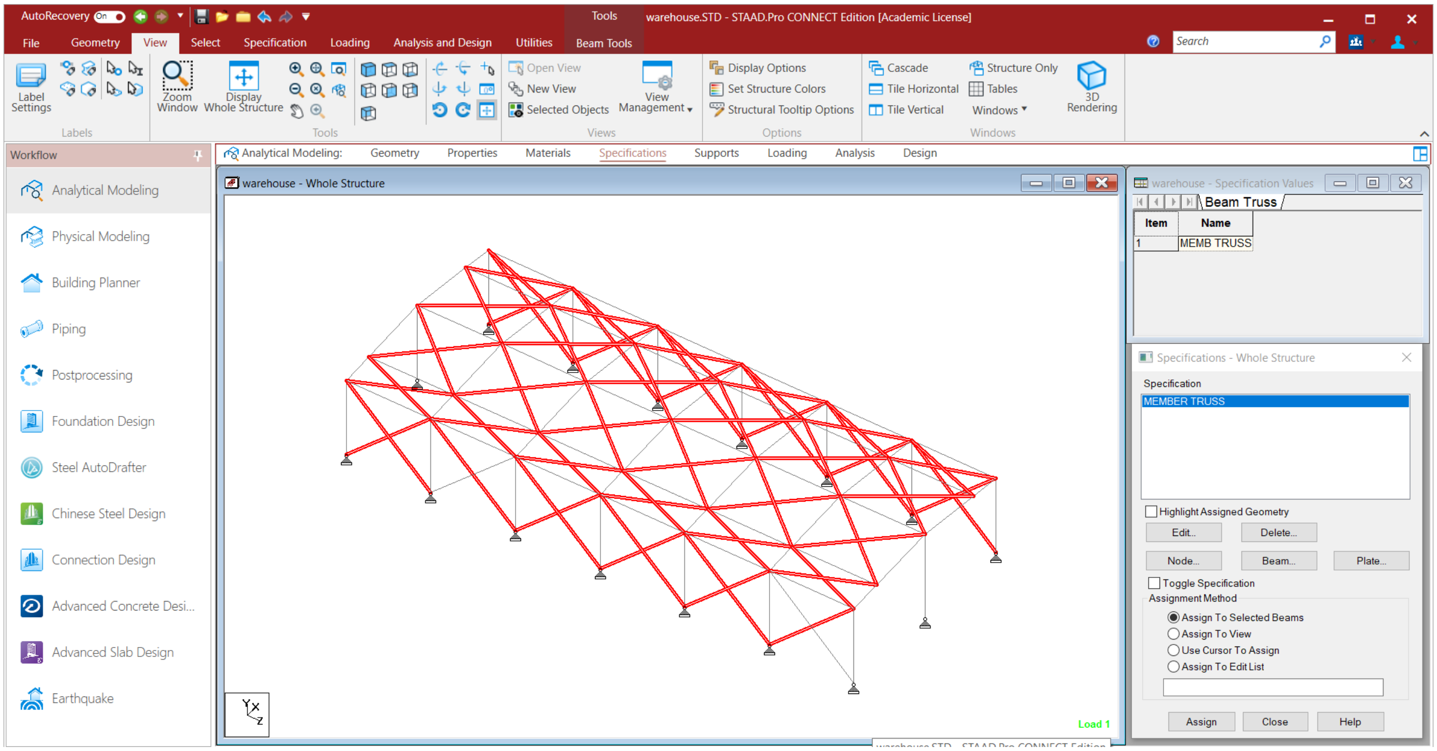

Fig. 3. 16– defining bracings a truss member

Step 14: Defining the Property of bracings.

Defining the bracings their Property according to the **IS STANDARDS as** pipe **PIP1143M.**

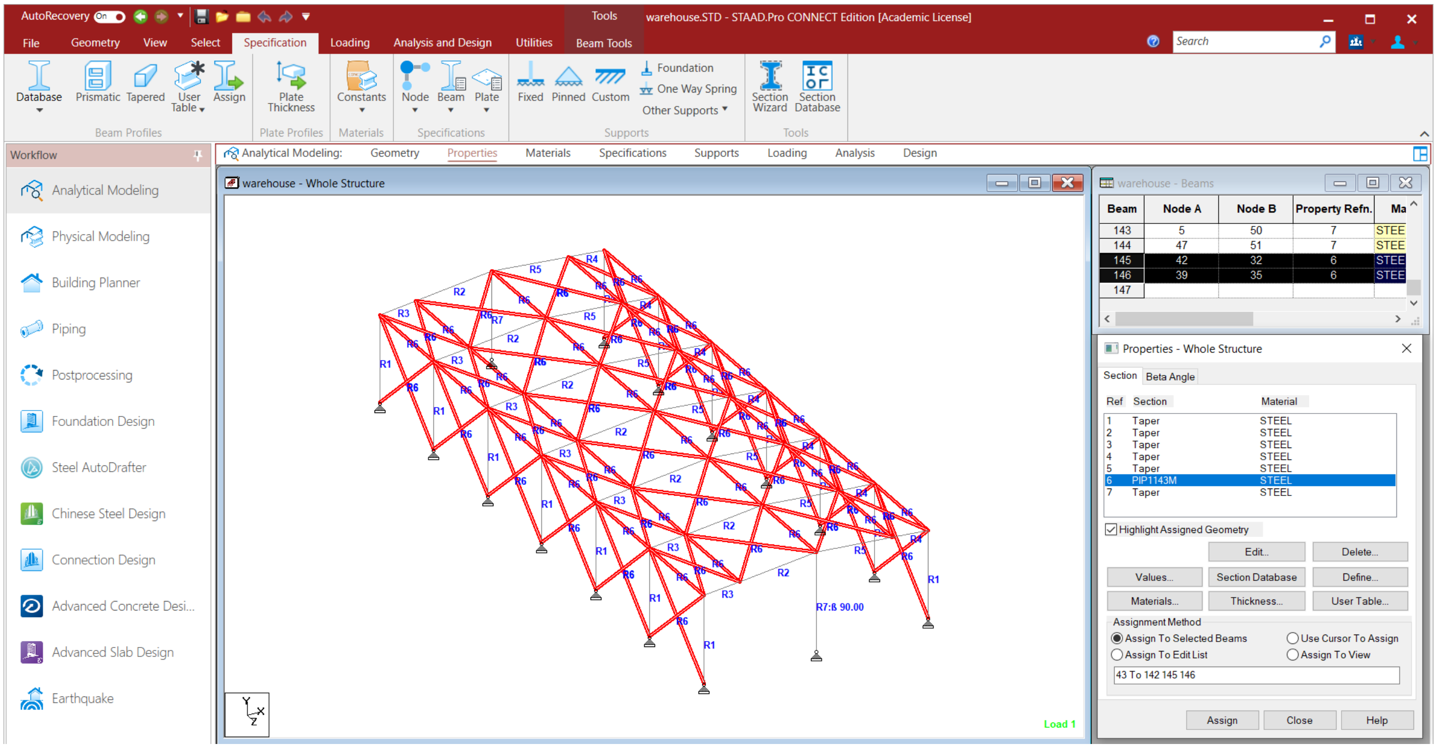

Fig. 3. 17– defining Property of bracings.

Step 15: Defining and construction of end wall column

First we have to define the nodes of end wall column and after that rotate its beta angle to 90 so as to counter the effect of wind load acting on it by means of major axis of our tapered section.

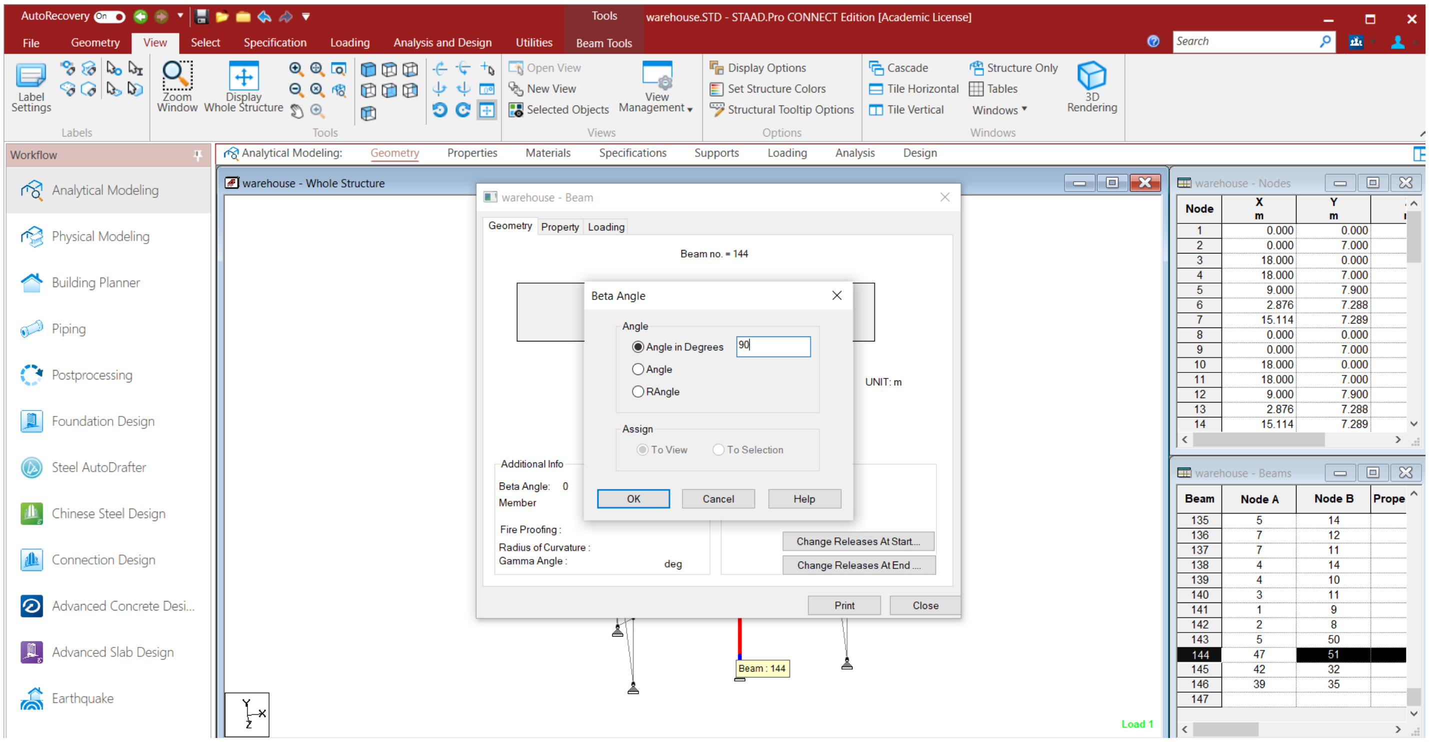

Fig. 3. 18– addition of end wall columns

Step 16: Analyze the final model of our warehouse

Analyzed the final model of our warehouse by means run and analysis command in the STAAD Pro.

The structure had been analysed as 0 error structure.

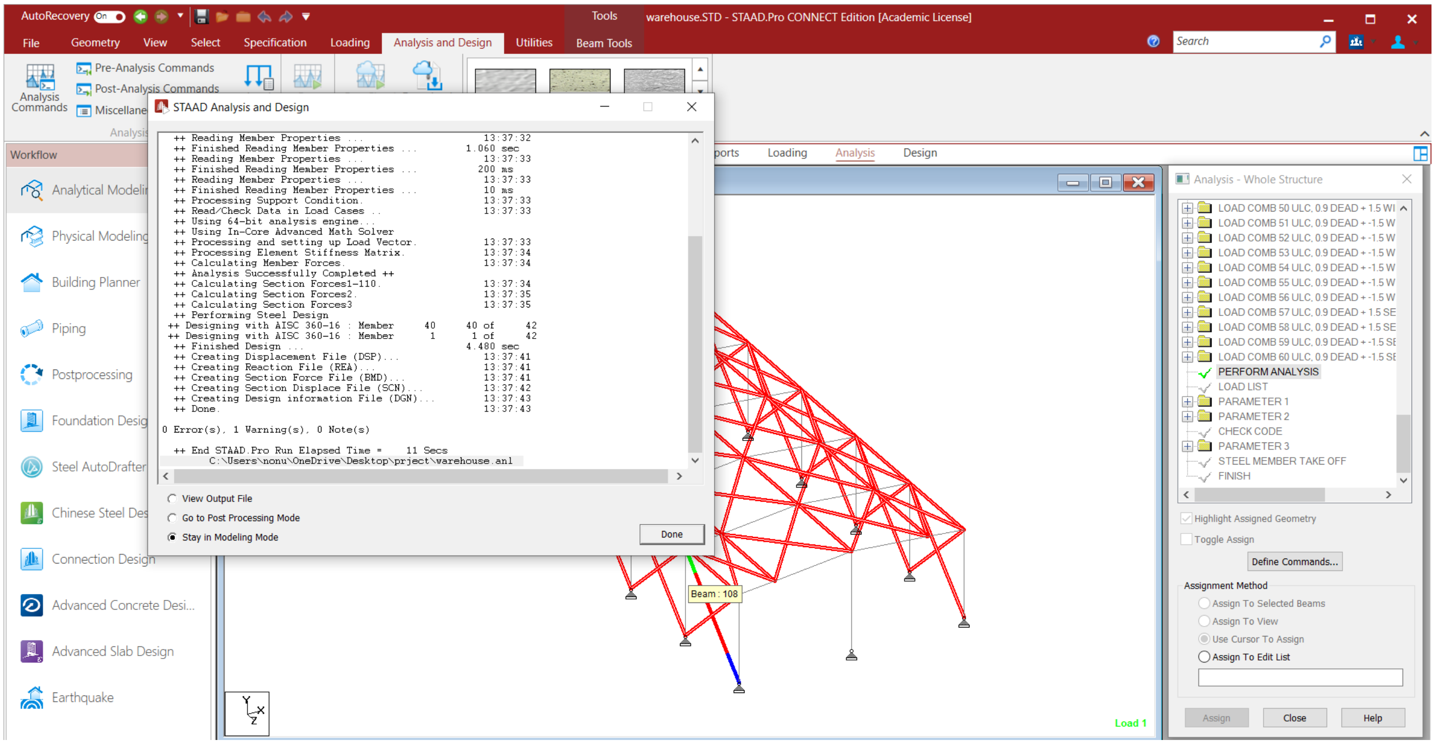

Fig. 3. 19 – analysis of our warehouse .

CHAPTER 4

RESULT AND DISCUSSION

4.1 ANALYSIS OF STRUCTURE IN STADD Pro

The two-dimensional structure of the steel framed warehouse is done through the software STADD Pro. Connect by calculating various loads manually with the help of IS Code **IS 875: Part 3.**

Various moments diagrams and their maximum and minimum value is calculated using the STADD Pro.

- Reaction at supports

Table 4.1: Reaction at supports of 2-D frame

REACTION AT SUPPORT FIRST	REACTION AT SUPPORT SECOND
Fx = -4.800 KN	Fx = -4.800 KN
Fy = -4.00 KN	Fy = -4.00 KN
Fz = 0.00 KN	Fz = 0.00 KN
Mx= FREE	Mx= FREE
My=FREE	My=FREE
Mz =FREE	Mz =FREE

- Maximum bending moments due to applied loads on **2-D Frame**

Beam	Node A	Length (m)	L/C		d(m)	Max My (kip in)	d (m)	Max Mz (kip in)
1	1	7.000	1: DEAD LOAD	Max +ve	0	0	7.000	213.233
				Max -ve	0	0		
			2: LIVE 1	Max +ve	0	0	7.000	1.07E+3
				Max -ve	0	0		
			3: EQX+	Max +ve	0	0	0	0.000
				Max -ve	0	0	7.000	-301.313
			4: WL1	Max +ve	0	0		
				Max -ve	0	0	7.000	-1.82E+3
			5: WL2	Max +ve	0	0	0.583	8.125
				Max -ve	0	0	7.000	-552.533

			6: WL3	Max +ve	0	0	0	0.000
				Max -ve	0	0	6.417	-1.29E+3
			7: WL4	Max +ve	0	0	7.000	207.712
				Max -ve	0	0		
			8: WL5	Max +ve	0	0	2.917	154.717
				Max -ve	0	0	7.000	-272.568
			9: COLLETRAL	Max +ve	0	0	7.000	355.412
				Max -ve	0	0	0	-0.000
			10: WL6	Max +ve	0	0	1.167	7.309
				Max -ve	0	0	7.000	-350.101
			11: EQX -	Max +ve	0	0	7.000	301.286
				Max -ve	0	0		

Fig. 4. 1*: beam maximum moments*

- Maximum shear force due to applied loads

Beam	Node A	Length (m)	L/C		d(m)	Max Fz (kN)	d (m)	Max Fy (kN)
1	1	7.000	1: DEAD LOAD	Max +ve	0	0		
				Max -ve	0	0	0	-3.441
			2: LIVE 1	Max +ve	0	0		
				Max -ve	0	0	0	-17.211
			3: EQX+	Max +ve	0	0	0	4.866
				Max -ve	0	0		
			4: WL1	Max +ve	0	0	0	42.270
				Max -ve	0	0		
			5: WL2	Max +ve	0	0	7.000	20.318
				Max -ve	0	0	0	-2.572
			6: WL3	Max +ve	0	0	0	43.710
				Max -ve	0	0	7.000	-2.140
			7: WL4	Max +ve	0	0		
				Max -ve	0	0	0	-4.675
			8: WL5	Max +ve	0	0	7.000	22.088
				Max -ve	0	0	0	-13.542
			9: COLLETRAL	Max +ve	0	0		
				Max -ve	0	0	0	-5.736
			10: WL6	Max +ve	0	0	7.000	13.247
				Max -ve	0	0	0	-2.014
			11: EQX -	Max +ve	0	0		
				Max -ve	0	0	0	-4.860

Fig. 4. 2: beam maximum shear force on 2-D Frame

- **Maximum shear force in beams at ends**

At nodes the maximum shear force is observed as

Table 4.2: maximum shear force of 2-D FRAME

At support nodes	17.211 KN
At node joining rafter and column	48.912 KN
At the node joining the rafters at their mid-point	32.849 KN

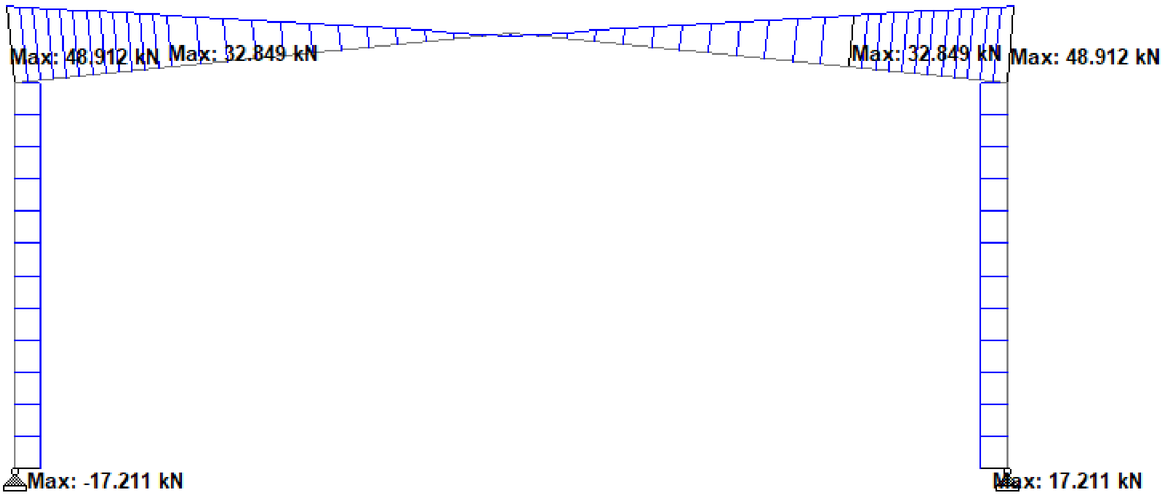

Fig. 4. 3: diagram of shear force on frame

- **Maximum bending moment diagram**

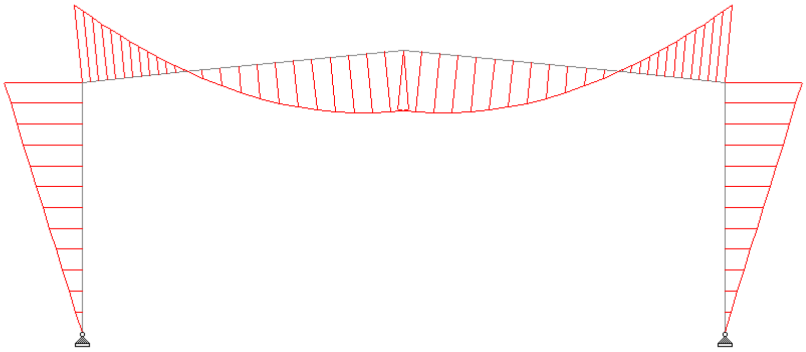

Fig. 4. 4: bending moment diagram

- **Maximum displacement**

  The below figure shows the maximum displacement our columns and beams can show after applying load .

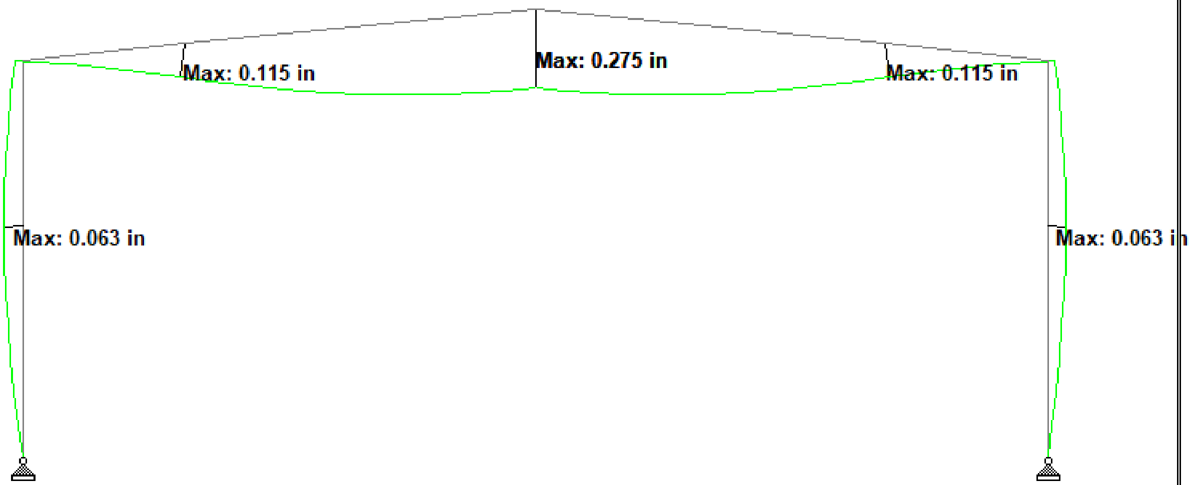

Fig. 4. 5: maximum displacement

The above value can be minimized by connecting the whole frame of warehouse with help of bracings, purlins.

- **Design results of all the beamsand columns**

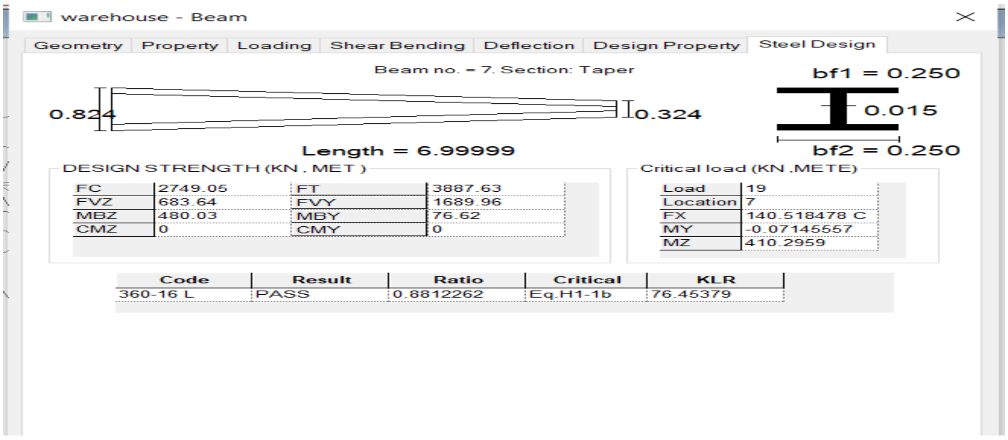

Fig. 4. 6: design steel taper 1

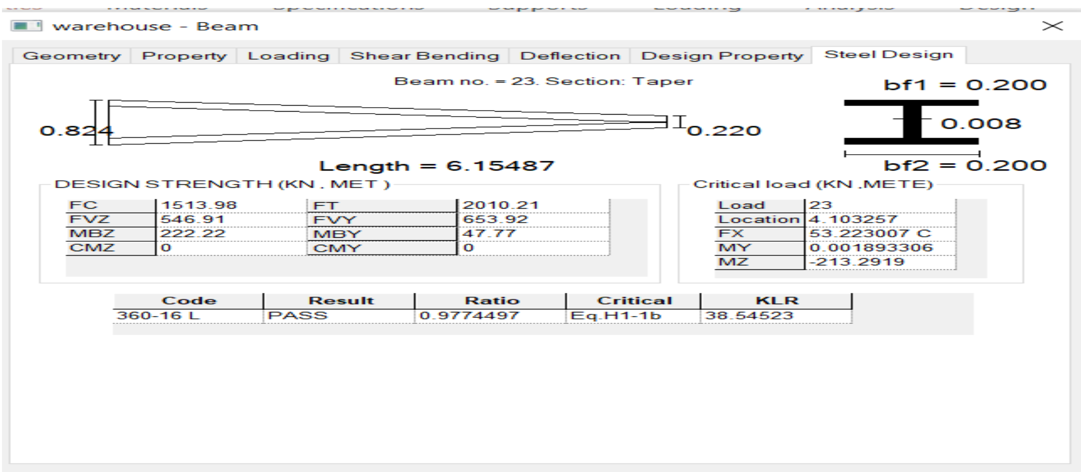

Fig. 4. 7: design steel taper 2

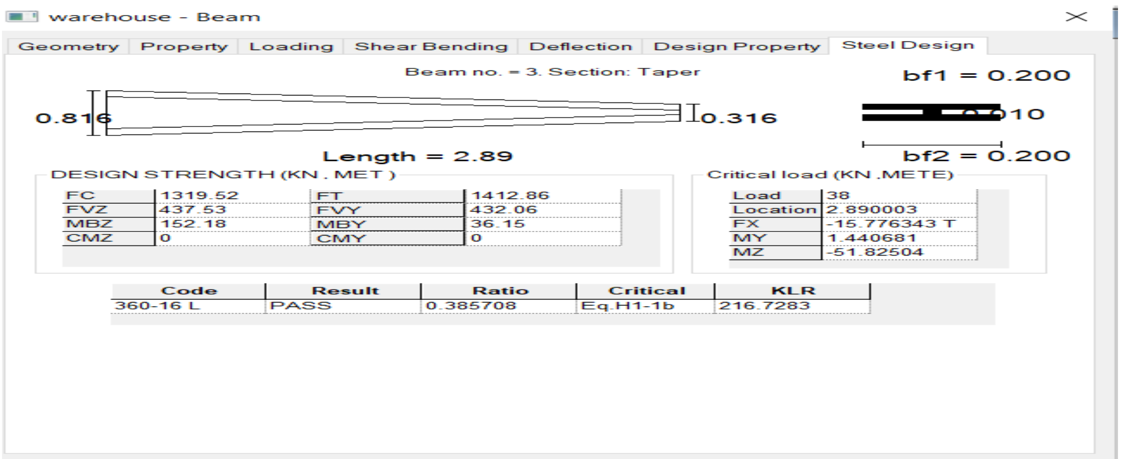

Fig. 4. 8: design steel taper 3

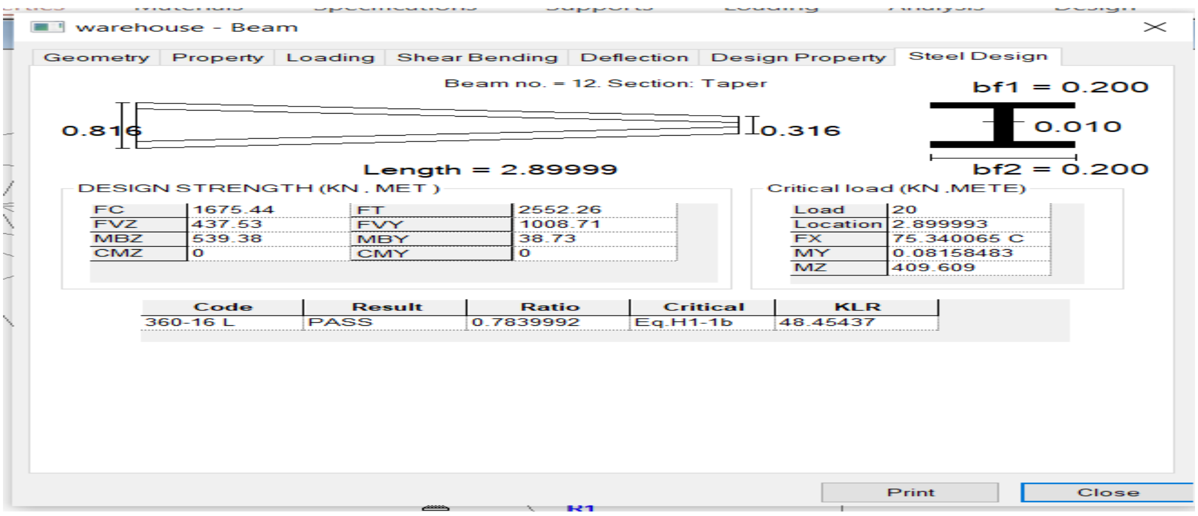

Fig. 4. 9: design steel taper 4

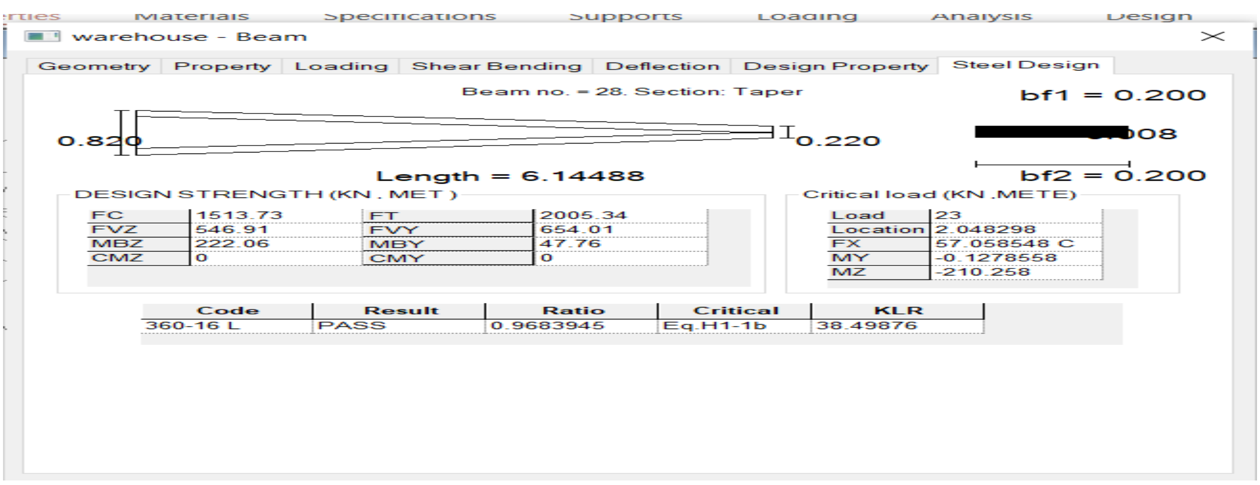

Fig. 4. 10: design steel taper 5

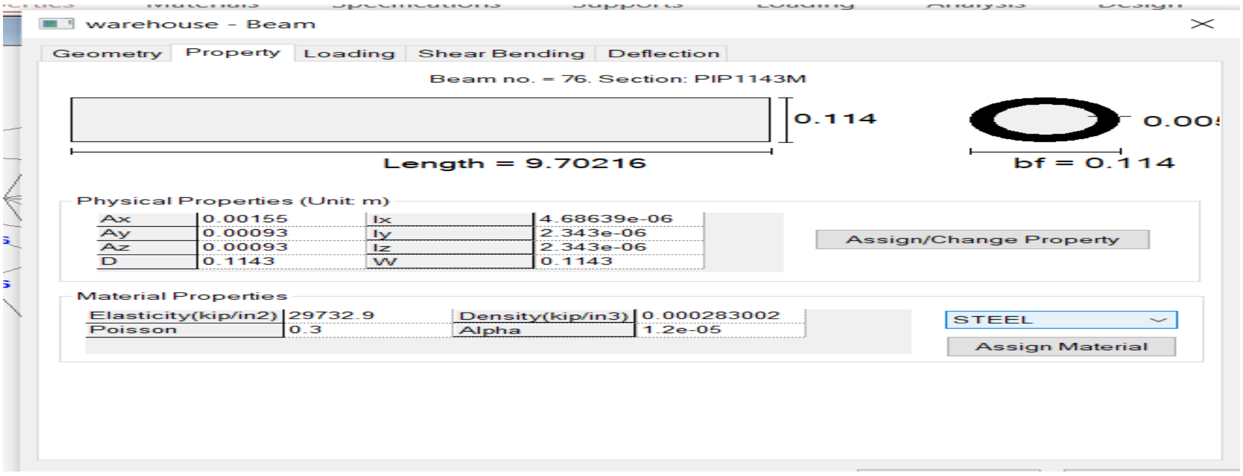

Fig. 4. 11: design steel pipe used for bracings

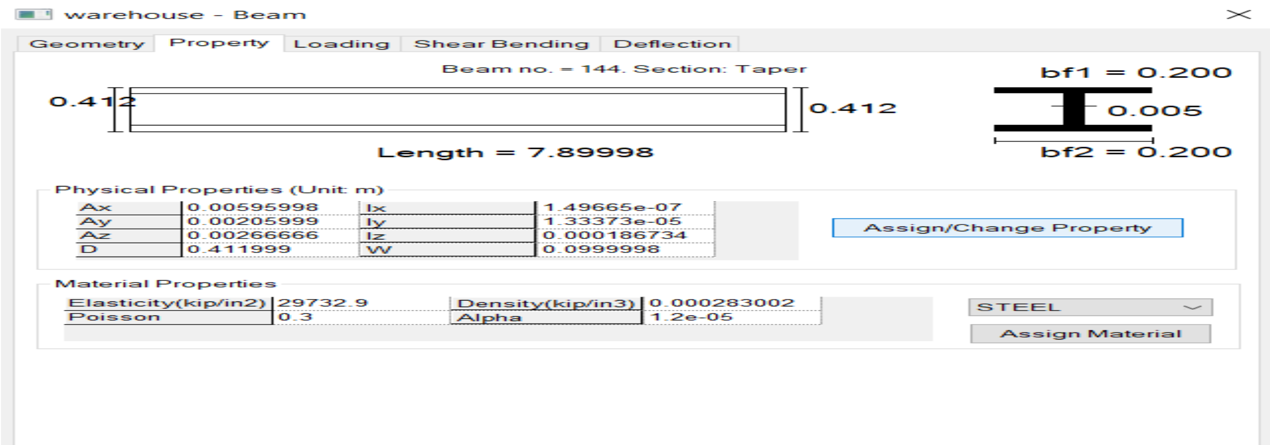

Fig. 4. 12: design steel taper 6

- **<u>Steel take off before optimization of 2-D Frame</u>**

The steel used in the two-dimensional frame is

STEEL TAKE-OFF

MEMBER	PROFILE	LENGTH (METER)	WEIGHT(KN)
1	Tapered	32.09	46.423
		TOTAL =	45.771

MEMBER	PROFILE	LENGTH (METER)	WEIGHT (KN)
1	TAPERED	7.00	10.127
2	TAPERED	7.00	10.127
3	TAPERED	9.04	13.085
4	TAPERED	9.04	13.085

TOTAL = 46.423

The total steel used in this frame is 46.423 KN. Means the total wight of steel is used is about 4733.83 kg

- **Steel take off after optimization of 2-D Frame**

L/C		Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
1	Loads	65.86	0	0	0	1482.336	-486.855
	Reactions	-65.86	0	0	0	-1482.34	486.855
	Difference	0	0	0	0	0	0
2	Loads	-65.86	0	0	0	-1482.34	486.855
	Reactions	65.86	0	0	0	1482.336	-486.855
	Difference	0	0	0	0	0	0
3	Loads	0	-252.707	0	5685.919	0	-2274.36
	Reactions	0	252.707	0	-5685.92	0	2274.363
	Difference	0	0	0	0	0	0
4	Loads	0	-712.285	0	16026.45	0	-6410.57
	Reactions	0	712.285	0	-16026.4	0	6410.565
	Difference	0	0	0	0	0	0
5	Loads	0	-237.428	0	5342.148	0	-2136.86
	Reactions	0	237.428	0	-5342.15	0	2136.855
	Difference	0	0	0	0	0	0
6	Loads	313.894	797.58	69.434	-17656.6	6437.723	5065.821
	Reactions	-313.894	-797.58	-69.434	17656.65	-6437.72	-5065.82
	Difference	0	0	0	0	0	0
7	Loads	-313.894	797.58	-34.717	-18090.1	-6750.18	9290.62
	Reactions	313.894	-797.58	34.717	18090.06	6750.176	-9290.62
	Difference	0	0	0	0	0	0
8	Loads	313.894	430.92	6.545	-9660.7	7003.724	1765.88
	Reactions	-313.894	-430.92	-6.545	9660.701	-7003.72	-1765.88
	Difference	0	0	0	0	0	0
9	Loads	-313.894	430.92	41.262	-9516.23	-7433.99	5990.68
	Reactions	313.894	-430.92	-41.262	9516.23	7433.987	-5990.68
	Difference	0	0	0	0	0	0
10	Loads	0	917.28	0	-20638.8	0	8255.521
	Reactions	0	-917.28	0	20638.84	0	-8255.52

	Difference	0	0	0	0	0	0
11	Loads	0	550.62	0	-12389	0	4955.58
	Reactions	0	-550.62	0	12388.98	0	-4955.58
	Difference	0	0	0	0	0	0

MEMBER	PROFILE	LENGTH (METER)	WEIGHT (KN)
1	TAPERED	7.00	7.175
2	TAPERED	7.00	7.175
3	TAPERED	2.90	1.931
4	TAPERED	6.15	3.776
5	TAPERED	6.15	3.776
6	TAPERED	2.90	1.931

TOTAL= 25.751

Static result check of reactions of warehouse structure

Summary of beam results

	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	143	23 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (5)	5	167.154	0.006	-0.213	0	1.493	0.04
Min Fx	19	45 ULC, 0.9 DEAD + 1.5 WIND (1)	23	-94.365	23.424	-0.003	0	-0.019	-297.741
Max Fy	21	19 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (1)	23	61.911	157.144	0.02	0	-0.014	450.463
Min Fy	24	20 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (2)	25	61.933	-157.11	0	0	-0.005	450.331
Max Fz	143	54 ULC, 0.9 DEAD + -1.5 WIND (4)	5	73.827	14.415	28.668	0	-8.103	100.902
Min Fz	143	32 ULC, 1.5 DEAD + 1.5 WIND (4)	5	-45.016	-14.413	-28.704	0	8.361	-100.89
Max Mx	67	20 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (2)	6	-2.248	0.031	-0.008	0.409	0.002	0.05
Min Mx	61	19 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (1)	7	-2.696	0.02	0.04	-0.409	-0.187	-0.026
Max My	143	32 ULC, 1.5 DEAD + 1.5 WIND (4)	5	-45.016	-14.413	-28.704	0	8.361	-100.89

Min My	143	54 ULC, 0.9 DEAD + -1.5 WIND (4)	5	73.827	14.415	28.668	0	-8.103	100.902
Max Mz	21	19 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (1)	23	61.911	157.144	0.02	0	-0.014	450.463
Min Mz	20	20 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (2)	25	150.925	49.045	0	0	0.003	-450.329

Summary of displacements

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	32	36 ULC, 1.5 DEAD + -1.5 WIND (2)	.016	-0.323	0.106	.017	0	0	-0.001
Min X	30	35 ULC, 1.5 DEAD + -1.5 WIND (1)	-.169	-0.324	-0.101	.17	0	0	0.001
Max Y	26	49 ULC, 0.9 DEAD + 1.5 WIND (5)	0.051	.753	-0.001	.753	0	0	0
Min Y	26	23 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (5)	-0.088	-.036	0.001	.036	0	0	0
Max Z	5	20 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (2)	.007	-0.954	.068	.168	-0.01	0	0
Min Z	47	19 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (1)	-.291	-.066	-.341	.476	0.002	0	-0.001
Max rX	50	48 ULC, 0.9 DEAD + 1.5 WIND (4)	0	0	0	0	0.037	0	0.009
Min rX	50	38 ULC, 1.5 DEAD + -1.5 WIND (4)	0	0	0	0	-0.038	0	-0.009
Max rY	43	23 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (5)	0	0	0	0	0	0.002	0
Min rY	43	49 ULC, 0.9 DEAD + 1.5 WIND (5)	0	0	0	0	0	-0.001	0
Max rZ	28	19 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (1)	-.223	-.25	-0.069	.37	0	0	0.012
Min rZ	27	20 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (2)	.042	-.133	0.141	.159	0	0	-0.012
Max Rst	26	19 ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (1)	-.969	-.898	-0.157	.76	0	0	-0.002

Steel take off of entire frame

STEEL TAKE OFF _

_
STEEL TAKE-OFF

PROFILE			LENGTH(METER)	WEIGHT(KN)
Tapered	MembNo:	1	98.00	100.202
Tapered	MembNo:	3	40.53	27.087
Tapered	MembNo:	4	43.01	26.435
Tapered	MembNo:	5	43.08	26.531

TOTAL = 180.255

_

MEMBER	PROFILE	LENGTH (METER)	WEIGHT (KN)
_			
1	**TAP ERED**	**7.00**	**7.157**
2	**TAP ERED**	**7.00**	**7.157**
3	**TAP ERED**	**2.89**	**1.931**
4	**TAP ERED**	**6.14**	**3.776**
5	**TAP ERED**	**6.15**	**3.790**
6	**TAP ERED**	**2.90**	**1.938**
7	**TAP ERED**	**7.00**	**7.157**
8	**TAP ERED**	**7.00**	**7.157**
9	**TAP ERED**	**2.89**	**1.931**
10	**TAP ERED**	**6.14**	**3.776**
11	**TAP ERED**	**6.15**	**3.790**
12	**TAP ERED**	**2.90**	**1.938**
13	**TAP ERED**	**7.00**	**7.157**
14	**TAP ERED**	**7.00**	**7.157**
15	**TAP ERED**	**2.89**	**1.931**
16	**TAP ERED**	**6.14**	**3.776**
17	**TAP ERED**	**6.15**	**3.790**
18	**TAP ERED**	**2.90**	**1.938**
19	**TAP ERED**	**7.00**	**7.157**
20	**TAP ERED**	**7.00**	**7.157**
21	**TAP ERED**	**2.89**	**1.931**
22	**TAP ERED**	**6.14**	**3.776**
23	**TAP ERED**	**6.15**	**3.790**
24	**TAP ERED**	**2.90**	**1.938**
25	**TAP ERED**	**7.00**	**7.157**
26	**TAP ERED**	**7.00**	**7.157**
27	**TAP ERED**	**2.89**	**1.931**
28	**TAP ERED**	**6.14**	**3.776**
29	**TAP ERED**	**6.15**	**3.790**
30	**TAP ERED**	**2.90**	**1.938**
31	**TAP ERED**	**7.00**	**7.157**
32	**TAP ERED**	**7.00**	**7.157**
33	**TAP ERED**	**2.89**	**1.931**
34	**TAP ERED**	**6.14**	**3.776**
35	**TAP ERED**	**6.15**	**3.790**
36	**TAP ERED**	**2.90**	**1.938**
37	**TAP ERED**	**7.00**	**7.157**
38	**TAP ERED**	**7.00**	**7.157**
39	**TAP ERED**	**2.89**	**1.931**
40	**TAP ERED**	**6.14**	**3.776**

41	TAP ERED	6.15	3.790	
42	TAP ERED	2.90	1.938	
		TOTAL =	180.255	

Result the total take off of a steel frame is 180.255 kN which is equal to 18380.89 Kg.

Total length of pipe used for bracings:

Member length (1) (in m)	No. of pipes (2)	Total length = (1*2) (in m)
9.7102	**24**	**233.04**
8.03	**24**	**192.72**
7.499	**6**	**44.994**
10.2592	**24**	**246.220**
	TOTAL=	**716.974**

Approximate length of pipe (PIP1143M) used for bracing = 720 m.

CHAPTER 5

CONCLUSION

Conclusions

The main objective of this study is to ANALYSIS AND DESIGN OF STEEL FRAMED STEEL STRUCTURE. The objective is to study the different parts of warehouse components and assign various types of load according to the recommended IS 875 (Part 3):2015. To achieve this objective, the structure was analyzed using STADD Pro and various parameters such as Design IS CODE, assigning Properties. And optimizing various parts of the steel frame by changing the dimension of the tapered I section. After performing the analysis on the structure, the following conclusions are drawn:

- Steel required in pre-engineered building is less than the conventional building.
- The column is to be designed should be narrow from the downward side and reactively broad from the upper side.
- The rafter beam is designed broad from the right side and relatively narrow at the point of zero bending moment.
- The main concept behind the alteration of the tapered section of the I beam is to minimize and maximize the section modulus to relatively change the stress where it comes to more.
- The two-dimensional analysis has been done with stress ratio equal to or less than 1 in order to maintain the stability.
- The bracings are the most important part of any pre-engineered building in order to stabilize it against the seismic and wind load.
- The end wall columns are to be placed at beta angle of 90 degree in order to maintain the wind load to be acted along the major axis of our steel column.

- The total weight of the steel used for the warehouse is 18380.39 Kg.
- The total length of pipe used is about 720 m.

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