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DESIGN AND ANALYSIS OF PRE ENGINEERED BUILDING STRUCTURE BY USING STAAD.PRO

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ABSTRACT: India's growing industrialization has created a demand for the manufacturing and storage of commodities, both of which can be accommodated by well-designed industrial warehouses. The study provides a suggestion for designing an industrial warehouse. The purpose of this project is to learn about the various forces/load effects that should be taken into account while constructing an industrial warehouse with the aid of a literature review. The suggested design for this structure complies with IS 800:2007, and the dead, live wind load study is completed in accordance with IS 875:1987. (Part 1- Part 2- Part 3). The suggested warehouse's location was chosen, and a competent architectural plan was created in accordance with the seismic zone's characteristics.
When one of the members is loaded, forces acting on the surrounding members are calculated by computing the axis stresses and ratios induced in the connected members as well as the moments and forces created. Then various warehouse components, such as truss members, columns, connectors, etc., were designed, and the end results were acquired. Finally, it is concluded that STADD Pro-V8i and IS standards can be simply used for warehouse design and analysis.
Keywords: Pre-Engineered Buildings, Industrial Warehouses, STAAD.Pro, Bending Moment and Shear Force, Wind load.

I.INTRODUCTION

Industrial buildings serve a variety of purposes and come in many different forms. Normal-type industrial buildings are often shed-like structures with a simple roof and open frames, used for workshops and warehouses, requiring large and unobstructed floor areas to enable any future changes in the production layout there should be no major alterations to the building. Special-type industrial structures are often steel mill buildings used for manufacturing heavy machinery, power production, or aircraft hangars. The specific needs of all industrial buildings dictate what degree of culture is required in the design and construction, involving various ideas, materials, manpower, and resources to create a structure that meets those needs.

1.1Warehouse:

A warehouse is usually a large plain building in industrial parks on the outskirts of cities, towns, or villages used by manufacturers, importers, exporters, wholesalers, transportation companies, and customs.

Types of warehouses

The warehouse is the most common type of storage, though other forms do exist (e.g., storage tanks, and computer server farms). As well as unloading numerous in-boat trunks and railroad cars with suppliers' products, some warehouses can also load multiple trucks for shipment to customers at the same time.

Private warehouse

A private warehouse is a storage facility that is owned and operated by a private company or individual. Private warehouses are typically used to store goods for a specific business, such as parts for manufacturing, retail merchandise, and finished products. They may also be used to store equipment and supplies for other businesses, such as construction materials. Private warehouses can provide additional security and convenience compared to public warehouses since they are not open to the general public.

Public warehouse

A public warehouse is a commercial storage facility that leases out space to store goods and merchandise. It can be used by businesses, individuals, or organizations who need extra space to store their products. Public warehouses offer several benefits, such as lower costs than private warehouses, the flexibility of short-term or long-term contracts, and easy access to stored items. They are also typically well-maintained and secure, making them ideal for storing valuable products.

Automated Warehouse

Robotics and computer technology have caused a dramatic rise in the level of automation in warehouses. Conveyor belts, warehouse robots, and other machines are used to move product-filled palettes around buildings efficiently and effectively. This allows for only a few people to store large quantities of products, many times the size of two or more football fields. This is the latest trend in warehouse automation.

1.2 History of Warehouse

The history of warehouses dates back to the early days

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of civilization. Warehouses have been used since ancient times when they were constructed as storage facilities for agricultural products and other goods. In the middle Ages, warehouses began to be used by merchants to store their merchandise until it could be sold or shipped to its destination. During this period, warehouses were often guarded by armed guards and had locks on the doors to protect the stored goods from theft. The Industrial Revolution saw a major shift in how warehouses were used. As businesses grew larger, they needed more space to store their products and so large commercial warehouses emerged. These new warehouses were often located near a railway line or port so that goods could easily be transported. Today, warehouses are used for a variety of purposes including storing food, clothing, furniture, and other items for retail outlets, as well as providing storage space for manufacturers. They can also be used as distribution centers for companies who need to ship products quickly across the country or around the world.

1.3 Loads and Load Combinations:

Dead load:

In accordance with IS: 875 (part 1) - 1987, dead load consists of the structure's own weight, roofing, G.I. sheets, gantry girders, crane girders, sag rods, bracings, and other accessories.

Live Load:

According to IS: 875 (part 2) - 1987, for a roof with no access provided, the live load can be taken in kN/m2.

Wind Load:

Wind load calculation as per IS 875 (part 3)- 1987 the basic wind speed for the location of the building is found to be 50 km/h.

Load combination:

According to IS: 875 (part 5) - 1987, Following the codes are used for deciding load combinations and for designing members according to them

1.4 Components of warehousing:

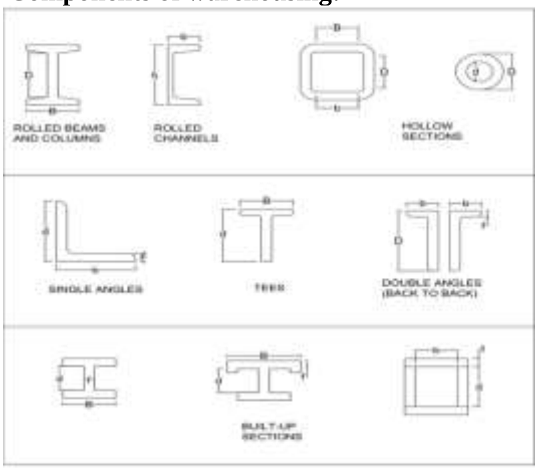

Fig 1 Various Types of Steel Sections

Fig 2 Components of PEB Warehouse

1.5 Pre-Engineered Buildings

A pre-engineered building is a type of construction that is assembled from factory-made components or modules. The modules are then transported to the site and assembled by trained personnel. This type of construction is also known as modular construction or off-site construction.

Pre-engineered buildings are commonly used for office buildings, warehouses, retail stores, schools, hospitals, and other types of commercial and industrial structures. They are also becoming increasingly popular for residential structures such as single-family homes, apartments, and condominiums.

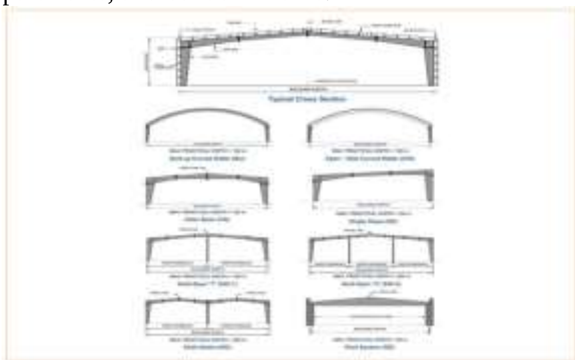

Fig 3 Various Types of PEB Structures

1.6 Advantages of Pre-Engineered Buildings

There are many advantages to using pre-engineered buildings over traditional methods of construction:

1. Speed of Construction: One of the biggest advantages of pre-engineered buildings is the speed of construction. Because the components are manufactured in a controlled environment (usually in a factory), they can be quickly assembled on-site. on-site save weeks or even months on the overall construction schedule.

2. Cost Savings: Pre-engineered buildings can also save you money. Because the components are manufactured in bulk, the overall cost is often lower than traditional methods of construction. In addition, there is often less waste generated during the construction process which further reduces costs.

3. Quality Control: When components are manufactured in a controlled environment, it is easier to maintain quality control standards. This means that you are more likely to get a high-quality product that meets your

specifications.

1.7 PEB Structure and Features

A pre-engineered building (PEB) is a steel structure built using standardized prefabricated components, such as columns, beams, trusses, and wall panels. These components are then shipped to the construction site and assembled by a contractor.

PEBs are often used for industrial and commercial buildings, such as warehouses and factories. They offer several advantages over traditional stick-built structures, including faster construction time, lower costs, and improved energy efficiency.

The most important part of a PEB is the frame, which supports the entire structure. The frame consists of columns and beams that are connected together doing bolts. The connection between the beams and columns is critical in ensuring the structural integrity of the building.

Wall panels are attached to the frame to enclose the space inside the building. They can be made from a variety of materials, including metal, wood, or concrete. The type of material used will depend on the specific needs of the building.

Roof panels are also attached to the frame to provide protection protects. They can be made from a variety of materials, including metal, asphalt shingles, or tile. Again, the type of material used will depend on the specific needs of the building.

1.8 Pre-engineered building by Staad.pro

Pre-engineered buildings (PEBs) are quickly becoming the go-to solution for fast and cost-effective construction projects. But what is a pre-engineered building? What makes it so beneficial, and how can Staad.pro help you design and construct one? In this blog post, we'll explore the many advantages of pre-engineered buildings, as well as how to design them using Staad.pro—the industry leading software for 3D structural analysis and design. We'll discuss how Staad.pro can save you time and money on your next project, all while ensuring your building meets the highest safety standards.

How can Staad.pro help you with your pre- engineered building projects?

If you're working on a pre-engineered building project, Staad.pro can help you with a variety of tasks. For example, it can help you design the structure, analyze the loads, and choose the appropriate materials. It can also help you verify the code compliance of your design and create construction documents.

1.9 SCOPE

Every business relies on the purchase of raw materials. Raw materials need to be kept in a safe place, which is why warehouses are constructed. A great need will arise in the future for economically constructed warehouses due to rapid industrialization. The design will serve the purpose of storing goods, manufacturing, motor garages, etc.

1.10 OBJECTIVE

• To identify various loads and load combinations acting on the structure.
• To design the industrial warehouse as per its drawing details.
• To check the structure as per IS-800 code calculations, with all the members as per the design.

II.LITERATURE STUDY

This Study discusses the literature review related to the design of industrial warehouses.

As per M. Suneetha's numerical study, the weight of a steel truss building that uses angle and pipe is less than that of a PEB, yet the weight of the channel purlin is higher.

C.M. Meera compared pre-engineered buildings (PEB) with conventional steel buildings (CSB) structural structure analysis and structural software STAAD PRO.

Subhrakant Mohakul designed an industrial warehouse and studied the behavior of members due to failure and joint connection.

Using hollow steel sections instead of conventional steel sections can reduce the consumption of steel in the entire industrial building, according to Manan D Maisuri. The starting tube starting is the most economical.

Shaiv Parikh's research paper emphasizes the importance of compression members and provides a brief description of their characteristics and behavior.

By comparing LSM and WSM, A. Jayaraman presents an analysis of the behavior and behavior of roof trusses and channel section purlins.

Bo Terja Kalsaas, Carlos Torres Formoso, and Daniela Dietz Viana In comparison to what has been published in the field of construction management, the systematic literature review found that the number of publications devoted to preventing waste in construction is rather low. Based on the notion that it is required to eliminate activities that do not add value from the perspective of the client, certain research from the lean construction community highlighted the necessity to employ a broader conceptualization of waste. In fact, several studies have argued that preventable nonvalue-adding activities should be distinguished from those that cannot be avoided because it would be uncomfortable to view all of them as waste since they cannot be totally eliminated.

III.METHODOLOGY

Based on the requirements and considering different parameters such as storage space needed, adequate lighting, etc., the proposed structure and dimensions were determined.

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3.1 Definition of loads and standards

Introduction

It is well known that construction must be planned to handle forces that may lead to destruction. The structure must be strong and firm so as to bear the tensions created by the loads. Presently, it is crucial to recognize the estimated loading conditions. Calculating the loads acting on a structure decides the maximum stress levels accepted during design. These values determine how columns, joints, and beams are designed in constructing the building. Loads on buildings can generally be split into two primary types; gravity loads which draw downwards due to gravity, and lateral loads which operate horizontally. They in turn have subcategories as shown in the figure.

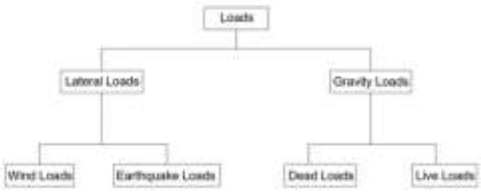

Fig 4: Classification of Loads

In many cases, these are the major loading types acting on a building. It is important to trace the load from one part of the structure to the other. Not all structural elements experience direct forces. A surface area's load is expressed in Newton's per square meter (N/m2), while a beam's load is expressed in Newton's per meter (N/m).

Dead Load

Dead load is the term used to refer to the permanent structural and non-structural components of a building. This includes the weight of walls, floors, roofs, ceilings, stairways, built-in cabinets, finishes, and other items permanently attached to the structure. It also includes any fixed equipment such as air conditioning units or elevators. A dead load of a building is typically calculated by considering all of the materials that make up the structure and their respective weights. The total dead load can then be determined by multiplying each material's weight by its volume and then adding these values together. A dead load of a structure must be considered when designing a building in order to ensure it is structurally sound and able to support the additional loads that are placed on it.

Mass = Density (Kg/mm3) * Volume (mm3)

Weight = Mass (Kg)* Gravity (m/s2)

Live Load

Live loads are temporary loads attached to a building. They are caused by the use and occupation of the building, such as environmental conditions or human interaction.

Wind Load

Wind load is a measure of the force exerted by wind on a structure, such as a building. Wind loads can be measured in terms of pressure (in pounds per square foot) or in terms of wind speed (in miles per hour). Wind load calculations are important for determining the strength and stability of structures, as well as for assessing potential damage from extreme winds.

The wind load is primarily by proper anchoring of the foundation and adding stiffening elements. Lateral forces tend to force the structure to move horizontally and this leads to high stresses on the foundation. In order to maintain columns in their original position, stiffening elements like braces are used. The figures below illustrate the effects of wind pressure on a structure.

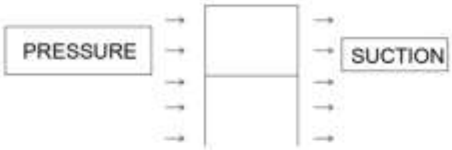

Fig 5 – The Structure before Wind Pressure

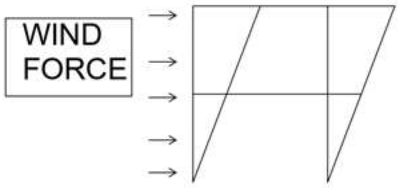

Fig 6 – The Structure after Wind Pressure

3.1.5 Earthquake Loads

Earthquake loads are forces that are applied to a building or structure as a result of an earthquake. These loads can cause significant damage, including the collapse of buildings and other structures. Earthquake loads include lateral (horizontal) forces, vertical forces, and torsional (rotational) forces. The magnitude of these loads depends on the intensity of the earthquake and the characteristics of the building or structure. It is important to design buildings and other structures to withstand earthquake loads so that they can remain standing after an earthquake.

IS 1893:2016 is an Indian Standard for Earthquake Resistant Design of Structures. It provides guidelines for the design, construction and evaluation of structures to resist seismic forces generated due to earthquakes. The standard consists of two parts. Part I deals with general provisions and applies to all types of structures such as buildings, bridges, dams, etc. while Part II contains specific provisions applicable to particular types of structures such as industrial buildings and multi-storeyed buildings.

3.1.6 Calculations for determining the loads

Many loads in standard manuals are expressed as pressure units, such as (kN/m2). It may be necessary to convert the pressure load to a uniformly distributed line load (kN/m) in some cases. Line loads and point loads can be used in some cases. It is important that the methods used to convert the loads are well-defined.

IV.Working with AutoCAD & STAAD.PRO

4.1 STAAD.Pro Procedure

Step 1: Gather Necessary Information The first step in creating a Staad. Pro file is to gather all the necessary information about the structure. This includes details such as the size, shape, material properties, loading conditions, boundary conditions and other relevant parameters. All this information must be accurately obtained in order for the analysis and design process to be successful.

Step 2: Create the Model Once all the necessary information has been gathered, it is time to create the model in Staad Pro. This involves setting up nodes, members and loads according to their respective properties and conditions. It should also include any additional features or options that may be needed for the analysis or design process.

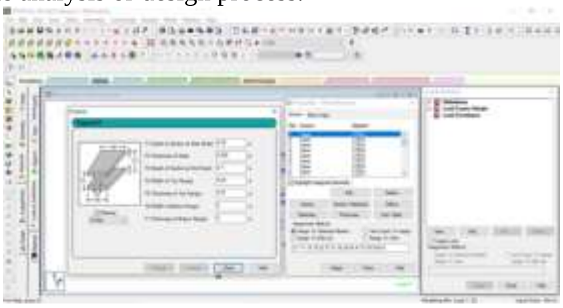

Fig 7 Column Tapered Section

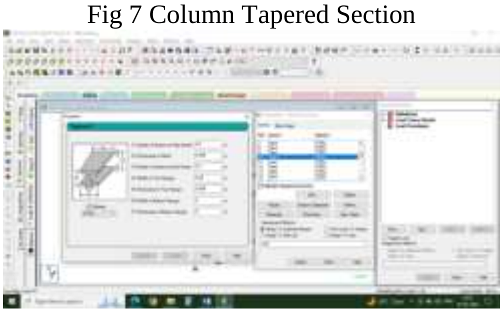

Fig 8 Rafter Size

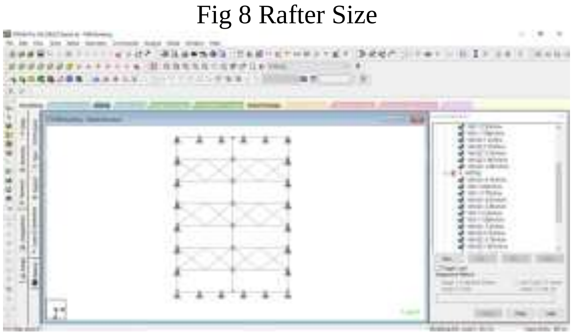

Fig 9 Plan View

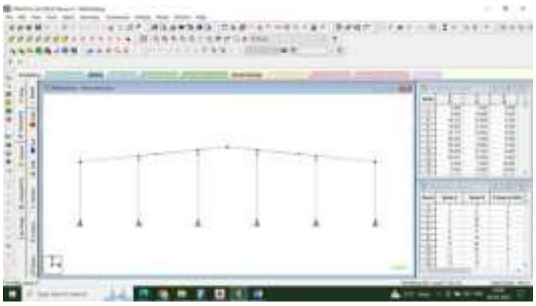

Fig 10 Front Elevation View

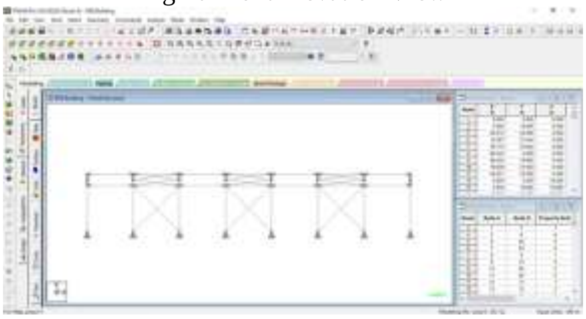

Fig 11 Side Elevation View

Step 3: Input Data into Staad Pro The next step is to input all the data into Staad Pro. This includes entering all the node coordinates and member dimensions as well as any other necessary parameters such as material properties or loading conditions. Once all this data has been entered correctly into Staad Pro, it is ready for analysis or design processes.

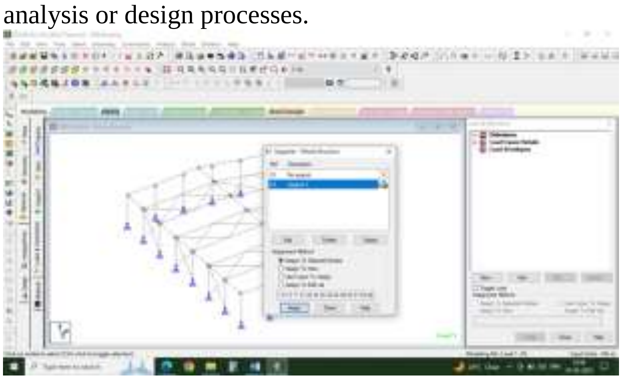

Fig 12 Adding Fixed Supports to Columns

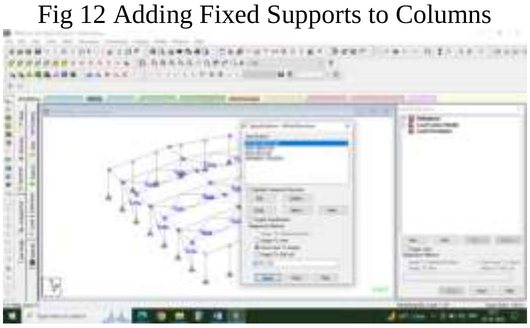

Fig 13 Joint Specifications

4.4 Loading Assumptions

Dead Load

In addition to the Dead Load of structure, roof sheeting at the middle Rafters is 1.5KN/m, and for END bays 0.75KN/m

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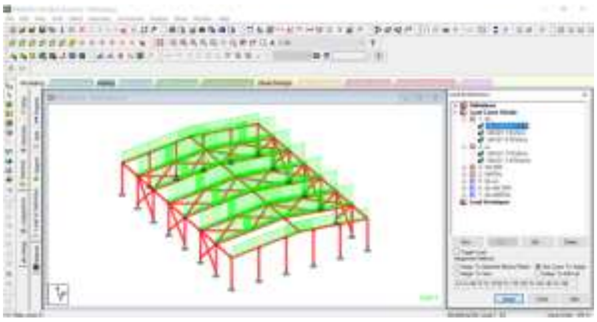

Fig 14 Dead Load

Live Load:-

1. Floor live Load – 3.75Kn/m

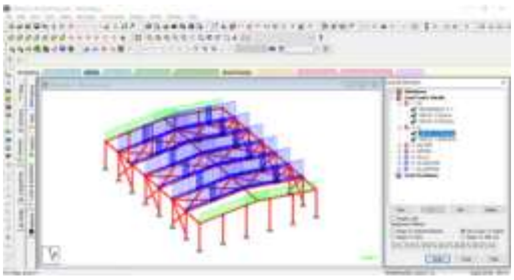

Fig 15 Live Load

1. Live load at END frame – 1.875Kn/m

Wind Load

Wind load calculations as per IS 875:2015 Part III, wind zone map as shown in below Fig:

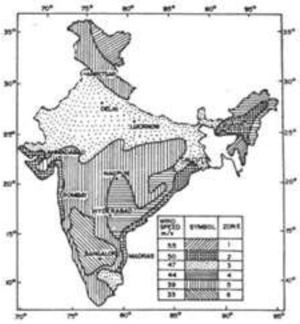

Fig 16 Wind Load Zones

Fig 17 Applied Wind Load

Seismic Loads:

As per Standard code IS 1893:2016 – part I

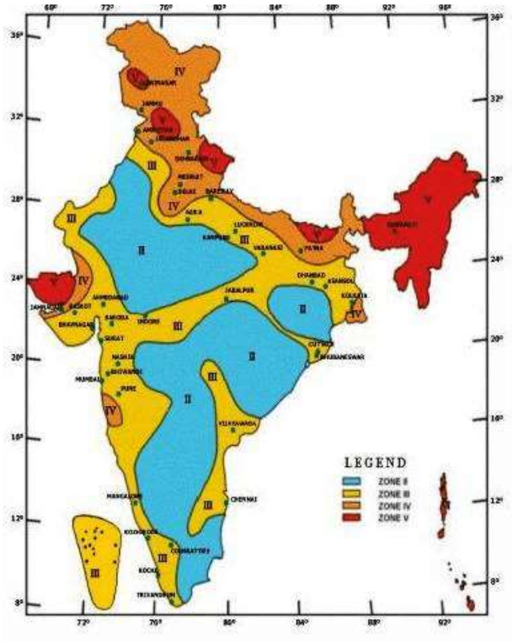

Fig 18 Seismic Zones

V.Design and Analysis Results

Discussed some of the sample analyses of structure at different locations and finding BMD.

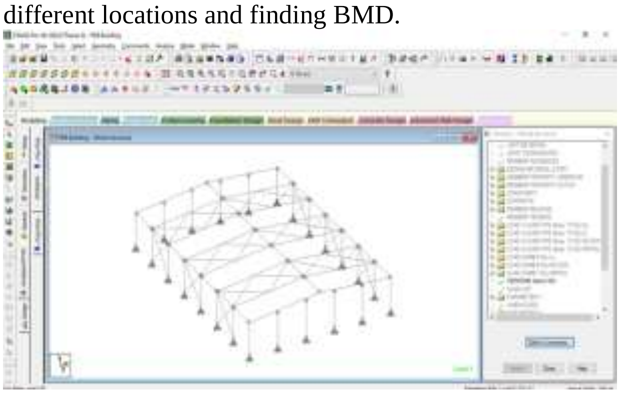

Fig 19 Members Isometric View

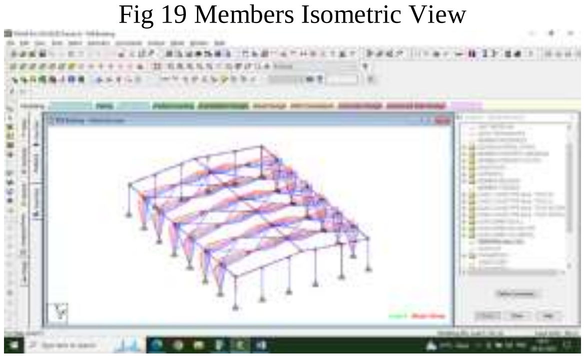

Fig 20 Beam Stress

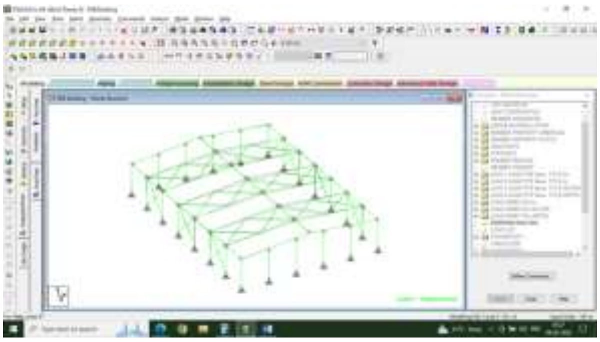

Fig 21 Displacement

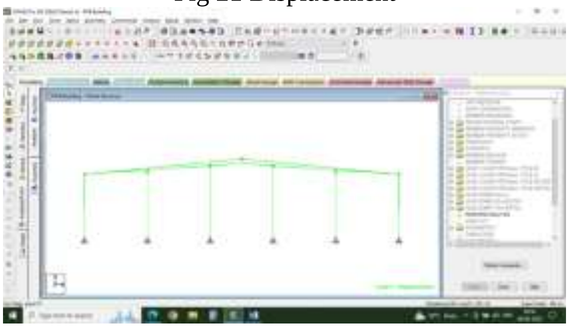

Fig 22 View of Displacement in front Elevation

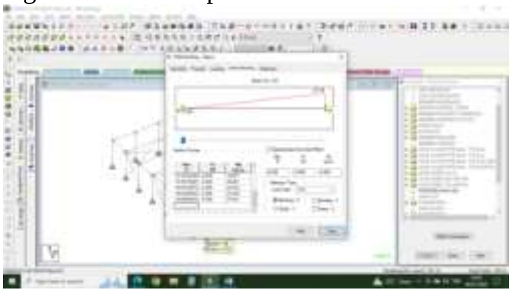

Fig 23 Shear Bending Moment of Beam No 59

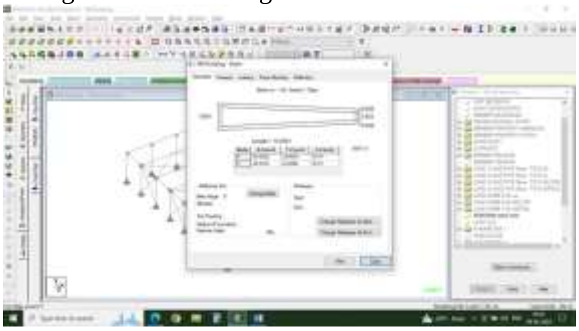

Fig 24 Geometry of Beam No 42

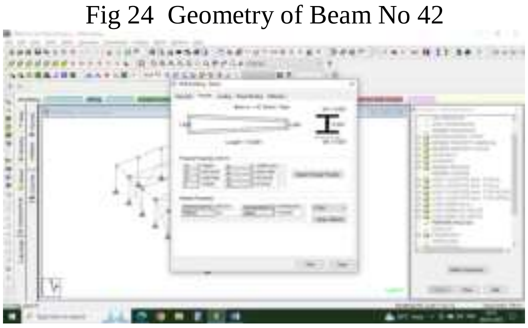

Fig 25 Property of Beam No 42

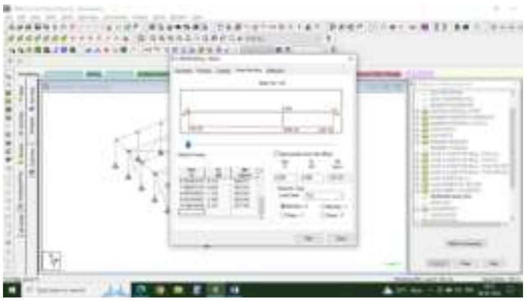

Fig.26 Shear Bending of Beam no 42

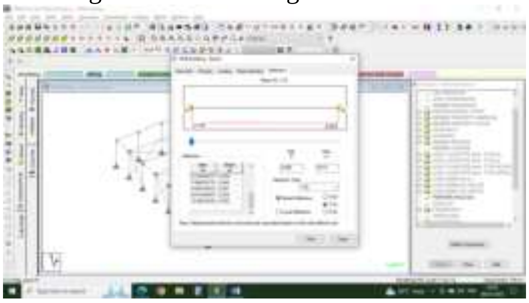

Fig 27 Deflection of Beam No 31

VI.POST-PROCESSING

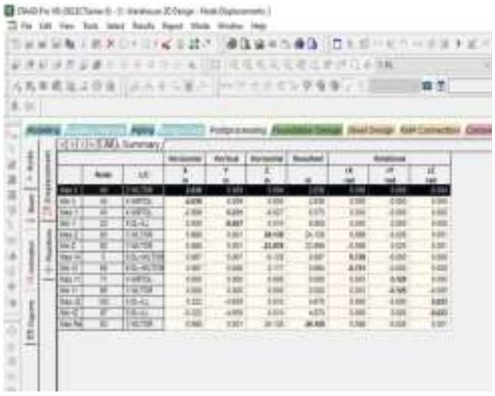

Fig: 28 POST-PROCESSING SUMMERY

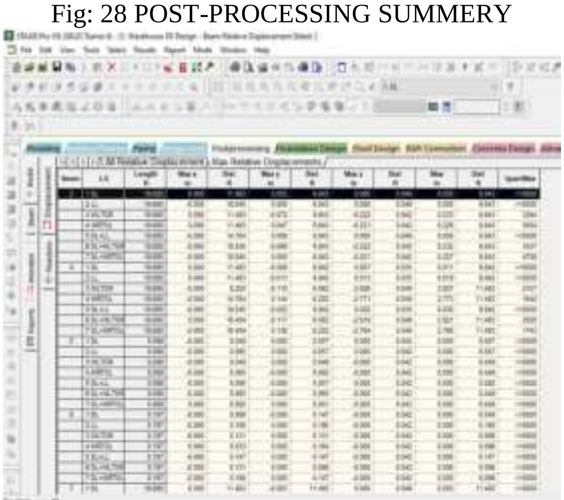

Fig: 29 Sample Max Relative Displacement

VII.CONCLUSION

Pre-engineered steel structure buildings can be designed using steel since it is a low-cost material that also offers strength, durability, design flexibility, adaptability, and recyclability. In the materials utilized for pre-engineered steel buildings, steel is the primary component. It contradicts local sources. Additionally, it entails selecting durable industrial items from a vast array of shapes and colors; it also entails quick site installation and minimal energy use. It entails deciding to uphold sustainability's guiding principles. Steel is the material that best reflects the requirements of sustainable development since it is infinitely recyclable.

REFERENCES

[1] DESIGN OF STEEL STRUCTURES BY DR.B.C. PUNMIA, ASHOK JAIN, ARUN KUMAR JAIN
[2] ANALYSIS OF STRUCTURES VOL I – DR. M.M RATWANI AND DR.S.K. DUGGAL
[3] ANALYSIS MANUAL FOR STAAD PRO (PRISM CADD)
[4] IS 800:2007 (CODE FOR GENERAL CONSTRUCTION IN STEEL STRUCTURES)
[5] IS 1893:2002 (CODE PRACTICE FOR INDIAN SEISMIC LOAD FOR BUILDING AND STRUCTURE
[6] KALESHA SHAIK, RATNAMALA REDDY B.S.S., DURGA CHAITANYA KUMAR JAGARAPU. "AN ANALYTICAL STUDY ON PRE-ENGINEERED BUILDINGS USING STAAD PRO", MATERIALS TODAY: PROCEEDINGS, 2020
[7] "ADVANCES IN MATERIALS RESEARCH", SPRINGER SCIENCE AND BUSINESS MEDIA LLC, 2021
[8] IMPACT OF THREE-DIMENSIONAL PARAMETRIC MODELING OF BUILDINGS ON PRODUCTIVITY IN STRUCTURAL ENGINEERING PRACTICE, RAFAEL SACKS, RONEN BARAK (FACULTY OF CIVIL AND ENV. ENGINEERING, TECHNION ISRAEL INSTITUTE OF TECHNOLOGY, ISRAEL, AUGUST 2007, ELSEVIER (SCIENCE DIRECT).
[9] METAL BUILDERS MANUFACTURING ASSOCIATION HTTP://WWW.MBMA.COM/
[10] INTRODUCTION TO PRE-ENGINEERED BUILDINGS, GURSHARAN SINGH, 2008. HTTP://WWW.ENGINEERINGCIVIL.COM/PRE-ENGINEEREDBUILDINGS.HTML.