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# TONNAGE ASSESSMENT OF PEB/CSB INDUSTRIAL SHED DESIGNED BY I.S AND MBMA CODE

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**Abstract -** *Steel construction is conservative and consultative. Structural components are hot rolled and employed in traditional construction. Materials are created or made at the facility and then transported to the job site.*

*Large column free areas are currently the most important need for any company, and with the introduction of computer software, this is now much easier to achieve. Computer software has greatly contributed to the increase of quality of life via new investigations as technology has progressed. One such revolution is the pre-engineered building (PEB). After planning, "pre-engineered structures" are fully produced in the factory, then brought to the job site in a completely knocked down (CKD) state, where all components are joined and erected with nut-bolts, shortening the construction time. The facility manufactures or produces pre-engineered steel buildings. Structural members are made according to the specifications of the customer. Because members are made with respect to design characteristics, the precise structural members are built for their specific position and are numbered, which cannot be changed. For transportation, these components are built in modular or knocked-down form. These supplies are delivered to the customer's location and assembled. Welding and cutting are not undertaken at the customer's location.*

***Key Words***: CSB, PEB, STAAD PRO, MBMA, IS CODE.

## 1.0 INTRODUCTION

Over the last decade, a positive trend has emerged in the form of increased demand for construction services in the residential, commercial, institutional, industrial, and infrastructure sectors. In comparison to past periods, modern structures are far more intricate and advanced. The current constructions are higher and slimmer, which is one of the key changes that everyone is seeing. The modern demand for buildings is that they be lighter while maintaining functioning. Steel, concrete, and other construction materials have been in a constant economic battle in civil engineering construction.

During the first part of the twentieth century, mill section structural steel structures gained popularity. Engineers could design steel structures using published properties and load tables for hot rolled steel mill sections produced by most steel mills. Steel structures were chosen by contractors over wood and concrete buildings since the fabricator handled the majority of the quality standards, enabling the contractor to focus only on erecting the steel framework. Steel structures were preferred by developers and owners because they were more cost-effective, faster to construct, and required less maintenance than reinforced concrete buildings, resulting in a higher return on investment. PEBs generate an endless number of building geometries using a pre-determined small range of raw material inventories to suit practically unlimited design needs, functional concerns, and aesthetic inclinations.

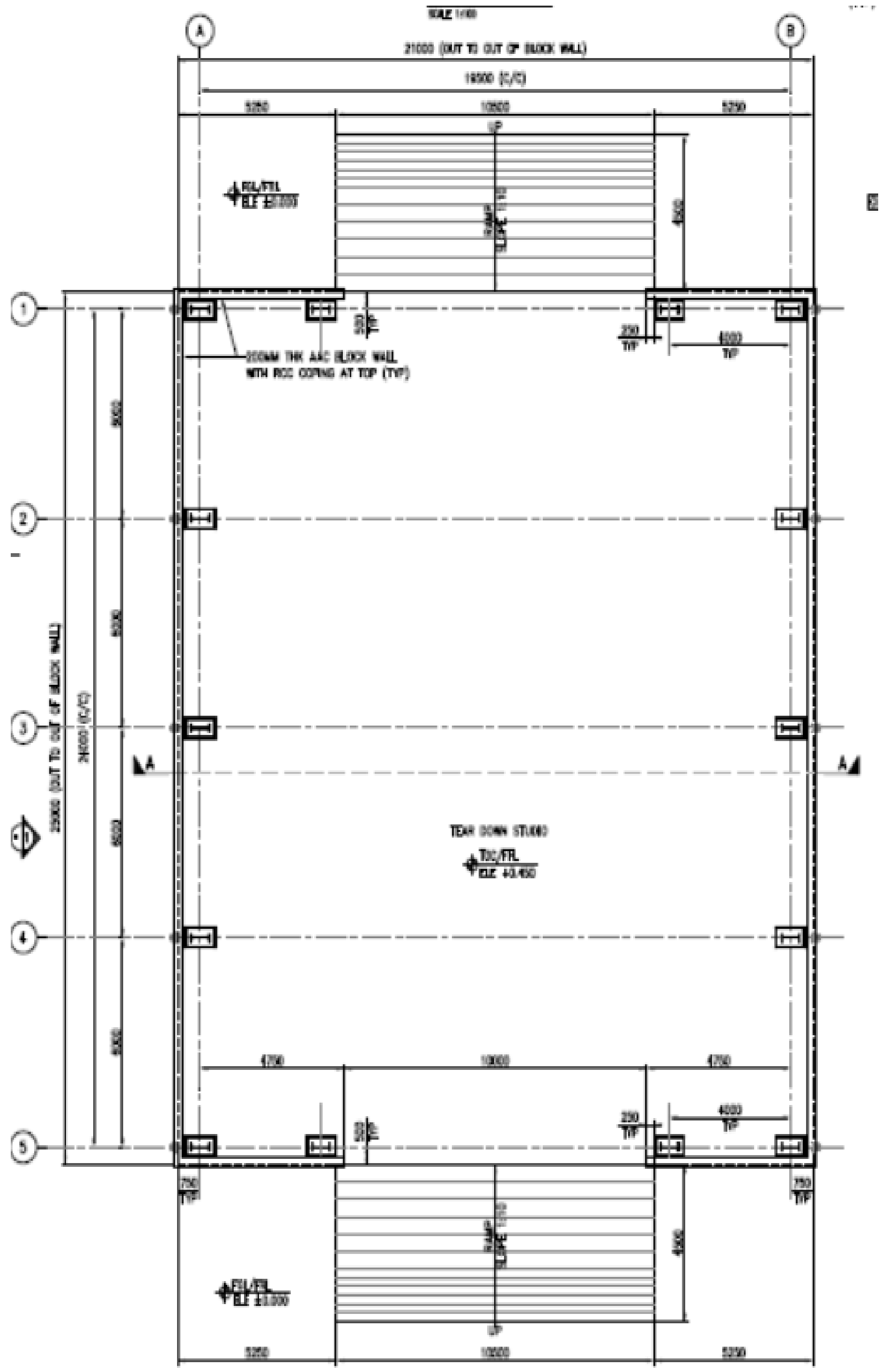
Different structural accessories, such as mezzanine levels, canopies, and internal partitions, can be added to pre-engineered steel buildings, and the structure is waterproofed with the use of specific mastic beads, filler strips, and trimmings. This is a very adaptable construction system that can be completed on the inside to fulfil any function and ornamented on the outside to produce appealing and distinctive architectural styles. It has a lot of advantages over traditional structures and is especially useful in low-rise building design.

The structural members are developed and manufactured in a controlled environment in order to create optimal sections by changing the thickness of the sections throughout the length of the member as required by the bending moment.

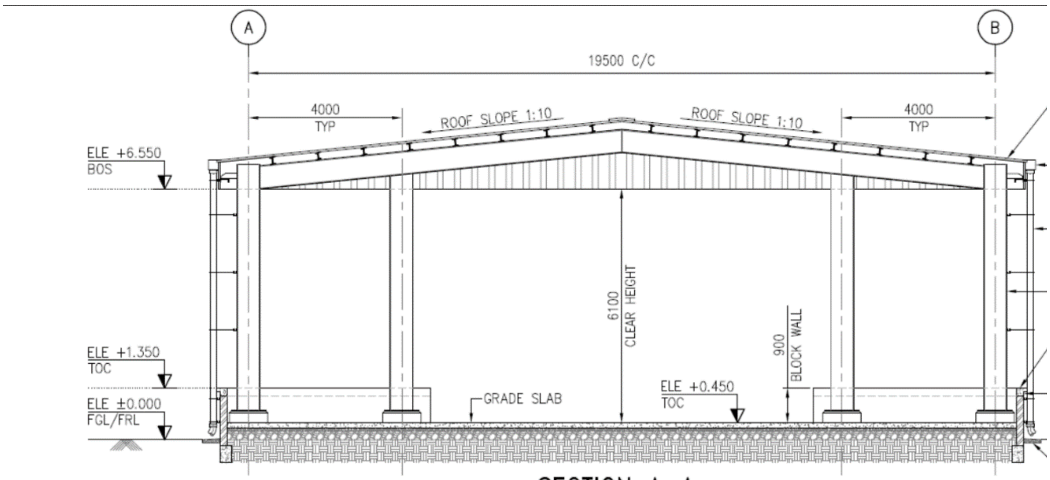
The study's main goal is to grasp the concepts of conventional steel buildings and pre-engineered buildings, as well as to understand the differences between these two terminologies in terms of design, member characteristics, components, and overall structure tonnage. The influence of varying parameters such as eave height, building width, building slope, and bay spacing on total tonnage is also investigated. Two distinct codes, the Indian code and the MBMA code, were used to develop the structure.

The models will be analysed and designed using STAAD PRO in accordance with INDIAN and MBMA standards. In addition, the benefits and drawbacks of both CSB and PEB, as well as practicality and cost, will be examined and emphasised.

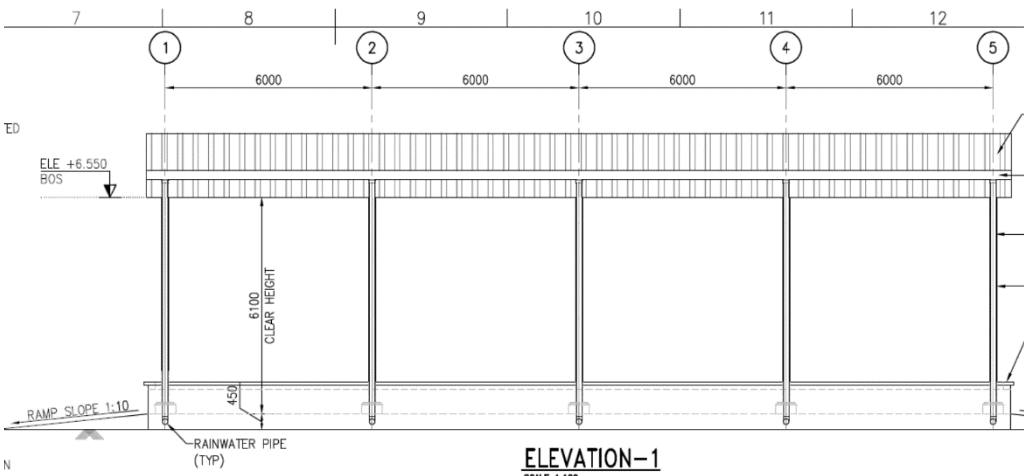
**2.0 BUILDING PARAMETERS AND GEOMETRY**




GROUND FLOOR PLAN




SECTION A–A




ELEVATION–1
SCALE 1:100

**3.0 LOADINGS**

The calculation of the loads operating on a structure is a difficult task. The nature of the loads is largely determined by the structure's architectural design, materials, and location. Loading conditions on the same structure may fluctuate over time, or they may change quickly.

**Dead load:**

Dead loads shall apply to the estimation of dead loads in the design of structures and shall be considered in accordance with IS: 875 (Part 1) - 1987 according to the densities of the available components.Main frames, purlins, girt, cladding, bracing, and connections, among other things, are included.

**Live Load:**

The imposed loads must be calculated according to IS: 875 (Part 2) – 1987. For the sake of analysis and design, a live load of 0.75 KN/sqm should be used.

**Seismic Load:**

In seismically active locations, earthquake loads have an impact on structural design. Seismic forces will be assessed for the planned structures in this project. IS: 1893-2002 will be used to determine the seismic zone (Part 1). Zone III should be examined for analysis and design.

According to the requirements of IS: 1893-2002 (Part 1) and IS: 1893-2005, earthquake analysis must be performed using STAAD PRO 2007. (part 4). The following are the analysis parameters to be used. The seismic load is calculated for Hyderabad, which is located in Zone II.

• Response Reduction Factor: 5
• Zone Factor: 0.16
• Importance Factor: 1.00

**Wind Load:**

The baseline wind speed and the design velocity that will be changed will be used. In accordance with IS: 875 (Part 3) – 1987. According to IS: 875, the fundamental wind speed in Vadodara is 44 m/sec (Part III). This must be taken into account while estimating wind loads.

Future extensions, if any, as specified in the building descriptions, will be included in the analysis, and critical forces will be used in the design.

**4.0 DESIGN PHILOSOPHY**

Because of the opening and shutting of the big sized Hangar Door, the structure has been built for wind loads in both enclosed and open conditions. The load calculations are carried out in the same way as they are in a normal frame. Because the PEB slopes are small, the crucial case controlling the designs is usually (DL+WL) or (DL+LL) (like 1 in 10).

The support conditions are typically hinged, but on a selected basis, a fixed condition with a gusseted base plate and Anchor bolt combination can be useful. The portion is typically tapered down and given with a Bolted connection to the base in Hinged base condition. All other joints are typically built as rigid joints, and steel connections are moment connections that transfer axial, moment, and shear values between the linked parts. The design wind pressures for wind load calculations should be determined after thorough study and combinations of internal and external pressure coefficients or force coefficients, as per IS-875 pt.3 l.

Adopting 'Fixed' or 'Pinned' column base conditions is the core idea of rigid frame design. A strong frame with a solid column base helps to reduce allowed deflection (side sway) in the frames. Fixed base frames are always preferred over pinned base frames by steel designers. On the contrary, foundation design becomes a nightmare for foundation designers, especially in wide span constructions. The frame is rigid in a fixed base construction, yet it transfers heavy moments to the foundations. Designing foundations becomes a difficult challenge when the earth is weak.

Similarly, the frame does not transfer any moment to the foundation, and only vertical and horizontal responses impact the foundation design. Controlling deflections of the frame in pinned base state may appear easy, but it is a difficult operation when huge spans are involved. Typically, interactive software is used to check the Combination Stresses and compare them to the limiting values (in LSD or WSD), which determines the section's Exploitation efficiency, i.e., if the Actual Stress/permitted Stress is 0.95, the section is exploited for 95% of its strength. The overall weight of the frame is computed for this. A variety of trails are built using variables like as flange thickness, web thickness, flange width, and web depth, such that the entire frame is theoretically safe and weighs as little as possible.

The next stage is to look for deflections. Frequently, sections must be changed to keep theoretical maximum deflections within acceptable limits. The easiest approach to manage this deflection is to raise the Geometrical properties/sectional sizes of the frame, however this is not recommended because it increases the tonnage of the entire building, increasing not only the seismic pressures but also the cost. We need a method that allows us to manage the frame's sway while without increasing the section sizes.

To limit the extra deflection, the best solution we found was to 'Brace' the frame. For this reason, we installed bracing at the eave level (braced eave) on both sides of the structure along its length. The span of this Eave bracing is around (L / 10) on either side.

In the following example, we can see how eave bracing aids in limiting horizontal deflections and resulting in a lighter foundation design. Some vendors use 90% of the section, leaving 10% for possible manufacturing, shipping, assembly, and erection errors. However, the rivalry has led (forced) many to assume that there are no flaws!

That is one of the benefits of pre-engineering. Purlins and Girts, for example, are constructed according to regulations for thin Cold Formed Sections with or without lip. To optimise the sections, numerous span reduction and lateral supporting techniques such as sag rods and knee bracings, as well as tie rods, can be used.

**5.0 LITERATURE REVIEW**

1. Pre-Engineered Building Design of An Industrial Warehouse by C.M MEERA (2013)

This article compares and contrasts the pre-engineered and ordinary steel building concepts. The study is accomplished by designing a typical frame for a proposed industrial warehouse building using both the concept and analysing the designed frames using the structural analysis and design software STAAD PRO. Based on the software analysis, the PEB roof structure is nearly 30% lighter than the CSB structure. According to the research, PEB has a considerably lower support reaction than CSB. As a result, a light-weight foundation may be used for PEB, lowering the cost of the foundation. PEB was 30 percent less expensive than CSB.

2. Apruv Rajendra Thorat, Santosh K. Patil. " A study of performance of Pre-Engineered Building of an Industrial Warehous for Dynamic Load" (June. 2017)

Pre-Engineered Buildings are those that are completely designed within an industrial facility after planning, transported in CKD (Completely Knocked Down) form, and all parts are assembled and erected on site with nut-bolts, decreasing the time it takes to complete. For Static analysis, Dynamic analysis, Secondary analysis, and Time History Analysis, structural analysis and design are performed. All dead, living, and accidental loads shall be checked against IS 875-1987. Part-IV of IS 1893-2002 will be used to confirm earthquake loads. Self Weight of Structure, Weight of Purlins, Wind Force in X, Wind Force in Z, and Negative Width are all included in the load combination. Ground motion in X and Z directions, Negative Wind Pressure in X direction, Negative Wind Pressure in Z direction Using Time History Analysis, the dynamic load action on pre-engineered buildings is observed and validated for El-Centro data in this study. Two parametric models of Pre-Engineered Buildings with and without bracing, each having a span of 21 metres.

3. A Comparative Study of Analysis and Design of Pre-engineered Building and Conventional Steel Building for a Polymer Factory by Pradeep V, Papa Rao G

The research and design of traditional steel frames with concrete and steel columns, as well as Pre Engineered Buildings, are presented in this article (PEB). STAAD Pro V8i is used to evaluate and design an industrial building with a length of 44 metres and a width of 20 metres, and a roofing system of conventional steel truss and pre-engineered steel truss. This article successfully illustrates that PEB buildings may be developed quickly and simply using basic design processes that adhere to country requirements.

## 5.0 STAAD

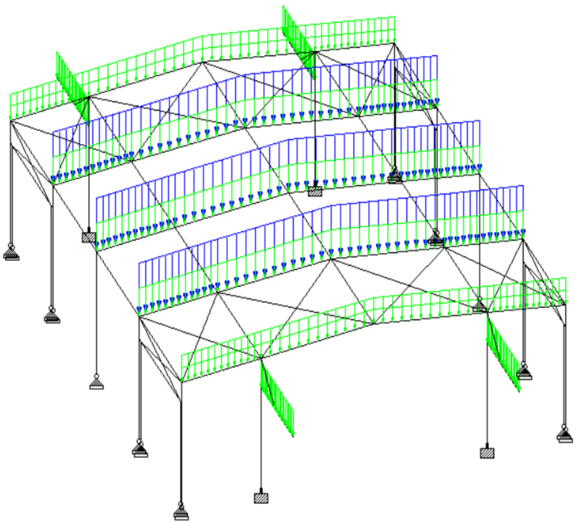


*Figure 1: Vertical Loadings*

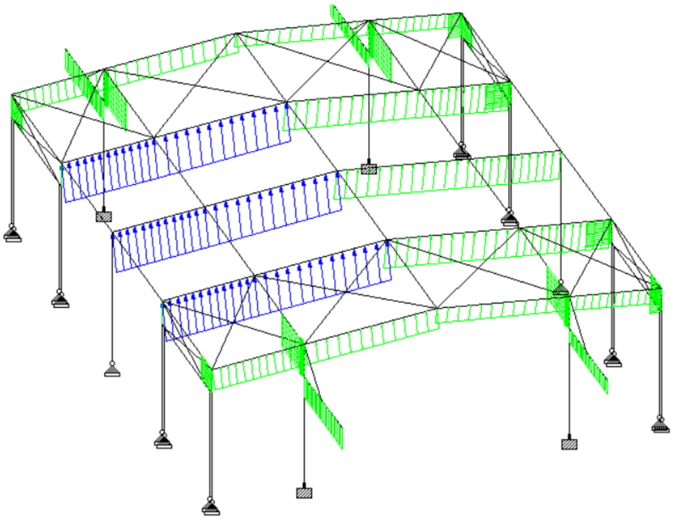


*Figure 2: Wind Load on Rafters*

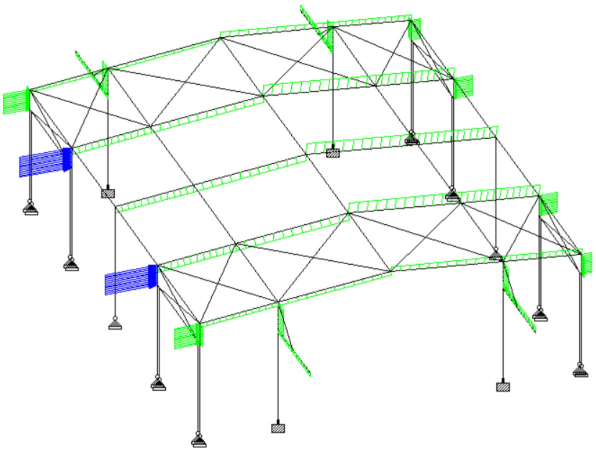


*Figure 3: Wind Load on Columns*

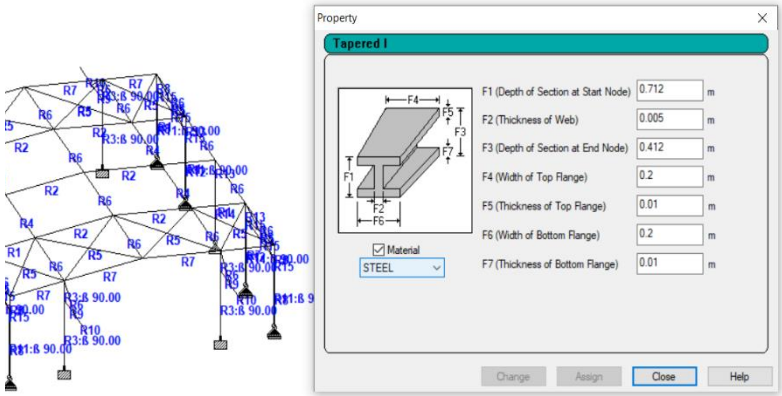



*Figure 4: Tapered Property*

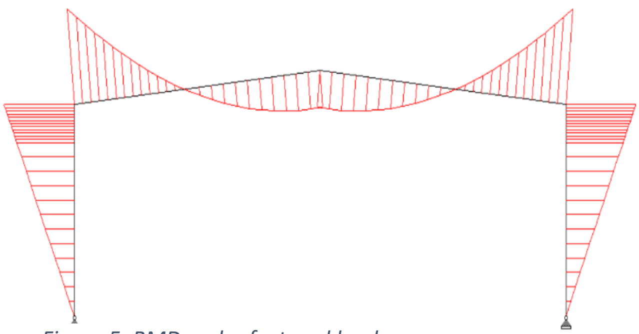


*Figure 5: BMD under factored loads*

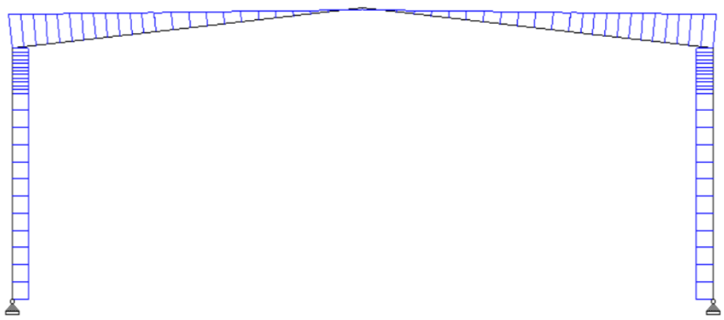


*Figure 6: SFD under factored Loads*

## 6.0 CONCLUSIONS

1. Plastic, Compact, and Semi-compact, thin cross-section sections are considered for design in Indian code. Many PEB manufacturers employ sections with very thin webs to reduce section weight and be more cost-

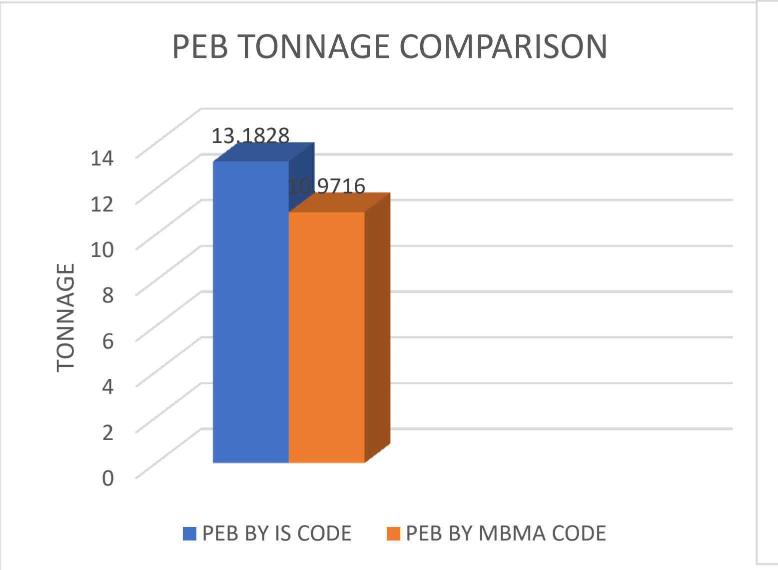
effective/competitive in their commercial offerings, however these thin webs do not meet the codal requirements of IS 800: 2007.

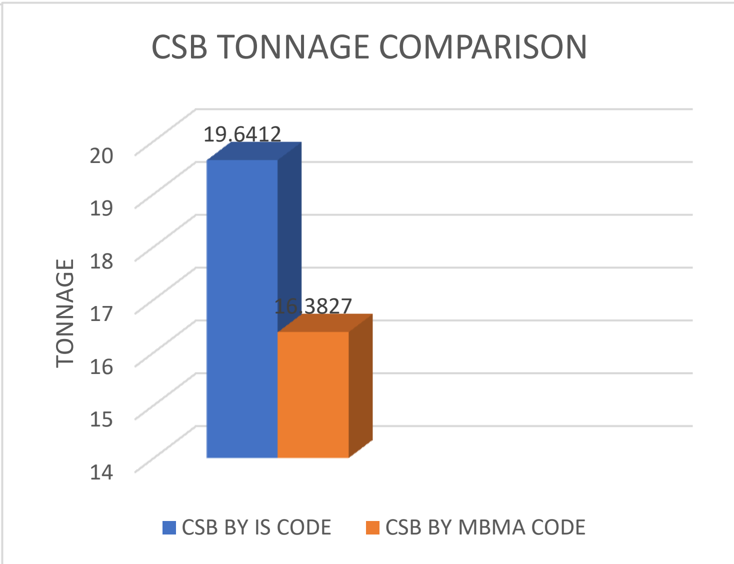
2. For PEB structure designed by MBMA weight is 16 % lesser than the weight of PEB structure designed by I.S code. Reason for higher weight in IS 800:2007 compared to AISC/MBMA is limiting ratio of the section.

3. The weight of PEB is determined by the bay spacing. As the bay spacing increases beyond a certain point, the weight decreases, and as the space increases further, the weight increases.

4. The steel take-off for PEB structure designed by I.S code is 13.1828 ton, while steel take-off for PEB structure designed by MBMA code is 10.9716 ton. Thus, saving 2.2112 tonnes of steel.

5. The steel take-off for CSB structure designed by I.S code is 19.6412 ton, while steel take-off for CSB structure designed by MBMA code is 16.3827 ton. Thus, saving 3.2585 tonnes of steel.

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- Apruv Rajendra Thorat, Santosh K. Patil. " A study of performance of Pre- Engineered Building of an Industrial Warehous for Dynamic Load" (June. 2017)
- Comparative Study of Analysis and Design of Pre-engineered Building and Conventional Steel Building for a Polymer Factory by Pradeep V, Papa Rao G
- Analysis and Comparative Study of Conventional Steel Structure with PEB Structure by T D Mythili
- ZAMIL STEEL