Comparative Analysis Of Pre engineered Building and Conventional Steel building by using Staad pro Software

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Abstract : In steel structure design the Pre-engineering building (PEB) system is a modern technology that provides economical, Eco-friendly and sustainable structures. Whereas before the establishment of the PEB system in steel structure construction Conventional steel building (CSB) system is used which is provide time-consuming, costly design. The CSB is costly due to more Consumption of steel because of using a uniform cross-section of the hot-rolled section throughout the member length. However, Based on the loading effect built-up section used in PEB and only bolted connections are provided at the construction site. PEB Consuming less time and provides lightweight design and it is advantageous over CSB when the span is large and column-free Space required. The design and manufacturing of structure members are done at plant and later its conveyed to the construction Site and the erection process will take place. The current study focuses on the ideas of conventional steel buildings and pre-engineered buildings. A Banquet hall of size 26mX 50m is analyzed and designed as Pre engineered building (PEB) and as Conventional steel building (CSB) by using STAAD Pro Software.

Keywords :Pre engineered building, Conventional steel building , STAAD pro

I.INTRODUCTION

Almost everywhere in the world ,steel buildings are getting more and more well-known. When people learned about steel's many benefits, its use became more widespread. Both residential and business buildings employ them. There are now many different steel building types available, including straight wall buildings, clear span buildings, and arch buildings. The arch buildings are employed for agricultural purposes since they are extremely robust and long-lasting. While having less strength than arched buildings, straight wall structures offer more interior room. The major use of the clear span structures is to store aircraft.The 1960s saw the advent of pre-fabricated buildings. It included a frame, a floor, and a ceiling. The building was constructed by assembling these components. Construction became simpler as a result. There are many different uses for steel buildings, and there is a rising need for them. Steel structures can be divided primarily into two types:

1) Conventional Steel Buildings (CSB).
2) Pre-Engineered Buildings (PEB)

In the steel industry, conventional steel buildings and pre-engineered buildings are used more frequently in industrial structures. The "I" or "C" sections are hot-rolled industry standards. High tensile strength, weather resistance, ease of installation, extended service life, and cost-effectiveness and economy are features of conventional steel buildings and pre-engineered buildings. Here, the word "economical" is used in the context of time and money. Pre-engineered buildings are one example of a steel structure that may be constructed quickly because time is the most essential factor (PEB).In pre designed buildings, extra steel is minimized by tapering the sections to meet the demands of the bending moment. In pre engineered buildings, all of the design work is completed in the factory, and the members are prefabricated in accordance with the design.

II. LITERATURE REVIEW

1. Neeraj Kumar et al 2022
In this study, industrial buildings with various spans (10, 15, 20, 25, 30, 40, & 50 m) are assessed and planned utilizing conventional hot-rolled sections and PEB tapered sections in accordance with Indian Standards, IS 800-2007. The PEB constructions are lighter than the conventional steel building structures for all spans. Simply

because of their small weight and variable depth, pre-engineered building structures have a higher displacement than average.

2. SwethaPantheeradi et al 2022

This study primarily focuses on the PEB and CSB principles, as well as how we might select the concepts for actual implementation. STAAD Pro is used to design a warehouse building as both a PEB and a CSB in order to complete the research.At ridge PEB's maximum bending moment exceeds CSB's by 4.81% and at haunch by16%. This is because all of the force will be centered in PEB, as opposed to CSB, where it is spread.At the ridge CSB , axial force exceedPEB by 18.31%, compared to haunch, PEB is superior by 27% to CSB. This difference is caused by the fact that in PEB, the whole force at haunch must transfer like a beam , whereas in CSB, it is similar to a truss arrangement.Due to the fact that the entire load will be concentrated in PEB, as opposed to CSB, where it is spread, the shear force at the building's crest and haunch is greater for PEB by 16.5% and 30%, respectively.

3. Vasudha S. Patil1, Mr. Rohan K. Choudhary2 et al 2021

In this study Pre-engineered metal buildings with a span of 48 meters were studied in the STAAD PRO designed and analyzed with conventional steel buildings of the same dimensions .According to the findings, pre-engineered steel buildings are 50% more cost-effective in both foundation and superstructure when compared to traditional steel buildings. And it's all suitable for any type of soil condition and climate. In accordance with the response spectrum technique, base shear is likewise 70% lower in PEB than CSB (seismic analysis). Therefore, we came to the conclusion that since all superstructure elements support horizontal loads as opposed to CSB members, base shear will be reduced, negating the requirement for a heavier substructure design.

4. Pradip S. et al 2021

Three plan dimensions—15 by 30 meters, 40 by 80 meters, and 90 by 180 meters—for an industrial pitched roof building are taken into consideration for the research work. Each is investigated for a building configuration’s PEB and truss arrangement, and a detailed comparative research is done. For mid and long span industrial building constructions with spans between 40 and 90 meters, PEB is shown to be more cost-effective than CSB .For the 15-meter building, there is a noticeable increment in steel usage in CSB than PEB. The serviceability had a major impact on the size of steel cross sections. The CSB for a span of 90 m demonstrated significant joint displacements relatedto the member sizes, resulting in comparatively less costeffectiveness in steel take off as compared to PEB. Because of the stiffness of the joints and the difference in member profiles throughout its length, the PEB model used less material than the CSB, but in narrow span buildings (15x30m), the CSB was more cost-effective because of its lighter members.

5.VishnuSai et al 2021

The performance of the structureof multiple bay systems in various wind zones has been compared in the current study (Vijayawada and Hyderabad). STAAD.Pro software has been used for investigation and outline. Shear force (SF) and bending moment (BM) magnitudes have been used to evaluate the structural behavior of pre-engineered buildings. It has been noted that the construction in Vijayawada weighs 11.04% more than in theHyderabad located building. When compared to the construction in Vijayawada, the building in Hyderabad has smaller section in sizes for its columns and rafters. Because the SFand BM are lower for the Hyderabad-based building. The variables have an impact on the section sizes and structural weight.

6. HumanaazArifQureshi, et al 2020

This article analyses and designs a G+3 industrial warehouse following IS 800-2007. (LSM).STAAD-pro software was used to analyze the warehouse building. Pre-engineered buildings PEB and CSB are also contrasted in this essay . IS 800:2007 is used for the design and analyze of the CSB (LSM).Due to the structure's lighter weight than the CSB structure, the PEB structure model created in accordance with IS 800:2007 has greater displacement. When compared to a CSB construction, the PEB structure model developed under IS 800:2007 offers greater wind resistance.Comparing cold form purlin to hot rolled purlin, the cold form purlin is 32.5% lighter.

7. AnishaGoswami, Dr. TusharShende et al 2018

Using the concept and the structural analysis and design programme STAAD Pro, a typical frame for an industrial warehouse shed is designed, and the study is then accomplished. Conclusion: A PEB building weighs 27% less than a CSB construction. Considering that purlin is almost 32% lighter than hot rolled steel, cold formed steel section is preferable.

8. D.Rakesh, V. Sanjay Gokul, G.Amar et al 2016
compared the performance of CSB and PEB. They came to their conclusions after carefully considering and designing an industrial shed. They discovered that the PEB's overall steel takeoff is comparable to the CSB's by about 60%. According to the author's observations, the weight of the frame depends on the distance between the bays; as the distance grows up to a certain point, the weight decreases, while after that point, it increases. Additionally, they discovered that axial force is greater in PEB than CSB whereas displacement is greater in PEB than CSB.

9. Rohit C. Pingle, P. J. Salunke, N. G. Gore, V. G. Sayagavi et al 2015
Using STAAD PRO V8i, this inquiry simulates the portal frame of a warehouse with varied spannings like 30 m, 25 m, 20 m, and 15 m, as well as varying crane capacities like 5 tonnes, 10 tonnes, 15 tonnes, and 20 tonnes on each span. And IS800-2007 is used to assist in the design computation. Additionally, IS801-1975 is used for the cold formed portions. For all spans with crane load, the design is completed for both PEB and CSB. The detailed calculations show that the quantity of steel was reduced by 13% to 15%, and the cost was decreased by 13%.

10. Pradeep V1, Papa Rao G2 et al Mar 2014
STAAD Pro V8i is used to assess and design a 44 m x 20 m industrial building with a typical steel truss and pre-engineered steel truss roofing system.This essay successfully demonstrates how easy it is to construct PEB structures using straightforward design processes that adhere to national requirements. PEB frames are more resistant to earthquake loads since they are flexible and light. Compared to conventional steel buildings, PEB roof structures are nearly 26% lighter. Lightweight "Z" purlins are employed in secondary members for PEB structures and heavier hot-rolled sections for CSB structures. According to analysis, For PEB support reactions are smaller than CSB.For PEB, a lightweight foundation can be used, which simplifies design and lowers foundation building costs. The CSB construction will need a strong foundation. The price of a PEB is 30.0% less than that of a CSB.

III. OUTCOMES

- Pre-engineered buildings are 30% to 50% more affordable than conventional steel buildings. Additionally, it is suitable for all climatic situations and soil kinds.
- Axial force is greater in CSB than PEB, although displacement is greater in PEB.
- Lightweight "Z" Purlins are employed in secondary members for PEB and for CSB heavier hot-rolled sections . Analysis shows that support reactions for PEB are lower than those for CSB.
- The PEB weight depends on bay spacing; when spacing of bay grows up to a degree, weight decreases, and subsequent increases makes weight greater. The most cost-effective PEB configuration has been discovered to have an 8m bay spacing.
- Due to the use of tapered sections, PEB is more stable and has a lower seismic weight during seismic analysis conditions.

IV. OBJECTIVES

Following are the objective of the work
- Comparative analysis of Pre-Engineering Building(PEB) and Conventional Steel Building (CSB) by using STAAD-pro software.
- Computation of the steel consumption in the both building.
- Optimization of the steel consumption and compare the results for both the buildings.

V. METHODOLOGY

The current study focuses on the ideas of conventional steel buildings and pre-engineered buildings. A Banquet hall is analyzed and designed as PEB and as CSB by using STAAD Pro Software.
- A pre-engineered building with a span 26 metres and length of 50 metres. Along the length, bay spacing is kept constant at 5.45 m c/c intervals. The building's eve height is 7.0 metres. Purlin spacing is kept at 1.42 m c/c and the roof's slope is assumed to be 1 in 10˚.
- A conventional steel building with a span 26 metres and length of 50 metres. Along the length, bay spacing is kept constant at 5.45 m c/c intervals. The building's eve height is 7.0 metres. Purlin spacing is kept at 1.42 m c/c and the roof's slope is assumed to be 1 in 5˚.

STRUCTURE PARAMETERS

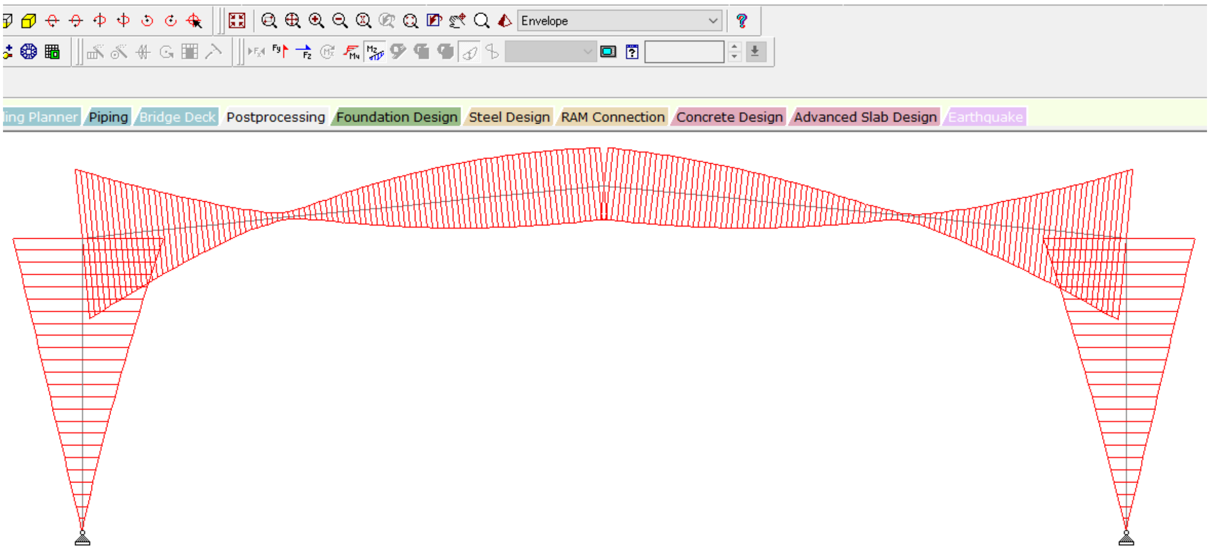
Sl .no	Parameters	Value
1	Type of building	Banquet hall
2	Location	KALABURAGI
3	Building dimension	26mx50m
4	Eave height	7 m
5	PEB Roof Slope	1 in 10
6	CSB Roof slope	1 in 5
7	Bay spacing	5.45 m C/C
8	Spacing of Purlins	1.42 m C/C
9	Basic wind Speed (Vb)	44 m/sec

SEISMIC PARAMETERS

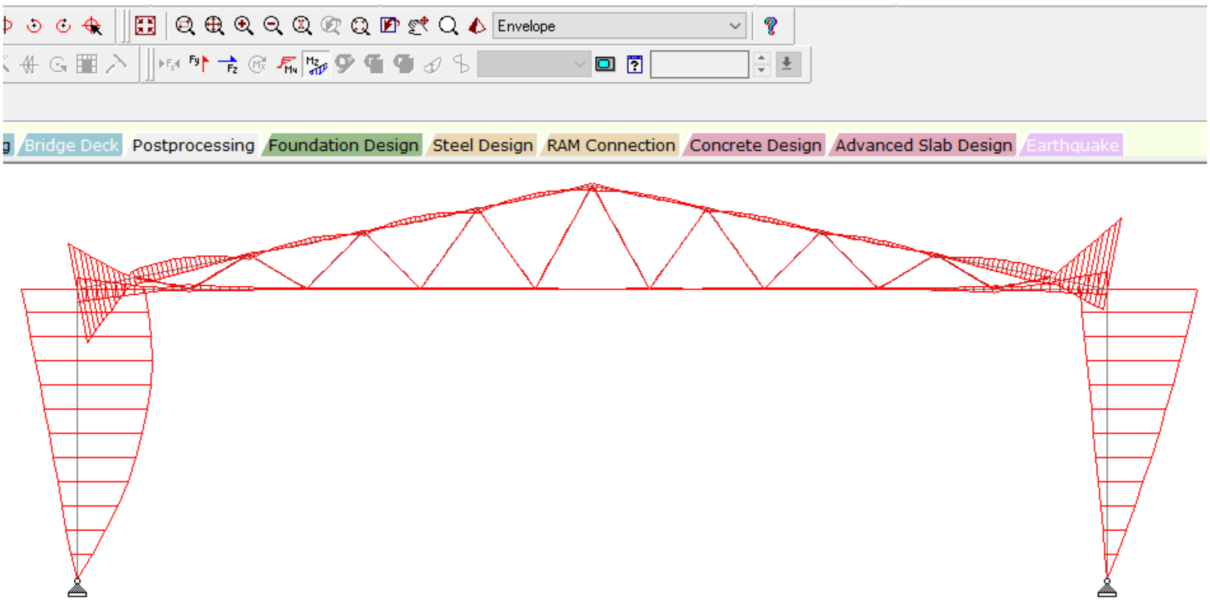
1	Seismic Zone factor (Z)	0.1
2	Response reduction factor (R)	3.0
3	Importance factor (I)	1.0
4	Soil type	Medium
5	Damping ratio	2%

5.1 BENDING MOMENT

PEB



CSB

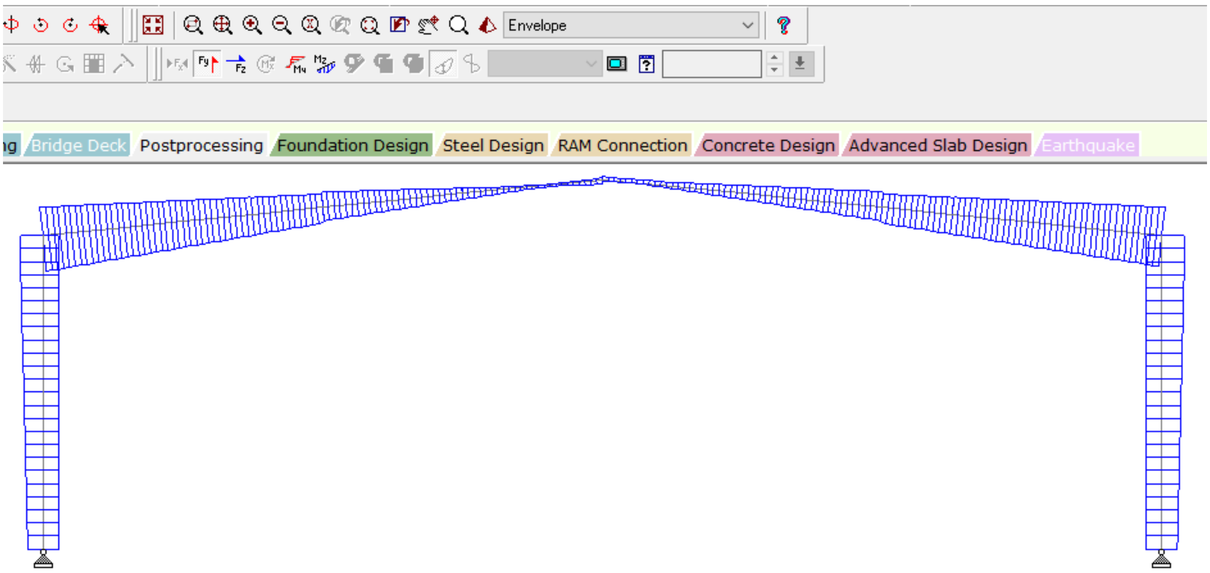


Max.BM (KN-m)

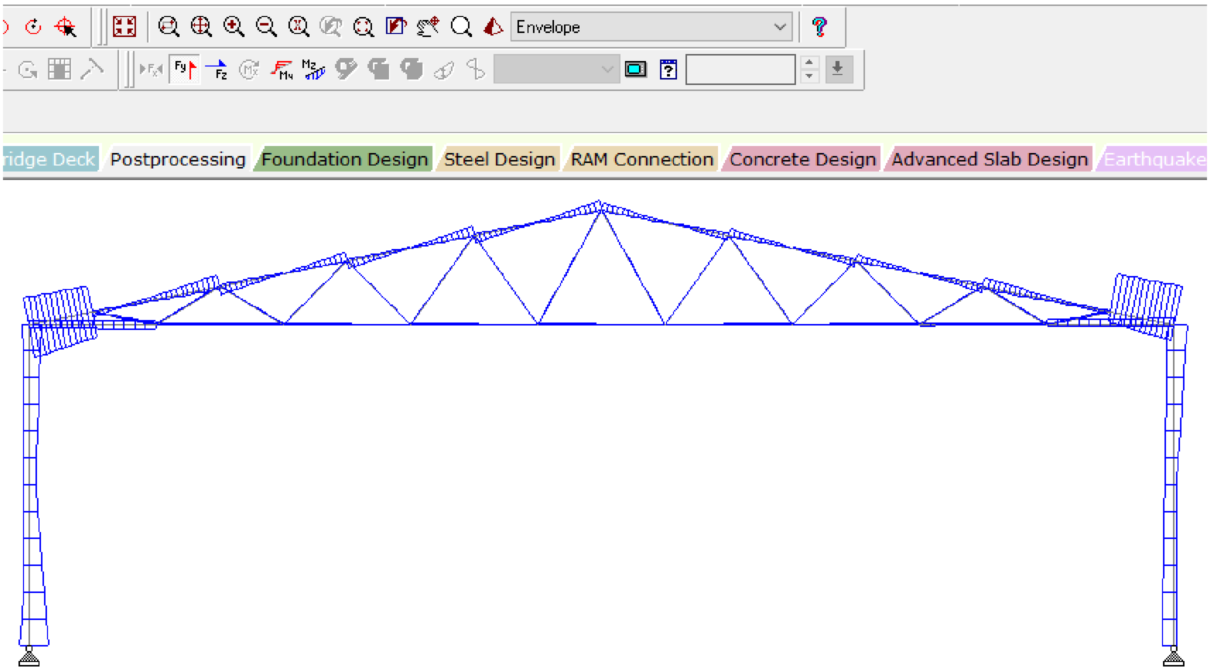
Max.BM	Column	Rafter
PEB	503.449	434.735
CSB	141.557	114.539

5.2 SHEAR FORCE

PEB



CSB

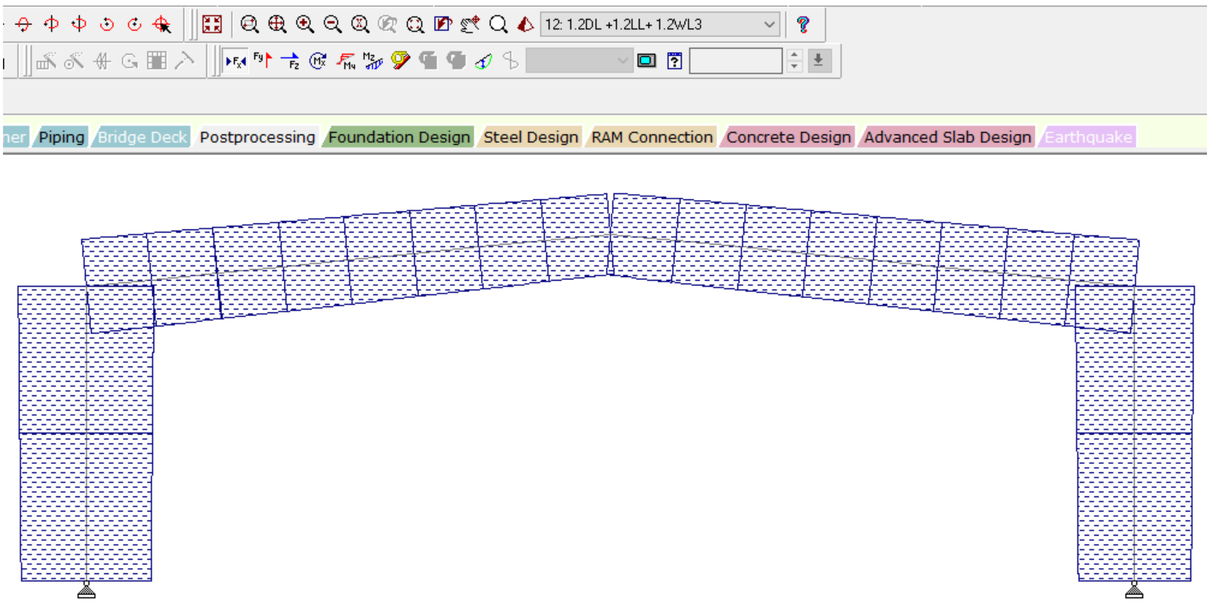


Max. SF (KN)

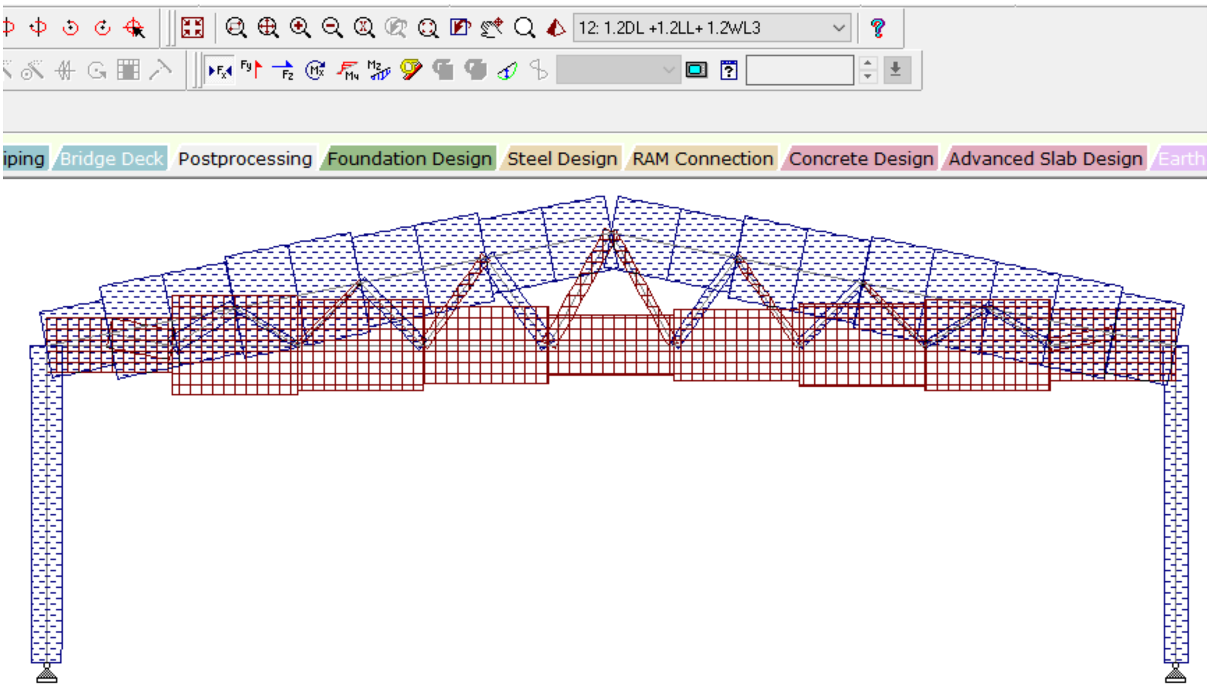
Max.SF	Column	Rafter
PEB	87.125	136.114
CSB	43.841	74.745

5.3 AXIAL FORCE

PEB



CSB

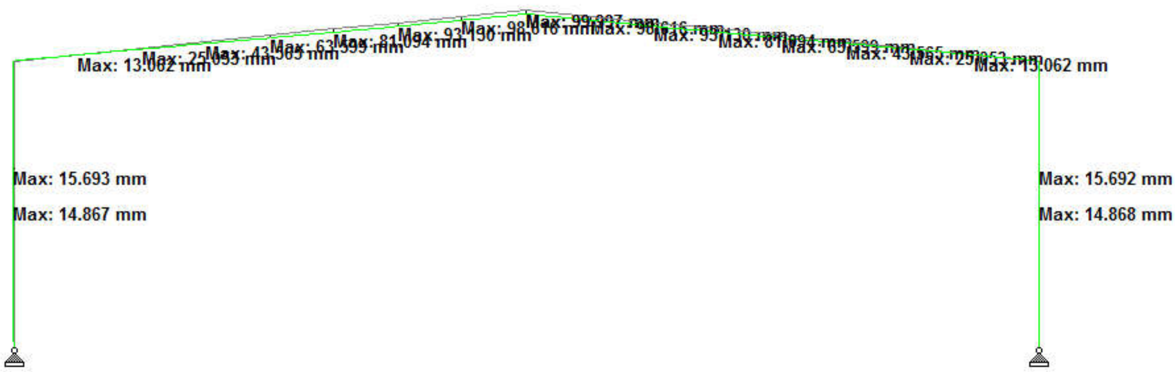


Max. AF (KN)

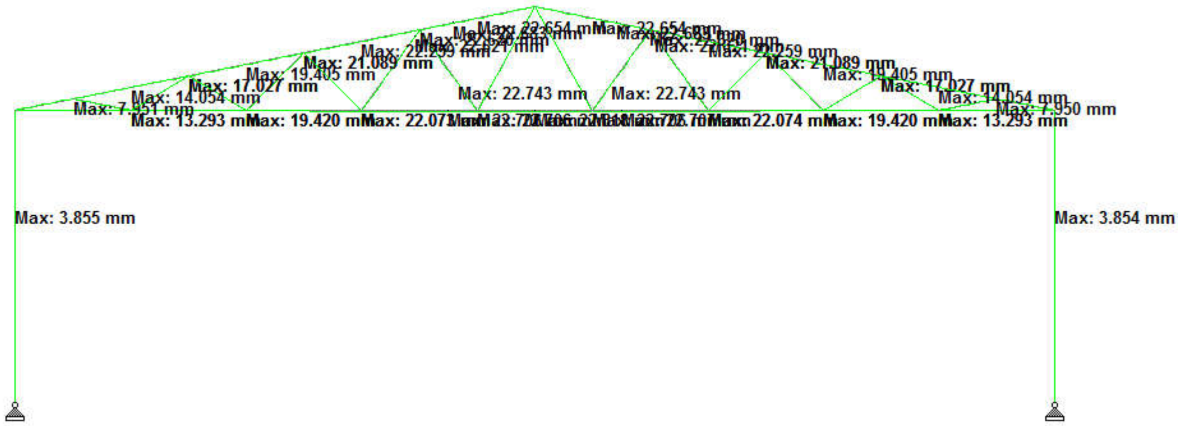
Max.AF	Column	Rafter
PEB	141.647	101.168
CSB	132.23	333.115

5.4 DEFLECTION

PEB



CSB



Max. Deflection (mm)

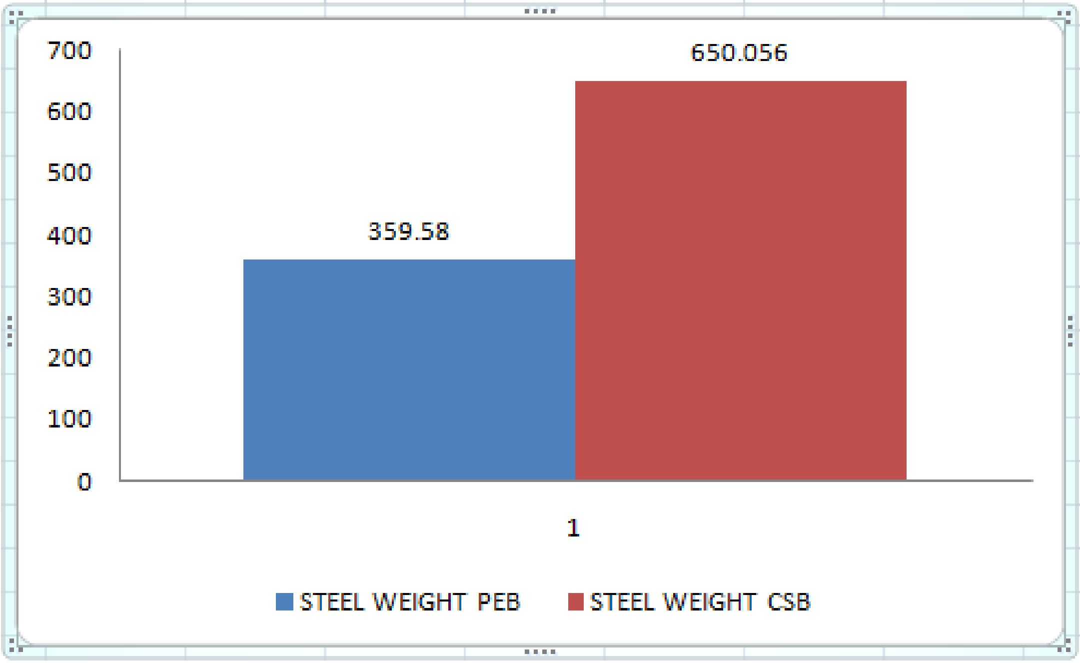
Max .Deflection	**Column**	**Rafter**
PEB	15.693	99.997
CSB	3.85	22.625

VI. RESULTS

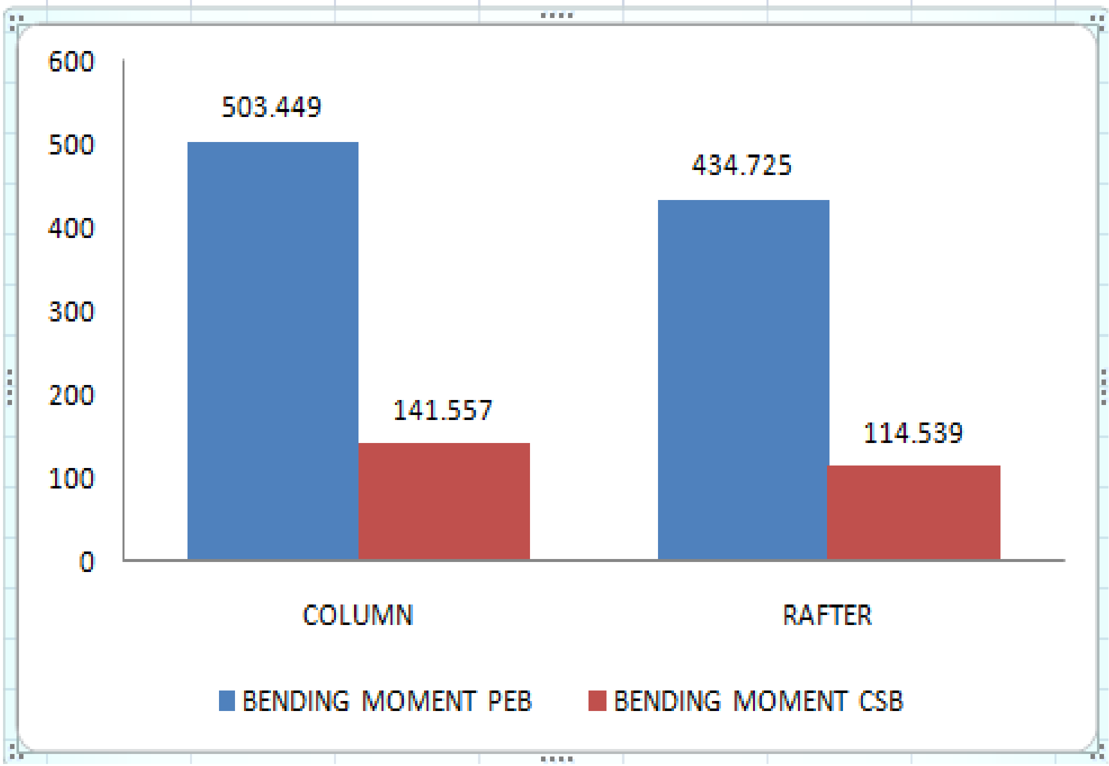
A banquet hall is analyzed and designed as PEB and CSB by using STAAD.pro as per IS 800 :2007. Following are the results obtained,

Sr.no	**Description**	**PEB**		**CSB**	
		Column	Rafter	Column	Rafter
1	Bending moment (KN-m)	503.449	434.725	141.557	114.539
2	Shear force (KN)	87.125	136.114	43.841	74.745
3	Axial force (KN)	141.647	101.168	132.23	333.115
4	Deflection (mm)	15.693	99.997	3.85	22.625
5	Steel weight (KG)	36,667		66,287	

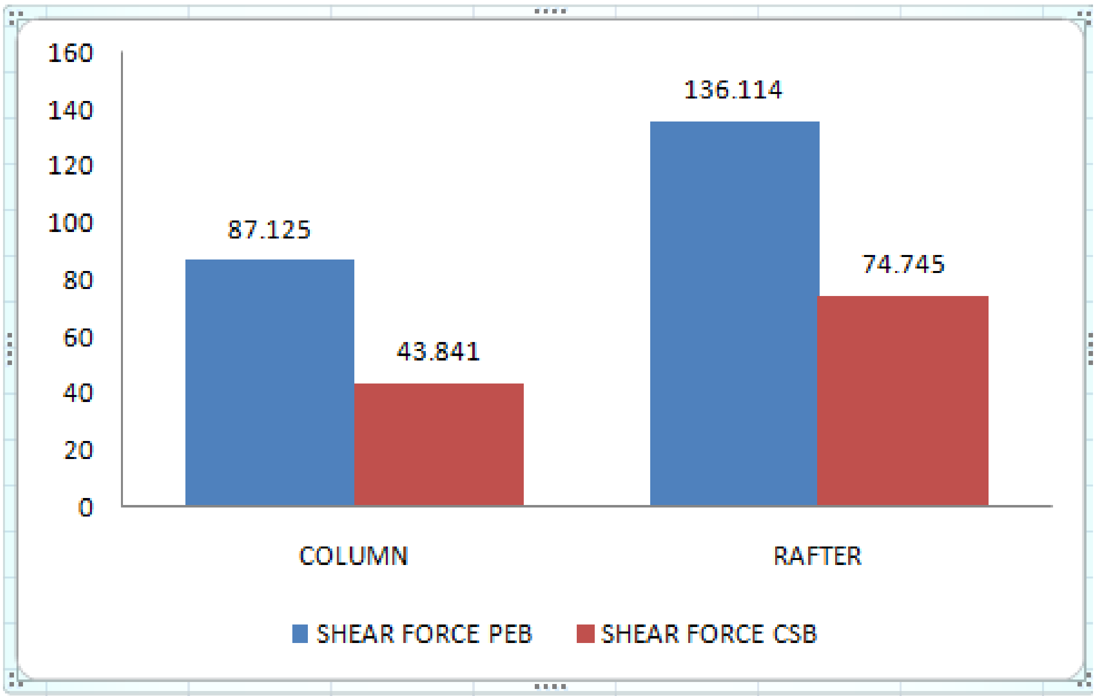
STEEL WEIGHT



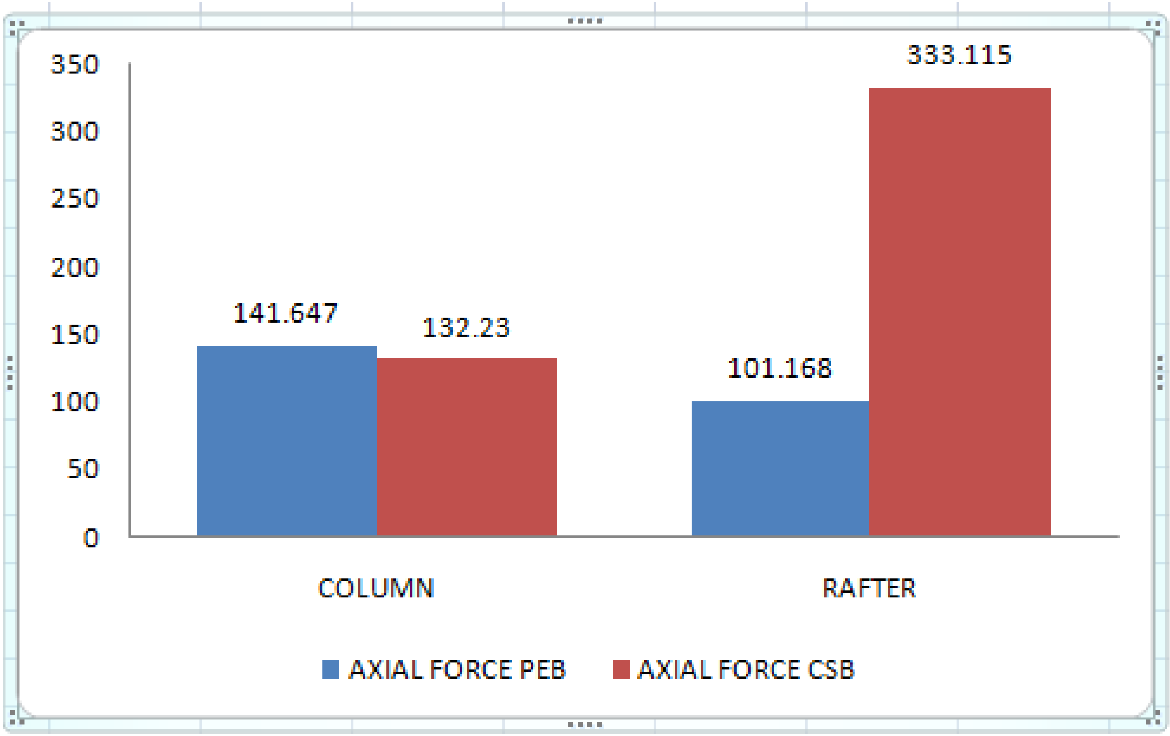
BENDING MOMENT



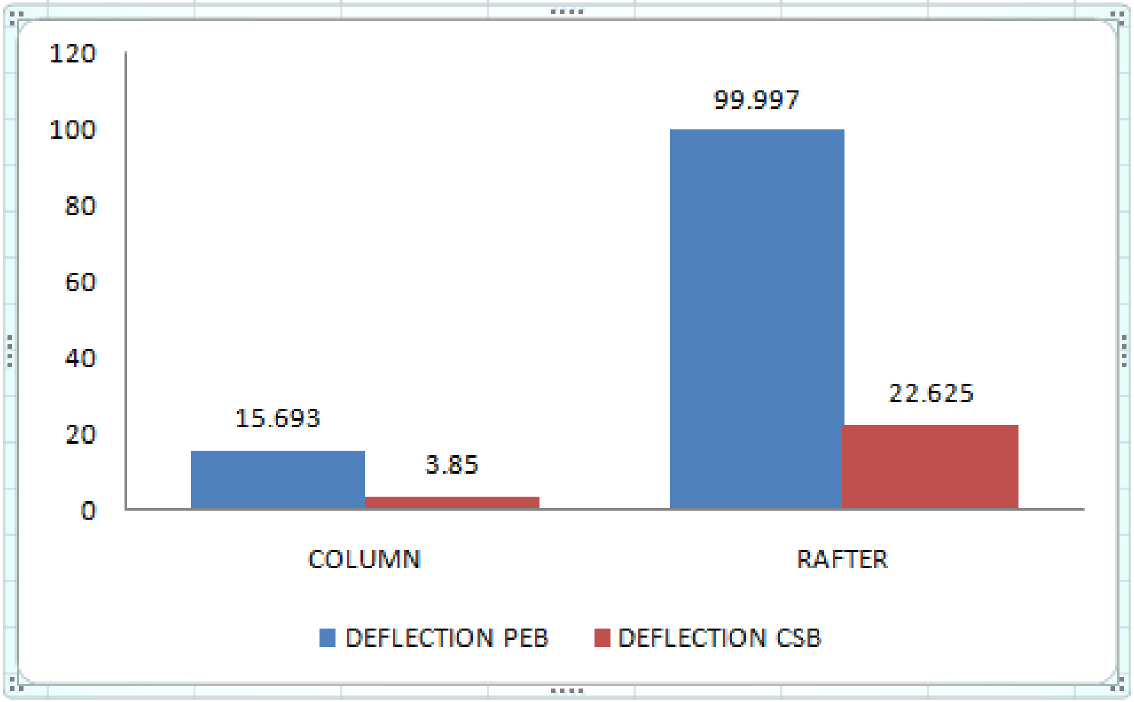
SHEAR FORCE



AXIAL FORCE



DEFLECTION



VII. OBSERVATIONS

- Due to tapered portions, PEB uses 45% less steel than CSB.
- Compared to hot rolled channel sections, cold formed z purlins weigh 55% less.
- In comparison to CSB column, PEB column has a 71.88% higher bending moment. Compared to CSB rafter, the PEB rafter has a 73.65% greater bending moment. This is a result of the load being distributed in CSB while being distributed in PEB.
- In comparison to CSB column, shear force in the PEB column is 49.68% higher. When compared to CSB rafter, shear force in PEB rafter is 45.08% more. The reason for this is because the load is distributed in PEB while being concentrated in CSB.
- In comparison to PEB column , Axial force is 6.63% higher than in the CSB Column. Due to nodal loading, PEB rafter axial force is 69.63% lower than CSB rafter.
- Compared to CSB, PEB has a greater horizontal deflection (75.46%). Due to the structure's light, the vertical deflection in PEB is greater than CSB by 77.37%.

VIII. CONCLUSION

- Compared toCSB, PEB is lighterby 45%.
- Cold formed purlins have a total weight that is 55% lower than hot rolled purlins.
- The maximum bending moment of the PEB column is 71.88% more than that of the CSB column. In comparison to CSB rafter, PEB rafter has a maximum bending moment that is 73.65% higher.
- The maximum shear force in the PEB column is 49.680% higher than in the CSB column. In comparison to CSB rafter, PEB rafter has a maximum shear force that is 45.08% higher.
- In comparison to CSB Column, the maximum axial force in PEB Column is 6.63% higher. comparison to CSB rafter, the maximum axial force in PEB rafter is 69.63% lower.
- In comparison to CSB, PEB has a greater maximum horizontal deflection by 75.46%. Compared to CSB, PEB has a greater maximum vertical deflection by 77.37%.

Regarding cost efficiency ,strength , durability, speed of construction , ease of erection & quality control pre engineered building outperform conventional steel building .

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