



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 9, September 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.569

 9940 572 462

 6381 907 438

 [ijrset@gmail.com](mailto:ijrset@gmail.com)

 [www.ijrset.com](http://www.ijrset.com)



# Comparative Study between Conventional Steel Building and Pre-Engineered Building to be used as an Industrial Structure

Sheetal Rajendra Patil<sup>1</sup>, Supriya Xavier Lopes<sup>2</sup>

PG (Structural Engineering) Student, Bapuji Institute of Engineering and Technology, Davangere, India<sup>1</sup>

Assistant Professor, Department of Civil Engineering, Bapuji Institute of Engineering and Technology, Davangere, India<sup>2</sup>

**ABSTRACT:** In recent years, construction of steel building is new thought in construction field. It is a concept of steel structures introduced in early 1960's. A modern technology of Pre-Engineered Building (PEB) is adopted to replace Conventional Steel Building (CSB). For construction of PEB tapered sections are used and for CSB hot rolled sections. PEB structural components are manufactured in factory under controlled environmental condition according to design standards and specification. The adaptability of PEB in place of CSB consists many advantages on simple and easy fabrication, no welding process, quality, faster construction, light weight and cost effective. Structure will be designed in plant and transported to site and then erected. In this study, a single-story industrial building with length 66m, 30m width, strut height 7m, with bay spacing 6m and considering slope 1:10, to conduct the study a model of a conventional steel structure and pre-engineered building is designed and analyzed on software Staad.Pro.V8i., wind load is calculated by excel sheet and load combination according to IS 800-2007.

We found that pre-engineered buildings have more advantages over conventionally designed buildings in terms of cost effectiveness, energy efficiency, time savings, more strength, long life span, design flexibility, and recyclability after analyzing both pre-engineered and conventional steel buildings. Total weight of Column, End Rafter and Mid Rafter in CSB is 56%, 61% and 67% more than PEB respectively. In column, Axial Force of PEB is 5% less than CSB, Shear Force and Bending Moment of PEB is 16% more than CSB. In End Rafter, Shear Force of PEB is 1% less than CSB, Axial Force and Bending Moment of PEB is 5%, 18% less than CSB. In Mid Rafter, Axial Force of PEB is 16% more than CSB, Shear Force and Bending Moment of PEB is 3%, 37% less than CSB. Compared to CSB (81067.42 Kg), the flexible and lightweight PEB frame (45989.19 Kg) has higher resistance to seismic and wind loads. From this we can conclude PEB is light weight structure and a simple foundation is required.

**KEYWORDS:** PEB, CSB, Tapered section, Hot rolled section, Staad.pro.V8i.

## I.INTRODUCTION

Steel is the construction material of choice for design due to its ductility and flexibility. Steel structure building is a kind of pre-fabricated structure which is mainly used to construct industrial structure. It has the least maintenance time and cost and can be easily moved to different locations.

Pre-engineered buildings are a combination of cold formed section and hot rolled section. This new technology is used to replace traditional steel building (CSB). The components of pre-engineered buildings are manufactured in accordance with design specifications and standards to achieve high quality, accurate products under controlled condition. It will be transported to the project site for installation. PEB structures are easily assembled because of its light weight compared to CSB. CSB structures fabricated with hot rolled sections and heavier than PEB. The material waste rate in CSB is high, cutting and welding process done on site but in PEB it is done at manufacturing plant only. Degree of accuracy and work performed is low. PEB erection is easy and faster than CSB because of its light weight. Pre-engineered buildings are accepted for larger industrial structures. These are economical, it gives flexibility for future growth and maintenance will be low.

## II. EXPERIMENTAL PROGRAM

The study includes analysis of single storey industrial building. The structure is proposed as a pre-engineered building with dimension of 66-meter in length and 30-meter in width, 7-meter eave height along with X-bracing and 6-meters bay spacing, analyzed according to Indian Standards IS 800-2007 using structural analysis and design software STAAD pro v8i. CSB is also designed and analyzed for same span and load. Members are assigned with built up section and tapered section. Dead load (IS 875 Part-I (1987)), live load (as per IS 875 Part-II (1987)) and wind load (IS 875 Part-III (1987)) are calculated as per IS 875-1987.

### Structural configuration

Type of building, detailed dimensions and wind speed are presented in table 1

Table 1: Structural Configuration

Type of Building	Industrial Building
Type of Structure	Single storey industrial structure
Length of Building	66m
Width of Building	30m
Bay Spacing	6m
No. of Bays	11
Eave Height	7m
Roof slope	5.71
Wind Speed	33m/s

### Details of structural member

Details of structural members presented in table 2. figure 1 and 2 shows 3D model of CSB and PEB.

Table 2: Details of Structural Members

Sl.no	Member	Property		Length in meter
		CSB	PEB	
1.	Column	ISMB600	Taper-1	168
2.	End Rafter	ISMB550	Taper-2	240
3.	Mid Rafter	ISMB550	Taper-3	120.792
4.	Bracing	PIP1937H	PIP1937H	264
5.	Girt	PIP1143H	PIP1143H	689.12

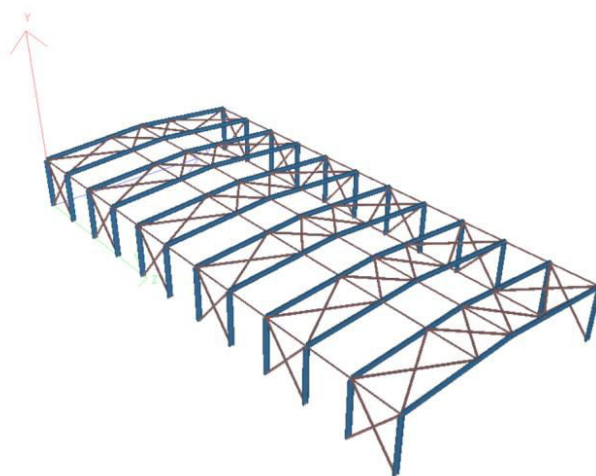


Fig. 1:3D Model of CSB

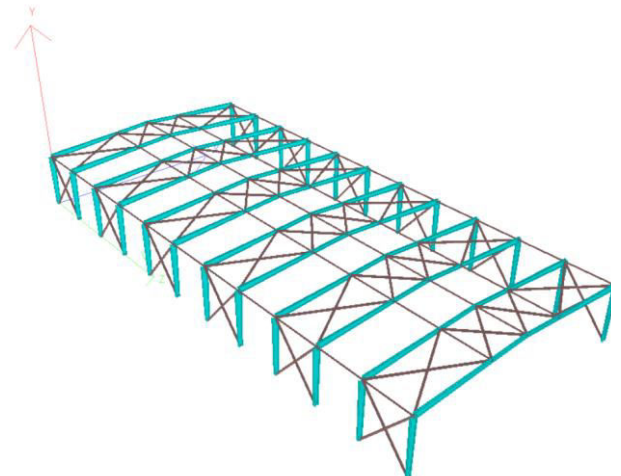


Fig. 2:3D Model of PEB



### Load Calculation

**Dead Load on Building:** (as per IS 875 Part-I (1987))

Weight of GI Sheeting =  $0.131 \text{ kN/m}^2$ .

Weight of fixings =  $0.025 \text{ kN/m}^2$ .

Weight of services =  $0.1 \text{ kN/m}^2$ .

Total weight =  $0.256 \text{ kN/m}^2$ .

Dead load on frame =  $0.256 \times 6$

=  $1.536 \text{ kN/m}$ .

**Live load on Building:** (as per IS 875 Part-II (1987))

Live load on non-accessible roof =  $0.75 \text{ kN/m}^2$ .

Total live load =  $0.75 \times 6$

=  $4.5 \text{ kN/m}$ .

### Wind calculation

IS 875 Part-III is used to determine wind loads (1987). The fundamental wind speed ( $V_b$ ) for this job is believed to be 33 m/s, and the building is considered to be open terrain with well-scattered obstructions with a height less than 10.0m and a maximum dimension greater than 50.0 m, thus factors  $K_1$ ,  $K_2$ , and  $K_3$  have been computed according to IS-875-Part-III (1987).

Terrain Category – 2

$K_1$  = Probability Factor = 1.0 (Table 1, clause 6.3.1)

$K_2$  = Terrain height and size factor = 1.0 (Table 2, clause 6.3.2.2)

$K_3$  = Topography factor = 1.0 (Clause 6.3.3.1)

$K_4$  = Importance factor for cyclonic region = 1.0 (Clause 6.3.4)

$V_b$  = 33 m/s

$V_z$  =  $V_b(K_1 \times K_2 \times K_3 \times K_4)$  (Clause 6.3)

$V_z$  = 33 (1.0 x 1.0 x 1.0)

$V_z$  = 33 m/s

$P_z$  =  $0.06 V_z^2$ .

$P_z$  =  $0.06 \times (33)^2$

$P_z$  =  $0.653 \text{ kN/m}^2$ .

$P_d$  =  $P_z(K_d \times K_a \times K_c)$  (Clause 7.2)

$K_d$  = Wind directionality factor = 0.9 (Clause 7.2.1)

$K_a$  = Area average factor = 0.9 (Clause 7.2.2)

$K_c$  = 0.9 (Clause 7.3.3.13)

$P_d$  =  $0.653(0.9 \times 0.9 \times 0.9)$

$P_d$  =  $0.476 \text{ kN/m}^2$ .

Ratio =  $H/W = 0.23$ ,  $L/W = 2.2$  (Table 5, Clause 7.3.3.1)

### Wind Pressure Co-efficient

The internal co-efficient are +0.2 and -0.2, respectively. The exterior and internal co-efficient were computed according to IS-875 Part-III (1987). Individual members' wind loads are then computed as follows:

$(C_{pe} - C_{pi}) \times A \times P = F$  (Clause 7.3.2.1)

Where  $C_{pe}$  and  $C_{pi}$  stand for exterior and internal co-efficient, respectively, and  $A$  and  $P$  stand for surface area and design wind pressure in  $\text{kN/m}^2$ .





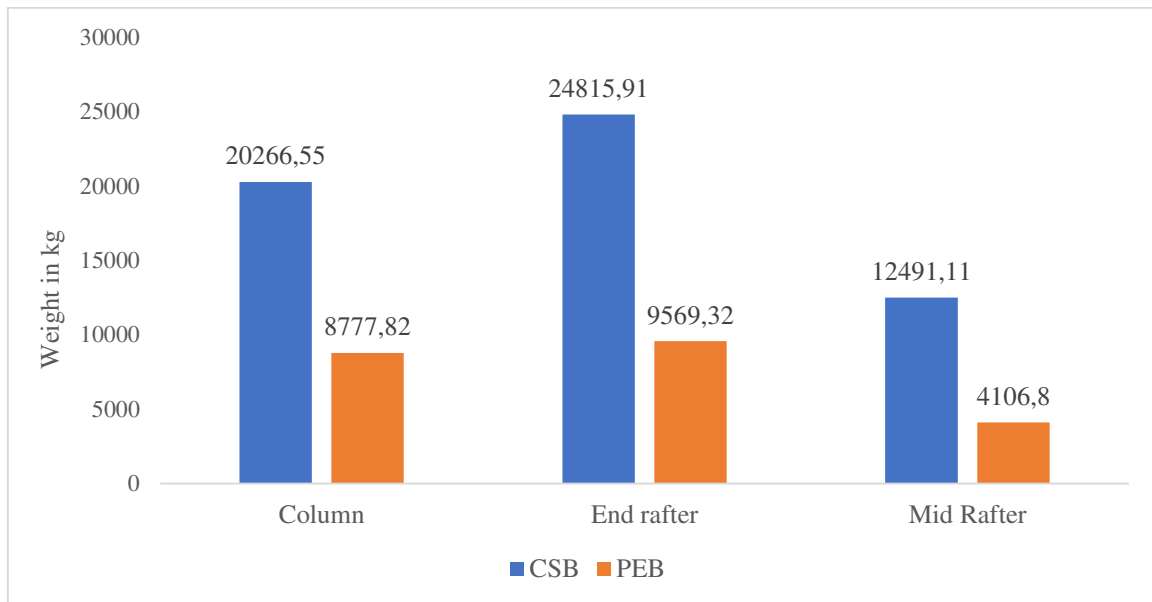
**III. RESULTS AND DISCUSSION**

**Quantities of steel in CSB and PEB**

Weight of structural member in CSB and PEB are tabulated in table 3 and same are represented graphically in fig.3.

**Table 3: Weight of Structural Members in CSB and PEB**

Sl. No	Member	Length	CSB		PEB	
			Weight in kN	Weight in kg	Weight in kN	Weight in kg
1	Column	168	198.747	20266.55	86.081	8777.82
2	End Rafter	240	243.361	24815.91	93.843	9569.32
3	Mid Rafter	120.79	122.496	12491.11	40.274	4106.8
4	Girt	330	46.898	4782.26	46.898	4782.26
5	Bracing	689.11	1842.2	18785.41	1842.2	18785.41



**Fig.3: Weight of Structural Members in CSB and PEB**

**Reactions and moments of CSB and PEB**

Reactions and moments of CSB and PEB are tabulated in table 4 and same are represented graphically in fig. 4 to 6.

**Table 4: Axial Force, shear Force, Bending Moment and Torsion Results of Column, End Rafter, and Mid Rafter.**

Sl. No	Member	Results		
		Forces	CSB	PEB
1	Column	Axial force	271.209kN	258.774kN
		Shear force	129.423kN	155.193kN
		Bending moment	902.182kN-m	1080kN-m
		Torsion	0.092kN-m	0.007kN-m
2	End rafter	Axial force	141.024kN	148.718kN
		Shear force	177.422kN	175.509kN
		Bending moment	887.448kN-m	1080kN-m
		Torsion	0.245kN-m	0.009kN-m
3	Mid rafter	Axial force	162.376kN	192.5kN
		Shear force	52.763kN	50.938kN
		Bending moment	586.397kN-m	369.515kN-m
		Torsion	0.034kN-m	0.002kN-m

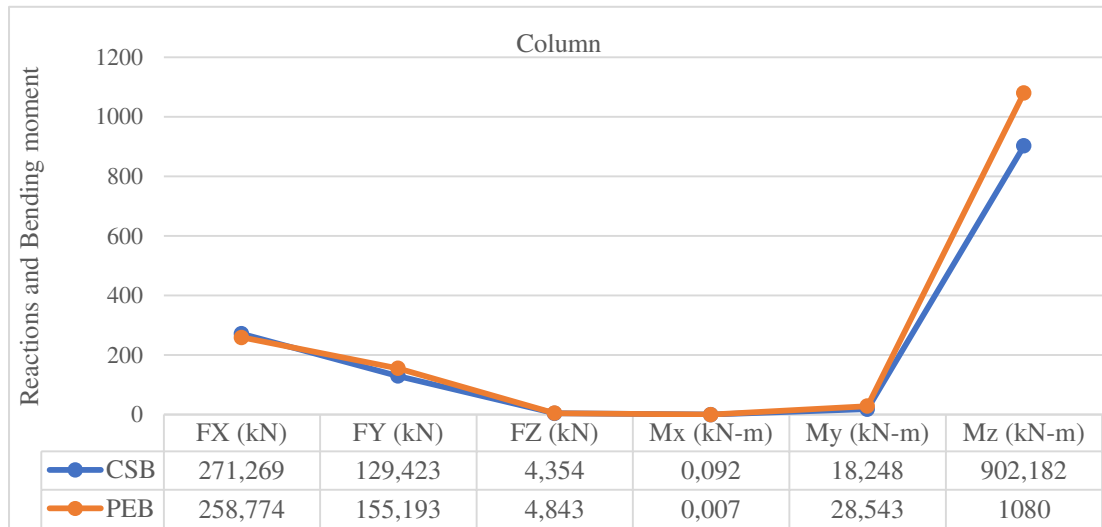


Fig. 4: Reactions and Bending moment of Column

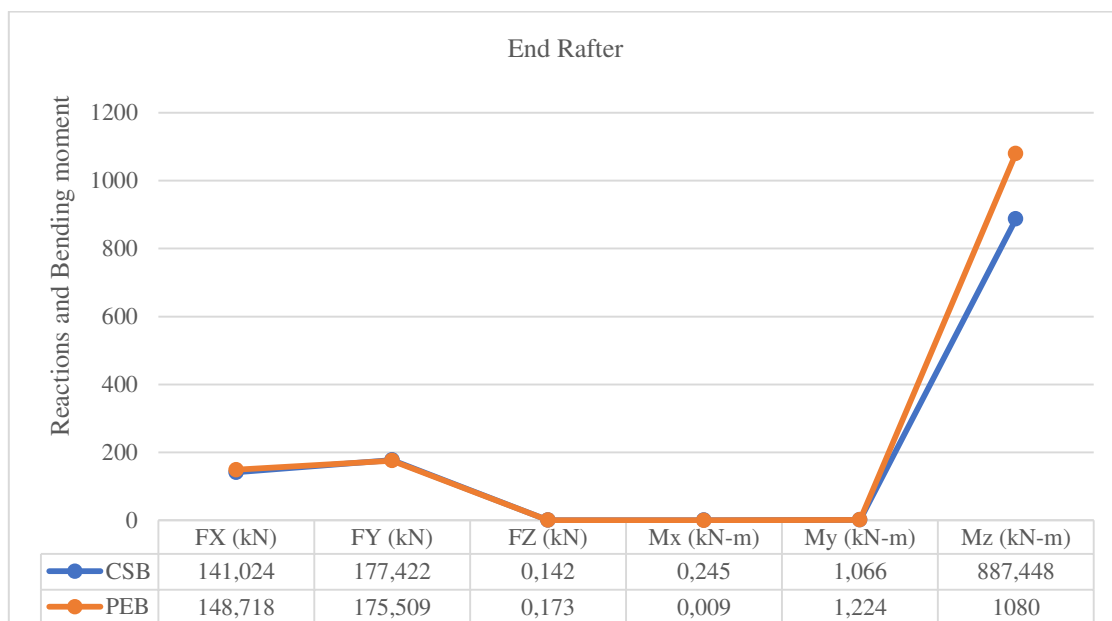


Fig. 5: Reactions and Bending moment of End Rafter

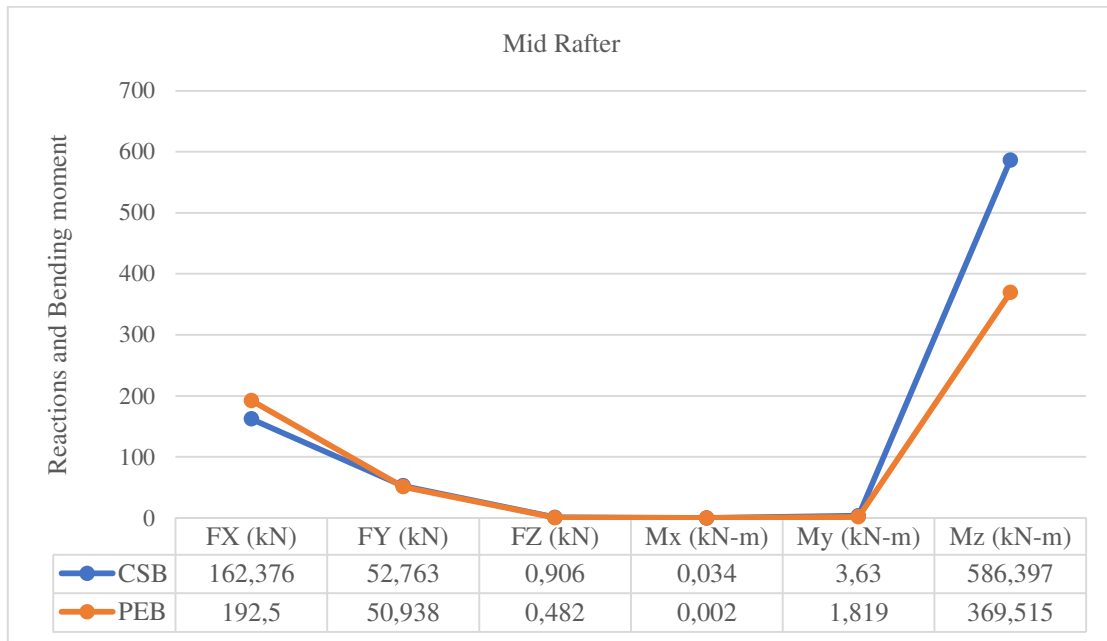


Fig. 6: Reactions and Bending moment of Mid Rafter

**Discussion**

- In column, the axial force in PEB (258.774kN) is less when compared to CSB (271.269kN). Shear force in PEB (155.193kN) is more when compared to CSB (129.423kN). The bending moment in PEB (1080kN-m) is more when compared to CSB (902.182kN-m). Torsion in CSB (0.092kN-m) is more than PEB(0.007kN-m).
- In end rafter, the axial force in PEB (148.718kN) is more when compared to CSB (141.024kN). Shear force in PEB (175.509kN) is less when compared CSB (177.422kN). The bending moment in PEB (1080kN-m) is more when compared to CSB (887.448kN-m). Torsion in CSB (0.245kN-m) is more than PEB(0.009kN-m).
- In mid rafter, the axial force in PEB (192.5kN) is more when compared to CSB (162.376kN). Shear force in PEB (50.938kN) is less compared to CSB (52.763kN). The bending moment in PEB (369.515kN-m) is less when compared to CSB (586.397kN-m). Torsion in CSB (0.034kN-m) is more than PEB(0.002kN-m).
- Total weight of column in CSB (20266.55kg) is more than that of PEB (8777.82kg).
- Total weight of end rafter in CSB (24815.91kg) is more than that of PEB (9569.32kg).
- Total weight of mid rafter in CSB (12491.11kg) is more than that of PEB (4106.8kg).

**IV. CONCLUSIONS**

In the present work, comparative study between conventional steel building and pre-engineered building to be used as an industrial structure is studied. An industrial building is designed and analyzed according to IS 800-2007 using structural analysis and design software Staad.Pro. V8i. Loads are calculated in accordance with IS 875-1987 (Part-I, Part-II, Part-III) and results are compared.

- Total weight of Column, End Rafter and Mid Rafter in CSB is 56%, 61% and 67% more than PEB respectively.
- PEB building cost is nearly 43% lesser than the cost of CSB structure. PEB offers low cost.
- Compared to CSB (81067.42 Kg), the flexible and lightweight PEB frame (45989.19 Kg) has higher resistance to wind loads.
- In column, Axial Force of PEB is 5% less than CSB, Shear Force and Bending Moment of PEB is 16% more than CSB.
- In End Rafter, Shear Force of PEB is 1% less than CSB, Axial Force and Bending Moment of PEB is 5%, 18% less than CSB.
- In Mid Rafter, Axial Force of PEB is 16% more than CSB, Shear Force and Bending Moment of PEB is 3%, 37% less than CSB.
- Torsion in CSB for Column, End Rafter, Mid Rafter is 92%, 96%, 94% more than PEB respectively.



- According to analysis, the reaction forces of the PEB column support is 5% lower than that of the CSB. PEB can reduce cost of foundation work by adopting a light weight foundation and a simple design.
- Compared to hot rolled steel sections, cold formed steel sections have less static load on the structure. The cross-sectional area of the cold formed section is small, which results in a lower unit weight of the component, so that static load on the structure is less in PEB.
- We found that pre-engineered buildings have more advantages over conventionally designed buildings in terms of cost effectiveness, energy efficiency, time savings, more strength, long life span, design flexibility, and recyclability after analyzing both pre-engineered and conventional steel buildings.

#### REFERENCES

1. IS 875(Part 1):1987, “code of practice for design loads (other than earthquake) for buildings and structures – dead loads”, BIS, New Delhi.
2. IS 875(Part 2):1987, “code of practice for design loads (other than earthquake) for buildings and structures – imposed loads”, BIS, New Delhi.
3. IS 875(Part 3):1987, “code of practice for design loads (other than earthquake) for buildings and structures – wind loads”, BIS, New Delhi.
4. IS 800 (2007), “General construction in steel - code of practice”, Bureau of Indian Standards, New Delhi, India.
5. BIRLA’S publications M.K.S. & S.I. UNITS Steel table by: Prof. R. Agor.
6. G. SaiKiran, A. KailasaRao, R. Pradeep Kumar (2014), “Comparison of Design Procedures for Pre-Engineering Buildings (PEB)”, International Journal of Civil, Architectural, Structural & Construction Engineering, Vol. 08, pp. 477-481.
7. Pradeep V, Papa Rao G (2014), “Comparative Study of Pre-Engineered and Conventional Industrial Building”, International Journal of Engineering Trends and Technology, Vol. 09, pp. 01-06.
8. AbhyudayTitiksh, AbhinavDewangan, AnkurKhandelwal, Akshay Sharma (2015), “Comparative Study of Conventional Steel Building and Pre-engineered Building to be used as an Industrial Shed”, International Journal of Engineering Research and Applications, Vol. 5, pp. 25-28.
9. Joshi Vaibhav Harish, V. B. Patel, V. A. Arekar (2016), “Parametric study of various pre -engineered building”, International Journal of Advance Research in Engineering, Science Technology, Vol.03, pp. 297-302.
10. VishwanathPujar, Ravi Tilaganji (2017), “comparative study of codal provisions for pre-engineered building”, International Research Journal of Engineering and Technology, vol. 4, pp. 2062-2069.
11. ShashankPattanshett, Sachin M. Kulkarni (2017), “Comparative Study on the Economy between Pre-Engineered and Conventional Steel Buildings”, International Research Journal of Engineering and Technology, Vol. 04, pp. 2708-2711.
12. Sunil Kumar, G.B. Bhaskar (2019), “Study and Analysis of Pre-Engineering Building Structure”, International Research Journal of Engineering and Technology, Vol. 06, pp.64-66.





**Impact Factor:  
7.569**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details