International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 05 | May 2021 www.irjet.net p-ISSN: 2395-0072

Comparative Study of Pre Engineered Building and Conventional Steel Building

Pornima Pritish Naik[1], Dr.S.H.Mahure[2]

[1]*M.E.(Structural Engg.)Student, Department of Civil Engineering, B.N. College of Engineering, Pusad (M.S.), India*
[2]*Professor and Head, Department of Civil Engineering, B.N. College of Engineering, Pusad (M.S.), India*

Abstract - *Cost of steel is increasing day by day and use of steel has become inevitable in the construction industry in general and in industrial building in particular. Hence to achieve economic sustainability it is necessary to use steel to its optimum quantity. Long span is the most essential in any type of industrial structures and Pre Engineered Buildings (PEB) fulfill this requirement along with reduced time and cost as compared to Conventional Steel Building. Pre-Engineered Building (PEB) concept is a new conception of single storey industrial building construction. This methodology is versatile not only due to its quality pre-designing and prefabrication, but also due to its light weight and economical construction. The concept includes the technique of providing the best possible section according to the optimum requirement. The work presents the comparative study and design of conventional steel frames with Pre Engineered Buildings (PEB). In this work, an industrial building of length 100m and width 30m with roofing system as conventional steel truss and pre-engineered steel frame is analyzed and designed by using STAAD Pro V8i.*

Keywords: Conventional Steel Building, Pre-Engineered Building, Staad.Pro Vi8, Tapered Section, Steel Structures

1. INTRODUCTION

India has the second fastest growing economy in the world. The construction industry has discovered, invented and developed a number of technologies, systems and products, one of them being the concept of Pre-engineered Buildings(PEB). For the past few decades, pre-engineered buildings have become popular in the construction industry. Pre Engineered building are the latest trend in India. Pre-engineered structure is an idea designed with a view to replace conventional steel structures as the structural components are manufactured under controlled environment conditions tend to produce products with high quality & precision, reduce resource wastages and decrease the budget considerably. As opposed to being on-site fabricated, Pre Engineered Buildings are delivered as a complete finished product to the site from a single supplier with a basic structural steel framework with attached factory finished cladding and roofing components. The structure is erected on the site by bolting the various building components together as per specifications. Pre Engineered Buildings are developed using potential design software. The onset of technological advancement enabling 3D modeling and detailing of the proposed structure and coordination has revolutionized Conventional building construction. Pre-Engineered Buildings is the future for India. Most of the Indian business community is just started to realize the benefits of Pre Engineered Buildings. Where you have been building with concrete for as long as anyone can remember, it is difficult to change. However India's most progressive companies are seeing the benefits of Pre Engineered Buildings.

1.1 Classification

I. Conventional Steel Building.

II. Pre Engineered Building.

1.2 Conventional Steel Building

Conventional steel buildings are constructed by rolled steel sections which are designed individually and fabricated at site using welding and cutting, offering the ability to design a unique building.

Conventional Steel Buildings are low rise steel structures with roofing systems of truss with roof coverings. Various types of roof trusses can be used for these structures depending upon the pitch of the truss. For large pitch, Fink type truss can be used; for medium pitch, Pratt type truss can be used and for small pitch, Howe type truss can be used. Skylight can be provided for day lighting and for more day lighting, quadrangular type truss can be used. The selection criterion of roof truss also includes the slope of the roof, fabrication and transportation methods, aesthetics, climatic conditions, etc. Several compound and combination type of economical roof trusses can also be selected depending upon the utility.

The Conventional Steel Building frame of the structure is considered in the study is as shown in Figure 1.1

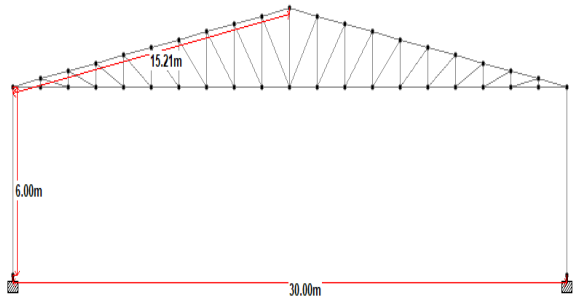

Fig 1.1 Conventional Steel Structure Frame

1.3 Pre Engineered Building

Pre-Engineered Building concept involves the steel building systems which are predesigned and prefabricated. As the name indicates, this concept involves pre-engineering of structural elements using a predetermined registry of building materials and manufacturing techniques that can be proficiently complied with a wide range of structural and aesthetic design requirements. The basis of the PEB concept lies in providing the section at a location only according to the requirement at that spot. The sections can be varying throughout the length according to the bending moment diagram. This leads to the utilization of non-prismatic rigid frames with slender elements. Tapered I sections made with built-up thin plates are used to achieve this configuration. Standard hot-rolled sections, cold-formed sections, profiled roofing sheets, etc. is also used along with the tapered sections. The use of optimal least section leads to effective saving of steel and cost reduction. The typical PEB frame of the structure is as shown in the Figure 1.4.

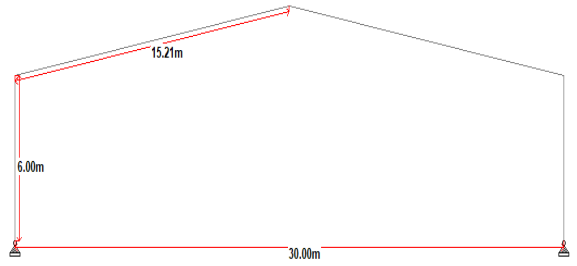

Fig. 1.2 Pre-Engineered Building Frame (PEB)

1.4 Advantages of Pre Engineered Building over Conventional Steel Building

- **Faster construction:**

The components of the Pre-engineered buildings are engineered before hand and standardized. Use of standardized components results in reduction of engineering, manufacturing and erection time. Standard building delivery may take 6-8 weeks including engineering time.

- **High strength to weight ratio:**

Use of high strength materials lead to lighter construction.

- **Lower cost:**

Owing to standardization and systematic approach, significant saving is possible in design, manufacturing and erection. From structural 10 design point of view the main frame section shape follows the stress diagram of the member, thereby causes weight reduction and less load on foundation.

- **Large clear spans:**

Clear spans of upto 80 metres are possible.

- **Flexibility of expansion:**

These buildings have the advantage of expansion in length by inclusion of additional bays in the future.

- **Quality control:**

Availability of certified material from steel mills having guaranteed strength and welding of the entire building components facilities undisputed quality control.

- **Architectural versatility:**

Various types of fascias, canopies, curved eaves etc. can be provided.

- **Energy efficient roof and wall systems:**

Numerous insulation materials are available for providing insulation to roof and walls.

1.5 Application of Pre Engineered Building

The most common applications of pre-engineered buildings are:

- **Industrial:** Factories, Workshops, Warehouses, Cold stores, Car parking sheds, Slaughter houses.
- **Commercial:** Showrooms, Distribution centres, Supermarkets, Fast food restaurants, Offices, Labour camps, Service station, Shopping centres.
- **Institutional:** Schools, Exhibition halls, Hospitals, Theatres/auditoriums, Sports halls.
- **Recreational:** Gymnasiums, swimming pool enclosures, Indoor tennis courts.
- **Aviation & Military:** Aircraft hangars, Administration buildings, Residential barracks.
- **Agricultural:** Poultry buildings, Dairy farms, Greenhouses, Grain storage, Animal

confinement.

2. MODELING

2.1 Warehouse Particulars

Type of building	Industrial building
Type of structure	single storey industrial structure
Location	Amravati
Area of building	7500 m^2
Area of Building	3000 m^2
Total width Building	30m
Total length Building	100m
Eave Height	6m
Spacing along length	5m
Support condition (CSB)	Fixed
Support condition(PEB)	Pinned
PEB roof slope	5.71^0
CSB roof slope	9.46^0

z

2.2. Load Calculations

2.2.1 Sample load Calculations for Conventional Steel Building

Dead load is calculated according to IS 875 (part I) 1987.

- **Dead load**

Weight of AC shetting = 27.36 kN

Weight of purlin =15 kN

Self wt of roof truss =22.5 kN

Wt of bracing = 3 kN

Total Dead load = 67.86 kN

- **Live load**

Live load is calculated according to IS 875 (part II)1987

Live load on slopping roof = 750 – 20(α -10) N/m^2

But slopping roof with slope upto and including 10 degree

Hence, Live load = 0.75 kN/m^2

2.2.2 Sample load Calculations for Pre Engineered Building

- **Dead load**

Weight of AC shetting = 27.36 kN

Weight of purlin =15 kN

Self wt of roof =22.5 kN

Total Dead load = 64.86 kN

- **Live load**

Live load is calculated according to IS 875 (part II) 1987

Live load on slopping roof = 750 – 20(α -10) N/m^2

But slopping roof with slope upto and including 10 degree

Hence, Live load = 0.75 KN/m^2

2.2.3 Wind load calculation for both the buildings

Wind load is calculated according to IS 875 (part III)2015

Wind load is calculated as per IS: 875 (Part 3) – 1987 Basic Wind speed V_b = 50 m/sec

Risk Coefficient K_1 = 1

Terrain, Height and Structure size factor K_2 = 1

Topography factor K_3 = 1

Design Wind Speed $V_z = V_b K_1 K_2 K_3$ = 50 m/sec

Design Wind Pressure $P = 0.06 V^2$ = 1.5 kN/m^2

The Internal Coefficients are taken as +0.5 and -0.5.

Wind Load on individual members are then calculated by

$$F = (Cpe – Cpi) \times A \times P$$

Where,

Cpe – External Coefficient

Cpi – Internal Coefficient

A – Surface Area in m^2

P – Design Wind Pressure in kN/m^2

3. STAAD PRO PROCEDURE

In the present study, Staad.pro software has been used in order to analyze and design Pre Engineered Structures and Conventional Steel Structure. It gives the Bending moment, Shear Forces, Axial Forces, Torsion, Beam Structures of a steel structure so that the design can be done using Tapered Sections and check for safety in Pre Engineered Buildings.

3.1 Analysis of Conventional Steel Building

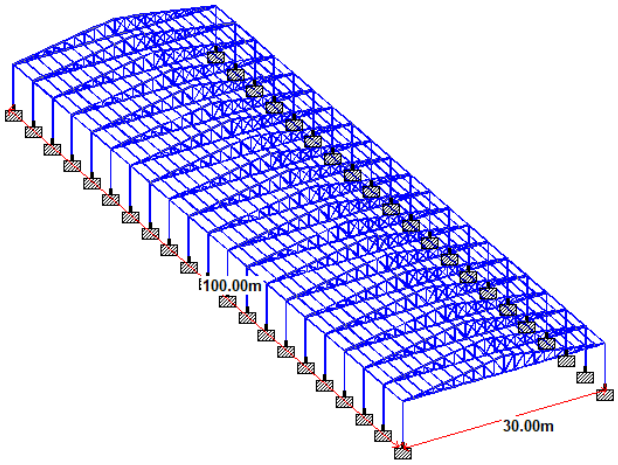

Fig -3.1: Three dimensional view (3D View) of Conventional Steel Building

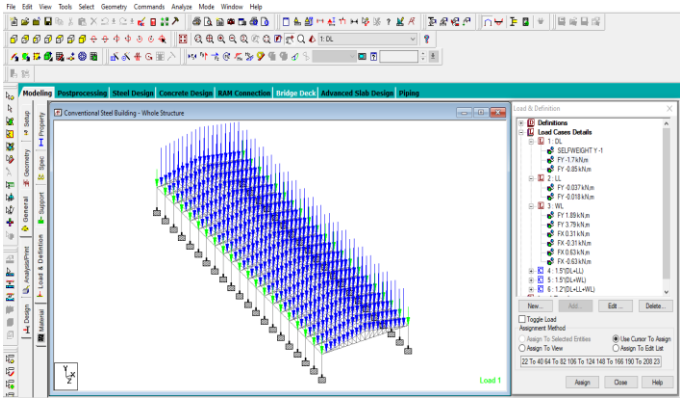

Fig -3.2: Conventional steel Building loading and load combinations

3.1.1 Load combinations of Conventional Steel Structure:

- 1.5(DL+LL)
- 1.5(DL+LL)
- 1.2(DL+LL+WL)

3.2 Analysis of Pre-Engineered Building

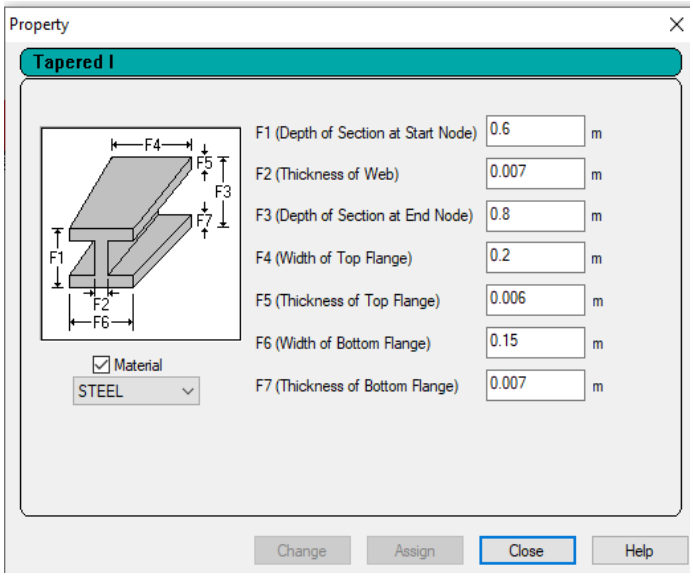

Fig-3.4: Property for Pre Engineered Building components

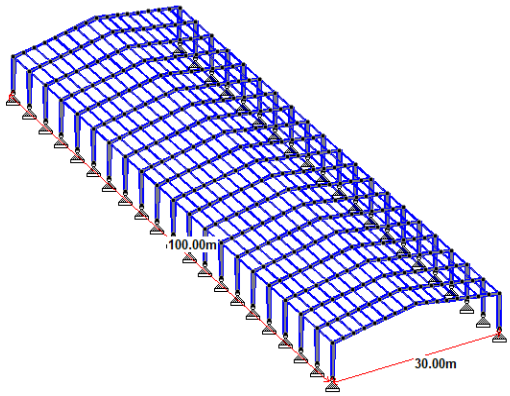

Fig-3.5: Three dimensional view (3D View) of Pre-Engineered Building Frame

3.2.1 Load combinations of Conventional Steel Structure

(1) DL+LL
(2) DL+WL1
(3) DL+WL2
(4) DL+WL3
(5) DL+WL4
(6) 1.5DL+1.5WL1
(7) 1.5DL+1.5WL2
(8) 1.5DL+1.5WL3
(9) 1.5DL+1.5WL4

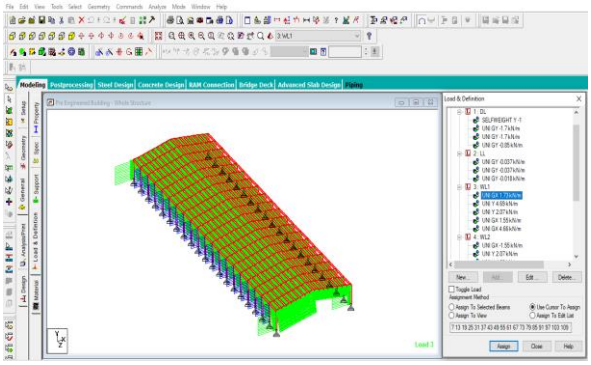

Fig-3.6: Pre Engineered Building Frame loading

4. RESULTS & DISCUSSION

4.1 Steel take off Result of Conventional Steel Building

Table-1 : Steel take off Result of Conventional Steel Building

Section profile	Length (m)	Weight (kN)
ISA200x150x18	120.83	55.448
ISA75x75x6	1287.91	85.679
ISA110x110x12	252.00	48.435
ISA200x100x12	1147.86	305.007
ISA80x80x8	4059.99	380.812
	Total	**875.401**

Total Weight of Conventional Steel Building= **875.401kN**

Total cost of Conventional Steel building= **Rs 38,89,260**

4.2 Steel take off Result of Pre Engineered Building

Table-2 : Steel take off Result of Pre Engineered Building

Tapered Member	Length (m)	Weight (kN)
1	252.00	136.651
3	3.80	1.532
5	3.80	1.721
9	304.14	136.585
11	304.14	157.798
127	1700.00	304.019
227	3.80	1.386
228	3.80	1.233
229	3.80	1.145
233	3.80	1.857
234	3.80	2.001
235	3.80	2.083
	Total	**748.012**

Total Weight of Pre Engineered building= 748.012kN

Total cost of Pre Engineered building = Rs **33,23,210**

On comparing the results of both the analysis, the following results were obtained as in table-3

Table-3 : Comparing results of both analysis

Building	Dimensions (m)	Weight (kN)	Cost (Rs)
Conventional Steel Building	30 x 100	875.401	38,89,260
Pre engineered building	30 x 100	748.012	33,23,210

4.3 Discussion

The structural analysis and design of the structural frame considered was done using the Staad.Pro software which is very user friendly and effective. First a typical frame is selected from the structure. Then the frame was analyzed and designed according to the Pre Engineered building concept and then by the Conventional Steel Building concepts. Pre-Engineered Buildings have vast advantages over the Conventional Steel Buildings. The results of the software analysis and literature studies conducted for both the concepts suggest the same.

5. CONCLUSION

Pre-Engineered Building structures can be easily designed by simple procedures using IS code. In this study and analysis, it can be concluded that Pre-Engineered Building are more advantageous than Conventional Steel Building in terms of cost effectiveness, quality control, speed in construction and simplicity in erection.

The weight and cost of Pre-engineered building is almost 15% less than the weight and cost of Conventional Steel Building.

Pre Engineered Building offers low cost, strength, durability, design flexibility, adaptability and recyclability. Pre-Engineered Building construction gives end users a much more economical and better solution for long span structures where large column free areas are needed.

Therefore, Pre-Engineered Building is more preferable than conventional steel building

REFERENCES

[1] S.K.Duggal "Design of steel structures" by Tata Mc graw hill.

[2] Dr.B.C.Punmia, Ashok Jain, Arun Kumar Jain "Design of steel structures" by Laxmi publications.

[3] IS: 875 (Part 1) – 1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Dead Load)

[4] IS: 875 (Part 2) – 1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Imposed Load).

[5] IS: 875 (Part 3) – 2015 Code of Practice for Design Loads (Other than Earthquake) for Buildings And Structures (Wind Load).

[6] IS: 800 – 2007 Indian Standard General Construction In Steel – Code of Practice.