JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN CIVIL ENGINEERING
ISSN 0975 – 6744 , Impact Factor: GIF: 00.9487 , SIF: 03.495

"Analysis and Cost Comparative study of Conventional Industrial building with PEB structure"

Vivek Thakre
M-Tech Student, Dept. of Civil Engineering
G. H. Raisoni Academy of Engineering & Technology
Nagpur – 16, India

Mr. Laxmikant Vairagade
Assistant Professor, Dept.of Civil Engineering
G. H. Raisoni Academy of Engineering & Technology
Nagpur

ABSTRACT

In this paper the pre-engineered steel building system construction has great advantages to the single storey buildings, practical and efficient alternative to conventional buildings, the System representing one central model within multiple disciplines. . The adoptability of PEB in the place of Conventional Steel Building (CSB) design concept resulted in many advantages, including economy and easier fabrication. In this study, an industrial structure (Ware House) is analyzed and designed according to the Indian standards, IS 800-1984, IS 800-2007 and also by referring MBMA-96 and AISC-89. The economy of the structure is discussed in terms of its weight comparison, between Indian codes (IS800-1984, IS800-2007) & American code (MBMA-96), & between Indian codes (IS800-1984, IS800-2007).

Keywords—AISC, Crane Beam, MBMA, Pre-Engineered-Buildings, Staad Pro, Utilization Ratio.

INTRODUCTION

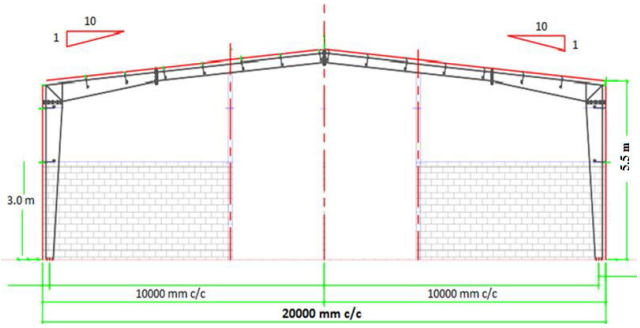
Steel industry is growing rapidly in almost all the parts of the world. The use of steel structures is not only economical but also eco friendly at the time when there is a threat of global warming. Here, "economical" word is stated considering time and cost. Time being the most important aspect, steel structures (Pre- fabricated) is built in very short period and one such example is Pre Engineered Buildings (PEB). Pre Engineered buildings are nothing but steel buildings in which excess steel is avoided by tapering the sections as per the bending moment's requirement. One may think about its possibility, but it's a fact many people are not aware about Pre Engineered Buildings. If we go for regular steel structures, time frame will be more, and also cost will be more, and both together i.e. time and cost, makes it uneconomical. Thus in pre Engineered buildings, the total design is done in the factory, and as per the design, members are Pre-fabricated and then transported to the site where they are erected in a time less than 6 to 8 weeks.
The structural performance of these buildings is well understood and, for the most part, adequate code provisions are currently in place to ensure satisfactory behavior in high winds. Steel structures also have much better strength-to-weight ratios than RCC and they also can be easily dismantled. Pre Engineered Buildings have bolted connections and hence can also be reused after dismantling. Thus, Pre Engineered buildings can be shifted and/or expanded as per the requirements in future. In this paper, a comparison will be made between Pre Engineered buildings and conventional steel structures.

Pre-Engineered Buildings

Pre-Engineered Building concept involves the steel building prefabricated systems which are predesigned. 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

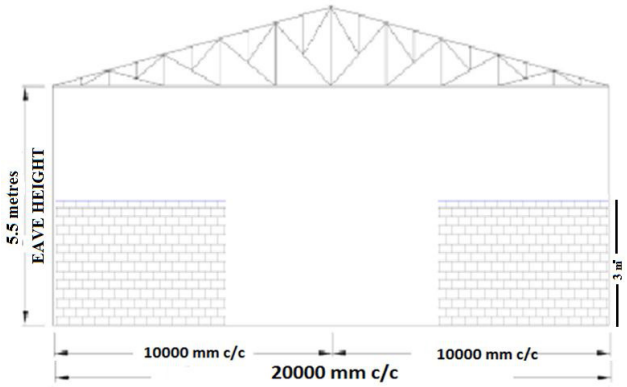
proficiently complied with a wide range of structural and aesthetic design requirements. The basis of the PEB concept lies in providing the section at a location only according to the requirement at that spot. The sections can be varying throughout the length according to the bending moment diagram. 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.



Single Frame of a Pre Engineered Building

Conventional Steel Buildings

Conventional steel buildings (CSB) 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. Standard hot-rolled sections are usually used for the truss elements along with gusset plates. The CSB frame of the structure considered in the study is as shown in Figure.



Single Frame of a Conventional Steel Building

Advantages of PEB

Following are some of the advantages Pre-Engineered building structure-

a) **Construction Time**: Buildings are generally constructed in just 6 to 8 weeks after approval of drawings. PEB will thus reduce total construction time of the project by at least 40%. This allows faster occupancy and earlier realization of revenue. This is one of the main advantages of using Pre-engineered building.

b) **Lower Cost:** Because of systems approach, considerable saving is achieved in design, manufacturing and erection cost.

c) **Flexibility of Expansion:** As discussed earlier, these can be easily expanded in length by adding additional bays. Also expansion in width and height is possible by pre designing for future expansion.

d) **Large Clear Spans**: Buildings can be supplied to around 90m clear spans. This is one of the most

important advantages of PEB giving column free space.

e) **Quality Control:** Buildings are manufactured completely in the factory under controlled conditions, and hence the quality can be assured.

f) **Low Maintenance:** PEB Buildings have high quality paint systems for cladding and steel to suit ambient conditions at the site, which in turn gives long durability and low maintenance coats.

g) **Energy Efficient Roofing:** Buildings are supplied with polyurethane insulated panels or fiberglass blankets insulation to achieve required "U" values (overall heat transfer coefficient).

h) **Erection**: Steel members are brought to site in CKD conditions, thereby avoiding cutting and welding at site. As PEB sections are lighter in weight, the small members can be very easily assembled, bolted and raised with the help of cranes. This allows very fast construction and reduces wastage and labor requirement.

From the numerous advantages of Pre-engineered building, in the present study, the points b and d are considered for the study, i.e. to save the steel, reducing cost and providing large clear spans, while all the other points are self explanatory.

Pre-Engineered Buildings by Staad Pro

The power tool for computerized structural engineering STAAD Pro is the most popular structural engineering software product for 3D model generation, analysis and multi-material design. It has an intuitive, user-friendly, visualization tools, powerful analysis and design facilities and seamless integration to several other modeling and design software products. The software is fully compatible with all Windows operating systems. For static or dynamic analysis of Pre-engineered building, STAAD Pro has been the choice of design professionals around the world for their specific analysis needs.

Structural Analysis and Design

STAAD Pro software can be used for analyzing and designing of the pre-engineered buildings. It gives the Bending Moment, Axial Forces, Shear Forces, Torsion, Beam Stresses of a steel structure so that the design can be done using tapered sections and check for the safety.

Static Analysis

1. 2D/3D Analysis based on state-of-the-art Matrix method to handle extremely large job.
2. Rafter, Column, Tapered Sections, Rigid Frames, Purlins, Eave Height.
3. Full/Partial Moment Releases.
4. Member Offset Specification.
5. Fixed, Pinned and Spring Supports with Releases. Also inclined Supports.

Dynamic / Seismic Analysis

1. Mass modeling, Extraction of Frequency and Mode shapes.
2. Response Spectrum , Time History Analysis.
3. Modal Damping Ratio for Individual Models.
4. Harmonic Load Generator.
5. Combination of Dynamic forces with Static loading for subsequent design.

Secondary Analysis

1. Forces and Displacement at sections between nodes.
2. Maximum and Minimum force Envelopes.
3. Load Types and Load Generation:
4. Loading for Joints, Members/Elements including Concentrated, Uniform, Linear, Trapezoidal, Temperature, Strain, Support Displacement, Prestressed and Fixed-end Loads.
5. Global, Local and Projected Loading Directions.
6. Automatic Wind Load Generation.

LOADS

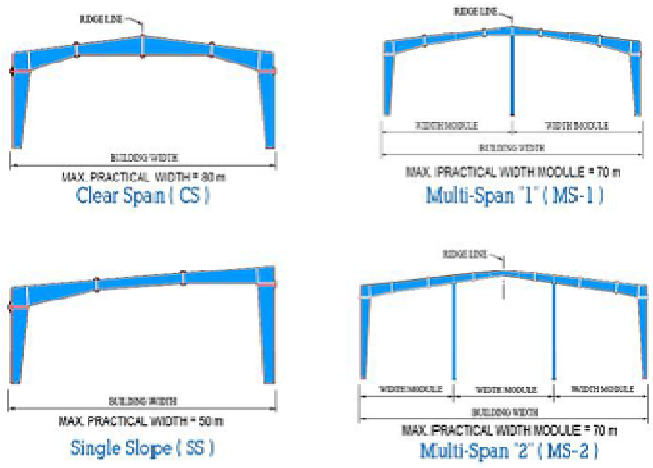
The loads acting on the structure includes dead load, live load, snow load, wind load, earthquake load, crane load, erection load, accidental load, etc. The load calculation for the structure can be carried out in accordance with IS : 875 – 1987 and IS : 1893 - 2000. For this structure wind load is critical than earthquake load. Hence, load combinations of

dead load, live load, crane load and wind load are incorporated for design.

Load Combinations Load combinations can be adopted according to IS: 800 – 2007. Sixteen different load combinations adopted for the analysis of the frame in both the concepts and are listed as follows:

1)	1.5DL+1.5LL+1.5CL1
2)	1.5DL+1.5LL+1.5CL2
3)	1.5DL+1.5LL+1.5CL3
4)	1.5DL+1.5LL+1.5CL4
5)	1.5DL+1.5WL(θ=0+)
6)	1.5DL+1.5WL(θ=90+)
7)	1.5DL+1.5WL(θ=0-)
8)	1.5DL+1.5WL(θ=90-)
9)	DL+LL+CL1
10)	DL+LL+CL2
11)	DL+LL+CL3
12)	DL+LL+CL4
13)	DL+WL(θ=0+)
14)	DL+WL(θ=90+)
15)	DL+WL(θ=0-)
16)	DL+WL(θ=90-)

Typical Pre-engineered steel frames



Pre Engineered Building types

CONCLUSION

This paper effectively conveys that PEB structures can be easily designed by simple design procedures in accordance with country standards. In light of the study, it can be concluded that PEB structures are more advantageous than CSB structures in terms of cost effectiveness, quality control speed in construction and simplicity in erection. The paper also imparts simple and economical ideas on preliminary design concepts of PEBs. The concept depicted is helpful in understanding the design procedure of PEB concept.

REFERENCES

[1] Dr. N. Subramanian, 'Design of steel structures' .
[2] Dr. N. Subramanian (2008), "Pre-engineered Buildings Selection of Framing System, Roofing and Wall Materials", The Masterbuilder, pp. 48-6.
[3] Indian Standard: 1893 (Part1); 2002. Criteria for Earthquake Resistant Design Structures: New Delhi: BIS; 2002.
[4] IS 875: Part 1 to 5 Code Of Practice For Design Loads (Other Than Earthquake) For Buildings and Structures,1st Revision, New Delhi: BIS.
[5] Indian Standard: 801 – 1975; Code Of Practice For Use Of Cold-Formed Light Gauge Steel Structural Member's In General Building Construction, 1st Revision, New Delhi: BIS.
[6] Indian Standard: 800 – 2007; General Construction in Steel — Code of Practice; 3rd S Revision, New Delhi: BIS.
[7] Indian Standard: 800 – 1984; Code of Practice for General Construction, In Steel; 1st Revision, New Delhi: BIS.
[8] MBMA: Metal Building Manufacturers Association-2006, Metal Building Systems Manual.
[9] AISC: American Institute of Steel Construction-1989, Manual of Steel Construction, Allowable Stress Design.
[10] Technical Manual, Zamil Steel, Saudi Arabia, Pre-Engineered Buildings Division.