ISSN 2348 – 7968

Comparison of Pre Engineering Building and Steel Building with Cost and Time Effectiveness.

Milind Bhojkar[1],MilindDarade[2]

[1] Post Graduation Student Civil Engineering Department, SavetribaiPhule Pune University
Dr. D Y Patil School of Engineering,Lohegaon
Pune, Maharashtra412105, India

[2]Assistant Professor Civil Engineering Department, SavetribaiPhule Pune University
Dr. D Y Patil School of Engineering,Lohegaon
Pune, Maharashtra412105, India

Abstract

Pre Engineering building means steel building system which is predesigned and prefabricated. In this study, know the Cost effective tool which helps to utilize the optimum cross-sections of steel. In this study the various concepts regarding the pre engineering building and its various applications. In this we know the structural member and component used for pre engineering building. There are various type of components like; Primary components, Secondary components, Sheeting etc. In this study we find out that Pre engineering building is more economical than conventional steel building for low rise building.

Keywords:Pre engineering building, Structural components, Metal Building Associations (MBMA), Conventional steel building.

1. 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).

Although PEB systems are extensively used in industrial and many other non residential constructions worldwide, it is relatively a new concept in India. These concepts were introduced to the Indian markets lately in the late 1990’s with the opening up of the economy and a number of multi nationals setting up their projects.

Pre engineered buildings are generally low rise buildings however the maximum eave height can go up to 25 to 30 meters. Low rise buildings are ideal for Offices, houses, showrooms, shop fronts etc. The application of pre engineered buildings concept to low rise buildings is very economical and speedy. Buildings can be constructed in less than half the normal time especially when complemented with the other engineered sub systems. PEB building cost is 30% lesser than the cost of CSB structure.

2. Background

Technological improvement over the year has contributed immensely to the enhancement of quality of life through various new products and services. One such revolution was the pre-engineered buildings. Through its origin can be traced back to 1960’s its potential has been felt only during the recent years. This was mainly due to the development in technology, which helped in computerizing the design.

Though initially only off the shelf products were available in these configurations aided by the technological development tailor made solutions are also made using this technology in very short durations. A recent survey by the Metal Building Associations (MBMA) shows that about 60% of the nonresidential low rises building in USA are pre-engineered buildings.

3. Methodology

For accomplishing this project, following points will be considered Collection of the information regarding conventional methods of building technologies and the limitations associated with it. Study various concepts of pre-engineered building and its various applications.

Recent innovations and substitute techniques that are implemented for pre-engineered building will be highlighted.

Cost-effectiveness of pre-engineered building over conventional buildings will be formulated.

4. Structural Components of PEB

4.1. Primary Component:

4.1.1. Main framing:

Main framing basically includes the rigid steel frame of the building. The PEB rigid frame comprises of tapered column and tapered rafters. Splice plates are welded to the ends of the tapered section. The frame is erected by bolting the splice plates of connecting section together.

Built up I section to build primary structural framing members (Column and Rafters).

4.1.2. Column:

The main purpose of the column is to transfer the vertical loads to the foundation. However a part of the horizontal action is also transferred through the columns.

Basically in pre engineering building columns are made up of I section which are most economical than others

4.1.3. Rafter:

A rafter is one of a series of sloped structural member that extended from the ridge to the wall plate down slope perimeter and that are designed to support the roof deck and its associated loads.

4.2. Secondary Components:

Purlins, Girts and Eave struts are secondary structural members used as support to walls and roof panels. Purlins and girts shall be cold-formed “Z” sections with stiffened flanges. Flange stiffeners shall be sized to comply with requirements.

4.2.1. Purlins and Girts:

Purlins and girts shall be roll formed Z section, 200 mm deep with 64 mm flanges shall have a 16 mm stiffening lip formed at 45 to the flange. Purlins and Girts shall be cold-formed “Z” sections with stiffness flange. They shall be pre punched at the factory to provide for field bolting to the rigid frames. Girts are beams subjected to unsymmetrical bending. These support vertical dead load from the sliding and horizontal wind loads. Usually these are unequal angle sections connected with the longer leg to withstand the effect of wind.

4.2.2. Eave Struts:

Eave struts shall be unequal flange cold-formed “C” sections. Eave struts are 200 mm deep with a 104 mm wide top flange, a 118 mm wide bottom flange; both are formed parallel to the roof slope.

4.2.3. Bracings:

The cable bracing is a primary member that ensures the stability of the building against forces in the longitudinal direction such as wind, cranes and earthquakes.

4.3. Sheeting or Cladding

The sheets used in the construction of pre engineering buildings are composed of the following;

Base metal of either galvalume coating steel conforming to ASTM a 792 M grade 345B or aluminums conforming to ASTM B 209M. The sheeting material is cold-rolled steel, high tensile 550 MPA yield stress, with hot dip metallic coating of galvalume sheet.

4.4. Framing system:

4.4.1. Clear Span (CS):

It is the span length between two columns without any obstruction. It has split beams with ridge line at the peak or centre of the building. The maximum practical width or span is up to 90 meters, but it can also be extended up to 150 meters in case of Aircraft Hangars.

4.4.2. Arched Clear Span:

The column is an RF column while the Rafter is curved. It has no ridge line and peak. The curved roof rafter is used in for aesthetic look. The maximum practical is up to 90meters, but can be extended to 120 meters.

4.4.3. Multi Span (MS1):

The Multi spans (MS1) are those which have more than 1 span. The intermediate column is used for the clear span in which width of each span is called width module.

4.4.4. Arched Multi Span (AMS1):

Arched multi span has frame column and a curved Rafter with one intermediate column. It has width module for the entire span. The multi spans can be extended up to AMS1, AMS2 and AMS3 etc.

4.4.5. Multi Span 2 (MS2):

The Multi Span (MS2) has more than one intermediate span. It has three width modules with one ridge line.

4.4.6. Single Slope:

It has two columns with different heights having Roof sloping on both the columns.

Pre-engineered building system is unmatched in its speed and value. Buildings, to suit specific needs, are designed, engineered, manufactured and shipped in less than 8 weeks * and at a cost that is as low as 30 percent of the cost of conventional steel buildings (when compared to speed of occupancy and space usability). Clear spans up to 93 meters wide and eave heights as high as 30 meters are possible.

The Merit of Pre-Engineered Buildings

- ☐ Low Initial Cost
- ☐ Superior Quality
- ☐ Fast Project Construction cycle time
- ☐ Functional Versatility
- ☐ Architectural Flexibility
- ☐ Low Maintenance & Operating Costs
- ☐ Large unobstructed space utility
- ☐ Clear spans Up to 90 M
- ☐ Easy to expandable on all Sides

The Following building configurations are significantly affecting the building Stability and Cost:-

1. Main Frame configuration (orientation, type, roof slope , eave height)
2. Roof purlins spacing
3. Wall girts (connection & spacing)
4. End wall system
5. Expansion joints
6. Bay spacing
7. Bracing systems arrangement
8. Mezzanine floor beams/columns (orientation & spacing)
9. Crane systems

The various types of Main frame for the basic supporting component in the PEB systems; main frames provide the vertical support for the whole building plus providing the lateral stability for the building in its direction while lateral stability in the other direction is usually achieved by a bracing system. The width of the building is defined as the out-to-out dimensions of girts/eave struts and these extents define the side wall steel lines. Eave height is the height measured from bottom of the column base plate to top of the eave strut.

5. Conventional Steel Building

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.

6. Field Application

The field applications of pre engineering buildings are as follows,

I. Factory building
II. Workshops
III. Showroom
IV. School
V. Industrial sheds
VI. Cold storage
VII. Office building
VIII. Community center
IX. Metro/Railway station
X. Petrol pump
XI. Parking
XII. Ware house
XIII. Sport complex
XIV. Distribution center
XV. Mall

7. Expected Outcomes

The output of this project will help construction manager to

a) Understand the concept of pre-engineered building and the advantages over conventional buildings.

b) Various aspects related to design and modeling of the structure.

c) Cost effectiveness of pre-engineered building over conventional buildings.
d) PEB roof structure is almost 26% lighter than Conventional Steel Building.
e) PEB building cost is 30% lesser than the cost of CSB structure.

References

1. Aijaz Ahmad Zende, A. V. Kulkarni, AslamHutagi, “Comparative Study of Analysis and Design of Pre-Engineered-Buildings and Conventional Frames”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Vol. 5, Issue 1, Jan. - Feb. 2013, pp. 32-43. 8
2. C. M. Meera, “Pre-Engineered Building Design Of An Industrial Warehouse”, International Journal of Engineering Sciences & Emerging Technologies, Vol. 5, Issue 2, June 2013,
pp. 75-82.
3. G. SaiKiran, A. KailasaRao, R. Pradeep Kumar, “Comparison of Design Procedures for Pre Engineering Buildings (PEB): A Case Study”, International Journal of Civil, Architectural, Structural and Construction Engineering, Vol.8, No: 4, 2014, pp. 480-484.
4.Pradeep V & Papa Rao G, “Comparative Study of Pre Engineered and Conventional Industrial Building”, International Journal of Engineering Trends and Technology, Vol.9, No. 1, Mar 2014, pp.1-6.
5. SagarWankhade& P. S. Pajgade, “Review Paper on Comparison of Conventional Steel Building & Pre-Engineering Building”, International Journal of Research in Advent Technology, Vol.2, No.5, May 2014, pp. 271-276.