

Comparative Study of Conventional Steel Building and Pre-Engineered Building to be used as an Industrial Shed

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ABSTRACT

The paper mainly focuses on the advantages of pre-engineered buildings over conventionally designed buildings. The different fields of comparison mainly constitute its cost effectiveness, time saving, future scope, subtleness and economy of pre-engineered buildings over conventionally engineered buildings and its importance in developing nations like India. It's a case study for Industrial Shed based on the review and various case studies which shows their experimental and analytical studies carried out in this field. The result shows that these structures are economical, energy efficient and flexible in design.

Keywords: Conventional Steel Building and Pre-Engineered Building

I. INTRODUCTION

Analyzing the various types of industrial buildings on the basis of type of roof truss and the pre-engineered structure i.e. Pre-engineered Building by going through various case studies so far in this subject. Through this case study we are going to present a comparison between best type of Industrial Building classified on the basis of its roof truss and the Pre-engineered Building.

Industrial building is generally classified as braced and unbraced framed structures. In braced buildings, the trusses rest on column with hinges and stability is provided by bracings in three mutually perpendicular planes. The basic function of a bracing is to transfer horizontal loads from frames i.e. loads like wind or earth quake or horizontal surge due to acceleration and breaking of travelling cranes over gantry girders to the foundation. The longitudinal bracing provides stability in longitudinal direction on each longitudinal end provides. The gable bracing provides stability in the lateral direction. The tie bracing at the bottom chord level transfers the lateral loads (due to wind or earthquake) of truss to the end gable bracings and similarly the rafter bracing and the bracing system at bottom chords work. Whereas the purlin acts as the lateral bracings to the compression chords of the roof trusses which increases the compression chord's design strength.

The unbraced frames such as portal frames are the most common type of frames used in industrial building construction because of its simple design, economy, easy and fast erection. This type of frames provides the large utility area with maximum column free space. In such type of structures the inner columns are eliminated, requires considerably less

Foundation and its area, the valley gutters and the internal drainage too. The portal frame is a rigid jointed plane made from hot rolled or cold rolled sections, supporting roofing and side cladding. Its typical span ranges from 30-40 m and its bay spacing could be 4.5-10 m.

The Pre-engineered Building is the combination of pre-casted and pre-fabricated structures. These are generally ideal for offices, houses, showrooms, shop fronts etc. The fast erection and economy are its importance. It could be supplied up to around 80m of clear span. 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 together they make 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.

II. LITERATURE REVIEW

1. Shrunkhal V Bhagatkar, Farman Iqbal Shaikh, Bhanu Prakash Gupta and Deepak Kharta (March 2015) on "A Study On Pre-Engineered Building – A Construction Technique". *International Journal of Engineering Research and Applications (IJERA)*, Vol. 5, Issue 3, (Part -2) pp.05-09

They observed that Pre-engineered Building (PEB) is a suitable Construction technique for developing countries. It is a combination of precast & prefabricated structures. Pre-engineered buildings are generally low rise buildings which are ideal for

offices, houses, showrooms, shop fronts etc. PEB will reduce total construction time of the project by at least 50%. This also allows faster occupancy and earlier realization of revenue. Buildings can be supplied with around 80m clear spans. Steel is 100% recyclable and is the most recycled material in the world. Thus, each ton of recycled steel saves 2,500 pounds of iron ore and approximately 1,000 pounds of coal. 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. Although PEB systems are extensively used in industrial and many other nonresidential constructions worldwide, it is relatively a new concept in India. They reviewed that PEB structures can be easily designed through simple design procedures in accordance with country standards, which is energy efficient, speedy in construction, saves cost, sustainable and most important it's reliable as compared to conventional buildings.

2. Milind Bhojkar and Milind Darade (December 2014) on "Comparison of Pre Engineering Building and Steel Building with Cost and Time Effectiveness". International Journal of Innovative Science, Engineering & Technology (IJSET), Vol. 1 Issue 10

They observed that, the Pre-engineered building system is unmatched in its speed and value and that's why they are said to be economical for modern construction. The erection time of the pre-engineered building is 50% of conventional steel building or less than 8 weeks. Clear spans up to 90 meters wide (could be extended up to 150 m in case of Aircraft hangers) and eave heights as high as 30 meters are possible. The cost may be approximate 30% of Conventional steel Building only. The various types of Main frame for the basic supporting component in the PEB systems; main frames provide the vertical support for longitudinal and lateral stability for the building in its direction while lateral stability in the other direction is could be achieved by application of bracing system. The Pre-engineered buildings could be high rise buildings 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. Standard hot-rolled sections are usually used for the truss elements along with gusset plates.

3. G. Sai Kiran, A. Kailasa Rao, R. Pradeep Kumar (August 2014) on "Comparison of Design Procedures for Pre Engineering Buildings (PEB): A Case Study". International Journal of Civil, Architectural, Structural & Construction Engineering (IJCASCE), Volume 8, No. 4

They observed that in recent years, the introduction of Pre Engineered Building (PEB) concept in the design of structures has helped in optimizing design. 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. In this study, a structure with length 187m,width 40m,with clear height 8m and having R-Slope 1:10,isconsidered to carry out analysis& design for 2D frames (End frame, frame without crane and frame with 3 module cranes). The economy of the structure as they discussed is in terms of its weight comparison, between Indian codes (IS800-1984, IS800-2007) & American code (MBMA-96), & between Indian codes (IS800-1984, IS800-2007).

4. Vrushali Bahadure, Prof. R.V.R.K. Prasad (January -February 2013) on "Comparison between Design and Analysis of Various Configuration of Industrial Sheds". International Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 1, pp.1565-1568

They observed that in the comparison between various configurations of industrial shed using various types of truss type which gave them the suitable shed for the industrial shed and which is more effective in strength and economical point of view. Design of various types of industrial frame by using STAAD-Pro 2007 software gave them the total design and suitability. A truss is essentially a triangulated system of (usually) straight interconnected structural elements; it is sometimes referred as an open web girder. The individual elements are connected at nodes; the connections are often assumed to be nominally pinned. The external forces applied to the system and the reactions at the supports are generally applied at the nodes. When all the members and applied forces are in a same plane, the system is a plane or 2D truss. They had analyzed three types of industrial shed using three types of truss which were portal frame type, A-type and saw tooth type by using STAAD-Pro from which they got

steel required, strength and economy of different sheds then they compared the respective results obtained found that Saw tooth type industrial shed is 65% more economical than portal and A-type frames which means it is economically good. They also compared Pre-engineered industrial shed with all above three and then went to the conclusion, which one is the best industrial shed economically and strength point of view and that was Pre-engineered industrial shed.

III. GAP IN LITERATURES

In the above research publications the Pre-Engineered Buildings were found to be more economical than Conventional Steel Buildings, especially for low-rise Buildings spanning up to 60m with eave height up to 30m. But for the low span or High-rise and the Multistorey Buildings the conventional Steel Building design were far better and there is the need of developing a new design method for PEB for respective very small or wide span and High Rise Building to achieve the economical construction of Industrial Building in the terms of cost and erection.

IV. INDUSTRIAL STEEL BUILDING

The Industrial Steel Building is a steel framed structure that could be used as warehouses, factories, offices, workshops, gas stations, showrooms, vehicle parking sheds, aircraft hangars, metro stations, recreational buildings, indoor stadium roofs, outdoor stadium canopies, railway platform shelters, bridges, auditoriums, etc. The Industrial Steel Building is classified as Braced Frames, Unbraced Frames, and Pre-Engineered Building.

1. Braced Frames

In braced buildings, the trusses rest on column with hinges and stability is provided by bracings in three mutually perpendicular planes. The basic function of a bracing is to transfer horizontal loads from frames i.e. loads like wind or earth quake or horizontal surge due to acceleration and breaking of travelling cranes over gantry girders to the foundation. The longitudinal bracing provides stability in longitudinal direction on each longitudinal end provides. The gable bracing provides stability in the lateral direction. The tie bracing at the bottom chord level transfer the lateral loads (due to wind or earthquake) of truss to the end gable bracings and similarly the rafter bracing and the bracing system at bottom chords work. Whereas the purlin acts as the lateral bracings to the compression chords of the roof trusses which increases the compression chord's design strength.

2. Unbraced frames

The unbraced frames as portal frames are the most common type of frames used in industrial building construction because of its simple design, economy, easy and fast erection. This type of frames provides the large utility area with maximum column free space. In such type of structures the inner columns are eliminated, requires considerably less foundation and its area, the valley gutters and the internal drainage too. The portal frame is a rigid jointed plane made from hot rolled or cold rolled sections, supporting roofing and side cladding. Its typical span ranges from 30-40 m and its bay spacing could be 4.5-10 m.

3. Pre-Engineered Building:

Pre-Engineered Building is a metal building that consists of light gauge metal standing seam roof panels on steel purlins spanning between rigid frames with light gauge metal wall cladding. In other words, it has a much greater vertical and horizontal deflection. Pre-engineered buildings are generally low rise buildings which are ideal for offices, houses, showrooms, shop fronts etc. 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.

V. COMPARISON BETWEEN THE CONVENTIONAL STEEL BUILDING AND PRE-ENGINEERED BUILDING

Note: The Saw-tooth type truss is taken into consideration as best suiting Conventional Steel Building analogous to Pre-Engineered Building.

Properties	Conventional Steel Building	Pre-Engineered Building
Design	Requires heavy detailing with modifications	Requires specialized computer design
Foundation	Widespread foundations are required	Easy to manage and light design work
Structural weight	Conventional steel section are used which are heavier than pre-engineered section	Efficient use of steel at different components of section which reduces the weight from 20% to 40 %
Erection	Sections are need to be modified as per site conditions	Pre casted sections are designed as per

		the site necessity
Erection cost and time	It takes time up to 10-12 weeks for erection and expensive as compared to PEB	Over all Erection time is less than 6 weeks which makes it cost effective
Overhead space	Use of standard sections limits the overhead space	It may vary according to convenience
Inside space	Large spans CSB with interior columns reduces the inside space.	Interior columns are completely eliminated due to which the inside space increases
Aesthetic	Average in terms of aesthetic experience	Aesthetically good
Seismic resistance	Rigid and heavy structural members do not perform well against the seismic reactions	Light structural members have the ability to perform well against seismic reactions
Safety and responsibility	Multiple supplier units results in inefficient management of building materials and sections	Order is fulfilled by a single supplier leads to better management of materials and sections
Performance	Faulty connections may leads to poor performance	Higher performance due to efficient bracing system
Economy	Economical in terms of cost but uneconomical in terms of erection time	Economical in terms of erection time and economy
Demount ability	May take more time for demounting	Less time required for demounting

VI. Comment

As per the current case study if the Industrial Steel Building is designed for 70m x 25m x 13m for a particular site as per site requirement and the respective loading conditions as per the IS codes by using either portal frame truss, A-type frame truss, saw-tooth type truss or pre-engineered sections then the saw tooth type truss framed structure is found to be 60% more cost effective than other conventional type of trusses and in comparison to this the pre-engineered building is found to be more 30% lighter in weight, economical, strength full, highly efficient with minimum chances of error etc. and best suiting

structure spanning from 20m to 80m for single storey building.

VII. Conclusion

Hence the pre-engineered buildings are more advantageous over conventionally designed buildings in terms of cost effectiveness, time saving, future scope, subtleness and economy. This paper of comparative study between conventional and pre-engineered building shows their experimental and analytical studies carried out in this field. The results show that the steel structures are far more economical energy efficient and flexible in design than other type of structures for industrial use.

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