PARAMETRIC STUDY OF PRE-ENGINNERING BUILDING WITH SPECIAL REFERENCE TO INDIAN STANDARD AND INTERNATIONAL STANDARD

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Abstract: *Analysis and design of industrial structure Pre-Engineered Building according to the Indian standards & International Standards. Analysis and design of these building frames is carried out using Staad-Pro software.*
A model for Pre-Engineered Building and Conventional Steel Building is considered and a parametric study is carried out to access the performance of the models in terms of weight comparison, cost comparison and time comparison. Design of the structure is being done in Staad Pro software and the same is then compared with conventional type, in terms of Different Parameters.

Keywords: ***Pre-Engineered Building, Convent Steel Building,***

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1. INTRODUCTION

1.1 General

Steel is the material of choice for design because it is ductile and flexible. Steel members have high strength per unit weight and the properties of the steel members mostly do not change with time. In recent years, the introduction of Pre-Engineered Building (PEB) design of structures has helped in optimized design. The construction of PEB in the place of Conventional Steel Building (CSB) design concept resulted in many advantages as the members are design as per bending moment diagram and thus reducing the material requirement. This methodology is versatile not only due to its quality pre designing and prefabrication, but also due to its light weight and economical construction. 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. This concept has many advantages over the Conventional Steel Building (CSB) concept of buildings with roof truss. These sections may differ along the length according to the bending moment diagram above. The use of optimal section leads to saving steel usage leading to reduction in the overall cost. Both Pre-engineered and conventional buildings have their own advantages. Choosing the right kind of building structure depends on design requirements and materials your project demands. One must consider budget, safety, durability and maintenance before arriving at a decision.

1.1.1 Categories Of Building

Over the past decade a healthy growth and increased demand has been seen in the construction of residential buildings, institutional buildings, commercial buildings and infrastructure sectors. The earlier period structures were much more simple and unsophisticated compared to the modern day structures. The major modification seen in today's structures is that they are taller loftier and thinner compared to that of olden days structures. The construction of structures has seen a, continuous economic competition between concrete, steel and other materials.

1. Reinforced Concrete Structures: These are the structures in which steel bars are used to improve the qualities of concrete. Over the recent years it has been used as a cost-effective construction material in various forms. It is possible to construct these structures with the help of local labours as cement; fine aggregates, coarse aggregates, water etc are widely accessible.

2. Conventional Steel Structures: In today's world, steel is bringing elegance, artistry and is functioning in endless ways contributing to new solutions for the construction of formidable structures, which were once unthinkable. Steel offers speedy construction right from the start. Due to its important characteristics like ductility, flexibility etc, steel is been widely used in the construction industry. It bends under the application of heavy loads rather than undergoing crushing and crumbling. Due to its strength, less rate, stability, flexibility and recyclability, it makes a great choice to use steel in construction. It is also seen that steel has some reserve strength in them. The conventional steel buildings are stable. Usually hot-rolled structural members are used in these buildings. Here the members are fabricated in factories and then transported to the site. The changes can be made during the erection by welding and cutting process. Normally trusses are used in this system. Conventional buildings are traditional buildings consisting of steel, brick and cement sections. These are fabricated and assembled at the site. Conventional building method involves welding and cutting, which is done largely at the construction sites. A conventional building is designed from scratch, requiring substantial designing inputs and detailing of the intricacies done by consultants.

3. Pre-Engineered Buildings [PEB]: PEB Steel welcomes technical inquiries from architects and consultants. We are prepared to assist you in writing specifications for pre-engineered steel buildings and to recommend suitable solutions to your building requirements. No Limit to Architectural Imagination Many impressive architectural projects have used pre-engineered steel buildings. Nowhere has this been more evident than in the USA. Although this trend is developing in Asia and Africa, still not many architects on these continents have fully realized the economy, versatility and aesthetic features of pre-engineered steel buildings these are produced in the plant, itself. Here according to the requirements of the customer the manufacturing of the members is done. The components are made in completely ready condition for transportation. These are then sent to the site and then the erection process starts. The manufacturing process doesn't takes place at the site. The pre-engineered buildings are normally constructed for office, shop fronts, ware houses etc. Here the extra amount of steel is avoided because the sections are tapered according to the bending moment diagram. The pre-engineered building technology, which entered the Indian construction area during the late nineties has over a period of time gained widespread acceptance among the end users and is steadily making inroads in the construction and infrastructure projects across the country. This is largely due to the fact that PEB based construction technique is offering the most innovative, hi-tech and quicker methods of construction ensuring efficient, cost effectiveness and speedy completion of projects. Pre-engineered buildings (PEBs) use a predetermined inventory of raw materials that has proven over time to satisfy a wide range of structural and aesthetic design requirements. This flexibility allows PEBs to fulfil an almost unlimited range of building configurations, custom designs, requirements and applications. The pre-engineered steel building is a building shell utilizing three distinct product categories as: Built-up "I" shaped primary structural framing members (columns and rafters). Cold-formed "Z" and "C" shaped secondary structural members (roof purlin, eave struts and wall grits) Refer fig 1.2. Roll formed profiled sheeting (roof and wall panels). Pre-engineered buildings are built mostly in steel and are factory made, shipped to site and bolted together. The rigid framing completes the roof, beams and columns. Then other exterior panels are assembled, along with structural elements and accessories. Pre-engineered Buildings revolutionized the construction market with its built-up sections in place of conventional hot-rolled sections. Larger column-free area sets PEBs apart, compared to its conventional counterparts.

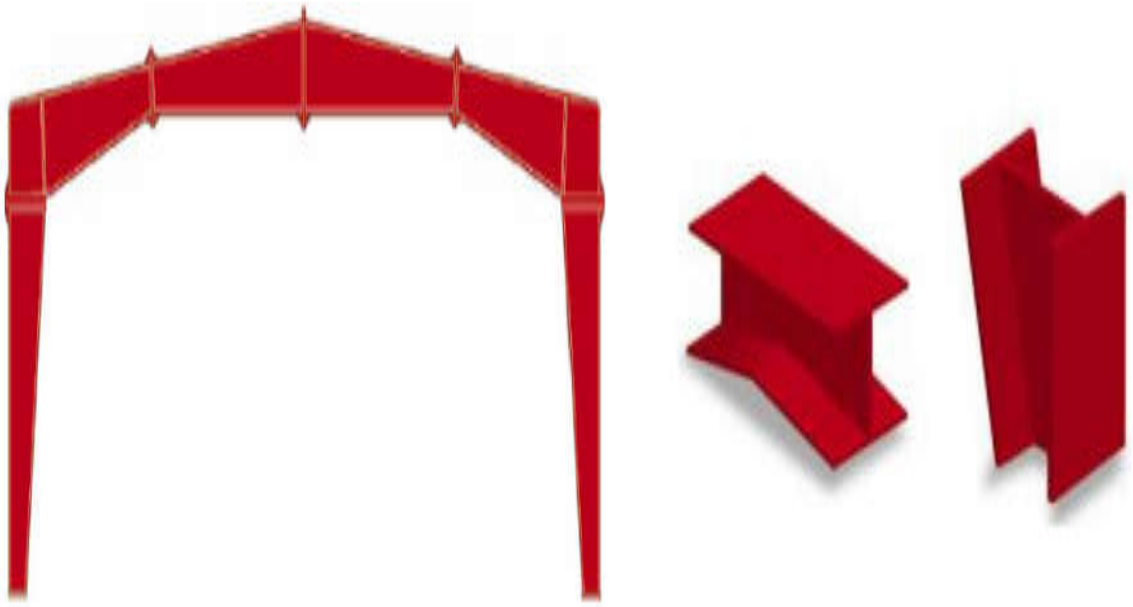

Figure 1. Built-Up "I" Shaped Primary Structural Framing Members.

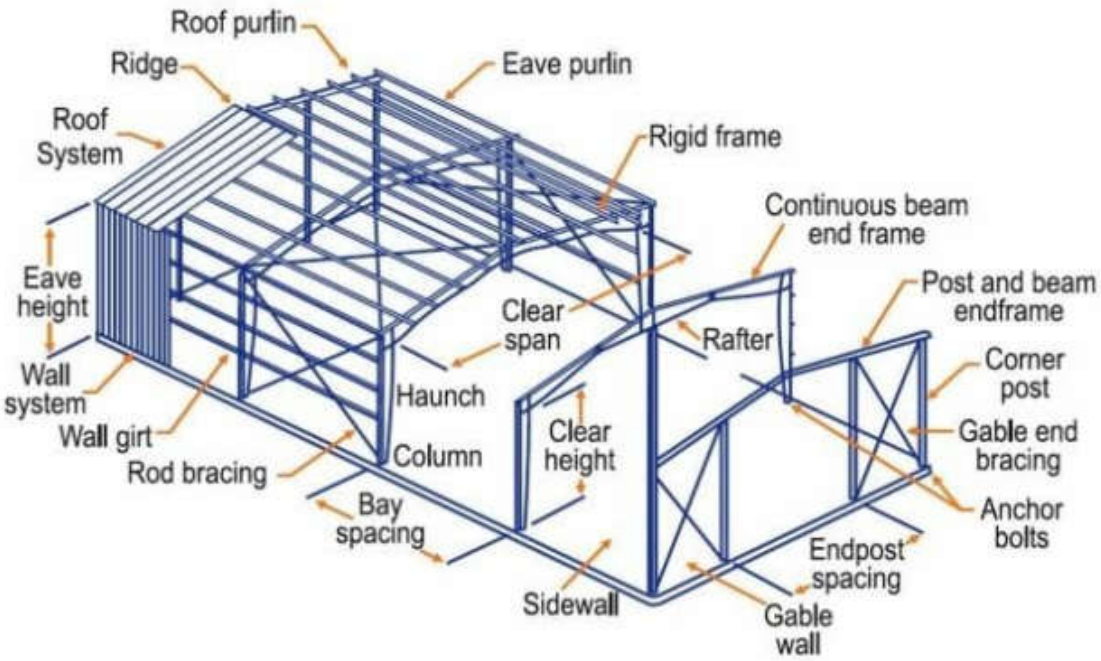

Figure 02. PEB Steel Structure

Fig.No.03. Conventional Steel Structure

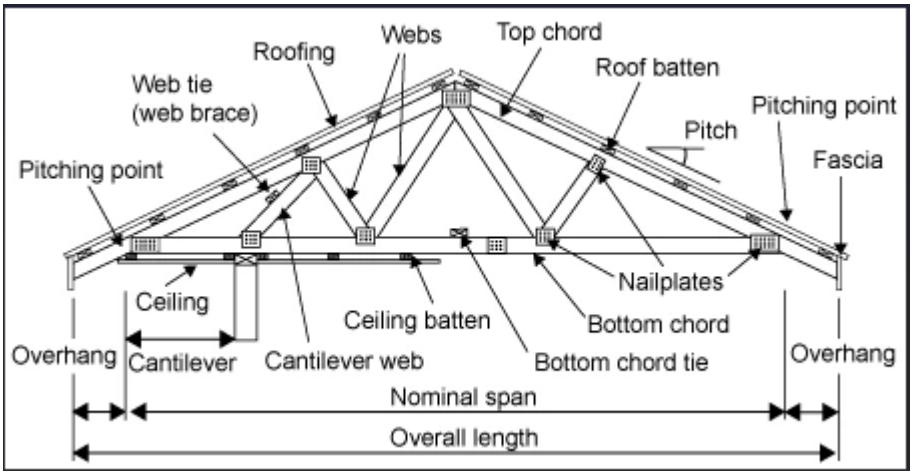

Fig.No.04. Component parts of Conventional Steel Structure

1.2 Advantages

1.2.1 Advantages of PEB:

Design: PEB's are mainly formed of standard sections and connections; the design time is significantly reduced. Specialized computer analysis and design programs optimize material require. Drafting also computerized using standard details that minimizes project custom details. The low-weight flexible frames offer higher resistance to seismic forces.

Lower Cost: Due to the systems approach, there is a significant saving in design, manufacturing and site erection cost. The structural elements are shaped to follow the stress diagram of the member, thus reducing weight, cost and load to foundations. The secondary members and cladding nest together reducing transportation cost. The overall price per square meter may be reduced as much as 30% lower than conventional steel.

Foundations: Pre-engineered Buildings are about 30% lighter than the conventional steel structures. Hence, the foundations are of simple design, easy to construct and lighter weights.

Erection: Since all the connections of the different components are standard, the erection time is faster.

Flexibility of Expansion: Buildings can be easily expanded in length by adding additional bays. Also, expansion in width and height is possible by pre-designing for future expansion.

Large Clear Spans: Buildings can be supplied to around 90M clear spans.

Quality Control: As buildings are manufactured completely in the factory under controlled conditions, the quality is assured.

Low Maintenance: Buildings are supplied with high quality paint systems for cladding and steel to suit ambient conditions at site, which results in long durability and low maintenance costs.

Energy Efficient Roof and Wall Systems: Buildings can be supplied with polyurethane insulated panels or fibreglass blanket insulation to achieve required 'U' values.

1.2.2 Advantages of Conventional building:

1. It can be assumed to be more or less monolithic.
2. Connections are homogeneous with rest of the frame.
3. It is easily used for two way structural systems.
4. It is not necessary to pay for crane on site.

1.3 Disadvantages:

1.3.1 Disadvantages of PEB :

1. Susceptible to Corrosion: If not properly maintained the steel frames are susceptible to corrosion, thus special coatings becomes necessary to resist the corrosion of steel.

2. Low Thermal Resistivity: Steel being a metal is good at conducting heat, thus it reduces the thermal comfort in the building.

3. Low Fire Resistance: During fire, this type of building becomes more susceptible to damage due its conductivity.

1.3.2 Disadvantages of Conventional building:

1. Needs high labour numbers and plant on site.
2. Erection of formwork is time consuming.
3. The quality control is difficult. Once the concrete has been cast it is to difficult to do any modifications.
4. Weather can create problems for curing, and for construction itself.
5. Concrete must cure before it is loaded.
6. Erecting and interconnecting them to form the final structure.

1.4 Objectives

The main objectives of undertaking the present study are as follows:

- Parametric study of Pre-Engineered building using Indian standard and its co-relevance with International Standard.
- To evaluate the steel quantity of the Pre-Engineered building with the Indian standard and International standard.
- To evaluate the performance of Pre-Engineered Building with Conventional Steel Building in context of Indian Standards.

2. LITERATURE REVIEW

For this project work, different research paper has been referred from various national and international journals. The following reviews have been done for each research paper.

1. **Ms Deepika et al (2012)**

Studied on Analysis and Design of steel framed buildings with and without Steel Plate Shear Walls.

They observed that the Deflection in case of without SPSW is very large & in case of with SPSW deflection is very less. With the use of steel shear walls in the buildings, the bending moments in the column are reduce. Due to relatively small thickness of SPSW compared to reinforced concrete shear walls, from architectural CSB.

2. **Milind Bhojkar et al (2012)**

Have studied that the cost can be minimized by utilizing optimum cross-section of steel.

They have shown the various application of PEB. They showed that for low rise building, PEB is found to be more economical than CSB. From their studies they concluded that CSB is 26% heavier than PEB and also PEB is 30% economical."

3. **Nitin Vishwakarma et al (2012)**

Have studied Pre Engineered and Conventional Steel Building concept of Design for Industrial building of 18 m long span located in Palwal near New Delhi, India.

A fully stressed design of Pre Engineered Building with members of varying thickness, Conventional Building with Conventional Steel members and Conventional Building with different hollow and compound section are discussed in paper. A total of five cases are studied. It concluded that more than PEB, truss bracing gives the best suited result based on the economical possibility and the structural safety. They have also concluded that the material cost is reduced by 40% to 42% from PEB portal, when only tube sections are adopted in portal with truss pattern.

4. **Sagar Wankhade et al (2012)**

Have given importance of using pre-engineered-structure in construction, mainly for single storey building. They also have shown that conventional steel-structure has disadvantages compared to pre-engineered-structure.

They have done comparative study of pre-engineered building with conventional steel-building. From their studies they have found that pre-engineered building can be designed using simple procedures. Also they concluded that pre-engineered-building has point of view, steel shear wall occupy much less space than equivalent reinforced concrete shear wall. Due to use of SPSW in building there is considerable decrease in value of bending moment, shear force, deflection and axial force for some columns and also quantity of steel is reduced. Hence steel building with SPSWs is economical compare to without SPSWs.

5. Vrushali Bahadure et al (2013)

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.

The external forces applied to the system and the reactions at the supports are generally applied at the nodes

6. C.M. Meera et al (2013)

Studied that Pre-engineered building is a versatile solution to all the single storey industrial building as along with providing a high-quality pre-design structure it is also economical and light weight construction technique.

PEB has many advantages over conventional steel structures such as providing a standard fabricated section according to the optimum requirement. In this paper author carried out a comparative study of PEB and CSB on the basis of design and analysis of a typical frame. Design of conventional steel frame include selection of a suitable roof truss built up from standard hot rolled sections. Analysis for both the steel frame using different concept shows that there is about 30% reduction in steel consumption in Pre-engineered building as compared to conventional steel frame, hence PEB are lighter than CSB. In this way PEB proves to be more advantageous from CSB in as it is more economical, quality control, speed in construction, longer span, durability, standard designs, ease in expansion and erection.

7. Aslam Hutagi et al (2013)

Observed that Pre-engineered steel structures building offers low cost, strength, durability, design flexibility, adaptability and recyclability. Steel is the basic material that is used in the materials that are used for Pre-engineered steel building.

It negates from regional sources. Infinitely recyclable, steel is the material that reflects the imperatives of sustainable development. Comparison in the second example showed that even though PEB structures provides clear span, it weighs 10% lesser than that of Conventional Buildings. Large and clear spans allow housing almost any type and/or business comfortably and efficiently, as well as to expand in future and change their setup whenever they desire. Structures with long span need to be carefully designed keeping a balance of all the aspects like its weight, deflections (sway) and also foundation forces. There are many combinations of designing large spans, like conventional truss & RCC column combination, truss & steel columns, Pre-engineered building (PEB) etc.

8. Aijaz Ahmad Zende1 et al (2013)

Results show that Large and clear spans allow housing almost any type and business comfortably and efficiently, as well as to expand in future and change their setup whenever they desire.

Structures with long span need to be carefully designed keeping a balance of all the aspects like its weight, deflections (sway) and also foundation forces. There are many combinations of designing large spans, like conventional truss & RCC column combination, truss & steel columns, Pre-engineered building (PEB) etc. With the concept of PEB, the major advantage we get is the use of high strength steel plates (Fe 350), lighter but high strength cold form purlins, and 550 Mpa. The use of PEB

not only reduces the weight of the structure because high tensile steel grades are used but also ensures quality control of the structure.

9. Aslam Hutagi et al (2014)

Studied on "Comparative Study of Analysis and Design of Pre-EngineeredBuildings and Conventional Frames."

Results show that the Pre-engineered steel structures building offers low cost, strength, durability, design flexibility, adaptability and recyclability. Steel is the basic material that is used in the materials that are used for Pre-engineered steel building. It negates from regional sources. Infinitely recyclable, steel is the material that reflects the imperatives of sustainable development.

10. B K Raghu Prasad et al (2014)

Studied on reason behind PEB being so high in demand is speed of construction and good control over the quality and when talking about the cost, there are several parameters responsible for it such as span, bay spacing, gable inclination.

In this paper, these Varieties of model have been analyzed by varying roof angles, span and bay spacing and keeping the load common for each model i.e. DL, EL, LL, and WL. Pre engineered buildings are fully factory fabricated and assembles at site using bolted connection unlike welding in conventional steel building. PEB uses hot rolled tapered sections in primary framing as required by the internal stresses hence using the steel in optimum quantity and eliminating wastage of steel which further reduces self-weight of structure.

11. S.D. Charkha et al (2014)

Observes that constantly increasing cost of steel giving rise to an uneconomical construction practice which needs to be altered using new innovative technology.

There are many reasons to choose PEB over CSB such as quality design, manufacturing, erection, low maintenance due to pre-painted sections, building can be dismantled and relocated easily and future extension without much hassle is possible due to bolted connection. Along with this PEB proves to be a better system because of its ability to span long distance as many other gable structures are limited to a span of about 100 ft. in cost effective manner. Mainly trusses are provided for longer span but significant design fabrication time is needed. Based on above parameters they concluded that choosing PEB over CSB reduces steel quantity which reduces dead load and hence size of foundation is reduced.

12. Chavan et al (2014)

Aims to evaluate the economic significance of the hollow structural sections (HSS) in contrast with open sections.

This study was carried out to determine the percentage economy achieved using hollow structural sections (HSS) so as to understand the importance of cost effectiveness. The technique used in order to achieve the objective included the comparison of different profiles for various combinations of height and material cross-section for given span and loading conditions. The analysis and design phase of the project was performed using Staad pro v8i. The sample results of Staad Analysis were validated with the results of manual analysis.

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15. Kumar et al (2014)

Studied the pre-engineered building (PEB) concept in the design of structures has helped optimizing design.

The ability 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, is800-1984, IS 800-2007 and also 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, is considered to carry out analysis & design for 2d frames (end frame, frame without crane and frame with 3 module cranes). The economy of the structure is discussed in terms of its weight comparison, between Indian codes (is800-1984, is800-2007) & American code (aisc-89) & between Indian codes (is800-1984, is800-2007).

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18. G. Sai Kiran et al (2014)

Studied 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 RSlope 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).

19. Milind Bhojkar et al (2014)

The erection time of the pre-engineered building is 50% of conventional steel building or less than 8 weeks.

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.

20. B.Meena Sai Lakshmi et al (2015)

This paper effectively conveys that Pre-Engineered steel Buildings can be easily designed by simple design procedures in accordance Low weight flexible frames of Pre-Engineered steel Building offer higher resistance to earthquake loads.

Steel take-off is more for PEB with flat roof compared to PEB with steep roof. The moments for both haunch and ridge portion are more in PEB.

21. Bishbu Jacob et al (2015)

Studied on Design comparison of conventional steel structure with pre- engineered structure.

They observed the pre- engineered structure was lighter than ordinary conventional portal frame structure. The secondary members in conventional structure were heavier than secondary members in pre- engineered building. The pre- engineered buildings are more economic in terms of steel take off.

22. Er. Tushar Loya et al (2015)

Studied on Comparative Study on Analysis and Design of Steel Building and Conventional RC Building.

They observed that the analysis when maximum displacement and story drift is compared it is quite higher in steel structure than in RCC. This shows that RCC is more durable and sturdy. Bending moment and Shear force in beams of RCC structures is more as compared to that of steel structures. Preferred boards fire protection a system simultaneously helps the building for resisting fire cause and hides all the exposing structural members. Steel building structure is environmentally protected and energy saving. Steel building fireproof performance is good. Steel building structure has quick construction speed and investment recovery is faster.

23. Vivek Thakre et al (2015)

Have shown that there are many advantages of pre-engineered buildings having single storey especially including economy and ease of fabrication.

Here they have analyzed and designed an industrial structure according to IS codes 800-1984, IS 800-2007 and by MBMA-96 and AISC-89. Later they have also compared the economy which is in terms of comparison of weight between IS codes and American codes. From their research they have concluded that the design of pre-engineered-structures is done by simple procedures with respect to IS codes. They have also found out that there are various advantages of pre engineered structures over conventional steel-structures in terms of cost, weight, erection etc

24. Hemant Sharma et al (2015)

Have studied comparison and analysis of PEB & CSB staad Pro.

In this case study comparison for industrial building is done for bending moments at different sections & the results are compared for economy and time saving in construction. After analysis and design the report is concluded with 37% material saving in case of PEB than that of various advantages over conventional steel-building in terms of cost, speed of construction etc

25. Phatangare Roshani Rambhau et al (2015)

Have studied behaviour of roof trusses and purlins for large spans for material saving and economy.

They have designed and compared two trusses for internal forces, co existing moments and shear forces at critical cross sections. The studies states that the truss provided along length required less material as compare to truss provided along width of span. They have concluded that cost of construction is less as compare to truss placed along width of span &this gives new method of truss placing in roofing system.

26. Neha R.Kolate et al (2015)

Made a comparative study between pre-engineered building and conventional steel building.

Observed that PEB has many advantages over CSB such as zero maintenance and superior strength, it is corrosion resistance and features an attractive appearance and it is high level technology innovation and better product over conventional material. PEB system has protection against non-uniform weathering. In this paper, they studied that most of the steel structures are made in a conventional way using conventional sections and this leads to uneconomical and heavy structure and this pushes forward technology to get a better replacement and that is Pre-engineered building having better properties than conventional steel frames.

27. Shrunkhal V Bhagatkar et al (2015)

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.

28. Swati Wakchaure et al (2016)

Have shown that by using pre engineered-structure in construction, there are various advantages because according to the bending moment diagram, the designing of members is done. As a result, the steel is reduced.

They have analyzed and studied according to IS 800-2007 and IS 800-1984 & the comparison of pre-engineered-structure with conventional steel-structure is done. They have also compared the weight of both the structures. From their studies they concluded that conventional steel-structure is 30% heavier than pre-engineered-structure and as a result the size.

29. Pratik R. Atwal et al (2017)

Analysis and Design of Pre-Engineered Building Using IS800:2007 and International Standards.

Results show that IS 800-2007 (LSM) as prepared (BIS–2006) is mostly based on international standards as is evident from the comparative charts shown above, with load factors and partial safety factors suiting Indian conditions. Another important aspect of IS800:2007 code is that this code does not totally do away with the existing Allowable Stress Design (ASD) method of analysis. As a matter of fact, one chapter in this code has been totally dedicated to design concepts based on the ASD method.

30. P.Sudheer Kumar et al (2017)

Studied on Dynamic Analysis Of Multi Storey Steel Structures.

They observed that the Zone II, III, IV, V, there is much difference in the values of Axial Forces as obtained by Static &Dynamic Analysis of the Steel Structure. Zone II, III, IV, V, t he values of Torsion at different points in the beam are Negative in Static analysis and for Dynamic Analysis the values for Torsion are

positive. The performance of Steel Framed Structure is analysed for zone II, III, IV, V for Dynamic Analysis and the results are tabulated. It can be concluded that the results as obtained for the Dynamic Analysis are increasing for every zone higher for the same points and conditions.

31. Gorakh Vinit et al (2018)

Studied on Comparative Study Of Rcc And Steel Structures For Different Floor Heights.

They observed that the axial forces are lower in Steel structures due to the lower Weight of Steel structure compared to RCC structure. As the number of storey increases, the gap between the cost of RCC and steel structures decreases. According to the results, the deflection of the Steel structure is quite higher than RCC as Steel is a ductile material and allows a larger deflection. Speedy construction facilitates quicker return on the invested capital & benefit.

32. Pankaj N. Gadakh et al (2018)

Studied on "Design and Implementation of PEB (pre engineering building) Under AWS D1.1."

They observed that Choosing steel to design a Pre-engineered steel structures building is to choose a material which offers low cost, strength, durability, design flexibility, adaptability and recyclability. y. Steel is the basic material that is used in the Materials that are used for Pre-engineered steel building. It negates from regional sources. It also means choosing reliable industrial products which come in a huge range of shapes and colours; it means rapid site installation and less energy consumption.

33. Gautami Kalal et al (2018)

Studied that the "Design of Industrial Warehouse."

The results show that the In this dissertation, Numerical study was completed considering Mumbai Region, the necessary and appropriate loads and loading combinations were adopted. AUTOCAD plan was prepared followed by load calculations. Based on which different members like truss members, columns, purlins, etc. were selected and designed. The entire process was completed as per the standards laid down by Indian Standard. The paper effectively conveys that the industrial warehouse can be easily designed by simple design procedure in accordance with the country standards.

34. Pankaj N. Gadakh et al (2018)

Studied the concept of Design and Implementation of PEB (pre engineering building) Under AWS D1.

Results show that The Choosing steel to design a Pre-engineered steel structures building is to choose a material which offers low cost, strength, durability, design flexibility, adaptability and recyclability. Steel is the basic material that is used in the Materials that are used for Pre-engineered steel building. It negates from regional sources. It also means choosing reliable industrial products which come in a huge range of shapes and colours; it means rapid site installation and less energy consumption. It means choosing to commit to the principles of sustainability.

Infinitely recyclable, steel is the material that reflects the imperatives of sustainable development.

35. Yash Patel et al (2018)

Studied the concept of Analysis and Design of Conventional Industrial Roof Truss and Compare it with Tubular Industrial Roof Truss.

Results shoes that the Total weight of one roof truss components in Kg was calculated for Top chord members, Bottom chord members and other members of conventional steel section as well as Tubular steel section. From the results, total weight of all seven roof trusses components was carried out. Comparison is made between both types of sections and from the results of weight of roof truss members cost estimation sheet is carried out. That helped us to witness advantages of Tubular steel section over Conventional steel section. Weight in kilograms of all section that has been used in designing of Conventional Industrial roof truss as well as in designing of Tubular Industrial roof truss was worked out and with the information of current market rates Cost comparison between Conventional and Tubular Industrial roof truss was carried out.

36. Shrunkhal V Bhagatkar et al (2018)

Studied that 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. 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).This review from the past experiences presents the results of experimental and analytical

37. Ankitha.K.S et al (2018)

Shows that Tubular section has proved to be more economical. Saving of 9186.615 INR per one roof truss is achieved with assigning Tubular steel sections instead of conventional steel roof truss.

Overall 18% saving has been achieved during this project work. From the present study and results we can conclude that because of comparatively less dead weight tubular section has proved more economical for the industrial roof truss as well as for other steel structures.

38. D.Rakesh et al (2018)

Studied that now a day there is a vital change in the steel industry, majorly in the industrial structures the usage of Conventional steel building and Pre-Engineered building is more.

Conventional steel building and Pre-Engineered building 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.

39. J. Jayavel murugan et.al (2018)

Studied that Buildings & houses are one of the oldest construction activities of human beings.

The construction technology has advanced since the beginning from primitive construction technology to the present concept of modern house buildings. The present construction methodology for buildings calls for the best aesthetic look, high quality & fast construction, cost effective & innovative touch.

40. Apurv Rajendra Thorat et al (2018)

Studied that in the present study Pre-engineered Buildings are designed and studied in accordance with Kirby Technical Specification which is based on ASCE-07.

Two examples have been taken for the study. Comparison of Pre Engineered Buildings (PEB) with bracings and Pre Engineered Buildings (PEB) without bracings is done in two examples. Later Pre Engineered Buildings (PEB) is analyzed for Dynamic loads using El-centro specified ground motion.

41. Vinit, G., Kadia et al. (2018)

Studied the Axial forces are lower in Steel structures due to the lower Weight of Steel structure compared to RCC structure.

As the number of storey increases, the gap between the cost of RCC and steel structures decreases. Composite structures are more economical than that of R.C.C. structure as shown in literature for commercial buildings having large spans. Speedy construction facilitates quicker return on the invested capital & benefit. According to the results, the deflection of the Steel structure is quite higher than RCC as Steel is a ductile material and allows a larger deflection.

42. Deepti D. Katkar (2018)

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. In terms of percentage, the steel required for primary frame in pre engineering building is 48.77% less as compared to conventional steel building.

43. Milner et al (2018)

Investigated the performance of pre engineered buildings in a broader way. This study focuses on improving the blast capacity of the pre-engineered buildings using finite element analysis and computational fluid dynamics technique.

This was a new concept in case of pre-engineered buildings designing and construction, as the factor of blast capacity is usually not considered in case of pre-engineered buildings. The study explains the structural behaviour of the pre-engineered buildings in such a way that it contradicts the term of cost optimization and cost minimization concerning the construction of pre-engineered buildings. It shows that the factor of cost optimization reduces the structural performance of the pre-engineered and it should be done up to some sustainable extent only.

44. Deepti D. Katkar et al (2018)

Studied on “Comparative Study of an Industrial Pre – Engineered Building with Conventional Steel Building.

The results show that 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.

45. Dumaru, Rodrigues et al (2019)

Studied the concept of engineered building and on engineered buildings and then investigated both the buildings with the help of probabilistic cost-benefit analysis. Four types of existing buildings were studied thoroughly, out of which two were engineered buildings and rest two were non engineered buildings.

The study compared the engineered building and non-engineered building through every possible technique but the main focus was on the retrofitting of the existing non engineered building with the help of various engineered building constructions techniques. The study promotes the usage and implementation of the engineered building through its cost benefit analysis as the cost variation of the engineered building and the non-engineered building was huge. The rigorous analysis was done to predict the differences in both type of buildings and it was found that there is huge cost variation between the retrofitting of existing engineered buildings and existing non engineered buildings. The entire study was performed on existing buildings situated in Nepal where the occurrence of earthquake is unpredictable so this study enhances the seismic performance of the existing non engineered buildings using various engineered buildings construction and retrofitting techniques.

46. Mayuri Patil et al (2019)

Studied the concept of Comparative Study of Analysis & Design of Pre-Engineered Building Using Is 800:2007 & Various International Codes.

Results show that the reasons to increase in weight in 1S800:2007 as compared other international standards are Serviceability Criteria". Deflection limits given by IS code are higher than deflection limits by other international standards. Load combinations as per limit state of strength. The reason for optimized tonnage in case of American code is mainly due to limiting ratios and serviceability criteria.

47. Shaik Kalesha et al (2020)

Presented an analytical study on pre engineered buildings using staad pro.

Results show that Design ratio which is the ratio of the load applied in real to the design capacity of the beam should be less than or nearly equal to one. Weights of the members in both the cases are 1301 and 2013 kg for PEB and conventional structure respectively. It clearly indicates that half the steel usage is reduced in PEB. The most appealing economy of civil construction can be achieved through the efficient use of high-grade steel and composited building form with advanced materials. The model building cost study showed that PEB structures are economical as the structural members ' effective sizes in PEB structures are smaller than CSB structures. The weight of PEB is almost about 50% or less than that of the steel used in conventional steel structures.

48. Mitaali Jayant Gilbile et al (2020)

Presented A Review on Comparative Study on the Structural Analysis and Design of Pre-Engineered Building [PEB] with Conventional Steel Building (CSB).

Results show that the implementation of PEB is increasing but use if PEB is less than expected. The researches show that PEB structures are easy to design. These designs are efficient and results in speedy construction. These structures are more reliable than CSB. Hence the more research required for more outputs for design methods and reducing material in PEB structures.

49. Abhyuday Titiksh et al (2020)

This 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. This case study for Industrial Shed based on the review & studies which shows experimental and analytical studies carried out in this field. The result shows that these structures are economical, energy efficient and flexible in design.

50. Lee et al (2020)

Studied the behaviour and performance of Exposed column-base plate strong-axis joints of low-rise steel buildings under axial and lateral loading.

This was mainly done to enhance the structural performance of the low rise steel building against seismic forces. The effect of earthquake forces over the low rise steel buildings can be devastating so with this concept of exposed column base plate strong axis joint this can be neutralized. A series of experiments were carried out to develop improved exposed column-base plate strong-axis joints of low-rise steel buildings. In total, seven large-scale column-base plate strong axis connection specimens were investigated under both axial compression and lateral cyclic loading. It was found that the hysteretic behaviour of such improper joints typically used in the field was unstable due to a ‘‘rocking” phenomenon between a base plate and concrete foundation by large plastic residual deformation of anchor bolts

51. Lovneesh Sharma et al (2021)

Presented a comparative study between the pre-engineered structures and conventional structures using STAADPRO.

Results show that design results and design ratios of a pre-engineered building it was found that the Pre-engineered building performed better as compared to the existing conventional steel building. The next aspect is the overall structural weight of both the buildings and concerning this aspect, it was found that the overall structural weight of the pre-engineered building is found to be 20 to 25 per cent lesser as compared to the conventional building and This aspect directly influences the usage of structural steel and the overall construction cost of the structure. The delivery speed of the complete project and in this parameter also, the pre-engineered buildings are much faster. The material used for the construction of the preengineered building is not only environmentally friendly but it is reusable and well as recyclable. After the requirement is fulfilled the material of dismantled pre-engineered building can be reused for a further new type of construction. This factor indirectly affects the cost parameters of the construction of the pre-engineered building.

52. R.Yazhini et al (2021)

Presented a Analysis And Design Of Pre-Engineered Building

Results show that PEB structures are preferable for large span structures up to a certain optimum span. For small span structures, use of PEB technology won’t affect the overall performance. PEB structure cost is 20.37% lesser than the cost of RCC structures.

53. P Poluraju et al (2021)

Presented Structural Performance of Pre Engineered Building: A Comparative Study

Results show that The section sizes of columns and rafters are less for the structure located in Hyderabad when compared to the structure located in Vijayawada. As the BM and SF are less for the structure located in Hyderabad. The parameters that affect the structural weight and section sizes are Wind speed and Seismic Zone.

54. Roshni Ramakrishnan et al (2021)

Presented Comparitive Study of Pre-Engineered Building and Truss Arrangement Building for Varying Spans

Results show that The size of steel cross sections was greatly influenced by the serviceability requirements in CSB models.The CSB model for 90m(large span building) showed great joint displacements and greatly influenced the member section sizes,hence giving comparatively lesser economy in steel take off as compared to PEB.

55. Pornima Pritish Naik et al (2021)

Presented Comparative Study Of Pre Engineered Building And Conventional Steel Building

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

Acknowledgments

Words are inadequate to express my deep sense of gratitude to my guide Dr. R. A. Dubal, for consistent guidance and inspiration throughout the project work, which I am sure, will go a long in my life.

I owe sincere thanks to Dr. D. S. Yerudkar (M.Tech co-ordinater) & Dr. R. A. Dubal Head of Civil Engineering Department and all civil department staff of Rajarshi Shahu College of Engineering, Tathawade, who have rendered their invaluable support and guidance for carrying out this project work successfully.

Last but not least, I express my deep sense of gratitude to my family and friends and all those who have helped me directly or indirectly for their constant support and motivation throughout the course of this project work.

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