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COMPARATIVE ANALYSIS OF PRE-ENGINEERED STEEL BUILDING AND CONVENTIONAL STEEL BUILDING USING ETAB-A REVIEW

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ABSTRACT

In these days, the cost and time of construction is in more priority for the client with the large working area for various uses. For the economically and minimum loss of material, pre-engineered building system (PEBs) has many advantages, because it gives more column free space at low cost. Pre-engineered metal buildings are more reliable for various uses like complex industrial facilities, warehouses and distribution centers, stock-house, shopping malls, resort, motor court, office, cabin, service complex, aircraft-hanger, athletics and fun stadium, study places, temples, hospitals, and any types of industrial structures. In the pre-engineered metal building system, the rigid frame consists of slab, walls are connected with primary member (beam and column). This frame can span large spacing without any intermediate columns. The frames widths are spaced at spacing between 15 m to 60 m and span can increase with column-free up to 300 m in proposed building structures. Therefore in this paper, an attempt has been made to analyze a pre-engineered metal building with a span of 40 m with the help of finite element based software ETABS (2013). For the comparison, for the same span of 40 m length a conventional steel building is analyzed in same software. The results were found from both analysis indicated the pre-engineered steel building is economic with the conventional steel building as well as stable also.

KEYWORDS: Pre-engineered metal building, Conventional building, ETAB

I. INTRODUCTION

The efficient and economic construction over conventional method of building construction Pre-engineered building (PEB) system was induced. the concept of pre-engineered steel metal building system made over all structural component like, beam, column, purlin, rafter as well as roof wall sheeting, primary members, secondary members, connected with each other and different structural components [Ref.8 and 9]. This technology is a built, structure with precast and prefabricated members which are erected at site. Pre-engineered steel buildings are mainly low height buildings which are useful for residential building, show-rooms, shopping malls etc. [Ref.2]. The PEBs system are very economical and faster to application for the low height buildings, with this system the construction time is reduced about half than conventional Steel building. Although pre- engineered steel building is widely used for any industrial purpose building or non-residential building construction globalized, In India, it is now new structural concept. [Ref.3and4].Now a days, large spaced area is the uttermost requirement for any type of industry and with the approach of computer software's it is now easily possible. With the advancement of technology, computer programs have made a major contribution to improving the quality of life through new research. The pre-engineered building (PEB) is one of these revolutions. "Pre-engineered buildings" are made completely in the factory by robotic methods after design, then they are transported directly to the site under completely destroyed conditions (CKD), and all components are assembled and mounted using connections like nuts, so this reduces the end time [ref. 1 and 7].

PEB constructions are more important for sustainable buildings with sustainable construction, with a high proportion of recycled content, which makes them 30-40% lighter than conventional steel buildings (CSB). Because the construction technology based on the PEB system contributes to the final modernization using high-tech and faster construction methods, ensuring efficient, economical and quick completion of the projects [refs. 3, 4 and 6]. As a result, today the PEB system is the most preferred option among consultants, architects, builders, developers and industrialists.

II. METHODOLOGY

Pre-engineered buildings use pre-defined stocks of raw materials at a lower weight, which is confirmed overtime to satisfy a wide range of structural and unique aesthetic design requirements. This flexibility allows PEB to meet

an almost unlimited range of building configurations, custom designs, requirements and applications. A pre-designed steel building is a building structure that uses three categories of products, such as: Elements of the primary structural structure in the form of "I" are built (columns and beams). Secondary structural elements in the form of "Z" and "C" cold deformation (roof slings, cornices and sand walls) laminated profiled sheets (ceiling and wall panels) are used in PEB.

III. LITERATURE

S. Seetharaman (2005) A PEB analysis and a traditional building using a case study of a three-story apartment (G + 3) located in Hubli, Karnataka. In this case, an attempt is made to analyze the building before designing and compare it with the usual structure in terms of cost and other criteria. In the superstructure, columns, beams, walls, floors, slabs, lintels, chajja, prefabricated elements are analyzed. Planning is carried out in accordance with the requirements and various activities related to the creation of this element are considered. The study is conducted using Spring P6 software, which is contained in the project management program.

Dabhade U. D. et al. (2009) noted that 55.3% time savings are achieved due to the use of a composite floor construction with steel frame instead of a prefabricated frame with precast concrete floor and 14.3% of time than that of the steel frame with a slab of precast concrete. The construction of a composite floor building with steel frame saves time, which leads to a general saving in net cost. The direct cost required for the steel frame with the composite floor is 23.10%, higher than a prefabricated frame with precast concrete floor and only 0.52% higher than the steel framed with precast concrete floor. Given the time-related savings, the net cost required for the steel frame with the composite floor is 12.99%, more than a prefabricated frame with precast concrete floor and 2.32% less than the steel frame with the prefabricated floor. The steel frame with precast concrete floor saves 35.83% of construction time than a prefabricated frame with precast concrete floor, which requires an additional 22.70% direct cost and 14.96% net cost. However, the study is restricted only to the structural framework.

Firoz Syed et al. (2012) noted that the construction of a pre-designed steel structure system has great advantages for single-story buildings, a practical and effective alternative to conventional buildings. The system is a central model in several disciplines. The pre-engineered building creates and supports multidimensional and data-rich real-time views with project support, which currently implements Stadd pro software packages for engineering and design. The choice of steel for designing a pre-engineered steel structure design is the choice of material that offers low cost, strength, durability, design flexibility, manufacturability, and recyclability. Steel is the main material used in the materials from which precast steel is made. It also means choosing reliable industrial products that come in a wide variety of shapes and colors; this means faster on-site installation and lower power consumption. This means choosing a commitment to sustainability. Steel is a material that reflects the imperatives of sustainable development.

Ahmad Zende Aijaz et al. (2013) noted that pre-designed buildings are the best solution for large structures without an intermediate inner column, as can be seen from this current work, the industrial structure was designed for 88 m. With the advent of software, the design possibilities became almost unlimited. Material savings in the low-voltage zone of the main frame elements make pre-engineered buildings cheaper than ordinary steel buildings, especially for low-rise buildings, covering up to 90.0 meters with a cornice height of up to 30.0 meters. , It has been found that PEB structures are expensive compared to conventional structures in the case of lightweight structures of smaller size. In conclusion, a pre-engineered building design gives end users a much cheaper and better solution for large structures where large areas without columns are needed.

Vrushali and Prasad (2013) noted that when comparing the various configurations of the industrial shed, several types of trusses were used, which gave them a suitable shed for the industrial shed and which is more effective in terms of strength and economic point of view. The design of various types of industrial frames using STAAD-Pro 2007 software provided them with a common design and usability. They analyzed three types of industrial shed using STAAD-Pro, from which they obtained the necessary steel, strength and cost-effectiveness of various sheds, and then compared the corresponding results obtained with the fact that the industrial barn of the saw tooth type is 65% cheaper than the Portal and frame type which means that it is economically good. They also compared the pre-designed industrial shed with the previous three, and then concluded that the designed industrial shed was the best in terms of economics and resistance.

M. Meera et al. (2013) this document is a comparative study of the PEB concept and the CSB concept. The pre-designed construction concept is widely used. The article begins with a discussion of the methods adopted in the study. An introduction to the PEB and CSB systems is then described, followed by the details of a case study. Loads and load combinations adopted for structural analysis are clearly defined in additional parts. A section describing the importance of the software used and the software procedure is followed. The final part explains the results obtained from the analysis of the case study software and the conclusions of the literature studies. The paper aims to develop an understanding of the design concepts of PEB structures and their advantages over CSB structures.

Thakar and Patel (2013) noted that pre-engineered buildings are more reliable due to the reduction of steel waste and their own weight and, therefore, the ease of foundations. International codes are mentioned in their design in accordance with the standards of MBMA (Association of Manufacturers of Metal Structures), which are more flexible and allow the use of sections made with a minimum thickness of 3.5 mm versus 6 mm as the minimum criterion in the sections. from ordinary steel. There is the use of high-strength steel (345 MPa), which indicates increased strength with the reasonable use of steel as a result of a conical profile. In places with high values of bending moment, a greater depth is used, and a smaller momentum stimulates the use of a shallower depth. In addition, unlike conventional steel profiles, where the moment of inertia (I) remains constant, this does not apply to P.E.B due to different depths.

M. Umair Saleem et al. (2013) observed differences in the use of the amount of steel using another type of PEB, such as regular PEB, mono suspension, and a curved frame. To do this, an analysis was carried out using an optimized cross-section for loads and load combinations calculated according to Excel worksheet taking DL, LL and WL into account, with a combination in accordance with IS 800: 2007. The analysis was performed using ANSYS software based on female voltage found for the calculated load and stress coefficient of the support frame was detected with the amount of steel and compared with each other to get the economic type of PEB. A typical circuit has also been adopted to determine which voltage is prevailing for failure.

Charkha S.D. and S Latesh (2014) noted that using PEB instead of CSB can reduce the amount of steel. Reducing the amount of steel, definitely reducing dead load. Reduced dead load by reducing the size of the base. The use of PEB enhances the aesthetic appearance of the structure.

Kumar et al. (2014) Studying a pre-designed concept of construction (PEB) in the design of structures helped to optimize the project. In this study, the production structure (warehouse) is analyzed and designed in accordance with Indian standards IS800-1984 and IS800-2007, and also refers to MBMA-96 and AISC-89. It is believed that the structure is 187 m long, 40 m wide, 8 m free height and 1:10 slope. The structure economy is compared in terms of weight of the structure as per the Indian codes (IS800-1984, IS800-2007) and the American code (AISC-89).

Chavan et al. (2014) its purpose is to evaluate the economic importance of hollow structural sections (HSS) as opposed to open sections. This study was conducted to determine the percentage of savings achieved by using hollow structural sections (HSS) to understand the importance of profitability. The technique used to achieve the goal included comparing different profiles for various combinations of material height and cross section for specific loading and tensile conditions. The analysis and development phase of the project was carried out using Staad pro v8i. The results of the Staad Analysis sample were confirmed by manual analysis.

Rao M.N. and Vishwanath (2014) He noted that PEB reduced the amount of steel used by 36% compared to CSB. The bending and cutting force of PEB is less than CSB, which in turn reduces the material needed for the structure. Lighter taper sections provide better seismic resistance than heavy CSB frames in seismic zones. You can save on PEB costs in many ways, such as saving materials, providing a lighter base, etc. In addition, PEBs are aesthetically pleasing at a lower cost. With PEB, costs can be reduced by up to 30%.

D. V. Swathi (2014) He noted that the construction of pre-engineered steel structures provides low cost, strength, durability, design flexibility, manufacturability and the possibility of recycling. The paper explains that 2D Plane Frame comparisons are performed for both pre-engineered buildings and conventional types. The flat frame has a width of 38.1 m and a distance between the bays of 6.25 m and a cornice height of 8.2 m. Based on the analytical

and design results, PEB depends on the distance between compartments, with an increase in the distance between compartments to a certain space, the weight decreases, and an additional increase increases weight.

Bhojkar and Darade (2014) they noted that the construction time for a pre-designed building is 50% of a typical steel building or less than 8 weeks. Clean areas up to 90 meters wide (in the case of an airplane suspension can reach up to 150 meters) and a cornice height of up to 30 meters. The cost can be approximately 30% of the usual steel structure just to make the UEB economical.

Raghu Prasad B K et al. (2014) studied that the main advantages of pre-engineered buildings are speed of construction and good quality control. However, there is little information about its economy. There are several parameters, such as the slope of the pediment, sections, compartment space, which control the cost of the structure. In this document, the above parameters are systematically changed and in each case the gable frame is designed for the common loads DL, LL, EQ and WL. The quantity is obtained in each case, and finally, a structure that regulates the smallest amount of steel is recommended.

Wankhade and Pajgad (2014) This document is an industrial steel armored building measuring 14 x 31.50 m, 20 x 50 m, 28 m x 70 m and a span of 5.25 m, 6.25 m and 7 m, respectively, with a column height of 6 m compared to Pre-engineered buildings of the same size. The design is based on IS 800-2007 (LSM). In the simulation, the following loads are taken into account: constant load, constant load, wind load and combinations specified in IS. Analysis results are observed for the base of the column as a hinged base. The results of industrial steel lattice buildings are compared with the same dimensions of pre-engineering buildings.

Sravan Kumar A. et al. (2014) deals with the concept of steel structures, introduced in the early 1960s, here the structure uses entire I-sections, and the beauty of this concept is that the welding process will not be carried out on the entire site. The whole structure will be designed and manufactured in the workshop, and it will be brought to sit and assemble, all the properties of the sections will depend just upon the moments at that specific locations so there won't be any excess steel used in the thus it is economical. Here I am designing such a PEB building by selecting a real time project consisting a 69m wide and 173m length textile building by IS 800-2007 Design code using STAAD Pro and explaining its each and every parameters and design and detailing.

V. Bhagatkar Shrunkhl et al. (2015) noted that the prefabricated building (PEB) is a suitable construction technique for developing countries. This is a combination of prefabricated and prefabricated structures. PEB will reduce the overall construction time of the project by at least 50%. Applying the concept of pre-designed buildings to low-rise buildings is very economical and fast. They considered that PEB structures can be easily designed using simple design procedures in accordance with country standards, which is energy efficient, quick to build, saves costs, is sustainable and, most importantly, reliable compared to ordinary buildings

Kolate and Kewate (2015) they studied the importance of having a long cross-section and structures that have column-free area in industrial structures, and pre-engineered structures are those that can satisfy this requirement. Another advantage of a pre-engineered design is its cost-effectiveness. Here they compared the analysis and design of prefabricated buildings and ordinary steel. As a result of their research, they found that ordinary steel structures are 23% heavier than prefabricated structures, as well as less waste from prefabricated metal structures, which reduces the cost of construction. In addition, a pre-designed building is 18% cheaper than ordinary steel. They also concluded that a conventional steel structure is used for clean areas up to 90 m, but a pre-designed structure is used for more than 90 m.

Lande and Kucheriya (2015) noted that a comparative study of conventional and PEB, as the economic aspects of cold-formed profiles in the form of tapes in comparison with the hot-rolled profile, traditionally used for industrial design, is measured by weight. The document states that the weight of the PEB structure is 35% less than that of the CSB structures. Compared to AISC / MBMA, the weight of the structure is greater in IS 800-2007 due to the limiting section selection relationship. Most likely, the weight of PEB depends primarily on the space of the compartment, where it will be increased to a certain limit after this weight. To reduce the weight of the structure by providing a secondary element as an easy calibration section of the Z-purlin.

Jayasidhan and Abhilash (2015) say design and analysis of a multi-story industrial building. This is a basement building G + 5 and G+ 3 floors located in Coratty. Analysis and design were carried out in accordance with the

standard specification as far as possible. The structure analysis was carried out using the STAAD PRO.V8i software package. All structural elements were developed manually. The reinforcement detail was made in AutoCAD 2013. It values a safer side than manual work.

Yash Patel et al. (2015) noted that tubular steel is the best alternative to ordinary steel with its comparatively better characteristics. Deadweight tends to decrease for many components, so it's clear that thanks to the pipe section this helps reduce overall savings. Economics is the main goal of this work, including comparing conventional structures with a tubular structure for given conditions. The results show that through the use of tubular sections, savings of up to 15-25% are achieved. Barn elements were analyzed using Staad Pro V8i software using manual Indian standards. Several Excel sheets for various structural elements, such as Purlin, Roof Truss, a compression element, a tension element, etc., were performed using Microsoft Office Excel. Finally, a score sheet is compiled for each section of the roof reinforcement, as well as for the section of tubular roof reinforcement.

J. Jayavelmurugan et al. (2015) noted that PEB uses a combination of engineered sections, hot rolled sections and cold rolled elements. PEB can be equipped with various structural elements, including mezzanines, awnings, panels, internal partitions, etc., and the building is waterproofed with special putties, putties and decorations. PEB, as a rule, are low-rise buildings, however, the maximum height of the cornice can reach 25-30 meters. Applying the concept of pre-designed buildings to low-rise buildings is very economical and fast. PEB will be the only solution for large industrial enclosures with thermal and acoustic characteristics. The main advantage of metal structures is the high speed of design and construction of buildings of various categories.

Gupta and Thawari (2016) It has been observed that PEBs are more economical with a cornice height of 30 m, and after 50-60 m this use is uneconomical for this, the study is carried out using STAAD-Pro, and seismic analysis is easily performed with a sufficient amount.

Thorat and K. Patil (2017) explained that in this study, pre-engineered buildings were designed and studied in accordance with the Kirby technical specification based on ASCE-07. Two examples were taken for the study. Comparison of predesign buildings (PEB) with fasteners and predesign buildings (PEB) without fasteners is carried out in two examples. Later, pre-engineered buildings (PEBs) are analyzed to determine dynamic loads using ground movement specified by El-Centro.

Bokade and Vairagade (2017) explain two types of industrial buildings. The two buildings are traditional, and the preliminary design of construction the concept of preliminary design of construction (PEB) is a new concept for the construction of one-story industrial buildings. This methodology is universal not only due to its design and high-quality assembly, but also due to its light and economical design. The concept includes a method to ensure the best cross-section in accordance with optimal requirements.

Darshan Kalantri et al. (2017) author says that the design of pre-designed building structures (PEB) helped optimize the design. The adoption of the PEB design concept instead of the conventional steel structure (CSB) concept has given many advantages since the elements are designed according to the bending moment diagram, thus reducing the demand for material. This methodology is universal, not only for the quality of previous projects and prefabricated production, but also for an easy and economical construction. This technique is very advantageous then CSB technique, which includes buildings with roof trusses.

IV. IMPORTANCE OF LITERATURE REVIEW

The study and work in pre-engineered steel building system are summarizing from literature review and previous study as below:

- Pre-engineered buildings can be adapted for a wide range of structural applications; The greatest savings will be achieved when standard parts are used in the structural structure.
- To comprehend the significance of budget efficiency.
- Low-weight buildings oriented towards a simple manufacturing process and simple construction for maximum structural efficiency. The minimum weight of the structure is proportional to the minimum cost and reduces seismic and gravitational forces.

- In industrial construction, the cost of materials and construction is minimized in the case of cold rolled steel, while in the case of conventional construction it was higher in both cases. Material and cost savings of approximately 25% can be achieved. Designing one-story industrial structures with large transparent sections using PEB is cheaper than designing a reinforcement cage.

V. GAP OF STUDY

According to all the reviews, it is observed that there is a scope of work in the comparison of pre-designed steel buildings with conventional steel buildings that use IS800: 2007, IS 875 and IS1893 (LSM), so here we try to compare the same study by designing actual industrial steel building using Indian specified code by LSM in ETABs software.

VI. OBJECTIVE

The objective of our project encompasses the entire pre-engineered steel buildings product line. The main objective of our project is to compare the design of pre-engineered steel structure with conventional steel structure system (industrial building) using IS 800:2007 IS 875 & IS1893. The key ideas of undertaking the present study are as follows:

- Design of industrial steel building using PEBs concept
- Design of industrial steel building using CSBs concept
- Comparing design results of PEBs with CSBs
- Comparing weight of steel taking off by PEBs concept and CSBs concept
- Comparing % variation in tonnage of both structures.

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