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Review on Structural Design and Analysis of Pre Engineered Buildings

Saima Parveen*, Dr. Ganesh Hegde **

** Research scholar, Department of Civil Engineering, Goa University, Goa College of Engineering, Farmagudi, Goa, 403401*

Email: saimaparveen039@gmail.com

***Professor, Department of Civil Engineering, Goa University, Goa College of Engineering, Farmagudi, Goa, 403401*

Email: gh@gec.ac.in

Abstract: Pre-Engineered Steel Buildings are generally manufactured as per customer requirement and in the plant itself. The current research reviews existing research work conducted on PEB (Pre Engineered Buildings) using experimental and numerical techniques. The numerical techniques used for analysis evaluation of PEB include FEA and simulation packages include staad pro, SAP 2000 etc. Different parameters like cost, strength and weight were evaluated and compared for both conventional steel structures and pre-engineered steel structure.

Key Words: *PEB, steel structure, stability*

1. INTRODUCTION:

Pre-Engineered Buildings (PEB) are the buildings which are engineered at a factory and assembled at site. Usually PEBs are steel structures. Built-up sections are fabricated at the factory to exact size, transported to site and assembled at site with bolted connections. This type of Structural Concept is generally used to build Industrial Buildings, Metro Stations, Ware houses etc. The adoptability of PEB in the place of Conventional Steel Building design concept resulted in many advantages, including economy & easier fabrication.

Figure 1: Pre-engineered building structure

These building structure can be finished internally to serve any functions that are actually help in low rise building design like warehouses, canopies and factories.

2. LITERATURE REVIEW

Phatangare Roshani Rambhau, Dr.Wakchaure M.R.[1] have studied behavior of roof trusses and purlins for large spans for material saving and economy. They have designed and compared two trusses for internal forces, coexisting 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.

Hemant Sharma [2] 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 CSB.

Abhyuday Titiksh, Abhinav Dewangan, Ankur Khandelwal , Akshay Sharma[3] “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".

Milind Bhojkar ,Milind Darade[4] have studied that the cost can be minimized by utilizing optimum cross-section of steel. Also 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."

Nitin Vishwakarma, Hardik Tayal[5] 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.

Muhammad Umair Saleem, Zahid Ahmad Siddiqi, Hisham Qureshi [6] had carried out design of PEB all members i.e. hot rolled sections and cold-formed sections. Minimum weight design of CSB was carried out to achieve the design of the PEB. They state that Minimum Weight is directly proportional to Minimum Cost. These two structures were compared not only economically but also for structural safety. They found that using cold-formed steel for secondary framing instead of hot rolled has decreased the weight by 60%, also by use of built-up sections in place of hot rolled sections for primary framing decreased the cost by 30%. The deflections and sway shown by hot rolled sections when used for primary and secondary framing is less when compared to others. They also stated that, rather built-up sections shows higher sway but is within the limits as specified in MBMA2005

Fahid Aslam, Wasim Abbass, Zahid Ahemed Siddiqi, Raja Rizwan Hussain [7] had carried out the analysis of a frame against the seismic forces. They have carried out comparison between ordinary moment resisting frame and special moment resisting frame. They have found that when there is increase in seismic load the steel required for ordinary moment resisting frame is much higher than special moment resting frame. They also stated that drift is more in ordinary moment frame as compared to special moment resisting frame. They found that steel can be saved by 7% for main frame and 60% to 30% for bracings by use of special moment resting frame.

G. Sai Kiran, A. Kailasa Rao, R. Pradeep Kumar [8] had made a study over various codes. They have compared various structural parameters between PEB and CSB by using various codes viz IS800:2007, IS800:1984, MBMA-96 and AISC-89. They have found that there is increase in section weight when designed by IS800:1984 as compared to IS800:2007. The deflections stated in Indian standard are higher than MBMA. When the design was compared between IS800:2007 and AISC/MBMAthe weight was greater. They also state that the loading provisions made in Indian code are higher than those made in MBMA. They have also stated that IS800:2007 does not consider slender sections which are often used in PEB. They have stated that the crane impact load in vertical direction is same as compared between Indian and American whereas in horizontal direction it is more in MBMA.

D.Rakesh, V. Sanjay Gokul, G.Amar [9] had carried out a comparison between CSB and PEB. They have obtained the results by analyzing and designing of an Industrial shed. They have found that the total steel takeoff of the PEB is about 60% as that of CSB. The author have observed that the weight of the frame is dependent on the bay spacing; with increase up to certain limit there is decrease in weight while after that limit it increases. They also found that displacement is more in CSB as compared to PEB whereas axial force is more in PEB as compared to CSB.

N. Subramanian [10] had studied over the PEB. He has made a brief description on the selection of framing system. Also he has made a description on the type of materials used for roof and wall. He has stated the types of structure and the types of framing system that can be used. He states that braced frames may be more economical than unbraced frame in situations where the labour cost is low. He has described about one of the roofing system through-fastened lapped-seam roofing. He states that rather this roofing system is more economical it is susceptible to leakage and hence standing-seam metal roofs consisting of metal panel running vertically on the roof deck are used in present day constructions.

Kiran et al. (2014) [11] analyzed and designed an industrial structure according to the Indian standards, IS 800-1984, IS 800-2007 and also by referringMBMA-96 and AISC-89. They concluded that loading as per Indian codes is greater than MBMA code and also observed that in industries most of the projects are done with AISC/MBMA.

Thakar et al. (2013) [12] Comparative study of PEB by varying depth of width and spacing of structure. They concluded that as

spacing of portal increased steel consumption is decreased by primary members and increased for secondary members.

S. Seetharaman et. al. [13] 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.

M. Meera et al. [14] this document is a comparative study of the PEB concept and the CSB concept. The predesigned 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.

Bhojkar and Darade et. al. [15] 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. [16] 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.

3. CONCLUSION

Various researches were conducted on usage of pre-engineered buildings for factories, warehouses etc. The use of braced frames is found to be more economical than unbraced conventional steel frames. The labor cost associated with PEB is less than conventional steel buildings. The results obtained from FEA simulation on PEB have shown that these structures are economical, energy efficient and flexible in design under seismic loading conditions.

braced frames may be more economical than unbraced frame in situations where the labour cost is low

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