A Review on Comparative Study on the Performance Pre-Engineered Building & Conventional Steel Building by Using STAAD Pro

Rutuja Khute[1], Atul Pujari[2], S.K. Patil[3]

[1]Post Graduate Student, Department of Civil Engineering, KJCOEMR, Pune, India
[2]Associate Professor, Department of Civil Engineering, KJCOEMR, Pune, India
[3]Head of Department of Civil Engineering, KJCOEMR, Pune, India

---***---

Abstract – *Pre-engineered building structures, or PEB systems, are mainly employed for low-rise, single-story buildings in industrial builds across the globe; however, multi-story buildings are still relatively new in India. Several stories Pre-engineered building structures are a cutting edge technology that solves issues with waste, safety, and risks while also providing affordable, sustainable, and environmentally friendly structures. CSB construction, which requires costly and time-consuming design. Because the CSB system uses a constant sample of the hot-rolled section along the whole member length, it is more expensive due to increased steel consumption. It is true that only bolted connections are provided at the building site and that the PEB's built-up section is based on the loading impact. The research of PEB with CSB is done in this work. is created and examined in compliance with Indian standards. Using staad-pro, two models—one for each of the PEB and CSB—are taken into consideration, each with a distinct seismic zone research. Examine the models' performance in relation to cost and weight comparisons. is created and examined in compliance with Indian standards. In the current work, the relative study of Pre-Engineered buildings and Conventional Steel structures takes into account different loads such as dead, live, wind, and seismic loads.*

***Key Words*: Pre-engineered building (PEB), Conventional Steel Building (CSB), multi storey structure, economical, eco-friendly, weight comparison, cost comparison, Staad Pro**

1. INTRODUCTION

Pre-engineered building conception involves the steel structure system which are pre-designed and prefabricated. Steel's hardness and inflexibility make it the preferred building material for design. One type of prefabricated structure that is built too quickly is the steel structure system. In the industrial, commercial, residential, and manufacturing sectors, building quickly is a necessary step. Choosing standard steel constructions will result in longer lead times and higher costs; taken together, these factors render the project unfeasible. Consequently, in a pre-engineered structure, all design work is completed in a factory, and in accordance with the plan, prefabricated members are sent to the construction site and assembled in less than six to eight weeks. Pre-engineered building structures offer shorter construction times and optimization of technology. Because PEBs are designed based on analytical results, the section pertaining to this specific ingredient is tapered in accordance with the findings. This design idea not only makes the structure lightweight but also yields the best sections based on optimal needs and cost effectiveness. It may be easily relocated to different sites and requires the least amount of time and money in upkeep. PEB construction is currently utilized for large-span multi-story buildings.

1.1 CONVENTIONAL STEEL BUILDING

Standard Steel Structures: Standard steel structures are made of hot-rolled sections with various cross sections. The conventional steel buildings are sturdy. The preferred steel profile type for building varies based on the design guidelines and requirements that call for precise construction. Sections are produced in various cross sections and shipped to the design location, where they are assembled and constructed to specifications. These manufactured corridors are joined together using welding or bolting. Through the use of welding and cutting, adjustments can be made while the structure is being built. The material waste rate in traditional steel structures is significantly higher than in pre-fabricated structures. There is little work and little delicacy.

1.2 PRE-ENGINEERED BUILDING

Pre-engineered buildings made from a mix of hot-rolled and cold-formed sections. Traditional steel structures are replaced with this new technology (CSB). Pre-engineered structure components are produced in compliance with design guidelines and standards to produce precise, high-quality goods under controlled circumstances. It will be delivered to the site of the design project so that it may be installed. For larger artificial constructions, pre-engineered structures are acceptable. These steel constructions are provident; they provide inflexibility for future growth, need little maintenance, and their structural components are easily fabricated.

FUTURE SCOPE

The following are the coming study areas that must be researched.

a) The examination of PEB and CSB structures utilising software similar as MBS, E-TAB, and SAP2005.

b) Design the structure using factors similar as a crane and a mezzanine.

c) Produce a PEB system for a multi storey residential structure.

d) For distinct zone analysis and PEB structure design. AISC, as well as transnational codes, is employed in the design of PEB.

2. REVIEW OF LITERATURES

B.Meena Sai Lakshmi , M. K. M. V. Ratnam , M. K. S. S.Krishna Chaitanya (2015) investigated versatility stems from its affordable construction and light weight, as well as from its excellent prefabrication and predesigning. Pre-Engineered Steel Buildings (PEB) and Conventional Steel Buildings are designed for both static and dynamic forces, such as seismic and wind forces, in the current job. The industrial building measured 60 meters in length, 30 meters in width, and 10 meters in eaves height is situated in Vijayawada. It has two distinct roof slopes, 5.71° and 7.125°, and is classified as a PreEngineered Steel Building. STAAD Pro V8i is used to analyze and design the building. The weight of the structure in Vijayawada is 11.04% greater than that of the structure in Hyderabad.

L. Maria Subashiniand Shamini Valentina (2015) this study clearly illustrates how simple design techniques in compliance with national requirements may be used to easily develop PEB structures. PEB's lightweight, flexible frames provide greater resilience to seismic loads18, 19. Comparing PEB roof construction to traditional steel building, it is nearly 26% lighter. Lightweight "Z" purlins are utilized in secondary members for PEB structure, while stronger hot-rolled sections are used for CSB. Analysis shows that support reactions for PEB are lower than those for CSB. For PEB, a lightweight foundation can be used, which simplifies design and lowers foundation building costs. The CSB construction will need a strong foundation. The cost of the PEB building is thirty percent less than the CSB structure17. PEB is inexpensive, strong, long-lasting, flexible in design, adaptive, and recyclable. In summary, "when large column free areas are required for long span structures, end users have a much better and more affordable option with pre-engineered building construction."

Pradip S. Lande, Vivek V. Kucheriya (2015) In this study, the structural analysis and design program STAAD-pro is used to evaluate and design an industrial structure (a warehouse) in accordance with the American code, MBMA-96, and the Indian standard, IS 800-2007. The structure's economy is examined in relation to the weight comparison between the American (MBMA-96) and Indian (IS800-2007) codes. Additionally, a comparison of hot-rolled sections for industrial structures with cold-formed sections as purlins has been done.

Swati Wakchaure, N.C.Dubey (2016) there are several benefits to using PEB instead of the conventional steel building (CSB) design idea. The members are designed according to the bending moment diagram, which reduces the amount of steel needed. An industrial structure, specifically a PEB Frame and CSB Frame, is examined and designed in this study in compliance with Indian standards, specifically IS 800-1984 and IS 800-2007.In order to do analysis and design for 2D frames, a structure measuring 80 meters in length, 60 meters in width, 11.4 meters in clear height, and with R-Slopes of 5.71 degrees for PEB and 18 degrees for CSB is taken into consideration. The economy of the structure is compared in terms of weight between Indian codes (IS800-1984, IS800-2007), as well as between the building structures of PEB and CSB. Index terms: IS code, Utilization Ratio, Staad Pro, Pre-Engineered Buildings, Tapered I Section

Monika Nakum, Jigar Zala, Darshan Shah (2017) The study of PEB with CSB has been conducted in the current work, and the conclusions drawn from it will be of great assistance to structural engineers in their day-to-day work. This study evaluated conventional steel buildings (CSBs) and pre-engineered steel buildings (PEBs) utilizing STAAD-pro analysis and IS: 800:2007 design. Here, we've used five distinct design areas and several material specifications for those plans in order to examine cost efficiency. Following the findings of the PEB & CSB Structure study, it was noted that strong material strength lowers construction costs.

Muhammad Umair Saleem, Hisham Jahangir Qureshi (2018) The performance of PEB steel frames in terms of making the best use of steel sections and comparing it to conventional steel buildings are covered in detail in this research study. A number of steel frames made of PEB and CSB are chosen and put under varied loading scenarios. A Finite Element Based analysis tool was used to study the frames, and American Institute of Steel Construction design specifications were followed during the design process. It has been determined that the frames can be compared in terms of their weights, lateral displacements (sway), and vertical displacements (deflection). The findings unmistakably showed that PEB steel frames are the most cost-effective option because they weigh less during construction and perform better than CSB frames.

Gite Kalyani Dilip, M. P. Wagh (2021) study the loading circumstances in particular, the portions of the building that were taken were thought to be the highest. The snow load, wind load, and the structure's own weight, or self-weight, were the three main loads operating on the structure. In order to lower the stress levels, high-stress areas of the structure were altered. The cross-section properties of the rafter members were altered, increasing the second moment of area. The type of material utilized on the beams was altered to boost rigidity. Isolating the structural members and adjusting the design to account for the high stresses came next. The analytical part included a lot of dependent processes. Ninety percent of the structure is made up of the parts that did not undergo significant stresses.

Neha Puri & Vikas Garg, (2021) the study demonstrates a number of advantages that pre-engineered structures have over traditional construction. The results of the current analysis show that the two structures' costs differed by ten lacs. Additional benefits include shorter construction times; conventional buildings may require one to one and a half years, but pre-engineered buildings only require 1.5 to 2 months once the design is finalized. Because pre-engineered buildings are designed specifically for a certain site and take into account past climatic conditions, they are significantly lighter and more durable than conventional buildings. Column without any spaces. Large, bulky machinery in industries typically need a lot of space, but conventional buildings are limited in this regard because of their numerous columns. Conversely, one benefit of pre-engineered buildings is that they offer a free span. For this reason, pre-engineered buildings, a novel idea in the construction sector, are highly advantageous for our nation's industrialists.

Mr. Mahesh Bhanudas Palve , Prof. S A Mishra (2022) noted the differences in the amount of steel used when using different types of PEBs, such as regular, mono slope, and curved frame PEBs. To do this, the analysis was conducted using the FEM-based software ANSYS, using the optimized section for loads and load combinations calculated by excel sheet, taking into account DL, LL, and WL with the combination in accordance with IS 800: 2007. In this instance, stresses were found for design loads, and the stress ratio of the support frame was found with quantity of steel and compared with each other to determine the most cost-effective type of PEB. The curved or arched frame is the most cost-effective of the three frame types—regular, mono slope, and curved—and it uses 8.84% less steel than the standard frame. Compared to standard frames, mono slope frames use 1.3 times as much steel. Additionally, a typical frame has been used to determine the major stress that leads to failure.

Nikita D Radake , R V R K Prasad (2022) The industrial building in question, which measures 60 meters in length, 30 meters in width, and 10 meters in eaves height, is situated in Vijayawada. Its roof slopes vary, ranging from 5.71° to 7.125°, and STAAD Pro V8i is used to analyze and design the structure. The structure weight in Vijayawada is 11.04% greater than that of the structure in Hyderabad. The PEB system is a cutting-edge technique in steel structure design that offers affordable, sustainable, and environmentally friendly constructions. This methodology's versatility stems from its lightweight and cost-effective construction as well as from its excellent pre-designing and prefabrication. Compared to the conventional steel building (CSB) design, which calls for structures with roof trusses, this idea provides a number of advantages. Using Staad Pro, a warehouse structure is designed as both a CSB and PEB in order to complete the study. AISC 360:10 is used to design and analyze the PEB, while IS 800:2007 (LSM) is used to create and analyze the CSB.

3. GENERAL GUIDELINES FOR PEB DESIGN

The following are the general rules that must be adhered to in order to safely design and construct PEB structures as required by numerous international standards:

i. The design must adhere to the IS codes (as specified by the client).

ii. Take Load into Account: Considerations made for general building construction loads. They are as follows:

According to IS:875 (Part 1), dead loads comprise the self-weight of frames and secondary components (purlins, roof and wall sheeting, insulation, etc.). usually accepted as 0.10 kN/m2.

b. Live loads: They must be calculated in accordance with IS: 875 (Part 2). According to the IS code, it is 0.75 kN/m2.

c. Wind Loads: Internal and external wind coefficients must be determined in accordance with IS code, as specified in IS: 875 (Part 3).

d. Seismic loads: In accordance with IS: 1893: (Part 1).2016.

e. Collateral Loads: As per IS: 875 (Part 1), it comprises the weight of additional permanent materials other than dead loads, such as solar panels. Usually measured in the range of 0.1 and 0.3 kN/m2

f. Load Combinations: According to section 5.3.3 of IS 800:2007, table 4. To assess the PEB system's performance, the study tabulates the various load combinations that are accessible in Table 6.

4. CONCLUSIONS

In the present work, PEB constructions are more cost-effective and save material. Although PEB is being used more frequently, its use is not as high as anticipated. The studies demonstrate how simple it is to create PEB structures. These plans are effective and enable quick construction. Compared to CSB, these structures are more dependable. Therefore, more study is needed to produce more outputs for design techniques and to reduce the amount of material in PEB structures.

Two models, one for the PEB and one for the CSB, are taken into consideration using staad-pro, multi-story commercial buildings. Each model has a different seismic zone research. Analyze the models' effectiveness in light of weight and cost comparisons. A commercial building is designed and analyzed using Staad.Pro. V8i, a structural analysis and design software, in accordance with IS 800-2007. Loads are computed using IS 875-1987 (Parts I, II, and III), and the outcomes are contrasted.

REFERENCES

[1] B.Meena Sai Lakshmi , M. K. M. V. Ratnam and M. K. S. S.Krishna Chaitanya " Comparative Study of Pre Engineered and Conventional Steel Building" International Journal of Innovative Research in Technology, Volume 2 Issue 3 ,2015

[2] Gite Kalyani Dilip, M. P. Wagh, "Design and Analysis of PEB Warehouse Using Staad-Pro" International Journal of All Research Education and Scientific Methods, Volume 9, Issue 7, 2021

[3] L. Maria Subashiniand Shamini Valentina "Comparative Study of Pre Engineered and Conventional Industrial Building" Indian Journal of Science and Technology, Volume 8(32), 2015

[4] Monika Nakum, Jigar Zala, Darshan Shah "cost effectiveness of multi storey CSB & PEB industrial steel building "Journal of Emerging Technology and Innovative Research, Volume 4, Issue 04 JETIR 2017

[5] Mr. Mahesh Bhanudas Palve1 , Prof. S A Mishra "Analytical Study PEB Over CSB Structure Using Intermediate Support: A Systematic Review On Recent Studies" Journal of Emerging Technology and Innovative Research, Volume 9, Issue 5 2022

[6] Muhammad Umair Saleem, Hisham Jahangir Qureshi "Design Solutions for Sustainable Construction of Pre Engineered Steel Buildings" Multidisciplinary Digital Publishing Institute, 2018

[7] Nikita D Radake , R V R K Prasad "A Review on Comparative Study between the Pre-Engineered Building and Conventional Steel Building" International Journal for Research in Applied Science & Engineering Technology, Volume 10 Issue 4, 2022

[8] Pradip S. Lande, Vivek V. Kucheriya "Comparative Study of an Industrial Pre-Engineered Building with Conventional Steel Building" Journal of Civil Engineering and Environmental Technology, Volume 2, 2015

[9] Neha Puri & Vikas Garg, "Cost And Comparative Analysis Of Pre-Engineered Buildings With Conventional Buildings" Amity Journal of Strategic Management, Volume 04, Issue 01, 2021

[10] Swati Wakchaure, N.C.Dubey "Design and Comparative Study of Pre-Engineered Building" International journal of Engineering Development and research, Volume 4, Issue 2,2016