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ANALYSIS AND DESIGN OF PRE-ENGINEERED BUILDING USING STAAD PRO

Dr. Mohd Zaker[1], Syed Asim Ahmed[2], Sufia Moiz[3], Abdul Mudassir[4], Syed Raiyaan Ahmed Hashmi[5]
[1] Associate Professor, Deccan College of Engineering and Technology
[2,3,4,5] UG, Deccan College of Engineering and Technology

ABSTRACT- This project focuses on the design of a casting yard using the Pre-Engineered Building (PEB) concept. Unlike conventional steel structures that rely on standard hot-rolled sections and often result in material wastage, PEBs use customized tapered sections fabricated from standard steel plates, allowing efficient material distribution and minimizing steel usage in low-stress areas. PEBs offer several advantages, including a 30–40% reduction in both steel consumption and construction time, making them highly cost-effective. Their prefabricated components enable faster project execution, improved quality control, and minimal on-site disruption. The flexibility in design allows the structure to meet specific architectural and industrial requirements while also supporting future expansion or modification. In this project, the casting yard—a covered facility for producing precast concrete elements such as I-girders, beams, and slabs—is planned with tailored functionality, ensuring adequate space, structural support, ventilation, and durability for heavy-duty operations. The use of the PEB system in such an application ensures a smart, modern, and sustainable approach to construction, delivering both efficiency and long-term value.

I. INTRODUCTION

A Pre-Engineered Building (PEB) is a steel structure designed and fabricated using efficient materials and methods to meet various structural and aesthetic needs. These buildings are pre-designed in standard sizes and use mass-produced components for roofing, cladding, gutters, windows, and more, allowing for faster and more economical construction. Advanced design software is used to optimize material use based on load conditions like wind, seismic forces, and snow. Steel is preferred for its strength, flexibility, and ease of modification.

The main frame of a PEB consists of welded I-shaped members, often tapered to match bending moment requirements—deeper where stress is higher. These are assembled on-site using bolted connections. Cold-formed Z and C sections are used as secondary members to support cladding and roofing. Compared to traditional steel buildings, PEBs offer greater efficiency, cost savings, and faster construction.

II. LITERATURE REVIEW

PRATIK A. RAUT1, PROF. S. V. SHELAR2 reviewed that long Span, Column free structures square measure the foremost essential in any sort of industrial structures and Pre designed Buildings (PEB) fulfills this demand at the side of reduced time and value as compared to standard structures. The Pre-engineered steel building system construction has nice blessings to the one level buildings, sensible and economical various to standard buildings, the System representing one central model inside multiple disciplines. Long Span, Column free structures square measure the foremost essential in any sort of industrial structures and Pre designed Buildings (PEB) fulfils this demand at the side of reduced time and value as compared to standard structures. this work involves the analysis and style of Pre designed Buildings (PEB) that is found in Chakan. During this work Drawing is done by AutoCAD package, Analysis is completed by Staad Pro package.

(MRUNALI SURPAM et al, 2022)

Nowadays, pre-engineered building (PEB) structures are getting very popular globally. These types of structures are manufactured in factories and erected on site. Also, these structures are economical, eco-friendly and recyclable. PEB heavy structures need advanced software like SAP2000 for analysis and design. The objective of the current study is to check performance of PEB structures. The parameters used for analysis and design are bay spacing, frame spacing, wind analysis and earthquake analysis. The bay spacings 5 m, 8 m and 9 m and the frame spacings 20 m, 35 m and 50 m are considered. Basic wind speed from 33 m/s to 50 m/s is selected for wind analysis and zone III is selected for seismic analysis. The design is carried out by using Indian Standard Code 800:2007. The comparison of the PEB structures and conventional steel building (CSB) structures has been determined on the basis of weight of the frame sections, sway and deflection of the steel frames. The result shows that, percentage of weight reduction of PEB structures is about 30% to 40% compared with CSB structures. Result of sway analysis shows that the span length increased from 20 to 50 m gives less deflection, and also in earthquake analysis PEB structures show less deflection compared with CSB structures. The study concludes that PEB structures are economical, lightweight and safer than CSB structures.

(T. BHARAT BHUSHAN GUPTA et.al, 2022)

This article used ETABS software to analyze and design a pre-engineered building that is 120 meters long, 35 meters wide, and 24 meters high at the eaves. In this thesis, I took into account different bay spacing like 5m, 7.5m, and 10m in order to understand the behavior of pre-engineered structures and to comprehend the geometric effect on pre-engineered buildings. Pre-Engineered Buildings, which take less time and money to construct than traditional structures, meet the criterion for long Span, Column Free Structures, which is the most important in any sort of Industrial Structures. All loads and load combinations are manually computed in accordance with IS 875 (Part I–IV) – 1987, and the ETABS programme assigns an earthquake load automatically. The ETABS 2019 modelling and analysis software is used for all models. Additionally, for different bay spacings, the studied performance based on analysis results such as bending moments, shear forces, and results of all centre and gable rafters and centre and gable columns are compared.

(PRITAM MALI et.al, 2019)

Long Span, Column free structures are the most essential in any type of industrial structures and Pre-Engineered Buildings (PEB) fulfills this requirement along with reduced time and cost as compared to conventional structures. The present work involves the comparative study and design of Pre Engineered Buildings (PEB) and Conventional steel frames. Design of the structure is being done in Staad Pro software and the same is then compared with conventional type, in terms of weight which in turn reduces the cost. Three examples have been taken for the study. Comparison of Pre-Engineered Buildings (PEB) and Conventional steel frames is done in two examples and in the third example, Pre-Engineered Building structure with increased bay space is taken for the study. In the present work, Pre Engineered Buildings (PEB) and Conventional steel frame's structure is designed for wind forces. Wind analysis has been done manually as per IS 875 (Part III)-1987.

- Analysis And Design of Pre-Engineering Building (2021) B Uday, A Nagaraju In this case study, analysis and design terminology for the pre-engineered building which can be also fitted with different accessories mezzanine floors, canopies, partition etc., compared with conventional steel buildings. Based on static and dynamic analysis the PEB has been designed and code provisions used are IS 800-2007, IS1893 (Part III), SP16 and IS 875-1987(Part III). This study provides the process of PEB from designing, fabrication and erection of the

structure.

- Jaya Tamrakar, Dr. Anil Kumar Saxena (2022) reviews the concepts of pre-designed building ideas incorporating pre-engineered steel building systems. This modern building method prioritizes aesthetics, quality, speed, and cost-effectiveness. Implementation of Pre-Designed Building (PEB) is a current concept in which steel structure is used and the design is providing economic security. Although compared to other building technologies, pre- engineered construction is more sustainable and stands out when compared to other technologies. In the current circumstances, revenue is becoming increasingly important in all industries, including the building business. Sustainability is something that the globe strives for. Using high-quality steel and sophisticated building forms can result in the most cost-effective construction. The building cost analysis of the model revealed that PEB structures are as economical as structural elements.

III. NEED OF STUDY

Through a variety of new products and services, technological advancements in each Industry has contributed to the improvement of quality of life. One of the construction Industry's revolutions is the pre-engineering building structure (PEB structure). Traditional steel building structures have long had a problem with excessive steel consumption and greater structure costs (CSB structure). However, the PEB structure concept includes appealing elements that optimize the design, such as members that are developed according to the steel frame's bending moment diagram, resulting in a structure that is efficient in terms of steel consumption and cost. In any sort of industrial structure, column-free structures with extensive spans are needed, and PEB structures meet this criterion while taking less time and money than CSB structures. That is why, in addition to maintaining the quality of predesign and prefabrication, this process is adaptable due to its lightweight and cost-effective design.

IV. OBJECTIVES OF STUDY

1. The main objective of Pre-Engineered Building (PEB) structures is to provide a fast, cost-effective, and durable building solution using standardized, factory-made components.

2. PEBs offer a modular system that expedites construction, reduces material waste, and allows for flexible design time. Also, addition and alteration can be made easily into steel structures. Historically, the primary framing structure of a pre engineered building is an assembly of I-shaped members, often referred as I-beams. In pre-engineered buildings, the I beams used are usually formed by welding together steel plates to form the I section. The I beams are then field-assembled (e.g. bolted connections) to form the entire frame of the pre-engineered building. Some manufacturers taper the framing members (varying in web depth) according to the local loading effects. Larger plate dimensions are used in areas of higher load effects. In conventional steel buildings, hot rolled sections are used. The size of each section is selected on the basis of maximum internal stress in the member. The Frames of the pre-engineered building are according to a bending moment diagram. Thus the BM is maximum at mid span and at fixed support. Thus, at maximum BM the depth of section is large and depth is reduced depending on BM. Cold formed Z and C Shaped members as secondary structural elements to fasten and support the external cladding.

V. METHOD

1. Utilization Ratio (UR):

A UR ≤ 1.0 means every member is strong enough for the applied loads.

It signifies the member is neither overdesigned (UR ≪ 1) nor under designed (UR > 1).

2. Structural Safety Achieved:

The structure is then safe and efficient under the applied load combinations and design parameters.

All checks (axial, bending, shear, etc.) are in accordance with the applicable code provisions (e.g., IS 800:2007 for steel).

VI. CRITICAL APPRAISAL

Evaluating how accurately STAAD Pro models the behavior of PEB structures under different load conditions is crucial. Assessing the software's ability to handle complex PEB designs, including tapered sections, cold-formed members, and various connection types, is important. Evaluating how well STAAD Pro facilitates the optimization of design parameters to achieve material economy and structural efficiency is essential.

VII. CONCLUSION

Analysis of Pre-Engineered Industrial Building was done by using STAAD Pro connect version for various load combinations. The results such as maximum bending moment, shear force, axial force were taken to the design of structural elements. Throughout the design of rafters, it was tried to reduce the maximum depth of the member based on bending moment at various sections. They also offer flexibility throughout the design phase. The building has a nice architectural viewpoint. PEB offers the least displacement under the load situation according to the investigation. PEB constructions are lighter and more wind-resistant. In the construction industry, among students and others, the understanding of PEB should be enhanced rather than concentrating on RCC.

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