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Study of Pre-Engineered and Conventional Steel Structure: A Review

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Abstract: ***Pre-Engineered Buildings (PEB) have gained significant importance in recent years due to their structural efficiency, economy, and reduced construction time compared to Conventional Steel Buildings (CSB). This paper presents a comparative study between a Pre-Engineered Building and a Conventional Steel Building using STAAD.Pro structural analysis software. Both structural systems are modeled with identical geometry, span, bay spacing, support conditions, and loading parameters to ensure a fair comparison. Dead load, live load, wind load, and seismic load combinations are applied as per Indian Standard codes IS 875 (Parts 1–3) and IS 1893 (Part 1). The comparison is based on parameters such as steel consumption, bending moments, shear forces, axial forces, storey displacement, and base shear. The results indicate that PEB structures provide significant reduction in steel quantity due to the use of tapered built-up sections while satisfying strength and serviceability criteria. The study concludes that Pre-Engineered Buildings designed using STAAD.Pro are more economical and structurally efficient than Conventional Steel Buildings.***

Keywords: Pre-Engineered Buildings, Conventional Steel Buildings, STAAD.Pro, Structural Analysis, Steel Optimization

I. INTRODUCTION

The rapid growth of industrialization and infrastructure development has increased the demand for fast, economical, and structurally efficient construction systems. Conventional steel buildings have been widely used for industrial and commercial structures; however, they often involve higher steel consumption and longer construction durations. With advancements in structural engineering and fabrication techniques, Pre-Engineered Buildings (PEB) have emerged as an effective alternative to conventional steel construction.

In PEB systems, structural members are designed as built-up tapered x`sections based on actual bending moment requirements, unlike conventional buildings where hot-rolled prismatic sections are used throughout. This optimization results in better material utilization and reduced overall cost.

Structural analysis software such as STAAD.Pro plays a crucial role in accurately analyzing and designing both PEB and conventional systems under various loading conditions. This study aims to perform a comparative analysis of Pre-Engineered and Conventional Steel Buildings using STAAD.Pro to evaluate their structural performance and economic feasibility under identical loading and boundary conditions.

II. LITERATURE REVIEW

Several researchers have carried out analytical and comparative studies on Pre-Engineered Buildings and Conventional Steel Buildings to evaluate their structural performance, economy, and suitability for industrial applications. With the advancement of structural analysis software such as STAAD.Pro, accurate modeling and comparison of different structural systems have become possible.

Pradip S. Lande and Vivek V. Kucheriya have contributed significantly to the comparative evaluation of Pre-EngineeredNBuildings (PEBs) and Conventional Steel Buildings (CSBs) for industrial structures. Their research aligns with broaderNstudies indicating that PEB systems provide improved structural efficiency through the use of tapered built-up sections and cold-formed steel members. Literature in this domain shows that conventional steel buildings, which rely on hot-rolled sections and roof truss systems, often result in higher structural weight and increased material consumption. Analytical investigations using STAAD.Pro have demonstrated that PEBs achieve better load distribution under dead, live, and wind loads, leading to reduced steel quantity and improved economy. Studies also highlight that cold-formed steel purlins used in PEBs offer superior strength-to-weight ratios compared to traditional hot-rolled purlins, contributing to overall weight reduction. Overall, research confirms that PEBs are more economical, faster to construct, and structurally efficient for large-span industrial buildings while satisfying codal safety and serviceability requirements.

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Nikita D. Radake and R. V. R. K. Prasad carried out a comparative investigation between Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) to evaluate their structural behaviour and economic efficiency for industrial applications. Their study demonstrates that PEB systems, which utilize tapered built-up sections and cold-formed secondary members, achieve significant reductions in overall steel weight compared to CSBs designed with hot-rolled sections. Using STAAD.Pro for analysis and design, the authors assessed structural performance under dead, live, and wind loads as per IS 800:2007, IS 875, and AISC 360 provisions. The results indicated lower support reactions and axial forces in PEB structures, leading to reduced foundation demand and improved material optimization. The study further highlights that although PEBs show higher bending and shear forces in certain members, they remain within permissible limits and offer superior economy. Overall, the research confirms that PEBs are more efficient and cost-effective than CSBs for large-span, single-storey industrial buildings.

K. Srinivasan and K. Selvakumar (2022) presented a comparative study between Pre-Engineered Buildings (PEBs) and space truss systems to evaluate their structural efficiency for different span lengths. Their research focused on industrial buildings with spans of 20 m and 30 m, analysed and designed using STAAD.Pro in accordance with Indian Standard codes. The study revealed that PEB systems, which use tapered built-up primary members and cold-formed secondary elements, perform efficiently for moderate spans due to optimized material distribution. However, for larger spans, space truss systems demonstrated better structural economy owing to their three-dimensional load transfer mechanism and reduced weight-to- area ratio. The authors highlighted that although PEB weight increases proportionally with span due to inclusion of secondary members, space truss structures become more economical as span length increases. Overall, the research provides valuable insight into span-dependent structural selection, indicating that PEBs are suitable for medium spans, while space trusses offer advantages for long-span applications.

Pornima Pritish Naik and S. H. Mahure (2021) carried out a comparative investigation between Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) to evaluate structural efficiency, material optimization, and cost effectiveness for industrial buildings. Their study focused on a large-span single-storey warehouse structure analysed and designed using STAAD.Pro V8i in accordance with Indian Standard codes. The research demonstrated that PEB systems, which utilize tapered built-up sections and optimized member geometry, result in significant reductions in overall steel weight and construction cost compared to CSBs employing hot-rolled sections and roof truss systems. The authors also highlighted that PEBs benefit from faster construction, better quality control due to factory fabrication, and reduced foundation loads. The comparative results showed that PEBs achieved nearly 15% savings in both weight and cost while maintaining structural safety and serviceability. Overall, the study confirms that PEBs are a more economical and efficient alternative to conventional steel buildings for long-span industrial applications.

Swetha Pantheeradi and Susan Abraham (2022) presented a comparative evaluation of Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) by analysing a warehouse structure designed using STAAD.Pro. Their study examined structural behaviour, steel quantity, and internal forces under dead, live, and wind loads as per Indian Standard provisions. The results showed that PEB systems, which utilize tapered built-up primary members and cold-formed Z- purlins, achieve substantial reduction in steel consumption compared to CSBs that rely on hot-rolled sections and roof truss systems. The authors also observed that bending moments and shear forces are generally higher in PEB frames at critical locations such as ridge and haunch due to concentrated load transfer, whereas CSB systems distribute forces through truss action. Despite this, PEBs were found to be more economical, faster to construct, and better suited for large-span industrial buildings. The study concludes that while PEBs offer significant advantages, selection between PEB and CSB should consider span, location, and project constraints.

Sudhir Singh Bhadoria and Yash Pathak (2017) conducted a comprehensive comparative study between Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) by analysing multiple structural models with spans ranging from 10 m to 50 m. Using STAAD.Pro software, both systems were evaluated under dead, live, wind, and seismic loads to assess steel consumption and cost efficiency. The study demonstrated that PEB systems, which employ tapered built-up primary members designed according to bending moment distribution and cold-formed secondary members, achieve significant reductions in steel quantity compared to CSBs using hot-rolled uniform sections. The results indicated that PEBs provide nearly 30% savings in steel consumption for spans up to 30 m, leading to reduced foundation loads and overall project cost. However, for larger spans beyond 40 m, the difference in steel quantity between PEB and CSB systems was found to be marginal. Overall, the research confirms that PEBs are structurally efficient, economical, and well-suited for industrial buildings, particularly for moderate clear spans.

Neeraj Kumar and K. S. Grover (2022) presented a detailed comparative study of Conventional Steel Buildings (CSBs) and Pre-Engineered Buildings (PEBs) using STAAD.Pro to evaluate structural behaviour, steel quantity, and lateral displacement. The authors analysed industrial buildings with varying spans ranging from 10 m to 50 m and designed them in accordance with IS 800:2007 and IS 875 provisions. Their study demonstrated that PEB systems, which employ tapered built-up primary members and cold-formed secondary components, result in lower steel consumption and reduced self- weight compared to CSBs using uniform

hot-rolled sections. Results showed that PEB structures generally exhibit slightly higher lateral displacement due to reduced stiffness; however, the values remained within permissible limits. The study also highlighted that reduced dead load in PEBs leads to smaller foundation sizes and improved construction economy. Overall, the research confirms that PEBs offer superior material efficiency and cost effectiveness for industrial buildings whilemaintaining structural safety and serviceability.

Tejashwini B. Siddangoudar and Parasharam Sawant (2024) carried out a comparative analysis of Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) for a large-span industrial warehouse using STAAD.Pro V8i. The study evaluated structural performance, steel quantity, displacement behaviour, and overall cost by analysing both systems under dead, live, wind, and seismic loads as per Indian Standard codes. The authors observed that PEB systems, which use tapered built-up primary members and cold-formed secondary elements, result in significant reduction in steel weight compared to CSBs with truss or uniform portal framing. Although PEB structures exhibited slightly higher lateral displacements due to reduced stiffness, the values were within permissible limits. The research also highlighted that load concentration in portal frames increases axial forces in PEB columns, yet overall economy is achieved due to reduced material usage and faster construction. The study concluded that PEBs are approximately 25% lighter and more cost- effective than CSBs, making them suitable for modern industrial buildings.

Chetan Tagade, A. D. Shende, B. S. Ruprai, et al. (2023) conducted a detailed analytical comparison of Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) to evaluate their structural behaviour, steel consumption, and economic feasibility. Their study focused on industrial buildings with spans of 15 m and 20 m, analysed using STAAD. Pro V8i under dead, live, and wind loads in accordance with IS 800:2007 and IS 875 provisions, while PEB design was also verified using AISC 360. The results indicated that PEB systems, which employ tapered built-up primary members and cold-formed purlins, significantly reduce overall steel weight compared to CSB structures using hot-rolled truss systems. Although PEB frames exhibited comparatively higher lateral displacement due to reduced stiffness, the values remained within permissible limits. The study further highlighted that reduced self-weight in PEBs leads to lower support reactions and foundation demands. Overall, the research confirms that PEBs are approximately 25–30% lighter and more economical than CSBs, making them suitable for modern industrial applications.

Hitesh Jibhkate and Dilip L. Budhlani (2021) presented a comparative analytical study of Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) using STAAD.Pro to evaluate structural performance, steel quantity, and overall efficiency. The authors analysed a G+3 industrial warehouse structure designed according to IS 800:2007 and IS 875 provisions. Their study revealed that PEB systems, which adopt tapered built-up sections and cold-formed secondary members, result in significant reduction in steel consumption compared to CSBs that use uniform hot-rolled sections throughout the member length. Although PEB frames exhibited higher lateral displacements due to reduced stiffness, these values remained within permissible codal limits. The results also indicated lower axial forces, bending moments, and supportreactions in PEB structures, leading to lighter foundations and reduced construction cost. Overall, the research confirms that PEBs offer superior material optimization, faster construction, and improved economy, making them a preferable solution for multi-storey industrial buildings.

Omkareshwar Prabhakar Tekale and Swati Ambadkar (2024) presented a detailed analytical comparison of Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) for industrial structures using STAAD.Pro. Their study evaluated multiple structural configurations under various loading conditions to examine displacement behaviour, support reactions, and internal forces. The results indicated that PEB models generally exhibit reduced displacement compared to CSB models due to optimized structural configuration and efficient material utilization. However, the authors also observed that certain PEB configurations with larger bay spacing resulted in higher reactions and beam forces, highlighting the importance of configuration-based design optimization. The study emphasized that although PEBs provide advantages such as reduced material usage, faster construction, and improved economy, careful selection of bay spacing and framing system is essential to control forces and reactions. Overall, the research contributes to a better understanding of the comparative structural performance of PEB and CSB systems and supports informed decision-making in industrial building design.

Syed Firoz, Sarath Chandra Kumar B., et al. (2012) presented a comprehensive study on the design concept of Pre-Engineered Buildings (PEBs), focusing on their structural efficiency, constructability, and suitability for industrial applications. The authors discussed the evolution of PEB systems and emphasized the role of cold-formed steel secondary members combined with tapered built-up primary frames in achieving optimized material usage. Their study highlighted that conventional steel buildings often use uniform hot-rolled sections, leading to excess steel consumption, whereas PEB systems closely follow bending moment distribution, resulting in lighter and more economical structures. The paper also detailed the application of STAAD.Pro software for analysis and design, demonstrating its effectiveness in modeling, load application, and member optimization for PEB structures. Additionally, the authors outlined various framing configurations, roof systems, and secondary components that influence structural performance

and cost. Overall, the study established that PEBs offer faster construction, improved design flexibility, and significant cost savings, making them a practical alternative to conventional steel buildings.

M. D. Gawade and U. P. Waghe (2018) presented a detailed study on the concept and design philosophy of Pre-Engineered Buildings (PEBs), emphasizing their efficiency, speed of construction, and material optimization compared to Conventional Steel Buildings (CSBs). The authors highlighted that the use of web-tapered built-up members for columns and rafters allows PEB systems to closely follow bending moment distribution, resulting in significant reduction in structural weight. The study discussed the practical limitation of Indian Standard IS 800:2007 in addressing tapered members, which leads PEB industries to adopt American standards such as AISC and MBMA for design while retaining Indian codes for load calculations. The authors also explained the role of cold-formed steel members used as secondary framing, contributing to improved strength- to-weight ratio and faster erection. Overall, the study established that PEBs provide superior economy, reduced construction time, and better design flexibility, making them suitable for modern industrial and commercial buildings.

Awais Iqbal and B. H. Shinde (2023) carried out a comprehensive comparative study between Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) to evaluate differences in steel consumption, cost, and structural performance. The study involved modelling and analysis of an industrial building using STAAD.Pro, with both systems designed according to relevant Indian Standard codes. The authors reported that CSB structures require a significantly higher quantity of steel compared to PEBs due to the use of uniform hot-rolled sections, whereas PEBs utilize tapered built-up members that closely follow bending moment distribution. Results showed that PEBs achieved nearly 40% reduction in steel quantity and overall construction cost. The study also highlighted that support reactions in PEBs are lower, leading to more economical foundation design. Although bending moments and shear forces were higher in some PEB members due to tapered geometry, all values remained within permissible limits. Overall, the research confirms that PEBs provide superior economy, faster construction, and efficient structural performance for industrial buildings. Pradeep V. and Papa Rao G. (2014) carried out a comparative analytical study of Pre-Engineered Buildings (PEBs) and

Conventional Steel Buildings (CSBs) for an industrial structure to evaluate structural behaviour, steel consumption, and overall efficiency. The study involved modelling both systems using STAAD.Pro V8i and analysing them under dead, live, wind, and seismic loads as per Indian Standard provisions. The authors reported that PEB systems, which employ tapered built-up primary members and cold-formed secondary members, result in significantly lower steel quantity compared to CSB systems using uniform hot-rolled sections. The results showed reduced axial forces and support reactions in PEB structures, leading to lighter foundations and lower construction cost. Although bending moments were higher in some PEB members due to tapered geometry, all values remained within permissible limits. Overall, the study concluded that PEBs provide better economy, faster construction, and improved material optimization, making them suitable for long-span industrial buildings.

Mustak Khan A. V., A. V. Patil, et al. (2025) carried out a parametric study on Pre-Engineered Buildings (PEBs) with emphasis on portal frame configuration incorporating varying bay spacing and roof angle. The study focused on understanding how geometric parameters influence structural behaviour, steel consumption, displacement, and overall efficiency of industrial warehouse structures. Using STAAD.Pro and designing as per AISC 360-16 provisions, multiple PEB models were analysed under dead, live, and wind loads. The results indicated that increasing bay spacing leads to higher bending moments, support reactions, and steel utilization, while roof slope variation significantly affects displacement and force distribution in rafters and columns. The authors observed that an optimal combination of bay spacing and roof angle can considerably reduce steel quantity without compromising safety or serviceability. The research highlights the importance of parametric optimization in PEB design to achieve economical and structurally efficient solutions, and provides valuable guidance for selecting suitable geometric parameters in industrial building design.

Pratik M. Londhe, Rohan Vilas Ambekar, et al. (2024) presented a case-study-based comparative analysis of Conventional Steel Buildings (CSBs) and Pre-Engineered Buildings (PEBs) to evaluate cost effectiveness and steel consumption. The study focused on an industrial building modelled with identical dimensions for both systems, and detailed cost estimation was carried out using Excel-based quantity calculations. The authors reported that CSBs, which rely on uniform hot-rolled sections, result in higher steel quantity, transportation cost, and labour requirements. In contrast, PEB systems use tapered built-up primary members and cold-formed secondary elements, leading to significant material optimization. The comparative results showed that PEB structures achieved approximately 40% overall cost savings compared to CSBs, mainly due to reduced steel weight and faster erection. The study concludes that PEBs are more economical and suitable for large-span industrial buildings, especially when cost and construction speed are critical factors.

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Abhyuday Titiksh, Abhinav Dewangan, et al. (2015) carried out a comparative study of Conventional Steel Buildings (CSBs) and Pre-Engineered Buildings (PEBs) for industrial shed applications. The study focused on evaluating construction time, material efficiency, structural performance, and economy. The authors highlighted that conventional steel buildings generally rely on hot-rolled truss systems with uniform cross-sections, leading to higher steel consumption and longer erection time. In contrast, PEB systems utilize pre-designed tapered built-up membersa nd prefabricated components, enabling faster construction and improved material optimization. Through analytical and case-study-based comparison, the research demonstrated that PEBs offer significant advantages in terms of reduced construction duration, lower self-weight, and enhanced flexibility for future expansion. The authors also emphasized the suitability of PEBs for large clear-span industrial sheds, where column-free spaces and rapid project execution are critical. Overall, the study concludes that PEBs are more economical, energy-efficient, and adaptable than conventional steel buildings for industrial applications.

Nitin Vishwakarma and Hardik Tayal (2018) presented an optimization-based comparative study of industrial buildings designed using Pre-Engineered Building (PEB) systems and Conventional Steel Building (CSB) systems under fully stressed design principles. The study analysed multiple structural models using STAAD.Pro by varying member sections and optimization constraints to minimize steel weight while satisfying strength and serviceability requirements. The authors compared PEB portal frames with conventional truss-based steel systems employing different section types such as ISMB, circular hollow sections, and rectangular hollow sections. The results indicated that PEB systems achieved substantial reduction in steel consumption due to the use of tapered built-up members that closely follow bending moment distribution. It was also observed that conventional steel systems resulted in higher portal weight and nodal deflections compared to optimized PEB frames. The study concluded that PEBs designed using fully stressed optimization techniques provide better structural efficiency, reduced material usage, and improved economy, making them highly suitable for large-span industrial buildings.

Pushkar Narendra Somvanshi, Dinesh Sanjay Nagare, et al. (2025) presented a comprehensive review comparing Conventional Steel Buildings (CSBs) and Pre-Engineered Buildings (PEBs) using STAAD.Pro for structural analysis. The study focused on industrial warehouse buildings designed as per IS 800:2007 and AISC specifications to evaluate structural efficiency, steel optimization, and performance under critical load combinations. The authors highlighted that PEB systems, which employ tapered built-up primary members and cold-formed secondary elements, offer significant reductions in steel quantity, construction time, and overall project cost when compared to CSBs using uniform hot-rolled sections. The review emphasized the role of STAAD.Pro in optimizing member sizes, assessing deflections, and ensuring compliance with codal provisions. Overall, the study concluded that PEBs provide improved economy, faster execution, and better adaptability for large-span industrial buildings, making them a preferred choice over conventional steel structures in modern construction practice.

Kavya Rao M. N. and K. N. Vishwanath (2014) presented a design-optimization-based comparative study of an industrial structure transitioning from a Conventional Steel Building (CSB) to a Pre-Engineered Building (PEB) system. The study involved modelling and analysing both systems using STAAD.Pro under dead, live, and wind loads as per IS 800 and IS 875 provisions. The authors observed that conventional steel buildings rely on standard hot-rolled sections, which often lead to excess steel usage due to limited flexibility in section sizing. In contrast, PEB systems utilize tapered built-up members designed according to bending moment distribution, resulting in reduced steel quantity and improved structural efficiency. The comparative results showed that PEBs exhibited lower bending moments, shear forces, and support reactions, which translated into lighter foundations and reduced construction cost. The study also highlighted faster construction timelines for PEBs due to factory fabrication and bolted connections. Overall, the research confirms that PEBs offer superior economy, optimized material usage, and improved performance for industrial building applications.

M. Varshitha and B. D. V. Chandra Mohan Rao (2024) carried out a detailed comparative analysis of Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs) with emphasis on steel take-off, structural response, and cost effectiveness. The study involved modelling identical PEB and CSB industrial structures using STAAD.Pro and analysing them under dead, live, wind, and seismic loads as per IS 875 and IS 1893 provisions. More than seventy load combinations were considered to identify critical design cases. The results showed that PEB systems, which utilize tapered built-up primary members and optimized secondary components, require significantly less steel than CSBs using standard hot-rolled sections. Comparative evaluation of bending moment, shear force, axial force, and support reactions indicated marginal variation between the two systems while maintaining structural safety. The authors reported that steel consumption in PEBs was reduced by approximately 25% compared to CSBs. Overall, the study confirms that PEBs offer superior material efficiency, reduced cost, and faster construction, making them suitable for sustainable industrial building construction.

Somasundhara Naathan M. G. and Ramadevi K. (2022) presented a comparative study on Pre-Engineered Building (PEB) structures and Conventional Industrial Buildings with a focus on steel quantity optimization and structural economy. The study emphasized the increasing cost of steel in industrial construction and highlighted the necessity of adopting efficient structural systems. The authors analysed industrial steel structures designed as roof truss systems with crane loads of 10 T, 15 T, and 20 T, and compared conventional steel framing with pre-engineered alternatives. Their findings indicated that PEB systems, due to optimized member sizing, prefabrication, and lighter structural components, achieve significant reduction in steel consumption compared to conventional industrial buildings. The study also noted that reduced self-weight leads to lower foundation demand and faster construction. Overall, the research supports the adoption of PEB systems for long-span industrial buildings where economy, speed of execution, and material efficiency are critical, especially in crane-supported structures.

Muhammad Umair Saleem (2018) presented an in-depth study on the design optimization of pre-engineered steel truss buildings with the objective of achieving minimum structural weight while satisfying strength and serviceability requirements. The research focused on industrial roof truss systems and investigated the influence of key parameters such as truss height, section type, and geometry on overall steel consumption. Using analytical modelling and optimization techniques, various configurations employing hot-rolled steel sections and hollow steel sections were evaluated. The study demonstrated that increasing truss depth initially reduces steel weight and deflection; however, beyond an optimum height, both parameters increase due to higher self-weight. The author highlighted that hollow steel sections provide better structural efficiency compared to conventional hot-rolled sections due to improved strength-to-weight ratio. The optimized pre-engineered truss systems showed significant reduction in weight, lateral sway, and deflection when compared to conventional steel truss configurations. Overall, the study establishes that design optimization plays a crucial role in enhancing the efficiency and economy of pre-engineered steel truss buildings.

Gokul P. T., Satheesh Kumar K. R. P., et al. (2023) presented a comprehensive review on optimization strategies for Pre-Engineered Buildings (PEBs) with the objective of enhancing structural efficiency and cost effectiveness. The review synthesizes findings from prior studies on geometric optimization, particularly the influence of bay spacing, roof angle, and span on steel consumption, internal forces, and displacement. The authors discuss tapering patterns in columns and rafters, noting that depth variation aligned with bending moment distribution leads to significant material savings. The paper also highlights observed failure patterns in moderate-to-long span PEBs and emphasizes the role of optimization in mitigating member overstress. Additionally, the review underscores the integration of computational methods and numerical optimization to balance structural safety with sustainability considerations such as reduced material use and improved energy efficiency. Overall, the study consolidates evidence that systematic optimization approaches are essential to unlock the full economic and performance benefits of PEB systems in industrial construction.

Mitali Jayant Gilbile and S. S. Mane (2020) presented a review-based comparative study on the structural analysis and design of Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs). The study synthesized findings from earlier analytical and experimental works to evaluate performance parameters such as steel consumption, support reactions, bending moments, and construction economy. The authors emphasized that CSB systems, which generally use hot-rolled uniform sections and truss-based framing, lead to higher steel usage and longer construction duration. In contrast, PEB systems adopt tapered built-up members designed in accordance with bending moment distribution, resulting in improved material optimization and reduced self-weight. The review also highlighted the effectiveness of STAAD-based analysis for comparing internal forces and displacements under dead, live, wind, and seismic loads as per Indian Standard codes. Overall, the study concludes that PEBs offer superior economy, faster execution, and flexibility for industrial buildings, making them more suitable than conventional steel structures for modern construction practices.

Roshni Ramakrishnan et al. (2022) carried out an extensive comparative study between Pre-Engineered Buildings (PEBs) &Truss Arrangement Buildings to evaluate their effectiveness for varying spans. The research addressed an identified gap in existing literature, where most studies focus on PEB versus conventional steel buildings rather than truss-based systems. Three industrial building configurations with plan dimensions of 15×30 m, 40×80 m, and 90×180 m were analysed using STAAD.Pro, considering dead, live, wind, and seismic loads as per Indian Standard codes. The comparative assessment included structural displacements, internal member forces, base reactions, and steel take-off quantities. The results demonstrated that PEB systems perform more efficiently for both smaller and larger spans due to optimized built-up sections and reduced self-weight. Truss arrangement buildings showed higher steel consumption and greater deflections for large spans. The study concluded that PEBs provide superior economy, structural efficiency, and adaptability, making them a more suitable solution for industrial buildings with varying span requirements.

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Shivangi Agrawal et al. (2021) presented a detailed review focusing on the wind performance of Pre-Engineered Buildings (PEBs) in comparison with Conventional Steel Buildings (CSBs). The study synthesizes earlier research related to wind load evaluation, structural response, and design practices for industrial steel structures. The authors highlighted that PEB systems, which utilize tapered built-up members and optimized framing, demonstrate improved efficiency under wind loading when compared to conventional steel frames designed with uniform hot-rolled sections. The review emphasized that accurate wind load assessment as per IS 875 (Part-3) plays a crucial role in controlling bending moments, shear forces, and deflections in long-span buildings. It was observed that reduced self-weight in PEBs leads to lower wind-induced forces and improved serviceability performance. The study concludes that PEBs provide a reliable, economical, and structurally efficient solution for industrial buildings subjected to significant wind effects, while highlighting the importance of software-based analysis tools such as STAAD.Pro in modern steel design.

Yash P. Dongare, Pradeep P. Tapkire, and Atul S. Chandanshive (2024) presented a comprehensive comparative study of Pre-Engineered Buildings (PEBs) and Conventional Buildings (CBs) for industrial warehouses using both Indian and international design standards. The study analysed warehouse structures with varying spans and heights using STAAD. Pro, considering dead, live, wind, and seismic loads as per IS 875, IS 1893, IS 800, and AISC provisions. The authors evaluated structural performance through parameters such as deformation percentage, shear force, and bending moment under different codal combinations. The results indicated that PEB structures generally exhibit lower deformation and improved stability compared to conventional systems, owing to optimized tapered members and efficient load transfer. Although shear forces and bending moments were higher in certain PEB configurations, the values remained within permissible limits. The study concluded that PEBs provide advantages in terms of material optimization, construction speed, and overall economy, making them a reliable and sustainable option for modern industrial warehouse construction.

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III.CONCLUSIONS

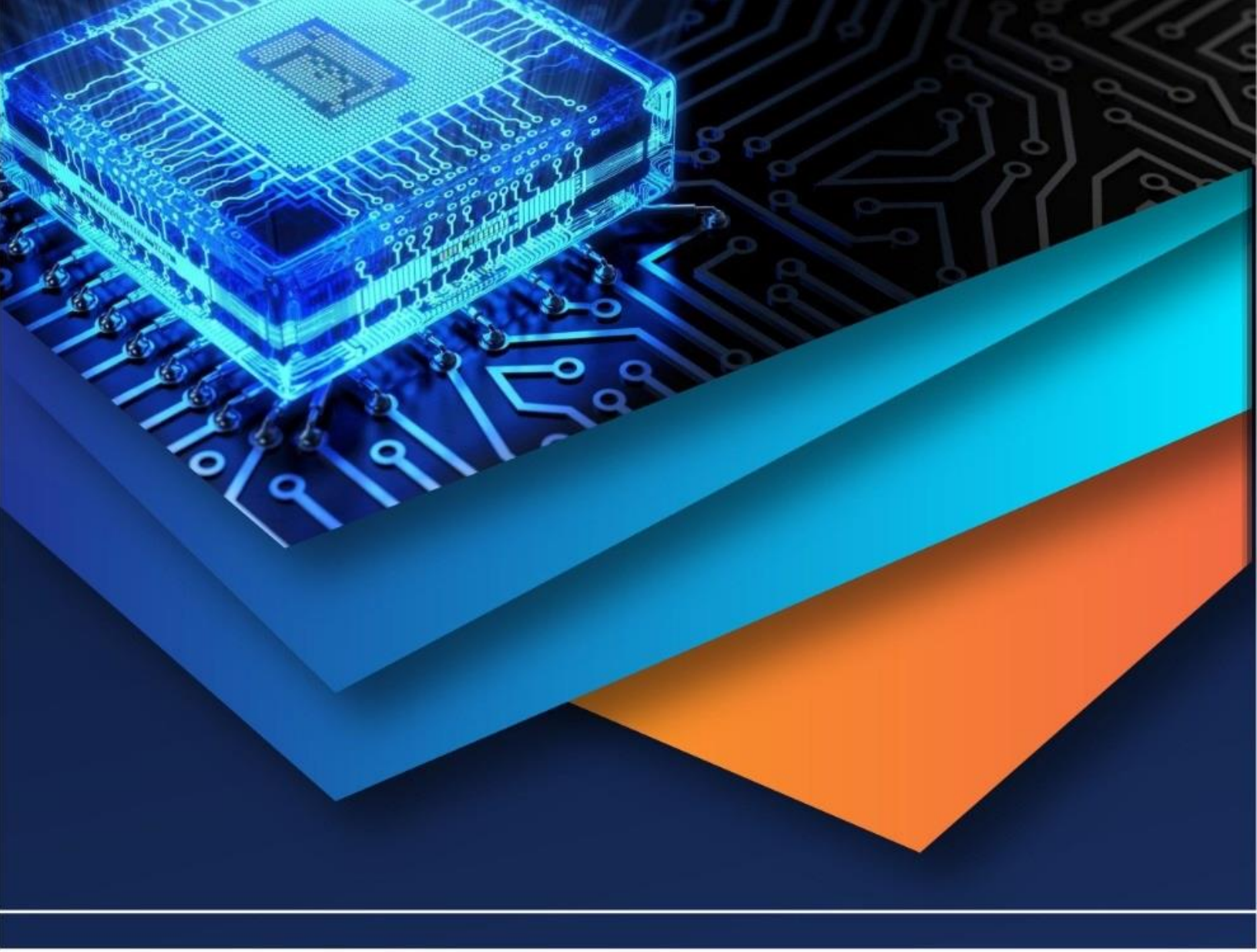
From the extensive review of literature on Pre-Engineered Buildings (PEBs) and Conventional Steel Buildings (CSBs), it is observed that most studies primarily focus on comparative evaluation based on steel quantity, cost efficiency, and basic structural response under dead, live, and wind loads using STAAD.Pro. While several researchers have highlighted the economic and constructional advantages of PEB systems, limited attention has been given to a unified parametric assessment considering the combined influence of span length, bay spacing, roof slope, and loading combinations on overall structural performance. Additionally, many studies analyze single-storey industrial buildings, with comparatively fewer investigations addressing multi-storey configurations or crane-loaded structures in detail. The majority of research emphasizes weight reduction and cost savings, whereas serviceability aspects such as displacement control, force redistribution, and performance consistency across varying geometrical configurations remain insufficiently explored. Furthermore, there is a lack of standardized comparison using identical modelling assumptions and load combinations under Indian Standard codes.

Hence, there exists a clear need for a systematic, parametric, and codal-based comparative study of PEB and CSB systems to evaluate their structural efficiency, serviceability behaviour, and economic performance comprehensively.

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