International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 10 | Oct 2021 www.irjet.net p-ISSN: 2395-0072

PARAMETRIC STUDY ON VARIATION OF PARAMETERS OF AN INDUSTRIAL BUILDING

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Abstract - *Steel construction is conservative and consultative. Structural components are hot rolled and employed in traditional construction. Materials are created or made at the facility and then transported to the job site. Large column free areas are currently the most important need for any company, and with the introduction of computer software, this is now much easier to achieve. Computer software has greatly contributed to the increase of quality of life via new investigations as technology has progressed. One such revolution is the pre-engineered building (PEB). After planning, "pre-engineered structures" are fully produced in the factory, then brought to the job site in a completely knocked down (CKD) state, where all components are joined and erected with nut-bolts, shortening the construction time. The facility manufactures or produces pre-engineered steel buildings. Structural members are made according to the specifications of the customer. Because members are made with respect to design characteristics, the precise structural members are built for their specific position and are numbered, which cannot be changed. For transportation, these components are built in modular or knocked-down form. These supplies are delivered to the customer's location and assembled. Welding and cutting are not undertaken at the customer's location.*

***Key Words*: CSB, PEB, STAAD PRO, MBMA, IS CODE.**

1.0 INTRODUCTION

Over the last decade, a positive trend has emerged in the form of increased demand for construction services in the residential, commercial, institutional, industrial, and infrastructure sectors. In comparison to past periods, modern structures are far more intricate and advanced. The current constructions are higher and slimmer, which is one of the key changes that everyone is seeing. The modern demand for buildings is that they be lighter while maintaining functioning. Steel, concrete, and other construction materials have been in a constant economic battle in civil engineering construction.

During the first part of the twentieth century, mill section structural steel structures gained popularity. Engineers could design steel structures using published properties and load tables for hot rolled steel mill sections produced by most steel mills. Steel structures were chosen by contractors over wood and concrete buildings since the fabricator handled the majority of the quality standards, enabling the contractor to focus only on erecting the steel framework. Steel structures were preferred by developers and owners because they were more cost-effective, faster to construct, and required less maintenance than reinforced concrete buildings, resulting in a higher return on investment. PEBs generate an endless number of building geometries using a pre-determined small range of raw material inventories to suit practically unlimited design needs, functional concerns, and aesthetic inclinations.

Different structural accessories, such as mezzanine levels, canopies, and internal partitions, can be added to pre-engineered steel buildings, and the structure is waterproofed with the use of specific mastic beads, filler strips, and trimmings. This is a very adaptable construction system that can be completed on the inside to fulfil any function and ornamented on the outside to produce appealing and distinctive architectural styles. It has a lot of advantages over traditional structures and is especially useful in low-rise building design.

The structural members are developed and manufactured in a controlled environment in order to create optimal sections by changing the thickness of the sections throughout the length of the member as required by the bending moment.

The study's main goal is to grasp the concepts of conventional steel buildings and pre-engineered buildings, as well as to understand the differences between these two terminologies in terms of design, member characteristics, components, and overall structure tonnage. The influence of varying parameters such as eave height, building width, building slope, and bay spacing on total tonnage is also investigated. Two distinct codes, the Indian code and the MBMA code, were used to develop the structure.

The models will be analysed and designed using STAAD PRO in accordance with INDIAN and MBMA standards. In addition, the benefits and drawbacks of both CSB and PEB, as well as practicality and cost, will be examined and emphasised.

2.0 BUILDING PARAMETERS AND GEOMETRY

Type of building	Industrial building
Type of structure	Single storey industrial structure
Location	Vadodara
Total bay length	42m
Single bay length for CSB	5.25m / 6m / 7m
Single bay length for PEB	5.25m / 6m / 7m
Width of building for CSB	15m / 20m / 25m
Width of building for PEB	15m / 20m / 25m
Eave height for CSB	6.5m / 7.5m / 8.5m
Eave height for PEB	6.5m / 7.5m / 8.5m
Wind speed	44 m/sec
CSB roof slope	5.71 / 6.71 / 8.13 degrees
PEB roof slope	5.71 / 6.71 / 8.13 degrees

An symmetrical Industrial building is selected having a length of 42m situated in Vadodara, Gujarat. Its other parameters such as eave height, slope of rafter, width of building and bay spacing are kept changing so as to determine the tonnage i.e weight of building and to predict the behaviour of building in different static and dynamic conditions.

The design has been done taking into consideration the primary shape of the members. The dimension of I- Section at the two extreme corners of each members have been decided on the basis of the required section modulus to carry the prerequisite bending moment. The flexural formula forms the basis in deciding the dimension of the members.

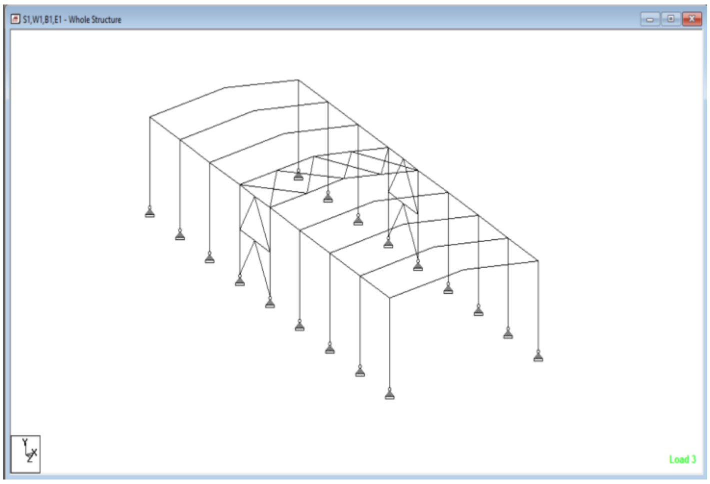


Figure 1:Typical Geometry of CSB

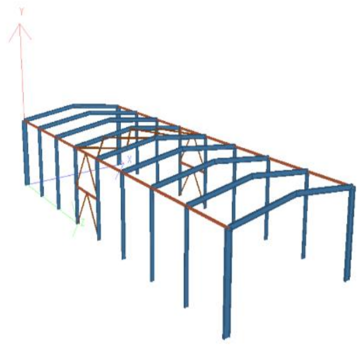


Figure 2:3-D Rendered view of CSB

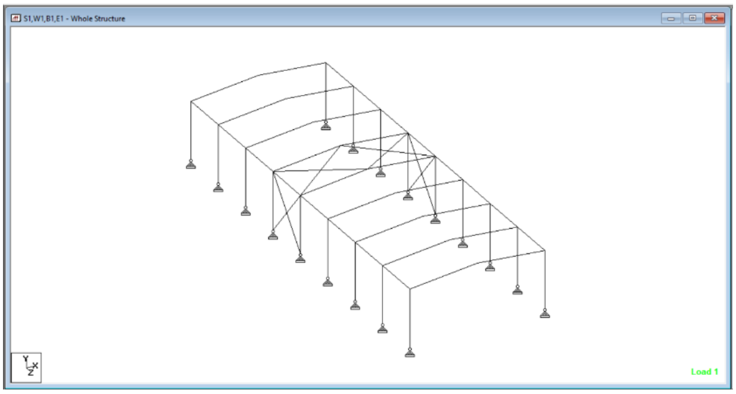


Figure 3: Typical Geometry of PEB

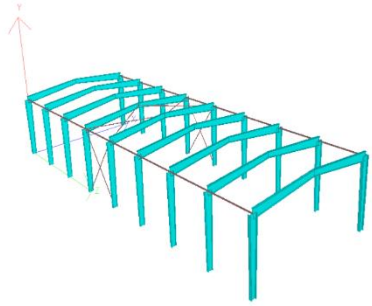


Figure 4:3-D Rendered view of PEB

3.0 LOADINGS

There are three types of loads operating on the structure: dead load, live load, and wind load. The structure's load calculation can be done in accordance with IS: 875 – 1987 and MBMA-2006. Although wind load is more important than earthquake load for this construction, load combinations such as dead load, live load, wind load, and earthquake load are taken into account.

According to the literature study, loads estimated according to IS codes are more conservative than those calculated according to MBMA/AISC.

Dead Loads.

In passing, dead load includes the structure's own weight, as well as the weights of roofing, steel sheets, purlins, sag rods, bracings, and other accessories. The dead load spread across the roof, omitting the self-weight, is estimated to be 0.25 kN/m2. While designing the 3D PEB structure, Indian code (IS 800-2007) and American code use this load as a uniformly distributed load over the rafter (AISC-ASD). The load is imposed as comparable UDL in the global Y axis over the rafters in the 3D CSB concept. Because the loads are so tiny, and to make a direct comparison, the loads for CSB and PEB constructions are the same.

Live loads.

According to IS : 875 (Part 2) – 1987, the live load for a roof with no access is 0.75 KN/m2, with a reduction of 0.02 KN/m2 for every one degree over 10 degrees of roof slope, as specified in IS 875 part 2. By Indian code (IS 800-2007), the total uniformly live load acting on the rafter of the 3D PEB structure is 0.75 KN/m2 x Spacing of rafter, and by American code (AISC-ASD), the live load on roof is 0.57 KN/m2, but for a direct comparison and on the conservative side, the load on PEB is taken the same as CSB structure.

Wind loads.

IS: 875 (Part 3) – 2015 and MBMA are used to determine wind load (1996). According to the regulations, the fundamental wind speed for the building's location is 44 m/s. Wind loads operating outward over the PEB rafter and point loads acting outward over the CSB panel points can be represented as evenly distributed loads acting outward over the roof. The wind load is applied to side walls as equally distributed loads acting inward or outward depending on the wind scenario.

STAAD PRO

Hot rolled steel sections such as ISMB, angles and channel sections which are readily available in the Indian market were used for analysing and design of CSB structure. While for PEB, Tapered members were used i.e I-sections were build using plates of different thickness such as 5mm, 6mm, 8mm and so on.

4.0 LITERATURE REVIEW

1. Pre-Engineered Building Design of An Industrial Warehouse by C.M MEERA (2013)

This article compares and contrasts the pre-engineered and ordinary steel building concepts. The study is accomplished by designing a typical frame for a proposed industrial warehouse building using both the concept and analysing the designed frames using the structural analysis and design software STAAD PRO. Based on the software analysis, the PEB roof structure is nearly 30% lighter than the CSB structure. According to the research, PEB has a considerably lower support reaction than CSB. As a result, a light-weight foundation may be used for PEB, lowering the cost of the foundation. PEB was 30 percent less expensive than CSB.

2. Apruv Rajendra Thorat, Santosh K. Patil. " A study of performance of Pre-Engineered Building of an Industrial Warehous for Dynamic Load" (June. 2017)

Pre-Engineered Buildings are those that are completely designed within an industrial facility after planning, transported in CKD (Completely Knocked Down) form, and all parts are assembled and erected on site with nut-bolts, decreasing the time it takes to complete. For Static analysis, Dynamic analysis, Secondary analysis, and Time History Analysis, structural analysis and design are performed. All dead, living, and accidental loads shall be checked against IS 875-1987. Part-IV of IS 1893-2002 will be used to confirm earthquake loads. Self Weight of Structure, Weight of Purlins, Wind Force in X, Wind Force in Z, and Negative Width are all included in the load combination. Ground motion in X and Z directions, Negative Wind Pressure in X direction, Negative Wind Pressure in Z direction Using Time History Analysis, the dynamic load action on pre-engineered buildings is observed and validated for El-Centro data in this study. Two parametric models of Pre-Engineered Buildings with and without bracing, each having a span of 21 metres.

3. A Comparative Study of Analysis and Design of Pre-engineered Building and Conventional Steel Building for a Polymer Factory by Pradeep V, Papa Rao G

The research and design of traditional steel frames with concrete and steel columns, as well as Pre Engineered Buildings, are presented in this article (PEB). STAAD Pro V8i is used to evaluate and design an industrial building with a length of 44 metres and a width of 20 metres, and a roofing system of conventional steel truss and pre-engineered steel truss. This article successfully illustrates that PEB buildings may be developed quickly and simply using basic design processes that adhere to country requirements.

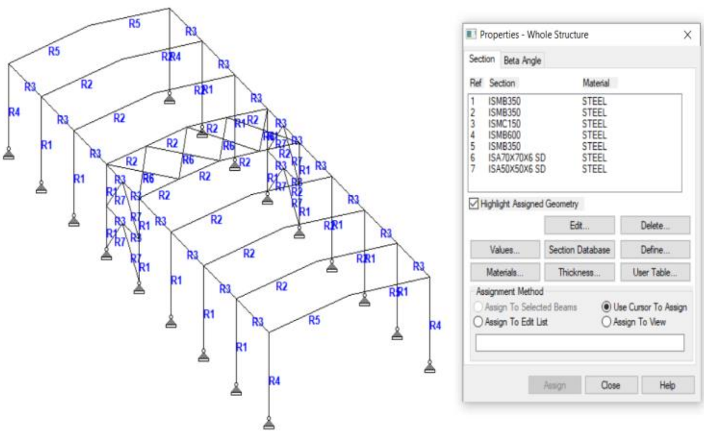


Figure 5: Section properties for CSB

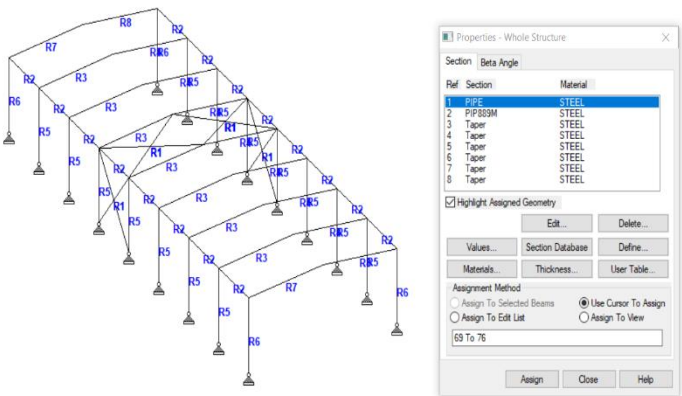


Figure 6: Section properties for PEB

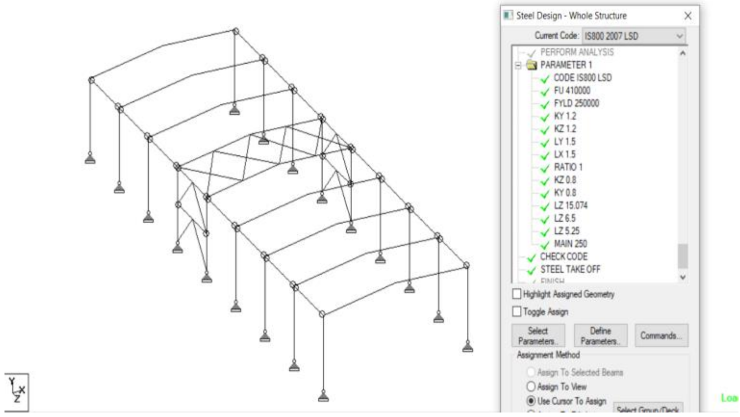


Figure 7: Tapered properties for PEB

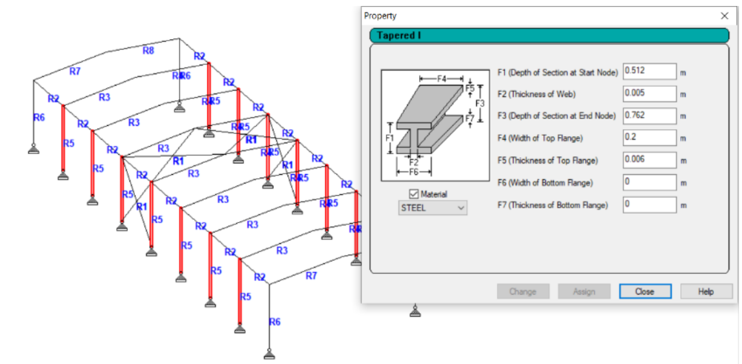
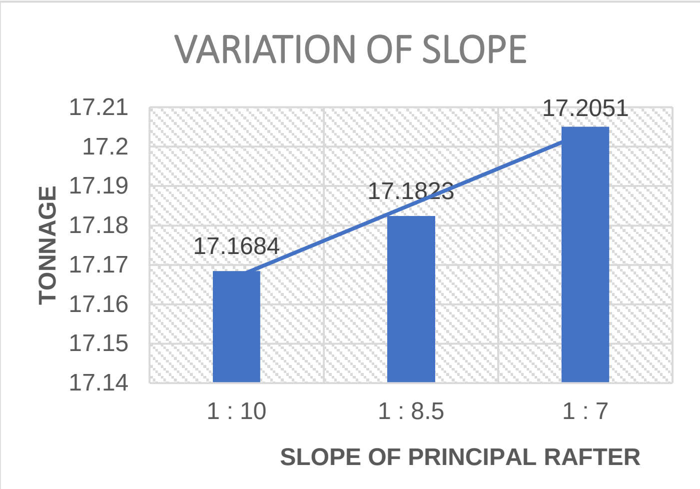
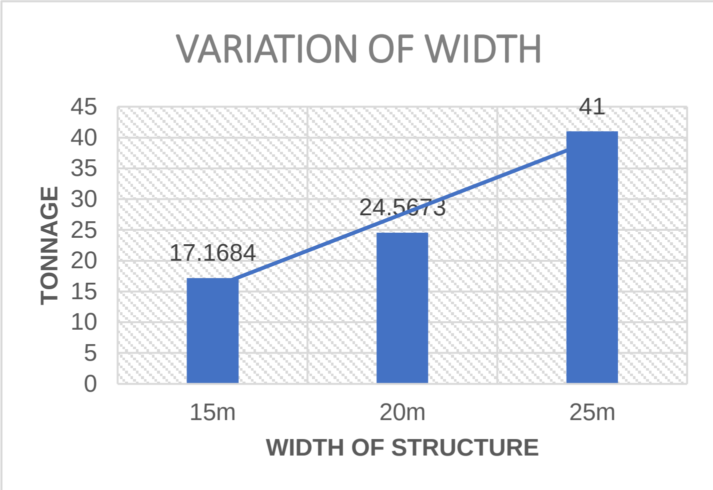


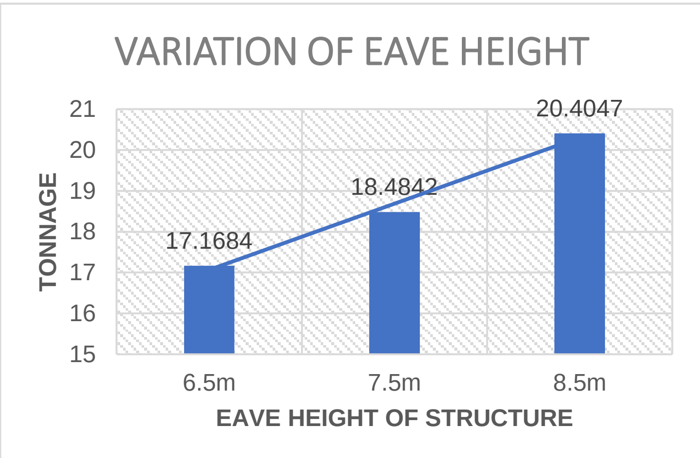
Figure 8: Staad Parameters

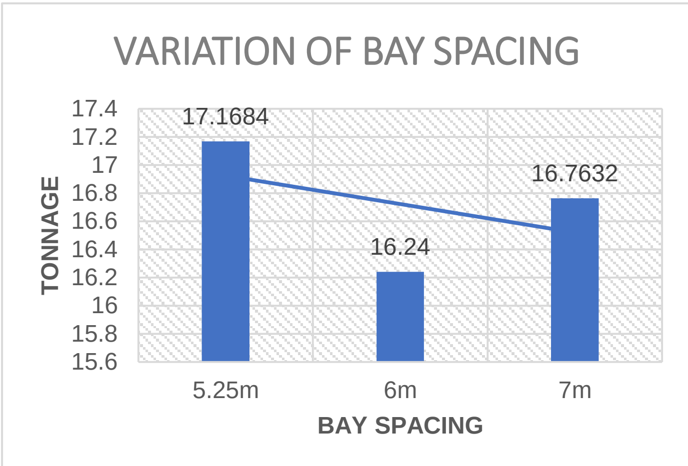
5.0 RESULTS

5.1 DESIGN BY I.S CODE 5.2 DESIGN BY MBMA CODE









6.0 CONCLUSIONS

PEB is being used more frequently as a result of prior advancements, although its use is not uniform across the building sector. PEB structures, as compared to traditional buildings, can be readily developed using simple design methods in compliance with country requirements, are energy efficient, quick to construct, save money, are sustainable, and most importantly, are dependable. Furthermore, MBMA code is considerably more cost-effective than IS code. As a result, the PEB technique must be adopted and explored in order to provide greater results.

7.0 REFERENCES

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- Analysis and Comparative Study of Conventional Steel Structure with PEB Structure by T D Mythili