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Analysis of Pre –Engineered Buildings

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Abstract: ***In this paper Pre-Engineered Building of 25m width & 6m Eave Height have been analyzed and designed by using STAAD Pro.2007 to understand the behaviour of Pre –Engineered structure & to check in which case it achieve the economy in steel quantity by varying bay spacing as 6m, 8m, 10m, & 12m. Long Span, Column free structures are the most essential in any type of industrial structures and Pre Engineered Buildings fulfils this requirement along with reduced time and cost as compared to conventional structures. In the present work, Pre Engineered Buildings (PEB) is designed for wind forces. Wind analysis has been done manually as per IS 875 (Part III) – 1987.***

Keywords: pre - engineered buildings, STAAD Pro, tapered sections , steel take -off , IS875 : 1987

1. Introduction

A pre engineered building (PEB) is a metal building that consist of light gauge metal standing seam roof panels on steel purlins spanning between rigid frames with light gauge metal wall cladding. it has a much greater vertical and horizontal deflection .The advantages of having a steel structure or building over traditional concrete are far too many. Primarily speed and quality of construction are the top two benefits. Steel buildings are fire, quake and cyclone resistant – hence from a safety and longevity perspective, these buildings are timeless. Considering India has extreme weathers as a part of the other seasons, a steel building proves to be very energy efficient, especially when insulated, because of its low thermal mass. The changing perception to a long term perspective and willingness to invest in quality is working towards the growth of PEB in the Indian construction industry.

Pre-engineered buildings are nothing but steel buildings in which excess steel is avoided by tapering the sections as per the bending moment's requirement. One may think about its possibility, but it's a fact many people are not aware about Pre Engineered Buildings. PEB concept is widely used in many of the industrialized countries. it consist of a complete steel framed building system, with components pre designed to fit together in a vast variety of combinations to meet the unique requirements of specific end uses. If we go for regular steel structures, time frame will be more, and also cost will be more, and both together i.e. time and cost, makes it uneconomical. Thus in pre engineered buildings, the total design is done in the factory, and as per the design, members are pre-fabricated and then transported to the site where they are erected in a time less than 6 to 8 weeks. The structural performance of these buildings is well understood and, for the most part, adequate code provisions are currently in place to ensure satisfactory behavior in high winds. Steel structures also have much better strength-to-weight ratios than RCC and they also can be easily dismantled. Pre Engineered Buildings have bolted connections and hence can also be reused after dismantling. Thus, pre-engineered buildings can be shifted and/or expanded as per the requirements in future.

2. Methodology

The particular tasks that were performed to achieve the main objectives of this research are summarized below.

2.1 Identification of Case Study Structure

In this study single storey pre engineered building having 25m width, 6.0m Eave Height bay spacing as, 6, 8m, 10m & 12m and 60m length is selected for analysis.. Study various concepts of pre-engineered building and its various applications. Recent innovations and substitute techniques that are implemented for pre-engineered building will be highlighted.

2.2 Modeling of the Structure

This work is aimed to complete with the help of Staad.pro soft ware. Staad pro gives more precise and accurate results than manual techniques. It is one of the effective software which is used for the purpose of analysis and design of structure by the structural engineers. The power tool for Computerized Structural engineering STAAD Pro is the most popular structural engineering software product for 3D model generation, analysis and multi-material design. It has an intuitive, user-friendly, visualization tools, powerful analysis and design facilities and seamless integration to several other modeling and design software products. The software is fully compatible with all Windows operating systems. For static or dynamic analysis of Pre Engineered Buildings, STAAD Pro has been the choice of design professionals around the world for their specific analysis needs. STAAD Pro software is used to understand the behaviour of Pre –Engineered structure & to check in which case it achieve the economy in steel quantity by varying bay spacing as, 6, 8m, 10m & 12m . Design is done based on IS: 800.

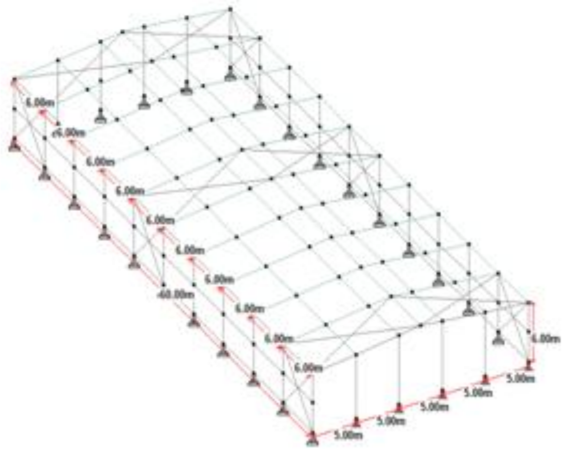

Figure 1: Structure of PEB of primary frame spacing of 6 m.

2.3 Structural Analysis and Design

STAAD Pro software can be used for analyzing and designing of the pre-engineered buildings. In the present work, using the Staad Pro software, 2D analysis has been done using Stiffness Matrix Method. All the components of Pre-engineered building are tapered using the in-built option of the Software. The software provides options for hinged, fixed, and spring supports with releases so as to analyze as per our requirement. Members and compression-only members for truss structures. Dynamic analysis has been done in the present work taking wind loads into consideration. The software provides automatic load generation for wind forces, however, the wind loads are calculated manually for the present work as per IS codes. The software also provides Loading for Joints, Members/Elements including concentrated, Uniform, Linear, Trapezoidal, Temperature, Strain, Support Displacement, Pre stressed and Fixed end Loads. It also provides the facility of Combination of Dynamic forces with Static loading for subsequent design.

3. Load Calculations

In this example, Static loads i.e., Dead loads and Live load are considered as per IS 875 (Part I) – 1987 & IS 875 (Part II) – 1987 and Dynamic loads i.e. Wind loads are considered as per IS 875 (Part III) - 1987 respectively.

3.1 Calculation of Static Loads

Dead loads are considered as per Table-2 of IS 875 (Part-1) – 1987
Total weight = 0.10 kN/m²
Total weight on frame for 6m bay spacing = 0.6 kN/m
Live load are considered as per Table-2 of IS 875 (Part-2) – 1987
Live load on the sloping roof = 0.75 kN/m²
Live load on rafter for 6m bay spacing = 4.5 kN/m

3.2 Calculation of Wind Loads

Wind loads are calculated as per IS 875 Part III (1987), For the Present work, the basic wind speed (Vb) is assumed as 44 m/s and the building is considered to be open terrain with well scattered. Obstructions having height less than 10m with maximum dimension more than 50m
Terrain Category- 2, Class- C
K1 = Probability factor = 1.0
K2 = Terrain, height and size factor = 0.93
K3 = Topography factor = 1
Design wind speed, Vz= Vb (K1 x K2 x K3) = 40.92 m/s
Design pressure, P= 0.6 V_z^2 = 1.005 kN/m²

4. Results and Discussion

For columns and rafters Tapered "I" sections of size 432x362mm and 486x486mm is assigned. Now using the above parameters the lengths and weights are calculated accordingly.

Table 1: Steel Take Off For 6m Bay Spacing

Profile	*Length(m)*	*Weight(kN)*
Tapered member number 1	242.69	231.359
Tapered member number 2	165.69	183.029
Prismatic steel	902.86	7312.145
Total		7726.532

Table 2: Steel Take Off For 8m Bay Spacing

Profile	*Length(m)*	*Weight (kN)*
Tapered member number 1	198.56	189.294
Tapered member number 2	135.56	149.750
Prismatic steel	792.82	6251.570
Total		6590.614

Table 3: Steel Take Off For 10m Bay Spacing

Profile	*Length(m)*	*Weight(kN)*
Tapered member number 1	130.44	124.349
Tapered member number 2	105.44	116.472
Prismatic steel	846.62	6500.333
Total		6741.154

Table 4: Steel Take Off For 12m Bay Spacing

Profile	*Length(m)*	*Weight(kN)*
Tapered member number 1	132.37	126.196
Tapered member number 2	90.37	99.833
Prismatic steel	1003.47	7986.557
Total		8212.586

It is seen that the weight of PEB depends on the Bay Spacing, with the increase in Bay Spacing of 8m spacing, the weight reduces and further increase makes the weight heavier

Table 5: Output of Analysis And Design

Sl no.	*Bay spacing (m)*	*Weight(kN)*
1	6	7726.532
2	8	6590.614
3	10	6741.154
4	12	8212.586

The variation in weight in accordance with bay spacing is as shown in fig 6.1.

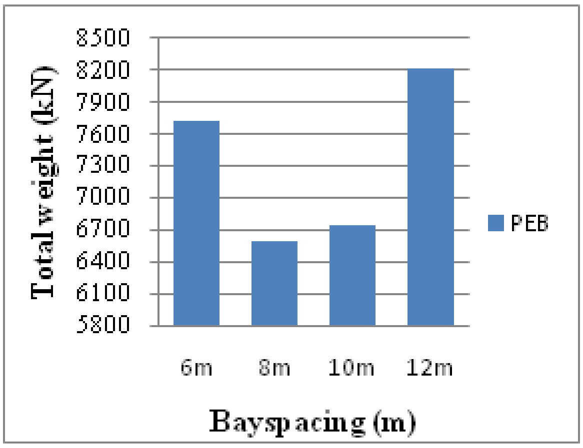

Fig 2: Bar chart Showing Weight And Bay spacing

It is seen that the weight of PEB depends on the Bay Spacing, with the increase in Bay Spacing up to certain spacing, the weight reduces and further increase makes the weight heavier. Pre engineered building with bay spacing 8m is found to be most economical.

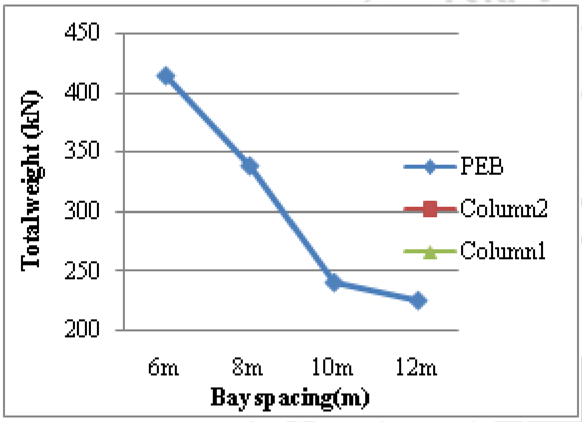

Figure 3: Line Diagram Showing Weight and Bay Spacing Of Primary Members

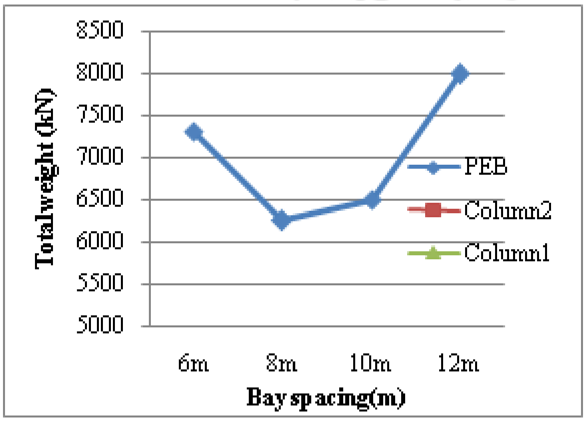

Figure 4: Line Diagram Showing Weight And Bay Spacing Of Secondary Members

Steel quantity is primarily depending on primary members and purlins. As spacing of portal increased steel consumption is decreased for primary members & Steel consumption is increased for secondary member (Purlin runner, girt etc.).With the increase in bay spacing from 6m to 8m weight of PEB decreases and from 8m to 10m weight increased and again from 10m to 12m weight increased. weight of tapered members decreases with increase in bay spacing

5. Conclusions

The following conclusions were made based on the results of this study:

- The weight of PEB depends on the Bay Spacing, with the increase in Bay Spacing up to certain spacing, the weight reduces and further increase makes the weight heavier.
- Pre engineered building with bay spacing 8m is found to be most economical
- Steel quantity is primarily depending on primary members and purlins. As bay spacing is increased steel consumption is decreased for primary members & Steel consumption is increased for secondary member

References

[1] .Aijaz Ahmad Zende, Prof. A. V. Kulkarni, Aslam Hutagia, "Comparative Study of Analysis and Design of Pre-Engineered- Buildings and Conventional Frames", IOSR journal of mechanical and civil engineering, Volume 5, Issue 1, Jan.- Feb. 2013, pp 32- 43.

[2] G. Durga rama naidu , K . srinivasa vengala rao ,Divya sri, M navakanth,G. V rama rao, " Comparative Study of Analysis and Design of Pre-Engineered Buildings and Conventional Frames" International Journal of Engineering Research and Development,Volume 10, Issue 9 (September 2014.

[3] Meera C.M, "Pre-Engineered Building Design of an Industrial Warehouse", International journal of Engineering Sciences and Emerging Technologies, Volume 5, Issue 2, June – 2013, pp: 75- 82.

[4] Pradeep V, Papa Rao G, " Comparative Study of Pre Engineered and Conventional Industrial Building",International Journal of Engineering Trends and Technology (IJETT) – Volume 9 Number 1 - Mar 20-2014

[5] Rohit C Pingle, P.J Salunke ,N.G GORE, V.G Sayagavi , "Comparative Study Of Conventional Steel Structure And Pre-Engineered Steel Structure (PEB) " ,International journal of emerging science and engineering ,volume 3,issue 7, May 2015.

[6] IS 875 (part 1,part 2, part3) "Code of practice for design loads (other than earthquake) for building and structures", New Delhi, 1987.

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