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Optimization of Pre-Engineered Building Structures

Advait Sagavekar[1], Prof. Virupaksh Khurd[2]

[1]M. Tech student, Dept. of Civil Engineering, Sanjay Ghodawat University, Kolhapur, Maharashtra, India.
[2]Professor, Dept. of Civil Engineering, Sanjay Ghodawat University, Kolhapur, Maharashtra, India.

Abstract - *The experimental study is conducted to analyze the effect of different parameters on pre-engineered buildings and comparison of pre-engineered building with conventional building. In first stage effect on structure for different roof angles and bay spacing is checked and the optimum structure is selected. Further effect of column height on structure are studied. Comparison made based on steel consumption, displacement, base reaction and moment values. From the models most optimized is selected and compared with conventional roof truss model. From pre-engineered buildings model with height 5.45m, roof angle 5.71° and bay spacing 7m is selected and compared with conventional structure of same properties but designed using truss members. Finally results shows that pre-engineered buildings are optimum and reduces steel consumption by approximately 25-30%.*

Key Words: Pre-engineered building, conventional building, steel consumption.

1. INTRODUCTION

The utilization of steel structures in an industrial building is developing quickly in all regions of the world. It isn't just financially beneficial yet additionally eco-friendly. For the most part, there are two kinds of steel structures, Conventional Buildings, and Pre-Engineered Buildings. The present study is formulated to accomplish the staggered plan-based enhancement of pre-engineered steel structures. To accomplish it, a wide range of PEB structures are considered for the study and will be planned under specific parameters to make the structure increasingly effective. The upsides of steel as a development material are generally acknowledged, and the idea of the pre-designing structure is a moderately new idea when contrasted with conventional steel building (CSB). The upside of pre-designed structures over conventional steel structures is in banter right now. Pre-engineered buildings (PEB) alludes to those steel structures which are pre-fabricated before being moved to the task site. As the name shows, it incorporates the pre-designing of every single basic part of the structure considering the engineering and architectural prerequisites. The structural concept of PEB is to utilize just the necessary profundity of the part that is required at that specific spot contingent on the bending moment. These outcomes in the tapered sections all through the range of the structure. The decreased shape is gotten by the built-up members. The utilization of tapered sections brings about diminishing the expense of the structure by cutting off superfluous steel.

2. Methodology

The first phase of this study is to model a PEB structure by using a commercial software. The further methodology is to take the modelled structure and try to optimize it by varying the following parameters:

1. Dimensions of structures – the optimum dimension is then chosen from 4 models of the structure.
2. Height of the structure – most optimum graded dimension for bay spacing and roof angle is then taken and the study is carried further.

The most economic structure will be chosen by carrying out all the above-mentioned parameters and further compared with a conventional steel structure.

3. Modelling

Building Dimension	-	42m x 22m
Clear eave height	-	5.45m
Maximum eave height	-	6.55m
Roof slope	-	2.86°, 5.71°, 10°
Weight of sheet and purlins	-	0.84KN/m
Live load of roof	-	5.25 KN/m
Basic wind speed	-	39 m/sec (Pune)
Seismic zone (Z)	-	Zone III- Pune

The analysis is performed using STAAD PRO V8i. In accordance with IS 875, load combinations are considered, which consist of static, temporary, wind and earthquakes. The parameters above are roof slope (θ), span (B) and column height (h). Also, a traditional truss model has been prepared for comparison.

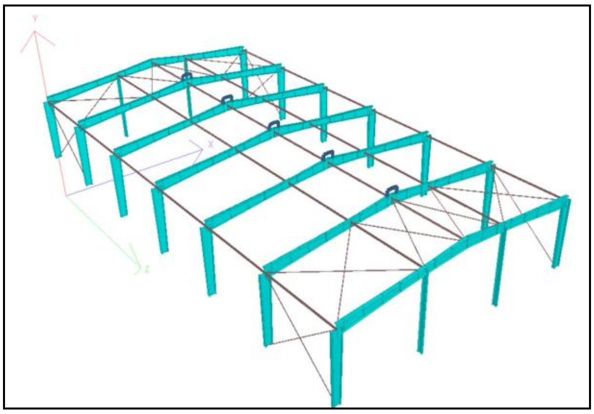


Fig -1: PEB model

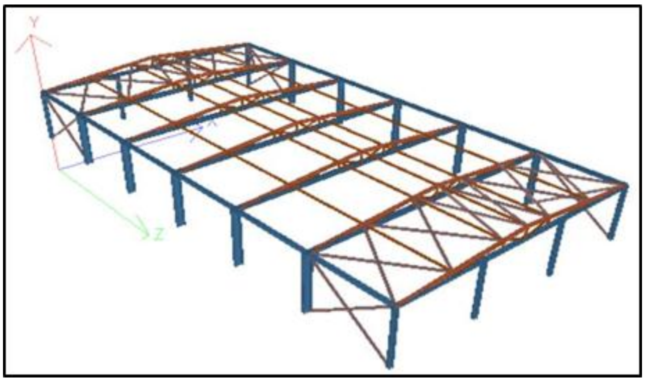
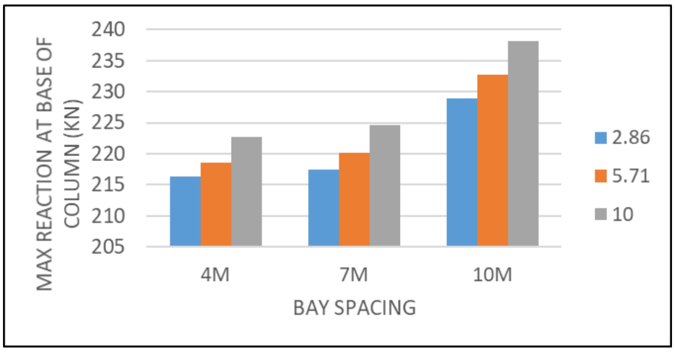


Fig -2: Conventional model

4. Results:

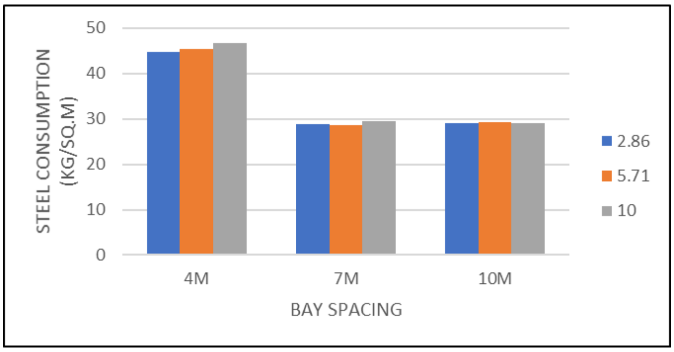
4.1. Comparison for Bay Spacing Vs. Roof Angle

4.1.1. Maximum reaction at the base of column



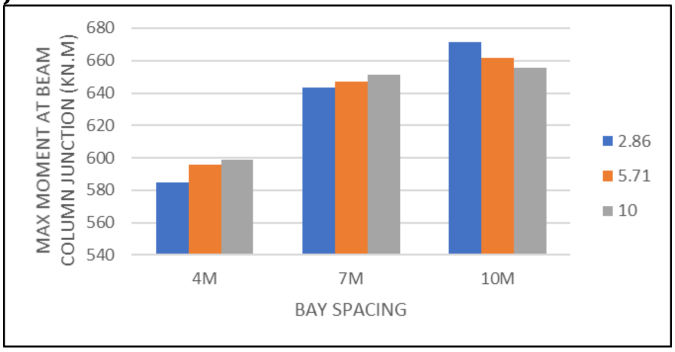
The primary response does not strongly depend on the angle of the roof, but increases slightly with the span. The largest base reaction is 238.112KN at θ = 10° for a distance between compartments of 10 m.

4.1.2. Steel consumption



For a frame span 42m, as the angle (θ) increases, consumption of steel increases. While along bay spacing, consumption of steel quantity decreases as the bay spacing increases. The minimum consumption of steel from table 7 is 28.716kg/m2 when θ = 5.71° and bay spacing is 7m.

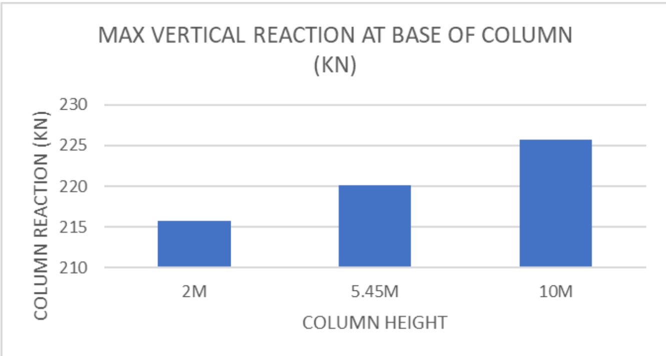
4.1.3. Maximum moment at beam column junction



The maximum value moments are tabulated for various inclinations of roof angle (θ) and bay spacing (B). It can be similarly observed that the max moments at the beam column junction increases with the bay spacing. The largest moment is 671.381 KNm when θ = 2.86° for a bay spacing 10m.

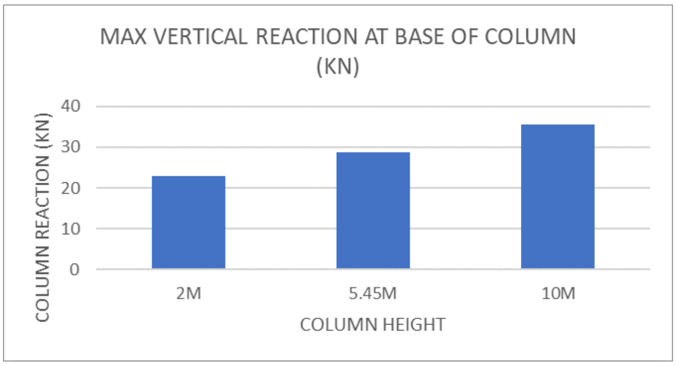
4.2. Comparison for Different Column Heights

4.2.1. Maximum vertical reaction at the base of column



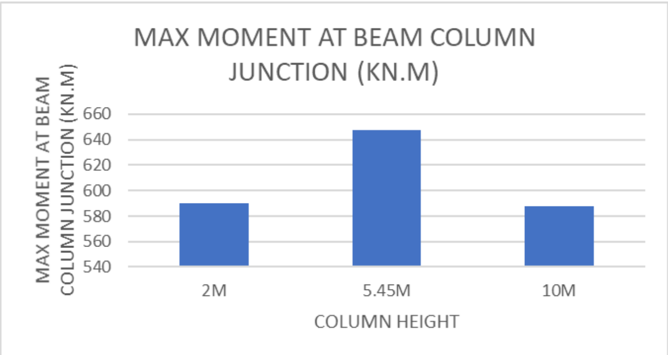
The vertical reaction at base does not seem to vary much with the column height, it increases marginally with the column height. The largest base reaction is 225.675kN when H= 10m.

4.2.2. Steel consumption



The consumption of steel increases as height of columns increases. For column height of 2m minimum value is observed.

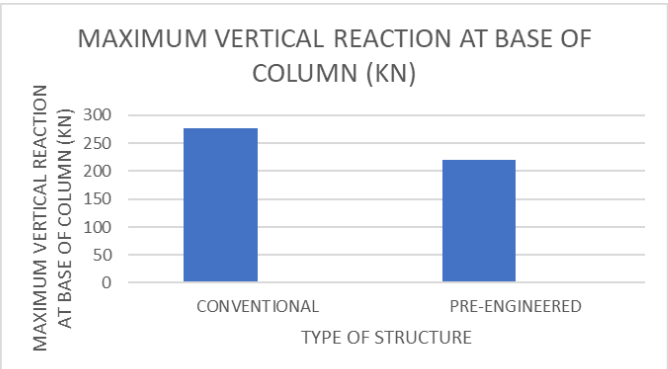
4.2.3. Maximum moment at the beam column junction



The maximum moment is observed at column height of 5.45m and value is 647.099KN.m.

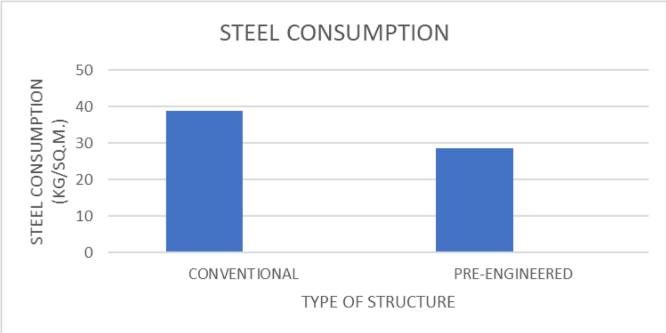
4.3. Comparison between Conventional Steel Building and Pre-Engineered Building

4.3.1. Maximum vertical reaction at the base of column



Maximum vertical reaction is seen in conventional structures i.e. 279.065KN and pre-engineered structures shows reduction in vertical reaction.

4.3.2. Steel consumption



Conventional structures more steel consumption as compared to pre-engineered buildings. From results pre-engineered buildings shows 26.211% decrease in steel consumption.

5. CONCLUSIONS

- From results it shows that with change of roof angle there is not much variation in steel consumption and other parameters as it is when the bay spacing is changed.
- When models are compared for different roof angle and bay spacing, it shows that model with 7m bay spacing and roof angle of 5.71 is optimum for every parameter and shows optimum steel consumption.
- When models are compared for different column height it shows that column with 2m height shows less consumption of steel, but in practical column with height of 5-7m are more and more used.
- When compared with conventional steel building, conventional building shows more vertical reaction at base. Also, when compared for displacement, values for conventional buildings are on higher sides.
- When steel consumption is compared, conventional buildings shows around 35.524% more steel consumption than pre-engineered building which is not economical and makes structure heavy.

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