COMPARATIVE ANALYSIS ON PRE-ENGINEERED AND CONVENTIONAL BUILDINGS WITH DIAGONAL BRACES

Gopika S Kumar[1], Krupa Mary Varghese[2]

[1]P.G. Student, Structural Engineering and Construction Management, Saintgits College of Engineering, Kottayam, Kerala, India

[2]Assistant Professor, Department of Civil Engineering, Saintgits College of Engineering, Kottayam, Kerala, India

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Abstract - *The most essential part of industrial structures and Pre Engineered Buildings (PEB) are long span column free structures. The advantages of PEB construction includes cost effectiveness, speed of construction, achievement of large span, standardization of materials and speed in delivery. The aim of the present study is to analyzed and compared the performance of PEB and conventional building (CB) and also studied the effect of diagonal braces. The present work consisted of analysis of frame of 15x75m under dead load, live load, wind load and its combinations in STAAD as per IS codes. The STAAD model was developed by using Channel section and unsymmetrical tapered I section with varied dimensions of flange width and web thickness. The parameters considered from the comparative analysis were quantity of steel and deflection. It is found that PEB is more effective in terms of deflection and it is more economical than compared to CSB.*

***Key Words*: Pre-Engineered buildings, Conventional Steel buildings, Unsymmetrical tapered I section, Channel section, STAAD.**

1. INTRODUCTION

Steel industry is considered as one of the super growing industries in every parts of the world. They are not just economical but also highly ecofriendly that is they are 100% recyclable and the most recycled material. The hot rolled sections of constant depth are used for columns and beams in CB and therefore it leads to excess design of the member on the areas of low internal stress. But the frames of PEB are designed by tapered sections and often have variable thickness plates as flanges and web based on the level of internal stress over the sections as shown in the Figure 1. With the introduction of PEB there has been a drastic change in the growth of steel industrial structures. Pre-engineered building consume less steel which is about 30% lighter than conventional steel structures. The main objective of this work is to study the performance of Pre- engineered buildings with diagonal braces and compare with the performance of conventional buildings.

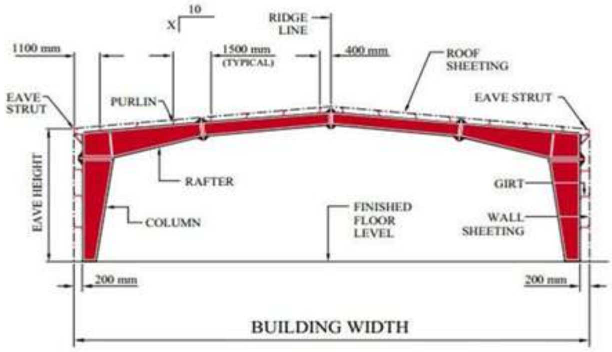

Fig-1: PEB Model

2. ANALYTICAL INVESTIGATION

2.1 Building Description

The study investigated the effectiveness of using Pre-Engineered buildings with diagonal braces and compared its performance with conventional buildings. PEB with different sections such as unsymmetrical tapered I section and channel sections were analyzed. A building of 15x75m located at Chennai having a wind speed of 50m/s was considered for the analysis. Dead load, live load, wind load and its combinations are assigned as per IS codes

2.2 Properties

The properties of both Conventional building and Pre-Engineered buildings are as shown in the Table 1.

Table-1: Properties of building

Properties	Details
Building dimension	15x75m
Height	10m
Bay spacing	5m
Wind speed	50m/s

The bracings adopted for conventional building is Tube section. The properties of beam, column and bracings of conventional building are tabulated in the Table 2. The STAAD model of CB frame is shown in the Figure 2. Beam is designated as R1 while bracings and columns were designated as R2.

Table-2: Section properties of CB

Beam	ISA 125X75X12
Column	ISA 130X130X16
Bracing	TUB 100X100X6

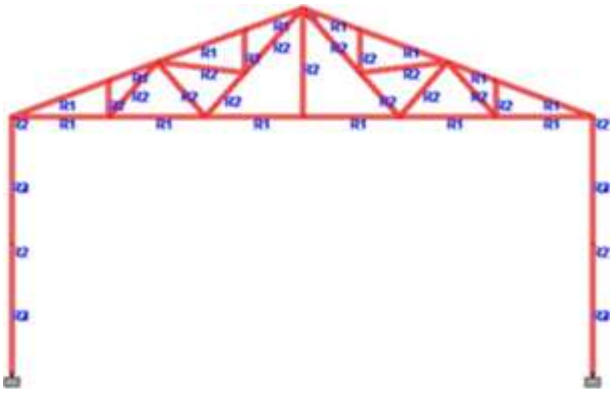

Fig-2: CSB Frame

Four tapered sections with different properties were provided for PEB and PEB model of the frame is shown in the Figure 3. Bracings were of tube section, TUB 125X125X6.

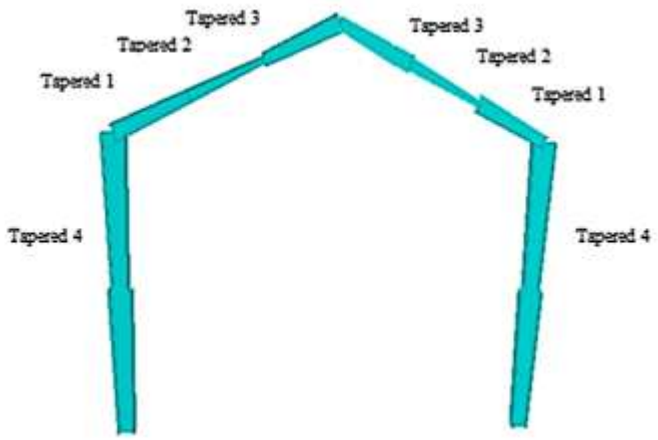

Fig-3: STAAD model of PEB Frame

Investigation was found to be less in PEB with channel sections. In the present study, ISMC 400 has been used for both beams and columns with diagonal bracings of tube section, TUB 125x125x6.

2.3 Modelling

The modelling of Conventional building and Pre-Engineered building was carried out in STAAD. Analytical analysis is done to find out the best section of PEB and compared it with CSB in terms of deflection and steel quantity take off. Dead load were assigned as per IS 875 Part 1-1987 and the value is 1.507kN/m. Live load was given as 3.75 kN/m. Wind loads were assigned as per IS 875 Part3-1987. .The building is considered to be open terrain with well scattered Different load combinations were considered for the study both under limit state of collapse and limit state of servicibility for CB and PEB. The 3D model of conventional building with diagonal braces is shown in the Figure 4.

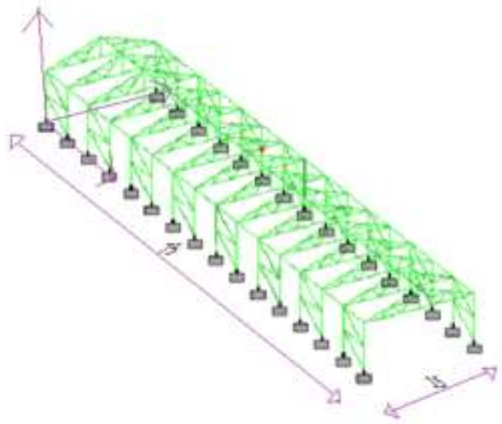

Fig-4: STAAD model of CB

STAAD model of PEB with diagonal bracing is developed by using the 4 tapered sections; tapered 1, tapered 2, tapered 3, tapered 4. Three cases were considered for the study

a) 0.04m thick web for all the 4 tapered sections

b) 0.06m thick web for all the 4 tapered sections

c) 0.06m thick web for 3 tapered sections and 0.08 m thick web for tapered 4

Bracings were provided with tube sections 125x125x6. STAAD model of PEB with bracings is shown in the Figure 5.

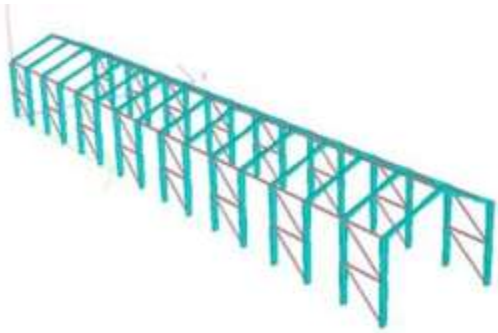

Fig-5: PEB Model

STAAD model of PEB with channel section with the desired properties for all members was also studied.

3. RESULTS AND DISCUSSIONS

3.1 Conventional building

The deflected model of CSB with diagonal braces after static analysis is shown in the Figure 6 and the maximum value of displacement is 7.244mm. It was observed that CSB model experienced higher deflection when the lateral loads are acted upon it.

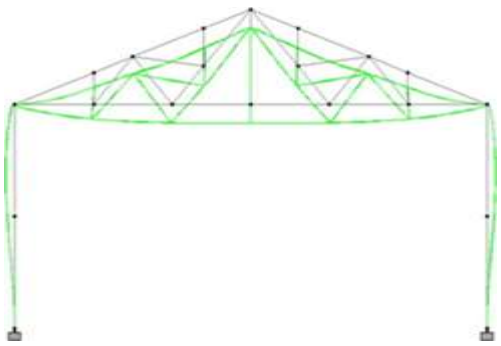

Fig-6: Deflection of CB

3.2 PEB with unsymmetrical tapered I section

The values of deflection and steel take off are tabulated in the Table 3 and the deflection diagram of PEB with unsymmetrical tapered I section is shown in the Figure 7. The deflection was found to be minimum for case (c) but the quantity of steel take off is minimum for case (a). It was clearly evident from the figures that by providing tapered sections both deflection and steel take off values can be controlled. Reduction in steel quantity will reduced the dead load and thereby reduction in foundation size.

Table-3: Deflection and steel take off

No	(a)	(b)	(c)
Tapered 1	0.04	0.06	0.06
Tapered 2	0.04	0.06	0.06
Tapered 3	0.04	0.06	0.06
Tapered 4	0.04	0.06	0.08
Deflection(mm)	3.583	3.435	3.219
Steel take off (kg)	340.623	373.142	411.039

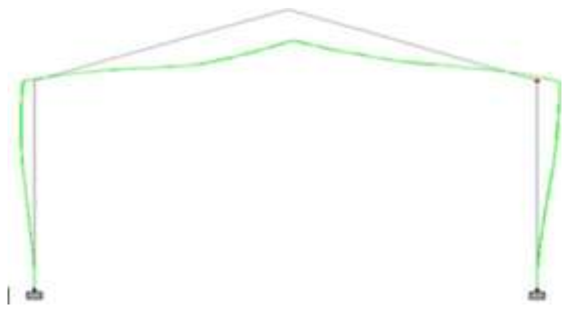

Fig-7: Deflection of PEB with unsymmetrical tapered I section

3.3 PEB with channel section

Deflection diagram of PEB with channel section is shown in the Figure 8 and the maximum value is 4.638. By providing channel sections, loads were uniformly distributed to other members. The main advantage in providing channel sections are reduction in steel take off.

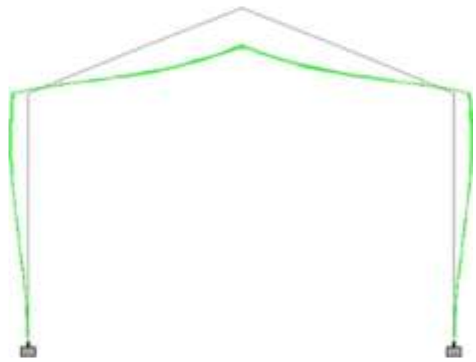

Fig-8: Deflection of PEB with channel section

Deflection and Steel take off values for all the models with diagonal braces are summarized in the Table 4. Primary importance was given to steel take off and therefore first case of unsymmetrical tapered I section was considered and tabulated in the table. It was found out that members like bracings will play an important role in the reduction of deflection of the buildings. It was concluded that PEB with unsymmetrical tapered I sections is more feasible among the different cases in terms of quantity of steel consumption.

Table-4: Deflection and steel take off of all models

Model	Deflection (mm)	Steel take off(kg)
Conventional building	7.244	793.149
PEB with unsymmetrical tapered I section	3.583	340.623
PEB with channel section	4.638	329.346

3.4 Discussions

STAAD model of PEB and CSB were modelled and the section properties were varied. The parameter like deflection and steel take off for various models were analytically investigated. The quantity of steel take off is reduced by 30 percentage. PEB with unsymmetrical tapered I section of 0.04m thick web shows higher displacement and consume less steel, whereas steel consumption is more for 0.06m thick web. By comparing PEB with unsymmetrical tapered I section and channel section steel take off value is lesser for channel section.

4. CONCLUSIONS

Static analysis of CSB made up of angle sections as well as PEB with tapered and channel sections was carried out in STAAD. Dead load, live load, wind load and its combinations were considered as per relevant IS codes. The results of analysis proved that PEB buildings got less deflection as well as less steel consumption. It is found that PEB reduced the steel quantity by an average value of 30% than that of required in Conventional steel structures. Among PEB with unsymmetrical tapered I section higher displacement is obtained for 0.04m thick web and steel consumption is more for 0.06m thick web. PEB with channel sections shown less quantity of steel consumption than that compared with unsymmetrical tapered I section. By reducing the steel quantity the cost of the structure can be reduced. The best possible way for material and cost saving is the adoption of PEB. Pre- engineered buildings are more economical than conventional steel structure since it requires lesser quantity of steel and thereby cost of structure is also very lower. Based on economical feasibility and the structural safety PEB with diagonal bracing gives the best suited results. Thus PEB proves to be efficient in terms of displacement and proves to be more economical.

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