2nd International Conference on Current Research Trends in Engineering and Technology
© 2018 IJSRSET | Volume 4 | Issue 5 | Print ISSN: 2395-1990 | Online ISSN: 2394-4099
Themed Section: Engineering and Technology

Comparative Study of PEB Industrial Building with CSB Industrial Building

Karnav Sukhadia[*1], Vijay R. Panchal[2], Vikram M. Patel[3], Ravikumar Ganti[4]

[*1]Post Graduate student (Structural Engineering) Department of Civil Engineering, Chandubhai S. Patel Institute of Technology, Charotar University of Science and Technology, Changa, Gujarat, India

[2]Professor and Head, Department of Civil Engineering, Chandubhai S. Patel Institute of Technology, Charotar University of Science and Technology, Changa, Gujarat, India

[3]Professor and Principal, Department of Civil Engineering, Adani Institute of Infrastructure Engineering, Ahmedabad, Gujarat, India

[4]Assistant Professor, Department of Civil Engineering, Adani Institute of Infrastructure Engineering, Ahmedabad, Gujarat, India

ABSTRACT

Pre Engineered Building (PEB) systems are extensively used for industrial buildings globally. Even though, PEB systems were introduced in India two decades back still it's not being used for majority of the Industrial Buildings in India. This concept involves the technique of providing the best possible section according to the optimum material requirement and cost effectiveness. Because of lack of awareness and confidence in design and execution of PEB buildings, still it is not the first choice of owner and designer in India. To overcome this issue, in the present work, a comparative study of PEB vs CSB (Conventional Steel Building) has been carried out in Staad.Pro to evaluate the structural design, construction technique, time and cost comparison. For a case study, Industrial PEB building located at Chikmangluru, Karnataka is taken.

Keywords: Pre Engineered Building, Industrial Building, Conventional Steel Building, Staad.Pro, Structural analysis and design, Steel structures, Connections

I. INTRODUCTION

Steel structures are becoming famous in almost all the parts of the world. The use of steel became more popular when people got the knowledge about its various advantages. They are being used for both residential and commercial structures. Various types of steel structures are available now like arch buildings; clear span buildings, straight wall buildings. The corporate world, manufacturing sector, residential and institutional sectors all demand quick construction. The Corporate giants always consider "Time" as the prime deciding factor in terms of profitability. For them, earlier construction of commercial buildings means earlier return on investments. Today, there is a dire need of cost effective technology especially in the ever growing field of construction. Pre-fabricated buildings came into existence in 1960's [1]. It had ceiling, floor, frame etc. These parts were put together to make the whole building. This made construction easier. Steel buildings are used in all kinds of applications and their demand is increasing.

There are mainly two categories in steel buildings- Conventional Steel Building [CSB] and Pre-Engineered Building [PEB].

In the recent research, Mythili [2], Wakchaure and Dubey [3] & Sharma [4] has compared CSB with PEB and concluded that PEB is economical and lighter as compared to CSB. They had taken assumed building models. But, in real life structure, actual conditions may be different. There is no study of real structure comparison of PEB and CSB. To address above concern, in this study real PEB structure located at Chikmangluru, Karnataka is taken and remodelled into CSB for comparison. The objective of the study is to compare the quantity, cost and time for construction of PEB and CSB.

II. CONCEPT OF CONVENTIONAL STEEL BUILDING

Today's world, steel is bringing elegance, artistry and is functioning in endless ways contributing to new solutions for the construction of formidable structures, which were once unthinkable. Steel offers speedy construction right from the start [1].

Due to its important characteristics like ductility, flexibility etc. steel is been widely used in the construction industry. It bends under the application of heavy loads rather than undergoing crushing and crumbling .

Due to its strength, less rate, stability, flexibility and recyclability, it makes a great choice to use steel in construction. It is also seen that steel has some reserve strength in them. The CSBs are stable [5]. Usually hot rolled structural members are used in these buildings. Here the members are fabricated in factories and then transported to the site. The changes can be made during the erection by welding and cutting process. Normally trusses are used in this system.

III. CONCEPT OF PRE-ENGINEERED BUILDING

These are produced in the plant itself. Here, according to the requirements of the customer the manufacturing of the members is done. The components are made in completely ready condition for transportation. These are then sent to the site and then the erection process starts. The manufacturing process doesn't takes place at the site. The PEBs are normally constructed for office, shop fronts, ware houses, etc. Here, the extra amount of steel is avoided because the sections are tapered according to the bending moment diagram.

Pre-Engineered Building concept involves the steel building structural systems which are predesigned and prefabricated [6].

In today's 21st century, it is very important to find an alternate resource for civil construction technology, seeing through the depleting natural resources. In India, the concept of PEB construction started in 1999-2000.

The growth rate of PEB construction is 20 percent annually. PEB concept has been very successful and well established in North America, Australia and is presently expanding in U.K and European countries. The PEB building shown in below Figure 1.

Figure 1: PEB Building

IV. MODELLING

The models of the CSB and PEB are analyzed and designed using Staad.pro software. One model each for CSB and PEB is prepared. The details about the models and the data adopted for the study are presented below in Table I.

TABLE I

Industrial building configuration

Parameter	Type/Value
Location	Chikmangluru, Karnataka
Total length	56 m
Total width	52 m
Clear height	10 m
Slope of roof	5.71°
Single bay length	7 m

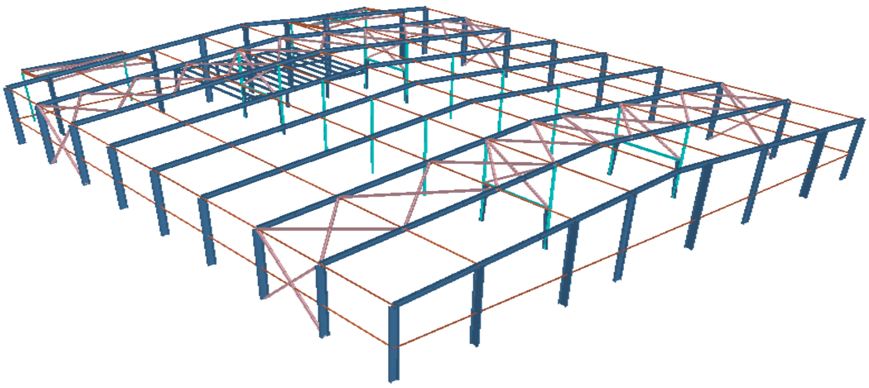

Figure 2 : 3D Rendered view of actual structure [8]

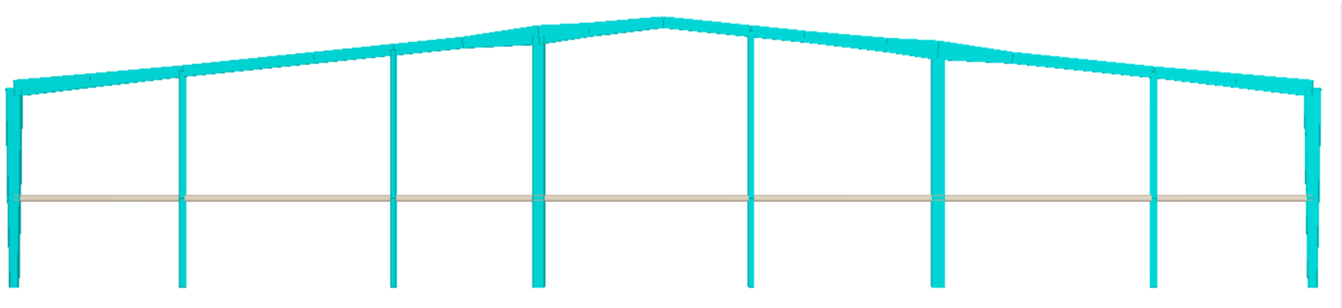

Figure 3 : Single Frame of PEB Model[8]

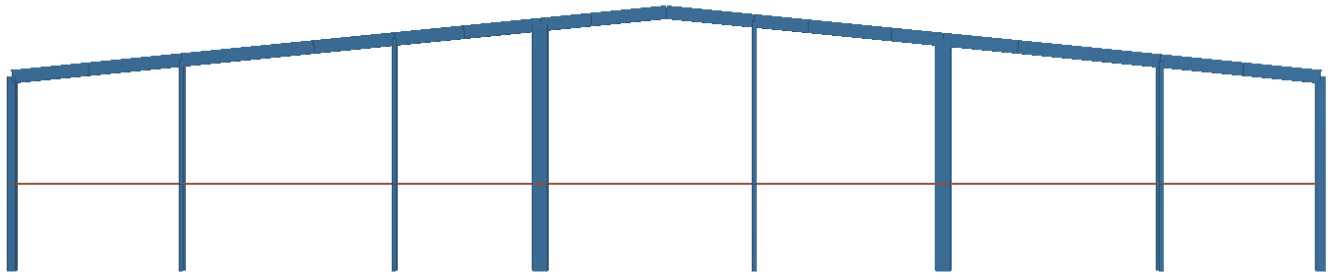

Figure 4 : Single Frame of CSB Model[8]

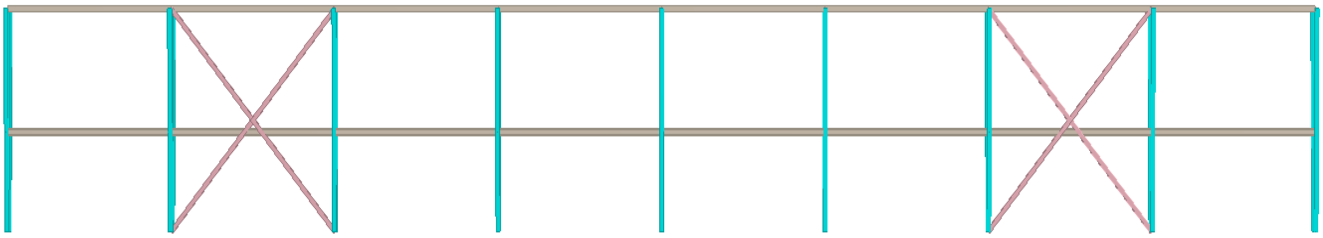

Figure 5 : Side View of PEB Model[8]

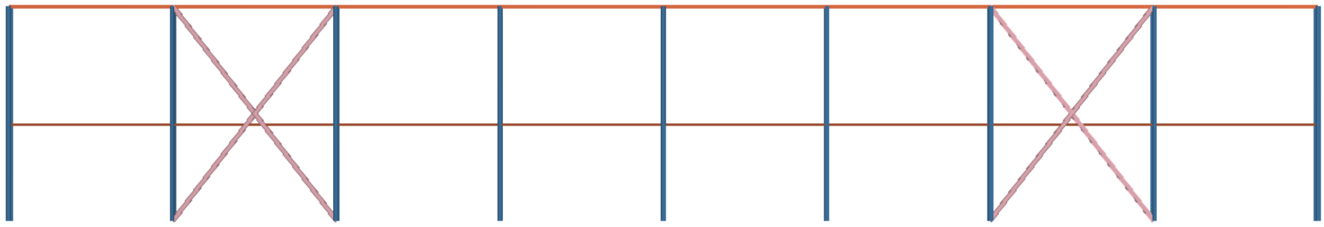

Figure 6 : Side View of CSB Model[8]

V. LOAD DATA

IS 800:2007-Clause 3.2 states that the various forces and loads must be considered while performing the design of steel structures [7]. Loading details are given in below Tables II, III & IV.

TABLE II
Dead load (As per IS 875-Part 1, 1987)

DEAD LOAD	
Self-weight	
Deck sheeting	0.1 kN/m²

TABLE III
Live load (As per IS 875-Part 2, 1987)

LIVE LOAD	
Roof	0.75 kN/m²
Mezzanine floor	4 kN/m²

TABLE IV
Wind load (As per IS 875- Part 3, 2015)

WIND LOAD	
Location	Bangalore
Wind speed	33 m/s
Building height	10 m
Design life of structure	50 years

VI. WIND LOAD CALCULATION USING IS-CODE 875 PART-III (2015)

The design hourly mean wind speed at height z can be obtained as :

$$V_z = V_b \times K_1 \times K_2 \times K_3 \times K_4 \quad (1)$$

where,

V_z = Design wind speed at height Z, in m/s

K_1 = Probability factor (risk coefficient)

K_2 = Terrain roughness and height factor

K_3 = Topography factor

K_4 = Importance factor for the cyclonic region

The wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind speed:

$$P_z = 0.6 \times V_z^2 \quad (2)$$

where,

P_z = wind pressure at height z, in N/m²; and

V_z = design wind speed at height z, in m/s.

The design wind pressure P_d can be obtained as

$$P_d = K_d \times K_a \times K_c \times P_z \quad (3)$$

where,

K_d = wind directionality factor,

K_a = area averaging factor, and

K_c = combination factor

The value of P_d, however shall not be taken as less than 0.70 P_z.

VII. STRUCTURAL ANALYSIS AND DESIGN

The loads combination taken for the analysis and design of the buildings are as follows:

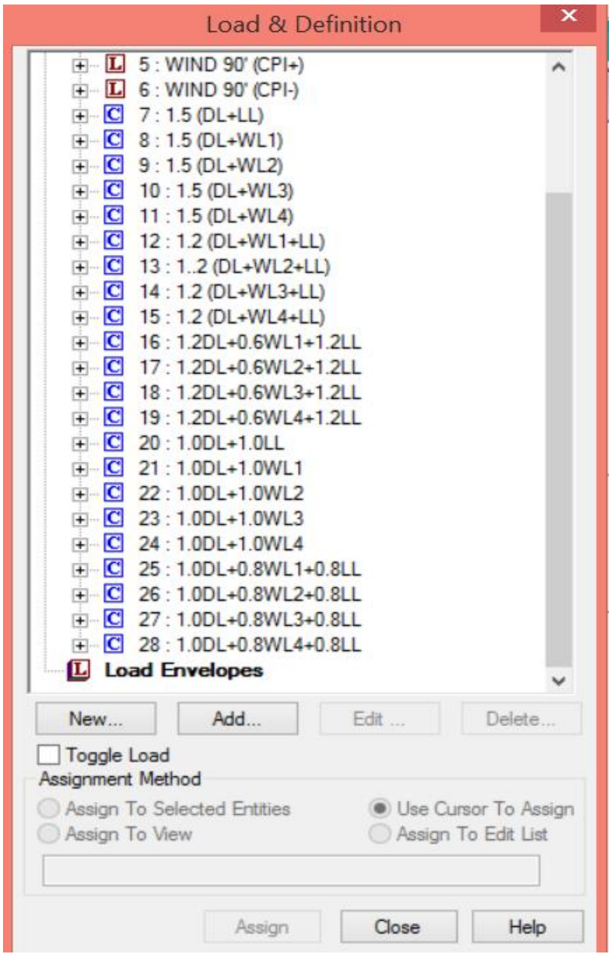

Figure 7: Load Combinations used in modelling [8]

VIII. RESULTS AND DISCUSSION

Table V

Comparison of the self-weight of models

Model	Weight of the Components (Metric Tonne)			Total Self-Weight (Metric Tonne)
	Primary Member	Secondary Member	Connections + Wastage + Sheeting	
CSB	96.5	5.1	47.4	149.1
PEB	83.1	3.3	33. 9	120.3

TABLE VI

Comparison of cost of construction

Model	Cost (lakhs)				Total Cost of Construction (Lakhs)
	Primary Member	Secondary Member	Connections + Wastage + Sheeting	Erection	
CSB	47.31	2.66	24.42	25.07	**99.48**
PEB	44.87	1.92	21.48	12.96	**81.24**

Table VII

Time for the construction of PEB building

Description	Time
Receipt of PO (Purchase Order)	Initial
Preparation for drawing and confirming that drawing	3 Weeks
Preparation of shop/fabrication drawing	4 Weeks
Fabrication/production of materials	8th Week
Supply of materials	9th Week
Erection of building	10th Week
Building completed	14th Week
Total time consumed	3 Month and 2 Week

Table VIII

Time for the construction of CSB building

Description	Time
Receipt of PO (purchase order)	Initial
Preparation for drawing and confirming that drawing	3 Weeks
Preparation of shop drawing	4 Weeks
Production of materials	8th Week
Supply of materials	9th Week
Erection of building	10th Week
Building completed	17th Week
Total time consumed	4 Month and 1 Week

Each of the two models is modelled and analysed using Staad.Pro. Later, the results obtained for the CSB and the PEB models are compared by using various parameters and the performance of the models is evaluated.

Following are the three parameters [1] considered for the comparison of the results for CSB and PEB models.

1. Self-weight of the building
2. Cost of construction
3. Time of construction

Each of these three parameters is worked out for both the models, which are presented below in Tables V, VI, VII & VIII respectively.

From the Table V, it is observed that % saving in quantity of steel for PEB as compared to the CSB is 19%. From the Table VI, it is observed that percentage saving in cost for PEB as compared to the CSB is 18%. From the Tables VII & VIII, it is observed that Construction of PEB building takes 3 weeks less time duration than that of time consumed for the construction of CSB building.

IX. CONCLUSIONS

Following conclusions can be drawn from the present study:

1. The study of self-weight of the models showed that the self-weight for PEB is less than that of CSB for the same geometry. With reduction in self-weight, the loads and hence the forces on the PEB will be relatively lesser, which decreases the effective sizes of the structural members. By the modeling, it concludes that PEB building is 19% lighter than that of CSB building.

2. The study of cost of construction of the models showed that PEB buildings are economical since the effective sizes of the structural members in PEB buildings are less than that of CSB buildings. Hence, the quantity of steel required for PEB buildings is less than that of CSB buildings. It is seen that there is about 18% saving in cost in PEB building compared to CSB building.

3. The study of time of construction of the models shows that PEB building can be constructed in a lesser time compared to the CSB building for the same building. The PEB building can be constructed in about 3 weeks less time duration than that of CSB building. Also, PEB technology can be adopted for the bigger sized buildings more effectively than the smaller sized buildings.

Hence, Use of PEB technology is preferred in today's world since it is advantageous by all means as compared to the CSB technology.

X. REFERENCES

[1] Kalantri, D., Deshpande, S. and Gudi, p. (2017), "A Comparative study on the Performance of PEB with CSB considering various parameters", International Research Journal of Engineering and Technology, Volume:04, pp.1082-1088.

[2] Mythili, D. (2015), "Analysis and Comparative Study of Conventional Steel Structure with PEB Structure", International Journal of Science and Research, Volume:06, pp.1876-1883.

[3] Wakchaure, S. and Dubey, N. (2016), "Design and Comparative Study of Pre-Engineered Building", International Journal of Engineering Development and Research, Volume:04, pp.2108-2113.

[4] Sharma, H. (2017), "A Comparative Study on Analysis & Design of Pre-Engineered & Conventional Industrial Building", International Journal for Innovative Research

in Science & Technology, Volume: 03, pp.69-74.
[5] Bhojakar, M. and Darade, M. (2014), "Comparison of Pre Engineering Building and Steel Building with Cost and Time Effectiveness", International Journal of Innovative Science, Engineering & Technology, Volume:01, pp.487-490.
[6] Pradeep, V. and Papa Rao, G. (2014), "Comparative Study of Pre-Engineered and Conventional Industrial Building", International Journal of Engineering Trends and Technology, Volume: 09, pp.1-6.
[7] IS-800:2007 (2007), "General Construction of Steel- Code of Practice", Bureau of Indian Standards, New Delhi.
[8] Staad.Pro V8i (Series 5), "Structural Analysis and Design Program", Bentley Systems Inc., USA.