Comparative Study On The Structural Analysis And Design Of Pre-Engineered Building [PEB] With Conventional Steel Building [CSB]

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Abstract : In this paper, an industrial structure (PEB & CSB Frames) is analyzed and designed according to the Indian standards. Three models each for PEB and CSB are considered having different widths and a parametric study is carried out to access the performance of the models in terms of weight comparison, cost comparison and time comparison. In this study, an industrial structure (factory truss) is analyzed and designed according to the Indian standards, IS 800-1984, IS 800-2007. The various loads like dead, live, wind, seismic and snow loads according as per IS codes are considered for the present work for relative study of Pre-Engineered Buildings (PEB) and Conventional Steel Building (CSB). To compare the consequences of the numerous parametric studies to perform the variations in terms of shear force, support reaction, weight correlation and cost evaluation**.**

IndexTerms **- Pre-engineered Building [PEB]. Conventional Steel Building [CSB], Modelling.**

I. INTRODUCTION

Steel is the material of choice for design because it is ductile and flexible. Steel members have high strength per unit weight and the properties of the steel members mostly do not change with time. In recent years, the introduction of Pre Engineered Building (PEB) design of structures has helped in optimized design. The construction of PEB in the place of Conventional Steel Building (CSB) design concept resulted in many advantages as the members are design as per bending moment diagram and thus reducing the material requirement. This methodology is versatile not only due to its quality pre-designing and prefabrication, but also due to its light weight and economical construction. 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. This concept has many advantages over the Conventional Steel Building (CSB) concept of buildings with roof truss.

In this paper, a comparison will be made between Pre Engineered buildings and conventional steel structures.

II. OBJECTIVES OF THE STUDY

The objectives of the present study are as follows-

1) To carry out structural analysis and design of a Conventional Steel Building (CSB) and compare the results with that of a Pre-Engineered Building (PEB).
2) To compare conventional fink truss of different spans with that of PEB truss with tapered sections
3) To carry out parametric study by considering different bay widths for the CSB and PEB models.
4) To replace complicated truss designs in CSB with tapered PEB trusses with simple designs.
5) To compare the results of the above parametric study using the following
   a. Self-weight of the Structure
   b. Cost of structure.

III. SCOPE OF STUDY

From the previous studies, it came to the realization that many researchers research on the different types of PEB & CSB with different parameters but there is lack of research on PEB trusses with tapering sections; hence it will be a new thing to check how complicated truss designs in CSB can be replaced by tapered PEB trusses with simple designs.

- This study deals with categories of building with its features and applications
- Truss designs for conventional steel truss for different spans
- Truss design with pre-engineered building
- Regular truss members and tapered pre-engineered members
- Manual design and validation of truss design

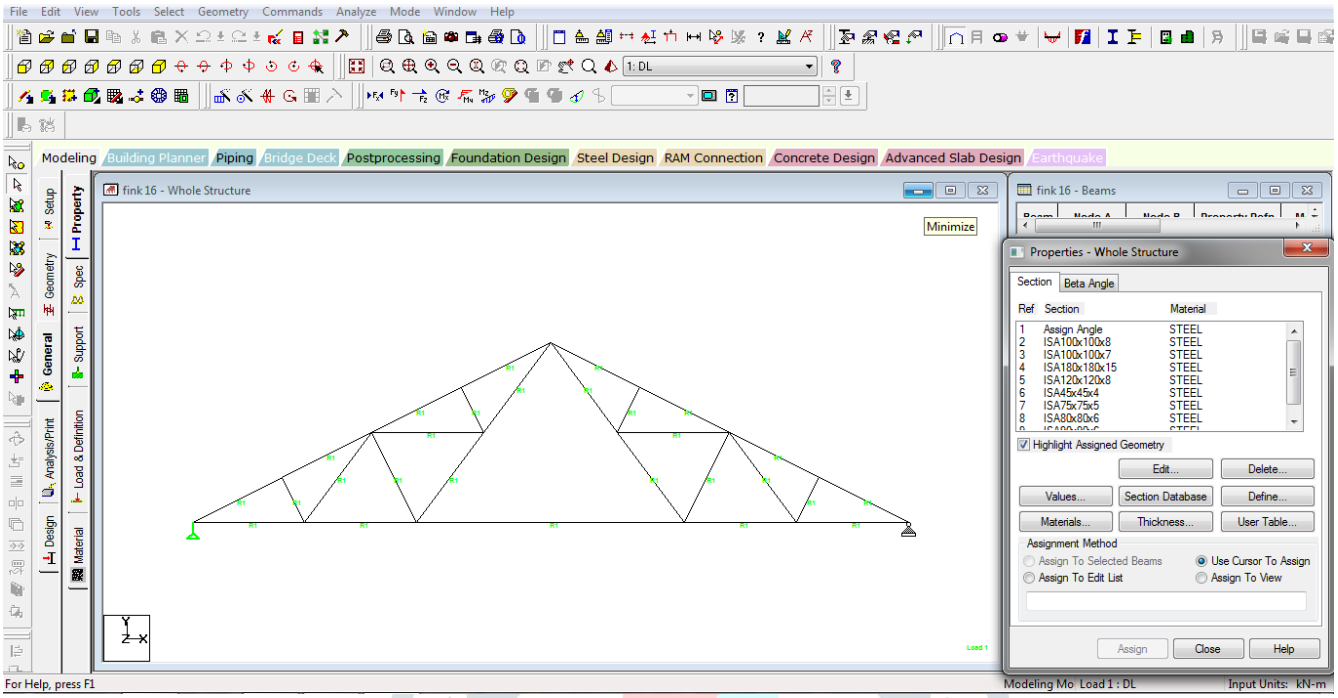
IV. SOFTWARE USED

For the present study, STAAD Pro V8i software package is used for the analysis purpose which is a well-known and latest version by Bentley Systems. This software is basically used for analysis of buildings, bridges, culverts, aquatic structures etc. made up of materials like concrete, steel, timber and cold-formed steel. It also includes various form of analysis like static analysis, response spectra, P-delta, time history. This software is worldwide accepted, validated, and tested by many international organizations"

V. MODELLING

The present work is comparative study on the structural analysis and design of pre-engineered building [PEB] with conventional steel building [PEB]. It an industrial structure (PEB & CSB Frames) is analyzed and designed according to the Indian standards. Three models each for PEB and CSB are considered having different widths and a parametric study is carried out to access the performance of the models in terms of weight comparison, cost comparison and time comparison.

5.1 Modelling for CSB



5.1.1 CSB 1

Table 5.1: Data adopted for CSB 1

PARAMETERS	VALUES
Type of building	Steel Truss for factory
Location	Kolhapur
Total length	40 m
Total width	12.3 m
Clear height	3 m
Slope of roof	26.565^0
Single bay length	4 m
Column section	ISHB 200 @ 40kg/m
Purlin section	ISMC 200 @22.1 kg/m
Truss members(Principal rafter, main tie, struts, ties)	90 x 90 x 6 (Single angle)

5.1.2 CSB 2

Table 5.2: Data adopted for CSB 2

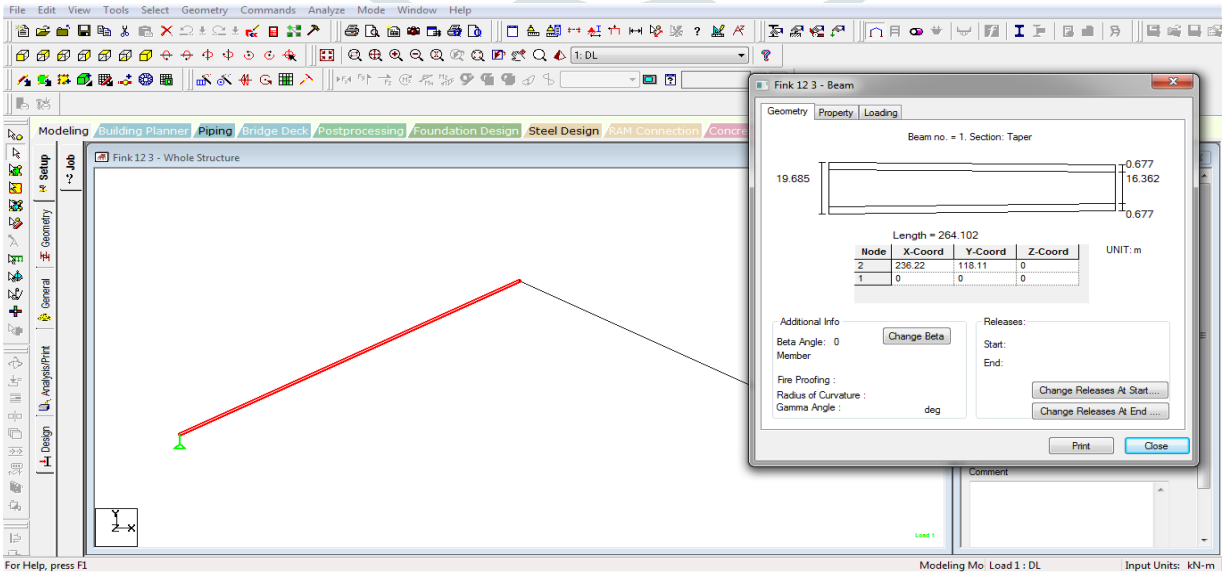
PARAMETERS	VALUES
Type of building	Steel Truss for factory
Location	Kolhapur
Total length	40 m
Total width	16 m
Clear height	4 m
Slope of roof	26.565^0
Single bay length	4 m
Column section	ISHB 200 @ 40kg/m
Purlin section	ISMC 175 @19.1 kg/m
Truss members(Principal rafter, main tie, struts, ties)	100 x 100 x 8 (Single angle)

5.1.3 CSB 3

Table 5.3: Data adopted for CSB 3

PARAMETERS	VALUES
Type of building	Steel Truss for factory
Location	Kolhapur
Total length	40 m
Total width	20.5 m
Clear height	5 m
Slope of roof	26.565^0
Single bay length	4 m
Column section	ISHB 200 @ 40kg/m
Purlin section	ISMC 200 @22.1 kg/m
Truss members(Principal rafter, main tie, struts, ties)	130 x 130 x 9 (Single angle)

5.2 Modelling for PEB



5.2.1 PEB 1

Table 5.4: Data adopted for PEB 1

PARAMETERS	VALUES
Type of building	Pre-Engineered building for Factory
Location	Kolhapur
Total length	40 m
Total width	12.3 m
Clear height	3m
Slope of roof	26.565^0
Single bay length	4 m

5.2.2 PEB 2

Table 5.5: Data adopted for PEB 2

PARAMETERS	VALUES
Type of building	Pre-Engineered building for Factory
Location	Kolhapur
Total length	40 m
Total width	16 m
Clear height	4 m
Slope of roof	26.565^0
Single bay length	4 m

5.2.3 PEB 3

Table 5.6: Data adopted for PEB 3

PARAMETERS	VALUES
Type of building	Pre-Engineered building for Factory
Location	Kolhapur
Total length	40 m
Total width	20.5 m
Clear height	5 m
Slope of roof	26.565^0
Single bay length	4 m

VI. RESULTS AND DISCUSSION

Each of the six models was modeled and analyzed using STAAD.Pro and designed using validated MS-Excel sheets. Later, the results obtained for the CSB and the PEB models were compared by using various parameters and the performance of the models was evaluated.

Following are the three parameters considered for the comparison of the results for CSB and PEB models-

1) Self weight of the Structure
2) Cost of Construction

Each of these three parameters was worked out for all the models which are presented below in Table 10.1 and Table 10.2 respectively. The weight of the connections was assumed as 12.5% of total weight for CSB models and 7.5% of total weight for PEB models.

Table 6.1: Comparison of the Self-Weight of the models

Model	**Total Self-Weight (kN)**	**Model**	**Total Self-Weight(kN)**
CSB-1	224.0028	PEB-1	110.14
CSB-2	507.0668	PEB-2	161.62
CSB-3	846.2892	PEB-3	325.76

% saving in material for PEB-1 compared to CSB-1= 50.83 %
% saving in material for PEB-2 compared to CSB-2= 68.126 %
% saving in material for PEB-3 compared to CSB-3= 61.51%

Table 6.2: Comparison of Cost of Construction

Model	Self- Weight (kg)	Rate of material per kg (Rs.)	MaterialCost (Rs.)	Labour Cost @ Rs.15 per kg(Rs.)	Total Cost of Construction (Rs.)
CSB-1	517064.13	40	2067128.8	775173.3	28,42,302
CSB-2	22829.47	40	913778.8	342442	12,55,620
CSB-3	86250.41	40	3450016.4	1293756.2	47,43,772
PEB-1	16471.66	43	708281.55	247074.96	9,55,357
PEB-2	11225.03	43	48294.16	168375.42	6,51,052
PEB-3	33200.16	43	1427606.72	498002.3	19,25,609

% saving in Cost for PEB-1 compared to CSB-1= 48.15 %

% saving in Cost for PEB-2 compared to CSB-2= 66.39%

% saving in Cost for PEB-3 compared to CSB-3= 59.41%

VII. CONCLUSION

Each of the six models was modeled and analyzed using STAAD.Pro and designed using validated MS-Excel sheets. Later, the results obtained for the CSB and PEB models were compared by using various parameters and the performance of the models was evaluated. 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 structures are smaller than those of CSB structures for the same geometry. Due to reduction in self weight the loads and forces decreases.
2. As the sizes of members' decreases the quantity of steel also decreases for PEB as compared to CSB of same geometry. Due to this cost of materials as well as labour cost reduces.
3. The Conventional Fink truss can be replaced by PEB truss with simple gable frame with tapered sections for required span. This results in material saving and cost minimizations.
4. In CSB structures, the components can be designed for a specific application on specific purposes. But Design and detailing mistakes are possible while connections. In PEB structures, the components are specified and designed such that to act together as a system for maximum efficiency, correct fit and best performance in the field.

Hence the PEB technology with tapered sections can be implemented in today's world due to its benefits as compared to the CSB technology.

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