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Design and Analysis of Pre Engineered Steel Building with Indian Standard Code and International Code

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Abstract - *Steel industry is growing rapidly in almost all the parts of the world. The use of steel structures is not only economical but also ecofriendly at the time when there is a threat of global warming. Long Span, Column free structures are the most essential in any type of industrial structures, and Pre-Engineered Buildings (PEB) fulfills this requirement along with reduced time and cost as compared to conventional structures. The work involves the detailed analysis and design of connections in Pre-Engineered Buildings (PEB). Mainly the work done is depend on the load combination and design parameters of the structure with the help of Indian Standard code and International codes. Analysis and design of the Pre-engineered building is to be done on STAAD Pro software and manually also. Result shows the difference between two different codes by total tonnage and the deflection criteria.*

Key Words: **PEB, IS 800:200, AISC, STAAD PRO**

1. INTRODUCTION

Steel Industry is growing rapidly in all the parts of the world. To meet the rising demand of construction, alternative way construction is to be incorporated. In structural engineering, a pre-engineered building (PEB) is designed by a manufacturer to be fabricated using a pre-determined inventory of raw materials and manufacturing methods that can efficiently satisfy a wide range of structural and aesthetic design requirements. The primary framing structure of a pre-engineered building is an assembly of I-shaped members, often referred as I beam. Also the sections used are Tapered sections. In PEB, I section beams used are usually formed by welding together steel plates to form of I section. I section beams are then field-assembled (e.g. bolted connections) to form the entire frame of the pre-engineered building. Cold formed Z and C-shaped members may be used as secondary structural elements to fasten and support the external cladding. To design a pre-engineered building, clear span between bearing points, bay spacing, roof slope, live loads, dead loads, collateral loads, wind uplift, deflection criteria, internal crane system and maximum practical size and weight of fabricated members are considered. In pre-engineered building concept the complete designing is done at the factory and the building components are brought to the site in CKD (Completely knock down condition). These components are then fixed / jointed at the site and raised with the help of cranes.

1.1 Aim of Study

The aim of design is the achievement of an acceptable probability that structures being designed will perform satisfactorily during their intended life.

1.2 Objective and Scope of study

Firstly to study the performance of Pre-engineered steel building under various loadings. It is design for the Indian code and international code. Comparing the results of IS 800:2007 with international code. Comparing tonnage between structures. Suggest better method for design of industrial sheds.

2. Summary of Literature Review

In recent years, the introduction of Pre Engineered Building (PEB) concept in the design of structures has helped in optimizing design. The adoptability of PEB in the place of Conventional Steel Building (CSB) design concept resulted in many advantages, including economy and easier fabrication. In this study, an industrial structure (Ware House) is analyzed and designed according to the Indian standards, IS 8001984, IS 800-2007 and also by referring MBMA-96 and AISC-89. In this study, a structure with length 187m,width 40m,with clear height 8m and having R Slope 1:10,isconsidered to carry out analysis& design for 2D frames (End frame, frame without crane and frame with 3 module cranes). The economy of the structure is discussed in terms of its weight comparison, between Indian codes (IS800-1984, IS800-2007) & American code (MBMA-96), & between Indian codes (IS800-1984, IS800-2007).

3. Methodology

Collection and study of literature. Study of various load combinations and design criteria on PEB. Modelling of steel building using Software Staad pro. Detail design of PEB with IS code and AISC code.Validation of results obtained for Pre engineered building. Comparing the results of PEB by IS code and AISC for better solution.

3.1 Technical Parameters related to PEB

Width or span of building: The centre to centre length from one end wall column to the other end wall column of a frame is considered breadth or span of the building. The basic span length starts from 10 to150 meters or above with intermediate columns. Roof slope: This is the angle of the roof with respect to the horizontal. The most common roof slopes are 1/10 and 1/20 for tropical countries like India. Design loads: Design loads for pre-engineered buildings are broadly classified into two groups: Dead Loads and Live Loads. Other loads considered are wind loads, earthquake load and load combinations as per codes.

3.2 Modelling of PEB

For basic understanding of the concepts, Model of a warehouse is prepared in Staad pro. Also for getting plastic moment the model has been done in staad pro. Further this model is designed and analyzed in STAAD PRO software. The total height of the building is 9.5m. The bay width is of 5m and there are 8 bays.

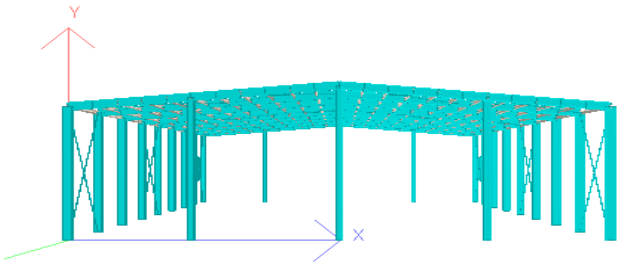

Fig -1: Front view of Warehouse

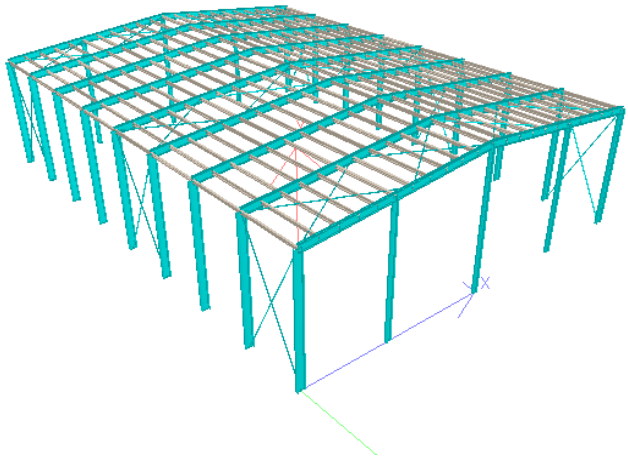

Fig -2: 3D view of Warehouse

3.3 Load Application

Dead load: The structure first of all carries the dead load, which includes its own weight, the weight of any permanent non-structural elements. It can be worked out precisely from the known weights of the materials and the dimensions on the working drawings.

Weight of roof covering (galvanized sheeting) =150 N/m^2.

Weight of purlins =100 N/m^2.

Weight of wind bracing =15N/m^2.

Live load: All the movable objects in a building such as people, desks, cupboards and filing cabinets produce an imposed load on the structure. This loading may come and go with the result that its intensity will vary considerably.

For model the Roof slope is <10 degrees.

For this case we provide access.

Live Load= 1.5kN/m^2 of plan area. (IS 875 part 2).

Wind load:

Wind load	Wx	Wy	Lx	Ly
WL1	1.53	3.37	1.84	1.22
WR1	-1.22	1.84	3.37	-1.53
WL2	2.75	2.14	0.61	0
WR2	0	0.6	2.14	-2.75
LW1	-2.14	3.06	1.84	2.14
LW2	-0.92	1.84	0.61	0.92

Table -1: Wind Load calculation

After application of wind load various load combinations are applied to the models. The models are then analysed for the different codes.

3.4 Load Combination

IS 800:2007	**AISC**
Limit State of Serviceability	
DL+LL	DL+LL
DL+WL	DL+0.75WL
DL+0.8LL+0.8WL	DL+WL
	0.6DL+WL
Limit State of Strength	
1.5DL+1.5LL	1.2DL+1.6LL
1.5DL+1.5WL	1.2DL+0.5LL+1.6WL
0.9DL+1.5WL	0.9DL+1.6WL
1.2DL+1.2LL+0.6WL	
1.2DL+1.2LL+1.2WL	

Table -2: load combination

After application of load combination further design parameters are given to the structure as per the IS800 LSD and AISC code and analysing the both structure then check for normalised ratio and then section sizes are varying as per ratio.

4. Results

After studying the pre-engineered building according to Indian Standard code and American code the result obtained is that the weight of structure which is design by AISC is less than the IS800:2007.

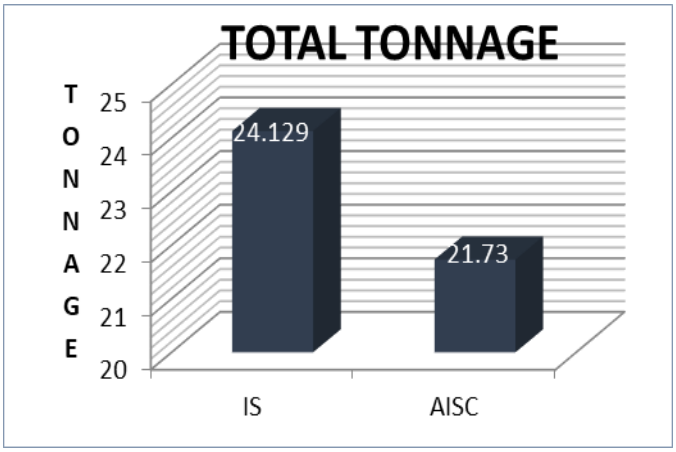

Chart -1: Tonnage comparison

The allowable deflection by AISC code is maximum over IS code

IS	AISC
For Column	
h/150	h/100
For Rafter	
W/180	W/180

Table -3: Criteria of deflection

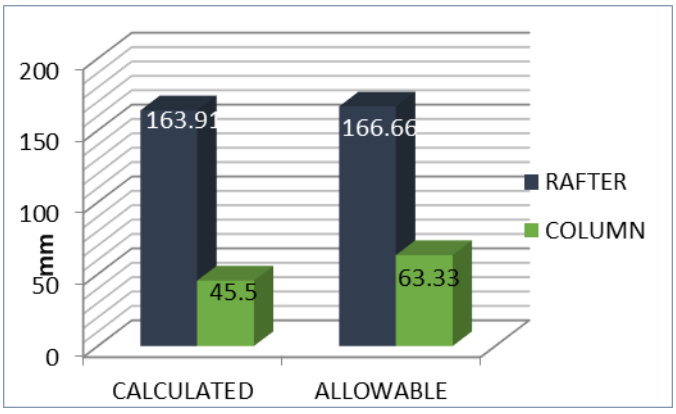

Chart -2 Deflection as per IS code

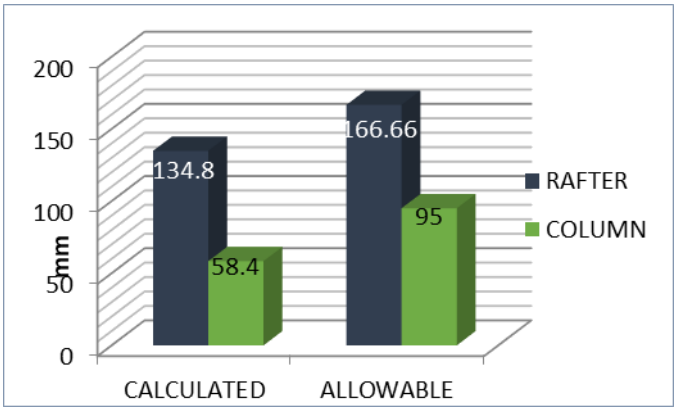

Chart -3: Deflection as per AISC code

One of the main reason to increase in weight in IS 800:2007compared to AISC is "Serviceability Criteria". Deflection limits by IS code are higher than deflection limits by AISC.

Also, the rate of steel as per today's market rate is 45rs per kg as per Indian currency it also affects the rate of whole structure.

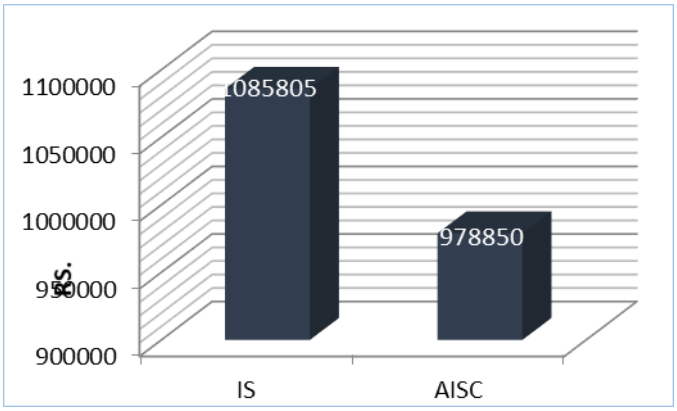

Chart -4: Cost Comparison

Cost comparison between two structures as per the IS code and AISC code is 1, 07,955rs. AISC code design is economical over IS code design.

5. Conclusions:

- It is concluded that PEB structures can be easily designed by simple design procedures in accordance with country standards, it is energy efficient, speedy in construction, saves cost, sustainable.
- "Pre-Engineered Building construction gives end users a much more economical and better solution for long span structures where large column free areas are needed.

- Live load is 0.75 KN/m2 in IS code & whereas it is 0.57 KN/m2 in AISC. Thus, concluded that loading as per Indian codes is greater than AISC code.

- As per design and detailing for wind load we have to consider additional load combination from IS 800:2007 this is the reason in increase weight as compared to AISC.

- Also criteria for deflection in AISC code is higher than IS code. So the section sizes get reduced and it affects on total tonnage of structure.

- Reason for higher wt. in IS 800-2007 compared to AISC is limiting ratios of the sections (Table 2 of IS800-2007).

- The main difference between the Indian Code (IS800:2007) to the other equivalent American Codes are in the classification of the cross-section of the steel member.

- As per Indian code, the classes of section considered for design are Plastic, Compact and Semi- compact, slender cross-section. It is well known that many PEB manufacturers use sections with very thin webs in order to reduce the weight of the section and be economical/competitive in their commercial offers, and these thin webs do not satisfy the codal provisions of IS 800: 2007.

- It is observe that in industries most of the projects done with AISC. Reasons to preferring AISC Code are IS 800:2007 has not considered slender sections which are often encountered in cold formed thin sections, because there is another code IS 801 for this. Hence people using cold formed sections cannot use IS 800.May be that is the reason people are using AISC code.

- The main reason to use the AISC code for PEB structures is due the fact that it leads to an economical structural solution as compared to the Indian Code.

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