CODAL COMPARISION OF DESIGN OF PRE-ENGINEERED BUILDING USING IS 800-2007 AND AISC 360-10 13TH EDITION

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Abstract
Pre-engineered buildings have become quite popular in the last few years. The main advantages of P.E. B are speed of construction and good control over quality. The pre- engineered building has a great advantage to the single storey buildings, practical and efficient alternative to conventional buildings. In this study, a brief comparison of pre-engineered building and conventional beam is done. Also, comparison is made between IS800:2007 & AISC 360-10. The entire range of pre-engineered building is studied while doing this comparison. A warehouse frame is designed using IS800:2007 & AISC 360-10 by keeping the loading parameters similar, all the loads are applied accordance with Indian codes. An attempt is made to study the variation in tonnage as per IS800:2007 and AISC 360-10 & possible reasons for variation in respective results. Analysis and design of these building frames was carried out using STAAD-PRO software. As per market study it observed that more than 70 % pre-engineered buildings are designed according AISC360-10.

Keywords: Pre-Engineered Building, Conventional Structure, Warehouse, Staad Pro Software,

1. Introduction

The scientific-sounding term pre-engineered buildings came into being in the 1960s. The buildings were pre-engineered because, like their ancestors, they relied upon standard engineering designs for a limited number of off the shelf configurations. Several factors made this period significant for the history of metal buildings. First, the improving technology was constantly expanding the maximum clear-span capabilities of metal buildings. The first rigid-frame buildings introduced in the late 1940s could span only 40 ft. In a few years, 50-, 60-, and 70-ft buildings became possible.

By the late 1950s, rigid frames with 100-ft spans were made ribbed metal panels became available, allowing the buildings to look different from the old tired corrugated appearance. Third, collared panels were introduced by Strand-Steel Corp. in the early 1960s, permitting some design individuality. At about the same time, continuous span cold-formed Z purlins were invented, the first factory- insulated panels were developed by Butler, and the first UL-approved metal roof appeared on the market.1st And last, but not least, the first computer-designed metal buildings also made their debut in the early 1960s. With the advent of computerization, the design possibilities became almost limitless. All these factors combined to produce a new metal-building boom in the late 1950s and early 1960s. As long as the purchaser could be restricted to standard designs, the buildings could be properly called pre-engineered.

Once the industry started to offer custom-designed metal buildings to fill the particular needs of each client, the name pre-engineered building became somewhat of a misnomer. In addition, this term was uncomfortably close to, and easily confused with, the unsophisticated prefabricated buildings, with which the new industry did not want to be associated. Despite the fact that the term pre-engineered buildings is still widely used, and will be often found even in this book, the industry now prefers to call its product metal building systems. Steel industry is growing rapidly in almost all the parts of the world. The use of steel structures is not only economical but also Eco-friendly at the time when there is a threat of global warming.

Pre-engineered buildings are nothing but steel buildings in which excess steel is avoided by tapering the sections as per the bending moment's requirement. One may think about its possibility, but it's a fact many people are not aware about Pre-Engineered Buildings. 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. Thus, in pre-engineered buildings, the total design is done in the factory, and as per the design, members are pre-fabricated and then transported to the site where they are erected in a time less than 6 to 8 weeks. The structural performance of these buildings is well understood and, for the most part, adequate code provisions are currently in place to ensure satisfactory behavior in high winds. Steel structures also have much better strength-to-weight
ratios than RCC and they also can be easily dismantled. Pre-Engineered Buildings have bolted connections and hence can also be reused after dismantling. Thus, pre-engineered buildings can be shifted and/or expanded as per the requirements in future. In this paper we will discuss the various advantages of pre-engineered buildings and also, with the help of three. Examples, a comparison will be made between pre-engineered buildings and conventional steel structures. Presently, large column free area is the utmost requirement for any type of industry and with the advent of computer software's it is now easily possible. With the improvement in technology, computer software's have contributed immensely to the enhancement of quality of life through new researches. Pre-engineered building (PEB) is one of such revolution. "Pre-engineered buildings" are fully fabricated in the factory after designing, then transported to the site in completely knocked down (CKD) condition and all components are assembled and erected with nut-bolts, thereby reducing the time of completion.

2. Analytical Investigation

2.1 Analytical Investigation

The present study is included in the design of an Industrial structure located at Chakan Pune. The structure is a factory sheds of Warale in Chakan Pune. The actual structure is proposed as a Pre-Engineered Building. The building configuration are

SR. No.	Parameter	Dimensions
1	Length	99 m
2	Width	49.5m
3	Clear Hieght	11 m
4	Bay spacing	7 m
5	NO. of Bay	17
6	Height of brick wall	3
7	Sloping angle	5.7
8	Design life of structure	50 years
9	Location	Chakan, Pune
10	Length of sag rod	1.7

11	Dia. Of sag rod	12
12	No. of brace tiers for roof	3
13	No. of brace tiers for column	2
14	No. of brace rod	4
15	Dia. Of brace rod	20
16	Brace angle	For alternate purlin
17	No.of canopy	4
18	Wieght of each canopy	350
19	Unit weight for sheeting	4.25
20	Unit weight for flashing	4.25

Table1. Building Specifications

2.2 Materials and Methods

Studying various types of parameters, referring IS 800-2001, AISC 360-1013th edition and research paper available on parametric analysis and design of industrial building Or warehouse which were previously published

3.1 Modelling

With respect to the consideration of the type of structure modelling has been done using Geometry and Structural Wizard tool.

3.2 Generation of Nodal point

As per the planning with respect to the position of column in building,their respective nodal point has been created on that model.

3.3 Property definition

Using General-Property command define the property as per size requirement to the respective building on STAAD-Pro.So, Rafter and columns have been generated after assigning to selected rafter and columns

3.4 Create and Assign Support & Member Property

After column definition at supports have been provided as fixed below each column by selecting columns using Node Curser and its cross-section assigning based on load calculations and property definition

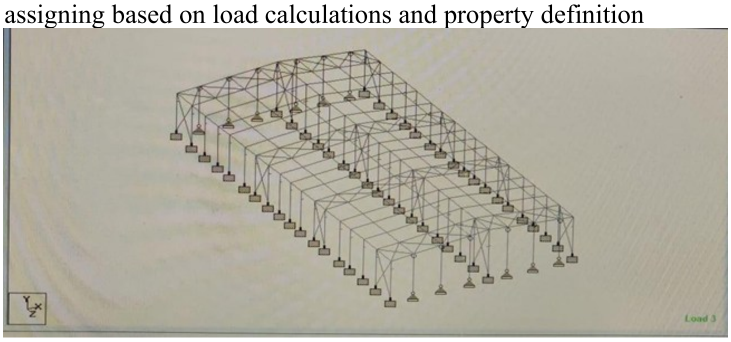

Fig.1 : Structure after Design

3.5 ***3-D Rendering***

After assigning the member property to structure the 3-D view of the structure can be shown using 3-D Rendering command

3.6 ***Load Assignment***

i. ***Dead Load***

Dead load calculation includes Purlins, sheeting, sag rod and insulation material. The total load transferring from these components is 0.150 KN/m². Total Dead load = 0.15*7(Bay Spacing) = 1.05 KN/m

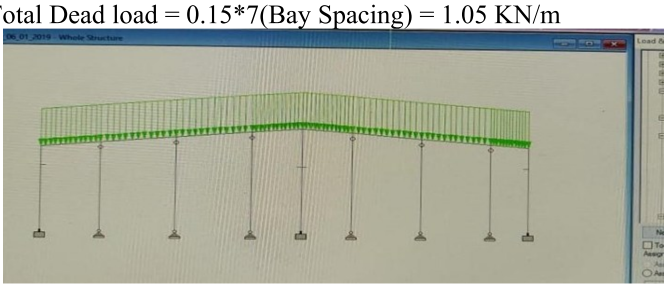

Fig.6 : Dead Load acting on Structure

ii. ***Live Load***

Live Load is considered as 0.75 KN/m² according to IS 875(part 2) – 1987 Table II for roof where access is not provide except for maintenance and for a roof where slope is greater than 10 degree then there is reduction of 0.02 KN/m² for every degree in increase above 10 degree.

Live Load = 0.75*7.5= 5.625 KN/m² For PEB frame

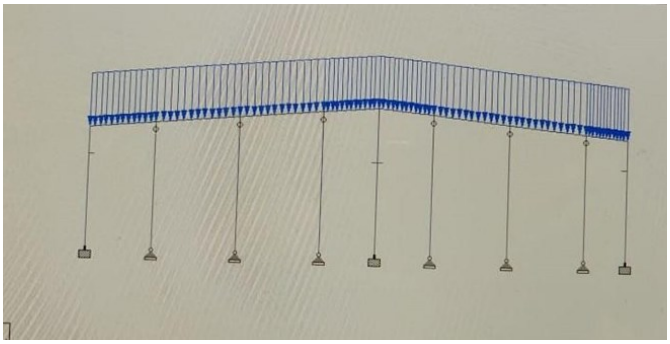

Fig.7 : Live load acting on Structure

iii. Wind Load

Wind load is calculated as per IS 873(Part II). The wind load over the roof can be provided as uniformly distributed load acting outward over the roof and which is calculated as per table 16 given in IS-875 part III . For side walls, the wind load is applied as uniformly distributed load acting inward or outward to the walls according to the wind cases

Wind angle θ = °	**Cpe**		**Cpi**	**(Cpe-Cpi)**		**Total wind KN (Cpe-Cpi) × Apd**	
	Windward	**Leeward**		**Windward**	**Leeward**	**Windward**	**Leeward**
0°	-0.942	-0.4	0.2	-1.142	-0.6	-32.547	-17.1
			-0.2	-0.742	-0.2	-21.147	-5.7
90°	-0.7	0.7	0.2	-0.9	-0.9	-25.65	-25.65
			-0.2	-0.5	-0.5	-14.25	-14.25

Table.2 : Total Wind load for Roof

Wind angle =θ	**Cpe**		**pi**	**(Cpe-Cpi)**		**Total wind (kN) (Cpe-Cpi) × Apd**	
	Windward	**Leeward**		**Windward**	**Leeward**	**Windward**	**Leeward**
0°	0.7	-0.25	.2	0.5	-0.45	15.85	-14.265
			0.2	0.9	-0.05	28.53	-1.585
90°	-0.5	-0.5	.2	-0.7	-0.7	-22.19	-22.19
			0.2	-0.3	-0.3	-9.51	-9.51

Table.3 : Total Wind load for Wall

3 MODELLING & ANALYSIS

After calculating all force a 2D model was framed keeping all input in place.Keeping Width = 49.5 meters, Length = 99 meters, Clear height = 8 meters, Location = Chakan, Pune

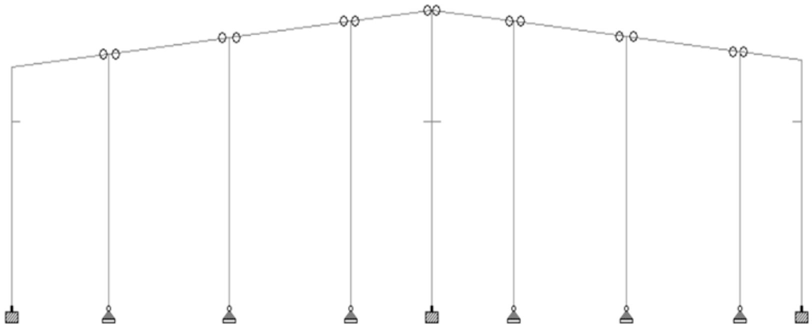

Fig.4 : Front view of the structure

As earlier mentioned section sizes are determined using BMD. Also BMD is helps to understand why tapered sections are need to be used in the PEB. Location where BMD is maximum, web height is kept maximum there and less web size where BMD is less, it will help in reduction in material and cost for the client also saving of steel.

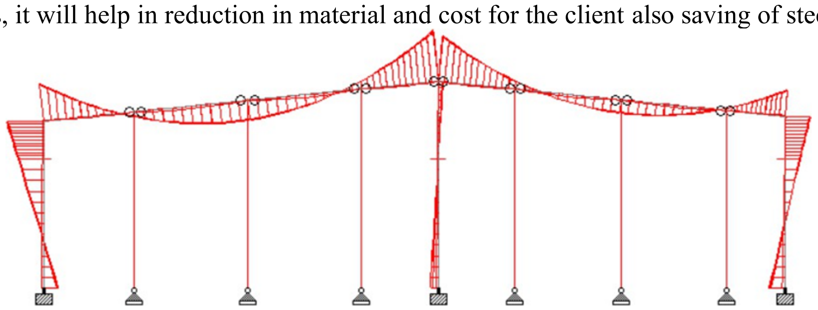

Fig.5 : BMD of Structure

After this the 2 D structure is translated and changed into 3 D for calculation of actual effect of wind. In many case incorporating C and D direction loading of wing stabilize the structure and help designers to optimize the structure more efficiently.Translation is done keeping bay length constant. If bay length changes all loading properties will be changed.
After incorporating all loading and codal properties in design section Utility ratio is checked and try to maintain UR at 90%. Percentage describe that this much section is getting utilised by the action of force. Utility ratio is ratio describing the load and moment acting on the section to the Moment / Force capacity of section.

4. RESULT AND DISCUSSIONS

4.1 Weight Comparison

Description	IS Code Weight(MT)	AISC Weight(MT)
Sheeting +Flashing	42.5	42.5
Purlin+ Girt	28.44	28.44
Anchor bolt	4.3	4.3
Base plate	16.50	16.50
Accessories	10.2	10.2
STAAD weight of sections	280.67	221

4.2 Percentage Change

Description	IS Code Weight (MT)	AISC Weight(MT)	Percentage Vaariation (%)
Sheeting +Flashing	42.5	42.5	0
Purlin+ Girt	28.44	28.44	0

Anchor bolt	4.3	4.3	0
Base plate	16.50	16.50	0
Accessories	10.2	10.2	0
STAAD weight of sections	280.67	221	27

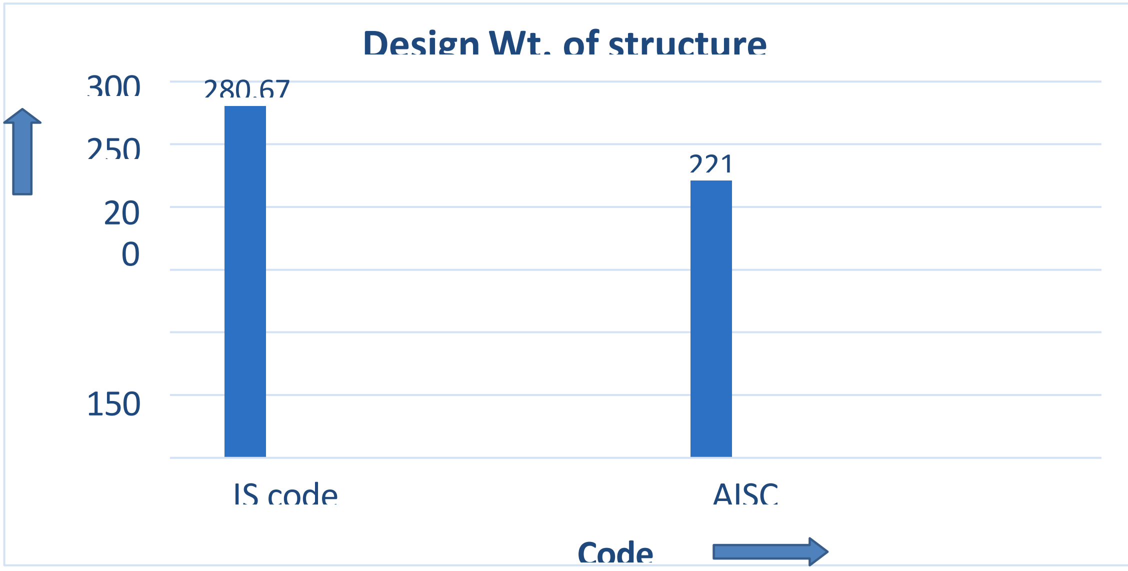

Fig.6 : design wt. of sructure

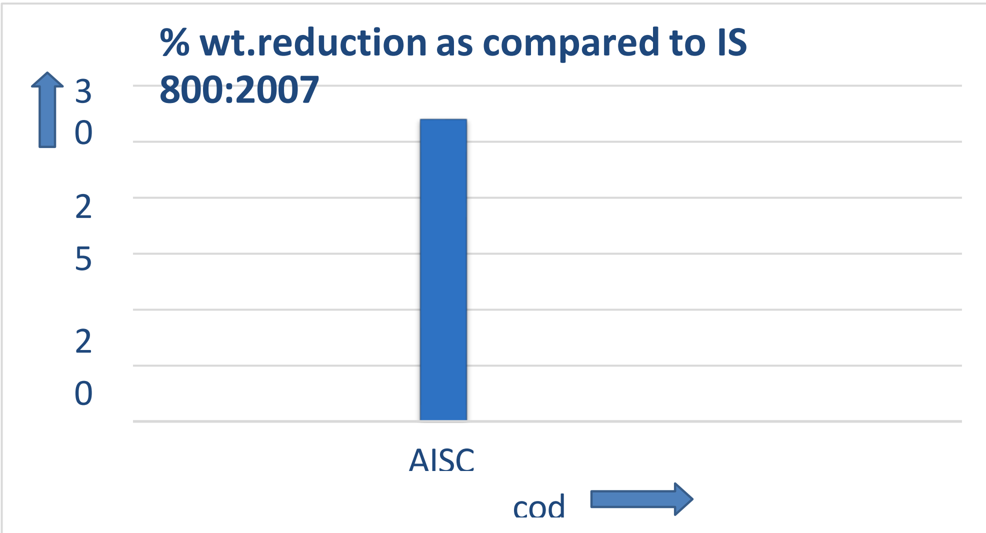

Fig.7 : % wt. reduction as compared to IS800:2007

5. SUMMARY & CONCLUSION

1. Pre-engineered steel structures building offers low cost, strength, durability, design flexibility, adaptability and recyclability. Steel is the basic material that is used in the materials that are used for Pre-engineered steel building. It negates from regional sources. Infinitely recyclable, steel is the material that reflects the imperatives of sustainable development.
2. As it is seen in the present work, the weight of steel can be reduced to 27% as per AISC compare to IS for industrial building , providing same load
3. It is also seen that the weight of PEB depends on the Bay Spacing, with the increase in Bay Spacing up to certain spacing, the weight reduces and further increase makes the weight heavier.

4. One of the main reason to increase in weight in IS 800:2007 compared to IS AISC is “Serviceability Criteria”. Deflection limits by IS code are higher than deflection limits by AISC.
5. Reason for higher wt. in IS 800-2007 compared to AISC is limiting ratios of the sections (Table 2 of IS800-2007).
6. 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.
7. 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.
8. It was observed 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.
9. It is observed that crane Impact load allowance is similar in case of vertical loads whereas in case of horizontal loads (surge, barking loads) the impact allowance is more in AISC compared to IS codes.
10. To Conclude “Pre-Engineered Building Construction as per AISC gives the end users a much more economical and better solution for long span structures where large column free areas are needed

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