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Analysis and Design of Pre-Engineered Building Using IS800:2007 and International Standards

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Abstract: In this report, comparison is made between IS800:2007 & International standards. The entire range of pre-engineered building is studied while doing this comparison. A school building is designed using IS800:2007 & International standards 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 & International standards & possible reasons for variation in respective results. Analysis and design of these building frames was carried out using Staad-Pro software & manually also. As per market study it observed that more than 70% pre-engineered buildings are designed according to American codes. As per the design result obtained during this dissertation work it is noted that the weight of structure is reduced by 23.97% as compared to IS800:2007. Even though most of the pre-engineered buildings are designed accordance to American code it is noted that by using Euro-03 weight of structure is reduced by 27.2% and by using BS5950-2000 weight of structure is reduced by 9.04% respectively as per obtained design results as compared to IS800:2007.

Keywords: PEB, Analysis, Design, LSM, LRFD, AISC-10, IS 800:2007, Euro-03, BS5950.

I. INTRODUCTION

The pre-engineered building technology, which entered the indian construction area during the late nineties has over a period of time gained widespread acceptance among the end users and is steadily making inroads in the construction and infrastructure projects across the country. This is largely due to the fact that PEB based construction technique is offering the most innovative, hi-tech and quicker methods of construction ensuring efficient, cost effectiveness and speedy completion of projects.

Concept

Pre-engineered buildings (PEBs) use a predetermined inventory of raw materials that has proven over time to satisfy a wide range of structural and aesthetic design requirements. This flexibility allows PEBs to fulfill an almost unlimited range of building configurations, custom designs, requirements and applications. The pre-engineered steel building is a building shell utilizing three distinct product categories as: Built-up "I" shaped primary structural framing members (columns and rafters) Refer fig 1.1.

Cold-formed "Z" and "C" shaped secondary structural members (roof purlin, eave struts and wall grits) Refer fig 1.2.

Roll formed profiled sheeting (roof and wall panels) Refer fig 1.3

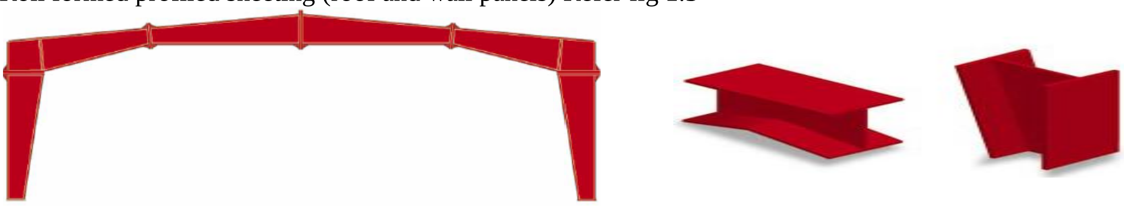

Fig.1.1 Built-Up "I" Shaped Primary Structural Framing Members.

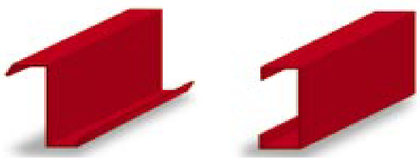

Fig.1.2 Cold-Formed "Z" And "C" Structural Members.

Fig.1.3 Roll Formed Profiled Shaped Secondary Sheeting.

II. OBJECTIVE

The objective of our project encompasses our entire pre-engineered steel buildings product line. The main objective of our project is to compare the design of pre-engineered (school building) using IS800:2007 & International standards.

The main objectives of undertaking the present study are as follows:

- Design of G+3 PEB structure for school building using IS800:2007 & International standards
- Comparing codal provision
- Comparing design results of IS800:2007 with International standards
- Comparing % variation in tonnage of structure.
- Suggest most efficient method & design code for industrial building.

III. LITERATURE REVIEW

Kumar et al **[2014]** studied the pre-engineered building (PEB) concept in the design of structures has helped optimizing design. the ability 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, is800-1984, is800-2007 and also 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, is considered 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 (aisc-89) & between Indian codes (is800-1984, is800-2007).

Chavan et al **[2014]** aims to evaluate the economic significance of the hollow structural sections (HSS) in contrast with open sections. this study was carried out to determine the percentage economy achieved using hollow structural sections (HSS) so as to understand the importance of cost effectiveness. the technique used in order to achieve the objective included the comparison of different profiles for various combinations of height and material cross-section for given span and loading conditions. the analysis and design phase of the project was performed using Staad pro v8i. the sample results of Staad Analysis were validated with the results of manual analysis.

IV. METHODOLOGY

The design codes are being updated and modified incorporating the results from the various researches and developments being carried out at the various R & D Centres in the country. Considering that the current practice all over the world is based on Limit State Method (LSM) or Load and Resistance Factor Design Method (LRFD), it was found essential during the year 2002 – 2003 that the code of practice for use of steel in general construction should be modified to LSM while maintaining Allowable Stress Design as a transition alternative. The IS800:2007 was thus prepared and published by the Bureau of Indian Standards (BIS) in 2008.

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 & faster construction. In this project work, an industrial structure (Pre-engineered Building) with loading as per Indian Standard codes will be analyzed and will be designed according to the various standards, i.e. IS 800-2007 (LSM), IS 800-2007 (ASD), AISC-10 LRFD, BS 5950:2000 and Eurocode-3 & design results will be compared in terms of steel consumption. Here an attempt will be made to highlight the essential contents of IS: 800-2007 while following Limit State Method, the corresponding stipulations as adopted by other International codes.

The project work will be carried out as,

- Design of G+3 PEB structure for school building using IS800:2007 & International standards
- Comparing codal provision.
- Comparing design results of IS800:2007 with International standards.
- Comparing % variation in tonnage of structure.

Selected structure is located in Maharashtra, India. Structure having the dimensions length 35m, width 15.2m, have height 15m, & with flat roof. Structure located in seismic zone III with wind speed 39 m/sec considered life span of structure as 50 years.
Complete structure configuration details can be found in Table 1 as follows

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TABLE 1. DESCRIPTION OF BUILDING

Location	Pune, Maharashtra
Length	35m
width	15.2m
Eave Height	14m
Seismic Zone	III
Wind Speed	39 m/s
Wind Terrain Category	2
Wind Class	C
Life Span	50 Years
Slope of Roof	Flat Roof
Soil Type	Medium
Importance Factor	1.5
Response Reduction Factor	5

TABLE 2. Load Combinations

AISC-10	BS-5950	IS 800:2007	EURO-03
Limit State of Serviceability	**Limit State of Serviceability**	**Limit State of Serviceability**	**Limit State of Serviceability**
(DL+LL)	(DL+LL)	(DL+LL)	(DL+LL)
(DL+0.75*WL/EL)	(DL+WL/EL)	(DL+WL/EL)	(DL+WL/EL)
(DL+ WL/EL)	(DL+LL+WL/EL)	(DL+0.8*LL+0.8*WL/EL)	
(0.6*DL+ WL/EL)	(DL+LL+WL/EL)		
Limit State of Strength	**Limit State of Strength**	**Limit State of Strength**	**Limit State of Strength**
(1.2*DL+1.6*LL)	(1.4*DL+1.6*LL)	1.5*(DL+LL)	(1.35DL+1.50LL)
(1.2*DL+0.5*LL+1.6*WL/EL)	(1.0*DL+1.4*WL/EL)	1.5*(DL+WL/EL)	(1.35DL+1.50WL/EL)
(0.9*DL+1.6*WL/EL)	(1.0*DL+1.2*WL/EL)	(0.9*DL+1.5 WL/EL)	
(1.2*DL+1.2*LL+0.6*EL)		(1.2*DL+1.2*LL+0.6*WL/EL)	
(1.2*DL+1.2*LL+1.2*EL)		(1.2*DL+1.2*LL+1.2 *WL/EL)	
(0.9*DL+1.5*EL)		(1.2DL+0.5LL+2.5EL)	
		(0.9DL+2.5EL)	

Table 3. Limiting Deflections

TABLE III : LIMITING DEFLECTIONS									
SR NO	DESCRIPTION	AISC-10		BS-5950		IS800:2007		EURO-03	
		VERTICAL	LATERAL	VERTICAL	LATERAL	VERTICAL	LATERAL	VERTICAL	LATERAL
1	Main Frame	L/180	H/60	L/200	H/100	L/180	H/150	L/250	H/100
2	Mezzanine	L/240	-	L/360	-	L/300	-	L/300	-

RESULT AND DISSCUSION

Design weight of structure as per IS800:2007

Frame weight	=	13160.0kg x 6	=	78960.0kg
Beam weight	=	308.0kg x 240	=	73920.0kg
Bracing weight	=	8523.0kg	=	8523.0kg
Total weight			=	**161403.0kg**

Design weight of structure as per BS5950

Frame weight	=	11092.0kg x 6	=	66552.0kg
Beam weight	=	308.0kg x 240	=	73920.0kg
Bracing weight	=	7556.0kg	=	7556.0kg
Total weight			=	**148028.0kg**

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Design weight of structure as per AISC:2010

Frame weight	=	10440.0kg x 6	=	62640.0kg
Beam weight	=	250.0kg x 240	=	60000.0kg
Bracing weight	=	7556.0kg	=	7556.0kg
Total weight			=	**130196.0kg**

Design weight of structure as per EURO:03

Frame weight	=	9890.0kg x 6	=	59340.0kg
Beam weight	=	250.0kg x 240	=	60000.0kg
Bracing weight	=	7556.0kg	=	7556.0kg
Total weight			=	**126896.0kg**

Table- 4 Weight Comparisons

Description	IS800:2007	BS-5950	AISC-2010	EURO-03
	Structure Weight			
	(Kg)	(Kg)	(Kg)	(Kg)
Framing	152880	140472	122640	119340
Bracing	8523	7556	7556	7556
Total Wt.	161403	148028	130196	126896
% REDUCTION	BASE	9.04%	23.97%	27.19%

RESULT

Following graphs shows the design weight of the structure and % reduction in tonnage as per International standards as compared to IS800:2007 in framing & bracing members.

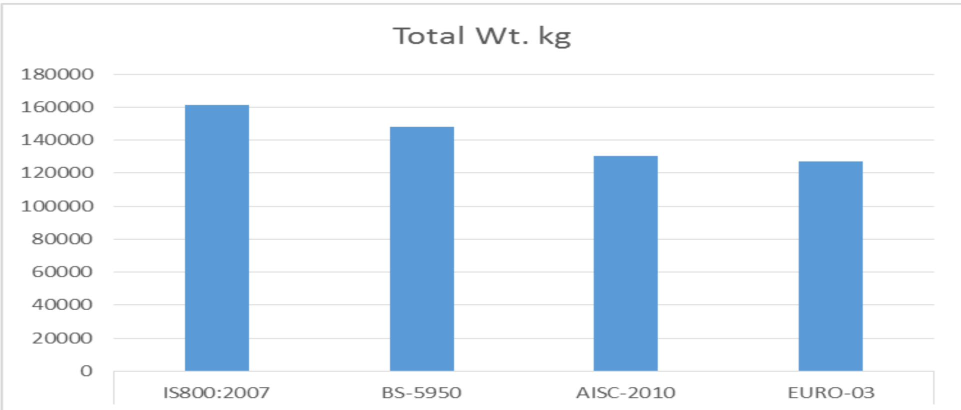

Fig.1 Design Weight of Structure.

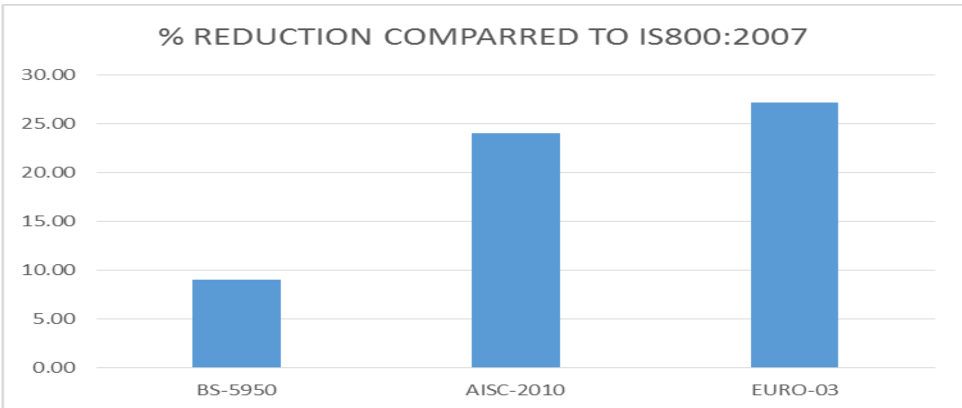

Fig.2. % Reduction in Tonnage

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CONCLUSION

Following are the conclusions which are observed:

1. As per market study it observed that more than 70% pre-engineered buildings are designed according to American codes. As per the design result obtained during this dissertation work it is noted that the weight of structure is reduced by 23.97% as compared to IS800:2007.
2. Even though most of the pre-engineered buildings are designed accordance to American code it is noted that by using Euro-03 weight of structure is reduced by 27.2% and by using BS5950-2000 weight of structure is reduced by 9.04% respectively as per obtained design results as compared to IS800:2007.
3. The reasons to increase in weight in IS800:2007 as compared other international standards are as mentioned below.
4. As per requirement of design and detailing for earthquake loads we have to consider additional Load combinations as per limit state of strength.
5. As per requirement of design and detailing for earthquake loads we have limit the slenderness value for bracing member to span by 120, which is critical as compare to International standards.
6. IS 800-2007 (LSM) as prepared (BIS–2006) is mostly based on international standards as is evident from the comparative charts shown above, with load factors and partial safety factors suiting Indian conditions.
7. The code has been mainly modelled in line with the Eurocodes, with some additional references taken from the existing British Codes also.
8. Another important aspect of IS800:2007 code is that this code does not totally do away with the existing Allowable Stress Design (ASD) method of analysis. As a matter of fact, one chapter in this code has been totally dedicated to design concepts based on the ASD method.

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