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Comparative study of different codes on steel building

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ABSTRACT

The paper mainly focuses on the comparison of two different code that is IS code is IS800: 2007 (LSM), IS 875: 1987 part (I, II, and III) and AISC LRFD code for a conventional industrial steel building. It's a case study for the industrial building based on the review and the various case studies which show their experimental and analytical study carried out in this field. Different structural design code provides different data and procedure of design to engineering. Comparisons of the different factor with the same loading. To conduct the study a 3D model of Industrial building having dimension 15m×45m, 20m×50m, 23m×65mwith three different spacing that is (4.5m,5m,6m); (5m,6m,7m); (5m,6m,7m) having column height 6m is designed and analyzed on STADD-Pro V8i structural design software.

Keywords— *IS800:2007(LSM) Limit State Method, IS875:1987 Part (I, II and III), AISC LRFD (Load and Resistance Factor Design), Industrial building, STADD-PRO V8i software*

1. 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 member mostly do not change with time. Also, addition and alteration can be made easily steel structure. In this study, an industrial warehouse is analyzed and designed according to Indian standard IS800:2007, IS875:1987 (Part I, II and III) and also referring AISC LRFD with the built-up member. The behaviour of the structure discussed with respect to its analysis result and weight between IS code and AISC code designed of structure done by two methods explained as follow:

1.1 Limit State Method (LSM)

The limit state method uses the concept of fitness of the structure to perform its function satisfactorily during its service lifespan. The condition or the state at which structure become unsafe is called the limit state and the philosophy based on this concept is called limit state philosophy of design. Several independent factors are used in the limit state design each of which plays a particular role to ensure the reliability of the structure and the guarantee against the occurrence of a limit state.

1.2 Load and Resistance Factor Design (LRFD)

In this method load on the structure is considered and the resistance factor of material is considered in design considering yield stress. Basically, LSM and LRFD both are the same. With the advantage of the modern state of the art design methodology in the form of limit state method or the load and resistance factor design method rationally and overall economy has become the keyword in the design of steel structure.

The advantages of steel construction are as follow:

(a) To provide high quality, strong, durable & stable structure.
(b) It has a high fire resistant property and is environmentally friendly material.
(c) Construction with the steel material is fast compared to other materials.
(d) The steel component can be recovered, recycled and reused effectively.

2. VARIOUS LOADS ON INDUSTRIAL BUILDING

2.1 Dead load

A dead load of truss includes a dead load of roofing materials, purlins, trusses and roof bracing system. The dead weight of trusses may be assumed to be equal to 10% of the load on the truss. A simple estimation of a roof truss is approximate in N/m^2.

2.2 Superimposed load

The load assumed to be produced by the intended use of occupancy of a building including the self-weight of the movable partition, distributed the concentrated load, the load due to change in temperature, creep, shrinkage and differential settlement specifies in IS875:1987 (Part II).

2.3 Wind load

The most critical load on the industrial building is wind load. For the roof and walls of an industrial building, consideration must be made for the pressure difference between the opposite faces of such elements to accounts for external and internal air pressures exerted by wind blowing against the building. When the negative air pressure is less than atmospheric pressure is known as suction. I875:1987 (Part III) specifies the following wind load coefficients to be assumed in the analysis of an industrial building.

The wind force F is obtained by:

$$F = (CP_e - CP_i)\, APz$$

2.4 Snow load

IS875:1987 (Part IV) specifies the following snow load to be assumed in the analysis of an industrial building. If the structure situated in an area where the roof is subjected to snow the load considered for design should be the maximum of live or snow load. The snow load depends upon the pitch of the roof, shape and roofing material. When the roof slope is greater than 50^{o} snow load is neglected.

3. LITERATURE REVIEW

3.1 C. M. Meera: Studied that Pre-engineered building is a versatile solution to all the single storey industrial building as along with providing a high-quality pre-design structure it is also economical and lightweight construction technique. PEB has many advantages over conventional steel structures such as providing a standard fabricated section according to the optimum requirement. In this paper, the author carried out a comparative study of PEB and CSB on the basis of the design and analysis of a typical frame. Design of conventional steel frame includes a selection of a suitable roof truss built up from standard hot rolled sections. Analysis for both the steel frame using different concept shows that there is about 30% reduction in steel consumption in Pre-engineered building as compared to the conventional steel frame, hence PEB are lighter than CSB. In this way, PEB proves to be more advantageous from CSB in as it is more economical, quality control, speed in construction, longer span, durability, standard designs, ease in expansion and erection.

3.2 S. B. Bagte, Rahul Patil: This paper is a comparative study of PEB concept and CSB concept. The study is achieved by designing a typical frame of a proposed Industrial Warehouse building using both the concepts and analysing the designed frames using the structural analysis and design software STAAD-Pro. The work is concluded that PEB is more economical than CSB because the use of tapered section in PEB quantity of steel reduces. In CSB bottom member and the inclined member is provided which increase steel quantity.

3.3 G. Sai Kiran, A. Kailasa Rao, and R. Pradeep Kumar: They observed that in recent years, the introduction of Pre Engineered Building concept in the design of structures has helped in optimizing the design. The adaptability of PEB in the place of Conventional Steel Building design concept resulted in many advantages, including the economy and easier fabrication. In this study, an industrial structure (Ware House) is analysed 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 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 as they discussed is in terms of its weight comparison, between Indian codes (IS800-1984, IS800-2007) & American code (MBMA-96), & between Indian codes (IS800-1984, IS800-2007). This work concluded that deflection limit by IS code is higher as compare to American code (MBMA-96) and loading also higher in IS code as compare to American code.

3.4 Swati Wakchaure, N. C. Dubey: Compare the Pre- Engineering building (PEB) and conventional steel building (CSB) with weight. The construction of PEB in place of CSB design concept resulted in many advantages as members are as per bending moment diagram and thus reducing steel as per requirement. In this study, PEB and CSB structure are analyzed and designed as per IS: 800-2007, IS: 800-1984. The economy of the structure is discussed in terms of weight comparison, between Indian code IS: 800-2007 and IS: 800-1984 and in between PEB & CSB building structure. PEB structure is 30% lighter than CBS, the deflection limit is higher in IS800-1984 compared to IS800-2007 and PEB structure is reduces a dead load of structure and hence reduce the size of foundation.

3.5 Trilok Gupta, Ravi Sharma: In this study comparison of a truss of three types of the section has been analysed using the conventional working stress method and recently adopted limit state method. The study includes the knowledge regarding steel trusses and design philosophies with a worked example. From the result, we can observe that the section designed using limit state method are more economical than the section are designed working stress method. It can also be observed that the tube section designed by limit state method is the most economical among the three sections which are used. The limit state provides a checklist of the basic structural requirement for which designed calculation may be required. Limit state design by providing consistent safety and serviceability, ensure economical use of material and wide range of application.

3.6 Pradip S. Lande reviewed the design and analysis of industrial steel structure (warehouse) according to Indian standard IS 800:2007 and American code MBMA-96 by using structural analysis and design software STADD-pro they also reviewed the

study between cold formed sections as purlin with traditional used hot rolled section for industrial structures. It is noted that PEB designed with IS 800: 2007 is of higher weight than the one designed with MBMA-96 and which is because limiting ratio of the section it is also noticed that PEB roof structure with Z purlin is 30% lighter than a traditional used hot rolled section.

3.7 Hemant Sharma: Compare the design and analysis of Pre-engineered industrial building with the conventional building by mainly comparing the bending moment at a different section. Also considered different components of the pre-engineered steel building. To design and analysis of PEB and CSB uses STADD-pro software. After doing a detailed analysis of PEB and CSB there observed 37% overall material saving and cost reduction in PEB compared to CSB.

3.8 Prof. S. S. Patil and L. A. Pansur: Compare the IS800-1984 which is based on the elastic method and IS800-2007 based on limit state method of design. The design methodologies for the steel structure namely the working stress method and limit state method briefly explained. The importance of limit state method design is highlighted. In this work, the detailed study of structural components as a tension member and compression members by designing limit state method and working stress method has been carried out and submitted the comparative study of the same in the form of a graph. This work concluded that the design of tension member by IS800:2007 is economical over IS800:1984 and for the compression member load carrying capacity increases by using IS800:1984 as compare to IS800:2007.

3.9 Amruta G. Whatte and S. S. Jamkar: Compare the design of structural member by using three different international code. Structural elements such as tension member, a compression member, flexural member, beam column, gusseted base and beam-column connection are designed for this comparative study. Same data is considered for the design of particular element and that element designed by using Indian standard (IS800:2007), American standard (AISC 13th Edition) and British standard (BS 5950, 1:2000). The design methodology used in this study is same for all the code but there is some difference in the constants or parameters depending on the code used finally the result is evaluated and compared in the tabular format. As per the result, it is observed that there is the variation in the value of strength obtained by three different code because there is variation in constant and the main thing is that there is the unavailability of same size section in all three code.

3.10 Sagar D. Wankhade and Prof. P. S Pajgade: Pre-Engineered Building (PEB) concept is a new conception of single storey industrial building construction. This methodology is versatile not only due to its quality pre-designing and prefabrication but also due to its light weight and economical construction. This concept has many advantages over the Conventional Steel Building (CSB) concept of buildings with roof truss. This paper is a comparative study of PEB concept and CSB concept. This paper effectively conveys that PEB structures can be easily designed by simple design procedures in accordance with country standards. The paper also imparts simple and economical ideas on preliminary design concepts of PEBs. The concept depicted is helpful in understanding the design procedure of the PEB concept.

3.11 Danny Jong, Miguel A. Serna: The paper presents a comparative study of a well-established steelwork design standard, the American AISC LRFD, and the new European code for the design of steel structures, Eurocode 3. The study is focused on the resistance capacity of steel members subjected to one of the following load cases: axial compression, bending, and combined axial compression and bending. First, the paper compares the formulation of both codes in order to identify similarities and differences. Particular attention is given to the resistance of beam-columns since many steel structural members in building structures fall into this category. In the case of pure bending and combined axial compression and bending, the paper considers two extreme cases of linear moment distribution: equal end moments and opposite end moments. The results are presented graphically in order to make possible their interpretation and to detect significant differences in resistance. The comparative study shows that the resistance capacities given by LRFD and EC3 can differ appreciably for some of the cases considered. Moreover, there are also significant differences between the two methods proposed by the Euro code when slenderness is high and the beam is subjected to linear moment distribution with opposite end moments. Finally, the paper stresses those points where each standard offers a simpler approach.

4. OBJECTIVE

The following are the objective of the work

- To design a system for different types of load (Dead, Live & Wind load).
- Evaluate the steel consumption in both the design system.
- Reduce the steel consumption and compare the results for both the design procedure (Shear force, support reaction, deflection etc).
- Find out which design procedure is more effective.

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