Study and Analysis of Pre-Engineering Building Structure

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Abstract - *In the present study Pre-engineered Buildings are analysis and studied in accordance with technical specification. Pre Engineered Building (PEB) concept in the design of structures has helped in optimizing design. Steel is the basic material that is used in the Materials that are used for Pre-engineered steel building. The latest version of the Code of Practice is IS 800:2007 is based on Limit State Method of design. The adoptability of PEB in the place of Conventional Steel Building (CSB) design concept resulted in many advantages, including economy and easier fabrication. PEB methodology is versatile not only due to its quality pre-designing and prefabrication, but also due to its light weight and economical construction. In this study, an industrial structure (Ware House) is analyzed and designed according to the Indian standard, IS 800-2007. The study of Pre Engineering Building with Conventional Steel Building has been carried out and the observations made based on this study are very much useful to the practicing structural engineers.*

Key Words: Pre-Engineering Building, Staad Pro., IS Code, Dynamic Load.

1. INTRODUCTION

Steel is the material of choice for design because it is inherently ductile and flexible. 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. PEB can be fitted with different structural accessories including mezzanine floors, canopies, fasciae, interior partitions, etc. The concept of PEB is the frame geometry which matches the shape of the internal stress (bending moment) diagram thus optimizing material usage and reducing the total weight of the structure. The complete designing is done at the factory and the building components are brought to the site in knock down condition. These components are then fixed/ jointed at the site and raised with the help of cranes. An Industrial Warehouse is a storage building and is usually characterized as single storey steel structures with or without mezzanine floors. The enclosures of these structures may be brick masonry, concrete walls or GI sheet coverings. These buildings are low rise steel structures characterized by low height, lack of interior floor, walls, and partitions. The roofing system for such a building is a truss with roof covering. The walls are generally non-bearing but sufficiently strong enough to withstand lateral forces caused by wind or earthquake. The designing of industrial warehouse includes designing of the structural elements including principal rater or roof truss, column and column base, purlins, sag rods, tie rods, gantry girder, bracings, etc. 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 expanded as per the requirements in future.

2. METHODOLOGY

The present study is included in the design of an Industrial Warehouse structure located at Persivni Nagpur. The structure is proposed as a Pre-Engineered Building of 40.90 meters Length, 5 bays each of 8.18 meters length and clear height 4.5 meters, peak height of 7.097 meters. In this study, a PEB frame of 32 meter width is taken into account and the design is carried out by considering wind load as the critical load for the structure. CSB frame is also designed for the same span considering an economical roof truss configuration. Both the designs are then compared to find out the economical output. The designs are carried out in accordance with the Indian Standards and by the help of the structural analysis and design software STAAD pro v8i.

3. Primary Pre-Engineering Frame

Assuming that a Pre-engineered building system is selected for the project at hand, the next milestone is choosing among the available types of Pre-engineered primary frame. Proper selection of the primary framing, the backbone of Pre-engineered buildings, goes a long way toward a successful implementation of the design steps to follow. Some of the factors that influence the choice of main framing include:

- Dimensions of the building: width, length, and height.
- Roof slope.
- Required Column-free clear frame
- Occupancy of the building and acceptability of exposed steel column
- Proposed roof & wall materials
- Multi-span rigid frame
- Lean to frame
- Single span and continuous trusses

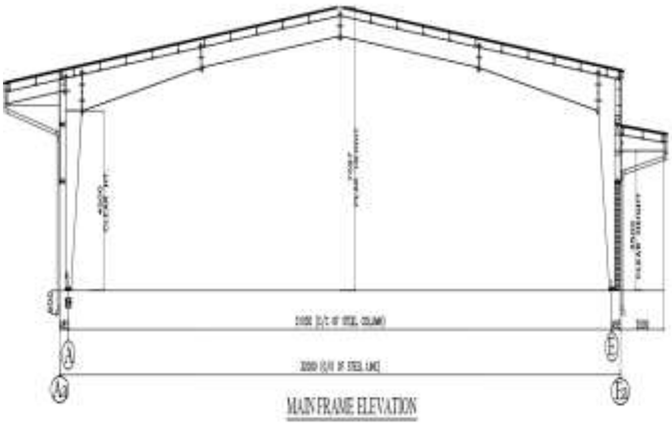

Fig. - Main Frame Elevation

Table -1: Structure Configuration Details

Location	Nagpur Maharashtra India
Length	40.9 m
Width	32.0m
Clear Height	4.50m
Peak Height	7.097m
Wind Speed (m/s)	44.0m
Seismic zone	III
Slope of roof	1:10
Bay Spacing	5@8.18

4. Literature Review

4.1 D.Duthinh; J.A.Main; A.P.Wright & E.Simiu

This paper presents a methodology for estimating the mean recurrence interval of failure under Wind loads that accounts for non-linear structural behavior and the directionality of the Wind speeds and the aerodynamic affects, and uses databases of Wind tunnel test results as well as Wind speed data from the NIST hurricane Wind speed database augmented by statistical methods. Under the assumption that uncertainties with respect to the parameters governing wind loading and material performance are negligible, our methodology results in a notional probability of failure during a 50-year period of the order of 1/2,000. This result was obtained for one particular low-rise steel structure at one particular location, but the method is general and can be applied to any structure anywhere provided the relevant meteorological and Wind tunnel data exist and non-linear finite element analysis is accessible. As different structures fail by different mechanisms, good engineering judgment is required to identify potential critical load cases and to limit non-linear analysis to a manageable number of cases.

4.2 D.Mahaarachi, M.Mahendran

This paper described an advance finite element model that accurately predicts the true behaviour of Crest-fixed steel claddings under Wind uplift. The results from the FEA and experiments agreed well for the trapezoidal steel claddings with wide pans used in this investigation. This demonstrates that non-linear finite element analysis can be used with confidence to carry out extensive parametric studies into the structural behaviour of profiled steel claddings, which undergo local pull-through failures associated with splitting or local dimpling failures. Once the use of finite element analysis to determine the most important pull-through failure load was validated using large scale two-span experiments, it was used to investigate the behaviour of trapezoidal steel claddings with varying geometry and material properties. Based on these FEA, improved design formulae have been developed for the local failures of trapezoidal steel claddings with wide pans. This paper has also discussed the disadvantages of using the Conventional one rib FEA model for multispan steel Cladding assemblies.

4.3 Saffir Dale C. Perry; James R. McDonald and Herbert S

During the past decade the engineered metal building has emerged as a competitive form of low-rise construction. 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. It would be comforting if more full-scale measurements on buildings were available to corroborate wind tunnel data on which the code provisions are based-but this will come. While recently an improvement in field performance has been noted, the additional steps alluded toin this paper should be implemented in order to protect fives and reduce wind damage to a minimum.

4.4 Dat Duthinh & William P. Fritz

This paper presented an improved version of the Non-linear data assisted technique method for estimating ultimate capacity under wind loads. The paper also showed how NLDAD can be used to substantially increase the safety level of the frame under wind loads with only modest or no increase in material consumption or save material & energy embodied there in while maintaining wind resisting capacity. The method consists of using databases of pressures measured in wind tunnel tests and applying these pressures in non-linear structural analysis

4.5 Timothy Wayne Mays

The purpose of this study is to show that elastic design of metal building systems for seismic forces is a feasible, economical and safe alternative to inelastic design and detailing. Even if the structural system is excited by an earthquake of a magnitude greater than the design earthquake only a small amount of inelastic deformation if any will occur.

5. CONCLUSION

By increasing the area of Industrial building material and cost of the building is minimized in case of PEIB while in case of Convention building the material and cost is not optimized if we increase the area of building.

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