Utilization of Cold Form Steel in an Industrial Building: A Review

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Abstract— Increasing world population and natural resource limitations has led to a growing demand for more efficient structural systems to achieve a sustainable economy and society. Cold-formed steel CFS) Structural systems are increasingly adopted as primary or secondary structural members in modern building construction because of their light weight, speed of construction, recyclability, and sustainability. However, the inherently low buckling resistance of thin sections results in relatively low strength and ductility in CFS elements, which limits their performance in tall buildings and under extreme loading events. However, the scope of study is to Utilize Cold formed steel sections in a industrial frame.

Key words: Analysis, Industrial Building, Steel Structure, Cold Formed Steel, Forces, Cost

I. Introduction

A large steel structures being built are only single storey buildings for industrial purpose. Secondary structural members span the distance between the primary building frames of metal building systems. They play a complex role that extends beyond supporting roof and wall covering and carrying exterior loads to main frames. Secondary structurals, as these members are sometimes called, may serve as flange bracing for primary framing and may function as a part of the building's lateral load–resisting system. Roof secondary members, known as purlins, often form an essential part of horizontal roof diaphragms; wall secondary members, known as girts, are frequently found in wall bracing assemblies. The majority of steel structures being built are only low-rise buildings, which are generally of one storey only. Industrial buildings, a sub-set of low-rise buildings are normally used for steel plants, automobile industries, light, utility and process industries, thermal power stations, warehouses, assembly plants, storage, garages, small scale industries, etc. These buildings require large column free areas. Hence interior columns, walls and partitions are often eliminated or kept to a minimum.

Most of these buildings may require adequate headroom for use of an overhead traveling crane. A third type of secondary framing, known by the names of eave strut, eave purlin, or eave girt, acts as part purlin and part girt—its top flange supports roof panels, its web, wall siding. Girts, purlins, and eave struts exhibit similar structural.

II. Problem statement

Industrial building frame of steel is quite costly which can be minimized using light weight material (cold formed steel) which is cheaper in cost too.

III. Aim

The primary aim of this work is to compare steel structure with light weight cold formed steel structure, to justify its implementation over general steel structure to enhance frame costing and stability.

IV. Literature review

Komara et. al. (2018) Review the current researches on Cold-formed steel (CFS) structures, particularly for screw connections, welded connections, bolted connections, and adhesive connections. The performance of different CFS connections is well discussed in order to capture the behavior of each type of connection. Based on the review assessment, the results highlighted that all types of connections except adhesive connections have shown the proper behavior that can trigger the change of any design codes. Otherwise, adhesive connections still have some gaps of knowledge that are needed to be filled with comprehensive future researches.

Kalyanshetti & Mirajkar (2017) this research involves the economy, load carrying capacity of all structural members and their corresponding safety measures. Economy was the main goal of this study involving comparison of conventional sectioned structures with tubular sectioned structure for given requirements. For study purpose superstructure-part of an industrial building is considered and comparison is made. Research reveals that, up to 40 to 50% saving in cost is achieved for square and rectangular tubular sections.

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Trilok Gupta, Ravi K. S Harma, (2013) The research involves various kinds of industrial roof trusses by using computer software. It also involves the knowledge regarding steel roof trusses and the design philosophies with worked examples. From the observations they concluded that, the sections designed using limit state methods are more economical than the sections using working stress method. It was observed that the tubular section designed by limit state method was the most economical among the three sections which were used.

Vaibhav B. Chavan et. al. (1990) This research's objective was to estimate the economic importance of the Hollow Sections in contrast with conventional sections. This paper was carried out to find out the percentage economy accomplished using Hollow Sections so as to understand the importance of cost efficiency. The technique used in order to reach the objective involves the comparison of various profiles for different combinations of height and material cross -section for given span and loading conditions. The analysis and design phase of the project was done utilizing

STAAD PRO V8i. The results of STAAD analysis were validated with the results of Manual analysis.

Davison and Birkemoe (1982) determined that there are two residual stress gradients in the longitudinal direction, one across the tube face and around the cross section, denoted as membrane, and the other perpendicular to the tube face through the material thickness, denoted as bending. "The perimeter (membrane) residual stress gradient represents the variation in the mean value of the longitudinal residual stress [and] the through thickness (bending) residual stress gradient is the deviation from this mean value normal to the perimeter through the material thickness".

Do dai thang et. al. (2009) presented a paper in which, optimum cost design of steel box girder bridge is carried out by varying of closed rectangular and open trapezoidal sections.

A joghataie and M. Takalloozadeh (2009), in their paper proposed new penalty function which have better convergence properties, as compared to the commonly used exterior and interior penalty function. They applied the old and new exterior and interior penalty function in conjuction with the steepest descent method to three-bar truss and ten-bar truss and compared the results. It was shown that the convergence speed and accuracy of the result were improved.

A Csebfalvi and G. Csebfalvi proposed a genetic algorithm for discrete weight design of steel planer frames with semi- rigid beam-to-column connections. It was revealed that the results of discrete minimal weight design are highly affected by the applied connection modelling method.

Stanislovas kalantal, Juozas, et al, in their paper, considered the optimal design problems of the elastic and elastic-plastic bars. The mathematical models of the problems, including the structural requirements of the strength, stiffness and stability, are formulated in the terms of finite elements method. The stated nonlinear optimization problems are solved by the iterative method, structures These problems are formulated as nonlinear discrete optimization problems.

Yasuyuki Nagano and T. Okamoto, et al, presented this paper; the purpose of this to show the practical applicability of a new optimum design method by the authors to an actual high-rise building structure with hysteretic dampers. They concluded that it possible to save structural cost and reduce computational cost than the conventional seismic resistant design methods, including iterative dynamic response analysis.

E. Kalkan and S.K. Kunnath (2004) revealed in their study that the suitability of using unique model combinations to determine lateral load confrigations that best approximate the inter-story depends in multi-story movement resisting frame buildings subjected to seismic loads.

Krishnan et. al. (2006) studied the responses of tall steel movement frame buildings in scenario magnitude 7.9 earthquakes on the southern San Andreas fault. This work used three-dimensional, nonlinear finite elements models of an existing eighteen-story moments frame building as it, and redesigned to satisfy the 1997 uniform building code. The authors found that the simulated responses of the original buildings indicate the potential for significant damage throughout the San Fernando and Los Angeles basins. The redesigned building fared better, but still showed significant deformation in some areas. The rupture on the southern San Andreas that propagated north-to-south induced much larger building responses that the rupture that propagated south-to-north.

Thomas Heaton, et al. (2007) simulates the response of 6 and 20-story steel movement- resisting frame buildings (US 1994. UBC) For ground motions recorded in the 2003 Tokachi-oki earthquake. They consider building with both perfect welds and also with brittle welds similar to those observed in 1994 Northridge earthquake. Their simulations show that the long- period ground motions recorded in the near-source regions of the 2003 Tokachi-oki earthquake would have caused large inter-story drifts in flexible steel moment – resisting frame buildings designed according to the US 1994, UBC.

Takanori OYA, takashi Fukazawa, et al (2009), In their paper introduced the application of a new type BRB to various structures. The brace has two buckling restraining parts (steel mortar planks), clipping a core plate being under axial forces. These parts are welded together and restrain the core plate of plastic behaviour, avoiding the out- of – plane deformation and the buckling.

V. Conclusion

The literature review has suggested that implementation of cold formed steel is possible I construction industry but none of them represented such study in an industrial building frame.

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