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Behaviour of Light Gauge Steel Section under Axial Compression Loading

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Abstract

Light gauge steel lipped channel sections are being used popularly in shops, factories, automobile engineering and industries on account of their high strength to width ratio, simplicity in construction, flexibility in fabrication and high structural efficiency. A lot of research work has been carried out to study the structural behavior of axially loaded light gauge steel lipped column sections considering different parameters. However, structural behavior of light gauge steel lipped channel sections under eccentric loading has not received much attention. The present paper focuses on the review of behaviour of the light gauge column section under loading.
Keywords: Cold form Steel

I. Introduction

Cold formed steel products are found in all aspects of modern life; in the home, the shop, the factory, the office, the car, the petrol station, the restaurant, and indeed in almost any imaginable location. The uses of these products are many and varied, ranging from "tin" cans to structural piling, from keyboard switches to mainframe building members. Nowadays, a multiplicity of widely different products, with a tremendous diversity of shapes, sizes, and applications are produces in steel using the cold forming process. Cold formed steel products such as sections have been commonly used in the metal building construction industry for more than 40 years. The popularity of these products has dramatically increased in recent years due to their wide range of application, economy, and ease of fabrication, and high strength to weight ratios. In market various shapes of these products are available C sections are predominantly used in light load and medium span situations such as roof systems. Their manufacturing process involves forming steel sections in a cold state (i.e. without application of heat) from steel sheets of uniform

thickness. The use of coldformed steel structures is increasing throughout the world with the production of more economic steel coils particularly in coated form with zinc or aluminum zinc coatings. These coils are subsequently formed into thinwalled sections by the coldforming process. They are commonly called "Light gauge sections" since their thickness has been normally less than 2.0 mm. However, more recent developments have allowed sections up to 25 mm to be coldformed, and open sections up to approximately 8mm thick are becoming common in building construction. The steel used for these sections may have a yield stress ranging from 250 MPa to 550 MPa. The higher yield stress steels are also becoming more common as steel manufacturers produce high strength steel more efficiently. Further, the shapes which can be cold formed are often considerably more complex than hot rolled steel shapes such as I sections and unlipped channel sections. The cold formed sections commonly have mono symmetric or point symmetric shapes, and normally have stiffening lips on flanges and intermediate stiffeners in wide flanges and webs. Both simple and complex shapes can be formed for structural and non structural applications as shown in Figure. Special design standards have been developed for these sections. The market share of cold formed structural steelwork continues to increase in the developed world. The reasons for this include the improving technology of manufacture and corrosion protection which leads, in turn, to the increase competitiveness of resulting products as well as new applications. Recent studies have shown that the coating loss for galvanized steel members is sufficiently slow, and indeed slows down to effectively zero, than a design life in excess of 60 years can be guaranteed. The range of use of cold formed steel sections specifically as load bearing structural components is very wide, taking in the Automobile industry, Shipbuilding, Rail transport, the Aircraft industry, Highway engineering, Agricultural and Industry equipment, Office equipment, Chemical, Mining, Petroleum, Nuclear and Space industries.

II. Literature review

S.P.Keerthana and K.Jothibaskar [2016], Cold form steel is also called as light gauge steel sections. In this paper investigation made on the built-up section to calculate the buckling loads using experimentally and theoretically. The built-up section is formed by two types of channel section with or without lip was tested as under axial compression. The Finite strip method is developed by CUFSM software. The buckling load value will be taken from GBTUL software. The sections have been chosen from IS 811:1975 for specifications. The column strength determined by Direct Strength Method based on AISI-S100:2007. The load carrying capacity of column compared with numerical, theoretical and experimental results.

W. Leonardo Cortes-Puentes, Dan Palermob, Alaa Abdulridhaa [2016], The axial compressive strength capacity of concrete-filled light gauge steel composite columns was assessed through an experimental program involving twelve long and fourteen stub-columns with width -to- thickness ratio of 125 fourteen casing steel section. A comparison between concrete only and confined stub-columns demonstrated that the stub column experiences an increase of strength of up to 16% due to confinement. The compressive strength contribution of the light gauge steel section was limited by local buckling. Specifically, the steel-only stub-column section slacking the concrete core experienced, on average, approximately 33% of its full compressive strength. The full-scale composite columns illustrated that the axial compressive strength capacity was controlled by end bearing capacity and local buckling of the light gauge steel. The axial compression strength capacity of the full-scale composite columns was satisfactorily predicted based on end bearing resistance of the concrete core and local strains in the light gauge steel. Furthermore, the 33% strength contribution established from the steel-only sections provided a satisfactory lower bound estimate for the calculation of axial compressive strength.

P. B. Patil1 and P. D. Kumbhar [2015], Light gauge steel lipped channel sections are being used popularly in shops, factories, automobile engineering and industries on account of their high strength to width ratio, simplicity in construction, flexibility in fabrication and high structural efficiency. A lot of research work has been carried out to study the structural behavior of axially loaded light gauge steel lipped column sections considering different parameters. However, structural behavior of light gauge steel lipped channel sections under eccentric loading has not received much attention. The present paper focuses on the experimental study of structural behavior of light gauge steel lipped channel sections under eccentric loading by varying loading position in between center of gravity and shear center of channel column section. Finite element analysis of the section is also done using Abaqus software for different positions of the load. The results indicate that, load carrying capacity of the section increases as the loading position shifts towards supported edge of the section. The failure of the section occurs in the form of local-distortional buckling approximately between 1/3rd - ½ of the height of column. Results obtained by software are found to be in good agreement with experimental results.

W. M. Quach And J. F. Huang [2011], Advanced numerical modeling for cold-formed light gauge steel structures, from manufacturing to the structural response under the applied loading, requires the knowledge of the stress-strain behavior of the material over the full range of tensile strains. Existing stress-strain models for carbon steels are either only capable of accurate predictions over a limited strain range or defined by many material parameters and the values of some material parameters are not available in most of existing design codes. Therefore, a new stress-strain relationship for light gauge carbon steels up to the ultimate strength is required for the advanced numerical modeling and needs to be modelled on the basis of three basic material parameters, the so-called Ramberg-Osgood parameters (the 0.2% proof stress 0.2, the initial elastic modulus E0 and the strain-hardening exponent n). This paper presents such new stress-strain models for light gauge carbon steels, which are able to describe the stress-strain relationship over the full range of tensile strains by using only three basic Ramberg-Osgood parameters. In the present study, the stress-strain data obtained from tensile coupon tests reported in existing literatures have been collected and analyzed, and these tested coupons were cut from both virgin steel sheets and cold-formed steel sections. The new models have been developed by a careful interpretation of these existing experimental data. The accuracy of the proposed models has been demonstrated by comparing their predictions with experimental stress-strain curves.

M. Meiyalagan, M. Anbarasu and Dr. S. Sukumar [2010], The Present thesis work aims at the study of buckling behavior of open web Open cross section with intermediate stiffener & corner Lips under compression. Introduction deals with the general idea about cold formed steel members, problems on investigation need for this Thesis, objective of the investigation, scope of the thesis methodology. Literature review details the review of the literature on torsional flexural buckling, Distortional buckling, Channel section with Stiffened Lip and Cold formed members and Open web sections. Expressions for distortional buckling stress & flexural torsional buckling stress has been obtained for mono symmetric open cross section compression members. Four test specimens have been fabricated with geometry of C Section with stiffened both Web and Flange with various thickness and experimented. Numerical analysis using FEM Software ANSYS 11 is performed on the tested models and the results are compared with the Experimental results. Design for maximum Limit strength of Columns using Indian Standard (IS 801 1975) is to be calculated. Comparison of experimental and analytical results using ANSYS and Indian Standard method values are presented under results and discussion. Finally Conclusion and scope for future work is presented based on the results.

Thanuja Ranawaka and MahenMahendran [2010], Fire safety design of building structures has received greater attention in recent times due to continuing loss of properties and lives during fires. However, fire performance of light gauge cold-formed steel structures is not well understood despite its increased usage in buildings. Cold-formed steel compression members are susceptible to various buckling modes such as local and distortional Buckling and their ultimate strength behaviour is governed by these buckling modes. Therefore a research project based on experimental and numerical studies was undertaken to investigate the distortional buckling behaviour of light gauge cold-formed steel compression members under simulated fire conditions. Lipped channel sections with and without additional lips were selected with three thicknesses of 0.6, 0.8, and 0.95 mm and both low and high strength steels (G250 and G550 steels). More than 150 compression tests were undertaken first at ambient and elevated temperatures. Finite element model soft he tested compression members were then developed by including the degradation of mechanical properties with increasing temperatures. Comparison of finite element analysis and experimental results showed that the developed finite element models were capable of simulating the distortional buckling and strength behaviour at ambient and elevated temperatures up to 800 1C. The validated model was used to determine the effects of mechanical properties, geometric imperfections and residual stresses on the distortional buckling behaviour and strength of cold-formed steel columns. This paper presents the details of the numerical study and the results. It demonstrated the importance of using accurate mechanical properties at elevated temperatures in order to obtain reliable strength characteristics of cold-formed steel columns under fire conditions.

Hassan Moghimi1 and Hamid R. Ronagh [2009], The performance of cold-formed steel (CFS) strap-braced walls is evaluated by experimental tests on full- scale 2:4 m 2:4 m specimens, and techniques to improve their behavior are presented. Different strap arrangements have been introduced, and their performance investigated by means of cyclic loading of a total of twenty full-scale walls. Several factors affecting the performance of cold-formed steel frame shear wall have been considered for each arrangement. This paper presents the failure modes of each system and the main factors contributing to the ductile response of the CFS walls to ensure that the diagonal straps yield and respond plastically with a significant drift and without any risk of brittle failure, such as connection failure or stud failure. Discussion of the advantages and disadvantages of including the non-structural gypsum board on lateral performance of the walls is also presented.

B.P. Gotluru , B.W. Schafer and T. Pekoz [2000], Thin-walled cold-formed steel members have wide applications in building structures. They can be used as individual structural framing members or as panels and decks. In general, cold formed steel beams have open sections where centroid and shear center do not coincide. When a transverse load is applied away from the shear center it causes torque. Because of the open nature of the sections, torsion induces warping in the beam. This paper summarizes the research on the behavior of cold-formed steel beams subject to torsion and bending. The attention is focused on beams subject to torque, because of the effect of transverse loads not applied at the shear center. A simple geometric nonlinear analysis method, based on satisfying equilibrium in the deformed configuration, is examined and used to predict the behavior of the beams. Simple geometric analyses, finite element analyses and finite strip analyses are performed and compared with experimental results. The influence of typical support conditions is studied and they are found to produce partial warping restraint at the ends. This effect is accounted for by introducing hypothetical springs. The magnitude of the spring stiffness is assessed for commonly used connections. Other factors that affect the behavior of cold-formed steel members, such as local buckling, are also studied.

III. CONCLUSION

1) The developed finite element model efficiently simulated the buckling behaviour of axially loaded intermediate stiffened partially closed complex channel section.
2) The open column fails by pure distortional buckling whereas due to the provisions of spacer plates the partially closed column fails by mixed local and flexural torsional buckling.
3) The spacer plate improves the torsional rigidity and increases the stiffness of the section.
4) Thickness, depth and spacing of spacer plates significantly affect the overall performance of the sections.

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