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BEHAVIOUR OF LIGHT GAUGE I SECTION UNDER COMPRESSION LOADING WITH DIFFERENT STIFFENER

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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 behaviour of the light gauge column section under compression loading.

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 cold formed 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 thin walled sections by the cold forming 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 cold formed, 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.

The development and use of cold-formed steel structural members in building construction began inthe mid eighteenth century in the United States and Great Britain. However, such steel structural members were not widely used in the building industry until in the mid nineteenth century where the first edition of the American Iron and Steel Institute (AISI 1946) Specification for the design of cold-formed steel structural members was published. The use of cold-formed steel structural members has increased rapidly in recent years. Cold formed members can be used economically in domestic and small industrial building construction and other light gauge structures.

As compared to thicker hot-rolled members, cold-formed members provide enhanced strength to weight ratio and ease of construction. The manufacturing process of fabricating cold-formed members usually involves brake-pressing and roll-forming of steel sheets and strip to produce a wide range cross-section shapes. Cold formed sections are normally thinner than hot-rolled sections and have a different forming process. Therefore, the buckling and material behaviour can be quite different.

Cold-formed columns commonly fail in two distinct modes of buckling; they are local buckling and overall buckling. Interaction of these two modes may occur in some cases. Both local and overall instability represent common causes of structural failure. Distortional buckling is also one of the modes of failure for some sections.

As a consequence, structural instability has grown into a major research area, where both analytical and experimental investigation have been undertaken to overcome the difficulties of the design of cold-formed steel structural members. Local buckling plays an important role in the design of slender sections. There is a fundamental different on the behaviour of pin-ended and fixed-ended locally buckled singly symmetric columns. This is due to the shift of effective centroid of singly symmetric slender sections.

II ANALYTICAL WORK

The analytical work was carried out for five different channel sections with different stiffeners.The loading was done on the extended length of plate to exactly produce the torsional moment in the section. The load at the failure where noted with the angular deflection on both side of section.

Properties of Steel material:

Poisson’s Ratio (μ) : 0.3.

Young’s Modulus (E) : 200000Mpa

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Maximum Yield stress (fy): 250Mpa

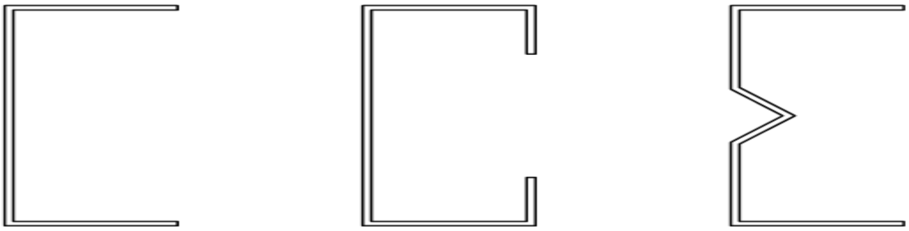

Fig 1 Specimens of cold formed steel channel section for the analytical work to prepare Column Section

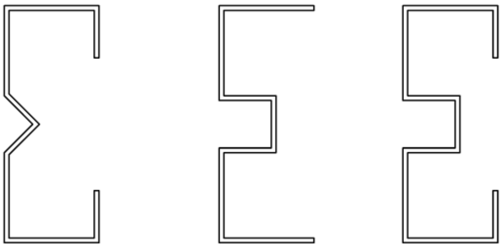

Fig 2 Specimens of cold formed steel channel section for the analytical work to prepare Column Section

The finite element program ABAQUS is a computational tool for modelling structures with material and nonlinear behaviour. ABAQUS version 6.13 was used to simulate the model and find buckling mode and strength of cold-formed steel column under compression a parametric analysis was performed, in order to investigate the influence of the width and height on the compression behaviour of the columns.

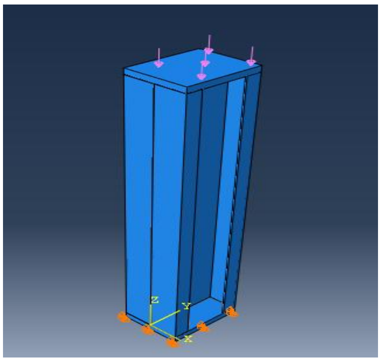

Fig 3 loading and Boundary condition for Column Section

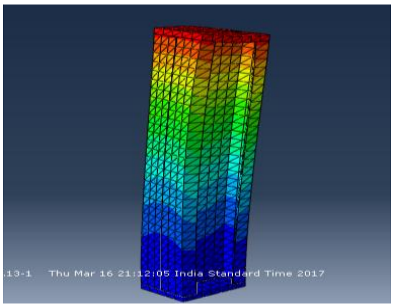

Fig 4 Meshing for Column Section

Sr No.	Specimen	Load	Percentage increase in load
1	C without lip	81.722	
2	C with lip	184.49	55.704
3	C with V stiffener	87.465	65.661
4	C with V stiffener and lip	196.45	58.401
5	C with Rectangular stiffener	128.05	36.18
6	C with Rectangular stiffener and lip	242.38	66.284

Fig 5 Results for Column Sectionunder compression.

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.

The Open Column with the rectangular stiffener and the Lip is performing good as compared to all other combination as load carrying capacity is 66.28% greater than plane channel section.

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