International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072

# REVIEW ON COLD FORMED LIPPED CHANNEL BEAM

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Abstract - Cold-formed and thin walled steel sections have been extensively used in residential, industrial and commercial buildings as primary load bearing structural components. The reasons for the popularity of cold-formed steel members include high strength to weight ratio, economy of transportation and handling, ease of fabrication, accurate detailing and quick and simple erection or installation. . Cold-formed steel members are mainly used as primary structural elements in buildings because of its availability of thin and high strength steels and advanced cold-forming technologies. The cold-formed steel structural members such as the 'C', 'Z' or tubular sections are commonly used in floor and roofing frame. Cold-formed steel members are also used as floor joists and bearers in buildings. They are made of thinner steels and their cross-sections are often mono-symmetric or unsymmetric.
Web crippling, flexural buckling, torsional buckling, local buckling are some of the failure modes of thin walled sections. Thickness of the thin walled structure is small compared to its other dimensions but it is capable of resisting bending in addition to membrane forces .Lipped channel beams (LCBs) are thin walled structure. In the cases of cantilever beams and continuous lapped purlins, where combined bending and shear occur at the purlin section just outside the end of the lap, thin-walled sections will buckle at a lower stress than if only one action is present without the other. Thin walled structures under relatively small compressive loads are prone to buckle and so must be stiffened to prevent this. Buckling load determination is easy for thin plates. But buckling load determination for stiffened will rely on an empirical solution. The buckling of the thin plates is a phenomenon which could lead to destabilizing and failure of the structure. Web crippling of a cold-formed steel section depends on many factors. The major factors that affect web crippling strength of LCB are bearing length, section type loading condition and sectional parameters. Generally flooring systems include openings in the web of floor joists or bearers so that building services can be located within LCBs.The use of web openings in a beam section results in reduction of its shear capacity due to the reduced web area. Hence in this thesis we are focusing on the analysis of lipped channel beams with web holes and stiffeners under interior two flange condition. Various parameters effecting the shear strength of LCBs are also studied. Parameters include web opening size,web opening position and bearing length.

**Keywords:- Lipped channel beams (LCB), Interior two flange loading(ITF)**

## 1. INTRODUCTION

In steel construction, there are two primary steel member types: hot-rolled steel members and cold-formed steel members. The hot rolled steel members are formed at elevated temperatures whereas the cold-formed steel members are formed at room temperatures. Over the last couple of decades, cold-formed and thin walled steel sections have been extensively in residential, industrial and commercial buildings as primary load bearing structural components. The reasons for the popularity of cold-formed steel members include their wide range of applications, high strength to weight ratio, economy of transportation and handling, ease of fabrication, accurate detailing and quick and simple erection or installation. . Cold-formed steel members are increasingly used as primary structural elements in buildings due to the availability of thin and high strength steels and advanced cold-forming technologies. Some of the commonly used cold-formed steel sections include channel (C) sections, Z-sections, angles (L), hat sections, I-sections and tubular sections such as rectangular hollow sections (RHS) and square hollow sections (SHS). The cold-formed steel structural members such as the 'C', 'Z' or tubular sections are commonly used in floor and roofing frame. Cold-formed steel members are also used as floor joists and bearers in buildings. They are made of thinner steels and their cross-sections are often mono-symmetric or unsymmetric. Hence their lateral-torsional buckling behaviour is more complicated than that of doubly symmetric hot-rolled beams. The Major advantage of Cold-formed steel beams over hot rolled beams is to be found in the relative thinness of the material from which the sections are formed .Web crippling, flexural buckling, torsional buckling, local buckling are some of the failure modes of thin walled sections.

Thickness of the structure is small compared to its other dimensions for thin walled structure but it is capable of resisting bending in addition to membrane forces. Thin plates (or thin sections or thin walled structures) under relatively small compressive loads are prone to buckle and so must be stiffened to prevent this. Lipped channel beams (LCBs) are thin walled structure that is commonly used as floor joists and bearers in buildings. Thin-walled section members can be subjected to axial force, bending and shear. For continuous lapped purlins,combined bending and shear occur in the purlin section just outside the end of the lap, thin-walled sections will buckle at a lower stress than if only one action was present without the other. Their shear capacities are determined based on conservative design rules.

## 2. LITERATURE REVIEW

**Soundharya et all (2017)** conducted the theoretical, experimental and the numerical investigation of back to back lipped channel section with circular web holes subjected to web crippling strength. The tests are conducted on concentrated loading condition and finite element models were used for the purposes of parametric study on effect of different size and position of web holes. The study concluded that the ratio of a/h and h/t are the primary parametric relationships influencing the web crippling behavior of the back to back lipped channel section with the web holes.

**Sudhir Sastry Y B et all (2014)** analyzed both thin Walled Dropped Flange and Rounded edge Channel beams of Aircraft Structures for buckling and finite element analysis of these structures for buckling were done using ANSYS . The behavior of the beams was examined by changing various parameter involved such as the length, thickness of the sheet, radius of the Circular ends, ratio of breadth and height with the help of finite element analysis. It concluded after the comparisons on the grounds of same thickness and mass that the open section c channel with Circular ends has more strength when compared with open section c channel with elongated open circular ends.

**Prakash M. Mohite et all (2015),** flexural strength of cold formed steel beams were predicted with the comparative study, parametric study conducted by varying the lip depth for selected sections through CUFSM analysis.

**Sobhana S et all (2015)** investigated the theoretical, experimental and the numerical investigation of back to back lipped channel section with and without circular web holes subjected to web crippling strength under concentrated loading conditions. Investigation was done for different sizes of the cross-sections and the web holes on the web crippling strength of the back to back lipped channel section. It is concluded that back to back lipped channel section with and without web holes shows good performance when loading is done.

**M. Macdonald et all (2006),** This paper illustrates the use of finite element analysis to model the web crippling behaviour of cold-formed steel flexural members and to investigate the influence of various geometric parameters on the web crippling strength. In order to have a wide range of test specimens for the experimental program the Section parameters and the loading were varied. This helped to compare the experimental results with FE analysis. ANSYS finite element package was used for the analysis and nonlinear techniques were employed in order to represent the plastic failure in the post yield region.

**Asraf Uzzaman et all (2012)** presented a parametric study of lipped channel sections with circular web holes subjected to web crippling. A non-linear finite element model was used in the parametric study, which has been verified against experimental test results. Evaluation show that the ratios a/h and N/h are the primary parameters influencing the web crippling behaviour of the sections with web holes. It also performed the reliability analysis to evaluate the reliability of the proposed strength reduction factors and found that the proposed strength reduction factors are capable of producing reliable limit state design when calibrated with the resistance factor of 0.90 (f¼0.90).

**M.A. Heiyantuduwa, et all (2012),** represents the study conducted develop an alternative design rule to predict the web crippling strength of cold-formed steel lipped channel beams. Tests and finite element analyses were carried out to examine the web crippling behaviour of cold-formed steel lipped channel members. Using the results of the parametric study the variation of web crippling strength against the critical parameters such as corner radii, web height and the bearing length was examined. This provided the basis to develop an alternative design formula with a number of coefficients whose values were mainly dependent on the loading conditions considered. The results indicated that the alternative design formula proposed can be successfully employed as a design rule for predicting web crippling strength.

**Poologanathan Keerthan, et all (2015),** the details of experimental and numerical studies into the behavior and strength of lipped channel beams with stiffened web openings subject to shear, and combined bending and shear actions. The research was conducted to develop the most suitable web stiffening arrangements for LCBs with circular web openings under shear and combined bending and shear actions. 15 tests were conducted using a three-point loading arrangement to investigate the effects of stiffener types (plate and stud stiffeners), sizes (thickness, width, and height), and screw fastening arrangements on the shear capacities of LCBs with web openings. Based on the results from both the experimental and numerical studies of the research, new plate stiffener systems with suitable sizes and screw-fastening arrangements have been proposed to restore the original shear capacities of LCBs.

**Abhijith V J, et all (2015)** analysed both IS and hollow flanged sections with and without web holes with the numerical models created in ANSYS and comparison was made on the basis of reduction in strength with increase in web hole diameter of two members with same clear depth and aspect ratio. From the study it is found that strength reduction is high in case of hollow flange sections than in IS sections due to the excess rigidity of flanges. In IS sections flange buckling is predominant. So web holes have only a little effect.

**Cilmar Basaglia, et all (2013),** This paper includes the available results of an ongoing investigation aimed at assessing the buckling, post buckling, strength, and collapse behavior of cold-formed steel continuous beams and simple frames and developing an efficient DSM-based methodology to design such slender structural systems, which invariably exhibit complex buckling and failure modes. The ultimate strength values yielded by geometrically and materially nonlinear shell finite-element analyses were compared with estimates provided by the DSM equations, and on the basis of this comparison, it is possible to identify some features that must be included in a DSM approach applicable to continuous cold-formed steel beams.

**Mahen Mahendran et all (2012)** describes a detailed numerical study on the member moment capacities related to lateral–torsional buckling of simply supported cold-formed steel lipped channel beams (LCBs) subject to uniform bending about the major axis. New design equations proposed in this paper can be used to predict the moment capacities accuratelyand can also be used with the direct strength method. The capacity reduction factor of 0.9 recommended in AS/NZS 4600 [7] can be used with the new equations.

**P. Nandini et all (2010),** In this report ABAQUS software based on finite element analysis is used to analyse the interaction behaviour of these buckling modes. Parametric studies was performed to evaluate the behaviour and strength of such beams under different types of interactions due to variation of material and member properties. The study results are used to evaluate different equations for calculating the strength of such cold-formed lipped Channel beams. Based on the comparison, a method for the design of lipped channel beams failing under the interaction of local, distortional and overall lateral torsional buckling is recommended.

**Yu Chen et all (2014),** This article investigated the web crippling behaviour of cold-formed steel lipped channel beams subjected to end-one-flange (EOF), interior-one-flange (IOF), end-two-flange (ETF), and interior-two-flange (ITF) loading conditions. Test was carried out in 48 cold-formed steel lipped channel beams with different boundary conditions, loading conditions, bearing lengths, and section heights were tested. Based on the experimental and numerical investigations it is concluded that the ultimate capacity and initial stiffness of all specimens under web crippling significantly increased with the increase of bearing plate lengths and the values of web crippling ultimate capacity in IOF and ITF loading conditions are larger than those in EOF and ETF loading conditions. It is also found that the proposed design equations of web crippling ultimate capacity were verified to be accurate and reliable for cold-formed steel lipped channel beams under web crippling.

**Mahen Mahendran et all (2015)** This paper report the details of an experimental study into the shear behaviour and strength of cold-formed lipped channel beams (LCBs). The comparison of ultimate shear capacities from tests showed that AS/NZS 4600 [4] and AISI S100 [2] design equations are very conservative for the shear design of LCBs. Based on the current shear strength design equations in AISI S100 [2] and experimental results new shear capacity equations were proposed. From the experimental study it was found that the interaction equations proposed to predict the combined bending and shear capacities of hollow flange channel beams can also be used for LCBs. This study only included eleven combined bending and shear tests and thus further experimental and numerical results are needed to adequately verify this finding.

## CONCLUSION

The ratio of a/h and h/t are the primary parametric relationships influencing the web crippling behavior of the back to back lipped channel section with the web holes. Open section c channel with Circular ends has more strength when compared with open section c channel with elongated open circular ends. Back to back lipped channel section with and without web holes shows good performance when loading is done.Strength reduction is high in case of hollow flange sections than in IS sections due to the excess rigidity of flanges. In IS sections flange buckling is predominant. So web holes have only a little effect. The interaction equations proposed to predict the combined bending and shear capacities of hollow flange channel beams can also be used for LCBs. the shear capacities of LCBs were reduced by up to 70% due to the inclusion of these web openings. Hence there is a need to improve the shear capacities of LCBs with web openings.

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