REVIEW ON COLD FORM STEEL COMPRESSION MEMBERS

N.Jayabal B.E.,
PG Student
Dhirajlal Gandhi College of Technology,Salem

V.Chandrikka M.E.,
Assistant Professor
Dhirajlal Gandhi College of Technology,Salem

K.Vijayasurya M.E.,
Assistant Professor
Dhirajlal Gandhi College of Technology,Salem

ABSTRACT: *A review of this paper related to the behaviour of cold-formed steel sections is subjected to compression carried out during the last fifteen years. Literatures pertaining to experimental, numerical and theoretical investigation are also presented in this paper.*

Keywords

Cold-formed steel, compression

1 INTRODUCTION

Cold-formed steel sections are increasingly using these days in structural applications due to their inherent high strength to weight ratio. Light weight steel construction plays an important role in industrial structures due to their economy, the ease and speed with which they can be fabricated and erected. They result in reduction of dead load, while fully meeting the strength requirements. Hence the usage of light weight and stiff structures are steadily increasing. In order to improve usage of steel, the solution lies in encouraging the manufacture of built-up (latticed) welded structures out of hot-rolled products and cold-formed sections.

In addition to their use in building construction, cold-formed steel structural elements are widely used in automobile, shipbuilding, railways, aircraft building, agricultural, mining, petroleum, nuclear and space industries. They have become an attractive material for the construction of electric transmission towers and towers supporting wind mill structures. It has been reported that the performance of low rise metal buildings which were built with cold-formed elements as major components, in actual earthquakes has generally been quite good. This is due to the inherent material property of the cold-formed steel elements, their light weight characteristics and the flexibility they offer in uniform mass and stiffness distribution in the case of light metal buildings.

2 BUCKLING OF CFS SECTIONS

2.1 Local Buckling of CFS sections under compression

Rajaskeran and Murray (1973) presented a study of coupled local buckling for a wide range of beam columns. They used the finite method of analysis with thin walled line elements and included deformation modes associated with distortion of the cross section.

2.2 Lateral Torsional Buckling of CFS sections under compression

Johnson and Will (1974) presented a study of lateral torsional buckling of I beams including the effect of cross sectional distortion. They also used the finite element method and subdivided the beam into a large number of rectangular elements. Plank and Wittrick (1974) used a complex finite strip method to study the buckling of thin, flat-walled structures. They presented graphs of buckling loads of channel section beams bent about the major axis.

2.3 Flexural Torsional Buckling of CFS sections under compression

Hancock (1978) presented a study of local, distortions, and flexural torsional buckling for I-beams bents about their major axis using the finite strip method. Desmond (1981) et al was the first to publish the paper describing the behavior of simple edge stiffener. Hancock (1985) presented a detailed study of a range of buckling modes (local, distortional and flexural torsional) in lipped channel sections. He showed that the gestational mode of buckling may control the design for certain geometries, especially those with rear flanges or lipped rear flanges.

2.4 Distortional Buckling of CFS sections under compression

Lau and Hancock (1987) provide simple analytical expressions to allow the distortions allow the distortional buckling stress to be calculated explicitly for any geometry of cross-section of thin-walled lipped channel section columns. Sridharan and Ali (1988) examined the phenomenon of interactive buckling of thin-walled columns with the design procedures at Cornell University in the seventies and the other recommended by the New American Iron and Steel Institute code with the test results.

Lau and Hancock (1990) provided design curves for the section where the distortional buckling stress and yield stress were approximately equal in these cases the failure occurred before the elastic distortional buckling stress was reached. The expression derived by Law and Hancock are now included in the Australian cold-formed steel structure code AS/NZS 4600.

Kwon and Hancock (1992) have studied the behavior of simple lipped channels with intermediate stiffeners under fixed boundary condition. They showed that the design equations in the American Specification (AISI, 1996) are unconservative for predicting the distortional buckling strength of channel sections made of high strength steel and there should necessarily be an alternative method for distortional buckling.

The Thin-wall computer program developed by Papangelis and Hancock (1995) can be used to investigate local, distortional and flexural torsional buckling modes. The procedure recommended by AISI and Euro code 3 for evaluating torsional-flexural buckling stress, disregards the effect of local buckling and the strength is evaluated by multiplying the stress with effective area (Kalyanaraman and Rao 1998).

In the evaluation of effective section properties, the effective width of the elements shall be taken into account for the membrane stress gradient on the element. Kesti and Davies (1999) assessed the applicability of Euro code 3 to the prediction of the minimum elastic distortional buckling stress in compression of short fixed end columns with different cross-section (C, heat and Rack upright sections).

2.5 Global Buckling of CFS sections under compression

Schafer (2002) presented the direct strength method. He carried out a parametric study of 170 cross-section to determine the accuracy of available manual methods in predicting the local, distortional and global buckling modes. Group of C's and Z's was studied, including the sections listed in AISI (1996) and commercially available dry wall studs. According to Schafer (2000), distortional buckling predictions of Schafer's method show slightly more accurate, but less conservative results when compared with Lau and Hancock's (1987) method. Further, Schafer argued that if failure mode is known as distortions, the ultimate strength can be predicted correctly from the elastic gestational stress. The parametric study was continued further by introducing stiffeners to the web of the section and it is shown that the elastic load buckling stress increases while the failure is governed by distortional buckling mode.

Schafer (2002) closed-form prediction of the buckling stress in the local mode , including interaction of the connected elements and the distortional mode , including consideration of the elastic and geometric stiffness at the web/flange junction are provided.

Narayanan and Mahendran (2003) have studied the distortional buckling behavior of a series of innovative cold-formed steel columns. All these columns failed by distortional buckling with very little post- formed steel columns. All these columns failed by distorsional buckling with little post buckling strength. The distorsional buckling and non linear ultimate strength behavior of the columns were investigated in detail using finite element analysis. The finite element analysis included relevant geometric imperfections and residual stresses. The ultimate design load capacities were evaluated using provisions of Australian Cold formed steel structures standard AS/NZS 4600-1996, and were compared with those from experiments and finite element analysis. A series of parametric studies were also carried out by varying yield strength, thickness and column strength.

Sukumar et al. (2003, 2004) in these paper new analytical models have been developed for flexural torsional buckling of axially and eccentrically loaded built-up compression member of open cross section, considering the shearing deformation due to lacing bars.

Talikoti and Bajoria (2005) presented a method which can be adopted to improve the torsional and the distorsional strength of thin walled cold formed steel columns used in pallet racking systems. Elastic buckling analysis of two different types of column sections of intermediate length was done to find the buckling strength and mode of failure, then the column section was made distorsionally stronger by adding simple spacers.

Wang et al. (2007) investigated the behavior of thirty pin-ended cold-form channel columns with inclined simple edge stiffeners and with three different lengths. All the columns loaded with positive eccentricity and the concentrically loaded columns loaded with positive eccentricity and the concentrically loaded columns with 45˚ sloping lip stiffeners failed in combined local and flexural buckling modes.

Ben Young (2008) conducted both experimental and numerical investigations on the strength and behavior of cold-formed steel channel columns. It was recommended that a fixed-ended singly symmetric column failing by local and overall buckling be designed as concentrically loaded member.

Milan Veljkovic and Bernt Johanson (2008) have studied the behavior of partially closed and an open cross - section of polygonal column. A numerical model has developed using ABAQUS and verified against test results. A series of parametric studies were also carried out by varying the column length. Test results compared with the predicted design strength from the Eurocode 3, part1-3 and direct strength method.

Anil Kumar and Kalyanaraman (2010) studied the suitability of the direct strength method (DSM) to evaluate the compressive strength of plain channel, I and rectangular tubular members. The comparative study with the test results and the effective width method showed that DSM estimates the strength with acceptable accuracy, for practical purposes.

3 CONCLUSION

Based on the literature review of the experimental, numerical and theoretical studies, though many studies have been performed on buckling of thin-walled columns, no studies have been made to the effect of stiffened element at the flange/web junction and edge/intermediate stiffener on the behavior and strength of intermediate length of cold-formed steel open columns. The present study is being conducted to analyse the buckling behaviour of cold-formed steel stiffened cold-formed steel open section with and without edge/intermediate stiffeners. Their effects on the strength and behaviour of the members are also studied.

REFERENCES

1. Anbarasu M. and Sukumar M. (2013), “Effect of Connectors Interaction in Behavior and Ultimate Strength of Intermediate Length Cold Formed Steel Open Columns”, Asian Journal of Civil Engineering (BHRC), Vol.14, No.2, pp.305-317.
2. Anil Kumar M.V. and Kalyanaraman, V. (2010), “Evaluation of Direct Strength method for CFS Compression Members without Stiffeners”, Journal of Structural Engineering, Vol.136, No.7, pp.879-885.

3. Ben Young (2008), "Research on cold – formed steel columns", Journal of Thin - Walled Structures, Vol. 46, pp. 731 – 740.
4. Davis JM, Jiang C (1998), "Design for distortional buckling", Journal Of Constructional Steel Research, Vol.46, pp.174-175.
5. Demoao Yang and Gregory J.H.(2004), "Compression Tests of High Strength Steel Channels Columns with Interaction between Local and Distortional Buckling", Journal of Structural Engineering ,ASCE, Vol.130,No.12,pp.1954-1963.
6. Desmond T.P.,Pekoz T. and Winter G. (1981), "Edge stiffeners for thin-walled members", Journal of Structural Engineering, ASCE, Vol.107, No.2, pp.329-353.
7. Hancock, G.J. (1978), "Local, distortional and lateral buckling of-I beams", Journal of Structural Engineering, ASCE, Vol.104, No.11, pp.1787-1798.
8. Hancock GJ (1985), "Distortional buckling of steel storage rack columns", Journal of Structural Engineering, Vol.111, No.12, pp.2770-2783.
9. Jintang Yan and Ben Young "Column tests of cold-Formed Channels with Complex Stiffeners", Journal of Structural Engineering, ASCE, Vol.128, No.6, pp.737-745.
10. Johnson,C.P. and Will, K.M.(1974), "Beam buckling by finite element procedure", Journal of Structural Engineering, ASCE, Vol.100, No.3, pp.669-685.
11. Kalyanaraman V. and Srinivasa Rao K. (1998), "Torsional-flexural Buckling of Singly Symmetric Cold-formed Beam Columns", Journal of Constructional Steel Research, Vol.46, No.1-3, pp.191-193.
12. Kesti J,Davis JM (1999), "Local and distortional buckling of thin-walled short columns", Thin-Walled Structures, Vol.34,pp .115-134.
13. Kwon Y.B. and Hancock G.J. (1992), "Tests of cold formed channel with local and distortional buckling", Journal of Structural Engineering, ASCE, Vol.117,No.7,pp.1786-1803.
14. Kwon YB, Hancock GJ (1991), "A nonlinear elastic spline finite strip analysis for thin-walled sections", Thin-Walled Structures, Vol.12,pp .295-319.
15. Lau SCW, Hancock GJ (1987), "Distortional buckling formulas for channel columns", Journal of Structural Engineering, ASCE, Vol.113, No.5, pp.1063-1078.
16. Lau SCW, Hancock GJ (1990), "Inelastic buckling of channel columns in the distortional in the distortional mode", Thin-Walled Structures, pp .59-84.
17. Milan Veljkovic and Bernt Johansson (2008), "Thin-walled steel columns with partially closed cross-section: Tests and computer simulations", Journal Of Constructional Steel Research, Vol.64, pp.816-821.
18. Narayanan S. and Mahendran M. (2003), "Ultimate Capacity of Innovative Cold-Formed Steel Columns", Journal of Constructional Steel Research, Vol.59, No.4, pp.489-508.
19. Papangelis JP, Hancock GJ (1995), "Computer analysis of thin-walled structural members", Computers and Structures, Vol.56, No.1, pp.157-156.
20. Plank, R.J and Wittrick , W.H.(1974), " Buckling under combined loading of thin , flat-walled

structures by a complex finite strip method", Int J. numer.Meth.in Engg., Vol.8,No.2,pp.323-339.

21. Rajasekaran S. and Murray D.W.(1973), "Coupled local buckling in wide-flange beam column", Journal of Structural Engineering, ASCE, Vol.99, No.6, pp.1003-1023.
22. Schafer B.W. (2002), "Local, distortional, Euler buckling of thin walled columns", Journal of Structural Engineering, ASCE, Vol.128, No.3, pp.289-229.
23. Schafer B.W., and Pekoz T. (1998), "Computational modeling of cold-formed steel: characterizing geometric imperfections and residual stresses", Journal Of Constructional Steel Research, Vol.47, pp.193-210.
24. Schafer BW, Pekoz T (1998), "Computational modeling of cold-formed steel:characterizing geometric imperfections and residual stresses", Journal Of Constructional Steel Research, Vol.47 , pp.193-210.
25. Sridharan S. and Ali, M.A. (1988), "Behaviour and design of thin-walled columns", Journal of Structural Engineering, ASCE, Vol.114, No.1, pp.103-120.
26. Standards Australia (SA), Australian/New Zealand Standards AS/NZS 4600.Cold formed steel structures, Sydney.1996.
27. Sukumar S.,Parameswaran P., and Jayagopal L.S.,(2003) "Behavior of built-up open cross-sections under axial load", Journal of Structural Engineering, SERC, Vol.30, No.2, pp.89-94.
28. Sukumar S.,Parameswaran P., and Jayagopal L.S.,(2004) "Torsional flexural buckling of built-up open cross-sections under eccentric load", Journal of Structural Engineering, SERC, Vol.30, No.4, pp.259-263.
29. Talikoti .R.S, Bajoria .K.M (2005), "New approach to improving distortional strength of intermediate length thin-walled open section columns", Electronic Journal of Structural Engineering, Vol.5, pp.69-79.
30. Wang C., Zhang Z. (2007), "Experiments on channels Columns With Inclined Simple Edge Stiffeners under Compression Loading" Forntier, Architecture, Civil Eng. China, Vol.1,No.3,pp.312-321.