BEHAVIOUR OF BUILT – UP COLD FORMED STEEL SECTIONS

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Abstract

Cold formed steel members have a major advantage over hot rolled steel shapes.This project reports a detail study on the flexural behaviour and load carrying capacity of cold formed built up I sections.Finite element analysis is carried out to study the behaviour of built up cold formed steel members and their different modes of failure.The load and different modes of failure such as local buckling, lateral buckling and distortional buckling critical are studied by this analysis. Then finally all the beams are investigated using finite element analysis software ANSYS.

Key words: ANSYS, Built-up section, Cold form steel section, Finite Element Analysis.

1.INTRODUCTION

In general building materials available are concrete and steel. In steel construction, there are two families of steel members. One is hot rolled and other one is cold rolled steel sections. Cold formed steel sections are increasingly used now a day in structural application, especially in light weight steel construction such as pre-fabricated building, small buildings, due to their high strength and weight ratio. Cold-formed steel structural members are made through cold forming a thin plate which is normally from 1. 2 to 6.4mm and has a section shape with the right purpose. One of the advantages of cold-formed steels is that the strength to weight ratio is much higher than that of common hot-rolled shapes, thus it can reduce the total weight of structures. Therefore the cold-formed steel members are considered to be economical for low-rise buildings when the beam spans are not too long. “Cold forming is a process where light gauge steel members are manufactured by rolling or shaping the steel after it is cold”. This process makes the steel stronger. Cold-formed sections are typically members that are fabricated from thin steel sheets through a series of bending /forming operations. Fabrication of cold formed steel sections can be divided into two basic processes; roll forming and press breaking.Industrial standard thickness typically ranges from 0.5 to 7 mm for both fabrication methods. The steel used for these sections may have a yield stress ranging from 250 Mpa to 550 Mpa.

2. MATERIAL PROPERTIES

Material nonlinearities can be defined as a nonlinear relationship between stress and strain; that is, the stress being a nonlinear function of the strain. Plasticity theories model the material’s mechanical response as it undergoes non recoverable deformation in a ductile fashion. The ANSYS program can account for much material nonlinearity. Plasticity theory provides a mathematical relationship that characterizes the elasto - plastic response of materials. There are three ingredients in the rate-independent plasticity theory, they are: a yield criterion, flow rule and hardening rule. Material nonlinearity of cold-formed steel sections has been incorporated by considering a perfectly elastic plastic material obeying von Mises yield criteria. The cold forming process introduces cold work into sections, especially in the corners. As a result, in corner regions the yield stress is increased and the ductility is decreased. The material at corner region may be anisotropic and in addition include residual stresses. Due to lack of test data, addressing these properties in the finite element model is extremely difficult. To make the model simple, the same material properties were adopted for the entire section. For all the members, young’s modulus E = 205000 MPa and Poisson’s ratio = 0.3.The yield stress for the sections were taken as 270 MPa. Cold-formed steel structural members are made through cold forming a thin plate which is normally from 1. 2 to 6.4mm and has a section shape with the right purpose

3. SPECIMEN DESCRIPTION

3.1 Specimen details

The specimen is provided with haunches in ordinary back to back channel section which increases load carrying capacity of a section. The parameters given in the Table 3.1 is tested on this section.

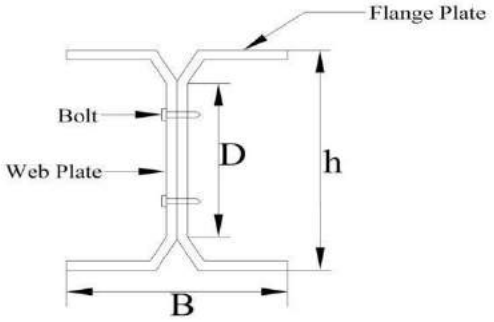

Fig: 3.1 General specimen

Table: 3.1 Details of General Specimen

Depth(D) in mm	Width (B) in mm	Length(L) in mm	Thickness(t) in mm
150	120	2300	2
200			
250			
300			
350			
400			

3.2 Final Specimens

3.2.1 Specimen-1

Specimen-1 refers to Control specimen which is made by connecting two channel sections back to back. The connection is made by using bolts.

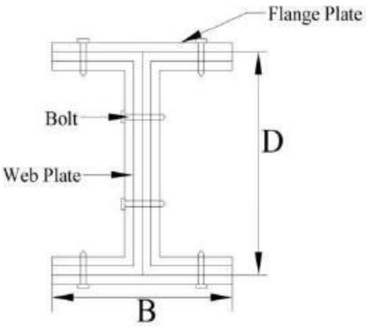

Fig: 3.2 Specimen-1

3.2.2 Specimen-2

Specimen-2 is two channel sections connected back to back which is having haunches at both ends of web, stiffeners to the web and flange plates in loaded and bearing points at both compression and tension zone.

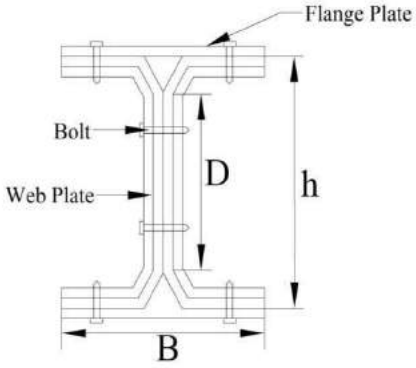

Fig: 3.3 Specimen-2

3.3ANSYS ANALYSIS

While analysing the general specimen, web crippling and web buckling occurs. This failure limits the transfer of load from flange to web. As a result the total load carrying capacity of specimen is reduced.To improve the capacity of the web and to avoid the web failure, stiffeners are provided at the loaded and end bearing points of specimen as shown in Fig 3.4. Though it increases the load carrying capacity of specimen, the failure is still occur in haunch portion. To overcome this failure flange plates are provided in the loaded and end bearing points at both compression and tension zone.

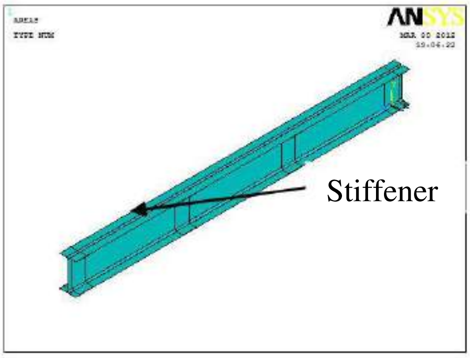

Fig: 3.4 Specimen with Stiffener

4. RESULT AND DISCUSSION

4.1 SPECIMEN D150 L2300

For Specimen-1 D150 B100 the critical load derived from the ANSYS result is 20.161 kN. For Specimen-2 D150 B120 the critical load derived from the ANSYS result is 28.361 kN. During the loading process it is observed that, initially failure occurs at loaded points for both specimens. In specimen-2 further application of load causes bearing failure at support. Finally both specimens fails by bending.

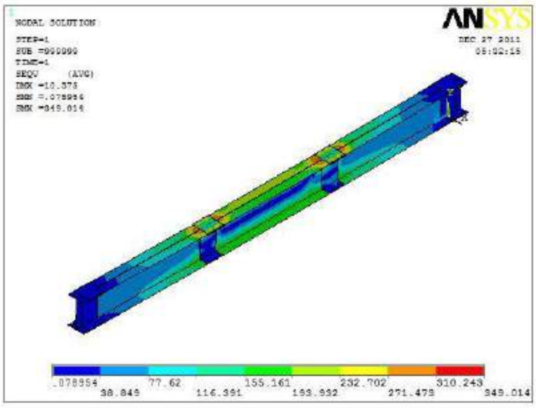

Fig: 4.1 Von Mises stress on deformed shape specimen-1

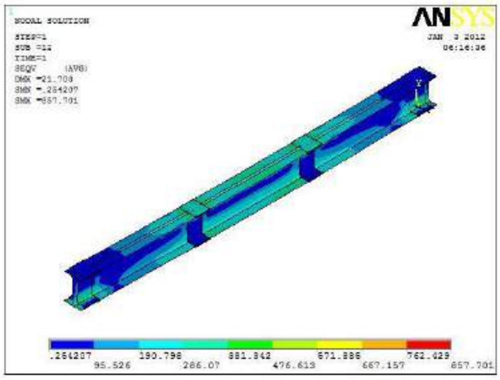

Fig: 4.2 Von Mises stress on deformed shape specimen-2

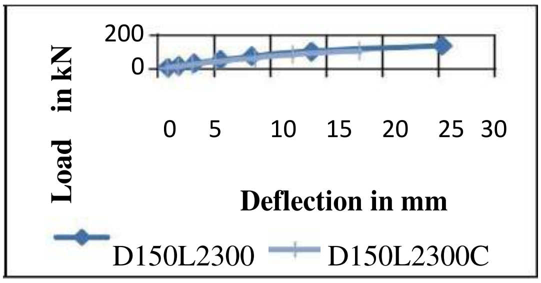

Fig: 4.3 Load vs Deflection curve for specimen D150

4.2 SPECIMEN D200 L2300

For Specimen-1 D200 B100 the critical load derived from the ANSYS result is 22.923 kN. For Specimen-2 D200 B120 the critical load derived from the ANSYS result is 29.522 kN. During the loading process it is observed that, initially failure occurs at loaded points for both specimens. In specimen-2 further application of load causes bearing failure at support. Finally both specimens fails by bending.

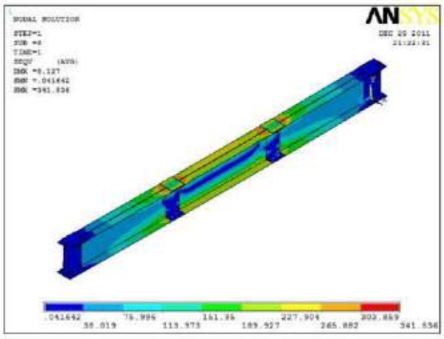

Fig: 4.4 Von Mises stress on deformed shape specimen-1

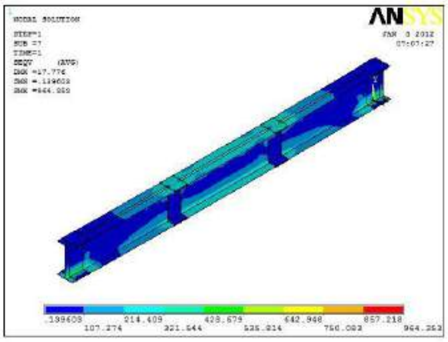

Fig: 4.5 Von Mises stress on deformed shape specimen-2

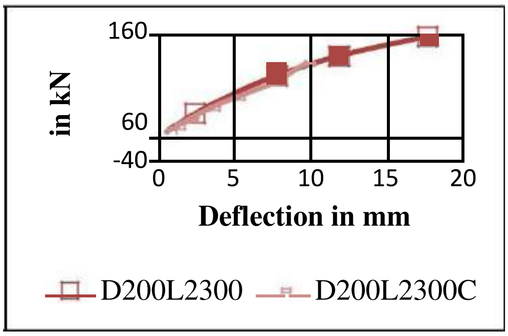

Fig: 4.6 Load vs Deflection curve for specimen D200

4.3 SPECIMEN D250 L2300

For Specimen-1 D250 B100 the critical load derived from the ANSYS result is 60.328 kN. For Specimen-2 D250 B120 the critical load derived from the ANSYS result is 72.49 kN. During the loading process it is observed that, initial mode of failure is bending in both specimens. Further application of load, mode of failures changes from bending failure to lateral torsional buckling. Finally both specimens fails by lateral torsional buckling.

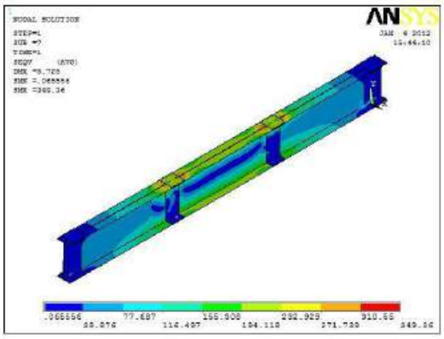

Fig: 4.7 Von Mises stress on deformed shape specimen-1

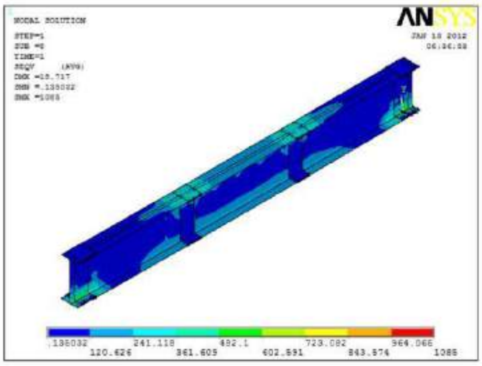

Fig: 4.8 Von Mises stress on deformed shape specimen-2

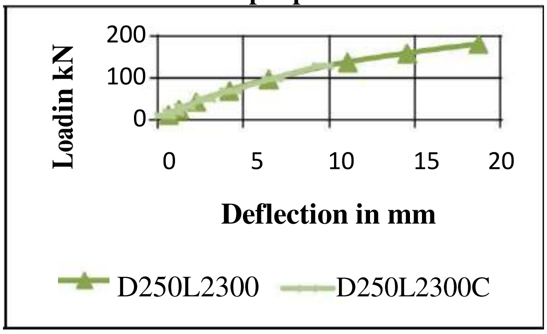

Fig: 4.9 Load vs Deflection curve for specimen D250

4.4 SPECIMEN D300 L2300

For Specimen-1 D300 B100 the critical load derived from the ANSYS result is 47.152 kN. For Specimen-2 D300 B120 the critical load derived from the ANSYS result is 55.792 kN. The critical load of the specimen is increased up to 250 mm depth and it starts decreasing from 300 mm depth. The failure mode of Specimen-1 and specimen-2 is lateral torsional buckling.

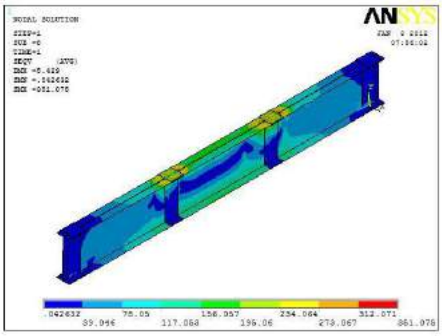

Fig: 4.10 Von Mises stress on deformed shape specimen-1

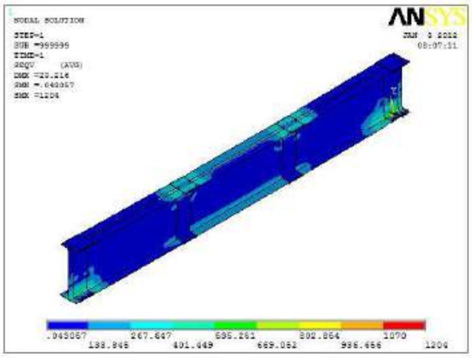

Fig: 4.11 Von Mises stress on deformed shape specimen-2

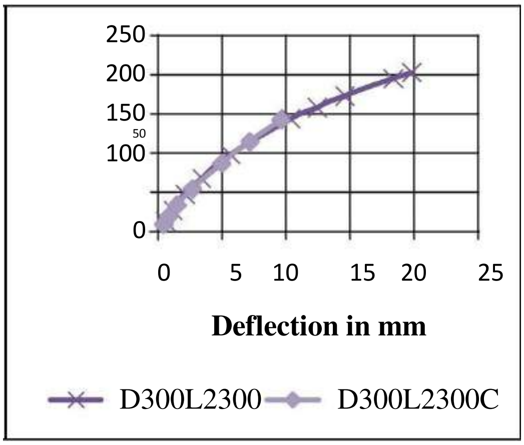

Fig: 4.12 Load vs Deflection curve for specimen D300

Table: 4.1 Mode of Failure

Depth(mm)	**Critical Load (kN)**		**Failure Mode**
	ANSYS		
	Specimen-1	**Specimen-2**	
150	20.161	28.361	BF
200	22.923	29.522	BF
250	60.328	72.490	LTB
300	47.152	55.792	LTB

BF-Bending Failure
LTB-Local Torsional Buckling

5. CONCLUSION

The load carrying capacity of the specimen is improved when haunches are provided in the section over a control specimen. The behaviour and load distribution of the section with haunches provides the better performance when compared to control specimens. Increase in cross sectional area and moment of inertia of the specimen, increases the load carrying capacity of the specimen. As the percentage of cross sectional area and moment of inertia of the specimen is reduced with increase in depth, the load carrying capacity of the specimen is also reduced.

REFERENCES

[1] Bambach M. R. and. Rasmussen K. J. R (2007) “Behaviour of Self-Drilling Screws in Light-Gauge Steel Construction”, Journal of Structural Engineering, Vol. 133, No. 6, pp.895–898

[2] Bambach M. R (2010) “Unified Element and Section Approach to Design of Cold-Formed Steel Structures”, Journal of Structural Engineering, Vol.136, No. 4, pp.343–353

[3] Cheng Yu, A.M.ASCE, Ke Xu, and Ibraheem Sheerah (2011) “Bearing Strength of Cold-Formed Steel Bolted Connections Using Oversized Holes without Washers”, Journal of Structural Engineering, Vol. 137, No. 1, pp. 156–159

[4] Feng Zhou and Ben Young(2007) “Experimental Investigation of Cold-Formed High-Strength Stainless Steel Tubular Members Subjected to Combined Bending and Web Crippling”, Journal of Structural Engineering, Vol.133, No. 7, pp.1027–1034

[5] Graciano C, Casanova E (2005) “Ultimate strength of longitudinally stiffened I-girder webs subjected to combined patch loading and bending”, Journal of Structural Engineering, Vol.105, No. 61, pp.93–111.

[6] Kiymaz G. Coskun E and Cosgun C. (2007) “Behavior and Design of beam-Welded Stainless Steel Circular Hollow Section Flexural Members”, Journal of Structural Engineering, Vol. 133, No. 12, pp.1792–1800

[7] Kwon Y. B, Chung H. S. and Kim G. D. (2006) “Experiments of Cold-Formed Steel Connections and Portal Frames”, Journal of Structural Engineering, Vol. 132, No. 4, pp.600–607

[8] Magnucki K.,. Paczos P and Kasprzak J. (2010) “Elastic Buckling of Cold-Formed Thin-Walled Channel Beams with Drop Flanges” Journal of Structural Engineering, Vol. 136, No. 7, pp.886–896

[9] Maura Lecce and Kim Rasmussen(2006) “Distortional Buckling of Cold-Formed Stainless Steel Sections: Finite-Element Modeling and Design”, Journal of Structural Engineering, Vol. 132, No. 4, pp.505–514

[10] Mohamed Elchalakani, Xiao-Ling Zhao, and Raphael Grzebieta(2003) “Tests of Cold-Formed Circular Tubular Braces under Cyclic Axial Loading”, Journal of Structural Engineering, Vol. 129, No. 4, pp.507–514