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Behaviour Of Cold-Formed Built-Up Closed Section With Web Stiffener Under Axial Compression

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Abstract— Cold formed steel sectioniscommonly used in modern steel construction, because ratio of High Strength to Weight. Light Gauge Steel otherwiseknown as cold formed steel Sections. The major concept of this project is to study the behaviour analysis of Cold Formed Built-up compression member with web stiffener under axial compression. Two cross sections of size 30-50-30mm and 50-50-50mm were chosen for the study with a slenderness ratio between10 to 42. The end conditions of the columns were chosen as hinged – hinged. The analysis of this project is considered as three major parts like Theoretical Analysis, Numerical Analysis and Experimental Analysis. Theoretical Analysis is performing by North American Standards for the Cold - formed Steel Design manual (NAS) manual – 2007. Numerical analysis is performing by using a Commercial Finite element analysis (ANSYS) and Experimental Analysis will be done in laboratory. All test specimens are tested until their failure. Load carrying capacity were establishing based on the theoretical, experimental and analytical investigations conducted on cold- formed built-up section subjected to axial loading and the effect of flat width to thickness ratio. When the D/t ratio increases the Ultimate load carrying capacity of the section has been increased. Failure pattern depends on the height of the specimen. Results show that local buckling failure for 540 mm height. Finite element analysis (FEM)results are in reasonably good matching with test results. ANSYS 19.0 program can be used to stimulate long columns.

Keywords— Cold formed steel, ratio of high strength to weight, web stiffener, NAS, ANSYS Software.

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I. INTRODUCTION

The Cold formed steel(CFS) is higher strength resulting in the reduction in dead weight. The thickness inthiscold formed steel strip or sheet are generally range value from 0.40 mm to 6.4 mm**.**the yield stress of steel sheet used I cold rolled section is at the minimum of 285 N/mm^2**.**Generally these are mostly present in these basic building components for assembly at the site area or as pre fabricated panels or frames. Occasionallythose are also calledCold Rolled Steel Sections (CRS) or Light Gauge Steel Sections.

II. LITERATURE STUDY

P Manikandan et al., (2015)a stiffened elements at theintersection of theweb/flangeand edge stiffener providea longitudinal support for the compression flanges, to can increase strength of the section and can be improve its behaviour member.The size, shape and location of the intermediate web stiffeners substantially affected to the constancy of the cold-formed steel section members.

K Sudha et al., (2014) the web element also contributing appreciably to the strength. To minimise bearing failure vertical stiffener is required at support and at the loading points

T Srinath et al., (2016)study on the collision of web openupon the flexuralbehaviour of latticed built-up I section.Cold formed steel (CFS)components are generally employed in steel modern construction because they are light weight and more efficient than traditional hot-rolled section.

J Jegan et al., (2016) Increase in cross-sectional (A)members and inertia of moment (I) of the specimen, make better the load carrying capacity for the specimen.The load carrying capacity for the specimen isto improve when haunches are provided in the section members over thecontroled specimen.

S P Keerthana et al., (2016) A stiffened elements at the web/flange junction and edge stiffener provide longitudinal support to the compression flanges, may increase strength and improve behaviour of the members.For light gauge panel elements, the buckling happens at low stress point.

M Meiyalagan et al., (2010) because of minimum thickness (t) of the Cold rolled Sheet (CRS), considering global buckling (the Local, torsional & distortional) characteristics for its behaviour study. Purpose of the ultimate compressive strength (UTM) test provided to check the yield point for quality control (QC), compression test finds the compressive yield point of the specimen.

III. LITERATURE SUMMARY

- Design of cold formed steel built-up closed beams requires consideration of local, distortional, bending, web buckling and lateral-torsional buckling.
- The intermediate web stiffener has a significant effect on the strength &behavior of the flexural member.
- The Flexural Strength increase with an increase in depth of intermediate stiffener.
- The finite element analysis should be used with a higher level of confidence in predicting the load capacity of the flexural member.

IV. WORK METHODOLOGY

4.1Details of the specimen

The specimens were model to form lipped C-channels sections with intermediate stiffener& then two of the open sections are connected at their lips to web using M10 Bolts to form a built-up closed box section. The bolts are normally placed at 20 mm distance from both end of the column, and after that the connection is made at 100 mm equal interval throughout the length of column. The typical cross section of the specimen and arrangement of bolts spacing are shown in Figure 4.1.

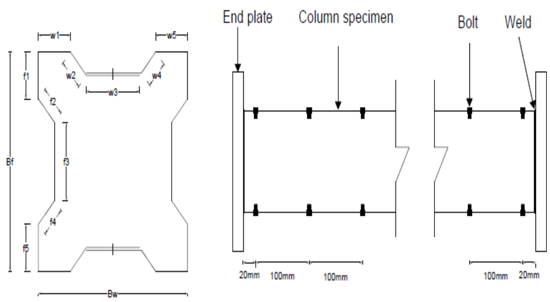

Figure 4.1 Typical Cross Section of the Specimens

4.2 Dimensions of the Specimen

The typical cross section dimensions of the specimens are given in following Table 4.1.

Table 3.1 Cross Sectional Dimensions of Specimen

S.No.	W1, W5 (mm)	W3 (mm)	W2, W4 (mm)	Width Of Specimen (mm)	Length or Span (mm)	Thickness (mm)
1	**30**	**50**	**21.21**	**140**	**540**	**1.6**
2	**30**	**50**	**21.21**	**140**	**740**	**1.6**
3	**30**	**50**	**21.21**	**140**	**940**	**1.6**
4	**50**	**50**	**21.21**	**180**	**540**	**1.6**
5	**50**	**50**	**21.21**	**180**	**740**	**1.6**
6	**50**	**50**	**21.21**	**180**	**940**	**1.6**

V. RESULT AND DISCUSSION

5.1 Theoretical Analysis Results

S.No.	Specimen	Length of Specimen (mm)	Ultimate load (kN)
1	30-50-30	540	279.53
2	30-50-30	740	277.39
3	30-50-30	940	275.16
4	50-50-50	540	315.97
5	50-50-50	740	313.17
6	50-50-50	940	310.90

Table 5.1 Ultimate Load Prediction from Theoretical Analysi

5.2 Ultimate Load Prediction By Ansys

From the above load vs displacement curves, the ultimate load carrying capacity (ANSYS) of the specimen were noted down and the predicted ultimate load values are noted in table 5.2

Table 5.2 Ultimate Load Predicted by ANSYS

S.No.	Specimen	Length of Specimen (mm)	Ultimate load (kN)
1	30-50-30	540	246.55
2	30-50-30	740	241.23
3	30-50-30	940	235.57
4	50-50-50	540	300.21
5	50-50-50	740	298.19
6	50-50-50	940	285.45

5.3 Experimental Results

The experimental program on built up column was done under fixed end conditions and column caps were used to distribute the axial load evenly through the section. From the experimental investigations, the Ultimate load carrying capacities (UDL) of the specimen were noted down and it is described in table 4.3.

Table 5.3 Ultimate Load Carried by Specimens in Experimental Analysis

S.No.	Specimen	Width of specimen (mm)	Length of specimen (mm)	w/t Ratio	Experimental Results (kN)	Failure mode
1	30-50-30	140	540	87.5	308.05	LB
2	30-50-30	140	740	87.5	282.40	LB + DB
3	30-50-30	140	940	87.5	268.00	LB + DB
4	50-50-50	180	540	112.5	332.45	LB
5	50-50-50	180	740	112.5	322.60	LB + DB
6	50-50-50	180	940	112.5	299.90	LB + DB

Where,

LB=Local Buckling DB=Distortional BucklingFB =Flexural Buckling

5.4 Comparison Results

For the different length of specimens, the Ultimate load carrying capacity of the specimens under numerical, theoretical calculation and experimental analysis listwas tabulated in table 5.4

Table 5.4 Comparison of Results

Description of specimen	Length of specimen (mm)	Slenderness ratio	Ultimate load (kN)			Ratio of ultimate load	
			Theoretical results	Numerical results	Experimental results	P_{Num}/P_{Exp}	P_{The}/P_{Exp}
30-50-30	540	10.14	279.53	246.55	308.05	0.80	0.90
30-50-30	740	13.89	277.39	241.23	282.40	0.85	0.98
30-50-30	940	17.65	275.16	235.57	268.00	0.87	1.02
50-50-50	540	10.12	315.97	300.21	332.45	0.90	0.95
50-50-50	740	10.49	313.17	298.19	322.60	0.92	0.97
50-50-50	940	13.33	310.90	285.45	299.90	0.95	1.03

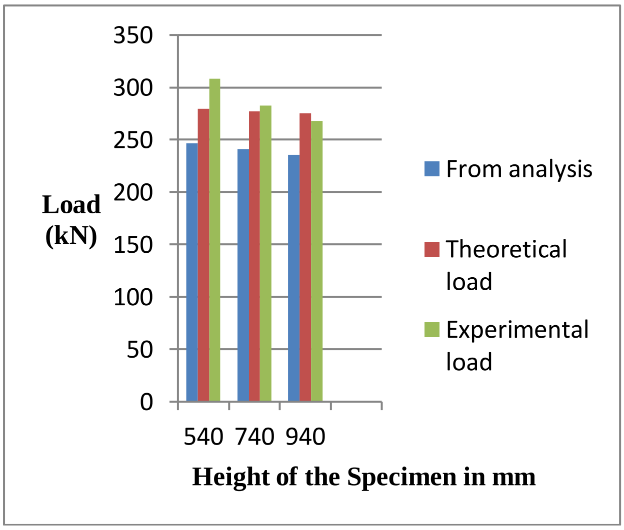

Figure 5.4.2 Load comparison with different heights of specimens in 30-50-30

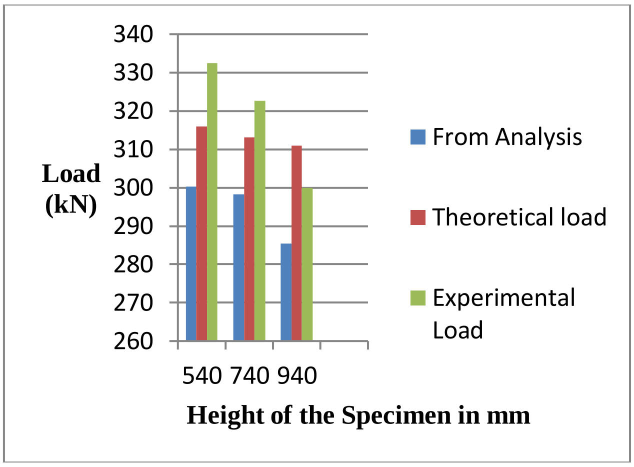

Figure 5.4.1 Load comparison with different heights of specimens in 50-50-50

VI. CONCLUSION

Load vs deflection Test were conducted on the cold formed built up sections under axial compression on two shapes with three different heights with hinged end conditions. The properties of the specimen were taken from the finite strip method software CUFSUM used for different built up cold formed steel columns.

Data obtained from the test are to be compared in the table 5.4. The ultimate load carrying capacity for the sections was compared with the theoretical and numerical analysis. The failure mode of the column involved local and distortional buckling of the web. Based on the theoretical, numerical and experimental investigation, the following determinations are made.

- When the D/t ratio increases the Ultimate Load carrying capacity of the specimens has been increased.
- With larger area, the failure is initiated by distortional buckling.
- For the intermediate column distortional buckling is the dominant failure.
- The failures pattern of Local Buckling was observed for 540 mm height of specimens.
- The failures pattern of Local and Distortional Buckling was observed for 740 mm and 940 mm height of specimens.
- Distortional Buckling and Flexural Buckling was observed when the height of specimen increases.
- Finite element results are in reasonably good matching with test result. ANSYS program might be used to simulate long columns, which could not be tested in our test program due to the limitation of the testing machine.

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