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Experimental Investigation on Buckling Behaviour of Light Gauge Steel Section with and without Lip

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Abstract— Cold form steel structures are used for numerous purposes in construction industry. An attempt has been made in this study to check the flexural behaviour of cold form steel, a closed built-up channel section with and without lip are experimentally and theoretically studied. Finally the experimental results are compared with theoretical results. Here the cold formed sheet of size 1.2mx2.4m is taken. And by cutting and bending the sheet channel sections with flange 70mm and web 180mm is made. Then the channel section is jointed with plate on both sides by welding inorder to make a built-up section . The distance between two channel section is 30mm and the lip of size 20mm is provided. Then by using 1000kN loading frame machine the built-up section is tested and LVDT is used to measure the deflection. For theoretical calculation IS 801-1987 code of practice for use of cold formed light gauge steel structural members in general building construction is used.

Key words: Cold Form Steel, Channel Section

I. INTRODUCTION

Cold formed steel is the common term for products made by rolling or pressing steel into semi-finished or finished goods at relatively low temperatures. Cold formed steel goods are created by the working of steel billet, bars, are sheet using stamping, rolling, are presses to deform it into a usable product. cold worked steel products, such as cold rolled steel(CRS) bar stock and sheet, are commonly used in all areas of manufacturing of durable goods, such as appliance or automobiles, but the phrase cold formed steel is most Prevalently used to describe construction materials.

The use of cold formed steel construction materials has become more and more popular since its initial introduction of codified standards in 1946. In the construction industry both structural and non-structural elements are created from thin gauges of sheet steel. These building materials encompass Beams, columns, joists, studs, floor decking, built-up sections and other components. Cold formed steel construction material differ from other steel construction materials known as hot rolled steel.

II. METHODOLOGY

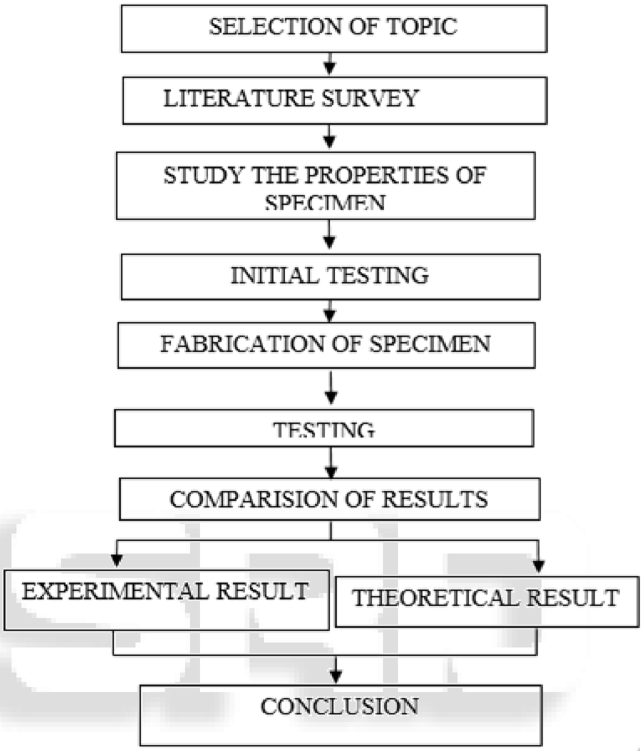

Fig. 1: Methodology

III. SPECIMEN DETAILS

Name of the specimen	Closed builtup channel section
Beam section	L x B x D x Lips
Depth, d (mm)	180
Width, b (mm)	70
Lips (mm)	20
Thickness of cover plate ,t (mm)	2
Design strength, fy (N/mm2)	250
Length of beam (mm)	1250
Type of weld	Point weld
Throat thickness (mm)	1.05
Weld spacing (mm)	140

Table 1: Detail of the specimen

A. *Cross-section of specimen:*

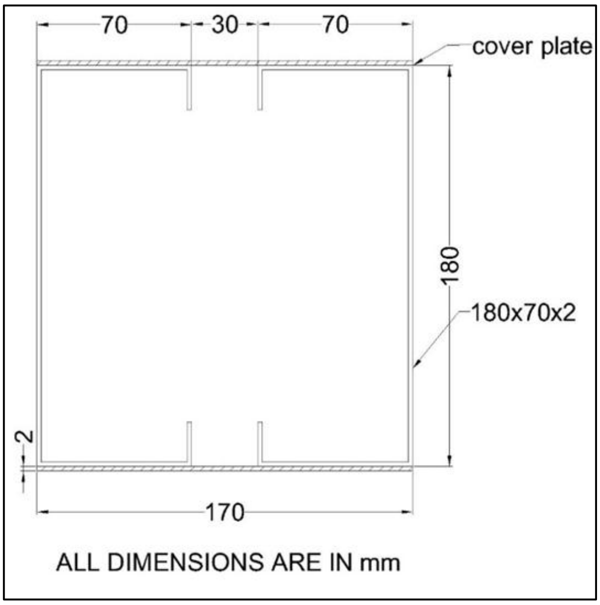

Fig. 2: cross sectional view of face to face section

Fig 3 Two point loading test setup

IV. EXPERIMENTAL INVESTIGATION

Cold formed closed built-up channel section of 1250mm length and 200 mm depth is tested in a loading frame of capacity 400 kN under two point loading at l/3 distances shown in Fig. A hinged support is provided at the ends, In order to avoid the lateral displacement and tilting of specimen a lateral clamping is given at ends of the specimen. LVDT's and load cell are used for measuring deflection and load increment. All the data are recorded in a Data acquisition system. Deflectometers were placed at three positions namely 1/3rd distance, mid span and at support. Also strain gauges of 120 ohms are placed in order to measure the strain. Strain readings were taken in the top compression flange and in the side web region.

V. EXPERIMENTAL RESULTS

s.no	Load (kN)	Deflection		
		under load from left side	centre	under load from right side
1	2	0.80	0.91	0.79
2	4	1.28	1.40	1.28
3	6	1.47	1.60	1.45
4	8	1.60	1.94	1.58
5	10	1.95	2.16	1.93
6	12	2.23	2.36	2.20
7	14	2.55	2.68	2.55
8	16	2.81	2.96	2.80
9	18	3.01	3.18	3.00
10	20	3.33	3.49	3.33
11	22	3.53	3.68	3.53
12	24	3.71	3.79	3.72
13	26	3.80	3.93	3.79
14	28	4.02	4.22	4.02
15	26	4.05	4.28	4.03
16	24	4.07	4.30	4.05
17	22	4.11	4.37	4.11
18	20	4.15	4.39	4.18

Table 3: experimental results for without lip specimen

s.no	Load (kN)	Deflection		
		Under load from left side	Centre	Under load from right side
1	2	0.47	0.48	0.47
2	4	0.98	1.01	0.96
3	6	1.25	1.30	1.24
4	8	1.40	1.47	1.40
5	10	1.50	1.64	1.50
6	12	1.72	1.8	1.70
7	14	1.83	1.93	1.81
8	16	1.95	2.06	1.96
9	18	2.08	2.18	2.05
10	20	2.19	2.30	2.18
11	22	2.32	2.45	2.32
12	24	2.54	2.61	2.53
13	26	2.80	2.96	2.79
14	28	3.04	3.21	3.04
15	30	3.42	3.58	3.40
16	32	3.68	3.86	3.68
17	34	3.85	4.13	3.84
18	30	3.97	4.25	3.94
19	28	4.09	4.44	4.08
20	26	4.15	4.57	4.17
21	24	4.24	4.60	4.22

Table 4: experimental results for with lip specimen

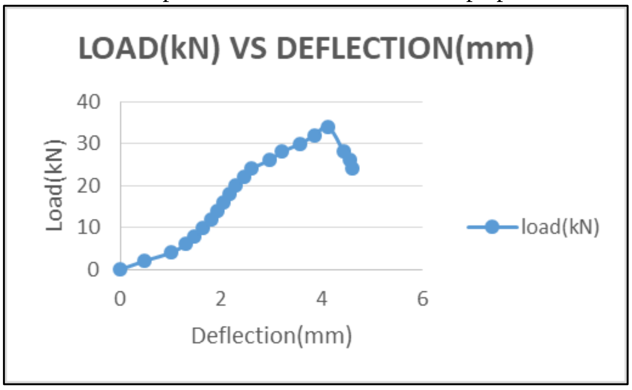

Fig. 4: Graph for central deflection of with lip specimen

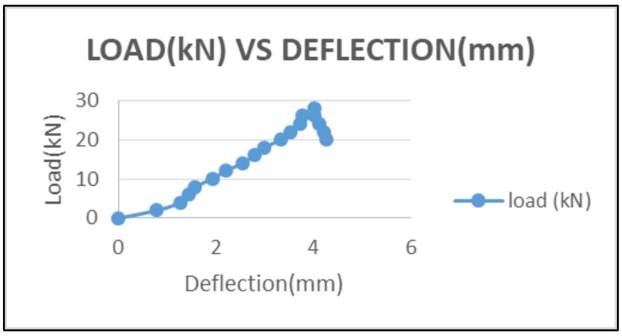

Fig. 5: Graph for central deflection of without lip specimen

Fig. 6: failure pattern of without lip specimen

Fig. 7: failure pattern of with lip specimen

VI. THEORETICAL ANALYSIS

Theoretical analysis are done using IS: 811-1974.

With lip specimen	
Maximum shear stress(N/mm^2)	22.2
I_{xx} (mm^4)	7.15x10^6
Section modulus (mm^3)	79.46x10^3
Web shear (N/mm^2)	72.44
Permissible safe load (kN)	35.52
Allowable deflection (mm)	4.30
maximum deflection (mm)	0.70
Without lip specimen	
Maximum shear stress(N/mm^2)	16.26
I_{xx} (mm^4)	11.62x10^6
Section modulus (mm^3)	132.04x10^3
Web shear(N/mm^2)	71.15
Permissible safe load (kN)	26.02
Allowable deflection(mm)	4.30
Maximum deflection (mm)	3.84

Table 5: Theoretical results

VII. RESULTS AND DISCUSSION

This paper has described a detailed investigation on the structural behavior of cold formed steel closed built-up channel beam with cover plates both top and bottom. Both experimental and theoretical analysis was conducted for better understanding of the behavior of the flexural member. They were validated by comparing their result with the corresponding experimental results.

With lip specimen	
Theoretical ultimate load (kN)	35.52
Max. allowable deflection (mm)	3.84
Theoretical deflection (mm)	3.5
Experimental ultimate load (kN)	34
Experimental deflection (mm)	4.13
Without lip specimen	
Theoretical ultimate load (kN)	26.02
Max. allowable deflection (mm)	3.84
Theoretical deflection (mm)	3.6
Experimental ultimate load (kN)	24
Experimental deflection (mm)	4.30

Table 5: Comparison of results for flexure

VIII. CONCLUSION

The following conclusions are made from the above study:

- The cover plate at top and bottom of flange increases the flexure capacity of the beam.
- Failure due to shear in web is eliminated due to the presence of cover plates.
- various codes are conservative.

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