EXPERIMENTAL STUDY ON FLEXURAL BEHAVIOUR OF COLD-FORM STEEL SECTION WITH AND WITHOUT SQUARE PERFORATION

Rajendiran M[1] Kumaran V[2] Muhammed Ansar S.M[3] Deva R[4] Irbaaz Afridi S[5] Jaya Kumar K[6]

[1,2]Assistant Professors. Dept. of Civil *Engineering, Loyola Institute of Technology, Chennai, India*
[3,4,5,6]*Student of 4th year BE Civil Engineering, Loyola Institute of Technology, Chennai, India*

---***---

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 behavior of cold form steel, closed built-up channel section with and without square perforated experimentally. Finally, the experimental results are compared theoretical results to know which is load carrying capacity is high. This study aims at the following objective by test performed on cold formed steel section to check the flexural behavior. Studies on the structural behavior of cold-formed steel (CFS) beam are increasingly popular in the last decades. We casted the cold form closed built-up channel section and applied Red Oxide Primer for corrosion resistance and sizes of the specimen and perforation is 200X80X2mm and 100X100mm. In this project the cold form steel section we check for deflection by applying two-point loads and finding out the value of central deflection and edge deflection by using LVDT (Linear Variable Differential Transformer). After the test results of both with and without square perforation the load taken by steel beam is more (or) less equal. Comparison between the theoretical and experimental results is presented and the agreements obtained are reasonably good.*

Key Words: **Cold-Formed steel, Square Perforation, Flexure, Deflection, Channel Section, Two-Point Load.**

1. INTRODUCTION

Cold-formed steel structures are steel structural products that are made by bending flat sheets of steel at ambient temperature into shapes which will support more than the flat sheets themselves. CFS is much more cost effective than heavier construction and it is totally non-combustible, can help developers and builders use land more efficiently by allowing taller and wider buildings for the same occupancy classification. The thickness of material that can be formed generally ranges between 0.004 (0.10mm) up to 0.312 inches (7.7mm), although heavy duty cold forming work can handle steel up to ¾ of an inch (19mm) thick. The yield strength of steel sheets used in cold-formed sections is at least 280 N/mm2, although there is a trend to use steels of higher strengths, and sometimes as low as 230 N/mm2.The ratio of tensile strength to yield strength for cold-formed steels commonly ranges from 1.2 to 1.8.

2. METHODOLOGY

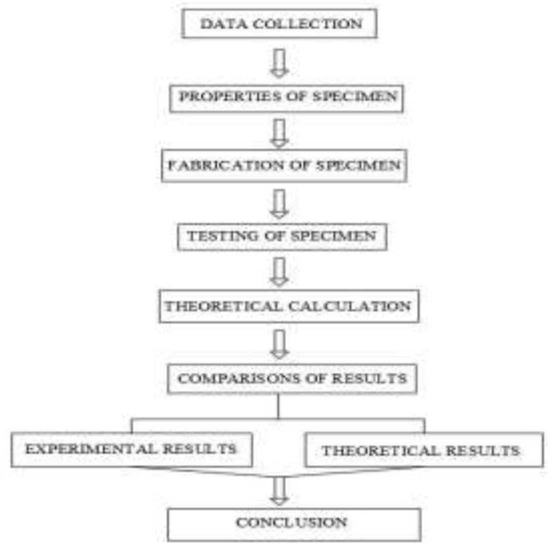

Fig -1: Methodology

3. SPECIMEN DETAILS

Table -1: Details of the specimen

Name of the specimen	Closed built-up channel section
Beam section	L x B x D
Depth, d (mm)	200
Width, b (mm)	80
Thickness of cover plate, t (mm)	2
Design strength, f_y (N/mm^2)	350
Length of beam (mm)	1250
Type of weld	Intermediate weld
Total length of weld (mm)	10
Weld spacing (mm)	140

4. CROSS SECTION OF SPECIMEN

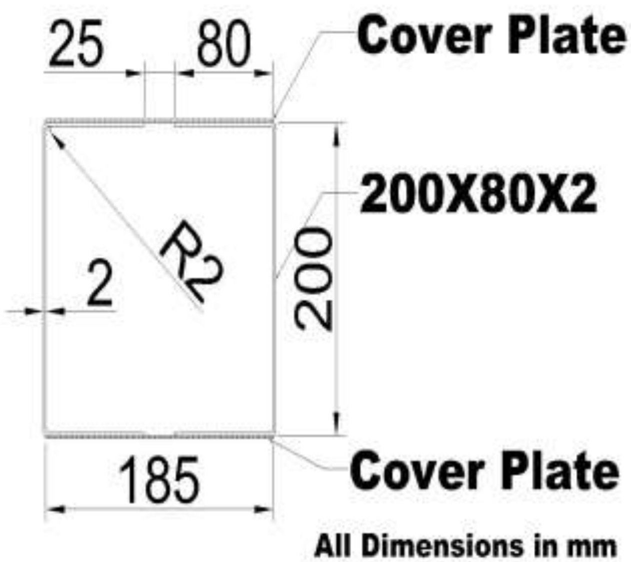

Fig -2: Cross Sectional View of Face to Face Section

Fig -3: Setup – Before Testing

5. 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 3. A roller 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 under load.

5.1 Experimental Results

Table -2: Experimental Results for without perforation

S.No	Load	LVDT in mm Centre	LVDT in mm Under Load
1	2	0.72	0.65
2	4	1.07	0.95
3	6	1.25	1.16
4	8	1.42	1.24
5	10	1.67	1.54
6	12	1.97	1.80
7	14	2.26	2.09
8	16	2.58	2.40
9	18	2.87	2.77
10	20	3.15	3.04
11	22	3.40	3.32
12	24	3.77	3.60
13	26	3.95	3.86
14	28	4.20	3.99
15	26	4.49	4.07

Table -3: Experimental Results for with perforation

S.No	Load	LVDT in mm Centre	LVDT in mm Under Load
1	2	0.48	0.45
2	4	0.76	0.74
3	6	1.05	1.00
4	8	1.23	1.14
5	10	1.40	1.30
6	12	1.52	1.45
7	14	1.70	1.60
8	16	1.95	1.80
9	18	2.12	2.02
10	20	2.37	2.25
11	22	2.60	2.44
12	20	2.84	2.68
13	18	3.02	2.76

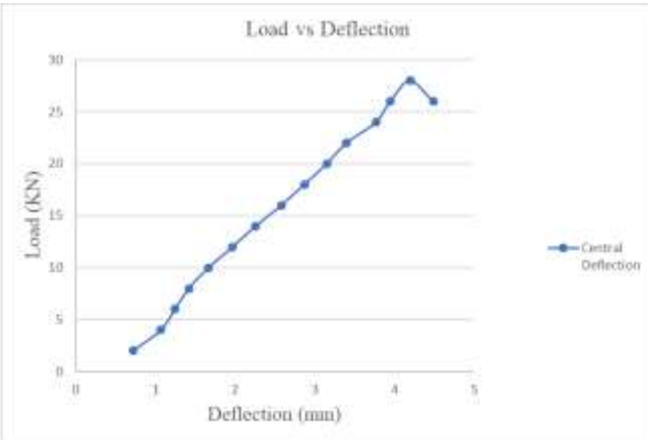

Chart -1: Load vs Deflection at center without Perforation

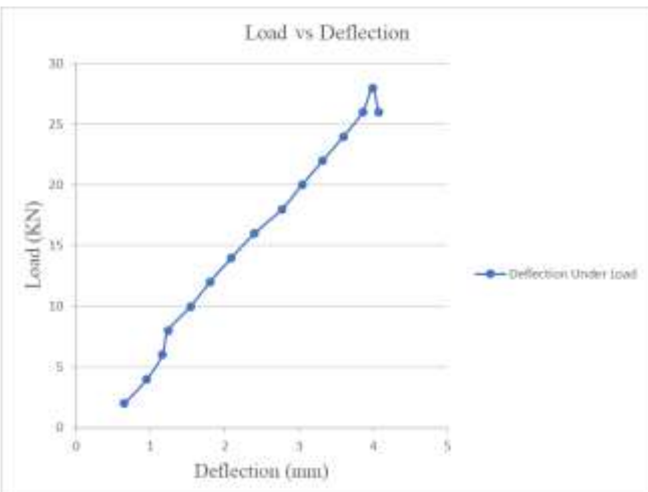

Chart -2: Load vs Deflection under Load without Perforation

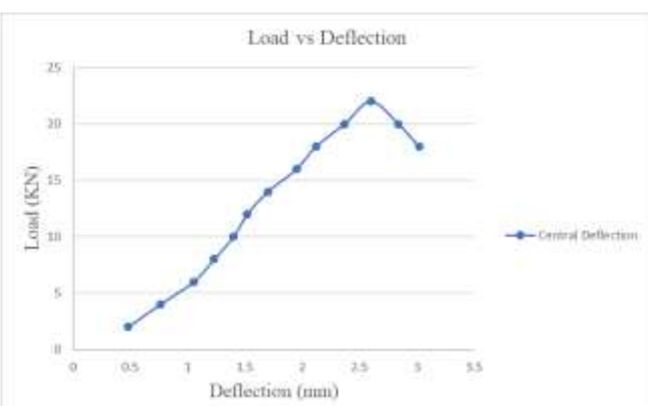

Chart -3: Load vs Deflection at center with Perforation

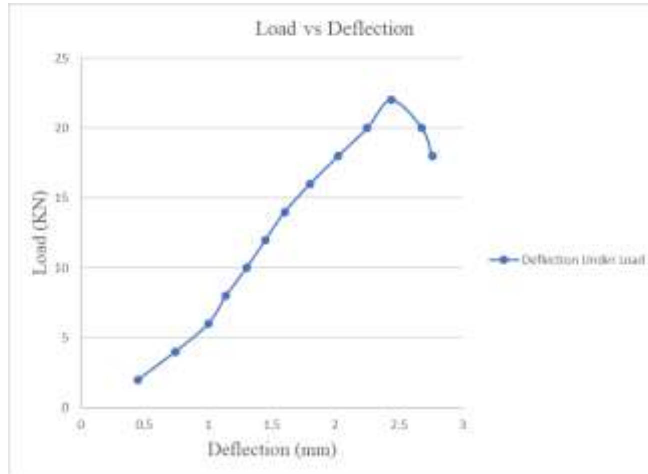

Chart -4: Load vs Deflection Under Load with Perforation

(a) Without perforation

(b) Without perforation

Fig -4: Failure patterns

6. THEORETICAL ANALYSIS

Theoretical analysis is done using IS:811-1974.

Specimen (mm)	200 x 80 x 2
I_{XX} (mm^4)	18.06 x 10^6
Section modulus, Z (mm^3)	184.28 x 10^3
Web shear (N/mm^2)	146.5
Permissible safe load (kN)	23.5
Allowable Deflection (mm)	3.84
Maximum Deflection (mm)	2.5

Table -4: Theoretical results

7. RESULTS AND DISCUSSION

This paper has described a detailed investigation on the structural behaviour 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 behaviour of the flexural member. They were validated by comparing their result with the corresponding experimental results.

Theoretical ultimate load (kN)	23.5
Maximum deflection (mm)	2.5
Allowable deflection (mm)	3.84
Experimental ultimate load (kN)	28
Experimental deflection (mm)	3.95

Table -5: Comparison of results for flexure without perforation

Theoretical ultimate load (kN)	23.5
Maximum deflection (mm)	2.5
Allowable deflection (mm)	3.84
Experimental ultimate load (kN)	22
Experimental deflection (mm)	2.60

Table -6: Comparison of results for flexure with perforation

8. CONCLUSIONS

The following conclusions are made from the above study:

- The cover plates at top and bottom of flange increases the flexural capacity of the beam.
- Numerical validation has been carried out to verify the appropriateness of the experimental results and find that they are quite closer to the corresponding test result.
- In this project the load caring capacity of both with and without perforation is more or less same, thus in manufacturing process itself the perforation can be done hence reducing the cost and self-weight of the CR sheet.
- The results obtained based on the various codes are conservative.
- With the increment of depth, the strength and stiffness of the beam also increases.
- In both the specimens the welding has been done in intermediate points only, if the welding had been done total length of the specimen the load caring capacity of the specimen would have been greater.

REFERENCES

1. **Study on flexural behaviour of cold formed C-Section purlin with different opening shapes** by Kaluram T. Jadhav in July 2017, ISSN (O) 2319-8354 & ISSN (P) 2319-8346
2. **Numerical study of buckling behaviour of cold-formed C-channel steel purlin with perforation** by Fatimah De'nan in December 2015, PP.1135-1141
3. **Finite Element Analysis of Perforated Beam – Column Connections** by Shubhangi P. Tippe in January 2018, ISSN (P) 2395-0072
4. **Investigation of flexural behaviour of C-section with and without web openings** by using cold form steel by G. Kutti Raja in March 2018, ISSN 2319-8753
5. **Finite Element Analysis of steel beam with web opening of different shapes** by Sharda P. Siddh in July 2011, ISSN 2221-8386
6. **Experimental Study on Flexural Behaviour of Light Gauge Steel Sections** by S. Sureshbabu in January 2016, ISSN 2321-0613
7. **Flexural failure of cold-formed Single channels connected Back-to-back** by M. Dundu in 2002
8. **Cold-Formed Steel Lipped Channel Columns Influenced** by Local-Distortional Interaction: Strength and DSM Design by Ben Young
9. **IS 801-1987** code of practice for use of "cold formed light gauge steel structural members in general building construction is used".