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Experimental Study on Cold Formed Steel Hollow Box Section Coupled with I section

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ABSTRACT

In comparison to hot rolled section, goods manufactured from rolling or pressing steel are known as cold formed steel. They are created at ambient temperature or at extremely low temperatures. By using presses, stamping, rolling, or other methods to distort steel billet, bar, or sheet into usable products and sections, cold-formed steel commodities are produced. Light gauge sections are used in the construction sector to make both structural and nonstructural components. Channel, I, Z, tubular, and hat sections are the most typical shapes for cold formed steel sections. When a load is applied, different sorts of sections fail in various ways. A unique kind of cold formed section is the hollow box coupled I section. In comparison to the box and I section, the section is made to support a greater weight. Its flexural and compressive behaviour is evaluated in this connected part (ie., as both beam and column). The section's failure pattern and maximum load are determined by the loading frame. In this study, experiments are conducted and the section's deflection and buckling are analysed. Based on analytical, experimental, and theoretical findings, a comparison study is made.

Keywords: Deflection and Buckling of Section, Box Coupled I Section

INTRODUCTION

"Cold-formed steel" (CFS) refers to goods produced by rolling or pressing steel into semi-finished or finished objects at relatively low temperatures (cold working). Stamping, rolling (including roll forming), or presses are used to manipulate steel billet, bar, or sheet so as to deform it into a usable product. Cold-worked steel products, such as cold-rolled steel (CRS) bar stock and sheet, are extensively utilised in all sectors of the production of durable goods, such as appliances or cars, even though the term "cold-formed steel" is most frequently used to describe building materials. The use of cold-formed steel construction materials has continuously expanded since the initial codification of regulations. Thin gauge sheet steel is used in the construction sector to make both structural and non-structural elements. Columns, beams, joists, studs, floor decking, built-up sections, and other elements are included in this group of building materials. Construction materials made of cold-formed steel are distinct from those made of hot-rolled steel. Compression tests of cold produced I-shaped open sections with stiffners," by Jia-hui Zhang and Ben Young, vol. 52 (2011) In this study, cold-formed steel I sections with edge and web stiffners are subjected to a number of columns tests. (3) To determine the material qualities, tensile coupon tests were carried

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out. Geometrical initial local and global flaws were measured. It was discovered that columns buckled locally, distortionally, and flexurally. The column specimens' ultimate strengths and modes of failure were presented. Specifications from Australia and North America were applied.

Within the steel grade range of s235-s960, the overall buckling behaviour of HSS members is investigated. During the hydraulic loading, the residual stress, geometric flaws, and material characteristics are identified. Prior to the buckling tests, the test specimens' precise form is measured. After loading each test specimen's corner, the size and shape of the flaw are determined. (4) A moving inductive displacement transducer-based special equipment is used to carry out the measurement.

Thin wall constructions, vol. 104 (2016), pp. 185–197, Lu Yang and Menghan Zhao The behaviour of stainless steel columns under flexural buckling has been thoroughly examined and explained in this work. Using a strength testing machine, critical and limit loads were identified. Results were assessed against analytical options. Non-standard channel beam flanges with closed profile shapes buckled more than flat standard flanges. The beams' geometrical flaws can be seen. (6) There was no more than a 15% discrepancy between experimentally determined crucial moments and their theoretical predictions. The outcomes of the experimental and analytical processes agreed in a satisfactory manner. (7)

EXPERIMENTAL INVESTIGATION

Beam Analysis:

The structural laboratory's 500KN loading frame is used for experimental analysis. For the flexural testing of the beam section, these high load bearing frames are utilised. The same specimen's beams 1 and 2 are put to the test. The same specimen makes up both beams. With a universal testing machine, the column is tested. (8) The buckling of columns 1 and 2 is examined. In the structural testing laboratory, the loading frame is used to assist with the beam analysis. The same load is applied to both specimens during the beam analysis.

Beam Analysis:

Fig 1 Beam – 1 Setup

Fig 2 Beam-2 Setup

3.3 Load and Deflection for Beam 1 and Beam 2:

TABLE 1 LOAD AND DEFLECTION FOR TWO BEAMS

LOAD(KN)	Beam – 1 Deflection(mm)	Beam – 2 Deflection(mm)
10	0	0
20	0	0
30	0.1	0.1
40	0.1	0.1
50	0.1	0.2
60	0.2	0.2
70	0.2	0.2
80	0.2	0.3
90	0.3	0.3
100	0.3	0.3
110	0.3	0.4
120	0.4	0.4
130	0.4	0.4
140	0.4	0.5

3.4 Load Vs Deflection for Beam:

The initial loading starts at 30KN, and the beam fails when an ultimate load of 260KN is attained. The load and the deflection for beam1 (blue) and beam2 (green) are presented and combined in the same graph. The beam buckles to the side and collapses.

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Figure 4 Load Vs. Deflection

This beam exhibits a twisting moment, and the web part and corners of the hollow section of the beam are where it fails. The beam broke with a 256KN ultimate stress. When a yield load of 150KN is seen, the beam exhibits twisting.

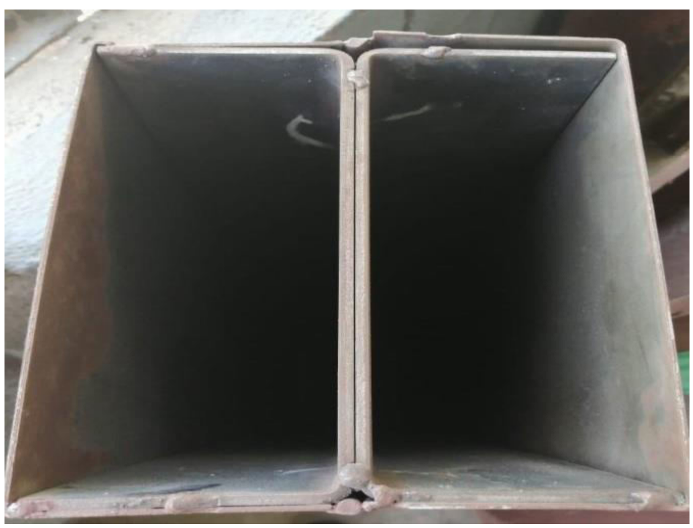

Fig 4 Failure pattern of the beam.

3.5 Column Analysis:

TABLE 2 COLUMN ANALYSIS 1

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LOAD(KN)	COLUMN-1 DEFLECTION(mm)	COLUMN-2 DEFLECTION(mm)
150	0.4	0.5
160	0.5	0.5
170	0.5	0.5
180	0.5	0.6
190	0.5	0.6
200	0.6	0.6
210	0.6	0.7
220	0.7	0.7
230	0.7	0.7
240	0.7	0.8
250	0.7	0.8
260	0.8	0.8

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FIG 5 COLUMN1 AND COLUMN 2

TABLE 3 COLUMN ANALYSIS THROUGH DATA ACQUISITION 2

LOAD (KN)	BUCKLING (DIAL GAUGE)	BUCKLING (DATA ACQUISITION)
10	0	0
20	0	0
30	0.01	0
40	0.02	0.01
50	0.05	0.08
60	0.07	0.15
70	0.09	0.29
80	0.1	0.41
90	0.3	0.59
100	0.7	0.64
110	0.9	0.77
120	1.1	0.90
130	1.1	0.98
140	1.1	1.10
150	1.2	1.17
160	1.2	1.28

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TABLE 4 COLUMN ANALYSIS THROUGH DATA ACQUISITION 2

LOAD(KN)	BUCKLING (DIAL GAUGE)	BUCKLING (DATA ACQUISITION)
170	1.3	1.32
180	1.3	1.47
190	1.4	1.52
200	1.5	1.62
210	1.6	1.72
220	1.7	1.90
230	1.9	1.96
240	2.0	2.01
250	2.2	2.13
260	2.3	2.20
270	2.4	2.35
280	2.5	2.39
290	2.6	2.52
300	2.7	2.52
310	2.8	2.57
320	2.9	3.02
330	3.0	3.22

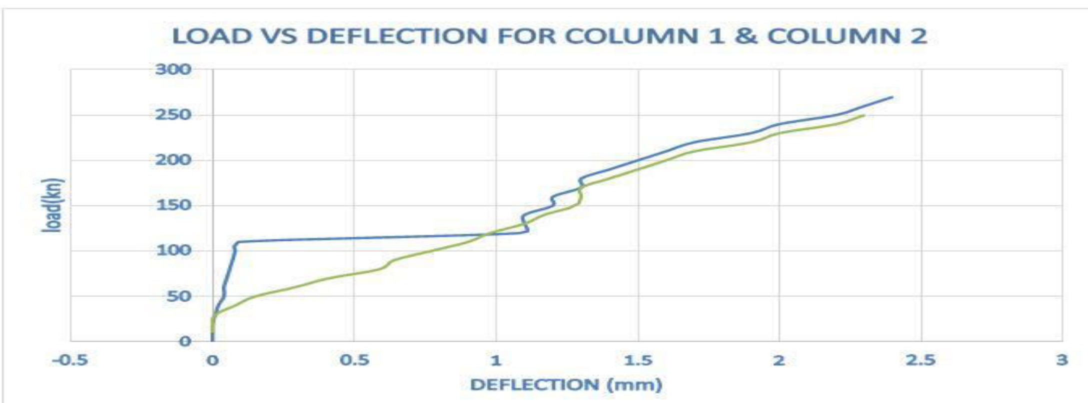

Figure 6 load vs deflection for column 1 and 2

3.6 Load Vs Deflection for Column:

The ultimate load is determined after measuring the load and buckling of the column section using two values from the dial gauge (blue) and data acquisition (green). (9)

TABLE 5 LOAD VS DEFLECTION FOR COLUMN

Section	Analytical	Theoretical	Experimental
Beam (Deflection)	1.29mm	10.5mm	1.6mm
Column (Deflection)	49.9N/mm^2	40.8N/mm^2	89N/mm^2

CONCLUSION

The use of cold-formed iron building material has continuously expanded since the initial codification of regulations. Thin, light gauge sheets of steel are used to make both structural and non-structural components in the construction sector. Thin, light gauge sheets of steel are used to make both structural and non-structural components in the construction sector. Thus, the beam deflection and column buckling of the linked hollow box section are tested. This section displays various failure patterns, deflection, and buckling behaviour depending on the application of load. The member's maximum load, deflection, and buckling are calculated. According to calculations, when a load of 500KN is applied, the span (1200mm) of the beam member deflects at a 1.29mm angle and the column buckles with a stress value of 49.9MPa and corresponding strain of 0.00022. As a result, the section's load-bearing capacity is greater than that of built-up hollow boxes and I sections. Due to its great load bearing capability, this type of section can be employed as a beam and column member. It is possible to compare these analytically determined values to those from an experiment. This section displays various failure patterns, deflection, and buckling behaviour upon application of load. Comparing the beam to an I section and a built-up box, the beam exhibits remarkable stability. Due to its great load bearing capability, this type of section can be employed as a beam and column member. Comparisons are made between the analytically obtained values and experimental and theoretical values.

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