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EXPERIMENTAL INVESTIGATION ON BEHAVIOUR OF COLD FORMED STEEL BATTEN COLUMN WITH ANGLES UNDER AXIAL COMPRESSION

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ABSTRACT

This paper presents the study on cold formed steel built-up battened Columns. CFS are highly advantageous when compared with the hot rolled section, it has comparable load carrying capacity and durability but still the usage of cold formed steels are not so high in practice. This study deals with the cold formed steels built up batten columns formed by using 4 cold formed angles fabricated from the cold formed thin sheets and all the angles are interconnected by batten plates of 2mm thick. According to the research it has been stated that the ultimate load carrying capacity of column increases with decrease in its slenderness ratio. In this investigation four angle sections (50x50x2) are connected with batten plates and the tests are carried out by varying its angle spacing only. The theoretical and experimental analysis was carried out for the proposed section to know the ultimate load carrying capacity and the results were compared

Key words: Built-up section, Cold formed steels, Load carrying capacity

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1. INTRODUCTION

Steel is an alloy of iron and carbon. Cold formed steel or light gauge member are thin sheet steel extensively used in construction, which are made by pressing and rolling steel under room temperature. These materials encompass column, beam, joist, studs, floor decking, built-up sections and other components. Built-up section CFS used for compression and tension member. The different types of sections available are channel, angle, Z-section, hat section, box section. CFS has characteristics as lightness in weight, high strength and stiffness, fast and easy erection, uniform quality, more accurate detailing and economical in transportation and handling.

Past research has highlighted that cold-formed steel members are subjected to various buckling modes including local, distortional and global modes, and their ultimate strength behavior is governed by these buckling modes. In designing cold-formed steel compression members, it is important to recognize the different buckling modes. Although cold-formed steel members have been researched for a long time, the stability problem is not fully understood. Generally, the following buckling modes were encountered from the earlier research works:

Local buckling is the mode having plate-like deformations or it is a state of instability of its geometry before the yielding of the material takes place. The plate elements of Cold-formed sections are normally thin with higher plate slenderness ratio and hence they buckle locally before yield stress is reached. Local buckling mode of a thin walled member depends on its Cross section geometry (shape & dimensions) and Support conditions.

Flexural Buckling mode compression buckles out weaker principle axis & collapses occur at rate following excessive buckling deformation (no twisting). Normally, Long columns will undergo flexural buckling along half wave lengths. Torsional buckling mode, the members will fail by twisting about the longitudinal axis through the Shear center (No bending).

Flexural- Torsional Buckling, Due to the smaller thickness the section has low torsional stiffness and their shear center and centroid are located away from each other. This causes flexural-torsional buckling. In this mode the member can bend and twist simultaneously. This type of behavior mainly occurs in long column with open cross sections and unsymmetrical sections. In our research conducted the four angle section are inter connected with batten plates of thickness 2mm, having same cross-section, length by varying its angle spacing. Connections are made by welding.

2. LITERATURE REVIEW

Deenadhayalan et al (2017) “study on the compression behaviour of corrugated steel section”, with ever advancing technology, this paper presents the cold-formed are being fabricated with high yield tensile stress materials with the use of high strength steel cones in thickness which leads to development of highly stiffened sections with more folds. Thus this paper concludes that, cold formed column steel sections can be strengthened by forming edge and web stiffener, corrugated cold formed column improves the torsional stiffness and local buckling is completely eliminated due to the provision of intermediate stiffener in the web.

Fengli Yang1 et al (2011) “Study on the behavior of cold formed angles”, This paper presents by Considering the structural characteristics, four section of cold formed angles with different slenderness ratio and types were selected for the experimental and numerical study. Cold formed has the advantage of reasonable section shape, relatively high integral stiffness and the ultimate load for the same cross section area.

Dr.M.Anbarasu et al (2014) “study on the capacity of cold formed steel built up batten column under axial compression”, this paper presents the theoretical and numerical investigation results of the pin ended cold formed steel built up battened column under axial compression by using the software “ABAQUS”. Cold formed steel is used as a compression member to carry heavier load and over longer span when a single individual section is insufficient. From this, the ultimate strength of the member decreased with the increase off overall slenderness ratio for irrespective of individual sections.

Mr.M.Ranjith, Mrs. G. Aruna (2016) “Study on behavior of cold formed built-up compression member” Cold formed built – up box shaped closed section was tested under axial compression and the ends of columns were simulated as hinged ends with varying lengths and fixed thickness. The failure modes of the columns involved local buckling, distortional buckling of the webs, and flexural buckling. The test strengths were compared with strength values obtained from theoretical and numerical results. When the slenderness ratio (L/r ratio) increases the ultimate load carrying capacity of the specimens have been decreased. 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.

FadhluhartiniMuftah (2014) “Ultimate load of built-up cold formed steel column”, Cold formed steel (CFS) has been used as the primary structure for flexural and compression member due to varieties of advantages such as high strength to weight ratio, high corrosion resistance, and ease of fabrication. Fast and easy fabrication can produce an efficient structure. Short column can easily attain its double strength, but the long columns are affected by varieties of buckling results in smaller strength to its double C strength.

S.P.Keerthana, K.Jothibaskar (2016) “Experimental study on behavior of cold formed steel using built-up section under axial compression”, the load carrying capacity of column compared with numerical, theoretical and experimental results. The section is formed by two types with and without lips under axial compression. The members with lips show higher load carrying capacity. For light gauge plate elements, the buckling occurs at low stresses resulting due to compression or bending or bearing.

3 METHODOLOGY

Experimental investigation is carried out to determine the ultimate load carrying capacity of the column section and to compare the results with theoretical analysis and numerical analysis

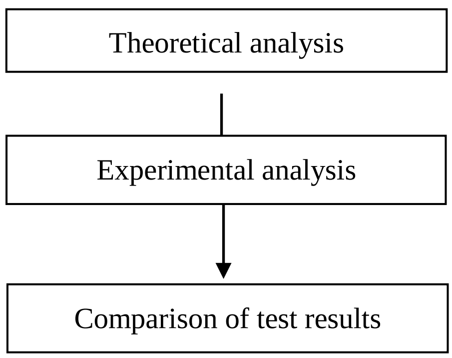

Figure 1 Methodology

4. EXPERIMENTAL INVESTIGATION

Experimental investigations are conducted to examine the behavior and mode of failure of the cold formed steel built-up section.

4.1. Coupon Test

From the code IS 1608 2005 PART 1, the coupon specification are taken for conducting the tensile test on CFS sheet of 2mm thickness. Three specimens were fabricated and test was conducted in an ultimate testing machine of 400KN capacity. Stress vs. Strain curve are plotted and the test setup are shown in Fig.2

Figure 2 Test setup for coupon test

Table 1 Test result of coupon

Specimen	Ultimate Load(KN)	Yield Stress N/mm^2	Young's Modulus $N/mm^2(10^5)$
1	7.8	234	2.09
2	7.7	231	2.04

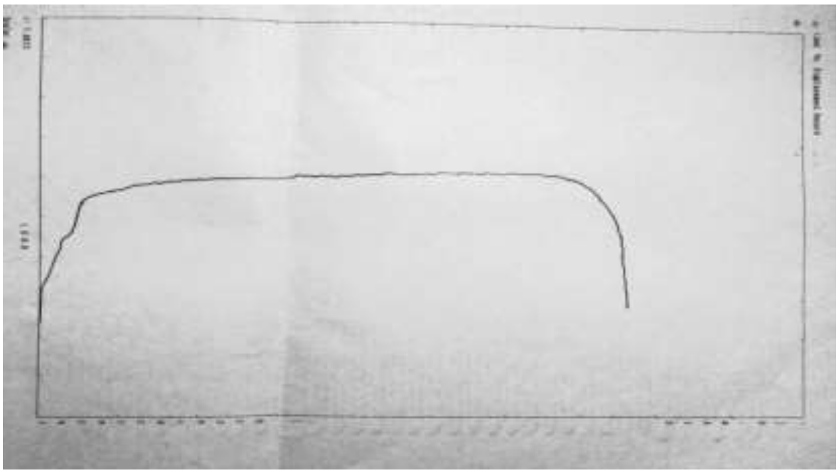

Figure 2 Stress vs. strain curve

4.2. Test Specimen

The specimens were fabricated from cold formed steel sheets. CFS built up batten columns formed by using 4 cold formed angles fabricated from the cold formed thin sheets and all the angles are interconnected by batten plates of 2mm thick. The specimens were connected by welded connection. Base plate of thickness 10 mm was provided at the top and bottom of the built-up angle section to apply the load uniformly.

Figure 3 Test specimen

4.3. Test setup

The built-up section was tested in the loading frame of capacity 200 tones. Simply supported is provided as end condition. By using the dial gauge the deflection of the specimen is noted. With the help of the hydraulic jack the axial load is applied to the column from the bottom of the specimen

Figure 4 Test Set up

4.4. Modes of Failure

By the application of axial load the column gets deflected. For each loading, the deflection is noted in both dial gauges. After the ultimate load given the failure mode of the column was examined. The observed failure mode was local buckling. The failure mode of CA 50x50x2 is shown in Fig.

Figure 5 Buckling mode

Table 2 Theoretical and experimental load calculation

Angle spacing	Theoretical load calculation(KN)	Experimental load calculation(KN)
40	157.42	190
50	205.36	240
60	280.18	300
70	382.5	390

Table 3 Comparison of results

Specimen	Angle spacing (mm)	P_{EXP} (KN)	Failure mode	P_{THEO} (KN)	P_{EXP}/P_{THEO}
CA 50X50X2	40	190	Local buckling	157.42	1.20
	50	240	Local buckling	205.36	1.16
	60	300	Local buckling	280.18	1.07
	70	390	Local buckling	382.5	1.01

5. RESULTS AND DISCUSSION

Initially the stress and strain were obtained from tensile coupon test. Theoretical vs. experimental load calculations for the different angle spacing of same angle section 50x50x2 are given below:

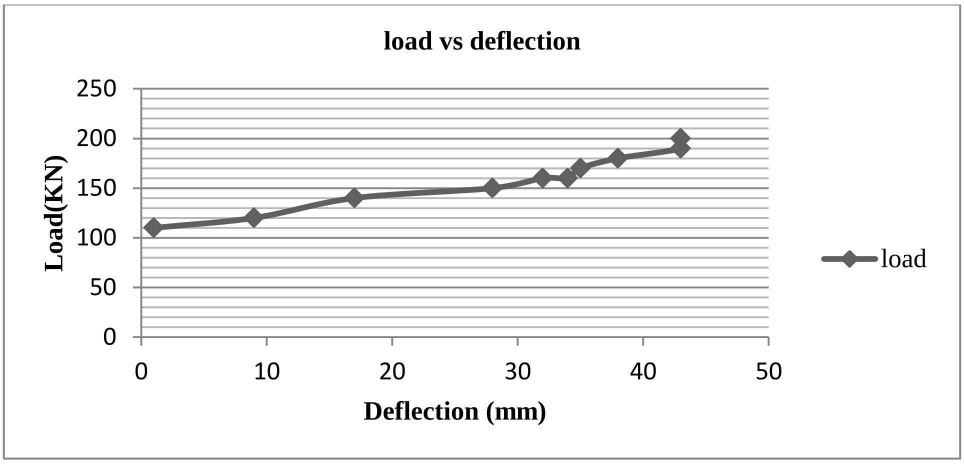

Figure 6 Load vs. Deflection curve of angle with spacing 40 mm

6. CONCLUSION

This paper has proposed that the ultimate load carrying capacity of the angle built-up section of same cross section with different angle spacing. It has been stated that the cross section with more spacing carries maximum load. The buckling mode observed was local buckling. When comparing the results of PEXP/PTHEO shows 1.2 ratio differences, which imply the theoretical results are approximate to that experimental result. Fig.5 shows the load vs. deflection curve of angle built-up section. In future different angle section can be chosen and the study can be done.

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