Investigation on Behaviour of Cold Formed Steel in Beam Column Connections

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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 behaviour of beam column connections by using self-tapered screw in cold form steel section theoretical, experimentally and analytically. Finally, the experimental results are compared with analytical results. This study aims at the following objective by test performed on cold formed steel section to check the behaviour connections. Studies on the structural behaviour of cold-formed steel (CFS) beam are increasingly popular in the last decades. Instability phenomena, such a failure of joints due to shearing and bearing their interactions are the most interesting and complex subjects within this research field. Understanding and dealing with these phenomena has been central focus of research efforts. The behaviour of Load carrying capacity of Light gauge beam column joints is studied. And the failure patterns of this section were extracted. A cold formed steel beam has been adopted for a span of 600mm and column 800mm it is verified with finite element analysis using ABAQUS software. Comparison between the theoretical and experimental results is presented and the agreements obtained are reasonably good.

Key words: Self drilling screws, cold form steel, shearing and bearing

I. INTRODUCTION

Thin sheet steel products are extensively used in building industry, and range from purlins to roof sheeting and floor decking. Generally these are available for use as basic building elements for assembly at site or as prefabricated frames or panels. These thin steel sections are cold-formed, i.e. their manufacturing process involves forming steel sections in a cold state (i.e. without application of heat) from steel sheets of uniform thickness. These are given the generic title Cold Formed Steel Sections.Sometimes they are also called Light Gauge Steel Sections or Cold Rolled Steel Sections. The thickness of steel sheet used in cold formed construction is usually 1 to 3 mm.

Much thicker material up to 8 mm can be formed if pre-galvanised material is not required for the particular application. The method of manufacturing is important as it differentiates these products from hot rolled steel sections. Normally, 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.

Manufacturers of cold formed steel sections purchase steel coils of 1.0 to 1.25 m width, slit them longitudinally to the correct width appropriate to the section required and then feed them into a series of roll forms. These rolls, containing male and female dies, are arranged in pairs, moving in opposite direction so that as the sheet is fed through them its shape is gradually altered to the required profile. The number of pairs of rolls (called stages) depends on the complexity of the cross sectional shape and varies from 5 to 15. At the end of the rolling stage a flying shearing machine cuts the member into desired lengths. Cold formed steel can be manufactured in two processes, such as brake pressing and rolled formed. Roll forming consist of feeding a continuous steel strip through a series of opposing rolls to progressively deform the steel plastically to form the desire shape. Roll forming is usually used to produce sections where very large quantities of a given shape are required. The initial tooling costs are high but the subsequent labour content is low. Brake pressing normally involves producing one complete fold at a time along the full length of the section using brake press dies. For section with several folds, it is normally necessary to move the steel plate in press and to repeat the pressing operation several times. Brake pressing is normally used for low volume production where a variety of shapes are required and the roll forming tooling cost s can't be justified.

II. SPECIMEN DETAILS

Name of the specimen	column
Beam section	L*B*D
Depth, d (mm)	100
Width, b (mm)	50
Thickness(t)	2
Name of the Specimen	Beam
Depth, d(mm)	80
Width , b(mm)	50
Thickness(t)	2
Length of column (mm)	800
Length of Beam (mm)	600

Table 1: Description of Specimen

III. PROBLEM DEFINITION

Recently, there has been an increased interest in CFS sections among home builders primarily due to their ease of installation and low material cost. The material thickness for such thin-walled steel members usually range from 0.4mm to about 6mm.welds, bolts, cold rivets, screws etc, are generally used in CFS connections. The easiest method is usage of self-drilling screws. Screws can provide a rapid and effective means to fasten sheet metal siding and roofing to framing members than other conventional methods of connections. The self-drilling screws have the ability to drill their own hole and form, or tap, their own internal threads without deforming their own thread. Various design standards outline the basic design equations for predicting the screw connection strength. For framed buildings, construction of cold-formed steel sections by using screw connections and evaluation of

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connection stiffness is an essential requirement. In view of this, are view has been conducted on the guide lines available in various codes of practices for screw connections and evaluations and also a comparative study on the strength joint with screws has been conducted. Limited studies are available on the performance of connection between CFS beams are columns by using screws. Hence, analysis of a single storey residential CFS frame has been conducted to predict the exact M-Ө behaviour of screw connections.

IV. Specimens

Fig. 1: Beam Column connections using Self Tapered Screws in staggered arrangement of bolts

Fig. 2: Beam column connections using Self Tapered Screws in Linear arrangement of bolts

V. Experimental investigation

Cold formed Beam column section of 800mm length and 100 mm depth is tested in a loading frame of capacity 400 kN under two point loading at l/3 distances . 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.

A. *Experimental Setup:*

Fig. 3: Test Setup

VI. Experimental results

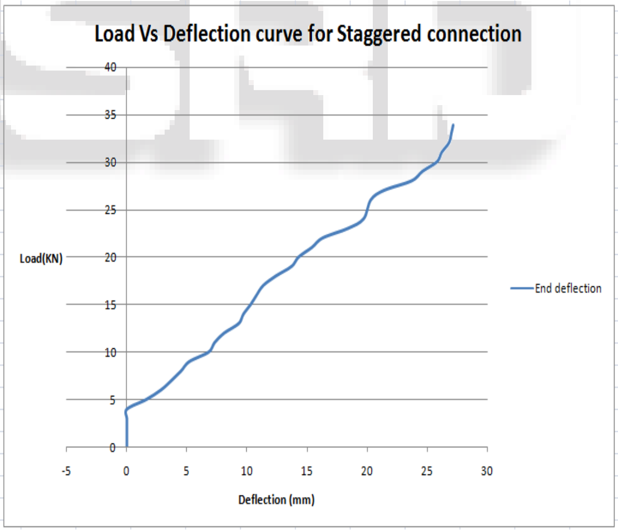

Fig. 4: Graph for staggered arrangement of bolts deflection

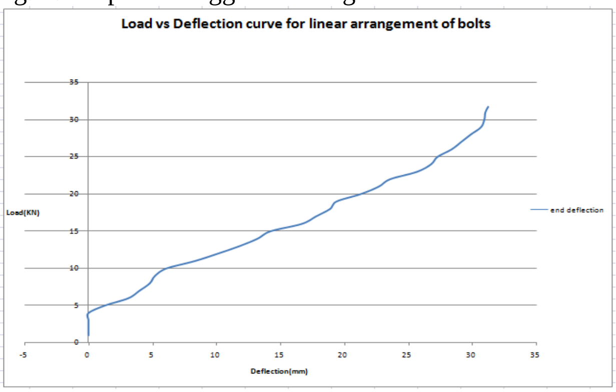

Fig. 5: Graph for linear arrangement of bolts deflection

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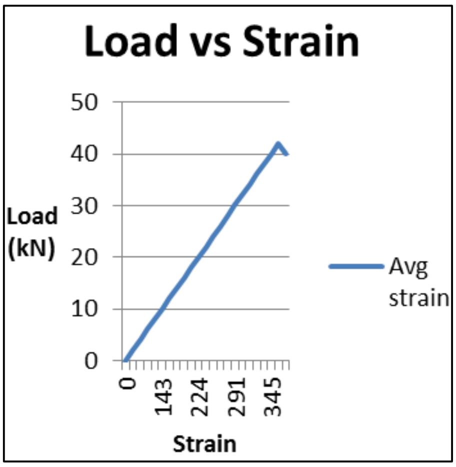

Fig. 6: Graph for load vs strain

VII. THEORETICAL ANALYSIS

Specimen (mm)	100*50*2
Max shear stress (N/mm^2)	34.70
I_{XX} (mm^4)	18060000.6
Section modulus, Z (mm^3)	184280.3
Web shear (N/mm^2)	27.2
Permissible safe load (kN)	33

Table 2: Theoretical analysis are done using IS:811-1974.

VIII. RESULTS AND DISCUSSION

This paper has described a detailed investigation on behaviour of cold formed steel beam column connections with using self drilling screws . Both experimental and theoretical analysis was conducted for better understanding of the behaviour of the cold formed steel beam and column. They were validated by comparing their result with the corresponding experimental results.

Theoretical ultimate load (kN)	37
Maximum deflection (mm)	3.28
Allowable deflection (mm)	3.85
Experimental ultimate load (kN)	42
Experimental deflection (mm)	3.12

Table 3: Comparison of Results

Fig. 7: Failure Pattern

IX. CONCLUSION

The following conclusions are made from the above study:

- As per journal if the connections are efficient to carry over the 85% to 100% of ultimate load of beam.
- The experimental results give 87.5% of ultimate load of beam. So that connections are efficient.
- To provide angle sections for improve the moment capacity of connections.
- 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..
- The results obtained based on the various codes are conservative.

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