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Investigation on Flexural Behaviour of Cold Formed Latticed Built-Up Beam

Vishnu Vardan.A[1] and Kaarthik.M[2]
[1]Student, Department of Civil Engineering, Coimbatore Institute of Technology, Coimbatore, Tamil Nadu, INDIA
[2]Professor, Department of Civil Engineering, Coimbatore Institute of Technology, Coimbatore, Tamil Nadu, INDIA

[1]Corresponding Author: vishnuvardan.kkr@gmail.com

ABSTRACT

There are two structural members used in steel construction the hot rolled members and the cold formed members. They are light members compared to the traditional heavier hot rolled steel structural members used in the field. They have high strength to weight ratio resulting in less dead weight making it a good option in construction of bridges roof trusses transmission line towers multi storied buildings and other structural members. This paper is done to understand the flexural capacity and to enhance it by developing innovative latticed cold formed steel beam. The impact of web opening of the cold formed beam on the flexural behavior of cold formed built-up I section under two point loading is investigated for the simply supported end conditions. Numerical analysis is performed using finite element analysis (FEM) software. From results, the load vs. Deflection curve, failure modes and ultimate load carrying capacity of the specimen presented in this paper. Therefore the main focus of this project is to investigate the flexural behavior of these steel members and by replacing the lattice hot rolled section by cold formed steel sections. The ultimate load carrying capacity with failure mode of simulated FEA models was compared with experimental results.

***Keywords*—** Cold-Formed Built-Up I Section, Flexural Behavior, Finite Element Analysis, Lattice Beam

I. INTRODUCTION

The hot- rolled steel members formed at higher temperatures and cold-formed steel members formed at room temperatures are the two primary structural steel member types. Steel member's lies with the 'thinness' of the material, which can be used, leading to an extremely light-weight construction [8]. The thickness of steel sheet used in cold formed construction is usually 1 to 3 mm [5]. The yield strength of steel sheets used in cold-formed sections is at least 280 N/mm^2, although there is a trend to use steels of higher strengths, and sometimes as low as 230 N/mm^2 [3]. It can be used in areas whenever a single section is not sufficient to carry the load. The buckling modes such as local buckling, distortional buckling, and flexural-torsional buckling has to be understood for the structural behavior. Both structural and non-structural elements are created from thin gauges of sheet steel such as columns, beams, joists, studs, floor decking, built-up sections and other components [4].

Various structural sections are combines and connected with lacing element (usually bent up at 45 degree inclination) to form Latticed built up sections and they produce relatively light members. They are used to resist axial compression (by means of struts), axial tension (by means of ties), bending (by means of beams). The built-up members are formed by connecting two or more cold-formed steel members together, such as I section member built-up by connecting two angle sections back to back at top chord and bottom chord [2]. These structural shapes can be used in buildings as eave struts, purling, grits, studs, headers, floor joists, braces and other building components.

This study is aimed at developing an innovative latticed cold-formed steel beam by utilizing the advantages of lacing and Cold Formed Steel (CFS) to enhance flexural capacity at minimum fabrication cost. In this research an attempt has been made to use similar type of a latticed beam, by replacing hot rolled section by cold formed steel sections. The latticed structural member utilizes the cold formed steel sections as top chord, bottom chord, bearings and lacing members. These types of sections are especially required to situations where the section with high section modulus is needed and this may also occupy space in the field of steel construction similar to hot rolled sections. In order to know the feasibility to produce an innovative latticed built-up cold formed steel which will be structurally efficient and economically sound as flexural member, to understand the behavior of latticed built-up flexural member, a research on latticed built-up cold formed steel flexural member is needed [1].

II. TENSILE COUPON TEST

The tensile test is carried out on standard tensile coupons cut to study the material properties of the cold formed steel sheets used for fabrication of sections. The tensile coupons measurements are in accordance with IS 1608-2005 [6] and tested in tension testing machine. Three coupons were tested and average is taken as the Yield

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strength and Young's modulus of the material. The offset method or the strain-under load method is used to determine the yield strength. In the offset method, the yield strength is the stress corresponding to the interaction of the stress-strain curve and a line parallel to the initial straight-line portion offset by a specified strain. The tensile strength of the steel sheets used for cold formed steel sections have no significant impact in design.

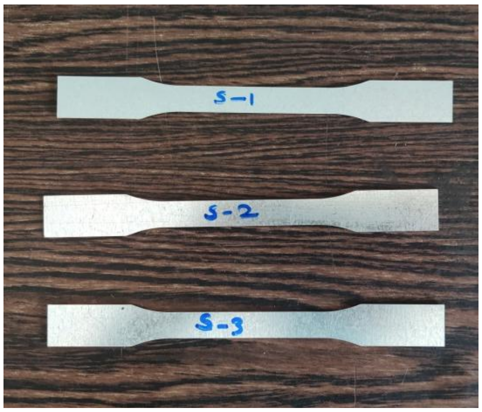

Figure 1: Samples of coupon

III. EXPERIMENTAL STUDY

Using hydraulic machines the cold formed sheets are formed with thickness 1.2mm of length 1200 mm are cut and bent to angle 50×50×15mm angle section. The 50x50 mm angle plates are used for stiffeners and lacing inclined at 45 degree. The lacing angle section is screwed with four angles and built up I sections are prepared. They are simple supported at the ends and testing done on beam with two point loading to obtain pure bending without shear. The built-up section is modelled by connecting equal angles back-to-back with stiffeners were provided at the ends and 1/3rd of the span [2]. The chords latticed by 50x50 mm angle section with length of specimen as 1200mm ,lip 15mm and 50x50 mm angle and 1.2mm thick sheets [9,10] were used to fabricate the angles.

Figure 2: Test setup

A hydraulic loading frame was used to test the latticed built-up beams. LVDTs [7] were used to measure the deflections were placed at three positions namely 1/3rd distance, mid span and at support [3] respectively. Specimens were placed on the loading frame and one hinge, one roller provided at both ends, for simply supported end and two rollers at the points of loading. Load values were taken by using a proving ring. The test arrangement was checked. The instruments were normalized and initial readings were taken. Two point loads were applied at L/3 distance from either ends on compression flanges. The loading was gradually increased up to ultimate load. The LVDTs [7] readings are notes at regular load increments. All the tests were carried out up to failure.

Figure 3: Connection failure

IV. ANALYTICAL STUDY

To obtain approximate numerical solutions to most engineering problems the finite element method is used .It is a numerical analysis technique and doesn't give exact closed form solutions. In this methodology the structures are divided into a finite number of elements having finite dimensions and reducing the structure having infinite degrees of freedom to finite degrees of freedom. It is an assemblage of these elements connected at a finite number of joints called Nodes or Nodal points. Element software ANSYS WORKBENCH 21, linear and Non-linear analysis is carried out and properties of materials are studied using coupon test. Load Deflection curve, Load carrying capacity and failure pattern of the specimen is observed by taking the yield stress of the cold formed angle as 325N/mm2 and poisson's ratio is given as 0.3.Density of steel material is given as 7850kg/m^3 [10].

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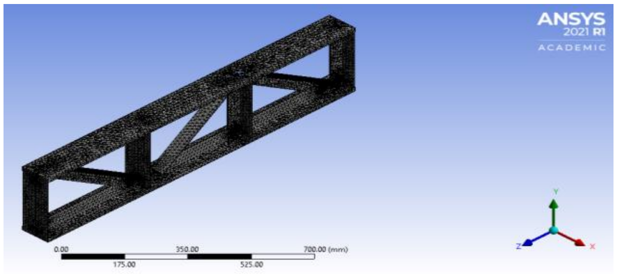

Figure 4: Element Meshing

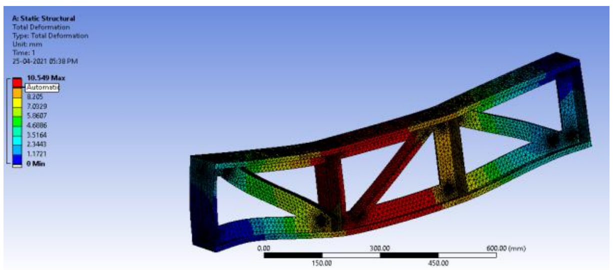

Figure 5: Stress Distribution

V. RESULTS

Table 1: Comparison of experimental and ansys results

Specimen	Ultimate Load (KN)	Deflection (mm)		Variation= ANSYS /Experiment (%)
		Exp.	ANSYS	
50-50-200-1.2-1200	12.6	10.04	11.01	9.21

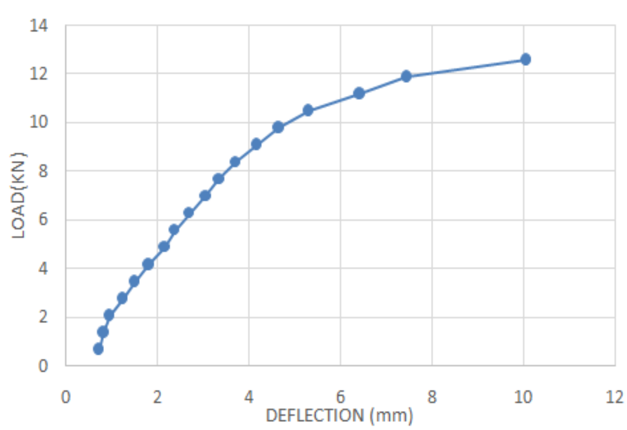

Figure 6: Load vs. deflection at midspan for 50-50-200-1.2-1200

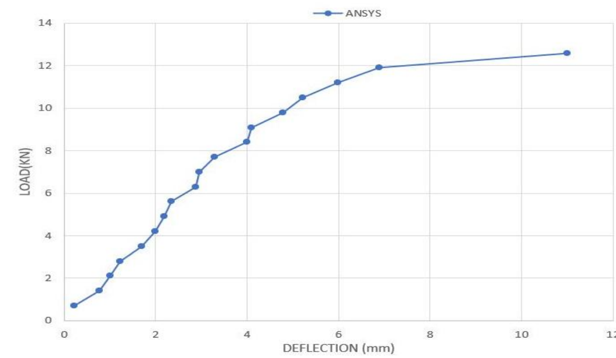

Figure 7: Load vs. deflection at midspan for 50-50-200-1.2-1200

VI. CONCLUSION

This thesis presents a detailed investigation on the behaviour of cold formed latticed beams. The behaviour of the proposed cold formed steel latticed beams is investigated experimental and finite element analyses. They are validated by comparing the load-deflection curves and buckling modes from the tests and finite element analysis. In addition to these compressive tests, the tensile coupon tests are also conducted to obtain the material properties of steels that are used to make the test specimens. The failure modes predicted by experimental and FE analysis are in good agreement with the failure modes. The obtained failure of the specimen is torsional buckling. Adding the stiffened element at the web and edge stiffeners at flanges has significant effect on the flexural strength and behaviour of the beams Design of cold-formed steel lattice beam requires considerations of local distortional buckling, flexural and flexural torsional buckling. As section are thin, symmetrical sections will have a better weight to load ratio.

REFERENCES

[1] Srinath & Shanmugarajan M B. (2016). Effect of web opening on the bending behaviour of cold formed steel built-up 'I' section. *International Journal of Science, Environemnt and Technology*, *5*, 102-110.

[2] N.Nandhini & K. Sudha. (2018). Investigation on flexural behaviour of cold formed steel latticed built-up I section with drop web. *Asian Journal of Engineering and Applied Technology*, *7*(S1), 65-68.

[3] Sudha.K & Sukumar.S. (2014). Behaviour of cold-formed steel built-up I section under bending. *Journal of Engineering and Technology*, 4622-4631.

[4] Chitra.S, Dr. Sudha.K, & Dr. Sukumar.S. (2016). Numerical investigation on effect of stiffeners on cold-formed steel latticed built-up I section with lipped angles.

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International Journal of Research and innovation in Engineering Technology, *02*(12), 1-7.

[5] Deepavani.R, Chitra.S, & Dr. Sudha.K. (2016). Analytical investigation on cold formed steel latticed built-up I beam with lipped angles under single point loading conditions. *International Journal of Research and Innovation in Engineering Technology*, *02*(12), 8-14.

[6] L.Krishnan, C.S.Dineshraj, & S.Prema. (2015). Experimental investigation of cold-formed steel section-flexural member with triangular web. *Journal of Mechanical and Civil Engineering (IOSR-JMCE), 12*(2) 36-39.

[7] J.Samuel, J.Pravin, R.Divahar, P.S.AravindRaj, & P.S.Joanna. (2020). Performance enhancement of built-up cold-formed steel beams with diagonal rebars in web. *Elsevier- Materials Today: Proceedings*, 102-110.

[8] M.Macdonald,, M.A.Heiyantuduwa, & J.Rhodes. (2008). Recent developments in the design of cold-formed steel members and structures. *Elsevier- Thin-Walled Structures*, 1047-1053.