Literature Study on Flexural Behaviour of Cold-Formed Steel Beams

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Abstract: In this paper various cold-formed steel built up I beam sections are studied from previous research works where the sections are numerically analysed using CUFSM and ABAQUS software and its moment carrying capacities has been investigated and reported. Cold-formed steel built up I sections are taken and the moment carrying capacities of that sections in terms of flexure are studied. This section in the form of I were subjected to flexure by two-point loading and four-point bending to ascertain the strength parameter by ABAQUS, and sectional properties by CUFSM. How the process carried out while analysing the sections are studied clearly and review for those sections also given. This study is going to be the benchmark for my upcoming works.

Keywords: Flexural strength, Cold-Formed steel, aspect ratios, ABAQUS, CUFSM.

I. INTRODUCTION

Cold-formed steel (CFS) section is the term used for products which are made by rolling or pressing thin gauges of steel sheets into goods. CFS goods are created by the working of thin steel sheets using stamping, rolling or presses to deform the steel sheets into a proper product which are usable. In the construction industry of steel, both the structural as well as the non-structural parts are formed using the thin gauges of steel sheets. The building materials can be of columns, studs, beams. floor decking, built up sections and other any parts of the structure CFS construction materials differ in many respects than other steel construction materials like hot rolled steel. The manufacturing of CFS products occurs at the room temperature with the use of rolling/pressing. The buckling property is used to analyse the strength of elements. The construction practices are just like the timber framing where the assembling stud frame using the screws. Making the hybrid sections is a new to the structural environment so, the present study aimed at analysis of hybrid sections which has two different yield stress material in one section.

II. LITERATURE REVIEW

[1] Sivaganesh selvaraj et al, (2021) did experimental and numerical investigation on the CFS built-up beams fabricated from back-to-back sigma sections: A total of 15 tests were carried out, containing three different lengths and five different intermediate connection spacing. The test specimens were laterally braced at webs and flanges were stiffened to avoid lateral torsional and local buckling to exhibit failure due to distortional buckling. Further, they conducted parametric studies using numerically validated model with five different lengths, two different sheet thicknesses and varying distortional slenderness's totalling to 160 specimens. They summarized numerical results and compared with the design strength predictions by AISI's direct strength method (DSM). The comparison indicates that the design predictions in general are conservative, however, over conservative for low slenderness range (Xg< 0.673). Therefore, they suggested a new limit for increasing the inelastic reserve buckling strength based on the experimental and numerical results.

[2] M. Anbarasu et al. (2020) discussed the flexural behaviour of cover plated CFS built up simply supported beams made up of lipped channels, under both three-point as well as four-point loading. The influence of moment gradient and constant moment loading on theses built-up beam specimens was investigated by the authors. The sectional compactness of the channel section and the aspect ratio of the built-up section were varied to assess the behavioural effect in the specimens with respect to the variations incorporated. They used Both the European

code as well as the North American Standards for developing the theoretical strengths and were compared with the test results. Some prominent results are given below:

- Both the aspect ratio (by varying the transverse spacing between channels at constant depth) as well as the sectional compactness of the channel sections (by varying the sectional depth at aspect ratio) influence the flexural behaviour of cover plated CFS built-up beams
- The sectional compactness affects the flexural strength more than the aspect ratio. However, the influence of the sectional compactness is dominant provided the sectional compactness doesn't exceed the limiting value recommended by the current codes.
- The stiffness characteristics are affected by both the variation in the aspect ratio as well as the sectional compactness, and this relationship is proportional.

[3] Deepak and Shanthi (2018) investigated the structural behaviour and evaluated the capacity of cloned-form full up thin-walled Double--Box Beams (DBS) and Hybrid Double-1-Bux Beams (DIBD). All the beams were modelled as ideal finite element models adopting simply supported boundary conditions and loads were applied as end moments. To acquire a large number of data, three varying parameters were considered namely, hybrid parameter ratio, that is, yield strength of flange steel to web steel (10, 13, 15 and 17) ratio of breadth to depths of the beam (46, 5/6, 66 and 7/6), and lengths of the beam (1.0, 2.5, 5.0, 10, 15, 20, 30, 40, 50 and 60 in m). The thickness of both the flanges and the webs were 2.5 mm.

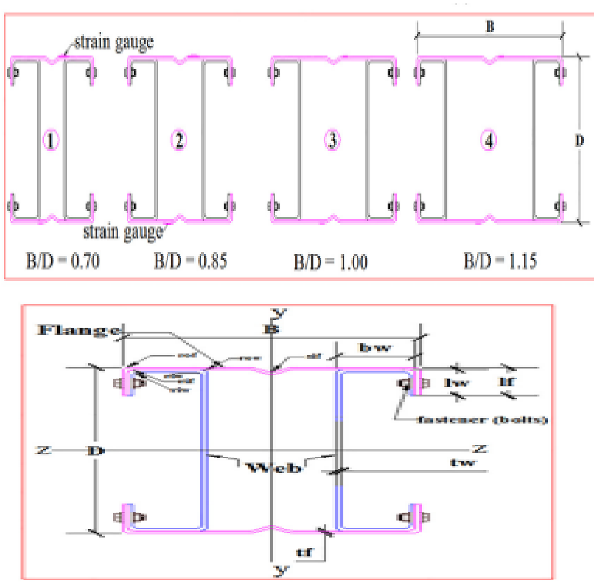

Fig 2.1 Hybrid Double-l-Box Beam Models

All these parameters alter the overall slenderness of the members. It was shown that at larger spans, Hybrid Double-1-Box Beams experience lateral buckling. The results obtained from the numerical studies were plotted on non- dimensional moment versus non-dimensional slenderness graph. These results were compared with the predictions using effective width method design rules specified in Euro codes EN 3-1-3 and buckling curve-d of EN 3-1-1, which was originally adopted lateral-torsional buckling capacities of hot-rolled steel "I' sections, and the adequacy is checked It was found that Hybrid Double-1-Box Beams has higher lateral-torsional buckling capacity than common 'I' or box sections. Hence, they proposed a new simplified design equation for determining lateral-torsional buckling capacity of Hybrid Double-1-Box Beams.

[4] Meza et al. (2016) conducted experimental investigation m buckling interaction between individual components of built-up steel beams. An experimental program was carried out on built-up steel beams, assembled by bolting four plain channels together. The built-up specimens were constructed by bolting two channels of 1.5 mm thickness back-to-back, and then bolting two channels of 1.2 mm thickness to the flanges of these channels, as illustrated in Figure 2.2. M6 bolts, tightened with a torque of 10 Nm, were used to assemble the specimens. All the steel sections were fabricated from pre-galvanized steel plates with a nominal yield stress of 450 MPa and a zinc coating with a nominal thickness of 0.04 mm. The built-up beams had a total length of 3400 mm, with a nominal distance between the end supports of 3000 mm. The specimens were loaded at two discrete locations, 1600 mm apart. The portion of the beam within these loading points constituted the constant moment span, while the portions of the beam which fell outside this region are referred to as the shear spans. The built-up specimens were designed with zero, two or three equally spaced connectors along the constant moment span. The spacing between the connectors along the shear spans was 100 mm for all the test specimens, to avoid failure outside the constant moment region. The specimens were tested in a four-point bending configuration and were designed to fail by local bucking within the constant moment span. Three different connector spacing's were used to study their effect on the ultimate capacity of the built-up specimens and on the way the individual sections interact with each other as they buckle. The tests revealed that the interaction between the component sections is significantly affected by the connector spacing and that

reducing the spacing between connector's results in an increase of the ultimate capacity. The paper also details the procedures followed to determine the material properties and the initial out-of-plane imperfections of the specimens. The test program revealed significant interaction between the components of the built-up specimens while buckling.

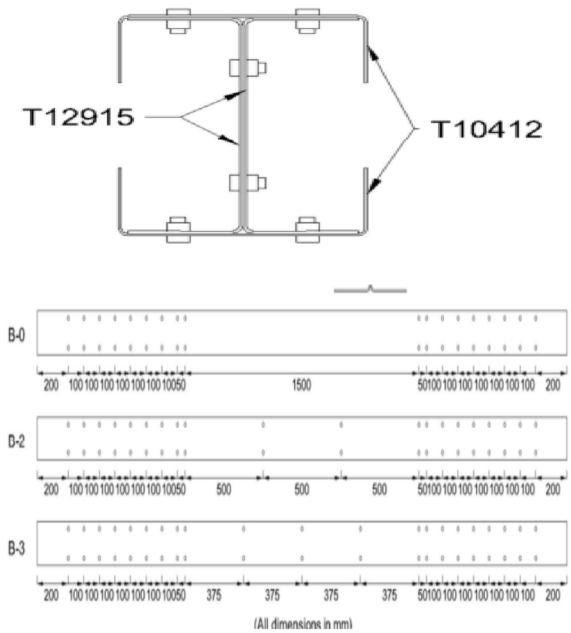

Fig 2.2 Built up cross section geometry and Connector Spacing

This interaction was more pronounced in the specimens with shorter connector spacing's. The tests also showed a relatively modest increase in the ultimate capacity of the built-up specimens when reducing the spacing between the connectors.

III. SUMMARY OF LITERATURE REVIEW

Steel sections are the most widely used manmade construction material in the world and its second only to water as the most utilized substance in the planet. Seeking steels for making sections and to make advancement is the present concern. Today sustainability has got top priority in construction industry. In the present study the different yield stress was used to prepare the cold-formed steel sections thereby providing a sustainable option to deal with the cost. There are many recycling plants across the world, but as steels are recycled, they lose their strength with the number of recycling. So, these steels will end up as earth fill. In this circumstance instead of recycling it repeatedly, if it is utilized to prepare steel sections, it will be a boon to the construction industry.

Most of the failures in steel structures occur due to the failure of flange and web by crushing of steels. Hybrid steel sections which have low and high yield stress will not be crushed as easily as the conventional one. These sections are also cost efficient when compared to ordinary sections. Since a complete substitution for same yield stress is not found feasible, a partial substitution with steel sections is done. Different yield stress substitution was employed in this investigation.

Hence in the present study is aimed at design of sections on five different aspect ratios, spacing between the two-channel section, thickness and three different yield stress (250,350,450 Mpa) with hybrid sections having two different yield stress in same section that will provide an advantage in reducing the cost that is going to be our future work.

IV. CONCLUSION

The literature study is done for our future work and based on this the cold-formed steel sections will be numerically analysed and the moment carrying capacities will be found out.

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