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# EXPERIMENTAL STUDY ON BEHAVIOUR OF COLD FORMED STEEL USING BUILT-UP SECTION UNDER AXIAL COMPRESSION

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***ABSTRACT-****Cold form steel is also called as light gauge steel sections. In this paper, the investigation made on the built-up section to calculate the buckling load using experimentally and theoretically. The built-up section is formed by two types of channel section with or without lip was tested as under axial compression. The Finite strip method is developed by CUFSM software. The buckling load value will be taken from GBTUL software. The sections have been chosen from IS 811:1975 for specifications. The column strength determined by Direct Strength Method based on AISI-S100:2007. The load carrying capacity of column compared with numerical, theoretical and experimental results.*

*Keywords-Built-up, Cold formed steel, finite strip method, GBTUL, Direct Strength Method*.

## I.INTRODUCTION

Cold formed steel is type of steel fabricated by cold forming process. Cold formed steel products are found in all aspects of modern life; in the home , the shop, the factory, the office, the car, the petrol station, the restaurant, and indeed in almost any imaginable location. The uses of products are easy to handle during construction and transportation. It possesses high strength to weight ratio of building material. Cold form steel is durable which provide long-term resistance to corrosion. It can be recycled and reused products. Applications of cold formed steel products are mainly used as structural members. Many varieties of cold form shapes are available which include open sections, closed sections and built-up sections. For large loads where a single section column is not enough to carry the design loads built-up columns are used. Built-up section can simply gain higher stability and capacity due to double of standard section produce greater cross-section properties, the symmetry of built-up section can eliminate the eccentricity between the shear and the gravity center of single section. they carrying heavier loads than single C-sections. Therefore, the behavior and strength of cold-formed steel built-up column using with lip or without lipped channel sections are investigated theoretically and numerically in this study. The numerical analysis has been performed using GBTUL software. Four specimens have been numerically analyzed and the results are compared. The column strengths predicted by the finite element analysis is compared with the design column strengths predicted by Direct Strength Method.In the calculation of the direct strength method, local buckling and distortional buckling are required.When compared minimum value of buckling load will be taken.

## II.LITERATURE REVIEW

Thomas H.-K. Kang Kenneth A. Biggs and Chris Ramseyer [6] were studied the different buckling modes of failures on built-up columns. To determine the maximum load carrying capacity of column. H.H.Lau and T.C.H. Ting. [1] Determines the compressive capacity of cold-formed steel built-up I sections with pin-ended using the finite element method (FEM) with various screws spacing along the column length i.e. 750 mm, 1000 mm, 1500 mm. They compared their results from numerical, theoretical and experimental value. The numerical analysis was done by nonlinear finite element model which was developed by LUSAS 4.0.In theoretical -analysis they calculated the compressive strength using effective width method and direct strength method. In experimental test they found buckling load value and its load factor. M.Anbarasu K.Kanagarasu and S.Sukumarthey did work on the web stiffened back to back channel section analyzed by finite element method using ABAQUS and also direct strength method was calculated. it was observed the different mode of failure in column using slenderness ratio. they concluded that the numerical model is reasonably good to predict the behavior of battened column .Dunai L. 2007 [3] has done a test on the box-up compression member connected by using self-drilling screw at the flange; the size was 150 mm and 200 mm depth. Young B. and Chen J. 2008.[4] has done a compression test on built-up closed sections with intermediate stiffeners connected using self-tapping screws also at the flange. Krisda Piyawat, Chris Ramseyer and Thomas H.-K. Kang [2] was tested on built-up and box up member connected by stitch welding. The objective of the study is to determine the ultimate load of the built-up column with the standard column length and thickness is to compared buckling load.

## III.NUMERICAL ANALYSIS

It is done by using GBTUL. GBTUL means generalized beam theory. This theory allows cross section distortion to be considered. It performs elastic buckling or vibration analysis of thin walled member with open cross sections, with several end support and/or loading conditions and made of isotropic or special orthotropic materials. The features include (i) the modal decomposition and identification (local-plate, distortional, global) of the member buckling or vibration mode, the possibility of performing analyses involving any number of selected deformation modes. The inputs associated with the cross section analysis, deformation mode selection member analysis and buckling solution. For given material properties and cross-section geometry, one begins by performing the cross-section analysis. The beam is made of steel (E=210 GPa, ν=0.3, ρ=7.800 kg/m$^3$). They analyze the buckling behavior of a open channel section. The result of analyses performed as buckling or vibration curve which provide the variation of the buckling load and 2D or 3D representation of the buckling.

## IV.THEORETICAL ANALYSIS

Direct strength method (DSM) finite strip analysis, CUFSM is used to determine the buckling load. The analysis was done by analyzing a built-up channel section. It shows the load factor ratio for basis of local and distortional buckling. It uses manual hand calculation to determine the elastic buckling load.In this study, the theoretical axial compressive strengths were determined by usingDirect Strength Method (DSM) which can handle the combined effect of local-plate, distortional and global buckling, and has already been included in the current North American (AISI S100-2007) specifications for cold-formed steel member design.

local buckling

$P_{nl} = P_{ne}$ for $\lambda_l \leq 0.776$

$P_{nl} = \{1 - 0.15 (P_{crl}/P_{ne})^{0.4}\}(P_{crl}/P_{ne})^{0.4}P_{ne}$ for $\lambda_l > 0.776$

$\lambda_l = \sqrt{}(P_{ne} / P_{crl}$

distorsional buckling

$P_{nd} = P_y$ for $\lambda_d \leq 0.561$

$P_{nd} = \{1 - 0.25(P_{crd}/P_y)^{0.6}\}(P_{crd}/P_y)^{0.6}P_y$ for $\lambda_d > 0.561$

$\lambda_d = \sqrt{}(P_y / P_{crd})$

Flexural torsional buckling

$P_{ne} = (0.658\lambda_c^2) P_y$ for $\lambda_c \leq 1.5$

$P_{ne} = (0.877 / \lambda_c^2) P_y$ for $\lambda_c > 1.5$

$\lambda_c = \sqrt{}(P_y / P_{cre})$

*Cross section of the specimen*:The geometric properties for the four selected specimens are presented in Table 1 & 2.Theoretical and numerical analysis was carried out for the 4 selected cross-sections of the specimen.

Table 1 geometric properties of the cross section with lip

| Specimen | Web (h)mm | Flange (b)mm | Lip(d) Mm | Thickness (t)mm | Length (L)mm |
|---|---|---|---|---|---|
| BU-1 | 140 | 60 | 25 | 1.6 | 600 |
| BU-2 | 120 | 50 | 15 | 1.6 | 600 |

Table 2 geometric properties of the cross section without lip

| Specimen | Web (h)mm | Flange (b)mm | Thickness (t)mm | Length (L)mm |
|---|---|---|---|---|
| BU-3 | 140 | 60 | 1.6 | 600 |
| BU-4 | 120 | 50 | 1.6 | 600 |

## IV.EXPERIMENTAL TEST

Laboratory tests were performed on 4 specimens of back-to-back built-up I sections. All these built up specimens had a standard length of 600mm, web width of 120mm, lip of 15mm and flange width of 50mm and thickness 1.6mm.All specimens were tested in axial compression with fixed end conditions. The end plate was attached to end of the column using stitch welding. The end plate is effective to eliminate local buckling failure by thicker the web thickness at the column at the end. This is to hold the test setup in position and to eliminate any possible gap and movements between the end plates and the specimen. Loading was applied to the column using hydraulic jack and 500 kN load cell that aligned to the column length. The specimen was centred in the test rig and each test specimen was compressed until buckling occurred. Then the compressive load was removed and the specimen released from compression. At this stage, the specimen looked like its original state, but its initial imperfection was different. tests were performed on each specimen until the compressive load reached to its ultimate value.

Fig.1 Experimental setup

## V.RESULTS AND DISCUSSION

Analytical compressive strength results using finite element (GBTUL), Direct Strength Method (DSM) and the experimental buckling load was determined using the method. The experimental results show good correlation with finite element method results. However, these finite element method results by GBTUL are un-conservative compared to Direct Strength Method.

Table 3 Comparison of Results

| Specimen | Numerical analysis(kN) | Theoretical analysis(kN) | Experimental test (kN) |
|---|---|---|---|
| 120x50x15xx1.6 | 149.58 | 112.702 | 152.2 |
| 120x50x1.6 | 86.11 | 82.586 | 89.70 |
| 140x60x1.6 | 73.66 | 67.69 | 84.02 |
| 140x60x25x1.6 | 137.106 | 136.79 | 157.6 |

Table 4 comparison of results from GBTUL Vs DSM

| Specimen | $P_{GBTUL}$ (kN) | $P_{DSM}$ (kN) | $P_{GBTUL}/P_{DSM}$ |
|---|---|---|---|
| 120x50x15x1.6 | 149.58 | 112.702 | 1.32 |
| 120x50x1.6 | 86.11 | 82.586 | 1.04 |

| | | | |
|---|---|---|---|
| 140x60x25x1.6 | 73.66 | 67.69 | 1.08 |
| 140x60x1.6 | 137.106 | 136.79 | 1.00 |

Table 5 Comparison of results from GBTUL Vs Experimental

| Specimen | $P_{test}$(kN) | $P_{GBTUL}$(kN) | $P_{test}/P_{GBTUL}$ |
|---|---|---|---|
| 120x50x15x1.6 | 152.2 | 149.58 | 1.017 |
| 120x50x1.6 | 89.70 | 86.11 | 1.041 |
| s140x60x1.6 | 84.02 | 73.66 | 1.140 |
| 140x60x15x1.6 | 157.6 | 137.106 | 1.149 |

## VI.CONCLUSION

Theoretical analysis was carried out on 4 specimens of built-up I sections. Direct Strength Method (DSM) with the help of finite strip analysis software (CUFSM) were used to analyze the built-up I sections. Numerical analysis(GBTUL) results show good correlations with the experimental results.

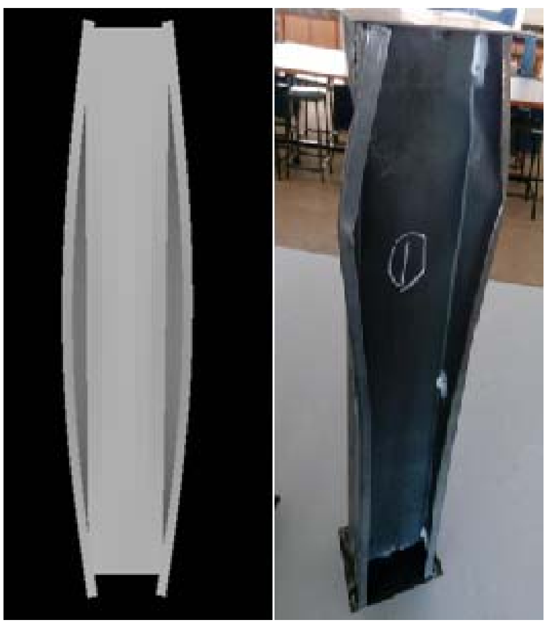

Fig.2 Failure modes with lip – Numerical Vs Experimental

Fig. 3 Failure modes without lip – Numerical Vs Experimental

- To compare both lip or with out lip when using lip the section occur sudden failure with minimum load but using with lip to withstand the maximum load.
- For this study, to identify different mode of failure in the specimen.
- Numerical analysis Load carrying capacity should decreases with increase in Length is to be analysed.
- The ultimate compressive strength test is used to check the yield point for quality control purpose and compression test determines the compressive yield points.
- For light gauge plate elements, the buckling occurs at low stresses resulting due to compression or bending or bearing.

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