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Flexural Behavior Of Cold Formed Steel Stiffened Web Sections

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Abstract- **Two types of structural steel members are being used, namely hot rolled steel and cold formed steel. The use of thin-walled, cold-formed high strength steel products in the building industry has significantly increased in recent years. These products are being widely used in various applications such as purlins, girts, portal frames and steel framed housing The performance of the Cold Formed Steel (CFS) sections is affected due to buckling mode involving flexural-torsional buckling and local buckling, distortional buckling, overall buckling and their interactions, which are invariably important facets of Cold Formed Steel sections. It is therefore important that these buckling modes are either delayed or eliminated to increase the ultimate moment capacity of the CFS sections. To overcome this limitation, the webs are stiffened by means proper bending on it. Stiffeners in the web of the C-section increase the local buckling stress, distortional buckling stress of the section. Due to the stiffeners, more distortional buckling modes occur in the section.**

In the present numerical investigation, web of the Cold Formed Lipped 'C' section are stiffened by means of proper bending, these web stiffened lipped channel section named as sigma section used as a purling and their effectives is analyzed using a commercially available Finite Element Software ANSYS 12.0. Specimens are modeled analyzed in simply supported coition for varing h/t ratio and d/t ratio and Von-Misses stress and strain variations, displacement were found. This is followed by determination of the load carrying capacity using ANSYS and compared with experimental results.

Keywords:-- Lipped C Section; Lipped C Sigma Section, Flexural Behaviour; Numerical Analysis; Experimental Valediction.

I. INTRODUCTION

Two types of structural steel members are being used, namely hot rolled steel and cold formed steel. The use of thin-walled, cold-formed high strength steel products in the building industry has significantly increased in recent years. These products are being widely used in various applications such as purlins, girts, portal frames and steel framed housing. With the availability of advanced roll-forming technologies and very thin (<1 mm) sections cold-forming process has become simple, efficient and economical, capable of producing a variety of efficient sections including the web stiffened sections.

However structural behaviour of light gauge steel high strength cold formed steel members characterised by various bucking mode not fully understood. The failure modes are local buckling, distortional buckling, overall buckling and their interactions. Distortional buckling is the highly influencing mode on the section strength. From the literatures, the cold formed steel beam section which are available in the market are studied. In the past studies attempt has not been made to determine the flexural behaviour like local buckling, distortional, lateral-torsional, and combined flexural performance for an web stiffened section. Hence an attempt is made to evaluate flexural behaviour of cold formed steel web stiffened beam section. Stiffeners in the web of the C-section increase the local buckling stress of the section. Due to the stiffeners, more distortional buckling modes occur in the section. On the other hand, the distortional buckling of the sigma-section is more complicated and there is often an interaction between the different distortional buckling modes and between the distortional

Stiffenes in the web of the lipped C-section increase the local buckling stress of the section. Due to the stiffeners, more distortional buckling modes occur in the section. Depending on the varying h/t ratio and d/t ratio stress , strain and displacement were found, In the investigation, the web is usually treated independently and considered as simply supported. The purpose of this chapter is to study flexural behaviour of the lipped C- and web stiffened C-section as a whole section.

Available advanced analysis techniques are computationally demanding and often not directly applicable to design. This work studies is about the flexural

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- torsional capacity by using ANSYS12.0. Comparison has been done with the Experimental results.

II. NUMERICAL WORK

ANSYS 12.0 is used to determine the flexural behaivor of the lipped C- and web stiffened C-section. Element type used in this linear analysis is Shell 181. Young's modulus and poison's ratio are taken as $2x10^5$ N/mm^2 and 0.3, which is a 4-node element with six degrees of freedom at each node. 6 specimens of 2.4m length and 1.0, 2.0 mm thickness with varying parameters such as height of web to thickness (h/t) and depth of lip to thickness (d/t) ratios are modeled and analyzed for the flexural and buckling performance. It was found that good simulation results could be obtained by using the element (mesh) size of approximately 20x20mm (length by width) for the web, flanges and lips. The ends of the specimens are simply supported.

The thickness of the shell may be defined at each of its nodes. The thickness is assumed to very smoothly over the area of the element. If the element has a constant thickness, only TK (I) needs to be input. If the thickness is not constant, all four thicknesses must be input. the mean values were used for all specimens. Material linearity in the in the specimens was modeled with von MISES yield criteria and isotropic hardening.

2.1 Beam Dimension

Lipped C section of height 200mm,flange width 60mm and having varying lip depth of 20mm, 15mm, and 10mm. Sections having thickness of 1mm, 2mm and length of the specimen is 2.4m . And lipped c sigma sections are having similar dimension of lipped c - section above mentioned excluding web portion, web is stiffened by proper bending on it those dimensions are shown below. Specimens are modeled analysed for Two point loading at the L/4 distance from the free end for the simply supported condition. The elevation of the beam is shown

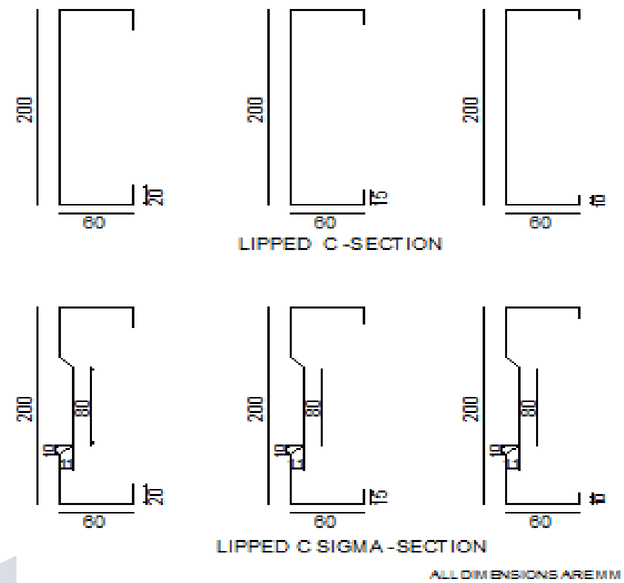

Fig 1 Fig 1 Elevation of the specimen

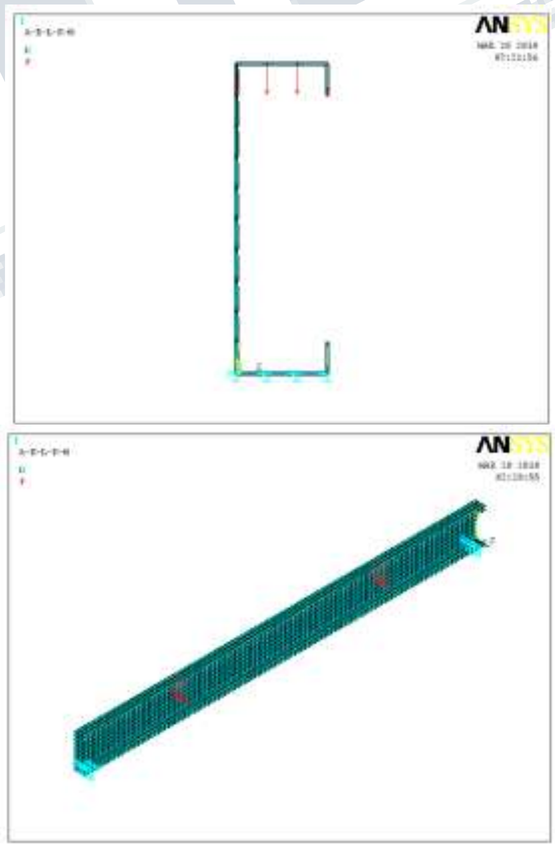

Fig 2 Elevation and mesh view of the lipped c - section with two point load

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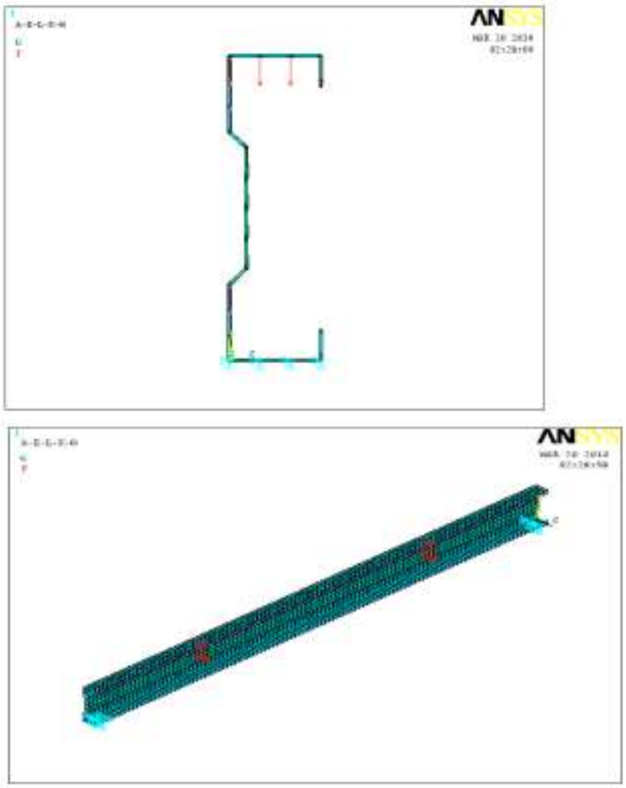


Fig 3 Elevation and mesh view of the lipped c sigma - section with two point load

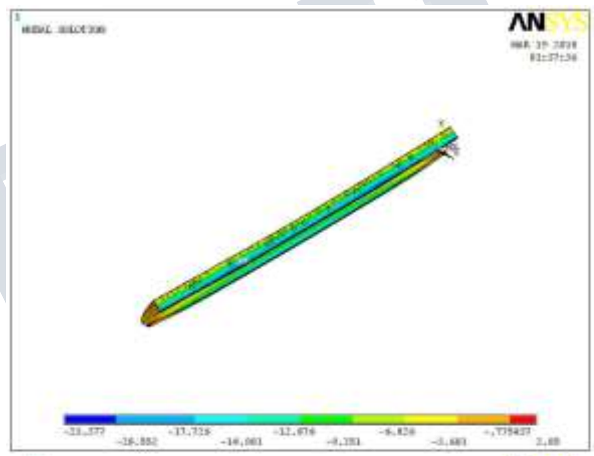
6 specimens of 2.4m length and 1.0, 2.0 mm thickness with varying parameters such as height of web to thickness (h/t) and depth of lip to thickness (d/t) ratios are modeled and analyzed for the flexural and buckling performance.

Table 1 Lipped C and Sigma Section Specimen Details

Beam No	SIZE hxbxd (mm)	Thickness (mm)	h/t	b/t	d/t
B1	200x60x10	2.0	100	30	5
B2	200x60x15	2.0	100	30	7.5
B3	200x60x20	2.0	100	30	10
S1	200x60x10	2.0	100	30	5
S2	200x60x15	2.0	100	30	7.5
S3	200x60x20	2.0	100	30	10

III. RESULTS AND DISCUSSION

The values of the vertical displacement, lateral displacement, von MISES stress and von MISES strain were tabulated for all beam specimens. The obtained results were plotted between von MISES stress and von MISES strain. Stress and strain values are almost linear for all beam specimens, because it was obtained from linear analysis. Ultimate values of vertical displacement, von MISES stress and von MISES strain values were tabulated



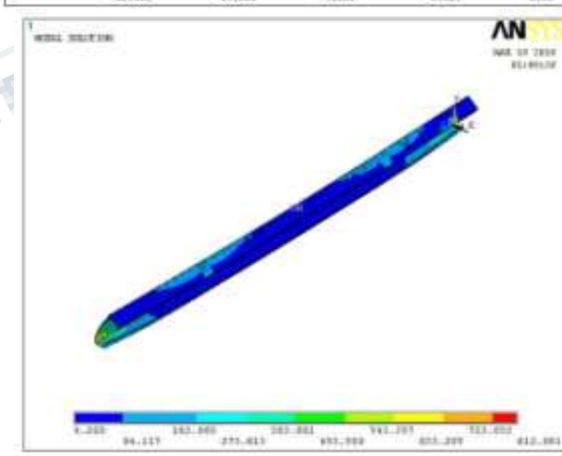
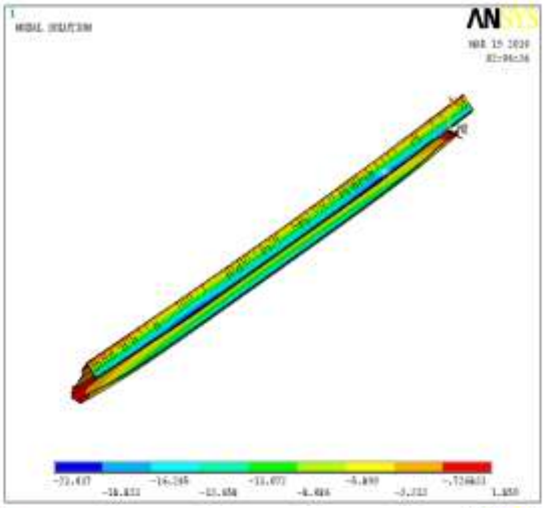


Figure 4. Y – Component displacement (B3)
Figur5. Von MISES stress(B3)



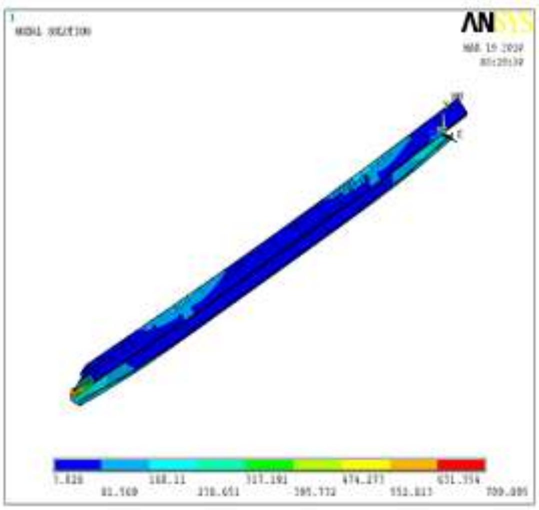


Figure6. Y – Component displacement (S3)
Figure7. Von MISES stress(S3)

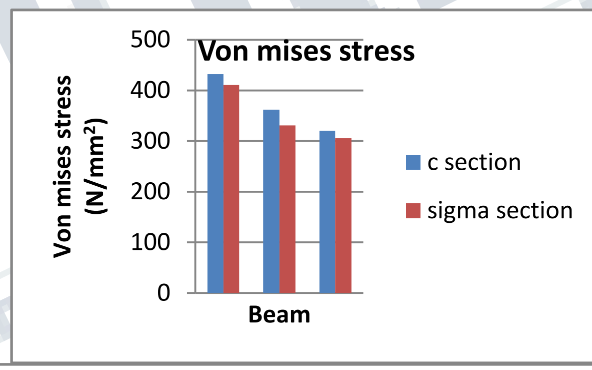
It is observed that the plots shows maximum displacement at the point of load applied section and the flexural behaviour is also seen.

Thus the maximum vertical displacements for all the beams are found to occur at the point of load applied and thus the corresponding von MISES stress and strain values are obtained for the all the beams from the above analysis and they are tabulated as follows

Table 2 showing the results obtained from analysis

Beam No.	Size h x b x d x t	Vertical displacement (mm)	Von MISES stress (N/mm^2)
B1(Lipped C section)	200X60X10	44.7	432
B2(Lipped C section)	200X60X15	41.6	362
B3(Lipped C section)	200X60X20	38.9	320
S1(Lipped C Sigma section)	200X60X10	40.3	411
S2(Lipped C Sigma section)	200X60X15	38.33	331
S3(Lipped C Sigma section)	200X60X20	35.65	306

Thus the maximum vertical displacements for all the beams are found to occur at the point of load applied and thus the corresponding von MISES stress and strain values are obtained for the all the beams from the above analysis and they are plotted as graph



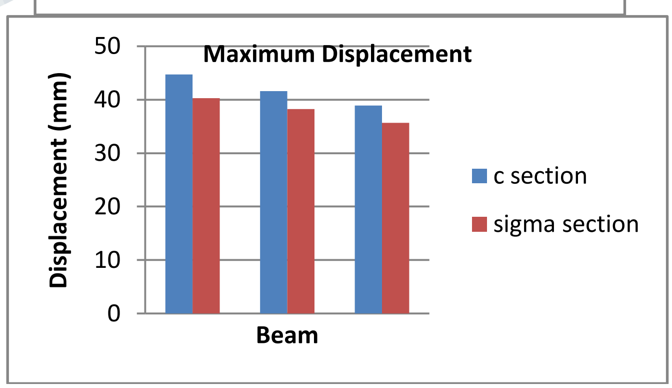


Fig.10 Maximum Vertical Displacement
Fig.10 Corresponding Von MISES Stress

IV. CONCLUSION

In the present numerical investigation, web of the Cold Formed Lipped 'C' section are stiffened by means proper bending, these web stiffened lipped channel section named as sigma section used as a purlin and their effectives is analysed using a commercially available Finite Element Software ANSYS 12.0. Specimens are modelled analysed in simply supported condition for varying h/t ratio and d/t ratio and Von-MISES stress and strain variations, displacement were found. The following conclusions can be made based upon the numerical results.

- ❖ Vertical displacement stiffened web sections were less compare to the lipped c section.
- ❖ Distortional buckling stress increase for the lipped c sigma section.
- ❖ With increasing in d/t ratio the moment carrying capacity of the section is reduced considerably because of reduction in lip stiffness.

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