

# Study on Capacity of Cold Formed Steel Sections

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**ABSTRACT:** Cold formed steel sections are currently widely used for buildings and structures which are gaining popularity in India for a decade. They are used as purlins and side rails or floor joist, and after that in the building envelopes. The strength of steel cold-formed members is usually computed by various design methods and as per design standards. The section selected for the study is CFS sigma and Z sections. The behaviour and capacity of the sections are studied. Sections selected were based on geometric ratio. Using CUFSM, the behaviour of the selected sections will be predict. The Ultimate load capacity of both sigma and Z sections will be predict from ANSYS and ABAQUS softwares. In this paper, identify the ultimate load carrying capacity of these sections and finding the suitable section which has the highest load carrying capacity.

**KEYWORDS:** CFS sigma and Z sections, Geometry Ratio, Various Thickness, Behaviour , Yield stress, Ultimate load.

## I.INTRODUCTION

Cold-formed steel members are an economic solution for many construction applications in buildings. The sections are cold-formed from steel sheets, strips, plates or flat bars by using roll-forming, press brake, or bending machines. Cold formed steel members have several advantages over other materials. Cold Formed thin steel sheet 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, that is their manufacturing process involves forming steel sections in a cold state from steel sheets of uniform thickness. These are called as 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 3mm. 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 coldformedsections is at least 280 N/mm<sup>2</sup>, although there is a trend to use steels of higher strengths, and sometimes as low as 230 N/mm<sup>2</sup>. Cold-formed steel members are thin, the width-to-thickness ratios are large, especially compared to hot-rolled steel shapes. Therefore the cold-formed members are much more susceptible to local buckling. The thin member's elements (flange, web, lip, etc) may buckle locally before reaching yield stresses when the member is subject to compressive, flexural, shear, or bearing loads. Local buckling is a major consideration in design of cold-formed steel members; this design must provide a good safety margin against local instabilities. The behaviour of CFS sigma and Z sections subjected to concentrated load is discussed in this paper.

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## II. RELATED WORK

A paper on Flexural behaviour on cold formed steel sections was conducted by Luis et al.[1](2013). On a simply supported beam, the load was applied at one third distance. The corresponding deflection was noted. A load deflection diagram was plotted. The effect of loading was the main focus of the study. Non-linear analysis was carried out. The results specified the buckling modes of the section. Anbarasu, M. and Sukumar, S., (2014). Local/Distortional/Global Buckling Mode Interaction on Thin Walled Lipped Channel. This paper it is considered Sigma and Z cross sections with variable geometry and Thickness. The critical buckling loads have been studied for several combinations of the geometry parameters of the beam with the help of CUFSM, load carrying capacity will be predict by using ANSYS and ABAQUS.

## III. COLD FORMED STEEL SECTIONS

Sigma and Z purlins are now more preferred than the conventional steel sections because of their better performance in resisting loads. These also have simply connection and easy adaptable. These also have shear centre close to the web. In addition these are light weight and economic. A typical sigma and Z sections are shown in Fig 1.

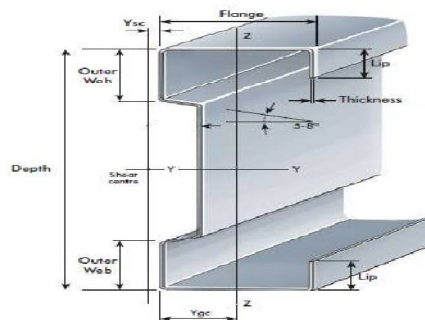


FIG 1. TYPICAL VIEW OF SIGMA SECTION

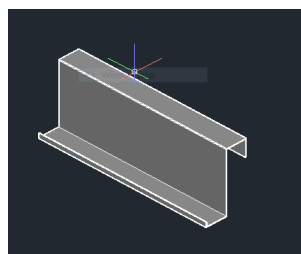


Fig.2.(A)

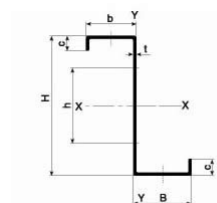


Fig.2.(B)

FIG 2.A,B) TYPICAL VIEW OF Z SECTION

Fig 1, Fig 2.A) and B) Shows that the geometry of Sigma and Z sections which I have taken for analysis.

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## IV.OBJECTIVES

1. To study the behaviour ,determine the load bearing capacity and failure of cold formed steel sigma and Z section with concentrated load and boundary conditions , one end hinged and other end roller.
2. To identify the highest load carrying capacity of CFS sections.

## V.METHODOLOGY

1. Experimental study on CFS sigma section with concentrated load and one end hinged and other end roller boundary condition.
- 2.Study on the behavior of CFS sections by using CUFSM Software .
3. Numerical analysis of the CFS sections by ANSYS and ABAQUS.

## VI.EXPERIMENTAL STUDY

An experimental study was carried out with a CFS sigma section of thickness 2.0 mm and span length 1000 mm. The experiment was carried out on a Universal Testing Machine. The support conditions was one end hinged and other end roller. Concentrated load was applied at the centre of the specimen and increased accordingly.

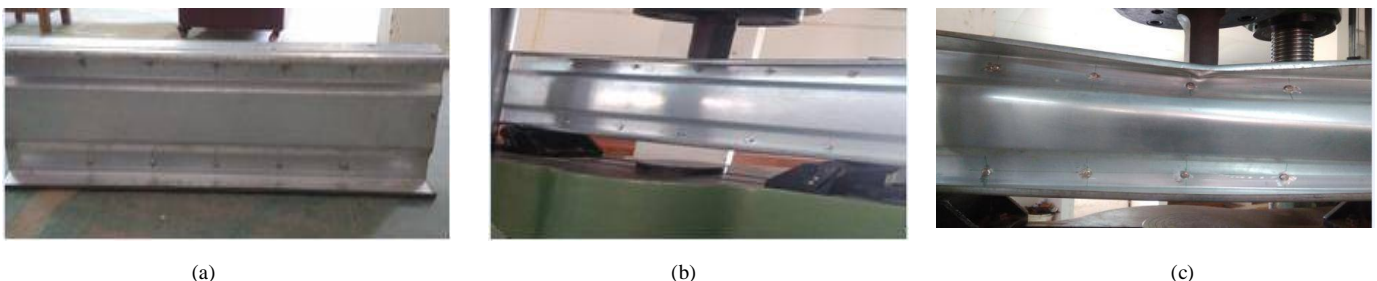


Fig. 3.(a) CFS sigma section (b) Universal Testing Machine with section (c) Deformation of flange

Above figure Fig 3 (a) mention that CFS sigma section which was used for analysis and that section Fig 3(b) was in UTM machine. After testing the section Fig 3 (c) under deformation .



Fig. 3 (d) Distortional buckling (f) Web buckling

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From fig 3 (d) mention that the section has failure pattern as distortional buckling and Fig 3 (e) web buckling.

The dimensions is shown in Fig 1 From the experimental study the ultimate load carrying capacity of the member was found to be 25 kN. The flange at the flange-web junction in numbers with edge stiffened elements. In members with intermediate stiffened elements distortional buckling is characterized by displacement of the intermediate stiffener normal to the plane of the element. Distortional buckling is a mode with distortion in the cross-section. This phenomenon is called distortional buckling.

## VII. NUMERICAL ANALYSIS

CUFSM is freely available software for exploring elastic buckling behavior developed by Schafer. Freely available from the website ([www.ce.jhu.bschafer/cufsm](http://www.ce.jhu.bschafer/cufsm)). CUFSM calculates the buckling stress and buckling mode of arbitrarily shaped, simply supported, thin-walled members. Using this software we can easily predict the occurrence of local and distortional buckling. The corresponding load factors are predicted with the help of the output curve. This load factors are incorporated in design procedure. It is also used to calculate cross sectional properties like Area, Moment of inertia, Warping Constant, Shear Centre, center of gravity etc...

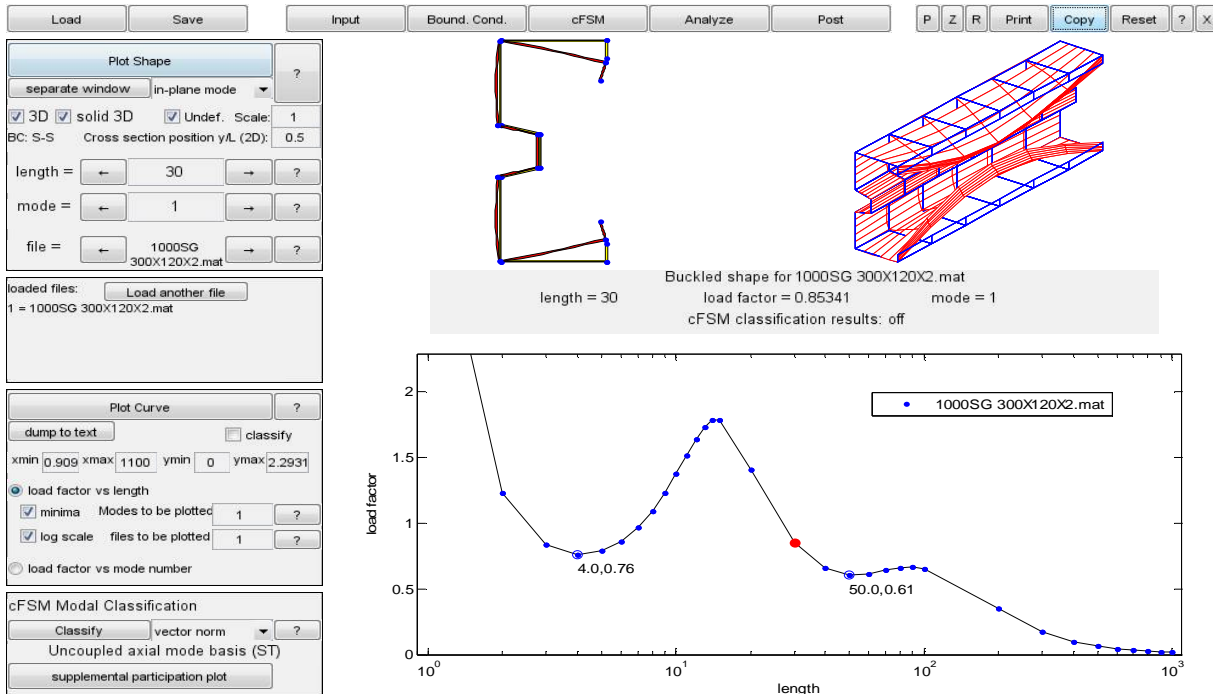


FIG 4. Signature Curve

The above Fig 3 shows the Signature curve for the CFS sigma section of thickness 2 mm and span length 1000 mm. From that signature curve, load factor was predicted and the failure pattern shows distortional buckling mode shape for that section. Depending upon the load factor, failure pattern will change. There are three kind of buckling mode

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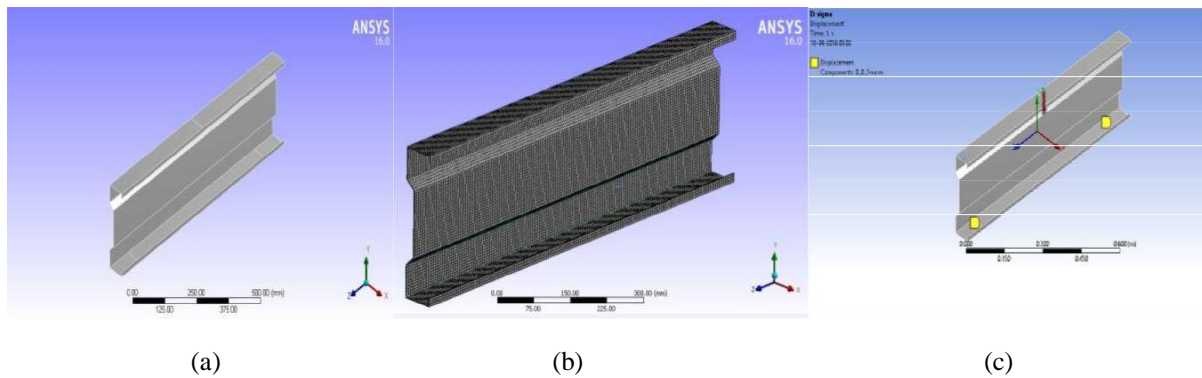
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which are Local, Distortional and Global buckling. In this CUFSM analysis, distortional buckling mode shape was obtained for most of the sections.

modelling of the sigma section and Z section was done in ANSYS and ABAQUS. the span of the member was taken to be 1000 mm. The support conditions selected was hinged at one end and roller at the other end. Concentrated load was applied at the center of the specimen. The modelling and analysis using ANSYS is shown in Fig 4 and ABAQUS is shown in Fig 5.



The above Fig.5 (a) shows that the model of CFS Sigma section, Fig 5 (b) the sigma section under Meshing Fig 5 (c) Boundary conditions and loading of the sigma section.

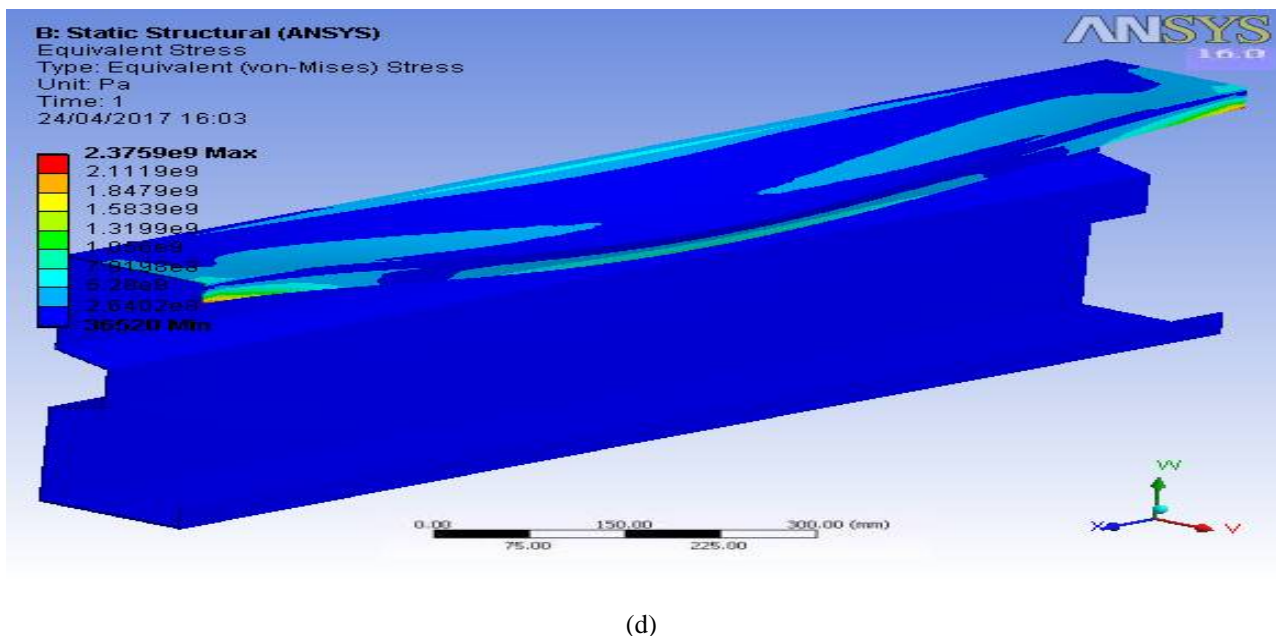
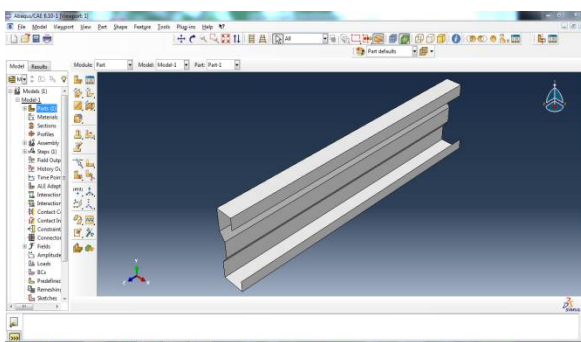


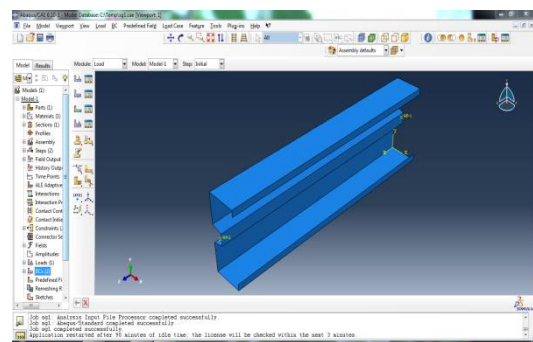
Fig.5 (a) CFS Sigma section model (b) Meshing (c) Boundary conditions and loading (d) Stress diagram



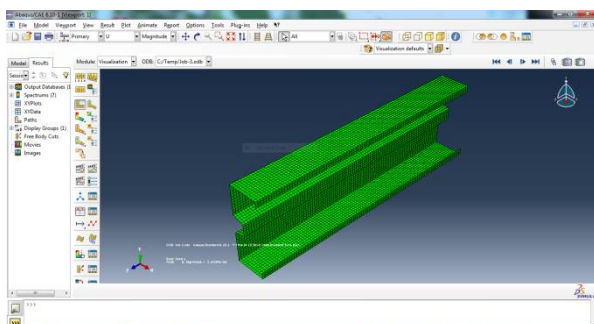
The Fig.5(d) Shows the Stress diagram of the analysed sigma section which result in yield stress of the section. From the stress, load can be calculated easily.



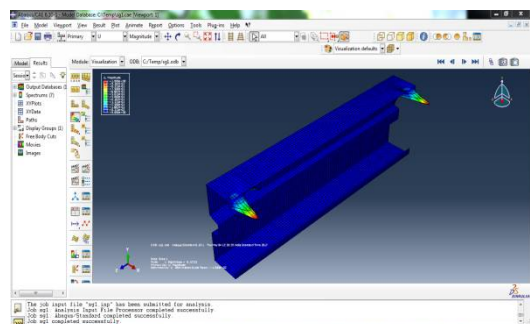
(a)



(b)



(a)



(d)

Fig.6 (a) CFS Sigma section model (b) Meshing (c) Boundary conditions and loading (d) Stress diagram

The above Fig.6 (a) shows that the model of CFS Sigma section, Fig.6 (b) the sigma section under Meshing Fig 6.(c) Boundary conditions and loading of the sigma section and Fig.6 (d) stress diagram of CFS sigma section. From the stress value, load carrying capacity can be calculated easily.

## VII. RESULTS

In the ANSYS analysis for CFS sigma section of thickness 2 mm and span length 1000 mm, the maximum load carrying capacity was obtained as 23.48 KN. In the ABAQUS analysis for the same section with dimensions, the maximum load carrying capacity was obtained as 25.06 KN. The both analysis were done for several sigma and Z sections by various dimensions. The behavior of CFS sigma and Z sections were obtained by using CUFSM software. By using ANSYS and ABAQUS software, Ultimate load carrying capacity of the both sections were determined.

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## VIII. CONCLUSION

- CFS sigma sections and Z sections with various dimension were analysed to determine the load carrying capacity and the failure patterns. The boundary conditions provided was hinged at one end and roller at other end.
- From CUFSM analysis the failure pattern for sigma section with varying dimension have distortional buckling mode shape whereas Z sections have Local buckling mode. Thus local buckling occurs easily than the distortional buckling. From this study Sigma section with varying dimension can resist more load.
- Comparison of Experimental results with an ANSYS and ABAQUS analysis, Sigma sections have more ultimate load carrying capacity than the Z sections. Comparison of both software ABAQUS gave better solution and accurate results.
- Increase in cross sectional area and moment of inertia of the specimen, Increases the load carrying capacity of the sections.
- Cold-formed steel sections are economical and gave better strength as equal as to Hot rolled steel sections.
- Finally cold- formed steel sigma section gave more loading capacity than the Z sections so it can be used as purlin to Industrial building.

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