Compatability Behaviour on Cold Formed Steel for I Section and C Section in Variable Parameters

S.Logesh, R.Ramesh, I. Padmanaban

Abstract: This Study represents compatibility on Cold formed steel in I-Section beams and C-section beams with variable length parameters was 1000mm, 1500mm, 2000 mm under simply supported end condition subjected to uniformly distributed loading. The Cold formed steel is of shell type in Numerical simulation is carried out using the Software ABAQUS. For validation the series of parameters studies have been carried out using the numerical model of different parameters, such as the effect of length, width, thickness. CFS I-Section steel in various thickness of 1mm, 2mm, 3mm and 4mm with same loading conditions. CFS C-Section steel in various uneven flange width such as 500mm at the top flange and bottom flange of different width such as 400mm, 300mm, 200mm respectively in variable lengths with various loading conditions and with the thickness of about 1mm. For both I-Section and C-Section Beams the Effective Length ranges, MISES(max and min) and deflections(max and min) were taken for the analyse of the Sections. This study gives the way of finding the effective Section by the analysis of behaviour of I-Section beam and C-Section beam through the deflection results in various length variations in the beam Section using the ABAQUS software for finding the Structural behaviour in the more accuracy manner by applying meshing more finer for the Element Section in the Analyse of beam. The loading condition and the supporting condition applied to the beam section in different loading for getting the effective Section. For further stability in effective section we can use different types of connection.

Keywords*: *Cold formed Steel, Beams, ABAQUS, deflection.

I. INTRODUCTION

Cold formed steel structure is used in the construction industry for structural (or) non structural items such as columns, beams, railway coaches,etc. Cold formed steel are made by rolling, pressing, stamping, bending methods, etc. It is used also in prefabrication and mass production with low weight. It is quick and simple erection. It adds strength and rigidity. Here I add some advantages of CFS Resistance against fire such as more efficient manufacturing process, Economic, preferred in high seismic zones, High strength to weight ratio can be achieved in cold sections.

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The use of cold-formed steel members in building construction began in the 1850s in both the United States and Great Britain. In the 1920s and 1930s, acceptance of cold-formed steel as a construction material was still limited because there was no adequate design standard and limited information on material use in building codes. One of the first documented uses of cold-formed steel as a building material is the Virginia Baptist Hospital, constructed around 1925 in Lynchburg, Virginia. The walls were load bearing masonry, but the floor system was framed with double back-to-back cold-formed steel lipped channels. According to Chuck Greene, P.E., of Nolen Frisa Associates, the joists were adequate to carry the initial loads and spans, based on current analysis techniques. Greene engineered a recent renovation to the structure and said that for the most part, the joists are still performing well. A site observation during this renovation confirmed that "these joists from the 'roaring twenties' are still supporting loads, over 80 years later!" In the 1940s, Lustron Homes built and sold almost 2500 steel-framed homes, with the framing, finishes, cabinets and furniture made from cold-formed steel.

This paper will report the effective varying length parameters in I-section and C-section Beam of Cold Formed Steel by analytical process.

II. LITERATURE STUDY

Srinath T (2016) From this paper, the impact of web opening on the flexural behaviour of Cold formed built-up I section under two point loading is investigated for the simply supported end conditions. Experimental investigation has been carried out on 8 specimens by varying the thickness and depth of the built-up beam. Numerical investigations have also been administered using finite element analysis software ANSYS13.0. Load vs. Deflection curve, failure modes and supreme load carrying capacity of specimens are presented during this work.

V.Raghul (2015) From this paper we studied the lateral torsional buckling and Distortion buckling of cold formed steel beam and paper provides numerical nonlinear simulations supported the finite element method using the software package ABAQUS/Standard (6.10). Towel FE models are created on channel section subjected to bending under two point loading conditions. A suitable finite element model was developed, and eventually , a parametric study was undertaken so as to research the influence of the depth and width of the beams on its structural behaviour.

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G.Jenitha (2016) This project deals with the experimental investigation of the two cold formed C beams, two cold-formed builtup C beams and one hot-rolled I beam. An experimental setup is placed the specimens on the loading frame for static loading and cyclic loading for the C beams and I beam section. The load is applied axially along the centroid of the beam and it is distributed into two points loading by distributor.Determined the load and deflection behavior stiffness, energy absorption and ductility with the number of cycles evaluated for cold-formed C beam and hot-rolled I beam. The load carrying capacity increases for the built-up member in comparison to the standard member. Cold-formed beams are preferred to hot-rolled beams when thermal insulation, light weight nature, easy moulding and economy is taken into account.

B.P. Gotluru (2000) From this paper we studied the behavior of cold-formed steel beams subject to torsion and bending. The attention is concentrated on beams subject to torque, due to the effect of transverse loads not applied at the shear center. A simple geometric nonlinear analysis method, supported satisfying equilibrium within the deformed configuration, is examined and wont to predict the behavior of the beams. Simple geometric analyses, finite element analyses and finite strip analyses are performed and compared with experimental results. The influence of typical support conditions is studied and that they are found to supply partial warping restraint at the ends.

III. PROPERTIES

Cold worked steels are typically harder and stronger than standard hot rolled steels. Cold rolled applies only in the form of sheets. Smooth surface that are often oily to touch.

A. Poisson's Ratio

Poisson's ratio is defined as the ratio of the change in the width per unit width of a material, to the change in its length per unit length, as a result of strain. The Poisson's ratio of CFS

Poisson ratio(v) = 0.3

B. Modulus of Elasticity

The elastic modulus is the measure of an object's or substance's resistance to being deformed elastically when stress is applied. The elastic modulus of an object is defined as the slope of its stress-strain curve in the elastic deformation region.

Modulus of Elasticity(E) = 203 G Pa

Fig.1. Cold formed steel sheet

Table 1. I-Section

Flange Width (mm)	Flange Depth (mm)	Web Depth (mm)	Web Width (mm)	Thickness (mm)	Length of Section (mm)
400	40	400	40	1	1000
400	40	400	40	2	1000
400	40	400	40	3	1000
400	40	400	40	4	1000
400	40	400	40	1	1500
400	40	400	40	2	1500
400	40	400	40	3	1500
400	40	400	40	4	1500
400	40	400	40	1	2000
400	40	400	40	2	2000
400	40	400	40	3	2000
400	40	400	40	4	2000

IV. NUMERICAL MODEL FRAMEWORK

Modelling approach of CFS Beams in ABAQUS are presented in I Section and C Section. Twelve CFS Beams of I Section and Nine CFS Beams of C Section. Details of the I-Section Specimens to be analysed in Numerical methods are presented in Table 1 with the images in ABAQUS for different sections in Fig.2 to fig.4.

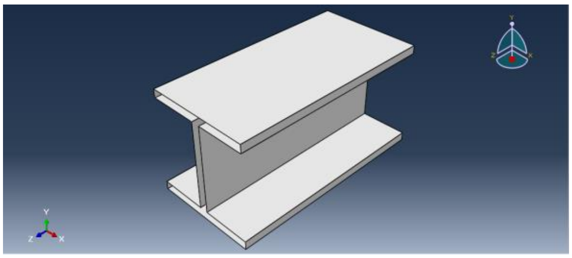

Fig.2. 1000mm I Section

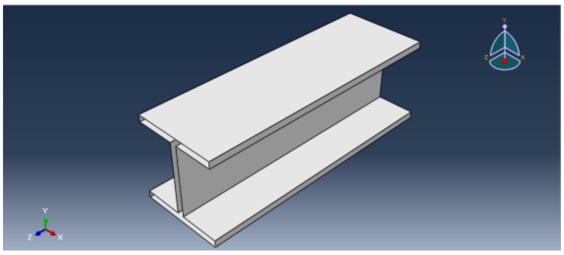

Fig.3. 1500mm I Section

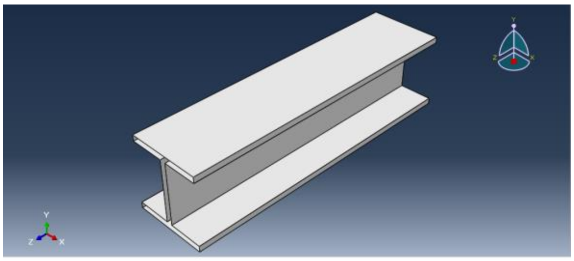

Fig.4. 2000mm I Section

Details of the I-Section Specimens are presented in Table 2 with the images in ABAQUS for different sections in Fig.5 to fig.7.

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Table 2. C-Section

Top Flange Width (mm)	Bottom Flange Depth (mm)	Web Depth (mm)	Thickness (mm)	Length of Section (mm)
500	400	500	1	1000
500	300	500	1	1000
500	200	500	1	1000
500	400	500	1	1500
500	300	500	1	1500
500	200	500	1	1500
500	400	500	1	2000
500	300	500	1	2000
500	200	500	1	2000

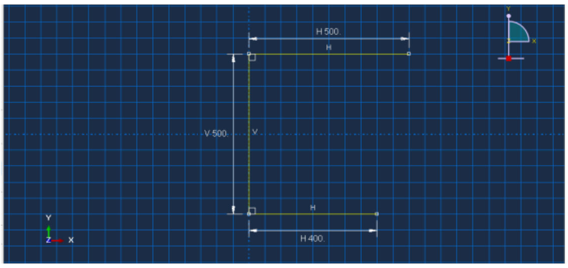

Fig.5. C Section (symmetry model 1)

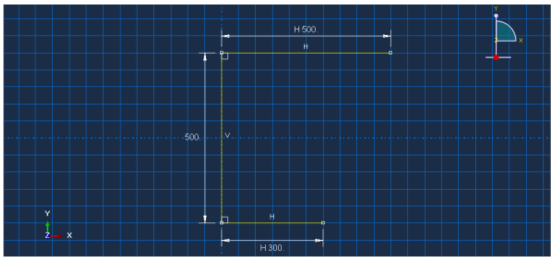

Fig.6. C Section (symmetry model 2)

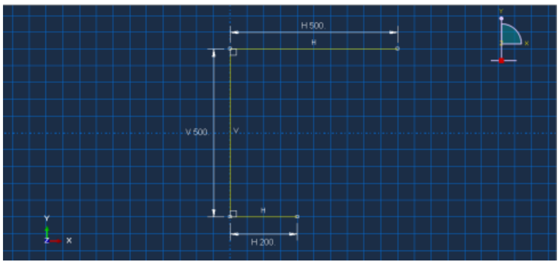

Fig.7. C Section (symmetry model 3)

V. ABAQUS MODELLING

ABAQUS Software is based on FEM that can be used for micro-element modelling of CFS I-Section and C-Section members. It can be used for macro-element modeling when simplifications are made.

The material properties in ABAQUS, modulus of elasticity parameters and Poisson's ratio in all three dimensions are required. In this study, as the result MISES and deflections can be taken.

Here the Boundary conditions used are Simply Supported condition. The loading conditions for I-section is 2000N/m and for C-Section different loading such as 1000N/m, 5000N/m, 15000N/m.

Finite Element Method involves breaking a member element into smaller element with simple geometry and theoretical solution. The elements are joined to each other at the Nodes. The mesh size is important to get better results. Fig. 7 shows the meshed model in ABAQUS.

The effect of mesh size in the Finite Element Model on the behaviour of CFS beams of 25 x 25mm were used for the accuracy of all FE simulations in this Study.

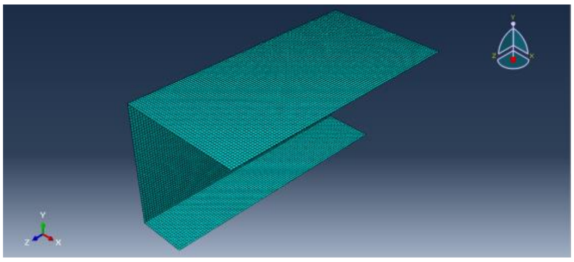

Fig.8. FEM meshed model

A. Finite Element Analysis

For every complete finite-element analysis there are 3 separate stages:

Pre-Processing or Modelling:

This stage involves creating an input file which contains an engineer's design for a finite-element analyzer also called as "Solver".

Processing or Finite Element Analysis:

This stage produces an output visual file.

Post-processing or generating report, image, animation form

Output File:

This stage is a visual rendering stage.

B. Abaqus Analysis Steps

On the basis of the central objectives of this research, 3 dimensional FE models of CFS Beam were developed and the modelling is addressed as follows.

- Element type
- Material property
- Assigning sections
- Defining step
- Specify boundary conditions
- Specify loading
- Meshing
- Assigning job
- Evaluating the results

VI. DEFLECTION AND MISES CURVE

Fig. 9 illustrated the comparison of deflection using ABAQUS for I-Section in same loading condition with various thickness such as 1mm, 2mm, 3mm and 4mm respectively. The effectiveness arrived by comparing the graph for both deflection and MISES of maximum in various parameters from fig. 9 and fig.12.

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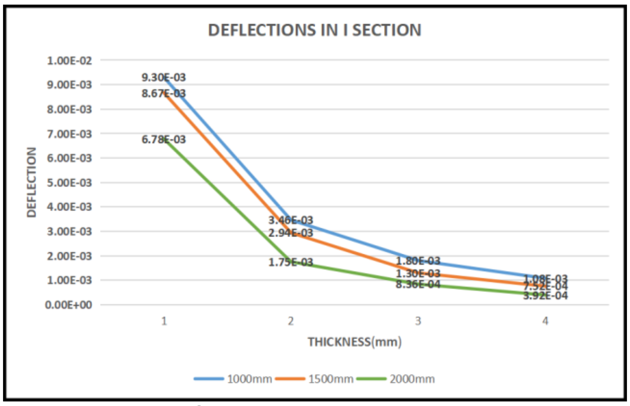

Fig. 9. Deflection in I Section(maximum)

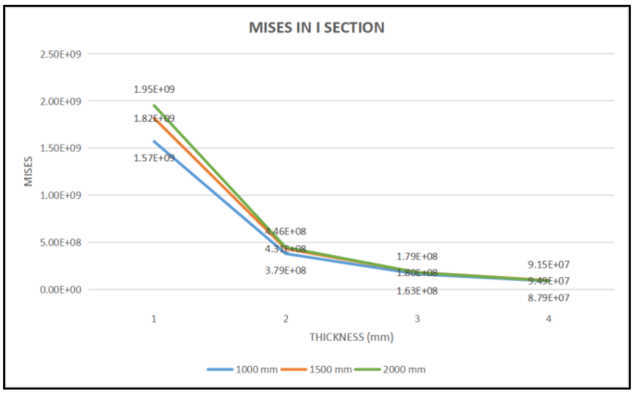

Fig. 10. MISES in I Section(maximum)

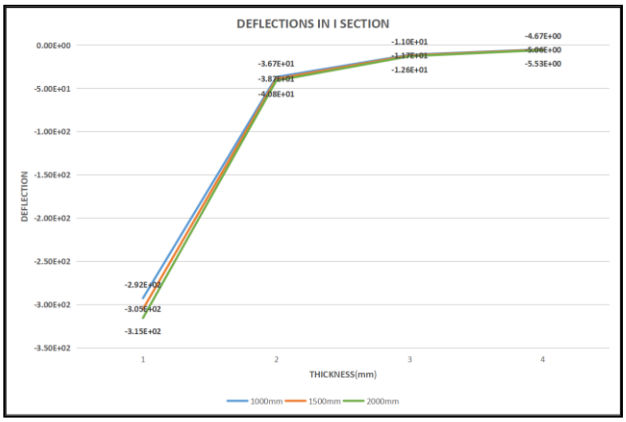

Fig. 11. Deflection in I Section(minimum)

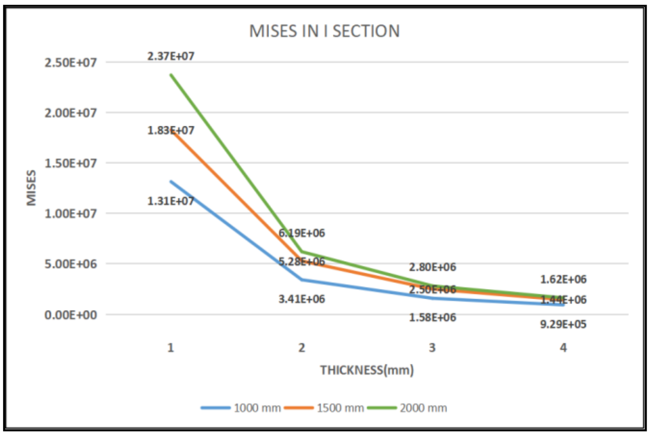

Fig. 12. MISES in I Section(minimum)

Table 3 showing the maximum and minimum deflections and MISES for the same loading conditions of 2000N/m in I-Section and Table 4 illustrated the comparison of deflection and MISES using ABAQUS for C-Section in different loading conditions such as 1000N/m, 5000N/m, 15000N/m. Fig. 13 to Fig.18 gives the Graph details of both I section and C section.

Table 3. deflection and MISES for I-Section

Length of Section (mm)	Thickness (mm)	Deflection U2 Maximum	Deflection U2 Minimum	MISES S Maximum	MISES S Minimum
1000	1	9.30E-03	-2.92E+02	1.57E+09	1.31E+07
1000	2	3.46E-03	-3.67E+01	3.79E+08	3.41E+06
1000	3	1.80E-03	-1.10E+01	1.63E+08	1.58E+06
1000	4	1.08E-03	-4.67E+00	8.79E+07	9.29E+05
1500	1	8.67E-03	-3.05E+02	1.82E+09	1.83E+07
1500	2	2.94E-03	-3.87E+01	4.31E+08	5.28E+06
1500	3	1.30E-03	-1.17E+01	1.80E+08	2.50E+06
1500	4	7.52E-04	-5.06E+00	9.49E+07	1.44E+06
2000	1	6.78E-03	-3.15E+02	1.95E+09	2.37E+07
2000	2	1.75E-03	-4.08E+01	4.46E+08	6.19E+06
2000	3	8.36E-04	-1.26E+01	1.79E+08	2.80E+06
2000	4	3.92E-04	-5.53E+00	9.20E+07	1.62E+06

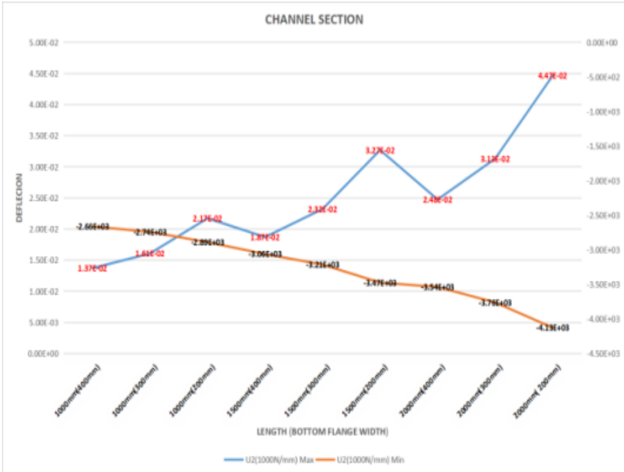

Fig. 13. Deflection in C Section under 1000N/m

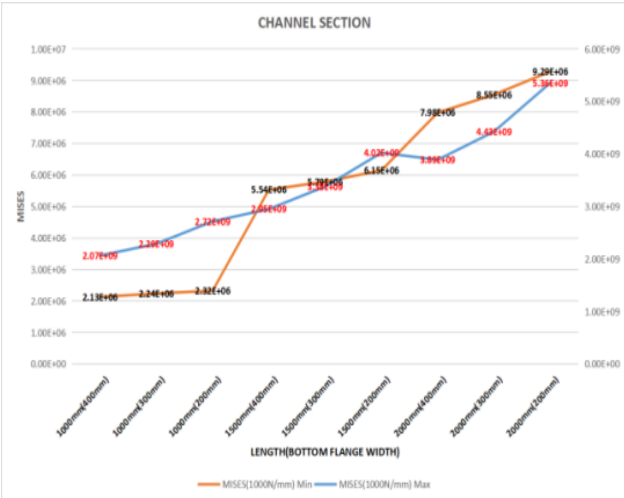

Fig. 14. MISES in C Section under 1000N/m

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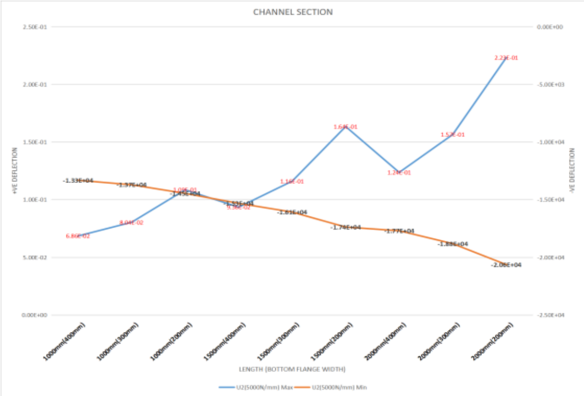

Fig. 15. Deflection in C Section under 5000N/m

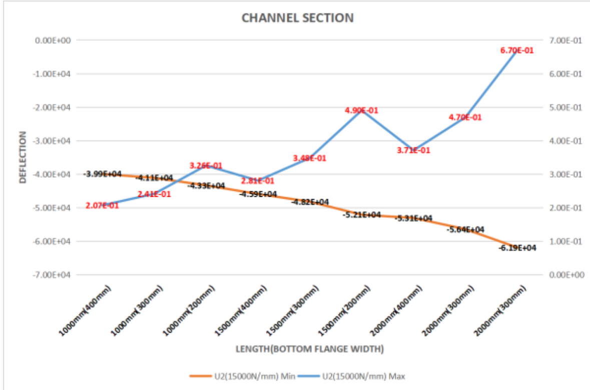

Fig. 17. Deflection in C Section under 15000N/m

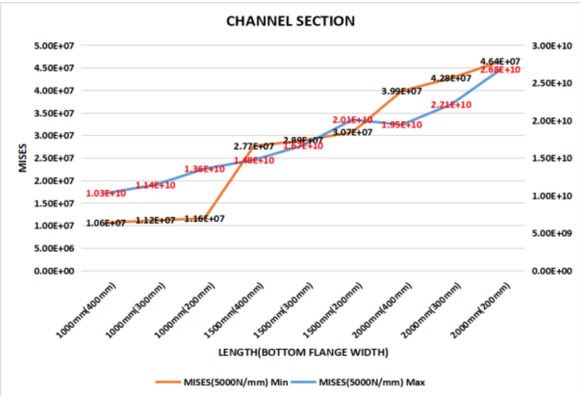

Fig. 16. MISES in C Section under 5000N/m

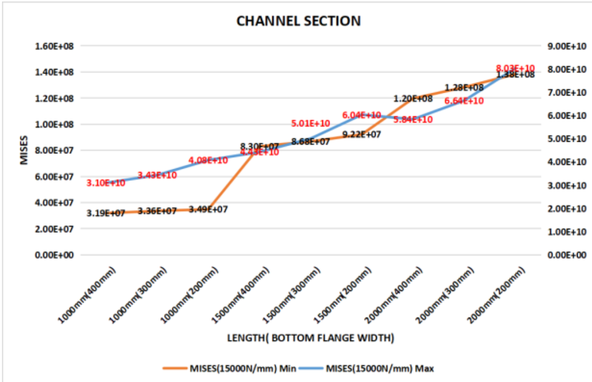

Fig. 18. MISES in C Section under 15000N/m

Table 4. C-Section deflection and MISES of maximum and minimum

Top Flange Width (mm)	Bottom Flange Depth (mm)	Web Depth (mm)	Thickness (mm)	Length of Section (mm)	Loading (N/m)	Deflection U2 Maximum	Deflection U2 Minimum	MISES S Maximum	MISES S Minimum
500	400	500	1	1000	1000	1.37E-02	-2.66E+03	2.07E+09	2.13E+06
500	300	500	1	1000	1000	1.61E-02	-2.74E+03	2.29E+09	2.24E+06
500	200	500	1	1000	1000	2.17E-02	-2.89E+03	2.72E+09	2.32E+06
500	400	500	1	1500	1000	1.87E-02	-3.06E+03	2.95E+09	5.54E+06
500	300	500	1	1500	1000	2.32E-02	-3.21E+03	3.38E+09	5.79E+06
500	200	500	1	1500	1000	3.27E-02	-3.47E+03	4.02E+09	6.15E+06
500	400	500	1	2000	1000	2.48E-02	-3.54E+03	3.89E+09	7.98E+06
500	300	500	1	2000	1000	3.13E-02	-3.76E+03	4.43E+09	8.55E+06
500	200	500	1	2000	1000	4.47E-02	-4.13E+03	5.36E+09	9.29E+06
500	400	500	1	1000	5000	6.86E-02	-1.33E+04	1.03E+10	1.06E+07
500	300	500	1	1000	5000	8.04E-02	-1.37E+04	1.14E+10	1.12E+07
500	200	500	1	1000	5000	1.09E-02	-1.45E+04	1.36E+10	1.16E+07
500	400	500	1	1500	5000	9.36E-02	-1.53E+04	1.48E+10	2.77E+07
500	300	500	1	1500	5000	1.16E-01	-1.61E+04	1.67E+10	2.89E+07
500	200	500	1	1500	5000	1.64E-01	-1.74E+04	2.01E+10	3.07E+07
500	400	500	1	2000	5000	1.24E-01	-1.77E+04	1.95E+10	3.99E+07
500	300	500	1	2000	5000	1.57E-01	-1.88E+04	2.21E+10	4.28E+07
500	200	500	1	2000	5000	2.23E-01	-2.06E+04	2.68E+10	4.64E+07
500	400	500	1	1000	15000	2.06E-01	-3.99E+04	3.10E+10	3.19E+07
500	300	500	1	1000	15000	2.41E-01	-4.11E+04	3.43E+10	3.36E+07
500	200	500	1	1000	15000	3.26E-01	-4.33E+04	4.08E+10	3.49E+07
500	400	500	1	1500	15000	2.81E-01	-4.59E+04	4.43E+10	8.30E+07
500	300	500	1	1500	15000	3.48E-01	-4.82E+04	5.01E+10	8.68E+07
500	200	500	1	1500	15000	4.90E-01	-5.21E+04	6.04E+10	9.22E+07
500	400	500	1	2000	15000	3.71E-01	5.31E+04	5.84E+10	1.20E+08
500	300	500	1	2000	15000	4.70E-01	-5.64E+04	6.64E+10	1.28E+08
500	200	500	1	2000	15000	6.70E-01	-6.19E+04	8.03E+10	1.38E+08

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VII. DISCUSSION

The purpose of this paper is to discuss about Deflections of I-section and C-sections as the results from ABAQUS and theoretical Calculation. The use of ABAQUS software is much easier to get the solution in a satisfactory level of accuracy.

In simulation, the stresses, strains and even deformed shapes can be viewed using ABAQUS software. This is very handy in designing the Sections or structure and lot of money can be saved by using ABAQUS.

When the testing is failed we have go once again for checking the safe parameters and requirements as per the software. The simulation software has many limitations. This analysis is generally used for modelling and to get their results. It has also been observed that ABAQUS does not provide ideal representation of the analysis.

However, ABAQUS can be modified to view more accurate results, more easily to understand the tables and plots.

The beam models are created in 3 dimensional. The Beam elements are pinned at the end points of the element structure. Then the load is applied uniformly and then they deforms at the nodes of the element.

On changing the mesh size, large region to smaller elements can be analyse critically. The accuracy of the results increases when increase of fine mesh.

The average maximum deflection and MISES are observed when different loading is applied at member elements under the I section and unsymmetrical C section in variable lengths parameters.

VIII. CONCLUSION

The following items can be concluded:-

- This paper presents a finite element model using ABAQUS program software which is used for analysis for the behaviour of CFS beam in I-Section and C-Section in various parameters.
- In CFS I-Section beam the effective length ranges appropriately above 1000mm and below 2000mm for the applied uniformly distributed loading under simply supported condition.
- In this I-Section beam when we increase the thickness of the CFS sheet, we come out with the results as decrease in deflection of the Section.
- In CFS Unsymmetrical C-Section beam the effective Section identified in various length parameters with top flange unchanged of 500mm and bottom flange with different width of 400mm, 300mm and 200mm.
- From this CFS Unsymmetrical C-Section we come out with the effective section as top flange of 500mm and bottom flange of 400mm
- For further stability of beam sections the connections can be used.

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