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Analytical Investigation on Behaviour of Cold Formed Deep Joist Channel Section

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Abstract: *The application of cold formed steel elements in construction is becoming very popular due to several advantages like Speedy construction, higher strength to weight ratio, dimensional stability and recycled material. CFS is proposed to use as building components as beams, columns, Joists, wall panels etc. The load carrying capacity of cold-formed steel (CFS) joists can be enhanced by employing optimization techniques. Recent research studies have mainly focused on optimizing the bending capacity of conventional channel with and without lips that are used as joists. The objective of the study is to examine the flexural strength, failure mode and load-deflection of the cold formed steel double furred channel section with and without web openings under flexure.*

Keywords: Cold-formed section, Flexural behavior, Furred section, Joist beam

I. INTRODUCTION

Cold-formed steel (CFS) cross-sections are used extensively in the construction industry as secondary load-carrying members, such as roof purlins and wall girts. Various shapes are also available for wall, floor and roof diaphragms and coverings. Open sections, closed sections and built up sections; C,Z, double channel I sections, hat, and angle sections are open sections while box sections and pipes are closed sections. The advantages are cross sectional shapes are formed to close tolerances and these can be consistently repeated for as long as required. Cold rolling can be employed to produce almost any desired shape to any desired length. Shear failure is critical in short spans while web crippling failure occurs when CFS beams subjected to concentrated loads. A theoretical study on the optimization of lipped channel beams under uniformly distributed transverse load was presented to maintain the local, distortional, and global buckling strength as well as yielding, in combination with allowable deflection limits. Manufacturers of cold formed steel sections purchase steel coils of 1.0 to 1.25 m width, slit them longitudinally to the correct width appropriate to the section required and then feed them into a series of roll forms. These rolls, containing male and female dies, are arranged in pairs, moving in opposite direction so that as the sheet is fed through them its shape is gradually altered to the required profile. In order to compensate some of the lost capacity, edge and intermediate stiffeners are fabricated into the web which complicates the characteristics and buckling model.

1.1 Why Cold Formed Steel?

- Cold-formed steel (CFS) members are made from structural quality sheet steel that are formed into C-sections and other shapes by roll forming the steel through a series of dies.
- No heat is required to form the shapes (unlike hot-rolled steel), hence the name cold-formed steel.
- A variety of steel thicknesses are available to meet a wide range of structural and non-structural applications.

1.2 Advantages Over Hot Rolled Steel

- Cold-rolled steel is typically about 20% stronger than its hot-rolled counterpart.
- In addition to being stronger, cold-rolled steel has an improved surface finish. It’s smoother and has fewer surface imperfections than hot-rolled steel.

1.3 Objective

- To find the Bending capacity and study the mode of failure of the cold-formed joist beam with double furred channel section.
- Different cross section of members are studied and the parametric differences will be recorded.
- The fabricated model will be analysed and studied analytically by ANSYS software.
- Comparing the analytical values and experimental results to find the efficiency of each model.

II. METHODOLOGY

The process of the figure is shown in flowchart below

OBJECTIVE
↓
LITERATURE REVIEW
↓
IDENTIFICATION OF PROFILE
↓
TESTING AND RESULTS
↓
FEM ANALYSIS IN ANSYS
↓
COMPARISON OF RESULTS

III. DESIGN INPUTS

1. Density = 7850 kg/m^3
2. Yield Stress (f_y) = 277.48 N/mm^2
3. Ultimate Stress (f_u) = 348.58 N/mm^2
4. Young's Modulus (E) = 2 x 10^5 N/mm^2
5. % of Elongation =30.62%
6. Poisson's Ratio = 0.3

IV. ANALYTICAL MODEL

4.1 Mesh Model

A mesh model has been created for all the cross sections. The created mesh model is as follows:

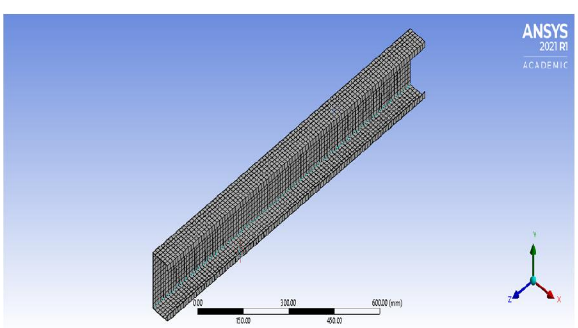

FIG NO.1: CH-1

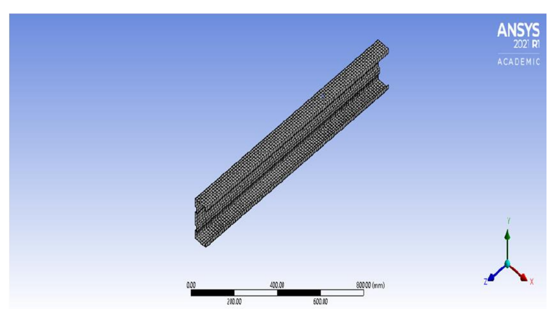

FIG NO.2: CH-2

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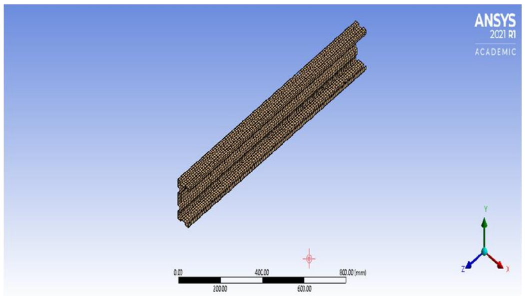


FIG NO. 3: CH-3

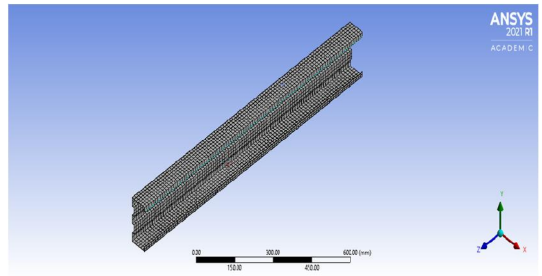


FIG NO. 4: CH-4

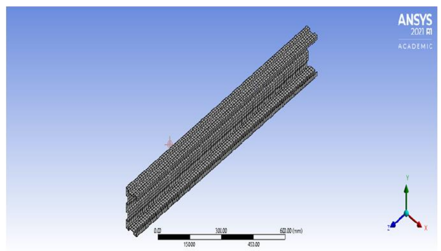


FIG NO. 5: CH-5

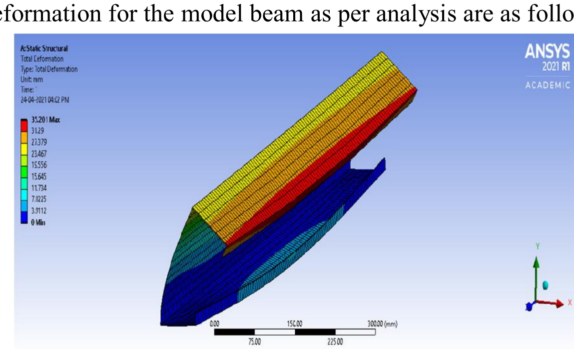
V. RESULTS

The mathematical model of the beam was analysed using ANSYS software. Based on the analysis, various results were extracted. They are as follows:

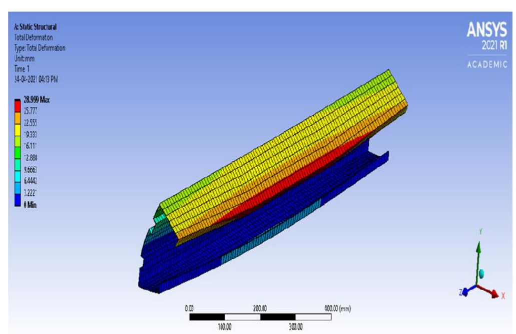
1. Directional Deformation
2. Load-Deflection Curve

5.1 Directional Deformation

The directional deformation result was taken along the Z axis of the Global Coordinate System. The directional deformation for the model beam as per analysis are as follows:



Deformation - CH-1



Deformation - CH-2

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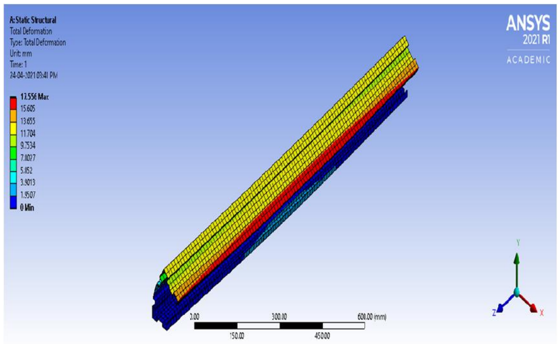
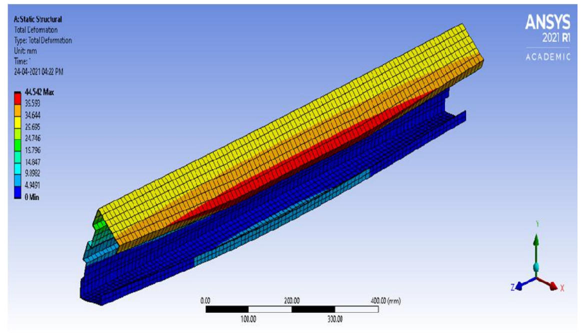
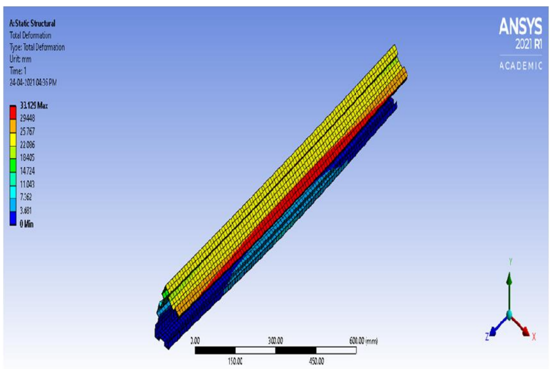


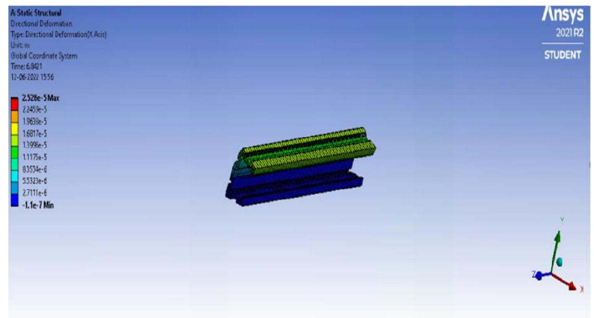
Deformation - CH-3



Deformation - CH-4



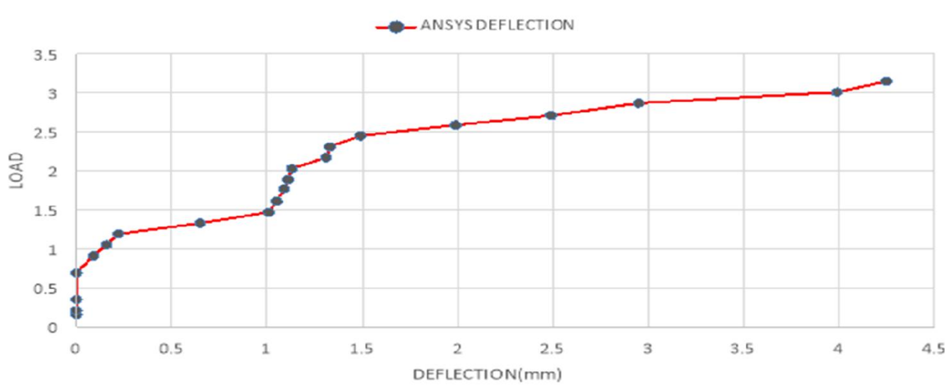
Deformation - CH-5



Deformation - New Section

5.2 Load-Deflection at Midspan

The graph has been plotted by using the analytics output from ANSYS.



5.3 Ultimate load carrying capacity of specimen

SPECIMEN	Load (kN) P_{ANSYS}	Deflection (mm) D_{ANSYS}	VARIATION= ANSYS MODEL vs CONVENTIONAL MODEL
CH1	2.31	2.85	21.46%
CH2	3.15	4.25	10.4%
CH3	3.57	2.01	31.83%

CH4	4.83	5.17	14.07%
CH5	6.37	4.29	12.4%
NEW SECTION	6.45	6.2	21%

VI. CONCLUSION

The Analytical work is performed under two-point loading to obtain the ultimate load capacity. the finite element model is created and analysed. Through this load-deflection and buckling modes are observed.

The analysis was carried out with specimens having same web depth, width of flange but varying cross-section profile.

The experiments were carried out with specimens having same web depth, width of flange but varying cross-section profile.

- From the analytical investigation it is found that the specimen with symmetrical furring in web carries more load than asymmetric furring, with comparison to the conventional channel with lip the asymmetric furred channel carries 30.8% more and channel with symmetric furring carries 70.5% more load.
- In addition to the web furring, flange furring was also provided to find out any increase the load capacity.
- The channel with symmetric furring in web carried more load than the counterpart. The CSF carried 56.4% more than CAF.
- As the sections are thin, the introduction of symmetrical stiffening will have a better resistance to buckle.

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