Analytical Study on Cold Formed Steel Beams using Shear Connectors

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Abstract— Cold formed steel sections are recently used in many areas especially in commercial and residential buildings. In this paper, the flexural behaviour of cold formed steel beams is investigated using the FEA package ABAQUS. To transfer horizontal shear between cold formed steel and concrete, shear connectors are provided. Two beams with shear connectors and two beams without shear connectors were created and tested under two point loading. The flexural strength of beam had noted. The analytical results have shown that, the load carrying capacity of beams with shear connectors has high strength when compared to beams without shear connectors.

Key words: Cold Formed Steel, Flexural Behaviour, Shear Connectors, FEA, ABAQUS

I. Introduction

Cold formed steel developed as a building material in 1930. On comparison with conventional steel construction, the cold formed structures are relatively new growth. Cold formed steel structures are also preferably called as Light Gauge steel.

Cold formed steel sections are light weight, strong, corrosion resistance and easy to install. Cold formed steel doesn't shrink, won't absorb moisture, termites and fire. Earlier, the use of cold formed steel was limited to building construction only but now it's used in midrise buildings, trucks, rail coaches, etc.,

II. Previous Studies

Divahar et al (2014) presented the Cold formed steel beam with trapezoidal corrugated web and found that the load carrying capacity with corrugated web is higher. Parvati et al (2014) studied the Flexural Behaviour of Cold Formed Steel Beams with end Stiffeners and Encased Web and found that the encased web beam is higher than other beams. Kimcheng Kang et al (2017) conducted the Experimental & Numerical investigation on cold formed steel C back to back beams and found that beam with 150mm depth and 1.5mm thickness gives higher flexural strength. Seema et al (2017) presented the Numerical investigation of flexural strength of cold form built-up beams and found that addition of edge stiffener adds to flexural strength of beams. Sudharsan et al (2018) carried out an experimental and numerical investigation of Cold-Formed Steel Composite Beams with Shear Connectors and found that beams with channel shear connectors carries more load than the beam with T type shear connectors.

III. Analytical Investigation

In this investigation, a total of four cold formed beams with and without shear connectors were created in ABAQUS software. The beam specimens were tested under two point loading for flexural behaviour.

S. no	Beam Specification	Beam designation
01.	Beam with shear connectors	WSC
02.	Beam without shear connectors	WOSC

Table 1: Beam Designation

A. Material Properties

The elastic properties of the material were allocated to the created model of WSC and WOSC beams. The value of young's modulus is $2X10^5$ N/mm^2. The Poisson's ratio is 0.3. The density of material is $7.8X10^{-6}$ N/mm^2.

B. Modelling

After adding the material type used in beam, its material property is assigned. Then, the geometric model was created. The beams were drawn using poly line and it will be assigned in XY plane and extruded for 1000mm. The WSC and WOSC beam was created as shown in Fig 1 and Fig 2. Then, the concrete part was drawn along with the steel.

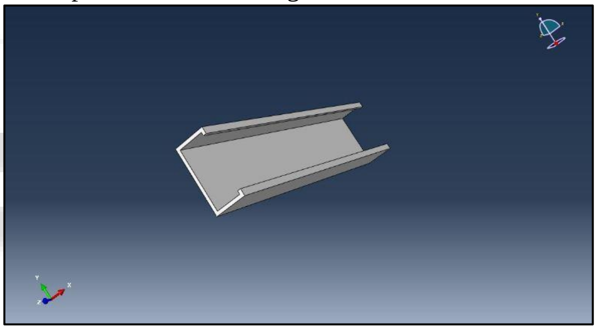

Fig. 1: WOSC Beam

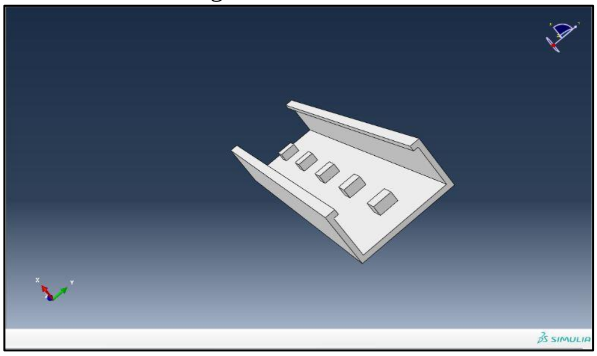

Fig. 2: WSC Beam

C. Meshing

The structural steel and concrete part was assigned to the geometry. For meshing approximate scale factor is given as 5. For beams and shear connectors, quad C3D8I type elements are used.

D. Load

The concentrated load was applied under two point loading condition. The loading arrangements are given vertically downwards at L/3 distance from supports. The beams after load applied were shown in fig 3.

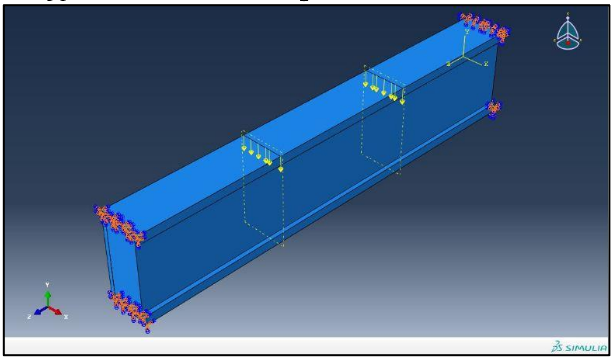

Fig. 3: Load applied in WSC and WOSC beam

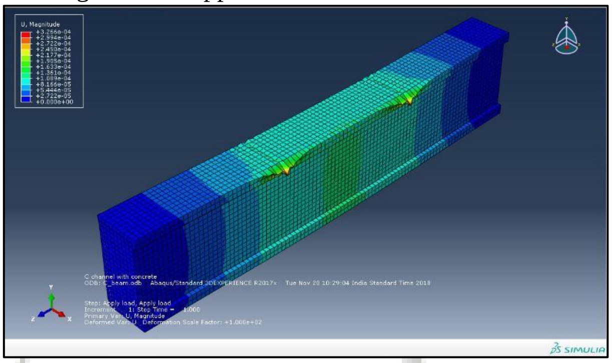

Fig. 4: Initial load failure in WOSC beam at 10kn

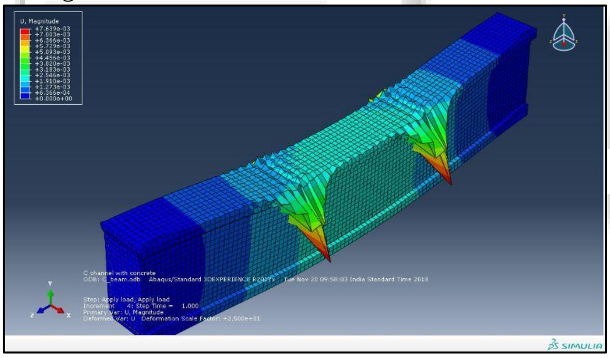

Fig. 5: Ultimate load failure in WOSC beam at 15kn

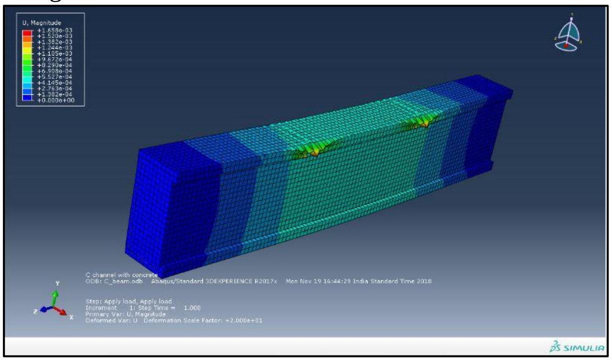

Fig. 6: Initial load failure in WSC beam at 10kn

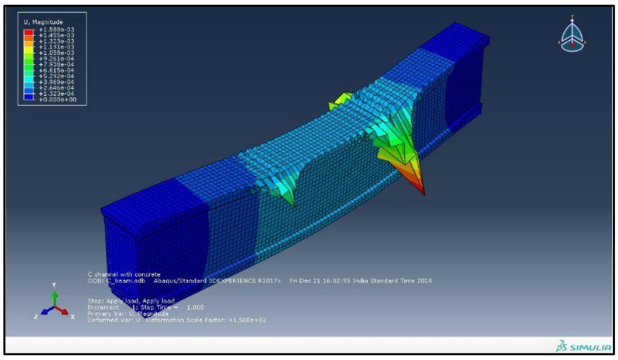

Fig. 7: Ultimate load failure in WSC beam at 26 kn

IV. RESULTS & DISCUSSION

Analysed result of two beams with shear connectors and two beams without shear connectors shows the failure of load.

Beam specification	Ultimate load in Kn	Ultimate deflection in mm
WOSC	15	6
WSC	26	11

Table 2: Ultimate loads and deflection of the models

The beam were unable to carry any further load is called as ultimate load. The ultimate load failure of WOSC beam had attained at 15kn. The ultimate load failure of WSC beam had attained at 26kn. The beam with shear connectors carries more loads compared with beams without shear connectors. The ultimate load of beams WSC and WOSC tested analytically shown in graph.

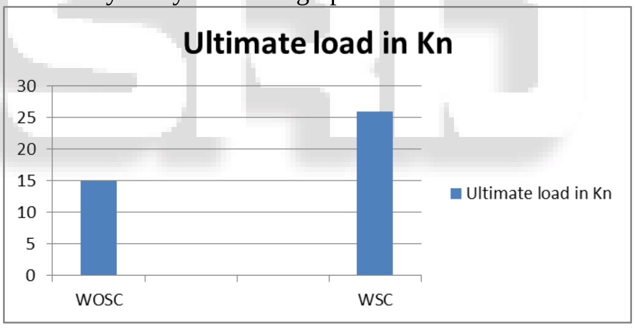

Fig. 8:

A. *Comparison of Ultimate Deflection*

Load deflection curve is the main element of the flexural strength of beams. Comparison of the ultimate deflection of WSC beams and WOSC beams were carried out. At 15kn the deflection for WOSC beam is 6mm and for the same load of WSC beam is 2.1mm. The comparison of ultimate deflection of WOSC and WSC beams were shown in graph.

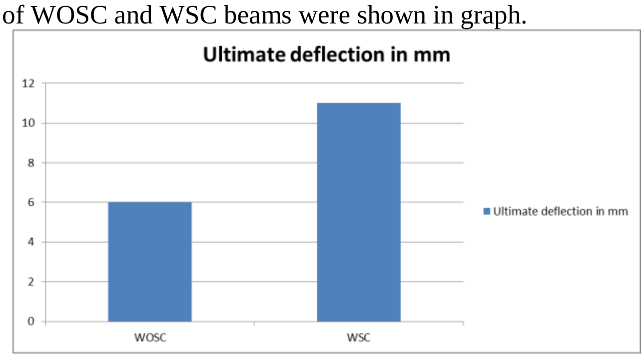

Fig. 9:

V. CONCLUSION

In this paper, an investigation into the flexural behaviour of cold formed steel beam with and without shear connectors was carried out analytically using FEA software ABAQUS.

From the tested results, the following conclusions are shown.

Cold formed steel beams with shear connectors withstand more flexural strength when compared to cold formed steel beams without shear connectors.

The ultimate load carrying capacity of beam without shear connectors (WOSC) was 15kn and the ultimate deflection was 6mm. The ultimate load of beam with shear connectors (WSC) was 26kn and the ultimate deflection was 11mm.

The ultimate load carrying capacity of WSC beam was 20-25% higher than that of WOSC beams.

The ultimate deflection of WSC beam was 10-15% lesser than that of WOSC beams.

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