

# COLD FORMED STEEL LIPPED ZED SECTION WITH AND WITHOUT WEB HOLES –WEB CRIPPLING BEHAVIOUR

N. Ajith Kumar<sup>1</sup>, D. Ajay Yogesh<sup>2</sup>, K. Akshay<sup>3</sup>, H. Allen Lloyd Swinton<sup>4</sup>

<sup>1,2,3,4</sup>UG Student, Department of civil engineering, K.Ramakrishnan College of Technology, Tiruchirapalli, Tamilnadu, India.

**Abstract** - Basically to find the Web Crippling Behavior for Cold Formed Steel Zed Section with and without Web Holes at the Centre of the selected Section is our objective. Cold-formed steel of various sections are used in many purposes like floor joists, rafter and truss work, wall studs etc., web holes are used in cold formed steel sections for installation purposes like installation of wiring, piping and bracing. Usually web holes are drilled in manufacturing industries. The Existing codes of cold formed steel do not consider the effect of web holes in the web. In this project, various analysis like theoretical, experimental and finite element analyses using ANSYS were found to investigate the effect of web holes on crippling behavior under uniformly distributed loading conditions. A comparison made between the theoretical analysis, experimental analysis and finite element analyses using ANSYS was obtained. In a theoretical analysis steel section similarly the results were found between the three conditions. Finite element models used for the purpose of parametric study of effect of different size and position of holes in web. For finite element analysis purpose the models are made and tested using ANSYS software. And the experimental analysis is done under computerized UTM.

**Key Words:** Web Crippling Behaviour, Cold formed steel, Lipped Zed Section, Web holes, Finite Element Analysis, Computerised UTM.

## 1. INTRODUCTION

The steel products which are made into finished or semi-finished products by rolling or pressing steel relatively at low temperature which is commonly called cold working. Various goods of cold formed steels are made by using steel billets, steel bars, and steel sheets by stamping, pressing or rolling to shape them into a usable product. Cold formed steel products like cold rolled steels (CRS) sheets, are commonly used in manufacturing of goods, such as automobile appliances. Cold formed steel of various sections are used as floor joists, wall studs. These type of sections are usually provided with web holes for installation purpose like installation of piping, wiring, or other services. These holes are usually made in manufacturing industries. Web crippling behavior of cold formed steel is said to have a well-known significant problem at points of concentrated, or localized load in thin walled beams, particularly in case of beams with slender webs, and is said to have high importance in the field of cold-formed steel members, because such members are generally not stiffened against this type of loading. Several lateral loading results local

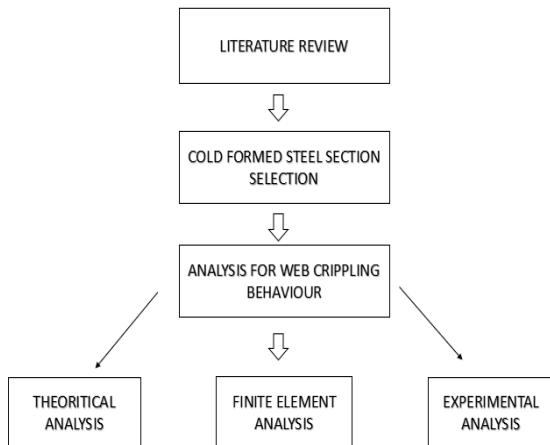
buckling or crippling in web of the beam section. For this type of section with holes, web crippling behavior consider importance and needed to be taken into account.

## 2. LITERATURE REVIEW

**Sudha.K and Sukumar:** done and presented a paper on numerical and experimental analysis on bending strength and behavior of cold formed steel built up flexure members. They have done test under two test specimen of various flange sizes like equal and unequal sizes. The specimens were built-up by using four numbers of Cold Formed steel angles with lip in the flange. The steel plates which was used by them are with yield stress of 230 N/mm<sup>2</sup> and young's modulus of  $1.98 \times 10^5$ . They have done finite element analyses using ANSYS software. And they have done experimental work by using 50KN capacity self-straining frame. The failure models used by them were mixed bearing, local, distortional and flexural. The experimental failure modes were in good agreement with ANSYS results. From their results equal Flange I-section has carried approximately about 40% more than that of unequal flange I – section.

**Azeem M, Prof. Dileep Kumar PG, and Prof. Merin Mathews (MAY 2017):** done web buckling analysis On Cold Formed Built-Up I Section. As per them the loading and boundary condition used by them include the values of Young's modulus  $2E+05$  MPa, Poisson's ratio was about 0.3, Yield strength was about 250 MPa & tangent modulus was about 1450 MPa. The specimen were modelled as back to back channels, Zed with unequal angles (case1), Channel with unequal angles, and finally Zed with unequal angles (case2). Buckling analysis were done using ANSYS software. Finite element analysis were done for both elastic and inelastic buckling. Loading condition adopted by them were Interior one flange loading condition and interior two point loading condition. As per their result, for interior two flange loading conditions back to back channel has more strength than zed with unerual angles and for all other condition zed with unequal angles has higher strength. This is due post buckling strength.

### 3. METHODOLOGY

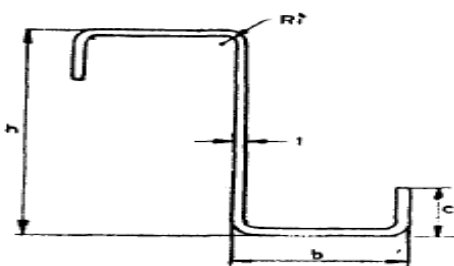


#### 3.1 OBJECTIVES

Cold-formed steel sections were used in wall studs or floor joists etc., hence such sections were often included web holes in them for easy installation. Cold-formed steel design codes such as IS801:1975 etc. do not consider the effect of web holes. In this paper, a combination of experimental tests, theoretical analysis and finite element analyses are used to investigate the effect of such holes on web crippling under simply supported uniformly distributed loading condition. Therefore comparison is made between the experimental tests, theoretical analysis and finite element analyses obtained. The finite element model was then used for the purposes of a study on the effect of holes in the web. It was found that the factors which influence the web crippling are the ratio of the web hole depth to the web depth and the distance from the edge of the bearing is divided by the flat depth of the web. Design recommendations for web crippling strength reduction factors were to be proposed, that are conservative to theoretical, the experimental and finite element results.

#### 3.2 PROPOSED SYSTEM

In this paper, a combination of theoretical analysis, experimental tests and finite element analyses (FEA) are used to find the effect of circular web holes on the web crippling strength of lipped zed sections for the uniformly distributed loading condition. The general purpose finite element program ANSYS are used.



### Cold-formed steel lipped zed section without web holes Specimen dimensions

Specimen	Web mm	Flange mm	Lip mm	Hole mm	Length(L) mm
ZS-140*2.0t	140	60	20	0	420
ZS-140*2.0t	140	60	20	42	420
ZS-160*2.0t	160	60	20	0	480
ZS-160*2.0t	160	60	20	48	480

### 4. THEORITICAL ANALYSES

#### BASED ON IS 801-1975

$$M_d = \beta_b Z_p f_y / \gamma_{m0}$$

Where  $\beta_b = 1.0$  (for plastic and compact section)

$$\text{Hence } M = f_y * Z_{xx}$$

Allowable load (W)

$$W = M * 8 / L^2$$

#### BASED ON BS 5950-1998

##### (Clause 5.2.2.2)

$$M = P_0 * Z_{xx}$$

$$P_0 = [1.13 - 0.0019 * (D_w / t) * (Y_s / 280)^{0.5}] * P_y$$

Where

$P_y =$  Design strength (N/mm<sup>2</sup>)

$D_w =$  section depth (mm)

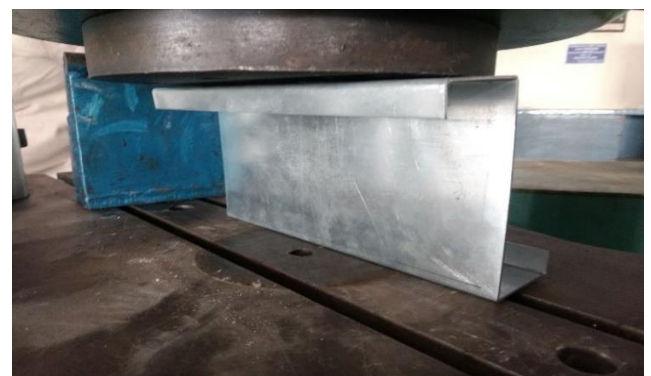
$Y_s =$  material yield stress (N/mm<sup>2</sup>)

$t =$  thickness of the web (mm)

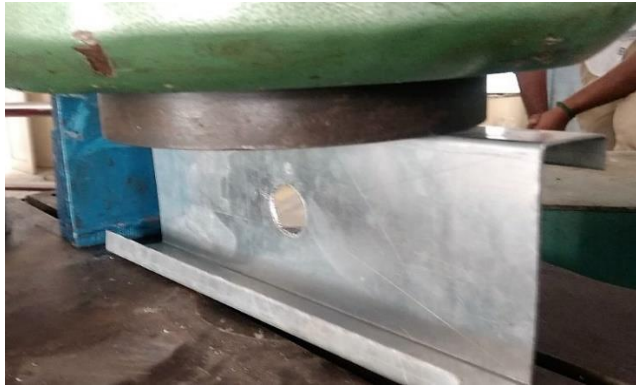
### 5. EXPERIMENTAL TEST

#### Test Setup

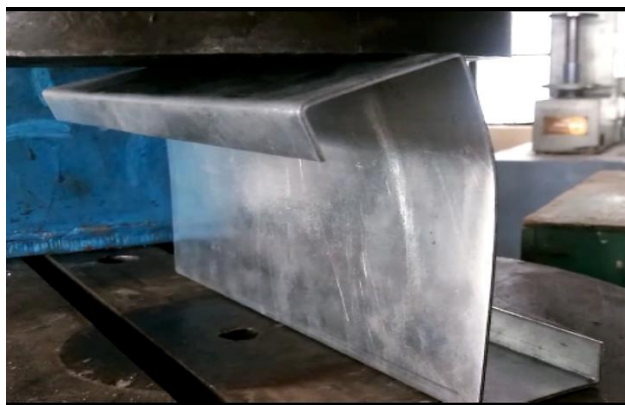
A test conducted on Lipped Zed sectional steel:



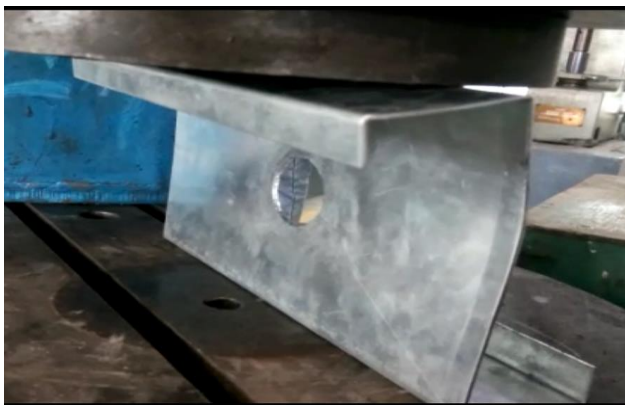
Uniformly loading condition without web holes



Uniformly loading condition with web holes



Loading condition on failure without web holes



Loading condition on failure with web holes

**FLEXURE TEST RESULTS**

**Table 5**

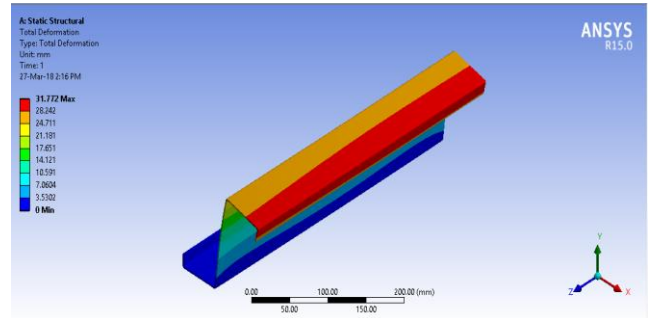
Section	B/D ratio	Peak Load in (KN)	Max deflection at mid span
ZS-140*2.0t	0.84	40.350	4.700
ZS-140*2.0t	0.84	38.000	3.300
ZS-160*2.0t	0.73	46.250	3.300
ZS-160*2.0t	0.73	44.350	4.500

**VI. FINITE ELEMENT ANALYSIS**

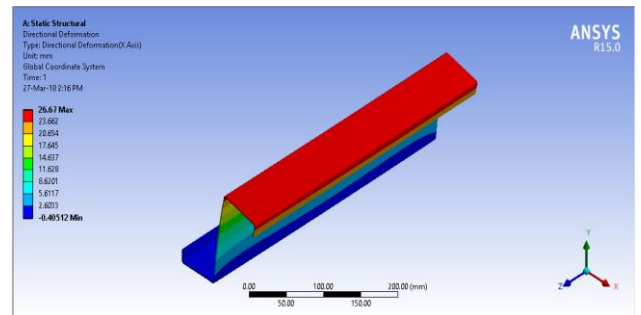
**ANSYS MODEL**

**SPECIMEN 1:**

**Total Deformation:**

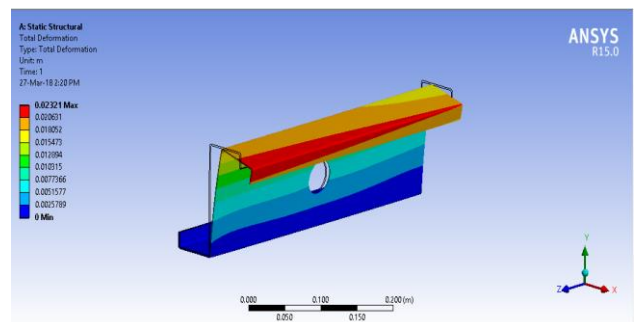


**Directional deformation:**

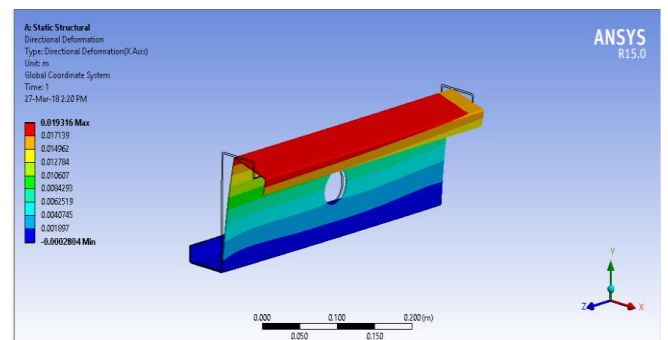


**SPECIMEN 2:**

**Total deformation:**

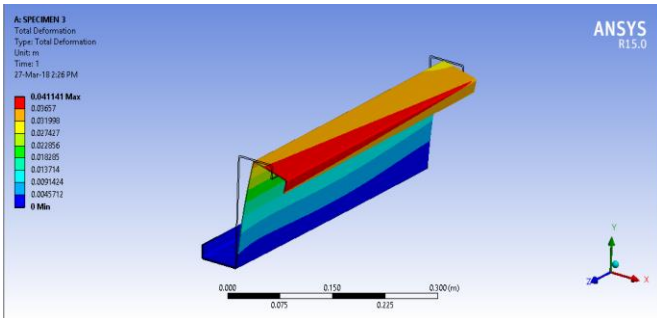


**Directional deformation:**

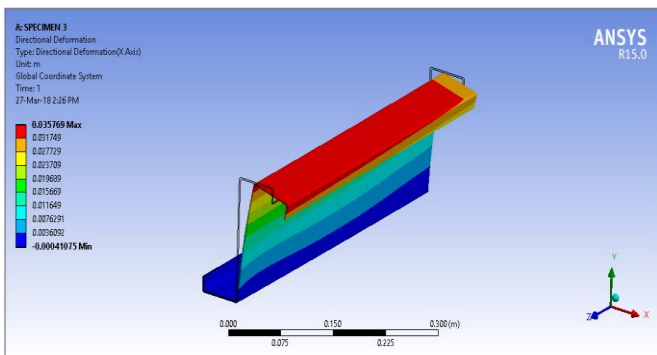


**SPECIMEN 3:**

**Total Deformation:**

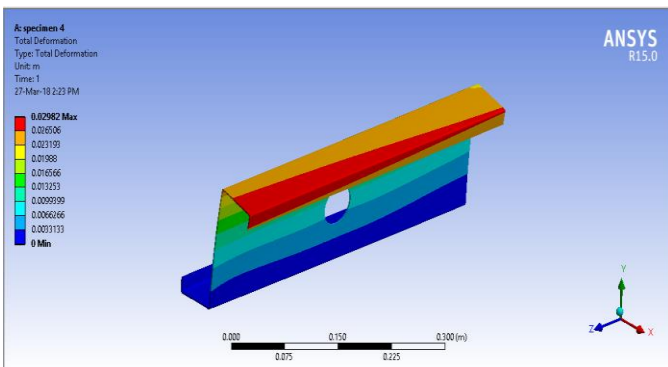


**Directional deformation:**

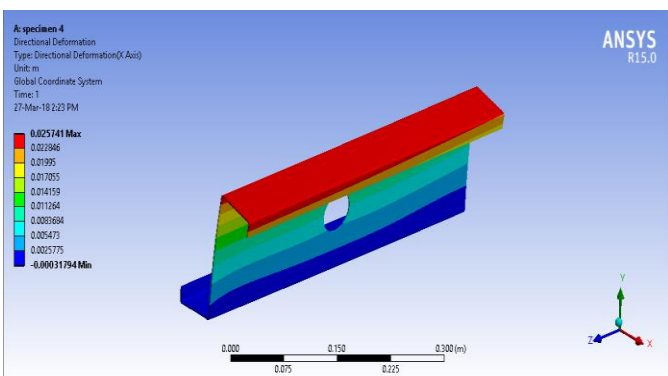


**SPECIMEN 4:**

**Total Deformation:**



**Directional deformation:**



**6.3 LOAD CARRYING CAPACITY OF THE SECTION**

SPECIMEN	Load carrying capacity (KN)
ZS-140*2.0t	40.350
ZS-140*2.0t	38.000
ZS-160*2.0t	46.250
ZS-160*2.0t	44.350

**COMPARISON OF WEB CRIPPLING STRENGTH FROM THE RESULTS OF THEORETICAL, EXPERIMENTAL AND NUMERICAL ANALYSIS:**

SECTION	IS801-1974 (N/mm)	IS5950-1998 (N/mm)	EXPERIMENT (KN)
ZS-140*2.0t	246.43	190.90	40.350
ZS-140*2.0t	246.43	190.90	38.000
ZS-160*2.0t	225.34	224.28	46.250
ZS-160*2.0t	225.34	224.28	44.350

**7. CONCLUSION**

The theoretical, experimental and the numerical investigation of Zed section with and without web holes subjected to web crippling strength are presented. The tests were conducted on uniformly loading condition. The finite element models are used to show the web crippling behavior of the cold formed Zed section both with and without web holes. Therefore, the parametric study of the effect of different sizes of the cross-sections and the web holes on the web crippling strength of cold formed Zed section. It is shown the ratio of a/h and h/t are the primary parametric relationships influencing the web crippling behavior of cold formed Zed section with the web holes. The strength reduction factors agree well with the experimental and numerical results but theoretical values are very high compare to the both.

**REFERENCES**

1. T.Soundharya, D.Gowsika, R.Kamalambigai. Cold-formed steel Back to Back Lipped Channel Section with and without web holes-Web crippling Behavior. ISSN: 2321-9939
2. Gunalan, M. Mahendran. Web Crippling Tests of Cold-formed Steel Channels under Two Flange Load Cases
3. Sudha,K, Sukumar. Behaviour of Cold-Formed Steel Built-up I Section Under Bending
4. K. Jothi Baskar, R.Aravindh, A. Ashik Elahi, B. Mohanraj, A. Prakash. Experimental Study on Behaviour of Cold Formed Steel using C Channel Section under Axial Compression: April 2016

5. S. Jayaraman, S. Suresh babu. Experimental Investigation on Flexural Behavior of Cold Formed Corrugated Steel Section: 2321-0613
6. R.Maheswari, K.Soundhirarajan,M.E. Web Crippling Behaviour of Cold-Formed CSection with and Without FRP Wrapping
7. Ashok M, Jayabalan P and Jaya Prabhakar K. Flexural Behaviour of Cold Formed Steel Hat Shaped Beam