Cold-formed steel Back to Back Lipped Channel Section with and without web holes-Web crippling Behavior

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Abstract **- Cold- formed steel sections are used as wall studs (or) floor joists, rafters and trusses, such sections include web holes for ease of installation. Cold-formed steel design codes does not consider the effect of such web holes. In this paper, combination of theoretical tests, experimental tests and finite element analyses are used to investigate the effect of such holes on web crippling under concentrated loading conditions. A good agreement between the theoretical, experimental tests and finite element analyses was obtained. The finite element models are used for the purposes of parametric study on effect of different size and position of web holes. The main factors influencing the web crippling strength are the ratio of the depth of hole to the depth of web. In these paper recommendations for web crippling strength reduction factors are proposed.**

Keywords **- floor joist, crippling, rafters**

I INTRODUCTION

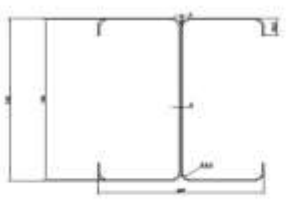
Cold-formed steel sections are used in building as wall studs (or) floor joists, rafters and trusses. The sections include web holes for used in ease of installation of wiring, piping and bracing. The web holes are usually manufactured in industry. Since 1960 the projects on the research and development of cold-formed steel products for housing. National Association of Home Builders Research Center to develop a prescriptive method for residential cold-formed steel framing. This project was sponsored by the American Iron and steel Institute, the U.S.Department of Housing and Urban Development (HUD) and the National Association of Home Builders (NAHB) in 1997.Prescriptive method were adopted by the International code council (ICC) for its one-and Two-Family Dwelling code. In this method standardizes C-Sections with lips and without lips for structural members.

It has been little research on the web crippling of cold-formed steel sections with web holes. La Boube et al 168 test on single lipped channel sections investigate the web crippling strength on loading conditions are Interior-one-flange loading condition and End-one-flange loading condition with the offset circular holes located on next to the bearing plate. Strength reduction factors are proposed. Langan et al [9] 168 test on single lipped channel sections investigate the web crippling strength on loading conditions are Interior-one-flange loading condition and End-one-flange loading condition with the offset rectangular holes located on next to the bearing plate. Investigate web crippling strength ratio of the depth of the hole to the depth of the web, and ratio of the distance from the edge of the bearing plate to the flat depth of web. Asraf Uzzaman et al [10]19 test on single lipped channel section investigate the web crippling strength on loading conditions are Interior-two-flange loading condition. In the case of flange fastened and unfastened conditions are considered with the web holes on offset circular holes located on the bearing plate. Strength reduction factors are proposed, the web crippling strength ratio of the depth of the hole to the depth of the web.

In this paper, a combination of experimental tests and finite element analyses (FEA) are used to investigate the effect of circular web holes on the web crippling strength of back to back lipped channel sections for the concentrated loading condition.

The general purpose finite element program ANSYS (11) are used for the numerical investigation. A good agreement between the theoretical, experimental tests and finite element analyses.

SPECIMEN - 1



SPECIMEN – 1

ALL DIMENSION IN MM

IITHEORITICAL ANALYSES

The sections are analyzed by the following codal provision.

<u>BASED ON IS 801-1974</u>

SPECIMEN 1-B-BLCS 142
Moment of Resistance
M = f x zxx
= 220 X $8.03X10^3$
=$1.76X10^6$ KN.m
Allowable Load
M=WL/6
W =M X 6/ L
=1.76 $X10^6$ X 6 / 501
=42.07 KN

Table 1-LOAD CARRYING CAPACITY OF THE SECTION

Section	f (N/mm^2)	M=fx.zxx (KN.m)	W= M X 6 /L (KN)
B-BLCS 142	220	1.76 $X10^6$	42.07
B-BLCS 142	220	3.88 $X10^6$	92.49
B-BLCS 144	220	3.94 $X10^6$	93.81
B-BLCS 144	220	3.97 $X10^6$	95.66

BASED ON BS 5950-1998
SPECIMEN 1-B-BLCS 142
MC = P0 X ZXX
PO = (1.13 – 0.0019 (DW/t) (Ys / 280)1/2)X P
= (1.13 – 0.0019 (142/2) (220 / 280)1/2)X 220
= 222.293 N/mm^2
MC = 222.293 X 8.03 X 10^3
= 1.78 X 10^6 Nmm
MC = WL / 6
W = MC X 6/ L
= 1.78 $X10^6$ X 6 / 501
=21.32 KN

Table 2-LOAD CARRYING CAPACITY OF THE SECTION

Section	f (N/mm^2)	MC=POX Z (KN.m)	W= M X 6 /L (KN)
B-BLCS 142	220	1.78 X 10^6	21.32
B-BLCS 142	220	3.96 X 10^6	47.33
B-BLCS 144	220	4.02 X 10^6	48.05

III Experimental Investigation-Test Setup
A test conducted on back to back lipped channel section as shown in fig 1and fig 2


Fig.1 Point loading condition without web holes


Fig.2 Point loading condition with web holes

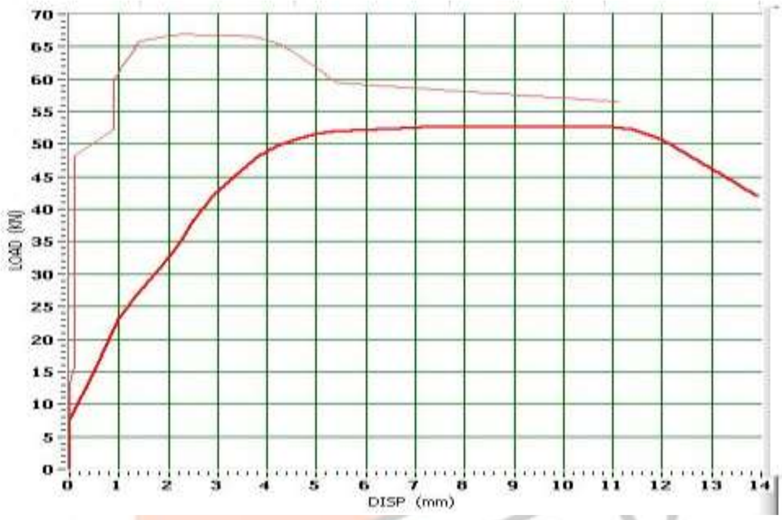
Using the readings obtained from the above experiment, the following graphs are plotted.

Table 3-FLEXURE TEST RESULTS

Section	B/D ratio	Ultimate Load in(KN)	Max deflection at mid span
B-BLCS 142	0.84	10.20	6.80
B-BLCS 142	0.85	9.99	6.70
B-BLCS 144	0.81	10.80	8.60
B-BLCS 144	0.83	10.80	8.60

Fig.3 SPECIMEN 1-B-BLCS 142 WITHOUT WEB HOLESLOAD VS DISPLACEMENT

Fig.4 SPECIMEN III-B-BLCS 144 with web holes LOAD VS DISPLACEMEN



IV MODE OF FAILURE

SPECIMEN 1-B-BLCS 142-without web holes

Fig.5 Local Buckling occurs at mid span at the compression Flange.

SPECIMEN III B-BLCS 144-with web holes

Fig.6 Local buckling occurs at the mid span of the compression flange

V NUMERICAL INVESTIGATION ANSYS MODEL

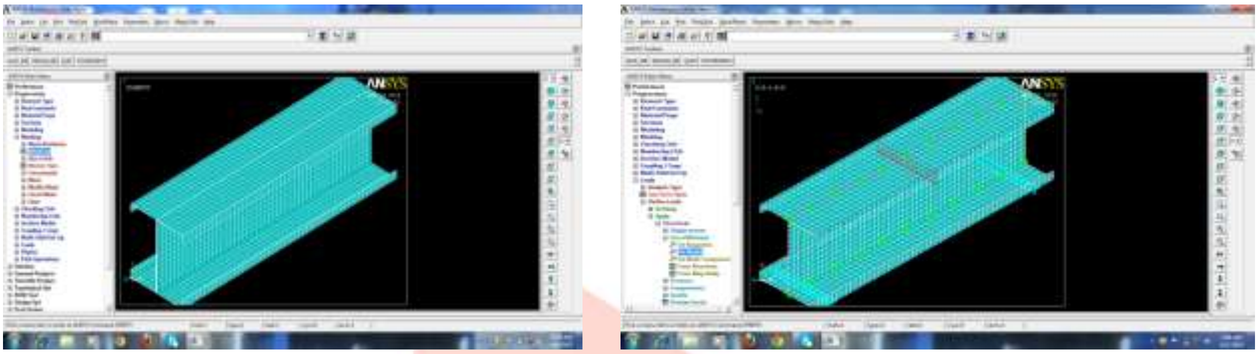


Fig.7 Ansys Model with Loading and Support Condition

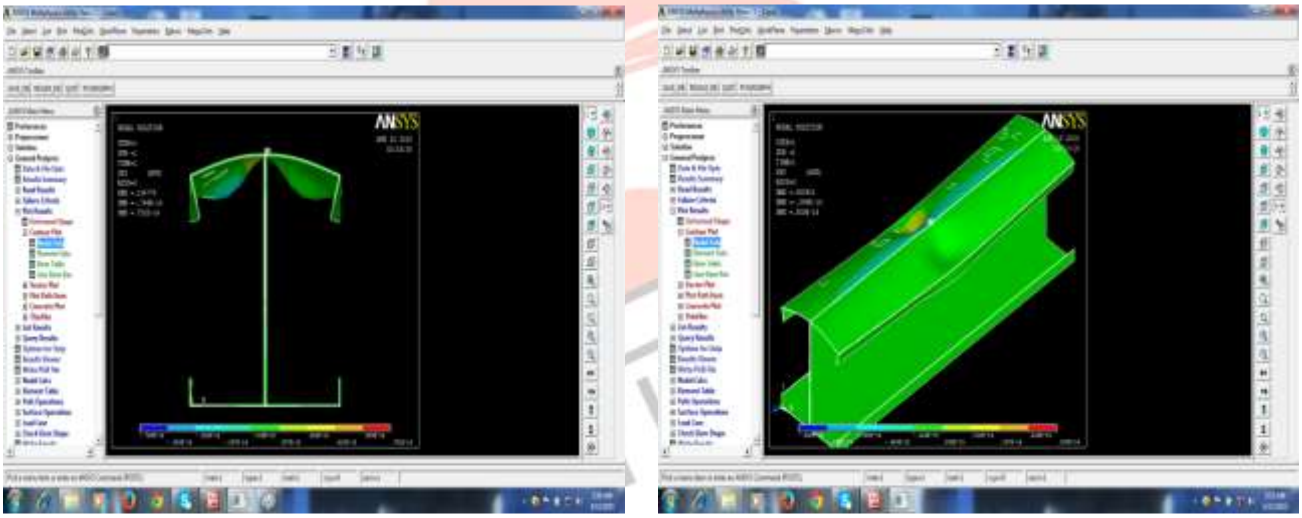


Fig.8 Local buckling initiate the failure as shown in occurance of the bending zone.

Table 4-LOAD CARRYING CAPACITY OF THE SECTION

Section	Load carrying capacity (KN)
B-BLCS 142	10.21
B-BLCS 142	9.79
B-BLCS 144	10.81
B-BLCS 144	10.79

VI Comparison of Results

The failure pattern obtained from the numerical analysis (ANSYS) matches with the experimental and it shown below.

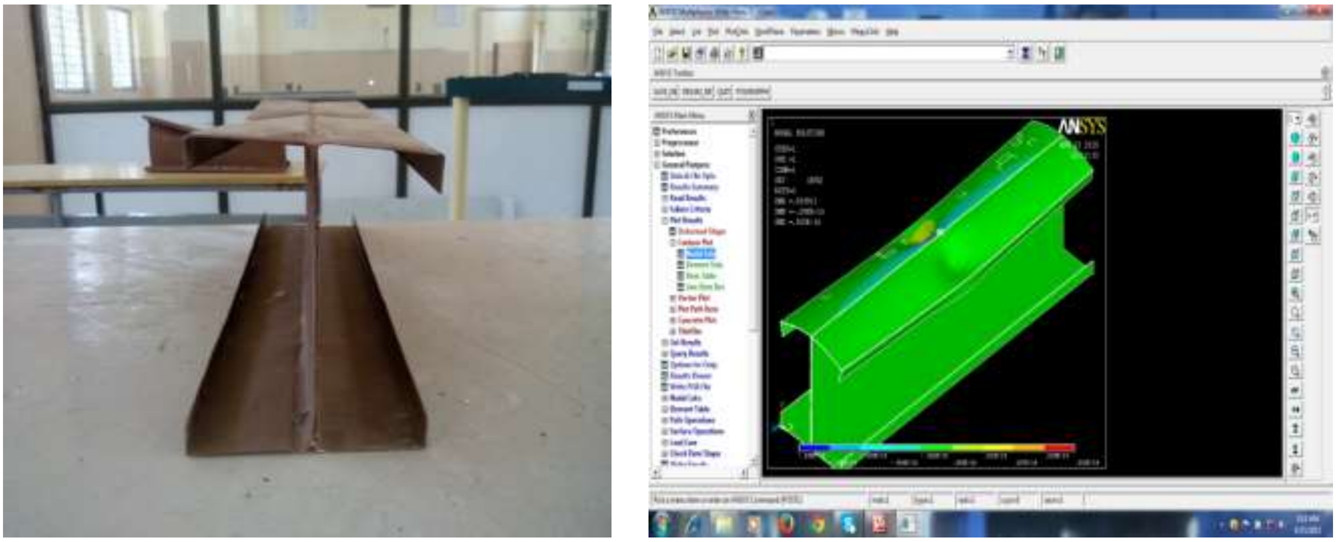
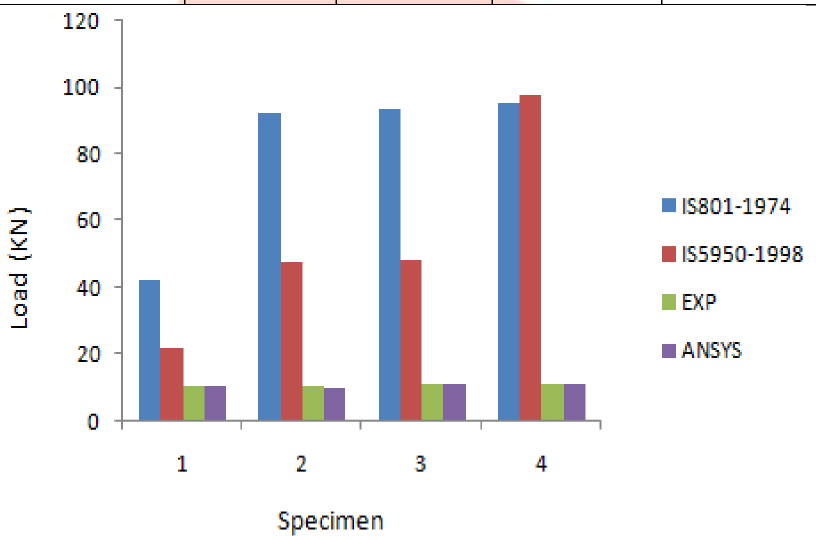


Fig.9 Buckling under the concentrated load

Table 5-Comparison of web crippling strength from the results of theoretical, Experimental and Numerical Analysis

SECTION	Web slenderness (h/t)	Ratio (a/h)	IS801-1974	IS5950-1998	EXPERIMENT	ANSYS
B-BLCS 142	70	0	42.07KN	21.32KN	10.20KN	10.21KN
B-BLCS 142	63.5	0	92.49KN	47.33KN	9.99KN	9.79KN
B-BLCS 144	64.4	0.4	93.81KN	48.05KN	10.80KN	10.81KN
B-BLCS 144	64.45	0.4	95.66KN	97.58KN	10.80KN	10.79KN



VII CONCLUSION

The theoretical, experimental and the numerical investigation of back to back lipped channel section with circular web holes subjected to web crippling strength are presented. The tests are conducted on concentrated loading condition. The web slenderness and diameter of web holes are varied to investigate web holes of the web crippling strength. The finite element models are shown the web crippling behavior of the back to back lipped channel section both with and without web circular 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 the back to back lipped channel section. It is shown the ratio of a/h and h/t are the primary parametric relationships influencing the web crippling behavior of the back to back lipped channel section with the web holes. The strength reduction factors are generally conservative and agree well with the experimental and numerical results but theoretical values are very high compare to the both.

VIII REFERENCES

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