Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406
International Journal of Advance Engineering and Research Development
Volume 5, Issue 04, April -2018

PARAMETRIC STUDY OF COLD-FORMED STEEL LIPPED CHANNEL COLUMN SECTION

Khyati A. Patel[1],Hitesh K. Dhameliya[2], Krutarth S. Patel[3]

[1]*M.Tech Structural Engineering Student, CGPIT, Bardoli, Gujarat, India*
[2]*Assistant Professor, Civil Engineering Department,CGPIT, Bardoli, Gujarat, India*
[3]*Assistant Professor, Civil Engineering Department, CGPIT, Bardoli, Gujarat, India*

Abstract — *Usage of cold formed steel structural components for buildings and structures is gaining popularity in India for a decade. Most effective use of Cold-formed steel can be made for different purposes since they are economical in production. This paper presents the details of the finite strip models developed to investigate the buckling behaviour of cold-formed steel column. Cold-formed steel is vulnerable to buckling due to its thinner section which affects the strength of the section. In order to assess the influence of buckling, four thicknesses (1.2mm, 2mm, 3.15mm, 4mm) were chosen. Finite strip analysis was performed using CUFSM software. Parametric studies have been conducted for ratio of web height to flange width and ratio of lip length to flange width.*

Keywords*-Cold-formed steel, Local buckling, Distortional buckling, Global buckling, Finite strip analysis, CUFSM, Parametric study*

I. INTRODUCTION

All over the world, applications of thin-walled sections have been a growing demand in all the engineering industry due to their low self-weight, high performance of structural systems with uniform quality, simple fabrication process and cost effective in both transport/erection. The buckling behaviour of the thin-walled column is governed by various parameters such as cross-sectional geometry, dimensions and slenderness ratio. [2]

Cold-formed steel members are made from steel sheets either through press-braking or rolling done at room temperature. Cold-formed steel sections are typically thin-walled with a thickness ranging from 0.4 mm to 6.5 mm. Cold-formed steel sections are widely used in lightweight steel construction. It may serve as efficient primary framing systems in low to mid-rise construction and secondary framing systems in high-rise construction. It is also used in speciality structures such as storage racks and greenhouses. The cold-forming process enables manufacturers to create various section types. [3]

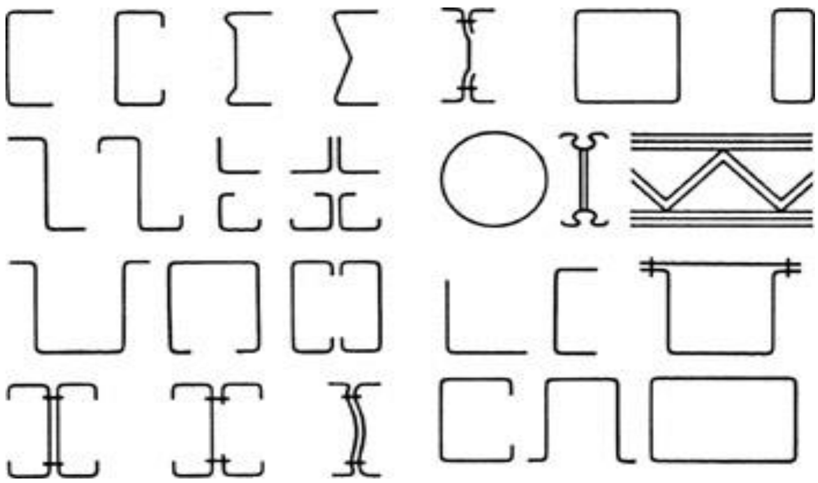

Figure 1. Various forms of cold-formed steel section [8]

Two main methods are used to produce cold-formed members: i) roll forming and ii) brake operation. Roll forming is the most popular manufacturing process while at the same time allows more automation to take place. Its use is beneficial when high production rates are required, especially if accompanied by identical cross-sectional shapes, resulting from the high tooling but low labor cost. On the other hand, brake operation can be efficient in low-volume and geometrically diversified production while limitations arise from the difficulty to produce lengths higher than 6-7m. [1]

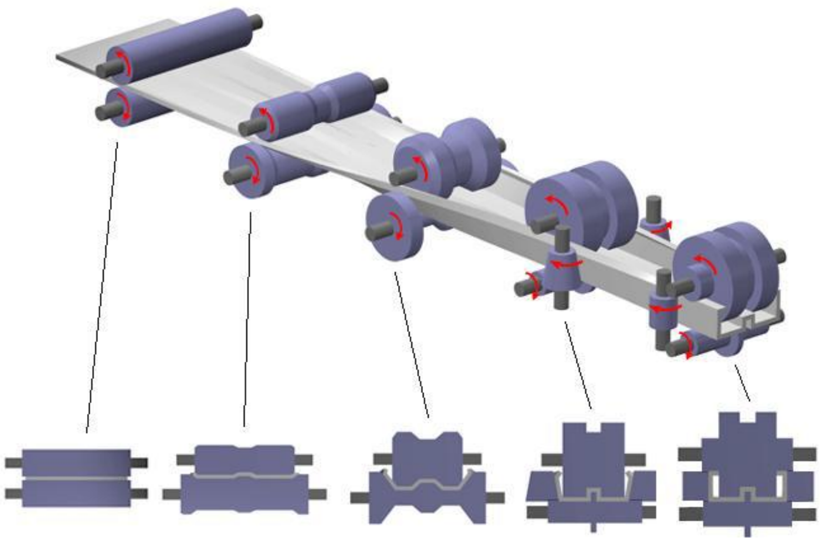

Figure 2. Roll forming process [6]

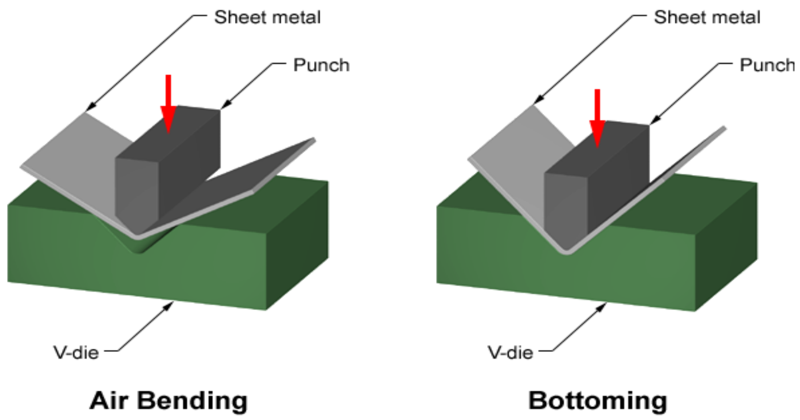

Figure 3. Brake forming process [7]

II. METHODOLOGY

The behaviour of cold-formed steel structures is more complex than that of hot-rolled steel structures. Past research has highlighted that cold-formed steel members are subjected to various buckling modes such as local, distortional and global modes and their ultimate strength behaviour is governed by these buckling modes.

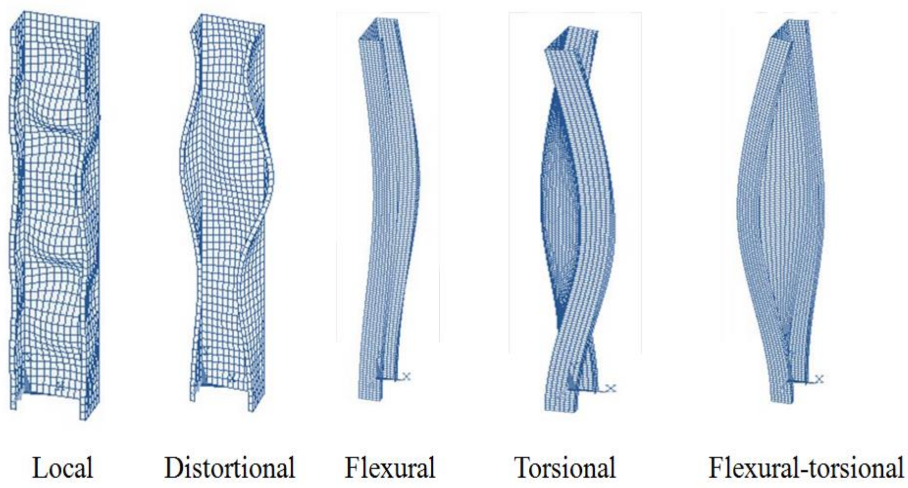

Figure 4. Buckling modes of cold-formed steel column

Finite strip models were developed for all the possible geometry (48nos.) of cold formed steel lipped channel section having 2mm thickness and 210mm perimeter. Similarly, 48 models for each 1.2mm, 3.15mm and 4mm thickness were developed. Total 196 finite strip models were developed using CUFSM.

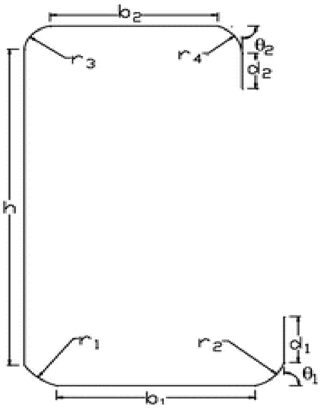

Figure 5. Section geometry

Parametric study was conducted in two phase:

- In first phase, parametric study for series-1 of total 48 specimens was conducted using thickness=2mm and perimeter=210mm. Effect of various geometric parameters like (h/b), (d/b) were studied.
- Similarly, parametric study for 1.2mm, 3.15mm and 4mm thickness was conducted in later phase.

Table 1. Section database for series-1

SR.NO.	SECTION	h (mm)	b (mm)	d (mm)	t (mm)	r (mm)
1	C60X60X15X2	60	60	15	2	3
2	C60X55X20X2	60	55	20	2	3
3	C60X50X25X2	60	50	25	2	3
4	C70X60X10X2	70	60	10	2	3
5	C70X55X15X2	70	55	15	2	3
6	C70X50X20X2	70	50	20	2	3
7	C70X45X25X2	70	45	25	2	3
8	C70X40X30X2	70	40	30	2	3
9	C80X55X10X2	80	55	10	2	3
10	C80X50X15X2	80	50	15	2	3
11	C80X45X20X2	80	45	20	2	3
12	C80X40X25X2	80	40	25	2	3
13	C80X35X30X2	80	35	30	2	3
14	C80X30X35X2	80	30	35	2	3
15	C90X50X10X2	90	50	10	2	3
16	C90X45X15X2	90	45	15	2	3
17	C90X40X20X2	90	40	20	2	3
18	C90X35X25X2	90	35	25	2	3
19	C90X30X30X2	90	30	30	2	3
20	C90X25X35X2	90	25	35	2	3
21	C90X20X40X2	90	20	40	2	3
22	C100X45X10X2	100	45	10	2	3
23	C100X40X15X2	100	40	15	2	3
24	C100X35X20X2	100	35	20	2	3
25	C100X30X25X2	100	30	25	2	3
26	C100X25X30X2	100	25	30	2	3
27	C100X20X35X2	100	20	35	2	3
28	C100X15X40X2	100	15	40	2	3
29	C110X40X10X2	110	40	10	2	3
30	C110X35X15X2	110	35	15	2	3
31	C110X30X20X2	110	30	20	2	3

32	C110X25X25X2	110	25	25	2	3
33	C110X20X30X2	110	20	30	2	3
34	C110X15X35X2	110	15	35	2	3
35	C120X35X10X2	120	35	10	2	3
36	C120X30X15X2	120	30	15	2	3
37	C120X25X20X2	120	25	20	2	3
38	C120X20X25X2	120	20	25	2	3
39	C120X15X30X2	120	15	30	2	3
40	C130X30X10X2	130	30	10	2	3
41	C130X25X15X2	130	25	15	2	3
42	C130X20X20X2	130	20	20	2	3
43	C130X15X25X2	130	15	25	2	3
44	C140X25X10X2	140	25	10	2	3
45	C140X20X15X2	140	20	15	2	3
46	C140X15X20X2	140	15	20	2	3
47	C150X20X10X2	150	20	10	2	3
48	C150X15X15X2	150	15	15	2	3

III. RESULTS AND DISCUSSION

Buckling analysis of all the models was done using CUFSM software and results were used for parametric study.

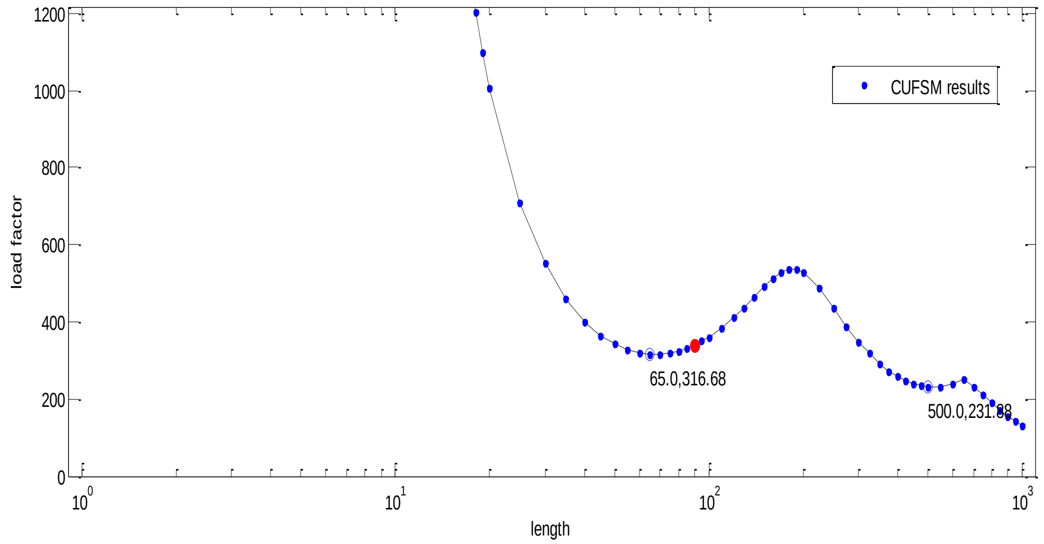

Chart 1. CUFSM result for C60X60X15X2

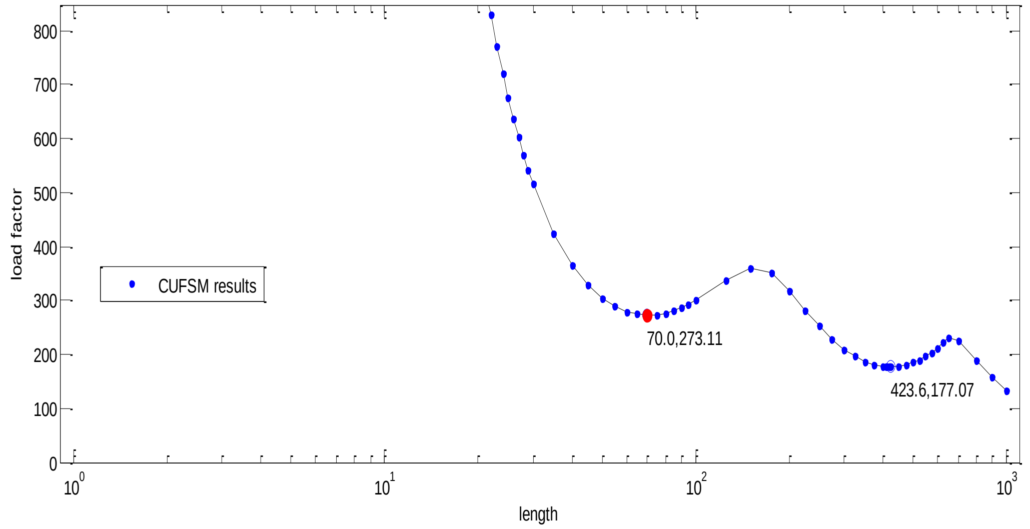

Chart 2. CUFSM result for C70X60X10X2

It can be observed from above chart 1 and 2 that buckling of cold formed steel compression member is not only governs by global/elastic buckling, but it is governs by Local, Distortional and Global buckling. Similarly, study on section database of all four series mentioned was conducted.

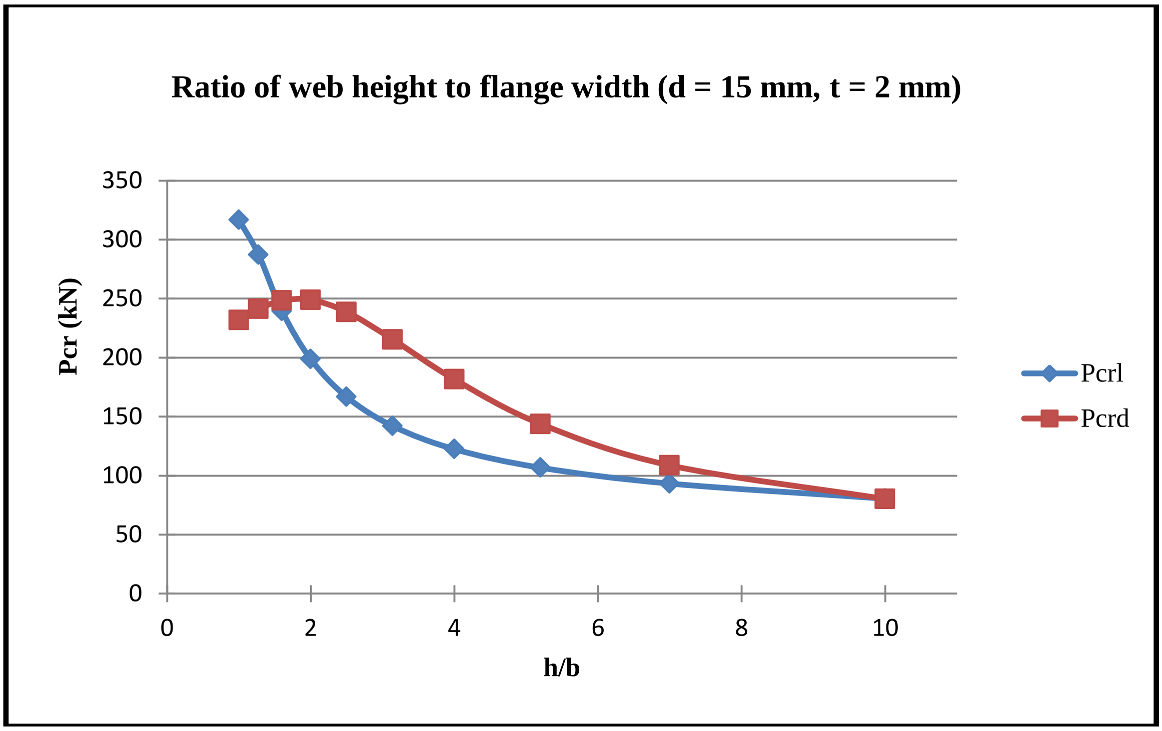

Chart 3. Effect of h/b for d=15mm, t=2mm

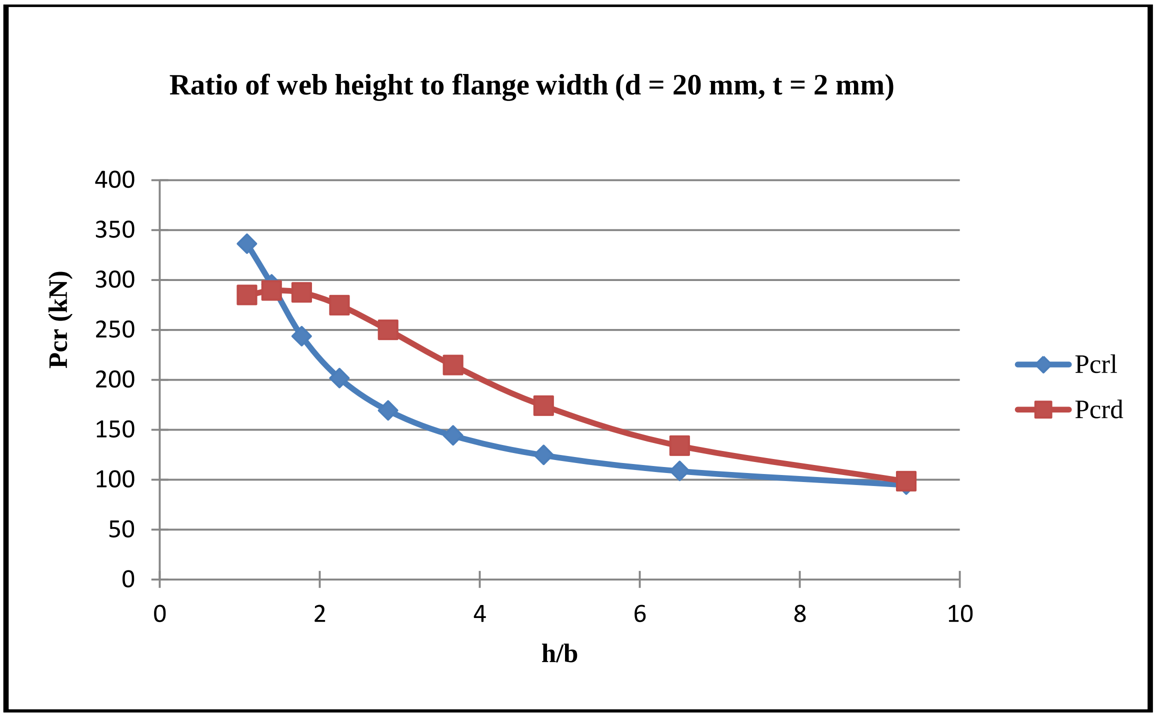

Chart 4. Effect of h/b for d=20mm, t=2mm

It can be observed from chart 3 and 4 that value of critical local buckling load (Pcrl) decreases with increase in ratio of web height to flange width ratio (h/b). No particular pattern has been observed for critical distortional buckling load (Pcrd).

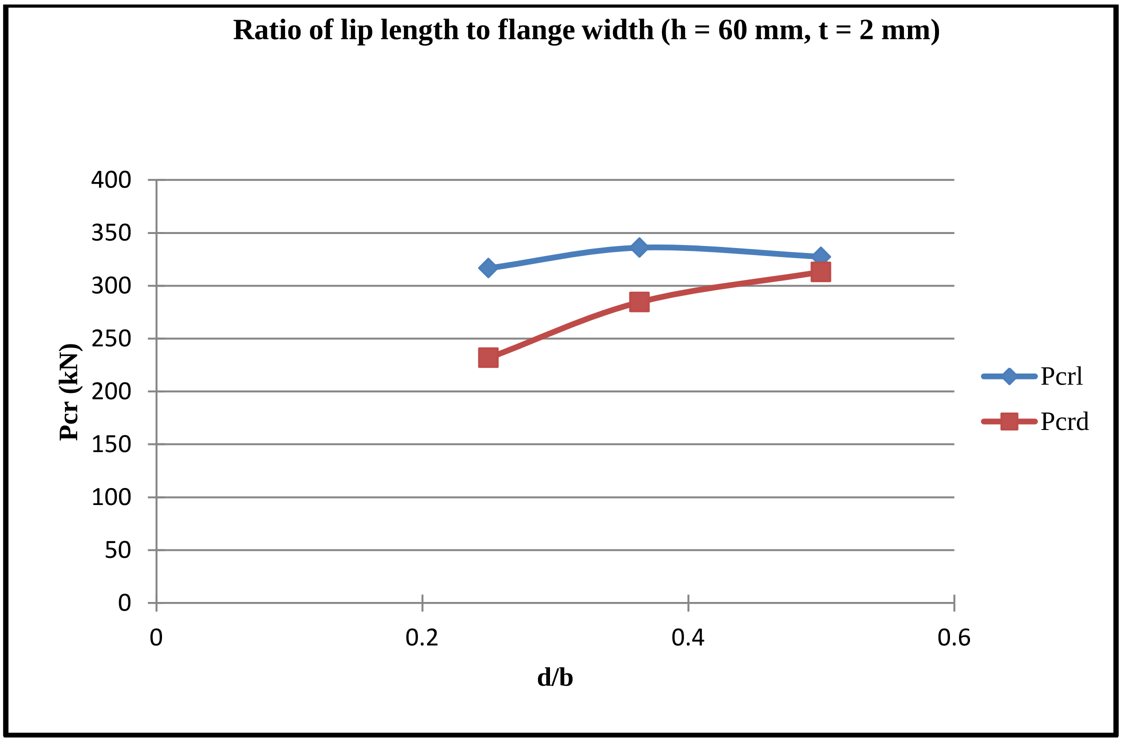

Chart 5. Effect of d/b for h=60mm, t=2mm

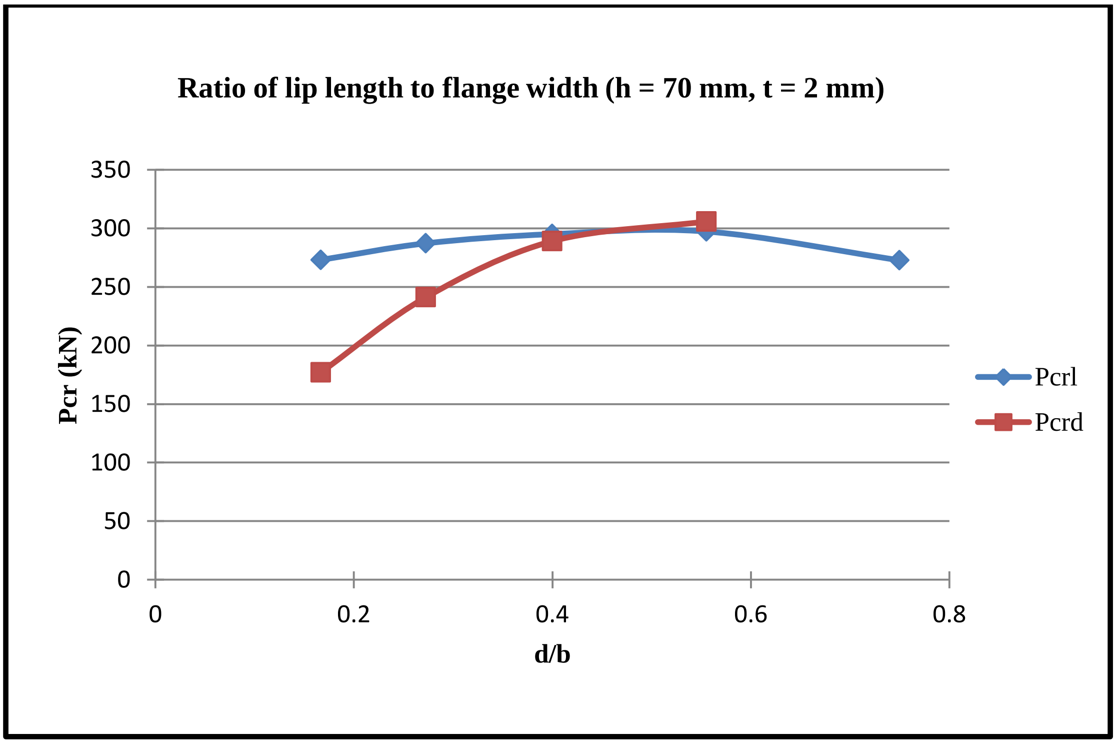

Chart 6. Effect of d/b for h=70mm, t=2mm

It can be observed from chart 5 and 6 that value of critical local buckling load (Pcrl) increases with increase in ratio of lip length to flange width (d/b). No particular pattern have been observed for critical distortional buckling load (Pcrd).

IV. CONCLUSION

1. From the finite strip analysis, it have been observed that buckling of cold formed steel compression member is not only governs by global/elastic buckling, but it is governs by Local, Distortional and Global buckling.
2. From the parametric study, it have been observed that ;

- Value of critical local buckling load (Pcrl) increases with increase in lip length (d) upto 20mm and later it decreases.
- Value of critical distortional buckling load (Pcrd) increases with increase in lip length (d) upto 25mm and later distortional buckling does not occur.
- Value of critical local buckling load (Pcrl) and critical distortional buckling load (Pcrd) decreases with increase in web height (h).
- By varying thickness of lipped channel section, results remains same as observed above only value of Pcrl and Pcrd increases with increase in thickness.

REFERENCES

[1] Hancock, G. J., Murray, T. M. and Ellifritt, D. S., Cold-Formed Steel Structures to the AISI Specification, New York: Marcel Dekker, Inc., 2001.
[2] P. Manikandan, N. Arun, “Behaviour of Partially Closed Stiffened Cold-Formed Steel Compression Member”, Arab J Sci Eng (2016) 41:3865–387
[3] S-J Bronkhorst, “An Open-Source Implementation to Predict Buckling Behaviour of Cold-Formed Sections”, March 2017
[4] IS: 801(1975), “Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members In General Building Construction”
[5] IS: 811(1965), “Specification for cold-formed light gauge structural steel sections”
[6] www.chicagoroll.com
[7] www.custompartnet.com
[8] www.globalspec.com

