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# NUMERICAL ANALYSIS OF COLD FORMED CHANNEL SECTIONS USING CUFSM

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***ABSTRACT--- This paper involves numerical and analytical investigation of cold formed channel section. Cold formed sections are used as light weight carrying members such as purlins, decks etc because of its high strength to weight ratio. The sections used are unlipped channel section with three different thicknesses. The thicknesses are 1.0mm, 1.2mm and 1.mm. Mostly cold formed channel sections are used as a column (compression member). In this paper cold formed channel section is used as a beam (flexural member). Load carrying capacity and deflection values are calculated theoretically with the reference to IS 801-1975. Then linear analyses of cold formed channel sections are carried out using CUFSM4.05 software. This software is used for determination of local, global and distortional buckling behavior of thin walled members. The maximum load carrying capacity, load factor and buckling behavior are obtained for the sections from the numerical analysis. From those values the ultimate moment and flexural strength are calculated by using direct strength method (DSM). It is an entirely new design method especially adopted for cold formed beams and columns. Then the theoretical load values and the load values obtained from direct strength method are compared.***

***Keywords: Cold formed sections, Direct strength method, buckling, flexural strength..***

## I. INTRODUCTION

Cold formed sections are generally used for light weight structures due to its high strength to weight ratio. The usage of CFS will be increased now a day because of the economical reason. Unlipped channel section of three varying thicknesses is used. Many literatures have been studied before analyzing the various cod formed sections. Mostly cold formed channel sections are used as columns. In this project the channel section is considered as beam. The linear analyses of those sections are done using CUFSM software. The deflection behavior of the channel sections due to application of load are analyzed from that software. Then by using those analytical values the ultimate moment and flexural strength are determined in direct strength method.

### *A. Properties of cold formed section:*

- Light in weight
- High strength and stiffness
- Easy erection and installation
- No formwork needed

- Uniform quality
- Economy in transportation
- Non combustibility
- Recyclable material

## II. METHODOLOGY

- Three different thicknesses of cold formed channel sections used are 1.0mm, 1.2mm and 1.6mm.
- Yield strength of cold formed channel section used is, $f_y = 250 N/mm^2$

## III. DESIGNATION

The designation of cold formed channel sections (CFCS) used are,

CFCS 1 = (100x40x1.0) mm

CFCS 2 = (100x40x1.2) mm

CFCS 3 = (100x40x1.6) mm

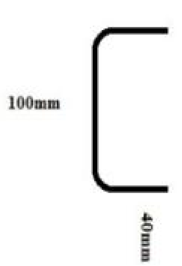


Figure 1 Channel Section of varying thicknesses 1.0 mm, 1.2 mm, 1.6 mm.

Table 1

Properties of CFCS

| Section designation | Length (mm) | Area of the section ($mm^2$) | Section modulus, Z ($mm^3$) |
|---|---|---|---|
| CFCS 1 | 750 | 180.64 | 296.25 |
| CFCS 2 | 750 | 212.90 | 352.18 |
| CFCS 3 | 750 | 290.322 | 460.82 |

## IV. NUMERICAL ANALYSIS OF CFCS USING CUFSM AND DSM

### *A. CUFSM*

CUFSM software has been successfully used by researchers for finite strip analysis of thin walled sections. The local and global buckling behavior of the cold formed sections was analyzed from this software.

### *B. Direct Strength Method (DSM)*

This method is new and reliable method which is alternate to traditional effective width method. There are no iterations in this method and single element calculation cannot be needed for this method. This method is used for calculate the critical buckling moment for cold formed steel channel sections. The moments calculated were as below,

- Local Buckling:

$$M_{nl} = M_{ne}[1-0.15[M_{crl}/M_{ne}]^{0.4}][M_{crl}/M_{ne}] \longrightarrow 1$$

Where,

$M_{crl}$ = Critical elastic local buckling moment.

$M_{nl}$ = Nominal flexural strength for local buckling.

$M_{ne}$ = Yield moment.

- Torsional Buckling:

$$M_{ne} = 10/9\, M_y[1-[10M_y/36M_{cre}] \longrightarrow 2$$

Where,

$M_{cre}$ = Critical elastic lateral torsional buckling moment.

$M_{ne}$ = Nominal flexural strength for global buckling.

$M_y$ = Yield moment.

### *C. Evaluation Of Buckling Behavior Using CUFSM*

The load carrying behavior of the cold formed channel sections are analyzed successfully. The CUFSM is very simple and ease

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to use comparing other software. The exact buckling images for three varying thicknesses of CFCS will be obtained from the CUFSM. The views of local and global buckling images are verified and presented in Table 3.

Table 3

Various buckling behavior of CFCS analyzed by CUFSM

| Section Designation | Local Buckling | Lateral Torsional Buckling |
|---|---|---|
| CFCS 1 |  |  |
| CFCS 2 |  |  |
| CFCS 3 |  |  |

## V. DESIGN CALCULATION AS PER IS 811-1984

Theoretical calculation would be done for channel section of three varying thicknesses with the reference of IS code 801-1975. The calculated values are listed in the Table 2. All the values are in S.I.units.

Table 2

Calculated Design Values As Per IS 801-1975

| Section | Load (kN) | Moment Of Inertia (mm□) | Section Modulus x $10^3$ ($mm^3$) |
|---|---|---|---|
| CFCS 1 | 2.34 | 26.92 | 296.25 |
| CFCS 2 | 2.78 | 20.32 | 352.18 |
| CFCS 3 | 3.64 | 17.01 | 460.81 |

## VI. RESULTS AND DISCUSSION

The CUFSM and DSM results of the sections are analyzed. The maximum load values will be taken from the CUFSM, then by using the values ultimate moments are calculated by using DSM. Direct strength method is very advanced method especially made for thin walled open sections. This method is preferable because of no need for element calculation and iterations unlike in effective width method. The critical elastic lateral torsional buckling moment for global buckling and critical elastic local buckling moment for local buckling moment are calculated from CUFSM. These values are given as input to DSM equations and the corresponding ultimate momemts $M_{ne}$ and $M_{nl}$ are obtained.

Table 4

Evaluation of ultimate local and critical elastic buckling moments

| Section designation | $M_{cre}$x10^6 (N-mm) | $M_{crl}$x10^6 (N-mm) | $M_{ne}$ ($N/mm^2$) | $M_{nl}$ ($N/mm^2$) |
|---|---|---|---|---|
| CFCS 1 | 74.06 | 14.43 | 7.95 | 4.22 |
| CFCS 2 | 83.34 | 24.96 | 3.31 | 5.17 |
| CFCS 3 | 89.67 | 59.28 | 2.30 | 6.16 |

## VII. RESULTS FROM NUMERICAL ANALYSIS

The critical elastic and local buckling moments are analyzed from the CUFSM. Then the results of local buckling moment for varying thicknesses sections will be presented in Figure 2. Then the elastic torsional buckling moment for varying thicknesses section will be presented in Figure 3.

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*A. Evaluation of critical local Buckling moment with varying thicknesses.*

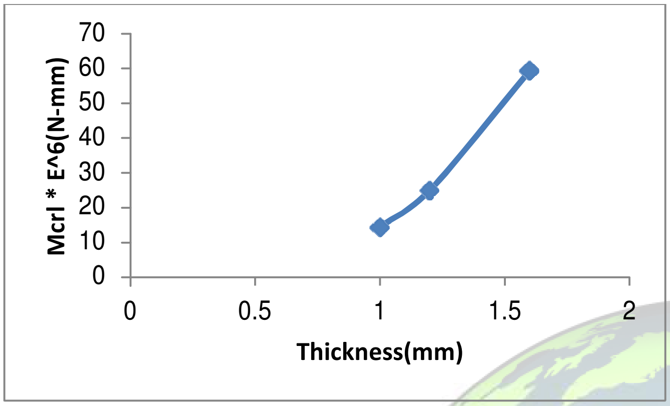


Figure 2 Critical local buckling moment Vs Varying thicknesses.

*B. Evaluation of critical global buckling moment with varying thicknesses.*

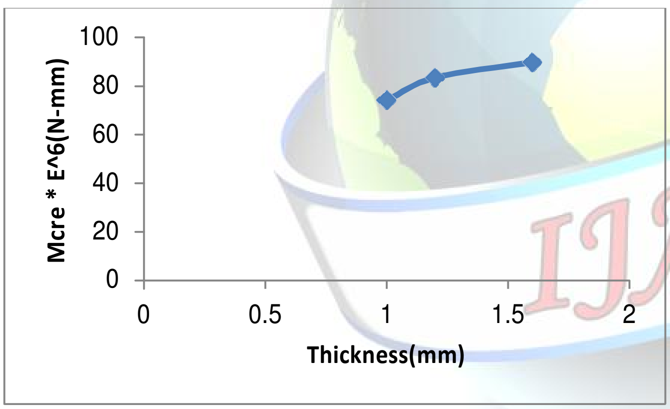


Figure 3 critical global buckling moment Vs varying thicknesses.

## VIII. RESULTS FROM DESIGN CALCULATION AS PER IS 801-1975

The loads for the individual CFCS are calculated as per IS 801-1975. Then the results obtained for varying thicknesses section will be shown in Figure 4. Then the deflection for individual sections is calculated and the results are shown in Figure 5.

*A, Evaluation of Load for varying thicknesses*

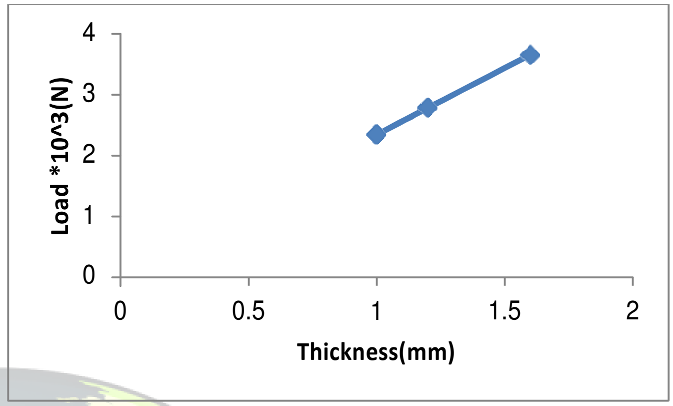


Figure 4 Theoretical Load Vs Varying thicknesses

*B. Evaluation of Deflection for varying thicknesses.*

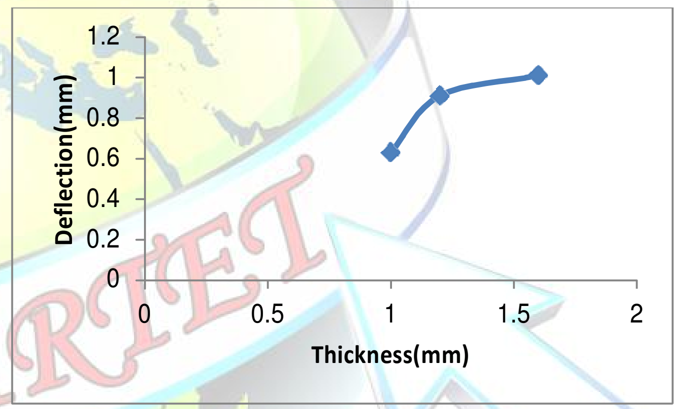


Figure 5 Theoretical Deflection Vs Varying thicknesses.

## IX. CONCLUSION

The flexural strength of several thicknesses of beams are determined analytically by the application of load in CUFSM software. From the above discussions and observed values the following results are obtained,

- Two types of buckling behaviors are obtained for three varying thickness sections.
- Buckling for section with lesser thickness will be high comparing to section with higher thickness.
- From the DSM results it is clearly identified that the local buckling is predominant for all types of sections than the global buckling.

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- The percentage of increasing of values for local buckling is 28.37% than the global buckling.

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