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NUMERICAL AND ANALYTICAL INVESTIGATION OF BUCKLING BEHAVIOUR OF COLD FORMED SECTION BY USING GFRP SHEET

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ABSTRACT--- This analysis 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 1.6mm thickness. In this investigation 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 and IS811-1984. Then linear analysis of cold formed channel sections are carried out using CUFSM 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). GFRP(Glass Fiber Reinforcing Polymer)is pasted over the channel section. . 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

A. *General*

In building construction, there are primarily two types of structural steel: hot-rolled steel shapes and cold-formed steel shapes. The hot-rolled steel shapes are formed at elevated temperatures while the cold-formed steel shapes are formed at room temperature. Cold-formed steel structural members are shapes commonly manufactured from steel plate, sheet or strip material.

B. *Cold formed sections*

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 1.6mm thickness is used. Many literatures have been studied before analyzing the various cold formed sections. Mostly cold formed channel sections are used as columns. In this project the channel section is considered as beam. The linear

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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. .[5] discussed about Microwave Semiconductor Devices such as Tunnel diode, Gunn diode and valanche transit time devices and analyzes Monolithic Microwave Integrated Circuits (MMIC)

C. 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

- 1.6mm thicknesses of cold formed channel section is used.
- GFRP will be pasted over normal sections to increase its strength.
- Yield strength of cold formed channel section used is,
  - fy = 250N/mm²

III. DESIGNATION

The designation of cold formed channel section (CFCS) used is,

CFCS = (120x50x1.6) mm

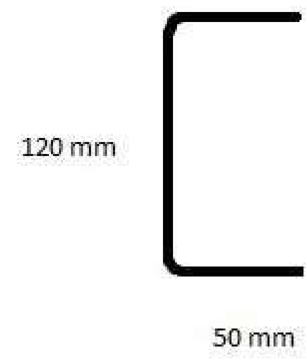

Figure 1 Channel Section of 1.6 mm thickness.

Table 1

Properties of CFCS

Section designation	Length (mm)	Area of the section (mm²)	Section modulus, Z (mm³)
CFCS	750	65	230

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,

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- Local Buckling:

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

Where,

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

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

$M_{ne} =$ Yield moment.

- Torsional Buckling:

$M_{ne} = 10/9\ M_y[1-[10M_y/36M_{cre}]$ ⟶ 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 to use comparing other software. There is no difficulty in making sections and applying load. 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 2.

Table 2

Various buckling behavior of CFCS analyzed by CUFSM

Section Designation	Local Buckling	Lateral Torsional Buckling
CFCS		

V. DESIGN CALCULATION AS PER IS 811-1984

Theoretical calculation would be done for channel section of 1.6mm thicknesses with the reference of IS code 801-1975. The calculated values are listed in the Table 3. All the values are in S.I.units.

Table 3

Calculated Design Values As Per IS 801-1975

Section	Load (kN)	Moment Of Inertia (mm^4)	Section Modulus x 10^3 (mm^3)
CFCS	2.34	155	230

VI. RESULTS AND DISCUSSION

The CUFSM and DSM results of the sections are analyzed. Direct strength method is very advanced method especially made for thin walled open sections. The maximum load values will be taken from the CUFSM, then by using the values ultimate moments are calculated by using DSM. 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	74.06	14.43	7.95	4.22

CONCLUSION

The flexural strength of several thickness of beams are determined analytically. From the above discussions and observed values the following results are obtained,

- Two types of buckling behaviors are obtained for 1.6mm thickness section.
- 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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