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Experiment on the Flexural Functioning of Cold-Formed Steel Built-Up Complex Hat Section

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Abstract: ***Cold-formed steel members are comprehensively utilized in the building construction industry, especially in residential, commercial, and industrial buildings. Thin sheet steel products are widely noticed in the building industry and range from purlins to roof sheeting and floor decking. Generally, these are used for basic building elements for the congregation at the site or as prefabricated frames or panels. They obtained the generic title 'Cold-Formed Steel Sections. The uses of these products are many and varied, ranging from "tin" cans to structural piling, from keyboard switches to mainframe building members. This paper dispenses an experimental and software analysis of the flexural behavior of cold-formed steel built-up sections. The experimental results are also verified with finite element analysis using Manual Designs and ANSYS Software. The analytical results obtained are better exposure to the experimental results.***
Keywords: Cold-formed Steel Section, Cold-rolled steel sections, Cold-Rolled tubular sections

I. INTRODUCTION

Cold-formed steel products such as sections have been often used in the metal building construction industry for over 45 years. The vogue for these products has dramatically increased in recent years due to their wide range of applications, economy, ease of fabrication, and high strength-to-weight ratios. Sometimes they are also known as Light Gauge Steel Sections or Cold Rolled Steel Sections. Cold-formed steel products occur in all aspects of modern life; in the home, the shop, the factory, the office, the car, the petrol station, the restaurant, and indeed in almost any imaginable location. In the market, various shapes of these products are available C-sections are predominantly used in light load and medium span situations such as roof systems. The use of cold-formed steel structures is getting increased across the Universe with the production of more economic steel coils, especially in coated form with zinc or aluminum/zinc coatings.

These coils are later formed into thin-walled sections by the cold-forming process. The steel regularly used for these sections may have yield stress for the various ranges.

II. OBJECTIVES

The prime objectives of this research are:

1) To inquire about the function of cold-formed steel (CFS) - Complex Hat sectioned beams.
2) To set the moment carrying capacity of specimens theoretically by using, NORTH AMERICAN COLD FORMED STEEL SPECIFICATION, 2007.
3) To the possible modes of failure of the members under static loading byperforming Eigen buckling analysis using ANSYS R2 software.
4) To resolve the moment carrying volume of specimen experimentally and to endorse the modes of failure arrived in numerical analysis..
5) To compare the results obtained from Theoretical and Numerical works with Manual designs and specific Software.

III. COMMENDATION OF COLD-FORMED STEEL SECTIONS

1) The steel members generally weigh low so that they will reflect low dead load resulting in less deflection. The notable view is that they are corrosion-resistant.
2) It can be used in large spans so we need not complicate splitting the parts for a perfect mold.
3) Economically, it is analyzed to be considered in comparison with the other components.
4) They are pre-tensioned and pre-casted members. The tensile carrying capacity is considerably high suiting for all places.
5) Lightness, High strength and stiffness, ease of prefabrication and mass production, fast and easy erection, non-shrinking, and accurate detailing.

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IV. MODEL CALCULATION FOR SPECIMEN BCH 90 - 90 - 1.811

1) *Validating Procedure for CUFSM:* Control specimen is taken from AISI- Manual for cold formed steel design. Specimen: 800S200-54

Material: F_y = 50 ksih_o = D = 8.000 in.

b_o = B = 2.000 in.

T = 0.0566 in.

d_o = d = 0.625 in.

R = 0.0849 in.

θ = 90°

Load factor = 1.03 @ half wavelength 18.7

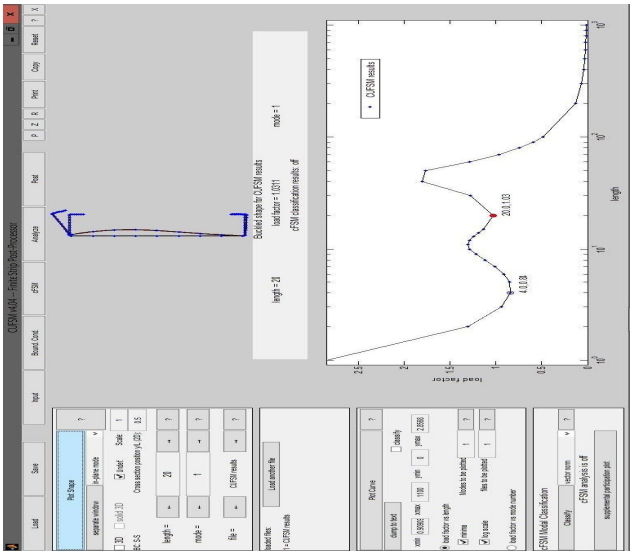


Fig.1 Model classification Plot for 800S200-54

2) *Elastic Distortional Buckling Stress From Cufsm*

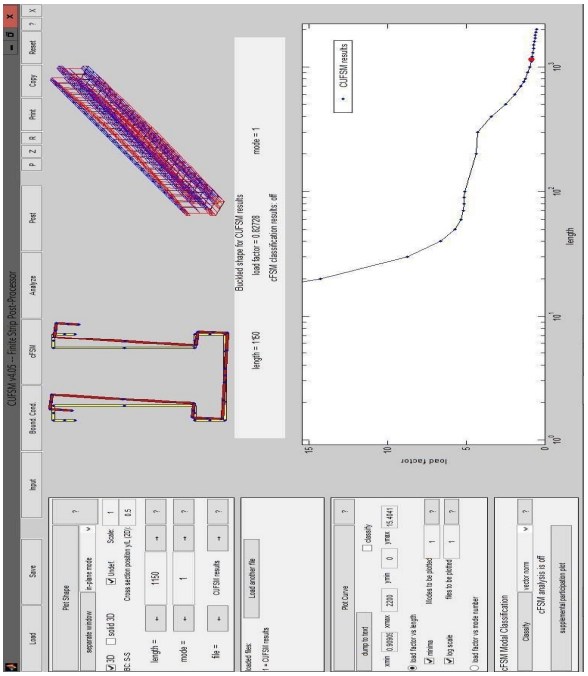


Fig.2 Modal Classification Participation for the Specimen BCH 90 - 115 - 1.2 – 1150

Load factor = F_{cr} / F_y

$M_{crd\ FSM}$ = Load factor x M_y

= 0.82728 x 5.84 *10^6

= 4.389155 kN

3) Material collection



Fig 3 Material Collection

a) Mild Steel

b) Cold-Formed Steel Section

4) Instrumentation

a) The displacement of beams were instrumented using, two Deflectometers.

- under the mid-span,
- Laterally lip in compression flange (mid span).

b) A load cell with the capacity of 100kN was placed at top of hydraulic jack in order to record the load. While testing of all specimens, displacements are recorded by using deflectometer.

c) Load is applied gradually up to failure (until load reversal).

5) Test Setup



Fig.4 Typical Experimental setup

SPECIMEN DETAILS

TABLE 1: Physical Properties CFS Section

Density of steel	7850 kg/m^3
Modulus of elasticity	2.5x10^5 N/mm^2
Poisson ratio	0.4
Modulus of rigidity	0.812 x10^5 N/mm^2
Yield Strength	220 N/mm^2

V. PROPERTIES OF STEEL

Steel has a number of properties, including hardness, toughness, tensile strength, yield strength, elongation, fatigue strength, corrosion, plasticity, malleability, and creep. The properties that are most important in wear and abrasion-resistant steel are:

1) HARDNESS is the material's ability to withstand friction and abrasion. It is worth noting that, while it may mean the same as strength and toughness in colloquial language, this is very different from strength and toughness in the context of metal properties.
2) TOUGHNESS is difficult to define but generally is the ability to absorb energy without fracturing or rupturing. It is also defined as a material's resistance to fracture when stressed.
3) YEILD strength is a measurement of the force required to start the deformation of the material
4) TENSILE strength is a measurement of the force required to break the material.
5) ELONGATION (or Ductility) is the "Degree" to which the material can be stretched or compressed before it breaks. It is expressed as a percent of the length being tested and is between the tensile strength and yield strength.

VI. NUMERICAL INVESTIGATION

Most of the engineering problems today make it necessary to obtain approximate numerical solutions to problems rather than exact closed form solutions. The basic concept behind the finite element analysis is that structure is divided into a finite number of elements having finite dimensions and reducing the structure having infinite degrees of freedom to finite degrees of freedom. The original body of structure is then considered as an assemblage of these elements connected at a finite number of joints called Nodes or Nodal points. This method of analysis has an advantage of that it can take care of any boundary and loading conditions.

VII. FINITE ELEMENT ANALYSIS

The results obtained from the ANSYS analysis of complex hat section with various dimensions beam models are presented. Comparisons were made between the ANSYS and experimental results. Discussions were carried out with respect to the comparisons of load capacities and the mode of failure occurred.

VIII. ABOUT ANSYS R2 SOFTWARE

1) ANSYS R2, Inc. is an American public company based in Canonsburg, Pennsylvania. It develops and markets engineering simulation software.
2) ANSYS R2 software is used to design products and semiconductors, as well as to create simulations that test a product's durability, temperature distribution, fluid movements,and electromagnetic properties.
3) ANSYS R2 develops and markets finite element analysis software used to simulate engineering problems. The software creates simulated computer models of structures, electronics, or machine components to simulate strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes.
4) ANSYS R2 is used to determine how a product will function with different specifications, without building test products or conducting crash tests.
5) For example, ANSYS R2 software may simulate how a bridge will hold up after years of traffic, how tobest process salmon in a cannery to reduce waste, or how to design a slide that uses less material without sacrificing safety.

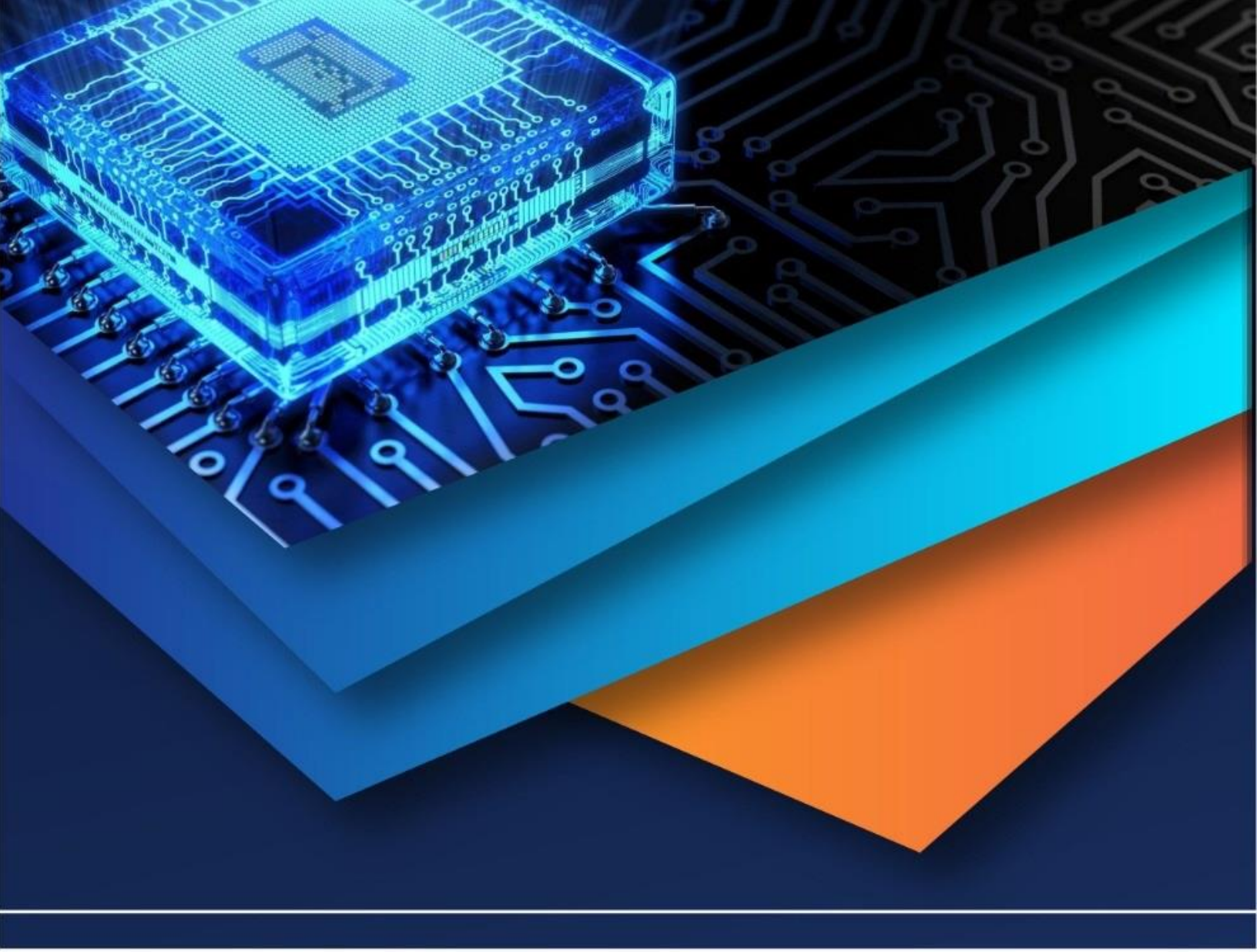
IX. SCOPE FOR FUTURE STUDY

1) Theoretical study by making use of the Eurocode BS EN 1993-1-3-2006, "Design of steel structures" and British Standard BS 5950-5:1998, "Structural use of steelwork in building". Code of rules for the design of cold-formed thin gauge section.
2) The exactness strip method and finite element method can be further extended by carrying out the precise test on specimens fabricated.
3) Following this, I will be testing the Cold-Formed Steel section by using Load Cell.
4) Load distortional Buckling especially mode 2 failure will be tested.
5) Load distortional Buckling especially mode 1 failure will be tested.
6) The finite element method is a numerical analysis technique for obtainingapproximate solutions to wide variety of Engineering problems.And I will be taking up the process with the same software.
7) The future results of Complex Hat Section with various dimensions will be carried out by ANSYS R2 Software.
8) The bit perfect of the imperfection factor can also be experimented.

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