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EXPERIMENTAL INVESTIGATION OF FLEXURAL BEHAVIOUR OF CORRUGATED COLD FORMED STEEL SECTION

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Abstract—Cold-formed steel members maintain a constant thickness around their cross-section, whereas hot-rolled shapes typically exhibit tapering or fillets. Cold-formed steel allowed for shapes which differed greatly from the classical hot-rolled shapes. The material was easily workable; it could be deformed into many possible shapes. Even a small change in the geometry created significant changes in the strength characteristics of the section. It was necessary to establish some minimum requirements and laws to control the buckling and strength characteristics. Also it was observed that the thin walls underwent local buckling under small loads in some sections and that these elements were then capable of carrying higher loads even after local buckling of the members.

Keywords— Cold formed steel, hot rolled shapes, buckling, strength characteristics, higher loads

INTRODUCTION

Cold-formed steel (CFS) is type of steel fabricated by cold forming process. CFS members have been used in buildings, bridges, storage racks, grain bins, car bodies, railway coaches, highway products, transmission towers, transmission poles, drainage products, transmission towers, transmission poles, drainage facilities, various types of equipment and others.Design standards for hot-rolled steel were adopted in 1930s, but were not applicable to cold–formed sections because of their relatively thin steel walls which were susceptible to buckling. Cold-formed steel members maintain a constant thickness around their cross-section, whereas hot-rolled shapes typically exhibit tapering or fillets.

In the United States, the first edition of the Specification for the Design of Light Gage Steel Structural Members was published by the American Iron and Steel Institute (AISI) in 1946 (AISI, 1946). The first Allowable Stress Design (ASD) Specification was based on the research work sponsored by AISI at Cornell University under the direction of late Professor George Winter since 1939. As a result of this work, George Winter is now considered the grandfather of cold-formed steel design. The ASD Specification was subsequently revised in 1956, 1960, 1962, 1968, 1980, and 1986 to reflect the technical developments and the results of continued research at Cornell and other universities (Yu et al., 1996). In 1991, AISI published the first edition of the Load and Resistance Factor Design Specification developed at University of Missouri of Rolla and Washington University under the directions of Wei-Wen Yu and Theodore V. Galambos (AISI, 1991). Both ASD and LRFD Specifications were combined into a single specification in 1996 (AISI, 1996).Thin sheet steel products are extensively used in building industry, and range from purlins to roof sheeting and floor decking. Generally these are available for use as basic building elements for assembly at site or as prefabricated frames or panels. These thin steel sections are cold-formed, i.e. their manufacturing process involves forming steel sections in a cold state (i.e. without application of heat) from steel sheets of uniform thickness.

ADVANTAGES OF COLD FORMED STEEL

Compared with other materials such as timber and concrete, the following qualities can be realized for cold-formed steel structural members.

1. Lightness
2. High strength and stiffness
3. Ease of prefabrication and mass production
4. Fast and easy erection and installation
5. Substantial elimination of delays due to weather
6. More accurate detailing
7. Non shrinking and noncreeping at ambient temperatures
8. Formwork unneeded
9. Termite-proof and rot proof
10. Uniform quality
11. Economy in transportation and handling

12. Non combustibility
13. Recyclable material
14. Turning gets rid of surface imperfections.
15. Grinding narrows the original size tolerance range.
16. Polishing improves surface finish
17. Substantial elimination of delays due to weather
18. More accurate detailing
19. No formwork needed

MATERIAL SPECIFICATION

A .Cold formed steel

In cold-formed steel constructions, built-up beams are often fabricated from two channel sections. Connecting two channels together is a technique which can achieve a structurally desirable cold-formed steel section. With this technique the structural bending capacity of the beam is expected to be more than double. Traditional, field fabricated, back to back or I-beam headers, consisting of two "C" sections with the webs screwed back to back, are the most popular built-up configuration in the construction industry. Due to this higher strength and stiffness Corrugated sections has been selected.

B.Specifications

I. *Beam-1(trapezoidal corrugation without Spacing*)

- Depth of the beam = 190mm
- Width of the beam(flange) = 140mm
- Lip of the section = 25mm
- Length of the specimen = 1200mm
- Thickness = 2.5mm
- Corrugation Angle = 45^o

II. *Beam-2(trapezoidal corrugation with Spacing)*

- Depth of the beam = 190mm
- Width of the beam(flange) = 165mm
- Lip of the section = 25mm
- Length of the specimen = 1200mm
- Thickness = 2.5mm
- Spacing = 25mm

III. *Beam-3(vertical corrugation)*

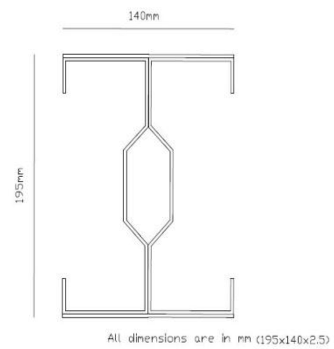
- Depth of the beam = 190mm
- Width of the beam(flange) = 140mm
- Lip of the section = 25mm
- Length of the specimen = 1200mm
- Thickness = 2.5mm

IV. *Plate*

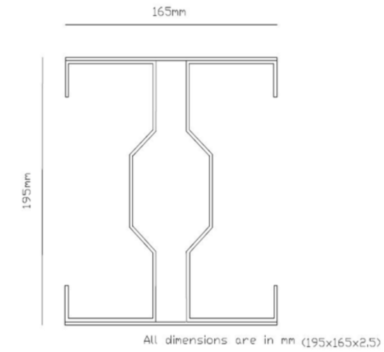
- Length of the plate = 1200mm
- Width (for beam-1) = 140mm
- Width (for beam-2) = 165mm.

C. Specification details

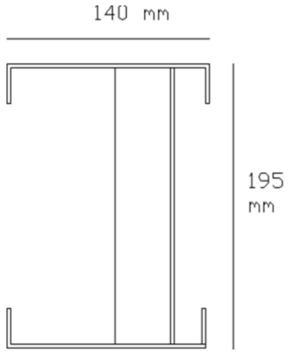
I. *beam-1 (trapezoidal corrugation without spacing*)



II. Beam-2(trapezoidal corrugation with spacing)



III. Beam-3(vertical corrugation)



EXPERIMENTAL INVESTIGATION

A.Loading frame

The test loading frame can be utilized to test the behaviour and load-carrying capacity of both full-size structures as well as separate structural members. This equipment is suited for producing static and repeated loadings.

At the SMC loading frame, two systems are available, with hydraulic cylinders of maximum loading capacities for 150 kN and 250 kN. When test loading a separate piece/member, 1-2 cylinders can be used positioned in different ways in respect to the tested piece/member.

The control system of the cylinders allows programming for test-specific timed loadings, for controlling the speed of the loading, and for controlling the loading so that the tested member reaches the desired displacement and displacement rate at a specified point. When two cylinders are used to load the tested piece/member the cylinders may function dependent on each other, thus enabling a simultaneous loading. Test measurement results are saved automatically on to a computer.

The more recently acquired equipment, capable for dynamic testing and 250 kN maximum loading per cylinder, was supplied to SMC in spring 2009, by the German company Instron Structural Testing Systems (IST).

B.Strain gauge

A **strain gauge** is a device used to measure strain on an object. Invented by Edward E. Simmonsand Arthur C. Ruge in 1938, the most common type of strain gauge consists of an insulating flexible backing which supports a metallic foil pattern. The gauge is attached to the object by a suitable adhesive, such as cyanoacrylate. As the object is deformed, the foil is deformed, causing its electrical resistance to change. This resistance change, usually measured using a Wheatstone bridge, is related to the strain by the quantity known as the *gauge factor.* A strain gauge takes advantage of the physical property of electrical conductance and its dependence on the conductor's geometry. When an electrical conductor is stretched within the limits of its elasticity such that it does not break or permanently deform, it will become narrower and longer, changes that increase its electrical resistance end-to-end. Conversely, when a conductor is compressed such that it does not buckle, it will broaden and shorten, changes that decrease its electrical resistance end-to-end. From the measured electrical resistance of the strain gauge, the amount of induced stress may be inferred. A typical strain gauge arranges a long, thin conductive strip in a zig-zag pattern of parallel lines such that a small amount of stress in the direction of the orientation of the parallel lines results in a multiplicatively larger strain measurement over the effective length of the conductor surfaces in the array of conductive lines and hence a multiplicatively larger change in resistance than would be observed with a single straight-line conductive wire.

C. Test Specimen details

The test specimens consist of cold-formed steel beams with 1,trapezoidal corrugation with spacing, 2,trapezoidal corrugation without spacing 3,vertical corrugation. The span of the beam was 1200 mm and the cross sections of the beams are 195 mm x 140 mm x 2.5 mm. The yield strength of steel used is 380 N/mm^2 .The cold-formed steel beam is built up by welding the flanges and the web using intermittent welds of 6mm thickness. A beam was provided at both the load points to minimize local effect due to concentrated loads

D. Experimental setup

The testing was carried out in a loading frame of 400kN capacity. All the specimens were tested for flexural strength under two point loading. The specimens were arranged with simply supported conditions having an effective span of 1.2 m. Loads were applied at one-third distance from the supports at a uniform rate till the ultimate failure of the specimens occurred. Beam deflections were measured at several locations using Linear Variable Displacement Transducers (LVDTs) . Strain gauges and LVDTs were connected to a data logger from which the readings were captured by a computer at every load intervals until failure of the beam occurred.

RESULTS AND DISCUSSION

All the specimen were tested for flexural strength under two point loading by using reaction type movable loading frames Deflection and strain readings are observed from DATA logger. The following observations were made during the progress of the tests. The observations are summarized in the following.

A.Failure pattern of beams

I. Beam1(trapezoidal corrugation without spacing)

II.Beam2(trapezoidal corrugation with spacing)

III.Beam3(vertical corrugation)

B.Ultimate load and deflections of the beams

TABLE1

BEAM DETAIL	ULTIMATE LOAD(KN)	DEFLECTION(mm)
Beam1(TCWOS)	33	6.7
Beam2(TCWS)	26	3.78
Beam3(VC)	43	4.27

C.Comparison of ultimate deflection and loadcarrying capacity

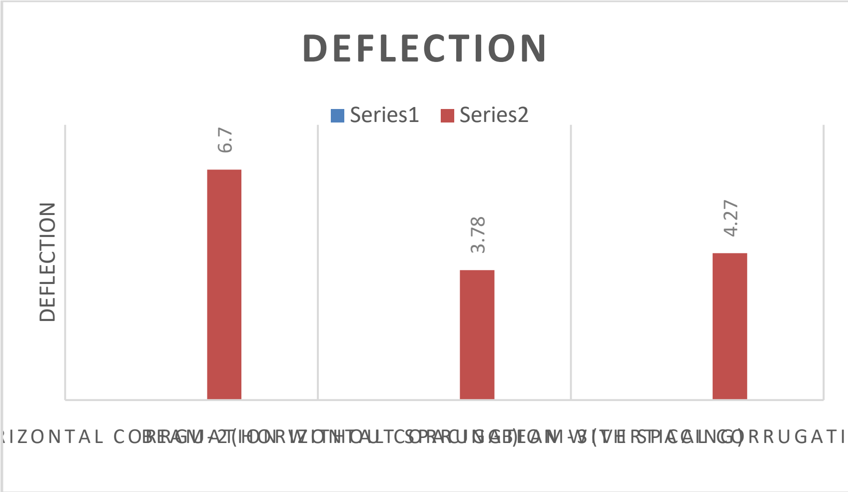


Fig 1. Comparison of ultimate deflection

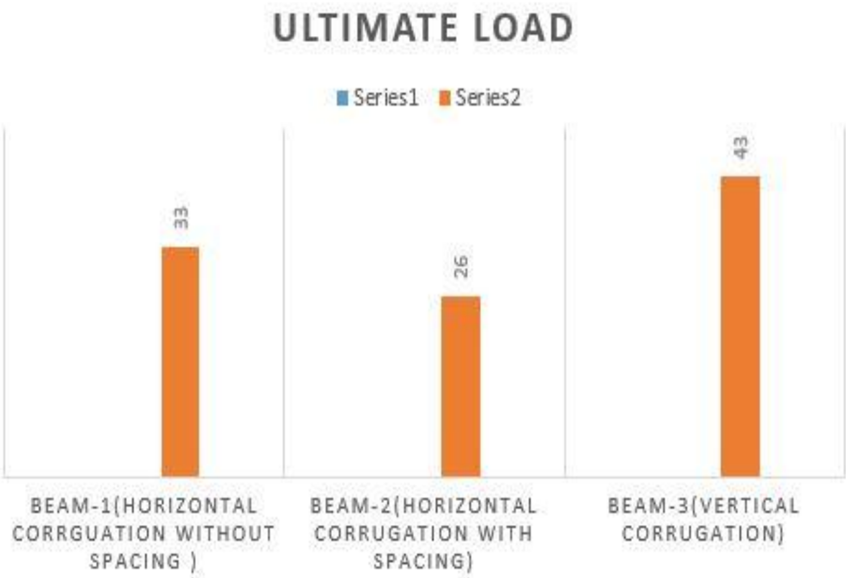


Fig.2.Comparison of Ultimate load carrying capacity

CONCLUSIONS

The main objective of the project was successfully accomplished. From the experimental investigations carried out to study the flexural behaviour of cold-formed corrugated web beams. From the results vertical corrugation obtain a high resistance to lateral buckling and corrugation acts as a stiffener for the beam. Cold-formed section with horizontal and vertical corrugation has resulted in increased resistance to lateral-buckling. Trapezoidal corrugation without spacing is obtained a load 7% higher than the with spacing and vertical corrugation is obtained a load about 17% and 10% higher than trapezoidal corrugation without and with spacing respectively.

REFERENCES

Hong-Guang Luo “Distortional buckling of thin-walled inclined lipped channel beams bending about the minor axis”. Journal of Constructional Steel Research 67 ,2011.

Jayaraman. A, V. Senthilkumar, S. Athibaran (2014), “Behavior and Design of Light gauge Cold Formed Steel Flexural Members (Comparison of Channel and Built up Channel Section)”, International Journal of Scientific Engineering and Technology Research ISSN 2319-8885 Vol.03, Issue.19,2014.

Hong-Xia Wan, MahenMahendran, “Behaviour and strength of hollow flange channel sections under torsion and bending”, Thin-Walled Structures 94 (612-623), 2015.

Jaya sheela. V, R. Vijayasarathy, B. Jose Ravindraraj (2015), “Experimental Study on Behaviour of Stiffened Cold Formed Steel Built Up Hat Section under Flexure by Varying the Depth by Finite Element Analysis”,International Journal of Engineering Trends and Technology (IJETT) – Volume23 Number 1

Amin Mohebkhah“Lateral–torsional buckling of Delta hollow flange beams under moment gradient”. Thin-Walled Structures 86 ,2015.

Yu Chen “Experimental and finite element analysis research on cold-formed steel lipped channel beams under web crippling. Thin-Walled Structures 87,2015.

Luis Laim “Flexural behaviour of beams made of cold-formed steel sigma-shaped sections at ambient and fire conditions” Thin-Walled Structures 87 ,2015.

Dan Dubina“Experimental investigations of cold-formed steel beams of corrugated web and built-up section for flanges”. Thin-Walled Structures 90 ,2015.

Guo-Qiang Li “Local buckling of compression flanges of H-beams with corrugated webs” Journal of Constructional Steel Research 112 , 2015.

B. G. ArunkumarEt Al, "Investigation On Cold –Formed Steel Lipped I Beam With Trapezoidal Corrugation In Web By Varying Depth", Issn: 2278 – 0211 Vol 2 Issue , 2015.

Liping Wang “Beam tests of cold-formed steel built-up sections with web perforations” Journal of Constructional Steel Research 11, 2015

Ying-Lei Li “Investigation on flexural strength of cold-formed thin-walled steel beams with built-up box section. Thin-Walled Structures 107, 2016.