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Comparative Analysis and Bending Behavior of Cold form Steel with Hot Rolled Steel Section

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Abstract: - Thin sheet steel products are extensively used in building industry, and range from purloins 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. These are given the generic title ***Cold Formed Steel Sections***.

Sometimes they are also called ***Light Gauge Steel Sections*** or ***Cold Rolled Steel Sections***. The thickness of steel sheet used in cold formed construction is usually 1 to 3mm. Much thicker material up to 8 mm can be formed if pre-galvanized material is not required for the particular application. The method of manufacturing is important as it differentiates these products from ***hot rolled steel*** sections. Normally, the yield strength of steel sheets used in cold-formed sections is at least 280 N/mm2, although there is a trend to use steels of higher strengths, and sometimes as low as 230 N/mm2.

The present study aims at following objectives by taken a test perform on cold steel

1. To study the maximum compressive strength.
2. To study bending and buckling behavior of steel
3. To study fluxreal strength.
4. Compair with hot rolled steel.

Keywords: *- cold-formed, Cold Formed Steel Sections, Light Gauge Steel Sections, hot rolled steel*

I. INTRODUCTION

1.1 Necessity

Cold-formed steel forms the basis for a number of lightweight pre-fabricated structures such as trusses, stud frame panels and portal frames .The term cold-formed distinguishes this category of material from hot rolled steel sections, typically universal beams, columns, angles etc., by the manufacturing methods used. Cold-formed sections are produced by bending and shaping flat sheet steel at ambient temperatures. There is great flexibility in the design using cold-formed steel. A number of innovative engineers and architects have been very successful in producing systems that are both innovative and practical. Cold-formed steel in either flat plates or coils is the primary raw material for a wide range of industries.

We are surrounded by applications, in washing machines, filing cabinets, storage systems, heating and ventilation and cars. About 40% of sheet steel production is used in the construction industry, in cladding, light structural frames and components such as purlins and lintels. The steel sheets can be cold-formed into many different shapes and forms by a variety of manufacturing processes.

The cruciform section was developed to deal with the 'inside-outside' corner detail, using the same connection. The trusses were fabricated from C sections and could span between 9.2 and 23 metres. The depth of the truss was constant to accommodate the services, although the steel thickness reduced as the span reduced. The profiled steel roof deck was attached to the truss during fabrication, folded against the web. On site the deck was opened out and welded to the top of the truss and was used as the top chord of the truss. The system was used on a large number of schools.

II. LITERATURE

Juile Mill (2004): Self drelling screw joint for cold form steel channel portal **:**This paper is has r/f the conclusion of earlier testing by the first auther that widly used bolted and plate moments coonection is not suitable.United sections sections having a lower design capcity than the australian section however this does not mean that the same problems with the conventional joints will not occure just that they may occure in sheds of slighty lesser dimension in the united states than in Australian and hence the proposed self drilling screw joints are a valid option to over come this problem in both countries

For used in the knew joint of portal frames constructed form thin cold formed channel section The other tradititionally used joint configuration of a mitered joint with two bolts is end plates may need to be sized conservatively.

Gillbert H.Begain(2009): Light gauge cold formed steel profile: for decks in housing unitsThe sheet metal can provide component with the cold formed steel .to meet the various need of the construction of dwlling at competitive prices.a new types of channel profiles has been developed and applied for building the deck of a family housethis channel profile space for heating ventilating and electrical conducits designing innovative steel light gaguge component thought ingenuity of the designer .the light weight bring ducts.as regards acoustics but it reduces the load on the foundation.

C.C Weng(1984): Compression test on cold form steel section:The flexural buckling strength of section is find out 1st.The stress and strain relation and forming or pres break opration used to form the section short section the test is to carried out redued proportional limits and good arrangements and magnitudes of the sections using formule IS 801 .the result shows the problems .compair the theorital values with experimental values evidence. In that a time we 93 column are check it out they are find out compressive strength along 68 column and 25short column using stress strain relationship and forming all oprations.

Panagiots Frantzis(2008): Durability of cold form steel:Joints are subjected to various constant loads in the presense of room tem. A graphite gauge technique is developed to monitor the incubation for the time for a crak to form and measure its subsequent velo.is applied fraflure energy.two methods are used 1.dt.testing ring 2.side and end projection formation was brittle in nature compared to the model not exceed 40 J/m2

Concluding Remark on Literature Work:

Employed for illustrating the concepts with suitablemodifications appropriate to Indian Indeed it is difficult to think of any industry in which ColdRolled Steel products do not exist in one form or the other. Besides building industry,they are employed in motor vehicles, railways, aircrafts, ships, agricultural machinery,electrical equipment, storage racks, and house hold appliances and so on. In recent years,with the evolution of attractive coatings and the distinctive profiles that can bemanufactured, cold formed steel construction has been used for highly pleasing designsin practically every sector of building construction.In this chapter, the background theory governing the design of cold formed steelelements is presented in a summary form. Designs of cold formed steel sections aredealt with in IS: 801-1975 which is currently due under revision. In the absence of asuitable Limit State Code in India, the Code of Practice for Cold Formed Sections in usein the U.K. (BS 5950, Part 5) .

It is observed from literature work that the experimental study on behaviorof cold form steelin bending, buckling and also comparative analysis such work with hot rolled steel section.

III. RESEARCH METHODOLOGY

1. EXPERIMENTS ON CHANNEL STEEL SHEETS IN BENDING

A In press brake forming, a work piece is positioned over the die block and the die block presses the sheet to form a shape.[1] Usually bending has to overcomeboth tensile stresses and compressive stresses. When bending is done, the residual stresses cause the material to *spring back* towards its original position, so the sheet must be over-bent to achieve the proper bend angle. The amount of spring back is dependent on the material, and the type of forming. When sheet metal is bent, it stretches in length. The *bend deduction* is the amount the sheet metal will stretch when bent as measured from the outside edges of the bend. The *bend radius* refers to the inside radius. The formed bend radius is dependent upon the dies used, the material properties, and the material thickness.

Experimental techniques are discussed. Attentions focused on evaluation of strain-gauge measurements (critical load determination and post-critical behavior) and on factors influencing the load carrying capacity (web buckling and load application).Cold-formed steel sheets of trapezoidal section are widely used for buildings in Sweden. The main consumption is for light industrial buildings. In the year 1973 about 5· 106 m 2 of such sheet was used for roofs and about 3. 5· 10 6 m2for wall cladding of industrial buildings, which means about 80 per cent and 65 per cent respectively of the Swedish market for this application. In Sweden the design of thin-walled cold-formed sheets has, until recently, been based on the AISI Specification for the Design of Light Gage Cold-

Formed Steel Structural Members (1). Since it was shown, however, that the load carrying capacity of sheets having low web buckling stressesmay be overestimated by the method of the AISI-Specification ,new design rules were published by the Swedish governonent authorities in 1974 . In these rules the post-critical behavior of the webs' taken into account by applying an effective width concept to the compressed part of the web. Professor and Associate Professor respectively. Division of Steel and Timber Structures, Chalmers University of Technology, Goteborg, Sweden.3) Tekn.lic., Norrbotten Steel (NJA), Building Products Division, Lulea, Sweden; formerly Research Assistant Divested and Timber Struck., Chalmers Univ. of Technology, Goteborg, Sweden

IV. LOAD CARRYING CAPACITY

The web buckling moment Macro of a light gage steel beam discussed in the previous section (point C in Fig. 2) may be taken as a lower bound of the bending strength, provided the stress is below the yield stress. For the 21 sheets tested in Ref. 2 1) the maximum moment obtained was 5 to 30 per cent greater than the predicted lower bound Mcrb·In the AISI Specification (1) the ultimate bending moment Mult miscomputed as the moment at which the compression flange (edge)stress rr reaches the yield point *rr* (point A in Fig. 2) or at which *e* Y -the tension flange starts to yield (O't =cry). A formal web buckling moment Mweb is also computed using Eq. 2 with k = 23. 9, cf. Fig.10. Then the smallest of the bending moments *Multi* 1. 67 and and M b/ 1. 23 is allowed. Although the 21 sheets of Ref. 2 havewe 1)

Reference was given to a limited test series comprising 21 failure tests of trapezoidal steel sheets all having the web slenderness ratio d/t"" 115. A number of experiences from this and other test series show the importance of proper determination of sheet geometry and material properties, of a suitable load application andof a careful selection of points for strain measurement.It may be advantageous to define the load when the neutral axis starts to move towards the tension flange as the experimental critical load. It was found that the buckling coefficient k= 4 in Eq.could be used for flange buckling in ordinary trapezoidal sheets. Some observed high critical loads could be explained by the initial form of the compression flange (cylindrical panel imperfection).After the flange has buckled the theoretical critical stress of the web will decrease due to the shift of the neutral axis. The web buckling moment of the plate assembly model is a lower bound for the load carrying capacity in bending. The behavior of a trapezoidal sheet in bending is suitably represented
by aM- **rr** -diagram, Fig. 2. Three parameters govern the post critical behavior of the sheet namely aft, y 0 /t sin *e*. andy 0/a sin *e*.

The results indicate that the method of the AISI-code ought to be modified for beams with slender webs. Recent approaches. which use an effective width both in flange and web, give failure loads
which agree fairly well with experimental results rather slender webs the allowable moment according to this~
K-factor is a ratio of location of the neutral line to the material thickness as defined by t/T where t = location of the neutral line and T = material thickness. The K-Factor formulation does not take the forming stresses into account but is simply a geometric calculation of the location of the neutral line after the forces are applied and is thus the roll-up of all the unknown (error) factors for a given setup. The K-factor depends on many factors including the material, the type of bending operation (coining, bottoming, air-bending, etc.) the tools, etc. and is typically between 0.3 to 0.5.
The following equation relates the K-factor to the bend allowance;

$$K = \frac{-R + \frac{BA}{\pi A/180}}{T}$$

The following table is a "Rule of Thumb". Actual results may vary remarkably.

Generic K-Factors	**Aluminum**		**Steel**
Radius	**Soft Materials**	**Medium Materials**	**Hard Materials**
Air Bending			
0 to Thickness	0.33	0.38	0.40
Thickness to 3 x Thickness	0.40	0.43	0.45
Greater than 3 x Thickness	0.50	0.50	0.50
Bottoming			
0 to Thickness	0.42	0.44	0.46
Thickness to 3 x Thickness	0.46	0.47	0.48
Greater than 3 x Thickness	0.50	0.50	0.50
Coining			
0 to Thickness	0.38	0.41	0.44
Thickness to 3 x Thickness	0.44	0.46	0.47

Greater than 3 x Thickness	0.50	0.50	0.50

The following formula can be used in place of the table as a good *approximation* of the K-Factor for Air Bending

V. RESULTS

Result: 4.1

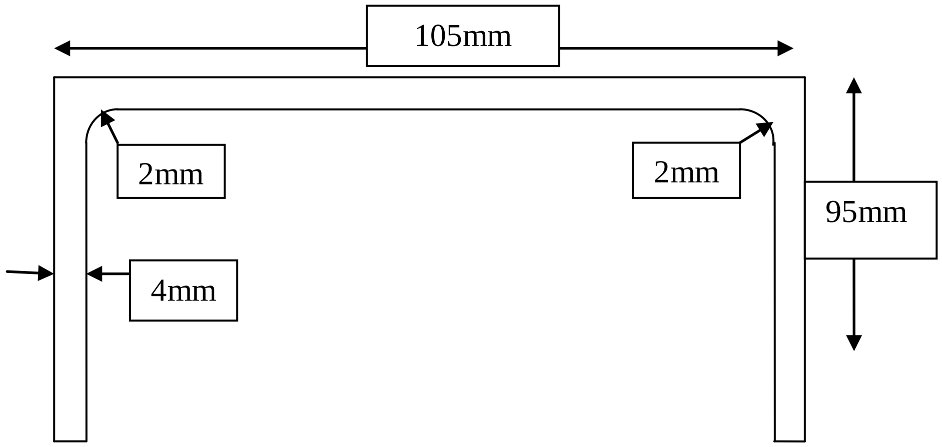
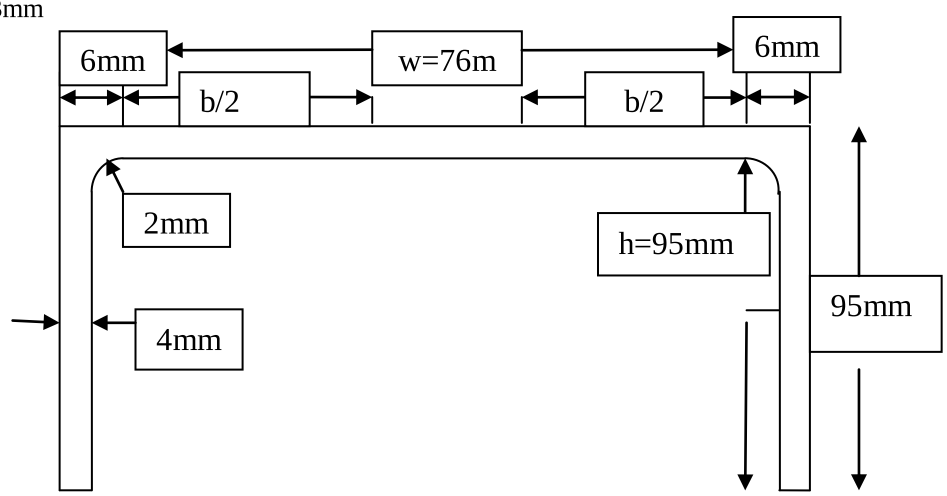


Fig. Shows the c/s of Channel section with a Top flange= 95mm, Web= 45mm with thickness= 4mm and root radius= 2mm. Yield point= 235 N/mm² and E= 2x 10^5 N/mm².load 43kn

Case 1: First section is having length = 1.05m i.e. 1050mm and taken a deflection 8.9mm. load 43kn

Case 2: Second section is having length = 0.72m i.e. 720mm and has taken a load = 34.10 kN. deflection :12.13mm



This is the case in which the compression flange is heavier. Both webs will yield first and the stress in compression flange will be smaller.

For such a case, the actual stress is found out by trial and error procedure. To start with, assuming full section to be *effective* the position of N.A. is found as under:

Element	**A(mm²)**	**y (from top fiber)**	**Ay (mm³)**
Top Flange	87x4= 348	2	696
Webs	2x95x4=360	22.5	8100
	708		8796

$\bar{y}$=8796/708 = 12.4mm

Allowable stress in tension= 0.6f_y = 0.6 x 235 = 141N/mm²

Stress in compression Flange= 0.6f_y x 12.4/ (45-12.4)

=141 x 12.4/ (45-12.4) = 53.6 N/mm²

This is based on full section to be effective. However, due to reduced effective width, N.A. will shift downwards, and hence stress in compression flange will increase. As a trial, let the stress in top flange = 60 N/mm^2.

Now, w/t = 95- (2x6) / 4= 20.75

4.2 Check for web shear:

For Case 1-

Max. Shear force= W/2 = 34.1/2= 17.05kN.

Max. Shear stress= $17.05 \times 10^3 / 2 \times 41 \times 4 = 51.98\ N/mm^2$

$h/t = 41/4 = 10.25$; $1425/\sqrt{fy} = 1425/\sqrt{235} = 92.96$

$h/t < 1425/\sqrt{fy}$

Hence, $fv = 396\sqrt{fy} / (h/t) = 396\sqrt{235} / 10.25 = 592\ N/mm^2$

$fv = 592 N/mm^2 > 51.98\ N/mm^2$

For Case 2-

Max. Shear force= W/2 = 43/2= 21.5kN.

Max. Shear stress= $21.5 \times 10^3 / 2 \times 41 \times 4 = 65.55\ N/mm^2$

$h/t = 41/4 = 10.25$; $1425/\sqrt{fy} = 1425/\sqrt{235} = 92.96$

$h/t < 1425/\sqrt{fy}$

Hence, $fv = 396\sqrt{fy} / (h/t) = 396\sqrt{235} / 10.25 = 592\ N/mm^2$

$fv = 592 N/mm^2 > 65.55\ N/mm^2$

Hence Safe in shear.

4.3 Check for bending Compression:

$fbw' = =141 \times 12.4 / (45-12.4) = 53.6\ N/mm^2$

Permissible $fbw = 3525000/(h/t)^2 = 3525000/(10.25)^2$

$=33551\ N/mm^2 > 53.6\ N/mm^2$.

Hence Safe.

4.4 Check for Deflection:

For taking check for deflection, whole width is considered as an effective width.

b=w= 83mm

Element	A(mm^2)	y (from top fiber)	Ay (mm^3)
Top Flange	(83+4)x4= 348	2	696
Webs	2x45x4=360	22.5	8100
	708		8796

$\bar{y}=8796/708 = 12.4mm$

$Ixx = (84+4) \times 4(12.4-2)^2 + 2 \times 4 \times 45^3/12 + 2 \times 4 \times 45(22.5-12.4)^2$

Ixx= 37639.68 + 60750 + 36723.6

Ixx= 135113 mm^4

Case 1-

$\delta = (WL)L^3/(48EI)$ For central point load

$\delta = (34 \times 1.05 \times 10^3) \times (1050)^3 / (48 \times 2 \times 10^5 \times 135113)$

$\delta = 31.86mm$

Permissible $\delta = L/325 = 1050/325 = 3.23mm$

Case 2-

$\delta = (WL)L^3/(48EI)$ For central point load

$\delta = (43 \times 0.72 \times 10^3) \times (720)^3 / (48 \times 2 \times 10^5 \times 135113)$

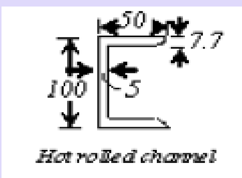
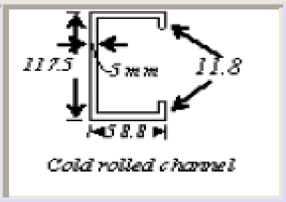
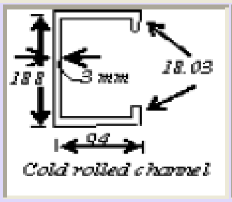
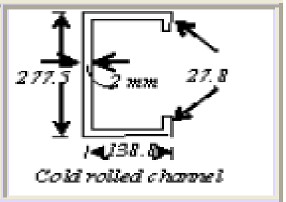
$\delta = 8.9mm$

Permissible $\delta = L/325 = 720/325 = 2.215mm$

VI. CONCLUDING REMARK

ISO 2604-II: 1975	Wrought seamless steel tube	Pressure purposes
ISO 2604-III: 1975	Electric resistance & induction welded steel tubes	Pressure purposes
ISO 2604-V: 1978	Longitudinally Welded	Austenitic stainless steel tubes, pressure purposes

ISO 2937: 1974	Seamless	Plain end steel tubes for mechanical application
ISO 3183-1: 1996	Steel pipe for pipelines	
ISO 3183-2: 1996	Steel pipe for pipelines	
ISO 3304: 1985	Seamless	Plain end precision steel tubes
ISO 3305: 1985	Welded	Plain end precision steel tubes
ISO 3306: 1985	As-welded & Sized	Plain end precision steel tubes
ISO 9329-3: 1997	Seamless	Unalloyed and alloyed steel tubes, specified low temp properties, pressure purposes
ISO 9330-3:1997	Electrical resistance & Induction welded	Unalloyed and alloyed steel tubes, specified low temp properties, pressure purposes
ISO 9330-5:2000	Submerged arc-welded	
Table no 6.1		

				
A	1193 mm^2	1193 mm^2	1193 mm^2	1193 mm^2
I_{xx}	$1.9 \times 10^6 mm^4$	$2.55 \times 10^6 mm^4$	$6.99 \times 10^6 mm^4$	$15.53 \times 10^6 mm^4$
Z_{xx}	$38 \times 10^3 mm^3$	$43.4 \times 10^3 mm^3$	$74.3 \times 10^3 mm^3$	$112 \times 10^3 mm^3$
I_{yy}	$0.299 \times 10^6 mm^4$	$0.47 \times 10^6 mm^4$	$1.39 \times 10^6 mm^4$	$3.16 \times 10^6 mm^4$
Z_{yy}	$9.1 \times 10^3 mm^3$	$11.9 \times 10^3 mm^3$	$22 \times 10^3 mm^3$	$33.4 \times 10^3 mm^3$

Environmental impact of steel concrete and timber
CMU- Concrete masonry unit blocks

		CMU		
	Steel Framed	Wall	Steel Trusses	Timber Framed
Material	4.45 (tons)	68.9 (tons)	2.16 (tons)	$24.5 m^3 \pm 2.5 m^3$
CO2 Intensiy	1.19 /ton	0.08 /ton	1.19 /ton	$0.96 / m^3$
CO2 Emissions	5.30 (Mt)	5.51 (Mt)	2.57 (Mt)	23.5 (Mt)
CO2 Index	1	1.52		4.44

Table 1: CO2 emissions for steel, CMU and timber houses

Engineering Research Centre, Chennai, INDIAAs The Indian code for cold-formed steel design, IS 801 was revised during 1975, which is in line with 1968 edition of AISI standard. Bureau of Indian standards is in the process of revision of IS 801 to catch up with the latest developments and design methods with the other codes of practices in the world. As a background for the development of codal provisions, the design provisions developed in the various codes of practices have been reviewed and a comparative study has been carried out on design flexural strength of cold formed steel lipped channel sections. For this purpose, experimental results are collected from the literature. Based on the comparative study, direct strength method (DSM), which gives flexural strength closer to experimental results has been chosen for further parametric studies. There are several failure modes among which distortional buckling is one such failure mode that affects the strength of the section. In order to assess the influence of distortional buckling, a parametric study has been conducted by varying the lip depth, which is the influencing factor for distortional buckling strength. This paper presents the details of the studies carried out and the conclusions arrived.

Cold form steel	Hot rolled steel
Working process in which metal deform under re crystallization	Working process in which metal deform under crystallization
Most often used to decrease thickness of plate	Totally difficult
Silp can be reduced by grain size of metal resulting in hall pitch Harding. formed in room temp.	Its formed elevated temp
Manufacturing of roof stip sheet press break operations	In a molting 25%stenght reduced
Primary concerned about type of buckling an unbraced beams	In it local buckling of individual constituent element will not occur before yielding

Cold-formed sections is at least 280 N/mm2, although there is atrend to use steels of higher strengths, and sometimes as low as 230 N/mm2.

In this project, we are going analyze the bending behavior with the help of IS801 and SP6 Handbook. Cold form research yet has not got a boom in India, so we also have to go through the literature review. Along with all this we'll try to suggest the use of cold form in industry.

VII. ACKNOWLEDGEMENT

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