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Investigation, analysis, and development of cold formed sections that conform to AISI standards

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ABSTRACT

Hot-rolled steel members have been used in the building sector for a long time. Light or moderately loaded structures can't benefit from hot rolled steel parts since they add weight. This issue has been solved by the development of cold formed steel (CFSS). Metal construction in the United States has relied on Z-purlin and other cold-formed steel products like it for more than 40 years because of the broad variety of applications, low cost and ease of production, as well as good strength-to-weight ratios. Z purlins are prevalent in roofing systems with low stress and modest spans. The literature review covers both stiffened and un-stiffened Lip channel portions. The tensile test was carried out using a Z-section test specimen that met with IS1608-2005. Mathematically-created cold-formed object.

Sections created via channelling, cold forming, and lip forming are all included in this category.

Introduction

Hot Rolled structural parts are widely used in construction. "Hot rolled members" are referred to as such because of the high temperature at which they are formed. After decades of improvement, hot rolled steel is all but extinct. Cold-formed steel members first appeared in American and British construction about 1850. In 1939, AISI supported research at Cornel University conducted by George Winter made steel members widespread. That wasn't until 1940 that steel members became common. George Winter was the primary researcher. Cold-formed steel sheets with a thickness of 1 to 3 mm are often used, and they are fabricated at room temperature. For the same reasons, it is also known as a light-gauge steel member. Due to the production method, these components are separate from hot rolled steel sections. Cold-formed sections manufactured from steel sheets typically need a yield strength of 280 N/mm2. Steel plates, sheets, and strips are often used in the fabrication of cold-formed steel structural parts. The material is pressed or cold rolled into shape during the production process. These fundamental forms are often made using the press-braking procedure. Panels for walls, floors, and ceilings are most often made using the cold roll forming process. Zees and Cees are two instances of structural components that were created. Sheets and coils up to 1.5 metres wide and 1,000 metres long may be used to make sections.

Component Rigidity

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An element that is sufficiently supported in the longitudinal directions by two adjacent components is considered stiffened in the stress direction. Due to the existence of flange supports, the web serves as a compression stiffening element in a channel segment. At least one-fifth of its full width is required for an element to be strengthened. The lowest moment of inertia between neighbouring parts for stiffened components has been calculated by AISI. Stiffened elements don't matter how thin they are, provided that the following requirements are satisfied. For stiffened components, AISI has developed a formula for the minimal moment of inertia between neighbouring parts.

Figure1:ExampleofPressBrakeOperation

Figure2:ImageshowingRolledFormedOperation
Un-stiffenedElement

Because the unstiffened portion is held only at one edge, just one longitudinal edge is being supported in the direction of stress. There is just one longitudinal length where flanges are supported in channel sections. A lack of protection has resulted in lower levels of protection for flanges, as a result One-fifth of the width of an unstiffened part may be used for the thickness. Depending on the cross section, the stiffness may either be totally unstiffened or completely stiffened, such as a box section, in a thin-walled cross section. Retightening of components on a regular basis.

This results in an item that is sporadically strengthened by intermediate stiffeners created as the material is rolled.

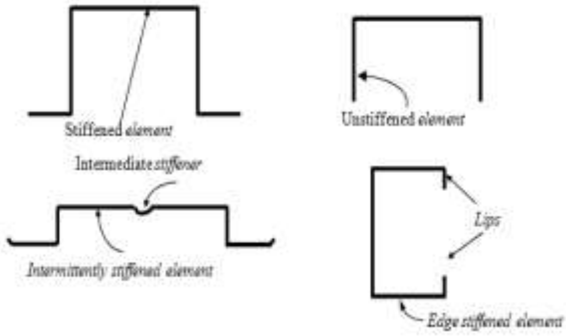

Figure3:Stiffened&UnstiffenedElement

EffectiveDesignWidth

It is common for plates to buckle when they are made thinner. Keep in mind that even if these components have a lot of post-buckling strength, it's crucial to keep this in mind The buckling components may nevertheless be able to sustain weight in spite of this. This is known as post-buckling strength. Designing for buckling and post-buckling strength makes use of the effective width approach. Intermediate stiffeners, for example, may be used to strengthen a flange. Squeezing them causes their centre to bend first, forcing the support strips to absorb the bulk of the stress (see figure). As a consequence, a non-linear stress distribution occurs, with greater strain being applied to the supported edges. Instead of a non-linear stress distribution, two rectangular portions of yield stress are used in the design process. Thus, it is referred to as "effective width"

Measurement of Compression Members' Moods and Behaviors. Local buckling is more likely to occur when buildings are made of thin plates. They should be noted that these components have outstanding post-buckling strength. The weight can still be supported by these sections even if they are broken. This is known as post-buckling strength. Designing for buckling and post-buckling strength makes use of the effective width approach. Intermediate stiffeners, for example, may be used to strengthen a flange. Squeezing them causes their centre to bend first, forcing the support strips to absorb the bulk of the stress (see figure). As a consequence, a non-linear stress distribution occurs, with greater strain being applied to the supported edges. Instead of a non-linear stress distribution, two rectangular portions of yield stress are used in the design process. This property is described by the phrase "effective width."

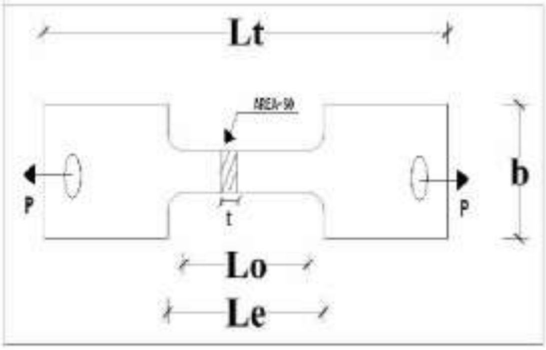

Figure4: StandardTensileTestSpecimen

Cold-formed steels are always yielding, but when hot-rolled and cold-formed, they have a defined yielding point and a yield plateau. Make a mental note of how tense you are.

- The following steps should be performed in order to perform a tension test and determine the modulus of elasticity:

- Using the Shear off machine, a standard-sized piece was cut from the Z section.
- The item was marked with a gauge length of 50.2mm and then connected to the testing instrument.
- The beginning thickness of the member is 2.5mm.
- It is tested using a 100-ton Universal Testing Machine (UTM) (UTM).
- For anyone interested in learning more about this project, you can find additional information here.
- f) The specimen has been photographed (before and after test).
  - g) A graph is drawn from the information.

Figure5:TestSpecimensbeforeTest

Figure6:TestSpecimensAfterTest

Result

Afterthetest,wehadobservedthefollowingresult

1. The thickness of member will become 1.86mm.
2. The final length of member will increase be 13.23%.
3. The reduction in area of member = 34.65%.
4. Modulus of elasticity (E) = 2.1 x 10^5 N/mm^2

Yieldstressofmember=350N/mm.

5. Manual calculation of Purlin as per AISI-1996 code

Loading of building as per Metal Building Manufactures Association (MBMA)

Dead Load = 0.15 kN/m2

Live Load = 0.57 kN/m2 (Adopted from Table 3.1)

Wind Speed = 44 m/sec. (Nagpur)

Wind Pressure = 0.84 kN/m2 (Adopted from Table 5.2 (b))

Vertical Deflection = L/180

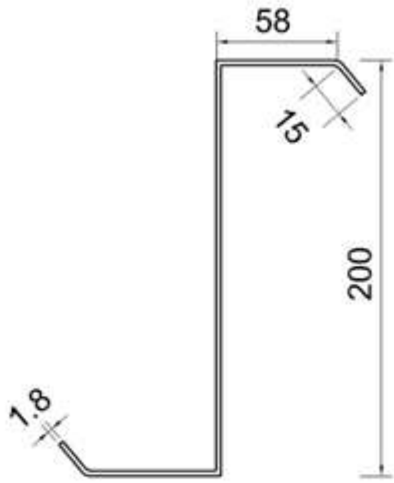

Figure8Zsectionprofile

SectionsusedforDesign

After the selection of loading parameters of purlin we need to select the section size for Design ofFrame.ThesectionpropertiesforColdformedmember iscalculatedbyusingCFSsoftware.Singlespanof3.5mw ith1.75mlaterallyrestraintandthewindco-efficientcalculatedasperMBMAis-1.1and+1.0.

PropertiesofsectionZ20018

Depth = 200 mm
Width=58
Thickness = 1.8mm

Inside radius = 7mm
Weight per m = 4.64kg/m
Moment of inertia=3.531x10^6 mm^4
Section modulus Se = 35.31x 10^3 mm^3
A=604mm^2
Fy=345N/mm^2

Loadcalculations

1) D.L=5kg/m2 +self wt of member

=(0.05X1.5)+0.047

=0.122 kN/m

2) L.L= 0.75 kN/m^2

=0.75X1.5 =1.125 kN/m

3) W.L=0.84X-1.2X1.5

(-1.2=Wind load co-eff. from MBMA, 0.84 = intensity of wind pressure)

= -1.512kN/m

LoadCombinations

1) D.L.+ L.L = 1.247 kN/m

B.M= $Wl^2/8$

=1.91kN.M

S.F = W.l/2

=2.18 kN

2) D.L +W.L= 0.122 +(-1.512)

= -1.39 kN/m

B.M=$Wl^2/8$

=-2.13 kN.M

S.F= W.l/2

=-2.43 kN

Checkforbending:

Moment capacity based on initiation of yielding (Equation C3.1.1-1 AISI 1996)

Mn=Se x Fy

Fy= design yield stress = 345N/mm^2

Se=section modulus = 35.31 x 10^3

Mn=35.31x10^3 x 345 =12.19 kN.m

Allowable Moment= $\frac{Mn}{\Lambda b}$

Where Λb is FOS for bending=1.67

Allowable Moment= $\frac{12.19}{1.67}$

=7.3 ≤ 1.91kN.m(O.K)

≤ 2.13kN.m(O.K)

Checkforshear

Shear strength is based on yielding or buckling depending on h/t ratio and mechanical properties of steel (equation C-3.2-4 AISI-1996)

h/t= 200/1.8= 111.11

for beam web having moderate h/t ratio nominal shear strength is based on inelastic shear buckling

$V_n = (0.64\, t^2)\sqrt{K_v F_y\, E}$

E = 2x10^5

Fy=345N/mm2

Kv=5.34 (for simple supports)

Vn=39.80 kN

Allowable Shear = $\frac{Vn}{\Lambda v}$

Where Λv = FOS for shear = 1.67

Allowable shear = 23.83 kN > 2.18 kN O.K

> 2.43kN O.K

3) Check for combined bending and shear (C-3.3 AISI 1996)

$$\left(\frac{\Omega b M}{M n x o}\right)^2 + \left(\frac{\Omega v V}{V n}\right)^2 \leq 1.0$$

c) D.L+ W.L (i) combination

$$\left(\frac{1.91}{7.30}\right)^2 + \left(\frac{2.18}{23.83}\right)^2 \leq 1.0$$

0.07 ≤ 1.0 (O.K)

c) D.L + W.L (i) combination

$$\left(\frac{2.13}{7.30}\right)^2 + \left(\frac{2.43}{23.83}\right)^2 \leq 1.0$$

0.09 ≤ 1.0 (O.K)

4) Check for web crippling (C3.4-1)

Condition = single web + Z section end reaction)

Nominal strength for concentrated load/reaction per web

$$Pn = t^2 K.C3.C4.C9.C\theta[331 - 0.61(h/t)].[1 + (0.01(N/t))]$$

K=894 x $\frac{Fy}{E}$ =1.54

C3=1.33-0.33K=0.8218

C4=1.15-0.15 $\frac{R}{t}$ ≤ 1.0 but not less than 0.5

=-0.183

∴ C4 = 0.5

C9=6.9

C =0.7+0.3 $(\theta/90)^2$ =1.0

N = Actual length of bearing = 120mm

Pn= 6206.15 N=6.21Kn

Allowable Strength= $\frac{Pn}{\Lambda w}$ = $\frac{6.21}{1.85}$

= 3.35 > 1.9 (O.K)

> 2.4 (O.K)

5) Check for deflection

$$\Delta = \frac{5Wl^4}{384EI} = 3.82mm$$

$$\text{Allowable} = \frac{L}{180} = 19.44mm \qquad (O.K)$$

Concluding Remarks

"stiffened," "undiffered," and the "effective width" of cold rolled sections are detailed in this chapter, as well as how to distinguish between them. An observation graph shows the results of a tensile test as a cold formed section.

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