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Comparative study on moment connections in cold formed steel sections With and without perforations

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Abstract

Now a day's cold formed structural steel sections are being used in many industrial sectors. Cold formed steel sections offer high strength and width to thickness ratio is very less so as to reduce inertia forces and transport costs. In this paper presents, a brief investigation on moment connections for typical cold formed steel sections. Beam and column members comprise of hollow rectangular sections. Bolted moment connections are provided by using angle section in different positions of beam-column joint. The models are analyzed through FEM software ANSYS. The performance of moment connection frame is evaluated in terms of deformation, Von-Mises stresses and shear stresses. It is preferable to use cold form steel sections with perforations in lower stress cases. It helps to reduce its self-weight, holes can accommodate plumbing, electrical, and heating conduits in the walls and ceilings of buildings. Thermal bridging effect can be reduced.

Keywords: *Cold formed steel, von mises stress, Finite element analysis.*

1. Introduction

Cold-formed steel (CFS) is the common term for products made by rolling or pressing thin gauges of sheet steel into goods. Cold-formed steel goods are created by the working of sheet steel using stamping, rolling, or presses to deform the sheet into a usable product. Cold worked steel products are commonly used in all areas of manufacturing of durable goods like appliances or automobiles but the phrase cold form steel is most prevalently used to described construction materials. In the construction industry both structural and non-structural elements are created from thin gauges of sheet steel. These building materials encompass columns, beams, joists, studs, floor decking, built-up sections and other components. The manufacturing of cold-formed steel products occurs at room temperature using rolling or pressing. It comprises advantages like easy transportation, handling as it is a light weight product, width to thickness ratio is very less meanwhile it offer high strength.

Cold-formed steel members have been used in buildings, bridges, storage racks, car bodies, railway coaches, highway products, transmission towers, transmission poles, drainage facilities, various types of equipment and others. Cold formed structural steel tubular sections are being used in many developing countries like Canada, India Hong Kong and Australia. In this project, a brief investigation on moment connections for typical cold formed steel tubular sections (with and without perforations) has to be conducted. Beam and column members comprise of hollow rectangular sections. A different moment connections has to be done by using stiffener plates and angle sections in different positions of beam-column joint. Using FEM software ANSYS analysis of different types of connection that provides more stability and safety is easy. The connected models are analyzed under point load with different stiffness of welded moment connections. The final results are evaluated in terms of deformation, Von-Mises stresses and shear stresses. The 2 sections are compared with the FEA results obtained (with and without perforations).

2. Experimental Analyses

2.1 Finite element analysis

A static finite element analyses were done using ANSYS 14.5. The following are the properties assigned for the specimens.

2.1.1Element Types

SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behavior. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions. The element supports plasticity, hyper elasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyperelastic materials.

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2.1.2 Material Properties

Material properties for steel as linear isotropic materials as

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- Young's Modulus E=1.995e5 MPa
- Poison's ratio v=0.3

Material properties for steel as bilinear isotropic materials as

- Yield stress = 268.89 N/mm2
- Tangent modulus = 1450

2.1.3 *Specimen Geometry*

Two models are of made rectangular cold formed steel hollow section. One with no perforations in the material and other with perforations The column beam connection is made to resist moment. Column and beam sections are connected by angle section with same material. The length of column is taken as 1800mm and the length of the beam is taken as 1000mm. The column, beam, angle section and bolts are first built in parts and then assembled finally. M 10 bolts are used as per Indian Standard IS 1364 HHB(grade A). The bolting is done with plane washer. The beam is connected at the centre of the column by 4 numbers of bolts in each plate with a pitch distance of 40 to 60mm in the models. Further, the thickness of beam and column is 4mm and that of angle plate is 6mm. The model was prepared with the following specifications and their images are shown below.

Table 1: Specimen details

Sl No:	Elements	Ultimate Load (N)
1	Column	75x75x4 mm, 1800mm
2	Beam	50x75x4 mm,1000mm
3	Angle section	100x100x6mm, 50mm

3. Results and discussions

The results of the ultimate load, maximum deflection of the beam, von mises stress and maximum principal stress are compared with specimens with perforations and with out perforations. Result files of different models are given below.

Table 2: Ultimate load

Sl No:	Specimens	Ultimate Load (N)
1	Model 1	6000
2	Model 2	4000

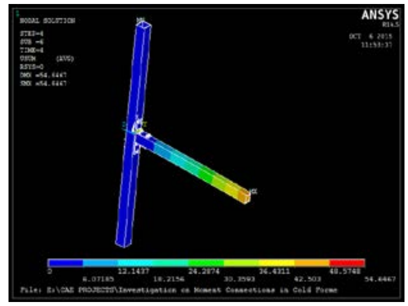

Fig.1: Static Analysis Results of Deflection of model 1

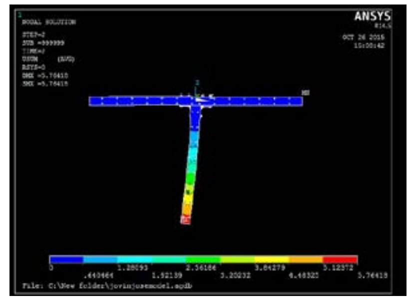

Fig.2: Static Analysis Results of Deflection of model 2

Table 3: Deflection

Sl No:	Specimens	Deflection (mm)
1	Model 1	3.96
2	Model 2	3.12

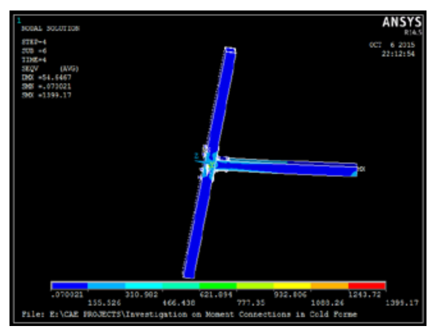

Fig.3: Static Analysis Results of Max.Principle stress of model 1

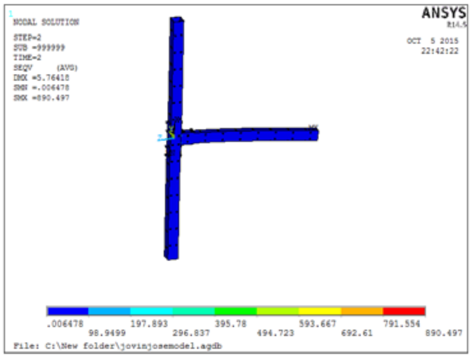

Fig.4: Static Analysis Results of Max.Principle stress of model 2

Table 4: Max.Principle stress

Sl No:	Specimens	Max.Principle stress (N/mm2)
1	Model 1	643.636
2	Model 2	513.973

Fig 5: Static Analysis Results of Von Mises Stress of model 1

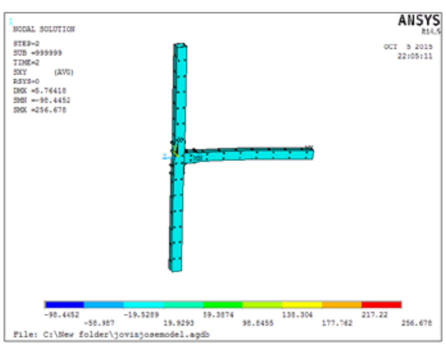

Fig 6: Static Analysis Results of Von Mises Stress of model 2

Table 5: Von mises stress

Sl No:	Specimens	Von mises stress (N/mm2)
1	Model 1	375.183
2	Model 2	518.006

4. Conclusions

The main objective of the project is to have a comparative study of cold formed steel sections with and with out perforations.

The following conclusions are drawn from the study

- Even if there are variations in result values the advantages of using perforated steel sections can be considered as good.
- All the results in the analysis are having a comparable value with both the models. Little higher value observed in von mises stress in case of model with perforations.
- Thus its preferable to use cold form steel sections with perforations in lower stress cases.
- It helps to reduce its self-weight, holes can accommodate plumbing, electrical, and heating conduits in the walls and ceilings of buildings. Thermal bridging effect can be reduced.

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