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Case Study of Element Types on Cold Formed Steel Angle Sections Under Tensile Using Ansys

Paul Makesh A[1], Arivalagan S[2]
[1]Research Scholar, [2]Professor and Dean
Department of Civil Engineering, Dr. M.G.R Educational And Research Institute University, Chennai, India

ABSTRACT
The effective sectional area concept was adopted to conduct the analysis of cold-formed tension members. Ansys software was utilized to simulate the behavior of cold formed steel angle under tension load. Structural steel members are extensively used in structures such as bridges, roof trusses, transmission line towers, multistoried buildings etc. It gives high strength to weight ratio, resulting in the reduction of dead weight. The paper describes the case study of element types on cold formed steel angle sections under tensile using ansys. ANSYS Workbench capabilities include a unique and extensive materials and sections for concrete and steel structures. A user-friendly beam and shell postprocessor included listing and plotting section geometry, reinforcements, beam stresses and strains inside the cross section.

KEY WORDS: *FEM, Mesh, Element Type, Angle sections*

I. INTRODUCTION

CivilFEM is a set of ANSYS integrated pre-processing, solution and post- processing tools that make it easier for the user to deal with civil engineering issues. The aim of the Finite Element Analysis is to develop a model that can study the behavior of single and double angle bolted cold-formed steel components. The behavior observed during the tests was used for preparing a finite element model, particularly during the non linear analysis. In angles under tension, the behavior is highly nonlinear as the failure approaches.

The model of finite elements included both geometric and nonlinear material effects. The front edge of the guesset plate is restricted in all directions except the longitudinal direction.On the front edge of the gusset plate, a longitudinal displacement limit condition is applied. The maximum stress and strain is obtained around the bolt hole.

II. LITERATURE REVIEW

Vinayak N and KalingSadanand M (2015) examine the connections in any structure is of primary importance because, it is always desirable the structural member to fail first instead of the connection. If the structural connection fails before the failure of the member it is always a brittle failure and catastrophic. Present study is focused out to determine the structural performances of various beam–columns with bolted moment connections on cold formed light gauge steel sections by analytical, FEM analysis and experimental tests. The analysis included four types of beam column connections with gusset plate. The number of bolts required for basic connection are determined from BS 5950-5 1998.Based on proposed four types of connection configuration, they are modeled in pro-e. Further, this modeled connection is analyzed in hypermesh, then experimental test have been carried out on the same connections. The relations between moment-rotation, moment resistance, model factor and various modes of failure were observed. From the experimental and FEM analysis it has been observed that there is always torsional buckling failure of beam section and distortion of gusset plate and from result model factor of proposed model is 0.731 and moment resistance of connection archives 32% to that of moment resistance of cold form steel section.

Soheila Maduliat and Priyan Mendis(2014) reported Flange edge stiffeners can increase the ultimate moment capacity of cold-formed channel sections up to their post-yielding (inelastic) capacity. This paper investigates the post-yielding behaviour under bending of cold-formed channel sections with partially stiffened elements. The relevant literature was reviewed, experimental studies were carried out and a semi-empirical analysis was performed. Experimental and numerical analysis was undertaken of 40 cold-formed channel sections, each with a partially stiffened element. The results were compared with the existing Australian design rules and revisions are proposed to these rules. In addition, by using the test observations and the yield line mechanism model, the ultimate capacity of the tested sections was determined and compared with the test results. The model was found to provide accurate and reliable capacity predictions for slender cold-formed channel sections under bending.

SonalBanchhor and M.K Gupta (2016) reported the tension members are used in a variety of structures such as trusses transmission towers etc. The most widely used structural shapes are the angle sections and the channel sections. Angle may use as single angle or double angles and the connection may be bolted or welded. Most of the design provisions for hot- rolled tension members are available and only few studies were reported in literature regarding behavior of cold formed steel bolted angle tension members. The main objective of this study is to investigate the behavior of cold steel single and double angle subjected to tension. Experimental, theoretical investigations were carried out for single angle, double angle connected to opposite sides of gusset plates and double angle connected to same side of gusset plates. As a result, highly non uniform stresses will be generated near the connection, and this can cause localized yielding in parts of the cross-section. The whole cross-section may not be fully utilized which causes a reduction in the net section efficiency. This loss of efficiency of the section is due to shear lag. An accurate estimation of this non-uniform stress distribution is necessary for determination of load carrying capacity of angles under tension.

Sudha K and Sukumar S (2013) presents an experimental and numerical investigation on the bending strength and behaviour of cold-formed (CF) steel built-up flexural members. Eight specimens in two groups, first group of four specimens with equal flanges and second group of four specimens with unequal flanges have been fabricated and experimented. The experimental results show the modes of buckling and their influence on the bending strength and behaviour of CF built-up I sections. The experimental results are also verified by simulating finite element models and analysed using FEM software ANSYS. The results obtained are in good agreement with the experimental results.

Thomas HK and Chris Ramseyer (2016) analyzed the goals of this study are to understand different buckling modes and maximum buckling capacity of the built-up C-channels, a with evaluate the AISI-2001 Specification. For these goals, the following was conducted, different buckling modes of cold-formed steel columns were investigated and the buckling test results of 42 cold-formed built-up columns were examined. The study and review help better understanding of the buckling modes and the effect of design or testing parameters on the buckling behavior. The orientation of the column substantially impacts the maximum load of the column (as much as 20%).The results show inconsistencies in the calculated values by AISI-2001 as compared to the maximum capacity loads determined from the buckling tests. The orientation of the member substantially impacts the maximum load of the member.

Vani G and Jayabalan P (2013) reported the numerical analysis of cold formed steel sections using effective width method is very conservative. Hence the direct strength method has been developed recently which effectively considers the elastic buckling behavior of the member. The present study is mainly focused on the investigation of elastic buckling and the non- linear behavior of pin-ended cold formed steel equal angles using the modern technique. A general purpose Finite Element software ABAQUS_6.11 has been used for the FE analysis and has been compared with the finite strip method. Three nominal section sizes are tested, ranging from non-slender to slender sections. The specimens are studied for b/t ratio such as 30, 45 and 60.The width is varied and the thickness (2 mm) is kept constant. They are analyzed for different lengths such as 300mm, 600mm, 900mm and 1200 mm. Detailed measurements of material properties are done by the tensile coupon test. The specimens are subjected to pressure loading to study the behavior of various sections. From the finite element analysis it is observed that the load carrying capacity of the section decreases as the b/t ratio increases. For the same b/t ratio as the length increases the load carrying capacity of the section decreases due to the slenderness effect. The non- linear analysis results are compared with the recent Direct Strength Method (DSM) and the traditional Effective Width Method (EWM) as well. The DSM method is found to predict the ultimate load capacities in a better way.

Valdier Francisco de paula et al (2008), presented experimental results of 66 specimens carried out on cold-formed steel angles fastened with bolts under tension. Out of the 66 specimens, four angles have one bolt and remaining 62 specimens have more than one bolt per line. These 66 specimens showed net section failure with two or more bolts in the cross-section of cold-formed angles. The specimens tested had equal or different legs, different cross-sections, various thicknesses and a varied number of bolts and bolt lines. He conducted multiple linear regression analysis and suggested the expression for net section efficiency (U) which depended on the geometrical factors such as connection eccentricity (x), connection length (L), width of connected leg of the angle (bc), net width of the angle with connected leg (bcn), width of unconnected leg (bd), nominal bolt diameter (d) and angle thickness (t).The proposed equation is$U = 1.19 – 0.26 (x /L) – (0.63b_{cn} + 0.17bd$ The effect of shear lag on cold-formed steel sections were much limited when ompared to studies on hot-rolled steel sections. The American Iron and Steel Institute, Australian/ New Zealand and British Standard codes were recently revised and incorporated the provisions. Hence there is a need to investigate the behaviour of cold-formed steel angles under tension.

III. PROPERTIES OF COLD FORMED STEEL

Lightweight: Cold formed steel components weigh about 35 percent to 50 percent less than their wood counterpart, making them easy to handle during construction and transport.

High-strength and stiffness: The cold-forming process gives cold-formed steel one of the highest strength-to-weight ratios of any building material. This high strength and rigidity lead to more design options, wider ranges and improved material use.

Fast and easy erection and installation: Building components made of cold-formed steel can be manufactured in a plant with high accuracy and then assembled on workstations that greatly increase erection efficiency and guarantee construction quality.

Dimensionally stable material: Cold formed steel does not expand or contract moisture content. Moreover, as time passes, it does not split or warp. It is therefore dimensionally stable. Cracked gypsum sheathed walls, nail head popping and other common problems with wood - framed structures in buildings with cold-formed steel stud walls can be virtually eliminated.

IV. ELEMENT TYPE

Geometry, loading and required results must all be evaluated in the selection process of the elements. The program ANSYS has a wide library of element types. Some of the features and groupings of the element types are described in this chapter to make it easier to select the element type. CONTRA 174, SOLID 186, SOILD 187, SURF 175 and TARGE 170 are element types was used to model the single angle sections and double angle sections.

The degrees of freedom of the element determine the discipline for which the element is applicable is static structural, The element type was chosen such that the degrees of freedom are sufficient to characterize the model's response. It has both bending and membrane capabilities. The element has plasticity, hyper elasticity, stress stiffening, creep, large deflection, and large strain capabilities, incompressible elasto plastic materials, and fully incompressible hyper elastic materials.

Contact and sliding between 3D target surfaces was used for CONTA 174. This element applies to structural 3D and coupling field contact analysis. The locations of the geometry and nodes are shown in Fig 1. The element is defined by eight nodes. it can degenerate into six nodes depending on the shape of the solid or shell elements underlying it. There are two types of geometry for this element. Surface smoothing and bolt thread surface smoothing is a geometry correction technique that eliminates facial element in accuracies. Bold thread modeling provides a method to simulate contact between a threaded bold hole and a bolt hole without modeling the detailed geometry of the thread.

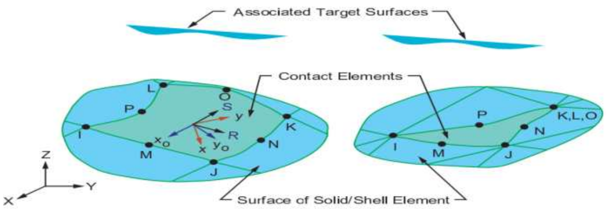

Fig 1 Element type of CONTA 174

SOLID 186 is a higher order 3D 20 node solid element with a quadratic behavior of displacement. The element is defined by 20 nodes with three degrees of freedom per node in the x, y and z directions.The element supports plasticity, hyper elasticity, stress stiffening, creep, large deflection, and large strain capabilities. It also has the ability to simulate deformations of almost incompressible elasto plastic materials and completely Incompressible hyper elastic materials in mixed formulation. Fig2 shows the geometry, the location of the node and the element coordinate system. SOLID 186 homogeneous structural solid is suitable for irregular mesh modeling.

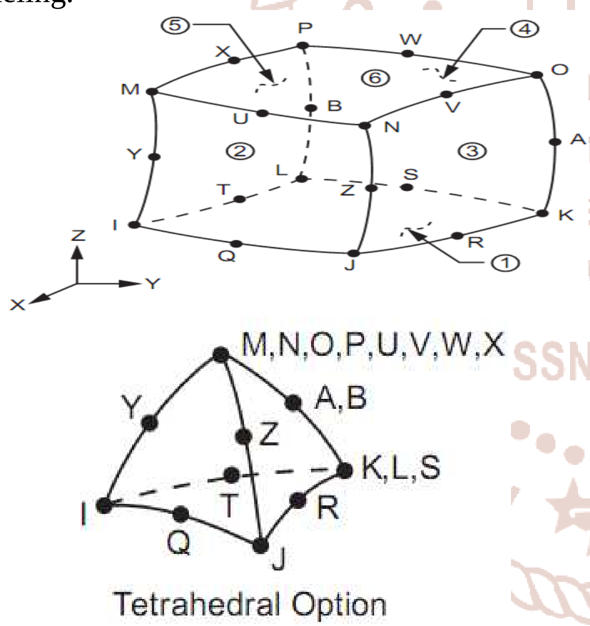

Fig 2 Element type of SOLID 186

The SOLID 187 element is a 3D, 10 node element in higher order. SOLID187 has a quadratic displacement behavior and is suitable for irregular mesh modelling. The element is defined by 10 nodes with three degrees of freedom per node in the x, y and z directions.The element has plasticity, hyper elasticity, creep, tension stiffening, high deflection and large strain capabilities. It also has the ability to simulate deformations of almost incompressible elastoplastic materials and completely incompressible hyperelastic materials in mixed formulation. The locations of the geometry and nodes are shown in Fig 3

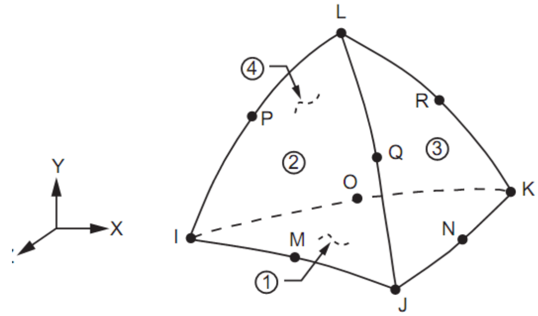

Fig 3 Element type of SOLID 187

SURF 175decribed the geometry, node locations and the coordinate system are shown in Fig 3.The elements are defined by four to eight nodes and the material properties. A triangular element may be formed by defining duplicate K and L node numbers as described in Degenerated shape elements. The default element x- axis is parallel to the I- J side of the element. The surface tension load vector acts in the element's plane as a constant force applied to the nodes, which seeks to minimize the surface area.

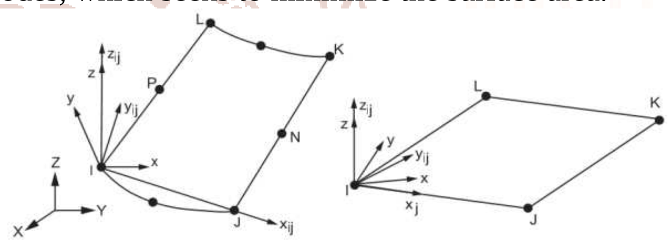

Fig 4 Element type of SURF 175

TARGE 170 is used to represent various 3D target surfaces for the associated contact elements. The contact elements themselves overlay the soild, shell or line elements describing the boundary of a deformable boby and are potentially in contact with the target surface. Fig 4 shows the available segment types for TARGE 170.The general 3D surface segments 3 node and 6 node triangles, and 4 node and 8 node quadrilaterals. Each target segment of a rigid surface is a single element with a specific shape, or segment type. The segment types are defined by several nodes and a target shape. Fig 5 shows the element type of TARGE 170.

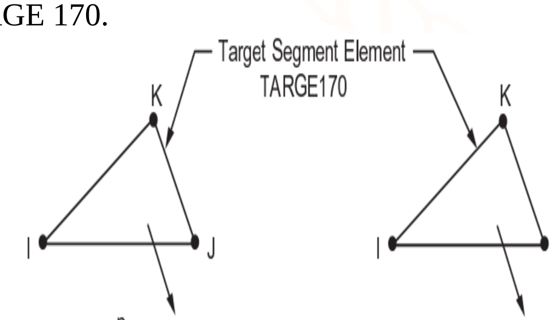

Fig 5 Element type of TARGE 170

V. MESH GENERATION WITH ANSYS WORKBENCH

Meshing is defined as the process of dividing the whole component into a number of elements so that it distributes the load uniformly called meshing when the tensile load on the component. The meshing operation of the section involves separating the section into several smaller finite elemental fragments for efficient interaction. Therefore adopting an appropriate elements refinement and size is necessary. To analyze these angle sections by using quadratic elements and a uniform meshing arrangement with a smoother surface transition for better results.

For analysis of the angle sections, the type of mesh element and the coarseness of the mesh were used. In the specimens, coarser mesh was used. Its shows accurate results than a more refined mesh and the coarser mesh are provide quicker analysis results as a tradeoff. The analysis of finite elements is a computer model of a material or design that is stressed and analyzed for specific results.Finite element analysis uses a complex system of points known as nodes that make a mesh grid. This mesh were been designed to contain the material and structural properties that define the reaction of the structure to certain loading conditions. Depending on the anticipated stress levels of a particular area, nodes are assigned to a certain density throughout the material. The mesh acts like a spider web in that from each node, there extends a mesh element to each of the adjacent nodes.

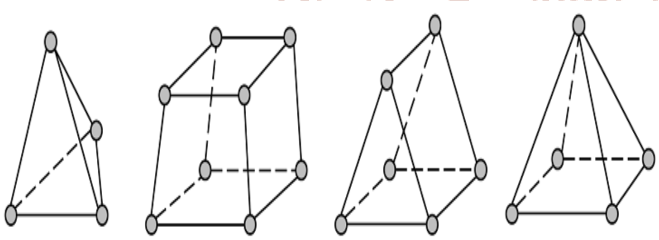

Fig 6 Tetrahedron mesh

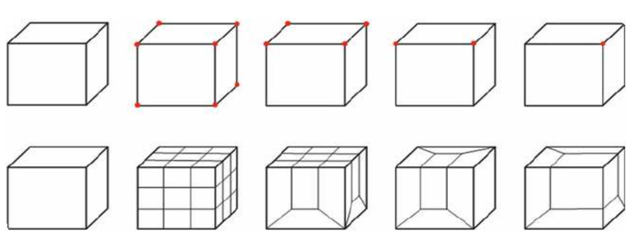

Fig 7 Hexahedral mesh

Fig 7 shows the Tetrahedron mesh and the Hexahedral mesh each of the angle specimens was analyzed using the linear elastic finite element package in the current study.During the preprocessing stage, modeling and meshing were carried out using the 3D computer Aided Engineering System. The success of mesh generation depends on the right choice of the size, shape and type of element.

VI. CONCLUSION

Geometry, loading and required results must all be evaluated in the selection process of the elements. The program ANSYS has a wide library of element types. Some of the features and groupings of the element types are described in this chapter to make it easier to select the element type. CONTRA 174, SOLID 186, SOILD 187, SURF 175 and TARGE 170 are element types was used to model the single angle sections and double angle sections.

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REFERANCES

1. ANSYS Release 8.1 (2004). ANSYS, Inc., USA. Google Scholar
2. AS/NZS (1996). Australian/New Zealand Standard, Cold- Formed Steel Structures, Sydney, Australia. Google Scholar
3. Desmond, T. P., Pekoz, T., and winter, G. (1981). “Edge stiffeners for thin-walled members.” Journal of Structural Engineering, 107(2), pp. 329–353.Google Scholar
4. Lam, S. S. E., Chung, K. F., and Wang, X. P. (2006). “Loadcarrying capacities of cold-formed steel cut stub columns with lipped C-section.” Thin-Walled Structures, 44, pp. 1077–1083.Google Scholar
5. NAS (2001). Specification for the Design of Cold-formed Steel Structural Members, North American Specification, Washington, D. C. Google Scholar