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FEA of Structural Tube Flange Weld Joint Under Torsional Load

V G VAMSI KRISHNA, RENUGADEVI K***
** Research scholar, Department of Mechanical Engineering, Sri Venkateswara College of Engineering,Tirupathi*
Email: vedamvamsikrishna@gmail.com
***Assistant Professor, Department of Mechanical Engineering, Sri Venkateswara College of Engineering,Tirupathi*
Email: renukasarath12@gmail.com

Abstract: Weld joints are used to join steel beams, girders, and other structural members in buildings, bridges, and other structures. The objective of current research is to investigate the structural characteristics of weld joint under torsional loading using techniques of finite element analysis (FEA). The modelling and FEA simulation is conducted using ANSYS simulation package. From the FEA simulation of tube flange weld joint, the structural characteristics are evaluated. The torsional load tends to cause distortion at the intersection region of tube flange weld joint. The intersection zone of horizontal and vertical feature has higher stresses and is more subjected to failure.

Key Words: *FEA, Weld joint, Response Surface Method*

1. INTRODUCTION:

The weld joint is created by heating the metal to its melting point and then using a filler metal to create a bond between the two pieces. The type of weld joint used depends on the type of metal being welded, the thickness of the metal, and the forces that will be applied to the joint.Welding joints are used in a wide variety of applications, including:

- Construction: Welded joints are used to build bridges, buildings, and other structures.
- Manufacturing: Welded joints are used to make cars, appliances, and other products.
- Aerospace: Welded joints are used to build airplanes, spacecraft, and other vehicles.
- Shipbuilding: Welded joints are used to build ships and other watercraft.

Welding joints are a versatile and reliable way to join two pieces of metal together. They are strong, durable, and can be used in a wide variety of applications. The design of a weld joint is important to ensure that it is strong and durable. The type of weld joint used, the size and shape of the joint, and the type of metal being welded all need to be considered when designing a weld joint. The strength of a weld joint depends on many factors, including the type of metal being welded, the thickness of the metal, the type of weld joint used, and the skill of the welder. However, in general, weld joints are very strong and can withstand a great deal of force.

2. LITERATURE REVIEW

Acevedo et. al. [1] This study investigated the effect of welding parameters on the mechanical properties of weld joints in steel. The parameters investigated were the welding current, the welding voltage, and the welding speed. The results showed that the welding current and the welding voltage had a significant effect on the tensile strength of the weld joints. The welding speed had a less significant effect on the tensile strength of the weld joints. The highest tensile strength was achieved with a welding current of 150 amperes, a welding voltage of 20 volts, and a welding speed of 10 millimeters per minute.

Chattopadhyay et. al. [2] This study investigated the microstructure and mechanical properties of friction stir welded dissimilar steel joints. The steels used were AISI 1018 and AISI 304L. The results showed that the microstructure of the weld joint was composed of a stir zone, a heat affected zone, and the base metal. The stir zone was characterized by a fine-grained structure, while the heat affected zone was characterized by a coarse-grained structure. The mechanical properties of the weld joint were comparable to the base metal.

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Cotrell et. al. [3] This study investigated the fatigue behavior of weld joints in steel. The weld joints were made using a gas metal arc welding process. The results showed that the weld joints had a lower fatigue strength than the base metal. The fatigue strength of the weld joints was improved by increasing the heat input during welding.

Donders et. al. [4] This study investigated the residual stresses in weld joints. The weld joints were made using a gas metal arc welding process. The results showed that the weld joints had significant residual stresses. The residual stresses were tensile in the weld metal and compressive in the heat affected zone. The residual stresses were reduced by post-weld heat treatment.

Ahmet et. al. [5] This study investigated the corrosion behavior of weld joints in steel. The weld joints were made using a gas metal arc welding process. The results showed that the weld joints were more susceptible to corrosion than the base metal. The corrosion rate of the weld joints was reduced by using a corrosion resistant filler metal.

3. OBJECTIVES

The objective of current research is to investigate the structural characteristics of weld joint under torsional loading using techniques of finite element analysis (FEA). The modelling and FEA simulation is conducted using ANSYS simulation package.

4. METHODOLOGY

The finite element method is a powerful tool that can be used to solve a wide variety of problems. The basic idea behind the finite element method is to divide the model into a finite number of elements. The FEA analysis of weld joint process involves modeling of weld joint, meshing of weld joint and applying structural boundary conditions.

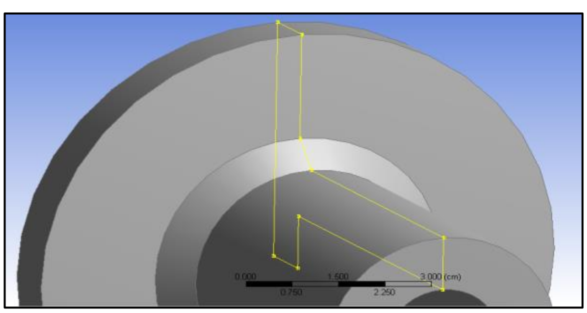

Figure 1: CAD modeling of weld joint using revolve tool

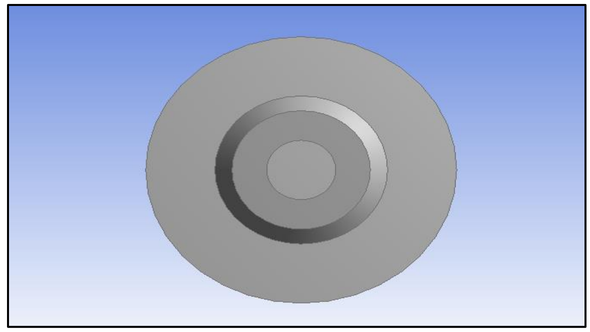

Figure 2: Front view of weld joint

The CAD model of weld joint is developed using revolve tool as shown in figure 1 and figure 2. The isometric view of weld joint is shown in 3.

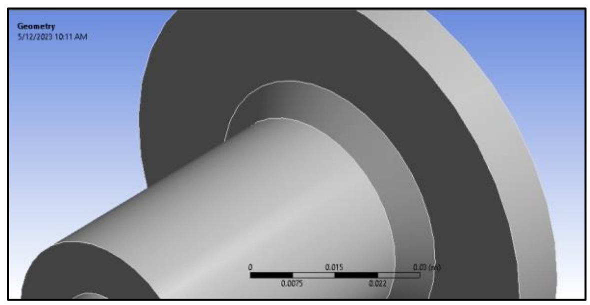

Figure 3: Isometric view of weld joint

After modeling, the meshing settings are defined. The mesh settings include fine relevance with adaptive shape function. The meshed model of tube flange weld joint is shown in figure 4.

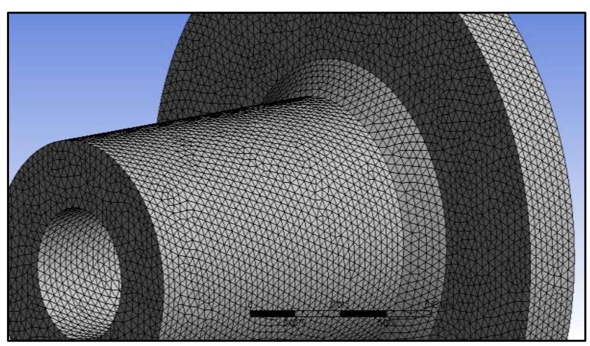

Figure 4: Meshed model of weld joint

The structural loads for tube flange weld joint includes fixed support at the rear face and moment on front face as shown in figure 5.

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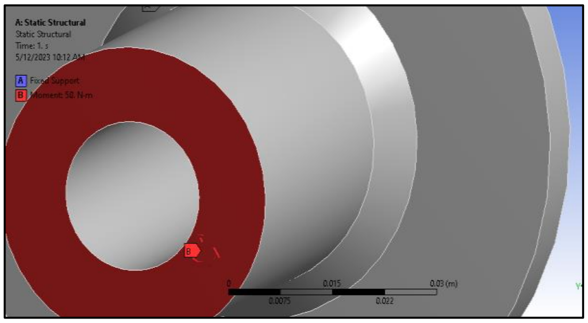

Figure 5: Applied loads and boundary conditions

After applying structural boundary conditions on tube flange weld joint, the simulation is run. The simulation process involves formulation of stiffness elements. After running the simulation, the nodal calculations are done for determining stresses and deformation.

5. RESULTS AND DISCUSSION

The structural analysis is conducted on weld joint to determine equivalent stress, shear stress and strain energy.

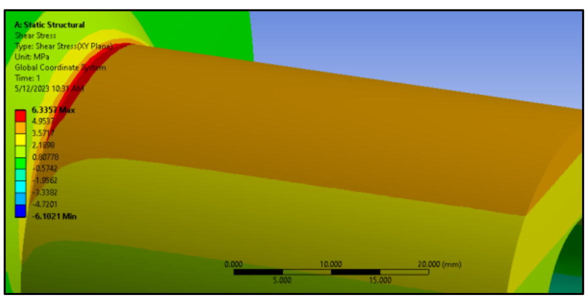

Figure 6: Shear stress distribution plot

The shear stress distribution plot is obtained for the tube flange weld joint. Due to torsional load, the shear stress value is maximum at the joint of weld joint. The value of shear stress at the intersection is more than 4.1MPa. The shear stress value is uniform along the length of the weld joint. The shear stress is lower at the mid-section of weld joint with magnitude of .807MPa.

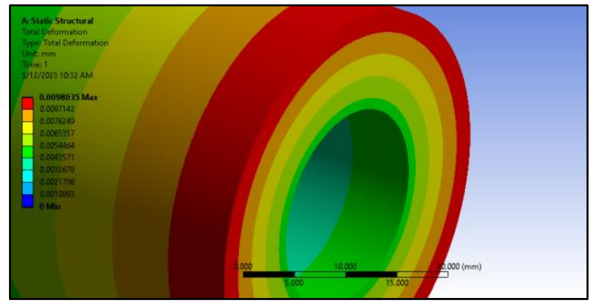

Figure 7: Total deformation distribution plot

The total deformation distribution plot is obtained for the weld joint. The deformation type is torsional with maximum value at the free end of the weld joint. The torsional deformation at the free end of weld joint is more than .0088mm. The torsional deformation reduces towards the inner regions of tube as shown in green colored zone.

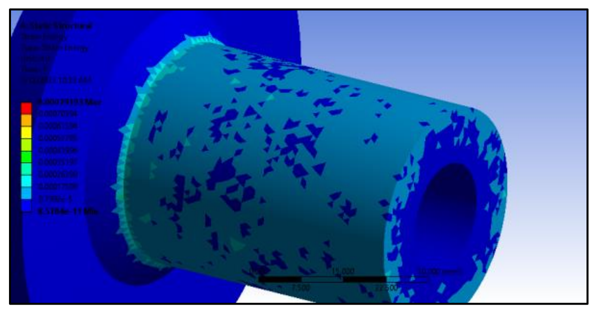

Figure 8: Strain energy distribution plot

The strain energy distribution plot is shown in figure 8 which signifies the energy stored in weld joint due to torsional loading. The strain energy is maximum at the intersection region of weld joint and lower on inner zones of weld joint. The maximum strain energy obtained due to torsional loading is .00079mJ.

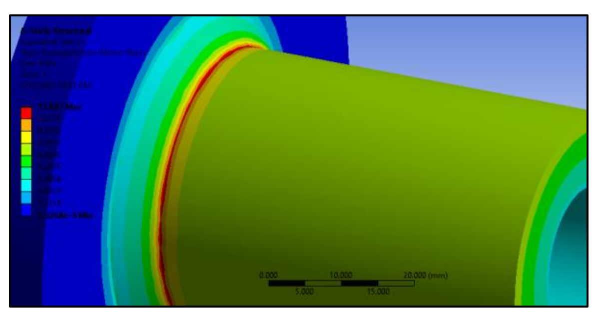

Figure 9: Equivalent stress distribution plot

For ductile materials, the equivalent stress is necessary to evaluate. The equivalent stress is higher at the corner of weld joint at the intersection region. The higher equivalent stress is due to higher distortion at this region. The equivalent stress is 9.25MPa.

5. CONCLUSION

From the FEA simulation of tube flange weld joint, the structural characteristics are evaluated. The torsional load tends to cause distortion at the intersection region of tube flange weld joint. The intersection zone of horizontal and vertical feature has higher stresses and is more subjected to failure.

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