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Review of Tube Flange Welded Joint

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Abstract- The fatigue cracks are the one of the major cause of failures in welded joints. The current research studies the various researches conducted in analyzing strength and life of welded joints. The testing of welded joints are done using experimental and numerical methods. The effect of different filler materials, heat input, welding current and gas flow rate on quality and strength of weld is also studied. The heat affected zone of friction stir welding is also investigated using techniques of finite element analysis.

Keywords:- Weld Joint, Fatigue Life, Safety Factor, ANSYS.

I. INTRODUCTION

The fatigue cracks are mostly found at weld root after numerous cycles and are difficult to detect. These cracks propagate through the throat thickness. The fatigue failure of weld joints is caused due to various factors which include material, method as well as misalignment of parts for weld and each has varying effect. It is almost impossible to avoid material imperfections as it is always deformed during welding process. The uneven welds due to poor workmanship results in stress concentrations. Depending on geometry of the joint, the misalignment can be axial or angular in different directions. The stress concentrations created through irregularities on the surface, holes, notches also affect fatigue life of weld.

II. LITERATURE REVIEW

Gadewar SP et al. [1] investigated the effect of process parameters on bead geometry of welded joints. TIG welding was performed on 3 mm thick 304 stainless steel. The test result shows that, as the welding current and gas flow rate increases with the thickness of the work piece the front width and back width value across the weld was also increases from 3 to 5 mm for 1 mm thick work piece and from 4 to 6 mm for 2mm thick work piece which affect the mechanical property of welds with great extent.

Wang Q et al. [2] studied the influences of process parameters of TIG arc welding on the microstructure, tensile property and fracture of welded joints of Ni-base super-alloy. For welding, plate width of 1.2-1.5 mm, welding current in the range of 55-90 A,with variable welding speed in the range 2100-2900 mm/min was used. From experimental result it was observed that, the heat input increases with increase of welding current and decrease of welding speed.

Raveendra A. et al. [3] performed experiment to check the effect of pulsed current on the characteristics of weldments by GTAW. The 3 mm thick sheet of steel were tested using different frequencies. More hardness found in the HAZ zone of all weldments may be due to grain refinement. Higher tensile strength found in the non-pulsed current weldments. The researcher observed that UTS and YS value of non-pulsed current were more than the parent metal and pulsed current weldments. The geometry of the weld specimen prepared by the author is shown below in Fig. 1.

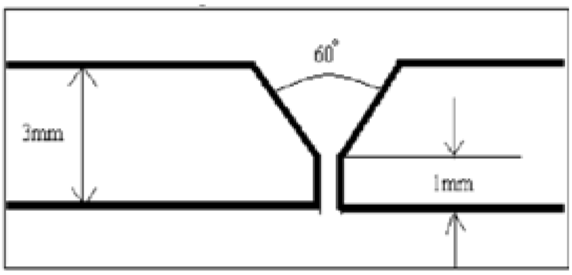

Fig 1. Edge Preparation of Weld Specimens [3].

The importance of parametric variation effect of GMAW process as reported by **Saha S et al. [4]** shows that higher welding speed along with higher welding current (at same heat input level) enhance the weld metal mechanical properties of AISI 304 SS welds of 4mm thickness. Failure of welded joint during tensile deformation is shown in the figure in which weld metal W1 shows comparatively higher strength than weld metal W2. The tensile stress-strain curve of weld metal is shown below in Fig. 2.

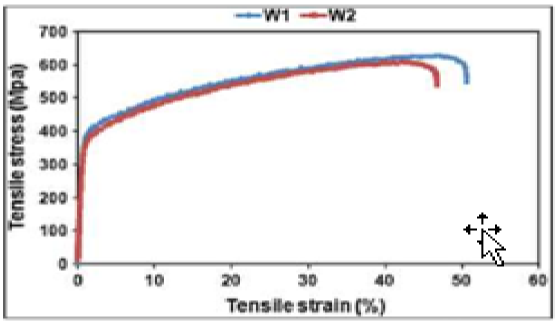

Fig 2. Tensile Stress-Strain Curve of Weld Metal [4].

Mathur A et al. [5] studied the properties of gas tungsten arc weld of AISI 304 stainless steel of 6 mm thickness. Welding was performed with current in the range 48-112 A and gas flow rate 7 -15 l/min. From the analysis it was concluded that, due to the presence of various alloying elements and post weld heat treatments the tensile strength and ductility of the base metal is significantly higher than the weld bead.

Khoushid AM et al. [6] studied the mechanical properties of welded aluminum 6061pipe using three different types of welds. Weldments with rotation speed (1800 RPM) and travel speed 4mm/min of MIG, TIG and Friction welding were compared. The microstructure of the welds, including the nugget zone and heat affected zone, has been compared and concluded that the micro hardness values are higher in the weld region of FSW joints compared to MIG and TIG. Furthermore, FSW welds exhibit higher strength values compared to others.

Kumar CR A et al. [7] studied the influence of process parameters i.e. current, welding speed and gas flow rate of 316LN stainless steel using TIG welding. The response surface methodology is employed to develop the empirical relationship. Using the Finite Element analysis numerical data generated on the influence of process variables on weld-bead geometry, regression models correlating the weld-bead shape parameters with the process parameters and the experimental result shows that the welded steel joint is at 95 % confidence level.

Singh N et al. [8] performed TIG welding of grade 202 AISI stainless steel and compare the single V butt and double V butt joint at different current rates by keeping other parameters constant. On the basis of tensile strength, micro hardness and micro structure of weldments it was obtained that the double v joint obtained at high current has more tensile strength, hardness and toughness than the single V joint.

The effect of microstructure, hardness distribution and tensile properties of welded butt joints of 6063 T6 aluminum alloy have been studied by **Singh P et al. [9]** using conventional TIG and Friction stir process. From result the heat affected zone of friction stir welding is narrower having higher strength and ductility at same temperature. Furthermore, friction stir welds required less pre-operations and prevents joints from fusion related defects compared to TIG welding joints.

Sivakumar J et al. [10] proposed simulations of the welding process of thermal welding for butt joint using finite element analyses. The base metal is aluminum alloy AA6061 – T6. The simulations are performed with the commercial software ANSYS.

The temperature distribution pattern and magnitude obtained from this simulation is used for computation of the residual stresses and distortion due to welding which are the major sources for weld crack. The residual stresses observed by the author at around 10 mm away from weld.

Prasad VV et al. [11] studied the residual stress developed during circumferential TIG welding by 3D simulation ANSYS code. For this the temperature histories for outer and inner surfaces are plotted. The high temperature gradients in the surfaces lead to a plastic deformation in and around the weld zone. During the cooling phase due to the shrinkage and deformation in the weld zones. High compressive stress is developed on the outer surface and a tensile residual stress is developed on the inner surface. That is, from outer surface to inner surface the nature of residual stress changes from compressive to tensile.

Limwongsakorn S et al. [12] proposed finite element model for determining the effect of corrosion fatigue from TIG welding process on AISI 304 stainless steel. The residual stress result obtained from the FEA model with testing condition of frequency (f) = 0.1 Hz and the equivalent load of 67.5 kN (equal to 150 MPa) with R = 0.25 showed that corrosion fatigue life of 1,794 cycles.

Aggarwal HK et al. [13] investigated the effect of thermal fatigue on mechanical behavior of the heat affected zone on ferritic side of bimetallic welds. The bimetallic weld of 6mm thickness of ferritic steel SA516 Grade 70 and stainless steel 304L were fabricated using TIG welding process. The result show that the ultimate tensile and yield strength increases with increasing number of cycles. Further, due to increase in number of cycles in thermal shock assessment of bimetallic weld zone the material hardens with decrease in ductility.

Skriko T et al. [14] investigated the effect of stress ratio on the fatigue strength of TIG-dressed fillet weld joints of S960 grade steel. Statistical analyses using finite element (FE) modeling were performed to define geometric parameters and their effect on the stress concentration of the TIG-dressed fillet weld joints. From the experimental result it was concluded that, the fatigue strength of TIG-dressed ultra-high strength steel fillet weld joints decreased when the applied stress ratio R, was increased. Moreover, TIGdressing produced high compressive residual stresses towards the base material in the vicinity of the TIG-dressed region.

Ferro P et al. [15] proposed a numerical model for the TIG-dressing process in which all metallurgical and mechanical phenomena were taken into account in the residual stress computational process. From the experiment, it was observed that the stress distribution at the weld toe of the as-welded joint was found to be positive (tensile stress) and highly concentrated at the notch tip. While, the residual stress redistribution induced through TIG-dressing is not singular and is changed from tensile in nature to compressive.

Hussain AK et al. [16] investigated the effect of welding speed on tensile strength of the welded joint by TIG welding process of AA6351 Aluminium alloy of 4 mm thickness. The strength of the welded joint was tested by a universal tensile testing machine. Welding was done on specimens of single v butt joint with welding speed of 1800 -7200 mm/min. From the experimental results, it was revealed that strength of the weld zone is less than base metal and tensile strength increases with reduction of welding speed.

Amudarasan NV et al. [17] studied the tensile and impact properties of AISI 304L stainless steel using Gas tungsten arc welding with austenitic and duplex stainless-steel filler metal. Welding was done on specimen of single V butt joint of 3mm thickness. From the experimental results, it was found that the austenitic stainless-steel joints fabricated using duplex stainless-steel filler metal are superior compared to the joints fabricated using austenitic stainless steel.

Mortezaie A et al. [18] have welded AISI 310S austenitic stainless steel with Inconel 718 using gas tungsten arc welding (GTAW) process using different filler combinations to determine the relationship between the microstructure of the welds and the resultant mechanical and corrosion properties comprising of austenitic as well as nickel based grades, where Inconel 82 filler metal has been reported to offer optimum properties at room temperature also it has exhibited higher corrosion resistance among all tested filler metals.

The effect of single pass and multipass (double and triple pass) on mechanical and corrosion behavior of GTA welded AISI 304L joints have been studied by **Mirshekari GR et al. [19]** and it is reported that due to the increase in the d- ferrite content and grain refinement the hardness values from the weld zone towards the base metal was increased in all weldments and also as the number of weld passes increase, the hardness and corrosion resistance of these joints also increases. The hardness at different zones of the weldments

VI. CONCLUSION

Various researches are conducted in improving strength of welded joint and reducing the fatigue failures. The incorporation of d- ferrite content and grain refinement increase the strength of weld joint. The filler materials like Inconel 82 has shown good corrosion resistance properties. The FEA analysis of TIG welding using ANSYS has shown that high compressive stress is developed on the outer surface and a tensile residual stress is developed on the inner surface.

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