Finite Element Analysis to Investigation the Response of Welded Joint under Cyclic Loading

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***Abstract*—This paper describes the study and testing of the fatigue life of dissimilar materials amalgamated by welding. For the reason that, further to externally applied load, the use of modern welding practice materials is subjected to thermal residual stress. This investigation will point out the finite element analysis for welded joint in order to deviate the induced stress due to load applied and thermal residual stresses with welded body thickness. Due to the effect of residual stresses in welding, residual plastic deformation, heat-affected zone and stress concentration, the lifetime fatigue of fused components is much lower than the parent metal effect. The result of Weld geometry is a micro crack, which typically causes fatigue damage because of residual stress and stress failure due to fatigue, is often the major or minor reappearance or load deviation causes fatigue failures that never reach a depth sufficient to cause a single load application failure. This is a time often for engineers to design more sustainable, safe and desirable social components and for finite-element analyzer tools to solve the more complex structures is more convenient and much less time needed.**

Keywords— ***Fatigue life, Thermal residual stresses, finite element analysis, elastic deformation, heat affected zone***

1. INTRODUCTION:

Joining or fabrication is the process of joining two similar or dissimilar metallic components. A wide range of joiningtechniques are used in various manufacturing operations, such as mechanical fasteners, adhesives, welding, brazing,and soldering. Most joining operations are more akin to assembly than to metal processing as in welding, brazingand soldering. Fillet welding is the way to join two metal parts perpendicular or angular between 80-100 degrees. These welds are known as butt joints or lap joints, which are stored next to each other or cover one part and are welded on the outskirts

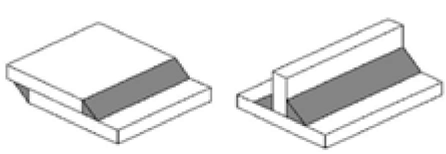

Fig. 1. Different Fillet welding Diagram

Life of fatigue implies only structural life in repetitive or fluctuating loading. Fatigue failure of the welded structure remains the most common defect. Sweated joints are typically more prone to fatigue than bolted joints. These failure costs are often extremely costly and 80-90% of all structural failures are estimated to be caused by fatigue. Statics indicate that over the past several years, fatigue failure caused 70-90 percent of the welded structure invalidation incidents.

Using the electric current arc, the model electrode is melted and the specimen is welded.The current electrical float produces an extreme arc with temperature varying from 3000 ^{o}C to 6000 ^{o}C by excessive resistance. Welding residual stress can have a different effect on the welded structure, such as an increase in solder susceptibility to fatigue loss, cracking and fracture through pressure crossing. Moreover, residual stresses developed in Butt-joint fillet welds made from steels are probableexceptional from those of full penetrated welds in magnitude. In addition, residual stresses in Butt-joint steel fillet welds are likely exceptional to that of full-penetrated welds. Residual stresses are inevitable and the consequences can't be ignored on welded structures. The characteristics of residual stresses in butt-joint fillet welds inside structures are therefore extremely important to clarify. Welded steel joints are always vulnerable to repeated loading fatigue damage. Even in low in-service pressures, fatigue failure may occur. For fact, even under constant amplitude conditions, tiredness shows significant dispersal.This phenomenon makes it extraordinarily important for statistical methods and it must be assumed that a certain sweat-probe under given environmental and loading conditions will have an opportunity for failure. The guiding force to accomplish this study task is that the use of finite element analysis to forecast lifestyles of welded structures must be made more comfortable. The physical examination is not much to look at with finite detailed analysis, which the lifestyles of systems are supposed to verify.FEA is a computer-based method of simulating / reading the performance of engineering systems and components under conditions.

In the engineering discipline, fillet weld is the most common welding and is almost everywhere in building structures. Finite element assessment of easy fillet welding compared with body testing will allow us to investigate additional complex structures with a minimum error.

2. FORMULATION OF A PROBLEM:

The ANSYS 17.1 models two square 30 mm X 50 mm x3 mm measuring plates, consisting of the SA106 and the STS 304 dissimilar cloths, separated by 3 mm spacings, and the distance is then modeled as a soil contact of the M309 filler cloth. The tensile pressure of 20KN shall be applied to keep the other end under fixed restrictions. The thermal load as temperature is again analyzed for the specimen. Specimens of butt welded joint by using GMAW methods have adapted to cyclical loading analysed. The heat input that is equal to the warmth produced by means of GMAW welding is completed at first thermal evaluation.In the next step, a structural assessment has changed to obtain the mechanical reaction of the structural model by employs the temperature records from the primary stage as a thermal load within the assessment. The fatigue measurement is then performed using cyclic loading on the same specimen.

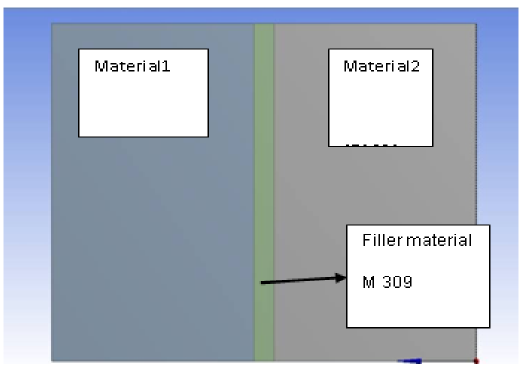

Fig. 2. Specimen of welded section

2.1 Analysis of Butt Welded Joint

The evaluation of the welded segment is commonly divided into various sections consisting of the modeling of the Butt joint in ANSYS WORKBENCH 17.1, and of the entire modeling process This is accompanied under tensile and thermal loading conditions by static structural analyses. This is found through thermal analysis of the welding process and the results it acquires are used to measure stress within the plate segment and to quantify the fatigue life of the specimens.

We know in traditional finite element analysis that the wide variety of elements increases the solutionaccuracy, so the length of the element is not always small. Smaller components take more time to evaluate and it is virtually impossible to run a model for some time. I have picked different details to find the most useful item size

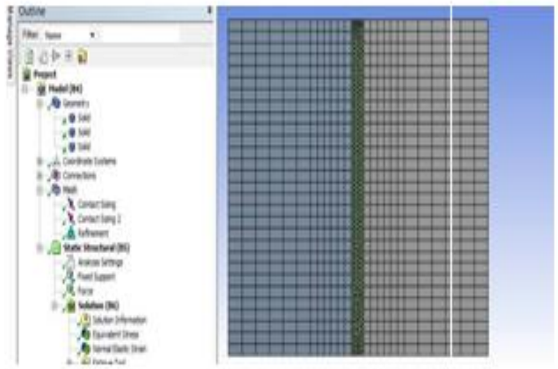

Fig. 3. Meshing of Butt weld joint

2.2 Boundary Conditions

2.2.1FixedSupport

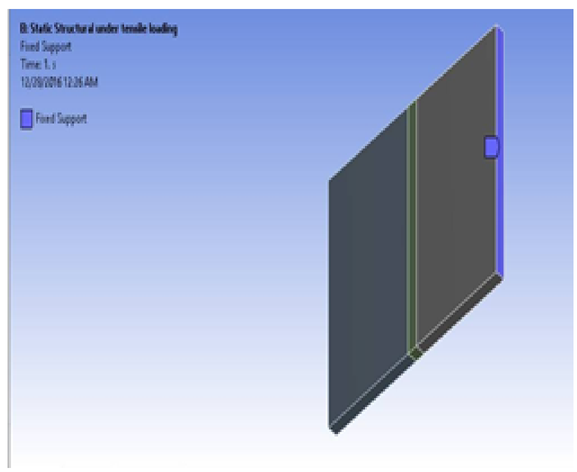

Fig. 4. Figure showing one end fixed

2.2.2 Application of Tensile Load

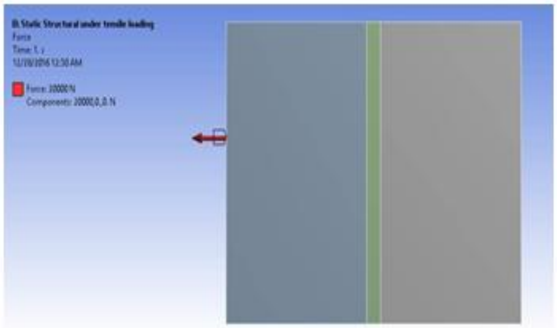

Fig. 5. Application of tensile load of 20KN on Butt weld joint

2.2.3 Equivalent Stresses

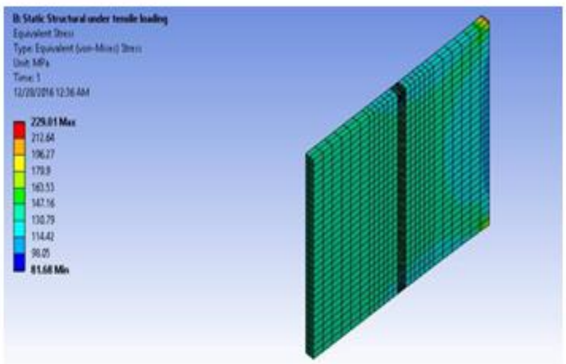

Fig. 6. Equivalent Stresses of tensile load of 20KN on Butt weld joint

2.2.4 Normal Elastic Strain

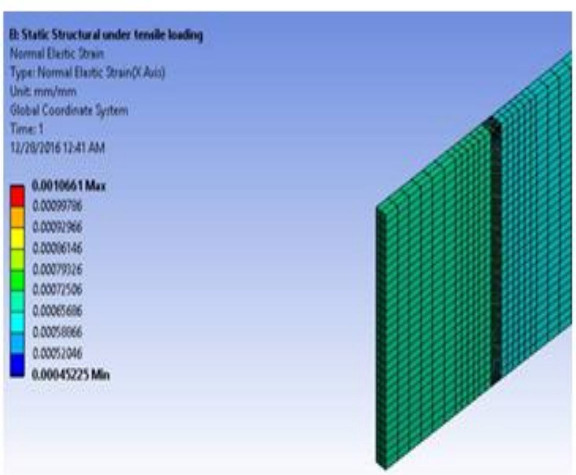

Fig. 7. Normal Elastic Strain in X direction under Tensile loading

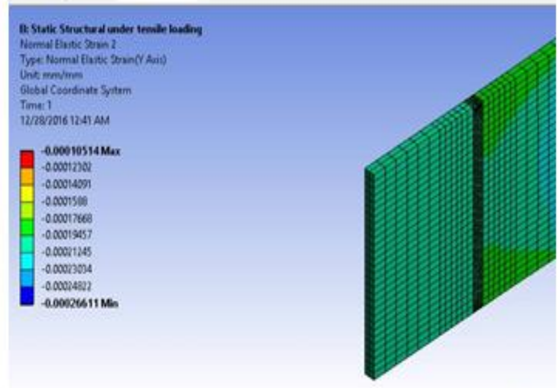

Fig. 8. Normal Elastic Strain in Y direction under Tensile loading

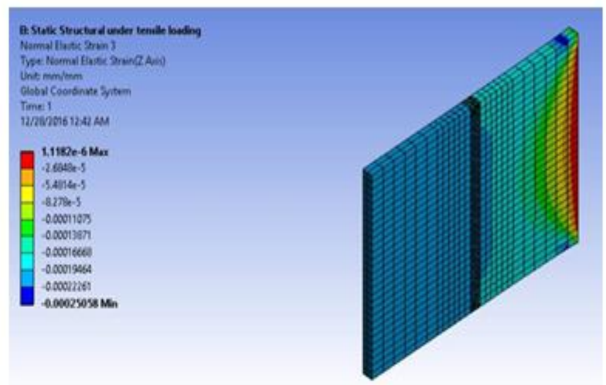

Fig. 9. Normal Elastic Strain in Z direction under tensile loading

2.3 STATIC STRUCTURAL ANALYSIS UNDER THERMAL LOADING

2.3.1 Thermal Load calculation

In the first step, a thermal analysis of the heat pipeline was carried out to acquire the temperature distribution over the structural model. The input of welding temperature, Q was measured in thermal analysis as arc efficiency, ÑA for GMAW 0.80. Furthermore, the coefficient of convective warmth transmission is taken as a stagnant air simplified case and reference temperature is taken at 22 ° C. The heat input parameters are chosen from modern-day and tensile values suggested for a particular solder thickness in which the voltage is equal to 22,73 V, modern-day is equal to 277 Amps, and soldering speed of 5 mm / sec.Substituting the above, we can estimate Q=1007.39 watt After locating Q, we can use the relation Q = Nc new8=V q = V = Substitutions q > SUBSUSTANDSUSTAILLE, we can use the relation Q=1007.39Watts After identified Q, we can apply following ratio = Nc new8=V SUBSUBSUST q = SUBSUBTANDSURE Here mass ' ms ' may be flooring warming because of the electrical present day and the potential difference.

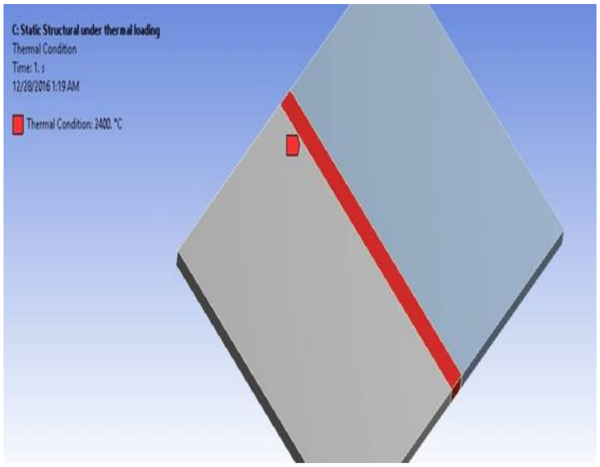

Fig. 10.thermal boundary condition

2.3.1 Equivalent stresses in thermal state

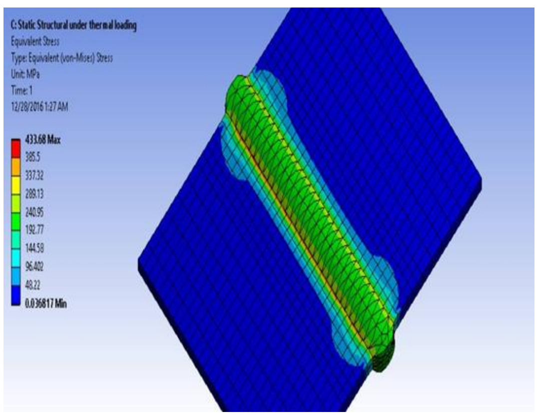

Fig. 11. Equivalent Stresses of thermal capacity on Butt weld joint

2.3.2 Deviation of the temperature in the welded specimen

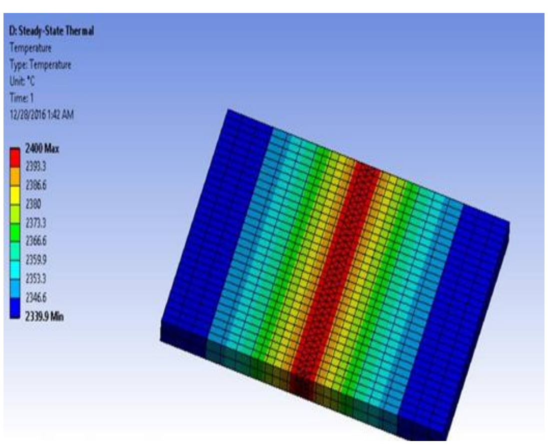

Fig. 12. Deviation of temperature on butt weld joint

2.3.1 Structural Analysis Under Thermal Load Computed From Thermal Analysis

The material version of elastic plastic based primarily on the Von Mises yield criterion and the insulating pressure hardening rule was selected, in order to determine its reaction to history by means of the residences inputing temperature-dependent fabric. Equivalent pressures on the soldering joint due to temperature variation

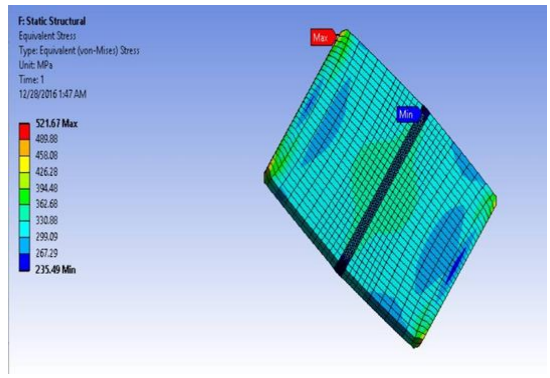

Fig. 13. Equivalent Stresses due to temperature difference

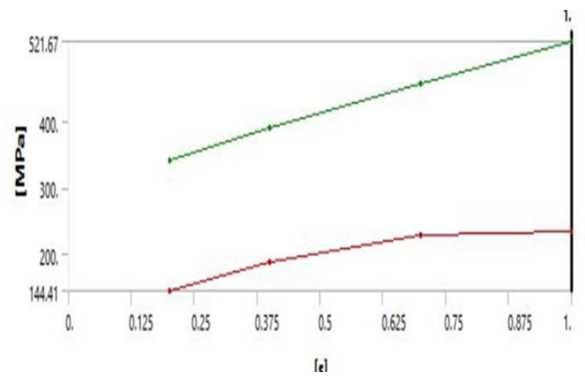

Fig. 14. Graphical representations of maximum and minimum Equivalent Stresses on Butt weld joint

1 FATIGUE LIFE

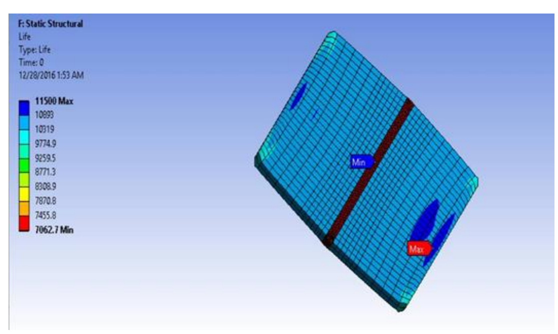

Fig. 15. Fatigue Life due to temperature difference

3.1 Design of Experiment

To apprehend the variation in theequal stresses underneath tensile loading and thermal loading, the alternate in maximum and minimum temperature and the fatigue existence with appreciate to thickness of plate, the design of**experiment** is used. This enables us to determine the values of the unknown without actually doing any change in the dimensions of the geometrical design.

3.1.1 Maximum Equivalent stress vs. thickness under tensile loading

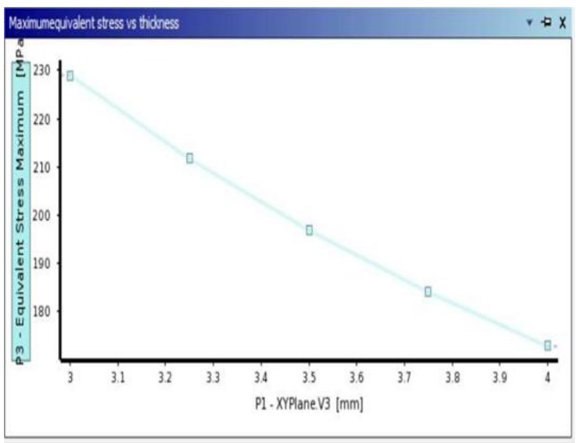

Fig. 16. Graphical representation of Equivalent stress by variation in plate thickness under tensile loading

3.1.2 Maximum Equivalent stress vs thickness under thermal loading

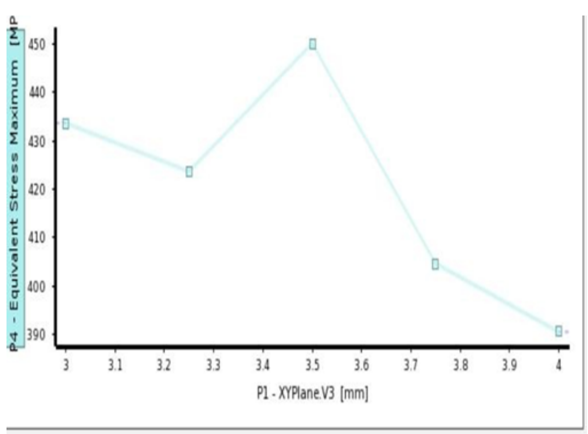

Fig. 17. Graphical representation of Equivalent stress by variation in plate thickness under thermal loading

3.1.3 Maximum and minimum temperature vs thickness under thermal loading

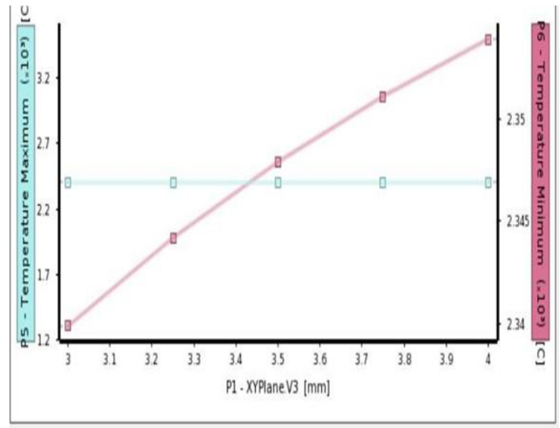

Fig. 18. Graphical representation of Maximum and minimal temperature with change in plate thickness under thermal loading

3.1.4 Maximum Equivalent stress vs thickness under temperature variations

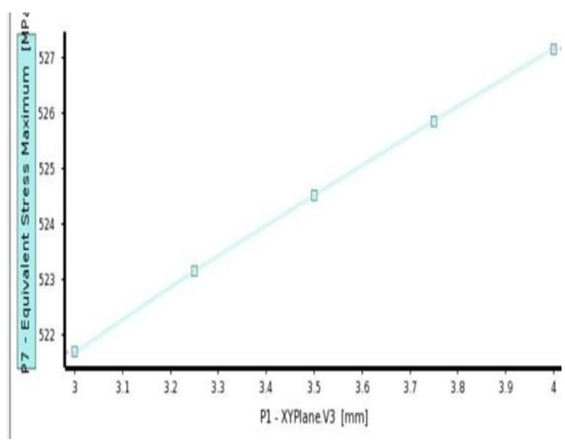

Fig. 19.Graphical representation of Equivalent stress with trade in plate thickness beneath temperature variation

3.1.5 Minimum Fatigue life

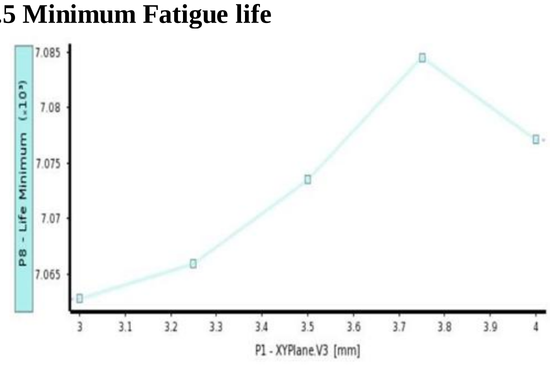

Fig. 20. Graphical illustration of Fatigue existence with trade in plate thickness

4. CONCLUSION

The following points can be concluded from the Fatigue analysis of dissimilar fabric welded specimen the usage of finite element analysis made from SA 106, STS 304 and filler weld material (M 309).
1.The Maximum equal stresses of welded specimen of thickness 3mm were determined to be 230MPa beneath tensile loading of 20kN (Figure 4.21). These stresses go on lowering with the will increase inside the thickness of the plate (Figure 4.31).
2.The Maximum equal stresses of the welded specimen of thickness 3mm were located to be 433 MPas underneath thermal loading (Figure 4.26). These stresses normally decreases as thickness of the plates will increase with the exception at thickness 3.5mm where most equal stresses was determined to be 450MPa (Figure 4.32).
3. The temperature decreases from hot surface (filler cloth) to bloodless surface (extremities of plates end) that is normal (Figure four.27). The minimal temperature is going on growing with the growth within the thickness of the plates (Figure 4.33).This proves thicker material retains warmth for the longer duration.
4 The most Equivalent stresses was located at the edges of the plates beneath thermal loading of temperature variation and random strain variation is shown within the figure 4.28.The maximum strain will increase linearly with time (Figure four.29). The maximum equal stresses will increase with the increases in thickness of the plates (Figure 4.34).5. The Fatigue life of the weld was found to be 7065 cycles. This means weld section becomes weaker with the application of thermal loading ofTemperature variation (Figure 4.30). The fatigue **existenceincreases** with the **growthin the** thickness of plates.

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