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Low Cycle Fatigue Strength Analysis of AA7075-T6 and A384.0-T6 Friction Stir Welded Aluminium Alloys of Butt Joint

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Abstract: Friction Stir Welding (FSW) is the fumeless solid state welding technique. In which the materials are joined by placing nearby with tightly clamped and a rotating tool was inserted with longitudinal feed and an axial load. Due to the stirring action, the metals plastically deformed and joined together. In this research the base metals are AA7075-T6 and A384.0-T6 aluminium alloys of 6.35 mm thickness butt joints. A design matrix was developed by using MINITAB-17 Software and the FSW was carried out in a friction stir welding machine. By using the FSW specimens, the Ultimate Tensile Strength (UTS) was conducted and find out the lowest UTS specimen to do fatigue test. The fatigue strength of the base metals of AA 7075-T6, A384.0-T6 and the same combinations of lowest UTS, FSW specimens are tested and analysed in low cycle fatigue strengths of $<10^5$ cycles.

Key words: Friction stir welding, base metals, ultimate tensile strength, low cycle fatigue, fatigue strength, design matrix

INTRODUCTION

When repetitive load or cyclic load occurs in any component, a small crack was developed. If the cyclic load was increased, at a stage the component may fail that load is called fatigue load (Lee *et al*., 2005). It is estimated that the 90% of the component failures occurs at a values of below the yield stress of that component. Cavaliere *et al*. (2005) conducted a cyclic fatigue test in the axial direction with R = 0.1, where "R" is the stress ratio ($\sigma_{min}/\sigma_{max}$). In the study of fatigue test research, the conclusion was the fatigue life is increased in the high cycle regime respect to the FSW 2024-T3 joints and a decrease in fatigue life respect to FSW 7075-T6 ones. Minak *et al*. (2010) investigate the fatigue resistance of FSW joints on as-cast particulate reinforced aluminium based composite (AA6061/22 vol.%/Al_2O_3p). In their research their conclusion was the parameters used to produce the joints with similar microstructure and comparable fatigue behavior. Hassanifard *et al*. (2014) investigates the effectof cold expansion on the improvement of fatigue life of friction stir spot welding joints in AA 7075-T6 plates and concludes the fatigue life of FSSW joints in all load ranges in high cycle regimes improve the fatigue life up to 6 times. D'Urso *et al*. (2014) studied the fatigue behavior of crack growth tests performed according to ASTM-E647 standard on CT specimens with propagation in the middle of joint along the weld nugget. The results show the influence of welding process parameters on mechanical properties and fatigue behavior.

In the fatigue failure, the three basic factors are important. They are the large number of cycles, maximum tensile stress and the fluctuation in the applied load. There are in general three types of fluctuating stresses. They are fully reversed stress cycle, the repeated stress cycleand the random or irregular stress cycle. The fluctuating stress is made up of mean stress or steady stress and an alternating stress or variable stress.

In the fully reversed stress cycle the maximum stress (σ_{max}) and the minimum stress (σ_{min}) are equal which was shown in Fig. 1. In Fig. 1 also shows σ_a is an alternating or variable stress. σ_r or $\sigma_?$ is called the stress range. The stress range is the difference between the maximum

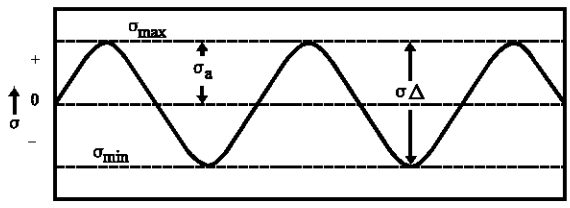

Fig. 1: Fully reversed stress cycle (Campbell, 2008)

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