Chapter 3

Scope and Objective

3.1. Motivation for the Present Work

Friction Stir Welding (FSW) is the most popular method for joining aluminium alloys because it can produce welds with less distortion, more reproducible properties than can be obtained by fusion welding, and post-weld residual stresses are minimum. Extensive research has been accomplished on developing the FSW process for the aluminium alloys used in aerospace applications. However, the fatigue crack propagation behaviour of the friction-stir-welded AA-7075-T6 alloy has not been reported extensively in the literature. The future launch vehicles will have to be reusable; this mandates the materials to have good fatigue properties, which prompts an investigation into the fatigue behaviour of the friction-stir-welded AA-7075-T6 alloy. The friction-stir-welded butt joints of AA-7075-T6 alloy were subjected to fatigue loading.

Variable amplitude loading was also studied with overloads at periodic intervals. Its effect on fatigue life is important since aerospace structures are subjected to different types of loading.

In addition to the analysis of the experimental data, it is also imperative to study the effect of the micro-structure, and the complex crack closure phenomenon affecting fatigue life.

Numerical analysis involving a fatigue life prediction scheme using a FE model will be useful to make better design decisions for damage tolerant design.

Numerical analysis was based on the Linear Elastic Fracture Mechanics (LEFM) theory. Finite element analysis with the model being subjected to cyclic loading and a non-linear solution method was used to evaluate the fracture mechanics parameters like Stress Intensity Factor (SIF). This is the basis on which fatigue life prediction scheme has been modeled. Apart from the traditional method of crack propagation in Finite Element Analysis (FEA) involving a node release scheme after every cycle, the new method of using non-linear interface elements on a predefined crack path, to simulate the physics of crack propagation phenomenon was been used to predict the fatigue life of the welded butt joint, and this method can be used to predict the fatigue life of FSW joints. The versatility of FEA can be used to predict the fatigue life of different kinds of joints in future.

3.2. Scope and Objectives of the Work

The FSW has permitted friction technology to be used to produce continuous welded seams for plate fabrication, particularly in light alloys. Also FSW is an environmentally cleaner process, due to the absence of various gases that, normally accompany in other types of welding.

The objectives of the work are furnished below.

- Studying the influence of AA7075-T6 Al Alloy friction stir welding process parameters on mechanical, metallurgical properties and fatigue life.
- Evaluating the effect of process parameters of butt joints on mechanical properties.
- Analysing the effect of Fatigue Crack Initiation and Propagation behaviour of Friction Stir Welded Butt Joints.
- Analysing the effect of Post weld aging and Heat treatment on Mechanical and

Metallurgical properties.

- Modeling and design of the FSW tool and weld fixture.
- Modeling and simulation of Fatigue crack growth and Propagation.