Chapter 9

Summary and Conclusions

Aluminium alloys have traditionally been used in aerospace structures. Aluminium alloys are known for their light-weight and toughness which makes them ideal for use in aerospace structures. Aluminium Zinc alloy AA-7075-T6 is the new age material being used in the construction of aero external tank, and other aerospace applications for its attractive combination of low density, high specific modulus, and excellent fatigue, and cryogenic properties.

Aluminium alloy structures used in aerospace applications are subjected to different kinds of high stress loading during takeoff, landing, supersonic speed maneuvering and extraordinary high gravitational forces. Cyclic loading and sudden overloads produce extremely high stresses on the wing structure. Traditional methods of joining like riveting is being used because of the difficulty faced while welding Aluminium alloys. FSW is a novel method of joining Aluminium alloys difficult to weld, which can be used to build aircraft structures.

In this investigation, to evaluate the Mechanical and Metallurgical properties of FSW AA7075-T6 Aluminium alloy joints were evaluated. Joint properties were improved by a simple precipitation (aging) treatment after welding, the whole of the weld zone hardening. To study the influence of post weld heat treatment on tensile behaviour, the welded joints were divided into four group viz., (i) As Welded (AW) joints (ii) Solution Treated (ST) joints (iii) Artificially Aged (AA) joints (iv) Solutions treated and Aged (STA) joints. Evaluation of transverse tensile properties such as yield strength, ultimate tensile strength, percentage of elongation, percentage of reduction in cross sectional area, notch tensile strength, notch strength ratio and joint efficiency of the fabricated joints, evaluation of fatigue behaviour (fatigue life, endurance limit, fatigue notch factor and notch sensitivity factor) of the welded joints was done. And also FEA model has been developed and a good correlation is obtained with good results. In this study very important conclusion obtained from the investigation are listed below.

(i) An appreciable difference present in microstructure and micro hardness does not exist between top surface of the welded joints and cross section of the welded joints.

(ii) Of the three PWHT joints, the weld metal region of STA joints consist of very fine grains present compared to other joints.

(iii) Very low hardness is recorded in AW joints (100 VHN) and the maximum hardness is recorded in STA joints (160 VHN).

(iv) Residual stress shows a measurable variation before and after PWHT as an effect.

(v) PWHT procedures are found to be effective to improve the joint efficiency of FS welded AA7075-T6 aluminium alloy.

(vi) Solution treated and aged (STA) joints are showing an elongation and reduction in cross sectional area of 9% and 8% respectively and the improvement in ductility is approximately 25% compared to the AW joints.

(vii) Solution treated and Aged (STA) joints exhibited very high joint efficiency of 78% artificially aged (AA) joints showed joint efficiency of 72% solution treated (ST) joints recorded joint efficiency of 64% and as welded (AW) joints yielded joint efficiency of 58%

(viii) Of the three post weld heat treated joints, the weld metal region of STA joint consist of very fine grains compared to other joints. This may be attributed for the superior hardness, tensile and fatigue properties of STA joints

(ix) Solution treated and Aged (STA) joints exhibited very high fatigue strength than artificially aged (AA) joints, solution treated (ST) As welded,(AW) joints.

(x) The fatigue life obtained with the interface element model and traditional FEA model compared with the experimental data has a near correlation.

Future scope of this study

The investigations carried on the hardness, tensile, residual and fatigue crack growth can further carried in different temperatures related to the application environment of the joints. It may be in elevated temperatures or in cryogenic temperature related to the application.

In this study, constant amplitude spectrum is used with the load spectrum for fatigue crack growth. With the same set up of loads variable amplitude spectrum can be used for further testing.

An improvement of a new technique for modeling cracks in the finite element framework is presented. A standard displacement-based approximation is enriched near a crack by incorporating both discontinuous fields and the near tip symmetry fields through a partition is used method. A methodology that constructs the enriched approximation from the interaction of the crack geometry with the mesh is developed. The new technique allows the entire crack to be represented independently of the mesh, and so remeshing is not necessary to model crack growth, that type of mesh less technique can be adapted for future study.