Effect of Aluminium alloys AA5754 joints welding motion and post-annealing of Friction stir welding (FSW)

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Abstract: *Recently BEHNKEN structure compared results uses for Aero space industries and automotive manufacturing companies. Tools with different pin heights were used inorder to obtain different sinking values.Finally,Influence of the annealing treatment and prior and after the friction stir welding process were studied. Process condition and the temper state that allow obtaining defect- free joints without occurrence of the oxide defects of kissing –bonds and faint zigzag line pattern in the NZ (stirred zone)was defined.It resulted that a pin deviation by R=0.5mm from welding centerline in the post-welded annealed condition and showed better tensile strength and respect to the conventional (T-type)welding.*

Keywords:friction stir welding, aluminium alloy, tool sinking, annealing treatment, microstructure, micro hardness

1.INTRODUCTION

Microstructure and inspections supported by the hardness and mechanical response is studied. RT-type motion of the pin tool with a radius of 0.5mm induced a low reduction of the mechanical response is studied. In the RT-type FSW ,as the radius increases and reaching 1.0mm,the microstructure showed the generation of oxide layers and lazy S-lines within the NZ(stirred zone) is studied. Mechanical response is discussed. AA5754-O showed UTS values are studied and close to the unwelded annealed sheet but with a ductilityis also studied. Post-weld annealing(PWA) is studied. The best experimental conditions are studied.

2.LITERATURE SURVEY

Esther T.AKINLABI et.al.(2014), Above researcher conduct experiments on effects of processing and lowest corrosionrate was obtained at welds produced at rotational speed of 950Rpm/min and feed rate of 300mm/min.**Ramona Gabor et.al(2013),** Above researcher conduct experiments on friction stir welding development of Aluminium alloys for structural connections.

P.Prasanna et.al(2013), Above researcher conduct experiments on effect of tool pin profiles and heat treatment process in the friction stir welding of AA6061 Aluminium alloy. **Mandeepsinghsidhu et.al (2012),** Above researcher conduct experiments on friction stir welding process and its variables:A Review .**Research Gap:** Above researcher is not done with the best experimental conditions were obtained at R=0.5mm and UTS was some 15%higher and ductility reduction range within 30% respect to the unwelded annealed sheet and not researched over the post-weld annealing(PWA)showed the best mechanical response respect to the un-welded annealed AA5754 sheet.

3.EXPERIMENTAL DETAILS

3.1 Friction stir welding settings

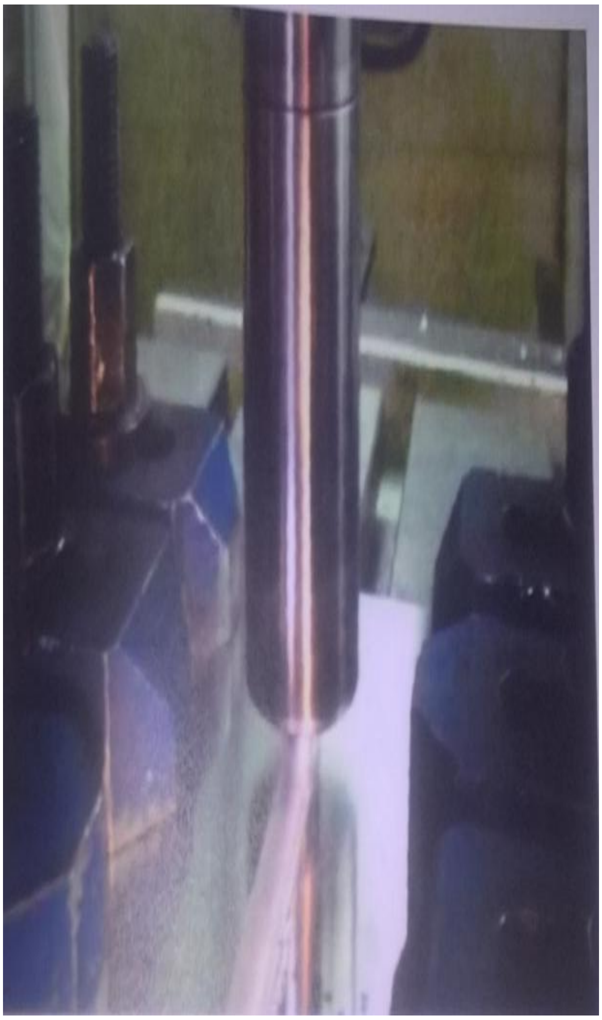

Fig-1: Friction stir welding process on AA5754 aluminium alloy

Friction stir welding was performed using a CNC machining centre to obtain butt joints on sheet blanks in AA5754 aluminium alloy ,185mm in length,80mm in width and 2.5mm in thickness in Fig.1.

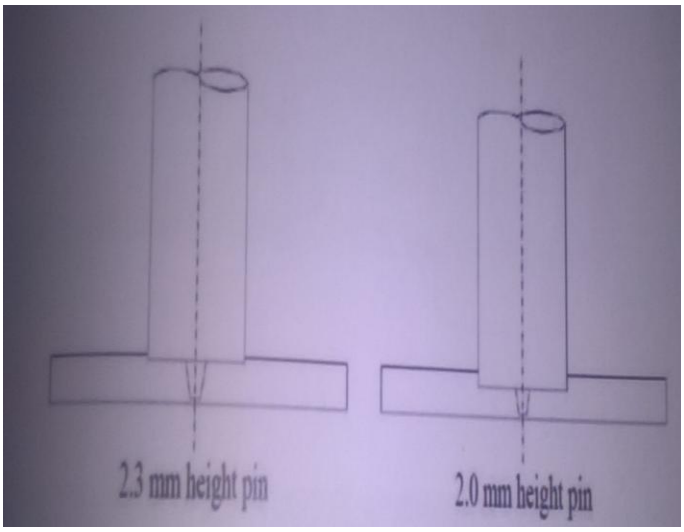

Fig- 2: Image for pin heights

Conical pin tools in H13 steel (HRC=52)with different pin heights and characterized by pin profiles with 3.9mm in diameter at the shoulder and 30^{0}in pin angle and 2.0 and 2.3mm in height respectively for different tool sinking values in Fig.2.

3.2 Material

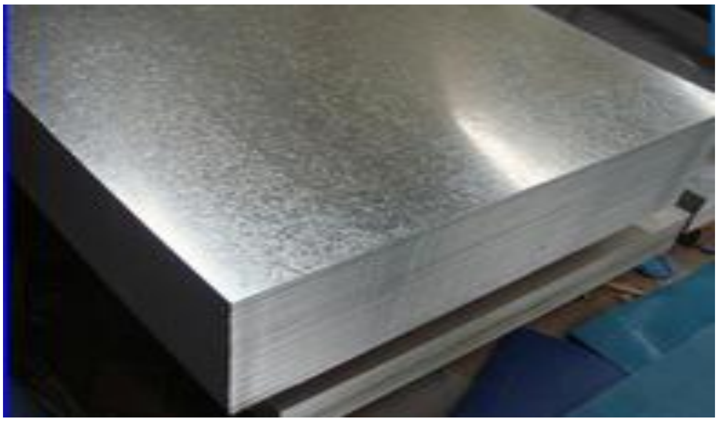

Fig-3:Image for parent material (AA5754 H111Plate)

In the present study two plates of AA5754 were FSW.This alloy is a solid solution hardened Al-Mg .

Table-1: Mechanical properties for aluminium alloy 5754H111 plate

EN 485 sheet thickness(2.5mm)	
Property	**Value**
Proof stress	60 Min MPa
Tensile strength	160-200 MPa
Elongation A50mm	12%Min
Hardness Brinell	44HB

Table-1: reports the mechanical properties of the AA5754 H111 (EN485) sheets. Metallurgical final thickness is 2.5mm.

4.METHODOLOGY

- The FSW carried out using the 2.3mm height pin was performed with a vertical force of the tool equal to 1.7KN and 35% lower than that measured using the 2.0mm height pin that was 2.3KN.
  i).Welding motion with rotation and with a radius equal to R
  ii).Welding motion with translation of the pin axis along a direction parallel to the welding line. Twodifferent R values 0.5mm and 1mm were taken into account.
- Motion occurred linearly along the welding line (T-type FSW,i.e R=0)
- In both the RT-type and T-type axis with a tilt angle equal to 2^0 imposed to enhance the extrusion effect.

- The RT-type and T-type FSW trials were performed with a rotational speed and a speed along the welding line equal to 2000Rpm and 30mm/min respectively. All experiments were carried out with a tool plunging speed 1.5mm/min. All experiments were carried out with a tool plunging speed of 1.5mm/min.
- AA5754 was subjected to an annealing treatment at 415^{0}C/3h followed by furnace cooling . Welding untreated sheets was homogenized after FSW

5. RESULT AND DISCUSSION

In the present study two different FSW set up in terms of shoulder pressure ,tool pin size and deviation from the welding line during FSW processing were compared . FSW setup was able to give proper experimental conditions for a sound joint .

5.1 The main results and findings can be summarized as follows

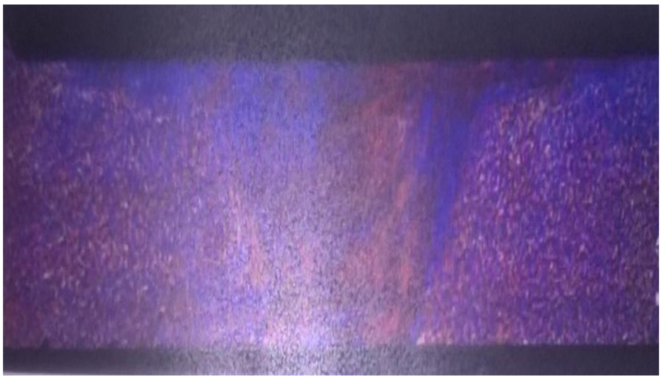

Fig-4: Microstructure

Microstructure overviews and inspections supported by the hardness profile across the FSW and the mechanical response showed a sound FSW AA5754 and 2.5mm thick sheet using a 2.3mmheight pin with vertical force of 1.7KN both using the conventional FSW (here named as T-type FSW)and by deviating the rotating pin by 0.5mm from the welding line (named as RT-type FSW)

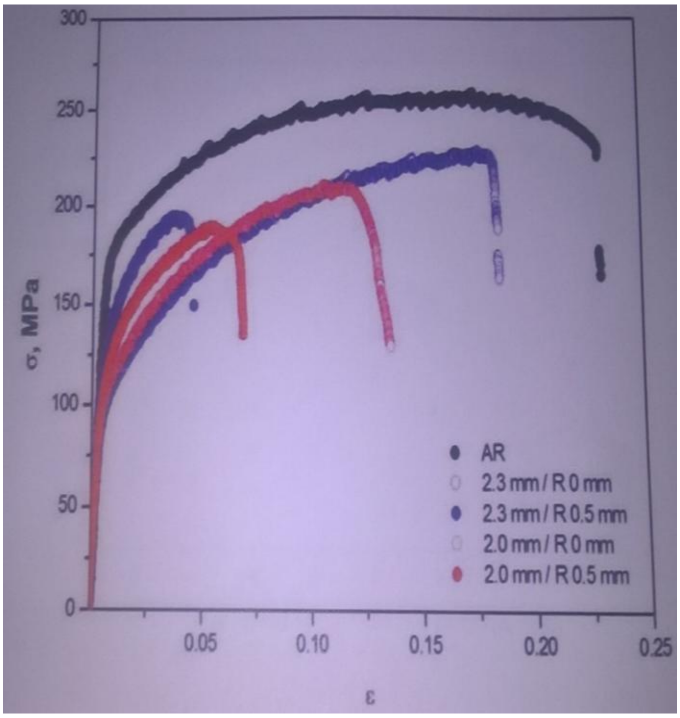

Fig-5: Stress- strain curve

Table-2:Tensile test parameters

Load (N)	Length of the profile	Speed (Rpm)	Time (min)	AA5754 Tensile strength (N/mm)	Frictional force(N)	Coefficient of friction
15	150	525	30	133.8	1	0.07

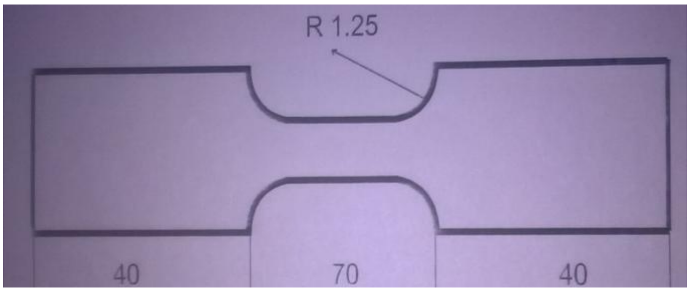

Fig-6.Tensile test specimen.

As prescribed by the design of matrix and the joints were fabricated. The welded joints were sliced using power hacksaw and then machined to the require dimension of the tensile specimens were fabricated by ASTM standard.

Mechanical properties and microstructure of the FSW joint showed that a RT-type motion of the pin tool with a radius of 0.5mm induced a low reduction .

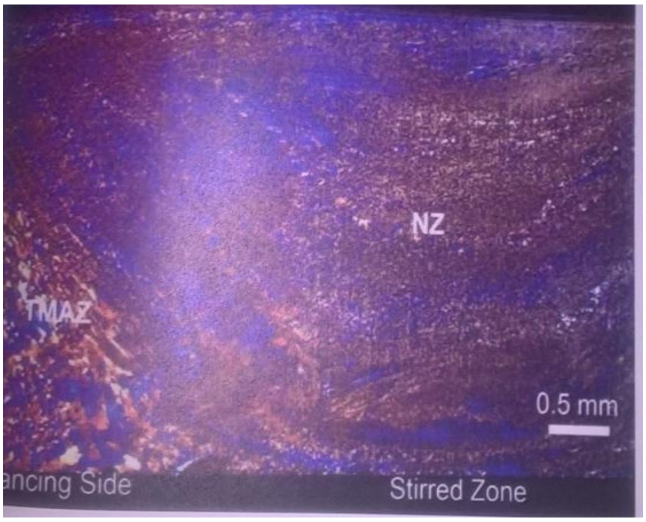

Fig-7: Hardness

In the RT-type FSW, as the radius increases reaching 1.0mm,the micro structure showed the generation of oxide layers obtained with R=0.5mm and under conventional FSW(T-type)

Fig-8: Post weld annealing

The AA5754-O showed UTS values close to the unwelded annealed sheet ,but with a ductility that was half at its best (for R=1mm)and down to one third for the conventional FSW (R=0mm).

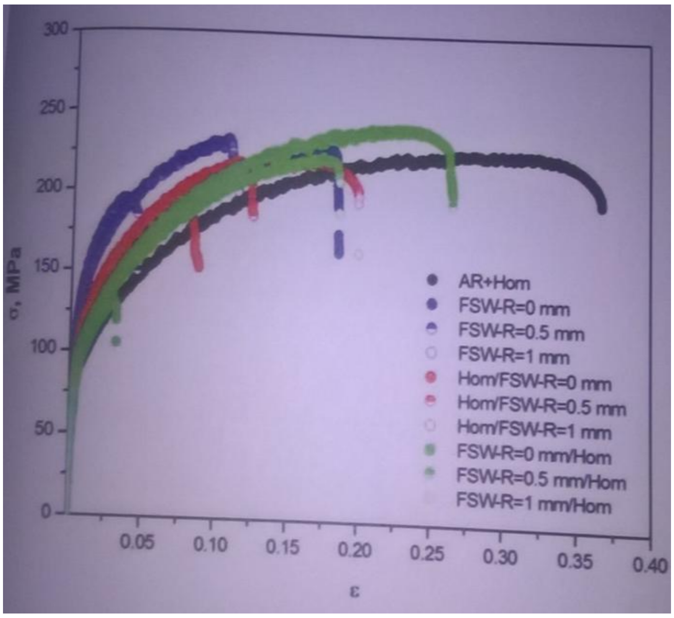

Fig-9: Stress-strain curve

The post-weld annealing (PWA)showed the best mechanical response respect to the unwelded annealed AA5754 sheet.The best experimental conditions were obtained at R=0.5mm ,where the UTS was some 15%higher with a ductility reduction of within 30%respect to the unwelded annealed sheet .In this condition ,the microstructure of the NZ appeared to be decorated by very coarse by the shoulder pressure (heat input),and the post-welding annealing thermal energy.

6. CONCLUSIONS

Microstructure and inspections supported by the hardness and mechanical response showed a sound FSW AA5754 (2.5mm thick sheet, 2.3mm height pin,1.7KN vertical force).

In the RT-type FSW, as the radius increases and reaching 1.0mm,the microstructure showed the generation of oxide layers and lazy S-lines within the NZ(stirred zone). Mechanical response was considerably lower respect to the one obtained with R=0.5mm and under conventional FSW(T-type).

AA5754-O showed UTS values close to the unwelded annealed sheet but with a ductility that was half at its best (for R=1mm) and down to one –third for the conventional FSW(R=0mm).

The best experimental conditions were obtained at R=0.5mm and UTS was some 15%higher and ductility reduction range within 30% respect to the unwelded annealed sheet.

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