Computer Language On Friction S Tir Welding Of Aa6061-Az61

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Abstract— The recent trend of research on joining of dissimilar alloys leads the interest towards the study and analysis of Friction Stir welding. Joining of different steel groups and Aluminium has been on the research interest on the previous decade. Recent innovative research and development area is on with Magnesium alloy groups. The Aluminium alloys and Magnesium alloys are investigated for the weld strength with respect to the change of welding parameters including tool geometry, the tool transverse speed, and the tool angular velocity. .

Keywords: Friction Stir Welding, Weld parameters, mechanical properties, Plunge Down time.

1. INTRODUCTION:

Friction stir welding is a vital research area in the field of welding. Majority of automobile, aerospace and ship building applications are utilised the Friction Stir Welding. It is essential to improve the strength of the joint and reduce the failure rate of the joint. To impart these properties it is needed to study the effect of weld parameters which is the vital role on the joint strength.

Friction Stir Welding (FSW) is a process of joining two similar and dis-similar metals by the non-consumable tool as shown in Fig.1. The major weld parameters involved are rotational speed, transverse speed and axial load. The joining of two metals is made by bonding the two similar and/or dissimilar metals. The weld strength is majorly characterised by tensile strength and bend strength.

The effects of probe length and tool rotational speed on 2-mm thick AZ31B-H24 alloy were investigated by Cao et al., in terms of mechanical properties, microstructure and welding defects. The tool rotational speeds were varied from 500 to 2000 rpm with a constant transverse speed of 20 mm/sec. The Tensile strength initially increases with increment of tool rotational speed up to 1000 r.p.m. but decreases with further increase of rotational speed [1].

Xie et al., analysed the Effect of Rotation Rate on Mechanical Properties of Friction Stir Weld of rolled Mg–Zn–Y–Zr plate with wide range of rotation rates of 600–1200 rev. /min with a constant traverse speed of 100 mm/min. If the rotation rate incresed the Ultimate Tensile Strength was similar and Yield Strength somewhat decreased, but the elongation increased clearly [2]. Xue et al., also tested the joint strength of FSW butt joint of Al-Cu alloys with different rotational speed with a range of 400 to 1000 r.p.m for a constant transverse speed of 100 mm/min. The defect free weld is obtained when the harder copper plate is fixed on the advancing side. The joint strength becomes weak when the rotational speed increases [3].

Vahid Firouzdor et al., investigated FSW of AA 6061 – AZ 31 alloys with different rotational and transverse speed. The decrement in transverse speed increases the heat input and thereby increasing the brittle intermetallic compound formation. The change in heat input inturns affect the material flow and these influences the weld strength [4].

Liu et al., studied the Effect of changes in welding speed on mechanical properties of friction stir welded 6061-T6 aluminum alloy. Keeping the constant rotation of 600 rpm, the welding speed increased from 50 to 200 mm/min. The grain size of the nugget zone increased, but the grain size of HAZ was almost not changed [5].

Guo et al., friction stir welded the dissimilar AA6061 and AA7075 alloy with a constant rotational speed of 1200 rpm and three variable transverse speeds of 2,3 and 5 mm/sec. The Ultimate Tensile Strength increases with the increase of welding speed. The Ultimate Tensile Strength of joints increases with the decrease in heat input induced by friction and correlates very well to the microhardness profiles [6].

Abbasi Gharacheh et al., investigated the mechanical properties of AZ31 magnesium alloy with different ratios of rotational speed (rpm) and transverse speed (mm/min). The incomplete root penetration defect probability is reduced when the ratio of rotational to transverse speed increases [7].

Chowdhury et al., analysed the Tensile properties of a friction stir welded AZ 31 B H 24 magnesium alloy by the Effect of change in pin profile and weld pitch. The variation of pin tool orientation is with left-hand threaded pin and right-hand threaded pin with welding speed range of 5–30 mm/s and rotational rate range of 1000–2000 rpm. The left hand threaded tool obtained a sound weld. With the increase in weld speed the tensile strength is increased but strain hardening exponent is decreased [8].

Influence of weld parameters of AA 6016-T4 are studied by Rodrigues et al., with the help of micro structural and tensile test investigation. The major weld parameter considered is the change in tool geometry as conical and scrolled shoulder. The scrolled shoulder displays a good deep drawing behaviour. The reduction in ductility is due to undermatch of hardness values [9].

Forcellese et al., investigated the changes in mechanical properties of AZ31 friction stir welding plates using ‘‘pin’’ and ‘‘pinless’’ tool profile. The pin tool profile exhibits better tensile properties [10].

However the literature shows the lack of study on consideration of PDT and strike rate of tool with base metal. This paper is represented the consideration of PDT as one of the important variable parameter to find the effects of changes in mechanical properties.

2. EXPERIMENTAL WORK:

In this experimental work, Friction stir welding (FSW) is carried out for thirty specimens with constant axial load and transverse speed. For three different Plunge Down Time(PDT), ten different Rotational speeds are selected as Variable parameters. The three different combinations are selected due to the research interest on investigation of stronger side for Aluminium alloy and Magnesium alloy for advancing side and retreating side. Tool tilt is set for 0° and the AA 6061 - AZ 61, base metal of 150 mm weld length with 6 mm thick is Friction Stir Welded with Butt configuration.

Table 1: Composition of AA 6061 –and AZ 61

Element (%)	Al	Mg	Si	Fe	Cu	Mn	Ni	Cr	Others
AA6061	96.2	1.0	0.6	0.5	0.3	0.1	0.04	0.3	0.96
AZ61	6.2	92.29	0.1	0.005	0.05	0.15	0.005	-	1.2

Table 2: Mechanical properties of AA 6061 – T6 and AZ 61

Material	Yield Strength (MPa)	Ultimate Tensile Strength (MPa)	Elongation (%)	Vicker's Hardness (0.5 kg)
AA6061	276	310	17	107
AZ61	230	306	16	68

The sample welded specimens are shown in Figure 2. The AA 6061 and AZ 61 plates for the current work is identified with the composition shown in Table 1. A common mechnical properties of AA6061 T6 and AZ 61 is shown in Table 2.

KN	RPM	MX/MN	TENSILE	BEND
10	600	30	311.2	243
10	600	40	312.6	241
10	600	50	310.8	245
10	600	60	312.9	243
10	600	70	311.8	243
10	600	80	312.7	242
10	800	30	312.9	245
10	800	40	312.8	241
10	800	50	311.4	245
10	800	60	313.2	241
10	800	70	312.2	243
10	800	80	312.8	243
10	1000	30	312.9	241
10	1000	40	312.7	242
10	1000	50	311.5	242
10	1000	60	312.9	243
10	1000	70	311.8	245
10	1000	80	312.7	243
10	1200	30	312.8	245
10	1200	40	310.8	241
10	1200	50	312.5	245
10	1200	60	312.9	243
10	1200	70	312.6	245
10	1200	80	311.5	241
10	1400	30	311.4	243
10	1400	40	312.2	245
10	1400	50	312.3	241
10	1400	60	311.8	245
10	1400	70	312.5	241
10	1400	80	312.8	243
10	1600	30	312.8	243

10	1600	40	310.5	241
10	1600	50	311.5	241
10	1600	60	311.1	243
10	1600	70	312.6	245
10	1600	80	312.5	241
12	600	30	312.2	242
12	600	40	312.9	242
12	600	50	312.6	243
12	600	60	312.9	241
12	600	70	311.8	242
12	600	80	312.7	243
12	800	30	312.7	245
12	800	40	312.7	241
12	800	50	311.5	243
12	800	60	311.6	241
12	800	70	312.8	245
12	800	80	312.8	243
12	1000	30	311.5	245
12	1000	40	311.6	245
12	1000	50	312.8	241
12	1000	60	312.9	242
12	1000	70	311.8	245
12	1000	80	312.9	243
12	1200	30	312.7	245
12	1200	40	311.5	245
12	1200	50	311.6	241
12	1200	60	312.8	245
12	1200	70	311.5	241
12	1200	80	311.6	243
12	1400	30	312.3	243
12	1400	40	312.9	241
12	1400	50	311.8	243
12	1400	60	312.7	243
12	1400	70	312.7	241
12	1400	80	311.6	245
12	1600	30	312.8	245
12	1600	40	312.6	243
12	1600	50	312.9	241
12	1600	60	312.2	242
12	1600	70	312.9	242
12	1600	80	312.6	243
14	600	30	312.9	241
14	600	40	311.8	242
14	600	50	312.7	242
14	600	60	311.5	243
14	600	70	311.6	243
14	600	80	312.6	241
14	800	30	312.9	245

14	800	40	312.5	243
14	800	50	312.2	243
14	800	60	312.9	242
14	800	70	312.6	245
14	800	80	312.9	241
14	1000	30	311.8	245
14	1000	40	312.7	241
14	1000	50	312.7	243
14	1000	60	311.5	243
14	1000	70	311.6	241
14	1000	80	312.8	242
14	1200	30	312.7	243
14	1200	40	312.7	242
14	1200	50	312.8	241
14	1200	60	312.5	245
14	1200	70	312.5	243
14	1200	80	312.9	244
14	1400	30	312.6	245
14	1400	40	311.4	241
14	1400	50	312.9	244
14	1400	60	311.6	242
14	1400	70	312.7	245
14	1400	80	312.7	241
14	1600	30	311.4	245
14	1600	40	311.5	241
14	1600	50	311.6	243
14	1600	60	312.8	243
14	1600	70	312.9	245
14	1600	80	312.6	243
16	600	30	312.5	243
16	600	40	312.5	243
16	600	50	312.9	241
16	600	60	312.6	242
16	600	70	311.5	243
16	600	80	311.6	243
16	800	30	312.8	243
16	800	40	312.9	241
16	800	50	312.8	243
16	800	60	312.7	243
16	800	70	311.5	241
16	800	80	311.6	245
16	1000	30	312.7	241
16	1000	40	312.7	243
16	1000	50	311.4	243
16	1000	60	311.5	242
16	1000	70	312.9	241
16	1000	80	312.8	245
16	1200	30	311.5	241

16	1200	40	311.6	242
16	1200	50	312.7	242
16	1200	60	311.4	243
16	1200	70	311.4	241
16	1200	80	312.9	245
16	1400	30	312.9	245
16	1400	40	312.6	241
16	1400	50	311.1	245
16	1400	60	312.6	241
16	1400	70	312.5	243
16	1400	80	312.5	243
16	1600	30	312.9	241
16	1600	40	312.6	245
16	1600	50	312.9	241
16	1600	60	311.8	245
16	1600	70	312.7	241
16	1600	80	312.7	245
18	600	30	311.8	243
18	600	40	312.7	241
18	600	50	312.7	244
18	600	60	312.8	243
18	600	70	312.9	243
18	600	80	312.8	245
18	800	30	311.5	243
18	800	40	311.6	244
18	800	50	312.7	245
18	800	60	311.4	241
18	800	70	312.9	245
18	800	80	312.7	241
18	1000	30	311.5	245
18	1000	40	311.6	241
18	1000	50	311.5	243
18	1000	60	311.8	243
18	1000	70	311.7	245
18	1000	80	312.8	243
18	1200	30	311.4	243
18	1200	40	311.2	244
18	1200	50	312.2	245
18	1200	60	312.6	241
18	1200	70	311.6	245
18	1200	80	311.6	241
18	1400	30	311.4	243
18	1400	40	311.9	243
18	1400	50	311.8	245
18	1400	60	311.5	243
18	1400	70	311.9	242
18	1400	80	312.9	242
18	1600	30	311.8	243

18	1600	40	312.7	243
18	1600	50	312.9	243
18	1600	60	312.8	243
18	1600	70	312.9	245
18	1600	80	311.8	241
20	600	30	312.8	245
20	600	40	312.8	242
20	600	50	312.8	242
20	600	60	311.4	241
20	600	70	311.4	243
20	600	80	311.5	243
20	800	30	311.6	245
20	800	40	312.8	243
20	800	50	312.6	242
20	800	60	312.5	242
20	800	70	312.8	242
20	800	80	312.8	243
20	1000	30	312.9	243
20	1000	40	312.6	243
20	1000	50	312.8	245
20	1000	60	312.9	241
20	1000	70	311.5	245
20	1000	80	311.6	242
20	1200	30	312.9	243
20	1200	40	311.4	241
20	1200	50	312.9	245
20	1200	60	311.6	241
20	1200	70	311.4	243
20	1200	80	311.4	243
20	1400	30	312.9	245
20	1400	40	312.6	243
20	1400	50	311.5	242
20	1400	60	311.6	243
20	1400	70	311.4	243
20	1400	80	311.4	241
20	1600	30	311.4	241
20	1600	40	311.8	242
20	1600	50	311.4	242
20	1600	60	311.4	243
20	1600	70	311.4	242
20	1600	80	311.4	241

The flow process chart for measurement of Plunge down time (PDT) is shown in Figure 4. The triggering of sensors action determines the decision of counting time in milliseconds. So the PLC controller is cabable of measuring the PDT accurately up to milliseconds.

.Pythone Code

```
from Keras.models import Sequential
from Keras.layers import Dense
import numpy
numpy.random.seed(7)
```

```
dataset = numpy.loadtxt("FSW.csv")
X=dataset[:,0:8]
Y=dataset[:,8]
model=Sequential()
model.add(Dense(12, input_dim = 8, activation = 'relu'))
model.add(Dense(8, activation = 'relu'))
model.add(Dense(1, activation = 'sigmoid'))
model.compile(loss = 'categorical_crossentropy', optimizer = 'adam', metrics = ['accuracy'])
model.fit(X, Y, epoches = 150, batch_size = 10)
scores = model.evaluate(X, Y)
```

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3. RESULT AND DISCUSSION

The effect of Plunge Down Time (PDT) is investigated for the change in tensile strength and microhardness on the weld zones. The sample tensile test specimens and fractured specimens are represented in Figure 6.

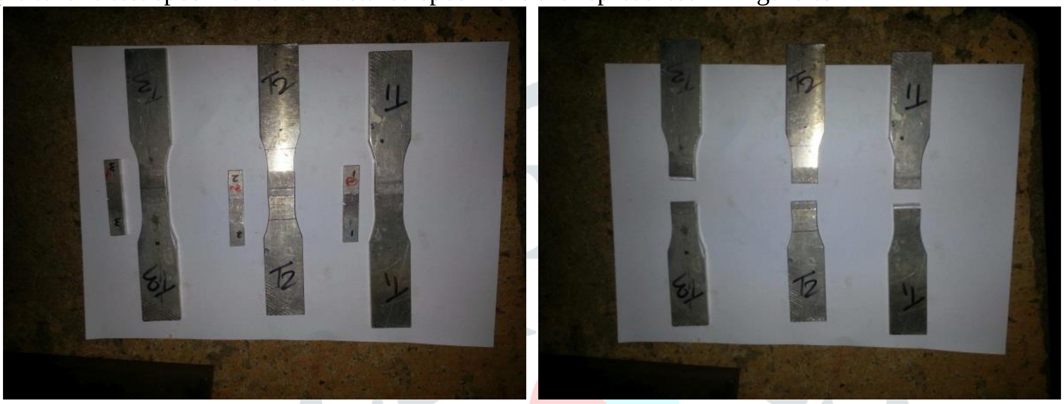

Figure 6.Butt joints of AA6061-AZ 61 tensile speimen: (a) before tensile test (b) after tensile test

The variation of tensile strength is due to the change in heat input during Friction Stir Welding (FSW) process. The reason for the change in heat input is due to the combination of different weld parameters. The lower PDT is responsible for higher heat during the FSW process. This higher heat input interms softens the metal during mixing and there by increasing weld strength during solidification.

4. CONCLUSION

From the investigation in Friction Stir Weld on AA6061 – AZ 61 alloys, it was concluded that the selection of advancing side plays significant role on weld strength. The material flow mechanism determines the tensile strength based on the material kept at advacing side. The AA 6061 on advancing side reveals comparatively better weld strength. Apart from normal welding parameters such as rotational speed, transverse speed and axial load the Plunge Down time also is equally important. The evaluation of Plunge Down Time rate can be measured with precise using the developed PLC embedded programmable controller. The lower the Plunge Down Time rate then higher will be the tensile strength. A direct propertinality exists between Plunge Down Time rate and Micro Hardness Value. According to SEM analysis, the harder material on advancing side makes the weld zone less suscetible to failure.

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