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To Design the Experimental Setup of Welding Joint Brass & Aluminium using Microstructural Behaviour

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Abstract

Welding is fabrication process that joins (aluminum and brass) usually metals or thermoplastic, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material (the weld puddle) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is contrast with soldering and brazing, which involve melting a lower-melting point material between the work pieces to form a bond between them, without melting the workpieces.

Keywords: *Welding Phases, Conventional Procedure, Friction Welding.*

1. Introduction

Friction welding is widely used solid state welding method for joining of similar or dissimilar metals. Friction welding requires rapid rotation of one component at high rpm and other component is brought into contact requires rapid rotation of one component at high and forging pressure to get upset. Two pieces rotate in contact and heat necessary for welding is generated on friction plane. The machine for the friction welding is similar to a milling machine.

Aluminum is an alloy, which is iron based and contains various combinations of other elements. To give its characteristics suitable for wide range applications, in the areas such as chemical, diary equipment's, food processing, pharmaceutical equipment's, cryogenic vessels, heat exchangers and beverage sectors. Friction welding is a solid state joining process that produces coalescence by harnessing heat developed through controlled rubbing of the faying surfaces. Due to heat, the material reaches the softened state, at which the plasticized material begins to form layer that intervene with one another and results in good quality weld. Friction has been shown to have significant economic and technical advantages. To produce good quality joint, proper process in which the quality of joint is closely associated with welding parameters.

2. Problem Formulation

Friction welding is widely used solid state welding process for joining of similar and dissimilar metals that uses rapid rotation of one component at high rpm and other component is brought into contact at high forging pressure to get upset. This approach is particularly useful in joining of dissimilar welds. The reason being the absences of any external filler material which may be further add in the heterogeneity of the weld structure.

From the literature survey, following limitation have been identified:

1. Friction welding of aluminum and brass weld joints has been reported.
2. Not much work done have been reported on analysis of friction welded joint using XRD with variation of friction welding parameters.

These bi-metallic welds impose a safety issue for the structural engineers. The bi-metallic welds present a heterogeneous interface, which results in variation of micro-structural and mechanical properties across a very narrow zone. These welds also show thermal fatigue and residual stresses. The joining of Aluminum and Brass is done by using Conventional welding procedure. The joining of Aluminum and brass should be done in such a way so as to reduce the material confirmation in welded specimens during process.

3. Experimentation

Experimental Setup Design

For doing friction welding vertical milling machine and lathe machine both can be used. We used lathe machine for doing friction welding of aluminum and brass machine.

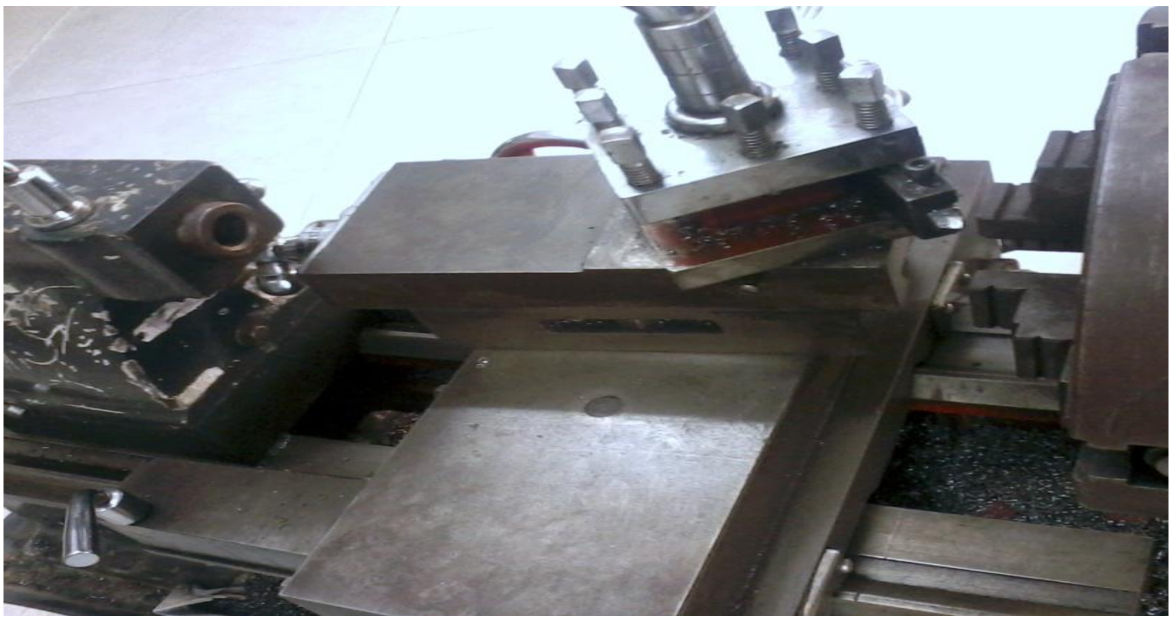

Figure 1.1: Experimental Set-up Design

1. **Lathe Machine:** We used lathe machine to weld aluminum and brass with friction welding. Main components of lathe machine are shown in fig 1.1 above.

2. Temperature Torch: Temperature torch was used to note down to temperature during friction welding.

3. Stopwatch: Stop watch was also used to note down the weld time during friction welding.

4. Vernier Caliper: This was used to note down the burn off length during welding.

Specimen Specifications:

The following are the specifications which will be used:

- Length of specimen : 75mm (each)
- Diameter of specimen : 12.5mm

Two cylindrical specimens of same size 75 mm lengths & 12.5mm diameter were used as shown in Fig.1.2.

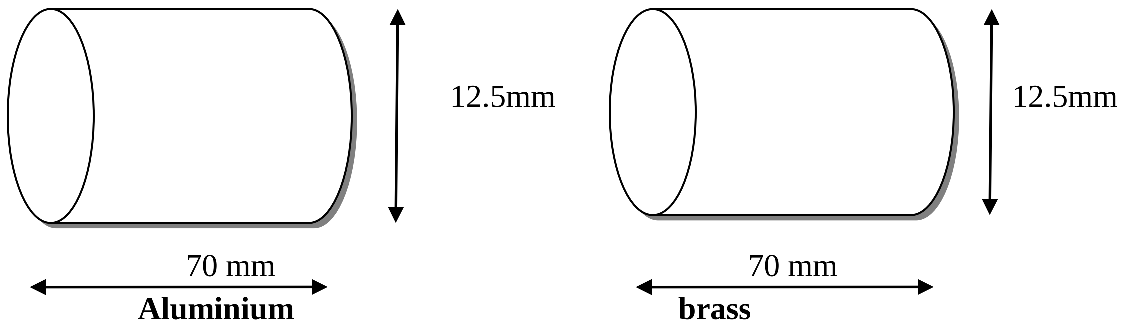

Figure 1.2: Dimensions of Cylindrical Pieces

For friction welding we put turning operation on the aluminium specimen and drilling in the brass.

❖ Changed Parameters:

The following are the three parameters which have been varied:

Weld Time: Weld time is the overall time in which joint is obtained between the aluminum & brass.

Burn off Length: Burn off length is the overall length loss of the specimens during the application of friction force & forge force. It can be original length minus length of welded component.

Revolutions per Minute: It is the revolutions of the rotating chuck in a minute.

Revolutions can be set according to the requirement. Total of 4 experiments were done.

❖ Fixed Parameters:

The following are the parameters that were kept constant throughout the experiment.

- **Diameter of the specimen:** 12.5mm
- **Length of the specimen:** 70mm each

Sample Preparation:

There are following steps for sample preparation:

Step1: Input:
- Bandsaw, Lathe
- Aluminium & brass
- Cutting tools
- Vernier Calliper

Step2: Cutting of aluminum, brass according to required length on band saw.

Step3: Fix the cutting tool on tool post & fix the aluminium, brass in rotating chuck on lathe

Step4: Turning of specimens to get the required diameter

Step5: Checking of required diameter with the help of vernier calliper

Step6: If required diameter is attained then go to step 7

Else

go to step 4

Step7: Turn over the aluminium and drill in the drill.

Step8: Specimen is ready for welding.

Step9: Finish

Firstly a rod of 12.5 mm diameter of Aluminium & Copper was cut into pieces of 75 mm Length (each) on Bandsaw (Fig 1.3).

Figure 1.3 Bandsaw used for Cutting of Specimens

After cutting operation of aluminium and brass, specimen was fixed in lathe machine but they are not joining. After that brass turn upto 2mm lenght on lathe machine and drilling took place in brass upto 2 mm depth. Then fix the aluminium specimen in the fixed tool of lathe machine and brass placed in the rotating chuck. Then start the machine aluminium is still fixed and brass is rotating with very high speed. Then during this friction welding we have noted down the temperature reading and time with the help of temperature gun and stopwatch respectively after that vernier calliper was used to measure the burn off length during the welding.

Element Confirmation of Friction Welded Specimens

For specimen 1

1 - $Zn[S_2O_4]$
2 - Al_2S_3, $CuAl_2O_4$
3 - Al_2S_3, Zn
4 - Al, Al_4Cu_9
5 - Al_2S_3
6 - Al_2S_3, Al_2O_3, CuZn, Zn
7 - Al, $CuAl_2O_4$
8 - Al_2S_3, $CuAl_2O_4$, Al_4Cu_9, $CuAl_2O_4$
9 - Al_2S_3, Al_2O_3
10 - Al_4Cu_9, CuZn
11 - Al, Al_4Cu_9
12 - CuZn
13 - Al, Al_4Cu_9, Al_2Cu
14 - Al_4Cu_9, CuZn
15 - Al, Al_2Cu, Zn
16 - Al_2O_3, CuZn, Zn
17 - Al_2Cu
18 - Al, Al_2Cu

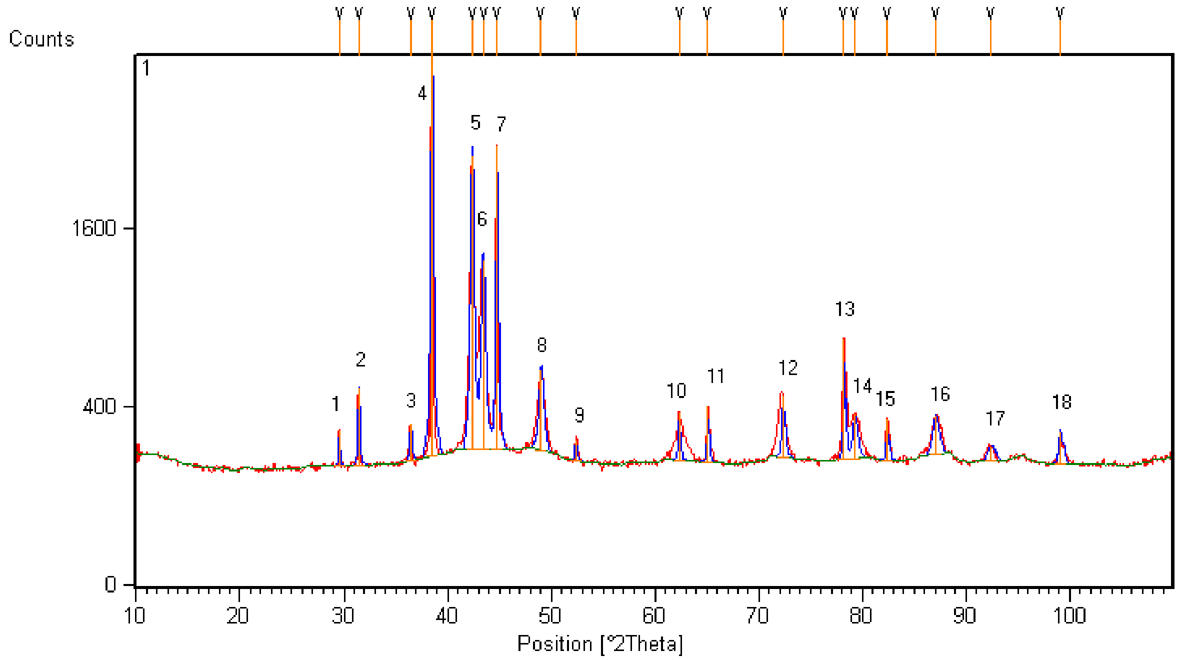

Figure 1.4: Representation of Counts

4. Results & Discussion

Macroscopic Behaviour

Table 1.1 Temp. Variation w.r.t Friction Time for Sample1

No. of Experiment	Parameters			
	RPM (R)	Burn off Length (L) in mm	Weld time in sec.	Temperature
1	1000	2	25	85
2	1000	1	23	82
3	1000	1	22	83
4	1200	1	21	81
5	1200	1.5	22	82
6	1200	1	21	84
7	1400	1.5	20	85
8	1400	2	22	84
9	1400	1.5	20	84

The following graphs show the variation of temperature with respect to friction time.

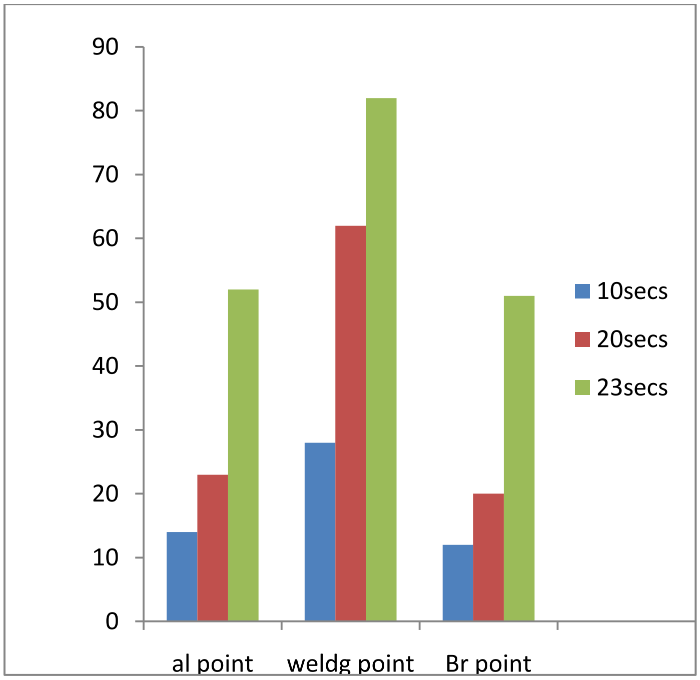

Figure 1.5: Temperature Variation w.r.t Friction Time for Sample 1

Discussion of Temperature Profile Results:

It is clear from the above that the highest temperature of 85 degree Celsius and lowest is 81 degree Celsius is observed when temperature is measured at a distance of 10 mm for specimen. When temperature is measured at 15 mm distance, maximum temperature observed is 85 degree Celsius.

Tensile Result and Discussion:

Table 1.2 Test Matrix for UTM Result

	Parameters			UTM result	
No. of Experiment	RPM (R)	Burn off Length (L) in mm	Weld time in sec.	UTS(N/mm2)	UTL(KN)
1	1000	2	25	66.5	7.5
2	1000	1	23	68.7	7.7
3	1000	1	22	69.1	7.8
4	1200	1	21	68.1	7.6
5	1200	1.5	22	68.7	7.7
6	1200	1	21	68	7.6
7	1400	1.5	20	69.1	7.8

8	1400	2	22	70	8.1
9	1400	1.5	20	71	8.2

Discussion on Tensile Strength: The effects of various parameters on the strength of the joints were examined in welding of equal diameter parts. From Table 1.2, it shows that maximum Ultimate Tensile Strength was observed for welded sample no.9 i.e. 70 N/mm2 and Ultimate Tensile Load 8.2 KN. Lowest Ultimate Tensile Strength for sample no. 1 i.e. 66.5 N/mm2 and UTL 7.5 KN. The values of Ultimate Tensile Strength for welded specimens were greater than that of aluminum bars in all cases.

Since the friction welding process is characterized by a fast applied thermal and stress/strain cycle causing micro structural changes, it would be expected that the mechanical properties of welded joints would be quite different from those of the base materials. In the entire cases sample is broken on Aluminium side.

5. Conclusions & Scope of Future

1) Friction welding has been successfully employed to weld dissimilar metals. Strength of the joints obtained was good.
2) The confirmation of welded material were observed in the specimen on the side of brass to aluminum due to high friction and high heat at the welding zone.
3) Temperature modelling of friction welded joint has efficiently accomplished.

In addition to the present work further work can be done in following directions:
1) Modelling of friction welding process can be carried out using Finite Element packages.
2) We can explore the evaluation of microstructure by using different diameter.
3) After residual stress measurements, we can carry out the fracture analysis of engineering or welding components of nuclear reactor part
4) We can measure and correlate fatigue and corrosion properties with different friction welding parameters.
5) There was lot of parameters (Weld time, Burn off length, RPM) which can be varied individually to see their individual effects rather than combining these parameters.
6) Modelling of residual stress generation during friction welding can also be carried out.

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