RESEARCH ARTICLE OPEN ACCESS

Design and Fabrication of Rotary Friction Welding on Lathe Machine

Rama Rao[1], A.Kiran Kumar Yadav[2], G.Sai Krishna Prasad[3]
1(Department of Mechanical Engineering, Madhura college, JNTUH,Hyderabad.
Email: ramarao_03@Yahoo.co.in)
2. (Department of Mechanical Engineering, TKR College of Engineering & Technology, JNTU Hyderabad
Email: aerrakiran@gmail.com)
3. (Department of Mechanical Engineering, TKR College of Engineering & Technology, JNTU Hyderabad
Email: saikrishnaprasad35@gmail.com)

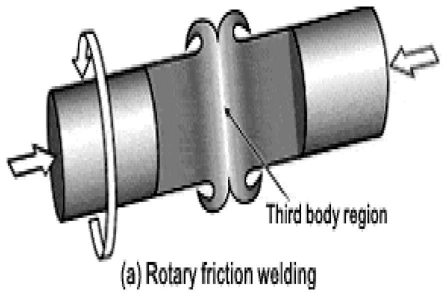
ABSTRACT
Friction welding is one of the most important types of solid-state welding process and it involves moving one component relative to the other component to generate required amount of heat and then applying lateral force (called upsetting force) to plastically displace and fuse materials. The mechanical properties obtained at different spindle speeds are recorded and hardness at the heat affected zone is measured. The findings proved that a lathe can perform friction welding up to 20mm diameter. Investigations are carried on mild steel (AISI 1040) and aluminum alloy (AA6351), both as similar and dissimilar combinations.

I. Introduction

Welding technology advanced quickly during the early 20th century as World War I and World War II drove the demand for reliable and inexpensive joining methods. In most of the welding processes the melting of materials take place. Those types of welding processes which doesn't involve melting of materials come under solid-state welding processes. Ultra sonic and friction welding are the most famous forms of solid-state welding. Lathe machine plays a very important role in manufacturing industry. Almost all operations can be done on this versatile machine. However, accuracy will vary from operation to operation. Several trials have been made to perform different types of welding on lathe. Welding processes like TIG welding, MIG welding, arc welding etc., can prove dangerous to be performed on lathe as they require proper grounding. Also, the safety of the operator goes for a toss. However, with proper attachments friction welding can be performed on lathe without any hassle. We are trying to perform rotary friction welding on a lathe machine by attaching necessary equipment to it.

II. Rotary Friction Welding

In late 1991 a very novel and potentially world beating welding method was conceived at TWI. The process was duly named friction welding **(FW),** and TWI filed for world-wide patent protection in December of that year. The Welding Institute **(TWI)** is a world famous institute in the UK that specializes in materials joining technology. Consistent with the more conventional methods of friction welding, which have been practiced since the early 1950s, the weld is made in the solid phase, that is, no melting is involved. Compared to conventional friction welding, Rotary Friction Welding (RFW) uses a rotating tool to generate the necessary heat for the process**.** Since its invention, the process has received world-wide attention and today two Scandinavian companies are using the technology in production, particularly for joining aluminum alloys. Also, RFW is a process that can be automated. It is also a cleaner and more efficient process compared to conventional techniques .



Rotary friction welding working

The combination of fast joining times and direct heat input at the weld interface, yields relatively small heat-affected zones. Friction welding techniques are generally melt-free, which avoids grain growth in engineered materials, such as high-strength heat-treated steels. Another advantage is that the motion tends to "clean" the surface between the materials being welded, which means they can be joined with less preparation. During the welding process, depending on the method being used, small pieces of the plastic or metal will be forced out of the working mass (flash). It is believed that the flash carries away debris and dirt. Another advantage of friction welding is that it allows dissimilar materials to be joined. This is particularly useful in aerospace, where it is used to join lightweight aluminum stock to high-strength steels. Normally the wide difference in melting points of the two materials would make it impossible to weld using traditional techniques, and would require some sort of mechanical connection. Friction welding provides a "full strength" bond with no additional weight. Other common uses for these sorts of bi-metal joins is in the nuclear industry, where copper-steel joints are common in the reactor cooling systems; and in the transport of cryogenic fluids, where friction welding has been used to join aluminum alloys to stainless steels and high-nickel-alloy materials for cryogenic-fluid piping and containment vessels.

Indentations and Equations

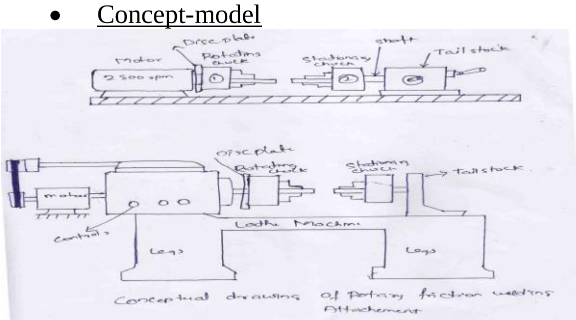
$$Q = \left(\frac{V \times I \times 60}{S \times 1000}\right) \times Efficiency$$

Where,
Q = heat input (kJ/mm), V = voltage (V),
I = current (A) and S = welding speed (mm/min)
The efficiency is dependent on the welding process used, with shielded metal arc welding having a value of 0.75, gas metal arc welding and submerged arc welding 0.9 and gas tungsten arc welding 0.8.

Heat affected zone

III. DEVELOPMENT OF FRICTION WELDING ATTACHMENT TO LATHE MACHINE

- <u>Concept-model</u>



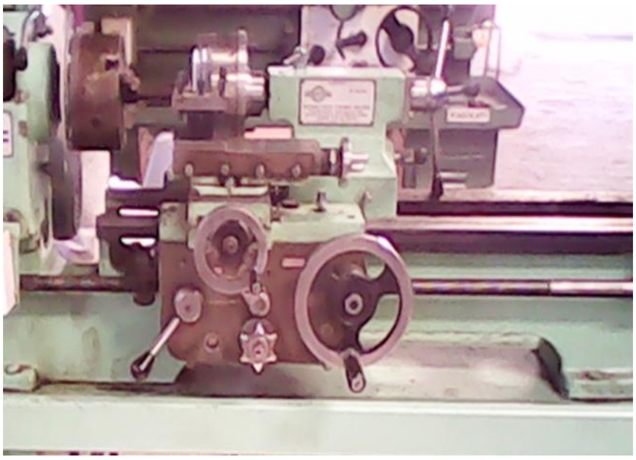


Figure captions appear below the figure, are flush left, and are in lower case letters. When referring to a figure in the body of the text, the abbreviation "Fig." is used. Figures should be numbered in the order they appear in the text.

Experimentation:

Different materials of specimens that we are taking up are mild steel **(MS),** brass, copper **(Cu)** and aluminum **(Al).**The performance of welding with similar and dissimilar combinations of materials. Combinations taken up are as follows,

1. MS-MS
2. MS-Al
3. Cu-BRASS
4. Al-Al

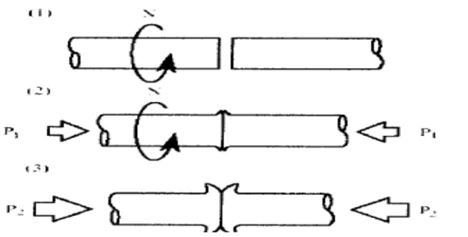
Parameters considered

The important parameter that influence the weld formation while performing welding are,

1) Friction load
2) Temperature
3) Time of welding
4) Diameter of specimens
5) Speed of rotation in rpm

Steps involved in performing rotary friction welding on lathe

- First, measure the diameters of the two jobs using vernier calipers and fix them in the two chucks firmly using key.
- Make sure that the shaft in the stationary housing is locked using the locking lever so that the 2nd work piece is not allowed to rotate.
- Now, turn on the lathe so as to rotate the 1st work piece at the required speed. Speed can be checked using a tachometer.
- Start the stop watch and apply the pressure manually. Slowly increase the pressure till the required amount of heat is generated and burr is formed.
- Using the infrared pyrometer note the temperature developed at the interface.
- Now, release the lock lever so that the two jobs rotate together and stop the watch and wrote down the time.
- Turn off the lathe and carefully take out the welded job out of the chucks. And take the specimen for further testing.



: *Basic steps in friction welding process*

Table 1: Welding of specimens at 1250 rpm speed

S. No	Material combination	Dia (mm)	Proving ring reading (div) 1div=0.0114 kN	Friction load (kN)	Temperature (^0C)	Time(seconds)
1	MS-MS	10	16	0.1824	390	15.3
2	MS-Al	10	9	0.1026	160	17
3	Cu-Brass	10	12	0.1368	115	12
4	Al-Al	10	19	0.2166	157	16
5	MS-MS	14	20	0.228	765	17
6	MS-Al	14	18	0.2052	241	20
7	Cu-Brass	14	17	0.1938	250	18
8	Al-Al	14	19	0.2166	184	17.5

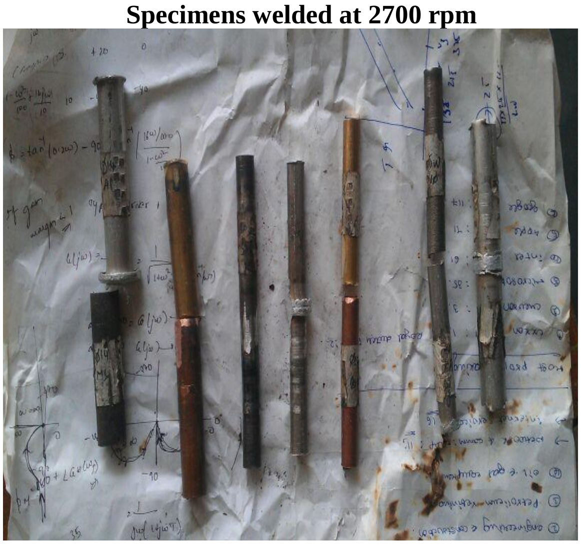
***Note:** Friction welding on the specimen combination of set CU-BRASS and MS-AL i.e. DISIMMILAR materials is a failure, they didn't join together at all, at any instinct of experimentation during welding.

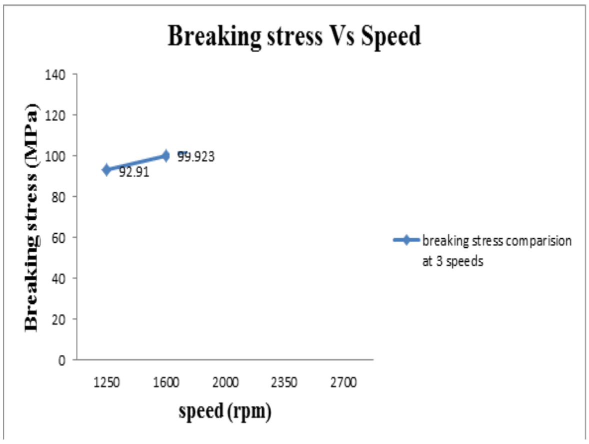
Specimens welded at 1250 rpm

Table 2: Welding of specimens at 1600 rpm speed

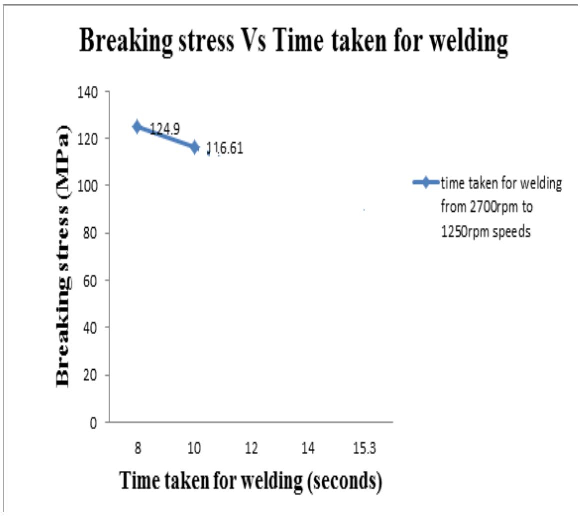
S. No.	Material combination	Dia. (mm)	Proving ring reading(div)1div =0.0114kN	Friction load (kN)	Temperature (°C)	Time (seconds)
9	MS-MS	10	15	0.171	410	14
10	MS-Al	10	9	0.1026	165	15
11	Cu-Brass	10	12	0.1368	140	11
12	Al-Al	10	17	0.1938	165	13
13	MS-MS	14	18	0.2052	759	15
14	MS-Al	14	18	0.2052	240	16
15	Cu-Brass	14	17	0.1938	250	15.5
16	Al-Al	14	18	0.2052	190	15.2

Specimens welded at 2700 rpm

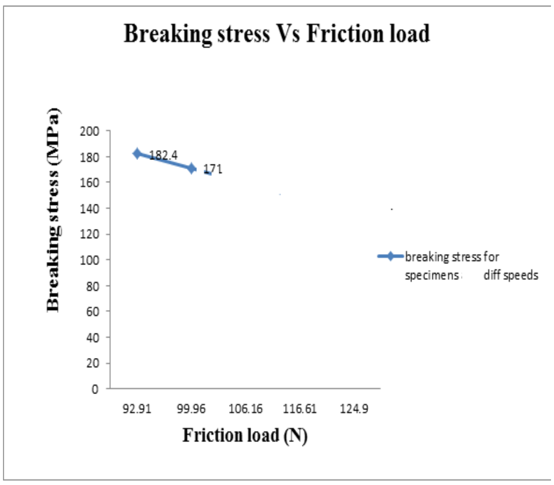




Graph 1: Breaking stress Vs Speed



Graph 2: Breaking stress Vs Time taken for welding



Graph 3: Breaking stress Vs Friction load

IV. CONCLUSION

1) Friction welding enables the joining of materials giving a weld of high strength with

many advantages over the other welding processes.
2) Friction welding is Indispensable tool for welding dissimilar metals.
3) The present attachment can weld up to work piece of diameter 20 mm.
4) It is safe on heavy duty lathe to perform friction welding up to bar diameter of 20 mm with good mechanical properties.
5) Thermal softening led to reduction of hardness for both similar and dissimilar metals near weld zone.
6) For friction welding of (ANSI 1080) MS-MS Ø14 mm combination, 1600 rpm was found to be the optimum speed for welding.
7) For friction welding of H3 (Strain Hardened and stabilized thermally) Al-Al Ø14 mm 1600 rpm was found to give the best results.
8) Among the material sets considered, MS-MS Ø14 mm welding has generated a highest temperature of 780^{0} C.
9) The future of friction welding is secure with new uses in the aerospace, automobiles, manufacturing industry etc.

REFERENCES

Journal Papers:

[1] G. Kiran Kumar, K. Kishore, and P. V. Gopal Krishna *"Investigating the Capabilities of Medium Duty Lathe for Friction Welding"* , Hyderabad, India, Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 1 (1): 36-39 © Scholar link Research Institute Journals, 2010

[2] Fuji, A., Kimura M., North, T.H., Ameyama, K. and Aki, M 1997, *"Mechanical Properties of Titanium 5083 Aluminium Alloy Friction joints"*, Material. Science. Technology. Vol. 13, pp. 673-678.

[3] Jessop, T.J. and Dinsdale, W.O. 1976, *"Mechanical Testing of Dissimilar Metal friction Welds*", Welding Res. Int., Vol. 6, pp. 1-22.

[4] Sassani, F. and Neelam, J.R. 1988, *"Friction Welding of Incompatible Materials"*, Welding J., Vol. 67, pp. 264-270.

[5] Yokoyama, T. and Ogawa. K 2001, Stress-Strain characteristics of S15C Carbon Steel Friction Welded Butt Joints under Impact Tensile Loading, Quar. J. JWS Vol.19 pp. 513-523