# Copper alloys joining by using EN31 circular thread profile tool through Friction Stir Spot Welding Process

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***Abstract*- Friction stir spot welding(FSSW) is a latest , solid–state fusion course. Tool pin with properties use for welding. The revolving tool generate friction heat in the specimen. Then,heated and hardend objects by plunging , a solid-state bond is made connecting the surface of the upper and lower sheet. From the experiment ,it was studied that for harder matter with harder tool .The pin tool ,revolving at a constant rate, plunges into C11000 specimens,2mm thickness, in spot-joint configuration. EN31 circular thread tool plunge pin depths of despair from 3.5 mm were examined and test by breaking load of friction stir spot weldment joints of like metal use in the learn.**

***Index Terms*- friction stir spot welding, copper plates (C11000) 100*55*2mm, EN31 tool of circular thread pin profile.**

## I. INTRODUCTION

Friction stir spot welding draw from from friction stir welding. This FSSW do not need filler bar, shield gases and the process do not have spatter and splash, The down tool force and the tool rotating rate produce a frictional heat stuck between the tool and work piece. In this experiment using harder tool like EN31 which can endure with copper material. In resistant spot welding copper material do not weld by copper electrode. To overcome this complexity friction stir spot welding is derive with no filler rod and electrode is required. Explain in this paper the role of tool geometry, proper selection of the tool material and shape of the tool acting an significant role. In the present study we are using EN 31 tools with circular thread profile.

## 2. LITERATURE REVIEW

By using friction stir welding till date a number of experiments have been conduct on Copper and Aluminum alloys. M.Milicic et al(2015) have conduct number of experiment on Copper alloys by tool profile. Masoud Jabbari et al(2014) conduct a experiments on Pure copper 4mm thick plate 25mm/min traverse speed and rotation speeds. Several of experiment have been conduct on a Al- Al alloys but experiments conducted on a copper is limited which give us massive concern to know new about the mechanisms of friction welding on Copper. The property of the Copper is high melting point, high thermal conductivity and it is extremely hard to obtain a sound weld. Our present study is focusing on Copper alloy plate of 2 mm thickness by using EN31 tool materials with Circular thread profile.

## 3. EXPERIMENTAL SETUP

On vertical milling machine friction stir spot welding is perform. The input parameter as mention before was taken for machine process parameters.

Experiment conducted on C11000 plates in the size of 100*55mm and 2mm thickness. Cutting of plates, finished the edges of plates by rough and smooth files.

Then two plates be clamp on machine bed tightly such that it can resist the force of tool motion without disjoint from its size.

Initial we have in use circular thread tool profile and speed of 900 rpm and feed of 38mm per minute. The process is started and the tool penetrated between two

plates. At the time of penetration some chips came out, after that the shoulder of tool made the material to stay inside and to form the good weld.

3.1 TOOL DESIGN: The drawing of the tool is a critical issue as a high-quality tool can get better both the prominence of the weld and the maximum potential welding speed. It is pleasant that the tool material is effectively tough, tough and hard wearing, at the welding temperature.

Table 1: Chemical composition of EN 31 Alloy Steel

| C | Si | MN | S | P | Cr |
|---|---|---|---|---|---|
| 0.90-1.20 % | 0.10-0.35 % | 0.30-0.75 % | 0.050 % max | 0.050 % max | 1.00-1.60 % |

Table 2: Mechanical properties of EN31Alloy Steel

| Tensile N/mm2 | Yield N/mm2 | Elongation % | Hardness HRC |
|---|---|---|---|
| 750 | 450 | 30 | 63 |

3.2 EN 31 TOOL SPECIFICATION

EN 31 is outstanding high carbon steel which offer a high determine of hardness with compressive strength and abrasion resistance. This grade is quite frequently use for wear resisting machine and for press instruments which don't advantage a extra difficult satisfactory. Standard high-speed steel grade, it's well-balanced alloy concerto form the base of its high toughness and good cutting edge retention, rendering it suitable for a large variety of applications.

3.3 COPPER (C11000)

General Description Electrolytic hard pitch (ETP) copper, alloy 110, has outstanding ductility and high electrical and thermal conductivity, upper than for any extra copper metal excluding oxygen free grade.

Table 2: The chemical composition of C11000 copper

| Element | C |
|---|---|
| Content (%) | 99.90 |
| Oxygen | 0.04% |

Table 3: The physical properties of UNS C11000 copper

| Density | Melting point | Coefficient of thermal Expansion | Thermal conductivity |
|---|---|---|---|
| 8.89g/cm² 0.322 lb/in³ | 1065 - 1083°C,1949°F | 17.7-10 | 388-W/(m. K) |

Table 4: Process variables

| Parameters | EN 31 |
|---|---|
| Tool Profile | Circular Tool |
| Rotational Speed(RPM) | 900 |
| Feed(mm/min) | 38 |
| Depth of cut(mm) | 3.5 |
| Inclination angle | 0.5 deg |
| Tool |  |

*Fig 1. Experimental set up*

3.4 MACHINE VARIABLES

3.4.1 Rotational Speed of the Tool: By increase in rotational speed, the heat produced by friction also increase which directly affect the temperature at welding point. For this experiment 900 RPM is selected.

3.4.2 Welding Feed Speed : The welding feed -speed which be able to be term as tool advance speed tool affects the eminence of welded joints. So the heat generated by friction also increase which directly affect temperature at welding location. Welding feed is 38mm/min selected properly.

3.4.3 Depth of Cut(Axial Force): The depth of cut is also term as Axial Force necessary to weld the joint. base on the thickness of the material this force is chosen. There is a limitation of this force base on the machine specifications and thickness of the materials chosen, in our case the depth of cut is fixed 3.5 mm.


*Fig 2:- FSSW of C11000 to C11000*

*Fig 3:- Breaking load test by using UTM*

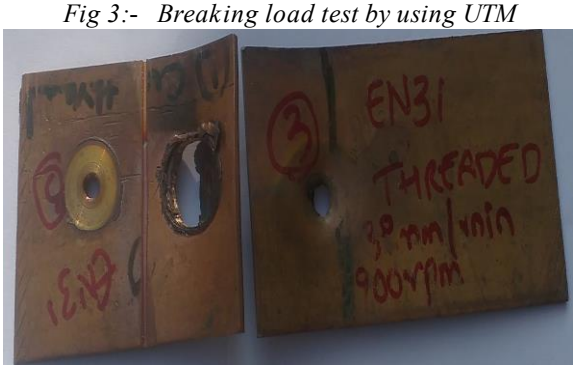
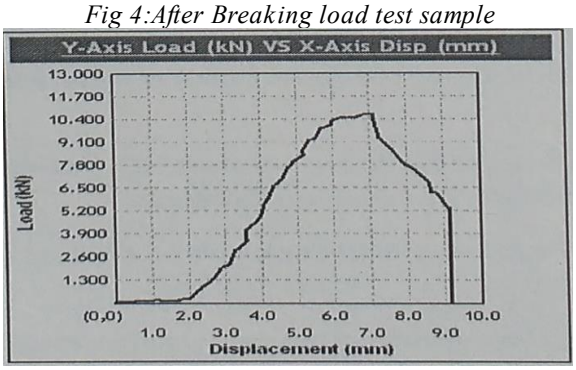



*Fig 4:After Breaking load test sample*




*Graph 1: Breaking load of C11000*

## 4. CONCLUSIONS

-The experiments have been conduct on a Vertical Milling machine by using EN31 with Circular thread tool profiles for Friction Stir Spot Welding on C11000.

-The samples are tested on a Universal Testing machine for breaking load.

-From test report ultimate load strength is 10.680 KN.

Compare to mechanical properties of C11000 is FSSW value is biggest.

- The biggest tensile strength were obtained with Circular thread tool(EN31) with Rotational speed(rpm) 900 , Feed(mm/min) 38 and Inclination angle 0.5 degree is C11000 –C11000 with circular tool(EN31) by test.

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