

## International Journal of Innovative Research in Science, Engineering and Technology

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# Experimental and Analytical Analysis on Friction Stir Welding Of Dissimilar Materials: Aluminium and Copper

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**ABSTRACT:** In this project, FEA analysis is performed for friction stir welding of aluminum alloy 5083 and copper using pin profile round and taper. The analysis is done using different rotational speeds 700rpm, 1150rpm and 1350rpm. The plate sizes are 130mmX45mmX3mm. The tool material is HCHCR steel. The tool shoulder dia is 22mm, tool pin dia is 5mm, pin length is 1.7mm. Modeling is done in Pro/Engineer and analysis is done in Ansys.

Experimental investigation is done to verify the mechanical properties of friction stir butt welded aluminum alloys 5083 and copper using pin profile round. The properties investigated are tensile strength and hardness, compared before and after welding. The experiments are conducted with speeds of 700rpm, 1150rpm and 1350rpm and feeds 30, 45 and 60mm/min. Experimental work is conducted on 3 axis vertical milling machine.

**KEYWORDS:-** aluminum alloy 5083, copper, HCHCR steel, Pro/Engineer, Ansys, friction stir butt welding

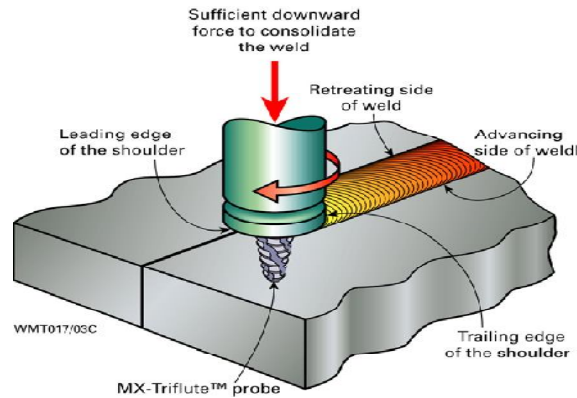
### I. INTRODUCTION

Friction Stir Welding is the most recent upgrade to the Space Shuttle's gigantic External Tank, the largest element of the Space Shuttle and the only element not reusable. The new welding technique—being marketed to industry—utilizes frictional heating combined with forging pressure to produce high-strength bonds virtually free of defects. Friction Stir Welding transforms the metals from a solid state into a "plastic-like" state, and then mechanically stirs the materials together under pressure to form a welded joint. Invented and patented by The Welding Institute, a British research and technology organization, the process is applicable to aerospace, shipbuilding, aircraft and automotive industries. One of the key benefits of this new technology is that it allows welds to be made on aluminum alloys that cannot be readily fusion arc welded, the traditional method of welding.

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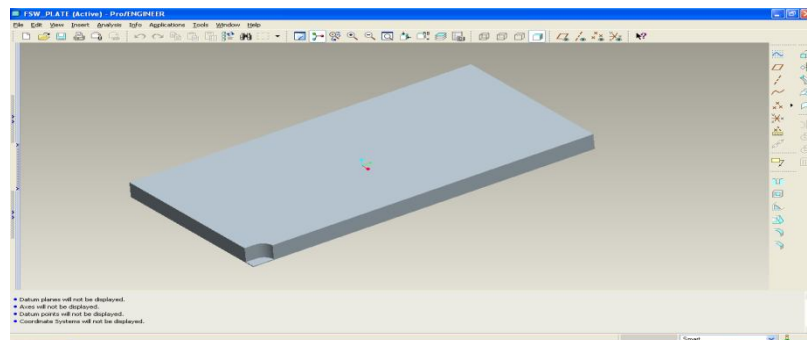
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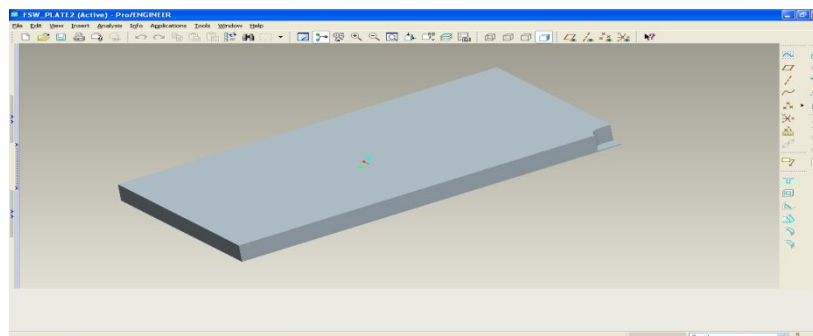
## II. TOOL DESIGN

Tools consist of a shoulder and a probe which can be integral with the shoulder or as a separate insert possibly of a different material. The design of the shoulder and of the probe is very important for the quality of the weld. The probe of the tool generates the heat and stirs the material being welded but the shoulder also plays an important part by providing additional frictional treatment as well as preventing the plasticised material from escaping from the weld region. The plasticised material is extruded from the leading to the trailing side of the tool but is trapped by the shoulder which moves along the weld to produce a smooth surface finish. Clearly, different materials and different thicknesses will require different profile probes and welds can be produced from just one side or by welding half the thickness then turning over to complete the other side.

### MODELS OF CUTTING TOOLS-ROUND TOOL PLATE1



### PLATE2

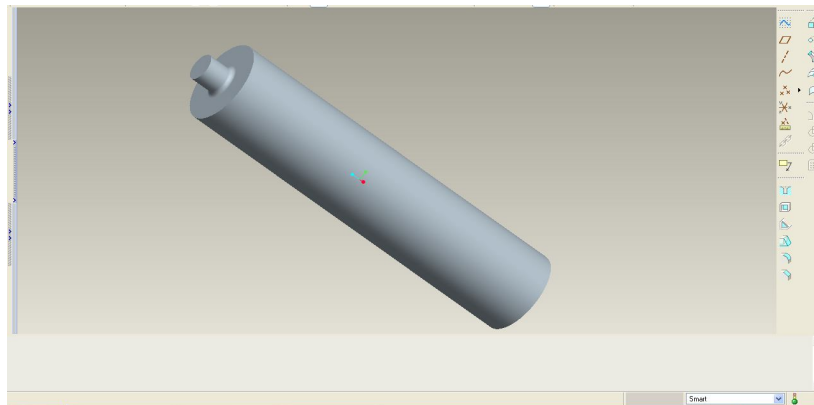


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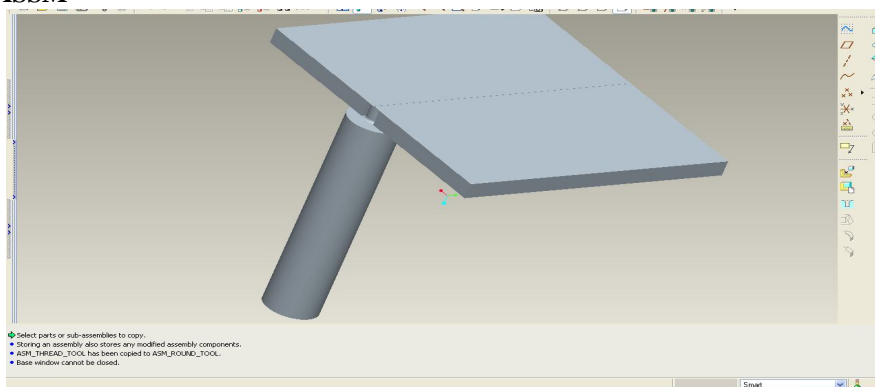
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### ROUND TOOL



### ROUND TOOL ASSM



### COUPLED FIELD ANALYSIS OF ALUMINUM ALLOY 5083 AND CAST COPPER

#### 700 RPM- ROUND TOOL

Select Preference select thermal

Select element type as a solid brick 20 node 90

#### Enter material properties

##### Work piece-Aluminum Alloy 5083

Thermal Conductivity – 0.177W/mmK

Specific Heat – 900 J/Kg K

Density – 0.00000266 Kg/mm<sup>3</sup>

##### Copper

Thermal Conductivity – 0.483 W/mmK

Specific Heat – 385 J/Kg K

Density – 0.000007764 Kg/mm<sup>3</sup>

##### Cutter-HCHCR Tool Steel

Thermal Conductivity – 0.020W/mmK

Specific Heat – 460J/Kg K

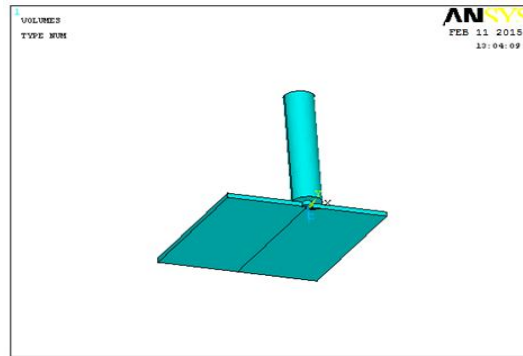
Density – 0.00000767Kg/mm<sup>3</sup>

#### Import IGES model

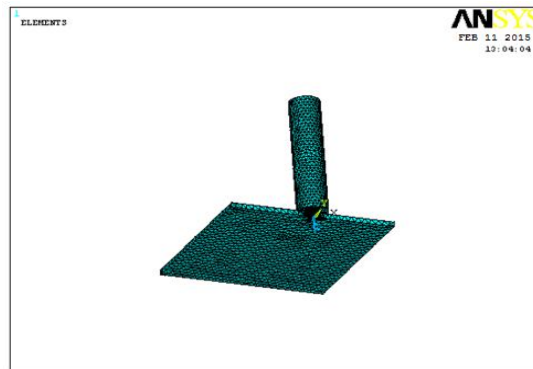
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## Meshed model



### Enter material properties

#### Work piece-Aluminum Alloy 5083

Young's Modulus – 70300 MPa

Poisson's Ratio – 0.33

Density – 0.00000266 Kg/mm<sup>3</sup>

#### Copper

Young's Modulus – 110000 MPa

Poisson's Ratio – 0.343

Density – 0.000007764 Kg/mm<sup>3</sup>

#### Cutter-HCHCR Steel

Young's Modulus – 209900 MPa

Poisson's Ratio – 0.3

Density – 0.00000767 Kg/mm<sup>3</sup>

## III. RESULTS TABLE

### ROUND TOOL

	700rpm	1150 rpm	1350 rpm
Nodal Temperature (K)	673	673	673
Thermal Gradient (K/mm)	323.413	575.392	758.425
Thermal Flux (W/mm <sup>2</sup> )	66.237	126.416	136.518
Displacement (mm)	0.030632	0.011474	0.011541
Stress (N/mm <sup>2</sup> )	143.246	143.464	144.21
Strain	0.006231	0.003058	0.003078

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### IV. EXPERIMENTAL INVESTIGATION

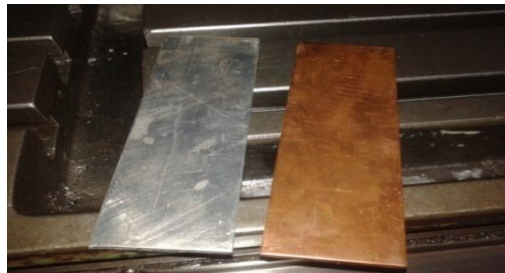
Experimental investigation is done to verify the mechanical properties of friction stir welding of aluminum alloy 5083 and copper. The properties investigated are tensile strength and hardness compared before and after welding. The welding is done on Conventional Vertical milling machine.

TOOL	SPEED (rpm)	FEED (mm/min)
Round	700	30
Round	1150	45
Round	1350	60

#### ROUND PROFILE TOOL



#### WORKPIECES BEFORE WELDING



#### AFTER WELDING:



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### TENSILE TEST

Type of test – Mechanical Tensile

Equipment used – UTM 250KN

Specimen Width – 28mm

Specimen Thickness – 3mm

	UTS (MPa)
Sample 1	30.14
Sample 2	35.74
Sample 3	27.02

### VICKERS HARDNESS TEST

#### MACHINE DETAILS

Name – VICKERS HARDNESS

Srl No: VM – 50 MCS

#### TEST DETAILS

Test Procedure – IS 1501:2002

Type of Hardness – HV

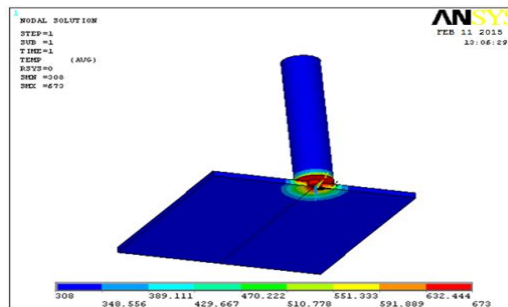
Indenter – Diamond

Load Applied – 5Kgs

		Observed Values in HV5			
	Location	Impression 1	Impression 2	Impression 3	Average
Sample 1	On Surface	210	206	206	207.33
Sample 2	On Surface	180	178	180	179.33
Sample 3	On Surface	210	212	210	210.67

## RESULTS

### Temperature distribution

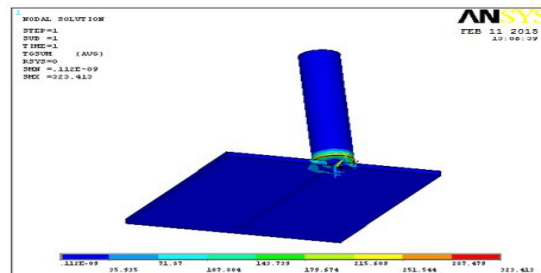


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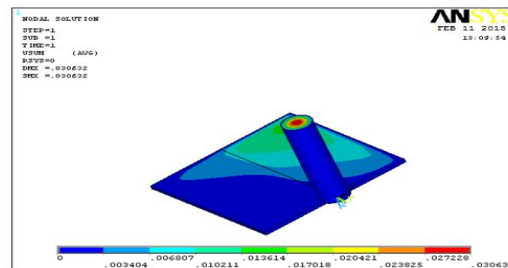
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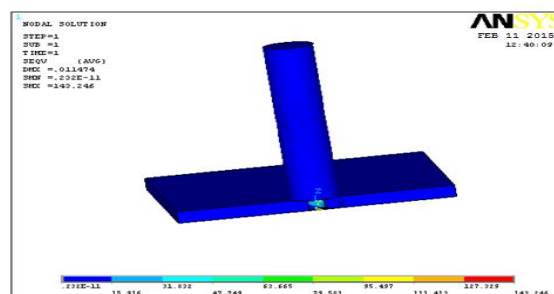
## Thermal flux



## Displacement



## Von mises stress



## V. CONCLUSION

By observing the tensile test results, ultimate tensile strength is more for the sample welded at speed of 700 rpm. By observing the hardness Test results, the hardness is more done at speed of 1350rpm. So it can be concluded that by increasing the speeds the strength decreases whereas by increasing the speeds the hardness increases.

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