

# *Review of Parametric Optimization of Friction Stir Welding Process Parameter on Aluminium Alloy6061 Material using Different Tool Profile*

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## **Abstract**

*This Article Considers Investigation Procedure for Friction Stir attachment in aluminum Alloy, via management of tool Profiles. FSW process allows the benefits of solid-state joining for fabrication of continuous linear welds, the most common form of weld joint configurations. The key element of the method is that the specially designed rotating tool that has two essential parts. The primary part is the profiled pin (or probe) extending on the axis of the rotating part. The second a part of the tool is that the Shoulder. The shoulder is that the working surface of the tool, normal to the axis of rotation. The project aim is to weld two plates of aluminum Alloy using different tool profiles and different welding parameter like Rotation speed, Traverse speed, Axial load and to optimize the strength of joint.*

**Keywords:** - *Frictions stir welding, tool rpm, tool feed, tool tilt angle;*

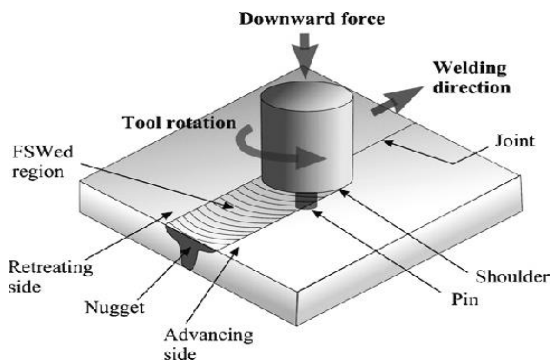
## **INTRODUCTION**

FSW a cylindrical, body part tool with a profiled probe is rotated and slowly plunged into the joint line between two items butted along. Friction heat is generated between the wear and tear resistant welding tool and also the material of the work pieces. The process is primarily used in industry to join aluminium alloys of all grades, whether or not solid, rolled or extruded. FSW has been shown to weld aluminium alloy butt joints with a thickness of between 0.3mm and 75mm during a single pass, counting on the parent material used the machine

power and the structural stiffness of the work piece.

Other materials that have been joined with FSW include magnesium, titanium, copper, and steel alloys, while plastics and metal matrix composites (MMC) have also been explored. This method has also been shown to be ready to join dissimilar mixtures of these materials. FSW has been used for a variety of applications across industries starting from aerospace to shipbuilding and rail to electronics as well as electron volt battery tray FSW. No filler materials, flux or shielding gas requirement for aluminium alloys. Friction stir

welding is environmentally friendly as it produces no fume, spatter, or UV radiation. Due to the lower temperatures there's a reduction in shrinkage and distortion within the material being joined. As a solid state welding process, FSW may be a mostly defect free joining method with no hot cracking, porosity or curing cracks.



**Figure 1 working principle of FSW**

## LITERATURE REVIEW

Kulwant Sing, Gurbhinder Singh, Harmeet Singh [1] Tool geometry is the most influential part of FSW process development. The tool Pin profile, shoulder diameter and tool material highly influenced the joint quality.

RajKumar.Va, VenkateshKannan.Ma, Sadeesh.Pa, Arivazhagan.Na, Devendranath, Ramkumar.Ka [2] Minimum transfer speed can give good weldability, mechanical and metallurgical characteristic show good agreement which is clearly evident from result obtain.

Md. Reza-E-Rabby, Anthony P. Reynolds [3] Intermediate threaded tool pins produced best quality welds with reduced defect production in both alloy systems so if keep high pitching of tool is good for weldability.

Ch. VENKATA RAO a, G. MADHUSUDHAN REDDY b, K. SRINIVASA RAO a, [4] Fsw is depend on tool shape and in this paper we found that triangle shape tool better compare to conical

type tool, also heat generation as well as peak temperature is relatively high in case of triangle pin profile compare to conical tool profile.

Ch. VENKATA RAO a, G. MADHUSUDHAN REDDY b, K. SRINIVASA RAO, [5] Tool geometry plays an important role in the weld nugget microstructure hexagonal tool profile due to relatively higher heat generation. The rate of heat generation as well as the peak temperature and dissolution of precipitates were relatively higher in the case of hexagon tool pin profile compared to other profiles.

J. Sai Sashanka, P. Sampatha, P Sai Krishnaa, R Sagara, S.Venukumara,\*, and S. Muthukumar [6] The welding process was carried out at a rotational speed of 700 rpm, 1000 rpm, 1500 rpm and traverse speed of 60 mm/min and 100 mm/min with 15 mm tool shoulder diameter so we found . The tensile strength of the specimen was found to better with weld made at a traverse speed of 60 mm/min and rotational speed of 700 rpm.

Yahya Bozkurta, Zakaria Bomerzoug [7] High carbon steel as a tool material defect free nugget zone and high tensile property. The maximum wear seen on uncoated tool. Porosity negligible in ALTI (aluminium and titanium) coated tool use in FSW.

T.E.AbiyeabH.ZuhailawatiaA.S.AnasyidaaS.A.Y ahayacB.K.Dhindawd [8] Friction stir welding of AA 6061-T6 resulted in grain refinement in the welded region. The grain refinement was enhanced with the addition of the reinforcement particles. B4C reinforced joint has the most uniform particle distribution with no noticeable particle agglomeration. SiC and Al<sub>2</sub>O<sub>3</sub> reinforced friction welded joints contain agglomerations of particles,

moderately dispersed particle region and particle free region in the stir zone.

Kush P. Mehta Vishvesh J. Badheka [9] The copper particles detached from base material were large and irregular in case of polygonal pin designs. Maximum irregular and large copper particles were reported in welds made by triangular pin profiles. The defects were decreased as the polygonal edges increases. Defect free macro joint was reported for cylindrical tool pin profile.

Dr. S. Ugender [10] AZ31 magnesium alloy was successfully friction stir welding without any macro level defect under the following range of process parameters: tool pin profile made of taper threaded, taper cylindrical and straight cylindrical, tool rotational speed of 900–1400 rpm, and welding speed of 25–75 mm/min.

M. I langovana S. Rajendra Boopathya V. Balasubramanianb[11] Threaded and tapered cylindrical pin profile tools yielded defect free joints (both surface and cross-sectional). The tensile properties of these joints are more or less similar ( $\pm 5\%$  variation). However, the threaded cylindrical pin profile tool is preferred over the tapered cylindrical pin profile tool due to the superior performance of the joints.

Venkatesh Kannan M, Rajkumar V, Avinash P, Arivazhagan N, Devendranath Ram kumar K, Narayanan S [12] The FSW process parameters were optimized with respect to mechanical and metallurgical properties of the weldments. In addition, tool pin profile has also influenced the weld quality. From this research work, it is inferred that the rotational speed of 710 rpm, traverse speed of 28mm/min and D/d ratio of 3, for

cylindrical pin, is considered to be the most efficient. Furthermore, better mechanical properties were observed with 6 mm squared pin, rotational speed of 1000 rpm and traverse speed of 40mm/min. in addition, the cylindrical threaded and squared pin tool profile are found to be the best among other tool profiles that were considered.

A. M. Sadounab A. Wagihb A. Fathy b A. R. S. Essa [13] The effect of tool area ratios on temperature distribution and heat generation ratios in FSWed 7075-O aluminum alloy at 500 rpm rotation speed and 50 mm/min welding speed is investigated. Using a tool with a semi-spherical pin and high ratio of pin side area (29.83%) produces a joint with finer grain size and larger tensile strength. The appropriate ratio of pin side area for a defect free joint can be in the range of 23.79–29.83%.

Khalique, Ejaz Ahmeda B. M. Nagesha B. S. Rajub D. N. Drakshayania Abhijit Sudhindra Chethan Holla [14] Rotational speed influences the formation of defects in the nugget region, the hardness of the nugget region, and subsequently the tensile strength of the friction stir welded Aluminum Alloy AA-6082 reinforced with varying percentage of Al<sub>2</sub>O<sub>3</sub>. Very high rotational speeds could raise the strain rate, and thereby influence the re-crystallization process; which in turn, could influence the FSW process.

Mahdi Masoumi Khalilabada, Yasser Zedana, Damien Texiera, b, Mohammad Jahazia, Philippe Bochera [15] In the present study, different tool designs were tested for joining dissimilar aluminum alloys AA2024 and AA2198. The raised fan shoulder with a tapered cylindrical pin

geometry that is easy to manufacture and provide good mechanical properties.

Marathe Shalin, Mistry Hiten [16] Tool transverse feed of 10, 15, and 20 mm/min and tool rotational speed of 2250, 2500, and 2750 rpm are taken for the study and total 27 numbers of experiments are conducted As a conclusion it has been derived that feed of 15 mm/min, tool rotational speed of 2750 rpm and tapered pin profile gives better weld strength for the given experimental condition.

Kalmeshwar Ullegaddi, Veeresh Murthy, Harsha R N, Manjunatha [17] The concave tool require more force compared to other tool, because in concave tool the material soften material store inside concave area like reservoir, it may push the tool away from the work piece, so more force need to apply to keep contact with work piece to generate good joint. Concave shoulder tool is shows high normal force compared to other tool, means produce enough temperature to provide good weld and also ensure that. Jalal Fathia Pejman Ebrahimzadeha Reza Farasatia Reza Teimouri [18] It is also found from the results for irrespective to cooling condition, the tensile strength of the joint enhances by increase of tool rotation speed, and hence 1400 rpm tool rotary speed is an optimal value causing maximum tensile strength. While, travel speed plays different role in deciding strength behaviour. For conventional process, the optimum value of travel speed is 50 mm/min while for water cooling condition the optimum value was 20 mm/min.

### RESEARCH GAP

From of the review of the published to the friction stir welding process is depending on tool geometric. And weld ability and mechanical properties is giving a good when tool speed is kept

to a minimum. Found out the from many research paper in, triangle shape of tool is better than conical tool, but hexagonal tool profile is generating the higher heat and high peak temperature and material mixing better in hexagonal tool. When a new designs and improvements can be made in that hexagonal tool as less work has been done it.

### CONCLUSIONS

Friction stir welding has hugely high potential within the field of thermo mechanical process of various alloys particularly the aluminum alloys. This project presents experimental investigation of friction stir welding of AA6061. The mechanical properties and also the resultant microstructure for friction stir welded AA6061 were given for different mixtures of tool rotational speed, tilt angle and travel speeds. The equivalence of mechanical properties and microstructure with the process parameters for the improvement of process may be a singular approach that has been the main motivation behind this project.

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