A

Seminar report

On

Friction Stir Welding (FSW)

Submitted in partial fulfillment of the requirement for the award of degree
Of Mechanical

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SUBMITTED BY:
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Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

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Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

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Preface

I have made this report file on the topic **Friction Stir Welding (FSW);** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

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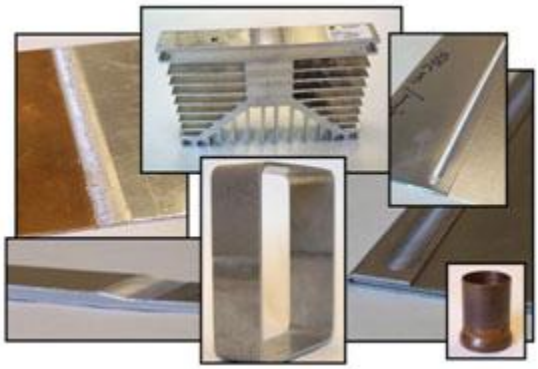
Introduction



Friction stir welding (FSW) is a relatively new joining process that has been used for high production since 1996. Because melting does not occur and joining takes place below the melting temperature of the material, a high-quality weld is created. This characteristic greatly reduces the ill effects of high heat input, including distortion, and eliminates solidification defects. Friction stir welding also is highly efficient, produces no fumes, and uses no filler material, which make this process environmentally friendly.

History

Friction stir welding was invented by The Welding Institute (TWI) in December 1991. TWI filed successfully for patents in Europe, the U.S., Japan, and Australia. TWI then established TWI Group-Sponsored Project 5651,"Development of the New Friction Stir Technique for Welding Aluminum," in 1992 to further study this technique.

The development project was conducted in three phases. Phase I proved FSW to be a realistic and practical welding technique, while at the same time addressing the welding of 6000 series aluminum alloys. Phase II successfully examined the welding of aerospace and ship aluminum alloys, 2000 and 5000 series, respectively. Process parameter tolerances, metallurgical characteristics, and mechanical properties for these materials were established. Phase III developed pertinent data for further industrialization of FSW.

Since its invention, the process has received world-wide attention, and today FSW is used in research and production in many sectors, including aerospace, automotive, railway, shipbuilding, electronic housings, coolers, heat exchangers, and nuclear waste containers.

FSW has been proven to be an effective process for welding aluminum, brass, copper, and other low-melting-temperature materials. The latest phase in FSW research has been aimed at expanding the usefulness of this procedure in high-melting-temperature materials, such as carbon and stainless steels and nickel-based alloys, by developing tools that can withstand the high temperatures and pressures needed to effectively join these materials.

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How Does FSW Work?

In FSW, a cylindrical, shouldered tool with a profiled probe is rotated and slowly plunged into the weld joint between two pieces of sheet or plate material that are to be welded together (**Figure 1**). The parts must be clamped onto a backing bar in a manner that prevents the abutting joint faces from being forced apart or in any other way moved out of position.

Frictional heat is generated between the wear-resistant welding tool and the material of the workpieces. This heat causes the workpieces to soften without reaching the melting point and allows the tool to traverse along the weld line. The resultant plasticized material is transferred from the leading edge of the tool to the trailing edge of the tool probe and is forged together by the intimate contact of the tool shoulder and the pin profile. This leaves a solid-phase bond between the two pieces.

The process can be regarded as a solid-phase keyhole welding technique since a hole to accommodate the probe is generated, then moved along the weld during the welding sequence.

The process originally was limited to low-melting-temperature materials because initial tool materials could not hold up to the stress of"stirring" higher-temperature materials such as steels and other high-strength materials. This problem was solved recently with the introduction of new tool material technologies such as polycrystalline cubic boron nitride (PCBN), tungsten rhenium, and ceramics. The use of a liquid-cooled toolholder and telemetry system has further refined the process and capability. Tool materials required for FSW of high-melting-temperature materials need high"hot" hardness for abrasion resistance, along with chemical stability and adequate toughness at high temperature. Material developments are advancing rapidly in different tool materials, each material offering specific advantages for different applications.

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Weld Quality

FSW produces excellent weld quality with these features:

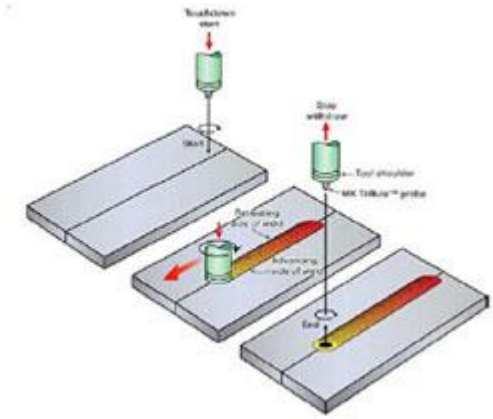

Figure 1

- **Low distortion.** In butt welding aluminum, for example, from 2.8 mm and thicker, the plate distortion in a properly built FSW machine is more or less zero. Tests on 12-m lengths have been carried out (**Figure 2**) in which sideway bends smaller than 0.25 mm (0.01inch) were achieved, and no twist was seen with material thicker than 2.8 mm. In thinner materials, a slight upward bend occurred, but no twist or side bends were seen.

- **Low shrinkage.** FSW produces the same predictable amount of shrinkage each time, normally found lower than 2 mm on 6-m-wide aluminum panel application.

- **No porosity.** Because the base material does not melt, there is no porosity.

- **No lack of fusion**. Because this is an extruding and forging joining method with a more accurate control of the heat, no lack of fusion is seen.

- **No change in material.**When joining aluminum, material properties change little from the parent material as the maximum temperature during the joining process is approximately 450 degrees C, and no filler material or anything other than heat is added to the joint (**Figure 3**). Due to the resultant finer grain structure in the weld nugget, the weld sometimes is stronger than the base material. In steels, most of these same advantages apply.

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Application:

- FSW is mostly used in aircraft industries for welding wings, fuel tanks, aircraft structure etc.
- Used in marine industries for structure work.
- Used in automotive industries to weld wheel rims, chassis, fuel tanks and other structure work.
- It is used in chemical industries for joining pipelines, heat exchanger, air conditioner etc.
- Friction stir welding is also used in electronic industries for joining bus bar, aluminum to copper, connectors and other electronic equipment's.
- It is widely used in fabrication industries.
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Advantages of FSW

For joining nonferrous materials, no filler material or shielding gases are required in this process, making FSW an economical joining method. For joining nonferrous materials, the tool is not consumed and is regarded as a spare part. For example, one tool typically can be used for more than 2,000 m of welding in 6000 series aluminum alloys.

This method also requires minimum surface preparation (normally only degreasing is needed), and uses only 20 percent heat input compared to traditional gas metal arc welding (GMAW or MIG) processes.

In both high and low melting temperature alloys, no fumes or toxic gases are produced that could threaten the health of the operator, and operators and other personnel are not exposed to radiation from any arc flash.

The resulting surface is ready to use, as no spatter has been produced. The root side is a perfect copy of the backing, and the top side has a smooth, scalloped appearance caused by the shoulder of the tool.

Another advantage to FSW is that dissimilar materials and alloys can be joined together (**Figure 4**). This has been demonstrated in combining copper with aluminum, aluminum with magnesium, and in the cladding of aluminum to steel.

Today most aluminum alloys have been welded with excellent results. Success has also been seen in welding copper, magnesium, zinc, steels, and titanium. Research continues to produce the data that is needed to facilitate the use of FSW in production for these and other nonweldable materials.

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Figure 2

Disadvantages

However, some disadvantages of the process have been identified:

- Exit hole left when tool is withdrawn.
- Large down forces required with heavy-duty clamping necessary to hold the plates together.
- Less flexible than manual and arc processes (difficulties with thickness variations and non-linear welds).
- Often slower traverse rate than some fusion welding techniques, although this may be offset if fewer welding passes are required.

Conclusion

- FSW opening up new areas of welding daily
- No distortion,spatter,fumes
- Welding at below m.p of work piece
- Good forging action by tool
- Create high strength weld in hard materials
- It is alternative to fusion welding

References

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