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Guidelines to Avoid Formation of Defects in Friction Stir Welding of Aluminum Alloy

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Abstract—*Friction Stir Welding (FSW) is a solid state welding well suitable to Aluminum alloys and has various applications. The performance of the friction stir welded joint is dependent on certain basic characteristics of the welding process. Any slight deviation of these characteristics range may result in defects in FSW joints. Some defects present on surface of the FSW joint may be detected simply with naked eyes, however some defects present beneath the surface cannot be detected with naked eyes. For detection of such defects we need to either cut the joint and inspect the cross section or use some expensive testing techniques. In present study probable causes and preventative measures have been described to avoid the defects.*

Introduction

FSW is a solid state welding emerged in early 90s [1]. In FSW the base plates to be joined are held together by suitable means and a rotating tool with a probe of requisite profile and dimension is plunged into the faying surfaces of the base plate until the shoulder touches the plates. The rotating tool is then moved along the joint line which in turn increases the temperature and plasticize the material of the joint. The plasticized material is moved front of the pin to trailing side of the pin and forged into the joint. For a defect free FSW joint the following parameters play an important role: Rotational speed of the tool, transverse speed of the tool, tool design, tool material, tool offset, tool tilt angle, axial pressure and tool plunge depth etc. Different types of flaws may incur in FSW joints due to various factors and these defects are slightly different from that of other welding processes. Some of the defects are voids, joint line Remnant and incomplete root penetration, groove and tunnel defects etc. Apart from this, some crucial factors have been described in the study.

Void

The voids are small vacant present in the stir zone generally on advancing side which may be cause of high tool travel speed at inadequate axial pressure [2]. High down force permits high tool travel speed to make defect free FSW joints [3]. Higher transverse speed requires higher rigidity of the friction stir welding machine. For different Friction Stir machines the range of tool transverse travel speed may have certain constraints depending upon the power of the motor of the machine, thickness of material and the material being welded. The rigidity of machine should be high enough to withstand the forces on the machine. Further the transverse movement of the tool should be along the joint line in a straight line. In case of tool is offset with respect to the joint line (in case of dissimilar alloys) the tool should not move inclined to its intended straight line path. In case of tool path is along a curve the tool movement should not be diverted from intended curved path.

Lazy S or kissing bond defect

Lazy S defect or kissing bond defect or joint line remnant is the defect that may present in FSW joints due to presence of oxide layer in stir zone[4]. The oxide layer may be present due to poor cleaning of the faying surfaces. Proper cleaning of the faying surfaces with appropriate cleaning chemical prior to FSW is recommended for checking the occurrence of this defect.

Tunnel defect

Tunnel defect is the continuous vacant space present along the length of the weld joint beneath the surface of the base plate. The cause of the tunnel defect may be due to shorter pin length which causes insufficient heat to consolidate the joint. The pin length is generally kept 0.3 mm less than the thickness of the plate [5], [6]. Tunnel defect may be detected by carefully examining the exit hole of the friction stir welded plates as illustrated in Figure 1. The plunge depth is an important parameter for omission of tunnel defect. Appropriate plunge depth along with correct pin length ensures defect free joint. The plates being friction stir welded should not bear bend. The faying surfaces of even small bend plates do not align properly when they are clamped suitably for friction stir welding. One should avoid using shear machine to size the plates to avoid bending. The anvil of friction stir welding machine should be aligned to complete accuracy so that the tool transverse movement does not cause variation in the axial pressure, as insufficient axial pressure may cause defects in FSW joints.

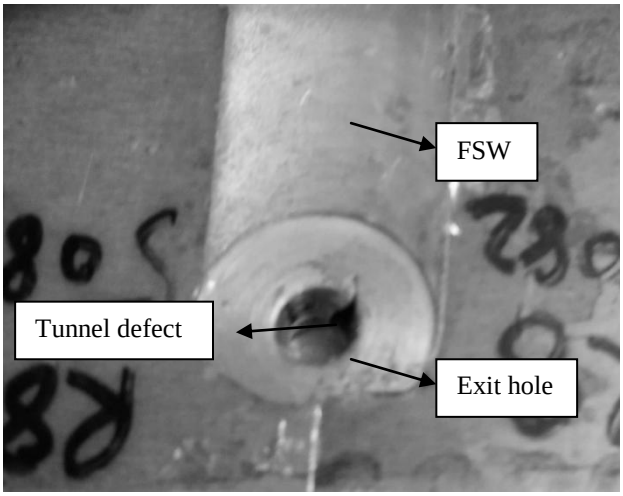

Figure 1: Tunnel defect detection from exit hole

Incomplete root penetration

This defect is a discontinuity due to insufficient length of tool pin i.e. tool pin is unable to consolidate the joint due to inappropriate distance between pin end and support of the base plate[4]. Plunge depth is an important factor in omission of this defect as it determines the final distance between anvil support and pin end. The more is the plunge depth the more will be the axial force. The axial force should be focused than the plunge depth, as it manifests better results. However, pin should be short enough to not touch the support anvil.

Conclusion

Friction stir welding should be preferred at sufficiently high rotation speed, axial force and correspondingly transverse speed to check the appearance of voids. Rigidity of machine is important while deciding the range of the welding speed and axial pressure. Bending of plates may be avoided before and after clamping of the base plates to be friction stir welding to avoid occurrence of defects. The transverse movement of the tool should be along the joint line in a straight line. In case of tool is offset with respect to the joint line the tool should not move inclined to its intended straight line path. For a intended friction stir tool curved path, diversion in it should be accurately avoided to check appearance of the defects. Tunnel defects may be detected by visually inspecting the exit hole in friction stir welding.

References

[1] W.M. Thomas, E.D. Nicholas, J.C. Needham, M.G. Murch, P. Templesmith, C.J. Dawes, G.B. Patent Application No. 9125978.8 (December 1991).

[2] P. City, "FLAWS IN FRICTION STIR WELDS A J Leonard and S A Lockyer TWI Ltd, Granta Park, Great Abington, Cambridge, CB1 6AL, UK," no. May, pp. 14–16, 2003.

[3] Esab, "Friction Stir Welding - the ESAB Way," *Weld. J.*

[4] R. S. Mishra and M. W. Mahoney, "Friction Stir Welding and Processing," p. 368, 2007.

[5] A. K. LAKSHMINARAYANAN, S. MALARVIZHI, and V. BALASUBRAMANIAN, "Developing friction stir welding window for AA2219 aluminium alloy," *Trans. Nonferrous Met. Soc. China*, vol. 21, no. 11, pp. 2339–2347, 2011.

[6] A. K. Lakshminarayanan and V. Balasubramanian, "An assessment of microstructure , hardness , tensile and impact strength of friction stir welded ferritic stainless steel joints," *Mater. Des.*, vol. 31, no. 10, pp. 4592–4600, 2010.