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EXPERIMENTAL STUDY OF TENSILE SHEAR TEST IN FRICTION STIR SPOT WELDING

ISPITIVANJE POPREČNIM ZATEZANJEM SPOJEVA TAČKASTO ZAVARENIH TRENJEM SA MEŠANJEM

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Keywords
- friction stir spot welding (FSSW)
- rotational tool speed
- spacing of spot welds
- overlap length

Abstract

In friction stir spot welding, individual spot welds are created by pressing a rotating tool with high force onto the top surface of two sheets that overlap each other in the lap joint. The frictional heat and high pressure develop yielding in the workpiece material, so that the tip of the pin plunges into the joint area between the two sheets and stirs-up the oxides. The pin of the tool is plunged into the sheets until the shoulder is in contact with the surface of the top sheet. The shoulder applies a high forging pressure which bonds the components metallurgically without melting. After a short dwell time, the tool is pulled out of the workpieces again so that a spot weld can be made about every 5 seconds. In this paper the tensile tests are studied, and the results obtained show that the rotational speed of the tool and the distance between two spot welds influences the friction stir spot welding process.

Ključne reči
- tačkasto zavarivanje trenjem sa mešanjem (FSSW)
- broj obrtaja alata
- korak tačkastih šavova
- dužina preklopa

Izvod

U postupku tačkastog zavarivanja trenjem sa mešanjem, pojedinačni tačkasti šavovi formiraju se pritiskivanjem rotirajućeg alata velikom silom na gornju površinu dva lima u preklopnom spoju. Toplota usled trenja i veliki pritisak izazivaju tečenje u radnom materijalu, tako da vrh alata (trn) prodire u oblast spoja, između dva lima uz mešanje oksidnog sloja. Trn alata prodire u materijal sve dok se ne ostvari dodir ramena sa površinom gornjeg lima. Preko ramena se prenosi veliki pritisak kovanjem čime se metalurški ostvaruje veza komponenata bez topljenja. Posle kratkog zastoja na kraju zavarivanja, alat se povlači sa komada i tako se ponavlja formiranje tačkastog spoja na skoro svakih 5 sekundi. U radu je obavljeno ispitivanje zatezanjem, a dobijeni rezultati pokazuju da broj obrtaja alata kao i rastojanje između susednih šavova zajedno utiču na postupak tačkastog zavarivanja trenjem sa mešanjem.

INTRODUCTION

Friction spot Stir Welding (FSW) is a revolutionary solid state welding technique invented at The Welding Institute (TWI) in 1991, /1/. The FSW process operates below the solidus temperature of the metals being joined and hence no melting takes place during the process. This process is a derivative of the conventional friction welding and is being used to produce continuous welded seams for plate fabrication /2/. Since its invention in 1991, continuous attempts have been made by researchers to understand, use and improve this process. Friction stir welding is a hot-shear joining process in which a non-consumable, rotating tool plunges into a rigidly clamped workpiece and moves along the joint to be welded, /3/.

Friction Spot Stir Welding (FSSW) is much more like the FSW process and applied to aluminium and its alloys in automobile manufacturing, /4-5/. This process allows welding superimposed plates. In contrast to the linear welding, the pin does not move longitudinally, as shown in Fig. 1, /6/. The tool in rotation, penetrates completely the upper sheet and partially the lower sheet (phases A and B). The pin allows mixing at the interface of the sheets providing the metallic bond (phase B). In the end of the cycle, the tool is retracted leaving a welded crown around its footprint (phase C).

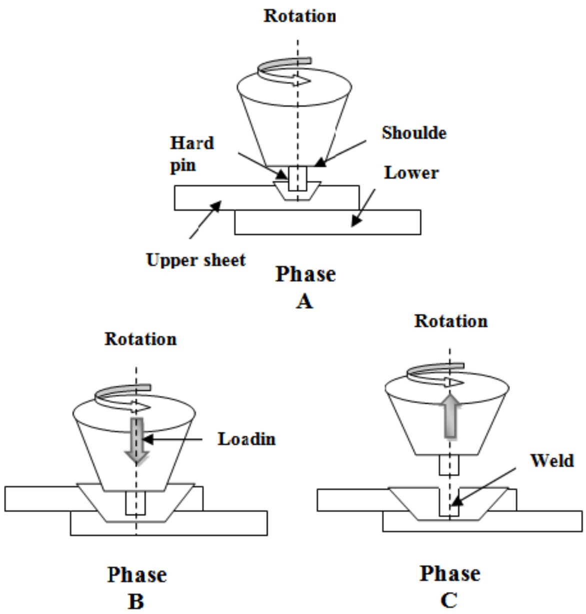

Figure 1. Principle of the friction spot stir welding process.

EXPERIMENTAL METHOD AND PROCEDURE

In this work, the commercial 3003 aluminium alloy is used, and sheet material is cut into 140 × 40 mm strips (Fig. 2). The specimens are joined as a lap joint (Fig. 3). The chemical compositions are given in Table 1.

Figure 2. Sheets of aluminium alloy 3003.

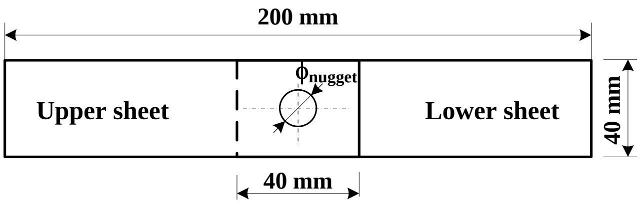

Figure 3. Dimensions of friction stir spot weld specimen.

Table 1. Chemical composition of aluminium alloy 3003 (wt. %).

Al	Fe	Zn	Cu	Mn	Pb
18.31	0.547	0.108	0.152	0.878	0.006

Welding tool

The friction stir spot welding is carried out using a mixing tool of high-alloy steel X210Cr12. Figure 4 shows a specimen during the welding process.

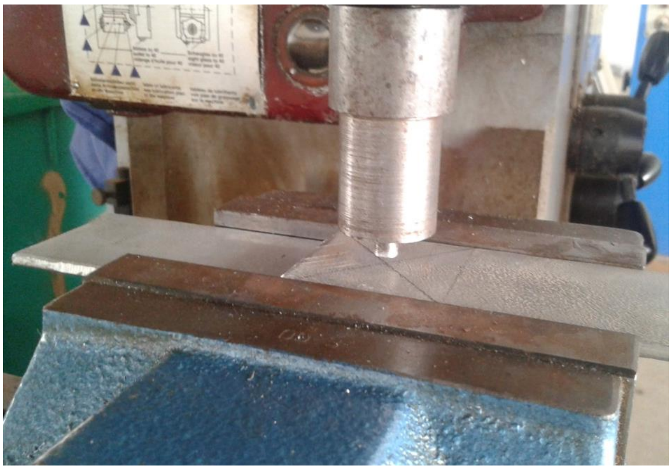

Figure 4. Specimens during the stir spot welding process.

Friction stir spot welding process

In this experimental tensile shear test study, the influence of the tool rotational speed, the distance between tow spot welding, and the overlap length are realized (Figs. 5, 6 and 7).

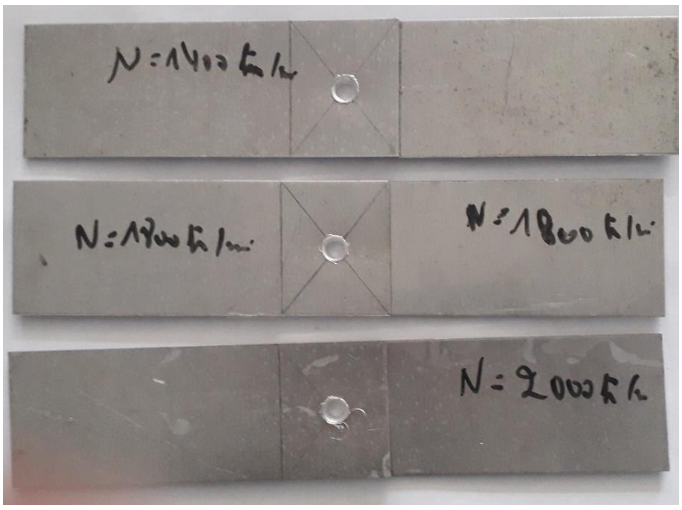

Figure 5. Influence of tool rotational speed.

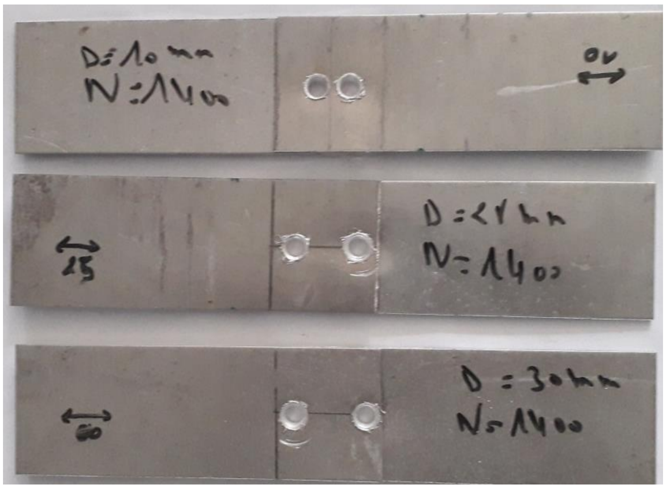

Figure 6. Specimens with different spacing between tow spot welds.

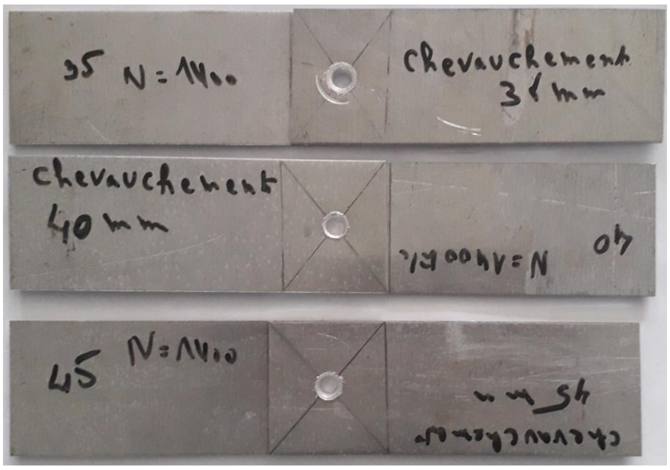

Figure 7. Specimens with different overlaps.

RESULTS AND DISCUSSION

In order to determine the influence of tool rotational speed, the distance between tow spot welds, and the overlap length in the friction stir spot welding process, Figs. 8, 9 and 10 indicate load-displacement curves obtained after the tensile shear test.

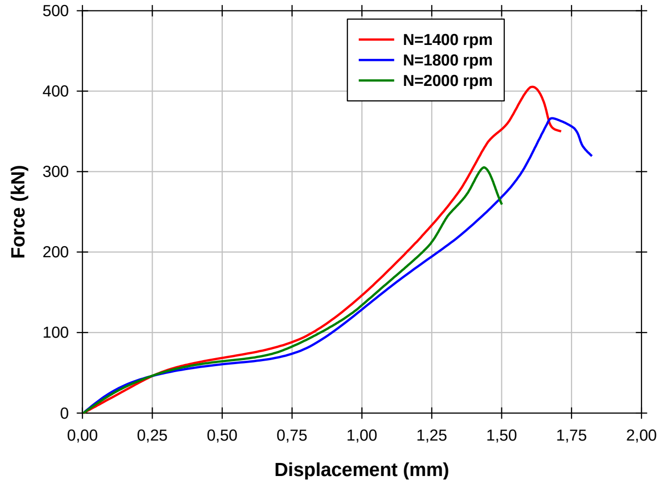

Figure 8. Force-displacement curves for different tool rotation speeds.

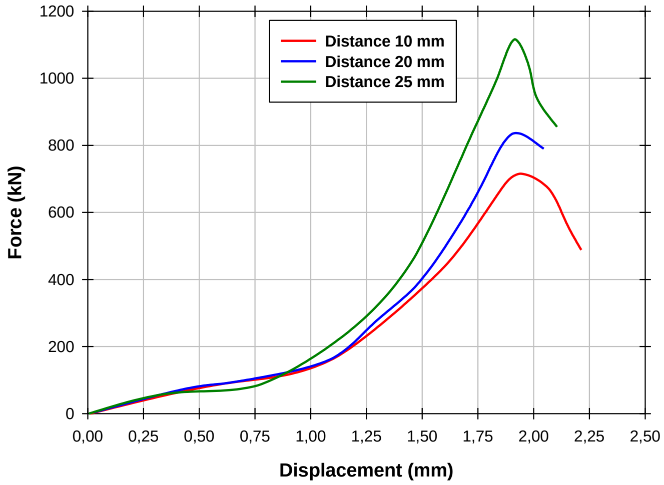

Figure 9. Force-displacement curves for distances between tow spot welds.

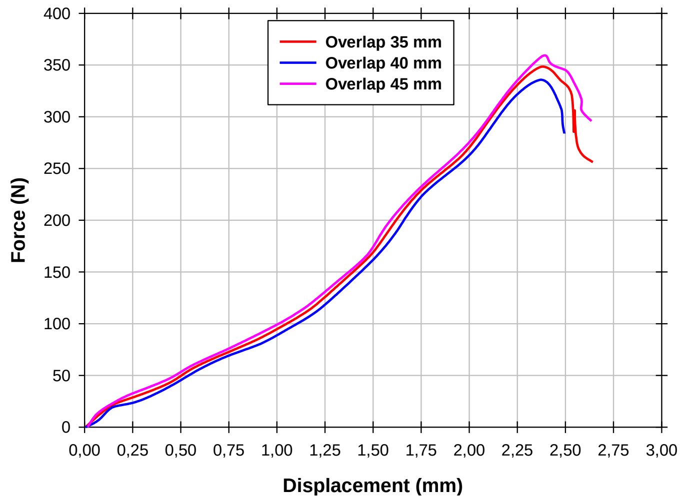

Figure 10. Force-displacement curves for different overlap lengths.

CONCLUSION

Friction spot stir welding is realized by frictional heat. This welding technique is ideal for aluminium. It provides high quality connection with minimal residual stress and distortion. An experimental study of the tensile test in friction spot welding process is conducted to show the influence of the tool rotational speed, the spacing between tow spot welds and the overlap length. From the results obtained, the augmentation of rotational speed can decrease the resistance of the spot weld, on the other hand, an increase in the spacing between tow spot welds can rise it, finally it is clear that the overlap length does not have a big effect on the friction stir spot welding process.

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