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THE INFLUENCE OF ELECTRODES' POSITIONS IN RESISTANCE SPOT WELDING PROCESS

UTICAJ POLOŽAJA ELEKTRODA KOD POSTUPKA ELEKTROOTPORNOG TAČKASTOG ZAVARIVANJA

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Keywords
- resistance spot welding
- electrode positions
- tensile shear tests
- peak load
- AISI 304

Abstract

Resistance spot welding (RSW) is a welding method using the principle of resistance welding with non-fusible electrode where, apart to the rise in temperature for obtaining the melting point of the metal, high mechanical pressure is also added. Two non-fusible copper electrodes compress metallic sheets to be welded and then pass a very high current through these sheets. In the presented experimental work, we are interested to see the influence of electrodes' positions in the resistance spot welding process. The tensile shear tests are studied with different positions of electrodes. This aims to show the best positions of the electrodes in the resistance spot welding process.

Ključne reči
- elektrooptorno tačkasto zavarivanje
- položaji elektroda
- ispitivanje zatezanjem i smicanjem
- opterećenje
- AISI 304

Izvod

Elektrooptorno tačkasto zavarivanje (Resistance spot welding - RWS) je postupak zavarivanja zasnovan na principu elektrootpornog zavarivanja primenom netopljivih elektroda, gde se one zagrevaju do temperature topljenja metala i istovremeno ostvaruju pritisak. Dve netopljive bakarne elektrode sabijaju metalne limove koji se zavaruju, a zatim se kroz njih propušta jaka struja. Cilj rada je da se ispita uticaj položaja elektroda u ovom postupku zavarivanja. Ispitivanja zatezanjem i smicanjem su izvedena pri različitim položajima elektroda, nakon čega je utvrđen najbolji položaj elektroda u procesu elektrootpornog tačkastog zavarivanja.

INTRODUCTION

Resistance spot welding is one of newer technologies, and it is widely used in the automotive industry. This is a welding process without a filler metal whose point (core) is obtained by melted metal (Joule effect), located between the sheets to be assembled. Resistance spot welding is generally applied to weld two thin sheets (0.1 to 3 mm) assembled by a weld point (or nugget). The sheets placed in contact are subjected to a pressure force by means of two electrodes and crossed by an alternating current of high intensity at a low voltage. In the industries, resistance spot welding is considered to be the most commonly used welding method and particularly on structural assemblies of automobiles and appliances containing thousands of weld points, /1/. The resistance spot welding 'RSW' technique is the most widely used technique in the automotive industry for joining thin-sheet assemblies. Indeed this technique guarantees a compromise between a solid structural result of the body work while using light materials, allowing both saving of energy and natural resources, /2/.

Reducing carbon consumption and gas emissions is a challenge for the automotive industry today. The objective can be achieved by reducing the weight of vehicles by deploying the realization of seals on high strength steels which have characteristics of high strength, good corrosion resistance, and good press behaviour, /3/. To be used in the automotive industry, steel must combine good mechanical characteristics and improved formability, but recently good weldability has become a necessary point to meet economic requirements in terms of the environment and safety. /4/. The shape and size of the nugget plays a key role in defining the quality and strength of welds. One can refer to a nugget diameter or its size to express the weld quality /5/. Researchers have investigated the optimisation of RSW welding parameters namely the welding current and time of AISI 316L grade austenitic stainless steel sheet, and also the effect of optimal welding parameters on the properties of RSW, /6/. In another study of spot welding austenitic stainless steel type 304, the relationship of nugget diameter and welding current was investigated, /7/, and another study

on 304 stainless steel spot welding investigates the effect of electrode force on resistance spot welding process which is a primary factor during the process, /8/.

In this work, the tensile shear tests are studied with different positions of electrodes. This aims to show the best positions of electrodes in resistance spot welding process.

EXPERIMENTAL METHOD

Material definitions

As a study material for this work, we have selected a single AISI 304 stainless steel sheet of size 140 × 40 × 1.5 mm (Fig. 1). Initial microstructures of the base metal are shown in Fig. 2.

Figure 1. Dimensions of resistance spot-weld specimens.

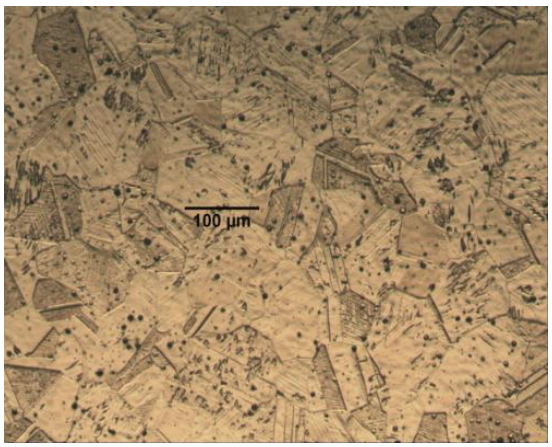


Figure 2. Initial microstructure of AISI 304.

Resistance spot welding process

In the experimental work, the spot welding machine THI 50 Digit type is used (Fig. 3). Figures 4 and 5 show the specimens during and after resistance spot welding process, in respect.

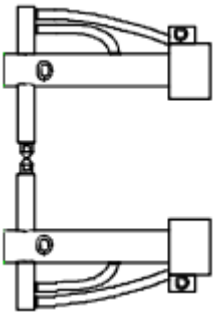
The study presents the influence of four electrode positions on the resistance spot welding as listed below (Fig. 6):

- two electrodes are placed vertically,
- the upper electrode is inclined 45°,
- the lower electrode is inclined 45°,
- the two electrodes are inclined 45°.

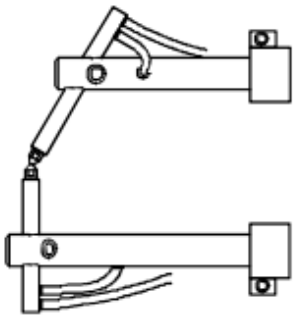
Figure 3. THI 50 Digit resistance spot welding machine.

Figure 4. Specimens during resistance spot welding process.

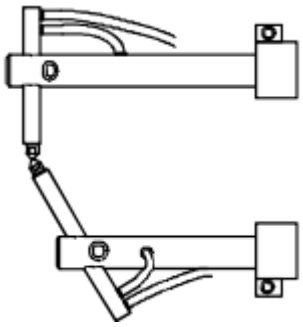
Figure 5. Specimens after resistance spot welding.



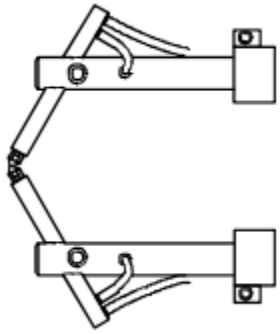
A) the two electrodes are placed vertically



B) the upper electrode is inclined by 45°



C) lower electrode is inclined by 45°



D) the two electrodes are inclined by 45°

Figure 6. Four possible positions of electrodes.

Tensile shear stress

In the tensile shear tests the Instron 8800 machine is used in order to determine the peak load of the welded joints. Figures 7 and 8 show respectively the specimen during and after the tensile shear test.

Figure 7. Specimen during the tensile shear test.

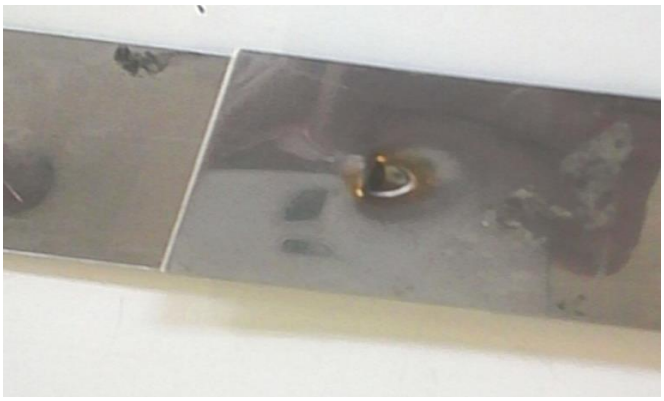


Figure 8. Failure mode in tensile test of the AISI 304 resistance spot weld.

RESULTS AND DISCUSSION

In order to determine the influence of the electrodes' positions, three tests are made for each position. Figures 9-12 indicate the load-displacement (L-D) curve for the four possible cases of electrode positions. Table 1 resumes the peak load for the four positions.

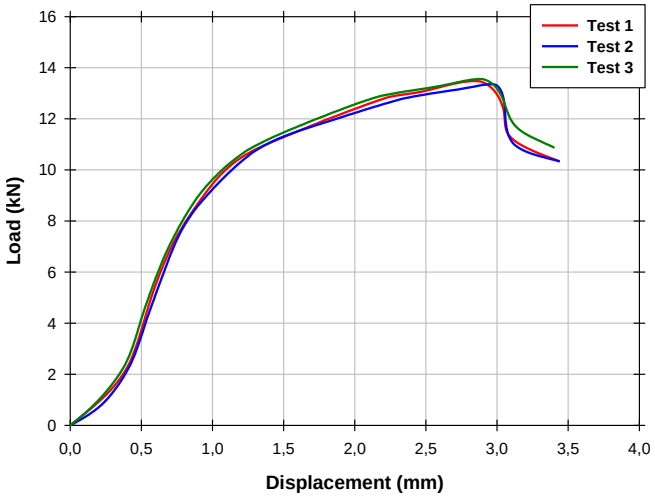


Figure 9. L-D curves when the two electrodes are placed vertically.

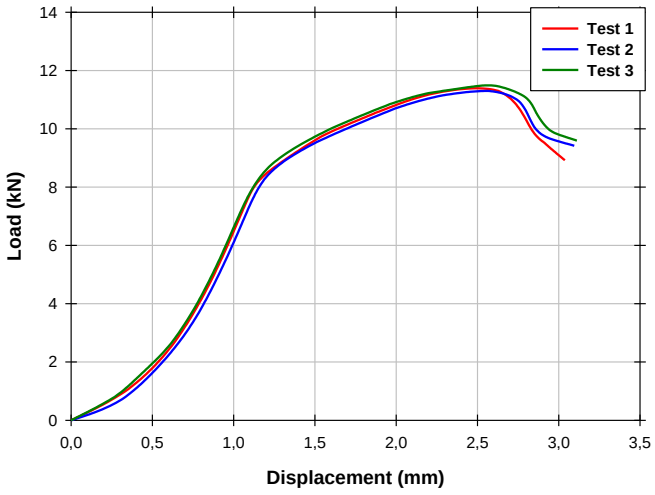


Figure 10. L-D curves when the upper electrode is inclined 45°.

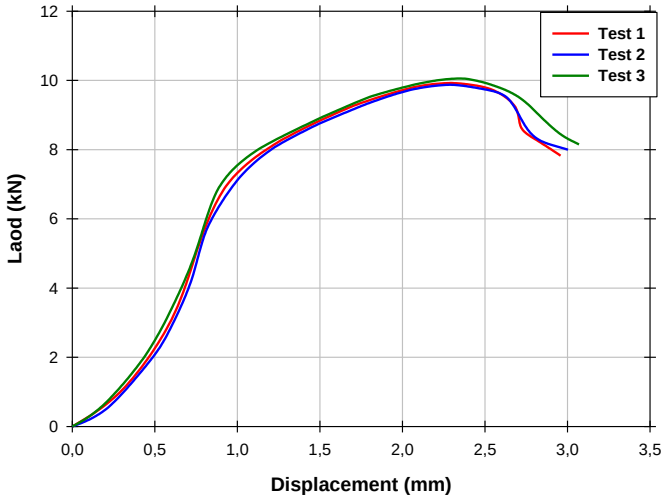


Figure 11. L-D curves when the lower electrode is inclined 45°.

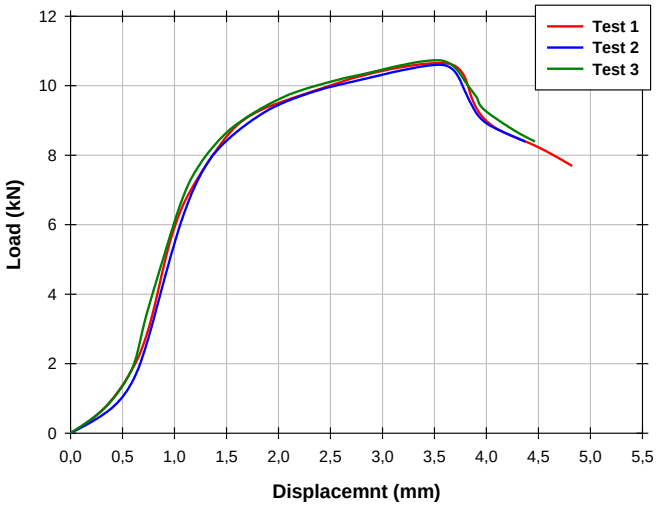


Figure 12. L-D curves when the two electrodes are inclined 45°.

Table 1. The peak load for every position.

Position	A	B	C	D
Peak load (kN)	13.39	11.40	10.00	10.62

CONCLUSION

Resistance spot welding is a widely used joining process for fabricating sheet metal assemblies in the automobile industry. In comparison to other welding processes, RSW is fast and easy for automation. This work focuses on the influence of electrodes' positions in the resistance spot welding process. The tests carried out are the tensile shear tests. We have studied the four possible electrode positions. Results obtained from force-displacement curves, the best position of the electrodes in resistance spot welding process is achieved when the electrodes are placed vertically.

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