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STRENGHT AND MICROSTRUCTURE ANALYSIS OF SPOT WELDED JOINTS

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ABSTRACT

This study presents an investigation on the strength of spot welded joints between a plate made of DC01 steel and a non-standard nut made by cold forming of C22 steel. In order to determine the influence of the welding current on the quality of such welded joints, three types of test specimens were produced using different welding currents. The strength of the welded joints was studied and microstructural analysis was carries out as well as the hardness of the welded contacts was measured.

Keywords: spot welding, welded joints, welding parameters.

INTRODUCTION

Spot welding is a widely used process in many industries. This process can be easily automated as it does not require additional components. In the automotive industry, spot welding is used in the entire cycle from joining of body parts to welding of various fasteners. Nuts and bolts for spot welding are designed with embosses which melts during welding in such way producing a welded joint.

Burca and Lucaciu (Burca, 2013) investigated joints between M8 nuts and thin (up to 3 mm) sheets by the projection welding method of electric welding by pressure derived from spot welding by pressure to which the joint is made by flanges. Marashi et al. studied dissimilar resistance spot welds between low carbon galvanized and austenitic stainless steels (Marashi, 2008). They studied the relationship between failure mode and weld fusion zone characteristics and found that spot weld strength in the pullout failure mode is controlled by the strength and fusion zone size of the galvanized steel side. The microstructure, fracture and fatigue behaviour of resistance spot-welded cold-rolled high strength austenitic stainless was analysed by Liu et al. (Liu, 2010). It was stated that the improper welding parameters easily caused folding interface in HAZ between welded-sheets. Sometimes determining the quality of a welded joint, the diameter of the welded point is evaluated as the investigated parameter. This parameter is strongly influenced by the welding current. That phenomenon was studied by M. Vural, A. Akkus, B. Eryürek (Vural, 2006).

As the welding parameters highly affect the welding quality, this paper investigates the influence of the welding current on the quality of spot welded joints of a nut and a thin sheet.

EXPERIMENTAL SET UP AND RESULTS

The strength test was carried out using a 25-ton tension-compression machine. Three types of specimens were manufactured, when the welding current *I* was altered, and the other parameters were unchanged. The specimens of the first type were welded with a welding current of 9.2kA, the specimens of the second type were welded with a current of 7.5kA, and The specimens of the first type were welded with a current of 9.7kA. After the strength test, a specimen is shown in Figure 1.

Fig. 1 - Specimen after tensile test

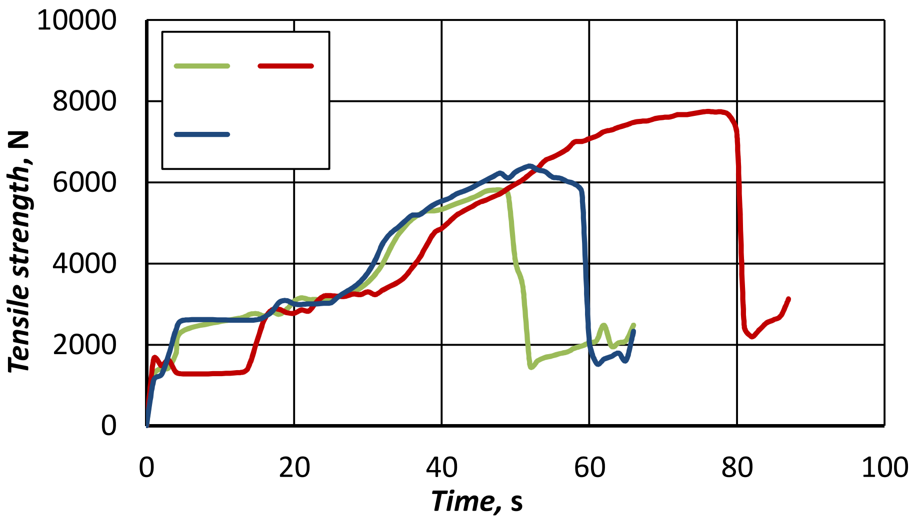

Fig. 2 - Tensile test results

The results after the tensile strength test are shown in Figure 2. It was found that the specimens that were welded with a current of 7.5 kA were able to withstand a longer time and broke down at 7749N. Meanwhile, the specimens that were welded with higher welding current broke down with a lower tensile force (when the welding current strength was 9.2kA at 5808N and the 9.7kA at 6402N).

A microstructural analysis was performed to compare the welded joints welded with different parameters and to determine the quality of the welded joint.

Three zones of microstructure can be distinguished by examining the sources. The first one is the base metal (BM), in this case it is the plate to which the non-standard nut was welded. The second zone is a welded nut (WN). The third zone is the molten metal (FZ) between the nut and plate, where the merging process takes place.

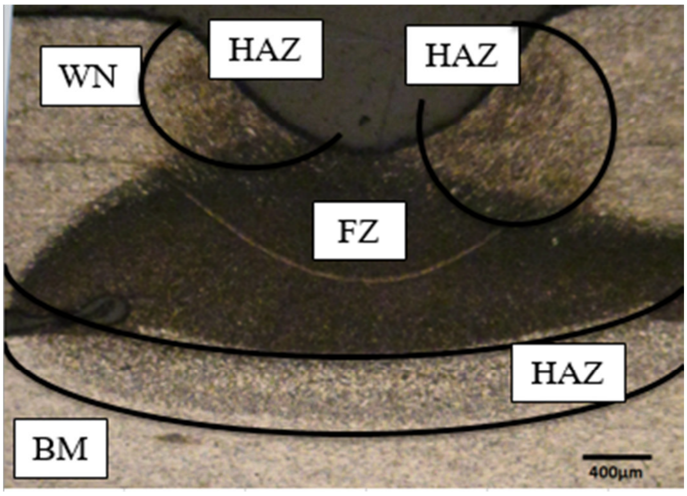

Fig. 3 - View of the microstructure of the first type of specimen

In the case of the first sample (Figure 3), when the welding current is 9.2 kA, it is seen that the asymmetry of the central FZ zone appears. Most often this symptom is due to the different thermal properties of metals, since the nut and test plates are made of different steel. Another cause of asymmetry can be the different geometry of the elements. In this case, we conclude that the nut material has a higher thermal conductivity than the parts.

When evaluating a second specimen with a welding current of 7.5 kA, we can distinguish the same zones as in the first sample. As shown in Figure 4, the FZ zone is asymmetric as in the first sample.

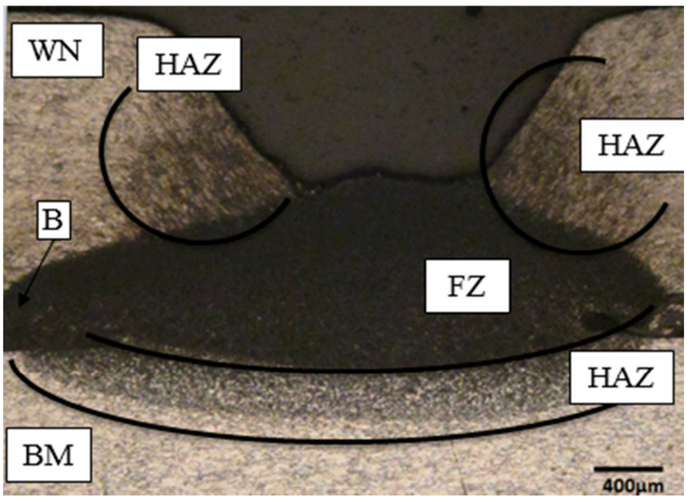

Fig. 4 - View of the microstructure of the second type of specimen

The HAZ area is larger on the nut side, but it is seen that in this specimen the HAZ area on the side of the part is smaller than in the first sample. Figure 4 shows welding defect - the hollow cavity. This zone is marked with letter B and shown in Figure 5.

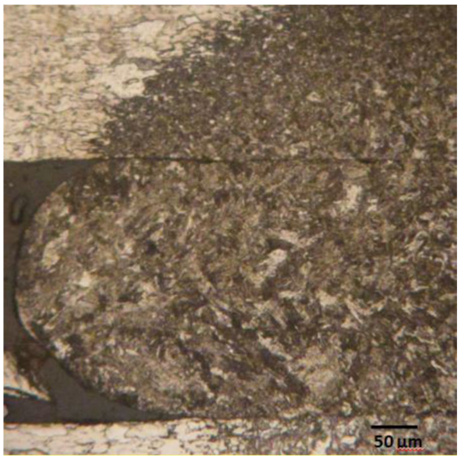

Fig. 5 - Zone B of the microstructure of the second type of specimen

In addition to the formation of separate metal structures that do not connect with the rest of the sample, it shows that there was an explosion in the metal in this area. The formation of this zone affects the strength of the welded joint. When the metal is thermally exposed, when structural changes occur, internal stresses are formed inside it, which may lead to the formation of micro-cracks after reaching a certain limit. Fig. 4 shows lines that are micro-cracks in the material.

CONCLUSIONS

Investigation of the strength of welded specimens was performed. It was found that the specimens that were welded with a current of 7.5 kA were able to withstand a longer time and broke down at 7749N.

Microstructure study of welded specimens was performed also. The microstructure of the specimens was analysed and the welding contact zones were determined. The welding contact zone was found to be asymmetric since materials have different thermal conductivity. This material parameter has a major influence on the asymmetry of the welded area. It has also been found that welding with higher welding current leads to more micro-cracks.

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