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Optimization on Spot Weld Parameters in Resistance Spot Welding Process on AISI 304

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Abstract

Spot welding process is an important component in many industrial operations. The spot welding parameters are the most important factors affecting the quality, productivity and cost of welding. This paper presents the influence of welding parameters like welding current, welding time on strength of different welding joint design. Automobile industries choose resistance spot welding (RSW) for manufacturing. This paper directed towards the optimization process parameter for resistance spot welding (RSW) and simultaneously the tensile tests and the spot weld diameter were studied. The objectives of this analysis is to understand the physics of the process and to show the influence of the electrical current, weld time and the type material in resistance spot welding process.

Keywords*: - Spot welding process, joint design, Automobile industries, productivity and cost of welding.*

INTRODUCTION

Spot welding is one of the most widely used processes in industry. It is type of resistance welding in which by use of resistance of workpiece for heat generation. Resistance welding is also known as pressure welding because pressure will apply during welding. This process is so different process then other because no flux or filler material is required for welding. Two or more Metals are joined by point to point in this process to its electrode tip shape. Workpieces are placed between then electrodes shown in

Fig 1 and high current is conveying between then the electrodes after applying pressure for short interval of time. In all the forms of resistance welding the parts are locally heated .The material between the electrodes is squeezed together and melts and destroying between the parts. After current is switched off "Nugget" of molten material develops after solidify and forming joints shown in Fig 2.

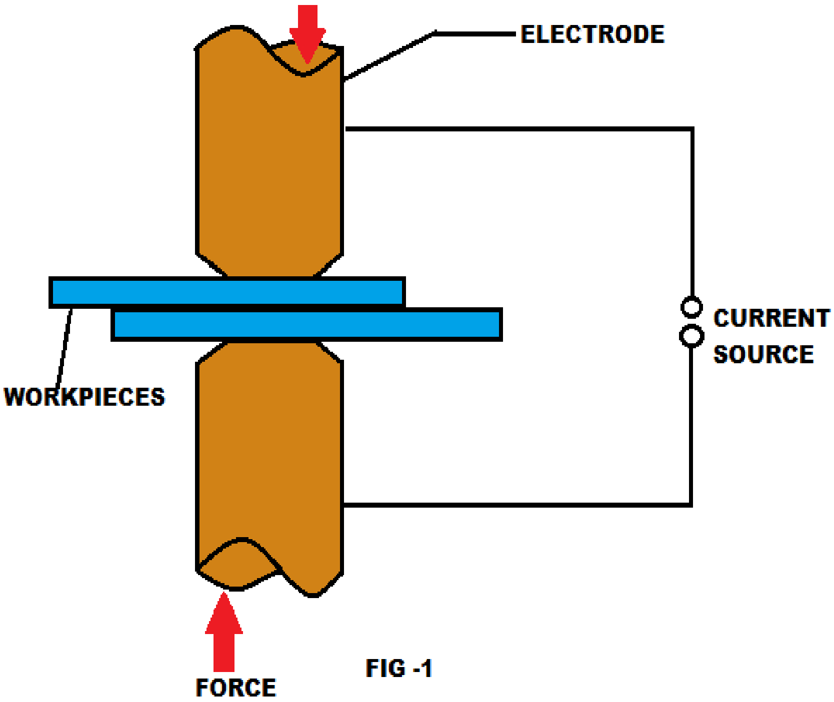

FIG -1

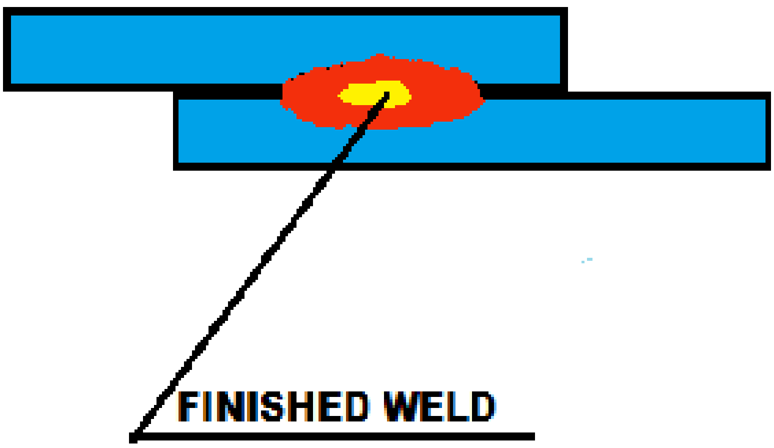

FIG-2

To create heat, copper electrode passes an electric current through the workpieces. The heat generated is depending upon the resistance of workpieces, thermal conductivity of the metal, and the time that current is applied. According to joule's law of heating we calculated how much heat will be generated.

E=I2*R*t

Where E is the heat energy, Iis the current, R is electrical resistance and t is the time that current is applied.

Copper is used for electrode because copper is reddish colored and takes bright metallic luster. It is malleable, ductile and a good conductor of electricity and heat, low resistance and high thermal conductivity compared to most metals. This ensures that the heat is generated in the workpiece instead of the electrode. Its melting point is 1356.6K, boiling point is 2840K.

LITERATURE REVIEW

V.J. Badhekaa et al., investigated mode of failure of resistance spot welded martenstic stainless steel .They concluded that faster cooling rate, higher carbon content, absence of post heating are responsible for cracking in the weld and subsequently interfacial failure.

Mehdi Mansouri Hasan Abadi et al.(2010) studied about the correlation between macro/micro structure and mechanical properties of dissimilar resistance spot welds of AISI 304 austenitic stainless steel and AISI 1008 low carbon steel.

Ladislav Kolarık et al. investigated the properties of dissimilar resistance spot welds between low carbon steel and austenitic CrNi stainless steel. They reported that the HAZ (Heat affected zone) of the low carbon steel sheet had been found broader than the HAZ of the austenitic stainless steel. The hardness was found to be higher in the fusion zone.

Nachimani Charde [28], analysed the effect of parametric changes for dissimilar joints using 304 austenitic stainless steel and carbon steel with two different thicknesses. He reported that hardness increments of welded side (from 55HRB to 100HRB and from 75HRB to 100HRB) do exist because of the heat treatment that happened during welding process.

Marius Chirileanu et al. [34], investigated the failure modes under tensile forces of the Resistance Spot Welding joints. The purpose of this work was to highlight the influences of joint materials and welding parameters on the tensile strength and on the failure mode of the joints.

EXPERIMENTAL METHODOLOGY AND MATERIALS

Resistance spot welding is a process of joining two or more metal parts by fusion at discrete spots at the interface of a workpiece. Resistance to current flow through the metal work pieces generates heat. Temperature rises at interface of the workpiece; when the melting point of the metal is reached, the metal will begin to fuse an Experimental Study of Spot Weld Parameters in Resistance Spot ... 181 a nugget begins to form. The current is then switched off and the nugget is cooled down slowly to solidify under pressure. In this work, commercial AISI 304 was used. The sheet materials were cut into 200 mm X 40 mm. The dimensions and the specimens were joined as lap joints for the three materials according to the configuration shown in figure 3; using spot welding machine type THI 50 Digit. The initial microstructures of the base metals are shown in Figures 4. Their chemical compositions are grouped in Table 1. Before starting the welding process, it is important to make sure that the setting on spot welding machine has two important dials: the first for the welding current and the second is for the welding duration. Another important step before starting the welding process is to run on the water supply for the electrodes; this is to cool the electrodes during the welding process.

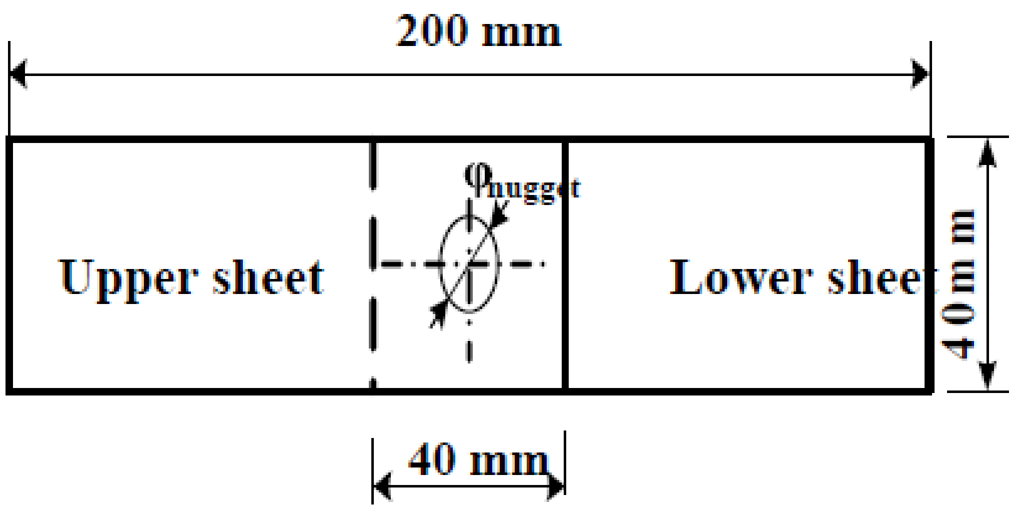

Figure 3 Dimensions of resistance spot-weld specimen (mm)

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Table.1 THE chemical composition of AISI 304

Chemical Composition	AISI 304
C	**0.07**
Mn	**1.75**
Si	**0.034**
Ni	**8.23**
Cr	**17.71**
P	**0.021**
S	**0.009**

Instron 5582 machine was used in the tensile tests. The Microstructure of different zone in resistance spot weld is shown in Figure 4. Figure 5 shows the failure mode in tensile test of AISI 304 resistance spot welding.

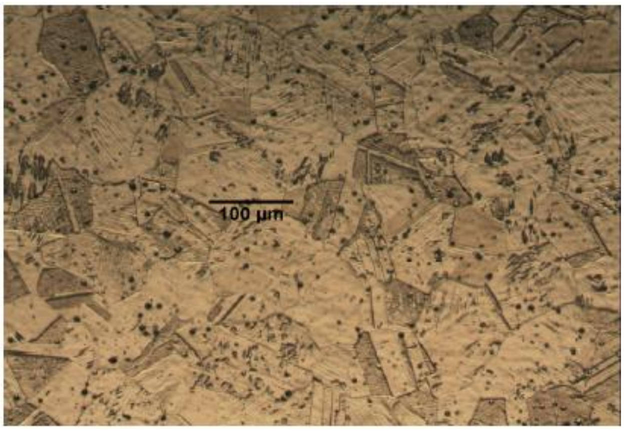

Figure 4 Initial microstructure of AISI 304

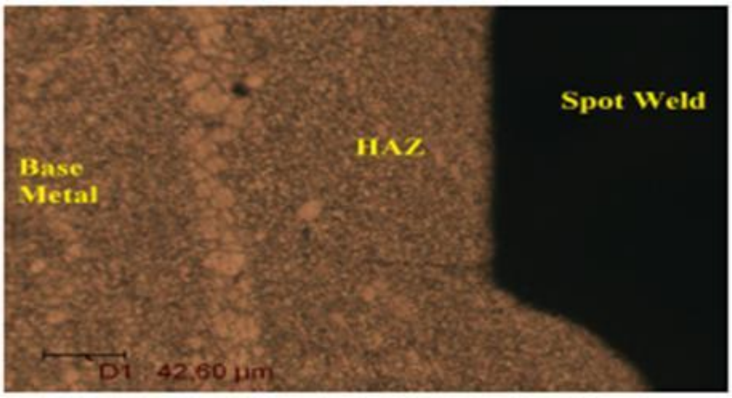

Figure 4 Microstructure of different zone in resistance spot welding

Figure 5 Failure modes in tensile test of AISI 304 resistance spot weld

RESULTS AND DISCUSSION

The Tensile Tests

In order to determine the influence of the thickness sheet on resistance of the pot weld, the Figure 6 indicates the influence of the sheet thickness on tensile test of welded joint using AISI 304 stainless steel, the graph shows clearly the difference of the peak load in the two thicknesses (e = 1.5 mm has the highest peak load). The tensile test of spot welded joints is shown in Figure 7 for different weld time. It can be seen that the weld time has an influence on resistance spot welding.

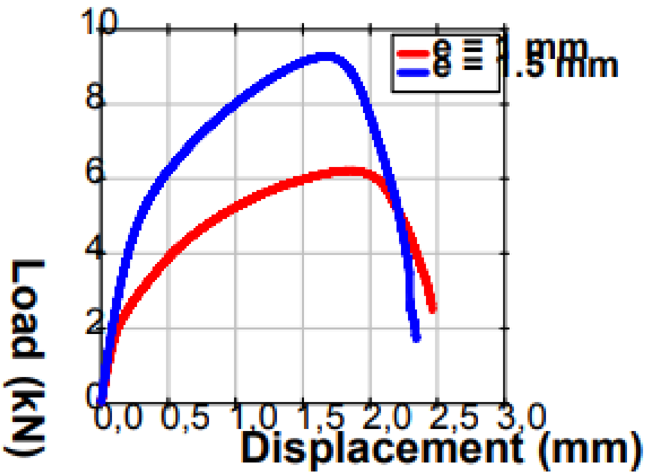

Figure 6 Influence of the sheet thickness on tensile test of welded joint: AISI 304, I = 6 kA, t = 0.6 s

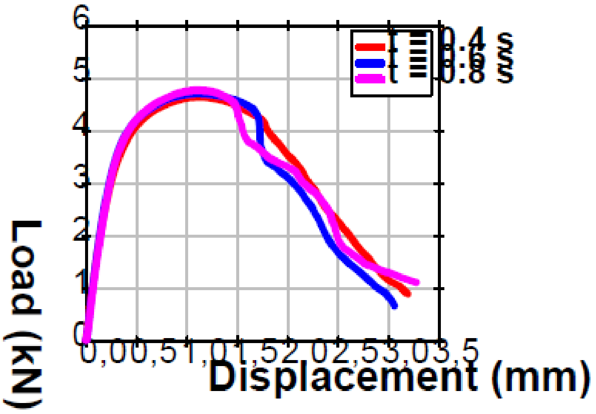

Figure 7 Influence of the weld time on tensile test of welded joint: AISI 403, I = 8 kA,

Table 2 Spot weld diameter with different electrical current

AISI 430			
Current intensity (kA)	6	6.5	7
Φ spot weld diameter (mm)	5.2	5.5	5.8

Spot weld diameter

To show the influence of the electrical current on spot weld diameter .we measured the spot weld diameter with different electrical current as it is indicated in Figure 9.

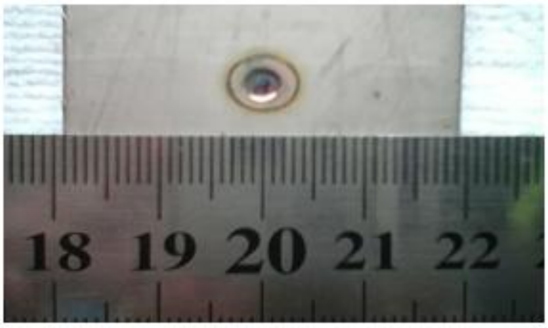

Figure 9 Measure of nugget diameter

Table 3 Spot weld diameter with different weld time, I = 6 kA

EXPERIMENT NO		WELD TIME	CURRENT	NUGGET SIZE
1	A	0.4	6kA	4.28
	B	0.60	6kA	5.2
	c	0.8	6kA	6

The Table 2 bellow explains that the electrical current has an effect on the spot weld formation. In the Table 3, the spot weld diameter was measured with different weld time using AISI 304 stainless steel. It is clear that the spot weld diameter increase with the welding time.

CONCLUSIONS

Resistance spot welding is widely used joining process for fabricating sheet metal assemblies in automobile industry. In comparison with other welding processes, RSW is fast and easy for automation. This process involves electrical, thermal and mechanical interactions.

In these experimental studies the tensile tests and the spot welding diameters were carried out to show the influence of thickness sheet, type material, and electrical current and welding time in resistance spot welding process. From the results obtained, these parameters have an influence in resistance spot welding process.

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