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

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ABSTRACT

The spot welding procedure is used in a variety of industrial applications. The most critical elements influencing welding quality, productivity, and cost are the spot welding parameters. This research examines the effect of welding factors such as welding current and welding time on the strength of various welding joint designs. Resistance spot welding (RSW) is used in the automotive industry for manufacturing. This research focused on the optimization of process parameters for resistance spot welding (RSW), as well as the tensile testing and spot weld diameter. The goals of this analysis are to comprehend the physics of the process and to demonstrate the effect of electrical current, weld time, and material type on the resistance spot welding process.

***Keywords*--** ASI 304, Spot Welding, Workpieces

I. INTODUCTION

Spot welding is one of the most used industrial operations. It is a sort of resistance welding in which heat is generated by using the resistance of the workpiece. Because pressure is applied throughout the welding process, resistance welding is also known as pressure welding. This procedure is distinct from others in that no flux or filler material is required for welding. In this procedure, two or more metals are bonded point to point to form the electrode tip shape. Workpieces are put between the electrodes depicted in Fig. 1, and high current is sent between them after applying pressure for a brief period of time. Parts are heated locally in all types of resistance welding. The material between the electrodes is forced together, melting and destroying the space between the sections. After the current is turned off, a "Nugget" of molten material forms after solidifying and establishing joints, as seen in Fig 2.

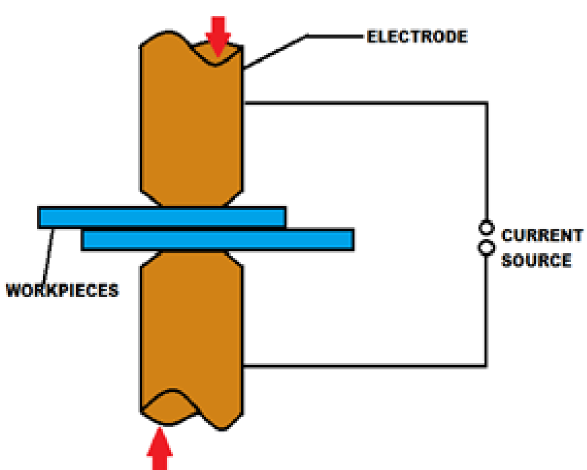

FIG -1

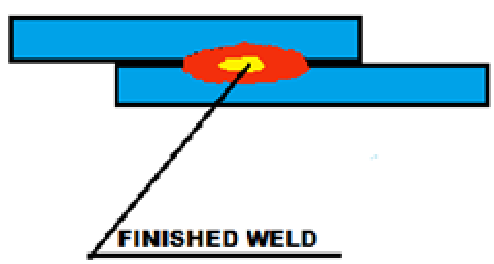

FIG-2

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Copper electrode conducts an electric current through the workpieces to generate heat. The amount of heat produced is determined by the resistance of the workpieces, the thermal conductivity of the metal, and the length of time that the current is applied. We computed how much heat will be generated using joule's equation of heating.

E=I2*R*t

Where E denotes heat energy, I denotes current, R denotes electrical resistance, and t is the duration that current is applied.

Copper is utilised as an electrode because it is reddish in colour and has a striking metallic shine. In comparison to most metals, it is malleable, ductile, and a good conductor of electricity and heat, with low resistance and high thermal conductivity. This guarantees that heat is produced in the workpiece rather than the electrode. It has a melting point of 1356.6K and a boiling point of 2840K.

II. LITERATURE REVIEW

V.J. Badhekaa et al. explored the mode of failure of martenstic stainless steel resistance spot welded. They concluded that faster cooling rates, increased carbon content, and the lack of post-heating are to blame for weld cracking and, as a result, interfacial failure.

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

The qualities of different resistance spot welds between low carbon steel and austenitic CrNi stainless steel were examined by LadislavKolark et al.

They discovered that the HAZ (Heat affected zone) of the low carbon steel sheet was larger than the HAZ of the austenitic stainless steel.

The fusing zone was found to have a higher toughness.

Nachimani Charde [28] investigated the impact of parametric modifications on dissimilar junctions made of 304 austenitic stainless steel and carbon steel of two different thicknesses. He reported that welded side hardness increments (from 55HRB to 100HRB and from 75HRB to 100HRB) exist as a result of the heat treatment that occurred during the welding process.

Marius Chirileanu et al. [34] evaluated the failure patterns of Resistance Spot Welding joints under tensile pressures. The goal of this study was to emphasise the effects of joint materials and welding settings on joint tensile strength and failure mechanism.

III. EXPERIMENTAL METHODOLOGY AND MATERIALS

Resistance spot welding is a method of attaching two or more metal pieces by fusion at distinct points at a workpiece's interface. Heat is generated by resistance to current passage via metal work components. Temperature builds at the workpiece interface; when the melting point of the metal is reached, the metal begins to fuse an Experimental Study of Spot Weld Parameters in Resistance. Spot... 181 a nugget is forming. The current is then turned off, and the nugget is progressively cooled to solidify under pressure. Commercial AISI 304 was used in this project. Sheet materials were cut into 200 mm x 40 mm pieces. The dimensions and specimens were joined as lap joints for the three materials using a spot welding machine type THI 50 Digit, as indicated in figure 3. Figures 4 and 5 illustrate the first microstructures of the base metals. Table 1 categorises their chemical makeup. Before beginning the welding process, ensure that the setting on the spot welding machine has two crucial dials: one for the welding current and the other for the welding duration. Another critical step before beginning the welding process is to turn on the water supply for the electrodes, which will keep the electrodes cool during the welding process.

Figure 3: Resistance spot-weld specimen dimensions (mm)

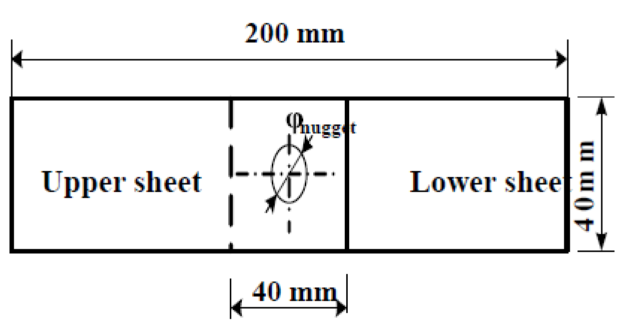

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Table 1: AISI 304'S Chemical Composition

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**

Tensile testing were performed on an Instron 5582 machine. Figure 4 depicts the microstructure of distinct zones in a resistance spot weld. Figure 5 depicts the failure mode in an AISI 304 resistance spot welding tensile test.

Figure 4: Initial microstructure of AISI 304

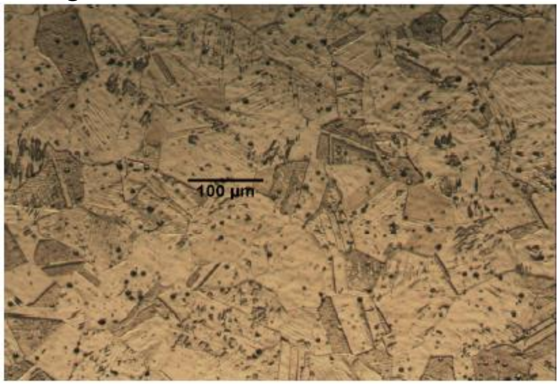


Figure 5: Different zone microstructures in resistance spot welding

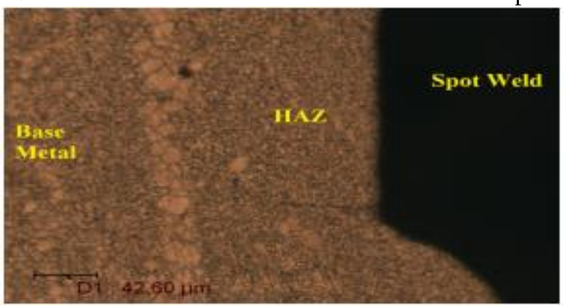
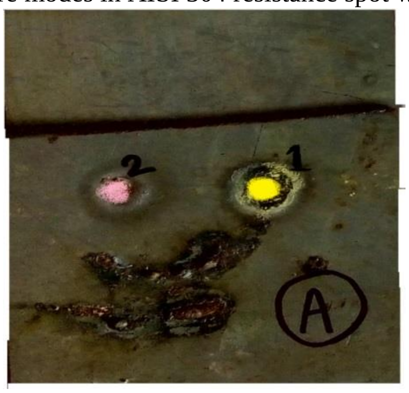


Figure 6: Failure modes in AISI 304 resistance spot weld tensile tests



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III. RESULTS AND DISCUSSION

The Tensile Tests

In order to determine the influence of sheet thickness on pot weld resistance, Figure 6 depicts the influence of sheet thickness on tensile test of welded joint using AISI 304 stainless steel, with the graph clearly showing the difference in peak load between the two thicknesses (e = 1.5 mm has the highest peak load). Figure 7 depicts the tensile test of spot welded connections at various weld times. It is clear that weld time has an effect on resistance spot welding.

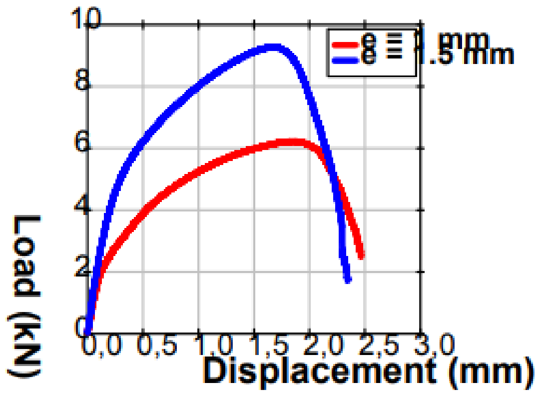

Figure 7: Influence of sheet thickness on welded joint tensile test: AISI 304, I = 6 kA, t = 0.6 s

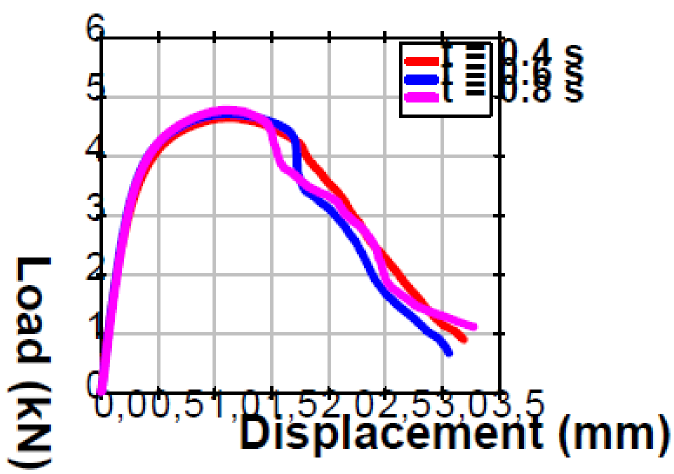

Figure 8: Weld time effect on tensile test of welded joint: AISI 403, I = 8 kA, e = 0.8 mm

Table 2: Spot weld diameter as a function of electrical current

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

3.2. Spot Weld Diameter

To demonstrate the effect of electrical current on spot weld diameter. We measured the spot weld diameter with various electrical currents, as shown in Figure 9.

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Figure 9: Measure of nugget diameter

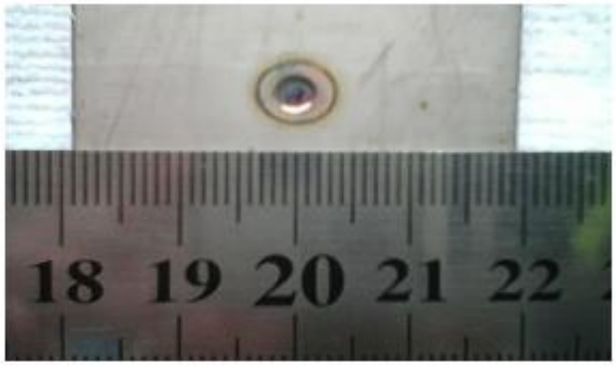

Table 3: Spot weld diameter varies with weld time, I = 6 kA

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 electrical current has an effect on the production of spot welds, as shown in Table 2. In Table 3, the spot weld diameter was measured using AISI 304 stainless steel at various weld times. It is obvious that the diameter of the spot weld increases with welding time.

IV. CONCLUSIONS

Resistance spot welding is a common joining method used in the automotive industry for manufacturing sheet metal assemblies. In comparison to other welding techniques, RSW is quick and simple to automate. This process is characterised by electrical, thermal, and mechanical interactions. Tensile tests and spot welding diameters were performed in these experimental studies to demonstrate the effect of thickness sheet, material type, electrical current, and welding time in the resistance spot welding process. According to the findings, these characteristics have an impact on the resistance spot welding procedure.

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