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Study related to hardness of spot weld joint

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Abstract

Due to flexibility, robustness and high speed of process combining with very high quality joints at very low cost, spot welding is widely utilized as a joining technique for the automobile structure. Due to extensive use of resistance spot welding, particularly in automobiles, even a small improvement would bring significant economic benefits. In the work experimental studies have been conducted for joining mild steel sheets of 0.8mm and 1mm. Three welding parameters, electrode force, welding current and welding time have been varied. Relationship between hardness and resistance spot welding parameters has been studied by using Tauguchi experimental design.

1. Introduction

Spot welding is widely used in automotive industries that assemble two or more metal plate which have low thickness, normally less than 3mm. The weld is made by combination of heat, pressure and time. The pressure exerted by the tongs and the electrode tips, through which the current flows, holds the parts to be welded in intimate contact, before, during and after the welding current time cycle. Essentially, welded joints can be produced by various combinations of welding parameters as well as joint geometries. These parameters are process variables which control the weld deposition rate and weld quality. The variables are welding current, electrode pressure, electrode diameter, welding speed and joint geometry. In the spot welding process, two or three overlapped or stacked stamped components are welded together as a result of heat created by electrical resistance as shown in fig. 1.1. Three zones can be identified as in fig.1.2

1) The base metal that is the metal to be joined
2) The heat affected zone
3) The fusion zone, that is, the region that has melted during welding

The interface of two surfaces forming the lap joint is the point of greatest resistance. In spot welding process a low voltage high amperage current flows from one adjoining plate to the other until the metal at the interface is heated to a high temperature to cause localized fusion which under applied pressure squeezes the molten metal from two plates to a homogenous mass called weld nugget. Electrodes are important part of spot welding unit. They serve four important functions, namely conduct the welding current to the work, transmit the desired force to the work pieces, dissipate a part of heat from the work pieces and provide jigging action to it. The electrodes are usually made of copper because copper has low electrical resistance and therefore allows the current to flow with ease.

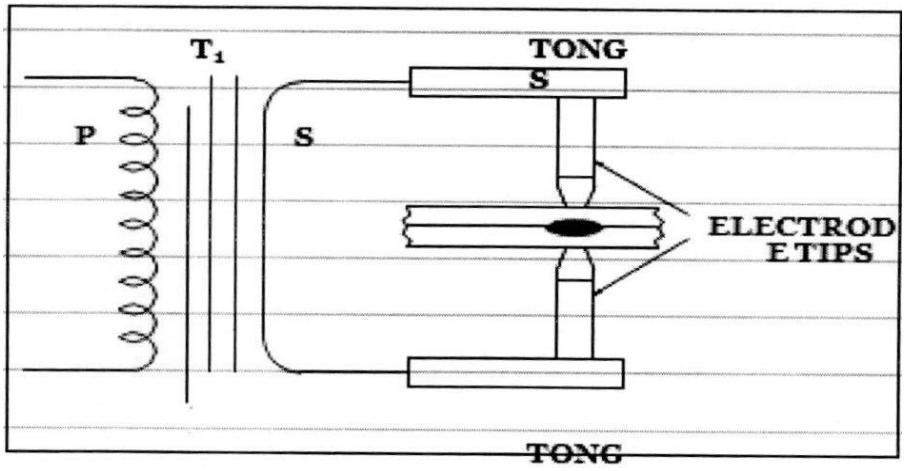

Figure 1.1. **Resistance spot welding machine with work [4]**

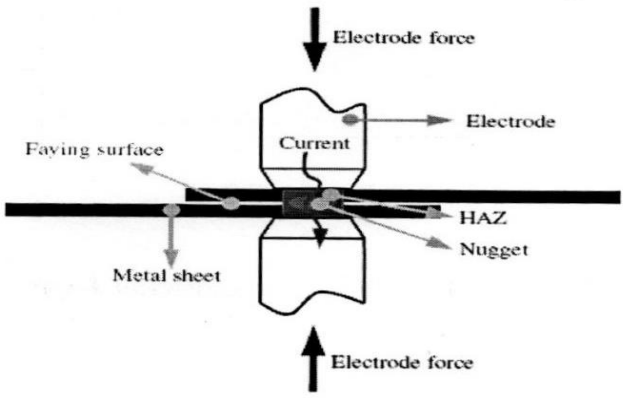

***Figure* 1.2: A scheme of resistance spot welding process [4]**

2. Working procedure

Trial samples were spot welded by varying one of the process variables to determine the working range of each variable. Three process variables are chosen that is electrode force, welding current and welding time with three levels. To find the hardness of the spot welded joint Brinell Hardness machine was used. Brinell Hardness chart was used to find the Brinell Hardness Number corresponding to the diameter of indentation. According to the Tauguchi design conceptL9 orthogonal array is chosen for the experiments. In the analysis, the observed values, welding current, electrode force and welding time are set to the maximum, minimum and medium levels respectively.

Experimental layout using an L_9 (3^3) Orthogonal Array

Experiment number	Electrode force	Welding current	Welding time
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3

6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

3. Experimental results

Table 1 shows results of hardness tests for RSW joint specimens of 0.8mm Ms Sheet. Hardness at the Centre of the nugget was considered as quality index.

Table 1: Experimental results of the Hardness for RSW joint specimens (0.8mm MS Sheet).

Experiment no.	Harness at the centre of the nugget(BHN)
	0.8mm
1	158
2	164
3	164
4	180
5	187
6	184
7	211
8	207
9	207

Similarly Table 2 shows results of hardness tests for RSW joint specimens of 1mm MS sheets.

Table 2: Experimental Results for the Hardness Test for 1mm MS sheet.

Experiment no.	Hardness at the centre of the nugget (BHN)
	1mm
1	174
2	174
3	177
4	202
5	207
6	202
7	249
8	244
9	234

4. CONCLUSION

This work has presented an investigation on the optimization and the effect of welding parameters on the hardness of spot welded MS sheets using Tauguchi method. Nine combinations of welding parameters were considered to evaluate the relative importance of welding parameters. The result of experimental confirmation revealed that the electrode force is the only significant factor.

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