OPTIMIZATION OF RESISTANCE SPOT WELDING PARAMETER TO ENHANCE PRODUCTIVITY

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ABSTRACT

Steel is the primary material to make the economically fabricated lightweight vehicles. Resistance spot welding is used to join the steel parts to get better strength. In resistance spot welding, its parameter plays a vital role for vehicle strength & productivity of vehicles. The purpose of this study is to carry out the optimum spot welding parameter for productivity. The study is conducted on in resistance spot welding no fisrequired0.6 mm thick Colled Rolled Close Annealed material grade JSC270C. This study shows that there are multiple combinations of spot welding parameters to get a better strength of vehicle structure by changing in parameter i.e. weld current & weld time on constant pressure & other parameters. This study also shows that increasing in weld current will increase the weld strength but at a certain current, weld aesthetic appearance starts to decrease.

Keyword: - *Resistance Spot Welding, Weld Current, Weld Time*

1. INTRODUCTION

Resistance spot welding [1] is defined as a process where merging is formed by the heat gained from the resistance of the workpiece to the flow of low-voltage, high-density electric current in a circuit of which the workpiece is a part. Pressure is always applied to ensure a continuous electrical circuit and to forge the heated part together. Heat is developed in the assembly to be welded, and welding machine applies pressure through the electrodes. During the welding cycle, the material surface of the parts is heated to a plastic state just before melting and are compressed together. The parts are usually merged as a result of heat and pressure and not they're being melted together. Fluxes or filler metals are not needed for this welding process.

Heat Generation [2]
The amount of heat produced in an electrical conductor depends on the following factors:
1. Amperage,
2. Resistance of the conductor (including interface resistance),
3. Duration of current.

These three factors affect the heat generated, as expressed by the following equation:
$Q = I^2Rt$

Where Q = Heat generated, joules (J); I = Current, amperes (A); R = Resistance of the workpieces, ohms (Ω); and t = Duration of current, seconds (s).

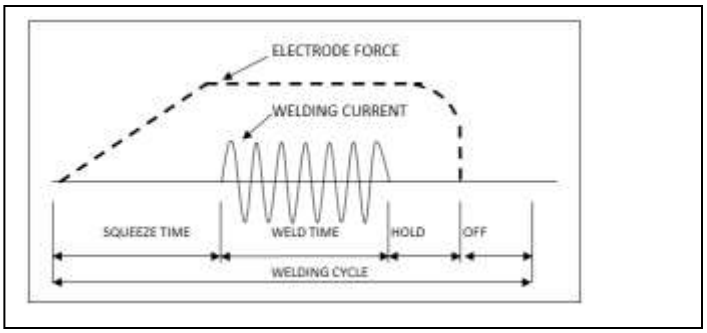

Fig. 1 Single Impulse Welding Cycle

The heat generated is proportional to the square of the welding current and directly proportional to the resistance and the time. Some of the heat is used to make the weld, and some is lost to the surrounding metal

1.1 LITERATURE REVIEW

H. Luo and all [3], in this study Resistance spot welding (RSW), was carried out on Magnesium Alloys AZ31B and AZ91D. The similarities and differences between these two materials about their welding characteristics and defect formation were investigated. A. Aravinthan [4], this experiment was carried out to analyze the growth of a spot weld in a mixed joint of mild and 302 austenitic stainless steel sheets. Manoj Raut [5] this experimental study is based on an investigation of the effect and optimization of welding parameters on the tensile shear strength in the Resistance Spot Welding (RSW) process. S.A.Jadhav [6], this paper is directed towards the optimization process parameter of resistance spot welding process and simultaneously consider multiple quality characteristics tensile strength and nugget diameter using Multi-Objective Taguchi Method. A. K. Pandey [7], This paper represents the optimization of various parameters of resistance spot welding. The experimental studies have been conducted under varying pressure, welding current, pressure, and welding time. In this investigation, the quality characteristic (tensile strength) has been considered using Taguchi Method. Manjunath R. Rawal, [8] An experimental study is conducted under various levels of process parameters. Spot welds are carried out on Cold Rolled Close Annealed (CRCA) material. Welding current, Electrode force and weld time are selected as process parameters with three levels of each. Taguchi quality design concept of L9 orthogonal array has been used to determine S/N Ratio, Analysis of Variance (ANOVA). Dipak V. Patil [9] the aim of this study is to find out the effect of spot weld parameters on the strength of spot weld. The effect factors of multiple spot-welded joints strength are analyzed including spot weld arrangement, the distance between two spot welds, spot weld diameter, and thickness based on finite element analysis (FEA) and experimental results. Y.Y. Zhao [10] The aim of this study to analyze the growth of a spot weld in a mixed joint of mild and 302 austenitic stainless steels

2. EXPERIMENTAL PROCEDURE

2.1 MATERIAL

Colled Rolled Close Annealed sheet 0.6 mm thick material used to conduct this study. Chemical & mechanical properties of this material are as given in Table 1 & Table 2.

Table -1: Material Mechanical Properties

Material Grade	Mechanical Specification						
	YS	***UTS***	***EL***	***HRB***	***RA***	***BEND***	***ECB***
JSC270C	Mpa	Mpa	%	%	µm	%	MM
	223	325	53	52	1.2	OK	9.4

Table -2: Material Chemical Specification

Material Grade	Chemical Specification						
	C	Mn	Si	S	P	AI	N
JSC270C	%	%	%	%	%	%	%
	.044	.21	.008	.018	.019	.036	34

2.2 MACHINERY

Following machines were used to conduct this study

1. Integral Transformer Resistance spot welding machine "36 KVA" used for this study, specification of this machine is as given in Table 3
2. Weld Checker
3. Vernier Caliper

Fig-2 **Integral Transformer Resistance Spot Welding Machine**

Table -3: Resistance Spot Welding Machine Specification

Resistance Spot Welding Machine Specification									
Throat Depth	Throat Gap	Air Pressure	Electrode Force	Initial Opening	Retraction Stroke	Total Stroke	Transformer Rating	Gun Model No	Weight (Approx.)
396 mm	120 mm	5 Bar	287 Kgf	32 mm	61 mm	93 mm	36 KVA	3024	75Kg

2.2 METHOD

To conduct this study total six trial taken at different weld current & weld time along with other parameters as constant as given in Table 4. In each trial 1000 spot, weld took and after every 100 no of spots weld nugget diameter & electrode tip diameter measure.

Table -4: Experimental Parameter

Experiment No.	*Squeeze Time (Cycle)*	*Welding Current (KA)*	*Welding Time (Cycle)*	*Hold Time (Cycle)*	*Electrode Force (KN)*	*Total Weld Time (Cycle)*	*$Q=I^2RT$ (Joule)*
1	20	4	63	6	2.5	89	201600020
2	20	7.1	20	6	2.5	46	201640020
3	20	10	10	6	2.5	36	200000020
4	20	12	7	6	2.5	33	201600020
5	20	14.2	5	6	2.5	31	201640020
6	20	15.9	4	6	2.5	30	202248020

3. RESULT AND DISCUSSION

Table -5: Weld nugget diameter w.r.t no of spot welds at different trials

No of Spot Weld	**Minimum Nugget Diameter Required (Millimeter)**	**Weld Nugget diameter in Millimeter at various welding parameters on no of spots weld**					
		4 KA, 63 Weld Cycle	***7.1 KA, 20 Weld Cycle***	***10 KA, 10 Weld Cycle***	***12 KA, 7 Weld Cycle***	***14.2 KA, 5 Weld Cycle***	***15.9 KA, 4 Weld Cycle***
0	3.8	0.0	3.9	4.3	4.0	4.8	5.0
100	3.8		2.9	4.6	4.2	5.5	5.4
200	3.8		2.4	5.3	4.4	5.5	5.7
300	3.8		0.0	5.4	4.4	5.7	6.0
400	3.8			5.5	4.7	5.9	6.1
500	3.8			5.5	5.1	6.1	6.1
600	3.8			5.6	5.3	6.2	6.4
700	3.8			6.5	5.6	6.5	6.6
800	3.8			2.8	5.7	6.7	6.7
900	3.8			2.4	5.6	6.9	6.8
1000	3.8			0.0	5.7	7.6	7.0

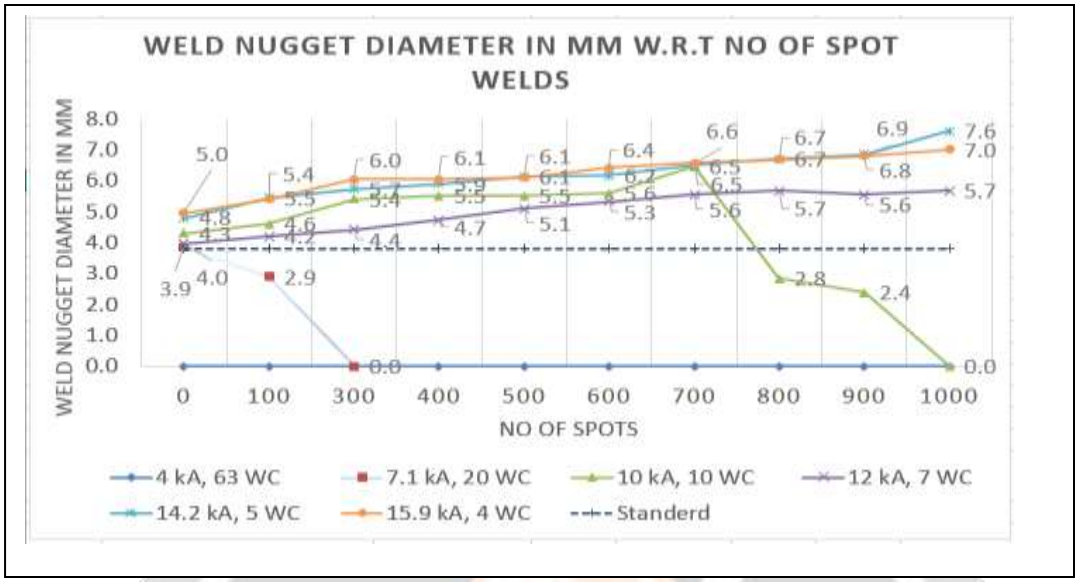

Chart -1: Weld nugget diameter w.r.t no of spot welds at different trials

Table -6: Weld Electrode Tip Diameter

No of Spots	Electrode tip diameter in millimeter at different welding parameters on no of spots weld					
	4 KA, 63 Weld Cycle	*7.1 KA, 20 Weld Cycle*	*10 KA, 10 Weld Cycle*	*12 KA, 7 Weld Cycle*	*14.2 KA, 5 Weld Cycle*	*15.9 KA, 4 Weld Cycle*
0	5.6	5.6	5.6	5.6	5.6	5.6
100		5.7	5.7	5.5	5.7	6.0
200		6.0	5.8	5.6	5.9	6.2
300		6.1	5.9	5.7	6.0	6.4
400			6.0	5.7	6.0	6.4
500			6.1	6.1	6.1	6.5
600			6.1	6.1	6.1	6.5
700			6.2	6.2	6.3	6.5
800			6.2	6.4	6.4	6.6
900			6.2	6.4	6.5	6.6
1000			6.3	6.5	6.5	6.8

Heat generation duration is very important is resistance spot welding. In the first trial heat generation was 201600020 Joules but duration of the weld was two high 63 weld cycle with a 4-kiloampere current so no weld happened between two sheets.

In the last trial, heat generation was 202248022 Joules, equal to the first trial but weld nugget was ok & both sheets getting the weld. After every trial, we increase the welding current & reduce the weld time. Rising in welding current weld strength increased but spot aesthetic quality decrease.

4. CONCLUSIONS

Weld strength increase as increase the welding current but spot aesthetic decrease after the third trial (10KA, 10WC). So as per experimental result weld current 10 Kiloampere & Weld cycle 10 is the optimal parameter for 0.6 mm thick sheet. Apart from that to get the continuous better result electrode tip need to reshape after every 400 spots.

5. ACKNOWLEDGEMENT

Authors are very thankful to Prof. P. B. Sharma, Vice Chancellor Amity University, Haryana for his kind support and motivation.

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