International Journal of Scientific & Engineering Research, Volume 4, Issue 7, July-2013
ISSN 2229-5518

PERAMETER OPTIMIZATION FOR TENSILE STRENGTH OF SPOT WELD FOR 316L STAINLESS STEEL

[1]Arvinder Singh, [2]Vanraj, [3]Kant Suman, [4]Suri N.M

Abstract

Experimental investigation on resistance spot welding has been carried out using L9Taguchi orthogonal array. 316L stainless steel material has been considered for experimental work. The spot welding input parameters, which are considered for this work are electrode force on plate, welding time and welding current, however tensile strength of nugget has been taken as output parameter. L-9 orthogonal array Results show that Welding current has significant impact on the tensile strength of nugget. The best suitable value of input parameters were found as follows Pressure (KN)3.1,Weldingtime(ms) 4,Welding current(kA)15.The output value maximum tensile strength is found to be 789.46(N/mm2).

Key Words: Spot welding, Tensile strength, Taguchi method, Stainless steel 316L grade,

1. Introduction

Resistance welding is a popular welding process due to its high speed and low cost combination. It also provides excellent reproducibility. Resistance spot welding (RSW) is one of the key metal joining techniques for high volume production in the automotive, biomedical and electronics industry. Large-Scale Resistance Spot Welding (LSRSW) has become the predominant means of auto body assembly, with an average of two to six thousands spot welds. Increasing application of very thin metal sheets in manufacturing electronic components and devices, Small-Scale Resistance Spot Welding (SSRSW) is attracting more and more researchers' attention. This work presents an approach to determine the effect of the process parameters(pressure, weld time and welding current) on tensile strength of resistance weld joint for austenitic stainless steel AISI 316L with the help of Taguchi method. The Taguchi method, which is effective to deal with responses, was influenced by multi-variables. This method drastically reduces the number of experiments that are required to model the response function compared with the full factorial design of experiments. The major advantage of this technique is to find out the possible interaction between the parameters. It is more resistant to general corrosion and pitting than conventional nickel chromium stainless steels such as 302-304. It has the following characteristics: Higher creep resistance, excellent formability, Rupture and tensile strength at high temperatures, Corrosion and pitting resistance

[1]M.E Student, [2]M.E Scholar, [3]Assistant Professor, [4]Associate Professor
arvinder1308@yahoo.com
+919466718078
Department of Production and Industrial Engineering
PEC University of Technology, Chandigarh

2. Steps involved in investigation

The research work was carried out in the following steps:

- First Identifying the important process control variables which influences the strength most.
- Finding the limits of the control variables.
- Conducting the experiment
- Recording the responses.
- Presenting the direct effects of different process parameters on tensile strength graphically.
- Analyzing the results.

3. Identifying the important process control variables:

Some of the important process control variable which influences the tensile strength and other characteristics of the spot welding are current, welding time, holding time, squeezing time, pressure, electrode diameter. But in our study we consider only welding time, welding current and pressure. So by general spot welding heat equation

$$H= I^2Rt$$

Where H= heat generated, I= Current, R=resistance, t=time
Also one of the other parameter which contributes in affecting tensile strength is Pressure.
In this study Cycle time, Current and the electrode pressure were considered as the parameters to study their effect on the tensile strength of Stainless steel of grade 316 L.
Upper and lower limits of these control variables have been fixed as under:
Cycle time- 4 to 16 ms, Current- 12 to 18 kA & Pressure- 50 to 75 psi

4. Experimental Procedure

ISSN 2229-5518

Preparation of the samples: - prepared the sample of dimension 150 x 25 x 1 mm and then join the two pieces by spot welding and set the range of parameter and calculate the tensile strength. This technique was used to prepare stainless steel. This method is most economical use in stainless steel. In this process the three different range Pressure, cycle time, heat is selected (50,62.5,75), cycle time (4,10,16)heat(12,15,18) is also selected for preparation of sample .

The chemical composition of these steels was analyzed as listed in Table 1.

Table.1 Chemical composition of mild steel

C %	Mn%	P%	S %	Si%	Cu%	Ni%	Cr
.016	.8443	.02817	.00586	.4298	.0661	10.07	17.22

Fig 1: Test specimens after tensile testing on UTM m/c

Steps in performing a Taguchi Experiment:

The process of performing a Taguchi experiment follows a number of distinct steps they are

Step1: Formulation of the problem–the success of any experiment is dependent on a full understanding of the nature of the problem.

Step2: Identification of the output performance characteristics most relevant to the problem.

Step3: Identification of control factors, noise factors and signal factors (if any). Control factors are those which can be controlled under normal production conditions. Noise factors are those which are either too difficult or too expensive to control under normal production conditions. Signal factors are those which affect the mean performance of the process.

Step4: Selection of factor levels, possible interactions and the degrees of freedom associated with each factor and the interaction effects.

Step5: Design of an appropriate orthogonal array (OA).

Step6: Preparation of the experiment.

Step7: Running of the experiment with appropriate data collection.

Step8: Statistical analysis and interpretation of experimental results.

Step9: Undertaking a confirmatory run of the experiment.

Copper alloy electrodes and the welding parameters according to the taguchi L9 method as listed in Table 3 were used in the experiment. In the whole experiment squeeze time and hold time were kept constant 90 and 20 ms respectively.

Table 2: L9 table formulation

L9 test.	Welding time (ms)	Current (kA)	Pressure (psi)
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

Table 3 Process parameters with their values at three levels

Level	Pressure	Welding time	Welding current
1	50	4	12
2	62.5	10	15
3	75	16	18

5. Recording the responses

Sample of dimension 150 x 25 x 1 mm were cut from a complete Stainless steel sheet of 1 mm thickness. Then the pieces were joined by spot welding

Table no. 4- Tensile strength response according to L9

TRAIL No. (RUNS)	CONTROL FACTORS			RESPONSE TENSILE STRENGTH (N/mm2)
	PRESSURE (kN)	WELDING TIME(ms)	WELDING CURRENT (kA)	
1	2.51	4	12	625.71
2	2.51	10	15	699.82
3	2.51	16	18	577.05
4	3.1	4	15	789.46
5	3.1	10	18	699.82
6	3.1	16	12	678.46
7	3.7	4	18	629.23
8	3.7	10	12	587.96
9	3.7	16	15	708.95

Graph 1: Effect of various parameters

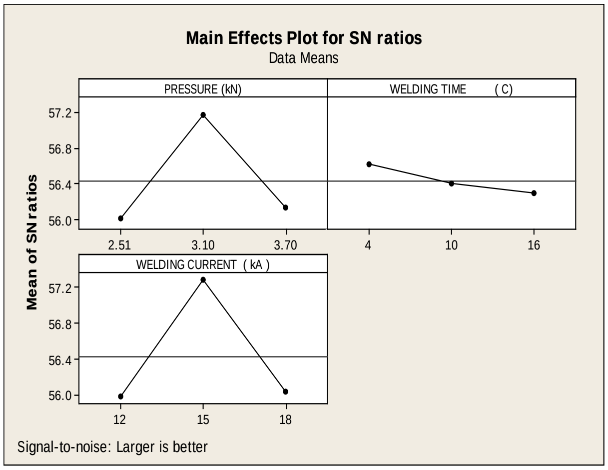

Table 5: Factor's SNR table

Pressure (kN)	Welding Time (ms)	Welding Current (KA)	Tensile Strength (N/mm2)	SNRAI
2.5	4	12	625.71	17.657
2.5	10	15	699.82	16.989
2.5	16	18	577.05	18.127
3.1	4	16	789.46	16.635
3.1	10	18	699.82	16.989
3.1	16	12	678.46	17.495
3.7	4	18	629.23	17.657
3.7	10	12	587.96	17.973
3.7	16	16	708.95	17.161

Table 6: Rank Table

Level	PRESSURE (kN)	WELDING TIME (ms)	WELDING CURRENT (kA)
1	56.02	56.62	55.98
2	57.16	56.4	57.29
3	56.13	56.29	56.03
Delta	1.14	0.33	1.3
Rank	2	3	1

6. Conclusion

Experiments have been carried out using L-9 Taguchi orthogonal array. Nine standard combinations of input parameters have been tried to get the betterment of response. It is revealed by experiments the input variable Pressure (kN) 3.1, Welding time (ms) 4, Welding current (kA) 15 however the best output value observed to be 789.46. This gives an edge to weld maker to get the optimal/near optimal input process parameters.

Reference

1. *William R. Oates, WELDING HANDBOOK Eighth Edition Volume 3 MATERIALS AND APPLICATIONS - PART I, AWS*
2. *W. H, Kearns, Welding Handbook Seventh Edition Volume 4, Metals and Their Weldability*
3. *J. Shen, Y. S. Zhang, X. M. Lai, and P. C. Wang 2012. Adhesive Placement in Weld-Bonding Multiple Stacks of Steel Sheets. Welding Journal 59s to 66s*
4. *Chang, B. H., Shi, Y. W., and Dong, S. J. 1999. Study on the role of adhesives in weld- bonded joints. Welding Journal 78(8): 275-s to 279-s.*
5. *Darwish, S. M. H., and Ghanya, A. 2000. Critical assessment of weld-bonded technologies. Journal of Materials Processing Technology 105: 221-229.*
6. *Wang, P. C., Chisholm, S. K., Banas, G., and Lawrence, F. V, Jr. 1995. Role of failure mode, resistance spot weld and adhesive on the fatigue behavior of weld-bonded aluminum. Welding Journal 74(2): 41-s to 47-s.*
7. *Darwish, S. M. H. 2003. Weld-bonding strengthens and balances the stresses in spot- welded dissimilar thickness joints. Journal of Materials Processing Technology 134(3): 352-362.*
8. *Goncalves, V. M., and Martins, P. A. F.2006. Static and fatigue performance of weld- bonded stainless steel joints. Materials and Manufacturing Processes 21: 774-778.*
9. *Long, X., and Khanna, S. K. 2008. Fatigue performance of spot welded and weld bonded advanced high strength steel sheets. Science and Technology of Welding and Joining 13(3): 241-247.*
10. *Sam, S., and Shome, M. 2010. Static and fatigue performance of weld bonded dual phase steel sheets. Science and Technology of Welding and Joining 15(3): 242-247.*
11. *Vogler, M., and Sheppard, S. 1993. Electrical contact resistance under high loads and elevated temperatures. Welding Journal 72: 231s to 298-s.*
12. *Thornton, P. H., Krause, A. R., and Davies, R.G. 1996. Contact resistances in spot welding. Welding Journal 75(12): 402-s to 412-s.*
13. *Guide for welding mild steel pipe. July 20, 2000. Prepared by AWS D10 Committee on piping and Tubing*
14. *Robert L. O'Brien, Welding Encyclopedia. Eighteenth edition. American welding society*