Prediction of Tensile Shear Strength of Resistance Spot Welded AA 5052 using Regression Analysis Model

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Introduction

Resistance spot welding (RSW) is a major sheet metal joining method that is increasingly being used in auto and aerospace industries. The reasons include:

- Lower processing cost
- increased speed and high flexibility for automation in high-volume and/or rapid production

RSW of aluminium alloys is also gaining increasing attention because aluminium alloys:

- High strength to weight ratio
- High corrosion resistance
- Low cost and high ductility

Due to these merits, RSW of aluminium alloys including AA5052 has been extensively investigated.

Applications

RSW has found applications in the fabrication of **car doors, frames, aircraft bodies etc.**

Major Challenge

However, **the major challenge is the inability to maintain consistency in quality between the welds.**

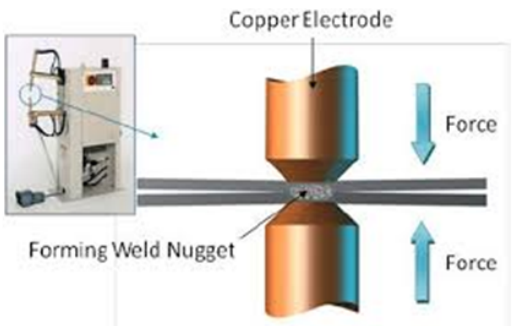
Efforts made

So far, various optimization techniques have been applied and improvements have been recorded. **However, developing mathematical models predicting the quality of resistance spot welds that will serve as guide for the sheet metal making companies in selecting appropriate parameters that will give optimal weld quality are still scanty.**

Methodology

Materials and Methods

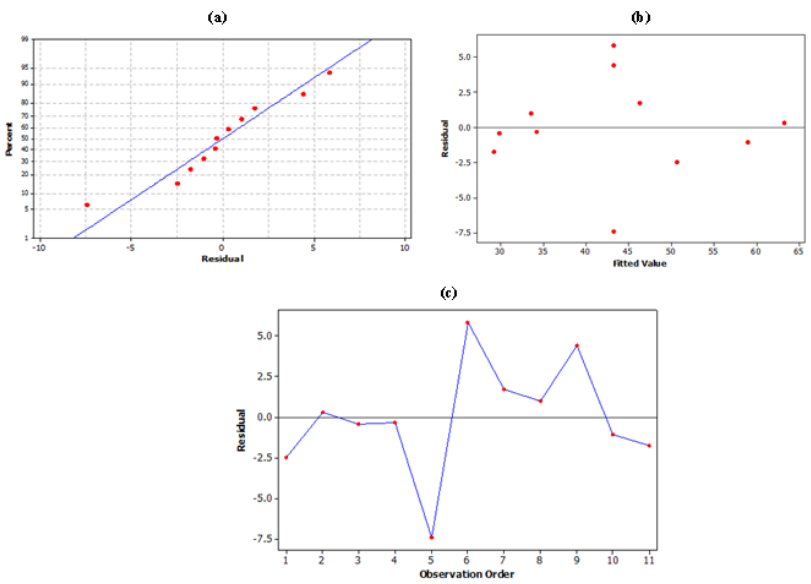
- AA 50552 (1.2 mm Ø)
- A NASH medium frequency Spot Welder (model: S-10-200MF)
- Full factorial design
- Tensile shear strength
- Nugget size measurements
- ANOVA + Hierarchy rule
- Regression analysis



Regression Model

The developed regression model predicting the TSS of AA 5052 RSW is

$$TSS = 193.018 - 11.9395I + 95.8389T - 291.238P + 17.589I * P$$



The plot of residuals (a) normal probability, (b) versus fit, and (c) versus observation order confirming the adequacy of the model

The result of the ANOVA after the model has been reduced by hierarchy rule until the difference **between R^2 and R^2adj is 5.2% is given in the Table 1.**

Table 1: Estimated coefficient of model from ANOVA

Term	Coefficient	SE Coefficient	P Value
Constant	193.018	1.367	0
Weld Current (I)	-11.9395	1.603	0.03
Weld Time (T)	95.8389	1.603	0.229
Weld Pressure (P)	-291.238	1.603	0.11
I*P	17.589	1.603	0.083

Table 2: The experimental and predicted values

Run Order	Weld Current (kA)	Weld Time (ms)	Weld Pressure (bar)	TSS (MPa) Experimental	TSS (MPa) Predicted	Deviation (%)
1	20	0.2475	0.936	48.15	48.96	1.6
2	20	0.2475	1.144	63.61	64.75	1.8
3	16.38	0.2025	0.936	29.45	27.37	7.6
4	16.38	0.2475	0.936	33.86	31.66	6.9
5	18.2	0.2025	1.04	36.84	40.61	9.3
6	18.2	0.2475	1.04	49.1	44.91	9.3
7	20	0.2025	0.936	48.09	44.66	7.7
8	16.38	0.2475	1.144	34.53	34.01	1.5
9	18.2	0.225	1.04	47.66	42.76	11.5
10	20	0.2025	1.144	57.93	60.45	4.2
11	16.38	0.2025	1.144	27.45	29.71	7.6

Conclusion: Resistance spot welding of 1.2 mm thick AA 5052 has been investigated within a range of parameters (weld current, weld time and weld pressure) and a mathematical regression model predicting the tensile shear strength of the welds up to an accuracy of 88% has been successfully developed and validated.