The effect of different thickness material stacking for four layer spot welding

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ABSTRACT – Spot welding is a common metal joining process in automotive industries. At actual production line, resistance spot welding of four layer metal sheet generally is more challenging than spot welding of three layers metal sheet, especially for welding gun optimization plan. This report intended to research the mechanical properties of four layer welded sheets of different thickness. In this research, the strength on the tensile shear-test of lap joint in spot welding of 2.80mm, 3.50mm and 4.4mm thickness of four layer welded sheet were investigated. All the results were then compared with three layer of welded sheet with thickness 2.80mm which was set as the benchmark.

1. INTRODUCTION

Resistance spot welding (RSW) process is one of the oldest in the electrical welding processes that are mostly used in the modern manufacturing technology such as bridges, shipbuilding, home appliance and more. The automotive industry has introduced the four-layer weld configuration, which represent new challenges compared to normal two-sheet and three-sheet lap welds. Nielsan et al.[1] stated that the process is more complicated by introducing various combinations of different material and different thickness. The development of new, four-sheet weld for use in the automotive industry represents new challenges to the industry, especially to ensure welding fusion for each 4-layer-sheet spot weld. The strength of resistant spot welded joints is important for improving auto body rigidity, which is one of the key factors in crash test activity.

Therefore, the objective of this project is to study the strength of four layer welded sheets from different thickness material combinations and to compare the strength of four layer welded sheets with three layer welded sheets.

2. METHODOLOGY

2.1 Sample Preparation

The sample was fabricated into lap joint. Each sheet was labeled according to Fig 1 since the plate assembly consists of four sheets for each specimen. The material composition is shown in Table 1.

I. a = JIS G3141 SPCC-1B
II. b = JIS G3141 SPCC-SD
III. c = JIS G3141 SPCC-SD
IV. d = JIS G3141 SPCC-SB

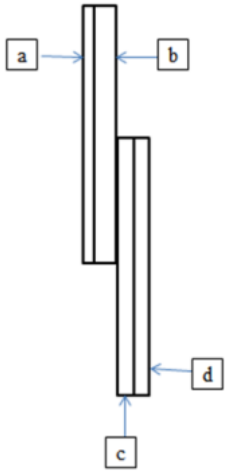

Figure 1 Welding Sample with Label

Table 1 Composition of the JIS G3141 SPCC metal sheet

Material	Element				
JIS G3141 SPCC	C 0.04%	Si 0.02%	Mn 0.16%	P 0.001%	S 0.004%

The material was cut according to drawing dimension. For all models, the sample length and width were held constant. All plates had the same dimension which were 100mm x 25mm. The thickness of each plate was different which were 0.5mm for the lowest thickness and 1.2mm for the highest thickness.

2.2 Welding Process

The RSW technique was ready to run after the sample preparation of sheet metal completed. For this project, the experiment was conducted on Inverter AS-25 weld gun. The specimens were the combination of different thickness of sheets metal which is from 0.5mm to 1.2mm. The current that applied for the welding was 9.0 kA and the electrode force is 2.5 kN. The parameter of spot weld machine was kept constant for all specimens.

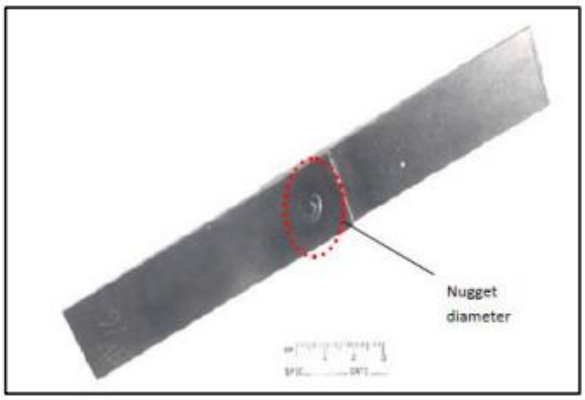

Figure 2 Specimen of Sheet Metal which is Lap Joints after RSW

2.3 Tensile Test

This method was suitable and simple to test the strength of the welded joint of sheet metal in terms of the tensile strength of the joint before fail or tear apart. Tensile-shear test was used to determine the maximum lap-shear force that can be achieved after the overlapping sheet metal joint together using RSW. A total twenty specimens underwent the tensile-shear test to obtain the maximum load before break due to shear force applied to weld area. The result is discussed in the next section.

3. RESULTS AND DISCUSSION

Table 2 shows the thickness of the specimen influences the maximum load, ultimate tensile stress and modulus young. Referring to Table 2, the tensile shear strength increased significantly with the increase of sheet thickness. Based on Table 2, it is showed that sheet 3.50mm-thickness value data requires further investigation. Based on the previous study, the ultimate value tensile stress will increase when the thickness of the welded sheet increases because the higher thickness will reach the breaking point much slower [2]. From the observation, it was predicted that this happened due to insufficient growth of weld nugget at the specimen. Insufficient growth of nugget may occur from insufficient current supply and also because insufficient weld time.

Table 2 Tensile test data for different thickness and layer

Total Layer	Thickness [mm]	Max Load [N]	Ultimate tensile Stress [MPa]	Modulus (Automatic Young's) [MPa]
3	2.80	7641.98	109.17	15584.31
4	2.80	7414.09	105.92	17703.26
4	3.50	8436.01	96.41	11148.32
4	4.40	11904.55	108.22	13876.35

4. CONCLUSIONS

Based on the project, the strength of four welded sheet can be said have higher tensile strength compared to the three layers. However, due to the result of sample 3.5mm thickness and 4 layer welded sheet, this research requires further investigation.

The mechanism of the strength of welded sheet with same layer but different thickness has been tested by using tensile shear test method. The weld strength of 4.4mm-sheet thickness measure by tensile shear test were found to be relatively high compared to the 2.80mm-sheet thickness and 3.50mm-sheet thickness. The study discovered that the maximum peak load for 3.50mm-sheet thickness is higher compared to 2.80mm-sheet thickness which means 3.50mm-sheet thickness was better than 2.80mm-sheet thickness. Even though, the less thickness of spot welded sheet would reduce the car weight and reduce petrol consumption it would also reduce the rigidity of the car. Lower strength of spot weld can lead into total destruction of manufacturing parts of car bodies. Therefore, the failure characteristics and performance of the spot welds significantly affect the durability and safety design of the vehicles [3].

5. REFERENCES

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