ISSN: 2088-5334

Vol 1, No 2 (2011)

International Journal of Advanced Science Engineering Information Technology

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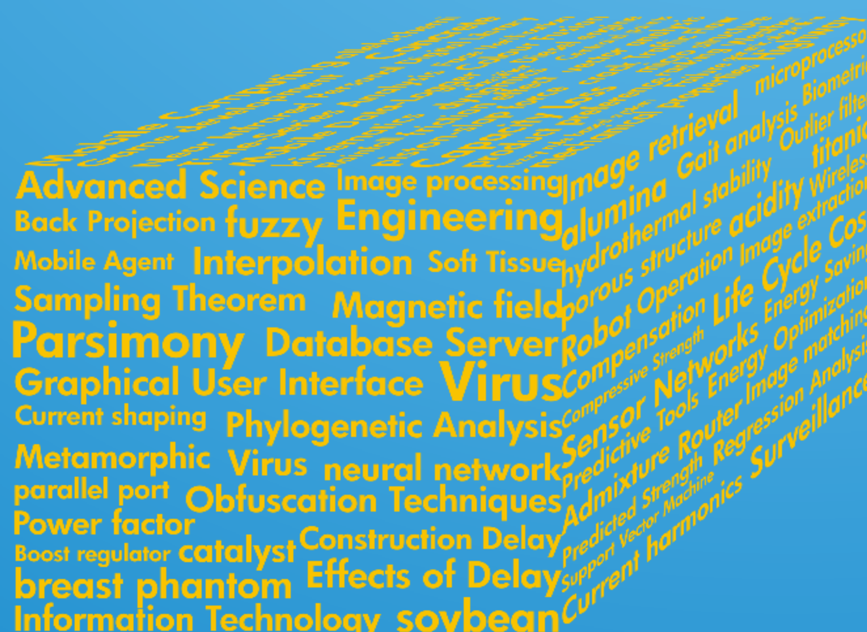
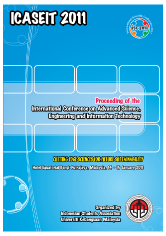


www.insightsociety.org

Proceeding of the International Conference on Advanced Science, Engineering and Information Technology 2011
Hotel Equatorial Bangi-Putrajaya, Malaysia, 14 - 15 January 2011
ISBN 978-983-42366-4-9



An Analysis of Resistance Spot Weld Growth on Mild and Stainless Steel with 1mm and 2mm Thicknesses

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***Abstract*— Resistance spot welding (RSW) is an essential welding technology today for joining two or more metals in various manufacturing industries. A statistic shows that one metal assembly out of five is joined using resistance spot welding mechanism, commercially. It uses traditionally two electrodes to hold the metal sheets and forces high current to pass through it. The growth of weld nugget is, at last obtained from a proper set up of its controlling parameters such as current, weld time, pressure of electrodes and also the tip size of electrodes. However, factors such as electrode deformation, dissimilar materials and materials with different thicknesses also affect weld growth. This paper looks into the effects of different thicknesses of two base materials .The materials that were used are mild steel and 302 authentic stainless steel with thicknesses of 1 mm and 2 mm. Mechanical tensile test and hardness test have been carried out to characterize the formation of weld nugget growth for different welding schedules. The results of the experiments showed that the growth of spot weld is strongly affected by the usage of materials with different thickness or types. The macrostructure of weld nugget also shows distinguishable differences in weld growth for the both mentioned cases. The tensile test was carried out on standard size samples but with different thicknesses and materials. It shows difference in yield strength for the same welding schedules. Meanwhile the hardness of welded materials varies from one another significantly but the hardness distribution along the welded areas seemed to almost same for each category of base metals.**

***Keywords*— Spot Welding of Mild Steel; Spot Welding of Stainless Steel, Spot Welding of Different Material and Thickness.**

I. INTRODUCTION

Spot welding process is a joining process that joins two or more metal sheets together through fusion at a certain point [1]. It is a simple process that uses two copper electrodes to press the work sheets together and forces a high current to pass through it. The growth of weld nugget is determined by its controlling parameters i.e. the current, pressure, weld time, and electrode tips [2]. The other factors that influence the weld growth are electrode deformation, material properties, corrosion and gaps between work sheets [3]. Automotive industry is one of the main industries that use spot welds to weld its metal structures. To date, a car's body may contain an average of 3000-4000 spot weld joints which do not alter the weight of materials very much as compared to traditional arc welding. The other industries such as marine, bridge and road, high rise buildings and aircraft engineering are also primarily anticipating the spot welding process for its body assemblies. So far many researches have been done on spot welding for various material such as low carbon steel, nickel, aluminium, titanium, copper alloy, stainless steel, austenitic stainless steel, galvanized low carbon steel, zinc coated steel, magnesium alloy and high-strength low alloy steel[1,2,4,8,9] but the mild and stainless steels are still widely preferred material for low cost metal assemblies. As such, this paper concentrates on the metallurgical study of the mild steel and the 302 authentic stainless steel and investigates the ability of producing sound welds using these metals. Welds were tested using tensile-shear [4,5] test and hardness test[7].

II. EXPERIMENTAL

The formation of weld is mainly influenced by controlling parameters of spot welding, as stated before. In this experiment, the pressure is kept constant at 3 bar and the other two important parameters (current and weld time) were varied for two different thicknesses to study the growth of weld nuggets. The test was conducted for two thicknesses of two different materials (mild steel and stainless steel). Table 1 shows the chemical composition properties of materials and table 2 shows the weld schedule that were used for this test.

TABLE 1 Chemical Composition

Element	Maximum wt%
Mild Steel	
Element	Maximum wt%
C	0.23
Mn	0.90
P	0.04
S	0.05
302 Authentic Stainless Steel	
Element	Maximum wt%
C	0.15
Cr	17-19
Ni	8-10
Mn	2.00
Si	1.0
S	0.03
P	0.04

The test was primarily conducted to study the difference in growth of weld nuggets between these metals. We have varied the parameters from lower range of weld schedule (Pressure= 3 bar; current= 8 kA; time= 8 cycles) to higher range of weld schedule (Pressure= 3 bar; current= 12 kA; time= 12 cycles) to analyze the nugget growth as well as the weld strength. The sample size was maintained the same (25mm x 200mm) throughout the experiment but thicknesses and materials varied (Figure 1).

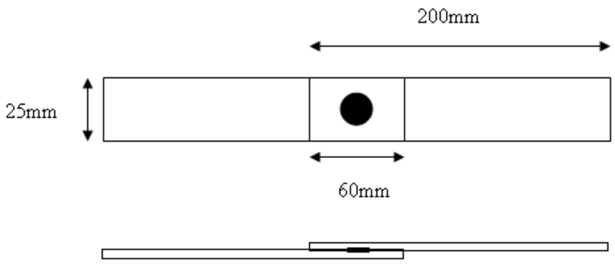

FIGURE 1 Test Sample

The tensile-shear (Figure 2) test was carried out to determine the yield strength of spot welded samples and also analyze the formation of weld nuggets. The ultimate tensile strength (UTS) was taken after which the breaking of weld occurred.

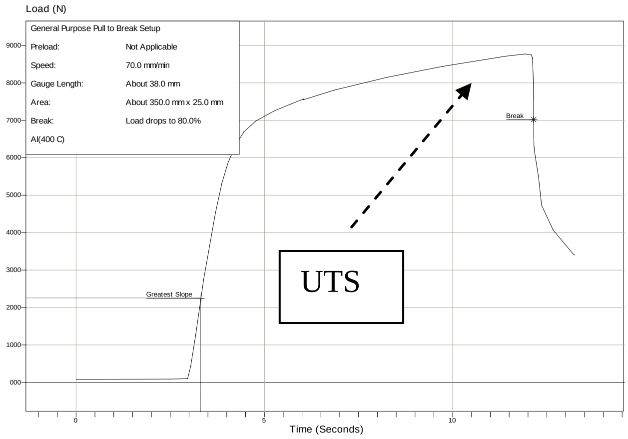

FIGURE 2 Tensile-Shears

The weld schedule was varied to analyze the weld formability on both the test materials. The samples are all welded using 50KVA spot welding machine. The pressure of electrodes was kept at 3bar; the current was increased for three level; 8 kA, 10 kA and 12 kA; the time cycle was also increased for three level; 8 cycle, 10 cycle and 12 cycle. Since the material is not coated, it does not require any pre-heating weld time to do so. Hence any additional set up was not made. Total of forty five (45) weld schedules were developed and 5 samples were considered for each weld schedule. An average strength value of the 5 samples was taken into account.

TABLE 2 Weld Schedule

Samples	**Materials (MS / SS)**	**Thickness (mm)**	**Pressure (Bar)**	**Current (kA)**	**Weld Time (Cycle)**
1-5	MS & SS	1 & 2	3	8	8
6-10	MS & SS	1 & 2	3	10	8
11-15	MS & SS	1 & 2	3	12	8
16-20	MS & SS	1 & 2	3	8	10
21-25	MS & SS	1 & 2	3	10	10
26-30	MS & SS	1 & 2	3	12	10
31-35	MS & SS	1 & 2	3	8	12
36-40	MS & SS	1 & 2	3	10	12
41-45	MS & SS	1 & 2	3	12	12

MS = Mild Steel ; SS = Stainless Steel ; mm = Mille Meters ;
kA =Kilo Amperes Bar = Bar and Cycle = Mille Seconds

The welded nuggets have also been analysed for hardness distribution along the welded zone and also the hardness of welded and un-welded areas. The hardness was measured for 5 repetitions along the diameter of nuggets using Rockwell Hardness Tester. Forty five samples were picked to do so. The results are graphically shown in Figure 6 and 7.

III. RESULT AND DISCUSSION