IJARESM
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN ENGINEERING, SCIENCE & MANAGEMENT

FABRICATION AND ANALYSIS OF RESISTANCE SPOT WELDING REGARDING ULTIMATE TENSILE STRENGTH

Dr. Piyush Jain[1], Milan Patel[2], Hardik Naik[3]
Professor, Mechanical Department., SNPIT&RC, Bardoli/Surat, Gujarat, India [1]
Assistant Professor, Mechanical Department. SNPIT&RC, Bardoli/Surat, Gujarat, India[2]
Assistant Professor, Mechanical Department., SNPIT&RC, Bardoli/Surat, Gujarat, India[3]

Abstract: ***Resistance spot welding (RSW) is one of the most used methods of joining sheet metals. The RSW process is based on Joule Lenz effect, of the electric current passing through the (similar or dissimilar) joining metal sheets positioned between the two contact electrodes. At welding process, some important changes occur in metallurgical and mechanical properties of the welded areas and heat affected zones (HAZ). The purpose of this work is to developed RSW machine and highlight the influences of joint materials and welding parameters on the tensile strength. By using constant pressure (force) of the electrodes and different values of current and welding time, three types of materials were welded. The welding samples have been subjected to tensile-shear tests. A simple model for spot weld joints is desirable in body-in-white automotive structures which contains thousands of them. Hence, comparative performance and failure prediction study of three simplified spot weld models in terms of their geometric and constitutive properties are presented in this paper.***

Keywords: **spot welding, galvanised steel, tensile-shear,**

INTRODUCTION

Resistance spot welding (RSW) is intensively used in top industries as automotive aerospace because of the relatively low cost of the process. Also RSW have a great adaptability for automation in high-rate production (there are about 5000 spot-welded joint in every car frame. [1] & [2]

RSW processes are extensively used for joining low carbon steel components, but ,with some cautions , the stainless steel, aluminium, titanium and copper alloys are also commercially spot welded [1] ,[2] ,[3] and [7] . In [4], [5] and [6] is revealed how by a special small scale RSW method , a Zr-based metal glassy alloy was successfully welded. The RSW process is based on Joule Lenz effect: a great amount of heat is generated by the current and the electrical resistance between the parts to be welded. The heat is developed using a low tension (12 V) and high intensity of the current (>5 kA) [5] and [6].The high temperature developed melts the surfaces and a core of lens shape is formed after cooling . The welding adjustable parameters of the RSW process are : the pressure of the electrodes, the current given by welding machine and the welding time.

To calculate the heat released during the welding process, is necessary to know the values of the factors on which that depends: electrical resistance of the conductor, amperage and length of time that current flows. The amount of heat generated Q (J) is calculated with formula (1)

$$Q = I^2Rt \quad \text{[joule] (1)}$$

Where: I= current intensity (A), t= time (s) ; R –electric resistance of joint (Ω) The strength of spot-welds depends on several factors : structure and property of base metals, characteristics and configuration of the welding machine (electrodes geometry , pressure force of the electrodes , current) , size and geometry of the specimens, test conditions [8] Several researches have examined the influence of these factors to predict failure of spot-welds with improved reliability. Kharaman in research paper [1] shows that the effects of parameters interaction regarding the weld diameter and the tensile-shear strength can be analyzed based on mathematical regression models of the welding process. The size of the fusion zone, the electrode penetration and the weld depth are significantly affected by welding current and welding time, [8] In [9] , Yang et al in [8] shows that for tensile-shear strengths the most important factors which affects the failure mode of welded joints are : thickness and length of weld nugget. The failure zone of the structure fulfils the zone with the smallest hardness of the length profile as is revealed by Mukhopadhyay et al in [10]. The paper aims to develop a comparative analysis between characteristics of welded structures of three different materials, the failure manner according to material type, the working parameter and implicitly the zone of failure.

The objective of this paper is to develop simple but realistic spot weld joint models with experimentally verified failure criterion. Generally the quality of spot welds is tested by destructive testing methods.

Design and fabricated model of RSW is shown in fig 1 and 2.

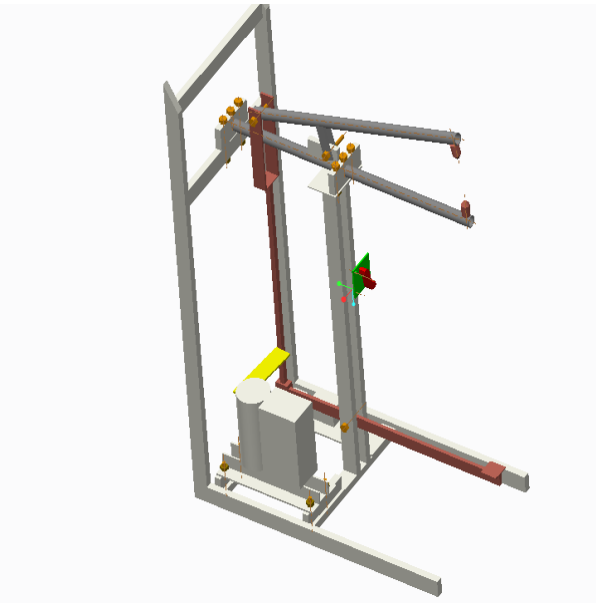

Figure 1: Design of RSW machine

Figure 2: Fabricated RSW machine

TABLE I: - MACHINE SPECIFICATION

Sr.No.	Process Parameter	Range	Unit
1	current	4-5	KA
2	Electrode force	2-3	Kg/cm^2 aprox.
3	Weld Cycle	6-10	Nil
4	Thickness of welding material	1.5	Mm
5	Electrode Type	Straight	Nil
6	Gap in electrodes	22	Mm
7	Electrode tip Diameter	3	Mm
8	Shape of electrode Tip	Circular	Nil
9	Electrode material	Chromium/ Copper	Nil

MATERIALS AND EXPERIMENT

A. *Materials*

Three types of steels sheets were RS welded: Galvanised steel-24 gauge, Galvanised steel-26 gauge, Galvanised steel-28 gauge. A batch of sheet samples in dimensions of 100mm × 30mm × 1mm were used for spot welding in order to determine weld quality. Electrode used was Cu Cr alloy.

TABLE II: - MATERIALS SPECIFICATION

Materials	Size	Thickness	Spot welded
Galvanised steel-24	100mm × 30mm	0.7010 mm	4
Galvanised steel-26	100mm × 30mm	0.5512 mm	4
Mild steel-28	100mm × 30mm	0.378 mm	4

TABLE III: - MATERIALS PROPERTIES

MATERIAL	THERMAL CONDUCTIVITY (W/M.K)	ELECTRICAL CONDUCTIVITY $(OHM.M)^{-1}$	ELECTRICL RESISTIVITY (OHM.M)	ULTIMATE TENSILE STRENGTH (MPA)
GALVANISED STEEL-24,26,28	17-19	0.3*107	8.9*10-7	605-780

B. *Experimental method*

Typically, there are three stages in RSW processes : in the first stage, the electrodes are brought together against the metal and pressure is applied before the current is turned on. Next stage, the current is turned on and is maintained a time (cycles) This is followed by the third stage, or hold time in which the current is turned off but the electrodes are still pressed on the weld joint.

The hold time forges the metal while it is cooling (figure 2, adapted from Kharaman)

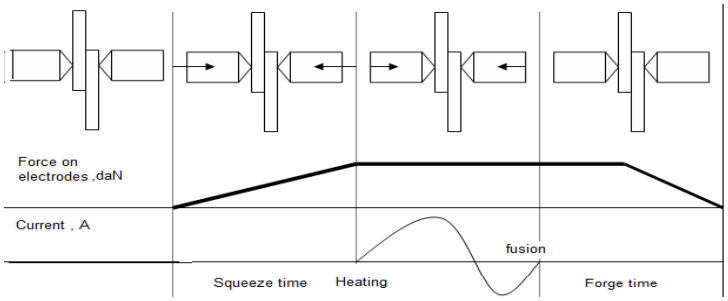

Figure 3: Typical RSW process (adapted from [1])

It were studied the effects of two main parameters of the process (current and welding time) on tensile-shear resistance of weld samples. The failure modes were also studied and commented. During the welding process the electrodes force was maintained constant.

In order to evaluate the weld quality of joined materials, the strength of welded joint was also determined. Structures employing spot weld are usually designed so that the welds are loaded in shear when the parts are exposed to tension or compression loading. In some cases, he welds may be loaded in tension, where the loading direction is perpendicularly to the plane of the joint or a combination of tension and shear [1].

In experimental setup were used three values for welding time, 5 , 6 and 7 cycles, and the welding currents was 3, 4 and 5 kA. The welded samples were subjected to tensile shear tests on the Universal Testing Machine.

RESULTS AND DISCUSSION

The welded samples were subjected to tensile shear tests on the Universal Testing Machine.

TABLE IV: - ULTIMATE TENSILE STRENGTH AND NUGGET WIDTH

Sr.n	Materials	Sample number	Ultimate strength 620mpa to 1027 mpa. kg per shot	Ultimate strength below 620 mpa. kg per shot	Weld nugget width
1	Galvanised steel-24	1	325	242	1.7525
		2	338	259	
		3	344	237	
2	Galvanised steel-26	1	339	172	2.2048
		2	241	165	
		3	238	181	
3	Mild steel-28	1	137	102	1.89
		2	165	116	
		3	152	108	

CONCLUSIONS

- This paper has presented an investigation on the optimization and the effect of welding parameters on the tensile shear strength of spot welded galvanized steel sheets.
- The level of importance of the welding parameters on the tensile shear strength is determined with using of different current and electrode force.
- Based on that, the highly effective parameters on tensile shear strength were found as welding current and welding time, whereas electrode force and electrode diameter were less effective factors.
- The results showed that ultimate tensile strength of galvanized steel-24 was higher than other two steel.
- Weld nugget width and depth of galvanized steel-26 was higher than other two steel.

REFERENCES

[01] kahraman n. the influence of welding parameters on the joint strength of resistance spot-welded titanium sheets. materials and design, 28(2), 420–427. 2007

[02] chen, z., shia y., jiao b., zhaoc h., ultrasonic nondestructive evaluation of spot welds for zinc-coated high strength steel sheet based on wavelet packet analysis, journal of materials processing technology 209, 2329–2337, 2009

[03] reiter a.e, brunner b. , ante m. , rechberger j. investigation of several pvd coatings for blind hole tapping in austenitic stainless steel surface coating technology (18–19), 5532–5541. 2006

[04] eugen axinte. metallic glasses from " alchemy" to pure science. present and future of design, processing and applications of glassy metals materials and design, 35, pp. 518-556, 2012.

[05] fujiwara k., fukumoto s., yokoyama y. , nishijima m. & yamamoto a., weldability of zr50cu30al10ni10bulk glassy alloy by small-scale resistance spot welding materials science and engineering a ,498,307, 2008,

[06] shin h.s., park j.s. , yokoyama y., dissimilar friction welding of tubular zr-based bulk metallic glasses journal of alloys and compounds 504s s275–s278, 2010

[07] goodarzi m., marashi s.p.h., pouranvari m., dependence of overload performance on weld attributes for resistance spot welded galvanized low carbon steel, journal of materials processing technology 209, 4379–4384, 2009.

[08] yang h.g., zhang y.s., lai x.m., chen g., an experimental investigation on critical specimen sizes of high strength steels dp600 in resistance spot welding, materials and design 29, 1679–1684, 2008

[09] mukhopadhyay g., bhattacharya s., ray k.k., effect of pre-strain on the strength of spot-welds, materials and design 30, 2345–2354, 2009

[10] yi l., jinhe l., huibin x., chengzhi x., lin l., regression modeling and process analysis of resistance spot. welding on galvanized steel sheet, materials and design 30, 2547–2555, 2009

[11] fukumoto s., fujiwara k., toji s., yamamoto a., small-scale resistance spot welding of austenitic stainless steels, materials science and engineering a 492, 243–249, 2008

[12] martín o., de tiedra p., lópez m., san-juan m., garcía c., martín f., blanco y., quality prediction of resistance spot welding joints of 304 austenitic stainless steel, materials and design 30, 68–77, 2009.

[13] cui y., lundin c.d., hariharan v. , mechanical behavior of austenitic stainless steel weld metals with microfissures .j.mater.process.technol 171(1), 150–155, 2006

[14] cui y., lundin c.d., austenite preferential corrosion attack in 316 austenitic stainless steel weld metals. materials and design 28(1), 324–328, 2007

[15] damborenea j.j. , cristobal a.b. , arenas m.a. , lopez v., conde a., selective dissolution of austenite in aisi304 stainless steel by bacterial activity. material letters , 61(3), 821–823, 2007

[16] satyanarayana v.v. , reddy g.m., mohandas t. dissimilar metal friction welding of austenitic–ferritic stainless steels. journal of materials processing technology;,160(2), 128–131, 2005

[17] dursunn ozyurek an effect of weld current and weld atmosphere on the resistance spot weldability of 304l austenitic stainless steel , materials and design 29, 597–603, 2008.

