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Comparative Study of Spot Welding Process Parameters on Microstructure and Mechanical Properties of ASS 304 and ASS 202 Steel

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Abstract: **The objective of this work is to report a comparative study the effect of welding parameters on resistance spot welds made on ASS304 and ASS202 stainless steels parameters chosen were current, electrode force and weld cycle , to determine their effect on microstructure and mechanical properties of the weld obtained , this study helps us to find out the optimum values for parameters, first joining two strips of 0.5mm each first ASS304 and ASS304 then joining 0.5mm ASS202 and ASS202 in last ASS304 and ASS202 and then to compare the result.**

Keywords: **Resistance spot welding, weld nugget strenght, stainless steel sheet joining.**

1. INTRODUCTION

Spot welding is one of the oldest welding processes. It's one form of resistance welding, which is a method of welding two or more metal sheets together without using any filler material by applying pressure and heat to the area to be welded. Resistance spot welding is a widely used joining process for fabricating sheet metal assemblies such as automobiles, truck cabins, rail vehicles and home applications due to its advantages in welding efficiency and suitability for automation. The method is adaptable to high speed automation and is under strict cycle times.The spot welding process is used to join sheet materials and uses shaped copper alloy electrodes to apply pressure and convey the electrical current through the work pieces. In all forms of resistance welding, the parts are locally heated. The material between the electrodes yields and is squeezed together. It then melts, destroying the interface between the parts. The current is switched off and the "nugget" of molten materials solidifies forming a weld nugget at the interface .

2. LITERATURE SURVEY

Pandey, Khan and Moeed [1] worked on optimization of resistance spot welding parameters using taguchi method , response of S/N ratio with respect to tensile strength indicates the welding current to be the most significant parameter that controls the weld tensile strength where as the holding time and pressure are comparatively less significant in this regard . Atzori B.et al [2] Investigated the effect of nugget diameter, heights of nucleus, nucleus size on mechanical properties i.e. tensile shear and tensile peel strength in electrical resistance spot welding of galvanized chromided micro alloyed steel sheets . Hirch Rogar B [3] has studied on the resistance spot Weldability of galvanized interstitial free steel sheets with austenitic stainless steel sheets. In micro hardness measurements, the maximum hardness values were in the middle of the weld nugget . Darwish S.M and Al-Dekhial [4] developed a mathematical model to study the influence of spot welding parameters (welding current, welding time, electrode force and sheet thickness) on the strength of spot welded Stainless steel sheets with commercial purity . Vural M., Akkus A and Eryurek B [5] investigated the effect of nugget diameter on the fatigue strength of resistance spot welded joints of galvanized steel and austenitic stainless steel(AISI 304) welded as lap joints . Bouyousfi B. Sahraoui T., Guessasma S. and Chaouch K.T. [6] have studied the effect of spot welding process parameters (are intensity, welding duration and applied load) on the mechanical properties and characteristics of the spot joints between two stainless steel sheets (304 ASS) having the same thickness. Micro hardness and tensile test results have shown that the weld resistance is important and highly correlated to the value of the process parameters especially the applied load . Shamsul J.B and Hisyam M.M [7] studied the influence of welding current on nugget size and hardness distribution in the plates of Austenitic Stainless Steel (AISI 304), which was placed as a lap joint and spot welded under varied welding current. The results have shown that increasing welding current increased the nugget size. The nugget size does not influence the hardness distribution .Ozyurek D [8] investigated the effect of the different welding medium and welding current on the resistance spot weld quality of 304L stainless steel and for this purpose, samples are welded in nitrogen at different currents and then cooled in atmosphere. Samples welded in atmosphere at different currents are then compared with the above samples to study the influence of different welding medium and current.

2.1 Resistance Spot Welding (RSW) Process Details:

Accodring to Aidun D.K and Bennett R.W [11] resistance spot welding is a welding process wherein coalescence is produced by the heat obtained from resistance to the flow of electric current through the workpieces held together under pressure by electrodes. The size and shape of individually formed welds are limited primarily by the size and contour of the electrodes. The control function of the welding machine defines the welding cycle. The particular steps controlled are squeeze time, welding time, hold time and off time . ASM Handbook [12] , however there are situations in which these joints are being used under fatigue loading . Over the last more than 45 years, many researchers have investigated the problem of the design of spot welded lap-shear joints in relation to their fatigue strength. They analyzed the stress field around the joint and also studied the experimental determination of the fatigue behaviour of joints with special geometries. None of the presently known studies, however, manages to provide an exhaustive and general interpretation of the phenomenon, able to correlate the data available and to set up the bases for reliable forecasts of the fatigue behavior of lap joints.

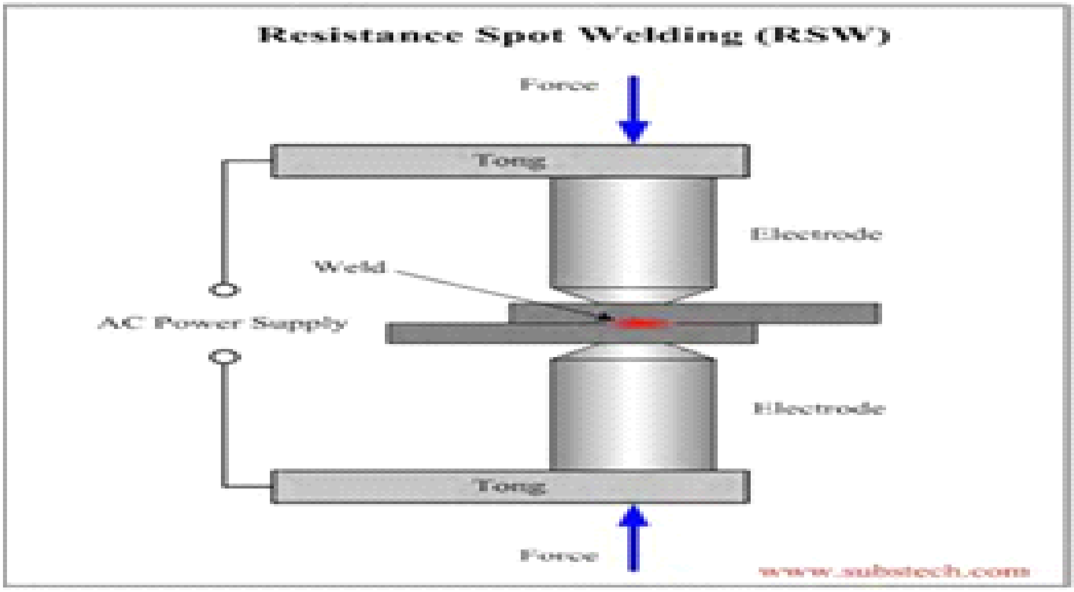

Figure: 1. Reseistance spot welding [13]

3. MATERIAL AND METHODOLOGY

3.1 Specification and composition of material used:

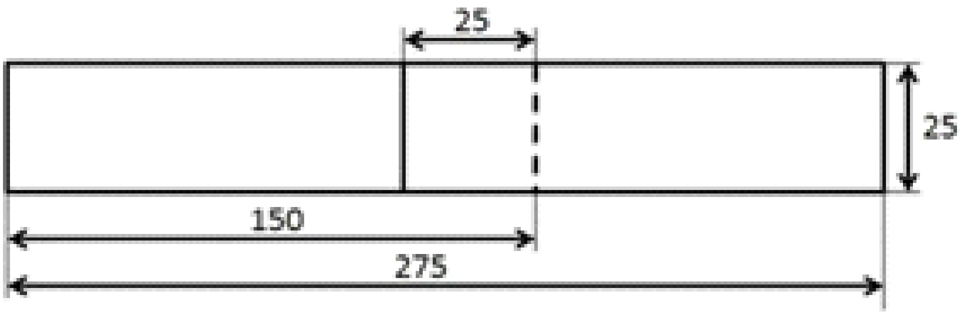

Figure: 2. Configuration and dimentions of specimen(all dimension in mm) [9]

Composition of material ASS 316

Element	C	Cr	Ni	Mn	Si	S	P	Mo
Wt.%age	0.08	16-18	10-14	2.0	1.0	0.03	0.04	2.0-3.0

3.2 Experimentation:

The three important process parameters viz. Current, Electrode Force and Weld cycles were selected (see Figures 3,4,and 5) Each experiment was repeated three times in each of the trial conditions. Thus, twenty seven work-pieces with 0.5 mm thickness each were welded in each of the trial conditions and for every replication, the hardness characteristics were measured.

Process parameters and their values at different levels

Symbol	Process parameters	Units	Level 1	Level 2	Level 3
C	Current	kA	4	4.5	5
P	Electrode force	kg/cm^2	2	2.5	3
N	Weld cycles	Nil	6	8	10
Thickness of ASS316 sheet: 0.5mm, Electrode Type: Straight, Gap in between the Electrodes: 22mm, Electrode Tip Diameter: 3mm, Shape of Electrode Tip: Circular, Electrode Material: Chromium copper, Type of Current Used: AC, initial plate temprature: (30 ± 2)°C					

3.3. Response Characteristics:

The effect of selected process parameters were studied on the Nugget Hardness response characteristics for the material ASS316. Nugget hardness was measured along the center line of the nugget crossection for thr three different specimens using Rockwell Hardness Testing machine.

3.4 Results:

D.S. Sahota, Ramandeep Singh, Rajesh Sharma and Harpreet Singh [9] it can be seen from Figure 3 that hardness of ASS316 increases as the value of the current, from level 1 to level 3. It means ASS316 is a material which becomes harder at weld nugget when temperature increases during welding process. Actually, Austenite stainless steels change its phase at high temperatures. It transforms into martensite. However, the transformation of austenite (γ) into martensite (α) cannot be the single cause of the increase of hardness. It is also influenced by the ratio between the main elements of stainless steel chemical composition: Cr, Ni and Mo. Figure 4 favours the results as written above and we know bigger value of weld cycle will increase the heat at nugget and consequently will transform austenite (γ) into martensite (α).In ASS 316 austenitic stainless steel deformation - induced α' martensitic transformation occurs by plastic deformation. Results of Figure 5 also are overlapping with the results of Figure 3 and Figure 4 written above. As we can see that hardness of the material is increasing as the value of electrode force is increasing from level 1 to level 3. Material becomes harder at the nugget with the increase of electrode force. Probable reason is transformation of Austenite to Martensite and with the increase of electrode force the material becomes more dense and hard at the nugget.

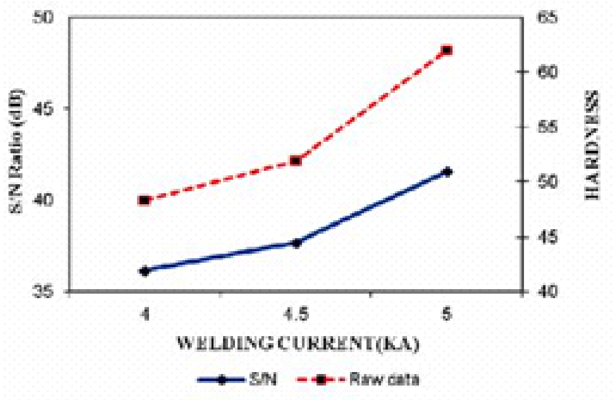

Figure 3. Effect of welding current on hardness

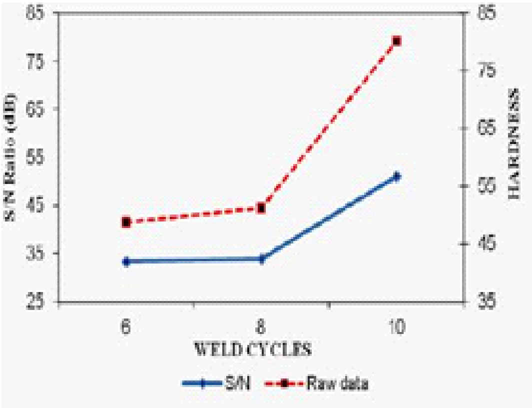

Figure 4. Effect of weld cycle on hardness

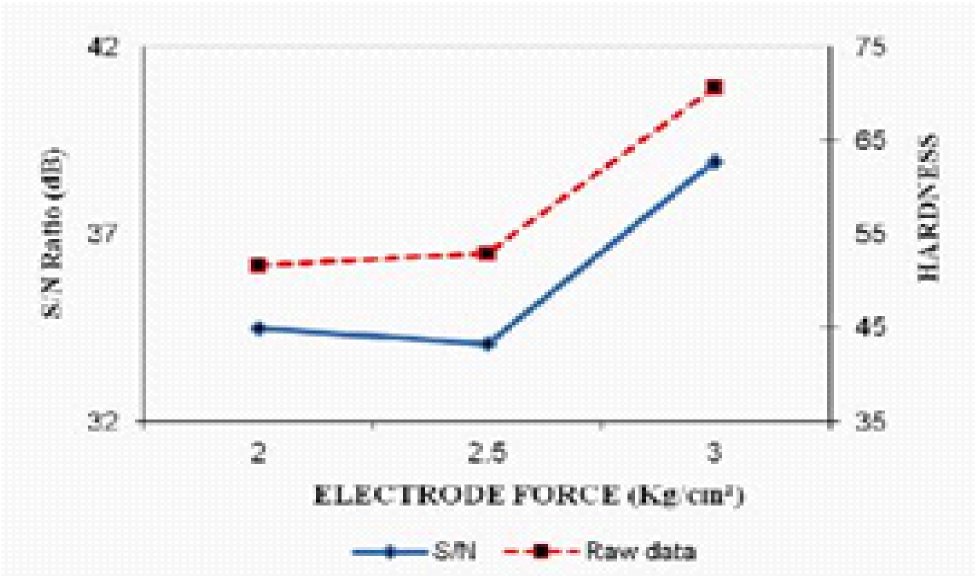

Figure: 5. Effect of electrode force on hardness

Mr. Niranjan Kumar Singh and Dr. Y. Vijayakumar [10] has presented an investigation on the optimization and effect of welding parameters on indentation of spot welded AISI 301L stainless steel. The level of importance of the welding parameters on indentation is determined by ANOVA (main effect plots). Based on anova method, the highly effective parameters onindentation are found as weld cycle, interaction between weld current & weld cycle and interaction between weld current, weld cycle & hold time whereas weld current, hold time and cool time were less effective factors . Not much work has been done in collaboration of ASS304 and ASS202 steel.

4. CONCLUSION

The current study are to detail study an compare the microstructure and mechanical properties two type of Austnitic Stainless steel. The examined steels include an: ASS304 and ASS202 (0.5mm in thickness each)

AISI/ASTM	Steel eq no to DIN EN	C Max	Mn Max	P Max	S Max	Si Max	Cr Max	Ni Max	Other elements
TP 202	1.4373	0.150	7.5-10	0.060	0.030	1.00	17-19	4-6	N-O.25 Max
TP 304	1.4301	0.080	2.0	0.045	0.030	1.00	16-20	8-11	

So we can see in the above table that their is a great difference in composition of (C-Mn-P-Cr-Ni) of ASS304 and ASS202 and by welding these two material together we would get a new different weld composition at nugget and microstructure and mechanical propereties will be changed.

As most work have been done on ASS316,AISI304, SAE 1010 but in current study both the metal ASS304 & ASS202 are quit different , ASS202 has low Ni and high Mn and weak in corrosion resistance and ASS304 is low in Mn , i will study how does these variation in compositon affects the microstructure and mechanical properties by first welding sheet of 0.5 mm each in combination of :

(a) ASS304 & ASS202

(b) ASS304 & ASS304

(c) ASS202 & ASS202

The current experiment will be to optimize the process parameter in resistance spot welding, the work will include (1) tensile strength testing. (2) Hardness of nugget using BHN Rockwell test. (3) microscopic examination of weld nugget.

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