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Research Article

Study of Microstructure and Microhardness of Stainless Steel Type ASS 304 and ASS 202 in Spot Weld

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Keywords

Microstructure, Microhardness, spot welding

Abstract

In this study , austenitic stainless steel sheets type ASS 304 and ASS 202 were welded by first joing two strips of 0.5 mm ASS 304 and ASS 304 then joining ASS 202 and ASS 202 and lastly by joining ASS 304 and ASS 202 with resistance spot welding . The microstructure properties were studied along with microhardness of the weld nugget cross section

Introduction

Resistance spot welding (rsw) is a process in which surfaces are joined at one or more spots due to the heat produced by the resistance to the flow of electric current through the work pieces that are clamped by the two copper electrodes .The metal at nugget surface experience a resistance and then heat is developed which in turns melts the metal forming a nugget . Resistance spot welding is widely used in automobile industries mainly truck cabin . rail coaches and cars . This method also uses high speed automation which increases the welding speed and precision.

Literature survey

Bouyousfi B. Sahraoui T, Guessasma S. and Chaouch K.T. [1] have investigated 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. Darwish S.M and Al-Dekhial [2] designed 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 [3] presented 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 . Pandey,Khan and Moeed [4] 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 [5] 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 .

Materials and Methods

The standard dimension for each plate to be spot welded is 80 mm length and 25 mm width, while the overlap for the lap joint is 20 mm (Figure 1). A numbers of stainless steel sheet of ASS 304 and ASS 202 in the three combinations with the thickness of 0.5 mm were cut into the standard dimension, placed as lap joint and then spot welded.

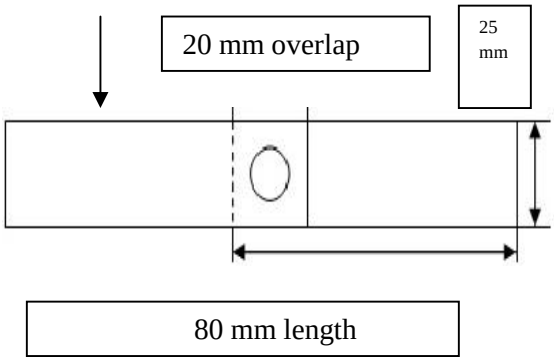


Figure 1 Standard dimensions for spot weld test

Figure 2 Original steel sheets used in experiment

Welding Equipments and Machines

- Resistance spot welding machine (5 KVA , PHASE 2, DUTY CYCLE 50 %) Max weld Amps : 200 : oil/air cooled
- Leica DMLM Metallurgical Microscope , special objective (1.6x to 250 x) with 20,22 and 25 mm fields of view .
- (OMNI) Semi Automatic Micro- hardness tester
  MVH- S Auto ; Vickers
  Load Range – 10 gms to 1000 gms
  Load Selection – Automatic / Manual
  Duel time 5 – 99 sec
  Microscope Magnification – 100 x , 400 x
  Measurement of indentation – Digital Fillar eyepiece.
  Max. measurement length – 175 microns
  Controls & Display –LCD touch screen for
  Power Supply - AC 230 V
- Polishing and grinding machine.
- Silicon carbide abrasive paper of grades 180,240,400,800,1000.

Microstructure Examination

To see the microstructure of the HAZ , the first step is to prepare the steel sheet for microscopic examination which includes the following steps : the weld nugget was in the middle of the sheet to obtain the cross section of the weld it was cut with shearing machine very precisely so as HAZ zone is not affected . Then it was fitted in a wooden block which can hold the nugget crossection . It was the grinded with grinding machine after that with various abrasive sand papers that have grades such as 240 ,360 , 400,600 , 800 and 1000 starting with the roughest till finest grade then these sample were polished with alumina solution and finally etching was done to reveal the microstructure of metal. Etching was done with a saturated aqueous solution of ferric chloride , containing a few drops of hydrochloric acid . This is applied using a cotton bud wiped over the surface few times , then the specimen was immediately washed with alcohol and dried and microscopic examination was done which revealed the following microstructure.

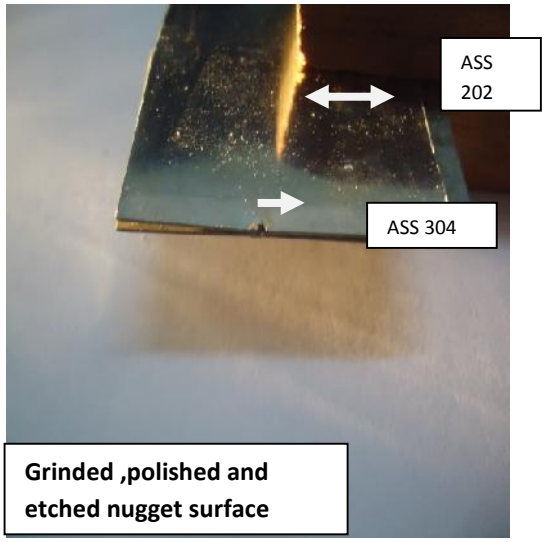


Figure 3 specimen used for microscopic examination

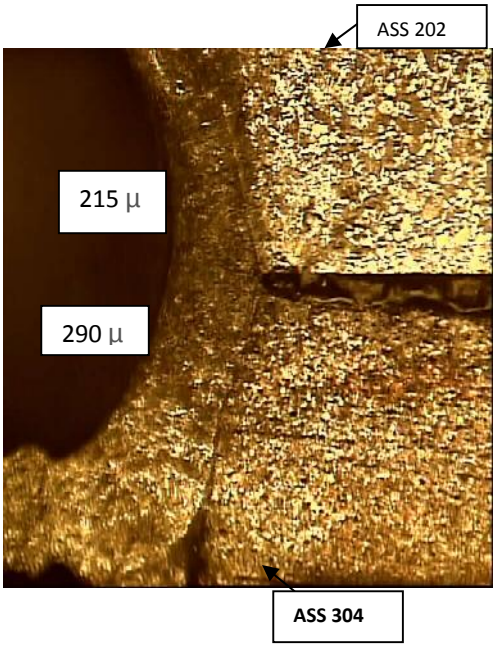


Figure 4 Microstructure of welded steel

The above figure shows the microstructure of the HAZ and the two different type of sheet forming a nugget the bottom sheet is having grains of 304 and top sheet having different grain structure of 202 . The width of HAZ at the junction of meating the two different sheets was 290 microns and as we move away from the junction of two meeting metals on the radius of HAZ the width decreases to 215 microns .

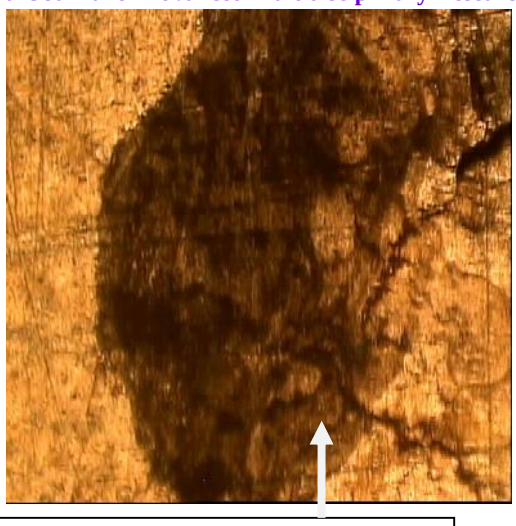


Figure 5 Cracks in nugget at 100 x in ASS 304- ASS 202

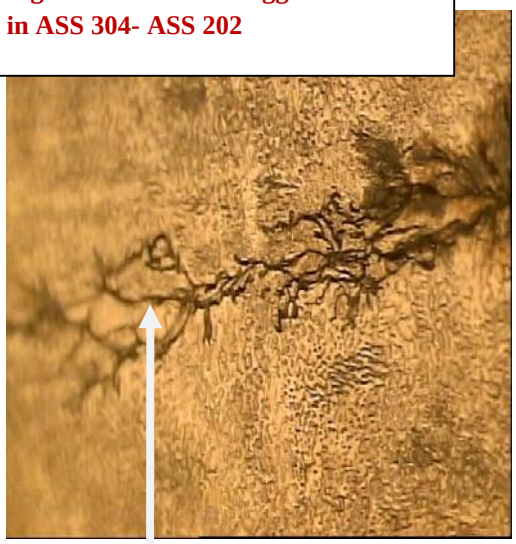


Figure 6 Cracks in nugget at 500 x in ASS 304 & ASS 202

We can see in the Figure 5. that in the nugget the dark brown colour and the crack indicates the transformation of austenite stainless steel changes its phase at high temperature , it transforms into martensite . The martensite present in the steel structure contributes to a special hardness of the steel. The area with martensite structure are stronger and harder than austenitic area but are less resistant to corrosion .

Microhardness of weld crosse-section

To reveal the mechanical properties microhardness test was done on three combination of steels sheet i.e. ASS 304-ASS 304 then ASS 202-ASS 202 and in last ASS 304- ASS 202 and for this the nugget cross section was cut into a rectangular shape with 10 mm width and 20 mm length . Then small PVC pipes were cut which would work as the mould . Then , portland cement and araldite mixture was moulded with steel sheet clamped in middle of the pipe as shown in Figure. 7 . The cold mounted samples were first grinded with silicon carbide abrasaive papers with gardes 180 , 400 ,800 ,1000 starting from the roughest till finest grade. Then these samples were polished followed by alumina . (OMNI) Semi Automatic Vickers Micro-hardness tester MVH- S Auto was used to measure the hardness.

Microhardness testing was done on cross section samples The reading was plotted along nugget diameter.

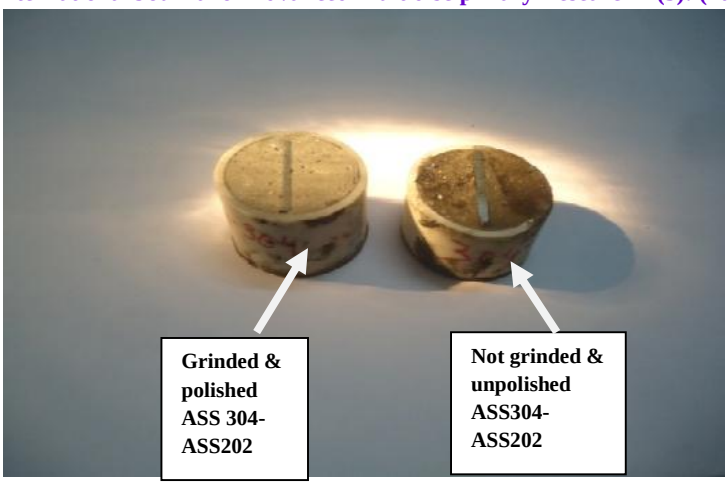
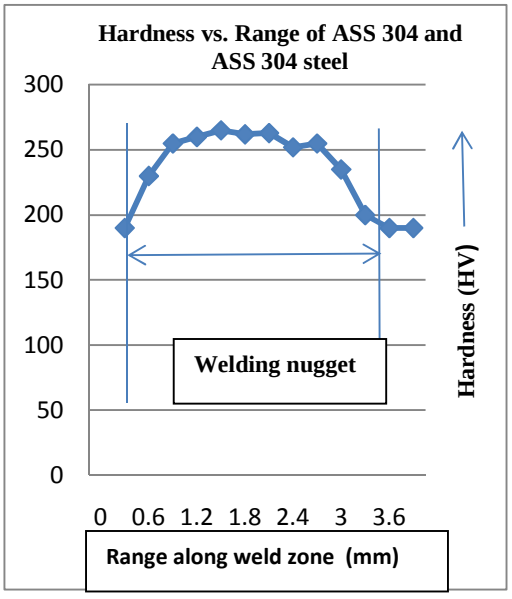
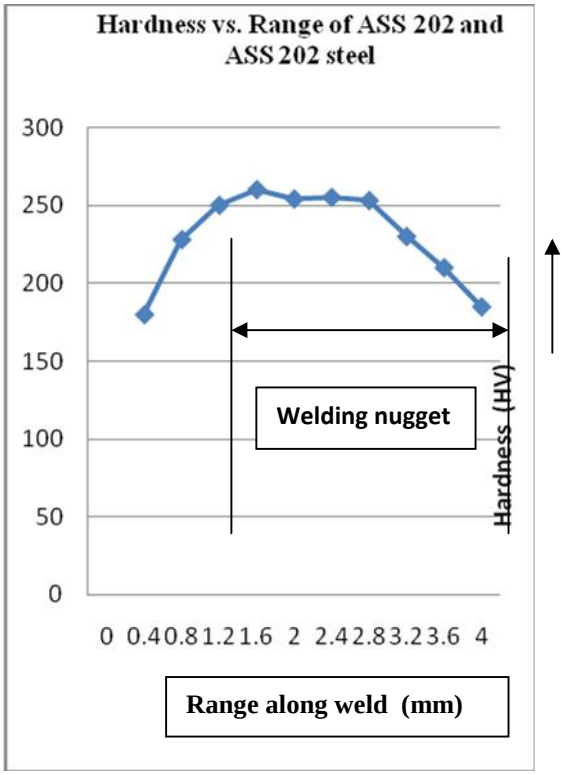


Figure 7 specimen used for Micrhardness test

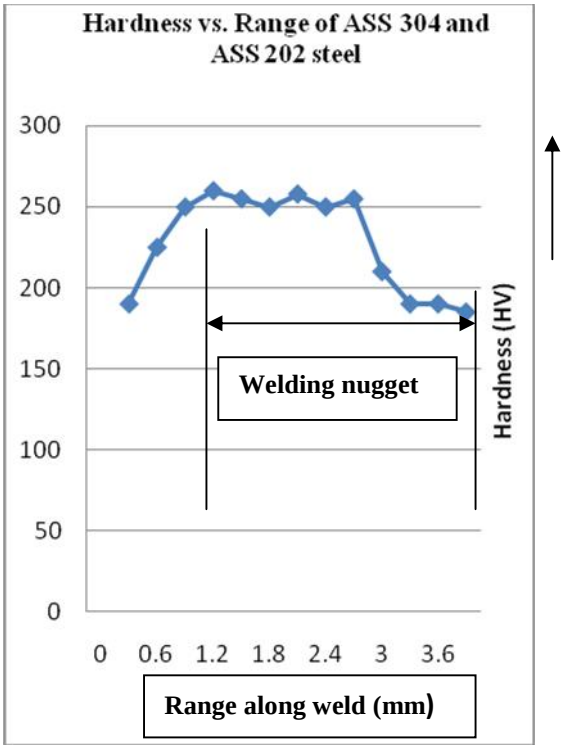
Figure 8 Showing pvc pipes and cement



Graph 1. Microhardness test ASS304-ASS304



Graph 2. Microhardness test ASS202-ASS202



Graph 3. Microhardness test ASS304-ASS202

Results

We can see from the Graph.1 that the microhardness value for ASS 304 and ASS 304 is higher value than ASS 202-ASS 202 and ASS 304-ASS 202 this may be due to low percentage of Mn (2 % Manganese) in ASS 304 which may help to transform more austenite to martensite and thus making it harder. The high composition of Mn(7.5 %-10 %) in ASS 202 helps to preserve the austenitic phase in steels . The hardness value increases in all three combination as we go closer to the centre of nugget , we can see in Graph.3 that there is high frequency of increasing and decreasing value of hardness and this indicates the combination of the two different types of microstructure i.e. ASS 304 and ASS 202 steels .

Conclusion

Austenitic staintless steel ASS 304 due to excellent corrosion resistance is more commercially used . While due to high composition of Mn in ASS 202 it resist the phase change and this can be seen from the microhardness values . This study was aimed at finding at optimum condition which can include the properties of both type of steels i.e. ASS 304 and ASS 202 that is having high corrosion resistance and high strength .

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