ANALYSIS OF RESISTANCE SPOT WELDING PARAMETERS WITH COPPER INTERLAYER OF ADVANCED HIGH STRENGTH DUAL PHASE (800) STEEL JOINTS

Analysing Parameters of Spot Weld

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Abstract: **Resistence Spot Welding (RSW) is still the most used form of welding in the automotive industry,primarly for welding steel and also most favorable method for joining Dual-phase steel. One of the advanced steel used in the automotive industry is dual phase steel,so it is important to properly select the welding parameters for these steel. Dual-Phase(DP800) are charecterized by a microstructure consisting of ferrite and martensite and offers favorable combination of high strength and good deformability.These properties have made them a potential candidate for the fabrication of automobile body frame structures,which help increase fuel economy by down-gauging material thickness and improving the car worthiness of the vechile.The objective of this work is to conduct experimental and theoretical studies on resistance spot welded advanced dual phase steel joint with copper interlayer.Here we evaluated the Mechanical properties and Metalluurgical charecterization of the base metal with different RSW parameters(Welding current,Time,Pressure) and it includes TSFL(Tenile Shear Facture Load),Hardness and Microstructural charecteristics of DP800 steel with copper interlayer.This experiment has evaluated by taking different value for the RSW parameters to a certain limit and we found out the area with higher hardness and lower hardness along the region of base metal and also the degree of softening in the HAZ(Heat Affected Zone) when the current increase.It is concluded that the major welding parameters was welding current 70(W),welding time(1sec),welding pressure(4.25bar) was founded by the experiment.**

Index Term: Dual Phase Steel, Analysing Parameters

1.INTRODUCTION

In the current scenario, there has been so much research done and still going on in the field of welding technology. Countless works are being carried on in the recent times in the different streams of welding with consideration of so many factors from every bit of materials and tools used during the process by changing the properties and values and usages etc. Let's start with the basic introduction along with storing the various types of the current research work importance will be discussed in this introduction section.It is always essential for joining separate pieces of metal together through an electrochemical reaction that renders them homogeneous and physically one piece. It's very important if you want to build something that demands material continuity, as in where joints and the fasteners would be insufficient or inappropriate for reasons of strength, pressure, corrosion or any other environmental concerns. Welding isn't meant for the weak people around in this demanding world. As someone who personally gave ourselves, we can tell you it's not as easy as it may seem as we are getting evolved with new and new challenges. This is a hot, difficult and physically tasking job as we all know absolutely cuts and infrastructures. Most people don't realize the importance of welding as it plays in day to day life from the consumers to the general public to the company leaders The different form of defining welding is that it is a fabrication or sculptural process that joins materials generally usually metals or thermoplastics by causing fusion, which is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal.

2. PRINCIPLE OF RESISTANACE SPOT WELDING

This is attained when current flow through electrode tips and the pieces of metal to be joined necessarily. The resistance of the base metal to electrical current flow causes localized heating in the required joints and the necessary weld is formed. Resistance welding processes are the fast and reliable means of joining thin sheets of metal together. Required weld is created by first applying the necessary pressure on the two parts to be joined. After attaining the correct amount of pressure is applied, current is passed between the two (or more) overlapped necessary sheets. The resistive heating results in the melting and formation of a "weld nugget" or a "weld seam". Resistance spot welding is the most common of the resistance welding processes widely used presently. It is used extensively in the automotive, appliance, furniture, and aircraft industries to join sheet materials for the various requirements. In this style of the welding process, water cooled, copper electrodes are used to clamp the sheets to be welded together into the place. The force applied to the electrodes ensures intimate contact between all the parts in the weld configuration mentioned as the requirement.The appropriate current is then passed across the electrodes through the sheets. The resistance of the metal to the localized flow of current produces heat,

Process variables

• Current

• Time

• Force

• Spot and seam welding

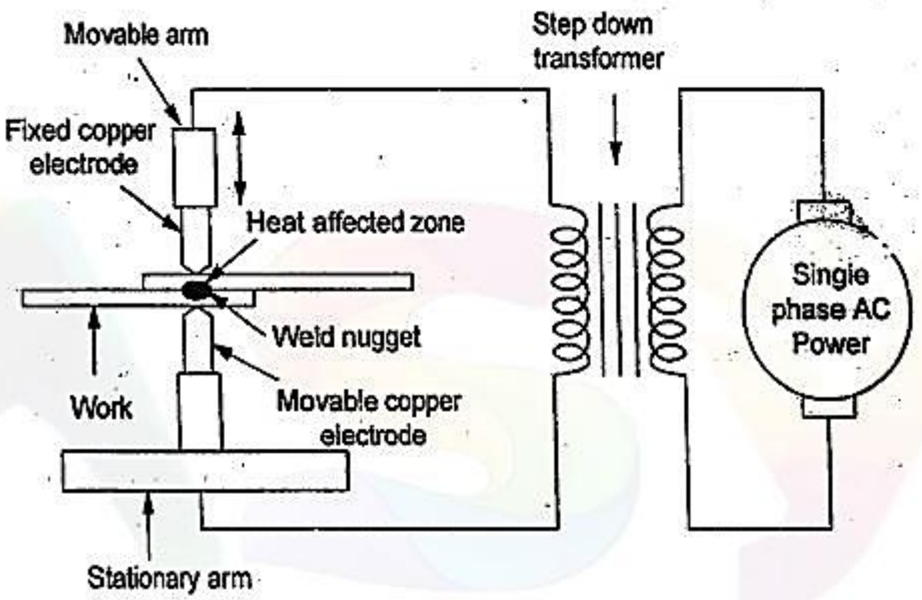


Figure 1.2 Schematic diagram of Electrical Resistance Spot Welding process

The Resistance spot welding machines are constructed with so minimum resistance which will be apparent in the transformer, flexible cables, tongs, and electrode tips etc. The resistance spot welding machines are destined to bring the welding current to the weldment in the most appropriate and efficient manner. The greatest relative resistance required is at the weldment. Here the term "relative" means with relation to the rest of the actual welding circuit used. There are maximum six major points of resistance in the work area and they are mentioned below:

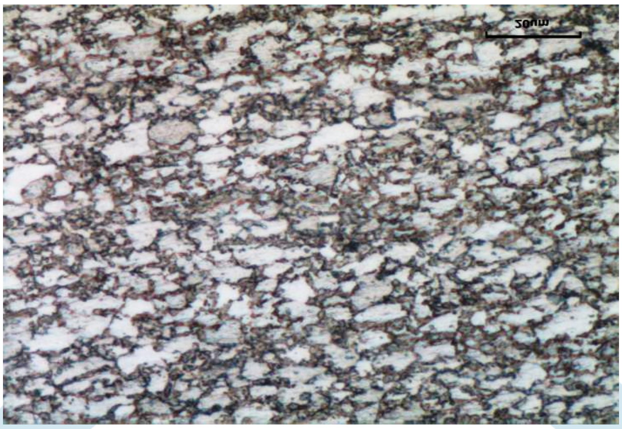
1. The point of contact between the electrode and the top workpiece.
2. The top workpiece.
3. The interface between the top and bottom workpieces.
4. The bottom workpiece.
5. The point of contact between the electrode and the bottom workpiece.
6. The resistance of electrode tips.

The resistances are always in series, and each point of the resistance will retard the flow of current. The necessary amount of resistance at the point are three and they are at the interface of the workpieces then it depends on the heat−transfer capabilities of the material, the material's electrical resistance, and finally the combined thickness of the materials at the welded joint. It is exactly at this part of the circuit that the nugget of the weld is formed preferably.

3. MATERIAL DATA AND CHARACTERIZATION

3.1 DP Steel

Dual Phase steel comes under the category of Advanced High Strength Steel (AHSS) and DP steels are comprised of a ferrite matrix with martensite islands dispersed throughout. DP steel is formed by inter-critical annealing where a portion of the austenite phase is transformed to ferrite, and then upon rapid cooling the remaining austenite is transformed to martensite. DP steels attain the necessary hardenability through increased carbon content and alloying additions. The martensitic phase causes strain to be concentrated in the ferrite, creating a high work hardening rate, this high work hardening rate increases the energy absorption characteristics, making DP steel suitable candidates for use in automotive chassis. Typical DP microstructure is shown in Figure with ferrite matrix (dark regions) and martensite stringers (bright regions),



The material used in this study, supplied by Kaizen cold formed Steel, is cold rolled galvanized sheet of DP800 steel with 1.5 mm thickness the chemical compositions are depicted in Table 3.1 and base metal mechanical properties were shown in Table 3.2 respectively. In low carbon steel with strengthening agent of manganese in moderately abnormal state, in addition to fraction of silicon and chromium elements are reassure the arrangement of dual phase microstructure and enhance the speculate properties of steels. The above shows comprise with microstructure about 85% alpha phase ferrite and 15% martensite. The normal grain size of ferrite was 7 µm.

Table 3.1 chemical composition (wt%) base metal

C	Si	Mn	Cr	P	S	Ni	Mo	Ti
0.146	0.88	1.500	0.025	0.007	0.0036	0.027	0.0018	0.0016

Table 3.2 Mechanical properties of base metal

Material	0.2% offset Yield Strength (MPa)	Ultimate Tensile Strength (MPa)	Elongation in 50 mm gauge length (%)	Microhardness (HV)
Dual phase Steel	410	590	26	264

4. WELDING EXPERIMENT

The welding experiment was carried in Resistance spot welding on a DP-800 steel plates with the dimension of 75x25x1.7mm(LxWxT)flat specimen as per ASTM standard.The work piece was extracted from sheets with the help of power hack cutter.The specimen surface were cleaned with acetone before conducting the experiments to remove the oxide layers formed over the surface of the material to be weld.The samples were welded in lap mode of configuration as per the standard ANSI/AWS/SAE/D8.9-97.Two types of spot-welded specimens have been made which are termed as tensile shear fracture load (TSFL), and cross tensile shear fracture load (CTSFL). ASTM guidelines were followed for preparing the test specimens. In order to examine the mechanical properties of the joint, tensile shear test was carried out in 100 KN, servo controlled Universal Testing Machine (Make: FIE-BLUESTAR, INDIA, Model: UNITEK 94100). Defect free tensile shear and cross tensile shear specimens were prepared from each joint to evaluate the TSFL, CTSFL and the results is presented in figure4. Vickers micro hardness testing machine (Make: Shimadzu and model: HMV-2T) was employed for measuring the hardness of the base metal with 0.5 kg load for 15 s [ASTM E8 M-05a] and the values are recorded. Representative specimens from the as-received steel sheets were cut for microstructural studies in the through thickness, transverse and longitudinal directions. The specimen blanks were mounted using phenolic resin, ground up to 400-grade emery paper, polished first using 0.6 µm and then using 0.25 µm diamond pastes. The polished specimens were etched with freshly prepared 25 ml ethanol, 1.25 ml hydrochloric acid to reveal the microstructures. Specimens were etched with 5% of Nital to reveal the macrostructures. All the joints fabricated in this investigation have been analyses at low magnification (10×) using stereo zoom optical macroscopic to reveal the quality of RSW regions. Microstructural analysis was carried out using a light optical microscope (MEIJI-MIL 7100-JAPAN). The base metal microstructure is shown in Figure3.1, which is predominantly influenced of ferrite structure.

a)Specimen Before Welding

b)Specimen After Welding

5.TEST RESULTS

The results obtained from TSFL, microhardness, nugget, metallographic study on dual phase steel similar joints welded using the RSW process was discussed in detail in this section.

5.1. TENSILE TEST

The base material yielded a maximum load of 410 MPa with an elongation of 26 % as shown in table 4.2. The optimized welded joint yielded a maximum of 21.4 KN with an elongation of 12 %. The weld failure occurred in interfacial manner. Table 5.1 shows the properties of the welded joint.

The table 5.1 shows the properties of the welded joint.

S.NO	Welding current (W)	Pressure (p)	Time (sec)	LOAD (KN)
1	55.00	5.00	1.00	10
2	55.00	4.25	2.25	7
3	40.00	4.25	1.00	12
4	70.00	4.25	3.50	18
5	40.00	4.25	3.50	17
6	40.00	5.00	2.25	14
7	55.00	3.50	3.50	13
8	40.00	3.50	2.25	19
9	**70.00**	**4.25**	**1.00**	**21.4**
10	55.00	5.00	3.50	20.1
11	70.00	5.00	2.25	19
12	70.00	3.50	2.25	18.7

5.2. HARDNESS TEST

To evaluate the microhardness measurement was done across the weld regions through the Vickers microhardness testing machine. The considered welding regions in the similar joints were the weld nugget area, interface and BM. The hardness was measured along the joint interface and the hardness was measured in a diagonal range enclosing the base metal and interface. The maximum hardness of 230 HV was achieved in the interface region. This is due to the finer refinement of the grains near the region compared to the grains near to the area adjacent to the base material. Figure 7.2 shows the hardness value of the joint.

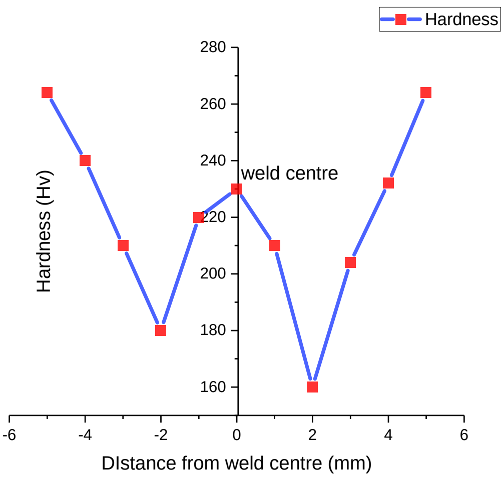


Figure 5.2Hardness graph

The hardness along with the diagonal shows there is an increase in the hardness range at the region 230HV at the weld nugget. The region that is affected around the nugget exposed to 220HV. The hardness measured along the interface exposed the maximum hardness at the nugget and the minimum hardness was observed near the base material.

5.3. MACRO AND MICROSTRUCTURAL FEATURES OF DP-800 STEEL

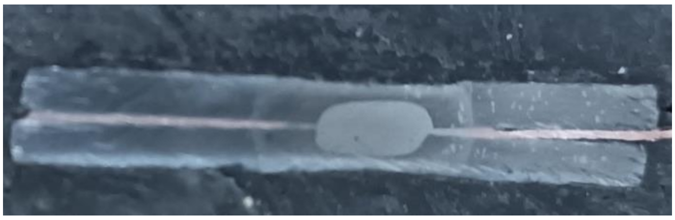
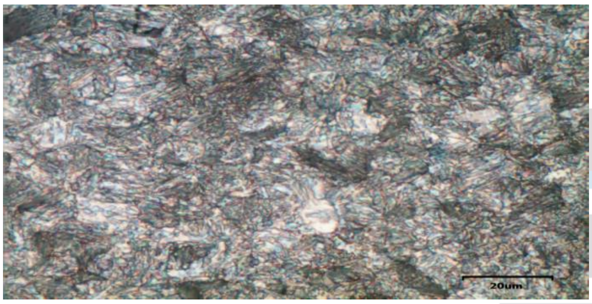


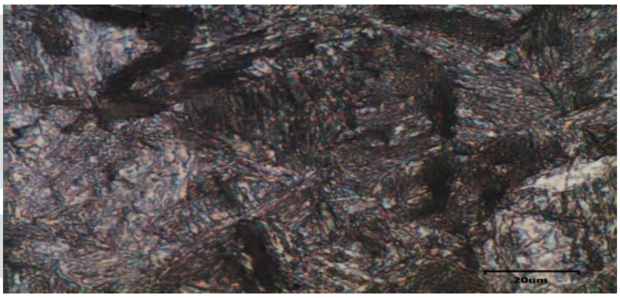
FIGURE 5.3 overview of macrostructure in welded DP-800 steel

Macrograph of similar Resistance spot-welded joint with copper interlayer reveal clear perspective although used classifies the various regions in the weldment. The overview photography of the weld joint figure.Useful for understanding and correlating with mechanical and metallurgical features. The macrostructure clearly shows that weld nugget formation occurs in the similar combination. it reveals the DP-800 has more impinge on the high manganese and silicon because of the DP steel sustains better properties in temperature resistance.

A.

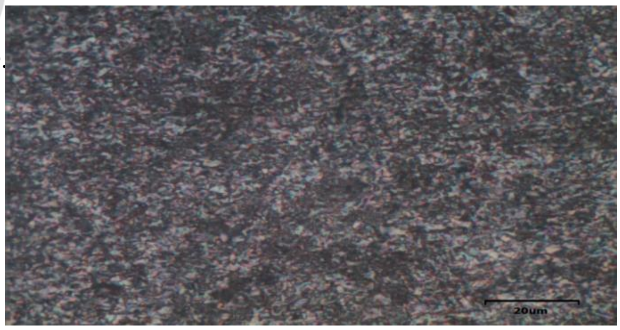


B



C.

D.



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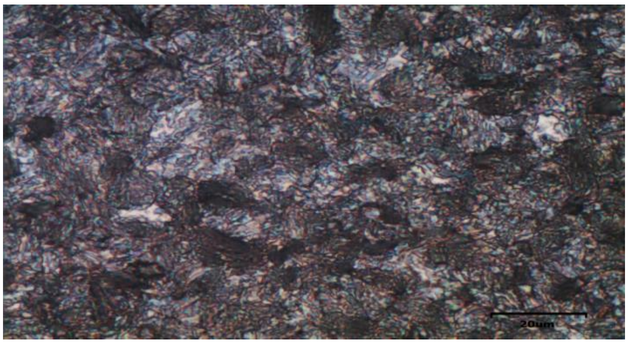

Figure 5.4 OPTICAL MICRO STRUCTURES OF RESISTANCE SPOT WELDED JOINTS FOR OPTIMAZED PARAMETER. (a)HAZ, b) FUSION ZONE, c) INTERFACE ZONE, d) FGHAZ ZONE, e) CGHAZ ZONE)

Microstructural examination of Resistance spot-welded DP-800 steel showed a sound and crack-free interfacial region. As illustrated by the optical micrographs given in figure 5.4. an overview of the Resistances pot joint revealed heat affected zone, fusion zone, interface zone, finer grain HAZ, CGHAZ, and different microstructural regions as indicated in the optical micrographs of figure 5.4.Optical microscopy of the weld zone revealed an evolution from fine grains in the heat-affected zone to coarse grains in the fusion zone. Since the highest temperature occurred in the fusion zone, the microstructures here were more closely examined. Fig. 5.4b shows columnar grains in the fusion zone. Their growing directions are approximately parallel to the electrode direction, i.e. along the direction of the temperature gradient. Within this zone, dendrites disappeared due to solid-solid transformation after solidification. The results indicate that the needle-like microstructure and the surrounding martensite lath have a cube-on-cube orientation relationship, which leads to their overlapping patterns. The HAZ consists of fully coarse-grained structure. In the as-welded condition. Shows in figure 5.4 b).

CONCLUSION

The mechanical properties and structural characteristics that were formed as a result of welding. The following conclusion can be drawn. The tensile shear strength is found to be increased with an increase in welding current up to a certain limit and then it decreases. The maximum tensile shear fracture load (21.4) kN was achieved in the optimized welding parameter.

1) The major welding parameter is welding current 70 (W), welding time 1 (sec), and welding pressure of 4.25 bar.
2) The higher hardness was recorded in the nugget area and the hardness reduces when the hardness was measured along the region along the interface to base metal.
3) The microhardness profile shows a peak hardness in the nugget zone (230HV) and the hardness is lower (160HV) in the HAZ.
4) The grains near the weld interface were found be to recrystallized compared to the grain size of the parent material, it is understood that increase in welding current led to an increasing degree of softening in the HAZ.

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