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Investigation of Mechanical Properties of Butt Joint Form in CMT-Brazed Joints of DP1000 Steel Plates Using Different Current Intensity[#]

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Abstract

In this study, DP 1000 (Dual Phase) steel plates having 1.2 mm thickness were joined by copper-based (CuAl8) wire in CMT-brazing (Cold Metal Transfer) technique. Specimens were prepared in joining forms as butt joint. CMT-Brazing operations were done with nine different CMT-Brazing current intensity of 40, 45, 50, 55, 60, 65, 70, 75 and 80 A. CuAl8 wire composed largely of copper serves as the filler metal were used. Having accomplished the CMT-brazing operations; tensile properties of joints were detected, and micro and macro-structures of joints were investigated in order to see the joinability of DP 1000 steel by CMT-brazing technique.

Keywords: DP1000 Steel, CMT-Brazing, Cold Metal Transfer

1. Introduction

The biggest factor in increasing usage of dual-phase steel DP in the automotive industry can be shown as favorable combinations of high strength and good ductility(Lee, 2015). DP steels, consisting of hard martensite islands in a continuous soft ferrite matrix (Jia, 2016). These two phases are high strength martensite and ferrite provide good elongation. So lightness, high strength and good formability properties of the automotive industry are provided by DP steels (Wang, 2016). In addition, methods of joining DP sheets are also important. There is a lot of work on this subject. Farabi (2011) DP600 and DP980, Wang (2016) DP1000 and Ma (2014), Xu (2012) DP980 sheets by laser welding, investigating their microstructure and mechanical properties. Ozsarac and Aslanlar studied the resistance spot welding of galvanized steels in automotive applications. In present paper, CMT process of DP1000 steels emphasis on the microstructure and strengthening behavior and mechanisms of the joint.

2. Experimental Studies

2.1 Materials

DP1000 steel plates was used in this study. In the tests DP1000 steel plates were 1.2 mm thickness. Steel plates were cut 200x200x1.2 mm. The sheets were positioned end to end to allow gaps between them 0.5 mm, and were subjected to joining by CMT-brazing process. The filler metal was a solid wire with a diameter of 1 mm, classified as AWS ER CuAl8, which is a copper-based, torch angle of 90°. Argon was used as the shielding gas at a flow rate of 12 L/min.

2.2 Methods and procedure

The surface of the samples was cleaned by acetone before CMT-brazing operations. The current values for CMT-brazing operation were determined as 40, 45, 50, 55, 60, 65, 70, 75 and 80 A in butt joint. Nine sets of welding parameters of different heat inputs were selected, as shown in Table 1. The heat input, HI is calculated using the Eq. (1) and (2) below.

$$HI_{linear} = \frac{(60 \times UI)\eta}{V} \qquad (1)$$

$$HI_{normalized} = \frac{HI_{linear}}{e} \qquad (2)$$

Where η_{CMT}: 0.7 is the arc efficiency factor, e: thickness (mm) U and I are the mean values for the arc voltage, respectively for the current intensity and V (cm/min.) is the CMT-brazing speed. CMT-brazing process parameters such as current intensity, voltage, wire feed speed, shielding gas at a flow rate of 12 L/min, brazing travel speed and brazing gap were presented in Table 1. All CMT-brazing tests were performed automatically on a machine with a robot.

3. Experimental Results And Discussion

3.1 Tensile tests

The experiments showed that most of tensile test specimens fractured from the base metal DP1000 steel. 55, 60, 65, 70, 75 and 80 A currents showed that the strength of the joint zone was higher than that of the DP1000 steel zone and the CuAl8 filler zone. It was obvious that the joint zone was strengthened. Moreover DP 1000 steel sheet, having 1.2 mm thickness, got punctured above 85 A. In Table.1 40, 45, 50 A, insufficient wetting occurred as a result of low heat input. Having examined the strength values in Table 1, it was observed that strength increased with the increase of current intensity.

3.2 Microhardness tests

Figure 1 shows the measured microhardness value of the joints for different CMT-brazing current intensity. It was seen that microhardness value was highest at HAZ and the HAZ hardness was higher than that of the copper filler and base material.

3.3 Macro and microstructures

Appearances of Macro and microstructures of the brazing seams for different current intensity are shown in Figure 2. The molten metal wetted the steel better when 80 A current intensity was used, comparing the samples brazed in 75, 80 A at lower heat input to samples brazed in 40, 45, 50, 55, 60, 65, 70 A. It was observed that the number of dendrites increased on the surface of the joint zone. These dendrites' action caused micro iron particles to melt and migrate, and to become distributed throughout the filler metal zone.

4. Conclusion

This work has presented an investigation on the effects of strength of current intensity. The conclusions from this study are given as follows;

- MIG-brazing method provided lower heat input in comparison with other fusion methods.
- The experiments showed that most of tensile test specimens fractured from the base metal DP1000 galvanized steel. In 40, 45, 50 A, insufficient wetting occurred as a result of low heat input. Moreover DP 1000 steel sheet, having 1.2 mm thickness, got punctured above 85 A.
- It was observed that strength decreased with the increase of current intensity. The best strength arose in 80 A current intensity.

Table 1. *experimental results for different current intensity*

Current intensity [A]	**Tensile strength [MPa]**	**Heat input [j/cm]**
40	10	676
45	403	767
50	470	860
55	655	962
60	680	1059
65	699	1165
70	705	1265
75	748	1378
80	752	1481

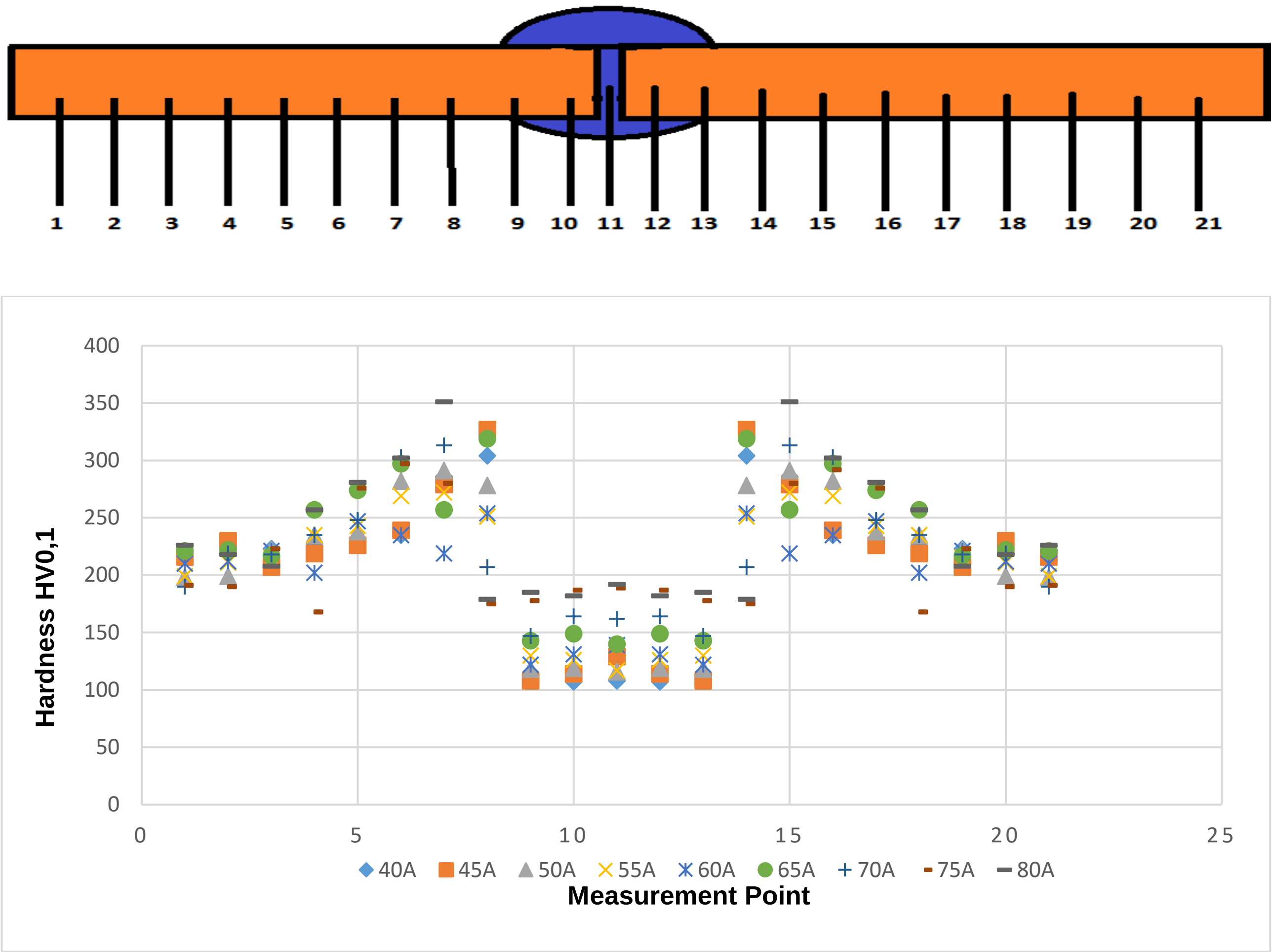

Figure 1. Hardness profile in Heat Affected Zone (HAZ) in DP1000

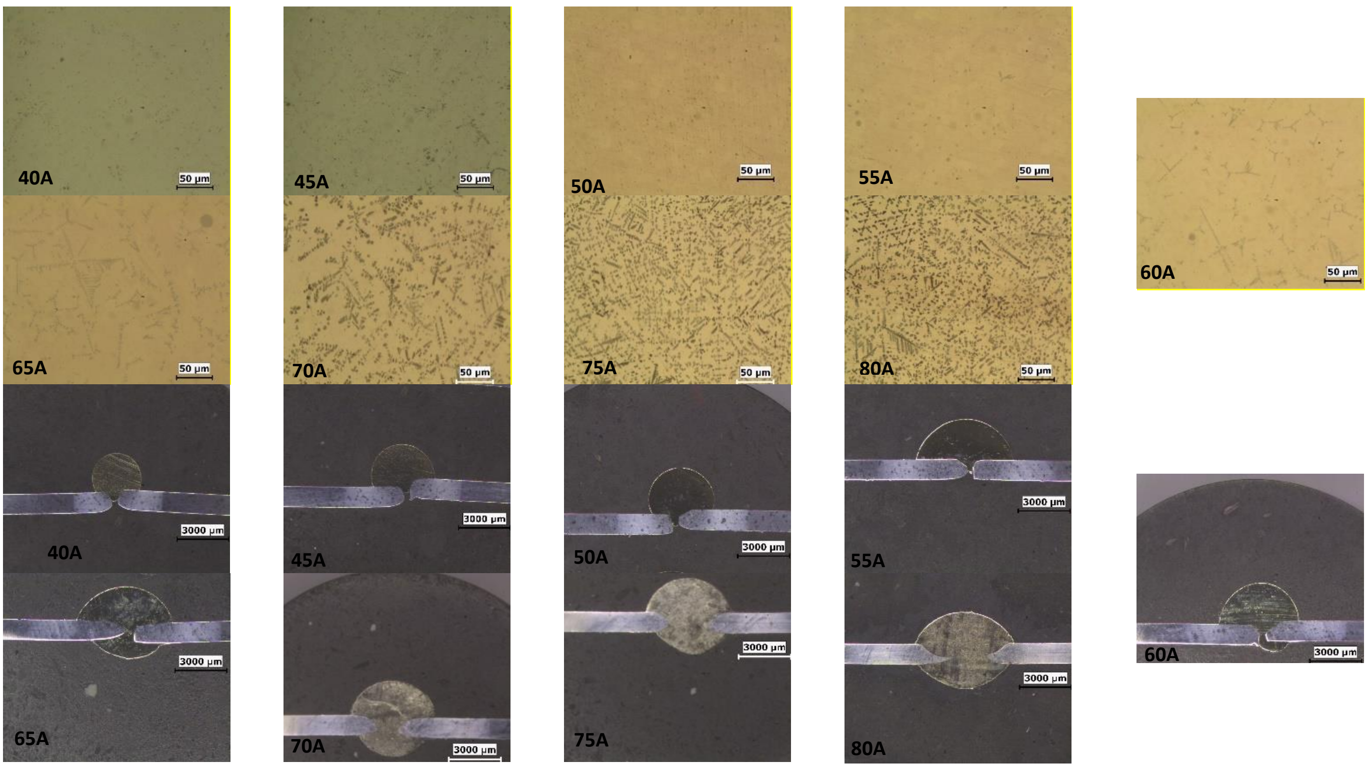

Figure 2. Macro and micro appearanceof the brazing seams for different current intensity

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