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An Effect of Weld Time on Dissimilar Welding Process of Dual Phase Steel and IF Steel

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In this study, dissimilar resistance spot weldability of galvanized DP steel and 7xxx series IF steel, which are widely used in the automotive industry, was investigated. In the welding process, the effects of welding time on three different cycles were examined. It was tried to examine the combinability of these two different types of steel and to determine elemental changes, hardness changes in the weld metal and SEM examination was performed. Breaking shapes are discussed.

Keywords; Automotive steels, Resistance spot welding, Microhardness, SEM.

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1. Introduction

Human beings are trying to develop products in a continuous phase. The main reason for this has been to provide human needs and comfort. The automotive industry is in the middle of these demands. Increased safety, environmental concern and high fuel expenses have to be necessary situation. Steel producers try to manufacture new steel kinds. The automotive industry is constantly evolving [1].

Dual phase steels (DP) with ferrite and martensite structures in its microstructure have high strength and formability and are frequently used in the automotive industry. DP steels, which were used in the early 1980s and occupy a large place in automobile manufacturing, have come up to date with increasing strength without compromising ductility. [2-4].

IF steels containing very little interstitial atoms show very good formability due to their low yield strength, high elongation and good deep drawability properties and are frequently used in the automotive industry [5-7]. One of the most important topics in the automotive industry is developing fuel-saving vehicles. One of the most important factors that provides this is the reduction of the vehicle weight and the vehicle weight.

The principle of electric resistance spot welding, which is a joining method in the automotive industry, is the method of welding with heat caused by the resistance of the workpieces against the electrical current passing through the workpieces held together under pressure between the electrodes. Resistance spot welding, one of the oldest electric welding processes using by the industry. The contact surface of the parts to be welded with a low voltage and high current applied for a short time and converted into a molten welding core. When the electric current is stopped, the molten metal cools rapidly and solidifies, so that the welding is finished [8-10].The weld is made by a combination of heat, pressure and time [11–15].

The connection between different steel types has used in automobile manufacturing. In this study, dissimilar joining was made. Point resistance welding properties of two different steels in three different welding time values were investigated.

2. Experimental Procedure

In this study, 7314 IF steel and DP 600 dual phase steel were used (Table 1).

Table 1. Chemical Compositions (wt%).

Steel	C	P	S	Mn	Al	Fe
DP 600	0,23	0,09	0,015	1,3	0,01	Kalan
IF7314	0,08	0,03	0,03	0,4	-	Kalan

1.0 mm thick steel and approximately 0.9 mm thick IF steel was cut in 30mm x 100mm dimensions. The materials placed on top of each other for 30 mm were applied on pneumatic and digital controlled point resistance welding machine at 8 kA welding current for 10, 20, 30 cycle welding time. 4 x 10^5 Pa electrode pressing force was carried out A microstructure study was observed with Zeiss microscope. tensile tests were carried out at a speed of 5mm / min on a tensile device with a capacity of 10 tons. SEM images were made at the MARGEM Laboratories of Karabuk University. In Figure 1 and 2, welding machine and welded sample sectional images are given.

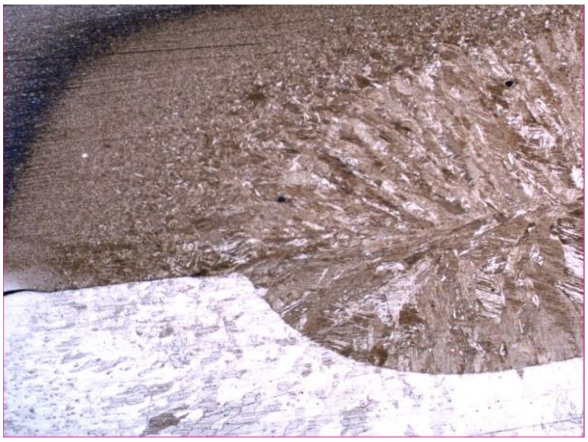
Figure 1. Welding Machine.

Figure 2. Cross section of sample

3. Results and Discussion

3.1. Microstructure

Microstructures of the welded connection are given below.



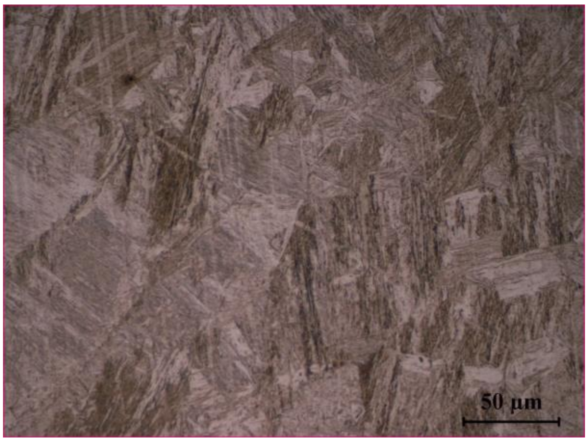


Figure 3. 500X 8kA- 10cycles; a) Welding button and HAZ b) fusion zone.

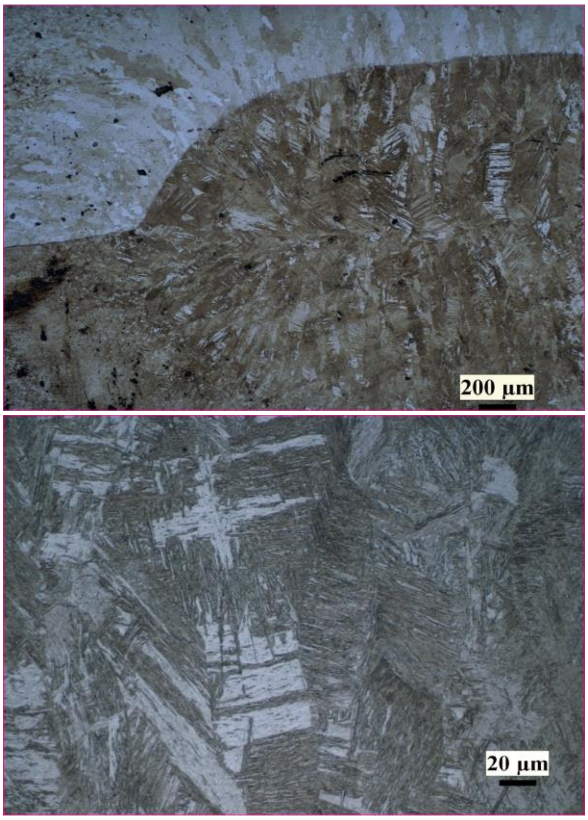


Figure 4. 500X 8kA – 20 cycle sample; a) weld button and HAZ b) welding metal.

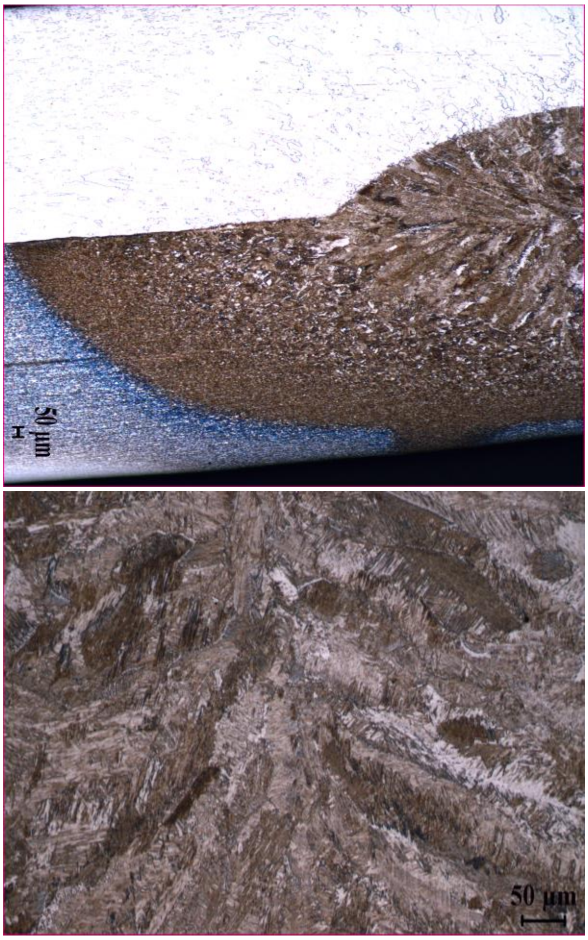
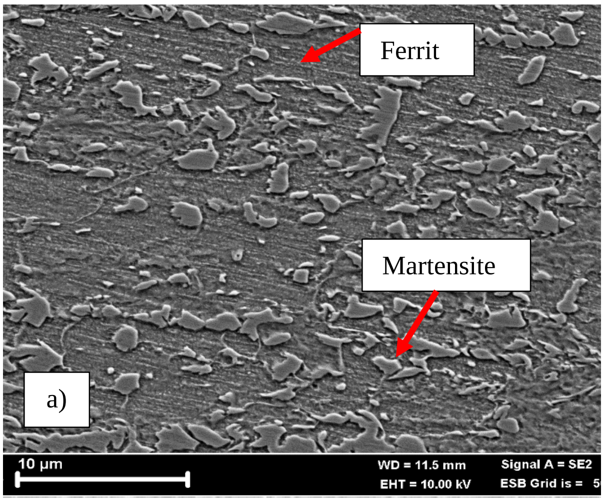


Figure 5. 500X, 8kA – 30 cycle a) IF HAZ, b) fusion zone.

It is thought that the images, especially in the weld metal, have been observed to grow. The reason for this is thought to be the longer exposure time of the materials with the welding time.

3.2. SEM Images

Microstructure photos of the samples before welding are given below (Fig 6).



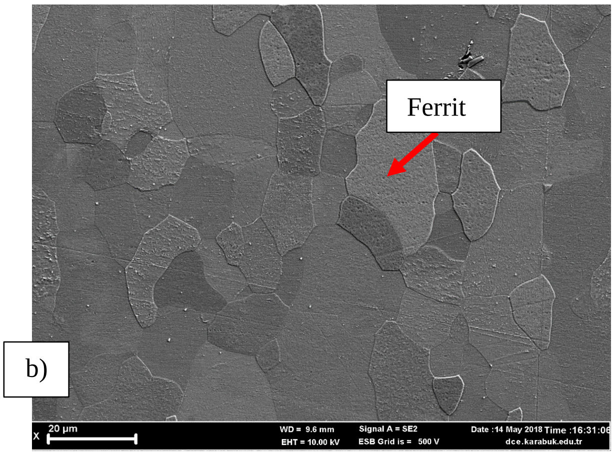


Figure 6. SEM images; a) DP steel, b) 7314 IF steel

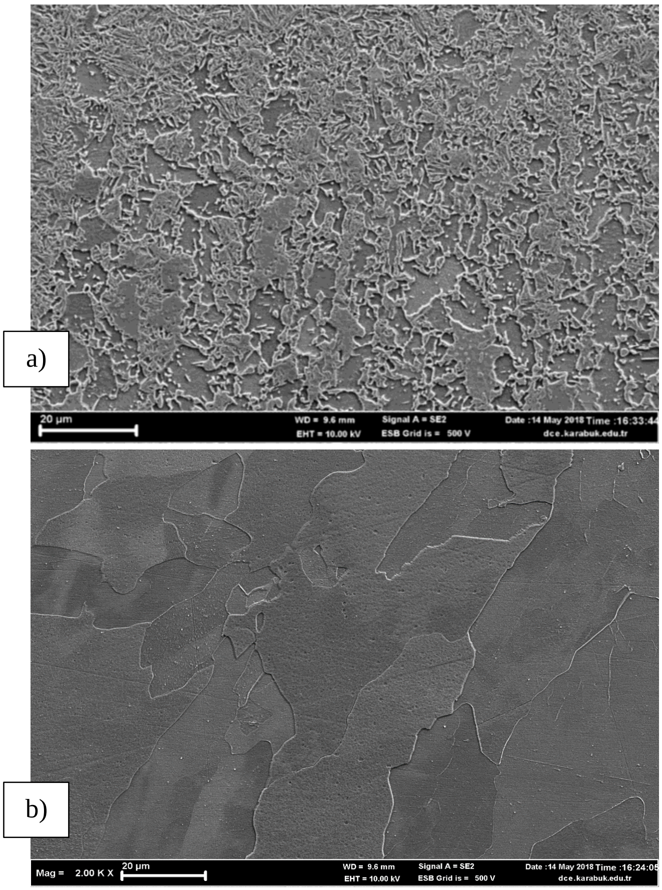


Figure 7. (2000x 8kA – 20 cycle a) DP 600 HAZ b) IF 7314 HAZ

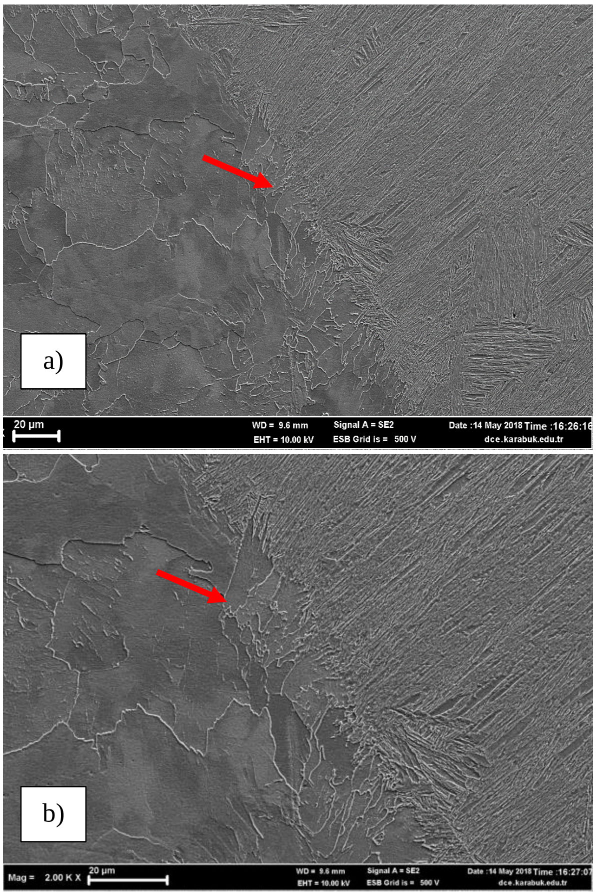


Figure 8. (2000x 8kA – 20 cycles) IF transition zone

According to SEM images, while the IF transition zone is rough, the DP region is thinner. In particular, a sharp orientation and grain size difference draws attention with the melting line of IF steel.

3.3. Hardness

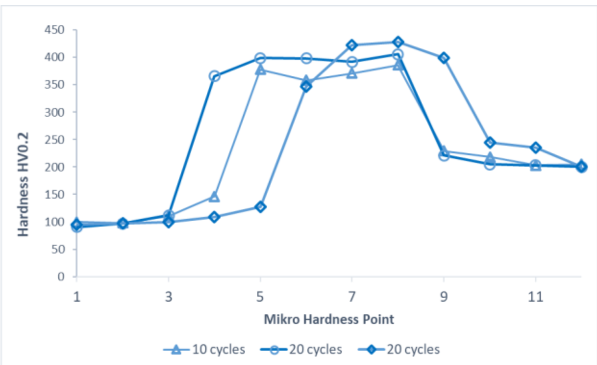


Figure 9. Hardness graphic.

The hardest area was the weld metal. the reason for this is the formation of martensite. Hayat [16], in his study, reported that DP600 steel is the metal of the hardest region in point resistance welding, and the values increase to 440Hv hardness. In our study, it was observed that there was no significant decrease despite dilution with IF steel. This is because the martensitic transformation occurs. If the elemental dilution was too high, a decrease in hardness would occur. However, there has been no dilution preventing the determining elements from taking an active role in the formation of martensite.

The photos below show the traces taken in the hardness test.

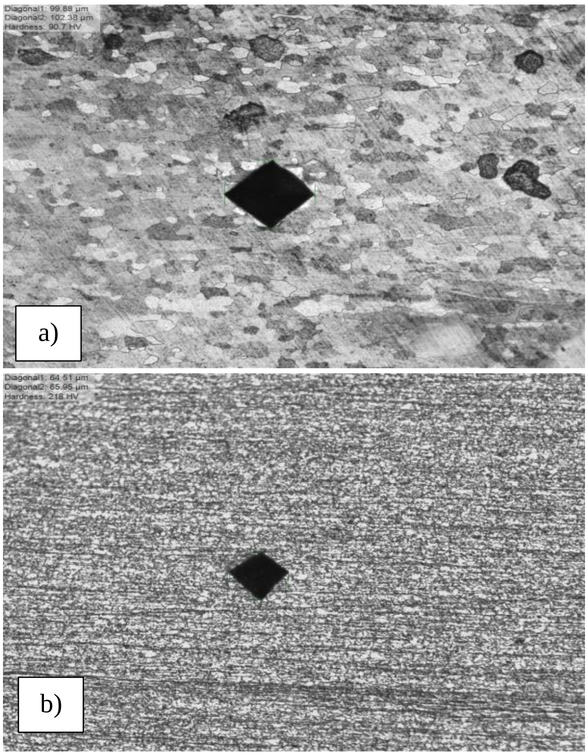
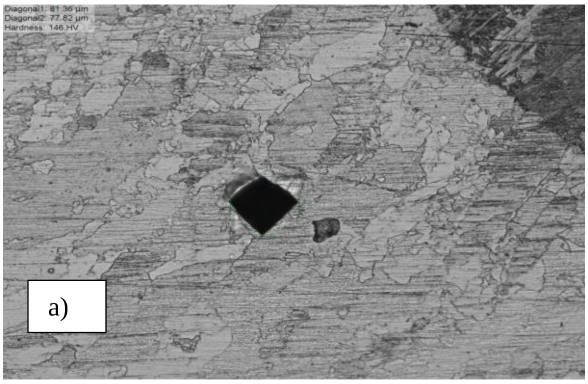


Figure 10. a) IF steel b) 7314 DP steel

According to the hardness results, the original hardness of IF steel is about 100 HV, while DP steel is about 200 HV. Transition zones and weld metal hardnesses were different. The hardness of the IF steel in the HAZ region increased as much as the weld center. The hardest area was observed in the HAZ of DP steel.



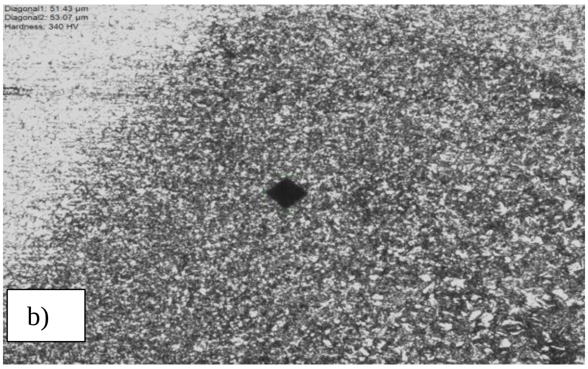


Figure 11. a) HAZ transion zone of IF steel b) HAZ transion zone of DP steel

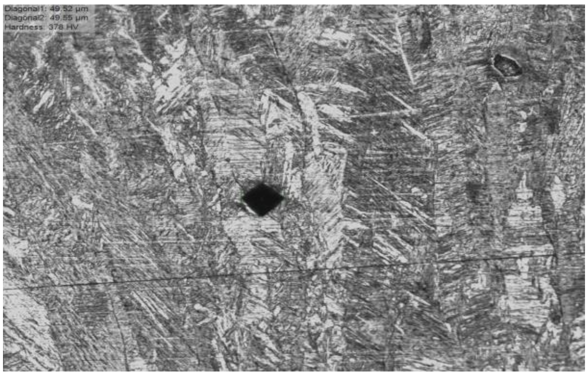


Figure 12. Fusion zone.

3.4. Tensile strength results

According to the pull shear test results of the welded connection, the values in the environment are as follows. The values of 120 MPa in 10 cycles, 121 MPa in 20 cycles and 119 MPa in 30 cycles were measured. Tearing photos are given below.

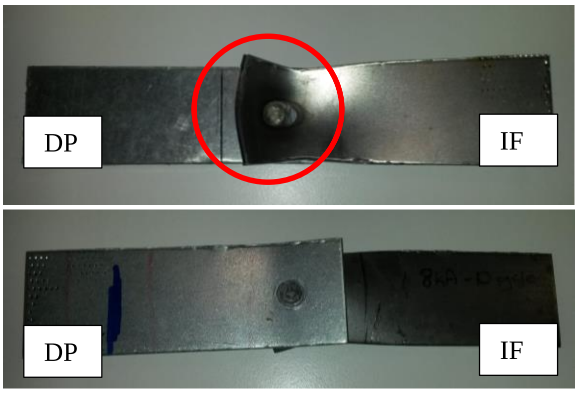


Figure 13. Tensile strength samples (after test)

In the tensile strength test, the splitting was on the side of the IF steel, which is ductile and low strength.

4. Conclusions

As a consequence,

The effect of weld time in 7314 IF steel and DP 600 steel joints with RSW was investigated.

• DP steel has a ferrite martensite microstructure, and IF steel has a ferrite microstructure.

• The HAZ transition zone of IF steel is coarse shape, while it is finer complex in DP steel.

• The softest region is determined in the basic structure of IF steel and the hardest region is determined in the HAZ of DP steel.

• As a result of the tensile test, it was determined that fracture occurred on the IF side.

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