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Mechanical Tests of the Dissimilar Welded Samples by Friction

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The paper presents the experimental achievement of heterogeneous joints, with dissimilar materials, as well as the analysis of these joints by mechanical and metallographic tests. After traction testing of the specimens, it was found that breaking occurred each time in the area of the base material, which leads to the conclusion that the strength of the welded joints is above the resistance of the base materials used.

Keywords: *heterogeneous joints, friction welding, mechanical tests*

1. Introduction.

Due to its special features, the friction welding has been imposed in relation to other welding processes, in terms of large productivity and the possibility of obtaining heterogeneous joints with dissimilar materials, sometimes metallurgically incompatible. [1]

2. Materials and equipment used.

The materials used are: general purpose steel S355JR, C45 quality steel and 34MoCrNi6 alloy steel.

When performing the welding of the components we used ZTa-10 type friction welding machine from the Welding Laboratory at the "Eftimie Murgu" University in Resita. The machine can weld bars and pipes, it is semiautomatic, the welding cycle is automatic and the handpiece is detached and detached by hand. The hydro-pneumatic system of the machine allows for stepwise adjustment of friction and discharge pressures. The control system contains transistorized time relays that control the welding cycle. The braking of the moving part is accomplished by reversing the rotation of the drive motor. The movable piece is trapped in an interchangeable elastic sleeve and the fixed piece is trapped pneumatically into the jets. The axial squeeze during friction and component splashing is controlled with a travel limiter. [2]

3. Parameters of friction welding regime.

The steel bars chosen above will be grouped as follows: 34MoCrNi6 + S355JR (2 samples), S355JR + C45 (2 samples) and 34MoCrNi6 + C45 (2 samples).

The input data required to determine the working machine parameters (friction pressure, friction time, discharge time, discharge pressure) are:

- bar diameter = 18 [mm];
- engine speed = 1500 [rpm];
- bar length = 150 [mm].

The friction time is chosen according to the thickness of the bars and will be chosen from figure 1.

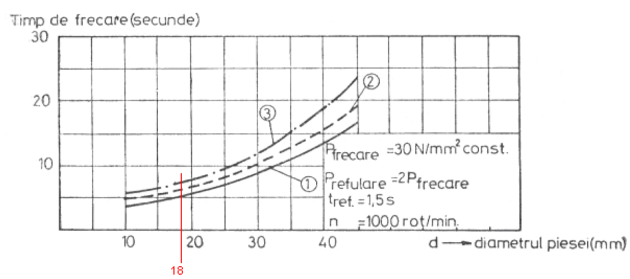

Figure 1. Determining the friction time depending on the thickness of the piece, [1]

Thus, with the diameter of the 18 mm bars, the friction time will be in the range of 5 to 8 seconds. The friction pressure depends on the material of the components, the carbon content and the alloying elements (increases with the alloying level), taking values of 30 – 60 N/mm^2 for the welding of non-alloy steels, respectively 60 – 120 N/mm^2 for austenitic stainless steels . The discharge time for steels will be within the range of 1 to 4 seconds. The discharge pressure is applied after the friction welding parts are welded by friction, and it is recommended that the discharge pressure be based on the friction pressure, preferably satisfying the ratio of:

$$\frac{P_{ref}}{P_{frec}} = 1{,}5 \div 3, \qquad (1), [1]$$

The axial slash is calculated with the following formula:

$$S_a = (0{,}5 \div 1) \cdot d \text{ [mm]}, \qquad (2), [1]$$

The parameters of the friction welding regime for the six samples are summarized in the table 1.

Table 1. Parameters of friction welding regime

Sample	Friction parameters		Discharge Parameters		Length of the samples	
	P_f [bar]	t_f [sec]	P_{ref} [bar]	t_{ref} [sec]	Before welding [mm]	After welding [mm]
1	5	8	4.5	2.5	300	279
2	3.5	6	4.2	2.5	300	282
3	3.5	6	4.2	2.5	300	286
4	3	6	4.0	2.5	300	285
5	3.8	8	4.2	3	300	283
6	3.5	8	4.0	3	300	284

4. Mechanical and metallographic tests.

From the six samples obtained, samples 2, 4, 6 were subjected to the determination of hardness, respectively samples 1, 3, 5 to the traction testing. The values resulting from these analyzes are presented in figures 2, 3 and 4.

There is an obvious increase in hardness in the areas adjacent to welded joints due to the hardening effect to which they are subjected. [3]

On the other hand, after traction testing of the specimens, it was found that breaking occurred each time in the core material area, which leads to the conclusion that the strength of the welded joints is above the resistance of the base materials used (figures 5, 6 and 7).

Macro and microstructural analysis was performed on samples 2, 4 and 6 (figures 8, 9 and 10).

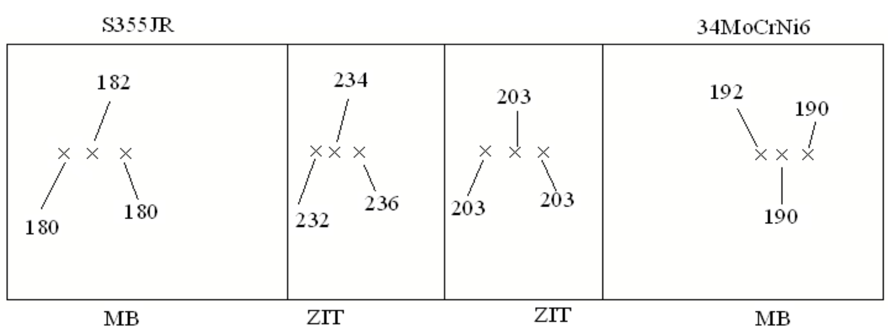

Figure 2. Sample 2: S355JR + 34MoCrNi6

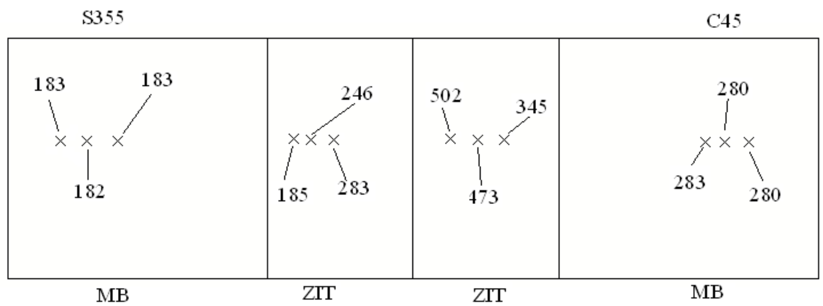

Figure 3. Sample 4: S355JR + C45

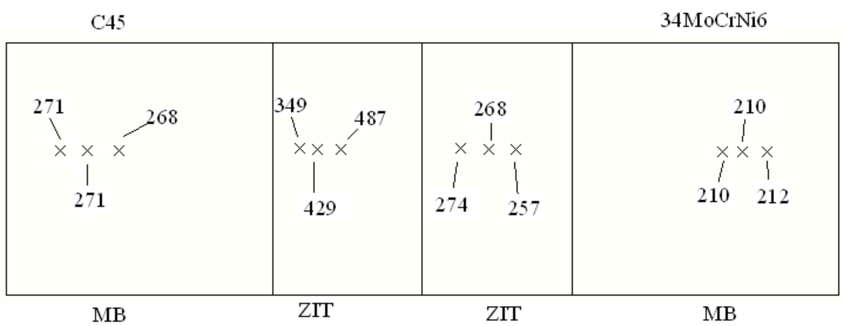

Figure 4. Sample 6: C45 + 34MoCrNi6

Figure 5. Sample no. 1 after the traction testing

Figure 6. Sample no. 3 after the traction testing

Figure 7. Sample no. 5 after the traction testing

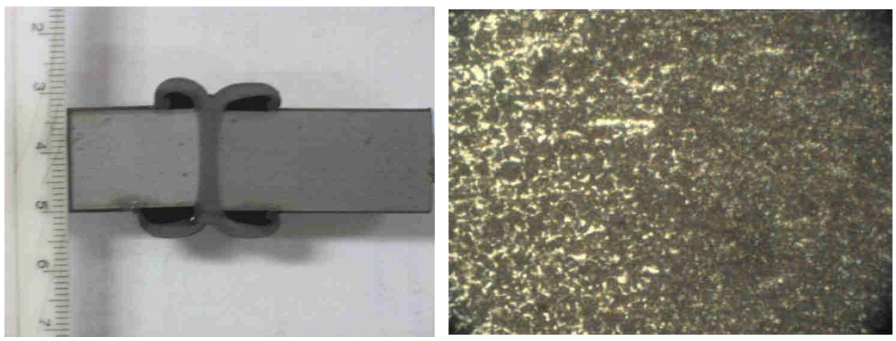

Figure 8. Sample no. 2: Macrostucture and shrinked area, 100x

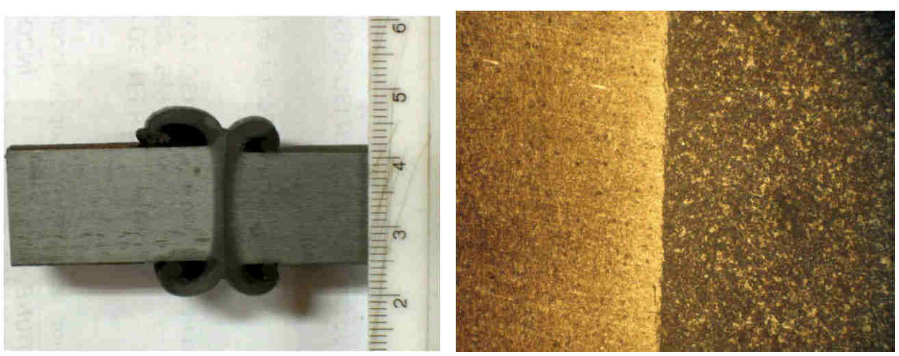

Figure 9. Sample no. 4: Macrostucture and shrinked area, 100x

Figure 10. Sample no. 6: Macrostucture and shrinked area, 100x

4. Conclusion.

As a result of the analysis of these samples, it can be stated that friction welding of dissimilar materials, sometimes even metallurgically incompatible, is a viable and productive technical solution.

References

[1] Ene T., *Pressure welding technologies*. Publishing house Eftimie Murgu, Reșița, 2012.
[2] Ene T., Megheleș M., Petrica A.V., *Pressure welding technologies*. Lab coordinator, Reșița, 1994.
[3] Petrica A.V., *General aspects of metallurgy and weldability of steels obtained by thermomechanical treatment or accelerated cooling,* Analele Universității "Eftimie Murgu" din Reșița, 1995.

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