3ème Conférence Internationale sur les Sciences Appliquées et l'Innovation (CISAI-2025)
Proceedings Book Series –PBS- Vol 25, 221-223

Box-Behnken optimization on RFW of AISI 304 stainless steel

D. SAIDI[1], A. DJABBAR HASSAN[2], A. BOUTIARA[1], Y. BELKACEMI[1]

1. Ecole Nationale Polytechnique, Alger, Algérie
2. Université des Sciences et de la Technologie Houari Boumediene, Alger, Algérie
djamel.saidi@g.enp.edu.dz

1. Introduction

In the field of mechanical engineering, welding processes play a crucial role in manufacturing of mechanical parts. Among these processes, rotary friction welding (RFW) stands out due to its ability to produce high quality joints with superior mechanical properties.
This article focuses on the optimization of parameters influencing rotary friction welding joints using the Box-Behnken designs approach.
The Box-Behnken design, a response surface methodology, offers an efficient way to explore the relationships between multiple parameters (rotational speed, friction pressure and time) and their effects on the response variable, ultimately leading to the optimization of the welding process.
The experimental work involves the preparation of AISI304 stainless steel specimens, the application of the RFW process under different conditions, and the subsequent testing of the welded joints for mechanical and metallurgical properties.
The optimized parameters can lead to improved joint quality, enhanced performance, and broader applications of RFW in various industries. Additionally, the use of the Box-Behnken design demonstrates a robust approach to process optimization that can be applied to other manufacturing processes [1, 2].

2. Results

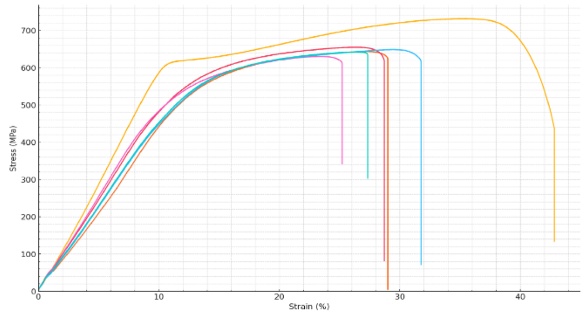
After varying the influencing factors, namely rotation speed, friction pressure and friction time, we obtained the results shown in the figure 1 below.

Figure 1. Welded test pieces

The welded specimens by varying the three influential factors, namely the rotation speed, the friction pressure and the time according to the Box-Behnken design.

ISSN: 2961-6611

Figure 2 shows the results of tensile tests carried out on standardized specimens welded by RFW.



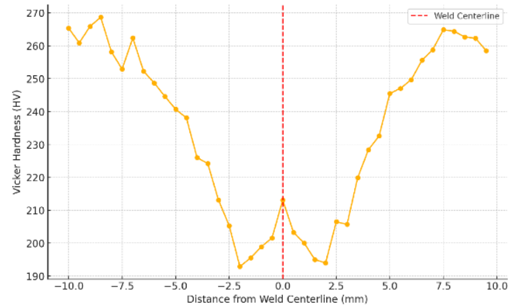


Figure 2. Stress-strain curves of specimens Figure 3. Hardness profile across the weld joint

The observations from the SEM images in Figure 4 and 5.

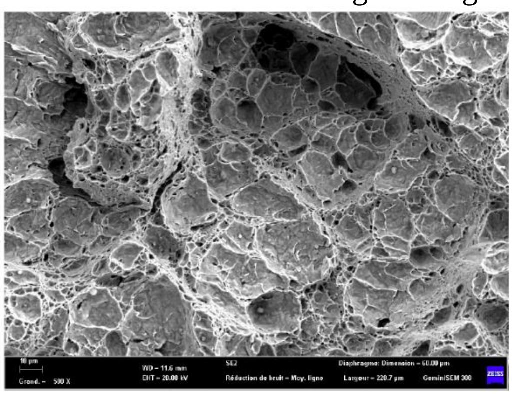


Figure 4. Base metal

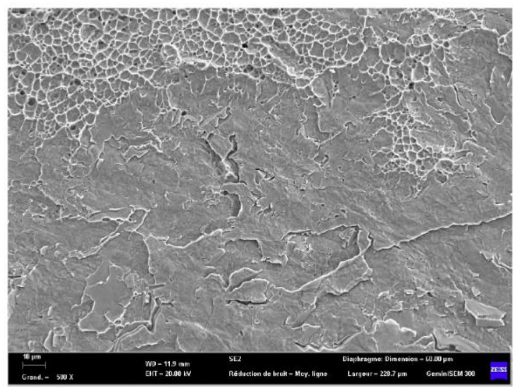


Figure 5. Welded specimen

3. Conclusion

The Box-Behnken design allowed for a comprehensive exploration of the interactions between multiple parameters, leading to the identification of the optimal conditions for the RFW process. The optimal parameters were found to be a rotational speed of 2500 Rpm, a friction pressure of 200 MPa and a friction time of 6 seconds. Experimental results demonstrated that these optimized welding parameters significantly enhanced the mechanical properties of the welded joints, and the microstructural analysis further confirmed the quality of the welds, with minimal defects and superior metallurgical structure according to the work carried out by researchers [3, 4, 5]. The use of analysis of variance provided a robust framework for interpreting the experimental data.

References

[1] Nisarg Shete and Swapnil Deokar. A review paper on rotary friction welding. 5:1557 – 1560, 06 2017.

[2] Roland CAZES. Soudage par friction. *Techniques de l'ingénieur Travail des matériaux-Assemblage*, (ref. article: b7745), 1996.

[3] M. Maalekian. Friction welding– critical assessment of literature. *Science and Technology of Welding and Joining*, 12(8):738–759, 2007.

[4] A. Jabbar Hassan, effect of friction time on microstructure, micro-hardness and tension-compression properties. *Acta Metallurgica Slovaca*, 26(3):78–83, 2020.

[5] PS. Gowthaman, P. Muthukumaran, J. Gowthaman, and CA. run. Review on mechanical characteristics of 304 stain less steel using smaw welding. *International Journal of Science and Technology*, 2(2):32–37, 2017.

ISSN: 2961-6611