Numerical and experimental analysis of aluminium Refill Friction Stir Spot Welding joints

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ABSTRACT

Friction stir welding is one of the newest methods of material joining. It is constantly developed and Refill Friction Stir Spot Welding (RFSSW) is one of its varieties. RFSSW is a solid-state joining technology. During the process, heat is generated as a result of friction between the tool and the joined materials as well as the material plastic deformation. RFSSW uses a rotating tool consisting of probe, sleeve and clamping ring [1]. RFSSW joints are produced in two ways. The difference between them is in the way the probe and sleeve plunge into the joined materials. In the first method the probe is plunged into the workpieces, but the sleeve is retracted. At the same time, the welded material is transferred to the sleeve location. Upon reaching the desired plunge depth, the tool is kept in that position. After that, the rotating probe is retracted from the welded joint and the material is pressed into the welded point by the sleeve. In the second method, the sleeve is plunged into the workpieces, but the probe is retracted [2]. RFSSW is an attractive process for manufacturers who need to reduce the weight of their assemblies by joining light-weight metals. To date the process is mainly used in the automotive and aerospace industries (the panel structures, load-bearing structures etc.).

In the paper numerical and experimental studies of tensile test of the uniform and welded samples are presented. The specimens are made of 7075 aluminium. The welded samples are made using RFSSW technology. Material properties, which have been determined experimentally for the uniform specimens, were assumed in the numerical calculations. The numerical calculations were performed with the ADINA System based on Finite Element Methods. For the uniform samples the experimental and numerical calculation results of elongation and changes in thickness were compared. For the welded samples, which varied in location of RFSSW spots, the tensile forces were determined experimentally, while the reduced stress and plastic strain distributions were determined numerically. The numerical studies of RFSSW spot welded specimens indicated that the initiation of failure occurred in the edge zone of the welds.

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REFERENCES

[1] Derlatka, A., Lacki, P., 2015, Numerical investigation of Refill Friction Stir Spot Welding joints, Computer Methods in Materials Science, 15, 144–149.

[2] Derlatka, A., Kudła, K. and Makles, K., 2014, Numerical analysis of RFSSW joints, 11th World Congress on Computational Mechanics (WCCM XI), eds, Oñate, E., Oliver, X., Huerta, A., Barcelona, Spain, 6807–6816