Process Optimization for flexible Self-Pierce Riveting of Multi-Material Structures

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Abstract. One of the most important mechanical joining technologies for mixed car body constructions is self-pierce riveting with semi-tubular rivet (SPR-ST). In order to achieve appropriate joint quality at SPR-ST, it is often necessary to use individual process parameters like die geometry or rivet length for each material and thickness combination. In this paper a method is presented, that allows to increase the flexibility of the SPR-ST process by an optimization of process parameters in regard to join several material combination with one die geometry. Thereby FEM simulation combined with statistical approaches are used to develop an optimized SPR-ST process.

In the presented investigation seven different material combinations with steel and aluminum sheets are considered. In the first step for each of these joints one individual parameter set (die geometry, rivet length) is used as reference joint. For all material combinations simulation models are validated by comparing the joint geometry as well as force-stroke-data of experimental references and the numerical simulation (Figure 1).

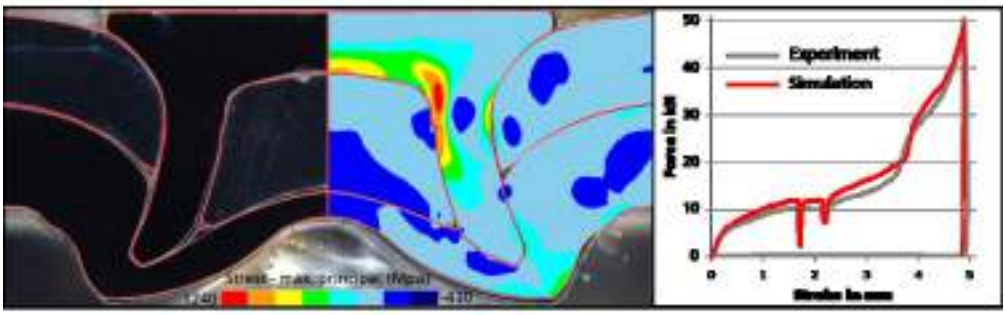

Figure 1: Validated simulation model for SPR-ST of EN AW-5182 in CR240YLA; left: joint geometry; right: force-stroke-data

Based on these validated models numerical sensitivity analyzes are executed for every material combination in order to investigate correlations between the process parameters and characteristic SPR-ST values (Figure 2).

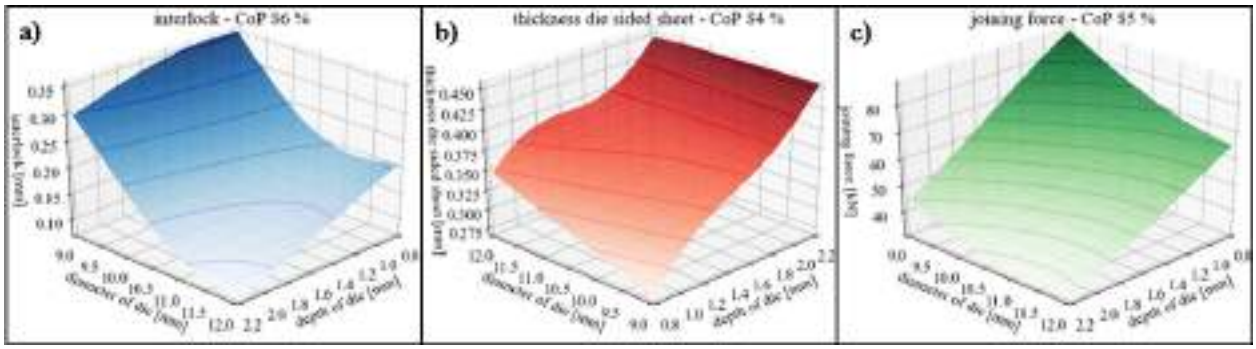

Figure 2: Results (metamodels) of the sensitivity analysis for SPR-ST of EN AW-5182 in CR380YLA

With the data of these analyzes, optimizations are exerted, in order to reduce the number of needed dies, without reducing the joint. Two different optimized die concepts are presented and compared with regard to flexibility.