Parametrization Of Bi-Parametric Friction Laws Through Inverse Modelling Of Conical Tube-Upsetting Tests

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Abstract. Friction is an important process parameter for metal forming processes. Thus, comprehensive knowledge about friction behavior is mandatory for knowledge based process design. Due to effects like increasing effective contact area or changes in surface topography, friction stresses often change during forming processes. Mono-parametric friction models like the Coulomb law or the friction factor model are not directly capable to consider above-mentioned effects. These models represent a dependency of the friction stress only on the normal stress or the yield stress, respectively. However, improved models consider influences like relative velocity between contact partners and plastification of the workpiece material. Most of these newer models though involve two or more parameters, which need to be determined. Consequently, these laws cannot be parametrized by conventional methods like comparison of the final workpiece geometry with pre-calculated nomograms. Therefore, in this study, the parametrization of a bi-parametric friction model through inverse modelling of the conical tube-upsetting test is presented. For this purpose, conical tube-upsetting tests of an industrial case hardening steel were carried out. During the forming process, the shapes of the specimen were measured online by a profile-laser. The measured profiles are used, to compare the evolution of the experimental shapes to those of an according FE-model. An algorithm automatically optimizes the parameters of the used bi-parametric friction model by minimizing a cost function. All experiments were repeated three times with equal testing conditions. Moreover, the optimization process was repeated several times with different start-parameters to avoid local minima. Using the finally determined parameters, the evolution of the simulated specimen shape is in good accordance with the experimental data. Hence, the paper presents an inverse modelling strategy to determine parameters of bi-parametric friction models.