Material modelling based on comparison between simulations and experiments

A.J. Koopman, H.J.M. Geijselaers, J. Huétink

Institute of Mechanics, Processes and Control - Twente
University of Twente
P.O. Box 217, 7500 AE Enschede, The Netherlands
phone +31-(0)53-4893405, email a.j.koopman@utwente.nl

Introduction

Simulations are used increasingly more in the aluminium extrusion die design practise. The simulations can predict velocities, stresses and forces. However an accurate material model is neccesary to get reliable results. The material properties of aluminium under extrusion conditions are hard to determine with simple experiments. We show a method, that uses the comparison between simulations and extrusion experiments to determine the material properties more accurately [1].

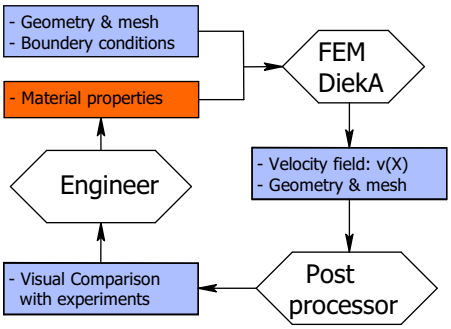

Figure 1 : Determining Material properties

Experiment

In figure 2 is shown how an aluminium billet is cut into slices, inbetween the slices a copper grid is placed. Then the compleet package is extruded op to a certain length. After extrusion the billet is cut in half and the deformation is made visible through the copper.

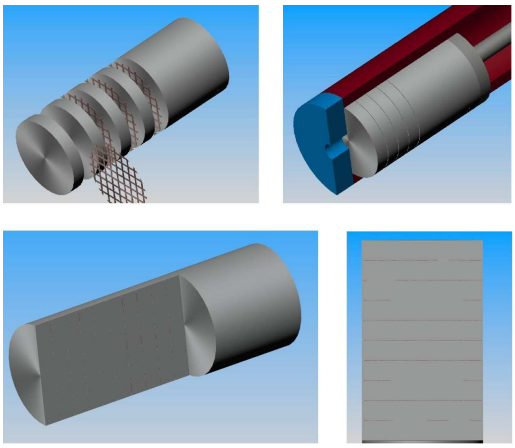

Figure 2 : Experiment

Simulation

Dieka is used to determine the steady state velocities inside the container and die (Figure 1). In the post-processing step these are the input to create the frontlines to match the experiments. During post-processing equation 1 is solved.

$$\frac{Df}{Dt} = \mathbf{v} \cdot \nabla f = 1 \tag{1}$$

The f-field represents the time it takes to travel from a point on the f=0 iso-line to another point in the domain. Iso-lines in that field should coincide with the experimental results. The above equation can rewritten in the waek form and using a SUPG method for stabilizing

$$\int_\Omega (w + \alpha \mathrm{h} \frac{\mathbf{v}}{\| \mathbf{v} \|} \nabla w)(\mathbf{v} \cdot \nabla f) d\Omega = \int_\Omega (w + \alpha \mathrm{h} \frac{\mathbf{v}}{\| \mathbf{v} \|} \nabla w) \quad d\Omega \tag{2}$$

Comparison

The material properties are now determined such that the results coincide best with experiment 1. In Figure 3 can be seen that after fitting also experiments 2 and 3 agree very well with the simulations.

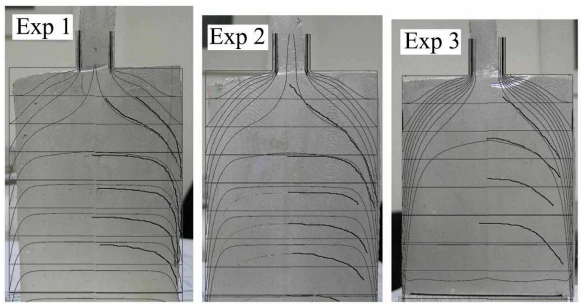

Figure 3 : Comparison

References

1. Koopman, A. J. et al (2007) A SUPG approach for determining frontlines in aluminium extrusion simulations and a comparison with experiments. AIP Conference Proceedings, Volume 907, pp. 602-607