

Anisotropic finite plasticity in production technology – experimental validation and finite element modelling

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The hard competition in economy requires a significant reduction of cost and time in production processes. For this reason computational modelling becomes more and more important. Future developments should bring us in the position to at least partially replace elaborate and expensive testing procedures by so-called virtual testing methods, i.e. process simulation.

The realistic modelling of production processes involves different crucial aspects. One point is the material description which has to be as accurate as possible. Most production processes include materials with metallic components which show complex inelastic phenomena, various hardening mechanisms and evolving anisotropy. The material behaviour strongly depends on temperature in most cases. A promising strategy to arrive at a good material model is to work at different scales, i.e. exploit the knowledge about the microstructural behaviour of metals and transfer it to the macro scale where the simulation is performed. In the present contribution we seek to combine such a procedure with the classical continuum mechanical modelling of inelastic materials. Very important is at this point the exploitation of data from multiaxial experiments.

However, the material model is usually not the reason for a possibly unsatisfactory numerical robustness of a process simulation. In this regard, the issues of finite element technology, the choice of the contact algorithm and finally the solution method, e.g. implicit or explicit, play the more important role. For this reason one part of the talk will be devoted to the modern state of the art in finite element technology. In particular, a new solid-shell formulation is presented which allows the implementation of arbitrary continuum mechanical material laws without additional kinematic assumptions. In its newest version, the element includes the ANS and the EAS concept as well as special procedures to improve mesh distortion sensitivity, numerical stability and the design of the hourglass stabilization.

The contribution closes with various applications in the field of production technology, ranging from typical forming simulation to robot-based incremental forming and ring-rolling. The challenge for the future to replace experiments by computational testing raises the question of a sufficient validation of both the numerical and the experimental results which will be also discussed at the end.