Optimum path and discrete 3D forming

technische universiteit eindhoven

Optimum path and discrete 3D forming

S.H.A. Boers, P.J.G. Schreurs, M.G.D. Geers
Eindhoven University of Technology, Department of Mechanical Engineering

Introduction

A discrete die enables a variable strain path during forming; products with an optimized internal strain distribution can be produced, e.g. the lifetime of parts carrying cyclic (thermal) loading can be enhanced considerably. From an industrial perspective, discrete die forming is a useful concept in a small-lot production environment because different products can be made with the same reconfigurable die and many resources are saved.

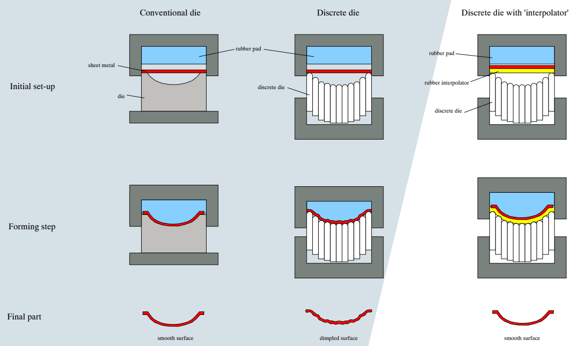

Figure 1 *The concept of discrete die forming uses reconfigurable pins in combination with a rubber interpolator to prevent the dimpling of the product.*

Objective

A numerical tool to calculate, using the deformation path dependent Teodosiu model, time-varying die shapes, yielding different internal strain distributions for geometrically identical products. Validation will be done by using the prototype of the discrete die.

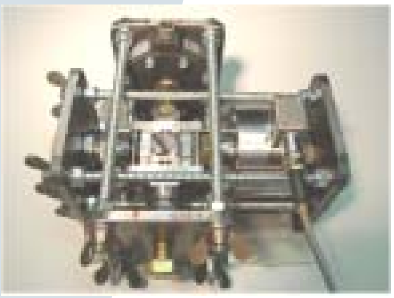

Figure 2 *Prototype of high resolution discrete die with a working volume of 10x20x30 mm that consists of more than 500 discrete elements.*

Methods

- ☐ Deformation path dependent forming experiments with the prototype for validating the numerical material model.
- ☐ Determination of strain distribution and product geometry with photogrammetry technique.
- ☐ Numerical algorithm, providing the intermediate die shapes for an optimally formed workpiece.

Results

Geometrically equal products have been fabricated with three different loading paths of which one is proportional and two are non-proportional. Different results are obtained for the two non-proportional loading paths. In a two-step forming experiment, a sample without defects is produced whereas the one-step formed sample has fractured at the center.

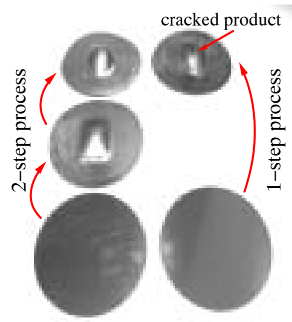

Figure 3 *Multi-step forming experiment with discrete die.*

The proportional loading path results in a sample with minimal thickness reduction at the center compared to the two non-proportional loading experiments.

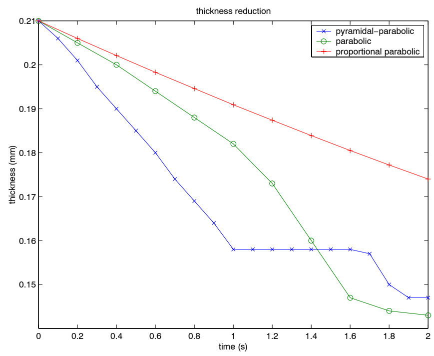

Figure 4 *Thickness reduction of the center for the proportional, one-step and two-step forming experiment.*

Discussion

- ☐ The Teodosiu model and material parameters must be validated by doing non-proportional loading tests with the prototype.
- ☐ A criterion must be formulated to define an 'optimally formed' workpiece.
- ☐ A numerical tool must be implemented within FEM framework to determine intermediate die shapes .

References

- ☐ S. Li, E. Hoferlin, A. v. Bael, P. v. Houtte and C. Teodosiu (2001), Finite element modeling of plastic anisotropy induced by texture and strain-path change,International Journal of Plasticity 19 (2003), 647-674

PO Box 513, 5600 MB Eindhoven, the Netherlands