Optimum path and discrete 3D forming

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

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. From a scientific point of view: a discrete die allows a changing 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.

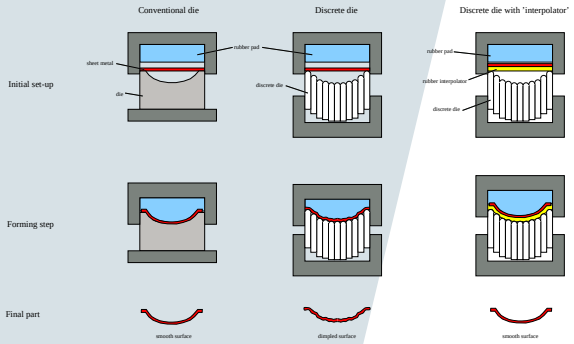

Figure 1 *Rubber pad forming with conventional die, reconfigurable die and interpolator.*

Objective

A numerical tool to calculate, using non-proportional forming-limit diagrams, time-varying boundary conditions of a deformation process, yielding different internal strain distributions in geometrically identical products. Validation will be done by using an experimental set-up. The numerical tool controls the internal strain distribution by means of non-proportional forming-limit diagrams.

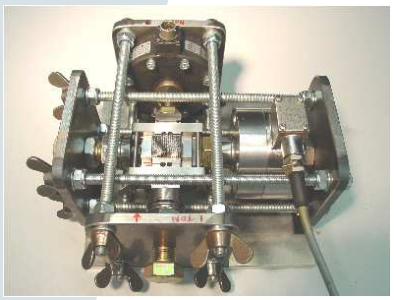

Figure 2 *Prototype of discrete die, surface dimensions: 20x30 mm, forming pressures up to 5 ton.*

Methods

- Experimental deformation process with discrete die prototype in which the strain path is variable.
- Determination of strain distribution and product geometry with photogrammetry technique.
- Numerical algorithm, providing boundary conditions for an optimal deformation process.

Results

Using the discrete die and photogrammetry technique, two geometrically equal products are produced with different strain distributions.

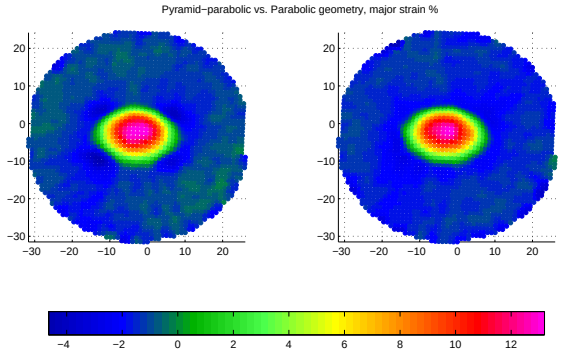

Figure 3 *Distribution of major plastic strain for two geometrically identical products.*

Using the reconfigurable die, a product without defects is produced with an intermediate forming step.

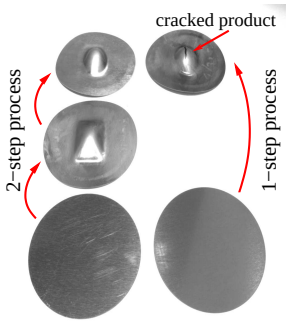

Figure 4 *Multi-step forming experiment with discrete die.*

Discussion

- Non-proportional loading tests must be done for model input.
- Implement numerical tool within FEM framework.
- Criterion must be formulated to determine optimal strain distribution.
- Automated control of discrete die is preferable.

References

1. 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
2. C. Zhongyi and L.Mingzhe, Optimum path forming technique for sheet metal and its realization in multi-point forming, Journal of Materials Processing Technology, Volume 110, Issue 2, 19 March 2001, Pages 136-141

PO Box 513, 5600 MB Eindhoven, the Netherlands