Optimum forming strategies with a 3D reconfigurable die

technische universiteit eindhoven

Optimum Forming Strategies
with a
3D Reconfigurable Die

S.H.A. Boers, P.J.G. Schreurs, M.G.D. Geers

Eindhoven University of Technology, Department of Mechanical Engineering,
PO Box 513, 5600 MB Eindhoven, the Netherlands

Discrete Die Forming

A reconfigurable die is an adequate solution for **small lot and prototyping manufacturing processes**, where conventional rigid dies are too expensive, especially when a rubber pad forming configuration is chosen with an additional rubber layer to prevent dimpling.

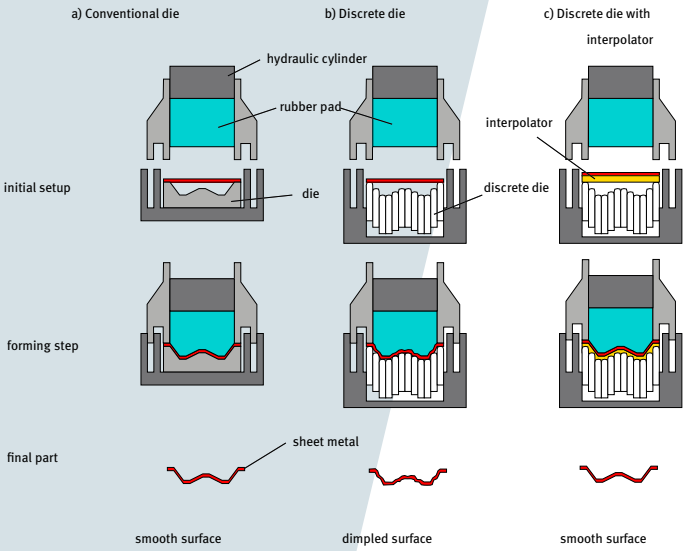

Figure 1 *Rubber pad forming with conventional die, discrete die and interpolator.*

This technique has a great potential for many applications with an increasing demand of special, personalized products, e.g. medical applications. Furthermore it can be used as a **research tool** to investigate **strain path dependent material** behavior through an efficient multi-step manufacturing process.

Research Method

A **fully automated forming device** has been developed where 1846 elements are reconfigured within a working volume of $40 \times 50 \times 25$ mm^3 in 5 minutes.

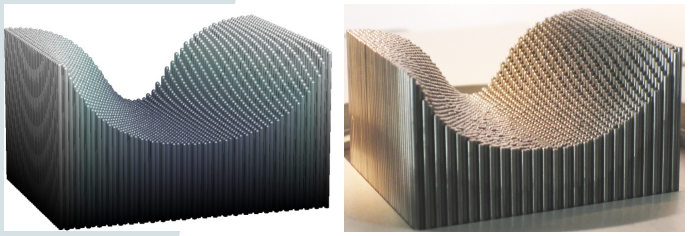

Figure 2 *The digital input geometry (left) and the real discrete surface (right) of the forming device.*

/department of mechanical engineering

The **Teodosiu strain path dependent model** has been used to optimize the thickness distribution of a benchmark product which is manufactured by applying 8 different loading paths.

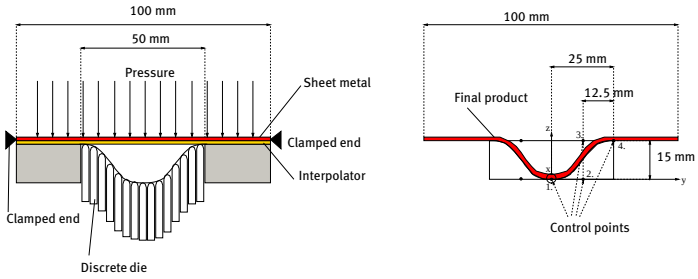

Figure 3 *Benchmark product of DC06 steel. The die shape is defined according a Bezier curve, which is determined by four control points.*

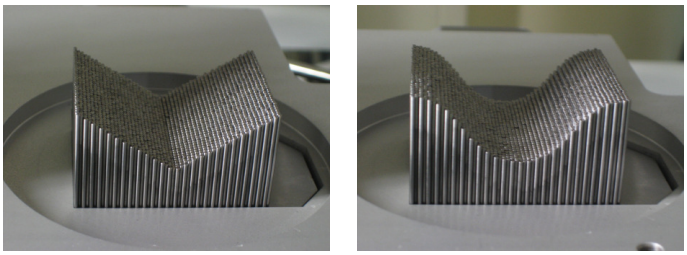

Figure 4 *Starting with 8 different die geometries, e.g. the geometry on the left, the final benchmark product is manufactured during 10 sequential steps, ending with the geometry on the right.*

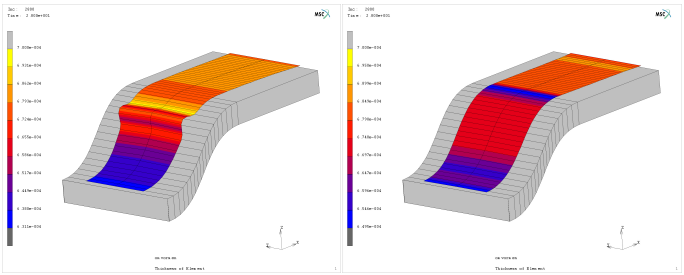

Figure 5 *The final thickness distribution is presented for two forming paths. A wrinkle is formed on the left whereas a nearly homogeneous thickness reduction can be observed on the right.*

Conclusions

- A fully **automated reconfigurable die** has been developed and used as a research tool for investigating strain path dependent material behavior.
- For DC06 steel, all 19 material parameters for the **Teodosiu model** have been determined by various experiments (pure bending, tensile and shear tests) combined with a finite difference method.
- A **optimum forming** sequence is proposed and validated with the discrete die for the multi-step fabrication of a benchmark product.
- The developed discrete die concept has a **great potential** for many forming applications where traditional dies are too expensive.