Numerical modelling of the blanking process

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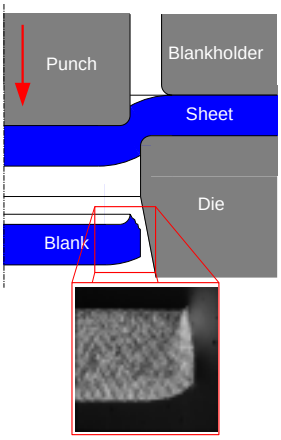
D. Brokken, W.A.M. Brekelmans and F.P.T. Baaijens

Eindhoven University of Technology,
Faculty of Mechanical Engineering,
Section Materials Technology,
P.O. Box 513, NL 5600 MB Eindhoven

1 Introduction



Knowledge : empirical

⇓

Process development :
trial and error

1.1 Objective

Validated finite element model to predict product shape

2 Problems

- ☐ Extreme deformation
- ☐ Ductile fracture
- ☐ Thermal and viscous effects

2.1 Large deformation

☐ Operator Splitted ALE :

1. Updated Lagrange step
2. Update nodal positions
3. Convective step :

Discontinuous Galerkin :

$$\int_\Omega w\left(\varphi_g - \varphi_g^{old} - \vec{u}_g \cdot \vec{\nabla}\varphi_g\right) d\Omega - \underbrace{\sum_{elems} \int_{\Gamma_e^i} w\vec{u}_g \cdot \vec{n}\,(\varphi_g - \varphi_g{}^{ext}) d\Gamma}_{Upwinding\ term} = 0$$

◇ $\varphi_g{}^{ext}$ handled explicitly → φ_g can be solved on element level

◇ Renumbering in flow direction → fast convergence

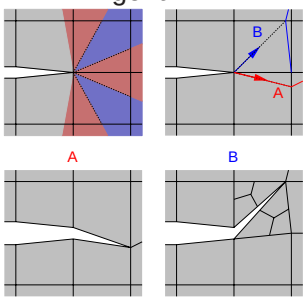
☐ Frequent remeshing needed

2.2 Ductile fracture

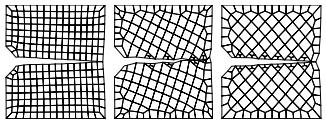
☐ Physics : growth and coalescence of voids

☐ Modelling : Discrete Crack approach

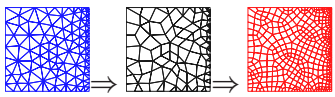
◇ Local Mesh Modification Algorithm :



Mesh objectivity :



◇ Global Mesh Modification :
Mesh generator :
Conversion △ → □ :



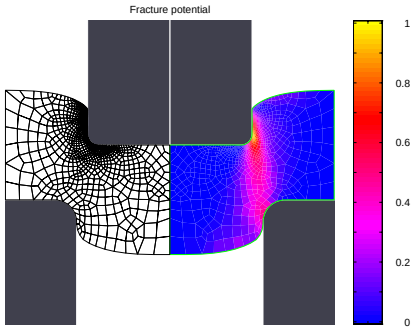
☐ Crack direction :

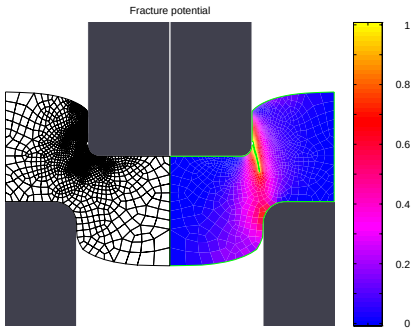
◇ Derived from crack potential (Damage like parameter, no influence on constitutive behaviour)

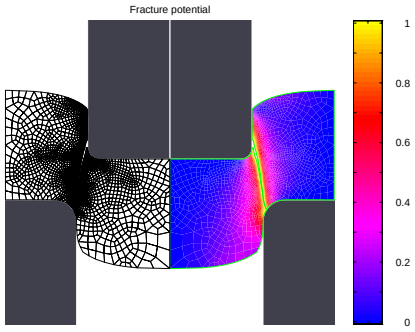
◇ Potential from void growth (Rice & Tracey)

$$\int_0^{\bar{\epsilon}_p^f} 0.427 \exp\frac{3\sigma_m}{2\bar{\sigma}} d\bar{\epsilon}_p$$

3 Results







4 Future

- ☐ Validation with experiments
- ☐ Inclusion viscous, thermal effects