

Adaptive coupled finite element analysis of the blanking process

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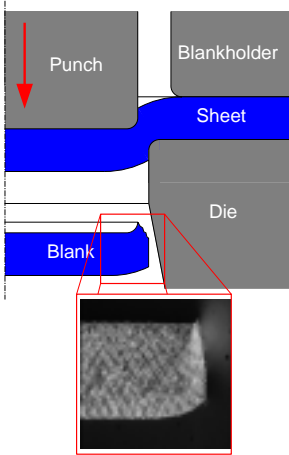
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Adaptive coupled finite element analysis of the blanking process

1 Introduction



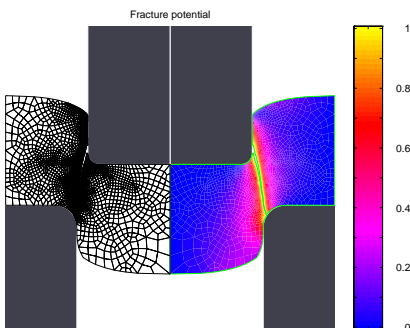
Knowledge : empirical
↓
Process development :
Trial and Error

1.1 Objective

Validated finite element model
to predict product shape

2 Solved problems

- Extreme deformation :
OS-ALE + remeshing
- Ductile fracture :
Discrete (fracture potential)



3 Open problems

- Solution accuracy ?
- Thermal and viscous effects

3.1 Solution accuracy

Remesh adaptively :

- Estimate element errors in stress σ^h and plastic strain $\bar{\epsilon}_p^h$:

$$e_\sigma = \int_{\Omega_e} \|(\sigma^h - \sigma^*) : (\sigma^h - \sigma^*)\| d\Omega$$

$$e_{\bar{\epsilon}_p} = \int_{\Omega_e} |\bar{\epsilon}_p^h - \bar{\epsilon}_p^*| d\Omega$$

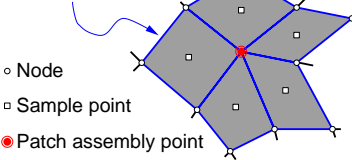
'exact' continuous σ^* and $\bar{\epsilon}_p^*$?

*Superconvergent Patch Recovery*⁴



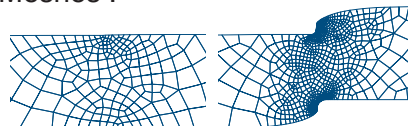
Least square approximation on patch assembly points :

element patch



- Predict element size h
- Generate mesh accordingly :
Conversion $\Delta^3 \rightarrow \square^2$

Meshes :

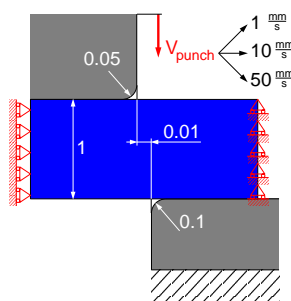


3.2 Thermal, viscous effects

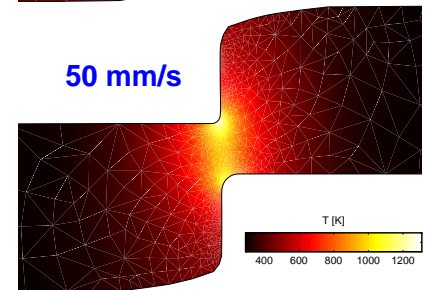
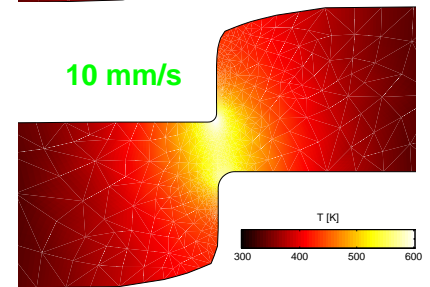
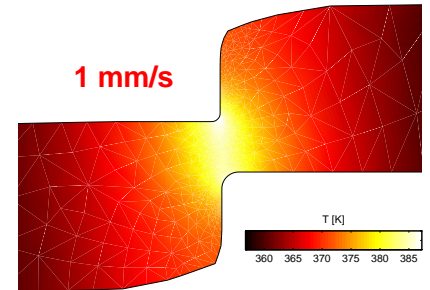
- Compressible Leonov
- Viscosity : *Bodner Partom*¹
with thermal influence

4 Results

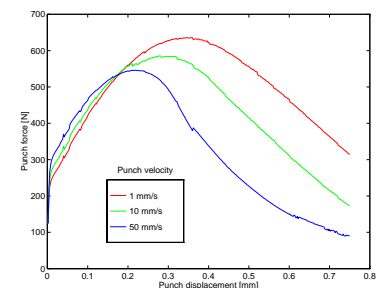
Model (no fracture) :



4.1 Temperature



4.2 Blanking force



5 Conclusions

- Adaptive → error control
- Significant thermal effect

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