Determination of elasto-plastic properties of aluminium

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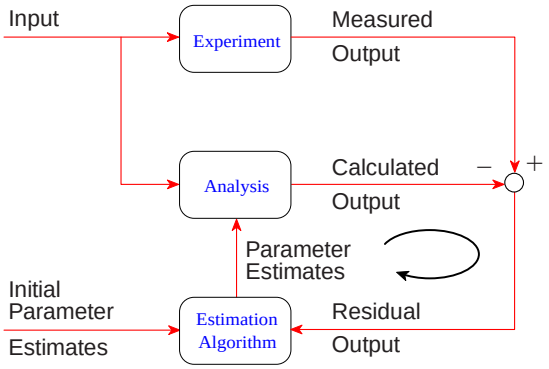
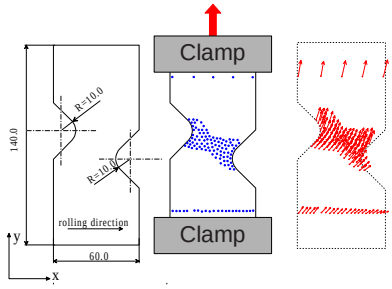
Introduction

Due to inelastic deformations, metals can exhibit anisotropic plastic behaviour. Typical examples are rolled sheets or plates. A mixed numerical-experimental method is used to determine parameters in a constitutive model describing this type of behaviour.

Numerical-Experimental Method



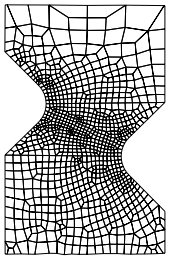
Experiment and Observations



Sample geometry, positions of markers, and measured displacements at 0.3 mm clamp displacement.

Model and Boundary Conditions

The sample is modelled using 985 bilinear plane stress elements. The measured displacements of the markers near the clamps and the measured clamp force are used as boundary conditions.



Finite element mesh.

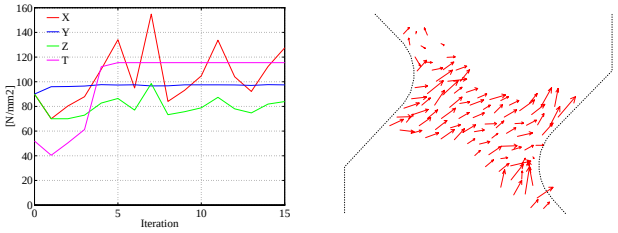
Elasto-Plastic Constitutive Models

Elastic part: Hooke's law.

Plastic part: Hill yield criterion.

Parameters: X (yield stress in x-direction)
Y (yield stress in y-direction)
Z (yield stress in z-direction)
T (yield stress in xy-plane)

Estimates and Residual Output



Estimated parameters and residual output for final parameter estimates

The estimate of Y is in good agreement with yield stresses determined from uniaxial tensile tests. The estimates of X and Z do not converge to stable values, while the estimate of T is unrealistic. Apparently the experiment doesn't contain sufficient information to determine these parameters. Most likely, this is caused by the particular alignment of the rolling direction to the tensile directions.
The residual output for the final estimates is approximately 5% of the measured output. Deterministic patterns can be discerned in the residual output which indicate the presence of one or more (small) modelling errors.

Conclusions

- Not possible to determine all parameters in Hill yield criterion using the current experimental setup.
- Better results are expected when rolling direction of the plate is not parallel or perpendicular to tensile direction.

Acknowledgements
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