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Published: 01/01/2002

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Download date: 02. Jan. 2019
Improving the opening behaviour of food cans
an experimental and numerical study

S.H.A. Boers, P.J.G. Schreurs, H.C.E. van der Aa, M.G.D. Geers
Eindhoven University of Technology, Department of Mechanical Engineering

Introduction
In recent years, food cans with a completely removable lid made of steel have become very popular.

The deformation mechanisms and formation of damage is critically observed because all experiments are done under the objective field of a microscope.

Numerical simulations
An elasto-plastic plane strain analysis is performed with a gradient enhanced damage formulation. A damage variable \( \omega_p (0 \leq \omega_p \leq 1) \) is introduced into the yield function:

\[
 f(\sigma, \varepsilon_p, \omega_p) = \sigma_{eq} - (1 - \omega_p)[\sigma_y(\sigma_{eq}, \varepsilon_p) \leq 0
 \]

To avoid mesh-dependency, the value for \( \omega_p \) is a function of a non-local variable. In this study it is related to the non-local effective plastic strain \( \varepsilon_p \). To obtain \( \varepsilon_p \) from the field of \( \varepsilon_p \):

\[
 \varepsilon_p = \frac{1}{l_m \omega_m} \nabla \cdot \varepsilon_p = \varepsilon_p 
 \]

B.C.: \( \nabla \cdot \varepsilon_p \cdot \bar{n} = 0 \)

in which \( l_m \) represents an intrinsic length scale of the material and is based on the size of plastic zones during the deformation process.

Conclusions
- Opening forces can be reduced considerably when the formation of damage during the groove forming process is controlled by combining different material properties, groove geometries and depths;
- The numerical analyses are capable of simulating very large deformation grades up to \( \varepsilon_p \) of 4. However, more research is needed to obtain more realistic analyses;
- The use of friction appears to be very important during the numerical simulations;
- More research must be done to relate local strain fields to the formation of damage;
- In the future, it will be possible to simulate the forming of a complete can lid from sheet metal. An appropriate load can be applied to obtain the mode-1 and mode-3 performance.