Modelling long term behaviour of glassy polymers

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Introduction

Long term failure of glassy polymers appears to be governed by plastic localisation phenomena. Whereas at high stresses ductile behaviour prevails, the amount of localisation increases with decreasing stress until finally brittle failure occurs (Figure 1).

A similar transition in failure mode is also observed in short term loading. Moreover, it proved possible to give good quantitative descriptions of the short term behaviour using the compressible Leonov model [1]. Therefore the objective is to investigate the applicability of the compressible Leonov model to long term loading conditions.

Material parameters

The material parameters required for the calculations can be determined from compression data as shown in figure 2 (left).

Table 1 Final material parameters for simulations.

<table>
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<th>Value</th>
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<td>E</td>
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<td>E.T.J. Klompen, L.E. Govaert, H.E.H. Meijer</td>
<td></td>
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</tbody>
</table>

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Observations

From the results of the numerical simulations shown in figure 3 the following can be observed:

1. Time to failure

The slope of the failure curve is captured well, but failure occurs too early. Reason for this is the first order evolution of the strain softening, resulting in a too pronounced softening at the yield point (figure 4, left). Reducing the softening strength results in an increasing time to failure (figure 4, right). A more realistic description of the strain softening would therefore improve the time-to-failure prediction considerably.

Future work

- Improve softening description and implement the improved kinetics
- Modelling of temperature and stress dependence of ageing kinetics
- Implementation of ageing kinetics

References:


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