Modelling of Material Damage Using Finite Elements and Time Homogenization in Case of Finite Strain

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Abstract

The limiting factor in the use of elastomeric parts is mainly the change of their mechanical properties due to mechanical loading and environment. Mechanical loading and various environmental factors lead to cumulation of microcracks and even changes in chemical composition of the material. Typical characteristics of service conditions in which elastomeric parts may operate are large deformations and multiaxial loading. To model such conditions accurately, nonlinearity of both the basic material properties and the damage-cumulation properties must be considered, which makes traditional approaches to fatigue calculation unsuitable. The long simulation in time domain is the most general procedure offering to incorporate various effects (such as fatigue or ageing). The downside of such approach is its computational cost in the case of high-cycle loading. Therefore, homogenization in time is addopted to make the simulation duration acceptable exploiting the fact that both the mechanical loading and the response of the material can be locally decomposed into a slow and fast (periodic) component. The method has been successfully used in the case of cyclic loading with different material models [1,2,3].

This contribution presents an application of the above mentioned method to a nonlinear finite-strain material model of strain-induced softening (damage) and numerical examples (initial boundary-value problems). Spatial discretization is done using finite element method and the time-stepping schemes are compared (full simulation against the homogenized formulation).

References

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