BUCKLING ANALYSES OF VISCOELASTIC STRUCTURES CONSIDERING AGEING AND DAMAGE EFFECTS

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Summary. In this work formulation, computational models and results for the buckling of structures made of ageing and damaged viscoelastic material are given, and compared with experimental and analytical results.

1 INTRODUCTION

The durability of structures in composites of polymeric base is affected by diverse factors, among which creep deformation, ageing and damage. The present work studies the viscoelastic buckling of ageing and damaged materials. Ageing is related to elapsed time (in different environment conditions) while damage is related to stress and strain effects. Two types of ageing may be considered: physical ageing and chemical (or environmental) ageing.

In the first case (here identified as hardening case), an increase of the elastic stiffness, and a decrease the viscoelastic compliance are observed; in the second (softening case) the opposite behaviour may occur. In the full paper, expressions for ageing and damage and the corresponding expressions for creep are given.

2 FORMULATION AND EXAMPLES

In [1] the general formulation for viscoelasticity with ageing is given, both for the hardening and softening cases, as well as the corresponding state variables equations.

The results for viscoelastic buckling in hardening and softening cases are given in Fig. 1. In the unaged and age-hardening situations, the buckling do not occurs because the applied load does not reach the creep-buckling load value.

In [2] a model for continuous damage combined with viscoelasticity was proposed. The starting point was the formulation connecting the elastic properties to the tensor of damage variables. A hardening law associated with the damage process was identified from available experiment results and the rate-type constitutive equations were derived. This elastic damage formulation was used to formulate an internal variable approximation to viscoelastic damage in the form of a nonlinear Kelvin chain. Elastic and viscoelastic equations were implemented into a finite element procedure. The corresponding code was checked against experimental results as shown in Fig. 2 and used to study the effect of damage on the buckling strength.
CONCLUSIONS AND FINAL COMMENTS

The buckling of structures made of ageing and damaged viscoelastic material is studied. Computational results are compared with experimental and analytical results. Although the examples given are simple, the Finite Elements code is sufficiently general, allowing the analysis of complex structural types.

REFERENCES