The Proper Generalized Decomposition applied to the numerical simulation of elastoplastic problems with thermomechanical loadings

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ABSTRACT

The Finite Element calculation of asymptotic states of elastoplastic structures subject to numerous loading cycles is generally a heavy task, when using classical step by step algorithms for time integration. The problem becomes even harder when ratchetting phenomena take place in the structure and must be estimated (see e.g. [1-3]). The aim of this work is to present the development of the Proper Generalized Decomposition in the case of elastoplastic problems and to show its ability to determine the elastoplastic states resulting from cyclic loadings [4].

The first part of this work is dedicated to the formulation of the problem. By separating space and time variables and using Finite Element approximations for both kinds of variables, it will be seen that the method leads to search a series of modes, each one being a solution of two coupled non-linear systems of equations and that such procedure can be applied for any kind of material constitutive equations. The implementation of the Proper Generalized Decomposition is also developed and different strategies of computation are discussed.

In the second part, examples will be given to demonstrate the capabilities of the method for efficiently solving elastoplastic problems and to simulate complex cyclic evolutions with ratcheting effects. In particular, the method is applied to industrial structures subjected to thermal and mechanical cyclic loadings.

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