An improved LATIN framework for fatigue damage computations

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ABSTRACT

The solution of structural problems with nonlinear material behaviour in a model order reduction framework is investigated in this work. A large time increment (LATIN) scheme is utilised with a focus on decoupling its linearised formulation from the constitutive model taken into account, as well as improving its computational efficiency to address variable loading cases.

A critical barrier to LATIN approaches is the simulation of variable fatigue loads due to the inapplicability of the two-timescale technique, usually utilised along with LATIN in fatigue cases [1]. The proposed implementation approximates the structural response within a material independent framework, i.e. different material models may be incorporated straightforwardly. Loads with variable amplitudes are addressed in a semi-incremental manner, where full cycles are simulated consecutively. A low-rank approximation, in terms of proper generalised decomposition (PGD) of the solution, is sought directly in the online phase of the LATIN scheme, and no offline phase is considered so far [2].

Different orthonormalisation techniques were tested to ensure the optimality of the PGD generated modes. Following the assessment, a randomised SVD algorithm, that introduces beneficial time saving by limiting the number of modes compared to a Gram-Schmidt procedure, was selected. A LATIN and a displacement formulated standard finite element incremental frameworks are implemented to illustrate their differences in terms of computational time and memory footprint. Examples with variable amplitude loading are investigated to demonstrate the numerical efficiency of the presented method.

REFERENCES

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