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High-order cycle jump integration of a fatigue damage model

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Accurate models for the long term behavior of concrete structures are important to ensure a durable and reliable design. A variety of interacting phenomena, such as the loss of prestress, the degradation due to chemical reactions or creep and shrinkage, influence the fatigue resistance. Therefore, a reliable numerical model to predict the performance of concrete over its lifetime is required.

The presented fatigue model is an extension of a static damage model to allow easy coupling in a multiphysics context. The evolution equation of the damage driving variable is enhanced to allow damage growth below the static limit [1]. The model is defined in the time domain and does not include the number of cycles as a parameter. Thus, it can capture both static and cyclic failure. Additionally, this allows calibrating the majority of the model parameters static experiments.

The model is integrated by resolving each loading cycle, requiring about ten time steps per cycle. The high computational costs are handled via a time scale separation [2, 3]. The short time scale describes one cycle with marginal changes in the internal variables. These changes are integrated along the large time scale of material deterioration. Various high-order time integration schemes are compared.

Wöhler curves relate loading amplitudes to the number of cycles that the material endures. They are used to validate the model against experimental data.

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