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A gradient-enhanced fatigue damage model to simulate compressive fatigue behaviour of high-strength concrete

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In many applications, high-strength concrete is subjected to cyclic compressive loads which may lead to fatigue damage and eventually failure of the concrete structure. In experiments one can observe that due to compressive fatigue loads high-strength concrete does not exhibit dominant discrete cracks but rather a widely distributed damage behaviour during the initial damage phase (phase I) and the Paris regime (phase II) of the fatigue process.

In this contribution, a fatigue damage model is presented based on a gradient-enhanced equivalent strain model and an equivalent strain history dependent reduction of the material strength similar to the fatigue phase-field approach presented in [1]. Compared to the fatigue phase-field model, the presented damage model has the advantage that it can reflect the distributed damage field accurately [2]. The model accounts for the very different behaviour of concrete under tensile and compressive loads. The material strength is reduced locally only during the loading phase of each load cycle to make sure that the unloading phase does not contribute to the weakening of the material.

By means of a comparison of the results for selected experiments and corresponding simulations of specific mesostructures of high-strength mortar and concrete it is demonstrated that the presented model can reflect the phase I, phase II and also phase III of the fatigue damage and failure process accurately.

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