A Three-Dimensional Constitutive Model for Low- and High-Cycle Fatigue Behavior of Concrete at the Meso-scale

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In this paper a new 3D visco-elastic-plastic damage model is proposed to describe the behavior of concrete subjected to cyclic loadings until failure. The proposed model uses a modified version of the pressure-dependent Menétrey-Willam yield surface [1] to account for damage and fatigue. Meanwhile, the viscous behavior is modelled by means of the B3 model by Bažant and Baweja, and implemented through the exponential algorithm [2]. Specifically, the damage formulation considers two damage variables to account for the different degradation processes in tension and compression, and a stiffness recovery function to account for crack-closure effects during the cyclic loadings [3]. The fatigue model is based on the assumption of the reduction of the size of the elastic-domain, by including a fatigue softening function to the Menétrey-Willam yield surface. The proposed model also allows for the assessment of fatigue accumulation within the yield surface, based on the amount of extension experienced during high-cycle fatigue. A random distribution algorithm for the placement and compaction of polyhedral shaped aggregates, in agreement with a prescribed gradation curve, is used for the solid modeling of concrete samples at the meso-scale. The effectiveness of the model is discussed based on the juxtaposition of numerical results obtained by the presented approach, and experimental ones available in literature.

References

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