Multiscale Concrete Modeling for Aging Degradation

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ABSTRACT

In this work, we propose to improve existing and develop new continuum damage models at different length scales within the framework of the finite element method (FEM) and the continuum strong discontinuity approach (CSDA) to assess the fatigue life and the deterioration of reinforced concrete structures. Efficient and robust multiscale continuum damage models of mechanisms that are responsible of the degradation at different length scales and their mutual effects on initiation and propagation of microcracks and macrocracks will be developed. Representative volume element (RVE) of different scales will define the mutual linkage of chemo-physics and mechanistic events, which are used to simulate the macroscopic behaviors of structural concrete under combined external loads and ambient conditions. The proposed approach will be incorporated within the eXtended Finite Element Method (XFEM) with embedded discontinuities to model the cracks. The realistic modeling of these processes of crack opening and propagation is a prerequisite for reliable prognoses of the safety and the durability of reinforced concrete structures. The computational scheme and material models will be implemented in user-defined subroutines of a commercial finite element code (ABAQUS/Standard) in which the XFEM will be integrated. The durability models will also be implemented in a post-processing user-defined subroutine to evaluate the performance life of concrete structures based on the material internal state variables. The proposed approach is expected to serve engineers in charge of design, planning, and policymaking the durability of NPP reinforced concrete structures.