Eigenerosion for Reinforced Concrete under High Dynamic Loads Considering Viscoplasticity

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ABSTRACT

A realistic fracture model comprises the consideration of different aspects in the material behavior and the underlying mathematics and physics. The problem becomes even more intricate when a complex material as concrete is considered. State-of-the-art approaches nowadays are based on a variational approach of fracture thoroughly documented in [1]. A subclass of the aforementioned theory is the variational eigenfracture introduced in [2] and generally elaborated into the Finite Element (FE) context in [3] via a regularized element erosion technique. Very good results have been achieved for static and dynamic Griffith-like brittle fracture in [4].

In this work, the material behavior of concrete is modelled via a rate dependent Drucker-Prager yield function with caps where the isotropic hardening depends on the plastic multiplier and its rate. This constitutive relation is built into the microplane framework to account for the induced anisotropy that the approach provides. Reinforcement in concrete is also considered and modelled using existing approaches. Furthermore, as far as fracture is concerned, the energy balance of the variational formulation is modified to account for plasticity. The model automatically delivers the increase in the concrete strength for high loading rates, an effect which in literature is represented by the Dynamic Increase Factor (DIF). The modification of the fracture energy maintains the sequential convexity of the energy functional ensuring the existence of minimizers even though, these might be merely local ones. Representative dynamic numerical examples are used to validate the capabilities of the method.

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