A coupled model for simultaneous damage, healing and capillary flow in cementitious materials

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ABSTRACT

Healing and damage processes frequently overlap in time and the two processes can never be decoupled; however, many numerical models that simulate damage and self-healing employ restrictive assumptions that do partially separate these two processes[1]. These assumptions have included, for example, that healing always takes place under zero-strain conditions and that healing and damage are never concurrent. There are many real situations for which these assumptions are reasonable but there are others that involve simultaneous damage and healing for which a less restrictive modelling approach is required. Such simultaneous damage-healing behaviour was observed in a series of tests conducted at Cardiff University on concrete samples with inbuilt vascular networks containing cyanoacrylate[2]. This contribution describes a new model that addresses this issue. The model uses a crack-healing cohesive zone formulation in which both the damaged and healed proportions of the cohesive zone can both grow and diminish, with no restrictions placed on the number or duration of these damage-healing events. The cohesive zone model is implemented in a finite element with strong discontinuity and coupled to a capillary flow model. The flow model simulates the transport of healing agents within the damage zone[3]. A particular feature of the approach is the way that flow and curing of the healing agent is tracked within the damage zones, which encompass both virgin damage zones as well as regions that have re-damaged after healing. Another important aspect of the damage-healing component of the model is the way that permanent strains are computed so as to satisfy the second law of thermodynamics. This is accomplished with the assumption that the stress in a component of healing agent is zero when it cures: this applies to both null and non-zero stress and strain fields. The new coupled model is assessed using data obtained from a number of experiments conducted at Cardiff University. The primary conclusion from the work is that the new model is able to represent multiple and simultaneous damage-healing *events* with good accuracy.

REFERENCES

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