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Modeling alkali-silica-reaction in reinforced concrete structures combining kinetics and fracture mechanics

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Alkali-silica reaction (ASR) is a reaction in concrete between alkali hydroxides and reactive siliceous aggregates. ASR is now recognized as a major cause of concrete deterioration in the USA and numerous countries worldwide [1]. Modelling brings more insight into ASR mechanisms and can, to some extent, estimate remaining service life [2].
The article presents a chemo-mechanical weakly coupled model for ASR. The chemical model predicts kinetics and volume expansion of macroscopically-free specimens [3]. The volumetric strain depends on aggregate composition, latency time, moisture ambient conditions and temperature. The mechanical material model is formulated on macroscale, taking volumetric strain as the main input. The volumetric strain governs deterioration of material characteristics (tensile strength, compressive strength, fracture energy) and contributes as an eigenstrain to material behaviour. The growths of ASR gel follows stress state where compression inhibits further expansion and prevents further deterioration. A fracture-plastic material model for concrete [4] delivers strain decomposition, stress, damage and plastic behaviour.
Validation focuses on macroscopically stress-free specimens where correct expansion is obtained. An example of reinforced concrete beam shows excellent performance for internally restrained concrete. The model has been implemented in ATENA software [5]. It extends its capability to examine lifetime of the structure [6].

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