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MODELLING COUPLED DISCRETE-CONTINUUM FLOW OF A HEALING AGENT IN CEMENTITIOUS MATERIALS

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Despite being one of the most widely used materials in construction, concrete is subject to a number of durability issues, often arising from cracking. These issues include acid-attack, reinforcing bar corrosion and calcium leaching, all of which contribute to the high maintenance/repair cost and requirements associated with concrete structures. One approach to mitigating this problem is to design the concrete to be self-healing (SH), enabling the healing of cracks as they form. The main techniques utilise embedded healing agents that are released/delivered to the crack, before healing the damage. The techniques differ in the method of release/delivery and in the healing agents used. The modelling of such systems is complex as SH mechanisms involve a large number of physical processes that need to be accurately captured. These include mechanical processes such as cracking, transport processes such as the flow of healing agents and chemical processes such as curing of healing agents. There is, however, an ever expanding body of literature on the numerical modelling of such systems[2], with significant progress being made.

In the present work, a coupled model is employed to simulate transport processes associated with a vascular self-healing system. A finite element approach is used in which cracks are simulated with embedded strong-discontinuities. The work focuses on the transport processes, specifically the coupled crack and matrix flow of a healing agent. The model employs a modified Lucas-Washburn equation to describe the discrete crack flow[3], which allows for stick-slip of the meniscus, dynamic contact angle and non-uniformity of the crack. A nonlinear moisture diffusion model is employed to describe the continuum matrix flow[1]. The two are coupled through a source/sink term, representing the moisture flow through the crack faces. The new coupled model has been calibrated and subsequently validated using data from an extensive experimental programme of work undertaken at Cardiff University. The results of the simulations undertaken to date are promising and suggest that the model is able to represent combined matrix discrete flow behaviour with reasonable accuracy.

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