# Simulation and assessment of concrete repair systems.

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## Abstract

The nucleus of this dissertation includes 2-D and 3-D finite element based computer models for simulation and assessment of concrete patch repair systems. A realistic phenomenological model incorporating the critical processes that are initiated when a repair layer is placed over a hardened concrete substrate has been developed. These processes are embodied in the finite element program DISH-3D, and include autogenous expansion due to time-state activated expansive agents, moisture diffusion in repair domain, drying shrinkage due to moisture loss and tensile creep activated due to shrinkage induced stresses.

The numerical model is complemented with comprehensive experimental investigation of time-dependent physical and structural properties of four commercially available, prepackaged repair mortars. These include laboratory studies on evolution of strength and stiffness, expansion-shrinkage regime, tensile creep characteristics, evolution of moisture loss, and evaluation of laboratory and field performance of miniature and prototype concrete repair systems. A combined experimental numerical approach using finite elements is used to find the coefficient of diffusivity of the repair materials. A new functional form of dependence of diffusivity on moisture content is proposed.

The key repair material parameters, which play a central role in its performance and long-term integrity, have been identified. These include the free expansion strain, free shrinkage strain, free tensile creep strain, tensile strength, tensile elastic modulus, the moisture diffusivity of the material, and the pull-off strength from the substrate. Finite element simulation of patch repair system has identified the tensile cracking through the thickness of the repair layer, tearing and delamination of the repair layer at the repair-host interface, and diagonal cracking at the corners as the principal modes of failure.

Risk factors, based on results from finite element modeling, are derived to predict the probability of failure of patch repair in direct cracking, peeling and delamination. It is believed that these risk factors constitute an advancement in the state of the art in helping repair engineers make decisions regarding the relative suitability of commercially available repair materials for use in the field.