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Laboratory Study of Crack Development and Crack Interaction in Concrete Blocks due to Swelling of Cracking Agent

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The main focus of this work was to investigate temporary and spatial features of crack development in concrete blocks due to the action of a swelling agent. A commercial available cement-based mortar which shows heavily swelling behaviour when hydrating is used to provide inside pressure in boreholes in conrete blocks and hence serves as cracking agent. As no data for the swelling behaviour of the cracking agent were available the maximum axial swelling stress and axial free swelling strain were determined experimentally. In a first series of tests on concrete blocks the influence of an external mechanical, unidirectional stress on the development-time and orientation of cracks has been investigated for a range of loading levels. The stress state in the blocks prepared with a single borehole was determined by a superposition of internal stresses caused by swelling pressure and external mechanical loading. For a second series of tests prismatic blocks with two boreholes where prepared. This test setup allowed to realize different orientation of boreholes with respect to the uniaxial loading direction. Complementary tests were done using the cracking agent in both, only one or none of the boreholes. Different modes of crack interaction and influence of filled or unfilled boreholes have been observed. Features of crack development showed significant sensitivity to external loading. Starting even at very low load levels crack orientation was primarely determined by the direction of the external load. Temporal change in crack development due to the different load levels was insignificant and no consistent conclusion could be drawn. Crack interaction phenomena only were observed with two boreholes orientated primarely in direction of the external loading. Even in these cases crack orientation was mainly determined by the external stress field and only locally influenced by other cracks or the unfilled borehole. The work provides us with an extensive catalogue of significant examples for crack development and crack interaction phenomena due to swelling pressure in a borehole in an isotropic medium in uniaxial external stress state which will form the basis of future numerical investigations on this topic.