Numerical modelling of concrete dams affected by swelling reactions

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ABSTRACT

In the last decades, the number of concrete structures with large evolving deterioration, identified as being caused by different types of swelling processes, has been growing, all around the world, but mainly in developed countries. Some of these structures involve large potential risks, such as dams, nuclear power plants, bridges or critical buildings, and usually with various years of operation.

In particular, there are a large number of dams suffering from swelling processes, due to internal chemical reactions. These expansive processes, if severe, might lead to early concrete deterioration, generalized cracking, impairing of the spillway operation, and to a reduction of the dam safety conditions.

Numerical models aiming to simulate the expansive processes occurring in the dams' body have to deal with the main factors influencing this process which include the thermal, the hygrometric and the stress fields. Moreover, to simulate the structural effects of the expansions, models have to consider the evolution throughout time of the concrete properties, including creep due to applied forces and relaxation due to imposed deformations, and also the concrete non-linear behaviour due to tensile cracking.

Along the years LNEC has been participating in numerous studies, in Portugal and abroad, involving the behaviour interpretation and safety evaluation of large dams affected by this pathology, which have the ultimate goal of supporting the dam owners in programming decisions about rehabilitation interventions or even, in the most extreme cases, the dam replacement.

In this work some recent case studies are presented, involving concrete dams with different degrees of deterioration and in different stages of the swelling process. The first part of the work describes the main dams' characteristics and its pathologies, while the second part presents the used finite element models and the main obtained results, which are compared with results of the dam monitoring and inspections.