Methodology and Numerical Strategy for Forecasting the Leakage Rate Evolution of Nuclear Reactor Buildings Inner Containments

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Abstract

The containment building represents the third and last protection barrier of nuclear reactors buildings (NRB). Yet ageing mechanisms of prestressed concrete could strongly affect the tightness capacity of the inner containment of a double-wall reactor building over time. That is a major issue considering the long-term operation and the potential life extension of NRBs while ensuring safety and regulatory requirements. Considering the size of those structures and the complexity of all interacting phenomena (such as drying, creep, shrinkage and cracking), it is very difficult from a computational perspective to build an industrial and operational tool modeling efficiently all the strong couplings occurring at different scales. In that context, a simple yet physically representative chained weakly-coupled strategy based on a macro-element discretization is implemented and applied to the VeRCoRs mock-up (scale 1:3). The proposed methodology adapts to feedback and data collected with time. It enables operators (1) to take into account variabilities and uncertainties of main parameters in order to quantify their impact on the total leakage rate, (2) to manually introduce defects coming from visual inspections and (3) to preempt and optimize leak mitigation actions in order to avoid outage extensions and associated losses of income.

Keywords: Porous and cracked concrete / Air leakage / Inner containment wall / Ageing / Long-term operation