Thermo-mechanical simulations of early-age concrete cracking with durability predictions

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Abstract. Concrete performance is strongly affected by mix design, thermal boundary conditions, its evolving mechanical properties, and internal/external restraints with consequences to possible cracking with impaired durability. Thermo-mechanical simulations are able to capture those relevant phenomena and boundary conditions for predicting temperature, strains, stresses or cracking in reinforced concrete structures. In this paper, we propose a weakly coupled thermo-mechanical model for early age concrete with an affinity-based hydration model for thermal part, taking into account concrete mix design, cement type and thermal boundary conditions. The mechanical part uses B3/B4 model for concrete creep and shrinkage with isotropic damage model for cracking, able to predict a crack width. All models have been implemented in an open-source OOFEM software package. Validations of thermo-mechanical simulations will be presented on several massive concrete structures, showing excellent temperature predictions. Likewise, strain validation demonstrates good predictions on a restrained reinforced concrete wall and concrete beam. Durability predictions stem from induction time of reinforcement corrosion, caused by carbonation and/or chloride ingress influenced by crack width. Reinforcement corrosion in concrete struts of a bridge will serve for validation.