Improved prediction of shrinkage for overlay concrete

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ABSTRACT

Concrete overlays can be used to strengthen and rehabilitate concrete structures. For this purpose, a layer of fresh overlay concrete is cast on top of a matured concrete substrate. The progressing cement hydration in the hardening overlay concrete causes changes in porosity as well as changes in pore humidity. The changes in pore humidity, which can also be caused by drying, trigger shrinkage strains, which are restrained by the substrate concrete. This induces stresses in the structure which are potentially harmful to the newly placed concrete overlay. It is therefore important to provide accurate predictions for the early-age shrinkage response of the overlay concrete, including good predictions of the autogenous shrinkage strain. This is the focus of the present contribution.

In the presented approach, the improved predictions are enabled by the use of a porosity-dependent desorption isotherm which is calibrated in a hygro-thermo-chemo-mechanical context. Measured values of the mass water content at given values of relative humidity are used to determine the shape of the desorption isotherm in the matured state. Autogenous shrinkage strain measurements [1] are used to determine the dependence of the desorption isotherm on porosity. An effective stress shrinkage model [2] is independently calibrated based on drying shrinkage measurements on thin matured concrete slices. The autogenous shrinkage strains are related to the pore humidity evolution in the sealed specimen using the same effective stress approach. In addition, the mass water content and porosity evolution in the specimen are also known since they are solely driven by hydration processes. The combination of the resulting data provides the required information to calibrate the porosity-dependence of the desorption isotherm.

The obtained results for the autogenous shrinkage are in excellent agreement with experimental data. The new formulation also proved to work well for drying shrinkage and compressive creep predictions of maturing overlay concrete.

REFERENCES