Early-Age Evolution of Non-Aging Creep Properties of Cement Pastes, Mortars, and Concretes

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ABSTRACT

Cementitious materials are highly creep active at early ages. In order to characterize the elastic stiffness and the creep properties, an innovative early-age creep testing protocol is used [1]. It consists of hourly-repeated three-minute-long macroscopic uniaxial creep tests. The first test on each specimen is carried out at a material age of 21 h and the last test eight days after production, resulting in a test series containing 168 ultra-short-term experiments per specimen. In order to ensure non-destructive testing, loading is limited by 15 % of the strength reached at the time instant of testing. Three minutes are so short that each individual experiment refers to a non-aging microstructure. Post-processing aims at identifying three material properties per test: the elastic Young's modulus, the creep modulus, and a power-law exponent. These properties intervene in a power-law-type creep function. Considering that significant creep strains already develop during the fast loading process which lasts for a few seconds only, i.e. distinguishing time-independent elastic behavior strictly from time-dependent visco-elastic behavior, it is found that quasi-static elastic Young's modulus is equal to the dynamic Young's modulus obtained from ultrasonics measurements [1]. Combining the early-age test data with a multiscale model for creep homogenization of cement pastes, allows for identifying universal creep properties of micron-sized needle-shaped cement hydrates [2]. These properties allow for a reliable prediction of the strain evolution of a 30-years-old cement paste in a 28-days-long non-aging creep test. This underlines the predictive capabilities of the creep homogenization model. Finally, creep homogenization is used to predict the creep performance of mortars and concretes, based on knowledge regarding (i) their composition and (ii) the creep properties of the cement paste matrix [3]. It is found (i) that oven dried aggregates take up water upon mixing and (ii) that this water is later soaked back into the cement paste matrix, which is reminiscent of so-called "internal curing".

REFERENCES

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