Determination of Effective Cross-Section Properties by Chemo-Mechanical Simulations

Lisa-Marie Czernuschka[1*], Ioannis Boumakis[1], Jan Vorel[1], Marco Marcon[1],

Roman Wan-Wendner[1],

[1]Christian Doppler Laboratory LiCRoFast, Institute of Structural Engineering, University of Natural Resources and Life Sciences, Vienna, Austria
*Corresponding Author Email: lisa.czernuschka@boku.ac.at

Abstract

The safety and sustainability of state of the art bridge structures is a crucial task in modern civil engineering practice. The long-term behavior of concrete is complex and influenced by many different phenomena such as aging, shrinkage, creep and their interactions. As widely known, the main source of these phenomena is the hydration of concrete, which is strongly influenced by the boundary conditions, the mix design, as well as the geometry of the structure. Hence, careful consideration of these effects is required especially for large concrete structures. The latter show significant spatial gradients in reaction degree, temperature and humidity, consequently also being visible in material properties. In order to be able to capture the behavior as accurately as possible, a strong numerical tool is of great importance.

This study presents the determination of effective cross-section properties by utilization of chemo-hygro-thermal simulations coupled with mechanical analysis in a multi-physics framework [1,2]. This framework is calibrated and validated based on an extensive experimental campaign, comprising temperature and humidity evolution measurements, as well as calorimeter, shrinkage and modulus data. Specifically, effective cross section properties of different practically relevant types under different boundary conditions are derived. Influences of environmental boundary conditions and cross-section characteristics on thermal strains, shrinkage and their interaction with creep are analyzed and discussed in detail.

[1] Di Luzio, G. and Cusatis, G., Hygro-thermo-chemical modeling of high performance concrete - I: Theory, Cement and Concrete Composites, 2009; 31:301-308.

[2] Di Luzio, G. and Cusatis, G., Hygro-thermo-chemical modeling of high performance concrete - II: Numerical implementation, calibration and validation, Cement and Concrete Composites, 2009; 31:309-324.