

Experimentally-informed modelling of micromechanical properties of blast furnace slag cement pastes

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Abstract:

Industrial byproducts are nowadays used in concrete as partial cement replacement for environmental reasons. In addition, use of blended cements has numerous technical benefits: for example, they are used to reduce heat of hydration in massive concrete structures and increase the durability of concrete subjected to chloride ingress or alkali-silica reaction. However, compared to ordinary Portland cement (OPC) pastes, little research has been devoted to understanding the deformation and fracture of blended cement pastes. In terms of micromechanical properties, these processes may be different compared to OPC pastes due to differences in porosity and hydration product distribution. Therefore, additional research would be useful.

This work aims to understand deformation and fracture processes in blast furnace slag cement pastes on the micro-metre length scale. Blended cement commonly used in infrastructural applications in the Netherlands - CEM III/B – is used. Based on our previous work¹, a micromechanical model which utilizes nanoindentation and X-Ray CT as input is created. Pastes with three different w/b ratios (0.3, 0.4, and 0.5) are used. The model is used to perform simulations of uniaxial tension tests using the Delft lattice model, providing measures of elastic modulus and tensile strength. To validate the results, advanced micromechanical experiments are performed to estimate the micro-scale tensile strength and elastic moduli of the tested material. This study will provide a basis for deeper understanding of micromechanical performance of blended cement paste systems.

¹ Zhang, H., Šavija, B., Luković, M., & Schlangen, E. (2019). Experimentally informed micromechanical modelling of cement paste: An approach coupling X-ray computed tomography and statistical nanoindentation. *Composites Part B: Engineering*, 157, 109-122.