6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Determination of process-dependent rheological properties of fresh concrete during setting using a suspension/phase-field model

Haiqin Huang[1] and Andreas Zilian[1]

[1] Faculty of Science, Technology and Communication, University of Luxembourg,
6, Avenue de la Fonte, L-4364 Luxembourg
haiqin.huang@uni.lu and andreas.zilian@uni.lu

Key Words: *Fresh concrete setting, rheological properties, phase-field, elasto-visco-plasticity, multi-component flow.*

Self-compacting concrete (SCC) is an innovative class of high-performance concrete with adjustable flow-ability and excellent segregation resistance, simplifying or avoiding classical vibration-based on-site compaction. The apparent rheological properties of the fresh concrete mixture are very important for optimal operation in casting and curing. The physical behaviour of fresh concrete changes over time mainly due to the structural build-up and breakdown of calcium-silicate-hydrates during cement hydration in the setting phase [1]. The mixture undergoes a (possibly reversible) transition between fluid-like and solid-like behaviour, linked to the progress of chemical reactions and environmental (mechanical/thermal) conditions.

This contribution presents a mathematical model that supports predictive quantification of spatio-temporal rheological properties of SCC. The fresh concrete is considered as multi-component flow (suspension) composed of cement paste and a number of further components representing the specific aggregate size characteristics. The cement paste component is modelled as phase-changing homogenised continuum driven by the evolution of thermo-mechanical-chemical processes. The phase transition is described by a phase-field variable whose evolution is governed by the Ginzburg-Landau equation and coupled to an elasto-visco-plastic constitutive model [2]. Implementation of the predictive model is demonstrated using the FEniCS framework, together with numerical examples supporting model validation.

REFERENCES

[1] S. Garrault, T Behr, A. Nonat, Formation of the C-S-H Layer during Early Hydration of Tricalcium Silicate Grains with Different Sizes, *J. Phys. Chem. B*, Vol. **110**, pp. 270-275, 2006.

[2] P. Saramito, A new constitutive equation for elastoviscoplastic fluid flows, *J. Nonnewton Fluid Mech*, Vol. **145**, pp. 1-14, 2007.