Modeling the rheological response of concrete paste

Undoubtedly, cement is one of the most important materials in the construction industry. For its effective use, it is particularly important to fully comprehend the reversible and irreversible rheological behavior of cement paste. When cement is mixed with water, a suspension is initially formed, while as the hydration reactions progress, the cement paste gradually solidifies, making a new irreversible structure. At the same time, the viscosity of the paste initially decreases with time, while at long times it increases due to the formation of the irreversible structure. We herein introduce a continuum model for predicting the rheological behavior of cement pastes. The model is developed using non-equilibrium thermodynamics, and in particular, the Generalized Brackets formalism, to guarantee model admissibility with thermodynamic laws. To this end, we consider two scalar structural variables: a reversible one, λ_{rev}, characterizing the reversible structure, and an irreversible one, λ_{irr}, characterizing the irreversible structure resulting from the hydrolysis reactions. Also, we consider a tensorial structural variable the conformation tensor **C**, to characterize the deformation of the complex structure. The predictions of the new model compare quite well with available experimental data. It is expected that the use of this model in concrete paste rheology simulators will allow for the *in silico* tailor-designing of specific concrete pastes to meet specific needs.

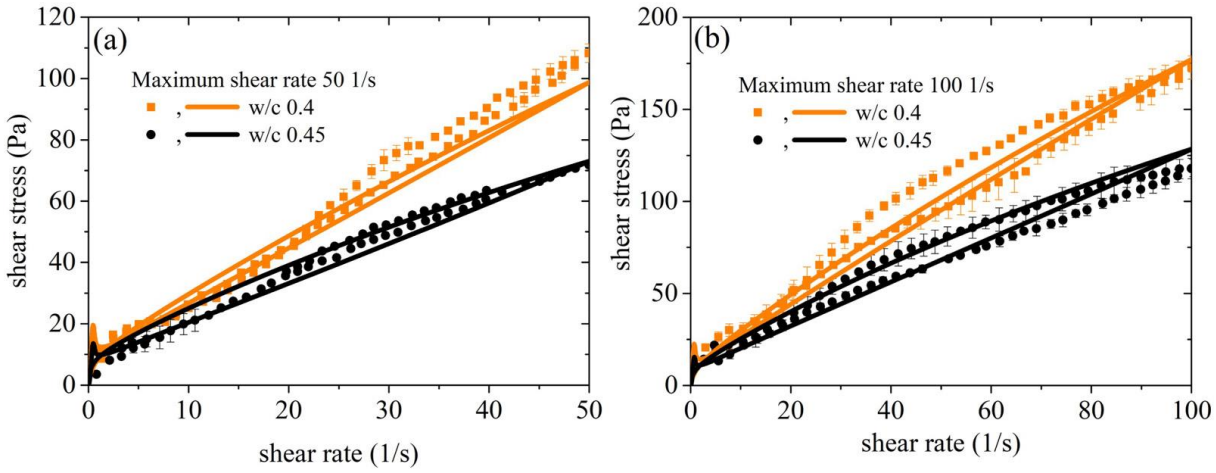

Figure: Comparison of the prediction (continuous lines) with the hysteresis of two different experimental protocols for a water/cement (w/c) mass ratio of 0.40 and 0.45 (symbols).

References

A. K. Ioannou, and P. S. Stephanou, "Non-equilibrium thermodynamics modelling of the rheological response of cement pastes", *J. Rheol.* 67, 849 **(2023)**. [Selected as Featured article and highlighted in *Scilight* 2023, 221109 **(2023)**.]