Analysing limitations of the FlowCyl as a one-point viscometer test for cement paste

The FlowCyl is a simple flow viscometer – a modification of the Marsh Cone test apparatus – developed to quantify the flow behaviour of cement pastes. The FlowCyl gives a one-parameter characterisation of rheology called the flow resistance ratio or $\lambda_Q$, which is defined as the average ratio between the flow loss of a measured fluid and theoretical flow of an ideal fluid. This paper reports a study on the limitations of the FlowCyl and appurtenant flow resistance ratio. The investigation includes rheological measurements of cement pastes incorporating crushed aggregate fines with a diameter below 125 µm and development of a numerical model in order to analyse the flow condition inside the FlowCyl. The numerical simulations are carried out both with the Bingham- and Herschel-Bulkley material model of the rheometer data. A comparison with the experimental $\lambda_Q$ results illustrates that only a minor error is introduced when describing the flow of cement paste in the FlowCyl with a two-parameter model (Bingham material model) as compared to a three-parameter model (Herschel-Bulkley model). The results also show that the one-parameter characterisation (i.e. $\lambda_Q$) mainly correlates to the plastic viscosity in the Bingham material model, while the yield stress only correlates if the dosage of superplasticizer per mass of cement is kept constant. The numerical simulations show that high shear rates at the outlet of the FlowCyl are responsible for the difference in the correlations.

General information
Publication status: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Technical University of Denmark, Norwegian University of Science and Technology
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Pages: 333-340
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Construction and Building Materials
Volume: 218
ISSN (Print): 0950-0618
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
Original language: English
Keywords: Cement paste, FlowCyl, Plastic viscosity, Rheology, Yield stress
DOIs: 10.1016/j.conbuildmat.2019.05.127
Source: Scopus
Source ID: 85066112584
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review