



Opponent's review of the Doctoral Thesis

Candidate: Michal Hlobil

Title of the doctoral thesis: Micromechanical analysis of blended cement-based composites

Branch of study: civil engineering

Tutor: Vit Smilauer and Bernhard Pichler

Opponent: Christian Hellmich

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Topicality of the doctoral thesis theme

Commentary: The thesis concerns a very timely topic: blended cement pastes and mortars.

Due to the requirements of CO₂ reduction, the amount of cement used for concrete production needs to be significantly decreased, and in this context, the development of blended mixtures is the current option of choice. However, this entails several challenges as regards the preservation of appropriate mechanical properties; and the present thesis gives very important contributions on how these challenges could be met in the foreseeable future.

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Fulfilment of the doctoral thesis objectives

Commentary: The thesis provides novel experimental insights into the physics and mechanics of blended cements, but also comprises important theoretical and computational novelties.

This is the maximum fulfillment of objectives, which may be required from a thesis on the micromechanical analysis of blended cement-based composites.

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Research methods and procedures

Commentary: The dissertant has applied a multitude of different experimental and theoretical methods. The collection of different methods (which have partially even been combined with each other) is remarkably wide and comprehensive; they range from thermo-gravimetry, X-ray diffraction with Rietveld analysis, scanning electron microscopy, isothermal differential calorimetry, quasi-static unloading tests, and ultrasonics; to Finite Element analyses as well as semi-analytical homogenization theory applied to elastic, strength, and fracture properties. This breadth of methods is most unusual to be found in a single PhD thesis.

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Results of the doctoral thesis – dissertant's concrete achievements

Commentary: The dissertant has achieved several really remarkable achievements, which have driven forward the international state-of-the-art in the field. They are:

(i) an unprecedented physico-mechanical data base on blended cement pastes and mortars; (ii) a novel

strength upscaling model solving the problem of OPC-based concrete upscaling, and revealing that hydration products from slag and fly ash increase the overall hydrate cohesion; (iii) the first ever molecular-to-macroscopic fracture upscaling scheme explaining the famous size-effects encountered with concrete strength.

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Importance for practice and for development within a branch of science

Commentary: This thesis, while fulfilling highest scientific standards, has very important implications in practice.

This is a direct consequence of the active involvement of LafargeHolcim, the largest cement producer on earth, and in particular of Dr. Gilles Chanvillard and his team.

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Formal layout of the doctoral thesis and the level of language used

Commentary: The layout and the level of language fulfill highest standards.

In particular, it should be mentioned that the dissertant made large investments into producing very easy-to-read figures which elegantly show experimental and computational results. Very often, these figures are largely self-explanatory. This will be very helpful for ongoing and future dissemination of the dissertant's remarkable results.

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Remarks

The thesis work has led to a total of four scientific papers, two already published in esteemed international journals, and two fully prepared for submission. There is even enough material for a fifth publication. This, by itself, underlines the very high quality standards maintained throughout Mr. Hlobil's doctoral studies.

Final assessment of the doctoral thesis

This thesis is a brilliant model for how nowadays a PhD thesis in the Civil Engineering Sciences should be composed and realized. It deserves highest appraisal.

Following a successful defence of the doctoral thesis I recommend the granting of the Ph.D. degree

yes no

Date: Oct 9, 2016

Opponent's signature: *Chris Hellmich*