23RD CONFERENCE AND WORKSHOP ON RHEOLOGY OF BUILDING MATERIALS

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After 23 years the meeting on Rheological Measurements of Building Materials has become a firmly established, international event. On March 12, around 160 guests and speakers from more than 10 countries gathered again in Regensburg for the seminar. The thirteen presentations covered several fields. In details: Flow simulation, 3D printing, self-compacting concretes, admixtures and testing systems.

The lecture series was opened with a welcome address by Markus Greim, CEO of Schleibinger Geräte and by Professor Thomas Falter and Professor Kusterle, OTH Regensburg. The topic of the first session was rheometer technology. Andraž Hočevar, IGMAT, Ljubljana, Slovenia, made tests with mortars in two different concrete rheometers. While the Contec5 and the ICAR rheometer are showing a good correlation with the viscosity values, the measured yield values are quite different for the most mortar mixes. Nevertheless the problems with rheometers are increasing with the particle size. Therefore Michał Drewniok, TU Gliwice, Poland, wants to predict the rheological properties of fresh concrete based on the rheological properties of mortar. A naive approach, for a given real concrete mix design, is the reduction of the maximum particle size to 2 mm. But unfortunately the resulting mortar will be unusual fluid. Obviously a certain amount of cement paste, covering the surface of the coarser aggregates has no influence in the flow properties of the fresh concrete. Therefore the cement paste volume in the model-mortar has to be reduced by a certain amount. Bogdan Cazacliu, IFSTTAR, Marne-la-Vallée, France, and Florian Fleischmann, OTH Regensburg, Germany, are both developing different instruments for measuring the flow curve of fresh concrete directly inside the mixer drum. Cazacliu measures the drag forces on two sensors during the mixing process, whereas Fleischmann is stopping the mix process and insert then automatically a sphere shaped probe into the material. Controlled by the measuring results, the concrete is optimized by adding stabilizing or plasticising agents and is mixed again.

The influence of different additives in the flow properties of mortars and concrete was another important topic of the conference. Yves Petit, Momentive Chemicals, Ribécourt, France, presented a rheological method to determine the thickness of a Cellulose Ether film on the surface of a tile glue mortar. If this film is too thin or too thick, the bonding of the tiles will be too weak. Not only chemical admixtures but even air bubbles have a big influence in the rheology of mortars. Maurizio Bellotto, Giovanni Bozzetto S.p.A., Filago, Italy shows that air bubbles, if they are big enough, will lower the viscosity. Each 1% of added air will increase the slump by 10 mm. The strength loss can partially compensated by reducing water and sand. The effectiveness of stabilizing agents in mortar depends not only on the chemical interaction but also on the particle size distribution explained Wolfram Schmidt, BAM, Berlin, Germany, in his presentation. Increasing the particle sizes increases the effect of the stabilizers in the yield stress, but decreases the effect on the plastic viscosity.

Concrete is the most used material on the world, but cement is also responsible for high emissions of greenhouse gas like CO_2 (5% global) and ocean acidification, as Moien Rezvani, TU Darmstadt, Germany, explained. So reduction of Portland cement clinker in concrete is necessary. Increase of limestone powder (LSP) content instead of cement results in an increase of plastic viscosity and remarkable reduction of superplasticizer (SP) dosage. Considering the used SP, the low-$CaCO_3$ limestone leads to a lower plastic viscosity but a higher SP dosage Also Emilio Garcia-Taengua, Queens University of Belfast, UK, shows that the use of mineral admixtures such as LSP or ground granulated blast furnace slag (GGBS) affects the interaction between superplasticizer and cement. Adding LSP is beneficial, it improves flowability and counterbalances the lack of SP efficiency. Addition of 30% LSP + 35% GGBS is a far better option than adding only GGBS. Concrete with such composite cements is also more cracking resistant than concrete with ordinary cement, as also Michał Drewniok mentioned in his presentation.

For nuclear waste containment structures, safety and reliability is the first design principle. The extended operation time of such a repository sets harsh demands for concrete durability and mix design. So materials used has to be long-term safety approved, for instance, superplasticizer are here completely forbidden said Tapio Vehmas from VTT Research Center in Finland. A traditional naphtalene based plasticizer was used and the rheological properties has been further adjusted by a ternary binder with an optimized grading curve. Finally, even with this traditional material, a slump flow of 650 mm has been reached. Not tradi-

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Figure 1: Participants during a lecture.

Figure 2: Participants at work.

tional but futuristic is 3D printing of concrete which is done by Mary Lilliman, Loughborough University, UK. Getting the mortar to have the required rheological parameters, for as long as possible, and at as low a cost as possible, is a key research area for unlocking the full potential of 3D concrete printing.

Making flow tests with fresh concrete in the lab is hard and dirty job, and for big structures not even possible. The numerical simulation of concrete flow properties was the topic of the presentations of Bianca Bund, TU Kaiserslautern, Germany, and David A. Lange, University of Illinois at Urbana-Champaign, USA. Bund is simulating the flow and orientation of steel fibres in fresh concrete. The simulation results are validated by real tests where the distribution and orientation of the fibers is measured by computer tomography. Lange is measuring the SCC pressure decay signature in a 1 m high column form equipped with pressure sensors. A computer model, realized as spreadsheet program requires as input this SCC characteristic decay signature, formwork geometry and strength, and the form filling rate. Then the program IlliForm provides a reasonable prediction of SCC formwork pressure.

After the conference at March 12th, like every year, things are furthermore discussed in the evening at a typical restaurant located in the historical city of Regensburg. With more than 60 participants the workshop for rheological measurements on March 13th was also well attended. First the basics of mortar rheometers are shown with some simple experiments, by Markus Greim, Schleibinger Geräte. The application of calorimetry equipment for cement/concrete technologists was shown in a lab by Thomas Lemke, C3 GmbH. Florian Fleischman from the OTH Regensburg presented the prototype of the newly developed inline mixer rheometer RheoCT as collaboration project between the OTH, Rohrdorfer Zement and Schleibinger Geräte. The 24th Regensburg colloquium and workshop will take place mid of March 2015 at the OTH Regensburg.

Most of the presentations are available online at http://www.schleibinger.com/k2014.html

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