20th Meeting on Rheological Measurements of Building Materials

Regensburg/Germany
March 1–2, 2011

A jubilee with record attendance! For the 20th time a conference about the rheology of building materials took place on March 1, 2011 in Regensburg, including a laboratory workshop on March 2, 2011. Nearly 200 researches from all over the world visited the historical world heritage city Regensburg to learn about the latest results at field of rheology of constructing materials, like mortar or fresh concrete. The 19 presentations given in two sessions focused on the interaction of cement and additives, computer based flow simulation, ultra high performance concrete and innovations in measurement instruments.

After 20 years of the workshop, "A look back" was presented by Prof. Jürgen Teubert, emeritus at the Hochschule Regensburg and one of the founders of building materials rheology 45 years ago. In 1969 he published a paper showing a three phase concrete model of cement paste + sand = mortar + aggregates = fresh concrete. The outlook of Jürgen Teubert pointed out that a three phase model must also be used in future concrete mixing and production technology to produce modern flowable and stable high performance concrete.

The 3 dimensional computer aided design of construction structures has been standard now for years. The computer based simulation of the flow of fresh concrete in the formwork is a field for research and development. Simone Palzer and Knut Krenzer, iff Weimar, Germany showed a flow simulation of mortar, based on a particle simulation model. In general, simulation underestimates slump flow and flowing time in the V-funnel. The rheological parameters of the mortars have been tested with the basket double gap probe. In a pipe test rig pressure loss and the volumetric flow rate have been measured. It could be shown that there is a good correlation between the results of the basket probe and the pipe test. Christian Heese, and Prof. Wolfgang Breit, Technische Universität Kaiserslautern, Germany focused on the simulation characterization of UHPC. The flow of this concrete on a shock table was simulated. The numerical model simulated a fluid with yield stress and a shear rate-dependent viscosity. It could be shown that thixotropic effects and the shear history also influence the flow properties of this kind of concrete.

The workability of UHPC was also the topic of Sandy Leonhardt, Technische Universität München, Germany. The presentation shows what would happen if high contents cost-intensive components, like cementa and silica fume, were replaced by fly ash. There is an improved workability with increasing replacement of cement by fly ash, whereas there is a loss of workability with increasing replacement of silica fume by ultra-fine fly ash. A window for the optimal workability of UHPC was given: The relative yield value should be below 4 Nmm and the relative viscosity below 7 Nmm*min (measured with the mortar probe of the Viskomat). The influence of fly ash in the viscosity of standard mortars were discussed by Prof. Jacek Golaszewski and Tomasz Ponikiewski, Silesian University of Technology, Gliwice, Poland. Two main conclusions were drawn: The rheological properties of cements with high-lime fly ash from workability point of view are worse, while the workability of cement with milled high-lime fly ash is better.

Replacing the expensive silica fume by metakaolin for SCC was the topic of the presentation of Assem Hassan and Mohamed Lachemi from the Memorial University of Newfoundland, and Ryerson University, Toronto, Canada. The results showed that the plastic viscosity and the yield stress increased with the increase percentage of metakaolin. The addition of silica fume did not affect the viscosity of the SCC mixture but a sharp increase in the yield value was detected as the percentage of silica fume was increased. Jens Herrmann, VDZ, Düsseldorf, Germany talked about the influence of replacing cement by limestone powder or slag cement components as well as PCE plasticizer. He could show that the granulometry of the limestone or slag has a main influence in the rheological properties of cement paste and fresh concrete. Increasing the amount of limestone or slag will reduce the demand of PCE, but also the pore solution is changing and therefore the adsorption of the PCE. It is important to determine the saturation dosage for the plasticizer.

Air bubbles also influence the rheology as discussed by Tor Arne Martius-Hammer, SINTEF Byggforsk, Trondheim, Norway. It is not clear, yet, how entrained air (EA) shall be treated in a particle / fluid phase model. Based on this problem, an investigation of the influence of EA on paste and mortar rheology was performed. The results suggest that entrained air reduces the consistency of cement paste, but increases the consis-

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tency of equivalent mortar. However, the consistency seems to increase less by increasing the air volume than by increasing the non air entrained matrix volume correspondingly. Sandra Hahn and Prof. Thomas Bier, TU Bergakademie Freiberg, Germany presented a research project where the influence of aging of the powder on air was investigated. After 7, 24 and 48 hours at 85% humidity the setting behavior was studied with a slow (1.1 rpm) running mixing type rheometer. Similar materials were evaluated in the presentation "The rheological properties of low cost grouts" by Prof. Luiz Antonio Pereira de Oliveira, University of Beira Interior, Covilhã, Portugal. The objective of this work was to verify the effect of different mineral admixtures on the cement-based grout rheological behaviour. The Marsh funnel test and rheometer test was applied to characterize the fresh properties of grouts produced with a Portland Cement The main conclusion was that the Marsh funnel test has a limited level of accuracy compared with the rheometer test, because it was observed different plastic viscosity values were found for a same Marsh funnel result.

Torsten Westphal, from the TU Bergakademie Freiberg, Germany, showed in his study rheometer tests and the classical workability tests with different stabilizers. Synthetic copolymers, polysaccharides, potato starch and cellulose types were used. A yield value could be detected: Only with the potato starch stabilizer type with increasing shear rate, whereas with decreasing shear rate all mortars have a yield value. For most mortars the low yield value with increasing shear rate was an indicator for high sedimentation. The second presentation about stabilizers was presented by Wolfram Schmidt, BAM Bundesanstalt für Materialforschung und -prüfung, Germany. Stabilizing agents affect both viscosity and yield stress. Typically used polymeric stabilizing agents for cementitious systems are polysaccharides, and normally they are non-ionic or anionic. In order to effectively reduce bleeding and segregation in case of PCE overdosage polymers with high capacity to immobilize water have to be chosen. To avoid quick loss of performance of SCC, a non adsorbing polymer should be chosen. SCC was also in the scope of Peter Ramge, also from the Bundesanstalt für Materialforschung und -prüfung BAM. He talked about segregation of Coarse Aggregates in Self Compacting Concretes.

Until now the construction of concrete pavements using slip-form paving requires a fresh concrete with low slump. The main goal of the research project of Diego Sarmiento and Prof. R. Breitenbücher from the Ruhr-University Bochum, Germany, is the development of a new type of self-compacting concrete (SCC) that can be applied in the slip-form paving process. This material has to exhibit a high flowability after mixing but later on it has to develop sufficient green strength in the resting state to ensure that the concrete can hold its shape in plastic state without any framework. For this purpose the thixotropic properties of the concretes has to be analyzed. Beneath of classical rheometers it is also possible to determine the elastic material properties with ultrasound. Markus Krüger from the Uni-

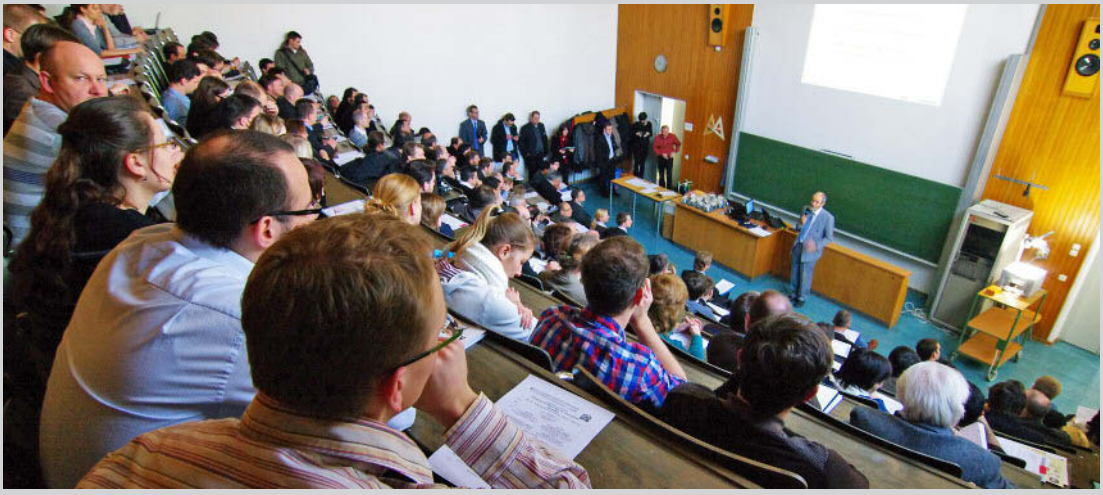

Figure 1:
Professor Kusterle is opening the conference.

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versität Stuttgart, Germany demonstrated a new experimental setup, where compression (p) and shear (s) waves are transmitted through fresh mortar or concrete. During setting amplitude and transition time of this waves will be changed. The wavelet transformation as mathematical tool for signal processing is used.

Ultrasound techniques were used to influence the elastic or workability parameters of cement paste, as shown in the paper of Simone Peters and Michael Kraus from the Bauhaus-Universität Weimar, Germany. The application of power ultrasound is known from cement chemistry to cause a faster setting. In this presentation also the influence in the rheological properties of cement paste was shown. A still unsolved problem is the relation between rheological properties of fresh concrete and pumpability of this material. Thomas Neumann, Schwenk Zement KG, Karlstadt, Germany, presented a big field test about determing the pumpability of fresh concrete in the lab and on the construction site. The shock table value of the fresh concrete gives no information about the pumpability. Concrete rheometers seems not be the right tools. If the volume of lime per cubic meter is less than 255 l/m³ the concrete pressures will increase dramatically. An additionally high amount of plasticizer will decrease the stability of the concrete and may cause a blocking in the tubes. Porous aggregates may also block the pumping process. Changing the grading curve to higher fineness will also decrease the pumpability. The shape of the coarse aggregate or the type of the plastisizer has nearly no influence.

In the closing plenary session Florian Fleischmann and Prof. Wolfgang Kusterle, Hochschule Regensburg, Germany presented a new project now started in Regensburg: The mix design and the control techniques in the concrete plant should make SCC a robust and reliable standard product. Test with several programs for the Viskomat rheometer has shown the big influence of the shear history in the measured viscosity. The 21. conference "Rheological Measurements of Building Materials" will take place in the second week of March 2012. Please check the web site http://www.schleibinger.com for detailed informations.

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