Lars Nyholm Thrane - Research outputs - DTU Orbit (07/11/2019)

Form Filling with Self-Compacting Concrete

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Flow Induced segregation in full scale castings with SCC
Though promising, pioneering work has been carried out with rheological characterization and numerical modelling of form filling with SCC, the approach is far from standard in the concrete industry and clearly the approach does not yet hold all the answers to relevant questions. In particular flow induced segregation is a major risk during casting and it is not yet clear how this phenomenon should be modelled. In this paper testing and numerical simulations of full-scale wall castings are compared. Two different SCCs and three different filling methods were applied resulting in different flow patterns during form filling. Results show that the flow patterns have a major influence on the risk of flow induced segregation and the surface finish of the hardened concrete. A hypothesis for the mechanism of flow induced segregation is put forth.

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A Blocking Criterion for Self-Compacting Concrete
To benefit from the full potential of Self-Compacting Concrete (SCC) prediction tools for the form filling ability of SCC are needed. This paper presents a theoretical concept for assessment of the blocking resistance of SCC. A critical concrete flow rate above which no blocking occurs is introduced. The critical flow rate takes into account the mix design, the rheological properties of the matrix and concrete, and the geometry of the flow domain.

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Computational modelling of SCC flow

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Determination of Bingham Rheological Parameters of SCC using On-line Video Image Analysis of Automatic Slump Flow Testing
A "touch one bottom" prototype system for estimation of Bingham rheological parameters of SCC has been developed. Video image analysis is used to obtain a series of corresponding values of concrete spread versus time during an automatic slump flow test. The spread versus time curve is subsequently used to estimate the Bingham rheological parameters by a least square search into a database. It takes less than 120 seconds from the start of the slump flow test to the SCC’s Bingham rheological parameters appear on the system’s PC.

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Mini Seminar on Form Filling Ability of Self-Compacting Concrete
The Nordic mini-seminar "Form Filling Ability of Self-Compacting Concrete" took place on 3-4 November 2003 at the Danish Technological Institute in Taastrup, Denmark. The mini-seminar gathered 12 participants from Finland, Sweden, Norway and Denmark. The objective was to present and discuss recent developments of Self-Compacting Concrete in the Nordic countries. In general, the seminar included results and observations on the effect of fresh concrete behaviour, casting technique, and organisation on site on the filling ability, passing ability, and surface quality. The seminar had participants from the industry, working with SCC at full-scale, as well as participants working with SCC at a research level. The seminar included presentations from each participant, based on short papers, and discussions. This paper summarises the outcome of the seminar.
Predicting the Yield Stress of SCC using Materials Modelling

A conceptual model for predicting the Bingham rheological parameter yield stress of SCC has been established. The model used here is inspired by previous work of Oh et al. (1), predicting that the yield stress of concrete relative to the yield stress of paste is a function of the relative thickness of excess paste around the aggregate. The thickness of excess paste is itself a function of particle shape, particle size distribution, and particle packing. Seven types of SCC were tested at four different excess paste contents in order to verify the conceptual model. Paste composition and aggregate shape and distribution were varied between SCC types. The results indicate that yield stress of SCC may be predicted using the model.
Simulation and Verification of Form Filling with Self-Compacting Concrete

This paper presents a form filling experiment and the corresponding 3D simulation. One side of the form is made of a transparent acrylic plate and to improve the visual observations of the flow behaviour, the first and second half of the form is cast with normal grey and red-pigmented SCC, respectively. Simulations are based on a FEM formulation of the Navier-Stokes equations and a Bingham model has been applied. Results show that the simulation corresponds to the behaviour observed in the experiment.

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2-d Simulations of Test Methods: Initial Results

One of the main obstacles for the further development of self-compacting concrete is to relate the fresh concrete properties to the form filling ability. Therefore, simulation of the form filling ability will provide a powerful tool in obtaining this goal. In this paper, a continuum mechanical approach is presented by showing initial results from 2-d simulations of the empirical test methods slump flow and L-box. This method assumes a homogeneous material, which is expected to correspond to particle suspensions e.g. concrete, when it remains stable. The simulations have been carried out when using both a Newton and Bingham model for characterisation of the rheological properties of the concrete. From the results, it is expected that both the slump flow and L-box can be simulated quite accurately when the model is extended to 3-d and the concrete is characterised according to the Bingham model.

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Axi-symmetric simulations of the slump flow test for self-compacting concrete

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Axi-Symmetric Simulation of the Slump Flow Test for Self-Compacting Concrete

One of the main obstacles for further development of Self-Compacting Concrete (SCC) is to relate the fresh concrete properties, form geometry, reinforcement configuration, and casting technique to the form filling ability. Simulation of the filling ability might provide a tool in obtaining this goal. For simulation according to a continuum mechanical approach, the rheological properties are required. However, in connection with onsite jobs, it is only possible to characterise the flow properties or workability according to simple empirical test methods, and among the most popular is the slump flow test. This paper presents a numerical axi-symmetric approach for simulation of the slump flow test. Simulations are compared to experimental test results on the rheological properties and slump flow. Former rheological investigations on SCC indicate a non-Newtonian behaviour according to the Bingham model.

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greyish concrete, and a pigmented (red) concrete during the filling process. Monitoring equipment has been produced and tested and is valuable as documentary evidence of the flow in combination with visual observations. In one experiment reinforcement gap sizes of 1.5 and 3-Dmax,agg have been applied and blocking occurred at 1.5-Dmax,agg. Pumping from the bottom corner at casting rate of 10 m/h resulted in hydrostatic pressure. Continuously shearing across the surface seems to have a positive effect on the surface quality (no blowholes).

Simulation of the Test Method "L-Box" for Self-Compacting Concrete
Both filling and passing ability are important properties to be considered for self-compacting concrete. This paper presents simulations of the L-box test and corresponding experiments. The assumption of a continuum mechanical approach, where the fluid rheology is described by the Bingham model, is tested.

Simulation of the Test Method "L-Box" for Self-Compacting Concrete
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Use of SCC in Prefabricated Concrete Elements: Examples and Observations

This paper presents observations made on the use of self-compacting concrete for pre-cast elements at Byggebjerg Beton A/S during the last 3 years. The elements include L- and sandwich elements and are mainly produced for agriculture purposes. In general, the flow properties and air content are very sensitive to small variations in temperature, aggregate size distribution, and moisture content. For instance, the air content seems to decrease as the temperature increases. For vertical form filling applications it is important to adjust the filling technique according to the properties of the concrete to achieve a good surface quality with a limited number of blowholes. For horizontal castings it is important to keep the concrete flowing to avoid casting joints. Blocking is avoided by using the right type of spacers and a maximum size aggregate of 8mm. However, if the concrete has to flow over longer distances blocking may become a problem.

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Form Filling with Self-Compacting Concrete

This paper describes a newly started Ph.D. project with the aim of simulating the form filling ability of Self-Compacting Concrete (SCC) taking into account the form geometry, reinforcement configuration, casting technique, and the rheological properties of the concrete. Comparative studies of the form filling during actual castings and simulations by a commercial Computational Fluid Dynamics (CFD) program will be carried out to verify if a continuum mechanical approach is valid, and if the SCC can be characterised by the Bingham model or other parameters, such as thixopropic behaviour, have to be taken into account. Furthermore investigations will be carried out to verify and further develop models based on the composite theory describing the effect of mixture composition on the rheological properties and stability of fresh SCC.

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On the effect of coarse aggregate fraction and shape on the rheological properties of self-compacting concrete

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