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COMPARISON OF MEASURED FIBER ORIENTATION IN FIBER CONCRETE WITH PREDICTIONS BY CFD SIMULATIONS

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ABSTRACT

In fiber concrete the mechanical properties are partly determined by the orientation and alignment of the fibers. In the presentation flow simulations predicting fiber orientations will be compared to experiments and experimentally obtained fiber orientations.

Keywords: fiber orientations, fiber concrete, flow simulations, flow experiments.

INTRODUCTION

Fiber concrete is becoming increasingly popular as a construction material, as it can potentially form a ductile concrete. The properties of the fiber concrete depend on the concrete recipe, the flow of the fresh concrete into the formwork, possible vibrating of the concrete and the fiber orientations. Thereby the fiber orientations are largely influenced by the flow of the concrete, which also depends on the formwork surface quality. A rough, sticky surface can produce a different fiber alignment than a smooth, non-sticky surface.

The flow of the fresh concrete mass can be simulated using computational fluid dynamics, in which the concrete is approximated by a Bingham-plastic model. According to the Bingham-plastic material model, a material behaves solid-like until a certain shear-stress is reached and after it behaves like a viscous fluid. The fiber orientations in the fluid can be simulated by coupling an equation for the fiber orientation distribution to the Navier-Stokes equations. Results of the simulations will be presented.

Fiber orientations in concrete are difficult to measure. It can be done in the hardened concrete using x-ray computed tomography. Results of the x-ray computed tomography analysis will be presented.

To be able to observe the change of fiber orientations during the flow, different experiments were performed. In these experiments the opaque concrete was replaced by a transparent matrix with similar rheological parameters as the fresh self-compacting concrete, see Fig. 1. In the presentation, these experiments will be compared to the simulations.

RESULTS AND CONCLUSIONS

The results from the flow simulations show, that the surface properties of the formwork have an influence on the fiber orientations. This can be explained by the fact, that a change of the slipperyness of the formwork surface changes the velocity gradient, which in turn has

influence on the rotation of the fibers in the flow field. This effect should be taken into account when designing the casting technology for structural elements made of fiber concrete, as it can be used to influence fiber orientations. Ignoring the effect, can on the other hand create unwanted and non-beneficial fiber orientations.

Fig. 1 - Casting experiment with fibers in polymer solution

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