Simulation of Formwork Filling By Cement Fluid: The Effect of the Formwork Structure on Yield-stress Fluid

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Abstract

Self-Consolidating Concrete (SCC) is a relatively new, very flowable type of concrete which does not require any energy for consolidation [1]. Consequently, the hardened properties of the cast structural element are largely influenced by the flow pattern of SCC in the formwork [2].

COMSOL Multiphysics® was used to perform numerical single-fluid simulations to identify critical rheological parameters of Self-Consolidating Concrete for which formwork filling problems in presence of rebars can occur.

In this study, the flow of SCC was modeled as a single-phase yield-stress fluid [3] using the user-defined viscosity model of COMSOL. The flow of SCC with varied rheological properties (yield stress and plastic viscosity) was verified in formworks with different structural parameters, such as formwork width, reinforcement bar diameter, concrete cover (distance between rebar and wall) and the distance between the rebars (to investigate group effects). The minimum and maximum limits for the rheological properties were identified to avoid the presence of dead zones or zones with very high shear rates.

Figure 1 shows the result of velocity magnitude from a simulation of a yield stress fluid in a formwork channel with rebars. Due to the effect of rebars, the flow between the channel wall and rebars has lower velocity than the center of the channel.

In conclusion, COMSOL simulation is used to identify the flow pattern of cement flow in formwork filling. COMSOL simulation can provide the information of how to change the rheological properties of cement flow or the geometry of rebars to avoid dead zones.

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Reference

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Figures used in the abstract

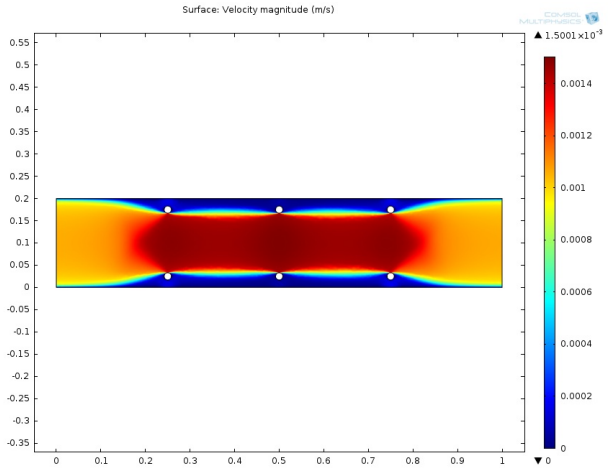

Figure 1: Velocity magnitude map of a yield stress fluid (yield stress=10Pa and plastic viscosity = 80Pa.s) flowing in a channel (height = 0.2m, rebar diameter =0.016m, rebard distance from a wall=0.025m, and distance between rebar=0.25m).