Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

S.J. Dasselaar

will give a presentation, entitled:

Numerical Simulation of Hopper Sedimentation

Date: Wednesday October 23, 2013

Time: 14:00

Room: **ZH 286**

Summary:
Dredging is applied worldwide for several purposes like land reclamation and maintenance of rivers, harbours and coasts. A Trailing Suction Hopper Dredger (TSHD) is often used for these purposes. Via the draghead, the solid-liquid mixture is transported through the suction pipes of the TSHD. Subsequently, the mixture enters the hopper in which solid particles settle. The redundant liquid-dominated flow leaves the hopper via the overflow. Following the loading process, the hopper contains a settled bed and a solids-dominated mixture above the settled bed.
In the present research, only sand-water mixtures are considered. Obviously, loss of sand through the overflow should be minimized since sand is the payload. There is a trade-off between the overflow loss (sand) and the loading time. A long loading time would result in less overflow loss, however, this is economically not favourable. Therefore the question arises: how can the overflow losses be reduced while maintaining fast loading of the hopper?

The objective of the present research is obtaining insight in the flow within the hopper in order to reduce the overflow loss. Therefore the flow field inside the hopper has been numerically simulated using the open-source CFD package OpenFOAM. The geometry of the DCI Dredge XIX (manufactured by IHC Merwede) has been adopted as test case for the numerical simulations.

Different mathematical models exist for the computation of mixture flows. In the present study, the Drift-Flux model has been chosen. In the Drift-Flux model, the momentum- and continuity equations are solved for the mixture. The transport of the solids is described by an additional advection-diffusion equation.
To account for turbulence, the k-ε turbulence model with wall functions has been applied to calculate the eddy viscosity. The Richardson & Zaki hindered settling function has been applied for calculating the relative velocity of particles with respect to the fluid. The existing Drift-Flux model has been modified in order to enable physically realistic results for sedimentation. One of the modifications is the implementation of the Bingham model for the viscous stress, which allows the formation of settled beds.

The mathematical model has been validated by comparing numerical results with a Poiseuille flow. Additionally, an experiment has been carried out for parameter estimation of the Bingham model. The performance of the modified Drift-Flux model has been investigated by carrying out various benchmarks on sedimentation experiments and slurry flow in a horizontal pipe.

Three different hopper configurations have been studied through numerical simulations, in which the position of the overflow has been varied. In the results a density current develops from the inlets towards the bottom. A uniform bed forms during the loading process. The resulting flow fields and the sedimentation within the hopper have been analysed. It has been observed that the mixture flow strongly depends on the position of the overflow.

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