DEL072 - Phase II of "Improving fines capture prediction: verification, application and improvement of Delft3D-Slurry."

This project improves the new module of the numerical tool Delft3D (Delft3D-slurry) as a tool to simulate slurry / soft sediment deposition, which is critical to improve our capabilities to building with mud and beneficial (and circular) use of soft sediment.

One of the key challenges in Delta Technology is related to possibilities of building on and with soft material. Soft materials (e.g. from dredged material and mine tailings) can be reused to form robust water defences, enclosure dams and for land building. The material can be used to combat settlement in Sustainable Delta Cities, as a cost-effective material for flood defences, and as the basis for nature-based land reclamations like Marker Wadden. As such, "Bouwen met Slib" has been identified as an important innovation to strengthen the international position of Dutch engineering companies.

The ability to improve the prediction capabilities of the sediment deposition dynamics as well as the characteristics and properties of the resulting deposits (e.g. distribution of sand and mud, strength, total settlement and time scale) is critical to reduce cost and risk of these activities. Current knowledge and predictive tool are nowadays limited. This project builds up on the positive development and findings of the previous phase (TKI DEL035), towards further improving understanding and modeling of soft sediments depositional processes.

Project activities

This project advances the development of Delft3D-slurry to improve prediction of geometry and material properties distribution in fine sediments and disposal site deposits, with specific focus on dewatering and basic 3D processes. The main activities of this project are:

1. Further validation of the new Delft3D-slurry module developed during Phase I (TKI DEL035)
2. Theoretical development of aging (i.e. time dependent strength development) function
3. Exploration of 3D performance

Example of Delft3D-slurry when simulating deposition of a sand-mud mixture from a pipe. Colours represent sand concentration. Sand settles near the pipe, while fines flow further. Inhomogeneity in deposit composition have significant implication on total settlement and strength of the final deposit, with consequences for reclamation and closure of the deposit itself. The left simulation in the foreground is one example of 3D simulation resulting form this DEL072 project. The background simulation (2DV) is an example from the DEL035 previous project).

Project Deliverables
This project collected and integrated current knowledge and physics of depositional processes, embed it into the current numerical tool, validated and tested the new tool against industry data, delivered the tool to the project partners, and produced various (conference) publications. Further, the knowledge and development of this project where included in a slurry deposition physics and modeling course, which was presented for the first time in Canada last December aside to the International Oil Sands Tailings Conference. This material is available for presentation in further course in Netherlands and abroad.

This model will be able to be utilized by the Dutch partners (e.g. dredging industry, ports or RWS) on large on-going soft sediment projects to improve accuracy of design and reduce risks and cost.

**Opportunities for further valorization aside to this TKI project**

This module can be applied in various tailings basins or reservoir world-wide to predicts / optimize deposition.

Further, we are currently investigating the applicability of this Delft3D-slurry module for prediction of risk related to mud-flows or tailings dam breach, as to timing and extension of the mud wave. This can be utilized in the definition of risk-maps and emergency evacuation plans. Applicability of this module is also being investigated for dredging application, such as Water Injection Dredging or other fluid-mud related simulations.

**Publication related to Delft3D-slurries (in italic those produced directly during this project)**

**Deltares (2017a) “Task 2A: IOL TT and FFT flow, segregation and mixing dynamics”. Delivered to IOL (Dave Rennard) in June 2017.**

**Deltares (2017b) “A research trajectory towards improving fines capture prediction with Delt3D-slurry Phase 1”. Delivered to COSIA in November 2017.**

**Deltares (2019) “A research trajectory towards improving fines capture prediction with Delt3D-slurry Phase 2”. Delivered to IOSI in February 2019.**


**Other publications related to sand-settling non-Newtonian slurries deposition**


Talmon, A.M (2018) "Rheology and segregation of sand-water-clay mixtures in deposition flow modelling". South Africa’s Society of Rheology (SASOR), Stellenbosch, Sept 25-28, South Africa.


