

The effect of initial conditions on the consolidation of mud

Barciela Rial, Maria; van den Bosch, Barend; Winterwerp, Han; van Paassen, Leon; Griffioen, Jasper; van Kessel, Thijs

Publication date

2017

Document Version

Final published version

Citation (APA)

Barciela Rial, M., van den Bosch, B., Winterwerp, H., van Paassen, L., Griffioen, J., & van Kessel, T. (2017). *The effect of initial conditions on the consolidation of mud*. 21-22. Abstract from INTERCOH 2017, Montevideo, Uruguay.

Important note

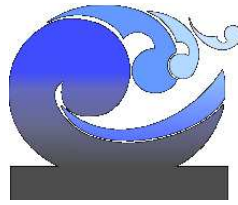
To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.



INTERCOH 2017
Montevideo - Uruguay
November 13 - 17

14th International Conference on Cohesive Sediment Transport Processes

Book of abstracts

13 to 17 November 2017
Montevideo URUGUAY

Courtesy of the U.S. Geological Survey.



UNIVERSIDAD
DE LA REPÚBLICA
URUGUAY



The effect of initial conditions on the consolidation of mud

Maria Barciela Rial¹, Barend A.P. van den Bosch¹, Johan C. Winterwerp¹, Leon A. van Paassen², Jasper Griffioen^{3,4} and Thijs van Kessel⁵

¹ Delft University of Technology, Faculty of Civil Engineering and Geosciences, The Netherlands
E-mail m.barcielarial@tudelft.nl

² Arizona State University, School of Sustainable Engineering and the Built Environment, Arizona

³ Utrecht University, Copernicus Institute of Sustainable Development, The Netherlands

⁴ TNO Geological Survey of the Netherlands, The Netherlands

⁵ Deltares, The Netherlands

Introduction

Sediment is becoming scarce. Therefore, soft sediments are progressively being used for nature building. The MarkerWadden is an example of an ongoing *Building with Nature* (BwN) project which aims to improve the ecology of Lake Markermeer (The Netherlands) by creating a wetland with the cohesive sediments from the bed of the lake. It represents one of the first projects using fresh unconsolidated mud as a filling material. However, building with these fine sediments represents a great challenge, because of their complex properties.

Various authors have studied the settling and consolidation behaviour of mud at initial concentrations below the gelling point, e. g. Merckelbach (2000), Dankers (2006). However, slurries at much higher initial sediment concentrations are used for BwN, and the consolidation behaviour of such mixtures has been less studied.

In this research, the influence of the initial concentration c_0 on the consolidation behaviour of mud was studied for mud mixtures with an initial concentration above the gelling point.

Methods

The material parameters of Markermeer mud were obtained with two different experimental methods: settling columns and the Seepage Induced Consolidation test (SIC). The two sets of parameters were used as input for a 1DV model to compute density profiles. To account for over-consolidated initial conditions, the effect of swelling was implemented in the 1DV-model. These computed profiles were then compared with the profiles measured with an Ultrasonic High Concentration Meter (UHCM). Further, the sensitivity of the model results was evaluated by interchanging the coefficients of the material properties.

Results and discussion

In our analysis, we presume self-similar sediment properties, and apply a fractal material model. The fractal dimension n_f and the effective stress coefficient K_b obtained with the settling columns and the SIC tests appeared to be of the same order of magnitude. However, the permeability coefficient K_k differed by a factor of 20, suggesting dependency on the initial concentration and/or sample preparation and/or accuracy problems with the methods deployed. Consequently, the final bed heights are predicted correctly when using the different sets of material parameters to model a hypothetical settling column of arbitrary height. However, the consolidation time may vary considerably due to the high variability of K_k .

Both sets of material parameters predict the density profile and bed height well for equilibrium conditions. The differences are minor, but the SIC material parameters provide a better agreement with respect to final bed height and shape of the density profile (Fig. 1).

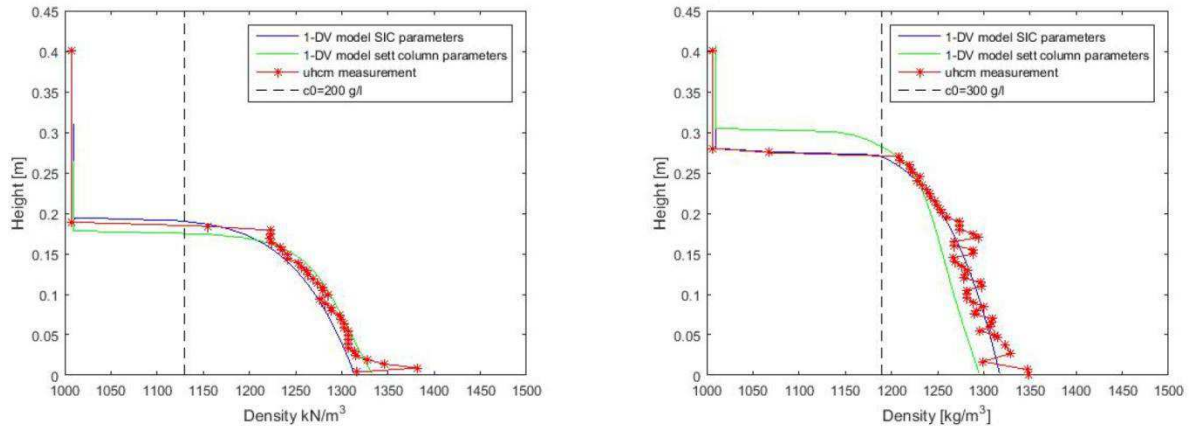


Fig. 1. Left panel: density profiles for $c_0 = 200$ g/l computed with material parameters obtained from the settling column experiment and SIC test. Both profiles are compared with UHCM measurement at $t = 67$ days. Right panel: density profiles for $c_0 = 300$ g/l computed with material parameters obtained from the settling column experiment and SIC test. Both profiles are compared with UHCM measurement at $t = 67$ days.

When the material parameters from columns with different c_0 were interchanged, the bed height and density profile agree less to the measurement (see Table I).

Table I. Offsets of the computed density profiles with respect to the measured ones.

$C_0=200$ g/l. Parameters:	Offset Profile [%]	Offset Bed height [%]	$C_0=300$ g/l. Parameters:	Offset Profile [%]	Offset Bed height [%]
SCE	2	7	SCE	8	9
SIC300	2	2	SIC300	4	0
SIC200	9	7	SIC200	5	6

Discussion and conclusions

This research presented two different experimental procedures, the settling columns and the SIC tests, which showed consistent results.

The results showed to be highly sensitive to the experimental procedure, notably to the sample preparation. The mixing method, together with the room temperature and light conditions, seem to be the most critical factors. The mixing procedure likely affects the size of flocs and the environmental conditions may induce gas production and the development of biofilms. Our results suggest that these factors affect in particular the consolidation time. We are carrying out further research on these effects.

The initial concentration of sediment was also found to play an important role in the consolidation behaviour. In the case that part of the initial column is over-consolidated, the consolidation curves showed an initial linear phase caused by a higher density than at equilibrium in the uppermost part of the mud layer. This excess of density acts like an overburden inducing what we defined as “piston effect”. Further, under over-consolidated conditions, swelling needs to be taken into account and be included in the model.

Thus, our study gives insight in the effect of the initial conditions on the consolidation of high concentrated mud mixtures. These initial conditions are particularly important for land reclamation and wetland construction, where the initial density may be high but the flocs may have been broken due to the mixing during the dredging process.

References

- Dankers, P. (2006). On the hindered settling of suspensions of mud and mud-sand mixtures. PhD-thesis, Delft University of Technology.
- Merckelbach, L. M. (2000). Consolidation and strength evolution of soft mud layers. PhD-thesis, Delft University of Technology.