Advancements in the characterization and preparation of HPMC viscous fluids for centrifuge testing

Centrifuge modelling of fast loading and immersed geo-mechanical processes requires the use of viscous fluids that compensate for the discrepancy between dynamic and diffusive timescales. However, the selection of a viscous fluid is non-trivial, as it involves ad-hoc preparation procedures and, on most occasions, a non-Newtonian aqueous solution. Currently, the most common alternative for the preparation of viscous fluids for centrifuge modelling is hydroxypropyl methylcellulose (HPMC), available in different presentations and prepared under different protocols. In this webinar, we explore the preparation procedures of three HPMC types: (i) Methocel F50; (ii) Methocel F450; and (iii) Methocel F4M, and evaluate its performance in the centrifuge for the installation of a monopile by an impact-blow-prolongation technology.

The rheology of the HPMC solutions is characterized over a wide range of shear rates, showing a non-uniform viscosity for the three HPMC types, being in the range of 20 to 100 mPa s. Results show that the linear viscoelastic region decreases with concentration and nominal HPMC polymer length, while absolute viscosity reduction increases. Based on these observations, we propose a unified fitting relationship to streamline HPMC viscous fluid preparation, using a single viscosity measurement at a known concentration. The proposed method unifies the existing concentration-viscosity relationships suggested by previous researchers.

Centrifuge tests were performed in a strongbox filled with dense sand and saturated with three different fluids: (i) water; (ii) Methocel F50; and (iii) Methocel F4M. All tests shared the same installation parameters. The results demonstrate that, during and directly after the dynamic blow-event, the soil shows an undrained response when using a viscous fluid. This observation supports that offshore pile installation occurs as an undrained process. Additionally, the study explores the influence of fluid shear-thinning on the pile-soil interaction, underscoring the need to consider the fluid rheology next to the soil mechanical behaviour when designing a physical model.

The Speakers

Ir. Tristan Quinten
GSE, Delft University of Technology

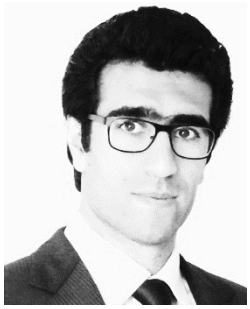
Tristan obtained his MSc degrees in Geo-engineering from Delft University of Technology (DUT). He joined DEME Group in Belgium as a Geotechnical engineer back in 2019. After working on several significant tenders and gaining international experience in Manila and Singapore, he returned to TU Delft in 2021 as a PhD candidate in the Geosciences and Engineering (GSE) department. He is currently working on the BLUE Piling project, which is a collaboration between DUT and IQIP. Withing this research consortium, Tristan investigates dynamic soil-pile interaction during dynamic pile installation. His research involves the design of a BLUE blow generator and the revision of an existing miniature impact hammer to simulate impact pile driving, the industry's benchmark installation technique. The aim of the project is to enhance understanding of soil behavioural principles in relation to the installation method, through a comprehensive comparison of physical and computational modelling. Ultimately, this should aid the development of driving hardware that can install the next generation of (mono)piles with fewer sound emissions and reduced fatigue accumulation.

Dr. Miguel Cabrera
GSE, Delft University of Technology

Miguel Angel Cabrera is Assistant Professor of Experimental Soil Mechanics in the Geo-Engineering section at Delft University of Technology. He specializes in the physical modelling of land instabilities and soil-structure interaction systems. His research centers on geotechnical engineering, addressing complex, multiphase geophysical and environmental flows, as well as soil-fluid-structure interaction systems. Miguel integrates fundamental understanding of these processes with real-world challenges through a combined approach, utilizing physical modelling, advanced measuring techniques, and numerical modelling. Miguel completed his Ph.D. at the University of Natural Resources and Applied Life Sciences, Austria. He was a Marie Skłodowska-Curie fellow under the MUMOLADE project, focusing on the simulation of granular flows in rotating systems. Miguel served as Assistant and then Associate Professor at Universidad de los Andes, Colombia, from 2016 to 2022, before joining TU Delft's Geo-Engineering section in August 2022.

Roland Klasen
GSE, Delft University of Technology

Roland Klasen became a part of the GSE-laboratory team in March 2020. He was hired as a lab-technician and area supervisor. Roland's responsibilities extend to overseeing the geotechnical-centrifuge and liquefaction-tank as a controller. Leveraging his technical background acquired during laboratory studies and his prior offshore-technician role at the geotechnical advisory bureau Fugro. His years at Fugro, working on projects such as the Hollandse Kust-windfarms and various oil and gas platforms in the West Nile Delta, equipped him with extensive technical knowledge and data-acquisition skills across diverse global environments. Following his offshore experiences, Roland decided to transition back to solid ground and joined TU Delft, contributing to the GSE-laboratory team. Starting in 2021, Roland took on an additional role in the Geotechnical department, expanding his contributions to include educational responsibilities alongside his work as laboratory technician.



Dr Amin Askarinejad
GSE, Delft University of Technology & Swiss Federal Office of Energy

Amin Askarinejad is the director of research and development at the dam safety section of the Swiss Federal Office of Energy (SFOE). He is also Associate Professor of Soil Mechanics at Delft University of Technology, the Netherlands. He received his PhD from ETH Zurich in 2013 and has about 20 years of experience in geotechnical engineering with a focus on monitoring of structures, physical modelling of geotechnical failure mechanisms and soil-structure interactions. He is the president ad in. of the working group on safety of small dams in the framework of the Swiss Committee of dams and the co-opted member of the technical committee of ICOLD on seismic aspects of dam design. He has been the representative of the Netherlands in the technical committees TC208 (slope stability) and TC104 (geotechnical physical modelling) of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). Moreover, Dr Askarinejad has served as the editorial board member of the Journal of Landslides (Springer Nature) and the International Journal of Physical Modelling in Geotechnics. Besides receiving the “Bright Spark Lecturer” award from the ISSMGE in 2018, in 2022 he received the premium award of George Stephenson Medal from the Institute of Civil Engineers in London for his research on triggering mechanisms of landslides.