POSEIDON – MSCA DN: DC04

UNIVERSITY OF TWENTE.

PhD Project Title: Towards a unified constitutive model for saturated granular fluids and solids

Enrolment in Doctoral degree(s): University of Twente

Supervisors: prof. S. Luding and dr. Hongyang Cheng

Recruitment host: University of Twente

Secondment host: Dr Xue Zhang (University of Liverpool),
Norwegian Geotechnical Institute,
Mr. Willem Hendrik Pater (State of the Art Engineering BV)

Background and aim:

Submarine landslides, from the mobilization to the transport of fluid-saturated sediments, involve the understanding and modelling of geomechanical processes at multiple length and time scales. One of the main challenges in submarine granular flows is the complex yielding transition from static to motion, which is governed by the spatially and/or temporally varying length scales, i.e., landslide threshold, and back to static conditions. This gap creates considerable difficulty in predicting the initiation and post-failure behaviour of submarine landslides. Questions such as the runout distance cannot be answered without understanding and quantifying the dissipation during this fluid-solid transition and back. The current frameworks (e.g., plasticity and effective stress theories) for modelling soil-fluid interactions going from fluid saturated solids to a fluid-dominated mixture have to be revised and improved.

Based on the simulation data of particle-fluid interaction (developed in a parallel DC project) and machine learning tools (GrainLearning) that aid constitutive modelling established in the group, we will enrich existing constitutive frameworks for describing the behaviour of saturated granular masses in the solid and fluid regimes, and their transition. Particle-scale simulations provide the essential data for this task, as they uniquely can inform the continuum framework. The end goal is to come up with a sensible model structure for a unified granular micromechanically based solid-fluid model by learning model structures from fully-resolved simulations particle-fluid systems, with the help of Bayesian learning.

Objectives:

i) Understand the capabilities of fluid-solid models for granular media and their limitations to model the collapse of saturated granular flows;

ii) Study the complex transitions from static to motion and back using coarse grained fluid-DEM simulations;

iii) Implement the unified model in a continuum solver to accurately predict the runout distance of submarine landslide and compare the results with experimental data.

Expected Results:

i) Assessment of the suitability of theoretical frameworks to describe solid-to-fluid (collapse) and fluid-to-solid (runout) transition in saturated granular masses;

ii) Micromechanical-based unified constitutive models that correctly capture these transitions;

iii) Comparison and validation via laboratory experiments

Your Profile:

The ideal candidate should:

This project has received funding from the European Union under Grant Agreement No **101120236**.

- Obtained a MSc degree in a relevant field such as civil engineering, mechanical engineering, computational physics, applied mathematics, materials science, or related areas;
- Good knowledge of the transport and constitutive behaviour of fluid-saturated sediments;
- Sound programming skills in C/C++, Fortran, Python or equivalent;
- Previous experience with rheological or plasticity laws for the constitutive modeling of sediments would be advantageous;
- You are an excellent teammate, able to collaborate intensively with industrial and academic parties in regular meetings and work visits;
- An appropriate qualification in the English Language together with excellent communication and organizational skills.

Planned Secondment(s):

Dr Xue Zhang (University of Liverpool, 3 months): collaborate with the DC on the implementation of the new constitutive model/framework into a particle finite element code available at University of Liverpool.

NGI, (3 months): discuss continuum frameworks for saturated granular fluid-solid transition; collaborate with the DC on the effect of particle shape on fluid-particle coupled systems; collaborate on the implementation and validation of the new constitutive model/framework with existing data.

Mr. Willem Hendrik Pater (State of the Art Engineering BV, 3 month): transfer the numerical results of submarine landslide simulations (e.g., runout distance, impact loads) onto the finite element model of offshore wind turbine foundations.

Information and application

Please submit your application before **February 28, 2024** via the following application link:

https://utwentecareers.nl/en/vacancies/1606/13-phd-positions-on-the-eu-horizon-2020-marie-skiodowska-curie-project-poseidon/

Submission must include:

- **Cover Letter:** A maximum of two A4 pages, highlighting your specific interest in the position, your qualifications, and motivations for applying. This letter should clearly articulate how your background and experiences align with the requirements of this project
- **Detailed Curriculum Vitae (CV):** The CV, should include, if applicable, a list of publications;
- **Bachelor and Master transcripts**;
- **Contact Details of Referees:** Provide the names and contact information of individuals who can professionally vouch for your qualifications and suitability for this position.

For general inquiries on the application procedures and the consortium please contact: info@poseidon-dn.eu

This project has received funding from the European Union under Grant Agreement No **101120236**.