POSEIDON – MSCA DN: DC06

UNIVERSITY OF TWENTE.

PhD Project Title: High-performance multi-phase, volume-coupled material point method for modelling submarine landslides

Enrolment in Doctoral degree(s): University of Twente

Supervisors: dr. Hongyang Cheng, prof. S. Luding and prof. V. Magnanimo

Recruitment host: University of Twente

Secondment host: Dr. Michele Larcher (Free University of Bolzano);

Dr. Xue Zhang (University of Liverpool)

Background and aim:

Submarine landslides involve the movement of saturated sediments down a slope, interacting with seawater and/or offshore infrastructure. During landslides, the bulk of the sediment material (usually considered as a porous medium), transits from solid-like to fluid-like, i.e., from stagnant to continuously flowing. In addition, the coupling between seawater and sediment is crucial in the landslide dynamics. Recent studies have shown that the material point method (MPM) can describe the movement of saturated sediment and the hydrodynamic coupling between soil skeleton and seawater, within a multiple-phase framework. Nevertheless, to accurately predict the dynamics of and dissipation within the sliding masses, the transition between solid and flowing states of sediments must be incorporated.

The doctoral candidate will implement constitutive models for saturated sediments in fluid- and solid-like states into an existing GPU-MPM code. The exchange of momentum, mass, and energy between these admissible states of saturated sediments will be achieved with overlapping subdomains where the transition can potentially take place. To further improve the computational efficiency, machine learning surrogates will be used to partially replace the expensive physics-based models to allow large-scale industrial applications. The project aims to provide more accurate, highly efficient, and physics-based predictions for submarine landslides in order to quantitively assess the risk of damages to offshore infrastructures (e.g., foundations anchors) and induced disasters (e.g., tsunamis).

Objectives:

i) Extend an existing MPM code from single-phase to multi-phase based on a volume-coupled formulation that incorporates mass, momentum, and energy exchange between slow- and fast-flowing sediments and water;

ii) Develop a reduced-order model of the multi-phase system using machine learning and integrate it into the volume-coupled numerical framework;

iii) Perform simulations of submarine landslides and assess their impact on offshore infrastructures;

iv) Calibrate model parameters using existing experimental data and compare the model predictions with experimental data obtained from laboratory flume experiments.

Expected Results:

i) A novel volume-coupled formulation to consider the transport and coupling of multiple phases;

ii) An open-source, multi-phase GPU-based MPM code with clear documentation, tutorials, and examples for future users;

iii) Benchmark cases validated using experimental data from laboratory-scale physical tests.

Your Profile:

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

As an ideal candidate you have:

- Obtained a MSc degree in a relevant field such as civil engineering, mechanical engineering, computational physics, applied mathematics, materials science, or related areas
- Experience with numerical methods for solving partial differential equations;
- Previous experience with multi-phase materials and transport phenomena and/or deep neural network solvers will be advantageous;
- Sound programming skills in C/C++, Fortran, Python or equivalent;
- 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. Michele Larcher (Free University of Bolzano, 2 months): Perform a laboratory-scale experiment on slope collapse and its interaction with foundation anchors in the flume device; the movement of sediment transport underwater will be recorded and analysed to validate the multiphase MPM model for submarine landslides. DC06 will build his/her work on the experiments previously performed by DC03 in UNIBZ.

Dr. Xue Zhang (University of Liverpool, 3 months): Improve the parallelization of the MPM code; incorporate structural mechanics into the code, e.g., using the finite element method, towards assessing the impact of the slides on submarine infrastructures; comparison of PFEM-MPM methods performances.

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

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