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PHD OPPORTUNITY – RESEARCH IN OFFSHORE RENEWABLES OCTOBER 2025 (3 YEARS, FULLY FUNDED)

INVESTIGATION OF PILE DRIVING RESISTANCE IN GLAUCONITE SAND USING CENTRIFUGE TESTING

Supervisors: Dr Matthieu Blanc, Dr Zack Westgate, Dr Christelle Abadie
Collaborators: Dr Federico Pisanò (Norwegian Geotechnical Institute)

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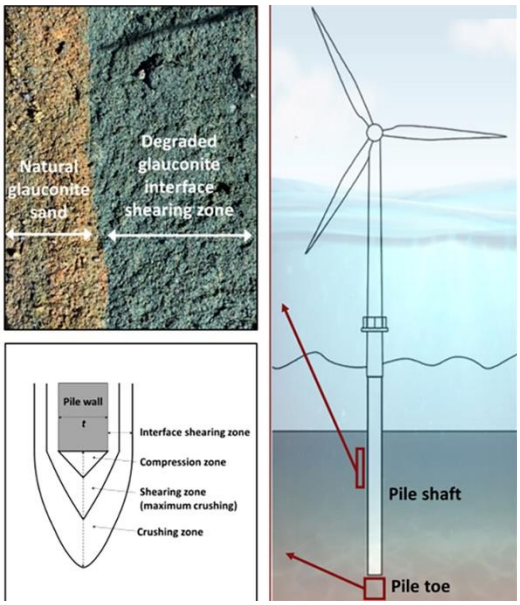
PhD specialty: Geotechnical Engineering, Offshore Geotechnics

1 | Project description



This PhD aims at providing better understanding of the behaviour of offshore wind foundations in challenging Glauconite soil conditions to permit further development of marine renewable energy along the US West Coast. In partnership with the US Joint Industry Project (JIP) Piling In Glauconitic Sands (PIGS) and the University of Massachusetts Amherst, this exciting position offers the opportunity to work on a unique experimental research project in collaboration with world-leading researchers and industry partners in offshore geotechnics in both France and the US.

Offshore wind development in the US has focused on the North Atlantic and Mid-Atlantic Outer Continental Shelf (OCS), primarily due to its proximity to high energy demand, shallow water depths suitable for fixed-bottom foundations, and strong wind speeds. The foundation types constructed to date, or now in the design stage, are primarily deep foundations consisting of jacket piles or monopiles. The Atlantic Outer Continental Shelf (OCS) features glauconite-rich sediments, which transform from coarse-grained soil to fine-grained soil upon shearing, causing uncertainty in geotechnical behaviour related to site characterisation and pile foundation installation and long term axial and lateral response.

The PhD student will take part in this JIP effort that aims to address the uncertainties arising from the behaviour of glauconite soils around piles through experimental testing comprising geotechnical centrifuge model testing and laboratory element testing.

Keywords: offshore wind, monopile, installation, glauconite, centrifuge testing.

2 | Project Objectives

The main objective of the PhD project is to develop an understanding of glauconite soil behaviour related to site characterisation and soil-structure interaction to develop a framework for assessing the impact of glauconite on offshore wind infrastructure development related to pile foundations.

Conducting pile foundation testing in offshore environments is cost-prohibitive. A common approach used by industry and academia working in offshore geotechnics is to utilize reduced-scale experiments performed in a geotechnical centrifuge. A reduced-scale model within a macro-gravity field replicates the same stress state on the model as experienced by the full-scale prototype. Consequently, a 1/100th scale model for example, when subjected to a 100×g macro-gravity field (equivalent to 100 times Earth's gravity), simulates the behaviour of the full-scale geotechnical system.

The University of Gustave Eiffel, located on the Nantes campus, boasts the exclusive geotechnical centrifuge in France and ranks among the top five largest capacity centrifuges in Europe. During this project, an experimental campaign involving reduced-scale models will be performed in the centrifuge, enabling tests on pile foundation installation using an impact hammer and subsequently subjecting the pile to axial and lateral load tests. Performing centrifuge tests permits control of environmental and boundary conditions, enabling a systematic and rigorous analysis of the soil-foundation system and allowing for accurate soil resistance to driving (SRD) model calibration and assessment of pile response to axial and lateral loading.

The project will utilize authigenic glauconite sediments collected from the US Atlantic coastal plain understood to be source material found at some offshore wind lease areas. The test program will focus on replicating aspects of the JIP onshore test site in New Jersey (Search Farm) and extending the work to other types of soils including allogenic (i.e. reworked) glauconite sands. Samples of crushed glauconite sands will be collected from the model pile walls to determine the degree of particle degradation from the driving process. Extensive instrumentation of the pile including strain gauges and optical fibre sensors will permit analysis of key mechanisms influencing the pile installation and long term performance, providing a unique dataset for future design of pile foundations in glauconite sands.

3 | Technical approach

Research Axis 1: Centrifuge test preparation

- Test program design using analytical and numerical analysis (provided by PIGS project personnel, see below in « Collaboration »)
- Model pile fabrication and instrumentation
- Design of the experimental set-up to install the model pile by impact hammering and subsequently load testing the model pile axially and/or laterally

Research Axis 2: Glauconite sand behaviour

- Pre-processing and laboratory testing of glauconite sand bulk samples collected from Search Farm and other outcrop locations
- Preparation of glauconite centrifuge samples
- Pile extraction and crushed soil sampling and testing

Research Axis 3: Experimental campaign in centrifuge

- Geotechnical characterization of centrifuge samples (CPT test, bender element testing)
- Model pile driving and load testing under different glauconite sand conditions

Research Axis 4: Test Analysis, modelling and discussion

- Global behaviour analysis of the piles using strain gauges at the pile head for driving forces and axial and lateral capacity assessment
- Local behaviour analysis using optical fibre sensors to assess pile bending, strain and internal force distribution.

- Calibration of SRD models and axial / lateral capacity and response prediction models for glauconite sands.

4 | Supervision

PhD co-director – Dr. Matthieu Blanc (HDR), from Gustave Eiffel University, has over 14 years of experience in centrifuge physical modelling applied to offshore geotechnics. Matthieu Blanc's current research explores topics related to physical modelling in geotechnics, particularly with the geotechnical centrifuge. He mainly works on soil-structure interactions under complex loading, such as soil reinforcement, and deep and shallow foundations. Recent applications are oriented towards foundations and anchoring systems for marine renewable energies. The ongoing challenge for each of these topics is to observe and understand the phenomena, and also to obtain appropriate experimental data to compare with numerical or theoretical models.

PhD co-director – Dr. Zack Westgate, from the University of Massachusetts Amherst, is an Associate Professor in the Department of Civil and Environmental Engineering and a faculty member of the UMass Wind Energy Center. He has 20 years of experience in industry and academia in the area of offshore geotechnics, investigating and teaching on topics related to site characterization, offshore foundation design, and pipeline/riser/cable-soil interaction. He is Chair of the Society for Underwater Technology's Offshore Site Investigations and Geotechnical committee, and currently leads the PIGS JIP with colleagues at the Norwegian Geotechnical Institute.

PhD supervisor – Dr Christelle Abadie, Gustave Eiffel University. After completing her PhD in 2015 at the University of Oxford on the cyclic behaviour of monopiles and the development of the HARM model, Christelle Abadie continued her research at the University of Cambridge as an assistant professor, focusing on geotechnics for sustainable infrastructure development in the context of climate change. Recruited at Gustave Eiffel University at the end of 2023, she continues to explore topics related to the emergence of new foundations for Marine Renewable Energies.

5 | Collaboration

This thesis will be co-supervised with the University of Massachusetts Amherst, potentially involving collaborative research visits to perform field sampling and/or laboratory testing at their test site and campus in the US.

This PhD research will be integrated within the framework of the PIGS JIP (https://www.ngi.no/en/projects/pigs/). Technical steerage from PIGS project is crucial in the success of the thesis to give strategic direction to the axes of research. The PhD student will participate in monthly PIGS project meetings, developing factual project reports, performing geotechnical analysis, creating an experimental database, and presenting research outcomes at public forums (e.g. conferences).

6 | Candidate's profile

We are seeking motivated candidates who possess a solid foundation in geotechnical engineering. Undergraduate/Master students in general engineering/civil engineering / geotechnical engineering / offshore geotechnical engineering are particularly welcome. Experience in programming is preferred. Prior experience in geotechnical laboratory experiments is not required but will be advantageous for performing the early test campaign. Proficiency in the English language is mandatory for the role.

7 | Location and Funding

Location

The PhD will take place in the Geotechnical Centrifuges Laboratory on the Nantes campus of Gustave Eiffel University. Please visit the website of the lab for more information: https://cg.univ-gustave-eiffel.fr/en/.

Funding

The PhD contract granted by Université Gustave Eiffel is for the time being 1858€ gross per month during the first two years and 2125€ gross per month during the third year. Teaching vacations or industrial missions can complement these PhD contracts.

8 | How to apply

To apply, please email:

- A CV
- A cover letter detailing your suitability and motivation for this position
- A copy of your transcript

Email to matthieu.blanc@univ-eiffel.fr & zwestgate@umass.edu & christelle.abadie@univ-eiffel.fr

Please, do not hesitate to get in touch for further information.