School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Funding and application details

Funding status: Self funded students only

Application instructions:
Detailed instructions are available at https://blogs.napier.ac.uk/scebe-research/available-phd-student-projects/

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:
- DIRECTOR OF STUDY: Daniel Barreto (Email: D.Barreto@napier.ac.uk)
- 2ND SUPERVISOR: Juan Bernal-Sanchez

Subject Group: Built environment

Research Areas: Civil Engineering

Project Title: The influence of particle characteristics on the field-scale geomechanical behaviour of soils

Project description:

It is well recognised that many geotechnical phenomena, such as liquefaction, crushing, dissolution effects and failure are affected by macro-scale properties such as initial density, anisotropy, permeability and compressibility, amongst others. On the other hand, it is well understood micro-scale properties such as particle morphology, roughness, particle shape and size distributions underlie many of these observed macro-scale behaviour. Much of this insight is the result of extensive experimental and numerical investigations. Of particular interest is the use of Discrete Element Method (DEM) simulations that account for the particulate nature of soils. There is significant advance on computational capabilities and

techniques to realistically model particle properties such as morphology, particle shape and soil-fluid interactions. In spite of this, the efficient DEM modelling of anything beyond laboratory scale soil element tests still remains a challenge.

This project aims to develop and validate efficient and realistic numerical techniques that enable the simulation of boundary-value problems including retaining walls, excavations, embankments, etc. A truly innovative micro-to-macro approach that includes particle properties via DEM, fluids via computational fluid dynamics (CFD) as well as homogenization techniques [1-3] optmised by machine learning approaches [4] will be validated by laboratory experiments and available field data of relevant construction scenarios.

As part of this project, you will help develop the required numerical techniques under the supervision of Dr Barreto and performing a limited set of laboratory experiments to validate the DEM simulations. Apart from joining one of the world experts in DEM you would be joining a dynamic research team whilst contributing to enable the next generation of DEM simulations for use in real life and large-scale industrial and engineering applications.

References:

[1] Guo, N., & Zhao, J. (2016). Multiscale insights into classical geomechanics problems. International Journal for Numerical and Analytical Methods in Geomechanics, 40(3), 367-390.

[2] Coetzee, C. (2020). Calibration of the discrete element method: Strategies for spherical and non-spherical particles. Powder Technology, 364, 851-878.

[3] Di Renzo, A., Napolitano, E. S., & Di Maio, F. P. (2021). Coarse-grain dem modelling in fluidized bed simulation: A review. Processes, 9(2), 279

[4] Tejada, I. & Antolin, P. (2021). Use of machine learning learning for unravelling hidden correlations between particle size distributions and the mechanical behaviour of granular materials. Acta Geotechnica.

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in civil engineering.

Subject knowledge:

- Soil mechanics
- Geotechnical engineering
- Programming languages (specially Python and C++)

Essential attributes:

- Great motivation, attention to detail and ability to work independently