

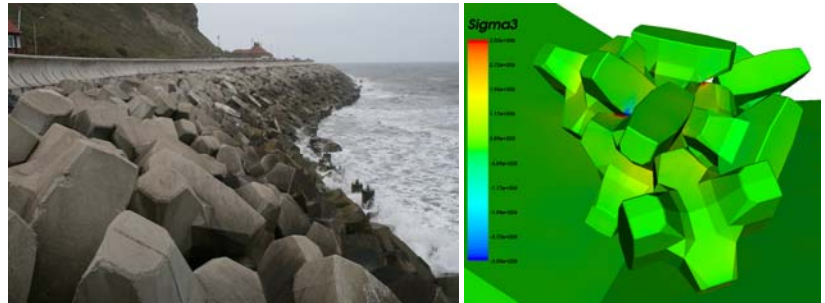
IMPERIAL COLLEGE LONDON - Department of Earth Science and Engineering

Two fully-funded EPSRC PhD Research Studentships - Duration 42 months each - Starts December 2010

Supervision: Dr JP Latham, Dr Jiansheng Xiang, Prof Chris Pain, Dr Gerard Gorman, Prof Bassam Izzuddin

Applications are invited for two PhD studentships to join [AMCG](#) (Applied Modelling and Computational Group) in the Department of Earth Science & Engineering.

Background: To meet this century's challenge of extensive and accelerating future coastal change, society will expect coastal engineers to design resilient structures to hold the line against flood and erosion. The first choice construction material and design approach for such structures will be to use armour layers of massive rocks or concrete units.



Currently, designers do not fully understand the details of how they work, and must rely on empirical methods. This £0.91m EPSRC- and Industry-funded project on **“forces and stresses in gigantic granular systems for coastal engineers”** will help reveal fundamental mechanisms that define the stability, or failure of rubble mound coastal structures and breakwaters using numerical models - transforming the way engineers design.

PhD Project 1: Very Coarse Granular Systems

The aim of the project is to take advantage of an already internationally leading computer code and to apply it to a uniquely problematic class of granular materials that remains poorly understood. The outer layers of most breakwaters comprise hundreds if not thousands of concrete units each one typically weighing anything from 5 to 80 tonnes. From a detailed mechanically deterministic modelling approach – the envy of many physicists working in such fields of particulate and granular mechanics – will emerge the statistical heterogeneity of the contact forces and stresses of the granular system. Both friction and interlock will contribute to stability. Currently, the in-house 3D FEMDEM modelling technology combines the multi-body particle interaction and motion modelling (i.e. Discrete Element Model, DEM) with the ability to model internal deformation and stresses of arbitrary shapes (Finite Element Model, FEM).

With the FEMDEM simulation tools (seen at [VGeST.net](#)), the candidate will model the construction process (normally performed by crane), examine inherent heterogeneity of these gigantic granular systems, explore concrete unit shapes, examine scale effects, and use vibration and other proxies for wave disturbance, all to study block motion, forces and stresses and the risk of concrete unit breakages. The PhD project scope includes validation of computer code through running two-body and multi-body experiments in the structures laboratory and performing numerical simulations with simple cases to start with, building towards increasingly realistic layered packs of concrete armour units. Results will be related to breakwater case histories of our French and Canadian industry partners who have many hundreds of project sites throughout the world ([see CLI](#)) and laboratories in Grenoble. The work has potential to link with our fluids modelling platform “Fluidity” and to model wave-structure interaction [1].

Successful candidates will join, and be supported by, a dynamic international research group with world-class expertise on modelling and coastal structures. The candidates will have the opportunity to develop their career and profile by presenting at international conferences in numerical and applied fields and publishing in high impact journals. Applicants should have an excellent bachelors or masters degree in physics, engineering, applied mathematics, science or a similar subject. We are looking for a strongly motivated scientist/engineer who is intrigued by this problem and will enjoy working with computer simulation as a research tool.

PhD Project 2: Computational Mechanics for Coastal Structures

The aim of the project is to take advantage of an already internationally leading computer code and improve its performance speed and versatility. Currently, the in-house 3D FEMDEM modelling technology combines the multi-body particle interaction and motion modelling (i.e. Discrete Element Model, DEM) with the ability to

model internal deformation of arbitrary shapes (Finite Element Model, FEM). The further enhancements will focus on the addition of inelastic constitutive properties relevant to concrete (where model validation is an essential part) and/or code parallelization. The code will be used by the team and consulting engineering companies (our funding partners) to study the forces and stresses in breakwaters comprising thousands of gigantic concrete units and the risk of concrete unit breakages in static and dynamic loading scenarios such as occurs under storm conditions. The work has potential to link with our fluids modelling platform “Fluidity” and to model wave-structure interaction [1].

Successful candidates will join, and be supported by, a dynamic international research group with world-class expertise on modelling and coastal structures. The candidates will have the opportunity to develop their career and profile by presenting at international conferences in numerical and applied fields and publishing in high impact journals. Candidates should have a diploma or masters degree in engineering, applied mathematics, physics or a similar subject. Good skills in mechanics, computational mechanics, numerical mathematics and finite element methods as well as computer programming are desirable.

[1] Latham, J.-P., Munjiza, A., Mindel, J., Xiang, J., Guises, R., Pain, C.C., Gorman, G. and Garcia, X. 2008. Modelling of massive particulates for breakwater engineering using coupled FEMDEM and CFD. *Particuology* 6, 572–583. [doi:10.1016/j.partic.2008.07.010](https://doi.org/10.1016/j.partic.2008.07.010)

This information can also be found on our website: www.ese.ic.ac.uk. The project is fully funded by EPSRC EU/UK applicants. A tax-free stipend of approximately £15,500 per annum and EU/UK fees are included. However, Overseas applicants would require the difference between Overseas and EU/UK fees (about £15,000) found from additional sources. Application forms and instructions can be obtained from our website (<http://www3.imperial.ac.uk/earthscienceandengineering/courses/phdopportunities/phdapplicationprocedure>) or from Ms Samantha Delamaine (E-mail: sam.delamaine@imperial.ac.uk, Tel: +44 (0) 207 594 7339). Further information about the project can be obtained from John-Paul Latham (j.p.latham@imperial.ac.uk). **Applications are accepted until the posts are filled.** *Committed to equality and valuing diversity. We are also an Athena Silver SWAN Award winner and a Stonewall Diversity Champion.*