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://www.napier.ac.uk/research-and-innovation/research-degrees/how-to-apply

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: John McDougall (Email: J.McDougall@napier.ac.uk)
- 2ND SUPERVISOR: Juan Bernal

Subject Group: Built environment

Research Areas: Civil Engineering, Dynamics, Geotechnical Engineering, Structural Engineering

Project Title: Sustainable Earthquake Protection for Developing World

Project description:

The key idea is that rubber soil mixtures (RSM) derived from shredded car tyres, can be installed (actually retrofitted), at beneficial economic and environmental costs. Combined with innovative timber construction, predicated on the unparalleled seismic resilience of the pagoda , seismic protection can be engineered in locations where earthquakes are most common and consequences are least affordable. This is a distinctive civil engineering project in that it has a direct consequence on human suffering.

Geotechnical researchers in SEBE have been exploring innovative and more environmentally friendly ways of managing seismic disturbance. The project team are well equipped to deliver on this aim. McDougall & Barreto have a track record in technical innovation, leading project development and funding success [1, 2]. There is emerging talent in Bernal and Dimitriadi, who are both ECRs and have completed doctoral studies on different aspects of the project topic [3, 4].

Building on existing SEBE expertise in timber engineering and as a direct consequence of recent MEng dissertation work, we have initiated a programme of timber structure testing to reveal the relative importance of the factors contributing to the resilience of Japanese pagodas: Dougong (unpinned timber joints able to dissipate energy), Shinbashira (a central free hanging column able to sway in opposition to, and thereby dampen, an oscillating structure), tiled eaves (provide stabilising mass and control ground conditions below). A key element of this workstream is the interpretation of the frictional interaction of Dougong. We have subjected a multi-storey unpinned scale model structure to seismic shaking in the laboratory to reveal the stick-slip and hence dynamic response.

References:

[1] J McDougall (2007) A hydro-bio-mechanical model for settlement and other behaviour in landfilled waste. Computers and Geotechnics 34 (4), 229-246

[2] D Barreto, C O'Sullivan (2012) The influence of inter-particle friction and the intermediate stress ratio on soil response under generalised stress conditions. Granular Matter 14 (4), 505-521

[3] J Fonseca, A Riaz, J Bernal-Sanchez, D Barreto, J McDougall (2019) Particle–scale interactions and energy dissipation mechanisms in sand–rubber mixtures. Géotechnique Letters 9 (4), 263-268

[4] VE Dimitriadi, GD Bouckovalas, YK Chaloulos, AS Aggelis (2018) Seismic liquefaction performance of strip foundations: effect of ground improvement dimensions. Soil Dynamics and Earthquake Engineering 106, 298-307

Candidate characteristics

Education:

A second class honour degree or equivalent qualification in Civil Engineering, Structural Dynamics, Geotechnical Engineering

Subject knowledge:

- Soil Mechanics
- Structural Dynamics

Essential attributes:

- An enquiring mind
- Ability to analyse large amounts of experimental data

Desirable attributes:

- Good standard or written English