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

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/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: Dr Aikaterini Marinelli (Email: A.Marinelli@napier.ac.uk)
- 2ND SUPERVISOR: Dr Daniel Barreto

Subject Group: Built Environment

Research Areas: Built Environment, Civil Engineering, Structural Engineering, Structural Mechanics

Project Title: From 3D Digital Documentation to Structural interventions for historic masonry structures

Project description:

Engineering problems related to conservation and restoration of Cultural Heritage are attracting increasing attention by researchers, offering opportunities for novel research and industry collaborations. Scotland's historic environment is an essential part of its cultural background and economy but the effects of ageing, environmental conditions and past natural hazards have caused significant degradation, urging for action (Hyslop et al., 2006).

The development of digital technologies, such as terrestrial laser scanning, has already helped produce accurate representations of structures with applications in conservation, monitoring and Building Information Modelling (BIM) projects. The exploitability of laser scanning outputs, in the form of point clouds, is however still challenging though with respect to application for structural analysis of the built heritage. Recent developments refer to a variety of approaches for the reduction of 3D point clouds of complex structures (D'Altri et al., 2018) into models making

use of advanced non-linear computational formulations based on the Finite Element Method (FEM) and Discrete Element Method (DEM), to facilitate and optimize capturing the mechanical behavior of historic masonry structures. This provides additional information for decision makers to ensure the maintenance, adaptability and resilience of existing masonry structures.

The aim of this PhD is to explore theoretical and procedural options for the development of highly accurate numerical models for structural purposes, linking 3D point cloud data to detailed modelling of masonry constructions. This innovative approach will incorporate current structural pathology and consider targeted on-site sensor measurements, to obtain semi-automated suggestions for future interventions. The outcome of this research is anticipated to offer an optimized decision-making route for structural interventions, reflecting the needs of a range of commonly encountered structural typologies and problems (Marinelli et al., 2019), with direct applicability to historic masonry structures in Scotland. It will revolutionarise practice for directly benefitted external practice for directly benefitted external stakeholders, especially those responsible for the care of masonry structures of significant heritage value, by informing the design, improving the structural monitoring and leading to targeted interventions as needed.

References:

[1] D'ALTRI, A. M., MILANI, G., DE MIRANDA, S., CASTELLAZZI, G. & SARHOSIS, V. 2018. Stability analysis of leaning historic masonry structures. Automation in Construction, 92, 199-213.

[2] HYSLOP, E. K., MCMILLAN, A. A. & MAXWELL, I. 2006. Stone in Scotland, Paris, UNESCO Publishing.

[3] MARINELLI, A., SANTA, S., SPILIOPOULOS, A. & DASIOU, M. E. 2019. Optimizing strengthening interventions on historic masonry walls: an experimental study. Procedia Structural Integrity, 18, 245-254.

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Civil Engineering, with emphasis on Structures and Structural Mechanics

Subject knowledge:

- Structural Analysis,
- Mechanics of Materials and
- Computational Mechanics

Essential attributes:

- Knowledge of Structural engineering with applications on masonry structures,
- Experience of fundamental reality capture technologies and their use in engineering,
- Competency in computational mechanics and the use of programming languages,
- Good written and oral communication skills,
- Strong motivation, with evidence of independent research skills relevant to the project,
- Good time management skils