Topic 2

Please get in touch: David Garcia Cava - david.garcia@ed.ac.uk

Adaptive and smart structures for operational variability and life extension

This project aims to investigate the capabilities of adaptive structures that change their geometry and mechanical properties to accommodate operational loading and extend their lifespan, thereby supporting sustainable infrastructure and a circular economy. The core objective of this project is to engineer a self-adapting structure that adjusts to the prescribed loading conditions. This adaptation is achieved by integrating local structures that accommodate stiffness variations along the global structure. The local structures will change their geometry and shape in response to the applied loads, resulting in emergent properties in the main global structure. Analytical modeling of the sub-structures will provide understanding and control for stiffness tailoring, which will translate into desirable mechanical properties in the main structure. The connection between global properties and sub-structure geometry changes aims to be achieved by understanding the relationships between geometric parameters and vibration response. The geometric nonlinearity induced by the local substructures may cause amplitude-dependent nonlinear dynamic responses. Thus, understanding the underlying physics in the coupling between local and global structures, along with the vibration response of the global structure, aims to facilitate feedback to passively control the mechanical properties of the structure. Consequently, this dynamic response leads to continuous shape and geometry modifications within the structure, ultimately enhancing its capacity to accommodate specified loading requirements more effectively. The adaptive structures will benefit operability by maximizing structural capacity during service.

Interests on: Structural mechanics and dynamics, Stochastic modelling and Uncertainty quantification.

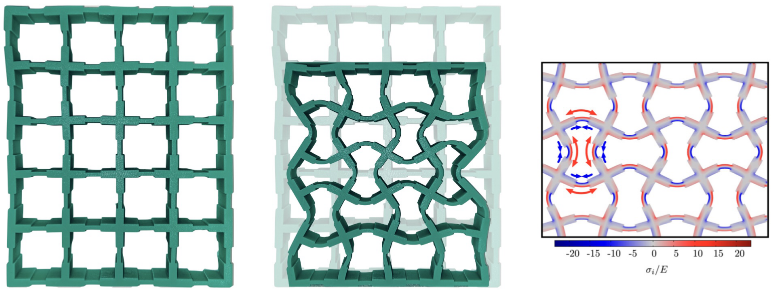

Figure 1: Smart adaptive structure

References:

(1) Sundararaman, V., O'Donnell, M.P., Chenchiah, I.V., Clancy, G. and Weaver, P.M., 2023. Stiffness tailoring in sinusoidal lattice structures through passive topology morphing using contact connections. Materials & Design, 226, p.111649.

(2) Zhao, B., Thomsen, H.R., Pu, X., Fang, S., Lai, Z., Van Damme, B., Bergamini, A., Chatzi, E. and Colombi, A., 2024. A nonlinear damped metamaterial: Wideband attenuation with nonlinear bandgap and modal dissipation. Mechanical Systems and Signal Processing, 208, p.111079.

(3) Rashid, Dashty Samal and Giorgio-Serchi, Francesco and Hosoya, Naoki and García Cava, David, Coupled Dynamics of Shank and Protruding End for Bolt Loosening.
Available at SSRN: *http://dx.doi.org/*10.2139/*ssrn.*4778676

Requirements: Minimum entry qualification - an Honours degree at 2:1 or above (or international equivalent) in a relevant science or engineering discipline, possibly supported by an MSc Degree. Applications are particularly welcome from candidates expecting to receive a first-class degree in mechanical engineering, physics, applied mathematics or a closely related subject.

Funding: Applications are welcomed from students who are applying for scholarships from the University of Edinburgh or elsewhere as well as self-funded students.

*Competition (EPSRC) funding may be available for an exceptional candidate but please note you must be a UK student or an EU student who has lived in the UK 3+ years.