Structural and Earthquake Engineering

Theme summary

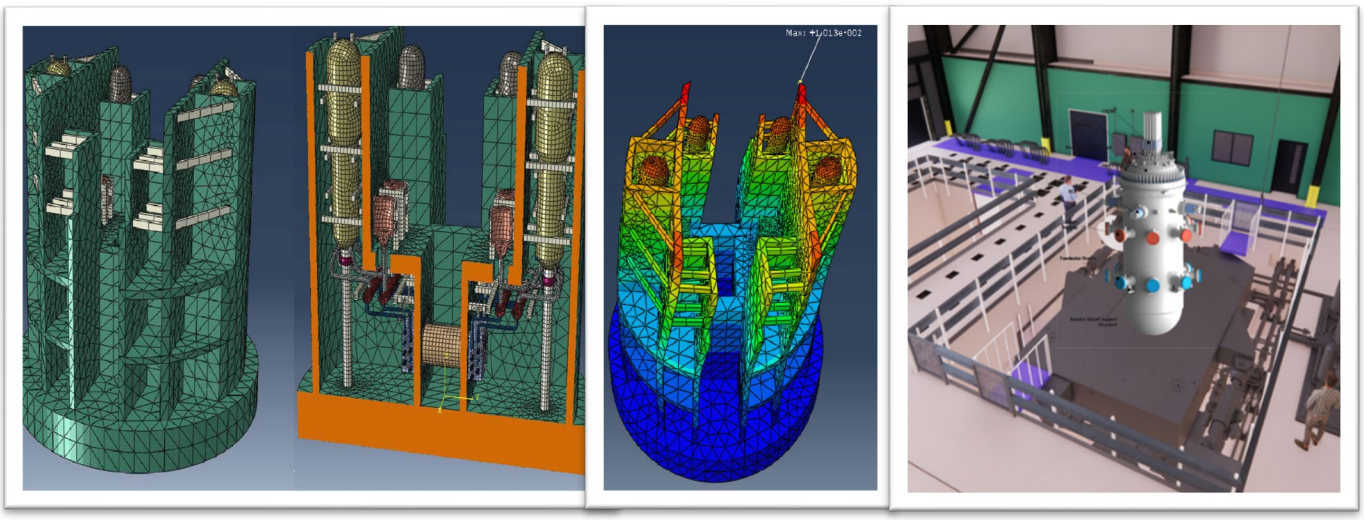
Structural and Earthquake Engineering addresses the understanding of the fundamentals of how structures behave to be able to develop more reliable methods of analysis and design. This area includes:

- Testing and modelling in the field of control
- Seismic analysis for plant life extension, nuclear new build and advanced nuclear plants e.g. SMRs and AMRs
- Structural dynamics and non-linear engineering
- Earthquake engineering and probabilistic assessment of seismic risk
- Novel techniques for enhancing the resilience of critical infrastructure
- High-performance computing and hybrid (i.e., sub-structured computational and experimental) testing
- Soil-foundation interaction

Incorporating seismic safety into the design of a nuclear plant can be very costly, and is often still done in isolation to other safety calculations, making safety margins overly conservative. Likewise, failure to model issues like the soil-structure interface will increase design and construction costs of plant if they are not integrated into the planning process from the start.

Research in this area attempts to develop more holistic modelling techniques to reduce these unnecessarily large safety margins and therefore reduce costs when designing a new build power plant, or making the case for life extension.

This also has applications for proposed Small Modular Reactor designs, but for many other industrial systems such as for ports and harbours.



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Theme Leads

Professor Adam Crewe

Professor of Earthquake Engineering, University of Bristol
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Adam's research interests are to develop a better understanding of how various types of structure respond to earthquakes and other types of dynamic loading, in many cases using large scale laboratory tests to validate his theories.

Professor Anastasios Sextos

Professor of Earthquake Engineering, University of Bristol
Contact: a.sextos@bristol.ac.uk

Anastasios' research work relates to earthquake engineering and structural dynamics, probabilistic assessment of seismic risk, seismic isolation, soil-structure interaction, high-performance computational structural engineering and hybrid testing.

Research facilities and capabilities

Earthquake and Large Structures (EQUALS) Laboratory

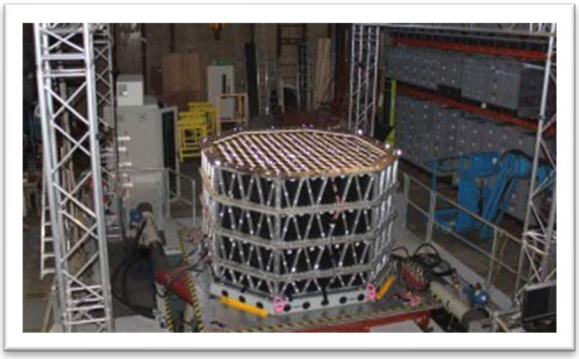
Key Academics: Professor Adam Crewe

The EQUALS laboratory is a unique facility that combines strong walls and strong floors allowing a wide range of different types of structures (e.g. intake towers, bridges, buildings etc.) to be tested. The facility also houses the 15t 6DOF shaking table so that large-scale seismic tests can be performed in addition to more conventional static or pseudodynamic testing.

The shaking tables in this lab and in SofSI are available for use on a commercial basis for seismic qualification of electro-mechanical plant.

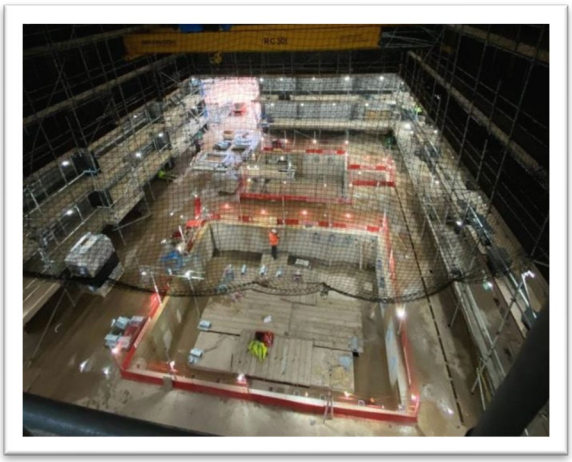
Case Study
PLEX – Plant life extension and seismic validation of AGR reactor cores

EDF Energy have worked closely with the University of Bristol for over ten years on the development of a quarter-sized physical model of a representative AGR graphite core. Information from the experimental programme now provides essential validation of the complex numerical models that are used to underpin seismic safety case arguments for plant life extension.



The AGR graphite core model in the EQUALS facility

National Facility for Soil Foundation Structure Interaction (SoFSI)



Key Academics: Professor Tasos Sextos, Professor Adam Crewe, Professor George Mylonakis

The SoFSI facility has been designed to be capable of dynamic testing large prototype foundations and structures, and testing piles under static and dynamic loading. It is part of the national UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC) network and it will be available for industrial and academic researchers to test large to full-scale equipment.

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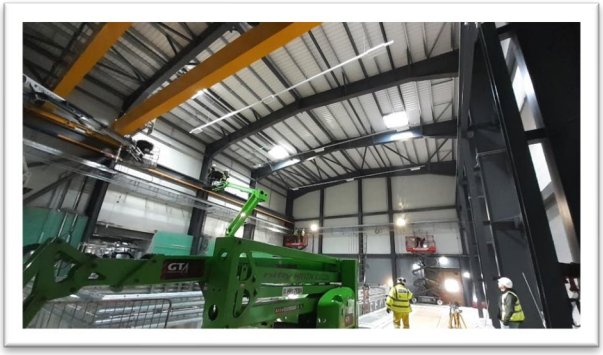
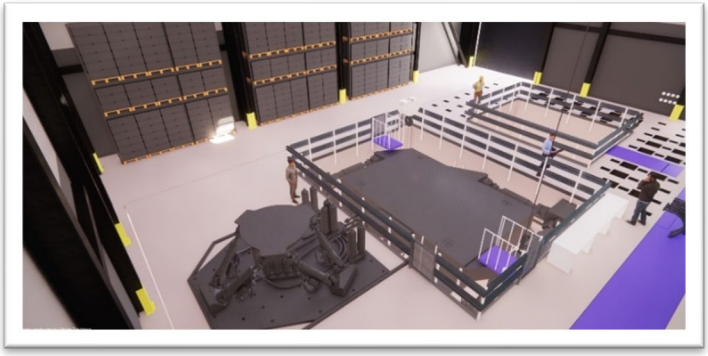
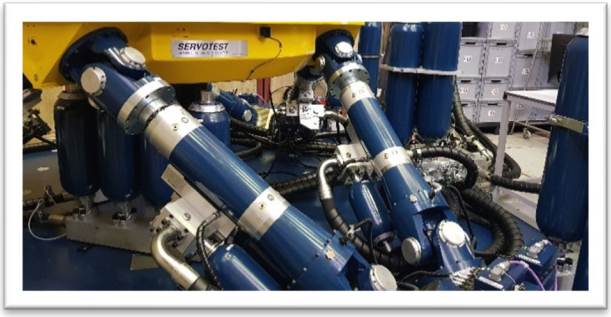
SoFSI equipment and capabilities







Overview of the new SoFSI National Facility (top left), rendering of the SoFSI Facility showing the hexapod, shaking table & soil pit (top right), Hexapod (as already operating in Queen's buildings pending installation in SoFSI.

Hexapod & Shaking table
Bi-axial shaking table: 6m x 4m, 50 tonne capacity, capable of achieving BELLCORE test standards.
Hexapod: 1m x 1m high performance shaking table – 500kg capacity, capable of reaching 10g.

Soil pit
Soil pit with actuators: 6m x 5m x 4m deep with flexible capability for saturated and unsaturated soil. Additional actuators can be added and a 1.5m trench allows for testing at multiple levels. Seismic testing of soils is also possible on the shaking table using a state-of-the-art laminar soil box.

UKRIC Bristol Infrastructure Collaboratory

Key Academics**:** Professor Theo Tryfonas, Professor Tasos Sextos

The University of Bristol is a founding partner in the UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC) which is a group of 13 facilities providing an integrated research capability with a mission to underpin the renewal, sustainment and improvement of infrastructure and cities in the UK and elsewhere.

This research is multi-disciplinary and works on cross-sector challenges, reflecting the multi-interface nature of infrastructure. Four key themes of this research relate to Infrastructure, Mobility and energy, Citizen sensing and City Digital Twins.

The UKCRIC Bristol Infrastructure Collaboratory is bringing together a range of initiatives and activities such as smart infrastructure test beds to establish Bristol as a 'living laboratory'. These test beds include structural health monitoring, water quality monitoring, transport sensing and energy use modelling. A key example is a group who are researching open data energy management to see how communities can 'collaborate' to reduce demand and create an energy system that both reduces energy use and enable the grid to become more responsive to demand.

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