Seismic Testing of an AGR for Plant Life Extension

Research area: Structural Engineering

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The Challenge

Sponsored by EDF-Energy Ltd, the ongoing PLEX (Plant Life Extension) project was initiated in 2008. To date EDF have invested around £6.5M in the project and work is expected to continue over the next few years. The main objective of the project is the validation of EDF's numerical modelling systems (GCORE, SOLFEC etc.)

This is vital as many of the UK's older, graphite core reactors are reaching the end of their estimated life cycle and new nuclear plants are yet to be available. Validation is carried out by testing a quarter scale model of a nuclear core (built by the PLEX team) on the shaking table in the Earthquake and Large Structures Lab.

The Solution

A complex, high precision, ¼ sized physical model of a representative AGR graphite core assembly has been developed over a period of seven years. This work culminated in 2016 with a fully commissioned rig, which can be shaken on the earthquake shaking table at the University of Bristol to reveal important insights into an aged graphite core's seismic behaviour and integrity. Information from the experimental programme now provides essential validation of the complex numerical models that are used to underpin the AGR seismic safety case arguments for life extension to 2023 of the oldest AGR stations.

Tests carried out by the PLEX team on the physical model in the lab are mirrored in the numerical model by the Atkins team. Once the university has analysed and validated the data received from testing the physical model, comparisons are made with the numerical model. The project is led by the University of Bristol (UoB) in close collaboration with EDF and Atkins, who manage the GCORE modelling system for EDF.

The bespoke rig contains over 40,000 components and 3,200 sensors in a package measuring approximately 2.5x2.5x2.0m. It enables exploration of the non-linear dynamic

Fig 1: physical model of AGR on the seismic testing table

responses of many different types and patterns of cracked graphite bricks, representing anticipated ageing effects.

The rig development involved integration of high precision structural engineering and manufacturing, innovative electronic sensor development, cutting edge data analysis and experimental techniques. The programme was carefully managed through an iterative, learning-focused approach that de-risked the design, justified the incremental investment case, and assured cost, quality and safety control.

The Impact

This is a unique, highly innovative and technically challenging earthquake engineering project that has provided vital evidence to underpin the seismic safety assessment of EDF Energy's ageing Advanced Gas-cooled Reactor (AGR) nuclear power station fleet.

Key outcomes of the project are:

- A better understanding of the behaviour within an ageing graphite core in the case of a seismic event.
- Reassurance in the output of the EDF numerical modelling systems.
- Evidence supplied by the University feeds into the Safety Case presented quarterly to the Office for Nuclear Regulation.
- Evidence that a graphite core near the end of its design life can still be operated and shutdown safely after a seismic event.
- Justification of plant life extension.
- The PLEX project won the EDF-Energy Award for Innovation in 2014 and is shortlisted for the ICE SW (Institute of Civil Engineers South West) Awards that will be held on 7th July 2017.