INDIAN INSTITUTE OF SCIENCE BANGALORE | DEPARTMENT OF CIVIL ENGINEERING

Department Seminar

Standardized designs for advanced nuclear reactors—the pathway to commercial viability

Speaker: Prof. Andrew Whittaker, SUNY Distinguished Professor, University at Buffalo (UB), USA

Date and Time: January 28th, 6 pm
Link: *Click here to join the meeting!*

Abstract: The overnight capital cost of nuclear energy in the United States is prohibitive. Drastic reductions in cost are needed for commercial viability. The Advanced Research Projects Agency-Energy (ARPA-E) of the US Department of Energy (DOE) funded a project at the University at Buffalo to explore opportunities to substantially reduce the overnight capital cost of advanced reactors and enable standardized designs using seismic isolation.

A major impediment to the development of standardized designs for advanced reactors is the seismic load case. Every reactor site has a unique combination of seismicity and near-surface geology, requiring site-specific analysis, design (or checking), equipment qualification, and regulatory review. Every plant is first-of-a-kind. Although the seismic load case is understood to significantly increase capital cost, there are no modern cost data. The ARPA-E project established relationships between total cost (engineering and fabrication) of safety-class equipment and ground shaking intensity for a molten chloride fast reactor and a high temperature gas reactor. The assembled cost data made clear the impact of first-of-a-kind engineering costs, which are comparable to first-of-a-kind fabrication cost and repeated for conventional (non-isolated) plant construction.

The implementation of seismic isolation technology, which is mature in non-nuclear sectors, can lead to significant improvements in nuclear safety. Impediments to the widespread use of isolation technology have included a) a lack of regulatory guidance, and b) data to support the financial benefits of seismic isolation. Recently published ASCE standards and regulatory reports are largely written around prior research products from the University at Buffalo on the seismic isolation of reactor buildings. The cost data assembled as part of the ARPA-E project have been mined to determine reductions in equipment total cost that could achieved by seismic isolation of reactor buildings, providing a clear pathway to standardized designs of buildings and safety-class equipment.

The on-going ARPA-E project also addresses the application of seismic isolation to safety-class equipment installed inside reactor buildings. Three Indian-born PhD students are working on different aspects of the project, executing analytical, numerical, and experimental research. Results of the analytical and numerical studies have been published. The testing program involves four sets of earthquake-simulator experiments. Two have been completed and two are under way. The products of the research project are being synthesized and used to support the writing of mandatory language and commentary for the next updates of ASCE Standards 4 (Chapter 12) and 43 (Chapter 9).

Speaker Bio: Andrew Whittaker is a SUNY Distinguished Professor in the Department of Civil, Structural and Environmental Engineering at the University at Buffalo. He is a registered civil and structural engineer in the State of California. Whittaker served as the Vice-President and President of the Consortium of Universities for Research in Earthquake Engineering (www.curee.org) from 2003 to 2011, and on the Board of Directors of the Earthquake Engineering Research Institute (www.eeri.org) and the World Seismic Safety Initiative from 2008 to 2010, and on the Advisory Board for the Southern California Earthquake Center from 2010 to 2017. Whittaker chaired his home department from 2010 to 2016, hiring more than 20 faculty members and growing the number of ladder faculty by 50+%. He has published more than 140 peer-reviewed journal articles, 11 books and book chapters, and more than 375 other papers and technical reports. He made significant contributions to the first generation of tools for performance based earthquake engineering (FEMA 273/274, 1992-1997) and led the structural engineering team that developed the second generation of these tools (FEMA P58, 2000-2013). Whittaker serves (and has served) on a number of national committees including AASHTO T3 (seismic isolation), ASCE 4, ASCE 7, ASCE 43, ASCE 59, and ASCE Codes and Standards, and ACI 349. He is Chair of the ASCE Nuclear Standards Committee. His research interests are broad and include earthquake, blast and impact engineering of buildings, long-span bridges, transportation infrastructure, and nuclear structures. The US National Science Foundation, US Department of Energy, US Nuclear Regulatory Commission, US Department of Transportation, US Federal Highway Administration, and Canadian Nuclear Safety Commission fund his research. He consults to federal agencies, regulators, consultancies, contractors, and utilities in the United States, Canada, United Kingdom, Europe and Asia.