UC San Diego, Calit2 Participate in NSF-funded Seismic Study of Nonstructural Building Systems

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Calit2 researchers will integrate their SketchIT simulation tool into the NEESit cyber infrastructure. Click here to view an enlarged version of the above graphic.

When a bridge collapses, testing how well structural systems hold up in the event of an earthquake or other disaster assumes added urgency. Little attention, however, is paid to the *non* structural systems that may also be damaged in the event of a temblor-potentially causing even more damage than the structure itself and threatening the lives of the structure's occupants.

To address shortcomings in the area of nonstructural seismic performance evaluation, the George E. Brown, Jr., Network for Earthquake Engineering Simulation (NEES) Research program of the National Science Foundation (NSF) has awarded a $3.6 million grant for the study of the seismic performance of ceiling-piping-partition systems. The project was awarded after a nationwide competition among universities to conduct a NEES Grand Challenge project. Of the total, $585,000 will go to structural engineering and computer science researchers at the University of California, San Diego.

"This proposal is unique in that we want to address not only the individual nonstructural element or component performance, but also determine the impact of its performance on losses at the regional level. At UCSD, research will focus on simulating and visualizing the interactions among the various nonstructural and structural systems under severe earthquake loading. Using numerical models, the fragility of these systems can be determined and used for estimating losses under scenario earthquakes," said Tara Hutchinson, associate professor of structural engineering at UC San Diego and co-principal investigator on the project.

The University of Nevada, Reno (UNR) is leading the multi-institutional consortium that will carry out the five-year "Simulation of the Seismic Performance of Nonstructural Systems" project. Participating institutions include the State University of New York - Buffalo (SUNY-Buffalo), Georgia Institute of Technology, the Consortium of Universities for Research in Earthquake Engineering (CUREE), University of California, San Diego and the UCSD division of the California Institute for Telecommunications and Information Technology (Calit2), where NEESit - the information-technology unit of NEES - is headquartered.

"Our information-technology research involves sketch-based modeling, simulation and visualization," said Falko Kuester, Calit2 professor for visualization and virtual reality and associate professor of structural engineering in UCSD's Jacobs School of Engineering. "This research will directly interface with NEEScentral, which is being developed by the NEESit initiative for the entire earthquake engineering community." NEEScentral is a web-based centralized data repository for managing, sharing, storing, and publishing data. It also enables real-time collaboration between researchers at different sites (tele-presence/tele-science) and the dissemination of data to the broader community.

The Federal Emergency Management Agency (FEMA) estimates that non-structural systems account for more than 75 percent of the potential future earthquake-related losses and insurance claims. Ceiling-piping-partition

systems are widely used in many kinds of buildings and represent a major portion of nonstructural earthquake vulnerability.

"This Grand Challenge project will integrate multidisciplinary, system-level studies for the first time to develop a simulation capability and implementation process for enhancing the seismic performance of the ceiling-piping-partition system," said project director E. "Manos" Maragakis, a professor and chair of civil and environmental engineering at UNR. "We'll develop an innovative test-bed structure that will be 64 feet long, 26 feet high and 14 feet wide. Then, we'll place it on the three shake tables in the Rogers and Weiner Large Scales Structures Laboratory."

UNR's Maragakis and a team of researchers will suspend a variety of ceiling-piping-partition systems that will be subjected to conditions simulating high-intensity earthquakes. "Ceiling-piping-partition systems consist of several components and subsystems, have complex three-dimensional geometries, and are spread over large areas in all directions," said the project director. "Their seismic response, their interaction with the structural system they are suspended from or attached to, and their failure mechanisms are not well understood, and yet they are critical to the safety of the majority of our buildings here in the U.S."

The Grand Challenge project will integrate multidisciplinary system-level studies that will develop, for the first time, a simulation capability and implementation process for enhancing the seismic performance of the ceiling-piping-partition system. A comprehensive experimental program is proposed that will use the UNR and UB NEES Equipment Sites to conduct subsystem and system-level full-scale experiments. Integrated with this experimental effort will be a numerical simulation program that will develop experimentally verified analytical models; establish system and subsystem fragility functions; and, develop visualization tools that will provide engineering educators and practitioners with sketch-based modeling capabilities. Public policy investigations at the building and metropolitan-level scales are designed to support the implementation of the research results.

The project pioneers an integrated education, outreach, dissemination and implementation program including involvement in project research tasks of undergraduate students from underrepresented groups and programs.

Co-principal investigators on the project include UC San Diego's Tara Hutchinson; former UCSD structural engineering professor Andre Filiatrault, now at SUNY-Buffalo; Georgia Tech's Steve French; and Bob Reitherman, executive director of CUREE.

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