Hospital Room "Shaken" by Earthquake Following University at Buffalo Symposium

Symposium Reviews Building Code Changes; Earthquake Demonstrations Mark Launch of World's Only Two-Tier Earthquake Simulator

Nearly 100 Participate Live; 200+ More View Demonstration Webcast Worldwide

Nearly 100 participants from 18 states, Canada and Mexico, gathered at the University at Buffalo (UB) for a one-day *Symposium on Seismic Regulations and Challenges for Protecting Building Equipment, Components & Operations.* These included building equipment and isolation/restraint manufacturers, engineers, healthcare facilities managers, faculty researchers, students, and other related practitioners. Following the symposium, participants observed two simulated earthquakes badly damage a fully-equipped hospital room, as University at Buffalo engineers demonstrated their newest earthquake simulation equipment, the world's only Nonstructural Components Simulator (UB-NCS).

The event, which took place on October 12, 2007, was jointly sponsored by the University at Buffalo Department of Civil, Structural and Environmental Engineering (CSEE), MCEER, UB's Structural Engineering and Earthquake Simulation Laboratory (SEESL), and the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES).

The main objectives of the symposium were to help participants:

- gain a better understanding of building code and regulatory changes that now require seismic qualification of mechanical, electrical and other important building equipment to protect it from earthquake damage;
- consider what code and regulatory changes mean to equipment manufacturers and other related businesses; and
- learn what's being done to better enable equipment manufacturers and others to meet changing and stringent requirements.

The inaugural test of the UB Nonstructural Components Simulator (UB-NCS) demonstrated the effects of earthquake floor motions on a full-scale composite hospital room, nonstructural components and contents... including patient.

Presentations were given in three sessions:

1. *Changing Codes, Regulations and Related Developments* – which illustrated new seismic requirements in the 2003 & 2006 International Building Code, as well as California's SB 1953 legislation for hospitals, which require certified installation of equipment;
2. *Implementation Issues and Challenges* – which featured practitioners' perspectives on the impacts of changing requirements; and
3. *Seismic Qualification and Testing of Equipment* – which discussed the various analytical and experimental methods that can be used to meet seismic qualification requirements.

The program also marked the dedication and inaugural demonstration of UB's new Nonstructural Components Simulator (UB-NCS), a recent addition to SEESL and NEES facilities at the University at Buffalo.

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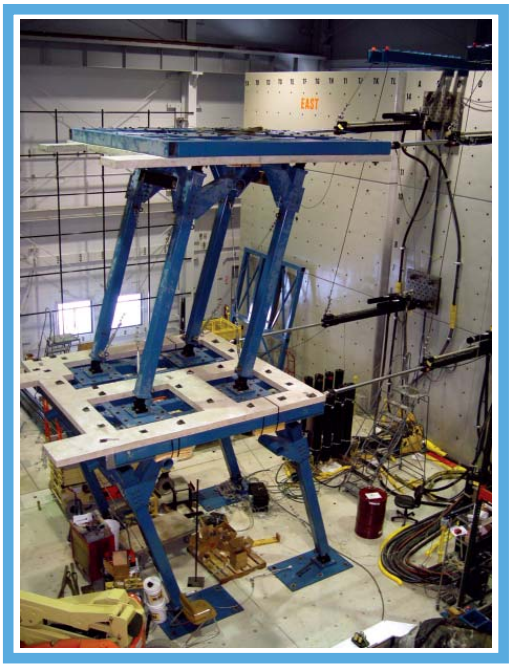
The UB-NCS is a $260 thousand, two-level simulator designed to replicate building floor motions induced by earthquakes. This unique equipment enables engineers to examine the effects of earthquakes on architectural systems, building equipment and contents, otherwise known as nonstructural components. The UB-NCS, funded through the National Science Foundation's (NSF) NEES program, is especially suited for the testing and qualification of distributed nonstructural systems, such as partition walls, water, sprinkler and medical gas piping, HVAC ductwork, etc. that run from one building level to the adjacent level above.



The dedication included a demonstration of the UB-NCS applying earthquake floor motions to a composite hospital room, fully equipped with patient (crash dummy), medical gurney, wall-mounted patient monitors, surgical video monitor, cabinets, intravenous infusion pumps, surgical lighting, medical gas lines and sprinkler system.

In addition to those in attendance, more than 200 people from throughout the US and around the world – Japan, Canada, Germany, Taiwan, France, Portugal, Romania, and Switzerland – viewed a live webcast of the demonstration.

Changing Codes, Regulations and Related Developments

The morning symposium opened with discussion of recent changes to building codes and regulations, requiring certified seismic installation of equipment and contents.

Two speakers, Robert Bachman, a consulting structural engineer from Laguna Niguel, California, and Christos Tokas, of the State of California Office of Statewide Health Planning and Development (OSHPD) opened with presentations on changes brought about by the 2003 and 2006 International Building Code (IBC) and California's SB 1953 legislation for hospitals, as well as the January 2008 adoption of the 2006 IBC in California. These included descriptions of current code requirements and test protocols for nonstructural components, and requirements in California's Hospital Seismic Retrofit Program, which is designed to ensure continuing operation of acute care facilities following an earthquake. Speakers also defined nonstructural components and systems in three categories:

1. Architectural Components – including cladding, ceilings, glazing, partitions, etc.;
2. Mechanical and Electrical Components and Systems – mainly utilities; and
3. Contents – which include medical and communications equipment, computers, shelves, bookcases, valuable contents on shelves, etc.

Implementation Issues and Challenges

Session two involved presentations from a group of practitioners, and focused on implementation issues that they currently face, as well as how they are attempting to meet challenges posed by changing codes. Jim Carlson of the Omaha Public Power District and member of MCEER's ASHRAE consortium explained how development of comprehensive codes, flexible implementation of code

application by building officials (with enhanced training), proper installation by contractors, and qualification of equipment by manufacturers have been used by the nuclear industry and can be used by other industries to reduce earthquake risk. Jay Lewis of Terra Firm Earthquake Preparedness provided a business perspective, explaining the economic advantages of performance-based design to building owners, because loss of function is more costly than designing buildings that will function after earthquakes.

Robert Bachman, S.E., Immediate Past Chair of ASCE 7 Seismic Task Committee (2002 and 2005 cycles) discusses code changes before a symposium audience of approximately 100 including manufacturers, engineers and other practitioners.

Scott Campbell of Kinetics Noise Control gave an overview of the harmonization of design parameters between structural and nonstructural components, emphasizing that limited nonstructural damage may produce loss of use of critical or expensive equipment. He was followed by Paul Hough of Armstrong World Industries who described the development of a protocol for testing and qualifying ceiling systems—which include light fixtures, sprinklers and other nonstructural components, and related issues, including unanswered questions related to code requirements.

Seismic Qualification and Testing of Equipment

Seismic qualification and testing of equipment was the subject of the final session. Steve Eder of Facility Risk Consultants discussed seismic qualification of equipment by analysis methods, and explained an alternative, using earthquake experience data, as the Seismic Qualification Utility Group, or "SQUG" has developed for the past 20 years. Andre Filiatrault, UB CSEE professor and SEESL Director, explained the testing equipment and protocols available to carry out qualification and seismic fragility testing of nonstructural components. Rodrigo Retamales, Ph.D. candidate from UB, described a novel testing protocol for experimental seismic qualification and fragility assessment of nonstructural components and systems using the UB-NCS.

Nonstructural Components Simulator Dedication

The dedication of UB's Nonstructural Components Simulator (UB-NCS), followed the symposium luncheon. It featured two demonstration tests of earthquake induced building floor motions and their effects on a full-scale composite hospital room containing various types of medical equipment. The demonstration test included nonstructural content typically found in an emergency room and other rooms in a hospital. This included steel stud partition walls, a suspended ceiling system, a sprinkler system with horizontal and vertical piping runs spanning between two stories, copper medical gas lines, a 180-lb. crash test dummy knick named "Ben" sitting atop a medical gurney, and a surgical lamp mounted to the ceiling on the UB-NCS' lower level.

Introductory remarks were made by University at Buffalo president, John B. Simpson, and CSEE chairman A. Scott Weber. They were followed by Filiatrault, who dedicated the UB-NCS in memory of earthquake victims around the world. He voiced hope that UB's new nonstructural component test capabilities will lead to advanced knowledge and contributions toward improving infrastructure and life safety in future earthquakes.

University at Buffalo President John B. Simpson welcomes participants to the NEES at Buffalo laboratory, and the dedication and inaugural demonstration of the UB Nonstructural Components Simulator (UB-NCS).

More than 340 thousand people have lost their lives in earthquakes since 1975, with an average of 20,000 per year perishing in the 20th century. If these numbers continue, it is estimated that two million people will die in earthquakes in the 21st century.

Gilberto Mosqueda, UB CSEE assistant professor, provided an overview of the UB-NCS and an explanation of the demonstrations to follow. Objectives of the demonstrations were two-fold: (1.) to showcase the capabilities of the UB-NCS and verify its performance with a realistic payload, and (2.) to examine the response of nonstructural components and building contents when subjected to building floor motions.

The first demonstration subjected the mock hospital room to 100% of the force of a design basis earthquake (DBE), with peak drifts of .87 percent, and peak accelerations of .77g. Real-time video from several cameras positioned within the mock hospital room and above its ceiling, gave more than 100 attendees a glimpse at the behavior of equipment and contents throughout the shaking.

After a brief examination of damage, the room was shaken for a second time—to a force equal to 150% of the design earthquake, or a maximum considered earthquake (MCE).

Mosqueda expressed surprise that two monitors had fallen during the first test—breaking off at their swivel mounts, while the mounts remained attached to the walls. Damage was also observed to the gypsum walls, several ceiling tiles, and to the surgical lamp, which crashed to the floor. While water and gas piping remained intact, gas piping within the walls was permanently bent into an "S" shape. During the larger MCE motion, however, more damage was seen, and "Ben," the crash test dummy was thrown off the gurney and almost out of the room.

Both demonstration tests – with viewing from all camera angles – are available online at http://nees.buffalo.edu/projects/ncs/webcast/. An archived webcast of the symposium will soon be available for viewing at the same web site. Researchers at UB will continue their study of nonstructural components using the UB-NCS, as well as the SEESL's twin shake tables. Future tests will be conducted under a NEESR Grand Challenge project that will examine earthquake effects on ceiling-piping-partition systems. The experiments will be conducted over the next four years, as part of a $3.6 million award led by the University of Nevada at Reno.

For more information on the UB-NCS or nonstructural components testing at the University at Buffalo, contact: Andre Filiatrault, SEESL director (716-645-2114 x2434; af36@buffalo.edu) or Don Goralski of MCEER (716-645-5151; goralski@buffalo.edu).

More than 100 attendees gather for remarks by UB Assistant Professor, Gilberto Mosqueda, as they prepare to witness the inaugural demonstration of the UB Nonstructural Components Simulator (UB-NCS), the latest addition to the NEES at Buffalo site.

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