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SeismicWaves
How the National Earthquake Hazards Reduction Program Is Advancing Earthquake Safety
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MCEER Research: Enabling Disaster-Resilient Communities

This is the last in an intermittent series of articles about the earthquake engineering research centers funded over the past decade by the National Science Foundation. These centers have "graduated" from the Foundation's engineering research centers program and are transitioning into the next chapters of their organizational lives. The articles briefly review their accomplishments and future plans.

Although *resilience* cannot stop all disasters from occurring, it can have a major impact on their severity. Earthquakes and other natural and man-made hazards repeatedly test the resilience of our physical, social, and economic systems, often with little or no warning. MCEER (The Multidisciplinary Center for Earthquake Engineering Research) is enabling communities at risk to improve their resilience and better withstand these unwelcome tests.

Headquartered at the University at Buffalo, State University of New York, MCEER is a consortium of researchers from many disciplines working at the Center's 16 member institutions. From 1997 through 2007, the National Science Foundation (NSF) provided substantial support for MCEER under grant award EEC-9701471, enabling the Center to develop the distinctive research competencies that it offers to NSF and other clients today.

Emphasis on Resilience

MCEER focused this NSF support on improving the resilience of facilities and organizations whose functions are essential for community well-being after an earthquake or other disaster. This critical infrastructure, which MCEER identified in collaboration with communities at risk for earthquakes, includes water and power distribution systems, acute-care hospital facilities, and organizations that are responsible for local emergency management activities.

To increase resilience, MCEER first had to define it in measurable terms. The Center developed a conceptual framework that defines disaster resilience as the ability of social units (e.g., organizations, communities) to mitigate hazards, contain the effects of disasters, and carry out recovery activities in ways that both minimize social disruption and mitigate the effects of future disasters. Resilience reduces the likelihood and consequences of failures—and the time required to recover from failures—among critical infrastructure in disasters.

Strategy for Success

Over the past decade, MCEER has pursued a three-pronged research strategy to develop the knowledge, tools, and technologies that can enable communities to enhance the resilience of their essential infrastructure. One research thrust has focused on evaluating and enhancing the seismic resilience of lifelines, particularly electric power and water supply systems. Another thrust has explored advanced technologies that can protect structural and nonstructural systems and components in acute-care facilities. A third thrust has studied post-earthquake response and recovery strategies.

The research in each of these areas has been shaped by several hallmarks of MCEER's work. These include the use of multidisciplinary research teams that bring together expertise from engineering, information technology, and earth and social sciences; the involvement of diverse collaborators ranging from universities, government agencies, and utility companies to infrastructure design professionals, materials and technology manufacturers, and other users of MCEER research products; and the incorporation of real-world observations made in post-disaster reconnaissance investigations.

MCEER research is strengthening critical infrastructure. Photo courtesy of MCEER.

MCEER has complemented its research with educational and outreach programs to share its findings with students, teachers, researchers, engineers, emergency managers, manufacturers, policy makers, and others. The Center has reached these groups by providing mentoring and leadership opportunities for students; by participating in conferences, workshops, and seminars; by publishing technical reports, proceedings, and other materials; by fostering communication through strategic partnerships and user advisory groups; and by operating the MCEER Information Service, which provides online access to reference services, databases, and other information.

Accomplishments

Through its research on the seismic resilience of lifelines, MCEER has developed improved models of post-earthquake restoration processes for power and water systems; advanced systems-analysis tools for evaluating the joint performance of water and power networks before and after earthquakes; and a state-of-the-art disaster loss modeling procedure used to evaluate how lifeline mitigation strategies can improve the disaster resilience of a community. MCEER used the utility networks of the Los Angeles Department of Water and Power as a test bed for development of the loss-modeling procedure, which has since been adopted by the department.


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MCEER research has advanced our understanding of how structural and nonstructural systems and components found in hospitals are affected by earthquakes, and has furthered the development of innovative technologies that can enhance the seismic performance of many such components. These findings have been integrated into new decision-support software systems, such as the Rehabilitation Decision Analysis Toolbox (RDAT), which MCEER created to help hospital managers evaluate and prioritize mitigation options for complex acute-care facilities.

As recent disasters have shown, speed and effectiveness are important attributes of response and recovery efforts. MCEER researchers have played a major role in developing advanced technologies that can help speed such efforts. These include Internet Map Server (IMS) and geographic information systems (GIS) applications, as well as remote-sensing imagery obtained via satellites or aircraft, that can be used to quickly assess damage, route aid, and monitor recovery following disasters, and to develop infrastructure inventories for disaster planning and mitigation. MCEER has also pioneered the development of social and economic models that can help communities plan effective disaster recovery strategies.

An Expanding Mission

While MCEER's NSF-funded accomplishments have centered on improving community resilience against earthquake hazards, they have also led MCEER into a broader mission, that of enhancing resilience against multiple hazards and the extreme events they can produce. Through its research on protecting infrastructure and its post-disaster reconnaissance work—which along with earthquakes has encompassed Hurricane Katrina and the September 11, 2001, attack on the World Trade Center—MCEER has seen similarities among the impacts inflicted by earthquakes and other disasters. Damage to critical infrastructure causes much of the societal disruption that follows such events.

In view of these similarities, MCEER is applying the knowledge, tools, and technologies it has developed for seismic resilience to other hazards, and to an expanding array of infrastructure. In research sponsored by the National Oceanic and Atmospheric Administration, for example, MCEER is leveraging its expertise in remote-sensing technologies to develop resilience indices for coastal communities facing hurricane hazards. Similarly, in research supported by the Federal Highway Administration, MCEER is investigating how bridges can be designed to mitigate multiple hazards.

Such cross-fertilization of solutions in support of multi-hazard resilience is an emerging trend. MCEER will continue to champion this approach to protect infrastructure, strengthen community resilience, and reduce losses from earthquakes and other hazards in the years ahead.

Additional information is available on the MCEER website at http://mceer.buffalo.edu/.