MCEER
MULTIDISCIPLINARY CENTER FOR EARTHQUAKE ENGINEERING RESEARCH
A National Center of Excellence in Advanced Technology Applications

Bulletin

Introducing the New MCEER Bulletin

Dear Readers,

As part of MCEER's effort to streamline our services and make information more accessible, we are migrating from traditional paper-based publications to electronic offerings on our web site.

A separate form is being mailed to everyone on the *MCEER Bulletin* mailing list to obtain your email address, and verify the information currently in our records. Notification of future issues of the *Bulletin* will be emailed to you, and the *Bulletin* will be posted on our web site (*http://mceer.buffalo.edu*) in PDF format. If you prefer a hard copy to be mailed, let us know on the reply form.

With this issue, we are introducing a new, more compact format. The length has been significantly reduced, and many articles will include hyperlinks to additional information available on the web. Our research activities and results will be compiled into one volume each year, and featured on our web site. Full text issues of the *Bulletin* from 1995 to the present are currently available on our web site in PDF format and future issues will continue to be posted.

This is the first phase toward our shift from print-based publications to an electronic environment. In the near future, we will be expanding the content of our technical report listings, and providing the full text of selected reports in PDF format. We also intend to offer our technical report series on CD-ROM, in addition to printed reports.

I welcome your feedback.

George C. Lee,

Director

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Inside

MCEER and ATC to Develop Bridge Design Specifications

A joint venture between the Applied Technology Council and MCEER has been selected by the AASHTO-sponsored National Cooperative Highway Research Program (NCHRP) to develop the next generation of seismic design specifications for highway bridges. NCHRP Project 12-49, "Comprehensive Specifications for the Seismic Design of Bridges," will result in the development of specifications, commentary, and design examples, which will be incorporated into the AASHTO LRFD Bridge Design Specifications. Work on this 30-month project started in August 1998.

The project will address all aspects of highway bridge seismic design, including the representation of seismic hazard, design and performance criteria, analysis methods, steel and concrete superstructure and substructure design and detailing, and foundation and retaining wall design. Chris Rojahn of ATC is the project administrative officer and Ian Friedland of MCEER is the project principal investigator. The project team includes R. Mayes, Dynamic Isolation Systems as project manager; and D. Anderson, CH2M Hill; M. Bruneau, University at Buffalo; G. Fenves, University of California Berkeley; J. Kulicki, Modjeski and Masters Inc.; J. Mander, University at Buffalo; G. Martin, University of Southern California; A. Nowak, University of Michigan; R. Nutt, consultant; M. Power, Geomatrix Consultants Inc.; A. Reinhorn, University at Buffalo; and BERGER/ABAM Engineers as the design example subconsultant. Project meetings were held October 1-2 and December 3-4.

A Project Engineering Panel, chaired by Ian Buckle, University of Auckland, will provide technical advice and guidance. More information on NCHRP activities can be found at *http://www2.nas.edu/trbcrp/*.

MCEER Awarded New 6-Year Contract by the FHWA

MCEER was recently awarded a new 6-year, $10.8 million contract by the Federal Highway Administration (FHWA) to conduct research on the seismic vulnerability of the national highway system (see web site announcement at *http://mceer.buffalo.edu/pr/fhwa.html*). This new effort is intended to draw on and extend the work being conducted under the current FHWA-sponsored contracts in the MCEER Highway Project.

The current projects are primarily focussed on the seismic design and retrofitting of typical highway bridges found throughout the United States. The new contract, which was awarded on September 30, 1998, will focus on several special issues considered to be critical to the future of the nation's highway transportation infrastructure. The research will address:

- Development of formal loss estimation methodologies for highway systems. This research will extend work currently being done by MCEER on the development of a seismic risk assessment methodology for highway systems.
- Development of a seismic design and retrofitting manual for long span bridges, which will include long span trusses, suspension, and cable-stayed bridges. The current research is developing a series of seismic retrofitting manuals for application to typical highway bridges and structures (retaining structures, slopes, tunnels, culverts, and pavements).
- Development or improvements for "smart" or "intelligent" earthquake protective systems, including bearings and dampers, specialty materials, and other passive and hybrid semi-active systems.
- Special studies related to foundation design and soil behavior and response, including large pile group behavior, long period ground motions, and improvements in ground remediation technologies.

The project will also address a series of special studies, including the development of post-earthquake nondestructive assessment technologies for retrofitted bridge components, support for NCHRP Project 12-49 (see related article) which is developing a new seismic design specification for highway bridges, and instrumenting the Cape Girardeau cable-stayed bridge, which is currently under construction, to record seismic free field and structural response data.

MCEER's George Lee is the project principal investigator and Ian Friedland is the project manager. Other key project team members include Ian Buckle, University of Auckland; Ron Eguchi, EQE International; John Mander, University at Buffalo; Geoffrey Martin, University of Southern California; and Charles Seim, T Y Lin International.

Western New Yorkers experienced a magnitude 5.2 earthquake on the afternoon of September 25. According to the USGS, the earthquake was located near the border of Ohio and Pennsylvania, about 15 miles north of Sharon, PA. This location is near the epicenter of a magnitude 5.0 event which occurred in January 1986. MCEER staffers in Buffalo felt the earthquake, as did others throughout New York, Michigan, Ohio, Pennsylvania and Southern Ontario, Canada. MCEER fielded over 100 calls in the minutes and hours following the event. Nearly 40 of these were from media, and a number of others were from emergency management and government agencies. For more information about this and other earthquakes, visit the U.S. Geological Survey's National Earthquake Information Center web site at *http://wwwneic.cr.usgs.gov/*.

Adapting Advanced Technologies to Earthquake Engineering

On August 26-27, 1998, MCEER hosted a workshop in Buffalo to discuss the application of advanced technologies to monitor, evaluate and control failures in critical facilities during and following an earthquake. About 30 researchers attended the workshop, the goal of which was to share knowledge between experts with experience from similar programs outside the civil infrastructure systems community (including DoD, DoE and NASA) with those in earthquake engineering.

The group identified the need to establish criteria for the systems, components and structures of interest that characterize failure at various levels. This may require quantification of error, measurement techniques and probabilistic modeling of specific systems. In addition, they noted that the desire to bring the technological advances from other areas (aerospace, automotive, defense) to bear on civil infrastructure problems may best be accomplished by proposing several benchmark systems for use by the both the earthquake and advanced technology communities. It was also noted that there is a need to establish a scientific connection between NDE methods and structural properties, which would assist in defining performance measures for post-event monitoring.

The workshop, sponsored by MCEER and NSF, was organized by Daniel Inman, Virginia Tech. Requests for information should be directed to Professor Inman at *dinman@vt.edu*.

MCEER-INCEDE Center-to-Center Project Update

A final workshop under the MCEER-INCEDE Center-to-Center project on post-earthquake reconstruction strategies was held August 24-25, 1998 in Newport Beach, California. The workshop represented a culmination of the three-year collaborative effort to develop tools and approaches that can aid earthquake responders in post-event recovery efforts. The tools and approaches were developed on the basis of lessons learned during reconstruction of damaged facilities in the earthquake-impacted cities of Northridge, California and Kobe, Japan. Representatives and researchers from both centers met with key end-users of recovery information to review and assess the effectiveness of the tools and strategies developed under the project. A searchable, digital-format sourcebook of lessons learned jointly developed by MCEER and INCEDE will reside on the centers' respective web sites for quick, convenient access to relevant reconstruction experiences. Although the present term of the project has been reached, both MCEER and INCEDE have discussed plans to expand the program to include more extensive considerations of building reconstruction and to develop recommendations for optimal reconstruction of urban areas. More information about the project can be found on MCEER's web site or at INCEDE's web site, *http://incede.iis.u-tokyo.ac.jp*.

MCEER Coordinates Development of Earthquake Loss Forecast for NYC Area

MCEER is acting as coordinator of a new study funded by the Federal Emergency Management Agency (FEMA) to establish a New York City area consortium for earthquake-loss mitigation (NYCEM). The study will focus on New York City and the adjacent regions of New York State and New Jersey (*see MCEER Bulletin, Vol. 12, No. 2, page 10*).

An informational seminar was held November 10 in New York City to kick off the two-year study. The Consortium's objectives are to develop a database about New York City's building stock, supporting infrastructure and socioeconomic systems, and overlay information about the regional geology and seismic hazards to identify areas and structures that face the highest risk. Professionals from emergency management, public service, engineering, architecture, academia, financial and insurance arenas were invited to attend the seminar. Consortium leaders provided an overview of the NYCEM project, its objectives, and benefits to the consortium and the community. Participants were asked to identity who from their respective organizations would be best suited to participate in future NYCEM tasks.

For additional information about the project, contact Bruce Swiren, Regional Earthquake and Hurricane Program Manager, FEMA Region II, at (212) 225-7230; or, Andrea Dargush, MCEER, at (716)645-3391, ext. 106, email: *dargush@acsu.buffalo.edu*.

Earth Science Week Activities

MCEER participated in the first nationally observed Earth Science Week this year. More than 1,400 people took part in Western New York Earth Science Day on Saturday, October 17, which featured demonstrations, exhibits and field activities. At the MCEER exhibit, hosted by Andrea Dargush, earthquake education materials were distributed to numerous teachers, students and parents. Visitors were also asked to complete a "felt survey" for the magnitude 5.2 Pennsylvania earthquake that was felt across much of the Northeast U.S. and adjacent Canada on September 25, 1998 (see page 2).

Recent MCEER Events

August 1, 1998 - December 31, 1998

August 24-25, 1998
MCEER-INCEDE Center-to-Center Workshop on Post-Earthquake Reconstruction Strategies
Newport Beach, California
http://incede.iis.u-tokyo.ac.jp

August 26-27, 1998
Workshop on Advanced Materials, Nondestructive Evaluation and Condition Assessment for Critical Facilities
Buffalo, New York
http://www.cimss.vt.edu

October 1-2; December 3-4, 1998
NCHRP 12-49 Research Team Meetings
San Francisco, California
Las Vegas, Nevada
http://www2.nas.edu/trbcrp/

October 17, 1998
Western New York Earth Science Day
Hamburg, New York

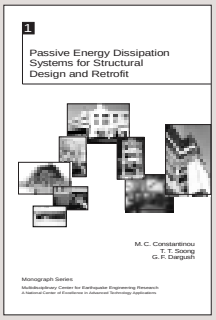
October 27-28, 1998
Workshop on Use of Innovative Technologies for Seismic Hazard Mitigation of Health Care Facilities in the Eastern and Central U.S.
New York City, New York

November 10, 1998
New York City Area Consortium for Earthquake Loss Mitigation (NYCEM) Informational Seminar
New York City, New York
http://mceer.buffalo.edu/pr/nycconsr.html

November 20-21, 1998
Research Committee Meeting
Buffalo, New York

Passive Energy Dissipation Systems for Structural Design and Retrofit

by M.C. Constantinou, T.T. Soong and G.F. Dargush



In recent years, serious efforts have been undertaken to develop the concept of energy dissipation or supplemental damping into a workable technology, and a number of these devices have been installed in structures throughout the world. This monograph introduces the basic concepts of passive energy dissipation, and discusses current research, development, design and code-related activities in this exciting and fast expanding field.

The authors provide basic definitions for passive energy dissipation systems, and provide basic design principles governing their use. The design and retrofit of the following devices are covered in depth:

- Metallic Dampers
- Viscoelastic Dampers
- Tuned Mass Dampers
- Friction Dampers
- Viscous Fluid Dampers
- Tuned Liquid Dampers

The final chapter in the monograph discusses semi-active control systems. Semi-active mass dampers and semi-active fluid dampers have been installed in buildings in Japan, and are discussed in some detail, along with current research in the field.

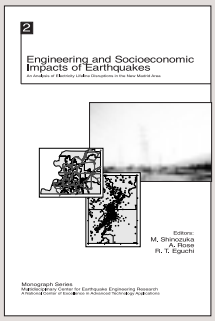
Tables are provided in the appendices that detail application of passive energy dissipation systems in North America, and active and semi-active systems in Japan.

Special Offer

John Wiley & Sons Ltd. has offered a 50% discount on their book, *Passive Energy Dissipation Systems in Structural Engineering* by T.T. Soong and G.F. Dargush, if purchased together with the monograph through MCEER (*To order, click here*). The Wiley book emphasizes the theory and applications of passive energy dissipation systems, while the monograph focuses on the practical applications of seismic design and retrofit. Taken together, the book and monograph provide a comprehensive and current view of this rapidly growing field.

Earthquake Education Resources Seminar for Teachers

For the third year, MCEER will be offering a seminar for secondary school teachers on earthquake education resources. Teachers will have an opportunity to learn about classroom materials that exist in both traditional and electronic forms that can be used to augment earthquake-related lesson plans. The full day seminar, to be offered in Buffalo on Saturday, February 20, features presentations, demonstrations, and hands-on exercises and is open to all interested educators. A nominal fee is assessed to offset duplication costs. A limited number of travel stipends are available for interested teachers outside the western New York area. Contact Andrea Dargush at dargush@acsu.buffalo.edu for details.



Engineering and Socioeconomic Impacts of Earthquakes

An Analysis of Electricity Lifeline Disruptions in the New Madrid Area

Editors: M. Shinozuka, A. Rose, R.T. Eguchi

The largest earthquakes ever to hit North America were centered in the New Madrid Seismic Zone near Memphis, Tennessee, in 1811-1812. Reports of these events were phenomenal. Rivers were rerouted, trees were said to have popped right out of the ground, and the ground shaking itself was felt as far away as Boston. Yet, total dollar damages associated with the earthquakes were probably less than $1 million. The reason is that the area was relatively uninhabited, and the city of Memphis was not founded until several years later.

How would the situation differ today? An earthquake of a similar or even lesser magnitude is projected to be able to cause damage in the billions of dollars. The difference is that the Memphis area is now highly populated and is the center of a sophisticated and highly interdependent regional economy. Moreover, it is also a major crossroads for the national economy.

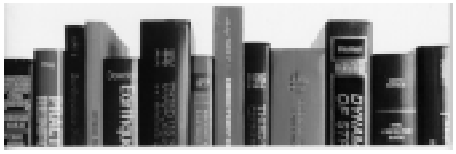
Engineering and Socioeconomic Impacts of Earthquakes: An Analysis of Electricity Lifeline Disruptions in the New Madrid Area, edited by M. Shinozuka, A. Rose and R. T. Eguchi, examines the potential effects of a repeat of the New Madrid earthquake to the metropolitan Memphis area. The authors developed a case study of the impact of such an event to the electric power system, and analyzed how this disruption would affect society. In nine chapters and 200 plus pages, the book is a first of its kind effort to develop and apply a multidisciplinary methodology that traces the impacts of a catastrophic earthquake through a curtailment of utility lifeline services to its host regional economy and beyond. Chapters include:

- Modeling the Memphis economy
- Seismic performance of electric power systems
- Spatial analysis techniques for linking physical damage to economic functions
- Earthquake vulnerability and emergency preparedness among businesses
- Direct economic impacts
- Regional economic impacts
- Socioeconomic and interregional impacts
- Lifeline risk reduction policy formulation and implementation

Contributors include: Dr. Juan Benavides, University of the Andes, Bogota, Colombia; Dr. Stephanie E. Chang, University of Washington and EQE Inc.; Dr. H. Sam Cole, University of Buffalo; Dr. James M. Dahlhamer and Dr. Kathleen Tierney, Disaster Research Center, University of Delaware; Mr. Ronald T. Eguchi, Center for Advanced Planning and Research, EQE, Inc.; Dr. Steven French, Georgia Institute of Technology; Dr. Howard H.M. Hwang, Center for Earthquake Research and Information, University of Memphis; Ms. Laurie Johnson, Risk Management Solutions; Dr. Adam Rose, The Pennsylvania State University; Dr. Masanobu Shinozuka, University of Southern California; and Mr. Philip Szczesniak, Bureau of Economic Analysis Division, U.S. Department of Commerce.

News from the Information Service

Overview of Recent Survey/Express News



Last spring, the MCEER Information Service distributed a survey to readers of its newsletter, the *Information Service News*, to evaluate its usefulness, content, format, timeliness and price. Out of its 600 subscribers, well over half responded to the survey. The overwhelming majority of readers are highly satisfied with the content and format of the *News*. More complete results from the survey were reported in the October 1998 issue of the *News*, which can be accessed at http://mceer.buffalo.edu/news/index.html.

Express News (ENews) is a customized, electronic service that alerts readers to earthquakes / hazards information selected from the most recent MCEER *Information Service News* based on the readers' self-defined interest profile. While paper copies of the *News* are available via subscription, electronic copies are posted free on our web site.

To subscribe to *ENews*, visit http://mceer.buffalo.edu/enews.

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New MCEER Technical Reports

MCEER technical reports are published to communicate specific research data and project results. Reports are written by MCEER-funded researchers, and provide information on a variety of fields of interest in earthquake engineering. The proceedings from conferences and workshops sponsored by MCEER are also published in this series. To order a report reviewed in this issue, fill out the *order form* and return it to MCEER. To request a complete list of titles and prices, contact MCEER Publications.

MCEER's web site offers a complete list of technical reports and their abstracts. The publications section allows users to search the report list by subject, title, author and keywords, and to place orders for these reports. Visit the site at *http://mceer.buffalo.edu/pubs.html*.

Extraction of Nonlinear Hysteretic Properties of Seismically Isolated Bridges from Quick-Release Field Tests

Q. Chen, B.M. Douglas, E.M. Maragakis and I.G. Buckle, 5/26/98, MCEER-98-0001, $10.00

Developing nonlinear models for use in seismic vulnerability assessments of isolated bridges was the goal of this highway project research task. The report describes the development of an optimized procedure to perform such an assessment. To develop the procedure, the authors first identified the properties of interest of the seismic isolators, then modeled the hysteretic characteristics of the bridge-isolator system. An analytical solution for the response of a bilinear SDOF system to quick-release excitation was derived. Data from two different quick-release tests were used to test the procedure. The predicted vs. observed test data were compared and showed good agreement. Thus, the authors concluded that quick-release field test data could be successfully used to extract nonlinear hysteretic properties of seismically isolated bridges.

Methodologies for Evaluating the Importance of Highway Bridges

A. Thomas, S. Eshenaur and J. Kulicki, 5/29/98, MCEER-98-0002, $15.00

This highway project research task focused on identifying, assessing and developing recommended improvements to existing methodologies for defining the importance of highway bridges. The report describes the work that was conducted leading to a simple bridge importance evaluation methodology developed by the authors. The 50 state transportation agencies were surveyed to identify how each state determines and classifies the importance of their bridges. Twelve importance methods were chosen from these replies for further investigation. Following a comparison of these methods, two were selected for further evaluation: one from Illinois and the other from Montana. A recommended method, based on these two methods and additional refinements, was developed which works with a state's existing National Bridge Inventory (NBI) data and does not require the collection of new data. The method fills a need for states in low to moderate zones which need to develop or implement an importance method at little or no cost.

Capacity Design of Bridge Piers and the Analysis of Overstrength

J.B. Mander, A. Dutta and P. Goel, 6/1/98, MCEER-98-0003, $15.00

The objective of this highway project research task was to develop seismic design and capacity detailing recommendations for portions of highway bridge substructures that do not participate as primary energy dissipation elements. This report describes the development of deterministic procedures to obtain overstrength factors for bridge columns on the basis of moment-curvature analysis. The authors propose a simplified design methodology based on plastic analysis of overstrength moment capacity, and demonstrate the methodology through its application to a design example.

Evaluation of Bridge Damage Data from the Loma Prieta and Northridge, California Earthquakes

N. Basoz and A. Kiremidjian, 6/2/98, MCEER-98-0004, $20.00

This highway project research task focused on correlating observed bridge damage resulting from the 1989 Loma Prieta and 1994 Northridge earthquakes to the local ground motions, bridge structural characteristics, and repair costs and time. Damage states reported after the earthquakes were investigated and new damage state definitions for concrete bridges were proposed. Bridges were grouped by their structural characteristics and correlation studies were performed to obtain ground motion-damage relationships and ground motion-repair cost ratio relationships. Logistic regression analysis was used to obtain empirical fragility curves. Currently available fragility curves and damage probability matrices were compared to observed damage data and the empirical relationships developed in this study.

Screening Guide for Rapid Assessment of Liquefaction Hazard at Highway Bridge Sites

T.L. Youd, 6/16/98, MCEER-98-0005, $10.00

The overall objective of this highway project research task was to provide procedures and guidance for highway engineers to conduct preliminary assessments of the vulnerability of existing highway structures to damage as a consequence of liquefaction-induced ground failure. This report provides a screening guide for performing a systematic evaluation of liquefaction hazard at bridge sites and a guide for prioritizing sites for further investigation or mitigation. The guide is intended for use by highway engineers with expertise and experience in geotechnical engineering practice, but not necessarily specialized knowledge in seismic hazard evaluation. It

presents a systematic application of standard criteria for assessing liquefaction, ground displacement potential, and vulnerability of bridges to damage. The screening process proceeds from least complex, least time-consuming, and least data-intensive evaluations to the more complex, time-comsuming, and rigorous analyses. At each level of screening, a conservative assessment of liquefaction hazard is made. Thus, many bridge sites can be evaluated and classified as having a low liquefaction hazard with very little time or effort.

Structural Steel and Steel/ Concrete Interface Details for Bridges

P. Ritchie, N. Kauhl and J. Kulicki, 7/13/98, MCEER-98-0006, $10.00

This highway project research task's objective was to review and evaluate the performance of steel and composite steel/concrete highway bridge components during earthquakes and, where possible, to develop improved conceptual details that enhance structural response. This report examines the seismic performance of steel bridge towers that extend from a massive concrete substructure to the superstructure, and other steel sub- and superstructure details for new construction. Issues addressed include identifying the most ductile cross sections, investigating the application of eccentrically braced frames, exploring details to replace buckled plates or shapes following an earthquake, investigating anchor bolt performance under lateral and uplift loads, and developing economical moment connection details between steel superstructures and substructures.

Capacity Design and Fatigue Analysis of Confined Concrete Columns

A. Dutta and J.B. Mander, 7/14/98, MCEER-98-0007, $20.00

Developing seismic design and capacity detailing recommendations for bridge substructures that have been validated through experimental testing was the focus of this highway project research task. Three common bridge failure mechanisms were examined: concrete failure due to lack of confinement; buckling of the longitudinal reinforcement; and shear failures both within and outside the plastic hinge zone. Design recommendations are presented as simple equations that require that the volumetric ratio of transverse reinforcement be determined based on three parameters: longitudinal steel volume, axial load intensity and the shear span aspect ratio.

Proceedings of the Workshop on Performance Criteria for Telecommunication Services Under Earthquake Conditions

Edited by A.J. Schiff, 7/15/98, MCEER-98-0008, $15.00

On April 16, 1998, MCEER sponsored the Workshop on Earthquake Performance Criteria for Communication Systems at Stanford University. The workshop focused on three issues: identification of key issues necessary to establish earthquake performance criteria for communication systems; identification of areas of research necessary to develop performance criteria; and formulation of measures for performance evaluation. Invited participants represented telephone service providers, government agencies, members of the emergency services community, consultants, and academics. The workshop proceedings contain a summary of the workshop and issues that were discussed, recommendations, and eleven papers.

Upcoming MCEER Events

February 28 - March 3, 1999

Mid-America Highway Seismic Conference, St. Louis, MO

Seismic Risks and Solutions for Highways and Bridges in the Central and Eastern United States

Web Site: *http://www.fhwa.dot.gov/seismic*

Contact:

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■ Sponsors: Federal Highway Administration, Missouri Department of Transportation, Mid-America Earthquake Center, and MCEER

August 14-19, 1999

Fifth U.S. Conference on Lifeline Earthquake Engineering ■ 5USCLEE Seattle, WA

Technical Program:

Donald Ballantyne, EQE International ■ Phone: (206) 442-0695
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Conference Registration:

Andrea Dargush, MCEER ■ Phone: (716) 645-3391 ext. 106
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■ Sponsor: ASCE Technical Council on Lifeline Earthquake Engineering

■ Conference Organizer: MCEER