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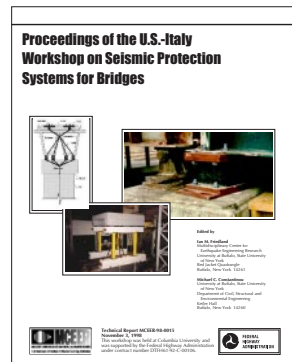
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Proceedings of the U.S.-Italy Workshop on Seismic Protective Systems for Bridges

Edited by I.M. Friedland and M.C. Constantinou, 11/3/98, MCEER-98-0015, 474 pages, \$35.00

Over forty participants attended the two day *U.S.-Italy Workshop on Seismic Protective Systems for Bridges* at Columbia University, New York City, New York. This workshop, held on April 27-28, 1998, was organized by MCEER and sponsored by the MCEER Highway Project, through the U.S. Federal Highway Administration, and the National Group for Defense Against Earthquakes, of the Italian National Research Council. The proceedings consist of 25 papers and focus on research and application of seismic protective systems for bridges, and the practice of bridge seismic isolation and energy dissipation within both the U.S. and Italy. The following themes are addressed:

- active control systems applications
- use of other advanced technologies for improving seismic performance of bridges
- development of bridge fragility curves applicable to performance of bridges with protective systems
- comparison of design philosophies and practices in both the U.S. and Italy
- discussion of standards currently in use by the U.S. and Italy.



Modeling of Pile Footings and Drilled Shafts for Seismic Design

I. Po Lam, M. Kapuskar and D. Chaudhuri, 12/21/98, MCEER-98-0018, 156 pages, \$30.00

This report reviews, assesses and provides recommendations concerning design guidelines for pile footings and drilled shafts. For both types of foundations, a two-step process was developed and various parameters that affect predicted foundation response are identified. The implications of the foundation modeling process in estimating structural response are described. The research examined the applicability of conventional p-y formulations in modeling soil-pile behavior, and assessed modifications to account for cyclic loading conditions, pile group effects, and soil-pile interaction behavior in liquefied soil. For both types of foundations, the report attempts to integrate the structural and geotechnical engineering points of view.

Technical Reports (continued)**Seismic Evaluation of a Masonry Infilled Reinforced Concrete Frame by Pseudodynamic Testing**

S.G. Buonopane and R.N. White, 2/16/99, MCEER-99-0001, 160 pages, \$30.00

This report presents the results from a seismic evaluation of masonry infilled frames performed by pseudodynamic testing. The test specimen was a two-story, two-bay half-scale model, which was subjected to four pseudodynamic tests of increasing magnitude. The experimental program provided detailed data on the behavior of frames and infills under realistic seismic loading conditions. The data can be used to calibrate and verify advanced finite element methods and to improve simple analytical models for evaluation and design.

Response History Analysis of Structures with Seismic Isolation and Energy Dissipation Systems: Verification Examples for Program SAP2000

J. Scheller and M.C. Constantinou, 2/22/99, MCEER-99-0002, 128 pages, \$25.00

SAP2000 is the latest version in the popular SAP series of commercial structural analysis programs. It was released in 1997 and can be used for the dynamic analysis of structures with seismic isolation and energy dissipation systems. In this report, five examples are used to verify the results obtained by SAP2000. Three of the examples involved seismically isolated structures: an 8-story building isolated with bearings, a liquid storage tank isolated with a friction pendulum isolation system, and a 7-story building model isolated with a friction pendulum system. Results from the 3D-BASIS analysis program and experimental testing were compared to the SAP2000 analysis, and produced excellent agreement. The other two examples involved structures with en-

ergy dissipation devices: a 3-story building model with linear and nonlinear viscous fluid dampers, and a model with a toggle brace-damper energy dissipation system. Results from the ANSYS analysis program and experimental testing were compared to the SAP2000 analysis, where most results were in good agreement. However, SAP2000 under-predicted the displacement response of the structure tested with nonlinear viscous dampers.

The input files for the programs used, the history of the seismic excitation and the experimental results are located in the Publications section of MCEER's web site at <http://mceer.buffalo.edu/publications/default.htm>

Experimental Study on the Seismic Design and Retrofit of Bridge Columns Including Axial Load Effects

A. Dutta, T. Kokorina and J.B. Mander, 2/22/99, MCEER-99-0003, 152 pages, \$30.00

This report extends the Control and Repairability of Damage (CARD) column design philosophy for new structures that uses replaceable fuse bars in the plastic hinge zone (see technical report NCEER-97-0013) for the design of new structures. The work reported herein resulted in the development of a new philosophy, ReCARD (Retrofit, Control and Repairability of Damage) that uses the same fuse-bar concept adopted in CARD designs. Fuse-bars are spliced into existing non-ductile columns that have vulnerable hinge zone details. This type of retrofit permits relatively rapid and cost-effective repairs following a damaging earthquake. Both the CARD and ReCARD details are examined to verify that they have adequate fatigue life under realistic seismic loading, including the effects of variable axial loads that arise from a combination of the framing action of multiple column pier bents and vertical ground motions.

Experimental Study of Bridge Elastomeric and Other Isolation and Energy Dissipation Systems with Emphasis on Uplift Prevention and High Velocity Near-Source Seismic Excitation

A. Kasalanati and M.C. Constantinou, 2/26/99, MCEER-99-0004, 238 pages, \$35.00

This report provides an assessment of the benefits offered by damping systems in near-source earthquakes and of the accuracy of currently available tools for analytical prediction of their seismic response. A two-span continuous deck bridge configuration was used in the test program. First, an isolator testing machine was designed and constructed that was capable of testing small bearings under controlled conditions. Next, three vastly different bearings (flat sliding, friction pendulum and elastomeric) were tested prestressed in the testing machine. Test results provided strong evidence for the capability of prestressing to prevent uplift or tension in isolation bearings. Finally, an experimental study of bridge elastomeric isolation systems with emphasis on near-source high velocity seismic excitation was performed. The addition of the damping devices caused a substantial reduction in displacement, provided relief to the vulnerable pier, caused a reduction in the total shear force transmitted to the bridge substructure, and provided for redistribution of the reduced inertia forces from the vulnerable pier to the presumed strong abutments.

The experimental results for the prestressed isolators, non-isolated configurations, and bridge model isolated with low damping elastomeric bearings, high damping elastomeric bearings, low damping elastomeric bearings combined with linear viscous dampers, and low damping elastomeric bearings combined with nonlinear viscous dampers are provided in the publications section of MCEER's web site at <http://mceer.buffalo.edu/publications/default.html>

Truss Modeling of Reinforced Concrete Shear-Flexure Behavior

J.H. Kim and J.B. Mander, 3/8/99, MCEER-99-0005, 230 pages, \$35.00

This report describes the development of a comprehensive theory for analyzing the inelastic shear force versus shear deformation behavior of columns. To achieve this, two concrete shear truss mechanisms (constant angle truss and variable angle truss) are investigated and as a result, new truss models based on numerical integration schemes are suggested and analyzed. These models will enable structural engineers to quantitatively as well as qualitatively understand the flow of forces at any instance of column deformation. They are suitable for hand (design office) analysis. However, more sophisticated truss models can easily be incorporated with comprehensive computational modeling-based techniques (such as DRAIN-2DX).



Experimental Investigation and Computational Modeling of Seismic Response of a 1:4 Scale Model Steel Structure with a Load Balancing Supplemental Damping System

G. Pekcan, J.B. Mander and S.S. Chen, 4/2/99, MCEER-99-0006, 216 pages, \$35.00

This report describes the development of a novel idea for placement of damping systems in structures to reduce their vibrations and eliminate damage even in the case of high velocity pulses expected near a fault. The work presents a detailed study of the new concept supported by rigorous nonlinear analytical modeling and simulations and moreover, supported by a consistent experimental study of scaled models tested on the shaking table. The study discusses the advantages of the proposed system and the remaining challenges to be resolved in the future, thus providing a base for further expansion of knowledge. The solution suggested in this study helps to advance the engineering knowledge of innovative structural applications.

Impact Assessment of Selected MCEER Highway Project Research on the Seismic Design of Highway Structures

C. Rojahn, R. Mayes, D. Anderson, J. Clark, D'Appolonia Engineering, S. Gloyd and R. Nutt, 4/14/99, MCEER-99-0009, 170 pages, \$30.00

This report presents an independent assessment of the results obtained from each of the studies conducted under the four-year MCEER research project on the "Seismic Vulnerability of New Highway Construction" (Project 112). It also provides an assessment of the potential impact of these results on future seismic design specifications for highway structures. This effort was conducted over an 18-month period as the final task of the project ([see related article on page 7](#)). The Applied Technology Council reviewed 32 MCEER final research and technical reports to develop recommendations regarding future bridge seismic design guidelines. The results of the research impact assessment and specification recommendations are documented in this report. A previously published report (MCEER-97-0002) reviewed and assessed current domestic and foreign seismic design criteria for new highway construction.

Recent Events ...

June 1, 1999 - September 30, 1999

June 2-4, 1999

EERC Trilateral Meeting
Las Vegas, Nevada

June 16-17, 1999

Health Care Facilities Project Meeting
Washington D.C.

July 12-14, 1999

International Workshop on Mitigational Seismic Effects on Transportation Structures
Taipei, Taiwan

July 20-21, 1999

Health Care Facilities Project Meeting
New York, New York

July 27-29, 1999

NSF Site Visit
Buffalo, New York

August 4, 1999

Cape Girardeau Cable-Stayed Bridge Seismic Instrumentation Meeting
Cape Girardeau, Missouri

August 12-14, 1999

ASCE/TCLEE 5th U.S. Conference on Lifeline Earthquake Engineering
Seattle, Washington

August 15-17, 1999

7th U.S.-Japan Workshop on Earthquake Resistant Design of Lifeline Facilities and Countermeasures Against Soil Liquefaction
Seattle, Washington

September 10-11, 1999

Geotechnical Performance Criteria Workshop
Las Vegas, Nevada

September 24-25, 1999

Research Committee Meeting
Buffalo, New York

September 23-25, 1999

National Cooperative Highway Research Program (NCHRP) Meeting
Las Vegas, Nevada