

INTRODUCTION TO SEISMIC RETROFIT OF TRUSS BRIDGES –  
A PILOT TRAINING COURSE  
GLENN SMITH, OFFICE OF BRIDGE TECHNOLOGY  
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For FHWA's Office of Bridge Technology, I am delighted that the Multidisciplinary Center for Earthquake Engineering Research (MCEER) has been able to put together this team from T. Y. Lin to develop and present this workshop. Only last week I was in Portland, Oregon, where Ian Buckle, Geoff Martin and Rick Nutt provided a similar course on the long awaited MCEER/FHWA Seismic Retrofit Manual for Bridges.

The Oregon DOT website has a range of material to support their seismic design program. I don't believe the Multidisciplinary Center for Earthquake Engineering Research (MCEER) could have selected a better informed audience for the first public display of the entire manual.

We have a smaller audience, I hope you will ask questions and study our evaluation form before we begin. I ask that you provide constructive feedback on the course evaluation form, note it is several pages long. Bridge Technology needs your ideas if we are to successfully implement the work MCEER has completed.

Over the next year Bridge Technology will be developing reference materials and examples to facilitate use of the bridge and truss manuals. An advisory group will be selected and I will propose that FHWA sponsor a workshop where states can share what they are already doing with seismic retrofit while listening to what the FHWA/MCEER manual recommends.

Also, the long awaited LRFD Specifications for new construction are now an almost complete document (without a Commentary or Worked Examples). FHWA will be giving thought to the compatibility of our Retrofit Manuals and the NCHRP 20-07 Task 193 body of work Roy Imbsen has developed.

There is a handout in your notebook that I updated to include the seismic design references I see crossing my desk. I have limited the

write-up to items I believe are directly relevant to practical seismic design and retrofit support.

## GENERAL COMMENTS

There has been an enormous amount of material developed on earthquake engineering. The Federal Highway Administrations three multi-year contracts with MCEER, beginning in the early 1990s, have developed over fifty published research reports and many unpublished reports. These programs are reported on the MCEER website.

Other multi-task efforts for FHWA have included a \$1.5 million earmark to Washington State University and several tasks and co-sponsorship of geotechnical and bridge seismic design workshops by the University of Missouri at Rolla.

Also, FHWA funded initiation of the Highway Innovative Technology Evaluation Center (HITEC) with the American Society of Civil Engineers (ASCE). Developers of new technologies can seek to have an expert panel develop testing, validation, and specification for their technology. This effort addresses the problem of individual states not being able to use a technology because it is not practical for them to develop standards for new products. Notable seismic applications are column wraps, seismic isolators, dampers, and shock transmission units.

The University of California at San Diego has had the most comprehensive seismic research program. They have done many studies for Caltrans. FHWA supported the construction of their large scale testing facility. The most comprehensive reference book (and the one some say is the most difficult to read) is still *Seismic Design and Retrofit of Bridges* by Priestley, Seible and Calvi.

When I was in San Diego for an ACI Convention, I visited the university bookstore and bought the class text for a seismic isolation course. Dr. Buckle later indicated that he also teaches a course on isolation. We have come a long way when seismic isolation is a common graduate course.

Caltrans funds research at several universities and has held research conferences almost yearly to share this work. The latest was this fall in Sacramento.

FHWA has supported National Seismic Conferences on Bridges and Highways almost biennially since 1996. The fourth was in Memphis in early 2004. MCEER is currently soliciting for abstracts for the next to be held in 2006.

FHWA also supports workshops with Japan that alternate yearly between the two countries. The proceedings consist of papers supporting the presentations made by each delegation and the agreements made.

Under FHWA's MCEER contract multiple joint US workshops have been held with Italy, the Peoples Republic of China, and Taiwan.

FHWA held an extreme events conference in Atlanta Georgia in 1996 that had a limited number of lengthy invited papers. Two earthquake related programs have been held in mid-America since then, one was the 2000 Post-Earthquake Response and Recovery Seminar.

The ASCE/SEI Structures Congress held each spring is typically the largest meeting of structural engineers. In recent years there have been as many as nine concurrent sessions. More than a full program has been devoted to seismic.

The American Concrete Institute holds spring and fall conventions. ASCE and ACI Technical committees typically meet twice a year at the conventions to develop action plans, plan conference sessions, and resolve ballots on standards and reports.

ACI supports the World Congress on Joints, Bearings and Seismic Systems for Concrete Structures every four years. The 6<sup>th</sup> will be in Halifax, Nova Scotia in September 2006. There is a call for papers and proceedings of past congresses are available from ACI.

ASCE/SEI Journals – Structural, Bridge Engineering, and others provide peer reviewed papers on many seismic issues, as do journals under geotechnical institute and other.

The Earthquake Engineering Research Institute (EERI) publishes their Earthquake Spectra every two months. They published a Monograph on Fundamentals of Seismic Protection for Bridges (Mon - 9) in late 2003. Their U.S. National Conference on Earthquake Engineering is held every four years. The next will be in 2006. They also hold annual meetings, have student chapters, fund a distinguished lectureship, a graduate fellowship and a professional fellowship.

There were three major bridge conferences in 2005, i.e.: the annual International Bridge Conference in Pittsburgh in June (that made almost no mention of seismic this year), the 6<sup>th</sup> International Bridge Engineering Conference in Boston in July (proceedings published as Journal of the Transportation Research Board, CD 11-2, with some presentations viewable on their website); 3<sup>rd</sup> New York City Bridge Conference in September (most papers published on a CD, but some published in their Bridge Journal, and others under review for publication in future issues of the Journal). Both the Boston and NYC conferences had seismic papers of interest.

The Transportation Research Board 85<sup>th</sup> Annual Meeting will be held in Washington, DC from January 22-26, 2006. The TRB Seismic Committee and many others meet and many technical sessions are held. Some papers appear on the CD, others appear later in TRB publications. Other presentations are simply not documented. The meeting draws over 9,000 attendees from across the country

I would be remiss, if I did not mention that Roy Imbsen has taught Seismic Design as a short course to more people more times than everyone else. The most complete version is typically taught at Berkeley for a week each year. The course is available through FHWA's National Highway Institute (NHI) and as a short course from ASCE.

I have notebooks on seismic design of bridges courses taught by others in Indiana, Kentucky, and South Carolina.

Professors at Virginia Tech, Barker and Puckett published a thick manual "Design of Highway Bridges" in 1996 to support the

implementation of LRFD. There is a good chapter on the seismic provisions. There is a very thick "Bridge Engineering Handbook" edited by Chen and Duan which devotes section four, twelve chapters to seismic design.

The Director of the Office of Bridge Technology serves as the Secretary of the AASHTO Bridge Subcommittee that holds its annual meeting about June of each year. FHWA ex-officio members serve on the Technical Committees. The T-3 Seismic Committee develops AASHTO seismic provisions. The office of Bridge Technology has funded the development of the Guidelines, the T-3 Trial Designs, a ground motion workshop, and the Roadmap for Version 2. Bridge Technology has also provides travel support to T-3 Members to meetings to move the LRFD and other seismic documents forward.

The National Science Foundation (NSF) has funded two additional centers for earthquake engineering research, i.e., the Mid-America Earthquake Center (MAE) and the Pacific Earthquake Engineering Research Center (PEER). Both have done some work related to Transportation structures. PEER publishes their reports on their website after a short delay. MAE provides theirs on CDs for a nominal charge.

In the future, as we go forward, I read this week that Caltrans has entered into a five year multi-million dollar program with PEER. Congress has funded five-year programs for FHWA at MCEER and the University of Nevada at Reno.

#### George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES).

Initially NSF has provided for the establishment of 15 large-scale earthquake engineering testing facilities. NSF is spending \$80 million dollars on the construction and first four years of operation. Some sites like MCEER found additional resources to substantially enhance their operations. NSF has further dedicated \$200 million dollars to support the operation of the facilities over a ten-year period with a requirement that financial partners support the work.

There will be large projects where several facilities will be used together. The facilities each have their strengths or range of capabilities and a computer network exists to exchange real time test data. The program is called the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). I believe Ian Buckle is chairman of the Consortium.

The Japanese also have developed facilities to accommodate large scale dynamic testing of bridge components.

**"The future is here, facilities for full size dynamic testing of bridge components and systems are available!"**

(Myint Lwin)