

# **FHWA GEOTECHNICAL SEISMIC ACTIVITIES PAST, PRESENT, FUTURE**

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## **Abstract**

The Federal Highway Administration (FHWA) National Geotechnical Team is actively involved in technology transfer activities and the development and delivery of state of the art reference documents and training courses in the geo-seismic area for the specific needs of the Highway Engineering Community. Through a corporate approach between the agency's Headquarters Geotechnical Unit, Resource Center Geotechnical Service Team, the Turner Fairbank Research Center and the National Highway Institute, the FHWA continues to address the changing needs of the State Departments of Transportation in the Geo-Seismic area. This paper provides an overview of past, present and future FHWA Geotechnical Seismic initiatives and links to available resources.

## **Background on FHWA's Geotechnical Program**

Geotechnical Engineering is a critical component of highway planning, design and construction activities in the United States (US) and has a significant role in many areas such as bridges and other structures, seismic design, load resistance factor design (LRFD), pavements, materials, environment, contracting, construction and maintenance and highway safety. In addition, the geotechnical discipline is an important component for the FHWA high priority areas of accelerated construction, asset management, quality and innovative contracting. FHWA Geotechnical Engineers maintain active involvement on the national level with AASHTO committees, State Departments of Transportation (DOTs), industry, American Society of Civil Engineers (ASCE) and other professional groups. The agency's geotechnical specialists are located in Headquarters (HQ), Research and Development (R&D), Resource Center (RC), and Federal Lands Highway Divisions (FLHD). The Geotechnical Engineers within the agency operate as a national team and share resources across units as needed. The success of the FHWA Geotechnical Program is attributed to this team structure and the synergy between the units as they work to achieve team goals. Geo-Seismic initiatives are relatively new for the team and represent a rapidly growing emphasis area for the discipline. Several major developmental efforts are currently underway to further progress the state of the art in geo-seismic engineering. The following sections will discuss the past, present and future geo-seismic initiatives.

## **Past Geo-Seismic Activities**

The seismic design of bridges has been a topic of great interest and much research for many years. Major earthquake events have precipitated needed research and updates to standards and guidelines as each event presents new information into this complex issue. Early design standards, guideline documents and training initiatives for the highway

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bridge community focused primarily on the superstructure with only minimum coverage being given to the geotechnical aspects of the design. Recommendations and guidelines in the geo-seismic area could be found in a variety of research documents, technical journals and articles; however one comprehensive reference document for the highway community did not exist. As a result, in the 1990's the FHWA Headquarters Geotechnical Unit began the development of the agency's first comprehensive guidance document on geotechnical earthquake engineering. The product, a two volume Geotechnical Engineering Circular, is titled: "Geotechnical Engineering Circular No. 3 - Earthquake Engineering for Highways, Design Principles, Volumes 1 and 2," FHWA publication numbers SA-97-76 and SA-97-77. This document served as the primary reference for highway design professionals and was later adapted to create a National Highway Institute training course, "Geotechnical Aspects of Earthquake Engineering." Hundreds of highway design professionals were trained through this effort resulting in an increased awareness and comprehension of the design standards and state of the practice at that time. The GEC continues to be one of the most widely referenced documents on this topic.

### **Present Geo-Seismic Activities**

The FHWA National Geotechnical Team is currently supporting several key seismic initiatives in an effort to continue to improve the state of practice and knowledge of geo-seismic issues nationwide. Present efforts include the FHWA/MCEER Retrofit Manuals, the FHWA Seismic Virtual Team and the new Transportation Research Board Subcommittee on Geo-Seismic Issues. Each of these efforts will be discussed in this section.

#### *FHWA/MCEER Manuals*

In an effort to continue to advance the state of practice in Seismic Engineering, the Federal Highway Administration's Turner Fairbank Highway Research Center continues to support research in this important area. University research, post earthquake reconnaissance studies and international technology exchanges have all been keys to addressing the complex issue of seismic design and retrofit for the highway community. A recent product of the on-going seismic research program is the two volume seismic retrofitting manual published by MCEER in 2005. Recent geotechnical guidance is covered in the document which was peer review by an FHWA led task group of national recognized geo-seismic experts. The manual is titled, "Seismic Retrofitting Manual for Highway Structures," and is contained in two volumes as follows:

- Part 1: Bridges
- Part 2: Tunnels, walls, slopes, culverts.

#### *FHWA Seismic Virtual Team*

The FHWA Geotechnical Team is actively involved in the FHWA Seismic Virtual Team. Keeping the Nation's bridges durable and safe is the goal of the Seismic Virtual Team (SVT) which is composed of the country's top seismic engineering experts. The team provides guidance and recommendations to FHWA, State highway agencies, and others on designing and constructing bridges to withstand earthquake-induced forces, displacements, and ground liquefaction. The team also investigates new technologies for

building seismically safe bridges and retrofitting existing bridges that were not designed to resist earthquakes. The SVT includes representatives from FHWA, State highway agencies, academia, and the private sector. Members' expertise includes teaching, code and specification development, seismology, geotechnical earthquake engineering, dynamic analysis, research, bridge design, and construction. The team is providing information on best practices across five focus areas: seismic hazards and ground motion, design issues, geotechnical issues, retrofit issues, and research and analysis. Projects to date have included studying ground motion characteristics, analyzing bridge designs, looking at improved ways to design and detail bridge foundations, and examining how to update older bridge structures. The team has created a Web site ([www.fhwa.dot.gov/bridge/seismic](http://www.fhwa.dot.gov/bridge/seismic)) that contains a range of technical information and research material, including an overview of the process for the seismic design of bridges. The site also features links to earthquake engineering research centers across the country, including the Pacific Earthquake Engineering Research Center, Mid-America Earthquake Center, Multidisciplinary Center for Earthquake Engineering Research, and the University of Nevada-Reno's Bridge Research and Information Center.

#### *Transportation Research Board Subcommittee on Geo-Seismic Issues*

In 2005, recognizing a need to further promote research and development in the geo-seismic area, a proposal was put forth to the Transportation Research Board to form a new subcommittee to address Geo-Seismic Issues. An excerpt from the proposal follows:

*“Geotechnical issues, including seismic hazard analyses, site response effects, characterization of strong ground motions, permanent ground deformation, and the dynamic stiffness and capacity of deep and shallow foundations, are important considerations in seismic design of bridges. While there is a TRB Committee on Foundations for Bridges and Other Structures, Committee AFS30, this committee is not explicitly concerned with seismic design issues. Furthermore, some of the geotechnical issues associated with the seismic design of bridge foundations, such as seismic hazard analysis, are not currently included in the scope of AFS30’s activities. Therefore, the proposed subcommittee will both serve as a bridge between AFS30 and the Seismic Design of Bridges committee (AFF50) and insure that the full scope of geotechnical issues associated with seismic design of bridges are accommodated within TRB.”*

The proposal was readily accepted and the new committee was formed. The inaugural meeting of the new committee was held in January of 2006.

#### **Future Geo-Seismic Initiatives**

In 2007, the FHWA will begin development of two new National Highway Institute comprehensive training courses on Seismic Engineering. The two new 5-day NHI Courses will combine the structural and geotechnical aspects and will be titled as follows:

- 1- Seismic Design and Analysis of Bridges, and
- 2- Seismic Design and Analysis of Geotechnical Highway Features including Structural Foundations, Earth Retaining Structures, Earth Works and Buried Structures (Tunnels and Culverts).

The courses are intended to form the primary basis for FHWA and AASHTO seismic design, analysis, and retrofit training through the next decade. It is the intention of FHWA that development of the two courses will be performed concurrently, but developed such that each is a stand alone training activity so that participants may take either or both courses in any sequence. The development team will be an interdisciplinary team of structural, geotechnical, and seismic hazard experts who will have both an in-depth development background, and a working knowledge in the latest national technical guidance on seismic hazard effects on transportation structures and features. The final course materials will include a comprehensive reference manual that will be directed to state of the practice implementation and journeymen level highway bridge designers.

Once completed, the FHWA will work closely with the State Departments of Transportation to raise awareness of modern design methods and improve the state of practice in Geo-Seismic Design and Analysis nationwide.

### **Technical Resources**

The FHWA Geotechnical Team has a wealth of technical resources available to the Engineering Community. The team develops and maintains numerous training courses, engineering software applications and a comprehensive technical library. Easy access to these resources is available through our website at the following addresses:  
[www.fhwa.dot.gov/bridge](http://www.fhwa.dot.gov/bridge); [www.fhwa.dot.gov/resourcecenter](http://www.fhwa.dot.gov/resourcecenter); [www.nhi.fhwa.dot.gov](http://www.nhi.fhwa.dot.gov).

### *Training*

The National Highway Institute (NHI) is the training arm of the FHWA. The FHWA Geotechnical Team is proud of its efforts in this area and the development, delivery and management of 20 NHI geotechnical courses. The NHI Geotechnical Training program is one of the most active training areas within the agency. The associated references are nationally recognized as premier guidance documents and are often referred to in State Design guidelines and specifications. A full list of the currently available NHI training courses is available at our NHI website at: [www.nhi.fhwa.dot.gov](http://www.nhi.fhwa.dot.gov). The courses listed are available upon request through the National Highway Institute. Instructors for the courses include FHWA Geotechnical staff as well as consultant instructors that are nationally recognized experts in specific technical areas.

### *Publications*

The FHWA maintains a comprehensive Geotechnical Library of over 100 publications that covers a broad range of geotechnical topics that relate to transportation design and construction. A complete list of available publications is available at our website at: [www.fhwa.dot.gov/bridge/geopub](http://www.fhwa.dot.gov/bridge/geopub). Ordering information is also provided on the website.