

## At the Intersection of Research and Practice

The National Institute of Standards and Technology and Its Contributions to NEHRP

In the United States today, the built environment supports everything we do. Researchers continue to discover new materials, technologies, and techniques that can potentially enhance that environment. But who translates these discoveries into safe and practical alternatives for those who design and build our structures and our transportation and utility systems? Many organizations play a role, but perhaps none a more authoritative or wide-ranging role than does the National Institute of Standards and Technology (NIST).

NIST has participated in the National Earthquake Hazards Reduction Program (NEHRP) since Congress established the program in 1977. NIST's involvement, which began as a natural outgrowth of its work on structural safety standards, has evolved along with the program.

### Early Avenues of Involvement

One of NIST's earliest earthquake-related activities was investigating structural damage sustained in the San Fernando, CA, earthquake of 1971, when the agency's recommendations led to modified design requirements for bridge columns. In the years since, NIST has led or taken part in many such investigations, both in the United States and abroad. NIST's findings following earthquakes in Miyagi-ken-oki, Japan, in 1978, Mexico City in 1985, and Loma Prieta, CA, in 1989 focused greater attention on structural design in areas where deep, soft soil deposits are likely to amplify earthquake ground motions. In the wake of the Northridge, CA, earthquake of 1994, NIST investigators and others found unexpected structural damage in buildings of welded steel moment-frame construction. This discovery led to a multiyear research and development effort that produced techniques for mitigating the risk of such damage.

NIST made important contributions to this effort. The Northridge investigations indicated that brittle beam-to-column connections were largely responsible for the damage found. NIST collaborated with the American Institute of Steel Construction (AISC) and university researchers to evaluate, through full-scale laboratory testing, methods for reducing stress at the beam-to-column connections. Based on their findings, the collaborators developed guide-

lines for the seismic rehabilitation of existing welded steel frame buildings that were published by AISC in 1999.

That was one of many instances over the years when NIST has applied its research capabilities to specific problems or needs brought to the attention of NEHRP by the earthquake engineering community. Along with problems uncovered through earthquake investigations, NIST has also responded to needs brought about by the emergence of new or unproven technologies. In the late 1980s, for example, builders could see potential advantages in using precast, rather than cast-in-place, concrete frames for buildings, but precast construction had not been shown to provide comparable earthquake protection. The key challenge was to design economical precast beam-to-column connections that could resist seismic forces. In cooperation with builders and university researchers, NIST developed a new precast hybrid connection and design guidelines that have since been incorporated into the *International Building Code* and the standards of the American Concrete Institute.

Soon after Congress established NEHRP, the Inter-agency Committee on Seismic Safety in Construction (ICSSC) was formed to integrate earthquake risk reduction efforts into the more than 30 Federal agencies with responsibilities for buildings and lifelines. Since 1982, NIST has chaired and provided administrative and technical support to the committee. The ICSSC has organized several major NIST-led earthquake investigations, including those following the Loma Prieta and Northridge earthquakes and the 1995 Kobe earthquake in Japan.

During the 1980s and 1990s, the ICSSC and NIST led efforts to develop seismic design and construction standards for Federal buildings. This included preparing an Executive order, issued in 1990, that required that ICSSC-approved standards be used in designing and constructing new Federal and federally assisted or regulated buildings. The inclusion of federally assisted structures provided the impetus needed to incorporate, for the first time, seismic provisions into the Nation's model building codes.

## An Evolving Role

*During its first 25 years in operation, NEHRP facilitated the growth of fundamental knowledge in engineering and earth sciences that is of great potential value for reducing seismic risks. Efforts to apply this knowledge did not keep pace with its growth, however, leading to a widening gap between research findings and their practical application.*

This was the conclusion reached by representatives of the design and construction industry during strategic planning undertaken by NEHRP from 1998 to 2001. While acknowledging the successes that NEHRP had achieved in transferring knowledge into practice via applied, problem-focused research, such as that carried out by NIST, the industry urged that more such work be performed. In 2002, NIST brought together leaders in earthquake engineering to create a research and development (R&D) "roadmap" prescribing focuses for this work.

These developments were reflected in the legislation that Congress passed in 2004 to reauthorize NEHRP. NIST was designated as the lead agency for NEHRP and was assigned new R&D responsibilities to help close the gap between earthquake engineering knowledge and practice.

The roadmap called for sustained, systematic efforts to narrow this gap, and NIST has begun building an earthquake engineering research program that is capable of such efforts. Since starting the program in 2007, NIST has continued to add personnel and projects as funding permits. Funds are being divided among intramural projects carried out within NIST and extramural projects conducted by universities and other research organizations.

In its first intramural project, NIST is developing an online database of findings generated over the years by NEHRP-funded research projects. This tool will help NIST and others access and apply the valuable knowledge that has been created through NEHRP, especially the results from basic research conducted in hundreds of projects supported by the National Science Foundation (NSF).

NIST has initiated several extramural projects through the NEHRP Consultants Joint Venture, a partnership between the Applied Technology Council and the

Consortium of Universities for Research in Earthquake Engineering. In one project, researchers are testing an improved method of quantifying the seismic performance of structural systems, a method developed for use with model building codes. Another project is responding to the need for seismic design guidance for the Nation's vital container-shipping ports. This team will carry out applied research to translate basic research results generated by an NSF-supported study into design prestandards for engineers and building-code developers.

These and other new research efforts are not the only ways in which NIST is contributing to NEHRP. NIST sponsors, alone and in cooperation with fellow NEHRP agencies and other partners, meetings and workshops that further its earthquake research. In 2008, for example, NIST engaged the Building Seismic Safety Council to hold a workshop and to report on the additional research needed to fully develop and implement performance-based seismic design. In 2007, NIST joined other NEHRP agencies in supporting a workshop that identified research needed to advance seismic rehabilitation of existing buildings in the United States.

As the lead agency for NEHRP, NIST operates the NEHRP Secretariat, which is housed within NIST's Building and Fire Research Laboratory in Maryland. In recent years, the secretariat has coordinated the development of NEHRP's annual reports to Congress as well as the program's new strategic plan. Following publication of the strategic plan in October 2008, the secretariat engaged the National Research Council to convene a national workshop and evaluate what must be done over the next 20 years to achieve the goals set out in the plan.

Through its leadership role and expanding research activities, NIST is more involved than ever before in shaping NEHRP's present and future impacts on earthquake safety. As always, NIST's involvement in NEHRP remains focused on applying the fruits of research to strengthen seismic resistance throughout the built environment. This is a fitting role for an agency that has stood very tall, since its founding in 1901, at the intersection of research and practice.

For more information, visit [www.nehrp.gov](http://www.nehrp.gov) or send an email to [info@nehrp.gov](mailto:info@nehrp.gov).



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