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SeismicWaves

How the National Earthquake Hazards Reduction Program Is Advancing Earthquake Safety

Interagency Report Seeks to Move Beyond Life-Safety Design Standards

A January 2021 report jointly prepared by the National Institute of Standards and Technology (NIST) and the Federal Emergency Management Agency (FEMA) provides a set of recommendations, tasks, and alternatives aimed at improving the time it takes to get buildings and infrastructure back in operation following an earthquake. Significantly, the report represents a potential shift in design standards from the current focus primarily on life safety to the additional goals of "timely reoccupancy" and "functional recovery."

The report, *Recommended Options for Improving the Built Environment for Post-Earthquake Reoccupancy and Functional Recovery Time,* is available at www.fema.gov/sites/default/files/documents/fema_p-2090_nist_sp-1254_functional-recovery_01-01-2021.pdf. Congress required the report as part of its 2018 reauthorization of the National Earthquake Hazards Reduction Program (NEHRP), originally established in 1977. NEHRP member agencies include NIST, as the lead agency, FEMA, the National Science Foundation and the U.S. Geological Survey.

In the U.S., "the design and construction of buildings is regulated by building codes and standards that are developed in the private sector and adopted at the state, local, tribal, and territorial government levels," explains the report. "Recognizing that earthquakes are inevitable, and that catastrophic life loss associated with these events is unacceptable to the public, a group of professionals — code officials, design professionals, construction industry representatives, and other code users — have worked within the codes and standards development processes to implement modern building codes that include life-safety protection against the effects of earthquakes."

The focus of building codes, as well as infrastructure design, has long been about life safety to prevent serious injuries or deaths in the event of a major disaster, says Chris Poland, a consulting structural engineer in Canyon Lake, California, who served on the report's technical panel. He also said "reoccupancy and functional recovery add another goal: determining the amount of time necessary before you can reoccupy a building, reopen a bridge, or start using other infrastructure again.

Critical Changes

The report outlined seven critical recommendations to Congress to "initiate changes in design and construction practice (in the U.S.) to improve the built environment." The first four recommendations focus on the physical built environment and the design and retrofit of buildings and lifeline infrastructure systems while the last three focus on the social environment.

The recommendations are as follows:

1) Develop a framework for post-earthquake reoccupancy and functional recovery objectives.
2) Design new buildings to meet recovery-based objectives.
3) Retrofit existing buildings to meet recovery-based objectives.
4) Design, upgrade, and maintain lifeline infrastructure systems to meet recovery-based objectives.
5) Develop and implement pre-disaster recovery planning focused on recovery-based objectives.
6) Provide education and outreach to enhance awareness and understanding of earthquake risk and recovery-based objectives.
7) Facilitate access to financial resources needed to achieve recovery-based objectives.

Although the report notes that "each recommendation can have a positive impact" on its own, the document also stresses that "maximum effectiveness will only be achieved when all of the recommendations are fully implemented." Still, the report notes that the first recommendation is the key first step because "development of a reoccupancy and functional recovery framework will provide the core policy, technical, and hazard level information needed as a basis for all other activities."

The report itself focuses on recovery after earthquakes, explaining that 150 million people — nearly half the U.S. population — live in areas across 42 states "that are at risk of experiencing a damaging earthquake within the next 50 years." At the same time, the document also notes that "recommendations in this report could be leveraged and adapted for other natural hazards." Indeed, it stresses that the "motivation for this report is the risk that the U.S. faces each year from all forms of natural hazards, including hurricanes, floods, wildfires, and earthquakes."

Considering historical incidents and future disaster scenarios, the report stresses that the potential "loss of life and property, and the negative impacts to the economy" during or from such events can be attributed directly to "the inability of the built environment to withstand the effects of earthquakes and other natural hazards." Consequently, the report concludes, "a change in building codes, building practices, and societal values is needed."

Future Focus

Stressing that the report only provides recommendations on how the goals of reoccupancy and functional recovery can be achieved, the document is really just the first step of the process, and so without clear direction and the necessary resources from Congress, the extensive work that these recommendations would require is not really possible. At the time of publication, Congress had not yet responded to NIST or FEMA regarding "how Congress would like us to proceed," notes Michael

Mahoney, a senior geophysicist at FEMA who served on the report's technical panel.

However, a major development could involve the International Code Council (ICC)'s adoption of the report's recommendations into its model code, known as the International Building Code. This is the code that government entities use as a basis to create their own codes, as does the federal government for federal buildings. ICC adoption could be prompted if the American Society of Civil Engineers (ASCE)'s standards committees were to incorporate the report's recommendations into ASCE standards, such as in ASCE 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* or ASCE 41, *Seismic Evaluation and Retrofit of Existing Buildings*, according to Poland. Integrating such changes into standards and eventually codes would take considerable time — most likely a decade or more.

"The code process is a long and difficult one by design," explains Mahoney, filled with "checks and balances so you have the opportunity to have any new material vetted." If the concept of functional recovery becomes part of building codes, "it will be a massive change," adds Poland. "But it's possible."

In the meantime, instead of waiting for new codes and standards to be developed, engineers can start promoting various aspects of the functional recovery provisions. For example, engineers can encourage the communities they live and work in to adopt a supplemental code that does not mandate the new provisions but instead allows them to be enacted voluntarily. The provisions could also be promoted as guidelines for private business owners to use if they want to have functional buildings after disasters.

During an Earthquake Engineering Research Institute meeting, presenters discussed several new building projects in which "the owners had worked with the structural engineers to develop a functional recovery plan," notes Steven McCabe, a NIST research structural engineer and NEHRP Director. These plans were developed without the codes requiring them or any government mandates, McCabe adds.

Communities can also take action if they are "ready to move beyond the current codes and standards," says Siamak Sattar, a NIST research structural engineer who served on the project technical panel. A community can simply designate a larger number of buildings as essential post-disaster, thus triggering the highest design requirements that are typically used exclusively for such crucial buildings as hospitals, fire and police stations, and similar critical facilities.

Additional Goal

The most important question is asking the community: "Which buildings and infrastructure systems do we need to be ready to function at what time following an event?" says Ryan Kersting, an associate principal at Buehler Engineering in Sacramento, California, who chaired the project technical panel.

Emergency-response facilities have long been deemed essential for immediate reoccupancy and uninterrupted service. At the other end of the scale, something intended strictly for entertainment — a bowling alley, for example — could be closed for months without seriously damaging the community, Kersting adds. But what about the buildings in between? The ongoing pandemic has certainly taught people how essential it can be for schools, grocery stores, and pharmacies to be up and functioning as soon as possible.

Likewise, warehouses are generally assigned to the lowest-risk hazard level in most building codes, says David Bonowitz, a structural engineer in San Francisco who served on the technical panel. But when a warehouse is a critical part of the food supply chain, it probably cannot be out of service for long periods. "It doesn't mean (warehouses) have to be designed like firehouses," Bonowitz explains. But in the aftermath of an earthquake or other disaster, "it does mean we need some understanding of what (that warehouse's) damage is going to be, translate that into recovery time, and ask if we're getting the recovery time we can handle," he concludes.

Infrastructure Efforts

It is not enough, however, for a building to simply be reoccupied post-disaster. To be functionally recovered, the building must have access to the same services it had before the earthquake or other disaster. "Who cares if my building is 'ready to go back to work' if I don't have electricity," water and wastewater, or communications systems? Although such infrastructure systems are not covered by traditional building codes, the concept of "restoration of service" is a critical aspect of functional recovery that engineers need to consider during infrastructure design.

To that end, FEMA and NIST are working on separate infrastructure-resilience projects that have grown out of the functional recovery project. On October 6, 2021 ASCE/UCLA held a public webinar summarizing the report.

This article is based on the full ASCE article at www.asce.org/publications-and-news/civil-engineering-source/civil-engineering-magazine/article/2021/04/groundbreaking-interagency-report-seeks-to-move-beyond-life-safety-design-standards/, with their persmission.