New report charts path toward superior earthquake recovery

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For the last century, seismic building codes and practices have primarily focused on saving lives by reducing the likelihood of significant damage or structural collapse. Recovery of critical functions provided by

buildings and infrastructure have received less attention, however. As a result, many remain vulnerable to being knocked out of service by an earthquake for months, years or for good.

A committee of experts, formed by the National Institute of Standards and Technology (NIST) and the Federal Emergency Management Agency (FEMA) under the direction of Congress, has urged officials at all levels of government to support research and policies that could help get the buildings and services society depends on up and running quickly after an earthquake. In a report delivered to Congress, the committee outlines seven recommendations that, if acted upon, may greatly improve the resilience of communities across the nation.

"As structural engineers we feel confident that the current building codes can deliver life safety design objectives. Now, it's time to go beyond that and think about recovery of function," said Siamak Sattar, a NIST structural engineer and co-author of the report.

In 2011, a magnitude 6.3 earthquake struck Christchurch, New Zealand. Over 180 lives were lost as a result, but many more were likely saved by modern building codes. However, the city's economy and quality of life were not spared.

The quake damaged the city's central business district to the point that hundreds of buildings were closed or demolished, displacing thousands of workers. Lifeline infrastructure systems—including power, clean water and roads—sustained heavy damage, further crippling the community's ability to bounce back. In total, the estimated costs of rebuilding the city amounted to 40 billion New Zealand dollars ($26.6 billion).

The toll taken by the Christchurch earthquake and other damaging events can in part be attributed to limitations in seismic codes and

standards, as most offer little guidance on designing buildings or lifelines to recover in a timely manner in the wake of extreme events.

To prevent major earthquakes from leaving such lasting impressions in the future, Congress entrusted NIST and FEMA—both member agencies of the National Earthquake Hazards Reduction Program (NEHRP), which NIST leads—with the responsibility of mapping a path to greater community resilience.

Drawing expertise from both public and private sectors, NIST and FEMA assembled a committee of more than 30 engineers, architects, building owners, code officials and social scientists—including several of their own researchers—to devise options for addressing gaps in codes, standards and practices, which are described in their report to Congress.

The first recommendation summarizes the core of the report. The authors call for members of the government, codes and standards organizations and industry to work together in developing a national framework for setting and achieving goals based on recovery time. To produce this framework, experts must first identify what level of function provided by buildings and lifelines should be maintained after an earthquake, and then determine an acceptable time for them to be out of commission.

"There are different metrics that we can use to help guide this framework. For example, a building may need to recover within a predefined number of days, weeks or months. If it is a hospital or emergency center then you may not want it to go down at all," said Steve McCabe, director of NEHRP.

The authors also highlight the need for new recovery-based design criteria for buildings and lifelines. If developed with recovery in mind, these criteria could steer design parameters—such as increasing a

school's structural strength to limit damage or designing an electrical power supply to return to service faster—toward improving community resilience. A critical phase of this process would be identifying the level of ground shaking that designs should be tailored to for recovery goals, which may vary by region.

Other recommendations seek to help leaders meet recovery goals aligned with the first recommendation, offering guidance on implementing new design requirements for buildings and lifelines. They also provide direction for pre-disaster planning—a key step in preparing authorities to make timely decisions in the immediate aftermath of a disaster.

The authors seek to empower communities as well by recommending the launch of an education campaign on earthquake risk and recovery, which could reach the public through social media, streaming services or other media.

"Informed citizens are an important resource needed to develop the kind of vision required for this effort, which may well represent the largest change in building codes in 75 years," McCabe said.

In the report, the authors encourage officials to consider adopting functional recovery approaches that go beyond the current requirements. They assert that the initial investments of adopting new recovery-focused codes and upgrading older buildings and lifelines could likely be offset by the reduction of future losses. They also suggest that increased access to financial resources through mechanisms such as grant programs, incentive systems and public financing would help local governments scale the upfront costs.

"The immediate aim of the report is to spark a national conversation about developing a consensus for recovery goals and timelines. This approach may eventually be reflected in building codes, but first, a

considerable amount of research must be tackled," Sattar said.

New policies could make use of the NEHRP agencies, such as NIST and FEMA, whose expertise may enable them to provide the necessary science for sound public policy.

The road toward this goal could take years to traverse, but it is critical.

In the meantime, the authors encourage early action by leaders at state and local levels, as each community may have needs that national guidelines cannot fully address. Their experiences with functional recovery planning and design could also make for valuable feedback at the national level, speeding up progress toward widespread earthquake resilience that preserves quality of life in addition to life itself.

More information: Siamak Sattar, Recommended Options for Improving the Built Environment for Post-Earthquake Reoccupancy and Functional Recovery Time, (2021). DOI: 10.6028/NIST.SP.1254

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