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LEGISLATIVE EFFORTS IN THE UNITED STATES TO CHANGE BUILDING CODE REQUIREMENTS FROM SAFETY-ONLY-BASED DESIGN TO FUNCTIONALITY-BASED (RESILIENT) DESIGN

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Abstract

In recent years, it has become more widely known that the design objective of the US building codes (e.g. ASCE 2010) is for buildings to be safe, but not necessarily to be functional or even repairable after an earthquake. Many have begun referring to code-compliant buildings as "safe but disposal." Several efforts are underway to consider design requirements that are also focused on building reparability and functionality, and the new terminology often being used is "design for Functional Recovery". These include efforts by the State of California such as Assembly Bill 393 [1,2], the federal government (through the recent National Earthquake Hazards Program, NEHRP, reauthorization and direction to NIST/FEMA to look into functional recovery standards), and efforts by local governments such as San Francisco [3].

This paper covers these recent efforts in the US to advance from a safety-only-based building code to a building code that also explicitly considered building functional recovery in the building design process. This paper also summarizes recent efforts to create those building code provisions using the FEMA P-58 analysis method for various functional recovery time goals (e.g. function within a week, within a month, or with 6 months). This paper concludes by providing the current status of these developments in the US and the charted next steps moving forward.

Keywords: Legislation, policy, resilient design, functional recovery, post-earthquake function, FEMA P-58, SP3

1. Introduction

This short summary paper provides a brief overview of the overwhelming trends the past few years in the United States, to begin looking at building design in terms of designing for post-earthquake function rather than only designing for safety (collapse prevention). These are active efforts in the United States, so this conference presentation will provide the most up-to-date and complete information on this topic.

2. Overview of Trends and Current Legislation in the United States

In recent years, in the United States, it has become more widely known that the design objective of our building codes (e.g. ASCE 2016 [4]) is for buildings to be safe, but not necessarily to be functional or even repairable after an earthquake. Many have begun referring to code-compliant buildings as "safe but disposal." Several efforts are underway to consider design requirements that are also focused on building reparability and functionality, and the new terminology often being used is "design for Functional Recovery". These include efforts by the State of California in Assembly Bill 393 [1,2], the federal government (through the recent National Earthquake Hazards Program, NEHRP, reauthorization and direction to NIST/FEMA to look into functional recovery standards), and efforts by local governments such as San Francisco [3]. The NIST/FEMA effort is currently working on a report on options for functional-recovery-based design, which will be submitted to the U.S. Congress in the summer of 2020.

In parallel with this new awareness of what the building code is providing (and not providing), analytical methods have now been developed to the point that engineers are able to analytically estimate building damage and function through a building-specific engineering analysis. This was not possible 10 years ago. These supporting research efforts have occurred over the past couple decades (e.g. [5,6]) and have coalesced with the 2012 release of the FEMA P-58 risk analysis method [7] and complementary extensions for repair times and downtimes [8,9]. Enabling software tools are also now available to support these engineering analyses [7,10]. Many in the Structural Engineering profession have been adopting and vetting the FEMA P-58 and REDi technologies starting in 2014, with most large California Structural Engineering firms now utilizing this new technology. This new technology has already been electively used to design recent buildings to be resilient, with limited building closure time and limited repair costs after the earthquake [11,12].

The above two recent developments (societal interest and new engineering technology) have created a remarkable situation and opportunity. Structural Engineers now have the technology to predict building damage and functionality, and they can use that information to iteratively design buildings to be better (e.g. building functionality within weeks). Many levels of government are now making it clear that they desire post-earthquake functionality and smoother recovery for their communities, rather than only safe (but disposable) buildings. This societal need, coupled with new technology available to Structural Engineers, puts our society in a good place to improve our building design practices and create more resilient buildings and communities. This paper focuses on how such resilient design can be achieved, both electively for individual building projects (which can start now and has already started), and through possible building code updates to change future design of all buildings (which will require a consensus development process to be completed to determine the building code changes).

3. Toward a U.S. Design Standard for Design for Functional Recovery

The next technical development step in this effort is to work toward a pre-standard for how structural design can be done to meet functional recovery goals. This includes running thousands of resilient design studies using the FEMA P-58 analysis method and then mining those data to determine prescriptive design requirements that can be shown to achieve functional recover goals (e.g. building will be functional within a week after a design-level earthquake).

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4. Summary and Next Steps

Technical development is ongoing, with the goal of having design recommendations for functional-recovery-based design available in September 2020. These findings and recommendations will be covered in the conference presentation, along with more details about the associated legislative and policy efforts in the United States.

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