Structural Engineer's Guide to Become Leaders in Community Resilience

By the SEAOC Resilience Committee

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This is the first of six newsletter articles about "earthquake resilience" and how this broad, new design goal is likely to affect structural engineering practice in California. Forthcoming articles will:

1. Introduce the new terms "community resilience" and "functional recovery."
2. Present the economic benefits of resilient design.
3. Discuss how building rating systems (e.g. USRC, SEAONC, REDi) can help communicate expected downtimes following an earthquake.
4. Summarize tools for resilient design (e.g. FEMA P58, SP3 software).
5. Offer tips for educational outreach to the public, policy makers, and our clients about the role of structural engineers in designing for community resilience.

"Community resilience" has been defined as the ability of a community to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.[1] While this concept is applicable for all hazards and includes both buildings and infrastructure, our discussion in this article series will be limited to the seismic performance of buildings only. How structural engineering might contribute to community resilience is unclear from the definition alone since we normally design or retrofit individual buildings, not whole communities, and since our work is guided by safety-based codes, not by planning or recovery objectives.

Yet the emphasis on "recovery" gives us a way in. To achieve community resilience, our building codes must go beyond safety and include a focus on recovery times. In addition to encouraging the adoption of such "resilience" or "functional recovery" building codes, the engineering community can make a direct and more immediate contribution by designing buildings to achieve specific recovery times based on the building's function, client desires, and expected hazards. We can also apply our expertise to facilitate emergency response and recovery planning.

Consider the experience in Christchurch, New Zealand when they experienced two large earthquakes in the span of six months in 2010-2011. While the building code successfully limited loss of life, it did not facilitate recovering normal functions. Figure 1 shows that it took nearly four years to demolish damaged buildings in the Central Business District because the damage was extensive, the city needed to develop a new plan, and rebuilding was delayed by insurance issues.

[1] "Preparing to Thrive: The Building Industry Statement on Resilience," (2016)
http://content.aia.org/sites/default/files/2016-05/Res-StatementOnResilience_2.pdf

2 weeks before the earthquake. ~4 years after the earthquake.

Figure 1 - 2011 Earthquake Impact on Downtown Christchurch, New Zealand.[2]

Policy makers at the national, state, and local levels understand the importance of increasing the resilience of our communities. At the national level, Congress has reauthorized the National Earthquake Hazard Reduction Program (NEHRP) with an additional mission to "increase the resilience of communities...to facilitate community-wide post-earthquake recovery in times of disaster." NIST and FEMA are preparing a report to Congress "on recommended options for improving the built environment and critical infrastructure to reflect performance goals stated in terms of post-earthquake reoccupancy and functional recovery time."[3]

At the state level, California legislators are considering AB 1997 which would convene a committee to "assess and recommend options for improving the built environment and critical infrastructure to reflect performance goals stated in terms of post-earthquake reoccupancy and functional recovery time."[4] And at the local level, numerous California cities are developing resilience programs; some have begun to identify and prioritize seismic retrofits with attention to community resilience.

To achieve Community Resilience, our building code and emergency planning procedures must transcend the goal of saving lives and include a focus on improving recovery times.

[2] Buckalew et. al. (2019), *SEAOC Resilience Committee Update and Report to the Membership*, Proceedings of Structural Engineers Association of California Annual Convention, Sacramento, SEAOC

[3] 42 U.S.C. § 7704, 2018. "National Earthquake Hazards Reduction Program." United States Code. (2019). https://www.congress.gov/115/plaws/publ307/PLAW-115publ307.pdf

[4] http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB1997

Policy makers and the public are turning to the structural engineering profession to help improve our built environment against natural disasters. Recent publications have helped to develop these ideas from our technical perspective:

- The Earthquake Engineering Research Institute (EERI) issued a white paper with policy options, “Functional Recovery: A Conceptual Framework with Policy Options,” to advocate “for all levels of government to develop community driven earthquake resilience plans...that would lead to more rapid and robust recovery from future earthquakes.”[5]
- The Structural Engineers Association of California (SEAOC) published a statement supporting “the evolution of our building codes and standards to consider performance in terms of acceptable recovery time, in addition to the current safety-based objective.”[6]
- The Federal Emergency Management Agency (FEMA) published a resource paper, “Resilience-Based Design and the NEHRP Provisions,” establishing a starting point for building codes to adopt recovery-based design provisions.[7]

Structural engineers play a critical role in the recovery process by designing buildings and infrastructure to meet the needs and expectations of the community. New tools such as FEMA P58 and H-B Risk Group’s SP3 software have been developed to facilitate evaluation of the earthquake impacts on buildings and communicate results as decision variables as illustrated in Figure 2. Downtime is the most important variable to enhancing a community’s resilience. Rating systems (USRC, REDi, and SEAONC) also provide an intuitive means of communication of building performance to our clients and the public. New buildings can now be designed and existing buildings can be retrofitted to quickly regain functionality after an earthquake to meet the operational needs of a community.

5 https://www.eeri.org/wp-content/uploads/eeri-policy-resilience.pdf

6 https://cdn.ymaws.com/www.seaoc.org/resource/resmgr/docs/newsletter/seaoc_letter_re_eeri_fr_whit.pdf

7 https://cdn.ymaws.com/www.nibs.org/resource/resmgr/bssc3/BSSC_Resilience_Based_Design.pdf

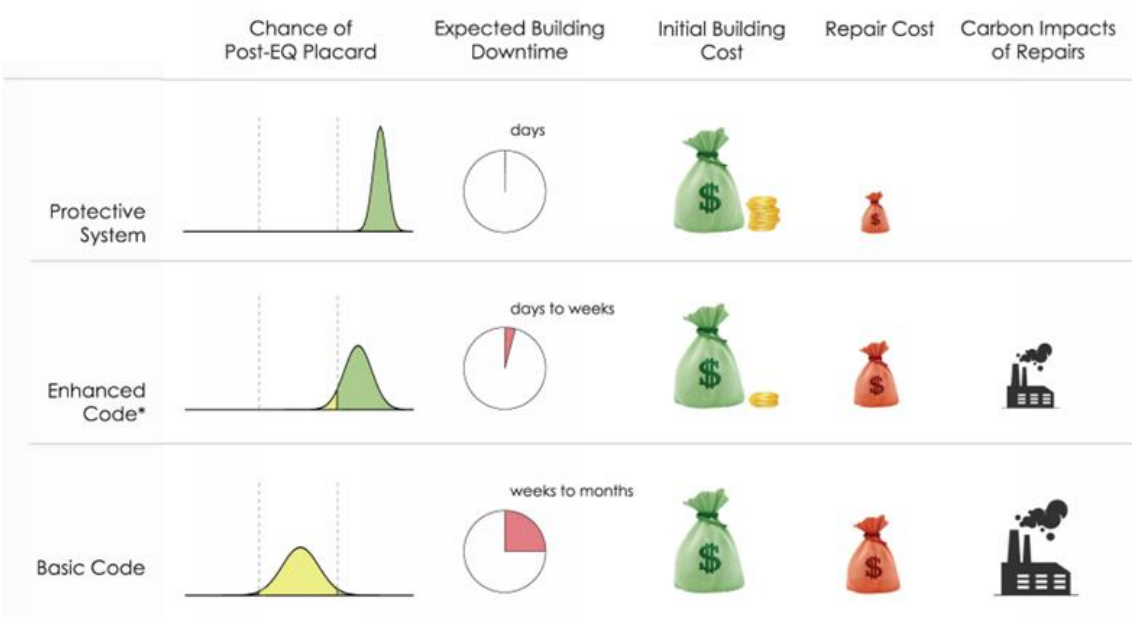

Figure 2 - Beyond Life Safety Building Performance Objective Metrics (FEMA P-58-7[8])

Our engineering profession is now equipped with the experience, policy direction, and tools to allow structural engineers to design buildings to meet the recovery goals of our clients and our communities. It is not necessary to wait for development of so-called “resilient building codes” to begin integrating these improvements in our designs. It is critical we relay these advancements to our clients so that developers, owners, and design teams wanting to do resilient design today know they can.

As a profession, we are uniquely positioned as technical experts and trusted sources of hazard awareness to lead the community resilience movement with respect to enhancing the performance of the built environment. The public’s awareness and interest in “community resilience” is changing at a rapid pace and the engineering community must adapt to keep up or risk being left behind. We must first begin by educating ourselves, our clients, the general public, and decision-makers on the expected performance of the built environment in order to meet society’s future demands.

If you are interested in joining the SEAOC Resilience Committee, please email Jonathan Buckalew (jbuckalew@nyase.com) and Anna Lang Ofstad (anna@zylient.com).

8 https://www.fema.gov/media-library-data/1557508361927-d67f745e88e04e54a1f40f8e94835042/FEMA_P-58-7_BuildingThePerformanceYouNeed.pdf