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MITIGATING RISK OF OLDER CONCRETE BUILDINGS - POLICY AND IMPLEMENTATION

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ABSTRACT

Reducing the damage and collapse risk posed by nonductile concrete buildings requires both technical and nontechnical approaches. Successful strategies consider the perspectives of the multiple stakeholders, which differ due to divergent concerns about potential consequences, tolerance for risk, available funds, and performance objectives. This panel provides various perspectives on the major policy and implementation issues that come into play when in developing mitigation strategies for nonductile concrete buildings.

Introduction

Nonductile concrete buildings pose a significant collapse hazard as evidenced in numerous earthquakes including Northridge (1994); Kobe, Japan (1995); Chi Chi, Taiwan (1999); Kocaeli, Turkey (1999); Sumatra (2005); Pakistan (2005); Sichuan, China (2008), L'Aquila, Italy (2009); and most recently Port-au-Prince, Haiti (2010). Numerous techniques exist for mitigating deficiencies in these buildings such as jacketing columns with concrete, steel or fiber wrap; adding braces; or adding shear walls; yet convincing stakeholders to invest in mitigation and to agree on an approach can be as challenging as implementing the strengthening project itself. Stakeholders include owners, tenants, architects, engineers, insurers, lenders, planners, code developers, building officials, and elected government representatives. Each has different perspectives and different responsibilities.

Policy Issues

Mitigating the risk posed by nonductile concrete buildings entails wrestling with policies for addressing the risk and decisions by owners about upgrading potentially hazardous structures. The former is problematic due to the fact that policymakers do not necessarily view this risk as a pressing problem, and they are reluctant to impose costs on building owners in mandating retrofits. The latter is problematic because in the absence of requirements for upgrades, many building owners are unlikely to take action. The challenge, then, is bringing about action given these political and economic constraints.

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The risks posed by nonductile concrete buildings present a number of public policy issues [1, 2]. There is the normative question of how paternalistic government should be in protecting citizens who do not seem to be particularly concerned about the risks. The relative obscurity of such risks in the absence of a major earthquake, and the dominance of technical experts in defining the extent of the risk, raise issues about the role of experts in shaping policy. In addition, there are questions about the design of feasible strategies for bringing about appropriate levels of risk reduction.

Nonductile concrete buildings make up a large component of the building stock in most countries of the world. In contrast, this building type is a small component of the U.S. building stock (which is 80-90% wood frame). For example, nonductile concrete buildings represent less than 1% of the building stock in California. As such, it is important to separate thinking about policies for the U.S. from those for other developed and developing nations in the world. However, even in the U.S. this issue cannot be ignored. The 1% of building area that is constructed of older concrete buildings represents well more than 1% of the total seismic building risk, which has led to a concentration of effort towards mitigation

In the U.S., we might suggest that mitigation polices for nonductile concrete could be modeled after retrofit policies for unreinforced masonry buildings (URMs) in California. However, there are some important considerations that require a different approach. First, URMs were typically built before seismic codes were developed, and they are typically small, 2-4 story buildings. The collapse hazard in URMs had been well documented, so it was relatively easy for policy makers to develop retrofit requirements for a building type that had been built before the development of modern seismic design standards. Although some nonductile concrete buildings were built in the 1920s, many were built in the 1960s and 1970s, when codes already existed. This creates a potential for "legal challenges" by owners, who would make a case against new requirements for buildings which did meet code when they were built.

The nonductile building stock is much more varied than URMs, and includes mid-rise housing, warehouses, office buildings, commercial and retail buildings as well as public buildings such as schools. Some building-use types will create "resource challenges" due to a lack of public funds for schools, or the inability to pass-through retrofit costs to residential tenants protected under rent control. Another challenge may simply be the lack of political will in a weak economy. These kinds of issues suggest that policies to improve seismic safety in nonductile concrete buildings will have to be tailored to local conditions and include incentives to encourage participation.

Owners' Concerns

In terms of decision-making by building owners about mitigating the risk, a number of constraints are evident [3, 4]. The buildings and their uses differ in size and in revenue base, which affect the affordability of retrofits and the ability to disrupt current uses. More important, building owners differ in their time horizons, tolerance for risk and uncertainty, and concern about the consequences of earthquakes for tenants. They also differ in terms of their financial ability to effect change. Believing in the necessity for change and wanting to make a change do not ensure the capacity to make a change [8, 9]. While no systematic studies have been done to test this theory, some suggest that the high cost of permits may be a hindrance to seismic retrofitting, particularly for homeowners [5]. The stakes in making decisions about risk mitigation differ greatly from those of a small business concerned about tomorrow's sales, to those of a medical office concerned about patient safety, to those of a university laboratory concerned about reliable operations.

Small businesses, for example, may not have access to the capital needed to retrofit their building, while larger businesses with multiple locations and asset types may be in a better position to acquire or tap into the capital needed to perform the requisite retrofits [8, 9]. Businesses without the wherewithal to address mandated change may decrease their economic footprint or simply go out of business, an unintended and perhaps undesired outcome. The decision to spend money retrofitting a building is one of many decisions that business owners must make in a state of uncertainty. It seems likely that decision makers will consider the full range of benefits and costs affecting the business over several alternative time periods when deciding whether to pursue a retrofit. In the end, if the decision to retrofit is perceived to threaten the life of the organization, perhaps because of costs that cannot be recouped in a reasonable time frame (e.g., the time the owner is planning to use the facility), it is unlikely to be adopted. Finally, building owners are boundedly rational [10]; they cannot consider all of the relevant alternatives because of cognitive and time limits.

While many potential obstacles stand in the way of owners' willingly retrofitting their buildings, potential facilitators are available as well. Monetary incentives that level the competitive playing field may encourage retrofit. Business leaders stating their preference for "safe" buildings may lead the way for other business owners to consider the expense of retrofitting. Institutional theory [11] suggests that businesses make decisions in part to reinforce their legitimacy, i.e., "if everybody else is doing it, perhaps we should do it too."

Architects and Engineers

The most troubling immediate challenge in the U.S. is identifying the older (pre-1980) buildings that are dangerous. There is a critical need to for efficient (and less expensive) procedures to assess collapse potential of these buildings so as to identify the particularly dangerous ones for detailed evaluation and retrofit. Current procedures (e.g. *ASCE 31*) provide valuable information with respect to potential deficiencies. However, practicing engineers have found uniformly that virtually all buildings built before the code changes of the mid-1970s will fail current evaluation procedures requiring relatively expensive detailed evaluation and retrofit. This poses a barrier for building owners who must invest substantial resources to learn if their building is truly dangerous. Furthermore, current common retrofit techniques are too expensive and intrusive, and the profession needs to develop alternatives. This situation poses a credibility issue for the engineering profession. If we raise the problem of potentially dangerous concrete buildings, we must have efficient and effective solutions.

In addition, the profession does not yet have a clear consensus on the definition of unacceptable performance. Is it purely collapse? Or should the performance definition include a level beyond collapse that would incorporate a resiliency measure?

Conclusions

Approaches to addressing the risks posed by nonductile concrete buildings must address these concerns while also considering innovative ways of inducing appropriate risk-reduction efforts. It is apparent that there is no one "best" solution. A range of policies must be considered that are appropriate to the risk (i.e., occupancy, location, value of contents). For some situations of lower risk or exposure no action may be required. For higher damage thresholds, policy proposals should focus on feasible mechanisms for encouraging mitigation based on such tools as rating schemes, markets for building services, information disclosure, and financial inducements that have proven workable as environmental tools [6]. Also relevant are institutional mechanisms (e.g. building owner coalitions, industry consortia) for advocating adoption of innovative rehabilitation measures as exemplified by the Green Building movement among commercial structures [7]. Effective mitigation policy for addressing these risks needs to expand, not restrict, the ways individuals, businesses, and public institutions meet and exceed earthquake-safety standards.

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