Towards Improving The Use Of Low-Damage Construction In New Zealand

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ABSTRACT

In the 2010-2011 earthquakes that struck the Canterbury region of New Zealand, a significant number of buildings sustained severe damage and more than 50% of commercial buildings in the CBD may eventually be demolished. The extent of damage, the cost of repairs, and business disruption has had substantial consequences on the community. This level of damage and disruption was widely seen by the community to not meet their performance expectations of buildings. The structural and earthquake engineering profession is challenged to improve community resilience to natural disasters by providing a more robust and resilient built environment. Low damage technologies are not new in New Zealand; however, mainstreaming these technologies in design has been a challenge. We have conducted a series of focus group meetings with participants representing key sectors in the building industry, including design and construction, researchers, and end users, to better understand the barriers to adoption of low damage technologies and identify potential solutions from the perspective of each stakeholder.

Introduction

Christchurch was impacted by a series of major earthquakes in 2010 and 2011. The most significant was the $M_w 6.2$ on 22 February 2011 with an epicenter only 6 km from the Christchurch Central Business District [1]. With a few notable exceptions, buildings in Christchurch met building code performance standards and survived the high intensity shaking without collapse; however the extensive structural and non-structural damage that displaced tenants, disrupted businesses, and led to huge economic losses led to questions about whether the building code provided for adequate building performance that met society’s expectations. A 2012 Royal Commission on Canterbury Earthquakes investigated the adequacy of current building and construction technologies, the performance objectives of current design standards following the earthquakes, and measures that could reduce damage to buildings in future earthquakes [2]. The Royal Commission concluded that low damage building technologies have a role to play in the rebuild of Christchurch as well as in developments elsewhere and made recommendations to help facilitate the use of these technologies.

Low Damage technologies are defined by the Royal Commission as those technologies that suppress damage to the lateral load resisting structure or limit it to readily replaceable elements [2]. Examples of such technologies include base isolation, PRESS frames, rocking

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walls, slot and hinge joints, and viscous dampers.

**Background**

The earthquake engineering profession has been slow in adopting innovative structural technologies and performance-based design procedures [3][4]. Building on the Royal Commission study, barriers to the adoption of new low damage technologies were investigated [4] and processes researched that can help facilitate the uptake of research findings in practice that have proven effective in other fields, such as medicine [5].

This paper identifies key findings from a GNS Science study on the development and use of low damage technologies by researchers, industry professionals, and end users (e.g. tenants, buildings owners, insurance providers, local governments) [6]. The objective of the study was to develop specific, actionable solutions that will help facilitate the Royal Commission recommendations to promote the more widespread use of low damage technologies and improve the resilience of New Zealand buildings and communities. Specifically, this study had three aims: (1) improve the understanding of the perceived risks and benefits of implementing low damage technologies, (2) gain greater insight into the underlying barriers to implementation and how they can be overcome, and (3) increase understanding of the marketplace for low damage products and technologies in the New Zealand context, and the role specific stakeholders can play in the uptake of these technologies.

**Method**

Three sector specific focus groups were held over the week of 13 May 2014 in Wellington, NZ with key stakeholder groups, including researchers, design professionals, and end users (e.g. city council, insurance industry, regulatory board, developers). A moderator led a discussion with each group that examined the definition of low damage technology, how information about low damage technology flows between researchers, designers and users, and the influence of market factors, regulations, and insurance. Participants were also asked about the role of low damage technologies in achieving a more resilient city and whether certain classes of buildings should be designed to achieve reduced downtime. The moderator asked designers about the challenges in learning and incorporating new technologies into building design and researchers were asked to what extent their research direction was influenced by the needs of designers and end users.

Following these focus groups, the researchers synthesized the findings by major theme and topic area. The results were then compiled to identify common barriers and solutions raised in all the focus groups, and identify areas where there was disagreement. A final focus group was held with representatives from each of the sector specific focus groups to prioritize a set of 18 key needs identified in the sector specific focus groups and develop a collective approach to implementing and addressing the prioritized needs. Meeting participants also identified key organizations that could take the lead in addressing the need, as well as important supporting organizations that should be involved. Following the ranking exercise, the group decided on several clear high priorities to discuss in more detail. After the meeting, GNS Science researchers counted the points and determined the final rankings for each priority. Each priority was assigned to four categories suggested by the focus group participants: policy, regulations,
technical guidance/training, and promotion/marketing.

Results

Six needs were determined by the participants to be the highest priority for action as listed in Table 1. See GNS report for full list of strategies and rankings [6].

Table 1 High priority needs to increase adoption of low damage construction.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Category</th>
<th>Needs</th>
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<tr>
<td>A1</td>
<td>Regulatory/Technical</td>
<td>Better integration of non-structural with structural performance in design (improved collaboration between engineers, architects and contractors).</td>
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<tr>
<td>A2</td>
<td>Policy</td>
<td>Consensus definition of low damage construction that clearly describes performance criteria and incorporates non-structural performance.</td>
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<tr>
<td>A3</td>
<td>Policy</td>
<td>Clear, acceptable performance objectives to be achieved at various hazard intensity levels within building standards/code.</td>
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<tr>
<td>A4</td>
<td>Technical/Promotion</td>
<td>General guidance documents explaining various low damage solutions, their benefits and limitations to assist building owners with decision making.</td>
</tr>
<tr>
<td>A5</td>
<td>Technical/Promotion</td>
<td>Improved understanding about how a low damage solution will behave as part of an overall system (testing needing on whole systems, not just low damage components).</td>
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<tr>
<td>A6</td>
<td>Promotion</td>
<td>Stronger market for low-damage construction.</td>
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</table>

The joint focus group discussion centered the need for a consensus definition with performance objectives and accompanying guidance documents (Priority A2-4). Participants felt that these three needs complimented each other and should be addressed together and that consistent definitions should be developed to inform three distinct audiences: (1) policy (central and local government), (2) technical (engineers, architects, general contractors, building trades), and (3) general publics (including developers, building owners, tenants, insurance, banks). Performance objectives and guidance documents should also specifically address each of these audiences. Participants felt that addressing these needs would pave the way for many of the other needs to be addressed and is a logical first step in a long-term plan. Participants agreed that the definition of low damage construction should be developed collaboratively by professional bodies and the public, be informed by the Christchurch experience, include consideration of performance related to non-structural and structural components, be solution independent, and specifically speak to policy, technical and general audiences.

The consensus definition should be used to develop clear performance objectives that meet community expectations, define desired performance from a community and individual building perspective, link performance to specific earthquake intensities or return periods, and to specific locations and seismic hazard.
Participants thought that the definition and performance objectives together could be used to inform revisions to the building code and form the basis for guidance documents directed to the three key audiences. For **policy audiences**, guidance documents should include discussion about developing incentives for key stakeholders to improve the uptake of low damage construction, including incentives for developers, building owners, engineers, and architects. For **technical audiences**, guidance documents for structural and non-structural technologies are needed that conform to New Zealand standards and are independently verified. Benefit-cost analysis at a community level can also help inform policy decisions around low damage buildings and community performance objectives. For the **general publics**, guidelines should have two objectives: (1) to increase the general understanding of the performance of buildings in earthquakes and (2) to inform decision making about owning and occupying buildings.

**Conclusions**

This study found that while there are significant barriers to overcome, increasing the use of low damage technologies in buildings would benefit New Zealand and improve the resilience of New Zealand communities. Regulators and building code developers have a significant role to play in coordinating the development of consensus definitions and performance objectives, enacting policies around performance of low damage buildings, and providing official recognition or approval of initiatives around low damage technologies so they are more widely accepted. Professional organizations as well as research centers are the primary organizations which can provide technical support and guidance to support broad policies through working groups. Participants of the focus groups recommended that the key needs be addressed by forming collaborative working groups comprised of key professionals groups and representatives from key public stakeholder groups to inform national level policy decisions.

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**References**


6. Mieler DH, Uma SR, Wright, KC. Overcoming the barriers to uptake of low damage construction: Perceptions from researchers, industry professionals, and end users. GNS Science Report 2014/38.