Revisiting the Role of Architectural Science in Design & Practice

50th International Conference of the
Architectural Science Association
7-9 December 2016, Adelaide, Australia

PROCEEDINGS

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Legislation revisited: New hope for the earthquake prone "home shop"?

ID 132

Abstract: A review of current earthquake-prone building policy undertaken by the New Zealand Ministry of Building, Innovation and Enterprise (MBIE) following the Christchurch earthquake, resulted in the Government introducing legislation to strengthen structural requirements for all earthquake-prone building to a minimum of 35% of the New Building Standard and within a time period of 15 years, and irrespective of a building location's seismic risk zone. The outcry against the original legislation led Parliament's Local Government and Environment Committee to change aspects of the Bill and call for re-submissions from the public on their appropriateness.

This paper will scrutinize these re-submissions and outline the significant changes subsequently made to the Bill as a result of this "community feedback". It will compare the resultant legislation with those countries of similar earthquake risk, specifically Japan and parts of the USA (California), and investigate the effect this new and revised legislation will have in the continued life of the small earthquake prone "home shop" unreinforced masonry buildings that make up a significant proportion of the urban fabric of the many small towns and suburban communities within New Zealand.

Keywords: Construction Technology; earthquake-prone buildings; unreinforced brick masonry

1. Introduction

Seismic retrofitting of existing buildings remains a complex and often politically difficult area for governmental authorities. Issues of heritage, construction complexity, social upheaval and financial considerations including loss of rental income, can put the building owner to considerable disadvantage and threaten the commercial viability of any retrofit project. This disruption has to be balanced against the advantages of building stock more resistant to earthquake damage, and hence a safer social environment for citizens.

Fardis (1998) acknowledges the major threat to human life comes from existing (older) buildings, however he asserts the emphasis of earthquake engineering research and of code writing efforts has been, and still is, on new construction. The reason: the redesign of an existing structure is a much more complex and technically demanding task than earthquake resistant design of a new structure. Issues of history and culture, building activity and heritage influence legislation. Adding to these factors is the issue of cost, which inevitably means, "..the vast majority of the building inventory in seismic regions worldwide is [and remains} by and large substandard and seismically deficient in the light of our current knowledge". Upgrading within a jurisdiction remains a fine balancing act between a desirable outcome and the unintended consequences of too severe an imposed timeframe (Fardis, 1998).

A 2006 OECD report suggests poor seismic retrofit outcomes can also originate from a lack of shared responsibility between national and local government, or governments and citizens, combined with weak incentives to undertake the work (OECD, 2006 p.27). Spence (2004) suggests a lack of financial incentive is a consideration. Given that the cost of seismic retrofit varies from 5-50% of the total rebuilding cost and with the return period of major earthquakes one hundred years or more, there is "..small incentive for the

building owner to make the investment worthwhile" (Spence, 2004, p.223). Wilkinson et al (2011) suggest building owners also lack trust in the ability of seismic strengthening techniques to perform under earthquake load. This lack of trust in the ability of design solutions to solve earthquake issues makes them reluctant to retrofit and strengthen.

Within this challenging social context, the New Zealand Government has embarked on the process of reform to its earthquake legislation, prompted by the events in the city of Christchurch, New Zealand's second most populated city. Here, on September 4th 2010, an earthquake of magnitude 7.1 struck the city. This was followed by another, some 6 months later on February 11th 2011, this time of magnitude 6.3. The February earthquake caused extensive damage across the city and was responsible for the deaths of some 185 people, mostly as a result of building collapse. The deliberations of The Canterbury Earthquake Royal Commission, assembled to examine the reasons for these collapsed buildings, concluded with a range of recommendations designed to improve the response of the nation to another future earthquake. These recommendations led to the introduction to the New Zealand Parliament of The Building (Earthquake-prone Buildings) Amendment Bill 2013, an amendment to the Building Act 2004, with the aim of improving methods of managing New Zealand's stock of earthquake-prone buildings (Figure 1).

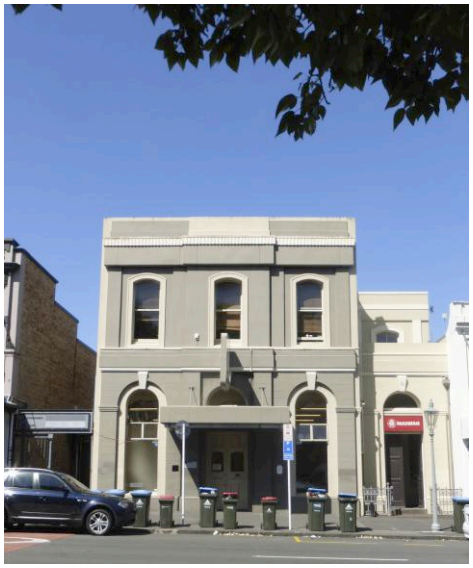

Figure 1 (Source: Author)

2. Background: Current earthquake policy

The seismic performance of existing buildings in New Zealand is managed through the Building Act, first and foremost the original Act of 1991, and latterly its successor, the Building Act 2004. The New Zealand Building Code, which contains the regulations under the Act, is a Performance Based Code, and marks a move away form the prescriptive standards based building codes common to New Zealand in the past. The performance-based regulation "establishes mandatory goals rather than enforcing prescriptive standards" and potentially offers the opportunity of achieving health, safety and environmental outcomes while at the same time promoting innovation and reducing regulatory cost (Mumford, 2010).

The path to an effective functioning performance-based system is not necessarily straight forward, as the New Zealand system has aptly demonstrated. The period of greatest building failure (in the form of leaking buildings) took place subsequent to the introduction of the 1991 Act, with the long road to remedial action beginning with the replacement 2004 Building Act, a more conservative and document (Murphy, 2011). That aside, the move to performance-based regulations is still expected in the long term to "alleviate the existence of requirements that are too complex and prescriptive, and a system unresponsive to technological change and innovation" (BIA, 1990).

Prior to the 1991 Building Act, the only national requirement for existing buildings was an Act of Parliament that required existing buildings unable to resist ½ of the forces of the 1965 Code to be strengthened. These forces were evidently very low and hence resulted in very few seismic refits. A voluntary program in the capital city Wellington (a high risk earthquake zone) resulted in the 1970s of retrofit or demolition of about 60% of the older building stock. The current regulatory system prior to the advent of this new legislation devolved much of the decision making to local authorities, with central government having a limited role in oversight and monitoring. Up until the Christchurch earthquake this process resulted in very few retrofits. The Christchurch earthquake of 2011 and the damage to existing buildings (including several "modern" buildings) that resulted from it provided the impetus for a review in earthquake policy.

As noted, giving emphasis to the need for a review was The Canterbury Earthquake Royal Commission's report on the Christchurch earthquake. The main recommendations for change included the creation of additional legislation to empower local authorities to ensure "timely improvements" in the strengthening of existing earthquake-prone URM buildings within their area of jurisdiction, and "..that the maximum time permitted to complete the evaluation and strengthening of existing buildings should be set nationally." TA problem with this was that the TAs lacked any comprehensive catalogue of earthquake buildings. The MBIE suggested in its Consultative Document that some 15000-25000 buildings would fall into the earthquake-prone category. This figure was as a very broad estimate, as only a few local authorities "can provide good data" (MBIE, 2012, p.6).

> Of the 66 local authorities, only 23 were able to provide any information on the number of earthquake-prone buildings in their districts, and much of the information received was incomplete (MBIE, 2012, p.12).

The Commission also recommended structural engineer skills in this area be improved and that a grading system be developed, capable of being understood by the general public, that adequately described the seismic performance of a building. Other recommendations of a more detailed nature gave advice on the degree of strengthening required. In general terms, to protect life safety, the Commission suggested the "shaking level" for these existing buildings be set at no less than "one third of the requirements for a new building. Where however elements of URM posed a particular threat to health and safety, that is, elements such as parapets, ornaments and external walls, that a higher level of protection would be warranted.

The Commission acknowledged some URM buildings were of historical importance but was of the view that if considered dangerous, and that demolition the only feasible option to making the building safe, then the building's status within the Historic Places Act should not prevent this demolition from being carried out (Canterbury Earthquake Royal Commission, 2012, p7).

3. The Earthquake-Prone Buildings Amendment Bill

3.1. 2013 Legislation

The Government response to the Commission's recommendations was to hold an internal ministerial policy review. It then combined its own ministry recommendations with those of The Commission and published a consultation document "Building Seismic Performance: Proposals to improve the New Zealand earthquake-prone building system: Consultation document". This document outlined the proposal options to improve the system for managing earthquake-prone buildings within New Zealand. It was released in December 2012, with submissions required on the proposals from the public by 8th March 2013. The submissions were themselves analyzed in a subsequent report: "Building Seismic Performance: Proposals to improve the New Zealand earthquake-prone building system: Summary of Submissions" (9 MBIE, 2013).

The review and the introduction of the Earthquake legislation in the form of the Building (Earthquake-prone Buildings) Amendment Bill 2013 is a move away from passive strengthening policies to active policies requiring strengthening upgrades to specified standards and within specified nationally imposed timeframes.

The legislation as initially drafted required Territorial Authorities to:

- Complete a seismic assessment of all non-residential, and multi-unit, multi-storey residential buildings in their areas "within 5 years of the legislation taking effect"
- Enter the results of these assessments into a central register of earthquake-prone buildings
- Ensure the buildings on this register are either strengthened or demolished within the 15 year specified timeframe.
- Require certain strategically placed and/or important buildings to be strengthened earlier than the national time frame.

The MBIE document acknowledged initial proposals in the legislation that specified a uniform timeframe to upgrade, regardless of the risk zone, met considerable resistance from submitters. Concerns were expressed about the "one-size fits all approach" inherent in the legislation, particularly the nationwide timeframe of 15 years for strengthening, regardless of risk.

> Whilst we agree with the retention of the current standard, the proposed timeframes and accountabilities appear too hard-hitting for our communities to absorb in any cost effective way (MBIE, 2013, p.11).

Whilst regional variation introduces complexity into legislation, submissions nevertheless suggested it was important any approach took into account such factors as seismicity, economic profile (high value, high rent versus low value and low rent), local heritage issues and the likely impact of the legislation on the local community.

3.2. The (Re)-Submission Process

3.2.1. Proposed Changes

To its credit, the Government's response to the obvious deficiencies was to make changes and invite the initial respondents to make additional submissions on the altered bill. The changes included:

- Reducing the scope of buildings covered by the bill, excluding now such structures as farm buildings, retaining walls, fences, monuments, wharves, bridges tunnels and the like.
- Lengthening the time frames for identification and remediation by categorizing New Zealand into three areas of high, medium and low seismic risk (by reference to the seismic hazard factor (Z factor).
- Requiring TAs to identify and assess only *potentially* earthquake-prone buildings within their jurisdiction (not *all* buildings as per the previous drafted legislation). This was required within a selected timeframes of up to 15 years, again depending upon seismic risk. Building thus identified would require registering on an earthquake-prone buildings register.
- Linking the remediation times for building strengthening to three seismic risk areas: High=15years; Medium 25years; Low= 35years –as against the sole time of 15 years, regardless of seismic area, operative with the previously drafted legislation.
- Defining priority buildings such as hospitals, school buildings, emergency service facilities such as fire stations, police stations and corridor buildings (building close to strategic access ways). Remediation for such buildings was to be *half* the timeframe of the seismic zone.

Provisions of the bill that were to remain largely unchanged include

- Exemption to remediate when the risk is assessed as very low.

- An extra 10 years to remediate for Category 1 listed historic places that are earthquake-prone.
- Authority for a TA (on a case by case basis) to grant building consent for an upgrade without requiring upgrades to the means of escape from fire and access and facilities for persons with disabilities.

3.2.2. 2015 Re-submissions

A Total of 121 submissions were received, with 48 late submissions (23 July 2015) specifically commenting on the proposed changes put forward by Cabinet. The stakeholder ratios are as per Table 1.

3.2.3. Timespans

A sizable minority (44%) specifically supported the general thrust of the changes, in particular remediation time extensions relative to seismic risk, even though they may have had reservations about other parts of the Bill.

> The proposed approach would be proportionate to risk and recognizes that for low risk zones, buildings would likely be replaced or significantly re renovated during the next 35 years regardless of earthquake requirements, meaning property owners would save money (Property council, 2015).

Table 1. Late Submission Breakdown

Stakeholder	Percentage
Individual	42%
Building Owners	18%
Local Government	10%
Architects and Engineers	10%
Others	20%

3.2.4. Priority buildings:

The original Bill proposed faster time frames for "priority buildings" regardless of seismic zone. Amendments proposed These priority buildings be limited to hospital and school buildings, emergency service facilities (eg police stations) and corridor buildings and restricted to areas of high and medium seismic risk.

A number of submitters (33) suggested shortening the timeframes for the strengthening of certain parts of unreinforced masonry buildings (such protrusions as verandas or parapets) due to the hazard such protrusions posed. The submission by Ann Brower, a sole survivor within a bus destroyed by falling building work in the Christchurch earthquake, seem to find particular favour with officials, with her suggested changes incorporated into the final Bill.

> Government should create a separate category for non-structural unreinforced masonry- parapets, gables, and chimneys- because: a. They are the cheapest to fix; b. They are the first to fall; c. They are the deadliest when they do fall…
>
> Fixing parapets, gables, and chimneys first would make the Bill more equitable for towns at lower earthquake risk. Fixing the most dangerous and least expensive bits first might render unnecessary the full building strengthening. (Ann Brower, 2015)

3.2.5. Definition of earthquake-prone

Most Territorial Authorities supported the definition of earthquake-prone as being a percentage less than 35% of the New Building Standard. A range of Engineering organizations, including GNS Science, and individuals took exception to the definition and asserted any definition realistically had to be linked to seismic risk and occupancy.

> Consideration must be taken for the occupancy rate of each specific building when determining its rating since it is clearly stated that the objective of the Bill is to protect people from injury or death from building failure during a future earthquake (GNS Science, 2015)

Ian Harrison's submission reiterated the belief outlined in his original submissions that the definition threshold is overly conservative and that it should be more closely defined in relation to a buildings potential for collapse, which in turn links it to seismic risk. A building in Auckland (low risk) is hence likely to be overly strengthened as against an equivalent building in Wellington, given the difference in risk levels between the two centres.

3.2.6. Low risk exemptions

This section did not arouse much comment, although GNS Science thought the now exemptions for such structures as farm buildings, bridges, retaining walls and tunnels, included in the original legislation, was a backward step. Most were realistic in their assessment however that such structure presented little risk to the public in the event of an earthquake.

3.2.7. Heritage Issues

Category 1 building so registered under the Historic Places Act 1993 can apply to the territorial authority for extensions of time for remediation of up to 10 years. 18 submitters (including eight territorial authorities) suggested the definition of heritage be widened. This would have had implications for the typical "home shop" building, typically of URM and the focus of this paper. Such buildings remain particularly vulnerable should this legislation be enacted as the vast majority is not, with few exceptions, of Category 1 heritage status.

3.2.8. Upgrade requirements

The Bill amends the Building Act 2004 and enables Territorial Authorities to allow dispensation in certain situations from the overall requirement to upgrade fire and egress requirements, and access and facilities for persons with disabilities when altering or upgrading the building to comply with earthquake strengthening requirements.

As could be expected, the discretion caused much comment. Thirty submitters supported the provision with 37 opposed. Supporters included organisations such as the Property Council, Local Government NZ and Historic Places Aotearoa. Dissenters included disability groups, and Human Rights Commission and several individual submitters.

> Article 9 of Convention of the Rights of People with Disabilities...requires States to take appropriate measures to ensure that disabled people have access, on an equal basis with others…(Human Rights Commission, 2015)

3.2.9. Financial incentives

A number of late submissions continued to call for financial incentives to lessen the burden on building owners required to remediate their buildings, even though this was not addressed in the changes to the Bill. This issue is particularly relevant for the small town low value and low rent "home shop" URM building where the loan-to-value ratios would all but rule out bank finance.

Auckland Council suggested "…Government grants for the upgrade of structures of significance, such as those of particular heritage value" and or that the "cost of a seismic retrofit to be deemed 'repairs and maintenance' rather than 'capital expenditure' for tax purposes (Auckland Council, 2015).

> Where territorial authority or other government support is not forthcoming, and the owner unable

or unwilling to remediate, then demolition of the building, with subsequent loss of streetscape heritage, remains the only viable alternative.

4. International seismic retrofit policies

New Zealand's attempt to instigate a more active national policy for Earthquake-prone buildings can be compared to other earthquake sensitive jurisdictions, particularly Japan and parts of the United States, notably California.

4.1 Japan

In Japan the increased cost of natural disasters, in particular the destruction caused by the Kobe earthquake has led to a revision of the building code to performance-based regulations, a measure similar to the introduction in New Zealand of the national performance based building code in 1991 (Ghobarah, 2001, p.878). The expectation is that the introduction of these performance-based requirements in Japan will assist with more flexibility in the area of local authority control and leave more room for innovation in design and material use. (Otani) Prior to the Kobe earthquake, seismic retrofit was given low priority Japan with a recent OECD report indicating an estimated 30% of the total building stock remain constructed according to outdated codes and standards (OECD, p.270). Whilst it is a leader in seismic hazard mitigation technology for new buildings, the national building code does not provide for existing buildings, except when structural members are changed or there are additions to the building. Unlike California et al, there is also no code requirement for strengthening where a change of use is proposed, and unlike the legislation currently proposed for New Zealand, no mandatory requirements to strengthen or mitigate the specific earthquake hazards in URM building, with the decision to upgrade left to the owner, who may determine the seismic force level for which the retrofit is to be designed (Kikuchi, 1992).

The introduction of the "Law Concerning the promotion of the Improvement of Earthquake- Resistant Construction" after the Kobe earthquake has also come, unlike New Zealand's legislation, with supporting financial aid for seismic retrofit of buildings such as apartment houses, offices and schools and later in 2002, houses (Yamomoto, 2005). The financial aid is modest, estimated between the range 13-16 percent, but combined with other incentives such as reduced housing loans taxation and reduced interest rates from the Housing Loan Corporation, presents a monetary incentive for an owner to upgrade, an incentive currently missing from the New Zealand legislation (OECD, p.28).

4.2 California

The Uniform Building Code (UBC) operating in California contains only one passive "trigger" and no clear active triggers for the seismic upgrade of existing buildings. The passive trigger is a change of use in the building, with discretion given to the building official to determine that the change of use is to a more hazardous occupancy. Most cities within the area have instigated additional regulations however that reflect the communities concern over safety issues associated with existing buildings, especially those constructed in URM. In this sense suggests Hoover, California continues "..to be a leader within the USA in the field of seismic mitigation." (California Seismic Safety Commission (CSSC), 2001, p.1). The active "triggers" require seismic retrofitting for certain building types, with the state mandating that the seismic hazards of unreinforced masonry buildings (URMs) in particular must be mitigated in a proactive manner, particularly in the area of parapet hazards, where the parapet upstand has often deteriorated and is not well secured to the structure. All regional building codes offer a standard for the seismic strengthening of URM buildings –viz. the Uniform Code for Building Conservation. The policy hence has similarities to the just passed legislation for URM buildings in New Zealand. Unlike New Zealand however, which is implementing a national policy with specific timeframes and retrofit requirements, there is within California a wide variation in the standards utilized within the different cities making up the Zone 4

earthquake area (the zone of highest risk). This is an unfortunate situation says Hoover, resulting in "..an uneven level of life safety between jurisdictions, unfair requirements of building owners, and inequitable economic competition between jurisdictions." [CSSC, 2001, p.2). There is a strong need, suggests Hoover (1992), for "uniform life safety standards for the assessment and retrofitting of existing buildings." The New Zealand nation-wide policy of seismic retrofitting regulations for earthquake-prone buildings would hence be seen by Hoover as a desirable outcome in the task of providing minimum life safety for building users in California.

The issue of compulsory retrofit within a specific timeframe remains a challenge in California, where for example, the issue of hospital seismic safety with a specified timeframe, imposed by a Senate Bill in 1994, comes up against the social consequences of demolition and closure for non complying buildings not capable, through lack of funds, of meeting the requirement to "survive earthquakes without collapsing or posing a threat of significant loss of life." (CSSC, p.2). In these more urgent cases the recommendation is for public funding for genuine hardship, but with a recommendation "to encourage new construction over retrofitting." (CSSC, p.5).

4.3. Other earthquake jurisdictions within the USA

Most other states adopt the Uniform Building Code (UBC) as the core state code, with many adding additional and different requirements beyond the sole UBC "change of use" trigger for seismically retrofitting existing buildings. Utah for example, home to the Wasatch fault has, within the city of Odgen, an ordinance requiring braces and wall anchorage for URM parapets, was well as snow load analysis, whenever a URM building is reroofed (Reaveley, 1992). Other jurisdictions have equally unique variations. Washington, whilst it adopts the UBC as its state code, requires a structural retrofit if there is extensive structural repair, a major re-modeling to extend the life of the building, a change in occupancy to a more hazardous use or has been vacant for more than a year (Hoover, 1992, p.72).

5. Conclusion

The seismic retrofit performance of existing building can be a vexing one for countries prone to earthquakes. New Zealand is no exception.

Policy makers, suggest Fardis, hope that the problem of substandard existing buildings will be solved by gradual attrition. The reality is that to bring these buildings up to the standard of new construction is very difficult and hence very expensive. Fardis suggests the trend is hence to accept "significantly lower performance requirements of existing or rehabilitated buildings, relative to those implicit in current codes for new buildings." The basis of this pragmatic attitude is not the presumably shorter remaining service life of an existing building but the recognition of the "higher cost of seismic retrofitting in comparison to new construction." (Fardis, p.131).

The OCED report suggests retrofitting should be encouraged with "a mix of regulatory obligations, incentives and support through public funds." Whilst the benefits of retrofit are evident, the process is a lengthy one and costs "may in some cases equal reconstruction." Research effort then, suggests the OECD report should be directed towards identifying cheap and rapid retrofitting methods (OECD, p.29).

Changes to the Bill have eased the burden for the small home shop and its owner. Time frames have been extended, especially for buildings in medium or low risk seismic zones. The TAs role is less onerous, with only potentially earthquake-prone buildings requiring identification and classification, and with more time to achieve this classification. Priority buildings still have a shortened time frame to remediate (half that of the seismic zone), but there is no blanket "one off" nationwide time span now required. A greater number of low risk buildings have been excluded from the provisions of the legislation, lessening the burden on farmers, owners of non-occupied structures (such as monuments) and civil support structures such as bridges. Moderate alterations to the building will still trigger the need for a seismic upgrade, but accessibility and fire egress requirements can be dispensed with (to the annoyance of some submitters) if the TA can be persuaded to agree with the view that such compliance is unreasonable.

The suggestion by Ann Brower and others for a separate category for non-structural unreinforced masonry parapets, gables and chimneys within all buildings, and for these appendages to be fixed first, would meet the "cheap and rapid retrofitting methods" recommended by the OECD.

> Fixing the parapets first would make the Bill more equitable for towns at lower earthquake risk. Fixing the most dangerous and least expensive bits first might render unnecessary the full building strengthening. …the benefits of fully retrofitting all 9794 buildings in Auckland below 33% of code are minimal, and far outweighed by the costs…If we fix the deadliest and cheapest first, we'll get the greatest safety bang for the retrofitting buck (Bower, 2015).

The legislation has partially accommodated her suggestion. Appendages such as the veranda and parapet require now require strengthening as a "priority" and within the priority time frame, *but only if* the building is on a high use pedestrian corridor. The legislation still insists on the full strengthening retrofit to be achieved by the particular timespan. Here the New Zealand legislation differs from other jurisdictions. The element of compulsion for full strengthening to the 34% NBS still remains, albeit to extended timeframes that better reflect the zone and hence level of risk.

No financial support has been offered to the building owner, another OECD recommendation; yet there are considerable penalties for failure to complete remediation by the deadline and a fine of up same amount, imposed by the TA, for failing to comply with safety requirements. Such an approach is contrary to Japanese policies and OECD recommendations and is likely to cause wholesale demolition of the small URM buildings in provincial areas, where values are relatively low and financial and insurance costs outweigh rental benefit likely from any strengthening.

Retrofit policy, suggests the OECD, needs to be carefully evaluated for its effectiveness. Passive policies may result in little change. More actively focused policies, such as currently before the New Zealand Parliament, may result in the wholesale demolition of buildings that are meeting quite satisfactorily the requirements of the local community, with subsequent loss of streetscape heritage and cultural value. That scenario should be avoided at all costs.

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