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TO STRENGTHEN OR DEMOLISH: THE FINANCIAL CHALLENGES FACING UNREINFORCED MASONRY BUILDINGS IN NEW ZEALAND

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Abstract *Auckland, New Zealand's largest city continues to be dogged by both the high cost and short supply of domestic housing. A combination of high immigration, high material costs, a lack of forward planning at both Governmental and Local Authority level and a shortage in the number of qualified tradespersons has placed considerable pressure on the domestic housing market, ensuring an ongoing shortfall in the number of suitable building stock to meet population requirements. Compounding this building pressure is an impending workload from legislation recently passed that will require the strengthening of all earthquake suspect buildings to a minimum of 35% of the New Building Standard, within time periods ranging from 15-35 years and irrespective of the earthquake zone within which the building is located.*

It will examine, through a series of case studies, the financial implications the legislation will have on the continued life of our small-scaled earthquake prone "home shop" unreinforced masonry buildings, many of them heritage buildings that make up a portion of the urban fabric in the many small towns and suburban communities within New Zealand. The "home shop" identifies a particular of style of Edwardian building built largely between the 1880s and 1930s, where the building owner was also the retailer who lived on the premises, usually in accommodation on the upper floor. These buildings number in the hundreds, and the financial and physical resources needed to implement this strengthening regime, assuming economic feasibility, will add further stress to the already stretched building industry and alter irrevocably the urban fabric of many of New Zealand's towns and cities.

1. INTRODUCTION

This paper addresses the issues around the financial implications for owner/operators to comply with the strengthening requirements required by The Building (Earthquake-prone Buildings) Amendment legislation, passed in 2016 by the New Zealand government. 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 the nation's building stock more resistant to earthquake damage, and hence providing a safer social environment for its citizens.

A 2006 OECD report suggests poor seismic retrofit outcomes often originate from a lack of shared responsibility between national and local government, or governments and citizens, combined with weak incentives to undertake the work [1]. Spence suggests a lack of financial incentive is also 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" [2]. Fardis acknowledges the major threat to human life comes from existing (older) buildings. He asserts however, the emphasis of earthquake engineering research and of code writing efforts has been, and still is, on new construction. 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 [3]. Wilkinson *et al* suggests a lack of trust in the ability of seismic strengthening techniques to perform under earthquake load is another impediment denting building owner's enthusiasm to retrofit and strengthen [4].

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 [5]. These recommendations led to the introduction to the New Zealand Parliament of The Building (Earthquake-prone Buildings) Amendment Bill, an amendment to the Building Act 2004, with the aim of improving methods of managing New Zealand's stock of earthquake-prone buildings.

3. INTERNATIONAL SEISMIC RETROFIT POLICIES

New Zealand's difficulties in attempting 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.

3.1 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 [6]. 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 [8]. 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 [1]. 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 unreinforced masonry (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 [8].

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 [9]. 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 [1].

3.2 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" [10]. The active "triggers" require seismic retrofitting for certain building types, with the state mandating that the seismic hazards of unreinforced URM buildings 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" [10]. There is a strong need, suggests Hoover, for "uniform life safety standards for the assessment and retrofitting of existing buildings" [11]. 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." In these more urgent cases the recommendation is for public funding for genuine hardship, but with a recommendation "to encourage new construction over retrofitting" [10].

3.3. 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 Ogden, an ordinance requiring braces and wall anchorage for URM parapets, as well as snow load analysis, whenever a URM building is reroofed [12]. 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-modelling 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 [11].

4.0. FINANCIAL IMPLICATIONS –CASE STUDY

To demonstrate the financial implications of the upgrade three case study scenarios estimating likely costs for the strengthening of a typical small scaled URM building for different parts of New Zealand are outlined. The strengthening is designed to take the building from an existing estimated level of 19% of the New Building Standard (NBS) to 34% of NBS, the minimum allowable under the new legislation for earthquake-prone buildings. Costs would be rated against rental values subsequent to any upgrade and the viability of the resultant financial situation accessed. The plan form chosen is that of an existing building located in the inner-city suburb of Mt Eden, a prosperous secondary rental location with a street heritage substantially effected by the legislation. The plan areas are typical of such buildings, with prime ground floor retail space of a limited size, ancillary spaces to the rear of the ground floor (storage) and the upper floor area, originally given over to “home shop” accommodation for the owner and family, but now predominantly used for a variety of activities, either related to the shop activity or sublet to other tenants.



Figure 1: Mt Eden URM Building

4.1 Case Study 1: Auckland

For the Auckland case study rental values were based on valuations for the building and other equivalent building valuations from similar areas. Summary values are indicated in Table 1. Building costs were derived from Contractor estimates. Auckland is a low risk earthquake zone. Strengthening is required within a 35year time zone.

Table 1. Rental Value and Building Strengthening Estimates –Auckland

Location	Area sm.	Rental Value \$	Estimated Upgrade Cost Excl. Tax \$
Ground floor	65.00	680.00psm-\$44,200	220,000.00
Rear ancillary area	38.33	250.00psm-\$9,582	80,000.00
First Floor	77.22	170.00psm-\$13,127	120,000.00
Total	~180.00 sm	~\$67,000.00	\$450,000.00

4.3 Case Study 2: Dunedin

The region is renowned for its heritage structures. The location remains a low-risk earthquake zone, and hence any strengthening requirements are required within the 35 year time frame. Rental values for similar URM structures in prime retail location are estimated as high as \$450-475, with secondary fringe city retail location estimated on average \$200-\$250 per square metre for ground floor retail. Building rates are again assumed as marginally cheaper than the Auckland rates, with savings to undertake the same amount of construction upgrade in the order of \$50,000.00.

Table 2: Rental Value and Building Strengthening Estimates –Dunedin

Location	Area sm.	Rental Value \$	Estimated Upgrade Cost Excl. Tax \$
Ground floor	65.00	455.00 psm \$29,614	220,000.00
Rear ancillary area	38.33	165.00psm \$6,324	80,000.00
First Floor	77.22	114.00psm \$8,795	100,000.00
Total	~180.00 sm	~\$45,000.00	\$400,000.00

4.2. Case Study 3: Suburban Napier

The region is renowned for its heritage structures, many of which were upgraded as a result of the 1931 Napier earthquake. The location remains a high-risk earthquake zone, and hence any strengthening requirements are required within the 15year time frame. Rental values have been estimated from real estate data for a secondary fringe city retail location and have been estimated in the region of \$150-160 per square metre. Building rates are marginally cheaper than the Auckland rates, with savings to undertake the same amount of construction upgrade in the order of \$50,000.00

Table 3: Rental Value and Building Strengthening Estimates -Napier

Location	Area sm.	Rental Value \$	Estimated Upgrade Cost Excl. Tax \$
Ground floor	65.00	400.00psm -\$26,100	220,000.00
Rear ancillary area	38.33	125.00psm-\$4,791	80,000.00
First Floor	77.22	85.00psm-\$6563	100,000.00
Total	~180.00 sm	~\$37,500.00	\$400,000.00

4.4. Findings

The conclusions from the case study investigation can best be illustrated by reference to Table 4 below. Bank finance costs, interest only, at 5.8% is assumed across the total upgrade cost. An improved lease/rental ability factor of 10% is assumed subsequent to strengthening.

Table 4. Cost breakdown summary analysis

Item	Auckland \$	Dunedin \$	Suburban Napier \$
Existing Rental income p.a.	67,000.00	45,000.00	37,500.00
LESS Bank finance costs p.a. (Interest only)	(26,100.00)	(23,200.00)	(23,200.00)
PLUS, Improved lease ability (10%)	6,700.00	4,500.00	3,750.00
Gross rental income p.a. after deduction of strengthening costs	47,600.00	26,300.00	18,050.00
Income LOSS due to strengthening p.a.	(19,400.00) -29%	(18,700.00) -41%	(19,450.00) -52%
VALUATION LOSS (Cap rate prior%/after%)	24% (7.5%/7%)	38% (8%/7.5%)	47% (10%/9%)

Rental income is gross excluding Tax and assumes costs for rates and insurance is the responsibility of the tenant. The results indicate an effective nett income reduction and valuation loss ranging from 26% in the Auckland, to a significant 47% for suburban Napier. All locations suffer loss of income. The most extreme loss related to value situation remains the Suburban Napier example, with income reduced from an estimated gross income of \$37,500 to an effective \$18,050.00 p.a. after strengthening costs are added against gross income. For properties such as this, the final return of \$18,050, and assuming a cap rate of 10%, reduces the book value of the property from an original \$375,000 to \$200,000, a loss in valuation in the order of 47%. If per annum maintenance costs are included, say \$6000.00, the effective nett rental profit *before* tax would be in the order of \$12,050.00 p.a., a sum that equates to a return on the original investment of 1.5%, less than an equivalent Bank term deposit.

5.0. CONCLUSIONS

The case study exercise demonstrates the difficulties facing building owners in their obligations to meet the requirements of the new legislation. In the Auckland example, high rental values ensure this case study remains the financially least effected by the legislation. However, the high value of land in similar inner city suburban locations and the prospect of a greater building intensification under new zoning regulations could present an attractive alternative in favour of demolition over retrofit and strengthening. In other outer suburb fringe areas, such as Otahuhu or Papakura, the decision as to what direction to proceed is less clear.

The Dunedin case study results in a significant effective valuation loss for the owner (38%), given the bank finance and resultant interest costs that would apply subsequent to any strengthening. The attractiveness of the demolition and redevelopment option would obviously depend on location and would need to be assessed on a case by case basis. With property and rental values considerably less than for an equivalent example in Auckland, the decision to proceed in this direction would require greater scrutiny and assessment of costs before any decision was made.

In the suburban Napier case study, the income loss (52%) and resultant nett income would render the retrofit and strengthening option marginal at best. Demolition is a likely option. Where such suburban centres are viable, the possibility exists that the vacant site will eventually be redeveloped. Where not, and for many small-town suburban centres with a falling population base, the prospect of long term gaps in the streetscape is a distinct possibility unless financial support is provided. The Auckland Council's submission to the original legislation recognised this dilemma and suggested that "bank loans be guaranteed for owners needing to upgrade buildings and for the cost of a seismic retrofit (just that component) be deemed 'repairs and maintenance' rather than 'capital expenditure' for tax purposes" [13]. To date, with the exception of minor government loan advances for parapet and veranda repairs to buildings in high earthquake zones requiring immediate repair, this funding has not been forthcoming, yet there are considerable penalties for non-compliance. These include a fine of up to \$200,000 if the seismic work is not completed by the deadline and a fine of up to the same amount for failing to comply with safety

requirements imposed by a territorial authority. Such a scenario will present difficulties in the quest to preserve the heritage streetscapes the presence of these small urban URM brick “home shop” buildings currently achieve.

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