

MANDATORY SEISMIC RETROFITTING – A CASE STUDY OF THE LAND USE IMPACTS ON A SMALL PROVINCIAL TOWN.

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ABSTRACT

As a result of the Christchurch Earthquake that occurred on 22nd February 2011 and the resultant loss of life and widespread damage, a Royal Commission of Enquiry was convened in April 2011. The Royal Commission recommended a number of significant changes to the regulation of earthquake prone building in New Zealand. Earthquake prone buildings are buildings that are deemed to be of insufficient strength to perform adequately in a moderate earthquake. In response to the Royal Commission recommendations the New Zealand Government carried out a consultative process before announcing proposed changes to the building regulations in August 2013. One of the most significant changes is the imposition of mandatory strengthening requirements for earthquake prone buildings on a national basis. This will have a significant impact on the urban fabric of most New Zealand towns and cities. The type of traditional cost benefit study carried out to date fails to measure these impacts and this paper proposes an alternative methodology based on the analysis of land use data and rating valuations. This methodology was developed and applied to a small provincial town in the form of a case study. The results of this case study and the methodology used are discussed in this paper.

Keywords: Mandatory seismic retrofitting, earthquake-prone buildings, land use impacts, Case Study

INTRODUCTION

The purpose of this research was to develop and test a method of measuring some of the likely social and economic impacts of the changes to the Building Act 2004 proposed by the New Zealand Government in response to the Christchurch earthquakes. The New Zealand Government is proposing to make it mandatory for the owners of earthquake prone buildings to either strengthen or demolish their buildings within 15 years of being identified as being earthquake prone. Earthquake prone buildings are defined as buildings that will have their ultimate capacity exceeded in the event of a moderate earthquake and are buildings with a seismic capacity of less than 33% of new building standard (NBS).

Earthquake mitigation measures such as seismic retrofitting of existing buildings are seen as a rational response to the risk posed by earthquakes. Evidence from past studies on hazard mitigation suggest that seismic retrofitting of earthquake prone buildings (EPBs) reduce loss of life and property, disaster relief costs, business interruption, and social and environmental losses from an earthquake disaster (Nutti and Vanzi 2003, Rose *et al.* 2007). However, despite these benefits and the growth of the technical knowledge base on earthquake risk mitigation, property owners are often unwilling to retrofit their EPBs (Hopkins 2005). The unwillingness of owners of EPBs to retrofit their EPBs has been a critical issue in earthquake pre-disaster planning and management. Many factors such as cost, risk perception and efficacy of mitigation measures interact to influence seismic retrofit decisions (Egbelakin and Wilkinson 2010, Lindell and Prater 2000a).

Studies in the social, economic and decision sciences have sought to address this dilemma from different perspectives. Many socio-psychologists have focused on the impact of risk perception on mitigation decisions, concluding that how people perceive and personalise earthquake risk significantly influences the types of protective decisions and behaviour adopted (Lepesteur *et al.* 2008, Lindell and Prater 2000b, Lindell and Prater 2002, Mulilis and Duval 1995, Tierney *et al.* 2001, Weinstein *et al.* 1998).

Sociologists have studied the social aspects of earthquake risk mitigation. The idea that risk is essentially a cultural and social construct has been strongly argued by sociologists such as Douglas and Wildavsky (1982). As they put it “the measurement of risk is scientific, the acceptability of risk is political”. The drive to reduce risk and make society safe is thus a phenomenon that has been the subject of a substantial body of research by sociologists. Sociologists have studied the way in which society has perceived and responded to risks through time and have shown how attitudes to risk have changed. In early times risks were perceived as something largely outside the control or understanding of man. Religion and superstition were central to the way people thought about and mitigated for risk. Risks were often seen as an act of god, fate or magic. Mitigation required rituals, sacrifices and religious observance. Elements of this attitude or world view can still be seen in societies that are deeply religious (Ghafory-Ashtiany, 2009) where a fatalistic attitude to earthquakes acts as an impediment to modern seismic mitigation. Starting with the age of enlightenment a new paradigm in terms of risk began to be accepted in western society. Risk came to be seen as a calculable mathematical probability that could be measured. The science of statistics was developed and has been applied to hazard assessment. Risks have become statistically predictable and therefore to some extent manageable with actuarial calculations providing a foundation on which to base insurance. The concept of risk also became increasingly important to the finance discipline with Frank Knight establishing the important distinction between risk (which can be measured) and uncertainty (which is immeasurable).

Recent research in New Zealand (Egbelakin and Wilkinson 2010, Egbelakin *et al.* 2011) has looked at the importance of behavioural and social impediments to the successful implementation of earthquake mitigation. They found that although the level of awareness was high amongst building owners that were surveyed there was limited appetite for carrying out seismic retrofitting. Perceptions regarding high cost and low benefits relating to seismic retrofitting were impediments, as were a lack of trust and belief in seismic techniques and professionals. The influence of multiple stakeholders in the seismic mitigation decision making process was also found to be important.

Researchers have also found that quality of risk information provided to owners, communication style, and characteristics of the agencies responsible for conveying this information affect building owners' willingness to adopt protective measures (Mileti and Fitzpatrick 1993, Mulilis and Lippa 1990, Pidgeon *et al.* 2003, Tierney *et al.* 2001).

Economists have focussed on the financial viability of valuation decisions and policies regarding hazardous situations, providing a rationale on the overall economic benefits of implementing various mitigation measures (Bernknopf *et al.* 1990, Cohen and Noll 1981, Schulze *et al.* 1987). Various studies on earthquake risk and property market prices found correlations between risks information and communication style, property values, location, government initiated policies and programs, house prices, investment decisions and owners' attitudes towards implementing mitigation measures (Beck *et al.* 2002, Onder *et al.* 2004, Palm 1985, Palm 1987, Willis and Asgary 1997).

Seismic retrofit decisions emphasised the reduction of the built environment's earthquake vulnerability (EERI 1998), while property investment decisions are based on ensuring that an investor achieves a satisfactory return on his investments in the market place in form of an income flow or capital gain or a combination of both (Adair *et al.* 1994). Arguably, various stakeholders, including property owners, investors, developers, occupiers, valuers, insurance and financial institutions, governmental agencies and hazard-related professionals contribute to property investment and earthquake risk mitigation decisions (Lindell *et al.* 1997, Luke *et al.* 2010). These stakeholders operate at different levels in the public and private sectors, having varying impacts on building owner's risk mitigation decisions (Lindell *et al.* 1997). It is also clear is that there are a number of other stakeholders either influencing or affected by the seismic retrofit decision. The occupier of the building (if different to the owner) is interested in the use value and especially in matters affecting business productivity and operating costs such as appearance, comfort, safety and energy efficiency. The need for employers to provide a safe working environment for their employees under the Health and Safety in Employment Act may well drive potential occupiers away from earthquake-prone buildings. Most building occupiers are generally unaware of the property's seismic risks, unless issues regarding the building safety are raised (Butcher and Cooper 2004).

Losses from natural disasters can have a severe impact on an insurer's financial situation. An insurer may limit coverage in any given area or charges higher premiums in order to keep the likelihood of insolvency at an acceptable level (Lindell *et al.* 1997).

The prevalence of similar stakeholders in property investment and seismic risk mitigation decisions suggests similarities and overlaps in both decision-making processes, such as making investment and retrofit decisions simultaneously at the time of purchase or construction. Other similarities include the impacts of real estate market conditions and level of uncertainty and risks associated with both decisions (Asgary and Willis 1997).

However, Bradley *et al.* (2008) explained that retrofit and investment decisions of existing buildings are usually considered individually, such that strengthening cost are not usually factored into property prices and investment decisions. Langston *et al.* (2008) highlight the need for a transformation in the traditional decision-making processes of property stakeholders towards more sustainable practices, strategies and outcomes.

In dealing with the risk relating to earthquakes there is clearly a scientific element relating to the need to study a natural phenomenon. However, what is an acceptable level of risk for society is a subjective and political question. In order to aid policy development and insurance underwriting a large body of literature has been produced by experts in the fields of engineering, insurance, and economics. In particular a lot of effort has been put into improving the field of hazard assessment and various types of cost-benefit analysis (CBA). Earthquakes are low probability but high consequence events. The challenge of calculating the probability of earthquakes occurring and of then estimating their likely impact has received a lot of attention from both the insurance industry and earthquake engineers (Cardona *et al.* 2008a, Cardona *et al.* 2008b, Vanzi 2002, Bommer 2002).

In New Zealand a mathematical model was developed by Hopkins and Stuart (2003) which calculated the benefit-cost ratio for 32 cities and towns in New Zealand using 18 input variables. The methodology used in this paper was then recommended by central government to be used by Territorial Local Authorities (TLAs) when preparing their earthquake prone building policies as required by the Building Act 2004. Thus this paper is highly significant though it would appear that very few TLAs actually followed the methodology when preparing their earthquake-prone building policies. It is interesting to note that this paper identified that earthquake risk varies substantially around NZ and this resulted in benefit-cost ratios ranging from over 6 to .01 – a ratio of 600 to 1. The paper concluded that account needs to be taken of the wide range of benefit-cost ratios in framing legislation governing earthquake risk buildings. This finding is also confirmed by the work of Cousins (2013) who calculated the probability of dying in an earthquake in different locations in New Zealand with high, medium or low seismic hazard. He concluded that there was more chance of dying in a compliant modern building in Wellington than in an un-strengthened URM building in Auckland and therefore that it is difficult to argue a case for blanket strengthening all old URM buildings in places of moderate to low seismic hazard.

Any CBA is reliant on the gathering of accurate data and sound scientific assumptions. This is particularly the case for low probability but high consequence events such as earthquakes. A traditional CBA has been applied as part of the policy development undertaken by the New Zealand government. This CBA (Martin Jenkins, 2012) calculated the present value of the benefits of strengthening which were then compared with the present value of the costs to arrive at the Net Present Value (NPV). The results of this study showed that the government proposals have a NPV of negative \$1,680 million compared with the current 'status quo' which has a NPV of negative \$933 million. The benefits were assessed as reduced building damage, and a reduced loss of life and injury. The analysis was done on a macro level with no attempt to split out the private and public components of the costs and benefits or to consider the costs and benefits on an individual building basis.

Any attempt to carry out CBA on seismic retrofitting buildings in New Zealand is currently hamstrung by a lack of good data relating to existing building stock and the costs of retrofitting. There has been significant research done on building performance (Ingham and Griffith, 2011), and retrofitting techniques (Goodwin *et al.* 2011), but basic information relating to earthquake strengthening costs is lacking in relation to New Zealand with the exception of some work done by Hare (Hare, 2009). Hare analysed the costs of seismic retrofitting a sample of

heritage buildings in Christchurch. The general lack of cost information was highlighted in the Royal Commission and appears to contrast with the situation in the USA where extensive research has been done by the Federal Emergency Management Agency (FEMA, 1994).

Cost benefit analysis tends to be on a macro level being either national, regional or city scale using methodology that looks at the total benefits and costs with no attempt to consider to whom the benefits accrue or who must bear the costs of the mitigation.

While this may be useful in terms of the insurance industry and policy analysts it fails to address the benefit to cost ratio from a building owner perspective. For many owners this ratio is negative and is a major impediment to both voluntary and mandatory seismic retrofitting as discussed by Nahkies (Nahkies, 2009, Nahkies, 2013). Although this problem has been highlighted in the media, professional publications and submissions to the government review there remains a lack of empirically based academic research in this area. This paper attempts to gather empirical evidence on the feasibility of earthquake strengthening from the perspective of the owner using readily available public information in order to supplement information gained from more traditional CBA methods.

METHODOLOGY

In order to develop and test the method a case study approach was followed using the central commercial area of Waimate as the subject. The town of Waimate was chosen as a case study example of a small provincial town in New Zealand typical of many others. Waimate is located in South Canterbury, in the South Island of New Zealand. The population in the Waimate urban area was assessed as 2,835 at the 2006 census. Early settlement in Waimate occurred in the 1870's and was based around the saw milling industry which utilised the nearby native forest and supplied the growing towns of Timaru and Oamaru. Over time the economy diversified into that of a typical provincial rural service town similar to many scattered throughout New Zealand.

The town suffered an economic downturn in the 1980's with the closure of the dairy factory and a number of sawmills. Recovery from this down turn has been slow and patchy with other economic setbacks occurring such as the closure of two furniture manufacturers and a vegetable processing plant early this century. However, there has been some recovery over the last 10 years as the local dairy farming industry has increased in significance.

A legacy of the comparatively prosperous early history is the significant number of substantial unreinforced masonry buildings that still line Queen Street, which is the main street of Waimate. The early prosperity was followed by a long period of limited economic growth. As a result there has been little building of 'new' commercial buildings in Waimate over the last 50 years with the following exceptions:

- BNZ bank building (1975)
- Council building (1982)
- Police Station (1996)
- Industrial warehouse (1997)
- Supermarket (1997)

As a result the main street of Waimate is still largely original in terms of its building stock and architectural appearance. This gives Queen Street a distinct Victorian and Edwardian ambience that is valued by residents and tourists alike. A "Historic Walk" brochure is published by the Waimate Information Centre which describes 37 historical items or buildings, many of them located in Queen Street.

Under current legislation all local authorities in New Zealand must have a policy prepared under section 131 of the Building Act 2004 setting out how the local authority manages the earthquake prone building problem in their jurisdiction. The current Waimate Earthquake-prone, Dangerous and Insanitary Buildings Policy was

formally adopted by the Council on 19th September 2006. The policy was reviewed in 2012 with the original policy left unchanged but with a proviso that it would be reviewed again once the results of the Royal commission became apparent.

The Waimate policy is a “passive” approach where seismic assessments and structural upgrades are triggered by an application for a change of use. The Council may also assess a building if application is made for building alterations, extension of life or when a complaint is received. Due to the lack of building activity occurring in the central area this has meant that little or no earthquake strengthening has been ‘triggered’ since the policy has been in effect. Only one shop has had some structural strengthening carried out.

Once identified as an earthquake prone building the upgrade time frame varies from 15 to 25 years depending on the existing strength of the building. Weaker buildings below 20% of New Building Standard (NBS) are given 15 years while those that are 25-32% of NBS have 25 years to carry out the strengthening work.

Due to the passive approach taken by the Council towards earthquake prone buildings and the limited economic growth occurring in the town there has been little activity in the form of either seismic strengthening or demolition and redevelopment. The government proposal to introduce mandatory strengthening will therefore be a significant change impacting on the property market and land use in Waimate.

While traditional CBA analysis has a place it is unable to provide useful information in terms of measuring the micro economic impacts on individual property owners. Seismic retrofitting is a form of property development and as such, alternative models of CBA are necessary to shed light on the likely impacts and subsequent investment decisions made by individual owners. These models based around the private financial costs and benefits to the private property owner typically take the form of a feasibility study where the legally permissible, physically possible and financially viable alternatives are considered.

The building owner served notice to strengthen or demolish under the proposed legislation effectively has four options to consider:

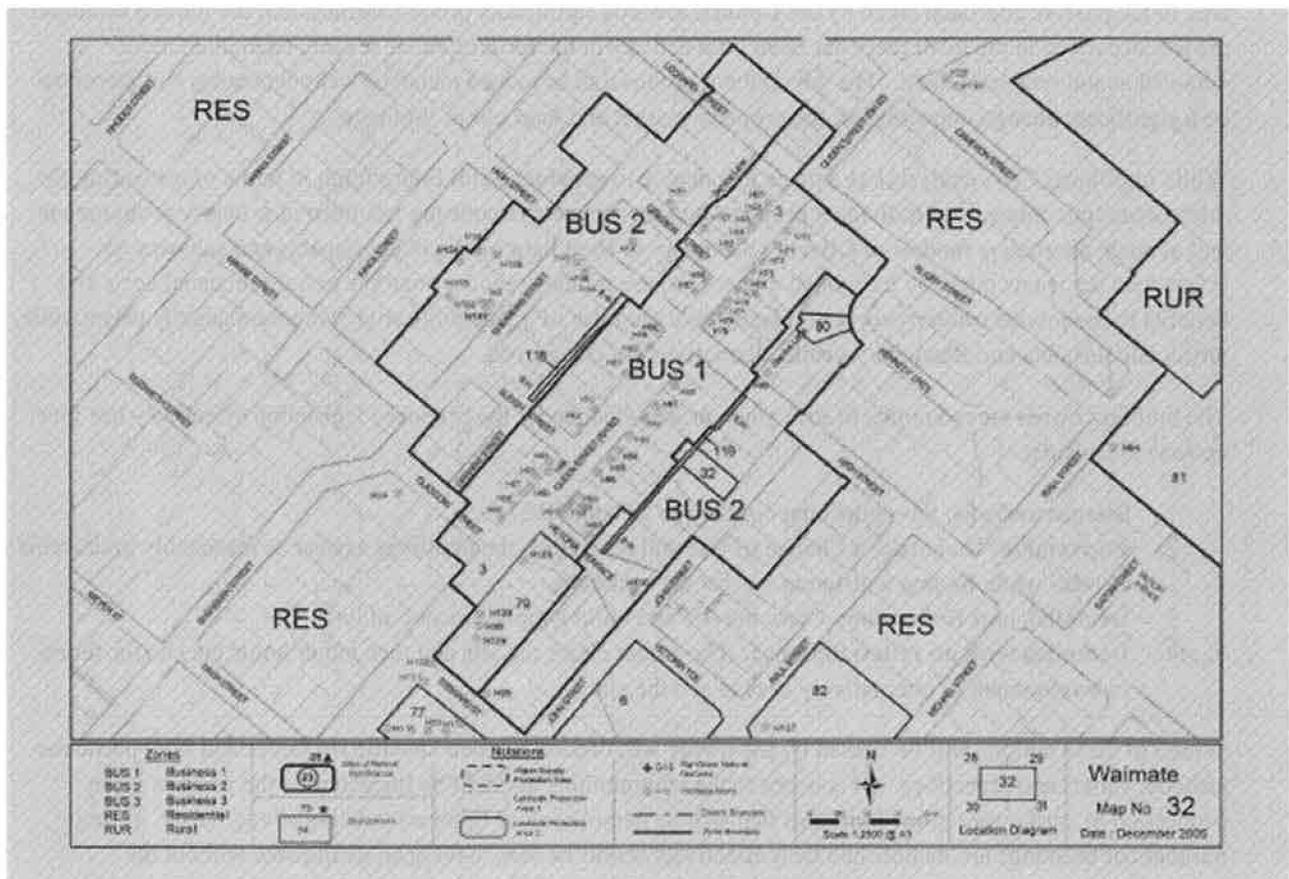
1. **Seismic retrofit:** Strengthen the building to 34% of NBS,
2. **Conversion:** Undertake a Change of Use and strengthen the buildings as near as reasonably practicable to NBS while finding a different use for the buildings.
3. **Demolish and Redevelop:** Clear the site and build a replacement building.
4. **Demolish with no redevelopment.** The owner clears the site and then either holds the site for future redevelopment or alternatively tries to sell the site.

Which of these options will be chosen by the owner will depend on their specific resources and their particular attitude, values and objectives. Of concern to the communities that will be impacted by the policies is the proportion of earthquake prone buildings that will be demolished as opposed to being strengthened. If large numbers of buildings are demolished then effectively it will be like “having an earthquake without the earthquake” as was stated by the Waitaki District Council chief executive Michael Ross (Littlewood, 2012). Clearly in the event of a ‘regulatory earthquake’ there will not be any loss of life or injury as would occur in a severe physical earthquake but the financial impacts on owners and communities are likely to be more damaging as there will not be any insurance money to fund any rebuild. The impacts on land use, heritage, local economies, and communities will be significant.

In order to accurately estimate the likely number of demolitions individual feasibility studies would be required on each earthquake prone building along with interviews with their owners to establish their likely response to their individual circumstances. This is clearly not a practical option for local authorities. As an alternative the methodology described in this paper was developed and tested using Waimate as a case study. Land use and valuation data was purchased from Quotable Value for all commercial property in the Waimate District Council area. Basic financial analysis was then carried out to try and identify those suspected earthquake prone buildings that were likely to be at risk of demolition if faced with mandatory earthquake strengthening.

From the land use data obtained from QV the central commercial area of Waimate was identified and split out as a separate study area. Using the Waimate District Council Operative District Plan as a basis the central business district (CBD) of Waimate was defined as the mix of “Business 1” zoned properties and the “Business 2” zoned properties clustered in and around the Queen Street precinct. The Business 1 (B1) zone comprises Queen Street itself with a strong emphasis on retail activity. The Business 2 (B2) zone is described as a “Mixed Business Use Area” surrounding Queen Street and allows for a mixture of commercial, service, industrial and residential activities. Initially all buildings in the B1 and B2 zones were considered for analysis but then any building not subject to earthquake-prone building policies such as residential houses were excluded from the sample. Vacant land once identified was also excluded from the analysis leaving a final pool of 80 commercial buildings located in the Waimate CBD that are likely to be ‘caught’ by earthquake prone building regulation. Refer to Figure 1 below.

FIGURE 1. Commercial Zoning Plan from the Waimate District Plan.



To aid in this study it was necessary to try and identify the number of buildings in the Waimate central business district (CBD) that would be considered earthquake prone. This was necessary as Waimate District Council has not yet prepared a register of earthquake-prone buildings. Buildings constructed prior to 1976 are typically considered to have the potential to be earthquake-prone. Buildings constructed after 1976 were required to meet more stringent building regulations and are unlikely to be earthquake-prone unless they suffer from design flaws creating what are known as critical structure weaknesses. For the purpose of the study earthquake-prone buildings were defined as those buildings built before the 1950's of unreinforced masonry (URM) and which had not been significantly earthquake strengthened.

The age of buildings were initially obtained using the land use data purchased from Quotable Value for the study area. However it was found that for many of the buildings the age was described as “mixed” as later additions had been made to the original building. These additions were often of a comparatively minor nature with the principal building clearly falling within the type and age of building that would constitute an

earthquake prone building. As a result this 'raw' land use data was audited and augmented by curb side field inspections over a two day period in February 2013. These curb side inspections were also supplemented by the use of aerial photographs viewed on "Google Earth" to help identify the different parts of buildings that were 'modern' where the land use data assessed buildings as being of mixed age. No attempt was made to enter the properties or to carry out any internal inspections of buildings.

Interviews were also undertaken with the building consents and regulatory staff of Waimate District Council to confirm what new construction and retrofitting had taken place in the town. Interviews were also undertaken with local real estate professionals to gather background information on the commercial property market in Waimate.

In carrying out the economic analysis the rating valuations were used as a proxy for market values. Due to the passive nature of the Waimate Earthquake- prone Buildings Policy there was little market concern regarding seismic building capacity prior to the Christchurch earthquakes. Therefore the cost and liability of compulsory earthquake strengthening is not priced into the market in terms of the 2010 values and there is little danger of double counting these costs in the economic analysis undertaken. Sales evidence relating to the study area was also examined but is very limited in nature making it difficult to draw conclusions regarding value changes post the earthquakes. For example only three property sales were recorded in the study area for the whole of 2012. Two sold above their 2010 rateable value while one sold below. It is unclear as to what extent the potential for mandatory strengthening and/or the impact of the Christchurch earthquakes is being factored into recent commercial property sales in Waimate.

The costs of earthquake strengthening were calculated based on \$400 m² as an average figure. This is slightly higher than the \$300 m² used in the Martin Jenkins CBA but this sum does not allow for non-structural costs of retrofitting which can be substantial. It was therefore considered prudent to increase the estimate for strengthening costs to \$400 m² to make some allowance for the non-structural costs likely to be incurred.

Demolition costs were estimated at \$180m² based on the analysis of the actual demolition costs of a small URM building in Christchurch. This was checked against Rawlinsons New Zealand Construction Handbook which provides a figure of \$152 m². Rawlinsons notes that demolition costs vary considerably depending on a number of factors and that a quote from a demolition contractor is advisable.

A comparison was made between existing values, as represented by the rating valuations and the costs of complying with the government proposals in terms of either strengthening or demolishing buildings. No attempt was made to allow for time delays in the completion of the demolition or strengthening work in the form of present value analysis.

For each building analysed the estimated costs of strengthening were deducted from the estimated value of the un-strengthened building. Where this resulted in a negative building 'value' then the existing value of the property would be reduced below the unencumbered land value. The costs of demolition were also estimated for each building and these demolition costs were then deducted from the estimate of land value to arrive at the redevelopment value of the building site. By looking at both these different values it is then possible to predict the likely option that would be taken by the owner forced to make a decision on their buildings due to legislation. Where the existing use value is higher than the redevelopment value than the highest and best use of the property is to retain and strengthen. Where this value is less than the redevelopment value then the highest and best use is to demolish the building.

The extent to which building owners choose the option to demolish rather than retrofit will potentially be affected by the impact of heritage protection on their buildings. The extent to which earthquake strengthening requirements under the Building Act 'trumps' the heritage protection objectives of the Resource Management Act is an area of developing case law. A recent decision by the Environment Court regarding the Harcourts Building in Wellington would indicate that heritage protection is still a significant factor to be considered.

The current Waimate District Plan recognises the amenity and heritage value of the existing building stock and street scene. It seeks to maintain this by the use of heritage protection rules. There are also building design controls over new and existing non-heritage buildings which were introduced in response to some of the more recent developments which were unsympathetic to the streetscape.

Section 8 of the current District Plan deals specifically with heritage protection. Under this section heritage items are identified in the District Plan as either Category A, B or C. The demolition or removal of a Category A item is a Non-complying Activity. For Category B items any demolition, removal, alteration or addition is a Discretionary Activity. For Category C items demolition or removal is a permitted activity while alterations or additions are a controlled activity.

This means that effectively there is no legal impediment to an owner demolishing a category C building. There is a requirement to delay any demolition for 3 months to allow a chance for alternatives to be explored. Photographs must also be taken.

There are a total of 135 heritage items listed in the District Plan. Of these 23 (17%) are Category A, 22 (16%) are Category B and 90 (67%) are Category C. Within the study area there are 46 listed buildings. One building is Category A (2%), two are Category B (4%) and the other 43 (94%) are Category C. Thus the great majority of heritage buildings in the study area can be demolished as of right and have little effective protection. Thus the decisions of the owners are expected to hinge around the economic impacts of the mandatory earthquake strengthening rather than heritage protection rules.

RESULTS OF STUDY

The current 2010 rating values are considered to be untainted by the impacts of either the Christchurch earthquakes or the resultant market corrections evident in many parts of the country. Any prudent purchaser expecting to be forced to earthquake strengthen their building under the current government proposals would therefore deduct the cost of the strengthening work from the current value.

A large proportion of the Waimate central business district is highly likely to be earthquake prone. This is summarised in the following Table.

Table 1. Analysis of Waimate Commercial Buildings

Likely Seismic Status	B1 Zoning Only	%	B2 Zoning Only	%	B1 & B2 Combined	%
Earthquake-prone	43	90	16	50	59	74
Complying	5	10	16	50	21	26
Totals	48	100	32	100	80	100

Of the total of 85 properties analysed there were 5 that were vacant. Of the remaining properties it was considered that 59 (74%) out of the 80 contained suspected earthquake prone buildings. In terms of floor area it was estimated that approximately 24819 square metres of building would likely require strengthening or demolition. Based on a strengthening cost of \$400m² to bring the buildings above 33.33% of NBS this equates to a total cost of \$9,927,440 dollars. On an aggregate basis the total rateable value of the buildings is only \$6,082,000. Therefore the cost to strengthen the buildings exceeds their current value by \$3,845,440.

On an individual building basis 46 (78%) out of the 59 suspected earthquake prone buildings have no residual building value once strengthening costs are deducted. Thus the impact of the government proposals would be to wipe out any economic value currently accruing to most of the existing buildings in the central business district. The impact of the government proposals regarding earthquake prone buildings will effectively give many of the buildings a hypothetical negative value.

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If just the B1 zone which largely comprises the Queen Street properties which go to make up the main street of the town is considered then the situation is even worse. Of the 48 properties making up this zone 43 comprise earthquake prone buildings. This means that approximately 90% of the main retail and service centre for the district would be considered earthquake prone.

Where an owner has an earthquake prone building with a negative value they may then attempt to limit their losses by choosing to demolish rather than strengthen. However, this means that the owner will incur a demolition cost which will reduce the net worth of their site. In extreme situations if the land value is low and demolition costs are high you can conceivably have the situation of negative land values. This is the situation for some sites in Waimate as the commercial land values are low. The rateable values for commercial land varies from between \$41m² and \$171m². The variation in land values is due to the large number of variables typically impacting on land values such as location, shape, access, frontage, size and zoning. The average land value calculated for the sites being studied is \$83m².

If large scale demolition occurs as predicted, this may lead to a secondary impact on land values. The supply of commercial land will considerably outstrip the demand for redevelopment and may drive commercial land values even lower.

Having identified that a large proportion of the buildings in Waimate are earthquake prone an estimate was made of the number of buildings where the owner might choose to demolish the buildings. This is difficult to do without interviewing the individual owners as their decisions will vary widely depending on the resources, attitudes and objectives of the owner.

The building owner served notice to strengthen or demolish under the current government proposals effectively has the four options of either a seismic retrofit with no change of use, a seismic retrofit with a change of use, to demolish and redevelop, or to demolish and not redevelop.

For the owner of a typical URM commercial building in Waimate all four options are problematic as the following examples illustrate. The examples are based on a hypothetical, but typical main street property in Waimate that closely approximates a number of actual buildings in terms of construction, age and size. The building is a two storey URM building. It has a floor area of 750 square metres and is on a section of 700m² in the Business 1 Zone with frontage to Queen Street. Based on a cost of \$400m² to strengthen to 34 % NBS the strengthening costs would be \$300,000. The cost of demolition has been estimated at \$180 m² or \$135,000. Property values are based on the level of values applied in the 2010 Rating Valuations.

Option 1 – Seismic retrofit

Current Value of Building	\$140,000
Current Land Value	<u>\$ 90,000</u>
Current Value of Property	\$230,000
Less costs of strengthening	<u>\$300,000</u>
Existing Use Value of property	-\$70,000

After deducting the costs of earthquake strengthening from the value of the buildings the buildings then have a negative value of -\$160,000. This negative value exceeds both the current land value and building value. It would therefore indicate that the current existing use value of the property assuming a compulsory seismic retrofit would be negative \$70,000.

It could be argued that a degree of “betterment” will occur with the retrofitted building, however this is likely to be limited due to the difficulty of attracting any enhanced investment returns. In addition a conservative cost of

strengthening has been used which takes limited account of the indirect costs of earthquake strengthening or consequential costs relating to fire safety and disabled access and facilities upgrades. These could both add substantially more to the strengthening costs as calculated previously.

Option 2 – Conversion to an Alternative Use

The building is currently subdivided into several shops and it unlikely that an alternative use will generate higher returns than currently available. In large cities such as Auckland and Wellington there is often potential to do this as obsolete office space can be converted to apartments due to the demand for inner city living. There is no such potential in Waimate.

A challenge of any building conversion is that the costs of conversion are considerably higher due to the requirements of section 115 of the Building Act. The costs of earthquake strengthening alone triggered by a change of use can be considerably higher as the building must be brought up to a level as near as reasonably practicable to that of a new building. This is often interpreted to be a level that is at least 66.66% of NBS.

The added cost of going to 66.66% of NBS will vary on a case by case basis however a study done by John Hare (Hare, 2009) of Holmes Consulting found that on average the cost increased by an average of 2.5 times that of 33.33%. This would increase strengthening costs to a rate of \$1,000/m² and costs of strengthening the building to \$750,000.

Option 3 – Demolition and Redevelopment

Assuming the owner elects to demolish their building and in the absence of any salvage value of materials then the financial situation of the owner will be as follows.

Land Value	\$ 90,000
Less costs of demolition	<u>\$ 135,000</u>
Redevelopment Value of property	-\$ 45,000

The owner would clearly have a number of challenges not the least being that his capital asset of \$230,000 is now a liability of \$45,000. He may now have considerable negative equity in the property but must also attempt to raise the money necessary to build a replacement building. He also has the problem of finding tenants for his new building as his existing displaced tenants may be unwilling to wait for the replacement building to be built, They may also be unable or unwilling to pay the higher rent necessary to make a new building financially feasible.

The buildings in the study area house a large number of businesses and also contain some residential accommodation. At best these businesses and residents would need to relocate to alternative space while strengthening took place. In the event of demolition, this displacement may become permanent for many of the businesses. The building owner will not replace their demolished building unless they can obtain a reasonable return on the capital invested in their replacement building. This is likely to cause severe affordability issues for the displaced tenants.

Current rents appear to be in the order of approximately \$100 m² gross rent. If the owner wished to get a return of 10% on a replacement building cost of \$2000 per square metre they would need to get \$200 m² net of expenses. This excludes any allowance for a return on the land value. It is therefore likely that replacement

buildings will need to be rented at double the amount of current rents. Many tenants will be unable to afford to pay double their existing rents.

Option 4 – Demolition with no rebuild.

This is a more likely scenario than Option 3 as the owner is unlikely to have the knowledge, experience or confidence necessary to undertake the role of property developer as required by Option 3. In larger more prosperous towns vacant sites can often be put to an alternative “interim use” such as car parking to off-set holding costs. This is unlikely in Waimate and the number of new development sites is likely to ‘flood’ the local market.

As the above examples illustrate the owner is faced with a difficult decision as none of the options are economically feasible. His best option is to abandon the property completely although this option is not legally possible as under current and proposed legislation the Council has the power to have the building demolished and then recover the costs from the owner.

On the figures presented above the highest and best use is to demolish the building as the value as a redevelopment site of - \$45,000 is higher than the existing use value of -\$70,000. Thus the financial loss from demolition will be slightly less than the retrofit option. Either way the owner will suffer a serious financial setback which may cause hardship.

Clearly the results of the various options are highly sensitive to the levels of costs and values used. If lower demolition costs or strengthening costs are assumed then either one or other of the options may become relatively more ‘attractive’ to the owner. However, it is highly unlikely that any of them will become financially feasible for the owners.

Current analysis shows that of the 59 suspected earthquake-prone properties, 26 will show a negative value regardless of the option chosen. This means they are a financial liability rather than an asset regardless of whether the owner chooses to strengthen or demolish.

Out of the 59 properties in 26 cases (44%) the best financial result can be achieved by demolition and on pure economic grounds this is the option that would be expected of the owner. Of note however, is that in 46 cases out of 59 the cost of strengthening is likely to exceed or equal the current value of the buildings. This means that 78% of the buildings would appear to have no economic value once the costs of earthquake strengthening are deducted and are therefore in some danger of demolition.

CONCLUSIONS

This paper proposes the use of a feasibility based cost benefit analysis conducted on a building by building basis utilising readily available land use data and rating valuations from QV. The method was tested using a small rural town as a case study. This case study analysis was useful in testing the accuracy and relevance of the data and highlighted a number of issues.

While the QV data provided good base information it suffers from a number of limitations in terms of a study of this type. The information is based on the information contained in the rating roll. Therefore information is collected for each separately defined Rating Unit. Such a rating unit may contain several different buildings or may include only part of a building. This creates difficulties in using the data for a building by building analysis.

Information on the age of the buildings is included but where there have been additions or alterations carried out then the age is given as “mixed”. When there are multiple buildings of differing age forming a rating unit then

the age is also described as mixed. This makes the data less useful in terms of identifying earthquake prone buildings. The Martin Jenkins CBA found similar problems using QV data as they found on a national basis that 41% of the buildings were age unknown.

In order to improve the usefulness of the raw QV data requires auditing of various types such as field inspection, inspection of building files or use of photographic records. Such auditing processes add time and cost to the process.

A study of this type must assess the seismic capacity of the commercial building stock. In order to do this accurately would require significant expert engineering input which was not available for this study. Instead reliance was placed on a basic analysis of the age and construction of the buildings to identify those likely to be earthquake prone. This lack of engineering data is a limitation of this study but eventually accurate lists of earthquake prone buildings compiled by T.As will be able to be used to supplement QV land use data thus making it unnecessary to estimate the numbers of earthquake prone buildings. However, the list of earthquake-prone buildings will still need to be matched with the land use data in relation to floor areas and building values.

Future studies of this nature may also have problems in terms of using rating valuations as a proxy for the market values of the buildings in their pre strengthened state as these valuations may include a value discount to reflect their low seismic capacity. If the cost of seismic retrofitting is deducted from these already discounted values then the costs of earthquake strengthening will effectively be double counted leading to incorrect results.

The economic analysis in this study by necessity is crude, with no attempt made to use discounting techniques to arrive at net present values for costs and benefits. For the case study, market analysis was also limited with no attempt made to quantify any betterment accruing to owners from earthquake strengthening.

However, despite the limitations of the methodology developed and tested in Waimate it does have some advantages. It is comparatively simple and cost effective and provides information that should be valuable to land use planners and policy analysts. For example, for this particular case study it would indicate that a significant proportion of the commercial building stock in Waimate is at risk of demolition given the proposed legislative changes. These changes have the potential to cause a sharp market correction in the value of any buildings considered earthquake prone. These buildings will likely suffer a significant drop in value that may render them economically obsolete and thus result in their demolition.

For towns such as Waimate where earthquake prone buildings represent a significant portion of the building stock, the economic and social impacts will be severe. Owners and tenants will suffer displacement which at best will be temporary but this displacement may become permanent where tenants cannot afford rent increases. Those tenants that can meet the rent increases necessary for new buildings are likely to protect their profit margins by passing on the increased rents to their customers. Ultimately the rental increases then become a cost to the community

It is highly likely that if owners are forced to take action on their buildings over a comparatively short time frame as per the government proposals that potentially 50% of the buildings in the study area could be demolished This compares with an estimate in the Martin Jenkins CBA of 10% which is "judgement based" rather than empirically based. The situation is likely to be exacerbated by the fact that most if not all of the owners will lack development experience and skills. Based on the analysis, any equity that owners have in their properties is liable to be severely eroded which will make it difficult to raise finance. Difficulties with insuring their retrofitted buildings may also impact negatively on the value of their property which may also reduce the feasibility of retrofitting.

Many of these buildings facing demolition will be heritage buildings. As discussed earlier the great majority of buildings have very limited heritage protection even if listed as having heritage value in the district plan. Of the 59 suspected earthquake prone buildings in the study area a total of 45 (76%) are heritage listed. Of the 45 only 1 is Category A, 3 are Category B and the balance are Category C. Demolition of Category C buildings is a permitted activity so over 90% of the heritage buildings are at risk of demolition. All the heritage listed buildings

in the study area are likely to be earthquake-prone and as the previous economic analysis shows are probably uneconomic to earthquake strengthen. Large numbers of heritage buildings are likely to be demolished and not replaced. This will leave significant gaps in the street scene and destroy much of the current heritage value of Queen Street.

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