The four R's – Reduce Risk, Raise Resilience: Local authority priorities and the Auckland perspective on engineering requirements for heritage buildings

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Abstract
This paper describes Auckland Council's roles and responsibilities in ensuring that the engineering of our heritage buildings is to levels of safety required legally and by the Government, the council's own policies on building safety as an employer, and as a kaitiaki of publicly accessed heritage places. The paper describes the level of investment required to achieve these aims as a regulator and a large portfolio holder, and examines the tension between this, the level of risk in relation to different types of natural events, and the need to represent the values and interests of its citizens and ratepayers. There is ultimately a need to consider whether the costs associated with retrofitting heritage buildings are proportionate to the risk of fatal harm from a seismic event, or indeed whether there are other, greater risks, or even more common reasons for undertaking such works.

1. Introduction

Local authorities have a statutory responsibility to develop policies and strategies on responding to natural disasters, chiefly at this time focused on the response to earthquakes and how buildings perform safely in a seismic event. For many, the 2010–2011 Canterbury earthquakes raised concerns over the safety of our places of living, and of work or public interaction. Councils across the country have had to respond to the reaction to the earthquakes, and the corresponding recommendations of the Government. Much of the focus has been on buildings of pre-1976, and particularly pre-World War 2, construction. These have a greater likelihood to be considered earthquake prone or possess associated hazards that could pose a reasonable risk to the public during a seismic event. Auckland's greater stock of heritage buildings falls largely into this "at risk" grouping, including many that are public buildings and places of employment for Auckland Council staff. The council has a responsibility to ensure private individuals and institutions are aware of, adhere to and uphold Government legislative requirements. At the same time, we as employers and custodians (kaitiaki) of treasured places need to ensure that we lead by example in the provision of safe places to work and the good management of heritage places.

2. The council roles

The council has three main roles with regard to heritage buildings in Auckland. These are:

- Regulator – of Building Act and Resource Management Act provisions;
- Owner – of a significant portfolio of heritage buildings and places of significance; and
- Advocate – through the Auckland Plan in particular, and through the grant support of maintenance works to privately owned heritage buildings in the Auckland Region.

A fourth role could be considered in the context of a major event, and that is the council as the lead role of civil defence provision and organisation. Many heritage buildings in Auckland are also public buildings, and include community halls and churches or other locations that become the focus for civil defence response in the event of a natural disaster or other crisis. The resilience of these buildings is important therefore, not just for the protection of heritage assets, but also to provide continuity of functions following a major incident, such as was observed at Canterbury.

The roles of regulator and portfolio owner could be considered to focus on the reduction of risk in relation to fatalities arising from environmental hazards, while the roles of advocate, and of a coordinator of civil defence, can be seen to focus on the importance of providing resilient places for communities to rally around.

2.1 Regulator

Seismic assessment procedures formally utilised in New Zealand entail a scoring system of percent New Building Standard (%NBS) as proposed by the New Zealand Society of Earthquake Engineering [17]. This indicates the expected capacity of the building as a percentage of the ultimate limit state (ULS) demands prescribed by current standards [16]. The phrase "new building standard" is indicative of the intent of the scoring system - a building that is assessed as having a resistance exceeding 100%NBS is expected to withstand the current ULS "design basis

earthquake" (DBE) demands, whereas a building assessed at 34%NBS is expected to withstand only one-third of the DBE. A building with a score of less than 34%NBS is deemed potentially "earthquake prone" and may be subject to regulatory measures per the Building Act [14] and current Auckland Council policy [4], warranting further assessment and possible structural retrofit.

Auckland Council is responsible, under the provisions of the Building Act [14], for ensuring that all commercial buildings and residential buildings subject to the provisions (two or more, and multiple occupancy units) are subject to an assessment of their likely seismic performance. This obligation has been made operative in Auckland by the council deciding to themselves undertake initial seismic assessments on all aforementioned buildings of pre-1976 construction, Post-1976 buildings are not likely to be earthquake-prone in Auckland due to low seismicity and more modern design standards, and are therefore reasonably excluded except where a known design deficiency is identified by the technical community.

To date, Auckland Council Building Control has assessed close on 6000 pre-1976 commercial and large residential buildings within its jurisdiction, and estimates that there may be another 6000 yet to do. Of that total, just over 700 have so far been indicated as potentially earthquake-prone, and forecast estimates put the final number somewhere around 2000-2500 total, although changes to the NZSEE assessment guidelines [17] being used for those may have a noticeable impact on that final figure. It has taken since mid-2011 to carry out this number of assessments and distribute them to owners for discussion before they become part of the public record. The estimated cost for this work to date has been put at $1.5 million.

Alongside the development and implementation of an operational programme for seismic performance assessments, Auckland Council has also been significantly active in regard to developing appropriate policy for the region on earthquake-prone buildings, and in discussing changes to legislation and resulting policy and operational methodologies with the Government. We have made submissions to, and presented before, the Canterbury Earthquakes Royal Commission of Inquiry, the Ministry of Business, Innovation and Employment, and to the Parliamentary Select Committee on the Building (Earthquake-Prone Buildings) Amendment Bill. We have also developed and published guidance material for the general public to improve awareness on what this work is about, and advocate strongly for more work to be done nationally in that regard.

2.1.1 Typologies of heritage buildings in Auckland

Of Auckland's heritage buildings potentially subject to the provisions of the Building Act, the majority are constructed using timber or unreinforced masonry (URM) techniques. Auckland's building industry was well served historically by timber (Kauri Logging being a major industry until the 1930s), and clay manufactured products (though no Auckland-based producers now survive). Materials and practices initially closely followed those from the United Kingdom or wider British Empire, and up until the 1960s materials such as steel were regularly imported from the mother country for use in Auckland's construction.

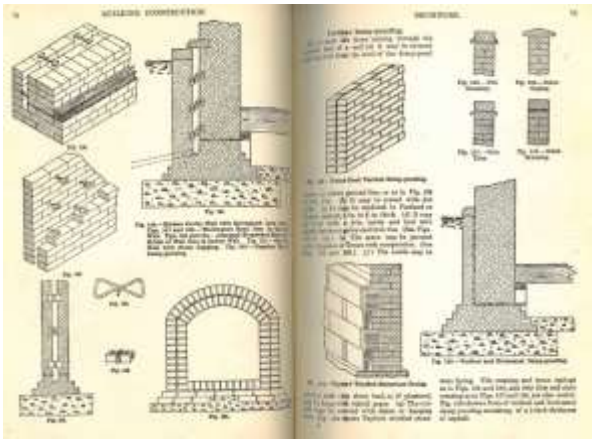

Figure 1: Traditional brick cavity wall construction methods (After Adams [1], 72f).

The construction of ceramic masonry buildings usually means the use of machine-pressed brick, the performance of which can probably be assessed as reasonably consistent, when compared to traditional hand-made stock bricks. One element to consider when assessing URM buildings, however, is the relative sizes of the units and the use of different types of brick in different areas of the structure. A cautionary note of advice is provided by a 1901 textbook on *Advanced Building Construction* [3]:

> Evils of facing with superior bricks.- It is a common practice, especially in using single Flemish bond, to build the face work with better bricks, and with thinner joints, than the backing. This leads to unsound work, and should not be allowed. In such cases, on account of the joints of the backing being thicker than those of the face work, the courses will not be of **same** in front and back. For example, it may require eight or nine courses of the face to gain the same height as six or seven of the backing (see Fig. 89) and it is only when they happen to come to a level as at aa (once in every eight courses or so), that headers can be introduced. Even the few that can thus be used are liable to be broken off by the inequality of settlement, caused by the difference in the thickness

of the joints. This may be partly remedied by using thinner bricks in the backing so as to have the same number of joints in the face and back; but even then the difference in the thickness of the joints in facing and backing tends to cause unnatural settlement, unless the work is built in very quick-setting mortar which will harden before any weight comes upon it. A further result of this practice is that, in order to economize the more expensive face bricks, dishonest bricklayers will cut nearly all the headers in half, and use "false headers" throughout the work, so that there is a detached slice, 4 ½ inches thick, on the face, having no bond whatever with the remainder of the wall.

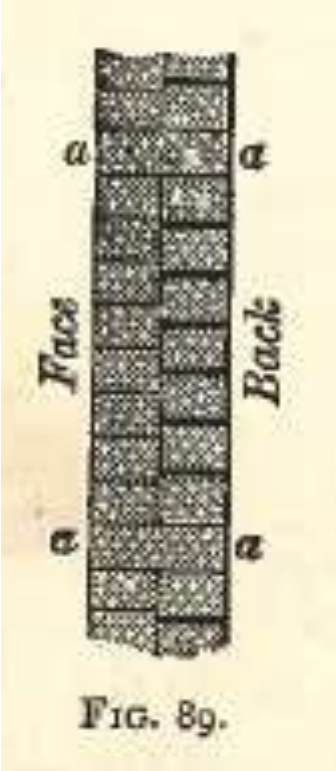

Figure 2: Description of poor building practice with facing bricks (after Burrell [3], 56).

Other proprietary systems were developed by the pioneering clay bakers. Clark's brickworks manufactured salt-glazed, hollow ceramic blocks for use as masonry units. Warkworth Town Hall is one of the few surviving buildings constructed with this unusual and challenging material, and forms the subject of our engineering case study – Strengthen, Remodel or Demolish? A Council Perspective on engineering retrofit in the historic portfolio.

Figure 3: Wellesley Street, Auckland; example of typical cross-section of an Edwardian URM building. Note the irregular coursing and variable mortar joints resulting from use of facing bricks (19 courses to top of column) and commons (20 courses to top of column) behind.

Stone masonry buildings are less common in Auckland, and statistically are perhaps not as significant from an engineering perspective. A handful of commercial stone buildings still survive, usually utilising local basalt; perhaps more relevant are the 'high architecture' projects, such as St Paul's Cathedral and Auckland War Memorial Museum. These structures do not typically represent our engineering retrofit scenarios. Conversely, the 'public good' of these places is self-evident and easy to defend in terms of costs.

By and large, Auckland historically is a city of timber, and brick, and to a lesser degree steel and concrete. These then are the essentially modest structures that nevertheless create the Victorian and Edwardian core to our city. They are not all formally protected, but are all redolent of a pioneering age, the spirit of which Aucklanders are in the main desirous to maintain.

One area where local innovation may have had more significant impact was in the manufacture of cement and reinforced concrete products. From the late 19th century reinforced concrete was being developed as a construction material, and is adopted quite widely and relatively early in Auckland. Often referred to as ferro-concrete (the Ferro-Concrete company of Australasia constructed the Grafton Bridge and Queen's Wharf) the material was used for infrastructure as

well as commercial buildings. Grafton Bridge, for example, was considered at the time of its construction to be the longest reinforced concrete span in the world. This led to the construction of some 'composite' buildings with reinforced concrete structures, containing brick cavity panels. The performance of this material has not been such a focus of Auckland Council's work to date, and is to some degree a reflection of the main construction typologies present in the Council's own portfolio (see Figure 8).

Auckland is the largest city in New Zealand, and because of the relative prosperity of Auckland during the period 1880–1935 when most URM buildings were being constructed, the city has the greatest stock of URM buildings in the country. Aspects studied while assessing the hazard posed by these buildings include:

- The number, location and age of these buildings, and the role that these buildings play in the built heritage of the city
- Their architectural attributes and material characteristics
- Earthquake prone building policy and other public legislation relevant to these buildings
- The seismic hazard in Auckland
- The expected performance of these building by extrapolating observations from the recent Canterbury earthquakes
- Past and current activities to earthquake strengthen Auckland's URM buildings, at both an owner and regional territorial level.

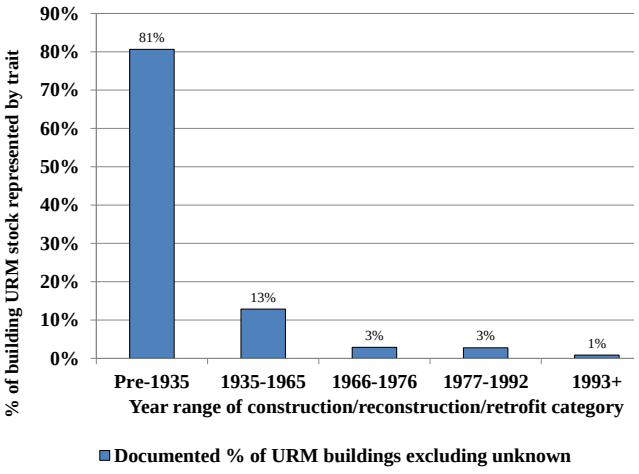

Figure 4: Proportions of documented non-domestic URM buildings in Auckland by year of construction, reconstruction, or seismic retrofit (after Walsh et al [21]).

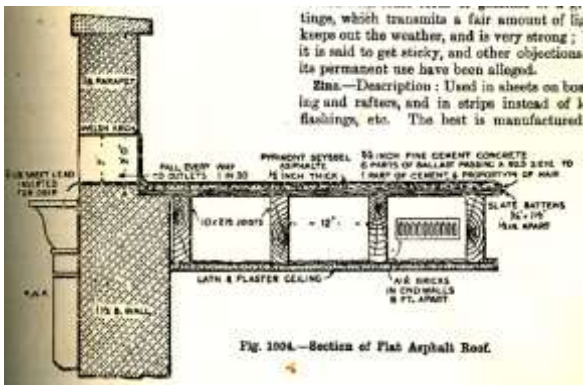

Figure 5: Typical cross section of a URM parapet and timber-framed roof diaphragm (after Adams [1], 261).

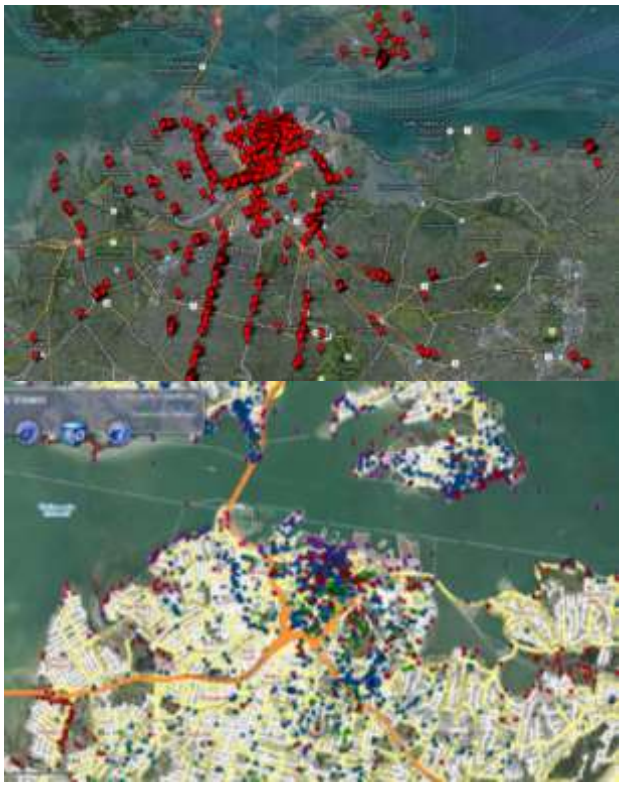

Figure 6: comparison between Earthquake-prone buildings identified in IEP process (red dots - top figure) and historic buildings identified on Auckland Council Cultural Heritage Inventory (blue squares bottom image)

2.2 Owner

As an owner of approximately 3500 buildings, including several constructed of URM, the Auckland Council Property Department (ACPD) began a seismic retrofit prioritisation programme in 2012. The intended result of this programme is a prioritisation framework which will categorise all council buildings in accordance with their seismic risk and council-assessed value in order to assign resources efficiently and effectively to both seismic inspections and future retrofit work. The programme will produce a methodology as well as a list of properties and a timeline for construction work. Corollary outputs will include a detailed, standardised inspection programme to be used by the Departments of Property and Building Control, as well as a standardised database index

system to be used across departments to aid in data procurement on current and future property projects. Furthermore, a strategic plan for building asset priorities is expected to be delivered to the executives of Auckland Council and referenced by other departments as part of their planning processes.

In addition to the requirements for buildings assessed with a seismic score of less than 33%NBS, a building with a score less than 67%NBS is deemed potentially "earthquake risk" and may be subject to the provisions of the Health and Safety in Employment Act [13]. Council has responsibilities under the Act to take all practicable steps to reduce risk in all workplaces (through structural enhancement and/or safety training) for which it is the employer, the entity in control of the workplace, or the principal (in regard to contractors and subcontractors) [19], [10]. These items are summarised in Table 1. Note that calculated risk levels are not proportional to the %NBS scoring range, as a building determined to have a score of 33%NBS is assumed to have a collapse or partial collapse risk that is approximately ten to twenty times higher than a building rated at 100%NBS [17].

Table 1: Associated values and implications of seismic assessment %NBS scores (after Walsh[21])

%NBS	EQ risk category	Potentially affected by Building Act (2004) and Council Policy (2011)	Potentially affected by Health & Safety in Employment Act (1992)	Non-compliant with current NZS (2004) loading standard
< 20	Prone	X	X	X
20 to 33		X	X	X
34 to 66	Risk		X	X
67 to 79	Low risk			X
80 to 100				X
> 100	Presumed to comply with current loading standard			

2.2.1 Managing large portfolios

Auckland Council manages the largest Local Authority portfolio of heritage buildings in the country. Nationally, other portfolio holders on this level are the Ministry of Defence, Department of Conservation, the Government estate and Housing New Zealand which all maintain large portfolios with significant numbers of heritage buildings, to a varying degree affected by the proposed amendments to the Building Act.

2.3 Advocate

The council role as an advocate for heritage buildings is strongly based around our strategy developed in the Auckland Plan, which **are** based on three principle drivers:

- Understand, value and share our heritage
- Invest in our heritage
- Empower collective stewardship of our heritage

Our actions around this include systematic survey of the Auckland Region to identify historic heritage places, to provide advice on consent applications relating to scheduled places, and to 'lead by example' in the care of our heritage portfolio. To this end, we have initiated a 'seismic exemplar' project, working with the Waitemata Local Board, Auckland University Engineering Department and locally experienced engineering teams to cost and implement retrofit solutions to different levels of code, and provide the learnings from that work to local business owners.

In a more practical sense, Council leads by example in the attitudes and approaches it takes to the heritage assets within its own portfolio. These rarely, however, include planned upgrades to heritage buildings in their own right, but are usually part of a broader adaption or upgrade of buildings whose primary function is the provision of public services in one form or another. Recent completed examples since the creation of the single Auckland Council include the Tepid Baths (swimming pool), Lopdell House and Art Gallery (arts and culture), and Shed 10 on Queen's Wharf (events and cruise ship terminal). Further upgrades are planned or commencing at Mt Roskill's former municipal building, Warkworth Town Hall (community and local board services), and the Ellen Melville and Pioneer Women's' Hall in the CBD (community services). The pattern that emerges here is clear – the level of use and function of places is critical to attracting the necessary budget to undertake such works. It is worth noting that there is no capital fund for upgrade purely allocated on the basis of heritage value alone.

3. Measuring risk and measuring value

3.1 Auckland's seismic hazard

Risk is the product of three components – hazard, vulnerability, and consequence. Regarding the risk component of hazard, the islands of New Zealand sit roughly along the boundary of two of the planet's lithospheric tectonic plates – the Australian Plate and the Pacific Plate, resulting in all of New Zealand having a moderate to severe seismic hazard relative to a global scale. The Pacific Plate subducts beneath the Australian Plate alongside the east coast of the North Island at an average rate of approximately 50 mm/year [11]. The Auckland region's seismic hazard is low relative to the rest of the country because Auckland resides further from this subduction zone, approximately 300 kilometres (km), than most other cities and towns in the North Island,.

Much of South Auckland's geology, especially along the west coast, is comprised of Pleistocene to Holocene marine and alluvial sediments and

dune sand [12]. Where unconsolidated, these soil types are prone to amplifying earthquake intensities up to two Modified Mercalli (MM) levels higher than intensities on neighbouring rock [6]. Fortunately, much of Auckland Central rests on volcanic and sedimentary rocks. Furthermore, liquefaction and lateral spreading are not likely to affect much of the region during an earthquake [5], although slope instability during seismic shaking could damage buildings across Auckland [6].

The only two faults near Auckland active in the past 125,000 years are the Kerepehi and Wairoa Faults [9], [6], in the South region. The Kerepehi Fault is located in the centre of the Hauraki Plains approximately 75 km from Auckland Central [9], [6], displaces approximately 0.13 mm/year [6], contributes approximately 2% to the 500-year peak ground acceleration (PGA) determination [18], and has a mean earthquake return period of 2500 years [9], [6], with a moment magnitude M_w 7.2 [18] capable of producing a shaking intensity of MM7-MM9 throughout the region [9], [6].

The Wairoa Fault (technically, separate North and South faults) is located near the Hunua Ranges approximately 35 km from Auckland Central, displaces approximately 0.1 mm/year [6], contributes approximately 4% to the 500-year PGA determination, and could produce an earthquake with a moment magnitude of M_w 6.7 [18]. However, distributed seismicity sources account for the majority of contribution to the determined 500-year PGA in the Auckland region [18], and these sources account for earthquake occurrences on currently unknown faults based on a nationwide distribution of seismic hazards [5]. Hence, the next intense earthquake in Auckland is considered more likely to come from an unknown or buried fault than from a known fault.

3.2 Vulnerability of historic buildings to earthquakes

The experiences of the 2010-2011 Canterbury earthquakes have demonstrated that there are certain characteristic reactions from, in particular, historic URM buildings (see Figure 7) that require an engineering response. These are:

- the reaction of URM walls to out-of-plane demands;
- the collapse of heavy elements resulting from traditional architectural practice and construction techniques (e.g., parapets and chimneys);
- The behaviour of double-skinned (cavity wall) construction compared to solid wall construction; and
- The behaviour of buildings of inconsistent geometries adjacent to one another (differential vibration, otherwise referred to as pounding).

(a) Building A parapet condition in October 2010

(b) Building A parapet condition in March 2011

(c) Building B facade condition in October 2010

(d) Building B condition in March 2011 – collapse of facade

(e) Building C post-22nd February 2011 – collapse of outer leaf of cavity wall

(f) Building C post-13th June 2011 – collapse of inner leaf of cavity wall

Figure 7: Post-earthquake observations of out-of-plane failures to URBM buildings in Christchurch (after Walsh et al. [21]).

3.3 Other risks

While there is great focus, and not without reason, on the potential risk of building collapse from earthquake activity, it is accepted that the probability of an earthquake event of sufficient magnitude to cause the type of damage witnessed during the Canterbury earthquakes is less likely than other major environmental risks, such as typhoon, flooding, landslide or tsunami. A geological event more likely to occur might be volcanic (according the Auckland Council Civil Defence website there is an 8% probability of such an event over an 80 year period), yet there is no requirement to retrofit or design new buildings for ash-loading from such fallout. The psychological difference is this – the Canterbury Earthquakes *occurred.* What was a risk became an actual event, with consequences.

More frequent, as part of the regular cycle of things, are the effects of inclement weather, particularly high wind, on ineffectively maintained

buildings, or other risks such as fire damage or vandalism. The greater geographic area of the new Auckland Council is rural, with many isolated places of historic value that are prone to anti-social behaviour, at risk from arson, or difficult to maintain. Prior to the Canterbury events, owners could mitigate the risk of such events through a standard insurance policy

3.4 Auckland Council's heritage portfolio and its exposure to the consequences of earthquakes

Auckland Council has a statutory responsibility to recognize and provide for the protection of historic heritage under the following Acts:

- The Health Act 1956;
- Burial and Cremation Act 1964
- Protected Objects Act 1975 (formerly known as the Antiquities Act);
- Reserves Act 1977;
- Conservation Act 1987;
- Resource Management Act 1991;
- Historic Places Act 1993;
- Local Government Act 2002; and
- Building Act 2004.

These Acts, as well as local policy, require Auckland Council to meet relevant statutory requirements for land it owns and administers, to obtain relevant Heritage New Zealand archaeological authorities for any work that may affect an archaeological site, to work within the Auckland Plan's strategic directions, directives and actions, and to lead by example when it comes to heritage protection. Auckland Council owns heritage properties through a number of means:

- Purchased for protection;
- Gifted to council;
- Built Heritage Acquisition Fund;
- Built for public service but become "heritage"; or
- Acquired for other purposes.

As of September 2014, Auckland Council has identified 217 buildings recognised as "heritage" with either Heritage New Zealand or the local authority. The estimated capital value of these buildings is almost one billion dollars (although one building – the Civic Administration Building on Greys Avenue – accounts for approximately 15% of that total). These heritage buildings accommodate a variety of council service functions, as well as house commercial tenants, as summarised in Table 2.

Table 2: Summary of functional uses being offered in heritage buildings owned by ACPD.

Functional uses	# bldgs	Avg. floor area (m^2)	Estimated total floor area (m^2)
Arts/Museum/Cultural Centre	6	880	5,280
Cafe/Restaurant	4	160	640
Camp/Hut/Lodge Building	3	?	-
Chapel/Crematorium	2	109	218
Childcare Facility	1	320	320
Commercial/Investment Building	23	1192	27,418
Community Centre	3	562	1,685
Community Facility	33	376	12,413
Community Hall	22	358	7,885
Community House	7	278	1,949
Council Office/Service Centre	8	7508	60,067
Farm Building	9	236	2,128
Fire Station	1	?	-
Library	6	624	3,744
Public Toilet/Changing Shed	24	45	1,087
Residential	41	787	32,256
Residential Garage	2	?	-
Sports Facility	6	280	1,678
Stadium/Grandstand/Arena	1	990	990
Swimming Complex/Aquatic Centre	2	1655	3,310
Visitor/Information Centre	2	?	-
Works Depot/Utility Building	7	318	2,223
Mixed Use	4	880	3,518
Total	**217**	**778**	**168,808**

Of the 217 heritage buildings owned by ACPD, 29 (13%) have been assessed as potentially "earthquake-prone" using either a preliminary or initial assessment method, 46 (21%) have been assessed as potentially "earthquake-risk," 12 (6%) have been assessed as either "low risk" or "compliant," and the remaining 130 (60%) have not yet been assessed. However, most of the buildings not assessed are buildings with low importance levels (e.g., toilets and infrequently occupied facilities) or buildings known to be constructed of timber framing (see Figure 8), so most are unlikely to be "earthquake prone." Nonetheless, the ACPD heritage portfolio is likely to have more seismically vulnerable buildings and building components (e.g., chimneys and parapets) than the Auckland non-domestic building population at large, given the relative age of the buildings in the portfolio. In Figure 9, the buildings are grouped into ranges of years of construction consistent with major updates to the loading standard and with previous typological groupings used in New Zealand [17], [20], and [7].

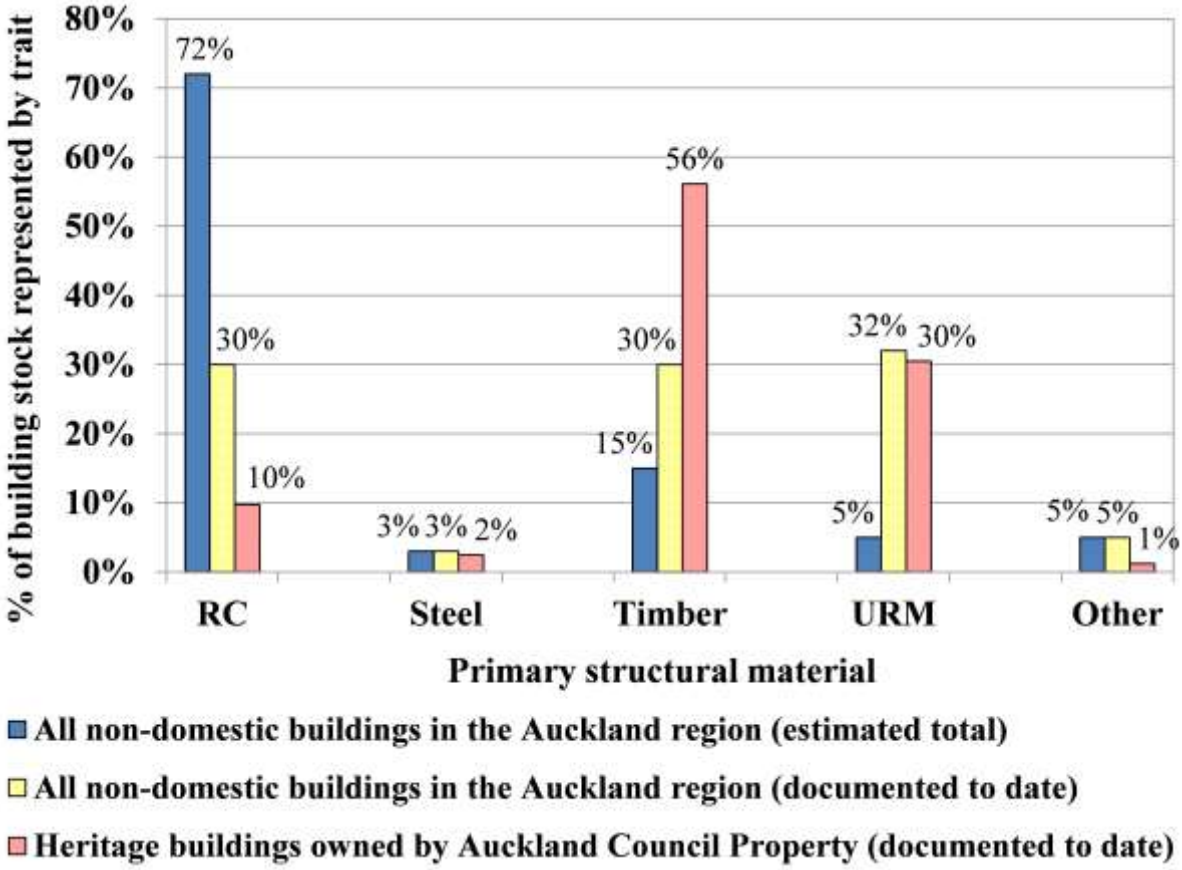

Figure 8: Proportions of estimated and documented non-domestic URM buildings in Auckland by primary structural material type.

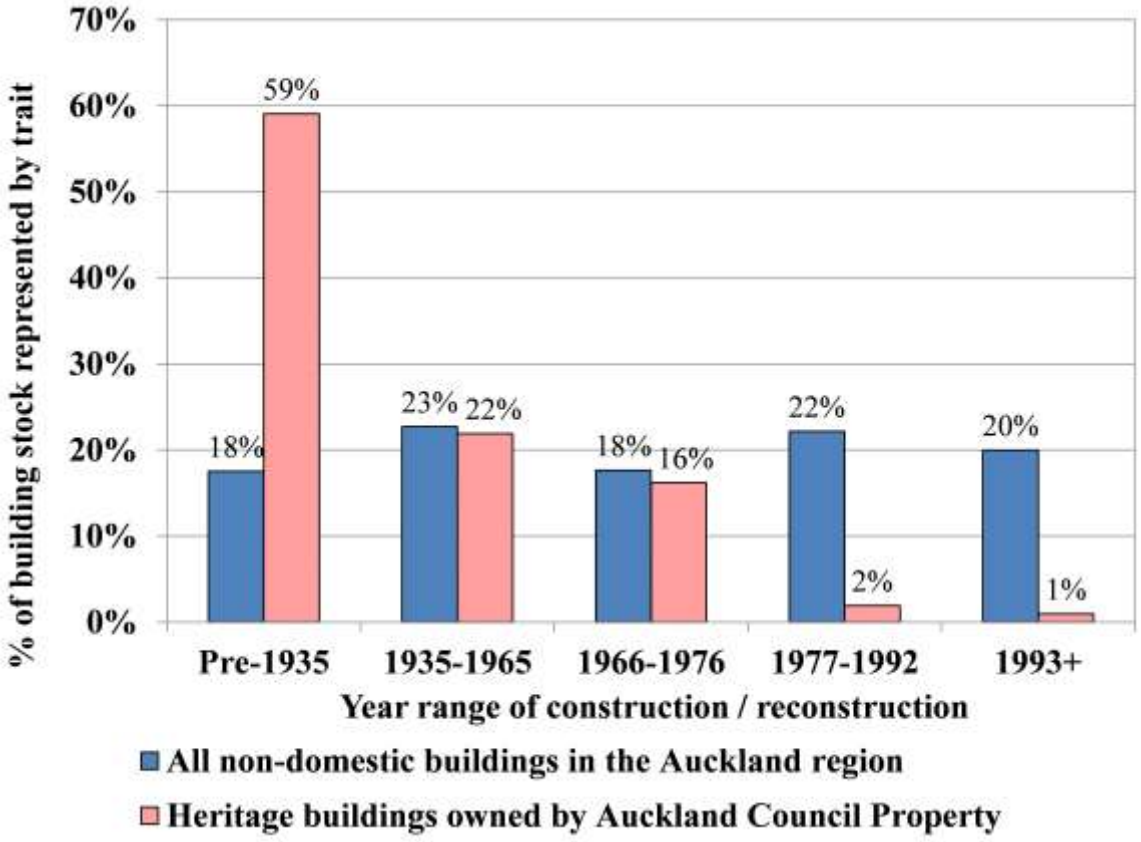

Figure 9: Proportions of documented non-domestic buildings in Auckland by year of construction or reconstruction.

3.4.1 Strengthen, remodel or demolish? A council perspective on engineering retrofit in the historic portfolio

Warkworth Town Hall was originally constructed in 1909, using a system of hollow, salt-glazed ceramic bricks patented by the Clark Brickworks, Hobsonville. The block was a large hollow rectangular brick with a vertical divider and was the precursor to the modern concrete block technology. This construction form is locally, regionally and nationally rare, with only four known buildings surviving regionally; the other three are all related to the former Clark works. Following the First World War, the hall was extended and internally altered in the 'Art Deco' style. Subsequent addtions in the latter half of the 20th century created unsympathetic **additions**. The building is registerd as a Category A building in the District Plan, and is also on the New Zealand Heritage List as a Category 1 historic place, largely because of its technological construction and its historical context.

Figure 10: Warkworth Town Hall; past, present and possible future iterations

The hall was assessed by the former Rodney Council in 2005 for seismic performance and found to be earthquake prone. Following amalgamation it was subsequently closed in 2011 after structural issues where identified. Public consultation was undertaken to determine its fate. The process was not without contention, as not all members of the community were keen to retain the building. What came through strongly in the end, however, was a community desire to recognise its own bonds through its built heritage. As one online commentator stated:

> This building is a significant landmark in the area and provides a link to the past. Located close to the centre of town, the Town Hall is large enough to accommodate many important and varied activities. These include weddings, debutante balls, dances, movies, shearing competitions, children's ballet classes, musical events, and art exhibitions, to name but a few. All those who use this space have a sense of ownership and regard this historic building as a community icon. I believe that we need to restore the Town Hall to a functioning building again so that we can keep enjoying this valued part of our community. [D Gannaway 2012]

Ultimately it was decided to keep the hall, and Art Deco extension, which also has heritage significance. The later accretions are to be removed in a phased programme of work, with a new extension and remodelling of the upper floor to accommodate a lift and link to the new extension. The overall budget for the first phase of development, including the new build extension, was $3 million. The role of the Rodney Local Board was critical in securing funds for the first phase, and leading the support for fundraising to meet the targets for the future planned phases of work.

Figure 11: Non-fire rated Art deco interior alteration of main hall

The need to consider retention of original fabric was weighed against the seismic upgrade requirements. The nature of the glazed bricks – a key heritage feature, created some issues in terms of seismic upgrade options. In the end it was proposed that the interior Art Deco cladding, itself a non-fire rated material, could be replicated with a superior modern product. The removal of the cladding could then allow opportunity for internal strengthening to be applied, maintaining the original exterior appearance of the glazed brickwork. In this instance, the more significant, if less aesthetic, heritage fabric could remain visible.

3.5 Tools for seismically assessing buildings and estimating costs

Seismic assessments are performed in three generic stages as prescribed in the NZSEE assessment guidelines [17] – preliminary, initial seismic assessment (ISA), and detailed seismic assessment (DSA, which can be performed using a variety of methods). The initial evaluation procedure (IEP) is the method for ISAs preferred by most territorial authorities and is a provisional, qualitative screening procedure that provides an

approximate assessment of seismic risk. In comparison, a detailed seismic assessment (DSA) typically provides more detail and involves calculations and/or computer models specific to the building being assessed. A "preliminary" assessment for purposes of this programme is effectively the IEP sans an assessment of critical structural weakness (CSWs, which are generally geometric irregularities). The procedure can be applied knowing only the building height, structural system, age of construction, and importance level [16].

As of mid-2014, over 500 seismic assessments had been performed on buildings owned by ACPD (including heritage as well as non-heritage buildings), including approximately 350 preliminary assessments, 160 IEPs, and 6 DSAs. Critical building characteristics needed for a risk assessment of the portfolio are summarised in Table 3. Floor areas were taken from representative buildings within each portfolio-risk group, and if not available from the service provider, were generally calculated as the footprint area measured from Auckland Council GIS multiplied by the number of storeys visible above grade. Extrapolated data intended to represent the entirety of each service portfolio was determined by taking the percentages of seismic risk groups for the buildings assessed within each service portfolio and applying them proportionally to those buildings that have not yet been assessed by any method.

Table 3: Summary of critical building attribute assumptions.

Service Portfolio -->	Corp-orate	Libra-ries	Comm-unity	Rec & Aquatic
Typical floor area of EQ-prone bldg. in portfolio (m^2)	900	570	500	5100
Typical floor area of EQ-risk bldg. in portfolio (m^2)	3000	720	700	4000
Importance Levels	2-4	2-3	2-3	2-3

Assumptions for preliminary cost estimates were based on a small number of case studies, as well as general proprietary knowledge provided to the technical leads at Auckland Council by local engineering consultants. Preliminary, empirical models for estimating the costs associated with commissioning detailed seismic assessments are shown in Figure 12. Note that these preliminary models do not account for differences in structural system, importance level, existing %NBS, target %NBS (desired after retrofit), or specific DSA methodology. Furthermore, ACPD expects that grouping buildings into packaged DSA projects may keep the cost of DSA per building lower than is indicated in Figure 12. DSAs are generally expected to be less expensive in Auckland/Hamilton than they are in Wellington, probably because of the higher design demands in Wellington and associated increased complexity of analysis and liability for the engineer.

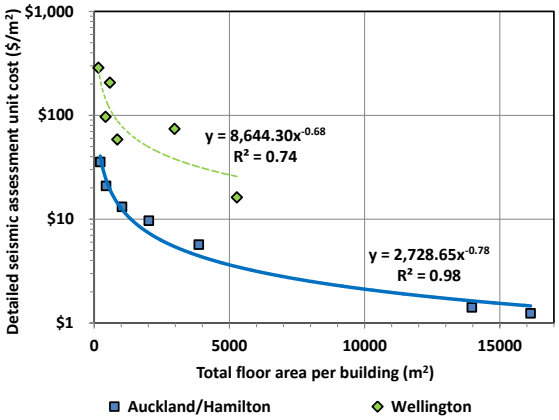

Figure 12: Preliminary, empirical models for estimating the cost to commission a detailed seismic assessment (DSA) in Auckland/Hamilton and in Wellington, respectively.

To date, seismic retrofit costs have been assumed to be approximately \$500/m^2 on average in order to upgrade buildings to 33%NBS and approximately \$600/m^2 on average in order to upgrade buildings to 67%NBS with variations accounting for existing %NBS and target %NBS considered. These values do not account for costs associated with non-seismic rehabilitation works, though such costs are being considered in ongoing efforts. The authors wish to emphasise the expectation of a very high variance in construction costs, and intend to control such variances as much as possible by packaging buildings of similar structural configurations and geographic locations together in future requests for proposal to engineers, architects, and contractors. Ongoing efforts to derive assessment and construction costs from recent seismic retrofit projects will lead to the development of more sophisticated models in the near future accounting for specific structural materials and systems, as well as other variables.

3.6 Responding to stakeholders

In a recent article on the earthquake strengthening of 217-221 Parnell Road (a 'typical' URM building of historic construction, though not listed or scheduled), a local newspaper, the *East and Bays Courier* captures some of the sentiment that Auckland Council recognises from its stakeholders.

> It's the building, with those bones, high ceilings, the beautiful leadlight windows. It's just part of that whole feel of something beautiful from a bygone era that can still be enjoyed in this time. A lot of my customers associate that with the shop. [8]

We see this almost daily at the planning coalface, as our heritage advisors and planners liaise with businesses, owners and tenants of commercial 'historic', or scheduled heritage buildings.

> This is affecting a lot of people. I've talked to people in Remuera, in the city, everywhere, in the same situation. [8]

The article describes the owner's concerns with the cost, but also their desire to absorb this and retain 217-221 Parnell typifies, 'the good steward'. Other examples relate not just to the cost of works, but effects on insurance premiums, to quote a reported example from Wellington:

> Simpson, like hundreds of other owners of properties that have been deemed earthquake-prone, finds himself caught in a financial pincer**.** He is trapped between the obligation to meet enormous insurance premium hikes while at the same time needing to save for the earthquake-strengthening work required on the old block of flats in which he lives. For Simpson being chairman of the body corporate at the 1928 Blythswood apartment building in central Wellington has begun to feel like a full-time ob. He says even before the Christchurch earthquakes, insurance cover for older buildings was drying up and premiums were slowly rising. But nothing prepared him and other owners of heritage apartments and buildings for the effect the Christchurch events would have on premiums. At Blythswood, building replacement insurance two years ago was $14,000 a year Last year it was $52,000. This year it is $132,000. [2]

Such stories have also been reported to the Heritage Unit in Auckland by building owners, prompting a proactive strategy to develop advice notes and liaise directly with insurance agents – but further work needs to be done here. The shift to 'sum insured' models also obscures the perceived cost in relation to insurance premiums, but for owners of heritage buildings finding an insurer can be a fraught process. In many cases the use of specialist chartered surveyors and insurance brokers, while incurring initial costs that owners are unused to paying, may result in long-term savings on premiums.

Others have also been caught by the interim response to the Canterbury Earthquakes. Five years ago, the Grade B scheduled Achilles House on Customs Street was upgraded, though not seismically. Responding to the government's proposed requirements for the Building Act, the owners are now seeking to retrofit seismic upgrades to the building, while seeking to maintain its tenants. In the main developers are meeting these costs themselves, but more support would be appreciated. In fact the authors are aware of only one specific grant for assisting earthquake strengthening that has been provided to the owner of a heritage building to date. This was for strengthening works to the Empire Hotel on Lorne Street, and was for less than $20,000. Other groups, in particular Churches whose assets are vulnerable but do not produce much in the way of economic return, are extremely concerned by such costs. This is requiring some hard decisions to be made around the retention of built assets.

3.6.1 The Auckland Council Seismic Steering group

In response to both the Canterbury Earthquakes Royal Commission of Inquiry report, and the proposed changes to the Building Act, Auckland Council formed a seismic steering group in 2013. The purpose of the group was to reflect key stakeholders within the Council Structure, who were able to identify and reach other internal departments, or to identify and liaise with external interests. The key areas of council represented by the Seismic Steering Group are:

- Property (ACPD);
- Building Control;
- Civil Defence and Emergency Management (CDEM);
- Community Facilities;
- Heritage;
- People and Capability Department;
- Communications; and
- Finance.

The role of the committee was to specifically consider an organisational response to the government's proposed amendments to the Building Act, and to make submission on behalf of the Council and the general community of Auckland. The importance of establishing such a group within an organisation of the size and complexity of the Council is clear. The role of the group is to continue to develop a policy response, and to consider the needs of its community and key stakeholders when providing internal advice to the organisation.

In the wake of the series of seismic events that struck Canterbury in 2010-2011, there has been a considerable increase in the perception of risk posed by earthquakes to communities across New Zealand. Particularly in places such as Auckland this has led to the need to communicate with building owners, tenants, the public, and other entities to balance the genuine needs for greater resilience with the practicalities and truths around such work.

For building owners there has been a lot of effort put in by council staff into providing points of contact and publishing guidance material to help them understand how buildings were being assessed, and what future action might need to be taken. Reassurance that the council is looking

pragmatically at how legislative requirements can be actioned has been of particular importance following concerns that the whole process was being done without ground-truth understanding.

Another set of stakeholders that the Council has engaged with are insurance companies, banks, and their respective collective councils. Driven by financial considerations around the management of risk to, or posed by, older buildings their initial reluctance to provide lending finance or insurance on such structures led to valid concerns around loss of tenants and the crippling of businesses through this work. Auckland Council had an involvement in this regard by liaising with, sharing information, and discussing long-term plans with these entities. Many have become a lot more confident in working with owners to find appropriate solutions, rather than withdrawing their involvement and support.

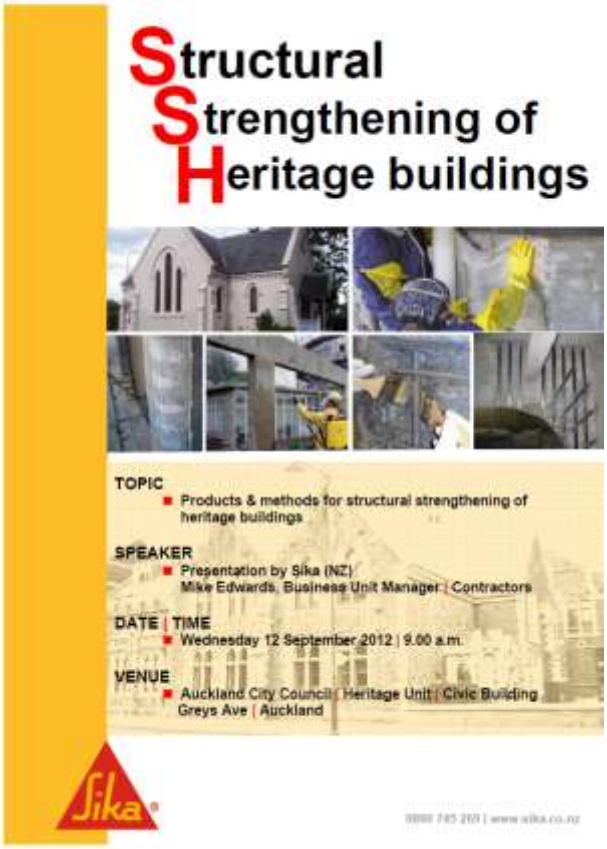

Figure 13: Example of practical advice to building owners - a seminar by contractors on earthquake strengthening techniques organised by Auckland Council Heritage Unit, 2012

3.7 Delivering Value

For the owners of 217-221 Parnell Road, there are business drivers, not the least of which is the cost on insurance, that determine their responses to the engineering risk of heritage buildings. But there are opportunities to explore here also. Costs are only economically unpalatable when there is no clear return on your investment to justify them. The Auckland Council as a property owner understands the problem of cost, but at least we have the ability to explain ours in terms of the long game, as custodians of the public benefit. We can demonstrate a social return on our investment, using the tools we have developed. In our experience, business owners often struggle to see this public good as justification, and perhaps fair enough – very often the 'status' of heritage is one not asked for by those who actually own and care for historic buildings.

We have explored the key areas of risk as experienced at Christchurch – poorly tied facades, unstable parapets. What is more, the failure of some of these elements can be triggered by factors that are non-seismic in nature, especially when combined with maintenance neglect. These things can be relatively cheap to retrofit, and to do it sensitively, but there is still a perception that there is no return on this investment. To the tenant, there may be increased safety from the risk of seismic event causing harm, but will they swallow the cost of increased rents to subsidise an owner, as for example at Achilles House? Where the owner is the occupier, there is no added value to be had here, except perhaps in reducing insurance premiums.

The local authority has potential to add value here. Systematic street upgrades might allow works to be undertaken, and also deliver a more inviting public realm, that in turn attracts new custom to commercial buildings. Flagship projects, such as the additions to Lopdell House and art gallery, or Shed 10, also signal intent by local government to invest in heritage buildings on part of the broader community, and can help to attract new investment. There is perhaps no clearer example in Auckland than the Britomart redevelopment programme, to highlight where a private-public partnership type approach can generate new economic and social interest, and create vibrant places.

Figure 14: Karangahape Road, Auckland. The Seismic Exemplar project combined with street upgrades might provide the opportunity to incentivise private owners of such buildings to upgrade.

4. Conclusions

Auckland Council recognises the responsibility to safety that needs to be respected when caring for

our heritage buildings. It also needs to recognise that there are inherent tensions in the message it is required to send as a regulator, and the message it wants to send as an advocate. Very often we are met with the response from private owners that 'Council' is placing a double-burden on them – to retain historic buildings for public benefit, while requiring additional expenditure. In fact there are more complex drivers here, including the role of central government, the lending requirements of banks, the premiums required by insurance companies, and market forces in relation to property value. However, it is easy to label one or another party as the cause of woe, especially in the emotive space between the desire to retain our heritage, our livelihood, and yet to address the risk to life.

Sometimes, as regulators, where we can best assist our stakeholders, ratepayers and communities is to accept our role, and absorb some of the negative emotion that comes with it. We have a statutory function, and that is to ensure that property owners, including ourselves, reduce risk of fatal harm from seismic events and other environmental hazards. But on top of all this is the question "is this cost worth it?" This question needs to be answered carefully, thoughtfully, as leaders by example and with the best data that we can make available to assist other people to make an informed choice. Then, and as advocates, we can seek for an appropriate balance to reduce risk, and raise resilience.

5. Acknowledgements

The authors wish to acknowledge the financial, resource, and informational support provided by the Auckland Council departments of Heritage, Building Control, Property (especially Nicola Short and Heather Crawcour), and Civil Defence and Emergency Management (especially Clive Manley and Richard Woods). Also the financial and community support from Waitemata Local Board and Rodney Local Board in relation to the Seismic Exemplar project and the Warkworth Town Hall project respectively. The work done by former and current students and researchers led by Professor Jason Ingham at the University of Auckland including Alistair Russell, Charlotte Knox, Dmytro Dizhur, Nasser Almesfer, Ronald Lumantarna, Chris Luttrell, and Kirby McClean; and by Professor Mike Griffith and Lisa Moon from the University of Adelaide is referenced herein.

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