From Disaster to Resilience: A Comparative Study of Legal Frameworks for Managing the Seismic Risk of Existing Buildings

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Acknowledgements

This research was bookended by some pretty extraordinary circumstances, concluding the same way it began – in the midst of a nationwide Level 4 lockdown. While the COVID-19 pandemic presented some interesting challenges to the research process, it also ironically thrust some core concepts from this thesis into the spotlight. The importance of disaster risk reduction and planning in advance for the impact of hazards is as true for a pandemic as for an earthquake. COVID-19 has demonstrated, in many countries, the consequence of being caught off guard and underprepared for a well-established, albeit "invisible", threat. I was inspired throughout the research period by many strong parallels between the handling of this pandemic and the importance of planning in advance for the next, inevitable, strong earthquake. Though rare, much like the pandemic, it is a matter of when, not if, this will occur. The need for preventative planning rather than reactionary response is paramount.

First and foremost, I would like to thank QuakeCoRE for funding this project and allowing me the opportunity to engage in such a vital research area. It has been almost three years since I was first involved with QuakeCoRE, first assisting with legal research focused on emergency cordons. I could never have guessed I would complete a Master of Laws, let alone on a topic as specific and unique as the regulation of existing buildings. I had to learn a substantial amount of engineering and scientific concepts for this research, which would not have been possible were it not for the wonderful contacts I have met through QuakeCoRE.

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Abstract

Though rare and unpredictable, earthquakes can and do cause catastrophic destruction when they impact unprepared and vulnerable communities. Extensive damage and failure of vulnerable buildings is a key factor which contributes to seismic-related disasters, making the proactive management of these buildings a necessity to reduce the risk of future disasters arising. The devastating Canterbury earthquakes of 2010 and 2011 brought the urgency of this issue to national importance in New Zealand. The national earthquake-prone building framework came into effect in 2017, obligating authorities to identify existing buildings with the greatest risk of collapse in strong earthquakes and for building owners to strengthen or demolish these buildings within a designated period of time. Though this framework is unique to New Zealand, the challenge of managing the seismic risk of such buildings is common amongst all seismically-active countries. Therefore, looking outward to examine how other jurisdictions legally manage this challenge is useful for reflecting on the approaches taken in New Zealand and understand potential lessons which could be adopted.

This research compares the legal framework used to reduce the seismic risk of existing buildings in New Zealand with that of the similarly earthquake-prone countries of Japan and Italy. These legal frameworks are examined with a particular focus on the proactive goal of reducing risk and improving resilience, as is the goal of the international Sendai Framework for Disaster Risk Reduction 2015-2030. The Sendai Framework, which each of the case study countries have committed to and thus have obligations under, forms the legal basis of the need for states to reduce disaster risk in their jurisdictions. In particular, the states' legal frameworks for existing building risk reduction are examined in the context of the Sendai priorities of understanding disaster risk, strengthening disaster risk governance, and investing in resilience.

While this research illustrates that the case study countries have each adopted more proactive risk reduction frameworks in recent years in anticipation of future earthquakes, the frameworks currently focus on a very narrow range of existing buildings and thus are not currently sufficient for promoting the long-term resilience of building stocks. In order to improve resilience, it is argued, legal frameworks need to include a broader range of buildings subject to seismic risk reduction obligations and also to broaden the focus on long-term monitoring of potential risk to buildings.

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I. Introduction

Despite contributing to only 8% of total global disasters, earthquakes caused one fifth of total direct economic losses and more deaths than any other natural hazard between 2000 and 2019.[1] Aside from tsunamis which are sometimes generated by powerful underwater ruptures, most harm and destruction experienced in earthquakes is the direct result of building failure.[2] Buildings designed with insufficient structural resistance to withstand the force of earthquakes are considered extremely vulnerable to damage and even total structural collapse when subjected to extensive shaking. Although generally lasting for only a matter of seconds or minutes, a short time is all that is required for earthquakes to cause catastrophe when they impact structurally-vulnerable buildings. For instance, despite lasting a mere 30 seconds, the 2010 Haiti Earthquake caused hundreds of thousands of buildings to collapse and produced a similar number of deaths.[3] The following year, in New Zealand, less than 20 seconds of strong shaking devastated Christchurch in what was described by then-Prime Minister John Key as "New Zealand's darkest day".[4] The force exerted on vulnerable existing built environments by these earthquakes, and many others around the world, serves as an example of the importance for better preparing buildings and societies to withstand the impact of earthquakes to prevent similar destruction in the future.

Today, many countries enforce building codes with strong seismic design requirements for the construction of new buildings. Nonetheless, many buildings which exist today were constructed prior to the introduction of these seismic codes and therefore remain a significant risk in earthquakes. Mitigating the risk of these buildings can be difficult, especially as earthquakes are unpredictable and low-probability events. This can often result in people

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[1] United Nations Office for Disaster Risk Reduction *Human Cost of Disasters - An Overview of the Last 20 Years: 2000-2019* (United Nations, United States, 2020) at 16.

[2] Shannon Abeling and others "Patterns of Earthquake-Related Mortality at a Whole-Country Level: New Zealand, 1840-2017" (2020) 36 Earthquake Spectra 138 at 138.

[3] David Randall "Earthquake in Haiti: Gone in 30 Seconds" (17 January 2010) The Independent <www.independent.co.uk>.

[4] "We May Be Witnessing New Zealand's Darkest Day: PM Says 65 Killed in Quake" The Sydney Morning Herald (online ed, 22February 2011).

having a low associated risk perception.[5] In fact, adequate preparedness remains relatively low for the impact of such rare and irregular events despite the potential destruction of earthquakes being well understood. Because risk perception is highly subjective, limited experiences with destructive earthquakes can lead to a general perception bias amongst individuals that such events are unlikely to impact them.[6] This can result in a limited incentive to mitigate risk. Strong leadership and regulation is necessary to motivate people, particularly building owners, toward taking preventative and risk-adverse action to reduce the seismic vulnerability of existing buildings.

With this in mind, all seismically-active countries face the shared enduring challenge of managing the risk presented by existing buildings to improve resilience. This research is an evaluation of New Zealand's legal response to this challenge, and compares it to the response of both Italy and Japan. The main purpose of this comparative study is to examine the legal approaches for reducing the seismic risk of existing buildings and consider any potential alternative approaches to managing building safety in New Zealand. Understanding how other jurisdictions utilise the law to prepare existing buildings for the impact of future earthquakes provides valuable insight into the different functional approaches used to address this shared challenge. Although unique circumstances and solutions have been adopted in New Zealand under the "earthquake-prone building" framework, the challenge of managing the seismic risk of existing buildings is far from unique. Critical insight from international experiences exposes potential gaps in the current framework applied in New Zealand and highlights methods which may be adopted for potential improvement. The ultimate goal should be to build on experiences and enable continued growth, developing legal frameworks which improve the resilience of building stocks and thus society to potentially damaging earthquakes.

This research is structured into three parts, each containing multiple chapters. The purpose of separating the work into three distinct parts is to clearly distinguish the content into core segments: background content, operational features of legal frameworks, and enforcement

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[5] Yibin Ao and others "Impact of Earthquake Knowledge and Risk Perception on Earthquake Preparedness of Rural Residents" (2021) 107 Natural Hazards 1287 at 1290.

[6] Miles H Crawford and others "The Low-Likelihood Challenge: Risk Perception and the Use of Risk Modelling for Destructive Tsunami Policy Development in New Zealand Local Government" (2019) 23 Australasian Journal of Disaster and Trauma Studies 3 at 7.

mechanisms for legal obligations. Part A – Frameworks for Reducing Existing Building Risk – introduces the reader to the theoretical background of disasters and hazard management. It also provides an overview of key concepts and general approaches to the management of existing buildings in the case study countries. Part B – Operational Features of Risk Reduction Frameworks – examines key features applied within legal frameworks to understand and manage the seismic risk of existing buildings in each of the countries. Part C - Key Mechanisms for Enforcing Legal Obligations – compares how relevant legal obligations are enforced against the owners of existing buildings, to ensure objectives for risk reduction are, in fact, achieved.

The first chapter outlines the theoretical basis used for this research. The Sendai Framework for Disaster Risk Reduction 2015-2030 is currently the leading international authority for the management of hazards and disasters. Adopted at the United Nations General Assembly in 2015, the Sendai Framework commits states to obligations under international law to pursue goals which reduce disaster risk in their communities.[7] The chapter highlights three priority areas for action listed within the Sendai Framework and establishes them as the basis for which the comparative study is assessed against. These include Priority One, Understanding Disaster Risk; Priority Two, Strengthening Disaster Risk Governance to Manage Disaster Risk; and Priority Three, Investing in Disaster Risk Reduction (DRR) for Resilience. Today, DRR is the main objective when dealing with hazards and their potential impacts, indicating a shift from managing disasters to managing the driving risks which cause disasters. The objective of DRR is led by a clear distinguishment between hazards and the resulting impact of hazards. This chapter argues that the shift towards DRR has been headed by a change in perception about disasters, understanding them not as “natural” events but rather social phenomena caused by the existence of underlying physical, social, economic and environmental risks. By understanding disasters as social phenomena, it becomes possible to develop appropriate DRR strategies to minimise the potential for disasters to occur.

With a relevant theoretical underpinning established, Chapter 2 then provides a general overview of the legal frameworks adopted in each of the case study countries to achieve risk reduction for existing buildings. A definition of ‘existing building’ is established for the purposes of this research, as a building considered to be seismically-vulnerable in relation to building codes enforced in the present day. Each of the case study countries applies a range of

[7] *Sendai Framework for Disaster Risk Reduction 2015-2030* GA Res 69/283 (2015).

voluntary and mandatory obligations for addressing the seismic risk of existing buildings. These are outlined in the context of the minimum legal standard of seismic risk adopted by each country, with a primary focus on protecting the life safety of building users and the wider general public. This includes assessing individual buildings and strengthening those which are considered to pose a high risk of collapse in earthquakes. The last section of the chapter argues for a more active intervention by states to address the seismic risk of existing buildings, in accordance with the preventative nature of DRR. This is needed not only to protect public safety, but also to minimise the overall disruption to livelihoods and communities from earthquakes.

Active approaches to the risk reduction of existing buildings generally involves authorities making assumptions about which specific buildings are likely to pose a significant threat of collapsing in earthquakes. Chapter 3 examines the way authorities identify existing buildings subject to risk reduction obligations, using building profiles. This typically involves physical characteristics such as the materials used to construct buildings and the year they were designed. Adopting these characteristics to identify existing buildings within risk reduction frameworks tend to focus on existing buildings with the greatest assumed seismic risk, which is argued to be a narrow focus on seismic risk and may lead to other at-risk buildings being overlooked within legal frameworks. "Priority buildings" provide a more holistic approach to understanding seismic risk, by considering the vulnerability of building occupants and the function of particular buildings. However, it is demonstrated that these buildings are targeted according to the aforementioned physical characteristics and the test is therefore also narrow in application. Finally, it is argued that the very limited inclusion of residential buildings within the risk reduction framework of New Zealand is counterproductive to improving resilience.

Chapter 4 compares the use of seismic hazard zones within legal frameworks for existing building risk reduction. Seismic hazard zones define areas based on their presumed seismic activity and are primary features within the legal frameworks of New Zealand and Italy. In practice, this means different legal obligations exist for the owners of certain buildings according to the seismicity of particular regions. Challenges surround the application of these zones, including the influence they have over people's perception of earthquakes and the need to engage with risk reduction measures. Seismic hazard is presented as seismic risk in New Zealand, which raises challenges in relation to the misuse of these terms. While seismic hazard zones can be useful for understanding where earthquakes are to be expected more or less frequently, caution is required to appreciate the uncertainty and limitations surrounding the knowledge used to create these zones. The potential for strong shaking should not be underestimated in any region of the case study countries, no matter how small the probability is assumed to be. Japan provides an example where risk reduction obligations for existing buildings apply equally in all areas of the country and not by seismic hazard zones, unlike New Zealand and Italy. A prominent example of this is the Christchurch region which, until the 2010/2011 Earthquake sequence, was located in a medium, not high, seismic zone.

The use of seismic building assessments to understand the nature of seismic risk amongst individual existing buildings is explored in Chapter 5. These assessments are often used to determine the need for significant legal risk reduction obligations and so the measures in place to ensure consistency and accuracy in their application are explored. In addition, requirements to publicise the risk information obtained from these assessments is also discussed, as a means of promoting risk reduction. There is also a tendency for restricted use of seismic assessments within risk reduction frameworks. Opportunities where their application may be useful are therefore missed, such as during periodic building maintenance and following strong earthquakes where no damage has been observed but where the structure may have nonetheless weakened. It is argued that seismic assessments should be used more widely as a practical means of promoting seismic resilience.

Chapter 6 examines the use of financial incentives provided to building owners for completing risk reduction. As a core feature of Priority 3 within the Sendai Framework, financial incentives not only help building owners to overcome often significant costs associated with seismic strengthening, but also work to encourage them to take action in the first place. It is argued that the New Zealand government still perceives costs associated with seismic risk reduction as unaffordable or burdensome in the short-term, rather than necessary long-term investments for the public good. Italy and Japan both offer a much wider range of financial incentives to existing building owners. This is compared to the much more limited range of incentives in New Zealand. It is also noted that access to financial incentives in New Zealand and Italy are restricted to areas with greater seismic hazard. It is argued that such restrictions delay the achievement of DRR and that incentives should be provided in all areas where existing building risk needs to be reduced, as is applied in Japan.

Chapter 7 examines the use of timeframes as a strategic planning tool used to enforce DRR obligations. Such timeframes are often used for establishing targets to be achieved within specific time periods, with statutory deadlines used in New Zealand to ensure building owners complete obligations by a certain date. The chapter argues that relying solely on regulation and the threat of formal sanctions is not the most efficient means of achieving risk reduction amongst existing building owners. Instead, focus should be placed on increasing the capacity for authorities to monitor and engage with building owners to assist with compliance. The use of compliance monitoring and a greater level of engagement between authorities and building owners is argued to be more proactive in attempts to achieve risk reduction within relevant timeframes.

The final chapter draws attention to an intersection between the seismic risk of existing buildings, and legal duties of care owed by owners to protect public safety. Such duties in each case study country require building owners to take all appropriate action to ensure people are not harmed by their buildings. Although external to administrative risk reduction frameworks for existing buildings, these duties present an interesting dynamic in relation to the obligations of building owners. While not explicitly designed with seismic risk in mind, they have nonetheless come to play a significant role in shaping risk reduction behaviour and expectations. In particular, challenges have arisen in relation to the sharing of risk knowledge about buildings and ambiguity around what action building owners are expected to take to comply with their duty of care. Greater clarity from authorities on this matter is argued as necessary. In addition, there is an important consideration to be had in relation to fulfilling these duties while operating within relevant timeframes allocated for building owners to remediate risk. This is particularly relevant within the context of statutory deadlines in New Zealand. It is argued that a duty of care may require building owners to take actionable measures to reduce risk from as soon as they become aware of risk, notwithstanding the official timeframe they have to carry out seismic strengthening or demolition.

The research ends much how it begins, advancing a call for a more active intervention to better understand and reduce seismic risk in line with the priority areas of the Sendai Framework. In recognition of the advancements made in recent years to more actively reduce the seismic risk of existing buildings, there remains much which can and should be done in order to enable long-term resilience. Legal frameworks today are largely designed to address existing buildings considered to pose the greatest threat to life safety in earthquakes, without providing a structure for addressing potential risk from other buildings which may nonetheless also pose a risk. In fact, this research demonstrates that legal frameworks to reduce the seismic risk of existing buildings is largely static, addressing risk for a single moment in time. Because risk is fluid and constantly changing, it is important for legal frameworks to provide flexibility in order to improve resilience.

Improving seismic resilience requires a collective effort, which becomes directly challenged when individual owners are provided the option to abstain from engaging in risk-adverse behaviour. Providing for the long-term resilience of existing buildings therefore ultimately requires a fundamental shift in the way building ownership and associated responsibilities are legally understood. As knowledge about seismic risk grows, the legal duty of states to manage and reduce this arguably provides increasingly less room for ignorance and turning a blind eye to the nature of such risk. Though the occurrence of earthquakes may be rare, the need to be prepared is evident and building owners should therefore be expected to incorporate this into the long-term management for buildings. Not only is this important to reduce harm and damage to persons and individual buildings, but also to minimise disruptions to communities and society as a whole.

II. Methodology

Siems argues good comparative law starts not with a legal topic, “but with a functional question”.[8] Beginning from a functional question is intended to free the researcher from any preconceived notions of how law is or should operate, and instead focuses on practical social issues common between jurisdictions. In this sense, the most simplistic purpose of functional comparative law is to compare the differences and similarities of legal solutions applied to shared problems.[9] A criticism of functional comparative law is that it over-assumes the similarity of social problems across legal systems.[10] In response to this, it is suggested that a clear distinguishment should be made to identify the intended function of a particular legal

[8] Mathias Siems *Comparative Law* (2nd ed, Cambridge University Press, Cambridge, 2018) at 16.

[9] Uwe Kischel *Comparative Law* (Oxford University Press, Oxford, 2019) at 8.

[10] Christopher Whytock “Legal Origins, Functionalism, and the Future of Comparative Law” (2009) 2009 Brigham Young University Law Review 1879 at 1886.

method and the consequence of whether this method has achieved its intended function.[11] This is logical since it considers the exact goals of jurisdictions in addressing particular issues, while also evaluating the success rate of the applied methods.

A quintessential element of comparison is not simply identifying the differences and similarities between legal solutions, but also investigating the logic behind why jurisdictions choose to adopt their particular approaches.[12] Such analysis raises challenges related to an awareness of inter-jurisdictional diversity, such as cultural, social, economic and political orders. There is a general tendency for functionalism to be impartial with different legal solutions, by disconnecting from particular meanings within legal systems and instead focusing on the relevant social issue. This is highlighted as a shortcoming of functionalism's ability to appropriately consider these quasi-legal factors. However, it is also noted that adequately representing all factors of contextual importance would be an entirely unrealistic standard for a comparative study to be capable of.[13] It is therefore necessary to strike a sensible balance between detachment of preconceived or biased legal norms and an appreciation for the deeper social characteristics that underpin the legal structures of each jurisdiction. This can, in part, be mitigated by examining jurisdictions that possess shared aspects of legal culture, as will be highlighted below.[14]

The purpose of this research is to examine the legal approaches taken by different countries to reducing the risk existing buildings from earthquakes. The functional question posed therefore asks how existing buildings are regulated to improve seismic resilience. It does not seek to propose superior legal solutions, but to illustrate a diversity of solutions for a common – and urgent – social problem. Buildings constructed before the enactment of modern building codes are assumed to have a greater potential of failure in large earthquakes, heightening the potential for disaster. From here, it is recognised that individual jurisdictions have different intentions and desired outcomes for addressing this challenge, which influence respective solutions. While this paper seeks to distinguish particular objectives of jurisdictions,

[11] At 1890.

[12] At 1890.

[13] At 1903.

[14] George Mousourakis *Perspectives on Comparative Law and Jurisprudence* (Pearson Education, Australia, 2006) at 54.

limitations related to the non-legal characteristics that influence legal systems are recognised in advance as inevitable. A concerted effort is made to detail the most important factors related to legal culture and allude to known limitations where relevant.

a. *Why Italy and Japan?*

As noted in the introduction, the decision was ultimately made to compare New Zealand with Italy and Japan. Several different options were initially considered for undertaking the comparative study, specifically an in-depth dual case study and a broader multi-country analysis. Three countries were considered to be an appropriate compromise, influenced by the length of this research and the potential to provide a detailed analysis. Two countries would have provided a narrow diversity of legal approaches to compare, while four or more countries was considered too many for a thorough analysis given the overall time constraints of this research project. In determining which jurisdictions to compare, consideration was given to those which share similarities with New Zealand in relation to the seismic risk of existing buildings. This includes seismic hazard and built environment, as well as the development level of each country.

Making a determination about the jurisdictions to use for the case study analysis in this research was influenced by their seismic hazard profiles and the national development levels, including economic and institutional capacity. The original intention was that this project would benefit from field research within the studied countries, including arrangements to visit the Graduate School of Disaster Resilience and Governance at the University of Hyogo in Japan. However, this became unavailable shortly into the initial stages of research as a result of COVID-19 travel restrictions. The resulting approach was therefore a desktop comparative study, which was then triangulated with interviews conducted over Zoom with professionals in earthquake engineering. Plans had been made to conduct Zoom interviews with professionals from both Italy and Japan, though ultimately only interviews with Italian professionals went ahead. Arrangements made with the Japanese professionals for interviews could not ultimately be carried through with as they did not respond to email requests for such. Despite this, the substantive number of published sources about the legal framework in Japan makes the author confident with the standard of analysis completed about Japan. While extensive research was still able to be conducted, the travel restrictions did provide less of a research foundation for the international jurisdictions as was originally imagined.

b. Seismic Hazard Profiles

New Zealand, Italy and Japan each demonstrate high levels of regular seismic hazard activity and share similarities in their built environments.[15] In these countries, powerful earthquakes are expected in the future and all have experienced multiple past earthquake-related disasters. Focusing on countries with high seismicity and experience of destructive earthquakes provides an opportunity to assess legal approaches which have a similar urgency in the need to address the risk of vulnerable existing buildings. It would not have been appropriate, for instance, to compare countries with no seismic risk, as the functional question in this research is directly focused on earthquakes. Each of the case study countries share a high susceptibility to frequent earthquakes, albeit of different strengths.

Earthquakes are typically understood according to their magnitude (M_w), with those of larger magnitude releasing more power than those of smaller magnitude.[16] An increase of 1 M_w represents an increase in the energy released by approximately 32 times.[17] For instance, an earthquake of M_w 6.0 produces approximately 32 times more energy than an earthquake of M_w 5.0, while an earthquake of M_w 7.0 produces approximately 1,000 times more energy. Thousands of earthquakes occur each day, though most have such a small magnitude that they are not noticed by humans. Earthquakes of M_w of 5.0 or greater are typically felt widely by humans and have the greatest potential for causing damage to vulnerable structures.

Each of the case study countries generally experience many earthquakes of M_w 5.0 or greater every year. Japan and New Zealand are located along the "Pacific Rim", which reaches across both sides of the Pacific Ocean and is the most seismically-active region in the world.[18]

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[15] Maxx Dilley and others *Natural Disaster Hotspots: A Global Risk Analysis* (The World Bank, Washington DC, 2005) at 43.

[16] There are many different ways to measure the magnitude of earthquakes. The most common measurement, especially for larger earthquakes, is the use of moment magnitude (M_w). M_w measures the amount of power released at the epicentre of earthquakes. For more detail on earthquake magnitudes, see: "Moment Magnitude, Richter Scale – What Are the Different Magnitude Scales, and Why Are There So Many?" United States Geological Survey <www.usgs.gov>.

[17] "Magnitude/Intensity" Pacific Northwest Seismic Network <www.pnsn.org>.

[18] Yong-Xian Zhang and others "Earthquakes and Multi-Hazards around the Pacific Rim, Vol. 1: Introduction" (2017) 174 Pure and Applied Geophysics 2195 at 2195.

Japan records the greatest number of large earthquakes of the three countries. Despite accounting for approximately 0.25 percent of the world's total landmass, the country has recorded more than 20 percent of global earthquakes registering above M_w 6.0 since modern records began.[19] This includes various major earthquakes including the infamous M_w 9.0 event experienced on March 11, 2011, which is one of the largest ever measured by humans.[20] In fact, there is an increasing understanding that similar-magnitude earthquakes may also be possible off the east coast of the North Island in New Zealand.[21] The largest earthquake recorded by humans in New Zealand was Mw 8.2 in the Wairarapa region in 1855, which caused the vertical uplift of approximately 5,000km^2 of land (or five times the size of Auckland).[22] Though events of this magnitude are rare, more than 15 earthquakes of M_w 7.0 or greater have been recorded in New Zealand since the beginning of the 20th century, totalling more than one per decade. Only two major earthquakes of M_w 7.0 or greater have been recorded in Italy since the beginning of the 20th century.[23] Nevertheless, damaging earthquakes have occurred in Italy on average every five years since the mid-20th century, with eleven registering at M_w 6.0 or greater.[24]

While each of the case study countries are susceptible to powerful earthquakes, a more accurate measurement of potential impact on humans comes not from M_w but from ground shaking. The ground shaking produced by earthquakes depends on multiple variables which interact with M_w, including depth and soil type. For instance, earthquakes which rupture deep within the Earth are likely to produce weaker overall ground shaking than earthquakes which rupture closer to the surface.[25] The proximity of earthquakes to human societies also significantly influence potential ground shaking, with more severe shaking expected nearer to an earthquakes' epicentre. For instance, the 2009 Dusky Sound Earthquake (M_w 7.8) ruptured

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[19] Aya Osada, Tayayuki Teramoto and Toshio Okoshi "Progress Report of Seismic Evaluation and Retrofit of Old Buildings Along the Specific Emergency Transportation Roads in Tokyo" (paper presented to 17th US-Japan-New Zealand Workshop on the Improvement of Structural Engineering and Resilience, 2018) at 2-3-1.

[20] "20 Largest Earthquakes in the World" United States Geological Survey <www.usgs.gov>.

[21] Crawford and others, above n 6, at 3.

[22] "Where Were New Zealand's Largest Earthquakes?" (24 November 2016) GNS Science <www.gns.cri.nz>.

[23] "A Timeline of Major Earthquakes to Hit Italy" (24 August 2016) The Guardian <www.theguardian.com>.

[24] Marco Donà, and others "Mechanics-Based Fragility Curves for Italian Residential URM Buildings" (2020) 19 Bulletin of Earthquake Engineering 3099 at 3099.

[25] "Shaking Intensity" GeoNet <www.geonet.org>.

in the largely isolated New Zealand region of Fiordland and caused relatively little damage, despite its power. In comparison, the 2011 Christchurch Earthquake (M_w 6.2) ruptured within the city boundaries. This close proximity, alongside a shallow depth of approximately 5km, caused significantly greater ground shaking than the 2009 event despite being of substantially lesser magnitude. Indeed, severe ground shaking has recently also caused significant harm and damage from smaller magnitude earthquakes in both Italy and Japan. In 2018, an earthquake of M_w 5.6 in Osaka, Japan, caused multiple deaths and damaged thousands of buildings.[26] In 2016, an earthquake of M_w 6.2 similarly caused severe shaking and led to hundreds of deaths and severe damage to thousands of buildings in central Italy.[27]

The vulnerability of the built environment in the communities where these earthquakes have occurred or may occur is ultimately a significant factor in determining the outcome of harm and damage. As imaginable, most of the buildings which have been severely damaged or collapsed in past earthquakes were not designed in accordance with appropriate seismic design standards. While the building stocks of the three case study countries are different in nature, they share many similarities in relation to seismic vulnerability. Sufficient seismic building regulations were not implemented until the late 20th century, meaning many buildings which exist today were constructed in the absence of, or with inadequate, construction techniques which help structures better resist the force of earthquakes (see Chapter 3). A large number of these buildings in Italy and Japan were constructed between the 1950s and 1970s, as part of reconstruction from the Second World War.[28] A significant portion of buildings designed prior to modern seismic codes also exist in New Zealand.[29] Many of these buildings have no information about their seismic capacity. As a result, much understanding of seismic risk amongst these buildings is purely assumed (see Chapter 3). This challenge is true for each of the case study countries, with a shared need to urgently attain such knowledge in light of high seismic threat. In New Zealand and Italy, this includes a noteworthy amount of heritage

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[26] Cabinet Office Japan *White Paper on Disaster Management in Japan 2019* (Government of Japan, 2019) at 14.

[27] See: Silvia Mazzoni and others "2016-2017 Central Italy Earthquake Sequence: Seismic Retrofit Policy and Effectiveness" (2018) 34 Earthquake Spectra 1671.

[28] Indera Syahrul and others "Incentives for the Conservation of Traditional Settlements: Residents' Perception in Ainokura and Kawagoe, Japan" (2015) 13 Journal of Tourism and Cultural Change 301 at 302.

[29] Martin Jenkins *Indicative CBA Model for Earthquake Prone Building Review: Summary of Methodology and Results* (Ministry of Business, Innovation and Employment, September 2012) at 7.

buildings, although many heritage buildings in Italy are substantially older than those in New Zealand.

Given the age of most heritage buildings, most completely lack sufficient seismic resistance. In Italy, more than half of all existing buildings are believed to have heritage value.[30] Both Italy and New Zealand have laws which strongly favour the conservation of heritage buildings, which inadvertently adds an extra layer of complexity to the challenge of seismic risk reduction when aiming to also preserve these buildings.[31] In comparison, Japan has less heritage buildings as building conservation protections were particularly relaxed, until the end of the 20th century.[32] Compared with many Western societies which generally tend to favour conserving heritage through material objects such as buildings, Japan has very few historic buildings owing to a more regenerative and non-material approach to heritage conservation.[33]

In addition to the actual structural vulnerability of buildings in these countries, it is also significant that growing population density increases the potential impact of earthquakes when they do occur in or near populated areas. On the whole, more people in Japan and Italy are exposed to earthquakes than are in New Zealand, which is reflected by the relatively few large earthquakes directly impacting populated areas despite their moderately frequent occurrence on average. For instance, the population density of New Zealand as of 2018 was estimated to be 19 people per km^2 of land, compared to 203 people per km^2 in Italy and 347 people per km^2 in Japan.[34] This is certainly a significant factor as to why there has been a greater number of earthquakes which have produced devastating effects in Japan and Italy compared to New Zealand. On the other hand, a greater concentration of people in fewer areas also creates its

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30 *Verso un Piano Nazionale per la Messa in Sicurezza delle Abitazioni e Dei Territori dal Rischio Sismico e Idrogeologico* (CR 401) Congiglio Nazionale Ingegneri (Rome, January 2013) (translation: *Towards a National Plan for the Safety of Homes and Territories from Seismic and Hydrogeological Risk* (CR 401) National Council of Engineers) at 49.

31 Alessandra Bellicoso "Italian Anti-Seismic Legislation and Building Restoration" (2011) 35 International Journal for Housing Science 137 at 140.

32 Eisuke Nishikawa "Development in Earthquake Countermeasures for Heritage Buildings in Japan" (2017) 8 Archeomatica 34 at 36.

33 See: Seung-jin Chung and Chang-sung Kim "The Development of Attitudes to Historic Conservation – From Eurocentrism to Cultural Diversity" (2010) 12 Architectural Research 25.

34 "Population Density" The World Bank <www.data.worldbank.org>.

own risks. The potential impact of earthquakes on such communities, if unprepared, may be significantly greater. This is true in all of the case study countries, where major urban centres in each are particularly vulnerable to the occurrence of strong earthquakes in the near future. When combined with structurally-vulnerable built environments, this produces a prime environment for disaster.

c. National Development Level

In addition to the seismic hazard profile of each country, the level of national development was also a significant factor when selecting comparator countries. Relatively similar circumstances were considered necessary to ensure an accurate and relevant study, including the governance capacity and economic strength of states to implement and enforce risk reduction measures. For instance, while New Zealand and Haiti are both seismically-active countries, there are marked differences in relation to their national wealth and institutional governance capacity to, for example, enforce strict seismic building standards. Given these circumstances, comparing the approach to seismic risk reduction between these countries would have been inherently problematic. For this reason, countries which share relatively similar standards of development to New Zealand were desired, such as Italy and Japan.

New Zealand, Italy and Japan are also considered wealthy economies by global standards and are all members of the Organisation for Economic Cooperation and Development (OECD). It is therefore reasonable to assume the three are in a strong position to implement and invest in risk reduction, relative to poorer countries. High up-front financial costs are commonly perceived as a barrier to implementing such measures, especially in relation to seismic strengthening of existing buildings where the cost of seismic strengthening may appear significant.[35] In addition, the greater development of a country is also likely to be a factor in a state's capacity to enforce with building codes, compared to low and middle-income countries.[36] Seismic building standards in New Zealand, Italy and Japan are often considered

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[35] Xijun Yao and others "Public-Private Partnership for Earthquake Mitigation Involving Retrofitting and Insurance" (2017) 23 Technological and Economic Development of Economy 810 at 811.

[36] Mary Picard *Effective Law and Regulation for Disaster Risk Reduction: A Multi-Country Report* (International Federation of Red Cross and Red Crescent Societies and United Nations Development Programme, New York, 2014) at 45.

amongst the most advanced in the world and often used as examples for building excellence. This shared assumed capacity to implement and enforce regulations for the built environment, alongside a similar seismic hazard profile, therefore warranted selecting these countries for the comparative study.

Part A
Frameworks for Reducing Existing Building Risk

Part A of this research serves as an introduction to the key components used for the comparative study in the latter parts of the thesis. It is separated into two Chapters, including a theoretical background and an overview of the legal approaches taken to reduce existing building risk. In order to understand the approaches taken to reducing the seismic risk of existing buildings, it is first necessary to recognise the exact purpose for seeking such an outcome.

Chapter 1 familiarises the reader with the concept of DRR and argues for a necessary change in perception of what constitutes a disaster, including the clear distinction between hazards and their associated impacts. DRR has become the foremost objective for the management of disasters around the world. This represents a shift away from managing disasters by aiming to minimise losses through a focus on response, and instead towards a more prevention-focused management and reduction of the risks that lead to disasters. This approach is at the centre of the primary international agreement for disaster management, the Sendai Framework for Disaster Risk Reduction 2015-2030. The Sendai Framework was universally adopted by the United Nations General Assembly in 2015 and has since been accepted into disaster management practices of the three case study countries. It serves as the functional basis for research analysis throughout this thesis, with legal approaches to existing building risk reduction examined in relation to the objectives and priorities of the Sendai Framework itself.

Chapter 2 of this research provides an overview of these legal approaches for risk reduction within the case study countries. Importantly, it provides an explanation for what is meant by the term ‘existing building’, within the scope of this research. Applying this definition, typical legal strategies to encourage or require existing building risk reduction are discussed, including seismic strengthening obligations when a building owner wishes to change the primary use or undertake major alterations of their building. Each of the case study countries apply a separate minimum standard of acceptable seismic risk for existing buildings and, consequently, adopt a variety of mandatory and voluntary obligations to drive building owners towards achieving the relevant standard. A better understanding of seismic risk posed by existing buildings and the policy objective of disaster risk reduction, as well as influence from previously-experienced seismic disasters, has seen governments of the case study countries take increasingly active legal intervention towards the reduction of existing building risk. Such a trend is necessary to adequately prepare for earthquakes and minimise the risk of future disasters occurring.

Chapter 1

The Intersection of Disaster Management and Law

> Disasters are no longer excuses or non-legal gaps; they are social phenomena that must be legally approached through our normal legal system, rather than as exceptions.
>
> Kristian Lauta[37]

Significant transformation has been made in recent years to focus on disaster prevention rather than simply disaster response. As a result, the main focus of disaster management has shifted from managing disasters and reducing losses, to managing and reducing the driving risks which create disasters themselves.[38] Each disaster is unique and offers its own complexities. As Kelman suggests, the "scale of a disaster is defined by its impacts".[39] These impacts are often understood through quantifiable factors, such as the scale of death and injury, physical and material damage, and economic losses.[40] The threshold for what constitutes a disaster ultimately differs based on cultural and social attitudes towards concepts such as misfortune, liability, and expectations around security.[41] In simple terms, a disaster may be understood as "a situation requiring outside support for coping".[42] Such an interpretation suggests that a disaster involves a significant disruption to a society and which subsequently requires external support to recover. Indeed, long-term impacts and recovery are intrinsic characteristic of disasters.[43] The United Nations Office for Disaster Risk Reduction (UNDRR) provides a more detailed definition of a disaster, being:[44]

> A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

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[37] Kristian Lauta *Disaster Law* (Routledge, Oxon, 2015) at 144.

[38] "New Zealand Strong on Sendai Framework (20 June 2015) United Nations Office for Disaster Risk Reduction <www.undrr.org>.

[39] Ilan Kelman (ed) *Disaster by Choice* (Oxford University Press, Oxford, 2020) at 45.

[40] John Hopkins "The First Victim – Administrative Law and Natural Disasters" (2016) 1 NZLR 189 at 199.

[41] Frank Furedi "The Changing Meaning of Disaster" (2007) 39 Area (London 1969) 482 at 486.

[42] Above n 39, at 15.

[43] Above n 40, at 199.

[44] "Disaster" (2021) United Nations Office for Disaster Risk Reduction <www.undrr.org/terminology>.

While this interpretation also includes the ideas of disruption and loss, arguably the most important aspect of the definition is the acknowledgement of "hazardous events interacting with conditions of exposure, vulnerability and capacity". The explicit separation of hazards from the resulting impacts on affected communities or societies establishes the disaster itself as a result of human-caused factors, namely exposure, vulnerability and capacity. This socialised interpretation of disasters forms the basis for DRR. DRR is the main policy objective of disaster risk management and has become the leading international approach to preventing future disasters.[45] By focusing on the drivers of the conditions which allow hazards to create the disruption and losses necessary for a disaster, planning and prevention measures can motivate the reduction of such disaster risks. This socialised perception of disasters has thus increased the focus of DRR, subsequently resulting in the Sendai Framework for Disaster Risk Reduction to coordinate this desired objective.

1.1 The Sendai Framework for Disaster Risk Reduction 2015-2030

The Sendai Framework for Disaster Risk Reduction 2015-2030 (referred to hereafter as the 'Sendai Framework') is the leading international authority for the adoption and implementation of DRR practices amongst states. The Sendai Framework promotes the concept of DRR as an operable instrument for the international community to draw upon, building on decades of work by the international community to better manage and prevent disasters from occurring.[46] It succeeded the previous Hyogo Framework for Action 2005-2015 (HFA), which sought to substantially reduce disaster losses.[47] Although successful for increasing public awareness and creating widespread political commitment to reducing disasters, the HFA ultimately failed in its goal to prevent a rise in disaster losses.[48] It was noted that exposure to hazards had increased at a far greater pace than vulnerability had decreased, leading to an increased number of persons and communities affected by disasters.[49] Instead of focusing

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[45] "Disaster Risk Reduction" (2021) United Nations Office for Disaster Risk Reduction <www.undrr.org/terminology>.

[46] *International Decade for Natural Disaster Reduction* GA Res 42/169 (1987) at 129.

[47] United Nations *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters* (22 January 2005) at [11].

[48] More than 1.5 billion people were affected by disasters between 2005 and 2015, including more than 144 million displaced persons, see: *Sendai Framework for Disaster Risk Reduction 2015-2030*, above n 7, at [3].

[49] At [4].

purely on reducing losses from disasters, the Sendai Framework seeks to minimise the occurrence of disasters by reducing the driving forces which significantly increase the potential for disasters in the first instance.[50] As mentioned in the previous section, this signals a shift "from managing disasters to managing risk [and] from focusing on disasters to focusing on risk".[51]

At its core, the Sendai Framework is designed to promote sustainable development by providing a framework for States to implement and follow more risk-adverse practices to avoid disasters.[52] The framework aims to achieve a substantial reduction in both disaster risk and disaster losses around the world by the year 2030, and includes seven tangible targets against which the progress of states is measured.[53] The international agreement is not designed to dictate specific risk reduction policies and strategies, but rather to help guide states on how to adopt and integrate risk reduction measures on a national and local level.[54] In this sense, the importance of the Sendai Framework can be understood as an interpretative tool and "methodological roadmap" to promote coherence for DRR planning around the world.[55]

By adopting the Sendai Framework and committing to a reduction in disaster risk, the Sendai Framework plays an important role in driving the behaviour of states under international law. Reducing disaster risk is understood as a legal duty, which states have a "primary" responsibility to implement.[56] Indeed, commitments to risk reduction under the Sendai Framework are derived from international human rights law, including treaties such as the

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[50] At [16].

[51] United Nations Office for Disaster Risk Reduction *Reading the Sendai Framework for Disaster Risk Reduction 2015-2030* (Geneva, 2015) at [31].

[52] The Sendai Framework is part of a broader international framework to promote risk reduction and sustainable development, alongside the 2015 Paris Climate Agreement and the United Nations Sustainable Development Goals, see: Emmanuel Raju and Karen da Costa "Governance in Sendai: A Way Ahead?" (2018) 27 Disaster Prevention and Management 278.

[53] Above n 7, at [16], [18].

[54] Above n 51, at [60].

[55] Eloísa Dutari and Cássius Chai "Disaster Risk Governance and Coherence: The Case of Incentives for Private Business to Foster Disaster Resilience and Sustainability" in K Samuel, M Aronsson-Storrier and K Bookmiller (eds) *The Cambridge Handbook of Disaster Risk Reduction and International Law* (Cambridge University Press, Cambridge, 2019) 275 at 279.

[56] Above n 51, at [89].

International Covenant on Civil and Political Rights (ICCPR) and the Universal Declaration of Human Rights (UDHR).[57] Implementing measures to reduce disaster risk is therefore not simply a desirable outcome, but one which states have legal obligations and commitments to achieving. The Sendai Framework is therefore designed as an authoritative instrument to both guide states toward DRR and to identify the overall progress made.

1.2 Understanding Disasters as Social Phenomena

Disasters are the result of a community or society failing to anticipate or adequately prepare for the potential impacts of hazards.[58] In this sense, disasters are not natural but instead social phenomena. When referring to disasters that transpire in the aftermath of natural hazards, there is a general tendency among professionals, media, and the public alike to describe them as 'natural disasters'. The phrase 'natural disaster' is itself a misnomer, as there is nothing natural about disasters. Although hazards and disasters are interconnected, they are in fact separate concepts. From a basic understanding, hazards may be understood as "something that is dangerous and likely to cause damage".[59] In law, hazards are generally understood as resulting from either human origin, such as war and technological failure, or natural causes, such as volcanic eruptions and earthquakes, and they often correlate to potential or actual harm to people and/or property.[60] The dangerousness of a hazard therefore comes not from its existence but rather its intersection with human society.[61]

When a hazard occurs within a human community or society, the readiness of the affected area to expect and endure the hazard will determine whether or not a disaster subsequently arises. For instance, recent earthquakes in Kobe (1995, M_w 6.9), L'Aquila (2009, M_w 6.3) and Christchurch (2011, M_w 6.2) are each examples of earthquakes resulting in disaster with significant human, physical and socioeconomic losses. The reason for these losses was failure amongst a significant amount of seismically-vulnerable buildings and infrastructure, which resulted in extensive displacement and disruption to the impacted communities. These

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[57] Above n 51, at [91].

[58] Tim Dixon *Curbing Catastrophe: Natural Hazards and Risk Reduction in the Modern World* (Cambridge University Press, Cambridge, 2017) at 36.

[59] "Hazard" (2021) Cambridge Dictionary <www.dictionary.cambridge.org>.

[60] Civil Defence Emergency Management Act 2002, s 4.

[61] Kelman, above n 39, at 40.

hazards led to disaster not because of the earthquakes themselves, but because the affected areas were unable to cope with the impacts of the earthquakes. While the occurrence of earthquakes may not be avoidable, the death, damage and disruption to society which they often bring is.

Distinguishing the hazard from the disaster in order to understand the latter as a socially-constructed, and therefore avoidable occurrence, has direct implications on legal approaches to disasters.[62] Perhaps the greatest implication is that disasters may no longer be understood as inevitable. Disasters have largely been understood throughout much of history to be what Quarantelli describes as "Acts of God" or "Acts of Nature".[63] When understood as an Act of God, a disaster is the result of supernatural or divine forces entirely disconnected from human beings, therefore invoking powerlessness in the ability to prevent them.[64] Around the age of enlightenment, with the experience of increasing secularism in many nations – at least in Western society – this perception shifted toward the concept of disasters being Acts of Nature.[65] Rather than extraordinary events sent by God, these phenomena were the result of natural environmental processes, such as the movement of plate tectonics causing movement of land.

The underlying assumption for these two perceptions of disasters was that they were either completely unavoidable (Acts of God), or were processes where some losses might have been minimised but were ultimately accepted as something which societies had to endure from time to time (Acts of Nature). As Quarantelli states, "if disasters are Acts of God, then a fatalistic attitude is proper [and] if disasters are Acts of Nature, then attempting engineering solutions is appropriate".[66] Today, owing to the distinguishment between disaster and hazard, disasters are broadly understood not as acts of God or nature but as social phenomena which

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[62] Lauta, above n 37, at 142.

[63] Enrico Quarantelli "What Should We Study? Questions and Suggestions for Researchers about the Concept of Disasters" (1987) 5 International Journal of Mass Emergencies and Disasters 7 at 8.

[64] Many legal systems still recognise "Acts of God" today as a defence for liability in relation to natural hazards, see: Graham G Dodds "'This Was No Act of God:' Disaster, Causality, and Politics" (2015) 6 RHCPP 44.

[65] Above n 63, at 9.

[66] Enrico Quarantelli "Disaster Planning, Emergency Management and Civil Protection: The Historical Development and Current Characteristics of Organised Efforts to Prevent and to Respond to Disasters" (Preliminary Paper no.301, University of Delaware Disaster Research Center, 2000) at 5.

result from a lack of preparedness against hazards. Importantly, this socialised understanding breaks the longstanding perception that disasters are inevitable and that engineering and technology-based solutions alone are the answer to minimising their occurrence. Disasters thus go from inevitable events associated with hazards, to avoidable occurrences when sufficient preparation and planning is undertaken in advance.

Distinguishing hazards from disasters also helps to re-frame the perception of a disaster as a process, rather than as an event.[67] It is inappropriate to characterise a disaster as an event because, as previously mentioned, disasters are phenomena which require long-term support and recovery. The event, often conflated with the disaster itself, is in fact the hazard and, in some instances, the emergency period used to respond to the hazard. An emergency is a situation which requires an urgent response, either in anticipation of a hazard (i.e. alerts for floods or storms) or in the immediate aftermath (i.e. search and rescue operations). As Hopkins suggests, "the fact that many disasters are also emergencies (or evolve from an emergency situation) should not blind us to the conceptual difference between the two terms".[68] A hazard may or may not lead to an emergency, which then may or may not ultimately lead to disaster. Though some hazards may immediately have such significant impacts that a disaster may appear obvious, such as the 2011 Christchurch Earthquake or the 1995 Kobe Earthquake, the disaster ultimately relates to the long-term consequences and recovery from emergency situations.[69] This distinction is important both conceptually and legally, as there is a general tendency for governments to rely upon emergency law when coping with disasters.[70] By reconceptualising disasters – from hazardous events to social phenomena – it arguably becomes easier to plan in a way that envisages preventing disasters themselves. Indeed, Matthewman argues that "event-based thinking avoids structures and processes leaving systems unchallenged".[71] This socialised understanding of disasters is a crucial element for contemporary disaster management planning around the world.

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[67] Michael D Cooper "Seven Dimensions of Disaster: The Sendai Framework and the Social Construction of Catastrophe" in K Samuel, M Aronsson-Storrier and K Nakjavani Bookmiller (eds) *The Cambridge Handbook of Disaster Risk Reduction and International Law* (Cambridge University Press, 2019) 36.

[68] Hopkins, above n 40, at 192.

[69] At 199.

[70] Lauta, above n 37, at 143.

[71] Steve Matthewman *Disasters, Risks and Revelation: Making Sense of Our Times* (Palgrave Macmillan UK, Basingstoke, 2015) at 136.

1.3 The Emergence of Disaster Risk Reduction

The fundamental purpose of understanding disasters separately from hazards is to strategise how to reduce the underlying risks which make communities and societies susceptible to the impacts of hazards in the first place. Concentrating on underlying disaster risk allows greater focus to be placed on reducing the overall impacts and disruption caused by hazards, therefore minimising the potential for disaster. Managing disaster risk signals a shift in emphasis from disaster response to disaster prevention, guided by the socialised understanding of disasters. As stated by the United Nations (UN) in 1994 at the first *World Conference on Natural Disasters*, "disaster response alone is not sufficient as it yields temporary results at a very high cost… [while] prevention contributes to lasting improvement in safety".[72] This requires greater energy and resource to be applied for addressing the driving forces of disasters, rather than responding to the consequences of hazards when they occur. It is this idea which DRR is premised upon and which forms the main principle of this research.

DRR is the desired objective of disaster risk management, and aims to both reduce existing and prevent new disaster risk within society.[73] Disaster risk may be understood as the existing susceptibilities of any given community or society which may cause or exacerbate the potential for disaster. The United Nations Office for Disaster Risk Reduction (UNDRR) defines disaster risk as "the potential [for disaster] which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity".[74] This definition clearly sets out disaster risk as an intersection between hazards and the concepts of exposure, vulnerability and capacity. Although exposure, vulnerability and capacity are conceptually distinguished, both exposure and capacity can be generally understood themselves as functions of vulnerability.[75] Indeed, disaster risk in this research is understood broadly as the product of hazard and vulnerability.

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[72] United Nations *Yokohama Strategy and Plan of Action for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation* World Conference on Natural Disaster Reduction (23 – 27 May 1994, Yokohama, Japan) at 4.

[73] Above n 45.

[74] "Disaster Risk" (2021) United Nations Office for Disaster Risk Reduction <www.undrr.org/terminology>.

[75] Alexander Fekete and Burrell Montz "Vulnerability: An Introduction" in S Fuchs and T Thaler (eds) *Vulnerability and Resilience to Natural Hazards* (Cambridge University Press, Cambridge, 2018) 14 at 21.

The concept of vulnerability within disaster management discourse is widely debated and is the subject of extensive research.[76] While such arguments are beyond the scope of the current research, it is nonetheless important to define vulnerability in the context of this study. Generally speaking, vulnerability relates to the susceptibility of individuals, groups, assets and/or systems to the impacts of hazards.[77] As Wisner suggests, vulnerability is "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, and resist and recover from the impact of a natural hazard".[78] While vulnerability is often thought of in relation to the fragility of physical assets, such as buildings and infrastructure, it also relates to the susceptibility of both people and systems in relation to their power to resist hazardous impacts. Vulnerability is therefore inherently political and constantly evolving depending on existing power imbalances both within and between communities.[79] This research is specifically focused on existing buildings. Therefore, vulnerability should be understood both as the physical fragility of these buildings and the susceptibility of communities owing to decisions about risk reduction obligations for them.

The goal of reducing these vulnerabilities is directly connected to the objective of enhancing the resilience of communities and societies against hazards. In the context of DRR, resilience "aims at a reduction of vulnerability by planning how to absorb shocks and minimise the impact of possible catastrophic events so that society can preserve its normal way of functioning".[80] Much like vulnerability, the term itself is widely debated in DRM discourse.[81] The official definition adopted by the United Nations understands resilience as the ability to "resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a

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[76] For further discussion on vulnerability, see: Sven Fuchs and Thomas Thaler (eds) *Vulnerability and Resilience to Natural Hazards* (Cambridge University Press, Cambridge, 2018) 14.

[77] "Vulnerability" (2021) United Nations Office for Disaster Risk Reduction <www.undrr.org/terminology>.

[78] Ben Wisner *At Risk: Natural Hazards, People's Vulnerability and Disasters* (2nd ed, Routledge, New York, 2004) at 11.

[79] Therese O'Donnell "Vulnerability and the International Law Commission's Draft Articles on the Protection of Persons in the Event of Disasters" (2019) 68 International & Comparative Law Quarterly 573 at 575.

[80] Alexia Herwig and Marta Simocini "Underpinning the Role of Law in Disaster Resilience: An Introduction" in *Law and the Management of Disasters* (online ed, Routledge, 2017) 1 at 5.

[81] See: Alexia Herwig and Marta Simoncini (eds) *Law and the Management of Disasters* (online ed, Routledge, 2017); Siri Wiig and Babette Fahlbruch (eds) *Exploring Resilience: A Scientific Journey from Practice to Theory* (Springer, 2018).

timely and efficient manner".[82] Despite being adopted by the international community as an objective of DRR, the ambiguity surrounding the concept of resilience has caused some to criticise the term as an "empty signifier" and effectively meaningless, with no clear definition or measurability.[83] Indeed, the UN definition of resilience is incredibly vague and arguably lacks clarity to be a truly operable objective of DRR.[84] However, Kimber argues that the concept of resilience is deliberately ambiguous, at least in part, to serve as a "driving force" for all States to coalesce around for the goal of creating "stronger and more robust" communities.[85] Kimber notes that resilience emerged in disaster management discourse in the late 20th century as a "positive replacement" to vulnerability; whereas vulnerability indicates a fixed susceptibility difficult to emerge from, resilience inversely suggests the potential to overcome and improve.[86] In this sense, resilience in DRR should not be understood as an optimal state of being but as a way to encourage strategic planning in communities to adapt and become more risk-adverse to hazards in the long-term. Failure to learn from previous disasters and adopt strategies to improve resilience against hazards arguably ignores the existence of underlying vulnerabilities and, therefore, does little to reduce disaster risk itself.[87]

It is a common perception that reducing disaster risk and improving resilience exclusively involves hard engineering and technological solutions.[88] This notion directly links into the perception of disasters as "Acts of Nature", as discussed above. While such measures are of course important for achieving DRR, so too is the use of soft non-physical measures, such as law and policy.[89] As Herwig and Simoncini argue, "law is an authoritative instrument for social steering".[90] Reducing disaster risk depends not simply on developing technology

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[82] "Resilience" (2021) United Nations Office for Disaster Risk Reduction <www.undrr.org/terminology>.

[83] Juergen Weichselgartner and Illan Kelman "Geographies of Resilience: Challenges and Opportunities of a Descriptive Concept" (2015) 39 Progress in Human Geography 249 at 249.

[84] Leah Kimber "Resilience from the United Nations Standpoint: The Challenges of Vagueness" in S Wiig and B Fahlbruch (eds) *Exploring Resilience: A Scientific Journey from Practice to Theory* (Springer, 2018) 89 at 93.

[85] At 93.

[86] At 93.

[87] Christopher Emrich and Graham Tobin "Resilience: An Introduction" in *Vulnerability and Resilience to Natural Hazards* (Cambridge University Press, Cambridge, 2018) 124 at 127.

[88] Roshani Palliyaguru, Dilanthi Amaratunga and David Baldry "Constructing a Holistic Approach to Disaster Risk Reduction: The Significance of Focusing on Vulnerability Reduction" (2013) 38 Disasters 45 at 52.

[89] At 52.

[90] Herwig and Simoncini, above n 80, at 3.

which can better resist the impacts of hazards, but also on assessing and changing behaviours and practices which ultimately create vulnerabilities in the first place. Law is a necessary component of this, as it helps to institutionalise clear expectations and duties to prevent the creation of new risk, reduce existing risk, and thereby improve resilience. As the core focus of this research is on reducing the risk for existing buildings in relation to earthquakes, law is essential for factors such as identifying potential risks and controlling building safety. Engineering and technological solutions are essential to, for instance, seismically strengthen existing buildings, but the requirement for and implementation of these measures is ultimately controlled by legal means.[91] In fact, a reliance on technology alone is not appropriate for resilience. The New Zealand Seismic Risk Working Group recently highlighted this, noting that "any implication that buildings can be designed to be 'earthquake-proof' should be avoided as a solution for resilience" and resilience should instead "reflect a broader set of controls and acceptance, under given circumstances, of effects that can be managed over a limited timeframe".[92] Guidance for practical and functional ways in which the seismic risk of existing buildings can be managed and reduced to improve resilience against earthquakes can be found within the Sendai Framework.

A final note should be mentioned that the term disaster risk is used interchangeably with seismic risk throughout this research. Seismic risk is merely used to describe disaster risk which is specific to the potential impact of earthquakes. It is recognised that the Sendai Framework encourages a "multi-hazard" approach to risk reduction, to appreciate the complex and often interconnected nature of hazardous impacts.[93] However, given the primary focus in this research is on existing buildings and the associated impact of earthquakes, seismic risk is adopted to emphasis this focus.

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[91] Sven Fuchs, Tim Frazier and Laura Siebeneck "Physical Vulnerability" in S Fuchs and T Thaler (eds) *Vulnerability and Resilience to Natural Hazards* (Cambridge University Press, Cambridge, 2018) 32 at 35.

[92] Seismic Risk Working Group *Rethinking Seismic Risk in the Building Control System: Options for Change* (Ministry of Business, Innovation and Employment, 3 November 2020) at 31.

[93] Above n 7, at [19].

1.4 Priority Areas of the Sendai Framework

As mentioned, the Sendai Framework highlights four key priority areas which require specific attention. It is the principal responsibility of states to ensure these priority areas are implemented within risk reduction frameworks.[94] They include 1) Understanding disaster risk; 2) Strengthening disaster risk governance to manage disaster risk; 3) Investing in disaster risk reduction for resilience; and 4) Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.[95] These priority areas are understood as essential for directing and focusing states to successfully achieve the goal of the Sendai Framework, to prevent new, and reduce existing, disaster risk and thus improve resilience.[96] Analysis of legal frameworks within this research is therefore completed with consideration of the extent to which they incorporate these priority areas. As this research is focused primarily upon the use of proactive and preventative action, only the first three priority areas listed in the Sendai Framework are considered.

1.4.1 Understanding disaster risk

Achieving a substantial reduction in disaster risk demands a sound comprehension of the presence, extent, and drivers of disaster risk itself.[97] For this reason, understanding disaster risk is perhaps the quintessential requirement for achieving risk reduction. The 2019 Global Assessment Report on DRR, commissioned by the UNDRR, highlights the importance of understanding disaster risk, noting:

> The ability to make a strong case for [providing] the evidence base for risk-informed development hinges on having access to risk information and knowledge. This entry point also encompasses public education and awareness campaigns to build a common understanding of why mainstreaming is important, and to secure the buy in of policymakers and other stakeholders to mobilise the resources and capacities needed.

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[94] United Nations Office for Disaster Risk Reduction, above n 51, at [16].

[95] Above n 7, at [20].

[96] Above n 51, at [30].

[97] At [47].

Understanding disaster risk is important not only for decision-makers in their ability to implement and require appropriate risk reduction measures, but also for the general public to have an awareness of disaster risk and what is expected from them. As the Sendai Framework outlines, DRR is an "all-of-society" effort and therefore requires buy-in from all stakeholders through the utilisation of appropriate knowledge, information, and education.[98] The measures applied within legal frameworks to understand the seismic risk presented by existing buildings is critical not only for establishing appropriate DRR measures, but also for ensuring that building owners and the general public alike have a sound awareness of the risk. Cooper argues the priority of developing a greater understanding disaster risk is the direct result of disasters coming to be perceived as social phenomena, and therefore the focus on reducing risk instead of simply losses.[99] In addition, Cooper suggests that an increased understanding of disaster risk raises fresh challenges in how the law should respond to this knowledge accordingly.[100] These ideas are explored throughout the course of this study.

1.4.2 Strengthening disaster risk governance to manage disaster risk

Strong disaster risk governance is necessary to establish "clear vision, plans, competence, guidance and coordination" of risk reduction duties, in order to foster compliance and collaboration amongst and between states.[101] Based upon observations from the HFA, the Sendai Framework identifies a lack of strong risk-based regulation as a contributing driver of disaster risk.[102] Strengthening disaster risk governance includes the establishment of clear roles and responsibilities for everyone in pursuit of achieving DRR, primarily through law, regulation, and policy.[103] Making explicit the obligations and responsibilities of all is crucial for engaging everyone in DRR and for providing a degree of certainty in relation to what is expected from them. As Mythen suggests, the goal of more risk-based governance is not to create "perfect safety", but instead to "seek to reduce levels of risk via probability assessment,

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[98] Above n 7, at [19(d)].

[99] Cooper, above n 67, at 51.

[100] At 51.

[101] Above n 7, at [26].

[102] Dutari and Chai, above n 55, at 281.

[103] United Nations Office for Disaster Risk Reduction *Global Assessment Report on Disaster Risk Reduction: 2019* (Geneva, 2019) at 335.

regulation and effective [risk] communication to the public and other stakeholders".[104] Strengthening disaster risk governance aims to integrate risk-adverse behaviour and practices within institutions and as part of normal operations. This shift away from reactionary measures, which has historically dominated disaster management, and toward prevention-based approaches, is an essential component of DRR.[105]

1.4.3 Investing in disaster risk reduction for resilience

Investing in disaster risk reduction for resilience relies on the institutionalisation of strong disaster risk governance.[106] Whereas the latter aims to establish clear and cohesive risk reduction responsibilities within states, investing in resilience puts these roles and responsibilities into action. It is noted that the Sendai Framework is "not a suitable instrument" for deciding specific investments which must or should be made, owing to social, economic, cultural, and environmental differences between states.[107] The framework instead aims to simply highlight the importance of making relevant investments better promote practices and behaviour which contribute to resilience**.** Relevant investments may include financial and logistical resources, as well as mechanisms which aim to promote, encourage and support risk reduction practices within the private sector.[108] The extent of the investment made ultimately depends upon the capacity of each state to do so. As the Sendai Framework identifies states as having a primary duty to promote and oversee risk reduction, it is important that states take a strong leadership role in establishing investments within their individual capacity.[109] As noted in the methodology, the three case study countries in this research are well-positioned to make such investments to promote DRR and lead by example.

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[104] Gabe Mythen "The Problem of Governance in the Risk Society: Envisaging Strategies, Managing Not-knowing" in U F Paleo (ed) *Risk Governance: The Articulation of Hazard, Politics and Ecology* (Springer, New York, 2015) 43 at 43.

[105] Sara Bouchon and Carmelo Dimauro "Multi-Risk Analysis: A New Paradigm for Territorial Resilience" in A Herwig and M Simoncini (eds) *Law and the Management of Disasters* (online ed, Routledge, 2017) 23 at 31.

[106] United Nations Office for Disaster Risk Reduction, above n 51, at [58].

[107] At [59].

[108] Above n 7, at [30].

[109] At [19(a)].

1.5 Summary

Today, the primary objective of disaster management is not to simply manage disasters and associated losses, but to manage and reduce the underlying risks which allow disasters to transpire. Rather than conflating disasters with hazardous events, a clear distinction is made between hazards and the impacts hazards have on communities or society owing to multiple variations of vulnerability. By understanding disasters as the intersection between hazards and the inability of societies to cope with the impacts of such hazards, it becomes possible to target the driving risks and thus aim to reduce the overall occurrence of disasters themselves. Indeed, the focus on reducing disaster risk makes it clear that while hazards such as earthquakes may be natural, disasters are very much social phenomena.

The socialised perception of disasters has been critical for the establishment of the Sendai Framework for Disaster Risk Reduction 2015-2030. A continued rise in disaster losses across recent decades, despite global efforts to prevent such losses, inspired the revised global commitment to reduce and manage existing disaster risk, prevent the creation of new disaster risk, and improve resilience against hazards. The Sendai Framework emphasises the need for preventive action to prepare for the impact of hazards, and guides states to implement frameworks for DRR to achieve this. In particular, the Sendai Framework highlights priority areas which require considerable focus to achieve risk reduction, three of which are the focus of this research. This includes making greater efforts to understand and identify disaster risk in communities, strengthening disaster risk governance to make coherent and comprehensive risk reduction frameworks, and investing significantly more in preventative risk reduction measures to decrease reactiveness and increase hazard resilience. Commitments made under the Sendai Framework to reduce disaster risk are inextricably tied to international human rights law. States, therefore, have a legal duty to work towards achieving this outcome. The Sendai Framework provides states with a structure to implement such measures, to institutionalise risk reduction within legal and governance frameworks to improve overall resilience.

Chapter 2

Applying Law to Risk Management Frameworks for Existing Buildings

> In spite of massive resources put into their prevention, disasters continue to cause extended [loss, disruption and suffering to] communities and societies. We are still largely unprepared to face events that we have seen occurring repeatedly for decades and in some cases for centuries, such as… earthquakes…

Bruna De Marchi[110]

Earthquakes, while often unhazardous when they occur in remote or unpopulated regions of the world, can be incredibly destructive when they come into contact with vulnerable communities and, in particular, vulnerable building stocks. Securing buildings to resist the force of earthquakes is one of the most effective ways to reduce risk and improve the resilience of communities located in locations prone to seismicity. While tough modern construction methods are used in many parts of the world to increase the seismic resistance of new buildings, a significant challenge remains to secure older, more vulnerable existing buildings. Reducing the risk of such buildings is critical for establishing a culture of disaster risk reduction and prevention.

This chapter is intended to provide a broad overview of the regulatory approaches applied to reduce the seismic risk of existing buildings in each case study country. Before undertaking a comparative analysis of different methods, it is first useful to have an understanding of the general strategies adopted to identify existing building risk and subsequent action to prepare for earthquakes. Although the legal approaches of each country differ quite significantly in function, there are many formal similarities**.** This section first defines the concept of 'existing' buildings for the purposes of seismic risk as examined in this research, distinguishing them from what would otherwise be considered 'new' buildings. From there, typical legal methods to address the seismic risk of existing buildings are examined, including a combination of mandatory and voluntary strengthening obligations. It is demonstrated that there has been a significant shift by governments in recent decades from

[110] Bruna De Marchi "Risk Governance and the Integration of Different Types of Knowledge" in U F Paleo (ed) *Risk Governance: the Articulation of Hazard, Politics and Ecology* (Springer, New York, 2015) 149 at 159.

passive approaches toward more active interventions to address the risk posed by existing buildings. This shift aligns with a more DRR-oriented strategy and is critical for achieving the expected outcome of the Sendai Framework.

2.1 What is an Existing Building?

An existing building may generally be understood as a building which has received a code compliance notice and is therefore legally permitted to be used and occupied.[111] In this context, existing buildings encompass all those which have been constructed and are currently in use. When defining an existing building through a lens of seismic risk management, the term is typically used to define buildings constructed prior to modern legal building codes for seismic design.[112] Existing buildings are therefore generally believed to be potentially more vulnerable to earthquakes owing to their construction with insufficient structural resistance to withstand earthquakes. This is in comparison to new buildings, which are generally thought to have greater seismic resistance as a result of modern and supposedly more robust seismic construction standards and technology.

Observations of damage from earthquakes around the world often indicate that buildings designed according to contemporary seismic design standards ultimately perform better in earthquakes and suffer less damage or destruction than do older existing buildings.[113] Legal building codes are periodically revised according to new information and engineering methods, including revisions to earthquake resistance designs. The purpose of these revisions, in theory, is to improve the robustness and safety of buildings against earthquakes using the latest available seismic knowledge and engineering practices. Ultimately, the prevalence of existing buildings designed and constructed prior to these modern building codes creates the

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[111] New Zealand Society for Earthquake Engineering *Technical Guidelines for Engineering Assessments, Part A: Assessment Objectives and Principles* (Ministry of Business, Innovation and Employment, July 2017) at A1-5.

[112] Maria Papathoma-Kohle and Thomas Thaler "Institutional Vulnerability" in S Fuchs and T Thaler (eds) *Vulnerability and Resilience to Natural Hazards* (Cambridge University Press, Cambridge, 2018) 98 at 103.

[113] See: Olga Filippova, Yu Xiao, Michael Rehm and Jason Ingham "Economic Effects of Regulating the Seismic Strengthening of Older Buildings" (2018) 46 Building and Research Information 711 at 712; Thomas Moullier and Keiko Sakoda *Building Regulation for Resilience: Converting Disaster Experience into a Safer Built Environment – the Case of Japan* (World Bank Group, Washington DC, 2018).

particularly difficult challenge of needing to improve their seismic resistance and thus reduce their likelihood of failure when subjected to strong, potentially damage-inducing shaking. This is achieved primarily through the practice of seismic strengthening or retrofitting methods, which involves reinforcing existing buildings to a higher design standard. Yet, while seismic building codes have typically improved over time to create more structurally-robust buildings, the discipline of earthquake engineering itself remains young.

Requirements for building standards to consider resistance to earthquakes in their design and construction were not widely introduced within the case study countries until the early 20th century. Requirements for buildings to withstand collapse in earthquakes were not introduced until much further into the century. Many buildings designed prior to or within this period of time, which remain in use today, were therefore constructed in the complete absence of sufficient seismic design regulations. In addition, many buildings were also designed according to seismic regulations which are now considered to be flawed or outdated, based on new information about earthquakes and practices of seismic engineering. Generally insufficient data and historic records of these buildings means there are significant gaps in knowledge about the exact nature of their seismic vulnerability. It is these existing buildings which are of particular concern and where most effort is therefore placed on identifying and remediating the associated risks they present. As is discussed in Chapter 3, frameworks designed to reduce the risk of these existing buildings require administrative decisions to be made about the type of buildings targeted for risk reduction measures in relation to acceptable standards of risk within relevant countries.

Understanding the vulnerability of existing buildings in relation to the seismic design regulations utilised when they were constructed fundamentally implies that, eventually, all buildings will be understood as "existing buildings" and considered to have a greater vulnerability than newer buildings. Seismic standards are often reactively changed or revised in the aftermath of damaging earthquakes, and improper implementation or enforcement of these standards in building design can significantly impact their overall effectiveness.[114] As more knowledge about seismic hazards and seismic engineering practices is generated, the overall perception of risk in relation to buildings will also evolve. This is a crucial consideration

[114] Above n 112, at 103.

when seeking to understand how to increase resilience in relation to the Sendai Framework (see Chapter 5).

2.2 Defining a Minimum Legal Standard of Seismic Risk

The requirement to reduce the seismic risk of existing buildings inherently requires a minimum legal standard of risk to be established which existing buildings should comply with. Seismic strengthening involves adapting and reinforcing buildings to provide them with a greater probable capacity to withstand the force of earthquakes. Each building is different and possesses a different likely capacity to withstand seismic forces, with numerous improvement methods available. While many new buildings today are designed to resist a higher level of both destruction and damage, improving existing buildings to similar standards can be extremely costly, difficult, and, for some older buildings, sometimes impossible to do without completely altering the architectural configuration of the building. A minimum standard is therefore typically imposed as the desired threshold for existing buildings to meet. The exact standard varies depending on the legal seismic standards and risk reduction objectives of individual countries. In each of the case study countries, the minimum legal standard expected for existing buildings is focused on protecting life safety. Buildings designed to now-inadequate seismic standards may endanger the life of building users or passersby as a result of external materials falling from above or through the collapse of a buildings' structure.[115] Securing these features of existing buildings is therefore a priority when strengthening or retrofitting. It should be noted that a higher threshold is typically applied to buildings which are considered important to the functioning of a society, such as hospitals, schools and buildings used for emergency management operations.[116]

The required life safety threshold required varies between each country and is expressed differently according to the building standards imposed. In New Zealand, the minimum life safety standard for existing buildings is one third of the minimum standard required for a building designed on the same site after 1 July 2017, according to the current building code.[117] This standard is provided as an 'earthquake rating' in the form of a percentage value relative

[115] Above n 111, at A3-1.

[116] At A10-4.

[117] At A1-5.

to the new building standard (%NBS).[118] A rating of 34%NBS is the minimum legal threshold for life safety, and buildings which fall below 34%NBS are considered "earthquake-prone" and targeted for seismic strengthening (see Chapter 2.2.1). The threshold for this value differs around the country to reflect the presumed seismicity of each region, meaning that buildings with 34%NBS in a high seismic area like Wellington are designed to withstand greater ground shaking than those with 34%NBS in a low seismic area like Auckland (see Chapter 4). Existing buildings falling beneath this standard are considered to have a high probability of collapse in strong earthquakes and therefore present a legally unacceptable life safety risk.[119]

Japan also expresses the life safety standard for existing buildings in numerical form. The minimum safety standard for existing buildings is expressed as a structural seismic resistant capacity index (*Is*) of 0.6.[120] The *Is* of a building is designed to be a measurement of its capacity to withstand earthquakes, with consideration to factors such as structural strength and potential deteriorations as a result of aging.[121] Much how buildings in New Zealand which have an earthquake rating lower than 34%NBS are assumed to have the greatest probability of collapse, buildings with an *Is* of less than 0.6 in Japan are also considered to have the greatest risk of collapse. It is these buildings which are actively targeted for risk reduction measures.

In comparison to New Zealand and Japan, there is no apparent required life safety standard applied to all existing buildings in Italy. Existing buildings used for essential purposes (i.e. hospitals, schools, government buildings) are expected to have a minimum of 60 percent of the minimum standard required for new constructions, according to the latest seismic standards.[122] As for all other existing buildings, however, there does not appear to be a clearly expressed minimum life safety standard which building owners are required to strengthen to, largely owing to the absence of legal obligations to complete such strengthening (see Chapter 2.3). There are, however, separate lettered risk classes to represent the potential life safety risk of existing buildings, from A+ to F. Buildings with a risk class of B or above equates to 60 percent or greater of the current seismic building code, while buildings with a risk class of E

[118] Building Act 2004, s133AC.

[119] Above n 111, at A3-9.

[120] Thomas Moullier and Keiko Sakoda *Building Regulation for Resilience: Converting Disaster Experience into a Safer Built Environment – the Case of Japan* (World Bank Group, Washington DC, 2018) at 52.

[121] At 52.

[122] Interview with Italian Earthquake Engineer (the author, Zoom, 25 March 2021).

or F represent less than 30 percent.[123] In fact, a similar lettered risk classification exists in New Zealand ranging from A+ to E, though in practice it is the %NBS earthquake rating which is primarily used to communicate the probable seismic risk of existing buildings.[124]

Of course, measuring life safety according to the probability of building collapse assumes structural failure is the only life safety consideration, and fails to consider other possible causes of injury or death in earthquakes. For instance, many of the deaths and injuries reported in the 2011 Tohoku Earthquake in Japan were the result of non-structural building features, such as dislodged ceiling boards.[125] Although some of these risks could be addressed through improved application of relevant legal health and safety obligations, a lack of overall clarity around what is expected or considered sufficient in relation to improving the non-structural safety of buildings remains largely unclear (see Chapter 8).[126]

Protecting persons from harm is ultimately only one of many considerations in risk reduction. Factors such as building damage and long-term usability following earthquakes, both of which significantly impact the level of disruption from earthquakes, are largely overlooked in current seismic risk reduction frameworks for existing buildings. Of the case study countries, only Japan considers damage limitation requirements in the seismic strengthening and retrofitting of existing buildings. Alongside a minimum life safety standard to prevent structural collapse, existing buildings in Japan are expected to avoid damage in earthquakes which register up to an Upper 5 on the Japanese Shindo Scale.[127] Shindo Upper 5 earthquakes can be expected to occur in Japan approximately every 30-50 years.[128] An earthquake of Shindo Upper 5 is described by the Japan Meteorological Agency as "hard to

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[123] Edoardo Consenza and others "The Italian Guidelines for Seismic Risk Classification of Constructions: Technical Principles and Validation" (2018) 16 Bulletin of Earthquake Engineering 5905 at 5910.

[124] New Zealand Society for Earthquake Engineering, above n 111, at A3-9.

[125] Masato Motosaka and Kazuya Mitsuji "Building Damage During the 2011 off the Pacific Coast of Tohoku Earthquake" (2012) 52 Soils and Foundations 929 at 930.

[126] "Information for PCBUs and Building Owners" (June 2018) WorkSafe <www.worksafe.govt.nz>.

[127] The Japanese Shindo Scale is the comparable to the Mercalli Intensity scale, and measures ground shaking intensity on a scale of 0 to 7. See: Roger M W Musson, Gottfried Grünthal and Max Stucchi "The Comparison of Macroseismic Intensity Scales" (2010) 14 Journal of Seismology 413.

[128] Mitsumasa Midorikawa and others "Performance-Based Building Code of Japan – Framework of Seismic and Structural Provisions" (paper presented to 12th World Conference on Earthquake Engineering, 2000) at 3.

move [and] walking is difficult without holding onto something stable”.[129] As these earthquakes are generally expected to occur potentially multiple times within a building’s lifetime, the requirement to minimise damage is designed to minimise disruption and losses anticipated on a relatively frequent basis. This represents the only consideration to damage limitation of buildings between the three countries.

2.2.1 The focus on earthquake-prone buildings in New Zealand

New Zealand takes a unique approach from the other case study countries in the risk reduction of existing buildings, by focusing on buildings which are considered to be ‘earthquake-prone’. An earthquake-prone building (EPB), defined below, is a building which is considered to have the highest probable chance of suffering structural collapse during an earthquake of any existing buildings in New Zealand.[130] Under the seismic risk reduction framework for existing buildings (hereon referred to as the EPB framework), local authorities are required to apply guidance from central government to identify buildings considered “potentially earthquake-prone” and require building owners to supply a seismic assessment report to confirm whether or not their building is in fact earthquake-prone and requires subsequent strengthening work. The concept of an EPB is strictly legal, meaning other existing buildings which may still pose a notable seismic risk are not captured within risk reduction obligations (see Chapter 3).[131] Unlike in Japan and Italy, where remediation of seismic risk is primarily understood according to the building code used in construction, New Zealand’s focus on the legal concept of EPBs provides a far narrower range of existing buildings subject to risk reduction.

The Building Act provides a definition for an EPB, noting that a building is considered earthquake-prone if:[132]

[129] “Tables Explaining the JMA Seismic Intensity Scale” Japan Meteorological Agency <www.jma.go.jp>.

[130] New Zealand Society for Earthquake Engineering, above n 111, at A3-9.

[131] At A3-9.

[132] Section 133AB(1).

(a) the building or part will have its ultimate capacity exceeded in a moderate earthquake; and

(b) if the building or part were to collapse, the collapse would be likely to cause —

(i) injury or death to persons in or near the building or on any other property; or

(ii) damage to any other property.

As mentioned in the previous section, the functional purpose of targeting EPBs is entirely to protect life safety. Ultimate capacity simply refers to a buildings' probable ability to maintain structural resistance against seismic forces, which is likely to result in building collapse when exceeded.[133] The threshold for an EPB is that a building's ultimate capacity will be surpassed in the event of a "moderate earthquake". This is a notable threshold as this type of earthquake is "not really likely to occur".[134] Rather, a moderate earthquake as imagined in the EPB definition refers to an artificial standard of shaking produced from an earthquake.[135] "Moderate earthquake" is defined in separate regulation as:[136]

> an earthquake that would generate shaking at the site of the building that is of the same duration as, but that is one-third as strong as, the earthquake shaking (determined by normal measures of acceleration, velocity, and displacement) that would be used to design a new building at that site if it were designed on 1 July 2017.

This legal definition of shaking significantly differs from the approach taken in Japan and Italy, where the seismic risk of existing buildings is measured against actual expected levels of shaking. For instance, as mentioned, strengthened existing buildings in Japan are expected at minimum to remain undamaged and withstand structural collapse in earthquakes registering at Shindo Upper 5 and Upper 6 to 7, respectively.[137] Earthquakes of Shindo Upper 6 to 7 roughly translate into those which are expected to occur approximately once every 500 years, similar to the minimum standard applied to existing building seismic risk in Italy and New Zealand. However, the "moderate earthquake", as defined in New Zealand law, is unlikely to occur. As earthquakes with lower shaking intensities do not generally last for the same

[133] Building (Specified Systems, Change the Use, and Earthquake-Prone Buildings) Regulations 2005, s 7.

[134] *University of Canterbury v Insurance Council of New Zealand Inc* [2015] 1 NZLR 261 at [19].

[135] At [19].

[136] Building (Specified Systems, Change the Use, and Earthquake-Prone Buildings) Regulations, s 7.

[137] Moullier and Sakoda, above n 120, at 52.

duration as larger and more powerful earthquakes, shaking for the same duration but one-third the strength of that used for the design of new constructions is considered incredibly rare.[138]

Whether or not a building is earthquake-prone has become inextricably linked to its earthquake rating, principally those with a rating of 33%NBS or less as discussed in the previous section. Since it is impossible to predict exactly how individual buildings will perform in earthquakes, earthquake ratings are designed to provide an approximate estimation of risk rather than a precise measurement.[139] Though the %NBS standard was designed to communicate seismic risk in a simplistic form, Ferner notes one of the observed impacts of its association with EPBs is the conflation between earthquake rating and a building's safety.[140] Many people consider that buildings not deemed earthquake-prone (i.e. 34%NBS or above) are safe, despite many still presenting a less-than-trivial seismic risk. Owing to a general lack of public awareness that EPBs concern risk to life safety only, many people have also expressed misplaced expectations that buildings not considered earthquake-prone will or should be undamaged and able to be reoccupied immediately following earthquakes.[141] These examples demonstrate just a few of the consequences of applying a legal definition to existing buildings in need of seismic risk reduction measures.

2.3 Imposing Legal Obligations on Building Owners to Reduce Seismic Risk

There has been a substantial shift over recent decades in the way governments have managed the seismic risk of existing buildings, increasingly moving toward a framework of more active legal intervention. The seismic capacity of existing buildings has generally been managed through passive measures, including requirements for seismic strengthening when building owners make alterations or change the use of their buildings. With increasing commitments to manage and reduce disaster risk, fueled by recent experiences of destruction caused by earthquakes, it has become obvious that passive measures alone are not enough to substantially reduce the seismic risk of existing buildings in a prompt manner as required by

[138] *University of Canterbury v Insurance Council of New Zealand Inc*, above n 134, at [19].

[139] Engineering New Zealand *Revised Version of C5 – Talking About %NBS* (10 October 2019) at 2.

[140] Helen Ferner "A Seismic Building Rating System – The New Zealand Experience" (paper presented to 17th US-Japan-NZ Workshop on the Improvement of Structural Engineering and Resilience, 2018) at 3-3-6.

[141] At 3-3-5.

the Sendai Framework. Each of the case study countries have adopted legal frameworks which aim to incentivise and mandate obligations for existing building owners to take appropriate action to address seismic risk. It should be mentioned at the outset that this research is interested in the national legal frameworks applied to reduce existing building risk, given the need for clear coordination of DRR on a state-level.

Such legal approaches taken to reduce the seismic risk of existing buildings follow familiar procedural characteristics in each case study country, yet their practical implementation in each legal system differs quite significantly. The general risk reduction structure applied consists of a three-step pattern: identifying relevant existing buildings considered likely to pose a significant risk in earthquakes; undertake seismic assessments on these buildings to confirm their likely seismic resistance; and finally, remediate the risk either through strengthening and retrofitting methods, or in some instances with demolition. Such a process allows for authorities and building owners alike to actually understand the seismic risk presented by existing buildings and thus target existing buildings according to those which are in greatest need of strengthening or retrofitting. While this general procedure is standard between each of the case study countries, how these measures are applied within legal frameworks differs significantly.

2.3.1 Change of building use and major alterations

As building codes have evolved, the need to address the seismic risk of existing buildings has also grown. Often building owners will choose to demolish and replace older existing buildings with new constructions over time. This subsequently reduces the risk posed by these particular buildings. However, it is also a reality that many older buildings are kept in use and not replaced with new constructions. Historically, passive legal approaches have been relied upon to reduce the seismic risk of existing buildings. These passive approaches have largely depended upon requiring building owners to undertake a seismic assessment and, if necessary, seismic strengthening, under two primary scenarios. This includes when building owners seek to either change the use of their building(s), or when they wish to make major alterations which could impact the buildings' structural capacity. These requirements are often referred to as 'trigger' clauses and depend upon building owners deciding to make the relevant changes.

Change of use or alteration "trigger" requirements exist in each of the three case study countries as a way of passively managing seismic risk. A change in use of an existing building may increase the potential risk of the building, depending on its intended use. For instance, converting an office space into a residential dwelling changes the building's primary use from a place where people work to a place where people sleep, thus leading to a change in dynamic of the seismic risk for building occupants.[142] In New Zealand, a seismic assessment must be completed to confirm whether or not a building is earthquake-prone before any planned change of use or substantial alterations can proceed, with strengthening required for subsequent EPBs.[143] A similar obligation exists in both Italy and Japan, requiring a seismic assessment to be undertaken when building owners plan to change the use or make significant alterations to their buildings, which would likely impact the overall seismic capacity of buildings.[144] In each case study country, including Japan, authorities are also able to require a seismic assessment from building owners if they have reason to suspect the building poses a particular risk, such as evident deteriorations or construction issues. While these measures are useful to improve the seismic resistance of existing buildings when changes are sought, their passive dependency on building owners to willingly complete such changes make them a drawn-out method for achieving risk reduction.

2.3.2 Mandatory and voluntary-based legal obligations

In an effort to achieve timelier seismic risk reduction of existing buildings, broader legal duties have recently been established which represent a more active intervention than relying on passive legal requirements. The implementation of such obligations in each case study country may be distinguished through the use of mandatory or voluntary enforcement. For instance, New Zealand imposes mandatory obligations to reduce risk. These require territorial authorities (TAs) to identify buildings which are potentially earthquake-prone, and the owners of such buildings to subsequently undertake a seismic assessment and, for buildings

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[142] "Change of Use, Alterations and Extension of Life" (17 March 2017) Ministry of Business, Innovation and Employment <www.building.govt.nz>.

[143] Building (Specified Systems, Change the Use, and Earthquake-Prone Buildings) Regulations, s 5-11.

[144] See: NTC 2008. Norme tecniche per le costruzioni. D.M. Ministero Infrastrutture e Trasporti 14 gennaio 2008, G.U.R.I. 4 Fabbraio 2008, Roma (translation: *Technical Standards for Constructions*. D.M. Ministry of Infrastructure and Transport, 14 January 2008 (G.U.R.I. 4 February 2008, Rome) at [8.3]; "既存建築物関連業務" The Building Center of Japan <www.bcj.or.jp> (translation: "Existing Building-Related Business").

which are in fact earthquake-prone, complete seismic strengthening or demolition. Japan and Italy stop short of imposing mandatory seismic strengthening obligations on building owners, instead relying primarily upon voluntary compliance through the use of various incentives to encourage risk reduction. In fact, the extent of mandatory obligations applied in New Zealand is unique relative to the other countries. On the one hand, mandatory legal obligations have the benefit of mandating compliance and therefore increasing the likelihood that action will be taken swiftly, relative to voluntary compliance. On the other hand, voluntary-based obligations have the benefit of being more flexible and accommodating to new risk information as it emerges.[145]

The decision in New Zealand to impose compulsory obligations to reduce the risk of existing buildings was a direct result of recommendations made by the 2012 Royal Commission report into the Canterbury Earthquakes, which investigated the causes of extensive building failure experienced in the 2011 Christchurch Earthquake (M_w 6.2).[146] The national mandatory framework (referred to in this research as the EPB framework) came into force on 1 July 2017. Prior to this national framework, TAs set their own individual policies for reducing the risk of existing buildings. Under the context of urgency in the aftermath of the disaster in Christchurch, the national EPB framework was seen as a necessary response to the untimeliness and generally low enforcement standard for risk reduction of EPBs under the de-centralised system.[147] The national EPB framework establishes deadlines of varying lengths throughout New Zealand for TAs to identify EPBs within their jurisdictions, and for EPB owners thereafter to either strengthen or demolish their building(s).[148] As previously mentioned the framework itself is focused only a specific subset of existing buildings legally understood to be "earthquake-prone", which represent existing buildings assumed to have the greatest seismic vulnerability.

Much like New Zealand in the wake of the Christchurch Earthquake, Japan similarly established a national risk reduction framework for existing buildings in the aftermath of a

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[145] United Nations Office for Disaster Risk Reduction, above n 51, at [128].

[146] Canterbury Earthquakes Royal Commission *Volume 4: Earthquake-Prone Buildings* (Wellington, released 7 December 2012).

[147] (12 February 2014) 696 NZPD 15912.

[148] Building Act, subpart 6A.

seismic disaster. In 1995, the port city of Kobe was struck by a Mw 6.9 earthquake which, owing to widespread seismic vulnerability of existing buildings, led to the death of thousands and caused extensive devastation to the region.[149] Shortly after the earthquake, the government of Japan sought to address the risk posed by existing buildings by implementing the Act on Promotion of Seismic Repair of Buildings (APSRB).[150] The APSRB established a coordinated national framework for managing and reducing seismically-vulnerable buildings across the country. It imposes administrative duties for government and building owners alike, including for central and local government to assist risk reduction through the provision of funds and dissemination of relevant knowledge, and for building owners to strive to make reasonable efforts to improve the seismic safety of their buildings where necessary.[151] The Act requires central government to develop a “Basic Policy” and for local governments to create “Basic Plans” to guide the seismic risk reduction of existing buildings across Japan, including numerical targets and goals for the amount of buildings to be assessed and strengthened over time.[152] These plans are updated periodically to reflect actual rates of risk reduction and to accommodate any new information. Similar to New Zealand, the framework requires local authorities to actively identify the owners of existing buildings assumed to pose the greatest risk, and to both encourage and provide directions to complete seismic assessments. Amendments were made to the APSRB in 2013, following the 2011 Tohoku Earthquake (M_W 9.0). For the first time, mandatory seismic assessments were required to be completed by the owners of certain “large-scale” buildings within a 24-month period, to confirm their seismic resistance (see Chapter 3.2.2).[153] However, there ultimately exists no mandatory legal duty under the APSRB for building owners to complete seismic strengthening, as there is in New Zealand.

Italy has a much less formally-structured national framework than Japan or New Zealand, although it does follow a similar voluntary and incentive-based approach to Japan. Much like the other countries, Italy has been very reactive in implementing seismic

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[149] Moullier and Sakoda, above n 120, at 6.

[150] The 1995 Kobe Earthquake is one of the most destructive experienced in Japanese history, with more than 100,000 buildings destroyed and 6,000 people killed.

[151] Act on Promotion of Seismic Repair of Buildings (Act No. 123 of 1995), art 3.

[152] Article 4.

[153] Ministry of Land, Infrastructure, Transport and Tourism *White Paper on Land, Infrastructure, Transport and Tourism in Japan, 2014* (Government of Japan, 2014) at 236.

strengthening plans for existing buildings in the aftermath of deadly and destructive earthquakes. The most significant national effort began with the issuance in 2003 of the Ordinance of the President of the Council of Ministers n. 3274 (OPCM 3274), following the 2002 Molise Earthquake (M_w 5.8). The earthquake resulted in the death of 27 children following the collapse of their primary school, which inspired a sense of collective urgency to ensure a similar tragedy did not occur again.[154] OPCM 3274 required the owners of "strategic and relevant" existing buildings (e.g. hospitals, schools, and emergency buildings) to complete a seismic assessment within a five-year period.[155] It also established a government fund of approximately €200 million (NZ$230 million) for any necessary strengthening work, with most funding provided to schools.[156] Although many building owners completed these assessments, the initial five-year period was subsequently extended beyond 2012 largely owing to a lack of thorough enforcement of the order.[157] Six years later, following the 2009 L'Aquila Earthquake which killed hundreds and caused extensive building damage, further legal reforms were made. While much of this was centred on revisions to the national seismic code (NTC 2008), the National Plan for Seismic Risk Prevention was established and provided additional government funding to continue the work of assessing and strengthening existing buildings of strategic importance.[158] Aside from this funding, no coherent national legal structure was implemented to ensure efficient and effective remediation of all existing buildings in the same way New Zealand and Japan did.[159] In fact, the most recent national efforts to reduce the seismic risk of all other existing buildings across Italy are based upon a tax incentive scheme known as Sismabonus, which allows building owners to claim tax deductions from expenses for completing seismic strengthening (see Chapter 6).[160] While this broadens the potential for

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154 Mazzoni and others, above n 27, at 1676.

155 Ordinanza del Presidente del Consiglio dei Ministri 20 marzo 2003 n.3274, *Gazzetta Ufficiale della Repubblica Italiana No. 105,* Rome. (translation: Ordinance of the President of the Council of Ministers. 20 March 2003, n.3274. Official Gazette of the Italian Republic, No. 105, Rome).

156 Mauro Dolce "The Italian National Seismic Prevention Program" (paper presented to 15th World Conference on Earthquake Engineering, 2012) at 6.

157 Above n 122.

158 Susanna Paleari "Natural Disasters in Italy: Do We Invest Enough in Risk Prevention and Mitigation?" (2018) 75 International Journal of Environmental Studies 673 at 679.

159 A lack of strategic governance for the risk reduction of existing buildings in Italy is obvious. For instance, only 23% of projects financed in 2012 under the National Plan had been completed as of 2018. At 679.

160 Consenza and others, above n 123.

seismic strengthening, it nonetheless relies entirely on incentivising owners to take action without a legal requirement to do so.

It is clear that the frameworks applied in each of the case study countries represent starkly different approaches to reducing the seismic risk of existing buildings. New Zealand and Italy can be assessed as sitting at opposite ends of the spectrum, with compulsory regulatory obligations and voluntary incentive-based models, respectively. The Japanese framework represents a combination of these two models. While no mandatory strengthening obligations exist for building owners, a clear strategic plan nonetheless exists under the APSRB for the long-term risk reduction of existing buildings. Each of these approaches have their own advantages and disadvantages for reducing seismic risk and improving resilience against earthquakes, which are explored throughout this research.

2.4 Adopting A More Active Approach to Achieve Seismic Risk Reduction

Ultimately, prolonging or ignoring the existence of risk promotes a culture of reaction to earthquakes rather than prevention before they occur. As observed by the UNDRR, "every disaster has had an enormous impact on enhancing awareness and safety… but if catastrophic failure is the most reliable driver of change, it is clearly not a sufficiently proactive mindset".[161] Inspired by seismic catastrophe, each of the case study countries have sought to adopt more active legal approaches to reducing the risk of existing buildings. As mentioned previously in this chapter, New Zealand introduced its national EPB framework with mandatory strengthening obligations following the devastating Christchurch Earthquake. Similarly, Japan and Italy also adopted their more active incentive-based frameworks to achieve risk reduction following seismic disasters which occurred in Kobe (1995) and Molise (2003), respectively. Designing frameworks which actively intervene to reduce the seismic risk of existing buildings is important for improving resilience and avoiding the need for reactive responses when, not if, future earthquakes occur. Not only are these active approaches more in-line with the risk reduction objectives outlined in the Sendai Framework, they are also ultimately more cost-effective strategies, both financially and in relation to the potential societal disruption from future earthquakes.

[161] Above n 103, at 166.

The observed trend toward more active national frameworks to address the seismic risk of existing buildings is the result of previous passive approaches often proving too slow for successfully identifying and reducing seismic risk. As mentioned, relying solely on legal requirements for completing seismic assessments and strengthening work when building owners choose to make significant alterations or change the use of their building(s) may take an excessively long period of time to be achieved, or economic circumstances may cause building owners to refrain from engaging in such action completely. Both of these prospects leave the potential seismic risk of existing buildings both unknown and unaddressed.[162] Such an outcome is unacceptable as it prolongs the existing vulnerability of communities and societies to the impact of earthquakes, contrary to the Sendai Framework's objectives of better understanding reducing disaster risk. In addition, it has been observed that as the efficiency of professional responses to hazards has improved, peoples' reliance on external support and perception that "risk prevention [is] someone else's business" tends to grow.[163] With a generally low risk perception held by many for rare events like earthquakes, the case for more active legal interventions by authorities to reduce risk grows stronger.

Proactively investing to reduce the seismic risk of existing buildings, rather than responding after earthquakes as they occur, is a wise economic investment for long-term resilience. It is estimated that for every US$1 (NZ$1.40) invested in preventative risk reduction measures, as much as US$15 (NZ$21) may be saved from what would otherwise be ultimately spent on disaster response and recovery operations.[164] Passive approaches to risk reduction are often preferred due to generally lower upfront financial costs. However, the inevitability of earthquakes means these costs will almost certainly be borne in the future if underlying risk is not promptly and effectively reduced. For instance, approximately €180 billion (NZ$300 billion) has been spent by the Italian government on earthquake response, recovery and reconstruction costs in the past 50 years alone, averaging approximately €3.6 billion (NZ$6 billion) per year.[165] For context, a national report commissioned by the Italian government estimated in 2019 that it would cost approximately €93 billion (NZ$158 billion) to strengthen

[162] New Zealand Society for Earthquake Engineering *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes* (NZSEE Study Group on Earthquake Risk Buildings, June 2006) at [2.6].

[163] De Marchi, above n 110, at 159.

[164] "Funding" (2021) United Nations Office for Disaster Risk Reduction <www.undrr.org>.

[165] Marco Donà and others "Mechanics-Based Fragility Curves for Italian Residential URM Buildings" (2020) Bulletin of Earthquake Engineering 3099 at 3100.

the seismic capacity of all residential homes across Italy.[166] Similar to Italy, hundreds of billions of dollars have been spent in response to earthquakes in both Japan and New Zealand across recent decades, with costs from the 2011 Christchurch Earthquake alone estimated to have totaled one-fifth of New Zealand's gross domestic product at the time (NZ$40 billion).[167] In fact, a 2012 report estimated the approximate cost for strengthening EPBs in New Zealand under the current framework to be around $NZ3.6 billion, or 9% of the total cost of the damage from the Christchurch Earthquake. The case for active risk reduction efforts and investments now is reflected by the cyclical occurrence of earthquakes, albeit statistically infrequently, which cause significant and extensive damage and disruption to communities.

While insurance can be an important component of minimising economic losses in earthquakes, it is not a sufficient tool in and of itself for reducing risk. Insurance is an important component of resilience, though it does not ultimately incentivise preventative action such as seismic strengthening. In many parts of the world, including Japan and Italy, coverage of earthquake insurance is particularly low or even nonexistent.[168] Low coverage in Japan, for instance, is attributed to limited availability and being "prohibitively expensive".[169] In New Zealand, earthquake insurance coverage is particularly high owing to the existence of a national government-backed mandatory scheme.[170] For instance, an extremely high rate of damage was covered by insurance in the 2011 Christchurch Earthquake, especially relative to damage from recent earthquakes in both Italy and Japan.[171] Yet, in the aftermath of the Christchurch Earthquake, New Zealand's national disaster insurance fund was entirely depleted, making it unreliable to cover losses from earthquakes anticipated to occur in the future, including in the

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[166] Paleari, above n 158, at 680.

[167] Olga Filippova and Ilan Noy "Earthquake-Strengthening Policy for Commercial Buildings in Small-Town New Zealand" (2020) 44 Disasters 179 at 179.

[168] Olga Filippova and others "Economic Effects of Regulating the Seismic Strengthening of Older Buildings" (2018) 46 Building and Research Information 711 at 721.

[169] Opus International Consultants *Economic Benefits of Code Compliant Non-Structural Elements in New Zealand* (Ministry of Business, Innovation and Employment, 21 March 2017) at 12.

[170] Above n 168, at 721.

[171] Approximately 80% of damages from the Canterbury Earthquakes were insured, compared to a rate of 17% in the 2011 Tohoku Earthquake in Japan and 14% in the 2009 L'Aquila Earthquake in Italy, see: Frederic Marquis and others "Understanding Post-Earthquake Decisions on Multi-Storey Concrete Buildings in Christchurch, New Zealand" (2015) 15 Bulletin of Earthquake Engineering 731 at 745.

Wellington region.[172] Indeed, overall trends indicate a steady decline in private earthquake insurance and an increasing tendency for governments to cover economic losses through ex-post aid and support throughout the world.[173] As Filippova and others argue, the decreasing private insurance market for earthquakes, and growing trend of post-earthquake government welfare, makes it increasingly necessary and urgent to invest in preventive measures to increase the resilience of existing building stocks.[174] Of course, long-term economic investments are only one consideration for the need to take more active approaches to reduce the seismic risk of existing buildings.

As mentioned, failure to swiftly improve the seismic capacity of existing buildings prolongs the vulnerabilities of individuals and communities at large. This includes not only the potential for physical harm to people, but also disruptions to lives, livelihoods, and social systems themselves. Actively seeking to reduce seismic risk therefore places people and communities at the heart of risk reduction, to protect them from these outcomes. As Mythen argues, "in a risk sensitive culture in which public tolerance for harm is low, the pressure on the State to act becomes greater".[175] For instance, in the 1995 Kobe Earthquake approximately 6,437 people were killed primarily as a result of the more than 100,000 buildings which collapsed.[176] Progress which was subsequently made to strengthen existing buildings was demonstrated in the 2011 Tohoku Earthquake, whereby most building damage and almost all of the more than 15,000 deaths were caused by the subsequent tsunami event and not by the earthquake itself.[177] Still, large earthquakes which are anticipated to impact heavily populated Japanese areas in the near future, such as Tokyo, make efforts to reduce existing building risk an ongoing and urgent task.[178] The same can be said for both Italy and New Zealand, where

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[172] Above n 168, at 722.

[173] Dwight Jaffee and Thomas Russell "The Welfare Economics of Catastrophe Losses and Insurance" (2013) 38 The Geneva Papers 469 at 470.

[174] Above n 168, at 722.

[175] Above n 104, at 49.

[176] Moullier and Sakoda, above n 120, at 6.

[177] See: Global Facility for Disaster Reduction and Recovery *Making Schools Resilient at Scale: The Case of Japan* (The World Bank, Washington DC, 2016) at 24; Shinji Nakahara and Masao Ichikawa "Mortality in the 2011 Tsunami in Japan" (2013) 23 Journal of Epidemiology 70 at 70.

[178] Ministry of Land, Infrastructure, Transport and Tourism *White Paper on Land, Infrastructure, Transport and Tourism in Japan, 2013* (Government of Japan, 2013) at 236.

large earthquakes are anticipated in heavily-populated areas on well-known fault lines, including New Zealand's capital city of Wellington. Deaths, like financial losses, are easily quantifiable in earthquakes. However, reducing the seismic risk of existing buildings is also important to protect against often harder-to-quantify factors in earthquakes, such as the immediate and long-term impact on livelihoods, social and psychological effects, or exacerbated inequalities and vulnerabilities of certain groups due to damage and disruptions. Consideration of these factors is therefore necessary when considering the importance of reducing seismic risk and improving the resilience of communities against earthquakes.

2.5 Summary

This chapter has provided an overview of the legal frameworks used by the case study countries to address the seismic risk posed by vulnerable existing buildings. Buildings which are presumed to have low seismic resistance against the force of earthquakes, primarily owing to insufficient seismic design regulations at the time of their construction, pose a significant threat to life safety. To understand and address this risk, passive legal duties exist which require building owners to complete seismic assessments and strengthening if they wish to carry out major alterations or change the use of their buildings. However, these depend on building owners to make decisions to engage in such action, which are often too slow as experienced by the devastation of past earthquakes. Each of the case study countries have therefore recently adopted a range of different approaches to increase the speed and efficiency at which existing building risk is reduced.

Each country appears to take functionally-similar yet practically-different legal approaches. High-risk "earthquake-prone buildings" are the target of authorities in New Zealand, with building owners required to complete mandatory seismic assessment and strengthening obligations. Japan and Italy, on the other hand, have adopted more voluntary and incentive-based approaches for existing building owners. Japan stops short of mandatory strengthening obligations, but adopts a structured framework which includes particular targets for achieving risk reduction amongst existing buildings. In comparison, Italy relies largely on existing building risk reduction through a purely incentive-based approach. Ultimately, leading a more active intervention for the risk reduction of existing buildings aligns with the objectives of the Sendai Framework. Investing in preventative risk reduction measures for existing buildings is not only more cost-effective in the long-term, but is also necessary to increase the resilience of communities and those who are most vulnerable to the impacts of earthquakes.

Part B

Operational Features of Risk Reduction Frameworks

The purpose of Part B is to examine specific operational features applied within the risk reduction frameworks of the case study countries. With a general overview of existing building management provided in Chapter 2, the chapters within Part B focus upon three particularly significant features of legal frameworks which aid efforts to reduce seismic risk. This includes the extent to which, and to whom, risk reduction obligations apply.

Chapter 3 examines the typologies applied by authorities to identify the existing buildings which are subject to assessment and strengthening obligations, highlighting potential gaps in seismic risk knowledge for buildings not included. Chapter 4 explores the use of seismic hazard zones as a method got implementing risk reduction measures for building owners according to the perceived seismicity of the particular location where buildings are located. Chapter 5 examines the use of seismic building assessments for understanding the nature of seismic risk posed by particular buildings, which help to inform potential strengthening responsibilities for building owners.

The case study countries each apply these operation features to varied extents within their respective risk reduction frameworks. Given they have direct implications for the degree of knowledge about disaster risk and for the ability to improve resilience, they are noteworthy features for comparison within this research.

Chapter 3

Typologies Applied to Identify Existing Buildings for Risk Reduction

> The acceptance that man cannot control everything raises operational considerations about when to develop resilience… Resilience can be accomplished passively in the time following a crisis, or it can be developed proactively before a crisis occurs by improving the system's capacity to deal with complex situations.

Julie-Maude Normandin et al.[179]

To identify existing buildings in need of risk reduction within legal frameworks, decisions need to be made about the exact types of buildings which are subject to relevant obligations. There appears to be a particularly narrow focus on identifying buildings which are assumed to pose the highest risk to life safety in strong earthquakes. While it is important to target these buildings to improve public safety, it is also important that the scope of existing buildings targeted for risk reduction obligations is not too restricted in its understanding of risk. Legal frameworks to reduce the seismic risk of existing buildings need to strike an appropriate balance between identifying all existing buildings which pose a significant seismic risk and being adaptable to new risk information as it arises. This is an important consideration for developing long-term resilience to earthquakes and the narrow range of existing buildings illustrates that current legal frameworks are not designed to achieve such an outcome.

This chapter examines the typologies applied to identify seismic risk of existing buildings in each of the case study countries and, importantly, gaps which emerge as a result. Physical characteristics of buildings are most commonly used to assume the seismic risk of existing buildings, including the construction materials and the year which buildings were designed. Certain construction materials indicate an inherent physical vulnerability to earthquakes and are therefore assumed to have a substantial risk of collapse. In addition, the year a building was designed implies the seismic building regulations in effect at the time of a buildings' design – if any – and is a useful indicator of potential structural resistance to

[179] Julie-Maude Normandin and others "The Definition of Urban Resilience: A Transformation Path towards Collaborative Urban Risk Governance" in G Brunetta and others (eds) *Urban Resilience for Risk and Adaption Governance* (Springer International Publishing, 2019) 9 at 11.

earthquakes. A more holistic approach to understanding seismic risk is adopted through the application of priority buildings, which include buildings of crucial importance for society, such as hospitals and schools. Yet, while this considers seismic risk from the perspective of building function and occupants, it is argued that the exact priority buildings targeted for risk reduction are too narrow as they are a secondary consideration to the described physical characteristics used to identify existing buildings. Finally, it is noted that most residential buildings are excluded from the EPB framework in New Zealand, in complete contrast to risk reduction efforts in both Japan and Italy. The argument is made that such an oversight does nothing to improve resilience in New Zealand and should be reconsidered as part of risk reduction obligations.

3.1 The Type of Existing Buildings targeted for Seismic Risk Reduction

Since not all existing buildings pose the same risk, typologies are often developed for legal frameworks to help identify those which require risk reduction. These typologies are designed to categorise existing buildings presumed most likely to fall beneath minimum legal standards of seismic resistance, as discussed in the previous chapter. Authorities therefore apply these typologies to identify and locate the buildings most likely to pose the greatest life safety risk. Relevant building owners are targeted thereafter to confirm and, if necessary, remediate seismic risk.

In New Zealand, TAs are tasked with identifying existing buildings most likely to be potentially earthquake-prone, with an earthquake rating of less than 34%NBS. To aid this process, the EPB methodology outlines three building profile categories which TAs are required to treat as potentially earthquake-prone. The owners of buildings which fit these profiles are then required to provide TAs with a seismic assessment to confirm whether or not they are earthquake-prone. The building profiles are: Category A, Unreinforced Masonry (URM) Buildings; Category B, pre-1976 (non-URM) buildings of three or more storeys or greater than 12 metres in height; and Category C, pre-1935 (non-URM) buildings of 1-2 storeys.[180] As can be seen, New Zealand focuses exclusively on seismic risk according to the physical characteristics of construction material and design year of existing buildings.

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[180] Ministry of Business, Innovation and Employment *EPB Methodology: The Methodology to Identify Earthquake-Prone Buildings* (version 1, Wellington, 3 July 2017) at 1.2.1.

Japan follows a similar methodology, actively targeting buildings according to the design year of buildings. All existing buildings designed prior to the year 1981 are assumed to have insufficient seismic resistance and are the primary area of focus for risk reduction. This reflects the year the national building standard law (BSL) was introduced, which is considered to include the minimum requirements for the seismic resistance of existing buildings.[181] In addition, residential homes which were designed prior to the year 2000 are also considered to be particularly vulnerable to strong shaking and have also been targeted for risk reduction since an amendment to the framework in 2002.

In contrast to New Zealand and Japan, Italy appears to apply a less prescriptive methodology for identifying existing buildings for risk reduction. This reflects the comparatively less active intervention of authorities identifying and requiring seismic assessments from building owners. Indeed, the majority of Italy's existing building stock was constructed prior to the introduction of a national seismic building code and is therefore considered to pose a high risk in earthquakes.[182]

3.2 Associating Seismic Risk to the Physical Characteristics of Buildings

There is a danger of leaving significant gaps in understanding seismic risk if the typologies applied to identify existing buildings within risk reduction frameworks are too narrow. Physical building characteristics help to provide a generalised understanding of existing buildings likely to pose a significant risk in earthquakes, however each building is different and it is therefore ultimately impossible to know for certain how they will perform in particular earthquakes. Experiences of building failure in past earthquakes and the particular construction regulations used to design particular buildings tell only part of the story and do not represent all seismic risk.

Relative caution should be exercised when developing risk reduction obligations in response to observations of existing building damage from individual events. For instance, the

[181] Moullier and Sakoda, above n 120, at 52.

[182] Anna Bosi and others *L'Aquila Earthquake of 6 April 2009: Report and Analysis from a Field Mission* (Publications Office of the European Union, Luxembourg, 2011) at [3.1].

Royal Commission into the Canterbury Earthquakes noted that the observations of building failure in Christchurch is not necessarily applicable for understanding seismic risk of existing buildings in other regions of New Zealand, citing differences in soil conditions and ground motion characteristics between individual earthquakes.[183] Indeed, this was observed between the high concentration of building failure amongst unreinforced masonry buildings in the Canterbury Earthquakes, and amongst later-designed, high-rise buildings in Wellington during the 2016 Kaikōura Earthquake. Identifying seismic risk amongst existing buildings according to physical characteristics such as design years and construction materials reflects knowledge of risk at a particular moment in time. The inherent uncertainty about how individual existing buildings will perform in different earthquakes increases the importance of minimising assumptions about seismic risk by expanding, not restricting, the scope of existing buildings targeted within risk reduction frameworks.

3.2.1 Construction materials associated with the risk of building failure

Where existing buildings are targeted for risk reduction according to construction materials, it appears to be largely reactive according to the experience of building damage from previous earthquakes. On the one hand, it is important to learn from previous experiences of building failure in earthquakes to address the risk of buildings which are known to pose a high risk, such as unreinforced masonry (URM) buildings. On the other hand, casting too narrow a net for the existing buildings subject to risk reduction obligations can lead to issues when newly-understood seismic risk becomes known, such as that posed by hollow core floors.

3.2.1.1 The long-understood danger of unreinforced masonry

Buildings constructed with URM have long been known to be particularly susceptible to collapse from earthquakes. Extensive building failure amongst URM buildings has been observed in many past earthquakes, including more recently in Kobe (1995), L'Aquila (2009) and Christchurch (2011). Each experience has re-emphasised the importance of reducing the

[183] Above n 146, at 208.

risk posed by these buildings.[184] URM buildings include those constructed of masonry materials (i.e. brick, stone, or block) with little or no existing support or reinforcement.[185] As a result, these buildings are only designed to withstand vertical forces (i.e. gravity) and are therefore especially susceptible to the impact of horizontal forces, such as seismic waves.[186] The construction of URM buildings largely ceased in the case study countries throughout the 20th century with the introduction of stricter seismic design standards. Construction with URM largely ceased in Japan and New Zealand following two devastating earthquakes, the 1923 Great Kanto Earthquake in Japan (M_w 7.9) and the 1931 Hawkes Bay Earthquake in New Zealand (M_w 7.8).[187] Construction was not ceased in Italy until much later into the century.[188] As a result, varying numbers of URM buildings remain today in each of the countries.

New Zealand is the only case study country which actively targets URM buildings, with the EPB methodology requiring such buildings to be treated as potentially earthquake-prone.[189] While the explicit focus on URM buildings is largely shaped by the poor performance of these buildings in the Canterbury Earthquakes, it is also a continuation of existing approaches to targeting seismic building risk in New Zealand.[190] In fact, URM buildings were the sole focus of seismic risk amongst existing buildings until the 2004 Building Act subsequently expanded the definition of an EPB.[191] Approximately 3,500 URM buildings were estimated to exist in New Zealand as of 2012, accounting for less than 2% of the country's total building stock (excluding standalone residential homes).[192] Most of these are believed to be used for

184 For instance, almost 80% of total deaths in the 2011 Christchurch Earthquake were connected to the failure of URM buildings, excluding the 133 deaths caused by the collapse of the CTV and PGC buildings, see: above n 146, at 27.

185 Ministry of Business, Innovation and Employment, above n 180, at 1.2.3.

186 Canterbury Earthquakes Royal Commission, above n 146, at 165.

187 Michel Bruneau and Koji Yoshimura "Damage to Masonry Buildings Caused by the 1995 Hyogo-Ken Nanbu (Kobe, Japan) Earthquake" (1996) 23 Canadian Journal of Civil Engineering 797 at 798; Leslie Megget "From Brittle to Ductile: 75 Years of Seismic Design in New Zealand" (2006) 39 Bulletin of the NZSEE 158 at 159.

188 Bellicoso, above n 31, at 139.

189 Above n 180, at 1.2.1.

190 Approximately 500 URM buildings were destroyed or subsequently damaged beyond repair as a result of the 2010/2011 Canterbury Earthquake sequence, see: Canterbury Earthquakes Royal Commission, above n 146, at 165.

191 Building Act 1991, s 66.

192 Above n 146, at 165.

commercial, industrial, or community purposes, including shops and churches.[193] In comparison, it is believed that more than 60% of the entire Italian building stock today consists of buildings constructed with URM.[194] While authorities in Italy do not actively target existing buildings according to particular building profiles, as is the case in New Zealand and Japan, the sheer prevalence of URM buildings in the Italian building stock nonetheless makes them a primary focus of risk reduction amongst existing buildings. At the other end of the spectrum, there are a very small number of URM buildings remaining in Japan today, the majority of which are largely unoccupied historic sites and monuments.[195] Japan does not explicitly target existing buildings according to construction materials. However, any existing URM buildings would likely be captured by authorities focused on pre-1981 buildings regardless.

Despite the low number of occupied URM buildings believed to remain in Japan today, there is nonetheless a particular focus on reducing the risk of unreinforced concrete block walls across the country. Efforts to reduce the risk of these URM walls is comparable to that of URM buildings and parts of URM buildings in New Zealand. Concrete block walls are common in Japan, used primarily as perimeter walls around properties or as non-bearing walls within existing buildings (i.e. walls which support themselves only, and not the structure of a building).[196] The need to reduce their seismic risk became a major area of focus particularly following the 1978 Miyagi Earthquake (Mw 7.4), where approximately 15,000 walls collapsed and caused two thirds of total deaths.[197] The revised building code implemented in 1981 included requirements for these walls to be secured including a reduction in their height. It became evident in the 2018 Osaka Earthquake (M_w 5.6), however, that the strengthening of these walls had largely been neglected when two people were killed by collapsing walls, including a 9-year-old girl outside her school.[198] A range of measures were passed in response,

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[193] Ministry of Business, Innovation and Employment, above n 180, at 1.2.3.

[194] Pietro Crespi, Nicola Giordano and Giuseppe Frascaro "Seismic Loss Estimation for an Old Masonry Building in Italy" (paper presented to 13th International Conference on Applications of Statistics and Probability in Civil Engineering, Seoul, May 2019) at 1.

[195] Michel Bruneau and Koji Yoshimura "Damage to Masonry Buildings Caused by the 1995 Hyogo-ken Nanbu (Kobe, Japan) Earthquake" (1996) 23 Canada Journal of Civil Engineering 797 at 797.

[196] At 798.

[197] At 798.

[198] Mari Yamaguchi "Japan to Check Concrete Walls After Osaka Quake Deaths" (20 June 2018) Associated Press <www.apnews.com>.

including a requirement for all concrete block walls at public schools across Japan to be assessed. In addition, an amendment to the APSRB required seismic assessments to be completed on all such walls located along emergency evacuation routes, with an associated grant to assist with removing any unsafe walls.[199]

The response is reminiscent of an emergency order issued in New Zealand shortly after the 2016 Kaikōura Earthquake (M_w 7.8). Parts of URM buildings located along busy traffic routes within four local government jurisdictions were required to be quickly assessed and remediated (see Chapter 7).[200] The order came into effect approximately four months before the EPB framework, and was designed to reduce the risk of these buildings urgently in a period where the heightened threat of aftershocks had the potential to cause further damage.[201] This order, as with the measures taken to reduce the risk of unreinforced concrete block walls in Japan, demonstrates how reactive responses are still relied upon following earthquakes despite the risk of these structures being well-understood. A lack of determination to address the risk in a prompt manner unnecessarily prolongs its existence and, as a result, involves reactive responses. The 2017 Order demonstrates the ability to remediate risk when urgency is applied to do so and, although URM buildings and parts of URM buildings in New Zealand are captured within the EPB framework, the length of time allocated for their risk reduction remains long relative to the urgent risk they pose (see Chapter 7). The Royal Commission into the Canterbury Earthquakes recommended that all URM buildings across New Zealand be identified and assessed within a two-year period, similar to that allocated within the 2017 Order.[202] As it currently stands, the EPB framework allows between 2.5 and 15 years for URM buildings to be identified for seismic assessment, and a further 7.5 to 35 years for remediation.[203] Given the relatively small number of remaining URM buildings in New Zealand and the well-known danger they pose, there remains the potential for this risk to be

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[199] Cabinet Office Japan, above n 26, at 16.

[200] Hurunui/Kaikōura Earthquakes Recovery (Unreinforced Masonry Buildings) Order 2017.

[201] Independent Review Team *Post-Implementation Review of the Hurunui/Kaikōura Earthquakes Recovery (Unreinforced Masonry Buildings) Order 2017 and URM Securing Fund* (Ministry of Business, Innovation and Employment, Wellington, 2020) at 9.

[202] The Royal Commission further recommended that five years be given to remediate URM buildings which are subsequently found to be earthquake-prone, see: above n 146, at 210.

[203] Building Act, s133AG; s133AM.

left unresolved by the time the next strong earthquake occurs near a populated centre. Such would once again require a reactive, not proactive, response.

3.2.1.2 Reacting to the danger of hollow core floor buildings

The prolonged effort to reduce the risk of URM buildings points to the wider challenge of responding to risks about particular buildings swiftly when and if new knowledge emerges, rather than the historically-typical approach of reacting in the aftermath of earthquakes. Addressing risk promptly and efficiently, rather than allowing it to remain unaddressed for years at a time, is important to ensure the success of prevention-based approaches to risk reduction. This is especially relevant for the recently understood danger of hollow core floors, which exist in many buildings across New Zealand. Despite some damage occurring in the 2011 Christchurch Earthquake, the danger of hollow core floor buildings in New Zealand was made especially prominent after the 2016 Kaikōura Earthquake when several multi-storied buildings suffered significant damage, many of which were relatively new.[204] In fact, the Kaikōura Earthquake neatly illustrates how not all earthquakes are likely to result in the same type of building damage. Much of the building damage sustained in the 2010/2011 Canterbury Earthquakes affected URM buildings. In contrast, ground shaking motions produced by the 2016 Kaikōura event meant that mid-rise multi-storey buildings sustained the most damage.

The use of hollow core concrete floors in buildings across New Zealand is extensive. Their existence in other earthquake-prone countries is not particularly common, making it somewhat "New Zealand's problem".[205] Generally speaking, hollow core floors are pre-set concrete floors which are designed to "reduce weight without any significant loss of strength of stiffness" in buildings.[206] Those designed prior to 2006 are presumed to be of potentially high seismic risk.[207] However, as is discussed in the following section, many were constructed

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[204] Sophie Boot "Govt Investigating Performance of Stats House, More Buildings in Wellington Evacuated" (17 November 2016) National Business Review <www.nbr.co.nz>.

[205] Nicholas James Brooke and others *ReCast Floors – Seismic Assessment and Improvement of Existing Precast Concrete Floors* (ReCast Floors Project, April 2019) at [1].

[206] *Seismic Performance of Hollow Core Floor Systems: Guidelines for Design Assessment and Retrofit* (Structural Engineering Society of New Zealand, New Zealand Society for Earthquake Engineering and New Zealand Concrete Society, Preliminary Draft, April 2009) at 1.

[207] Above n 205, at [1].

from the 1980s onward and are therefore not captured within the EPB framework. Technical guidelines have since been created to assist engineers when completing seismic assessments of hollow core concrete buildings. However, these have not yet been incorporated into the EPB framework and, in fact, seismic strengthening options for these buildings are still largely experimental, leaving current remediation options particularly limited.[208] Of particular interest is that, while more research has been completed in recent years to better understand the seismic risk presented by these floors, their potential seismic weakness has been known since at least the early 2000s.[209] The growing understanding of this risk highlights the importance of ensuring flexibility in the methodologies used to identify existing buildings to understand seismic risk and the need to better understand this risk to take appropriate preventative measures rather than reacting to earthquakes themselves.

3.2.2 Using the design year of buildings to assume seismic risk

The year a building was designed is also a useful indicator of its likely seismic risk. As mentioned, the design year of buildings relates to the building code in force at the time of construction. Based on this, assumptions are made about the seismic resistance a building is likely to have according to the seismic standards used within its design. Design years are therefore useful for categorising the potential seismic risk of buildings on a broad scale. Since legal frameworks are primarily concerned with life safety risk, design years are typically applied to capture buildings most at risk of structural collapse. Generally speaking, the most crucial factor considered when determining the relevant design year for identifying existing building risk is the requirement of building ductility within design standards. Ductility simply refers to ability of a building's structure to absorb horizontal forces (i.e. seismic waves), which therefore increases likely resistance against structural collapse.[210] Requirements for ductility were largely omitted from seismic building standards in each case study country until the late 20th century, with vertical forces (i.e. gravity) the primary design consideration in construction. As previously mentioned, relevant design standards were introduced in New Zealand and Japan in 1976 and 1981, respectively. As a result, only buildings designed prior to these dates in each respective country are actively targeted by authorities for seismic risk reduction. In Italy, most

[208] At [1].

[209] Above n 206, at 50.

[210] Megget, above n 187, at 161.

existing buildings are not actively targeted by authorities for risk reduction. Nevertheless, buildings constructed prior to the first national seismic code in 1974 are generally assumed to have no structural resistance to earthquakes, while many designed thereafter between the 1970s and 1990s are assumed to have been constructed with insufficient structural resistance.[211]

By focusing on identifying existing buildings designed prior to these years, it is clear that risk reduction frameworks for existing buildings are primarily intended to remediate only buildings with absolute worst potential risk. As a result, two assumptions in particular are made about buildings constructed after these design years: first, that the seismic design code used for construction provides sufficient structural resistance to earthquakes and, second, that these later-designed buildings were in fact designed properly in accordance with the design standards. Because these are broad assumptions, it is important that the design years used to target buildings within legal frameworks are not so narrow that they are ignorant to potential risk from later-designed buildings.

The EPB framework in New Zealand adopts a particularly narrow focus in relation to the type of buildings targeted for risk reduction. As mentioned, the EPB methodology requires TAs to treat pre-1976 buildings of three or more storeys or greater than 12 metres in height (Category B), and pre-1935 buildings of 1-2 storeys (Category C), as potentially earthquake-prone.[212] This means that only buildings designed prior to 1976 are targeted for seismic risk reduction in New Zealand. This is a result of the legal definition provided to an EPB, which relates to buildings with an earthquake rating of less than 34%NBS (refer to Chapter 2). According to the NZSEE, buildings considered most likely to be potentially earthquake-prone are believed to have been primarily designed prior to the 1976 seismic code.[213] Two gaps arise through the focus on buildings only which fit these profiles.

The first is in relation to Category C buildings. These buildings represent those which were constructed before the New Zealand's first national seismic code was introduced

[211] Bosi and others, above n 182, at [3.1].

[212] Above n 180, at 1.2.1.

[213] New Zealand Society for Earthquake Engineering *Technical Guidelines for Engineering Assessment, Part B: Initial Seismic Assessment* (Ministry of Business, Innovation and Employment, July 2017) at B4-3.

following the devastating 1931 Napier Earthquake of 1931 (M_w 7.8).[214] Category C buildings are targeted for remediation within regions of high and medium seismic hazard, but not those of low hazard (see Chapter 4). By omitting these buildings from risk reduction obligations in these areas, the ability to more thoroughly understand the risk presented by these buildings is extremely limited. This is problematic, considering these buildings would be treated by authorities as potentially earthquake-prone if not for their existence in low hazard areas (where, as is discussed in Chapter 4, there is still the potential for strong shaking). There is no other rationale to target Category C buildings exclusively within high and medium seismic hazard areas other than it being an intentional attempt to limit the number of buildings captured by the EPB framework, and therefore limit the number of building owners subject to mandatory strengthening obligations.

Additionally, the EPB framework assumes the threat of EPBs comes solely from pre-1976 buildings and ignores the need to assess the potential risk of later-designed buildings. Again, this is a probabilistic assumption as the existence of EPBs amongst post-1976 buildings, in fact, "cannot be discounted entirely".[215] There are no legal requirements for later-designed buildings to be seismically assessed, however, leaving an extremely limited opportunity to understand and reduce potential risk amongst such buildings. As many as 50,000 existing buildings designed after 1976 are estimated to be potentially "earthquake-vulnerable".[216] Unlike EPBs, which have an earthquake rating of less than 34%NBS, earthquake-vulnerable buildings include those with an earthquake rating of between 34-66%NBS. Although outside the legal definition of "earthquake-prone", these buildings still pose a "medium" risk of collapse in a moderate earthquake approximately 5-10 times greater than buildings designed after 1 July 2017.[217] In fact, though seismic strengthening is not legally required for earthquake-vulnerable buildings in New Zealand, the de facto policy of many public agencies in recent years has seen existing buildings rated below 67%NBS deemed unsafe for continued occupation, including Parliament's Bowen House in central Wellington.[218] There is a clear need to better understand this seismic risk in order to make progress toward reducing it and

[214] Megget, above n 187, at 159.

[215] Above n 213, at B4-3.

[216] Martin Jenkins, above n 29, at 17.

[217] New Zealand Society for Earthquake Engineering, above n 111, at A3-9.

[218] "Quake Risk: Work Under Way to Relocate Bowen House Politicians, Staff" (19 February 2020) Radio New Zealand <www.rnz.co.nz>.

improving resilience. However, efforts to understand this risk is hindered by the exclusive focus on targeting pre-1976 existing buildings.

It worthwhile noting the original draft of the EPB framework was intended to require seismic assessments for all multi-storey buildings designed prior to the enactment of the current building regulations, in March 2005.[219] Such a requirement would have provided greater certainty about the seismic risk amongst buildings which are omitted from the framework. Although the policy objective of identifying EPBs aligns with this pre-1976 focus, having a more accurate understanding of seismic risk amongst a broader range of the building stock would better position New Zealand to improve overall seismic resilience. This is especially relevant given no seismic assessment information exists for tens of thousands of post-1976 buildings in New Zealand.[220]

While Japan similarly targets only existing buildings designed prior to 1981, the standard of seismic resistance required in the 1981 code appears to be greater than that of the 1976 New Zealand code (see Chapter 2). In fact, the 1981 BSL is considered somewhat of a gold standard for existing building seismic safety in Japan and buildings which comply with the code are considered to have a "low possibility" of failure or collapse.[221] The Kobe Earthquake of 1995 (M_w 6.9) was the first major test of effectiveness for the 1981 BSL. Of the more than 100,000 damaged or collapsed buildings, approximately 97% were believed to have been constructed prior to the building code.[222] Observations of building damage from subsequent earthquakes has also been primarily concentrated amongst pre-1981 buildings, including the 2011 Tohoku Earthquake (M_w 9.0) and the 2016 Kumamoto Earthquake (M_w 7.3).[223] It should also be noted that this building damage has been observed across multiple earthquakes in Japan. Much fewer strong earthquakes have impacted urban centres in New Zealand in recent history and the discrepancy in building damage between the 2011

[219] Building (Earthquake-Prone Buildings) Amendment Bill 2015 (182-1), s 133AF(3).

[220] Ministry of Business, Innovation and Employment *Regulatory Impact Statement: Earthquake Prone Policy Review* (27 November 2012) at 9.

[221] Moullier and Sakoda, above n 120, at 52.

[222] At 6.

[223] See: Motosaka and Mitsuji, above n 125, at 930; Keiko Morita and Mineo Takayama "Lessons Learned from the 2016 Kumamoto Earthquake: Building Damages and Behaviour of Seismically Isolated Buildings" (paper presented to AIP Conference Proceedings 1892, October 2017) at 1.

Christchurch event and 2016 Kaikōura event demonstrate that seismic risk is not limited to buildings designed prior to 1976. Furthermore, a significant difference between the focus on pre-1981 buildings in Japan and potentially earthquake-prone buildings in New Zealand is the assumed probability of collapse in strong earthquakes. As mentioned, buildings designed according to the 1981 BSL in Japan are considered to have a low risk of collapse, while buildings recognised as earthquake-prone in New Zealand are considered to have a high potential of collapse.[224] It therefore appears that the buildings targeted within the Japanese framework is similar to if New Zealand targeted both earthquake-prone and earthquake-vulnerable buildings.

As mentioned previously, an assumption made restricting legal obligations to buildings designed prior to a particular year is that later-designed buildings were constructed in accordance with relevant seismic regulations of the time. Experiences in the case study countries indicate that a more thorough understanding of seismic risk amongst later-designed buildings, which are assumed to better withstand collapse in strong earthquakes, would be beneficial. Although the assurance of complete safety in earthquakes is not attainable, a greater awareness of the potential risk of these existing buildings would nonetheless help to understand which buildings require the most attention and effort to increase seismic resilience. In the Canterbury Earthquakes, observations indicated the majority of building damage was concentrated amongst pre-1976 buildings.[225] However, this also ignores the wider context that 115 of the 185 deaths in the 2011 earthquake were the result of one building collapse: the six-storey CTV building, constructed in the mid-1980s. The Christchurch experience, and other earthquakes around the world for that matter, illustrates that tragedy requires merely one building to fail. The CTV building, alongside the many mid-rise buildings damaged in the 2016 Kaikōura earthquake, was constructed after 1976 and therefore would have been outside the scope of obligations under the EPB framework. It also demonstrates the potential consequence of assuming post-1976 were, in fact, designed with appropriate seismic resistance according to relevant building codes of the time. Experience over the previous decade highlights the failure for the seismic risk posed by many modern built existing buildings to be applied within

[224] New Zealand Society for Earthquake Engineering, above n 111, at A3-9.

[225] SR Uma, Rajesh P Dhakal and Mostafa Nayyerloo "Evaluation of Displacement-Based Vulnerability Assessment Methodology Using Observed Damage Data from Christchurch" (2014) 43 Earthquake Engineering and Structural Dynamics 2319 at 2324.

regulatory practice. Targeting a broader range of existing buildings would not only help capture other potentially earthquake-prone buildings, but also to more comprehensively understand the seismic risk of earthquake-vulnerable buildings across the country. Such knowledge would better enable resilience to be improved across the nation's existing building stock.

3.3 Priority Buildings Represent a More Holistic Approach to Identifying Seismic Risk

Though construction materials and the design year of buildings can signify potential physical vulnerabilities of buildings, a more holistic approach to understanding the seismic risk of existing buildings includes consideration to factors such as function and occupancy. Such an approach to identifying the seismic risk of existing buildings considers risk according to the vulnerability of building users and/or the social importance of particular buildings themselves. Existing buildings identified according to these characteristics may be generally referred to as "priority buildings". Although the exact types of buildings considered to have priority status and the terminology used to define them varies between each country, the phrase 'priority building' is used in this research to broadly describe existing buildings which are explicitly identified as such within legal frameworks for the purpose of being subject to risk reduction obligations. Priority buildings in the case study countries share typical characteristics, including those which serve an essential societal purpose and whose failure would be particularly disruptive to society were they to be unusable after earthquakes (i.e. hospitals and buildings used by emergency services), as well as buildings which are occupied by particularly vulnerable groups of people (i.e. schools).

Each of the case study countries prioritise existing buildings which largely serve a key function in emergency management and which have failed in past earthquakes, though Japan includes a broader range of existing buildings to include large facilities commonly-used by the general public. Hospitals, schools, and buildings required in emergency situations, such as shelters, emergency management centres, or stations for emergency services, are all considered priority buildings within the legal frameworks for risk reduction of existing buildings in each case study country.[226] In Italy, priority buildings (referred to as "strategic" and "relevant" buildings) appear to be primarily associated to those deemed critical for emergencies, with a

[226] See: Building Act, s 133AE; Ordinanza del Presidente, above n 155; Moullier and Sakoda, above n 120, at 47.

particular focus on schools following the collapse of a primary school in San Giuliano during the 2002 Molise Earthquake (see Chapter 2).[227]

A slightly broader understanding is given to priority buildings in both New Zealand and Japan, similarly based on experiences of building failure. For instance, dangerous parts of certain URM buildings are considered priority buildings within the EPB framework in New Zealand, owing to the significant deaths and injuries suffered in the 2011 Christchurch Earthquake.[228] Parts of URM buildings considered to be priority buildings include those which could fall in an earthquake onto a road or thoroughfare with "sufficient vehicle or pedestrian traffic to warrant prioritising", rather than all URM buildings in general.[229] These are identified by TAs through a public consultation process under the Local Government Act.[230]

In Japan, amendments to the APSRB made in response to the 2011 Tohoku Earthquake prioritised the risk reduction of specific "large-scale" buildings across the country. Relevant priority buildings include large buildings used by unspecified numbers of people (i.e. hotels, department stores, and various public recreation facilities), as well as large buildings used by groups of people likely to need special assistance to evacuate (i.e. aged care homes).[231] Many of these buildings sustained extensive damage primarily to non-structural elements in the 2011 earthquake and left many unsafe to occupy, including those which were designed to be used as emergency shelters.[232] The prioritisation of buildings such as large stores, public facilities and aged care homes represents a more holistic view to seismic risk than the definition of priority buildings applied within Italy and NZ, beyond primarily emergency-related buildings.

[227] Mazzoni and others, above n 26, at 1676.

[228] Parts of URM buildings were recognised as priority buildings within the EPB framework primarily owing to the efforts of Anne Brower, who was the sole survivor on a bus which was crushed by falling URM in the 2011 Christchurch Earthquake, see: (17 February 2016) 711 NZPD 9136.

[229] Building Act, s 133AE(1)(e).

[230] Section 83.

[231] These buildings are recognised with priority status in addition to hospitals, schools, and other buildings critical to emergency management, see: Ministry of Land, Infrastructure, Transport and Tourism, above n 153, at 236.

[232] Tatsuo Narafu and Mikio Ishiwatari *Building Performance* (The World Bank, Washington DC, 2013) at 13.

While priority buildings offer an opportunity to approach seismic risk reduction holistically, the extent to which they are subject to risk reduction obligations appears to ultimately be restricted in New Zealand and Japan. Indeed, the identification of seismic risk amongst these buildings according to their priority status is secondary to the pre-determined physical characteristics used to target existing buildings within risk reduction frameworks. For instance, TAs in New Zealand are required to first identify whether a building meets an appropriate description of a priority building under the Building Act, before proceeding to then apply the building profile categories within the EPB methodology to identify whether or not the building is "potentially earthquake-prone".[233] If the building is not considered potentially earthquake-prone as per the EPB methodology, the building is not legally subject to risk reduction obligations. Similarly, in Japan, only relevant large-scale buildings which were constructed prior to 1981 are considered priority buildings within the scope of obligations under the APSRB. The result of these restrictions for identifying priority buildings is that seismic risk is less understood for those buildings which were designed later than the design years applied within relevant frameworks. Because Italy does not apply a particular methodology to identify existing buildings for risk reduction, priority buildings do not appear to be restricted by any particular design year or construction material. As argued in the previous section, the design years applied within New Zealand and Japan do not necessarily capture all seismic risk amongst existing buildings. Given the stated importance of priority buildings compared to other existing buildings, it is unsuitable to identify the potential seismic risk of only some buildings and not all.

The limitation of identifying seismic risk amongst priority buildings is further exacerbated in New Zealand, with a restriction of priority buildings to areas of medium and high seismic hazard (see Chapter 4). As a result, buildings located in areas of low seismic hazard, which would otherwise be treated as priority buildings, are subject to the same risk reduction obligations as all other buildings identified by authorities as potentially earthquake-prone. In practice this means that hospitals, schools, and other such buildings defined as priority buildings within the Building Act, are treated with the same urgency in low seismic hazard areas as are other existing buildings. Although they are still subjected to mandatory strengthening obligations, they have multiple decades for this to be completed. Priority

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[233] Ministry of Business, Innovation and Employment *Priority Buildings: A Guide to the Earthquake-Prone Building Provisions of the Building Act* (Wellington, July 2017) at [5.2].

buildings in Italy, which were subject to seismic assessment requirements under the 2003 Ordinance, also only applied to buildings located within the highest two hazard zones. However, it should be noted that seismic strengthening for these buildings was not legally compulsory as it is in New Zealand. The focus on priority buildings in high hazard zones in Italy was a deliberate decision by the government to prioritise resources and state-funding according to perceived earthquake threat. Conversely, the EPB framework in New Zealand imposes risk reduction obligations on buildings across the entire country. It would therefore be more appropriate for the recognition of priority buildings to apply in all regions.

3.4 Residential Homes

Perhaps the most notable exclusion from the risk reduction framework for existing buildings in New Zealand is residential homes. Indeed, the statutory definition of an EPB excludes buildings "used wholly or mainly for residential purposes".[234] An exception applies for buildings of two or more storeys in height used as hostels and boardinghomes, or buildings which contain three or more residential units, which are both included within the EPB definition. Of the 1.8 million private residential buildings in New Zealand, most are detached homes constructed with wooden structures.[235] Approximately 47 percent of existing homes were constructed prior to 1980 and so unlikely to have been designed with sufficient seismic design standards.[236] With the exception of some multi-storey buildings, the majority of homes in New Zealand are not targeted for obligations to reduce seismic risk.

This is in complete contrast to Italy and Japan, where seismic strengthening or retrofitting is strongly encouraged amongst residential homes. In Italy, almost 90 percent of residential buildings are believed to be made of masonry and reinforced concrete materials.[237] Of these buildings, 90 percent of those constructed with masonry and 55% of those constructed

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[234] Building Act, s 133AA(2).

[235] Statistics New Zealand *Housing in Aotearoa: 2020* (New Zealand Government, 2020) at 17.

[236] Notably, the number of residential buildings constructed prior to 1980 goes up to almost 60% of all homes in the earthquake-prone region of Wellington. At 18.

[237] K Gkatzogias and others *Integrated Techniques for the Seismic Strengthening and Energy Efficiency of Existing Buildings: Pilot Project Workshop 16-19 November 2020* (Publications Office of the European Union, Luxembourg, 2021) at 10.

with reinforced concrete were built without seismic design standards, respectively.[238] Japan's housing stock more similarly compares to New Zealand's with half of all residential buildings consisting of detached homes, largely made of wood.[239] However, many older homes have masonry integrated into their construction which make them also more vulnerable to damage. One third of all houses in Japan were constructed prior to 1980 and are of particular seismic concern, although this number rises to more than 55 percent when considering houses built prior to 2000.[240] The governments of Japan and Italy both provide various incentives to encourage and assist homeowners complete seismic strengthening where homes are understood as having inadequate resistance to earthquakes (see Chapter 6). One of the main factors for this drive to reduce the seismic risk of residential homes in Italy and Japan is the result of low-uptake, or the nonexistence, of earthquake insurance amongst homeowners (see Chapter 2.4). As a result, the government is increasingly left to foot the expense of helping people with repair or reconstruction efforts. The Act Concerning Support for Reconstructing Livelihoods of Disaster Victims ensures homeowners in Japan are provided with a certain level of public funds to compensate for damage or destruction in earthquakes, albeit this is a relatively small amount (approximately NZ$26,000 toward the reconstruction of destroyed homes).[241]

Damage and destruction to residential homes in New Zealand is covered by a mandatory national earthquake insurance scheme, EQC.[242] This uniquely high penetration of insurance against seismic events amongst residential homes in New Zealand provides a layer of financial protection against any potential earthquake damage. From a disaster risk reduction perspective, however, it appears to be a significant oversight in the seismic risk reduction efforts in New Zealand to exclude residential homes from seismic strengthening duties. While insurance provides a security net for losses, it does not ultimately promote preventative action and risk-adverse behaviour in relation to seismic strengthening. The insurance industry does not currently distinguish between seismically resilient buildings and seismically inadequate buildings, providing no incentive to reduce such risk (see Chapter 6). As a result, the seismic

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[238] At 10.

[239] "我が国の住宅ストックをめぐる状況について" (2018) Ministry of Land, Infrastructure, Transport and Tourism <www.mlit.go.jp> (translation: About the Situation Surrounding Housing Stock in Japan) at 7.

[240] At 9.

[241] Shoichi Ando "Evaluation of the Policies for Seismic Retrofit of Buildings" (2012) 6 Journal of Civil Engineering and Architecture 391 at 391.

[242] New Zealand Earthquake Commission <www.eqc.govt.nz>.

risk of residential homes in New Zealand is not widely understood nor is it promoted within legal frameworks.

3.5 Summary

Typologies are applied within risk reduction frameworks to identify the specific buildings in need of risk reduction obligations. Owing to a priority on life-safety, the existing buildings targeted within the case study countries primarily concentrate on those which are assumed to be most at-risk of potential collapse. As a result, there is a strong focus on understanding seismic risk according to building materials and the year of a building's design. It is important that the line drawn between buildings which are and are not subject to risk reduction obligations is not so narrow that it ignores a significant amount of potential seismic risk. This is particularly relevant in New Zealand where, aside from URM buildings, only buildings designed prior to 1976 are treated as potentially earthquake-prone by authorities. By omitting the need to confirm the seismic risk of later-designed buildings, risk is purely based on the assumption the seismic code they were constructed with provided sufficient resistance and the buildings do, in fact, comply with the code. In fact, EPBs represent buildings with the greatest assumed risk of collapse but are by no means the only buildings which present a risk. Authorities in Japan target existing buildings designed prior to the national seismic code of 1981, which are believed to pose a low risk of collapse. If a similar approach was taken in New Zealand, thousands of post-1976 buildings would be required to confirm their seismic risk. Instead, the pre-1976 approach has been adopted to limit the number of buildings subject to obligations and, as a result, leaves much ignorance about existing building risk.

Some buildings are also classified as priority buildings, in an attempt to focus on seismic risk from a more holistic perspective. These buildings are largely categorised according to their essential function or vulnerable occupants, such as hospitals and schools. Nonetheless, these buildings also appear to be identified according to their construction materials and design years. Once again, assumptions are made about the risk of buildings which would be considered priority buildings yet are not targeted for risk reduction, since they sit outside of the typologies used within legal frameworks. In New Zealand and Italy, the classification of priority buildings is also limited to particular regions according to seismicity, rather than across the entire country.

Also of relevance within existing building typologies are residential buildings. These are largely excluded from risk reduction obligations in New Zealand, compared to both Italy and Japan where they are a central aspect of risk reduction. The decision to exclude most residential buildings from the EPB framework in New Zealand, again, misses an opportunity to promote broader seismic resilience, especially since destroyed housing is likely to exacerbate potential disaster. Japan and Italy both target housing for risk reduction measures, largely owing to the lack of insurance coverage in these countries and thus the greater reliance on government support after damaging earthquakes. Yet, the focus remains relevant even in New Zealand, where all residential buildings are covered by a mandatory government insurance scheme, since insurance does not ultimately incentivise or encourage risk reduction measures to be undertaken. Greater focus should be placed on encouraging home owners in New Zealand to complete seismic strengthening, rather than do nothing at all.

Chapter 4

Using Seismic Hazard Zones to Manage Risk

> A highly vulnerable building in a highly populous but low seismicity region is arguably as important, if not more important, than a rarely occupied, earthquake-prone building in a [lesser populated region of high seismicity].
>
> New Zealand Society for Earthquake Engineering (NZSEE)[243]

In countries which are susceptible to strong earthquakes, some regions are more seismically-active than others and can therefore expect a greater frequency of strong shaking. These regions are often distinguished within building codes and other law by seismic hazard zones, which identify regions according to the expected frequency of earthquakes. While seismic hazard zones are useful to conceptualise the seismic hazard of different areas, various challenges arise in relation to their application within risk reduction frameworks for existing buildings. Three challenges in particular are discussed in this chapter.

The first of these challenges relates to a conflation between the concepts of seismic hazard and risk, which is of particular relevance in New Zealand. The Building Act defines the seismic hazard of different New Zealand regions as areas of "seismic risk". As explained in Chapter One, hazard and risk are conceptually different and it is therefore important to differentiate between hazard threat and risk itself. This distinction is important also as seismic hazard zones directly influence people's risk perception about earthquakes, which subsequently influences risk reduction behaviour. Since a low seismic hazard simply means there is a low frequency of earthquakes within a specific time period, it is important that risk reduction obligations in these regions appropriately reflect the potential for such rare events. A low seismic hazard does not mean there is no risk, especially since the potential for earthquakes is still substantially higher relative to other non-seismically-active countries. Indeed, there is still a large amount of uncertainty which surrounds the occurrence of earthquakes and seismic hazard zones ultimately reflect seismic knowledge at a particular time. Unexpected events can and do occur which is an importance consideration when using seismic hazard zones to regulate for the seismic risk of existing buildings.

[243] New Zealand Society for Earthquake Engineering "Oral Submission to Local Government and Environment Select Committee on the Building (Earthquake-Prone Buildings) Amendment Bill 2015" at 2.

4.1 What are Seismic Hazard Zones?

Before discussing seismic hazard zones, it is first useful to outline specifically what they are and how they are created. As mentioned, some regions within earthquake-prone countries are understood to be more seismically-active than other regions. Seismic hazard zones reflect the probability of an earthquake causing a specific strength of ground shaking to be exceeded within a particular period of time.[244] These estimations are typically generated through the study of known seismic faults and occurrences of historical earthquakes which have been generated from these faults, including their estimated frequency and intensity.[245] This data is then formulated by scientists into seismic hazard maps, to visualise and communicate the expected danger of earthquakes across a national territory.[246] Much like how climate and weather maps are used to visualise where particular atmospheric and climatic events are expected to occur, seismic maps are a best estimate tool to illustrate the intensity of ground shaking which may occur in different regions.[247] Of course, as it is not possible to predict exactly when and where earthquakes will occur, seismic hazard maps simply provide an indication of potential seismic shaking within a specific period of time (Chapter 4.2.2).

Seismic hazard modelling can be difficult for non-experts to interpret or understand, and so this is often translated into law as seismic hazard zones. One of the main purposes for this is to draw clear boundaries between jurisdictional territories so that different regulation can be easily applied according to the likely seismic hazard of regions. For instance, seismic hazard zones are often applied within building codes to ensure that buildings constructed in areas with a higher frequency of seismic activity are developed to a greater seismic resistance than buildings constructed in areas with a lower frequency of seismic activity. Seismic hazard zones

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[244] Seth Stein and others "Challenges in Assessing Seismic Hazard in Intraplate Europe" in A Landgraf and others (eds) *Seismicity, Fault Rupture and Earthquake Hazards in Slowly Deforming Regions* (2017) 432 Geological Society, London, Special Publications 13 at 13.

[245] At 13.

[246] Michele Marti, Michael Stauffacher and Sefan Wiemer "Difficulties in Explaining Complex Issues with Maps. Evaluating Seismic Hazard Communication – the Swiss Case" (2019) 19 Natural Hazards and Earth System Sciences 2677 at 2677.

[247] At 2677.

are also often used to apply different legal obligations within risk reduction frameworks for existing buildings, including in both New Zealand and Italy.

In New Zealand, the Building Act divides the national territory into three distinct seismic zones of low, medium, and high "seismic risk areas".[248] These areas are determined within the Act according to their allocated seismic hazard (Z) factor. Similarly, the national territory of Italy is separated into four seismic hazard zones. These zones also ascend progressively in relation to earthquake frequency, with zone four having the greatest expected seismicity and zone one having the least expected seismicity.[249] In contrast to both Italy and New Zealand, Japan does not apply seismic hazard zones to inform risk reduction obligations for existing buildings and obligations under the APSRB framework are applied equally nationwide.[250] In complement to this, special planning legislation exists for local governments to prioritise risk reduction measures in locations anticipated to be impacted by major earthquakes in the foreseeable future, including in the Tokyo Metropolitan Area. This offers a unique comparison opportunity as an alternative to seismic hazard zones as a regulatory tool for managing existing buildings.

4.1.1 How are hazard maps applied to reduce existing building risk?

The use of seismic hazard zones as a tool for managing the risk reduction of existing buildings is ultimately a political decision. The absence of these zones from Japan's risk reduction framework for existing buildings illustrates this. In fact, obligations within the EPB framework in New Zealand were originally intended to apply equally across the country without discrepancy between hazard zones.[251] The integration of seismic hazard zones into the framework was a product of political compromise during the design phase in Parliament. This is necessary to understand, as it demonstrates that the use of seismic hazard zones within risk reduction frameworks for existing buildings does not derive from a normative understanding of seismic risk.

[248] Section 133AD(1).

[249] "Classificazione Sismica" Dipartimento della Protezione Civile <www.rischi.protezionecivile.gov.it> (translation: "Seismic Classification" Department of the Civil Protection).

[250] *Preparedness Map for Community Resilience: Earthquake – Experience of Japan* (Global Facility for Disaster Reduction and Recovery, Government of Japan and The World Bank, 16 December 2016) at 1.

[251] Building (Earthquake-Prone Buildings) Amendment Bill, s 133AO.

There are two main functions of seismic hazard zones within the legal frameworks for managing existing buildings in both New Zealand and Italy. The first is to form a basis for prioritising legal responsibilities for building owners to reduce risk, including through separate timeframes for which to achieve these in New Zealand (see Chapter 7). Additionally, seismic hazard zones are used within legal frameworks to determine access to various financial incentives aimed at assisting building owners achieve their obligations. The objective rationale for using seismic hazard zones to determine these factors is to ensure a finite amount of resources are prioritised toward areas with the greatest probability of experiencing damaging ground shaking in the foreseeable future. As these earthquakes are expected to occur more frequently in high hazard zones, reducing the risk of existing buildings in these areas first simply makes logical sense. However, this rationale should not mean risk reduction efforts in low seismic areas are overlooked or neglected. While low seismic zones are expected to experience strong ground shaking less frequently, the potential nonetheless exists and thus so too does the underlying seismic risk in these areas.

Prioritising legal responsibilities according to seismic hazard zones are a central feature of the EPB framework in New Zealand, with greater urgency given to risk reduction in high seismic regions. This directly influences the type of existing buildings subject to assessment and strengthening obligations under the Building Act, the time in which these obligations must be completed, and access to financial incentives (see Chapter 6). For instance, priority buildings and those which are identified as Category C buildings within the EPB methodology (pre-1935 buildings of 1-2 storeys), are subject to risk reduction obligations only in medium and high seismic hazard areas (refer to Chapter 3).[252] In addition, the time period within which potential EPBs must be identified, assessed and, if necessary, strengthened are staggered according to hazard zones. Longer time periods are allocated to the remediation of existing buildings in low hazard areas compared to those located within medium and high hazard areas, while priority buildings must be remediated in half the time of other buildings (see Chapter 7).[253] This is an intentional feature of the EPB framework, to account for perceived urgency of risk reduction across the country in relation to seismic hazard threat.[254] While such an approach

[252] Above n 180, at 1.2.1.

[253] Building Act, s 133AD(1).

[254] (10 May 2016) 713 NZPD 10918.

is intended to address seismic risk in areas with the greatest probability of experiencing earthquakes, it also assumes that areas of high seismicity are in fact going to experience strong shaking prior to other areas. Though statistically more probable, this does not necessarily reflect an accurate reality of where strong shaking may next occur. The Canterbury earthquakes demonstrated this, which occurred in what was then classified as an area of medium seismic hazard (as discussed later in this chapter).

Similar to New Zealand, the Italian State also uses seismic hazard zones to assess and strengthen priority buildings. Ordinance 3274 of 2003 directed the owners of all priority buildings to seismically assess and, if necessary, strengthen their structure(s), though this only applied to buildings within the higher seismic hazard zones one and two. Italy's national risk reduction tax incentive scheme, Sismabonus, also originally applied to existing buildings within zones one and two, but was expanded in 2017 to also include zone three.[255]

4.2 Challenges and Limitations of Seismic Hazard Maps

Communicating seismic danger through hazard maps is complex and many people often struggle to correctly understand them, especially non-experts.[256] While seismic hazard maps may be useful to prioritise risk reduction obligations and resources within legal frameworks, they also present challenges which may ultimately hinder people from taking appropriate risk reduction measures. Three such challenges are discussed in this section, including a terminological conflation of the concepts of hazard and risk, the potential influence hazard maps have on public perception for the need to take preventive action against earthquakes, and the overall challenge of regulating with limited and evolving scientific knowledge.

While each of these examples include their own unique set of circumstances, they each demonstrate the difficulty of transferring scientific knowledge into law. While it may not be possible to predict exactly where and when earthquakes will occur, or how powerful they may be, it is possible to create legal risk reduction frameworks which account for these

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[255] "Sisma Bonus: Le Detrazioni Per Gli Interventi Antisismici" (2019) L'Agenzia Informa (translation: "Bonus Earthquake: Deductions for Anti-Seismic Interventions" The Agency Informs) at 4.

[256] Marti, Stauffacher and Wiemer, above n 246, at 2679.

uncertainties. Prioritising obligations toward high and medium hazard areas is both pragmatic and logical, yet excluding obligations from lower hazard areas entirely is inappropriate given the uncertainty of earthquake activity. The decision to expedite the remediation of priority buildings only within higher hazard zones in New Zealand and Italy overlooks risk posed by these buildings in low seismic areas, where strong shaking can still be expected albeit on a less frequent basis. The omission of Category C buildings located in low hazard regions from the EPB framework in New Zealand (see Chapter 3) is similarly concerning, as it overlooks the risk of these existing buildings by focusing on the likelihood of certain levels of ground shaking. Owing to the uncertainty of potential of seismic hazard, vulnerable existing buildings should be targeted for remediation in all regions regardless of seismic hazard zone.

4.2.1 The use and misuse of seismic "hazard" and "risk"

Although the terms hazard and risk represent two different concepts, they appear to be conflated within the EPB framework in New Zealand. As mentioned, the Building Act establishes low, medium and high seismic hazard zones across New Zealand, which are defined as areas of "seismic risk".[257] While the use of risk here is likely intended to represent the threat or danger of seismic activity, the correct use of terminology is imperative when applying scientific knowledge within law. As discussed in Chapter One, hazards and risk are conceptually different and DRR requires them to be clearly distinguished to understand risk as the function of hazards intersecting with vulnerability.[258] Though such differentiation may seem trivial, accurate risk communication directly informs understanding of hazard and promotes preventative action.[259] This is critical because, as expressed in the NZSEE quote used at the beginning of this chapter, just because a region is considered to have a low seismic hazard does not mean the risk presented by existing buildings is also low.[260]

In fact, the legal definition of risk applied within the main legislation for managing building safety appears to be used interchangeably with the threat of hazards. The Building Act

[257] "How the System for Managing Earthquake-Prone Buildings Works" (24 August 2018) Ministry of Business, Innovation and Employment <www.building.govt.nz>.

[258] Above n 74.

[259] Marti, Stauffacher and Wiemer, above n 246, at 2679.

[260] New Zealand Society for Earthquake Engineering, above n 243, at 2.

explicitly defines "seismic risk areas" according to the Z factor, or seismic hazard factor, of individual regions, which represents the potential frequency of ground shaking.[261] The same conflation also appears within the Civil Defence Emergency Management Act 2002 (CDEM), which defines risk as "the likelihood and consequences of a hazard".[262] Both of these definitions outline risk as the likelihood of, or potential for, a hazard occurring. This understanding of seismic risk is inconsistent with that used within the New Zealand Government's 2019 National Resilience Strategy, which outlines the country's long-term plan to manage disaster risk and improve resilience.[263] In fact, the strategy adopts the vulnerability-based definition of risk applied within the Sendai Framework, which clearly distinguishes hazards from risk. The use of consistent definitions which recognise risk as the product of human decisions is preferable for achieving the overall goal of risk reduction. As noted by the New Zealand Seismic Risk Working Group, hazard factor as it is applied within the Building Act "[does not] consider other factors influencing the actual risk, including the density of buildings, their fragility and occupants' exposure".[264]

Describing regions according to seismic risk mischaracterizes seismic frequency with the potential impact of earthquakes, when in fact existing buildings with insufficient structural resistance present a risk wherever the potential for earthquakes exists. For instance, although the seismic hazard factor of Auckland is low, the potential seismic risk in Auckland is high due to factors including a high population density and extreme concentration of national commerce.[265] This is not obvious when looking at the seismic hazard map, however, which describes Auckland as "low seismic risk". In contrast, although the region of Fiordland is considered "high seismic risk", much of the region is in fact unpopulated and therefore presents a far lower risk in relation to vulnerability. Directly conflating seismic risk with the probability of a hazard occurring misrepresents the potential impacts of earthquakes and associated vulnerability. Italy appropriately defines its regions according to seismic hazard and not by seismic risk. It would be appropriate for the terminology within the Building Act in New

[261] Section 133AD.

[262] Section 4.

[263] *Disaster Resilience Strategy* (Ministry of Civil Defence and Emergency Management, Wellington, April 2019) at 6.

[264] Above n 92, at 22.

[265] David Dempsey and others "Ground Motion Simulation of Hypothetical Earthquakes in the Upper North Island of New Zealand" (2020) 63 New Zealand Journal of Geology and Geophysics 1 at 1.

Zealand to be changed from seismic risk to seismic hazard, to more accurately represent risk from a Sendai Framework perspective. This would more clearly demonstrate that seismic zones represent the likelihood of seismic hazard, and not the vulnerability of communities to the impact of earthquakes.

4.2.2 Preparing for infrequently-occurring earthquakes?

The seismic hazard factor of particular regions as expressed within legal hazard zones is used to illustrate likely seismicity within a relatively short time period and does not account for all earthquake activity which may occur. This is important to understand as these zones directly influence the hazard perception of those living within them. The geological time scale on which earthquakes occur directly conflicts with human perceptions of time, especially as some regions may only experience strong earthquakes on time scales of hundreds or even thousands of years. To strike a balance between human time scales and long-term planning requirements, the most typical form of conveying seismic hazard within building regulation is according to ground shaking which is modelled to have a return period of approximately 475 years.[266] The seismic hazard zones used within frameworks for existing buildings in New Zealand and Italy both account for shaking on this time period. However, as earthquakes are not modelled to occur on regular intervals, using a return period to communicate seismic hazard may be misleading and is commonly avoided.[267] In fact, a study which examined the use of flood hazard maps in Europe found many people struggled to understand the concept of return periods in particular.[268] Because of this, seismic hazard zones are instead commonly expressed using an exceedance probability.[269] For seismic hazard zones, this involves a ten percent chance of occurring within a 50 year period.[270] This is largely used since buildings are typically

[266] Marti, Stauffacher and Wiemer, above n 246, at 2682.

[267] "Seismic Hazard Work: Glossary" GNS Science <www.gns.cri.nz>.

[268] Volker Meyer and others "Recommendations for the User-Specific Enhancement of Flood Maps" (2012) 12 Natural Hazards and Earth System Sciences 1701 at 1710.

[269] Mario Andrés Salgado Gálvez "Probabilistic Assessment of Earthquake Losses at Different Scales Considering Lost Economic Production Due to Premature Loss of Lives" (PhD Dissertation, Polytechnic University of Catalonia, 2016) at 24.

[270] Graeme H McVerry "From Hazard Maps to Code Spectra for New Zealand" (paper presented to Pacific Conference on Earthquake Engineering, Christchurch, 2003) at 8.

designed to last a minimum of 50 years before repair or maintenance work may be required.[271] Therefore, seismic hazard zones in both New Zealand and Italy represent the ground shaking which buildings are estimated to have a 10% chance of experiencing within their typical minimum, functional lifetime.

Although seismic modelling based on earthquakes with an expected return period of 475 years is useful for illustrating the potential for strong shaking in regions of higher seismicity, it may misrepresent and underestimate the potential for shaking which occurs on longer time periods. This is especially true for areas identified as having a low seismic hazard, where the occurrence of strong ground shaking is much rarer. The New Zealand Seismic Risk Working Group recently recognised that the application of a seismic hazard model based on a 10% probability within a 50 year period (or 475-year return period) does not account for "variation in the shape of the hazard curve" and therefore may not appropriately appreciate potential seismic risk "to the degree that it probably should" in medium and low seismic areas.[272] In fact, the group highlights that "every city in New Zealand will at some point experience strong shaking even if the [return period] is in the [thousands] of years".[273] For instance, the ground shaking experienced in the 2011 Christchurch Earthquake had a return period equivalent to 10,000 years, or an exceedance probability of approximately 0.5% within 50 years.[274] This level of shaking far exceeds that used to define legal hazard zones within the Building Act. Even in Auckland, which has a low seismic hazard factor, earthquakes of up to M_w 7.2 are possible within 40km of the central city, albeit these events are only expected to occur approximately every 10,000-20,000 years.[275] Similarly, Dunedin, which is also located in a low seismic area, may expected earthquakes of up to M_w 7.0 on a return period of approximately 3,500 years.[276] Without overstating the hazard factor, such possibility (despite

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[271] See: Wendy Saunders *How Long is Your Piece of String – Are Current Planning Timeframes for Natural Hazards Long Enough* (GNS Science, Upper Hutt, 2010).

[272] Above n 92, at 24.

[273] At 41.

[274] Anna Kaiser and others "The M_w 6.2 Christchurch Earthquake of February 2011: Preliminary Report" (2012) 55 New Zealand Journal of Geology and Geophysics 67 at 87.

[275] WJ Cousins, Mostafa Nayyerloo and Natalia Deligne *Estimated Damage and Casualties from Earthquakes Affecting Auckland* (GNS Science Consultancy Report, February 2014) at 14.

[276] At 35.

being extremely low) emphasises the potential seismicity in regions widely understood as seismically quiet and therefore the ultimate need to be prepared.[277]

Understanding the limitations around low-frequency ground shaking events expressed within seismic hazard zones is imperative to informing appropriate obligations of risk reduction. Where certain regions are identified as having a lower seismic hazard, it may be more difficult to engage with or convince people on the need to take preventative measures. For instance, a 2011 study evaluated risk perception of stakeholders involved in EPB retrofitting practices across New Zealand. It found that persons living in low and medium hazard areas had a reduced awareness of the potential for earthquakes and therefore a lower perception of seismic risk, compared to those living in high seismic hazard areas.[278] In Japan, a low overall perception of seismic hazard and risk contributed to the unpreparedness in Kobe for the earthquake which devastated the port city in 1995. A government survey conducted in 1991 found only 8% of people living within the Japanese region where Kobe is located believed a significant earthquake could occur there, compared to approximately 23% of people nationwide who thought such.[279] This low risk perception was correlated to the generally high number of existing buildings with inadequate seismic capacity at the time both in Kobe and across the country. Interestingly, a recent study in Switzerland, which has a much lower seismic hazard factor than New Zealand and Japan, observed a similar outcome. People who perceived a "low probability" of destructive earthquakes more likely to underestimate potential impacts of such risk and therefore be less convinced to take precautionary action.[280] Although the

[277] It is noted that the potential risk of buildings constructed in areas of low seismic hazard in New Zealand during the late 20th century may be underestimated owing to a lesser seismic building standard used in these areas, compared to areas of higher seismicity. At 26.

[278] Temitope Egbelakin and others "Challenges to Successful Seismic Retrofit Implementation: A Socio-Behavioural Perspective" (2011) 39 Building Research and Information 286 at 293.

[279] Organisation for Economic Co-operation and Development *OECD Studies in Risk Management: Japan Earthquakes* (OECD Publications, France, 2006) at 16.

[280] Michele Marti and others "Communicating Earthquake Preparedness: The Influence of Induced Mood, Perceived Risk, and Gain of Loss Frames on Homeowners' Attitudes toward General Precautionary Measures for Earthquakes" (2017) 38 Risk Analysis 710 at 719.

overall seismic hazard in Switzerland is moderate to low, the potential impact of earthquakes is nonetheless considered very high.[281]

While overstating the potential of rare earthquakes with reoccurrence intervals in the thousands of years should be avoided, it is nevertheless important for the potential of such events to be clearly communicated and understood to appropriately address disaster risk. Avoiding ignorance to the potential for such hazards is necessary both to encourage risk reduction action amongst the general population and to influence decision-makers to implement risk reduction measures. As mentioned, low frequency of seismic hazard does not equal low risk.[282] This is an essential consideration when applying seismic hazard maps within legal risk reduction frameworks. As seismic hazard maps used within frameworks for existing building risk reduction do not consider these rare yet substantially more powerful earthquakes, caution should be exercised to ensure this is not misunderstood to mean they cannot or will not occur.

4.2.3 Accounting for scientific uncertainty in drr regulation

In addition to earthquakes expected to occur on a much longer time frame, it is also relevant that there remains much scientific uncertainty about the potential occurrence of earthquakes altogether. As Stein and others assert, when it comes to earthquakes often "[the] Earth does not behave as expected".[283] This statement encapsulates the notion that there are always, ultimately, limitations in human knowledge about the occurrence of earthquakes. Scientific knowledge about earthquakes is constantly evolving and, while there have been many great advancements made in recent decades, new discoveries are nonetheless made regularly.

To accommodate this, it is important that existing legal standards and regulations are designed to be flexible and adaptive to newfound information. For instance, the subduction

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[281] Irina Dallo, Michael Stauffacher and Michèle Marti "What Defines the Success of Maps and Additional Information on a Multi-Hazard Platform?" (2020) 49 International Journal of Disaster Risk Reduction 101716 at 101716.

[282] New Zealand Society for Earthquake Engineering, above n 243, at 2.

[283] Stein and others, above n 244, at 15.

zones which produced the 2004 Indian Ocean Earthquake and 2011 Tohoku Earthquake were previously assumed to be capable of producing earthquakes only up to magnitude 8.4, despite respectively registering as magnitude 9.1 and 9.0 events.[284] Subsequent research determined the underestimation of these events was influenced by a limited knowledge of historic earthquake patterns in the areas, which subsequently required thinking to accommodate the possibility for other similar subduction zones also producing more powerful earthquakes than previous estimated.[285] In fact, the 2011 Tohoku Earthquake produced ground shaking of damage-inducing Shindo Upper 5 across an area ten times larger than had been anticipated.[286] Research off the East Coast of New Zealand is ongoing to learn more about the "poorly understood" Hikurangi Subduction Zone, which may be capable of producing "megathrust" earthquakes potentially similar to those experienced elsewhere in the world, and certainly greater than anything experienced in modern New Zealand history.[287]

Though not common, earthquakes may also sometimes occur on undiscovered seismic faults or in areas previously considered to have a low seismic hazard threat. For instance, the 2010 Darfield Earthquake (M_w 7.1) and subsequent 2011 Christchurch Earthquake (M_w 6.3) ruptured on a series of seismic faults previously undetected by seismologists.[288] The occurrence of these earthquakes led to a revision of the seismic hazard zones within building regulation. Christchurch and the surrounding region was raised from medium seismic hazard to high seismic hazard, in part to account for heightened potential aftershock activity.[289] The unpreparedness for such earthquake and existing seismic risk in this area led to New Zealand's deadliest and most destructive earthquake in 80 years, despite the "very low probability" of the

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284 The underestimation of the size of the 2011 Tohoku Earthquake resulted in a lack of preparedness for the resulting tsunami, see: Chris Goldfinger and others "Superquakes and Supercycles" (2013) 84 Seismological Research Letters 24 at 24.

285 At 30.

286 Junko Sagara and Keiko Saito *Risk Assessment and Hazard Mapping* (The World Bank, Washington DC, 2013) at 5.

287 "Hikurangi Subduction Earthquakes and Slip Behaviour" (2020) East Coast Lab <www.eastcoastlab.org.nz>.

288 "The Hidden Fault That Caused the February 2011 Christchurch Earthquake" (2011) GNS Science <www.gns.cri.nz>.

289 William T Holmes, Nicolas Luco, and Fred Turner "Application of the Recommendations of the Canterbury Earthquakes Royal Commission to the Design, Construction, and Evaluation of Buildings and Seismic Risk Mitigation Policies in the United States" (2014) 30 Earthquake Spectra 427 at 436.

Canterbury earthquakes actually occurring.[290] In a submission for the EPB framework, former NZSEE president, Dr. Quincy Ma, noted:[291]

> We should be reminded that low [hazard] does not equal no risk, and the timing and severity of earthquakes cannot be predicted with certainty. Christchurch has reminded us that our seismic hazard knowledge is incomplete and earthquakes do not always occur when and where they are expected.

Indeed, officials decided it would have been inappropriate to exclude low hazard areas, such as Auckland, from obligations under the EPB framework owing to the importance of accounting for potential unknown faults in and around these regions.[292] This provides a level of contingency against events discussed in the previous section which, though of much lower probability than those used to define seismic hazard zones, are not impossible and in fact likely to occur at some point in the future.[293]

A similar seismic hazard re-zoning experience also occurred in Italy following the 2002 Molise Earthquake (M_w 5.8). The earthquake struck an area which had not been assigned within a seismic hazard zone at the time.[294] Until 2003, Italy was divided into three seismic hazard zones with a remaining portion of the country not classified as having a seismic hazard. Despite a 1998 government report recommending a re-classification of seismic hazard zones in Italy – including to place the Molise region within zone two (a medium seismic hazard) – this was implemented only following the 2002 disaster, largely inspired by the national shock expressed for the death of multiple school children.[295] While the Molise example is primarily an issue related to governance and politics, it nonetheless demonstrates the potential shortcomings of seismic hazard maps as they are reflected within law and their correlation to seismic risk.[296]

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[290] Kaiser and others, above n 274, at 87.

[291] Above n 243, at 2.

[292] Building (Earthquake-Prone Buildings) Amendment Bill 2015 (182-1) (select committee report) at [68] - [69].

[293] Seismic Risk Working Group, above n 92, at 41.

[294] Luis Decanini and others "Seismic Hazard and Seismic Zonation of the Region Affected by the 2002 Molise, Italy, Earthquake" (2004) 20 Earthquake Spectra 131 at 131.

[295] At 134.

[296] A destructive earthquake coincidentally struck the region of Emilia in 2012, which had also not been classified within a seismic hazard zone until the changes following the 2002 Molise Earthquake, see: *The 29th May 2012*

Even in Japan, where seismic hazard maps are not used to regulate the risk reduction of existing buildings, destructive earthquakes have occurred in regions estimated to have low seismic hazard, including two in 2016 which led to widespread building failure and caused more than 50 deaths.[297]

4.2.4 Prioritising for anticipated seismic events: an example from Japan

As mentioned at the beginning of the chapter, Japan is distinguished from New Zealand and Italy in the sense that seismic hazard zones are not applied within the country's framework for existing building risk reduction. This highlights an interesting point of comparison and once again emphasises the idea that the use of seismic hazard zones to reduce the seismic risk of existing buildings is ultimately a decision of political compromise. All relevant existing buildings are targeted for risk reduction measures equally across Japan according to the APSRB, with no discrepancy between regions according to seismic hazard. However, the government has in recent years established plans which prioritise risk reduction and preparation in regions known to be at risk of large earthquakes in the future.

Separate Acts govern the preparation efforts for anticipated earthquakes based on scientific modelling and forecasting of potential impacts. Primarily examples of these include the Special Measures Act on Measures for Nankai Trough Earthquakes and the Act on Special Measures against Tokyo Inland Earthquake.[298] The Acts designate areas likely to be impacted by these anticipated earthquakes (and likely tsunamis) to provide a legal mandate for DRR plans and policies to be established, including the establishment of bodies tasked with coordinating the implementation of these measures through government and other relevant bodies.[299] For instance, there is a 70% probability that ground shaking of up to Shindo 7 (the highest level of shaking) will occur in the Tokyo Metropolitan area between 2020 and 2050,

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Emilia Romagna Earthquake: EPICentre Field Observation Report (University College London, London, June 2012) at 8.

[297] Morita and Takayama, above n 223, at 1.

[298] See: Special Measures Act on Measures for Nankai Trough Earthquakes (Act No. 92 of 2002); Act on Special Measures against Tokyo Inland Earthquake (Act No. 88 of 2013).

[299] Cabinet Office Japan *White Paper on Disaster Management in Japan 2015* (Government of Japan, 2015) at 88.

with "tremendous" damage anticipated to people, property, and economic activity.[300] Amongst a range of other specific prevention measures, emergency risk reduction targets for existing buildings are established and authorities have a mandate to engage with building owners to swiftly achieve these targets.[301]

The pieces of legislation prioritise risk reduction efforts within the wider national framework and serve as the closest comparison to the use of seismic hazard zones in New Zealand and Italy. A key difference is that obligations are prioritised according to anticipated seismic hazard threats, but not excluded. Seismic hazard zones are used to prioritise risk reduction within New Zealand and Italy, but they are also applied in a way which exempts certain building owners from the need to engage in risk reduction measures. In Japan, existing buildings across the entire national territory are subject to obligations under the APSRB and the above "special measures" legislation is used to apply urgency to risk reduction efforts as an extra layer of preventive action. This provides an interesting model for how risk reduction may be prioritised within areas with high seismicity while still supporting efforts in all regions. As has been argued throughout this chapter, seismic hazard zones may create a misunderstanding of potential seismic risk and the need to engage in DRR in areas considered to have low seismicity. Such an approach could also be a useful consideration in New Zealand to complement the EPB framework, as a way of encouraging more than simply the bare minimum of seismic risk reduction in areas which are anticipated to experience severe earthquakes in the near future.[302]

4.3 Summary

The use of seismic hazard zones can be useful for requiring a certain degree of seismic resistance in the design of new buildings, however there should be more caution when applying them within risk reduction frameworks for existing buildings. In particular, their influence on

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[300] See: Ministry of Land, Infrastructure, Transport and Tourism *White Paper on Land, Infrastructure, Transport and Tourism in Japan, 2019* (Government of Japan, 2019) at 124; *Tokyo Metropolitan Government Disaster Prevention Guide Book* Tokyo Metropolitan Government (February 2020) at 31.

[301] See Chapter 7 of this research for further discussion on stakeholder engagement in the risk reduction process.

[302] For instance, there is a high likelihood of the Wellington region experiencing strong shaking in the near future, as there also is for communities within close proximity to the Alpine Fault, see: "Alpine Fault: Probability of Damaging Quake Higher than Previously Thought" (20 April 2021) Radio New Zealand <www.rnz.co.nz>.

hazard perceptions and therefore the willingness of persons to engage in risk reduction should not be underestimated, especially in areas of lower seismicity. Indeed, the use of "seismic risk" to describe the hazard factor of regions across New Zealand does not appropriately align with the Sendai understanding of risk and may, in fact, lead to a misunderstanding of potential risk in these areas. In New Zealand, the exclusion of priority buildings and Category C buildings from the same obligations as are required in areas of high and medium seismic hazard do not appropriately reflect the seismic risk in these areas. Although Italy prioritised the risk reduction of certain buildings with zones of higher seismicity (namely priority buildings), the EPB framework actively excludes the above-mentioned buildings from obligations in low hazard areas. This is short-sighted, given that seismic hazard zones do not account for seismic events which occur on a longer time period.

Seismic hazard zones ultimately represent expected ground shaking on a return period of approximately 475-years. As a result, they inadvertently underestimate the potential for seismic events on a much larger return period which are likely to occur in regions which have lower seismicity. This is an important consideration when aiming to reduce the seismic risk of existing buildings, as seismic hazard maps do not account for such long-range events. In addition, there is ultimately much we simply do not know about earthquakes and their occurrence. This further emphasises the need to not underestimate or neglect the importance of identifying and reducing existing building risk in all regions of the earthquake-prone case study countries. Ultimately, the use of seismic hazard zones within risk reduction frameworks for existing buildings is a political decision, as exemplified by their absence from the Japanese framework. Rather than allocating legal obligations according to seismic hazard zones of the country, Japan instead imposes such obligations across the whole country and provides additional prioritisation of risk reduction in areas anticipated to be impacted by large earthquakes in the near future. This approach would be beneficial to consider in New Zealand, as it ensures uniformed risk reduction across the entire country while still mandating more comprehensive risk reduction planning measures in regions prone to strong shaking on a more frequent basis.

Chapter 5
Seismic Building Assessments

> There are plenty of examples showing the due to corruption, indifference, or lack of qualified professionals, building codes are not implemented properly, leading to unnecessary loss and damage. It is therefore clear that the introduction or reform of building codes is not enough to reduce disaster consequences…
>
> Maria Papathoma-Kohle and Thomas Thaler[303]

While generalised assumptions are made about seismic risk based upon the characteristics (Chapter 3) and location (Chapter 4) of a building, a more detailed understanding of risk is achieved through the use of seismic building assessments. Seismic assessments establish a specific knowledge about the nature of seismic risk presented by individual buildings, therefore helping to determine the danger they are likely to pose in earthquakes. The type of seismic assessments examined in this chapter are those which evaluate the structural integrity of buildings as part of hazard preparation and risk reduction efforts. Improving knowledge about the likely structural integrity of existing buildings enhances the understanding of potential risks to decision-makers and the public alike, and this is subsequently used to drive relevant risk reduction behaviour. Indeed, the results produced from these seismic assessments are used to determine the level of state intervention in relation to seismic strengthening obligations of existing buildings. They are not to be confused with rapid building safety assessments, which are typically carried out in the aftermath of earthquakes to evaluate any sustained building damage. Rapid assessments are designed to evaluate potential safety risks in relation to the immediate re-occupation of buildings following an earthquake, based upon observed damage. These are therefore designed as a response mechanism, rather than a tool for the proactive reduction of risk, as are the structural seismic assessments discussed in this chapter.

The purpose of this chapter is to examine how seismic building assessments are applied within legal frameworks to improve knowledge of seismic risk and enhance resilience. How and when these assessments are used is therefore of particular importance. Because seismic assessments are fundamental for establishing legal seismic strengthening obligations, it is

[303] Above n 112, at 103.

crucial to ensure they provide results which are as accurate as possible and that there is sufficient oversight to ensure consistency between assessments. In addition, the way in which knowledge obtained through these assessments is used to communicate risk to the public is also an important consideration. While this can be useful to make the public more aware of potential risk, it is also important that the exact nature of this risk is properly understood. Finally, the instances in which seismic assessments are used to identify seismic risk is also relevant when considering ways in which to enhance resilience against earthquakes. Legal frameworks largely apply seismic assessments in a limited style, as a one-off requirement to confirm the structural integrity of buildings targeted by authorities. Two further instances are considered for more regular use of these assessments to improve long-term resilience, including on a periodic basis as a means of building maintenance and following strong earthquakes regardless of whether any observed damage has been sustained. The former would provide greater flexibility for changes to building assessment methods and would identify any potential building deformations over time. The latter instance, following strong earthquakes, would also help to better understand potential hidden changes in a building's seismic capacity given that buildings are designed to withstand a particular level of shaking from individual events. Though such consideration is more response-based, its discussion is nonetheless relevant for preventative risk reduction as it would help identify risk which may otherwise go unnoticed.

5.1 Providing Assessments with Accuracy and Oversight

Simplified seismic assessment methods allow for the seismic risk of large numbers of existing buildings to be easily and efficiently evaluated.[304] There appears to be a strong reliance on the use of simplified seismic assessment methods in New Zealand, however, without appropriate and strict oversight mechanisms to manage the consistency and reliability of assessment results. Two standardised procedures were developed to assess existing buildings across New Zealand: the Initial Seismic Assessment (ISA), designed as a simplified, qualitative assessment which considers generic building characteristics, to estimate likely seismic resistance, such as age and materials; and the Detailed Seismic Assessment (DSA), designed as a comparatively more comprehensive, quantitative assessment of existing buildings, which

[304] Consenza and others, above n 123, at 5918.

provides a more reliable estimation of seismic resistance.[305] The ISA is intended to be a low-resource and low-cost alternative to the DSA, with an external building evaluation the only recommended feature requiring an in-person visit to a building itself.[306] In practice, however, the ISA has become the standard seismic assessment used by building owners across New Zealand, due to significantly lower costs and minor invasiveness of the assessment method. The decision regarding whether an ISA is insufficient to determine the earthquake-prone status of a building and a DSA is thus needed, is entirely left to the discretion of the engineer who undertakes the seismic assessment.[307]As Ferner has noted, the ISA has evolved from an "initial screening tool" for existing buildings" into a frequently-used process to "provide a rating upon which significant financial decisions are being made".[308] Officially, the ISA is regarded as reliable for TAs to make determinations on whether an existing building meets the legal definition of earthquake-prone. However, the unintended dependence on this simplified seismic assessment method to make such decisions means a very limited standard of knowledge is actively being applied make determinations about seismic risk and the need for risk reduction measures for existing buildings in New Zealand. The recent vacation of staff from the Inland Revenue Department (IRD) building in Wellington illustrates the difference in knowledge about seismic risk between an ISA and DSA. The decision was made to obtain a DSA as part of the IRD's lease renewal, which found the building to have greater safety concerns than had been previously understood.[309]

Simplified seismic assessment methods are also used to examine existing buildings in Italy and Japan, although there appears to be measures to mitigate potential issues of accuracy. In Italy, a simplified method and more detailed conventional method were designed for the assessment of existing buildings.[310] Much like the ISA in New Zealand, the simplified assessment method in Italy is intended to act as a preliminary evaluation using macro characteristics such as a building's age and materials. To account for this, building owners which use this assessment method are only permitted to improve their building by one seismic

305 New Zealand Society for Earthquake Engineering, above n 111, at A3-2, A7.7.2.

306 At A7.4.2.

307 Ministry of Business, Innovation and Employment, above n 180, at 2.3.

308 Above n 140, at 3-3-6.

309 Joel MacManus "Seismic Risks in Wellington's Largest Office Building: Inland Revenue Sends 1000 Staff Home" (14 July 2021) Stuff <www.stuff.co.nz>.

310 See: Consenza and others, above n 123.

risk class when accessing the Sismabonus seismic strengthening incentive scheme (Chapter 6).[311] The conventional assessment method, which provides a more detailed building evaluation, permits for the improvement of more than one seismic risk class. Similarly, it appears that simplified seismic assessment methods in Japan cannot be used to determine the likely seismic resistance of existing buildings if a buildings' design documents are not accessible to the professional undertaking the assessment. In such an instance, a detailed assessment is required to make any decisions around whether or not the buildings should be targeted for strengthening interventions by authorities.[312] It is notable that, while these measures exist in Italy and Japan to mitigate accuracy levels of seismic assessments, no mandatory strengthening obligations ultimately exist in these countries. With mandatory strengthening required for EPBs in New Zealand, reliance on the simplified ISA crucially risks missing or incorrectly assessing buildings which would otherwise be considered earthquake-prone.

The accuracy of knowledge obtained from seismic assessments is also crucial to promote consistency between assessments, and to communicate seismic risk to relevant stakeholders. Contradictory assessment methods have previously impacted the seismic assessments of hospitals in Italy, with contradictory seismic resistance evaluations illustrating the need for more harmonised assessment methods needed to control the potential for such discrepancies.[313] Standardised seismic assessment methods for existing buildings with regulatory authority to promote consistency was a recommendation of the Canterbury Earthquake Royal Commission implemented into the EPB framework with the ISA and DSA assessment methods.[314] Yet, despite the standardised methods, it remains possible (and even anticipated) that equally-qualified engineers will determine different earthquake ratings when

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[311] Ministero delle Infrastrutture e dei Trasporti *Al via la Classificazione del Rischio Sismico delle Costruzioni per Prevenzione e Sismabonus* (Roma, 28 Febbraio 2017) (translation: Ministry of Infrastructure and Transport *The Classification of the Seismic Risk of Buildings for Prevention and Sismabonus* (Rome, 28 February 2017) at 7.

[312] "What is Seismic Diagnosis?" Japan Home Shield <www.j-shield.co.jp>.

[313] See: Angelo Masi and others "Seismic Risk of Italian Hospitals: Analysis of Assessment Results to Define Criteria for Intervention Prioritisation" (paper presented to Italian National Conference on Earthquake Engineering, September 2015).

[314] Above n 146, at 195.

undertaking an ISA.[315] Though potential inconsistencies may be mitigated by a secondary review of the assessment results, the EPB framework allows seismic assessments to be conducted by a single qualified engineer and offers no requirement for peer-review or oversight.[316] In other words, despite the real potential for fluctuating assessment results, there is no mechanism used as a backstop to promote greater consistency from the widely-used ISA. This could likely cause issues when engineers are pressured to complete multiple assessments for buildings identified by TAs as potentially earthquake-prone, where the incentive is to complete many assessments as quickly as possible. There is also a danger that this potential discrepancy between assessment results is not communicated effectively to relevant stakeholders.[317] These issues with the accuracy of the ISA is something which needs to be properly understood by building owners and the general public to allow informed decisions about risk reduction to be made.

Ensuring consistent and reliable risk assessments is also important for maintaining public trust in the engineering profession. A scandal emerged in Japan during 2005 when it was reported that several high-risk buildings constructed between the 1990s and early 2000s had been constructed with insufficient seismic resistance due to a falsification of data and a lack of subsequent administrative oversight to detect this.[318] The revelations significantly impacted the public trust in the construction industry and those authorities responsible for ensuring buildings are safe to use.[319] In fact, trust toward the industry was found to be a major deterrent for persons undertaking seismic risk reduction for existing buildings in a survey of homeowners in Japan, demonstrating the long term impact of the scandal.[320] While this is an extreme example of failed oversight, and concerned building construction rather than the seismic assessment of existing buildings, it nonetheless stands as an important lesson about the value of ensuring effective oversight for the best possible accuracy. This is a crucial

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[315] New Zealand Society for Earthquake Engineering, above n 213, at B3.5.

[316] See: New Zealand Society for Earthquake Engineering, above n 162, at 32; Ministry of Business, Innovation and Employment, above n 180, at 2.2.

[317] Ferner, above n 140, at 3-3-6.

[318] See: Wataru Gojo "The Aneha Scandal: Building Fraud in Japan" (2011) 164 Forensic Engineering 179.

[319] Ministry of Land, Transport Infrastructure and Tourism *White Paper on Land, Infrastructure and Transport in Japan 2005* (2005) at 21.

[320] Masayuki Kohiyama and others "Incentives and Disincentives Analysis for Improving Policy for Seismic Risk Management of Homeowners in Japan" (2008) 9 Natural Hazards Review 170 at 177.

consideration for the EPB framework in New Zealand where, in practice, the difference between mandatory strengthening and no risk reduction measures for existing buildings currently depends upon the judgement exercised by individual engineers when completing seismic assessments.

5.2 Raising Awareness through the Publication of Seismic Building Risk

When seismic assessments are completed for potentially earthquake-prone buildings in New Zealand, the subsequent results are publicised to further promote risk reduction and encourage an awareness of seismic risk. In particular, seismic risk is required to be published for existing buildings which authorities determine to be earthquake-prone. The aim of publicising such information is primarily to produce a market-based demand for seismic strengthening amongst existing buildings, by creating a distinction between existing buildings considered to present a significant seismic risk and those which comply with relevant legal standards of risk. In addition, the publication of seismic risk information about existing buildings also helps to increase the understanding and awareness of such risk to the general public. Publishing seismic risk is also a feature of the legal framework for existing building risk reduction in Japan. No similar scheme appears to exist in Italy, with information related to the seismic risk of existing buildings remaining between building owners and the national civil protection department.[321]

While New Zealand requires public notice to be given for all existing buildings determined as earthquake-prone, the publication of seismic risk information is limited in Japan to large-scale priority buildings identified in Chapter 3. Under the EPB framework in New Zealand, local authorities must register EPBs on an online public national database and building owners must also display an EPB notice on or near their building to indicate the relevant seismic risk.[322] The publication of this information includes the particular earthquake rating (%NBS) of each building and the deadline building owners are required to remediate the seismic risk within.[323] There is some evidence to suggest that the publication of EPBs has enhanced awareness of seismic risk and contributed to a market demand for seismic

[321] Above n 122.

[322] See: "Register of Earthquake-Prone Buildings (EPB Register)" Ministry of Business, Innovation and Employment <www.epbr.building.govt.nz>; Building Act, s 133AU(2)(a).

[323] Building Act, s 133AL.

strengthening amongst existing buildings, especially in Wellington city.[324] In comparison, Japan requires the seismic risk of large-scale priority buildings to be published online only. The online publication of seismic assessment results for these existing buildings was made compulsory under the 2013 amendment to the APSRB, after many of these buildings suffered non-structural damage in the 2011 Tohoku earthquake.[325]

The requirement in Japan differs from that in New Zealand as all relevant buildings are required to have their seismic assessment results publicised, rather than simply those which are non-compliant. Approximately 15,697 large-scale buildings were required to obtain a seismic assessment and have the results publicised by the end of 2015, with one quarter of these buildings subsequently found to have insufficient seismic resistance.[326] In addition, building owners are able to obtain a certificate of seismic compliance to publicly display for buildings which meet legal requirements.[327] Although not much information about this initiative is available, it appears to be an optional tool for individual building owners who desire to display such information on their building and is not automatically issued. The publicly-available information about the seismic risk of these buildings and optional compliance certificates are designed to incentivise seismic strengthening amongst owners in the absence of mandatory strengthening requirements in Japan.

One of the challenges of publicising the seismic risk of existing buildings is ensuring that building users and owners properly understand the associated risks. In New Zealand, the requirement to display a building's EPB status for building users indicates the intention of authorities to improve the risk perception of EPBs amongst the general public. There are real concerns that an EPB status is conflated with building safety, therefore leading to an interpretation that buildings not earthquake-prone are "safe".[328] As explained in Chapter 3, an EPB status refers only to potential danger to life safety. In fact, the seismic risk of buildings is completely probabilistic and so any assumption of complete safety or protection in earthquakes

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[324] Olga Filippova, Michael Rehm, and Chris Dibble "Office Market Response to Earthquake Risk in New Zealand" (2017) 35 Journal of Property Investment and Finance 44 at 51.

[325] Moullier and Sakoda, above n 120, at 47.

[326] "建築物の耐震化の進捗状況 - 国土交通省" (April 2020) Ministry of Land, Infrastructure and Transport <https://www.mlit.go.jp> (translation: "Progress of Earthquake Resistance of Buildings").

[327] Ministry of Land, Infrastructure, Transport and Tourism, above n 153, at 236.

[328] Ferner, above n 140, at 3-3-6.

is misplaced, even amongst buildings considered to have greater seismic resistance. This is a potential challenge in Japan, where seismic compliance certificates are available for buildings which comply with the minimum seismic standard. It is ultimately important for people to not misinterpret compliance with minimum seismic requirements as meaning guaranteed safety or freedom from building damage.

As mentioned in Chapter 2, EPBs are considered to present the highest danger of collapse in moderate earthquakes but those with an earthquake rating of between 34-66%NBS are still considered to present a medium risk. This has been observed in the market, with many tenants and owners alike opting for seismic strengthening of 67%NBS or greater since the potential for building failure is considered low.[329] From the perspective of building users, however, the absence of any public notice about the seismic resistance of buildings other than EPBs may inadvertently create a misunderstanding of potential seismic risk of existing buildings in New Zealand. Indeed, the lack of requirement for seismic assessment results to be published for buildings not determined to be earthquake-prone inherently creates the perception that no risk should be expected from these buildings. The requirement in Japan to publicise the seismic assessment results for all priority buildings and not simply those which fall below the legal minimum standard of risk arguably allows for a better risk perception of existing buildings amongst building users.

5.3 Integrating Seismic Assessments into Building Safety

Relevant also to the effectiveness of seismic building assessments to help improve resilience is the instances when they are used. There is a clear tendency for seismic assessments to be utilised in a way which understands risk as something which is fixed in time. Each of the case study countries use these assessments to confirm the likely risk of certain existing buildings in one moment of time and, depending on assessment results, manage the risk in that moment. While this approach assists with risk reduction of existing buildings at the time, it ignores the potential for risk to change over time. Indeed, risk is not stationary and will continue to evolve with new technology, scientific discoveries, and changes to the make-up of society itself.[330] To deal with the constantly changing nature of risk, the Sendai Framework highlights

[329] Filippova, Rehm, and Dibble above n 324, at 45.

[330] United Nations Office for Disaster Risk Reduction, above n 51, at [128].

the importance of periodicity when it comes to assessing and understanding risk.[331] Tracking the evolution of seismic risk amongst existing buildings, and adapting to manage and reduce it, will be a critical aspect for improving resilience to earthquakes, and seismic building assessments are an important part of this process. As one of the best tools for understanding how well existing buildings are likely to resist earthquakes, it is argued that seismic building assessments can be better integrated into risk reduction frameworks to understand potential changes in seismic risk over time. There are two instances in particular where seismic assessments are largely missing from frameworks currently, and where more regular use would help to enhance resilience. This includes the use of seismic assessments as part of the regular building maintenance practices, which would account both for building decay and for any developments in scientific knowledge about earthquake risk. Additionally, clearer legal structures to provide for the use of seismic assessments in the aftermath of strong earthquakes would assist with indicating any potential building deformations as a result of seismic shaking.

5.3.1 Seismic assessments as a function of regular building maintenance and inspections

While regular maintenance is a common feature for many buildings to ensure safe continued occupation, seismic risk is not a typical consideration made when completing such maintenance. It is inevitable that buildings will degrade as they age, owing to the natural decay of building materials and through exposure to external forces over time.[332] In theory, the older a building becomes the greater maintenance will be required to ensure it can be safely used, sometimes well beyond its design lifetime. Additionally, new developments in seismic science and technology are inevitable across the lifetime of a building, directly impacting and shifting the legally-acceptable standard of seismic risk for existing buildings. Integrating these considerations of seismic risk into regular building maintenance is therefore critical for promoting long-term resilience. The Royal Commission into the Canterbury Earthquakes highlighted this in its 2012 report, recommending the continued active monitoring of existing buildings in New Zealand beyond the deadlines established within the EPB framework to account for "the deterioration of buildings with the passage of time".[333] As previously

[331] At [49].

[332] Samuel Y Harris *Building Pathology: Deterioration, Diagnostics, and Intervention* (John Wiley & Sons, Canada, 2001) at 4.

[333] Above n 146, at 210.

mentioned in Chapter 2, seismic assessments are typically required to confirm the seismic resistance of buildings when owners intend to complete major alterations or change the use of their building. Though this promotes an understanding of seismic risk amongst existing buildings over time, it depends entirely on the intentions of building owners and not as an integrated feature of periodic maintenance.

Periodic building maintenance for existing buildings in New Zealand currently focuses on the functionality of building operation systems rather than the actual buildings. A building warrant of fitness (BWoF) is legally required every 12 months for buildings with specified services to inspect their operability.[334] Relevant services include the operability of features such as emergency building evacuation and lighting systems, elevators, and fire-prevention controls such as sprinkler systems.[335] These inspections are carried out by "independently qualified" persons, certified by local authorities to perform BWoF inspections, and are designed to ensure the relevant listed systems are operable, not to inspect the physical condition of the buildings.[336] Authorities have separate powers to impose safety measures on buildings if they appear deteriorated to the point they are considered to pose a potential danger to public safety and property, although this does not explicitly reference the ability to compel seismic assessments.[337] Indeed, for existing buildings which do not fit the profile categories of potentially earthquake-prone buildings, it appears unlikely that local authorities would request a seismic assessment. Similar requirements exist in Italy, with a requirement for existing buildings to undergo seismic assessment to evaluate life safety considerations when there are evident structural deformations or material degradation, in addition to a proposed change of use or significant building alterations.[338] While this requirement is more assertive than it is in New Zealand in relation to the explicit need for a seismic assessment, it nonetheless remains reactive to observed building deterioration.

Japan appears to have the most preventative-based approach to monitoring the structural integrity of existing buildings over time of all three case study countries, though this

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[334] Building Act, s 108.

[335] "Buildings with Compliance Schedules for Specified Systems" (15 March 2016) Ministry of Business, Innovation and Employment <www.building.govt.nz>.

[336] Building Act, s 108(3)(c).

[337] Subpart 6.

[338] NTC 2008, above n 144, at [8.3]

is also not entirely focused on seismic safety. Similar to the annual BWoF inspections in New Zealand, "special buildings" in Japan have been subject to periodic inspections since 2008.[339] This includes buildings of greater than five storeys and a total floor area of 1,000m^2 or greater, and "special buildings" with a total floor area of 100m^2 or greater, such as schools, hospitals, apartment buildings, and other high-use public facilities.[340] Unlike BWoF inspections, which focus on essential building systems, these inspections also include the evaluation of building features including finishing materials, external walls, foundations, and stairwells.[341] These inspections are required to be completed between every six months to three years, depending on the specific building.[342] Although these inspections are not specifically seismic assessments, they certainly provide for greater attention to be made toward structural and non-structural features of buildings on a regular basis, enhancing the potential for identifying any potential distortions. It should be pointed out that no equivalent requirement exists for buildings in Italy. However, there are examples in other parts of Asia where periodic building assessments are legally required, albeit unrelated to seismic risk.

For instance, a mandatory building inspection scheme was implemented in Hong Kong during 2012, to address concerns about the jurisdictions' aging and quickly deteriorating existing building stock.[343] Inspections are completed every ten years for all buildings greater than three storeys in height which are 30 years old or above.[344] Similarly, in Singapore, section 28 of the Building Control Act imposes requirements for periodic structural inspections to be completed for existing buildings every ten years for multi-storey residential buildings, and every five years for all other existing buildings.[345] Building owners are obligated to remediate

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339 Building Standards Act (Act No. 201 of 1945), art 12.

340 Ministry of Education, Culture, Sports, Science and Technology *Guidebook for Earthquake Protection for Nonstructural Members of School Facilities, Revised Edition: Protecting Children from Falling and Tumbling Objects Due to an Earthquake – Implementing Earthquake Resistance Inspection* (Government of Japan, revised in March 2015) at 12.

341 At 12.

342 At 12.

343 Daniel Chan and others "Overview of the Development and Implementation of the Mandatory Building Inspection Scheme (MBIS) in Hong Kong" (2014) 4 Built Environment Project and Asset Management 71 at 72.

344 At 76.

345 "Periodic Structural Inspection of Buildings" (22 September 2017) Building and Construction Authority <www.bca.gov.sg>.

any deficiencies which, such as through building strengthening measures.[346] Much like Hong Kong, these inspections are designed to identify structural deficiencies in existing buildings owing to poor maintenance and general wear and tear over time.

The periodic building inspections in Japan, as well as those in Hong Kong and Singapore, are not designed to account for seismic safety, yet ultimately illustrate how regular monitoring of structural and non-structural building features may be integrated into routine maintenance for long-term resilience. Each represent a preventative approach to understanding potential risk for existing buildings as it evolves over time. Integrating seismic assessments into routine building maintenance would not only help to improve the resilience of existing building stocks over time in seismically-active countries, but it would also enable a smoother process for building inspections when and if legal seismic standards change in light of new research. While building owners want certainty over their obligations and expectations for seismic strengthening, this must be balanced against the evolving nature of risk and objectives of risk reduction. Risk reduction demands an explicit understanding that building ownership comes with a responsibility to ensure continued safety and resilience – including the need to be adaptable, when necessary, to identify and reduce new standards of risk as it emerges.

5.3.2 Inspecting buildings in the aftermath of earthquakes

In addition to routine inspections, resilience would also be improved by mandating structural seismic assessments for buildings following earthquakes. In the aftermath of earthquakes which generate particularly significant ground shaking and which some damage is observed, it is standard practice to carry out rapid building assessments to evaluate individual buildings and identify any indicators of damage. These assessments are designed to quickly (typically within hours or days) identify potential damage and make determinations about whether or not it is safe for immediate re-entry into buildings.[347] While these rapid assessments are designed to protect the public from danger, they are designed to address immediate risk and do not typically consider the viability for long-term occupancy of buildings. More detailed

[346] Building and Construction Authority *Owner's Guide to Periodic Inspection of Buildings* (Government of Singapore, July 2016) at A1.

[347] Ministry of Business, Innovation and Employment *Field Guide: Rapid Post Disaster Building Usability Assessment – Earthquakes* (Wellington, May 2014) at [5].

seismic assessments are required to make such decisions, though there appears to be limited legal mandates to ensure these assessments are, in fact, carried out. Consequently, for buildings which suffer minimal or no observable damage after strong earthquakes and which are deemed safe to immediately re-occupy, potential reductions in seismic resistance may therefore go unobserved.

Buildings are designed with "ultimate limit states" in mind to resist individual seismic events of particular strength. Existing buildings may therefore perform as expected in earthquakes and avoid collapse or sustaining any damage at all, but nonetheless have endured a substantial volume of their ultimate limit state. As a result, these buildings may be weakened and, ultimately be more susceptible, to future shaking, including potential aftershock events. This was observed amongst many buildings in Christchurch, which suffered substantial damage or total collapse in the 2011 earthquake, but not in the 2010 Darfield Earthquake five months prior.[348] The Royal Commission into the Canterbury Earthquakes noted, that following the 2010 event:

> …subsequent superficial examination of URM buildings resulted in many being classified as having minimal obvious damage and reoccupation was permitted. Several of those buildings were further damaged in February 2011, and the failure of some caused death.

The 2010 earthquake produced ground shaking at the 475-year design level standard within the current building code and, while many existing buildings performed reasonably well considering (and thus were re-occupied), the 2011 event caused shaking of up to double that of the design standard and resulted in a high level of damage and collapse.[349] In 2016, the Kaikōura Earthquake caused particularly severe damage to various multi-storey buildings within the Wellington CDB. In response, full structural building assessments were mandated only for buildings which had observable damage owing to concerns from central government about potential disruption to government functions within Wellington city.[350] No equivalent mandate was issued to evaluate the structural capacity of seemingly un-damaged buildings, meaning that it is not currently known whether the seismic resistance of existing buildings in

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348 Canterbury Earthquakes Royal Commission, above n 146, at 166.

349 At 209.

350 Simon Fleisher "Wellington City's Emergency Management Response to the November 2016 Kaikōura Earthquake" (2019) 23 Australasian Journal of Disaster and Trauma Studies 91 at 93.

Wellington was in fact reduced as a result of the event. This is of particular relevance considering that Wellington has a high danger of being subjected to strong shaking in the near future, which could cause these potentially already-weakened buildings to fail.

It is for this reason that rapid seismic assessments used in Japan following damaging earthquakes are designed to not only identify potential building damage for the sake of short term re-occupation, but also for their long-term use.[351] Even for buildings which appear to have no damage and are deemed safe to re-occupy, more detailed assessments are completed to determine whether the buildings have sustained a reduction in their structural capacity.[352] Requiring structural building assessments in these instances better reflects an approach to understanding risk beyond simply responding to individual events and toward long-term resilience. In New Zealand, changes to the Building Act in 2019 provided authorities with the power to request structural building assessments from building owners regardless of whether or not there has been a declared civil defence emergency.[353] While this increased the circumstances within which authorities may legally require building owners to produce seismic assessments, it appears that these powers are reactive for managing buildings which sustain visible damage in earthquakes.[354] Of course, relying on buildings to sustain damage for obtaining a structural assessment is counter-intuitive to the preventative objective of risk reduction. Accounting for potential shifts with the vulnerability of existing buildings in the aftermath of strong earthquakes is imperative for both long-term occupation and the resilience of communities. As Borri and Corradi note, in relation to building deformation from previous earthquakes, “the principle of older construction [equals] good construction is again challenged by the inevitable march of time”.[355] A standard of regular monitoring for potential deficiencies is appropriate to account for such risk.

[351] Agostino Goretti and Giacomo Di Pasquale “An Overview of Post-Earthquake Damage Assessment in Italy” (paper presented to Eeri Invitational Workshop, Pasadena, September 2002) at 3.

[352] Masaki Maeda, Hamood Alwashali and Kazuto Matsukawa “An Overview of Post-Earthquake Damage and Residual Capacity Evaluation for Reinforced Concrete Buildings in Japan” (paper presented to 7th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, 24-26 June 2019) at 932.

[353] Subpart 6B.

[354] (11 September 2018) 723 NZPD 6519.

[355] Antonio Borri and Marco Corradi “Architectural Heritage: A Discussion on Conservation and Safety” (2019) 2 Heritage 631 at 633.

5.4 Summary

Seismic building assessments are particularly useful tools for understanding the specific nature of seismic risk amongst existing buildings. Simplified methods have been developed for the purposes of efficiency, however there are insufficient structures within the EPB framework in New Zealand to ensure the accuracy of assessment results. An over-dependence from building owners on the cheaper ISA and the absence of a requirement for peer-review of assessments completed by individual engineers has created an environment where seismic assessments may not provide a particularly accurate or thorough understanding of seismic risk. While simplified assessment methods are also applied within Italy and Japan, more restrictions on the ability to complete seismic strengthening exist to manage potential issues of accuracy. In addition, both New Zealand and Japan publicise the seismic assessment results of particular buildings to promote a better understanding of seismic risk. New Zealand requires the earthquake-prone status of buildings to be publicised both on the physical buildings and on an online register, while Japan requires the online publication of seismic risk for large-scale priority buildings subject to mandatory assessment requirements in 2013. Both illustrate useful means of communicating potential seismic risk to the public and fostering a greater awareness for risk reduction.

Seismic assessments also play a largely restricted role in each of the case study countries, as a one-off obligation. This approach limits the ability of authorities to have an understanding of potential changes or deformations to existing buildings over time, thus limiting the ability to ensure long-term resilience. While buildings are subject to regular maintenance obligations, Japan is the only case study country which requires periodic structural inspections to be carried out, for special buildings such as schools, hospitals, and other large buildings used by the general public. These periodic structural inspections, which are replicated in the legal systems of both Hong Kong and Singapore, are critical for the long-term resilience of existing buildings. Integrating these assessments into New Zealand's building framework should be considered. This includes stronger requirements for seemingly un-damaged buildings to be structurally-assessed following strong earthquakes, rather than leaving it to the discretion of individual building owners to do so. Structural assessments are pertinent for ensuring the safe long-term occupation of buildings and more frequent use of them would help to improve resilience.

Part C

Key Mechanisms for Enforcing Legal Obligations

Part B of this research examined key operational features applied within risk reduction frameworks, including the methods used to identify relevant existing buildings, the application of seismic hazard zones to impose risk reduction obligations, and the use of seismic building assessments to understand risk and improve resilience. With these features in mind, Part C moves to explore key mechanisms within risk reduction frameworks which influence the enforcement of legal obligations amongst building owners. Enforcing the risk reduction obligations of building owners is crucial for achieving risk reduction itself, and largely rests upon strong governance and thorough investment in resilience, as per priorities two and three of the Sendai Framework.[356]

Chapter 6 compares the use of financial incentives in each of the case study countries to incentivise building owners for completing seismic strengthening. The notable lack of financial support for building owners in New Zealand is highlighted, in comparison to the more prevalent use of such incentives in both Japan and Italy. Chapter 7 examines the use of timeframes within risk reduction frameworks as a mechanism for enforcing obligations and the structures in place for authorities to both monitor the progress of and engage with building owners to ensure obligations are achieved within relevant timeframes. Finally, Chapter 8 details the role of relevant duties of care, owed by building owners to ensure the safety of building users and passersby. These are explored as potential, indirect means of imposing and enforcing risk reduction obligations for existing building owners.

[356] Above n 7, at [20].

Chapter 6

Supporting the Cost of Risk Reduction with Financial Incentives

> While there is some difficulty predicting the remediation costs [for earthquake-prone buildings] at this early stage of the system, early evidence indicates the estimated costs of remediating through [seismic] strengthening… may not be economically feasible for many owners.

Ministry of Business, Innovation and Employment[357]

Incentives are considered fundamental for encouraging compliance with and empowering stakeholders and communities to engage in risk-adverse behaviour.[358] Because States have the primary responsibility to promote DRR, government-led incentives are considered essential for supporting relevant practices and obligations.[359] From the perspective of DRR, incentives can be understood as "tipping points for behavioural change towards prospective disaster risk management and risk-sensitive choices at a significant scale".[360] In relation to the seismic risk reduction of existing buildings, incentives may help to encourage and empower building owners both to better understand the seismic risk of their buildings and to subsequently take appropriate measures to reduce this risk. While there are a variety of existing and potential incentives for reducing the seismic risk of existing buildings, this chapter focuses on the existence of financial incentives used to support building owners to assess and strengthen their existing structures.

High-upfront costs associated with seismic assessments and strengthening work, and a lack of perception regarding the benefits of investing in these measures, are often observed as deterrents for building owners to take appropriate preventative action.[361] An obvious potential solution to this challenge is through the use of financial incentives to encourage relevant risk reduction measures. Indeed, a lack of incentives to encourage private investment in DRR has

[357] Ministry of Business, Innovation and Employment *Early Insights – Initial Evaluation of the Earthquake-Prone Building System* (March 2021) at 4.

[358] *Sendai Framework for Disaster Risk Reduction 2015-2030*, above n 7, at [19(f)].

[359] United Nations Office for Disaster Risk Reduction, above n 103, at 348.

[360] Melanie Gall, Susan L Cutter, and Khai Hoan Nguyen *Incentives for Disaster Risk Management* (United Nations Office for Disaster Risk Reduction, Beijing, 2014) at 4.

[361] Yao and others, above n 35, at 811.

been highlighted as one of the core drivers of disaster risk itself.[362] Enhanced investment is therefore viewed as a necessary component for states to achieve commitments to DRR within the Sendai Framework. This chapter argues that authorities need to consider the expenditure associated with seismic risk reduction not as unaffordable costs, but rather as necessary and strategic investments for the future. Access to public financial incentives should be made available to help building owners assess and strengthen their buildings as necessary within frameworks, and this should be available to everyone who is subject to risk reduction obligations. It should be mentioned that the purpose of this chapter is not to evaluate the economics or effectiveness of individual financial incentive schemes. Instead, what is evaluated is the existence of such schemes and their availability to building owners who are legally required to undertake relevant seismic risk reduction measures.

6.1 Investing in Risk Reduction as a Public Good

A historically dominant focus on economic investments for short-term benefits has often led to under-investment in long-term measures for resilience.[363] In fact, for countries which are considered wealthy and therefore in a position to make such long-term investments, failure to do so is related to a combination of risk perception and priority areas of individual governments.[364] Achieving a substantial reduction in disaster risk and improving resilience – which all countries have committed to achieving through their endorsement of the Sendai Framework – requires a substantial shift in thinking by states away from short-term economic considerations. Instead of investment in preventative DRR measures being a burdensome or unaffordable cost, it should instead be understood as a wise and beneficial long-term investment to improve resilience. The Sendai Framework offers an opportunity to convince decision-makers to make such long-term investments, through its focus on the proactive reduction of risk rather than simply aiming to minimise losses and reacting as necessary following hazardous events.[365] Indeed, as governments increasingly become the "insurer of last resort" for the impacts of earthquakes and other hazards, greater financial incentives in DRR

[362] Above n 7, at [6].

[363] United Nations Office for Disaster Risk Reduction, above n 103, at 350.

[364] At 350.

[365] At 166.

measures are considered essential to improving resilience.[366] Providing financial incentives and assistance to achieve this outcome is therefore considered a necessity for the overall public good. In relation to existing buildings, the benefits to public safety and improvement in resilience against the disruption of earthquakes justify public investment in risk reduction measures, including seismic assessments and strengthening.[367] The seismic vulnerability of existing buildings today is through no fault of building owners themselves, but instead a reflection of modern legal expectations for seismic risk.

There is a lack of willingness to make long-term investments to reduce seismic risk in New Zealand, as evidenced by the limited and restricted financial incentives available to EPB owners. It appears the Government's focus is the use of mandatory strengthening obligations to achieve risk reduction within the EPB framework. Legislative records related to the design of the EPB framework clearly indicate it was Parliament's intention that building owners should bear the expense of remediation work for EPBs.[368] Since the national EPB framework first came into force in 2017, only two financial assistance schemes have been developed by the state. The Heritage EQUIP scheme was established in 2017 and provides financial grants to assist heritage EPB owners with costs of strengthening and expert consultation for establishing seismic strengthening plans.[369] Additionally, the Residential EPB Financial Assistance scheme was established in 2020, which offers low-interest government loans to owner-occupiers of earthquake-prone residential units within multi-unit or multi-storey buildings.[370] It is also worth mentioning that a financial grant scheme was established by the central government to assist the owners of URM buildings remediate dangerous facades and other parts of these buildings, under the 2017 Hurunui/Kaikōura Earthquakes Recovery (Unreinforced Masonry Buildings) Order. However, this applied only in four regions and for buildings located along streets pre-determined within the order.[371] The Heritage EQUIP and Residential EPB schemes are very restrictive in relation to who can access them. For instance,

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[366] Jaffee and Russell, above 173, at 470.

[367] Filippova and others, above n 168, at 721.

[368] NZPD, above n 254, at 10918.

[369] Heritage EQUIP Earthquake Upgrade Incentive Programme (2021) <www.heritageequip.govt.nz>.

[370] "Residential Earthquake-Prone Building Financial Assistance Scheme" (2020) *Kāinga Ora* <*www.kaingaora.govt.nz*>.

[371] The Hurunui/Kaikōura Earthquakes Recovery (Unreinforced Masonry Buildings) Order 2017 is discussed further in Chapter 7.

Heritage EQUIP grants are allocated in a lottery-style manner and priority is given to heritage buildings which have a higher protection status (i.e. Category 1 heritage buildings).[372] It should be noted that, as of June 2021, the Heritage EQUIP grant scheme has been indefinitely suspended, having provided funding for approximately 80 heritage buildings over five years. The government loans for residential EPB units are available only to owner-occupiers who can prove financial hardship, including being unable to obtain a regular bank loan without resulting in such hardship.[373] The scheme is designed to provide at least 40 loans, despite more than 1,000 earthquake-prone residential units believed to exist in Wellington alone.[374] Limiting the types of existing buildings eligible for financial assistance treats all building owners as homogenous, which ultimately advances real issues of equity in regard to expectations of risk reduction. After all, the owners of large earthquake-prone commercial buildings in major centres are likely to have greater access to resources and capital for achieving their obligations than do private owners of smaller earthquake-prone buildings.[375] Financial incentives should be offered to building owners, regardless of building type, as the overall objective of risk reduction is to improve public safety and societal resilience to earthquakes.

Financial assistance and incentives are far more prevalent within the risk reduction frameworks for existing buildings in Japan and Italy. In Japan, public funding to reduce the seismic risk of existing buildings is perceived as a key tool for enhancing resilience and safety.[376] For this reason, Japan provides the broadest range of financial assistance of each case study country to incentivise compliance, with an assortment of subsidies, grants, low-interest government loans and tax relief for residential property owners.[377] All pre-1981 buildings in need of risk assessment and, if necessary, strengthening work, are entitled to subsidies and grants for both. For instance, central and local governments generally subsidise the cost of seismic assessments by 66% and the cost of seismic strengthening by 23%, with the potential

[372] Heritage EQUIP (2021) <www.heritageequip.govt.nz>.

[373] "Residential Earthquake-Prone Building Financial Assistance Scheme" (22 October 2020) Kāinga Ora <www.kaingaora.govt.nz>.

[374] Up to 20% of these owners are assumed to face financial hardship for seismic strengthening, translating to approximately 250 units, see: Cabinet Office Circular "Residential Earthquake-Prone Building Financial Assistance Scheme" (17 February 2020) CAB at 3.

[375] Ministry of Business, Innovation and Employment, above n 357, at 19.

[376] Ando, above n 241, at 392.

[377] Moullier and Sakoda, above n 120, at 48.

for this to increase or decrease depending on potential limited-time offers.[378] Originally available only for non-residential buildings, these subsidies were expanded in 2002 to include standalone residential homes.[379] In Italy, the State allocated more than €1.1 billion between 2003 and 2016 toward the seismic assessment and strengthening of (mainly public) existing buildings.[380] This was distributed proportionately between regions according to seismic hazard zones.[381] Efforts to more broadly incentivise risk reduction amongst existing building owners have been made with the 'Sismabonus' tax deduction scheme, first introduced in 2013 and expanded in both 2016 and 2020. Sismabonus is designed to provide existing building owners with tax deductions from costs incurred as a result of completing strengthening work.[382] The deduction available is related to the level of strengthening work completed, with a greater percentage offered where more extensive risk reduction measures are completed. A standard rate of 80% is offered for a maximum of €96,000 per building unit.[383] In response to the economic challenges of the COVID-19 pandemic in 2020, the Italian State temporarily increased Sismabonus to a maximum deductibility of 110% for seismic strengthening work amongst residential buildings, to attempt at incentivising greater compliance.[384] As noted by Taffoni, Sismabonus means that "for the first time, voluntary action with strong state incentives for seismic prevention on existing buildings can be implemented on a large scale and without [barriers according to the type of building]".[385] Though no data currently exists to indicate the uptake of the Sismabonus scheme, Paleari does indicate that the aggregate expenditure on

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378 See: Kenji Okazaki *Global Assessment Report on Disaster Risk Reduction 2011 – Incentives for Safer Buildings: Lessons from Japan* (United Nations Office for Disaster Risk Reduction, 2010) at 4; Moullier and Sakoda, above n 120, at 48.

379 Okazaki, at 4.

380 This figure is relatively small when considering estimates from 2013, which indicate the cost of merely securing all seismically-vulnerable homes across Italy could total at least €93 billion, see: *Verso un Piano Nazionale per la Messa in Sicurezza delle Abitazioni e Dei Territori dal Rischio Sismico e Idrogeologico*, above n 30, at 3.

381 Paleari, above n 158, at 679.

382 Consenza and others, above n 123, at 5908.

383 At 5908.

384 "SuperBonus 2020" Eco Sisma Bonus <www.ecosismabonus.it>.

385 Giorgio Taffoni "Applicazione Del Sisma Bonus Alle Strutture In Calcestruzzo Armato" (Corso Di Laurea Magistrale In Ingegneria Edile, Politecnico Di Torino, 2019) (Translation: "Application Of The Seismic Bonus To Reinforced Concrete Structures" Master Of Science in Building Engineering, Polytechnic of Turin, 2019) at 16.

building renovations in Italy (including seismic strengthening) doubled between 2011 and 2016 alone.[386]

It is clear that both Japan and Italy have sought to provide a more extensive range of financial incentives to building owners than New Zealand. While both countries do rely more heavily on financial incentives to encourage compliance in their largely voluntary-based risk reduction frameworks, relying on compliance through mandatory obligations with heavily restricted financial support is less likely to provide for a desirable outcome of risk reduction.[387] Indeed, this has been recognised and while further public financial incentives have previously been considered to assist EPB building owners in New Zealand, none have thus far been implemented. For instance, a tax deduction scheme was also originally considered to assist with seismic strengthening of EPBs, however this was not picked up by the government of the day and has not been adopted since.[388] As a result, building owners cannot claim tax deduction on seismic assessments or strengthening work required to comply with the law, though may do so if their building is badly damaged or suffers collapse in an earthquake.[389] This exposes a current inequity in the ability to comply with risk reduction obligations and, in the absence of wider financial assistance, does nothing to incentivise preventative, risk-adverse behaviour. Tax deductibility for building depreciation was recommended by the recent tax working group in New Zealand as a way of incentivising greater compliance with seismic strengthening for existing buildings.[390] While the ability to claim tax from building depreciation was in fact reintroduced in 2021 as part of the economic response to COVID-19, this was not specifically targeted at seismic assessments and strengthening and it therefore remains uncertain whether it will have any impact on incentivising such action.[391]

Financial incentives are not only relevant for EPB strengthening requirements, but also for driving risk reduction action amongst owners of earthquake-vulnerable buildings not captured by the statutory mandate. The provision of financial assistance and incentives for all

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[386] Above n 158, at 679.

[387] Ministry of Business, Innovation and Employment, above n 357, at 4.

[388] NZPD, above n 254, at 10918.

[389] (10 May 2016) 713 NZPE 10918.

[390] Tax Working Group *Future of Tax: Final Report Volume I, Recommendations* (New Zealand Government, Wellington, 21 February 2019) at 77.

[391] "COVID-19 Depreciation and Low-Value Assets" Inland Revenue <www.ird.govt.nz>.

owners of buildings in need of seismic strengthening in Japan and Italy align better with the objectives of the Sendai Framework and is something New Zealand should also seek to establish, to encourage more than simply the bare minimum. Fiscal restrictions of local governments in New Zealand restrict the financial incentives which may be provided locally and, therefore, assistance from the state is necessary to support seismic risk reduction efforts.[392] In fact, it has been acknowledged that relying on individual TAs to administer their own financial incentive schemes would be impractical and that centralised schemes are likely to be more efficient.[393] Although local incentives are more common in Italy and Japan, schemes led by the central government are still prominent within their risk reduction frameworks. In addition, local and regional governments in Italy and Japan enjoy greater financial powers and autonomy required to generate revenue to implement incentives of particular significance. In fact, almost 90% of revenue and expenditure in New Zealand is controlled by central government, making local governments of the least financially-autonomous in the OECD.[394]

It should also be noted that even in New Zealand, where residential earthquake insurance is near universal, it does not encourage risk reduction. Proposals have been made for different risk classes to be created for insurance purposes to distinguish those which have been seismically strengthened and those which have not. This is itself a wider issue which affects all existing buildings as, financially, there is currently no differentiation in the insurance market between existing buildings which have been seismically strengthened and those which have not.[395] For instance, a distinguishment of insurance premiums between strengthened and non-strengthened buildings may help to further incentivise people to undertake risk reduction measures.

6.1.1 Prioritising financial assistance according to seismic hazard zones

Aside from the mere existence of public investments in seismic risk reduction for existing buildings, relevant financial assistance and incentives should be available to building

[392] Filippova and Noy, above n 167, at 182

[393] Cabinet Office Circular, above n 374, at 11.

[394] Organisation for Economic Co-operation and Development *Government at a Glance 2017* (OECD Publishing, Paris, 2017) at 73-81.

[395] Temitope Egbelakin and others “Incentives and Motivators for Improving Building Resilience to Earthquake Disaster” (2017) 18 Natural Hazards Review 04017008-1 at 04017008-10.

owners in all areas where action is necessary or desired. Financial assistance schemes in New Zealand and Italy are both currently restricted according to particular hazard zones established under seismic hazard maps (see Chapter 4). For instance, the residential EPB loan scheme in New Zealand is available only to relevant building owners located in areas of high seismic hazard.[396] While the Heritage EQUIP grant scheme was technically available to heritage buildings across the entire country, priority of funding was largely oriented toward buildings in high and medium hazard zones.[397] Interestingly, two of the country's largest urban centres, and in fact the majority of estimated EPBs across the country, are believed to be located within low hazard areas where there is currently little-to-no financial incentives available.[398] In Italy, the Sismabonus scheme was originally available only to building owners located within seismic hazard zones 1 and 2 (regions with the highest seismicity), although this was extended in 2017 to also include zone 3.[399] With approximately two thirds of Italy's 60 million people residing within zones 3 and 4, the expansion of Sismabonus to zone 3 has increased those eligible but still leaves it unavailable to approximately one-third of the population.[400] In comparison to both Italy and New Zealand, access to financial incentives in Japan is made available across the entire country in recognition of the importance of achieving seismic risk reduction amongst existing buildings everywhere. If the ultimate goal is, in fact, risk reduction in all regions, more consideration needs to be provided to nationwide financial incentive schemes rather than in regions of more frequent seismicity. Vulnerable existing buildings present a risk regardless of their location and access to financial incentives should ultimately reflect this, especially where obligations to reduce risk exist in all regions (as explored in Chapter 4).

While the decision to restrict financial incentive schemes according to seismic hazard areas in Italy and New Zealand is clearly intended to prioritise risk reduction in areas presumed to have a greater relative threat of earthquakes, it ultimately does little to encourage the need for risk reduction in presumed low seismic areas. It is of course possible that assistance will be made available to EPB owners in low seismic areas at a later date, in relation to the staggered deadlines between regions for achieving obligations (see Chapter 2). However, the goal should

396 Kāinga Ora, above n 373.

397 Heritage EQUIP, above n 372.

398 Ministry of Business, Innovation and Employment *Progress toward Identifying Potentially Earthquake-Prone Buildings 2019* (Wellington, November 2019) at 19.

399 Above n 255, at 4.

400 Above n 30, at 1.

be to encourage and incentivise building owners to complete risk reduction measures as soon as reasonably practical. Obligations are ultimately required for all buildings, regardless of seismic hazard zone, and therefore it does not make sense to delay access to the very assistance designed to help achieve efficient risk reduction. It makes more sense to invest in risk reduction obligations upfront and incentivise compliance as soon as possible.

6.2 Summary

Investing in DRR is a key priority highlighted within the Sendai Framework. When considering the risk reduction of existing buildings, this requires states to consider making long-term investments to improve resilience, rather than simply consider short-term costs associated with seismic assessments and strengthening. While financial incentives are not a silver bullet for achieving risk reduction amongst existing buildings, they are ultimately a useful tool within risk reduction frameworks for assisting building owners. The EPB framework in New Zealand places burdensome mandatory requirements on EPB owners to strengthen their buildings, but does not provide any consideration to the financial challenges many building owners are likely to face in achieving these obligations. Indeed, it appears that an over-reliance has been placed on the mandatory obligations for achieving risk reduction, and has overlooked the very real potential for many building owners to be unable to do so without greater financial assistance.

Government financial incentives are more prominent in Japan and Italy, where they are used to encourage uptake in the voluntary-based seismic strengthening frameworks. Similar incentive schemes have been previously considered in New Zealand, though none have since eventuated. It is clear that a greater investment from the state is required, both to achieve DRR and to promote equity within the EPB framework. This includes providing such incentives to building owners in all regions where risk reduction is required or encouraged. While Japan offers financial incentives across the country, both New Zealand and Italy currently restrict access to incentives for building owners in areas of higher seismicity only. Such an approach may lead to stalled progress towards DRR and drag it out for longer than it may otherwise need to be.

Chapter 7

Timeframes and Monitoring the Progress of Building Owners Across Time

> …it is important that normative instruments provide for the monitoring of progress and the verification of compliance… [to] provide important information on compliance and necessary corrective and pre-emptive measures to adopt.

United Nations Office for Disaster Risk Reduction[401]

The success of risk reduction obligations is largely dependent upon the long-term strategies and planning undertaken by authorities. The Sendai Framework highlights the establishment of clear DRR targets and deadlines as an effective means of strengthening disaster risk governance.[402] Implementing timeframes for achieving DRR obligations and goals is a particularly useful tool for reducing the seismic risk of existing building, given the length of time taken to identify vulnerable buildings and subsequently plan for appropriate intervention. In fact, deadlines for authorities to identify potential EPBs and for the owners of EPBs to subsequently strengthen or demolish the structure are a central feature of the EPB framework in New Zealand.

This chapter explores the use of timeframes in planning to achieve the risk reduction of existing buildings and argues that regulation alone should not be relied upon for success. In particular, there is a significant reliance in New Zealand on achieving the risk reduction of EPBs within relevant deadlines by deterring building owners against non-compliance with the threat of formal sanctions. It is argued that this primary reliance on deterring building owners into compliance is not the most effective means of achieving risk reduction and greater assistance should instead be provided by authorities. This includes better use of compliance monitoring to ensure authorities understand progress made by building owners relative to their deadlines. Additionally, greater engagement to assist building owners navigate the process of seismic risk reduction is also important for increasing the chance obligations will be met. Examples from Japan and Italy are explored to provide perspective for integrating these into New Zealand's legal framework.

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[401] Above n 51, at [119].

[402] Above n 7, at [27(b)].

7.1 Timeframes as an Enforcement Mechanism within Risk Reduction Frameworks

The use of timeframes within legal frameworks helps to provide certainty and guide the completion of risk reduction obligations within a particular period of time. Timeframes for the risk reduction of existing buildings are prominent features in the frameworks of both New Zealand and Japan, albeit with very different purposes. In New Zealand, the Building Act sets out statutory deadlines for TAs to identify potentially earthquake-prone buildings and for relevant owners to strengthen their buildings if they are found to be earthquake-prone.[403] Time periods provided for these deadlines are progressively staggered between seismic hazard zones, with the longest deadlines in low seismic zones and shortest deadlines in high seismic zones. These range anywhere between ten years for priority buildings in high seismic zones, to more than 50 years for buildings in low seismic hazard zones. While timeframes are also a prominent feature for reducing the seismic risk of existing buildings in Japan, they are instead used to outline government targets for risk reduction since mandatory strengthening obligations do not exist. In accordance with plans set by central and local governments under the APSRB, percentile targets are set within timeframes of approximately five-year periods for the sought number of strengthened existing buildings.[404] Periodic surveys monitor the actual progress of seismic strengthening in relation to these goals, and policy is adjusted or updated where necessary if the actual rate of strengthening is below the target rate.[405]

In comparison to both Japan and New Zealand, timeframes do not appear to be a feature for reducing the seismic risk of existing buildings in Italy. The exception to this was a five-year deadline introduced under Ordinance 3274 of 2003 to complete seismic assessments of all priority buildings within seismic hazard zones one and two.[406] The deadline, which was subsequently extended multiple times beyond the initial five year period, appears to be the only experience of timeframes within Italy for reducing risk of existing buildings.[407] This lack of timeframes or goals largely reflects the comparatively hands-off approach of the Italian state

[403] Section 133AG; s 133AM.

[404] Act on Promotion of Seismic Repair of Buildings, art. 4.

[405] Moullier and Sakoda, above n 120, at 51.

[406] Mazzoni and others, above n 26, at 1676.

[407] Fabio Casciati and Sara Casciati "Amelioration and Retrofitting of Educational Buildings" (2018) 17 Earthquake Engineering and Engineering Vibration 47 at 48.

to reducing seismic risk existing buildings. The number of existing buildings understood to require seismic strengthening in Italy is substantially greater than in New Zealand and Japan, totally more than 60% of the building stock. This scale of vulnerable buildings may therefore be a contributing factor as to why no national timeframe exists for completing this risk reduction.

7.2 The Challenge of Relying on Deterrence to Achieve Risk Reduction

There appears to be an over-reliance on the use of formal sanctions for achieving obligations within the EPB framework in New Zealand. Formal sanctions are integrated into the framework owing to the existence of mandatory requirements for EPBs to be strengthened or demolished. This compares to Italy and Japan, where there is no compulsory requirement for vulnerable existing buildings to undergo remediation work. Formal sanctions (which include financial penalties and the ability for TAs to seek application to act on the behalf of building owners) enable authorities to respond to instances of non-compliance when they arise, but are ultimately not preventative in nature.[408] There is a danger in solely relying on formal sanctions to achieve risk reduction of existing buildings, principally that many owners may fail to comply within relevant deadlines. Penalties and formal sanctions should be a secondary measure to hold accountable stakeholders who willingly refuse to comply, while more effort should be made to assist building owners to achieve their obligations in the first instance.

Moreover, there is a degree of ambiguity in relation to how the risk of EPBs will be remediated if building owners fail to comply within relevant deadlines, especially if there are multiple buildings involved. TAs in New Zealand may apply to the District Court for an order to carry out strengthening work on behalf and at the expense of building owners if they fail to comply with, or are "not proceeding with reasonable speed in light of" relevant deadlines.[409] What would constitute a "reasonable speed" is largely ambiguous, with no relevant guidance provided by Parliament nor interpretation from the courts. Indeed, the power itself would rely upon a currently non-existent system of compliance monitoring, making it unlikely to be utilised. Experience with such applications indicates a reluctance from the courts to grant orders for generic work, instead favouring plans which outline the specific work which TAs

[408] Building Act, s 133AR-133AU.

[409] Section 133AS(1).

propose to do with relevant buildings.[410] In *Wellington City Council v Lakhi Maa*, the District Court recognised the significant variability in the type of work which may be completed to reduce the seismic risk of existing buildings (including strengthening, demolition, or a combination of both).[411] Citing previous cases, the court noted that the court has a precedent to consider "expert evidence and, where appropriate, [granting] orders for specific work to be conducted", rather than simply permitting TAs to make such decisions after a court order has been made.[412] Developing specific plans for seismic work, including gathering expert evidence and consultation, would be a heavy workload for authorities, especially in a situation where risk is needed to be remediated for multiple buildings at once. Generally speaking, TAs in New Zealand undertake court action as a "last resort" owing to insufficient finances and resources, with a greater incentive to deal with issues of non-compliance through less resource-intensive means.[413] In fact, the Wellington City Council recently expressed concern to MBIE around the authorities' "ability to use [its] enforcement powers effectively and efficiently, given the cost and resource required to go through the District Court".[414] It would be reasonable to assume that similar concerns exist amongst other TAs, especially those which are smaller and have substantially fewer resources.

An additional consideration to this remedial power is that TAs "may" apply for a court order, implying the power itself is discretionary. Additional powers to impose safety requirements on non-complying buildings may be a preferred alternative for TAs, including the erection of safety barriers around a buildings' perimeter or issuing restrictions on access to the building.[415] While this may increase the safety of building users and passersby in the short-term, it does not ultimately reduce the overall existence of disaster risk. Where an application for a court order is made, it remains uncertain whether or not the court has discretionary power to refuse such an order.[416] There is a precedent for intrusions upon private property rights to be

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[410] *Wellington City Council v Lakhi Maa Ltd* [2020] NZDC 26755.

[411] At [6].

[412] At [30].

[413] Mark Wright "When Crime Pays: 'Environmental Civil Prosecutions' and the Resource Management Act 1991" (PhD Dissertation, University of Canterbury, 2020) at 118.

[414] Ministry of Business, Innovation and Employment, above n 357, at 20.

[415] Building Act, s133AR(1).

[416] *Wellington City Council v Lakhi Maa Ltd*, above n 410, at [19].

as reasonably minimal as possible "to satisfy some overriding objective".[417] While the overriding objective in relation to the EPB framework is to protect public safety, it is difficult to determine what may be considered "reasonable" in the absence of a TA having a specific vision for what it intends to carry out on the relevant building. Such a scenario connects back to the above argument considering the apparent reluctance of courts to grant generic orders to TAs, requiring a more resource-intensive role from authorities.

The uncertainty around the effectiveness and efficiency of formal sanctions to achieve risk reduction for existing buildings highlights the important role of central and local governments in assisting and incentivising building owners to comply with relevant deadlines. As mentioned at the beginning of this section, incentivising compliance is central to risk reduction and a sole reliance on formal sanctions does not align with the principle of shared responsibility as outlined in the Sendai Framework.[418] This is not to say that formal sanctions are not necessary to address non-compliance, but rather that they should be applied as a final backstop and not as the primary tool for promoting risk reduction obligations. As has been discussed thus far in the current chapter, the EPB framework in New Zealand places an inequitable responsibility on building owners to achieve risk reduction within the statutory deadlines and may, consequently, result in challenges if formal sanctions are relied upon to remediate seismic risk at the end of these deadlines. Building owners should be supported to achieve their obligations in advance of authorities using powers to sanction non-compliance.

7.3 Monitoring the Compliance of Building Owners across Time

Monitoring the long-term progress of building owners to reduce the seismic risk of existing buildings is relatively straightforward yet incredibly beneficial for understanding the likelihood of achieving targets. Compliance monitoring informs authorities about trends in risk reduction and enables them to proactively adapt approaches if necessary to stay on track. As mentioned, Priority Two of the Sendai Framework encourages regular monitoring of obligations and the use of progress reports as a means of promoting strong disaster risk governance.[419] This enables authorities to maintain an updated awareness of how building

[417] *Grubmayr v Bloxham* [2004] NZAR 577 at [23].

[418] Above n 51, at [44].

[419] Above n 7, at [27(e)].

owners are progressing with meeting their relevant obligations. It also provides authorities with knowledge about whether or not it appears likely that obligations will be achieved within relevant timeframes or in relation to the targets sought.

Although statutory deadlines are a central feature of achieving risk reduction within the EPB framework in New Zealand, there is no structure for monitoring the progress of building owners. This is an oversight which may lead to a reactive situation outlined in the previous section, where multiple owners fail to comply within relevant deadlines and where authorities are left to respond at the time. The oversight is especially interesting, given there is an equivalent duty for monitoring the progress of TAs. Under the Building Act, TAs must periodically report the progress they have made in identifying potentially earthquake-prone buildings to the Chief Executive of the Ministry of Business, Innovation and Employment (MBIE).[420] This is a feature to promote compliance amongst authorities and has thus far been recognised as essential for helping authorities stay on track with finding EPBs. In fact, a 2021 national progress report from MBIE stated that the information to be provided from TAs in upcoming progress reports will be essential for identifying the TAs most at risk of failing to identify EPBs within the deadlines.[421] It was noted that this information would be used to "provide support" to ensure TAs were able to meet their obligations on time.[422] Despite the noted importance of compliance monitoring and progress reports for TAs, there is no equivalent requirement for monitoring the progress of building owners in relation to seismic strengthening obligations. The current structure of the framework effectively transfers all responsibility for risk reduction to owners once an EPB is identified, with no obvious structure to ensure authorities maintain an ongoing understanding of how building owners are tracking to meet their deadlines.

The framework for reducing the risk of existing buildings in Japan illustrates that regulation alone is insufficient for ensuring compliance amongst building owners and that tracking long-term progress is essential.[423] Regular monitoring, complemented by progress

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[420] Section 133AG(2).

[421] Ministry of Business, Innovation and Employment *Progress Toward Identifying Potentially Earthquake-Prone Buildings 2020* (Wellington, March 2021) at 14.

[422] At 14.

[423] Moullier and Sakoda, above n 120, at 58.

reporting, is crucial for informing any potential changes which may be required to ensure targets can in fact be met. This includes establishing new incentives or addressing potential issues such as shortages in professionals to complete strengthening work.[424] As previously mentioned, owing to an absence of mandatory legal strengthening requirements in Japan, timeframes are instead used within a broader long-term strategy to meet government-set targets aimed at incrementally increasing the number of existing buildings with adequate seismic resistance.[425] Routine surveys commissioned by government departments are used to update authorities on the estimated number of existing buildings which have in fact completed or are in the process of completing seismic strengthening. For instance, a 2% gap was identified in 2008 between the target number and actual number of strengthened existing buildings in Japan, which resulted in renewed financial incentives to promote the closure of this gap.[426] Such an approach is likely to be required again, with data from 2018 indicating seismic strengthening to be slightly short of the 90% target by 2015.[427] By integrating routine monitoring into the national risk reduction framework for existing buildings, Japan has been able to maintain a clear long-term strategy for increasing the number of seismically-resistant existing buildings, while remaining flexible to regulatory or policy changes where compliance appears off-track. The absence of similar compliance monitoring of building owners' progress within New Zealand reflects the more static nature of the EPB framework and restricts the capacity for making efficient targeted changes to enable building owners to meet their statutory deadlines. This fundamentally relies on building owners being deterred from non-compliance through the existence of these compulsory deadlines alone, without any additional widespread support from authorities.

7.3.1 Monitoring risk reduction across lengthy time periods

The argument for integrating stronger compliance monitoring amongst building owners in New Zealand is further emphasised by the particularly lengthy time periods provided within

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[424] At 58.

[425] Figures on the progress made with the seismic strengthening of existing buildings in accordance with government targets are provided by the Ministry of Land, Infrastructure, Transport and Tourism, see: "住宅・建築物の耐震化について" Ministry of Land, Infrastructure, Transport and Tourism <www.mlit.go.jp> (translation: "Architecture: Earthquake Resistance of Houses and Buildings").

[426] Moullier and Sakoda, above n 120, at 51.

[427] Ministry of Land, Infrastructure, Transport and Tourism, above n 425.

the Building Act, which increases the potential for deadlines to be missed. Depending on the seismic hazard area and whether or not a building is considered a priority building, the deadlines for identifying, assessing, and strengthening EPBs in New Zealand range from approximately ten years to more than 50 years, as shown below in Table A.

Table A. Statutory Deadlines for EPB Risk Reduction in New Zealand (Building Act 2004)

Seismic Hazard Area	**Deadline to identify potential EPBs**		**Deadline to obtain seismic assessment (from date of request)**	**Deadline to complete strengthening or demolition (from issue of EPB notice)***		[redacted]	**Total approximate time for remediation**	
Building	**Priority**	**Other**		**Priority**	**Other**		**Priority**	**Other**
High Hazard Area	2 years, 6 months	5 years	12 months (with potential 12-month extension)	7 years, 6 months	15 years		10 years	20 years
Medium Hazard Area	5 years	10 years		12 years, 6 months	25 years		17.5 years	35 years
Low Hazard Area	n/a	15 years		n/a	35 years		n/a	50 years

*An additional strengthening extension of up to ten years may be granted for certain heritage buildings

The lack of compliance monitoring across lengthy time periods highlights the over-dependence on achieving obligations through regulation and deterrence alone. Permitting remediation deadlines which span decades, in the absence of any wider obligations to track progress, absolves too much responsibility from authorities in the effort to ensure targets are achieved. Omitting a requirement for TAs to monitor the compliance of building owners essentially leaves them, and central government, ignorant to the progress of EPB remediation over time. The New Zealand Society for Earthquake Engineering (NZSEE) has previously voiced its objection to the lengthy deadlines, stating they effectively amount to "a dismissive requirement".[428] In many instances, it is likely that the responsibility for seismic strengthening will have long passed on from current building owners by the time the deadlines require action

[428] New Zealand Society for Earthquake Engineering "Supplementary Submission to Local Government and Environment Select Committee on the Building (Earthquake-Prone Building) Amendment Bill 2015" at 3.

to be completed. In Japan, at least 33% of existing buildings were estimated to have inadequate seismic resistance as of 2005, approximately ten years after the APSRB was enacted in 1995.[429] In 2018, this number was believed to be approximately 13% amongst residential buildings and 11% amongst non-residential buildings, against targets of 10% by 2015, 5% by 2020, and effectively zero by 2025.[430] As mentioned above, progress monitored over the past three decades has allowed the government to stay on top of risk reduction efforts and react appropriately if they appeared to stagnate. This is not the case in New Zealand, where the multi-decade effort to remediate EPBs is set to be undertaken with no such monitoring. The estimated number of EPBs across New Zealand is between 15,000 and 25,000, representing approximately 8-13% of the total building stock (excluding most residential homes).[431] More than 80% of these buildings are believed to be located within areas of medium and low seismic hazard, where statutory deadlines range from approximately 17.5 years to more than 50 years.[432] This is a significant period of time for there to be no requirement for authorities maintain a record of progress made, and reduces the ability to proactively respond in the event compliance is lower than that which is sought.

In the absence of obligations to monitor and report progress of building owners, timeframes spanning multiple decades also decreases the perceived urgency to reduce seismic risk. The median time for identifying and remediating EPBs under the current national framework is approximately 27 years. This represents an almost negligible difference in comparison to the average of 28 years taken to identify and remediate EPBs under the previous, de-centralised system, which the current EPB framework was designed to speed up.[433] It also far exceeds the 15-year period initially recommended by the Royal Commission into the Canterbury Earthquakes, and that which was proposed in the initial draft bill of the EPB framework.[434] This would have provided a five-year period for TAs to identify all potential

[429] *National Report of Japan on Disaster Reduction for the World Conference on Disaster Reduction* (Government of Japan, Kobe-Hyogo, 18-22 January 2005) at [1.5].

[430] Ministry of Land, Infrastructure, Transport and Tourism, above n 425.

[431] These numbers are based on estimates from 2012 and therefore may change as more regions begin the process of identifying potentially earthquake-prone buildings, see: Ministry of Business, Innovation and Employment, above n 220, at 9.

[432] Ministry of Business, Innovation and Employment, above n 398, at 11.

[433] Building (Earthquake-Prone Buildings) Amendment Bill (select committee report), above n 292, at [108].

[434] Above n 146, at 210.

EPBs and a further ten-year period for EPB owners to complete strengthening obligations. In fact, the average time period of 27 years is similar in practice to the non-enforceable timeframes applied to incremental risk reduction targets for existing buildings in Japan. There, the current target is to have effectively all existing pre-1981 buildings seismically strengthened by the year 2025, or 30 years since the APSRB framework was first implemented.[435] Of course, as discussed above, there is a far greater effort made to monitor the progress of building owners in Japan across this time period to ensure targets are met.

7.4 Engaging with Stakeholders

While compliance monitoring provides authorities with a holistic overview of risk reduction progress, it is also important that authorities develop a strong partnership and engagement with building owners to assist them in achieving their obligations. Kohiyama suggests that a strong exchange of information and interaction between building owners and authorities would incentivise greater compliance with seismic strengthening.[436] Navigating seismic risk reduction for existing buildings is likely to be unfamiliar territory for many, and some may not fully appreciate legal requirements or lack knowledge about how to manage seismic assessment and strengthening work. For instance, the owners of private residential units under a body corporate arrangement have expressed greater challenges and uncertainty in relation to engaging with seismic strengthening requirements than have owners of large commercial buildings in New Zealand.[437] Other factors, including language barriers, are also relevant considerations which can challenge or stall compliance.[438] Relying on formal sanctions and regulation alone to achieve risk reduction homogenises building owners and these potential barriers for complying with relevant obligations. Ensuring a strong level of engagement and sharing of information between building owners, authorities, and the professionals involved in seismic assessments and strengthening, would contribute to a smoother overall risk reduction process by addressing individual needs or issues.

Despite understanding the importance of bridging information gaps to achieve risk reduction, current frameworks for reducing the seismic risk of existing buildings tend to place

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[435] Ministry of Land, Infrastructure, Transport and Tourism, above n 425.

[436] Kohiyama and others, above n 320, at 177.

[437] Ministry of Business, Innovation and Employment, above n 357, at 19.

[438] Independent Review Team, above n 201, at 31.

most responsibility on building owners to self-navigate planning and consulting with engineering professionals and accessing specific information relevant to their obligations. In Italy, the onus for understanding the seismic risk of existing buildings is entirely dependent upon the voluntary willingness of building owners to engage with professionals.[439] The Sismabonus tax incentive scheme discussed in Chapter 6 attempts to incentivise greater uptake by building owners with seismic strengthening, yet it ultimately lacks a significant motivating factor to assist building owners to take action in the first instance.[440] The circumstance is slightly different in Japan and New Zealand, where authorities have attempted to bridge this gap by identifying existing buildings in need of seismic risk reduction and directly contacting the owners of relevant buildings to advise them on their obligations. Beyond this initial contact, however, engagement remains similarly low during the assessment and strengthening processes. A survey of homeowners in Japan highlighted common deterrents for undertaking seismic strengthening, including a lack of trust toward relevant contractors and insufficient knowledge about the process itself.[441]

Recent experience in New Zealand demonstrates the importance of having an active engagement between stakeholders to achieve risk reduction targets within designated timeframes. Issued a few months after the 2016 Kaikōura Earthquake (M_W 7.8), the Hurunui/Kaikōura Earthquakes Recovery (URM Building) Order 2017 required dangerous parts of certain URM buildings across the jurisdiction of four TAs to be identified and strengthened or removed within 12 months, though this was subsequently extended by six months.[442] A subsequent review into the order indicated that the key influence for its overall success was owed to the high-engagement case management approach taken between authorities, engineers and building owners. The authors noted:[443]

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[439] *Rapporto sulla Promozione della sicurezza dai Rischi naturali del Patrimonio abitativo* (Presidenza del Consiglio dei Ministri, Stuttura di Missione Casa Italia, June 2017) (translation: Report on the Promotion of Safety from Natural Hazards of the Housing Stock, Presidency of the Council of Ministers) at 101.

[440] At 95.

[441] Kohiyama and others, above n 320, at 176.

[442] Hurunui/Kaikōura Earthquakes Recovery (Unreinforced Masonry Buildings) Order, above n 200, s 3.

[443] Independent Review Team, above n 201, at 21.

> The close working relationship between [TAs] and MBIE was one of the key factors in making the project successful. It enabled the policy to be responsive to new information and issues during the project.

A slow initial response from building owners in relation to issued strengthening notices from authorities raised concerns that the statutory deadline of 12 months would not be met. This led authorities to adopt a more active engagement approach for the process.[444] A chain of engagement was created between stakeholders to achieve the order's public safety objective.[445] TAs regularly engaged with building owners to monitor progress made and the overall confidence of owners in their ability to complete their obligations on time. This progress was updated fortnightly and reported to central government, alongside any potential issues identified or concerns raised directly by building owners or engineers. This was then periodically reviewed by the Minister to make any necessary changes to the order. The authors of the report noted that the regulatory deadline and associated financial assistance provided to building owners were "insufficient alone" to achieve obligations and, in fact, the close engagement and responsiveness to queries or practical concerns was "crucial" for completing the strengthening work.[446] This experience provides important insights which may be applicable to the completion of obligations under the EPB framework, especially considering the current lack of compliance monitoring requirements. It is possible that the subsequent 6-month extension granted to complete obligations could have been avoided had this engagement model and compliance monitoring been adopted by authorities from the beginning of the order's effect.

Improving the responsiveness of authorities to the questions and concerns from building owners would significantly assist the process of seismic assessments and strengthening. Such an operation exists in Japan, known as the Seismic Repair Support Centre (SRSC). In 2006, the SRSC was designated by the Japanese government as national organisation designed to provide information and technical support to building owners for seismic assessment and strengthening.[447] The centre has a dedicated website with a range of relevant information, from knowledge about financial incentives and lists of approved

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[444] At 21.

[445] At 13.

[446] At 21.

[447] Moullier and Sakoda, above n 120, at 47.

businesses able to conduct assessments and strengthening within each prefecture, to more general educational brochures explaining legal obligations.[448] The novelty of the SRSC is the consolidation of necessary information and the organisation's sole mandate to support building owners through the seismic assessment and strengthening process. More accessible information and a dedicated entity to coordinate and respond to inquiries from building owners has been recommended for the EPB framework in New Zealand.[449] MBIE is currently responsible for managing the EPB framework on the national level, which has no centre or team that deals exclusively with EPBs. Similarly, there is no dedicated national entity designed to engage with building owners for risk reduction in Italy. The Italian earthquake engineering professional interviewed for this researched stated that access to relevant information and support in Italy is very much a self-led process, noting building owners largely "have to go and do the looking".[450] Such an entity seems worthwhile for improving the capacity of building owners to engage with risk reduction obligations and better enable them to directly raise any barriers to authorities.

7.5 Summary

Timeframes help to provide coherence and clarity of obligations within risk reduction frameworks. Though not generally used in Italy, timeframes are key components of frameworks in both New Zealand and Japan for reducing the seismic risk of existing buildings. In New Zealand, deadlines are included within the Building Act to enforce formal sanctions against EPB owners who fail to comply with mandatory remediation obligations on time. In comparison, authorities in Japan use timeframes to set long-term goals for risk reduction, which are measured approximately every five years. The structure of the EPB framework in New Zealand appears to place significant reliance on achieving risk reduction through deterrence, with the threat of penalties. Though necessary to enforce the deadlines, there is a danger of failing to remediate EPBs on time by relying on formal sanctions alone. Though New Zealand places more reliance on achieving risk reduction through statutorily-enforceable deadlines, it is within the best interests of authorities to ensure that reliance on remediating the risk of EPBs is not placed upon formal sanctions. Such a process would likely be lengthy, expensive, and

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[448] "耐震改修支援センター" (2020) Japan Building Disaster Prevention Association <www.kenchiku-bosai.or.jp> (translation: "Seismic Repair Support Centre").

[449] Independent Review, above n 201, at 27.

[450] Above n 122.

ultimately uncertain in relation to its impact on reducing seismic risk, and therefore formal sanctions should only be an option of final resort.

Achieving risk reduction within relevant timeframes is likely to be more assured through a greater partnership between authorities and building owners. This includes better use of compliance monitoring by authorities, to track to the progress of seismic strengthening across long periods of time. Experience in Japan illustrates how routine monitoring can be effective for identifying potential shortcomings in achieving remediation targets and therefore adapting strategies to address this. The EPB framework does not provide a mechanism for such monitoring of strengthening obligations amongst building owners, despite routine monitoring for the efforts of TAs in identifying potentially earthquake-prone buildings being crucial for authorities in achieving their statutory deadlines. Authorities are therefore less informed about the progress made by building owners within these timeframes and therefore increase the potential for reactive responses at the end of deadlines, especially considering many deadlines span multiple decades.

In addition to regular compliance monitoring, a higher level of engagement between building owners and authorities is also important for assisting compliance. Lack of experience or knowledge are just some relevant factors which may prevent or stall building owners from completing seismic risk reduction. Despite this, the frameworks of each case study country still appear to place a great responsibility on building owners to self-navigate the process. Experience in New Zealand with a 2017 URM remediation order demonstrated the importance of engagement between authorities and building owners, to enable any queries or concerns to be efficiently heard and responded to. Japan has attempted somewhat to bridge this gap by designating the online Seismic Repair Support Centre, which provides a range of relevant sources and information within a single platform. New Zealand may benefit by requiring authorities to take a more active engagement with building owners in helping them achieve their obligations, rather than leaving owners to their own doing. This approach would be more equitable for building owners and may help them to remediate EPBs in a timelier manner.

Chapter 8

A Duty of Care to Protect the Public from Vulnerable Buildings

> If something goes wrong, and harm occurs, then the issues become [health and safety] issues, capable of investigation and prosecution by WorkSafe. The effect of this approach is that WorkSafe is under no obligation to take any action until harm has actually been suffered. In other words, WorkSafe has no role in providing any sort of safety net regarding the hazards contained in defectively constructed buildings.

John Goddard[451]

With the Sendai Framework understanding risk as the function of hazards intersecting with vulnerability, the concept of accountability is a central underlying theme of DRR.[452] The perception of disasters as social phenomena has fundamental implications for the responsibility, accountability and liability for harms or losses resulting from hazards.[453] Indeed, the Sendai Framework alludes to enforcement of DRR through this area of law in its emphasis on strengthening disaster risk governance, including through health and safety obligations.[454] In a multi-country report which analysed DRR practices within different legal systems, the United Nations Development Programme (UNDP) highlighted the potential for legal liability to support the enforcement of DRR practices. In particular, the report noted "civil liability… may be useful to address the misconception that natural hazards unavoidably cause disasters, and could help to increase government accountability for the risks that authorities either create or allow to accumulate".[455] While an important consideration, the report did ultimately highlight the significant uncertainty which currently exists in this area of law and cautioned that more comprehensive research is necessary to understand the potential impacts of legal liability as a means of enforcing DRR.[456]

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[451] John Goddard "Adopting a Health and Safety Framework for the Assessment and Remediation of Earthquake-Prone Buildings" (2018) 43 NZJER 18 at 30.

[452] Above n 51, at [80].

[453] See: Lauta, above n 37.

[454] Above n 7, at [27(d)].

[455] Picard, above n 36, at 78.

[456] At 78.

Nonetheless, there are relevant considerations necessary to highlight within this research which relate directly to the management of seismic risk for existing buildings. These are important considerations in relation to risk reduction obligations for existing buildings, when examining legal duties of care to protect people from harm and ensure public safety. As the seismic risk reduction of existing buildings has become more widely mandated and actively sought within the case study countries, very real legal questions have arisen in relation to these duties of care and their relationship to the enforcement of seismic risk reduction obligations. This primarily concerns the legal responsibility of building owners or managers to ensure their buildings do not cause harm to occupants or passersby. In particular, it is arguable that these duties have expanded into a broader, yet perhaps unintended, responsibility for building owners to also manage the seismic risk of their buildings. Consideration to this argument is heavily entrenched within each of three priority areas of the Sendai Framework examined within this research. In particular, an increased understanding of seismic risk (such as through the use of seismic building assessments) arguably increases the duty of building owners to take actionable measures to reduce this risk. This is regardless of whether such obligations are compulsory within formal risk reduction frameworks. This raises two key challenges in particular. The first is the expectation of building owners to both share and act upon seismic risk they become aware of. The second is the need to provide greater clarity for exactly what action is required from building owners to comply with their duty of care. Both are increasingly essential considerations and ones which have a substantial impact on structures within disaster risk governance and on the enforcement of risk reduction obligations.

It should be mentioned that this is an incredibly complex and uncertain area of law, which deals with various aspects of tort and criminal law in each of the case study countries. Discussion of the topic within this chapter is therefore not intended to be comprehensive. Instead, the intention is to identify and allude to relevant challenges which arise in relation to the seismic risk reduction of existing buildings. Having an understanding of these issues is important given the impact of duties of care as a driving force for risk reduction of existing buildings.

8.1 A Duty of Care to Protect Building Users and the Public

Each of the case study countries have relevant public safety duties of care which interact with obligations of existing building owners to reduce seismic risk. In New Zealand, the Health and Safety at Work Act 2015 (HSWA) requires persons conducting a business or undertaking (a PCBU), or officers of a PCBU, to manage workplace safety in order to protect persons from harm, which extends to ensuring their buildings are safe.[457] The HSWA is especially relevant to the enforcement of risk reduction obligations owing to the unique Accident Compensation Corporation (ACC) scheme in New Zealand, which removes liability for personal injury as a trade-off for providing universal compensation. Equivalent duties of care also exist within the civil and criminal legal systems of Japan and Italy. These duties, which comparably under private law, require building owners or occupiers to protect public safety by preventing harm arising from any "defect" in the construction or maintenance of a building.[458] While only building owners are responsible for this duty in Italy, building owners in Japan have secondary liability if the building occupier has in fact "used necessary care" to prevent relevant damages arising.[459] As is discussed, this conflicts with seismic strengthening duties given that such a responsibility is required from building owners, not tenants. It is significant that each of these duties in the case study countries were not originally conceived with the intention to influence seismic risk reduction for existing buildings, but have since become increasingly important for such in light of the increasing pursuance of prevention-based risk reduction frameworks.

8.2 Coming into Knowledge of Seismic Building Risk

The effort to reduce the seismic risk of existing buildings appears to have created a paradox. As building owners become more aware of the potential seismic risk of their structures owing to relevant assessment obligations, so too, in effect, does the duty for them to respond appropriately and reduce this risk.[460] A key consideration of this paradox is the duty of building owners to communicate this knowledge of risk when they become aware of it, in

[457] For purposes of clarity, a PCBU or officer of a PCBU includes both the owner and occupier of a building, whether commercial, industrial, residential, or otherwise. For a detailed explanation of persons who have obligations under HSWA, see: Tracy Hatton and others *Leveraging the Health and Safety at Work Act (2015) for Disaster Risk Reduction* (Resilient Organisations, 2021) at 4.

[458] Civil Code of Japan (Act No. 89 of 1896), art 717(1); Civil Code of Italy (Royal Decree No. 262 of 16 March 1942), art 2053; Criminal Code of Italy (Royal Decree No. 1398 of 19 October 1930), art 434 (Collapse of Buildings or Other Wilful Disasters) and art 677 (Omission of Work in Buildings or Constructions that Threaten Ruin).

[459] Civil Code of Japan, art 717(1).

[460] Mythen, above n 104, at 45.

order to take all reasonable steps to protect persons both within and nearby their building(s). The importance of communicating and acting upon known seismic risk has been explored in each of the case study countries.

In New Zealand, the Real Estates Agent Disciplinary Tribunal heard such a case in 2018. A tattoo parlor in Christchurch – which had been previously damaged in the 2010 Darfield Earthquake – partially collapsed in the 2011 Christchurch Earthquake, killing one tenant and injuring another. The building was managed on behalf of its owner by a real estate agent, who had failed to disclose relevant information to the tenants about the structural integrity of the building following the 2010 earthquake. In particular, the agent was aware that the building was deemed "structurally unsafe to occupy" by engineers and would require seismic strengthening to allow occupancy to continue.[461] This was not, however, passed onto the building tenants, despite them raising multiple concerns and requests for the agent to disclose information about the building's safety.[462] In addition, the agent did not communicate to the building owner any concerns in relation to the safe continued occupancy of the building, despite being privy to knowledge indicating otherwise.[463] In its finding the agent did not meet the relevant standards expected from the real estate industry, the tribunal noted in particular that important health and safety information should be passed onto tenants and that this should not be reliant on the owner's approval, as the agent had argued.[464] In a 2016 High Court decision, where the legal basis for tribunal charges against the agent were considered, the court agreed that "failing to disclose information as to the integrity and safety of the building" may amount to "disgraceful conduct" of a real estate agent acting as a building manager.[465] Significantly, the circumstances of this case pre-dated the HSWA. Under the Act, PCBUs are required to stay updated with new information related to potential risk, which includes new information about risk posed by buildings themselves.[466] It is likely that similar matters related to the disclosure of building safety information today could fall within the jurisdiction of this

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[461] *C v Real Estate Agents Authority* [2016] NZHC 414 at [13].

[462] *CAC 304 v Chapman* [2018] NZREADT 6 at [97].

[463] At [100].

[464] At [97].

[465] *C v Real Estate Agents Authority*, above n 461, at [39].

[466] Hatton and others, above n 457, at 6.

legislation, primarily through the duty to keep updated with relevant information and manage all known risks as far as reasonably practicable.[467]

A comparable situation played out before the Kobe District court in Japan, against the owner of a 1950s-apartment building in 1999. The building partially collapsed in the 1995 Kobe Earthquake and caused the death and injury of multiple tenants on the first floor.[468] The court found that the building had not been designed in compliance with the technical requirements in force at the time of its construction and this was a contributing factor to its ultimate collapse in the 1995 earthquake. However, despite this defect in installation, the owner at the time of the earthquake was not found in violation of their duty of care to protect the building users. The court reasoned that the owner could not have been reasonably expected to know about the defect, owing to a lack of structural drawings at the time of purchase and being under no legal obligation at the time to examine the structural capacity of the building. Since this case concerned a building which collapsed before the modern APSRB framework had been enacted, it is interesting to consider how it may have been decided now in light of seismic assessment expectations for existing buildings under the APSRB. Indeed, it would likely be more difficult to be ignorant to seismic risk given the obligations for building owners to undertake seismic assessments.

A similar point of law was also addressed by the Supreme Court of Italy in 2016. There, the director of a boarding house in L'Aquila was convicted for failing to adopt appropriate risk reduction measures in light of known information about the seismic inadequacy of the building.[469] The building partially collapsed during the 2009 L'Aquila earthquake and killed some of the occupants. Despite being privy to long-term maintenance observations and an engineering report which had highlighted multiple risks in relation to the building's seismic capacity, the court found the director to have been negligent, among other factors, in failing to ensure the safety of the students within the boarding house. The court made it clear that the

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[467] For instance, the HSWA requires multiple PCBUs who have a shared duty under the Act to consult, co-operate and co-ordinate with each other when responding to relevant risks, see: Health and Safety at Work Act 2015, s 34.

[468] See: Ueshima v Masuda (Kobe Dist. Ct., No. Hei 8 (Wa), No. 1533, September 20, 1999) (accessed at <www.atlaslaw.net>).

[469] Cassazione Penale, Sez. 4, 21 Gennaio 2016, n. 2536 (translation: Italian Supreme Court of Criminal Cassation, Section 4, 21 January 2016, n.2536) (accessed at: <www.olympus.uniurb.it>).

director's failure to act in light of his knowledge about the buildings' seismic risk was unacceptable. For instance, some students had expressed safety concerns about the building in a foreshock that had struck the city prior to the main earthquake which led to the building's collapse. Regardless, the director chose not to evacuate the building despite his prior knowledge about its seismic shortcomings. The level of knowledge understood by the director was therefore considered a significant factor in the negligence to reduce the risk, and is a relevant consideration in relation to the duty of care. It should be noted that this case was decided upon the basis that the boarding school director had an obligation to reduce the seismic risk under an agreement previously made with the provincial government to improve the building's structural capacity.

Although the law is not particularly extensive in this area, the three cases highlighted within this section each point to the underlying significance around the disclosure of risk information and taking appropriate action to reduce this risk. As DRR becomes more integrated into governance and building regulation in particular, these duties of care to protect public safety are likely to have an increasingly profound impact on seismic risk reduction. Whereas previously the circumstances where building owners were required to assess the seismic capacity of their buildings, modern seismic risk reduction frameworks change such dynamic. In this sense, the requirement for seismic assessments, for instance, may be useful to inadvertently nudge building owners toward risk reduction measures to comply with their duty of care to take reasonable steps to protect persons from harm.

8.3 Clarifying the Requirements of Building Owners to Reduce Seismic Risk

Despite the need for building owners to respond appropriately to knowledge about seismic risk, what constitutes an appropriate response is itself ambiguous. This ambiguity currently leaves the relevant duties of care as tools for responding when harm has already occurred. Greater clarity should be provided in order for these duties to operate in a more preventative manner, as a means of encouraging proactive risk reduction. This is a challenge especially where there are no clear mandatory obligations to reduce risk. In New Zealand, this is a significant consideration in relation to existing buildings which are not considered earthquake-prone by the legal definition, but nonetheless present a seismic risk. For instance, new information has emerged in recent years concerning the potential danger of buildings with hollow core concrete floors, exemplified by the partial collapse of multiple modern high-rise buildings in Wellington during the 2016 Kaikōura Earthquake (refer to Chapter 3). Although a revision to the technical guidelines used for assessing potentially earthquake-prone buildings was made in 2018 to include consideration of this, the EPB framework has not yet been amended to capture these buildings.[470] Additionally, most of these buildings were constructed after 1976 and so are not actively targeted by authorities to complete seismic assessments under the EPB framework. This leaves building owners in a position where they are required to understand seismic risk but have no particular clarity around what steps are expected to be taken in response.

In addition, existing buildings in New Zealand which have an earthquake rating of between 34-66%NBS are still considered earthquake-vulnerable (refer to Chapter 3). Building owners who become aware of this through seismic assessments (or who should be expected to know this risk through their obligation to keep up with relevant knowledge) therefore have a health and safety duty to manage this risk. While WorkSafe has issued a policy-statement advising that building owners are not required to take any further action than what is required within the Building Act (i.e. strengthening EPBs to greater than 33%NBS), the known potential seismic risk of these buildings make this argument less convincing and even potentially ignorant to such risks.[471] The potential challenge may become increasingly relevant in the instance where a building user, such as a tenant or an employee, raises valid concerns or queries owing to a building's seismic safety. Building owners have a responsibility to manage risk they become aware of to protect building users and passersby, even if they are permitted multiple decades to comply with their strengthening obligations.

A similar paradox has also recently been highlighted in Japan. There, a 2013 amendment to the APSRB made it mandatory for the seismic assessment results for certain large buildings to be made public (refer to Chapter 3). Tomita argues that in the absence of a mandatory obligation to complete seismic strengthening in Japan, the requirement to publish the seismic capacity of buildings causes direct conflict with the legal duty of care to ensure

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[470] Hatton and others, above n 457, at 25.

[471] WorkSafe, above n 126.

public safety through the preservation and maintenance of buildings.[472] As mentioned, a breach of this public safety duty of care in Japan relies upon harm being caused owing to a "defect" either from a building's construction or maintenance. In 1981 the Sendai District Court heard a case which concerned an unreinforced concrete block wall which had caused a death when it overturned in the 1978 Miyagi Earthquake (Mw 7.4). The court held that because the wall had been built in compliance with legal standards in effect at the time of its construction, it could not be considered to have had a "defect" in preservation owing to the absence of a legal requirement to complete seismic strengthening.[473] Therefore, despite the wall being below the seismic standard required by the building code in force at the time of the earthquake, the owner was found not to have breached their public safety duty of care.

Today, in relation to obligations for seismic assessments to be undertaken and the results publicised, Tomita contends that the very nature of buildings being assessed as seismically vulnerable warrants an interpretation that buildings do indeed have a "defect in preservation" in relation to the duty of care. To insist otherwise would, ultimately, result in no one being responsible for reducing the risk. It is difficult to imagine the government would have intended for building owners to identify seismic risk but not have any duty whatsoever to take steps to protect public safety. Tomita argues that the government either needs to introduce a legal requirement for building owners to seismically strengthen vulnerable buildings or to explicitly clarify that the public safety duty of care does not apply for existing buildings subsequently found to be seismically-vulnerable. Indeed, with the increased focus on public safety and the urgency of reducing the seismic risk of existing buildings, it is difficult to accept the notion that building owners should be under no obligation to remediate known risks. This same principle can be applied to the health and safety obligations of PCBUs in New Zealand, for buildings which are not legally considered to be earthquake-prone.

[472] Hiroshi Tomita "耐震改修促進法改正の問題点と工作物責任" (2013) 27 Journal of Japan Real Estate Association 74 (translation: "Problems of Revisions of the Seismic Repair Promotion Law and Responsibility for Workplaces") (accessed from <www.jstage.jst.go.jp>) at 75.

[473] At 76

8.4 Making a Reasonable Effort to Comply with Risk Reduction Obligations

The health and safety duties of building owners in New Zealand also relate to actions taken, or lack of actions, within the timeframes discussed in the previous chapter. While building owners are legally permitted the length of relevant deadlines to remediate the risk of their buildings, there is arguably an expectation nonetheless for reasonable action to be taken toward achieving these minimum obligations within this period as soon as reasonably practicable. This is especially relevant when from the time building owners become aware of the risk their building presents based on seismic assessment results. The implied expectation to mitigate potential risk as soon as reasonably practicable aligns with the overall objective of improving public safety and, therefore, aligns with the obligations of building owners under the HSWA.

The idea of such an expectation relative to achieving seismic risk reduction of existing buildings within a legal deadline was explored in the United States case of *Myrick v Mastagni* in 2010. The case concerned an appeal by building owners against a conviction for the wrongful death of two employees who were killed in a 2003 earthquake when part of their 19th century URM office building collapsed onto them. The building had been subject to a seismic strengthening notice under a 1992 ordinance. The ordinance had required all URM buildings in the city of Paso Robles to be seismically strengthened within 15 years, though an amendment was made in 1998 which subsequently extended this deadline until the year 2018.[474] At the time of the earthquake, the building owners had delayed the completion of strengthening work owing to this extension. The building owners argued on appeal that the jury had been improperly directed to consider their omission to complete seismic strengthening by the time of the earthquake in relation to negligence, instead of the deadline outlined within the ordinance.[475] In discussing expectations of action associated with legal standards, the court stated:[476]

> A statute, ordinance or regulation ordinarily defines a minimum standard of conduct. A minimum standard of conduct does not preclude a finding that a reasonable person would have taken additional precautions under the circumstances.

[474] *Myrick v Mastagni* (2010) 185 Cal.App.4th 1082 at [1085].

[475] At [1087].

[476] At [1087].

The court went on to note that the overriding purpose of the strengthening mandate was not to promote the interests of building owners, but to improve public safety. An interpretation that building owners had no duty to act to reduce risk so long as the deadline still applied "would frustrate the very [public safety] policy that the ordinance was designed to promote".[477] Legal deadlines for compliance with strengthening obligations are designed to provide building owners with a reasonable period to plan measures to reduce risk, and not simply to delay action to a later date. Such consideration is relevant for building owners in New Zealand who have been issued with an EPB notice and are expected to carry out seismic strengthening (or demolition) within the deadlines listed in the Building Act.

The Building Act states EPB owners are required to complete seismic strengthening "on or before" relevant statutory deadlines.[478] This implies that Parliament intended for building owners to have a grace period to organise and make plans for strengthening work or demolition, while simultaneously encouraging such work to be completed prior to the legal deadline. It would be inappropriate to interpret this differently given the multi-decade deadlines allocated within the EPB framework, as discussed in Chapter 7. Much like the purpose of the seismic strengthening ordinance discussed in the United States case of *Myrick*, the fundamental purpose of the EPB framework in New Zealand is public safety. The requirement for EPBs to be strengthened above 33%NBS represents a minimum standard of conduct, and therefore the need to take meaningful steps to manage this risk arguably begins from when owners become aware. Though EPB owners are compliant with their obligations under the Building Act so long as relevant work is completed on time, there is uncertainty about how this translates to building owners' meeting health and safety obligations. Goddard argues that once buildings have been identified as earthquake-prone and become subject to relevant risk reduction obligations, "the timeframes for addressing critical structural weaknesses mean that most of the health and safety risks are borne by employers and workers".[479] It is imaginable that, as in *Myrick*, harm caused from an EPB as a result of an earthquake during relevant deadline periods may subsequently result in health and safety consequences. Although this would depend upon particular circumstances, including whether or not building owners had taken any reasonable

[477] At [1090].

[478] Section 133AM(1).

[479] Goddard, above n 451, at 31.

steps to develop strengthening plans, it nevertheless stands to reason as an important consideration for building owners. A reasonable move may be to make it clear that building owners must take actionable measures to plan and reduce risk from as soon as their buildings are identified as earthquake-prone, while still allowing the deadline people to complete actual remediation work. This would prevent instances where building owners sit on EPB notices for potentially years without developing any for how to reduce risk.

8.5 Summary

Legal duties of care to ensure public safety within each of the case study countries play a significant, yet currently ambiguous, role in seismic risk reduction frameworks for existing buildings. Of course, this is an incredibly complex and uncertain area of law, but is nonetheless important to understand in the context of risk reduction for existing buildings. As legal frameworks require an increasing number of building owners to assess their buildings and therefore better understand potential seismic risk, the influence of such duties on risk reduction arguably increases. Whereas once building owners may not have been aware of the seismic risk presented by their buildings, today the claim of ignorance is less convincing.

It is clear that building owners have a responsibility to consider the potential seismic risk their buildings pose and, in the instance that such knowledge is understood, for appropriate measures be taken to manage and reduce the risk. Exactly what is considered an appropriate response, however, needs to be better clarified by officials to allow building owners to more confidently fulfill their duty of care. These duties of care were not considered when developing legal frameworks for reducing the seismic risk of existing buildings, but have now come to be sufficiently interconnected. Moving forward, it is clear that such duties will be influential in helping to guide risk reduction behaviour beyond minimum expectations set out within statutes or regulation. As DRR is further integrated into legal frameworks, and indeed the importance of reducing seismic risk amongst existing buildings is increasingly brought into the public arena, conversations around accountability and acceptable risk will undoubtedly involve public safety duties of care for building owners. Their ability to drive preventative action will require greater certainty in relation to appropriate expectations.

Chapter 9

Conclusion

There is a widespread misconception that earthquakes and disasters are synonymous with one another, and that the latter is unavoidable when a strong earthquake impacts a community. While earthquakes can and do have serious impacts, a disaster arises only when the affected community is unprepared to anticipate and cope with such event. Disasters are therefore the product of human choices and, in particular, the failure to reduce the vulnerability and risk of communities in advance of hazards occurring. Just as disasters occur as a result of failing to address underlying risk, they can equally be avoided by making decisions to actively reduce risk and, therefore, improve the resilience of communities and systems to hazards. This research has emphasised the importance of taking preventative action to reduce the risk associated with earthquakes, in relation to that presented by existing buildings.

Active intervention to reduce the seismic risk of existing buildings is critical for improving the resilience of communities against earthquakes. Not only is building failure one of the leading causes of death and injury in earthquakes, widespread damage and destruction to buildings also creates long-term disruption to livelihoods and the everyday functioning of communities. Existing buildings constructed before the introduction of modern seismic design regulations present the greatest risk as they were not designed to sufficiently withstand seismic shaking, and are therefore of particular interest for risk reduction efforts. Far from unique to New Zealand, this a challenge shared by many seismically-active countries around the world. This research examined the national legal approaches taken by New Zealand, Italy and Japan to reduce the risk of existing buildings. Each have sought to address the challenge with an increased sense of urgency, by adopting legal frameworks which promote obligations for identifying and remediating the risk of vulnerable buildings. Not only is preventative action more cost-effective than reacting to hazards as they occur, it is also essential for minimising the potential for disasters to transpire. The case study countries have obligations to plan and implement risk reduction strategies under the Sendai Framework, with each adopting the principles and priorities of Sendai into their national frameworks.

Looking outward to other countries to understand alternative strategies for reducing existing building risk was useful to provide insight into how New Zealand may seek to improve its current EPB system. Indeed, compared to the legal frameworks of Italy and Japan, New Zealand's EPB framework is unique in its strong regulation-based approach. This is seen through compulsory requirements for TAs to identify all potential EPBs within their jurisdictions and for owners to thereafter complete a seismic assessment of their building and, if necessary, carry out strengthening work or demolition. In contrast, Italy and Japan have opted for more incentive-based frameworks for risk reduction, stopping short of imposing mandatory strengthening requirements. In Japan, the national APSRB framework provides a long-term strategy to remediate existing buildings and, like New Zealand, requires authorities to actively notify building owners who need to complete a seismic assessment. the long-term stopping short of imposing mandatory requirements for seismic strengthening. There is a comparably less-structured legal framework in Italy. For buildings not understood as having priority status, reducing risk is largely relied upon through the will of individual building owners aided by financial incentives. On the one hand, imposing compulsory obligations to remediate buildings identified as below the minimum legal standard provides clear expectations around the action required and the ability of authorities to enforce such obligations. On the other hand, regulation itself is likely insufficient to ensure building owners successfully reduce existing building risk. Lessons from the case study countries provide insight into the mixture of strategies used.

9.1 Broadening the Focus of Risk Reduction Efforts

There is a narrow focus of risk reduction efforts in relation to the type of buildings targeted. The primary focus of existing building frameworks in each case study country is to protect the life safety of building users and passersby. As a result, the buildings targeted for risk reduction measures are those which are assumed to have the greatest chance of collapse in a strong earthquake. Though life safety is a crucial element of risk reduction, this focus restricts overall knowledge of seismic risk and thus limits the ability to improve resilience against earthquakes. For instance, targeting only post-1976 and post-1981 buildings in New Zealand and Japan, respectively, limits knowledge of seismic risk and relies on assumptions about the safety of later-designed buildings. It also means that risk reduction is perceived from a purely life safety perspective and does not include wider considerations such as damage limitation and building functionality. Wider efforts should be made by authorities to promote risk reduction amongst these later-designed buildings, to ensure risk reduction is not confined only to buildings with the greatest presumed risk of collapse.

This narrow focus on risk is further exacerbated in New Zealand and Italy, where legal obligations are delegated according to seismic hazard zones. As discussed in Chapter 4, these hazard zones assume potential ground shaking of different areas according to a return period of approximately 500 years and therefore underestimate seismic risk in regions which experience strong ground shaking on a much longer return period. Restricting obligations to identify and reduce seismic risk according to these zones represents political decisions to limit the scope of legal frameworks according to areas with more frequent seismicity. Though important to address risk in these areas promptly, it is also important to not misrepresent the potential for strong shaking in areas considered to have a low hazard factor. In fact, the characterisation of regions in New Zealand according to "seismic risk" is in and of itself misleading, since risk and hazard represent two separate concepts. This is something which should addressed in order to establish a greater awareness of seismic risk and the importance of engaging in risk reduction measures.

9.2 A More Proactive Approach to Monitoring Risk Reduction

Efforts within legal frameworks to remediate existing buildings also requires strategic long-term planning and management from authorities, in order to support the process across extended periods of time. Although statutory deadlines in New Zealand provide clarity for when risk reduction obligations are required to be achieved, there is a clear reliance on compliance being achieve through the threat of formal sanctions, as discussed in Chapter 7. Once buildings have been identified as earthquake-prone, the onus of remediating them is entirely shifted to building owners with little to no duty for authorities to continue monitoring progress to understand the likelihood of deadlines being achieved. Japan offers a slightly different approach, where compliance monitoring of building owners is an integral aspect of ensuring long-term goals of seismic strengthening are achieved within government timeframes. Whereas the Italian framework does not apply any general timeframes for building owners to achieve risk reduction within, the Japanese framework highlights the importance of active monitoring by authorities across time. This approach appears to be more responsive to the potential challenges and needs of building owners when aiming to achieve obligations. Compliance monitoring provides information useful for avoiding situations where authorities have to react at the end of timeframes if building owners have failed to comply.

As recommended in Chapter 7, a duty for authorities to monitor the compliance of building owners, and periodically report this information back to central government, should be considered in New Zealand. Such a duty would be akin to the requirement for TAs to report their progress in identifying potential EPBs to MBIE. This would enable a more proactive approach with assisting building owners across relevant deadlines, as it would allow the government to make targeted interventions in a similar way to what is done in Japan. As the framework currently stands, multiple decades will pass without any assurance that TAs have maintained an understanding of remediation progress. It would be within the best interest of authorities to stay engaged with the process and seek to assist building owners achieve their obligations.

9.3 Supporting the Enforcement of Risk Reduction for Existing Buildings

A disengagement from authorities is also apparent from the general lack of assistance provided to support building owners achieve their obligations. For many building owners, seismic risk reduction is likely to be one of the most significant undertakings of their lives. Nonetheless, the general structure of legal frameworks examined within this research appears to place a similar expectation on building owners to self-navigate and engage in the process. As was also discussed in Chapter 7, this homogenises building owners and fails to consider the different barriers faced in completing such measures.

Consideration should be given to authorities more closely working with building owners, to support them and actively respond to any potential issues or challenges faced. This would also help to personalise the entire process and potentially garner a greater level of trust between stakeholders. None of the case study countries appeared to operate under such a model, with the closest example being that experienced under the 2017 Hurunui/Kaikōura Earthquakes Recovery Order in New Zealand, as detailed in Chapter 7. The Seismic Repair Support Centre in Japan does provide an example of attempting to bridge the information gap between authorities and building owners. It operates as a designated government support centre with the sole mandate of assisting building owners navigate the risk reduction process.

Of course, there is also a clear difference between the frameworks in relation to the way financial assistance is provided to building owners. Japan and Italy heavily depend upon financial assistance as a means of incentivising risk reduction, since there are no mandatory seismic strengthening requirements. In contrast, almost all EPB owners in New Zealand are expected to bear the cost of remediation with the exception of a few restricted schemes to support heritage buildings and residential units in apartment blocks. When combined with the lack of compliance monitoring and engagement by authorities, the lack of financial support further increases the potential that some owners will fail to meet their obligations on time. This approach places significantly onerous responsibilities on building owners, while simultaneously minimising the responsibilities of government in overseeing and helping to achieve risk reduction. As was argued in Chapter 6, there is a legitimate argument for public funding to support the remediation of existing buildings given the wider public safety benefits. Greater access to financial assistance for building owners in New Zealand should be considered. Schemes similar to those used in Japan and Italy, including tax incentives, have been previously debated in Parliament and should be revisited with relative urgency in relation to statutory deadlines.

9.4 Moving Away from a Linear Understanding of Risk

A key takeaway from this research is that the frameworks in each country primarily treat the seismic risk of existing buildings as static. Obligations to identify and remediate buildings considered most vulnerable to collapse in earthquakes are one-off, meaning no consideration is provided to the long-term management of risk. The requirement to verify the life safety index of existing buildings once, with no further obligation to monitor potential changes in risk, is a significant gap within legal frameworks in the ability to improve resilience. Risk posed by buildings is not linear but instead constantly changing over time. Since buildings are likely to deform as they age (owing either to the natural passage of time or from the impact of external forces), there is a need for a sustained practice of risk management.

One of the principal ways to improve the long-term resilience of buildings against earthquakes would be to create a legal requirement for periodic building assessments, as discussed in Chapter 5. This is akin to the requirement in Japan for “special” buildings to be assessed for safety approximately every three years, as is required for multi-storey buildings in Singapore and Hong Kong between every five and 30 years respectively. These practices are designed to monitor buildings over time and capture any physical changes which may pose a danger. Such a requirement in New Zealand would provide authorities with a greater understanding of risk amongst the building stock and improve the ability to take preventative action if and when necessary. Indeed, this requirement could be similar to the current building warrant of fitness scheme, which requires the annual inspection of emergency operation systems in buildings across New Zealand. Such a scheme would also help to ensure that risk management is practiced for all buildings and not simply those currently targeted under the EPB framework. This would provide a more comprehensive picture of the potential risk posed by a wider range of buildings and, therefore, improve the capacity for targeted interventions.

A requirement for periodic building assessments would also help to promote a shift in expectations amongst building owners in relation to the management of seismic risk. As DRR increases the focus on proactive intervention to reduce risk, the responsibility of building owners in this process needs to be made much clearer. This involves making clear that, as stated above, risk is something which needs to be managed over time rather than as a one-off obligation. Indeed, as the ability to understand and reduce seismic risk improves, and commitments to doing so increases (including under the Sendai Framework), it is necessary to expect long-term maintenance not to be an exceptional or selective requirement, but a natural obligation of building ownership. This shift in responsibility is already being observed to an extent in relation to duties of care owed by building owners, as discussed in Chapter 8. Requirements for building owners to be aware of potential seismic risk and take appropriate action to manage and reduce this risk is perhaps greater than what has been expected in the past, as DRR increases the potential for liability where this is not followed.

Though the occurrence of earthquakes may be rare, the need to be prepared is evident and building owners should therefore be expected to incorporate this into the long-term management of buildings. It is up to authorities to implement legal frameworks which guide such behaviour and manage expectations. As knowledge about earthquakes and engineering technology evolves over time to provide a greater understanding of seismic risk, it is likely that so too will risk tolerances and therefore national conversations about acceptable legal minimum standards. Disrupting the concept of risk being linear is key for supporting the ongoing management of this risk. In fact, this shift in thinking is necessary to better prepare and establish resilience against earthquakes as anticipated hazardous events, not exceptional disasters.

9.5 Limitations and Areas for Future Research

This research has focused primarily on the legal management of physical remediation approaches to existing buildings, including seismic assessments and strengthening methods. Of course, as discussed in Chapter 1, engineering and technology-based approaches to risk reduction are merely one consideration relevant for improving resilience. It would therefore be beneficial for future research to examine the legal frameworks of other relevant systems which directly relate to the seismic resilience of communities.

For instance, improving the resilience of infrastructure which delivers essential services to buildings (such as water and power) is an equally important consideration for the continued function and occupation of buildings in the aftermath of earthquakes. A building which sustains no serious damage in an earthquake may nonetheless be unable to be used if essential services are not able to be maintained. In this sense, the seismic risk of buildings should be considered in coordination with the seismic risk of infrastructure services, not separate from one another. This would provide a more holistic representation of seismic risk within communities.

Additionally, this research could be expanded upon by examining a broader range of "soft" considerations related to the overall resilience of building stocks. This may include factors such as the legal frameworks for providing social safety nets and business continuity plans. These are both examples of how the potential disruptions of earthquakes may be softened in the event that buildings become unusable or unable to be occupied for a certain period of time. Planning ahead for these sorts of measures is an important component of improving resilience, since the complete physical protection of buildings from earthquakes cannot, ultimately, be provided with certainty.

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