MBIE Review of Seismic Risk Management in Existing Buildings

NZSEE Position Statement | 8 November 2024

nzsee
NEW ZEALAND SOCIETY FOR EARTHQUAKE ENGINEERING

In a nutshell

NZSEE supports and is engaged with the seismic risk review. This paper reiterates the principles that have guided New Zealand's journey to this point, and highlights some initial observations and opportunities on the current regime.

The premise of seismic risk management

That our communities want safer buildings, particularly in regard to older weaker buildings that we know can be a danger in earthquakes.

These are community decisions—and different communities (and individuals) take different views on the risks they are prepared to tolerate, the level of action they want, and their reasons.

Objectives and challenges

Proportionate risk reduction, over time.	**Enabling continued, comfortable use of existing buildings.**	**Protect our heritage, and minimise carbon emissions.**
A system which gives us enough information about the risks, to make informed decisions. Economically sustainable generational improvement requires steady, consistent effort. Prioritising the 'worst of the worst' – the building types we know are at most risk of failure, with the greatest consequence.		Avoiding unnecessary demolition of buildings (*before* earthquake) solely due to seismic risk concerns.

The key challenge:

Major earthquakes are low likelihood, high impact events.

For these types of risks, weighing the benefits and costs are difficult.

Making decisions on regulatory settings that work in conjunction with the market, promoting steady effort to an affordable minimum threshold of safety is a key challenge for any policy or regulation design.

Opportunities

Learning from 50 years of evolution

- There is a lot to learn from over 50 years of evolution in seismic risk management in Aoteroa New Zealand *and* internationally.
- Some countries have become more targeted in their approach to seismic policy, which might be helping them realise benefits faster, and maximise value relative to investment.

One-size fits-all, or flexible standards?

- The cost-benefit equation can vary significantly based on regional seismicity, building typology, and the regional versus city-scale contexts. The economics are significantly different too.
- Although simple, the current centralised system may not be allowing enough flexibility to best cater for these differences.

Considering and communicating consequence

- Opportunity exists to improve the way we consider and communicate the consequence of failure in engineering assessments.
- This would help direct effort to where its most needed and most effective, both in market led risk reduction, and in policy or regulation design.

Making better use of simplified approaches

- Simplified or standardised strengthening approaches suit some common typologies, and they can reduce costs and other barriers to retrofit.
- Supporting current efforts to develop approaches for one to two storey unreinforced masonry or concrete buildings should be a priority.

Intersecting issues

- Historically, life safety has been the core objective. Over time (and especially in the past decade), other issues such as insurance and insurability, managing non-compliant design, and workplace health and safety law reform have become more prominent. This has put more strain on the system and needs thoughtful consideration.

Empowering consistency in information

- The current system lacks an essential feedback loop for monitoring and improving the quality and consistency of engineering information.
- The support of the regulator is needed to create a more effective feedback loop.

BACKGROUND

In April 2024, the Minister for Building and Construction announced the commencement of a review of the Earthquake-prone Buildings system that was put in place in 2017. The terms of reference for the *Review of Seismic Risk Management in Existing Buildings* ('the review') were finalised in May 2024, and are available on MBIEs website.

NZSEE's support for the review

NZSEE has had a long history in the development of guidance and advice for existing building management for the benefit of engineers and their communities, and also in assisting local and central government to develop policy and regulation. NZSEE supports the review wholeheartedly. The purpose of this position statement is to:

- Reiterate the key objectives and underpinning principles of seismic risk management.
- Summarise our "journey to here", and encourage the review to extract maximum value from the lessons learned in 50+ years of seismic policy evolution (in Aotearoa New Zealand and abroad).
- Pass initial observations on key challenges and opportunities that the review should consider.

THE OBJECTIVES OF SEISMIC RISK MANAGEMENT

Proportionate, continual and sustainable risk reduction in our built environment, over time.

The objectives of seismic risk management in existing buildings are built on the premise that our communities want safer buildings, particularly regarding the older, weaker buildings that we know can be a risk in earthquakes. Whilst individuals and communities' perceptions and tolerance of risk varies, some action and improvement is wanted.

Broadly categorised, this can be achieved both through the design and construction of resilient new buildings, in combination with the gradual improvement and minimisation of risk in our existing buildings.

In our reality of limited resources, we should focus on buildings that are the most seismically vulnerable *and* which society considers having the greatest consequence of failure. This requires an understanding of the risk, and hence, categorisation and a level of engineering assessment that is appropriate to the likelihood of problems being present. Where necessary, proportionate action (such as retrofit) should follow in a reasonable timeframe that balances the level of risk, cost, and the availability of resources.

Risk assessment alone provides no risk reduction. Beyond reassurance and direction, it provides little actual value to New Zealanders (and in some cases, brings potentially harmful anxiety). Thus, it is important that as much resource as possible is redirected towards action (where deemed necessary) once a satisfactory understanding of risk is reached.

In the ideal case (considering constrained resources), seismic retrofit work should be aligned with broader asset management planning and maintenance, and refurbishment cycles. Potentially, seismic work can be staged to advance simpler risk mitigation works as an interim measure. This can make simple and effective risk mitigation work more accessible, without necessarily losing sight of the longer objective[1]. Collectively this allows the continued confident use and re-use of existing building stock, where seismic risk is simply one facet.

To avoid significant embodied carbon emissions in new building work, and to preserve our built heritage, retrofit (where necessary) is certainly preferable to demolishing buildings *before* an earthquake occurs, solely because of concerns over their seismic status.

Enabling continued, confident use and re-use of existing buildings, and the avoidance of unnecessary demolition.

[1] The model bylaws proposed by the 1985 NZSEE "Red Book" explicitly encouraged such an approach (drawing on similar approaches in California), by proposing an extension of timeframes to complete strengthening to the required levels if a simpler suite of 'securing' works were carried out. Uptake at that time was relatively limited, however there are many factors. A modern exploration of this idea that considers those experiences and earthquake engineering developments since that time is likely to have some merit.

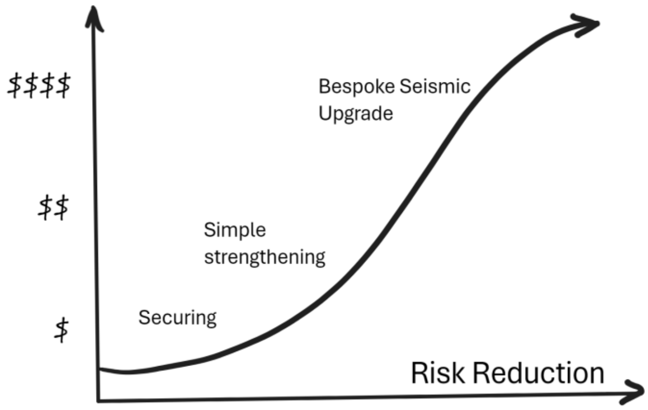

Figure 1: A concept proposing that relatively simple and cost-effective interventions can make a big difference for some types of structures and can prevent many fatalities—even if longer term work is still desirable for better long-term comfort. This concept is widely held to be applicable to many unreinforced masonry structures and could be applicable to other typologies too.

The objectives of regulation, specifically

Throughout the past five decades (the 'modern era' of seismic risk awareness), NZSEE has provided technical inputs and risk advice to policy makers and elected officials who are responsible for making such decisions about regulatory settings and design on behalf of communities. These are not engineering decisions. They must be community decisions.

In general, the objectives of regulation focus on matters of public safety—and less on an individual's own decision on risks they are prepared to accept. However, an individual's agency to *practically* influence decisions that impact their safety and risk exposure blurs these lines substantially. This interpretation can affect the types of risk outcomes that society decides to influence through regulation. Recent health and safety law reforms (and their varied and often cautious interpretations in regard to earthquake risk) have changed this landscape significantly.

The role of economic forces, policy settings (including policy incentives), and the maturity of the market in delivering effective and proportionate risk reduction (*outside* of regulation) bears plenty of relevance to decisions on appropriate settings to apply *within* regulation.

Science and engineering inputs can help to inform the development of appropriate risk thresholds and the operationalisation of regulation, and the development of technical methodologies that give it effect. In guiding regulation, the following set of pragmatic technical principles have prevailed throughout this era:

- Focussing on non-ductile failures at relatively low levels of earthquake shaking—the 'worst of the worst'. These buildings are by far the most likely to cause significant fatalities, and their improvement is generally the closest within reach of economically sustainable risk reduction programmes.
- At its core, a focus on life safety. And in particular, a focus on minimising the risk of *considerable* casualties in significant earthquakes. Improved community and economic resilience should not be discounted when the benefits and successes of any proposed system or regulation are measured. But these considerations have not *historically* been the core purpose.
- Acceptance, given practical realities, that severe earthquakes are almost certain to result in injury and fatalities from the failure of buildings or their parts. In a seismically active country it is difficult, if not entirely impractical, to prevent some such outcomes in the context of workable and affordable regulation.
- Making appropriate and pragmatic concessions for existing buildings—both in timeframes for action and the manner in which risks are assessed and managed.

The availability and accessibility of consistent technical information to support appropriate and proportionate market led risk reduction is a difficult but important challenge, and it directly impacts the required breadth of regulation.

THE CHALLENGE OF MANAGING EARTHQUAKE RISK

Managing high consequence, low likelihood events

Earthquakes stand out from other hazards in terms of the frequency of very large impact events and the individual risk they present to people in high-risk locations. But averaged over the whole population and long periods of time they have a lower impact than some other hazards such as road accidents[1]. This does not mean that road accidents are acceptable. However, it highlights the difficulties in quantifying benefits of seismic risk reduction that beleaguer traditional cost-benefit analysis—a real challenge for policy design.

The science tells us the plausible scale of earthquakes that could occur in different regions (and are likely to, given an indefinite timescale). The science also tells us how often they tend to occur, and how likely it is that they might occur in a given timeframe of interest. But science cannot predict them.

New Zealanders need to decide what outcomes they would be prepared to accept in these different earthquake scenarios, and what we are prepared to invest (and over what timeframe) to bring us closer to that reality. Alternatively, and on the basis that such significant events are rare, New Zealanders need to decide how comfortable we are for part of our risk management strategy to rely on the low likelihood of an earthquake occurring in timescales that are relevant to us—and what the concept of timescales and legacy means to different peoples and cultures.

Unfortunately, such decisions are subjective and swayed by many forms of cognitive bias. Traditionally, social and political license to take action ebbs with the time passed since a direct earthquake experience, with an outcome that society judges in hindsight to have been either acceptable or unacceptable. This also affects how much voluntary risk reduction the market will deliver.

A BRIEF HISTORY OF NEW ZEALAND'S SEISMIC JOURNEY

Basic seismic design requirements for new buildings first appeared in regulation in 1935, in the form of new model bylaws. This followed New Zealand's earthquake experiences in the 1920s and 1930s (notably the devastating Napier 1931 earthquake). These were later amended as a result of observed international experiences in earthquakes. The 'modern era' of seismic design is generally considered to comprise the period from the mid-1970s to today. As seismic design practice evolved over this time, so too did awareness of the risks posed by older, weaker buildings. The first regulatory mechanisms and technical approaches empowering territorial authorities to act developed over the early 1970s—although uptake was slow at first.

Before the 2000s, the focus of existing building management was almost solely unreinforced masonry buildings (or unreinforced concrete). Concern grew that non-ductile reinforced concrete buildings were not being satisfactorily addressed, despite clear evidence about their vulnerability from every significant overseas earthquake. The actions of a 1995/1996 NZSEE Study Group led to the broadening of scope beyond unreinforced masonry, and eventually to a newly defined threshold for *Earthquake-prone Buildings, a term* first defined in the Building Act 1991. This definition was revised in 2016/17, to better align with the intent.

Whilst technical approaches evolved and different regulatory mechanisms were explored, the concept that we focus on "worst of the worst" was a constant throughout this whole era (in reference to legislation's role). The corollary was that some level of tolerance for risk in the remainder of our building stock is unavoidable, and arguably this is just part of life in a seismically active land. However, individuals or organisations could always choose to invest in a higher standard of safety, and NZSEE has always supported this.

Over the same period, other seismically active countries had been grappling with similar challenges. Some were reeling from the *direct* impacts of significant events in their own region's recent history. Others were looking across borders or continents to the experiences of *others*, and, informed by developments in the earthquake sciences, were starting to understand that they faced similar risks. Bear in mind that socially, and politically, these are very different contexts.

Notwithstanding the growth of global community, the social and political license for market led or regulatory driven risk reduction tends to have a lifespan less than a decade following a significant and devastating event *in that same region*. Travelling international keynotes to NZSEE's annual technical conference and members of NZSEE reconnaissance teams to the aftermath of international earthquakes have frequently made these observations when speaking on the evolution of seismic policies. If it were accepted that the scale of work required only *modest* but *steady* investment *over a generation*, then this is a key challenge (especially considering the impacts of fluctuating demand for risk reduction on the skill base of the engineering and construction sector).

For some context, the figures that follow provide a high-level timeline of events in New Zealand and abroad that have shaped our understanding of earthquakes and building performance. Internationally, there are many lessons on the effectiveness of various engineering solutions, and many examples of policy design approaches and of communities' responses to regulation and policy.

There is a significant amount we can learn from 50 years of engineering and policy evolution in seismically active countries.

[1] Tony Taig, TTAC Limited and GNS Science (July 2012): *A Risk Framework for Earthquake Prone Building Policy*. A report produced for the New Zealand Department of Building and Housing.

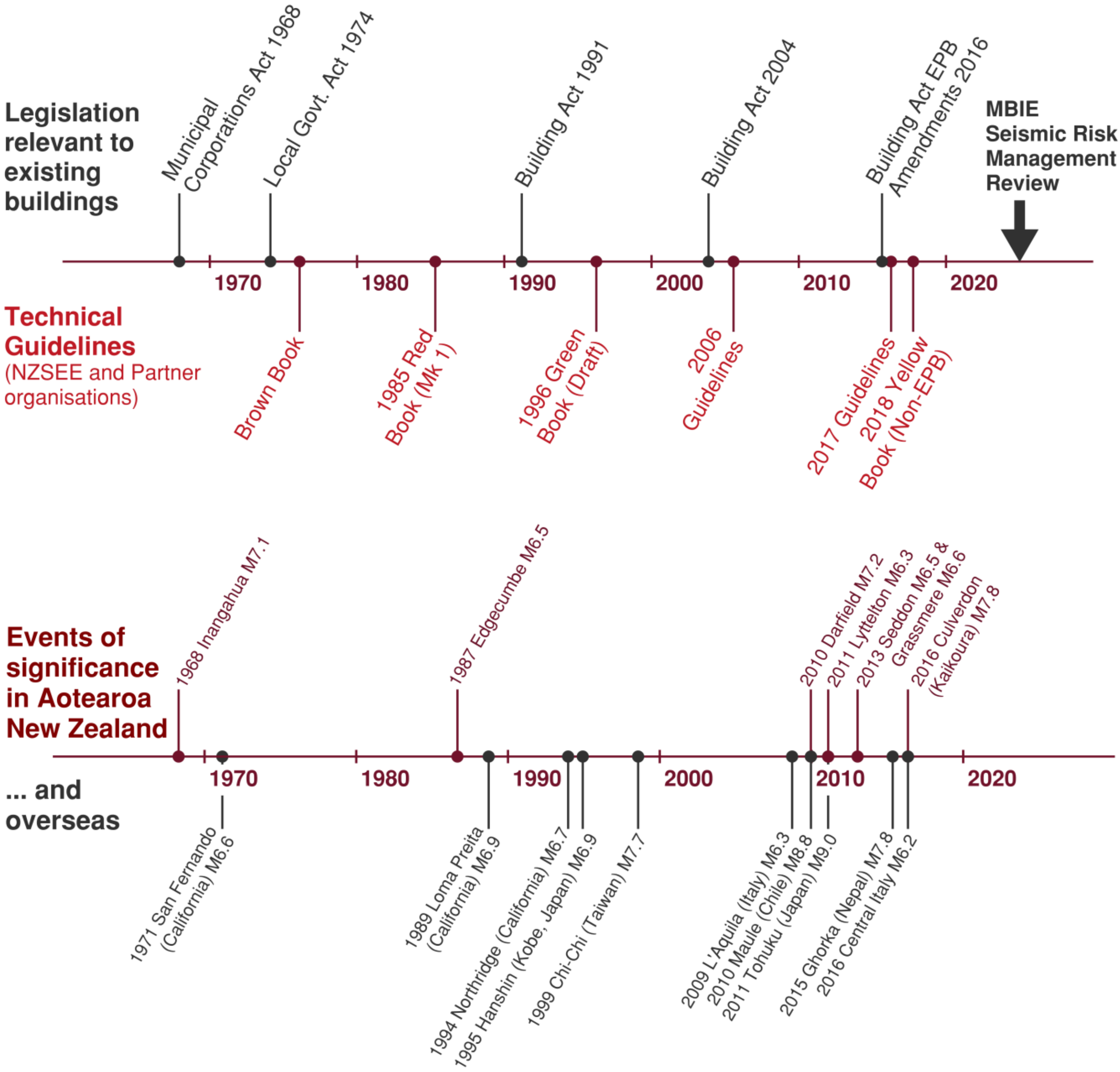

Figure 2: A history of developments in technical guidance, policy and legislation in Aotearoa New Zealand, alongside notable earthquake events in the 'modern era' of seismic design from 1970 onwards

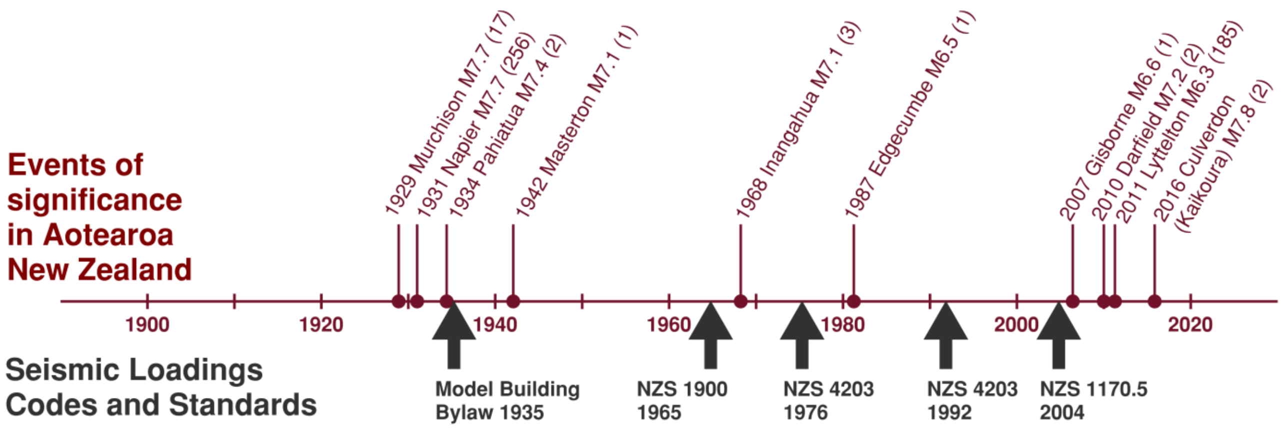

Figure 3:Significant events in New Zealand's earthquake catalogue from 1900 to today (bracketed values are known or estimated fatalities), and development of structural design standards for new buildings.

OBSERVATIONS AND OPPORTUNITIES

Progress in the remediation of Earthquake-prone Buildings

Slow progress in retrofit and challenges in meeting deadlines has been observed in particular areas—particularly regional centres, small commercial properties, or multi-unit residential. A number of factors are cited, including affordability and lack of an economic case. Considered in the context of nearly 50 years of regulation, it is unlikely that extension of deadlines will change these outcomes. If our communities want to see regulated risk reduction in these areas, then a change in approach is probably needed, including discussion around where the significant proportions of cost best lie (given who benefits). Below, we also encourage exploration of simplified approaches to retrofit that are likely to suit some types of buildings and which could significantly reduce costs (and cost uncertainty) and other barriers to implementation in these cases.

On the other hand, we presently see quite substantial demand for higher performance in some commercial markets. It is good that this is happening. However, it contrasts against the much slower progress in our most risky buildings which ideally would be the nearer term focus.

Simplified or targeted strengthening and securing approaches

Some building typologies have common vulnerabilities which suit a common and targeted approach. Some examples that have led to action (with a range of regulatory backing) include the 2011 egress stair reviews, the 2012 non-ductile column review programme, and the securing of parapets and facades under the Hurunui/Kaikōura Earthquakes Recovery (URM) Order 2017[1]. These techniques are common overseas, and there is growing evidence of their success in terms of policy implementation and some evidence of performance outcomes in earthquakes. They may be underutilised in New Zealand.

Simplified strengthening approaches must be a key focus of the review. Specifically, a work programme of the Joint Committee for Seismic Assessment and Retrofit is developing a proposal for simplified strengthening of one or two-storey unreinforced masonry buildings. It is critical that this work progresses so that it can inform the review recommendations. The review should also consider the extent to which securing or simplified approaches could apply to other typologies, and their potential role in regulation as an "off-ramp" to the current approach.

"XX %NBS… So what?". Better recognition (and communication) of consequence

Physical consequence is key to establishing the presence of a 'significant life safety hazard' in engineering assessments. The measurement of consequence is implicit in some further aspects of the guidelines, such as the concept of a Severe Structural Weakness. However, beyond these simple tests, there is a sense amongst engineers that there should be more ability to account for vast range in consequences that can result from different structural weaknesses, beyond what the simple *%NBS* metric conveys. This has probably not been helped by the vigorous adoption of *%NBS* (in certain commercial markets at least), the dogmatic insistence that a certain level of performance be achieved, and the inability of sensible conversations around consequence and risk to prevail in the context of commercial transactions or boardroom policy.

There has been excellent work published in recent times covering risk communication and guidance on occupancy assessments which gives consistent frameworks to consider these very things[2]. However, this remains quite a lengthy process for the average person to negotiate.

The 2012 TTAC/Tony Taig report made similar observations regarding consequence. For many older low-rise unreinforced masonry buildings, the outwards collapse of facades is a greater risk to neighbours and passers-by than occupants. This was contrasted with non-ductile concrete buildings, which even if they are less likely to collapse, are more likely to be lethal to occupants if they do.

The way we consider, measure and communicate consequence of failure in both regulatory and market assessment processes should form part of the review.

Impact of the Canterbury Earthquakes

The Canterbury Earthquakes experience obviously had a strong influence on the present regime. The outcomes of that event generally reinforced the underpinning objectives, particularly in relation to the focus on older non-ductile buildings. However, it did highlight our blind spot regarding post-1976 buildings, discussed under the subheading below.

The experience itself and the lengthy proceedings and reviews that followed did make engineers more concerned about their liability in relation to post-earthquake damage assessments and seismic assessments more generally. This is likely to have had some impact on the level of detail considered appropriate in assessment, the role of judgement-based processes (which has always been a central part of engineering assessments) and the potential for cautious bias in judgement.

[1] DBH Practice Advisory 13: Egress stairs – earthquake checks needed for some, September 2011; MBIE Guidance: Securing parapets and facades on unreinforced masonry buildings, First edition 2017 (revised 2018).

[2] For example, MBIE's Seismic Risk Series (Seismic Risk Guidance for Buildings, Seismic Risk Resource For Commercial Building Tenants), Communicating Seismic Risk Information with Tenants (Resilient Organisations, Massey University Joint Centre for Disaster Research).

Exposing our 'blind spot' in more modern (post-1976) concrete buildings

The Canterbury Earthquakes highlighted vulnerabilities in some modern concrete buildings. That is, post-1976 buildings that continued to incorporate some significant non-ductile characteristics (either due to design code peculiarities, or design flaws). What had been forewarned by some engineers and researchers was proven beyond doubt.

One part of this issue is the prevalence of precast construction throughout the modern era, but especially the 1980s to early 2000s. There are several common detailing practices which have proved to be vulnerable and non-ductile. Understanding this vulnerability has been one of the standout challenges under the present regime. Our engineering understanding of failure potential has improved markedly in recent years (reflected in 2024 proposals to update these guideline sections). However, our understanding of the potential *consequences* of failure, the likely distribution and extent of failure or collapse in multistorey buildings with poorly detailed precast floor systems, and our tolerance to those outcomes (given the costs of retrofit), remains a key area of uncertainty and measured concern.

Exposing poor design practice—conflated issues

At the same time, some instances of poor design practice have been exposed in other structural types through the seismic assessment process. These have come about as part of market driven seismic assessment. In many cases, the deficiencies in lighter-weight structures pose less risk than some of the rating outcomes imply. Education and improved calibration of assessment outcomes in the guidelines may help to better align outcomes with risk (and are being considered). However, what this really highlights is the lack of any other pathway in regulation to manage defective design or construction work identified post-CCC.

Because the seismic assessment process is the only obvious pathway to identify and resolve potential issues, these two distinct matters are frequently conflated, sometimes unhelpfully. They have strained the intent of "identify at any time" pathway in the legislation and the EPB Methodology, (for structures which are not part of the profile categories). These outcomes have also driven a higher than anticipated demand for seismic assessments and "*%NBS* Ratings" for relatively new buildings. In some cases, careful investigation of defective issues and their management/remediation is appropriate. But in other cases, these issues may be distracting us from our core objective.

The review might consider if/how the following distinct issues could be better separated:

- Significant seismic hazards in our existing stock that warrant explicit consideration and possible action—the purpose of seismic risk management in existing buildings.
- The treatment and triaging of defective design or construction practice in new or recently constructed buildings.
- The continual improvement of design and construction standards over time, so that generationally (and as a proportion of our building stock), we are required to tolerate less risk—and so that society is more economically resilient.

Good information, better decisions

Good information leads to good decisions, and consistent quality in engineering advice helps a market mature. Incremental improvements are being made in this area. However, there remains a high burden on engineers to maintain the appropriate level of competence and quality in assessment work, and particularly in consistency of judgement.

A centralised audit process should be put in place to monitor the quality and consistency in assessments. Currently, centralised mechanisms to collect data and create a feedback loop for quality improvement are woefully inadequate. Given the role of market, there is every interest in ensuring that seismic assessment work and communication of outcomes meets a consistent acceptable standard. This is something that the market alone has not been able to deliver, and it is pointless to hope that it might suddenly eventuate without an improved system in place, supported by the regulator, that facilitates this essential feedback loop.

Avoided emissions and protection of our heritage

One part of the landscape that has changed significantly in recent years is the Climate Change Response (Zero Carbon) Amendment Act 2019 and the engineering sector's awareness of the significant contribution of embodied carbon emissions from building and construction to New Zealand's net greenhouse gas emissions.

New Zealand can ill afford to solve the earthquake problem by demolition and reconstruction *before* any earthquake has occurred solely for the purpose of seismic risk management. Our existing buildings present too great an opportunity for avoided building and construction related emissions[1]. The review should quantify and consider the benefits of avoided emissions through retrofit of seismically risky buildings, rather than demolition.

Is a universal minimum performance or risk threshold a false ideal?

The concept of uniform risk and a consistent minimum performance threshold is embedded within new building design frameworks and responds well to the principle of fairness. However, an existing building's context is different, especially regarding regulation. The cost-benefit of risk reduction may look very different for different building types (and for different social and economic settings). Whilst consistent expression of performance and a clear consistent benchmark (*%NBS*, for example) is probably necessary

[1] Understanding potential avoided upfront carbon emissions through strengthening of seismically deficient buildings. Research Report prepared for MBIE by Beca, Aurecon New Zealand Limited and Holmes, September 2024. https://www.building.govt.nz/getting-started/climate-change-work-programme/resources#jumpto-research

to enable market driven risk reduction, it is possible that the concept of a uniform threshold of acceptable performance is a flawed ideal in the context of regulation.

Some other international approaches recognise this in the way that they design ordnances (mandatory retrofit programs) or policy incentives, and they might be getting better outcomes as a result. Centralising the legislation has had the benefit in reducing inconsistencies in application of the principles by local authorities. However, it has significantly reduced the ability to tailor the requirements to recognise local social/economic factors and allow the benefits per dollar invested to be maximised.

Scenario based approaches

Continuing from the above, an exploration of scenario-based approaches to defining thresholds of performance could offer some value. This is more relatable than entirely probabilistic approaches, and more easily aligned with a layperson's articulation of their desired outcomes. It can also offer a different backdrop to cost-benefit analysis. There are risks and benefits in these approaches, but there is some international precedent that we could share, and we believe it is worth exploration as part of the review.

Further engagement with the review

The above points comprise preliminary and broad observations of a complex problem, from the point of view of a diverse group of technical professionals, researchers and scientists who have been engaged in these issues for many decades. NZSEE and our partner organisations look forward to engaging with and supporting MBIE in their work on this important review.

FEEDBACK, AND MEMBER SUBMISSIONS

NZSEE is collecting feedback on matters relating to MBIE's *review on seismic risk management in existing buildings*, to help inform its inputs into this process.

Please send any comments or feedback on this document to the NZSEE Executive Officer at exec@nzsee.org.nz with subject prefix *Seismic Risk Review*.

Copies of this document may be downloaded from the New Zealand Society for Earthquake Engineering website www.nzsee.org.nz.