The New Zealand Building Code – a rethink?

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ABSTRACT

Are the regulatory settings for structural and geotechnical design of structures in New Zealand currently appropriate? It is contended that they are not.

New Zealand led the world in performance based building regulation when the Building Code was first established in 1992. The Building Code reflects societal expectation of performance, what people are prepared to accept balanced against how much it will cost. Clause B1- Structure has remained essentially unchanged since that time, focused on life safety and not damage. Meanwhile we have experienced a significant spike in seismic activity with historically unprecedented losses and disruption. It is clear that perception of earthquake risk is very different to what it was in 1992.

Internationally there has been a significant shift to providing greater clarity and specificity for the regulatory outcomes being demanded within the building code system. The goal of the 2006 Building Code review was attempting to do this. Unfortunately, apart from the C clauses for fire safety causing significant issues in implementation, this has not happened. Standards supporting the Code have however been changed, reflecting improved understanding of system performance and capacity. This cannot be said for seismic hazard, where demand parameters for design are two decades out of date despite our increased understanding. The idea of providing more specific tolerable impacts for various levels of shaking has been proposed, but so far this work has not progressed.

The paper proposes key steps to be followed if New Zealand aspires to best practice building regulation.

1 INTRODUCTION

There has been a lot of discussion recently about whether the Building Code is currently fit for purpose. The scale and complexity of insurance losses across housing and commercial buildings in Canterbury since 2010-2011, followed within the decade by further commercial and infrastructure losses due to earthquakes (2013 and 2016) throughout central New Zealand are starting to bite with insurance either not being available, or increasingly unaffordable. A Wellington Mayoral Insurance Taskforce which was convened to address these issues has recommended regulatory changes to include damage avoidance and not just life safety protection when constructing new buildings (WCC 2019).

The Building Code is an important instrument of policy for determining the outcome of building performance in New Zealand. As an early example of performance-based building regulation, New Zealand's approach was considered best practice internationally when a national Code was first developed in 1992. Since then Code Clause B1 for structure has remained unchanged. Is this appropriate when there has been considerable heartache and learning from the 'leaky building crisis', the impact of earthquakes, and international trends and experience?

It does need to be remembered that the Code is only part of the picture. The Building Code is only one part of a much wider system that will influence outcomes. These include commercial arrangements and incentives, legal and taxation systems, liability, access to finance, insurance, expectations of users, research and advances in knowledge, land-use planning, consents/approvals processes, and the competence and ethics of all parties to the building process.

Taking all this into account, the paper argues that a wider societal discussion about expectations of building performance is needed and that targeted reforms are desirable, including:

1. providing an opportunity to gauge public appetite for the dual goals of life-safety AND damage avoidance
2. using existing operational policy mechanisms, eg section 175 Building Act (BA s.175) guidance, as a means to be more specific about what performance is expected, including the tolerable impacts of particular scenarios
3. undertaking a full review of Code and supporting documents to simplify and reflect accumulated experience and knowledge of the past two decades.

2 THE BUILDING CODE SYSTEM

2.1 Aims

Why do we even need a Building Code, given that regulation can impose costs, limit freedoms, stifle innovation, and give rise to other unintended consequences?

Building regulation and building codes date back to ancient Mesopotamia[1] and have evolved progressively as major disasters such as the 1666 great fire of London and the 1906 San Francisco earthquake have occurred. The 1931 Napier earthquake was the catalyst for the development of model building bylaws that were administered by local authorities throughout New Zealand. Therefore, building codes and regulation were generally an instrument to protect people, with rules about structural stability, fire safety, protection against falling and hygiene. Increasingly they are being used to support social policy and community wellbeing, such as access for all, sustainability, noise protection and resilience.

It is clear that where a sound and well-enforced Building Code has been in place, the population has substantially benefited. The World Bank has concluded that "Building and land-use regulation has proven to be the most effective tools for reducing disaster and chronic risk in the developed world (World Bank 2015)." They point out that low- and middle-income countries have suffered disproportionately, one of the reasons being a lack of robust regulation, and are promoting the adoption of Building Codes and regulation

[1] Hammurabi, Babylonian ruler around 1800 BC established the first legal code that included a presumption of innocence but it had severe penalties*: 'If a builder has built a house for a man and his work is not strong, and if the house he has built falls in and kills the householder, that builder shall be slain. If the child of the householder be killed, the child of that builder shall be slain.'* While harsh, this did recognise the information asymmetry between builder and owner, still very much a driver for today's codes.

to provide a greater degree of resilience, reducing the consequences of disasters. Sri Lanka, a country that has suffered greatly from tsunami, storm surge and other weather-related events, is just one example of their focus.

The New Zealand Building Code is performance-based regulation under the Building Act 2004. It was first developed under the 1991 Building Act and came into effect as Schedule 1 of Building Regulations 1992. Modifications have been made to some code clauses but its structure and contents have not changed markedly since then.

What do we need from a Building regulatory system?

Drawing from the 'Government Expectations for Good Regulatory Practice' (NZ Government, 2017) and experience from examples of New Zealand regulatory failure (Searancke, 2014), building regulations should:

- reflect societal expectations (recognising the social compact between the ruled and their rulers)
- be aligned with other regulatory systems, constitutional principles and treaty obligations
- be proportionate, consistent and fair to all parties
- be clear, easy to access and to interpret requirements
- be flexible, pro-active and evolving, responding to changing circumstances or new information (not 'set and forget')
- encourage affordable and efficient building practices and promote innovation
- reflect current knowledge and sector competence and practice

How are we doing against these criteria?

2.2 New Zealand experience

The last two decades have been turbulent times for the sector. It is not often that building regulations become a high-profile political issue as they have in New Zealand during this period. The "leaky building crisis" in the early 2000s really put the spotlight on the system, with the Hunn report concluding there had been 'systemic failure' (Hunn 2002). The 2002 open letter by John Scarry on the 'parlous state of the structural engineering industry in New Zealand' further raised public concern. These resulted in a new Building Act 2004, effectively abandoning the private building certifier experiment, creating new powers and introducing additional requirements, particularly bolstering consumer protection for housing. It also saw the creation of the Department of Building and Housing (DBH), bringing the agency that was previously responsible for building regulations, the Building Industry Authority, into core government services. DBH has subsequently been subsumed into the Ministry of Business, Innovation & Employment (MBIE). This brought much greater political scrutiny and oversight, enabling some urgent change and action. Having the regulator leading the industry to change building practices is unusual but was necessary at the time. It included addressing weathertightness (requiring drainage cavities behind house cladding) and energy efficiency (requiring double glazing thereby encouraging product investment). Other positive examples include, facilitation of collaboration needed to assist the sector respond to, and recover from, the Canterbury earthquakes (Stannard 2014, 2016), and legislative changes promoted by the engineering technical societies requiring urgent strengthening of reinforced masonry buildings in areas with heightened seismic risk following the 2016 Kaikoura earthquake.

However, the move of the building regulator into central government inevitably was accompanied by tension regarding role and accountability. Central regulators do need to maintain some separation from the sector they are regulating to avoid being captured, but technical oversight and monitoring is also essential to avoid becoming divorced from operational experience. This hasn't always happened. A lack of dialogue and appreciation of the implications of proposed changes have sometimes resulted in less than optimum outcomes. Examples include aspects of the 2004 Act and regulation that are unnecessarily complex, or which have produced unintended consequences. Equally, there has been at times an undervaluing of technical expertise and sector experience within government, limiting evidence-based policy decision making. At worst, in my view, this has been a contributing factor in the gravity of tragic events like the 1995 Cave Creek viewing platform collapse, and the 2010 Pike River mine explosion.

A balance is needed, with all parties showing respect and a willingness and capability to credibly engage and collaborate. In the case of building regulation, MBIE is the steward of the system responsible for promoting a sector culture that will facilitate engagement and true listening at all levels, not just at a business leader level. It is also up to the sector, and technical societies as their representatives, to continue to show willingness to engage, debate issues to achieve coherence on issues, and provide the front-line experience that the regulator cannot be expected to have.

We have learned much from earthquakes during the past decade. The Canterbury Earthquakes Royal Commission provided urgency and impetus for making system level improvements. An intense period of collaborative engagement between MBIE and the technical societies occurred, supported by the Earthquake Commission, resulting in the development of the Seismic Assessment of Existing Buildings guidelines, the Earthquake Geotechnical Engineering series, the New Zealand Geotechnical Database, and the SESOC Interim Design Guidance recommendations, to name just a few (CERC 2012, MBIE 2017). National research consortia like QuakeCore and the Quake Centre at the University of Canterbury are consolidating and extending these gains. However, many challenges remain. The use of ACP panel combustible cladding (highlighted by the 2017 Grenfell Tower disaster in London), the underperformance of non-structural elements in earthquakes, alleged structural design deficiencies reported in buildings such as Masterton industrial buildings and 230 High Street Christchurch, and the 2019 Auckland Convention Centre fire are merely symptoms of a building sector that is sometimes performing at a level that is less than desirable.

Liability issues prevail, often to the detriment of the overall project. Home owner insurance is becoming more expensive and sometimes not available. The seismic hazard levels set in the Loading Standard are well out of date although recently prioritised for review. Implementation of the framework for building management following emergencies remains incomplete. The Code remains high level and open to interpretation with vague terms like ‘low probability’. The plethora of unnecessarily different ways to categorise buildings within the Code and regulations remain, creating complexity and confusion. Fundamental linkages are missing between the regulatory treatment of risk within a lot boundary or single building footprint, and the aggregate exposure of the neighbourhood and wider community. Land-use and building controls urgently require better coordination, if not integration, for risk assessment and sustainable development.

We have made real gains in the efficiency and effectiveness of the system over the past two decades, but there remains considerable room for improvement. The urgency and importance of reform remains. Now is not the time for a retreat from oversight and intervention.

2.3 International experience and trends

New Zealand is not alone in experiencing building related issues. Failures elsewhere and follow-up review recommendations illustrate that building is a complex business and there is no ‘magic bullet’. Care is always needed when considering responses to issues arising elsewhere as the legal and building practice contexts can be quite different. However, a universal theme is the need for on-going and proactive monitoring with change or adjustments appropriate to the local situation.

The Inter-jurisdictional Regulatory Collaboration Committee, IRCC, is the international body of building regulators that espouse performance-based building regulations. New Zealand has been a member since it was first formed in the early 1990s and has learned from and contributed to other countries' experiences. (IRCC 2010). Performance-based regulation has been demonstrated to have had substantial benefits. Australia has estimated benefits of $A1.1 billion per annum (CIE 2012).

However, there are downsides if requirements are not clear, or are restrictive. The IRCC has recommended a greater degree of specificity be incorporated somewhere within the code system (Meacham 2017). Australia is including greater quantification of requirements within their National Construction Code. However, as New Zealand learned from its attempts to have greater quantification of Code fire safety requirements in 2014, care is required. There can be unintended consequences, unnecessarily restricting products and methods. Sometimes, we don't have the data or the necessary understanding of performance, and the impact of earthquakes on buildings is a case in point.

We must continue to learn from international experience. The 2017 Grenfell Tower fire in London example is instructive. Dame Judith Hackitt in her follow-up independent review of Building Regulations and Fire Safety stated:

> "The new regulatory framework must be simpler and more effective. It must be truly outcomes-based (rather than based on prescriptive rules and complex guidance) and it must have real teeth, so that it can drive the right behaviours. This will create an environment where there are incentives to do the right thing and serious penalties for those who choose to game the system and as a result put the users of the 'product' at risk.
>
> This approach also acknowledges that prescriptive regulation and guidance are not helpful in designing and building complex buildings, especially in an environment where building technology and practices continue to evolve, and will prevent those undertaking building work from taking responsibility for their actions." (Hackitt 2018)

It is clear from Dame Hackitt's report that 'prescriptive regulation and guidance' means the Approved Documents (equivalent to Acceptable Solutions and Verification Methods in New Zealand), which form part of the building regulations in England and Wales, but not what is the equivalent of New Zealand's Building Act s. 175 guidance which is discussed in Section 2.5.

In my view, more use could be made of BA s.175 Guidance, being an existing mechanism, to provide greater detail and specificity of performance outcomes in the New Zealand context, refer to Figure 1 and Section 2.5.

2.4 Code use in practice

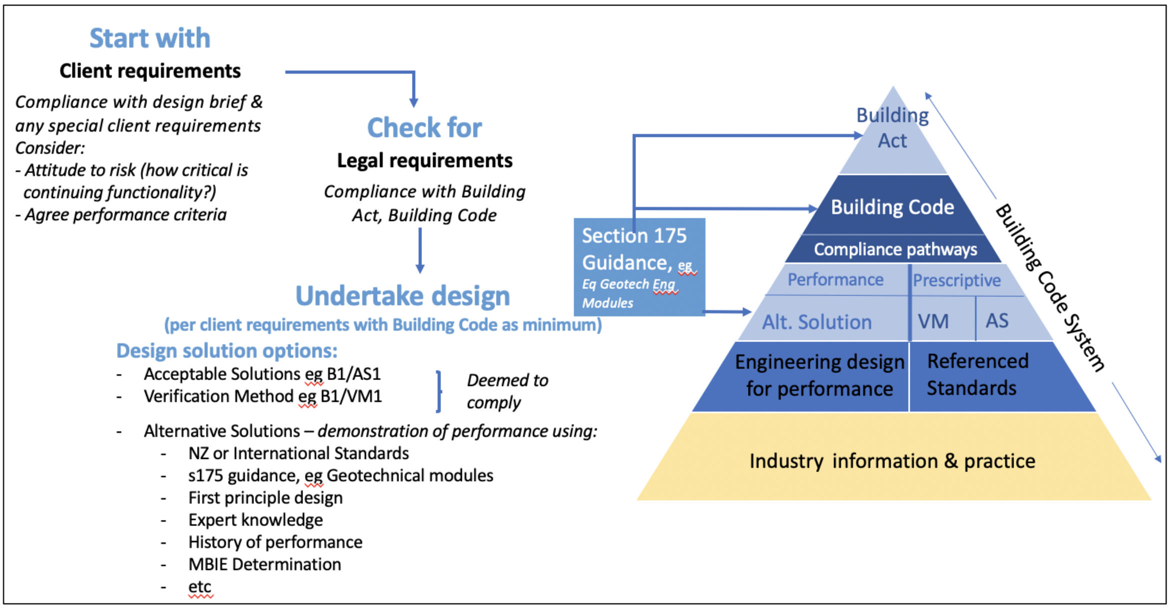

Figure 1 Design Process and Legal Context

Figure 1 provides an overview of the design process and the interaction with legal requirements. Getting a clear understanding of client requirements is always the starting point. Then, from this brief, deciding the appropriate design approach; the ground investigations needed, the process for estimating ground motion parameters, and whether a simplified or more complex non-linear dynamic analysis is appropriate. The design is undertaken following a check for legal minimum requirements, with close collaboration of all parties, architect, structural, geotechnical, fire and building services designers and Building Consent Authorities (BCA).

Performance-based Building Codes allow for innovation in methods and materials used, greater flexibility to meet client requirements and quicker uptake of new knowledge. They are in accordance with Dame Hackitt's plea, in the example mentioned above, to have a 'truly outcomes-based (rather than based on prescriptive rules ..)' system. In New Zealand, the Objective, Functional Requirement, and Performance is stated in the Code, reflecting a societal minimum outcome and it is up to the designer to meet these outcomes rather than hiding behind some prescriptive design exercise, 'just following the rules'. The overall Code system in New Zealand does contain Acceptable Solutions and Verification Methods that provide a 'deemed to comply' pathway, but these are not comprehensive and most projects have an Alternative Solution element, requiring greater analysis and understanding.

The building process can be complex. There are numerous site conditions, products, design methods and building systems that can be used to carry out a construction project and there is an inherent uncertainty about performance outcomes associated with many aspects of these. Even if a very comprehensive ground investigation has been carried out, there can always be surprises in the geotechnical understanding of the site. Each earthquake is unique and will impact structures differently. Material and product properties vary and their performance, when fitted into the larger soil-structural or architectural system, is not always perfectly understood. Additionally, while engineering design methods have evolved with a long history of research and practical experience, it would be arrogant to think we have all the answers. Although much has been learned from the Canterbury and Kaikoura earthquake sequences, it takes time to translate refined methods into common practice and there remain approximations and unknowns.

Earthquake risk (both life safety and damage) will depend on a number of factors, including: the likelihood of an earthquake occurring; the intensity, duration and pattern of shaking (dependent on factors such as distance from the earthquake source, fault characteristics, the direction of rupture, the magnitude of the earthquake, geomorphology, the type of ground the structure is situated on and the ground the earthquake waves have travelled through); the structural capacity of the structures and their components and services; the design assumptions made as to how the structures (ductility/flexibility) will respond in an earthquake; and whether there are irregularities or any critical structural weaknesses.

This highlights the importance of sound engineering decision making throughout the course of the project to provide the client with a robust outcome. Relevant experience, robust analysis and judgement, using the latest research and methods to understand likely performance outcomes is key to good decision making. Good design is not a 'box ticking' exercise. Asking the 'what if' questions and adding redundancy and resilience for such eventualities is important. It is difficult to address all these aspects in prescriptive documents; sound and experienced engineering judgement considering likely failure modes is required throughout.

2.5 Guidance as part of the Code system

As mentioned earlier, the 2002 Hunn investigation into the 'leaky building crisis' in New Zealand concluded there had been systemic failure. One factor was the inadequacy of the Building Code and the accompanying Acceptable Solutions and Verification Methods. The report recommended the development of "guidelines on the interpretation of the Building Act and companion documents to provide an educational and reference document", adding that it "should provide guidance on the interpretation of the Building Code provisions for Objective, Functional Requirement, and Performance".

This resulted in new powers being introduced into the 2004 Building Act enabling the Chief Executive of MBIE to develop and publish guidance under s.175 of the Building Act.

Figure 1 illustrates that s.175 guidance can be targeted towards three areas: a better understanding of Building Act provisions (the top arrow in the Figure); more detailed explanations for design solutions including Alternative Solutions (the bottom arrow); and for providing greater understanding and specificity for Building Code performance requirements (centre arrow).

Starting with the top arrow, Guidance has been used to explain some more complex Act decision making, such as exemptions from the need to obtain a building consent. Examples of its use at the design solution level (the bottom arrow) have been the residential and industrial repair and rebuild guidance to aid the Canterbury recovery, and the earthquake geotechnical engineering practice series of modules. Given the complexity and uncertainties associated with more complex earthquake geotechnical engineering decisions, guidance was determined to be the best means of lifting standards and getting better consistency in general practice. General principles are explained using latest research knowledge so that practitioners are aware of issues and can take them into account, rather than producing detailed calculation methods, often available in text books and journal publications.

Guidance, coupled with training, is therefore now an integral part of the Building Code system. Following guidance does not automatically mean acceptance by the Building Consent Authority when processing consent applications. However, section 19(2)(b) of the Building Act specifically allows BCAs to have regard to s. 175 guidance when applying the code compliance 'reasonable grounds' test in consenting decisions.

In the Grenfell Tower review, Dame Hackitt recommends guidance being developed by the technical societies with oversight from the regulator. The current model of using Engineering New Zealand to undertake projects on behalf of MBIE, such as finalising the Geotechnical modules, reviewing the proposed technical revision of Section C5 Concrete Buildings in the Seismic Assessment of Existing Buildings guidelines, and developing low-damage design guidance, is in accordance with this recommendation and appears to be working well. The engineering sector is better engaged and the final product should better reflect industry experience and needs.

Where guidance hasn't yet been used, and in my view an important lacuna, is to explain the outcome objectives of code requirements as illustrated with the centre arrow of Figure 1. This approach did commence with the development of 'tolerable impacts' for earthquake scenarios based on the ICC Performance Code. (Lawrance 2014, Stirrat 2017, ICC 2018), but it has not progressed. We don't yet have sufficient data to fully and reliably predict performance of a particular design in an earthquake, and therefore providing greater specificity for performance requirements in the legally binding Code risks creating issues such as those that occurred when quantitative requirements were put into the Code fire provisions in 2014. The latter caused real angst whereas such provisions could be issued in guidance, providing engineers and Standards writers with greater certainty about what we are trying to achieve without it being mandatory. The Building Code Handbook (refer https://www.building.govt.nz/building-code-compliance/building-code-and-handbooks/building-code-handbook/) could be an ideal place to do this; eventually greater performance detail could be done for all Code clauses.

3 OPTIONS FOR CODE DEVELOPMENT

3.1 Act and Code amended to include property protection

The purpose of the Building Act 2004 (s. 3) currently provides for people who use buildings to be safe and not endanger their health; they can escape from the building if it is on fire; and other property is protected (s. 4). It does not provide for property protection and damage avoidance of the building itself. This is translated into the Code.

The Japanese Code, in a country with a similar tectonic setting and level of seismicity to New Zealand, does provide for property protection. The contrast between the impact of the damage in similar levels of shaking occurring in the 2017 Kumamoto Earthquake and the February 2011 Christchurch earthquake was stark (Sarrafzadeh 2017). Arguments have been made that Japan is a much richer country and can afford the higher standards. However, on a GDP per capita (purchasing power parity) there is little difference, $US44k vs $US40k. Further work would need to occur to get comparative costing between designing for damage avoidance and undertaking a cost benefit of reducing some of the $40 to $50 billion costs from Christchurch. However, evidence already points towards the possibility of significant overall national savings by improving resilience. Designs that limit the onset of damage at moderate levels of shaking are not necessarily cost prohibitive (Hare 2019, Porter 2019). Increasing insurance premiums, and in some cases no cover being available, is a threat to sustainable urban development and economic wellbeing. Not surprisingly, the Wellington Mayoral Insurance Taskforce, comprising a range of community interests and expertise specifically recommended change to include damage avoidance and not just life safety protection when constructing new buildings (WCC 2019).

Lifting the standard for new buildings can impact the assessment of existing buildings. The New Building Standard, NBS, a measure of seismic assessment for existing buildings is pervasive in the market. Lease agreements are sometimes linked to maintaining a specific NBS rating. NBS was developed to support earthquake-prone building legislation designed to strengthen or remove the most vulnerable buildings. The legislation amended in 2017 is now specifically linked to the standard new buildings are required to meet as at 1 July 2017 (s. 133 AD (2)). This is a fixed standard and decisions to deem a building 'earthquake-prone' are not affected by changing standards for new construction unless there is a change to legislation. Perhaps we should try and influence the market to also ignore any changing standards for new buildings by calling NBS Notional rather than New Building Standards to reflect the standard in force on 1 July 2017?

It is now almost 10 years since the commencement of the Canterbury earthquake sequence. A public discussion of the merits of damage avoidance for new buildings is timely and overdue. It would be easier and less costly to build resilience into new buildings than to increase further the standard being set for existing buildings.

3.2 Act and Code amended to resolve current complexity and improve compliance

The Code fits into a wider building regulatory system. Other requirements impact on Code implementation and compliance. If we are to have a world class building regulatory system that fairly distributes costs and benefits and remains responsive to innovation and learning, then constant attention needs to be paid to all areas. There are a several stand-out issues to address for seismic performance in the existing system, let alone tackle some of the wider issues such as the contribution of buildings to climate change. I list a few that in my view will make a difference:

1. Reduce the different building categories in the Code and regulation to one. We currently have:
   - Classified uses in Code clause A1
   - Importance Levels in Code clause A3 and in NZS 1170.5, not identical

- Risk groups in the fire C clauses
- Uses of buildings in Change the Use regulations
- Risk groups for Clause F6 Visibility in escape routes, different from C clause risk groups

This is an example of the silos existing between code clauses and the complexity and confusion it causes. With some discussion, decisions could be made about which buildings, individually and in aggregate, are most important for society and to reflect this throughout the Code on a risk basis. The ICC Performance based model code from the USA is a useful starting point where they base the performance requirements on Performance Groups (ICC 2018).

2. Resolve responsibilities for oversight of the design, supply and installation of non-structural elements and structural-fire design. Currently there are significant gaps and sometimes the requirements and accountabilities to meet or oversee these aspects of building performance can be ignored or are ambiguous.
3. Withdraw B1/VM4, the Verification Method for Foundations or significantly amend the document to clearly restrict its use. Its narrow scope of application is often not well understood and aspects of it no longer meet current design practice. The Earthquake Geotechnical Engineering Modules are sufficient.
4. Introduce an audit system where structural, geotechnical and fire design are audited on a random basis by experienced approved practitioners to improve code compliance, accountability of designers and highlight issues to the wider engineering community. Audits would be best done prior to a consent being issued, it being desirable to pick up design issues prior to construction rather than trying to correct later or waiting for failure. This will require changes to the Act to empower the schema, provide powers to take pro-active action when issues arise, and resolve time limits for issuing consents (possibly deferring those until the targeted design has been audited). Liability and issues for auditors will need addressing. Knowing they may have their designs checked by peers will increase designer accountability, and being able to publish findings, anonymously if necessary, will assist all engineers to improve funding designs. Scotland, for example, has an audit system and the Standing Committee on Structural Safety (SCOSS) provides a confidential reporting system in the UK highlighting issues that need addressing.
5. Address the outdated seismic hazard levels set in NZS 1170.5 that were established from the 2002 National Seismic Hazard Model, NSHM. An international review found that, while the model was appropriate for the time, it is now out of date (latest science and techniques not necessarily incorporated); is inadequately funded; no longer follows international best practice; is not transparent and reproducible (assumptions not adequately documented); does not adequately recognise uncertainty; does not meet stakeholder needs with little awareness by decision makers; and lacks appropriate governance (Abrahamson 2017). It is understood that an update of the model is planned to address these issues and results will be available in the next couple of years. A robust and up to date NSHM is important for the country, not only as the basis for building design, but also for insurance loss modelling, financial contingent liability risk, and infrastructure design. It is particularly important for assessing liquefaction triggering and slope stability analysis to have the best hazard information available to avoid overly conservative or unconservative designs. A system for making carefully considered hazard adjustments to design practices over time needs to be an important part of the process. While the review is underway, the implications for building design of any significant shift in hazard level is being considered by MBIE. This presents an opportunity to rethink our design processes and methods. Can we be more differentiated in our approach, simpler structures being designed using a simplified approach rather than using NZS 1170.5? Should we revert to a simpler seismic zonation (Hare 2019)? The principle of being conservative when using less demanding design and investigation procedures should apply, but with greater design effort, including the use of more detailed field investigations and laboratory testing, peer

reviewed site specific hazard analysis, and post-elastic design methods for complex structures, a better understanding of likely performance may result in a more refined design.

6. The seismic hazard review provides the opportunity to undertake a fundamental review of B1/VM1 and NZS 1170, simplifying where possible, but providing the flexibility to undertake advanced design methods where appropriate. Adjustments may be needed if a decision is taken to include damage avoidance as a purpose to the Act. A first principle review of the Limit States, aligning them with the tolerable impacts, and clarifying current anomalies (SESOC 2019), should also be on the agenda. Should the serviceability limit state be increased to a 1-in-50 year event (Pettinga 2018)? Introducing an Intermediate Limit State, using say a 1-in-100 year event would better address the binary nature of liquefaction triggering and its impact on structural design.
7. Better integrate Standards and Acceptable Solutions and Verification Methods using technology to improve Code system accessibility. Even Building CodeHub (https://codehub.building.govt.nz), remains essentially a limited, paper-based search engine. Standing committees for key Standards would also provide better continuity and response to new knowledge.
8. Introduce a more systematic and transparent approach to monitoring how the sector is performing. As steward of the system, this is MBIE's clear leadership responsibility. All available feedback mechanisms should be integrated in order to decide if any intervention is appropriate and necessary, whether it be education and training, further targeted investigation into particular methods or practices, guidance or regulation change. Feedback and data can be collected from the consenting and inspection experience of BCAs, queries and complaints that come to MBIE, formal 'Determinations', and advice provided by the sector to MBIE through various channels. Better linkage is needed between the statutory Building Advisory Panel, BAP, (B.A. s.171-174) and other MBIE advisory groups, such as the Seismic Risk Working Group and the Building Code Technical Risk Advisory Group, BCTRAG. The only visibility of advisory group activity during 2019 is provided on Page 167 of the MBIE Annual Report with little discussion of recommendations. Should the BAP report to the Minister as it does in the United Kingdom with public access to its advice?

3.3 Greater performance specificity set in Guidance

As mentioned in Section 2.3, the trend internationally is to have performance-based regulation, but with better definition of performance included somewhere in the Code system. What do we mean by 'low probability of rupture'? This is currently left to Standards' committees to define, when actually it is a public policy issue and should not be their responsibility. Section 2.5 above introduced the work already undertaken, but which has not progressed, to define the 'tolerable impacts' that society might accept in various earthquake scenarios, considering dollars, damage and downtime and the preference for this to be in non-mandatory guidance rather than as a mandatory code requirement. Describing the intended continuum of performance using the ICC Performance Based Building Code tolerable impacts framework provides, in lay person language, what is tolerable across various levels of earthquake shaking, what we are aiming for in terms of impact on people, building occupation, damage and contents.

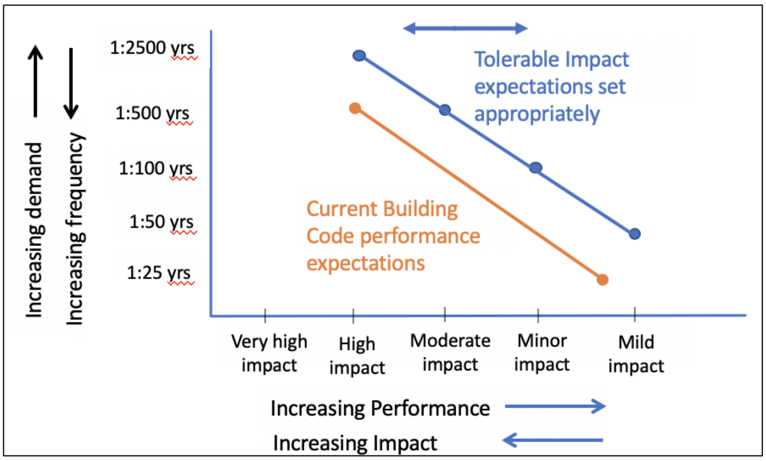

Figure 2 Tolerable Impact framework

The brown line in Figure 2 shows approximately the performance expectations currently in NZS 1170.5. The blue line is how it might be if property protection were to be included. The positioning of the line could be adjusted in either direction depending on decisions made. This would provide the clarity and direction to Standards committees and designers to turn these descriptions into engineering criteria and 'limits' for the likes of ductility, inter-storey drift, accelerations, and floor level and verticality tolerances.

3.4 Promotion of low damage design though guidance

This is a project that is already underway, being led by SESOC and managed by Engineering New Zealand providing technical project services to MBIE. If the Act and Code are not changed to introduce property protection, then this could still be a powerful way to influence the market towards producing damage avoidance structures. There remains a question about how it might address resilience at an urban scale.

4 CONCLUSIONS

The paper has argued that changes are needed to our building regulatory system if we are to achieve expectations for good regulatory practice and have a well performing building sector. The past two decades have included some of the most challenging historical experiences for New Zealand building practices. There is now a much greater public understanding of the impact of earthquakes in a contemporary social and economic context and significant learning for engineers about the performance of our design and building methods. However, the locally prolonged economic and social disruption associated with earthquake damage (in tandem with complex insurance claim processes) have dented public confidence and trust in the sector. Expectations have evolved with experience and there needs to be wider engagement on what we expect from our buildings. The events of the past decade point to property protection as a desirable objective to complement that of life safety. I argue we could achieve this in part through greater specificity of performance requirements using 'tolerable impacts', to describe what we expect the outcomes will be in various design scenarios. The Building Act s.175 guidance is an important existing mechanism that could be used to do this, enhancing the ability of all parties to comply with the Act.

A number of other actions are recommended that should reduce confusion and improve the efficiency and effectiveness of the overall system. Effective implementation will take leadership, bold and innovative thinking, effort, and genuine engagement and collaboration between the sector and regulator. Are we up for the challenge?

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