The Resilient Buildings Project

Resilient Buildings: Contextual Considerations

Stage 2B Final Report

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nzsee
NEW ZEALAND SOCIETY FOR EARTHQUAKE ENGINEERING
EQC
EARTHQUAKE COMMISSION

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Acknowledgements

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Contents

Executive Summary

How do Kiwis in the 2020s want buildings to perform during and after an earthquake? Do New Zealand's current systems and approaches provide buildings that meet these 21st century expectations or what changes may be appropriate?

The Resilient Buildings project was conceived to explore these and associated questions in order to rethink the framework for New Zealand's earthquake standards and design approach and lay the groundwork to develop resilient building design, fit for the 21st century.

This report "Contextual Considerations" outlines work carried out between April to June 2022 to complement and further develop an understanding of the parameters impacting building seismic performance following research to explore societal expectations for the seismic performance of buildings which the project published in March 2022.

This stage of the resilient buildings project sought to delve into the societal expectations research and provide more detailed data reporting, explore the complexities and interdependencies for change in the built environment and the options available to address gaps. It also sought to review earlier work undertaken, identify key issues and develop a prospective methodology for articulating contemporary expectations of tolerable performance and establishing performance objectives in buildings.

Key findings from this study were:

- Safety is non-negotiable, Kiwis want more than life safety. In particular, social and economic recovery are important objectives.
- Suggestion that people conflate life safety with functionality, so there is need for greater clarity of expectations and outcomes.
- Significant changes in the New Zealand urban environment are anticipated, particularly greater urban density in large cities and increased investment in public transport. Technology and an increasingly service-based economy are changing building usage in urban areas providing more flexibility to work in different locations for some.
- The recent societal expectations research highlighted ambiguities in the current New Zealand building code which contemplates 'amenity' but does not differentiate between tolerable and acceptable outcomes.
- Increasing awareness that risk tolerance and built environment resilience are not well aligned across the existing range of legislation and existing land use rules are also not well aligned.
- "A code (minima) designed building is a barely legal building". There is a need to change the communications around seismic risk and building design.
- Improving building resilience to mitigate the onset of damage by natural hazards, and developing a coherent science-led national view of risk(s) will help sustain New Zealand's access to insurance.
- Improving the resilience of buildings is a system wide issue of which design performance objectives is but one part. Others include procurement, construction, consenting and liability management.

Future stages of the project aim to use these investigations to inform development of tolerable impacts leading to performance criteria and a framework.

1. Introduction

The Resilient Buildings Project was conceived in late 2019 as a programme of work to rethink the framework for New Zealand's earthquake standards and design approach. Recent seismic events and related learning provide strong drivers to redevelop the current approach.

Our vision is to develop a framework that articulates performance objectives and outcomes for different building usages, taking into account the perspective and expectations of building users. The framework should:

- Encompass technical standards that are scalable for different desired outcomes above the mandated code minimums (that building owners can easily opt into)
- Use clear consistent language, and
- Have the scope to describe existing building characteristics (and potentially utility infrastructure) in relation to the agreed standards.

The impacts of the recent New Zealand earthquakes have been widely observed and commented upon by stakeholders, policy makers and the public, including both the personal and wider social impacts. Buildings typically span decades of use and may experience multiple earthquakes or repeated repurposing of function. Design standards and their application through construction and the subsequent lives of buildings therefore have consequences for all

Minimising the likelihood of death and injury in earthquake or fire has been a fundamental imperative for building design standards for over 50 years. However, there are other performance outcomes which have risen to prominence during recent years in New Zealand and abroad, including, for example, the ability to shelter in place in multi-storey residential buildings after a significant event; and to reduce disruption or swiftly restore economic and social well-being, and reduce waste by constructing repairable buildings.

The Canterbury Earthquakes Royal Commission made 189 recommendations for change including many on our approach to building design and various EQ related standards. Other recent key initiatives to identify the issues include, for example: the Built Environment Leaders Forum held in September 2015, the 2019 Wellington Mayoral Insurance Task Force and the investigation of Statistics House, a modern building on the Wellington waterfront that experienced severe damage following the Kaikoura earthquake. Much earthquake resilience research has been initiated and undertaken through the QuakeCoRE academic consortium and through other related programmes of work to better understand key issues associated with seismic risk and building resilience.

The National Seismic Hazard Model (NSHM) is currently being updated for the first time in more than a decade and changes will be addressed when next updating the earthquake loadings standard. A Seismic Risk Working Group (SRWG) commissioned by MBIE in 2020 to anticipate this requirement, made a series of recommendations on how the NSHM should be applied within the Building Code in their report dated November 2020. This included recommending "the need for a review of the current building code clauses (including consideration of seismic risk settings) to ensure they articulate societal expectations and are reflected in the Building Act, thereby emphasising the need for the Resilient Buildings Project.

The Resilient Buildings Project was conceived to rethink the framework to support this upcoming, as well as future, reviews of the building standards. The revised NSHM results will be published in 2022 and followed by a series of updates to the seismic loadings standard NZS1170.5 beginning in 2023 with an updated design spectrum, then a later and more extensive update in 2025 is contemplated focussed on changes to seismic design.

2. Project Approach

This project, since inception, has been developed as a multi-staged project to allow collaborative modifications through the project course designed to leverage complementary insights and relevant activities leading to enhanced outcomes. These have been envisaged as:

Stage 1: Set the scene, establish the need and set the vision for the project.

Stage 2: Gain an understanding of current societal expectations for the seismic performance of buildings.

Stage 3: Establish tolerable impacts and building performance objectives.

Stage 4: Translate the building performance objectives and tolerable impacts into appropriate and enduring approaches to meet societal needs.

Concurrently through all stages of the project:

- Sustain engagement with the engineering design community with transparency and openness.
- Engage with government and community interests to ensure alignment or awareness of the project and its purpose among parallel or complementary initiatives.

3. Project Progress to date

Stage 1 was an establishment phase undertaken in 2020 to contextualise the project, frame the issues, establish the project structure and framework with three main tasks:

- Engaging with the engineering community about the issues, context and vision for this project
- Clarifying and mapping the relationships between the various seismic projects recently completed and underway and how these relate
- Forming an establishment group to:
    a. frame the problem
    b. develop key considerations
    c. develop the proposed operational structure for the project, and
    d. convene a steering group to provide project guidance and overview of Stage 2.

Key outputs were summarised in the Project Establishment Report dated 25 September 2020. These included:

- Focus and scope of the project is vertical buildings and their services, i.e., informed by relevance to NZS1170.5 with project outputs structured so they can directly inform seismic design of other built environment infrastructure e.g., bridges.
- The project contemplates all levels of earthquake shaking and across all levels of building performance.
- The project comprises multiple stages: an initial focus on exploring societal preferences; then development of a clear definition of building resilience and tolerable performance across all levels of earthquake shaking; then recommended objectives for seismic design and appropriate approaches to develop the objectives with appropriate levels of sophistication.

Stage 2, undertaken in 2021, focussed on an engagement process using interviews and focus groups at selected towns and cities throughout New Zealand to collect data on perceptions and expectations of tolerable performance of the built environment in earthquakes. Participants were asked to consider expected performance of different types of buildings (functions, settings, user groups, geographic setting) in different earthquake scenarios considering human, social, financial and natural capital outcomes.

The findings were gathered into a report titled "*Societal expectations for seismic performance of buildings*" dated February 2022[1]. The findings show that peoples' risk perceptions are diverse. Life safety remains of central importance in our built environment with participants also emphasising social and mental wellbeing including the need to focus on reducing disruption and swiftly restoring economic and social wellbeing as well as reducing waste by constructing repairable buildings.

The aim of the next stages 3 and 4 is to use the research findings developed in Stage 2 to identify tolerable impacts and then establish performance objectives, then to develop and inform practical options for revising the building control system and engineering design practices for seismic risk and to deliver the rationale to support the proposed changes.

The Steering Group, at the conclusion of Stage 2, identified that several enabling activities were required in order to then move forward to Stage 3. Stage 2B, Contextual Considerations was developed accordingly with the following scope of work:

1. Preparation of two supplementary detailed data reports to the Societal expectations report.
2. Preparation of a policy brief
3. Engagement workshops
4. Gap analysis - built environment
5. Development of tolerable performance methodology
6. Intervention analysis

[1] https://www.nzsee.org.nz/db/PUBS/RBP_SocietalExpectationsReport-FINAL-for-Release.pdf

The aim of these activities is to provide contextual inputs for the work to follow, rather than stand-alone outputs.

4. Contextual Considerations Activities, and Outputs

4.1 Data Reports and Policy Brief to the Societal Expectations Report

The supplementary data reports[2] provide information on the data and collection methods for the Societal Expectations for Seismic Performance of Buildings research. Both reports are being issued via digital release.

A policy brief accompanied the Research Report and was issued on 12 April 2022 via digital release[3].

Key Takeouts:
i. Safety is non-negotiable.
ii. Kiwis want more than life safety. In particular, social and economic recovery are important objectives.
iii. Speed of recovery is a particular priority for some building types – marae, community centres, and homes – that currently are not a priority.
iv. Appetite for risk and expectations of buildings seismic performance varies significantly amongst Kiwis.

4.2 Engagement Workshops

The purpose of these workshops was to ensure the findings of the societal expectations research was shared with stakeholders responsible for facilitating technical feedback and options for the proposed changes to New Zealand's earthquake standards and design approaches.

- **Integrating Societal Expectations into the Design of Buildings** held 30 March 2022 with 32 attendees.

[2] Abeling et al (2022) Societal expectations for seismic performance of buildings: detailed report on interviews. The Resilient Buildings Report NZSEE. June 2022
Horsfall et al. (2022) Societal expectations for seismic performance of buildings detailed report on focus groups. The Resilient Buildings Project Report. NZSEE June 2022.

[3] https://www.nzsee.org.nz/db/PUBS/Policy_Brief_Resilient_Buildings_FINAL110422.pdf

- **NZSEE Conference Plenary: The Resilient Buildings Project** held 28 April 2022 with 230 attendees

4.2.1 Integrating Societal Expectations into the Design of Buildings, 30 March 2022

The purpose of the session was:

1. To explore and test findings from the NZSEE resilient buildings project against expert opinion/research
2. To explore how societal expectations can be mapped to engineering-based design principles and targets.
3. To identify future research needs to enable integration of societal expectations into engineering design.

The 3-hour virtual workshop involved three activities completed in groups, following a briefing about the project objectives and findings from the societal expectations research. The specially curated groups comprised a range of social science, engineering, policy, practice and research perspectives. As well as testing the societal expectations, the workshops were an exploration of methods for connecting societal expectations with engineering based outcomes.

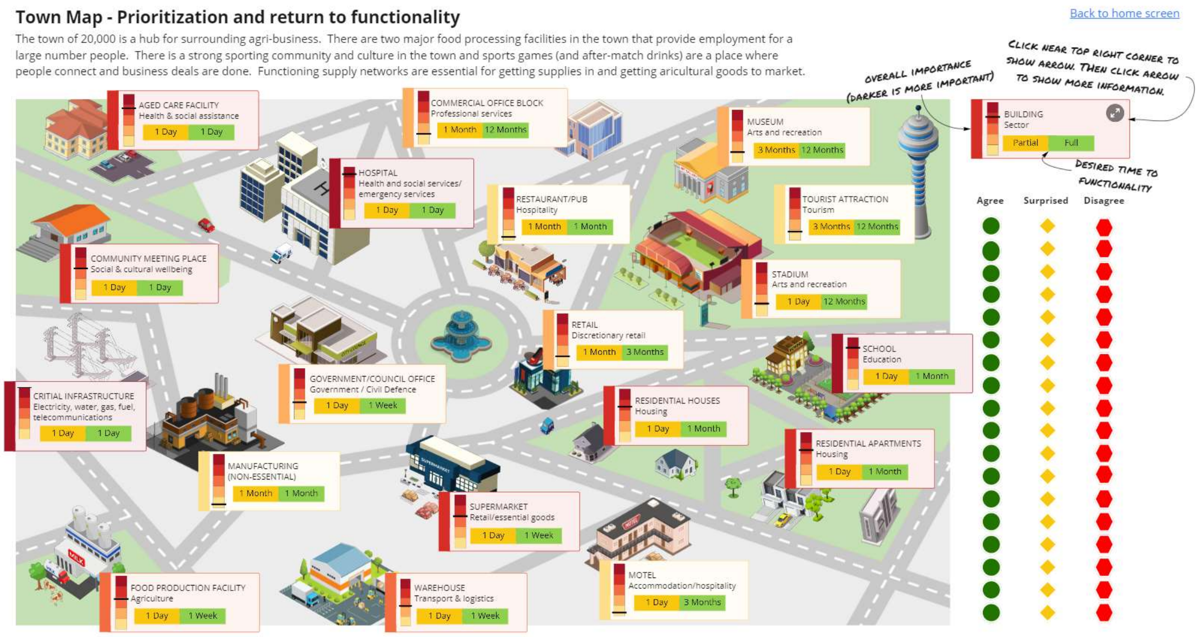

Figure 1: Typical town map used in the societal expectations research

Activity 1 focussed on sense checking the societal expectations findings against expert knowledge and understanding of disaster impact and recovery following earthquakes.

Each group was provided a map of a typical town or city with a range of common building types and prioritisation from a disaster recovery perspective as indicated by the survey. The groups were asked if they agreed or not with the research findings.

Activity 2 focussed on reviewing with participants the prioritisation from an engineering perspective and exploring if/why they think current code / design practice/ regulations do not meet these expectations for the different building types.

Activity 3 focussed on exploring ways in which building user experiences and impacts of disruption could be mapped to engineering performance criteria (at a building level). Each group was assigned a building type. For each building they explored the elements of the building, and their minimum condition for five states of performance, ranging from fully operational through partially operational, shelter, life-safe during an earthquake, or near-collapse. They then considered the relative level of earthquake shaking that would be acceptable for each building performance state (see Figure 2).

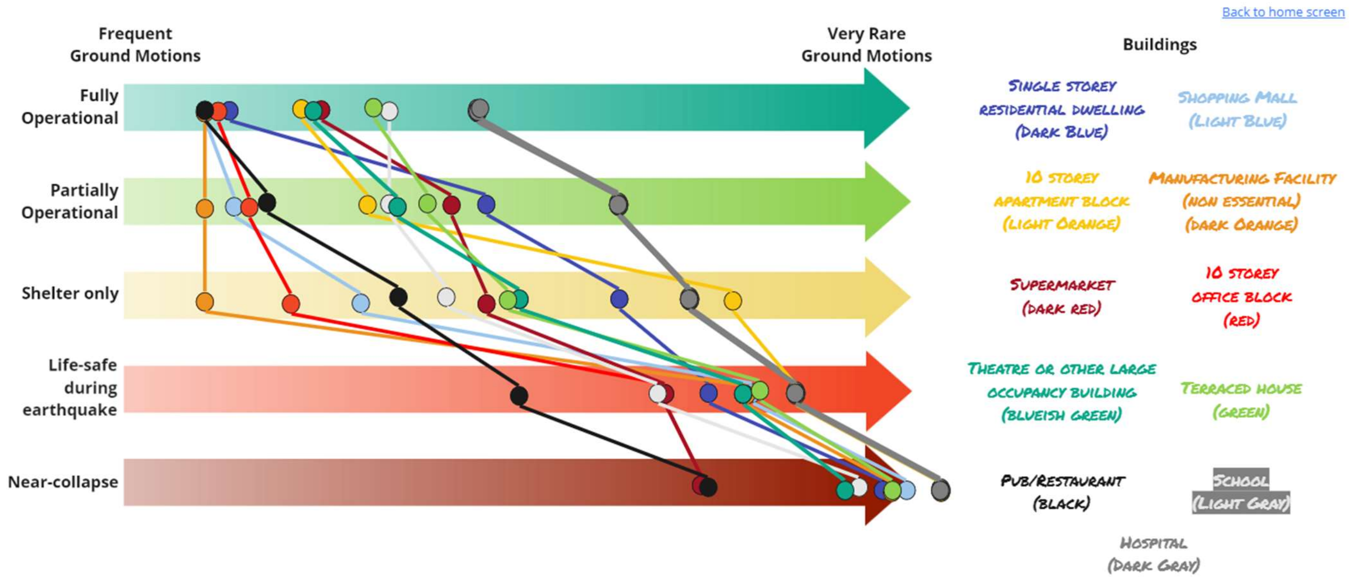

Figure 2: All Groups

The workshop concluded with a discussion of the research gaps identified to better integrate societal expectations into engineering design.

Key Takeouts:	
i.	Surprise about people's perceptions of acceptable recovery times for different building types, noting expectations for return to function were significantly shorter than anticipated. Are they attainable?
ii.	Acknowledgement that a schema for prioritising buildings for rapid return to function needs review, in particular to assess the needs of vulnerable groups e.g., aged care residents.
iii.	Suggestion that people conflate life safety with functionality, so there is need for greater clarity of expectations and outcomes.
iv.	Consultation needed to determine the actual cost difference for more resilient buildings and willingness to pay.

4.2.2 NZSEE Conference Plenary - The Resilient Buildings Project, 28 April 2022

The purpose of the session was to report the results of the Resilient Buildings Project snapshot of societal expectations and tolerance toward seismic risk to inform future performance objectives for new buildings. This session was designed to inform and engage the earthquake engineering and related technical community in the project.

The session provided background to the project and an overview of the project method and research findings. Participants were asked to participate through a Miro board developed using the results of the research[4].

Participants were also asked to contribute to a series of interactive polls with questions posed throughout the session. The primary goal of these polls was to bring to life the findings from the study and to engage the audience.

1. What does life safety mean to you?
    a) Protecting the most people possible
    b) Prioritising protection of the most vulnerable people
    c) Preserving capacity for recovery
    d) Reducing pyschosocial trauma

2. Of the following buildings, which would you prioritise most for improved seismic performance?
    a) Marae or other community meeting places
    b) Residential houses
    c) Residential apartments
    d) Supermarkets
    e) Aged care facilities

3. All communities have the same priorities for investment in seismic resilience?
    a) Yes
    b) No, communities place different values on different buildings
    c) No, community context (geography, isolation, capacity) impacts risk tolerance and resilence priorities
    d) I don't know

4. Building owners and users believe seismic resilience is the most important aspect of a building design?
    a) Yes, life safe and low damage design is critical
    b) Yes, but only the life safety part of seismic resilience
    c) No, seismic resilience is something forced upon them by regulation
    d) It depends on the type of building

The session included a discussion among panelists: David Kelly (CE, Master Builders), Dan Neely (Manager, WREMO), Eric Crampton (Chief Economist, NZ Initiative) and Alistair Luke (Principal, Jasmax Architects).

Panel discussion questions:

- The voices we heard through the project had a very broad take on concepts such as 'life safety' and 'immediate post-event functionality'. What are your view(s) on these concepts based on your role and lived experience?
- It seems a building stock that is able to support social and economic recovery following an earthquake is becoming an important priority. What is your sense of what enables social and economic recovery?
- The study identified a diversity of risk tolerance and preferences across participants and communities. What are your thoughts on communities having different seismic risk preferences

[4] https://miro.com/app/board/uXjVO6UoTUY=/?share_link_id=39111383631

and risk tolerances? Is this your experience? And should/could we be doing more to account for this?

- The RBP project asked participants to put seismic resilience in the context of all the other priorities in our built environment, where do you think seismic risk sits against other things building owners, occupiers and communities are concerned about? And do you anticipate that might change over time?

The session concluded with all participants being asked to consider:

- Having heard about the RBP findings – How does this compare to what you are hearing in your respective markets and social circles?
- What are clients demanding? In your mind, what are the priorities for improving seismic resilience of our building stock?

The session offered participants an insight into some of the complexities of the topic, together with comment on the need for a systems view (and approach) to improvements in seismic risk treatment – in client conversations, in policy and regulation, and greater clarity around the possible distribution of potential costs and benefits.

4.3 Gap analysis built environment

The purpose of this activity was to undertake a comparision of the built environment (housing types, urban and town building typologies, density and concentration of risk) as it was when the current building code settings were first conceptualised in the 1970s with that of current and possible future buildings. The exercise provided context for how and why our engineered buildings have evolved over time and identified the complexities and interdependencies for change, particularly drivers for the expansion or densification of urban centres. The objective was to establish ‘stylised facts’ about the New Zealand built environment to inform development of tolerable performance objectives.

The workshop on 16 June 2022 was informed by both a literature scan and exploratory interviews with experts in the field to provide a distillation of knowledge on changes over time for land use planning and resilient building design in New Zealand.

The workshop provided briefings on changes in land use planning, changes in the policy environment and changes in the insurance environment and explored the following series of questions:

- How have residential, commercial, industrial and public buildings changed and how we use them over time? Possible future changes?
- What were the drivers for change?
- Have the interdependencies between building types and infrastructure changed over time?
- How have urban centres in New Zealand changed over time?
- Are there also geographic differences across NZ? Are there differences between urban and more rural areas in different parts of NZ?

Key Takeouts:

i. Significant changes in the New Zealand urban environment are anticipated, particularly greater urban density in large cities and increased investment in public transport. This is largely to reduce transport emissions in response to climate change. Social acceptability of consequences of this policy not well established.

ii. Technology and an increasingly service based economy are changing building usage. Particularly evident in increased working from home, leading to reduced office space requirements in urban centres and allowing more remote working in general for some professions.

iii. Risk tolerance and built environment resilience not well aligned across existing range of legislation. Increasing awareness of this but whether better alignment is achieved in the future is not clear.

iv. Land use rules not currently well aligned with building regulation for natural hazard risk management including climate change adaptation.

v. The New Zealand insurance market is underpinned by global reinsurance capital. While the latter remains well capitalised it is increasingly constrained by risk aversion to natural hazard exposure with claim levels persistently higher in recent years affecting profitability.

vi. New Zealand is one of the most highly insured countries and has retained protection despite a decade of unprecedented insurance losses. Partly this reflects the stabilising effect of the compulsory EQC natural disaster scheme, which provides a government-guaranteed ‘floor’ to the residential insurance market. However, the recent loss experience together with rising natural disaster impacts world-wide mean that terms for insurance cover are more stringent than before.

vii. The potential for underinsurance is rising as inflation of property asset values and rebuild costs threaten to outstrip insurance covers and overall capacity for the local market. Insurers are managing their exposure to earthquake in high seismic risk areas, and greater scrutiny is anticipated for exposure to flooding and coastal hazards.

viii. Improving building resilience to mitigate the onset of damage by natural hazards, and developing a coherent science-led national view of risk(s) will help sustain New Zealand’s access to affordable risk capital.

4.4 Tolerable performance methodology development

The purpose of this activity was to assemble and review previous work in developing tolerable impacts, identify key issues and a prospective methodology for articulating contemporary expectations of tolerable performance and establishing performance objectives in buildings.

The work was completed with the Steering Group through a workshop held on 8 June 2022. The work was informed by a literature scan and exploratory interviews with experts in the field, shared and debated in the workshop.

The group identified an appropriate way forward is to rework Activity 3 of the 30 March workshop and map five states of performance ranging from fully operational through partially operational, shelter, life-safe during an earthquake, to collapse, ranked against earthquake return frequency for each building type. Then to combine the findings from this study with a fragility curve for each building type focussed particularly on amenity values. Future analysis will explore using a scenario based approach the limits of likelihood and consequence associated with the updated national seismic hazard model which is due for release in late 2022.

Key Takeouts:

i. Need to consider progressively tolerable impacts (as felt by end user)→ informing tolerable performance → leading to performance criteria and a framework.

ii. A desire for specificity when considering tolerable performance objectives has led in the past to dead ends. The level of specificity required needs careful consideration to avoid repeating past mistakes.

iii. Consistent terminology is required within the project (and across natural hazard risk tolerance criteria more generally), a "data dictionary" is required.

iv. Protection of property is not in current New Zealand legislation; unlike for example, Japan. A potential change for consideration is to include property protection which would encourage the mitigation of damage in smaller earthquakes thus improving building resilience.

v. The recent societal expectations research highlighted ambiguities in the current New Zealand building code which contemplates 'amenity' but does not differentiate tolerable and acceptable outcomes.

vi. Amenity values are a key focus area relevant to improving building resilience.

vii. Scenarios offer a way to communicate risk (and to test possible approaches to risk treatment).

viii. A diagram of the interdependencies for a building from design through whole of life would be a useful step in identifying hierarchies of need for information, sufficiency and sequencing for decision making and to test the efficacy of accountabilities and liabilities as currently assigned.

4.5 Intervention analysis

The purpose of this activity was to investigate the options available to address the gaps between societal expectations and current code settings and explore the economic implications of reform to improve building resilience.

The work was completed with the Steering Group through a workshop held on 8 June 2022. The workshop was informed by both a literature scan and exploratory interviews with experts in the field Ken Elwood (MBIE EQC Chief Engineer Building Resilience), Eric Crampton (NZ Initiative), David Dowdell (BRANZ), David Johnson (Massey University), Hugh Cowan, Helen Ferner (NZSEE). The aim was to clarify the knowns and known-unknowns for a group of key questions:

- Is there a cost premium and if so, what is its level for improving seismic resilience in new building construction?
- What are the types or categories of potential economic benefits for improving seismic resilience and how large are the likely benefits in economic terms?

- Why don't we find many buildings in New Zealand constructed above code when Kiwis seem to want more resilient buildings?
  - What factors are at play on the supply side? Perceptions of increased costs, inertia including traditional building industry construction structure and practices? Others?
  - What factors are at play on the demand side? Insurance policy distortions to people not understanding risk for low frequency high impact events? Others?
- What policy levers exist in addition to the seismic provisions of the building code to improve new building seismic resilience?

Key Takeouts

i. Building structural irregularity costs money and reduces building resilience. Incentivising more structurally-regular building designs would yield significant resilience benefits at no cost and without unduly inhibiting architectural objectives.

ii. "A code (minima) designed building is a barely legal building". There is a need to change the communications around seismic risk and building design.

iii. Improving the resilience of buildings is a system wide issue of which design performance objectives is but one part. Others include procurement, construction, consenting and liability management.

iv. Improving professional collaboration and oversight of the quality of work is required to lift system benefits and deliver more resilient buildings.

v. Land condition needs to be considered explicitly, either by discouraging development on sites that do not meet agreed resilience criteria, or by setting performance requirements that meet if not exceed them.

vi. Amending and improving liability frameworks across the construction industry to better align risk, capacity, competency, responsibility, and liability will improve building resilience.

5. References

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Appendix A: Workshop 30 March 2022

A.1 Examples of Miro Board Outputs

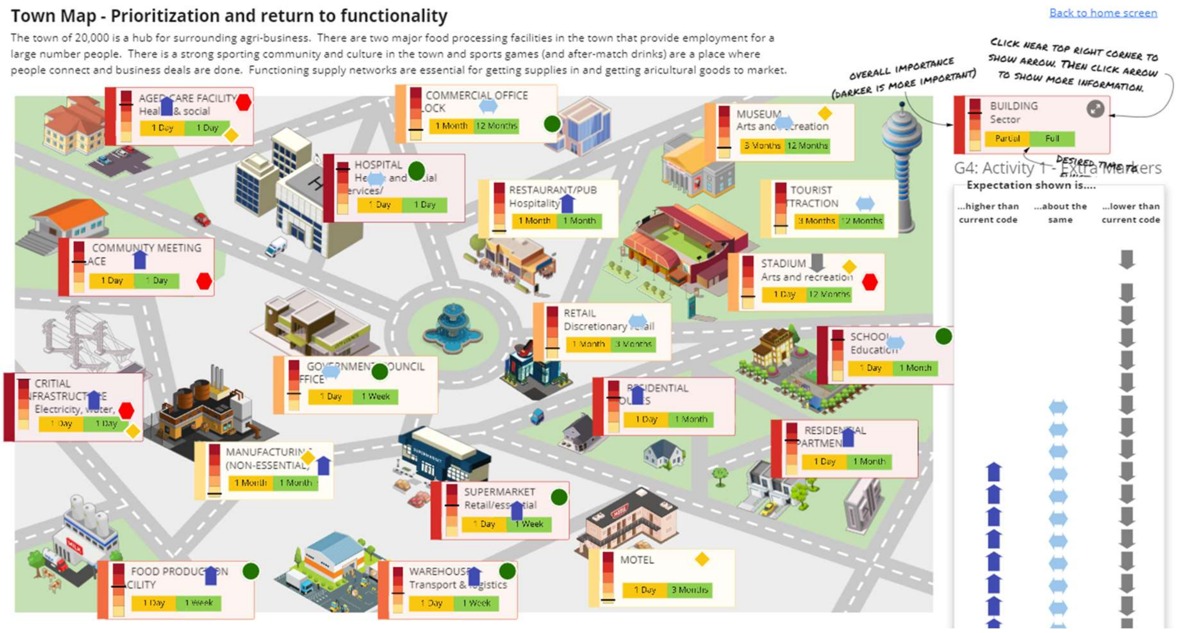


Figure 3. Completed Activity 1. Participants were asked their reactions to the RBP findings for the overall importance and desired time to return to functionality for each building. They could agree (green circle), be surprised (yellow diamond) or disagree (red hexagon). They were then asked if how the expectation shown aligned with the current code. An up arrow indicated that the expectation was more than the code currently delivers, sideways arrows indicates that it was generally aligned with code, and a down arrow indicates that the expectation is below code.

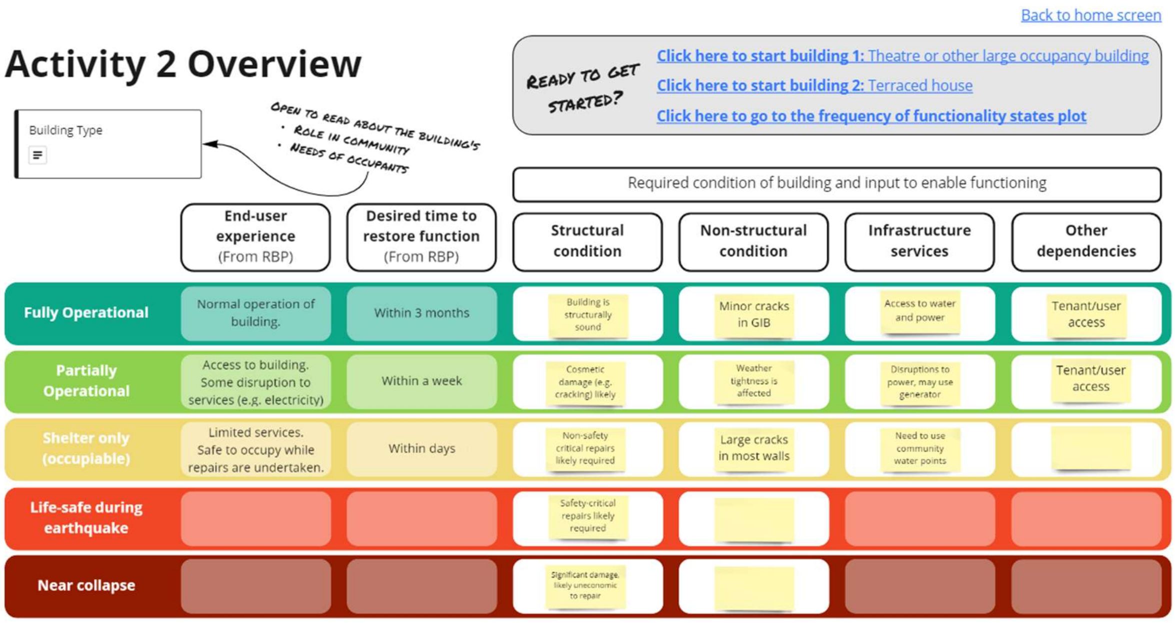


Figure 4. Overview of Activity 2

Table 1. Example output from Activity 2 for a Theatre or other large occupancy building. Shaded

Role in the Community	Short-term: Potential community gathering space / temporary shelter / staging emergency supplies Long-term: Support community wellbeing					
Damage State	**End-user experience (from RBP)**	**Desired time to restore functionality (from RBP)**	**Structural condition**	**Non-structural condition**	**Infrastructure services**	**Other dependencies**
Fully operational	Return to full and normal use	Within 12 months	"main" structure repaired; parts may still need repair/have restricted access	non-structural elements repaired to level that restores fire/smoke cells	access to sanitation	people want to be there - perception of risk
			minor repairs to accessible elements may be completed over time	HVAC fully operational	fire systems working	building services (etc) require wider infrastructure networks to be functioning
			structural repairs to inaccessible and below ground elements complete	all bwof elements repaired/reinstated	Electricity	Demand to use the theatre, people feeling safe being inside.
			safe egress	Disable access available	Telecoms	insurance/financing resolved
			weathertightness	access and egress systems fully restored		neighbouring buildings stable
				Lighting, sound, service access		access to area unhindered
				acoustics		
				storage/staging areas		

Partially operational	Flexible space for supporting recovery (community activities)	Within 1 month	life safety critical repairs only completed ...or life safety hazards removed Some shoring may still be in place full capacity may not be required but minimum threshold to be met Critical structural support elements in place?	Fire egress paths restored fully or alternative management in place HVAC operational reduced HVAC functionality may be ok safety critical bwof elements to be operational mostly weathertight	Electricity Portloo	availability of people to complete assessments, repairs and sign-off removal of other hazards like asbestos CDEM vs Building Act considerations Removal of debris to allow reasonable access needs flexibility in TA approach to opening in another use
Shelter only	Flexible space for supporting response (shelter, staging, gathering)	Within days	assessed and approved as adequately safe qualitative assessment temporary shoring if needed immediate falling hazards assessed and removed unsafe areas cordoned off	non-structural damage ok, provided no risk of falling or blocking egress limited or no service available temporary lighting or ventilation ok	Electricity available (generators or grid) portaloos etc available	appropriate assessors available, preferably with prior knowledge engineering inspection completed safe access to site
Life-safe during earthquake			should remain standing during reasonably foreseeable aftershocks, Still standing, people can get out safely	No major falling hazards egress paths protected emergency systems remain active unusable		
Near collapse			as life-safety?	nothing may be active		

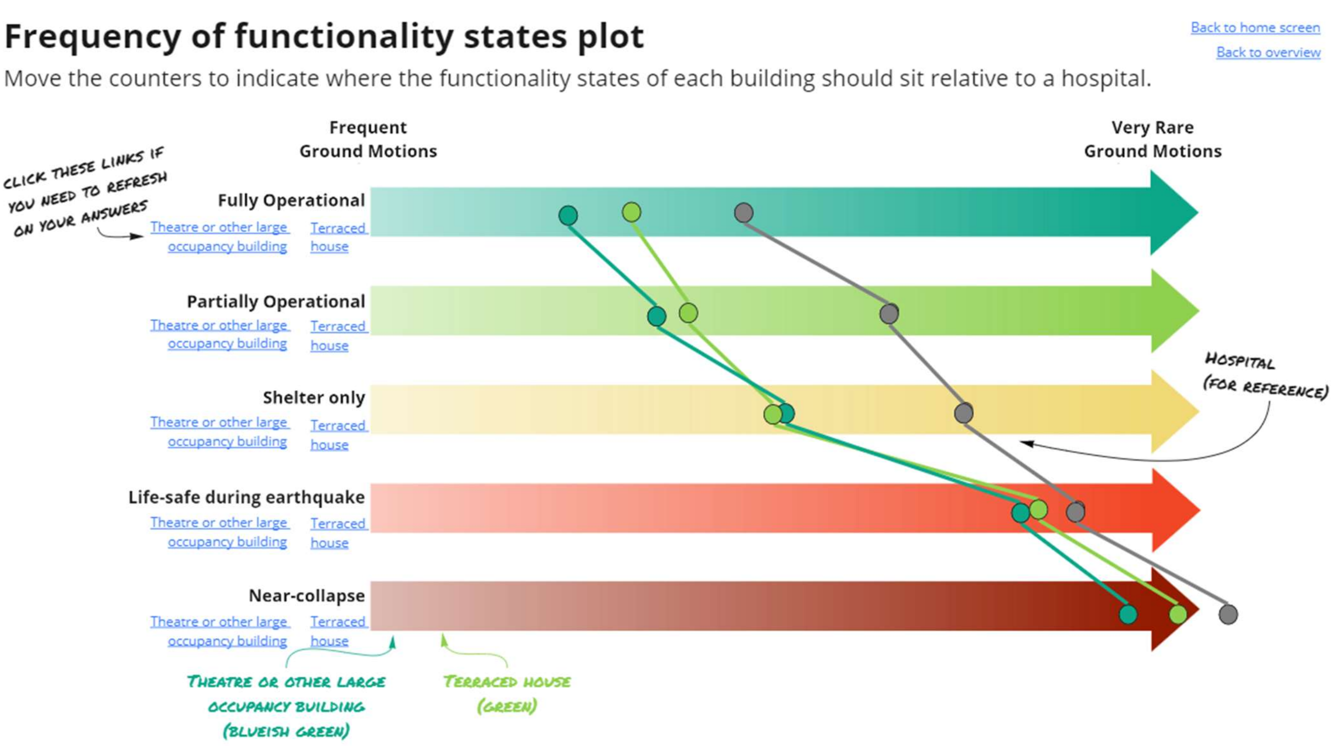


Figure 3. Activity 3

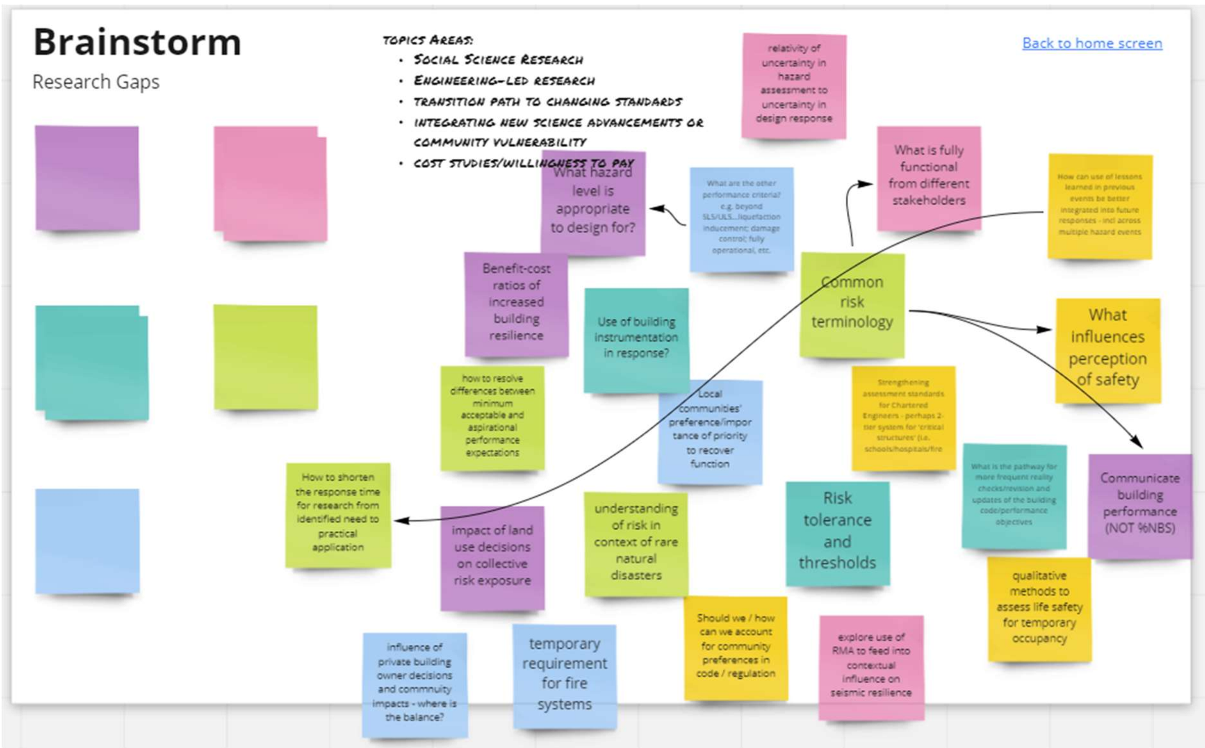


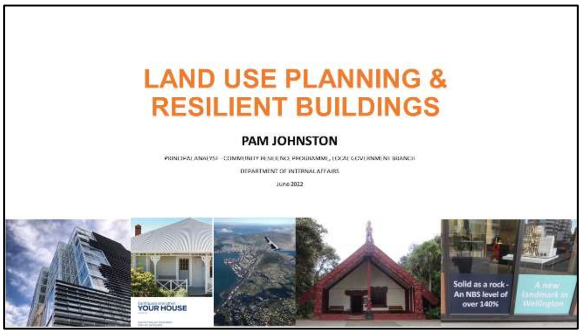
Figure 3. Activity 3

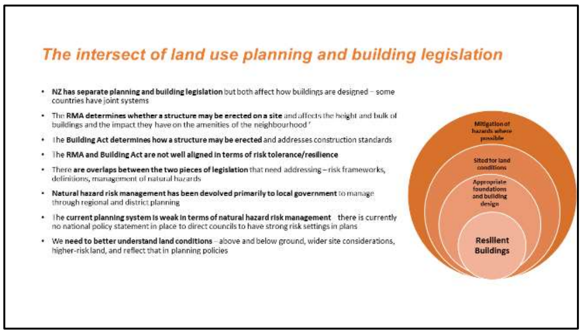
Appendix B: Gap Analysis Built Environment Workshop

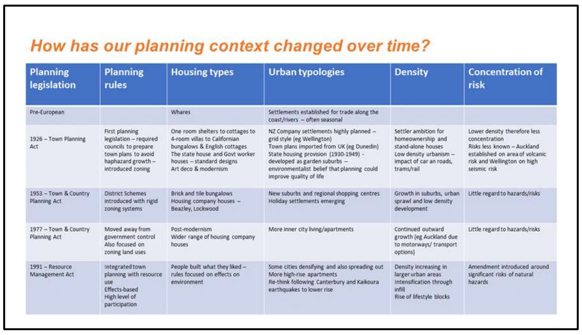
B.1 Presentations

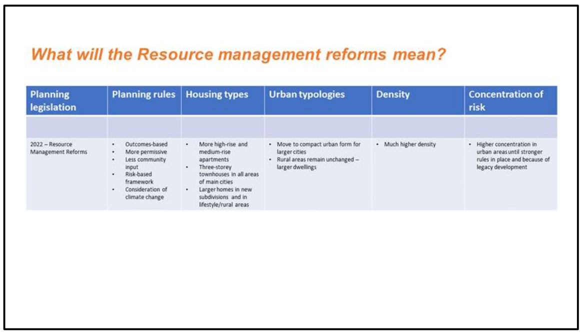
B.1.1 Land Use Planning & Resilient Buildings

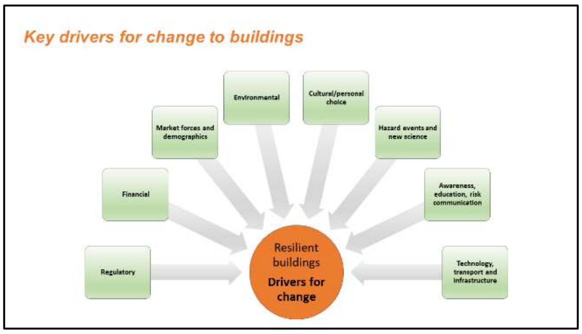
Presenter: Pam Johnston

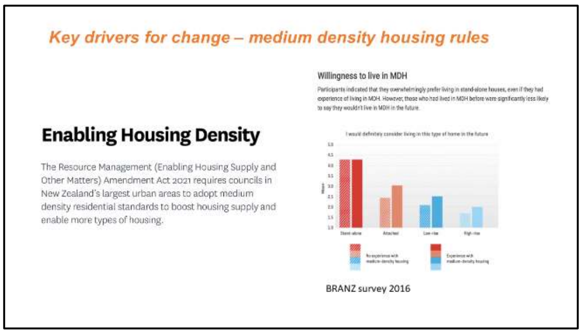


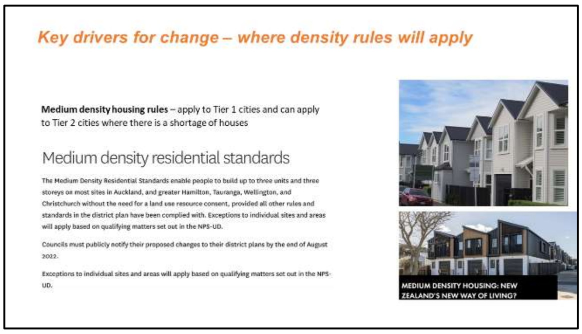




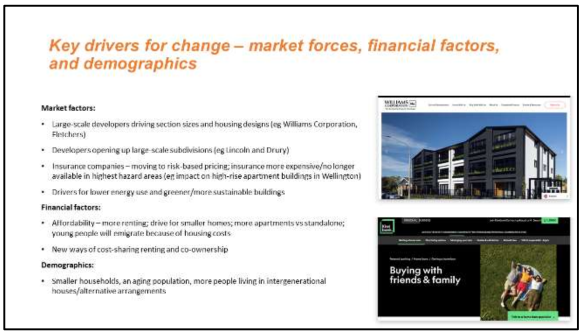





Key drivers for change – medium density housing rules
Enabling Housing Density
The Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021 requires councils in New Zealand's largest urban areas to adopt medium density residential standards to boost housing supply and enable more types of housing.
Willingness to live in MDH
Participants indicated that they overwhelmingly prefer living in stand-alone houses, even if they had experience of living in MDH. However, those who had lived in MDH before were significantly less likely to say they wouldn't live in MDH in the future.
I would definitely consider living in this type of home in the future
Stand-alone
Attached
Low-rise
High-rise
BRANZ survey 2016


Key drivers for change – where density rules will apply
Medium density housing rules – apply to Tier 1 cities and can apply to Tier 2 cities where there is a shortage of houses
Medium density residential standards
The Medium Density Residential Standards enable people to build up to three units and three storeys on most sites in Auckland, and greater Hamilton, Tauranga, Wellington, and Christchurch without the need for a land use resource consent, provided all other rules and standards in the district plan have been complied with. Exceptions to individual sites and areas will apply based on qualifying matters set out in the NPS-UD.
Councils must publicly notify their proposed changes to their district plans by the end of August 2022.
Exceptions to individual sites and areas will apply based on qualifying matters set out in the NPS-UD.
MEDIUM DENSITY HOUSING: NEW ZEALAND'S NEW WAY OF LIVING?

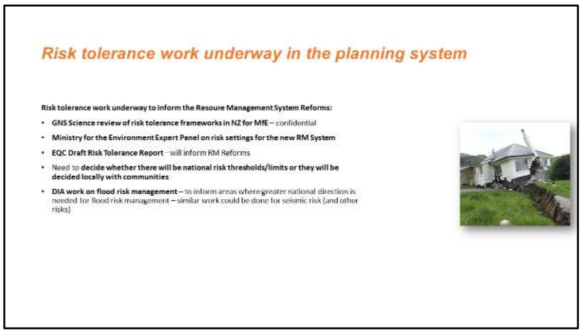

Key drivers for change – Resource Management Reforms
Resource Management Reforms:
Focused on outcomes – one key outcome is achieving natural hazard risk reduction and climate change adaptation
Will introduce a risk-based framework across the legislation
EQC Report on Risk Tolerance & MfE Expert Panel on Risk Thresholds/Tolerance – need to connect with the Building System work on risk
Natural and Built Environments Act
National Planning Framework – brings together all national direction in one document – conflicts; have agreement for stronger direction on natural hazard risk reduction/climate adaptation in the first tranche to direct regional spatial strategies (through DIA input to legislative processes)
Spatial Planning Act – regional spatial strategies
Climate Adaptation Act – mechanisms and funding for managed retreat
Existing national direction applies until new NBA plans in force (around 7 years away – a lot of new risk is still being created)
Resource management system reform

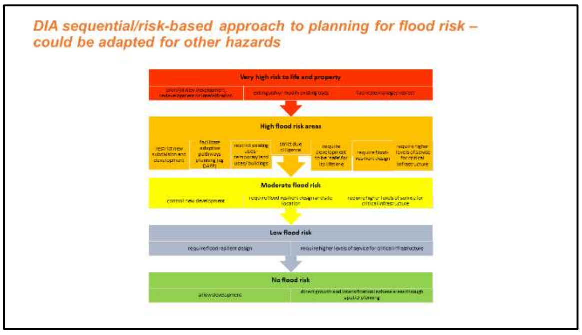

Key drivers for change – market forces, financial factors, and demographics
Market factors:
Large-scale developers driving section sizes and housing designs (eg Williams Corporation, Fletchers)
Developers opening up large-scale subdivisions (eg Lincoln and Drury)
Insurance companies – moving to risk-based pricing; insurance more expensive/no longer available in highest hazard areas (eg impact on high-rise apartment buildings in Wellington)
Drivers for lower energy use and greener/more sustainable buildings
Financial factors:
Affordability – more renting; drive for smaller homes; more apartments vs standalone; young people will emigrate because of housing costs
New ways of cost-sharing renting and co-ownership
Demographics:
Smaller households, an aging population, more people living in intergenerational houses/alternative arrangements
Buying with friends & family


Key drivers for change – environmental/cultural
Environmental factors:
Sustainability/resilience drivers – desire to live off-grid; tiny house movement; more people having vegetable gardens/fruit trees; water storage; valuing sunshine
Green homes and buildings– desire for solar homes, energy efficiency
Climate change drivers – desire for homes to be adapted for climate change
Cultural/personal choice factors:
Do people want to live in apartments – or are they living there as that's all they can afford?
Energy efficiency/self-sufficiency – off the grid/vegetable gardens/orchards
Resilience - climate and natural hazards – raising awareness of risks (eg AF8)
Choices – cost of building for resilience versus home which are cheaper have to be built back transportable/relocatable homes in highest risk areas; temporary houses
Materials – wood versus concrete in high seismic areas
More papakainga /iwi/Maori housing
BUILDING A GREEN HOME


Key drivers for change – technology, transport and infrastructure
Technology
More kitset/factory-built/prefabricated homes
3D houses?
Viscous dampers/base isolated buildings becoming more common
More online shopping – people not travelling to shops/CBD's emptying out
Transport and infrastructure
Greater investment in public transport and cycleways to encourage compact urban form
Uber/car sharing - no need to own cars
Parking no longer required by planning rules in many city areas for new apartments
Driverless cars – easier to live further away and being doing something else (eg work) while you take the trip
Earthquake technology in new Wellington buildings like giant 'shock absorbers'
Government moves to end minimum carpark requirements and remove low height-limits in bid to increase dense housing


Key drivers for change – hazard events, new science, education and risk communication
Hazard events
COVID pandemic – working from home – live anywhere not based on work location – young people in apartments doesn't work so well cf those in larger homes/older/wealthier people
Canterbury and Kaikoura earthquakes – lead to better understanding of land conditions and appropriate foundation design – technical category zoning in Chch, liquefaction guidance, basin edge effects, apartment dwellers perceptions study
New science
National Science Challenges, University research programmes etc – informing changes needed to building design
Public education and risk communication
Reform of the LIMs system; EQC Risk and Resilience Portal, MfE climate adaptation portal
National Science Challenges
Homes and spaces for generations


Risk tolerance work underway in the planning system
Risk tolerance work underway to inform the Resoure Management System Reforms:
GNS Science review of risk tolerance frameworks in NZ for MfE – confidential
Ministry for the Environment Expert Panel on risk settings for the new RM System
EQC Draft Risk Tolerance Report – will inform RM Reforms
Need to decide whether there will be national risk thresholds/limits or they will be decided locally with communities
DIA work on flood risk management – to inform areas where greater national direction is needed for flood risk management – similar work could be done for seismic risk (and other risks)


DIA sequential/risk-based approach to planning for flood risk – could be adapted for other hazards
Very high risk to life and property
High flood risk areas
restrict new subdivision and development
strict due diligence
require flood-resilient design
Moderate flood risk
control new development
Low flood risk
require flood resilient design
No flood risk
allow development

B.1.2 New Zealand Insurance Environment

Presenter: Hugh Cowan

New Zealand Insurance Environment

Resilient Buildings Project
Gap Analysis Workshop

Hugh Cowan
16 June 2022

Market Drivers

Softer Market
- Abundant capital
- Benign losses
- Topline growth
- Marketing trumps underwriting

Harder Market
- Severe losses
- Uncertain settlements
- Bottom line profitability
- Diminished investor interest
- Ratings pressures
- Underwriting trumps marketing
- Some withdraw

Historical

- Abundant insurance capacity (benign claims environment, lightly regulated market and few disputes)
- A State-mandated 'floor' to the market encourages strong insurance culture
- Earthquake and War Damage withdrew from "all tangible assets" in 1993
- Conversion of commercial buildings to residential (cheaper natural disaster cover) coincided with rising demand for apartments and better residential returns.
- Reform posed challenge for other 'non-residential' building owners, including churches, non-profits. Uneven cover for long-term accommodation of the elderly
- New Zealand market largely underwritten by global capital via Australia. Much stronger focus on risk selection and exposure management today

Current Environment

- Insurers are managing loss limits and retentions are rising (esp Wellington)
- Scrutiny of materials (expanded polystyrene and aluminium composite)
- Asset valuations and build cost inflation driving rates up on fixed (capital) capacity
- Limits to capacity for D&O and PI covers (defence and litigation costs)
- Reinsurance supply constrained by risk aversion not capacity – inflation, climate change impacts, cyber terrorism – grow uncertainty
- Reinsurance market is well capitalised, but earnings under pressure since 2017 (next slide), Covid losses, prior year loss creep, expensive retrocession cover and low interest rates.
- Emphasis on risk selection to reduce volatilities as investors and rating agencies question premium adequacy (understanding of risk)
- New Zealand insurers recorded local losses in 2021 ($324m) the highest since ICNZ records began in 1968

Peak Perils comprise Tropical Cyclone, European Windstorm and Earthquake.
Secondary Perils comprise Severe Convective Storm, Flooding, Drought, Wildfire, Winter Weather and Other.
Source: Aon Catastrophe Insight, April 14, 2022.

So What?

- Underinsurance (cause: asset values inflating and insurers reaching their aggregate limits earlier than expected)
- Claims inflation (cause: build cost inflation and supply chain disruption means delayed and higher final settlements)
- Terms of coverage challenging (more exclusions and complexity: communicable diseases, war, cyber, sanctions compliance)
- Retentions and low attaching covers (those exposed to frequent loss risk) are under pressure, so earnings volatility increasing for insurers

Market Resilience?

- Our non-life solvency standard requires that insurers are able to withstand the insurance losses from a major earthquake with a 1-in-1000 year return period. The insurance losses are to be the greater of an earthquake affecting Wellington only (defined as a 50km radius from the Beehive) or affecting anyplace other than Wellington
- First Insurance Industry Stress Test in April 2021 with the participation of the five largest New Zealand incorporated General Insurers.
- Purpose to assess the resilience, in particular the solvency, of the large General Insurers to severe but plausible stress scenario(s);
- Exercise highlighted the importance of reinsurance arrangements in providing New Zealand insurers capital support to meet solvency requirements.

Outlook

- Some insurers modelled reducing their exposure to high seismic risk areas as a potential mitigating action in the 2021 GIIST
- Actions will be driven by global reinsurance market and investor sentiment
- Factors for reinsurers
  - Availability and price of retrocession covers (ILS capital in play)
  - Premium adequacy in the local market (Australasia)
  - Global risk appetite for NatCat (how was Florida this year?)
- Local influences
  - Losses
  - Asset valuations and build costs
  - Hazard and risk modelling

Defensive Options

To maintain re/insurance capacities:

- Sustaining science infrastructure (sensor networks, data sharing, testing and simulation tools) and translation of hazard to risk
- Developing a coherent national view of risk(s) with balanced treatment options
- Mitigating loss is becoming crucial – managing the onset of damage
- Differentiating advocacy roles from professional responsibilities to maintain public and investor confidence
- Accepting that losses will drive markets, and relationships matter

B.1.3 Gap Analysis 16 June DG Stylised Facts

Presenter: Derek Gill

NZIER NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

Looking back to 1990 and looking forward to 2050

What trends might effect the build environment?

Name of presenter Derek Gill
Date of presentation 16 June 2022

Caveats

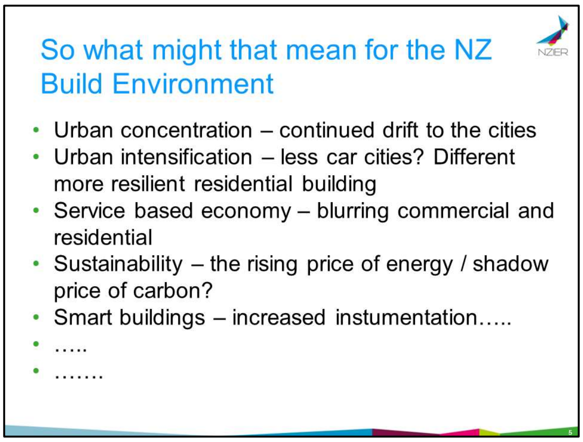
- Making predictions is hard, especially about the future (Danish proverb)
- In the futures space, the trick is to distinguish between the *trends that will continue* to play out over time from the *discontinuities* that have the potential to throw things off course
- People can't pick turning points at the time
- Scans on trends post Covid found a lot of wishful thinking & cheap talk, but little robust analysis

Long term trends that shape policy

Domain	1990 - 2020	2020-2050
Political		
NZ	MMP driving 2 major parties into the centre	Collapse of major party/ies
International	The collapse of communism	The rise of populism and authoritarianism, reemergence of the nation state
Economic		
NZ	Market liberalisation and macro stabilisation	Decline in CO2 emissions exposed industries – Tourism Dairy
International	Globalisation – people, goods, capital ideas	Adjusting to China not US centered global order Moving online and adopting new energy technologies in response to climate change

Long term trends that shape policy

Domain	1990 - 2020	2020-2050
Social		
NZ	Reduced social cohesion/ increased disadvantage	Ageing population Urban concentration
International	Reduced global inequality, increased inequality within and between countries	Ageing populations in developed countries & expanding middle classes in developing countries
Technological	Convergence of IT and Communications tech	4th industrial revolution – digitisation, A I, cloud technology, big data analytics, high-speed mobile
Environmental		
NZ	Erosion of natural capital	Protecting delicate ecosystems
International	Deforestation and growing CO2 emissions	Responding to climate change

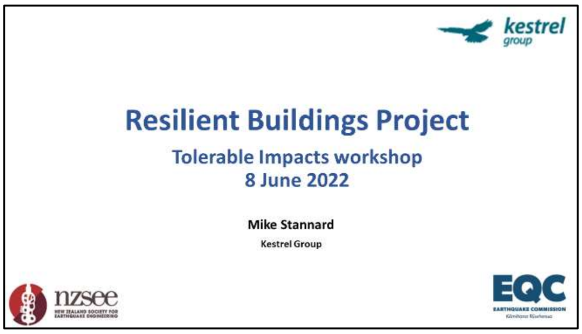

So what might that mean for the NZ Build Environment
NZIER
• Urban concentration – continued drift to the cities
• Urban intensification – less car cities? Different more resilient residential building
• Service based economy – blurring commercial and residential
• Sustainability – the rising price of energy / shadow price of carbon?
• Smart buildings – increased instumentation…..
• …..
• …….

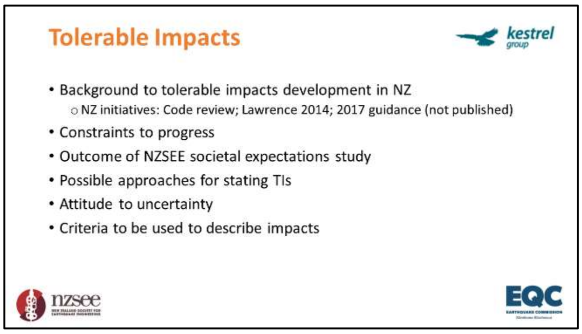

Your Thoughts
NZIER
• Residential ……..
• Commercial…
• Industrial…..
• Government….

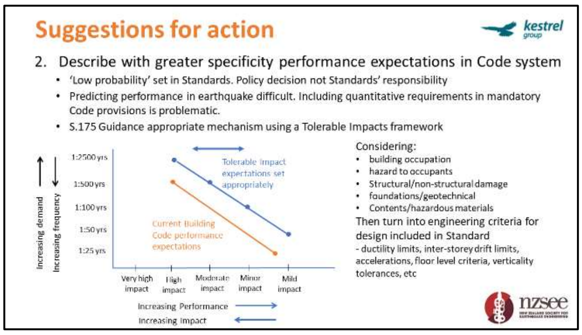
Appendix C: Tolerable Performance Workshop

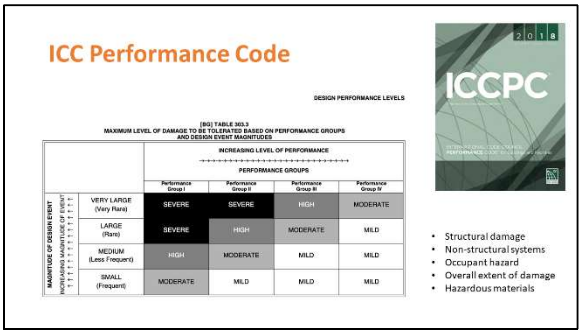
C.1 Presentation

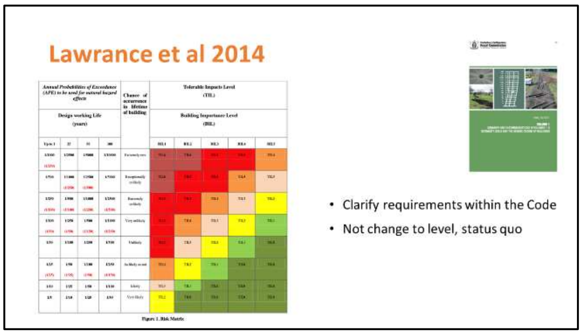
Presenter: Mike Stannard

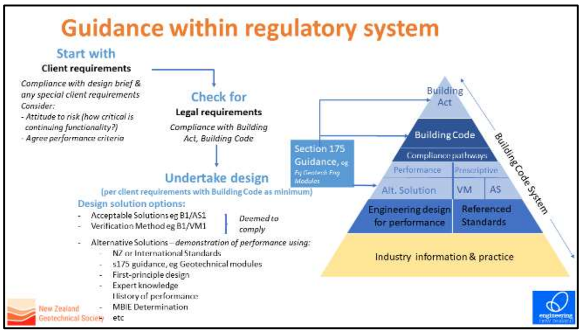


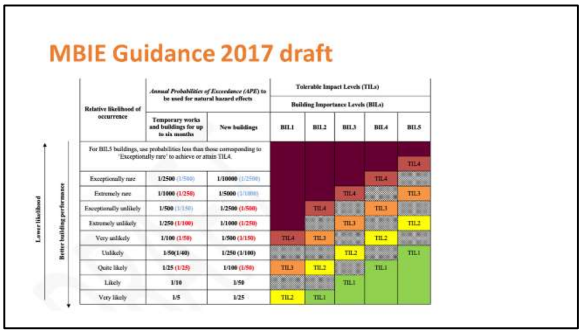












Tolerable impact criteria described

- Fatalities
- Injuries
- Ability to escape
- System damage
  - structural integrity
  - structural stability, slope stability,
  - means of support/liquefaction/lateral spreading vulnerability
  - deformation, ground settlement
- Element damage
- Non-structural system damage/functionality
- Building contents damage
- Hazardous materials
- Ability to reoccupy/functionality
  - This relies also on supporting infrastructure?
- Ability to repair
- Time to repair

Other TIL considerations:

- Buildings by type/use – different expectations for different buildings taking into account:
  - Importance Levels, refined to account for
  - Insights from NZSEE/EQC Societal Expectations study
  - Location of building in its setting within the community
    - rural/provincial/central high rise CBD
  - Essential community services – medical, pharmacies, food retail, etc
  - Infrastructure – bridges, etc
- Magnitude of events – how many?
  - Small to very large (4 steps) ICCPBC
  - Very likely to exceptionally rare (9 steps) 2017 unpublished guidance

- Wider societal issues
  - Confidence and trust in the building regulatory system
  - Designer/engineer reputation
  - Environmental/sustainability/embodied carbon in need for rebuild
  - Uncertainty – demand/capacity

Bullets In Red: additional to considerations in these previous initiatives

Constraints to previous progress

- **Challenging environment with many crises to deal with** – *leaky buildings, sustainability, Canterbury/Kaikoura earthquakes, rebuild, consenting, liability, affordability*
- **Changing priorities and personnel churn.** *9 Ministers, 3 changes of government and 10 bosses to report to from 2003 to 2017.*
- **Culture** – *personal agendas, lack of overall team vision, mutual support and trust.*
- **Issue of the day – urgent vs important.** *To be fair, there were many fires to extinguish during the period.*
- **Short term wins (*looking like it's under control)* vs in-depth horizon scanning and understanding to develop a longer term vision for the building regulatory system**
- **Shortage of real building sector/industry expertise within government** – *technical (hard T!) seen as less important than policy*
- **Liability concerns about changing the Code (mandatory requirements) when there was too much uncertainty about building performance in specific earthquake events** – *Addressed by stating elsewhere within the Building Code system – non mandatory s.175 guidance that would aid Building Standards writers and any consenting of alternative solutions*
- **Poor centralised data access** – *constraints on understanding what is occurring in practice*
- **Uncertainty in quantifying performance:**
  - Demand – loading based on research and modelling 20+ years out of date – *resulted in commissioning Norm Abrahamson to review structure and process for seismic hazard analysis, and eventually the HSHM being reviewed*
  - Capacity – *on-going new learning, pre-cast concrete floors, etc.*
- Costs involved in making regulatory change – regulatory impact statement and cost-benefit required.

THE WORLD BANK

International comparison of code performance objectives

	Aust	England	Japan	IBC	Europe	NZ	India
Safety protection	✓	✓	✓	✓	✓	✓	✓
Health & wellbeing	✓	✓	✓	✓	✓	✓	✓
Protection of other property	✓	✓	✓	✓	✓	✓	✓
Escape event of fire	✓	✓	✓	✓	✓	✓	✓
Resilience/property protection	✓		✓	✓			
CO2 minimization	✓	✓	✓	✓	✓	✓	
Energy efficiency	✓	✓	✓	✓	✓	✓	✓
Water efficiency	✓	✓	✓	✓	✓	✓	✓
Security/crime prevention		✓	✓	✓	✓		

Note: some of these objectives are not explicit in legislation
- Indicative only

1. Legal and administrative infrastructure

Questions

- Are there other criteria that should be added to the lost of criteria to describe tolerable impacts?
- Is there another way to describe what society's tolerance for risk?
- What insights are provided from the NZSEE societal expectations review that can help set the level of risk tolerated?

Opportunity

"Victory belongs to the most persistent" – Roland Garros

Appendix D: Intervention Analysis Workshop

D.1 Presentation

Presenters: Derek Gill & Tal Sharrock-Crimp

Resilient Buildings Intervention Analysis Workshop

Wednesday 8th June

Derek Gill & Tal Sharrock-Crimp

Structure of the workshop

1. Introduction
2. Cost Premium
3. Objectives and Benefits
4. The Counterfactual – building above code
5. Levers

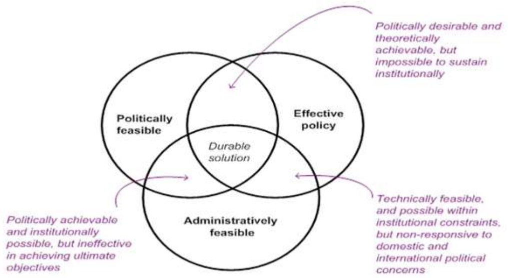
Refreshment Break

6. Packages of levers
7. Challenges/ Next steps

1 Introduction

- Purpose – identify the policy levers/options and explore possible packages of levers - and highlight unresolved questions
- Scope – explore wide range of possible levers affecting resilience of new buildings
- Test initial findings from interviews with selected stakeholders and the literature scan
- Style - 1st pass / broad brush /order of magnitude - high to low, ordinal not cardinal rankings

Possibility space



2 Cost Premium

The 'stylised fact' that emerges from range of mainly US studies is that increasing building stiffness and strength by say 50% adds comparatively little to new building construction costs (midpoint of 1% in a range of 0-2.0%)

- *Is this result transferable to New Zealand?*

2 Cost Premium

Other potential levers include changes in design practices (regularity, capacity design, tying and redundancy) and tightening the control regime applying to non-structural elements.

- *How do the costs of improved seismic design practices compare with the 1% for building stiffness and strength?*
- *What about the costs of tightening the use of non-structural elements?*

3 Objectives and Benefits – the size of the prize

The NIBS study has a well-defined list of potential benefits by avoiding: property damage (33%), death, injury, PTSD (18%), business Interruption and residential displacement costs (32%), other economic loss e.g. unemployment (14%), social impact, environmental loss, other /intangibles.

- *Do you agree these categories are equally applicable to NZ ?*
- *What should the objectives be - life safety, LS + reduced time to recovery, LS + RTR + environmental sustainability ?*

4 The Counterfactual – building above code

The stylised fact from research and interviews is that building above code for seismic risk in NZ is so rare that the exceptions prove the rule. This raises a puzzle as the Phase 1 Social Expectations research strongly suggested that Kiwis wanted buildings that are more resilient to earthquakes.

- *Why doesn't Kiwis desire for more resilient buildings (at the macro level) reflected in more buildings in NZ constructed above code (at the micro level)?*

5 Potential Levers

Policy levers are interventions that the Government can use to achieve objectives such a subsidies, tax concessions, primary legislation, secondary rules, tertiary guidance, risk communication programmes etc .

- *Apart from the seismic provisions of the building code, what other policy levers should be considered?*

Options Exercise – Road Map

1. As individuals brainstorm options
2. Pick your top 4 and fill in the assessment grid, stick them on the wall
3. Put remaining post-it in the parking lot

Break (NZIER to aggregate duplicates)

4. As a group discuss co-dependences, inter-dependences and independence of options

Options Brainstorm

Benefit/Impact	Costs	Confidence	Implementation	Other indirect

Benefit: What is the likely impact of the proposed option? (1 low – 4 high)
Costs: What is the likely cost of the proposed option? (1 low – 4 high)
Confidence: How likely are the benefits and costs assumed likely to be true? (1 low – 4 high)
Implementation: How easy or difficult will the proposed option be to implement or introduce (1 low – 4 high)
Other indirect: Other impacts/costs/externalities (1 low – 4 high)

Options Brainstorm – example

Seismic code refocused on reduced time to recovery

Benefit/Impact	Costs	Confidence	Implementation	Other indirect
4 High ($NZ 200m.)	2 Low (1% on new buil dings)	3 Medium (US seismic risk and economy differ)	1 Minimal	4 High (environment al co-benefits)

Benefit: What is the likely impact of the proposed option? (1 low – 4 high)
Costs: What is the likely cost of the proposed option? (1 low – 4 high)
Confidence: How likely are the benefits and costs assumed likely to be true? (1 low – 4 high)
Implementation: How easy or difficult will the proposed option be to implement or introduce (1 low – 4 high)
Other indirect: Other impacts/costs/externalities (1 low – 4 high)

Refresh stop

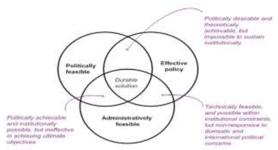
6 Packages of Levers

Packages generally combine mixtures of structural and behavioral levers.

- *Co-dependent - What levers must be used together?*
- *Interdependent - What levers work better together?*
- *Independent – Do any levers stand alone?*

Key Challenges

- *What more do we need to know about what works?*
- *What are the key implementation risks?*
- *How to best expand the feasibility space?*
- *Others?*



Reflections and Next Steps

- *Key reflections/ take aways / insights from the workshop?*
- Next steps finalise the packages of levers, highlight the unresolved questions, clarify approach for Stage 3

Selected References

- Levente Timar, Arthur Grimes, Richard Fabling, "That sinking feeling: The changing price of urban disaster risk following an earthquake," *International Journal of Disaster Risk Reduction, Volume 31, 2018, Pages 1326-1336*," https://doi.org/10.1016/j.ijdrr.2018.01.02.
- McClure, J., Wills, C., Johnston, D., & Recker, C. (2011). "How the 2010 Canterbury (Darfield) earthquake affected earthquake risk perception: Comparing citizens inside and outside the earthquake region." *Australasian Journal of Disaster and Trauma Studies , 2011*(2), 3–10.
- NIBS "Natural hazard mitigation saves: 2019 report" https://www.nibs.org/projects/natural-hazard-mitigation-saves-2019-report

6 Packages of Levers – 3 starters for ten

1. Extending the objectives of the Building Code to cover speed of recovery
- significant increase in mandatory code requirements focused on reduced time to recovery, suite of measures to improve seismic design, new package for non-structural elements augmented by optional standard on environmental sustainability
2. Mandating environmental sustainability in the Building Code
- this option augments Option 1 by expanding the minimum seismic provisions in the Building Code that provide for environmental sustainability objectives as well as recovery of economic and social functions
3. Using voluntary standards and guidelines
- This differs from Option 1 as wider objectives are embodied in voluntary and guidelines backed by enhanced testing and certification. Also includes, measure to improve resilience of design and use of non-structural elements/locations

D.2 Outputs for possible levers to improve building resilience in new buildings

- **Aspiration/goal**
    - **Lever**
        - **Tool/mechanism/policy**

- **Designing and building more seismically resilient buildings**
    - Make it more difficult/discourage building on sites that do not fulfil criteria for seismic resilience
        - Tax sites that do not meet resilience criteria
        - Increase communication between the building industry and land use planning sectors
    - Improve compliance of process from design to build
        - Introduce and improve strong compliance monitoring processes from beginning to end. Needs to involve everyone involved in the project from all involved industries – to occur regularly
    - Amend and improve liability frameworks to align responsibility with actual capacity for 'assurance' and in turn encourage better outcomes
        - Amend liability frameworks to better reflect empirical uncertainties in risk and risk treatment, so to clarify where residual performance risks lie and how legal frameworks might better apply.
    - Incentives for higher building performance
        - Subsides for higher building performance – based on community define desired performance? tax concessions?
        - Incentives for building for climate change (resilience expressed in environmental/carbon benefits, emphasis on reparability)
        - Improve building code or guidance material
            - Improve the design and build of small 1-2 storey nominally ductile buildings, but provide more specific guidance
        - Incentivise design of more regular buildings/fewer irregular buildings
            - Irregular lateral-load resisting designs would pay higher levies
            - Highlight the benefits of regular buildings to the industry and to the developers
            - 50-year performance bonds for developers to incentivise enduring approaches to design/build
        - Re-examine insurance incentives
- **Improve the collaboration and quality of work of contributing professions**
    - Improve the regulation of engineers to lift and appropriately define competency levels and limits
    - Improve and incentivise communication and collaboration throughout the design and build process –clarify roles and responsibilities
- **Communicate seismic resilience**
    - Improve the transparency of seismic hazard and risk information
        - Provide an open database where the seismic performance of any given building can be accessed by anyone including regularly updated compliance monitoring

    - Regular inspection regime to ensure compliance continues
  - Upskill buyers and developers on the need/benefit of seismic resilience.