The Resilient Buildings Project

Societal expectations for the seismic performance of buildings

Reflections for critical infrastructure

nzsee NEW ZEALAND SOCIETY FOR EARTHQUAKE ENGINEERING

EQC EARTHQUAKE COMMISSION Kōmihana Rūwhenua

Background

New Zealand has gone through a period of unprecedented losses from seismic activity, which has highlighted shortcomings in the seismic settings of our building regime.

Engineering knowledge in designing for earthquakes has advanced significantly since the current approach to building design was developed in the 1970s.

New Zealand's urban landscape has also changed profoundly with more multi-storey development, in-fill housing etc.

New Zealand's Building Code has not kept up with these developments. New Zealand's seismic thresholds for damage are relatively low, meaning Kiwis are exposed to considerable economic and social disruption after earthquakes.

A recent review commissioned by MBIE from the Seismic Risk Working Group raised fundamental issues about Building Code's seismic regime objectives and who makes the value tradeoffs required.

Project Team

Charlotte Brown
Resilient Organisations

Shannon Abeling
University of Auckland

Sophie Horsfall
Resilient Organisations

Helen Ferner
NZSEE

Hugh Cowan
Hugh Cowan Consulting

Steering group

- **Sarah Beaven**, University of Canterbury
- **Dave Brunsdon**, Krestel
- **Caleb Dunne**, EQC
- **Ken Elwood**, MBIE/EQC
- **Derek Gill**, NZIER
- **John Hare**, Holmes Consulting Group
- **Jo Horrocks**, EQC
- **Rob Jury**, Beca

What we did

INTERVIEWS

32 individuals who represented different:

- seismic hazard zones
- geographies
- socioeconomic groups
- industry groups
- ownership / occupancy perspectives
- cultural contexts

FOCUS GROUPS

6 geographically based groups

- urban centres & towns
- different seismic hazard levels

Groups comprising 3-7 individuals who represented:

- local civil defence
- business community
- health sector
- welfare sector
- environmental interests
- Māori world view

Focus Group – City/Town Map

1. How important is it to preserve live within each building?
2. Which buildings are most important to reduce **social impacts**?
3. Which buildings are most important to reduce **economic impacts**?
4. For a new building, how much functionality should each building have in the given timeframe?
   - 1 day
   - 1 week
   - 1 month
   - 3 months
   - 12 months

5. How would you invest in buildings (pre-event) to reduce the impact of earthquakes?

Focus Group – Risk Matrices

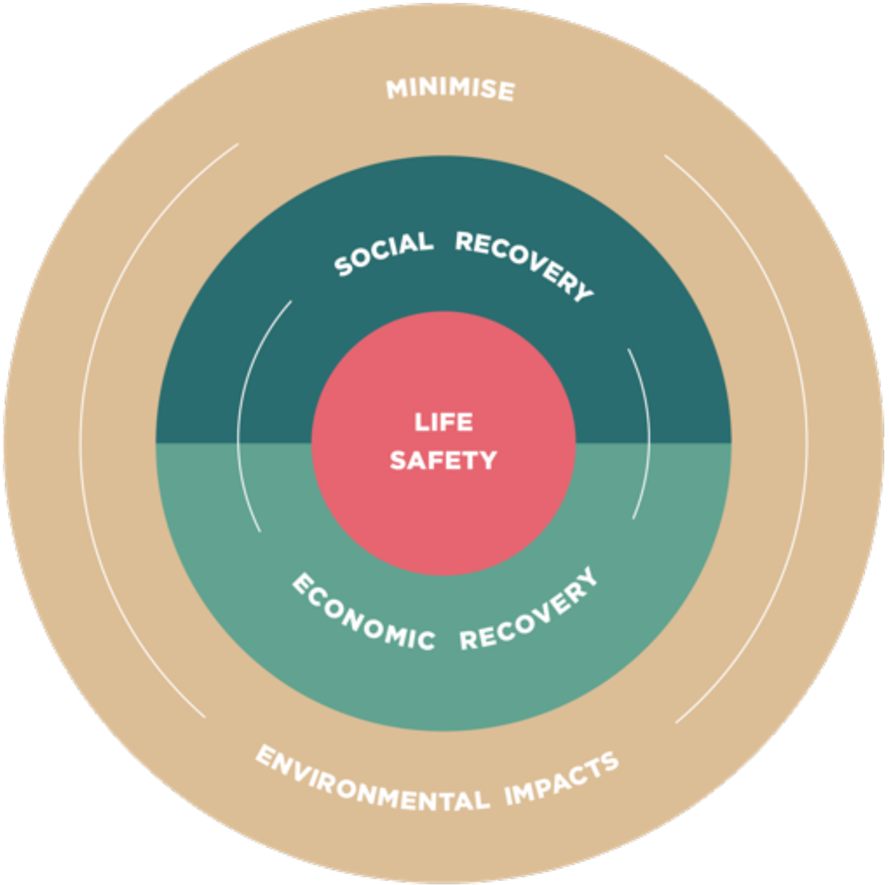
New Zealand's Expectations on Seismic Resilience of Buildings

INTOLERABLE	no way – risk is so great that it can't be justified
TOLERABLE	I can put up with this but would like it to change
ACCEPTABLE	part of daily life – these things happen

Average FREQUENCY and LIKELIHOOD	CONSEQUENCE (HUMAN) I • Low impact on human wellbeing *(capacity to work, study recreate, socialise)*	II • < 1 in 20,000 people injured • Some education temporary closures *(< 1 week)* • Some social and recreational activities disrupted *(< 1 week)*	III • No or minimal fatalities • Between 1 in 20,000 and 1 in 2,000 people injured • Education facilities temporary closures *(< 1 month)* • Temporary disruption to social or recreational activities *(< 1 month)* • Some ongoing mental health challenges *(6-12 months)*	IV • Multiple fatalities • > 1 in 2,000 people injured • Education facilities prolonged closures • Limited or no access to social or recreational activities for significant period • Significant and ongoing mental health challenges *(>12 months)*
Less than once every 2500 years (extremely rare) <2% chance in typical building life (extremely unlikely)				
Once every 1000-2500 years (very rare) 2-5% chance in typical building life (very unlikely)				
Once every 250-1000 years (rare) 5-20% chance in typical building life (unlikely)				
Once every 100-250 years (occasional) 20-50% chance in typical building life (less than likely)				
Once every 50 - 100 years (sometimes) 50-100% chance in typical building life (likely)				
Once every 0-50 years (often) Probably once in typical building life (very likely)				

Seismic resilience performance objectives

Seismic resilience performance objectives



1: LIFE SAFETY

Avoid mass casualty events
Protect vulnerable persons
Ensure safety at mass gathering points
Preserve high value skills and resources
Support immediate response activities

2: SOCIAL RECOVERY

Ensure equitable access to essential goods and services
Enable effective governance
Have plans to connect
Return a sense of normalcy
Retain a sense of place and cultural identity

3: ECONOMIC RECOVERY

Restore enabling services and industries
Enable people to work
Build business confidence

4: MINIMISE ENVIRONMENTAL IMPACT

Minimise waste generation
Avoid hazardous waste or potential public health risks
Reduce embodied carbon

Recovery progression

Recovery Progression

BUILDING TYPE	1 DAY	1 WEEK	1 MONTH	3 MONTHS	12 MONTHS
Critical Infrastructure (water, electricity, etc)					
Hospital					
Community Meeting Place					
Aged Care Facility					
Supermarket					
Government/Council Office					
Food Production Facility					
Motel					
Residential Apartments/Houses					
Warehouse					
School					
Stadium					
Restaurant/Pub					
Manufacturing (non-essential)					
Commercial Office Block					
Retail					
Museum					
Tourist Attraction					

TOWN/CITY MAP

COLOUR KEY:

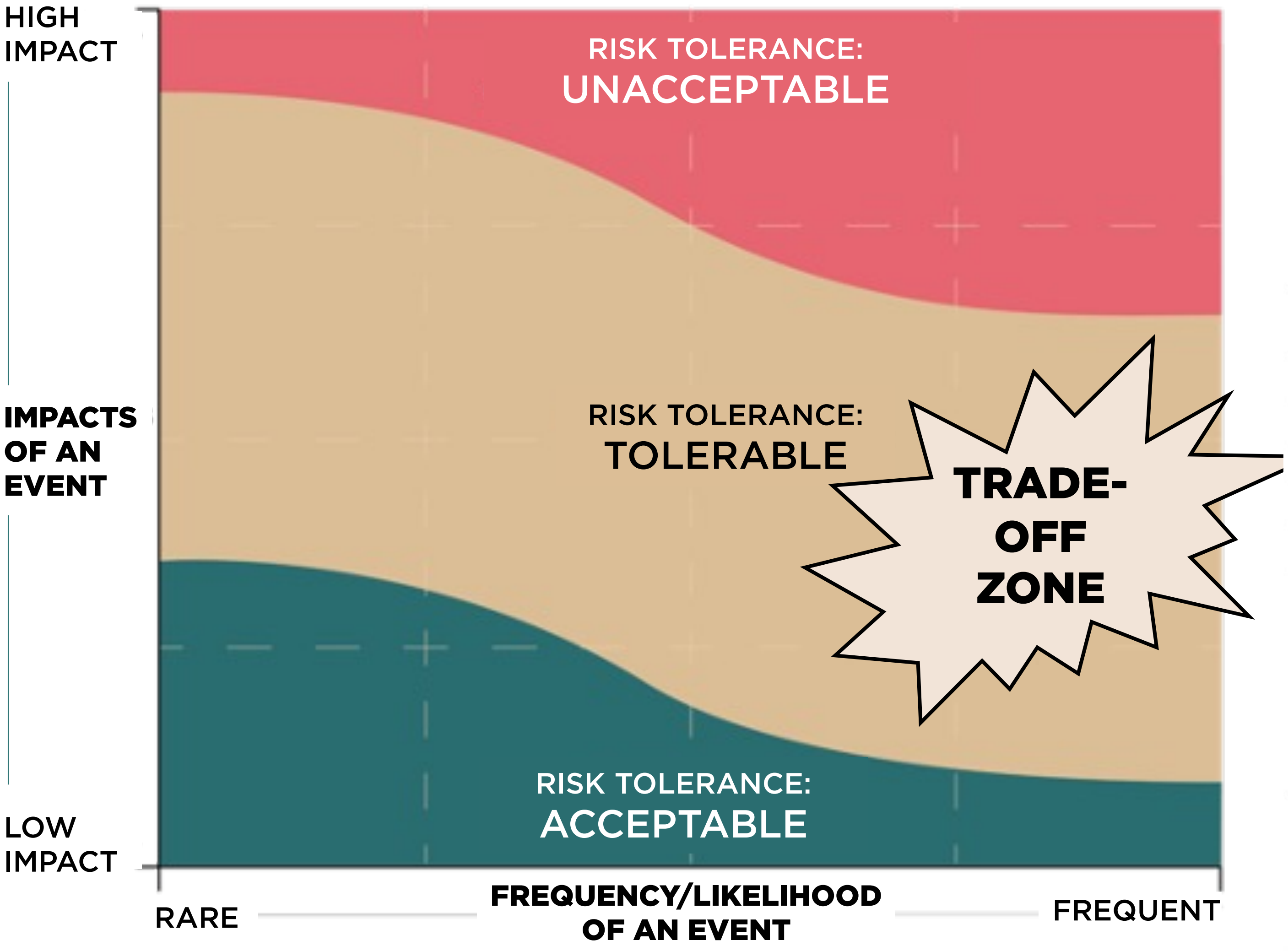
NOT FUNCTIONAL — FULLY FUNCTIONAL

Risk Tolerance

Risk Tolerance

COMMUNITIES WITH LOWER TOLERANCE FOR RISK	COMMUNITIES WITH HIGHER TOLERANCE FOR RISK
LOW hazard zone	HIGH hazard zone
Geographically ISOLATED	NOT geographically ISOLATED
HIGH density built environment	LOW density built environment
LOW recovery capacity	HIGH recovery capacity

Risk Tolerance



Risk Tolerance: Unacceptable
Multi-Generational Impacts

Social or environmental impacts that undermine the social fabric of a community, e.g. loss of trust in governance, environment degradation.

Risk Tolerance: Tolerable
Trade-Off Zone

Tolerance depends on cost to community today and opportunities for co-benefits.

Tolerance varies through space and time.

Risk Tolerance: Acceptable
Normal Maintenance

Low levels of damage that do not disrupt regular building use.

Tolerable Risks: Managing trade-offs

INCENTIVES

- Long-term perspective
- Return on investment
- Buoyant rental and real estate market
- Perception of safety
- Tight insurance market
- Co-benefits
- Government regulations or incentives
- Reduced down time and rebuild cost

HINDERANCES

- Competing priorities
- Supressed rental and real estate market
- Perception of cost
- Concern over where costs fall
- Insurance availability
- Assumed government support post-event
- Pooled risk across business operations
- Neighbourhood effects
- Infrastructure damage
- Lack of trust in engineering and construction sector

Seismic resilience in context

Seismic resilience in context

SAFETY
Fire safety
Safety day to day (🔗 *Wellbeing*)
Earthquake life safety

WELLBEING
Acoustics
Lighting
Temperature
Access to amenities
Indoor air quality (🔗 *Safety*)
Accessibility (🔗 *Functionality*)

FUNCTIONALITY
Usability
Accessibility (🔗 *Wellbeing*)
Adaptability (🔗 *Longevity*)

LONGEVITY
Durability (🔗 *Sustainability*)
Adaptability (🔗 *Functionality*)
Repairability

ENVIRONMENTAL SUSTAINABILITY
Embodied carbon
Operational carbon
Material choice
Durability (🔗 *Longevity*)

AESTHETIC AND CULTURAL VALUE
Architectural design
(🔗 *Functionality and Wellbeing*)
Heritage (🔗 *Longevity*)

COST
Capital cost
Whole of life cost
(🔗 *Sustainability and Longevity*)
Return on investment

Reflections for Critical Infrastructure

- Method – some transferrable elements
- Findings are generally transferrable but specifics for infrastructure would be useful, especially around recovery timelines
- More nuance around risk tolerance, specific to infrastructure disruption may be useful (e.g. is there anything beyond hazard zone, geographic isolation, density built environment and recovery capacity?)
- Incentives and disincentives for resilience investment may be different due to different ownership structures and financing of infrastructure?
- Interesting to explore infrastructure resilience relative to other built environment priorities – tension between sustainability / community amenity

The Resilient Buildings Project

Link to report and policy brief

https://www.resorgs.org.nz/our-projects/risk-and-resilience-decision-making/nzsee-resilient-buildings-project/

nzsee New Zealand Society for Earthquake Engineering EQC Earthquake Commission

Questions + Discussions