Post-Earthquake Response: Update On The Improvements To The Rapid Building Assessment Process And Building Management In Emergencies

P.A. Campbell, D.R. Brunsdon, J.R. Farrell, R. Green,
WSP, Auckland, New Zealand, Kestrel Group, Wellington, New Zealand,
Whakatāne District Council, Whakatāne, New Zealand, Rori Green Consulting, Christchurch, New Zealand
A. Macauley & E Herbert
Ministry of Business, Innovation and Employment, Christchurch, New Zealand

ABSTRACT

It is vital that New Zealand has both the systems in place and trained personnel ready to respond to earthquakes and other natural disasters. Rapidly assessing the usability of affected buildings and identifying an appropriate management response is key to safeguarding people whilst imposing the minimum appropriate level of restrictions on a community.

The Ministry of Business, Innovation and Employment (MBIE), as lead agency has legislative responsibilities for the management of buildings in emergencies. To ensure an appropriate level of technical advice, MBIE formed a Building Management in an Emergency (BMIE) Technical Working Group (TWG). The TWG membership includes Engineering, Territorial Authority/ Building Consent Authority and Government Agency representation. With a mandate for continuous improvement, the TWG have updated, re-instigated and delivered Rapid Building Assessment (RBA) training, introduced a training competency framework, and reviewed and updated the forms and placards used by assessors during emergencies.

There has been both legislative changes and increased knowledge and experience since the Christchurch and Kaikoura RBA operations. This paper looks at how these changes have been incorporated into our systems, processes and procedures, and the rationale behind those changes. Looking forward, increasing use of technology for data management, developing Tier 1 operational leadership capability, improving structural and geotechnical capacity and capability, and providing improved guidance documents are all on the TWG work programme. We also discuss the need for geographic capacity and capability of assessment resources, the importance of maintaining mental

wellbeing of assessors as a core component of successful deployment, as well as the latest international thinking around cordon management.

1 INTRODUCTION

It is vital that New Zealand has both the systems in place and trained personnel ready to respond to earthquakes and other natural disasters. The Ministry of Business, Innovation and Employment (MBIE) has roles and responsibilities under the Building Act 2004 and the Civil Defence Emergency Management Plan Act 2015. These include:

1. Managing the setting of national building standards, codes, and processes that address the risks of hazards.
2. Planning for the national co-ordination of building management in an emergency
3. Co-ordinating the:
    a. training of building professionals who are able to assess buildings during and after an emergency.
    b. maintenance of rapid building-assessment processes; and
    c. maintenance of arrangements for mobilising and demobilising trained rapid building assessors
    d. maintaining sufficient capability and capacity of assessors nationally to respond to events.
4. Providing national co-ordination of building management support to a Civil Defence Emergency Management (CDEM) Group when requested by the Director or the National Controller.
5. Leading rapid building assessment functions in a state of national emergency.
6. Advising and reporting on operational building management needs and options to the Director or the National Controller.
7. Providing building management policy advice to the Government as requested.
8. Leading the securing and management of compromised building sites for forensic investigations.
9. Advising the Government, during recovery after an emergency, on the requirements for facilitating the efficient and effective recovery of building stock and functions.

It is important that all structural and geotechnical engineers and building control officials are aware of the Rapid Building Assessment systems, and take opportunities to be trained in the processes when they arise.

2 BACKGROUND TO BUILDING MANAGEMENT IN EMERGENCIES

2.1 Scope and Origins

The Canterbury earthquakes highlighted the need for a set of arrangements to enable co-ordination and delivery of the various activities involved after large-scale events that damage significant numbers of buildings. These arrangements include scoping the extent of rapid building assessments (including liaison with the FENZ USAR operations), putting in place management systems for the assessments (including managing the large volume of data that is generated), and management of aspects such as barricades and cordons. This also extends to activities that continue on for the months following the initial response to the event.

The scope of these activities is covered in *Managing buildings in an emergency, Guidance for decision makers and territorial authorities* (MBIE 2020). Developments following the Canterbury and Kaikoura earthquakes are outlined in an earlier Pacific Conference paper (Brunsdon et al 2019).

Building Management in Emergencies is therefore more encompassing that the immediate rapid assessment of buildings, but nevertheless has this as one of the key focal points.

2.2 Stewardship, Governance and Leadership of the System

Pre-event

To ensure an appropriate level of technical advice, in 2021 MBIE formed a Building Management in an Emergency (BMIE) Technical Working Group (TWG). The TWG members typically have experience in a number of event responses, and the group includes representatives from the engineering technical societies, Territorial Authority/ Building Consent Authority and from government agencies including the National Emergency Management Agency (NEMA) and Fire and Emergency New Zealand (FENZ). With a mandate for continuous improvement, the focus of the TWG is on the stewardship of the system.

MBIE also chair the Building Emergency Management Oversight Group to provide governance to the programme. This group features representatives from the government agencies noted above, in addition to local government and Engineering New Zealand.

Post-event

The management of an event is usually led by the affected local territorial authority with external assistance as required. A more central response is required if multiple territorial authorities are affected or if the scale of the event is greater than the capacity and/or capability of the territorial authority to manage. MBIE co-ordinates the building emergency management activities when a national emergency is declared.

Engineers and building control officials with operational experience that are on MBIE's national register of trained resources are available to help/augment local territorial authority capacity and capability as required.

3 RAPID BUILDING ASSESSMENTS

3.1 Overview

New Zealand's Rapid Building Assessment (RBA) system has evolved from the US Applied Technology Council (ATC 20 & ATC 45). This evolution is shown in figure 1.

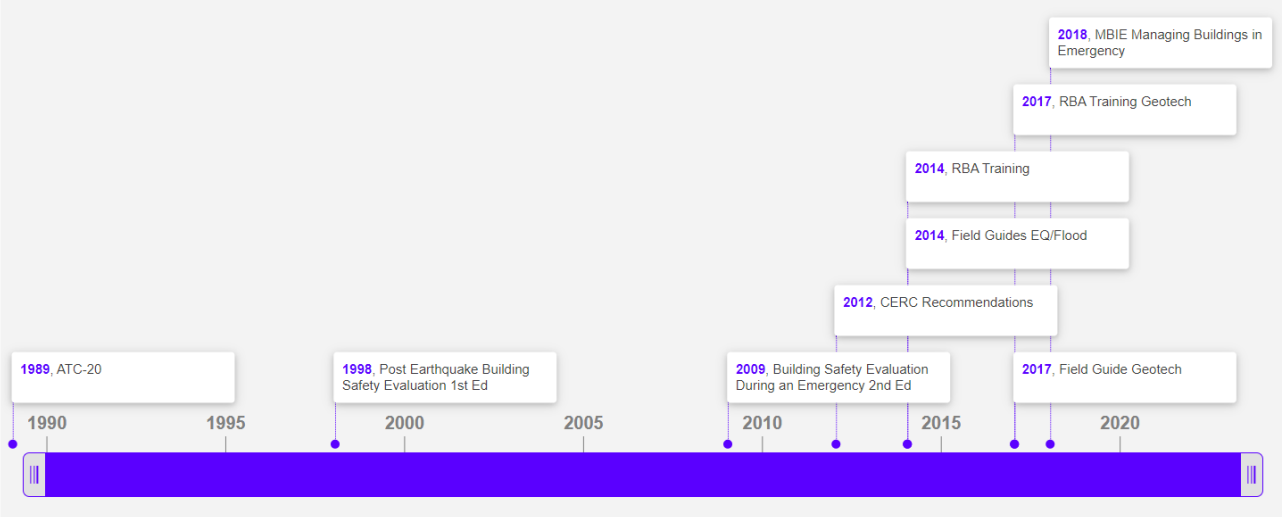

Figure 1 Evolution of the RBA system in NZ

Part of the evolution of NZ RBA system has been driven by recommendations 111-137 of the Canterbury Earthquakes Royal Commission (CERC 2012).

The goal of the RBA is to assess the impact of *observed* damage on continued use of the building, land, or property. The focus is on public safety. In deciding whether the damage warrants any restrictions on future use, the test used is - 'can people safely occupy the building under reasonably foreseeable events?, which include:

- Normal service loading
- Wind loading
- Earthquake aftershocks of a similar magnitude or lesser than the main shock
- Slope instability
- Normal rainfall

Inherent in accepting this *reasonably foreseeable test* is an acceptance that larger events could cause failure, which may have serious safety consequences. Assessments are based on actual damage (or new risk) caused by the event rather than previously recognised risk, and shouldn't be unduly influenced by hazard zones, etc.

The New Zealand system distinguishes between residential and commercial assessments. In practice this allows inspection teams to tailor their skill set to the task at hand. Traditional residential housing in New Zealand is one or two storey, stand alone and can be designed with very little to no professional structural engineering involvement. This means that inspection teams can comprise building control officials/inspectors with minimal structural engineering involvement unless land instability has occurred or could occur. It is noted that residential inspections generally require a high level of welfare support for occupants. Commercial inspections tend to require less welfare support but significantly more engineering input.

A unique feature of NZ's system is that we have a process specifically for geotechnical inspections (MBIE, 2018). This was developed from our experience following Canterbury Earthquakes for buildings, that posed a safety risk to building occupants due to imminent geotechnical threats. The US Federal Emergency Management Agency recommended that a similar process for assessing geotechnical hazards be developed for the US context and incorporated into their disaster response procedures (FEMA, 2019).

3.2 Legislative Mandate and Considerations

Both NZ Building Act 2004 (BA 2004) and Civil Defence Emergency Management Act 2002 (CDEM 2002) contain powers that can be used to carry out RBA operations. However, the BA 2004 (as amended in 2019) is to be used (s.133BL) unless it is "necessary or desirable" to use the CDEM Act. It is important that all parties understand the powers and limitations they have when carrying out a RBA inspection. Additionally a RBA operation can only be undertaken in a designated area under the Building Act or a declaration under CDEM Act.

A unique feature of managing buildings is clause "133BN Principles for exercise of powers" which requires actions to be proportionate to the risk being managed, minimal in terms of restrictions, consider future events and be based on up-to-date information.

3.3 Training and Competency Framework

Experience and recommendation 133 of the CERC means that MBIE have introduced a competency framework to support the training. The competency framework seeks to ensure that assessors have appropriate competency and attributes. The framework is designed for minimal experience entry level (Tier 3), progressing through to team participation and leadership (Tier 2) to technical management and overall operational leadership and strategic advisor to controllers (Tier 1). The competency framework and capability tiers are shown in figure 2.

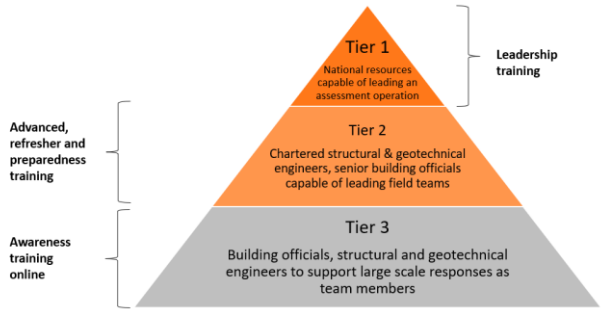

Figure 2: Three Tiers of Capability

The intent of the three tiers of capability is to have a progression plan where Tier 3 training is online and Tier 2 face to face from the Tier 3 pool or BCA recommendation. Tier 1 assessor training is by invitation with candidates being selected from the Tier 2 pool, preferably, with significant operational experience.

The goal is to have a national register of approximately 200 Tier 3 assessors, 500 Tier 2 assessors and 30 Tier 1 operational leaders spread across the country.

The training is designed to identify both structural (building) hazards and geotechnical (land) hazards. Updated training for structural assessors is currently being offered around the country. Updated geotechnical training is currently under development and will be offered in the near future.

RBA training includes both technical and people skills. Significant emphasis is put on personal and team safety, including mental health. RBA assessors who have had deployment experience, have been surveyed. One of the strongest feedback themes was mental wellbeing. Assessors told us that a stand-down period post-event was needed but often not taken as they did not want to let down colleagues doing business as usual. As part of the training, all assessors are invited to attend additional training with Hato Hone St John for a Mental Health First Aid course.

3.4 The Assessor and Assessment Teams

Depending on the nature and scale of event, assessment teams will generally comprise two to four people and be led by a Tier 2 trained assessor. Resource availability will influence team makeup, but for other than large scale events it is likely that the whole team will comprise Tier 2 assessors. For residential inspections, it is desirable to send welfare resources out with the RBA teams.

For larger events, Tier 3 assessors will make up team membership under Tier 2 leadership. Tier 1 leaders are largely based at operations centres and unlikely to spend much time in the field.

3.5 Forms, Placards and Field Guides

Ideally, only trained assessors will be authorised to issue placards, however the controller or authorised person has the ability to delegate powers to assessors who have not undergone training at the time of the event.

New RBA forms and placards were released on 1 November 2023. Changes from previous versions were designed to make placards easier to understand for the public and streamline the forms for assessors.

Placards

The three-colour system (white, yellow, and red) corresponding to ‘can be used’, ‘restricted access’ and ‘unsafe’ is used. Note that the green placard (can be used) used in ATC 20 was replaced by the white placard in NZ at the recommendation of the CERC.

The new placards have been updated to reference the current legislation regarding the authority under which they are placed. A QR code has been added to enable members of the public to obtain updated event information. The biggest change is to 'restricted use' and 'unsafe' placards where 'short term entry' (Y2) and the 'external hazard' (R2) are now distinguished by a black dashed boarder. These changes were made to make the distinction between placard types more visual.

Figure 3: New Placards

Forms

The number of rapid assessment forms has been reduced from three to two. The previous structural earthquake and flooding forms (level 1 & 2) have been updated and combined into a single 'building' form that covers all event types/levels. A separate geotechnical form has been retained, recognizing that the information collected for geotechnical hazards is specialist and unique .

Increased use of technology and electronic data capture is becoming more common. The new forms have been designed to take advantage of this technology. Updated paper forms are available as a backup and reduce the number of forms required in the field.

Field Guides

Three field guides exist: Post Disaster Building Usability Assessment – Earthquakes, Flooding & Geotechnical. The earthquake and flooding field guides were first published in May 2014 and the geotechnical first published in May 2017. All were subject to minor updates in November 2018.

These field guides, combined with RBA training essentially comprise the RBA methodology. Review and updates to these field guides are planned for 2024.

3.6 Challenges and Gaps in our System

Recent weather events and both the Christchurch and Kaikoura earthquake events have challenged the system in two main ways:

1. The RBA system is designed to deal with hazards on a property-by-property basis. Hazards such as rock fall or slope instability can affect multiple properties. This has resulted in multiple copies relating to one hazard being filed on multiple property files.

2. The RBA system was initially conceived to deal with structural hazards. Weather events can cause non-structural hazards such as biohazards, making properties unfit for short/long term occupancy. The treatment of these hazards is often time-dependent and locking up a building growing mould may only exacerbate the issue.

These events have highlighted the limited training that has been delivered during the period 2017 to 2022. A new training programme was commenced in 2023, with 10 Tier 2 buildings courses delivered in 7 locations to 300 engineers and building control officials. Online training modules covering legislation and system overview were produced and hosted on the MBIE website.

Work is planned to further develop geotechnical training. Lessons from biohazards will be considered for future updates.

4 INFORMATION MANAGEMENT

4.1 Pre-Event: National Register of Technical Resources

MBIE holds and maintains a national register of trained RBA assessors (Tier 1-3). Ensuring currency of contact details is a vital task that requires on-going effort.

4.2 Post-Event: Forms and Placards

A RBA operation produces significant amount of data. Every inspection generates an inspection form, a placard, and multiple photographs. All of this data is typically stored by building address in a GIS system before being copied to local authority property files. Increasingly dashboards are being set up to summarise the data in real time to inform event management decisions. These GIS dashboards are used for multiple purposes from assigning inspection teams, follow-ups to the worst affected areas, prioritising recovery effort and reporting purposes.

Additionally, the forms continue to contain basic building information to enable post-event analysis of how differing structural typologies performed. This information is used to inform potential changes in design standards, Codes and Standards.

Local authorities also provide this information in land information and project information memoranda.

Whilst paper inspection forms have been designed, it is intended that they only be used when electronic versions are not available. Electronic forms are able to be uploaded in real time (when connectivity is available) and more importantly, the functionality of electronic templates can generate efficiencies in data entry and minimise data entry errors and reporting timeframes. Placards remain paper based and are required to be prominently fixed to the building.

4.3 Electronic Forms

Electronic forms enable real time data capture, GIS tagging, and photographic records. Connectivity, battery life and device robustness can be problematic in an emergency.

A project to agree a common operating language and to design the form architecture such that it is operating system and device agnostic is progressing. Most building consent authorities use digital tools for their building consent inspections, and it seems natural to use the same platform for RBA purposes. Typically, these platforms require user/login credentials. It is vital that generic login credentials are set up pre-event or the ability to set up quickly exists to allow use by non-BCA resource.

4.4 Public Communication

Increasingly it is being acknowledged that controlling the information to the public is important for a smooth recovery. To facilitate this, the new placards have a QR code to enable the public to be directed to an official website.

5 CORDONING

5.1 Guidance

Cordoning guidance is an area that is receiving national and international attention. FEMA P-2055-2/September 2023 is the latest guidance, which is being reviewed for NZ adoption.

The first NZ guidance was established in draft form in September 2010 as part of internal Christchurch City Council Building Evaluation Transition Team (BETT) operating procedures, as summarised in Table 1 below.

Table 1: Draft Cordoning Guidance.

Type of Potential Failures	
• Total Building • Top Storey only • Parapet Only	(1.5 building height) (1.5 top storey height) (2 meters outside veranda fascia or 3m from building)
Mass of material in potential failures (add base width of potential material pile to above)	

This is similar to California Building Officials (CALBO) "Guidance for Barricading, Cordoning, Evaluating and Stabilizing Buildings with Substantial Damage in Disasters" which advises "Erect barricades initially at a generous distance of up to 1.5 times the height of buildings that are vulnerable to collapse until they can be further investigated". This is unsurprising as this guidance references the Canterbury Earthquake event and is consistent with US first responders (fire services) 1.5x the building height.

Current RBA training around cordons includes:

- Consider the construction materials of the building and the likely failure mode:
  - Concrete panels typically fall 1.0 x height.
  - Brick walls typically spill 1.5 x height.
  - Potential for full building collapse (consider full building height)
  - Limited to top storey collapse (consider height of top storey)

The accurate placement of cordons requires knowledge of how a building will collapse. In some cases the damage observations of the RBA inspection will not give sufficiently detailed information to accurately place cordons. The authors propose that, for RBA purposes, all buildings are initially barricaded at 1- 1.5 times the height dependant on material as per current training. As soon as a cordon office or management programme is set up, all buildings greater than 2/3 storeys should have their cordon positions reviewed to the FEMA P-2055-2/September 2023 guidance. Note that this may require further building assessment to better understand construction materials etc.

FEMA P-2055-2/September 2023 does not necessarily consider the appropriate form of the barricade, nor does it offer guidance on how to reduce distance of the cordon through engineering design.

5.2 Definitions

NZ uses definitions to distinguish who has the delegated authority to instruct the cordons, which indicate that:

- Cordoning is instructed by the Controller.
- Barricading is instructed by the Building Response Manager.
- Barrier Tape is instructed by the Assessor.

FEMA P-2055-2 introduces the terminology:

- Collapse shadow: Area to be cordoned to provide safety from potential collapse of building. Also termed fall shadow.
- Debris shadow: Area to be cordoned to provide safety from falling debris.

6 FUTURE WORK

6.1 Systems

- Building Management in Emergency, Technical Working Group.

  Feedback into this group is important as this drives updates and improvements into the system. This group must continue to have active participation from central government agencies, territorial authorities, and subject matter experts. This work is underway and ongoing.
- Tier 1 Operational Leadership Group

  This group needs to be formalised and relationships/team building exercises carried out so that when they need to respond there is a pre-established teamwork bond. This work is planed but yet to be done.
- Updating of the Field Guides

  The field guides are to be updated in 2024 to reflect learnings from recent events and the updated placards, forms, and systems. This work is planed but yet to be done.
- Section 133BQ Post-event Assessment

  Section 133BQ of the Building Act refers to a methodology (if any). Work to develop this methodology is currently underway. This work is planed but yet to be done.

6.2 . Processes

- Geotechnical RBA Processes needs review and updating. This work is underway
- Cordon policy needs review and updating for consistency with FEMA P-2055-2. This work is planed but yet to be done,
- An official digital form, for recording Rapid Building Assessments, needs sign off and agreement form all stakeholders. This work is underway.
- The register and deployment process needs wider understanding. This work is planed but yet to be done,
- The RBA training calendar and cadence of refresher training needs to be funded, implemented, and understood by stakeholders. This work is planed but yet to be done,

6.3 . Guidance Documents

- Training manual guidance documents (geotechnical & structural) needs review and updating to align with training updates. This work is planed but yet to be done,
- Field Guides for earthquake, flooding & geotechnical need review and updating. A decision on what form these will be published in also needs consideration. This work is planed but yet to be done
- Territorial Authority guidance document needs review and updating. This work is planed but yet to be done
- Guidance on the process to remove placards needs to be developed. This work has started.

7 SUMMARY

The Ministry of Business, Innovation and Employment has roles and responsibilities under both the Building Act 2004 and the Civil Defence Emergency Management Plan Order 2015 to ensure NZ is ready to respond to natural hazard events. To help discharge this responsibility, a Building Management in an Emergency Technical Working Group has been formed to advise MBIE. The TWG is focused on of continuous improvement for NZs systems, processes, and guidance documents.

Professional engineers are actively encouraged to become familiar with response arrangements and attend training courses when delivered in their region.

It is vital that New Zealand has both the systems in place and trained personnel ready to respond to earthquakes and other natural disasters.

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