



Department of
Building and Housing
Te Tari Kaupapa Whare

Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch

June 2012

1.0 Introduction

This guidance is for engineers asked to help owners make decisions about the continued use of their buildings in the wake of the Canterbury earthquakes. The guidance seeks to ensure there is consistency in the advice being given to owners, to clarify the responsibilities of owners and engineers in the decision-making process and to clarify how to apply the modified definition of dangerous building under the Building Act 2004 (Building Act), as modified by the Canterbury Earthquake (Building Act) Order 2011.

Over the next three years the Canterbury Earthquake Recovery Authority (CERA) will be progressively asking owners of non-residential and multi-unit residential buildings in greater Christchurch (comprising Christchurch City, Selwyn District and Waimakariri District) to have a Detailed Engineering Evaluation (DEE) prepared for their buildings. Building owners will be required to provide a copy of their DEE to CERA.

The purpose of the DEE is to:

- inform decisions by owners about the continued use of their buildings
- provide a starting point for decisions on any repair work to be carried out; and
- ascertain the state of buildings generally.

2.0 Purpose

The purpose of this guidance is to:

- provide engineers with guidance on what they should include in their building evaluations to assist owners to make informed decisions about the use and repair of those buildings; and
- clarify the responsibilities of building owners and engineers in the decision making process.

This guidance is at a general level only and focuses on what may be required under the Building Act. However the Building Act imposes limited obligations on owners to upgrade the building structure and is not a complete legal code. There are potentially other legal obligations under common law or under other legislation such as the Canterbury Earthquake Recovery Act 2011 (the CER Act).

This document does not provide guidance on carrying out any repairs or strengthening work, nor does it address non-seismic and non-structural issues. This is interim guidance and may be updated in future.

This document's status

This document is issued as guidance under section 175 of the Building Act 2004. While the Department has taken care in preparing this document it is only a guide and, if used, does not relieve any person of the obligation to consider any matter to which that information relates according to the circumstances of the particular case. The document may be updated from time to time and the latest version is available from the Department's website at www.dbh.govt.nz.

3.0 Key points to note

- Even if an undamaged building is 33%NBS or less (and therefore earthquake-prone) it does not necessarily mean that the building is unsafe and should not be occupied. Building owners need to make their own decisions about how to manage their buildings (subject to any notices that may be given by the respective council or CERA), taking into account the individual circumstances of each building and the risks that are present in each case.
- Engineers providing advice to owners should be qualified Chartered Professional Engineers (structural) with appropriate experience in seismic design and evaluation of existing buildings in consultation with a Chartered Professional Engineer (Geotechnical) regarding the site conditions and foundation characteristics, as appropriate.
- Engineers should only provide recommendations about the continued use of buildings once a suitable level of investigation has been completed. Preliminary screening tools such as the Initial Evaluation Procedure (IEP) should not generally be considered adequate for significant decisions about ongoing occupation or strengthening decisions.
- The mitigation of earthquake risk in buildings needs to be considered in terms of what needs to be undertaken in the short-term and what can be carried out over a period of years as part of a longer-term risk reduction programme.

4.0 Requirements of the Building Act 2004

The Building Act gives councils powers to require the strengthening or upgrade of dangerous buildings or earthquake prone buildings. The Building Act also requires councils to have a policy on how they will exercise their functions in respect of dangerous buildings and earthquake-prone buildings. If a council is satisfied that a building is “dangerous” or “earthquake-prone” as defined in sections 121 and 122 respectively, the council may give notice to the owner requiring the owner to upgrade their building. However, building owners should not wait for the council to take action before addressing concerns about building structure.

For greater Christchurch the definition of “dangerous” building in the Building Act has been extended (by the Canterbury Earthquake (Building Act) Order 2011) to include buildings at risk of collapsing in a moderate earthquake (that is, buildings with ultimate limit state (ULS) capacity at or below 33% new building standard or NBS).

This extension of the definition of “dangerous’ buildings does not necessarily mean that those additional buildings now included are to be considered dangerous in the ordinary dictionary meaning. The purpose of the change was to give Councils greater flexibility in applying their powers in respect of the many buildings damaged by, or at risk as a result of, the Canterbury earthquakes in the months following the declared emergency period. In particular, this modification allowed the council to treat buildings as dangerous buildings rather than earthquake-prone buildings for the purposes of the council’s policy. This meant the council could set shorter time periods for carrying out strengthening works. It allowed the council to address concerns about building safety in light of continuing aftershocks.

The assessment of a building as “dangerous” within the meaning of the legislation is no substitute for a detailed, technical assessment of the actual risk posed by that building. Decisions as to use and repair should be determined by reference to this detailed technical investigation, rather than being based solely on whether the building comes within statutory definitions.

The Department of Building and Housing understands that widened scope of the definition of “dangerous building” has led to concern amongst owners and engineers that undamaged buildings in greater Christchurch which are 33%NBS or less (and therefore earthquake-prone) should not be occupied. As noted above, this is not necessarily the case. An assessment of each building should be carried out and all relevant information provided to the owner to enable the owner to make an informed decision about the ongoing use and occupancy of their building.

Where a council requires a dangerous building or an earthquake prone building to be upgraded, it may prohibit the use of the building until the works are carried out. Unless the council has issued a notice under the Building Act preventing the use of the building, the decision about whether to continue to use the buildings is a matter for the owner to consider, with advice from their engineers as to the risk of continued use. There may be other factors outside of the Building Act that influence how an engineer advises an owner, including any relevant considerations in respect of use in the council earthquake-prone building policy, or whether CERA has issued a notice under section 45 of the CER Act restricting or prohibiting access to any specified area or building.

5.0 Engineering evaluations of buildings

The relevant engineering evaluations are summarised below, with additional information provided in the appended table. The relationship between the types of evaluations is represented in the process flowchart appended.

If it is not possible to carry out a Detailed Engineering Evaluation (DEE) before making decisions about the ongoing use of the building, this guidance provides for an Interim Use Evaluation (IUE), detailed below. Special consideration should be given where the building is an unreinforced masonry building.

All engineering evaluations must be completed by or under the supervision of a Chartered Professional Engineer (structural) with appropriate experience in seismic design and evaluation of existing buildings. Where appropriate, this should be done in consultation with a Chartered Professional Engineer (geotechnical) regarding the site conditions and foundation characteristics.

5.1 Detailed Engineering Evaluations (DEE)

As noted above, all owners of non-residential and multi-unit residential buildings will be asked by CERA to have detailed engineering evaluations completed on their buildings. The form of these assessments has been described in the Detailed Engineering Evaluation (DEE) guidelines, draft currently available at www.sesoc.org.nz. This assessment procedure is aimed at identifying earthquake damage and assessing its impact on future performance of the building.

Note: As part of undertaking a DEE, an Initial Evaluation Procedure (IEP) may be completed as an initial step.

5.2 Initial Evaluation Procedure (IEP)

The IEP is largely a qualitative procedure, intended in part as a sifting device in order to identify buildings that are potentially high risk buildings. A building with an IEP rating greater than 33% NBS which is undamaged and has no other secondary hazards, (for example, falling hazards from a neighbouring site) may be considered suitable for use, and no further quantitative assessment will be required.

However, in all other circumstances, any decision to vacate or strengthen a building should not be made solely on the basis of an IEP. Some buildings that are identified as potentially high risk on the basis of IEP scores may subsequently be found not to be high risk following more detailed evaluation.

5.3 Interim Use Evaluation (IUE)

It is not always practically possible to complete a DEE for all structures ahead of the need to make decisions regarding use. Engineering resources may be stretched for some time, and priority may go to the most critical facilities. However, safety should be considered proactively.

In such cases, an Interim Use Evaluation (IUE) may be appropriate in the interim until a more detailed evaluation can be undertaken. An IUE is a qualitative assessment under which the engineer must be satisfied that they can understand the primary load-resisting systems of a building (both gravity and seismic), and can view all critical elements in the load paths. Where there is no damage to either that would impair its continued function, the building may be considered suitable for continued use.

The IUE is a similar review to a Level 2 Rapid Building Safety Evaluation, but with the added requirement of identification and review of the primary vertical and lateral load paths. The Level 2 Rapid Safety Evaluation is only intended for assessment of damage in the post-earthquake emergency phase.

The specific requirements for undertaking an IUE for an unreinforced masonry building are outlined in section 6. For buildings that are not unreinforced masonry, the IUE procedure should follow the steps below:

- 1 The inspecting engineer should firstly complete a review of the building structure; sufficient to identify both the vertical (gravity) and lateral (seismic) load resisting elements.
- 2 Once the structural load paths are identified, the engineer needs to ensure that the critical elements of each can be seen and inspected for critical damage. Critical damage is damage which, in the opinion of the engineer, may be sufficient to significantly impair the building's capacity to resist either gravity or seismic actions.
- 3 Provided that there is no significant damage that may impair the primary structure's function, the engineer may now complete a review of the balance of the building for life safety hazards. Elements for consideration include:
 - a) exterior toppling hazards such as parapets or cladding panels, particularly over access points and egress paths;
 - b) neighbouring buildings, where global failure or failure of elements may result in life safety hazard, or otherwise may threaten egress paths etc in the building;
 - c) internal egress paths where critical elements such as stairs may fail, trapping people in the building; and
 - d) particularly heavy suspended ceilings or other elements that may fall causing life safety hazard.
- 4 Where there is impaired capacity or life safety hazard from secondary elements such as those noted in 3 above, the building, or parts of the building, the engineer should recommend that the building is not used until works are carried out to make it safe. If the hazard is limited to an area that may be effectively isolated, limited use may be recommended if:
 - a) the areas to be occupied are protected from risk of collapse from other areas of the building, and
 - b) fire egress is not compromised by loss of the inaccessible area, and
 - c) the safe use of the building is not otherwise compromised by the collapse of the affected area.
- 5 "Make safe works" may be completed to remove or mitigate the hazards in the short term. It is important to note that all building work needs to comply with the Building Code and will generally require a building consent, or will need to have a Certificate of Acceptance once the work is completed. Check requirements with the building consent authority.

6.0 Unreinforced Masonry Buildings (URMs)

The Canterbury earthquakes have shown that URMs are particularly hazardous, not only for those in the buildings, but for those in path of falling masonry outside the building. However, the risk of URMs can be significantly reduced by upgrading works which are well designed, well-implemented and if the buildings are well maintained. It is of significance to note that most of the death and injury attributed to masonry buildings as a result of the earthquake of 22 February 2011 affected people outside the building that failed, caused by falling masonry. Of the 42 deaths associated with buildings other than CTV or PGC, all but one were from falling masonry, and only five of these deaths were within the failed building.

Because of the additional hazards associated with URMs it is not recommended that the IUE is used unless the building has been previously strengthened to greater than 33% NBS. This will typically apply only to buildings strengthened over the last 10 years or so, although there may be some exceptions (generally heritage buildings).

For URMs that have been strengthened the IUE must include: a review of the roof (to verify that the parapet connections have retained their integrity and that there is no evidence of distortion at flashings) and a review of floor or ceiling to wall junctions (to verify no evidence of movement indicating failure of ties).

For URMs that have not been strengthened, a DEE will be necessary. It is considered beneficial for engineers to complete an IEP in accordance with Section 3 and Appendix 3B (for URM buildings) of the NZSEE guidelines *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes* before proceeding to detailed assessment, as this will assist engineers in focusing attention on potentially critical areas that will need to be addressed.

7.0 What should be considered when deciding how to use a building?

7.1 Where the building is damaged

Where a building has suffered damage to the seismic or gravity load resisting system that is sufficient to impair or significantly reduce the ability to resist further loads, then it is in a condition under which further deterioration may be expected in future aftershocks. Such a building should be repaired as soon as possible.

If the building in its damaged state is capable of resisting a moderate earthquake without collapse (ie, it is not earthquake-prone) it may be used while repairs are taking place provided user safety is not compromised (for example, by blocking fire egress paths).

If the building is damaged and is not capable of resisting a moderate earthquake without collapse it should not be used until such time as repairs to the primary load path have been completed. However, this does not necessarily mean that the building needs to be strengthened to comply fully with council requirements before the building is reoccupied for use. However, interim shoring or strengthening may comprise part of a longer term upgrading programme. This will need to be negotiated with the council on a case-by-case basis.

7.2 Where the building is not damaged

Where a building has not suffered damage to the seismic or gravity load resisting system that would reduce its ability to resist further loads, regardless of its assessed capacity, it may still be considered suitable for continued use. If the building is earthquake-prone the council may in the future exercise its powers under the Building Act in accordance with the time frames and other provisions of the council's earthquake-prone building policy.

7.3 Could parts of the building be used?

Use may be restricted to only parts of a building provided that:

- a) it can be satisfactorily demonstrated that the areas to be occupied are protected from risk of collapse in other areas of the building;
- b) fire egress is not compromised by loss of the inaccessible area; and
- c) the safe use of the building is not otherwise compromised by the collapse of the affected area.

It may be possible to partially mitigate the most significant risks in the short term to allow continued use of all or part of a building while plans are put in place for a longer term solution. Engineers should be able to identify where such opportunities exist and to advise building owners accordingly.

In all cases, consideration must also extend to neighbouring buildings where such building may contribute to the hazard for the building under consideration; or where the building under consideration may represent a hazard to the neighbouring property.

7.4 Buildings used by the public

Where a building (or part of a building) is open to or used by members of the public then the building owner may require a certificate for public use (under section 363A of the Building Act) if the owner wishes to use part of the building affected by building work. Building owners should discuss this with the council.

8.0 Engineering Reports

Engineering reports should summarise the following:

- 1 The level of structural damage in the building resulting from the Canterbury earthquake sequence
- 2 The level of overall strength in relation to current code (%NBS, which may well be expressed as a range to reflect any uncertainties in the assessment), and the level of evaluation undertaken (eg IEP, IUE, DEE)
- 3 The requirements in the current city or district council earthquake-prone buildings policy for buildings with that level of strength
- 4 Any mitigation of particular risk items that could be undertaken as a short-term/immediate measure to decrease the risk to occupants and increase the level of overall strength
- 5 Other strengthening measures that should be undertaken over a longer time frame that is consistent with both council's EPB policy and the owner's current circumstances and future plans

Items 4 and 5 should be expressed in the form of recommendations. The first three items above, in conjunction with any risk mitigation recommendations, provide the owner with the risk information necessary to consult with others and form a decision regarding the resumption or continuation of occupancy.

9.0 Responsibility for the decision-making process

Although engineers provide advice to owners about building capacity and risk, the decision about continued use rests with the owners. It is important that owners receive clear advice from professional engineers that enables the owners to understand the risks of continued use, and what their options and responsibilities are.

Owners may also wish to seek advice from other professional advisors, such as lawyers, and should discuss certain matters with the council, along with tenants and owners of neighbouring buildings. If the property is a unit titled multi-unit residential property then the body corporate will need to be involved.

The two key decisions building owners need to make are:

- what repairs or short-term mitigation to carry out and when to carry out this work; and
- how the building can/should be used until the repairs are carried out and while the repairs are being carried out.

These decisions are likely to be interdependent, as allowing for ongoing use of the building may influence the repair solution chosen and the staging of the repairs.

Each case will need to be determined on its own specific facts and it is not possible for general guidance such as this to be a substitute for the judgement of owners based on the available information and the advice of their consultants.

Building owners should be aware that if they fail to act in a responsible manner, or if for any other reason their building or adjacent buildings create a level of hazard that is considered inappropriate by CERA or the council for continued occupancy, further action may be taken including the issuance of a section 45 or 124 notice (under the CER Act or Building Act respectively) restricting access to the site.

Appendix: Building Evaluation Methodologies

Assessment Method	Scope of application	Output	Following steps	Reference
Rapid Evaluation (RE)	Used during State of Emergency, for rapid evaluation of buildings in an earthquake affected area.	Level 1 and Level 2 reports for buildings, and building placards.	Detailed Engineering Evaluation is recommended for all affected buildings.	New Zealand Society for Earthquake Engineering Building Safety Evaluation during a State of Emergency. Guidelines for Territorial Authorities. August 2009. Note: This is currently under revision
Interim Use Evaluation (IUE)	For use after (or in lieu of) the RSE, or after further aftershocks, in order to establish suitability for continued use only. Only an interim evaluation until a full Detailed Engineering Evaluation is possible or practicable.	Engineering report establishing whether building is suitable for continued use. May include recommendation for partial repairs prior to use. May recommend restricted use.	Detailed Engineering Evaluation is recommended for all affected buildings.	
Detailed Engineering Evaluation (DEE)	To gain understanding of building performance in earthquake(s) and to identify damage and its consequence for future building performance and risks that may affect ongoing use. <u>Qualitative</u> Assessment Procedure may be used initially to determine need for further analysis. <u>Quantitative</u> Assessment Procedure will be required in cases where there is significant damage, and/or when the building capacity <33% NBS.	<p>1 Qualitative Assessment Procedure: Detailed Engineering Evaluation Report, with Standardised Report Form. Report will summarise damage and its consequence, and establish capacity of the building.</p> <p>2 Quantitative Assessment Procedure: Detailed Engineering Evaluation report with Standardised Report Form. Report will summarise damage and its consequence, and establish capacity of the building.</p>	The Owner is to submit the report to the appropriate authority, to verify that sufficient review has been completed (CERA); and as support for building consent for repair and retrofit work (BCA).	Engineering Advisory Group Draft Guidance on <i>Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury - Part 2 Evaluation Procedure</i> . May 2012
Initial Evaluation Procedure (IEP)	Generally used as a screening tool to identify buildings that may be potentially earthquake-prone. Not intended as a tool to evaluate damaged buildings. This may be used for the capacity determination in the Qualitative Assessment Procedure in the DEE.	Lower-bound estimate of the capacity of an existing building, expressed as %New Building Standard (% NBS).	Further detailed analysis is required to verify likely capacity of the building in cases where IEP score <33% NBS, or where a more comprehensive capacity calculation is required.	New Zealand Society for Earthquake Engineering Assessment and Improvement of the Structural Performance of Buildings in Earthquakes, June 2006. Note: This is currently under revision.

Flow Chart: Building Evaluation and Use

