Guidance for Territorial Authorities and Property Owners on Initial Seismic Assessments

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Contents

1. Introduction and scope

This document provides an overview of Initial Seismic Assessments for Territorial Authorities (TAs) and property owners. It accompanies the update to Section 3 of the New Zealand Society for Earthquake Engineering (NZSEE) *Guidelines for the Assessment and Improvement of the Seismic Performance of Buildings in Earthquakes*[1] released in October 2014.

Seismic assessments are typically undertaken on behalf of TAs and property owners for buildings falling within the scope of the earthquake-prone provisions of the Building Act[2]. These are commercial buildings as well as residential buildings with two or more storeys and containing three or more household units.

TAs have a specific purpose under the Building Act and associated regulations for conducting Initial Seismic Assessments; that is, to identify potentially earthquake-prone buildings (as defined in section 122 of the Act). However, property owners may have a broader agenda that includes their general asset and risk management practices.

The update to Section 3 of the NZSEE Guidelines includes significantly more explanatory material to help assessors to complete an ISA and to improve consistency and understanding. However, if previous assessments have been completed with the required level of judgment, these changes are not expected to alter ISA outcomes.

Alert:

The process of seismic evaluation of buildings is technical in nature and should be undertaken by experienced and competent CPEng (Chartered Professional Engineers) structural engineers with relevant training, with input from experienced and competent CPEng geotechnical engineers as appropriate.

This guidance has been prepared by members of the steering group established by the Ministry of Business, Innovation and Employment and the Earthquake Commission to oversee the review and update of the 2006 NZSEE Guidelines. The steering group includes representatives from territorial authorities and Local Government New Zealand.

This document replaces the original guidance issued in November 2013. Please check the NZSEE website www.nzsee.org.nz for any further updates.

[1] http://www.nzsee.org.nz/db/PUBS/2006_AISPBE_Corrigenda_3%20.pdf
[2] http://www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html

2. Key terms

IEP	**Initial Evaluation Procedure** The principal engineering 'tool' for identifying potentially earthquake-prone buildings as part of an Initial Seismic Assessment.
ISA	**Initial Seismic Assessment** The recommended first step in the process of determining whether a building may be earthquake prone. It is intended to be a coarse evaluation involving as few resources as reasonably possible. The ISA must be completed by an experienced professional engineer to provide a valid assessment.
DSA	**Detailed Seismic Assessment** A quantitative assessment and report by structural engineers, with appropriate geotechnical engineering input. It involves calculations and can also involve structural computer modelling.
DDE	**Detailed Damage Evaluation** (previously referred to as Detailed Engineering Evaluation) This evaluation is only undertaken in a post-earthquake (recovery) context. It encompasses both qualitative and quantitative approaches.
%NBS	**% of New Building Standard** Describes the seismic capacity of the building relative to New Building Standards for a design life of not less than 50 years.
SW, CSW	**Structural Weakness, Critical Structural Weakness** A Structural Weakness is any weakness in the building structure that could potentially influence its performance at any level of earthquake shaking. One of the outcomes of an ISA is to identify potential Critical Structural Weaknesses. These may be rated as insignificant, significant or severe.
EPB	**Earthquake-Prone Building** A legally defined[3] category which describes a building that has been assessed as likely to have its ultimate limit state capacity exceeded in moderate earthquake shaking (which is defined in the regulations as being one third of the size of the shaking that a new building would be designed for on that site).
ERB	**Earthquake Risk Building** A general description developed by the NZSEE for buildings that are rated as being less than 67*%NBS* – i.e. representing more than twice the risk of a new building.

[3] http://www.legislation.govt.nz/act/public/2004/0072/latest/DLM306897.html
http://www.legislation.govt.nz/regulation/public/2005/0032/latest/DLM313976.html

3. Initial Seismic Assessments versus Detailed Seismic Assessments

The two broad types of seismic assessment are Initial Seismic Assessments and Detailed Seismic Assessments. However, it is important to appreciate that these lie on a continuum, as shown in Figure 1.

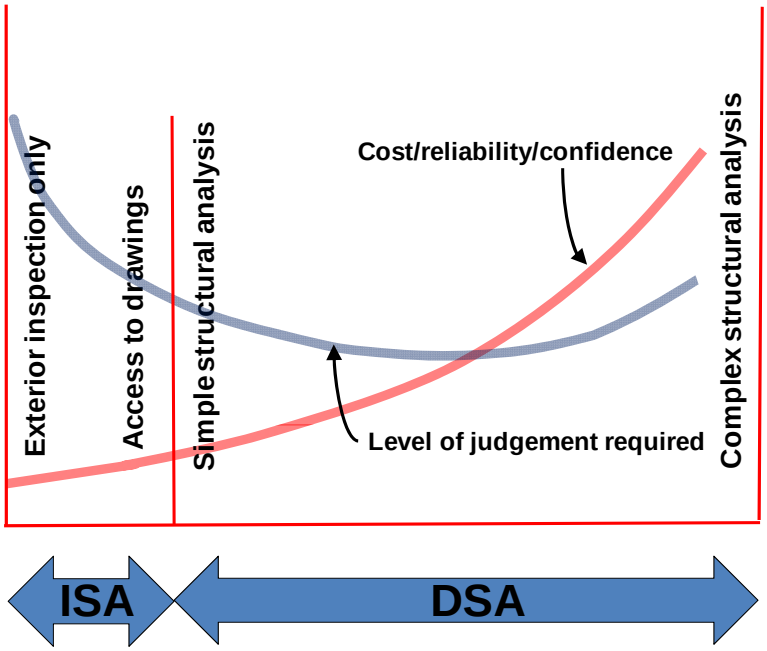

Figure 1: The continuum of seismic assessment

Their key features are summarised as follows:

Initial Seismic Assessment (ISA)

The ISA is a high level screen to indicate the likely seismic performance of a building. It provides a broad indication of the expected seismic rating of a building taking into account its type and age of construction, local seismicity, ground conditions and any identifiable structural weaknesses.

- TAs may initiate an ISA as part of a programme to identify buildings that are potentially earthquake prone as defined in the Building Act (section 122).
- Property owners may commission an ISA to establish where their buildings sit on the earthquake performance spectrum, and as part of their risk management practices.

The Initial Evaluation Procedure (IEP) is a nationally standardised engineering tool typically used to carry out an ISA. It requires considerable judgment from an experienced professional engineer to provide a valid assessment.

The output of an ISA is expressed as a percentage of New Building Standard *(%NBS*) and by an alpha rating. An indicative relative risk level can also be assigned.
ISAs also aim to identify any potential critical structural weaknesses in a building: these will need further assessment if they are identified as significant or severe.

Alert:

An ISA provides an initial, or interim result, given the typically limited time inputs from engineers. It therefore reports a potential status for the building that may be revised following receipt of additional information or on further analysis. The nature of an ISA leaves the possibility that structural weaknesses that are not readily apparent may remain undetected.

Detailed Seismic Assessment (DSA)

A DSA is typically the next step after an ISA if property owners or TAs want more information or reliability. It is a more detailed quantitative appraisal by professional engineers to more clearly identify the likely seismic rating of a building.

- DSAs can be triggered by an ISA rating below or near 34*%NBS* where a more definitive assessment is required to determine the building's earthquake-prone status.
- Property owners may also commission a DSA if they want to better understand the seismic performance of their building.
- A DSA may be required to support a building consent application to undertake seismic strengthening works on an existing building or if the building is undergoing a change of use.

Engineers use a range of techniques to assess the rating of the building quantitatively as part of a DSA. The results are again expressed as *%NBS*, a grading level and a relative risk level.

Note for property owners:

TAs typically require a DSA to respond to an ISA which suggests a building is potentially earthquake prone, unless that outcome is accepted by the owner. A combination of additional information and the more detailed engineering consideration that comes from a DSA may indicate that a higher score is appropriate from the original ISA. In some circumstances a DSA may identify structural weaknesses that were not observed or were not apparent during the ISA, leading to a decrease in score.

If you require a higher level of confidence about the structural performance of your building, it could be more cost effective for you to commission a DSA directly rather than first obtaining an ISA. However, it is recommended that an Initial Evaluation Procedure (as described in section 5.2 of this document) is still carried out in advance of a DSA as this often puts the assessor on the right track. In this case, it would not be necessary to obtain a full ISA report.

4. Preliminary screening and prioritisation

The ISA process allows buildings to be assessed against broad criteria and assumptions to identity those buildings whose seismic performance in an event is likely to be rated below 34*%NBS*.

For TAs seeking to undertake a programme of seismic evaluation across all buildings in the community:

- A preliminary desktop screening exercise is appropriate to identify which buildings need assessment (and which clearly don't) in accordance with their earthquake-prone building policy.

- Prioritising the assessments then follows this screening process, with the scope and extent of the ISA programme to be undertaken depending on the objectives and priorities of the TA under current legislation (noting the likely changes to come from the Buildings (Earthquake-prone Buildings) Amendment Bill currently before Parliament, as this will implement a national earthquake-prone building policy to replace the current policies developed by individual TAs).

Owners of a portfolio of buildings may wish to undertake similar screening, in accordance with their organisational policies. The updated Section 3 of the NZSEE Guidelines outlines a preliminary screening process (in section 3.2.2 of the Guidelines) that can assist with this step.

5. Conducting an Initial Seismic Assessment

5.1 Who should carry out an ISA

An ISA is primarily a qualitative process. It requires considerable knowledge of the earthquake behaviour of buildings and the ground on which they sit, as well as judgment regarding key attributes and their effect on building performance.

Therefore, it is essential that this level of assessment be carried out or supervised by Chartered Professional Engineers (CPEng), or equivalent, who have:

- sufficient relevant experience in the design and evaluation of buildings for earthquake effects to exercise the degree of judgment required, and
- specific training in the objectives of, and processes involved in the initial evaluation procedure.

Engineering graduates may undertake and process the initial assessment. However, the final ISA report must be reviewed and signed off by a CPEng with competency and experience in seismic design and assessment.

You can check an engineer's CPEng status on the Institution of Professional Engineers New Zealand (IPENZ) website[4].

Alert:

Specific geotechnical engineering input is usually not required for an ISA provided sufficient knowledge of the soils under the building is available to assign a generic classification. However, it is typically required for a DSA as part of the more detailed analysis and associated judgment required to determine a building's earthquake behaviour.

5.2 What an ISA involves

An ISA can be carried out with varying levels of information, as indicated in Figure 1. It can be completed solely on the basis of an exterior inspection or, at the other extreme, involve a detailed review of the drawings. The use of drawings will allow a review of interior details such as stairs, column detailing and floor construction type. Having access to the original calculations will also improve the accuracy of the ISA.

A site visit represents a minimum requirement to assess the site, type of construction of the building, the materials used and the relationship to neighbouring buildings.

[4] http://www.ipenz.org.nz/ipenz/registration/Search/Chartered_Professional_Engineers/index.cfm

About the Initial Evaluation Procedure, or IEP

ISAs are typically completed using an Initial Evaluation Procedure (IEP), which is a high-level assessment tool. Although the IEP involves calculations, it is first and foremost a judgment-based assessment.

Alert:

The October 2014 update to Section 3 of the NZSEE Guidelines included a number of refinements to the IEP, including the development of a standard IEP spreadsheet, to improve consistency and make the principles easier to apply. As significant assumptions are built into the formulas within the IEP, the outcome of the ISA still represents only an interim finding.

The IEP is in the form of a spreadsheet which covers the following:

a. Description of the building

- The building name (if any) and address, a photo, a description of its general construction, construction date (if known), building outline and site map

b. Determination of baseline *%NBS*

- Assessment of the baseline *%NBS*, given the age of building and the applicable design standards at the time of construction
- This will consider applicable soil conditions likely to impact on the building's response in a seismic event.

c. Determination of the Performance Assessment Ratio (PAR)

Discusses the configuration and structural features of the building, and attempts to identify aspects that are likely to reduce the seismic performance of the building (Structural Weaknesses); such as:

- whether it is long and narrow or otherwise irregular in shape
- irregular distribution of walls within the building
- whether this building could "pound" or hit its neighbour in a seismic event
- whether the land platform is flat or sloping
- the column height, number of columns and any significant changes in building mass at height
- in multi-storey buildings, the presence of non-ductile columns, gap and ledge stairs and precast floors of certain configurations.

d. Determination of *%NBS*

- Based on previous inputs, this will produce a *%NBS* score.

Alert:

The current spreadsheet provided by NZSEE rounds this score to the nearest 5% except around the 34% and 67% thresholds, where the IEP spreadsheet has been calibrated to report *%NBS* scores of 34*%NBS* and 67*%NBS* for buildings that just meet the criteria to be considered not earthquake prone and not earthquake risk respectively.

e. Grading

- A grade (alpha rating) will also be assigned corresponding to the *%NBS* (refer to Table 1 in section 6 of this document).

f. Potentially earthquake prone (or not)

- If the number in d) above is below 34*%NBS*, the building is *potentially* earthquake prone (as defined in section 122 of the Building Act).

g. Potentially earthquake risk (or not)

- If the number in d) is below 67*%NBS*, the building is potentially an earthquake *risk* building.

Alert:

NZSEE recommends that buildings are strengthened to at least *67%NBS* to elevate them above this earthquake risk threshold.

5.3 Consideration of Building Importance Levels

Building types, based on their use, are categorised into Importance Levels. The importance levels are defined in Clause A3 of the New Zealand Building Code and Section 3.3 of AS/NZS 1170.0:2002, and broadly speaking are as follows:

IL1 - This describes the lowest level of people occupancy. Non-habitable ancillary structures and outbuildings fall into this category.

IL2 - Describes buildings which don't fall into the other categories; e.g. normal office buildings and normal residential buildings.

IL3 - Describes buildings where large numbers of people can congregate in one space. Conference centres and hotels typically fall into this category.

IL4 - Buildings that must be operational immediately after an earthquake or other hazard event.

The Importance Level of a building must be factored into an ISA as it affects a building's seismic capacity to take account of the consequences of failure. For example, a building assessed as 26-31*%NBS* at IL2 reduces to 20-25*%NBS* at IL3 because of the higher occupant risk and the higher reference standard.

5.4 Identifying potential Critical Structural Weaknesses

A primary aspect of the ISA is the identification and qualitative assessment of the effects of any aspects of the structure and/or its parts that would be expected to reduce the performance of the building in earthquakes – that is, the presence of structural weaknesses.

The objective of an ISA is to identify any structural weaknesses that increase the life safety risk to occupants and/or adversely affect neighbouring buildings and people. At the ISA stage, such deficiencies in the building are referred to as potential Critical Structural Weaknesses. They may be classified as insignificant, significant or severe.

Alert:

Anyone reading an ISA report should look for any indication by the engineer that a significant or severe potential Critical Structural Weakness is present. These have the potential to adversely affect seismic performance.

It is important to note that buildings may have potential Critical Structural Weaknesses that are assessed as *insignificant*; that is, with relatively minor adverse impact on the building's overall performance.

A DSA will generally need to be undertaken to provide more confidence about the significance of a potential Critical Structural Weakness and how this may govern the behaviour of a building in an earthquake.

The relationship between the levels of structural weaknesses is shown in Figure 2.

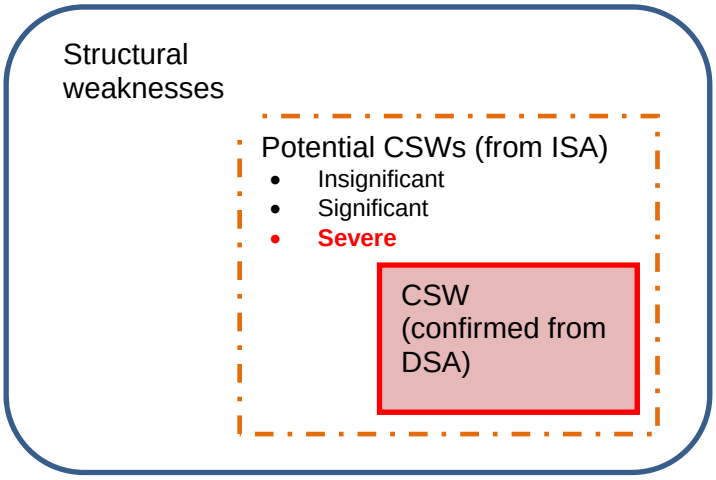

Figure 2: Relationship between Structural Weaknesses and Critical Structural Weaknesses

5.5 Approach for post-1976 buildings

Buildings designed and constructed using seismic design codes from 1976 onwards need to be approached from a slightly different perspective when undertaking an ISA. While they are unlikely to be earthquake prone in terms of the current Building Act definition, they can contain Structural Weaknesses that could lead to a sudden, non-ductile mode of failure at levels of seismic shaking less than intended by current design standards. It is important that buildings that may be earthquake *risk* buildings – that is, assessed as being less than *67%NBS* – with unacceptable failure modes are identified.

The development of new structural systems during the 1980s and 1990s and other architectural innovations led to the adoption of sometimes quite complex structural configurations and lateral load paths in buildings of this era. This problem has been exacerbated by the use of new structural materials and systems. Whereas for earlier buildings it might have been possible to identify a generic structural form from an exterior inspection, it is often difficult to pick this for post-1976 buildings.

This is particularly the case for mixed-use buildings involving competing structural layouts with, for example, accommodation, offices and car parking on different levels. These structures typically feature offset columns or other transfer structures causing

irregular steps in the load path that may or may not have been appropriately taken into account in the original design.

As a result, it is important that ISAs on post-1976 buildings involve both a full interior inspection and a review of available structural documentation.

6. Results and reporting of an Initial Seismic Assessment

An ISA typically refers to a *%NBS* value as the principal outcome or result. It should also detail an alpha rating and the relative risk, as shown in Table 1 below (which is taken from *Table 2.1: Grading system for earthquake risk* in Section 2-13 of the NZSEE Guidelines).

Table 1: ISA outcomes (potential building status)

Percentage of New Building Standard *(%NBS)*	Alpha rating	Approx risk relative to a new building	Life-safety risk description
>100	A+	Less than or comparable to	Low risk
80-100	A	1 - 2 times greater	Low risk
67-79	B	2 – 5 times greater	Low to Medium risk
34-66	C	5 – 10 times greater	Medium risk
20-33	D	10 – 25 times greater	High risk
<20	E	25 times greater	Very high risk

The ISA should also identify potential Critical Structural Weaknesses.

The reporting of the ISA results should be appropriate for the particular circumstances. In particular, if ISA reports are being sent to building owners and/or tenants, they should include such explanatory information as the:

- description of the building structure
- results of the ISA
- level of information the assessment was based on, and
- limitations of the process.

Alert:

When the results of a TA-initiated ISA are being reported, building owners must be advised of the limitations of the process employed.

There are two template letters in Section 3 of the NZSEE Guidelines to help with this:

- For a TA-initiated ISA programme: for TAs to send to building owners following the assessment of their building
- For ISAs commissioned by building owners: to accompany ISA reports sent by engineers directly to the building owner

An ISA report should highlight specific areas of potential concern in relation to the seismic performance of the building. This provides a clear pointer for the areas that a subsequent DSA should focus on.

Alert:

An ISA is only an *initial assessment* based on information available at the time and judgments based on this. Accordingly, an ISA report is **not**:

- a report that should be used to support the sale or purchase of a property
- a document of confidence in supporting an investment decision
- a document that might support a change of use decision that might give rise to additional strengthening requirements.

7. Next steps following receipt of an ISA

The result from an ISA must be considered an initial or interim result, given the typically limited time inputs from engineers. It therefore reports a *potential* status for the building.

Accordingly, the following steps are suggested based on the ISA findings:

- If the *%NBS* rating is less than *34%NBS* (i.e. the building is potentially earthquake prone in terms of the Building Act), property owners may either wish to go straight to a strengthening (or other) solution that will require specific analysis and design, or commission a DSA to more specifically determine the *%NBS* rating. The DSA will either establish that the building warrants a higher rating and may not be earthquake prone, or will confirm that it is earthquake prone. In the latter case, the DSA should be the first step towards developing a strengthening solution.
- If the *%NBS* rating is more than *34%NBS* but less than *67%NBS*, owners will need to reflect that the building still poses a much higher risk than an equivalent new structure. Accordingly, it is generally recommended that the owner commissions a DSA to more clearly establish the *%NBS* rating.

Building owners are encouraged to ask questions of their engineer or Territorial Authority, as they are there to help.

Alert:

If *significant* or *severe* potential Critical Structural Weaknesses have been identified by the engineer, ask for further advice. Even though a building may not be earthquake prone, it is important that the potential failure mode, which may be brittle and hence sudden, is understood.

If the building is declared earthquake prone following a DSA by the confirmation of *significant* or *severe* Structural Weaknesses, correcting these elements may be all that's needed to increase the seismic rating to over *34%NBS* so the building is no longer considered earthquake prone.

Please contact the New Zealand Society for Earthquake Engineering's Executive Officer at exec@nzsee.org.nz if you require further information on Initial Seismic Assessments.