INTERIM ADVICE ON THE 2022 NATIONAL SEISMIC HAZARD MODEL RELEASE

Purpose

This document provides interim guidance to design professionals and messaging to their clients in the period between the National Seismic Hazard Model (NSHM) release and its incorporation into the New Zealand Building Code (NZBC). The technical societies are planning a limited seminar on *earthquake design for uncertainty* and additional guidance in the near future.

Key Messages

- *The NSHM represents the latest scientific knowledge in earthquake hazard and is an important input into managing earthquake risk in the built environment.*
- *The NSHM informs design standards and design actions. It is not a design standard or design actions standard and should not be used as such.*
- *Specialist knowledge is required to properly compare the NSHM (either the new 2022 model or previous 2010 model) against the design spectra in NZS1170.5:2004. More information will be given on this topic in the planned seminars.*
- *Risk is a combination of likelihood and consequence. In this case likelihood is the potential for a damaging earthquake to occur. Large earthquakes are rare events. MBIE's document **Seismic Risk Guidance for Buildings** [3] gives guidance on risks posed by buildings to occupants.*

For New Design

- *Engineers should remember that the minimum compliance pathway has not changed. Until B1/VM1 is updated, B1/VM1 continues to cite NZS1170.5:2004.*
- *For geotechnical design the Section 175 Guidance in Earthquake Geotechnical Engineering Practice Module 1 (V1, 2021) has not changed and can continue to be used. That guidance will be reviewed in parallel with the update of B1/VM1.*
- *It's recommended that engineers discuss the existence of the new earthquake hazard information with clients, and MBIE's intent to progress some building regulation updates in the coming years. Ensure they are aware that the 2022 NSHM itself is not a design standard, and that any proposed changes will be consulted.*
- *Refer to the August 2022 document "**Earthquake Design for Uncertainty**", [1] for good design principles to assist with better performance in the face of hazard uncertainty.*

For Assessments

- *Use the design earthquake actions of NZS 1170.5:2004 (as cited by B1/VM1 on 1 July 2017) and Earthquake Geotechnical Engineering Practice Module 1 (V0, 2016) for all seismic assessments when calculating the %NBS rating. This is a legal requirement for EPB assessments, and allows for fair comparative assessments of all buildings.*

Introduction

The New Zealand Society for Earthquake Engineering (NZSEE), the Structural Engineering Society of New Zealand (SESOC) and the New Zealand Geotechnical Society (NZGS) along with Te Ao Rangahau Engineering New Zealand support any improvements and advancements to the art or science of engineering.

In October 2022, an updated National Seismic Hazard Model (NSHM) was released. The NSHM provides the base seismic parameters which help inform the design of structures to meet societal performance expectations and inform seismic risk assessment. It does not provide information that can be used directly with existing design standards. MBIE's Seismic Risk Working Group is currently looking at how to integrate the NSHM into seismic design practice, including changes to building regulations. Any changes to building regulations would be consulted publicly. Further information and consultation is expected during 2023.

This advisory has been prepared by NZSEE, SESOC and NZGS as collaborating technical societies to provide interim guidance for our members while we navigate this time of transition.

The National Seismic Hazard Model

The NSHM provides key information for understanding the hazard that earthquakes pose around our country, and the 2022 update is a leap forward for earthquake preparedness and resilience. The outputs of the 2022 NSHM are more accessible than previous editions, available via an online portal. The updated model will be used to inform our design PGAs and spectra in the future, but it is important to remember that it is not intended to be used as the basis of design in its raw form.

Some of the reasons for this relate to technical details, and the type of raw output data that these new models produce:

- The 2022 NHSM outputs different types of spectra to those used in the development of NZS 1170.5. For some types of applications, they could need to be adjusted before use.
- Changes in PGA (relative to previous models) won't necessarily be in the same proportion to changes in spectral accelerations, and so simply relating 2022 NSHM PGA values to "Z factors" could be a poor comparison (and would be inappropriate for design).
- Further, the Z factors in NZS 1170.5:2004 relate to a PGA on rock sites but are in fact derived differently (as described in the commentary to the standard). They are also different to PGA values for geotechnical design, because they're used for different purposes.

Specialist engineering seismology expertise should be sought to properly interpret the 2022 NSHM outputs if they are intended to be used to inform design.

Other reasons relate to the important distinction between hazard, and risk. New Zealand's Building Code objectives relate to managing risk. This requires consideration of structural and geotechnical behaviour, consequences, and tolerable outcomes. Whilst practising engineers don't routinely do this explicitly, it is taken into account when developing design standards—and it affects how design loads are set.

If engineers intend to use information from the 2022 NSHM under the current construct of NZS 1170.5 and current material design standards, it should be via a site-specific "Special Study". Any site-specific "Special Study" should be guided by NZS 1170.5, the current revision of B1/VM1, and the Earthquake Geotechnical Engineering Practice Modules. Users will need to have, or engage, the appropriate level of competence in engineering seismology aspects. Clients and engineers should be cautioned that future Building Code revisions could use different ways of setting design actions from hazard models than they have in the past. This means that the hazard model does not tell us the future Building Code provisions.

Example: Sometimes, "risk adjustment" of ULS seismic demand can be appropriate. This allows standards committees to account for the ways that structures could perform across the full spectrum of demand, whilst still keeping the design process simple by presenting straightforward ULS design actions. Risk adjustment depends on how structures and foundations are designed. This has not been done explicitly in NZ before, but has been done by standards developers in other countries.

Truncation of the acceleration spectrum to give the short period "plateau" is an example of a more coarse, implicit risk adjustment that is sometimes applied (but only affecting a small part of the design spectrum).

For the 2022 NSHM release, some comparative material has been produced by the NSHM team. This material has been provided to aid in scientific comparison of the new 2022 NSHM information to previous hazard models (such as the 2010 model, which did not feature in any building regulation update). Be aware when reviewing any comparative material that these are not comparisons to the design earthquake loads routinely used in limit state design.

Consider the following messaging when talking with clients

- *The NSHM represents the latest scientific knowledge in earthquake hazard and is an important input into managing earthquake risk in the built environment.*
- *The NSHM informs design standards and design actions. It is not a design standard or design actions standard and should not be used as such.*
- *Specialist knowledge is required to properly compare the NSHM (either the new 2022 model or previous 2010 model) against the design spectra in NZS1170.5:2004. More information will be given on this topic in the planned seminars.*
- *Risk is a combination of likelihood and consequence. In this case likelihood is the potential for a damaging earthquake to occur. Large earthquakes are rare events. MBIE's document **Seismic Risk Guidance for Buildings** [3] gives guidance on risks posed by buildings to occupants.*

Design Advice for New Buildings

The release of the 2022 NSHM highlights uncertainty in earthquake demands. Engineers know that there are two sides to every equation. When we design structures, our simplest aim is to ensure that the capacity of our structure is greater than the demands it is subjected to.

The demand side of the equation is an important piece of the design process. Decisions around how much wind to design for, what snow loads, and indeed the level of seismic demands are made in a regulatory setting. Engineers are interested and informed parties—however the setting of acceptable levels of societal risk is a regulatory decision. Irrespective of the demands specified by the regulator, engineers must be aware that earthquake demands are far from certain and that a "greater than design level" earthquake could occur anywhere and at any time.

It is important for engineers to remember that while we do not dictate the demand side of the equation, our work on the capacity side of the structure has the ability to reduce or mitigate uncertainty. There are many, often cost neutral, things that can be done to enhance a buildings performance, robustness and resilience. The joint Technical Societies document "Earthquake Design for Uncertainty", revision 1, August 2022 [1] has some excellent guidance. Simple design fundamentals like regularity, improving tolerance to

foundation compliance, keeping displacements low, and detailing for ductility while assuming low ductility when determining design actions, all enhance the robustness and performance of buildings.

If you are designing new buildings, from a Building Act compliance point of view, the current design actions are acceptable as a legal minimum until such time as they are changed. At this stage, MBIE is planning to consult on an initial set of proposed changes to B1/VM1 in mid-2023. This initial review will consider how to incorporate the new hazard information into the current design approach. The timing for this consultation will depend on how long it takes to develop technically robust proposals, and MBIE intends to confirm timeframes in the coming months. Information on Building Code update processes can be found on MBIE's website under *Building Code compliance: **Maintaining the Building Code***.

It is important to note that clients can choose to do more than just meet legal minimum requirements. Engineers should talk to clients, explain the uncertainties we are facing and possible options to mitigate any future impacts.

> *Example: For an example of an effective approach being applied in practice, engineers can refer to guidance from the Ministry of Education. The Ministry has their own design rules for building enhanced resilience to their portfolio that can be found in their **Structural and Geotechnical Requirements** [2]. These design rules include keeping displacements low and the structural system elastic at an enhanced SLS return period. The Ministry of Education have elected to apply this approach in their role as a large portfolio holder of school buildings*.

Consider the following when designing new structures

- *Engineers should remember that the minimum compliance pathway has not changed. Until B1/VM1 is updated, B1/VM1 continues to cite NZS1170.5:2004.*
- *For geotechnical design the Section 175 Guidance in Earthquake Geotechnical Engineering Practice Module 1 (V1, 2021) has not changed and can continue to be used. That guidance will be reviewed in parallel with the update of B1/VM1.*
- *Discuss the existence of the new earthquake hazard information with clients, and MBIE's intent to progress some building regulation updates in the coming years. Ensure they are aware that the 2022 NSHM itself is not a design standard, and that any proposed changes will be consulted.*
- *Refer to the August 2022 document "**Earthquake Design for Uncertainty**", [1] for good design principles to assist with better performance in the face of hazard uncertainty. General themes include:*
  - *Adopt robust design practices, and consider the sensitivity of the design to an increase in demand.*
  - *Consider using low global ductility for the purpose of determining design actions but detailing for full ductility.*
  - *Ensure close collaboration with geotechnical engineers in the configuring of building foundation systems. Test the potential for ground deformation or significant degradation of strength (including liquefaction effects) at levels of shaking beyond ULS—so that instability or collapse potential can be mitigated/minimised.*

Advice for Seismic Assessment of Existing Buildings

Existing building assessment intends to identify potential life safety risks in our building stock, and incentivise risk reduction over time—particularly the riskiest vulnerabilities or "structural weaknesses". Assessment outcomes are presented in relative terms, using the %NBS Earthquake Rating index. This rating compares a building's capacity to the minimum standards required of a similar new building on the same site. Therefore, when calculating %NBS ratings, the ULS seismic demand as defined in B1/VM1 should be used and should not be greater than that given in NZS 1170.5:2004. For geotechnical aspects Earthquake Geotechnical Engineering Practice Module 1 (V0, 2016) should be used.

Furthermore, for Earthquake Prone Buildings legislation (EPB purposes) seismic demands are benchmarked to those within the version of B1/VM1 and Earthquake Geotechnical Engineering Practice Module 1 (V0, 2016) in effect on 1 July 2017.

The collaborating technical societies advise that the seismic demands in NZS1170.5:2004 (as cited by B1/VM1 on 1 July 2017) and Earthquake Geotechnical Engineering Practice Module 1 (V0, 2016) should be used to determine %NBS for *all* assessments (whether for EPB purposes or for voluntary assessments).

MBIE has convened a committee called the Joint Committee on Seismic Assessment of Existing Buildings (JCSAEB) and NZSEE, SESOC and NZGS are represented. The JCSAEB is considering how voluntary seismic assessments are used in response to market drivers beyond the life safety focus inherent in the EPB legislation and its 34% NBS threshold. The JCSAEB is expected to produce advice on how future B1/VM1 revisions might impact the way voluntary assessments are best reported.

SESOC, NZSEE and NZGS recommends the following advice for the assessment of existing buildings

- *Continue to use the design earthquake actions of NZS 1170.5:2004 (as cited by B1/VM1 on 1 July 2017) and Earthquake Geotechnical Engineering Practice Module 1 (V0, 2016) for all seismic assessments when calculating %NBS ratings. This is a legal requirement for EPB assessments, and allows for fair comparative assessments of all buildings.*
- *Risk is a combination of likelihood and consequence. In this case likelihood is the potential for a damaging earthquake to occur. Large earthquakes are rare events. MBIE's document **Seismic Risk Guidance for Buildings** [3] gives guidance on risks posed by buildings to occupants.*

Conclusion

The release of the 2022 NSHM is a major step forward in understanding seismic hazard in New Zealand. It will help us to make our built environment more earthquake resilient. The 2022 NSHM is not a design standard itself, however MBIE have commenced a programme of work to develop Building Code updates related to seismic risk and the 2022 NSHM. Consultation on changes is currently anticipated in mid-2023.

The new information may create some commercial uncertainty as well as genuine safety concern from the public and property sector—both of which should be respected. In new design work, applying the guidance set out in the **Earthquake Design for Uncertainty** document, can help to mitigate this uncertainty. A well-conceived, well designed and constructed, code compliant building has reserve capacity. It is important that engineers and our colleagues in the building sector act responsibly, avoid unnecessary concern and exercise responsible leadership.

The changes in seismicity primarily relate to the design of new buildings, and how we take uncertainty into account. The changes don't require adjustment in the way we view current levels of risk posed by existing buildings and the way we report on that risk—which should continue to use NZS 1170.5.

The objective of existing building assessment is to identify life safety risks in buildings and incentivise risk reduction over time—focussing on the riskiest vulnerabilities. The existing framework can continue to be used for this purpose, and the principles in the **MBIE Risk Guidance** can help to place some of the outcomes into a practical context. The collaborating technical societies of NZSEE, SESOC and NZGS along with MBIE via the JCSAEB are considering the impact that any future Building Code updates may have on the way we manage existing building assessment. We will continue to advise our members, work with other stakeholders and show leadership in this important area.

References

[1] NZSEE, SESOC, and NZGS (2022) *Earthquake Design for Uncertainty*. New Zealand Society for Earthquake Engineering, Wellington, New Zealand. 11p.

[2] MOE (2020) *Designing Schools in New Zealand: Structural and Geotechnical Requirements* (Version 3.0). Ministry of Education, Wellington, New Zealand. 86p.

[3] MBIE (2022) *Seismic Risk Guidance for Buildings*. Ministry of Business, Innovation and Employment, Wellington, New Zealand. 25p.

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