NEW ZEALAND SOCIETY FOR EARTHQUAKE ENGINEERING

SEISMIC RISK AND BUILDING CODE – INTEGRATING GEOTECHNICAL REQUIREMENTS FOR NEW BUILDING DESIGN

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ABSTRACT

Regulatory stewardship is at the heart of how Ministry of Business Innovation and Employment (MBIE) performs its role overseeing the Building Act and associated regulations including the Building Code. In recent years, MBIE Building System Performance branch (being the national building regulator) has reviewed how it administers the Building Code and what best practice delivery entails. One of the critical gaps in the current building design system for new buildings is the incorporation of ground conditions, foundation performance and soil-structure interaction effects in the design process (i.e. geotechnical requirements). Existing provisions do not adequately address ground failure (e.g. liquefaction), non-liquefaction related foundation settlement and consideration of 'off-site' geotechnical hazards.

This paper presents overview of the building regulatory system including the legislative framework, MBIE's stewardship outlining (at a high level) the comprehensive work being undertaken by the Seismic Risk Working Group (SRWG). An important piece of this work is integrating the geotechnical considerations into the building design requirements for new buildings. Deliverables from the SRWG are being project managed and delivered by Engineering NZ (ENZ) for MBIE. The products delivered to MBIE will need careful consideration (including policy analysis work and cost benefit analysis) before being incorporated into the Building Code compliance documents (Verification Methods, Acceptable Solutions and Standards). This paper also dwells at a high level into geotechnical considerations for the seismic assessment of existing buildings and it is important to understand the wider context of geotechnical guidance in the building regulatory system.

1 INTRODUCTION

The foundation of the building regulatory system in New Zealand is the Building Act 2004. The Building Act required the creation of a number of different sets of regulations. One of these sets of regulations is the Building Code (Schedule 1 of the Building Regulations 1992). The purpose of the Building Code is to provide a set of functional requirements and performance criteria that provide more detailed requirements that support the Building Act. The Building Act and Building Code work together to form a set of mandatory legal requirements that must be complied with when undertaking building work in New Zealand. An overview of the regulatory system is outlined below

2 OVERVIEW OF THE REGULATORY SYSTEM

The regulation and performance of buildings in New Zealand sits under the following four-part framework (Figure 1).

1. The Building Act 2004 is the legislation that contains the provisions for regulating building work. It sets out the legal requirements for ensuring all new building designs, repairs, alterations, demolition and removal will comply with the supporting Building Regulations and the New Zealand Building Code.
2. The various building regulations, in particular the Building Regulations 1992 which contain the New Zealand Building Code within Schedule 1. The Building Code establishes a performance-based system by setting performance standards that all new building work must meet. These standards cover aspects such as stability, durability, protection from fire, access, moisture, safety of users, services and facilities, and energy efficiency.
3. Verification Methods and Acceptable Solutions, which are provided for all Building Code Clauses. These provide one way (but not the only way) of complying with the Building Code. The performance-based Building Code system allows Alternative Solutions, provided the design can be shown to meet the performance criteria of the Building Code, to the satisfaction of the Building Consent Authority.
4. Guidance (Building Act s.175) published to assist with complying with the Building Act. This document is issued as guidance under Section 175.

The New Zealand Building Code sets out the performance criteria to be met for all new building work. The Building Code does not prescribe how work should be done but states how completed building work and its parts must perform. The Building Code covers aspects such as stability, protection from fire, access, moisture, safety of users, services and facilities, and energy efficiency.

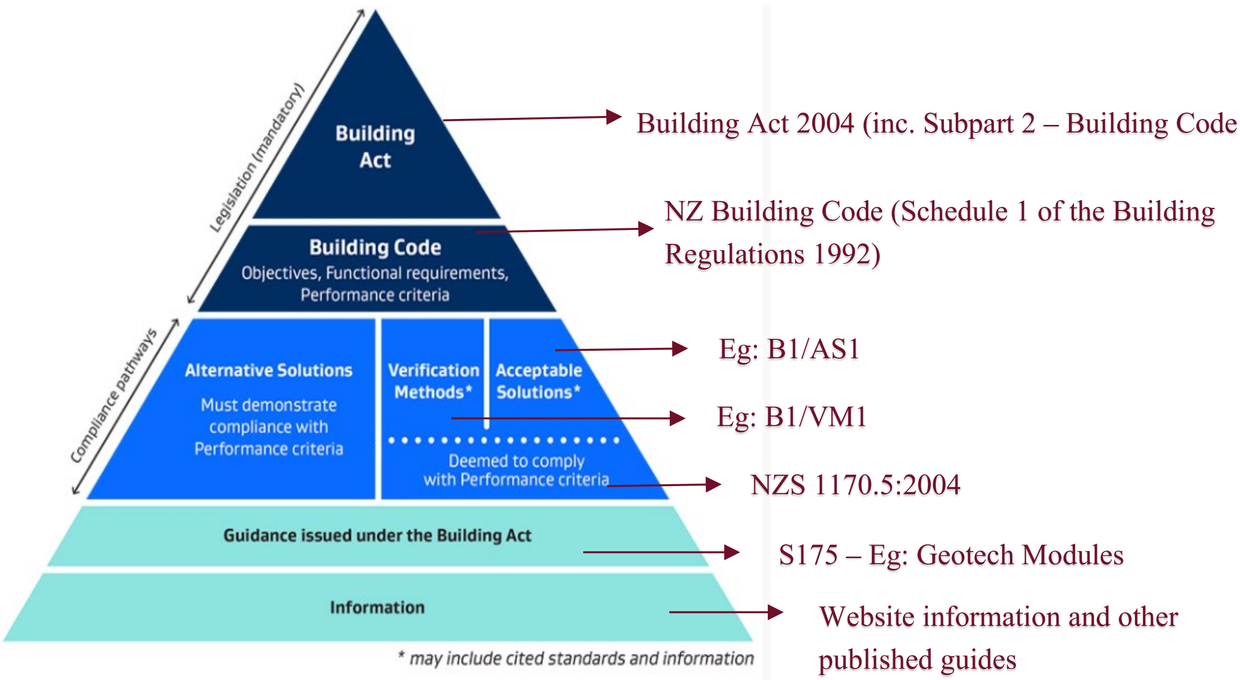

Figure 1: The Building Code regulatory framework

2.1 Provisions across the Building Code system

The Building Code system proposed by the Building Industry Commission[1] in 1991 introduced a five-level performance-based framework for building behaviour. Adapted definitions of the levels are:

1. **Objectives**: describe the social objectives that buildings must satisfy, usually expressed in terms of human needs
2. **Functional requirements**: statements describing how buildings and their parts must function in order to meet the stated social objectives
3. **Performance**: statements of the behaviour in use of buildings and their parts, that will fulfil the functional requirements
4. **Verification Methods**: methods of predicting performance and [methods of] verifying compliance with the Building Code [or with building product specifications]
5. **Acceptable Solutions**: detailed technical solutions that will produce buildings or building parts that are deemed to comply with a Building Code clause

In general terms, levels 2 to 4 progressively elaborate on how buildings must function to achieve the level 1 social objectives. This progression, illustrated in Figure 2, flows from work approaches to methods and then procedures. This progression introduces detail and simultaneously narrows the range of buildings the sets of provisions can be applied to.

Figure 2 introduces the key parts of the Building Code system, with a focus on how these parts support technical solutions that prescribe how to construct a building, part of a building, or a system using specific locations, sizes, grades, or classes of building product.

[1] *Building Industry Commission (Jan 1991) Reform of building controls: Report to the Minister of Internal Affairs*

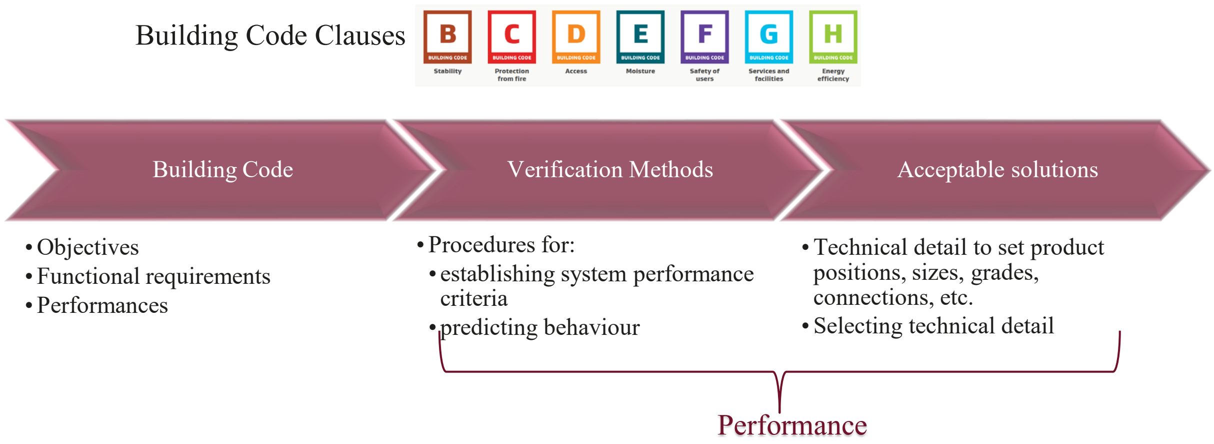

Figure 2: Key documents and provisions across the Building Code system

2.2 New Zealand Building Code Stewardship

Each Verification Method outlines the provisions of the Building Code clause to which it relates. Complying with an Acceptable Solution or Verification Method are ways of complying with that part of the Building Code.

Other options for establishing compliance are listed in section 19 of the Building Act. The Building Performance & Engineering team (BPE) are the stewards of the Building Code System, providing technical leadership and critical thinking to give effect to the purpose and principles of the Building Act. The team reviews, maintains and develops the Building Code system, and the Acceptable Solution and Verification Method documents - a core function under the Building Act 2004 (Figure 1)

The Verification Method for ‘B1 Structure’ cites several standards for designing buildings that meet earthquake requirements which include NZS 1170.5:2004 - *Structural design actions,* primarily used for design of structures.

2.2.1 Mandatory requirements

The functional requirements and performance statements within the technical clauses of the Building Code set out the mandatory ways that buildings must function and perform during their construction and use.

Ideally, the performances should include qualitative performance criteria and the approaches that must be used to assess compliance to allow more than one Verification Method to be used.

However, this pattern is not followed uniformly across the Building Code clauses and their supporting documents. For example, in different clauses of the Building Code, performance statements give:

1. qualitative performance criteria and the approaches to complying with the criteria
   a) For clauses like B1 *Structure*, the detailed procedures for calculating the criteria and for verifying that a building meets the calculated values are given in B1/VM1.
2. quantified performance criteria
   b) For example, the 50-, 15-, and 5-year minimum service lives in clause B2.3 *Durability* and events with a 2% probability of occurring annually in clause E.1.3.2.
   c) Clause B2.3 gives values but the approach to verifying performance is in B2/VM1. Neither says whether the values are average lives, or they must never be exceeded. Because B2/VM1 is not a procedure, it needs expert interpretation. Most users are only able to follow the technical solutions in B2/AS1.

d) Clause E.1.3.2 gives an absolute value but offers no guidance on whether physical conditions such as waves (i.e. whether freeboard should be added) should be considered when determining whether surface water could enter a building

2.2.2 Compliance pathways

Verification Methods and Acceptable Solutions provide the starting points for compliance pathways that can be used to demonstrate that proposed construction will comply with the Building Code. Technically, construction can only ever be deemed to comply with the Building Code. Reasons for this include:

1. There is no way to demonstrate with absolute certainty that buildings will comply with the Building Code because many Building Code clauses have qualitative performance criteria
2. Verification Methods and Acceptable Solutions that do quantify performance would need to produce identical construction when the circumstances are identical.
3. Older buildings that have been altered may never comply with every clause of the Building Code.

In the past, Verification Methods and Acceptable Solutions were called both approved documents (1991-2004) and compliance documents (2004-2012). In 2012, the term compliance document was removed from the Building Act 2004 (the Act) because it misleadingly infers that following a compliance pathway will make construction comply with the Building Code.

The Act requires Building Consent Authorities (BCA) to consider construction in accordance with consented plans and specifications will comply with the Building Code once it is completed. They must also grant consents for plans and specifications when they are produced in accordance with Verification Methods and Acceptable Solutions.

3 SEISMIC RISK IN NEW ZEALAND

3.1 The 2022 National Seismic Hazard Model (NSHM)

The National Seismic Hazard Model (the Model) is key to understanding New Zealand's risk from earthquakes. It models the likelihood and strength of earthquake ground shaking that might occur at any given site in New Zealand over specified time periods. The 2022 update[2] to the Model is essential for ensuring that New Zealanders are ready and prepared for such events.

Our knowledge of the seismic hazard has advanced significantly since the last revision of the science behind the Model in 2002, and it shows that the seismic hazard is higher than what we previously believed it to be. The 2022 Model update shows that New Zealand can expect to get bigger earthquakes, more frequently, particularly in areas such as Wellington, Masterton and Blenheim. In other areas, the increase in the earthquake hazard is more limited. The earthquake hazard increase ranges from negligible change in some areas to more than doubling in others (e.g., Masterton), with an average increase of around 50% or more across the country.

A significant contributor to the changes in earthquake hazard estimates is a better understanding of the Hikurangi Subduction Zone, another is the Alpine Fault. These are important sources of earthquakes. The updated 2022 Model also enhances our understanding of previously little-known faults and how shaking from earthquakes on these faults may affect different regions in New Zealand. Prior to the Model revision, MBIE began considering what the updated modelling results mean for building design standards. From a

[2] GNS Science was commissioned by MBIE and Natural Hazards Commission (NHC) to undertake the revision of NSHM in 2020

seismic resilience perspective, it is crucial to construct buildings and infrastructure that can better withstand the anticipated geo hazards namely earthquakes and landslides.

3.2 Practical implications of new science for building regulation

As the national building regulator, MBIE has an obligation to consider how new earthquake science is incorporated into the Building Code system so that it remains up-to-date and fit-for-purpose. Under the Building Act, the most common means of demonstrating compliance with the minimum seismic requirements of the Building Code is to follow an Acceptable Solution or a Verification Method, including any Standards that are incorporated into these documents.

The updated 2022 Model results suggest that the relevant Verification Method, B1/VM1, may need to be reviewed and updated. Verification Method 'B1/VM1' incorporates the technical standard New Zealand Standard NZS 1170.5:2004 (Earthquake actions)[3]. This Standard was based on now-superseded science produced as part of the 2002 National Seismic Hazard Model, and is now over two decades old.

3.3 Work commissioned by MBIE

In early 2020, MBIE commissioned Engineering New Zealand (ENZ) to help prepare for the release of an updated NSHM (the Model). ENZ brought together an expert group to discuss the current building regulatory system and identify possible improvements ahead of the Model's release. To this effect, ENZ produced a report titled "Rethinking seismic risk in the building control system – options for change"[4] which outlined some key recommendations for MBIE to consider following the Model release.

Following the report recommendations, MBIE's Building Performance and Engineering (BPE) team has been working with ENZ to ensure it is prepared to implement the outputs of the Model quickly and efficiently within the building regulatory system and mitigate any potential impacts. The Seismic Risk Work Programme (SRWP) is a result of this engagement which aims to integrate the outputs of the Model.

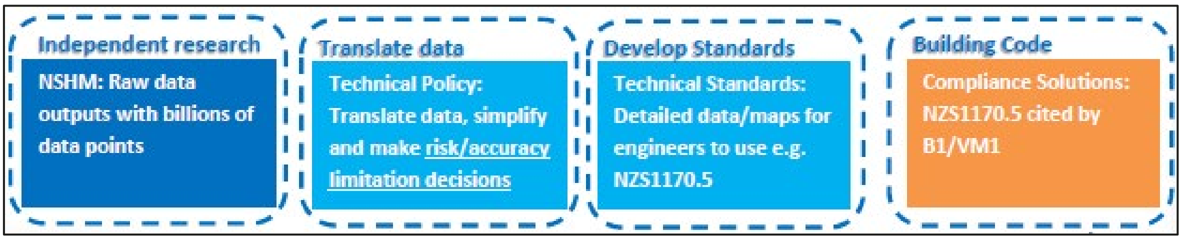

Figure 3: Process for translation of scientific research into regulatory settings

Currently, most of the content for the seismic design and loading requirements are within a suite of 1170 standards series and NZS 1170.5:2004 in particular. MBIE commissioned Engineering New Zealand (ENZ) for the development and completion of a technical product (draft Technical Specification) which was then handed over to Standards New Zealand (SNZ) [5]. SNZ used this product to develop a new Technical

[3] This standard is used by engineers to calculate the earthquake loads used in the design of buildings. Buildings designed in accordance with the provisions of this standard in conjunction with the other requirements in the Verification Method are expected to achieve a level of performance during earthquakes that meets the performance requirements set out in the Building Code.

[4] Report submitted to MBIE by Engineering NZ dated 14 July 2020

[5] Operating under its own legislation (Standards and Accreditation Act 2015, Standards NZ is New Zealand's independent and internationally recognised national standards body. Standards NZ develop and publish national and regional standards and standards-related solutions. They also represent New Zealand for the International Organization for Standardization (ISO) to ensure that New Zealand has a voice in the international standards community.

Specification (TS), i.e. TS 1170.5:2024 that could be citied in the current building design standard.[6] The timeline of citing the TS in the Verification Method document B1/VM1 is yet to be determined.

The Standards committee responsible for incorporating recommendations into a new TS comprises a range of representatives from key technical societies, BCAs, and other impacted stakeholders (such as Ministry of Education, Ministry of Health, Building Officials Institute NZ, and BRANZ). The draft TS prepared by this committee is based on international best practice and reflects industry expectations that current seismic loads used in building design need to increase in order to maintain life safety objectives in the Building Code.

The TS provides updated engineering guidance for designers to determine the earthquake loads on new buildings informed by new science in the updated Model. Depending on location and underlying geology, buildings will need to be stronger and resilient to maintain the current life safety targets. A draft TS 1170.5 was released for public comment / consultation by Standards NZ in April 2024. The new TS 1170.5 is expected to be published in the first half of 2025.

3.4 Existing compliance pathway for foundations

Verification Methods and Acceptable Solutions often reference specific New Zealand or international standards, eg 1170.5 is referenced in B1/VM1 and NZS 3604 is referenced in B1/AS1. However, geotechnical engineers need to be sure that the VM or AS being referenced is appropriate for their specific application. Alternative Solutions provide an opportunity for the designer to propose and demonstrate that their design fully meets the performance requirements set in the Code. Acceptable Solutions and Verification Methods are not fully comprehensive, and most projects have an Alternative Solution element, requiring additional analysis and considerations.

This is particularly the case for geotechnical engineering as considerable complexities are often encountered in projects but are not necessarily considered in following the prescriptive pathway. Caution is necessary if using the prescriptive ('deemed to comply') pathway, as the relevant Verification Method, B1/VM4, has a narrow scope of application, and some aspects no longer meet current design practice. This is an area being reviewed by MBIE to plug the gaps and make it more consistent with TS 1170.5 and geotechnical modules. Geotechnical modules – Module 1 (overview of the modules) and Module 2 (Geotechnical investigations for earthquake engineering) are being revised and will be published at the time of TS 1170.5 publication.

3.4.1 Current practice limitations

As mentioned above, the only explicit geotechnical considerations are found in Verification Method B1/VM4, which has several fundamental caveats/limitations. It assumes general ground or slope stability and provides methods only for ensuring against local failure of the foundation. It is inapplicable to the design and verification of performance of entire structures when the ground conditions may have significant consequences for design. In most cases, the assumption of ground stability cannot be confirmed without geotechnical investigation and analysis, and the methods in B1/VM4 do not "ensure" that foundation failure will not occur. Some notable drawbacks in the current B1/VM4 are:

1. Application of VM4 is limited due to soil type and soil conditions
2. Presents only one method for carrying out calculation of bearing capacities for shallow foundations and piled foundations

[6] Standards NZ develop and publish national and regional standards and standards-related solutions. They also represent New Zealand for the International Organization for Standardization (ISO) to ensure that New Zealand has a voice in the international standards community.

3. Strength reduction factors are outdated and doesn't align well with existing geotech modules i.e. Module 4 – Earthquake resistant foundation design.
4. No explicit requirement requirements in relation to liquefaction hazards
5. Also limited to formulations that consider only shear strength parameters (cohesion, internal friction angle, undrained shear strength etc)
6. No explicit inclusion of determining bearing capacity through co-relations with in-situ testing and settlement calculations.

3.5 Geotechnical Considerations

Some of the key aspects of seismic design and performance are related to damage threshold, limit states and post-earthquake performance of the structure. But more importantly, the seismic performance of a building is fundamentally liked to the performance of both its foundations and the underlying soils (ground). NZS 1170.5:2004 in its current state doesn't explicitly incorporate geotechnical criteria into structural performance objectives nor does it provide guidance on important issues that need to be considered in relation to ground and foundations. Verification Method B1/VM4 in its current state doesn't consider the above mentioned inherent geotechnical considerations either as part of foundation performance.

In view of the above, the SRWG is looking into integrating these geotechnical considerations as part of future update to TS 1170.5. The performance of the foundation soils is being considered as part of the verification process. In general, consideration of the behaviour of the foundation soils and the performance of the foundation should cover liquefaction, lateral spreading, earthquake-induced settlement, down drag on piles, lateral soil loads, buoyancy effects, and slope stability, particularly when a potential 'step-change' in the behaviour of the foundation soils is indicated. A 'step-change' is defined as a dramatic loss of stiffness and strength of soils that leads to a large increase in soil strain or displacement, and, therefore, potential foundation damage. MBIE/NZGS Geotechnical Earthquake Engineering Practice Series[7] (Modules) provides further guidance on how to consider the above "step-change" behaviour.

The following geotechnical considerations are deemed integral to design of buildings:

1) Soil strength i.e. bearing capacity,
2) Settlement (differential, lateral and total),
3) Liquefaction and lateral spreading,
4) Requirements for geotechnical assessment
5) Soil structure interaction (SSI) in geotechnical assessment,
6) Foundation requirements

Soil settlement and bearing capacity are important considerations when evaluating design actions for a building. Differential settlements of foundation soils induce stresses in a structure – the relevance of which depend on the magnitude of the soil deformation, and the structural form. Currently, assessment of settlement characteristics and bearing capacity of soils is not explicitly required by NZS 1170.5 (although assessment is implicitly required in current TS 1170.5 to satisfy the requirement that the ground supporting the foundations does not jeopardize the assumed behaviour of the structure). There is also a lack of consistency in how information related to foundation settlement and bearing capacity is communicated between geotechnical and structural engineers and there is a lack of clarity in how this data should be used in structural design.

[7] MBIE NZGS Earthquake Geotechnical Engineering Practice Series (Modules) published 2021

Incorporating soil liquefaction and lateral spreading considerations into design is also equally important. Soil liquefaction is one of the most prevalent seismic hazards in NZ. It is highly relevant for building design as much of the urban land in NZ has moderate-to-high liquefaction potential. Importantly, at such sites liquefaction is predicted to occur frequently (i.e., on average, within 50-100 years return period). The following (as a starting point) should be considered as part of liquefaction and lateral spreading considerations:

1. Effects of liquefaction on bearing capacity
2. Liquefaction-induced settlement (for ground and shallow foundations)
3. Treatment of uncertainties and scenario considerations
4. Consideration of liquefaction effects in analysis methods (e.g., springs, loads, SSI).
5. Negative skin friction, load transfer mechanisms on piles/drilled shafts etc and their implications on settlements).

The current design approach focusses on life safety (ULS), uses very low return period for SLS (25 years), and does not explicitly aim to limit/control damage for IL2 structures (in the VM and AS pathways). Given that damage is expected (allowed) for intensities greater than SLS, the lack of consideration of liquefaction hazards is not critical (in most of the cases), as liquefaction would be only one of the contributing factors to the damage that is anyway expected (allowed for) to occur. The lack of explicit consideration of liquefaction in the current approach is unconservative in some cases in which severe effects of liquefaction (lateral spreading) may jeopardise life safety at ULS (and beyond). The Canterbury earthquake sequence[8]

3.6 Potential solutions

Considering the above, in the context of seismic performance it is imperative that geotechnical considerations are integrated into design and performance of buildings. This will ensure a consistent and robust approach that will provide confidence to designers and end users that target performance criteria and objectives are achieved. Provisions such as ground conditions, foundation behaviour and soil structure interaction effects in the design process would reference to ground failure (liquefaction), non-liquefaction related foundation settlement and consideration of 'off-site' geotechnical hazards. B1/VM4 needs a comprehensive overhaul or revision to ensure it is up to date and fit for purpose. MBIE NZGS Earthquake Geotechnical Engineering Practice Series (modules) provide a more robust basis for technical reference and should be incorporated as reference into B1/VM4.

4 GEOTECHNICAL CONSIDERATIONS FOR THE SEISMIC ASSESSMENT OF EXISTING BUILDINGS

4.1 Geotechnical considerations and existing buildings

While this paper primarily focuses on the updating of geotechnical provisions for the design of new buildings, it is important to understand the wider context of geotechnical guidance in the building regulatory system. In addition to work undertaken by the SRWG outlined above, MBIE is currently stewarding a work programme through the Joint Committee for the Seismic Assessment of Existing Buildings (JC-SAR). Part of the Joint Committee work programme includes updating geotechnical considerations to address identified gaps in the seismic assessment of existing buildings.

[8] Canterbury earthquake sequence – series of earthquakes that occurred in the Canterbury region of New Zealand's South Island between 2010 and 2011.

In 2017, MBIE published *Seismic Assessments of Existing Buildings – Technical Guidelines for Engineering Assessments* (the 'Seismic Assessment Guidelines'). Informally known as the 'Red Book', these Guidelines must be used when carrying out seismic assessments under the earthquake-prone building system. Within the Seismic Assessment Guidelines, chapter C4 Geotechnical Considerations provides guidance on the geotechnical considerations for a Detailed Seismic Assessment. The stated purpose of C4 is to provide tools to:

1) identify the level of influence that ground behaviour (e.g. soil deformation or specific geotechnical hazards such as slope instability) may have on structural performance during earthquake shaking and,
2) where possible, to quantify these effects and provide an appropriate level of input to the overall assessment.

The initial and current version of C4 was published as in July 2017. C4 includes several areas of geotechnical practice which had not been previously included in guidance, including provisions for geotechnical step change.

The Seismic Assessment Guidelines have now been in use for over seven years. Feedback obtained through the Joint Committee has identified gaps in the existing version of C4.

Updates are required to clarify guidance on:

1) How, when, and why the geotechnical step change allowance is applied to foundation capacity.
2) Selection of geotechnical parameters and the level of conservatism to be applied.
3) How to allow for uncertainty.

Identified gaps in C4 include a lack of guidance on how to account for:

1) Ground displacement due to liquefaction and lateral spread or cyclic displacement.
2) Post liquefaction settlement.
3) Heave of basements due to liquefaction.
4) Ground displacement due to slope movement triggered by earthquake shaking.

Updates to C4 would benefit from further development of the guidance for:

1) Desktop geotechnical assessments and reporting.
2) Soil structure interaction.

The shortcomings identified by the Joint Committee could result in inconsistencies between the assessments of individual buildings. In response, a geotechnical work programme has therefore been commissioned through the Joint Committee to address the identified shortcomings of the current C4 document. The objective of the update is to improve the clarity of the C4 guidance and provide a basis for consistent and appropriate assessments for buildings where ground conditions significantly influence the seismic behaviour of buildings.

4.2 Coordination of geotechnical guidance

MBIE recognise the importance of ensuring that geotechnical guidance is appropriate, fit-for-purpose, current, and compatible within and across the building regulatory system. Efforts are underway to ensure the compatibility of geotechnical guidance produced for both new and existing buildings as outlined in this paper. In addition, MBIE recognise the need to work with industry stakeholders and the geotechnical community to ensure that update do not contradict or cause confusion in relation to other industry guidance (such as the MBIE/NZGS Geotechnical Modules). Ultimately, is important that any updates with the building regulatory system (e.g. new building work) align with other Guidance within the system.

An update B1/VM4 – the design method for foundations is required as the work to integrate geotechnical requirements is on-going with TS 1170.5. Knowledge in geotechnical engineering and design has significantly progressed since the last update of B1/VM4 in 2008. Hence a scoping project is proposed to identify how to best address issues with B1/VM4 and achieve alignment with the MBIE NZGS Geotechnical Modules and the future direction of structural design. A preliminary review has identified the following areas to update:

1) Determination of soil settlements and bearing capacity,
2) Minimum geotechnical performance requirements,
3) Assessment of liquefaction and calculation of deformations

Some of the areas above are currently being filled in part by the Geotechnical Modules, published under Section 175 of the Building Act. However, as these documents do not provide a deemed-to-comply pathway, users do not have to use them, and BCAs do not have to accept them. Achieving alignment between B1/VM4 and the Geotechnical Modules would improve the consistency of design and assurance of new building work.

5 CONCLUSIONS

This paper summarises the regulatory stewardship role fulfilled by MBIE in the New Zealand building performance sector and outlines geotechnical work programmes that are underway to improve the geotechnical aspects of seismic assessment for buildings.

1) In recent years, MBIE Building System Performance branch (being the national building regulator) has reviewed how it administers the Building Code and what best practice delivery entails.
2) The National Seismic Hazard Model (NSHM) is the foundation of many of the safety critical building performance settings in the Building Code. In particular, the NSHM underpins seismic performance requirements by calculating the likelihood and expected strength of earthquake shaking in different parts of New Zealand.
3) One of the critical gaps in the current building design system for new buildings is the incorporation of ground conditions, foundation performance and soil-structure interaction effects in the design process.
4) Existing provisions do not adequately address ground failure (e.g. liquefaction), non-liquefaction related foundation settlement and consideration of ‘off-site’ geotechnical hazards.
5) Comprehensive work is being undertaken by the Seismic Risk Working Group (SRWG) to integrate geotechnical considerations into building design requirements for new buildings. Parallelly, an initial scoping exercise to determine the extent of update required to B1/VM4 to achieve consistency with Geotechnical Modules.
6) In addition, a work programme is underway to update existing guidance on geotechnical considerations for the seismic assessment of existing buildings (C4).

Before technical updates can be incorporated into the Building Code compliance documents (Verification Methods, Acceptable Solutions and Standards), MBIE will undertake policy analysis including estimated cost impacts and test risk tolerance to fully understand implications of the proposed updates. If the TS 1170.5 gets published by Standards New Zealand later on in the year, It is very important to note that

1) There will be no change to the current minimum regulatory requirements for new buildings
2) TS 1170.5 is intended to be used on a voluntary basis only.
3) No impact on MBIE's Earthquake Prone Buildings (EPB) regulatory system for identifying and remediating EPB's.

MBIE does have an obligation to consider and advise on how new science is incorporated to keep building regulation modern and up to date. Any changes would happen only after further public consultation. MBIE looks forward to working with the sector on all aspects of intended impacts before incorporating into the Building Code compliance documents.

The authors would like to acknowledge the members of the Seismic Risk Working Group, the Building Performance and Engineering team (MBIE) and Engineering New Zealand for their contribution and support in writing this paper.

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