



Consultation document  
Building Code update 2022  
**Structural stability of  
hollow-core floors**

Amending Verification Method B1/VM1

2 MAY 2022



## Ministry of Business, Innovation and Employment (MBIE)

### Hīkina Whakatutuki – Lifting to make successful

MBIE develops and delivers policy, services, advice and regulation to support economic growth and the prosperity and wellbeing of New Zealanders.

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# Preface

The Building Code forms a key part of our building regulatory system in New Zealand. It sets the minimum performance for the design of buildings. The Ministry of Business, Innovation and Employment (MBIE) is responsible for updating the Building Code and its documents so we can keep pace with innovation, current construction methods and the needs of contemporary New Zealand.

At MBIE, we aim for a balance between setting minimum performance requirements where necessary to ensure buildings are safe, healthy and durable, and encouraging higher standards of performance where this will impact positively on outcomes for the country.

The changes we are proposing aim to ensure new buildings better protect the safety of the people who use them.

This consultation document includes the details of the proposal for the structural stability of hollow-core floors. We are proposing changes to the compliance pathway for hollow-core floors to make new buildings safer in the event of earthquakes. This proposed change follows new structural engineering research findings in New Zealand on the supports for these floors.

Please take the time to let us know your thoughts. MBIE will carefully consider and weigh all submissions before making any decisions. You can provide feedback by following the instructions on MBIE's [Have Your Say webpage](#).

Final decisions on the changes will be made and communicated later this year.

# Seeking feedback on structural stability of hollow-core floors

In this consultation, we seek your feedback on the proposal for the structural stability of hollow-core floors.

## How to provide feedback

We invite you to submit feedback on the Building Code update by 5:00pm on Friday, 1 July 2022.

- › You can provide your feedback by completing a survey online via MBIE's [Have Your Say webpage](#), or
- › You can download a form at [www.mbie.govt.nz](http://www.mbie.govt.nz) and send it to us by email or post.
  - Email to: [buildingfeedback@mbie.govt.nz](mailto:buildingfeedback@mbie.govt.nz), with subject line Building Code consultation 2022
  - Post to:

Building System Performance  
Ministry of Business, Innovation and Employment  
PO Box 1473  
Wellington 6140

Your feedback will contribute to further development of the Building Code.

## Release of information

MBIE may publish copies or excerpts of submission to MBIE's website at [www.mbie.govt.nz](http://www.mbie.govt.nz). MBIE will consider you to have consented to publishing by making a submission, unless you clearly specify otherwise in your submission.

If your submission contains any information that is confidential or you otherwise wish us not to publish, please:

- › indicate this at the start of your submission, with any confidential information clearly marked within the text
- › provide a separate version excluding the relevant information for publication on our website.

Submissions will also become official information, which means it may be requested under the [Official Information Act 1982](#) (OIA). The OIA specifies that information is to be made available upon request unless there are sufficient grounds for withholding it. If we receive a request, we cannot guarantee that feedback you provide us will not be made public. Any decision to withhold information requested under the OIA is reviewable by the Ombudsman. If you have any objection to the release of any information in the submission, and in particular, which parts you consider should be withheld, please set this out in your submission together with the reasons for withholding the information. MBIE will take such objections into account and will consult with submitters when responding to requests under the Official Information Act 1982.

## Private information

[The Privacy Act 2020](#) establishes certain principles with respect to the collection, use and disclosure of information about individuals by various agencies, including MBIE. Any personal information you supply to MBIE in the course of making a submission will only be used for the purpose of assisting in the development of advice in relation to this consultation or for contacting you about your submission. We may also use personal information you supply in the course of making a submission for other reasons permitted under the Privacy Act 2020 (e.g. with your consent, for a directly related purpose, or where the law permits or requires it). Please clearly indicate in your submission if you do not wish your name, or any other personal information, to be included in any summary of submissions that MBIE may publish.

We will only retain personal information as long as it is required for the purposes for which the information may lawfully be used. Where any information provided (which may include personal information) constitutes public records, it will be retained to the extent required by the [Public Records Act 2005](#). We may also be required to disclose information under the Official Information Act 1982, to a Parliamentary Select Committee or Parliament in response to a Parliamentary Question. You have rights of access to and correction of your personal information which can be found on the MBIE website at [www.mbie.govt.nz](http://www.mbie.govt.nz).

# 1. Structural stability of hollow-core floors

We are proposing changes to the compliance pathway for hollow-core floors to make new buildings safer in the event of earthquakes. The proposed change will include the removal of a deemed to comply solution for the support of hollow-core floors from Verification Method B1/VM1.

## 1.1. Reasons for the change

Hollow-core floor units are proprietary precast concrete floor systems that are manufactured in an offsite factory and subsequently transported to the construction site for installation. Hollow-core floor units became increasingly popular from the early 1980s because they were fast to construct and cost-effective.

Hollow-core floor units perform adequately under static and wind loading in isolation. However, under seismic conditions the performance of hollow-core floor units is dependent on the system they are part of and may be impacted by other building components, such as supporting beams and walls. Concerns over the seismic vulnerability of hollow-core floor systems were raised after severe damage and collapse of such systems occurred during the 1994 Northridge earthquake near Los Angeles. The design of hollow-core floor systems for seismic conditions is complex, and significant research has been undertaken since 1994, to investigate these floor systems under simulated earthquakes<sup>1</sup>.

NZS 3101.1: 2006 Concrete structures standard is cited by B1/VM1 document and is used by professional structural engineers to design concrete structures including hollow-core floor systems in New Zealand. Instructions for design of hollow-core floor systems have been improved through the progressive updates to NZS 3101.1: 2006 and its amendments, and updates to the industry guidelines. In August 2010, MBIE published [Practice Advisory 5: Allow for movement - Precast hollow core floor assemblies](#). This addressed some technical challenges associated with construction practices and detailing of hollow-core floors in line with research findings at the time.

Following the 2016 Kaikōura earthquake, detailed investigations and observations of the BNZ building<sup>2</sup> in Wellington indicated that even under low levels of earthquake movements, some cracks appeared in the hollow-core flooring systems. This reaffirmed that even modern hollow-core floor systems are vulnerable to excessive damage during earthquakes, some beyond economic repair potentially impacting building function and health and safety of occupants.

In 2018, the ReCast Floors research project<sup>3</sup> was initiated as a three-year joint project funded by BRANZ, the Earthquake Commission and a number of other research organisations. The ReCast Floors project has been focusing on the seismic behaviour and retrofit of hollow-core floor systems. Subsequently, in August 2021<sup>4</sup>, New Zealand Society for Earthquake Engineering (NZSEE) and Structural Engineering Society New Zealand (SESOC) published updated technical advice on hollow-core floor design and construction for engineers. This indicated that there is no known way of showing that all hollow-core units comply with the technical and performance requirements of standard NZS 3101.1: 2006. Specifically, the seating detail recommended by the standard and referenced in B1/VM1 was not able to accommodate the deformation of the primary structure without compromising the integrity of the hollow-core units. Further, the study emphasised that the use of

<sup>1</sup>“Seismic Performance of Hollow Core Floor Systems – Preliminary Draft”, published by SESOC, NZSEE, and NZCS, April 2009, available online at [www.nzsee.org.nz](http://www.nzsee.org.nz).

<sup>2</sup> Siddiqui, U., Parker, W., Davey, R., & Therklason, S., “Seismic response of BNZ Building in Wellington following the 2016 Kaikoura Earthquake”. SESOC Conference 2019, Auckland, NZ, available online at [www.sesoc.org.nz](http://www.sesoc.org.nz).

<sup>3</sup> Refer to the ReCast Floors Programme Analyses Precast Retrofits available online at [concretenz.org.nz](http://concretenz.org.nz).

<sup>4</sup> Refer to the advice on hollow-core floors from SESOC and NZSEE available online at [www.sesoc.org.nz](http://www.sesoc.org.nz).

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hollow-core floors in new buildings is not considered good structural engineering practice and is not recommended.

In response to the research findings and recommendations from the engineering community, changes are required to the deemed to comply pathway in B1/VM1 for the support of hollow-core floor systems.

## 1.2. Proposed change

It is proposed to remove the deemed to comply pathway in B1/VM1 for the support of hollow-core floor systems. This includes modifying the citation of NZS 3101.1: 2006 within B1/VM1 Paragraph 3.1.1. The proposed modification would delete Clause 18.7.4.4 of the standard. Engineers looking to use these types of floors would have to demonstrate that the design of the support complies with the Building Code as an alternative solution. The proposed changes in B1/VM1 are provided in Table 1.1.

As part of this proposed change, MBIE would remove [Practice Advisory 5: Allow for movement - Precast hollow core floor assemblies](#) from our website at the end of the transition period. This practice advisory refers to the use of the design details in NZS 3101.1 which would no longer be included as part of the verification method.

**TABLE 1.1: Proposed amended text for B1/VM1 Paragraph 3.1.1**

Current text (red text to be removed)	Proposed text (blue text to be added)
Verification Method B1/VM1 Paragraph 3.0	
<p><b>3.0 Concrete</b></p> <p><b>3.1 NZS 3101: Part 1</b> subject to the following modifications:</p> <p><b>3.1.0 Referenced Documents</b> Replace reference to AS/NZS 4671: 2001, in NZS 3101: Part 1 with the 2019 version that is referenced in this Verification Method.</p> <p><b>3.1.1 Clause 18.7.4.4 Detailing requirements for support of hollow core floors</b> At the end of Clause 18.7.4.4 (b) add an additional sentence: “The details given by C18.6.7 (e) may be applied to hollow-core units where the depth of the precast unit is equal to or less than 400 mm.”</p>	<p><b>3.0 Concrete</b></p> <p><b>3.1 NZS 3101: Part 1</b> subject to the following modifications:</p> <p><b>3.1.0 Referenced Documents</b> Replace reference to AS/NZS 4671: 2001, in NZS 3101: Part 1 with the 2019 version that is referenced in this verification method.</p> <p><b>3.1.1</b> Delete the existing Clause 18.7.4.4 and replace with ‘support of hollow-core floors is not part of this verification method’.</p>
	<p><b>COMMENT:</b></p> <p>1. The proposed detail for the support of hollow-core flooring units in Clause 18.6.7 (referenced by Clause 18.7.4.4 of NZS 3101.1: 2006) is in the Commentary ( NZS 3101.2: 2006). The Commentary is not part of the normative content of the standard, and hence is not part of this verification method. The detailing requirements for support of hollow-core floors, including use of the proposed detail in Clause 18.6.7, comprises an alternative solution.</p> <p>2. It is expected that additional evidence (both testing and analysis) would be required to demonstrate the compliance of support design for the hollow-core floors This would need to include demonstrating that the support is able to accommodate deformation of the structure taking into account three-dimensional boundary conditions and diaphragm inertial loads.</p>

### 1.3. Options

MBIE has considered the following options against the status quo:

**Option 1. Sponsoring an update of the cited standard NZS 3101.1 to address hollow-core floors** – This option would require a standards committee to amend the standard. This may require a significant amount of testing and research to come up with suitable and generic detailing for general use. This may not be warranted given the current downward trend in demand for this floor system. This may take many months or years to complete and as a result was not considered a timely option to address the latest research findings and field observations on the seismic performance of hollow-core floor systems.

**Option 2. Developing new deemed to comply requirements** – This option is similar to Option 1, but would require MBIE to develop a new prescriptive detail or other options for the design of hollow-core floors. This was therefore not considered a timely option to address the issues in the standard for the reasons noted in Option 1.

**Option 3. Amend B1/VM1 to remove the portion of the standard relating to the support of hollow-core floors (Recommended)** – This option focuses on modifying the existing compliance pathway for technical detailing requirements for the support of hollow-core floors. It removes the details which are no longer supported in engineering practice. This option does not propose technical solutions for the way hollow-core floor units should be connected to their supports in buildings, as this would be part of an alternative solution to demonstrate compliance.

Based on this, Option 3 provided the only reasonable option for further analysis.

### 1.4. Analysis of the proposed change

#### 1.4.1. Objectives of the proposal

The key objective of this proposal is to minimise the chance of excessive damage or injury from poorly designed hollow-core floor systems in the event of a range of potential earthquakes. This is in line with the Building Code Objective B1.1, Functional requirement B1.2, and Performance criteria B1.3.1 and B1.3.2. These state:

#### Objective

- B1.1** The objective of this provision is to:
- (a) safeguard people from injury caused by structural failure,
  - (b) safeguard people from loss of amenity caused by structural behaviour, and
  - (c) protect other property from physical damage caused by structural failure.

#### Functional requirement

- B1.2** Buildings, building elements and sitework shall withstand the combination of loads that they are likely to experience during construction or alteration and throughout their lives.

#### Performance criteria

- B1.3.1** Buildings, building elements and sitework shall have a low probability of rupturing, becoming unstable, losing equilibrium, or collapsing during construction or alteration and throughout their lives.
- B1.3.2** Buildings, building elements and sitework shall have a low probability of causing loss of amenity through undue deformation, vibratory response, degradation, or other physical characteristics throughout their lives, or during construction or alteration when the building is in use.

The key intent of this proposal is to modify the compliance pathway for the connection of hollow-core floor to their supports in buildings. Practice Advisory 5 already notes that designers should consider three-dimensional effects when using precast hollow-core floor assemblies in a building or structure. The latest research findings indicate that the support design of all hollow-core floor units based solely on the current details in NZS 3101.1: 2006 Amendment 3 and its commentary, may lead to poor design outcomes in some buildings. Better design outcomes would require additional analysis and full-scale tests to take account of three-dimensional boundary conditions.



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Since the performance of hollow-core floor units is dependent on their connection to the overall structure of the building, it is essential that testing is conducted at the system level. A three-dimensional test set-up takes into account the complex interactions between the structural elements and the hollow-core floor units.

### 1.4.2. Impact of the proposed changes

The costs and benefits of the proposed option were assessed qualitatively. The intent of this proposal is not to prohibit the use of hollow-core floor units and MBIE expects the following from this change:

- › The detailing of hollow-core floor units will move from a deemed to comply solution to an alternative solution compliance pathway. Hollow-core floor units can still be used in specific projects provided that the compliant solution for detailing of supports is substantiated through the alternative solution pathway.
- › Engineers looking to design the supports of hollow-core floor units will be unable to use the existing design methods without additional evidence. It is expected that additional testing and analysis will be necessary to demonstrate that the design of the support complies with the Building Code. It is expected this would consider three-dimensional effects in both the analysis and testing method.
- › Demonstrating compliance as an alternative solution will require more technical scrutiny during the consenting process than in the existing pathway. Building consent authorities may seek additional evidence such as analysis (calculations) and project specific test methods from the applicants to substantiate whether the project specific detailing for hollow-core floor units meets the intended performance requirements of the Building Code.
- › To avoid an alternative solution pathway, designers may also opt to use other flooring systems. We understand that several alternative floor systems are available in the market.
- › Using another flooring system or demonstrating compliance through an alternative solution, will:
  - Minimise the unintended risk to life associated with non-complaint detailing for support of hollow-core floor units.
  - Minimise the chance of excessive damage or injury a range of potential earthquakes from the use of poorly designed hollow-core floor systems.
  - Assist in achieving the relevant objectives and performance criteria of the Building Code.
- › Costs for demonstrating compliance of a hollow-core floor system will increase since the process to confirm the technical solution will be more complex. There is an opportunity for manufacturers and designers to develop innovative technical solutions for the support of hollow-core floor units under an alternative solution pathway.
- › There may be a reduced demand for hollow-core floors. However, MBIE understands that there is already a downward trend in use of these systems following the 2016 Kaikōura earthquake and the advisory note from SESOC and NZSEE technical societies in 2021.

In consideration of these factors, MBIE considers that the benefits of the change exceed the costs.

## 1.5. Transitions

**Effective date:** 3 November 2022

**Transitional arrangements:** 12 months

It is proposed that the existing verification method will remain in force, as if not amended, for a period of 12 months until 2 November 2023 (the proposed transition period cessation date) as described in Table 1.2

**TABLE 1.2: Proposed transitional arrangements for the amended B1/VM1**

Document	Before 3 November 2022	From 3 November 2022 (effective date) To 3 November 2023 (cessation date)
Existing B1/VM1 Amendment 20	If used, it will be treated as complying with the Building Code	If used, it will be treated as complying with the Building Code
Amended B1/VM1 Amendment 21	It does not apply to building consents issued before this date.	If used, it will be treated as complying with the Building Code

### 1.6. Questions for the consultation

- 1-1 Do you support amending Verification Method B1/VM1 Paragraph 3.1.1 as proposed to make the design of hollow-core floor supports an alternative solution?
- 1-2 What impacts would you expect for you or your business from the proposed options?  
These impacts may be economic/financial, environmental, health and wellbeing, or other areas.
- 1-3 What support, if required would you or your business would need to implement the proposed changes if introduced?
- 1-4 Do you agree with the proposed transition time of 1 year for the new requirements to take effect?
- Yes, it is about right
  - No, it should be longer (2 years or more)
  - No, it should be shorter (less than 1 year)
  - Not sure/no preference

