

# Determination 2023/006

**Regarding the compliance of a bracing design for a single-storey dwelling**

**8 Lovelock Avenue, Rolleston**

## **Summary**

This determination considers whether the bracing design for two external walls of a single-storey timber-framed dwelling complied with the Building Code. In deciding this matter, I have considered whether the bracing design complied with the means of compliance stated in the building consent application, which was New Zealand Standard NZS 3604:2011 Timber-framed buildings.

In this determination, unless otherwise stated, references to “sections” are to sections of the Building Act 2004 (“the Act”) and references to “clauses” are to clauses in Schedule 1 (“the Building Code”) of the Building Regulations 1992.

The Act and the Building Code are available at [www.legislation.govt.nz](http://www.legislation.govt.nz). Information about the legislation, as well as past determinations, compliance documents (eg, Acceptable Solutions) and guidance issued by the Ministry, is available at [www.building.govt.nz](http://www.building.govt.nz).

## 1. The matter to be determined

- 1.1. This is a determination made under due authorisation by me, Peta Hird, Principal Advisor Determinations, Ministry of Business, Innovation and Employment (“the Ministry”), for and on behalf of the Chief Executive of the Ministry.<sup>1</sup>
- 1.2. The parties to the determination are:
  - 1.2.1. the owners of the dwelling (“the owners”) who applied for this determination, represented by a building company as their agent
  - 1.2.2. Selwyn District Council (“the authority”), carrying out its duties as a territorial authority or building consent authority
  - 1.2.3. the licenced building practitioner concerned with the relevant building work, L Platt (“the designer”).
- 1.3. This determination arises from a dispute over parts of an external wall bracing design for a single-storey dwelling. The parties disagree on whether elements of the bracing design comply with the Building Code.
- 1.4. The matter to be determined, under section 177(1)(a), is whether specific elements of the external wall bracing as originally designed (“the original bracing design”) complied with Building Code clause B1 Structure by way of NZS 3604:2011.<sup>2</sup>
- 1.5. In deciding this matter, I must consider whether the original bracing design satisfied the requirements of NZS 3604:2011, which was the means of compliance stated in the building consent application (number 212950).
- 1.6. The building consent has since been amended, and a code compliance certificate issued for the construction of the dwelling. However, it is the original bracing design that remains in dispute.

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<sup>1</sup> The Building Act 2004, section 185(1)(a) provides the Chief Executive of the Ministry with the power to make determinations.

<sup>2</sup> New Zealand Standard *NZS 3604:2011 Timber-framed buildings*. This is referenced in *Ministry of Business, Innovation and Employment Acceptable Solutions and Verification Methods for New Zealand Building Code Clause B1 Structure*, First edition, Amendment 20, effective on 29 November 2021, which was the current version when the building consent was granted and issued by the authority.

## Issues outside this determination

- 1.7. This determination is limited to the Building Code compliance of the original bracing design by way of the means of compliance stated in the building consent application. I have not considered whether the building work proposed in the building consent application otherwise complies with the Building Code.
- 1.8. I also have not considered:
  - 1.8.1. the authority's decision to grant and issue the building consent that incorporated the original bracing decision
  - 1.8.2. whether the two amendments to the bracing design complied with the Building Code<sup>3</sup> or the authority's decision to issue the code compliance certificate for the completed building work
  - 1.8.3. whether the original bracing design complied with the Building Code by other means, including as an alternative solution.
  - 1.8.4. the bracing capacity of the internal walls, or the bracing capacity of the external walls across the building ie on bracing lines M, N, P and Q (refer to Figure 1).
  - 1.8.5. whether the bracing calculations provided on plan A2.03 are correct.

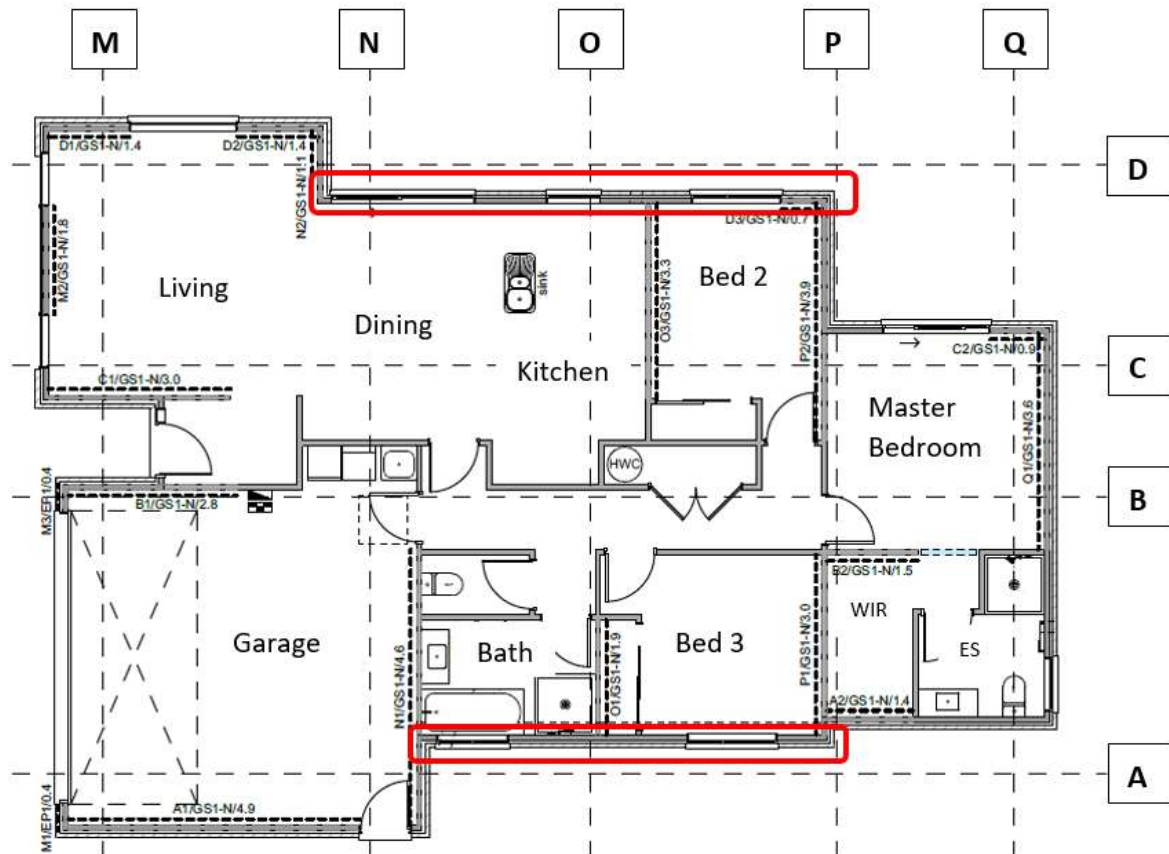
## 2. The building work

- 2.1. The original bracing design was detailed in a plan submitted with the initial building consent application 212950. Figure 1 shows the original bracing design, including the relevant bracing elements and the two external walls discussed in this determination.<sup>4</sup>

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<sup>3</sup> The amended designs were granted by the authority and incorporated in the building consent on 2 May 2022 and 1 June 2022 respectively.

<sup>4</sup> Figure 1 is reproduced from Plan A2.03, dated 29 November 2021 (revised on 1 February 2022).



**Figure 1: Original bracing plan (not to scale)**

Notes: The bracing lines are represented by the letters A to D for ‘along’ the building, and M to Q for ‘across’ the building.<sup>5</sup>

- 2.2. The building consent application stated the building work will comply with clause B1 Structure based on the relevant Acceptable Solution and Verification Method (refer to footnote 2).
- 2.3. The original bracing design plan (A2.03) stated that all bracing panels and the bracing calculations comply with NZS3604:2011. The same means of compliance was stated in the project specifications. A certificate of design work<sup>6</sup> from the designer was also provided, which stated the bracing design was in accordance with the Building Code and NZS 3604:2011.
- 2.4. The building consent application also included a specification and installation manual<sup>7</sup> from the manufacturer of the proprietary plasterboard bracing system

<sup>5</sup> The terms ‘along’ and ‘across’ are described in the definition of “bracing line” in NZS 3604:2011.

<sup>6</sup> Refer to section 45(3) of the Act, and Form 2A of Schedule 2 of the Building (Forms) Regulations 2004.

<sup>7</sup> Dated August 2016.

used on the project.<sup>8</sup> The document referred to wall bracing for light timber-framed buildings constructed in accordance with NZS 3604:2011 and compliance with clause B1 Structure.

### 3. Background

- 3.1. On 3 February 2022, the authority granted and issued a building consent (BC212950) for the construction of the owners' dwelling. The consent documentation included the plans and specifications for the original bracing design.
- 3.2. Construction commenced and continued until the authority carried out a framing and pre-wrap inspection on 24 March 2022. During the inspection, the authority reached a view that the original bracing design did not comply with the means of compliance stated in the building consent application. The authority's inspection record states:

Revised Bracing plan to be supplied demonstrating compliance with NZS:3604:2011 section 5.4.7.2 which states, Each external wall in any storey shall have a total bracing capacity of no less than the greater of that required by section 5.4.7 or 15 Bracing units per metre of external wall length. Specifically considering the external walls along brace line A for the bathroom and bedroom and the wall on brace line D for the Kitchen, dining and bedroom 2.

- 3.3. The owners' agent did not agree with the authority and considered the original bracing design incorporated sufficient bracing in those walls. The owners sought external expert advice from a structural engineer ("the engineer") who was a member of the standards committee involved in the current revision of NZS3604:2011. The engineer believed:

...the offset between the portions of brace lines D and A are less than 2 metres, so all bits of the wall can contribute to the required total, as the designer has done. There is no need for any revision to the bracing plans.

- 3.4. However, following consultation with the authority, the engineer agreed that the wording in paragraph 5.4.7.2 of NZS3604:2011 was "not clear regarding external walls".
- 3.5. The owners decided to amend the bracing design, as requested by the authority, to enable construction to proceed. Amendment 1 was granted by the authority on 2 May 2022 to "Add 2 bracing elements". One bracing element was included in the

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<sup>8</sup> It appears the copy of the manufacturer's literature included in the building consent documentation is incomplete (several pages are missing). Therefore, I have referred to a complete copy of the same literature available from the manufacturer's website (accessed on 1 March 2023).

external wall to the dining and kitchen area on bracing line D, and another bracing element was added to the external wall of bedroom 3 on bracing line A.<sup>9</sup>

- 3.6. Construction continued in accordance with the first amendment to the building consent, and the authority issued a code compliance certificate on 19 September 2022.
- 3.7. However, the owners' agent still wanted clarification whether the original bracing design complied with the Building Code by way of NZS3604:2011. The Ministry received an application for a determination on 25 May 2022.

## 4. Submissions

### The owners

- 4.1. The owners (through their agent) submitted that the authority had required extra bracing to be added to two external walls to achieve compliance with the requirements in paragraph 5.4.7.2 of NZS3604:2011. However, the engineer had advised that there was sufficient bracing in these walls. The owners sought:

Clarification on NZS3604:2011 Clause 5.4.7.2 that the external wall is the entire wall along that line as written in that clause "Parallel external walls offset no more than 2m from each other may be treated as one bracing line".

### The authority

- 4.2. The authority did not make a submission in response to the application for a determination. However, its position is set out in its inspection report of 24 March 2022 and in correspondence sent to the owner's agent on 4 May 2022.
- 4.3. The authority considered that additional bracing was required on the external walls for bracing lines A and D (shown in red in Figure 1) to ensure compliance with NZS3604:2011.
- 4.4. The authority acknowledged that this bracing requirement may change if the standard is updated, but it is the current standard that applies. The authority considers that the original bracing design does not comply with this standard.

### The designer

- 4.5. The designer considers that:

4.5.1. the authority has incorrectly interpreted paragraph 5.4.7.2 of NZS 3604:2011

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<sup>9</sup> The second building consent amendment application proposed to use a different proprietary product for the wall linings (including the bracing).

- 4.5.2. a “balanced understanding” is required that includes the historical context of its application, expert understanding, and industry authority
- 4.5.3. the historical understanding of building consent authorities throughout New Zealand, and expert structural engineers (including the engineer referred to above), is “that the requirements for bracing of the external wall on [a bracing line] is applied to the sum of the individual walls that make up the length of the side of the house and not individual walls”
- 4.5.4. in practical terms, paragraph 5.4.7.2 “cannot be read as the individual walls within [a bracing line] due to the fact that the requirement cannot be applied to a small length of wall”, for example, “an external wall of less than 2m” in length.

## 5. Discussion

- 5.1. This determination considers whether the original bracing design detailed in building consent application 212950 complied with clause B1 Structure by way of NZS 3604:2011.
- 5.2. Section 17 states all building work must comply with the Building Code to the extent required by the Act. A means of establishing compliance with the Building Code includes using an Acceptable Solution or Verification Method.<sup>10</sup>
- 5.3. In this case, the building consent application elected to establish compliance with clause B1 by way of Acceptable Solution B1/AS1, which cites NZS 3604:2011. The plans and specifications that accompanied the building consent application also cited NZS 3604:2011 as the means of compliance for the original bracing design. The relevant section of the standard is section 5 “Bracing design”, including sub-section 5.4 “Wall bracing design”.
- 5.4. The basis of the parties’ dispute arises from the wording used in paragraph 5.4.7.2 of NZS 3604:2011, which relates to the minimum bracing capacity required of external walls. Paragraph 5.4.7.2 reads:

### 5.4.7.2 Minimum bracing capacity of external walls

Each *external wall* in any *storey* shall have a total *bracing capacity* no less than the greater of that required by 5.4.7 or 15 *bracing units* per metre of *external wall* length....

Parallel *external walls* offset no more than 2 m from each other may be treated as one *bracing line*.

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<sup>10</sup> Sections 19(1)(b) and (ba), 20, 22, and 23 of the Act.

- 5.5. Specifically, it is the terms 'external wall' and 'bracing line', as used in this paragraph that are at issue. Both terms are defined in subsection 1.3 of the standard:

**BRACING LINE.** A line along or across a building for controlling the distribution of *wall bracing elements*.

**EXTERNAL WALL.** Any vertical exterior face of a building consisting of primary and / or secondary elements intended to provide protection against the outdoor environment.

- 5.6. The parties' attention has been focused on their different interpretations of paragraph 5.4.7.2. However, consideration must also be given to other parts of the standard that relate to wall bracing design. An assessment of a wall bracing design is not isolated to just one paragraph within the standard.
- 5.7. For example, the distribution of the bracing elements is an important factor. Paragraph 5.4.3 reads:

**5.4.3 Distribution of bracing throughout building**

*Wall bracing elements* shall be located as close possible to the corners of the *external walls* and evenly distributed throughout the building.

*Bracing elements* shall be evenly distributed along each line as far as is possible.

- 5.8. The manufacturer's specification and installation manual, supplied with the building consent application (refer to paragraph 2.4), refers to the same requirements for the even distribution of bracing, as well as the consequences of poor distribution.<sup>11</sup>
- 5.9. In this case, the original bracing design relies on the greatest proportion of the bracing elements, and by extension the quantity of bracing units, being located at one end of the building. The bracing elements D1 and D2 in the lounge are on bracing line D, and bracing element A1 in the garage is on bracing line A (refer to Figure 1). There was only one short bracing element (D3) in the corner of bedroom 2, and nothing was specified for the remainder of the external wall for the kitchen and dining area. Further, there was no bracing element included in the external wall for the bathroom and bedroom 3 along bracing line A. For these reasons, I consider the original bracing design did not meet the requirements of paragraph 5.4.3 of the standard because the bracing elements were not evenly distributed along bracing lines A and D.

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<sup>11</sup> The manufacturer's literature includes a cross-reference to Building Research Association of New Zealand (BRANZ) Appraisal number 928 [2016] (5 September 2016). Paragraph 3.2 of the appraisal refers to the bracing distribution rules contained in the manufacturer's bracing software, which are in accordance with section 5 of NZS 3604. Paragraph 7.1 of the appraisal also refers to the same issue of the distribution of bracing elements linked to NZS 3604.



5.10. In addition to the distribution of the bracing elements, I also need to consider the bracing capacity of the external walls (specifically those walls located along bracing lines A and D). Paragraph 5.4.7 reads:

**5.4.7 Minimum bracing line values**

No bracing line shall have a bracing capacity less than the greater of 100 bracing units or 50% of the total bracing demand divided by the number of bracing lines in the direction being considered (along or across). For this purpose bracing lines less than 1m apart shall be considered one line. In addition the limits of 5.4.7.1<sup>12</sup> and 5.4.7.2 apply.

5.11. In effect, the minimum bracing values required for a bracing line are the greater of:

5.11.1. 100 bracing units, or

5.11.2. 50% of the total demand divided by the number of bracing lines in the direction being considered, or

5.11.3. 15 bracing units per metre of external wall length (as per paragraph 5.4.7.2 of the standard).

5.12. In this case, it is the meaning of the term “each external wall” in paragraph 5.4.7.2 that is the basis of the dispute between the parties. The owners’ agent and the designer are of the view it is the entire (or total) length of the external walls combined along each bracing line that is relevant, whereas the authority has referred to individual parts of the external walls in its inspection report from 24 March 2022 (refer to paragraph 3.2).

5.13. The current version of NZS 3604:2011 does not make it clear whether “each external wall” refers to the individual sections of external wall, **or** to the total length or sum of external wall along a bracing line. However, it is clear the total length or sum of external wall along a bracing line may include parallel external walls offset no more than 2m from each other.

5.14. To resolve the issue, it is important to consider the context and purpose behind the wording used in NZS 3604:2011, and how this may apply to the overall performance of the building.

5.15. As a starting point, I have considered the “outcome statement” at page 8 of NZS 3604:2011 which includes:

NZS 3604:2011 *Timber-framed buildings* sets a minimum standard for the design and construction of timber-framed buildings...[and] provides...users with a cost effective means of compliance and practical guidance for designing and building to meet New Zealand Building Code requirements, without the need for specific engineering design.

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<sup>12</sup> Paragraph 5.4.7.1 – Minimum bracing capacity of internal bracing lines.

- 5.16. The general principles behind bracing design are described in subsection 5.1 of NZS 3604:2011. This includes that wall bracing must be designed and built to provide bracing capacity<sup>13</sup> that exceeds bracing demand<sup>14</sup>. The overall performance of a building is reliant on a bracing design that exceeds the bracing demand forces for both wind and earthquake actions for the whole structure.
- 5.17. A factor to consider is the distribution of bracing throughout the building. This requires a more holistic approach beyond looking at individual sections of external walls along a bracing line or within a certain distance of each other.
- 5.18. This could be particularly relevant if consideration is given to short lengths of some external walls.<sup>15</sup> If “each external wall” in paragraph 5.4.7.2 is read as meaning individual sections of external walls, it may not be possible to meet the minimum bracing requirements without having to consider an alternative approach not available in NZS 3604:2011 (such as a specific engineering design, which would be at odds with the “outcome statement” mentioned earlier).
- 5.19. Further, I have considered the whole of the sentence in paragraph 5.4.7.2, “each external wall in any storey shall have a **total bracing capacity** [my emphasis] no less than the greater of that required by 5.4.7 or 15 bracing units per metre of external wall length”. ‘Total’ implies a complete or whole amount. If the correct interpretation of NZS 3604:2011 was to treat all individual sections of external wall along a bracing line as separate items regardless of length, it is difficult to see how a total bracing capacity could be provided for each individual section of external wall without significantly departing from the standard.
- 5.20. Further, I have also considered the statement in paragraph 5.4.7.2 that parallel external walls offset no more than 2m from each other may be treated as one bracing line. It is apparent from the inclusion of this clarification that it is the total length or sum of external wall along the bracing line rather than the individual sections of external wall that is relevant in determining the bracing capacity. Conversely, if the standard intended to refer to the individual sections of external wall, it is difficult to understand how this statement applies.

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<sup>13</sup> Bracing capacity – Strength of bracing of a whole building or of elements within a building. Bracing capacity is measured in bracing units (BUs) and shall be determined from section 5 (refer to subsection 1.3 “Definitions” of NZS 3604:2011).

<sup>14</sup> Bracing demand – The horizontal forces resisted by a whole building or an element within a building. These horizontal forces are a result of wind or earthquake action. Bracing demand forces measured in bracing units (BUs). They shall be determined as set out in [subsections] 5.2 (wind) or 5.3 (earthquake) (refer to subsection 1.3 “Definitions” of NZS 3604:2011).

<sup>15</sup> In referring to short lengths of external walls, I have not attempted to determine a minimum numerical value for the length of a wall (as each design will be different). However, I note that manufacturer’s specification and installation instructions invariably provide minimum lengths of walls for their bracing products to achieve a certain value of bracing units if fixed in accordance with those instructions.

- 5.21. For these reasons, I am of the view “each external wall” in paragraph 5.4.7.2 relates to the total length or sum of external wall along a bracing line, rather than the individual sections.
- 5.22. In this case, the total length or sum of external wall on bracing line A is approximately 16.45m. With 15 bracing units per metre length of wall, a minimum bracing value of 246.75 is required (ie 16.45 x 15). This is the greater of the three criteria, described in paragraph 5.11 above, based on the designer’s bracing calculations provided on plan A2.03. For bracing line A, the designer has calculated that for ‘wind’ loading 438.9 bracing units is achieved, and for ‘earthquake’ loading 376.2 bracing units is achieved. Therefore, the original bracing design did meet the requirements of paragraphs 5.4.7 and 5.4.7.2.
- 5.23. Similarly, the total length or sum of external wall on bracing line D is approximately 13.08m. With 15 bracing units per metre length of wall, a minimum bracing value of 196.2 is required (ie 13.08 x 15). Again, this is the greater of the three criteria, described in paragraph 5.11 above, based on the designer’s bracing calculations provided on plan A2.03. For bracing line D, the designer has calculated that for ‘wind’ loading 222.8 bracing units is achieved, and for ‘earthquake’ loading 199.1 bracing units is achieved. Therefore, the original bracing design did meet the requirements of paragraphs 5.4.7 and 5.4.7.2.
- 5.24. However, despite the outcome reached in respect of compliance with paragraphs 5.4.7 and 5.4.7.2, the non-compliance with paragraph 5.4.3 of NZS 3604:2011 must be taken into account.
- 5.25. Accordingly, I conclude the original bracing design did not comply with the means of compliance stated in the building consent application for clause B1.

## 6. Decision

- 6.1. In accordance with section 188 of the Building Act 2004, I determine that the original bracing design for building consent 212950 did not comply with Building Code clause B1 Structure by way of NZS 3604:2011.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 17 March 2023.

**Peta Hird**

**Principal Advisor Determinations**