MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HIKINA WHAKATUTUKI

Determination 2020/007

Regarding the compliance of sub-floor fixings to the foundations of a house at 43B Armagh Terrace, Marton

Summary

This determination considers whether some of the fixings in the subfloor framing to a house meet Building Code Clause B1 Structure. The house was built under a building consent in respect of work described in a national multiple-use approval issued under section 30F of the Act.

The matters in dispute arise from the on-site substitution of galvanised rolled steel bearers that have a different profile to that described in the building consent, and the location of bolt fixings that connect the steel bearers to the timber piles.

1. The matter to be determined

1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004 ("the Act") made under due authorisation by me, Katie Gordon, Manager Determinations, Ministry of Business, Innovation and Employment ("the Ministry"), for and on behalf of the Chief Executive of the Ministry.[1]

1.2 The parties to the determination are:

- the owners of the house, T and L Brandon ("the applicants"). The owners are represented by N Colliver, and later by J Colliver, as their agents[2]. N Colliver is a licenced building practitioner ("LBP")[3] and is named in the building consent documentation as the designer (referred to herein as "the designer")
- Rangitikei District Council ("the authority"), carrying out its duties as a territorial authority or building consent authority.

1.3 This determination arises from a dispute about the fixings to the rolled steel sub-floor bearers installed in the house ("the installed bearers"). The authority issued a notice to fix because it was of the view that some of the fixings to the installed bearers did not comply with Clause B1 of the Building Code.

1.4 The installed bearers differed from the bearers specified in the building consent documentation ("the consented bearers"); the difference amounted to a change in the profile of the bearer web, which had an adverse effect on the fixings described in the

[1] The Building Act and Building Code are available at www.legislation.govt.nz. The Building Code is contained in Schedule 1 of the Building Regulations 1992. Information about the Building Act and Building Code is available at www.building.govt.nz, as well as past determinations, compliance documents and guidance issued by the Ministry.
[2] J Colliver only provided the responses to the draft determination.
[3] LBP No. BP121530, Licence classes: Site, Carpentry and Design

building consent. The authority also raised concerns about the bolted connection of a bearer to a timber pile that did not arise from the change in bearer profile. The matters to be determined[4] are therefore:

- whether some fixings to the installed bearers comply with Clause B1 of the Building Code;
- whether the authority was correct to issue a notice to fix in regard to this.

1.5 Determination 2019/058[5] also considered the durability of steel sub-floor bearers installed in four prefabricated buildings, which had been issued with national multiple-use approvals. One of the houses that were the subject of that determination was 43B Armagh Terrace, Marton. Determination 2019/058 found that the bearers installed to the houses did not comply with Building Code Clause B2 Durability.

1.6 This determination is limited to considering the fixings to the installed bearers with Clause B1. The consented and installed bearers have the same, or very similar, dimensions, material and sectional properties; there is no dispute that the installed bearers are equivalent to the consented bearers themselves in terms of structural performance. The dispute arises from the change in the web profile and the effect this had on the bearer's fixings as detailed in the consent, as well as the bolted fixing of some bearers to the timber piles.

1.7 The determination does not consider the compliance of the bearers themselves with Clause B2 of the Building Code; this matter was decided in Determination 2019/058. In addition, this determination does not consider other elements of the house or other clauses of the Building Code.

1.8 In making my decision, I have considered the submissions from the parties and the other evidence in this matter.

2. The building work

2.1 The building consent for the house was issued on 22 August 2018; the consent was in respect of building work described in a national multiple-use approval[6].

2.2 The house has a simple rectangular floor plan, with floors, walls, and roof formed using 150mm thick structurally insulated panels ("SIPs") which consist of colour-coated metal bonded to both faces of an expanded polystyrene foam ("EPS") core. The roof is a 15° pitch gable roof.

2.3 The floors are supported on H5[7] treated timber piles and the installed bearers, which are formed from continuously rolled high-tensile galvanised steel.

2.4 The consented bearers were continuously rolled high-tensile galvanised steel bearers, which are 150mm high, 65mm wide and have a base metal thickness (BMT) of 1.45mm. The profile of the consented bearers is shown in Figure 1.

[4] Under sections 177(1)(a), 177(1)(b) and 177(2)(f) of the Act.
[5] Determination 2019/058 Regarding the durability of steel sub-floor bearers installed in our houses that have been built in respect of building consents issued on the basis of national multiple-use approvals (27 November 2019).
[6] A 'national multiple-use approval' is a certificate issued under section 30F of the Act being "a statement by … [the Ministry] that a set of plans and specifications for a building complies with the Building Code".
[7] Hazard class ratings (Hx) are specified in NZS 3640:2003. H5 is for timber products used in ground contact, or severe or continuous wetting.

2.5 The installed bearers are 152mm high, 65mm wide and also have a BMT of 1.45mm. The profile of the installed bearers is shown in Figure 2.

2.6 Adjacent bearers are joined using a splice plate that transfers the load from one bearer to the next and to secure the joined bearers to the anchor piles providing vertical and lateral support to the structure above.

2.7 The web's inward projection at the mid-depth of the installed bearers has an impact on fixing plates and brackets fixed flat to the web as shown in:

- Figure 3 – the fixing of the angle bracket used to support the SHS[8] post (paragraph 4.4, 2nd bullet point refers), and
- Figure 4 – the splice plates used to join the two ends of adjoining bearers to the timber anchor piles (paragraph 4.4, 1st bullet point refers).

2.8 The inwards projection of the installed section is 6.55mm, compared to 3.05mm for the section described in the building consent.

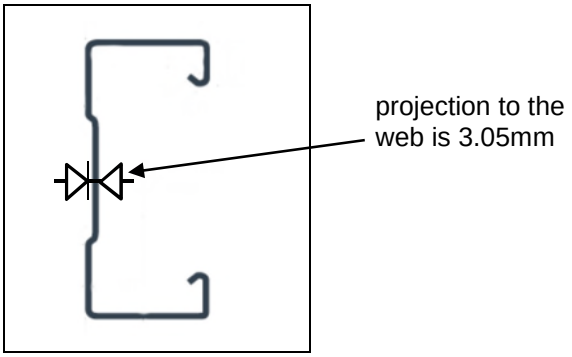


Figure 1: Profile of the consented bearers

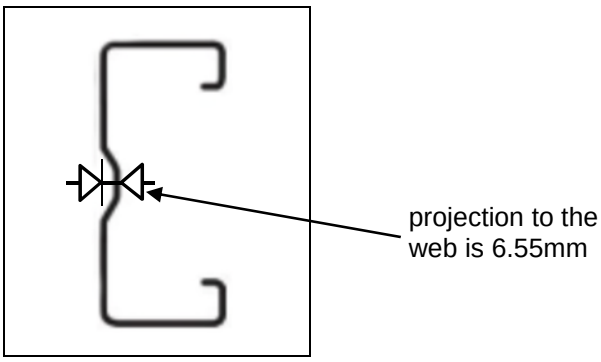


Figure 2: Profile of the installed bearers

[8] Square hollow section

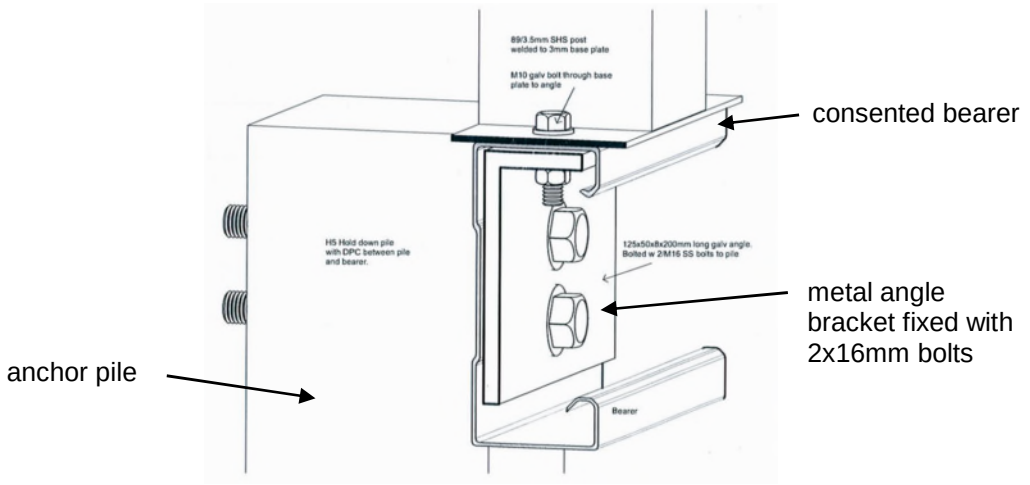


Figure 3: Detail from the consent drawing (Dwg 406) showing the 125x50x8mm metal angle bracket supporting the SHS steel post above

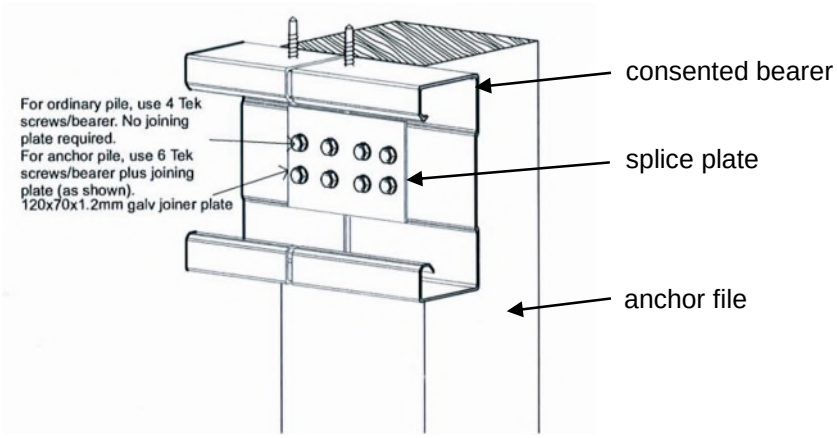


Figure 4: Detail from the consent drawing (Dwg 401) showing the splice plate fixing adjoining bearers to an anchor pile

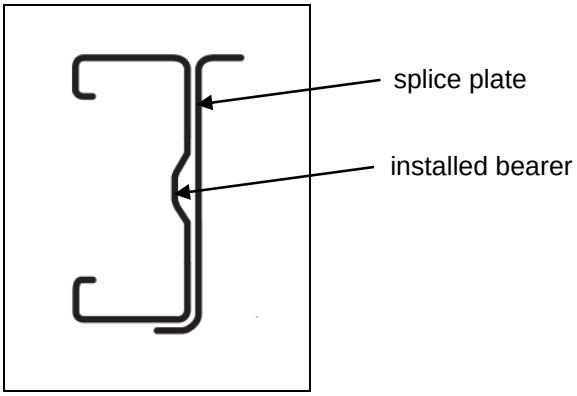


Figure 5: Profile of proprietary splice plate for use with the installed bearers

3. Background

3.1 The authority issued building consent 180248 on 22 August 2018 for the construction of a new three-bedroom house.

3.2 The authority issued the building consent based on the applicable ‘MultiProof Certificate’, ‘The Bigbach’, Certificate Number A10135, issued on 5 November 2016.

3.3 The consented specification describes the consented bearers as:

> Bearers to be [named manufacturer] or other 150x65x1.5mm or 1.2mm as per bearer plan galvanised steel purlins.

3.4 During the construction process, the consented bearers were substituted for the installed bearers.

3.5 It appears that the authority carried out inspections and the house was substantially completed by early 2019. The authority issued a notice to fix (notice to fix No. NF0312) on 1 February 2019. As well as durability issues, which are outside the scope of this determination (refer to paragraph 1.7), the notice to fix details the contravention or non-compliance as:

> Installing metal bearers that are not as per the Multiproof Certificate A10125

3.6 The Ministry received an application for a determination on 18 March 2019.

3.7 The authority carried out a final inspection on 21 March 2019. The inspection record noted a number of issues with respect to subfloor junctions and fixings, and that previous inspections had not yet passed.

4. The submissions

4.1 The information provided by the designer in the application for determination included:

- building consent including the plans and specifications
- a Producer Statement – PS1 – Design dated 13 December 2018 for 'specific engineering design for [the Ministry] multi proof approval including steel bearers, comparison of [the installed bearers] with [the consented bearers]'

4.2 The authority acknowledged the application on 28 March 2019. In response the authority made a submission dated 24 April 2019, commenting as follows:

- the installed bearers are assumed to have the same dimensions as the consented bearers but have a different profile, which raises questions about the fixing details and the structural stability with regard to the profile of the bearer and its fixings
- the consented details show bearers join and connect to anchor piles via a fixing plate that bears against the flat mid-section of the bearer. This enables all components to be hard up against each other to provide the calculated connection strength to resist both horizontal and vertical forces
- because of the changed profile, the materials are not hard up to each other and as a consequence the connecting bolts/screws are not able to reach their full capacity. This is particularly significant for the fixing of the SHS post to the bearer and pile
- the consented plan shows the SHS post is fixed directly onto the bearer via an 8mm thick bracket (refer Figure 3). As installed, the fixing plate is on an angle due to the profile of the bearer, and the bolt fixings are located between two piles.

4.3 The authority also commented on durability issues, which are not within the scope of this determination (refer to paragraph 1.6).

4.4 The authority provided inspection records including nine photographs for the final inspection on 21 March 2019. Of relevance to the matter to be determined (refer Appendix A for the following four photographs):

- photograph 1, showing a bearer splice plate (refer Figure 4 for the consented detail)
- photograph 3, with description '[angle] plate not hard to bearer' (refer Figure 3 for the consented detail)
- photograph 4, with description 'bolt at top of pile and pile hard up to flooring'
- photograph 5, with description 'bolts in join [between two] piles'.

4.5 On 24 April 2019 the designer provided a copy of the notice to fix dated 1 February 2019 referred to in paragraph 3.5.

4.6 A draft determination was issued to the parties for comment on 19 February 2020. The authority accepted the draft on 20 February 2020 but noted a typographical error, which has been corrected.

4.7 The applicant's agent did not accept the draft, and in submissions received on 5 and 6 March 2020 contended in summary that:

- the determination referred to information, including photographs, that the agent had not received
- the items now in dispute should have been identified by the authority during earlier inspections
- the builder should have been identified as a party to the matter and disputed items were a workmanship issue
- some items were 'easy' to remedy and possible remedies were outlined.

In a later submission (dated 9 March 2020) the agent said that the bearers had been substituted by the designer.

4.8 I note the following in response to the agent's submissions:

- all the information referred to in the determination had been provided to the agent at the time it has been received by the Ministry on 24 April 2019; the Ministry provided the same submission again to the agent on 5 March 2020
- the agent had not identified the builder as a party to the matter when the application for determination was made
- the matters for determination arise in large from the substitution of the steel bearers by the designer and the use of details described in the building consent, rather than from workmanship issues.

5. Discussion

5.1 General

5.1.1 The authority is concerned about the adequacy of the as-built details because the consented bearers were substituted for the installed bearers, which have a different profile and required different splice plates and fixing details.

5.1.2 The functional requirement of Clause B1 Structure is:

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

5.1.3 The performance requirements for Clause B1 Structure include:

> 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.

5.1.4 In order to determine whether the installed bearers comply with these requirements of Clause B1, I have considered the adequacy of the as-built details of the fixings to the installed bearers.

5.1.5 It is accepted that the installed bearers have comparable sectional properties to the consented bearers and there is no dispute that the installed bearers are not equivalent to the consented bearers in terms of the structural performance of the members.

5.2 The fixings

5.2.1 Based on the information about the as-built construction I have identified the following three areas of concern arising from the way the installed bearers have been fixed:

1. the splice plates, and their fixing, used to join the two ends of adjoining bearers to the timber anchor piles (the consented detail is shown in Figure 4)
2. the fixing of the angle bracket used to support the SHS post (the consented detail is shown in Figure 3) in respect of the alignment of the angle bracket
3. the location of the bolts securing the angle bracket to the hold down pile.

As noted in paragraph 1.4, items one and two above arise from the change in bearer profile, item 3 is a construction matter and not something explicitly detailed on the building consent. I consider each item below.

The splice plate detail

5.2.2 I note the following:

- In fixing the splice plate to the installed bearer it has in effect been folded over the central rib to the web as shown in photograph 1 (refer paragraph 4.4, 1st bullet).
- The proprietary splice plate made for the installed bearer is designed to be fixed at the rear of the bearer as shown in Figure 5 (in this case between the bearer and the pile) so the fixings hold the bearer and splice plate in close contact. The proprietary splice plate for the installed bearer has not been used.

- The metal screw fixings are angled through the splice plate above and below the central rib leaving a gap between the splice plate and the web. The fixings do not hold the splice plate and the bearer in close contact with the timber piles. This gap will allow the joint to move before the fixings take up the intended load, leading to the joint's design capacity not being achieved.
- Excessive movement at these joints may result in a loss of amenity to the structure.

5.2.3 The splice plate as installed means the designed lateral capacity of these joints (between adjoining bearers and between the bearers and the anchor pile) is unlikely to be achieved. The foundation may have more anchor piles than might be necessary to achieve compliance and consequently these joints may not need to achieve full capacity for the structure to perform as intended, but I not been provided with any information from the applicant to verify this or to put forward such an argument.

5.2.4 Information about the basis of the design of the joints and the capacity that the joints are required to achieve has been requested but not provided. I consider insufficient information has been provided to demonstrate that the as-built splice plate detail is adequate, and that sufficient capacity can be achieved by these joints.

The angle bracket detail

5.2.5 As consented the 125x50x8mm angle bracket supporting the point load from the SHS post is fixed through the web of the installed bearer to hold-down anchor piles with 2x16mm diameter bolts (refer Figure 3). The consented plans show SHS post brackets at two locations. The authority has provided photographs of only one of the two brackets (refer paragraph 4.4, 2nd bullet point); I have not been provided with any evidence about how the second bracket is fixed.

5.2.6 The following is noted regarding the angle bracket's alignment and fixing:

- the bracket is not fixed flat or in close contact with the web of the bearer and the anchor pile, lacking proper alignment to either the bearer or the pile
- as a result of this misalignment the top of the bracket has rotated towards the anchor pile (around the central rib to the web) as shown in photograph 3 (refer paragraph 4.4, 2nd bullet) so the point load from the SHS post above is concentrated on the outside edge of the 50mm angle leg.

5.2.7 I have not been provided with evidence that sufficiently addresses the concerns raised by the authority regarding the misaligned bracket and whether the bracket can achieve the required design capacity with respect to uplift. Therefore, I am not satisfied the bracket is providing a compliant load path for the SHS post above.

Location of bolts securing the angle bracket to the anchor pile

5.2.8 The photographs provided by the authority (refer paragraph 4.4, 3rd & 4th bullet points) show 2x M16[9] bolts at one location securing the angle bracket to the hold-down pile. The following is noted:

- both bolts are installed though the vertical junction between two piles located side by side, i.e., along the adjoining faces of two piles (photograph 5 supplied by the authority appears to show one skew nail joining the piles)

[9] M16 – 16mm diameter (nominal) hexagonal head machine bolt

- The end distance from the top M16 bolt to the top of the pile is in the order of 10 to 15mm (judging from the location of the top bolt to end of one pile in photographs 5 and 6)
- both M16 bolts have small round washers under the nuts installed against the timber pile.

5.2.9 Minimum timber end and edge distances to the M16 bolts to reach full load capacity of the joint are described in NZS 3603[10] - the minimum end and edge distances are determined by:

- the nature and direction of the load
- the timber species
- the fixing diameter.

5.2.10 In this case, the load is tension, the piles are Radiata Pine and the fixings are 16mm diameter (M16) bolts. , the minimum timber end and edge distances (the distance from the bolt to the timber edges) are therefore:

- end distance – 8x the fixing diameter (8x16mm) being 128mm
- edge distances – 2x the fixing diameter (2x16mm) being 32mm.

5.2.11 I note:

- the location of both M16 bolts on the joint between the two piles means any fixing at this point will be ineffectual as it is unable to transfer the load from the bracket to the pile
- Applying NZS 3603, the top bolt also has insufficient end distance.

5.2.12 Information about the design of these joints and the capacity they are required to achieve has been requested but not provided. However, given the location of both M16 bolts on the junction between the two piles and the lack of any other information that shows how the piles may have been secured together, I consider there is sufficient evidence to show that the fastening of the angle bracket to the piles as built is not compliant.

5.3 Conclusion

5.3.1 I consider the as-built details do not comply with Building Code Clause B1 as either insufficient information has been provided to demonstrate that the joints are adequate given the design loads in the case of the bearer splice detail, or that sufficient capacity can be achieved.

[10] New Zealand Standard NZS 3603:1993 Timber Structures Standard

6. The decision

6.1 In accordance with section 188 of the Building Act 2004, I hereby determine that:

- insufficient evidence has been provided regarding the splice plate to installed bearers with respect to compliance with Clause B1 of the Building Code
- the angle bracket as constructed under the SHS post does not comply with Clause B1 of the Building Code

6.2 Therefore, I conclude that the authority was correct to issue a notice to fix No. NF0312 in regard to both matters, and confirm that decision.

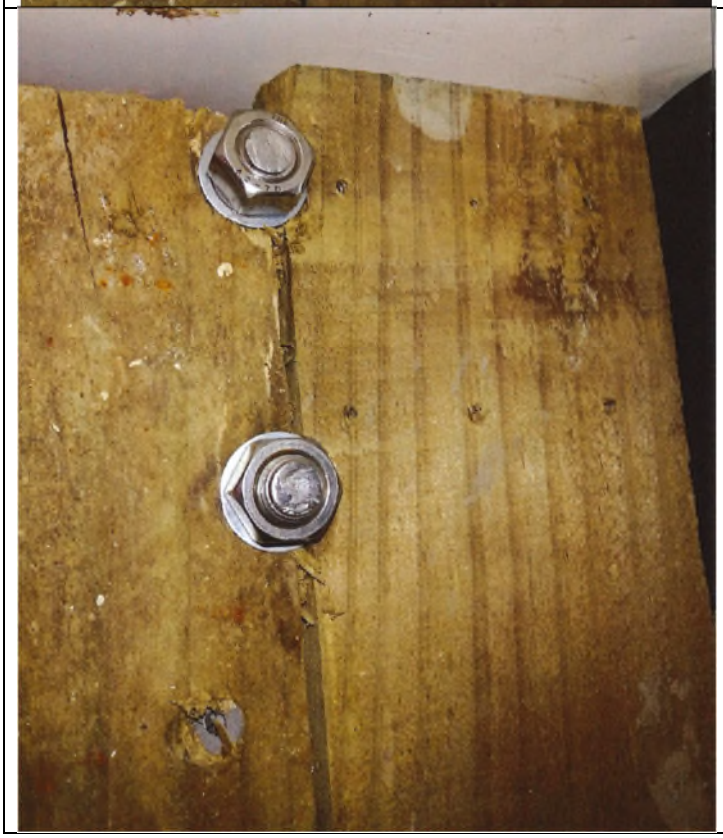
Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 11 May 2020.

Katie Gordon
Manager Determinations

Appendix A: The photos of the as-built work supplied by the authority

The following photographs are taken from the authority's submission dated 24 April 2019, refer paragraphs 4.2 and 4.4.

	**Photograph 1** showing a bearer splice plate (refer Figure 4 for the consented detail). The splice plate is shown to the far right of the photograph
	**Photograph 3** showing the metal angle bracket supporting the SHS steel post above; the bottom fixing bolt is obscured by electrical cabling.

	**Photograph 4** showing the top bolt fixing to the metal angle bracket supporting the SHS above (the photograph is taken from the other side of the pile from Photograph 3).
	**Photograph 5** showing both bolts fixing to the metal angle bracket supporting the SHS above.