



Determination 2019/003¹

Regarding the ground preparation for a house's foundations and its compliance with Clause B1 Structure at 15 Dow Square, Christchurch

Summary

This determination considers the ground preparation to a site before a house with a proprietary foundation had been constructed. The site is in the Canterbury region and is classified as TC2². The determination considers whether the site and its preparation meet Building Code Clause B1 Structure, and whether the authority was correct to issue the code compliance certificate in respect of this work.

1. The matters to be determined

1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004³ (“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.

1.2 The parties to this determination are:

- the owner of the house, M Murray, who applied for the determination (“the applicant”)
- C Ellerm, the licensed building practitioner (“LBP”) who carried out the building work (“the builder”). The building firm contracted to build the house is acting as the LBP’s agent (“the building firm”)
- B Cameron, the Chartered Professional Engineer responsible for the foundation design and supervision (“the engineer”). The engineer is a party to the determination because he is deemed to be an LBP under the Act⁴
- Christchurch City Council, carrying out its duties as a territorial authority or building consent authority (“the authority”).

¹ This determination is subject to a clarification under section 189 of the Building Act 2004. The determination was originally issued on 11 February 2019.

² In terms of the Ministry’s foundation repair guidance *Repairing and rebuilding houses affected by the Canterbury earthquakes* (December 2012), issued by the then Department of Building and Housing under section 175 of the Act, TC2 is defined as having minor to moderate land damage possible from liquefaction in future significant earthquakes.

³ The Building Act, Building Code, compliance documents, past determinations and guidance documents issued by the Ministry are all available at www.building.govt.nz or by contacting the Ministry on 0800 242 243.

⁴ Chartered Professional Engineers under the Chartered Professional Engineers of New Zealand Act 2002 are treated as if they were licensed in the building work licensing class Design 3 under the Building (Designation of Building Work Licensing Classes) Order 2010.

- 1.3 The determination arises from the applicant's concerns about how the ground under the house was prepared for its foundation. The applicant asked whether the ground preparation was carried out in accordance with the building consent, and whether the authority was correct to issue a code compliance certificate for the completed work.
- 1.4 I note that section 177(1)(a) of the Act⁵ is limited to assessing compliance against the Building Code. Establishing the compliance of completed consented work is a two-step process:
- firstly, I need to consider whether the work was completed in accordance with the building consent; and
 - secondly, I need to consider whether the work meets the requirements of the Building Code.
- 1.5 While the determination discusses both of these matters, the decision made under section 177(1)(a) rests on the code-compliance of the work and not solely on whether the work has been carried out in accordance with the building consent.
- 1.6 Accordingly, I consider the matters to be determined⁶ are:
- whether the completed work, namely the site and its preparation to receive the house's foundation, complies with the Building Code with respect to Clause B1 Structure, and
 - the authority's exercise of its powers of decision in issuing a code compliance certificate for this work.
- 1.7 This determination is confined to the matters described in paragraph 1.6 and I have not considered any other aspect of compliance with the Building Code. Other disputes and contractual issues are also outside the scope of the determination.
- 1.8 In making my decision I have considered the submissions of the parties, the report of the independent engineering firm engaged by the Ministry ("the experts"), and the other evidence in this matter.
- 1.9 For clarity, I note that the term "subgrade" is used to describe existing material at the base of the excavation for building foundations. The terms "raft" or "gravel raft" refer to imported material placed on top of the subgrade.
- 1.10 The relevant sections of the Act under which this determination is considered are provided in Appendix A.

2. The building and the site

- 2.1 The house is located on a flat site of approximately 600m² in Wigram, Christchurch, and was completed in early 2017. It is a single-storey, four-bedroom home with an attached double garage. It has steel stud framing, brick veneer cladding, a pressed metal tile roof, and aluminium joinery.
- 2.2 The house sits on a proprietary reinforced concrete foundation slab ("the proprietary foundation") which comprises 1100 x 1100 x 200mm expanded polystyrene formers located on a 1200mm two-way grid and is a type of "waffle" foundation. The proprietary foundation has a nominal thickness of about 300mm with a slab thickness of 85mm.

⁵ In this determination, references to sections are to sections of the Act and references to clauses are to clauses of the Building Code.

⁶ Under sections 177(1)(a) and 177(2)(d) of the Act

- 2.3 The foundation system is described by the experts (paragraph 6.2.4) as an enhanced foundation slab; being “Option 4”, as described in the guidance published by the Ministry’s predecessor⁷ which includes foundation options for TC2 land and which is referred to here as “the residential guidance”. Guidance information given for Option 4 says:
- The ground immediately beneath the polystyrene and ribs [in the waffle foundation] must have a minimum geotechnical ultimate bearing strength of 200 kPa, or the system should be subject to specific engineering design ...”.
- 2.4 The site itself is located on the southwestern side of the Dow Square subdivision. On 5 October 2014 a geotechnical engineer⁸ prepared a completion report for this subdivision (“the 2014 geotechnical report”) which indicated that the site is underlain by interbedded sands, sandy silts and clayey silts extending from the surface to about 10m below ground level.
- 2.5 As the subdivision was developed in 2014-2015 engineered fill was placed in a number of places across the site in accordance with NZS 4431⁹ to elevate the building platform. At that point the geotechnical engineer carried out a site-specific investigation to confirm its general soil profile and relevant ground bearing pressures. This investigation included ground testing with one hand auger and four dynamic cone penetration tests.
- 2.6 The geotechnical engineer’s report of this investigation, dated 31 May 2015 (“the 2015 geotechnical report”), identified the site as Foundation Technical Category TC2 for the purposes of selecting the house’s foundation type. The geotechnical engineer said in the report that its investigation had established the presence of “good ground”¹⁰ beneath the topsoil depth, which was partly engineered fill that had been certified following completion of the subdivision earthworks.
- 2.7 Regarding foundations, the 2015 geotechnical report said:
- Foundation Requirements
- We recommend that any organic-rich material is to be removed and replaced with a 300mm thick AP40 or AP65¹¹ gravel raft without geo-grid reinforcement¹² at the discretion of the designer. The raft should extend 1.0m beyond the overlying dwelling footprint and be compacted to $\geq 95\%$ MDD¹³ in layers not exceeding 200mm in thickness. A rib-raft, waffle slab or conventional reinforced concrete slab is to be placed on the gravel raft in order to provide adequate protection against future land movement, but provision for re-levelling is not required
- 2.8 In respect of liquefaction the report noted:
- There is no evidence for liquefaction in any of the shaking events during the recent Canterbury Earthquake Sequence (CES), and none is predicted at the ground surface given the dominance of clays and clayey silts in the top 5-10m.

⁷ In Repairing and rebuilding houses affected by the Canterbury earthquakes (refer summary on page 1) “Option 4 – Construct a waffle slab over the existing soil”

⁸ The geotechnical engineer is a separate person to the engineer identified in paragraph 1.2.

⁹ New Zealand Standard NZS 4431:1989: Code of practice for earth fill for residential development

¹⁰ The term “good ground” is not defined in the 2015 geotechnical report; however it is defined in the Acceptable Solution B1/AS1 and this definition is referred to in various New Zealand Standards for construction.

¹¹ Grades of compacted aggregate: for example, AP40 has a maximum size of 40mm.

¹² Geo-grid reinforcement is made from polymers such as polypropylene or polyethylene in the form of an open mat. Geo-grid reinforcement is used to stabilise ground in the construction of retaining walls, roadway bases, etc, and to provide resistance to lateral spreading or to mitigate issues in soft soils.

¹³ Maximum Dry Density

2.9 The report concluded saying:

Geotechnical investigations ... have confirmed satisfactory bearing capacity for a conventional dwelling foundation. Our site-specific investigation has established the presence of good ground below the topsoil depth, which is partly engineered fill that has been certified following earthworks completion.

...No liquefaction or lateral spreading has occurred on Lot 9, or on adjoining land, during the Canterbury Earthquake Sequence.

[the geotechnical engineer] advises removal of any topsoil material, extending 1.0m beyond the building footprint as per standard design for TC2 land. It is to be replaced by a 300mm AP40 or AP65 gravel raft ... with a waffle slab or suitably reinforced concrete slab building foundation.

3. Background

3.1 On 5 May 2016 the applicant obtained a copy of the 2015 geotechnical report from the then owner of the site and supplied this to the building firm. On 1 June 2016 the applicant signed a contract with the building firm to construct a house on the site.

3.2 On 25 July 2016 the authority granted building consent BCN/2016/6320 for the house. The consented documents included the foundation plan¹⁴, which said “Excavation and hardfill to a depth as required to reach good ground bearing”, and the site plan¹⁵, which said:

Excavation and foundation compaction to be in accordance with the geotechnical report accompanying the drawings and referenced in the engineer’s PS1. Average depth of organic topsoil is 300mm. Approximate depth to achieve 100 kPa is 300mm (allowable bearing strength). (To be confirmed on site during excavation.)

Consent Drawing 10 of 40 (Details FD 003 and FD 004) contains details of the proprietary foundation, noting that it is to be underlain by “compacted hardfill (when required)”. The approved specification says “If bearing is not to NZS 3604¹⁶ ... [reference to ‘Foundations’ and ‘Determination of good ground’ paragraphs from that standard] then excavate further and backfill with material as follows. Confirm any changes with the territorial authority.”

3.3 The consented documents also included the engineer’s PS1 (producer statement – design) dated 25 June 2016 for “Design of [the proprietary] foundation floor” and the foundation drawings with calculations that referred to the 2015 geotechnical report. A schedule of inspections attached to the PS1 required one inspection for “Pre-pour inspection of; [damp proof membrane] Placement of pods, reinforcing steel and chairs¹⁷” by “the engineer or authorised person”.

3.4 The calculations accompanying the PS1 noted that the floor slab had been designed in accordance with Ministry guidance for TC2 sites to “allow for potential settlement with no supporting ground for 4m sections of floor and 2m at extreme ends”.

3.5 The ‘Schedule of Specified Inspections’ attached to the building consent listed nine inspections “required to be carried out by a Council inspector”. In respect of the foundation and floor slab these inspections comprised:

201 - Pre Pour Foundation

203 - Pre Pour Floor

¹⁴ Foundation plan dated 18 July 2017, sheet 9 of 40 from consented plans.

¹⁵ Site plan dated 18 July 2017, Drawing 2 of 40 of the approved consent plans.

¹⁶ New Zealand Standard NZS 3604:2011 Timber Framed Buildings

¹⁷ Reinforcing chairs locate and hold reinforcing in place.

- 3.6 On 29 July 2016 the applicant went to the site after learning that excavation had begun that morning. By the time the applicant arrived, an excavated area of 100mm deep had been completed and the excavated material left on site as the applicant had requested. In the applicant’s view there was no sign that anything else had been delivered or removed. According to the applicant, material which the applicant describes as “sand” was then placed on top of the excavated area at some point between 2 August and 5 August 2016.
- 3.7 On 15 August 2016 the authority completed a combined “pre-pour foundation” and “pre-pour floor slab inspection” noting “300kPa good ground” with a “pass” result.
- 3.8 An untitled email from the builder to the engineer, dated 15 August 2016, said “I need a PS4¹⁸ for this one please”. The email contained 12 photos of the pre-pour proprietary foundation.
- 3.9 A separate inspection report by the builder to the engineer, dated 16 August 2016, for inspection of “[proprietary] slab and footings” noted the result of the 11 items checked as “Good” and included the advice “Ready to pour”. The inspection report included the same photos as provided in the above email.
- 3.10 The PS4 issued by the engineer was dated 14 February 2016 (given preceding events it is a reasonable assumption that this date is incorrect). The PS4 was issued in respect of “[the proprietary foundation] floor construction inspection and certification”.



Figure 1: Detail of ground and foundation on 21 August 2016 (image supplied by the applicant)

- 3.11 Construction proceeded, but on 25 January 2017 the applicant noticed that a subcontractor’s invoice passed on by the building firm described a “200mm Dig”. The applicant queried this in a letter dated 26 January 2017 that noted there was no mention of removal or addition of topsoil and said: “to our knowledge no material was removed from the site and neither was any brought in”.

¹⁸ Producer Statement – Construction Review

- 3.12 The applicant also referred to discussions with the building firm on 1 June 2016 when the applicant signed the contract, saying:
- Based upon the geotechnical investigation report available to us at the time, we agreed with [the building firm] that excavation of more than 100mm was unlikely to be required. We also were aware that certainty was not possible until the excavation was in progress.
- 3.13 The applicant and the building firm continued to debate the excavation details during February and March 2017. In an email to the applicant dated 27 January 2017 a representative of the building firm said “The foundation and 100mm dig under the allocated PC¹⁹ sum” and later in the same email that “The additional 200mm dig came in over the PC sum”. In an email to the applicant dated 1 February 2017 the same representative said “it appears 200mm was dug out”.
- 3.14 On 17 February 2017 it said the authority had “the PS4 documentation in relation to the excavation and foundation work so there is no issue there”. It subsequently provided copies of till receipts, details of the roller it said was used on site and photos showing an excavation depth.
- 3.15 The applicant responded that only 100mm had been excavated and a shallow layer of sand placed to provide a surface that was levelled for the proprietary foundation. The applicant queried the process as well as some of the information provided by the building firm.
- 3.16 Around this time the applicant also engaged the geotechnical engineer to carry out further testing. On 7 March 2017 the geotechnical engineer wrote to the applicant saying it had tested at three sites around the slab element. It found that ground bearing was adequate (“ $\geq 300\text{kPa}$ ”) but it was clearly not possible to confirm that all organic-rich material had been removed from beneath the foundations.
- 3.17 The geotechnical engineer said it was “concerned that good geotechnical practice does not appear to have been followed in the preparation of the ‘gravel raft’ foundation element”, but that “the earthworks²⁰ have been signed off by a Chartered Professional Engineer...”.
- 3.18 The geotechnical engineer concluded that, on the basis of its certification of engineered filling carried out when the subdivision was developed and on site-specific testing for the previous owner:
- “...we are satisfied that the ground has been adequately prepared to receive a dwelling of the type that is being constructed for you. Our limited ground testing of the area around the placed slab element does not indicate any long-term settlement concerns.”
- 3.19 On 10 March 2017 the authority issued a code compliance certificate for the completed house. Documents supporting the application for code compliance included the engineer’s PS4 (as noted in paragraph 3.10) accompanied by the builder’s 16 August 2016 inspection report described in paragraph 3.9.
- 3.20 In the months following, the applicant queried the issue of the code compliance certificate with the authority. The authority’s response to the applicant included a site visit undertaken on 27 April 2017.
- 3.21 On 15 March 2018 the applicant applied to the Ministry for a determination.

¹⁹ Provisional or prime cost

²⁰ The applicant considers this position was correct at the time the statement was made, but now contends that the PS4 issued by the engineer was in respect of the foundation slab only and not the ground preparation.

4. The initial submissions

4.1 The applicant

4.1.1 The applicant sent a submission and description of events with the application for determination. With this and later submissions the applicant also supplied a substantial amount of information including, but not limited to:

- the 2014 and 2015 geotechnical reports and associated information including the clearance and earthworks cut fill plan for the subdivision
- contract documents for the house construction, the land information memorandum; consent documents including the PS1, plans and specifications; the building firm's construction information; and photographs taken on site
- relevant correspondence including with the building firm, the geotechnical engineer and the authority.

4.1.2 Following a request from Ministry for more information about why the applicant considered the completed work was not code-compliant, the applicant replied (on 17 April 2018) that a specific densification procedure for the ground preparation, designed by a geotechnical expert, was required by the building consent. The applicant also referred to the requirements on the consented plans (refer paragraph 3.2).

4.1.3 The applicant said that for subsoil type E²¹ and site classification of TC2 land the Building Code required excavation to a depth sufficient to allow full removal of topsoil and construction of a 300mm gravel raft that was properly densified and tested. The applicant said neither was done and therefore the structure did not comply with the building consent or the Building Code.

4.1.4 Key points from the applicant's initial submission of 15 March 2018 included:

- The building firm said it was its standard practice to excavate 100mm, but the applicant said "they did not appear to read geotechnical reports, plans or consent conditions".
- The engineer had said he was not responsible for ground preparation, yet had the builder reporting to him about checking the building consent and the excavation to produce a PS4.
- Even though a geotechnical report was already prepared (one which had site preparation recommendations for an earthquake-prone city specified as part of the building consent), the building firm did not follow these.

4.1.5 However, the applicant also described initial discussions about the excavation depth with the building firm on 1 June 2016, before signing the contract, which indicated that the engineer would be onsite and an initial excavation of 100mm may be increased to 200mm.

4.1.6 The applicant expressed concern about compliance of the building work with the building consent and considered sufficient evidence has been provided to support the applicant's contention that a code compliance certificate should not have been issued because the completed work did not comply with the consent.

²¹ Subsoil classification from the New Zealand standard NZS 1170.5:2004 Structural design actions - Part 5: Earthquake actions - New Zealand

- 4.1.7 The applicant described ongoing discussions with the building firm and the applicant's reasons for concluding only 100mm had been excavated from the site and no further material added apart from some sand. This included the applicant's observations after the excavation was complete and "verbal communication with the contractor doing the work" that sand was placed on top of the excavated area and "only levelled".
- 4.1.8 The applicant had contacted the authority's inspector in February 2017 about the pre-pour foundation inspection (refer paragraph 3.7) as it included a statement about the ground bearing capacity, which had passed. The applicant said the inspector had acknowledged relying on "paper statements" and that the ground could not be viewed because it was covered by the foundation at the time.
- 4.1.9 The applicant disputed information provided by the building firm as evidence the foundation preparations were properly completed, noting the applicant's own calculations based on the invoices and till receipts for gravel supplied showed otherwise. The applicant said the photographs it supplied had no identifying location or date; specifications for a roller was not evidence that one had been used on site; and while there might have been gravel of about 200mm in depth if it had been compacted, the excavated area would have had to be 300mm or the ground would have been level, which was not consistent with what the applicant saw.
- 4.1.10 Based on observation of ground preparation at neighbouring properties, the applicant considered a morning was also not enough time for the ground preparation to be completed in accordance with the building consent.
- 4.1.11 On 17 March 2018 the applicant responded to the authority's submission (refer paragraph 4.2 below). The applicant took issue with the authority's reference to "assumptions" made by the geotechnical engineer, who the applicant said was the geotechnical engineer for the development, including the subject property, and who was on site at times throughout the development process. The applicant also challenged the authority's checking requirements and the inspections and documents it relied on; and its statement that the as-built foundation might exceed Building Code requirements by some margin.
- 4.1.12 On 3 April 2018 the applicant responded to the builder's submission (refer paragraph 4.3). The applicant's comments included that the foundation design had to have been based upon more than "assumptions from ground testing" and the authority's inspector based the pass for "ground bearing" on the consented plan statement (though the ground underneath was not visible as it was covered by the foundation at the time of inspection). The applicant also commented on the responsibilities of the engineer regarding foundation design and supervision, and on inadequacies and inconsistencies in the process. The applicant did not accept the builder's statement that the ground preparation was "compliant" and questioned what it was compliant with.

4.2 The authority

- 4.2.1 The authority provided a submission on 16 March 2018 that said:
- The building consent included details that showed the expected ground condition based on assumptions from ground testing.
 - The foundation was designed based on those assumptions, "with the proviso that the engineer or an 'authorised person' would carry out a pre-pour

inspection and report to the [authority]” (this was part of the consented documents).

- The authority accepted this as appropriate and it was recorded in the construction advice notes issued with the building consent.
- At the pre-pour inspection the authority recorded that an engineer’s report was required to be carried out before pour.
- It received a copy of a report prepared by the engineer’s authorised person as well as a PS4 issued by a chartered professional engineer.
- The authority believed the work was carried out in accordance with the consented documents, and it had reasonable grounds to issue the code compliance certificate.

4.2.2 The authority also said that, as the original foundation design was based on assumptions from a limited ground assessment of spot locations, it was anticipated that there might well be minor variations on site.

This is the purpose of the engineer, or his representative, inspecting on site in order to validate the original assumptions or to make variations as appropriate.

4.2.3 The authority considered that those variations were within expected tolerances and did not require specific reporting back to the authority. It also commented that the raft foundation system used was very robust and on “good ground” and added:

We believe that the foundation system as built may well exceed Building Code requirements by some margin.

4.3 The building firm

4.3.1 On 27 March 2018 the building firm submitted that:

- the approved building consent included a foundation design based on assumptions from ground testing
- the authority inspected the foundation at pre-pour stage
- the work carried out was compliant and a PS4 was completed by the engineer
- the authority correctly issued the code compliance certificate, and
- the ground preparation was compliant.

4.4 The engineer

4.4.1 The engineer made no submission in response to the application.

5. The draft determination and submissions received in response

5.1 A draft of this determination was issued to the parties for comment on 4 October 2018. The draft concluded that the as-built work (the site and its preparation to receive the foundation) complied with Clause B1 of the Building Code and that the authority correctly issued the code compliance certificate in respect of this work. I have reviewed the parties’ responses to the draft and amended the determination as I consider appropriate.

5.2 The builder's, engineer's, and the authority's responses

5.2.1 The builder's agent accepted the draft on 9 October 2018 with no further comment.

5.2.2 The authority accepted the draft on 16 October 2018 saying:

We have considered the comments in [paragraphs 7.2.6 and 7.2.7] and believe that the inspector is likely to have had good grounds to believe that the ground bearing pressure was acceptable. However; in the absence of the reasons for that decision being on the inspection document, we accept that the comments in the draft are appropriate.

5.2.3 In an email dated 6 November 2018 the engineer advised he did not intent to respond to the draft determination.

5.3 The applicant's responses

5.3.1 The applicant provided detailed responses to the draft determination on 5, 12, and 29 November 2018, which are summarised below. The applicant provided other correspondence related to these submissions, the determination process, and in response to advice sought from the Ministry about the nature and intent of the submissions made. The applicant also supplied an amended version of the draft determination that included various proposed edits and deletions. In line with many of the comments made in the applicant's submission, the deletions included some of the background information and experts' responses to the applicant's queries, plus proposed edits to the discussion section.

5.3.2 The applicant contended the site preparation could not be proven, there was no question of the engineer using his discretion, and that the Ministry had used selective extracts from some of the documentation in the draft determination.

5.3.3 The applicant was of the view the draft determination contained errors and believed the determination should also provide an opinion "as to whether an engineer used discretion in his design".

5.3.4 The applicant did not accept that the conditions of the building consent had been met, and submitted the following points (in summary):

- The building firm should have prepared the ground by arrangement with the engineer and according to the geotechnical report but did not do so. The paperwork supplied by the building firm proved the ground preparation was not in accordance with the building consent and there was no engineering involvement in its preparation.
- The applicant had provided "more than sufficient data to show" that the building work was not completed in accordance with the building consent and this should be addressed in the determination.
- Neither the 2015 geotechnical report nor the residential guidance allowed for the designer's discretion. The engineer did not refer to exercising any discretion, and had also said he was not responsible for the ground preparation of the site. The PS4 only related to the foundation and not the ground preparation.
- The applicant objected to the determination referring to a note on the consented plans regarding "compacted hardfill (when required)" (refer paragraph 3.2), saying such statements were "generic".

- Referring to the authority’s inspection on 15 August 2016, the applicant said the inspector could not see the ground but relied on the consent documentation.
- The land was part of the liquefaction management area identified on the Christchurch District Plan, and “the foundation was built on a section which is susceptible to liquefaction”. The gravel raft was not to replace the topsoil to a suitable depth but to reduce the possibility of liquefaction damage.
- The applicant queried the experts’ statement that there was no evidence of topsoil remaining in the excavation, saying they and the Ministry could not be any more certain of this than the applicant was.
- The applicant did not accept the determination’s statement that the provision of a gravel raft was not an explicit requirement of the consent, listing references to the consented plans, the 2015 geotechnical report, and statements on the land title which referred to the requirements of a notice issued under the RMA that said the foundation design “shall consider the potential for liquefaction”.

5.3.5 The applicant criticised the rationale for the decision in the draft determination, saying:

... I understand why the decision has been/will be made and the basis for that decision, i.e. that the fundamental ground bearing of the site is probably good, i.e. ≥ 300 kPa. That does not mean that the rationale for the decision does not matter.

I also accept that the determination will confirm that the authority... had to issue the code compliance certificate based on the information provided to them. That does not mean that the authority cannot or should not be questioned about possible gaps in their processes and procedures that allow such as what happened to occur.

6. The experts’ report

6.1 General

- 6.1.1 As mentioned in paragraph 1.8, I engaged a firm of consulting engineers with specialist expertise in geotechnical engineering to assist me (“the experts”). The personnel used included an engineering geologist and a geotechnical engineer.
- 6.1.2 The experts were asked to provide their view on compliance with Clause B1 of the completed foundation in terms of the prepared ground under the proprietary foundation and the minimum bearing pressure required. I also asked them to identify the differences between the work as-built and as detailed in the building consent.
- 6.1.3 The experts received copies of material supplied by parties and visited the site on 28 May 2018. I received their final report on 27 June 2018 and sent this to the parties on the same day. I note that I have incorporated some minor corrections to this report (as identified by the applicant and accepted by the experts) in the summary below. The experts also refer to the residential guidance noted in paragraph 2.3.

6.2 Key findings

- 6.2.1 The experts concluded that the as-built foundation and associated subgrade were “most likely” to be compliant with Clause B1.

Whether the excavation was 100mm or 200mm below ground is unknown; however, in our opinion, it is most likely that the materials are adequately competent to support the house and to provide the 200 kPa bearing capacity required for the enhanced foundation slab in [the residential guidance].

6.2.2 The experts were unable to verify whether the as-built gravel raft was consistent with the consented plans: there was a lack of documentation to clearly verify the construction details; there were discrepancies in the existing documents; and there were conflicting reports about what occurred on site.

Ultimately, [the engineer] who signed and issued the PS4 document and [the authority] who issued the code compliance certificate should have both requested verification of the depth of excavation and cross-checked this with the consented plans to ensure compliance with the Building Code and the original investigation report [the 2015 geotechnical report].

6.2.3 Observations from their site visit included:

- Subgrade soils were visible at various locations around the house, while soil conditions appeared consistent with the descriptions in the 2015 geotechnical report.
- There was a hairline crack in the concrete slab of the garage but no other evidence of cracking in the brickwork or house foundations.
- The foundation excavation extended about 400mm from the house's southwestern perimeter and the subgrade material extended about 1m from the perimeter of the house on the north-eastern corner.

6.2.4 In commenting on whether the completed work complied with Clause B1, the experts noted the house had an enhanced foundation slab ("Option 4" as described in the residential guidance). This option required a minimum of 2 blows per 100mm of penetration using dynamic cone penetration ("DCP") testing for ground deemed to have 200 kPa bearing capacity.

6.2.5 The experts said the 2015 geotechnical report showed AP65 and native sand beneath the topsoil at an approximate depth of 200mm. DCP tests recorded greater than 2 blows per 100mm of penetration from a depth of 100mm below ground level.

6.2.6 Based on the site visit and review of photographs, the experts noted there was no evidence of topsoil remaining in the excavation. The data reviewed suggested that the foundation was bearing on a combination of undisturbed soils and imported compacted AP65. These materials had been geotechnically tested (as described in the 2015 geotechnical report) to show that they achieved greater than 2 blows per 100mm, and accordingly satisfied the requirements of the residential guidance.

6.2.7 In considering the as-built work versus the consented plans, the experts highlighted differing references to the excavation depth (from 100mm to 400mm) in various reports, plans and communications. The experts noted that the engineer's PS1 was accompanied by foundation design plans and the calculations in the consented plans referred back to the 2015 geotechnical report. However, in the experts' view there was a lack of supporting documentation accompanying the engineer's PS4 and uncertainty about the actual excavation depth.

6.2.8 The experts noted no verification testing had been provided to them "nor, as it appears to us, to the engineer... who signed the PS4". They also noted that the authority inspector had indicated "300 kPa good ground" and passed the bearing capacity but did not document the excavation depth.

Based on the information provided and a number of conflicting reports, we are unable to verify the excavation depth that occurred on site.

6.3 The applicant's response and experts' reply

6.3.1 The applicant responded to the experts' report on 1 July 2018. The applicant's comments were passed to the experts who responded to them in a letter dated 21 August 2018; the experts' letter was provided to the applicant. The applicant's comments and the experts' response are summarised as follows:

The applicant's comment

The applicant questioned the experts' observations on site and other assumptions.

The experts' reply

The experts had not assumed a gravel raft was constructed, and said the material directly underneath the foundation appeared to comprise unsaturated (i.e. non-liquefiable) silty sandy gravels underlain by sand, saying:

The material appears in our geotechnical opinion to be free of visible organic material and topsoil. The material observed in the shallow investigation appears to be consistent with the ground model in [the 2015 geotechnical report]. Unsaturated sands and gravels are considered in our opinion to be a suitable subgrade for a single storey residential development.

The applicant's comment

The applicant queried the experts' references to the extent of the excavation from the housing perimeter.

The experts' reply

The experts said in their opinion this excavation from the house perimeter should have extended 1.0m from the building footprint where possible. While this did not occur, they did not believe it would create an issue for the foundation behaviour or preclude code-compliance.

The applicant's comment

The applicant questioned the experts' statement that there was no evidence of topsoil remaining in the excavation and supplied a relevant photograph.

The experts' reply

The experts said this appeared to be an alluvial silty sandy gravel, rather than a topsoil, and gave their reasons for concluding that no topsoil remained.

The applicant's comment

The applicant disagreed with some of the experts' interpretation of the 2015 geotechnical report. The applicant's interpretation of the engineer's discretion applied to the need for geo-grid reinforcement and "not the gravel raft nor the removal of topsoil".

The experts' reply

The 2015 geotechnical report's recommendations were consistent with the residential guidance as both allowed for the designer's discretion and recommended that topsoil be replaced with gravel fill if required. Geo-grid reinforcement was used to "provide resistance against lateral spreading and to mitigate issues in soft soils", neither of which were present on this site. A recommendation from the geotechnical report says "gravel raft without geo-grid reinforcement", meaning the geo-grid was not recommended.

The 2015 geotechnical report's recommendations were also based on the assumption that there was topsoil to a depth of 300mm across the site, but allowed for change once the site was stripped. The experts noted:

It would not be required to excavate out subgrade material that achieves the design recommendations in order to achieve an arbitrary depth.

6.3.2 The applicant provided a further response on 4 September 2018, saying that:

- If a layered gravel raft had been constructed its edge should be visible in the photograph supplied by the applicant (refer Figure 1).
- What dictated that a gravel raft should have been constructed on site was that the engineer incorporated the recommendations of the 2015 geotechnical report in his PS1 which formed part of the building consent. This meant the recommendations were no longer recommendations but requirements.
- The experts' view on appropriate subgrade for a single storey residential development was not relevant to whether or not a gravel raft should have been properly constructed, as recommended and apparently accepted by the engineer responsible for the PS1.

6.4 The authority's response

6.4.1 The authority responded on 3 July 2018, noting the experts' references to the residential guidance and pointing out that this was not a "deemed to comply document" under section 19 of the Act. However, the authority accepted that construction in accordance with the guidance would achieve a code-compliant building.

6.4.2 The authority considered the experts' comments about its actions, and those of the engineer, with regard to verifying the excavation depth were outside the scope of the experts' brief.

7. Discussion

7.1 Matter One: compliance with Clause B1 Structure

7.1.1 The first matter to be determined is whether the completed work (the preparation of the site to receive the foundations) complies with the requirements of Clause B1 Structure. As I have explained earlier, this includes my consideration of whether this work was completed in accordance with the building consent, though the determination turns on compliance with the Building Code.

7.1.2 As highlighted by the applicant and the experts there are differing references to the excavation depth in various documents and it is not clear what was done on site to prepare for the house foundations.

7.1.3 I note that the applicant discussed the excavation with the building firm before signing a contract and understood that excavating more than 100mm was unlikely to be required (refer paragraphs 3.12 and 4.1.5).

7.1.4 The documents subsequently approved for building consent included a site plan which stated: "Excavation and foundation compaction to be in accordance with the geotechnical report accompanying the drawings and referenced in the engineer's PS1".

- 7.1.5 The geotechnical report this refers to is the 2015 report described in paragraphs 2.6 to 2.9, which recommends removing any organic-rich material and replacing it with a 300mm thick gravel raft “at the discretion of the designer”. It then gives dimension and compaction details for such a raft. Consent Drawing 10 of 40 indicates that “compacted hardfill (when required)” is to underlay the foundation.
- 7.1.6 In terms of construction review, a PS4 was issued for “[the proprietary foundation] floor construction inspection and certification” although the date of this document does not appear to be correct as it predates completion of the work on site by about six months. From the information provided, the PS4 appears to have included the pre-pour inspection (which the builder carried out on 16 August 2016 as the engineer’s authorised person).
- 7.1.7 What happened in terms of excavation and foundation preparation and compaction is less clear. After the applicant received an invoice for a 200mm dig and queried this, the building firm provided till receipts for aggregate, photographs showing the edge of an excavation, and specifications for a roller to support its assertion that a gravel raft of at least 200mm was laid and compacted beneath the foundations.
- 7.1.8 I agree with the applicant that this is not unequivocal evidence that a gravel raft was installed. As the experts commented in their report, no verification testing was provided and they were unable to confirm what occurred on site. The builder’s August 2016 inspection noted that the excavation was checked but gave no further details, while the authority’s inspector indicated “300 kPa good ground” and passed the bearing capacity but did not document the depth of any excavation.
- 7.1.9 However, what is not in dispute is that at least 100mm was excavated from the dwelling footprint to prepare for foundations, as evidenced by the applicant’s own observations on site. Further, the experts also consider there is no evidence of topsoil remaining in the excavation – i.e. that the organic-rich material was removed as recommended in the 2015 geotechnical report – and I accept these findings.
- 7.1.10 I note that the experts responded to the applicant (paragraph 6.3.1) that both the 2015 geotechnical report and the residential guidance recommended that any topsoil be replaced with a gravel raft, if required, at the discretion of the designer. This position is disputed by the applicant who contends that the designer’s discretion applied to the geo-grid reinforcement and not to the need for a gravel raft.
- 7.1.11 The relevant section from the 2015 geotechnical report says:
- Foundation Requirements
- We recommend that any organic-rich material is to be removed and replaced with 300mm thick AP40 or AP65 gravel raft without geo-grid reinforcement, at the discretion of the designer.
- 7.1.12 The 2015 geotechnical report’s recommendations were consistent with the residential guidance; both allowed for the designer’s discretion and recommended that topsoil be replaced with gravel fill if required. I accept the experts’ view that geo-grid reinforcement is used to “provide resistance against lateral spreading and to mitigate issues in soft soils”, neither of which were present on this site. The recommendation in the report says “gravel raft without geo-grid reinforcement”, meaning the provision of the reinforcement was not required if a gravel raft was to be installed.
- 7.1.13 The experts noted the report’s recommendations were also based on the assumption that there was 300mm topsoil across the site, but allowed for change once the site was stripped, saying “it would not be required to excavate out subgrade material that achieves the design recommendations in order to achieve an arbitrary depth”.

- 7.1.14 I consider the provision of a 300mm gravel raft was only required if it was to replace material that did not provide adequate bearing for the foundation, and that the provision of a 300mm gravel raft was not an explicit requirement of the approved building consent.
- 7.1.15 The applicant discounts reference to what the applicant considers are “generic details” in the consent that provided for compacted hardfill to be placed under the proprietary foundation to replace any topsoil that may have been present. While the details and the notes contained in the approved consent documentation lack some consistency, the generic details are none-the-less consistent with the recommendation in the 2015 geotechnical report. In my view the details cannot be dismissed as not describing the approved consented work and I do not consider there is sufficient reason to form a view that the as-built work was not completed in accordance with the approved consent.
- 7.1.16 I now consider whether the completed work complies with Clause B1. The experts reviewed the relevant information (refer paragraphs 6.2.4 to 6.2.6) and concluded that the materials the foundation were bearing on satisfied the requirements of the residential guidance.
- 7.1.17 I accept the experts’ findings but note that, as the authority has correctly pointed out, the residential guidance is not cited in section 19 of the Act as a means of establishing compliance with the Building Code that must be accepted by the authority in the same manner as an Acceptable Solution or Verification Method²². However, this guidance has been endorsed by the authority, and two other adjacent authorities, such that “if followed, consents will be issued”²³.
- 7.1.18 I also note that the geotechnical engineer carried out a further investigation for the applicant after the foundation was completed that included some, necessarily limited, site testing (refer paragraphs 3.15 to 3.17). While critical of the process that had been followed, the geotechnical engineer said he was “satisfied that the ground has been adequately prepared to receive a dwelling of the type that is being constructed for you”.
- 7.1.19 After considering this and the other evidence in this matter it is my view that the completed work complies with the requirements of Clause B1.
- 7.1.20 I appreciate that the applicant has concerns about liquefaction at this site and what the applicant considers insufficient ground preparation for the building’s foundations. I note that the 2015 geotechnical report (refer paragraphs 2.6 to 2.9 herein) identified the site as TC2 for the purposes of selecting the house’s foundation type, but said no liquefaction was predicted at the ground surface given the dominance of clays and clayey silts in the underlying ground, and no liquefaction had occurred on the site or on adjoining land during the Canterbury Earthquake Sequence.

²² Acceptable Solutions and Verification Methods provide ways to comply with the Building Code, but it is not mandatory to use them. If followed, they must be accepted by a building consent authority as complying with the related Building Code provisions.

²³ Section 1.3 of this guidance (‘Regulatory context’)

7.1.21 The report also said the geotechnical investigations had confirmed satisfactory bearing capacity for a conventional reinforced concrete slab foundation. The applicant's house has been built using an enhanced proprietary foundation designed to accommodate potential loss of support due to settlement (refer paragraph 3.4). I note that while this type of proprietary foundation is commonly used throughout New Zealand, and most notably in Canterbury, it is none-the-less a specifically-designed foundation system.

7.2 Matter Two: the decision to issue the code compliance certificate

7.2.1 The second matter to be determined is the authority's exercise of its powers of decision in issuing a code compliance certificate for this work.

7.2.2 A building consent authority must issue a code compliance certificate if it is satisfied, on reasonable grounds, that the building work complies with the building consent (under section 94(1)(a) of the Act).

7.2.3 In this case the authority relied on the PS1 and PS4 statements in forming its view as to compliance of the building work. As the Ministry's website notes: "In considering whether to accept a producer statement, a council will normally assess the credentials of the author to ensure that person has the appropriate experience and competence in their particular field of expertise and make their own inspections of the building work".

7.2.4 However, both the PS1 and PS4 only reference the proprietary foundation floor with the PS1 itself only requiring a "pre-pour steel inspection" (the inspection by the builder only references the completion of the proprietary foundation itself). Ground preparation under the slab is not referenced in either producer statement and is not verified other than by the inspection carried out by the authority (refer paragraph 7.2.6). The date of the PS4 also appears to be incorrect which would have been apparent at the time it was received and accepted by the authority.

7.2.5 The approved plans state "Excavation and foundation compaction to be in accordance with the geotechnical report... Approximate depth to achieve 100 kPa is 300 mm (allowable bearing strength) (To be confirmed on-site during excavation)"; and "compacted hardfill (when required)" (refer paragraph 3.2).

7.2.6 The authority carried out its own inspection on site and was satisfied that the ground was adequate, however, this was a combined "pre-pour foundation" and "pre-pour floor slab" inspection which appears to have been completed after all the formwork for the proprietary foundation was in place – it is therefore not clear how the ground bearing pressure under the slab itself was assessed.

7.2.7 While such decisions by the authority are made on reasonable grounds, it would have been prudent for the authority to verify the excavation and site preparation that occurred on site and record this. As noted above the producer statements provided do not cover this aspect of the work.

7.2.8 While the authority may have erred in this respect, I am satisfied that the foundation meets Clause B1 and accordingly I confirm the authority's decision to issue the code compliance certificate for the completed work.

8. The decision

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

- the as-built work (the site and its preparation to receive the foundations) complies with Building Code Clause B1, and
- I confirm the authority's decision to issue the code compliance certificate in respect of this work.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 11 March 2019.

Katie Gordon
Manager Determinations

Appendix A

A.1 The relevant provisions of the Building Act that describe the matters that are able to be determined include:

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- (1) A party may apply to the chief executive for a determination in relation to either or both of the following:
 - (a) whether particular matters comply with the building code:
 - (b) the exercise, failure or refusal to exercise, or proposed or purported exercise by an authority in subsection (2), (3), or (4) of a power of decision to which this paragraph applies by virtue of that subsection.
- (2) Subsection (1)(b) applies to any power of decision of a building consent authority in respect of all or any of the following:
 - (a) a building consent:
 - (b) an extension under section 52(b) of the period during which building work must be commenced before a building consent lapses:
 - (c) an extension under section 93(2)(b)(ii) of the period during which the authority must decide whether to issue a code compliance certificate:
 - (d) a code compliance certificate:
 - (e) a compliance schedule:
 - (f) a notice to fix.