



## Determination 2018/020

# The refusal to issue a code compliance certificate for a 9-year-old house with rammed-earth walls at 107 Harleston Road, RD1, Sefton



### Summary

This determination considers the compliance of the second stage of a house built with rammed-earth walls used as a structural element and as a cladding. The determination considers the compliance of the as-built work, the on-going maintenance of the rammed-earth walls, and whether the authority was correct in declining to issue a code compliance certificate for the work.

### 1. The matter to be determined

- 1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004<sup>1</sup> (“the Act”) made under due authorisation by me, Katie Gordon, Manager Determinations and Assurance, Ministry of Business, Innovation and Employment (“the Ministry”), for and on behalf of the Chief Executive of the Ministry.
- 1.2 The parties to the determination are:
  - the owners of the house, C and M Dickey (“the applicants”) acting through an agent (“the owners’ agent”)
  - the Waimakariri District Council (“the authority”), carrying out its duties as a territorial authority or building consent authority.
- 1.3 This determination arises from the decision of the authority to refuse to issue a code compliance certificate for the second stage of a 9-year-old house. The refusal arose because the authority is not satisfied that the building work complies with certain clauses<sup>2</sup> of the Building Code (First Schedule, Building Regulations 1992); in particular in regard to the weathertightness of the external building envelope, given the earth wall construction used for most of the walls.

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<sup>1</sup> The Building Act, Building Code, compliance documents, past determinations and guidance documents issued by the Ministry are all available at [www.building.govt.nz](http://www.building.govt.nz) or by contacting the Ministry on 0800 242 243.

<sup>2</sup> In this determination, references to sections are to sections of the Act and references to clauses are to clauses of the Building Code.

- 1.4 The matter to be determined<sup>3</sup> is therefore whether the authority was correct to refuse to issue a code compliance certificate for the reasons given in its letter dated 18 October 2016. In deciding this matter, I must consider:
- (a) Whether the external building envelope of the house complies with Clause B2 Durability and Clause E2 External moisture of the Building Code. The external walls include the components of the envelope (such as the roofing, the rammed-earth walls, the reinforced concrete beams, the AAC<sup>4</sup> veneer cladding, the windows, the flashings and the coatings) as well as the way the components have been installed and work together. .
  - (b) Whether the rammed-earth walls comply with B1 Structure of the Building Code, considering the particular risks and special durability considerations that apply to the type of construction used in this house.
  - (c) Whether other items identified by the authority comply with relevant Building Code clauses: namely and E3 Internal moisture.

## 1.5 Matters within this determination

- 1.5.1 The applicants were represented by their son-in-law for some of the work carried out on the property with all consents, correspondence and inspection records using his name as the ‘owner’. To distinguish him from the applicants, this determination describes him as the “owner/builder”.
- 1.5.2 The subject building consent (No. 050904) was issued on 18 May 2005 for completion of the house (“Stage Two”). This determination is limited to Stage Two and to the concerns identified by the authority associated with the clauses outlined in paragraph 1.4: it does not address other building work on the property or other clauses of the Building Code.
- 1.5.3 I note that a contractor was appointed by the authority to provide some of the building regulatory services in relation to this work on the authority’s behalf (“the authority’s contractor”).
- 1.5.4 I also note that the owners can apply to the authority for a modification of durability provisions to allow the durability periods specified in Clause B2.3.1 to commence from the date of substantial completion in 2008. I leave this matter to the parties to resolve after other matters are satisfactorily resolved.

## 1.6 The evidence

- 1.6.1 In making my decisions, I have considered:
- the submissions of the parties
  - reports commissioned by the Ministry to advise on this dispute from:
    - the independent expert (“the expert”)
    - the independent specialist experienced in earth building construction (“the earth specialist”)
  - the other evidence in this matter.

<sup>3</sup> Under sections 177(1)(a), 177(1)(b) and 177(2)(d) of the Act

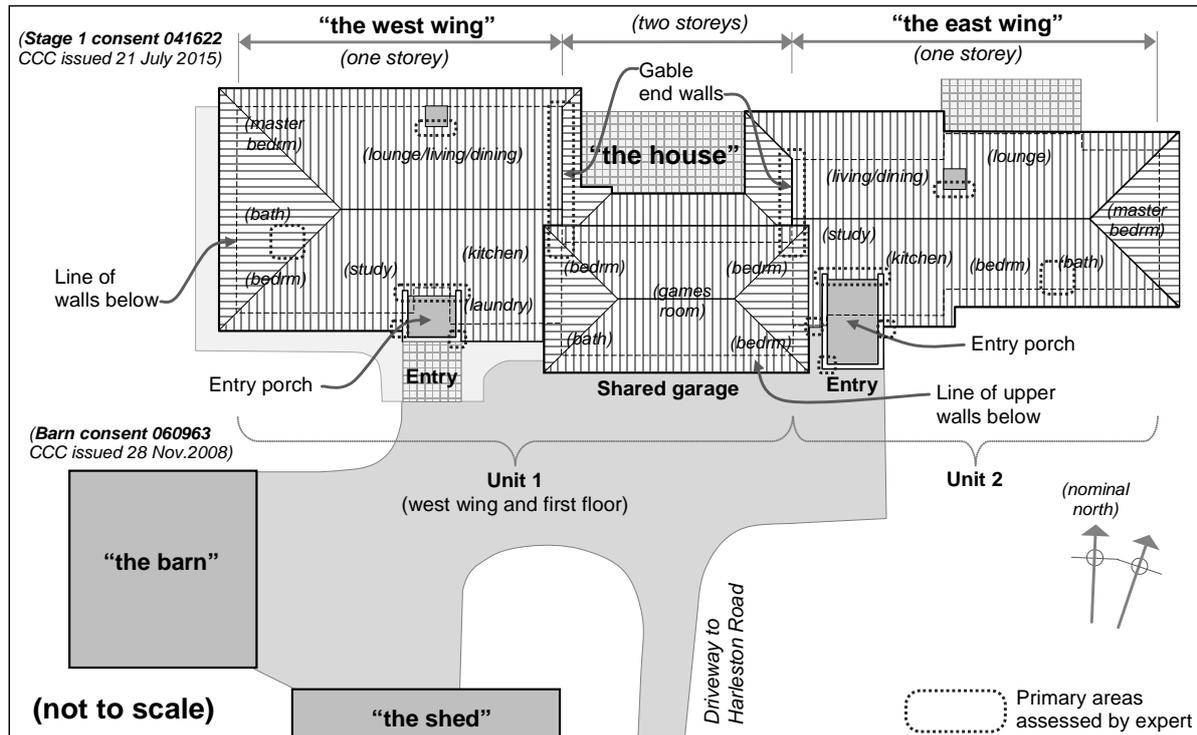
<sup>4</sup> Autoclaved aerated concrete

## 2. The building work

2.1 The building work consists of a seven-bedroom house situated on a large level rural site in a medium wind zone for the purposes of NZS 3604<sup>5</sup>. The building was designed as two self-contained dwellings as shown in Figure 1, with:

- a single-storey two-bedroom unit to the east (“the east wing”)
- a single-storey wing extending to the west (“the west wing”), with the upper floor of the central section forming a five-bedroom unit
- a central four-car garage.

**Figure 1: Approximate plan**



2.2 As shown in Figure 1, the house accommodates the following:

- The west wing and central upper floor (Unit 1):
  - entry porch and foyer to the south, a study to the west, laundry and store to the east, with stairs leading up to the upper floor
  - open plan living/dining/lounge opening onto paving to the north, with the kitchen to the south
  - master bedroom, bathroom and one bedroom to the west
  - in the upper floor, three bedrooms, bathroom and a central games room above the ground floor four-car garage.
- The east wing (Unit 2):
  - entry and foyer to the south, a study to the north, laundry to the west
  - open plan living/dining opening onto a veranda to the north, with the kitchen area to the south
  - a lounge with a projecting bay to the north, opening onto paving,

<sup>5</sup> New Zealand Standard NZS 3604:1999 Timber Framed Buildings (version current at the time the consent was issued)

- master bedroom to the east and second bedroom to the south, with a bathroom between.

- 2.3 The house is specifically engineered, with a reinforced concrete foundation and floor slab, a timber framed floor to the upper level and a 4m long reinforced concrete block internal wall within the garage. Ground floor walls are generally rammed-earth, with conventional light timber framing to some ground floor interior partitions, the entry porches, the upper level walls and the roofs.
- 2.4 The drawings call for upper wall framing to be H1.2<sup>6</sup>, with entry porch framing to be H3.1. The pre-roof inspection of the upper level noted '90 x 45 H3.1 framing'. Given this evidence and the date of construction in 2006, I consider that external wall framing is likely to be treated to resist fungal decay.

## 2.5 The rammed-earth walls

- 2.5.1 The structural drawings call for the rammed-earth walls to include reinforced 'concrete columns' at all corners and beside all window and door openings. These are poured into PVC pipes set within the wall during erection of the rammed-earth ("the pipe columns"). Reinforced concrete lintel and bond beams are poured directly onto the rammed-earth and include permanent timber boxing as shown in Figure 2.
- 2.5.2 Vertical reinforcing rods within the pipe columns are tied into the continuous bond beam at the top and also the concrete lintels above joinery openings, with timber plates retained as permanent boxing to the beams to form 350mm thick external walls and 250mm internal walls. In regard to the construction method, the specification called for:
- Walls to be constructed in panels no longer than 3.6m. Control joints as per NZS 4299 and shown on sheet 8 of drawings.
- Panels allowed to dry for 2 weeks before adjoining walls are built and before lintels or bond beams are poured.
- 2.5.3 Earth walls are made up of cement stabilised<sup>7</sup> rammed-earth; plastered on the inside and outside with a 'compatible and breathable plaster of a traditional mix' of cow manure, clay and sand ("the earth plaster"). The specification calls for construction to accord with the three standards for earth buildings<sup>8</sup> ("the earth standards").

## 2.6 The wall claddings

- 2.6.1 The lower walls are generally finished with the earth plaster as described above, with aluminium windows and doors recessed within the wall thickness, timber plate boxed lintels, plastered reveals and sloping plastered AAC sills. The gable end walls to the east and west wings are timber framed and clad in fibre cement sheet. Although drawings call for the cladding to be 'plastered 6mm cement board on cavity', the expert reports that the fibre cement sheets are butt-jointed and painted.
- 2.6.2 The veneer system to the timber framed upper walls and entry porches is a proprietary monolithic cladding system, with 75mm thick AAC panels fixed into 22mm deep horizontal metal top hat sections. In upper walls, top hat sections are fixed over 75 x 45mm H3.1 treated vertical battens, which are screw-fixed through

<sup>6</sup> Timber treatment class to New Zealand Standard NZS 3602: Part 1: 2003 Timber and wood-based products for use in building.

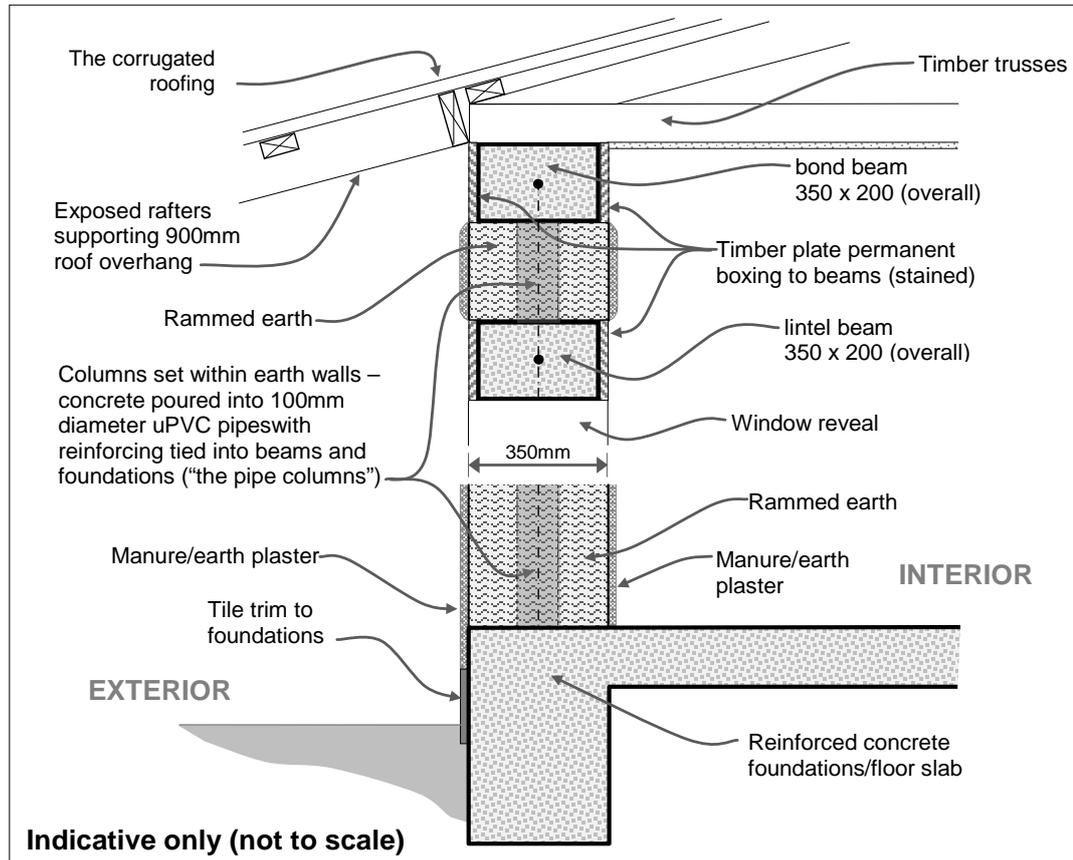
<sup>7</sup> Cement stabilises rammed-earth by reducing its ability to react with water and therefore the likelihood of expanding when wet

<sup>8</sup> NZS 4297:1998 Engineering design of earth buildings,  
NZS 4298:1998 Materials and workmanship for earth buildings,  
NZS 4299:1998 Earth buildings not requiring specific design

the building wrap to the framing. The latter increases the overall wall thickness to provide deep window reveals similar to those within ground floor earth walls.

- 2.6.3 In the entry porches, 50mm thick AAC panels are fixed into 22mm deep horizontal metal top hat sections, which are in turn fixed through the building wrap to the framing. The AAC cladding is finished with a proprietary mesh-reinforced plaster system to form a monolithic finish.

**Figure 2: Sketch of typical exterior wall**



## 2.7 The roofs

- 2.7.1 The multi-level 15° hipped roofs incorporate eaves of more than 900mm overall, except for a projecting north wall to the lounge of the east wing which has no roof overhang. Gable ends to lower roofs (at the intersection with the central section) have no verge overhangs and the main entry porches have parapet walls.
- 2.7.2 Pitched roofs are clad in a proprietary corrugated roofing (“the corrugated roofing”) manufactured from bitumen-impregnated cellulose fibre and pre-finished on the outer side with a pigmented resin. The roofing had a BRANZ Appraisal Certificate No. 431 (2002), which was withdrawn prior to the building consent for Stage Two. That certificate stated that the product may age prematurely in very warm climates ‘owing to degradation by solar heat and UV, especially if the product has not been given a protective coating system’.
- 2.7.3 The low-pitched roofs to the entry porches are clad in butyl rubber membrane (“the membrane roofs”), with the AAC-clad porch walls extended up to form roof parapets. The parapets are capped with sloped metal flashing, with porch roofs sloped to internal membrane-lined gutters along the front.

### 3. Background

#### 3.1 The Stage 1 work

3.1.1 The authority issued a building consent (No. 041622) on 30 March 2005 under the Building Act 1991 for 'foundation/slab & drains for dwelling'. A code compliance certificate for this consent was issued on 21 July 2015, which noted a modification<sup>9</sup> of the durability provisions of the Building Code.

#### 3.2 The Stage 2 work

3.2.1 The authority issued a building consent (No. 050904) on 18 August 2005 for 'dwelling (Stage 2) superstructure'. The consent was issued subject to 18 conditions, which included (in summary with the authority's reference number in brackets):

- an electrical certificate of compliance to be provided (8)
- inspections of solid fuel heaters (12)
- engineer's producer statement for construction review required (14)
- rammed-earth to be maintained to prevent moisture ingress and erosion (15)
- installation instructions for solid fuel heaters to be supplied (17)
- BRANZ appraisal required for corrugated roofing before installation<sup>10</sup> (18).

3.2.2 The structural engineer's documentation included a 'schedule of inspections', which noted that 'a producer statement, construction observation, could be issued' once the following inspections were completed:

- 2 inspections of the rammed-earth walls
- 2 inspections of concrete bond beams and lintels
- 1 inspection of blockwork wall
- 1 prelining inspection.

#### 3.3 Construction

3.3.1 It appears that construction was protracted, with construction taking place over about five years. The authority's contractor carried out inspections of the house during construction, which included:

- Pre-pour blockwork on 13 September 2005 (which noted 'all inspections by engineer until pre-roof').
- Pre-roof inspections on 10 July, 22 July and 15 September 2006 - which passed, and also noted 'engineer's site report sighted for bond beam pre-pour').
- AAC cladding installation to upper walls on 21 November 2006 - which passed but noted incomplete items.
- Pre-line framing, plumbing and insulation on 16 February and 4 April 2007 - which passed.
- Waterproof membrane to two bathrooms on 10 May 2007 - which passed.

<sup>9</sup> The durability periods described in Clause B2.3.1 were to commence from the date of substantial completion and not from when the code compliance certificate was issued.

<sup>10</sup> BRANZ Appraisal 431[2002] was withdrawn before the issue of the building consent

- 3.3.2 In a letter to the applicants dated 22 January 2009, the authority's contractor noted the delay in completing the house and stated the Act required an owner to apply for code compliance certificate 'as soon as the relevant building works are complete'.
- 3.3.3 The authority's contractor carried out two further inspections on 10 and 16 February 2009, which were limited to the unfinished west wing bedroom and shower. The inspection passed; the inspection record noting the membrane installed to shower but that a 'Tanking Cert.' was required.

### **3.4 The 2011 site visit**

- 3.4.1 It appears that the owner/builder stopped work on all of the building work on the property sometime after the February 2009 inspections. Those inspections were the last carried out by the authority's contractor.
- 3.4.2 The authority visited the site on 12 January 2011 to carry out a 'progress' inspection of the house. A 'notice of inspection' was left on site, which required the owner/builder to contact the authority for a final inspection.
- 3.4.3 During the inspection, the authority took photographs of the exterior of the house, which included photos that showed:
- no plaster applied to earth walls, erosion apparent to areas exposed to rain (at the SW corner, lower west walls and beside the north lounge bay)
  - no plaster coating to AAC veneer cladding
  - no plaster coating to fibre-cement gable walls, with moisture stains apparent
  - water-stained plywood to entry porches, indicating leaking butynol above
  - water-stained roof framing indicating flashing leaks above
  - timber boxing to lintels bowing away from concrete
  - unfinished joinery installation.
- 3.4.4 In an internal memo dated 12 January 2011, the authority's inspector noted:
- I have serious concerns on the durability and structural integrity of the rammed earth walls, these have yet to be sealed. I would like to see the consulting engineer provide a report prior to patching them up.
- 3.4.5 It appears that in about August 2011 the authority approved a further two-year extension to complete the work, so it is likely that the rammed-earth walls were plastered with the earth plaster during that interval (during 2012 or 2013), although I have seen no progress photographs or inspection records during that time.

### **3.5 The 2013 final inspection**

- 3.5.1 In a letter to the owner/builder dated 29 August 2013, the authority noted that 'your building consent is now more than two years old' (see above) and an application for a code compliance certificate should be submitted and a final inspection booked.
- 3.5.2 The applicants applied for a code compliance certificate on 6 September 2013. In an email to the applicants dated 10 September 2013, the authority suggested 'the best step forward' to progress the matter. The authority noted the concerns that its 2011 inspection had raised about the exterior cladding. Because the authority had not inspected any remedial work carried out since, it suggested the following be sought:
1. A producer statement from the engineer who oversaw the exterior cladding work

2. A producer statement and full details on the repair of the exterior cladding
3. An inspection at this point to see where to from here.

3.5.3 The structural engineer provided a ‘producer statement – construction monitoring’ dated 16 September 2013 for the ‘concrete foundations and slab, partially reinforced rammed-earth walls, concrete reinforced columns, bond beams and lintels’; which stated that, based on his review and information provided during the building work, the engineer believed on reasonable grounds that the work had been completed in accordance with the building consents and with Clause B1 Structure.

3.5.4 The authority carried out a ‘final/progress’ inspection of the solid fuel heaters and cooker on 18 October 2013, identifying a list of items requiring attention. On the same day, the exterior and interior of the house was inspected, and the inspection record included the following exterior areas to be addressed (in summary):

- lack of spreaders to upper roof downpipes
- lack of vents to clad chimneys
- unpainted fibre cement and lack of flashings to chimney
- lack of head flashing to north doors to east wing lounge
- unfinished gable end wall cladding and lack of underlap to barge flashings
- unflashed gable cladding/AAC cladding junction
- bowed timber formwork to lintel beams
- unfinished door sills
- unfinished AAC cladding
- timber beads needed to windows and doors
- parapet flashings and gutter outlets
- unfinished blocking above garage doors and under verandas
- damaged roofing
- some incomplete or drummy plaster to earth walls
- unfinished soffit linings to entry porches.

### **3.6 The 2015 final inspection**

3.6.1 In response to a further reminder on 23 March 2015, the applicants emailed the authority on 27 March to explain that of the 46 items identified during the 2013 inspection, 32 had been completed. However, they estimated that a further year was needed to complete the remaining areas and therefore requested an extension of time. On 7 April 2015, the authority agreed to ‘extend the timeframe’, which meant that an application for a code compliance certificate ‘must’ be made by 7 April 2016.

3.6.2 The authority re-inspected the house on 14 July 2015 to assess the items identified during the 2013 final inspection: the original 2013 list of outstanding items was reduced to the following (in summary):

- fit beads to west wing entry door
- paint fibre cement to one clad chimney
- door sills still unfinished

- some AAC panels still unplastered
- some earth walls still to be completed
- netting to internal gutter outlets
- fit spreaders to upper roof downpipes
- seal kitchen bench/wall junction
- block off between floor joists in garage
- check pipe lagging in roof space.

### 3.7 The 2016 final inspections

3.7.1 The authority re-inspected the house on 3 May 2016 to assess the items remaining from the 2015 final inspection and provided the following list of ‘passed items’:

- timber beads now fitted to entry door
- [fibre-cement sheet] on-site and will be painted – removed to check flue clearance – all OK plus vents fitted
- brick sills now completed
- all [AAC] panels, columns now plastered and sealed
- temporary steps now in place to doors
- all [rammed-earth] walls now lime washed and west wall of west wing now plastered
- entry roof outlets now have “cages” fitted
- all downpipes fitted with spreaders
- kitchen bench now sealed to wall and grouted
- garage floor joists now blocked off
- water pipes now lagged
- heating units now checked and comply.

3.7.2 In a letter to the applicants dated 13 May 2016, the authority listed documentation required before a code compliance certificate could be issued (some of which was subsequently provided) and noted that reinspection was still required:

...to view upstairs bench sealed to wall, safety glass to upstairs bathroom, restrictors to the windows, final exterior photos.

3.7.3 A subsequent reinspection on 21 September 2016 ticked off the above items as an ‘audit check’ and took photographs of the completed work.

### 3.8 The refusal to issue a code compliance certificate

3.8.1 In a letter to the applicants dated 18 October 2016, the authority noted that following a review of ‘the working file for your job’ it refused to issue the code compliance certificate, stating that:

The reason for refusal is Council does not believe the rammed earth perimeter walls and the [corrugated] roof cladding are capable of meeting the performance requirement of B2 durability (B2.3.1) (a) 50 year structural durability & (b) 15 year roof cladding durability.

3.8.2 The authority attached a series of photographs taken during 2011 and subsequent inspections during 2013, 2015, and 2016. The authority noted that the photographs ‘show the location of cracking and delamination of the rammed-earth walls and weathering of the roof cladding’, adding:

We also note that the delamination of the rammed earth walls highlight the fact the original maintenance programme is insufficient for ensuring the durability and weathertightness of the dwelling.

We also note the roof cladding is showing signs of weathering and we understand the required maintenance has not been completed for this cladding too.

3.8.3 In addition to the above, the authority also noted that the following documentation was also required:

1. The records of maintenance for the rammed earth walls and [corrugated] roofing
2. Installer sheet for the [solid fuel] heater
3. Producer statement for the waterproof membrane
4. Producer statement for the butynol roofing installation
5. Electrical certificate.

3.9 The applicants obtained some of the required documentation but failed to resolve the outstanding matters and the Ministry received an application for a determination from the applicants on 21 August 2017.

## 4. The submissions

4.1 In a statement accompanying the application, the applicants noted that they believed 'we have satisfied the issues numbered 1-5 and have enclosed supporting evidence' (see paragraph 3.8.3). The applicants also noted:

Given some time has passed since the building was first constructed and the code of compliance has been applied for, we are happy to discuss a waiver or modification of relevant building code clauses in order for the code of compliance certificate to be issued.

4.2 In a subsequent email to the Ministry dated 31 August 2017, the applicants clarified the supporting evidence considered to satisfy the authority's list of required documentation and included in the application (in summary):

- earth wall maintenance confirmed by:
  - plasterer's statement dated 9 October 2015 for AAC plaster
  - erosion test result on earth sample dated 20 June 2005
  - purchase records for lime wash paint product
- Corrugated roofing maintenance confirmed by:
  - roof cleaning, sealing and painting statement dated 21 November 2016
  - purchase records for cleaning product
  - photograph of roof paint used
- solid fuel cooker installation confirmed by:
  - certificate of compliance of 20-year-old cooker dated 30 November 2004
  - producer statement for installation of cooker
  - records of inspection of completed installation
- waterproof membrane to shower areas confirmed by:
  - cover plates to shower fittings removed and substrates photographed
  - records of inspections of membrane during construction

- lack of evidence of leaking since installation
  - butyl membrane installation confirmed by:
    - producer statement for butynol installation dated 9 November 2016
  - electrical work confirmed by electrical certificates for staged work:
    - switchboard and mains supply from road to barn dated 3 December 2004
    - switchboard to east wing of house (first stage) dated 13 June 2007
    - inspection of all electrical work<sup>11</sup> to west wing dated 3 February 2017.
- 4.3 The applicants also provided a copy of the authority's complete property file, which included:
- the original consent documentation for Stage Two
  - building consents and code compliance certificates for Stage One and the barn
  - the authority's contractor's inspection records from 2005 to 2009
  - the authority's progress inspection and internal memo in January 2011
  - the authority's 2013 inspection records for the Stage Two
  - the 2015 and 2016 final inspection records
  - the authority's refusal to issue a code compliance certificate dated 18 October 2016
  - correspondence between the applicant and the authority
  - various certificates, statements, technical brochures, photographs and other information.
- 4.4 The authority acknowledged the application on 21 September 2017 and provided a copy of the property file but made no submission in response to the application.
- 4.5 A draft determination was issued to the parties for comment on 25 January 2018. The authority accepted the draft without comment on 31 January 2018.
- 4.6 The owner made enquires of the Ministry as to the determination process on 30 January 2018 which were responded to on the same day. The owner accepted the draft without comment on 1 February 2018.

## 5. The expert's report

### 5.1 General

- 5.1.1 As mentioned in paragraph 1.6, I engaged an independent expert to assist me. The expert is a member of the New Zealand Institute of Building Surveyors and inspected the house with the earth specialist on 16 October 2017, and again on 31 October 2017. The expert provided a report, which included the earth specialist's report (as outlined in paragraph 6) as an addendum. The combined report was finalised on 24 November 2017 and forwarded to the parties for comment on 28 November 2017.
- 5.1.2 The scope of expert's role was to provide an assessment of the reasons provided for the authority's refusal to issue a code compliance certificate, taking into account 'the building's features and weathertightness risk profile, the maintenance that has been

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<sup>11</sup> Noted as 'done by another electrician'

carried out to the building, and the proven performance (or otherwise) of the building elements since its completion.’ Assessment was required in regard to the performance of:

- the rammed-earth walls
- the corrugated and butyl rubber roofs
- the membrane to the showers.

5.1.3 The expert noted that the ‘overall shape and form of the building is largely in accordance with the architectural design concept of the construction drawings reviewed.’

## 5.2 Clauses E2 External moisture, and B2 Durability

5.2.1 The expert inspected the external building envelope of the house, taking into account the age of the building work and the risks applying for particular junctions and intersections. (Refer to Figure 1 for locations of significant observations.)

5.2.2 In regard to the corrugated roofing, the expert noted that:

- roofing is fixed to purlins at 600mm centres, with nails through every second crest within the body of the sheets and every crest at the laps – in line with the manufacturer’s instructions
- there was no sagging of sheets between purlins and no elongated nail holes as sometimes seen on other roofs with the same cladding
- the roofing had been painted, with no holes or gaps apparent and the new coating ‘well adhered to the substrate’
- the repaint used a proprietary roof coating (I note that the quotation for roof restoration’ was signed as completed on 7 March 2017; and included cleaning and removing moss from the roof followed by a clear seal coat, an oil-based undercoat and the top coat)
- because the ends of roof sheets cannot be turned up under the ridge flashings, it is recommended that compressible foam is installed at the junction of the sheets and the flashing
- there is no visual evidence of leaks into the roof spaces.

5.2.3 The expert concluded that the corrugated roofing appears to be ‘adequately maintained and is meeting the mandatory requirements of code clause B2 Durability and E2 External moisture.’

5.2.4 In regard to the membrane roofing and parapet flashings, the expert noted that:

- parapet cappings appear satisfactory, with the tops sloped at 8° and ends ‘well flashed’ at the intersection with the corrugated roofing
- the butyl membrane has a fall and appears to be satisfactorily installed, with laps laid in the correct direction and no joints within the internal gutters
- the overflows to internal gutters are installed ‘far too high’, which risks water spilling into adjacent roof spaces before it can reach the overflow outlets.

5.2.5 In regard to other roof flashings, the expert noted that:

- spreaders have been installed to downpipes from the upper roof

- although water is pooling on some chimney flashings, there is no sign from the roof space below that moisture is penetrating as a result
- although roof/wall junctions at the northeast and northwest corners of the upper level are ‘poorly detailed’, there is no water staining or other evidence of moisture penetrating the junctions
- a large gap risks rodent entry into the roof space at the top of the valley below the upper northeast corner
- the bottom of the apron flashings to each side of the entry porches lack effective kickouts to prevent water from penetrating behind the AAC cladding, with staining of exposed timber visible on the west side of the east porch.

5.2.6 In regard to the rammed-earth walls, the expert noted that:

- the earth specialist advises that vertical cracks showing in some photographs are typical of those generated by vertical reinforcing rods and are not considered to be of structural concern; such cracking can be addressed with regular inspection and maintenance of the earth wall surfaces
- although drummy in places, the modified plaster system appears to be ‘generally sound and well adhered’, with the mesh able to hold the system together
- areas where plaster has chipped away are well sheltered under deep eaves, and minor repairs and maintenance should provide adequate protection
- vent grilles to the base of the west wing chimney are not sealed to the plaster.

5.2.7 The expert concluded that the rammed-earth walls appear to be ‘adequately maintained’.

5.2.8 In regard to the fibre-cement gable end walls, the expert noted that:

- some of the sheet edges are not recessed or plastered, with some sheets butt jointed and sealed with flexible sealant and then painted
- despite the lack of joint protection, there are no signs of water stains to the gable framing when viewed from within the roof space.

### 5.3 **Clause E3 Internal moisture**

5.3.1 The expert noted that the east wing shower cubicle included one exterior rammed-earth wall, with timber framing to the other walls – and to all walls around the west wing shower cubicle. Both showers had recently been used, so surface moisture prevented moisture levels being recorded from inside the showers.

5.3.2 The expert took invasive moisture readings in the surface of the plasterboard, and into the skirtings in the adjacent rooms backing onto the showers in the east and west wings; all readings ‘well within an acceptable range of 8% to 12%’. Where it was not possible to take invasive moisture readings, capacitance moisture readings ‘gave no indication of elevated moisture’.

5.3.3 The expert also noted that the shower membranes had been inspected and passed on 10 May 2007 and 16 February 2009 (see paragraph 3.3). I note that these inspections records specifically record the installation of named membrane installed on 9mm fibre cement board, with ‘reinforced mesh to corners’.

## 5.4 The expert's conclusions

5.4.1 The expert concluded that the following areas do not comply with the Building Code (with relevant clauses shown in brackets):

- the bottom of the apron flashings to the entry porches (E2, B2)
- the risk of rodent entry into the roof space (B2)
- the lack of ground clearances to the tops of the gully traps (E1, G13).

5.4.2 Based on his investigations and taking into account the age and performance of the construction to date, the expert strongly recommended that the following should also be attended to (in summary):

- installation of compressible foam to gaps between ridge flashings and roofing
- increasing clearances from rammed-earth to soil in some areas
- sealing of all cladding penetrations
- lowering the levels of overflow outlets to internal gutters in the entry porches.

5.5 In respect of the shower tanking membranes, the expert concluded that the showers appeared to be 'meeting the mandatory requirements of Clause E3 Internal moisture'.

## 6. The earth specialist's report

### 6.1 General

6.1.1 As noted in paragraph 1.6, the expert commissioned an independent specialist, on the Ministry's behalf, to provide specialist assessment of the rammed-earth construction. The specialist is the Chairman of the Standards Technical Committee for New Zealand earth building standards and a proponent of earth construction, and has been the primary author for BRANZ on earth building guidelines.

6.1.2 The specialist inspected the house on 16 October 2017 with the expert, providing a report completed on 24 October 2017, which was attached as addendum to the expert's report.

6.1.3 The specialist noted that his investigation was carried out to provide 'specific information' required by the Ministry as part of its determination process and his report was based on his 'long experience with earth buildings and their performance in general, and rammed earth in particular' together with the current earth standards NZS 4297, 4298 and 4299 ("the earth standards").

6.1.4 Verification Method B2/VM1 cites NZS 4297 and NZS 4299 as a means of establishing the durability requirements, with NZS 4299 addressing durability in section 2.5 and noting 'compliance with this section is necessary to satisfy the requirements of Clause B2 of the New Zealand Building Code'.

6.1.5 Section C2.5.1 of NZS 4299 provides the context of the specialist's observations outlined in the following paragraphs by including the statement that:

A structure is durable if it withstands expected wear and deterioration throughout its intended life without the need for undue maintenance. Deterioration of earth-walls depends on the severity of wind-driven rain, on the orientation of the wall, the height and width of the eaves, on the weather resistance of the wall material, on surface coatings, on the surface finish and on the stability of the material whether naturally occurring or achieved by the addition of stabilisers.

6.1.6 Although the consent documents described the area as a medium wind zone, the

specialist noted that the house site is partially sheltered ‘but has some vulnerability from southerly/south westerly storms.’

6.1.7 The specialist inspected the rammed-earth walls from within the garage (which were not plastered); observing that these ‘raw’ surfaces are generally ‘hard and tight, and show good earth workmanship’, with:

- rammed layers visible, with each about 50 to 100mm high
- the surface texture of each layer varying from moderately rough at the bottom to smoother at the top, which is normal.

## 6.2 The design features of the house

6.2.1 The specialist reviewed the consent documentation for the rammed-earth walls and the as-built situation, and included the following comments (in summary):

- The rammed earth walls have been designed to comply with the earth standards and did so ‘in all but some minor aspects’.
- Eaves over the earth walls are generally 900mm deep, in accordance with NZS 4299 for E2 compliance in a medium wind zone.
- Pre-construction erosion tests of a sample submitted by the owner/builder were carried out in accordance with NZS 4298, which included a pressure spray test for durability and the sample achieved an erodibility index of 1<sup>12</sup>.
- Although rammed earth corners beside the projecting north bay to the east wing are exposed, this would still comply with NZS 4297 for area with eaves less than 600mm given satisfactory sample test results. However, despite further sample testing called for in the specification, no test results were seen.
- The in-situ reinforced bond and lintel beams were poured directly over the rammed earth using permanent timber boxing – and are well protected beneath deep eaves. Wall openings and joinery junctions within earth walls appear to accord with NZS 4298 and NZS 4299, with no moisture problems apparent.
- The earth walls were specified to be plastered with a traditional ‘compatible and breathable plaster’ mix of cow manure, clay and sand (“the earth plaster”).

## 6.3 The past condition of the rammed-earth walls

6.3.1 In regard to the context of the specialist’s comments, NZS 4299 refers to normal maintenance expected for earth building material as including ‘the repair of damage or deterioration of the wall surface’ and states in section C2.5.1:

Earth walls are particularly susceptible to moisture, whether this is from rising damp, water ingress from the top, driving rain, water splashing, or moisture generated internally in a building. For this reason it is important that any design considers the need to protect earth walls from excessive moisture.

6.3.2 The specialist reviewed photographs taken in 2011 when the rammed earth surface had been left exposed and included the following comments (in summary):

- The southwest corner of the house had ‘proven to be more weather exposed in service than a medium wind zone would suggest’, which lead to the loss of

<sup>12</sup> The erodibility index (1 to 5) measures the extent to which the surface erodes when sprayed with water: 1 being the least amount of erosion and 5 being a fail.

some surface material from more exposed surfaces, with some areas ‘heading towards the upper limits of acceptable material loss’.

- Paragraph 2.5.1.1 of NZS 4299 also sets limits of material loss in as follows:
  - An earth wall will be deemed to comply with the durability performance criteria if, provided that normal surface maintenance has been carried out, its thickness has not decreased by more than 5% nor by more than 30mm at any point during the 50 year building life.
- Comparing the above limit with the subject external walls, ‘for a 350mm thick rammed earth wall, 5% of wall thickness is 17.5mm and maximum point loss in the body of a wall is 30mm.’
- The worst case of weather damage was to the southwest corner and the photo showed some patching to areas that had been damaged. The applicants have since undertaken the required ‘surface maintenance’ to prevent further material loss.
- Other photographs in the authority’s file also included some cracking to the rammed earth walls, including at construction joints and below the lintel timber plate boxing.

## 6.4 Current condition of the rammed-earth walls

6.4.1 NZS 4299 refers to the qualities of surface finishes for earth walls, stating:

Any applied coatings or surface finishes shall allow the wall to “breathe” to prevent moisture becoming trapped inside an earth wall. To “breathe” in this context means to allow the diffusion of air and water vapour.

6.4.2 The specialist inspected the rammed-earth walls and included the following comments (in summary):

- Apart from the garage, all interior walls are finished with the earth plaster. Most exterior walls are plastered with the same earth plaster, finished with a breathable lime wash paint that provides weather resistance and is considered acceptable for such walls.
- Despite the earth plaster surface ‘showing some areas of hairline cracking and some areas of drumminess on tapping’, the drummy areas were not considered a concern and no problems were found ‘that regular inspection and maintenance could not address.’
- The western end of the house included exposed lower walls and the SW corner shown in the authority’s photos (see paragraph 3.4.3). These walls have now been finished with a different plaster system that extends along the west wall and around the corners.
- The newer plaster is a polymer-modified cement-based plaster reinforced with a synthetic fibre mesh, and is expected to have lower ‘breathability’ than the traditional earth plaster applied to other walls.
- Despite ‘minor drumminess’ to some lower walls, the synthetic plaster ‘appears to be performing OK’, with ‘no visual indication of moisture having penetrated through any of the walls into the interior.’
- The permanent timber boxing to bond and lintel beams ‘are well protected under wide eaves and no moisture penetration was evident’. Structural details

for the house (see Figure 2) indicate that the cracking shown in some photos ‘is of minor concern.’

- The house experienced the effects of the Canterbury earthquake sequence<sup>13</sup> resulting in ‘some minor cracking in some walls that have been, or are being, plastered over’.

## 6.5 The specialist’s conclusions

6.5.1 The specialist concluded that, in his opinion, the rammed-earth walls would continue to be weathertight and durable providing that:

- ground clearances of 225mm to soil and 150mm to paving are maintained
- roofing and guttering are well maintained to prevent water penetration into rammed-earth walls
- walls are regularly inspected for damage, which ‘should occur at least annually and also following major storms or strong earthquakes, and any damage that is evident repaired’
- the lime wash paint system is regularly maintained, with the specific product requiring re-coating every 3 to 5 years.

## 7. Discussion: Clause E2 External moisture

7.1 The authority has concerns about the weathertightness and durability of the external envelope, taking into account the prolonged construction of the house, the corrugated roofing material, and rammed-earth construction used for ground floor walls.

7.2 Inspection records indicate that the roofing and the un-plastered rammed-earth walls would have been installed by about October 2006. I have taken that into account when considering the performance of those elements, which appear to have continued to perform for 11 of the minimum 15 years (for the roof cladding) and 50 years (for the rammed-earth wall structure) required by Clause B2 of the Building Code.

7.3 I accept the earth specialist and the expert’s conclusions that the rammed-earth walls have remained structurally sound and weathertight; and are generally well maintained at present. The remaining wall claddings also generally appear to have been installed in accordance with the building consent and the relevant manufacturer’s installation. However, some specific areas require attention.

7.4 Generally, the roof claddings appeared to have been installed in accordance with the manufacturer’s instructions at the time. However, I note the expert’s comments on roofing and associated flashings requiring attention to ensure weathertightness.

7.5 Taking account of the expert’s report, the earth specialist’s report and the other evidence, I consider that the following areas require attention:

- inadequate ground clearances below some areas of the earth walls
- the chipped plaster at some junctions with the timber boxing to concrete beams
- the unsealed vent grilles to the west wing chimney wall
- the joints to the fibre cement cladding to the gable end walls

<sup>13</sup> The Canterbury Earthquake Sequence includes the ‘Darfield Earthquake’ of 4 September 2010 with a moment magnitude of 7.1, followed by a series of aftershocks that included a 6.3 magnitude shake on 22 February 2011.

- the lack of compressible foam to gaps between ridge flashings and roofing
- the lack of vermin proofing at the top of the valley below the upper northeast corner
- the bottom of the apron flashings to the entry porches, with moisture penetration into framing apparent in one area
- inadequate overflows at the end of internal gutters to the entry porches.

7.6 I also note the expert's remaining comments in paragraph 5.2.5 and accept that these areas are adequate in the particular circumstances.

7.7 The expert's report has established that the current performance of the external building envelope is not adequate because there is evidence of moisture penetration into one area of timber framing. I am therefore satisfied that the house does not comply with Clause E2 of the Building Code.

## **8. Discussion: Clause B2 Durability**

### **8.1 General**

8.1.1 The relevant provision of Clause B2 of the Building Code is that building elements must, with normal maintenance, satisfy all the objectives of the Building Code throughout their effective life. That includes the requirement for claddings to remain weathertight for at least 15 years and the underlying construction to remain adequate for a minimum of 50 years, unless a lesser specified intended life is stipulated.

8.1.2 The identified cladding faults referred to in paragraph 7.5 occur in discrete areas, and I am able to conclude that satisfactory rectification of those faults will result in the roof and wall claddings complying with Clauses B2 of the Building Code insofar as it applies to Clause E2 (i.e., a minimum the 15-year durability period). However, as consented the rammed-earth walls form part of the structure of the house and are therefore required to perform for a period of not less than 50 years.

### **8.2 The durability of the rammed-earth walls**

8.2.1 The inspection records indicate that the rammed-earth walls were installed under the engineer's supervision during the first half of 2006 but were not plastered when the authority visited the site in January 2011, with some of the walls still not plastered in October 2013. During a period of five to seven years, the earth walls were therefore unfinished and unmaintained. However, the specialist's report confirms the current weathertightness of the plastered walls.

8.2.2 The earth specialist also concluded that the earth walls are likely to continue to be weathertight and durable providing appropriate inspections and maintenance are carried out. In my view account must be taken of the particular risks involved in rammed-earth construction and its specific maintenance requirements. Clause B2.3.1 of the Building Code requires that the cladding be subject to 'normal maintenance', however, that term is not defined in the Act.

8.2.3 The earth walls to this house require particular maintenance to ensure ongoing performance. Taking account of the earth specialist's report, I observe that:

- 'normal maintenance' as outlined in B2/AS1 section 2.1.3 is contemplates activities such as washing or applying coating and sealants; and not major repair work

- B2/VM1 cites NZS 4297 and NZS 4299 as a means of the establishing the durability requirements<sup>14</sup>, and NZS 4299 includes:
  - the repair of damage or deterioration as part of normal maintenance
  - that structures are expected to withstand expected wear and deterioration without ‘the need for undue maintenance’
- weathertightness and durability of these rammed-earth walls is dependent on:
  - maintaining adequate ground clearances
  - maintaining roof and guttering systems
  - inspecting walls annually and also following major storms or strong earthquakes, with prompt repair of any damage
  - re-coating the lime wash paint system every 3 to 5 years.

8.2.4 Although the external envelope appears to be reasonably well maintained at present, photographs taken in 2011, 2013, and 2015 indicate that completion and maintenance were deferred for some years, which resulted in premature deterioration of some areas. I therefore consider it important to ensure that the specific maintenance required for the rammed-earth construction is carried out on a regular basis now and into the future as the structural performance of the house relies on the completion of regular and ongoing maintenance.

8.2.5 I therefore consider the building consent No. 050904 for Stage Two of the house should be amended to include the required maintenance regime for the rammed-earth walls, including:

- visual checks for cracks or other damage annually and after storm or earthquake events
- prompt repair of any cracks or damage
- re-coating the lime wash paint system at maximum intervals of 5 years (note that only a breathable lime-based paint system may be used).

Note that only materials fully compatible with the rammed-earth substrate and earth plaster should be used for repair and maintenance.

8.2.6 If such an amendment is not made, it would not appear unreasonable for the consent to be amended so that the consented work had a ‘specified and intended life’ for some period less than 50 years as provided for under section 113 of the Act (refer Appendix A). This amendment will require action by the parties at the expiry of the specified and intended life.

### 8.3 Clause B1 Structure

8.3.1 As noted above the structural engineer’s producer statement issued in 2013 confirms the engineer’s construction observations of the foundations and slab, the rammed-earth walls and the compliance of the completed structure. The Building Code is performance-based and the structure does not appear to have been significantly affected by the Canterbury earthquake sequence which was a severe test of its performance.

8.3.2 The earth specialist’s report confirms the current condition of the external rammed-earth walls and has provided advice in relation to the maintenance of the walls in relation to their ongoing durability. While I am satisfied that the rammed-earth walls

<sup>14</sup> B2/VM1 Section 3.4.1

presently satisfy Clause B1 Structure, the defects to the rammed-earth wall with respect to Clause E2 as noted in paragraph 7.5, indicate that the walls may not satisfy Clause B1 for the minimum period stated in Clause B2.3.1(a), being not less than 50 years.

## **9. Discussion: The authority's remaining concerns**

### **9.1 Clause E3 Internal moisture**

9.1.1 The expert's investigations have confirmed that the tiled showers are currently watertight, with no evidence of past moisture penetration into adjacent timber framing. In addition, the inspection records have noted the product manufacturer, the use of an appropriate substrate and the application of mesh to corners.

9.1.2 Taking account of the expert's investigations and the inspection records, I am satisfied that the waterproof membranes underlying the tiled showers were properly installed and inspected during construction of the house. I am therefore able to conclude that the tiled showers comply with Clause E3 of the Building Code, notwithstanding the lack of a producer statement for the waterproof membrane.

### **9.2 Clause G13 Foul water**

9.2.1 During his inspection, the expert also observed the lack of ground clearance to the tops of gully traps, which risks surface water draining into the sewer pipes. Taking account of the expert's observations, I am therefore satisfied that the gully traps do not comply with Clause G13 Foul water.

### **9.3 Documents required by the authority**

9.3.1 In regard to the list of documents required by the authority (see paragraph 3.8.3), I note that the applicants have provided various producer statements and electrical certificates that appear to address the items identified by the authority particularly when considered in conjunction with the inspection records pertaining to some of these items.

9.3.2 The authority is of the view that various producer statements are now required to establish compliance. There is no basis in the Act for an authority to demand a producer statement as a condition for establishing compliance and for issuing a code compliance certificate.

9.3.3 Although a producer statement may be evidence, an authority should not rely on these to the exclusion of other evidence that demonstrates code compliance. An authority accepts a producer statement at its discretion in the belief that the author of the producer statement is creditable.

### **9.4 Time in which to issue a code compliance certificate**

9.4.1 The provisions of section 93 of the Act require an authority to make a decision about the compliance of consented work after the two-year anniversary of the issue of the building consent. The provisions of section 93 have been considered in past determinations, including 2008/040<sup>15</sup> and 2014/012<sup>16</sup>.

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<sup>15</sup> Determination 2008/040 Refusal to issue a code compliance certificate for a farm shed because the building consent was more than two years old at 58 Levi Road, RD 5, Christchurch *Department of Building and Housing*, 22 May 2008

<sup>16</sup> Determination 2014/012 Regarding the exercise of an authority's powers in refusing to grant an extension of the period during which it must decide to issue a code compliance certificate for building work at 117 Aberdeen Road, Christchurch *Ministry of Business, Innovation and Employment*, 21 February 2014

9.4.2 The provisions of section 93 require an authority to make a decision as to the compliance of the completed work. If the work is not found to be compliant the building consent in question remains open and an owner can reapply for a code compliance certificate at a later time. Paragraph 6.14 of Determination 2008/040 noted:

There is no statutory timeframe within which a [code compliance certificate] has to be issued but there is a timeframe within which a decision is to be made by a building consent authority in relation to [code compliance certificates]. Even though the two year period has elapsed, this does not mean that a [code compliance certificate] cannot be issued.

## 10. What happens next?

10.1 I note the building consent for Stage Two of the house was issued to the applicants as the current owners of the house and so the authority may issue a notice to fix that requires the applicants to bring the house into compliance with the Building Code. The notice should include the defects identified in paragraph 7.5 and 9.2.1, and refer to any further defects that might be discovered in the course of investigation and rectification. (Alternatively, the authority may elect to deal with the matter via a notice issued under section 95A of the Act.)

10.2 I suggest that the parties adopt the following process to meet the requirements of paragraph 10.1. Initially, the authority should issue a notice. The applicants should then produce a response to this in the form of a detailed proposal to specifically address the matters noted herein produced in conjunction with a competent person. If necessary any outstanding items of disagreement can then be referred to the Chief Executive for a further binding determination.

## 11. The decision

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

- I have insufficient information on which to determine whether the rammed-earth walls comply with Clause B1 Structure for the minimum durability period described in Clause B2.3.1(a)
- the exterior building envelope does not comply with Clauses E2 and B2
- the tops of the gully traps do not comply with Clauses E1 and G13

and accordingly, I confirm the authority's decision to refuse to issue a code compliance certificate for Stage Two of the house.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 17 May 2018.

Katie Gordon  
**Manager Determinations**

## Appendix A: The legislation

### A.1 Relevant provisions of the Building Act 2004

A1.1 The relevant sections of the Act discussed in this determination include:

#### **113 Buildings with specified intended lives**

- (1) This section applies if a proposed building, or an existing building proposed to be altered, is intended to have a life of less than 50 years.
- (2) A territorial authority may grant a building consent only if the consent is subject to—
  - (a) the condition that the building must be altered, removed, or demolished on or before the end of the specified intended life; and
  - (b) any other conditions that the territorial authority considers necessary.
- (3) In subsection (2), specified intended life, in relation to a building, means the period of time, as stated in an application for a building consent or in the consent itself, for which the building is proposed to be used for its intended use.

#### **114 Owner must give notice of change of use, extension of life, or subdivision of buildings**

- (1) In this section and section 115, change the use, in relation to a building, means to change the use of the building in a manner described in the regulations.
- (2) An owner of a building must give written notice to the territorial authority if the owner proposes—
  - (a) to change the use of a building; or
  - (b) to extend the life of a building that has a specified intended life; or
  - (c) to subdivide land in a manner that affects a building.
- (3) A person commits an offence if the person fails to comply with subsection (2).
- (4) A person who commits an offence under this section is liable on conviction to a fine not exceeding \$5,000.