



Determination 2009/111

Dispute over a building consent for a house with clay block walls at 10 Greenway Drive, Kerikeri

1. The matters to be determined

- 1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004¹ (“the Act”) made under due authorisation by me, John Gardiner, Manager Determinations, Department of Building and Housing (“the Department”), for and on behalf of the Chief Executive of that Department. The applicant is the owner M Eyer (“the applicant”) and the other party is the Far North District Council (“the authority”), carrying out its duties as a territorial authority or building consent authority.
- 1.2 This determination arises from a decision by the authority to refuse to grant a building consent for a proposed house, because it considered it had received insufficient information in the supporting documentation to be satisfied that the proposed clay block wall system within it would comply with certain clauses of the Building Code¹ (Schedule 1, Building Regulations 1992).
- 1.3 I consider that the matter for determination in terms of section 177(b)(i) of the Act² is whether the authority was correct in its decision to refuse to issue the building consent. In order to determine this matter I must also consider, under section 177(a), whether the proposed clay block wall system (refer paragraph 2.5) complies with the Building Code.
- 1.4 Based on the information available to me, the authority’s concerns are about the clay block wall system in regard to its compliance with Clauses B1 Structure, B2 Durability, E2 External Moisture and H1 Energy Efficiency of the Building Code. I have received no evidence relating to a dispute about any other matters related to this proposed building, and this determination is therefore limited to the abovementioned clay block wall system.
- 1.5 In making my decision, I have considered the submissions of the parties, the report of the engineering consultants commissioned by the Department to advise on this dispute (“the consultants”) and other evidence in this matter (refer paragraph 5.1).

¹ The Building Act, Building Code, Compliance documents, past determinations and guidance documents issued by the Department are all available at www.dbh.govt.nz or by contacting the Department on 0800 242 243

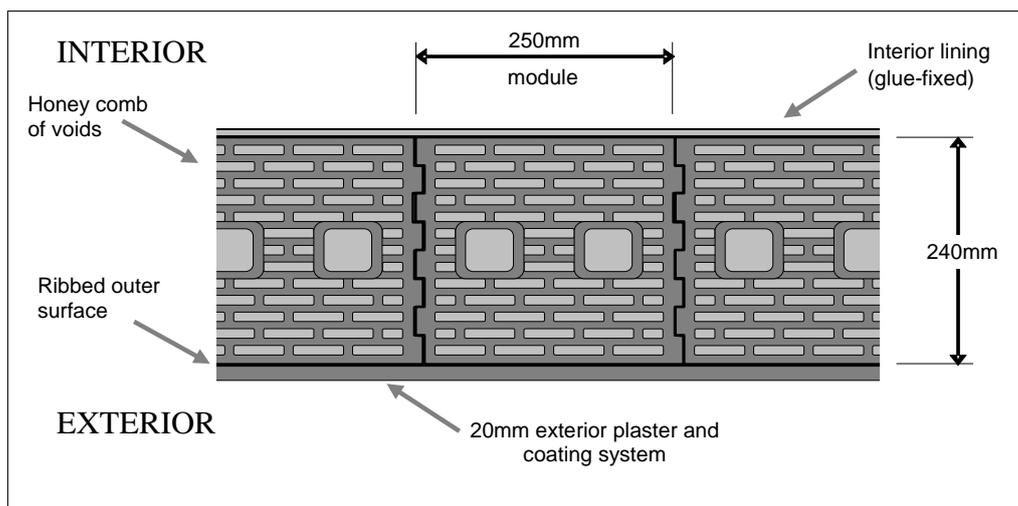
² In this determination, unless otherwise stated, references to sections are to sections of the Act and references to clauses are to clauses of the Building Code.

2. The building work

- 2.1 The authority has issued a building consent for the foundations of the house, and the building work considered in this determination covers the remaining construction.
- 2.2 The proposed house is a single-storey detached house and attached garage situated on a gently sloping rural site in a high wind zone for the purposes of NZS 3604³. Construction is specifically designed in terms of its engineering features, with concrete slabs and foundations, concrete block foundation walls, reinforced concrete ceilings, load-bearing clay block walls and PVC double-glazed windows. The design of the house is assessed as having a low weathertightness risk.
- 2.3 The house plan is a simple U-shape, with a rectangular garage to the south. The house and garage are beneath the same roof, although separated by an open 'breezeway'. The simple hipped roof is single level profiled metal with a pitch of 30° and eaves projections of 600mm. A pre-finished insulating board is installed over the roof rafters.
- 2.4 The structural design for the house, including the clay block wall system described below, has been undertaken by the applicants' design engineer ("the design engineer").

2.5 The clay block wall system

- 2.5.1 The block walls in the house comprise a proprietary wall system that consists of interlocking clay blocks with interlocking dry perp end joints and thin joint laying mortar. The manufacturer produces a range of blocks of varying thicknesses and profiles to suit different applications and junctions. The exterior wall system for this building is shown in the following sketch:



Plan view of blocks

- 2.5.2 The wall system includes regularly spaced reinforced concrete 'posts' within the walls. These use special 'column' blocks that form 150mm x 150mm reinforced columns (as specified in the column block plan in the drawings provided to the

³ New Zealand Standard NZS 3604:1999 Timber Framed Buildings

authority with the building consent application). The top bond beams/lintels also use special blocks that allow voids for 150mm thick continuously reinforced concrete around the wall perimeter. At ceiling level, the bond beams are tied to a proprietary reinforced slab system that acts as a structural diaphragm for the building

- 2.5.3 A proprietary reinforced 20mm three-coat modified cement-based plaster system finished with an acrylic paint coating system is applied to the exterior surface of the wall system. The walls are lined with glue-fixed plasterboard to the inside.

2.6 The windows and doors

- 2.6.1 The bond beams act as lintels to window and door openings, and the architectural drawings show no rebates provided at window and door openings. The soffit aligns with the top of the bond beam, resulting in the window and door heads at about 250mm below the soffits (in contrast with head heights shown in the elevations).
- 2.6.2 The architectural drawings show the windows set into the rough openings, with a proprietary compressible 'continuous seal' between the window frame perimeter and the block reveal. Continuous self-adhesive flashing tape ('permanent seal tape') is shown extending from behind the continuous seal to overlap the block reveal.
- 2.6.3 The windows and doors are recessed by about 80mm from the face of the plaster coating. At the jambs and heads, the exterior plaster coating carries into the reveal, with a fillet of sealant applied at the junction of the plaster and the window frame. Sloping aluminium sill flashings with end upstands are shown at the sills. Granite sills are shown on the inside, with an additional air seal shown below the edge.

3. Background

- 3.1 The applicant lodged an application for a building consent for the building work (No. BC-2009-1649/0).

3.2 The authority's response

- 3.2.1 In a letter to the applicant dated 22 July 2009, the authority noted that the application had been suspended and outlined requirements for 'further information to be provided to enable the process of issuing your consent to continue'.
- 3.2.2 The authority listed 13 items, some of which are routine matters outside the scope of this determination. I note that the applicant has since submitted additional information relating to these items, and I therefore leave these matters to the parties to resolve.
- 3.2.3 In regard to the matters considered in this determination (see paragraph 1.3), the authority requested (in summary):
- a 'specialist report from an appropriately qualified New Zealand Body' on the insulation value of the clay block wall system, including the impact of the reinforced concrete columns (see paragraph 8)
 - a peer review of the structural engineering, due to the specific design and the type of wall system proposed (see paragraph 6)

- confirmation that the roof structure is part of the structural design and takes into account the insulated panel system loadings (see paragraph 2.5.2)
- proof of compliance of the window details as alternative solutions (see paragraph 7.4.1, bullet point 4 and paragraph 7.4.2)
- confirmation that the appraisal of the plaster system allows for installation over the clay block walls (see paragraph 7.4.1, bullet point 2)
- information, in the form of an appraisal from 'a suitable organisation', a peer review from 'an organisation who has independent test laboratories' or 'accreditation from the Department', confirming that the clay block system will comply with the requirements of B1, B2, E2 and H1.

3.3 The Department received an application for a determination on 12 August 2009.

4. The submissions

4.1 The applicant forwarded copies of:

- the consent drawings and specifications
- the Producer Statement – PS1 – Design dated 29 June 2009 for structural engineering work
- the design engineer's information, details and calculations
- manufacturer's information and certificates for the clay block wall system
- specifications and the BRANZ Appraisal Certificate for the plaster coating
- various test reports for the PVC windows
- information about the roof insulation panels
- various other statements and information.

4.2 The authority acknowledged the application but made no submission in response.

4.3 A draft determination was issued to the parties for comment on 29 October 2009. The authority accepted the draft without comment. The applicant did not accept the draft determination but made no submission.

4.4 On 1 December 2009 the authority confirmed its acceptance of a design agreed between the design engineer and the consultants as a basis of a reasonable grounds assessment for the code compliance of the building (refer paragraph 6.2.8).

5. The code compliance of the wall system

5.1 The available evidence

5.1.1 In order for me to form a view as to code compliance of the clay block wall system; I need to establish what evidence is available. In this case, the evidence includes:

- the technical information submitted by the applicant, which includes:

- the detailed drawings and specifications for the house
- the engineer's drawings and calculations for the wall system
- information and statements from the wall system manufacturer.
- the consultants' opinion of the structural performance of the wall system
- the history of use of comparable wall systems.

5.2 The history of use

5.2.1 While this type of clay block wall system has been used in Germany and other European countries for many years, I am not aware of comparable products being used in New Zealand. I am consequently not able to compare the likely structural performance of the proposed clay block system with that of local products.

5.2.2 However, with regard to joinery installation details and other junctions within the wall, I consider that the wall system may be compared to a solid masonry structure. I also consider that the surface finishes of the wall system are commonly used materials.

Matter 1: Structural compliance

6. Discussion

6.1 In regard to the likely compliance of the wall system proposed for this house, the structural performance of these clay block walls is not readily comparable to other wall systems used in New Zealand and I therefore sought specialist advice on the matter.

6.2 The consultants' report

6.2.1 As mentioned in paragraph 1.5, I engaged independent engineering consultants ("the consultants") to provide an assessment of the design engineer's design and calculations of the clay block wall system, taking into account the requirements of the Building Code and the relevant international standards. The consultants are part of a multi-disciplinary civil and building consultancy with international engineering experience and expertise, this latter being an attribute I consider to be a requirement in assessing compliance in this material in this particular case.

6.2.2 Following correspondence with the consultants and the design engineer as to the appropriateness of some of the standards used in the design engineer's calculations, it was agreed that the consultants would assess the design using alternative calculation methods and standards. The consultants assessed the structural design and reported to the Department in a letter dated 9 October 2009.

6.2.3 The consultants' report dated 22 September 2009 attached a section entitled 'Shear capacity check of masonry units' which recalculated the shear resistance of the wall

system using the relevant standards considered appropriate and included a design cross-check against the older German standard DIN 1053-1⁴ to confirm the findings.

6.2.4 The consultants' report confirmed two main concerns about the engineering design of the wall system related to the structural standard BS 5628-1:2005⁵ used as the basis for the design engineer's calculations. These concerns were as follows:

- The standard used refers to bricks with voids of less than 40% to achieve the design strengths, whereas the clay blocks have voids in excess of 40%.
- Tables in the standard have been used to determine the compressive strength, but those tables are not valid for clay bricks.

6.2.5 As the clay blocks are certified by the manufacturer as complying with EN 771-1⁶, the consultants considered that structural design using the clay blocks should be based on the standards BS EN 1996-1:2005⁷ and BS EN 1996-3:2006⁸, which provide lower stress values than the standard used by the design engineer.

6.2.6 The consultants therefore recalculated the shear resistance of the walls (using seismic loading information from the design engineer's analysis), and concluded that:

- The design does not 'satisfy the compliance requirements for this type of construction relying on the brittle behaviour of bonded voided clay bricks'.
- Despite adopting a 'reasonably liberal view' on the adopted capacity factors used in the ULS⁹ analysis, the load capacity is not adequate to achieve compliance.

6.2.7 However, the consultants also made the following comments:

- The reinforced columns within the block walls were not allowed for in terms of the seismic behaviour, and these additional elements could provide some ductility to improve the behaviour of the structure, making it less vulnerable to brittle failure under seismic conditions.
- For similar forms of construction to be acceptable in New Zealand, there 'is precedent in requiring some degree of partially ductile behaviour beyond the brittle behaviour of the bricks or the adhesive alone'.

6.2.8 The design engineer amended his design in response to the consultants report and provided revised structural details. The consultants commented on the revised calculations with suggestions and raising two further matters. The design engineer responded with further revised calculations dated 18 November 2009. The consultant confirmed that the latter revised calculations had satisfied its concerns, and but noted that it was not, in their view, necessary to provide concrete columns at each intersection of a non-load bearing wall and shear wall.

6.2.9 From this I have concluded that, whilst the adhesive bonded brick is essentially a brittle shear panel system, the incorporation of regularly spaced reinforced concrete columns and bends introduce some limited degree of ductility that permits

⁴ German Standard DIN 1053-1: 1996 Masonry - Design and construction

⁵ British Standard BS 5628-1:2005 Code of practice for the use of masonry - Part 1: Structural use of unreinforced masonry

⁶ EN 771-1:2003 European Standard Specification for clay masonry units

⁷ BS EN 1996-1-1:2005 Eurocode 6. Design of masonry structures. General rules for reinforced and unreinforced masonry structures

⁸ BS EN 1996-3:2006 Eurocode 6. Design of masonry structures. Simplified calculation methods and simple rules for masonry structures

⁹ Ultimate Limit State

consideration of the system in terms of the Clause B1 compliance document NZS 1170.5.

6.3 Conclusions

- 6.3.1 Taking account of the consultants' advice, I am satisfied that the design engineer's calculations of structural performance of the clay block wall system, when submitted as part of the original consent application, did not adequately demonstrate compliance with Clause B1
- 6.3.2 However, taking account of subsequent amendments to the structure made by the design engineer, I am satisfied that the structural performance of the clay block wall system, when resubmitted as part of the consent application, will demonstrate compliance with Building Code Clause B1.
- 6.3.3 I record here that I do have concerns with the sufficiency of the plans and specifications as amended, and particularly the clarity of those with regard to what has been approved for construction. Notwithstanding the above, given the complexity of application, I consider that consent conditions should include a requirement for construction monitoring by the design engineer. This is a matter for the authority and the applicant to resolve.

Matter 2: Weathertightness

7. Weathertightness risk

- 7.1 The evaluation of building work and the risk factors in regards to weathertightness have been described in numerous previous determinations (for example, Determination 2004/1).
- 7.2 This house has been evaluated using the E2/AS1 risk matrix. The risk matrix allows the summing of a range of design and location factors applying to a specific building design, with the resulting level of risk ranging from 'low' to 'very high'. This house has the following features which influence its weathertightness risk profile:

Features increasing risk

- the house is in a high wind zone

Features decreasing risk

- the house is one-storey high
- the plan and form is fairly simple, with a continuous roof
- all walls have 600mm eaves projections to shelter the walls
- there is no timber framing in the exterior walls that might be subject to decay if it became wet
- the external masonry walls are finished with a waterproof plaster system

- 7.3 When evaluated using the E2/AS1 risk matrix, these features show that all elevations of the house demonstrate a low weathertightness risk rating.

7.4 The weathertightness of the walls

7.4.1 With regard to the likely weathertightness of the proposed wall system, I make the following observations on the proposed construction of this house:

- The clay block exterior walls are about 250mm thick and finished with a continuous modified plaster and paint system.
- The modified plaster system has been appraised by BRANZ as complying with Clause E2 when applied to a solid backing of concrete or clay masonry surfaces.
- The windows are recessed back from the exterior face by about 80mm, with the heads about 250mm below 600mm deep soffits and metal sill flashings.
- There are test reports on the weathertightness performance of the specified PVC windows, excluding the installation.

7.4.2 There are several areas where I consider that some details provided in the application for a building consent are unclear or not sufficient to ensure the weathertightness, including:

- the lack of head and jamb flashings to windows and doors, with no drip edges to the head reveals and an apparent reliance on sealants and flashing tapes
- the lack of detail at the junction of the sill with the plastered jamb detail
- the lack of clarity regarding the garage and door sill detail
- inconsistencies between the elevations and the section.

7.5 Weathertightness conclusion

7.5.1 Providing the matters noted in paragraph 7.4.2 are resolved to the satisfaction of the authority, I am satisfied that the clay block wall system is likely to be weathertight and durable when installed in accordance with the manufacturer's instructions.

7.5.2 Although the authority has sought an appraisal, a peer review, or accreditation for the wall system, I am of the view that such assessments might necessarily relate to representative design cases. It might not necessarily include consideration of weathertightness detailing, as such matters may well be up to the designer to provide in each specific instance. The authority would then still be required to make its own assessment of the system against the requirements of Clauses E2 and B2.

7.5.3 In this instance the weathertightness of the clay block wall system itself will be dependent on the weathertightness risk features of the building as a whole, the features that protect the walls from the weather, the application of the modified plaster, the weathertightness detailing, and the consequences and likelihood of failure on the building elements themselves. These features can be considered on their merits and independently of the clay blocks as a structural system.

7.5.4 Taking account of information provided subsequent to the building consent application I consider that there is now sufficient information for the authority to make its own reasonable grounds assessment to determine compliance with relevant clauses of the Building Code.

Matter 3: Thermal insulation

8. Discussion

8.1 The authority considered that it had insufficient information with the building consent application to verify that the building would comply with Clause H1. The applicant submitted calculations and information on the particular products proposed for this building with the building consent application.

8.2 I note that the the glazing area is within the limits set for the use of the schedule method in H1/AS1. I have also considered the thermal conductivity of specified wall and ceiling lining materials and details specified as they are less commonly used:

- The clay block manufacturer's certificate¹⁰ dated 22 November 2007 states that the particular block system used in this design has an R-value of 2.2. When the plaster coating and plasterboard lining is added, the R-value is likely to be in the order of 2.26.
- The roof insulation is a rigid polyurethane foam in the form of 80 mm thick composite board with an R-value of 3.57 confirmed by the German manufacturer.
- The PVC windows are double-glazed and likely to provide R-values in the order of 0.36.

8.3 Based on the above values, I consider it likely that the proposed building work is likely to comply with Clause H1. However the applicant will be required to resubmit the heat loss calculations to the authority to confirm compliance and should clarify the following;

- The assumptions made to arrive at the values of 2.4, 1.5 and 3.6 used in the calculations.
- The use of values for solid walls rather than non solid walls in the reference house calculations
- Verify the calculations for the reference house.
- Verify the wall areas and the Area to Perimeter ratio of the proposed house.

8.4 The applicant may wish to use another method to verify compliance with Building Code Clause H1.

9. Conclusion

9.1 In relation to Clause B1 of the Building Code, I am of the opinion that the information included within the original consent application was insufficient for the authority to establish compliance with this clause. However, I am of the opinion that the subsequent amendments made by the design engineer will result in a code-compliant building.

¹⁰ Statement of product conformity to the harmonised specifications (no. 0803-BPR-021)

- 9.2 In relation to Clauses E2 and H1 of the Building Code, I am of the opinion that the information included in the consent application was not sufficient for the authority to be satisfied on reasonable grounds that the building work would comply. Supplementary with the information, as described paragraphs 7.4.2 & 8.3, together with any other matters raised by the authority as part of its normal checking processes, will be sufficient for the authority to establish compliance with these clauses.
- 9.3 It is emphasised that each determination is conducted on a case-by-case basis. Accordingly, the fact that a particular wall system has been established as being code compliant in a specific instance, does not of itself mean that the same system will be code compliant in other situations.

10. The decision

- 10.1 In accordance with section 188 of the Building Act 2004, I hereby confirm the authority's decision to refuse to issue the building consent based on inadequate information originally supplied to the authority with the building consent application to ascertain on reasonable grounds that:
- the clay block wall system would comply with Building Code Clause B1
 - the weathertightness detailing would comply with Building Code Clause E2
 - the building would comply with Building Code Clause H1.
- 10.2 I also determine that, based on the information now supplied the clay block wall system will comply with Building Code Clause B1, subject to a consent condition being agreed between the owner and the applicant regarding construction monitoring by the design engineer.

Signed for and on behalf of the Chief Executive of the Department of Building and Housing on 22 December 2009.

John Gardiner
Manager Determinations