Department of Building and Housing
Te Tari Kaupapa Whare

Determination 2009/50

The code compliance of a cement bonded particle board clad and steel framed house at 37/5 Driftwood Place, Mangawhai

1. The matters to be determined

1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004[1] ("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, R Port ("the applicant"), acting through an agent, and the other party is the Kaipara District Council ("the authority"), carrying out its duties as a territorial authority or building consent authority.

1.2 This determination arises from the decision of the authority to refuse to issue a code compliance certificate for a 2-year-old house because it was not satisfied that the cladding complied with Clauses B2 and E2 of the Building Code[2] (First Schedule, Building Regulations 1992).

1.3 The matter for determination, in terms of section 177(a) and 177(b) of the Act[3] are:

- whether the cladding as installed on the house ("the cladding") complies with Building Code Clause B2 Durability and Clause E2 External Moisture. By

[1] The Building Act 2004 is available from the Department's website at www.dbh.govt.nz.
[2] The Building Code is available from the Department's website at www.dbh.govt.nz.
[3] 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.

"the cladding as installed" I mean the components of the system (such as the sheets, the joints, the flashings and the paint coatings), as well as the way the components have been installed and work together.

- whether the authority was correct in its decision to refuse to issue a code compliance certificate.

1.4 Additional matters regarding compliance with Building Code Clauses H1 Insulation, B1 Structure, G9 Electrical Services and E3 Internal Moisture have been brought to my attention and consequently I have included reference to these in my decision.

1.5 In making my decision, I have considered the submissions of the parties, the report of the expert commissioned by the Department to advise on this dispute ("the expert"), and other evidence in this matter. I have evaluated this information using a framework that I describe in paragraph 6.1.

2. The building work

2.1 The building work consists of a small single-storey detached building that is situated on a gently sloping coastal site in a high wind zone for the purposes of NZS 3604[4]. The building has a fairly simple rectangular shape comprising a 70m^2 house section ("the house"), with a garage structure ("the garage") attached at the eastern end.

2.2 The construction is specifically designed, with steel wall and roof framing, wood fibre/cement board cladding and infill framing, profiled metal roofing and aluminium windows. The garage floor is a concrete slab and the house floor is steel-framed, with the steel RHS posts welded to baseplates that are bolted concrete pads.

2.3 The building has two 5^o pitch skillion roofs, with the garage roof set at a lower level than the house roof. Roof projections are limited to oblique eaves of about 300mm along the north elevation, except for a projecting wall on the west elevation.

2.4 A free-standing timber-framed deck extends along the north elevation. I note that, at the time of the expert's inspection, the timber decking was removed from the deck.

2.5 The wood fibre/cement particleboard

2.5.1 The house and garage have different wall systems based on the proprietary product described as 'structural cement bonded particle board' ("CBPB"). The material is a proprietary board made up of about 70% Portland cement, with reconstituted wood fibres and bonding agents. Sheets are 1200mm wide and available in thicknesses of 8mm, 12mm and 18mm. The CBPB board can be glued in layers to provide various components, including 'studs' as used in this house.

2.5.2 The board is supplied unpainted, unless ordered as 'factory-sealed'. The manufacturer's information notes that the CBPB board must be primed and painted with an acrylic paint for exterior use, recommending that both sides be sealed. Fixings are generally the same as used for conventional particle board.

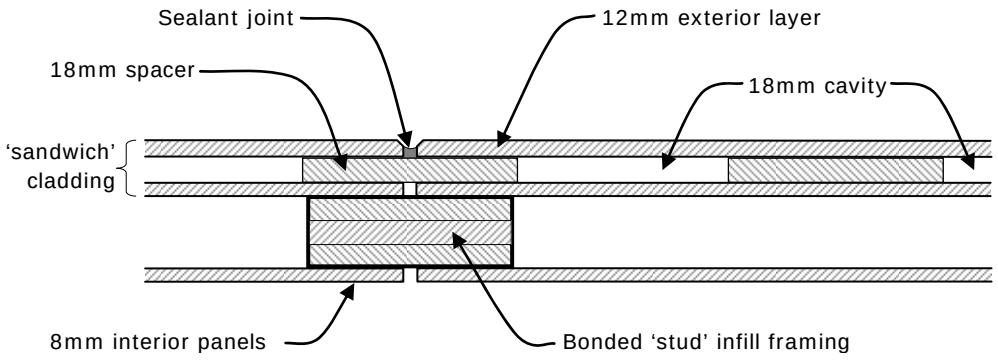
[4] New Zealand Standard NZS 3604:1999 Timber Framed Buildings

2.5.3 An engineering consultancy ("the engineer") has provided a 'certification' dated 10 November 2005, which describes the CBPB board and its application. The certification notes that panels may be used externally 'as a ventilated cavity system' subject to certain recommendations, which include:

- the provision of 10mm wide sealant-filled vertical expansion joints, using an appropriate sealant recommended by the board manufacturer
- the factory-priming of panels on both sides, with cut edges coated on-site using an appropriate primer recommended by the board manufacturer
- protection from the weather during construction
- exterior painting to provide 'crucial' protection against moisture absorption.

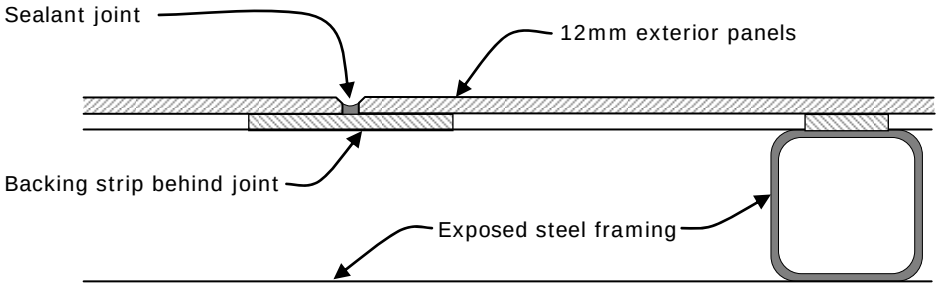
2.6 The wall cladding systems

2.6.1 The expert reports that the exterior walls of the house part of this building are made up of exterior "sandwich" CBPB panels, infill CBPB "studs" of about 150mm x 50mm and interior CBPB linings as indicated in the following sketch:



2.6.2 The exterior CBPB panels are screw-fixed from the outside, with metal washers used at the screws. Metal angles are used as flashings at corners, with other joints sealant-filled. The expert noted that the house cladding is likely to have been supplied as prefabricated panels.

2.6.3 The garage walls are unlined and have no infill framing. 12mm CBPB panels are fixed directly to the steel framing, with CBPB glued to form vertical backing strips behind the joints as shown in the following sketch:



3. Background

3.1 The authority issued a building consent for the house (No. 051047) on 13 February 2006, under the Building Act 2004. The consent conditions did not include any specific inspections required during construction.

3.2 The authority carried out various inspections during construction, including a pre-line inspection on 14 September 2006. A final inspection was undertaken on 14 September 2007, with re-inspections on 4 and 14 February 2008.

3.3 In a letter to the applicant dated 15 February 2008, the authority refused to issue a code compliance certificate 'due to the lack of pre cladding inspections and lack of building paper in the walls'.

3.4 The Department received an application for a determination on 23 March 2009 and sought further information from the applicant, which was received on 20 April 2009.

4. The submissions

4.1 The applicant forwarded copies of:

- some of the consent documentation
- a 'Producer Statement – Design' dated 20 December 2005 for the building
- the consent drawings
- a summary listing the inspections and re-inspections
- some of the correspondence with the authority
- various statements, technical information and other information.

4.2 The authority acknowledged the application and made no submission.

4.3 Copies of the submissions and other evidence were provided to each of the parties. Neither the applicant nor the authority made any further submissions in response to the submissions of the other party.

4.4 A draft determination was issued to the parties for comment on 26 June 2009. The authority accepted the draft without comment. The applicant accepted the draft acknowledging that work was required to rectify the matters of non-compliance in order to obtain the code compliance certificate.

5. The expert's report

5.1 As mentioned in paragraph 1.5, I engaged an independent expert to provide an assessment of the condition of those building elements subject to the determination. The expert is a member of the New Zealand Institute of Building Surveyors. The expert inspected the house on 18 May 2009 and provided a report dated 24 May 2009.

5.2 The expert noted 'numerous departures' from the consent drawings, including:

- changes to windows and doors
- the omission of a "chimney" to the north elevation
- the omission of eaves, except to the north elevation
- the deck changed from attached to free-standing
- the removal of the attached pergola structure
- the garage cladding changed to single-layer panel cladding
- the omission of the steel gussets beside the garage door
- various changes to cladding construction details

5.3 The expert noted that the general quality of construction was poor. The expert observed that the site is very sandy, and wind-blown sand has built up under and around the house in some areas. The effect of corrosive salts in the sand and the air has resulted in corroding steel and metal flashings in the two years since construction.

5.4 The wall cladding system

5.4.1 The expert inspected unpainted off-cuts of the CFPB that had been left exposed around the site, and noted that they appeared sound, with no signs of delaminating at glue joints and minimal swelling. The expert observed that the material appeared to absorb very little moisture, in contrast to conventional particle board, and considered that it generally appeared 'very forgiving and generally robust'.

5.4.2 The expert observed the bottom of the cladding panels from the underside and noted the cavities between the spacers within the 'sandwich'.

5.4.3 The expert noted that the consent drawings did not specify the use of building wrap. Given the nature of construction and the cavities, the expert was 'not sure what benefit (if any) building wrap would add to this particular situation'. (However, I note that a building wrap would have separated the steel framing from the CFPB in the case of the garage construction shown in paragraph 2.6.3).

5.4.4 The expert noted that the windows are face-fixed with metal head flashings. The windows appeared to be sealed between the jamb flanges and the cladding face. The expert removed an architrave from the inside, and noted that no air seals had been installed. An aluminium extrusion extends partly over the rough window opening, with a timber reveal and architrave installed to trim the opening.

5.5 Moisture levels

5.5.1 The expert inspected the interior wall panels and no evidence of current moisture was observed. Due to the nature of the materials in the construction, conventional moisture testing was not appropriate, except for establishing relative levels in different areas. However the expert carried out some indicative testing of samples that suggested the moisture content was likely to be within about 12%.

5.5.2 The expert measured temperature and humidity within the main frame cavity and compared these to interior measurements. The dew point was established as being at about 12^{o}C, which indicated that some condensation may form in the closed frame cavities on cold nights. The expert did not consider that this would lead to any problems for the CFPB. (However, the effect of moisture on any steel exposed within the frame cavity must also be considered, although I note that the likelihood of condensation occurring is low for this particular house).

5.6 The wall cladding

Commenting specifically on the wall cladding, the expert noted that:

- the exterior panels were not painted or primed prior to installation and there are unsealed areas behind the deck
- corner flashings were installed following the deck construction and stop at the decking level, with corner joints open below
- the panel joints should be 10mm wide to allow effective sealants, but joints vary and are too narrow in some areas, with inadequate sealing of the joints
- there are some sealant-filled horizontal joints between panels
- the panels are screw-fixed from the outside, with some missing washers and signs of corrosion beginning
- sand has blown up to cover the bottom of the cladding in some area, and will continue to do so
- penetrations through the cladding are poorly sealed
- there are obvious gaps beneath two windows on the south elevation
- the ends of the head flashings have no stop-end, and rely on heavy application of sealant for weathertight
- when the garage door head flashing was installed, the side cladding has been cut through and sealant-filled
- where the pergola has been removed, the back flashing is corroding and fixing holes have been crudely plugged with sealant.

5.7 The roof cladding

Commenting specifically on the roof cladding, the expert noted that:

- There are signs of corrosion of fixings and flashings
- the apron flashing upstand does not extend around the vertical corners at each end of the roof step, with the lower south corner covered with a metal angle that allows water flowing down the slope to penetrate behind the reverse lap
- aerial fixings are through the troughs, and are inadequately sealed.

5.8 The structural steel

The expert also inspected the visible areas of steel framing and noted the following:

- in the sub-floor, corrosive wind-blown sand has covered the bottom of some steel posts
- the baseplates below the sub-floor posts sit directly onto concrete pads and are corroding in some areas
- where steel framing has been cut, edges have not been protected and corrosion has started and is visibly spreading
- many of the site-welds are rusting, with severe corrosion in some areas.

5.9 Other matters

While observing the cladding and structure, the expert observed various other aspects, including the following matters (the relevant Building Code Clauses are shown in brackets):

- Steel gussets shown in the consent drawings as bracing to the sides of the garage door have not been installed (Clause B1).
- Wind has blown out some of the polystyrene under-floor insulation panels (Clause H1).
- There is an unprotected electric cable under the floor (Clause G9).
- The insulation in the skillion roof is installed hard up against the roofing, with no air gap to allow ventilation of the roof space (Clause E3).

5.10 A copy of the expert's report was provided to the parties on 18 May 2009.

6. Evaluation for code compliance

6.1 Evaluation framework

6.1.1 In evaluating the design of a building and its construction, it is useful to make some comparisons with the relevant Acceptable Solutions[5], which will assist in determining whether the features of this house are code compliant. However, in making this comparison, the following general observations are valid:

- Some Acceptable Solutions cover the worst case, so that they may be modified in less extreme cases and the resulting alternative solution will still comply with the Building Code.
- Usually, when there is non-compliance with one provision of an Acceptable Solution, it will be necessary to add some other provision to compensate for that in order to comply with the Building Code.

6.2 As described in paragraph 2.6, the wall structure of this house uses a proprietary wood and cement-based panel system. The relevant Acceptable Solution E2/AS1 is

[5] An Acceptable Solution is a prescriptive design solution approved by the Department that provides one way (but not the only way) of complying with the Building Code. The Acceptable Solutions are available from The Department's Website at www.dbh.govt.nz.

limited to buildings that fall within NZS 3604 and the cladding of this house must therefore be considered as an alternative solution.

6.3 Weathertightness evaluation

6.3.1 The approach in determining whether building work is weathertight and durable and is likely to remain so, is to apply the principles of weathertightness. This involves the examination of the design of the building, the surrounding environment, the design features that are intended to prevent the penetration of water, the cladding system, its installation, and the moisture tolerance of the external framing. The Department and its antecedent, the Building Industry Authority, have also described weathertightness risk factors in previous determinations[6] (for example, Determination 2004/1) relating to cladding and these factors are also used in the evaluation process.

6.3.2 The consequences of a building demonstrating a high weathertightness risk is that building solutions that comply with the Building Code will need to be more robust. Conversely, where there is a low weathertightness risk, the solutions may be less robust. In any event, there is a need for both the design of the cladding system and its installation to be carefully carried out.

6.4 Weathertightness risk

6.4.1 This house has the following environmental and design features which influence its weathertightness risk profile:

Increasing risk

- the house is in a high wind zone and is exposed to corrosive salts
- there are 200mm oblique eaves to one elevation only

Decreasing risk

- the house is 1-storey high
- the house is simple in plan and form
- the wall cladding panels incorporate a drained cavity
- the house has a steel structure, with no timber framing within the walls
- the partly completed deck is not attached to the building
- the pergola has been removed from the building.

6.4.2 The 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. The resulting level of risk can range from ‘low’ to ‘very high’. The risk level is applied to determine what claddings can be used on a building in order to comply with E2/AS1. Higher levels of risk will require more rigorous weatherproof detailing; for example, a high risk level is likely to require a particular type of cladding to be installed over a drained cavity.

[6] Copies of all determinations issued by the Department can be obtained from the Department’s website.

6.4.3 When evaluated using the E2/AS1 risk matrix, the weathertightness features outlined in paragraph 6.4.1 show that all elevations of this house demonstrate a low weathertightness risk rating.

6.5 Weathertightness performance

6.5.1 It is clear from the expert's report that the cladding installed on the house is unsatisfactory in terms of its weathertightness risk and performance perspectives and considerable work is required to make the house code-compliant. Although the cladding material appears sound and there is no evidence that the house is leaking at the present time, the cladding has not been installed in accordance with good trade practice or to the manufacturer's instructions. There are a number of significant defects and omissions that may endanger the ongoing performance of the cladding.

6.6 Weathertightness conclusion

6.6.1 I am satisfied that the current performance of the cladding is inadequate because it has not been installed according to good trade practice or to the manufacturer's instructions and has significant defects at present. In particular, it demonstrates the key defects listed in paragraph 5.6. The known weathertightness risk factors present in this house have to be considered in combination with the faults identified in the cladding system. However, I have not received sufficient evidence to show that the cladding is allowing the ingress of moisture and, as a consequence, does not comply with Clause E2 of the Building Code.

6.6.2 However, the building work is also required to comply with the durability requirements of Clause B2. Clause B2 requires that a building continues to satisfy all the objectives of the Building Code throughout its effective life, and that includes the requirement for the house to remain weathertight. Because the cladding faults on the house are likely to allow the ingress of moisture in the future, the cladding does not comply with the durability requirements of Clause B2.

6.6.3 I find that, because of the extent and apparent complexity of the faults that have been identified with the cladding and the nature of the particular construction in this house, I am unable to conclude, with the information available to me, that remediation of the identified faults, could result in compliance with the relevant clauses of the Building Code. I consider that final decisions on whether code compliance can be achieved by either remediation or re-cladding, or a combination of both, can only be made after a more thorough investigation of the cladding.

6.7 The structural steel

6.7.1 The expert's report has established that the structural steel in the building is corroding, with severe corrosion apparent in a number of areas. The extent of corrosion evident in the two years since construction indicates a significant risk to the long-term structural integrity of the house.

6.7.2 The corrosion apparent in the structural steel in the two years since construction is likely to increase in the future, with consequential risks to the structural integrity of the house, and therefore the structural steel does not comply with the durability

requirements of Clause B2. I consider that decisions on remediation can only be made after a more thorough investigation of the structure by a structural engineer.

6.7.3 I also note the expert's comment (see paragraph 5.9) on the omission of the steel gussets as bracing to the sides of the garage door. Taking into account this omission, I am unable to determine whether the building complies with Clause B1 Structure.

6.8 Other matters

6.8.1 I also note the expert's comments in paragraph 5.9, in regard to other clauses of the Building Code. While these are not matters noted by the authority when refusing to issue a code compliance certificate I consider that the expert's report has established that the building work does not comply with Clauses B1, E3, G9 and H1 and therefore a code compliance certificate could not be issued.

6.9 Maintenance

6.9.1 Effective maintenance of a building is important to ensure ongoing compliance with Clauses B2 and E2 of the Building Code and is the responsibility of the building owner. The Department has previously described these maintenance requirements, (for example, Determination 2007/60).

6.9.2 In this instance the ongoing maintenance of the protection to the structural steel frame is of particular importance given the building's location in an extreme coastal environment.

7. What is to be done now?

7.1 A notice to fix should be issued that requires the owners to bring the building into compliance with the Building Code, identifying the items listed in paragraphs 5.6 to 5.9 and referring to any further defects that might be discovered in the course of investigation and rectification, but not specifying how those defects are to be fixed. It is not for the notice to fix to stipulate directly how the defects are to be remedied and the house brought to compliance with the Building Code. That is a matter for the owner to propose and for the authority to accept or reject. Any outstanding items of disagreement can be referred to the Chief Executive for a further binding determination.

7.2 In response to the notice to fix and as discussed in paragraph 6.6.3 and 6.7, the owner should engage a suitably qualified person to undertake a thorough investigation of the house and advise on remediation. The continued integrity of the steel frame is of particular concern given the consequential risks to the house. Detailed proposals describing how the defects are to be remedied should then be provided and submitted to the authority for approval. Any outstanding items of disagreement can then be referred to the Chief Executive for a further binding determination.

7.3 I note that the expert has identified a large number of variations between the drawings and the house as constructed, and I leave this matter to the authority to resolve with the owners as it considers appropriate.

8. The decision

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

- the cladding does not comply with Building Code Clause B2
- the structural steel does not comply with Building Code Clauses B2
- the building work does not comply with Building Code Clauses B1, E3, G9 and H1

and accordingly I confirm the authority's decision to refuse to issue a code compliance certificate.

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

John Gardiner
Manager Determinations