Determination 2017/014

Regarding a building consent for the recladding of apartments at 10-14 Hobson Street, Auckland

Summary

This determination is concerned with the compliance of a panel façade cladding system used in the recladding of two apartments at the top of a multi-level building. Due to its height, the building is outside the scope of the Acceptable Solution and Verification Method, and the determination considered the effect of wind pressures likely to be imposed on the cladding system.

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1. The matter 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 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:

- Body Corporate BC161064 as owner of common areas and representing the owners of apartments 4A, 4B and 4C, Apple Investments Ltd ("the owners"). The Body Corporate is represented by a building consultant ("the consultant") who is the property and building consultancy company responsible for consent documentation and project management of the remedial work project.
- Auckland Council ("the authority"), carrying out its duties as a territorial authority or building consent authority and who applied for this determination.

1.3 The matter to be determined[2] is the authority's exercise of its powers of decision in granting building consent no. B/2014/14852 in regard to the proprietary cladding system specified for proposed remedial work to an existing apartment structure. In making my decision I must consider whether the proprietary cladding system installed as proposed will comply with the relevant clauses of the Building Code (First Schedule, Building Regulations 1992)[3].

1.4 Matters outside this determination

1.4.1 This determination is one of three determinations currently before me concerning the alterations to this property:

- Determination 2794: The original determination sought by the consultant on behalf of the owners about consent conditions imposed by the authority for the proposed remedial work to the upper level apartments.
- Determination 2823: Regarding the compliance of the altered building as a whole with section 112 of the Act concerning means of escape from fire.
- Determination 2860 (this determination): Applied for by the authority as to whether the building consent had been correctly issued, particularly in regard to the effect of wind pressures likely to be imposed on the proposed wall cladding system.

1.4.2 This determination is limited to the granting of the building consent in regards to the compliance of the wall cladding facade system only and does not consider matters addressed in the other two determinations. Given the relationship of the issues covered in this determination and 2794, references are made to relevant reports and submissions submitted for both determinations.

[1] The Building Act, Building Code, Acceptable Solutions, past determinations and guidance documents issued by the Ministry are all available at www.building.govt.nz or by contacting the Ministry on 0800 242 243.
[2] Under sections 177(1)(b) and 177(2)(a) of the Act.
[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.

1.5 The evidence

1.5.1 Evidence considered in this determination includes a number of reports provided by a variety of advisors to the consultant, the authority, and the Ministry.

1.5.2 In making my decisions, I have considered:

- relevant parts of submissions from the parties for the three determinations
- relevant parts of the following reports prepared by the consultant or commissioned by the consultant and forwarded to the authority:
  - November 2014: engineering calculations by the consulting engineers for the project ("the first engineer")
  - December 2014 (revised March 2015): alternative solution review report for the facade prepared by a consultant for the authority
  - July 2015: structural engineering wind pressures calculations by a civil and structural engineering consultancy ("the second engineer")
  - August 2015: facade engineering report by a structural and facade engineer ("the third engineer")
- reports of experts commissioned by the Ministry to advise on this dispute:
  - 15 December 2015: the report by the architect expert ("the architect")
  - 19 August 2016: the initial report by the engineer expert ("the expert")
  - 21 September 2016: the updated report by the expert
- 1 April 2016: report by a facade engineer commissioned by the authority to review the architect's report ("the fourth engineer")
- the other evidence in this matter.

1.5.3 Some reports include evidence for all three determinations, while others relate only to the subject matter in this determination. Within this determination, relevant reports are given the following titles:

Table 1: The relevant reports

Date	Report provided by:	Report for:	Title given in this determination
Nov 14	the consultant	authority	"the consultant's remedial works plans"
Nov 14	first engineer	consultant	"the first engineer's report"
Dec 14/ Mar 15	the consultant	authority	"the alternative solution facade report"
July 15	second engineer	consultant	"the second engineer's report"
Aug 15	third engineer	consultant	"the third engineer's facade report"
Dec 15	the architect	Ministry	"the architect's report"
April 16	fourth engineer	authority	"the fourth engineer's facade report"
May 16	the architect	Ministry	"the architect's response"
Aug 16	the expert	Ministry	"the expert's initial report"
Sept 16	the expert	Ministry	"the expert's updated report"

1.5.4 In regard to the calculation of wind pressure design parameters and expected loads, this determination refers to values calculated for Ultimate Limit State ("ULS") conditions and Serviceability Limit State ("SLS") conditions.

2. The building work

2.1 The existing building

2.1.1 The property is an existing apartment block situated within the city centre. The building includes ground floor and basement car parking, with the remaining five upper floors containing apartments. The apartments undergoing the re-clad make up the fourth and fifth floors.

2.1.2 The building was originally constructed as a warehouse, and in the late 1970s was converted to a commercial building. In early-to-mid 1990s it was converted to apartments, and at that time the upper level timber-framed apartments (4A, 4B and 4C) were constructed atop the existing reinforced concrete construction.

2.1.3 The two-storey upper level apartments were originally clad with a direct fixed EIFS[4] system, with a texture-coated modified plaster finish. One of the apartments (4A) was re-clad in 2011/2012 with an express joint panel cladding over a rigid air barrier (RAB) – this is the same proprietary cladding as specified in the building consent application that is the subject of this determination.

2.2 The alterations

2.2.1 The subject alterations include:

- remediation and replacement of deck membranes for all three apartments, which requires cladding removal to allow upstands to be installed to all deck/wall junctions
- cladding reinstated to apartment 4A on completion of the above work
- remediation of existing timber framing to external walls and re-cladding of apartments 4B and 4C to match apartment 4A.

2.2.2 This determination considers the recladding work to apartments 4B and 4C.

2.3 The cladding system

2.3.1 The new cladding system is installed over the remediated existing external walls where the timber studs are at 600mm centres maximum. The structural battens are to be installed at 600mm centres maximum, to align with the timber studs spacing.

2.3.2 The proprietary cladding is a negative expressed joint cladding system consisting of a rigid air barrier, weather seal tapes, horizontal joint socket and façade panels fixed to proprietary structural fibre-cement-based battens which form a cavity between the panels and the rigid air barrier. The facade cladding panels are 9mm thick medium density fibre-cement sheets and the 19mm thick x 70mm wide structural battens are provided by the cladding manufacturer.

The consultant's technical specification

2.3.3 The consultant's technical specification accompanying the building consent application stated the following:

> PERFORMANCE, WIND
>
> The design wind pressures are to AS/NZS 1170.2[5]. [The manufacturer's] technical specifications are suitable for these conditions. Refer to technical specification to check the wind pressure limits.

[4] Exterior insulation and finishing system

[5] Australian/New Zealand Standard AS/NZS 1170.2:2011 Structural design actions – Part 2: Wind actions

Up to:

- 2.5kPa ULS [proprietary] panel on [proprietary] structural cavity batten...

2.3.4 The consultant's technical specification provided a general description of the panel as a product, noting that it was manufactured to AS/NZS 2908.2[6], was tested to AS/NZS 4284[7] for weathertightness, and BRANZ appraised (refer paragraph 2.3.6).

The manufacturer's technical specification

2.3.5 The manufacturer's technical specification covers the use of the cladding system on buildings where the maximum wind pressure on the façade is up to 2.5kPa ULS.

The BRANZ Appraisal

2.3.6 The proprietary cladding system has a BRANZ Appraisal[8] ("the appraisal"), which includes the following limitations in scope and relevant requirements:

- Maximum wind pressures for structural and weathertightness design to be:
  - 1.5 kPa ULS and 1.0 kPa SLS for studs at maximum 600mm centres
  - 4.5 kPa ULS and 3.0 kPa SLS for studs at maximum 400mm centres.
- Limited to residential buildings within scope of E2/AS1, which covers buildings with 'a maximum height from ground to eaves of to 10m'
- All buildings incorporating the cladding system to be subject to specific engineering and weathertightness design. Designers will be responsible for the frame design and for the incorporation of the cladding system in accordance with the manufacturer's instructions.
- Window and door joinery installations in the cladding system to be subject to specific weathertightness design. The appraisal relies on joinery being subject to specific engineering design with regards to wind load and deflection for the design wind pressures.

3. Background

3.1 The consultant attended a pre-consent application meeting with the authority on 8 August 2014, with the advice notes stating the following:

19. Reclad application shall include:

    19.1 A completed [authority] agreement to provide a quality assurance programme on completion of the building work form, and

    19.2 A project specific quality assurance programme specifically outlining methodology for reconstruction of the building for each elevation …

31. Buildings over 10m high are outside the scope of New Zealand Standard NZS 3604[9], and Acceptable Solution E2/AS1. Specific engineering and weathertightness design shall be submitted e.g. wind pressure calculations, framing structural requirements etc.

32. Buildings incorporating façade cladding systems are subject to specific weathertightness and engineering design in order to demonstrate compliance with the [Building Code]. Application shall include supporting producer statement (PS1/PS2). Compliance with AS/NZS 4284 to be demonstrated.

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6 Australian and New Zealand Standard AS/NZS 2908.2 Cellulose-cement products - Flat sheets
7 Australian and New Zealand Standard AS/NZS 4284:2008 Testing of building facades
8 BRANZ Appraisal No.467 (2005) amended 30 August 2013
9 New Zealand Standard NZS 3604:2011 Timber framed buildings

3.2 The alternative solution facade report

3.2.1 As part of the building consent application lodged on 4 December 2014, the consultant provided a report on the proposed facade panel system ("the alternative solution report"), which reviewed project documentation to assess compliance of the wall cladding system with relevant performance requirements of the Building Code.

3.2.2 The report included the following comments (in summary):

- A 'peer review process' would be undertaken by the cladding manufacturer during construction, with a producer statement provided on completion verifying that the cladding was installed in accordance with instructions.
- Although the wind zone of the building falls within the scope of 'normal compliance documents', the building's size and location is beyond that scope and a specific review of the facade system is therefore required.
- The building falls within the design parameters nominated by the cladding manufacturer and the cladding system has been designed accordingly.

3.3 The first engineer's report

3.3.1 The consultant's report attached engineering calculations, which included design and wind pressure calculations for the wall cladding system (see Table 2 below, with maximum values highlighted and shown in bold):

Table 2: The first engineer's wind calculations

Maximum pressures	Positive wind pressures (kPa)	Negative wind pressure (kPa)	Design wind pressure (kPa)
Within 2m of corner	**1.10 ULS 0.70 SLS**	**-1.40 ULS -0.90 SLS**	**0.72 ULS 0.49 SLS**
Main body of wall	0.80 ULS 0.50 SLS	-0.70 ULS -0.50 SLS	
Design wind speed			34.7m/s (ULS) max. 28.50m/s (SLS) max
Design wind zone			Medium
Height above ground			24 metres

3.4 Requests for further information

3.4.1 On 21 January 2015 the authority wrote to the consultant with a request for further information ("RFI"), including that the alternative solution report should be 'signed by both the author and peer reviewer'.

3.4.2 On 3 February 2015 the authority wrote to the consultant regarding the alternative solution report, noting that the authority was unable to be satisfied on reasonable grounds as to compliance with the Building Code and setting out a number of comments in relation to the report's content. On 19 February 2015 the consultant responded to the RFI of 21 January, noting an intention to address cladding issues.

3.4.3 In a letter dated 2 March 2015 the authority advised the consultant of items from the RFI that were resolved, noting the remaining outstanding cladding issues, which the consultant addressed in a letter dated 3 March 2015.

3.4.4 On 16 March 2015 the authority wrote to the consultant with a request for further information, noting that the use of the verification method E2/VM1 was restricted to buildings up to 10m in height, and requiring a façade engineer's confirmation that wind pressures would be no greater than those in NZS 3604 or E2/VM1.

3.5 The second engineer's report

3.5.1 The consultant engaged another civil and structural engineering consultancy ("the second engineer") to undertake more detailed wind pressure calculations for the building. The second engineer provided the consultant with a report dated 1 July 2015 which considered individual elevations of the upper two levels of the building, zoning each elevation as follows:

- Area A: 2.8m from outer corners
- Area B: 2.8m from inner corners
- Area C: Main body of wall (remaining wall)

3.5.2 The report included design and wind pressure calculations for the wall cladding system on each face of the building. I have derived the associated SLS figures using the engineer's calculated SLS/ULS ratios and include these within Table 3 (below) with maximum values highlighted and shown in bold:

Table 3: The second engineer's wind calculations

Maximum pressures	**Positive wind pressures**				**Negative wind pressures**			
Elevations[10]	North	East	South	West	North	East	South	West
Area A (outer corners) (ULS kPa) (SLS kPa)	 **1.36** 0.94	 0.85 0.59	 0.65 0.42	 1.04 0.71	 -1.12 -0.77	 **-1.47** -1.01	 **-1.12** -0.73	 **-1.47** -1.01
Area B (inner corners) (ULS kPa) (SLS kPa)	 **1.36** 0.94	 0.85 0.59	 0.65 0.42	 1.04 0.71	 -0.84 -0.58	 **-1.10** -0.76	 **-0.84** -0.55	 **-1.10** -0.76
Area C (main body) (ULS kPa) (SLS kPa)	 **1.36** 0.94	 0.85 0.59	 0.65 0.42	 1.04 0.71	 -0.56 -0.39	 **-0.73** -0.50	 -0.57 -0.37	 **-0.73** -0.50
Design wind pressures (ULS kPa) (SLS kPa)	 **1.13** 0.78	 0.71 0.49	 0.54 0.35	 0.86 0.59	 1.13 0.78	 -0.71 -0.49	 -0.54 -0.35	 **-0.86** -0.59
Design wind speed (ULS kPa m/sec max) (SLS kPa m/sec max)	 **43.40** 35.96	 34.40 28.50	 30.00 24.22	 37.80 31.32	 **43.40** 35.96	 34.40 28.50	 30.00 24.22	 37.80 31.32

3.5.3 I note the highest positive wind pressures calculated by the second engineer apply to the north wall of apartment 4A, which was re-clad in 201l and will remain unchanged. For east, south and west walls that are being re-clad, maximum wind pressures are the highlighted negative values. In contrast, the expert's recalculated values show highest positive and negative values apply to the south and west elevations as shown in Table 5 (see paragraph 6.5.3).

3.6 The third engineer's facade report

3.6.1 The consultant engaged a structural and facade engineer ("the third engineer") to review documentation and wind pressure assessments and to provide an opinion on the compliance of the proposed wall cladding system with Clause E2 of the Building Code as an alternative solution. The third engineer described the proposed construction and reviewed the documentation and calculations provided to date.

[10] Sheilding applied to North, East and South faces

3.6.2 The third engineer noted that the cladding manufacturer had fulfilled requirements for assessing the cladding system in accordance with the following key aspects of the relevant standard AS/NZS 4284 (in summary):

- The facade cladding to be designed as a complete system.
- Test samples and components to be representative of the building facade.
- Materials of the test samples to be same type, size, method of construction, details, flashings and fixings as the building facade.
- Tests to include water penetration, structural SLS and strength ULS testing.
- Testing to be undertaken by an accredited testing facility.

3.6.3 The third engineer summarised the calculations carried out by the first and second engineers, analysing maximum wind pressures as follows (I have included associated SLS figures within the table):

Table 4: The third engineer's analysis

Wind analysis		**Maximum corner wind pressures**	**Maximum main body wind pressures**
Non-directional wind	(ULS kPa) (SLS kPa)	1.10 0.70	0.80 0.50
North directional wind	(ULS kPa) (SLS kPa)	1.36 0.94	1.36 0.94
East directional wind	(ULS kPa) (SLS kPa)	**-1.47** -1.01	-1.10 -0.76
South directional wind	(ULS kPa) (SLS kPa)	-1.12 -0.73	-0.84 -0.55
West directional wind	(ULS kPa) (SLS kPa)	-1.47 -1.01	-1.10 -0.76
Maximum governing wind pressures (negative pressure)			**-1.47**
Maximum allowable wind pressure per manufacturer's testing[11]			**±2.50**

3.6.4 The third engineer also reviewed documentation against the performance requirements of Clause E2 and the Verification Method E2/VM1 and noted the satisfactory performance of the cladding system used in similar projects and locations, including that installed to Apartment 4A in the same building in 2011.

3.6.5 The third engineer recommended that construction monitoring be provided to ensure that 'all construction details are successfully applied on-site' and concluded that:

> ...[the cladding system] used as an alternative solution for the proposed re-clad at apartment units 4B & 4C will establish compliance with the objective, functional requirement and performance of the NZBC Clause E2.

3.7 The building consent and conditions

3.7.1 The consultant provided the second and third engineers' reports to the authority and on 10 September 2015 the authority advised the consultant that 'the report for E2 can be accepted'. The authority noted that the report referred to construction monitoring to confirm compliance and asked the consultant to confirm who would be responsible for monitoring the cladding work. The consultant responded on 15 September 2015, advising that the consultant would undertake construction monitoring and provide a producer statement.

[11] Based on installation on the proprietary structural battens

3.7.2 The authority issued the building consent, No. B/2014/14852, on 24 September 2015. In an attached schedule of inspections and documentation required, the authority included PS3 – Producer Statement Construction for the rigid air barrier and the installation of the cladding, along with a PS4 – Producer Statement Construction Review for the cladding installation together with observation records.

3.8 The determination applications

3.8.1 On 13 October 2015 the Ministry received an application for determination # 2794 from the consultant on behalf of the owners regarding the building consent issued with requirements for construction monitoring and certification of the cladding system.

3.8.2 During the processing of the above application the authority asked for the scope of the determination to be expanded to address the matter of the authority's decision to grant the building consent. The consultant, on behalf of the owners, did not agree to the scope of the matter being amended.

3.8.3 On 7 July 2016 the authority applied for a separate determination (this determination #2860) on the exercise of its power of decision to issue the building consent, noting that this was in regard to the proprietary cladding system specified for the building work.

3.9 The initial submissions

3.9.1 The authority made no separate submission for this determination, noting that the matter was limited to the proposed cladding system specified for the building work covered by the building consent.

3.9.2 In the original application for a determination, the consultant had provided copies of the following documents that I consider are also relevant to this determination:

- the consent drawings
- correspondence with the authority
- copies of reports relevant to determination 2860 as listed in Table 1
- technical information and test data from the cladding manufacturer
- the BRANZ appraisal for the cladding system
- various other correspondence and information.

4. The architect's report

4.1 In determining the matter regarding conditions on the consent (determination #2794), I engaged an independent expert who is a registered architect to provide an opinion on the authority's requirements that a specialist façade engineer be engaged and the wind speed calculations peer reviewed. The expert provided a report dated 15 December 2015 which was forwarded to the parties on 16 December 2015.

4.2 The architect noted that his report was limited to the cladding design in order to address (in summary):

- the consent condition that the building work be monitored by a third party
- the adequacy of the consent application documentation

- the authority's requirement for a specialist facade engineer
- the authority's requirement for peer review of the wind calculations.

4.3 The architect made a number of observations that are relevant to the matter considered in this determination, and I summarise those as follows:

- The cladding system appears to be the standard proprietary system covered by the manufacturer's technical specification for maximum wind pressures of 2.5kPa (ULS).
- The building work does not fall within the parameters of either E2/VM1 or E2/AS1 due only to the limitation in scope to buildings up to 10m in height, with the outcome that 'this project is faced with the hurdles for the assessment of so-called alternative solutions'.
- Specific wind pressure calculations provided by the first engineer were subsequently calculated for each elevation by the second engineer. All were 'well below' the manufacturer's limit of 2.5kPa.
- Although variable, the first and second engineers' calculations confirm that site wind pressures are well within the manufacturer's parameters.
- There is no apparent risk or concern from the manufacturer's point of view in the use of this particular product for this particular project.

4.3.1 The architect noted that the wind speed calculations provided as part of the application 'seem nothing out of the ordinary' and that the peer review did not add any value as it simply repeated the calculation and did not comment on any differences but stated that the results were less than the maximum wind pressures allowable from the manufacturer.

4.3.2 Taking account of the size and nature of the building work and his assessment of relevant factors that must be considered in assessing the cladding system for the purpose of establishing compliance, the architect saw no need for a specialist facade engineer to be involved in the project.

4.4 The architect's conclusions

4.4.1 As far as the cladding is concerned, the design and documentation submitted with the consent were adequate for the purposes of processing this building consent.

4.4.2 The local wind pressures were well within the limitations identified by the manufacturer in the technical information (see Table 4), and together with the previous use of the cladding system on apartment 4A, the building consent 'should have been a relatively straight forward one to process with respect to compliance of the proposed cladding system'.

5. The fourth engineer's facade report

5.1 The authority engaged a facade engineer ("the fourth engineer") to review and respond to the architect's report and provide an opinion on the matters relating to the façade cladding system. The fourth engineer reviewed the architect's report and the other documentation and provided a report dated 1 April 2016.

5.2 The fourth engineer made detailed comments on the architect's report, which the architect responded to (refer paragraph 6.8).

5.3 General

5.3.1 The fourth engineer commented on the steps involved in assessing a façade, noting that the assessor must then use their ‘experience and knowledge to fill in any gaps in the available information and make his assessment’, which may be positive or negative.

5.3.2 The fourth engineer considered that it was reasonable for the authority to require detailed monitoring by a third party because (in summary):

- The BRANZ appraisal requires ‘specific engineering and weathertightness design’, which was not included in the consent documents and which should have been carried out by a facade professional.
- A facade professional who understands specialist facade design is the appropriate person to carry out inspections and monitoring.
- An authority inspector is a generalist and therefore cannot properly assess the facade construction.

5.3.3 The fourth engineer noted that the architect’s report and the third engineer’s report both claim to be primarily concerned with weathertightness compliance. The fourth engineer concluded that neither the architect’s nor the third engineer’s report ‘have substantiated their conclusions’, and included the following comments (in summary):

- Required weathertightness performance must be determined then assessed against a confirmed weather performance rating, which can only be determined by prototype testing for a specific project.
- AS/NZS 4284 can be used to test any facade and its use for the subject facade was limited to ‘typical details’ and to set principles for junction design. None of the test reports adequately confirm performance of the specific facade.
- There is no cladding standard that requires testing of facades, so the proof of adequacy is the responsibility of the parties involved in a specific project. Without specialised knowledge to correctly assess limited information, it is reasonable to require the involvement of a specialist facade consultant.
- There is no evidence of performance rating of the metal joinery and associated junctions for the subject facade.

5.3.4 The fourth engineer reviewed the facade specification and commented that the most significant performance parameters for the subject facade are ‘design wind pressures and thermal, seismic and building movement effects, which impose displacements on the facade’. In regards to wind pressures the fourth engineer noted:

- The design wind pressures calculated by the first and second engineer appear ‘low as they do not consider that windows can be left open in a wind event’.
- The wind pressures noted in the facade specification ‘are also low and should not be used for facade design’.
- The second engineer provided only ULS pressures, but SLS pressures are required in facade design to assess deflections of major components and to derive the water penetration rating from the positive design pressure.

5.3.5 The fourth engineer considered that it was reasonable for the authority to require the engagement of a specialist facade engineer and to require the facade wind pressure calculations to be peer reviewed because ‘none of the facade design wind pressures were correct or complete’.

6. The expert’s report

6.1 As noted in paragraph 1.5.2, I engaged an expert to assist me who is a Chartered Professional Engineer (“the expert”). I requested the expert review the available documentation for the use of the specified cladding system and provide a report with respect to the appropriate design wind speeds and wind loading for the cladding.

6.2 The expert provided an initial report dated 19 August 2016, which was forwarded to the parties on the same day. Following responses, the expert provided an updated report on 21 September 2016, which was forwarded to the parties on 23 September.

6.3 Review of calculations

6.3.1 The expert calculated the side wall cladding wind pressures, finding that no values exceeded the maximum design wind pressures. However the expert also considered the different limits for different stud spacing called for in the appraisal as shown in Table 5 (see paragraph 6.5.3), noting:

- some values exceed the maximum limits for 600mm stud spacing (only in walls within 2.8m of building corners)
- all values are within maximum limits for 400mm stud spacing.

6.4 The expert considered reasons for differences between his calculations and earlier calculations, noting that:

- differences from the first engineer’s calculations resulted from the expert’s consideration of shielding and the application of internal pressure coefficients
- differences from the second engineer’s calculations resulted from the expert’s consideration of wind terrain category and the application of local pressure factors for cladding at building corners.

6.5 The expert’s updated calculations

6.5.1 In response to the expert’s report the first engineer contacted BRANZ seeking clarification of pressures stated in the appraisal and whether these referred to the differential between the exterior of the cladding and the wall cavity or between the exterior of the cladding and the interior of the building. The first engineer emailed the expert on 31 August 2016 to advise that the response from BRANZ was that the appraisal ‘used an internal pressure coefficient for the cavity = 0’.

6.5.2 The expert provided an updated report dated 21 September 2016, which noted the consultation with the first engineer and referred to a BRANZ Report[12] on design wind speeds that assumes internal pressure of zero where the internal walls are fully lined. The expert recalculated the design parameters for the external cladding (while maintaining the former values for checking wall framing).

[12] BRANZ Report (STS0888/1-V2) Face load pressure box tests of [a proprietary] aluminium weatherboard system

6.5.3 The expert recalculated the maximum wind pressures using an internal coefficient of zero that resulted in reduced negative design pressures (-1.3kPA (ULS) and 0.88kPa (SLS)), which were within all maximums specified in the appraisal Certificate for the cladding system.

Table 5: The expert's wind calculations

(Maximum figures highlighted and shown in bold)

Maximum pressures		**Positive wind pressures**				**Negative wind pressures**			
Elevations[13]		North	East	South	West	North	East	South	West
Area A (corners)	(ULS kPa)	0.87	0.92	**1.00**	**1.00**	-1.47	-1.56	**-1.70**	**-1.70**
	(SLS kPa)	0.59	0.62	**0.68**	**0.68**	-0.99	-1.06	**-1.15**	**-1.15**
Area B	(ULS kPa)	0.87	0.92	**1.00**	**1.00**	-1.10	-1.16	**-1.27**	**-1.27**
	(SLS kPa)	0.59	0.62	**0.68**	**0.68**	-0.74	-0.79	**-0.86**	**-0.86**
Area C (main body)	(ULS kPa)	0.87	0.92	**1.00**	**1.00**	-0.91	-0.96	**-1.05**	**-1.05**
	(SLS kPa)	0.59	0.62	**0.68**	**0.68**	-0.61	-0.65	**-0.71**	**-0.71**
Maximum design wind pressures						Wall framing		External cladding	
	(ULS kPa)	1.00				-1.70		**-1.30**	
	(SLS kPa)	0.68				-1.15		**-0.88**	
Maximum wind pressures per BRANZ Appraisal:									
Studs/battens at 600mm centres maximum					ULS	1.50 kPa			
					SLS	1.00 kPa			
Studs/battens at 400mm centres maximum					ULS	**4.50** kPa			
					SLS	**3.00** kPa			
Maximum wind pressure per manufacturer's testing[14]						±2.50			

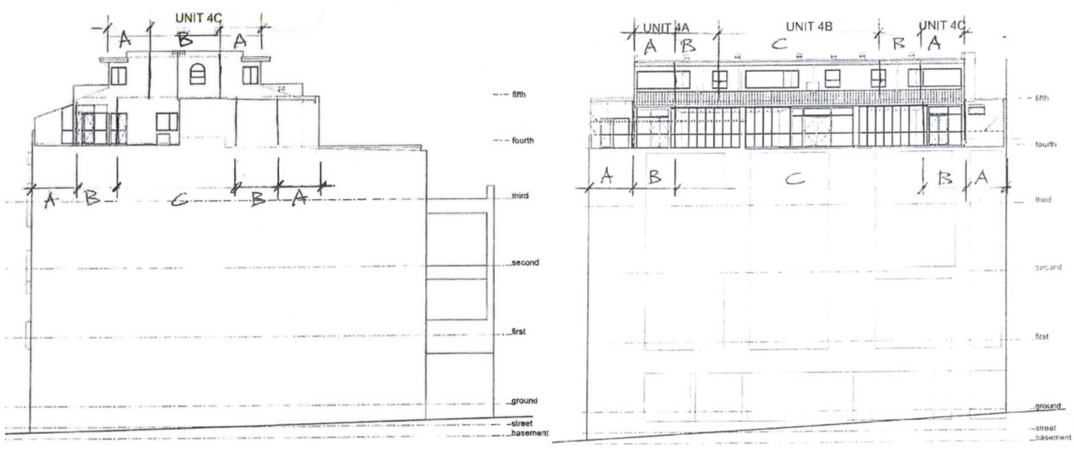

Figure 1: West and South elevations indicating Areas referred to in Table 5 above

6.5.4 In contrast to the second engineer's values shown in Table 3 (see paragraph 3.5.2), I note that the expert's calculations in Table 5 show the highest values for both positive and negative wind pressures apply to external walls of apartments 4B and 4C on the south and west elevations, which are to be re-clad.

[13] Sheilding applied to North, East , South and West faces

[14] Based on installation on the proprietary structural battens

6.6 Building displacements

6.6.1 The expert noted that the appraisal limited its scope to buildings where the maximum seismic displacement is 10mm, which is assumed to be an inter-storey drift displacement. Although compatible with deflection limits expected for NZS 3604 type structures, those limits may well be exceeded in multi-storey buildings including timber framed structures constructed on a reinforced concrete building.

6.6.2 The expert noted that in the case of the subject building work:

> ...because of the number of storeys and the change in building materials we are not able to verify if this condition is satisfied. The building would have to be modelled to establish inter storey displacements and that exercise is beyond the scope of this report.

6.7 The expert's conclusions

6.7.1 In regard to the wind pressures imposed on the cladding system, the expert concluded that:

> Considering the internal pressures are applied to internal wall lining only and the internal pressures in the cavity are zero, the design wind pressures for external cladding are within the maximums specified in [BRANZ Appraisal 467].

6.8 The fourth engineer's response

6.8.1 The fourth engineer responded to the expert's initial report and the authority forwarded his response to the Ministry on 9 September 2016. The engineer noted that the report did not consider the weatherproof performance of the cladding system and stated that:

> ...a full review of any cladding system must include a review of B1, B2 and E2, but this review considered only B1.

6.8.2 The fourth engineer included the following comments on the report (in summary):

- This was clearly a desktop study and the expert relies on BRANZ while giving no indication that he understands weatherproofing.
- The appraisal limits its scope to buildings up to 10m high, so the appraisal does not apply and any design or review must be on specific design.
- Values assigned to some inputs into the expert's analysis are challenged, such as the terrain category, shielding factors and no allowance for windows being left open in regard to internal pressures.
- The expert has no idea of the cladding system's capability to resist seismic racking and its effect on weathertightness and the manufacturer is 'equally ignorant' as no testing has been carried out.
- The expert could have given some indication of inter storey displacement from his experience, so it appears that he has no experience in AS/NZS 4284 testing including seismic racking and repeat air and water tests to determine the effect on weathertightness after racking.

7. The submissions made at a hearing

7.1 After receiving a draft of determination #2794 regarding the consent conditions, the authority requested a hearing be held on that matter; the authority did not accept the analysis or decision, and submitted that the opinion of their façade expert either had not been taken into consideration or had been disregarded in the determination.

7.2 On 13 October 2016 I held a hearing in Auckland. I was accompanied by a Referee engaged by the Chief Executive under section 187(2) of the Act, together with three officers of the Ministry. The hearing was attended by three officers of the authority, the façade expert engaged by the authority, the authority's solicitor, and two representatives of the consultant acting on behalf of the applicant. Prior to the hearing a preliminary draft of this determination was provided that set out the background and a summary of the various reports received.

7.3 Although the hearing had been called for, and was held in respect of determination #2794, there is an inherent relationship between the questions raised in this determination regarding compliance of the cladding system and the matter considered in #2794 regarding the conditions on the consent. The discussions during the hearing canvassed topics relating to the compliance of the cladding system relevant to this determination, and I have summarised the views put forward by the parties in the table below:

Table 6: Summarised views

General
Authority
The fourth engineer's report raises the question of whether there was enough evidence and material in the building consent application to be satisfied that the building work would comply. The authority cannot ignore the advice it received from the fourth engineer.
The evidence is same for both determinations, and there is an interrelationship of issues involved.
If determination #2794 removes the conditions on the consent, it then raises the issue of whether the consent can 'survive' – it is the authority's view that the consent cannot. Without the conditions included in the advisory notes the authority could not be satisfied as to compliance and would not have granted the building consent.
There is a difference of positions between various experts that must be reconciled in this determination. The authority provided its reasons for why the fourth engineer's assessment and conclusions should be preferred.
Information provided in support of the building consent[15]
Authority
The information provided was insufficient and was inadequate in regards to the cladding. The building consent was not relatively straightforward, and the application lacked the specific engineering and weathertightness design required.
Specific engineering and weathertightness design needs to be undertaken by a 'qualified façade specialist'.
There is a higher standard and quality of evidence required for an alternative solution – the height of the building being outside the Acceptable Solution was an indicator that the consent application needed a careful review.
The fourth engineer
The BRANZ Appraisal calls for specific engineering design.
The fourth engineer's review considered whether the information provided to the authority was adequate; if the information, including wind pressures were adequate and correct and could be relied on as being correct, there would be no reason for the authority to impose the conditions it did.
The fourth engineer is not concluding that the cladding system isn't compliant; the cladding

[15] Much of the discussion regarding the information provided in support of the building consent is covered in determination #2794

system *may* be adequate, but the information to establish this has not been provided. The reports didn't deal with weatherproofing at all; the air infiltration and water penetration ratings have not been provided, and no information on the capacity to resist these has been provided. The third engineer didn't put forward the right sort of analysis to establish compliance.
The engineers have relied on published data without considering how that data was derived.
Rather than reliance on the manufacturer's statement of compliance under wind pressures of 2.5kPa, a report is needed from a façade engineer that notes they have properly considered all of the issues (i.e. the E2/AS1 "gap analysis"), with analysis and justification and a PS2.
An adequate assessment would need to: - look at the available test reports and identify the gaps for the proposed use in the particular circumstances - carry out a comparison with the Acceptable Solution, and identify the gaps in the information - analysis by a façade engineer to establish whether the information is adequate and whether the identified gaps can be bridged - ideally the façade engineer would provide a PS2, undertake monitoring and issue a PS4.
The differences between the experts regarding wind loadings are not significant as they are all 'in the same ball park'. As an industry there is not enough testing and more work to be done there.
The consultant
The consultant acknowledged that façade engineering input and testing information was required when providing the information for the consent, but was of the view sufficient information had been provided. As well as reliance on the BRANZ appraisal and testing to establish compliance, the consultant engaged three engineers and & sought advice from the manufacturer and sought manufacturer's review of the design. The manufacturer has provided advice during the process, reviewed the drawings, and supported the use of the cladding system in this particular case. If the information provided was not acceptable to the authority, it would be difficult to know where to turn to for advice on this type of project.
The third engineer was a person on the authority's list of approved producer statement authors. Relevant code clauses are stated on the report. The third engineer is supposed to have understanding of weatherproofing, and the cladding manufacturer has given specific advice that they consider the cladding will perform to achieve compliance. However the consultant does disagree with the third engineer's view regarding monitoring
There is nothing about the building that sits outside of the parameters contemplated in E2/AS1 for standard NZS3604 buildings other than the height. The only reason the height becomes an issue is the wind pressures, and it was the consultant's view that this aspect was adequately addressed in the consent documents. The wind loadings are equivalent or similar to those covered by E2/AS1 for NZS3604 buildings, and the consultant believed they could rely on standard manufacturer's details.
The authority should be able to come to a view as to whether the cladding system is or is not compliant, rather than repeating that it *may* be compliant.
Compliance
The consultant
The history of the building should be taken into context – there were two isolated leaks in the existing EIFS cladding that were unrelated to the EIFS cladding itself, otherwise the cladding had generally performed from a weathertightness perspective. So suggestions that the building is subject to excessive loadings is not representative of what is seen from the in-service history of the existing EIFS cladding. In addition there is no evidence of leaks in the same proprietary cladding system that has already been consented and applied to apartment 4A – some level of assurance can be drawn from the in-service performance during this time (which is 1/3 of its durability period)
The consultant has been provided with test certification from the manufacturer (refer paragraph 7.5), including an AS/NZS4284 certificate that says the system has been tested to 2.5kPa; the consultant should be able to rely on the manufacturer's advice supported by

the testing. The AS/NZS4284 structural test was up to 2.5kPa (SLS) according to the certification, and along with the manufacturer's advice the consultant should be able to rely on the testing and the test certificate.
The maximum wind pressure the cladding system will be exposed to is 1.7kPa, which is still well below the test limit in AS/NZS4284.
The panel has been tested in accordance with the testing requirements in E2/VM1 – if the certificate is not accepted in this case it has wider implications. The sample used for testing was representative in terms of the detailing and features included in the sample panel.
The proposed use of the cladding system is no worse than that contemplated in E2/AS1 in regards to the RAB.
The consultant doesn't consider there was anything presented during the hearing that indicates the cladding is not compliant.
The fourth engineer
The most important parameters are structural adequacy (in effect resistance to wind pressure), weather resistance (including water penetration and air infiltration or air leakage), and seismic.
It is the RAB, rather than the cladding panel, that will resist the pressures when the cavity between the panel and the RAB equalises. The differential is across the RAB when the cavity pressure equalises. This was not addressed in the information provided. At 6mm thick the RAB has less than half the strength of the 9mm thick panel. It is the RAB that determines the strength of the system.
Design wind pressures The wind calculations reviewed to date don't give an adequate design wind pressure for this project. All of the design wind pressures from the structural engineers are low and do not address the fact that it is the RAB that is the critical element.
The fourth engineer disputes the use of Terrain Category 4 – City Buildings by the MBIE expert; the Terrain Category is High-density metropolitan, which is TC3.5. Which will give a roughly 5% increase in wind load. Internal pressure was not included in the pressure calculation from the MBIE expert on the basis that the internal lining will resist the pressure. Without confirmation of a detailed inspection of that internal lining being fully sealed this conclusion cannot be reached; a conservative view should be taken that the internal pressure will apply to the internal face of the cladding. The internal pressure calculation in the report of the MBIE expert is incorrect as it does not allow for windows being left open. Windows are often the only way to get air into the room and are left open in wind events.
Weatherproofing Only the first engineer's report referred to testing for weatherproofing, but that considered only water penetration and not air infiltration.
Testing & test certificates The test reports do not provide assurance that the cladding system will work in this case as they don't accurately reflect what is there; neither the cladding, nor the interfaces between the cladding and the windows, nor the windows and the doors. It cannot be accepted that test Certificate 423 is in accordance with AS/NZS 4284 – because: - the required test specimen drawings required by the Standard were not included - none of the reports provided show results for all of the tests required in AS/NZS 4284; there is nothing provided for weatherproofing - the specimen in the E2/VM1 test is the cladding panels nailed to a timber frame with some sort of sealing on the panels – whereas the building work subject to this determination is a cavity façade that consists of a timber frame, RAB, building wrap, battens and the cladding panels, so the test certificate provides no useful information in respect of this project - the sample in the E2/VM1 test was too small to be considered a 'reasonable representation'; for example there are no inter-story joints and the corners are too small; testing of an appropriately sized sample would require a larger test rig

- the test size parameters in E2/VM1 appear to provide for the use of smaller rigs, whereas there would be a limitation to testing given the lack of larger rigs in NZ; this is a "gap" that requires façade engineering input. - The analysis needs to cover these issues; for example that the RAB will work better than the building paper that is in the test, and calculations provided to show the RAB size is structurally adequate/backed with the BRANZ appraisal. The test reports provided are incomplete and irrelevant. The E2/VM1 is for residential, not multi-story. No ultimate test was applied in the AS/NZS4284 test: it should not state that the system works at 2.5kPa when it hasn't been tested at 2.5kPa.
Seismic serviceability The fourth engineer is of the view that testing should also include seismic serviceability test followed by a repeat water penetration and air infiltration tests to establish whether the seismic test has broken the seals. After a serviceability seismic event it should still be structurally adequate and should still exclude the weather to the requirement of the original specification for a period of 25 years. The RAB seals may be damaged in such an event, meaning the cladding may not be weatherproof after such an event - there is no research available on that. The cladding may be able to withstand a serviceability seismic event without damage, however this is not known at this time as the inter-story drift for this structure has not be determined. The requirement during a seismic event is that it be structurally adequate such that the cladding does not collapse/fall from the building (either outside or inside); it is possible that after the event it may need to be rebuilt.
The fourth engineer doesn't consider the cladding system easy to access/replace and so a 15 years B2 period is not appropriate.
Comparison with E2/AS1 and the "gap assessment" approach
There was a general discussion at the hearing regarding the limitation on use of the Acceptable Solution for buildings up to 10m in height, and that the significance of the height of this building being outside that limit needs to be identified and addressed in the consent application, namely: - a calculation for design wind pressure - there may be an impact of the wind load on the structure in terms of creating a greater degree of deflection and distortion on the structure - potentially greater moisture attack due to differences in wind driven rain at that height - whether the Acceptable Solution is inherently conservative - consideration in the analysis for how far from the limitations in E2/AS1 it is; at some point extrapolating from the compliance document is not sustainable. It was also acknowledged that as this is a timber building on top of a concrete building and not a timber building on the ground the accelerations in a seismic event will be different. This may not be relevant given the region for the subject building if comparison is made to a NZS3604 structure in the worst seismic region in New Zealand.
The consultant
Buildings designed to NZS3604 at ground level can also be outside the limitations of E2/AS1 for wind loads and pressures, and equally would require specific engineering design – so in this case there is equivalence in that consideration was required for the design wind pressures.
The pressures and loadings it is subject to are the same as a house on the ground which would be covered by E2/AS1. The wind loading in this case was not high enough to mean it fell outside the scope of the pressures within E2/AS1 that are contemplated in the wind zones[16] for NZS 3604 buildings
The consultant used the E2/AS1 weathertightness risk matrix for comparison: the risk score for this building was 21 – for a higher wind zone the risk score would have increased by two points, to 23.
The first engineer had provided advice on the inter-story drift under seismic load, which was that it was in the order of 30mm ULS and 8mm SLS per storey, which is about what timber framed bracing panels are estimated to deflect under seismic loading.

[16] Relevant to buildings up to three storeys or10m in height

The fourth engineer
The building is outside of E2/AS1, there is incomplete information, and it needs a façade engineer to fill in the gaps and sign a PS2 that the cladding is adequate.
The risk matrix table in E2/AS1 doesn't have value as it doesn't apply in this case.
It isn't appropriate to extrapolate the water penetration test, as it is not possible to know at what point it would fail.
The water load in testing is massive, the testing does take account of the wind driven rain at these heights. (Rain radiates at a point approximately 2/3 of the building height)

7.4 Two items of correspondence were tabled during the hearing:

- an email dated 25 January 2016 from the third engineer to the authority, which reinforced the engineer's view that construction monitoring was required to ensure proper installation of the cladding and that he considered this should be carried out by a 'registered façade engineer[17] or an experienced façade professional', and that the authority's inspecting officers 'are not qualified to perform any façade construction monitoring of any residential or commercial multi-storey projects of heights exceeding 10m … due to their ability to sign off Producer Statement Construction Review – PS4 certificates'
- correspondence dated September/October 2016 between the consultant and a technical support manager from the manufacturer. The manufacturer provided two test certificates (see paragraph 7.5 below) and stated that:

> This system has been tested in accordance with E2/VM1 as well as AS/NZS 4284. The system as per [an attachment] AS/NZS 4284 certificate states clearly that it is tested to 2.5kPa SLS. So I am not sure how [the fourth engineer] has concluded that the system is tested to just under the SLS pressures acting on this project.
>
> Considering the scope of the project and the information provided at the time, we confirmed the [cladding system panels] are suitable and product will be covered under our standard warranty. …
>
> I have also been to the site and [have] viewed few areas of the RAB board and [cladding] installation and based on this visual observation it appeared fine to me.

7.5 The consultant also tabled two test certificates from the manufacturer:

- Certificate Number 583 dated 3 December 2013: Weathertightness testing of the proprietary cladding on cavity battens in accordance with Verification Method E2/VM1
- Certificate Number 423 dated 4 November 2006: Testing of the proprietary cladding on cavity battens in accordance with AS/NZS 4284:1995

7.6 The consultant noted that if further information or analysis was required from a façade engineer for the purpose of reaching a decision in regards to compliance, it is likely there would be delays due to long lead-in times and general lack of availability of suitably experienced engineers.

7.7 After the hearing, on 25 October 2016 I sought further information from the consultant in regards to deflection and testing of the window joinery. The request was clarified further on 22 November 2016.

7.8 On 9 December 2016 the consultant provided further information from a structural engineer as follows (in summary):

[17] I note here that while there is a register of engineers in New Zealand and there are façade engineering societies, there is no formal qualification or register of façade engineers in New Zealand.

- The inter-storey deflections have been confirmed as less than 10mm specified for the cladding (copies of structural calculations and engineer's advice were attached). The consultant noted that seismic SLS loads govern over the wind loads.
- The joinery manufacturer reviewed the joinery against the wind speeds contained in the expert's report and confirmed that the windows supplied have sufficient structural strength. The manufacturer also provided test results to demonstrate that the joinery units have been tested to a Very High wind zone.

7.9 A draft determination was issued to the parties for comment on 12 December 2016. The consultant accepted the draft without comment on 14 December 2016. The authority accepted the draft on 27 January 2017 but noted their concerns about the weighting the Ministry gave their facade engineer ("the fourth engineer").

8. Discussion

8.1 In a draft of determination 2794 I have considered whether the authority correctly exercised its powers of decision in requiring independent construction monitoring and certification of the cladding system when considering granting the consent. In making that decision I have to consider whether there was sufficient information provided in the building consent application, and available to the authority as part of its own inspections, without the independent construction monitoring and the certification for the cladding system to allow the authority to be satisfied on reasonable grounds that the building work would comply with the relevant clauses of the Building Code if the building work was carried out in accordance with the plans and specifications.

8.2 In response to a draft of that determination, the authority sought the opinion of the fourth engineer on the matters relating to the façade cladding system. Consequently the authority reviewed its decision to grant the building consent with regard to the effect of wind pressures that are likely to be imposed on the proposed wall cladding system. The authority then applied for this determination.

8.3 For the purpose of this determination I do not revisit the issue of the adequacy of the information provided in the building consent application; however I have taken into account all of the information that has been provided to date, as set out in paragraph 1.5, in considering whether the cladding system installed as proposed will comply with the Building Code and whether the authority's decision to issue the building consent, in respect of the compliance of the cladding system, should be confirmed or reversed in accordance with section 188 of the Act.

8.4 Compliance

8.4.1 Establishing whether a cladding system complies with the Building Code in a particular case can be done by considering one or more of the following:

- a comparison with an Acceptable Solution
- an assessment of weathertightness risk for the building concerned
- a technical assessment of the product and the construction details
- the quality control procedures to be followed in the cladding's installation.

8.4.2 In evaluating the design of a building it is common practice to make comparisons with the relevant Acceptable Solution[18], in this case E2/AS1. In making a comparison with E2/AS1, it can be taken into account that some Acceptable Solutions are written conservatively to cover the worst case scenario.

8.4.3 Paragraph 1.1 of E2/AS1 states:

> The scope of this Acceptable Solution is limited to the materials, products and processes contained herein, for buildings with the scope of NZS 3604, and;
>
> a) up to 3 storeys with a height measured from lowest ground level adjacent to the building to the highest point of the roof (except for chimneys, aerials and the like) of 10 m or less…
>
> Where buildings are based on NZS 3604 but require specific engineering design input, the framing shall be of at least equivalent stiffness to the framing provisions of NZS 3604.

8.4.4 In turn, section 1.1.2 of NZS 3604 states:

> NZS 3604 shall only apply to buildings within the following limits: …
>
> The total height from the lowest ground level to the highest point of the roof up to 10m; …
>
> The building wind zone determined from 5.2.1 and table 5.1 shall be Low, Medium, High, Very High or Extra high (i.e. L, M, H, VH or EH). Specific engineering design (SED) in table 5.4 indicates the application is outside the scope of the Standard.

8.4.5 Paragraph 1.2 of E2/VM1 states:

> The scope of this Verification Method shall be restricted to buildings that:
>
> a) are in accordance with the scope of Paragraph 1.0 of E2/AS1, and within the wind zones covered by section 5 of NZS 3604, and
>
> b) have claddings that include a drained and vented cavity of nominal 20 mm minimum depth with minimum ventilation opening of 1000 mm2/m at the foot, including any claddings that require a rigid wall underlay in accordance with Paragraph 9.1.7.2 of E2/AS1, and
>
> c) include window and door units that are manufactured to comply with the relevant requirements of NZS 4211[19], and
>
> d) may include buildings based on (a), (b) and (c) above, but with specific engineering design frame elements of at least equivalent stiffness to the framing provisions defined in NZS 3604.
>
> This Verification Method may also be used for individual buildings that comply with (a) to (d) above, and that are designed for specific wind pressure up to a maximum ultimate limit state (ULS) of 2500Pa.

8.4.6 E2/AS1, NZS 3604 and E2/VM1 are all intended for buildings of a similar scope, generally limited by a maximum height of 10m and a wind zone not exceeding EH, although E2/VM1 also may be used for buildings whose ULS wind pressure does not exceed 2500 Pa (2.5 kPa).

8.4.7 In this case the building falls outside the scope of the Acceptable Solution E2/AS1 and Verification Method E2/VM1 due to the fact that the building is approximately 24m in height. The compliance of the cladding may therefore be considered in terms of the effect of that difference in height, and whether there is sufficient information

[18] An Acceptable Solution is a prescriptive design solution approved by the Ministry that provides one way, but not the only way, of complying with the Building Code. The Acceptable Solutions are available from the Ministry's Website at www.building.govt.nz.
[19] New Zealand Standard NZS 4211 Specification for performance of windows

to establish that the cladding will comply notwithstanding that difference, or whether there are any mitigating features in the proposed use of the cladding system that compensate for it being a higher building.

8.4.8 The characteristics of this building and the proposed cladding system include:

- the maximum design wind pressures are 1.7kPa
- the framing is at 600mm centres
- the cladding is to be constructed over a cavity that will provide ventilation and drainage of trapped moisture
- any external wall framing remaining will be treated with a site-applied preservative, and any new framing is treated to a level that provides resistance to the onset of decay if the framing absorbs and retains moisture
- the results of the proprietary cladding system being tested in accordance with AS/NZS 4284 and E2/VM1
- the results of the proprietary joinery being tested in accordance with NZS 4211[20]

8.4.9 At the hearing, the technical discussion identified that the following matters could be considered when comparing the weathertightness behaviour of a two storey building at ground level against the weathertightness behaviour of an identical building constructed on top of an existing three storey building:

- The wind pressures on the cladding.
- The quantity, speed and direction of wind driven rain that wets the façade.
- The amount and nature of deformations – i.e. structural deflections within structure to which the cladding will be attached, given that it is supported by a suspended concrete floor within a building, rather than at ground level, on a potentially much more rigid foundation.
- The potential effects on people if any part of the cladding can fall during an ULS seismic event.

8.4.10 When considering the effects of wind on the cladding, various analyses of the SLS and ULS wind speed and wind pressure on cladding elements have been presented, and their accuracy and relevance have been discussed at length by the various experts.

8.4.11 Although, strictly speaking, wind zones are only defined for buildings of up to 10m in height, it is useful to assess whether the effects of wind on this building are no worse than the effects on an otherwise similar building at ground level located within a more severe wind zone.

8.4.12 One of the effects of an increase in building height is an increase in the area of a building face that could be affected by extreme localised pressures. In AS/NZS 1170.2, the local pressure factor (K_l) varies with height (h).

8.4.13 Although there are some differences of opinion between the various engineers, none calculated the maximum ULS wind pressure on cladding elements to be higher than

[20] The testing was undertaken in 2006 and 2009 to New Zealand Standard NZS 4211:1985 Specification for performance of window and NZS 4211:2008 respectively.

1.7 kPa. If a non-conservative estimate of the effects of internal pressure is taken, this figure would be lower.

8.4.14 Wind pressure is a function of basic wind speed and also factors such as building shape, location of the cladding element on the building, and whether and to what extent the interior of the building will be affected by wind entering through deliberate or inadvertent openings in its envelope.

8.4.15 For an indication of the wind zone that would result in a ULS wind pressure of approximately 1.7 kPa on a cladding, a number of sources of information are available, including:

- NZS 4211 Table 5, which states that windows intended for use in a VH wind zone must pass a ULS strength test at a test pressure of ±1.76 Pa. A window in a façade would be subject to whatever internal pressure effects occurred within the room in which it is located, and NZS 4211 makes allowance for the action of internal pressures.
- The BRANZ appraisal for the RAB used in the proposed cladding system, which states that the RAB can be used with studs at 600mm centres under wind pressure "≤ 1.5 kPa ULS (NZS 3604 Wind Zone Very High)". BRANZ has advised the consultant that it considers an internal pressure co-efficient ($C_{p,i}$) of zero is appropriate for walls which use their RAB product, as these will have an internal lining shielding the internal face of the RAB from the effects of internal pressure.

8.4.16 A conservative interpretation of the above discussion is that, if internal pressures do not act on the facade, the ULS wind pressures are unlikely to be worse than 1.4 - 1.5 kPa. If internal pressure do act on the façade, ULS wind pressures are unlikely to be worse than 1.76 kPa, This means that the façade is exposed to winds that are no more than the equivalent of a VH wind zone on a building at ground level.

8.4.17 It therefore follows that, where the effects of wind pressure on the cladding are being considered, a design solution appropriate for a VH wind zone on a building at ground level will be adequate for this building. I note that this assessment of wind effects is in relation to the façade design and is not intended to compare performance for structural design.

8.4.18 The fourth engineer stated at the hearing that he does not believe enough information was provided in the building consent application documents to assume that an internal pressure co-efficient of 1.0 is appropriate when considering whether the RAB is exposed to internal pressures. There may be parts of the façade where such shielding is not effective, such as unlined areas or where services penetrations perforate internal linings.

8.4.19 For analysing the cladding of this building, the internal pressure is relevant when considering stud spacing and the support of the RAB during wind pressure. Where the RAB is well supported, the manufacturer's and the BRANZ appraisal state that it is capable of performing in much higher wind conditions.

8.4.20 An analysis of the drawings shows in any areas of new cladding to walls that are unlined the RAB will be directly supported by horizontal framing members or blocking between studs. In other words, the RAB will only be required to span the full 600 mm between studs in wall areas which have internal linings. The proposed linings are plasterboard with stopped joints. Linings of this nature, even if not perfectly airtight at services penetration, can act as an air barrier for buildings constructed to E2/AS1 (except for buildings in EH wind zones or unlined gable end walls where other forms of air barrier are required). These linings are therefore likely to shield the internal face of the RAB from the effects of internal pressure to an extent sufficient that it does not lose airtightness given the 600mm stud spacing, in the manner anticipated by the BRANZ appraisal of the RAB.

8.4.21 The actions of internal pressure do not vary with building height and this same consideration would occur for a building at ground level.

8.4.22 The proposed RAB in any case exceeds the minimum requirements of E2/AS1, which would allow a flexible underlay for buildings subject to the wind pressures that are expected to act on the cladding. Furthermore, where E2/AS1 does require a rigid underlay (including for claddings in EH wind zones), this may consist of 6mm fibre-cement sheet supported on studs at 600mm, as long as the depth of those studs is sufficient for them to resist the loads on the wall.

8.4.23 The technical discussion at the hearing also considered the quantity and direction of wind driven rain. The fourth engineer advised that he considers that the water load used in AS/NZS 4284 and E2/VM1 water penetration tests is likely to exceed that caused by wind driven rain on this building.

8.4.24 The consultant stated at the hearing that the first engineer had provided advice on seismic deflections of the building structure at the levels of the recladding work. The maximum deflections of 30mm ULS and 8mm SLS are in the order of those experienced by timber framed structures at ground levels. Because there is no suggestion that the supporting structure will flex or distort at its upper levels to a greater degree than if it was supported by a continuous foundation at ground level, it is not necessary for me to apply any scaling to this lateral deflection in making this evaluation. The maximum SLS seismic deflection as confirmed by the consultant (see paragraph 7.8) is also within the 10mm allowable amount recorded in the BRANZ appraisal, and within the span/250 allowable amount stated by the cladding manufacturer.

8.4.25 No information is available on the potential effects on people if any part of the cladding can fall on them during an ULS seismic event. There is also no requirement for testing this behaviour in E2/VM1. The consultant stated at the hearing that the building layout (with the upper level apartments being set back from the perimeter of the original structure) meant that in an ULS seismic event, people below these apartments would not be affected if any part of the cladding did fall. This appears to be the same result that would occur with a similar building at ground level.

8.4.26 The fourth engineer stated that no assessment of the suitability of the window and door joinery is available.

8.4.27 The E2/VM1 testing of the cladding system did include a small window intended to demonstrate performance of the window installation details (but not the window itself) at head, sill and jamb.

8.4.28 In New Zealand, NZS 4211 can be used to determine the suitability of windows for use at particular wind pressures or wind zones. Based on the discussion earlier in this section, I am of the view that where new windows are proposed, as these meet the NZS 4211 requirements for use in a Very High (VH) wind zone, they are appropriate for this building. I note the specification currently calls for windows adequate for an M wind zone: I suggest the proposal be amended to achieve VH performance levels.

8.4.29 Where existing windows are to be refurbished and reused, the building work proposed does not include providing a new window, although it does include re-installing the windows. Section 112 of the Building Act applies. The refurbished windows themselves can be expected to continue to comply to the same extent as they complied before the work started; the junctions with the cladding constitutes new building work and must comply to the extent required under section 17.

9. The decision

9.1 In accordance with section 188 of the Building Act 2004, I hereby determine that the proprietary cladding system installed as proposed will comply with the relevant clauses of the Building Code discussed herein; accordingly the authority correctly exercised its powers of decision in granting building consent no. B/2014/14852 and I confirm that decision.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 9 March 2017.

John Gardiner
Manager Determinations and Assurance