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Face load pressure box tests of the Flashman Bevelbord aluminium weatherboard system

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Face load pressure box tests of the Flashman Bevelbord aluminium weatherboard system

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2. INTRODUCTION

This report describes the face load pressure box testing performed on a FLASHMAN wall cladding system where the FLASHMAN Bevelbord aluminium weatherboard was screwed through battens to timber studs. The purpose of this testing was to determine the design level of differential pressure able to be resisted by the FLASHMAN Bevelbord wall cladding system.

Based on these test results, values for design wind speeds and wind pressures were calculated corresponding to the wind zones of New Zealand's timber framed building standard NZS 3604[1] and also wind zones specified in Australia's Residential timber-framed construction standard, AS 1684.2 [2].

This report, Version 2, only uses the results of the first two tests, as the specimen failure in the third test was due to failure of the timber studs which was not a function of any failure of the cladding.

3. LIMITATION

The results reported here relate only to the item/s tested.

4. DESCRIPTION OF TEST SPECIMENS

The test walls covered a nominal area of 2.4 m x 2.4 m and were constructed by the client.

The specimen size was selected to fit into the opening in the laboratory pressure chamber. The framing was constructed from 90 x 45 mm MSG8 radiata pine timber. Studs were at 600 mm centres and were affixed to the top and bottom plates with two 90 x 3.15 mm power driven nails. No nogs were used. 45 x 20 mm radiata pine battens were nominally fixed through the battens to the external face of the framing. Each specimen had a sheet of 250 µm plastic installed between the external face of the battens and the back face of the aluminium boards as shown in Figure 1 to Figure 3 to maintain air tightness without affecting specimen strength.

The framing was clad with FLASHMAN Bevelbord aluminium weatherboards. Each board was screwed to each stud with one Tek screw as shown in Figure 2 and Figure 4. The aluminium weatherboards have a nominal thickness of 2 mm and an overall width of 165 mm. The cross sectional details are shown in Figure 3 and Appendix B.

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A cut down portion of weatherboard was used at the top of the walls to close and seal the gap.

As can be seen in Figure 1, to help prevent failure of the studs and stud-to-plate connections, the following frame strengthening was used:

- A strong back was used at mid-height of the specimen to share the load between studs;
- Short lengths of dummy stud were fixed to the top of each stud. These extended past the top of the pressure box and thus stud shear load was partially transferred to the top of the pressure box via these dummy studs.
- A strong-back was used at the bottom of the specimen. This extended past the sides of the pressure box and thus stud shear load was partially transferred to the sides of the pressure box via this strong-back.
- These strong-back modifications were not considered to prejudice the conclusions reached in this report as the tests are intended to test the cladding and cladding fixings and not the framing.

5. TEST DESCRIPTIONS

5.1 Date and Locations of Tests

The tests were carried out at the Structures Testing Laboratory of BRANZ, Judgeford, Porirua during February and March 2012.

5.2 Test Equipment

The specimen was secured in an upright position within the front opening of an airtight pressure chamber with the aluminium weatherboards on the inside of the pressure box. The framing timber top and bottom plates were securely fixed to the perimeter of the chamber with Tek screws. The sides of each specimen were not fixed, but were sealed all around using the polythene sheet and adhesive tape so that the studs of the test construction could deflect without restraint from the side of the chamber.

Negative pressure (suction) was applied to the chamber using a centrifugal air pump. The fan speed was manually controlled during the test to the target cyclic loading regime.

The test pressure was measured with a manometer and the wall deflection was monitored during the test.

5.3 Test Procedure

The specimens were tested under negative pressure applied to the chamber shown in Figure 1 corresponding to “suction” on a building. The pressure was applied in increasing steps of 0.1 kPa. Each pressure step was held for one minute. The pressure was then released back to zero for 15 seconds before the next level of pressure was applied to the specimen. This test procedure is based on AS 4040.2:1992 [3].

6. OBSERVATIONS, RESULTS AND ANALYSIS

6.1 Specimen 1

The maximum pressure resisted for at least one minute was 6.3 kPa. The test was then stopped as this was the limit of the test equipment. At 3.9 kPa one stud failed at a knot (see Figure 6). A second stud failed at 5.9 kPa and some gaps were noted between battens and boards.

6.2 Specimen 2

The maximum pressure resisted for at least one minute was 6.3 kPa. No failures were noted in this test.

6.3 Specimen 3

The maximum pressure resisted for at least one minute was 5.0 kPa. At 5.1 kPa three studs failed (see Figure 5) which resulted in the test being stopped. This result is excluded from the analysis as the failure was not a function of the cladding system being tested.

6.4 Analysis

Appendix B of AS/NZS 1170.0[4] states that the design capacity is the minimum value of test results divided by the appropriate factor for variability (k_t). The value of k_t was taken as 1.64 from Table B1 of Appendix B of AS/NZS 1170.0 for two test specimen with a 15% variability as this value of variability was considered appropriate based on the test components used. The Ultimate Limit State (ULS) design differential pressure, p_d, is therefore given by p_d = 6.3/1.64 = 3.84 kPa.

7. DESIGN WIND SPEEDS

The analysis given below is only applicable to the exterior walls of buildings which for timber framed buildings falls within the scope of NZS 3604[1] and AS 1684.2[2]. These standards both assume:

- The interior of walls are fully lined and consequently wall cavity internal pressures are taken as zero in this analysis.
- The framing is separately designed for the design wind speeds calculated below.

The wind loadings are based on AS/NZS 1170.2:2002[5]. The design wind pressure, p, is given by Eq 2.4(1) of AS/NZS 1170.2 as:

$p = 0.6V_{des}^2 \times C_{fig} \times C_{dyn}$ (pascals)

where:
C_{fig} is the aerodynamic shape factor
C_{dyn} is the dynamic response factor = 1.0 for walls of a building.

The aerodynamic shape factor from Eq 5.2 of AS/NZS 1170.2 is given by:

$C_{fig} = C_{pe}K_aK_cK_LK_p$ for external pressures and $C_{fig} = C_{pi}K_aK_c$ for internal pressures.

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For houses maximum C_{pe} = 0.65 suction, K_a = 1.0, K_L = 2.0 within 0.5a of a corner and 1.5 within 1.0a of a corner, (where 'a' = 0.2 times the length of the wall), K_c = 1 for a single wall and generally K_p = 1.0.

Substituting these values gives the external pressure, p_e, on a wall as:

$p_e = 0.6V_{des}^2 \times 0.65 \times 1 \times 1 \times 2 \times 1 = 0.78V_{des}^2$ within 0.5a of a corner.

The internal pressure coefficient, C_{pi}, has been taken to be zero as discussed in the assumptions listed above and thus the internal pressure, p_i, on a wall = 0.

Thus, p_z = the differential pressure across the cladding, is given by:

$p_z = (p_i + p_e) = (0 + p_e) = p_e = 0.78V_{des}^2$

Hence, $V_{des}^2 = p_z/0.78$ ...... (1)

For a design differential pressure, p_z = **3.84 kPa,** as calculated in Section 6.4, the ultimate design wind speed is calculated from:

V_u^2 (pascals) = 3840/0.78, giving V_u = 70.2 m/sec.

As the design ultimate limit state wind speed for Extra High wind zones, as stipulated in NZS 3604, is 55 m/sec the cladding system tested is suitable for lined buildings complying with the scope of NZS 3604 in all NZS 3604 wind zones up to and including Extra High for stud spacing up to 600 mm and for construction as described in this report. The design ultimate limit state wind speed for wind classification N4 in Australia is stipulated to be 61 m/sec and thus the construction is also suitable for such wind zones.

8. CONCLUSIONS ON DESIGN WIND PRESSURES

The conclusions below assume that the framing is separately designed for the design wind loading and the construction is as described in this report.

The wall system for stud spacing up to 600 mm can be:

- designed for differential pressures up to 3.8 kPa
- used in wind zones up to and including Extra High for houses in New Zealand complying with NZS 3604:2011; and
- used in wind zones with classifications up to and including N4 for houses in Australia complying with AS 1684.2.
- used for buildings located where site wind speeds do not exceed 70 m/s.

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9. REFERENCES

(1) Standards New Zealand. NZS 3604:2011. Timber Framed Buildings. SNZ, Wellington, New Zealand

(2) Standards Australia. AS 1684.2 – 2006. Residential timber-framed construction. SA, Sydney, Australia.

(3) Standards Australia. AS 4040.2 – 1992. Method of testing roof and wall cladding. Method 2: Resistance to wind pressures for non-cyclone regions. SA, Sydney, Australia.

(4) Standards New Zealand. AS/NZS 1170.0:2011. Structural design actions. Part 0: General Principles. SNZ, Wellington, New Zealand.

(5) Standards New Zealand. AS/NZS 1170.2:2011. Structural design actions. Part 2: Wind actions. SNZ, Wellington, New Zealand.

Appendix A. Photographs of the wall components and construction

Figure 1. Test specimen in pressure box under high suction load. Note, curvature of studs.

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Figure 2. General view of metal cladding and cladding fixing

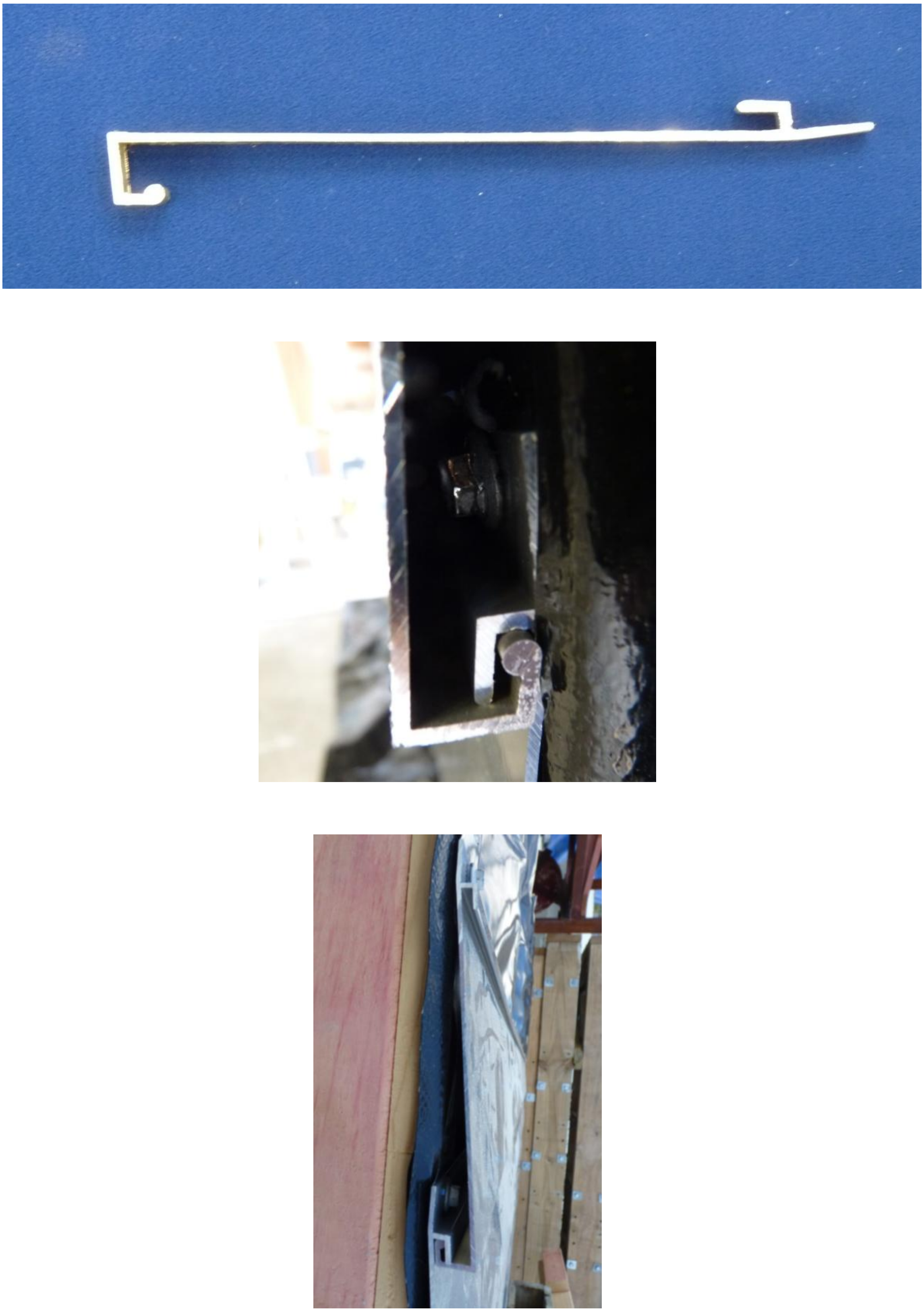


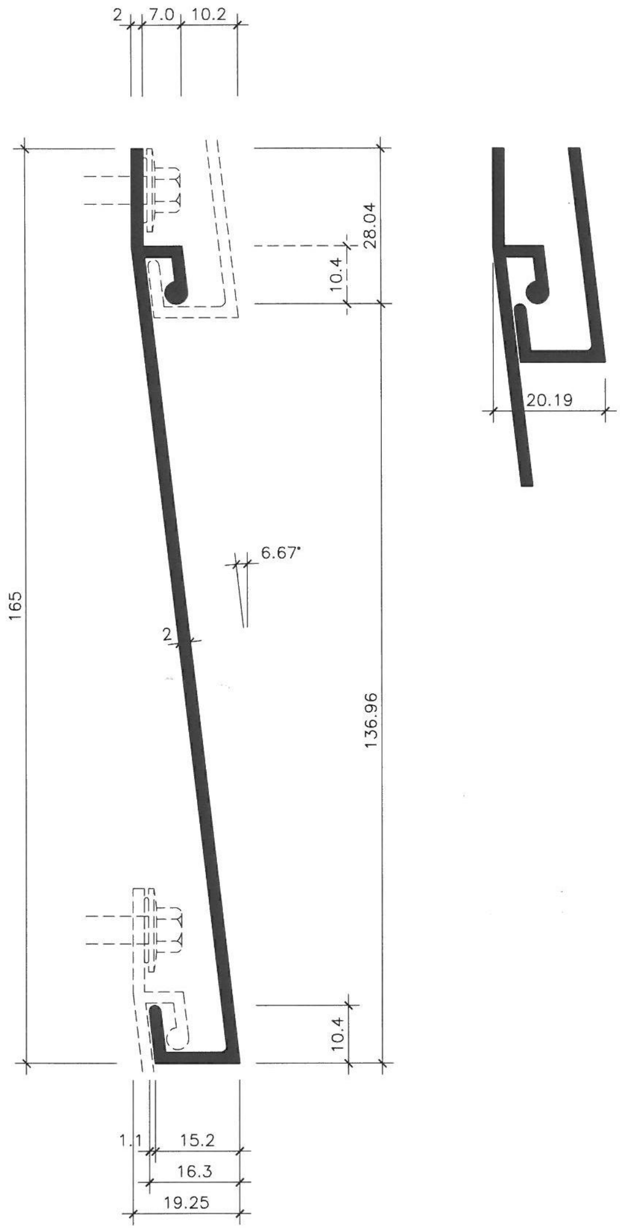
Figure 3. Sectional views through cladding

Figure 4. Tek screw used to fix cladding to timber framing. Measured overall length = 55 mm, 14 mm steel washer under hex head, 4.8 mm outside thread diameter

Figure 5. Failure of timber studs in Test 3.

Figure 6. Failure of timber stud in Test 1

Appendix B. Client supplied drawing



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