ST0791/1

Pull-through tests of anchors connecting Rockcote AAC panels to timber framing in the Rockcote wall cavity system

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   iii. any defects in the Products the subject of the Services; or

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Pull-through tests of anchors connecting Rockcote AAC panels to timber framing in the Rockcote wall cavity system

1. CLIENT

Rockcote Resene Ltd
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2. OBJECTIVE

To determine the characteristic pull-through strength of Rockcote anchors in nominal 50 mm thick autoclaved aerated concrete (AAC) for the Rockcote cavity wall system.

3. DESCRIPTION OF SPECIMENS

The products used are shown in a drawing of the test setup in Figure 1 and a photograph in Figure 2. The products were supplied by the client already assembled for the tests. The anchor was drilled through the Rockcote panel and batten and then anchored to the stud. The batten was not otherwise attached to the stud.

This report pertains to the products tested only. The products used for each test are described below.

- A 100 mm long, hot dipped galvanised steel anchor with an 14 mm diameter head. The anchor had a shank of 5.0 mm diameter, with the bottom 50 mm threaded with an outside thread diameter of 6.4 mm and it was designed to be self drilling in timber.
- An autoclaved aerated concrete panel with a measured density of 622 kg/m^3 and nominal dimensions 300 x 300 x 50 mm thick. A steel mesh with 3.2 mm diameter bars at nominal spacing of 180 mm in one direction and a single mid-width bar in the other directions was embedded centrally in the lightweight concrete.
- A polystyrene batten of dimensions 50 x 20 x 100 mm long.
- A radiata pine kiln dried timber stud of dimensions 90 x 45 x 100 mm long.

4. DESCRIPTION OF TESTS

4.1 Date and Location of Tests

The tests were carried out in August 2009 at the Structural Engineering Laboratory of BRANZ Ltd, Judgeford, New Zealand.

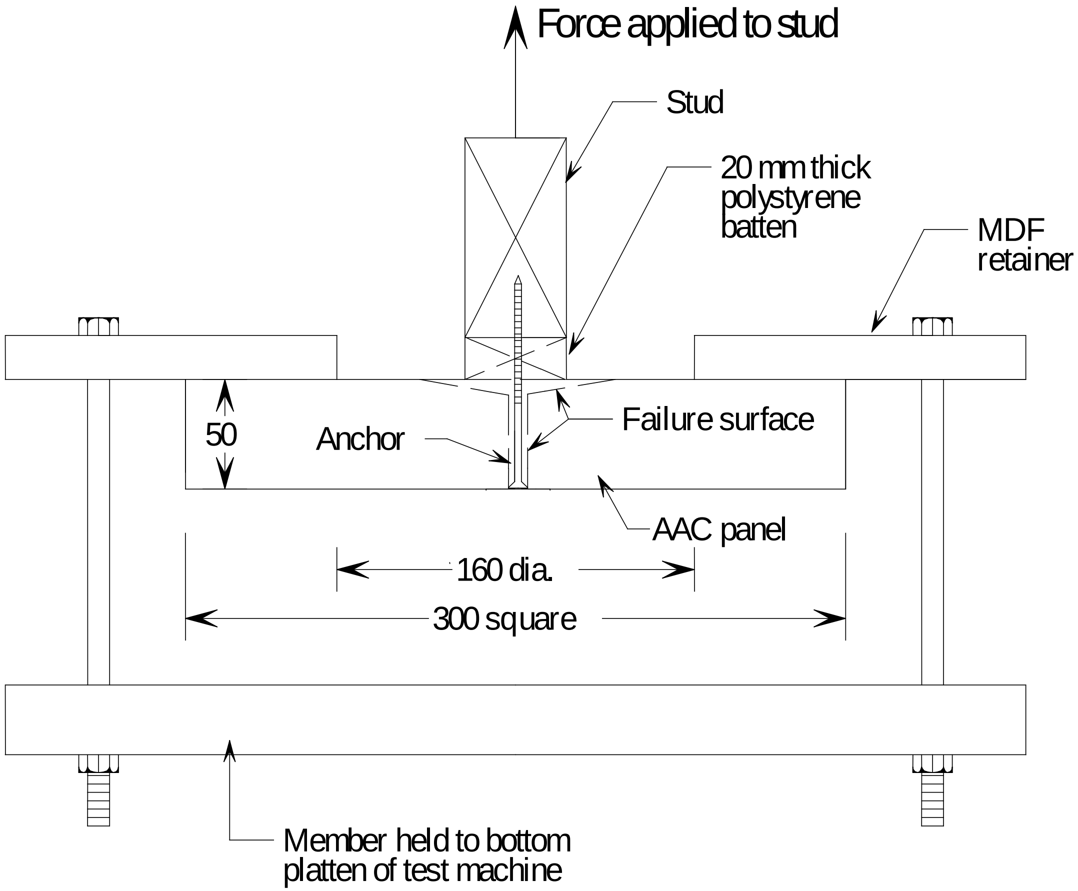

Figure 1. Cross section showing a schematic view of test setup, specimen construction and failure surface in the AAC

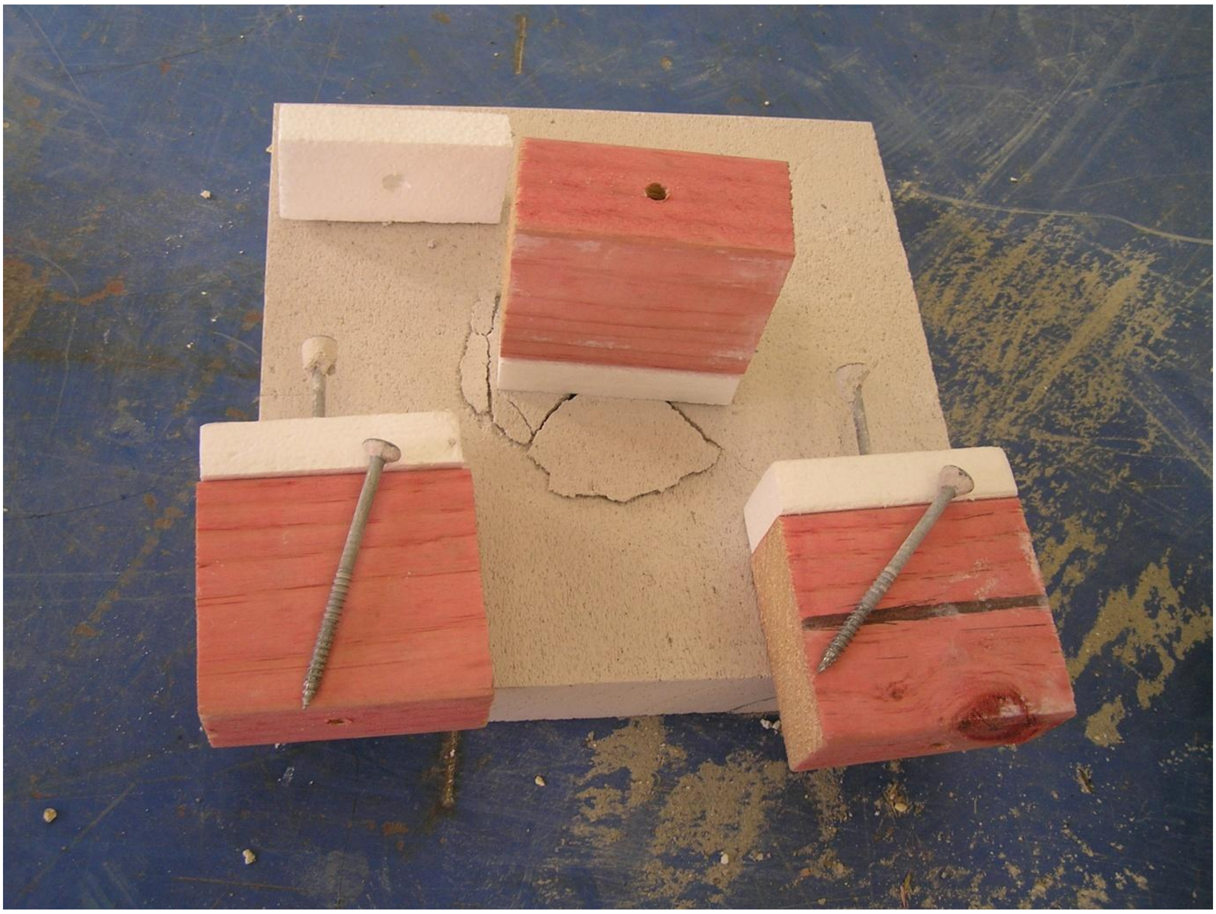

Figure 2 Products used. Photograph taken after testing.

4.2 Test Arrangement and Equipment

The tests were undertaken in a Dartec Universal testing machine. A view of the test setup is given in Figure 1 and Figure 3.

The test load was measured with a 10 kN loadcell calibrated to International Standard EN ISO 7500-1 1999 Grade 1 accuracy. The loadcell output was monitored on a datalogger which also recorded the test machine load and deflection.

4.3 Test Procedure

Each Rockcote panel was supplied fixed to the stud through the batten with an anchor. One end of an eyebolt was anchored into the stud and the other end was pinned to the load cell anchored into the upper platen of the test machine. The Rockcote panel was retained against the underside of a plate with a 160 mm diameter hole at its centre. This plate was fixed to the bottom platen of the test machine (see Figure 3).

The top platen was raised at a cross head displacement rate of 20 mm per minute until failure.

5. OBSERVATIONS

At peak load the anchor head crushed the Rockcote panel beneath leaving a cylindrical hole of the same diameter as the anchor head for most of the thickness of the Rockcote panel until a shallow cone broke out of the inside face as shown in Figure 1 and Figure 2.

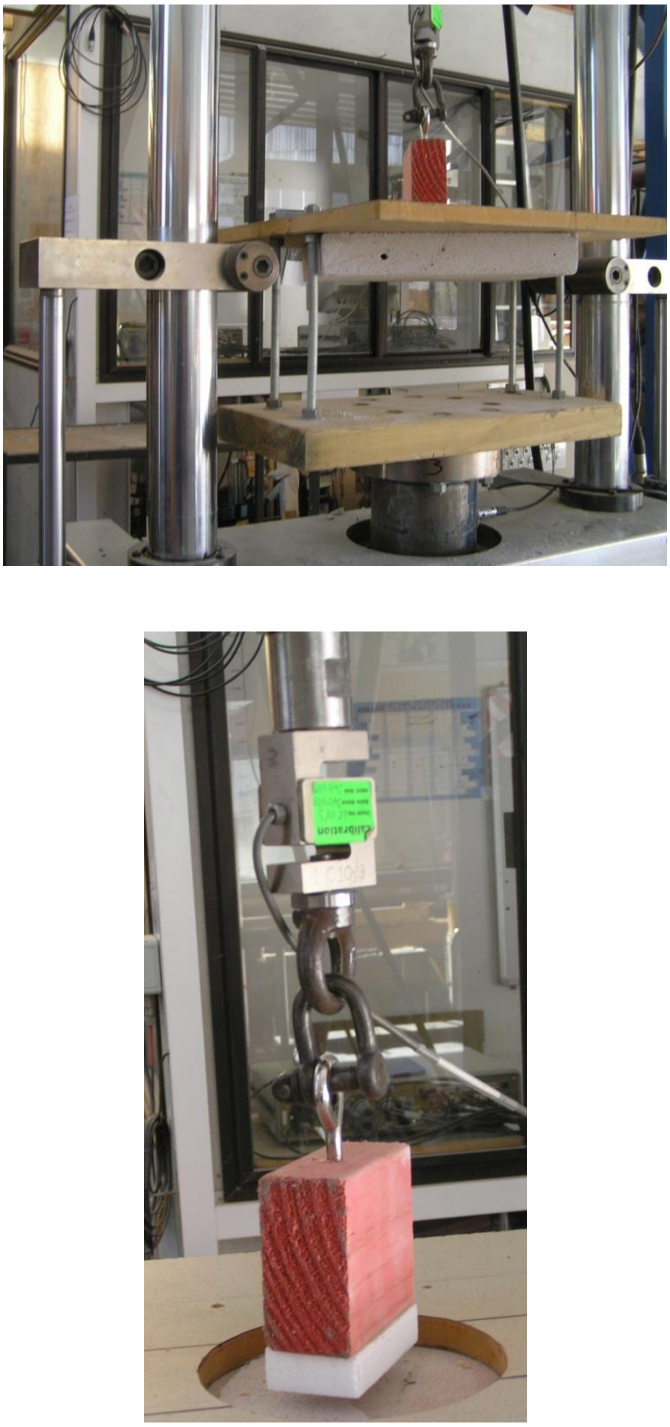

Figure 3 Test setup

6. RESULTS

The characteristic strength, determined using the procedure outlined in BRANZ Evaluation method EM1 [4] as shown in Appendix A, was 1.268 kN. The design strength of the Rockcote anchor fixing is taken as 0.7 times the characteristic strength = 0.7 x 1.268 = 0.888 kN where 0.7 is the strength reduction factor which was taken from Section 2.5 of NZS 3603:1993 *Timber Structures Standard* for "other fasteners". For anchor spacing of 300 mm and a stud spacing of 600 mm, this gives a design differential pressure of 0.888/(0.6 x 0.3) = **4.93 kPa**. Note, this only considers the fixing strength and not the ability of the sheet to span between fixings nor the required stud strength.

A typical load deflection plot from the pullout tests is given in Figure 4.

7. DESIGN WIND SPEEDS

The analysis given below is only applicable to the exterior walls of buildings which fall within the scope of NZS 3604[1]. It assumes:

- 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.

For design to NZS 3604, serviceability limit state is not a design criteria.

NZS 3604 wind loadings are based on NZS 4203:1992[2]. The basic ultimate wind pressure, q_z, is given by Eq 5.5.1 of NZS 4203 as:

$q_z = 0.6V_u^2$ (pascals)

The ultimate limit state design external wind pressure on the walls of a building, p_e, from Eq 5.6.3 of NZS 4203 is given by:

$p_e = C_{pe}K_aK_LK_pq_z$

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) and generally K_p = 1.0.

Substituting these values gives: $p_e = 1.3q_z$ within 0.5a of a corner.

The internal pressure, p_i, has been taken to be zero as discussed in the assumptions listed above. Thus, the ultimate design wind speed is calculated from:

V_u^2 (pascals) = 4930/(1.3 x 0.6), giving V_u = 79.5 m/sec. .... (1)

If the cladding is used for a fully lined building in a Very High wind zone the basic ultimate limit state wind pressure = 1.50 kPa (from Shelton, [3]). From NZS 4203:1992 the serviceability limit state (SLS) basic wind pressure = $(\frac{0.75}{0.93})^2$ x 1.5 = 0.976 kPa. The corresponding SLS design differential pressure for lined buildings complying with NZS 3604 = 1.3 x 0.976 = 1.27 kPa. For fasteners at 600 x 300 mm spacing, this represents a force of 1.27 x 0.6 x 0.3 = 0.229 kN. From Figure 4 fasteners will displace 0.461 mm at this load. It is possible that slight plaster cracking may occur at this serviceability level wind load displacement.

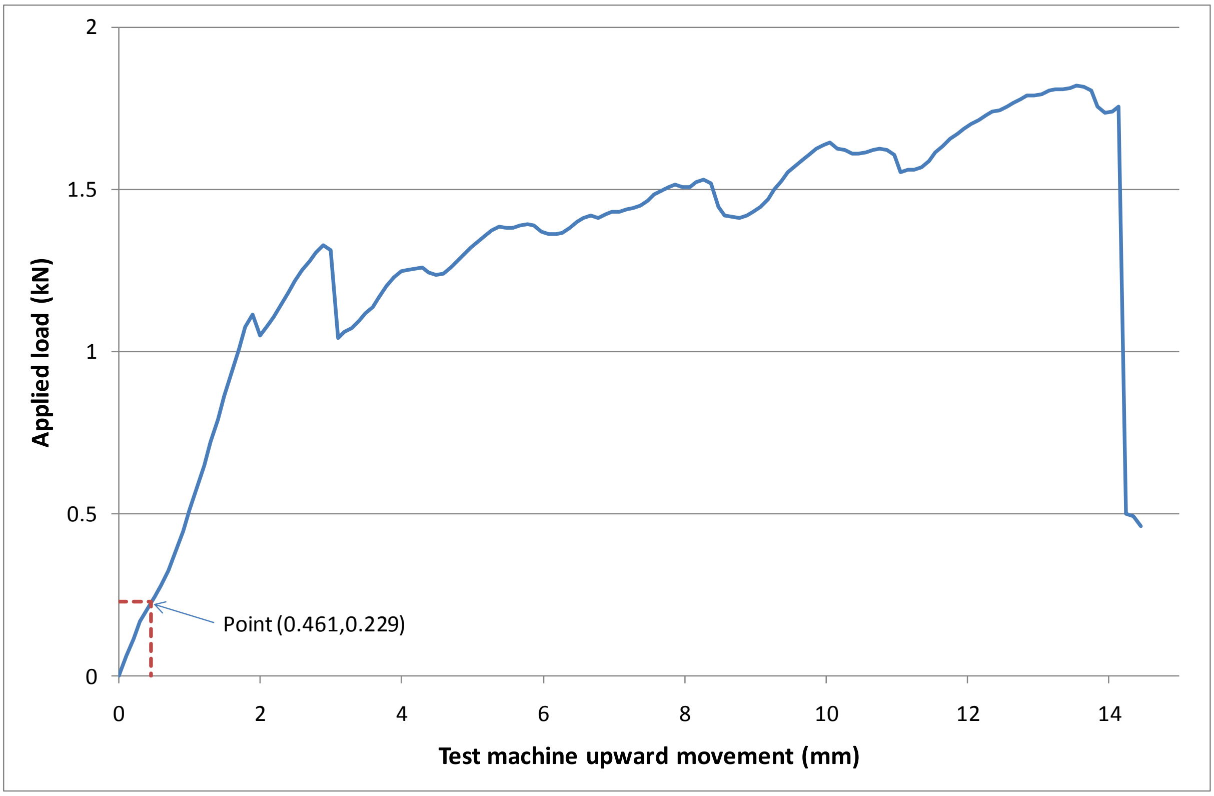

Figure 4. Typical plot of load versus displacement

8. BRANZ TEST ST0793/3

BRANZ test report ST0793/3 has shown satisfactory performance of a complete wall panel under face load pressures. There was no failure of the cladding or cladding fixings during the test for which the maximum applied pressure was 6.4 kPa. Thus, the cladding in this test had the ability to span between fixings at this pressure. Using a factor for variability of 1.5, a design wall pressure of 6.4/1.5 = 4.32 kPa was derived in BRANZ test report ST0793/3.

Substituting the design pressure of 4.32 kPa into eqn (1) above gives a lower design wind speed:

V_u^2 (pascals) = 4320/(1.3 x 0.6), giving V_u = 74.4 m/sec. .... (1)

As the design ultimate limit state wind speed for Very High wind zones, as stipulated in NZS 3604, is 50 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 Very High for stud spacing up to 600 mm and fastener spacing along the studs not exceeding 300 mm.

9. CONCLUSIONS

The conclusions in the following paragraph are based on the results of the fastener pullout tests and the face load pressure test of BRANZ test ST0793/3. They require the wall framing to also be designed for the stipulated wind speeds and pressures. The building must be internally lined. The anchors are at maximum centres of 600 mm in the horizontal direction and 300 mm in the vertical direction.

The Rockcote Cavity System, when fixed as described herein, may be used as exterior wall cladding in NZS 3604 type construction for all wind zones up to and including "Very High". It can resist an ultimate limit state differential wind pressure across the cladding up to 4.32 kPa for all buildings fixing the cladding as described herein.

10. REFERENCES

(1) Standards New Zealand. NZS 3604:1999. *Timber Framed Buildings*. SNZ, Wellington, New Zealand

(2) Standards New Zealand. NZS 4203:1992. *Loadings standard*. SNZ, Wellington, New Zealand.

(3) Shelton, R H 2007. The engineering basis of NZS 3604. BRANZ study report No 168.

(4) BRANZ, 1990. Evaluation Method No. 1 (1999). Structural joints – strength and stiffness evaluation. BRANZ Evaluation Method No 1.

Appendix Test results

Test No	Peak Strength (kN)
1	**1.801**
2	**2.475**
3	**1.907**
4	**1.393**
5	**1.914**
6	**1.743**
7	**1.741**
8	**1.64**
9	**1.818**
10	**1.899**
11	**1.963**
12	**1.749**

Mean	1.837	kN
Std dev	0.252	kN
CoV (Std dev/mean)	0.1374	

Calculation of Characteristic Strength for Ultimate Limit State Design

The characteristic strength determined from BRANZ Evaluation Method EM1

$R_k = (1 - 2.7v/n^{0.5})P_{0.05}$

where

$P_{0.05}$ = Fifth percentile of the measured data	1.420
= mean - 1.65 x standard deviation	
n = number of samples	12
v = coefficient of variation (CoV)	0.1374

Thus

Rk = Characteristic Strength = 1.268 kN