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TEST REPORT

ST1197

CONNECTION TESTING FOR ROCKCOTE

CLIENT
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LIMITATION

The results reported here relate only to the items tested.

TERMS AND CONDITIONS

This report is issued in accordance with the Terms and Conditions as detailed and agreed in the BRANZ Services Agreement for this work.

SIGNATORIES

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1. INTRODUCTION

Testing was performed to determine the characteristic pull-out strength of a Rockcote cavity wall system using nominal 50 mm thick autoclaved aerated concrete (AAC) for the cladding and including expanded polystyrene battens and a layer of plywood on timber studs. These connection tests were conducted to assess the strength of the fastenings between the AAC cladding and studs.

2. DESCRIPTION OF TEST SPECIMENS

Ten replicate specimens were provided to determine the connection strength between studs and AAC panels. Test specimens were provided by the client and were delivered to BRANZ such that they were ready to be tested with only minimal modifications as described below. Pull-off specimens consisted of a 50 mm x 300 mm x 300 mm AAC panel fixed to a 100 mm long segment of SG8 90 x 45 mm timber stud through a 20 mm thick expanded polystyrene batten and 12 mm thick plywood, as shown in Figure 1. The plywood layer was originally 300 x 300 mm as supplied by the client, but it was necessary to carefully trim down the plywood to approximately 85 x 130 mm so that it would fit within the testing apparatus shown in Figure 1 and Figure 2. The AAC panels were fixed to studs using a single 100 mm x 6.4 mm countersunk screw with a 14 mm diameter head and threaded along the full length of the shaft.

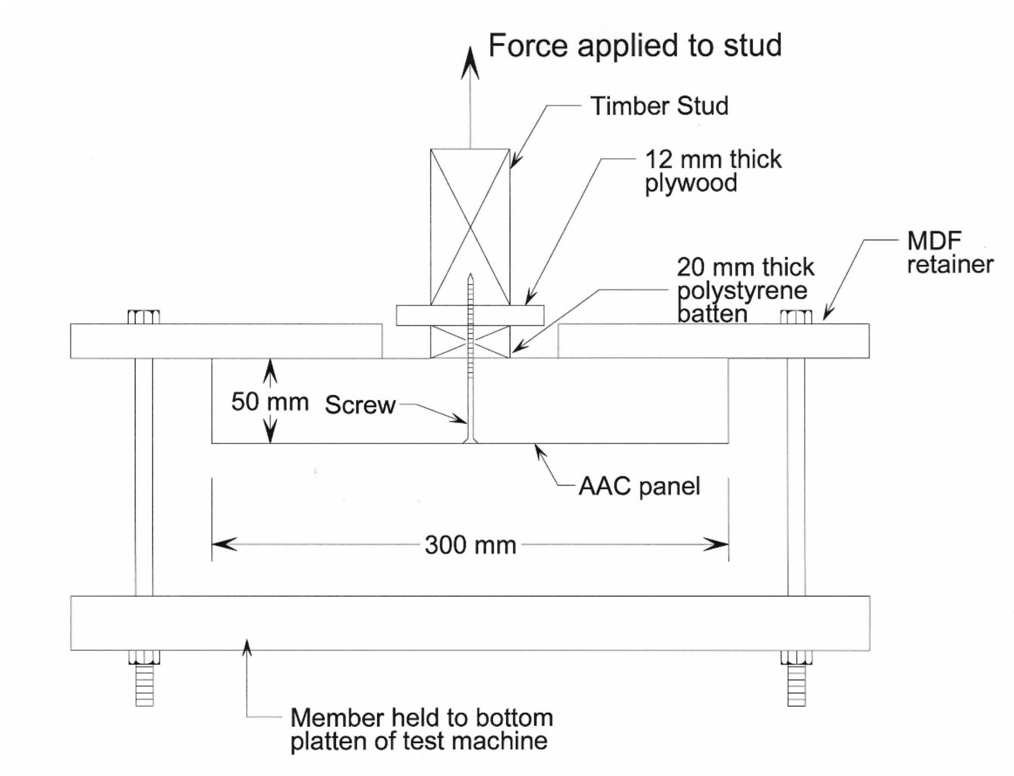

Figure 1. Rockcote Pull-Off Specimens and Connection Testing Apparatus

Figure 2. Typical Rockcote Pull-Off Specimen during Testing

3. DESCRIPTION OF TESTS

3.1 Date and Location of Tests

The tests were carried out in May 2017 at the Structural Engineering Laboratory of BRANZ Ltd, Judgeford, New Zealand.

3.2 Test Arrangement and Equipment

The tests were undertaken in a Dartec Universal testing machine. A view of the test setup is provided in Figure 2. The test load was measured with a 10 kN load cell calibrated to International Standard EN ISO 7500-1 2004 [1] Grade 1 accuracy. Loads were recorded continuously during testing using a computer controlled data acquisition system.

3.3 Test Procedure

Specimens were placed in a Dartec Universal test machine with the stud fitted though a hole in a particle board reaction plate as shown in Figure 2. A hole was drilled into the stud of each specimen. A rod was passed through the hole and raised by the test machine through the load cell during testing at a rate of 0.5 mm per second.. The AAC panels were held in bearing against the underside of the medium density fibreboard

(MDF) retainer plate which was secured to the bottom platen of the test machine using threaded rods and a timber block.

4. OBSERVATIONS, RESULTS AND ANALYSIS

All connection pull-off specimens were tested until they achieved a maximum load which was followed by a rapid decrease in load considered to be the failure of the specimens. Failure occurred due to the heads of the screws pulling through the AAC panels and pulling out chunks of the AAC while being pulled through as seen in Figure 3.

Figure 3. Typical Damage to Rockcote AAC Panels during Testing

Test results and analyses from connection pull-off tests are provided in Table 1. The connection pull-off load capacity per screw was derived using methods described in Appendix B of AS/NZS1170.0 [2]. According to AS/NZS1170.0, the design capacity is considered to be S_{min} / k_t where S_{min} is the minimum value of the test results and k_t is a derived factor based on the variation of test values and the number of specimens tested. Based on the coefficient of variation from the tested specimens, it was assumed that the parent population would have a coefficient of variation of no more than 10% and this was used for the analysis.

Table 1. Results and Analysis from Rockcote Connection Testing

Specimen	Max. Load (kN)
1	1.66
2	1.40
3	1.41
4	1.47
5	1.55
6	1.28
7	1.65
8	1.48
9	1.46
10	1.55
Average	1.49
St. Dev.	0.11
COV	7.6%
k_t	1.21
Design	1.06

5. ANALYSIS OF RESULTS TO DETERMINE WIND RESISTANCE

5.1 Demand Wind Pressure

The analysis given below is only applicable to the exterior walls of buildings which fall within the scope of NZS 3604 [3]. 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.

NZS 3604 wind loadings are based on AS/NZS 1170.2:2002 [4]. The design wind pressure, p, is given by Eq 2.4(1) of AS/NZS 1170.2 as:

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

where:

- V_{des} is the design wind speed applicable to the relevant wind zone.
- 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.

For house walls near corners, the maximum C_{pe} = 0.65 suction, K_a = 1.0, K_L = 2.0, 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 and lower values further away. Generally the width of New Zealand houses does not exceed 12 m. Hence, 'a' is taken as 0.2 x 12 = 2.4 m. Thus, within 1.2 m of a corner K_L = 2.0 and elsewhere K_L = 1.5.

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 demand level differential pressure across the cladding, is given by:

$p_z = (p_i + p_e) = (0 + p_e) = p_e = 0.78V_{des}^2$ .... (1)

The demand ultimate limit state wind speed for each wind zone stipulated in NZS 3604 [3] is given in Table 2. Using these wind speeds, Table 2 provides the demand level ultimate differential pressures across the cladding for each wind zone. These were calculated using Equation (1).

Table 2. Demand differential pressures across wall claddings on buildings complying with the scope of NZS 3604

NZS 3604 Wind Zone	Wind Speed (m/s)	Basic Pressure (kPa)	Differential Pressure (Cpe = -0.65) (kPa)
L	32	0.614	0.799
M	37	0.821	1.068
H	44	1.162	1.510
VH	50	1.500	1.950
EH	55	1.815	2.360

5.2 Demand Wind Pressure Compared with Measured Capacity

The design capacity of the single fastener into the stud for the tested configurations was shown in Section 4 to be 1.06 kN. Thus, for Rockcote AAC panels secured using the tested screws at 300 mm centres on studs installed using 600 mm centres, the allowable differential pressure across the cladding = 1.06/(0.3 x 0.6) = 5.9 kPa. From Table 2 it can be seen that the highest NZS 3604 wind zone in which this system may be used is Extra High for studs at 600 mm centres.

6. CONCLUSIONS

Conclusions provided in this report are only applicable to wall systems constructed utilising the same components and fasteners as the tested specimens. The conclusions below assume that the framing is separately designed for the design wind loading and the construction is as described in Section 5.2. It applies to timber-framed construction, fully lined internally, which falls within the scope of NZS 3604.

The Rockcote system tested may be used in wind zones up to and including EH in New Zealand when studs are on 600 mm centres and the screws are installed every 300 mm along studs.

7. REFERENCES

1) International Organisation for Standardisation (ISO). 2004. *Metallic Materials – Verification of Static Uniaxial Testing Machines, Part 1: Tension/Compression Testing Machines – Verification and Calibration of the Force-Measuring System*. ISO, Geneva, Switzerland.

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

3) Standards New Zealand. NZS 3604:2011. *Timber Framed Buildings*. SNZ, Wellington, New Zealand.

4) Standards New Zealand. AS/NZS 1170.2:2002. *Structural design actions. Part 2: Wind actions.* SNZ, Wellington, New Zealand.