  

TEST REPORT

TV11968-001-01

BOTTOM PLATE ANCHOR TESTING FOR MAXRAFT

CLIENT
MBSS, trading as MAXRaft
PO Box 2606
Queenstown
New Zealand

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.

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1. OBJECTIVES

The objective for this project was to verify the strength of a screw anchor used for securing the bottom plates of timber framed walls to concrete slabs formed with MAXRaft polystyrene edge forms. The testing was as required by NZS 3604:2011 [1], clause 7.5.12. (shear in the plane of the wall, shear perpendicular to the plane of the wall, and uplift).

In addition, the strength of the anchors in tension was determined for their use with end stud hold-downs for wall bracing elements.

2. DESCRIPTION OF TEST SPECIMENS

2.1 Products tested

MAXRaft polystyrene edge forms were supplied to BRANZ by the client for testing. These were 2400 mm long, 495 mm wide and 250 mm high, with a tapered edge approximately 20 mm thick at its narrowest. Plain edge forms and corner sections (600 x 600) were supplied (see Photograph 1).

Photograph 1. MAXRaft edge form as supplied

To maintain adequate concrete embedment of the bottom plate anchors, they must be installed at an angle of 11 degrees to the vertical as required by the client. Details of the installation are shown in Figure 1.

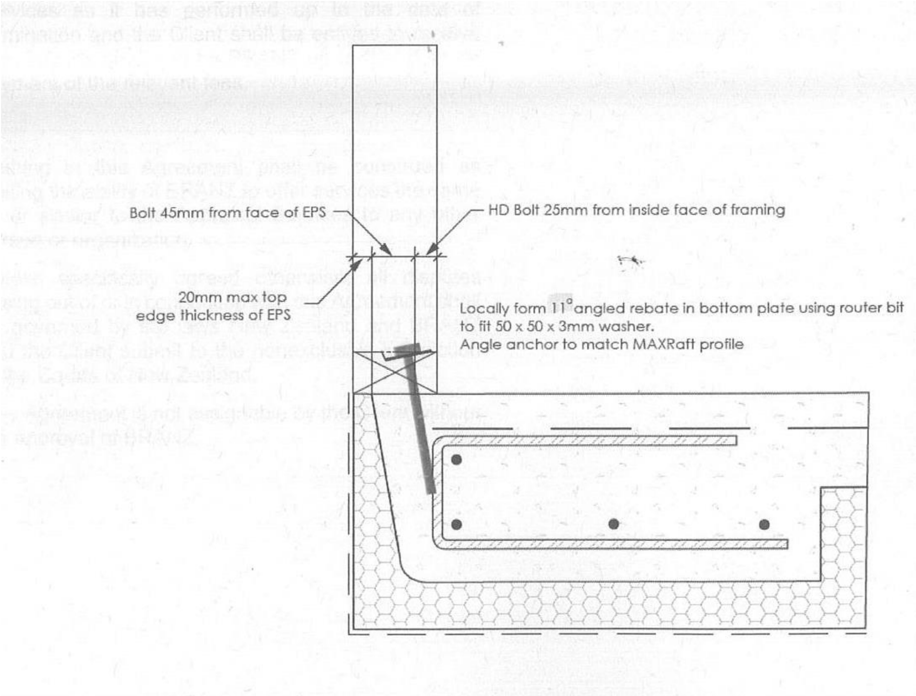


Figure 1. Detail of anchor installation at concrete edge (client supplied)

The bottom plate fastener supplied by the client was a Simpson StrongTie THD10160MG screw anchor (see Photograph 2). Measured length was 160 mm underneath the head (75 thread length). Shank diameter was 9.9 mm for the unthreaded shank and 9.65 mm for the threaded shank. Outer diameter over the threads was 12.25 mm.

Photograph 2. Screw anchor (Simpson StrongTie THD10160MG)

2.2 Specimen construction

To test the bottom plate anchors, four concrete slabs were cast, 2,400 mm long and 600 mm wide. They had three MAXRaft edges and one plain long edge. They were reinforced with deformed reinforcing bars as required to provide sufficient strength for handling.

The minimum 28 day concrete strength prescribed by NZS 3604 is 17.5 MPa so this was ordered from a ready-mix concrete supplier. Test cylinders were made and tested at specified dates before testing began.

The anchors were installed into pilot holes in the concrete, drilled using a jig supplied by the client to ensure the drill angle was 11^0 from vertical (see Photograph 3).

Photograph 3. Jig used for drilling pilot hole for anchor.

The bolts were screwed into the concrete and tightened over the timber used for the bottom plates with a spanner until they were just snug tight against the plate. For the direct tension tests, the bottom plate was substituted with a steel fixture to avoid timber plate breakage, see Photograph 7.

Six replicate tests were undertaken in each loading direction. In addition, six direct tension tests were carried out to failure.

3. DESCRIPTION OF TESTS

3.1 Date and location

Testing was carried out between October and December 2019 at the Structures Testing Laboratory of BRANZ Ltd, Judgeford, Porirua City.

3.2 Set up and equipment

A separate test set-up was used for each of the three loading directions (shear in the plane of the wall, shear out of plane, and axial tension). Details of these are shown in Figures 2, 3 and 4 respectively, together with Photograph 4, Photograph 5, and Photograph 6.

The slabs were rigidly fixed to the laboratory strong floor or reaction frames and loads were applied to the anchors with a 100 kN capacity closed loop hydraulic actuator and measured with a 25 kN or 50 kN load cell as required. The load cells used were within International Standard EN ISO 7500-1 2004, Grade 1 accuracy. Deformation of the anchors was measured with the LVDT within the actuator, reading to an accuracy of ±1.0 mm.

The test load and displacement measurements were recorded using a computer-controlled data acquisition system.

Loads were applied to the bottom plate anchors through a 90 mm by 45 mm kiln dried SG8 grade radiata pine timber plate member as shown in Figures 2, 3 and 4.

For the out-of-plane shear tests, the load was applied to the timber plate at points centred 188 mm on either side of the anchor. For the in-plane load tests, the end distance to the anchor was a minimum of 150 mm. For the initial tension tests on bottom plate anchors, the load was applied to the plate via two steel fixtures spaced 108 mm on either side of the anchor.

Early tension tests on the bracing hold-down anchors caused the bottom plate to fail in flexure and so the timber was replaced with a direct application of load on the anchor using a steel fitting (see Photograph 7).

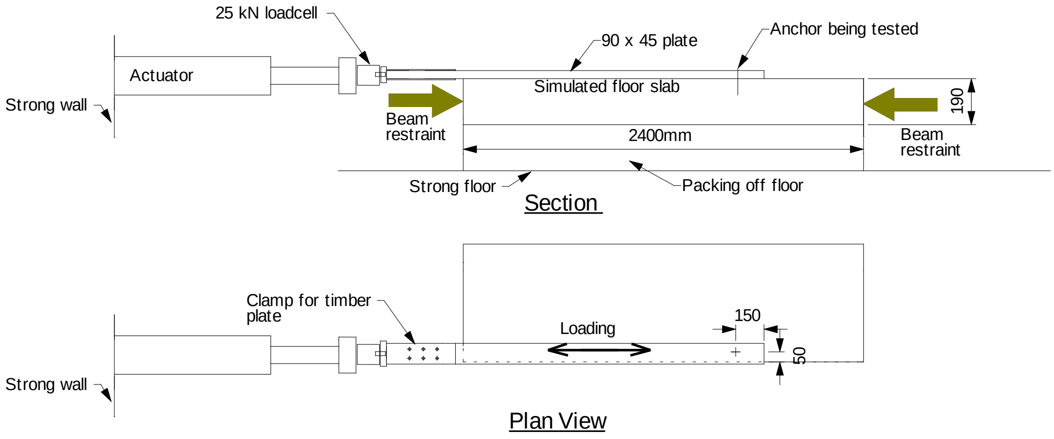


Figure 2. Test set-up for in-plane loading, parallel to bottom plate

Photograph 4. Set-up for in-plane tests

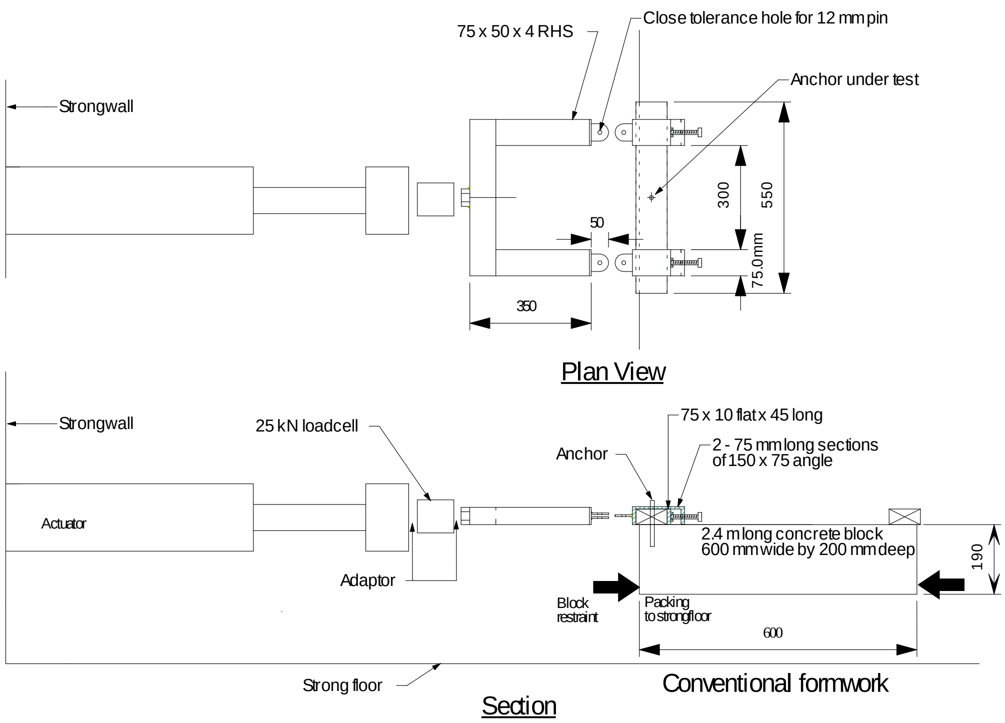
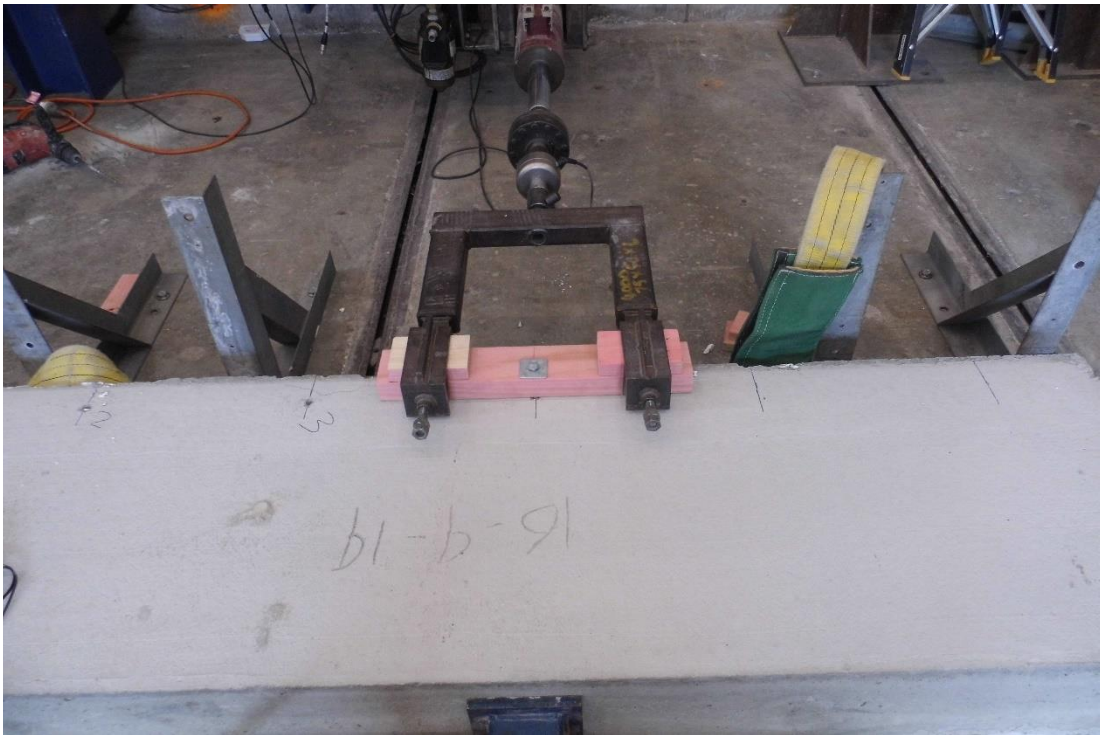


Figure 3. Test set-up for out-of-plane loading perpendicular to bottom plate



Photograph 5. Test set-up for out-of-plane loading

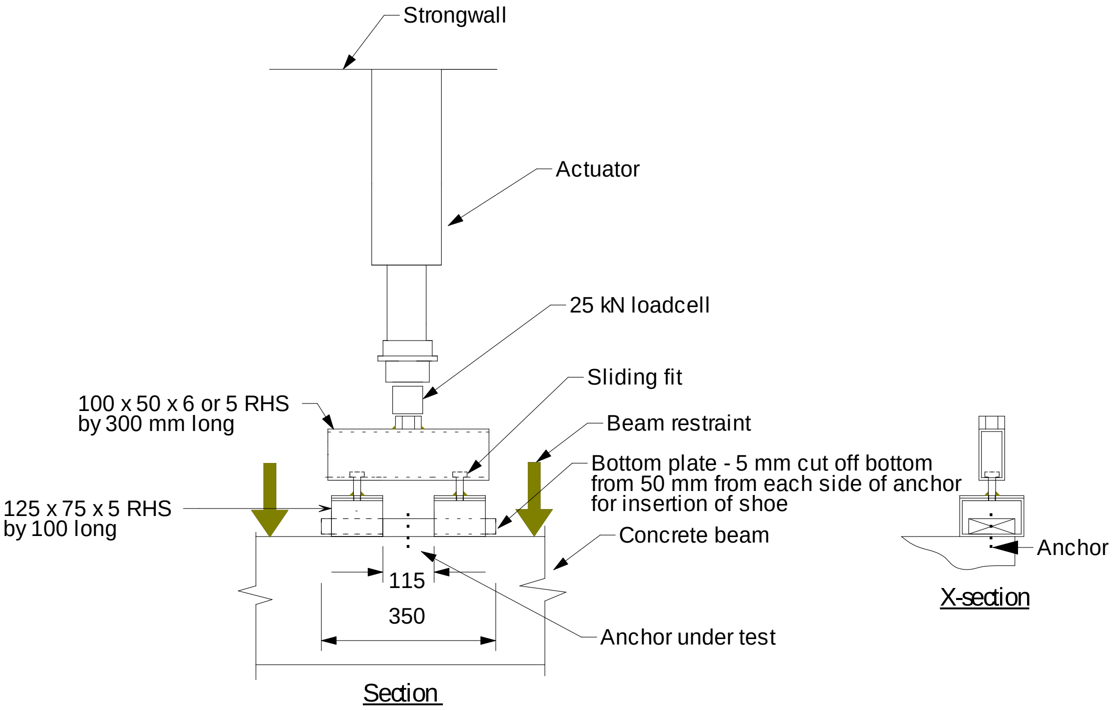


Figure 4. Set-up for tension tests on bottom plate anchors

Photograph 6. Test set-up for axial tension loading (bottom plate anchors)

Photograph 7. Steel fitting used for axial tension tests (without bottom plate)

3.3 Test procedure

The required capacities for proprietary bottom plate anchors as specified by clause 7.5.12 of NZS 3604:1999 are as follows:

External walls:

Horizontal loads in the plane of the wall	2 kN
Horizontal loads out of the plane of the wall	3 kN
Vertical loads in axial tension of the anchor	7 kN

Further, if the anchor is to be used to hold down bracing elements of up to 150 bracing units per metre, the characteristic load is required to be greater than or equal to 15 kN.

The loading regimes were cyclic under load control, in accordance with BRANZ Evaluation Method No 1 (1999), as required by NZS 3604:2011.

For the in-plane loading tests, each specimen was cycled three times to load levels corresponding to ±0.2, ±0.4, ±0.6, ±0.8, ±1.0, ±1.2, ±1.4, ±1.6, ±1.8 times the capacity load specified in NZS 3604.

For the out-of-plane shear tests, the loading regime involved cycling three times, in an outward direction only, then back to zero, to each of +0.25, +0.5, +0.75, +1.0, +1.25, +1.5, +1.75, etc times the capacity load specified in NZS 3604.

For the bottom plate tests in tension, the loading regime involved cycling three times in tension from zero load to each of 5.25 kN, 6.13 kN, 7.0 kN, 7.88 kN, 8.75 kN, 9.63 kN, 10.1 kN, 11.38 kN, 12.25 kN. Additional tension tests for the purpose of anchoring brace element hold-downs followed a similar regime, but were continued to failure.

4. OBSERVATIONS AND RESULTS

4.1 Observations

4.1.1 In-plane tests

No failures were observed up to a maximum load of 3.6 kN, or 1.8 times the target load of NZS 3604.

Photograph 8. Undamaged in-plane test.

4.1.2 Out-of-plane tests

Specimen 3 cracked at the edge, but the remainder of the tests were undamaged up to 7.2 kN, when the test was stopped.

Photograph 9. Edge cracking after out-of-plane test.

4.1.3 Uplift tension tests

The tension test specimens were undamaged up to 12.4 kN when the tests were stopped.

The additional bracing hold-down tension tests were carried out to failure. Failure occurred either by concrete tension cone failure (Photograph 10), or edge breakout (Photograph 11).

Photograph 10. Concrete cone failure under tension loading

Photograph 11. Concrete edge breakout under tension loading.

4.2 Results

Representative plots of load against bottom plate displacement are shown in Figures 5, 6 and 7.

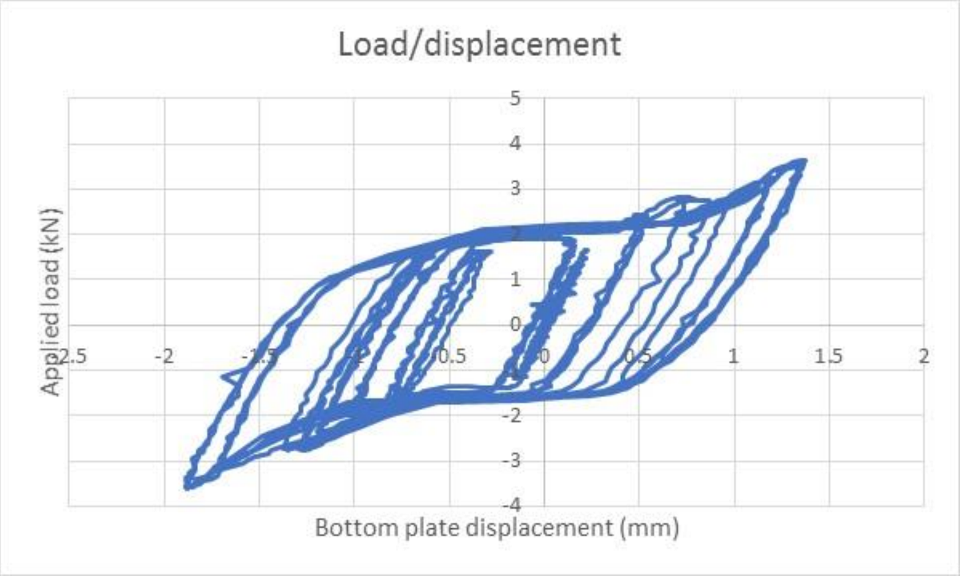


Figure 5. In-plane load direction

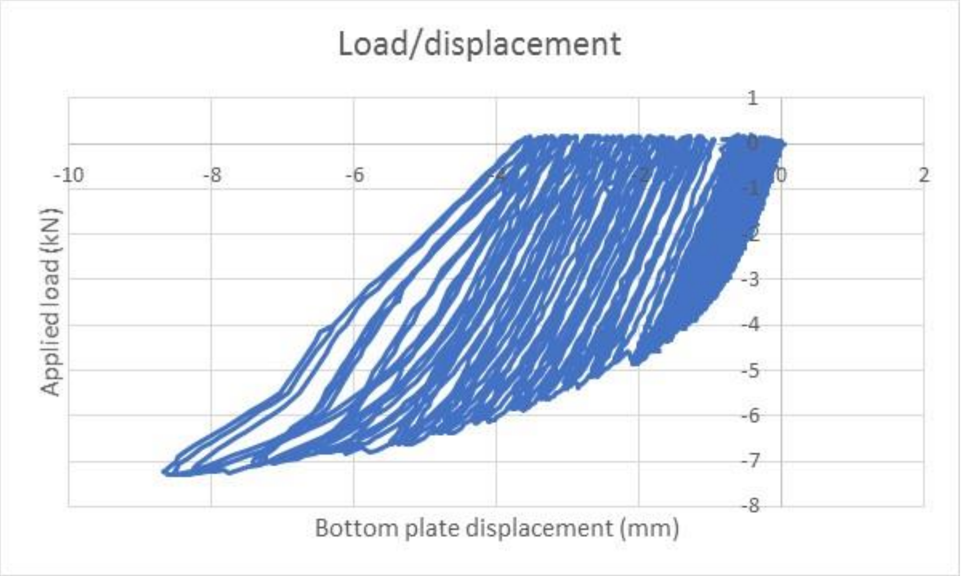


Figure 6. Out-of-plane loading direction.

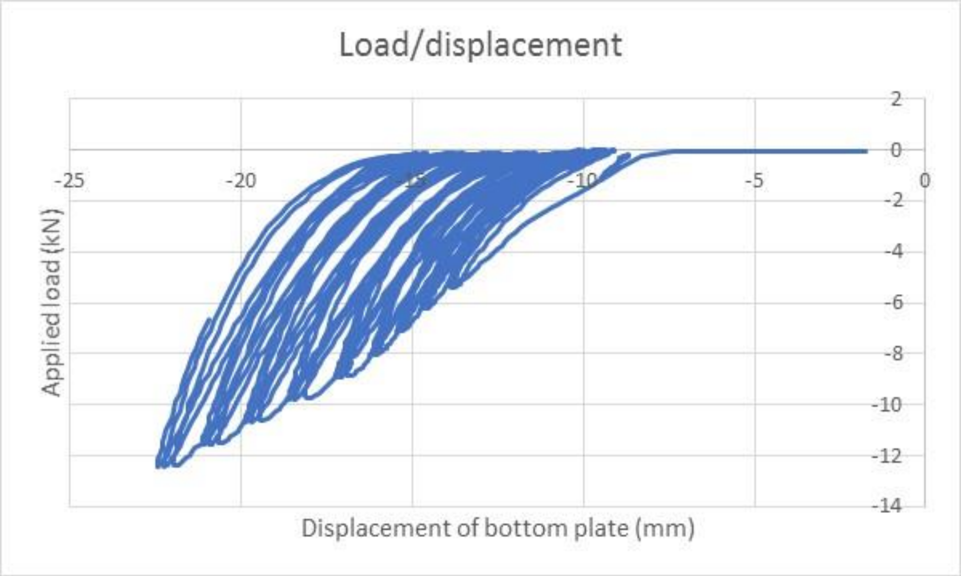


Figure 7. Tension loading direction.

All in-plane, uplift tension, and out-of-plane tests passed the required target loads of NZS 3604 without significant failure.

The bracing element tension test results are summarised in Table 1.

	Peak load (kN)	
Test id	All results	Unused slab only
7	33.0	33.0
8	31.4	31.4
9	28.6	28.6
10	34.4	34.4
11	36.0	36.0
12	19.6	-
13	21.3	-
Mean	29.2	32.7
Std. deviation	5.9	2.5
CoV	0.20	0.08
Minimum	19.6	28.6
k_t	1.60	1.21
Characteristic	12.25	23.64

Table 1. Results of bracing element tension tests

Note, the peak quoted in the table is the maximum load sustained during the 3 cycles of loading immediately prior to failure.

Tests 7 to11 were carried out on a slab that had not been previously used for testing. However due to extensive edge breakouts, tests 12 and 13 had to be carried out on a slab previously used for testing (although apparently undamaged). The two low results indicated this slab had been compromised by the previous tests, so the set of results was re-examined with these results ignored (third column of the table).

Results evaluation followed the procedure of AS/NZS 1170.0 [2]. The design capacity is given by the following equation:

Design capacity = $\frac{minimum\ test\ result}{k_t}$

where k_t is a factor to account for variability between test results. The factor is set out in Table B1 of AS/NZS 1170.0 and depends on coefficient of variability and number of results. The coefficient of variation is determined by the standard deviation of the results, divided by the mean.

5. CONCLUSION

Simpson StrongTie concrete screw anchors used as bottom plate anchors with slab edges formed by MAXRaft polystyrene edging will comply with Clause 7.5.12.2 of NZS 3604.

The same anchors will provide a 15 kN fixing for end studs of bracing wall elements.

Both conclusions depend on the anchors being accurately located with respect to the edge of the slab, and installed at the 11^0 vertical angle recommended by MAXRaft.

6. REFERENCE

[1] NZS 3604: 2011. Timber framed buildings. Standards New Zealand, Wellington, NZ.

[2] AS/NZS 1170.0:2002. Structural design actions, Part 0: General principles. Standards Australia, Sydney, Australia.