STRUCTURES TEST REPORT

ST11534-001-01

DETERMINATION OF THE BENDING STRENGTH AND POINT LOAD RESISTANCE OF 75 MM THICK ROCKCOTE RESENE INTEGRA FLOOR PANELS

CLIENT
Rockcote Resene Ltd
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All tests and procedures reported herein, unless indicated, have been performed in accordance with the BRANZ ISO9001 Certification

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. OBJECTIVE

To determine the live load carrying capability of the Rockcote Resene Ltd 75 mm INTEGRA lightweight concrete (LWC) flooring system when supported on timber floor joists spaced at 450 mm centres.

2. DESCRIPTION OF SPECIMEN

2.1 Product description

The 75 mm thick INTEGRA lightweight concrete flooring system consists of 75 mm thick panels that are 1800 mm long and 600 mm wide. The panels have a tongue and groove edge and are reinforced with two layers of reinforcing mesh. The mesh bar spacings are 130 mm in both directions and the bars are 5 mm diameter. The mesh layers are oriented so that the longitudinal bars are located respectively 25 mm below the upper and lower faces of the panels.

The panels are laid in a staggered bond pattern over timber or steel joists and are fixed down with 14g by 100 mm long galvanised INTEGRA screws in the body of the panels and 14g by 150 mm long galvanised INTEGRA screws at the ends of the panels. The screws have a countersunk head and are installed with the top of the screw flush with the upper surface of the panel.

2.2 Specimen construction

2.2.1 Uniform distributed load simulation

Three specimens were constructed to conduct testing to simulate a uniformly distributed live load. Each specimen consisted of a frame of three 800 mm long 90 x 45 SG8 Radiata Pine dry framing supporting members (‘joists”) spaced at 450 mm centres. These were fixed to two 945 mm long 90 x 45 SG8 Radiata Pine dry framing side members with two 90 mm x 3.15 mm diameter power driven nails at each junction.

923 mm long by 400 mm wide INTEGRA panels were screw fixed to the three joists with 14g by 100 mm long galvanised INTEGRA screws. At one end the panel finished at the centre of the joist, as would be expected at an end to end panel junction in the field, while at the other end it finished flush with the outside edge of the joist. Five screws were used to fix the panels to the outer joists and three to the inner joists. At the end where the panel finished at the centre of the joist, the screws were installed at an angle, as instructed by the client.

A view of the construction of the test specimens is presented in Figure 1.

2.2.2 Concentrated load simulation

Three specimens were constructed to conduct concentrated load testing. Each specimen consisted of a frame of five 800 mm long 90 x 45 SG8 Radiata Pine dry framing supporting members (‘joists”) spaced at 439 mm centres. These were fixed to two 1800 mm long 90 x 45 SG8 Radiata Pine dry framing side members with two 90 mm x 3.15 mm diameter power driven nails at each junction.

1800 mm long by 400 mm wide INTEGRA panels were screw fixed to the five joists with 14g by 100 mm long galvanised INTEGRA screws. Five screws were used to fix the panels to the outer joists and two to the inner joists (Figure 2).

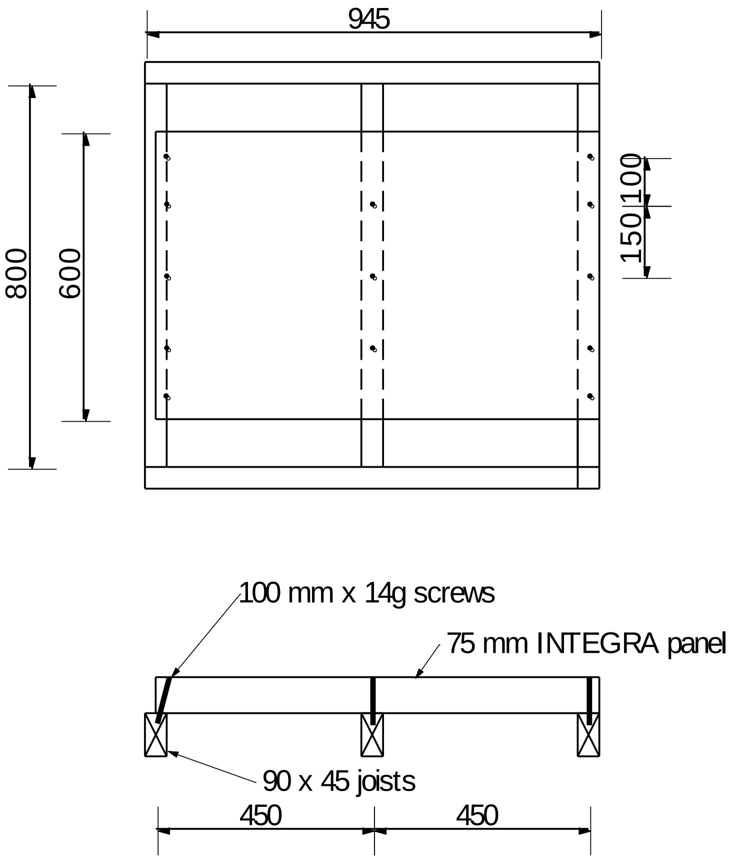

Figure 1 Plan view and section of the specimens for uniform load simulation

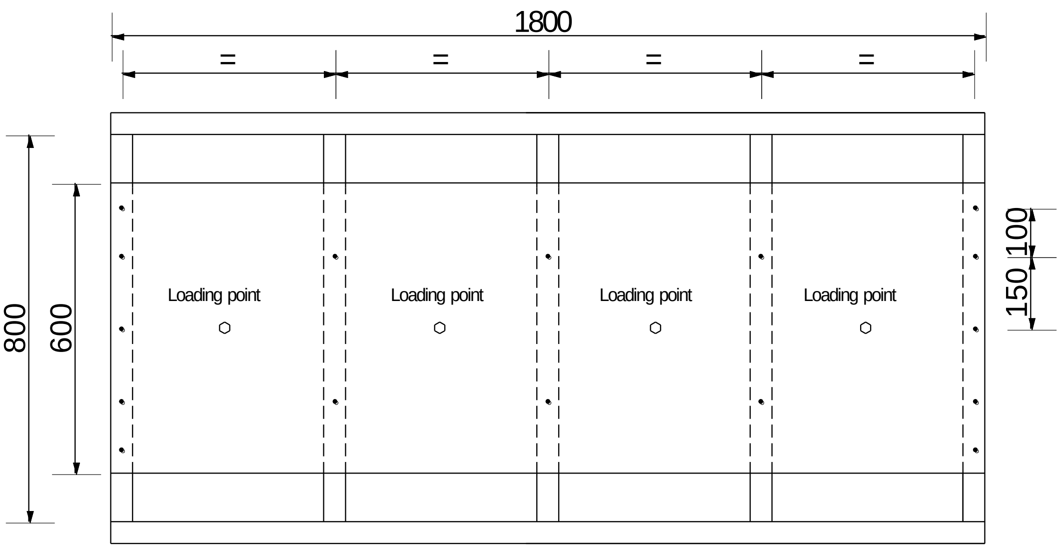

Figure 2 Plan of the concentrated load test specimen

3. DESCRIPTION OF TEST

3.1 Date and location of test

The tests were carried out in May 2019 at the Structural Engineering Laboratory of BRANZ Ltd, Judgeford, New Zealand.

3.2 Test arrangement and equipment

3.2.1 Uniform distributed load simulation

The specimens were supported on the laboratory strong floor. Line loads were applied to the specimens at the midpoints of the two spans via 50 mm x 50 mm RHS members, connected via a 75 mm x 75 mm steel strongback. A ram and hand pump were used to apply the load to the specimens via a 25 kN loadcell. 50 mm displacement transducers were used to measure the downward displacement of the panels at the location of the applied load. A diagram of the loading arrangement is presented in Figure 3 and a view of a typical test setup is given in Figure 4.

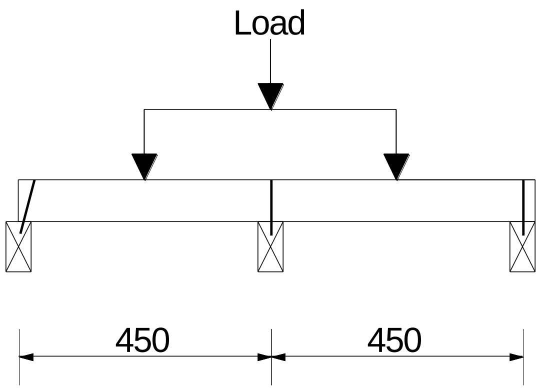

Figure 3 Section through the test setup showing the loading arrangement

The test load and displacement measurements were recorded using a computer-controlled data acquisition system. The load cell was calibrated to International Standard EN ISO 7500-1:2018 [1] Grade 1 accuracy and the linear potentiometers were calibrated to an accuracy of 0.2 mm.

3.2.2 Concentrated load simulation

The specimens were supported on the laboratory strong floor. Concentrated loads were sequentially applied to the specimens at the midpoints of the four spans. To achieve this the specimens were moved between individual tests so that the loading rig was situated directly above the loading point for each test.

A ram and hand pump were used to apply the load to the specimens via a 25 kN loadcell. A diagram of the loading arrangement is presented in Figure 2 and a view of the test setup is presented in Figure 5.

The test load was recorded using a computer-controlled data acquisition system. The load cell was calibrated to International Standard EN ISO 7500-1:2018 [1] Grade 1 accuracy.

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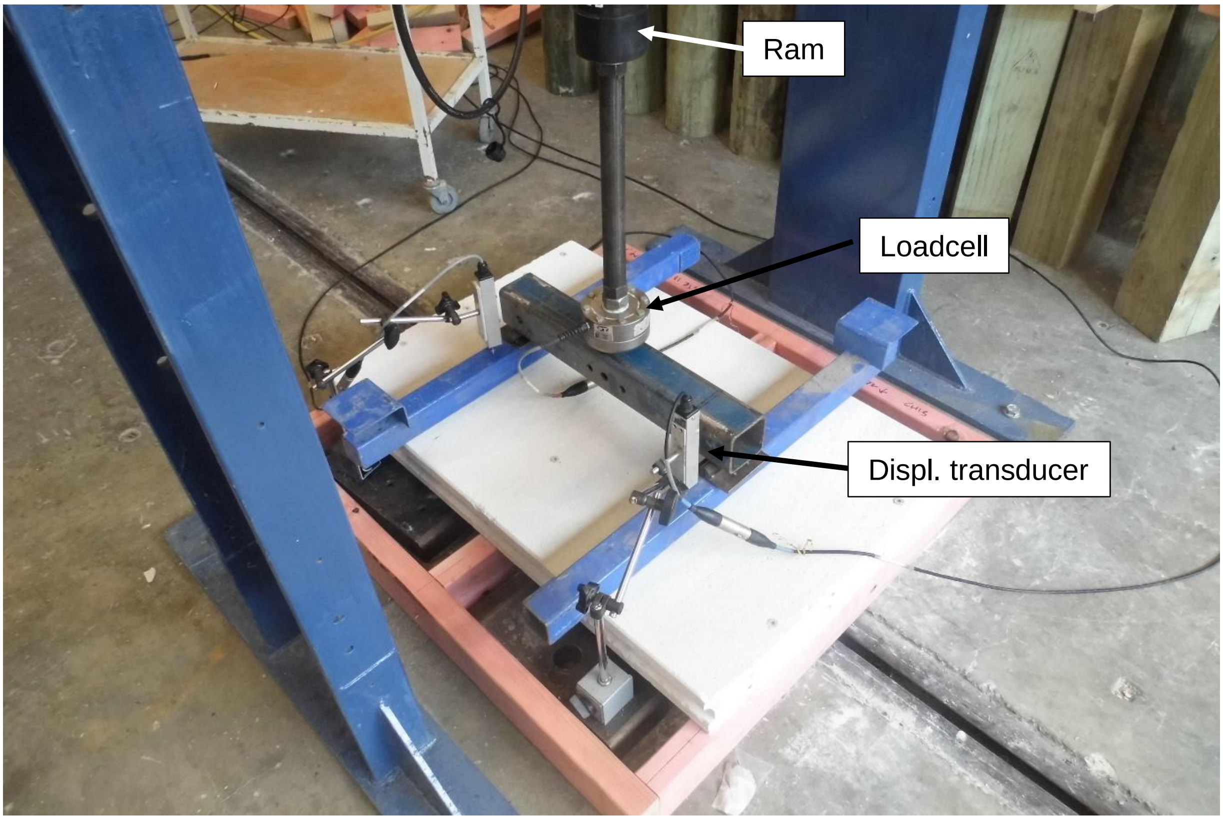

Figure 4 View of the test setup

Figure 5 Concentrated load simulation tests underway

3.3 Test procedure

3.3.1 Uniform distributed load simulation

The relationship between the bending moment at the centre support caused by two identical line loads at the centres of the spans of a two-span floor and that caused by a uniformly distributed load on the same two spans is determined from the following equality:

$wL^2/8 = 3PL/16$

Where w is the uniformly distributed load (kN/m), P is the line load on one span (kN) and L is the length of the span (m). By rearranging the equation, w can be found in terms of P as follows:

$w = 8x3PL/16L^2 = 1.5P/L = 3.33P$ when L = 450 mm (0.45 m).

Load was applied at a slow rate until the specimen failed while the deflection of the spans was recorded against the applied load.

3.3.2 Concentrated load simulation

Concentrated loads were slowly applied independently at the four loading points on the specimens until failure occurred. At the four loading points on Specimen 1, a 20 mm diameter foot was used to apply the load to the specimen. On Specimens 2 and 3, a 100 mm x 100 mm square steel foot was used to apply the load.

AS/NZS 1170.1:2002 [2] Table 3.1 specifies the imposed floor actions for building occupancy types. Type A1 (Self-contained dwellings) has a concentrated action of 1.8 kN applied over an area of 350 mm^2 (or a diameter of 21 mm). For several other occupancy types in Table 3.1, the concentrated action is specified as 4.5 kN over an area of 0.01 m^2 (or 100 mm x 100 mm).

4. OBSERVATIONS

4.1.1 Uniform distributed load simulation

As the loading progressed on all three test specimens, cracks developed on the top surface of the INTEGRA panels near the central support joist (Figure 6). Flexural cracking also occurred on the underside of the panels nearer the end support joists and there was some local compression crushing of the top surface under the loading beams (Figure 7).

4.1.2 Concentrated load simulation

When the load was applied by the 20 mm diameter foot on the top surface of the panel a clean hole resulted through the top surface of the panel (Figure 8) as a cone failure occurred on the underside of the panel (Figure 9).

When the load was applied by the 100 mm x 100 mm steel plate on the top surface of the specimen local crushing of the top surface occurred under the plate (Figure 10). A wide area of cracking occurred on the underside of the panel (Figure 11), which was likely to be due to the contribution of the steel mesh layers to the load resistance.

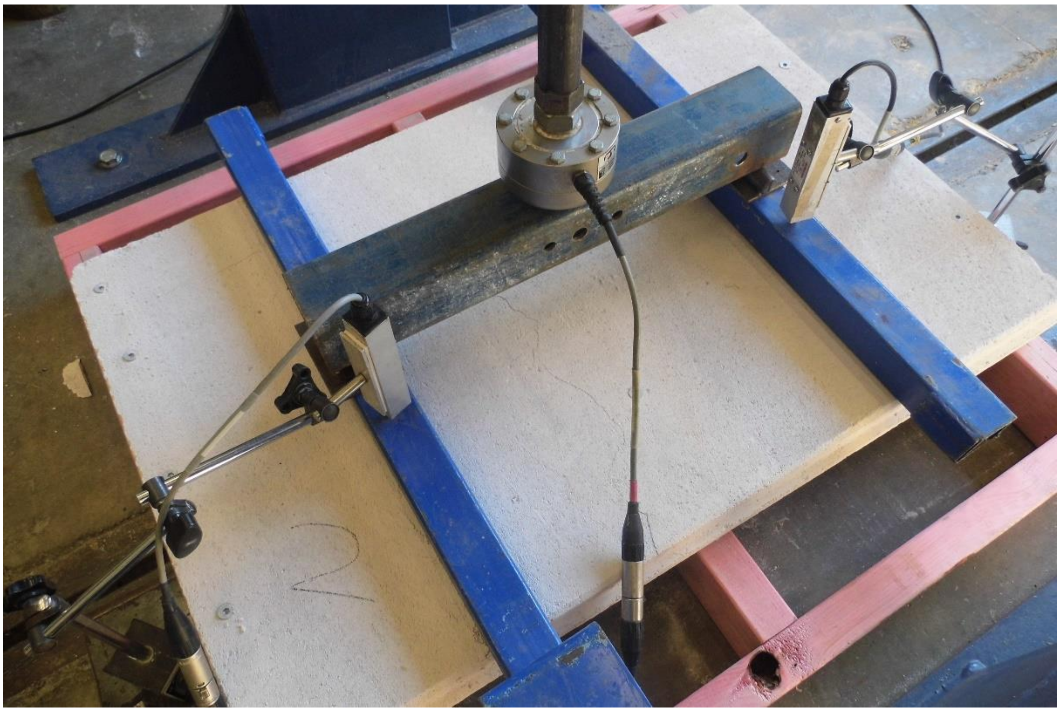

Figure 6 View of Specimen 2 showing the crack development at the centre joist during uniform distributed load simulation testing

Figure 7 Flexural cracking and local compression crushing during uniform distributed load simulation testing

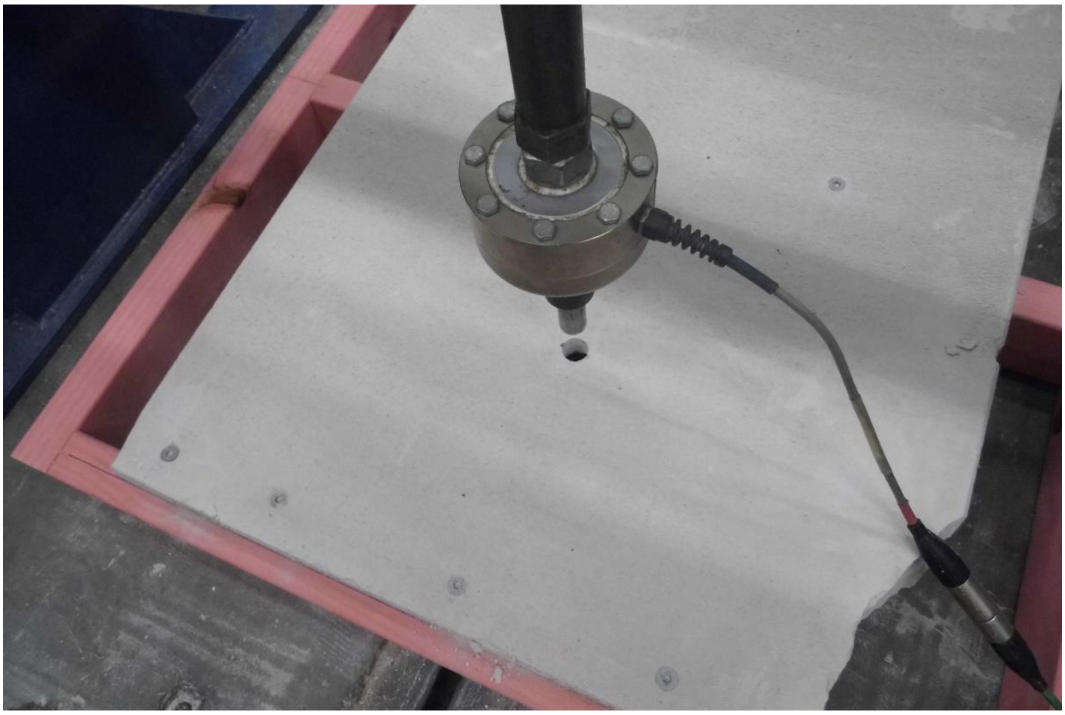

Figure 8 Typical panel failure under the 20 mm diameter foot

Figure 9 Typical view of the underside of the panel after the 20 mm foot punched through

Figure 10 Typical local crushing of the top surface of the panel (100 mm x 100 mm foot)

Figure 11 Typical failure pattern on the underside of the panel (100 mm x 100 mm foot)

5. RESULTS

5.1.1 Uniform distributed load simulation

The results of the uniform distributed load tests on the INTEGRA panels are presented in Table 1. The analysis has been conducted in accordance with Appendix B of

AS/NZS 1170.0:2002 [3]. Clearly, the flexural strength of the panels was well beyond any of the uniformly distributed loading conditions specified in AS/NZS 1170.1:2002.

Table 1 Uniform distributed load test results

Specimen		Peak load (kN)
1		35.1
2		38.1
3		35.5
Mean		36.2
Std dev		1.6
CoV		0.04
k_t (1170.0 App B)		1.15
Design capacity (load on one span)		**15.3**
Negative moment (kNm)		1.3
Equiv w (kN/m)		51.0
UDL (kPa)		**85.0**

5.1.2 Concentrated load simulation

The results of the concentrated load tests are presented in Table 2 for the 20 mm diameter foot and Table 3 for the 100 mm x 100 mm square foot. The design capacity for the 20 mm diameter foot (based on four replicate specimens and a COV of 5.0%) is greater than the factored load from Table 3.1 of AS/NZS 1170.1 for occupancy Type A1 (Self-contained dwellings) including general areas, private kitchens and laundries in self-contained dwellings, but not stairs or landings. The design capacity for the 100 mm x 100 mm square (based on eight replicate specimens and a COV of 16.0%) foot exceeds the factored action of 1.5 x 4.5 kN = 6.75 kN for the other occupancy classes, where 1.5 is the imposed action factor.

Table 2 Concentrated load test results (20 mm diameter foot)

Specimen	Position	Load (kN)
1	1	4.41
1	2	4.28
1	3	4.34
1	4	4.53
Mean		4.39
Std Dev		0.11
CoV		0.02
k_t (1170.0 App B)		1.15
Design capacity		**3.72**

Table 3 Concentrated load test results (100 mm x 100 mm square foot)

Specimen	Position	Load (kN)
2	1	11.11
2	2	10.69
2	3	11.86
2	4	12.3
3	1	13.11
3	2	16.61
3	3	12.97
3	4	15.7
Mean		13.04
Std Dev		2.11
CoV		0.16
k_t (1170.0 App B)		1.42
Design capacity		**7.53**

6. REFERENCES

(1) International Organisation for Standardisation (ISO). 2018. *ISO 7500-1:2018 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 (SNZ). 2002. AS/NZS 1170.1:2002. *Structural design actions Part 1: Permanent, imposed and other actions*. Standards NZ, Wellington, NZ.

(3) Standards New Zealand (SNZ). 2002. AS/NZS 1170.0:2002. *Structural design actions Part 0: General principles*. Standards NZ, Wellington, NZ.