STRUCTURES TEST REPORT

ST10247-001-01

TESTING OF "TIMBA TIE" PILE/BEARER CONNECTIONS FOR DAVID REID BUILDERS

CLIENT
David Reid Builders
69 Archers Road
Auckland 0629
New Zealand

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

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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.

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DOCUMENT REVISION STATUS

ISSUE NO.	DATE ISSUED	DESCRIPTION
01	Click or tap to enter a date.	Initial Issue

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1. OBJECTIVE

The objective of the tests was to assess the structural suitability of the “Timba Tie” timber connector as an alternative to the pile/bearer connection and as a general fixing for use under NZS 3604:2011 [1]. Currently these fasteners are specified in NZS 3604 as wire dogs, also commonly referred to as “Z nails”.

- Details of the ordinary pile/bearer connection are set out in Figure 6.3 (c) of NZS 3604. No performance figures are given to provide a benchmark against which to assess the new fasteners, so tests were carried out to establish the performance of the wire dog connection as specified. Tests were designed to load the connection in a shear direction parallel and perpendicular to the bearer. Both round and square piles were tested.
- The Timba Tie connector is also suitable as a general timber connector, as exemplified by the batten/rafter connection (fixing type T in NZS 3604). Tests were carried out to tests this connection in a tension (pull-off) direction.

2. DESCRIPTION OF SPECIMEN

2.1 Product description

The Timba Tie is a length of galvanised steel wire bent into a double loop arrangement as shown in Photograph 1 and is intended to perform a similar function as a wire dog (or Z nail). The wire measured 4.4 mm diameter (over galvanising), the fastener measured 110 mm long over the loops and was supplied with 2 hex head self drilling wood screws. The screws measured 5.6 mm diameter (outside of threads) and were 35 mm long.

Photograph 1 Timba Tie with screws as received

2.2 Specimen construction

Nine configurations of test specimens were constructed, as described in Table 1:

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Table 1. Test schedule

Test	Configuration	Member 1	Member 2	Fastener	Load direction	Number of replicates
A	Pile/bearer	Round pile	90x45	3604*	Parallel bearer	5
B	Pile/bearer	Round pile	90x45	Timba Tie	Parallel bearer	5
C	Pile/bearer	Square pile	90x45	3604*	Parallel bearer	5
D	Pile/bearer	Square pile	90x45	Timba Tie	Parallel bearer	5
E	Pile/bearer	Round pile	90x45	3604*	Perpendicular bearer	5
F	Pile/bearer	Round pile	90x45	Timba Tie	Perpendicular bearer	5
G	Pile/bearer	Square pile	90x45	3604*	Perpendicular bearer	5
H	Pile/bearer	Square pile	90x45	Timba Tie	Perpendicular bearer	5
I	Purlin/rafter	90x45	90x45	Timba Tie	Tension	30

Note: * NZS 3604 connections are 2 wire dogs and 2 skew nails [1].

3. DESCRIPTION OF TESTING

3.1 Date and location of test

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

3.2 Test set-up

Two configurations were used for the tests as follows:

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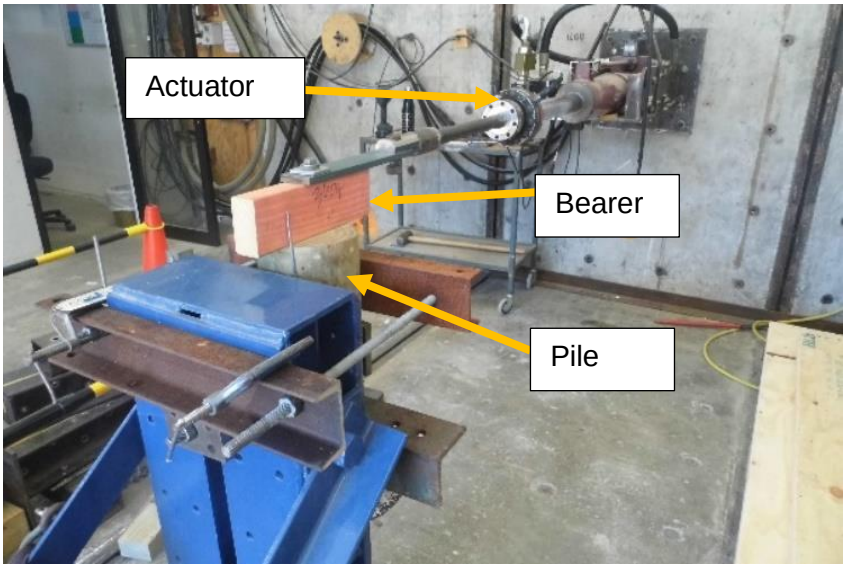
1. Pile to bearer configuration

Piles (round and square) were clamped in a vertical orientation to a buttress fixed to the laboratory strong floor (Photograph 2).



Photograph 2. Test set up for pile to bearer connection (parallel to bearer shown)

Short lengths of 90 x 45 bearer were attached to the top of the pile using either the standard NZS 3604 details (2 skew nails plus 2 wire dogs), or two Timba Tie connectors. The bearers were fixed parallel or perpendicular to the loading direction. These combinations are set out in Table 1.

Load was applied to the bearer by a closed loop servo-hydraulic actuator through a steel link bar fixed to the top of the bearer (shown in Photograph 2). Applied loads were measured using a 25 kN load cell, and a linear potentiometer internal to the actuator was used to measure the horizontal displacement of the bearer.

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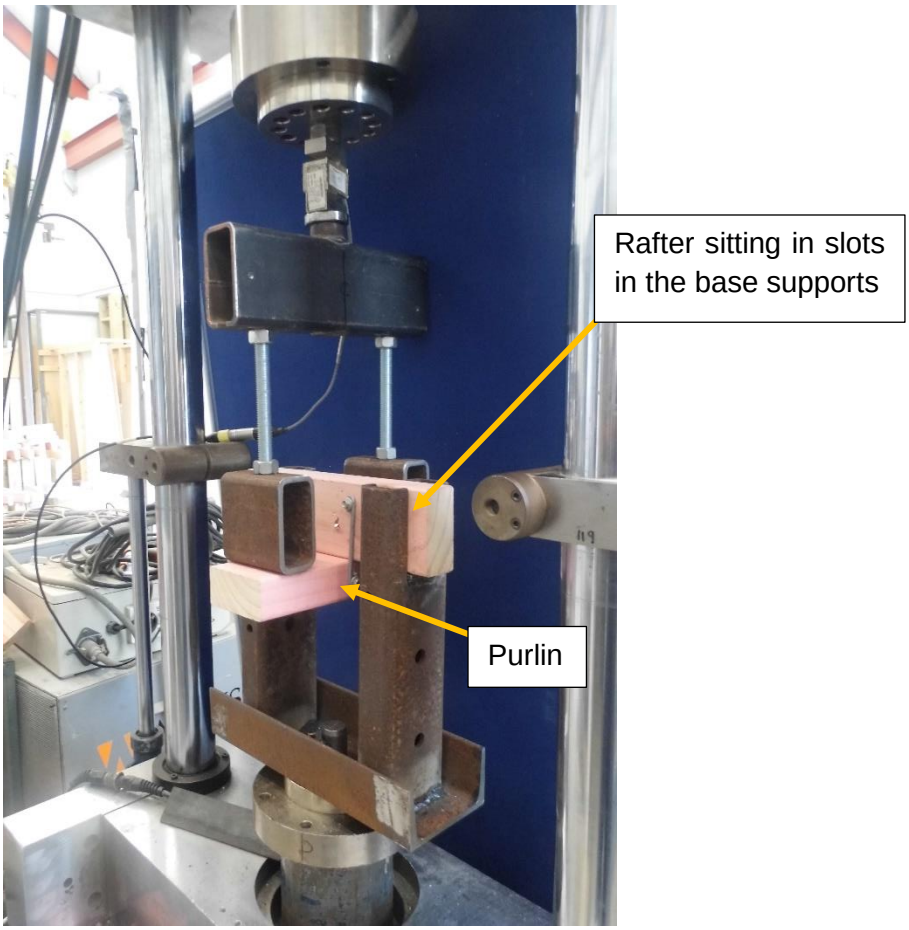
2. Purlin to rafter configuration.

The purlin to rafter specimens were tested in a Dartec Universal Testing Machine by supporting the rafter on the base of the machine, with a load bridge attached to the machine crosshead to push the purlin off the rafter. A view of the set up may be seen in Photograph 3. Applied loads were measured using a 10 kN load cell. A linear potentiometer reading the machine crosshead movement was used to measure the vertical displacement of the purlin. The potential eccentricity of some of the specimens required additional support to keep the members in correct alignment as they would be in a normal roof situation where support is provided by roofing and other framing. This was achieved by cutting slots in the base supports, as can be seen in Photograph 5.



Photograph 3. Test set up for purlin to rafter connection

For all configurations, load and displacement measurements were recorded using a computer-controlled data acquisition system. Both load cells were calibrated to International Standard EN ISO 7500-1:2015 [2] Grade 1 accuracy and the linear potentiometers were calibrated to an accuracy of 0.2 mm.

3.4 Test procedure

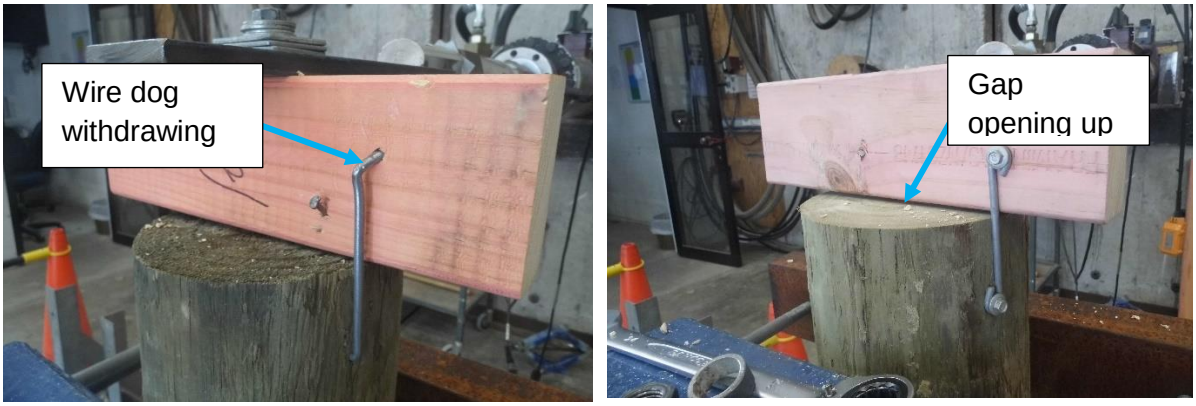
The pile to bearer connection configuration required an assessment of seismic loading, so the loading regime consisted of 3 displacement-controlled cycles of the bearer to displacements of ±5 mm, ±10 mm, ±15 mm, ±20 mm at a load rate of 5 seconds per cycle.

The purlin/rafter configuration, representing wind uplift was tested monotonically at a load rate of 10 mm per second.

4. OBSERVATIONS

4.1 Pile to bearer

Both the wire dog and the Timba Tie bent to accommodate the reversing displacement, and at the end of the test the wire dog and skew nail in the 3604 detail worked their way partly out of the timber (Photograph 4). The Timba Tie connection also lifted off the pile somewhat (Photograph 4 right) although no specimens became detached over the full duration of the testing.



Photograph 4. Pile to bearer connectors during shear testing. Left: Z nail withdrawing from bearer. Right: Bearer separating from pile during the Timba Tie testing.

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4.3 Purlin to rafter

For the purlin to rafter configuration, the screws withdrew from the timber and the joint pulled apart with some specimens suffering severe splitting of the timber (see Photograph 5).

Photograph 5. Purlin to rafter connection under a pull-off test.

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6. RESULTS

6.1 Pile to bearer connection tests

A representative plot of load against deflection for the pile to bearer tests is shown in Figure 1.

Figure 1. Representative load/deflection plot for pile to bearer test

The peak loads resisted during the third deflection cycle of each specimen (shown as the horizontal blue and grey lines in the plot) were extracted from the measurements, and the positive and negative values averaged. The averages for each specimen were tabulated, and the sample standard deviation calculated for the five results to get a measure of the variability of the joint. The results for each configuration are presented in Table 2. For most configurations, the Timba Tie mean values were slightly higher than the Z nail values, but the differences are not significant, considering the small size of the sample.

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Table 2. Results summary for pile to bearer tests

Round pile, parallel to bearer			Square pile, parallel to bearer		
Test	**NZS 3604**	**Timba Tie**	**Test**	**NZS 3604**	**Timba Tie**
1	3.2	3.6	1	3.2	2.7
2	2.8	2.7	2	2.8	2.2
3	3.0	2.8	3	3.3	2.9
4	2.4	2.9	4	3.6	3.2
5	3.1	3.7	5	3.3	2.6
Mean	2.9	3.1	Mean	3.2	2.7
Stddev	0.32	0.47	Stddev	0.29	0.37
Cov	0.11	0.15	Cov	0.09	0.14
Round pile, perpendicuar to bearer			**Square pile, perpendicular to bearer**		
Test	**NZS 3604**	**Timba Tie**	**Test**	**NZS 3604**	**Timba Tie**
1	1.8	2.5	1	2.4	2.5
2	1.6	2.3	2	2.7	2.8
3	2.2	2.3	3	2.3	2.6
4	2.3	2.4	4	2.2	2.9
5	2.2	2.2	5	2.2	2.5
Mean	2.0	2.3	Mean	2.4	2.7
Stddev	0.30	0.11	Stddev	0.21	0.18
Cov	0.15	0.05	Cov	0.09	0.07

6.3 Purlin to rafter tests

A representative plot of load against deformation for the purlin to rafter tests is shown in Figure 2.

Figure 2. Typical load/deformation plot for purlin to rafter connection tests

Peak loads recorded for each specimen are presented in Table 3, together with the statistical data required to calculate the characteristic load according to BRANZ Evaluation Method EM1:

Characteristic value: $R_k = (1- \frac{2.7v}{\sqrt{n}})xP_{05}$

where v = coefficient of variation of the sample

n = number of specimens in the sample

P_{05} = mean – 1.65 x std deviation.

The equation in clause 2.4.7 of NZS 3604 was then used to calculate the connector capacity R, using a value for ϕ of 0.7, taken from NZS 3603 (other fasteners).

R = 5.94 x 0.7 = 4.16 kN.

This compares with the value of 2.4 kN for fixing T from Table 2.2 of NZS 3604.

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Table 3. Summary of purlin rafter connection test results

Specimen	Peak load				
1	6.75				
2	6.89				
3	7.76				
4	6.45	Mean peak load		7.35	kN
5	7.81	Std. deviation		0.68	kN
6	7.75	Coef of variation		0.09	
7	6.80		P_{05}	6.22	kN
8	8.62		R_k	5.94	kN
9	6.40				
10	6.92				
11	6.07				
12	7.19				
13	7.17				
14	7.51				
15	6.96				
16	7.10				
17	7.19				
18	7.07				
19	7.58				
20	6.73				
21	7.39				
22	6.97				
23	8.03				
24	6.85				
25	8.85				
26	7.84				
27	7.97				
28	8.89				
29	7.04				
30	7.91				

7. SUMMARY

Timba Tie pile to bearer connectors were tested in shear parallel and perpendicular to the bearer on square and round piles and compared with the equivalent Z nail connections from NZS 3604. The difference in strength was not significant, indicating that the Timba Tie connector can be used as a substitute in NZS 3604.

Timba Ties were tested in purlin to rafter connections (joint T from Table 2.2 of NZS 3604) and the results analysed using the equation in clause 2.4.7 of NZS 3604. The calculated capacity was 4.16 kN, which is greater than the alternative fixing capacity in Table 2.2.

8. REFERENCES

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

[2] 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.

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