CYCLONE TESTING STATION

WITHDRAWAL STRENGTH OF

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WITHDRAWAL STRENGTH OF GROOVED NAILS IN PINE

Part 1 - Results and Analysis

G.F. Reardon

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SUMMARY

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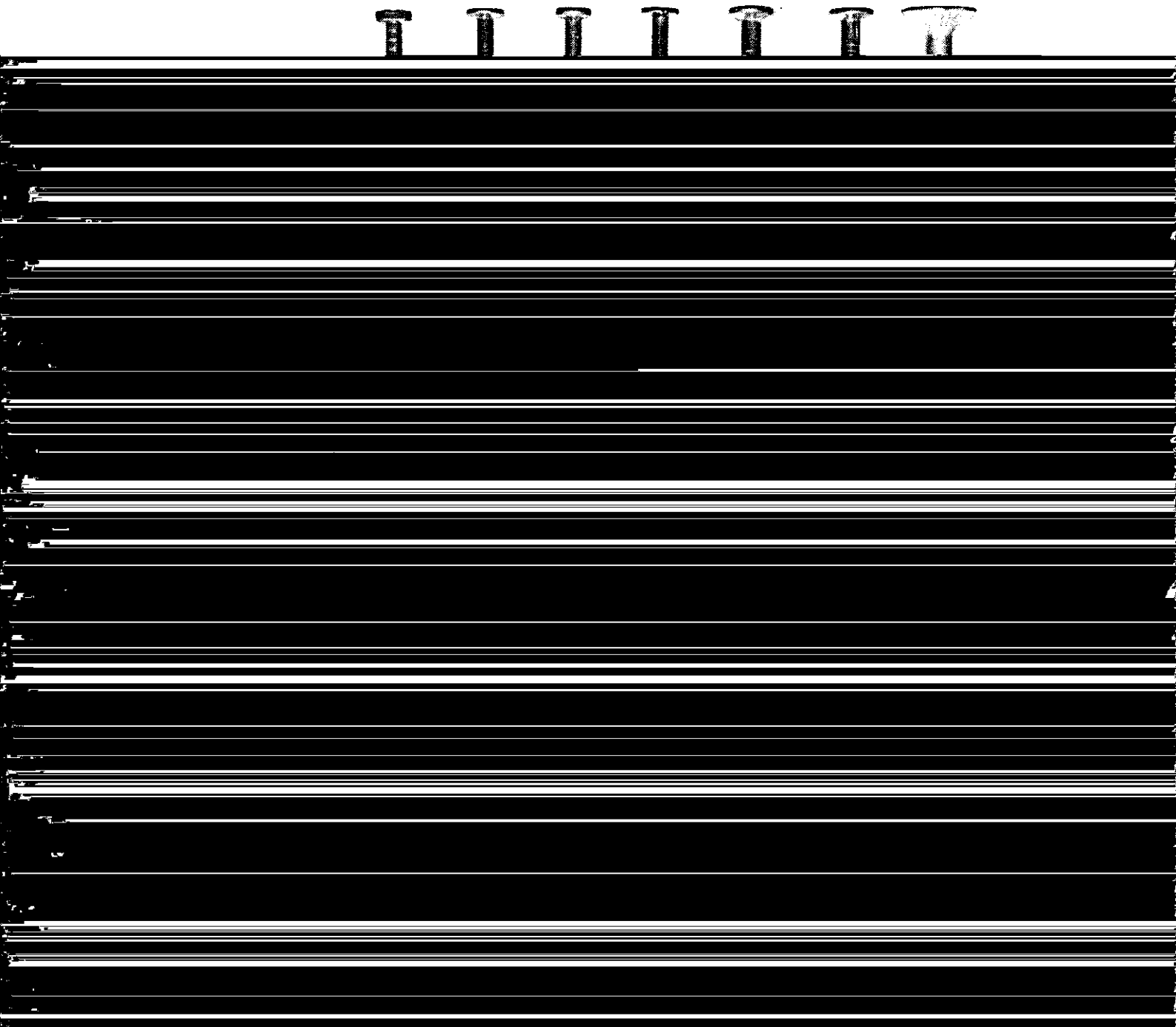
1. INTRODUCTION

Over the past eight or nine years the manufacturers of roofing materials have significantly improved the capacity of fasteners used to secure roofing to roof structure. It is now common for roofing fasteners or tile clips to be tested for cyclone conditions by applying a series of load cycles. This research is meant to ensure that the roofing remains securely anchored to the house during a wind storm. However all that is really achieved is that the

2. TEST PROGRAMME

2.1 Details of Nails

Six different types of grooved nail were included in the programme. All were nominally 75 mm long and had measured diameters varying from 3.1 to 3.75 mm on the plain portion of the shank. The nails were supplied by Able Staples, Bostitch, Jambro, National and Sidney Cooke. Two different types of Jambro nail were included. Figure 1 shows the different nails. Both the National and the Sidney Cooke nail were hand driven whereas the others were driven by nailing guns supplied by the manufacturer.



Number and length: 56 grooves in 44 mm

(b) Bostitch - power driven

Length: 75 mm from point to top of head

Diameters: 3.2mm at shank, 3.4 mm on grooves

Type of groove: annular, double

Number and length: 29 grooves in a section 20 mm from the start of the point,7 mm plain shank, 18 grooves in next 14 mm.

(c) Lambye Square - power driven (Lambye 1)

power driven nails, except the Jambro annular, had part of the head removed so that the nails could be closely stacked in line in the gun magazines. The Jambro uses coil stacking. The number of grooves stated above may occasionally be in error as they were difficult to count.

As well as the six grooved nails, a 75 x 3.75 plain shank nail was included in the test programme. This was used as a datum against which the performance of the grooved nails could be measured. It is called the "control nail" in the results.

2.2.2 Density

It has long been accepted that strength properties of timber are proportional to density. Mack (1979) shows that average withdrawal loads for plain shank nails and screws are also proportional to density, on a logarithmic basis. In an earlier publication (Mack, 1978) he proposed revised limits for joint strength

example Kingston and Risden (1961) measured air dry density samples from 46 different trees of plantation grown radiata pine as having a mean of 593 Kg/m^3. Bolza and Kloot (1963) measured samples from 78 trees to obtain a mean value of 506 Kg/m^3. TRADAC (1980) publish a value of 540 Kg/m^3, from Queensland Department of Forestry data. One would expect much closer agreement of mean

TABLE 2

MEAN DRY DENSITIES OF SPECIES TESTED

[redacted]

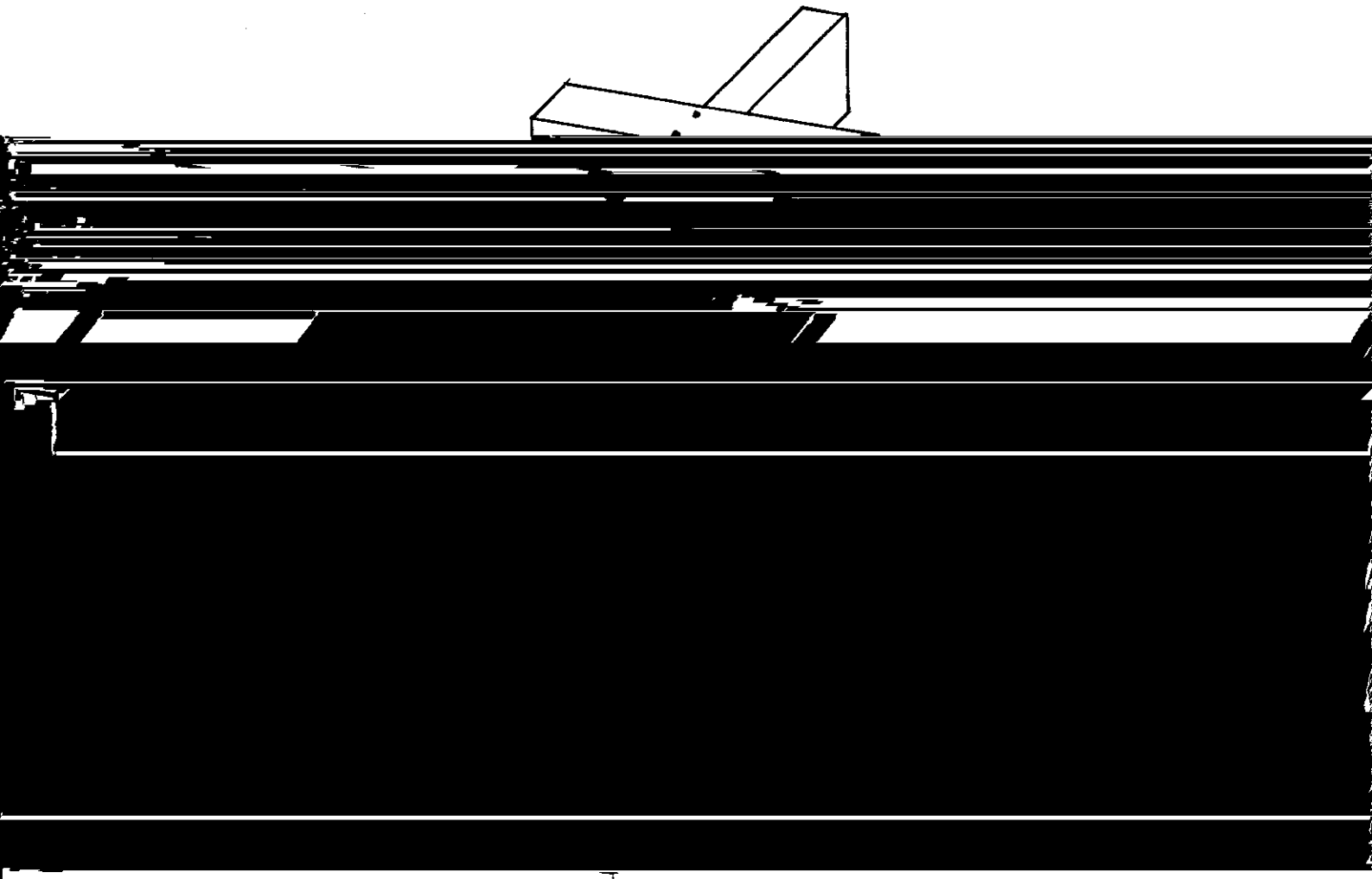


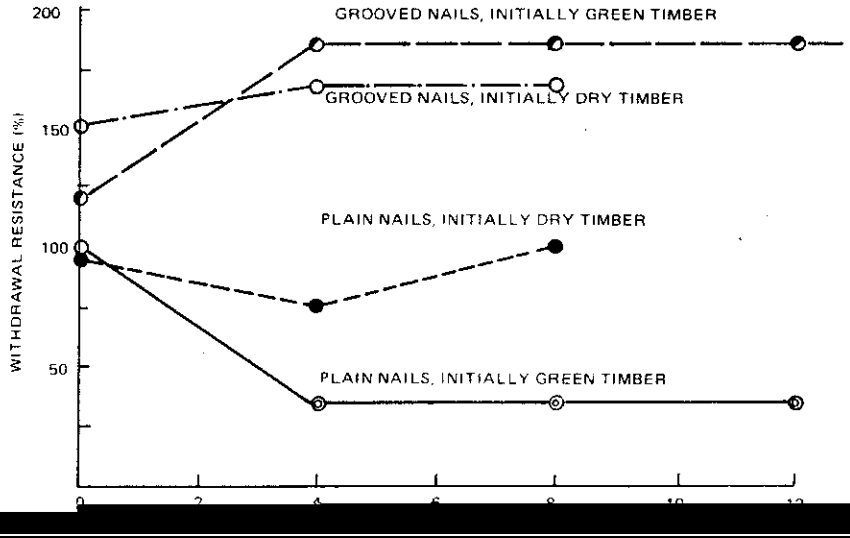
FIGURE 2 Typical test joint.

number 14 screw driven through 38 mm thick hardwood battens into the pine rafters. Only ten replications of this type of joint in each species were tested.

It should be noted that for conventional steel wood screws, with cut threads, the size number relates to the shank diameter which is the same as the thread diameters. A number 14 wood screw has a nominal shank diameter of 6.3 mm. This is not the case with self drilling "type 17" screws which have rolled threads. The screw number is apparently related to the outer diameter of the thread. A "type 17" screw of number 14 size has a shank diameter of about 5.1 mm.

2.5 Departures from Code Specifications.

used for withdrawal tests. A pair of nails representing a real joint was considered more appropriate for these tests. Also the joints were not conditioned in an atmospheric environment controlled to 20°C and 65% relative humidity, as such facilities were unavailable.


GROOVED NAILS, INITIALLY GREEN TIMBER
GROOVED NAILS, INITIALLY DRY TIMBER
PLAIN NAILS, INITIALLY DRY TIMBER
PLAIN NAILS, INITIALLY GREEN TIMBER
WITHDRAWAL RESISTANCE (%)
200
150
100
50
0
2
4
6
8
10
12

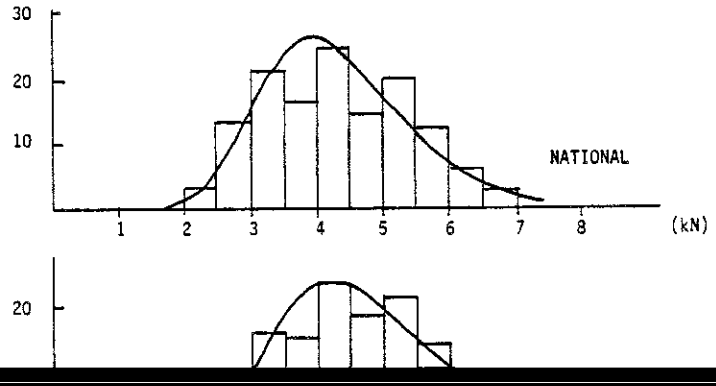
pitch of grooves,
total length of grooves.

Depth of penetration is also a parameter affecting withdrawal resistance,

[redacted]

TABLE 3

AVERAGE FAILING LOADS FOR DOUBLE NAILED JOINTS


30
20
10
NATIONAL
1
2
3
4
5
6
7
8
(kN)
20

the amount of scatter for each nail in all of the species, that is 132 results per nail type.


WAL RESISTANCE, Rdi (N/mm)
100
90
80
70
60
50
40

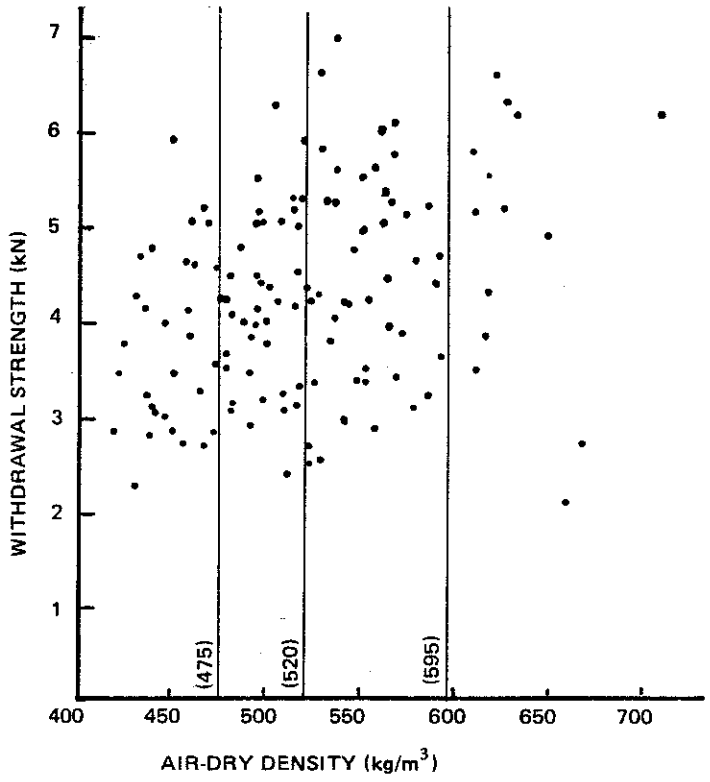


FIGURE 7 Plot of withdrawal resistance of National nails and air dry density.

[redacted]

in Table 4 are the positions in ascending order from minimum to maximum withdrawal load for each of the nail types in Caribbean pine, eg. for the

one must assume that it affected the holding power of the nails, possibly offering some form of lubrication.

In contrast, stick 10 had very high holding power, and a reasonably high density.

[redacted]

TABLE 5

RESULTS OF SCREWED JOINTS
(One 14 x 75 mm "Type 17" screw per joint)

Timber species	Average Withdrawal Load (kN)	C. of V. (%)	one percentile (kN)
radiata	6.07	16	3.78
hoop	6.61	19	3.76

5.2 Design Loads for each Species

The design load calculated for each type of nail in each species is listed in Table 6. This information could be used when the designer is sure that a particular species of pine would be used, for example radiata pine in Adelaide.

TABLE 6
DESIGN LOADS FOR DOUBLE NAILED JOINTS
IN INDIVIDUAL SPECIES OF DRY PINE

Species of pine	Design Loads (kN)						
	Control	National	Sid Cooke	Bostitch	Able	Jambro 1	Jambro 2
radiata	0.34	0.92	1.45	0.80	0.89	0.46	1.28
hoop	0.72	1.74	2.00	0.96	0.81	0.55	1.08
Caribbean	0.40	1.30	1.90	0.98	0.78	0.29	1.58
slash	0.37	1.40	1.44	1.08	0.78	0.30	0.64
loblolly	0.35	1.02	1.14	0.68	0.81	0.54	1.00
s.p.f.	0.42	1.30	1.26	0.67	0.61	0.28	1.16
patula	0.32	1.03	0.99	0.58	0.87	0.50	1.08

calculated design load for each joint type are listed in Table 7

[redacted]

IN STRENGTH GROUP JD4
(based on density range 475-520 kg/m^3)

	Control	National	Sid Cooke	Bostitch	Able	Jambro 1	Jambro 2

Of the 132 sticks of seasoned pine used in these experiments, only 87 were within the specified density range for JD4 (see Table 1). Of those, 40 were within the specified range for test and the results of those 40 have been

92 tests on each nailed joint type have been disregarded in the calculation of design load. An investigation has therefore been made into the statistics of these discarded results to compare them with the "chosen 40".

TABLE 8

STATISTICS FOR DOUBLE NAILED JOINTS IN
IN DIFFERENT DENSITY RANGES

Density		Control	National	Sid Cooke	Bostitch	Able	Jambro 1	Jambro 2
	Mean (kN)	1.73	4.91	5.69	3.67	3.87	1.93	3.92
above	C of V	24.0	34.1	21.3	29.6	34.7	41.5	22.1

TABLE 9

DESIGN LOADS FROM DIFFERENT PERCENTILE VALUES

	Design Loads (kN) for						
	Control	National	Sid Cooke	Bostitch	Able	Jambro 1	Jambro 2

TABLE 11

DESIGN LOADS FOR 14 x 75 mm SCREWS IN JD4 TIMBER

	Based on current code	Based on draft code
[redacted]		

Reardon, G.F. (1979a). "The Strength of Batten-to-rafter Joints. Part 1 - Test results and derivation of design loads", Technical Report No. 2, James Cook Cyclone Structural Testing Station.

Reardon, G.F. (1979a). "The Strength of Batten-to-rafter Joints. Part 2

APPENDIX A

The appendix contains the raw data obtained from the tests described in this report.

TABLE A1
DENSITIES OF TEST STICKS

Stick Number	Density (kg/m^3) at 12% moisture content.						
	Radiata	Hoop	Caribbean	Slash	Loblolly	SPF	Patula
1	609	430	555	509	666	505	570
2	521	536	462	560	584	474	472
3	566	465	494	551	564	542	461
4	534	485	625	561	492	501	457
5	534	468	514	517	511	494	437
6	524	550	497	517	498	436	481
7	523	481	546	558	528	424	438

[redacted]

TABLE A3

WITHDRAWAL LOADS PER DOUBLE NAILED JOINT
OF SEASONED PINE SPECIES

NAILS: National, 2-75 x 3.75 mm

Stick Number	Withdrawal Load (kN) in pine species						
	Radiata	Hoop	Caribbean	Slash	Loblolly	SPF	Patula
1	3.52	4.26	5.66	3.25	2.72	4.22	3.90
2	4.35	5.60	4.47	5.05	3.25	4.56	2.83
3	5.78	5.20	4.48	4.97	3.97	2.94	4.60
4	5.27	4.81	5.21	5.38	2.92	4.39	4.65
5	5.29	5.05	4.17	5.30	2.41	5.04	2.83
6	3.36	4.92	4.40	5.01	3.18	3.22	4.46

TABLE A4

WITHDRAWAL LOADS PER DOUBLE NAILED JOINT
OF SEASONED PINE SPECIES

NAILS: Sidney Cooke, 2-75 x 3.75 mm

Stick	Withdrawal Load (kN) in pine species						
[redacted]							

TABLE A5

WITHDRAWAL LOADS PER DOUBLE NAILED JOINT
OF SEASONED PINE SPECIES

NAILS: Bostitch, 2-75 x 3.2 mm

[redacted]

TABLE A6

WITHDRAWAL LOADS PER DOUBLE NAILED JOINT
OF SEASONED PINE SPECIES

NAILS: Able Staple, 2-75 x 3.1 mm

Stick Number	Withdrawal Load (kN) in pine species						
	Radiata	Hoop	Caribbean	Slash	Loblolly	SPF	Patula

TABLE A7

WITHDRAWAL LOADS PER DOUBLE NAILED JOINT
OF SEASONED PINE SPECIES

NAILS: Jambro square, 2-75 x 3.1 mm

Stick	Withdrawal Load (kN) in pine species

TABLE A8

WITHDRAWAL LOADS PER DOUBLE NAILED JOINT
OF SEASONED PINE SPECIES

NAILS: Jambro annular, 75 x 3.2 mm

Stick Number	Withdrawal Load (kN) in pine species						
	Radiata	Hoop	Caribbean	Slash	Loblolly	SPF	Patula

TABLE A9

[redacted]