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The decay resistance of Poplar in an accelerated framing test

The condition of samples after 24 months exposure

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Report information sheet

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Executive summary

Samples of untreated and boron-treated Poplar were provided by Northland Regional Council to determine the decay resistance using an accelerated decay framing test. Untreated and boron-treated radiata pine samples were also provided by Northland Regional Council. Untreated radiata pine from a Central North Island sawmill was included in this study.

The method of testing followed the procedure described in the Australasian protocols, in this case for the Hazard class H1.2. This test method simulates the common framing joint in house framing between studs and plates, where in a leaky building, moisture may become trapped and provide suitable conditions for fungi to establish.

Before exposure in the high humidity conditions, samples were soaked in water for two hours. All of the framing samples were periodically sprayed with water at approximately two weekly intervals to maintain the moisture content of the timber at a level suitable for decay to develop and progress. Samples were assessed and reported after twelve months exposure, and the trial was continued for a further twelve months.

After twenty-four months of exposure:

- Most of the untreated Poplar samples had failed due to decay.
- Decay had not developed on the boron-treated Poplar.
- The untreated radiata pine from Northland and Central North Island had failed due to decay or had severe decay.
- No decay was found on the boron-treated radiata pine.

The decay resistance of Poplar in an accelerated framing test

The condition of samples after 24 months exposure

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Introduction

This trial was established to determine the decay resistance of untreated and boron treated Poplar. Samples were supplied by Northland Regional Council, and were exposed in an accelerated decay test developed by Scion (Singh, Page and van der Waals; 2014) and described in the Australasian protocols for assessment of wood preservatives (Australasian Wood Preservation Committee; 2015). Untreated and boron treated radiata pine was also included in the study. This test method simulates the common framing joint in house framing between studs and plates, where in a leaky building with moisture problems, moisture may become trapped providing suitable conditions for fungi to establish. Results have been previously reported for exposure for twelve months (Simpson and Singh; 2022).

This report presents results after twenty-four months exposure in accelerated decay conditions.

Materials and methods

Preparation of samples

Northland Regional Council supplied two sets of NZ grown Poplar, one set was untreated and the other set was boron treated. Northland Regional Council also supplied two sets of radiata pine, one set was untreated and the other set was boron treated (Table 1). A set of untreated radiata pine sourced from a Central North Island sawmill was also included in this study. The dimensions of all samples were 90 x 45 mm. Appendix 1 shows the matching between the sample ID used in this study and the label assigned to the original piece of timber by Northland Regional Council.

Table 1: Summary of the groups of samples

Group	Number of samples	Sample ID's
Poplar, untreated	10	11 to 20
Poplar, boron treated	10	1 to 10
Radiata pine, untreated – Supplied from Northland	10	31 to 40
Radiata pine, untreated – Sourced from Central North Island	10	41 to 50
Radiata pine, boron treated	10	21 to 30

After discarding 50 mm from an end, cross sections were cut from the treated samples for preservative analysis. A 100 mm long block was then cut from both ends of all samples, and both ends of the 100 mm block were end coated. The 100 mm blocks were then stapled across the ends of the 650 mm long sample to form an "I" shape.

The "I" shaped samples were soaked in a tank of water for 2 hours until the weight of the sample approached the estimated weight equivalent to 30% moisture content. The soaking also aims to simulate rain wetting that may occur during building construction.

Feeder blocks were inoculated with two brown rot fungi *Antrodia xantha* and *Oligoporus placenta* (isolated from New Zealand leaky buildings). Individual fungi were grown in the laboratory on the feeder blocks for 4 weeks.

A feeder block inoculated with each fungus was nailed to the face of each "I" sample near the joint with the 100 mm end block, with *A. xantha* fungus attached near one end of the sample and *O. placenta* fungus attached near the other end of the sample.

The "I" frame samples were stacked in the Accelerated Decay House (a controlled environment room maintained at 25 - 27°C with more than 85% relative humidity). All the samples were sprayed with water at approximately two weekly intervals to maintain the wood moisture content at a level suitable for decay to progress. The intention is to keep the timber's

moisture content above 30% to ensure maximum fungal growth as would be the case with a weather tightness failure or leaks from water pipes.

This trial was assessed and reported after twelve months exposure (Simpson and Singh; 2022). The trial was continued for a further twelve months and results after twenty-four months exposure are now reported.

Assessment methods

At assessment time, samples were removed from the stack and assessed for spread of mycelium from the feeder blocks. The surfaces of each sample were tested with a blunt probe to determine whether the decay fungi were damaging the framing. Staples were removed from one end of the sample so that the end joints could be opened, and the internal joint area could also be assessed for decay. Samples were also visually assessed for mould and surface mycelium.

Mould and surface mycelium are common in damp environments. The presence of mould and surface mycelium can provide an optimal environment for the initiation of decay. However, the presence of surface mycelium or mould does not always indicate that decay is present or likely to occur.

The rating systems (ASTM D 1758) for the deterioration were as follows:

Description of assessment ratings

Mycelium spread

1 No mycelium development onto the sample surface from the feeder block.
2 Mycelium growth from the feeder block onto the surface, spread less than 5 mm.
3 Mycelium from the feeder block on the surface, spread 5 - 50 mm.
4 Active mycelium from the feeder block on the surface, spread greater than 50 mm.
5 Extensive mycelium over the sample surface, less than 50% of the surface area.
6 Extensive mycelium over the sample surface, more than 50% of the surface area.

Decay ratings

10 No decay or insect damage.
T Trace, discolouration, mycelium or softening, not positively identified as decay.
9 First stages of decay, small areas, not more than 1 mm deep.
8 Lightly established decay, patches 1 - 5 mm deep.
7 Well established decay, extensive surface decay or patches to 20 mm deep.
6 Established and progressive decay over wide areas, greater than 20 mm deep.
4 Severe decay over the majority of the surface with patches more than 40 mm deep.
0 Failed. Decay completely through the sample.

Mould ratings

1 No perceivable mould.
2 Light mould in small patches or widely scattered spots.
3 Extensive mould as numerous scattered spots or widespread light mould.
4 Severe mould, up to 50% of the surface covered.
5 Severe mould, more than 50% of the surface covered.

Results and discussion

Boron retention

Table 2 shows the results of the boron analysis of samples as received. The full report is contained in Appendix 2.

Table 2: Summary of boron analysis and sapwood percentage (10 samples in each group)

Group	Mean calculated retention in cross section (% m/m BAE)		Sapwood (%)
	Cross section	Central 9th	
Poplar, boron treated	0.96	0.51	70
Radiata pine, boron treated	0.89	0.19	48

All of the boron-treated Poplar had more than 0.40% BAE (boric acid equivalent). All of the boron treated radiata pine samples met the cross-section retention requirements for H1.2 specification.

Assessment results

Assessment results for each group after twenty-four months exposure are summarised in Table 3. Full assessment results for individual samples are listed in Appendix 3.

Table 3: Summary of assessment results after twenty-four months exposure.

Group and treatment	Mycelium (Lower rating is better)		Decay – Surface (Higher rating is better)		Decay – Joint (Higher rating is better)		Mould (Lower rating is better)	
	Op[1]	Ax[1]	Op	Ax	Op	Ax	Op	Ax
Poplar, untreated	4.4	4.5	1.2	0.6	0.8	0.4	4.6	4.1
Poplar, boron treated	1.1	1.1	10.0	10.0	10.0	10.0	1.6	2.0
Radiata pine, untreated – Supplied from Northland	5.7	5.0	0.4	0.4	0.4	0.6	2.4	3.1
Radiata pine, untreated – Sourced from Central North Island	5.6	3.9	1.3	3.2	0.6	2.6	4.3	4.3
Radiata pine, boron treated	1.3	1.0	10.0	10.0	10.0	10.0	2.6	3.0

[1] Op and Ax represent different ends of the "I-frame" samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.

The untreated Poplar samples had extensive mycelium on the surface (Figure 1). Nine of the ten untreated Poplar samples failed due to decay on the surface or in the joint, with the tenth sample containing severe decay (Figure 2). Extensive mould was observed on many of the untreated Poplar samples (Table 1).

The boron-treated Poplar samples did not have mycelium on the surface (Figure 3). No decay was observed on any of the boron-treated Poplar samples (Figure 4). Minor mould was observed on some of the boron-treated samples (Table 1)

The untreated radiata pine supplied from Northland or Central North Island had extensive mycelium at both feeder blocks (Figure 5). Eight of the ten untreated radiata pine samples from Northland failed due to decay after twenty-four months exposure, and the remaining samples failed at one end of the sample and had severe decay at the other end (Figure 6). Two of the ten untreated radiata pine samples from Central North Island had failed due to decay and the remaining samples

had failure due to decay at one end of the sample and contained established or severe decay at the other end.

Most of the boron-treated radiata pine samples did not have mycelium growth on the surface. No decay was observed on any of the boron-treated radiata pine samples (Figure 7). Minor to establish mould was observed on some of the boron-treated radiata pine samples (Table 1).

Conclusions

After twenty-four months exposure:

- Severe decay had developed on the untreated Poplar samples with most of the samples failing due to decay.
- No decay was observed on any of the boron-treated Poplar samples.
- Severe decay had developed on the untreated radiata pine from Northland and Central North Island, with many of the samples failing due to decay.
- No decay was observed on any of the boron-treated radiata pine samples.

References

Australasian Wood Preservation Committee; 2015. Protocols for assessment of wood preservatives.

Simpson, I. & Singh, T.; 2022. The decay resistance of Poplar in an accelerated framing test. The condition of samples after 12 months exposure. Report prepared for Northland Regional Council, June 2022.

Singh, T., Page, D. & van der Waals, J.; 2014. The development of accelerated test methods to evaluate the durability of framing timber. International Biodeterioration & Biodegradation 94: 63-68.

Figure 1: Untreated Poplar sample with extensive mycelium at the Op end (sample 13).

Figure 2: Untreated Poplar sample with failure due to decay on the surface at both ends (sample 16).

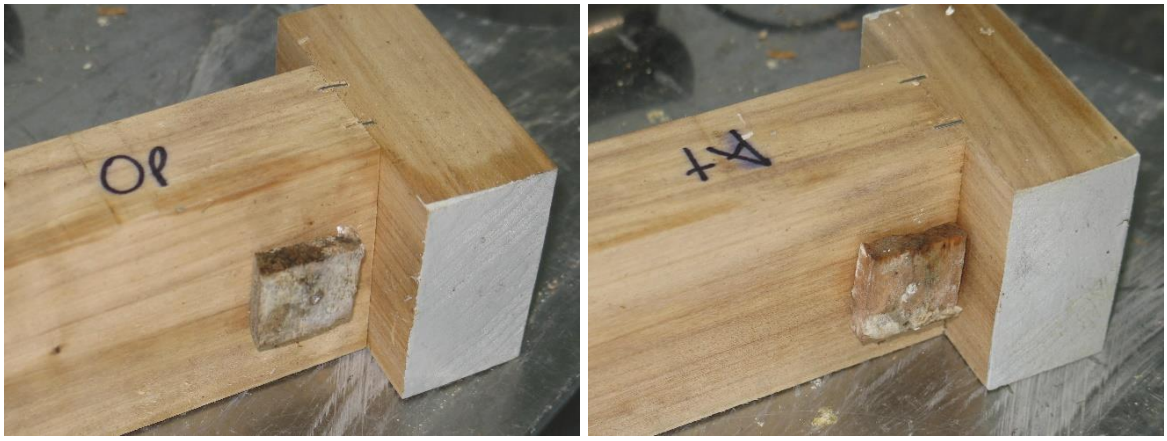

Figure 3: Boron treated Poplar sample with minor mould and no mycelium at either feeder block (sample 7).

Figure 4: Boron treated Poplar sample without decay on the surface or in the joint at either end (sample 9).

Figure 5: Severe mycelium on both ends of a sample of untreated radiata pine from Northland (sample 31).

Figure 6: Untreated radiata pine from Northland with decay to full depth at both ends (sample 39).

Figure 7: Established mould but no decay observed on boron treated radiata pine sample (sample 30).

Appendix 1: Allocation of samples

Table 4 shows the matching between the sample ID used in this study and the label assigned to the original piece of timber by Northland Regional Council.

Table 4: Allocation of samples

Sample ID	Original label
Poplar, boron treated	
1	KT4-1
2	KT4-3
3	KT14-1
4	KT17-1
5	KT15-2
6	KT17-1
7	KT15-2
8	KT14-1
9	KT4-3
10	KT14-1
Radiata, boron treated	
21	TR1
22	TR2
23	TR3
24	TR4
25	TR1
26	TR2
27	TR3
28	TR4
29	TR3
30	TR4

Sample ID	Original label
Poplar, untreated	
11	K4-1-1
12	K4-4-1
13	K8-2-1
14	K8-2-2
15	K8-3-1
16	K11-1-1
17	K12-3-1
18	K17-2-1
19	K17-3-1
20	K17-3-2
Radiata, untreated - Northland	
31	URH/S
32	URH1
33	URH1
34	URH2
35	URH2
36	URS1
37	URS2
38	URS3
39	URS3
40	URH/S

Appendix 2: Analysis results and spot tests (samples as received before the exposure trial)

Table 5: Retention in cross section and central 9th (% m/m BAE)

Sample ID	Cross section BAE (%m/m)	Central 9th BAE (%m/m)	Sapwood (%)
Poplar, Boron treated			
1	1.21	0.49	10
2	0.62	0.32	95
3	0.83	0.39	60
4	0.83	0.34	85
5	0.99	0.65	50
6	0.71	0.34	85
7	1.65	1.14	60
8	0.9	0.58	75
9	0.68	0.29	100
10	1.19	0.59	75
Radiata pine, Boron treated			
21	No sample	0.38	0
22	0.85	<0.01	25
23	1.01	0.4	100
24	0.93	0.08	50
25	No sample	0.15	0
26	0.64	0.02	55
27	0.94	0.42	100
28	0.9	0.01	10
29	1.08	0.36	75
30	0.78	0.08	65

Note: ‘No sample’ means that there was no sapwood for the Cross section analysis.

Timber Testing Report

Applicable Standard NZS 3640: 2003

Client	Scion	Site	Rotorua
Address:	49 Sala Street, Private Bag 3020, Rotorua		

Plant No.	.	Charge No.	Ian Simpson	Job Reference	56769A
Preservative	Boron	Hazard Class	H 1.2	Species	Poplar
Date Treated	15/06/2021	Date sampled	15/06/2021	Sample Type	X-Section
Product Description	Poplar boron treated, HWSW and spot P, retention (SW only) and P by Lab on central 9th.			Sawn timber in final size/shape/form	
				New Zealand	

Test Results

Test Type Sample	Sapwood %	Penetration Spot Test	Central 9th Penetration by Lab Analysis Result % m/m	Retention Analysis BAE %m/m (Critical Level 0.4000)	Retention Analysis Outcome
1	10	Pass	0.49	1.21	Pass
2	95	Pass	0.32	0.62	Pass
3	60	Pass	0.39	0.83	Pass
4	85	Pass	0.34	0.83	Pass
5	50	Pass	0.65	0.99	Pass
6	85	Pass	0.34	0.71	Pass
7	60	Pass	1.14	1.65	Pass
8	75	Pass	0.58	0.90	Pass
9	100	Pass	0.29	0.68	Pass
10	75	Pass	0.59	1.19	Pass

Test Outcome Samples 1-10 meet the requirements of the specifications for H 1.2 Boron treated Timber & roundwood for use in New Zealand as per NZS 3640:2003

Comments Central 9th sections for all samples were sent for Penetration by Laboratory Analysis at client request. Results are reported above. Central 9th section for sample 1 was complete heartwood.

Method Summary

Test	Method Description	Standard/Reference
Heartwood Sapwood	Tested at IVS using VBRT test with ammonia buffer.	AS/NZS 1605.1 2018
Penetration Spot Test	Tested at IVS using Turmeric Acid test	AS/NZS 1605.2 2018
Retention Analysis	Submitted to IVS Labs to analyse levels of Boron. For method refer to IVS Labs report ref:	56769
Penetration by Lab Analysis	Central 9th submitted to IVS Labs to analyse presence of Boron. For method refer to IVS Labs report ref:	56769

Approved By:

Kieran Monaghan
Independent Verification Services 22 June 2021

56769A is an Amended Test Report and it replaces the original Test Report 56769 issued on 17/06/2021 due to correction of timber species and client.

Timber Testing Report

Applicable Standard NZS 3640: 2003

Client	Scion	**Site**	Rotorua
Address:	49 Sala Street, Private Bag 3020, Rotorua		

Plant No.	.	**Charge No.**	Ian Simpson	**Job Reference**	56770A
Preservative	Boron	**Hazard Class**	H 1.2	**Species**	Radiata Pine
Date Treated	15/06/2021	**Date sampled**	15/06/2021	**Sample Type**	X-Section
Product Description	Radiata boron treated, HWSW and spot P, retention (SW only) and P by Lab on central 9th.			Sawn timber in final size/shape/form New Zealand	

Test Results

Test Type Sample	Sapwood %	Penetration Spot Test	Central 9th Penetration by Lab Analysis Result % m/m	Penetration by Lab Analysis Outcome	Retention Analysis BAE %m/m (Critical Level 0.4000)	Retention Analysis Outcome
1 21	0	Pass	0.38	-	N/A	Pass
2 22	25	Pass	<0.01	-	0.85	Pass
3 23	100	Pass	0.40	-	1.01	Pass
4 24	50	Pass	0.08	-	0.93	Pass
5 25	0	Pass	0.15	-	N/A	Pass
6 26	55	Fail	0.02	Pass	0.64	Pass
7 27	100	Pass	0.42	-	0.94	Pass
8 28	10	Pass	0.01	-	0.90	Pass
9 29	75	Pass	0.36	-	1.08	Pass
10 30	65	Pass	0.08	-	0.78	Pass

Test Outcome Samples 1-10 meet the requirements of the specifications for H 1.2 Boron treated Timber & roundwood, Softwood for use in New Zealand as per NZS 3640:2003

Comments

Samples 1 and 5 were not assessed for retention as complete heartwood and therefore deemed to have met the requirements of the standard for Boron H1.2 treated timber.

Central 9th section for sample 6 was sent for Penetration by Laboratory Analysis after initial spot test fail. The result was a pass as per IVS Labs report 56770.

Central 9th sections for all other samples were sent for Penetration by lab analysis at client request, results reported as above.

Central 9th sections for samples 1, 2, 5 and 8 were complete heartwood.

Method Summary

Test	Method Description	Standard/Reference
Heartwood Sapwood	Tested at IVS using VBRT test with ammonia buffer.	AS/NZS 1605.1 2018
Penetration Spot Test	Tested at IVS using Turmeric Acid test	AS/NZS 1605.2 2018
Retention Analysis	Submitted to IVS Labs to analyse levels of Boron. For method refer to IVS Labs report ref:	56770
Penetration by Lab Analysis	Central 9th submitted to IVS Labs to analyse presence of Boron. For method refer to IVS Labs report ref:	56770

Approved By:

Kieran Monaghan
Independent Verification Services 22 June 2021

Heartwood\sapwood and Boron penetration tests

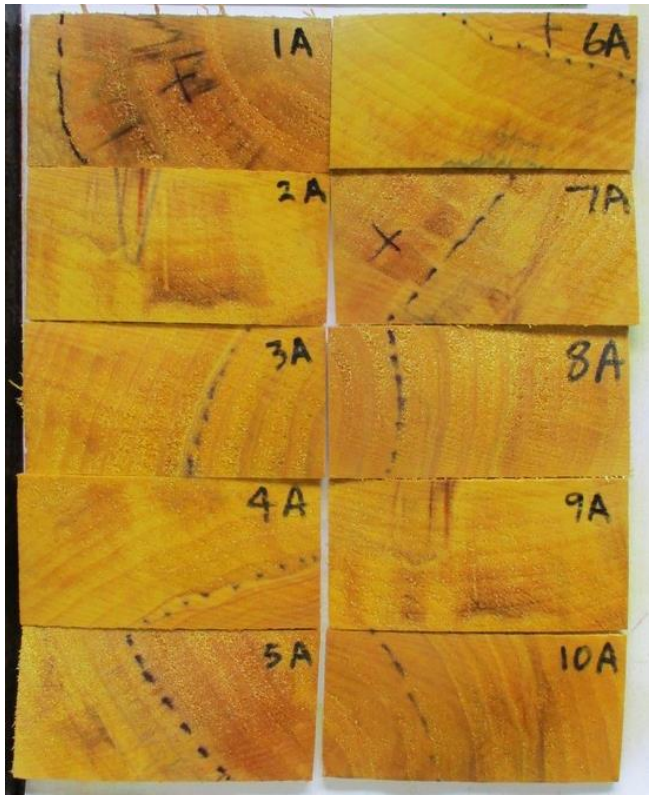

Figure 8: Heartwood\sapwood spot tests for Poplar boron treated 90 x 45 mm

Figure 9: Penetration spot tests for Poplar boron treated 90 x 45 mm

Note: Boron penetration and heart\sap wood distribution needs to be determined on actual samples, photographs should be considered as indicative only as colour will vary with the image collection device, printer and computer screen used (this note applies to all spot test images).

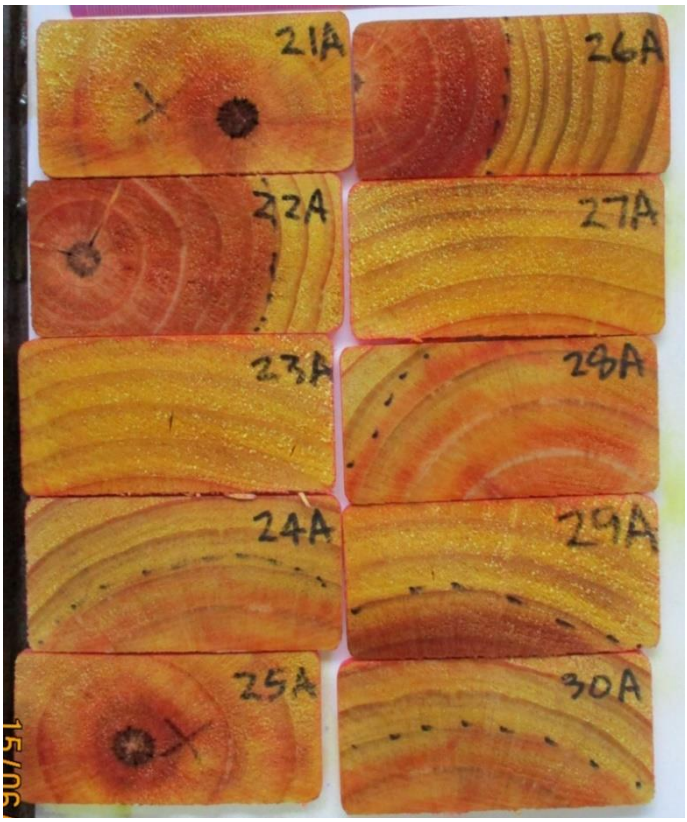

Figure 10: Heartwood\sapwood spot tests for radiata pine boron treated 90 x 45 mm

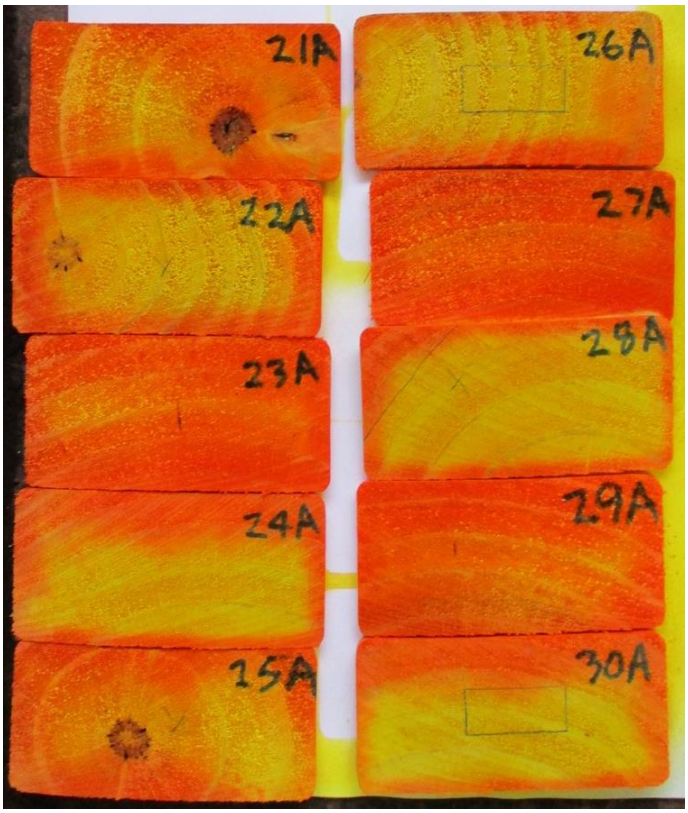

Figure 11: Penetration spot tests for Poplar boron treated 90 x 45 mm

Appendix 3: Individual sample ratings

Table 6: Individual sample rating after twenty-four months exposure in accelerated decay conditions

Sample ID	Op[1] Mould	Op Mycelium	Op Decay Surface	Op Decay Joint	Ax[1] Mould	Ax Mycelium	Ax Decay Surface	Ax Decay Joint
Poplar, boron treated								
1	1	1	10	10	1	1	10	10
2	2	1	10	10	2	1	10	10
3	2	1	10	10	3	2	10	10
4	1	1	10	10	2	1	10	10
5	2	1	10	10	2	1	10	10
6	2	1	10	10	3	1	10	10
7	1	1	10	10	1	1	10	10
8	2	1	10	10	2	1	10	10
9	1	1	10	10	2	1	10	10
10	2	2	10	10	2	1	10	10
Poplar, untreated								
11	5	4	0	0	5	6	0	0
12	5	3	6	4	5	1	0	0
13	5	6	0	0	3	6	0	0
14	5	5	0	0	5	6	0	0
15	5	5	0	0	5	3	0	0
16	2	6	0	0	3	6	0	0
17	5	1	6	4	4	1	6	4
18	5	6	0	0	5	5	0	0
19	5	3	0	0	5	5	0	0
20	4	5	0	0	1	6	0	0

[1] Op and Ax represent different ends of the “I frame” samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.

Table 6 continued: Individual sample rating after twenty-four months exposure in accelerated decay conditions

Sample ID	Op[1] Mould	Op Mycelium	Op Decay Surface	Op Decay Joint	Ax[1] Mould	Ax Mycelium	Ax Decay Surface	Ax Decay Joint
Radiata pine, boron treated								
21	1	1	10	10	1	1	10	10
22	1	1	10	10	1	1	10	10
23	3	2	10	10	3	1	10	10
24	5	1	10	10	4	1	10	10
25	1	1	10	10	2	1	10	10
26	3	1	10	10	3	1	10	10
27	2	1	10	10	5	1	10	10
28	3	1	10	10	4	1	10	10
29	2	1	10	10	3	1	10	10
30	5	3	10	10	4	1	10	10
Radiata pine, untreated – Supplied from Northland								
31	1	6	0	0	1	5	0	0
32	3	4	0	0	1	6	4	6
33	1	6	0	0	4	6	0	0
34	3	6	0	0	4	2	0	0
35	1	6	0	0	3	5	0	0
36	1	6	0	0	3	6	0	0
37	3	6	4	4	5	3	0	0
38	5	5	0	0	4	6	0	0
39	1	6	0	0	2	6	0	0
40	5	6	0	0	4	5	0	0
Radiata pine, untreated – Sourced from Central North Island								
41	4	4	6	0	4	3	0	4
42	5	5	7	6	5	3	7	4
43	3	6	0	0	4	3	7	0
44	5	6	0	0	4	5	0	0
45	4	6	0	0	4	5	4	0
46	5	5	0	0	5	2	4	4
47	5	6	0	0	4	4	6	6
48	5	6	0	0	4	3	4	4
49	4	6	0	0	5	5	0	4
50	3	6	0	0	4	6	0	0

[1] Op and Ax represent different ends of the “I frame” samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.