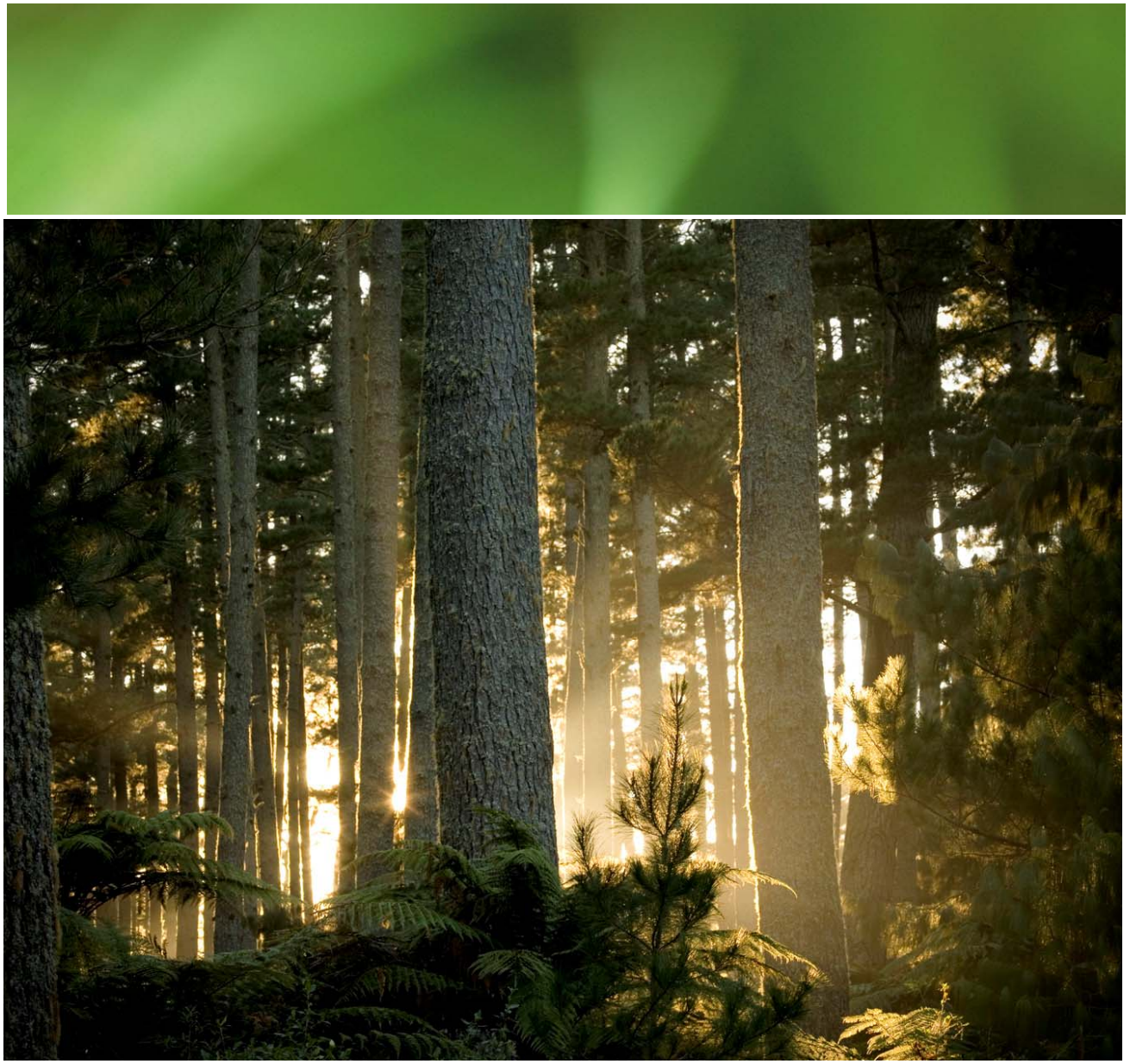
REMEDIAL TREATMENT OF DIFFICULT TO ACCESS FRAMING TIMBER
COMPARISON OF TWO TREATMENT METHODS

Dave Page and Tripti Singh



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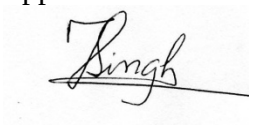

Project Leader

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REMEDIAL TREATMENT OF DIFFICULT TO ACCESS FRAMING TIMBER COMPARISON OF TWO TREATMENT METHODS

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SUMMARY

Multiple stud framing units constructed with plaster board fixed to one side were treated with boron or copper naphthenate formulations using 'double coat brush-on' or 'double coat brush-on plus injection treatment between studs' application systems. These were disassembled and sampled after two weeks to determine preservative coverage onto concealed surfaces and penetration of preservative from timber surfaces and overall preservative retentions.

Results showed that in the 'double coat brush-on' process, the concealed surfaces were left largely untreated resulting in variable preservative retention between components and relatively low overall preservative retention in the multiple stud units. The 'double coat brush-on plus injection treatment between studs' application gave much better preservative spread onto concealed surfaces resulting in more consistent and higher preservative retention in all components.

For the boron using 'double coat brush-on plus injection treatment between studs' application method, the cross section boron retention analyses in all components were similar to the 0.40% BAE m/m, required by the H1.2 treatment specification. For the 'double coat brush-on' only treatments, boron treated units, the minimum retention was only achieved on nogs where three surfaces were accessible for preservative application. For the copper naphthenate brush-on treated units, preservative retention varied from less than 0.01% to 0.03 % (w/w Cu). For 'double coat brush-on plus injection treatment between studs' method, the preservative retention was more consistent between studs, but on average only 0.02% (w/w Cu) retention was achieved. These copper retentions are significantly lower than the approved H3.1 and H3.2 retentions for copper naphthenate.

INTRODUCTION

In remediation of leaky buildings, wall lining or claddings are usually removed, decaying framing is replaced and remaining framing is coated in situ with a surface applied preservative. There are many situations in timber frame construction where some surfaces of the framing are not exposed and are difficult to treat during normal surface application of preservative. This may give inadequate protection to the timber if a subsequent leak develops in that area.

This test was established to determine that in comparison to 'double coat brush-on' a system using 'double coat brush-on plus injection treatment between studs' would give more complete surface coverage and retentions of the two common remedial treatment chemicals; boron and copper naphthenate.

MATERIALS AND METHODS

Unit construction

Thirty-two multiple stud units were assembled using three 2.4 m lengths of 90 x 45 mm planer gauged MSG 8, kiln dried, radiata pine framing, nailed together with 90 mm galvanised flat head nails. In half of the assemblies, two 400 mm long nogs were nailed to one of the outside studs, 800 mm from each end (Figure 1). Standard 10 mm thick plaster board was fixed to the edge of the central stud and to the nogs in the assemblies with 32 mm long plasterboard screws at 300 mm centres.

Preservative Treatment

Two preservative formulations were used. A boron/glycol solution was made up using 149 g boric acid, 175 g borax pentahydrate, 750 g monoethylene glycol, 12 g benzalkonium chloride and 136 g water. This treatment has a red colourant added to it. The second formulation was copper naphthenate concentrate (5.7% w/w copper) diluted with white spirits in a 1:3 ratio. The treatment solution is a bright natural green colour.

This gave four treatment groups, each of eight units as follows:

1. Boron,'double coat brush-on' (units with nogs)
2. Copper naphthenate, 'double coat brush-on' (units with nogs)
3. Boron, 'double coat brush-on plus injection treatment between studs'
4. Copper naphthenate, 'double coat brush-on plus injection treatment between studs'

The unit numbers were BB1 to BB8 for boron, 'double coat brush-on'; BC1 to BC8 for Copper naphthenate, 'double coat brush-on'; IB1 to IB8 for boron, 'double coat brush-on plus injection treatment between studs'; IC1 to IC8 for copper naphthenate, 'double coat brush-on plus injection treatment between studs'.

The units with nogs were brush coated on all exposed surfaces with preservative solution, eight with the boron formulation and the other eight with copper naphthenate. The units were supported vertically to simulate on-site application. After the first coat of preservative was applied, the units were left to dry for at least 30 minutes before the second coat application. The amount applied to each unit was determined by weighing the preservative before and after each application.

Holes were drilled at 300 mm intervals along the two interfaces between the studs in the units without nogs (Figure 2). The holes were 6 mm in diameter and 80 mm deep at an angle of approximately 30 degrees to horizontal, sloping downwards so that liquid inserted would run into the unit. The units were brush coated with preservative, following the procedure used for the units with nogs. After the two coat brush-on application was completed approximately 10 ml of preservative was injected in each of the pre-bored holes using a syringe with a long nozzle that fitted tightly into the hole (Figures 3-4). The units were left to dry for at least 30 minutes and then a second 10 ml injection procedure was completed.

When the treatment processes were complete, the units were stacked vertically in an open storage shed where they were protected from rain for two weeks.

Sampling and Analyses

After the two-week stabilisation period the plaster board was removed and the framing units were separated into their individual components. Photographs (Figures 5-12) were taken of the concealed timber surfaces that had been in contact with the plaster board to record the preservative coverage. Cross sectional samples were cut from the components for penetration testing and chemical analyses. Samples were taken from the midpoint in each of the studs and 100 mm from the stud-end of the nogs for the brush-on treated units. For studs from the brush-on + injection treated units, samples were taken 600 mm from each end. Colorimetric penetration tests were conducted on one cross-section biscuit cut from each of the sampling points using a tumeric (curcumin) reagent with a salicylic acid buffer for boron treated samples and rubeanic acid reagent with an ammonia buffer for the copper naphthenate treated samples. Tested samples were photographed.

Chemical analyses were carried out on total cross-section of biscuits from each sampling point using the following methods:

Boron - Wilson, W.J. Anal. Chim. Acta. 1958, 19, 516
Vogel, A. I. Quantitative Inorganic Analysis, 3rd Ed., Section III-17, 252

Copper - AWPA A7-93 - digestion of samples
AWPA A11-93 - analysis of samples using AAS

RESULTS AND DISCUSSION

Preservative Treatment

The amount of preservative applied during brush-on treatments is summarised in Table 1. Individual unit data are in Appendix I.

Table 1 – Average Preservative Application Rates

Treatment Group	Preservative Application			
	Coat 1(g)	Coat 2 (g)	Total (g)	Rate (ml/m^2)
BB - Boron, 'double coat brush-on' only	117	79	195	172
IB - Boron, 'double coat brush-on plus injection treatment between studs'	97	57	154	167
BC - Copper naphthenate, 'double coat brush-on' only	102	63	164	215
IC - Copper naphthenate, 'double coat brush-on plus injection treatment between studs'	82	34	116	188

The application rates in Table 1 include the small amount of preservative that would have been applied to the plaster board and lost by splashing during application. The boron

preservative was relatively viscous and tended to stay in the area where it was applied whereas the copper naphthenate was much more mobile. The ‘double coat brush-on’ only units also had two horizontal nogs on them which provided a more complex profile than the three-stud ‘double coat brush-on plus injection treatment between studs’ units which explains why more preservative was used on the former.

When the ‘double coat brush-on’ units were disassembled preservative spread beyond the area where it was immediately applied was negligible (Figures 5-8). There were occasional small areas where it had penetrated between the framing components and the plaster board or at the two stud interfaces but these were very irregular. The most consistent penetration away from the exposed surfaces appeared to be along the upper section of the interface between the plasterboard and the nogs.

In the disassembled ‘double coat brush-on plus injection treatment between studs’ units there were large patches of preservative penetration extending out from the holes bored between the studs and limited patchy penetration between the studs and the plasterboard (Figures 9-12). While the injection application did not achieve full cover on the concealed surfaces, particularly at the top of the units, the proportion left untreated was generally less than 50%.

Preservative Penetration and Retention

Preservative penetration into the timber in the ‘double coat brush-on’ boron treated components seldom exceeded 10 mm and was generally closer to 5 mm from the surface that it was applied to (Figure 13). For the ‘double coat brush-on plus injection treatment between studs’ treated units patchy penetration was also present from concealed surfaces (Figure 15).

In the copper naphthenate ‘double coat brush-on’ treated units penetration was again almost solely from the exposed component surfaces (Figure 14). Although the penetration envelop was not deep, evidence of deeper penetration was observed via ray cells. And this could be the reason why penetration was more variable than boron treated units. With the ‘double coat brush-on plus injection treatment between studs’ units there was preservative penetration from most surfaces, but somewhat patchy from concealed surfaces (Figure 16).

Chemical analyses results are summarised in Table 2. Individual component retention data are in Appendix II. These show that for the ‘double coat brush-on’ treated units the preservative retention was directly associated with the number of surfaces that were exposed, i.e., the highest retention was on the nog where three surfaces were exposed and the lowest was on the middle stud where only one edge was exposed. In the boron ‘double coat brush-on’ units the minimum cross-section requirement (0.40% BAE m/m) was only achieved in the nogs where two faces and one edge were treated.

Table 2 - Summary of Chemical Analysis Results

Treatment group	Left Stud	Middle Stud	Right stud	Nog
	BAE* retention (% m/m oven dry weight of wood)			
Boron, 'double coat brush-on' only	0.36	0.14	0.37	0.51
Boron, 'double coat brush-on plus injection treatment between studs'	0.44	0.45	0.47	-
	Copper retention (% m/m oven dry weight of wood)			
Copper naphthenate, 'double coat brush-on' only	0.017	0.007	0.015	0.030
Copper naphthenate, 'double coat brush-on plus injection treatment between studs'	0.021	0.019	0.022	-

*BAE = Boric Acid Equivalent

In the 'double coat brush-on plus injection treatment between studs' units the preservative was much more evenly distributed and all components had similar preservative retention for both preservatives. Injection has significantly improved the middle stud retention so the left, middle and right stud chemical retention are more alike.

The injection holes were less than 3 ml in volume and much of the 10 ml of preservative that was injected at each application either ran down the outside of the studs or came out of gaps between the studs, to the extent that small pools of preservative formed on the ground at the base of the units. The syringes used were not ideal for this purpose and a better application system would be required if this method was to be practicable for on-site remedial treatment of buildings. The viscous nature of the boron preservative also caused some problems with loading the syringes. However, even with the identified practical problems and losses of preservatives using injection method, the analytical results (Table 2, Appendix II) shows the preservative loading in the middle stud significantly increases for both preservatives.

The minimum cross-section retention requirement for H1.2 boron treated framing is 0.40% BAE m/m, and this was achieved in most of the 'double coat brush-on plus injection treatment between studs' units although distribution and penetration was quite variable. This remedial treatment did not achieve the evidence of penetration throughout the cross-section so did not achieve H1.2 specification regarding penetration. If this timber were allowed to get wet/damp, boron redistribution through cross-section is very likely, which would not be the case with copper naphthenate.

There is no H1.2 specification for copper naphthenate and for H3.1 specification, 0.05% copper m/m is specifically excluded from framing. The H3.2 specifications require a minimum copper retention of 0.1% m/m but the retentions achieved using both treatment methods in this research were only a fraction of that.

CONCLUSIONS

Remedial treatment using ‘double coat brush-on’ only preservative application resulted-in poor penetration onto concealed surfaces of complex multi-piece framing assemblies. In brush-on method, the retention of the preservatives were directly associated with number of exposed surfaces, for example, nogs had three exposed surfaces hence the highest retention was achieved compared to middle stud, which had only one edge exposed hence lowest retention was achieved. However, ‘double coat brush-on plus injection between the studs’ system significantly improved the retention of chemicals on concealed faces including middle stud and hence preservatives were much more evenly distributed in all component of the units.

Using ‘double coat brush-on plus injection between studs’ system, the retention of boron formulation achieved the required 0.40% BAE m/m for H1.2 framing. Since there is no H1.2 specification for copper naphthenate, a direct comparison can not be made but the retentions of copper naphthenate were significantly lower than required treatment specifications for H3.1 and H3.2.

Based on the current research, boron/glycol formulation would be a recommended preservative for remedial treatment using ‘double coat brush-on plus injection between studs’ system. On the other hand, the use of copper naphthenate may pose a potential risk as a remedial treatment chemical. Use of higher concentrations of copper naphthenate could be an option which needs further investigations.

This research has demonstrated a potential, simple, in-situ remedial treatment method on difficult to access framing timber. However, the work was only conducted on vertical components and its suitability for complex horizontal components such as lintels, beams and joists needs to be tested before the final recommendations for remedial treatment are made.

Figure 1 – Brush application of copper naphthenate to brush-on units. ‘Brush on plus injections between the studs’ units stacked for drying are visible to the right background.

Figure 2 – Brush application of boron to ‘brush on plus injections between the studs’ units. The injection holes are visible between the studs

Figure 3 – Injection of copper naphthenate to ‘brush on plus injections between the studs’ units. Injection was done after ‘double coat brush-on’ application using a syringe with a long tapered nozzle.

Figure 4 – Injection of copper naphthenate to ‘brush on plus injections between the studs’ units. Preservative tended to run out of the hole and down between the studs to pool on the floor during injection.

Figure 5 – Boron ‘double coat brush-on’ units with the plaster board removed (showing the edges of studs originally attached to plasterboard) starting with unit BB1 on the left to unit BB3 on the right. Very little preservative had penetrated between the plasterboard and the framing except from the upper face of the nogs. Preservative had not penetrated sufficiently between studs to reach the plasterboard.

Figure 6 – The concealed faces of ‘double coat brush-on’ boron treated studs (after dismantling), unit BB1 on the left through to unit BB4 on the right. Preservative had only spread a few mm between studs from the edges that it was brushed on to.

Figure 7 – Copper naphthenate ‘double coat brush-on’ units with the plaster board removed (showing the edges of studs originally attached to plasterboard) starting with unit BC6 on the left through to unit BC8 on the right. Very little preservative had penetrated between the plasterboard and the framing except from the upper face of the nogs. Preservative had not penetrated sufficiently between studs to reach the plasterboard.

Figure 8 – The concealed faces of ‘double coat brush-on’ copper naphthenate treated studs (after dismantle), unit BC5 on the left through to unit BC8 on the right. Preservative had not spread far from the surfaces that it was brushed on to.

Figure 9 – Boron ‘brush on plus injections between the studs’ units with the plaster board removed (showing the edges of studs originally attached to plasterboard) starting with unit IB1 on the left through to unit IB8 on the right. The preservative had penetrated from the injection holes through to the plasterboard in irregular patches but there was little penetration from the brushed surfaces.

Figure 10 – The concealed faces of ‘brush on plus injections between the studs’ boron treated studs (after dismantle), unit IB1 on the left through to unit IB4 on the right. Preservative had spread out from the injection holes.

Figure 11 – Copper naphthenate 'brush on plus injections between the studs' units with the plaster board removed (showing the edges of studs originally attached to plasterboard), starting with unit IC1 on the left through to unit IC8 on the right. The copper naphthenate has penetrated from the injection holes through to the plasterboard in patches but there was little penetration from the brushed surfaces.

Figure 12 – The concealed faces of 'brush on plus injections between the studs' copper naphthenate treated studs (after dismantle), unit IC1 on the left through to unit IC4 on the right. Preservative had spread out from the injection holes.

Figure 13 – Penetration of boron in 'double coat brush-on' treated units, BB1 at the bottom, through to unit BB3 at the top. Samples, from the left side, are left stud, middle stud, right stud and nog. There was generally 5-10mm penetration only from the surfaces that the preservative was brushed on to.

Figure 14 – Penetration of copper in ‘double coat brush-on’ treated units, BC1 at the bottom, through to unit BC3 at the top. Samples, from the left side, are left stud, middle stud, right stud and nog. Penetration was variable from the exposed surfaces and was largely via the medullary rays i.e., at right angles to the growth

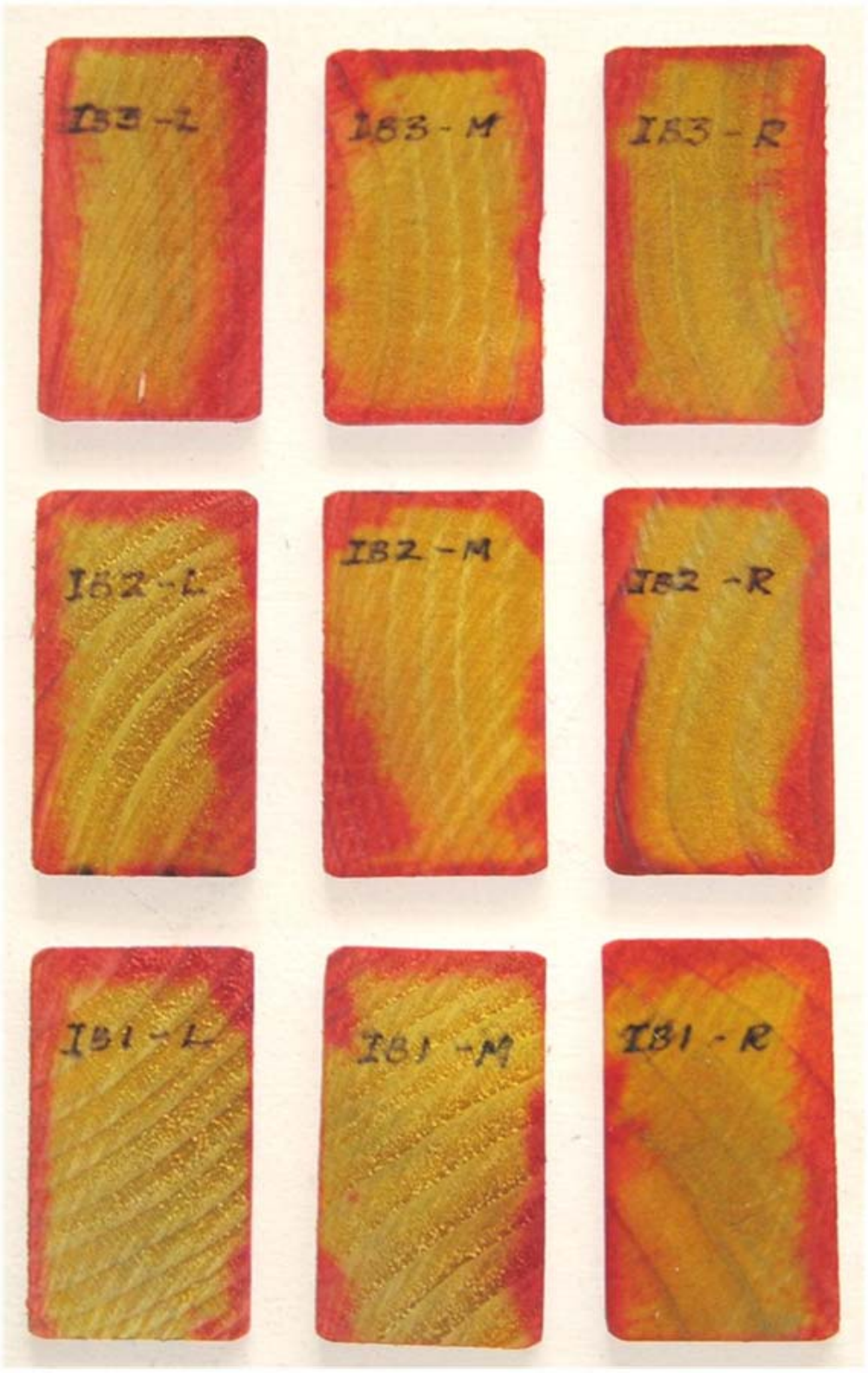

Figure 15 – Penetration of boron in 'brush on plus injections between the studs' treated units, IB1 at the bottom, through to unit IB3 at the top. Samples, from the left side, are left stud, middle stud and right stud. There was penetration from all surfaces but it was somewhat patchy from concealed surfaces.

Figure 16 – Penetration of copper in 'brush on plus injections between the studs' treated units, IC1 at the bottom, through to unit IC3 at the top. Samples, from the left side, are left stud, middle stud and right stud. There was patchy penetration from three surfaces but very little from the edge against the plaster board.

APPENDIX I - INDIVIDUAL UNIT TREATMENT DETAILS.
(Brush-on Application only)

Unit Number	1st Coat (g)	2nd Coat (g)	Total (g)	Total (ml/m^2)
Boron – 'double coat brush-on' units				
BB1	88	82	170	149
BB2	104	73	177	155
BB3	114	84	198	174
BB4	88	80	168	147
BB5	129	68	197	173
BB6	147	71	218	191
BB7	128	85	213	187
BB8	135	87	222	195
Average	**117**	**79**	**195**	**172**
Copper naphthenate – 'double coat brush-on' units				
BC1	95	55	150	196
BC2	108	63	171	224
BC3	89	65	154	201
BC4	101	55	156	204
BC5	106	60	166	217
BC6	101	72	173	226
BC7	105	62	167	218
BC8	109	68	177	231
Average	**102**	**63**	**164**	**215**
Boron – 'brush on plus injections between the studs' units				
IB1	120	71	191	208
IB2	90	61	151	164
IB3	86	58	144	157
IB4	88	45	133	145
IB5	84	48	132	143
IB6	95	55	150	163
IB7	90	59	149	162
IB8	119	60	179	195
Average	**97**	**57**	**154**	**167**
Copper naphthenate – 'brush on plus injections between the studs'				
IC1	79	36	115	186
IC2	79	44	123	199
IC3	78	34	112	181
IC4	76	29	105	170
IC5	80	31	111	180
IC6	85	33	118	191
IC7	99	29	128	207
IC8	81	37	118	191
Average	**82**	**34**	**116**	**188**

APPENDIX II – INDIVIDUAL COMPONENT PRESERVATIVE RETENTION

Unit Number	Preservative retention (% m/m oven dry weight of wood)			
	Left stud	**Middle stud**	**Right Stud**	**Top Nog**
Boron – 'double coat brush-on' units, BAE* retention (% m/m oven dry weight of wood)				
BB1	0.26	0.13	0.29	0.39
BB2	0.47	0.11	0.35	0.46
BB3	0.36	0.19	0.22	0.43
BB4	0.35	0.10	0.27	0.59
BB5	0.32	0.15	0.41	0.54
BB6	0.45	0.19	0.49	0.47
BB7	0.30	0.11	0.56	0.61
BB8	0.36	0.12	0.37	0.57
Average	**0.36**	**0.14**	**0.37**	**0.51**
Copper naphthenate – 'double coat brush-on' units, Cu retention (% m/m oven dry weight of wood)				
BC1	0.016	0.009	0.013	0.057
BC2	0.015	0.009	0.018	0.033
BC3	0.016	0.005	0.018	0.025
BC4	0.018	0.005	0.020	0.028
BC5	0.020	0.008	0.015	0.034
BC6	0.011	0.008	0.013	0.024
BC7	0.023	0.004	0.015	0.013
BC8	0.016	0.006	0.012	0.028
Average	**0.017**	**0.007**	**0.015**	**0.030**
Boron – 'double coat brush-on plus injection treatment between studs' units, BAE* retention (% m/m oven dry weight of wood)				
IB1	0.50	0.40	0.53	
IB2	0.44	0.55	0.44	
IB3	0.39	0.34	0.39	
IB4	0.37	0.37	0.60	
IB5	0.47	0.36	0.45	
IB6	0.41	0.53	0.34	
IB7	0.38	0.42	0.51	
IB8	0.55	0.67	0.51	
Average	**0.44**	**0.45**	**0.47**	
Copper naphthenate – 'double coat brush-on plus injection treatment between studs' units, Cu retention (% m/m oven dry weight of wood)				
IC1	0.013	0.015	0.019	
IC2	0.018	0.021	0.018	
IC3	0.021	0.016	0.023	
IC4	0.031	0.023	0.033	
IC5	0.012	0.012	0.018	
IC6	0.022	0.018	0.020	
IC7	0.023	0.024	0.018	
IC8	0.026	0.025	0.029	
Average	**0.021**	**0.019**	**0.022**	

*BAE = Boric Acid Equivalent