PART III

Treatability of Red Pine Timbers from Ontario and Michigan Treated with Various Water-Borne Wood Preservative Systems

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BACKGROUND

Red pine sawn timbers are used extensively in Eastern Canada for many products covered under CSA O80 including cribbing, landscape ties, building posts, highway guardrail posts and spacer blocks, bridge and mine timbers, and other important structural applications. Historically treating plants have had major difficulty in meeting the requirements of the CSA Standard with red pine timbers with both CCA, and ACQ because the current penetration and retention requirements for red pine sawn timbers in the CSA O80 Standards is very difficult to meet, especially for large dimension timbers even with proper incising. It is likely that the standards for these products have not been reviewed for some time and may no longer reflect the preservatives being used commercially or the wood fibre source currently available. It is likely these requirements were adopted from oilborne systems many years ago and were never achievable on a consistent basis with waterborne preservative systems.

The CSA O80 Standard for treatment of red pine timbers for commercial and industrial use currently requires 13mm of penetration in the heartwood as well as 90% penetration of the sapwood. Samples for penetration and retention analysis should be taken from both heartwood and sapwood. On the other hand, the AWPA Standard for red pine timbers requires that samples for penetration and retention analysis be taken from the sapwood only. Therefore, there is a major difference in both the sampling methods as well as the assessment of penetration and retention between the US and Canadian Standards.

PURPOSE

The purpose of this project was to evaluate the treatability of red pine 6x6 timbers treated with various waterborne preservatives. Commercially produced red pine 6x6 timbers were sourced from Ontario and Michigan. This project utilized Timber Specialties mini portable retort appropriately nicknamed “MicroOne” for most of the treatments. MicroOne is a small (67” diameter x 8’ long) computer controlled treating cylinder capable of replicating processes currently utilized at full size treating plants. The ACQ, CA-B and MCA treatments were all completed in MicroOne while the CCA treatments were conducted at a commercial CCA treating plant.

Wood for this project was selected from two different geographical areas. The first source was selected from properly seasoned S-Grn Ontario red pine 6x6-16' timbers. The second source was from KD-HT Michigan red pine. The wood closely represented the species, moisture content conditions, and grade typically treated in Ontario for agricultural and commercial applications. Wood which would normally be considered "cull" or would be considered unsalable was not included in the study. The initial moisture content of the wood was between 19-28% measured with an electrical resistance moisture meter using 2" needles directly before treatment (see Figure 6). The material was incised to a minimum depth of between 8-13mm on all four sides with an incision density of approximately 4500 incisions per square meter (418/ft2). For this study, two different incising patterns were evaluated, namely the GenII Incisor with RJH cleaning system (identified as "P" in Figure 9) and the GenII Incisor with patented "Clean Rings" (identified as "T" in Figures 7 and 8). It should be noted that the incision density of the "P" incisor was greater than the "T" incisor but the incisions were generally deeper for the "T" incisor than the "P".

Following incising, the wood was cut into 4 matching sections and labelled accordingly. The order of the cut pieces was shifted for each consecutive parent board to distribute the location of the cut pieces, within the board, across the different treatments. One quarter of the samples were treated with MCA, one quarter with ACQ, one quarter with CCA, and the final quarter with CA-B. Each charge of material consisted of 32 pieces 4' long. Therefore, 32 pieces of red pine 6x6-16' were required to complete each set of treatments for the 4 preservative systems. Figure 1 below shows the incising and treating matrix for all treatments. Prior to treatment, the average moisture content of each piece in each bundle was sampled and recorded. Also, all cut ends were sprayed with heartwood/sapwood reagent. outlined with a marker and photographed prior to treatment for easy identification of the heartwood (see Figures 10 and 11).

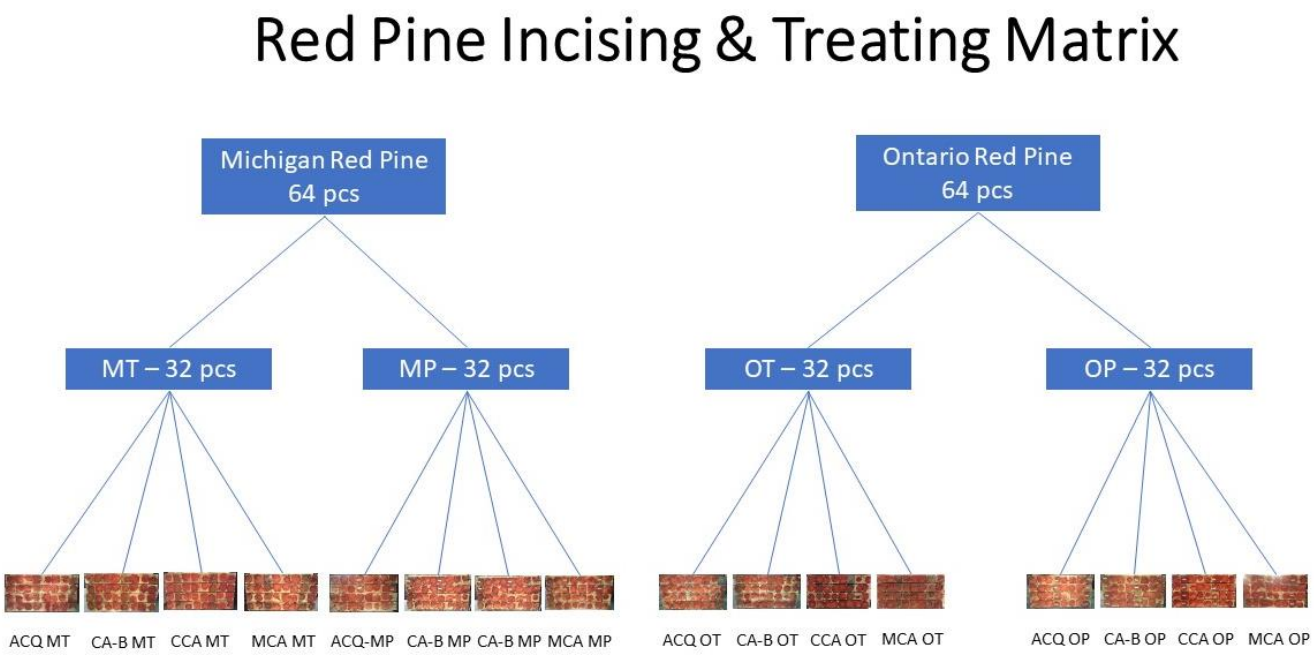

Figure 1. Red Pine Incising and Treating Matrix

MATERIALS

Wood: The following material was supplied for the study:

SIZE	LENGTH*	SPECIES	M.C.%	INCISING	MINIMUM # OF PIECES	MINIMUM # BUNDLES REQUIRED
6" x 6" Incised Posts	16'	Red Pine	S-Grn	YES	32/lift	2
6" x 6" Incised Posts	16'	Red Pine	KDHT	YES	32/lift	2
					Total	4

*Note: Samples were cut into 4 equal pieces 4' long from 16' material.

Wood Preservatives:

MCA: Timber Specialties MP200C-TS; Canadian PMRA registration number 30196 which contains 28.0% copper metal concentrate and Timber Specialties MTZ; Canadian PMRA registration number 30379 containing 33.95% tebuconazole.

CCA: Timber Specialties K-33 CCA; Canadian registration number 19612.

ACQ-C: Timber Specialties NW100; Canadian registration number 28634.

CA-B: Timber Specialties NW CA-B; pending registration.

Mold Inhibitor: Thor Acticide 14; Canadian registration number 28013 which contains 14% CMIT/MIT active ingredients will be added to the treating solutions in the study at the recommended use rates for ACQ and MCA. Note: In addition, Thor Acticide 45; Canadian registration number 27271 was added to MCA at a rate of 150ppm.

PROCEDURE

Treating Solution:

The treating solution concentration for each preservative was as follows:

MCA: 1.4% as total actives

CCA: 2.0% as total actives

ACQ: 2.4% as total actives

CA-B: 1.2% as total actives

Treatment Process:

All charges were treated to the minimum following parameters:

Minimum Solution Temperature – 75F

Initial Vacuum – 30 minutes @22"Hg

Pressure Cycle – 180 minutes 180 psi (Note: CCA was treated at 150-psi)

Final Vacuum – 30 minutes @22" Hg

The initial moisture content of the wood prior to treatment for the Ontario pine was 21% for ACQ, 20% for MCA and 19% for CA-B. The Michigan pine moisture contents were 26% for ACQ, 25% for MCA and 23% for CA-B. Unfortunately, moisture content readings were not taken for CCA, but they were about the same range as the others prior to treatment.

All treatments for this study were conducted by Timber Specialties personnel and were treated in accordance with the CSA Standards for sawn products in Table 5 of CSA O80.2 for UC4.1. The solution temperature was maintained at or about 80 F during the study. The commercial evaluation included the following:

- Determination of the ability of the treated wood to meet the specified treatment requirements of the CSA Standard. For sawn red pine 6x6 timbers, the penetration requirements in Table 5 of the CSA O80.2 standard were used whereby 13mm and 90% of the sapwood is required. The assay zone is 0-25mm as shown in Table 4 of the CSA O80.2 Standard. The retention requirements for ground contact in UC4.1 are specified in Table 10 of CSA O80.1 as follows: ACQ and CCA are 6.4 kg/m3. CA-B and MCA are 3.3 kg/m3.

- Borings for evaluation of penetration and retention were taken from each piece from all four sides. Each side was assigned a letter from A-D. Borings were intentionally not taken from the spaces between groups of incisions. In addition, borings were taken between incisions rather than on an incision. All borings were assessed for penetration using reubeanic acid indicator and heartwood sapwood indicator. Measurement of the penetration was made to the nearest millimeter. Photos were taken of all borings prior to cutting to length. After assessing penetration, the borings were cut to the correct assay length (25mm) and sent to Koppers laboratory in Griffin Georgia for determination of retention.

All treatment information including gross and net absorptions, absorption rates, retention by weight gain, penetration and assay retention were recorded and compiled for each charge. Chemical analysis was completed by Koppers Performance Chemicals for each charge to verify the active ingredients. Separate solution samples were prepared for CA-B and ACQ for determination of mold inhibitor concentration using acid to stabilize the samples.

RESULTS

The penetration and retention results are shown in Appendix A. Below is a summary chart showing the results of the penetration for each treatment combination (Figure 2). The red boxes indicate that the charge did not pass the penetration requirement of 13mm in the heartwood while the green boxes indicate a pass. It is interesting to note that none of the preservatives charges passed the minimum heartwood penetration requirement. However, with respect to sapwood penetration, everything passed for ACQ, followed by MCA with only two sapwood failures, CA-B with 7 sapwood failures, and lastly CCA with 9 sapwood failures. Looking at the data more closely, most of the sapwood failures occurred in the Michigan red pine which was heat treated as opposed to the Ontario red pine which was air-dried. In order of sapwood penetration, the ACQ treated best overall followed by MCA, then CA-B and lastly CCA. In terms of heartwood penetration, ACQ treated best overall followed by CA-B, CCA, and lastly MCA.

	ACQ		CA-B		CCA		MCA	
	Pene	Sapwood	Pene	Sapwood	Pene	Sapwood	Pene	Sapwood
MP A								
MP B								
MP C								
MP D								
MT A								
MT B								
MT C								
MT D								
OP A								
OP B								
OP C								
OP D								
OT A								
OT B								
OT C								
OT D								
# Passing	0	16	0	9	0	7	0	14

Figure 2.- Penetration results for ACQ, CA-B, CCA, and MCA Red Pine Treatments

With respect to the assay retention, none of the preservatives met the minimum retention specifications. This data is summarized below in Figure 3. Interestingly, the Michigan red pine has slightly higher average retention than the Ontario red pine even though there were more sapwood failures. Also, comparing the two incising patterns, the "P" incising pattern seems to have slightly higher average retention for all treatments than the "T" incising. This is most likely due to the closer spacing of the teeth on the "P" incisor.

Red Pine 6x6 Assay Retention Results (0-25mm)

	ACQ	CCA	CA-B	MCA
	(pcf)	(pcf)	(pcf)	(pcf)
MP A	0.249	0.344	0.164	0.242
MP B	0.362	0.326	0.137	0.116
MP C	0.420	0.185	0.197	0.127
MP D	0.301	0.263	0.145	0.101
Average	**0.333**	**0.280**	**0.161**	**0.147**
MT A	0.294	0.264	0.100	0.125
MT B	0.250	0.147	0.105	0.102
MT C	0.329	0.202	0.093	0.099
MT D	0.285	0.126	0.140	0.090
Average	**0.290**	**0.185**	**0.110**	**0.104**
OP A	0.256	0.301	0.147	0.139
OP B	0.264	0.237	0.102	0.158
OP C	0.269	0.204	0.178	0.192
OP D	0.299	0.242	0.103	0.200
Average	**0.272**	**0.246**	**0.133**	**0.172**
OT A	0.312	0.170	0.108	0.149
OT B	0.230	0.244	0.111	0.133
OT C	0.267	0.179	0.116	0.100
OT D	0.311	0.276	0.100	0.135
Average	**0.280**	**0.217**	**0.109**	**0.129**

Figure 3.- Red Pine Retention Results for all Treatments

SUMMARY AND DISCUSSION

As noted previously, the heartwood of red pine is quite refractory and is very difficult to penetrate, especially radially between the incisions. Successful incising relies not only on the depth of the incisions but also the spacing of the incisions to ensure the preservative penetrates between incisions. With ACQ there is generally very good radial penetration between incisions which helps explain why the ACQ samples had the best penetration results. Also, because retention is linked directly to penetration, the ACQ samples had the best retention. On the other hand, CCA had the worst penetration, especially in the sapwood compared to the other treatments. This may be related to the fact that the CCA treatments were performed at 150-psi as opposed to 180-psi but is more likely due to the nature of the preservative itself. CCA tends to fixate prematurely which impedes penetration. In terms of overall penetration in this study, MCA and CA-B penetrated better than CCA but not as good as ACQ. Normally it would be expected that CA-B would penetrate as well as ACQ as they are both amine-based, but it did not materialize in this study.

As described previously, the wood was sampled according to the CSA Standards whereby borings were taken from both heartwood and sapwood faces. In this study, all four sides of each piece were sampled so it was known exactly which borings contained heartwood and which contained only sapwood. Therefore, to compare the AWPA sampling procedure to the CSA sampling procedure, the actual number of sapwood borings can be calculated from each group and

compared with the AWPA Standard for compliance. Also, the retention for each group can be recalculated using the ratio of sapwood to total borings to estimate the retention had the retention sample not contained untreated heartwood. The results of this analysis are shown below in Figure 4:

Average Ajusted Retentions - Sapwood Borings Only				
	ACQ	CA-B	CCA	MCA
MP	91	83	88	75
MT	81	71	66	70
OP	90	89	69	76
OT	68	60	65	126
Total Sapwood Borings	330	303	288	347
Sapwood Factor (sap borings/512)	0.645	0.592	0.563	0.678
Average Retention - MP	0.333	0.16075	0.2795	0.1465
Average Retention - MT	0.2895	0.1095	0.18475	0.104
Average Retention - OP	0.272	0.1325	0.246	0.17225
Average Retention - OT	0.28	0.10875	0.21725	0.12925
Adjusted Retention - MP	**0.517**	**0.272**	**0.497**	**0.216**
Adjusted Retention - MT	**0.449**	0.185	0.328	0.153
Adjusted Retention - OP	**0.422**	**0.224**	**0.437**	**0.254**
Adjusted Retention - OT	**0.434**	0.184	0.386	0.191
UC 4.1D Minumum Retention (PCF)	**0.400**	**0.210**	**0.400**	**0.210**

Figure 4. - Average Adjusted Assay Retentions for Sapwood Only

As can be seen in the table above, the adjusted retentions are much higher using the results from the sapwood borings only. The actual ratio for each group is shown in the table with 288 sapwood borings for CCA, 303 for CA-B, 330 for ACQ and 347 for MCA. In total 512 borings were taken for each preservative system. The results of the comparison show that ACQ would pass for all treatments, while CCA, CA-B and MCA would pass on 2 of the 4 incising-source combinations. In addition, the adjusted retention values for CA-B, MCA and CCA did not fail the minimum retention by much so with a little adjustment in the initial solution concentration the remaining incising-source combinations would also pass.

In conclusion, this study showed that with current incising technology the existing requirements in the CSA Standard for red pine timbers could not be met on a consistent basis with any of the four water-borne systems tested. It was also shown that if the borings were taken from the sapwood as per AWPA Standards, most of the charges treated would have passed both penetration and retention.

EFFICACY STUDIES

In total, 128 pieces of red pine were treated with each of the 4 preservatives for a total of 512 pieces. All the posts, including untreated red pine posts have been installed in two test sites in Canada to generate meaningful efficacy data on the treatment of this full-size material. One half of the treated posts were installed in the FP Innovations test site in Petawawa Ontario (see Figure 5 below) and the other half at the Malcolm Knapp Research Forest test site in Maple Ridge BC. The material was installed in ground contact at a depth of 18" and will be monitored periodically for decay. It is expected that this material will provide good data in the future to support future standards.

Figure 5.- Red Pine Posts being installed at the FP Innovations Test Site in Petawawa Ontario

Figure 6 – Moisture Content Readings being taken with electrical resistance moisture meter prior to treatment in MicroOne

Figure 7 – 15ST Side Head Pattern used on the GenII Incisor identified as "T"

Figure 8 – 15ST Top Head Pattern on the GenII Incisor identified as "T"

Figure 9 – 16ST Incising Pattern Pattern of the RJH Incisor identified as "P"

Figure 10 – CCA Michigan Red Pine Sprayed with Heartwood-Sapwood reagent and outlined with Marker

Figure 11 – CCA Ontario Sprayed with Heartwood-Sapwood reagent and outlined with Marker.