FIELD TESTING OF PRESERVATIVE TREATED WOOD IN CANADA:

VII PERFORMANCE OF TREATED LUMBER AGAINST TERMITES IN ONTARIO

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Summary

Subterranean termites are established in a number of locations in southwestern Ontario. They have become one of the major factors limiting the service life of wood products in this area. If preservative treatment can be demonstrated to prevent termite attack, the market for wood products can be maintained and expanded. With the assistance of the town of Kincardine, Ontario, Forintek set up a termite test site in 1988.

Most of the lumber for installation in the test plot was provided by Canadian wood treating plants. Additional lumber was purchased at local retailers. The majority of the material was red pine, lodgepole pine, jack pine, white spruce or mixed spruce-pine-fir. Treatments included chromated copper arsenate type C (CCA-C), ammoniacal copper arsenate (ACA) and, in western hemlock only, ammoniacal copper quat (ACQ). Both incised and unincised lumber was included in the tests where possible. CCA-treated hem-fir plywood was also used. All the cut ends were brush-treated with copper naphthenate.

The material was inspected in the summer of 1996. Treated material for the most part was generally performing well with some pieces starting to show initial signs of termite attack. In most cases this consisted of signs of superficial surface feeding or "cosmetic damage". A few of the samples that had lower assay retentions and preservative penetrations showed more than just trace nibbles where termites appeared to have actually penetrated through the outer treated zone. It also seemed that termite entry occurred in areas on the wood surface where defects may have facilitated such entry. Material that came close to meeting CSA O80 standards for ground contact generally suffered only minor damage.

Introduction

The eastern subterranean termite, *Reticulitermes flavipes* (Kollar), is probably the most widespread and destructive termite species in North America and is the only species that has gained a significant foothold in Canada. The range of this termite in Canada is at present limited to an isolated local infestation in Winnipeg, Manitoba and parts of southwestern Ontario. The first Canadian infestation was reported as early as 1929 in Point Pelee National Park (Kirby 1967). Metropolitan Toronto, where termite activity was first reported in 1938 in the vicinity of the waterfront, has become the site of a major urban infestation (McLaughlin 1983, Grace 1987, 1990b). As the infestation in Ontario spreads, property losses resulting from termite attack continue to grow. Although pressure treatment is widely recognised as conferring protection against termites, there was very little data on the performance of treated Canadian species. Municipal building inspectors were thus not confident that the product available in Canada would give the desired performance. They also expressed concern over the lack of compliance with CSA O80 standards of most treated wood on the market. Because of these concerns, the Buildings and Inspections Department of the City of Toronto stated that "use of pressure-treated wood is probably not an effective safeguard against termites" (McLaughlin 1983).

In an attempt to ensure the continued growth of markets for treated wood products in the termite-infested areas of southern Ontario, it was necessary to demonstrate that wood treated to the requirements of the CSA 080 standard can provide effective termite resistance. With the assistance of the town of Kincardine, Ontario, Forintek set up a termite test site in 1988 (Doyle 1990). This site has been reported to support a population of at least one million termites (Grace 1990a). The performance of test material after three to four years exposure was reported by Doyle (1992). The present report summarizes the results of the 1996 evaluation of test material.

Methodology

Most of the material for installation in the test plot was provided by various wood treating plants in Canada. This material consisted of various commodities, i.e., 2"x4" (50x100mm), 2"x6" (50x150mm), 4"x4" (100x100mm) and 6"x6" (150x150mm) of four species (jack pine, red pine, lodgepole pine and white spruce) treated with either chromated copper arsenate type C (CCA-C) or ammoniacal copper arsenate (ACA) preservatives, reportedly to the requirements of the CSA 080.2 standard (Canadian Standards Association 1989a) for ground-contact applications. Incised as well as non-incised lumber was included. Samples of hem-fir plywood treated with CCA-C to the requirements of the CSA 080.15 standard (Canadian Standards Association 1989b) and one lot of hemlock (2"x6") treated with an experimental ammoniacal copper/quaternary ammonium compound (ACQ) preservative were also included in the installation. Finally, in addition to the material provided by the industry specifically for this purpose, additional pieces of CCA-C treated lumber (2"x4", 2"x6", 4"x4"and 6"x6") were purchased at local lumber retailers to represent material available to the homeowner. This particular material could have been treated to either an above-ground (4.0 kg/m³) or ground-contact (6.4 kg/m³) specification. Also, since species identification was not carried out on every piece of this material, the species was simply reported as spruce-pine-fir (SPF). These particular pieces are referred to in the report as random selections.

Test specimens measuring 3.0 feet (0.91m) in length were cut from each piece of treated lumber for installation in the test plot. The remaining length of the lumber was then cut to provide a 1.0 foot (0.30m) assay section and a 4.0 foot (1.22m) end-matched piece for installation in Forintek's field test site at Petawawa, Ontario (data from the Petawawa site are not reported here). Cores were removed from the assay section for treatment penetration and assay retention determinations. Treatment penetrations were measured directly after first splitting the cores longitudinally and then spraying with chrome azurol S solution to stain the treated zones (American Wood Preservers' Association 1995a). For determination of assay retention, assay zones specified in the CSA 080.2 standard were cut from each core, combined for each set of replicates (termed a "lot") and then ground to 40 mesh in a Wiley mill. The resulting powders were then analysed for copper, chromium and arsenic by energy dispersive x-ray spectrometry (American Wood Preservers' Association 1995b). Results were reported on an oxide basis.

The cut end of each piece of lumber intended for installation in the test plots was given a double brush coating of commercial copper naphthenate field-cut preservative and each piece was identified with an appropriate lot and sample number. The lumber was installed in the termite plot in an upright position approximately 18" (450 mm) into the soil, using a spacing of 24" (600 mm) between rows and approximately 18" (450 mm) between samples.

Half of the pieces in each lot were planted with the pressure-treated ends down while the remaining samples were placed with the cut, and brush-treated, ends down. Untreated controls consisted of red pine, jack pine and white spruce (2"x3", 2"x4"). All samples were installed in a randomized pattern throughout the test plot area. The row and position of each piece of test material was recorded and subsequently entered into a database.

The initial batch of test material (lot numbers 4245-4280) was installed in August 1988, filling all available space within the compound area. In order to accommodate the remaining test material, a request was made to Kincardine town council to increase the size of the plot by extending the original fencing. The request was granted and the remaining test material (lot numbers 4283-4307) was installed in May 1989 in this annex.

Test material is rated yearly by visual examination for signs of termite attack. This report summarizes the results of the 1996 ratings. Each sample was carefully removed from the ground, examined and then assigned a grading using a scale of 0-4 as recommended by the

International Union of Forestry Research Organizations (IUFRO) based on Becker's (1972) proposed standard method. An explanation of the rating systems is given in Table 1 below. The same system was used to visually grade for decay caused by fungi starting in 1995. Before 1995, the presence of deterioration caused by fungi was noted in the records when encountered. All ratings were subsequently entered into the field test database.

Table 1
Termite Attack Grading System

IUFRO Rating	Description
0	Sound
1	Trace of attack
2	Moderate attack
3	Heavy attack
4	Failure by termite attack

Results and Discussion

At the time of the 1996 inspection, the original group of test material (lot numbers 4245-4280) had been in service for approximately eight years while the second group (lot numbers 4283-4307) had been in service for approximately 7 years and 4 months. Termite attack ratings are given in Table 2 together with the percentage compliance of each lot with 5mm (CSA080.32) and 10mm (CSA 080.2) penetration requirements.

In general, the trends in performance of treated and untreated wood observed by Doyle (1992) have continued with the exception that the activity in the annex area is now comparable to activity in the main plot. There was heavy attack on the untreated controls with mean ratings ranging from 2.3 to 3.7 for lumber and 3.8 for plywood (Table 2). This attack appeared to be fairly uniform in the main test area and the controls in the annex area also showed quite extensive foraging activity.

Most of the treated material was performing well, but some pieces were starting to show initial signs of surface grazing or more serious termite attack. In a few of the samples that had lower assay retentions and preservative penetrations, termites had penetrated the outer treated shell. It appeared that termite entry often occurred where defects, such as checks, may have facilitated such entry. However, in several cases, termites had tunnelled directly through the very shallow treated zone to access the untreated interior. This confirms the observations of Wilcox (1984), and Richards & McNamara (1997). Grace (1997) also found that CCA does not act as a termite repellant.

Copper naphthenate field-cut preservative was also generally performing well although, like a small number of the pressure-treated ends, a few ends that were brush treated with the copper naphthenate had started to show signs of termite attack and end-grain decay. For the most part, there was no difference whether the treated end was up or down, indicating that this oil-based field-cut preservative is quite effective against termite attack, possibly because of the insect repellant characteristics of naphthenates.

Although termite attack was still relatively limited, it is worth looking in more detail at the individual types of treatment. Two-thirds (24 of the 33 lots) of the CCA-treated samples were performing well with mean ratings of 1.00 (trace of attack) or less. The remaining third, nine lots, had mean ratings higher than 1.00 (trace to moderate attack) and relatively low proportions in compliance with 10 mm or 5 mm penetration requirements. Considering compliance with CSA 080.2, only one of the nine had 20% of the pieces with over 10mm penetration and the rest had 0% over 10mm. Considering compliance with CSA 080.32, six of the nine had only 0% or 20% greater than 5mm. Only one set out of these nine was incised.

There were 11 incised CCA-treated lots and only one, that already mentioned above, had a mean rating higher than 0.8. There were 22 unincised CCA-treated lots and eight had ratings greater than 1.0.

Very little of the test material met the CAN/CSA O80 M89 standards. One lot of lodgepole pine (4279) met the above-ground standard and had a mean rating of 0.5. Four lots of red pine (4287, 4289, 4290 and 4291) met the permanent wood foundation (PWF) standard and these had mean ratings of 0.8, 0.7, 1.0 and 0.7 respectively. Among the CCA-treated lots where the wood species was identified, all species had a similar range of mean ratings, with the exception of jack pine where fewer lots of unincised material were installed.

All the unincised ACA-treated lumber had mean ratings less than 0.7, possibly because every set had 60% or more pieces with over 5mm penetration. The ACQ-treated hemlock had 80% of pieces over 5mm penetration and a mean rating of 0.2. Residual ammonia in the treated lumber may also have played a role in repelling termite attack, though Tamashiro *et. al* (1988) did not find ammoniacal copper zinc arsenate (ACZA)-treated wood to be repellant to termites.

Similar studies with unincised and incised CCA-treated Canadian species exposed in Florida have revealed very similar results to those reported here (Richards & McNamara 1997). After eight years, only 17 of the 840 CCA-C treated 2x6 stakes showed slight decay and/or termite attack and only three additional stakes showed moderate decay and termite attack. Eighteen of the 20 stakes were unincised. The two incised stakes showed only a suspicion of decay and no termite attack. Nineteen of the 20 had CCA-C penetration on one face of 1.5mm or less (Richards & McNamara 1997).

Deep penetration of preservative is very important for protection against subterranean termites. This can be ensured by purchasing treated wood from suppliers participating in a third-party quality assurance program.

Conclusions

- There is a high level of termite activity throughout the plot area.
- CCA-treated lumber is susceptible to surface grazing resulting in cosmetic or non-structural damage.
- Termites can penetrate through a CCA-treated shell if it is only a few millimeters deep.
- Deep penetration of preservative is very important for protection against subterranean termites.
- Commercial copper naphthenate field-cut preservative provides protection against termites.

Recommendations

Pressure-treated wood for use in termite-infested areas should be produced under a third-party quality assurance program to ensure it meets CSA O80 standards.

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Table 2

PERFORMANCE OF DIMENSIONAL LUMBER IN SERVICE AT KINCARDINE TERMITE TEST PLOT

LOT #		COMMODITY DESCRIPTION	SPECIES[2]	# IN TEST	AVG. ASSAY RETENTION (kg/m^3)	AVG. TRT.DEPTH mm (STD DEV)	% OF CORES WITH PENETRATIONS		AVG. UFRO RATINGS	
							> 5 mm	> 10 mm	1995	1996
UNTREATED CONTROLS										
4245	PLYWOOD	5/8" X 6"	Hem-Fir	6	-	-	-	-	3.8	3.8
4254		2 X 4	RP	16	-	-	-	-	3.7	3.8
4255		2 X 4	JP	20	-	-	-	-	3.6	3.6
4280		2 X 4	SPF	6	-	-	-	-	3.3	3.5
4307		2 X 4	RP	10	-	-	-	-	2.4	2.6
4307S		2 X 4, 2 X 3	SPF	20	-	-	-	-	2.3	2.3
CCA-C TREATED LUMBER										
4256	NON-INCISED	2 X 4	SPF	6	0.9	2.3 (2.3)	33	0	0.5	0.5
4257	NON-INCISED	2 X 4	SPF	6	1.8	3.7 (2.9)	33	0	1.2	1.2
4258	NON-INCISED	2 X 4	SPF	6	5.9	11.3 (4.2)	100	67	0.7	0.7
4259	NON-INCISED	2 X 6	SPF	4	4.4	7.0 (7.1)	50	50	0.8	0.8
4260	NON-INCISED	2 X 6	SPF	4	0.9	2.0 (0.0)	0	0	1.8	2.0
4261	NON-INCISED	2 X 6	SPF	4	1.1	3.5 (0.7)	0	0	1.0	0.8
4262	NON-INCISED	4 X 4	SPF	4	1.5	8.5 (0.7)	100	0	1.3	1.3
4263	NON-INCISED	4 X 4	SPF	6	0.5	1.0 (0.0)	0	0	1.3	1.3
4264	NON-INCISED	4 X 4	SPF	6	6.1	9.7 (4.9)	67	67	0.8	0.5
4265	NON-INCISED	6 X 6	SPF	4	5.9	4.0 (0.0)	0	0	1.3	1.5
4266	NON-INCISED	6 X 6	SPF	4	N/A	N/A	N/A	N/A	0.8	0.5
4274	NON-INCISED	2 x 6	LPP	10	0.9	3.2 (1.8)	20	0	1.3	1.3
4275	NON-INCISED	2 x 4	LPP	10	1.7	3.0 (2.9)	20	0	0.9	0.9
4276	NON-INCISED	2 x 6	LPP	10	5.4	7.0 (6.9)	40	40	1.1	1.0
4277	NON-INCISED	4 X 4	LPP	10	1.8	3.4 (3.9)	20	20	1.1	1.1
4278	INCISED 6 mm	4 X 4	LPP	10	5.9	10.0 (4.7)	100	40	0.7	0.7
4279	INCISED 13 mm	4 X 4	LPP	10	4.7	10.0 (1.9)	100	80	0.6	0.5
4293	NON-INCISED	2 x 4	S	10	1.8	2.6 (2.7)	10	10	0.5	0.5
4294	NON-INCISED	2 x 6	S	10	1.2	2.9 (4.3)	10	10	0.5	0.4
4295	NON-INCISED	4 X 4	S	10	1.9	2.0 (1.5)	10	0	0.7	0.7
4296	INCISED 6 mm	4 X 4	S	10	2.7	1.3 (1.0)	0	0	1.0	1.1
4297	INCISED 13 mm	4 X 4	S	10	2.8	1.7 (1.3)	10	0	0.5	0.5

LOT #		COMMODITY DESCRIPTION	SPECIES[2]	# IN TEST	AVG. ASSAY RETENTION (kg/m³)	AVG. TRT.DEPTH mm (STD DEV)	% OF CORES WITH PENETRATIONS		AVG. UFRO RATINGS	
							> 5 mm	> 10 mm	1995	1996
4298	INCISED 13 mm	6 X 6	S	5	4.8	3.6 (0.9)	20	0	0.6	0.6
4286	NON-INCISED	2 x 4	JP	10	4.8	7.4 (5.2)	60	20	0.6	0.7
4285	NON-INCISED	2 x 6	JP	10	4.2	4.7 (5.0)	20	20	0.8	0.6
4284	INCISED (FT)1	2 x 6	JP	10	3.6	7.7 (4.6)	60	40	0.7	0.4
4283	INCISED	6 X 6	JP	10	6.8	8.8 (4.2)	90	30	0.7	0.6
4292	NON-INCISED	2 x 4	RP	10	2.9	6.8 (6.8)	80	0	1.0	1.1
4290	NON-INCISED	4 X 4	RP	10	10.1	13.3 (3.9)	90	90	1.0	1.0
4289	INCISED (FT)	4 X 4	RP	10	10.0	13.5 (4.5)	100	80	0.8	0.7
4288	INCISED (FT)	2 x 4	RP	10	3.5	6.3 (5.3)	10	20	0.7	0.6
4291	INCISED	4 X 4	RP	10	10.8	14.2 (3.3)	100	80	0.8	0.7
4287	INCISED	6 X 6	RP	10	9.7	14.8 (2.0)	100	100	1.0	0.8
ACA TREATED LUMBER										
4267	NON-INCISED	2 x 4	RP	10	10.2	15.0 (2.2)	100	100	0.5	0.4
4268	NON-INCISED	2 x 4	JP	10	3.4	6.8 (4.6)	60	20	0.0	0.0
4269	NON-INCISED	2 x 6	RP	10	4.2	8.2 (5.4)	60	40	0.6	0.5
4270	NON-INCISED	2 x 6	JP	10	3.2	5.2 (2.3)	60	0	0.7	0.5
4272	NON-INCISED	4 X 4	RP	10	6.2	8.2 (5.3)	80	40	0.7	0.6
4273	NON-INCISED	4 X 4	JP	10	3.1	7.0 (5.2)	60	20	0.6	0.4
ACQ TREATED LUMBER										
4271	NON-INCISED	2 x 6	Hemlock	10	1.5	7.4 (5.3)	80	20	0.4	0.2
CCA-C TREATED PLYWOOD										
4246-48		5/8" X 6"	Hem-Fir	12	8.4 - 9.9				0.7	0.7

Nominal size (inches)

Species: RP = Red Pine; JP = Jack Pine; SPF = Spruce, Pine, Fir; LPP = Lodgepole Pine; S= Eastern Spruce

Lot numbers 4256 - 4266 were selected randomly from local lumber retailers; all remaining treated material was provided by the wood treating industry specifically for use in the test plot.

Lot number 4274 was treated to an above-ground specification (4.0 kg/m³)

(FT) = Fine-tooth incisor