CWPA Proceedings, 2002, pp 156-169

FIELD TESTING OF WOOD PRESERVATIVES IN CANADA XI:

NINE-YEAR INSPECTION OF THE CITW DECKING TEST

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Summary

A field test of decking under natural weathering conditions was established in 1991 at two locations in Canada to assess the performance in service of untreated, unincised-treated and incised-treated lumber of eleven species. The wood was sourced from an earlier study comparing CCA-C treatability of incised and unincised boards treated under identical conditions. Mini-decks were prepared from each species/treatment variable, and visually inspected for decay and dimensional stability after five and nine years of exposure. After nine years the CCA-treated samples were virtually free of fungal attack, whatever the preservative penetration, while decay of the untreated wood was moderate to severe. Western red cedar was the most dimensionally stable species in terms of cupping and checking. Incising the wood tended to increase cupping and reduce checking.

Introduction

A new standard was published in 1997 by the CSA 080 Technical Committee on Wood Preservation in response to concerns within the Canadian wood preservation industry regarding the fact that much of the above ground residential treated (AGRT) lumber produced in Canada was not being treated to meet a recognized standard. This standard, 080.32-97 "Preservative Treatment of Decking Lumber with Waterborne Preservatives by Pressure Processes", specifies a minimum 5 mm penetration in 16 of 20 core samples rather than the 10 mm specified in CSA 080.2, and a retention of 6.4 kg/m^3 in a 5 mm assay zone rather than 4.0 kg/m^3 in a 16 mm assay zone. The American Wood Preservers Association T2 Committee has recently approved a similar standard, partly on the basis of the data in this paper.

To support this alteration, in-service performance data must be available on material treated to meet the new standard and exposed to the intended hazard. This requirement can be addressed by the above-ground field exposure study of eleven wood species, untreated and treated with chromated copper arsenate (CCA-C), put into test by Forintek on behalf of the Canadian Institute of Treated Wood (CITW) in 1991 at two locations in Canada. Although scheduled for evaluation after ten years in service, the inspection was

brought forward a year in order to generate data for the AWPA in 2000. In Ottawa both decay and dimensional stability was assessed in June, while the Vancouver decks were evaluated for decay in June, and checking and cupping at the end of July. This report describes the condition of the lumber in this test in terms of decay and dimensional stability after nine years of exposure.

Materials and Methods

Deck preparation

Boards used in this test were originally part of a treatability study in which incised and unincised lumber of commercial species were treated with chromated copper arsenate (CCA-type C) at the same treating plant using identical treating schedules. Collection, preservative treatment, and sampling of the material was described in an earlier report (Morris, 1991a). Selection of the material and construction of the decks was described in a second report (Morris, 1991b). Briefly, 2 x 6" lumber, 0.6 m in length, of three treatment types (untreated, incised and treated, or unincised and treated) was included for seven wood species: western hemlock, lodgepole pine, jack pine, western spruce, eastern spruce, alpine fir, and balsam fir. Four species with two treatment categories (untreated, and unincised and treated) were used: western red cedar, ponderosa pine, red pine, and southern pine. Incised boards were selected based on penetration most closely meeting the proposed 5 mm standard. The untreated and unincised-treated boards were end-matched to the incised boards wherever possible. Where possible, 60 boards from each treatment category of every species were selected from which three decks of 20 boards each were constructed, with end-matched duplicates at Vancouver and Ottawa. Four decks each of double-density incised white spruce, lodgepole pine, and alpine fir were also included at Vancouver. Due to a shortage of matched material, untreated red pine decks were not prepared for the Ottawa site.

The decks were constructed using double-dipped, galvanized, twisted shank nails with the experimental boards nailed in two rows of ten replicates to treated 2 x 6" boards (Figure 1). Boards on one side of each treated deck were brush-coated with two applications of copper naphthenate (2% copper) field-cut preservative on the cut ends, while the boards on the other side were uncoated. The decks were mounted on concrete blocks in fenced areas adjacent to Forintek's Vancouver (Figure 2) and Ottawa laboratories in the summer of 1991. The Ottawa decks were moved to the grounds of the Central Experimental Farm in Ottawa in 1994.

Due to late supply of certain wood, at Vancouver one of the three untreated ponderosa pine decks, one of three unincised-treated ponderosa pine, two of three unincised-treated western red cedar decks, and two of the untreated western red cedar decks were not put out to test until the spring of 1993. In addition, at Ottawa one of the three untreated

ponderosa pine decks, the three unincised-treated western hemlock decks and two of the untreated western red cedar decks were not set out until October 1994.

Vancouver and Ottawa are in the zone of medium above-ground decay potential, as calculated by Setliff (1986) using Scheffer's (1971) climate index. The index for Vancouver is 45.6, while Ottawa is 41.2. In Vancouver temperatures annually average 10^{o} C, with a December average of 3^{o} C and a July average of 17^{o} C. The site receives about 1900 hours of bright sunshine and approximately 1250 mm of precipitation per year, with an average 34 mm of rain in July and 140 mm of rain in December. In Ottawa, the temperature averages 6^{o} C annually, with an average of -7^{o} C in December and 21^{o} C in July. Approximately 920 mm of precipitation falls annually at the Ottawa site, with 90 mm being received in July and 92 mm in December.

Inspection of test material

After nine years of exposure, each board was assessed for decay. The inspection method involved gentle probing of checks and end-grain with a metal spatula for signs of softening or cavities. Particular attention was paid to areas of high moisture content, discoloration, or collapse visible on the surface, and areas sounding hollow or dull when tapped with the blunt end of the spatula. Basidiomycete fruitbodies were noted on the ends and undersides of some deck members. Each deck board was rated using the AWPA system:

Rating	Condition of the board
10	no attack
9	suspicion of, or superficial, decay
7	evident but moderate decay
4	severe decay
0	failure due to decay

Each board was also assessed for checking and cupping. Surface checking was rated on a scale of 0 (no checks) to 4 (split all the way through or multiple checks). The depth of the deepest check on each board was measured in millimetres by probing with a thin metal feeler gauge. Cupping was also measured in millimetres, and was defined as "a deviation in the face of a piece from a straight line drawn from edge to edge of a piece, and measured at the point of greatest distance from the straight line" (NLGA 1996).

Results and Discussion

Decay

The mean CCA retention and penetration of the test boards, and their decay ratings after nine years at the two test sites are given in Table 1. No decay was found at Ottawa in incised-treated boards of any species. The vast majority of incised-treated specimens in Vancouver were also decay-free, with mean ratings of 10.0. Although one or two boards of the 60 replicates in some species were rated 9 for a suspicion of decay, the mean ratings were 10.0 except for balsam fir without end treatment, which was rated 9.9.

The unincised-treated samples were generally sound with the following exceptions. In Ottawa after nine years, one western spruce and one jack pine board without end coating contained a suspicion of decay, although the mean rating for the 60 replicates remained 10.0. In Vancouver uncoated western hemlock, eastern spruce, jack pine and ponderosa pine, and end-coated western and eastern spruce and red pine decks had mean ratings of 9.9 due to a few boards rated 9. Several western spruce and balsam fir boards without end treatment were rated 9, resulting in a mean rating of 9.7. One uncoated western spruce board was moderately decayed, rated 7. Uncoated red pine decks, and end-coated balsam fir were rated 9.8 due to a few boards rated 9. One ponderosa pine board without end treatment was rated 7.

Since there was virtually no decay present in CCA-treated boards after nine years of exposure, it is still too early to comment on the comparative effectiveness of end-coating wood for above-ground exposure.

Decay in untreated samples of all species progressed substantially in the four years between evaluations. After five years in test, slight decay was present in all species except eastern spruce and western red cedar at Ottawa which remained free of attack. Usually only one or two boards of 60 replicates were rated 9 or 7 at one or both sites. The exceptions were lodgepole pine in Ottawa, and ponderosa pine and southern pine at both locations, in which some boards were substantially decayed. At the nine-year inspection, in Ottawa eastern spruce and western red cedar remained un-attacked, however all other untreated decks at each location contained decay, in some instances severe.

At Ottawa, attack was limited in untreated western spruce and alpine fir, with mean ratings of 9.7 and 9.8 respectively. Two western spruce boards were rated 7 for moderate attack and one was rated as severely decayed, rated 4. Three alpine fir boards were rated 7. Generally moderate decay was present in western hemlock, with 11 boards rated 7, one rated 4 and one sample failed due to decay, for a mean rating of 9.1. Similarly, jack pine decks were rated an average of 9.3 due to 10 boards rated 7 and one rated 4. The remaining four species contained extensive attack. Of the reduced number of 20 balsam fir replicates, 11 were rated as moderately or severely decayed, for a mean rating of 8.2. This attack had become established since the last evaluation in 1996, where no decay had

been noted. Three lodgepole pine samples had failed, four were rated as severely decayed, and seven were moderately attacked, resulting in a mean rating of 8.6. Of 40 ponderosa pine boards, one had failed, seven were severely attacked and 13 were moderately decayed, for a mean rating of 7.6. Southern pine decks were in the worst condition of any of the eleven species tested. Six boards had failed due to decay, 11 were severely deteriorated, and 19 were moderately attacked, resulting in a mean rating of 6.8.

In contrast to Ottawa, after nine years' exposure in Vancouver, untreated eastern spruce was moderately decayed, with one board rated 4 and ten rated 7 for a mean rating of 8.9. Western red cedar also showed early signs of decay, with one board rated 7 and an average rating of 9.8. Western spruce was also more extensively decayed in Vancouver, with two failed boards, three severely decayed, and 14 moderately attacked, resulting in an average 8.3 rating. Paired *t*-tests verified statistically at the 0.05 probability level that decay was worse in Vancouver than Ottawa in untreated eastern spruce, western red cedar, and western spruce. Balsam fir, on the other hand, was in better condition in Vancouver than Ottawa. Only one of 20 untreated balsam fir boards in Vancouver was moderately attacked, for a mean rating of 9.4. This difference in performance between the two sites was also confirmed statistically by a paired *t*-test. Untreated red pine decks, which were present only in Vancouver, contained one severely decayed board, and six boards in moderate condition, for a mean rating of 9.1. The condition of the remaining species was similar at the two locations. In Vancouver, untreated western hemlock was rated 9.0, with two failed boards, one rated 4, and 7 found to be moderately decayed. Jack pine decks contained two boards rated 4 and four rated 7, for a mean rating of 9.5. Alpine fir was in good condition, with an average rating of 9.9 and only one board rated 7. Three lodgepole pine boards had failed, one was severely decayed, and six were moderately decayed, for a mean rating of 8.9 (Figure 3). Ponderosa pine decks contained one failed board, two rated 4, and 16 rated 7, resulting in a mean rating of 8.4. As in Ottawa, southern pine was by far in the worst condition: six failures, five severely decayed, and 27 moderately attacked, for a mean rating of 6.8 (Figure 4). Only four of 60 untreated southern pine replicates remained free of attack.

Table 3 illustrates the proportion of untreated boards which had essentially failed, defined as those rated 4 or 0, after nine years in service. As noted above, the worst performance was shown by lodgepole pine and ponderosa pine in Ottawa, and southern pine at both locations. On these decks, on average, more than 10% of the boards would require replacement.

It should be noted that when a target retention of 6.4 kg/m^3 in the outer 6 mm of wood, which was the penetration typically achieved in the incised-treated samples in this study, is expressed in terms of a 16 mm analysis zone, it becomes 2.4 kg/m^3. Since a 16 mm assay zone was used for the boards in this study (Morris, 1991a), it would be legitimate to compare the retentions achieved with the 2.4 kg/m^3 requirement, except for ponderosa and southern pine, and the double-density incised boards, which contained a much deeper

preservative penetration. Incised western hemlock, western spruce, lodgepole pine, and jack pine met this standard. In addition, unincised western hemlock, lodgepole pine, and jack pine contained over 2.4 kg/m^3 of CCA. It can be concluded that the material in this study is well suited to test the new CSA 080.32 retention and proposed AWPA standards, since samples both meeting and not meeting the standard are included.

Richards and McNamara (1997) reported on the above-ground performance of CCA-C treated refractory softwoods, including western hemlock, western and eastern spruce, jack pine, lodgepole pine, and balsam fir in Hagersville, ON, which would have a similar climate to Ottawa. This material was incised prior to treatment and retentions averaged approximately 5 kg/m^3, based on solution uptake, and penetrations averaged only 2 to 3 mm on the heartwood face. After eight years of exposure in a deck, no decay was detected. These authors concluded that a uniform penetration shell of 5 mm is adequate to provide long-term protection to refractory softwoods, and that a modification to the North American wood preservation standards is technically justifiable.

Crawford *et al* (1999) reported on decking tests established for ten years at Cumberland, ME (climate index 36) and Amherst, MA (climate index 45) which included incised and unincised eastern spruce, balsam fir, and red pine. While no retention or penetration data were presented, the treatment schedule used was similar to that followed in this study. Again, no decay was detected in treated samples, while untreated controls showed decay within ten years.

Choi *et. al* (2001, 2002) have developed considerable amounts of data to support Smith's (1997) hypothesis that small amounts of mobile CCA components move into checks and protect the exposed untreated surfaces from colonisation by wood-rotting fungi. This hypothesis would explain the unexpectedly good performance of decking made from species with a non-durable heartwood given a thin shell of preservative treatment.

Dimensional stability

Table 2 summarizes checking and cupping measurements at the two sites. There was little difference in cupping between species, with the exception of western red cedar and ponderosa pine at both sites, and treated southern pine at Ottawa, which were significantly less cupped than the other species, shown by two-sample *t*-tests ($P<0.05$). Measurements of cupping taken after nine years of exposure were similar to those taken after five years in Ottawa, but had significantly increased in Vancouver. Cupping was much lower in Ottawa than Vancouver, often by a factor of two times. This may have been partially due to the higher moisture content of the boards in Ottawa when cupping was measured early in the summer compared to Vancouver in late July. Due to the more humid summer climate in Ottawa, wetting and drying cycles are also less intense than in Vancouver.

Incising increased the amount of cupping in western hemlock, lodgepole pine, alpine fir, eastern spruce, and balsam fir in Vancouver, and in western and eastern spruce, lodgepole pine, and jack pine in Ottawa. These differences were shown to be statistically significant by two-sample *t*-tests.

Ratings of the degree of checking on the 0 to 4 scale after nine years of exposure were similar in Ottawa and Vancouver. In addition, the depth of checking, which was found to be consistently lower in Ottawa than Vancouver at the five-year inspection, was now also very similar at the two sites (Table 2). As was the case with cupping, western red cedar at both sites was significantly less checked, both on the 0 to 4 scale and in depth, than the other species. Checks in jack pine were also more shallow than other species. A statistical comparison of checking in incised and unincised boards showed that incising reduced checking on the 0 to 4 scale in all species tested in Vancouver, and in western hemlock, western and eastern spruce, and lodgepole pine in Ottawa.

Conclusions

After nine years of exposure above-ground, deck boards CCA-treated by typical commercial processes generally remained in excellent condition irrespective of whether or not they were incised or end-coated.

With the exception of western red cedar and alpine fir, all the untreated decks would have required replacement of individual boards. In the case of untreated southern pine at both locations plus untreated ponderosa pine and lodgepole pine in Ottawa, the entire deck would probably have been replaced by most homeowners.

The Vancouver and Ottawa sites showed similar overall rates of decay, consistent with their similar Scheffer indices.

Incising the boards tended to increase cupping and decrease checking. Cupping was greater in Vancouver than Ottawa, possibly due to moisture content of the wood. The degree and depth of checking was similar at the two sites.

Acknowledgements

Forintek would like to thank the Canadian Institute of Treated Wood for funding this work and for permission to publish this paper. Ownership of the double-density incised material, and the data from it, resides with Forintek Canada Corp. Forintek Canada Corp. would also like to thank its industry members, Natural Resources Canada (Canadian Forest Service) and the Provinces of British Columbia, Alberta, Saskatchewan, Quebec,

Nova Scotia, New Brunswick and Newfoundland for their guidance and financial support for this research.

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Table 1: Mean CCA retention, penetration, and decay after nine years' exposure

Species	Treatment	Retention (kg/m^3)	Mean Penetration (mm)	Decay at Vancouver		Decay at Ottawa	
				uncoated	end-coated	uncoated	end-coated
Western hemlock	untreated	0.0 (0.0)	0.0 (0.0)	9.0 (2.0)	NA	9.1 (1.8)	NA
	unincised-CCA	2.8 (0.4)	3.4 (3.3)	9.9 (0.3)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)
	incised-CCA	4.3 (1.1)	7.0 (1.8)	10.0 (0.2)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)
Western spruce	untreated	0.0 (0.0)	0.0 (0.0)	8.3 (2.2)	NA	9.7 (0.1)	NA
	unincised-CCA	1.5 (0.4)	2.4 (2.9)	9.7 (0.6)	9.9 (0.3)	10.0 (0.2)	10.0 (0.0)
	incised-CCA	2.5 (0.7)	6.4 2.0)	10.0 (0.2)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)
Lodgepole pine	untreated	0.0 (0.0)	0.0 (0.0)	8.9 (2.3)	NA	8.6 (2.6)	NA
	unincised-CCA	2.8 (1.3)	5.3 (4.7)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)
	incised-CCA	3.0 (1.1)	6.8 (2.1)	10.0 (0.0)	10.0 (0.2)	10.0 (0.0)	10.0 (0.0)
alpine fir	untreated	0.0 (0.0)	0.0 (0.0)	9.9 (0.5)	NA	9.8 (0.6)	NA
	unincised-CCA	1.4 (0.2)	3.2 (3.4)	10.0 (0.2)	10.0 (0.2)	10.0 (0.0)	10.0 (0.0)
	incised-CCA	2.0 (0.5)	6.2 (3.0)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)
Eastern spruce	Untreated	0.0 (0.0)	0.0 (0.0)	8.9 (1.2)	NA	10.0 (0.0)	NA
	unincised-CCA	0.8 (0.2)	2.1 (1.4)	9.9 (0.2)	9.9 (0.3)	10.0 (0.0)	10.0 (0.0)
	incised-CCA	2.0 (0.5)	5.9 (1.4)	10.0 (0.0)	10.0 (0.2)	10.0 (0.0)	10.0 (0.0)
jack pine	Untreated	0.0 (0.0)	0.0 (0.0)	9.5 (1.3)	NA	9.3 (1.3)	NA
	unincised-CCA	2.2 (0.4)	5.3 (4.4)	9.9 (0.2)	10.0 (0.0)	10.0 (0.2)	10.0 (0.0)
	incised-CCA	3.6 (0.9)	6.8 (1.7)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)	10.0 (0.0)
balsam fir	Untreated	0.0 (0.0)	0.0 (0.0)	9.4 (0.7)	NA	8.2 (1.8)	NA
	unincised-CCA	1.4 (0.1)	3.5 (3.9)	9.7 (0.4)	9.8 (0.4)	10.0 (0.0)	10.0 (0.0)
	incised-CCA	2.0 (0.6)	6.2 (3.4)	10.0 (0.0)	9.9 (0.2)	10.0 (0.0)	10.0 (0.0)
red pine	Untreated	0.0 (0.0)	0.0 (0.0)	9.1 (1.1)	NA	NA	NA
	unincised-CCA	1.5 (0.1)	5.6 (4.7)	9.8 (0.4)	9.9 (0.2)	10.0 (0.0)	10.0 (0.0)
Ponderosa pine	Untreated	0.0 (0.0)	0.0 (0.0)	8.4 (1.8)	NA	7.6 (2.5)	NA
	unincised-CCA	7.9 (0.1)	11.3 (5.9)	9.9 (0.5)	10.0 (0.2)	10.00 (0.0)	10.0 (0.0)
Southern pine	Untreated	0.0 (0.0)	0.0 (0.0)	6.8 (2.7)	NA	6.8 (3.0)	NA
	unincised-CCA	11.6 (0.5)	16.0 (0.0)	10.0 (0.0)	10.0 (0.2)	10.0 (0.0)	10.0 (0.0)
western red cedar	untreated	0.0 (0.0)	0.0 (0.0)	9.8 (0.5)	NA	10.0 (0.0)	NA
	unincised-CCA	1.1 (0.0)	1.2 (0.6)	10.0 (0.2)	10.0 (0.2)	10.0 (0.0)	10.0 (0.0)
alpine fir	double-incised-CCA	6.5 (0.5)	12.0 (3.4)	10.0 (0.2)	10.0 (0.2)	NA	
Western spruce	double-incised-CCA	5.8 (1.3)	11.2 (4.2)	10.0 (0.2)	10.0 (0.0)	NA	
Lodgepole pine	double-incised-CCA	4.6 (0.3)	11.3 (4.1)	10.0 (0.0)	10.0 (0.2)	NA	

Standard deviations are given in parentheses.

Table 2: Mean cupping and checking after nine years' exposure

Species	Treatment	Vancouver	Ottawa	Vancouver		Ottawa	
		Maximum cupping (mm)		Checking (0-4)	Check depth (mm)	Checking (0-4)	Check depth (mm)
Western hemlock	untreated	1.7 (1.0)	0.8 (0.8)	2.4 (0.6)	14.7 (7.7)	2.2 (0.8)	13.9 (6.0)
	unincised-CCA	1.4 (1.0)	0.8 (0.7)	2.2 (0.4)	14.2 (6.2)	1.9 (0.6)	13.3 (3.9)
	incised-CCA	2.3 (1.3)	0.8 (0.8)	2.2 (0.7)	15.7 (9.4)	1.5 (0.5)	13.5 (4.2)
Western spruce	untreated	2.0 (1.2)	0.8 (0.8)	2.3 (0.5)	11.8 (5.9)	1.7 (0.7)	12.9 (8.3)
	unincised-CCA	1.9 (1.0)	0.5 (0.6)	2.2 (0.4)	9.9 (3.6)	1.5 (0.6)	10.2 (3.9)
	incised-CCA	2.2 (1.1)	1.0 (0.8)	1.7 (0.5)	10.2 (4.4)	1.2 (0.4)	10.8 (3.1)
Lodgepole pine	untreated	2.0 (1.1)	0.8 (0.8)	2.3 (0.5)	12.4 (5.7)	2.0 (0.8)	14.0 (9.3)
	unincised-CCA	1.8 (1.1)	0.5 (0.7)	2.0 (0.5)	9.0 (2.8)	1.7 (0.5)	11.0 (3.5)
	incised-CCA	2.3 (1.0)	0.9 (0.9)	1.5 (0.5)	7.4 (4.2)	1.2 (0.6)	8.8 (4.4)
alpine fir	untreated	2.1 (1.2)	0.8 (0.7)	2.2 (0.5)	10.8 (4.3)	1.9 (0.6)	11.5 (5.5)
	unincised-CCA	1.7 (1.1)	0.7 (0.8)	2.7 (0.9)	17.5 (12.5)	1.6 (0.7)	9.9 (5.3)
	incised-CCA	2.2 (1.3)	0.9 (0.9)	2.1 (0.4)	11.6 (5.1)	1.5 (0.7)	9.3 (4.5)
Eastern spruce	Untreated	2.2 (1.2)	0.8 (0.8)	2.2 (0.5)	11.9 (5.4)	1.7 (0.7)	10.0 (7.1)
	unincised-CCA	1.6 (1.0)	0.9 (0.8)	2.2 (0.4)	11.2 (3.5)	1.8 (0.5)	11.4 (3.7)
	incised-CCA	2.6 (1.0)	1.2 (0.8)	2.1 (0.5)	10.3 (5.1)	1.5 (0.5)	11.2 (4.1)
jack pine	Untreated	1.8 (1.6)	0.9 (0.7)	2.0 (0.3)	8.3 (2.9)	1.3 (0.5)	7.5 (4.3)
	unincised-CCA	1.8 (0.9)	0.7 (0.6)	2.1 (0.3)	8.0 (3.9)	1.3 (0.5)	8.7 (3.6)
	incised-CCA	2.1 (1.2)	1.0 (0.8)	1.5 (0.6)	5.4 (3.8)	1.2 (0.6)	8.7 (4.2)
balsam fir	Untreated	1.8 (1.1)	1.0 (0.8)	2.1 (0.4)	10.8 (5.4)	2.0 (0.6)	13.7 (7.5)
	unincised-CCA	2.2 (1.2)	1.2 (0.9)	2.2 (0.4)	9.3 (2.9)	1.6 (0.6)	9.9 (4.6)
	incised-CCA	2.7 (1.2)	1.3 (0.9)	2.0 (0.3)	9.6 (3.0)	1.5 (0.6)	9.6 (4.4)
red pine	Untreated	1.7 (0.9)	NA	2.3 (0.7)	11.9 (6.8)	NA	NA
	unincised-CCA	1.7 (1.2)	1.0 (0.8)	2.3 (0.5)	12.5 (6.1)	2.1 (0.7)	13.0 (4.7)
Ponderosa pine	Untreated	0.8 (0.8)	0.4 (0.6)	2.1 (0.5)	10.1 (5.2)	2.3 (0.9)	16.9 (10.0)
	unincised-CCA	1.3 (0.9)	0.3 (0.5)	1.9 (0.4)	8.2 (5.8)	1.8 (0.7)	11.2 (5.8)
Southern pine	Untreated	1.1 (1.3)	0.8 (0.9)	2.5 (0.6)	14.5 (6.4)	2.5 (0.9)	23.4 (8.4)
	unincised-CCA	0.7 (0.8)	0.3 (0.5)	2.1 (0.3)	11.1 (3.6)	1.9 (0.4)	12.9 (4.1)
western red cedar	untreated	0.3 (0.6)	0.3 (0.5)	1.3 (1.1)	6.8 (7.5)	1.0 (0.7)	6.6 (5.9)
	unincised-CCA	0.1 (0.4)	0.7 (0.6)	1.2 (0.9)	5.9 (5.2)	1.1 (1.0)	5.7 (5.3)
alpine fir	double-incised-CCA	2.1 (1.2)	NA	1.8 (0.6)	10.2 (5.0)	NA	NA
Western spruce	double-incised-CCA	1.2 (1.1)	NA	1.7 (0.5)	8.1 (4.0)	NA	NA
Lodgepole pine	double-incised-CCA	2.4 (1.2)	NA	1.5 (0.5)	7.1 (3.2)	NA	NA

Standard deviations are given in parentheses.

Table 3: Percentage of failed boards (rated 4 or 0) after nine years' exposure

	Vancouver			Ottawa		
Species	**Unincised-CCA**	**Incised-CCA**	**Untreated**	**Unincised-CCA**	**Incised-CCA**	**Untreated**
Western hemlock	0	0	5	0	0	3
Western spruce	0	0	8	0	0	3
Lodgepole pine	0	0	7	0	0	12
Alpine fir	0	0	0	0	0	0
Eastern spruce	0	0	2	0	0	0
Jack pine	0	0	3	0	0	2
Balsam fir	0	0	0	0	0	5
Red pine	0	0	2	0	0	NA
Ponderosa pine	0	0	5	0	0	20
Southern pine	0	0	18	0	0	28
Western red cedar	0	0	0	0	0	0

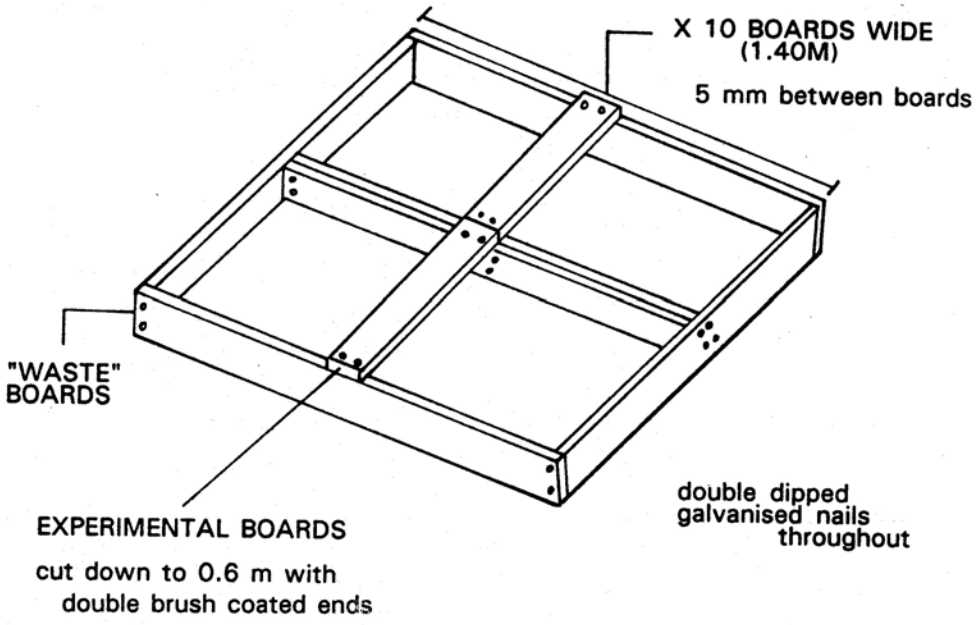

Figure 1: Mini-deck design

Figure 2: Overview of decks in Vancouver

Figure 3: Lodgepole pine untreated deck in Vancouver

Figure 4: Southern pine untreated deck in Vancouver