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FIELD TESTING OF WOOD PRODUCTS IN CANADA XVI: INITIATING TESTS OF NATURALLY DURABLE SPECIES

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Abstract

Field tests of six wood species reputed to be naturally durable were installed in ground and out-of-ground contact (decking test) in the autumn of 2004 and spring 2005 at four test sites in Canada and the USA. Decay results for the ground contact tests are reported after two years of exposure. Although it is too early to draw conclusions regarding relative performance of the different species, as expected samples containing sapwood are deteriorating faster than those containing all heartwood. There is no obvious difference at this point between decay in old-growth and second-growth samples.

1. Introduction

It may be surprising to some people that there would be a need to set up field tests of naturally durable species in the 2000s. Sale and use of these species has up to now been largely based on long-term experience and anecdotal evidence of good performance. Unfortunately, these days a reputation for durability may not be sufficient in existing markets and hard data will likely be required to support sales in new markets. There is a lack of hard data on the performance of many of the naturally durable species in North America, both in ground contact and above-ground exposure. There is almost no data on the durability of second growth and there are arguments over the effect of small amounts of sapwood on the durability of commodities. With the withdrawal from the residential market of CCA (chromated copper arsenate), the accepted standard preservative for wood in residential use for over thirty years, there is increased interest in alternatives, including untreated naturally durable wood. At around the same time, Paul Morris of Forintek Canada Corp. (now FPInnovations – Forintek Division) and Peter Laks of Michigan Technological University recognised a need to generate some hard data on the natural durability of a range of species that grow in Canada and the Northern USA. The rating and ranking of naturally durable species is based mainly on laboratory pure culture decay tests and ground contact tests but the majority of this material is used in above-ground applications. Above ground, the moisture conditions are less stable, there is a greatly reduced influx of minerals that could act as micronutrients or help detoxify extractives, the

typical inoculum will be spores rather than mycelium or mycelial cords, and conditions may be less favourable for growth of organisms that might detoxify extractives. Since the conditions in ground contact differ so radically from the conditions above ground, it may be appropriate to define different ratings for ground contact and above ground exposures.

Tests of untreated samples of species reputed to be naturally durable, both in ground contact and above ground (decking test), were established in 2004 at four test sites. These were: Forintek's test sites at Petawawa, ON (continental climate) and Maple Ridge, BC (temperate climate), and Michigan Technological University's test sites at Gainesville, Florida (subtropical climate) and Hilo, Hawaii (tropical climate). This report describes establishment of the ground contact tests and two-year inspection data for the ground-contact material at BC, ON, FL and HI.

2. Materials and Methods

2.1 Test Sites

The Petawawa test site is located within the Petawawa Research Forest of Natural Resources Canada near Ottawa, ON at an elevation of 170m. It is cleared natural forest surrounded by mixed coniferous/deciduous trees and has mean annual temperature of 4.3°C. It receives mean annual precipitation of 822 mm. The soil is classified as a dark brown loam with an average moisture holding capacity of 25% down to about 18 cm, below which lies coarse sand. The climate there also places it within the zone of medium out-of-ground decay hazard with a climate index of 41 (Setliff 1986).

The test site at Maple Ridge, near Vancouver, BC, is located within the University of British Columbia Malcolm Knapp Research Forest at around 130m above sea level. The soil is a sandy loam with high organic matter content. This site has a rainfall of over 2000 mm per year and a mean annual temperature of 9.6°C. It falls within the moderate decay hazard zone for outdoor above-ground exposure using Scheffer's climate index (Scheffer 1971; Setliff 1986), with a climate index of 55. This zone includes most of the major population centres of North America.

Michigan Technological University (MTU)'s test site in Florida is located in the Austin Cary Forest near Gainesville. It is 7 m in elevation, with a sandy soil. The mean annual temperature is 20^{o}C and it receives annual precipitation of 1280 mm, with a Scheffer climate index of approximately 110.

MTU maintains several test sites in Hawaii. The material was installed originally at the Mountain View site near Hilo, where the soil is a silty clay loam, at an elevation of 513 m. Precipitation averages 4660 mm annually and the mean annual temperature is 20^{o}C, resulting in a Scheffer index of 400. After one year, the test material was transferred to the "Kipuka" test site in Keaau, near Hilo. This site is located at an elevation of 151 m, the soil is silty clay loam, and the Scheffer climate index is 350, due to an average annual

temperature of 23^{o}C and precipitation of 3220 mm per year.

2.2 Materials

8-ft long, 2 x 6" and 2 x 4" kiln-dried boards were obtained of six species traditionally believed to be naturally durable: western red cedar (*Thuja plicata*), yellow cedar (*Chamaecyparis nootkatensis*), eastern white cedar (*Thuja occidentalis*), western larch (*Larix occidentalis*), tamarack (*Larix laricina*), and Douglas-fir (*Pseudotsuga menziesii*), plus ponderosa pine (*Pinus ponderosa*) for comparison with a perishable species. With the exception of ponderosa pine and Douglas-fir, half of the boards were chosen to contain all heartwood, and the other half contained a mixture of heartwood and sapwood. Ponderosa pine boards were all sapwood, and Douglas-fir boards were all heartwood. Where possible, half of the boards were from old-growth trees, and the other half second-growth. It was not possible to obtain second-growth white cedar or old-growth tamarack.

The wood was procured from the following sources: western red cedar and yellow cedar boards from Delta Cedar Products in Delta, BC; the eastern white cedar from Scierie MSG in Bouchette, PQ; the western larch from Kalesnikoff Lumber Co. in Thrums, BC; the tamarack from Eloie Moisan in St Gilbert, PQ; the Douglas-fir from West Wind Hardwood Inc. in Sidney, BC (Vancouver Island); and ponderosa pine from George Sherbinin Lumber Ltd. in Westbridge, BC.

2.3 Test Design

Forintek's stake tests are conducted in accordance with the procedures of the American Wood Protection Association Standard E7: Standard Method of Evaluating Wood Preservatives by Field Tests with Stakes.

Twenty 8-ft long 2 x 4" kiln-dried boards per species/wood type were each cut into four 460 mm long end-matched stakes for installation at the four test sites. This resulted in a total of 380 stakes for installation at each location. The stakes were installed to half their length spaced approximately on a 0.7 m^2 grid with as much randomization as possible in their placement. Stake holes were pre-drilled using a six-inch diameter powered auger.

The stakes were installed at Forintek's test sites at Maple Ridge, BC, and Petawawa, ON, in October 2004. To offset variations in soil conditions within the Maple Ridge test site the stakes were split between the four quadrants of this test site and a sample layout map was prepared. The Hawaii samples were installed in November 2004 at the Mountain View site, then moved to Kipuka in November 2005. The Florida samples were installed in February 2005.

2.4 Inspection

In late October 2005 and September 2006 at Maple Ridge and Petawawa, November 2005 and 2006 in Hawaii, and February 2006 in Florida, each stake was removed from the soil,

loose grass and dirt were brushed off, and then it was examined visually for indications of decay such as the presence of fungal mycelium or discolouration. If decay was suspected, the area of interest was gently probed with a metal probe. Each specimen was then assigned a rating for decay, based on the new AWPA E7 grading system:

Rating	Description
10	Sound
9.5	Trace or suspicion of attack
9	Slight decay up to 3% of cross section
8	Moderate decay from 3 to 10% of cross section
7	Moderate/severe decay from 10 to 30% of cross section
6	Severe decay from 30 to 50% of cross section
4	Very severe decay from 50 to 75% of cross section
0	Failure

Commonly, a rating of 9.5 was given when mycelium with the appearance of wood-rotting basidiomycetes was seen on the wood surface but no softening was detected.

3. Results and Discussion

After two years exposure, Florida appears to be the most aggressive test site (Table 1) possibly because very little attack occurred in Hawaii in the first year (data not shown). However, the differences among sites are not as large as would have been expected, possibly due to the particularly aggressive microflora of the soils at Maple Ridge and Petawawa. It should be noted that minor variations in ratings among the Canadian and American sites can be expected due to different inspectors performing the evaluations. This will be addressed by a comparative rating exercise when staff from Forintek and MTU can get together at one site.

Table 1 Summary of stake mean decay results after 2 years

			Ontario	BC	Florida	Hawaii
Yellow cedar	Old growth	heartwood	9.0	9.0	8.1	9.2
Yellow cedar	2nd growth	heartwood	9.0	9.0	8.0	8.9
Yellow cedar	Old growth	heart-sapwood	8.7	8.8	7.7	8.5
Yellow cedar	2nd growth	heart-sapwood	7.8	8.4	7.3	8.6
Western red cedar	Old growth	heartwood	8.8	8.9	7.6	8.6
Western red cedar	2nd growth	heartwood	8.6	8.6	7.1	9.1
Western red cedar	Old growth	heart-sapwood	8.6	8.6	7.7	8.7
Western red cedar	2nd growth	heart-sapwood	8.4	7.9	6.0	8.3
Eastern white cedar	Old growth	heartwood	8.8	8.8	7.5	8.6
Eastern white cedar	2nd growth	heartwood	NA	NA	NA	NA
Eastern white cedar	Old growth	heart-sapwood	8.7	8.5	7.6	8.6
Eastern white cedar	2nd growth	heart-sapwood	NA	NA	NA	NA
Douglas-fir	Old growth	heartwood	8.9	9.1	6.9	9.2
Douglas-fir	2nd growth	heartwood	8.9	8.6	7.3	8.7
Douglas-fir	Old growth	heart-sapwood	NA	NA	NA	NA
Douglas-fir	2nd growth	heart-sapwood	NA	NA	NA	NA
Larch	Old growth	heartwood	8.6	8.8	6.5	8.9
Larch	2nd growth	heartwood	8.6	8.9	4.7	9.4
Larch	Old growth	heart-sapwood	8.3	8.5	6.2	7.3
Larch	2nd growth	heart-sapwood	8.2	8.7	6.0	7.9
Tamarack	Old growth	heartwood	NA	NA	NA	NA
Tamarack	2nd growth	heartwood	8.3	8.7	6.1	8.5
Tamarack	Old growth	heart-sapwood	NA	NA	NA	NA
Tamarack	2nd growth	heart-sapwood	8.2	8.5	6.7	7.2
Ponderosa pine	NA	sapwood	7.6	8.8	1.7	4.6

NA: not applicable

These early results do show the expected trend of increased attack in stakes containing some sapwood compared to those which were all heartwood. The question is, will this continue into the heartwood or will it stop at the heartwood-sapwood boundary. At this point there does not generally appear to be a decay difference between old-growth and second-growth stakes possibly because our second growth comes from managed forests with relatively slow growth rates compared to plantations. The differences among species do not appear as large as might have been expected, possibly due to the aggressiveness of these test sites. Annual monitoring of these stakes will continue.

4. Conclusions

Although it is too early to draw conclusions regarding relative performance of the different species, as expected samples containing sapwood are deteriorating faster than those containing all heartwood. There is no obvious difference at this point between decay in old-growth and second-growth samples.

5. Acknowledgements

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