Use of through-boring to improve CCA or ACZA treatment of refractory Douglas-fir and grand fir

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Abstract

Large quantities of smaller diameter materials are available in the overstocked forests of eastern Oregon and Washington, but the costs of removing these materials and the long distances from markets sharply reduce the potential of this resource. Failure to thin these forests will sharply increase the likelihood of catastrophic wildfires. One potential use for these materials is as treated fence posts. Unfortunately, the wood of many of the species in this region (inland Oregon and Washington) is highly resistant to conventional pressure treatment. In this report, we describe tests to improve treatment using combinations of ammoniacal-based preservatives and through-boring. Through- boring had little overall effect on treatment results, while the use of an ammoniacal-based system markedly improved treatment.

The eastern portions of Oregon and Washington contain vast areas of overstocked forests (Gast et al. 1991). These forests represent a legacy of selective removal of more valuable ponderosa pine (*Pinus ponderosa L.*), coupled with over a century of vigorous fire suppression. Many of these stands contain large quantities of small-diameter Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and grand fir (*Abies grandis* (Dougl.) Lindl.). The small diameter of the trees in these stands makes them difficult to thin economically. Yet, without thinning, these stands remain vulnerable to disease or insect outbreaks, and ultimately, large-scale wildfires. Removing small-diameter logs can have benefits in restoring forest health, while encouraging the development of sustainable employment (Jaindl and Quigley 1996).

One potential use for smaller diameter logs is to produce small posts and poles. Both Douglas-fir and grand fir lack significant natural durability in direct soil exposure (Morrell et al. 1999). As a result, the application of supplemental preservatives is essential for producing effective service lives with these products. Achieving acceptable treatment of Douglas-fir from this region poses a major challenge (Miller 1961). Miller and Graham (1963) surveyed the treatability of Douglas-fir in Oregon and found that not even the sapwood of trees from the eastern regions of the state could be easily treated. Subsequent studies suggested that this difficulty could be attributed, in part, to a reduced degree of pitting (Krahmer 1961, Krahmer and Côte 1966). Treatment difficulties were found not only with solid wood, but also with plywood (Mitchoff and Morrell 1991).

The refractory nature of interior Douglas-fir may pose a major challenge to the development of market applications dependent upon the ability to treat to current industry standards. The American Wood Preservers' Association Standards currently require that 9 mm and 100 percent of the sapwood up to 25 mm of a Douglas-fir post be treated (AWPA 1999a). Although incising could be used to enhance treatment, many smaller operators in the region lack proper equipment or the capital to purchase those capabilities. In many cases, traditional pole incisors are too large to accommodate smaller pole sections.

One alternative to incising to improve treatment is to use a modified through-boring process (Morrell and Schneider 1994). Through-boring involves drilling slightly angled holes from one face through the post to the op-

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Forest Prod. J. 53(6):33-35.

Table 1. — Effect of through-boring on penetration of CCA or ACZA in increment cores removed from grand fir, freshly cut Douglas-fir, or salvaged Douglas-fir posts.[a]

		Non-through-bored zone					Through-bored zone				
		Sapwood depth		Preservative penetration			Sapwood depth		Preservative penetration		
Wood species	Treatment	Range	Mean	Mean	Range	Accepted	Range	Mean	Mean	Range	Accepted
		(mm)				(%)	(mm)				(%)
Douglas-fir fresh	ACZA	2 to 38	15 (6.3)	21 (9.5)	6 to 50	86	3 to 30	15 (6.3)	24 (9.4)	7 to 50	96
Douglas-fir old		4 to 30	15 (7.0)	20 (8.9)	7 to 37	86	4 to 18	15 (7.0)	23 (10.7)	7 to 45	94
Grand fir[b]		- -	- -	42 (16.0)	14 to 60	100	- -	- -	53 (6.1)	43 to 70	100
Douglas-fir fresh	CCA	3 to 33	16 (5.7)	9 (5.0)	3 to 26	20	3 to 36	15 (6.9)	10 (6.7)	3 to 32	34
Douglas-fir old		4 to 26	13 (4.9)	8 (9.5)	2 to 21	28	7 to 24	14 (3.9)	10 (4.7)	2 to 20	44
Grand fir[b]		- -	- -	15 (3.2)	3 to 57	56	- -	- -	15 (13.9)	4 to 52	44

[a]Values represent means of 25 grand fir, 36 salvaged Douglas-fir, or 50 freshly cut Douglas-fir posts. Posts were sampled at groundline (non-through-bored zone) and 75 mm above a through-bored hole at the post midpoint (through-bored zone). Values in parentheses are standard deviations.
[b]Sapwood was not determined.

posite side. Through-boring patterns typically space holes 50 to 100 mm apart across the cross section and 150 to 200 mm longitudinally. This process produces nearly complete treatment of the bored zone, largely eliminating the risk of groundline decay.

Through-boring of posts should be far less intensive, given the small diameter of the wood. A series of single holes at appropriate longitudinal spacings may produce an acceptable treatment pattern in these materials. This process could conceivably be mechanized and performed during peeling to reduce cost.

There is, however, little data on the ability of through-boring to improve treatment of interior Douglas-fir or grand fir. In this report, we describe through-boring tests on these two species using two waterborne treatments.

Materials and methods

Douglas-fir and grand fir posts measuring 90 to 160 mm in diameter at the butt and 3.0 m in length were processed at a sawmill near Joseph, Oregon. The Douglas-fir posts were classified as being cut from either freshly felled or dead standing trees. We obtained 100 posts from freshly felled Douglas-fir, 72 posts from salvaged Douglas-fir, and 50 posts from grand fir. Some salvaged posts had exit holes and other evidence of existing beetle attack.

A single 9-mm-diameter hole was drilled radially through the middle of each post. This process exposed additional transverse area to longitudinal fluid penetration. It also created the opportunity for radial or tangential flow within the post, although we expected flow in these latter two directions to be negligible. The amount of sapwood visible on the end of each Douglas-fir post was measured. Sapwood was not measured on grand fir as it is difficult to distinguish visually from the heartwood. Resistance-type moisture meter readings were then taken 12 mm from the surface of sample posts from each group. The posts from each species/age group were then randomly assigned to one of two treatment groups. The two groups of posts were then shipped to one of two facilities in western Oregon for pressure treatment. One plant used chromated copper arsenate (CCA), Type C, while the other used ammoniacal copper zinc arsenate (ACZA) (Standard P5, AWPA 1999b).

For the CCA treatment, a vacuum was drawn for approximately 30 minutes (66 cm Hg) then treating solution (1.5% oxide basis) was added and the pressure was raised to 1035 MPa and held for approximately 1.5 hours. The pressure was released and the solution drained, then the wood was subjected to a short vacuum (30 min.) to hasten solution recovery.

For ACZA treatment, the wood was steamed for 2 hours (117°C), then a vacuum was drawn for 30 minutes (66 cm Hg) and treating solution (1.75% oxide basis) was added. The pressure was raised (1035 MPa), held for 3 hours, and then released, and the solution was drained. Finally, the wood was subjected to a 45-minute vacuum. In both cases, the wood was held on a drip pad for at least 48 hours after treatment to allow surface fixation reactions to proceed.

After treatment, the posts were transported to Oregon State University where preservative penetration was assessed by removing increment cores from both the intended groundline and 75 mm above the through-bored zone, in line with the through-bored hole. Preservative penetration and sapwood depth (where appropriate) were assessed visually on each core.

Results and discussion

Douglas-fir

There was little or no difference in preservative penetration in freshly harvested and salvaged Douglas-fir posts (**Table 1**). One might expect preservative penetration to increase in salvaged timber as decay fungi invading this material increased permeability, but this apparently had not yet happened in the material tested. The salvaged Douglas-fir had a slightly lower moisture content (8% compared with 18% for green posts) prior to treatment, but this appeared to have little effect on treatment.

Salvaged and freshly cut Douglas-fir posts averaged 15 mm of sapwood. This would make it difficult to collect an adequate number of 25-mm-long sapwood cores for assay purposes, as per AWPA Standard C5 (AWPA 1999b). Preservative penetration of CCA-treated posts averaged 8 or 9 mm, respectively, for freshly cut or salvaged materials. Only 20 and 28 percent of cores met the minimum sapwood penetration using this preservative. Clearly, CCA treatment of interior Douglas-fir poses a major challenge.

Treatment of posts with ACZA produced markedly better preservative penetration. Freshly harvested and salvaged posts averaged 21 and 20 mm of penetration, respectively; thus, 86 percent of the posts met the treatment standard. The improved treatment results are consistent with the benefits of using ammonia-based systems, which tend to swell the wood slightly and solubilize materials that can coat pit membranes.

The use of through-boring improved treatment results with both species, although the differences were slight. Average ACZA penetration increased by 2 mm and the acceptance rate increased to 95 percent. CCA penetration increased by 1 or 2 mm for freshly cut or salvaged posts, improving the acceptance rate to 34 or 44 percent, respectively. Clearly, through-boring alone is unlikely to result in acceptably treated products of this species when CCA is used, unless numerous holes are drilled in a tightly spaced pattern to take advantage of the minimal longitudinal fluid flow observed. The high number of holes would increase preparation costs and likely reduce material properties of the resulting posts.

Grand fir

Grand fir does not produce an easily distinguished sapwood, but it is considered to be more easily treated than Douglas-fir (Kumar and Morrell 1989, FPL 1999) (**Table 1**). Many grand fir trees had been attacked by beetles whose galleries increased the pathways for fluid flow. Pretreatment moisture content of this material averaged 14 percent.

Preservative penetration in grand fir was considerably better than in the Douglas-fir with either treatment. ACZA penetration averaged 42 mm in non-through-bored posts and 53 mm in the through-bored zone. All of the ACZA-treated posts were acceptably treated. CCA treatment averaged 15 mm in both non-through-bored and through-bored material, again indicating that this process did little to improve treatment with this chemical. Only 56 and 44 percent of non-through-bored and through-bored materials, respectively, were acceptably treated with CCA.

Implications

Previous tests have shown that CCA treatment of Douglas-fir poses a major challenge. CCA appears to react more quickly in this species, inhibiting further fluid ingress (Forsyth and Morrell 1990). Although through-boring produced slight treatment improvements, the levels were far below those required in current U.S. standards. Higher density boring patterns might produce acceptable treatment, but these processes weaken the posts and the process adds expense to a material that generally does not command a premium price. As a result, through-boring does not appear to be a feasible approach for improving treatment of this material. These trends also appear to hold for grand fir.

The use of ACZA produced markedly better treatment, a finding consistent with the benefits associated with ammonia-based systems. Through-boring enhanced treatment with this system, but this degree of improvement was far in excess of the standard and is probably not economically justified.

Literature cited

American Wood-Preservers' Association (AWPA). 1999a. Standard P5. Waterborne preservatives. Book of Standards. AWPA, Granbury, TX.

__________1999b. Standard C5. Fence posts, preservative treatment. Book of Standards. AWPA, Granbury, TX.

Forsyth, P.G. and J.J. Morrell. 1990. Hexavalent chromium reduction in CCA-treated sawdust. Forest Prod. J. 40(6):48-50.

Gast, W.R., D.W. Scott, C. Schmidt, D. Clemens, S. Howes, C.G. Johnson, Jr., R. Mason, and F. Mohr. 1991. Blue Mountains forest health report: New perspectives in forest health. FS-R6. USDA Forest Serv., Pacific Northwest Region, Malhuer, Umatilla, and Wallowa-Whitman National Forests, LaGrande, OR.

Jaindl, R.G. and T.M. Quigley. 1996. Finding a solution. *In*: Search for a Solution: Sustaining the Land, People and Economy of the Blue Mountains. American Forests in cooperation with the Blue Mountains Natural Res. Inst., Washington, DC. pp. 285-299.

Krahmer, R.L. 1961. Anatomical features of permeable and refractory Douglas-fir. Forest Products Journal 11(9):439-441.

__________ and W.A Cote. 1966. Changes in coniferous wood cells associated with heartwood formation. Tappi 46(1):42-49.

Kumar, S. and J.J. Morrell. 1989. Penetration and absorption of different CCA composites in six western conifers. Forest Prod. J. 39(10):19-24.

Miller, D.J. 1961. Permeability of Douglas-fir in Oregon. Forest Prod. J. 11(1):14-16.

__________and R.D. Graham. 1963. Treatability of Douglas-fir from western United States. *In*: Proc. Am. Wood-Preservers' Assoc. 59:218-222. AWPA, Granbury, TX.

Mitchoff, M.E. and J.J. Morrell. 1991. Preservative treatment of plywood panels from the Pacific Northwest. Forest Prod. J. 41(9):11-18.

Morrell, J.J. and P.F. Schneider. 1994. Through boring of poles for improving treatment: Distribution of preservative and effect on performance. *In*. Proc. American Wood-Preservers' Assoc., Granbury, TX. 90:317-324.

__________, D.J. Miller, and P.F. Schneider. 1999. Service life of treated and untreated fence posts: 1996 Post-farm Rep. Res. Cont. 26. Forest Res. Lab. Oregon State Univ., Corvallis, OR.

USDA Forest Service, Forest Products Laboratory (FPL). 1999. Wood Handbook: Wood as an Engineering Material. Gen. Tech. Rept. FPL-GTR-113. Forest Prod. Soc., Madison, WI. 463 pp.