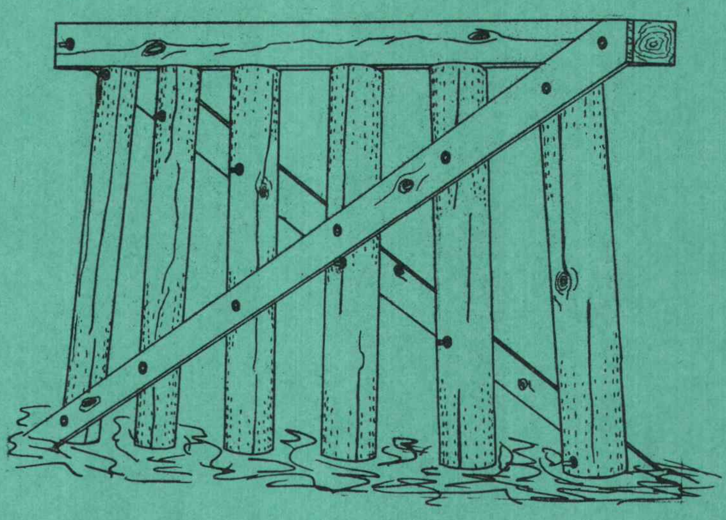
Full-Cell Treatment of Kiln-Dried Coast-Type Douglas Fir Piling With Creosote and Creosote-Coal Tar

By

D. J. Miller

R. D. Graham



Report No. P-2

April 1957

OREGON FOREST PRODUCTS LABORATORY

State Board of Forestry and School of Forestry,
Oregon State College, Cooperating
Corvallis

THE OREGON FOREST PRODUCTS LABORATORY was established by legislative action in 1941 as a result of active interest of the lumber industry and forestry-minded citizens. It is associated with the State Board of Forestry and the School of Forestry at Oregon State College.

An Advisory Committee composed of men from representative interests guides the research program that is directly pointed toward the fuller utilization of Oregon's forest resources. The following men constitute the present membership of the Advisory Committee:

CONTENTS

Ref. 2250

Draft

15 Apr. 57

ACKNOWLEDGMENTS

The Oregon Forest Products Laboratory acknowledges with thanks donations of creosote-coal tar by Tar Products Division, Koppers Company, Inc., and of creosote by Bernuth Lembecke Company, Inc. Assistance of J. H. Baxter Company in obtaining materials is appreciated greatly.

SUMMARY

To help resolve controversy over merits of viscous creosote-coal tar solutions for treating Douglas fir piling to be installed in coastal waters, eight poles were sectioned, kiln-dried, and treated by a full-cell process.

The piling was more difficult to treat with creosote-coal tar than with creosote alone.

Kiln drying green, round, Douglas fir before preservative treatment appeared feasible.

Full-Cell Treatment of Kiln-Dried Coast-Type
Douglas Fir Piling with Creosote and Creosote-Coal Tar

D. J. Miller
R. D. Graham

INTRODUCTION

Creosote-coal tar mixtures are being used in increasing quantities for preservative treatment of Douglas fir piling to be installed in coastal waters. Lack of adequate data on treatment of Douglas fir with this preservative has resulted in considerable controversy as to results that might be expected.

Since previous attempts to Boulton process and treat Douglas fir piling at the Oregon Forest Products Laboratory with creosote-coal tar had produced unsatisfactory results, the present work was initiated using kiln-dried Douglas fir piling to obtain:

- data on kiln drying round Douglas fir;
- comparisons of penetrations and retentions of a 70-30 creosote-coal tar solution and a creosote now used on the West Coast for Douglas fir piling.

MATERIAL AND EQUIPMENT

Wood

Eight class 4, 35-foot machine-peeled coast-type Douglas fir poles were studied. Sapwood depth varied from 0.8 to 2.6 inches in thickness and from 67 to 121 per cent in moisture content on a dry-weight basis. Although the average specific gravity (oven-dry-weight, green-volume basis) was 0.46, the sapwood was consistently higher in specific gravity than was the heartwood. The green peeled poles averaged 47.6 lb per cu ft (pounds per cubic foot).

Preservatives

The 70-30 creosote-coal tar solutions was supplied by Koppers Company, Inc., and the creosote was supplied by Bernuth Lembecke Company, Inc.

At 200 to 220 F, viscosities of unused creosote-coal tar and used creosote were similar; but there was marked increase in viscosity of creosote-coal tar at temperatures under 180 F. Used creosote-coal tar was much higher both in viscosity and in specific gravity than were unused creosote-coal tar and used creosote.

Equipment

All charges were treated in an experimental plant having a cylinder 3 feet in diameter and 10 feet long. Treating cylinder and overhead Rueping tank were equipped with steam coils.

PROCEDURE

Preparation of charges

Four 5-foot specimens were cut from a 25-foot length at the butt end of each pole. Sections for moisture content (dry-weight basis) and specific gravity (oven-dry weight and green volume) determinations were cut between specimens. The 5-foot specimens were weighed and their oven-dry weights were calculated. Both ends were coated twice at a 24-hour interval with a urea-formaldehyde resin. In previous experiments, this resin was effective in reducing both end-drying and end-penetration of the preservative.

Two specimens from each pole were dried to moisture contents of 25-30 per cent, and the remaining two pieces from each pole were dried to 15-20 per cent. The eight 5-foot specimens in each charge represented 4 poles, with 1 specimen from each pole dried to each of the 2 moisture content ranges. Two charges containing matched specimens were treated with each schedule. One charge for each of the two schedules was treated with creosote, the other with creosote-coal tar.

Kiln drying

All specimens were placed in a reversible cross-circulation kiln and dried at 150 F. During the first 10 days the kiln was maintained at EMC (equilibrium moisture content) conditions of 12 per cent. For the remaining 10 days EMC conditions of 8 per cent were maintained.

Each specimen was weighed frequently and was removed from the kiln when the desired moisture content range was reached. A third end-coating of resin was applied prior to treatment.

Moisture distribution in dried specimens was measured with a resistance-type moisture meter at depths from 0.25 to 2 inches, with nails for electrodes.

Checks occurring during drying were rated as moderate, large, or very large, as illustrated in Figure 1.

Preservative treatment

Charges 180 and 183 were pressed for 14 1/2 hours at 127 psi and charges 181 and 185 were pressed 11 hours at 140 psi. Charges 180 and 181 were treated to refusal with creosote-coal tar at slightly over 200 F, and charges 183 and 185 were treated with creosote. Preservative recovery during final vacuum was determined by draining the retort contents into a small pressure vessel that was isolated and drained at 15-minute intervals.

Individual retentions were determined by weighing all specimens prior to and after treating. Each treated specimen was bored twice on opposite sides of the center. Solid-black and ringed (summerwood only) penetrations were measured to the nearest 0.05 inch.

A foot-long section was cut from the center portion of each specimen, from which other cross sections were cut as needed. One 6-inch-long cross section was turned on a lathe to expose a clean end-surface for photographing to show penetration.

Two-inch cross sections were cut from 6 of the best creosote-coal tar treated specimens and from matching specimens treated with creosote. These cross sections were forwarded to the U.S. Forest Products Laboratory for extraction analyses.

RESULTS

Kiln Drying

Drying rate

During initial drying conditions of 150 F and EMC conditions of 12 per cent, average moisture content of 21 specimens was reduced from 56 down to 26 per cent in 10 days. Rate of drying declined after 6 days.

Reducing the EMC conditions to 8 per cent accelerated drying of the 16 specimens dried further, whose average moisture content decreased to 18 per cent in the following 10 days.

Moisture distribution

Specimens dried to a moisture-content range between 25 and 30 per cent had a moisture content of 20 per cent at 0.5 inch from the surface and 28 per cent at 1.5 inches from the surface.

Specimens dried to a moisture-content range between 15 and 20 per cent had a moisture content of 13 per cent at 0.5 inch, and of 21 per cent at 1.5 inches from the surface.

The average moisture content determined by weighing corresponded to an average meter reading at a depth of 1.3 inches, or about 13 per cent of the diameter.

Checking

A few surface checks developed in most pieces early in the drying schedule and increased in size as drying continued. At completion of drying, most pieces contained large or very large checks, many of which exceeded 1/2 inch in width and extended to the pith (Figure 1).

Moderate checks developed at a moisture content of 30 per cent, becoming large checks at 26 per cent and very large checks at 21 per cent moisture content.

The urea-formaldehyde resin coating was in excellent condition at completion of drying and appeared an effective method for preventing excessive end-drying.

Preservative Treatment

Higher retentions and deeper penetrations were obtained with creosote than with creosote-coal tar (Table 1). Refusal was reached 4 hours and 1.5 hours earlier with creosote than with the mixture at pressures of 127 and 140 psi (pounds per square inch), respectively. Pressures used did not increase checking, nor did treated material bleed during subsequent indoor storage.

Retention

Average net retentions determined by weighing specimens were from 47 to 60 per cent (about 6 lb per cu ft) greater with creosote than with creosote-coal tar (Table 1). Increasing the pressure from 127 to 140 psi and reducing the pressing time from 14.5 to 11 hours lowered retentions with both preservatives and reduced solid-black penetration with creosote-coal tar.

Consistently high retentions were obtained with both preservatives in specimens kiln-dried to the low moisture content range (Table 1). Although average moisture content differences between the two groups of dried specimens were less than 5 per cent at a depth of 1.1 inches, average retentions were from 3.3 to 4.6 lb per cu ft higher in specimens dried to the low moisture content than were retentions in other specimens.

Penetration

Solid-black penetration was much deeper and more uniform with creosote than with creosote-coal tar (Table 1). Penetrations of the matched charges are illustrated in Figures 3 and 4. On individual borings, solid-black creosote-coal tar penetration was as low as 0.1 inch; no boring from a creosote-treated specimen had a solid-black penetration of less than 0.9 inch.

All 16 creosote-treated specimens had average solid-black penetrations of an inch or more. Twelve of the 16 creosote-coal tar-treated specimens had less than one inch average solid-black penetration and 9 had less than 0.75 inch solid-black penetration.

Solid-black penetrations ranged from 14 to 111 per cent of the sapwood depth with creosote-coal tar and from 59 to 154 with creosote.

Solid-black penetration was consistently deeper in those specimens that had been kiln-dried to the low moisture content range even though there was only slight difference in moisture content at time of treatment (Table 1).

The end-coating still was in excellent condition after treating. When several specimens were split length-wise and examined (Figure 2), the coating appeared an effective barrier to end-penetration.

Preservative recovery during final vacuum

Average recovery of both preservatives during the 1-hour final vacuum was 1 lb per cu ft. Eighty-five per cent was recovered during the first 15 minutes, and 95 per cent was recovered during the first 30 minutes.

Extraction analysis

The following results of the extraction of small pie-shaped sections from the round poles were obtained by the U.S. Forest Products Laboratory:

Preservative	Number of specimens	Retention	
		By weighing	By extraction
		Lb per cu ft	
Creosote	4		
Average		21.0	20.5
Range		16-20	16-23
Creosote-coal tar	10		
Average		14.8	9.8
Range		12-17	8-12

Retention by extraction when expressed as a percentage of retention by weighing was 97.6 per cent for creosote and 66.2 per cent for creosote-coal tar.

DISCUSSION OF RESULTS

Kiln drying

The time required to dry Douglas fir piling to an average moisture content of 26 per cent could have been reduced to 9 days and possibly less, if EMC conditions at 150 F had been dropped from 12 to 8 per cent on the sixth day. Drying time might be reduced greatly by using high temperatures and low initial EMC conditions. A drying time of 4-6 days for round Douglas fir appears feasible and merits investigation.

Preservative treatment

Poor penetrations and low retentions obtained with creosote-coal tar indicate that increased care will be needed with this preservative to meet minimum specifications of the American Wood-Preserver's Association.

Treating results with creosote-coal tar might be improved by seasoning wood to low moisture contents and by long pressure periods. Presence of residue, screened from this preservative at 204 F, suggests that suspended material could be a factor contributing to its poor performance. Filtering hot creosote-coal tar might improve penetration, particularly where the preservative is subject to prolonged heating.

There appears to be little need for long final vacuum periods to recover excess preservative.

Although these results cannot be applied directly to Douglas fir piling conditioned by the Boulton process, there is reason to expect similar differences in treating with these preservatives. Extended Boulton processing at high temperatures should favor increased penetration of creosote-coal tar, providing those conditions will not affect too adversely the physical properties of the preservative. Regardless of the preservative used, thorough inspection of treated material seems mandatory to insure maximum service.

CONCLUSIONS

Kiln drying green, round, Douglas fir prior to preservative treatment appears feasible and merits further investigation.

To meet consistently minimum penetration and retention requirements, greater care will be required in treating with creosote-coal tar than in treating with creosote.

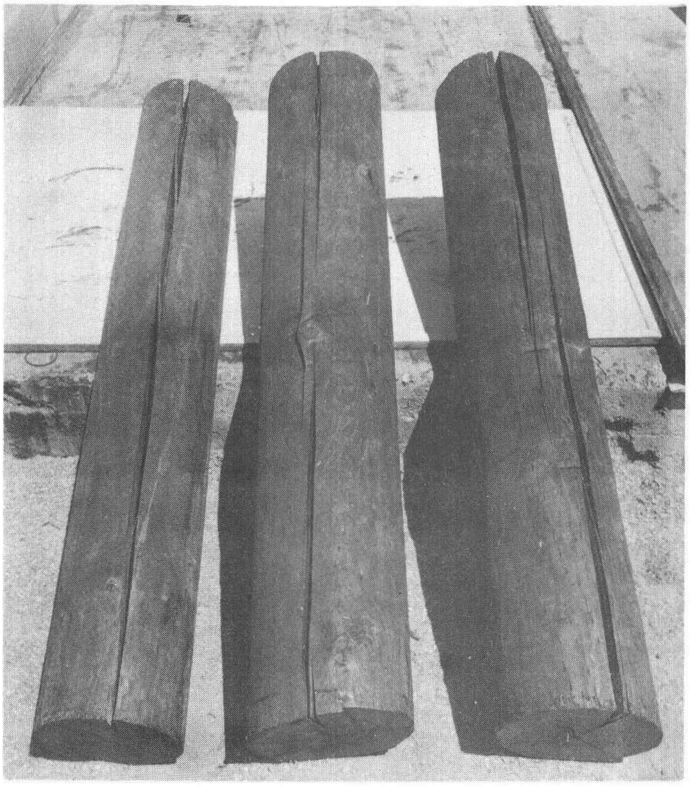


Figure 1. Dried and treated Douglas fir poles rated visually from left to right as having large, moderate, and very large surface checks. Preservative treatment did not influence surface checking.

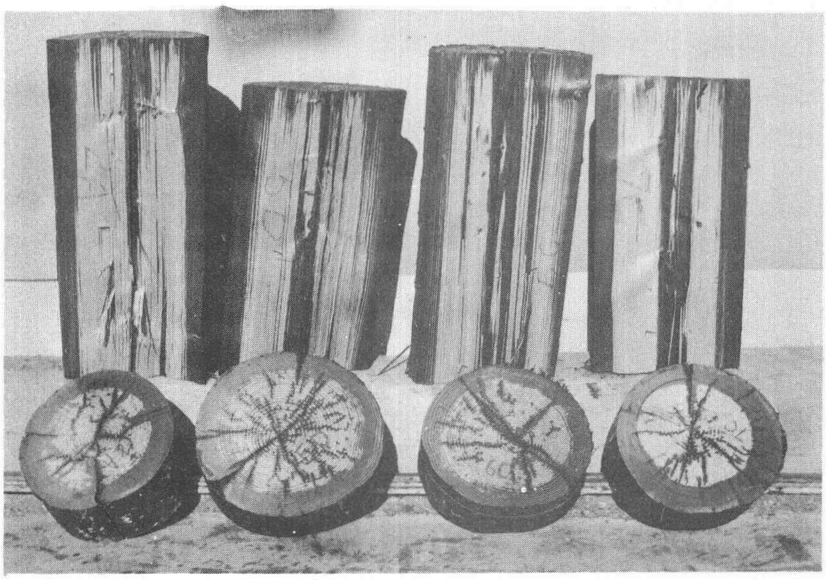


Figure 2. Longitudinal and cross sections from Douglas fir pole sections treated with creosote-coal tar showing sapwood penetration and relative absence of end penetration.

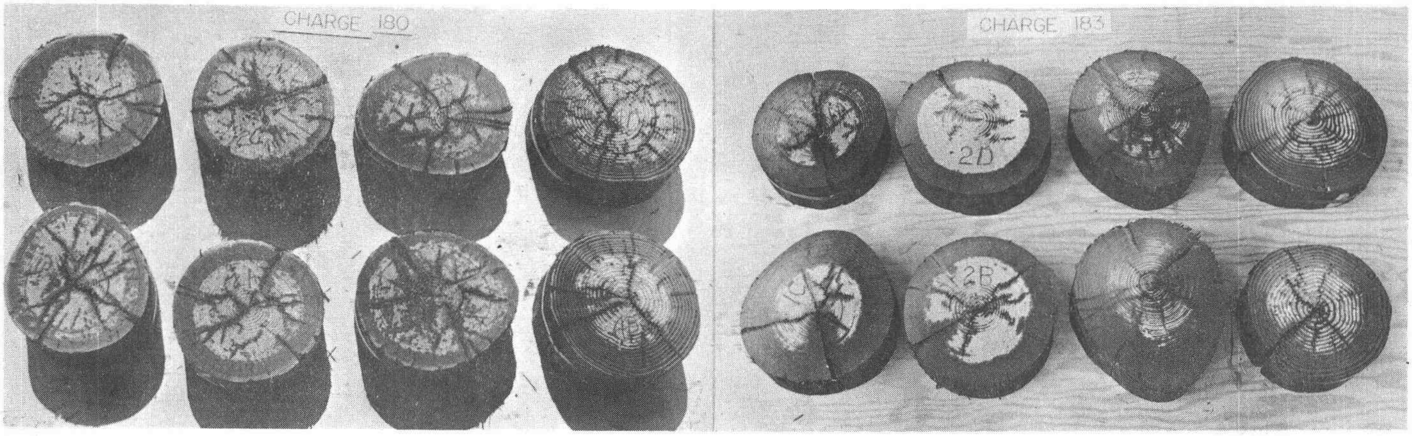


Figure 3. Penetration in cross sections of Douglas fir poles from charges pressed for 14 1/2 hours at 127 psi with a 70-30 creosote-coal tar solution (charge 180) and with creosote (charge 183).

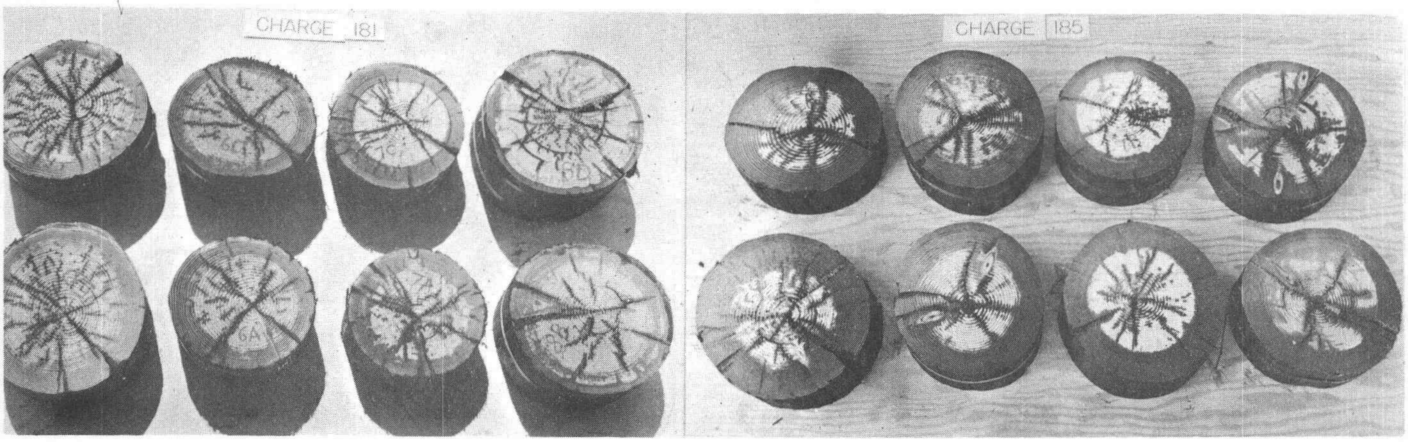


Figure 4. Penetration in cross sections of Douglas fir poles from charges pressed for 11 hours at 140 psi with a 70-30 creosote-coal tar solution (charge 181) and with creosote (charge 185).