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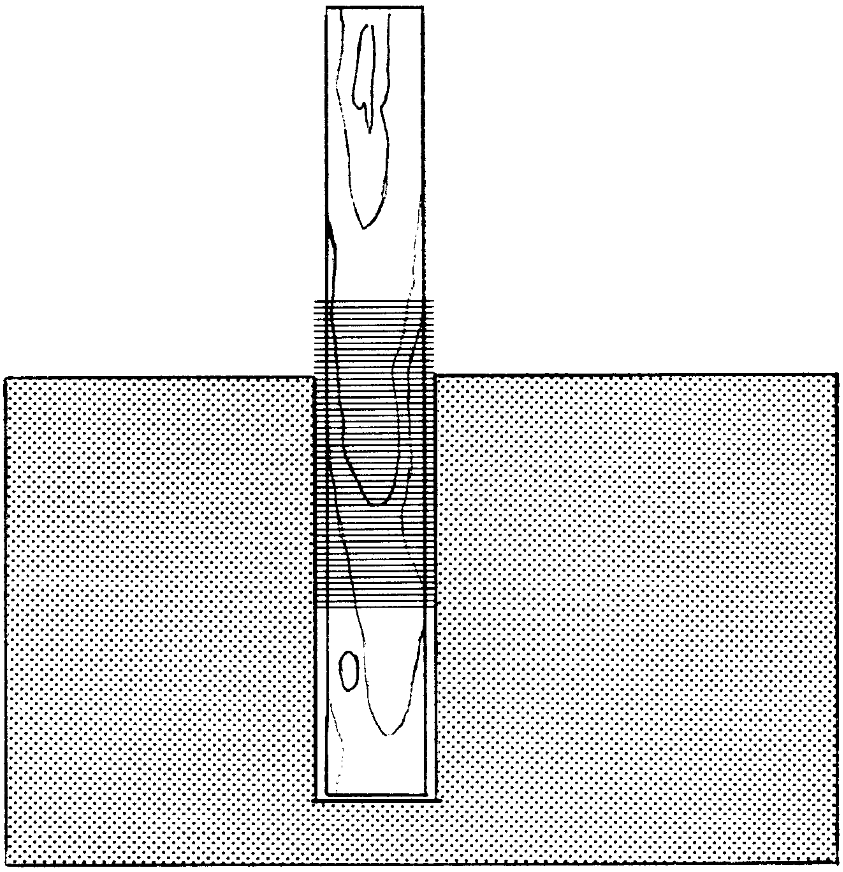
FPL 409

Groundline Treatments of Southern Pine Posts



Abstract

In 1957, 12 groundline treatments were applied to untreated green southern pine posts set in a field plot in the Harrison Experimental Forest of southern Mississippi. When supplemented with an effective cap treatment, groundline treatments substantially extended post life. The relative performance of groundline treatments to posts was strongly influenced by the formulation. Different formulations also provided different modes of protection to posts at the groundline. Push tests, used to monitor the posts, gave results that are useful in estimating likely performance of posts in agricultural and urban fences, but did not provide estimates of residual strength nor measure depths of protected wood prior to breakage at the groundline.

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Groundline Treatments of Southern Pine Posts

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Introduction

Groundline treatments of utility poles are frequently used to provide supplemental protection against biodeterioration at or near the ground level. In 1957, 12 groundline treatments were applied to untreated, green southern pine posts in an attempt to characterize the relative performance of treatments available at that time. Except for a supplemental treatment applied to the top of each post, no other preservative was used in that experiment. Twenty-two years after installation several of those posts still resist breakage at the groundline, although upper portions may be in advanced stages of deterioration. With some treatments such residual strength appears due to a central column of firm wood, in other treatments to an outer shell of firm wood at the groundline. This paper presents a final interpretation of results from this long-term study initiated by Edward Panek *(8)*.[2]

Experimental

Untreated, green southern pine posts were used to determine the protection provided by groundline treatments alone-without the supplemental effects from preservatives in previously treated posts or poles. A preservative in a previously treated post conceivably could affect the rate at which components of the groundline treatment penetrate the post. The preservative might also interact with chemicals added as a groundline treatment to enhance or retard their biological effectiveness.

During September 1957, 130 posts were cut from southern yellow pine trees[3] on the Harrison Experimental Forest near Saucier, Miss. Posts were 2.1 m (7 ft) long and averaged 14.7 cm (5.8 in.) in groundline diameter.

Field Plot

The posts were set in a clearing of poarch fine sandy loam *(10)* in the Harrison Experimental Forest. This soil is classified according to the current classification system by Family: coarse-loamy, siliceous, thermic; Subgroup: Plinthis Paleudults; Order: Ultisols. The soil is strongly or very strongly acid (table 1), receiving an average annual rainfall of 1.6 m (63 in.) in a subtropical climate.

Posts were set in a grid pattern 0.9 m (3 ft) deep and 1.5 m (5 ft) apart. Treatments and control designations were randomly assigned to locations within the grid. Most posts were cut, set, and groundline treated on the same day, (Sept. 11 -Sept. 27, 1957), but the maximum time that elapsed between cutting and treating of any post was 3 days. Ten randomly selected posts were used with each treatment and in the control.

Treatments

Information on groundline treatments and methods of application are taken from the FPL installation report

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[2] Italicized numbers in parentheses refer to literature cited at the end of report.

[3] The species of southern pine trees is not identified in the installation report filed at the Forest Products Laboratory by Edward Panek in 1958 (Study:Pres. 5-2-5).

filed by Panek in 1958 *(8).* Twelve groundline treatments were used: Androc, Barrett (including a pole sealer), Cobra, Mycotox, Osmoplastic, Pol Nu, Woodtreat A, pentachlorophenol with sodium fluoride (NaF), pentachlorophenol without NaF, Pentaplastic, Wood Preserva, and a Forest Products Laboratory treatment.

Androc Penta-Creo Paste, (Androc Chemical Co. Minneapolis, Minn.) was reported to be composed of coal-tar creosote, 15 percent; pentachlorophenol, 10 percent; sodium fluoride, 10 percent; and penetrating oils, jelling agents, and fillers, 65 percent.

The Barrett Liquid Grade Creosote No. 24 CB (Barrett Division, Allied Chemical and Dye Co.) was reported to conform with American Wood Preservers' Association Standard P7-54, Creosote for Brush and Spray Treatment. The Barrett Pole Sealer was a pitch-base product containing a filler and solvent.

The Cobra salts (Cobra Wood Treating Co., New York, N.Y.) were reported by the supplier to contain sodium fluoride, 47 percent; dinitrophenol, 23 percent; arsenious anhydride, 23 percent; and binding substances, 7 percent.

Mycotox (Muncie Poletreat Co., Muncie, Ind.) was reported by the supplier to contain creosote, 45 percent; sodium fluoride, 38 percent; pentachlorophenol, 5 percent; potassium bichromate, 2 percent; and silicone 10 percent.

Osmoplastic (Osmose Wood Preserving Co. of America, Inc., Buffalo, N.Y.) was reported to consist of sodium fluoride, 46.3 percent; dinitrophenol, 3.4 percent; potassium bichromate, 2.0 percent; coal-tar fortified with 2.5 percent pentachlorophenol, 33.9 percent; asbestos, 2.9 percent; and solvent and gel, 11.5 percent.

Pol Nu (Chapman Chemical Co., Memphis, Tenn.) was reported to contain 10 percent of technical pentachlorophenol by weight. However, in ten of the twelve 14.1-kg cans shipped to the Harrison Experimental Forest (Lot P1858917), the Pol Nu was too fluid and would not adhere to either the plastic face of the bandage or to the post surface. These 10 cans were replaced by the supplier with preservative (Lot P1861327) of improved consistency.

Woodtreat A (Wood Treating Chemicals Co., St. Louis, MO.) was reported to consist of 87 percent by weight of an aromatic petroleum solvent containing 10 percent by weight of technical pentachlorophenol; the balance (13 pct) was special emulsifiers or dispersing agents and water.

The pentachlorophenol solution used for the groundline treatments was the "B" Wood Preservative AT7104 used by the Bell Telephone System (Chapman Chemical Co.). This solution is reported to contain 5.0 percent of pentachlorophenol (conforming to AWPA Standard P8) and 95.0 percent of petroleum (conforming to AWPA Standard P9).

Technical-grade sodium fluoride (Fisher Scientific Co.. Chicago, Ill.) was used with the pentachlorophenol solution.

Pentaplastic (distributed by Pentaplastic Co., Allentown, Pa., and contributed by Debevoise Co., Brooklyn, N.Y.) was reported to contain sodium pentachlorophenate, 11.13 percent; refined bituminous pitch, 28.37 percent; and emulsifier, water, soap, and clay, 60.50 percent.

Preserva Life (Wood Preserva Products, Seattle, Wash.) was reported to contain sodium fluoride, 21.48 percent; dinitrophenol, 13.36 percent; water, gas, tar, and oil, 12.21 percent; arsenious anhydride, 9.56 percent; pentachlorophenol, 4.26 percent; other chlorophenols, 0.61 percent; aromatic petroleum solvents, 3.75 percent; and binders, special solvents, blending agents, and cohesives, 34.77 percent.

The Forest Products Laboratory treatment consisted of five chemical compounds, mostly of technical grade, purchased from various sources and mixed at the Laboratory. This mixture was packaged 2.6 kg (5.75 lb) per bag, or the amount used to treat an individual post. Each bag then contained borax (including water of crystallization), 26.1 percent; boric acid, 26.1 percent; sodium fluoride, 26.1 percent; sodium pentachlorophenate, 17.4 percent; and chlordane, 4.3 percent.

The Cobra salts were prepared in the field as a suspension in water, containing approximately 60 percent salts. The other proprietary preservatives were used in the form received but were agitated where required by the producer.

Application

The quantity of preservative applied to each post was determined and the weights appear in table 2.

A liberal brush coat of Barrett's creosote was applied to a zone extending from 30.5 cm (12 in.) above to 33.0 cm (13 in.) below the post groundlines. After the creosote **was** absorbed, a sealer coat of 0.3 **-** 0.6 cm (1/8 - 1/4 in.) thick was applied over the creosoted area with a plasterer's trowel. The sealer was covered in turn with a single thickness of kraft paper held in place by staples.

Androc Penta-Creo Paste was applied with a scoop to a zone extending from 15.2 cm (6 in.) above to 45.7 cm (18 in.) below post groundlines. A preservative coat approximately 0.6 cm (1/4 in.) thick was applied and then a sheet of polyethylene film and a kraft paper backing were wrapped around the treated zone with the polyethylene face against the treated surface. This bandage was held in place by staples.

The Cobra solution was injected into the green posts with a horizontal injection machine furnished by the

Table 1.– Representative profile of Poarch fine sandy loam soils In Harrison County, Mississippi *(10)*

Horizon	Depth		pH at 1:1 suspension KC1	pH at 1:1 suspension Water	Organic C	N	Extractable iron as Fe
	Cm	(in.)			Pct	Pct	Pct
Ap	0-15	(0-60)	4.9	5.4	1.16	0.07	0.4
B21t	15-27	(6-11)	4.1	4.8	.22	—	1.1
B22t	27-60	(11-24)	4.1	4.9	05	—	.9
	60-77	(24-35)	4.0	4.9	[1]—	—	.7
B23t	77-108	(35-43)	4.0	5.3	.02	—	.6
B24t	108-130	(43-52)	4.0	4.9	—	—	1.0
B25t	130-148	(52-59)	4.0	4.9	—	—	1.5
B26t	148-183	(59-73)	4.0	4.9	.02	—	.9
B27t	183-210	(73-84)	4.0	4.8	.01	—	1.9

[1] **Not** given in original source.

preservative supplier. Five 5.0-cm (2-in.)-deep injections were spaced 10.1 cm (4 in.) apart in vertical rows extending from 12.7 cm (5 in.) above to 38.1 cm (15 in.) below the groundline. The rows were spaced 5.0 cm (2 in.) apart and the injections staggered to correspond in alternate rows. No bandage was applied over the treated zone.

Mycotox and Osmoplastic were applied with a window brush to a post zone extending from 15.2 cm (8 in.) above to 45.7 cm (18 in.) below the groundline. A 0.1- to 0.3-cm (1/16- -1/8-in.) layer of the preservative was applied. Immediately following this application, a 2-mil sheet of-polyethylene glued to a kraft paper backing was wrapped around the treated zone, polyethylene face in, and held in place by staples. (Thus, the Mycotox application and all but the top 7.6 cm (3 in.) of the Osmoplastic application were covered.) The backfill was kept below the top of the paper.

A layer of Pol Nu approximately 0.6 cm (1/4 in.) thick was applied to a 61-cm (24-in.)-wide bandage with a plasterer’s trowel. The bandage was then wrapped around the post, preservative side in, so as to cover a zone extending from 15.2 cm (6 in.) above to 45.7 cm (18 in.) below the groundline. It was held in place by staples. A duplex bandage similar to that used with Osmoplastic was used, and the Pol Nu applied to the polyethylene face.

Woodtreat A was applied to a zone extending 10.1 cm (4 in.) above to 35.8 cm (14 in.) below the groundline of the posts. It was applied about 1.3 cm (1/2 in.) thick with a metal scoop provided by the supplier. No bandage was used. Care was taken in backfilling to avoid disturbing the band of preservative.

In the treatment with pentachlorophenol solution plus sodium fluoride, green posts were set and backfilled to a depth of about 45.7 cm (18 in.) from the groundline. Approximately 0.4 kg (1 lb) of NaF powder was first dusted as uniformly as possible onto the surface of the posts from about 7.6 cm (3 in.) above to about 45.7 cm (18 in.) below the groundline. (A corner was torn from a bag and the bag tapped against the post.)

After the NaF applications the post hole was about two-thirds filled with dirt. A v-shaped trench was shoveled around the post to the depth of 45.7 cm (18 in.) and 2.85 liters (0.75 gal). of the pentachlorophenol solution was then applied with a sprinkling can having a slit-type spout and held about 38.1 cm (15 in.) above the groundline. The solution poured slowly as the container was rotated around the post. At least two complete revolutions were made during application, ensuring complete coverage of the surface. After the excess oil drained from the trench, the backfill was completed and a second v-trench was made around the post, about 12.7 cm (5 in.) deep. Some 0.95 liter (0.25 gal) of the pentacnlorophenol solution was then applied as before but in one complete revolution around the post. The trench was filled and the dirt banked against the post to complete the treatment.

The technique described above was also used to apply the solution in the straight pentachlorophenol solution treatment.

A coat of Pentaplastic less than 0.1 cm (1/16 in.) thick was applied with a window brush to a zone of green posts extending from 5.0 cm (2 in.) above to 45.7 cm (18 in.) below the groundline. Immediately following application a single thickness of 6.8-kg (15-lb) asphalt saturated felt was placed over the treated zone and held in place by staples.

A heavy (<O.1-0.1 cm) brush coat of Preserva Life was applied to a zone extending 15.2 cm (6 in.) above to 45.7 cm (18 in.) below the groundline of the green posts. Following the application, a 2-mil sheet of polyethylene with a kraft paper backing was wrapped around the treated zone, polyethylene face in, and held in place by staples.

Posts that were to receive the Forest Products Laboratory treatment were set and backfilled to a depth of 45.7 cm (18 in.) below the groundline. Approximately 0.4 kg (1 lb) of the chemical mixture was sprinkled slowly on the surface as the container was rotated around each post at groundline level. A small amount of chemical adhered to the surface, but most of it drop-

Table 2.– Preservative quantities applied in groundline treatment of untreated green southern yellow pine posts[1]

Post number	Groundline diameter	Preservative applied	Post number	Goundline diameter	Preservative applied	Post number	Groundline diameter	Preservative applied
	cm (in.)	kg (lb)		cm (in.)	kg (lb)		cm (in.)	kg (lb)
	POL NU			COBRA			WOOD PRESERVA	
1	154.9 (6.1)	2.38 (5.25)	41	167.6 (6.6)	0.34 (0.75)	81	124.5 (4.9)	0.23 (0.50)
2	134.6 (5.3)	1.81 (4.00)	42	172.7 (6.8)	0.23 (0.50)	82	134.6 (5.3)	0.14 (0.31)
3	134.6 (5.3)	2.27 (5.00)	43	154.9 (6.1)	0.23 (0.50)	83	116.8 (4.6)	0.28 (0.62)
4	162.6 (6.4)	2.27 (5.00)	44	170.1 (6.7)	0.34 (0.75)	84	139.7 (5.5)	0.25 (0.56)
5	132.1 (5.2)	2.27 (5.00)	45	154.9 (6.1)	0.23 (0.50)	85	170.2 (6.7)	0.31 (0.69)
6	160.0 (6.3)	2.50 (5.50)	46	116.8 (4.6)	0.11 (0.25)	86	142.2 (5.6)	0.17 (0.38)
7	152.4 (6.0)	2.61 (5.75)	47	177.8 (7.0)	0.23 (0.50)	87	175.3 (6.9)	0.28 (0.62)
8	124.5 (4.9)	1.59 (3.50)	48	172.7 (6.8)	0.23 (0.50)	88	139.7 (5.5)	0.11 (0.25)
9	139.7 (5.5)	2.04 (4.50)	49	177.8 (7.0)	0.23 (0.50)	89	152.4 (6.0)	0.28 (0.62)
10	127.0 (5.0)	1.47 (3.25)	50	160.0 (6.3)	0.23 (0.50)	90	134.6 (5.3)	0.25 (0.56)
Average	142.2 (5.6)	2.12 (4.68)	Average	162.5 (6.4)	0.24 (0.52)	Average	142.2 (5.6)	0.23 (0.51)
	ANDROC			PENTACHLOROPHENOL[2]			BARRETT[3]	
11	154.9 (6.1)	2.50 (5.50)	51	188.0 (7.4)	—	91	160.0 (6.3)	0.05 (0.12)
12	157.5 (6.2)	2.16 (4.75)	52	114.3 (4.5)	—	92	160.0 (6.3)	0.05 (0.12)
13	180.3 (7.1)	2.61 (5.75)	53	142.2 (5.6)	—	93	170.2 (6.7)	0.09 (0.19)
14	124.5 (4.9)	2.04 (4.50)	54	182.9 (7.2)	—	94	167.6 (6.6)	0.05 (0.12)
15	149.9 (5.9)	1.93 (4.25)	55	132.1 (5.2)	—	95	154.9 (6.1)	0.11 (0.25)
16	134.6 (5.3)	1.93 (4.25)	56	172.7 (6.8)	—	96	121.9 (4.8)	0.03 (0.06)
17	188.0 (7.4)	2.84 (6.25)	57	139.7 (5.5)	—	97	134.6 (5.3)	0.09 (0.19)
18	157.5 (6.2)	1.70 (3.75)	58	190.5 (7.5)	—	98	142.2 (5.6)	0.11 (0.25)
19	124.5 (4.9)	1.25 (2.75)	59	165.1 (6.5)	—	99	111.8 (4.4)	0.03 (0.06)
20	154.9 (6.1)	1.81 (4.00)	60	137.2 (5.4)	—	100	172.7 (6.8)	0.05 (0.12)
Average	152.4 (6.0)	2.08 (4.58)	Average	157.48 (6.2)	—	Average	149.9 (5.9)	0.07 (0.15)
	OSMOPLASTIC			PENTACHLOROPHENOL AND SODIUM FLUORIDE[4]			FOREST PRODUCTS LABORATORY[5]	
21	180.3 (7.1)	0.97 (2.00)	61	147.3 (5.8)	—	101	180.3 (7.1)	—
22	127.0 (5.0)	0.68 (1.50)	62	116.8 (4.6)	—	102	142.2 (5.6)	—
23	127.0 (5.0)	0.68 (1.50)	63	137.2 (5.4)	—	103	119.4 (4.7)	—
24	172.7 (6.8)	0.97 (2.00)	64	144.8 (5.7)	—	104	152.4 (6.0)	—
25	134.6 (5.3)	0.57 (1.25)	65	116.8 (4.6)	—	105	114.3 (4.5)	—
26	116.8 (4.6)	0.45 (1.00)	66	127.0 (5.0)	—	106	172.7 (6.8)	—
27	140.0 (5.5)	0.34 (0.75)	67	162.6 (6.4)	—	107	175.3 (6.9)	—
28	172.7 (6.8)	0.57 (1.25)	68	142.2 (5.6)	—	108	137.2 (5.4)	—
29	149.9 (5.9)	0.57 (1.25)	69	157.5 (6.2)	—	109	121.9 (4.8)	—
30	160.0 (6.3)	0.57 (1.25)	70	154.9 (6.1)	—	110	165.1 (6.5)	—
Average	147.3 (5.8)	0.63 (1.38)	Average	139.7 (5.5)	—	Average	147.3 (5.8)	—
	WOODTREAT A			MYCOTOX			PENTAPLASTIC	
31	162.6 (6.4)	3.97 (8.75)	71	162.6 (6.4)	0.79 (1.75)	111	144.8 (5.7)	0.05 (0.12)
32	140.0 (5.5)	2.16 (4.75)	72	180.3 (7.1)	0.79 (1.75)	112	144.8 (5.7)	0.09 (0.19)
33	154.9 (6.1)	2.38 (5.25)	73	154.9 (6.1)	0.68 (1.50)	113	121.9 (4.8)	0.09 (0.19)
34	160.0 (6.3)	3.86 (8.50)	74	132.1 (5.2)	0.57 (1.25)	114	142.2 (5.6)	0.09 (0.19)
35	142.2 (5.6)	3.06 (6.75)	75	172.7 (6.8)	0.68 (1.50)	115	144.8 (5.7)	0.09 (0.19)
36	147.3 (5.8)	3.74 (8.25)	76	119.4 (4.7)	0.57 (1.25)	116	177.8 (7.0)	0.11 (0.25)
37	132.0 (5.2)	4.08 (9.00)	77	149.9 (5.9)	0.57 (1.25)	117	139.7 (6.5)	0.09 (0.19)
38	177.8 (7.0)	3.74 (8.25)	78	139.7 (5.5)	0.43 (1.00)	118	160.0 (6.3)	0.11 (0.25)
39	124.5 (4.9)	2.38 (5.25)	79	144.8 (5.7)	0.68 (1.50)	119	149.9 (5.9)	0.09 (0.19)
40	165.1 (6.5)	3.63 (8.00)	80	172.7 (6.8)	0.43 (1.00)	120	121.9 (4.8)	0.05 (0.12)
Average	149.8 (5.9)	3.30 (7.28)	Average	152.4 (6.0)	0.63 (1.38)	Average	147.3 (5.8)	0.09 (0.19)

[1] Posts 121 through 130 are controls.
[2] Some 3.8 liters (1 gal) of pentachlorophenol applied to each post.
[3] Sealer applied averaged 3.14 kg (6.92 lb) per post.
[4] Some 3.8 liters (1 gal) of pentachlorophenol and 2.2 kg (1 Ib) of sodium fluoride applied to each post.
[5] A mixtureof dry chemicals containing 0.68 kg (1.50 Ib) each of borax, boric acid, and sodium fluoride, 0.45 kg (1.00 lb) sodium pentachlorophenol, and 0.11 kg (0.25 Ib) chlordane was applied to each post.

ped to the bottom of the 45.7-cm (18-in.) depression, forming a band of chemical adjacent to the post. This procedure was repeated at 30.5 cm (12 in.) and 15.2 cm (6 in.) below groundline. The chemical remaining in the bag (approximately 1.2 kg or 2-314 lb) was poured around the post at groundline. To complete this treatment, soil was banked against the post to cover the chemical.

To provide protection to the tops of all posts, a 0.3-cm (1/8-in.)-thick cap of Osmoplastic was applied to all green posts. This cap covered the immediate top and about 5.0 cm (2 in.) of the vertical surface.

Monitoring

Posts were monitored annually with a lateral push test from the second through the ninth year after installation. Thereafter, they were monitored biennially with a moderate push at the top.

In June 1979, almost 22 years after installation, the bases of posts that had survived the push test and that had been treated with Androc, Cobra, Mycotox, or Pol Nu were examined below the groundline. Soil was excavated to a depth of 15.2 cm (6 in.) around each post. Exterior wood firmness was determined by visual inspection and by testing with a hand-held probe (screwdriver). Firm wood depth from perimeter to the center of post was estimated from the lengths of 9.5-mm (3/8-in.) diameter cores obtained at the groundline with a battery-powered drill. Where wood was sufficiently firm, four cores were taken 90° apart. No microscopic examinations or physical tests were made of wood in these cores.

These cores were used to estimate the amount of preservative chemical remaining in the posts. Cores were cut into 1.3-cm (1/2-in.) segments and corresponding segments within each post combined for quantitative analysis.

Results

Application of all groundline treatments to the green, southern pine posts increased resistance of those posts to deterioration at the groundline. Posts in all treatments resisted breakage by the push test substantially longer than did the controls (table 3). Major differences were detected between formulations of pentachlorophenol-based products and between formulations of NaF-based products (table 3).

Application of polyethylene and kraft paper wraps that held the preservative against the post also appears to contribute to treatment efficacy. Four of five treatments wrapped with polyethylene and kraft paper as well as the Cobra injection treatment resisted breakage longer than other treatments (table 3).

Eight of the 10 posts which received no treatment (controls) resisted breakage at the groundline when given the push test 2 years after installation. Of these, seven were broken in the following annual inspection.

Twenty-two years after installation most of the surviving treated posts had severe top decay. Some were reduced to stubs not more than 1.6 m (2 ft) high while others had rather firm aboveground portions. Posts treated with Androc, Cobra, Mycotox, or Pol Nu had groundline resistance to breakage under pressure from a lateral push due to different protection modes. In Androc-, Cobra-, and Mycotox-treated posts, outer wood just below the groundline was severely decayed. All Mycotox-treated posts had severe decay around their entire circumference, in some to a depth of 3.8 cm (1.5 in.). All but one of the Cobra-treated posts had similar decay. Thus, residual strength in Mycotox- and Cobra-treated posts appeared to be due to a central column of wood. However, the central columns in some of these posts had been attacked by termites.

Androc-treated posts had from one-third to two-thirds of their cross-sectional areas severely decayed below the groundline. However, this decay had developed as pockets and was not equally distributed around the circumference of the post.

Pol Nu-treated posts had a hard outer shell and residual groundline strength resulted from this shell of well-protected wood at the edge of the posts. Internal portions of many Pol Nu-treated posts were either soft or severely decomposed.

Twenty-two years after installation and groundline treatments, the tops of most Pol Nu-treated posts were severely decayed. Nevertheless, the groundline portion of the posts were sound enough to survive the push test. Cores were removed from the firm perimeters at the groundline of nine posts (one had previously been removed for observation, even though it had not broken at the groundline). Firm wood was present in 100 percent of the cores at a depth of 1.3 cm (112 in.) from the post surface, in 75 percent from 1.3 to 2.5 cm (1/2 to 1 in.), and in 33 percent from 2.5 to 3.8 cm (1 to 1.5 in.). The remaining 67 percent had wood at this depth destroyed by termites and decay (table 4). Pentachlorophenol was detected to a depth of 0.5 to 2.5 cm (1 in.) at the groundline of 9 posts and to a depth of 3.8 cm (1.5 in.) at the groundline in 12 cores obtained from 7 posts (table 5).

The extensive decay at the groundline of posts treated with Androc, Cobra, and Mycotox largely precluded their sampling. However, four posts treated with Androc and one treated with Mycotox had firm wood at the groundline to a depth of 2.5 cm (1 in.) from the post surface. Three Androc-treated posts had NaF detected in the outer 1.3 cm (1/2 in.) and one had it detected in the outer 3.8 cm (1.5 in.). One Cobra-treated post also had NaF detected in the outer 3.8 cm (1.5 in.) (table 5).

Table 3.—Number of years after installation that southern pine posts did not break at the groundline when subjected to a push test[1,2]

Treatment	Wrap[3]		Active ingredient[4]					Number years after installation	
			C	P	D	FL	B	Ail posts withstood groundline push test	≥50 percent of posts withstood groundline push test[5]
	P	K	Pct						
Androc	+	+	15	10		10		11	21
Barrett		+		5				7	11
Mycotox	+	+	45	5		38		11	21
Osmoplastic	+	+	34		3	46		13	19
Cobra					23			11	21
Preserva Life	+	+			13	21		7	11
Special dust				17		26	52	[7]—	15
NaFl + Penta				5				6	11
Penta solution				5				4	5
Pentaplastic				11				4	6
Pol Nu	+	+		10				[6]21	[6]21
Woodtreat A				10				5	11
Controls				10				—	2

[1] All posts in-this field plot were nonloadbearing.
[2] Last push test was in 1978, 21 years after installation.
[3] Application of polyethylene (P) and/or kraft paper (K) wraps around post after treatment and before backfilling is indicated by a "+." Cobra treatments were injected into posts. Poles treated with pentaplastic were wrapped with a 15-pound asphalt saturated felt.
[4] Active ingredients are C-coal tar and/or creosote, P-pentachlorophenol, D-dinitrophenol, FI-sodium flouride, and B-borax and/or boric acid. Some formulations contain active ingredients in addition to those shown here. Percentages are rounded to nearest whole number.
[5] Posts were monitored annually from the second through ninth years in test, and biennially thereafter. The maximum time spans for post performance that were actually observed are indicated here; i.e., if 50 percent of the posts withstood breakage after 11 years, but not after 13 years, a time span of 11 years would be entered in this table.
[6] One post removed for analysis in 1972.
[7] No observation made at end of first year.

Table 4.—Maximum depth from post edge having firm groundline wood in surviving posts 22 years after groundline treatment[1,2]

Groundline treatment	Number of posts firm enough to sample[2]	Total number of cores obtained	Number of cores with firm wood at indicated depths from post edge[3]			
			First 1.3 cm (1/2 in.)	Second 1.3 cm (1/2 in.)	Third 1.3 cm (1/2 in.)	Fourth 1.3 cm (1/2 in.)
Pol Nu	[4]9	36	36	27	12	0
Androc	5	18	18	18	2	0
Cobra	1	4	4	4	3	0
Mycotox	0	0	0	0	0	0

[1] Includes only treatments with five or more posts surviving the lateral push test 21 years after installation. Each treatment was originally applied to 10 posts.
[2] Includes only posts with groundline outer wood sufficiently firm to permit removal of at least one 9.5 mm-diameter core with a drill.
[3] Four cores were taken from each post unless serious decay was present at the groundline.
[4] One post was removed prior to this observation, even though it had not broken at the groundline.

Discussion

Push Tests

Post serviceability measured by the push test relates to customary use of posts in agricultural and residential fences. Traditional reports on post performance in field plots indicate that posts breaking off under this push or otherwise so badly deteriorated in the top that they will not hold staples or support a fence are considered to have failed (2). However, in this and in previous reports on these posts *(6)* failure is indicated only by breakage of the post at the groundline. In fact, most posts that have not broken at the groundline after 21 years of exposure have serious decay in the tops. In some cases only the protected portion of the post at the groundline remains.

Results of post tests are usually reported as average service life of the candidate treatments *(2)* and results of this field test have previously been so interpreted *(6).* The "service life" or "average life" of posts in such tests estimates the time at which 60 percent of the posts will have failed. Mortality curves developed for railway ties (7) are often used to estimate service lives for candidate treatments before 60 percent of field units have failed. Interpreted in this manner, results from push tests on posts indicate the potential performance of candidate treatments for posts to be used in agricultural and residential fences.

Although a destructive test, the push test provides no quantitative estimate of residual post strength. Results from push tests, therefore, cannot be related to electric safety code requirements for minimum residual strength properties of poles in service nor can they be directly related to requirements utilities may set for minimum depths of sound wood around the entire perimeter of poles in service.

This study does demonstrate that groundline treatments provide protection for posts at the groundline. The study also demonstrates some marked differences between treatments in mode and efficacy of preventing biodegradation as evidenced by resistance to groundline breakage.

Preservatives

Judgments about the efficacy of groundline chemical treatments to protect existing utility pole plants must consider the depth to which treatments penetrate poles as well as the amount of chemical moving into the pole and its longevity.

The minimum amount (threshold level) of preservative that must be present in wood to prevent decay depends upon the type of decay fungus attacking the wood and upon interactions between chemicals within the wood. The decay fungus *Lentinus lepideus* predominates in pine poles (4). Threshold values of sodium fluoride reported for *L. lepideus* in untreated wood are: 1.338 to 2.097 kg/m^3 (0.0836-0.131 lb/ft^3) *(1)* and 1.921 to 2.401 kg/m^3 (0.12-0.15 lb/ft^3) *(5).*

The pentachlorophenol-petroleum (5 pct penta) threshold for 13 of 25 isolates of *L. lepideus* tested by Duncan *(3)* was between 11.05 and 22.41 kg/m^3 (0.69 and 1.4 lb/ft^3) and the threshold value for seven isolates was greater. Estimated threshold values for pentachlorophenol-petroleum (5 pct penta) in southern pine blocks when tested against 17 species of fungi ranged from 11.20 to 65.64 kg/m^3 (<0.7-4.1 lb/ft^3) *(3).*

In addition, Fahlstrom *(5)* observed an interaction between subthreshold levels of preservatives. He concluded that threshold concentrations of supplementary preservative chemicals, as determined by Standard ASTM D1413 soil-block techniques on untreated wood, are not required for protection when supplementing subthreshold retentions of creosote.

Other field work has tested groundline preservative treatments on freshly pressure-treated pole stubs of five important pole species at three locations under different climatic conditions. In these tests maximum concentrations of the groundline preservatives pentachlorophenol and NaF were found within 1 year after application under dry site conditions, and within 3 months under somewhat wetter conditions. Two years after groundline treatments by surface applications, the preservatives pentachlorophenol and/or NaF were confined mostly to the outer 1.3.cm (1/2-in.) zone of a pole *(9).*

In the study reported here, pentachlorophenol was detected to a depth of 3.8 cm (1.5 in.) in two of nine pentachlorophenol-containing groundline treatments 22 years after application to green southern pine posts (table 5).

A companion study at the Harrison Experimental Forest was made of groundline treatments to stubs of 20-year-old southern pine poles previously treated with creosote. That study was initiated at the same time as this post study *(8)* and the pole stubs used received most of the groundline treatments given here. Table 6 presents the results of chemical analyses for five pole stubs from borings taken 3 months and 1 year and from disks taken 2 years after applying groundline treatments. Pentachlorophenol did not move more than 2.5 cm (1 in.) into the southern pine poles in 2 years when applied in four different proprietary treatments to the stubs of previously treated poles (table 6).

Two years after application of groundline treatments to stubs of previously creosote-treated southern pine poles, pentachlorophenol at above-threshold levels for *L. lepideus* was found up to a depth of 2.5 cm (1 in.). NaF levels for Osmoplastic and Cobra treatments were at or approaching threshold levels 5 cm (2 in.) into the poles (table 6).

Twenty-two years after groundline treatments, near threshold levels of NaF were present in the outer 1.3 cm (1/2 in.) of 4 of 10 southern pine posts receiving the Androc treatment and in one post receiving the Cobra

Table 5.—Chemical analysis of groundline borings of southern pine posts 22 years after groundline treatments[1,2]

Treatment	Distance from perimeter of post: First 1.3 cm (1/2 in.)	Second 1.3 cm (1/2 in.)	Third 1.3 cm (1/2 in.)
	kg/m³ (lb/ft³)		
PENTACHLOROPHENOL			
Pol Nu	0.372 (9)	0.109 (9)	0.034 (7)
Androc	.068 (5)	.034 (5)	.023 (2)
SODIUM FLOURIDE			
Androc	.063 (4)	.045 (3)	[3]—
Cobra	.111 (1)	.078 (1)	.047 (1)
As_2O_3			
Cobra	.005 (1)	.005 (1)	.005 (1)

[1] Chemical analysis performed by Jim Han, FPL. Concentration of chemicals shown are averages of all posts sampled.
[2] The number of posts with firm wood at each respective depth from the post edge is shown in parentheses. Includes only posts with groundline outer wood sufficiently firm to permit removal of at least one 9.5-mm-diameter core.
[3] Not obtained.

Table 6.—Chemical analyses of borings and disks taken after groundline treatment to stubs of old, creosote-treated southern pine poles *(6)*[1,2,3,]

Groundline treatment	First 1.3 cm: Borings after 3 months	First 1.3 cm: Borings after 1 year	First 1.3 cm: Disks after 2 years	Second 1.3 cm: Borings after 3 months	Second 1.3 cm: Borings after 1 year	Second 1.3 cm: Disks after 2 years	Third 1.3 cm: Borings after 3 months	Third 1.3 cm: Borings after 1 year	Third 1.3 cm: Disks after 2 years
	kg/m³ (lb/ft³)								
PENTACHLOROPHENOL									
Osmoplastic	—	—	0.03	—	—	0.01	—	—	—
Pol-Nu	0.73	0.73	.78	0.17	0.15	.24	—	—	—
Woodtreat A	.36	.41	.41	.05	.05	.05	—	—	—
Penta solution + sodium fluoride	—	—	.06	—	—	.02	—	—	—
SODIUM FLUORIDE									
Osmoplastic	2.2	.38	.35	.03	.11	.16	0.02	0.04	0.11
Penta solution + sodium fluoride	.03	.06	.04	.03	.02	.02	.02	.01	.02
Cobra	.21	.09	.09	.13	.14	.06	.20	.28	.09

[1] Poles were on the Harrison Experimental Forest, Saucier, Miss.
[2] Each value is the average of five pole stubs.
[3] This table was originally published.

treatment (table 5). Levels of pentachlorophenol at or above the lower limit of threshold values for *L. lepideus (3)* were detected to a depth of 2.5 cm (1 in.) in all Pol Nu-treated posts and in five Androc-treated posts. At a depth of 2.5 to 3.8 cm (1 to 1-1/2 in.) from the outer edge, above minimum threshold levels of pentachlorophenol were detected in seven Pol Nu-treated posts (table 5). However, retention levels of preservatives at each depth increment into the post were unevenly distributed around the post at groundline. The declining numbers of firm cores obtained at each subsequent 0.6-cm (1/2-in.) depth increment from the post edge reflects this distribution pattern.

Conclusions

When supplemented with an effective cap treatment, groundline treatments to untreated southern pine posts substantially extend the life of posts.

The relative performance of groundline treatments on posts is strongly influenced by the formulation;

pentachlorophenol-based treatment, Pol Nu, and the multicomponent formulations Androc, Cobra, and Mycotox provide different modes of protection to posts at the groundline.

Push tests give results that are useful in estimating likely performance of posts in agricultural and urban fences, but do not provide estimates of residual strength nor measure depths of protected wood, prior to breakage at the groundline.

Notice

Precaution

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Groundline treatments of southern pine posts, by Rodney C. DeGroot, Madison, Wis., FPL
9 p. (USDA For. Serv. Res. Pap. FPL 409).

Reports protection performance of different formulations applied in 1957 as groundline treatments to untreated green southern pine posts. Test posts were in a field of the Harrison Experimental Forest in southern Mississippi. Push tests, used to monitor the posts, gave results that are useful in estimating likely performance of posts in agricultural and urban fences, but did not provide estimates of residual strength nor measure depths of protected wood prior to breakage at the groundline.

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