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Protecting piles from decay; end treatments

by

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Summary

Millions of dollars are spent each year to replace decayed marine piling. The primary avenue of decay infection is through the ends where untreated wood is exposed after piles are cut off. Thus, several fungicides were evaluated for their ability to protect the top cutoff end of creosoted Douglas-fir piles from decay. Supplementary treatment with a 20 percent ammonium bifluoride solution or Osmoplastic provides at least 5 years of protection against decay in a high decay hazard climate. Pile tops treated with copper-8-quinolinolate, sodium borate, ammoniacal-copper-borate, sodium pentachlorophenate, and pentachlorophenol were decayed without a cap and, therefore, should only be used where a cap can be maintained.

Introduction

Premature failure of marine piling because of interior decay is a major problem leading to costly repair and replacement. The U.S. Navy alone estimates that it spends over $5 million a year for pile replacement (personal communication, Robert Page, formerly Naval Facilities Engineering Command, 1973). The problem is particularly serious in fender piles, which are required to protect both the docking vessel and the pier or wharf from possible impact damage.

Conventional treating generally will not provide adequate penetration of preservative into the heartwood of those species commonly used for marine piling. Therefore, each pile has an untreated centre surrounded by a treated outer shell. This untreated heartwood is a considerable portion of the total volume of some species, e.g., Douglas-fir. Thus, the primary avenue of infection by decay fungi is through the ends where untreated wood is exposed after the piles are cut to desired height.

Previous studies (Helsing and Graham, 1980; Highley and Scheffer, 1975,1978) have demonstrated that in-place application of a suitable fungicide, followed by a capping material, protected Douglas-fir cutoff tops from decay for at least 10 years. On active piers, however, pile caps are often damaged, and the wood below is exposed. This creates a severe decay hazard. Hence, an ideal fungicide end treatment should protect against decay in the event the capping material is damaged. Penta and creosote are ineffective without caps (Helsing and Graham, 1980; Highley, 1980; Highley and Scheffer, 1975, 1980). However, ammonium bifluoride crystals applied in holes or saw cuts in the cutoff end (Highley, 1980; Highley and Scheffer, 1975, 1980) and a trowel application of fluor-chrome-arsenic-phenol (FCAP) paste both prevented decay in pile tops without caps (Helsing and Graham, 1980).

Because of this success with solid ammonium bifluoride crystals and FCAP paste, various other waterborne preservatives were evaluated for their ability to prevent decay without caps. The preservatives were applied by brush or trowel because such application is easier, and therefore more likely to be used, than an application requiring cutting of the pile surface. This paper reports the results from in-place treatment of pile segments exposed in southern Mississippi.

Procedure

Creosoted Douglas-fir piles were cut into 2-foot sections with a chain saw and the sections randomized into the different treatment groups. The basal ends of all sections were thoroughly flooded with 40 percent pentachlorophenol concentrate and then coated with Nokorode Seal Kote (Monsanto). The pile sections were placed upright with the basal ends contacting the ground.

Eight replications were made of each of nine fungicidal treatments brushed or troweled on the pile top and no cap added. All treatments were made within 24 hours after the pile segments were cut. Eight fungicidal treatments were applied with a brush. The first six were sodium borate (Polybor, U.S. Borax) (10% in H_2O),

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copper-8-quinolinolate (Chapman) (10% in H_2O), sodium pentachlorophenate (Monsanto) (5% in H_2O), ammoniacal copper borate (J. H. Baxter) (8% in H_2O), ammonium bifluoride (Fisher) (20% in H_2O), and pentachlorophenol (Koppers) (5% in mineral spirits). Osmoplastic (Osmose) (sodium fluoride (43.7%), creosote (40%), potassium dichromate (3.1%), 2,4-dinitrophenol (2.0%)) was troweled onto another set of pile tops in a $^1/_4$ inch layer.

One year after these treatments, a new set of pile cutoffs were treated with the two remaining brushed-on fungicides: copper-8-quinolinolate (2%) and ammoniacal-copper-borate (2%). After 4 years, half of the ammonium bifluoride and Osmoplastic-treated pile tops were retreated.

Two years following the initial fungicidal treatments, fused preservative rods (Kai R. Spangenberg) of boric oxide, boric oxide plus copper oxide, sodium borate, and sodium borate plus copper oxide were inserted into holes drilled at various spacings in the untreated portion of 16 new creosoted Douglas-fir pile cutoffs (Table 1).

Two epoxy compounds were evaluated as covering materials on pile cutoff ends that had not received fungicidal treatment – Bitumastic No. 300 (Koppers) and Aquaguard 88 (Const. Specialist Co.).

Pile sections were exposed at the Forest Service National Exposure Site near Gulfport, Mississippi. Decay inside the pile sections was judged from increment borings taken at various intervals along the sides of the sections. Holes left by borings were treated with 5 percent penta and plugged with penta-treated dowels to protect against infection.

Results

Table 2 shows the results of the brush- or trowel-applied fungicidal treatments at 3, 4 and 5 years. By 3 years all of the untreated control piles were decayed in the heartwood centre. However, Osmoplastic, ammonium bifluoride, penta in mineral spirits, and ammoniacal-copper-borate (8%) had protected pile tops from decay. After 4 years, only Osmoplastic and ammonium bifluoride provided protection against decay, and after 5 years these treatments were still effective.

Pile tops treated by insertion of fused preservative rods have only been exposed 3 years at the writing of this report. However, they are free of decay whereas all controls have advanced decay.

Both of the epoxy coverings proved ineffective as capping compounds after only one year of exposure. Both cracked, permitting wetting of the pile top.

Discussion

Douglas-fir pile tops were protected from decay for 5 years in a high decay hazard climate by brush treatment with ammonium bifluoride or troweled-on Osmoplastic without the benefit of a cap. Previously we reported protection of Douglas-fir pile tops by application of ammonium bifluoride in holes drilled in the pile tops (Highley, 1980; Highley and Scheffer, 1975, 1980). Helsing and Graham (1980) also reported protection of Douglas-fir pile tops from decay with ammonium bifluoride crystals applied in saw kerfs. Whether or not brush treatment with ammonium bifluoride will protect as long as treatment with the crystals is yet to be determined.

The failure of pentachlorophenol and sodium borate to protect Douglas-fir pile tops from decay agrees with previous results (Helsing and Graham, 1980; Highley, 1980; Highley and Scheffer, 1975, 1980). The rather insoluble pentachlorophenol probably does not move into checks as they are formed, and the highly soluble sodium borate is too rapidly lost to provide protection. Insertion of fused borate rods in pile tops appears to offer better protection than borate (Polybor) in solution. The borate rods, however, have only been in test for 3 years, which is not sufficient to judge their effectiveness.

This study also showed that fluoride plays a significant rôle in preventing decay. The only two materials preventing decay at 5 years contained fluoride. Another fluoride-containing material, FCAP, was also effective in protecting Douglas-fir pile tops from decay in a study by Helsing and Graham (1980). Evidently, fluoride ions are able to migrate deep into checks as they form, yet the ions remain in sufficient quantity near the top to protect against decay. The migration of fluoride into wood has been demonstrated particularly by in-place, ground-line treatments of poles (Becker, 1973; Johanson, 1974; Smith and Cockroft, 1967a, b). On the average, Smith and Cockroft (1967a, b) found about 50 percent of the initial content of fluoride injected by the "Cobra" process still remained in conifer poles after 6 years of service.

Apparently, only a small amount of fungitoxic chemical is required for protection of a moderately decay-resistant wood, such as Douglas-fir heartwood, in aboveground exposures. Long-term protection of Douglas-fir heartwood simply by brush or dip treatment with a preservative has been demonstrated in other studies (Highley, 1980; Scheffer, 1971; Scheffer and Eslyn, 1978; Scheffer *et al.,* 1963). Scheffer and Eslyn (1978) report little decay in dip-treated Douglas-fir floor panels exposed above ground for 22 years despite the presence of very small amounts of residual penta. However, less decay-resistant species are more difficult to protect by brush or dip treatment (Highley, 1980; Scheffer, 1971; Scheffer and Eslyn, 1978; Scheffer *et al.,* 1963).

Bituminous compounds such as Treheal (Flintkote) or Nokorode Seal Kote (Monsanto) are superior as end coatings to epoxy compounds tested thus far. The two epoxy compounds tested failed as moisture barriers after only one year of exposure as did a previously tested epoxy material (Highley and Scheffer, 1978). The epoxy compounds also have the disadvantages of higher cost and more difficult application in that they must be applied in a two-component system.

Conclusions and recommendations

Long-term protection against decay entering the cutoff end of Douglas-fir pile tops can be expected from brush treatment with a 20 percent aqueous solution of ammonium bifluoride or troweled-on Osmoplastic immediately after piles are cut off. Retreatment does not appear necessary for at least 5 years.

Brush treatment of pile tops with ammonium bifluoride is easier and cleaner than troweled-on Osmoplastic and may be more readily used in combination with a capping material. Grease-type preservatives are not desirable because of accidents from slippage on the greasy pile top. Even though Douglas-fir pile tops were protected from decay with the above treatments without a cap, a cap in combination with a preservative is recommended to prevent excessive checking.

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Table –1

Treatment of pile tops by insertion of fused preservative rods.

Treatment	Core size		Spacing on pile top (inches)
	Diameter (inches)	Length (inches)	
Sodium borate plus copper oxide	1/2	4	2 4 6
Sodium borate	1/4	4	2 3 4 6
Sodium borate plus copper oxide	1/2	3	2 4 6
Boric oxide	1/2	3	2 4 6
Boric oxide plus copper oxide	1/2	3	2 4 6

Table - 2
Five-year evaluation of supplementary brush or trowel treatments of Douglas-fir pile tops with a fungicide

Treatment	Percent piles with visual decay		
	3 years	4 years	5 years
Polybor (10%, H_2O)	13	100	100
Cu-8-quinolinolate (10%, H_2O)	25	63	75
Cu-8-quinolinolate (2%, H_2O)*	50	83	—
Osmoplastic	0	0	0
Penta (5%, mineral spirits)	0	75	100
Sodium penta (5%, H_2O)	25	88	100
Ammoniacal-copper-borate (8%)	0	38	50
Ammoniacal-copper-borate (2%)*	62	100	—
Ammonium bifluoride (20%)	0	0	0
Control	100	100	100

* Exposed only 4 years at time of evaluation