Controlling Decay in Above-Water Parts of Waterfront Structures

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Abstract

Shallow penetration of preservative, and deep checking, in some Douglas-fir piles and associated members above water, suggested a need for supplementary treatment. Pentachlorophenol- and creosote-treated curbs with deep checks required supplementary treatment as decay was noted in some as early as 4 years after installation. However, unexpectedly, curbs with deep checks that were treated with fluor-chrome-arsenic-phenol did not show decay. Supplementary treatment by flooding preservative solutions into checks provided little protection against decay in creosote-treated curbs, because at the time of treatment infection might have been already too deep. In areas of heavy traffic, planking treated with creosote showed little checking and wear, whereas planking treated with fluor-chrome-arsenic-phenol was heavily checked and had slivered surfaces. Although under heavy traffic creosoted planking apparently outwore FCAP planking, both types of treated planking outlasted untreated planking. Simple supplementary treatment of Douglas-fir piles on the top cutoff surface, applying a fungicide followed by a capping compound, apparently could add substantial service life to piles.

WOOD, because of its many desirable properties, is one of the most widely used materials for waterfront construction. If used improperly, however, wood can be greatly deteriorated by biological forces and its service life shortened. Decay and marine borer damage cause annual losses of about 500 million dollars to waterfront structures.

In 1966, T. C. Scheffer, then at the Forest Products Laboratory, conducted a survey of U.S. Navy waterfront facilities. He reported many premature wood failures from decay in superstructure components. Measures to control decay were discussed. Solutions to some of the problems were not readily apparent; thus an investigation was initiated in 1969 in cooperation with the U.S. Naval Facilities Engineering Command.

In-service structures above water and special simulated deck units and pile segments were investigated to answer the following questions: 1) Can supplementary treatment extend service life of untreated or shallowly pressure-treated wood? 2) Is preservative-treated planking advantageous where vehicular traffic causes large amounts of physical abrasion to the planking? 3) Which of the available preservatives and coating compounds will best prevent decay from entering the untreated heartwood exposed at the cutoff top surface of Douglas-fir piles?

Performance after 7 years' observation is summarized in this article for 1) in-service structures above water in the Seattle, Washington, area and 2) fender pile segments exposed at Gulfport, Mississippi. In an earlier article (2), performance after 5 years in service was summarized for short pile segments and simulated decks.

Procedure

Suitable facilities for the in-service experimental work were piers 1 and 2 at the Naval Torpedo Station, Keyport, Washington, and piers 90 and 91 at the Naval Station, Seattle. Included for experimentation were creosotetreated and fluor-chrome-arsenic-phenol (FCAP)-treated Douglas-fir deck planks (4 in. by 12 in.), creosote, pentachlorophenol (penta)- and FCAP-treated deck curbs (usually 10 in. by 10 in. or 12 in. by 12 in.), and creosote-treated Douglas-fir fender piles. In the treated members, preservative penetrated to a depth of about 1/2 inch in the sawed items and to at least 1 inch in the piles.

Selected planks pressure-treated with FCAP that had developed deep checks that penetrated the zone of treated wood, and curbs pressure-treated with creosote and FCAP that also had deep checks that penetrated the zone of treated wood, were flooded with the following preservatives: 1) sodium pentachlorophenate (5%) and wax (emulsion) (1%) in water; 2) same as treatment 1 without the wax; 3) penta (5%) and water repellents in mineral spirits (commercial, ready-to-use solution); 4) FCAP, 12 percent mixture in water (4%

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solution) (commercially available as Wolman salts and Osmosalts). Less leachable waterborne preservatives could be used, but moderate leachability seemed desirable to enhance penetration.

Pile-capping materials with the following qualities were sought: ease of application; continued flexibility; durability; cleanliness after setting; and reasonable wear under docking stresses (e.g., hawser scraping). Materials selected to meet these criteria were coal tar products of troweling consistency: 1) Noah's pitch (Phillip Carey), 2) Epoxy-Rock tar (Detroit Graphite), 3) Treaheal (Flintkote), and 4) Nokorode Seal Kote (Monsanto). The Noah's pitch and the Epoxy-Rock tar were applied to creosoted Douglas-fir pile tops at piers 90 and 91 in Seattle and the Treaheal and the Nokorode Seal Kote to creosoted southern pine piles at a pier in Gulfport.

Details of the fungicidal treatment of tops of experimental Douglas-fir pile sections have been reported (2). The fender piles were conventionally pressure-creosoted before they were cut into the sections and exposed at Gulfport. The treatment variables were 1) penta in a greaselike matrix ("penta-grease"), 2) 12.5 percent penta in mineral spirits, 3) 25 percent penta in No. 2 fuel oil (these three preparations were troweled or brushed on), 4) solid ammonium bifluoride or 12.5 percent penta in fuel oil in holes drilled in the fender pile top, and 5) no fungicide. Ten replications were used for each fungicidal treatment; seven of them, the fender piles, were capped with Noah's pitch, and three were not capped, to indicate possible results if damaged caps were not repaired on heavily used piers.

Results of Observations

Treated Decks in Service

Our results show preservative treatment of Douglas-fir planking subjected to physical wear by traffic can significantly extend service life beyond that of untreated planking. Service life of both FCAP-treated planks and creosote-treated planks of Douglas-fir in areas of heavy traffic clearly will far surpass that estimated for untreated Douglas-fir in the Seattle area—12 years. The oldest observed creosoted planking (13 yr.) had no decay and very little checking. The planking showed almost no physical deterioration from heavy traffic (Fig. 1A). The capacity of creosote to protect surfaces against weather checking and fiber loosening apparently occurs in many products. Despite extensive checking and some surface slivering, the FCAP-treated Douglas-fir planking was free of decay and, in general, structurally sound with apparently many more service years beyond its 17 years (Fig. 1B).

Seven years ago supplementary flood-treating of decks was tried only on FCAP-treated planks because these decks were the only ones in which deep checks penetrated the shell of treated wood. Any benefit from this type of treatment was not yet apparent, however, because of the absence of decay in FCAP-treated control planks with no supplementary treatment.

Treated Deck Curbs in Service

Large timbers such as deck curbs, chocks, and wales developed larger seasoning checks than did planks (Fig. 2). Decay differed markedly in checks of Douglas-fir curbs pressure-treated with penta or creosote from curbs treated with FCAP. Penta-treated (4 yr.) and creosote-treated (10 yr.) curbs were decayed at the base of deep checks, but surprisingly no decay was found after 17 years in the FCAP-treated curbs. It is doubtful that the creosote- and the penta-treated curbs with deep checks will be serviceable much longer than curbs without treatment. There were some creosoted curbs as old as 25 years that were without significant checking or decay, but an explanation for the limited checking in these instances was not apparent.

The lack of decay in the FCAP-treated Douglas-fir curbs with deep checks suggests a unique superiority of this waterborne preservative to protect untreated, interior wood exposed by deep checks in wood not in contact with soil. One or more of the constituent chemicals of FCAP apparently was leached from treated to untreated wood in amounts presumably small but sufficient to prevent infection by fungal spores. The outer surfaces of the wood were not decayed indicating that sufficient preservative remained

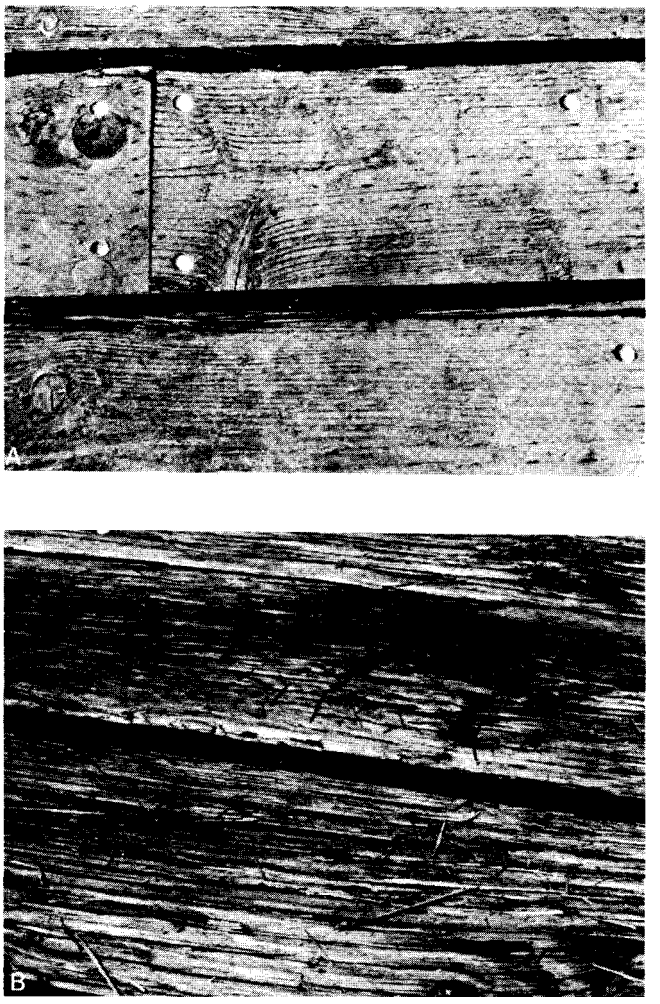

Figure 1. - Douglas-fir planks treated with creosote and fluor-chrome-arsenic-phenol (FCAP) after long service under heavy traffic in the Seattle area. After 13 years, creosoted deck planks show little wear or checking *(A)*; after 17 years, FCAP-treated deck planks have extensive checks and slivering of surface fibers, but no decay *(B)*.

Figure 2. - Upper surface of 17-year-old curb treated with fluor-chrome-arsenic-phenol (FCAP) that has deep checks that, in turn, expose untreated, interior wood. Decay did not develop in checks of FCAP-treated curbs, whereas decay was present in checks of creosote- and pentachlorophenol-treated curbs.

to protect these areas. This indication of potential to protect interior wood is so unexpected that it warrants securing additional experimental data; this includes data for other major waterborne chemicals in addition to that for FCAP in wood not in contact with the ground.

Bioassays of wood from checks of curbs 1 year after supplementary treatment indicated that preservatives had penetrated to the untreated wood at the base of checks; this presumably provided these areas some protection against decay organisms. Nevertheless, 7 years later all of the creosote-treated and penta-treated curbs given supplementary treatment with various preservatives had decay in checks, and decay fungi were isolated from the checks. Because as noted, all the observed FCAP-treated curbs were free of decay; there was no evidence whether or not they had benefited from the supplementary treatment.

The rapid development of decay in checks of creosote- and penta-treated Douglas-fir curbs indicates a need to continue experimental assessment of flood treatment of checks to protect these large wood members. Preservatives applied by ordinary flooding penetrate wood only slightly. For any possibility of success, therefore, the preservatives will have to be in the checks before fungal infection. Moreover, the treating may have to be repeated occasionally as long as the checks deepen.

If decay is established in large members, fumigation with volatile fungicides has promise. This type of treating is proving effective against interior decay in utility poles (1).The fumigant is applied in holes, as a liquid, then it diffuses for several feet as a toxic gas.

Treated Tops of Fender Piles

All fungicidal treatments supplemented with capping to prevent checking through the treated surface are continuing to effectively control decay in the heartwood center of 2-foot sections of conventionally pressure-treated Douglas-fir piles exposed at Gulfport. Thus far the treatments have more than doubled the life of these sections.

Some fungicidal treatments without addition of a pile cap continue to offer protection to pile tops after 7 years: a spread of penta-grease, solid ammonium bifluoride in 1- and 2-inch diameter holes in the pile top, and 12.5 percent penta-in-oil and 2-inch diameter holes. These results are promising evidence that certain simple early treatment of pile tops apparently can add substantially to the service life of creosoted Douglas-fir fender piles.

Other treatments were less effective. At 6 years, decay was extensive in one of three uncapped sections treated with 12.5 percent penta-in-oil placed in 1-inch holes. Of six pile tops brush-treated with penta (three tops with 12.5% and three with 25%), five were

extensively decayed at 6 years. Of the three sections capped with coal-tar pitch but without fungicidal treatment, one section at 5 years developed a decay pocket, whereas the remaining two at 7 years were still free of decay.

The excellent protection of uncapped piles by ammonium bifluoride in drilled holes was unexpected because it had been anticipated that losses from leaching of this highly water-soluble chemical would leave the pile top susceptible to decay. This result agrees with that noted for results from FCAP treatment on curbs, by indicating some waterborne chemicals may have unexpected ability to protect items with deep checks. Because of the performance of the waterborne compounds, using these compounds for brush-flooding onto pile cutoffs might be profitable. This would add insurance against decay if a fungicidal treatment could provide substantial protection without a cap, should the cap become damaged and not be repaired.

Two coal-tar materials (Treaheal and Nokorode Seal Kote) applied to fender pile tops on a heavily used pier in the subtropical climate of the gulf coast most closely approximated the criteria mentioned for protective capping of pile cutoffs. These materials, however, were susceptible to damage (by hawsers, etc.); thus more persistent materials (polysulfides, polyurethanes, and epoxys) are being sought.

Summary

Large Douglas-fir members not in contact with the soil, and pressure treated with creosote or pentachlorophenol, require some type of supplementary treatment to prevent decay from developing in checks that penetrate the zone of pressure treatment. However, supplementary treating by flooding conventional preservative solutions into checks was not effective, possibly because decay infection had progressed too deep to be reached by the preservative. FCAP-treated members with deep checks were not decayed; thus they may not require supplementary treatment.

Creosote-treated planking apparently will wear better under heavy traffic than will fluor-chrome-arsenate-phenol (FCAP)-treated planking, but both will far outwear untreated planking.

Simple supplementary treatment of Douglas-fir piles on the top cutoff surface apparently could add substantial service life to piles.

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