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In-place Treatment of Simulated Waterfront Structures for Decay Control

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1. Introduction

A survey of naval waterfront facilities (T. C. SCHEFFER, 1966) indicated opportunities for simple maintenance procedures to control decay in above-water components of piers, wharves, and docks. A cooperative study was initiated[1] to answer several questions: (1) Is it possible to extend the service life of untreated or of shallowly pressure-treated deck planks by supplementary treatment whereby preservative solution is flooded into weather checks that go deep into the wood and expose untreated wood? (2) Which of the available preservatives and coating compounds would best keep decay from entering the untreated heartwood exposed at the cutoff top of (Douglas-fir piles? (3) Are there advantages to using preservative-treated planking on areas where there is considerable physical abrasion by vehicular traffic? Structures in service and special units simulating decking and pile cutoffs were included for study.

This paper reports the results from the simulated items after 5 years' exposure at the USDA Forest Service's National Exposure Site near Gulfport, Miss. The purpose of experiments on simulated decks was

[1] The study was made in cooperation with the Naval Falicities Eng. Command, U. S. Dep. of the Navy. Y-F 51.543.002.02.002. 1969.

to determine the additional service life to be expected from in-place "flooding" treatment of decks constructed of untreated planks, and from flooding of decks that had initially been pressure treated but without adequate penetration of the preservative. The purpose of experiments directed at treated simulated Douglas-fir piles was to find a preservative chemical that could be sprayed onto the untreated heartwood centers of pile cutoffs, making them resistant to infection by decay fungi. A moisture-resistant compound was also sought, which, when spread on the pile tops after preservative treatment, would keep it from acquiring checks that penetrate through the preservative-treated surface. In all these experiments the aim is to keep decay fungi from getting established in untreated wood at the base of deep checks.

2. Methods[2]

2.1 Treatment of Simulated Decks

Fig. 1 shows the construction of panels forming the simulated decks. These were built of untreated 4- by 10-inch planks of southern pine sapwood or of Douglas-fir heartwood. The southern pine lumber was grade 2 and better, unseasoned, surfaced on four sides, and dipped at the mill in antistain solution. The Douglas-fir lumber was construction grade, unseasoned, and surfaced on four sides. The planks and stringers were prebored for the nailing spikes, and the holes in all but the control panels were treated with 5 percent pentachlorophenol with water repellents dispensed from a squirt-type oil can. Such preparatory treating is considered an advisable supplementary measure for any decking that is only partially penetrated by the primary preservative.

Twenty-five deck units of each wood were prepared, five planks per unit. The plank ends and the lower edges of the stringers were flooded with penta concentrate (25 percent penta) and coated with a viscous coal-tar pitch, "Noah's Pitch" (Philip Carey Co.), to avoid complication by decay entering at these places.

Immediately after construction, the simulated decks were placed, untreated, on the exposure site to allow development of checks as would normally be present in the upper sides of planks that have been in service several months. After a year of exposure, the decks were subjected to one of five treatments: (1) No treatment (control), (2) 5 percent sodium pentachloro-

[2] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U. S. Department of Agriculture of any product or service to the exclusion of others which may be suitable. - Mention of a chemical in this publication does not constitute a recommendation; only those chemicals registered by the U. S. Environmental Protection Agency may be recommended, and then only for uses as prescribed in the registration and in the manner and at the concentration prescribed. The list of registered chemicals varies from time to time; prospective users, therefore, should get current information on registration status from the Environmental Protection Agency, 401 M Street, NW, Washington, DC 20024.

phenate plus an emulsion of 1 percent wax in water, (3) same without the wax, (4) 5 percent pentachlorophenol plus water repellents in mineral spirits, and (5) 12 percent FCAP (fluor-chrome-arsenic-phenol)[3] in water.

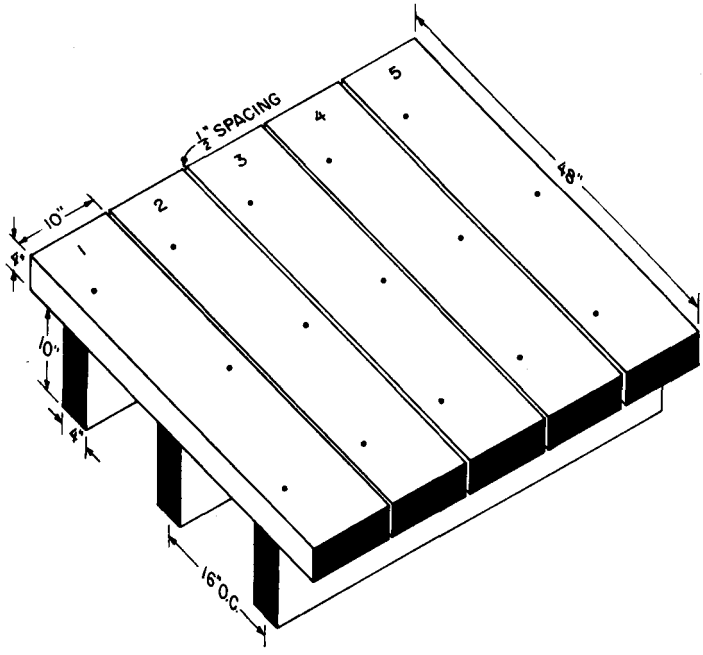

Figure 1. Experimental unit of simulated deck.

Each year after the initial treatment, planks 1, 3, and 5 (fig. 1) of the test units were treated again with the preservative initially used. (Controls, of course, were not treated, but merely observed each year.) Planks 2 and 4 of the test decks were not treated again after the initial application. Preservatives were flooded from a brush over the tops of the planks for each application in an attempt to disperse the solutions comparably to what would be done in practice by spraying or sprinkling.

The individual planks were rated numerically for condition according to class of decay, thus:

0 No evidence of decay
40 Definite but limited decay
60 Decay general but not warranting replacement of the item in practice
80 Decay sufficient to warrant replacement of the item
100 Item failed.

[3] Approximately 25 percent sodium fluoride, 37.5 percent sodium chromate, 25 percent sodium arsenate, and 12.5 percent dinitrophenol.

2.2 Treatment of Simulated Pile Tops

In finding a chemical to control decay in the untreated heartwood centers of pile cutoffs, 2-foot Douglas-fir pile sections[4], of class A piling, were treated with No. 1 coal-tar creosote to a final retention of 12 pounds per cubic foot in accordance with AWPA specifications (AWPA, 1964). The sections were cut with a chain saw from eight 20-foot piles, and the 80 sections were randomized into the different treatment groups. The basal end of all sections was thoroughly flooded with 25 percent penta concentrate and then coated with a mixture of one part epoxy and three parts rock tar (Detroit Graphite Company) to prevent decay from ground contact.

Ten replications were made of each of seven fungicide treatments; there were 10 untreated control sections. A cap of Noah's Pitch was applied to 7 of the 10 section tops in each treatment group. Three tops were left bare to indicate what might happen if damaged caps are not repaired on active piers. The fungicidal treatments were:

1. Penta-grease (a soft, greaselike preparation containing 10 percent pentachlorophenol), troweled on to a thickness of 1/4 inch and then covered with a sheet of 6-mil polyethylene for 48 hours to reduce loss of volatile oil carrying the penta.
2. Pentachlorophenol, 12.5 percent, plus water repellents in mineral spirits, applied by flooding from a brush.
3. Same as (2) except 25 percent penta in No. 2 fuel oil.
4. Solid ammonium bifluoride, applied by filling holes drilled in the section top. Six holes, 1 inch in diameter and 2 inches deep, distributed uniformly over the heartwood.
5. Solid ammonium bifluoride in six 2-inch holes, 1 inch deep.
6. Pentachlorophenol, 12.5 percent, plus water repellents in No. 2 fuel oil, six 1-inch holes, 2 inches deep.
7. Same as (6) except for 2-inch holes, 1 inch deep.

For the control sections, seven were uncapped and three were capped - the latter to indicate what may be expected if piles are capped without additionally providing fungicidal protection.

Both the simulated deck units and the pile sections are exposed on the ground at the National Exposure Site near Gulfport, Miss. Decay inside the pile sections was judged from increment borings taken at various intervals along the sides of the sections. Holes, left by the boring, were plugged with penta-treated dowels to protect against infection.

3. Results and Discussion

3.1 Simulated Deck Units

All southern pine deck planks treated in-place on the upper surface with the three penta formulabions suffered almost as much decay as the untreated, control planks (table 1). This was true for units treated

4 Piles conformed to American Society of Testing and Materials. 1964. "Standard Specification for Round Timber Piles". ASTM Desig. D 25-58. Philadelphia,Pa.

annually as well as for those that received just the initial treatment. The prevalent fungus was Gloeophyllum saepiarium (Wulf. ex Fr.) P. Karst. [Lenzites saepiarium (Wulf. ex Fr.) Fr.].

There was no apparent decay, however, in the southern pine planks treated with FCAP. Similarly, all the Douglas-fir planks, both treated and untreated, appeared sound.

Table 1. Average decay ratings of southern pine deck planks[4] after 5 years' above-ground exposure in Mississippi.

Preservative		Average decay rating[b,c])	
Treatment	%	Initial treatment only	Annual treatment
None (control)		66	
Sodium pentachlorophenol	5		51
Sodium pentachlorophenol plus water repellents	5	56	5
Pentachlorophenol in mineral spirits plus water repellents	5	60	60
FCAP	12	0	0

it had been expected that at least the annual treating with penta would protect the pine deck units by getting the fungicide into checks as they developed. The treating did protect the upper surface, on which it was directly applied, but this clearly was not sufficient for such a (decay-susceptible wood as southern pine sapwood. Distribution of fungal fruiting bodies showed that decay had entered the planks from the untreated edges and the lower surface at the plank-stringer interface. Because of the proximity of the planks to the ground (10 inches), decay undoubtedly was favored by the resultant retardation of drying of the wood between rains. Nevertheless, decay characteristics were similar to those observed in (decking of piers and wharves under similar climatic conditions.

Pine deck planks on wharves in active service have been estimated to have a service life of only 2 to 3 years (T. C. SCHEFFER, 1966). High susceptibility of southern pine to decay in above-ground exposure in

Mississippi also has been observed in onsite treating experiments on outside flooring (T. C. Scheffer et al. 1963, 1971). Untreated pine floor units failed in 6 years and decay was beginning to appear at the seventh year in units that had (been treated on all surfaces by dipping for 3 minutes in 5 percent penta solution. By the fifteenth year only 29 percent of the treated boards were still in good condition.

Thus for successful onsite treating of pine deck planks with penta, it would seem necessary to initially cover all surfaces prior to construction, and thereafter periodically flood the upper surface to protect checks as they develop. On the other hand, only top coverage may be needed for maintenance treating when using certain waterborne preservatives. Such outstanding protection as that afforded the southern pine planks by In-place flooding with FCAP had not been anticipated. A similar result has been reported by J. KRZYZEWSKI and J. K. SHIELDS (1971) in Canada, where brush treatment was continuing to protect hemlock superstructure wharf members in Quebec after 7 years' exposure. Perhaps the moderate leachability of the FCAP components is sufficient to protect the planking on other surfaces (besides the treated top. In any case, these results are highly encouraging and suggest that much might be gained from further onsite treating experiments with this and other waterborne compounds.

That the planks of Douglas-fir heartwood are still sound is not surprising in view of use experience and our earlier experimental results with this wood in above-ground locations. Although Douglas-fir heartwood has only moderate decay resistance when in ground contact, it tends to have a relatively long service life when used above ground. In the Mississippi flooring experiments by T. C. SCHEFFER et al. (1963), for example, 55 percent of the untreated Douglas-fir boards and 97 percent of boards that had been dipped in 5 percent penta solution were still sound at the end of 15 years.

3.2 Simulated Pile Tops

The heartwood interior of all the uncapped controls of the Douglas-fir pile cutoffs was decayed throughout the entire 2-foot length of the sections. The decay was evident to a depth of 6 inches or more after only 3 years. The control sections covered by the bituminous cap of Noah's Pitch have thus far remained free of noticeable decay.

The only decay observed in sections treated with fungicide was in a few that were not capped. Decay was apparent in one of the three uncapped sections treated with 12.5 percent penta-in-oil placed in 1-inch-diameter, 2-inch-deep holes in the section top, and in two

uncapped sections, brush-treated on top with 12.5 percent penta with water repellents in No. 2 fuel ail. The excellent protection of uncapped sections provided by the water-soluble fungicide, solid ammonium bifluoride, in drilled holes is encouraging. There had been some concern that unless this chemical were sheltered against rain wetting, its potential advantage in superior diffusibility might be offset by losses from leaching.

It appears from these results that simple supplementary treatment of the cutoff tops can add substantially to the service life of piles. Evidently infection through checks in the sides of adequately pressure-treated piles is relatively negligible. After 5 years, it is too early to tell whether any of the fungicidal treatments can continue to give the desired protection without the addition of a pile cap to prevent weather checking of the treated wood. Future inspections are expected to answer this question and also indicate clearly the relative merits of the different fungicidal treatments.

4. Summary

Experiments were started to improve the service life of inadequately protected Douglas-fir and southern pine plank decks of waterfront structures and of Douglas-fir fender piles by simple preservative treating of the items in-place. This is a 5-year-progress report on a segment of the experiments being conducted in Mississippi on simulated decks and on 2-foot sections of conventionally treated piles. The deck experiments were aimed at controlling decay by flooding the top surface of the planks with fungicidal solution, getting the preservative into weather checks where rainwater accumulates and supports decay. The purpose of the piling experiments was to prevent decay from entering the untreated heartwood exposed at the top of the pile. A fungicide was applied to the cutoff surface or into drilled holes, and on some specimens, a bituminous pile cap was applied to prevent checking through the protective layer of fungicide. - A single flooding application of 12% FCAP commercial wood preservative, made at the end of the first year of exposure, has prevented decay in previously untreated planking of southern pine sapwood, but annual flooding with 5% pentachlorophenol in oil or sodium penta in water was ineffective. None of the planks of Douglas-fir heartwood, including controls, was visibly decayed. - All the untreated Douglas-fir pile sections were decayed throughout. Sections were still sound where protected by a spreading application of 10 percent penta in a “grease”, by brush-flooding with 25% penta plus water repellents in fuel oil, by 12.5% penta plus water repellents in fuel oil placed in 2-inch-diameter drilled holes, and by solid ammonium bifluoride placed in 1-inch- or 2-inch-diameter holes. Results were the same for piles both with and without bituminous pile caps. Beginning failures were seen only in uncapped sections: Those brush treated with 12.5% penta plus water repellents in mineral spirits and those with 12.5% penta plus water repellents in fuel oil - placed in 1-inch holes.

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