Treatment Methods – Wood Preservation for Fresh Water Uses
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WOOD PRESERVATION FOR FRESH WATER USES

TREATMENT METHODS

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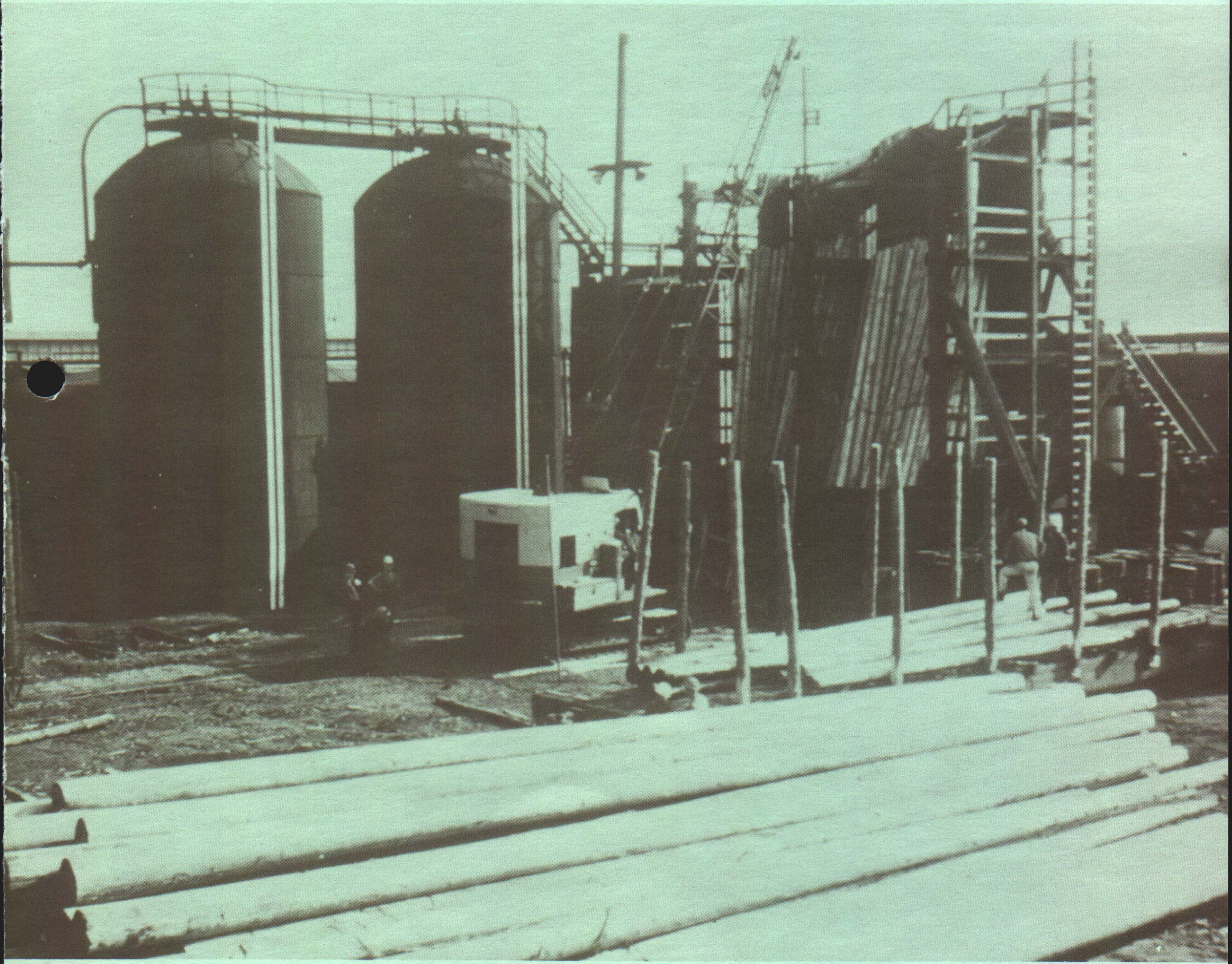

Butt treating cedar poles by the thermal process.

The United States Environmental Protection Agency is currently reviewing the safety and registration of pentachlorophenol, arsenicals, and creosote/coal tar. These products can continue to be sold and used as wood preservatives until a final decision is made. In some cases that could be 4 years away.

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INTRODUCTION

MARINAS, DOCKS, WHARVES, and other wooden structures encircle the Great Lakes. Wood exposed to constant dousing is very vulnerable to decay. Consider wood preservation when building wooden structures to use near fresh water (Fig. 1).

The four publications in this series describe fungi and insects that attack wood, and they provide information on preservatives and their application, and how to use treated wood.

Fig. 1. These structures need protection from decay.

THIS BOOKLET DESCRIBES methods used to preserve wood chemically.

Successful wood treatment usually requires commercial methods. Some do-it-yourself repair or touch-up preservative applications are possible.

Besides the preservative, the most important part of wood preservation is getting it into wood. Even the best preservative will not protect wood if it lies only on the surface. How long the wood lasts, treated by methods available, largely depends on depth of penetration and amount of preservative deposited in wood. Exposure is important but has little bearing on preservative penetration.

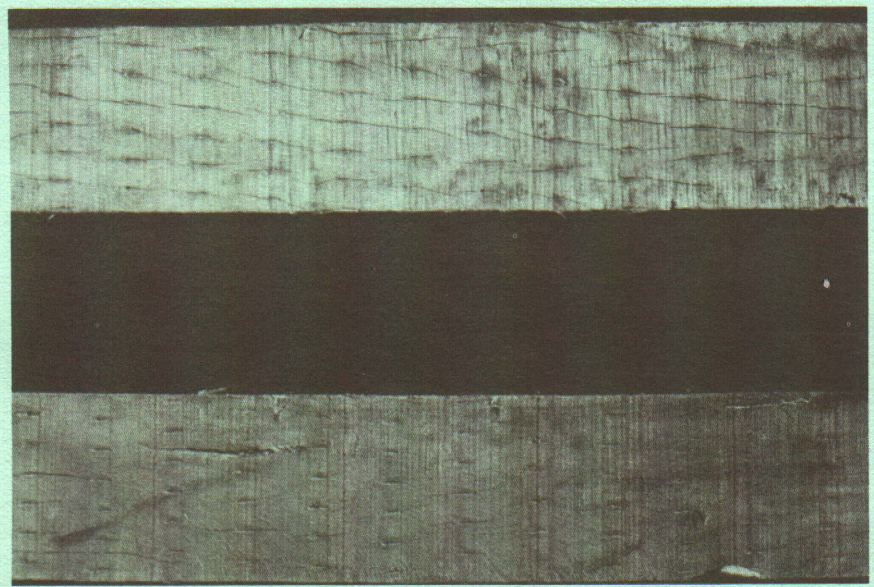

Fig. 2. Incising pattern used on timbers. Spacings of punctures improve preservative distribution.

PREPARING WOOD FOR TREATMENT

For most treatment, moisture in wood must be partly removed. Any softwood lumber purchased at a retail or wholesale yard, bearing the marks, MC-15, or S-DRY, is dry enough for treatment. Round stock is not marked, and moisture content would have to be measured with a meter or other means to determine its suitability for treatment.

Bark is impenetrable to liquids and must be removed before wood is treated, especially in round form.

Because many woods resist penetration, a process called **incising** is sometimes used to improve penetration. Wood is more receptive to treatment on end grain than on the sides. Sharp, steel teeth are pressed into the sides of boards, timbers or poles to open small areas of end grain (Fig. 2). Douglas fir, larch, jack pine, white pine and hemfir must be incised before treatment to meet AWPA Standards (Fig. 3).

Preservative application is divided into nonpressure and pressure methods. What constitutes pressure treatment is a moot question since there is no federal regulation or definition. The dividing line is 50 pounds per square inch but the AWPA definition also states: "above atmospheric or above any initial air pressure."

NONPRESSURE TREATMENTS

Brush applications of preservative to wood are the simplest and least effective. PCP solutions are most often used for brush treatment since they are readily available. Penetration is minimal and preservative retention is low. Brushing is useful for cut surfaces of treated lumber where untreated wood is exposed, e.g. piles or planks. It is also used on structures of low decay hazard away from soil, moist concrete or water — like trim on buildings before painting. Wood must be dry — below 30% moisture

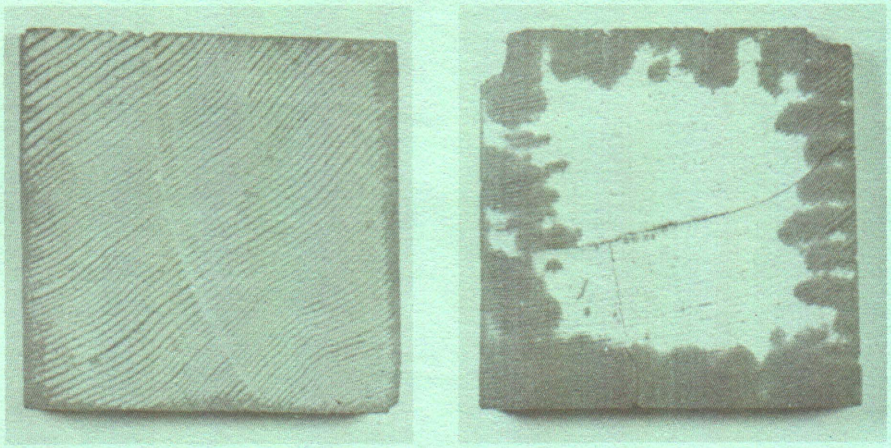

Fig. 3. Incising improves penetration of Douglas fir heartwood (unincised, left; incised, right) after treatment with creosote.

Fig. 4. (Below) Immersion treating of posts. (Photo courtesy TVA, Forestry Division.)

for treatment. Apply as much preservative as wood will absorb, especially on end grain.

Apply sprays only in factories on unassembled parts because PCP solution or creosote spray irritates eyes, nasal passages and the throat. Do not spray PCP solutions around water because of the possibility of pollution and fish kills.

Fairly effective treatment of pine sapwood and red oak results from immersion of air-dry wood in solutions of pentachlorophenol or creosote (Fig. 4). Solids form in some creosotes at outdoor temperatures, except in summer, which limits this treatment to PCP solutions unless a heated tank is available. Depth of penetration of sapwood as a percentage of its thickness is an indicator of treatment effectiveness. Sapwood is more readily penetrated than heartwood in most trees. In fact, many heartwoods are difficult to penetrate even under pressure.

Most pines and oaks have over 80% sapwood penetrated with more than 2.5 pounds per cubic foot retention of preservative (Table 1). Even though aspen, cottonwood and elm have greater retentions, percent of sapwood penetrated is small. This indicates that preservative is entering wood ends but not the sides. Long posts or piles would have little protection except for 1 or 2 feet from the end.

Grease and gel preservatives used on poles, posts or timbers below ground are applied directly to the cleaned wood surface or to a membrane plastic-paper laminate on which the grease is spread. For best results, separate greases from backfilled soil with a paper-plastic barrier.

In the vacuum process, atmospheric pressure is used to help impregnate wood. Lumber is placed in a strong, reinforced steel tank with an airtight cover. After the tank is closed, a vacuum of the maximum attainable with available equipment is created, and preservative is then drawn into the tank to cover the lumber and fill the tank (Fig. 5). The vacuum is broken, and lumber is allowed to soak for a time before preservative, which was not absorbed, is drained. A short recovery vacuum is created to remove surface liquid.

Table 1 — Penetration and retention of preservative in round 4-5 inch posts in period shown by immersion in 5% PCP or creosote.*

Wood	Immersion time, hr	Retention of preservative lb/ft³	Sapwood depth in. Average	Penetration, in.	Sapwood penetrated %
Balsam fir	48	1.3	.53	.03	5.7
Eastern hemlock	48	1.1	.39	.09	23
White pine	48	3.1	1.00	.86	86
Jack pine	48	2.8	1.21	.93	77
Red pine	48	3.6	2.15	1.01	47
Spruce	48	0.8	1.72	.02	1.2
Tamarack	48	1.8	1.23	.03	2.4
White cedar	48	1.3	.65	.01	1.5
Aspen	168	8.1	2.09	.23	11
Cottonwood	168	6.5	1.57	.10	6.4
Elm	48	3.2	.40	.10	25
Red oak	66	2.6	.42	.32	76
White oak	48	3.3	.62	.43	69

(Data from Forest Products Laboratory Report 1445)

This process is used most often with PCP water repellent solutions, but a variation has also been used with waterborne preservatives.

Double Diffusion

Double diffusion process, invented at the Forest Products Laboratory, a branch of the U.S. Department of Agriculture at Madison, Wis., has produced excellent results on softwood round stock. Few hardwoods exhibit as good results. Posts must be freshly cut or contain most of the original water for effective diffusion. Generally, debarked wood is immersed in a 10% copper sulfate solution for a day or two. The solution is then drained from a tank, and the posts are removed and lightly rinsed with water to remove surface chemical. Posts are transferred to a 10% solution of sodium arsenate and allowed to remain in it for 1 or 2 days. After removal, light rinsing, and 2 weeks in storage, the treated wood is ready for use. A few plants use this process to produce posts for sale, but double diffusion treated wood is largely a "do-it-yourself project."

Thermal or Hot-cold Method

Perhaps the oldest nonpressure commercial process is the thermal or hot-cold method. Its greatest use is for cedar utility poles. It is also used on other woods with a narrow sapwood such as lodgepole pine. Poles are placed horizontally in a tank. The tank is usually buried with the top just above the ground line. Hot preservative (maximum temperature 230°F) is pumped over the poles and allowed to remain until it heats the sapwood and expels some of the air from the wood. Hot liquid is pumped out, and cold preservative replaces it. This contracts the air remaining in sapwood and draws preservative in (Fig. 6). Some cedar is only butt-treated. The poles are set upright in an open tank. Since cedar sapwood resists penetration of preservative, it is usually incised over the critical ground line portion before treating.

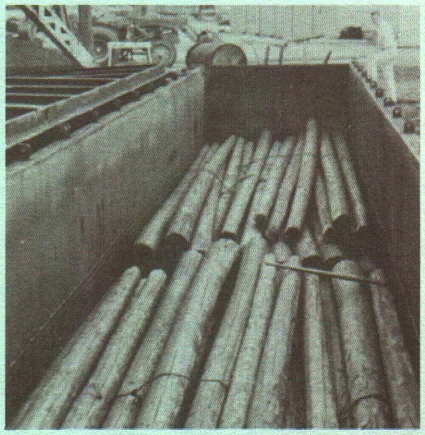

Fig. 6. Thermal treating. Hot preservative is used to expand air in sapwood. After wood is hot, cold preservative is pumped over wood. Steel cover is securely fastened to keep floating poles under treating solution.

Fig. 5. Treating lumber with PCP water repellent solution by vacuum process. Tank cover will be closed and vacuum drawn on lumber. (Photo courtesy of Robert's Consolidated Industries.)

PRESSURE TREATMENTS

Pressure treatments have several advantages over nonpressure treatments. These are: deeper penetration, especially across the grain, better control over amount of preservative forced into wood, more uniform penetration and retention, and adaptability to large volume operations. Where termite and decay hazards are high, pressure treated wood is the best choice. Not all wood needs pressure treatment. Where decay or termite hazard is low, a nonpressure method is preferred for economic and application reasons.

Fig. 7. Three treating cylinders used for full cell or empty cell pressure treating.

Full Cell Process

The oldest pressure treating process was first used in 1838 when a British patent was granted to John Bethell. The name is based on the inaccurate assumption that all wood cells fill with preservative.

Wood is placed in a horizontal cylinder up to 180 feet long and 6 feet in diameter. A vacuum is created in the cylinder. Preservative then enters the cylinder followed by pressure applied to the preservative. After the required time, pressure is released, the cylinder drained, and a final vacuum applied to help dry off the surface without withdrawing much preservative (Fig. 7).

The full cell process is generally used where large amounts of preservative are needed in wood such as piling or bridge timbers. It is also used for waterborne preservatives where concentration of treating solution can be adjusted easily.

Since retentions are high and more difficult to control by the full cell process, it is not often used with creosote or pentachlorophenol for posts, poles, lumber, construction timber and the like. It gives high retentions but not necessarily any deeper penetration than other processes. With oily or oilborne preservatives, the full cell process is used for salt water piling, ferry slips and piers where surface oiliness is more acceptable.

Empty Cell Processes

Empty cell processes were invented to overcome excess preservative in wood with accompanying deep penetration. Retention control is better with empty cell than full cell processes. Air is injected into wood before preservative is added in the Rueping process. Air already in the wood is compressed, then followed by preservative in the Lowry process. The name *empty cell* stems from the inaccurate notion that cells of treated wood are largely empty with only a thin coating of preservative.

Magnitude of pressure of compressed air is one control for preservative retention. For example, if 30 pounds per square inch (psi) air pressure were used it might leave 10 pounds per cubic foot (pcf) of preservative but 60 psi might be used to leave 8 pcf. Length and intensity of the period of preservative pressure are also important.

After the pressure period, preservative is drained from the cylinder and a vacuum applied (Fig. 8). For an especially clean and dry surface, wood is steamed at atmospheric pressure just before it is withdrawn from the cylinder. Some pieces will still exude preservative when withdrawn from the cylinder.

More wood is treated by the Rueping process than any other. Research has recently produced an empty cell process for use with waterborne preservatives. This may become more attractive than full cell treatments. Empty cell processes are used for lumber, timber, poles, posts, cross ties, etc. Nearly all PCP-treated lumber available at lumber yards is empty cell treated.

PATENTED AND TRADEMARKED PROCESSES

Several modifications of pressure processes that yield treated wood with properties well suited for marinas, boat docks and other marine structures have recently surfaced. Most were developed to overcome undesirable surface oiliness and painting difficulties of wood treated with PCP in conventional oil carriers.

Cellon (registered and patented by Koppers Co.) is a name applied to a wood treating process with PCP dissolved in liquified petroleum gas (bottled gas) containing other ingredients to improve performance. When pressure in the treating cylinder is released, the liquid remaining in the wood is transformed into gas and recondensed. The treated wood is free of any liquid that would interfere with paint or leave the wood oily.

The *Dow* process uses methylene chloride, a low boiling point liquid, as a solvent for PCP. After the usual empty cell process, solvent remaining in wood is volatilized by steam and recondensed. Special inhibitors are used to reduce corrosion and decomposition of methylene chloride. Treated wood has a dry, paintable surface.

The *LSD* process uses a naphtha-like solvent with additives to prevent crystallization of PCP on wood surface (blooming). The solvent evaporates after removal of treated wood from the cylinder, leaving it dry.

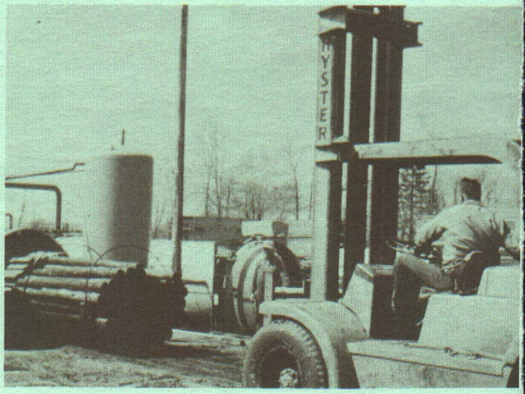

Fig. 8. Pulling wood from pressure cylinder after treatment with PCP solution.

Sontek is a patented process used to improve penetration and distribution of creosote or oilborne preservatives in wood. Surface condition is not necessarily improved. Shock waves are sent through liquid preservative while wood undergoes pressure impregnation. *Sontek*-treated wood resembles conventionally treated wood.

POST-CONSTRUCTION TREATMENT

Untreated wood is often used in construction through an error in planning, or because treated wood may have been unavailable (Fig. 9). Treated wood is also cut, exposing untreated wood. What can be done to extend the life of such wood susceptible to decay or termites?

When piles are trimmed to correct height after driving or jetting, untreated wood is exposed. In high rainfall areas or where waves keep the cut end wet, some protection is needed or decay will start and hollow-out the pile (Fig. 10). Bituminous coatings (*Noah's pitch* or similar) give good protection. A thickened preservative or preservative grease may also prevent decay. Both are dark and oily and may be undesirable since light-colored lines looped over the pile may be stained. Use a black polyethylene wrapping to overcome this problem. Remove the plastic after the bituminous compound has lost its thinner or the oil from the grease has penetrated the pile end. An aluminum or galvanized cover could also be used for preservative grease.

Greases have been used on untreated wood joints with mixed results, depending on dimensions and kind of wood. A 2 × 4 post-base unit is well protected but a cross-brace unit is not when a preservative grease is applied after the joint is in place. Protection is better if grease is applied before the joint is made (Fig. 11).

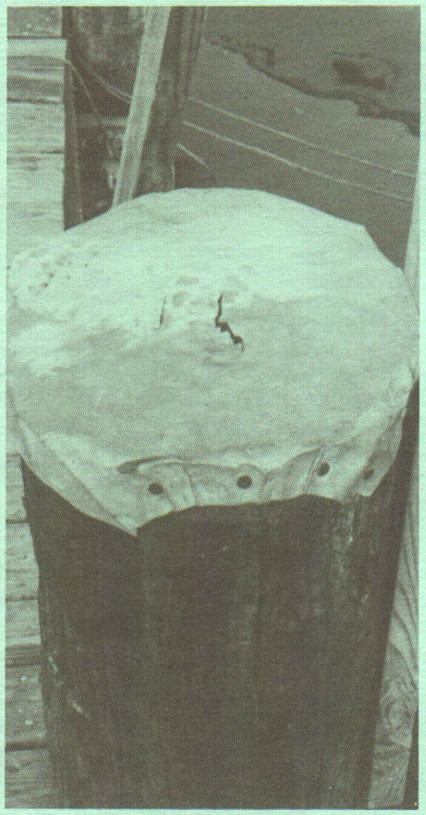

Fig. 9. (Left) Deterioration of unprotected pile. Fig. 10 (Above) Metal cap to protect piling. If metal is broken, water can enter and protection is reduced. Coal tar pitch or grease preservatives also can be used.

Fumigation of infected wood with Vapam(R)[1] has been practiced on utility poles already in use to kill decay. This method might also be useable on pilings or marina posts. The method was developed on Douglas fir, and its suitability to other woods is unknown although it should work. Downward sloping holes are bored in the area of decay and suspected decay. Liquid fumigant is carefully poured into the holes, and then holes are plugged with a dowel. Decay is arrested in Douglas fir for at least 5 years.

Brush or spray application of preservative to joints after wood structures are built has limited usefulness because not enough preservative reaches areas that need protection.

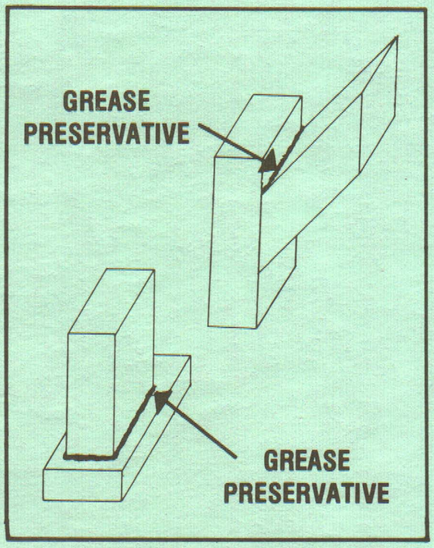

Fig. 11. Types of construction joints that benefit from an application of preservative grease. Application of grease shown as wide, dark lines.

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[1] (R) Registered TM of Stauffer Chem. Co.

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ALWAYS USE WOOD PRESERVATIVES ONLY AS DIRECTED ON THE LABEL

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