AN OVERALL LOOK AT WOOD DETERIORATION[1]

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Introduction

Except for damage by insects, practically all deterioration of wood is caused by primitive plants known as fungi. The wood-attacking fungi fall into two broad groups: (1) sap-stain and mold fungi that produce disfiguring discolorations but have little effect on strength properties of wood (the discolorations by molds usually are superficial, but those by stainers extend deeply into the sapwood); (2) a wide variety of decay fungi, all of which attack the wood cells and eventually weaken and destroy the wood.

None of the wood-attacking fungi can grow in wood with a moisture content below 20 percent. On the other hand, completely water-logged wood lacks enough oxygen for growth. Temperatures of 70° to 85° F. provide optimum conditions but growth is very slow even at 50° to 55° F. Of the factors affecting growth, moisture is by far the most important, and it can be most readily controlled in the manufacture and use of many wood products. Unfortunately, this basic principle is too often overlooked, as increasing emphasis is placed on more artificial methods of protection. Of course, many wood products require chemical help, because control of moisture is impossible under their conditions of use.

Recent Findings of Importance in Deterioration Problems

Any factor that changes the wood-moisture relationship obviously is important in the deterioration problem. Recent findings are that common molds that occur on pine lumber and round products during seasoning and storage are such a factor. Heretofore, these molds were regarded only as superificial discoloring agents. They are now known to penetrate deeply into the sapwood and greatly

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increase the permeability of sapwood to rainwater and to oil and aqueous preservative solutions. Thus, heavily molded wood has been found to absorb 4 to 6 times as much solution as uninfected wood during short-time soaking treatments.

What does this changed absorptiveness of the wood mean in relation to decay occurrence and its control? It means that molded wood exposed to the elements absorbs abnormally large amounts of rainwater. This build-up of water is accentuated by paint or other coatings that retard the drying out of the wetted wood. Furthermore, swelling and shrinking of the wood are increased, leading to opening of joints and loosening of fastenings so that additional entrance and collection points for water are provided. It is now known that this factor of invisible mold infection has been associated with some of the early decay in untreated siding, trim, porch flooring, window frames, and other exterior lumber in buildings. It also has been important in such products as boxes, posts, timbers, and various other wood items exposed to moisture during use.

Another aspect of the problem is that nonuniform changes in permeability of wood may seriously affect the efficiency of preservative treatments. Erratic penetration and absorption have been common in treating wood by both nonpressure and pressure methods. The usual assumption has been that wood of a given size and species that is seasoned for the same length of time will be similar in treatability. Actually, mold infection, which has been disregarded, varies within wide limits even in the same seasoning pile. Such nonuniform infection is now known to be responsible for some of the variable treatment that formerly was ascribed to natural differences in wood.

The findings on fungus infections in relation to permeability already have found application in the old problem of "sinker stock" encountered in treating ponderosa pine millwork with preservatives. Such stock has led to increased treating costs, through excessive absorption of the preservative, and to later discoloration and failure of paint on millwork in use. When used untreated, it is now apparent that such stock also contributed to early decay failures in exterior millwork, due to its ready pick-up of rainwater. Recent studies in several laboratories are disclosing that mold and other infections are often found in "sinker stock," and explain at least some of its high absorptiveness.

Some Deterioration Problems

Round Products and Large Timbers

Rapid enough reduction of moisture to prevent deterioration of large round products and timbers during seasoning or storage is difficult at best and often impossible. Seasoning or storing only as long as is necessary, utilizing the oldest material first, and cutting and storing in the fall or winter are basic principles of protection that should be followed as much as possible. When these are not sufficient, use of surface protective treatments or storage in water are additional safeguards.

Logs and bolts.--Submergence in water is the surest way of avoiding damage during prolonged storage. Two problems requiring further work are: (1) the maximum safe delays in getting the logs into the water during different seasons of cutting; (2) what chemical discolorations must be guarded against in submerging certain species (for instance, a storage pit in iron-bearing soil might cause trouble if woods containing tannic acid are present).

Other uses of water for storage are as water sprays or in wetting hay employed as a covering. Water sprays that keep logs thoroughly soaked should be effective, but most trials of sprays have not been thorough. Further work with the method is needed to determine the volume of water necessary and the best placement of sprays. The covering of bolts with wet hay prior to warm spring weather has been practiced with some success in the Northeast. This method might be improved by applying fungicidal sprays to the upper ends of the bolts before covering the bolts with the hay.

Antiseptic spray solutions applied to ends and barkless places are another possible control method for logs and bolts. These usually give protection for 2 to 3 months at least; for longer storage, an end coating to prevent seasoning checks is an added safeguard. If insects occur, the incorporation of an insecticide and entire log treatment are required. The success of such antiseptic treatments depends usually on immediate or early application of the solution after log or bolt cutting. For beech and possibly some other woods, their effectiveness is limited because the bark can be penetrated by fungi. Questions that still need answering are: (1) will early spring treatment benefit logs cut in winter? (2) what is the maximum permissible delay in applying the treatment to wood cut in different seasons?

Poles, piling, ties, large timbers.--In the dry and colder parts of the country, rapid peeling or sawing followed by open piling often are sufficient to keep deterioration low. If checking is serious, end coatings or the use of surface fungicidal treatments that permit somewhat closer piling can be helpful. In warm, humid regions, however, air-seasoning of large items often is not rapid enough to avoid deterioration. Surface fungicidal treatments help to reduce damage but often are not sufficiently effective to permit safe air-seasoning of poles, piles, and large timbers. A need exists for more efficient preseasoning treatments for large items in such regions as the South. Unfortunately, the prospects of success are limited by the shallow penetration of surface treatments and the checking into untreated and moist interior wood that almost invariably occurs.

Pulpwood.--Losses in stored pulpwood have been studied in several localities but more needs to be done, particularly in the North and West. Sinkage studies during driving in the Northeast indicate that rot present in bolts when cut increases sinkage and that top bolts in the tree tend to sink more than butt bolts. In the Deep South, losses during storage of peeled and rough pine have been determined for different lengths of time and seasons of storage. Several ways of reducing damage in both rough and peeled wood have been disclosed. Present studies indicate that losses in stored southern hardwood pulpwood are not much different from those in pine, and that the factors leading to low and high losses are fairly similar for both kinds of wood.

Lumber, Veneer, and Similar Products

For such items as lumber and veneer, much of the information required to control deterioration during seasoning, storage, and manufacture is already available. Therefore, better application of what is known rather than additional research is largely needed. For instance, there usually is little excuse for staining, molding, or decay of lumber prior to use. Measures are available for preventing losses, as proper air seasoning, kiln drying, or the use of cheap and effective antistain dips to supplement air drying when necessary. The proper storage of lumber demands only that dry lumber be stored under conditions that will keep it dry. Losses in these products often result from carelessness or from lack of effective dissemination of available information to those who should make use of it.

Wood in Use

A variety of deterioration problems are encountered in wood in use. A brief description will be given of only a few that are being investigated by the Division of Forest Pathology.

Decay in buildings.--One phase of this problem is the use of soil cover to reduce condensation and decay in crawl spaces of basementless houses. The value of such soil cover as 55-pound asphalt roofing has been demonstrated over a 10-year period in the more northerly parts of the country. Although cold floors following ventilation are less troublesome in the South, the tendency to close vents during the winter has made it advisable to test soil covers in the South also. The increasing number of products that are being exploited for soil cover purposes attests to the wide use that is now being made of this control method.

Another phase of the building studies concerns decay prevention in such exterior lumber as siding, porch floors, steps, and other exposed millwork. Although decay in these items is not frequent, costly replacements are necessary at times. The principal factors associated with decay are use of infected lumber, poor gutters or insufficient roof overhang, and use of nonbreathing papers directly under siding. Current studies are disclosing that on-the-job preservative treatments greatly justify their cost wherever there is a decay hazard and pressure impregnated lumber is not available. For wood that is painted, short-time soaks in pentachlorophenol or copper naphthenate solutions have given a surprising amount of protection. The performance of these treatments on wood left unpainted has been less satisfactory, but has been improved by incorporating water repellents in the treating solution. A long-recognized short-coming in protecting building items from decay has been the frequent unavailability of small quantities of pressure-treated material.

Protection of boxes and other containers.--Agricultural field boxes and certain military and other containers face a service life that often is shortened by wood-attacking fungi. Comparisons of a number of short-time soaking treatments for the protection of several kinds of containers are being conducted in several places. It is hoped that these tests will disclose cheap, effective, and safe treatments to take care of a need that so far has not been satisfied by pressure treatments.

Deterioration of cooling tower wood.--The problem of deterioration of wood in cooling towers has received increasing attention in recent years. Samples from towers showing varying degrees of deterioration usually disclose fungus infections of several kinds. However, the effects of long-continued exposure to water alone, and to water of varying chemical composition, also are involved, making it difficult to determine the primary agent of destruction. Trials are being made by several agencies of preservative-treated redwood, employing both pressure and double-diffusion processes. The full story on cause and prevention of deterioration will not be known until such tests are followed for years in different towers.

Decay in decks of aircraft carriers.--Critical amounts of moisture have built up in Douglas-fir decking of aircraft carriers in storage. Decay has been minor so far, but increased damage is expected if present moisture conditions continue. Work on the problem has involved moisture determinations, attempts to reduce moisture pick-up, and exploratory trials of fungicidal solutions applied to the wood in place.

Decay in wooden boats.--Surveys and inspections are being conducted to determine the parts of boats most vulnerable to decay and the adequacy of current attempts to avoid damage. These attempts involve use of naturally decay-resistant woods, preservative treatments, ventilation, and tight joint construction. Data already obtained should help to reduce future decay losses in new boats and in those under repair and in storage.

Basic Studies Relating to Deterioration Problems

Greater progress on some basic studies related to the deterioration problem would aid greatly in reducing losses and in improving the performance of both untreated and treated wood. A few of these are as follows:

Natural Decay Resistance of Woods

Along with control of moisture and impregnation with preservatives, the use of naturally decay-resistant heartwood has been a major method of avoiding deterioration. Although resistant woods are becoming increasingly scarce, there probably always will be a field for such material. There are several reasons why studies on natural decay resistance must continue. (1) There is no assurance yet that growing decay resistance in the tree may not be more efficient than imparting it artificially, particularly for such products as posts. (2) Even when preservative treatments are employed, there is the problem of thin-sapwood species, such as cedars, larches, and possibly Douglas-fir, which have impenetrable heartwoods. For such woods, satisfactory service of treated material requires that the heartwood be naturally resistant. This introduces the question whether present and future timber supplies of these species are as adequate in this respect as past supplies. (3) Present-day manufacturing methods often involve the use of high temperatures that should be studied from the standpoint of effect on natural decay resistance. (4) An increasing volume of foreign woods of reputed high decay resistance is being introduced. These woods require testing against important native fungi.

To facilitate work of the above type, we now have accelerated laboratory methods nearing standardization that can provide worthwhile data on decay resistance in a short time.

Improved Methods of Detecting Deterioration

There still is some dubious rejection and acceptance of discolored wood because of our inability to distinguish unimportant from important blemishes in all cases. For example, there are certain chemical and so-called mineral stains in woods that resemble fungus discolorations but have little effect on wood properties. New types of discolorations of this kind appear occasionally, particularly as species considered inferior before or as lower-grade logs of all species find increasing utilization. Studies directed at improved methods of diagnosis or detection require intensive effort that too often is difficult to provide in current work programs.

Fungus Associations in Relation to Deterioration

The attack of wood by fungi is affected by competition not only among decay, stain, and mold fungi but probably also from yeasts, bacteria, and other organisms. Certain of these associated organisms may predispose both treated and untreated wood to attack by decay fungi, while others may be antagonistic and therefore help to protect wood from them. Along similar lines, certain common molds are known to be exceptionally tolerant of specific preservative chemicals. When wood is treated with these chemicals, the tolerant molds develop luxuriantly, to the practical exclusion of other fungi. Such heavy molding has been found to increase the permeability of even Douglas-fir sapwood, which normally is very difficult to impregnate with solutions. Furthermore, it has seemed to contribute to the control of decay fungi, either because of an antibiotic or straight competitive effect. Greater knowledge of many such fungus associations in practice undoubtedly would reveal more efficient methods of combating present damage to wood.

Conclusions

Losses due to deterioration caused by fungi are still estimated to approximate $300,000,000 a year, excluding the cost of such protective measures as preservative treatments. A large part of this loss results from failure to follow relatively simple precautions, such as drying the wood properly and keeping it dry, or using preservative treated or naturally decay-resistant woods when excess moisture cannot be controlled. However, wood products undoubtedly will continue to be used in many ways in which some deterioration cannot be avoided; furthermore, there are a number of instances where we still lack preventive measures that are fully practicable. When consideration is also given to the increasing proportion of susceptible sapwood in our wood supplies, the need for intensified research on the causes and control of deterioration is obvious.