MUSHROOM AND TERMITE DAMAGE IN BUILDINGS

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(FUNGUS AND TERMITE DAMAGE IN BUILDINGS)

By CARL HARTLEY and WILLIS W. WAGENER
of the U. S. Bureau of Plant Industry

Editor's Note:—The paper on "Termite and Fungus Damage in Buildings," by Mellen C. Greeley, A.I.A., published in the March number of The Octagon, was submitted to the authors of the paper which follows. In turn, both articles were submitted to Mr. George M. Hunt, in charge of the Section of Wood Preservation, of the Forest Products Laboratory, Department of Agriculture, Madison, Wis. His observations will be found at the conclusion of this section.

The Institute takes this opportunity to thank Mellen C. Greeley, A.I.A., Dr. Hartley, Mr. Wagener, and Mr. Hunt for their valuable contributions to a subject which, apparently, is of great interest to the architectural profession in a large number of states. Requests for more than a thousand reprints of Mr. Greeley's article have been filled. In anticipation of like interest in the papers appearing in this number, reprints have been ordered which will be available on request, and without charge except in large quantities.

The writers have been given the opportunity to supplement the excellent article on the above subject by Mr. Greeley in the March number of The Octagon.

The rots, due to fungi, are emphasized in the present paper, not because of any failure to appreciate the importance of termites, but because the writers are engaged in the study of fungi. Only a termite expert would presume to add materially to Mr. Greeley's treatment of the termite phase of the subject.

The technical facts so far as they are known are better presented in bulletins already existing than they can be here. Well-illustrated publications are available on building rots in general,¹ on decay in mill


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construction, and on termite injury. The termite shields mentioned by Mr. Greeley are described in detail in publications by Dr. Snyder of the U. S. Bureau of Entomology. The best contribution that can be made here will be to present a general picture of the situation with respect to the organic enemies of wood in construction, and discuss briefly some of the fundamental factors affecting the fungi.

The ordinary mold fungi, although some of them grow luxuriantly in sapwood and discolor it, so far as we now know have little or no effect on the cell walls of wood and need not be considered here. On the other hand, the wood destroying fungi, of which there are some dozens of fairly common species, grow not only in sapwood but also to a considerable extent in heartwood of all but the most extremely durable species. They corrode the cell walls or dissolve some of their essential constituents thus affecting the mechanical properties of the wood. Wood that has been recently infected may still be normal in all the easily determined characteristics, such as color and density, and may be scarcely reduced in resistance to compression parallel to the grain, but in certain other qualities may be measurably injured. Infected wood may become brash and lose most of its resistance to impact bending before it shows any signs of infection that superficial examination would detect. The decay fungi in their early development rarely produce fruiting bodies and cause no such mechanical signs of their presence as do the wood-tunneling insects, with the result that incipient decay often goes unrecognized.

As Mr. Greeley has indicated, the moisture content of wood is the most important of the easily controlled factors that govern decay liability. No decay is believed to take place in wood that does not have at least 20 percent of moisture (oven dry weight basis). Many fungi can persist in air-dry wood in a dormant state for months or years ready to start growth when supplied with moisture, but it is probable that for most of the fungi from 21 to 25 percent is a minimum for actual growth. It is only at high humidities or low temperatures that wood in equilibrium with air will contain more than 20 percent of moisture. If wood is thoroughly air-seasoned to start with and protected from water or excessive humidity, it is permanently safe from attack by most fungi. The only exception to this occurs in the so-called dry rots. This term is technically limited to the work of two notorious fungi, Merulius lachrymans and Poria incrassata, which can bring water with them from some source of moisture. This water-conducting ability makes them the most dangerous of the structural fungi. Strictly speaking there is no such thing as a dry rot in wood. On the contrary when the causal fungi are at the height of their activity, such decays are very moist and it is only after fungus action has nearly ceased and the contained moisture has had a chance to evaporate that the decay assumes the dry, rectangularly checked form from which its common name is derived.

Hoxie, P. J. (Inspection Department, Associated Factory Mutual Fire Insurance Companies.) Decay of Wood in Industrial Buildings, 1930.
Whereas most fungi can attack only wood that has retained its moisture after it has been put into the building green or has absorbed water from leaks, stagnant damp air, moist soil, or cold surfaces on which it has condensed, the water-conducting fungi, starting at a source of moisture, can extend rapidly into comparatively dry wood. Dry rot has been known to reach the third floor of a building in regular occupancy. The moisture that appears in wood infected by these two fungi may be in part absorbed from the air as Mr. Greeley suggests, but is probably supplied in the main by transportation through the strands of fungus threads extending from the water supply at the point of origin or from wood in which they are already working actively. Water is formed in the decay process through the oxidation of the wood substance by the fungus, and there is evidence to indicate that once these fungi are actively established in a closed situation where the evaporation loss will not be great, conduction of water from the original source may be cut off and the fungi will still be capable of progressing for a time by means of the metabolic water resulting from the breaking down of the wood. This is one reason for the recommendation that in treating an active case of dry rot in a building all wood to well beyond the limits of the decay should be removed. However, a source of moisture must be available before these fungi can get an active start in the first place. Because of their water-conducting ability, it is necessary for the safety of the entire wooden structure that no part of it be in direct contact with the soil or with moist concrete unless it is heartwood of a highly durable timber species or has had pressure treatment with an efficient wood preservative.

The increase in the menace from fungi and termites mentioned by Mr. Greeley is traceable to a number of different causes, some of them connected with changes which have taken place in the character, distribution, and use of our lumber supply. For example, with the passing of the virgin forests over large parts of the country an increasing proportion of the lumber used is sapwood. It is well known that even in timber species with extremely durable heartwood the sapwood is not strongly resistant to either termites or decay and it is therefore not surprising that the greater use of sapwood should be accompanied by some increase in damage.

Changes in architectural styles have tended to provide another source of increased hazard, particularly from decay. Whatever the architectural or other shortcomings of the nineteenth century American wooden house, in most parts of the country it was built well off the ground and was provided with plenty of underneath ventilation. The trend in recent years toward Old World exterior design based on types built directly on the ground with stone, tile, or earthen floors has resulted in a general lowering of first floor levels so as to bring them as close to grade as possible. With this has come the substitution, for the piers that formerly served as foundations in the Southern States, of solid foundation walls which interfere with ventilation under the lower floor.

Coupled with the later trends in house design has been the extensive use of stucco and waterproofed building papers in sections of the country where wooden exteriors were formerly the rule. If building paper was used at all in the older construction it was likely to be of the familiar gray felt, nonwaterproof type, employed solely to reduce air leakage. Perhaps because the newer type of construction allows less ventilation of the wooden members
of the wall, there seems to have been more trouble in stucco houses than
where siding is used. Moreover the use of large or conspicuous ventilators
at the ground floor level is not in harmony with good stucco design from the
standpoint of appearance and in consequence the tendency is to cut such ven-
tilators to a minimum or to place them where they will be inconspicuous with
their ventilating efficiency left as a secondary consideration. The effect-

Even within the house chances for evaporation of excess moisture are
being reduced through the wide adoption of cemented linoleums and similar
waterproof floor coverings. Cases are known in which buildings have been
used for years without any trouble from decay as long as the floors were not
covered, but in which rot developed rapidly as soon as cemented linoleums
were laid. This is an argument not against linoleum, but for attention to
subsurface moisture conditions when linoleum is to be used.

The reduction in opportunity for evaporation from walls and floors has
assumed an added significance in those sections of the country where the use
of unseasoned or partly seasoned lumber for framing, subfloors, and sheathing
has become common practice. Under this development, green lumber can be laid
down on the job cheaper than the seasoned product. There is also a tendency
to leave dry lumber exposed to rain after delivery, or to use subflooring
for concrete forms before it goes into the building, practices which probably result in considerable moisture pick-up in some cases. In using wood
that it not air-dry, the builder is gambling that sufficient drying will
occur during handling and in the course of erection to render it safe from
decay. The fact that he does not always win adds just another source for the
increase in decay liability.

Not the least of the losses from the organic enemies of wood are
traceable to the increase in speculative building. Too often the builder is
more interested in cost cutting than in the permanence of his structures and
oversteps sound building practice in the attempt to get a few more dollars of
profit. It is the hidden details which offer the best chance for slighting
and short cuts and it is these same hidden spots which are most likely to be
the site of fungus attack.

Looking at the matter from another angle we can say that the diffi-
culties are chargeable in some degree to a lack of knowledge on the part of
architects, builders, and the general public of the chance of injury to wood
and to other building materials of organic composition from the activity of
fungi and insects. It might improve the situation if the courses in biology
at colleges that feature architecture or engineering were to include wood-
tunneling insects and wood-rotting fungi among the organisms used as illus-
trative material. No animals could be more interesting than the termites
with their social organization and complex symbiotic relationships. These
practically important organisms might prove quite as valuable for general
educative purposes as lichens, diatoms, or starfish. In default of such as-
sistance from biology, the architect's professional training might conceiva-
ble include a little special instruction as to how wood is decayed and how
termites and powder-post beetles live and work.
A good builder is rarely guilty of putting in direct contact with soil untreated wood of any but the most extremely durable species, but many are content to leave it separated from soil only by a layer of stucco, or actually to imbed floor stringers in concrete that is in contact with soil.

An altogether inexcusable fault is the leaving of piles of wood trash under the building in contact with the joists, and wooden concrete forms still in place where they can serve as a convenient route through which fungi and termites can get up from the soil into the building. No wood trash should be left under the building.

Incipient decay present in the lumber when it is delivered on the job and originating in the logs or from improper seasoning or yard storage conditions of the lumber has undoubtedly played a part in subsequent fungus development in erected buildings. Although there has been a decided betterment in lumber yard storage practice during recent years, some room for improvement still remains. Studies are now under way in cooperation with the American Pitch Pine Export Company on the surface treatment of logs and freshly sawed lumber to prevent sap stain, and as an important byproduct of the studies it is expected that the treatment will also reduce the chances for the establishment of incipient decay infections during the period of seasoning and storage. Not all traces of early stages of decay which may be found in lumber are necessarily dangerous. The true "sound red heart" of pine and other softwoods is an example. This is due to the incipient attack of a specific fungus, Trametes pini, that works in the living tree, but does not ordinarily continue to develop after the lumber has been properly seasoned. Such lumber, while reduced somewhat in strength, is perfectly suitable for certain purposes. The ordinary sap stain, due to fungi very different from those that cause decay, is believed to have little if any weakening effect. The failure to differentiate between different kinds of fungus defects has sometimes caused the needless rejection of lumber; but lumber suspected of fungus infection should be accepted only after inspection by someone familiar with the different types.

Treated lumber suitable for small house construction is not yet obtainable in all parts of the country. The National Committee on Wood Utilization, The American Wood-Preservers' Association, and cooperating agencies are making an effort to improve this situation by prevailing on distributors to stock lumber treated with standard preservatives, and have already met with some success in Ohio.

On most of these points the remedy is obvious and the chief need is a campaign of education. There are, however, a number of respects in which present knowledge is not an adequate basis for setting up positive recommendations. Decay has been little studied from the standpoint of the small house or building and there is a danger that we may go too far in setting up safeguards and thus jeopardize their chances for being put into general practice. Prevention practices must be both inexpensive and simple. On a number of points the basic facts are not yet sufficiently determined to permit recommendations that meet this requirement.

As examples of subjects on which further information is needed the following may be mentioned:
(1) What indications of fungus infection are proper causes for rejection of lumber?

(2) Minimum requirements for safe ventilation of basements and under houses in different types of situations. A ventilation ratio which proves to be entirely satisfactory for one region or set of conditions may be very inadequate in others and no authoritative data exist on which to set down rules.

(3) The effect of chemical disinfection of underlying soil or concrete on the incidence of decay in wood above. It is entirely probable that trouble with floors laid on concrete can be easily and cheaply prevented by a proper antiseptic in the concrete.

(4) The relations between the soil-nesting termites and decay fungi. There sometimes appears to be a connection between the activities of the two.

(5) Better information on the origin of decay infections. There is still some question as to how the majority of infections are brought about, whether by wind-borne spores of the fungus, by vegetative spread in wood or soil, by direct contact of sound with infected wood, or by other means.

(6) Determination of representative moisture contents actually present in the wood of different parts of a building and closer definition of the maximum safe moisture content of wood from the decay standpoint. Preliminary studies of this sort are now under way by the Forest Service and Bureau of Plant Industry.

(7) There is still some question as to what preservatives can be used safely and effectively in dwellings, and an effective technic is needed for protecting ends of treated timbers that are cut on the job so that untreated cores are exposed.

(8) Further experimental study on the control of decay infections by heat or by the in-place application of toxic substances. Dry heat has been used successfully against Merulius lachrymans infections, while steam has been employed with striking results in killing infections in the roofs of oil storage tanks.

The elimination of infections that have already gained a foothold in buildings is also in need of attention. There are too many cases on record of householders and even professional builders who have made repeated attempts to exterminate either termites or the dry-rot fungi, only to have the attack promptly renewed and extended and the whole process in need of repetition. As an extreme example, a hardwood floor replaced after attack by a dry-rot fungus in a new brick school building in Texas was ruined in six months. The residence mentioned in Mr. Greeley's first paragraph is a particularly interesting case. There is need of field follow-up studies to determine the cause of these failures. Our present knowledge leads us to believe that any infection can be definitely stopped at the first attempt if the right methods are followed. The principles are known, but the details evidently require further attention.
We know that the cases of trouble that are reported are usually from buildings where certain precautions have been neglected; but we know also that there are great numbers of houses in which some of those same precautions have been ignored, and which nevertheless have given decades of creditable service without any termite or fungus injury. The cases of acute injury from dry-rot fungi are particularly difficult to trace to specific malpractices, since the hazard from these fungi is somewhat like fire hazard; there are many houses whose construction would seem to lay them open to such attack, but the damage is concentrated in a few. What is needed is a survey, in which both termite and fungus investigators take part, in consultation with architects, engineers, and builders, and supported by supplementary laboratory studies. These should be extensive enough to enable us to say for each of the several important regions of the country what malpractices are really dangerous enough to deserve stress. For a successful campaign of education, or for improvement of municipal building codes, we must know what precautions are unnecessary and can be omitted, as well as what to emphasize. Building rots are not now being studied anywhere in the United States. The termite problem is being investigated comprehensively only as it affects California, on funds from California sources; termite study on a comparable scale is badly needed in other parts of the country.

The writers wish to join Mr. Greeley in avoiding the appearance of pessimism. Wood is the natural building material for many purposes, and particularly in small dwellings and farm structures, generally it is expected to remain so. In millions of buildings in the United States it has given thoroughly good service for long periods of time. The cases of real trouble, while numerous enough in the aggregate to require attention, are relatively infrequent when the whole number of structures is considered. There is every evidence that wooden construction can be made safe without any undue expense or sacrifice of aesthetic values. Investigation in the direction of simplifying safeguards, and followed by an educational campaign, should reduce the insect and fungus hazard to negligible proportions.

Comments on Preceding Papers

By George M. Hunt
Forest Products Laboratory

After having read Mr. Greeley's article which you enclosed and the manuscript of the article by Dr. Hartley and Mr. Wagener, it seems to me that there is very little I could add to the discussion of decay and termite damage and their prevention that would be of interest to your readers. Mr. Greeley points out the necessity for sanitation, care in selection and construction, and the provision of safeguards that are necessary for the protection of buildings in termite infested territory. If his recommendations, which are substantially those of the U. S. Bureau of Entomology, are followed with care, I think there is little likelihood of serious damage by termites.

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Similarly, Dr. Hartley and Mr. Wagener show how decay may be avoided. Fortunately the methods that are effective against one are for the most part effective against the other.

Suitable preservative treatment will undoubtedly protect wood in buildings from termite destruction and decay, but throughout most of the United States it is at the present time not very practicable for a man to secure properly treated wood in the sizes and small quantities needed for residence construction. It is a simple matter for large consumers like railroads, other public utilities, and the like that use large quantities to secure treated timber especially suited to their needs, either from their own treating plants or from commercial treating plants. It is not easy, however, for the small consumer to secure the kind and quantity of treated material he needs for there is as yet, except in very few cases, no provision for the retail distribution of well treated lumber. In a few cities in Ohio the National Committee on Wood Utilization with the cooperation of wood preserving companies and lumber dealers has made treated lumber available in retail lumber yards. I believe treated lumber can also be obtained at a few retail yards in St. Louis, in southern California, and Florida, and perhaps a few other places, but thus far this opportunity is very limited. Until adequately treated lumber becomes more generally available to the house-builder he cannot make much use of it.

Lumber can, of course, be dipped or brushed with preservative by the contractor as the building is constructed, but treatments of this kind are very superficial in character and cannot be counted upon for much protection even when conscientiously made. In some cases, no doubt, the treatments would not even be conscientiously made. For these reasons, therefore, it seems to me that the principal hope for both termite and decay prevention in small buildings at the present time lies in observing the precautions discussed by Dr. Hartley and Mr. Greeley rather than in relying upon preservative treatment.