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Wood Minesweepers Are Sound After 15 Years of Service

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Abstract

Inspection revealed that after approximately 15 years of service, eight wood minesweepers were in generally sound condition, and could be expected to remain serviceable for a number of years. No typical fungus rot of major significance was found. Some surface joint separations and checking in the laminated frames (usually white oak. *Quercus* sp.) at the turn of the bilges in the engine rooms and some chemical breakdown of wood near frame and keelson bolts wetted by bilge water were observed, but these were not considered serious.

ALTHOUGH MOST OF THE SHIPS of the U.S. Navy are of steel hull construction, the service requirements of some vessels necessitate fabrication from wood. This applies particularly to minesweepers, the Navy's largest wood ships (MSO class, approximately 192 ft. long, Fig. 1), for which wood is used because the ship must be of a nonmagnetic nature to combat magnetic mines.

In the current MSO minesweeper force, laminated wood (generally untreated white oak (*Quercus* sp.) bonded with phenol-resorcinol resin) has been substituted for solid wood in the large structural members. This is the first major use of laminated wood in the large structural components of a ship. During World War II, however, an appreciable amount of laminated wood for smaller craft such as LCVP and PT boats was used. Laminated members should be much safer than solid timbers because they are dry and free from infection when installed. However, there is little documentation of service records on the durability of laminated wood in ships.

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Recently, the Navy asked for an appraisal of the general soundness of the major structural components of the MSO minesweepers. all of which had been in service about 15 years. The information was needed to estimate the additional serviceability and the maintenance requirements that could reasonably be expected. This report describes the condition of wood in representative minesweepers and is based on a survey made in cooperation with Naval Ships Systems Command (NSSC).

Inspection Procedure

Eight ships were examined that were representative of a range of builders, operating conditions, and maintenance history of the MSO minesweeper force. All accessible spaces in the ships were inspected. Types of deterioration particularly looked for were decay; "metal sickness" (chemical deterioration from electrolytic action) around fasteners; cracks, or checks in the wood; separation of glue joints; and loosening or slipping of mechanical joints. Of foremost concern was the inspection of these types of deterioration on the primary structural members. Also of concern was the deterioration of less stressed parts that might require repair and remedial measures, (topside structures, usually Douglas-fir).

By extracting plugs at representative places where deterioration might occur, the wood could be examined on the interior as well as on the surface. The plugs, generally 3/8 inch in diameter, were extracted by a commercial plug cutter. This provided a sample large enough for immediate examination of the wood as well as for more complete examination later in the laboratory. Most of the internal inspections were made in the engine rooms where shallow "metal sickness" was common around frame and keelson bolts. Since this area of the ship is probably the most highly stressed, it seemed appropriate to give it special attention.

Results of Inspection

Decay

In general, the typical biological form of decay caused by fungi was negligible despite poor ventilation in spaces such .as the forepeak and transom areas. No significant decay was found in the laminated structural members. Where the most severe cases of decay did occur, they were localized in the platform under the chillroom in two ships, and were promoted by condensation from damp air onto the cold surfaces. Proper ventilation could probably have prevented the condensation. Insofar as could be determined, there were no occurrences of typical decay supported by salt water wetting. This agrees with general experience that wood members near or below the bilge water level are rarely decayed in ships continuously in seawater. That the amount of decay observed was small can probably be credited to good protection of the sweepers against rain seepage through weather decks onto deck beams, frame heads, and other items below the waterways. Rain wetting is generally recognized as the chief cause of decay in wood vessels.

Chemical Deterioration of Wood Around Bolts Wetted by Salt Water

Considerable shallow deterioration was found around bolts wetted by bilge water; this was noted particularly

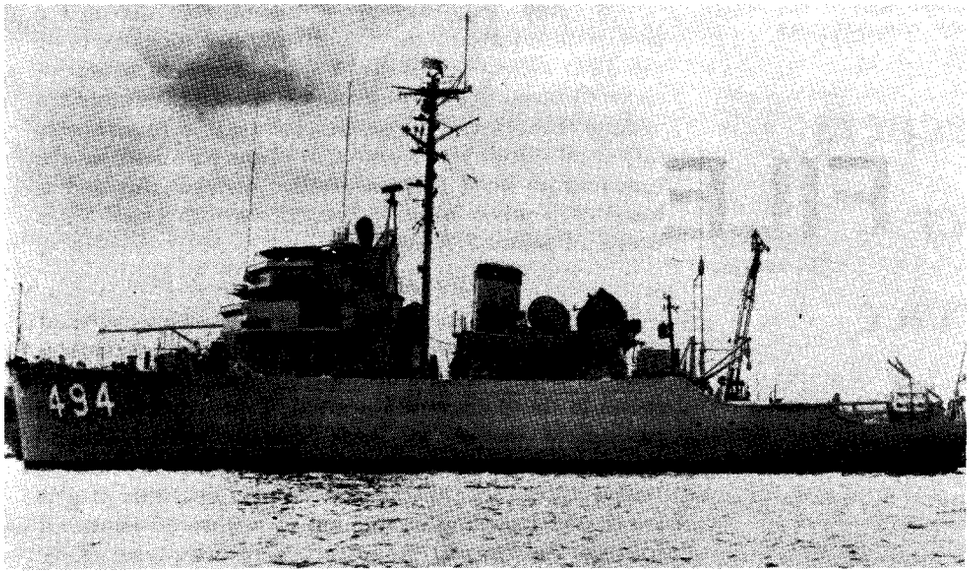

Figure 1. - An MSO wood minesweeper of the U.S. Navy similar to the vessels examined in a recent inspection.

around through-bolts in the keelson and frames in the engine rooms (Fig. 2).

The deterioration was diagnosed as being chemically caused. Microscopical examination eliminated the possibility that organisms might have been involved. The affected wood was discolored, shades of gray ranging in intensity to almost black in the more severe cases. Wood with the greatest damage was so disorganized structurally that when gently scraped or rubbed it separated into fibers and short particles of broken fibers. The condition was suspected to be "iron sickness"; instead of iron, however, copper from the bronze bolts was the metal involved. Analysis of typically discolored wood invariably revealed the presence of copper. Evidence of copper diffusion from large bolts into adjacent wood was further indicated by resistance of the wood to fungus infection when assayed. (If there is enough copper, the copper ion is toxic to most fungi.)

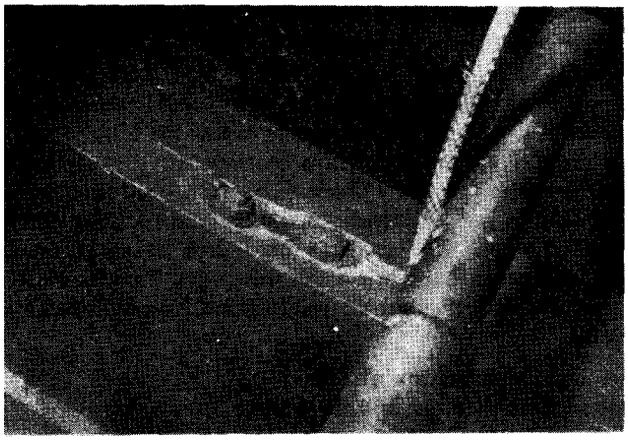

Figure 2.- Shallow nonbiological deterioration ("metal sickness") around bolts in frames in engine room of minesweeper.

When wood is deteriorated by iron, and presumably the action is the same by copper, the degradative action of the metal on wood is caused by an acid and alkaline condition coupled with catalyzed oxidation of the wood that results from electrolytic action of dissimilar metals.[1] In the minesweepers, this type of wood deterioration generally did not extend much below the hole made for the bolt washers. Thus, this form of damage presumably has had little influence on the overall strength of the ships and probably will not be harmful for many years. In new construction, however, some consideration might be given to prevent this form of damage.

Checking and Glue-Joint Separation In Laminated Frames

Some glue-joint separation and some checking in the wood were observed on a number of frames in almost all of the ships inspected. These were examined in detail to determine the magnitude and the cause of the separations as well as to estimate the possible chances for further separations.

By far the most frequent occurrence of checking and joint separation was in the engine rooms at the area of the turn of the bilges. Radial tension might be suspect as the cause, but NSSC personnel indicated that the bending imposed on the frames tends to decrease the curvature and results in radial compression. After considering several factors that could have caused the separations, it was concluded that shrinkage stresses were the most logical major cause. The frames at the turn of the bilges are subjected to wetting and drying when the ship is rolling and bilge water is present. This essentially constitutes a cyclic soaking-drying exposure since the temperature in the engine room is often well above 100°F. when the engines are running, and results in high drying stresses between periods of wetting. These stresses are known to be conducive to checking and joint separation. Fore and aft of the engine

[1]Marian, J. E., and A. Wissing. The chemical and mechanical deterioration of wood in contact with iron, Part II. Chemical decomposition. Svensk Papperstidn. 63: 98-106. 1960.

rooms, it is not likely that the frames are ever exposed to significant elevated temperatures; hence rapid drying and high shrinkage stresses are not likely to occur.

The stresses created by changing moisture conditions have already been largely relieved by the resulting separations; therefore the separations are not expected to progress appreciably. There was evidence that the separations and the checking had been present for many years. Further, based on the experience of the Forest Products Laboratory, it is believed that the separations have not significantly impaired the strength of the members.

Miscellaneous Observations

Topside structures appeared in good condition except for typical localized minor damage at scattered places. This type of damage was of little importance and did not relate to the overall structural integrity of the ships. No indications were observed of slipping at faying surfaces between planking and heavier members such as frames or deck beams, *etc.*, that would indicate loosening at major joints. Similarly, no splitting or cracking of items was observed that could be attributed to racking stresses.

A few localized cases of strictly salt damage were observed. This type of damage occurs in wood subjected to intermittent wetting by salt water during which the concentration of salt builds up in the the wood. The accumulated salt within the wood cell walls physically forces the wood fibers apart and creates a shredded or fibrous appearance.

The keels outside the hull of three ships in dry dock were examined. With the exception of a small area of severe marine borer damage on one keel, other damage of this type was only shallow and sporadic.

Summary and Conclusions

After approximately 15 years of service, eight minesweepers were critically inspected for the condition of their wood components. The inspection revealed that with comparatively small differences, all of these ships were in generally sound condition. Fungus decay was negligible. Some surface joint separations and checking in the laminated frames at the turn of the bilges in the engine rooms were found as was some chemical breakdown of wood near frame and keelson bolts that were wetted by bilge water, but these conditions were not considered serious. Thus, it was concluded that the minesweepers could be serviceable for a number of years and would not require excessive maintenance because of wood or joint deterioration.