"Treating" Treated Wood—Decks

Terry L. Amburgey and Kevin W. Ragon

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Abstract

The majority of the residential and non-residential decks in the US are fabricated using wood that has been pressure-treated with a water-borne preservative system. These preservatives will provide literally decades of protection from decay fungi and insects such as termites. However, it must be remembered that only the sapwood in "treated" materials is treated with preservative. Since any untreated heartwood that is present will be exposed as "treated" materials are cut to size, all cut surfaces should be treated by brush, spray or dip application on site with one of the preservative formulations that can be found at building supply stores. "Treated" cut ends of structural support members should be oriented away from the soil and protected from direct rain wetting by covering them with deck boards or capping them.

Although they are protected from biological deterioration, the walking surfaces of approximately 1/3 of all decks are replaced for aesthetic reasons after a few years of service. While the preservatives used to treat deck boards protect them from biological deterioration, they provide little protection from water absorption. Changes in moisture content of decking may result in checking, splitting, warping, cupping, or corrosion of fasteners. The "washboard" feel of some decks is caused by applying the boards "bark side down". That is, applying the boards with the growth rings of the wood "cupping" toward the walking surface. We recommend that decking boards be installed "bark side up" to avoid splinters formed during "cupping". All of these aesthetic defects can be minimized or eliminated by "treating" the exposed surfaces of treated decking with periodic topical applications (e.g. brush or spray) of a preservative formulation containing a water repellent, also available at building supply stores. We recommend that these topical "treatments" be applied as soon as the deck is finished, after the first year, and thereafter at 3 or 5 year intervals.

This publication is intended demonstrate to both those considering constructing new treated wooden decks, and those contemplating how to maintain them, the proper uses of treated wood to assure maximum service life through proper construction and maintenance techniques. Published averages from a survey of 205 deck builders and 213 home builders across the United States suggest that one third of the decks currently being constructed are replacements for failing (primarily aesthetically displeasing) decks (5). As discussed at the 2007 American Wood Protection Association (AWPA) annual meeting, some replacement decks are failing due to inadequate structural supports, but not mentioned was that more often decks are replaced because of aesthetic deterioration and/or corrosion of fasteners caused primarily by relatively large changes in wood moisture content that cause wood to swell, warp, cup, twist, check, and split. The objective of this paper is to focus on moisture, its role in the slow deterioration of treated decking, and methods of preventing or minimizing moisture-related aesthetic deterioration of decks. Decks fabricated with untreated, naturally-durable wood, as may occur primarily in the western U.S., or composite/synthetic/extruded decking materials will be discussed only briefly. It should be remembered that, even when using alternative materials to treated wood for the walking surface, the framing still should be treated wood.

Dimensional stability of wood is affected by moisture, and cycles of wetting (e.g., rain) followed by drying (e.g., combinations of wind, sun, and changes in temperature….collectively referred to as weathering) that eventually will lead to the aesthetic defects listed above. Weathering affects wood materials differently depending on species and size (12). These tend to be greater, and develop faster, in wider decking boards, so nominal six-inch wide decking usually is specified. While dimensional stability is, in general, not a problem with the composite/synthetic/extruded decking materials, many of these materials require that the framing members placed under them be closer together than with wood decking to minimize sagging and a "bouncy" feel. In addition, these materials tend to absorb heat from sunlight and may become very hot during the summer months.

Most decking boards are installed without regard to the grain orientation, and this often results in weathering-related defects such as splinters from cupping or raised grain. In new decks, we suggest orienting the decking boards "bark side up" (Figure 1). That is, the growth rings form arcs from the bottoms to the tops of the boards when viewed from the ends. It is common to see cupping and checking in boards installed "bark side down" that allow water to pool on the surfaces and, eventually, cause splinters to form and the surface to assume a "washboard" feel. In boards installed "bark side down", the growth rings cup towards the upper surface when viewed from the ends (Figure 2).

Figure 1. A cross section of an older decking board showing the grain orientation bark side up, Bark side up orientation will help reduce weathering-related defects.

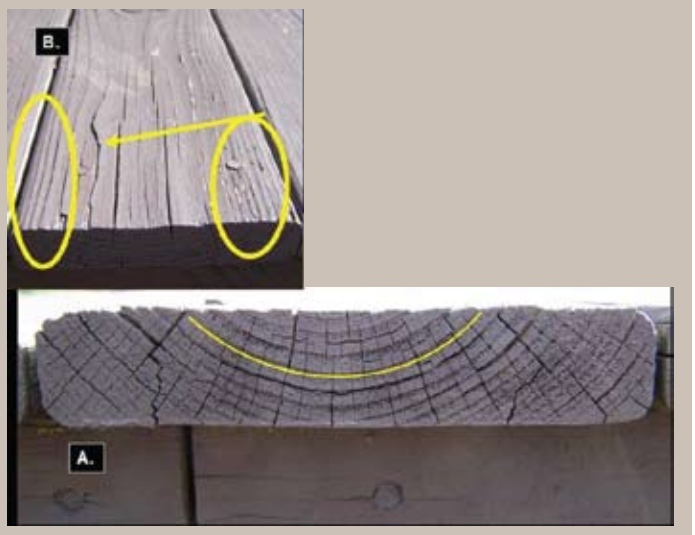

Figure 2. (A.) is a cross section of a painted decking board that has been installed with the grain orientation bark side down. (B shows moderate raised grain (circled) and loosened grain (arrow). In unpainted wood these problems can lead to checking, splinters in bare feet, or tripping on the walking surface.

The types of fasteners used in deck construction are very important for maintaining the long-term durability of decks because wood of most species used in deck construction is acidic, and treated wood may contain chemicals that are corrosive to some metals. Since the preservative formulations used to treat decking are water-borne, wood treated with nearly all of them has little water repellency and can absorb water from rains, especially at the ends and at holes created by fasteners. Since moisture accelerates corrosion, water accumulating adjacent to fasteners assures that those fabricated from metals incompatible with the preservative system used will occur (Figure 3).

The International Building Code R319.3 (IBC, Chapter 3 BUILDING PLANNING, SECTION R319, PROTECTION AGAINST DECAY, R3 19.1 Location Required), has set a minimal standard for treated metal fasteners and reads as below (11):

*R319.3 Fasteners.

Fasteners for pressure preservative and fire-retardant-treated wood shall be of hot-dipped, zinc-coated, galvanized steel, stainless steel, silicon bronze or copper. The coating weights for zinc-coated fasteners shall be in accordance with ASTM A-153.

Exceptions:

1. One-half-inch diameter or larger steel bolts.
2. Fasteners other than nails and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B-695 (1), Class 55, minimum.

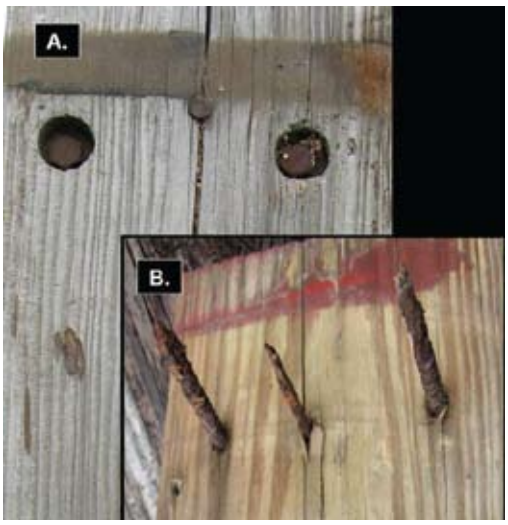

Figure 3. (A.) shows a top view of 3 ½ inch treated lag screws and a nail inside the decking, (B.) is the bottom view of the same board withdrawn from its support on a 28 year old deck. In (B.) the corrosion of the lag screws (no threads) and nail have allowed the decking to move freely on its supports which was common to the majority of the boards on the deck. Notice the splitting near the end grain where moisture is absorbed by wood and where fasters are used for connection to the deck framing.

Generally, coated or dipped fasteners and connectors should conform to ASTM A153 which specifies a minimum coverage of 0.85 oz/ft2 of zinc and for areas in high corrosion zones a thicker coating (> 1.0 oz/ft2) is available from some manufactures (12). Most decking materials are treated with a formulation containing a form of copper such as CCA, ACQ, or ACZA and galvanized connectors and fasteners are recommended if not using stainless steel. The Southern Pine Council at southernpine.com states that when fasteners and connectors are used together they should be of the same composition to avoid galvanic corrosion. Typically, fasteners are not specified for either untreated, naturally-durable wood species or wood treated with specific preservative formulations. The US Forest Service recommends that hot-dipped galvanized steel fasteners be used with at least 0.85 oz/ft2 of zinc treatment (the same is recommended for connectors) (12). Most manufacturers of wood preservative formulations recommend the types of fasteners to use with wood treated with their system (e.g., coated or stainless-steel nails or screws). For information on treatment type and fastener choice for treated southern pine decking, go to southernpine.com, and click on Pressure Treated followed by Fasteners and Connectors. We suggest stainless steel lag screws or spiral shanked stainless steel nails for decking used in the southeast. In the eastern portion of the US (Figure 4), especially the southeast, rainfall can be acidic in nature, ranging from pH 4.3-4.7 (4). This, along with the specific wood treatment chemistry, is another reason why it is important to choose fasteners that are fabricated from materials that will resist corrosion.

Generally speaking, deck maintenance is a "reactionary" practice, meaning that maintenance is only done after damage is noticed. Wooden decks have a life expectancy of 20 years according to Citi Bank and the National Home Builders Association (NHBA). If decks were built and maintained properly, their life expectancy should be double or triple this figure. It was estimated that 4.4 billion board feet of treated lumber are used annually to build replacement decks and, overall, pressure treated wood dominated materials in the construction of decks (5, 10).

So, how can we "treat" treated wood decks, both during construction and maintenance activities?

1. Treated wood columns (posts) used as either structural supports for deck surfaces or railings, if cut to expose new wood, should be installed with the original end oriented toward the soil and the freshly-cut end oriented upward. The upper end should be treated by brush or spray application with a water-repellent wood preservative (WRP) * (available from building supply stores) and covered with a cap or railing board to avoid direct exposure to the weather (Figure 5) (9). This is because only the sapwood of most wood species is treatable, so if there is any heartwood in the column, and it is not re-treated with a WRP and protected from weathering, the untreated heartwood will decay and the piece need to be replaced (Figure 6). Also, avoid

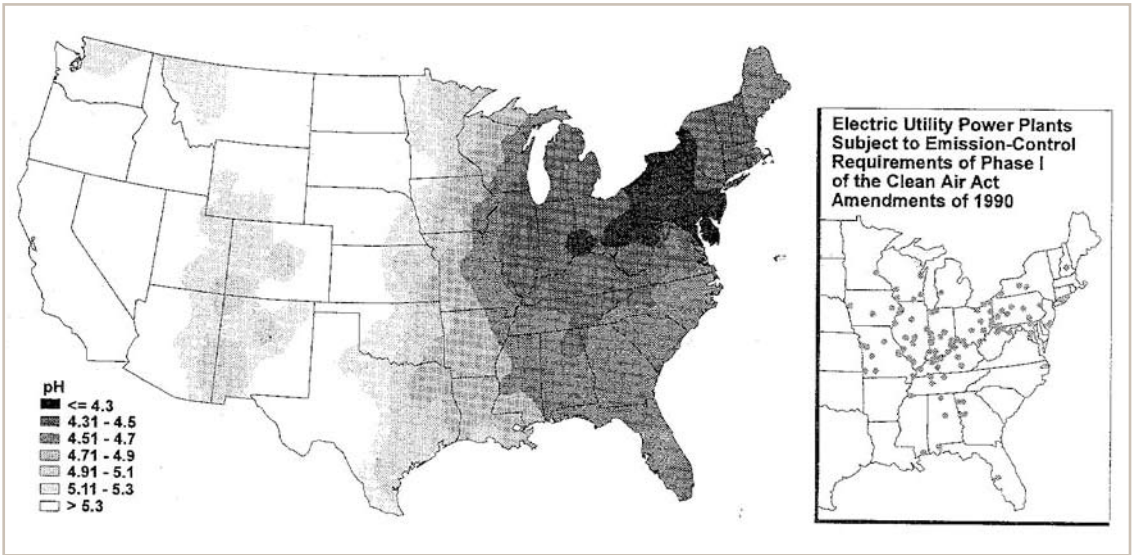

Figure 4. Average pH of rain (1991), showing regions where water impacting decks would be most likely to contribute to fastener corrosion. http://www.eia.doe.gov/cneaf/pubs_html/rea/feature1.html (accessed in 2008)

Figure 5. A cap (circle) or railing board (arrow) should cover exposed end-grain of wood, after treatment with a water-repellent preservative, to deter moisture from pooling on the end-grain of the wood.

Figure 6. End grain of a CCA-treated southern pine support column from a deck exposed in AWPA Decay Hazard Zone 4 for 26 years that had been cut to size and not protected by either a supplemental brush-on preservative treatment or a cap to cover the freshly-cut surface. The outer treated sapwood remains intact, but the inner non-treated heartwood has decayed, necessitating replacement of the column.

placing the lower ends of columns directly into the soil and, as is frequently done, pouring cement around them. This practice traps water at the column bottoms and may lead to depletion of preservative and failure. Rather, either place them on raised concrete footings or pour concrete into holes where columns are to be placed, fill them to within a few inches (e.g., 12 inches or less) of the surface with concrete, allow the concrete to solidify, place the columns on top of the concrete, and fill the area around the columns with washed gravel. Ideally, the bottoms of the columns should be placed into a bucket of WRP for a minute or two before being put into place or treated with a ground-line preservative such as is used with utility poles (Figure 7). When ordering treated wood for use as columns, specify that materials are to be treated to ground contact retentions (tags on the material should indicate that it is treated for use in ground contact) (Use Categories UC4B or UC4C as specified in the AWPA Book of Standards) (2).

2. Decking components should be joined with fasteners compatible with the preservative system that was used to treat them, as discussed above.

3. Place decking boards with the "bark side up" (as discussed above) to avoid a "washboard" feel to the upper surface and to avoid splinters (Figures 1 and 2).

4. Space the decking boards approximately 1/8-inch apart unless the decking was kiln-dried following preservative treatment (stamped KDAT), in which case wider (e.g., ¼ inch spacing) would be preferred before fastening into place. This will prevent buckling of boards as they shrink and swell with changes in moisture content.

5. "Treat" the upper surfaces and ends of decking by brush or spray application of a WRP as soon as possible after construction is completed. This will minimize changes in moisture content and thereby decrease checking and splitting (9). These formulations will not prevent decking from turning gray, because surface "graying" is a result of interactions of the wood and sunlight (ultra-violet rays) at the wood surface. However, some WRP formulations also contain pigments to permit the homeowner to maintain whatever color is desired.

6. After the first winter, re-treat the upper deck surfaces with WRP to increase their water repellency.

7. Re-treat the upper deck surfaces in the spring either annually or at 3 to 5 year intervals with supplemental applications of WRP to maintain water repellency and minimize checking and splitting.

** WRP formulations differ from water repellants because of an addition of a fungicide; a few examples are UltrawoodR, Wolman ExtraR, and WeatherShield (6).*

Figure 7.Treated wood columns (posts) used as either structural supports for deck surfaces or railings, if cut to expose new wood, should be installed with the original end oriented toward the soil and the freshly-cut end oriented upward. (A.) the original treated end of the treated column was treated with a copper-boron paste (CuWrap 20) as a supplemental treatment before installation (B.) the treated end was covered with plastic to encourage diffusion and protect the treatment from the environment (a hole was cut into the bottom of the plastic to allow moisture to drain).

New Decks

When building a new or replacement deck, it is important to plan ahead regarding design, materials to be used (wood columns treated to ground contact retentions and wood decking treated to above ground retentions), compatible fasteners, caps for column tops, and a WRP to be applied to decking and column tops as soon as possible after construction is completed. Since most treated wood decking materials are southern pine, much of this information can be obtained from the Southern Pine Council (southernpine.com) or the Southern Forest Products Association (http://www.woodfibre.com). These organizations produce volumes of literature on proper designs, grades of lumber, and use categories for building in AWPA Decay Hazard Zones.

Once a design is chosen, list the decking materials to be purchased. Wood for use as decking, framing, and railings should be treated to above-ground retentions (noted on the tags, Figure8, and columns (posts) should be treated to ground-contact retentions (noted on tags). Fasteners should be compatible with the preservative system used (when in doubt, stainless steel screws or spiral-shanked nails should be specified). Unless the design chosen features techniques for protecting the column (post) tops from direct exposure to weather, metal or treated wood caps should be ordered. The supplemental treatment (WRP) chosen to be applied to decking and column tops should contain both a preservative and a water repellent.

Treated materials usually arrive at the construction site with a moisture content ranging between 35 and 75% unless they were kiln-dried following treatment (stamped KDAT) and kept dry (7). It is important to know the relative moisture content of the wood because of dimensional stability issues. KDAT materials will swell (increase in width) before reaching their equilibrium moisture content whereas treated wood not kiln-dried following treatment will shrink in width before reaching its equilibrium moisture content. In general, KDAT decking should be spaced farther apart (e.g., ¼ inch) than decking that has not been dried following treatment (e.g., 1/8 inch). Application of a WRP to the deck surface as soon as possible after construction and thereafter at periodic intervals (see previous discussion) will decrease the shrinking and swelling of decking. Also as discussed earlier, it is important to pay attention to the grain orientation (bark side up) when fastening decking to the framing

Figure 8.A.) Replacement materials for the deck in Fig. 13. The tags on the ends of the new decking (B) indicate that the lumber was treated with alkaline copper quaternary (ACQ) compounds, Type D by Georgia Pacific to a retention of 0.25 pounds per cubic foot and is to be used in AWPA use categories U1, UC3B (exterior construction, above ground) as defined in the AWPA Book of Standards. Each board was stamped on one face showing that the wood was inspected by an SPIB inspector who determined its grade to be No.2.

Supports

Larger wood materials may contain more heartwood not penetrated during treatment. Supports like 4"x4", 6"x6", and so on are cut to size during installation. It is important to make sure that the uncut end is placed into the soil, supplement treatments are also available for posts that are going to be installed in harsh environments.

In Figure 6, a post is being installed with the uncut end down, a copper borate paste, (Cu Wrap) has been toweled onto the post and covered to aid in the protection of the worker, soil, and penetration into the wood. The addition of pastes has been shown to significantly increase the life of wood (3).

The tops of installed posts are exposed and will require

treatment. There is a wide range of oil-based topical treatments, borate applications, physical shaping, water repellants, and caps that can aid in protecting them. Water repellants can be applied by spray to support posts as seen in Figure 9. A cap, (Figure 4), can be used like the angled cut to shed water. Figure 6 shows the top of a deck post that had no WRP applied and another post from the same deck also was not treated with WRP, but was shaped to shed water (Figure 10). A viscous borate formulation (Jecta) maybe applied to allow diffusion treating the untreated area before a protective cap is placed on the post (Figure 11).

A 28 Year Deck – Example

A 28 year old CCA-treated southern pine deck that was exposed to weather conditions at a site in American Wood Protection Association (AWPA) Decay Hazard Zone 4 (Figure 12) will serve to illustrate the points discussed above. Wood exposed in AWPA Zone 1 has a relatively low risk of deterioration and that exposed in Zone 5 has a severe risk. Wood exposed in Hazard Zones 2, 3, and 4 have increasingly higher risks of deterioration. This deck was exposed to heat, cold, ice, water, wind, and UV exposure with no supplemental treatments with a WRP. The deck surface and railings were replaced after 28 years for $21,000.00 because of unsightly checks, splitting, and corrosion of fasteners. The treated wood had only limited decay in a few boards and was not in danger of failing. However, corrosion of fasteners had made the decking loose and it had begun to warp.

The walking surface of the deck (Figure 13) at first glance shows extreme graying from UV exposure, warping, checking, and splitting giving the impression that the boards were decaying. The wood had been exposed to an average annual rainfall of 52 inches (1456 inches total) and an average temperature of 640F (180C), (high 770F (250C) and low 520F (110C)) (8, 14, 15). These exposures, with no added WRP, resulted in checking and splitting, especially near the end grain, and accelerated the corrosion and subsequent failure of the mild steel fasteners (Figure 13). It was estimated that over 30% of the fasteners that held the sills, decking, and railing in place had corroded and were no longer functional. One decking board that had a section of heartwood showed signs of decay during its removal, a consequence of no supplemental maintenance treatments (Figure 14). The appearance of the walking surface, the feel of walking on loose boards and the decay seen in the untreated heartwood section on an initial inspection could indicate that the decking was unsound, but further inspection indicated just the opposite. Figure 15 compares the walking surface to the bottom surface of the decking, indicating that the biological degradation of the wood was less than 1% of the total deck. Observing the bottom surface of the deck boards you could guess that the 28 year old wood was 3-5 years old until you looked at the walking surface. Figure 16 shows this comparison with the bottom surface. Although one split penetrates to the bottom side, the lower surface is free of checks and graying; the wood is sound. It is reasonable to believe that with periodic supplemental WRP treatments the deck would not have been replaced.

A Research/Demonstration (R/D) house being constructed near campus by the Mississippi State University Southern Climatic Housing Research Team* (SCHR) should be completed by summer, 2008. One of the primary objectives of the design features, construction techniques and experiments in the house is to determine/demonstrate methods of increasing the durability of residences in the southern climatic region to wood-inhabiting fungi and insects such as subterranean termites as well as to high wind events. One of the principal features of the R/D house is a deck and associated walkway that separate two components of the structure and provide access to them. The deck/walkway will be 320 feet long and will provide (40) 8-feet long test sections where alternative decking materials (both wood and non-wood), fasteners, preservatives (pressure and topically-applied), and periodic maintenance treatments can be assessed in replicated sections. In addition, the R/D house has two roofed porches and an open deck

Figure 9. Water repellants can be applied by spray or brush to the top of support posts to protect them from moisture and decay.

Figure 11. (A.) A viscous borate solution being applied to the top of a deck railing post before it was covered by a galvanized top.

Figure 10. In contrast to the post shown in Figure 6, this post on the same deck was cut at the top to shed water and experienced much less decay.

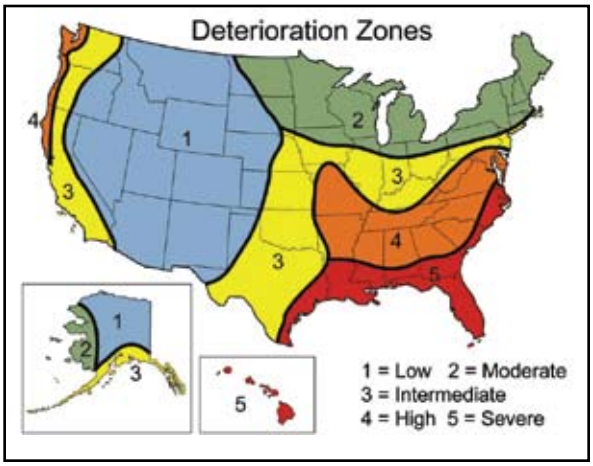

Figure 12. American Wood Protection Association (AWPA) Decay Hazard Zones. Wood exposed in AWPA Zone 1 has a relatively low risk of deterioration and that exposed in Zone 5 has a severe risk. Wood exposed in Hazard Zones 2, 3, and 4 have increasingly higher risks of deterioration.

Figure 13. A 28 year old CCA-treated southern yellow pine deck exposed in AWPA Decay Hazard Zone 4 that had no supplemental maintenance treatments.

Figure 14. A decking board that had a section of heartwood that showed signs of decay during its removal, a consequence of no supplemental maintenance treatments.

Figure 15. The top (A) and the bottom (B) horizontal surfaces of the deck in Fig. 13. The upper surface (A.) is characterized by discoloration, splitting, checking, cupping, warping and loose boards resulting from failure of fasteners whereas the bottom surface (B.) looks essentially new.

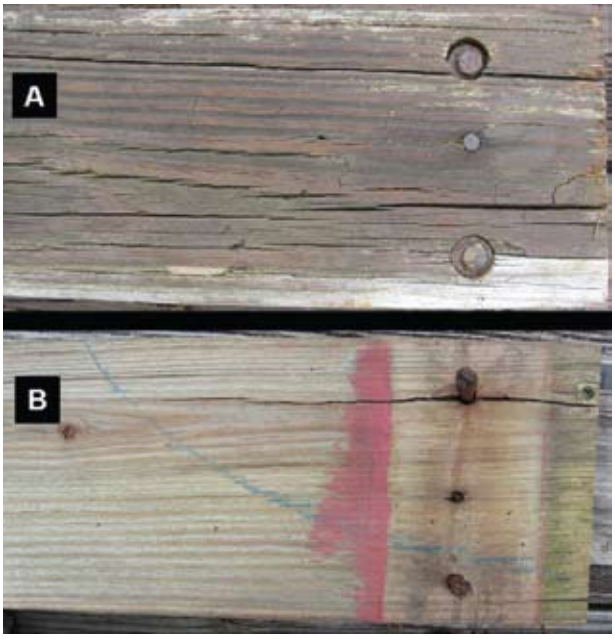

Figure 16. The top (A) and bottom (B) surfaces of a deck board removed from the deck in Fig. 13. (B) shows that the fasteners (lag bolts and screws) were deteriorated but the wood looks good except for one split that originated from a check on the upper surface. The bottom side indicates that, if protected from weathering, treated wood will deteriorate very slowly.

where these variables can be tested.

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