BY JIM MAILEY

Selecting Hardware for Use With Treated Wood

Selecting the code-required options for pressure-preservative-treated (PPT) wood and hardware will extend the life of a properly built deck, porch, or outdoor structure. In this article, I'll first review the proper treated wood for above-ground vs. ground-contact applications. Then, drawing on the knowledge I gained over three decades with Simpson Strong-Tie, I will cover in detail the considerations that must be made for selecting hardware for various environmental conditions.

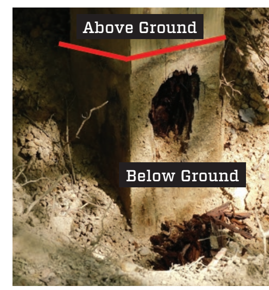
PRESSURE-PRESERVATIVE-TREATED WOOD (PPT)

In the United States, the American Wood Protection Association (AWPA) sets the consensus standard for the appropriate level of preservative treatment for wood for outdoor decks and other uses. This standard, *AWPA U1 – Use Category (UC) System: User Specification for Treated Wood*, classifies wood treatment for decks and porches into three levels: "Above Ground," labeled AWPA UC3B; "Ground Contact," labeled UC4A; and "Heavy Duty Ground Contact," labeled UC4B (awpa.com/standards/ucs). The following descriptions of the use categories are from AWPA:

- **"Above Ground":** *Wood and wood-based materials used in exterior construction that do not come into contact with the ground. These materials do not require an additional exterior coating; however, these materials may be finished to achieve the desired aesthetic appearance. UC3B materials are used for a variety of applications in either horizontal or vertical positions such as decking, sills, walkways, railings, and fence pickets.*
- **"Ground Contact":** *Wood and wood-based materials used in contact with the ground, fresh water, or other situations favorable to deterioration. … Examples are sawn fence posts, sawn deck posts, sawn guardrail posts, structural lumber, joists and beams for decks …*
- **"Heavy Duty Ground Contact":** *Wood and wood-based materials used in contact with the ground either in severe environments … in climates with a high potential for deterioration … permanent wood foundations, and wood used in salt water splash zones.*

This last category is of particular note, as IBC Section 1807.3 states: *Embedded (sawn timber and round timber) posts & poles shall be treated in accordance with AWPA UC4B.* While this is commercial code, it helps guide what is best practice for embedded wood.

Once contractors have chosen the correct level of wood treatment for each part of a deck, they need to be aware of the consequences of those choices. A higher level of treatment will increase the durability of the structure but will also increase the cost. In addition, the level of treatment, in particular UC4B, dictates the type of hardware that can be used. In the following sections, we'll look at how the level of preservative in the lumber guides the types of hardware used. In addition, we will detail how environmental conditions can also influence what hardware is deemed best for the job.

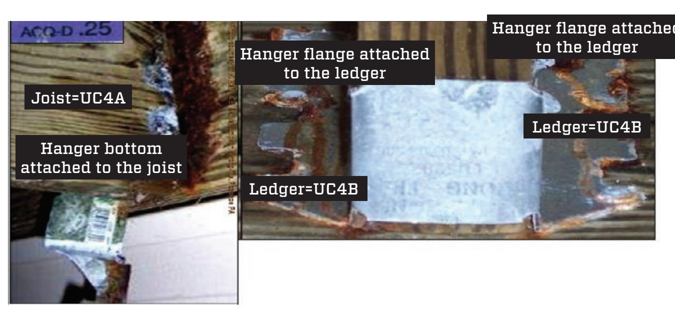


A 10-year-old embedded post treated to the level of UC4A has prematurely decayed where the wood is below ground.

CORROSION CRISIS

Prior to 2004, selecting the wood and hardware for building a deck was fairly simple. There was not much focus on choosing the right materials, because outdoor structures seemed to last, and there were few code requirements.

But when manufacturers voluntarily discontinued producing chromated copper arsenate (CCA) for residential use in December 2003 and started treating lumber with alternative preservatives, problems started occurring with hardware corrosion. The North American Deck and Railing Association (nadra.org) was founded at this time to address these issues. The primary problems occurred during 2004 and early 2005, as treaters and builders transitioned



On a deck built after CCA was discontinued for residential use, a joist treated to the level of UC4A did not corrode the joist hanger; however, the ledger, treated to UC4B, caused significant corrosion in less than six months.

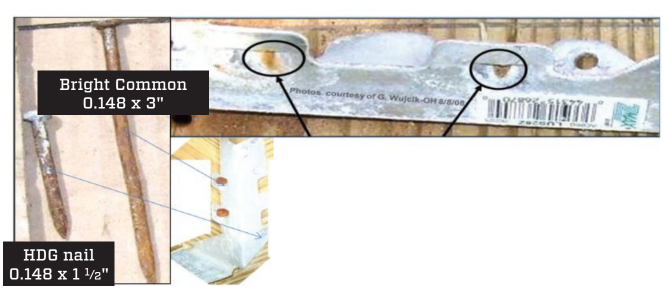
Photos by Kevin Kelly; table by Jim Mailey from CCA to the alternatives. During this time, about 2.5 million decks were built, according to NADRA.

The deck pictured on the previous page, bottom right, was one of those decks that had corrosion problems. Though the wood for the ledger and the joist came from the same batch of lumber from the same lumberyard at the same time, the part of the hanger flange attached to the ledger was corroding after six months, whereas the hanger bottom in contact with the joist wasn't. A chemical analysis of the wood by Simpson Strong-Tie showed that the copper oxide content for the ledger was 0.579 pcf, or UC4B, and the copper oxide content for the joist was 0.335 pcf, or UC4A. Researchers found higher levels of copper oxide in the wood than what was listed on the tag, which stated 0.25 pcf, or UC4A, for this ACQ-D-0.25 treatment. Inconsistent levels of the chemical treatment during the transition year resulted in premature hardware corrosion only where the retention levels were greater than UC4A.

Stainless steel is recommended when the chemical retention level is greater than 0.40 pcf for ACQ-Type D or the treated wood is rated at greater than or equal to UC4B. Therefore, if you would like to embed a post in soil, the wood should be treated to UC4B and the hardware used should be stainless steel.

HARDWARE SELECTION FOR TREATED WOOD

Building codes include guidelines to assist in selecting hardware for use with PPT wood. The IRC frequently states that any metal or flashings should be corrosion resistant. For example, Section R317.3.1 states: *Fasteners, including nuts and washers, for PPT wood shall be hot-dipped galvanized steel, stainless steel, silicon bronze or copper.* The IRC references numerous ASTM International standards (formerly known as the American Society for Testing and Materials; astm.org) for the required coating weights for zinc-coated fasteners and connectors: *Fasteners shall be in accordance with ASTM A153. … timber rivets shall be permitted to be of ASTM B695, class 55, minimum.* And, *connectors with preservative-treated wood shall be in accordance with the connector manufacturer's recommendation. In the absence of manufacturer's recommendations, a minimum of ASTM A653, G185 or equivalent, shall be used."*



Zinc from the hanger was sacrificed to protect the uncoated, bright common nail on a one-year-old deck. Where a hot-dip galvanized (HDG) nail was used, there was no transfer of zinc between the nail and the hanger.

Zinc Coating Standard (grade)	Thickness (microns)	Detail
ASTM A653 (G90)	~20/side	Connectors—referred to as G90 (0.90 oz./ft² on both sides), continuous sheet galvanizing applied prior to fabrication
ASTM A641 (class 1)	6–25	Fasteners, anchors—electroplated (0.2–1.0 mil thickness coating ≈ 0.15–0.53 oz./ft²)
ASTM A653 (G185)	~42/side	Connectors—referred to as G185 (1.85 oz./ft² on both sides), continuous sheet galvanizing applied prior to fabrication
ASTM A123 (HDG ~grade 95)	~95	Connectors—HDG, "batch" or post hot-dip galvanizing applied after fabrication
ASTM A153 (class C)	~53	Fasteners, anchors >3/8 in.—hot-dip method (2.1 mils ≈ 1.25 oz./ft²)
ASTM A153 (class D)	~43	Fasteners, anchors ≤3/8 in.—hot-dip method (1.7 mils ≈ 1.0 oz./ft²)
ASTM B695 (class 55)	~53	Fasteners, anchors—mechanically deposited (2.1 mils)

The table above shows levels of zinc coating needed to resist corrosion on fasteners and hardware used with PPT wood.

Most metals will corrode under ordinary conditions, except noble metals such as gold, platinum, and palladium, which are obviously not called for by code. The most common solution for corrosion resistance is zinc.

Zinc, which is used in galvanization, has a lot of attributes that make it an ideal coating for many applications. It is the 23rd most abundant element in the earth's crust, with estimates of global supply at more than 750 years with current extraction levels, and it is less expensive to mine than many other metals. Zinc forms a zinc carbonate film about one to two years after being exposed to oxygen that greatly retards its corrosion rate. Zinc will also migrate to protect areas that have less zinc, so, in effect, zinc will sacrificially protect any small areas and will even allow "self-healing" (see photo, below left).

Generally, the more zinc, the better resistance the material has to corrosion. Fasteners should have the same level of zinc or an equivalent corrosion resistance as the connector they're in contact with. As you can see from the table above, when you use a connector galvanized to the level of ASTM A653 (G185, which denotes a coating thickness of 42 microns) you should use a fastener or anchor galvanized to the level of ASTM A153 (class C or D) or ASTM B695 (class 55) as a minimum because these fasteners will have the same or thicker coating level.

MATERIAL SELECTION BASED ON ATMOSPHERIC CONDITIONS

According to the International Zinc Association (galvinfo.com), many factors influence hardware and fastener corrosion. Salt exposure, pollution, humidity, temperature, fog, and rainfall all play a role in the annual corrosion rate.

The 304 stainless steel nails are corroding after one year of being near the coast and exposed to chlorides. The 316 stainless steel joist hanger shows no signs of corrosion.

IRC Table R507.2.3 specifies fastener and connector material and coating for use with decks. The table recommends ASTM A153 (class C and class D), or equivalent coatings and finishes, for nails, bolts, and lag screws, and ASTM A653 (G185) or ASTM A123 (grade 85) minimum for connectors.

There are conditions for which an even higher level of corrosion resistance is recommended. IRC Table R507.2.3, footnote b, states, *Fasteners and connectors exposed to saltwater or within 300 feet of a saltwater shoreline shall be stainless steel (SS).*

The distance of 300 feet is derived from a corrosion study by the International Molybdenum Association (imoa.info) Specialty Steel Industry of North America. The study, "Stainless Steel for Coastal and Salt Corrosion," states, "The distance airborne salt is carried can vary significantly with local wind patterns. Generally, locations within five to ten miles of saltwater are considered at risk for chloride-related corrosion. In some locations, marine salt accumulations are only a factor within the first 0.9 miles. In others, salt deposits have been measured 27 miles or more inland."

The code states "stainless steel" but does not recommend a type of stainless steel in the section referenced above. To choose the correct type of stainless steel for a specific application, we need to look at the types available and their performance levels. The most common used in construction are Type 304 (typically nails, some connectors and anchors), Type 305 (typically screws), and Type 316 (fasteners, connectors, and anchors). Types 304 and 305 stainless steel are less resistant to applications that involve chloride-type corrosion. The addition of molybdenum to Type 316 gives it superior performance in environments containing chlorides (salts), and this type of stainless steel is considered to be adequate for hardware near the ocean or in applications that are exposed to chloride-type corrosion (see photo, above). The Cedar Bureau (cedarbureau.org) recommends 316 stainless steel within 15 miles of salt water.

Type 410 stainless steel (used for some screws and concrete screw anchors) is optimized for hardness. It comes in two grades—one has a coating without a barrier that is recommended only for interior, noncorrosive applications, and the other has an additional coating or barrier that offers a moderate level of corrosion resistance.

Other possible exposure to salts should be considered by the builder. Deicing salts, salts used to melt snow, or atmospheric conditions that cause metal to corrode that are not addressed in IRC Table R507.2.3 should still be factored in to hardware selection. For example, the Illinois Department of Transportation reports (in "Atmospheric Dispersion Study of Deicing Salt Applied to Roads" by Allen L. Williams and Gary J. Stensland, January 2006) that sites within about 300 feet to 3,000 feet of highways appear to have salt accumulations from the use of deicing salts comparable to moderate to severe coastal areas. The NADRA Decks Done Right Education program recommends using 316 stainless steel within 10 miles of a salt-water shoreline, within about 300 feet to 3,000 feet from highways that use deicing salts, and wherever the hardware will be exposed to chlorides.

HARDWARE AND FLOOD RISK

According to "The First National Flood Risk Assessment," a 2020 study by First Street Foundation (a nonprofit organization that seeks to quantify climate risk in financial terms), more than 21 million properties in the U.S. are at risk of flooding, and more than 14 million of those properties are at substantial risk.

Homeowners insurance doesn't cover flood losses; buildings (defined by two or more outside rigid walls and a roof) and contents may be covered under a National Flood Insurance Policy. However, property and belongings outside the building envelope are generally *not* covered. Because the deck or porch is typically not covered by insurance, it should be built strong enough to withstand a flood event, or the homeowner or building owner will have to pay for the repairs out of their own pocket.

The American Society of Civil Engineers (ASCE) standard *Flood Resistant Design and Construction* (ASCE 24) is recognized by the codes as the default document for all structures in floodways or for structures built based on the IBC. For exposed materials below the design flood elevation (DFE), ASCE 24 sections 5.2.2.1 (Corrosive Environments) and 5.2.2.2 (Noncorrosive Environments) state that *exposed straps and anchoring devices shall be stainless steel or hot-dip galvanized after fabrication ... .*

The table on the previous page shows that ASTM A653 (G185) (typical trade names include Zmax for Simpson Strong-Tie and Triple-Zinc for Mitek) designates hot-dip galvanization under a continuous galvanizing process but prior to fabrication. Based on ASCE 24, connectors would have to be "batch" or post hot-dip galvanized to ASTM A123, for which designation the zinc is applied after fabrication. The one word "after" in the standard changes the requirement from ASTM A653 (G185) to ASTM A123. Or you can use stainless steel. In some cases, 316 stainless steel may be a less expensive option than using post hot-dip galvanized connectors.

SUMMARY

Being aware of the codes and standards for outdoor structures, along with the conditions that can shorten their service lives, will allow you to provide a better product to your clients. You will be able to explain issues that may result when incorrect materials are chosen, and you won't have to worry about your clients being dissatisfied or the building inspector identifying issues with your project.

Jim Mailey is retired after 32 years with Simpson Strong-Tie, where he developed programs on the structural code requirements and product solutions for decks and porches, wood-framed structures, and buildings in flood-hazard areas. He currently advises NADRA on technical issues and is the instructor for the Deck Evaluation class and the Decks Done Right Education program.