Using Boron Rods As A Source For Dual Treatment

The Forest Products Laboratory (FPL), part of the USDA, in Madison, Wis., along with its new satellite laboratory in Starkville, Miss., have been involved in the examination and testing of wood preservative systems to improve durability of railroad ties for the last 110 years.

In his first address to the American Wood Preservers Association annual meeting in 1911, FPL Director McGarvey Cline stated in his closing statements, "The actual value of this laboratory, however, depends on the ability to obtain results of practical value."

In keeping with the spirit of this statement, FPL continues to devote a significant portion of its research efforts toward applied research in wood preservation, often in collaboration with industry and university partners.

In September 2018, the FPL Starkville group along with Wood Care Systems of Kirkland, Wash., set up a test to examine diffusion of boron from boron rods placed in green high-moisture content red and white oak timbers and ties. Since it is costly and labor intensive to prematurely replace crossties and bridge timbers, extending the service life of these materials is of great importance.

Traditional creosote treatment of these wood products has been aided by an initial treatment with soluble borate applied via dipping or pressure treatment. The boron diffuses through the wood and gives internal protection after the timber or tie is treated with creosote or other oil-borne preservative approved by the AWPA for dual treatment.

The oil-borne preservative treatment limits the soluble boron from leaching out of the dual-treated wood. Dual treatment has been shown to greatly extend the service life of wood, especially in high-decay and termite hazard areas.

As the dual treatment process has caught on in the wood treatment industry, some facilities that would like to perform this type of treatment cannot because of the initial cost or lack of space to install a pressure cylinder or dipping system for the borate treatment.

Figure 1. Bridge timbers treated with boron rods, treated with creosote, and placed at Harrison Experimental Forest in Saucier, Miss., in 2018.

A possible alternative is internal treatment with borates using non-pressure applications similar to those used in remedial treatments of wood in service.

We are examining a method for dual treatment that does not require additional capital expenditures for borate treatment. This method may be advantageous over dip or pressure treating in that it delivers an exact dosage of boron directly to the center of a tie or timber, requires no mixing, additional equipment and no boron loss during creosote vacuum-pressure treatment. Boron rods could also be placed in areas of the tie or timber that are critical to its function. For example, under the tie plate to prevent decay and possibly limit spike kill.

Borate rods are solid, fused borate containing 98 percent disodium octaborate tetrahydrate (DOT) and have been shown to readily diffuse in high moisture conditions when used to remedially treat wood in service. In the study, fused borate rods were placed in timbers and ties that were then treated with creosote. We are monitoring the boron levels using increment cores at various longitudinal and transverse points from the fused rod application point.

For the study, timbers and borate rods were supplied by Wood Care Systems. Boron rods were placed in five-inch-deep, three-quarter-inch holes spaced 13.25 inches apart along the length of green 10" x 10" x 10' timbers. Bore holes were plugged, and the timbers were pressure treated with creosote.

Timbers were shipped to the Harrison Experimental Forest (HEF) in the Desoto National Forest in south Mississippi and installed in September 2018.

Figure 1 shows some of the bridge timbers and the location of the rods (plugged rod holes) at the center of the timber.

Moisture content of the timbers was measured at six weeks by taking two six-inch cores from each timber.

After 11 weeks, the condition of the borate rods was monitored by removing the plugs of the rod holes for every other plug on the timbers and examining the rod condition using a flashlight. Rod holes had either been filled with rainwater, and we could not detect the presence of a rod or they were empty, indicating the borate rods had completely dissolved 11 weeks after application.

After 15, 30 and 50 weeks, increment cores were taken in a cruciform pattern in three red oak and three white oak timbers starting at the second rod hole away from the end of the timber as shown below in Figure 2. Cores were dried and sprayed with

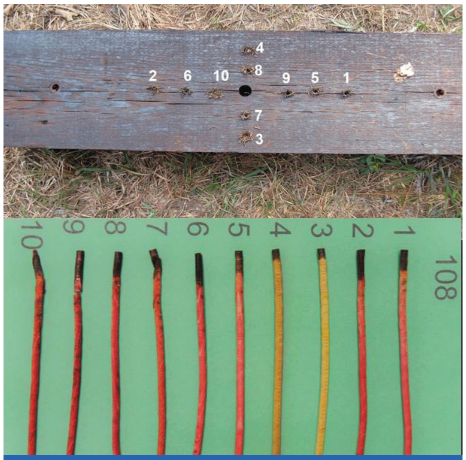

Figure 2. Sampling pattern (top) and corresponding increment cores stained with boron indicator (bottom).

boron indicator that changes a red color in the presence of boron. Figure 2 shows the sampling pattern around the rod holes and stained cores from the numbered positions.

The average moisture content for red and white oak timbers at six, 15, 30 and 50 weeks remained at levels above 60 percent. Boron diffuses readily above a wood moisture content of 30 percent.

High moisture levels for all periods sampled indicate that conditions were suitable for boron diffusion. It is unlikely the rods dissolved at all during the creosote Boultonizing process; however, diffusion should have begun almost immediately since moisture contents of the timbers were above 60 percent in both species. Many rod holes inspected 11 weeks after treatment contained rainwater that most likely aided in boron diffusion.

Cores treated with boron indicator showed the presence of boron at all sampling points except outer tangential points (Figure 2, positions 3 and 4). Boron was well distributed at the longitudinal positions from the initial boron rod location, particularly positions near the rod hole. The inner core sections were generally stained darker suggesting higher boron levels in the inner part of the timber at longitudinal sample points. We observed less red staining (lower boron) in cores removed from the tangential positions suggesting reduced boron movement.

Analytical results for boron levels in the core samples from both red and white oak timbers showed high levels of boron near the boron rod placement point then decreasing away from it (Figure 3). Boron levels were higher in the longitudinal directions from the boron rod point and much lower at points in the tangential directions from the rod placement point.

Boron levels after 50 weeks were approaching the AWPA-required level for dual treatment in the longitudinal points from the boron rod placement point. Boron levels were lower in the outer parts of the cores (away from the center of the timber) at the 15, 30 and 50 week samplings. However, boron levels were similar in the inner and outer parts of cores 50 weeks after treatment.

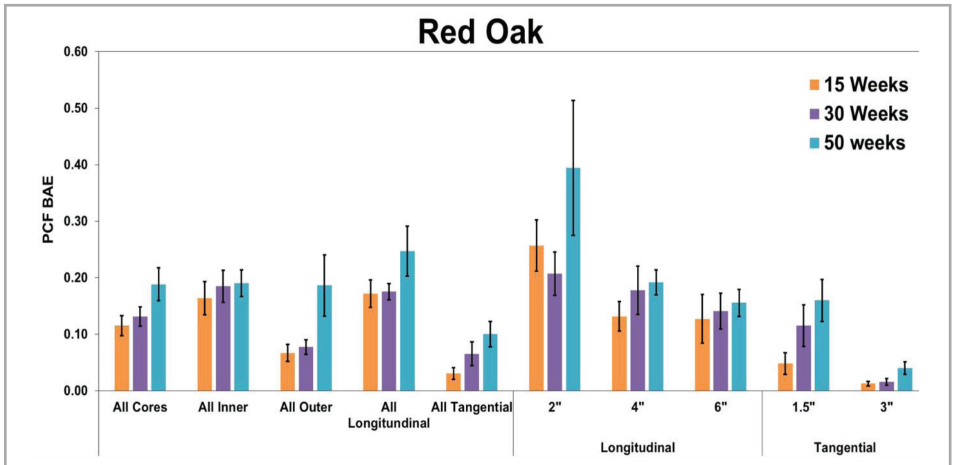

Figure 3. Boron levels (boric acid equivalent—BAE) from cores taken at 15, 30, and 50 weeks from green red oak bridge timbers treated with borate rods and creosote.

Figure 3 shows boron levels in all cores, inner, outer sections, longitudinal point cores and tangential point cores for red oak bridge timbers 15, 30 and 50 weeks after rod placement and creosote treatment.

Figure 4 shows a cross-sectioned mine timber 50 weeks after initial placement of the boron rods and creosote treatment. The red color indicated the presence of boron. The boron is notably highest around the initial rod placement spot but can be observed two, four and six inches away.

Pre-treatment of red and white oak bridge timbers with boron rods resulted in effective levels of boron near the point of application, but treatment patterns may need to be altered to produce complete protection across the timbers. The sampling points discussed here represent only a small fraction of the volume of these large timbers and further sampling is planned at 1.5-, 2-, and 2.5-year time points. We expect much more even distribution of boron in the future as moisture contents remain high and diffusion continues. ■

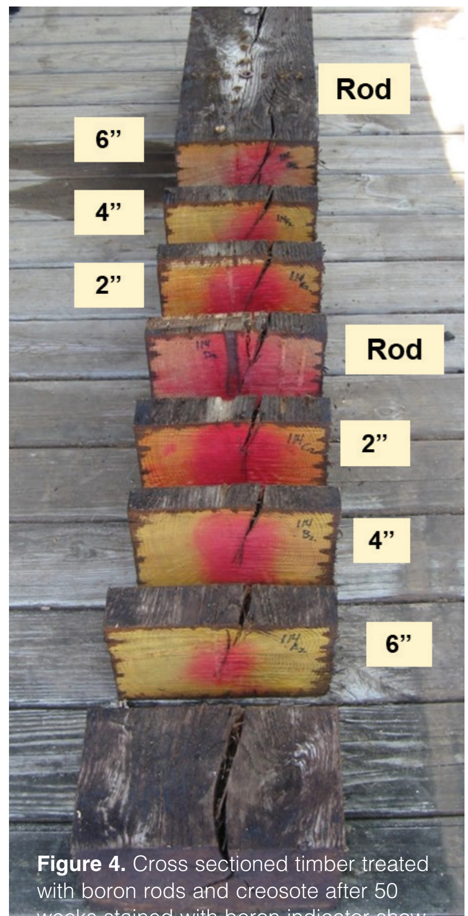

Figure 4. Cross sectioned timber treated with boron rods and creosote after 50 weeks stained with boron indicator showing the movement of boron (red) from initial rod location.

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