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SESSION IA
PROPERTIES OF TREATED WOOD

Effects of Waterborne Preservative Treatments on the Mechanical Properties of Wood

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Waterborne preservatives provide an odor-free, paintable, stainable, decay-resistant product. They also provide enhanced safety for the environmental and the user because the toxic preservative chemicals do not readily leach out of the treated product into the surrounding environment. The waterborne preservatives (WBP) achieve this optimized leach-resistance through two mechanisms. For WBP utilizing an ammonia co-solvent (e.g., ammoniacal copper zinc arsenate and ammoniacal copper arsenate (ACA)), the metal salts/oxides precipitate as water-insoluble complexes within the wood cell lumens (cavities) as the ammonia evaporates. Conversely, for WBP utilizing hexavalent chromium (Cr^{+6}) (e.g., chromated copper arsenate (CCA)), the metal salts/oxides precipitate (in a hydrolytic process commonly termed "fixation") as water-insoluble complexes within the cellular structure or upon the cell lumens as the chromium is reduced to the trivalent state and the wood material is oxidized. These fixation or precipitation processes give waterborne preservative-treated products their desirable properties, but can reduce wood strength.

To understand the effects of WBP on mechanical properties, one must understand the treatment process. Lumber and timber is usually dried before treatment to enhance treatability because the treating solutions usually are dilute 1 to 5 percent solutions of preservative in water. After this treatment, the treated product has a post-treatment moisture content well above the fiber saturation point. Accordingly, the wet treated product is often dried after treatment to improve dimensional stability, reduce shipping weight, and enhance preservative fixation.

As might be expected, the magnitude of the treatment effect is directly related to the chemistry of the WBP and the temperature, duration, and temperature-moisture content regime to which the treated wood is exposed in the treating process and in kiln-drying after treatment. WBP treatment effects appears to be directly related to several key factors.

Redrying temperature

Redrying temperature appears to be the predominant and most controllable factor affecting strength reductions. Redrying temperatures of 190°F do not significantly reduce bending strength of No. 2 grade material below the 20th to 40th percentile, but have reduced the lower tail properties of No. 1 and better.

WBP composition or type

The relative effect on mechanical properties appears to be directly related to the chromium content of the WBP. For example, ACA reduces strength less than CCA-Type C which, in turn, reduces strength less than CCA-Type A.

WBP retention

Few differences in their effects on mechanical properties have been found in WBP retentions between 0.25 to 0.60 lbs./ft^3.

Species-grade-size combination

Few relative differences appear to exist between different species of treated wood. Higher grades and smaller sizes seem to be reduced in strength more than lower grades and larger sizes.

Initial kilndrying temperature

Initial kilndrying temperature appears to be linked to the magnitude of subsequent WBP and redrying effects. While still preliminary in nature, cooperative work between Mississippi Forest Products Laboratory and the Forest Products Laboratory in Madison, Wis. has shown that initial kilndrying temperatures of 235° F amplify the WBP and redrying effects on bending strength when compared to initial kiln-drying temperatures of 196° F. Tensile strength appears to be less affected than bending strength.

Incising

Incising is required to obtain adequate WBP penetration in several difficult-to-treat species. The effects of incising are related to the incision depth, pattern density, and pattern geometry. Incising appears to significantly amplify subsequent WBP and redrying effects.

Mechanical property being considered

Energy-related properties (i.e., work to maximum load, toughness, impact bending, etc.) appear to be affected more than strength properties (i.e., modulus of rupture, ultimate tensile strength). Elastic properties (i.e., modulus of elasticity) seem to be affected least, and bending and tensile properties appear to be affected more than compressive properties.

Each factor will be reviewed individually, but the interactive nature of these factors will be stressed. Thus, this discussion will highlight the complexity of the seemingly simple question, "Exactly how do WBP affect mechanical properties?" and subsequently document the reasoning behind the recent decision of the American Wood Preservers' Association (AWPA) to implement a maximum limit on post-treatment redrying temperatures in several AWPA treatment standards.