Resiliency of Treated Wood Products to Flooding and Natural Disasters

Grant Kirker
USDA-FS Forest Products Laboratory
Madison, Wisconsin

ABSTRACT

Flooding is an increasingly destructive hazard for wood-based construction, creating conditions that reduce structural performance, promote mold growth, and complicate post-disaster recovery. This paper examines the resiliency of treated and engineered wood products exposed to flooding and natural disasters, with emphasis on material behavior below the Base Flood Elevation (BFE). Current guidance from Federal Emergency Management Agency (FEMA) and its associated National Flood Insurance Program (NFIP), and opportunities to improve regulatory recognition of treated wood materials are also considered. Existing FEMA guidance identifies flood damage–resistant materials and restricts many untreated and engineered wood products below BFE, while allowing limited use of only marine-grade pressure-treated plywood. However, advances in preservative treatments and current AWPA Use Class Category listings suggest that additional treated wood products may be suitable for frequent or prolonged wetting conditions. This paper introduces and highlights the need for updated testing, technical outreach, and clearer guidance to support broader, evidence-based use of treated wood products in flood-prone construction.

INTRODUCTION

Flooding is one of the most destructive natural hazards affecting the built environment, and its impacts on wood-based construction materials are particularly significant. Since 2010, North America has experienced more than 500 major flooding events, each contributing to substantial economic losses, widespread displacement, and long-term structural damage (Saharia *et al*. 2017). Wood, being both anisotropic and hygroscopic, is vulnerable to moisture infiltration and prolonged water exposure. Understanding how treated and engineered wood products perform under flood conditions is essential for improving building resilience and there has been significant research investigating these effects (Pasek and Frankl 2014, Becker et al. 2011, Becerra-Stasiewicz et al. 2024).

FLOODING IMPACTS ON WOOD STRUCTURES

Floodwaters compromise wood structures primarily through water infiltration, which weakens the mechanical properties and overall stability. When wood absorbs water, its cell walls swell, reducing stiffness and strength while increasing the likelihood of warping, buckling, and joint failure. Fasteners may loosen as surrounding fibers lose their structural integrity, and assemblies designed for dry service conditions can experience significant deformation.

Moisture retention also creates ideal conditions for mold growth, which poses both health risks and material surface appearance depreciation (Brandt *et al*. 2006). Mold colonization accelerates deterioration by increasing moisture retention and promoting conditions favorable for fungal wood decay. Persistent moisture not only affects the wood itself but also contributes to poor indoor air quality and complicates post-flood remediation efforts. Because of these risks, effective drying, remediation, and prevention strategies are essential to minimize long-term damage. Rapid drying, mechanical ventilation, and the use of moisture-resistant materials can significantly reduce the severity of flood-related deterioration.

FLOODING TRENDS AND REGIONAL CONTEXT

The frequency and severity of flooding events in North America have increased markedly over the past decade. Increased flooding events have occurred since 2010, reflecting both meteorological shifts and increased development in flood-prone areas. Asheville, North Carolina, serves as a notable example, having experienced severe flooding in both 2018 and 2021. These events brought record rainfall, widespread property damage, and significant infrastructure disruption. In response, Asheville has continued to enhance its flood mitigation strategies, focusing on improved planning, resilient construction practices, and updated response measures. Other regional case studies underscore the

importance of selecting materials capable of withstanding prolonged water exposure and highlight the need for updated standards that reflect modern building practices and environmental realities.

FEMA, NFIP, AND REGULATORY FRAMEWORKS

FEMA's 2022 Building Code Strategy (Horn and Lee 2023) outlines a national effort to improve building performance and resilience against flood damage. The strategy focuses on integrating building codes and standards across FEMA programs, strengthening nationwide capability for superior building performance, and encouraging public engagement with building codes. These goals reflect a broader shift toward proactive mitigation rather than reactive recovery.

The National Flood Insurance Program (NFIP) plays a central role in shaping material requirements for flood-prone structures (Crowell *et al*. 2007). NFIP provides underwriting policies and guidance for agents and insurers, covering all aspects of servicing flood insurance. Because NFIP requirements influence local building codes and insurance eligibility, they significantly affect material selection—particularly for components located below the Base Flood Elevation (BFE).

FEMA Technical Bulletin 2 (TB-2) provides detailed guidance on flood damage–resistant materials. It defines what constitutes a flood-resistant material and includes a comprehensive comparison of building codes and NFIP requirements (www.fema.gov/fema_tb_2_flood_damage-resistant_materials_requirements_01-22-2025.pdf). TB-2 also provides tables rating the flood resistance of common structural and finish materials, which serve as the basis for determining which materials may be used below BFE. These classifications are critical for designers, builders, and regulators seeking to ensure compliance and minimize flood-related damage.

BASE FLOOD ELEVATION AND MATERIAL RESTRICTIONS

The BFE represents the predicted height of floodwaters during a base flood event, typically defined as a flood with a 1% annual chance of occurrence. BFE serves as a critical reference point for determining safe construction elevations and identifying areas where flood-resistant materials are required. Structures built above BFE face significantly lower flood risk, while those with components below BFE must comply with strict material requirements.

Current FEMA guidelines impose substantial restrictions on the use of wood products below BFE. Materials such as oriented strand board (OSB), parallel strand lumber (PSL), laminated veneer lumber (LVL), and most other engineered wood products are not permitted for use in these areas. The only widely accepted engineered wood product for below-BFE applications is marine-grade pressure-treated plywood. These guidelines appear outdated relative to current material performance data and current AWPA Use Class Category listings (AWPA 2026), suggesting a need for updated testing and revised classifications that reflect advances in engineered wood technology.

FEMA FLOOD INSURANCE MATERIAL GUIDELINES

FEMA's material guidelines emphasize the importance of selecting materials that can withstand direct and prolonged exposure to floodwaters without experiencing significant degradation. Materials used below BFE must be capable of resisting saturation, contamination, and repeated wetting and drying cycles. In addition to water resistance, materials must be easy to clean and capable of returning to their pre-flood condition without requiring extensive repair or replacement.

The guidelines specifically advise against using materials such as untreated wood, carpeting, and drywall in flood-prone areas. These materials deteriorate rapidly when exposed to water and can harbor mold, making them unsuitable for locations below BFE. FEMA's guidance reflects a conservative approach to material selection, prioritizing durability and cleanability to reduce long-term maintenance and improve building resilience.

WOOD USAGE BELOW BFE: RISKS AND MITIGATION

Mitigation strategies for wood used below BFE include elevating structural components above the flood line, selecting pressure-treated wood rated for ground or freshwater contact, and designing assemblies that promote drainage and drying. These strategies help reduce the likelihood of long-term moisture retention and improve the overall resilience of wood structures in flood-prone environments.

RESEARCH OPPORTUNITIES IN THE CONTEXT OF CURRENT FEMA GUIDELINES

As mentioned previously, there are several engineered wood products listed in the current AWPA Use Class Category System (AWPA 2026) that could be suitable for BFE as they do have listed treatment options that conform to frequent and prolonged wetting. Technical outreach from the Association could result in meaningful dialogue to inform regulatory officials on the full spectrum of treated wood products, their proper usage, and clear a path for wider adoption on wood-based materials in these scenarios.

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