TITLE: Fire-Retardant-Treated Wood

DESIGNATION: iibec-TA-009-2015 (updated 2017)

OBJECTIVE: To provide information and recommendations on strength loss of wood treated with fire-retardant (FR) treatment and corrosion of ferrous metal in contact with such treated wood.

A. BACKGROUND

- FR treatment is applied to wood components such as plywood used in roof decks or sheathing, and structural framing lumber (i.e., roof trusses, exterior stairs, exterior walkways, etc.) to comply with building code requirements for combustibility of these types of components.
- FR-treated wood has been used in construction as an option to concrete and steel in the construction of buildings.
- No problems have been identified with the fire-retardant capabilities of the treatment. Problems with strength loss of wood and corrosion of metal components when used with FR-treated wood products have been documented for many years by public and private research.

B. PROBLEMS

- An analysis of FR-treated wood from various roof trusses revealed that the average reduction in the modulus of rupture (MOR) was approximately 40 percent. The reduction of MOR is a problem because prior to 1986, engineers were designing structures with the understanding that the maximum strength loss of wood was only 10 percent; the 10 percent loss in strength was based on the National Design Specification (NDS) for wood construction.
- FR-treated wood degradation in roofing systems is exacerbated due to exposure to elevated temperature and humidity levels. Chemicals in FR treatments disperse through the wood due to moisture migration caused by temperature changes and humidity cycles. The dissociation of FR chemicals causes the pH level in the wood to become acidic, initiating an acid-catalyzed dehydration process. Acid-catalyzed dehydration causes the wood to become brittle and lose strength. This same chemical release causes corrosion of ferrous metal fasteners and related hardware in contact with and penetrating through FR-treated wood.

C. VARIABLES AFFECTING DEGRADATION PROCESSES

- The chemicals used in the FR treatment typically only cause a small percent of degradation in wood components. However, when certain variables are present, the chemicals in treatments begin to cause severe degradation. The degree for which wood degrades and ferrous metal corrodes depends on the amount of exposure to the following variables:

C.1 TEMPERATURE

- Recent research shows that exposure of wood components to varying temperature and humidity cycles affects the extent to which degradation can occur. Fluctuation of temperature and humidity levels creates a cycling effect that allows water to migrate through wood members. Inorganic salts that were used in early FR treatments become mixed with moving moisture and thus diffuse with the moisture through the wood. The diffusion of inorganic salts into wood members alters the pH level of the wood and causes a dehydration process that reduces the structural properties of wood.
- The rate of degradation is proportional to temperature. For this reason, roof framing members and roof deck sheathing, where in-service temperatures can reach 130 to 180°F during the summer, are particularly susceptible to this type of degradation.

C.2 FIRE-RETARDANT CHEMICALS

- The most common chemicals used in early FR treatments were inorganic salts. The key elements typically included phosphorous, nitrogen, and boron. As stated above, these treatments resulted in a lower pH level of wood components. The pH level of the treatment is proportional to the rate of degradation; that is, the lower the pH, the higher the rate of degradation. For this reason, current FR-treatment formulas include buffers to raise the pH level, serving to minimize the degradation process.

C.3 KILN DRYING

- An initial loss of strength in FR-treated wood can be attributed to kiln drying. The NDS shows that after kiln drying, the strength of wood can be reduced by 10 to 25 percent.
- Research has shown that the temperatures used in kiln drying after treatment are one of the key factors that affect the magnitude of the initial strength loss of wood. The American Wood Preservers Association has limited the maximum temperature of kiln drying after treatment to 160°F so that strength loss is limited.

D. RECOMMENDATIONS

- As a result of decades of discovery, research, and analysis of in-situ failures of wood components, it has been found that wood-framing components treated with FR chemicals can experience reduction in structural properties. Reduction in MOR is the direct result of chemicals used in the FR treatments and environmental variables to which the wood components are exposed. It is recommended that wood components be studied to determine if they are FR-treated.

- Historically (1986 and earlier), a 10 percent reduction factor was used to compensate for strength lost in wood due to FR treatments. However, the 10-percent adjustment has been found to be inadequate when predicting long-term strength loss of wood components. Follow the manufacturer's recommendation.
- FR-treated wood in roofing systems poses a major safety concern, especially in hot/humid climates. Special precautions should be taken when working on roofing structures composed of wood components (including framing members) that are FR-treated.
- Use of other structural members is an option to consider. However, the current FR-treatment formulas include buffers to raise the pH level, serving to retard the degradation process. Confirm the pH level of wood members being specified for new or replacement projects when other structural members cannot be used. Non-ferrous fasteners and related hardware should also be considered.

E. UPDATED INFORMATION

- With the onset of the International Codes in 2000, many provisions were included in the code to address fire-retardant-treated wood. Section 2302.2, Fire-retardant-treated wood, requires testing, labeling, strength adjustments, requirements for wood structural panels, and moisture content. In addition to the code requirements that have been added, manufacturers reformulated the treatment processes and worked to establish a number of ASTM standards addressing fire testing, test methods for hygroscopic properties, test method of evaluating the flexural properties, effects of high temperatures on structural properties, practice for calculating bending strength design adjustment, and standard practice for calculating design value treatment adjustment factors.

- IIBEC staff contacted the American Wood Council (AWC) about these strength issues. AWC stated that there were issues with fire-retardant-treated wood in the 1980s. But, with the changes introduced into the code, reformulation of the treatments, and development of the current ASTM standards, the industry has addressed and resolved the issues. If problems with strength occur in buildings constructed after 2000, please contact IIBEC or AWC.

F. SUPPORTING DOCUMENTATION

- American Wood Preservers Association Standards C20 and C27
- 2012 International Building Code, Chapter 23, WOOD, Section 2303.2

G. REFERENCES

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