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Wood Handbook

Wood as an Engineering Material



Abstract

Summarizes information on wood as an engineering material. Presents properties of wood and wood-based products of particular concern to the architect and engineer. Includes discussion of designing with wood and wood-based products along with some pertinent uses.

Keywords: wood structure, physical properties (wood), mechanical properties (wood), lumber, wood-based composites, plywood, panel products, design, fastenings, wood moisture, drying, gluing, fire resistance, finishing, decay, sandwich construction, preservation, and wood-based products

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On the cover: (Left to right, top to bottom)

1. Research at the Forest Products Laboratory, Madison, Wisconsin, contributes to maximizing benefits of the Nation's timber resource.
2. Testing the behavior of wood in fire helps enhance fire safety.
3. The all-wood, 162-m (530-ft) clear-span Tacoma Dome exemplifies the structural and esthetic potential of wood construction (photo courtesy of Western Wood Structures, Inc., Tualatin, Oregon).
4. Bending tests are commonly used to determine the engineering properties of wood.
5. Engineered wood trusses exemplify research that has led to more efficient use of wood.
6. The Teal River stress-laminated deck bridge is located in Sawyer County, Wisconsin.
7. Kiln drying of wood is an important procedure during lumber manufacturing.
8. Legging adhesive (photo courtesy of Air Products and Chemicals, Inc., Allentown Pennsylvania). Adhesive bonding is a critical component in the performance of many wood products.

Pesticide Precautionary Statement

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

Caution: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife, if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Wood Handbook

Wood as an Engineering Material

**Forest Products Laboratory
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Madison, Wisconsin**

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Preface

Efficient use of our nation's timber resource is a vital concern. Because a major use of wood in the United States is in construction, particularly housing construction, good practice in this endeavor can have a profound impact on the resource. This handbook is intended as an aid to more efficient use of wood as a construction material. It provides engineers, architects, and others with a source of information on the physical and mechanical properties of wood and how these properties are affected by variations in the wood itself. Continuing research and evaluation techniques hold promise for wider and more efficient utilization of wood and for more advanced industrial, structural, and decorative uses.

This handbook was prepared by the Forest Products Laboratory (FPL), a unit of the research organization of the Forest Service, U.S. Department of Agriculture. The Laboratory, established in 1910, is maintained at Madison, Wisconsin, in cooperation with the University of Wisconsin. It was the first institution in the world to conduct general research on wood and its utilization. The accumulation of information that has resulted from its engineering and allied investigations of wood and wood products over nine decades—along with knowledge of everyday construction practices and problems—is the chief basis for this handbook.

The *Wood Handbook* was first issued in 1935, and slightly revised in 1939, as an unnumbered publication. Further revisions in 1955, 1974, and 1987 were published by the U.S. Department of Agriculture as Agriculture Handbook No. 72. This current work is a complete revision of the 1987 edition. This revision was necessary to reflect more recent research accomplishments and technological changes.

The audience for the *Wood Handbook* is fairly broad. Therefore, the coverage of each chapter is aimed at providing a general discussion of the topic, with references included for additional information. Past versions of the *Wood Handbook* tended to report only the findings and applications of FPL research. Although the handbook is not intended to be a state-of-the-art review, this approach would now leave significant gaps in some important areas. The current edition has broadened the sources of information to provide better coverage of important topics.

The organization of this version of the *Wood Handbook* is similar to previous ones, with some modifications:

- Plywood (chapter 11 in the previous version), insulation board, hardboard, medium-density fiberboard (part of chapter 21 in the previous version), and wood-based particle panel materials (chapter 22 in the previous version) are now included in a new chapter on wood-based composites and panel products.
- Structural sandwich construction (chapter 12 in the previous version) is now included in the chapter on glued structural members.
- Moisture movement and thermal insulation in light-frame structures (chapter 20 in the previous version) are now part of a new chapter on use of wood in buildings and bridges.
- Bent wood members (chapter 13 in the previous version), modified woods, and paper-based laminates (chapter 23 in the previous version) are now included in a chapter on specialty treatments.

Consistent with movement by many U.S. standards agencies and industry associations toward use of metric units and near-universal implementation of metric usage in the international community, units of measurement in this version of the handbook are provided primarily in metric units, with customary inch–pound equivalents as secondary units. All conversions in this handbook to metric units, including conversions of empirically derived equations, are direct (or soft) conversions from previously derived inch–pound values. At some future time, metric expressions may need to be derived from a reevaluation of original research.

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