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Since 2009

# Wood as a Sustainable Material

PDH Credits:

**2 PDH**

Course No.:

**WSM101**

Publication Source:

**US Forestry Service**

**“Wood as a Sustainable Building Material”**

*General Technical Report FPL-GTR-190*

*Wood Handbook*

*Chapter 1*

Release Date:

April 2010

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# Wood as a Sustainable Building Material

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Few building materials possess the environmental benefits of wood. It is not only our most widely used building material but also one with characteristics that make it suitable for a wide range of applications. As described in the many chapters of this handbook, efficient, durable, and useful wood products produced from trees can range from a minimally processed log at a log-home building site to a highly processed and highly engineered wood composite manufactured in a large production facility.

As with any resource, we want to ensure that our raw materials are produced and used in a sustainable fashion. One of the greatest attributes of wood is that it is a renewable resource. If sustainable forest management and harvesting practices are followed, our wood resource will be available indefinitely.

## Wood as a Green Building Material

Over the past decade, the concept of green building<sup>1</sup> has become more mainstream and the public is becoming aware of the potential environmental benefits of this alternative to conventional construction. Much of the focus of green building is on reducing a building's energy consumption (such as better insulation, more efficient appliances and heating, ventilation, and air-conditioning (HVAC) systems) and reducing negative human health impacts (such as controlled ventilation and humidity to reduce mold growth). However, choosing building materials that exhibit positive environmental attributes is also a major area of focus. Wood has many positive characteristics, including low embodied energy, low carbon impact, and sustainability. These characteristics are important because in the United States, a little more than half the wood harvested in the forest ends up as building material used in construction.

### Embodied Energy

Embodied energy refers to the quantity of energy required to harvest, mine, manufacture, and transport to the point of use a material or product. Wood, a material that requires a minimal amount of energy-based processing, has a low level

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<sup>1</sup>Green building is defined as the practice of increasing the efficiency with which buildings use resources while reducing building impacts on human health and the environment—through better siting, design, material selection, construction, operation, maintenance, and removal—over the complete building life cycle.

**Table 1–1. Wood products industry fuel sources<sup>a</sup>**

Fuel source	Proportion used (%)
Net electricity	19
Natural gas	16
Fuel oil	3
Other (primarily biomass)	61

<sup>a</sup>EPA (2007).

of embodied energy relative to many other materials used in construction (such as steel, concrete, aluminum, or plastic). The sun provides the energy to grow the trees from which we produce wood products; fossil fuels are the primary energy source in steel and concrete manufacture. Also, over half the energy consumed in manufacturing wood products in the United States is from biomass (or bioenergy) and is typically produced from tree bark, sawdust, and by-products of pulping in papermaking processes. The U.S. wood products industry is the nation's leading producer and consumer of bioenergy, accounting for about 60% of its energy needs (Table 1–1) (Murray and others 2006, EPA 2007). Solid-sawn wood products have the lowest level of embodied energy; wood products requiring more processing steps (for example, plywood, engineered wood products, flake-based products) require more energy to produce but still require significantly less energy than their non-wood counterparts.

In some plantation forest operations, added energy costs may be associated with the use of fertilizer, pesticides, and greenhouses to grow tree seedlings. During the harvesting operation, energy is used to power harvesting equipment and for transporting logs to the mill. Lumber milling processes that consume energy include log and lumber transport, sawing, planing, and wood drying. Kiln drying is the most energy-consuming process of lumber manufacture; however, bioenergy from a mill's waste wood is often used to heat the kilns. Unlike burning fossil fuels, using bioenergy for fuel is considered to be carbon neutral. Also, advances in kiln technologies over the past few decades have significantly reduced the amount of energy required in wood drying. Overall, the production of dry lumber requires about twice the energy of producing green (undried) lumber.

The Consortium for Research on Renewable Industrial Materials (CORRIM) found that different methods of forest management affect the level of carbon sequestration in trees (Perez-Garcia and others 2005). They found that shorter rotation harvests can sequester more total carbon than longer rotation harvests.

CORRIM also calculated differences in energy consumed and environmental impacts associated with resource extraction, materials production, transportation, and disposal of homes built using different materials and processes.

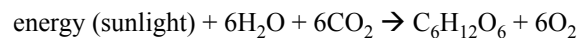
Their calculations show that the energy consumed in the manufacture of building materials (mining iron and coal for steel or harvesting wood for lumber) and the construction of a steel-framed house in Minneapolis is 17% greater than for a wood-framed house (Lippke and others 2004). The difference is even more dramatic if one considers the use of bioenergy in the manufacture of wood products. By this comparison, the steel-framed house uses 281% more non-bioenergy than the wood-framed house (Perez-Garcia and others 2005). Global warming potential, air emission index, and water emission index are all higher for steel construction than for wood construction (Table 1–2).

These analyses indicate that the amount of energy necessary to produce wood products is much less than comparable products made from other materials. If wood is substituted for these other materials (assuming similar durability allows equal substitution), energy is saved and emissions avoided each time wood is used, giving it a distinct environmental advantage over these other materials (Bowyer and others 2008).

### Carbon Impact

The role of carbon in global climate change and its projected negative impact on ecosystem sustainability and the general health of our planet have never been more elevated in the public's consciousness.

Forests play a major role in the Earth's carbon cycle. The biomass contained in our forests and other green vegetation affects the carbon cycle by removing carbon from the atmosphere through the photosynthesis process. This process converts carbon dioxide and water into sugars for tree growth and releases oxygen into the atmosphere:



A substantial amount of carbon can be sequestered in forest trees, forest litter, and forest soils. Approximately 26 billion metric tonnes of carbon is sequestered within standing trees, forest litter, and other woody debris in domestic forests, and another 28.7 billion tonnes in forest soils (Birdsey and Lewis 2002). According to Negra and others (2008), between 1995 and 2005 the rate of carbon sequestration in U.S. forests was about 150 million tonnes annually (not including soils), a quantity of carbon equivalent to about 10% of total carbon emissions nationally.

Unfortunately, deforestation in tropical areas of the world is responsible for the release of stored carbon, and these forests are net contributors of carbon to the atmosphere. Tropical deforestation is responsible for an estimated 20% of total human-caused carbon dioxide emissions each year (Schimel and others 2001).

Carbon in wood remains stored until the wood deteriorates or is burned. A tree that remains in the forest and dies releases a portion of its carbon back into the atmosphere as the woody material decomposes. On the other hand, if the tree

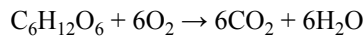
**Table 1–2. Environmental performance indices for above-grade wall designs in residential construction<sup>a</sup>**

	Wood frame	Steel frame	Difference	Change <sup>b</sup> (%)
<b>Minneapolis design</b>				
Embodied energy (GJ)	250	296	46	+18
Global warming potential (CO <sub>2</sub> kg)	13,009	17,262	4,253	+33
Air emission index (index scale)	3,820	4,222	402	+11
Water emission index (index scale)	3	29	26	+867
Solid waste (total kg)	3,496	3,181	–315	–0.9
<b>Atlanta design</b>				
Embodied energy (GJ)	168	231	63	+38
Global warming potential (CO <sub>2</sub> kg)	8,345	14,982	6,637	+80
Air emission index (index scale)	2,313	3,373	1,060	+46
Water emission index (index scale)	2	2	0	0
Solid waste (total kg)	2,325	6,152	3,827	+164

<sup>a</sup>Lippke and others (2004).

<sup>b</sup>% change = [(Steel frame – Wood frame)/(Wood frame)] × 100.

is used to produce a wood or paper product, these products store carbon while in use. For example, solid wood lumber, a common wood product used in building construction (the building industry is the largest user of sawn wood in the United States), sequesters carbon for the life of the building. At the end of a building’s life, wood can be recovered for re-use in another structure, chipped for use as fuel or mulch, or sent to a landfill (usual fate). If burned or mulched, stored carbon is released when the wood decomposes, essentially the reverse process of photosynthesis:



Carbon contained in wood products currently in-use and as wood debris in landfills is estimated at 2.5 billion tonnes and accumulates at a rate of about 28 million tonnes per year (Skog 2008). Much of the carbon contained within wood products resides in the nation’s housing stock, estimated at 116 million units in 2000. Skog (2008) estimated that in 2001, about 680 million tonnes of carbon was stored in the nation’s housing stock, nearly a third of the total carbon (2.5 billion tonnes) cited above.

As indicated in Table 1–3, carbon emitted to produce a tonne of concrete is about eight times that emitted to produce a tonne of framing lumber. A similar comparison for steel indicates that its production emits about 21 times as much carbon as an equal weight of framing lumber. Wood products also mitigate carbon emissions to the degree that they substitute for steel or concrete, which emit more greenhouse gases in their production.

Also, because wood products have this low level of embodied energy compared with other building products and because wood is one-half carbon by weight, wood products can actually be carbon negative (Bowyer and others 2008).

Comparisons of the environmental impact of various wood products have also been made using life cycle analysis software (Calkins 2009). The more processing involved in the manufacture of wood products (such as flaking, veneer cutting, added heat for pressing, gluing, kiln drying), the more impact on energy use, solid waste production, pollution production, and global warming potential (carbon).

### Sustainability

Unlike metals and fossil-fuel-based products (such as plastics), our forest resource is renewable and with proper management a flow of wood products can be maintained indefinitely. The importance of forest-based products to our economy and standard of living is hard to overemphasize—half of all major industrial raw materials we use in the United States come from forests. However, the sustainability of this resource requires forestry and harvesting practices that ensure the long-term health and diversity of our forests. Unfortunately, sustainable practices have not always been applied in the past, nor are they universally applied around the world today. Architects, product designers, material specifiers, and homeowners are increasingly asking for building products that are certified to be from a sustainable source. For the forest products sector, the result of this demand has been the formation of forest certification programs. These programs not only ensure that the forest resource is harvested in a sustainable fashion but also that issues of biodiversity, habitat protection, and indigenous peoples’ rights are included in land management plans.

### Forest Certification Programs

More than 50 different forest certification systems in the world today represent nearly 700 million acres of forestland and 15,000 companies involved in producing and

**Table 1–3. Net carbon emissions in producing a tonne of various materials**

Material	Net carbon emissions (kg C/t) <sup>a,b</sup>	Near-term net carbon emissions including carbon storage within material (kg C/t) <sup>c,d</sup>
Framing lumber	33	–457
Medium-density fiberboard (virgin fiber)	60	–382
Brick	88	88
Glass	154	154
Recycled steel (100% from scrap)	220	220
Concrete	265	265
Concrete <sup>e</sup>	291	291
Recycled aluminum (100% recycled content)	309	309
Steel (virgin)	694	694
Plastic	2,502	2,502
Aluminum (virgin)	4,532	4,532

<sup>a</sup>Values are based on life-cycle assessment and include gathering and processing of raw materials, primary and secondary processing, and transportation.

<sup>b</sup>Source: EPA (2006).

<sup>c</sup>From Bowyer and others (2008); a carbon content of 49% is assumed for wood.

<sup>d</sup>The carbon stored within wood will eventually be emitted back to the atmosphere at the end of the useful life of the wood product.

<sup>e</sup>Derived based on EPA value for concrete and consideration of additional steps involved in making blocks.

marketing certified products. These programs represent about 8% of the global forest area and 13% of managed forests. From 2007 to 2008, the world's certified forest area grew by nearly 9%. North America has certified more than one-third of its forests and Europe more than 50% of its forests; however, Africa and Asia have certified less than 0.1%.

Approximately 80% to 90% of the world's certified forests are located in the northern hemisphere, where two thirds of the world's roundwood is produced (UNECE 2008). In North America, five major certification systems are used:

- Forest Stewardship Council (FSC)
- Sustainable Forestry Initiative (SFI)
- American Tree Farm System (ATFS)
- Canadian Standards Association (CSA)
- Programme for the Endorsement of Forest Certification (PEFC) schemes

In terms of forest acreage under certification, the Forest Stewardship Council and the Sustainable Forestry Initiative dominate in the United States. These two systems evolved from different perspectives of sustainability. The FSC's guidelines are geared more to preserve natural systems while allowing for careful harvest, whereas the SFI's guidelines are aimed at encouraging fiber

productivity while allowing for conservation of resources (Howe and others 2004). The growing trends in green building are helping drive certification in the construction market in the United States.

### Forest Stewardship Council (FSC)



FSC is an independent, non-governmental organization established to promote responsible management of the world's forests and is probably the most well-known forest certification program worldwide. More than 280 million acres of forest worldwide are certified to FSC standards and are distributed over 79 countries. The FSC program includes two types of certifications. The Forest Management Certification applies FSC standards of responsible forestry to management of the forest land. A Chain-of-Custody (COC) certification ensures that forest products that carry the FSC label can be tracked back to the certified forest from which they came. More than 9,000 COC certifications are in use by FSC members. The FSC has certified 18 certification bodies around the world. Four are located in the United States, including the non-profit Rainforest Alliance's SmartWood program and the for-profit Scientific Certification Systems. Both organizations provide up-to-date lists of FSC-certified wood suppliers across the country.

### Sustainable Forestry Initiative (SFI)



The SFI program was established in 1994 and currently certifies over 152 million acres in the United States and Canada. This program has a strong wood industry focus and has been adopted by most of the major industrial forest landowners in the United States. It is based on the premise that responsible forest practices and sound business decisions can co-exist. The SFI program includes third-party certification, which verifies the requirements of the SFI 2010–2014 Standard. Independent certification bodies evaluate planning, procedures, and processes in the forest and in wood processing operations. Annual surveillance audits are mandatory on all certified operations, and a full recertification audit is required for forest operations every 3 years.

### American Tree Farm System (ATFS)



The American Tree Farm System, a program of the American Forest Foundation's Center for Family Forests, is the oldest of forest certification programs and was established in 1941. The ATFS focuses its program on private family forest landowners in the United States. Currently, ATFS has certified 24 million acres of privately owned forestland and more than 90,000 family forest owners. The ATFS forest certification standard requires forest owners to develop



a management plan based on strict environmental standards and pass an inspection by an ATFS inspecting forester. Third-party certification audits, conducted by firms accredited by the ANSI–ASQ National Accreditation Board (ANAB) or the Standards Council of Canada (SCC), are required for all certifications of the ATFS.

### Canadian Standards Association (CSA)



The Canadian Standards Association is a non-profit organization and has developed over 2,000 different standards for a variety of industries. The CSA first published Canada's National Standard for Sustainable Forest Management (SFM) CAN/CSA-Z809 in 1996. The SFM program has four components: the SFM Standard itself, a Chain-of-Custody program, product marking, and the CSA International Forest Products Group, which promotes the program. The CSA Standard has been adopted by the major industrial forestland managers in Canada. As of June 2007, about 60% (198 million acres) of Canadian forests were certified under the CAN/CSA-Z809 SFM Standard.

### Programme for the Endorsement of Forest Certification (PEFC) Schemes



The multitude of certification programs with competing standards and claims has made it difficult for land managers, members of the wood industry, and consumers to determine which certification program fits their needs (Fernholz and others 2004).

The Programme for the Endorsement of Forest Certification schemes was developed to address this issue and serves as an umbrella endorsement system that provides international recognition for national forest certification programs. Founded in 1999, the PEFC represents most of the world's certified forest programs and the production of millions of tons of certified timber. The FSC, SFI, and ATFS programs have received official PEFC endorsement.

### Additional Information

Helpful online tools provide more information and data on forest certification, including the Forest Certification Resource Center ([www.metafore.org](http://www.metafore.org)), which identifies forests, manufacturers, distributors, importers, and retailers certified under FSC, SFI, and CSA programs. The database is searchable by product, location, and certification system. Another helpful resource is the Forest Products Annual Market Review ([www.unece.org](http://www.unece.org)), which provides general and statistical information on forest products markets in the United Nations Economic Commission for Europe (UNECE) and covers the regions of Europe, North America, and the Commonwealth of Independent States.

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**Adherend.** A body that is held to another body by an adhesive.

**Adhesion.** The state in which two surfaces are held together by interfacial forces, which may consist of valence forces or interlocking action or both.

**Adhesive.** A substance capable of holding materials together by surface attachment. It is a general term and includes cements, mucilage, and paste, as well as glue.

**Assembly Adhesive**—An adhesive that can be used for bonding parts together, such as in the manufacture of a boat, airplane, furniture, and the like.

**Cold-Setting Adhesive**—An adhesive that sets at temperatures below 20 °C (68 °F).

**Construction Adhesive**—Any adhesive used to assemble primary building materials into components during building construction—most commonly applied to elastomer-based mastic-type adhesives.

**Contact Adhesive**—An adhesive that is apparently dry to the touch and that will adhere to itself instantaneously upon contact; also called contact bond adhesive or dry bond adhesive.

**Gap-Filling Adhesive**—An adhesive capable of forming and maintaining a bond between surfaces that are not close fitting.

**Hot-Melt Adhesive**—An adhesive that is applied in a molten state and forms a bond on cooling to a solid state.

**Hot-Setting Adhesive**—An adhesive that requires a temperature at or above 100 °C (212 °F) to set it.

**Room-Temperature-Curing Adhesive**—An adhesive that sets in the temperature range of 20 to 30 °C (68 to 86 °F), in accordance with the limits for Standard Room Temperature specified in the Standard Methods of Conditioning Plastics and Electrical Insulating Materials for Testing (ASTM D 618).

**Solvent Adhesive**—An adhesive having a volatile organic liquid as a vehicle. (This term excludes water-based adhesives.)

**Structural Adhesive**—A bonding agent used for transferring required loads between adherends exposed to service environments typical for the structure involved.

**Air-Dried.** (See **Seasoning.**)

**Allowable Property.** The value of a property normally published for design use. Allowable properties are identified with grade descriptions and standards, reflect the orthotropic structure of wood, and anticipate certain end uses.

**Allowable Stress.** (See **Allowable Property.**)

**American Lumber Standard.** The American Softwood Lumber Standard, Voluntary Product Standard PS-20 (National Institute of Standards and Technology), establishes standard sizes and requirements for the development and coordination of lumber grades of various species, the assignment of design values when called for, and the preparation of grading rules applicable to each species. It provides for implementation of the standard through an accreditation and certification program to assure uniform industry-wide marking and inspection. A purchaser must, however, make use of grading association rules because the basic standards are not in themselves commercial rules.

**Anisotropic.** Exhibiting different properties when measured along different axes. In general, fibrous materials such as wood are anisotropic.

**Assembly Joint.** (See **Joint.**)

**Assembly Time.** (See **Time, Assembly.**)

**Balanced Construction.** A construction such that the forces induced by uniformly distributed changes in moisture content will not cause warping. Symmetrical construction of plywood in which the grain direction of each ply is perpendicular to that of adjacent plies is balanced construction.

**Bark Pocket.** An opening between annual growth rings that contains bark. Bark pockets appear as dark streaks on radial surfaces and as rounded areas on tangential surfaces.

**Bastard Sawn.** Lumber (primarily hardwoods) in which the annual rings make angles of 30° to 60° with the surface of the piece.

**Beam.** A structural member supporting a load applied transversely to it.

**Bending, Steam.** The process of forming curved wood members by steaming or boiling the wood and bending it to a form.

**Bent Wood.** (See **Bending, Steam.**)

**Bird Peck.** A small hole or patch of distorted grain resulting from birds pecking through the growing cells in the tree. The shape of bird peck usually resembles a carpet tack with the point towards the bark; bird peck is usually accompanied by discoloration extending for considerable distance along the grain and to a much lesser extent across the grain.

**Birdseye.** Small localized areas in wood with the fibers indented and otherwise contorted to form few to many small circular or elliptical figures remotely resembling birds' eyes on the tangential surface. Sometimes found in sugar maple and used for decorative purposes; rare in other hardwood species.

**Blister.** An elevation of the surface of an adherend, somewhat resembling in shape a blister on human skin; its bound-



aries may be indefinitely outlined, and it may have burst and become flattened. (A blister may be caused by insufficient adhesive; inadequate curing time, temperature, or pressure; or trapped air, water, or solvent vapor.)

**Bloom.** Crystals formed on the surface of treated wood by exudation and evaporation of the solvent in preservative solutions.

**Blow.** In plywood and particleboard especially, the development of steam pockets during hot pressing of the panel, resulting in an internal separation or rupture when pressure is released, sometimes with an audible report.

**Blue Stain.** (See **Stain.**)

**Board.** (See **Lumber.**)

**Board Foot.** A unit of measurement of lumber represented by a board 12 in. long, 12 in. wide, and 1 in. thick or its cubic equivalent. In practice, the board foot calculation for lumber 1 in. or more in thickness is based on its nominal thickness and width and the actual length. Lumber with a nominal thickness of less than 1 in. is calculated as 1 in.

**Bole.** The main stem of a tree of substantial diameter—roughly, capable of yielding sawtimber, veneer logs, or large poles. Seedlings, saplings, and small-diameter trees have stems, not boles.

**Bolt.** (1) A short section of a tree trunk. (2) In veneer production, a short log of a length suitable for peeling in a lathe.

**Bond.** (1) The union of materials by adhesives. (2) To unite materials by means of an adhesive.

**Bondability.** Term indicating ease or difficulty in bonding a material with adhesive.

**Bond Failure.** Rupture of adhesive bond.

**Bondline.** The layer of adhesive that attaches two adherends.

**Bondline Slip.** Movement within and parallel to the bondline during shear.

**Bond Strength.** The unit load applied in tension, compression, flexure, peel impact, cleavage, or shear required to break an adhesive assembly, with failure occurring in or near the plane of the bond.

**Bow.** The distortion of lumber in which there is a deviation, in a direction perpendicular to the flat face, from a straight line from end-to-end of the piece.

**Box Beam.** A built-up beam with solid wood flanges and plywood or wood-based panel product webs.

**Boxed Heart.** The term used when the pith falls entirely within the four faces of a piece of wood anywhere in its length. Also called boxed pith.

**Brashness.** A condition that causes some pieces of wood to be relatively low in shock resistance for the species and, when broken in bending, to fail abruptly without splintering at comparatively small deflections.

**Breaking Radius.** The limiting radius of curvature to which wood or plywood can be bent without breaking.

**Bright.** Free from discoloration.

**Broad-Leaved Trees.** (See **Hardwoods.**)

**Brown Rot.** (See **Decay.**)

**Brown Stain.** (See **Stain.**)

**Built-Up Timbers.** An assembly made by joining layers of lumber together with mechanical fastenings so that the grain of all laminations is essentially parallel.

**Burl.** (1) A hard, woody outgrowth on a tree, more or less rounded in form, usually resulting from the entwined growth of a cluster of adventitious buds. Such burls are the source of the highly figured burl veneers used for purely ornamental purposes. (2) In lumber or veneer, a localized severe distortion of the grain generally rounded in outline, usually resulting from overgrowth of dead branch stubs, varying from one to several centimeters (one-half to several inches) in diameter; frequently includes one or more clusters of several small contiguous conical protuberances, each usually having a core or pith but no appreciable amount of end grain (in tangential view) surrounding it.

**Butt Joint.** (See **Joint.**)

**Buttress.** A ridge of wood developed in the angle between a lateral root and the butt of a tree, which may extend up the stem to a considerable height.

**Cambium.** A thin layer of tissue between the bark and wood that repeatedly subdivides to form new wood and bark cells.

**Cant.** A log that has been slabbed on one or more sides. Ordinarily, cants are intended for resawing at right angles to their widest sawn face. The term is loosely used. (See **Fitch.**)

**Casehardening.** A condition of stress and set in dry lumber characterized by compressive stress in the outer layers and tensile stress in the center or core.

**Catalyst.** A substance that initiates or changes the rate of chemical reaction but is not consumed or changed by the reaction.

**Cell.** A general term for the anatomical units of plant tissue, including wood fibers, vessel members, and other elements of diverse structure and function.

**Cellulose.** The carbohydrate that is the principal constituent of wood and forms the framework of the wood cells.

**Cellulosic Fiberboard.** (See **Wood-Based Composite Panel.**)

## Glossary

**Check.** A lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses set up in wood during seasoning.

**Chemical Brown Stain.** (See **Stain.**)

**Chipboard.** A paperboard used for many purposes that may or may not have specifications for strength, color, or other characteristics. It is normally made from paper stock with a relatively low density in the thickness of 0.1524 mm (0.006 in.) and up.

**Cleavage.** In an adhesively bonded joint, a separation in the joint caused by a wedge or other crack-opening-type action.

**Close Grained.** (See **Grain.**)

**Coarse Grained.** (See **Grain.**)

**Cohesion.** The state in which the constituents of a mass of material are held together by chemical and physical forces.

**Cold Pressing.** A bonding operation in which an assembly is subjected to pressure without the application of heat.

**Collapse.** The flattening of single cells or rows of cells in heartwood during the drying or pressure treatment of wood. Often characterized by a caved-in or corrugated appearance of the wood surface.

**Compartment Kiln.** (See **Kiln.**)

**Composite Assembly.** A combination of two or more materials bonded together that perform as a single unit.

**Composite Panel.** (See **Wood-Based Composite Panel.**)

**Compound Curvature.** Wood bent to a compound curvature, no element of which is a straight line.

**Compreg.** Wood in which the cell walls have been impregnated with synthetic resin and compressed to give it reduced swelling and shrinking characteristics and increased density and strength properties.

**Compression Failure.** Deformation of the wood fibers resulting from excessive compression along the grain either in direct end compression or in bending. It may develop in standing trees due to bending by wind or snow or to internal longitudinal stresses developed in growth, or it may result from stresses imposed after the tree is cut. In surfaced lumber, compression failures may appear as fine wrinkles across the face of the piece.

**Compression Wood.** Abnormal wood formed on the lower side of branches and inclined trunks of softwood trees. Compression wood is identified by its relatively wide annual rings (usually eccentric when viewed on cross section of branch or trunk), relatively large amount of latewood (sometimes more than 50% of the width of the annual rings in which it occurs), and its lack of demarcation between earlywood and latewood in the same annual rings. Compression wood shrinks excessively longitudinally, compared with normal wood.

**Conditioning** (pre and post). The exposure of a material to the influence of a prescribed atmosphere for a stipulated period of time or until a stipulated relation is reached between material and atmosphere.

**Conifer.** (See **Softwoods.**)

**Connector, Timber.** Metal rings, plates, or grids that are embedded in the wood of adjacent members, as at the bolted points of a truss, to increase the strength of the joint.

**Consistency.** That property of a liquid adhesive by virtue of which it tends to resist deformation. (Consistency is not a fundamental property but is composed of rheological properties such as viscosity, plasticity, and other phenomena.)

**Construction Adhesive.** (See **Adhesive.**)

**Contact Angle.** The angle between a substrate plane and the free surface of a liquid droplet at the line of contact with the substrate.

**Cooperage.** Containers consisting of two round heads and a body composed of staves held together with hoops, such as barrels and kegs.

**Slack Cooperage**—Cooperage used as containers for dry, semidry, or solid products. The staves are usually not closely fitted and are held together with beaded steel, wire, or wood hoops.

**Tight Cooperage**—Cooperage used as containers for liquids, semisolids, or heavy solids. Staves are well fitted and held tightly with cooperage-grade steel hoops.

**Copolymer.** Substance obtained when two or more types of monomers polymerize.

**Corbel.** A projection from the face of a wall or column supporting a weight.

**Core Stock.** A solid or discontinuous center ply used in panel-type glued structures (such as furniture panels and solid or hollowcore doors).

**Coupling Agent.** A molecule with different or like functional groups that is capable of reacting with surface molecules of two different substances, thereby chemically bridging the substances.

**Covalent Bond.** A chemical bond that results when electrons are shared by two atomic nuclei.

**Creep.** (1) Time-dependent deformation of a wood member under sustained wood. (2) In an adhesive, the time-dependent increase in strain resulting from a sustained stress.

**Crook.** The distortion of lumber in which there is a deviation, in a direction perpendicular to the edge, from a straight line from end-to-end of the piece.

**Crossband.** To place the grain of layers of wood at right angles in order to minimize shrinking and swelling; also, in plywood of three or more plies, a layer of veneer whose grain direction is at right angles to that of the face plies.

**Cross Break.** A separation of the wood cells across the grain. Such breaks may be due to internal stress resulting from unequal longitudinal shrinkage or to external forces.

**Cross Grained.** (See **Grain.**)

**Cross-Link.** An atom or group connecting adjacent molecules in a complex molecular structure.

**Cup.** A distortion of a board in which there is a deviation flatwise from a straight line across the width of the board.

**Cure.** To change the properties of an adhesive by chemical reaction (which may be condensation, polymerization, or vulcanization) and thereby develop maximum strength. Generally accomplished by the action of heat or a catalyst, with or without pressure.

**Curing Agent.** (See **Hardener.**)

**Curing Temperature.** (See **Temperature, Curing.**)

**Curing Time.** (See **Time, Curing.**)

**Curly Grained.** (See **Grain.**)

**Curtain Coating.** Applying liquid adhesive to an adherend by passing the adherend under a thin curtain of liquid falling by gravity or pressure.

**Cut Stock.** (See **Lumber for Dimension.**)

**Cuttings.** In hardwoods, portions of a board or plank having the quality required by a specific grade or for a particular use. Obtained from a board by crosscutting or ripping.

**Decay.** The decomposition of wood substance by fungi.

**Advanced (Typical) Decay**—The older stage of decay in which the destruction is readily recognized because the wood has become punky, soft and spongy, stringy, ringshaked, pitted, or crumbly. Decided discoloration or bleaching of the rotted wood is often apparent.

**Brown Rot**—In wood, any decay in which the attack concentrates on the cellulose and associated carbohydrates rather than on the lignin, producing a light to dark brown friable residue—hence loosely termed “dry rot.” An advanced stage where the wood splits along rectangular planes, in shrinking, is termed “cubical rot.”

**Dry Rot**—A term loosely applied to any dry, crumbly rot but especially to that which, when in an advanced stage, permits the wood to be crushed easily to a dry powder. The term is actually a misnomer for any decay, since all fungi require considerable moisture for growth.

**Incipient Decay**—The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood. It is usually accompanied by a slight discoloration or bleaching of the wood.

**Heart Rot**—Any rot characteristically confined to the heartwood. It generally originates in the living tree.

**Pocket Rot**—Advanced decay that appears in the form of a hole or pocket, usually surrounded by apparently sound wood.

**Soft Rot**—A special type of decay developing under very wet conditions (as in cooling towers and boat timbers) in the outer wood layers, caused by cellulose-destroying microfungi that attack the secondary cell walls and not the intercellular layer.

**White-Rot**—In wood, any decay or rot attacking both the cellulose and the lignin, producing a generally whitish residue that may be spongy or stringy rot, or occur as pocket rot.

**Delamination.** The separation of layers in laminated wood or plywood because of failure of the adhesive, either within the adhesive itself or at the interface between the adhesive and the adherend.

**Delignification.** Removal of part or all of the lignin from wood by chemical treatment.

**Density.** As usually applied to wood of normal cellular form, density is the mass per unit volume of wood substance enclosed within the boundary surfaces of a wood-plus-voids complex. It is variously expressed as pounds per cubic foot, kilograms per cubic meter, or grams per cubic centimeter at a specified moisture content.

**Density Rules.** A procedure for segregating wood according to density, based on percentage of latewood and number of growth rings per inch of radius.

**Dew Point.** The temperature at which a vapor begins to deposit as a liquid. Applies especially to water in the atmosphere.

**Diagonal Grained.** (See **Grain.**)

**Diffuse-Porous Wood.** Certain hardwoods in which the pores tend to be uniform in size and distribution throughout each annual ring or to decrease in size slightly and gradually toward the outer border of the ring.

**Dimension.** (See **Lumber for Dimension.**)

**Dipole–Dipole Forces.** Intermolecular attraction forces between polar molecules that result when positive and negative poles of molecules are attracted to one another.

**Dote.** “Dote,” “doze,” and “rot” are synonymous with “decay” and are any form of decay that may be evident as either a discoloration or a softening of the wood.

**Double Spread.** (See **Spread.**)

**Dry-Bulb Temperature.** The temperature of air as indicated by a standard thermometer. (See **Psychrometer.**)

**Dry Kiln.** (See **Kiln.**)

**Dry Rot.** (See **Decay.**)

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**Dry Strength.** The strength of an adhesive joint determined immediately after drying under specified conditions or after a period of conditioning in a standard laboratory atmosphere.

**Drywall.** Panel product used as an interior wall and ceiling covering made of gypsum plaster with paper facings. The gypsum plaster may be reinforced with recycled fiber.

**Durability.** A general term for permanence or resistance to deterioration. Frequently used to refer to the degree of resistance of a species of wood to attack by wood-destroying fungi under conditions that favor such attack. In this connection, the term “decay resistance” is more specific. As applied to bondlines, the life expectancy of the structural qualities of the adhesive under the anticipated service conditions of the structure.

**Earlywood.** The portion of the growth ring that is formed during the early part of the growing season. It is usually less dense and weaker mechanically than latewood.

**Edge Grained.** (See **Grain.**)

**Edge Joint.** (See **Joint.**)

**Elastomer.** A macromolecular material that, at room temperature, is deformed by application of a relatively low force and is capable of recovering substantially in size and shape after removal of the force.

**Embrittlement.** A loss in strength or energy absorption without a corresponding loss in stiffness. Clear, straight-grained wood is generally considered a ductile material; chemical treatments and elevated temperatures can alter the original chemical composition of wood, thereby embrittling the wood.

**Encased Knot.** (See **Knot.**)

**End Grained.** (See **Grain.**)

**End Joint.** (See **Joint.**)

**Equilibrium Moisture Content.** The moisture content at which wood neither gains nor loses moisture when surrounded by air at a given relative humidity and temperature.

**Excelsior.** (See **Wood Wool.**)

**Extender.** A substance, generally having some adhesive action, added to an adhesive to reduce the amount of the primary binder required per unit area.

**Exterior Plywood.** (See **Wood-Based Composite Panel.**)

**Extractive.** Substances in wood, not an integral part of the cellular structure, that can be removed by solution in hot or cold water, ether, benzene, or other solvents that do not react chemically with wood components.

**Extrusion Spreading.** A method of adhesive application in which adhesive is forced through small openings in the spreader head.

**Factory and Shop Lumber.** (See **Lumber.**)

**Failure, Adherend.** Rupture of an adhesive joint, such that the separation appears to be within the adherend.

**Failure, Adhesive.** Rupture of an adhesive joint, such that the plane of separation appears to be at the adhesive–adherend interface.

**Failure, Cohesive.** Rupture of an adhesive joint, such that the separation appears to be within the adhesive.

**Feed Rate.** The distance that the stock being processed moves during a given interval of time or operational cycle.

**Fiber, Wood.** A wood cell comparatively long ( $\leq 40$  to  $300$  mm,  $\leq 1.5$  to  $12$  in.), narrow, tapering, and closed at both ends.

**Fiberboard.** (See **Wood-Based Composite Panel.**)

**Fiber Saturation Point.** The stage in the drying or wetting of wood at which the cell walls are saturated and the cell cavities free from water. It applies to an individual cell or group of cells, not to whole boards. It is usually taken as approximately 30% moisture content, based on oven-dry weight.

**Fibril.** A threadlike component of cell walls, invisible under a light microscope.

**Figure.** The pattern produced in a wood surface by annual growth rings, rays, knots, deviations from regular grain such as interlocked and wavy grain, and irregular coloration.

**Filler.** In woodworking, any substance used to fill the holes and irregularities in planed or sanded surfaces to decrease the porosity of the surface before applying finish coatings. As applied to adhesives, a relatively nonadhesive substance added to an adhesive to improve its working properties, strength, or other qualities.

**Fine Grained.** (See **Grain.**)

**Fingerjoint.** (See **Joint.**)

**Finish (Finishing).** (1) Wood products such as doors, stairs, and other fine work required to complete a building, especially the interior. (2) Coatings of paint, varnish, lacquer, wax, or other similar materials applied to wood surfaces to protect and enhance their durability or appearance.

**Fire Endurance.** A measure of the time during which a material or assembly continues to exhibit fire resistance under specified conditions of test and performance.

**Fire Resistance.** The property of a material or assembly to withstand fire or give protection from it. As applied to elements of buildings, it is characterized by the ability to confine a fire or to continue to perform a given structural function, or both.

**Fire Retardant.** (See **Flame Retardant.**)



**Fire-Retardant-Treated Wood.** As specified in building codes, a wood product that has been treated with chemicals by a pressure process or treated during the manufacturing process for the purpose of reducing its flame spread performance in an ASTM E 84 test conducted for 30 min to performance levels specified in the codes.

**Flake.** A small flat wood particle of predetermined dimensions, uniform thickness, with fiber direction essentially in the plane of the flake; in overall character resembling a small piece of veneer. Produced by special equipment for use in the manufacture of flakeboard.

**Flakeboard.** (See **Wood-Based Composite Panel.**)

**Flame Retardant.** A treatment, coating, or chemicals that when applied to wood products delays ignition and reduces the flame spread of the product.

**Flame Spread.** The propagation of a flame away from the source of ignition across the surface of a liquid or a solid, or through the volume of a gaseous mixture.

**Flat Grained.** (See **Grain.**)

**Flat Sawn.** (See **Grain.**)

**Flecks.** (See **Rays, Wood.**)

**Flich.** A portion of a log sawn on two or more faces—commonly on opposite faces leaving two waney edges. When intended for resawing into lumber, it is resawn parallel to its original wide faces. Or, it may be sliced or sawn into veneer, in which case the resulting sheets of veneer laid together in the sequence of cutting are called a flich. The term is loosely used. (See **Cant.**)

**Framing.** Lumber used for the structural member of a building, such as studs and joists.

**Full-Cell Process.** Any process for impregnating wood with preservatives or chemicals in which a vacuum is drawn to remove air from the wood before admitting the preservative. This favors heavy adsorption and retention of preservative in the treated portions.

**Furnish.** Wood material that has been reduced for incorporation into conventional wood-based composites; including flakes, particles, and fiber.

**Gelatinous Fibers.** Modified fibers that are associated with tension wood in hardwoods.

**Girder.** A large or principal beam used to support concentrated loads at isolated points along its length.

**Gluability.** (See **Bondability.**)

**Glue.** Originally, a hard gelatin obtained from hides, tendons, cartilage, bones, etc., of animals. Also, an adhesive prepared from this substance by heating with water. Through general use, the term is now synonymous with the term “adhesive.”

**Glue Laminating.** Production of structural or nonstructural wood members by bonding two or more layers of wood together with adhesive.

**Glued Laminated Timber (Glulam).** A manufactured structural timber product composed of layers of dimensional lumber glued together.

**Glueline.** (See **Bondline.**)

**Grade.** The designation of the quality of a manufactured piece of wood or of logs.

**Grain.** The direction, size, arrangement, appearance, or quality of the fibers in wood or lumber. To have a specific meaning the term must be qualified.

**Close-Grained (Fine-Grained) Wood**—Wood with narrow, inconspicuous annual rings. The term is sometimes used to designate wood having small and closely spaced pores, but in this sense the term “fine textured” is more often used.

**Coarse-Grained Wood**—Wood with wide conspicuous annual rings in which there is considerable difference between earlywood and latewood. The term is sometimes used to designate wood with large pores, such as oak, keruing, meranti, and walnut, but in this sense, the term “open-grained” is more often used.

**Cross-Grained Wood**—Wood in which the fibers deviate from a line parallel to the sides of the piece. Cross grain may be either diagonal or spiral grain or a combination of the two.

**Curly-Grained Wood**—Wood in which the fibers are distorted so that they have a curled appearance, as in “birds-eye” wood. The areas showing curly grain may vary up to several inches in diameter.

**Diagonal-Grained Wood**—Wood in which the annual rings are at an angle with the axis of a piece as a result of sawing at an angle with the bark of the tree or log. A form of cross-grain.

**Edge-Grained Lumber**—Lumber that has been sawed so that the wide surfaces extend approximately at right angles to the annual growth rings. Lumber is considered edge grained when the rings form an angle of 45° to 90° with the wide surface of the piece.

**End-Grained Wood**—The grain as seen on a cut made at a right angle to the direction of the fibers (such as on a cross section of a tree).

**Fiddleback-Grained Wood**—Figure produced by a type of fine wavy grain found, for example, in species of maple; such wood being traditionally used for the backs of violins.

**Flat-Grained (Flat-Sawn) Lumber**—Lumber that has been sawn parallel to the pith and approximately tangent



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to the growth rings. Lumber is considered flat grained when the annual growth rings make an angle of less than 45° with the surface of the piece.

**Interlocked-Grained Wood**—Grain in which the fibers put on for several years may slope in a right-handed direction, and then for a number of years the slope reverses to a left-handed direction, and later changes back to a right-handed pitch, and so on. Such wood is exceedingly difficult to split radially, though tangentially it may split fairly easily.

**Open-Grained Wood**—Common classification for woods with large pores such as oak, keruing, meranti, and walnut. Also known as “coarse textured.”

**Plainsawn Lumber**—Another term for flat-grained lumber.

**Quartersawn Lumber**—Another term for edge-grained lumber.

**Side-Grained Wood**—Another term for flat-grained lumber.

**Slash-Grained Wood**—Another term for flat-grained lumber.

**Spiral-Grained Wood**—Wood in which the fibers take a spiral course about the trunk of a tree instead of the normal vertical course. The spiral may extend in a right-handed or left-handed direction around the tree trunk. Spiral grain is a form of cross grain.

**Straight-Grained Wood**—Wood in which the fibers run parallel to the axis of a piece.

**Vertical-Grained Lumber**—Another term for edge-grained lumber.

**Wavy-Grained Wood**—Wood in which the fibers collectively take the form of waves or undulations.

**Green.** Freshly sawed or undried wood. Wood that has become completely wet after immersion in water would not be considered green but may be said to be in the “green condition.”

**Growth Ring.** The layer of wood growth put on a tree during a single growing season. In the temperate zone, the annual growth rings of many species (for example, oaks and pines) are readily distinguished because of differences in the cells formed during the early and late parts of the season. In some temperate zone species (black gum and sweetgum) and many tropical species, annual growth rings are not easily recognized.

**Gum.** A comprehensive term for nonvolatile viscous plant exudates, which either dissolve or swell up in contact with water. Many substances referred to as gums such as pine and spruce gum are actually oleoresins.

**Hardboard.** (See **Wood-Based Composite Panel.**)

**Hardener.** A substance or mixture of substances that is part of an adhesive and is used to promote curing by taking part in the reaction.

**Hardness.** A property of wood that enables it to resist indentation.

**Hardwoods.** Generally one of the botanical groups of trees that have vessels or pores and broad leaves, in contrast to the conifers or softwoods. The term has no reference to the actual hardness of the wood.

**Heart Rot.** (See **Decay.**)

**Heartwood.** The wood extending from the pith to the sapwood, the cells of which no longer participate in the life processes of the tree. Heartwood may contain phenolic compounds, gums, resins, and other materials that usually make it darker and more decay resistant than sapwood.

**Hemicellulose.** A celluloselike material (in wood) that is easily decomposable as by dilute acid, yielding several different simple sugars.

**Hertz.** A unit of frequency equal to one cycle per second.

**High Frequency Curing.** (See **Radiofrequency Curing.**)

**Hollow-Core Construction.** A panel construction with faces of plywood, hardboard, or similar material bonded to a framed-core assembly of wood lattice, paperboard rings, or the like, which support the facing at spaced intervals.

**Honeycomb Core.** A sandwich core material constructed of thin sheet materials or ribbons formed to honeycomb-like configurations.

**Honeycombing.** Checks, often not visible at the surface, that occur in the interior of a piece of wood, usually along the wood rays.

**Hot-Setting Adhesive.** (See **Adhesive.**)

**Hydrogen Bond.** An intermolecular attraction force that results when the hydrogen of one molecule and a pair of unshared electrons on an electronegative atom of another molecule are attracted to one another.

**Hydrophilic.** Having a strong tendency to bind or absorb water.

**Hydrophobic.** Having a strong tendency to repel water.

**Impreg.** Wood in which the cell walls have been impregnated with synthetic resin so as to reduce materially its swelling and shrinking. Impreg is not compressed.

**Incising.** A pretreatment process in which incisions, slits, or perforations are made in the wood surface to increase penetration of preservative treatments. Incising is often required to enhance durability of some difficult-to-treat species, but incising reduces strength.

**Increment Borer.** An augerlike instrument with a hollow bit and an extractor, used to extract thin radial cylinders of

wood from trees to determine age and growth rate. Also used in wood preservation to determine the depth of penetration of a preservative.

**Inorganic-Bonded Composites.** Manufactured wood-based composites where an inorganic binder, typically gypsum, Portland-cement, or magnesia-cement, acts as a continuous matrix and fully encapsulates the wood elements.

**Intergrown Knot.** (See **Knot.**)

**Interior Plywood.** (See **Wood-Based Composite Panel.**)

**Interlocked Grained.** (See **Grain.**)

**Interlocking Action.** (See **Mechanical Adhesion.**)

**Internal Stresses.** Stresses that exist within an adhesive joint even in the absence of applied external forces.

**Interphase.** In wood bonding, a region of finite thickness as a gradient between the bulk adherend and bulk adhesive in which the adhesive penetrates and alters the adherend's properties and in which the presence of the adherend influences the chemical and/or physical properties of the adhesive.

**Intumesce.** To expand with heat to provide a low-density film; used in reference to certain fire-retardant coatings.

**Isotropic.** Exhibiting the same properties in all directions.

**Joint.** The junction of two pieces of wood or veneer.

**Adhesive Joint**—The location at which two adherends are held together with a layer of adhesive.

**Assembly Joint**—Joints between variously shaped parts or subassemblies such as in wood furniture (as opposed to joints in plywood and laminates that are all quite similar).

**Butt Joint**—An end joint formed by abutting the squared ends of two pieces.

**Edge Joint**—A joint made by bonding two pieces of wood together edge to edge, commonly by gluing. The joints may be made by gluing two squared edges as in a plain edge joint or by using machined joints of various kinds, such as tongued-and-grooved joints.

**End Joint**—A joint made by bonding two pieces of wood together end to end, commonly by finger or scarf joint.

**Fingerjoint**—An end joint made up of several meshing wedges or fingers of wood bonded together with an adhesive. Fingers are sloped and may be cut parallel to either the wide or narrow face of the piece.

**Lap Joint**—A joint made by placing one member partly over another and bonding the overlapped portions.

**Scarf Joint**—An end joint formed by joining with adhesive the ends of two pieces that have been tapered or beveled to form sloping plane surfaces, usually to a feather-edge, and with the same slope of the plane with respect

to the length in both pieces. In some cases, a step or hook may be machined into the scarf to facilitate alignment of the two ends, in which case the plane is discontinuous and the joint is known as a stepped or hooked scarf joint.

**Starved Joint**—A glue joint that is poorly bonded because an insufficient quantity of adhesive remained in the joint.

**Sunken Joint**—Depression in wood surface at a joint (usually an edge joint) caused by surfacing material too soon after bonding. (Inadequate time was allowed for moisture added with the adhesive to diffuse away from the joint.)

**Joint Efficiency or Factor.** The strength of a joint expressed as a percentage of the strength of clear straight-grained material.

**Joist.** One of a series of parallel beams used to support floor and ceiling loads and supported in turn by larger beams, girders, or bearing walls.

**Kiln.** A chamber having controlled air-flow, temperature, and relative humidity for drying lumber. The temperature is increased as drying progresses, and the relative humidity is decreased.

**Kiln Dried.** (See **Seasoning.**)

**Knot.** That portion of a branch or limb that has been surrounded by subsequent growth of the stem. The shape of the knot as it appears on a cut surface depends on the angle of the cut relative to the long axis of the knot.

**Encased Knot**—A knot whose rings of annual growth are not intergrown with those of the surrounding wood.

**Intergrown Knot**—A knot whose rings of annual growth are completely intergrown with those of the surrounding wood.

**Loose Knot**—A knot that is not held firmly in place by growth or position and that cannot be relied upon to remain in place.

**Pin Knot**—A knot that is not more than 12 mm (1/2 in.) in diameter.

**Sound Knot**—A knot that is solid across its face, at least as hard as the surrounding wood, and shows no indication of decay.

**Spike Knot**—A knot cut approximately parallel to its long axis so that the exposed section is definitely elongated.

**Laminate.** A product made by bonding together two or more layers (laminations) of material or materials.

**Laminate, Paper-Based.** A multilayered panel made by compressing sheets of resin-impregnated paper together into a coherent solid mass.

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**Laminated Strand Lumber (LSL).** (See **Structural Composite Lumber**.)

**Laminated Veneer Lumber (LVL).** (See **Structural Composite Lumber**.)

**Lap Joint.** (See **Joint**.)

**Latewood.** The portion of the growth ring that is formed after the earlywood formation has ceased. It is usually denser and stronger mechanically than earlywood.

**Latex Paint.** A paint containing pigments and a stable water suspension of synthetic resins (produced by emulsion polymerization) that forms an opaque film through coalescence of the resin during water evaporation and subsequent curing.

**Lathe Checks.** In rotary-cut and sliced veneer, the fractures or checks that develop along the grain of the veneer as the knife peels veneer from the log. The knife side of the veneer where checks occur is called the loose side. The opposite and log side of the veneer where checking usually does not occur is called the tight side.

**Layup.** The process of loosely assembling the adhesive-coated components of a unit, particularly a panel, to be pressed or clamped.

**Lbs/MSGL.** Abbreviation for rate of adhesive application in pounds of adhesive per 1,000 ft<sup>2</sup> of single glueline (bondline). (See **Spread**.) When both faces of an adherend are spread as in some plywood manufacturing processes, the total weight of adhesive applied may be expressed as Lbs/MDGL (pounds per 1,000 ft<sup>2</sup> double glueline).

**Lignin.** The second most abundant constituent of wood, located principally in the secondary wall and the middle lamella, which is the thin cementing layer between wood cells. Chemically, it is an irregular polymer of substituted propylphenol groups, and thus, no simple chemical formula can be written for it.

**London Dispersion Forces.** Intermolecular attraction forces between nonpolar molecules that result when instantaneous (nonpermanent) dipoles induce matching dipoles in neighboring molecules. London forces also exist between polar molecules.

**Longitudinal.** Generally, parallel to the direction of the wood fibers.

**Loose Knot.** (See **Knot**.)

**Lumber.** The product of the saw and planing mill for which manufacturing is limited to sawing, resawing, passing lengthwise through a standard planing machine, crosscutting to length, and matching. Lumber may be made from either softwood or hardwood (See also **Lumber for Dimension**.)

**Board**—Lumber that is less than 38 mm standard (2 in. nominal) thickness and greater than 38 mm standard (2 in. nominal) width. Boards less than 140 mm standard (6 in. nominal) width are sometimes called strips.

**Dimension**—Lumber with a thickness from 38 mm standard (2 in. nominal) up to but not including 114 mm standard (5 in. nominal) and a width of greater than 38 mm standard (2 in. nominal).

**Dressed Size**—The dimensions of lumber after being surfaced with a planing machine. The dressed size is usually 1/2 to 3/4 in. less than the nominal or rough size. A 2- by 4-in. stud, for example, actually measures about 1-1/2 by 3-1/2 in. (standard 38 by 89 mm).

**Factory and Shop Lumber**—Lumber intended to be cut up for use in further manufacture. It is graded on the percentage of the area that will produce a limited number of cuttings of a specified minimum size and quality.

**Matched Lumber**—Lumber that is edge dressed and shaped to make a close tongued-and-grooved joint at the edges or ends when laid edge to edge or end to end.

**Nominal Size**—As applied to timber or lumber, the size by which it is known and sold in the market (often differs from the actual size).

**Patterned Lumber**—Lumber that is shaped to a pattern or to a molded form in addition to being dressed, matched, or shiplapped, or any combination of these workings.

**Rough Lumber**—Lumber that has not been dressed (surfaced) but has been sawed, edged, and trimmed.

**Shiplapped Lumber**—Lumber that is edge dressed to make a lapped joint.

**Shipping-Dry Lumber**—Lumber that is partially dried to prevent stain and mold in transit.

**Shop Lumber**—(See **Factory and Shop Lumber**.)

**Side Lumber**—A board from the outer portion of the log—ordinarily one produced when squaring off a log for a tie or timber.

**Structural Lumber**—Lumber that is intended for use where allowable properties are required. The grading of structural lumber is based on the strength or stiffness of the piece as related to anticipated uses.

**Surfaced Lumber**—Lumber that is dressed by running it through a planer.

**Timbers**—Lumber that is standard 114 mm (nominal 5 in.) or more in least dimension. Timbers may be used as beams, stringers, posts, caps, sills, girders, or purlins.

**Yard Lumber**—A little-used term for lumber of all sizes and patterns that is intended for general building purposes having no design property requirements.

**Lumber for Dimension.** The National Dimension Manufacturers Association defines both hardwood and softwood dimension components as being cut to a specific size from

kiln-dried rough lumber, bolts, cants, or logs. Dimension components include Flat Stock (solid and laminated) for furniture, cabinet, and specialty manufactures. This term has largely superseded the terms “hardwood dimension” and “dimension parts.” (See also **Lumber**).

**Lumen.** In wood anatomy, the cell cavity.

**Manufacturing Defects.** Includes all defects or blemishes that are produced in manufacturing, such as chipped grain, loosened grain, raised grain, torn grain, skips in dressing, hit and miss (series of surfaced areas with skips between them), variation in sawing, miscut lumber, machine burn, machine gouge, mismatching, and insufficient tongue or groove.

**Mastic.** A material with adhesive properties, usually used in relatively thick sections, that can be readily applied by extrusion, trowel, or spatula. (See **Adhesive**.)

**Matched Lumber.** (See **Lumber**.)

**Mechanical Adhesion.** Adhesion between surfaces in which the adhesive holds the parts together by interlocking action.

**Medium-Density Fiberboard.** (See **Wood-Based Composite Panel**.)

**Millwork.** Planed and patterned lumber for finish work in buildings, including items such as sash, doors, cornices, panelwork, and other items of interior or exterior trim. Does not include flooring, ceiling, or siding.

**Mineral Streak.** An olive to greenish-black or brown discoloration of undetermined cause in hardwoods.

**Modified Wood.** Wood processed by chemical treatment, compression, or other means (with or without heat) to impart properties quite different from those of the original wood.

**Moisture Content.** The amount of water contained in the wood, usually expressed as a percentage of the weight of the oven-dry wood.

**Molecular Weight.** The sum of the atomic weights of the atoms in a molecule.

**Moulding.** A wood strip having a curved or projecting surface, used for decorative purposes.

**Monomer.** A relatively simple molecular compound that can react at more than one site to form a polymer.

**Mortise.** A slot cut into a board, plank, or timber, usually edgewise, to receive the tenon of another board, plank, or timber to form a joint.

**Nanoindentation Hardness.** A hardness measurement conducted at the nanometer scale. Nanoindentation hardness uses an extremely small indenter of a hard material and specified shape to press into the surface of a specimen with sufficient force to cause deformation.

**Naval Stores.** A term applied to the oils, resins, tars, and pitches derived from oleoresin contained in, exuded by, or

extracted from trees, chiefly species of pines (genus *Pinus*). Historically, these were important items in the stores of wood sailing vessels.

**Nominal-Size Lumber.** (See **Lumber for Dimension**.)

**Nonpolar.** (See **Polar**.)

**Nonpressure Process.** Any process of treating wood with a preservative or fire retardant where pressure is not applied. Some examples are surface applications by brushing or brief dipping, soaking in preservative oils, or steeping in solutions of waterborne preservatives; diffusion processes with waterborne preservatives; and vacuum treatments.

**Oil Paint.** A paint containing a suspension of pigments in an organic solvent and a drying oil, modified drying oil, or synthetic polymer that forms an opaque film through a combination of solvent evaporation and curing of the oil or polymer.

**Old Growth.** Timber in or from a mature, naturally established forest. When the trees have grown during most if not all of their individual lives in active competition with their companions for sunlight and moisture, this timber is usually straight and relatively free of knots.

**Oleoresin.** A solution of resin in an essential oil that occurs in or exudes from many plants, especially softwoods. The oleoresin from pine is a solution of pine resin (rosin) in turpentine.

**Open Assembly Time.** (See **Time, Assembly**.)

**Open Grain.** (See **Grain**.)

**Oriented Strandboard.** (See **Wood-Based Composite Panel**.)

**Oriented Strand Lumber (OSL).** (See **Structural Composite Lumber**.)

**Orthotropic.** Having unique and independent properties in three mutually orthogonal (perpendicular) planes of symmetry. A special case of anisotropy.

**Ovendry Wood.** Wood dried to a relatively constant weight in a ventilated oven at 102 to 105 °C (215 to 220 °F).

**Overlay.** A thin layer of paper, plastic, film, metal foil, or other material bonded to one or both faces of panel products or to lumber to provide a protective or decorative face or a base for painting.

**Paint.** Any pigmented liquid, liquifiable, or mastic composition designed for application to a substrate in a thin layer that converts to an opaque solid film after application.

**Pallet.** A low wood or metal platform on which material can be stacked to facilitate mechanical handling, moving, and storage.

**Paperboard.** The distinction between paper and paperboard is not sharp, but broadly speaking, the thicker (greater than



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0.3 mm (0.012 in.)), heavier, and more rigid grades of paper are called paperboard.

**Papreg.** Any of various paper products made by impregnating sheets of specially manufactured high-strength paper with synthetic resin and laminating the sheets to form a dense, moisture-resistant product.

**Parallel Strand Lumber (PSL).** (See **Structural Composite Lumber.**)

**Parenchyma.** Short cells having simple pits and functioning primarily in the metabolism and storage of plant food materials. They remain alive longer than the tracheids, fibers, and vessel elements, sometimes for many years. Two kinds of parenchyma cells are recognized—those in vertical strands, known more specifically as axial parenchyma, and those in horizontal series in the rays, known as ray parenchyma.

**Particleboard.** (See **Wood-Based Composite Panel.**)

**Particles.** The aggregate component of particleboard manufactured by mechanical means from wood. These include all small subdivisions of wood such as chips, curls, flakes, sawdust, shavings, slivers, strands, wafers, wood flour, and wood wool.

**Peck.** Pockets or areas of disintegrated wood caused by advanced stages of localized decay in the living tree. It is usually associated with cypress and incense-cedar. There is no further development of peck once the lumber is seasoned.

**Peel.** To convert a log into veneer by rotary cutting. In an adhesively bonded joint, the progressive separation of a flexible member from either a rigid member or another flexible member.

**Phloem.** The tissues of the inner bark, characterized by the presence of sieve tubes and serving for the transport of elaborate foodstuffs.

**Pile.** A long, heavy timber, round or square, that is driven deep into the ground to provide a secure foundation for structures built on soft, wet, or submerged sites (for example, landing stages, bridge abutments).

**Pin Knot.** (See **Knot.**)

**Pitch Pocket.** An opening extending parallel to the annual growth rings and containing, or that has contained, pitch, either solid or liquid.

**Pitch Streaks.** A well-defined accumulation of pitch in a more or less regular streak in the wood of certain conifers.

**Pith.** The small, soft core occurring near the center of a tree trunk, branch, twig, or log.

**Pith Fleck.** A narrow streak, resembling pith on the surface of a piece; usually brownish, up to several centimeters long; results from burrowing of larvae in the growing tissues of the tree.

**Plainsawn.** (See **Grain.**)

**Planing Mill Products.** Products worked to pattern, such as flooring, ceiling, and siding.

**Plank.** A broad, thick board laid with its wide dimension horizontal and used as a bearing surface.

**Plasticizing Wood.** Softening wood by hot water, steam, or chemical treatment to increase its moldability.

**Plywood.** (See **Wood-Based Composite Panel.**)

**Pocket Rot.** (See **Decay.**)

**Polar.** Characteristic of a molecule in which the positive and negative electrical charges are permanently separated, as opposed to nonpolar molecules in which the charges coincide. Water, alcohol, and wood are polar in nature; most hydrocarbon liquids are not.

**Polymer.** A compound formed by the reaction of simple molecules having functional groups that permit their combination to proceed to high molecular weights under suitable conditions. Polymers may be formed by polymerization (addition polymer) or polycondensation (condensation polymer). When two or more different monomers are involved, the product is called a copolymer.

**Polymerization.** A chemical reaction in which the molecules of a monomer are linked together to form large molecules whose molecular weight is a multiple of that of the original substance. When two or more different monomers are involved, the process is called copolymerization.

**Pore.** (See **Vessel Elements.**)

**Postformed Plywood.** (See **Wood-Based Composite Panel.**)

**Post Cure.** (1) A treatment (normally involving heat) applied to an adhesive assembly following the initial cure, to complete cure, or to modify specific properties. (2) To expose an adhesive assembly to an additional cure, following the initial cure; to complete cure; or to modify specific properties.

**Pot Life.** (See **Working Life.**)

**Precure.** Condition of too much cure, set, or solvent loss of the adhesive before pressure is applied, resulting in inadequate flow, transfer, and bonding.

**Preservative.** Any substance that, for a reasonable length of time, is effective in preventing the development and action of wood-rotting fungi, borers of various kinds, and harmful insects that deteriorate wood.

**Pressure Process.** Any process of treating wood in a closed container whereby the preservative or fire retardant is forced into the wood under pressures greater than one atmosphere. Pressure is generally preceded or followed by vacuum, as in the vacuum-pressure and empty-cell processes respectively;



or they may alternate, as in the full-cell and alternating-pressure processes.

**Progressive Kiln.** (See **Kiln.**)

**Psychrometer.** An instrument for measuring the amount of water vapor in the atmosphere. It has both a dry-bulb and wet-bulb thermometer. The bulb of the wet-bulb thermometer is kept moistened and is, therefore, cooled by evaporation to a temperature lower than that shown by the dry-bulb thermometer. Because evaporation is greater in dry air, the difference between the two thermometer readings will be greater when the air is dry than when it is moist.

**Quartersawn.** (See **Grain.**)

**Radial.** Coincident with a radius from the axis of the tree or log to the circumference. A radial section is a lengthwise section in a plane that passes through the centerline of the tree trunk.

**Radiofrequency (RF) Curing.** Curing of bondlines by the application of radiofrequency energy. (Sometimes called high-frequency curing.)

**Rafter.** One of a series of structural members of a roof designed to support roof loads. The rafters of a flat roof are sometimes called roof joists.

**Raised Grain.** A roughened condition of the surface of dressed lumber in which the hard latewood is raised above the softer earlywood but not torn loose from it.

**Rays, Wood.** Strips of cells extending radially within a tree and varying in height from a few cells in some species to 4 or more inches in oak. The rays serve primarily to store food and transport it horizontally in the tree. On quartersawn oak, the rays form a conspicuous figure, sometimes referred to as flecks.

**Reaction Wood.** Wood with more or less distinctive anatomical characters, formed typically in parts of leaning or crooked stems and in branches. In hardwoods, this consists of tension wood, and in softwoods, compression wood.

**Relative Humidity.** Ratio of the amount of water vapor present in the air to that which the air would hold at saturation at the same temperature. It is usually considered on the basis of the weight of the vapor but, for accuracy, should be considered on the basis of vapor pressures.

**Resilience.** The property whereby a strained body gives up its stored energy on the removal of the deforming force.

**Resin.** (1) Solid, semisolid, or pseudosolid resin—An organic material that has an indefinite and often high molecular weight, exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally. (2) Liquid resin—an organic polymeric liquid that, when converted to its final state for use, becomes a resin.

**Resin Ducts.** Intercellular passages that contain and transmit resinous materials. On a cut surface, they are usually inconspicuous. They may extend vertically parallel to the axis of the tree or at right angles to the axis and parallel to the rays.

**Retention by Assay.** The determination of preservative retention in a specific zone of treated wood by extraction or analysis of specified samples.

**Rheology.** The study of the deformation and flow of matter.

**Ring Failure.** A separation of the wood during seasoning, occurring along the grain and parallel to the growth rings. (See **Shake.**)

**Ring-Porous Woods.** A group of hardwoods in which the pores are comparatively large at the beginning of each annual ring and decrease in size more or less abruptly toward the outer portion of the ring, thus forming a distinct inner zone of pores, known as the earlywood, and an outer zone with smaller pores, known as the latewood.

**Ring Shake.** (See **Shake.**)

**Rip.** To cut lengthwise, parallel to the grain.

**Roll Spreading.** Application of a film of a liquid material to a surface by means of rollers.

**Room-Temperature-Setting Adhesive.** (See **Adhesive.**)

**Rot.** (See **Decay.**)

**Rotary-Cut Veneer.** (See **Veneer.**)

**Rough Lumber.** (See **Lumber.**)

**Sap Stain.** (See **Stain.**)

**Sapwood.** The wood of pale color near the outside of the log. Under most conditions, the sapwood is more susceptible to decay than heartwood.

**Sash.** A frame structure, normally glazed (such as a window), that is hung or fixed in a frame set in an opening.

**Sawn Veneer.** (See **Veneer.**)

**Saw Kerf.** (1) Grooves or notches made in cutting with a saw. (2) That portion of a log, timber, or other piece of wood removed by the saw in parting the material into two pieces.

**Scarf Joint.** (See **Joint.**)

**Schedule, Kiln Drying.** A prescribed series of dry- and wet-bulb temperatures and air velocities used in drying a kiln charge of lumber or other wood products.

**Seasoning.** Removing moisture from green wood to improve its serviceability.

**Air Dried**—Dried by exposure to air in a yard or shed, without artificial heat.

**Kiln Dried**—Dried in a kiln with the use of artificial heat.

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**Second Growth.** Timber that has grown after the removal, whether by cutting, fire, wind, or other agency, of all or a large part of the previous stand.

**Semitransparent Stain.** A suspension of pigments in either a drying oil–organic solvent mixture or a water–polymer emulsion, designed to color and protect wood surfaces by penetration without forming a surface film and without hiding wood grain.

**Set.** A permanent or semipermanent deformation. In reference to adhesives, to convert an adhesive into a fixed or hardened state by chemical or physical action, such as condensation, polymerization, oxidation, vulcanization, gelation, hydration, or evaporation of volatile constituents.

**Shake.** A separation along the grain, the greater part of which occurs between the rings of annual growth. Usually considered to have occurred in the standing tree or during felling.

**Shakes.** In construction, shakes are a type of shingle usually hand cleft from a bolt and used for roofing or weatherboarding.

**Shaving.** A small wood particle of indefinite dimensions developed incidental to certain woodworking operations involving rotary cutterheads usually turning in the direction of the grain. This cutting action produces a thin chip of varying thickness, usually feathered along at least one edge and thick at another and generally curled.

**Shear.** In an adhesively bonded joint, stress, strain, or failure resulting from applied forces that tends to cause adjacent planes of a body to slide parallel in opposite directions.

**Sheathing.** The structural covering, usually of boards, building fiberboards, plywood, or oriented strandboard, placed over exterior studding or rafters of a structure.

**Shelf Life.** (See **Storage Life.**)

**Shiplapped Lumber.** (See **Lumber.**)

**Shipping-Dry Lumber.** (See **Lumber.**)

**Shop Lumber.** (See **Lumber.**)

**Side Grained.** (See **Grain.**)

**Side Lumber.** (See **Lumber.**)

**Siding.** The finish covering of the outside wall of a frame building, whether made of horizontal weatherboards, vertical boards with battens, shingles, or other material.

**Slash Grained.** (See **Grain.**)

**Sliced Veneer.** (See **Veneer.**)

**Soft Rot.** (See **Decay.**)

**Softwoods.** Generally, one of the botanical groups of trees that have no vessels and in most cases have needlelike or scalelike leaves, the conifers, also the wood produced by

such trees. The term has no reference to the actual hardness of the wood.

**Solid Color Stains (Opaque Stains).** A suspension of pigments in either a drying oil–organic solvent mixture or a water–polymer emulsion designed to color and protect a wood surface by forming a film. Solid color stains are similar to paints in application techniques and in performance.

**Solids Content.** The percentage of weight of the nonvolatile matter in an adhesive.

**Solvent Adhesive.** (See **Adhesive.**)

**Sound Knot.** (See **Knot.**)

**Specific Adhesion.** Adhesion between surfaces that are held together by valence forces of the same type as those that give rise to cohesion.

**Specific Gravity.** As applied to wood, the ratio of the oven-dry weight of a sample to the weight of a volume of water equal to the volume of the sample at a specified moisture content (green, air dry, or oven-dry).

**Spike Knot.** (See **Knot.**)

**Spiral Grained.** (See **Grain.**)

**Spread.** The quantity of adhesive per unit joint area applied to an adherend. (See **Lbs/MSGL.**)

**Single spread**—Refers to application of adhesive to only one adherend of a joint.

**Double spread**—Refers to application of adhesive to both adherends of a joint.

**Squeezeout.** Bead of adhesive squeezed out of a joint when pressure is applied.

**Stain.** A discoloration in wood that may be caused by such diverse agencies as micro-organisms, metal, or chemicals. The term also applies to materials used to impart color to wood.

**Blue Stain**—A bluish or grayish discoloration of the sapwood caused by the growth of certain dark-colored fungi on the surface and in the interior of the wood; made possible by the same conditions that favor the growth of other fungi.

**Brown Stain**—A rich brown to deep chocolate-brown discoloration of the sapwood of some pines caused by a fungus that acts much like the blue-stain fungi.

**Chemical Brown Stain**—A chemical discoloration of wood, which sometimes occurs during the air drying or kiln drying of several species, apparently caused by the concentration and modification of extractives.

**Sap Stain**—A discoloration of the sapwood caused by the growth of certain fungi on the surface and in the interior of the wood; made possible by the same conditions that favor the growth of other fungi.

**Sticker Stain**—A brown or blue stain that develops in seasoning lumber where it has been in contact with the stickers.

**Starved Joint.** (See **Joint.**)

**Static Bending.** Bending under a constant or slowly applied load; flexure.

**Staypak.** Wood that is compressed in its natural state (that is, without resin or other chemical treatment) under controlled conditions of moisture, temperature, and pressure that practically eliminate springback or recovery from compression. The product has increased density and strength characteristics.

**Stickers.** Strips or boards used to separate the layers of lumber in a pile and thus improve air circulation.

**Sticker Stain.** (See **Stain.**)

**Storage Life.** The period of time during which a packaged adhesive can be stored under specific temperature conditions and remain suitable for use. Sometimes called shelf life.

**Straight Grained.** (See **Grain.**)

**Strand.** (1) A type of wood flake with a high aspect ratio which allows for orientation. It is used in oriented strand board, oriented strand lumber, and laminated strand lumber. (2) A wood element with a high aspect ratio manufactured from veneer. It is used in parallel strand lumber.

**Strength.** (1) The ability of a member to sustain stress without failure. (2) In a specific mode of test, the maximum stress sustained by a member loaded to failure.

**Strength Ratio.** The hypothetical ratio of the strength of a structural member to that which it would have if it contained no strength-reducing characteristics (such as knots, slope-of-grain, shake).

**Stress-Wave Timing.** A method of measuring the apparent stiffness of a material by measuring the speed of an induced compression stress as it propagates through the material.

**Stressed-Skin Construction.** A construction in which panels are separated from one another by a central partition of spaced strips with the whole assembly bonded so that it acts as a unit when loaded.

**Stringer.** A timber or other support for cross members in floors or ceilings. In stairs, the support on which the stair treads rest.

**Structural Composite Lumber (SCL).** (Wood elements glued together to form products that are similar in size to solid-sawn lumber)

**Laminated Strand Lumber (LSL)**—Similar to oriented strand lumber with somewhat longer strands.

**Laminated Veneer Lumber (LVL)**—Structural composite lumber manufactured from veneers laminated

into a panel with the grain of all veneer running parallel to each other. The resulting panel is ripped to common lumber dimensions.

**Oriented Strand Lumber (OSL)**—Structural composite lumber made from wood strand elements similar to those used in oriented strand board. The strands are oriented primarily along the length of the member.

**Parallel Strand Lumber (PSL)**—Structural composite lumber made from high aspect ratio wood strand elements manufactured from veneer oriented primarily along the length of the member. It is manufactured in billets and cut to lumber dimensions.

**Structural Lumber.** (See **Lumber.**)

**Structural Timbers.** Pieces of wood of relatively large size, the strength or stiffness of which is the controlling element in their selection and use. Examples of structural timbers are trestle timbers (stringers, caps, posts, sills, bracing, bridge ties, guardrails); car timbers (car framing, including upper framing, car sills); framing for building (posts, sills, girders); ship timber (ship timbers, ship decking); and crossarms for poles.

**Stud.** One of a series of slender wood structural members used as supporting elements in walls and partitions.

**Substrate.** A material upon the surface of which an adhesive-containing substance is spread for any purpose, such as bonding or coating. A broader term than adherend. (See **Adherend.**)

**Surface Inactivation.** In adhesive bonding to wood, physical and chemical modifications of the wood surface that result in reduced ability of an adhesive to properly wet, flow, penetrate, and cure.

**Surface Tension.** The force per unit length acting in the surface of a liquid that opposes the increase in area of the liquid (spreading).

**Surfaced Lumber.** (See **Lumber.**)

**Symmetrical Construction.** Panels in which the plies on one side of a center ply or core are essentially equal in thickness, grain direction, properties, and arrangement to those on the other side of the core.

**Tack.** The property of an adhesive that enables it to form a bond of measurable strength immediately after adhesive and adherend are brought into contact under low pressure.

**Tangential.** Strictly, coincident with a tangent at the circumference of a tree or log, or parallel to such a tangent. In practice, however, it often means roughly coincident with a growth ring. A tangential section is a longitudinal section through a tree or limb perpendicular to a radius. Flat-grained lumber is sawed tangentially.

**Temperature, Curing.** The temperature to which an adhesive or an assembly is subjected to cure the adhesive. The

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temperature attained by the adhesive in the process of curing (adhesive curing temperature) may differ from the temperature of the atmosphere surrounding the assembly (assembly curing temperature).

**Temperature, Setting.** (See **Temperature, Curing.**)

**Tenon.** A projecting member left by cutting away the wood around it for insertion into a mortise to make a joint.

**Tension.** In an adhesively bonded joint, a uniaxial force tending to cause extension of the assembly, or the counteracting force within the assembly that resists extension.

**Tension Wood.** Abnormal wood found in leaning trees of some hardwood species and characterized by the presence of gelatinous fibers and excessive longitudinal shrinkage. Tension wood fibers hold together tenaciously, so that sawed surfaces usually have projecting fibers and planed surfaces often are torn or have raised grain. Tension wood may cause warping.

**Texture.** A term often used interchangeably with grain. Sometimes used to combine the concepts of density and degree of contrast between earlywood and latewood. In this handbook, texture refers to the finer structure of the wood rather than the annual rings. (See also **Grain.**)

**Thermoplastic.** (1) Capable of being repeatedly softened by heat and hardened by cooling. (2) A material that will repeatedly soften when heated and harden when cooled.

**Thermoset.** A cross-linked polymeric material.

**Thermosetting.** Having the property of undergoing a chemical reaction by the action of heat, catalyst, ultraviolet light, and hardener, leading to a relatively infusible state.

**Timbers, Round.** Timbers used in the original round form, such as poles, piling, posts, and mine timbers.

**Timber, Standing.** Timber still on the stump.

**Timbers.** (See **Lumber.**)

**Time, Assembly.** The time interval between the spreading of the adhesive on the adherend and the application of pressure or heat, or both, to the assembly. (For assemblies involving multiple layers or parts, the assembly time begins with the spreading of the adhesive on the first adherend.)

**Open Assembly Time**—The time interval between the spreading of the adhesive on the adherend and the completion of assembly of the parts for bonding.

**Closed Assembly Time**—The time interval between completion of assembly of the parts for bonding and the application of pressure or heat, or both, to the assembly.

**Time, Curing.** The period during which an assembly is subjected to heat or pressure, or both, to cure the adhesive.

**Time, Setting.** (See **Time, Curing.**)

**Toughness.** A quality of wood that permits the material to absorb a relatively large amount of energy, to withstand repeated shocks, and to undergo considerable deformation before breaking.

**Tracheid.** The elongated cells that constitute the greater part of the structure of the softwoods (frequently referred to as fibers). Also present in some hardwoods.

**Transfer.** In wood bonding, the sharing of adhesive between a spread and an unspread surface when the two adherends are brought into contact.

**Transverse.** Directions in wood at right angles to the wood fibers. Includes radial and tangential directions. A transverse section is a section through a tree or timber at right angles to the pith.

**Treenail.** A wooden pin, peg, or spike used chiefly for fastening planking and ceiling to a framework.

**Trim.** The finish materials in a building, such as moldings, applied around openings (window trim, door trim) or at the floor and ceiling of rooms (baseboard, cornice, and other moldings).

**Truss.** An assembly of members, such as beams, bars, rods, and the like, so combined as to form a rigid framework. All members are interconnected to form triangles.

**Twist.** A distortion caused by the turning or winding of the edges of a board so that the four corners of any face are no longer in the same plane.

**Tyloses.** Masses of parenchyma cells appearing somewhat like froth in the pores of some hardwoods, notably the white oaks and black locust. Tyloses are formed by the extension of the cell wall of the living cells surrounding vessels of hardwood.

**Ultrasonics.** (See **Stress-Wave Timing.**)

**van der Waal Forces.** Physical forces of attraction between molecules, which include permanent dipole, induced dipole, hydrogen bond, and London dispersion forces.

**Vapor Retarder.** A material with a high resistance to vapor movement, such as foil, plastic film, or specially coated paper, that is used in combination with insulation to control condensation.

**Veneer.** A thin layer or sheet of wood.

**Rotary-Cut Veneer**—Veneer cut in a lathe that rotates a log or bolt, chucked in the center, against a knife.

**Sawn Veneer**—Veneer produced by sawing.

**Sliced Veneer**—Veneer that is sliced off a log, bolt, or flitch with a knife.

**Vertical Grained.** (See **Grain.**)



**Vessel Elements.** Wood cells in hardwoods of comparatively large diameter that have open ends and are set one above the other to form continuous tubes called vessels. The openings of the vessels on the surface of a piece of wood are usually referred to as pores.

**Virgin Growth.** The growth of mature trees in the original forests.

**Viscoelasticity.** The ability of a material to simultaneously exhibit viscous and elastic responses to deformation.

**Viscosity.** The ratio of the shear stress existing between laminae of moving fluid and the rate of shear between these laminae.

**Wane.** Bark or lack of wood from any cause on edge or corner of a piece except for eased edges.

**Warp.** Any variation from a true or plane surface. Warp includes bow, crook, cup, and twist, or any combination thereof.

**Water Repellent.** A liquid that penetrates wood that materially retards changes in moisture content and dimensions of the dried wood without adversely altering its desirable properties.

**Water-Repellent Preservative.** A water repellent that contains a preservative that, after application to wood and drying, accomplishes the dual purpose of imparting resistance to attack by fungi or insects and also retards changes in moisture content.

**Weathering.** The mechanical or chemical disintegration and discoloration of the surface of wood caused by exposure to light, the action of dust and sand carried by winds, and the alternate shrinking and swelling of the surface fibers with the continual variation in moisture content brought by changes in the weather. Weathering does not include decay.

**Wet Strength.** The strength of an adhesive joint determined immediately after removal from water in which it has been immersed under specified conditions of time, temperature, and pressure.

**Wet-Bulb Temperature.** The temperature indicated by the wet-bulb thermometer of a psychrometer.

**Wettability.** A condition of a surface that determines how fast a liquid will wet and spread on the surface or if it will be repelled and not spread on the surface.

**Wetting.** The process in which a liquid spontaneously adheres to and spreads on a solid surface.

**White-Rot.** (See **Decay.**)

**Wood-Based Composite Panel.** A generic term for a material manufactured from wood veneer, strands, flakes, particles, or fibers or other lignocellulosic material and a synthetic resin or other binder.

**Cellulosic Fiberboard**—A generic term for a low-density panel made from lignocellulosic fibers characterized by an integral bond produced by interfelted of the fibers, to which other materials may have been added during manufacture to improve certain properties, but which has not been consolidated under heat and pressure as a separate stage in manufacture; has a density of less than 496 kg m<sup>-3</sup> (31 lb ft<sup>-3</sup>) (specific gravity 0.50 ) but more than 160 kg m<sup>-3</sup> (10 lb ft<sup>-3</sup>) (specific gravity 0.16).

**Exterior Plywood**—A general term for plywood bonded with a type of adhesive that by systematic tests and service records has proved highly resistant to weather; microorganisms; cold, hot, and boiling water; steam; and dry heat.

**Fiberboard**—A generic term inclusive of panel products of various densities manufactured of refined or partially refined wood (or other lignocellulosic) fibers. Bonding agents may be added.

**Flakeboard**—A generic term indicating a manufactured panel product composed of flakes bonded with a synthetic resin.

**Hardboard**—A generic term for a panel manufactured primarily from interfelted lignocellulosic fibers (usually wood), consolidated under heat and pressure in a hot press to a density of 496 kg m<sup>-3</sup> (31 lb ft<sup>-3</sup>) or greater. May be manufactured using either a dry-process or wet-process.

**Interior Plywood**—A general term for plywood manufactured for indoor use or in construction subjected to only temporary moisture. The adhesive used may be interior, intermediate, or exterior.

**Medium-Density Fiberboard**—A dry-process fiberboard manufactured from lignocellulosic fibers combined with a synthetic resin or other suitable binder. The panels are manufactured to a density of 496 kg m<sup>-3</sup> (31 lb ft<sup>-3</sup>) (0.50 specific gravity) to 880 kg m<sup>-3</sup> (55 lb ft<sup>-3</sup>) (0.88 specific gravity) by the application of heat and pressure by a process in which the interfiber bond is substantially created by the added binder.

**Oriented Strandboard**—A type of flakeboard product composed of strand-type flakes that are purposefully aligned in directions that make a panel stronger, stiffer, and with improved dimensional properties in the alignment directions than a panel with random flake orientation.

**Particleboard**—A panel product manufactured from wood particles usually in three layers. For good surface characteristics, the outer layers have smaller particles and the interior uses coarser particles. The particles in the core may or may not be aligned.

**Plywood**—A glued wood panel made up of relatively thin layers of veneer with the grain of adjacent layers at right



## Glossary

angles or of veneer in combination with a core of lumber or of reconstituted wood. The usual constructions have an odd number of layers.

**Wood Failure.** The rupturing of wood fibers in strength tests of bonded joints usually expressed as the percentage of the total area involved that shows such failure. (See **Failure, Adherend.**)

**Wood Flour.** Wood reduced to finely divided particles, approximately the same as those of cereal flours in size, appearance, and texture, and passing a 40 to 100 mesh screen.

**Wood Substance.** The solid material of which wood is composed. It usually refers to the extractive-free solid substance of which the cell walls are composed, but this is not always true. There is not a wide variation in chemical composition or specific gravity between the wood substance of various species. (The characteristic differences of species are largely due to differences in extractives and variations in relative amounts of cell walls and cell cavities.)

**Wood-Thermoplastic Composite.** Manufactured composite materials consisting primarily of wood elements and thermoplastic. The wood element may either serve as a reinforcement or filler in a continuous thermoplastic matrix, or the thermoplastic may act as a binder to the wood element.

**Wood Wool.** Long, curly, slender strands of wood used as an aggregate component for some particleboards and cement-bonded composites. Sometimes referred to as excelsior.

**Workability.** The degree of ease and smoothness of cut obtainable with hand or machine tools.

**Working Life.** The period of time during which an adhesive, after mixing with catalyst, solvent, or other compounding ingredients, remains suitable for use. Also called pot life.

**Working Properties.** The properties of an adhesive that affect or dictate the manner of application to the adherends to be bonded and the assembly of the joint before pressure application (such as viscosity, pot life, assembly time, setting time).

**Xylem.** The portion of the tree trunk, branches, and roots that lies between the pith and the cambium (that is the wood).

**Yard Lumber.** (See **Lumber.**)