Architectural Woodwork Standards

LUMBER

SECTION 3
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# Section 3

## Lumber

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INTRODUCTION

Section 3 is the first of two “material” sections and covers hardwood and softwood lumber. Included is a basic primer identifying wood characteristics and considerations. Basic rules pertaining to all solid wood as well as specific Hardwood Rules and Softwood Rules make up most of this section.

Quality assurance can be achieved by adherence to the AWS and will provide the owner a quality product at competitive pricing. Use of a qualified Sponsor Member firm to provide your woodwork will help ensure the manufacturer’s understanding of the quality level required. Illustrations in this Section are not intended to be all inclusive, other engineered solutions may be acceptable. In the absence of specifications; methods of fabrication are the manufacturer’s choice. The design professional, by specifying compliance to the AWS increases the probability of receiving the product quality expected.

LUMBER

Lumber used in architectural woodwork is divided into two groups:

- **Hardwoods**: Lumber obtained from angiosperms, usually deciduous trees (broad leaf trees). There are more angiosperms on Earth than any other plant group, over 200,000 species. About 900 of those species are commonly available for lumber or veneer throughout the world.

- **Softwoods**: Lumber obtained from gymnosperms, about 600 of which are coniferous trees such as pine, spruce and fir. The gymnosperms are among the largest and oldest living plants.

The above groups have no relationship to the density or “hardness” within or between various species. Some softwoods are harder than some hardwoods, and hardness varies greatly between species within each group.

ARCHITECTURAL WOODWORK STANDARDS (AWS)

The selection of the proper wood species for an architectural design can be the end result of a number of contributing factors and conditions. Intended use, costs, hardness, and relative stability are among many important considerations.

Lumber grades should always be referenced when specifying architectural woodwork. Selection of an AWS Grade (Economy, Custom, or Premium) for the finished product will define both materials and workmanship for that product. Lumber grades defined by the lumber manufacturers’ associations allow some defects which the manufacturer must remove (cut out), or otherwise work around (by gluing, etc.).

The architect and designer may make his selection from a large variety of foreign and domestic species, now commercially available. The unique quality that wood imparts to design is that each species has its own distinguishing characteristics. Once the species is chosen, its effectiveness may vary according to the manner in which it is sawn, sliced as veneer, treated, and finished.

This Section is designed to advise the architect and designer in the comparisons, considerations, and species which should be evaluated before decisions are made and specifications are written. This Section will help you correlate and tabulate the information needed. An informed choice will reward the owner with the best possible performance by a natural building material.

WOOD AS A PLANT

The trunk and its branches: The cross section of a tree shows the following well-defined features in succession from the outside to the center: (1) bark and cambium layer, (2) wood, which in most species is clearly differentiated into sapwood and heartwood, and (3) pith, the small central core. The pith and bark, of course, are excluded from finished lumber.

Most branches originate at the pith, and their bases are inter-grown with the wood of the trunk as long as they are alive. These living branch bases constitute inter-grown or tight knots. After the branches die, their bases continue to be surrounded by the wood of the growing trunk and therefore loose or encased knots are formed. After the dead branches fall off, the stubs become overgrown, and subsequently clear wood is formed.

Growth in thickness takes place in the cambium layer by cell division. No growth in either diameter or length takes place in wood already formed; new growth is purely the addition of new cells, not the further development of existing cells.

ANNUAL RINGS

Most species grown in temperate climates produce well-defined annual growth rings, which are formed by the difference in density and color between wood formed early and late in the growing season. The inner part of the growth ring formed first is called “spring wood,” and the outer part formed later in the growing season is called “summer wood.”

Spring wood is characterized by cells having relatively large cavities and thin walls. Summer wood cells have smaller cavities and thicker walls, and consequently are more dense than spring wood. The growth rings, when exposed by conventional methods of sawing, provide the grain or characteristic pattern of the wood. The distinguishing features of the various species are thereby enhanced by the differences in growth ring formation.

Some tropical species, on the other hand, experience year long even growth which may result in less obvious growth rings.

SOFTWOODS and HARDWOODS

Native species of trees and the wood produced by these trees are divided into two botanical classes: hardwoods, which have broad leaves; and softwoods, which have needle-like or scale-like leaves. This botanical classification is sometimes confusing, because there is no direct correlation between calling a species a hardwood or softwood and the hardness or softness of the wood itself. Generally, hardwoods are more dense than softwoods, but some hardwoods are softer than many softwoods. If hardness is a desired characteristic, refer to the Comparative Table of Wood Species later in this section.

HEARTWOOD

Heartwood consists of inactive cells formed by changes in the living cells of the inner sapwood rings, presumably after their use for sap conduction and other life processes of the tree have largely ceased. The cell cavities of heartwood may also contain deposits of various materials that frequently provide a much darker color. Not all heartwood, however, is darker.
Photodegradation is the effect on the appearance of exposed wood faces caused by exposure to both sun and artificial light sources. If an entire face is exposed to a light source, it will photodegrade somewhat uniformly and hardly be noticeable, whereas partially exposed surfaces or surfaces with shadow lines might show nonuniform photodegradation. Some woods, such as American Cherry, Fir and Walnut, are more susceptible than others, and extra care should be taken to protect against the effects of nonuniform photodegradation.

OXIDATION
Oxidation is the effect on the appearance of exposed wood faces caused by exposure to atmosphere. This is analogous to browning reactions in freshly cut fruit; for instance, apples. Hardwoods can develop deep yellow to reddish brown discolorations on the surface of the wood when exposed to air immediately after sawing or peeling.

MEDULLARY RAYS
Medullary rays extend radially from the pith of the log toward the circumference. The rays serve primarily to store food and transport it horizontally. They vary in height from a few cells in some species to four or more inches in the Oaks, and produce the fleck (sometimes called flake) effect common to the quarter-sawn lumber in these species.

PHOTODEGRADATION
Photodegradation is the effect on the appearance of exposed wood faces caused by exposure to both sun and artificial light sources. If an entire face is exposed to a light source, it will photodegrade somewhat uniformly and hardly be noticeable, whereas partially exposed surfaces or surfaces with shadow lines might show nonuniform photodegradation. Some woods, such as American Cherry, Fir and Walnut, are more susceptible than others, and extra care should be taken to protect against the effects of nonuniform photodegradation.

COMPARATIVE TABLE OF WOOD SPECIES
In order to simplify species selection, the following Comparative Table of Wood Species has been prepared showing pertinent characteristics of some species of domestic and foreign woods used by the architectural woodwork industry. The table can aid a design professional in proper species selection after studying the characteristics.

- **Cost** has been broken into Low, Moderate, High, and Very High (V. High). The cost of lumber, as with other commodities, is influenced by supply and demand, both of which are constantly changing.
- **Hardness** is broken into Soft, Medium, Hard and Very Hard and takes into consideration the ability of the lumber species to sustain stress; resist indentation, abuse and wear; and to carry its anticipated load in applications such as shelving and structural members.
- **Dimensional stability** is helpful in selecting woods for use where humidity conditions may vary widely and where design or fabrication of a wood product does not allow free movement or the use of sheet products. The column figures indicate extreme conditions and show the maximum amount of movement possible in a 12" (305 mm) wide piece of unfinished wood where its moisture content increases or decreases from 10% to 5%. The possible change in dimension demonstrates that unfinished interior woodwork must be carefully protected prior to finishing by keeping it in rooms where relative humidity is between 25% and 55%. The column also shows the variation between species, and between flat grain and edge grain where such cuts are available commercially.
## Table: 3-002 - COMPARATIVE WOOD SPECIE VALUES

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<td>Length</td>
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<td></td>
<td></td>
<td>in</td>
<td>in</td>
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<tr>
<td>Alder, Red</td>
<td>Low</td>
<td>1-1/2&quot;</td>
<td>5-1/2&quot;</td>
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</tr>
<tr>
<td>Anigre</td>
<td>High</td>
<td>1-1/2&quot;</td>
<td>5-1/2&quot;</td>
<td>12'</td>
</tr>
<tr>
<td>Ash, White</td>
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<td>2-1/2&quot;</td>
<td>5-1/2&quot;</td>
<td>12'</td>
</tr>
<tr>
<td>Basswood</td>
<td>Low</td>
<td>2-1/2&quot;</td>
<td>5-1/2&quot;</td>
<td>10'</td>
</tr>
<tr>
<td>Beech, American</td>
<td>Low</td>
<td>1-1/2&quot;</td>
<td>5-1/2&quot;</td>
<td>12'</td>
</tr>
<tr>
<td>Beech, European</td>
<td>Moderate</td>
<td>2-1/2&quot;</td>
<td>7-1/2&quot;</td>
<td>16'</td>
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<td>Birch, Yellow - natural</td>
<td>Moderate</td>
<td>1-1/2&quot;</td>
<td>5-1/2&quot;</td>
<td>12'</td>
</tr>
<tr>
<td>Birch, Yellow - select red</td>
<td>Moderate</td>
<td>1-1/2&quot;</td>
<td>4-1/2&quot;</td>
<td>11'</td>
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<tr>
<td>Birch, Yellow - select white</td>
<td>Moderate</td>
<td>1-1/2&quot;</td>
<td>4&quot;</td>
<td>11'</td>
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<td>Cedar, Western Red</td>
<td>High</td>
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<td>16'</td>
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<td>Cherry, American Black</td>
<td>High</td>
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<td>7&quot;</td>
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<td>Fir, Douglas - flat grain</td>
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<td>Hickory, True Group</td>
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<td>12'</td>
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<td>Mahogany, African - plain sawn</td>
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<td>9&quot;</td>
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<td>15'</td>
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<tr>
<td>Mahogany, American</td>
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<td>Makore</td>
<td>High</td>
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<td>Oak, Red - rift sawn</td>
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<td>Redwood, vert. grain heartwood</td>
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<td>16'</td>
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<tr>
<td>Teak</td>
<td>V. High</td>
<td>1-1/2&quot;</td>
<td>5-1/2&quot;</td>
<td>8'</td>
</tr>
<tr>
<td>Walnut, American Black</td>
<td>Moderate</td>
<td>2-1/2&quot;</td>
<td>4&quot;</td>
<td>6'</td>
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</tbody>
</table>

(1) Market conditions will cause these relationships to vary. These are raw costs without consideration of labor.
(2) Maximum practical sizes without laminating/gluing. Only 10% of any order is required to be at maximum sizes.
(3) These figures represent possible width change in a 12" (304.8 mm) board when moisture content is reduced from 10% to 5%. Figures taken are for plain sawn unless indicated otherwise in the species column.
ALDER, RED (Alnus rubra)

Red Alder (also known as Oregon, Pacific Coast and Western Alder) has become an important utility lumber. Stable, economical and plentiful, it is used as a core for veneer and in the solid for mass produced furniture. The inner bark turns a reddish orange when exposed to the air, hence the name. Sourced predominately from the states of Oregon and Washington. Varies in color from almost white to pale pinkish brown and there is no visible boundary between heartwood and sapwood. Moderately light in weight and intermediate in most strength properties with relatively low shrinkage.

ANIGRE (Aningeria poteria)

Anigre grows in Africa and is most common in the tropical areas of east Africa. The color varies from light yellowish brown with a pinkish tinge in the heartwood to golden brown. The grain is straight with uniform texture but can be wavy producing a mottled figure. Overall working characteristics are fair. Good nailing, screwing, gluing and staining properties. Used for cabinetwork and furniture.

ASH, WHITE (Fraxinus americana)

While White Ash has always enjoyed widespread use for industrial products where hardness, shock resistance, stability and strength were important, its acceptance for architectural woodwork is increasing. It is open grained and has a strong and pronounced grain pattern. The heartwood is light tan or brown and its sapwood creamy white. Color contrast between the two is minor and its blonde effect makes it particularly appealing when a light or near natural finish is desired. Finished with darker tones it presents a bold effect. Its cost is moderate and it is readily available in lumber form. In veneered form some size limitation may be experienced but it can be easily produced on special order.

BASSWOOD (Tilia americana)

Basswood is well suited to woodcarving and pattern making. Its critical quality is there being no contrast between early wood and late wood. This is unusual in wood, as normally the late wood would tear as you attempt to work against its natural bias. Otherwise basswood is almost featureless. Creamy white to light tan in color with a pink hue; yellows when a finish is applied. Has a straight grain with fine and even texture. Shrinkage in width and thickness during drying is high; however, seldom warps in use.

BEECH, AMERICAN (Fagus grandfolia)

Beech grows in Eastern U.S. and adjacent Canadian Provinces. Color varies from nearly white sapwood to reddish brown heartwood; however, sometimes there is no clear demarcation between them. Heavy in weight with hard and strong properties that are highly suitable for steam bending. Machines smoothly, wears well, is well suited for turning and is easily treated with preservatives. Used for flooring, furniture, veneer, woodwork and when treated, for railroad ties.

BEECH, EUROPEAN (Fagus sylvatica)

European Beech grows from the southern parts of Scandinavia to Sicily and from the French Atlantic coast to Poland. The color varies from pale pink brown heartwood to reddish brown tone when steamed and may have some dark veining. The grain is straight and fine with an even texture. The steam bending properties are exceptionally good. Stains well and is permeable for preservation treatment. Used for cabinetwork, furniture, flooring, heavy construction and marine piling (when pressure treated).

BIRCH, YELLOW - natural, select red, select white (Betula alleghaniensis)

Yellow Birch has been and continues to be one of the prominent wood species used for architectural woodwork. This is due not only to its attractive appearance but also to its general availability both as lumber and as veneered products, its adaptability to either paint or transparent finish, and its abrasion resistance. The heartwood of the tree varies in color from medium to dark brown or reddish brown while its sapwood, which comprises a better than average portion of the tree, is near white. Despite its wide usage some confusion exists as to the common terms used to describe Birch lumber and/or veneer. Virtually all commercially used Birch is cut from the Yellow Birch tree, not from the White Birch tree, which botanically is a distinct species. The term “Natural” or “Unselected” Birch means that the lumber or veneer may contain both the sapwood, or white portion, as well as the heartwood, or dark portion, of the tree in unrestricted amounts. The term “Select Red” Birch describes the lumber or veneer produced from the heartwood portion of the tree, and the term “Select White” Birch describes the lumber or veneer produced from the sapwood portion of the tree. To obtain “Red” or “White” Birch exclusively requires selective cutting with corresponding cost premium as well as considerable restriction on the width and length availability in lumber form. Birch, in veneer form, is readily available in all “selections” and is usually rotary cut. While some sliced veneer is produced which simulates the same grain effect as lumber, its availability and cost reflect the same cutting restrictions that are incurred in producing the “select” forms of Birch lumber.

CEDAR, WESTERN RED (Thuja plicata)

Found in the Pacific Northwest and along the Pacific Coast to Alaska. With nearly white sapwood which is typically narrow, its heartwood runs reddish or pinkish brown to dull brown. It is generally straight grained with uniform coarse grain. With very low shrinkage, its lightweight, moderately soft, low in strength; however, very resistant to decay. Principally used for shingles, exterior siding, decks, standing and running trim, sash and doors.
CHERRY, AMERICAN BLACK (Prunus serotina)

Wild Black American Cherry is a fine and especially stable close grained cabinet and veneer wood. Its heartwood color ranges from light to medium reddish brown. Its sapwood, which is a light creamy color, is usually selectively eliminated from the veneer and lumber. In some respects it resembles Red Birch, but has a more uniform grain and is further characterized by the presence of small dark gum spots which, when sound, are not considered as defects but add to its interest. Cherry is available in moderate supply as lumber and architectural paneling and is usually plain sawn or sliced. Exceptionally rich appearance is achieved with transparent finishes which, together with its machining characteristics, justifies its identity with Early American cabinetry and furniture manufacturing, thus adding to its prestige as one of our most desirable native woods.

HICKORY, TRUE GROUP (Carya ovata, glabra, and lacinosa)

Harvested typically in the Middle to Southern Atlantic and Central U.S. The sapwood is white and usually quite wide with reddish heartwood. It is extremely tough, heavy, hard, strong and experiences considerable shrinkage in drying. Typically used for implement handles, ladder rungs, furniture and flooring.

MAHOGANY, AFRICAN - (Khaya ivorensis)

This, one of the true Mahoganies, is perhaps the most widely used of the several Mahogany species. This is due to its excellent cutting and working characteristics and versatility. While its use has been largely for interior purposes, its innate stability and moderate decay resistance justifies its consideration for selected and demanding exterior applications. It has a very pleasing open grain, with its heartwood ranging in color from light to medium dark reddish brown. In lumber form it is more readily available as plain sawn and selectively so as quartersawn. In veneer form the quarter or “ribbon striped” cut predominates, but plain sliced, as well as many of the exotic “figure” cuts, can be produced on special order.

MAHOGANY, AMERICAN - (Swietenia macrophylla - CITES listed)

This Mahogany species is commonly known as “Honduras Mahogany,” but actually encompasses all of this species that grow throughout Mexico, Brazil, Peru, and Central America. Its traditional identity with casework and furniture justifies its position as one of the finest woods for this purpose. Its stability, workability, warm appearance, and firm grain make it a favorite of all woodworking craftsmen. It is a semi open grain wood, with its heartwood color ranging from light tan to a rich golden brown depending to some extent on the country of its origin. Its outstanding stability and decay resistance expands its potential to include exterior applications for “monumental” projects. It is most generally available as plain sawn lumber and plain sliced veneer with different veneer cuts available on special order.

MAKORE (Tieghemella heckelii, Tieghemella africana)

Makore grows in Western and Middle Africa. The color varies from pink to reddish brown. The grain has a fine texture with closed pores and can be straight, interlocked or wavy. Generally easy to work, although sections with interlocked grain can cause tear out during planing. Suitable for turning and is easy to glue and finish. Used for cabinetwork, furniture, flooring, boat building and turned objects.

MAPLE, SOFT GROUP (Acer saccharinum, rubrum, negundo and macrophyllum)

Typically found in Eastern U.S. with some in the Oregon Pacific Coast. Similar in appearance to hard Maple, heartwood is somewhat lighter in color than sapwood and wider. Soft Maple is not as heavy, hard or strong as Hard Maple. Typically used for railroad ties, furniture, veneer and wooden ware.

MAPLE, HARD GROUP - natural or select white (Acer saccharum and nigrum)

Hard Maple is very similar in general characteristics to Yellow Birch. It is heavy, hard, strong, and resistant to shock and abrasion. The heartwood of the tree is reddish brown and its sapwood is near white with a slight reddish brown tinge. Another natural characteristic is the prevalence of dark mineral streaks (predominantly in the heartwood), which can be minimized in the sapwood by selective cutting. Like Birch, common usage of descriptive terms does occasion some confusion. The term “Natural” or “Unselected” Maple indicates that the lumber or veneer may contain both the white sapwood and the darker heartwood. The term “White” Maple means that the lumber or veneer is selected and separated from the pieces containing the dark heartwood. Unlike Birch, the heartwood is so low in content that no comparable selection is available. Maple’s close identity with furniture and specialized industrial use overshadows its potential for architectural woodwork. Its modest cost, and pleasing, mild grain pattern warrants its consideration, especially on items subject to hard usage.
OAK, ENGLISH BROWN (Quercus robur)

The English Brown Oak, or Pollard Oak is a tree which varies in height from 60’-130’ (18-40 m) depending on soil conditions. It varies in color from a light tan to a deep brown with occasional black spots. It produces burrs and swirls which are very brittle and fragile, but beautiful wood can be obtained with their use. English Brown Oak is considered one of the finest woods in use today. English Brown Oak is obtained from trees which have had their tops cut out before reaching maturity. This pruning leads to the production of a number of new branches around the cut, and if these are subsequently lopped off, more new branches are formed. This wood is difficult to season and to work, tending to warp and twist in drying and to tear in working. The best figure is obtained from trees which have been cut out regularly every few years, the branches never being left sufficiently long for the production of large knots. The constant exposure of freshly cut surfaces promotes attack from parasites, the result being that a considerable portion of these trees become decayed sooner or later. This has made the timber relatively scarce and costly.

OAK, RED - (Quercus rubra)

Red Oak is one of the most abundant of our domestic hardwoods. Its moderate cost, strength, wearability, and appealing grain characteristics make its use widespread. It is open grained and in its plain sawn or sliced form expresses a very straight grained effect or frequently quarter sawn, producing straight grain, but with the fleck (sometimes called flake) of the medullary ray accentuated. Some sacrifice in width and length availability occurs when producing either rift or quarter sawn lumber.

OAK, WHITE (Quercus alba)

White Oak, like Red Oak, is perhaps one of the best known hardwoods in the world, and its use for architectural woodwork is widespread. It is hard and strong. Its heartwood has good weathering characteristics, making its use for selected exterior applications appropriate. It is open grained and in its plain sawn form is highly figured. The heartwood varies considerably in color from light grayish tan to brown, making the maintenance of color consistency difficult. Its sapwood is much lighter in color, is fairly prevalent, and its elimination is accomplished by selective ripping. White Oak is often rift sawn or sliced, producing a very straight grained effect or frequently quarter sawn or sliced, producing straight grain, but with the fleck (sometimes called flake) of the medullary ray greatly pronounced. The special cuts mentioned are more readily attained in veneer form since the solid lumber cutting techniques greatly restrict its width and length potential.

PINE, SOUTHERN YELLOW - short leaf (Pinus echinata)

Southern Yellow Pine, commonly called Short Leaf Pine, is commercially important in Arkansas, Virginia, Missouri, Louisiana, Mississippi, Texas, and South and North Carolina, and is found in varying abundance from New York and south central Pennsylvania, south and westerly to eastern Texas and Oklahoma. The yellowish wood is noticeably grained, moderately hard, strong, and stiff. A cubic foot of air dried Southern Yellow Pine weighs 36 to 39 pounds. It is used extensively in house building, including framing, ceiling, weather boarding, panels, window and door frames, casing, and carved work. The grain shows well in natural finish or when stained. Frames of overstuffed furniture, chairs, desks, agricultural machinery, wood pulp, mine props, barrels, and crates are also made of this Pine.

PINE, SUGAR (Pinus lambertiana)

The world’s largest species of pine typically found in California and South Western Oregon. It’s heartwood is buff to light brown and sometimes tinged with red. It’s straight grained with fairly uniform texture, low shrinkage and dimensionally stable, lightweight, soft, and moderately low in strength and stiffness. Used almost exclusively for boxes, sashes, doors, frames, general millwork and foundry patterns.

PECAN (see Hickory, Pecan Group)

PINE, PONDEROSA (Pinus ponderosa)

Ponderosa Pine is said to be the softwood species most commonly used for exterior and interior woodwork components. Its heartwood is tannish pink while its sapwood is a lighter creamy pink. Its supply is extensive; found in commercial quantities in every state west of the Great Plains. Ponderosa Pine grows in pure stands and is abundant in mixed stands. Also, like most Pines, the proportion of sapwood is high and its heartwood has only a moderate natural decay resistance. Fortunately, its receptivity to preservative treatment is high, and since all Pines should be so treated when used on the exterior, it can be used interchangeably with them.

PINE, EASTERN WHITE (Pinus strobus)

Found from Maine to Northern Georgia and the Great Lake States, it is typically called White Pine. Heartwood light brown, often with a reddish tinge and turns darker when exposed to air. Has relatively uniform texture, straight grain, low shrinkage and high stability. It’s light weight, moderately low in strength and stiffness. Extensively used in patterns, sash, doors, furniture, interior woodwork, knotty paneling and caskets.

SECTION 3

Lumber

REDWOOD - heartwood (Sequoia sempervirens)

Redwood is the product of one of nature’s most impressive accomplishments. The enormous size and unique inherent characteristics of this tree produce a material ideally suited for exterior applications. Its heartwood color is a fairly uniform brownish red, while its very limited sapwood is lemon colored. In its plain sawn form medium “cathedral” type figure develops, while in the vertical grain a longitudinal striped figure results. Its availability in “all heartwood” form with its outstanding natural resistance to decay accounts for its wide usage for exterior purposes. It is considered a very stable wood and its paint retention qualities are excellent. Redwood’s principal identity with painted exterior application should not preclude its consideration for either exterior or interior use with transparent finish. Its pleasing and uniform color lends to a variety of such finishes suggesting the warmth and honesty of wood in its natural state. The size of the trees yields lumber of unusually character free widths and lengths.

TEAK (Tectona grandis)

Teak is one of the most versatile and valuable woods and has attained great prestige value. The figure variations are extensive and it is available in both lumber and veneered products. Adding to its appeal is its distinctive tawny yellow to green to dark brown color, often with light and dark accent streaks. It is perhaps most appealing in plain sawn or sliced cuts. While it has unique stability and weathering properties, making it ideal for exterior applications, its high cost usually limits its use to decorative interior woodwork, most often in veneer form. Its great beauty and interest dictate it being finished in its near “natural state.”

WALNUT, AMERICAN BLACK (Juglans nigra)

American Black Walnut is perhaps our most highly prized domestic wood species. Its grain pattern variations are extensive and in veneered form produces, in addition to its normal plain sliced cut, quartered or “pencil striped” as well as specialty cuts such as crotches, swirls, burls, and others. Its heartwood color varies from gray brown to dark purplish brown. The sapwood, which is very prevalent in solid lumber, is cream colored and its complete elimination by selective cutting is very costly. Fortunately, if this natural effect is felt to be undesirable, its appearance can be neutralized by sap staining in the finishing process. The growth conditions of Walnut result in significant width and length limitations in its lumber form. Its potential is best expressed in veneered products.

OTHER SPECIES

There are many other species, both domestic and imported, used in woodworking. Nearly all are ecologically sound and appropriate for use. Using hardwoods for architecture gives value to the species, encouraging improved forest management techniques and the continuation of the species.

ENDANGERED SPECIES


USE OF RECLAIMED TIMBER AND LUMBER

Interest in timber reclaimed from old logs cut from old growth forests and lumber salvaged from old structures has increased recently.

Sources and types of reclaimed materials coming from underwater salvage as well as demolished buildings and structures vary greatly in their type, quality, availability, aesthetics and cost. A sample of the material used for selection may not match actual available material in species, color, texture, surface quality or structural composition when it comes time to make a purchase. Design professionals and specifiers should be aware of the limitations of availability of species, cut, quantity, lead time, waste factor and cost of material. These materials are normally sold “as is” and are not returnable.

Design professionals need to be aware that there is no NHLA Grade for reclaimed materials, therefore there are no measurable characteristics and defects established by which to reject unsuitable materials once they are delivered. It is advisable that the design professional and woodworker see the material at the supplier to determine the availability and suitability for the intended use.

Logs harvested over 100 years ago and transported by water often sank en route to mills. The resulting “lost underwater forest” lay on the bottoms of rivers and lakes until recently as proper environmental and mechanical procedures for retrieving them have been developed.

Reclaimed submerged materials are utilized in all aspects of construction of furniture, architectural woodwork and musical instruments. Submerged lumber is generally processed in both solid lumber, plain sliced and rotary veneer.

The uniqueness of the harvesting procedures, the high quality of the material and unusual aesthetic qualities are a few of desirable traits associated with this special material.
ENGINEERED PRODUCTS

Structural Composite Lumber (SCL) — A man made composite that utilizes grain oriented wood strands from a variety of tree species, providing an alternative to dimension lumber. The material is engineered for strength and stability. While SCL is not really “lumber,” it is marketed as a lumber substitute. SCL can be specified as core, stile backers, and core for stiles and rails, so long as all other criteria of the AWS are met in relation to its use.

AESTHETIC CHARACTERISTICS

One of the qualities which contributes to the widespread use of wood is the option offered for aesthetic selection. It varies between species, between two logs of the same species, and between two boards from the same log. Aesthetic considerations in specifying wood are influenced by the following characteristics:

• **Color** - The basic hue of the species, which may be further enhanced by the finishing process employed.

• **Sapwood and heartwood** - The color of wood within a tree varies between the “sapwood” (the outer layers of the tree that continue to transport sap), which is usually lighter in color than the “heartwood” (the inner layers in which the cells have become filled with natural deposits). If desired, sapwood may be stained in the finishing process to blend with the heartwood. This difference in color is so pronounced in certain species that the sapwood is marketed under a different nomenclature from the heartwood.

Some examples are:

• Select White Birch - sapwood of Yellow or Paper Birch

• Select Red Birch - heartwood of Yellow Birch

• Natural Birch - both sapwood and heartwood of any Birch

• Select White Ash - sapwood of White or Green Ash

• Select Brown Ash - heartwood of Black Ash

• Natural Ash - both sapwood and heartwood of any Ash

• Select White Maple - sapwood of the Sugar Maple

• **Grain** - The appearance produced by the arrangement of wood fibers and pores of the species. Lumber grain may not match veneer grain.

• **Open Grain and Closed Grain** - Open grain woods are said to be ring porous and usually show a distinct grain pattern. Close grain woods are said to be diffuse-porous with even grain. The size and distribution of the cellular structure of the wood influences the appearance and uniformity. Open grain hardwoods, such as Elm, Oak, Ash, and Chestnut are ring-porous species. These species have distinct figure and grain patterns. Close grain hardwoods, such as Cherry, Maple, Birch, and Yellow Poplar, are diffuse-porous species. Most North American diffuse-porous woods have small, dense pores resulting in less distinct figure and grain. Some tropical diffuse-porous species (e.g., Mahogany) have rather large pores.

• **Figure** - Various species produce different grain patterns (figures), which influence the selection process. There will be variations of grain patterns within any selected species. The manufacturer cannot select solid lumber cuttings within a species by grain and color in the same manner in which veneers may be selected.

• **Finishing Characteristics** - The many species of wood vary considerably in their receptivity to the multitude of finishing processes on the market. Some woods, because of their open pores, will accept fillers while tighter grained woods will not. Some will show greater contrast between the “early wood” and the “late wood” when stained than others. Design professionals should take into consideration the finish that will be applied when selecting a particular species. Consult with a Sponsor Association member about finishing prior to selection or specification. Providing large samples of the desired finish to manufacturers during the design phase and bidding process will assure the designer of obtaining an acceptable final product, while enabling the manufacturer to be aware of exactly what is required. Lumber might not accept transparent finishes in the same manner as veneer and special finishing techniques may be required.

METODS OF SAWING

Lumber is typically furnished plain sawn unless otherwise specified. Sawing methods, and the selection of boards after sawing the log, as shown below, produce the following types of lumber:

- Plain Sawn - Plain sawing, the most common type of lumber sawing, yields broad grain, the widest boards and least waste. The annual rings are typically 30 degrees or less to the face of the board.

- Rift Sawn - Sawn at 22.5° angle to the grain, yields a “rift” grain pattern, and is used for better grain figure. The annual rings are usually between 45° and 60°.

- Quarter Sawn - Sawn at a 90° angle to the grain, yields a “quarter cut” or “true quarter cut” grain pattern, and is used for very fine grain figure. The annual rings are usually between 60° and 90°.
METHODS OF SAWING (continued)

- Quarter Sawn - Most often cut as Rift and Quartersed, and then sorted for appearance, quarter sawn lumber is available in certain species, yields a straight grain, narrow boards, and fleck (sometimes called flake) or figure which runs across the grain in some species (notably the Oaks). Dimensional stability across the grain is the best. The annular rings run approximately 60 to 90 degrees to the face of the board, with the optimum being 90 degrees. Quartered lumber is generally narrower and more expensive than plain sawn of the same species.

- Rift Sawn - Rift sawing produces small flecks caused by cutting through the wood rays. Only certain species produce these flecks, primarily Red and White Oak. Rift cutting reduces yield and increases cost. The annular rings run about 30 to 60 degrees to the face of the board, with the optimum being 45 degrees.

AVAILABILITY and SIZE LIMITATIONS

The supply of lumber is in constant flux throughout the world. It is affected by many factors such as current demand, export regulations of the country of origin, natural forces of weather, fire, disease, political situations, etc. Certain trees (species) naturally grow larger, thus producing longer and wider lumber. Other trees are smaller and produce narrow and shorter boards. The manufacturer must work with the available lumber, which must be considered when selecting any species. Consult a Sponsor Association member before specifying an uncommon species, or thickness, and/or long lengths which may not typically be available. If available, the cost may be substantially higher. Economies can be realized by detailing and specifying thicknesses and widths within the finish sizes of these standards.

VENNEERED CONSTRUCTION

Lumber can be used to secure wide and thick members in species with limited cutting potential. An acceptable technique is to apply thin lumber or veneer to the faces and edges of a compatible density lumber, structural composite lumber (SCL), or a medium density fiberboard core.

DIMENSIONAL STABILITY, RELATIVE HUMIDITY, and MOISTURE CONTENT

All woods are affected significantly by moisture and to a lesser degree by heat. Lumber swells and shrinks primarily in two directions: thickness and width. There is insignificant change in length. The changes in dimension due to moisture vary with different species, thus influencing the selection of lumber to use and the design elements.

Prevention of dimensional problems in architectural woodwork products as a result of uncontrolled relative humidity is possible. Wood products perform, as they have for centuries, with complete satisfaction when correctly designed and used. Problems directly or indirectly attributed to dimensional change of the wood are usually, in fact, the result of faulty design or improper humidity conditions during site storage, installation, or use.

Wood is a hygroscopic material, and under normal conditions all wood products contain some moisture. Wood readily exchanges this moisture with the water vapor in the surrounding atmosphere according to the relative humidity. In high humidity, wood picks up moisture and swells. In low humidity, wood releases moisture and shrinks. As normal minor changes in humidity occur, the resulting dimensional response in properly designed construction will be insignificant. To avoid problems, it is recommended that the appropriate recommendations from Section 2 of the AWS be maintained. Uncontrolled extremes are likely to cause problems. Together with proper design, fabrication, and installation, humidity control is the important factor in preventing dimensional change problems. The book Understanding Wood by Bruce Hoadley contains excellent data of wood and moisture.

EXPANSION Due to Moisture in the Air

<table>
<thead>
<tr>
<th>25% relative humidity</th>
<th>85% relative humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/8&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>1 1/4&quot;</td>
<td>1 1/2&quot;</td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>2 1/4&quot;</td>
</tr>
</tbody>
</table>

Figure: 3-008

Availability and Size Limitations

The supply of lumber is in constant flux throughout the world. It is affected by many factors such as current demand, export regulations of the country of origin, natural forces of weather, fire, disease, political situations, etc. Certain trees (species) naturally grow larger, thus producing longer and wider lumber. Other trees are smaller and produce narrow and shorter boards. The manufacturer must work with the available lumber, which must be considered when selecting any species. Consult a Sponsor Association member before specifying an uncommon species, or thickness, and/or long lengths which may not typically be available. If available, the cost may be substantially higher. Economies can be realized by detailing and specifying thicknesses and widths within the finish sizes of these standards.

VENNEERED CONSTRUCTION

Lumber can be used to secure wide and thick members in species with limited cutting potential. An acceptable technique is to apply thin lumber or veneer to the faces and edges of a compatible density lumber, structural composite lumber (SCL), or a medium density fiberboard core.

DIMENSIONAL STABILITY, RELATIVE HUMIDITY, and MOISTURE CONTENT

All woods are affected significantly by moisture and to a lesser degree by heat. Lumber swells and shrinks primarily in two directions: thickness and width. There is insignificant change in length. The changes in dimension due to moisture vary with different species, thus influencing the selection of lumber to use and the design elements.

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SHRINKAGE
Due to Drying

LENGTH
(Longitudinal)
0.1%-0.2%

WIDTH
(Tangential)
5%-10%

THICKNESS
(Radial)
2%-5%

Wood is anisotropic in its shrinkage characteristics. It shrinks most in the direction of the annual rings when it loses moisture from the cell walls. This illustration from USDA’s The Wood Handbook (latest edition), published by their Forest Products Laboratory, shows the typical distortion of cuts from various parts of a log.

Shrinkage of 1” x 8” x 10’ (25.4 x 203 x 3,048 mm)
Dried from Green to Oven Dry
Approximate: 3/64” (1.2 mm) in thickness
3/4” (19 mm) in width
1/8” (3.2 mm) in length

Figure: 3-009

ADAPTABILITY FOR EXTERIOR USE

Years of performance have shown certain species to be more durable for exterior applications. Heartwood shall be furnished when these species are designated for external use, excluding the sapwood. The following is a list of species generally considered acceptable for exterior use, from USDA’s The Wood Handbook (latest edition), published by their Forest Products Laboratory:

- Cherry, Black
- Chestnut
- Douglas, Fir
- Eastern and Western Red Cedar
- Locust, Black
- Mahogany, American
- Oak, White
- Redwood, heartwood
- Spanish Cedar
- Teak, old growth

Baldcypress (Taxodium distichum) has a long tradition as a species resistant to decay, but beware! There are at least nine other species of four different genus which are marketed under the common name cypress. Only the heartwood of Baldcypress, often marketed as Tidewater or Red Cypress, is decay resistant. Sinker Cypress, that is old trees which have been brought up from below water in which they have been submerged for some time and properly cured and dried, is also resistant. None of this Cypress will come from new cutting, but as salvaged wood.

PRESERVATIVE TREATMENTS

Modern technology has developed methods of treating certain species to extend their life when exposed to the elements. Some lumber species used for exterior architectural woodwork may be treated with an industry tested and accepted formulation. One such formulation is a liquid containing 3-iodo-2-propynyl butyl carbamate (IPBC) as its active ingredient, which must be used according to manufacturer’s directions.

The Window & Door Manufacturers Association (WDMA), through the treatments and coatings committee, has reviewed information from third party testing laboratories which indicates that the number of formulations at the stated in use concentration meet the requirements of WDMA I.S.4 (latest edition). The formulations are acceptable for use under the WDMA Hallmark Water Repellent Non Pressure Preservative Treatment Certification Program and are adopted to meet all requirements.

FLAME SPREAD CLASSIFICATIONS

This is the generally accepted measurement for fire rating of materials. It compares the rate of flame spread on a particular species with the rate of flame spread on untreated Oak. Most authorities accept the following classes for flame spread:

- Class I or A. 0-25
- Class II or B. 26-75
- Class III or C. 76-200

Moisture can also cause iron stain (oxidation) in wood, also referred to as blue/black stain. Iron stain is a natural reaction of acids with iron, oxygen, and moisture (either high relative humidity or direct moisture) in wood. Control of moisture is a simple way to protect wood products from iron stain.
**SECTION 3**
Lumber

**Table: 3-011 - FLAME SPREAD and SMOKE DEVELOPED INDEXES**

Common woods species, adapted from USDA’s The Wood Handbook (latest edition), published by their Forest Products Laboratory, and based on 3/4” (19 mm) thick solid lumber:

<table>
<thead>
<tr>
<th>Species</th>
<th>Flame Spread Index</th>
<th>Smoke Developed Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOFTWOODS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow Cedar</td>
<td>78</td>
<td>90</td>
</tr>
<tr>
<td>Baldcypress</td>
<td>145 - 150</td>
<td>---</td>
</tr>
<tr>
<td>Cedar, Western Red</td>
<td>70</td>
<td>213</td>
</tr>
<tr>
<td>Fir, Douglas</td>
<td>70 - 100</td>
<td>---</td>
</tr>
<tr>
<td>Fir, Pacific Silver</td>
<td>69</td>
<td>58</td>
</tr>
<tr>
<td>Hemlock, Western</td>
<td>60 - 75</td>
<td>---</td>
</tr>
<tr>
<td>Pine, Eastern White</td>
<td>85 - 215</td>
<td>---</td>
</tr>
<tr>
<td>Pine, Ponderosa</td>
<td>105 - 230</td>
<td>---</td>
</tr>
<tr>
<td>Pine, Red</td>
<td>142</td>
<td>229</td>
</tr>
<tr>
<td>Pine, Southern</td>
<td>130 - 195</td>
<td>---</td>
</tr>
<tr>
<td>Pine, Western White</td>
<td>75</td>
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</tr>
<tr>
<td>Redwood</td>
<td>70</td>
<td>---</td>
</tr>
<tr>
<td>Spruce, Eastern</td>
<td>65</td>
<td>---</td>
</tr>
<tr>
<td>Spruce, Sitka</td>
<td>74 - 100</td>
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<tr>
<td><strong>HARDWOODS</strong></td>
<td></td>
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<tr>
<td>Birch, Yellow</td>
<td>105 - 110</td>
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</tr>
<tr>
<td>Cottonwood</td>
<td>115</td>
<td>---</td>
</tr>
<tr>
<td>Maple</td>
<td>104</td>
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</tr>
<tr>
<td>Poplar, Yellow</td>
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</tr>
<tr>
<td>Oak, Red / White</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Sweetgum</td>
<td>140-155</td>
<td>---</td>
</tr>
<tr>
<td>Walnut</td>
<td>130 - 140</td>
<td>---</td>
</tr>
</tbody>
</table>

**FIRE RETARDANT WOOD**

The natural fire retardant qualities and acceptability of treatments vary among the species. Where items of architectural woodwork are required to have a flame spread classification to meet applicable building and safety codes, the choice of lumber species must be a consideration. Most treated species are structural softwoods.

Following are some references to assist in making these choices. Additional data on various species may be available from USDA’s The Wood Handbook (latest edition), published by their Forest Products Laboratory.

- **Built-up construction** to Improve Fire Rating:

  In lieu of solid lumber, it is often advisable, where a fire rating is required, to build up members by using treated cores clad with untreated veneers not thicker than 1/28” (1 mm). Some existing building codes, except where locally amended, provide that facing materials 1/28” (1 mm) or thinner finished dimension are not considered in determining the flame spread rating of the woodwork.

  In localities where basic model building codes have been amended, it is the responsibility of the specifier to determine whether the application of the facing material specified will meet the code.

- **Fire retardant treatments** (FRT): Some species may be treated with chemicals to reduce flammability and retard the spread of flame over the surface. This usually involves impregnating the wood, under pressure, with salts suspended in a liquid. The treated wood must be re-dried prior to fabrication. FRT wood may exude chemicals in relative humidity above 85%, damaging finishes and corroding metals in contact with the FRT surface. Consult with a manufacturer about the resulting appearance and availability of treated woods prior to specification.

  Hardwoods currently being treated (Flame spread less than 25) include 4/4 Red Oak, and 4/4 to 8/4 Poplar. These woods can be machined after treatment, although machining may void the label classification. Fire retardant treatment does affect the color and finishing characteristics of the wood.

According to the traditional model codes in the USA and subject to local code modifications, untreated wood and wood products can usually be used in up to 10% of the combined surface area of the walls and ceiling. Casework, furniture, and fixtures are rarely fire rated, and can be built of combustible materials.
### SPECIFY REQUIREMENTS FOR

- **UNIFORM COLOR**: special finishing techniques might be required (see Section 5).

- **SPECIAL CHARACTERISTICS**, such as sapwood, heartwood, ribbon stripe, quarter sawn, rift sawn, or vertical grain are only required if so specified.

- **Natural** as a type selection of a species allows an unlimited amount of heartwood or sapwood within a face and is the default selection.

- **Select Red** or **White** means all heartwood or sapwood, respectively for Birch and Maple.

- **Select Brown** means all heartwood for Ash.

- **EXTERIOR APPLICATIONS**, where species selection should take decay resistance into consideration. The following species, when selected for **heartwood only**, exhibit the listed decay resistance adapted from USDA's *The Wood Handbook* (latest edition) published by their Forest Products Laboratory:

  - **DECAY RESISTANT WOODS**:
    - **VERY RESISTANT**:
      - **Domestic**:
        - Locust, Black
        - Yew, Pacific
      - **Import**:
        - Goncalo Alves
        - Lignumvitae
        - Ipe (lapacho)
        - Purpleheart
        - Jarrah
        - Teak (Old Growth)
    - **RESISTANT**:
      - **Domestic**:
        - Baldcypress (Old Growth)
        - Juniper
        - Cedar
        - Oak, White
        - Cherry, Black
        - Redwood (Old Growth)
        - Chestnut
        - Walnut, Black
        - Cypress, Arizona
    - **Import**:
      - Mahogany, American
      - Spanish Cedar
    - **MODERATELY RESISTANT**:
      - **Domestic**:
        - Baldcypress (Young Growth)
        - Redwood (Young Growth)
        - Fir, Douglas
        - Tamarack
        - Larch, Western
      - **Import**:
        - Avodire
        - Mahogany, African
        - Benge
        - Meranti, Dark Red
        - Bubinga
        - Sapele
        - Keruing
        - Teak (Young Growth)

- If none of the above species is specified, these standards require exterior woodwork to be treated with an industry-tested and accepted preservative formulation listed by WDMA.
The **COMPLIANCE** portion of this Section has been intentionally excluded to protect our sale of Grade Rules, which allows us to provide these standards free of charge to Design Professionals.