

## Unit VI – Material Selection, Plan Reading, and Interpretation

### Lesson 3: Selecting Building Materials

Knowing how building materials are classified, measured, and sold is important for selecting the right materials for a project. This knowledge is also essential to preparing an accurate and clear bill of materials. This lesson discusses the ways that common building materials are measured and sold.

#### Classification of Softwood and Hardwood

Projects in agricultural mechanics are commonly constructed of softwood and hardwood. The grouping of woods as softwood or hardwood indicates the type of tree from which they are cut. Softwoods are cut from coniferous trees (trees that do not shed their leaves), such as pine, cedar, or redwood. Hardwoods are cut from deciduous trees (broad-leaved trees that shed their leaves each fall), such as oak, walnut, and ash. The terms “softwood” and “hardwood” do not indicate the actual softness or hardness of the wood. For example, balsa is a soft wood that comes from a hardwood tree.

Some of the common uses for softwood are framing, studs, and construction of structures. Hardwood is often used for furniture, flooring, and cabinets. Understanding the various ways that softwood and hardwood are classified is a key factor in selecting and purchasing the most suitable wood for a project. For example, if a project will be painted or does not require a near-perfect appearance, buying a satisfactory wood of a lower grade saves money while not sacrificing the usefulness of the project.

#### Softwood

Ways that softwood is classified include the following:

- How the wood will be used
  - Construction or yard lumber: This type is the least expensive and most readily available lumber. It is not reworked before it is sold and it is used for general construction.
  - Factory and shop or remanufacture lumber: This type is made and graded to be reworked for specific applications, such as the manufacture of doors or windows.
- By the size of the wood: See the table on the next page for more detail.
  - Boards: Boards have a nominal thickness of less than 2 in.
  - Dimension lumber: This distinction indicates the nominal thickness ranges from 2 in. to 5 in.
  - Timbers: Timbers have a nominal thickness and width of 5 in. or greater.
- By how much the wood has been dressed (surface trimmed and smoothed) or worked
  - Rough lumber: This type of lumber has been sawed and trimmed to length, but none of the surfaces have been dressed.
  - Dressed or surfaced lumber: This lumber is cut to length and at least one surface has been planed smooth. The number of smooth surfaces and edges are indicated by a letter and number code. For example, a piece of lumber with the designation of S2S1E has been surfaced on two sides and one edge.
  - Worked lumber: This lumber has been surfaced and has had some additional processing. For example, it may be cut for tongue-and-groove joints or shaped to use for molding.
- By the grade of the wood
  - The grade of a piece of wood is an indication of its quality. Softwood grades are based on the American Softwood Lumber Standard (PS 20-70), which is published by the U.S. Department of Commerce. Lumber associations, such as the Western Wood Products Association, have developed additional rules and details about the grades to help the buyer determine the quality of the wood.
  - When softwood is graded, it is evaluated for moisture content, intended use, and the location and size of irregularities, such as knots, splits, decay, and manufacturing defects. Wood used for general construction is typically graded on a number system ranging from 1 to 5, with 1 being the best quality or producing the least waste. There may also be a grade of select or premium that surpasses the no. 1 grade. Wood used for finishing, such as flooring or paneling, is given a letter grade that ranks it for appearance. This grade ranges from A to D, with A being the best quality.

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## Common Softwood Classifications and Grades

Classification and Grade	Description or Use
<b>Finish or selects – Up to 1 1/2 in. thick, 2 in. or more wide; graded on basis of appearance</b>	
B & BTR	Nearly clear, with only minor defects; suitable for natural finish
C	More and larger defects than B & BTR but suitable for paint finish
D	A little lower in quality than C but still suitable for paint finish
<b>Boards – Up to 1 1/2 in. thick, 2 in. or more wide; graded for suitability for use in construction</b>	
SEL MER or 1	Use in housing and light construction for exposed paneling, shelving, etc.
CONST 2	Used for subfloors, roof sheathing, etc.
STD 3	Used about the same as CONST 2 grade but a little lower in quality
UTIL 4	Combines usefulness and lower cost for general construction purposes
ECON 5	Used for low-grade sheathing, crating, and bracing
<b>Dimension – 2 to 5 in. thick, 2 in. or more wide</b>	
<b>Structural light framing</b>	2 to 4 in. thick, 2 to 4 in. wide; for engineered used when higher strength is needed
Select structural (SEL STR)	Used where high strength, stiffness, and good appearance are needed
No. 1	Used about the same as SEL STR grade but a little lower in quality
No. 2	Recommended for most general construction uses
No. 3	Used for general construction where appearance is not a factor
<b>Light framing</b>	2 to 4 in. thick, 2 to 4 in. wide; provides good appearance where high strength and high appearance are not needed
Construction	Recommended and widely used for general framing purposes
Standard	About the same uses as construction grade but a little lower in quality
Utility	Used for studding, blocking, plates, etc., where economy and good strength are desired
Economy	Suitable for crating, bracing, and temporary construction
<b>Studs</b>	2 to 4 in. thick, 2 to 4 in. wide; only one grade for studs, which is suitable for all stud uses
<b>Structural joints and planks</b>	2 to 4 in. thick, 6 in. and more wide; for engineering applications
Select Structural	Used where high strength, stiffness, and good appearance are needed
No. 1	Used about the same as SEL STR grade but a little lower quality
No. 2	Recommended for most general construction use
No. 3	For use in general construction where appearance is not a factor
<b>Appearance and framing</b>	2 to 4 in. thick, 2 in. and more wide
A	Used in housing and light construction for high strength and finest appearance
<b>Timbers – 5 in. or more in least dimension</b>	
Select Structural	Used where superior strength and good appearance are needed
No. 1	Similar to SEL STR grade but a little lower in quality
No. 2	Recommended for general construction
No. 3	Used for rough general construction

Adapted from *Structures and Environmental Handbook*, Midwest Plan Service.

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- o Wood that is graded according to the American Softwood Lumber Standard is stamped with the following information: 1) the grading agency that issued the grade stamp, 2) the species of the wood, 3) the grade, 4) the mill identification (appears as a name or number), and 5) the moisture content of the wood when it was stamped.

### Hardwood

The majority of hardwood is graded according to its size and the number of pieces without defects that can be cut from it. The best grade, First and Seconds, has the highest percentage of usable area. The lowest grade, Number 3 Common, has the lowest percentage. The minimum cutting widths and lengths also decrease as the grade gets lower. Grades of hardwoods are:

- Firsts and Seconds (FAS)
- Selects
- Number 1 Common
- Number 2 Common
- Number 3 Common

The grades may be sold separately or several grades may be sold together. The standards for grading hardwood are established by the National Hardwood Lumber Association.

### Measurements and Specifications for Lumber

Information about lumber that must be specified on a bill of materials includes the board feet (volume); the grade; and the thickness, width, and length. Lumber is commonly measured and priced by the board foot. It is helpful to remember that a board foot is equivalent to a piece of lumber 1 in. thick, 12 in. wide, and 12 in. long, or 144 cu in. The way to determine the number of board feet in a piece of wood is to multiply the thickness in inches by the width in inches by the length in feet and then divide by 12:  $(T'' \times W'' \times L') \div 12$ . When several boards with the same measurements are being used, include the number of boards as a multiplier in the formula. See the following examples.

$$\begin{aligned} &2'' \times 4'' \times 14' \text{ board} \\ (2'' \times 4'' \times 14') \div 12 &= 9.333 \text{ board feet} \end{aligned}$$

Formula for 3 boards that are the size above and cost \$0.35 per board foot:

$$(3 \times 2'' \times 4'' \times 14') \div 12 = 28 \text{ bd ft} \times \$0.35 = \$9.80$$

Boards that are less than 1 in. thick are figured as 1 in. Boards that are more than 1 in. thick are figured using their nominal size. The nominal size is the measurement of a board when it is green and has not been planed. The actual size is the measurement after the board has dried and been planed. Boards are sold using their nominal measurements, but their actual size is smaller. For example, a 2'' x 4'' actually measures 1 1/2'' x 3 1/2''.

When ordering lumber, the grade should be specified per the standards established by the appropriate lumber association. Nominal sizes should be used and they should be written in standard thickness, width, and length. Common softwood lengths range from 8 ft to 20 ft in 2-ft intervals. Because hardwood is not as readily available as softwood, it is usually cut and sold in random widths and lengths.

### Classification and Measurement of Plywood

Plywood is a structural panel used extensively in construction. Common uses include subfloor (first layer of floor) and roof and wall sheathing (first outer layer of roof or wall). Plywood is made of a core material with a thin sheet of wood on each side. The thin sheets of wood are called face veneers. The layers are bonded together by adhesives. Typical plywood cores include additional sheets of veneer, thin boards laid side by side, and composite materials, such as wood chips or pressed paper. Plywood is classified by type of wood and adhesive and by grade.

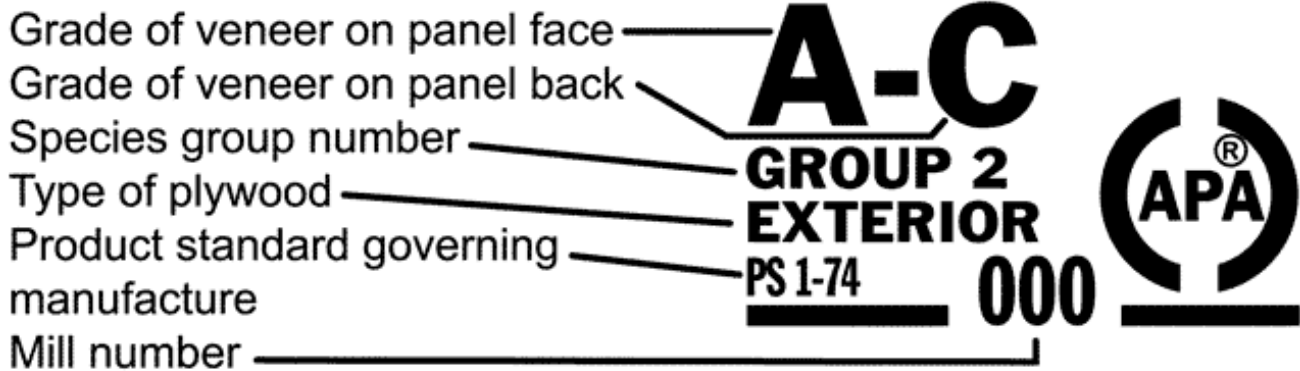
#### Type of Wood and Adhesive

Plywood is either softwood or hardwood, depending on the type of wood used for the face veneers. Plywood is either exterior grade or interior grade, based on the kind of adhesive used to bond the layers. Exterior grade is manufactured with adhesives that are fully waterproof. This type of plywood is designed for structures that must withstand excessive moisture. The adhesives used for the interior grade are moisture resistant. Interior grade plywood is intended for structures that will not be exposed to the weather.

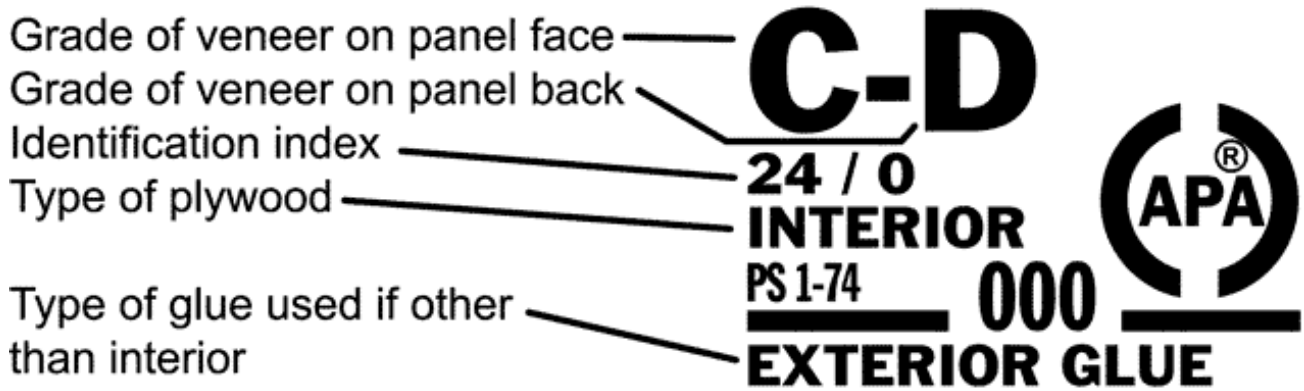
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Figure 3.1 – Examples of Plywood Grade Stamps and Their Meanings

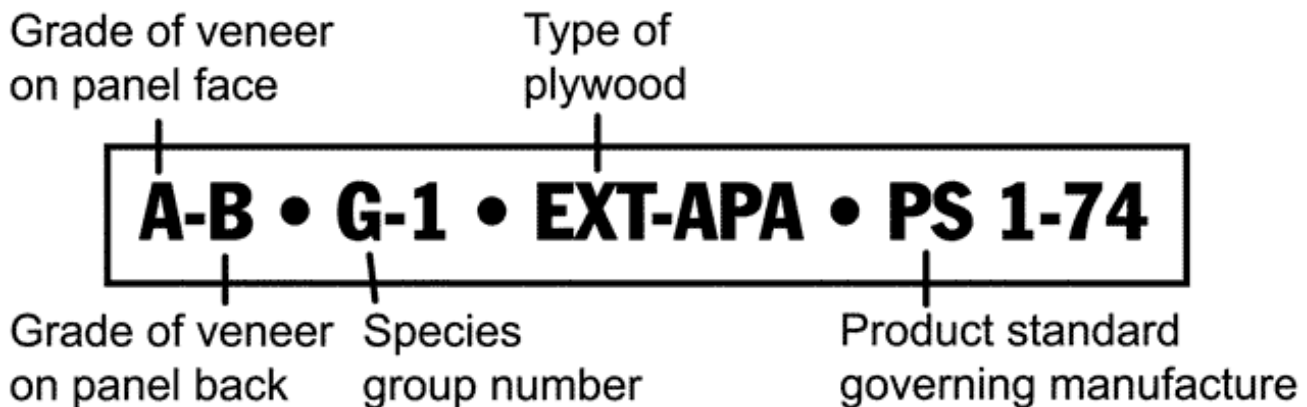
### Typical sanded panel back-stamp



### Typical unsanded panel back-stamp



### Typical edge stamp



Adapted from *Structures and Environmental Handbook*, Midwest Plan Service.

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### Grading of Softwood and Hardwood Plywood

Both softwood and hardwood plywood are commonly designated by the general grade G2S or GIS. G2S means “good on two sides” and GIS means “good on one side.” They may also be referred to as S2S or SIS, meaning surfaced or sanded on two sides or one side. Each plywood panel is stamped with a grade stamp by the group that oversees their manufacture. See Figure 3.1. The stamp includes the following information:

- Species of wood on the face veneer
- Quality of the face veneer
- Type of adhesive used
- Standard governing manufacture

### Mill Identification Grading Information Specific to Softwood Plywood

Manufacturers associations, such as APA–The Engineered Wood Association, set the standards for grading softwood plywood. The standards are based on specifications written by the National Bureau of Standards. The grade of a piece of softwood plywood depends on the quality of the front and back veneers. Letter grades (N, A, B, C, D) are given to each side of the panel. N is the highest grade; it is given to materials that have a natural finish. D is the lowest grade. See Figure 3.2 for a description of some of the grades. For example, a panel with a grade of A-D has good-quality veneer on one side and bad quality on the other. For softwood plywood, the grade stamp also includes a group number from 1 to 5 that is based on the strength of the type of wood. Group 1 is the strongest species and Group 5 the weakest. The group number given is based on the weakest type of wood used in the face veneer. If the panel is sanded, the stamp will include the wood species also.

### Grading Information Specific to Hardwood Plywood

Much of hardwood plywood is manufactured for uses where appearance is important. Standards for grading hardwood plywood are set by the Hardwood Plywood & Veneer Association. A grading system of numbers (1 to 4) is used to rank the quality of both face veneers. A No. 1 ranking is the best, indicating few defects, and a No. 4

ranking is the worst. Like softwood plywood, hardwood plywood can be ordered that is made from various types of wood and grades of veneer faces.

Figure 3.2 – Grades for Plywood Veneers

<b>A</b>	Smooth, paintable. Not more than 18 neatly made repairs, boat, sled, or router type, and parallel to grain, permitted. Wood or synthetic repairs permitted. May be used for natural finish in less demanding applications.
<b>B</b>	Solid surface. Shims, sled or router repairs, and tight knots to 1 inch across grain permitted. Wood or synthetic repairs permitted. Some minor splits permitted.
<b>C</b> Plugged	Improved C veneer with splits limited to 1/8 inch width and knotholes or other open defects limited to 1/4 x 1/2 inch. Wood or synthetic repairs permitted. Admits some broken grain.
<b>C</b>	Tight knots to 1-1/2 inch. Knotholes to 1 inch across grain and some to 1-1/2 inch if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength permitted. Limited splits allowed. Stitching permitted.
<b>D</b>	Knots and knotholes to 2-1/2 inch width across grain and 1/2 inch larger within specified limits. Limited splits are permitted. Stitching permitted. Limited to Exposure 1 or Interior panels.

Source: *Agricultural Structures*. Instructional Materials Laboratory, University of Missouri Columbia, 1999.



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## Measurements for Plywood

Plywood is sold by the sheet or square foot. The standard sheet size is 4' x 8' and it is available in various thicknesses (e.g., 1/4", 3/8", 1/2", 5/8", 3/4", and 1"). To calculate the square feet of a sheet of plywood, multiply the length in feet by the width in feet. A 4' x 8' sheet has 32 sq ft. The cost of a sheet of plywood can be calculated by multiplying the length by the width by the price per square foot. The formula below is for a one 4' x 8' sheet that costs \$0.39 per square foot.

$$4' \times 8' \times \$0.39 = \$12.48$$

## Measurements and Specifications for Metal

Metal is another common material used in building. Knowing the names, shapes, and standard sizes of metal is useful for selecting the correct metal for a project. See Figure 3.3. This knowledge is also important when preparing a bill of materials and communicating information about metal to others on the job. Common names and sizes of steel building materials are as follows:

- **Rounds:** These are bars of solid metal. The external diameter should be specified when ordering. The standard length is 20 ft.
- **Angle iron:** An angle iron has two legs that are set at a 90-degree angle to each other. The width of each leg and the thickness should be specified when ordering. The standard length for angle iron is 20 ft.
- **Flats and strips:** Flats and strips are flat pieces of metal. Flats are 1/4 in. or more thick and strips are 3/16 in. or less thick. The width and thickness should be specified when ordering. They are commonly available in 20-ft lengths.
- **Channel iron:** A channel iron is shaped like a C. The depth of the channel and width of the flange should be specified when ordering. The standard length is 20 ft.
- **Black or galvanized steel pipe:** This pipe has a tubular shape and a standard length of 21 ft. The inside diameter of the pipe should be specified when ordering.

## Measurements and Specifications for Other Common Building Materials

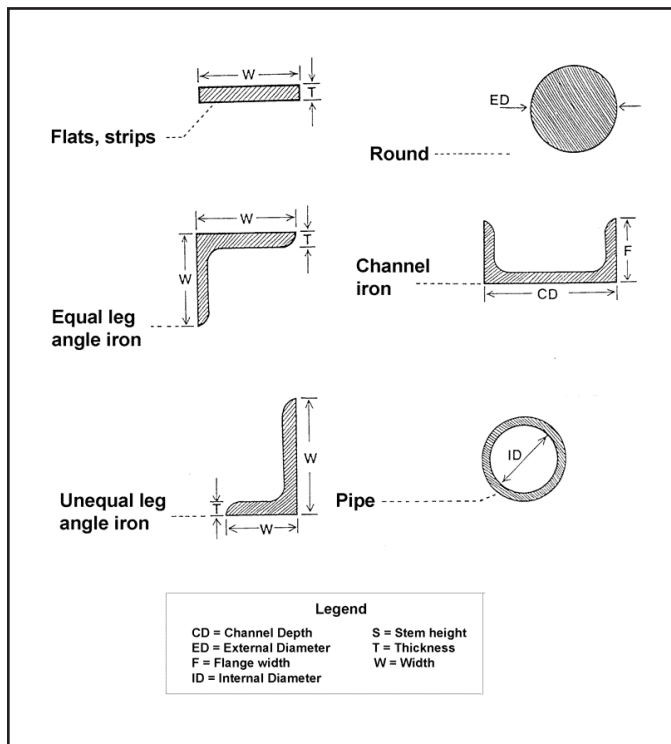
The following list includes other common building materials and how they are measured and sold.

- **Molding and dowel rod:** These are measured and sold in linear or running feet. A measurement in linear feet is the actual length of the material and does not include the thickness.
- **Roofing:** This is sold by the square (1 square equals 100 sq ft). A bundle of shingles contains 1/3 of a square.
- **Hardware cloth and screening:** These are sold by the running foot.
- **Hardboard, waferboard, and particle board:** Like plywood, these are generally manufactured in 4' x 8' sheets and are measured in square feet.

## Summary

Knowing how common building materials are classified, measured, and sold helps to ensure the correct materials are chosen and the bill of materials is prepared correctly. Wood is grouped as a softwood or hardwood, depending

Figure 3.3 – Shapes and Dimensions of Steel Stock



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on the type of tree from which it is cut. Softwood and hardwood lumber, as well as softwood and hardwood plywood, are classified by grading systems established by various manufacturer and trade associations. Lumber is measured and sold by the board foot. Plywood is measured and sold by the square foot. Construction metal is available in different shapes and sizes. Sizes should be specified in the standard units of measurement used for the metal.

### **Credits**

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